2020

Livestock Improvement Corporation Limited GHG Inventory Report - FY20

Executive summary

LIC has committed to becoming carbon neutral by 2050 in line with the New Zealand Government's Climate Change Response (Zero Carbon) Amendment Act 2019, and in accordance with its pledge as a signatory to the Climate Leaders Coalition. This report details LIC's year one GHG emissions for the period 1 June 2019 to 31 May 2020.

LIC has defined the following science-based climate change targets to reduce greenhouse gas emissions and limit the temperature increase to 1.5°C of pre-industrial levels:

- 46.2% reduction of Scope 1 and 2 emissions (excluding biogenic methane) by 2030 against our 2018/19 base year
- 28.88% reduction of Scope 3 emissions (excluding biogenic methane) by 2030 against our 2018/19 base year
- 10% reduction of biogenic methane by 2030 against 2017 emissions

Below is a summary of LIC's emissions in 2019/20, compared to 2018/19, which also serves as LIC's base year that all future emissions will be compared against.

Comparison of total GHG emissions by scope for FY20 to base year (FY19).

Scope	2018/2019 tCO_2-e base year	2019/2020 tCO_2-e	tCO_2-e Percentage of change from base year
Scope 1 direct emissions	4,281.61	4,151.69	-3.03% ↓
Scope 2 indirect emissions	363.21	344.65	-5.11% ↓
Scope 3 indirect emissions	6,160.98	5,394.71	-12.44% ↓
Total emissions	10,805.80	9,891.05	-8.47% ↓

Scope	2018/2019 CH_4 (tCO_2-e) base year	2019/2020 CH_4 (tCO_2-e)	CH_4 (tCO_2-e) Percentage of change from base year
Scope 1 biogenic methane emissions	2,622.99	2,624.37	0.05% ↑
Scope 3 biogenic methane	3,141.04	3,153.27	0.39% ↑
Total emission	5,764.03	5,777.64	0.24% ↑

In 2019/20, LIC's total GHG emissions fell by 8.47% from the previous year. Biogenic methane emissions rose by 0.24%. Some of the decreases are likely attributed to the coronavirus (Covid-19) global pandemic and limitations set on New Zealand in the regard to national lockdown, the associated limitations on international travel, and people required to work from home.

This report provides LIC with a baseline greenhouse gas emissions inventory based on 2018/19 emissions, compares the 2019/20 year against the 2018/19 baseline, and enables LIC to meet its requirement under the Climate Leaders Coalition to make its greenhouse gas footprint publicly available.

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Introduction

LIC is an agri-tech and herd improvement co-operative which empowers livestock farmers through the delivery of superior genetics and technology. With origins dating back to 1909, when the first organised routine herd testing service commenced, LIC has a long history of providing world-leading innovations for the dairy industry. The company has committed to becoming carbon neutral by 2050 in line with the New Zealand Government's Climate Change Response (Zero Carbon) Amendment Act 2019, and in accordance with its pledge as a signatory to the Climate Leaders Coalition.

LIC is committed to its business strategy of Optimise the core, Enhance the core and Capture value beyond the core - keeping in mind "There's always room for improvement". In alliance with these strategies, LIC has defined the following science-based climate change targets to reduce Greenhouse Gas (GHG) emissions and limit the temperature increase to 1.5°C of pre-industrial levels:

- 46.2% reduction of Scope 1 and 2 emissions (excluding biogenic methane) by 2030 against our 2018 to 2019 base year
- 28.88% reduction of Scope 3 emissions (excluding biogenic methane) by 2030 against our 2018 to 2019 base year[1]
- 10% reduction of biogenic methane by 2030 against 2017 emissions[2]

The following report is LIC's year one GHG emissions inventory report, for the period 1 June 2019 to 31 May 2020 (FY20).

Statement of intent

This GHG inventory report contributes to part of LIC's commitments to assessing our climate change risks and publicly disclosing them. The report guides the Senior Leadership Team in their decision-making relating to the corporation's sustainability and environmental good governance. As signatories of the Climate Leaders Coalition, LIC intends to make this report publicly available to all stakeholders.

GHG inventory summary for FY20

Total GHG emissions for the period June 2019 to May 2020 (FY20) fell by 8.47% from the base year June 2018 to May 2019 (FY19) (Table 1).

Table 1: Comparison of total GHG emissions by scope for FY20 to base year (FY19).

Scope	2018/2019 tCO_2-e base year	2019/2020 tCO_2-e	tCO_2-e Percentage of change from base year
Scope 1 direct emissions	4,281.61	4,151.69	-3.03% ↓
Scope 2 indirect emissions	363.21	344.65	-5.11% ↓
Scope 3 indirect emissions	6,160.98	5,394.71	-12.44% ↓
Total emissions	**10,805.80**	9,891.05	-8.47% ↓

[1] For full scope definitions refer to Appendix 1
[2] In accordance with NZ Government, Climate Change Response (Zero Carbon) Amendment Act 2019, Part 1B Emission Reduction, Subpart 1 - 2050 target, 5Q Target for 2050 1(b)(i).

However, some of the decreases are likely attributed to the coronavirus disease (Covid-19) global pandemic and limitations set on New Zealand in the regard to national lockdown for April 2020 (approx.), limitations on international travel, and people continuing to work from home.

Total biogenic methane emissions for the period June 2019 to May 2020 (FY20) rose by 0.24% from the base year June 2018 to May 2019 (FY19) (Table 2).

Table 2: Comparison of total GHG emissions by scope for FY20 to base year (FY19).

Scope	2018/2019 CH_4 (tCO_2-e)[3] base year	2019/2020 CH_4 (tCO_2-e)	CH_4 (tCO_2-e) Percentage of change from base year
Scope 1 biogenic methane emissions	2,622.99	2,624.37	0.05% ↑
Scope 3 biogenic methane	3,141.04	3,153.27	0.39% ↑
Total emission	5,764.03	5,777.64	0.24% ↑

Almost every category emission source saw a reduction for FY20 reporting year (Table 3). Emissions from rental cars had the greatest reduction of approximately 64% from FY19.

Table 3: Comparison of total GHG emissions by category between base year FY19 and FY20.

Emission source	tCO_2-e - FY19 base year	tCO_2-e - FY20	tCO_2-e percentage of change from base year
Scope 1			
Stationary combustion	203.12	145.95	-28.15% ↓
Direct travel	3,293.33	3,205.11	-2.68% ↓
Rental car	28.29	10.17	-64.07% ↓
Direct water supply	0.52	0.25	-53.20% ↓
Direct wastewater treatment	1.07	0.91	-14.89% ↓
Refrigerants[4]		28.40	
Manure management	2.77	2.97	7.14% ↑
Fertiliser use	184.86	189.00	2.24% ↑
Agricultural soils	567.64	568.93	1.29% ↑
Scope 2			
Electricity	363.21	344.65	-5.11% ↓
Scope 3			
Water supply	8.89	9.03	1.56% ↑
Indirect wastewater treatment	47.61	44.96	-5.58% ↓
Transmission and distribution losses for natural gas Emissions	12.46	10.49	-15.84% ↓
Transmission and distribution losses for electricity Emissions	27.51	26.104	-5.11% ↓
Domestic air travel	254.98	166.49	-34.71% ↓
International air travel	881.48	680.64	-22.78% ↓
Accommodation	109.26	61.46	-43.75% ↓
Indirect passenger vehicle travel	4,818.78	4,395.54	-8.78% ↓

[3] Methane and nitrous oxide within this report are expressed in kg or tCO_2-e using the conversion factors of 25 and 298 respectively.

[4] Refrigerant survey conducted in 2020 and as such not included in base year.

Most emission sources saw a reduction for FY20 reporting year (Table 4). Emissions from direct wastewater treatment had the greatest reduction of approximately 10.37% from FY19.

