2021

Livestock Improvement Corporation Limited GHG Inventory Report - FY21

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 two GHG emissions for the period 1 June 2020 to 31 May 2021.

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 2020/21, compared to the 2018/19 base year.

Comparison of total GHG emissions by scope for FY21 to base year (FY19) and FY20.

Scope	2018/2019 tCO_2-e base year	2019/2020 tCO_2-e	2020/2021 tCO_2-e	tCO_2-e Variation from base year
Scope 1 direct emissions	5,089	5,141	5,272	3.60%▲
Scope 2 indirect emissions	378	351	307	-18.78%▼
Scope 3 indirect emissions	7,062	6,451	6,141	-13.04%▼
Total emissions	12,529	11,943	11,720	-6.45%▼

Scope	2018/2019 CH_4 (tCO_2-e) base year	2019/2020 CH_4 (tCO_2-e)	2020/2021 CH_4 (tCO_2-e)	CH_4 (tCO_2-e) Variation from base year
Scope 1 biogenic methane emissions	3,215	3,332	3,219	0.13%▲
Scope 3 biogenic methane	543	544	544	0.16%▲
Total emission	3,758	3,876	3,763	0.14%▲

In FY21, LIC's total GHG emissions fell by 6.45% from the base year and in comparison to FY20 where emissions fell by 4.53%. Biogenic methane emissions rose by 0.14% compared to the base year whilst emissions fell by 2.90% when compared to FY20. 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 comparison of our 2020/21 GHG emissions 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 that 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 two GHG emissions inventory report, for the period 1 June 2020 to 31 May 2021 (FY21).

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 FY21

Total GHG emissions for the period June 2020 to May 2021 (FY21) fell by 6.45% from the base year June 2018 to May 2019 (FY19) (Table 1)[3]. From FY20 to FY21 total GHG emissions fell by 1.87%.

Table 1: Comparison of total GHG emissions by scope for FY21 to base year (FY19).

	FY19 tCO_2-e (base year)	FY20 tCO_2-e	FY21 tCO_2-e	tCO_2-e Variance of FY21 from FY19	tCO_2-e Variance of FY21 from FY20
Scope 1 direct emissions	5,089	5,141	5,272	3.60%▲	2.55%▲

[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).
[3] LIC attained further information for all three reporting years in addition to carrying out recalculation of our emissions using the New Zealand Governments latest emissions factors. LIC also recalculated our agricultural emissions based on data collated on Overseer.

	FY19 tCO_2-e (base year)	FY20 tCO_2-e	FY21 tCO_2-e	tCO_2-e Variance of FY21 from FY19	tCO_2-e Variance of FY21 from FY20
Scope 2 indirect emissions	378	351	307	-18.78%▼	-12.56%▼
Scope 3 indirect emissions	7,062	6,451	6,141	-13.04%▼	-4.80%▼
Total emissions	**12,529**	**11,943**	**11,720**	-6.45%▼	-1.87%▼

However, some of the decreases observed in this inventory report are still likely attributed to the coronavirus disease (Covid-19) global pandemic and limitations set on New Zealand in regards to limitations on international travel, and people continuing to work from home.

Total biogenic methane emissions for the period June 2020 to May 2021 (FY21) rose by 0.14% from the base year June 2018 to May 2019 (FY19) (Table 2). However, there was a reduction in biogenic methane emissions between FY20 and FY21 of 2.90%.

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

Scope	2018/2019 CH_4 (tCO_2-e)[4] base year	2019/2020 CH_4 (tCO_2-e)	2020/2021 CH_4 (tCO_2-e)	CH_4 (tCO_2-e) Variation of FY21 from base year	CH_4 (tCO_2-e) Variation of FY21 from FY20
Scope 1 biogenic methane emissions	3,215	3,332	3,219	0.13%▲	-3.39%▼
Scope 3 biogenic methane	543	544	544	0.10%▲	0.05%▲
Total emissions	3,758	3,876	3,763	0.14%▲	-2.90%▼

50% of LIC emission source categories saw a reduction for the FY21 reporting year from the base year (Table 3). Emissions from international travel had the greatest reduction of 98.95% from FY19. In comparison, FY21 and FY20 had overall reductions to 75% of emission source categories, with international air travel having the greatest reduction of 98.64%.

Table 3: Comparison of total GHG emissions by category between FY21 and base year and betweenFY20 and FY21.

