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DELIVERING SUSTAINABLE CHANGE

EECA
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ENERGY EFFICIENCY & CONSERVATION AUTHORITY

Poultry Growing Technology Scan

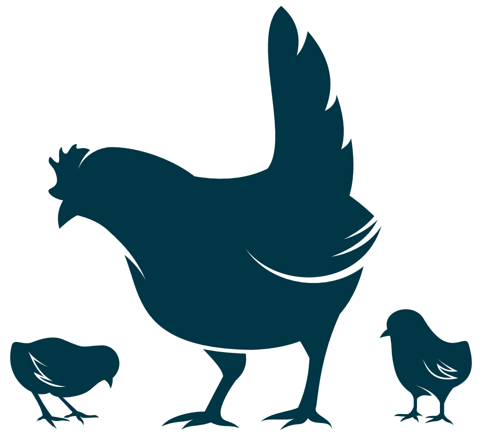
Executive Summary

EECA are working with the poultry industry to increase energy efficiency by identifying the best technologies for new and existing poultry farms.

Current risks around the supply of natural gas and the increasing cost of carbon are increasing the pressure to consider lower emission alternatives.

Heating is the biggest energy demand in poultry sheds – 88% of the energy used in poultry sheds in New Zealand is for heating by fossil fuels.

This global technology scan, part of EECA's sector programme, assesses the best opportunities for energy efficiency and renewable energy based on criteria such as emissions reduction, ease of implementation, capex and opex.



Quick Wins

The most promising technologies identified for quick wins are

- Change out to LED lights
- Variable Speed Drives (VSD) for fan motors
- Insulation

Retrofit

The best solution for retrofit of an existing farm depends on the existing heating mechanism:

- If direct space heating is currently used, this can be replaced with electrical alternatives for minimal capital cost, however the current relatively high electricity price makes these unattractive for this relatively inefficient heating mechanism.
- Where indirect air heating is currently used, this can be replaced by an air source heat pump to produce hot air.
- If indirect water heating is currently used, heat pumps are an efficient alternative option

Greenfield new builds

For greenfield new builds, the use of heat pumps for generation of hot water for underfloor heating is the most energy efficient option, along with smart control systems to control fan speeds on VSDs, and ventilation requirements, to minimise heating of cold fresh air.

Introduction

The poultry growing industry in New Zealand contributes to greenhouse gas emission through the consumption of fossil fuels and electricity to provide the required growing conditions.

Fossil fuels are mostly used to produce the required heat inside the sheds *and*

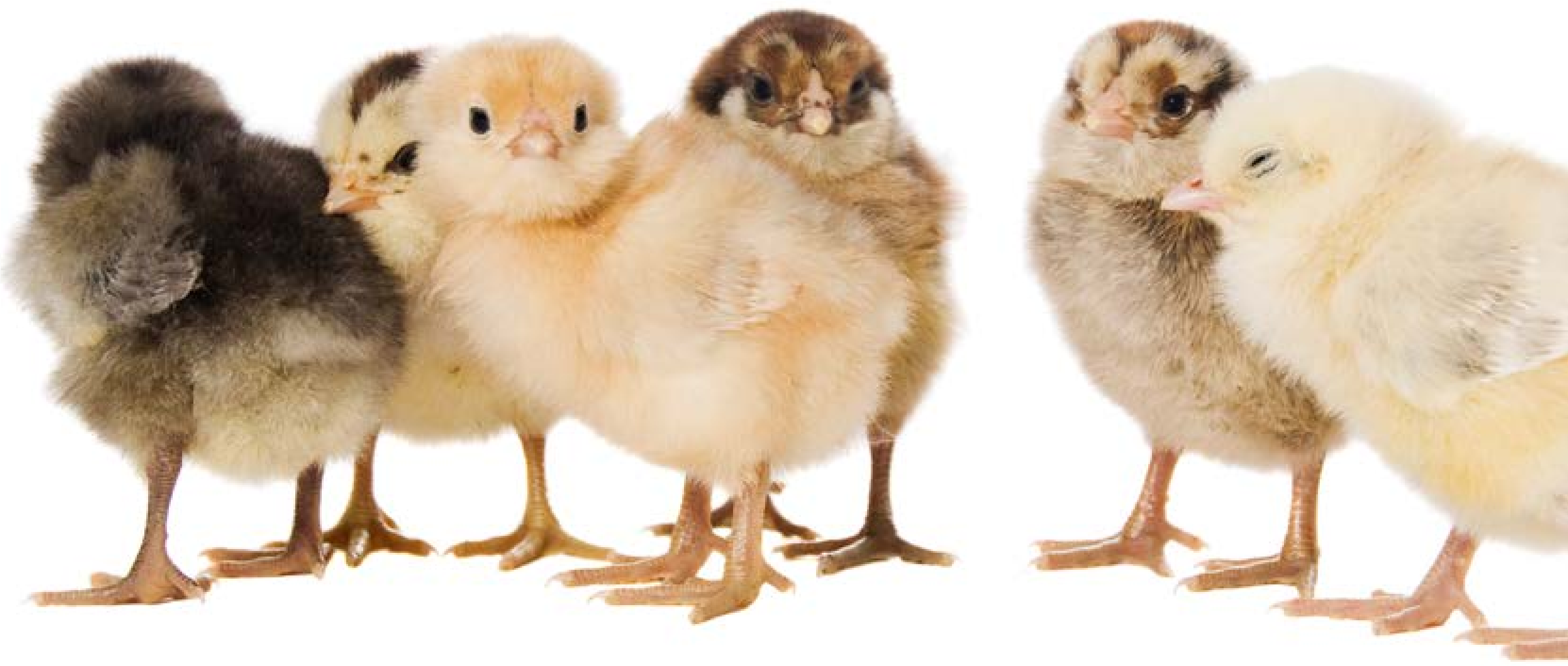
electricity is used for lighting and operating other equipment of the farm facilities, such as water pumps, ventilation fans etc.

There are approximately 420 chicken farms identified in New Zealand, spread across the whole country. This includes broilers, broiler and layer breeders, layers, and rearing. **This report focuses on broiler chicken farms**, as their growth conditions are similar to those of other poultry, and broiler farms are the primary users of gas and electricity.

This Global Technology Scan of the Poultry Sector provides **recommendations to poultry growers on technologies to reduce their greenhouse gas emissions and focuses on reduction of the emissions** from energy (fuels and electricity).

This technology scan is part of EECA's **sector programme**, designed to accelerate energy efficiency and renewable energy by driving transformational change at a sector level. The sector programme aims to provide the most up-to-date innovations to ensure New Zealand businesses can make the **best, most effective long-term energy efficiency and fuel-switching decisions for businesses, the sector, and New Zealand Inc.**

Methodology: Emissions Reduction



This study aimed to develop a “Technology Scan for Decarbonising the Poultry Growing Sector”. Worley adopted a fully collaborative approach, partnering with EECA and various stakeholders, including the Poultry Industry Association New Zealand and New Zealand Poultry Meat Producers Society. They leveraged their team’s expertise alongside Worley’s local and global experience with similar projects in the industry. The graphic below illustrates Worley’s systematic approach to developing this document.

Alignment, Framing, and Data Review

Task 1

Alignment and Framing
- Project kick-off to confirm scope, objectives and methods with EECA and other Stakeholders

Data Review
- Review any existing Energy Audits, research papers, and ETA/ ETP reports

Idea Generation and Screening

Task 2

Idea Generation
- Identify available market-ready technologies for the sector
- Identify technology Suppliers

Screening
- Agree screening criteria with EECA and industry representatives
- Screening workshop with EECA and other stakeholder

Review of Techno-economic Parameters

Task 3

Technical Parameters
- Energy efficiency and emission reduction potential
- Technology maturity
- Advantages and disadvantages of each opportunity

Economic Parameters
- Relative capital and operating expenditure

Reporting

Task 4

Reporting
- Technology Summary and Rating Table
- Results summary
- Recommendations
- Supplier List

Presentation
- Report Presentation to stakeholders, EECA and industry feedback

Methodology: Assessment Criteria

Each decarbonisation opportunity was scored across two primary categories: Strategic and Commercial criteria, with several sub-criteria.

Each criterion was scored from 0 to 3, with a score of 3 indicating the highest level of performance. This assessment was conducted in collaboration with Worley Subject Matter Experts, EECA, and representatives from industry bodies.

Weightings were applied to each criterion, resulting in a final score that shows the best option. However, the highest score may not suit all farms, as opportunities should fit individual needs.

Category Definition

Primary Category	Secondary Category	Description	Weighting
STRATEGIC	GHG EMISSIONS REDUCTION	Relative to base case (site-wide) (on an absolute lifetime emissions reduction basis tCO2-e). Scope 1 and 2.	2
STRATEGIC	TECHNOLOGY MATURITY	Technology maturity, complexity of operation and maintenance, local support	1
STRATEGIC	COMPLEXITY (EASE OF IMPLEMENTATION)	How difficult would this be to implement at an existing Poultry farm, or changes to a new farm. Consider operational impacts of implementation + maintenance	0.5
STRATEGIC	OTHER BENEFITS/ IMPACTS	e.g. Bird health, litter moisture content, regulation, safety	0.5
COMMERCIAL	CAPITAL COST	Consider equipment purchase, network upgrades, heating system mods	2
COMMERCIAL	OPERATIONAL COST	Opex cost of energy compared to fossil fuel base case. Also consider insurance, maintenance other operational costs	2
COMMERCIAL	FUEL SECURITY	Fuel future security and availability, risk mitigation.	1

Overview of New Zealand's poultry industry and its energy usage.

An overview on poultry growing industry

Poultry farming

Various types of birds, such as chicken, turkey, duck, geese, and quail, are classified as poultry. Poultry farming aims to produce meat, eggs, feathers, fat, and down.

Poultry farm types

There are two main types of poultry farms: free-range and barn-raised. Free-range systems allow birds to roam outside and forage from 21 days of age, with shelters available. Barn-raised farms use large buildings called sheds or houses, which can reach lengths of up to 150 meters and widths of 15 meters, hold up to 40,000 birds and have automated features for temperature, ventilation, feeding, and watering.

Growing cycle

The farms operate on a growing cycle of approximately **42 days**, from arrival of 1 day old chicks to fully grown birds leaving the farm. Between the growing cycles, the sheds are cleaned and prepared for the next arrival. When farms consist of multiple sheds, these are generally **operated at the same stage in the growing cycle**.

Preparation

Newly hatched chicks are raised in prepared farms that must be **clean, disinfected, and preheated**. The environment needs to maintain specific temperature, humidity, and litter conditions to ensure healthy growth and maximum profitability.

Litter

Litter consisting of wood shavings, small bark, rice husks, etc. is used to line the floors of the sheds. Maintaining healthy litter is critical to bird health as it helps control ammonia levels, provides a healthy flock environment, and reduces bird diseases. The litter is disposed at the end of each growing cycle, sold as fertiliser to the farming sector.

Moisture content is one of the most important parameters related to litter. The higher moisture content will increase the shed energy use and increase the risk of poultry disease.

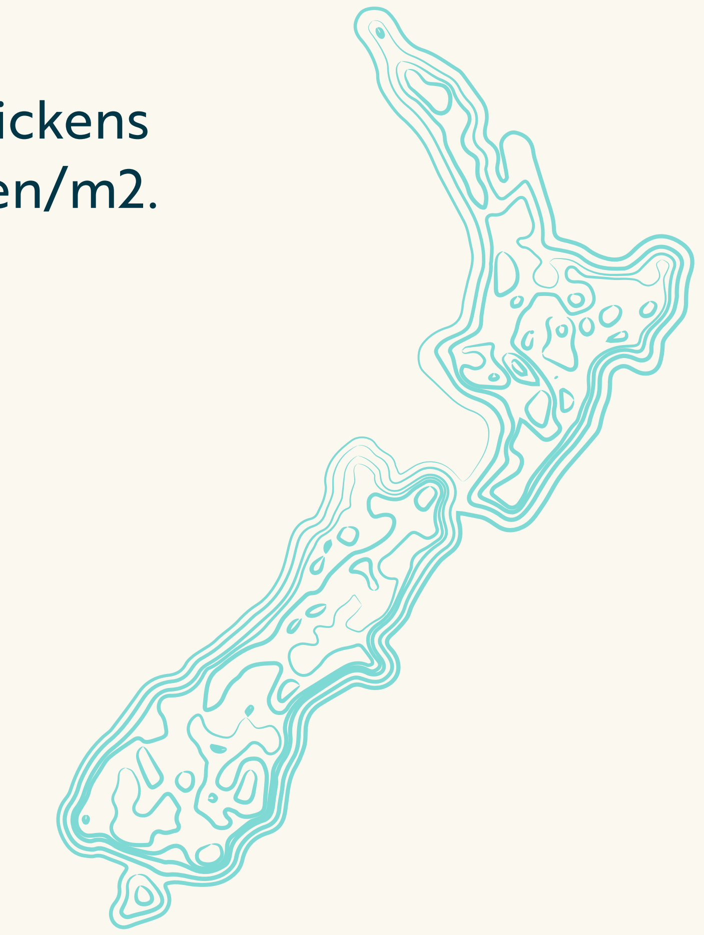
There are approximately 420 chicken farms identified in New Zealand. These farms are spread across the whole country in the North Island and the South Island.

New Zealand Farm type	Number of Farms
Broiler	149
Broiler and Layer Breeder	77
Layers	173
Rearing (Hatching)	20

The typical average density of chickens in New Zealand farms is 16 chicken/m2.

There is no standard shed size in New Zealand, but the most common shed sizes are

- 150 m x 20 m x 5 m
- 140 m x 18 m x 5 m
- 100 m x 15 m x 5 m



Important factors for poultry growing

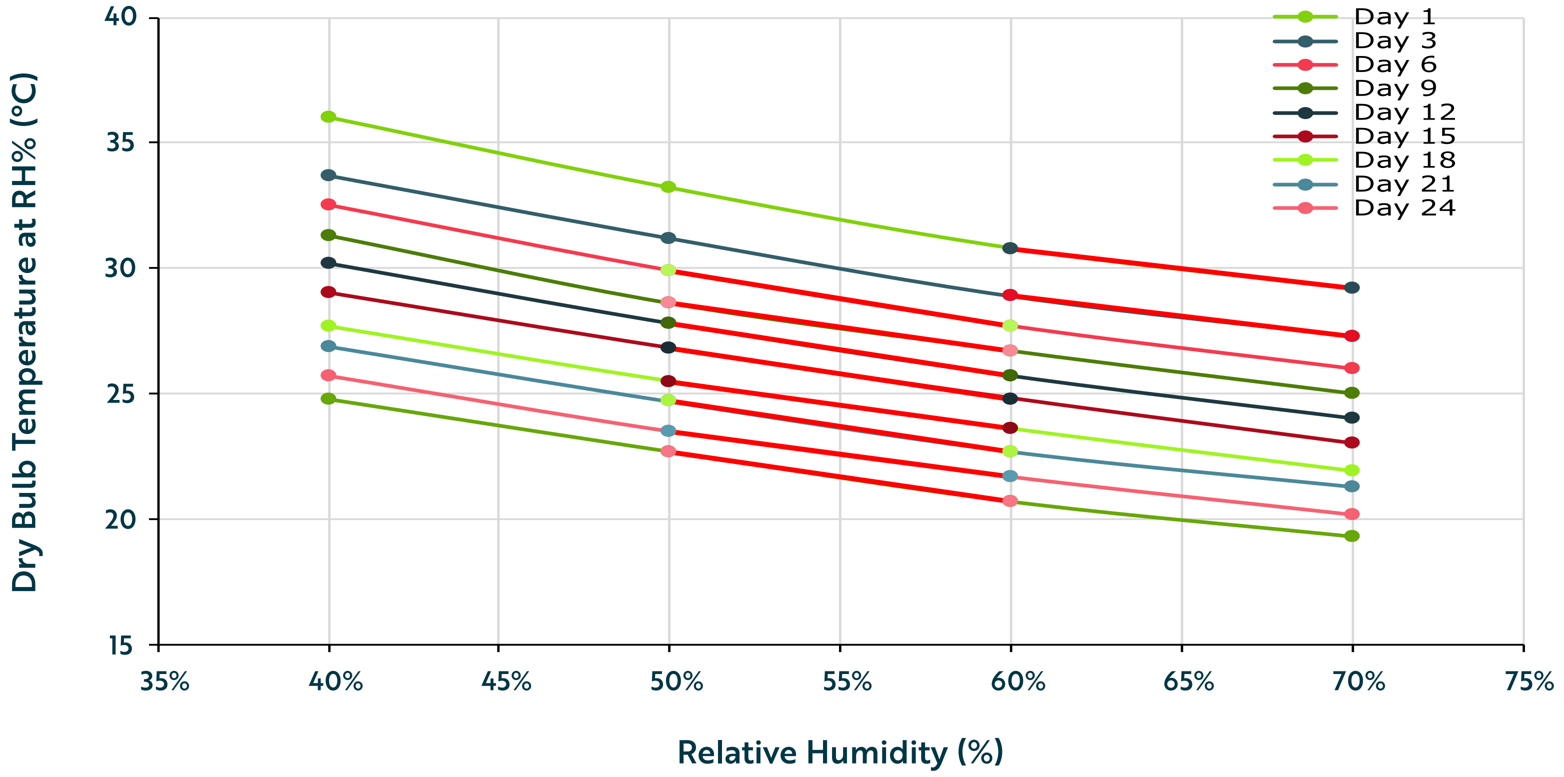
Crucial factors influencing the growth cycle of chickens are:

- **Temperature** – stabilisation, variation related to bird age
- **Light** – intensity, duration, colour
- **Hygiene** (reflected in bird pad score) – litter condition, ease of cleaning, moisture content
- **Air quality and volume** – gas removal, humidity

Any alternative technology must be able to **provide the required heating and cooling, vary this** throughout the growing cycle, **not introduce additional moisture** or other harmful conditions, and handle **pressure washing** for cleaning and disinfection between cycles.