Table 4: Comparison of total biogenic methane emissions by category between base year FY19 and FY20.

Emission source	CH_4 (tCO_2-e) FY19 base year	CH_4 (tCO_2-e) FY20	CH_4 (tCO_2-e) percentage of change from base year
Scope 1: Biogenic methane			
Direct wastewater treatment	0.70	0.67	-10.37% ↓
Enteric fermentation	2,556.80	2,556.00	-0.03% ↓
Manure management	65.75	68.01	3.44% ↑
Scope 3: Biogenic methane			
Indirect wastewater treatment	22.83	21.86	-4.25% ↓
Waste	3,118.21	3,131.42	0.42% ↑

Organisational boundary

In accordance with The Greenhouse Gas Protocol the organisational boundaries were set to include the following entities:

- Maui Street, Hamilton, Waikato
- Newstead, Hamilton, Waikato
- Riverlea Road, Hamilton, Waikato
- Produce Place, Christchurch, Canterbury
- Palmerston Street, Awahuri, Manuwatu
- LIC Farms
    - Awahuri Farm, Awahuri , Manuwatu
    - Chudleigh Farm, Tauwhare, Waikato
    - Innovation Farm, Rukuhia, Ohaupo
    - Newstead - Vailes Road Farm, Hamilton, Waikato
    - Feilding Farm, Feilding, Manawatu

- LIC Depots
    - Ashburton, Canterbury
    - Bell Block, Taranaki,
    - Christchurch, Canterbury
    - Gore, Southland
    - Greymouth, West Coast
    - Hawera, Taranaki
    - Invercargill, Southland
    - Morrinsville, Waikato
    - Palmerston North, Manawatu
    - Te Awamutu, Waikato
    - Te Hana, Northland
    - Te Kauwhata, Waikato
    - Te Puke, Bay of Plenty
    - Tokoroa, Waikato
    - Whakatane, Bay of Plenty
    - Whangarei, Northland

LIC has excluded from this report the following business entities:

- Ireland
- Australia
- UK

Inventory boundary

LIC has elected to report on Scope 1 - Direct emissions, Scope 2 and Scope 3 - Indirect emissions. Table 5 outlines emissions sources and LIC's commitment to reporting on them.

Table 5: Emission sources.

Emission sources	Included in LIC GHG inventory
Stationary combustion fuel	Yes
Transport fuel	Yes
Biofuels and biomass	No
Transmission and distribution losses for reticulated gases	Yes
Refrigerant use	Yes
Purchased electricity, heat and steam emission factors	Yes
Transmission and distribution losses for electricity	Yes
Passenger vehicles	Yes
Employee commuting	Yes
Public transport	No
Domestic air travel	Yes
International air travel	Yes
Accommodation	Yes
Freight transport emission factors	No
Water supply and wastewater treatment emission factors	Yes
Materials and waste emission factors	Yes
Land use, land-use change and forestry (LULUCF)	No
Agriculture	Yes

Coronavirus disease (Covid-19)

During the 2019 to 2020 reporting year, the globe was affected by a pandemic, Covid-19. As a result of the pandemic, LIC was considered to be an essential service and continued to operate in accordance with New Zealand restrictions put in place. Restrictions for New Zealand included a four-week lockdown starting 11.59pm on 25 March, two-metre social distancing and border restrictions. What this meant for LIC was that employees who could work from home did so and those who were not able to (farm staff, laboratory staff, etc.) continued to work on site. Consequently, the Covid-19 pandemic may skew the outcome of the FY20 dataset and as such return misleading positive reductions.

Methods and uncertainties

This GHG inventory was prepared in alignment with The Greenhouse Gas Protocol standard guidance (GHG-Protocol, 2015) and Measuring Emissions: A Guide for Organisations (NZGovt, 2019).

LIC used Microsoft Excel spreadsheets to calculate GHG emissions. Datasets that were unable to be obtained are excluded from the results (for justifications see Appendix 1).

Science-based targets

At the time of reporting, LIC calculated Science-based Targets (SBT) that were in line with the Paris Agreement target to keep global temperature increase below 2°C, with a further commitment to limit temperature increase to 1.5°C of pre-industrial levels. Based on climate science research LIC has

committed to reducing its absolute Scope 1 and 2 GHG emissions by 46.2% by 2030 from the FY19 base year, excluding biogenic methane which will be reduced in line with the targets set out in the New Zealand Climate Change Response Act. LIC has also committed to reducing Scope 3 GHG emissions by 28.88% of the base year by 2030, also excluding biogenic methane (Figure 1). LIC used the recommended 4.2% linear reduction approach to determine our SBT (Science Based Targets iniative, 2020).

In accordance with the New Zealand Government's Climate Change (Zero Carbon) Act 2019, LIC is also committed to reducing our biogenic methane from agriculture and waste by 10% by 2030 from a 2017 base year[5].

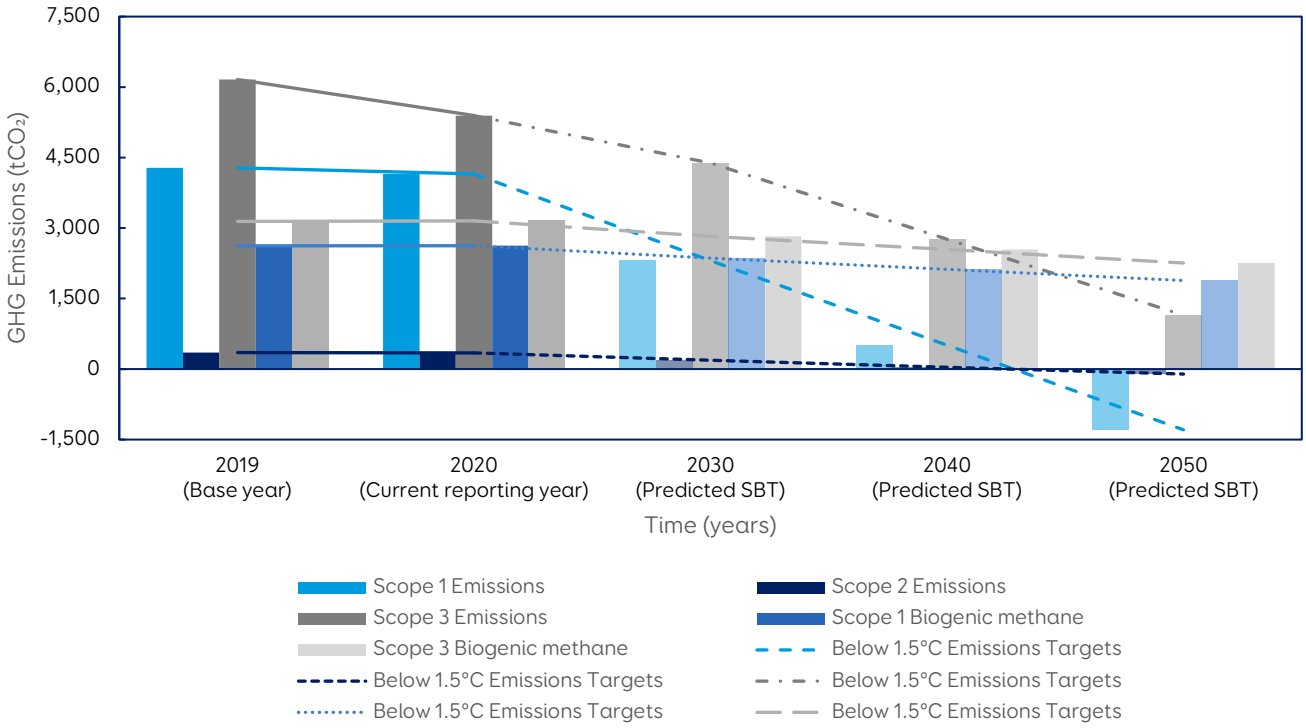

Figure 1: Current trajectory of GHG gases with projected science-based targets to meet 1.5°C temperature increase.