	Emission Source	tCO_2-e - FY19 (base Year)	tCO_2-e - FY20	tCO_2-e - FY21	Variance from FY21 to FY19	Variance from FY21 to FY20
Scope 1	Stationary Combustion	203.99	146.59	152.68	-25.15%▼	4.15%▲
Scope 1	Transport fuel	3,315.90	3,332.21	3,523.22	6.25%▲	2.55%▲

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

	Emission Source	tCO_2-e - FY19 (base Year)	tCO_2-e - FY20	tCO_2-e - FY21	Variance from FY21 to FY19	Variance from FY21 to FY20
Scope 1	Direct water supply	316.55	328.44	318.36	0.57%▲	-3.07%▼
Scope 1	Agricultural emissions	1,252.57	1,334.02	1,278.02	2.03%▲	-4.20%▼
Scope 2	Electricity	377.87	351.01	306.92	-18.78%▼	-12.56%▼
Scope 3	Domestic Air Travel	254.98	166.49	161.73	-36.57%▼	-2.86%▼
Scope 3	International Air Travel	841.58	649.71	8.84	-98.95%▼	-98.64%▼
Scope 3	Indirect passenger vehicle travel	5,965.29	5,634.77	5,970.67	0.09%▲	5.96%▲

Biogenic methane emission sources saw an increase in agricultural emissions for the FY21 reporting year of 0.13% from the base year, with a reduction seen when comparing FY21 with FY20 of 3.39%. Waste had a marginal increase when comparing both FY19 (0.16%) and FY20(0.05%) when compared to FY21 (Table 4).

Table 4: Comparison of total biogenic methane emissions by category between FY21 and base year and between FY20 and FY21.

	Emission Source	CH_4 (tCO_2-e) FY19 (base year	CH_4 (tCO_2-e) FY20	CH_4 (tCO_2-e) FY21	Variance from FY 21 to FY19	Variance from FY21 to FY20
Scope 1 Biogenic Methane	Agricultural emissions	3,214.88	3,332.04	3,219.20	0.13%▲	-3.39%▼
Scope 3 Biogenic methane	Waste	543.06	543.67	543.93	0.16%▲	0.05%▲

Organisational boundary

Following the methodology described in 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
    - Barrons, Newstead, Waikato
    - 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

The GHG protocol allows two distinct approaches to consolidate GHG emissions, equity share or control approaches (financial or operations). LIC has opted to disclose our GHG emissions using the operational control approach for our New Zealand operations.

Inventory boundary

GHG emission source inclusions

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

Table 5: Emission sources inclusions.

Scope	Emission sources	Detail and uncertainty
Scope 1	Stationary combustion fuel	Data obtained from supplier invoices
Scope 1	Direct travel	Data obtained from Leaseplan
Scope 1	Direct water supply	Data obtained by daily staff meter readings on-farm and data from Halo™ Systems®
Scope 1	Agricultural emissions	N_2O and CO_2 emissions derived from OverseerFM data and calculations
Scope 2	Purchased electricity, heat and steam emission factors	Data obtained from supplier invoices
Scope 3	Domestic air travel	Data obtained from Orbit World Travel
Scope 3	International air travel	Data obtained from Orbit World Travel. Whilst the data for this reporting year is defined as *de minimus* International travel is still reported on as previous years flight emissions exceed the 1% threshold of exclusion.
Scope 3	Indirect passenger vehicle travel	Estimated data based on census data and Artificial Breeding Technicians travel km reimbursement data.

Scope	Emission sources	Detail and uncertainty
Scope 1 biogenic methane	Agricultural emissions	CH_4 emissions data derived from OverseerFM data and calculations
Scope 3 biogenic methane	Waste	Estimates based on collection bins, food waste composting and recycling of paper and cardboard from supplier invoices.

GHG emission source exclusions

LIC recognise that a certain proportion of our GHG emission sources contribute a small proportion to our total inventory with many individual GHG emissions contributing to less than 1% per emission source category. When collated these emission sources have totalled less than 2% of our total GHG emissions inventory and as such we have deemed them *de minimus*. Table 6 outlines the GHG emission source exclusions and justifies exclusions, further data justification can be found in Appendix 1.

Table 6: GHG emission sources excluded from LIC inventory.