Relation between temperature and relative humidity inside poultry sheds

The segments highlighted in red are at ideal humidity range.









AGE	AIR TEMP. (FLOOR)	LIGHT INTENSITY	LIGHT HOURS
0-3 DAYS	35-36°C	30-50 LUX	22 hours or intermittent Program
4-7 DAYS	33-35°C	30-50 LUX	21 hours or intermittent Program
8-14 DAYS	31-33°C	25 LUX	19 hours or intermittent Program
15-21 DAYS	29-31°C	25 LUX	17.5 hours
22-28 DAYS	26-27°C	25 LUX	16 hours
29-35 DAYS	23-25°C	10-15 LUX	14.5 hours
36-42 DAYS	21°C	10-15 LUX	13 hours

Growth and Development

Reference: Ross an Aviagen Brand – Broiler Pocket Guide 2018

Required relative humidity

- **HATCHING** 80%
- **TRANSPORTATION TO FARM** 70%
- **BROODING PERIOD (0-7 days)** 60%
- **GROWING** 40% minimum
- **LAYING** 40% minimum

Relative humidity and airspeed both change the way a temperature feels to the bird (apparent temperature), so these must be considered along with air temperature, and adjusted accordingly.

Reference: Hy-Line® Brown – Alternative Systems – Australia – Management Guid 2016

The type of **heating mechanism** installed will influence the best decarbonisation option, because the extent of modification to retrofit can be prohibitive.

Three major heating mechanisms are used to provide the required temperature profile inside the sheds.

Direct space heating (radiation, convection)

- Radiant Brooders: Use fossil fuels for open-flame heating. They produce visible flames and take air for combustion from within the building.
- Common types include circular radiant brooders, which can cover up to 65 m², and rectangular radiant brooders, a patented design. These brooders can be controlled by thermistor, or adjusted in height to manage temperature as chicks grow.
- Radiant Tube Heaters are a closed-flame systems that source air from outside. A fan forces hot combustion gases through the tube, which radiates energy to the litter. and require less maintenance than brooder systems. Exhaust gases are typically discharged into the house and then removed through the ventilation system. These can be controlled by thermistor, to control the level of heating. They are generally larger than radiant brooders so heat a larger portion of the litter than round radiant brooders, and require fewer units to be installed.

Circular open-flame radiant brooder Image credit: Mississippi State University

Rectangular open-flame radiant brooder Image credit: University of Kentucky

Closed-flame radiant tube brooder Image credit: University of Kentucky

Hot air space heating

- Forced hot-air heaters burn fuel to heat air with fans.
- Hot air fans burn oil, natural gas, or LPG, to heat air which is distributed by fans.
- A hot water boiler burns fuel to produce hot water, which is used in a heat exchanger to heat the air
- These heaters work well in later growth stages but may struggle with warm temperatures near the litter during early brooding. Stir fans can help circulate air effectively; sometimes both space and radiant heat systems are used.

Portable forced air LPG heater. Image credit: Head Chef

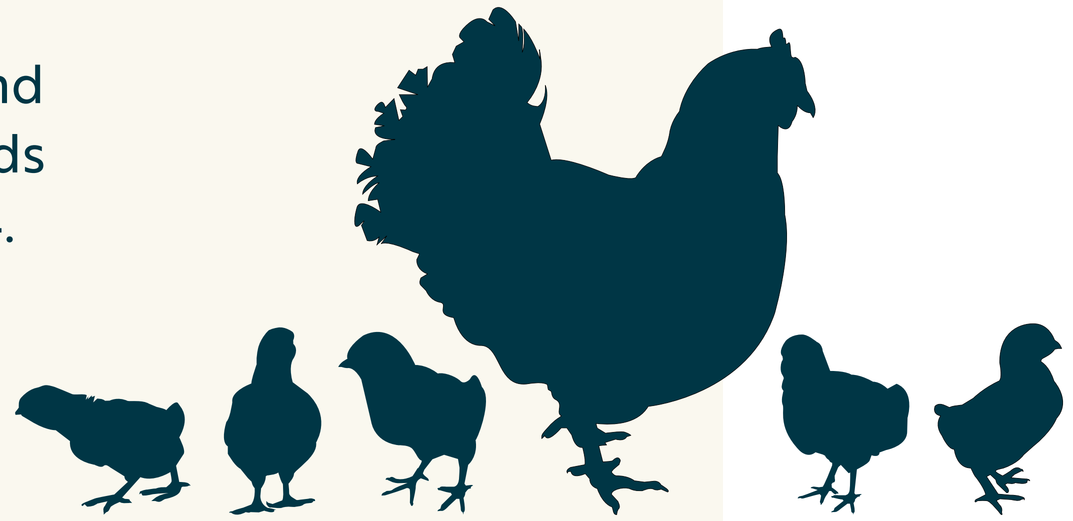
Hot water space heating

- Underfloor Heating is a highly effective method that uses hot water from boilers circulated through pipes under the concrete floor.
- This method keeps litter dry and is silent, maintaining a comfortable environment for chickens.

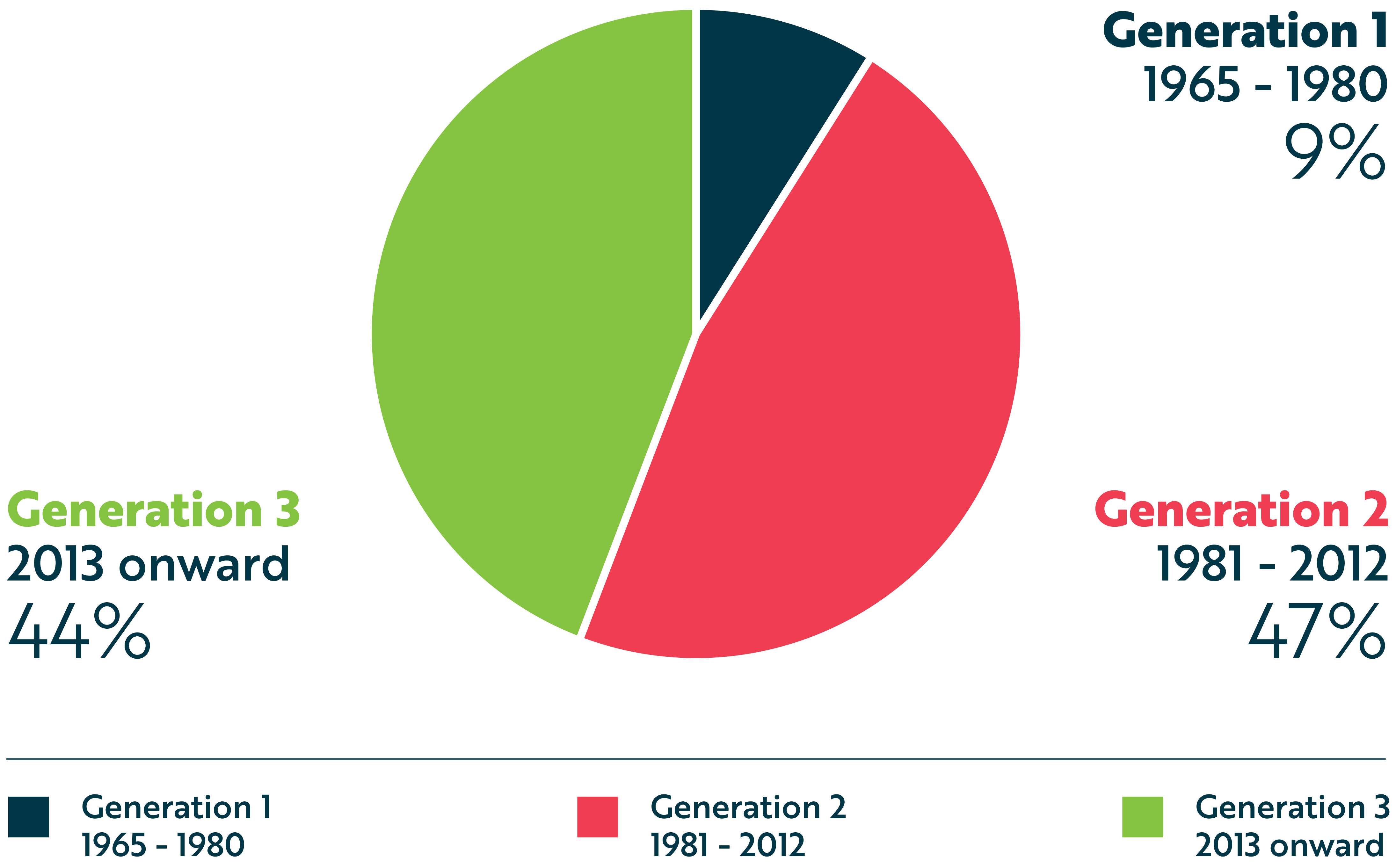
Age of poultry sheds in New Zealand

Various types of poultry sheds have been built in New Zealand and the type, construction material, and construction requirements have changed over time. The graph shows the frequency of existing poultry sheds based on the construction generation. From 2016 new build sheds are able to be operated as both free range and barn raised.

The age of the shed influences the energy efficiency and renewable energy options due to better insulation and air tightness, heating mechanisms, newer ventilation fans and more advanced climate control systems. Three generations of sheds have been identified for the New Zealand poultry industry, most of the generation 2 sheds have been renovated and upgraded after 2014.



New Zealand poultry sheds by age

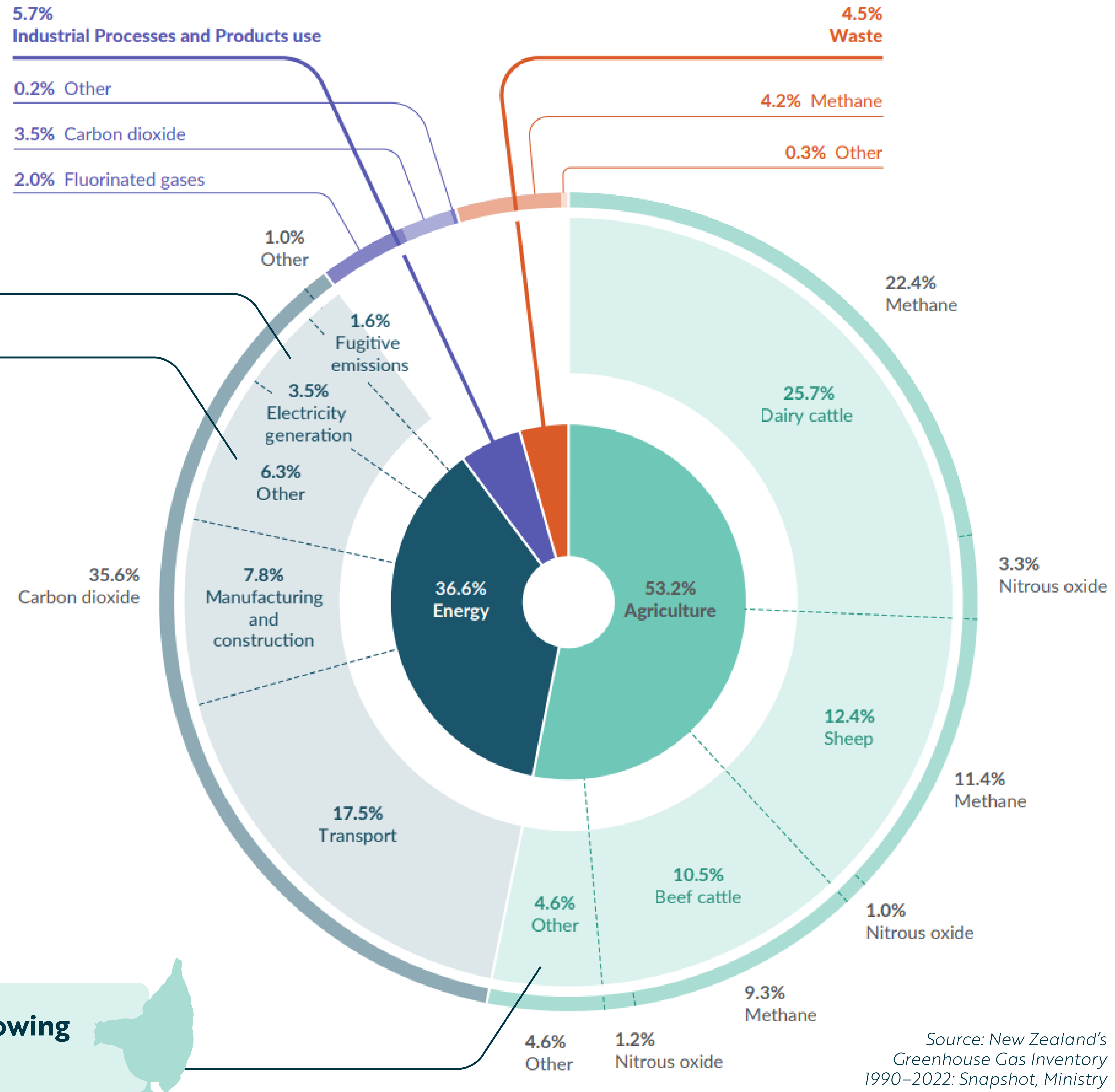


Greenhouse gas emissions from poultry growing

The poultry industry contributes to New Zealand's overall greenhouse gas emissions through methane and nitrous oxide emissions from manure (represented in the 4.6% of 'other' agricultural emissions in the figure below), as well as the consumption of fossil fuels and electricity (represented in the 6.3% of 'other' energy emissions and 3.5% of electricity generation emissions). This technology scan focuses on **reduction of the emissions from energy (fuels and electricity).**

New Zealand Gross Greenhouse Gas Emissions percentages in 2022 by sector, category and gas type

Fossil fuels and electricity used in poultry growing (focus of this technology scan)



Agricultural emissions from Poultry Growing (out of scope of this study)

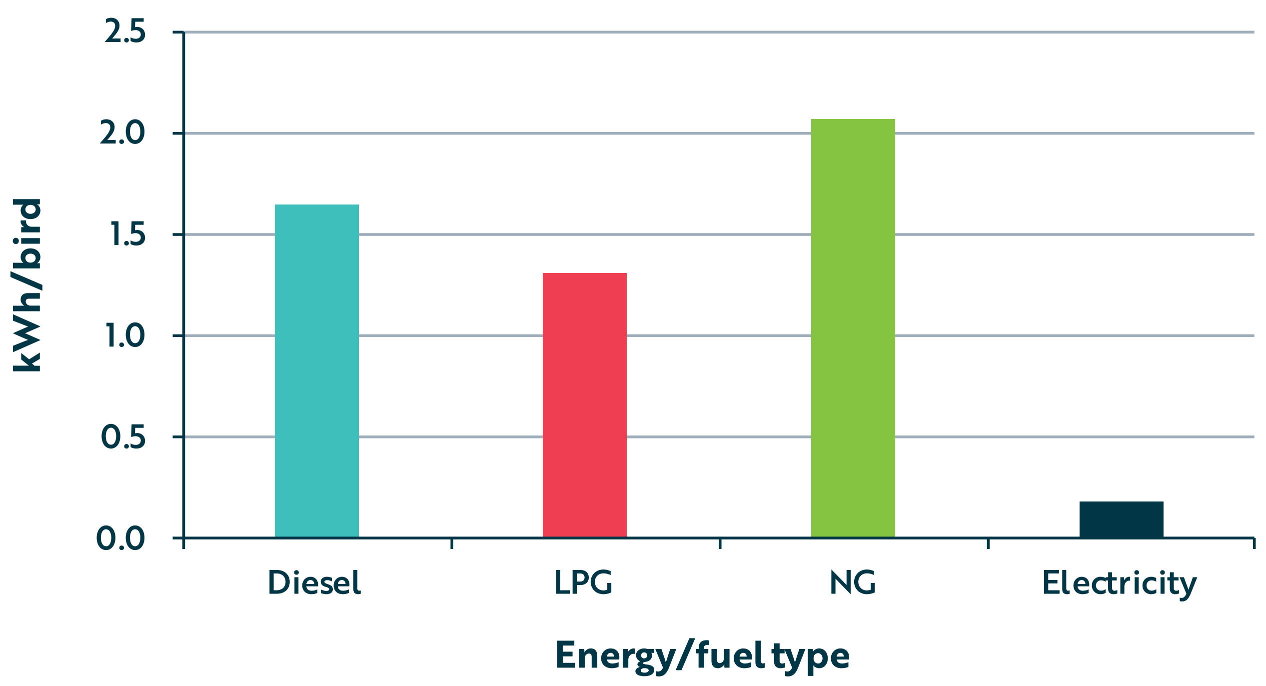
Source: New Zealand's Greenhouse Gas Inventory 1990–2022: Snapshot, Ministry for the Environment, April 2024