Emissions source inclusions and exclusions

Fuel emissions factors

Stationary combustion fuel

Stationary combustion fuels are direct (Scope 1) emissions that occur from the combustion of fuels that the reporting company owns or controls. LIC's stationary combustion fuels are derived from reticulated gas systems at the Riverlea Road, Hamilton (natural gas) and Produce Place, Christchurch (reticulated LPG) sites. There was also a property on Peachgrove Road, Hamilton that was tenanted for a brief period from 2018 to August 2019 that had a reticulated natural gas connection. LPG and natural gas stationary combustion calculations were based on supplier invoices per month for the reporting year.[6]

[5] Note: Figure 1 depicts base year as FY19.

[6] LIC suppliers of natural gas are: Contact and Genesis. LIC's supplier of LPG from June 2018 to August 2019 was Contact. From September 2020 to present the supplier is Rock Gas.

LIC has two diesel generators on-site at Newstead. Diesel emissions from the generators were calculated based on their storage capacity and any diesel fuel added during periodic servicing.[7] The top-up and storage capacity was used only as an indication of our diesel stationary combustion. There is a high uncertainty of emissions derived from the generators as they are only used for backup power occasionally. Therefore the calculation is likely to overestimate LIC's actual diesel stationary combustion emissions.

The LPG, natural gas, and diesel emissions were multiplied by the emission factors for stationary combustion fuels commercial use (Table 6) and combined to determine total stationary combustion GHG emissions.

Table 6: Emission for stationary combustion fuels commercial use (NZGovt, 2019).

Emission source	Unit	kg CO_2-e/unit	kg CO_2/unit	kg CH_4/unit	kg N_2O/unit	Uncertainties kg CO_2 - e/unit
Diesel	litre	2.66	2.65	0.00272	0.00649	0.50%
LPG	kg	3.02	3.02	0.00119	0.00142	0.50%
Natural gas	kWh	0.194	0.194	0.00081	0.0000966	2.40%

Overall stationary combustion emissions produced by LIC are negligible, contributing to 2.7% of LIC's total Scope 1 GHG emissions for FY20. Table 7 outlines LIC's stationary combustion GHG emissions for FY20 compared to FY19 broken down into category; diesel, LPG, and natural gas. There was a reduction of 42.38 tCO_2-e for LPG and 14.79 tCO_2-e reduction of natural gas from base year to FY20. There was no change in diesel emissions however it only equates to 2% of total stationary combustible GHG emissions and as such is negligible.

[7] Diesel service records from NES Hire.

Table 7: Break down of stationary combustion GHG for FY20 in comparison to FY19 at LIC.

	Total tCO_2-e	tCO_2	tCH_4	tN_2O
Stationary combustion GHG emissions FY20				
Diesel	2.61	2.60	0.00	0.01
Reticulated LPG[8]	49.00	49.00	0.02	0.00
Reticulated natural gas	94.34	94.34	0.39	0.05
Stationary Combustion GHG FY19				
Diesel	2.61	2.60	0.01	0.01
Reticulated LPG[1]	91.38	91.38	0.04	0.00
Reticulated natural gas	109.13	109.13	0.46	0.05

Transport fuel

Transport fuels are used in engines to power vehicles. The direct (Scope 1) emissions from transport fuels are derived from vehicles controlled by the reporting company. LIC transport fuel emissions come from our fleet of leased[9] vehicles which include:

- Cars
- Light commercial vehicle (LCV) 2WD and 4WD Utes
- Sport utility vehicles (SUV)
- LVC Vans
- Trucks

The transport fuel emissions were multiplied by the emission factors for transport fuels use (Table 8) and combined to determine total transport fuel GHG emissions.

Table 8: Transport fuel emission factors (NZGovt, 2019).

Emission source	Unit	kg CO_2-e/unit	kg CO_2/unit	kg CH_4/unit	kg N_2O/unit	Uncertainties kg CO_2-e/unit
Diesel	Litres	2.69	2.65	0.00354	0.0422	0.90%
Regular petrol	Litres	2.45	2.35	0.0276	0.0797	1.80%
Premium petrol	Litres	2.45	2.34	0.0277	0.0801	1.80%
Petrol - Default	Litres	2.45	2.34	0.0276	0.0798	1.80%

Transport fuel emissions contribute to 47.5% of LIC's Scope 1 GHG emissions for FY20. Table 9 outlines LIC's transport fuel GHG emissions for FY20 compared to FY19 looking at diesel and petrol-default[10] use. There was a reduction of 118.36 tCO_2-e for diesel use from FY19 to FY20. However, emissions from petrol-based vehicles increased by 30.15 tCO_2-e from base year to FY20.

Table 9: Break down of transport fuel GHG emissions for FY20 in comparison to FY19 at LIC.

	Total tCO_2-e	tCO_2	tCH_4	tN_2O
Transport fuel GHG FY20				
Diesel	2,614.91	2,576.03	3.44	41.02
Petrol - Default	590.20	563.70	6.65	19.22
Transport fuel GHG FY19				
Diesel	2,733.27	2,692.63	3.60	42.88
Petrol - Defaults	560.05	534.91	6.31	18.24

[8] LIC did not take into consideration 9kg LPG cylinders on-site for this inventory.
[9] LIC fleet leased from LeasePlan New Zealand Limited.
[10] LeasePlan does not differentiate between premium and regular petrol on data supplied, as such default emission factor used to calculate GHG emissions.

LIC is looking at reducing GHG emissions produced by our vehicles and is in the process of procuring 10 hybrid/electric vehicles to replace existing vehicles, with another 20 vehicles to be procured in 2021.

Biofuels and biomass

Biofuels and biomass when combusted emit biogenic carbon dioxide (CO_2), meaning the CO_2 that is released during combustion comes from what was absorbed by the feedstock during its lifespan. As a result, the carbon dioxide released from biofuels combustion is considered carbon neutral. However, the burning of biofuels generates anthropogenic emissions in the form of nitrous oxide and methane. Whilst the CO_2 emissions from biofuels are carbon neutral, companies are advised to report on their emissions and referring to these as 'outside of scope' emissions.

At the time of reporting LIC has not determined its combustion of biofuels or biomass.

Transmission and distribution losses for reticulated gases

Transmission and distribution losses for reticulated gases account for fugitive emissions during the delivery of natural gas to the end-user. LPG is disregarded in the calculation of fugitive emissions due to its chemical composition.

LIC has reticulated natural gas being piped to Riverlea Road and to the previously tenanted property at Peachgrove Road. The natural gas use was multiplied by the transmission and distribution loss emission factor for natural gas (Table 10) to determine LIC GHG emissions.

Table 10: Transmission and distribution loss emission factor for natural gas (NZGovt, 2019).

Emission source	Unit	kg CO_2-e/unit	kg CO_2/unit	kg CH_4/unit	kg N_2O/unit
Natural Gas Used	kWh	0.0228	n/a	0.0228	n/a

Transmission and distribution losses for natural gas emissions contribute to 0.12% of LIC's Scope 3 GHG emissions for FY20 and as such are negligible. Table 11 outlines LIC's transmission and distribution losses for natural gas GHG emissions for FY20 compared to FY19 looking at reticulated natural gas use. There was a reduction of 1.97 tCO_2-e of transmission and distribution losses from natural gas from FY19 to FY20.

Table 11: Comparison of transmission and distribution losses for natural gas between FY19 and FY20.