Scope	GHG emission source	Reason for exclusion
Scope 1	Biofuels and biomass	LIC does not use biofuels or biomass
Scope 1	Rental car	LIC rental car emissions equated to 0.9% of LIC total emissions and were determined to be *de minimus*.
Scope 1	Fugitive emissions from refrigeration, air-conditioning units and vehicle air conditioning units	Data was difficult to quantify and was determined to be *de minimus* following the FY20 assessment.
Scope 1	Direct wastewater treatment	Determined to be *de minimus*. 0.0004% of LIC total emissions.
Scope 3	Indirect business-related emission factors (emissions associated with employees working from home)	LIC has determined that this information will be difficult to quantify due to seasonal fluctuations and a mix of staff working from home and on-site across all business units.
Scope 3	Water supply	Determined to be *de minimus*. 0.01% of LIC total emissions
Scope 3	Indirect wastewater water treatment	Determined to be *de minimus*. 0.05% of LIC total emssions
Scope 3	Transmission and distribution losses for natural gas	Determined to be *de minimus*. 0.05% of LIC total emissions.
Scope 3	Transmission and distribution losses for electricity	Determined to be *de minimus*. 0.22% of LIC total emissions.
Scope 3	Waste	Determined to be *de minimus*. 0.02% of LIC total emissions.
Scope 3	Accommodation	Determined to be *de minimus*. 0.05% of LIC total emissions.
Scope 3	Freight transport emissions	LIC has excluded freight as it is difficult to obtain data.
Scope 3	Public transport and taxi travel	LIC has excluded public transport and taxi travel as it is difficult to obtain data.
Scope 1 biogenic methane	Direct wastewater treatment	Determined to be *de minimus*. 0.35% of LIC biogenic methane emissions.

Scope	GHG emission source	Reason for exclusion
Scope 3 biogenic methane	Indirect wastewater treatment	Determined to be *de minimus*. 0.09% of LIC biogenic methane emissions.

Coronavirus disease (Covid-19)

During the 2020 to 2021 reporting year, the globe was still affected by the Covid-19 pandemic. As a result of the pandemic. LIC found a new normal for BAU which included flexible working, supporting those employees that can work from home or choose to if they so wished and limited international travel. With these elements in play results from some emissions may be skewed by either over or under-representation of true emission. LIC has endeavoured to ensure that information provided in this report is as representative as possible given the circumstances.

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, 2020).

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

Detailed 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. LPG and natural gas stationary combustion calculations were based on supplier invoices per month for the reporting year.[5]

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.[6] The top-up and storage capacity was used only as an indication of our diesel stationary combustion. There is 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 and combined to determine total stationary combustion GHG emissions.

Overall stationary combustion emissions produced by LIC are negligible, contributing to 1.30% of LIC's total GHG emissions for FY21. Table 7 outlines LIC's stationary combustion GHG emissions for FY21

[5] 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.

[6] Diesel service records from NES Hire. It is assumed that on average the same quantity of diesel is stored in the generators and they had not been used or topped up more than usual.

compared to FY19/FY20. There was a reduction of 51.31 tCO_2-e for FY21 when compared to the base year. When compared to FY20 there was an increase of 6.08 tCO_2-e.

Table 7: Break down of stationary combustion GHG for FY21 in comparison toFY21 and FY19/FY20 at LIC.

	Total tCO_2-e	tCO_2	tCH_4	tN_2O
Stationary combustion GHG emissions FY21	152.68	152.00	0.31	0.08
Stationary combustion GHG emissions FY20	146.59	145.94	0.30	0.08
Stationary combustion GHG emissions FY19	203.99	203.11	0.42	0.10

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[7] vehicles which include:

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

The transport fuel emissions were multiplied by the emission factors for transport fuel use and combined to determine total transport fuel GHG emissions.

Transport fuel emissions contribute to 30.06% of LIC's total GHG emissions for FY21. Table 8 outlines LIC's transport fuel GHG emissions for FY21 compared to FY19/FY20. There was an increase of 207.32 tCO_2-e transport fuel emissions from FY19 to FY21. LIC transport fuel emissions increased by 191.01 tCO_2-e between FY20 and FY21.

Table 8: 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 FY21	3,523.22	3,451.99	11.81	67.42
Transport fuel GHG FY20	3,332.21	3,267.40	10.18	62.08
Transport fuel GHG FY19	3,315.90	3,249.56	10.01	61.60

Biofuels and biomass

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

Transmission and distribution losses for reticulated gases

LIC has reticulated natural gas being piped to Riverlea Road and the previously tenanted property at Peachgrove Road. LIC calculated our transmission and distribution losses for reticulated gases and have determined the emissions to be *de minimus*.