Energy consumption in poultry growing

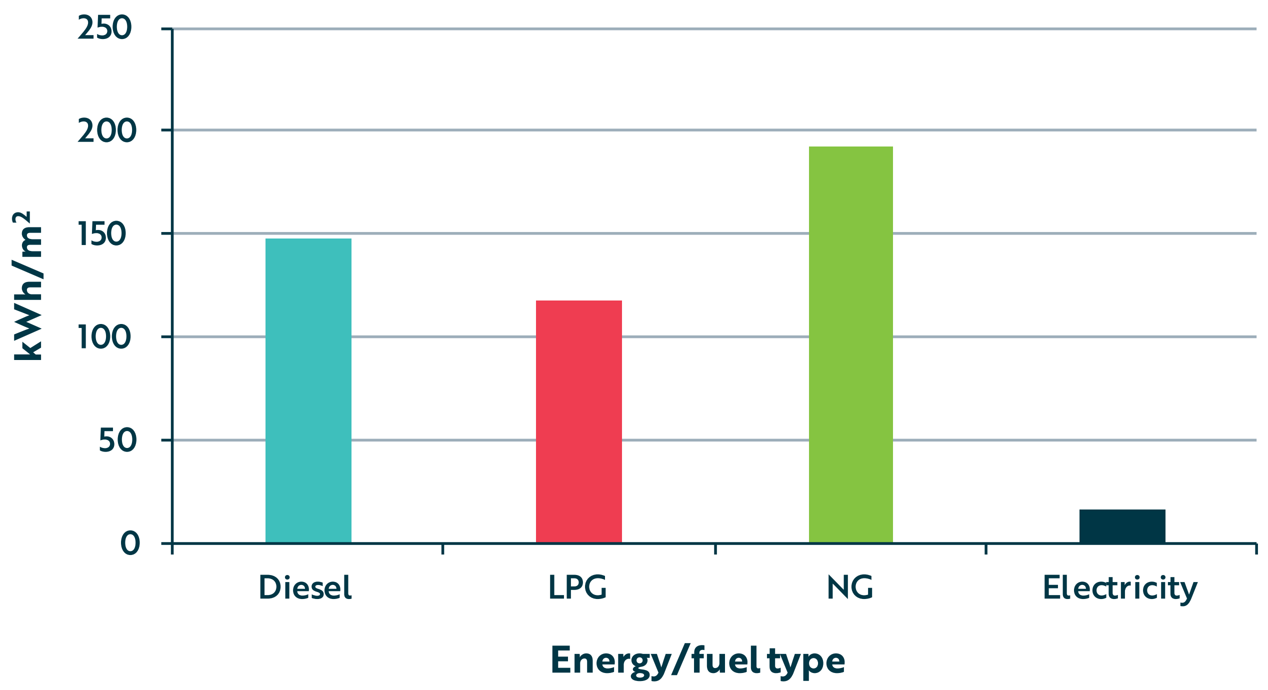
Various types of fuels are used in poultry growing farms worldwide. Fossil fuels are mostly used to produce the required heat inside the sheds and electricity is used for lighting and operating other equipment of the farm facilities, such as water pumps, ventilation fans etc. Traditionally, only a small portion of the electricity is used for space heating.

The presented graph depicts the breakdown of energy consumption in the New Zealand poultry growing sector. LPG and natural gas are the most common energy sources for poultry growers in New Zealand, with most natural gas usage on the North island, and LPG usage on the South Island.

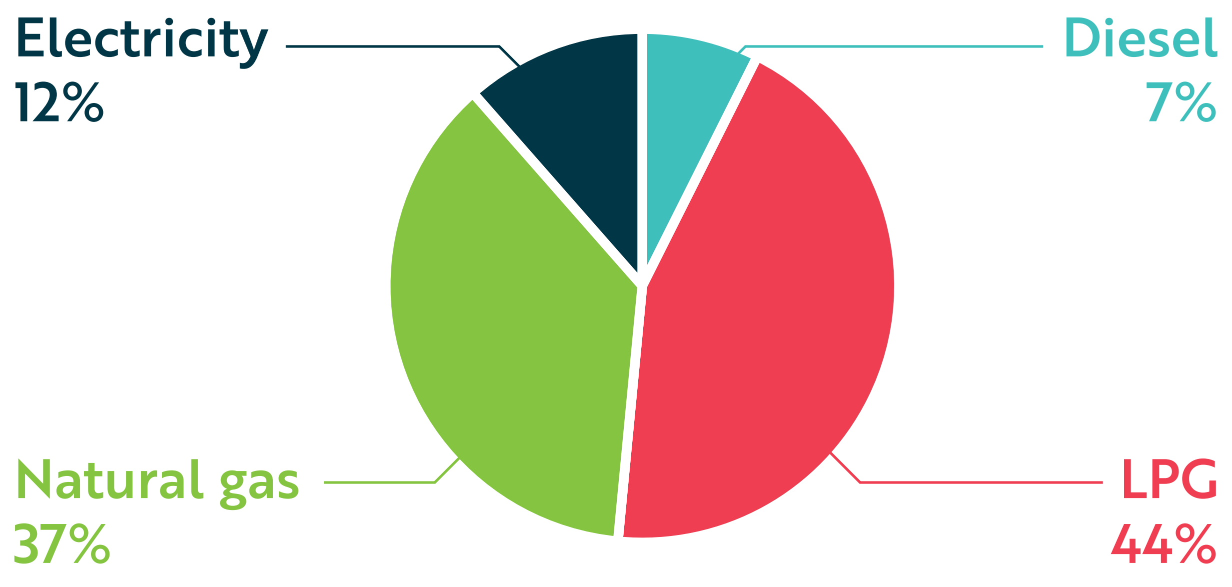
Energy consumption per bird



Energy consumption per m² of shed



Energy consumption breakdown in New Zealand poultry growing farms



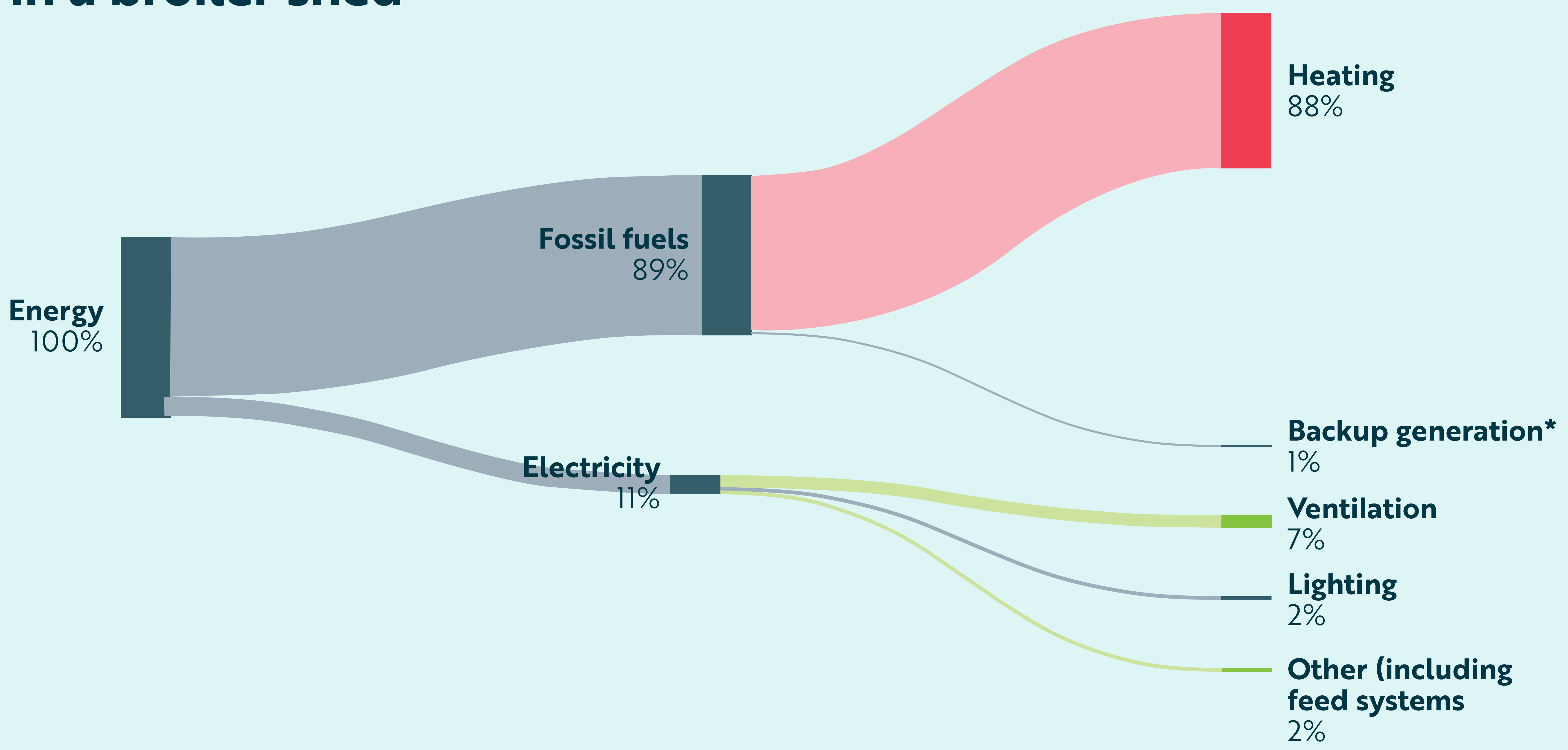
Benchmarking can provide useful measurement and comparison of energy usage. This can be measured as energy used per bird and per shed area, as shown above. However, benchmarking is highly climate-dependent and even in a large country with different climates multiple benchmarks may need to be considered.

Where is energy used in poultry growing?

Heating is the biggest energy demand in poultry sheds – 88% of the energy used in poultry sheds in New Zealand is for heating by fossil fuels.

Electricity accounts for around 11% of the energy usage in poultry sheds, this is used in ventilation cooling systems (68% of total electricity consumption), lighting (14%) and other uses, including feed distribution (17%).

A typical breakdown of energy usage in a broiler shed



Fossil fuels may be used intermittently as backup electrical generation, the amount needed depends on the stability of the local network, this is an indication only.

Global trends

Best practice opportunities

Current best practice for energy efficiency and fuel-switching in the wider poultry growing industry include:

Energy systems (fuel-switching opportunities)

- Electrification of direct space heating
- Ground source heat pumps
- Onsite solar electricity generation
- Biomass boilers
- Advanced air conditioning

Operational processes (technology change)

- New generation of LED lighting
- Insulation

Waste utilisation

- Onsite-biogas generation

Initiatives in key global markets

Australia

- Biogas
- Ground source heat pumps

Europe and UK

- Biofuel
- Biomass boilers
- Advanced air conditioning

North America

- Biofuel
- Advanced air conditioning
- Hot air heat recovery

Asia

- Insulation

Middle-East

- Advanced air conditioning

Worldwide

- LED

Energy efficiency and fuel-switching opportunities

- Demand reduction
  - Using LED lights
  - Insulation
  - Shed air conditioning
    - Advanced controls for fans
    - Advanced ventilation system
    - Heat recovery
- Fuel-switching
  - Direct space heating
    - Electric brooders
    - Infrared heaters
    - Flat panel radiant heaters
    - Electric fan heaters
  - Biofuels
  - Indirect space heating
    - Heat pump
      - Air source heat pump
        - Hot water ASHP
        - Hot air ASHP
      - Ground source heat pump
        - Hot water GSHP
        - Hot air GSHP
    - Boiler
      - Biomass boiler
        - Hot water
        - Hot air
      - Electrode boiler
        - Hot water
        - Hot air
- Renewable energy use
  - On-site biogas generation
  - Solar thermal heating systems
  - On-site electricity generation
    - Solar panel installation
- Advanced technology
  - Application of AI in the industry

Demand reduction

Demand reduction involves optimising existing technology, utilising alternative technology or process changes to **reduce the overall amount of energy** required

Using LED lights

Farmers around the world are switching the lighting in broiler houses from incandescent bulbs, compact fluorescent lamps, high-pressure sodium lamps, and cold cathode lamps to energy-efficient Light-emitting diodes (LEDs). Since their introduction, newer generations of LEDs have been designed for various industries, including a focus on minimizing flicker in poultry settings.

LEDs can **reduce electricity consumption by 30-80%**, depending on existing lighting (lighting typical accounts for around 14% of total electricity consumption). Retrofit in existing sheds is generally simple with change out of the lighting bracket.

Other benefits:

- LEDs last significantly longer, so ongoing maintenance costs are reduced
- LEDs can be supplied in different colours which can affect the behaviour of chickens.
  - Research shows broilers raised under red and white light were more active, whereas birds raised under blue and green light are more calm, and spent a higher percentage of time sitting and dozing.

Maximum Power Saving	✓	✗	✗	✗	✗
Shock Proof / Water Proof	✓	✗	✗	✗	✗
Balanced for Animals	✓	✗	✗	✗	✗
Good for Retrofits	✓	✗	✗	✗	✗
Endless Repositioning	✓	✗	✗	✗	✗

Image credit: Agrilight

ALIS system Image credit: Greengage

Image credit: BigDutchman

STRATEGIC AND TECHNICAL PARAMETERS				COMMERCIAL PARAMETERS			TOTAL
GHG REDUCTION	TECHNOLOGY MATURITY	COMPLEXITY (EASE OF IMPLEMENTATION)	OTHER BENEFITS	CAPEX	OPEX	ENERGY SECURITY	
1	3	3	3	2	3	3	21

Suppliers:

- Greengage (Enlightened Farming)
- AGRILIGHT® (Better Light. Better Life)
- SUNBIRD® (Poultry Lighting Systems)
- GK®
- 鸿远微思 Hontech-wins
- Big Dutchman

Thermal insulation

Insulation in poultry sheds improves energy efficiency in summer and winter and keeps a comfortable temperature. It can cut heating by 60%

An additional benefit is reduced heat gain in hot ambient temperatures. In older sheds, and some newly built sheds there might be gaps in the wall joints, ceiling, around the doors and air vent chambers that increase the heat loss potential. Proper insulation and filling of these gaps will reduce the energy cost and emissions caused by the additional energy demand of the farm.

Roof

Fiberglass quilt roll is commonly used for the roof due to its large coverage and thickness. It can also be applied to sides and gables, while insulation blocks are another option. Insulated panels for the roof may not be cost-effective due to size.

Walls

Polystyrene or Styrofoam boards are typical for walls.

Floors

Floors are usually not insulated on top of underfloor heating, but proper insulation is recommended in other conditions, which usually aligns with the same material used in concrete slabs for houses and residential buildings.

Retrofitting

For retrofitting, choosing the right insulation thickness is crucial for efficiency since it needs air to circulate. Squashed side panel insulation can reduce effectiveness.

Suppliers:

Neo

Globe Panels

Maru Cool™ Insulation & Acoustic

Bubble Insulation Thermal Wrap. Image credit: Neo

Metalized Bubble Insulation. Image credit: Neo

Metalized Film Insulation Sheet. Image credit: Neo

Key considerations for selecting insulation materials

- High R-Value
- High reflectivity
- Low emissivity
- Fire Resistant
- Cost-effective
- Eco-friendly
- Energy efficiency
- Easy to install and low maintenance
- Lightweight and durable

STRATEGIC AND TECHNICAL PARAMETERS				COMMERCIAL PARAMETERS			TOTAL
GHG REDUCTION	TECHNOLOGY MATURITY	COMPLEXITY (EASE OF IMPLEMENTATION)	OTHER BENEFITS	CAPEX	OPEX	ENERGY SECURITY	
2	3	2	2	2	3	3	22

Shed air conditioning

Opportunities:

- Advanced control for fans
- Advanced ventilation systems
- Heat recovery – preheating fresh air to the sheds

Many poultry farmers still use conventional practices to manage the climate in their sheds, while some use automated systems to control air vents and monitor temperature and humidity.

Keeping the shed temperature stable is important according to the birds' age. However, handling humidity is more complicated. Early in development, higher humidity is vital for the birds' respiratory growth, but too much humidity later can cause issues like damp litter and moisture on surfaces. To control humidity, farmers often increase the shed temperature, creating a comfortable environment. However, this leads to opening vents for fresh air, resulting in heat loss, increasing energy use and emissions.

Advanced control for fans

Air circulating fans are crucial in poultry sheds for maintaining a healthy environment for poultry growth. They help keep litter dry, control ammonia levels, and reduce the risk of injuries such as breast blisters and hock burns. The fans promote moisture removal from litter by moving hot, dry air downwards, enhancing evaporation.

iFan Image credit: FanCom

As fans usually run at full speed, with only on/off control, they consume a lot of electricity. To lower energy usage, options include:

- Utilising new fans with variable speed drives
- Intelligent fans with timer options to control the speed of VSD-equipped fans
- Control system to optimise the most efficient operation of fans to achieve the required environmental conditions

These changes are generally simple to implement, depending on the control system currently used.

Fans are far more energy efficient at a lower RPM.

- A fan operating at full speed uses up to eight times more energy than a fan operating at half speed
- If fans ran at half speed for half the day, this would lead to a 44% reduction in electricity for fans

To improve efficiency of fans:

- Reduce fans running at full capacity, use multiple fans at optimal speeds
- Run fans at lower speeds when preheating sheds, before delivery of the new flock
- Adjust fan speeds based on day and night temperatures. more moisture can be withdrawn during the day, and less at night at night due to lower temperature and humidity

Suppliers:

Termotecnica Pericoli

Fancom – forward thinking

RM Heating & Cooling

FAMtech – Famtech International Co.,Ltd.