Transmission and distribution losses for natural gas	Total tCO_2-e	tCH_4
FY20	10.49	10.49
FY19	12.46	12.46

Refrigerant use emissions factors

Refrigerant use

The GHG emissions of hydrofluorocarbons (HFCs) are connected to unintended leaking of air conditioners, heat pumps and refrigeration units. Whilst emissions are only a small portion of the inventory the global warming potential (GWP) of these gases is significant (upward of 1,300 to 3,300 times greater than CO_2) (Table 12).

Table 12: Refrigerant gases used at LIC and their global warming potential (various sources).

Refrigerant gas	GWP
R12	10,200
R134a	1,300
R170	5.5
R22	1,810
R290	3.3
R32	675
R404a	3,922

Refrigerant gas	GWP
R407D	1,627
R410A	2,053
R438A	2,265
R452A	2,141
R502	4,657
R508B	13,214
R600a	3
R601A	4
R601C	25
R744	1

At the time of reporting, LIC did not have records to calculate the emissions of refrigerant gases using the recommended top-up method. As a result, data was collected and calculated using the screening method whereby refrigerant type and gas volume was retrieved from the air conditioning unit plates multiplied by the default leak rate percentage and multiplied by the GWP (Table 13). Domestic and commercial refrigerants were estimated based on capacity (litres), default leakage rates and default refrigerant charges where unit plates could not be accessed or located.

Table 13: Default refrigerant charges for refrigeration and air-conditioning equipment (NZGovt, 2019).

Refrigeration unit type	Default refrigerant charge (kg)	Default leakage rate (operating - ALR)	Method A	Method B
Small refrigerator or freezer (<150 litres[65])	0.07	3%	Recommended	Acceptable
Medium refrigerator or freezer (150–300 litres)	0.11	3%	Recommended	Acceptable
Large refrigerator or freezer (>300 litres)	0.15	3%	Recommended	Acceptable
Small commercial stand-alone chiller (<300 litres)	0.25	8%	Acceptable	Screening method only
Medium commercial stand-alone chiller (300-500 litres)	0.45	8%	Acceptable	Screening method only
Large commercial stand-alone chiller (>500 litres)	0.65	8%	Acceptable	Screening method only
Small commercial stand-alone freezer (<300 litres)	0.2	8%	Acceptable	Screening method only
Medium commercial stand-alone freezer (300-500 litres)	0.3	8%	Acceptable	Screening method only
Large commercial stand-alone freezer (>500 litres)	0.45	8%	Acceptable	Screening method only
Water coolers	0.04	3%	Recommended	Acceptable
Dehumidifiers	0.17	3%	Recommended	Acceptable
Small self-contained air conditioners (window mounted or through-the-wall)	0.2 kg per kW cooling capacity	1%	Acceptable	Screening method only
Non-ducted and ducted split commercial air conditioners (<20 kW)	0.25 kg per kW cooling capacity	3%	Acceptable	Screening method only
Commercial air conditioning (>20kW)	Wide range	Wide range	Unacceptable	Unacceptable

To date, vehicle air conditioning has been excluded from the GHG inventory.

Refrigerant GHG emissions account for 0.42% of the total Scope 1 emission for FY20. As such they are considered negligible. As the refrigerant assessment was conducted in 2020 for the first time using the screening method there is no comparison between the base year and reporting year (Table 14).

Table 14: Total refrigerant emissions for FY20.

Total Refrigerants	tCO_2-e
FY20	28.40

LIC is ensuing their refrigeration is not contributing to GHG emissions by systematically replacing both internal and external units as they become defunct using certified technicians. Newly installed units use the least harmful refrigerant gases.

HFC, PFC, and SF6

LIC has a number of refrigeration and air-conditioning units that contain hydrofluoro carbons (HFC) as reported in the section 'Refrigerant use' which contribute to a proportion of the refrigerant emissions reported on[11]. At time of reporting LIC was not aware of the use of either perfluorocarbons (PFC) or sulphur hexafluoride (SF6) on any of our sites.

Purchased electricity, heat, and steam emissions factors

Direct emissions from purchased electricity from the New Zealand Grid

Purchased electricity from the New Zealand grid is a Scope 2 indirect emission. LIC calculated the emissions from purchased electricity from monthly energy provider[12] invoices and multiplied it by the emission factor for purchased electricity (Table 15).

Table 15: Emission factor for purchased gird-average electricity (NZGovt, 2019).

Emission source	Unit	kg CO_2-e/unit	kg CO_2/unit	kg CH_4/unit	kg N_2O/unit
Electricity used	kWh	0.0977	0.0932	0.00439	0.000861

GHG emissions from purchased grid-average electricity contribute to 100% of LIC's Scope 3 emissions.

During FY20 LIC gained possession of two properties, Chudleigh Farm, Tauwhare and Mannering Street, Tokoroa. In August 2019 LIC was no longer in control of the Peachgrove Road property. However, the acquisition of properties appears to have had a marginal impact on electricity use emissions, with a reduction of 18.56 tCO_2-e being seen from FY19 to FY20 (Table 16).

Table 16: Comparison of purchased grid-average electricity between FY19 and FY20.

	Total tCO_2-e	tCO_2-e	tCH_4-e	tN_2O-e
FY20	344.65	328.77	15.49	3.04
FY19	363.21	346.48	16.32	3.20

Transmission and distribution losses for electricity

Transmission and distribution losses for electricity are Scope 3 emission factors that account for additional electricity that has been generated to make up for electricity that has been lost in the transmission and distribution network (Table 17).

[11] A full data set available upon request.
[12] LIC purchased electricity providers are: Genesis, Trustpower, Mercury, and Contact.

Table 17: Emission factor for electricity transmission and distribution losses (NZGovt, 2019).

Emission source	Unit	kg CO_2-e/unit	kg CO_2/unit	kg CH_4/unit	kg N_2O/unit
Electricity used	kWh	0.0074	0.00706	0.00333	0.00000653

LIC's transmission and distribution losses for electricity were calculated from monthly supplier invoices totalled for each site per month and multiplied by the emission factor for electricity transmission and distribution losses. Table 18 outlines the differences between the base year and FY20, with FY20 having a reduction in electricity losses of 1.41 tCO_2-e. Transmission and distribution losses related to electricity only contribute 0.31% of LIC's GHG emissions and as such are negligible.

Table 18: Comparison of transmission and distribution losses for electricity between FY19 and FY20.

	tCO_2-e	tCO_2	tCH_4	tN_2O
Transmission and distribution losses for electricity FY20	26.10	24.90	11.75	0.02
Transmission and distribution losses for electricity FY19	27.51	26.25	12.38	0.02

Imported heat and steam

LIC does not import heat or steam and as such these are not included in this GHG inventory report.

Geothermal energy

LIC does not use geothermal energy and as such it is not included in this GHG inventory report.

Travel emissions factors

Travel emissions are the result of travel associated with the business, and these are generally paid for by the company. However, there are some exceptions to this, for example, employee travel to and from work.

Passenger vehicles

Passenger vehicle emissions are associated with business travel and include:

- Private vehicles (Scope 3 emissions)
- Rental vehicles (Scope 1 emissions)
- Taxis/Uber/other rideshare vehicles (Scope 1 emissions)

Scope 1 rental vehicle travel emissions were calculated using the default rental car emission factors based on the kilometres travelled (Table 19). The data was provided by Orbit World Travel (Hamilton) and based on information provided to them from rental car agencies. As such data is limited and only a partial reflection on LIC business travel in rental vehicles. Taxis, Ubers and other modes of paid vehicle business transport have been excluded from the data set.

Table 19: Default rental car emission factors per km travelled (NZGovt, 2019).