Refrigerant use emissions factors

Refrigerant use (fugitive emissions)

LIC did not conduct a fugitive emissions assessment in FY21. The FY20 screening method assessment determined that the GHG emissions generated by LIC are *de minimus.*

[7] LIC fleet leased from LeasePlan New Zealand Limited.

LIC is ensuring 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 hydrofluorocarbons (HFC) as reported in the section 'Refrigerant use' which contribute to a proportion of the refrigerant emissions reported[8]. At the time of reporting LIC was not aware of the use of either perfluorocarbon (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[9] invoices and multiplied it by the emission factor for purchased electricity.

GHG emissions from purchased grid-average electricity contribute to 100% of LIC's Scope 3 emissions, but only 2.62% of LIC's total GHG emissions.

During FY21 LIC continued to have reductions in electricity GHG emissions with a reduction of 70.95 tCO_2-e being seen from FY19 to FY21 and 44.09 tCO_2-e from FY20 to FY21 (Table 9).

Table 9: Comparison of purchased grid-average electricity between FY19 and FY20.

	Total tCO_2-e	tCO_2	tCH_4	tN_2O
Electricity GHG emissions FY21	306.92	294.77	11.85	0.43
Electricity GHG emissions FY20	351.01	337.11	13.55	0.49
Electricity GHG emissions FY19	377.87	362.90	14.59	0.52

Transmission and distribution losses for electricity

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 and have determined the emissions to be *de minimus*.

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.

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

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 and have determined the emissions to be *de minimus*. The data was provided by Orbit World Travel (Hamilton) and based on information provided to them from rental car agencies. Taxis, Ubers and other modes of paid vehicle business transport have been excluded from the data set.

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 passenger vehicle data was combined and multiplied by the indirect passenger emissions factor.

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 the 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[10] 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 accounted 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 the 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.

LIC Scope 3 indirect passenger vehicle travel emissions contribute to 50.94% of LIC's total GHG emissions. There was an increase of GHG emission derived from travel of 5.38 tCO_2-e from FY19 to FY21 and an increase of 335.90 tCO2-e for indirect passenger vehicle travel emissions FY20 to FY21. This increase in emissions is most likely the result of staff returning to work at LIC premises following the pandemic (Table 10).

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

Table 10: LIC staff commuting to and from work, AB staff travel and total private vehicle travel comparison between FY19, FY20 and FY21.

	Total tCO_2-e	tCO_2	tCH_4	tN_2O
Passenger vehicle travel GHG emissions FY21	5,970.67	5,700.30	67.59	202.78
Passenger vehicle travel GHG emissions FY20	5,634.77	5,379.61	63.79	191.37
Passenger vehicle travel GHG emissions FY19	5,965.29	5,695.17	67.53	202.59

Looking into future reporting LIC endeavours to capture specific commuting routines of staff to better understand Scope 3 passenger data. In particular, those choosing the flexible work option and splitting their time between commuting to the office and home.

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 multiplied by passenger kilometres (pkm)[11] 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.

Domestic air travel emissions contribute to 1.38% of LIC's total GHG emissions for FY21. Table 11 outlines LIC's domestic air travel GHG emissions for FY21 compared to FY19 and FY20. There was a reduction of 93.25 tCO_2-e for total domestic air travel from FY19 to FY21, and a reduction of 4.76 tCO_2-e between FY20 and FY21. The decreases are 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 11: LIC's domestic air travel emissions comparison between FY20, FY19, and FY20.

	Total tCO_2-e	tCO_2	tCH_4	tN_2O
Domestic air travel GHG emissions FY21	161.73	159.41	0.61	2.28
Domestic air travel GHG emissions FY20	166.49	164.13	0.62	2.35
Domestic air travel GHG emissions FY19	254.98	251.36	0.96	3.61

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

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 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. When travel class was unknown the average passenger factor was used.

International air travel emissions contributed to 0.08% of LIC's Scope 3 GHG emissions for FY21. Table 12 outlines LIC's international air travel GHG emissions for FY21 compared to FY19 and FY20. There was a reduction of 832.74 tCO_2-e for total international air travel from FY19 to FY21 and a reduction of 640.87 tCO_2-e from FY20 to FY21. However, the reductions are a result of continued Covid-19 restrictions on international travel through FY20 and FY21.