STRATEGIC AND TECHNICAL PARAMETERS				COMMERCIAL PARAMETERS			TOTAL
GHG REDUCTION	TECHNOLOGY MATURITY	COMPLEXITY (EASE OF IMPLEMENTATION)	OTHER BENEFITS	CAPEX	OPEX	ENERGY SECURITY	
1	2	2	2	3	3	3	21

Advanced ventilation systems

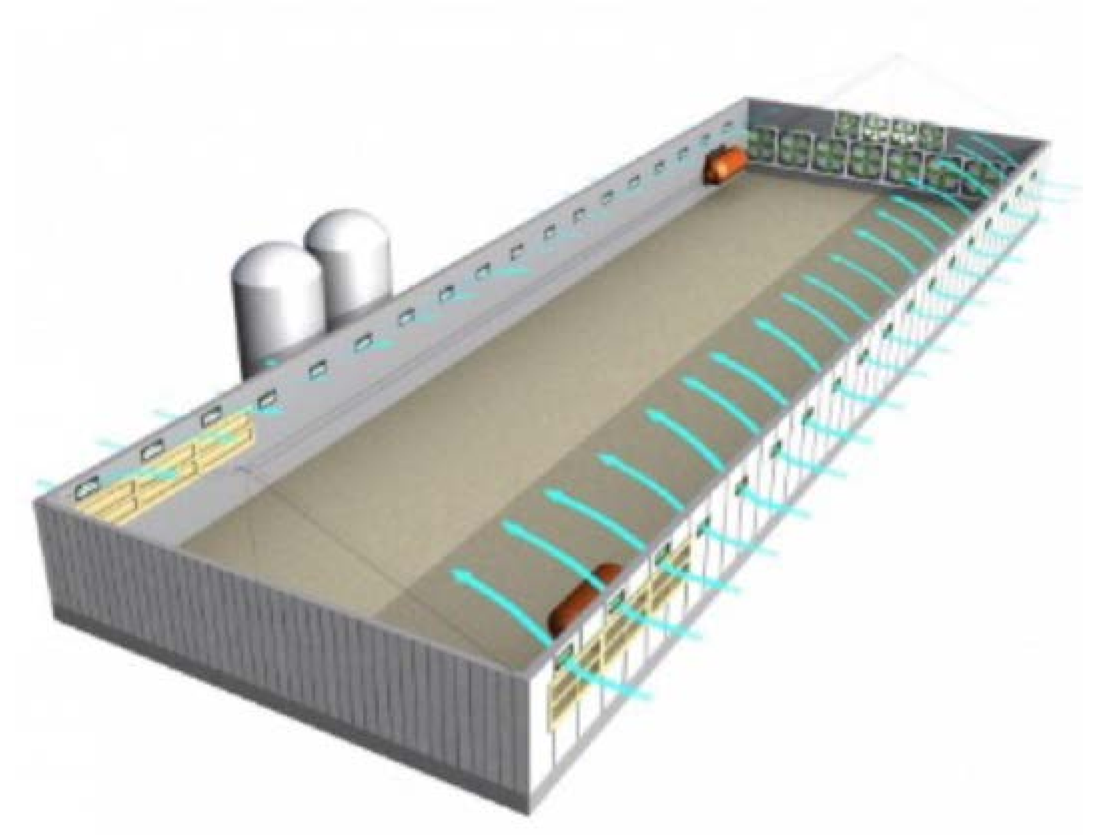
Maintaining the climate in poultry sheds at the right levels is crucial for poultry growth and energy efficiency.

Ventilation is important to remove harmful substances like carbon dioxide, ammonia, moisture and dust and moisture while providing oxygen-rich air, which helps young birds develop their respiratory systems and reduces respiratory diseases. High humidity can worsen litter quality and lead to health problems for birds.

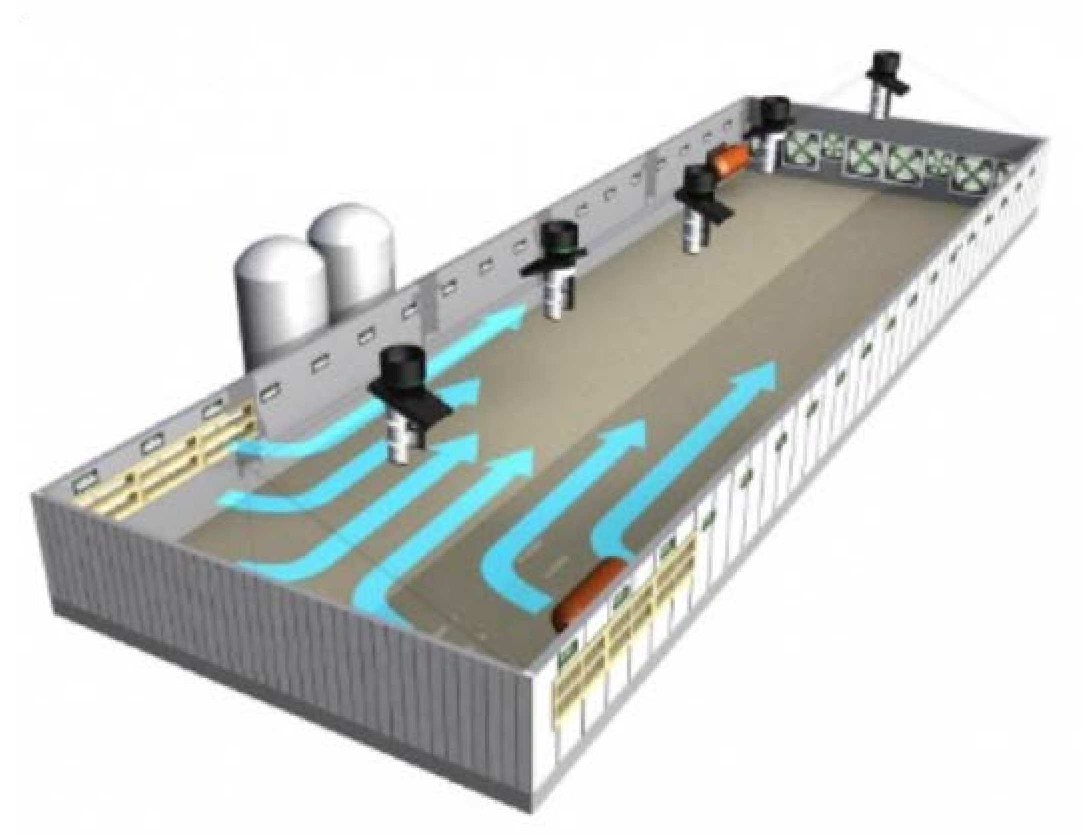
Farmers often ventilate when humidity or temperature increases, which raises energy use to reheat cold air.

Advanced ventilation systems effectively control airflow, reducing heating needs and preventing disturbances. They achieve this by **managing air intake from the sides** of the shed and **using fans to extract air in the ridge or end gables**. The airflow can be **controlled accurately** and is **distributed evenly** throughout the shed, even with low air speeds. This design minimizes ventilation and therefore heating demands while keeping airflow consistent.

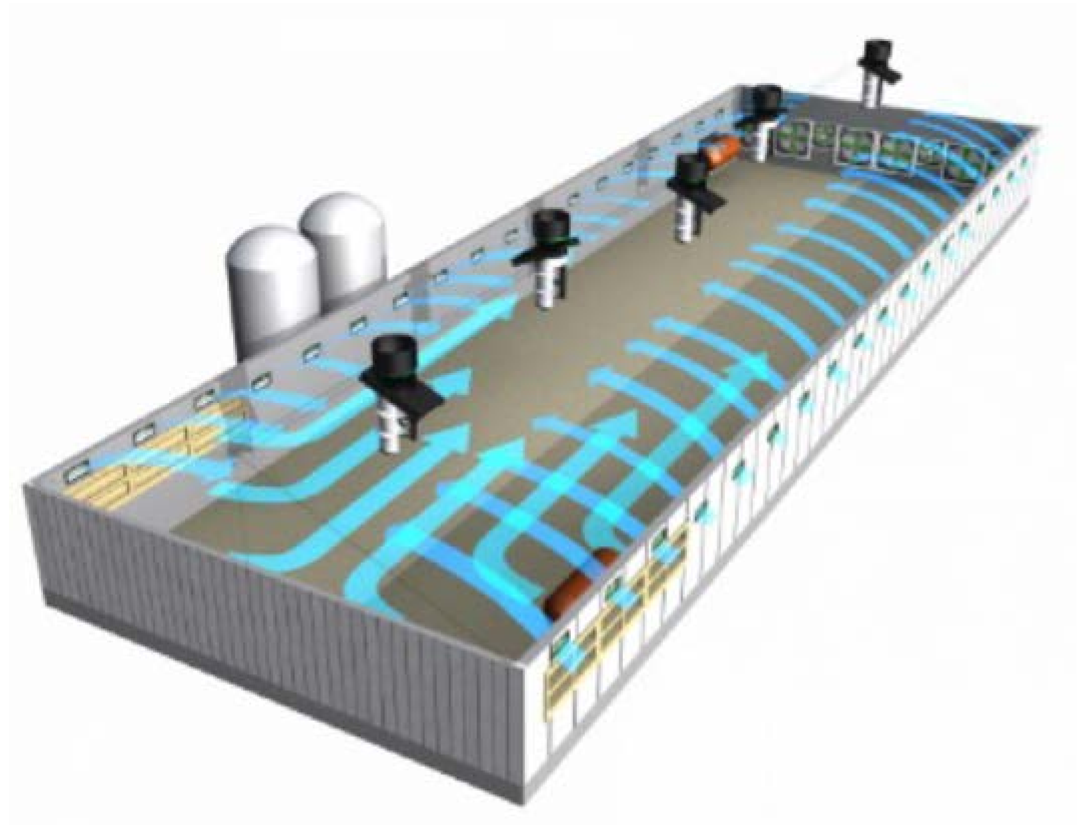
Additional benefits of advanced ventilation systems include less noise, no drafts, steady light conditions, up to 10% faster growth, even bird distribution, improved feed conversion, and lower mortality rates.



Combi-ventilation Image credit: FanCom



Tunnel ventilation Image credit: FanCom



MTT ventilation system Image credit: FanCom

STRATEGIC AND TECHNICAL PARAMETERS				COMMERCIAL PARAMETERS			TOTAL
GHG REDUCTION	TECHNOLOGY MATURITY	COMPLEXITY (EASE OF IMPLEMENTATION)	OTHER BENEFITS	CAPEX	OPEX	ENERGY SECURITY	
1	2	3	2	3	2	3	19.5

Suppliers:

TERMOTECNICA PERICOLI

FANCOM forward thinking

condair

Big Dutchman

RM HEATING & COOLING

Heat recovery – preheating fresh air to the sheds

Preheating the fresh air introduced to the sheds can significantly decrease the energy consumption on the farm, especially in colder climates or in the winter when the growers use ventilation to replace the fresh air with the humid air inside the shed.

An Air-Air plate heat exchanger can be utilised to preheat the fresh air, with two fans to push air through separate paths in the heat exchanger. The core has many small tubes with a shared wall. Warm air heats one side of the wall, while fresh air on the other side absorbs that heat.

Although the preheated air still needs additional heating for poultry comfort, it requires **much less energy**. In **moderate climates**, larger units may be needed due to smaller temperature differences, making them **less cost-effective**.

Case Study

Advancements in heat exchangers revolutionise the poultry industry

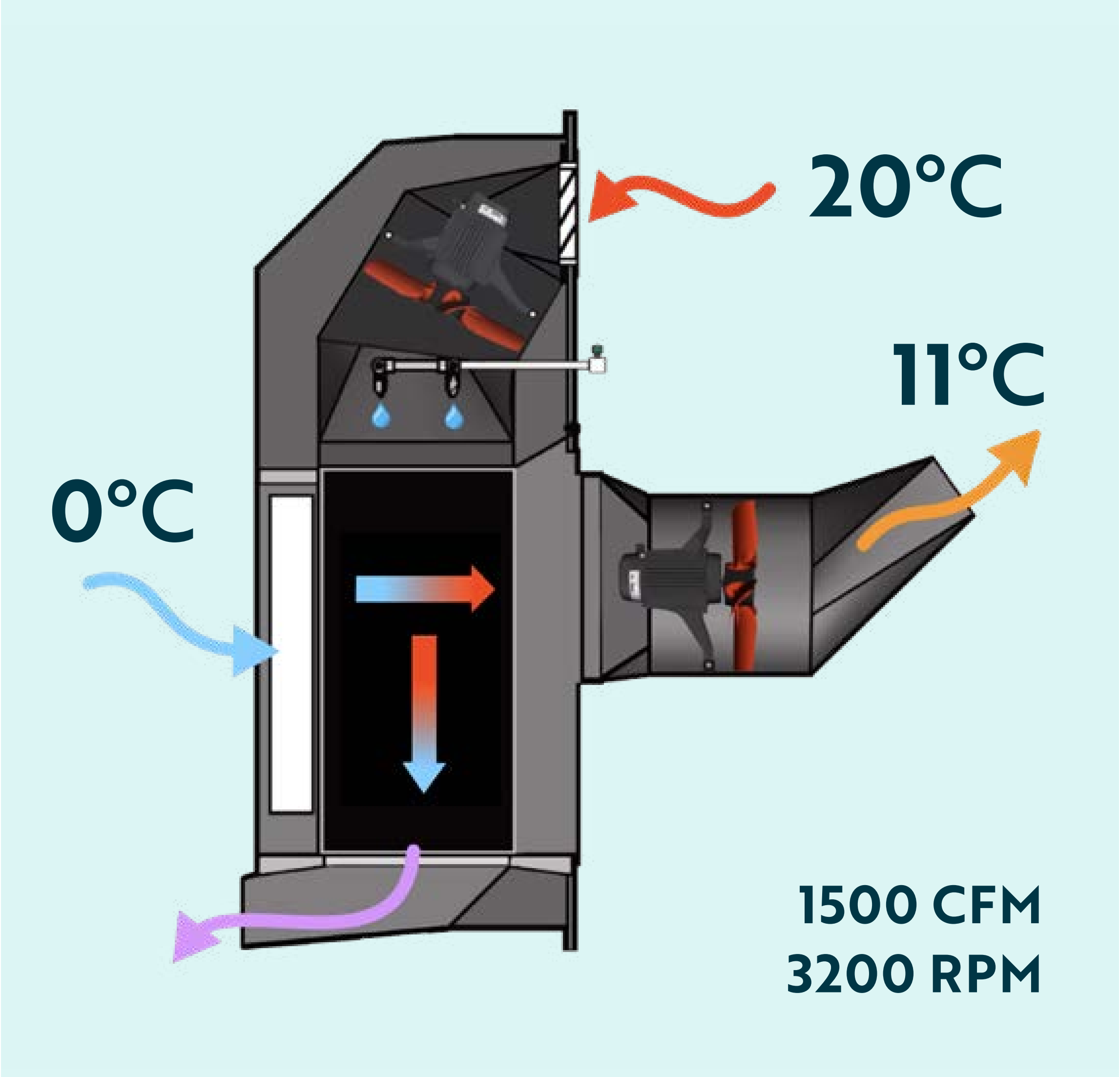


Image credit: Avi-Air

Image credit: Vencomatic

Suppliers:

AVI AIR

Vencomatic Group
Agro Supply - Prinzen - Van Gent - Vencomatic

esa SERIES

EXACON INC.

STRATEGIC AND TECHNICAL PARAMETERS				COMMERCIAL PARAMETERS			TOTAL
GHG REDUCTION	TECHNOLOGY MATURITY	COMPLEXITY (EASE OF IMPLEMENTATION)	OTHER BENEFITS	CAPEX	OPEX	ENERGY SECURITY	
1	3	1	1	2	2	3	17

Fuel switching

Fuel switching involves changing the fuel from a fossil-based fuel to a lower emissions intensity fuel and renewable energy.

Direct space heating

Opportunities in direct space heating include:

- Electric brooders
- Infrared heaters
- Flat-panel radiant heaters
- Electric fan heaters

Switching from hydrocarbons to electricity allows the facility to take advantage of New Zealand's largely renewable electricity supply (approximately 85%).

The existing electrical infrastructure on site is a major factor in the selection of electrification options as upgrades can be costly.

Direct space heating from combustion of fossil fuels leads to increased humidity which needs to be removed. Electrification of direct space heating has an added benefit of reducing humidity.

Electric brooders

Electric brooders can easily be installed as a direct replacement for gas brooders, with similar area coverage and weight as the equivalent gas brooder. Electric brooders and gas brooders are compared in the table below.

Image credit: Chishtiya

Factor	Electric Brooders	Gas Brooders	Comments
Energy Efficiency and Temperature Control	‣ Higher heat output per kW of electricity ‣ Good control with thermostatic controls to adjust temperature	‣ Lower heat output per kW of fuel ‣ Temperature can be adjusted, slower response	‣ Using advanced thermostatic controls and insulation minimises energy waste. ‣ Consistent heat reduces waste and enhances the growth rate of chicks, leading to better productivity with fewer resources.
Cost-effective	‣ Electrical network upgrades may be required. ‣ Electricity cost is higher per unit of energy	‣ Gas costs currently cheaper per unit of energy, but expected to rise significantly. ‣ Potential fuel shortages or unavailability.	‣ Both have similar capital costs.
Coverage and heat distribution	‣ Capacity of brooding 1,000 chicks in 16.9 m² (200 sqft) area, with 2 kW of electricity consumption ‣ More uniform heat in the shed	‣ Capacity of brooding 1,000 chicks in 16.9 m² (200 sqft) area, with 2.8 kW of fuel consumption	
Renewable Energy	‣ Can be integrated with renewable energy sources, including on-site generation such as solar panels	‣ Cannot use renewable energy	
Safety and maintenance	‣ No additional ventilation required ‣ ow maintenance - general inspections only	‣ Require ventilation to remove combustion products ‣ Open flame increases fire risk ‣ Requires regular gas line inspection	‣ Ventilation causes heat loss and increase energy consumption
Humidity	‣ No additional humidity introduced	‣ Higher humidity level, additional H_2O as combustion product	
Smart Technology Integration	‣ Easy with thermostatic controls adjust temperature	‣ Difficult to integrate into smart systems	‣ Electric brooders can be integrated into smart farm systems that optimise energy use across poultry operations, reducing overall energy consumption. These systems can use sensors and Internet of Things (IoT) to automate brooding based on chicken's behaviour and environmental conditions.