Emission source	Unit	kg CO_2-e/unit	kg CO_2/unit	kg CH_4/unit	kg N_2O/unit
Petrol	km	0.207	0.198	0.002	0.007

LIC's Scope 1 rental car emissions were calculated from monthly supplier invoices. The km for each trip per rental car per month was totalled and multiplied by the emission factor (Table 19). Table 20 outlines the differences between the base year and FY20, with FY20 having a reduction in rental car travel emissions of 18.13 tCO_2-e. Rental car emissions only contribute 0.15% of LIC's GHG emissions and as such are negligible.

Table 20: LIC rental travel emission comparison FY19 and FY20.

	tCO_2-e	tCO_2	tCH_4	tN_2O
Rental car travel FY20	10.17	9.72	0.10	0.34
Rental car travel FY19	28.29	27.06	0.27	0.96

Scope 3 passenger vehicle travel emissions were measured using data based on estimated staff commuting to work and Artificial Breeding (AB) staff recorded monthly kilometres travelled. The data was combined and multiplied by the indirect passenger emissions factor (Table 21).

AB staff travel

LIC's AB staff are reimbursed via a travel subsidy based on their kilometres travelled per month. The AB staff travel emissions were then calculated using the 'Petrol - Default' emission factor.

Employee travel

Indirect passenger emissions are estimates based on a number of employees working for LIC per month. That number was multiplied by workdays per month and an average km round trip of 37.05 km less an estimated 148 staff per month who drive LIC fleet vehicles[13] to work. Information on distance travelled to and from work was derived from the 2018 New Zealand census. A subsample of 528 out of 1,344 people who stated they drive to work in Ruakura from various parts of the Waikato was used (StatsNZ, 2020). The calculated information was extrapolated out to assume a similar average distance is travelled by LIC employees who work at other sites across New Zealand. The data accounts for Covid-19 restrictions - assuming not all workers were able to work at home and were still working at the varying sites throughout New Zealand during April and May 2020. These estimates were based on maximum daily staff likely to be on site during the restrictions (Ngawhare & Wollaston, 2020). As LIC did not have information on vehicle type or fuel used by each employee, the emission factor 'Petrol - Default' was used to calculate GHG emissions (Table 21).

Table 21: Indirect passenger emission factor (NZGovt, 2019).

Emission source	Unit	kg CO_2-e/unit	kg CO_2/unit	kg CH_4/unit	kg N_2O/unit
Petrol - Default	km	0.268	0.257	0.003	0.009

LIC Scope 3 passenger emissions contribute to approximately 51% of our Scope 3 GHG emissions. There was an estimated 423 tCO_2-e reduction in emissions from FY19 to FY20 for staff commuting to work. This reduction in emissions is most likely the result of staff working from home during the pandemic rather than changing their travel habits. AB staff have continued to work through the pandemic as essential workers and there was an insignificant change in their emissions between base year and FY20 (Table 22).

Table 22: LIC staff commuting to and from work, AB staff travel and total private vehicle travel comparison between FY19 and FY20.

	tCO_2-e	tCO_2	tCH_4	tN_20
Scope 3 Passenger travel FY20				
AB Staff travel	95.15	91.25	1.07	3.20
Staff commuting to and from work	4,300.38	4,123.87	48.14	144.42
Total	4,395.54	4,215.12	49.20	147.61
Scope 3 Passenger travel FY19				
AB Staff travel	95.21	91.30	1.07	3.20
Staff commuting to and from work	4,723.57	4,529.69	52.88	158.63
Total AB Staff travel and Staff commuting	4,818.78	4,620.99	53.94	161.82

[13] *Based on report from Lease Plan.*

Looking into future reporting LIC endeavours to capture specific commuting routines of staff to better understand Scope 3 private vehicle passenger data.

Public transport

LIC has not accounted for public transport in this report.

Air travel

Domestic air travel

Scope 3 domestic air travel emissions were calculated using the domestic air travel emission factors with radiative forcing based on data collected from Orbit World Travel. The domestic air travel emissions were calculated using the emission factors in Table 23 multiplied by passenger kilometres (pkm)[14] per year. The emission factor was chosen based on the size of aircraft travelled in (jet, medium, small aircraft) when aircraft size was unknown the national average was used.

Table 23: Domestic air travel emission factors with radiative forcing (NZGovt, 2019).[15]

Emission Source	Unit	kg CO_2-e/unit	kg CO_2/unit	kg CH_4/unit	kg N_2O/unit
National average	pkm	0.242	0.238	0.0009	0.003
Jet aircraft	pkm	0.134	0.132	0.0005	0.002
Medium aircraft	pkm	0.213	0.21	0.0009	0.003
Small aircraft	pkm	0.659	0.647	0.0024	0.009

Domestic air travel emissions contribute to 1.95% of LIC's Scope 3 GHG emissions for FY20. Table 24 outlines LIC's domestic air travel GHG emissions for FY20 compared to FY19 looking at aircraft size and total emissions. There was a reduction of 88.50 tCO_2-e for total domestic air travel from FY19 to FY20. However the reduction is likely a result of Covid-19 as no domestic air travel was undertaken in April 2020 and minimal domestic air travel in May 2020.

Table 24: LIC's domestic air travel emissions comparison between FY20 and FY19.

	tCO_2-e	tCO_2	tCH_4	tN_2O
Domestic air emissions FY20				
National average	0.75	0.74	0.00	0.01
Jet aircraft	11.13	10.97	0.04	0.17
Medium aircraft	153.34	151.18	0.00	2.16
Small aircraft	1.26	1.24	0.00	0.02
Total	166.49	164.13	0.70	2.35
Domestic air emissions FY19				
National Average	-	-	-	-
Jet aircraft	18.69	18.41	0.07	0.28
Medium aircraft	233.59	230.30	0.99	3.29
Small aircraft	2.70	2.65	0.01	0.04
Total	254.98	251.36	1.07	3.61

[14] pkm = the number of passengers on a flight multiplied by the distance travelled.

[15] *"Radiative forcing (RF) is a measure of the additional environmental impact of aviation. These include emissions of nitrous oxides and water vapour when emitted at high altitude. Organisations should include the influence of radiative forcing RF in air travel emissions to capture the maximum climate impact of their travel habits. However, it should be noted that there is very significant scientific uncertainty around the magnitude of the additional environmental impacts of aviation. Organisations should produce comparable reporting. Therefore, they should avoid reporting with uplifted air travel conversion factors in one year and without in another year as this may skew the interpretation of their reporting." (UKGovt, 2020).*

International air travel

Scope 3 international air travel emissions were calculated using the international air travel emission factors with radiative forcing based on data collected from Orbit World Travel. The international air travel emissions were calculated using the emission factors in Table 25 multiplied by pkm per year. The emission factor was chosen based on distance travelled (short haul <3,700 km) or long haul (>3,700 km) and the travel class the passenger travelled in (Table 25) when travel class was unknown the average passenger factor was used.

Table 25: International air travel emission factors with radiative forcing (NZGovt, 2019).

Emission source	Travel Class	Unit	kg CO_2-e/unit	kg CO_2/unit	kg CH_4/unit	kg N_2O/unit
Short Haul (<3,700 km)	Average passenger	pkm	0.162	0.162	0.00001	0.001
	Economy	pkm	0.16	0.159	0.00001	0.001
	Business	pkm	0.24	0.238	0.00001	0.001
Long haul (>3,700 km)	Average passenger	pkm	0.213	0.212	0.00001	0.001
	Economy	pkm	0.163	0.162	0.00001	0.001
	Premium economy	pkm	0.26	0.259	0.00001	0.001
	Business	pkm	0.472	0.47	0.00002	0.002
	First	pkm	0.651	0.648	0.00002	0.003

International air travel emissions contribute to 7.96% of LIC's Scope 3 GHG emissions for FY20. Table 26 outlines LIC's international air travel GHG emissions for FY20 compared to FY19 looking at travel class for short and long haul flights and total emissions. There was a reduction of 200.84 tCO_2-e for total international air travel from FY19 to FY20. However the reduction is likely a result of Covid-19 as no international air travel was undertaken in April or May 2020.