Table 12: LIC's international air travel emissions comparison between FY21 and FY19 and FY20.

Travel Class	tCO_2-e	tCO_2	tCH_4	tN_2O
International travel emissions FY21	8.84	8.78	0.00	0.06
International travel emissions FY20	649.71	646.61	0.03	4.07
International travel emissions FY19	841.58	837.41	0.03	5.33

Accommodation

Accommodation emissions are an indirect Scope 3 emission source. LIC's accommodation emissions were calculated by multiplying room per night per employee by country of stay emission factor and were determined to be *de minimus*.

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

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.

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 2.72% of LIC's total GHG emissions. Complete data sets were not available for FY20 and FY19. As a result, water supply data

for FY19 and FY20 are based on average water take over all records obtained to date (Table 13)[12]. There was an increase of 1.81 tCO_2-e for direct water supply from FY19 to FY21 and a reduction of 10.08 tCO_2-e from FY20 to FY21.

Table 13: Comparison between LIC's bore water supply emission FY21 to FY19 and FY20.

	Total tCO_2-e	tCO_2	tCH_4	tN_2O
LIC total water supply emissions FY21	318.358	308.088	14.377	0.308
LIC total water supply emissions FY20	328.439	317.844	14.833	0.318
LIC total water supply emissions FY19	316.547	306.336	14.296	0.306

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, Maui Street, 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 was calculated based on the per capita emission factor. Calculating the depots using the per capita emission factor for water supply provides an overestimate of actual water supply emissions generated by LIC. The GHG emissions derived from indirect water supply were determined to be *de minimus*.

Wastewater treatment (WWT)

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 several septic tanks located on the rural farm properties.

The WWTP at Newstead is a unique system that uses anaerobic digestion and a constructed wetland to filter waste, as a result, the WWT GHG emissions from the Newstead WWTP were calculated using the All other type[13] emission factor and determined to be *de minimus*.

Scope 1 biogenic methane from wastewater treatment (WWT)

WWT GHG emissions from on-farm septic tanks were calculated using the per capita septic tanks emissions factor, the emissions equated to less than 1% of LIC total biogenic methane emissions and as such determined to be *de minimus*.

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, Maui Street 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

[12] As a result of incomplete data set the FY20 reporting year a reduction in water supply emissions is not observed.

[13] The All other type emission factor was newly added to the Measuring Emissions: A Guide for Organisations: 2020 Detailed Guide issued by the New Zealand Government - Ministry for the Environment. As a result we recalculated our baseline and FY20 reporting years which saw a significant reduction of GHG emissions from the WWTP at Newstead than previously reported.

factor for WWT provides an overestimate of actual WWT emissions generated by LIC. The combined indirect WWT emissions were determined to be *de minimus*.

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 for 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 compiling LIC's first inventory report, LIC was uncertain of the type of landfill its waste was being disposed to.[14] As a result, LIC took a conservative approach for calculating waste emissions using the landfills without gas recovery emission factors.

For this report (FY21) LIC was able to determine the type of landfill waste was going to and recalculated baseline and FY20 data. Furthermore, whilst cardboard and paper and food were previously calculated as going to landfill we have now calculated food waste as compostable and cardboard and paper are now calculated based on tonnes per km collected and taken for recycling.

LIC waste emissions were calculated using the waste emission factors without landfill gas recovery (LGR) for our New Plymouth and Putaruru depots, for all other sites waste is going to municipal landfills with gas recovery. The waste emissions were determined by multiplying the waste collected per site and the appropriate emission factor. As such the GHG emissions from waste disposal are much lower than previously reported and tCO_2-e emissions were determined to be *de minimus*. However, Scope 3 biogenic methane derived from our waste streams contributed 14% of our total biogenic methane emissions. There was a reduction of 0.32 tCO_2-e for total waste disposal from FY19 to FY21, and a 0.05 tCO_2-e increase from FY20 to FY21 (Table 14).

However, whilst this year's reporting is a better representation of LIC's waste emissions we endeavour to produce a more accurate assessment in future reports once provided a complete data set from our vendors.

Table 14: Waste disposal emission comparison between FY21 and FY19/FY20.

	Total tCO_2-e	t CO_2	tCH_4 (biogenic methane)	tN_2O
LIC total waste emissions FY21	2.407	0.601	479.651	1.806
LIC total waste emissions FY20	6.334	4.470	479.391	1.864
LIC total waste emissions FY19	7.514	5.632	478.780	1.882

[14] *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.