STRATEGIC AND TECHNICAL PARAMETERS				COMMERCIAL PARAMETERS			TOTAL
GHG REDUCTION	TECHNOLOGY MATURITY	COMPLEXITY (EASE OF IMPLEMENTATION)	OTHER BENEFITS	CAPEX	OPEX	ENERGY SECURITY	
3	2	2	3	3	1	3	21.5

Suppliers:

Chishtiya Poultry Services Pvt. Ltd.

Our Poultry Place

Vijay Raj Poultry Equipments Pvt. Ltd

Infrared heaters

Electric infrared heaters can replace oil-fired heaters in poultry farms. They provide quick heat without air movement, save energy, and work well in dusty areas like sheds. The units are easy to use as a plug-and-play model and are energy efficient.

Since these types of heaters can be installed in the same location as existing infrared oil-fired heaters, there is minimal capital cost for replacement, and if the site is generating solar electricity these heaters can be considered as a zero-emissions alternative to fossil-based heating systems.

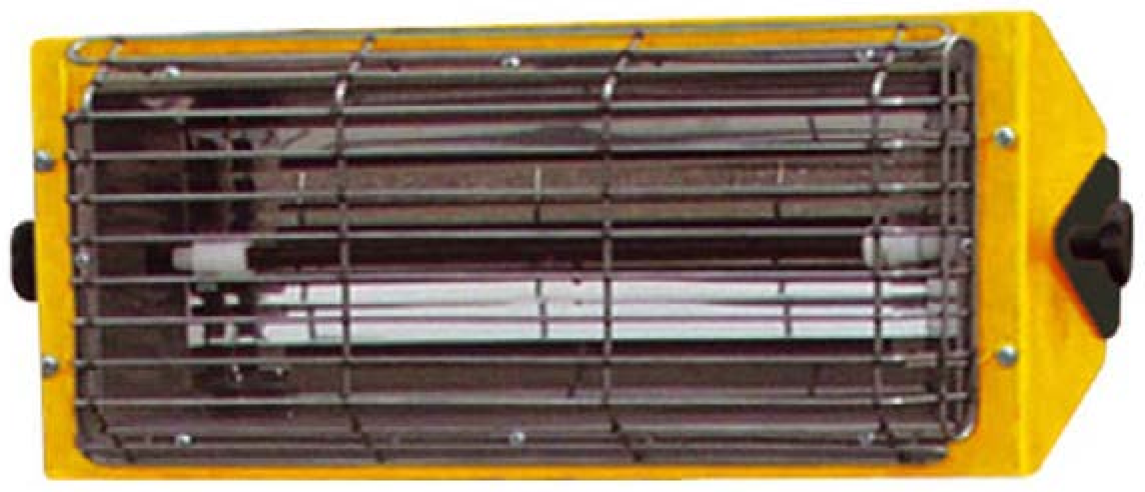


Image credit: Dantherm

Image credit: Dantherm

STRATEGIC AND TECHNICAL PARAMETERS				COMMERCIAL PARAMETERS			TOTAL
GHG REDUCTION	TECHNOLOGY MATURITY	COMPLEXITY (EASE OF IMPLEMENTATION)	OTHER BENEFITS	CAPEX	OPEX	ENERGY SECURITY	
3	2	2	2	3	1	3	21

Suppliers:

DANTHERMGROUP

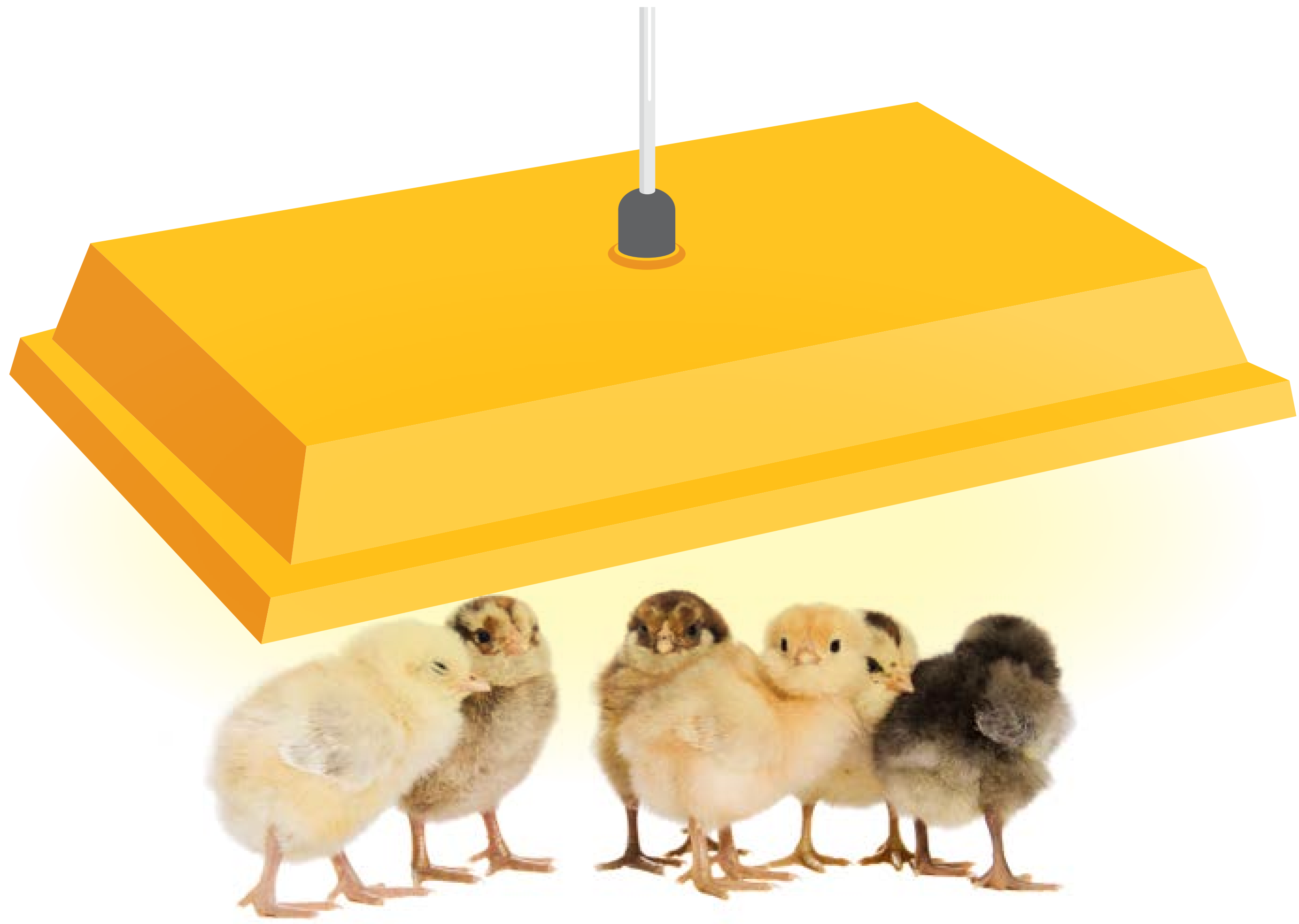
SRP SUPERIOR RADIANT PRODUCTS

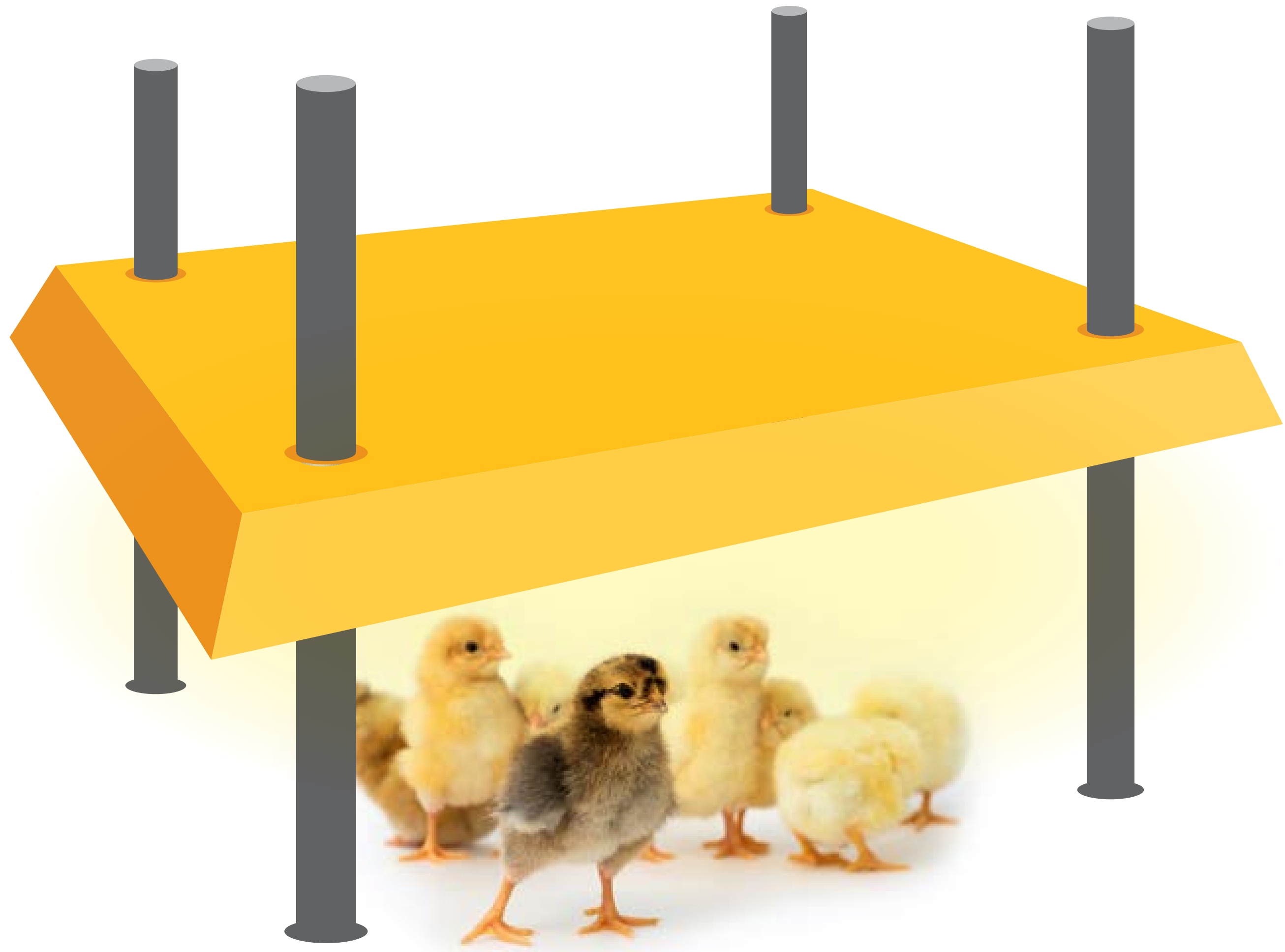
STABLE FARM & TACK
Affordable Goods For Your Horse And Barn

Flat-panel radiant heaters

Flat-panel radiant heaters are the most common poultry heaters worldwide. They provide direct heat from above, ensuring consistent warmth in the poultry house. For young chickens, they create a safe environment similar to what a hen provides.

These heaters are energy efficient, safe, and adaptable, allowing for installation at different heights. They are easy to install, and if the site uses solar electricity, they can be a zero-emissions alternative to fossil-based heating systems.





STRATEGIC AND TECHNICAL PARAMETERS				COMMERCIAL PARAMETERS			TOTAL
GHG REDUCTION	TECHNOLOGY MATURITY	COMPLEXITY (EASE OF IMPLEMENTATION)	OTHER BENEFITS	CAPEX	OPEX	ENERGY SECURITY	
3	2	2	3	2	1	3	21.5

Suppliers:

COZY WINTERS

Ubuy

TSC TRACTOR SUPPLY CO

Electric fan heaters

Electric fan heaters are efficient devices that can replace gas or oil fan heaters easily. They offer clean, quick, and safe heating. These heaters are user-friendly, need little maintenance, and are portable.

If a farm uses oil or gas heaters already, switching to electric heaters can be cost-effective depending on electricity prices. If solar power is available, these heaters can serve as a zero-emissions option.

Image credit: Dantherm

Image credit: Dantherm

Image credit: inter Warms

STRATEGIC AND TECHNICAL PARAMETERS				COMMERCIAL PARAMETERS			TOTAL
GHG REDUCTION	TECHNOLOGY MATURITY	COMPLEXITY (EASE OF IMPLEMENTATION)	OTHER BENEFITS	CAPEX	OPEX	ENERGY SECURITY	
3	2	2	2	2	1	3	19

Suppliers:

Winterwarm heating solutions

DAMLY Environment Technology

DANTHERMGROUP

Biodiesel in direct-fire heaters

Biodiesel is typically produced from waste oils and fats, it is a **direct drop-in replacement** for conventional diesel, so could be considered for farms that are currently using a liquid fuel. There is generally no capital modifications required, however the **operating costs may be significantly higher** due to the higher cost of producing Biodiesel. Currently, there is **almost no supply of biodiesel in New Zealand,** however, this opportunity can be considered for the construction of future poultry farms when the sustainable supply of biodiesel to the New Zealand market begins.

Biodiesel offers lower net CO_2 emissions, helping to reduce the carbon footprint of farms. Some European countries support BioFuel

Some European countries have already taken a strong decision to embrace Biodiesel, especially after the announcement at COP26. The UK had already ordered that after March 2022, only HVO 100 (100% pure renewable diesel fuel) will be allowed for use on construction sites. Norway and Sweden are also heading in the same direction with many other countries expected to follow suit.

Image credit: inter Warms

Suppliers:

DANTHERMGROUP

Crown Oil
Fuels and Lubricants

NESTE

STRATEGIC AND TECHNICAL PARAMETERS				COMMERCIAL PARAMETERS			TOTAL
GHG REDUCTION	TECHNOLOGY MATURITY	COMPLEXITY (EASE OF IMPLEMENTATION)	OTHER BENEFITS	CAPEX	OPEX	ENERGY SECURITY	
3	3	3	1	1	0	1	14

Indirect space heating

Opportunities in indirect space heating include:

- Heat pumps (air source and ground source)
- Biomass boilers
- Electric boilers

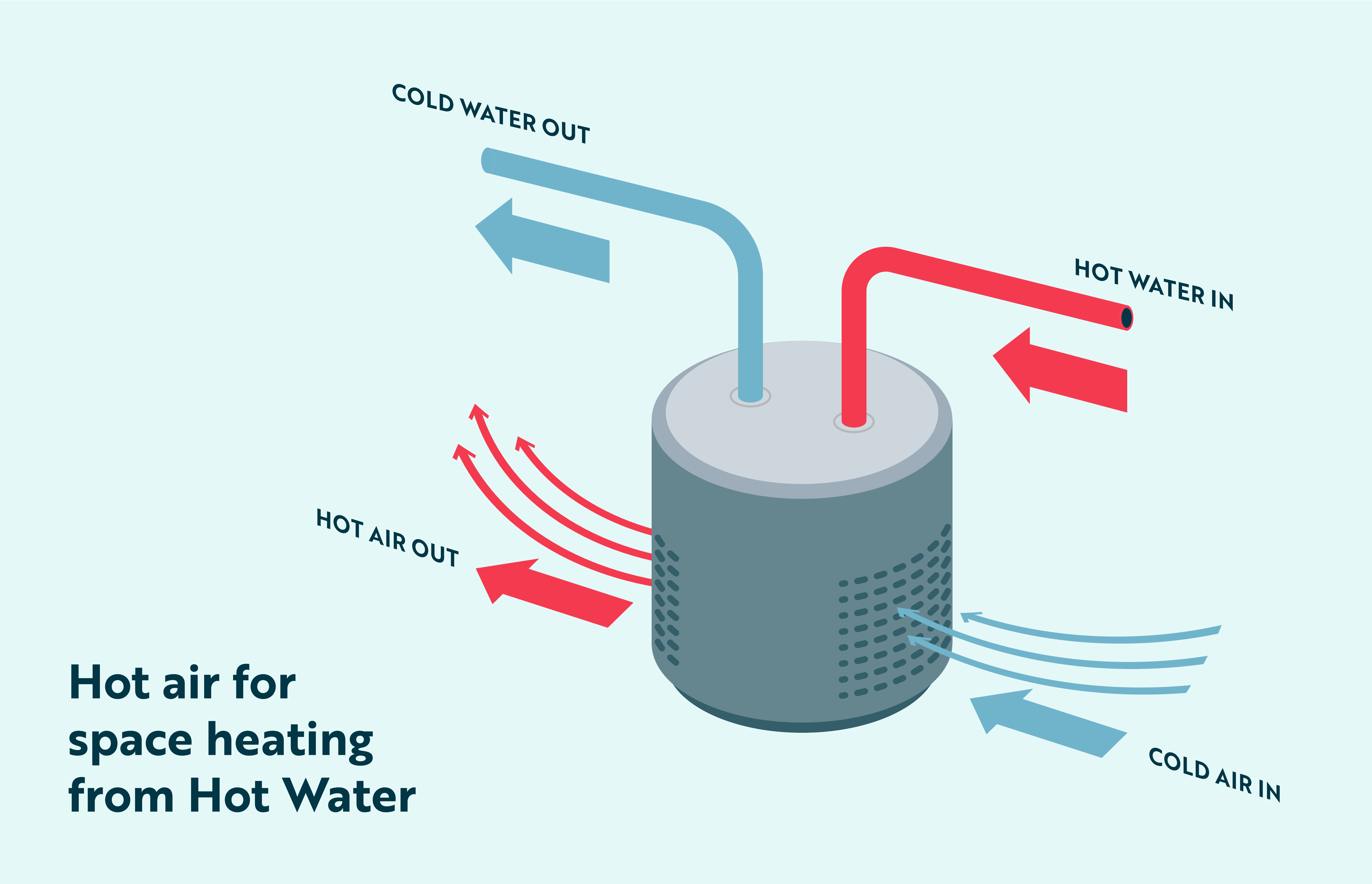
Indirect space heating can include either hot air or hot water as the heating medium. The best option will depend on the existing mechanism.