Table 26: LIC's international air travel emissions comparison between FY20 and FY19.

	Travel Class	tCO_2-e	tCO_2	tCH_4	tN_2O
International travel emissions FY20					
Short Haul (<3,700 km)	Economy	37.98	37.75	0.00	0.24
	Business	17.61	17.46	0.00	0.07
Long haul (>3,700 km)	Economy	90.51	89.94	0.00	0.57
	Premium economy	151.72	150.45	0.01	1.60
	Business	382.83	379.64	0.02	1.60
Total international travel emissions		680.64	675.23	0.03	4.07
International travel emissions FY19					
Short Haul (<3,700 km)	Economy	48.61	48.31	0.00	0.30
	Business	24.34	24.14	0.00	0.10
Long haul (>3,700 km)	Economy	190.21	189.02	0.00	1.19
	Premium economy	169.98	168.57	0.01	1.87
	Business	448.34	444.60	0.02	1.87
Total international travel emissions		881.48	874.63	0.03	5.33

Accommodation

Accommodation emissions are an indirect Scope 3 emission source. Table 27 and Table 28 outline the emission factors per room by country. LIC's accommodation emissions were calculated by multiplying room per night per employee by country of stay emission factor.

Table 27: Accommodation emissions factors (NZGovt, 2019)

Country	Unit	kgCO_2-e/unit
Australia	Room per night	65.1

Country	Unit	$kgCO_2$-e/unit
Austria	Room per night	19
Belgium	Room per night	13.9
Brazil	Room per night	14.1
Canada	Room per night	19.6
Chile	Room per night	56
China	Room per night	72.3
China (Hong Kong)	Room per night	93.3
Costa Rica	Room per night	16.1
Czech Republic	Room per night	29.7
France	Room per night	6.6
Germany	Room per night	20.8
India	Room per night	103.1
Ireland	Room per night	30
Italy	Room per night	24.9
Japan	Room per night	75.5
Netherlands	Room per night	21.7
New Zealand	Room per night	12.3
Singapore	Room per night	48.4
South Africa	Room per night	62.2
Spain	Room per night	23.5
Switzerland	Room per night	8.9
United Arab Emirates	Room per night	117
United Kingdom	Room per night	26.4
United States	Room per night	25.6

Table 28: Accommodation emission factors (Greenview, 2020)

Accommodation Emissions	Unit	$kgCO_2$-e/unit
Ethiopia	Room per night	29
Israel	Room per night	52
Kenya	Room per night	17
Rwanda	Room per night	44
Tanzania	Room per night	18
Uganda	Room per night	44
Croatia	Room per night	39
Fiji	Room per night	16
Peru	Room per night	18

Accommodation emissions contribute to 0.72% of LIC's Scope 3 GHG emissions for FY20, and as such are negligible. Table 29 outlines LIC's accommodation GHG emissions for FY20 compared to FY19. There was a reduction of 47.80 tCO_2-e for total accommodation from FY19 to FY20. However, the reduction is likely a result of Covid-19 as business travel undertaken in April 2020 and minimal business travel for May 2020.

Table 29: LIC's accommodation emissions comparison between FY20 and FY19.

	tCO_2-e
Accommodation emissions FY20	61.46
Accommodation emissions FY19	109.26

Freight transport emission factors

Road freight

LIC has not taken into consideration freight in this report.

Rail freight
LIC has not taken into consideration freight in this report.

Air freight
LIC has not taken into consideration freight in this report.

Coastal and international shipping freight
LIC has not taken into consideration freight in this report.

Water supply and wastewater treatment emission factors

Water supply and wastewater treatment (WWT) emissions are an indirect Scope 3 emission source if the organisation does not control or own the facilities (Water supply - Table 30. WWT - Table 33).

Water supply
LIC currently has 23 sites that are supplied water from municipal sources as well as bore water wells on-site. LIC's water supply emissions were calculated by multiplying water supply from meter readings (bore and council meters) or per capita (where data was unavailable) multiplied by the water supply emission factors in Table 30.

Table 30: Water supply emission factors (NZGovt, 2019)

Emission source	Unit	kg CO_2-e/unit	kg CO_2/unit	kg CH_4/unit	kg N_2O/unit
Water supply	m^3	0.0313	0.0299	0.0014	0.00003
	Per capita	4.07	3.89	0.183	0.0036

Scope 1 GHG emissions from water supply
LIC's Scope 1 GHG emissions from water supply is derived from bore water wells on site from seven metered wells. Water supply GHG emissions from the bores contribute to 0.004% of the Scope 1 emissions, equivalent to 0.28 tCO_2-e and are as such negligible. However, at time of reporting a complete data set was not provided for FY20 and as such water supply from bores controlled by LIC are under-reporting GHG emissions (Table 31)[16].

Table 31: Comparison between LIC's bore water supply emission FY20 to FY19.

	Total tCO_2-e	tCO_2	tCH_4	tN_2O
LIC total water supply emissions FY20	0.245	0.234	0.011	0.000
LIC total water supply emissions FY19	0.524	0.500	0.023	0.001

Scope 3 GHG emissions from water supply
LIC's Scope 3 GHG emissions from water supply were derived from both emission factors methods of calculation based on data provided at the time of inventory creation and site processes. As a result, the Newstead, Christchurch, and Riverlea sites were based on water meter readings recorded on an annual and quarterly basis using the m^3 of water supplied emission factor. Water supply from the depots were calculated based on the per capita emission factor (Table 32). Calculating the depots using the per capita emission factor for water supply provides an overestimate of actual water supply emissions generated by LIC. The result has a minor effect on LIC's overall emissions but will be revisited when more accurate data is available in following reports.

[16] As a result of incomplete data set the FY20 results do not result in a reduction in water supply emissions.

Combined the water supply emissions from all sources equated to 9.03 tCO_2-e or 0.11% of LIC's Scope 3 emissions and are as such negligible. There was an increase of 0.14 tCO_2-e for total water supply emissions from FY19 to FY20.

Table 32: Comparison between LIC's municipal water supply emission FY20 to FY19.

	Total tCO_2-e	tCO_2	tCH_4	tN_2O
LIC total water supply emissions FY20	9.03	8.63	0.41	0.01
LIC total water supply emissions FY19	8.89	8.50	0.40	0.01

Wastewater treatment (WWT)

Table 33: Emission factor for wastewater treatment (NZGovt, 2019).

Emission source	Unit	kg CO_2-e/unit	kg CO_2/unit	kg CH_4/unit	kg N_2O/unit
Wastewater treatment plants	m^3 water supplied	0.447	0.077	0.151	0.218
	per capita	48.5	8.4	16.4	23.7
Septic tanks	per capita	0.202	n/a	0.202	n/a
Dairy processing	m^3 of milk	0.119	n/a	n/a	0.119

Scope 1 GHG emissions from wastewater treatment (WWT)

LIC's Scope 1 GHG emissions from WWT include a wastewater treatment plant (WWTP) at the Newstead site and a number of septic tanks located on the rural farm properties.

WWT GHG emissions from the Newstead WWTP and site and on-farm septic tanks contribute to 0.02% of the Scope 1 emissions, equivalent to 1.54 tCO_2-e and are as such negligible There was a marginal reduction of 0.23 tCO_2-e between FY20 and FFY19. The WWTP on-site at Newstead was calculated using daily discharge water meter readings provided by S3 who monitor and maintain the system. However, at time of reporting a complete data set was not provided so septic tank waste is based on estimated per capita use (Table 34).

Table 34: Comparison between LIC's Scope 1 WWT emissions FY20 to FY19.