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 wintering off and are 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.

In 2020 when we reported on LIC's emissions including agriculture we used the Measuring Emissions: A Guide for Organisations method for calculating emissions from the farms. This methodology was very limited in its ability to differentiate animal stock classes which would have had an impact on the results we got from this method. It was decided to have all agricultural emissions from LIC farms calculated using OverseerFM to enable better estimates of feed and therefore emissions from the range of stock types LIC operates. In this report (FY21) we have recalculated the baseline using the OverseerFM data and as such it shows some different values and trends from those reported earlier. As LIC is committed to reducing our overall emissions we see it essential that we use the most accurate methodology that reflects our farming enterprise and will enable greenhouse gas mitigation measures to be undertaken.

Agricultural GHG emissions from our farms contribute to 10.9% of LIC's total GHG emissions. There was an increase of 25.45 tCO2-e for agricultural emissions from FY19 to FY21, and a reduction of 55.99 tCO2-e from FY20 to FY21.

Agricultural GHG emissions from our farms contribute to 99.52% of LIC's Scope 1 biogenic methane emissions. There was an increase of 4.32 tCO2-e for agricultural emissions from FY19 to FY21, and a 112.84 tCO2-e reduction from FY20 to FY21 (Table 15).

Table 15: LIC Agricultural emissions comparison for FY21 against base year and FY20.

	Total tCO_2-e	t CO_2	t CH_4 (biogenic methane)	t N_2O
LIC Agricultural emissions FY21	1,278.02	343.36	3,219.20	934.66
LIC Agricultural emissions FY20	1,334.02	372.65	3,332.04	961.36
LIC Agricultural emissions FY19	1,252.57	345.89	3,214.88	906.68

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 the following GHG inventory report will include an explanation as to the changes.

Verification of GHG inventory

As LIC is committed to the 2019 Climate Leaders Coalition statement. We will have our GHG 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.

References

GHG-Protocol. (2015). *A corporate accounting and reporting standard REVISED EDITION.* Washington & Geneva: World Resources Institute & World Business Council for Sustainable Business. Retrieved 2020, from https://ghgprotocol.org/corporate-standard#supporting-documents

Greenview. (2020). *Hotel Footprinting Tool*. Retrieved from https://www.hotelfootprints.org/footprinting

Ngawhare, T., & Wollaston, B. (2020). Source: Email corrospondance. *LIC*. Waikato, New Zealand.

NZGovt. (2020). *Measuring Emissions: A Guide for Organisations.* Wellington: Ministry for the Environment.

Science Based Targets Initiative. (2020). *Science-Based Target Setting Manual Version 4.1.* Science Based Targets initiative.

StatsNZ. (2020). *Commuter Waka*. Retrieved from https://commuter.waka.app/

UKGovt. (2020). *Greenhouse gas reporting: conversion factors 2020*. Retrieved from GOV.UK: https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2020

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 are 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, 2020).

Justifications

Table 16: Overview of data per scope, with explanations on data gathering.

Emission source	Per cent of total GHG (excluding biogenic methane)	Per cent of Scope	Complete data set	Details
Scope 1				
Stationary combustion	1.30%	2.89%	Yes	Minimal data missing - data filled with estimated usage based on averages.
Transport fuel	29.91%	66.70%	Yes	Supplier invoices provide complete data set.

Emission source	Per cent of total GHG (excluding biogenic methane)	Per cent of Scope	Complete data set	Details
Rental car	0.08%	0.19%	No	Rental car data incomplete, limited data provided by the supplier.
Direct water supply	2.70%	6.03%	No	Incomplete data set from numerous sites. As such estimated water take has been determined using an all-time data average. LIC farm staff are working on improving their data capture methods and recording data.
Direct wastewater treatment	0.0004%	0.001%	Yes	Data from maintenance vendor. Estimates for sites with septic tanks. Missing some data but only a small fraction of emissions so likely to be minimal impact.
Refrigerants	N/A	N/A	No	LIC did not assess the refrigerants and fugitive gases in FY21. Previously no data was collected from the Tempero building roof, Diagnostics roof. Only used screening method.
Agricultural emissions	10.85%	24.19	Yes	Complete data set
Scope 2				
Electricity	2.61%	100%	Yes	Minimal data missing, gaps filled using estimate average monthly use per site.
Scope 3				
Indirect water supply	0.01%	0.03%	No	LIC has 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 the following years.
Indirect wastewater treatment	0.06%	0.11%	No	LIC has 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 the following years.
Transmission and distribution losses for natural gas emissions	0.05%	0.09%	Yes	Minimal data missing - data filled with estimated usage based on average monthly use per site.