Indirect space heating

Indirect space heating can include either hot air or hot water as the heating medium. The best option will depend on the existing mechanism.

Heat pumps and boilers can both produce hot water, however heat pumps can also directly produce hot air.

Hot water can be used to produce hot air in a heat exchanger



	Electrode Boiler	Biomass Boiler	Ground Source Heat Pump	Air Source Heat Pump
Produce Hot Air for Indirect Space Heating	✗	✗	✓	✓
Produce Hot Water for Indirect Space Heating	✓	✓	✓	✓
Produce Hot Water for Indirectly Producing Hot Air for Space Heating	✓	✓	✓	✓

Indirect heating with hot water - advanced underfloor technology

Underfloor heating using hot water is recognised as one of the most efficient methods for space heating in the poultry industry. The table below highlights the distinctions between the current underfloor heating technology and the newly developed versions. These new technologies not only allow for the modification of existing sheds but also offer improved heat transfer, resulting in lower energy consumption and reduced emissions for the farm.

Photos Image credit: Central Heating New Zealand

Type	Description	Pros	Cons
In slab Underfloor Heating system:	The most common warm water underfloor heating system installed in New Zealand. The underfloor heating pipework is tied to the reinforcing mesh in the construction slab	• Cost-effective to install in a standard poultry shed with a concrete floor slab. • Quick installation.	• Can only be installed in new sheds as the existing sheds already have a slab in place.
VarioComp Underfloor Heating System:	Hot water pipes are placed in a gypsum board panel and filled with screed for levelling compounds or floor coverings to be applied.	• Lightweight system that can be used in both new and existing poultry sheds.	
EzyMix Underfloor Heating System:	Known as the European screed method, a popular way to heat floors using hot water insheds and buildings. Hot water pipes are attached to an insulation base hich sits on top of the new or existing slab, then covered with a self-leveling EzyMix solution.	• Can be used in new or existing poultry sheds.	• Installation in existing sheds requires major renovation and a loss of room height (85mm).
Spreader Plate Underfloor Heating System	This system works for sheds with joisted floors. An aluminium spreader plate is placed between the joists to press the pipe into it. The pipe's heat moves to the spreader plate, which then heats the floor surface, warming the area above.	• Can be used in new or existing poultry sheds. • Makes pouring a concrete slab or screed over the pipe unnecessary, ideal for new and existing poultry sheds.	• Does not have high output and is most effective with boiler-powered systems, will likely require supplementary heating at times.

Floor heating suppliers

Central Heating NEW ZEALAND

RM HEATING & COOLING

GRAT

Heat pumps

Heat pumps are among the most efficient available devices for producing hot water or hot air for space heating and other hot water demands. Heat pumps would be well suited to a new build, or retrofit where indirect air or water heating is currently used.

Hot air can be blown directly to the poultry sheds for space heating. Hot water can also be used in the underfloor heating systems or to be used to produce hot air using a hot water-air heat exchanger to be blown in the shed.

Coefficient of performance (COP)

Heat pumps are more efficient than electrode boilers to producing hot water. The efficiency of electrical devices is known as the Coefficient of Performance (COP). Heat pumps are more efficient than electrode boilers, with a coefficient of performance **(COP) ranging from 3 to 6**, compared to around 1 for electrode boilers. This means that one unit of electricity provides 3 to 6 units of heat in a heat pump, whereas in an electrode boilers one unit of electricity provides only one unit of heat.

Heat sources

The heat content of the wastewater as a waste heat source can be used by heat pumps to increase efficiency; however, these are not likely to be available on a poultry farm. Therefore, air is used as the heat source for an air source heat pumps (ASHP) and ground soil or underground water is used as the heat source for ground source heat pumps (GSHP), either by laying coils, or drilling of deep wells. Ground source heat pumps can be very effective in areas with high-temperature groundwater, such as the Bay of Plenty.

Electrical infrastructure upgrades are likely required for heat pump installation which can be costly.

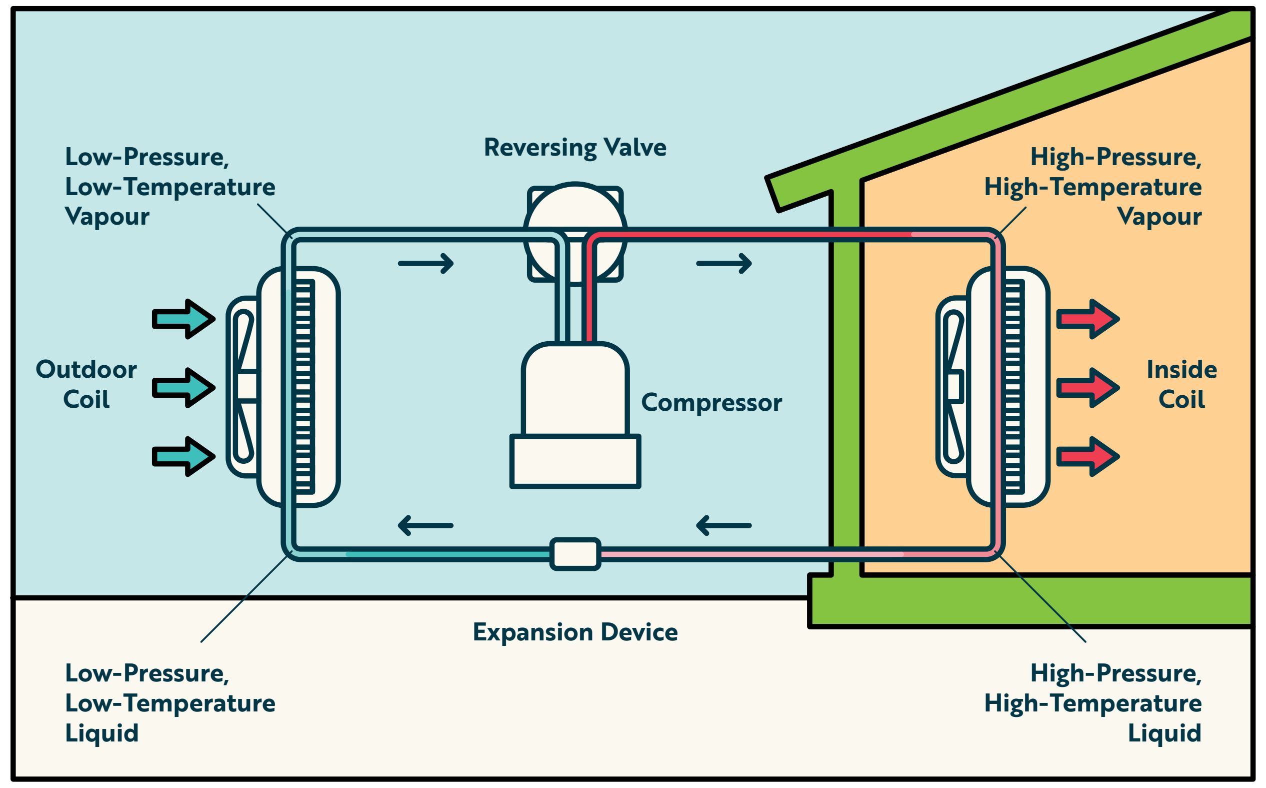
Heat pumps can also be used for cooling if required.

Pros

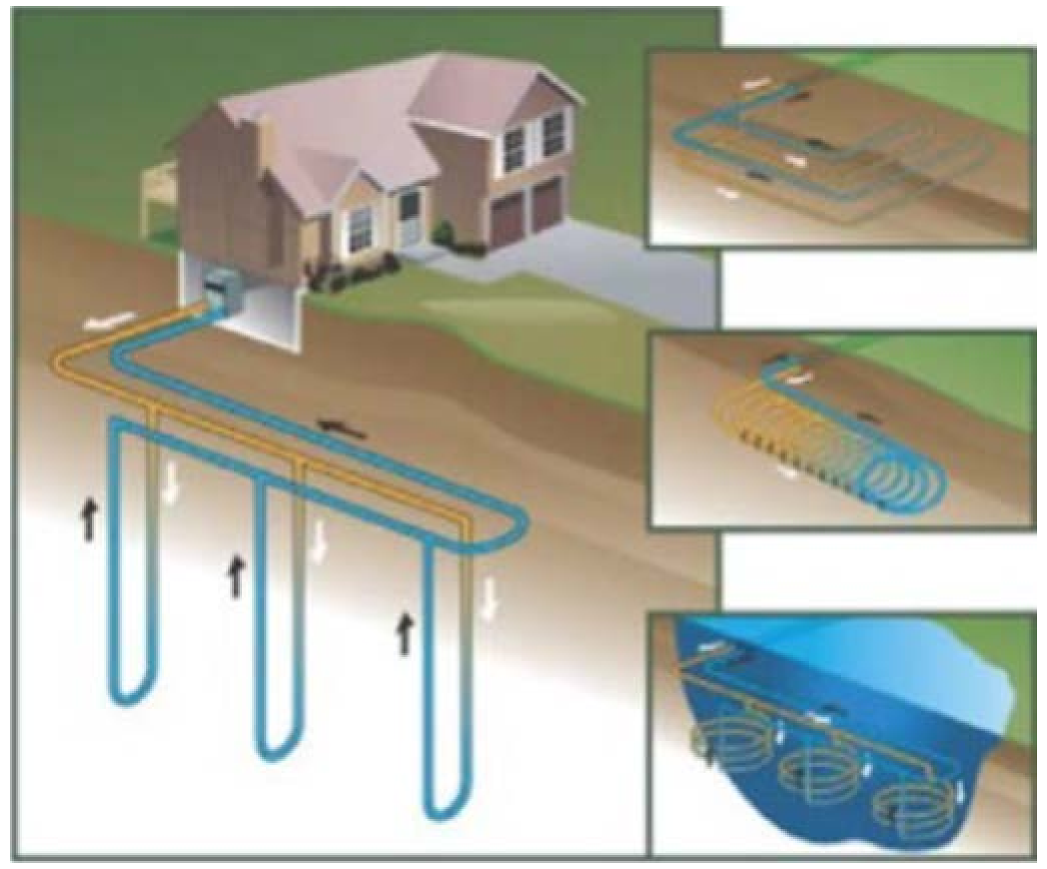
- Heat pumps can also be used for cooling if required.
- High COP, very efficient

Cons

- Higher maintenance costs (refrigerant checks, cleaning)
- Electrical infrastructure upgrades likely required, can be costly.



Air Source Heat Pump installation



Ground Source Heat Pump installation

GSHP Suppliers:

Central Heating New Zealand

Therma

Oilon

ASHP Suppliers

GRAT

Mitsubishi Electric — Changes for the Better

Ground source vs air source heat pumps

Technology	Air source heat pump	Ground source heat pump
Lower CAPEX	✓	✗
Lower OPEX	✗	✓
Higher efficiency (COP)	✗	✓
Longer lifespan	✗	✓
Silent operation	✗	✓
Weather independency	✗	✓
Lower carbon emissions	✗	✓
Less space requirement	✓	✗
Ease and lower cost of installation	✓	✗
Ability to integrate with renewable electricity	✓	✓

Ground source and air source heat pumps evaluation

TECHNOLOGY	STRATEGIC AND TECHNICAL PARAMETERS				COMMERCIAL PARAMETERS			TOTAL
	GHG REDUCTION	TECHNOLOGY MATURITY	COMPLEXITY (EASE OF IMPLEMENTATION)	OTHER BENEFITS	CAPEX	OPEX	ENERGY SECURITY	
GSHP Hot Water	3	2	1	2	1	3	3	20.5
ASHP Hot Water	3	3	2	2	1	2	3	20
GSHP Hot Air	3	2	1	2	1	3	3	20.5
ASHP Hot Air	3	3	2	2	1	2	3	20

Renewable fuel boilers

Opportunities:

- Biomass boilers
- Electrode boilers

Both biomass and electric boilers use renewable fuel to generate hot water. This can then be used directly in underfloor heating systems, or through an air-water heat exchanger to produce hot air, depending on the current heating arrangement of the farm. Traditionally, utilising boilers to produce hot water for space heating, including underfloor heating, is less common in New Zealand. However, this technology is proven in the rest of the world and could be considered for sustainable future farms in New Zealand.

Biomass boilers

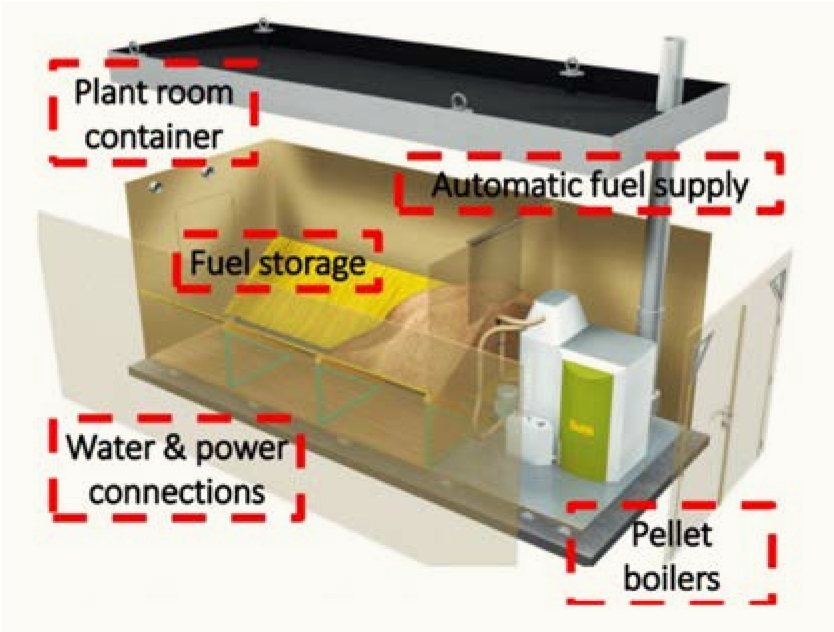
Biomass energy is a good alternative to fossil fuels for boilers. Burning **wood chips and pellets** in biomass boilers offers similar performance to fossil fuel boilers, and can replace fossil fuel boilers without changing the heat distribution system. These boilers can provide **hot water directly** for sheds with existing underfloor heating, or **heat air in a hot water-air heat exchanger** for use in sheds. Smaller boilers can be **supplied in a container** for easy placement on farms with little modification and consenting.

The **cost of woodchip can be similar to that of natural gas, or even lower**, depending on your location – proximity to a sawmill or forestry operation can mean very low biomass prices. There are large potential reserves of biomass available; early discussions with biomass suppliers is critical to lock in supply contracts.

Wood pellets

Wood pellets are a good fuel supply for biomass boilers as they are more energy dense, can be blown directly from a truck into a silo and automatically fed to the boiler, removing manual handling. There are a few major suppliers of pellets currently in New Zealand, and it is expected these will increase to meet demand, however pellets are more expensive than wood chip.

Biomass Boiler Image credit: Apricus Eco



Biomass Boiler Image credit: Apricus Eco

Biomass Boiler Image credit: Apricus Eco

Operational and Economic Parameters	Woodchip	Wood Pellet
Boiler capital cost	↑	↓
Fuel cost	↓	↑
Materials handling	↑	↓
Fuel flexibility	↑	↓
Heating Value	↓	↑
Fuel Bulk Space requirement	↑	↓

STRATEGIC AND TECHNICAL PARAMETERS				COMMERCIAL PARAMETERS			TOTAL
GHG REDUCTION	TECHNOLOGY MATURITY	COMPLEXITY (EASE OF IMPLEMENTATION)	OTHER BENEFITS	CAPEX	OPEX	ENERGY SECURITY	
3	3	2	1	1	1	2	16.5

Suppliers:

Treco

MYRIAD HEAT AND POWER PRODUCTS

INNASOL SUPER POWER

ApricusECO hot water + heating

Electric boilers

Electric boilers can produce hot water to be used in underfloor heating systems or to produce hot air though a water-tot air heat exchanger. They can be either electric resistance boilers (<3 MW) or electrode boilers (>3 MW).