	Total tCO_2-e	tCO_2	tCH_4	tN_2O
LIC total WWT emissions FY20	1.54	0.24	0.63	0.67
LIC total WWT emissions FY19	1.77	0.28	0.70	0.79

Scope 3 GHG emissions from WWT

LIC's Scope 3 GHG emissions from WWT were derived from three separate methods of calculation based on data provided at the time of inventory creation and site processes. As a result, the Christchurch and Riverlea sites were based on water meter readings recorded on an annual and quarterly basis respectively using the m^3 of water supplied emission factor. WWT from the depots were calculated based on the per capita emission factor, and the disposal and treatment of the milk, bromide, and grease traps at the Riverlea and Christchurch sites were calculated using the dairy processing emission factor from m^3 of milk. Calculating depots using the per capita emission factor for WWT provides an overestimate of actual WWT emissions generated by LIC. The result has a minor effect on LIC's overall emissions but will be revisited when more accurate data is available in following reports.

Combined the emissions from all sources equated to 66.26 tCO_2-e or 0.78% of LIC's Scope 3 emissions (Table 35). There was a reduction of 5.64 tCO_2-e between FY20 and FY19 base year.

Table 35: Comparison between LIC's Scope 3 WWT emissions FY20 to FY19

	Total tCO_2-e	kg CO_2	kg CH_4	kg N_2O
LIC total WWT emissions FY20	66.26	11.73	21.86	33.23
LIC total WWT emissions FY19	71.90	12.42	22.83	35.19

Materials and waste emission factors

Construction materials

LIC has not taken into consideration construction materials in this GHG inventory report.

Waste disposal

Waste disposal emissions only account from the GHG emissions produced from the processing of waste. Units of emission are based on kg CO_2-e per kg of waste and the methane emissions derived from the organic decomposition of organic materials in landfills. At the time of inventory reporting, LIC was uncertain of the type of landfill its waste was being disposed to.[17] As a result, LIC has taken the conservative approach for calculating waste emissions using the landfills without gas recovery emission factors. Furthermore, whilst cardboard and paper are collected for recycling it has been included in this section as at the time of reporting LIC was unable to determine freight from each site to recycling plants[18]. As such the GHG emissions from waste disposal overestimate is provided in this report.

LIC waste emissions were calculated using the waste emission factors without landfill gas recovery (LGR), multiplying the waste collected per site and the appropriate emission factor (Table 36).

Table 36: Waste emission factors with and without landfill gas recovery (UKGovt, 2020).

Emission Source	Unit	kg CO_2-e/unit	kg CO_2/unit	kg CH_4/unit	kg N_2O/unit
General waste With LGR	kg	0.242	n/a	0.381	n/a
General waste Without LGR	kg	1.17	n/a	1.17	n/a
Paper waste with LGR	kg	0.62	n/a	0.62	n/a
Paper waste without LGR	kg	3	n/a	3	n/a
Food waste with LGR	kg	0.233	n/a	0.233	n/a
Food waste without LGR	kg	1.13	n/a	1.13	n/a

Estimated waste disposal emissions may contribute to up to 37% of LIC's Scope 3 GHG emissions for FY20. Table 37 outlines LIC's estimated waste disposal GHG emissions for FY20 compared to FY19. There was a reduction of 33.47 tCO_2-e for total estimated waste disposal from FY19 to FY20. However, as stated previously the data is based on calculating emissions by the waste emission factors without landfill gas recovery and as such could be significantly lower.

LIC endeavours to produce a more accurate assessment in future reports.

Table 37: Estimated waste disposal emission comparison between FY20 and FY19.

	tCO_2-e	tCH_4
Estimated waste disposal emissions FY20		
General waste Without LGR	3,083.47	3,083.47
Paper and card waste Without LGR	19.74	19.74

[17] Two types of landfill:
With gas recovery - Landfill where some of the CH_4 produced during decomposition is captured.
Without gas recovery - Landfill where the CH_4 produced during decomposition escapes to the atmosphere.
[18] In accordance with New Zealand Government (2019), Measuring Emissions: A Guide for Organisations, organisations who are interested in calculating the emissions from recycling could do so independently by accounting for the distance travelled by the waste to the recycling plant using the freight emissions factors.

	tCO_2-e	tCH_4
Food waste Without LGR	28.20	28.20
Total Without LGR	3,131.42	3,131.42
Estimated waste disposal emissions FY19		
General waste Without LGR	3,083.47	3,083.47
Paper and card waste Without LGR	6.54	6.54
Food waste Without LGR	74.88	74.88
Total Without LGR	3,164.89	3,164.89

Agriculture, forestry and other land use emissions factors

Land use, land use change and forestry (LULUCF)

LIC has not undertaken any land use, land use change or forestry operations on land it controls, therefore emissions from LULUCF are not included in this report.

Agriculture

LIC has a total of five farms across the Waikato and Manawatu Regions. Innovation Farm in the Waikato is a dairy farm, the other four farms are used for bull grazing and classed as non-dairy farms. LIC's also owns some animals in various research and novelty breeding programs, these are grazed on several properties throughout New Zealand. These animals have been grouped as they may be owned for various tenures and may shift locations at various stages within a year for breeding and research purposes. LIC's livestock in Ireland have been excluded in this report.

LIC's agricultural emissions are based on monthly average stock numbers and estimate emissions have been determined for enteric fermentation, manure management, fertiliser use, and agricultural soils using the appropriate emissions factors. At time of reporting LIC did not have a complete dataset in Overseer. In future reports LIC will report agricultural emissions using Overseer and re-establish the baseline in FY21.

LIC's agricultural emissions contribute to approximately half of all Scope 1 greenhouse gas emissions.

Enteric fermentation

Enteric fermentation for LIC was calculated based on animals per head and type of agricultural livestock (dairy/non-dairy) multiplied by the enteric fermentation emission factors (Table 38).

Table 38: Enteric fermentation emission factors (NZGovt, 2019).

Emission source		Unit	kg CO_2-e/unit	kg CO_2/unit	kg CH_4/unit	kg N_2O/unit
Enteric fermentation	Dairy cattle	per head	2,060	n/a	2,060	n/a
	Non-dairy cattle	per head	1,500	n/a	1,500	n/a
	Sheep	per head	300	n/a	300	n/a
	Deer	per head	560	n/a	560	n/a

Enteric fermentation emissions contribute to 37.9% of LIC's Scope 1 GHG emissions for FY20. Table 39 outlines LIC's enteric fermentation GHG emissions for FY20 compared to FY19. There was a reduction of 0.8 tCO_2-e for total enteric fermentation from FY19 to FY20.

Table 39: LICs enteric fermentation emissions comparison between FY20 and FY19.

	Total tCO_2 -e	tCH_4/unit
Enteric fermentation emissions FY20	2,556	2,556
Enteric fermentation emissions FY19	2,556.80	2,556.80

Manure management

Manure management for LIC was calculated based on animals per head type of agricultural livestock (dairy/non-dairy) multiplied by the manure management emission factors (Table 40).

Table 40: Manure management emission factors (NZGovt, 2019).

Emission source		Unit	kg CO_2-e/unit	kg CO_2/unit	kg CH_4/unit	kg N_2O/unit
Manure management	Dairy cattle	per head	150	n/a	141	9.91
	Non-dairy cattle	per head	19.9	n/a	19.9	n/a
	Sheep	per head	3.15	n/a	3.15	n/a
	Deer	per head	6.59	n/a	6.59	n/a

Manure management emissions contribute to 1.04% of LIC's Scope 1 GHG emissions for FY20. Table 41 outlines LIC's enteric manure management GHG emissions for FY20 compared to FY19. There was an increase of 2.44 tCO_2-e for total manure management from FY19 to FY20.

Table 41: LICs manure management emissions comparison between FY20 and FY19.