Emission source	Per cent of total GHG (excluding biogenic methane)	Per cent of Scope	Complete data set	Details
Transmission and distribution losses for electricity emissions	0.22%	0.43%	Yes	Minimal data missing - data filled with estimated usage based on average monthly use per site.
Domestic air travel	1.37%	2.61%	Yes	Supplier invoices provide complete data set.
International air travel	0.08%	0.14%	Yes	Supplier invoices provide complete data set.
Accommodation	0.05%	0.09%	Yes	Supplier invoices provide complete data set.
Waste	0.02%	0.04%	No	Food and general waste are estimated based on the number of collections per month per site. Cardboard and paper are a complete data set.
Indirect passenger vehicle travel	50.69%	96.46%	No	Staff commuting is estimated. Look at detailed staff survey in future. AB technician travel is a complete data set.

Emission source	Per cent of total GHG (biogenic methane)	Per cent of Scope	Complete data set	Details
Scope 1				
Direct wastewater treatment	0.41%%	0.48%	Yes	Data from maintenance vendor. Estimates for sites with septic tanks. Missing some data but only a small fraction of emissions so likely to be minimal impact.
Agricultural emissions	84.74%	99.52%	Yes	Complete data set.
Scope 3				
Waste	14.72%	99.12%	Yes	Food and general waste are estimated based on the number of collections per month per site. Cardboard and paper are a complete data set.
Indirect wastewater treatment	0.13%	0.88%	Yes	LIC has followed protocols but due to people only spending their working hours on-site that this is grossly overestimating wastewater treatment. This has a minor

Emission source	Per cent of total GHG (biogenic methane)	Per cent of Scope	Complete data set	Details
				effect on our overall emissions but will be revisited when more accurate data is available in the following years.

Appendix 2
Calculating LIC Agricultural emissions

Scope:
We have scoped our agricultural emissions as the emissions which come from the farms and animals owned by LIC in New Zealand.

In 2021 this includes:

1. Innovation Farm, dairy farm, Ngahinapouri, Waikato
2. Newstead Bull Farm, Newstead, Waikato
3. Chudleigh Bull Farm, Tauwhare, Waikato
4. Awahuri Bull Farm, Awahuri, Manawatu
5. Feilding Farm, Feilding, Manawatu
6. All animals grazing on LIC farms regardless of ownership
7. External grazing arrangements for:
    a. Innovation Farm dairy cattle
    b. Research cattle
    c. Breeding scheme cattle

It specifically excludes:

1. All animals not owned by LIC (except for a small number of animals grazing on LIC owned farms)
2. Animals owned by other parties used for:
    a. periodic contracted mating arrangements,
    b. used for semen collection at third party semen collection centres,
    c. used for embryo collection at third party locations,
    d. phenotype data capture,
    e. research measurements.
3. Animals not in New Zealand.

For LIC owned farms:
We have created OverseerFM files for each of the LIC owned farms to calculate agricultural emissions. These emissions are predominantly from animals and fertiliser products. It includes direct emissions of enteric methane, indirect emissions from dung, urine and effluent applied to soils; and direct and indirect emissions from fertiliser and lime products applied.

For external grazing arrangements:
For LIC owned animals that are not grazing on LIC farms, we have also estimated their methane and nitrous oxide emissions directly associated with these animals. We estimate this accounts for 80-90% of the total greenhouse gas emissions associated with these animals.

The classes of animals included in this section are:

1. Innovation Farm Cattle:
    a. Replacement heifers (Up to May 2020)
    b. Wintering off dry cows
2. Breeding Scheme Animals
    a. Short Gestation Length (SGL) breeding scheme animals
    b. KiwiBeef breeding scheme animals
    c. Slick breeding scheme animals

3. Research animals
    a. Production Variant heifers (until 2020)

These grazing arrangements are contractually based and we do not have access to any other emissions associated with the properties these animals graze on regarding other livestock, fertiliser and farm practices, therefore have not estimated other emissions associated with these animals.

These emissions have been estimated by using feed intake requirements per animal over the periods they are subject to external grazing arrangements and multiplied by emissions factors for both methane and nitrous oxide.