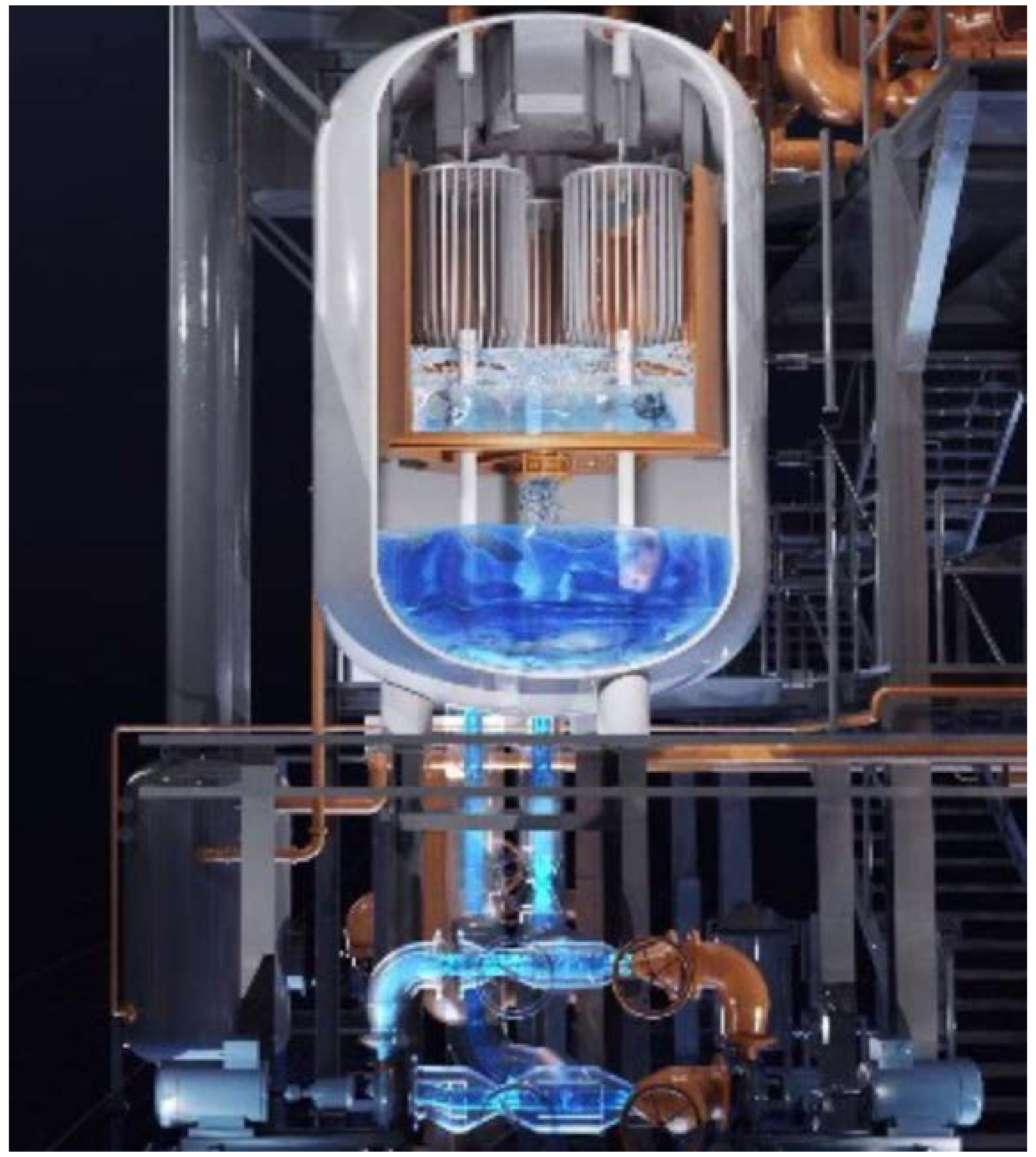
Advantages

Electric boilers respond quickly to load changes, require low maintenance, have a compact footprint and can be integrated with renewable on-farm electricity generation like solar.

Disadvantages

Electric boilers are low COP (around 1), and significant electrical infrastructure upgrades may be required to the site. Heat pumps would generally be a more economical solution as they require smaller electrical upgrades and use less electricity.

Current electricity costs are around twice that of natural gas, so moving to electric boilers can significantly increase OPEX. However, if the farm is producing its own electricity, this cost would be significantly reduced.



Electrode Boiler Image credit: Windsor Energy

Electric Resistance Boiler Image credit: Windsor Energy

STRATEGIC AND TECHNICAL PARAMETERS				COMMERCIAL PARAMETERS			TOTAL
GHG REDUCTION	TECHNOLOGY MATURITY	COMPLEXITY (EASE OF IMPLEMENTATION)	OTHER BENEFITS	CAPEX	OPEX	ENERGY SECURITY	
3	3	2	2	1	0	3	15.5

Suppliers:

Windsor Energy

Cooke Industries

Advance Boiler Services

Energy Plant Solutions

Comparison of indirect heating mechanisms

Technology	Heat Pump	Biomass Boiler	Electric boiler
Lower CAPEX	✗	✗	✓
Lower OPEX	–	✓	✗
Electrical infrastructure upgrades not required	– *(depends on current capacity)*	✓	✗
Higher efficiency (COP)	✓	✗	✗
Flexibility of operation	✓	✗	✓
Weather independency	✗	✓	✓
Low operational + maintenance complexity	✗	✓	✓
Ability to integrate with renewable electricity	✓	✗	✓
Outdoor installation	✓	✓ *(can come in small containers)*	✗

Renewable energy use

Biogas usage

Natural gas can be substituted by biogas, created from the anaerobic digestion of a biogenic source. This is a good option because it easily fits into current setups with little change needed.

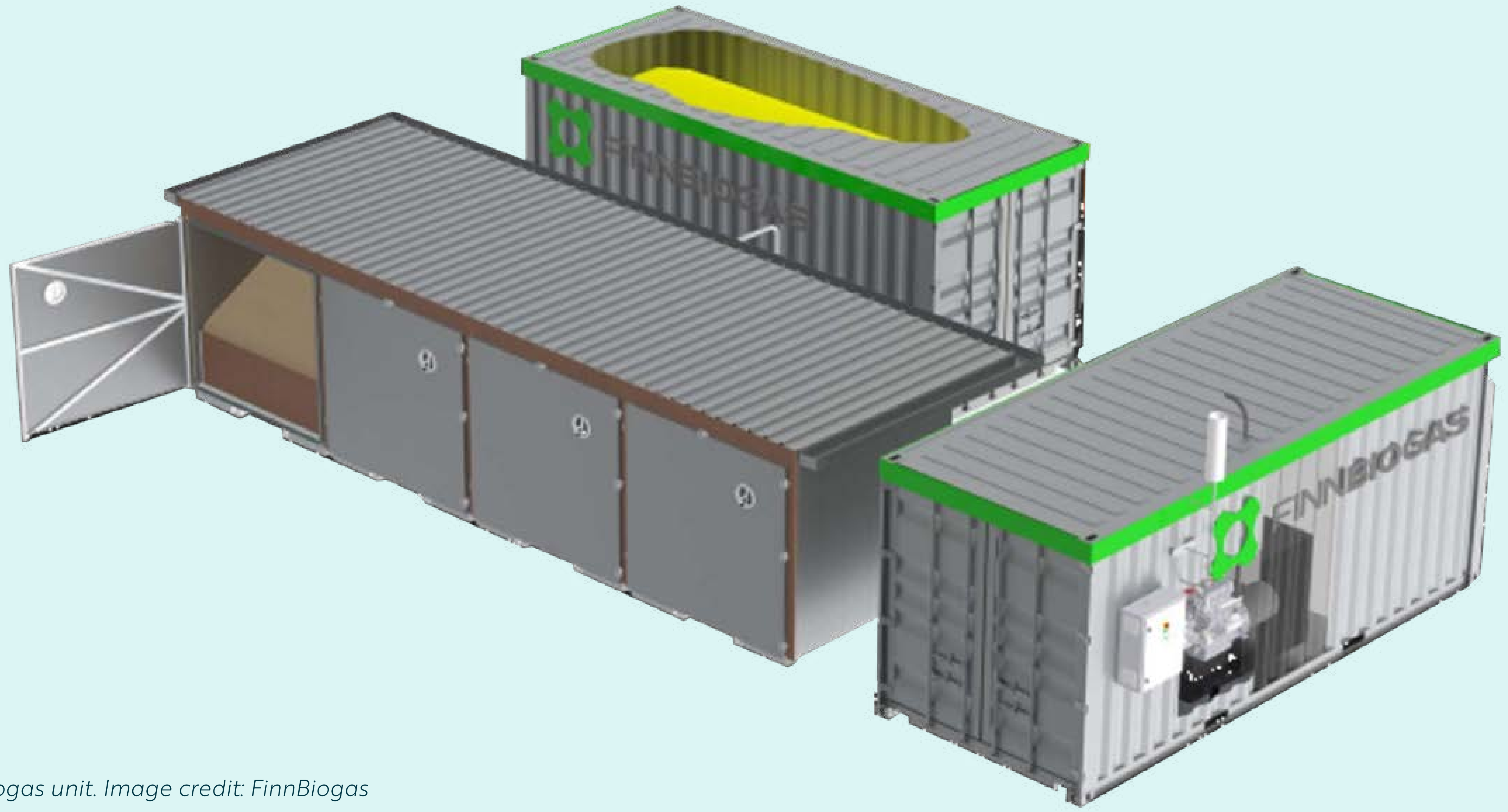
Biogas may replace natural gas in gas boilers to generate hot air or hot water for space heating, or it can be utilised in direct radiant heating systems, such as open flame brooders and indirect fire heaters. The best application will depend on the current heating arrangement.

As chicken litter will produce biogas with high hydrogen sulphide levels (>2000 ppm), this needs to be removed in a scrubber using activated carbon filters, and moisture removal. For scenarios with elevated hydrogen sulphide concentrations, the installation of purpose-built biogas boilers is recommended to increase corrosion resistance.

Biogas contains less methane and has a lower calorific value than natural gas (16-28 MJ/m³ compared to 34-52 MJ/m³), so boiler burners or brooders may be modified to work with biogas.

Typical biogas composition

- **55-65%** methane (CH_4)
- **13-45%** carbon dioxide (CO_2)
- **2,000 - 5,000** ppm hydrogen sulphide (H_2S)
- **Water**
- Traces of siloxanes



Portable biogas unit. Image credit: FinnBiogas

STRATEGIC AND TECHNICAL PARAMETERS				COMMERCIAL PARAMETERS			TOTAL
GHG REDUCTION	TECHNOLOGY MATURITY	COMPLEXITY (EASE OF IMPLEMENTATION)	OTHER BENEFITS	CAPEX	OPEX	ENERGY SECURITY	
3	2	1	0	1	3	3	19.5

Onsite biogas generation

Biogas is naturally produced through the anaerobic decomposition of organic materials, such as fruit and vegetable waste, animal manure, and carcasses. The digestate resulting from the anaerobic digestion can be applied to land as a fertiliser.

The waste generated from farms is a substantial source of feedstock for biogas production. Global sectors that commonly harness biogas include:

- Piggeries
- Dairies and cattle feedlots
- Poultry processing
- Aquaculture

The scale of the poultry farm dictates the type of Anaerobic Digestion (AD) equipment that should be considered for onsite installation or construction. Options range from small AD units housed within containers, suitable for smaller operations, to larger installations designed for extensive farms.

In the poultry sector, the feedstock available for anaerobic digestion may include litter, manure, mortalities, and food remnants. However, the specific mixture of feedstock can vary significantly from one farm to another, necessitating tailored designs for each unique operation. Key parameters influencing biogas yield and quality include ammonia content in the manure, the type of bedding material used (such as sawdust or wood chips), liquid content in the waste stream, and the ratio of feathers present in the waste.

It is likely that onsite biogas production using waste litter could produce around 50% of the total site heating demand, however the timing of the waste production and biogas demand would need to be considered with the biogas vendor, to determine requirements for storage of waste and produced biogas.

Currently, the litter waste is sold as fertiliser, so this would need to be factored into the overall economics of the opportunity. Digestate from the digestor could also be on sold as fertiliser.

Few real-life examples of poultry farm waste being used for onsite biogas generation are available, however there are some examples of being co-located with a poultry processing site, which also uses the sludge and waste streams from the poultry slaughterhouse.

A digester tank of 2000m³ can handle approx. 17 ton of chicken litter/day

This would give you 3400m³ of biogas

1,000 kg of chicken litter = 200m³ of biogas

In 30 days

= 420 kWh electricity + 500 kWh of heat in a biogas engine

Onsite biogas from waste litter could produce **50%** of the total site heating demand

Suppliers:

FINNBIOGAS

nijhuis

BPO

Gaia EnviroTech

Case Study

Nijhaus Ukraine

A large poultry industry biogas plant in Europe

Feedstocks:

- Chicken litter
- Sorghum
- Sludge and waste streams from poultry slaughterhouse
- Waste water for dilution

- Produces 2,200 m³ biogas/hr.
- 5 MWe Combined heat and power (CHP)
- Biogas for heating chicken sheds

Image credit: Nijhaus

STRATEGIC AND TECHNICAL PARAMETERS				COMMERCIAL PARAMETERS			TOTAL
GHG REDUCTION	TECHNOLOGY MATURITY	COMPLEXITY (EASE OF IMPLEMENTATION)	OTHER BENEFITS	CAPEX	OPEX	ENERGY SECURITY	
3	2	1	0	1	3	3	19.5

Solar thermal heating systems

Solar thermal energy is a clean technology used in various industries for space heating. It can replace boilers on farms for producing hot water for space heating (floor heating or hot air).

The efficiency of energy production depends on the region's climate, collector performance, radiation levels, and the temperature above ambient levels. Higher radiation increases efficiency, while needing higher temperatures leads to more losses.

Typically, systems provide hot water around 60°C, with a maximum of 90°C. Hot water can be stored in insulated water tanks to manage sunny day excess for cloudy days. Two tanks are needed: one for hot water and another for warm return water which is sent to the collectors.

Payback periods

Payback periods are typically 3 to 5 years, but a backup heating system is necessary for extended cloudy periods.

Retrofit

Installation on the roof of an existing shed can be challenging if it is not suitable for supporting the additional weight of the panels and the water they contain. Installation on new sheds is likely a good opportunity.

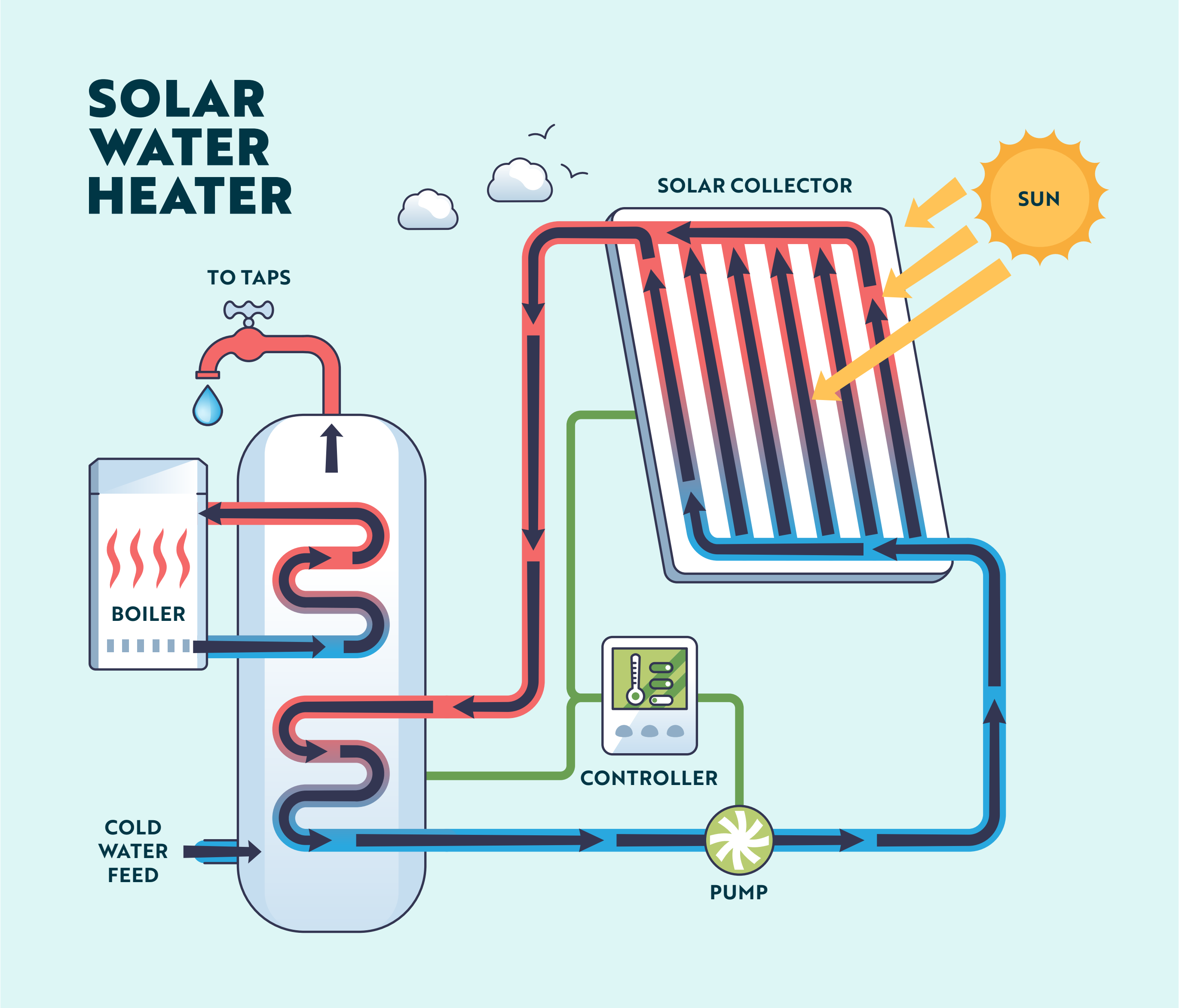


Image credit: Solar Peak

Suppliers:

EWA Solar

SolarPeak

sunz SOLAR ENERGY SPECIALISTS

STRATEGIC AND TECHNICAL PARAMETERS				COMMERCIAL PARAMETERS			TOTAL
GHG REDUCTION	TECHNOLOGY MATURITY	COMPLEXITY (EASE OF IMPLEMENTATION)	OTHER BENEFITS	CAPEX	OPEX	ENERGY SECURITY	
3	3	2	2	1	3	3	22

Onsite solar electricity generation

Solar photovoltaic technology to generate on-site renewable electricity is a proven efficient technology. Agricultural buildings are ideal for modern solar photovoltaic (PV) systems due to their large roof areas. With the advanced panels and battery, it is now possible to generate up to 80% of the energy farms need depending on the size of the farm and its energy demand.