	Total tCO_2 -e	tCH_4-e/unit	tN_2O/unit
Manure management emissions FY20	70.71	68.01	2.97
Manure management emissions FY19	68.27	65.75	2.77

Fertiliser use

Fertiliser use GHG emissions for LIC were calculated based on kilograms of fertiliser used per farm multiplied by the fertiliser use emission factors (Table 42).

Table 42: Fertiliser use emission factors (NZGovt, 2019).

Emission source		Unit	kg CO_2-e/unit	kg CO_2/unit	kg CH_4/unit	kg N_2O/unit
Fertiliser use	Non-urea nitrogen fertiliser	kg	5.4	n/a	n/a	5.4
	Urea nitrogen fertiliser not coated with urease inhibitor	kg	5.07	1.59	n/a	3.48
	Urea nitrogen fertiliser coated with urease inhibitor	kg	4.86	1.59	n/a	3.27
	Limestone	kg	0.44	0.44	n/a	n/a
	Dolomite	kg	0.477	0.477	n/a	n/a

Fertiliser use emissions contribute to 2.8% of LIC's Scope 1 GHG emissions for FY20. Table 43 outlines LIC's fertiliser use GHG emissions for FY20 compared to FY19. There was an increase of 4.4 tCO_2-e for total fertiliser use from FY19 to FY20.

Table 43: LICs fertiliser use emissions comparison between FY20 and FY19.

	Total tCO_2-e	tCO_2	tN_2O
Fertiliser use emissions FY20	189.00	59.38	129.62
Fertiliser use emissions FY19	184.86	57.98	126.88

Agricultural soils

Agricultural soil emissions for LIC was calculated based on animals per head type of agricultural livestock (dairy/non-dairy) multiplied by the agricultural soils emission factors (Table 44).

Table 44: Agricultural soil emission factors (NZGovt, 2019).

Emission source		Unit	kg CO_2-e/unit	kg CO_2/unit	kg CH_4/unit	kg N_2O/unit
Agricultural soils	Dairy cattle	per head	514	n/a	n/a	514
	Non-dairy cattle	per head	321	n/a	n/a	321
	Sheep	per head	71.5	n/a	n/a	71.5
	Deer	per head	128	n/a	n/a	128

Agricultural soil emissions contribute to 8% of LIC's Scope 1 GHG emissions for FY20. Table 45 outlines LIC's agricultural soils GHG emissions for FY20 compared to FY19. There was an increase of 1.29 tCO_2-e for total agricultural soils from FY19 to FY20.

Table 45: LICs agricultural soils emissions comparison between FY20 and FY19.

	Total tCO_2 -e	tN_2O/unit
Agricultural soil emissions FY20	568.93	568.93
Agricultural soil emissions FY19	567.64	567.64

GHG information management and monitoring procedures

Information management

LIC's GHG emissions are calculated annually and compared against the base year (FY19). Procedures detailing methods for, but not limited to data collection, data entry, GHG calculations, and record-keeping are used to prepare our annual report. The procedures are reviewed on an annual basis to ensure LIC is using the most up to date methodology.

Base year recalculation

LIC may in the future be required to recalculate our base year as a result of historical data uncovered, improvements in data gathering, reporting boundaries, and changes to calculation methods or other contributing factors. As such the base year is to be reviewed, recalculated and in the following GHG inventory report will include an explanation as to the changes.

Verification of GHG inventory

As LIC is committed to the 2017 Climate Leaders Coalition pledge, it is not currently having its GHG inventory report verified by a third party. LIC is currently in the process of committing to the 2019 pledge and in the future will have the inventory assessed and verified by an independent third party verifier. The current inventory has been verified internally by a separate business unit to the reporting business unit.

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Appendix 1
Scope definitions

Scope 1 – Direct GHG emission sources
Direct emissions are generated by sources owned or controlled by the company. For example emissions derived from the combustion of fuel in vehicles, stationary combustion fuels (generator diesel or piped natural gas), refrigerant use (air conditioning units) or agriculture.

Scope 1 – Biogenic methane
Scope 1 biogenic methane emissions are generated from enteric fermentation, manure and wastewater treatment (WWT). Enteric fermentation emissions are based solely on the methane produced by animals whilst the manure and WWT emissions are divided into methane and nitrous oxide. Methane derived from manure management and WWT are included in Scope 1 biogenic methane emissions, and the nitrous oxide derived from manure is included in Scope 1 direct GHG emissions.

Scope 2 – Indirect GHG emission sources
Indirect emissions are derived from the generation of purchased energy such as steam, heat, or electricity that is used by the company.

Scope 3 – Other GHG indirect emission sources including Scope 3 biogenic methane
Other indirect emissions are derived from the activities that are carried out by the company but from sources not controlled by the company. For example indirect emissions from travel such as air travel, freight transport, refrigerant use from chilled transport or air conditioning, and passenger owned vehicles used by AB staff. Other indirect GHG emissions from products the company uses such as water supply and wastewater treatment, transmission and distribution losses, materials and waste (NZGovt, 2019).

Justifications

Table 46: Overview of data per scope, with explanations on data gathering.

Emission source	Percent of total GHG	Percent of Scope	Complete data set	Details
Scope 1				
Stationary combustion	0.94%	2.17%	Yes	Minimal data missing - data filled with estimate usage based on averages.
Direct travel	20.50%	47.50%	Yes	Supplier invoices provide complete data set.
Rental car	0.07%	0.15%	No	Rental car data incomplete, limited data provided by supplier.
Direct water supply	0.002%	0.02%	No	Missing data from June 2019 to January 2020 for bores on farm.

Emission source	Percent of total GHG	Percent of Scope	Complete data set	Details
Direct wastewater treatment	0.01%	0.004%	Yes	Data from maintenance vendor. Estimates for sites with septic tanks. Missing some data but only small fraction of emissions so likely to be minimal impact.
Refrigerants	0.18%	0.42%	No	No data from Tempero building roof, Diagnostics roof. Only used screening method.
Enteric fermentation	16.35%	37.88%	Yes	Will use Overseer in the future for more site specific accurate modelling.
Manure management	0.45%	1.05%	Yes	
Fertiliser use	1.21%	2.80%	Yes	
Agricultural soils	3.45%	8.00%.	Yes	
Scope 2				
Electricity	2.21%	100%	Yes	Minimal data missing, gaps filled using estimate average monthly use per site.
Scope 3				
Water supply	0.06%	0.11%	No	Maui Street water take not captured. Innovation Farm – Not enough information provided. Future data from farms ideally will be captured and recorded digitally. LIC have followed protocols but due to people only spending their working hours on-site that this is grossly overestimating water supply consumption. This has a minor effect on our overall emissions but will be revisited when more accurate data is available in following years.
Indirect wastewater treatment	0.42%	0.78%	No	Maui Street water take not captured. LIC have followed protocols but due to people only spending their working hours on-site that this is grossly overestimating wastewater treatment. This has a minor effect on our overall emissions but will be revisited when more accurate data is available in following years.
Transmission and distribution losses for natural gas emissions	0.07%	0.12%	Yes	Minimal data missing - data filled with estimate usage based on average monthly use per site.
Transmission and distribution losses for electricity emissions	0.17%	0.30%	Yes	Minimal data missing - data filled with estimate usage based on average monthly use per site.
Domestic air travel	1.06%	1.94%	Yes	Supplier invoices provide complete data set.
International air travel	4.35%	7.96%	Yes	Supplier invoices provide complete data set.
Accommodation	0.39%	0.72%	Yes	Supplier invoices provide complete data set.

Emission source	Percent of total GHG	Percent of Scope	Complete data set	Details
Waste	20.03%	36.64%	No	Estimated. Unclear on landfill type.
Indirect passenger vehicle travel	28.11%	51.43%	No	Estimated. Look at detailed staff survey in future.