Solar photovoltaics produce the most electricity in summer, at the same time of the highest electrical demand for ventilation fans.

If this is used for electrical heating, additional grid electricity or a backup heating system will be needed as heating demand is highest in winter when solar production is lower, and due to the variability of renewable sources of energy.

For retrofit, installation on the roof of an existing shed can be challenging if it is not suitable for supporting the additional weight of the panels. Installation on new sheds is likely a good opportunity.

Where the generated solar electricity can be used on the farm?

- Lighting System
- Electric heating system
- Ventilation Fans
- Automated Feed Dispensers
- Well Pumps
- Waste Management Systems
- Electric Fences

Advantages of generating on-site solar electricity:

- Protect against rising energy costs
- Energy independence
- Reduce greenhouse gas emissions
- Reduce operating costs

Case Study

Sustainable off-grid poultry farming | Energy Smart Farming

Case Study

Solar-powered poultry barns experience in Canada

Image credit: Canadian Poultry Magazine

STRATEGIC AND TECHNICAL PARAMETERS				COMMERCIAL PARAMETERS			TOTAL
GHG REDUCTION	TECHNOLOGY MATURITY	COMPLEXITY (EASE OF IMPLEMENTATION)	OTHER BENEFITS	CAPEX	OPEX	ENERGY SECURITY	
1	2	2	2	1	3	3	17

Suppliers:

SUNERGY SOLAR

MYRIAD HEAT AND POWER PRODUCTS

Big Dutchman

victron energy BLUE POWER

Difengou Farming

Application of AI in the poultry growing industry

Artificial Intelligence (AI) can be effectively integrated into the poultry farming industry, much like in other industrial sectors. By monitoring external climate trends, evaluating the chickens' responses to changing conditions, and analysing their behaviors using traditional parameters such as temperature, humidity, and light intensity, we can gather valuable data. This information can then be analysed to develop optimal solutions, which can be incorporated into the environmental control systems within the sheds. This approach aims to enhance production efficiency, improve energy use, and ultimately reduce the farm's emissions.

STRATEGIC AND TECHNICAL PARAMETERS				COMMERCIAL PARAMETERS			TOTAL
GHG REDUCTION	TECHNOLOGY MATURITY	COMPLEXITY (EASE OF IMPLEMENTATION)	OTHER BENEFITS	CAPEX	OPEX	ENERGY SECURITY	
2	1	3	3	3	2	3	21

Other potential opportunities

Some other opportunities have also been identified; where due to reasons such as lower maturity of the technology and economical unreliability, these options are considered infeasible. However, these may be a feasible option in the coming years where the situation changes.

Dehumidification/ humidification

Although the control of humidity in different ages of the birds inside the poultry sheds plays a significant role in the health and growth cycle of poultry varieties, the humidity level is still controlled using traditional ventilation techniques by opening the vents, which is inefficient due to heat losses, or by implementing the advanced ventilation systems. There is a potential opportunity to use a dehumidifier inside the shed to collect and store the extra humidity in the growth cycle and use the stored water to spray when higher humidity levels are required through a humidifier. These systems should be able to be integrated into the farm's climate control systems. This equipment is not currently well developed as a standalone unit suitable for the poultry shed environment.

Hot Water heating/ preheating from Boiler Exhaust

Heat recovery from the boiler exhaust is one of the common energy efficiency techniques for the sites that produce steam or hot water. In the poultry industry, this opportunity can be considered if hot water is produced by a boiler for space heating. Whilst this could have a slight reduction in boiler fuel, this would require significant investment in a fossil fuel asset, which could not be used when the boiler is changed out for a lower emission alternative. If the farm considers replacing the fossil-fuelled boiler with a biomass boiler, this option must be considered in the package.

Fresh air heating from Boiler Exhaust

When ventilation is an option to control the humidity level of the sheds, the inlet fresh air can be preheated to reduce extra energy demand for replacing the lost heat through humid air. This can also be considered and have a great cost impact in the preparation of the sheds for introducing a new batch of poultry folks.

This option requires extra ducting and an air-air or air-water heat exchanger that is unlikely to be economically viable.

Other potential opportunities

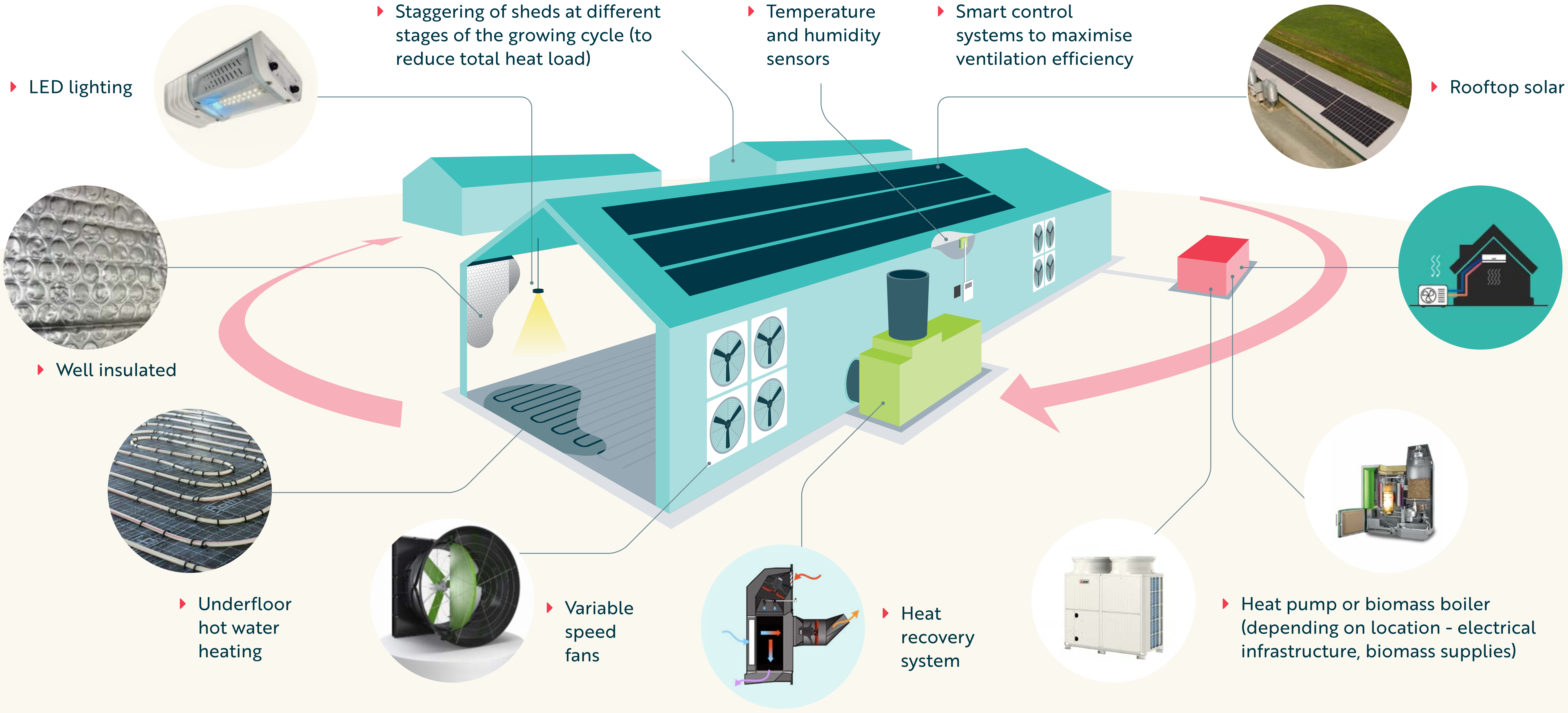
TECHNOLOGY	STRATEGIC AND TECHNICAL PARAMETERS				COMMERCIAL PARAMETERS			TOTAL
	GHG REDUCTION	TECHNOLOGY MATURITY	COMPLEXITY (EASE OF IMPLEMENTATION)	OTHER BENEFITS	CAPEX	OPEX	ENERGY SECURITY	
Dehumidification/ humidification	1	2	2	2	2	2	3	17
Heat Recovery from boiler exhaust	1	3	2	1	2	2	3	17.5
Fresh air heating from Boiler Exhaust	1	3	1	1	2	2	3	17

Recommendations - retrofit

The best technology for retrofit depends on how the sheds are currently heated

Current heating		Best options for retrofit	These options can suit all farms
Direct space heating (radiant brooders)	→	Electric brooders	‣ Insulation ‣ LED Lights ‣ VSD drives
Hot air space heating	→	Flat panel radiant heaters / Electric fan heaters	
Hot Water space heating	→	Heat pump or biomass boiler	

What about a new build - Farm of the future?



Summary and recommendations

The optimum solution for a farm is highly dependent on the current infrastructure and heating systems.

QUICK WINS
(EASY TO IMPLEMENT WITH GOOD RETURN)

- Change out to LED lights
- VSD drives for motors
- Insulation

EMERGENT TECHNOLOGIES

Modular onsite biogas generation

- This is a rapidly developing technology.
- Benefits including reduce energy costs, energy security and reduced waste.
- They are better suited to larger sites due to their increased complexity, and may see benefits if co-located with a processing facility to incorporate these waste streams.

WATCH & WAIT

Electricify brooders and other direct space heating.

- Good option if the existing electrical infrastructure can support it.
- Electricity pricing (vs gas) needs to be considered - unlikely to be cost effective currently if grid electricity is used
- Good option if coupled with solar. Provides some de-risk against anticipated gas price increase.

DEMAND REDUCTION

Advanced ventilation systems

- Can provide multiple benefits to reduce energy consumption and bird health if the farm is equipped to support these changes.
- If there is minimum automation currently this can be costly to retrofit.

FUEL SWITCHING

The best opportunities for decarbonisation involve switching to a low emission fuel – electricity or biomass.

Heat pumps are the most efficient way of providing this heat, whether utilising low emissions grid or onsite generated electricity. COPs of 3-6 mean less energy input is required to generate the heat. Heat pumps are **best installed in greenfield new builds**, or sites currently using hot water as the heating medium.

Summary and recommendations

The optimum solution for a farm is highly dependent on the current infrastructure and heating systems.

ELECTRICAL INFRASTRUCTURE

Upgrade costs of electrical infrastructure **can be prohibitive** when electrifying. This is very dependent on the spare capacity existing in the grid, and the parts of the grid that require upgrade, which varies significantly from site to site. To minimise the size of the required upgrades, **staggering of sheds** could be considered, so all sheds are at different stages of the growing cycle. This would **spread out the heating demand**, so a smaller upgrade is required.

GREENFIELD VS RETROFIT

Whilst most opportunities can technically be retrofitted, the costs involved are often prohibitive and **all opportunities are easier** to implement in a **greenfield** new build

The opportunities hardest to retrofit involve change in heating mechanism (radiant heating to hot air) or heating medium (hot air to hot water), ground source heat pumps and onsite biogas generation due to the required space, and solar thermal or solar PV if the shed roofs are unable to support the additional weight.

RELATED OPPORTUNITIES

VSD control of fans and **advanced ventilation systems** are **best carried out in conjunction**, tied into an overall smart control system, as their operations will interact.

Generally, only one heating mechanisms required, although a **combination of heating mechanisms** may be used where one does not achieve all the required heating, or limited by other constraints such as electrical capacity.

Solar electricity generation can be linked with **any onsite electrical usage**.

HUMIDITY CONTROL

Humidity control is crucial for poultry shed management for both bird health and energy management.

Direct space heating from combustion of fossil fuels increases humidity from combustion products, which needs to be removed. **Electrification of direct space heating** or using indirect space heating have the **added benefit of reducing the humidity** in the shed, so less ventilation, and heating of fresh air is needed to reduce humidity.

Appendix 1

Scoring criteria detail

Methodology: Assessment Criteria

Each decarbonisation opportunity was scored across two primary categories: Strategic and Commercial, with several sub-criteria as outlined in the table below.

Each criteria was scored from 0 to 3, with a score of 3 indicating the highest level of performance. This assessment was conducted in collaboration with Worley Subject Matter Experts, EECA, and representatives from industry bodies.

Weightings were applied to each criterion, resulting in a final score that shows the best option. However, the highest score may not suit all farms, as opportunities should fit individual needs.

Category Definition			Scoring Criteria				
Primary Category	Secondary Category	Description	0	1	2	3	Weighting
STRATEGIC	GHG EMISSIONS REDUCTION	Relative to base case (site-wide) (on an absolute lifetime emissions reduction basis tCO2-e). Scope 1 and 2.	None	<5%	5-30%	> 30%	2
STRATEGIC	TECHNOLOGY MATURITY	Technology maturity, complexity of operation and maintenance, local support	Technology not currently commercially available, highly complex, only overseas support for maintenance	Complex operation, local maintenance possible with some overseas support	Straightforward operation, maintenance by grower and local tradespeople	Straightforward operation, maintenance by grower	1
STRATEGIC	COMPLEXITY (EASE OF IMPLEMENTATION)	How difficult would this be to implement at an existing Poultry farm, or changes to a new farm. Consider operational impacts of implementation + maintenance	Very difficult - necessitates rebuild	Significant changes required, causing operational downtime	Minor impacts, some local modifications	No impact	0.5
STRATEGIC	OTHER BENEFITS/ IMPACTS	e.g. Bird health, litter moisture content, regulation, safety	Negatively impacts	No net impact	Some benefits	Multiple benefits	0.5
COMMERCIAL	CAPITAL COST	Consider equipment purchase, network upgrades, heating system mods	Very High	High	Medium	Low	2
COMMERCIAL	OPERATIONAL COST	Opex cost of energy compared to fossil fuel base case. Also consider insurance, maintenance other operational costs	Significantly higher than fossil alternative current or future cost	Slightly higher - cost neutral	Minor savings	Significant savings	2
COMMERCIAL	FUEL SECURITY	Fuel future security and availability, risk mitigation.	Fuel unlikely to be available in New Zealand market	Fuel available in small quantities	Fuel currently abundantly available, some doubt over future supplies	Fuel abundantly available for the foreseeable future	1

Appendix 2

Summary table of all scorings

Poultry screening scores summary

	TECHNOLOGY	STRATEGIC AND TECHNICAL PARAMETERS				COMMERCIAL PARAMETERS			TOTAL
		GHG EMISSIONS REDUCTION	EASE OF IMPLEMENTATION	TECHNOLOGY MATURITY	OTHER BENEFITS/ IMPACTS	CAPITAL COST	OPERATIONAL COST	FUEL SECURITY	
DEMAND REDUCTION	Using Light-emitting diodes (LED)	1	3	3	3	2	3	3	21
	Insulation	2	2	3	2	2	3	3	22
	Advanced control for fans	1	2	2	2	3	3	3	21
	Advanced ventilation systems	1	3	2	2	3	2	3	19.5
	Heat recovery	1	1	3	1	2	2	3	17
FUEL SWITCHING	Electric brooders	3	2	2	3	3	1	3	21.5
	Infrared heaters	3	2	2	2	3	1	3	21
	Flat-panel radiant heaters	3	2	2	3	3	1	3	21.5
	Electric fan heaters	3	2	2	2	2	1	3	19
	Using biofuel	3	3	3	1	1	0	1	14
	ASHP hot air	3	2	3	2	1	2	3	20
	ASHP hot water	3	2	3	2	1	2	3	20
	Ground source heat pumps hot air	3	1	2	2	1	3	3	20.5
	Ground source heat pumps hot water	3	1	2	2	1	3	3	20.5
	Biomass boiler units	3	2	3	1	1	1	2	16.5
	Electric boiler	3	2	2	3	1	0	3	15.5
RENEWABLE ENERGY USE	Biogas generation units	3	1	2	0	1	3	3	19.5
	Solar thermal heating system	3	2	3	2	1	3	3	22
	Onsite solar electricity generation	1	2	2	2	1	3	3	17
ADVANCED TECHNOLOGY	Artificial intelligence	2	3	1	3	3	2	3	21
OTHER POTENTIAL OPPORTUNITIES	Dehumidification	1	2	2	2	2	2	3	17
	Heat recovery from boiler exhaust	1	2	3	1	2	2	3	17.5
	Fresh air heating from boiler exhaust	1	1	1	3	2	2	3	17

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