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EECA
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ENERGY EFFICIENCY & CONSERVATION AUTHORITY

Orchard & Packhouse Technology Scan

Technology and Best Practice Opportunities for Energy and Emissions Savings

June 2025

Executive Summary

EECA (Energy Efficiency and Conservation Authority) works with orchard and packhouse businesses to help them become more energy efficient as well as provide practical tools, resources and advice. Through the Sector Programme, EECA aims to catalyse transformative changes within the industry. This Technology Scan highlights opportunities for energy savings and decarbonisation in the orchard and packhouse sector, showcasing existing and new technology and practices that will have an impact on energy use, operating costs and emissions.

Opportunities are grouped as follows, with the 14 feature opportunities each expanded upon in its own slide:

Efficient Orcharding

- Multi-row and multi-linkage machinery
- Drip irrigation
- Monitoring systems
- Future Orchard Planting Systems (FOPS)

Electric and Autonomous Orcharding

- Battery-electric mobile machinery
- Electric pumps
- Electric frost fans
- Autonomous vehicles and machinery
- Drone technology

Packhouse Efficiency

- LED lighting
- Packhouse site layout

Packhouse Electrification Opportunities and Renewable Electricity

- Battery-electric passenger fleet vehicles
- Solar electricity generation

Low Emission Domestic Freight

- Freight transport electrification

Recommendations

There are many opportunities available for orchard and packhouse operators to reduce energy consumption, costs and emissions from their activities. After reading this report the biggest challenge may be deciding what to do first. To help you with that, the following is a list of recommended next steps.

1. **Investigate the identified opportunities:** Review the feature opportunities highlighted in this report, which were selected based on their potential impact on energy use, operating costs, and emissions within the New Zealand context.

2. **Assess viability for your specific operation:** Recognise that the actual energy use and the viability of each opportunity are highly dependent on factors unique to your site, such as fruit type, equipment, size, location, and domestic freight requirements. Use the "Where is this most viable?" and "Pros / Cons" sections for each opportunity as a starting point for screening which opportunities may be most suitable for your site.

3. **Focus on efficient practices first:** Remember that efficient energy use is usually the cheapest energy. Opportunities like good maintenance practices for high-energy equipment (tractors, irrigation, frost fans) and compressed air systems can offer significant savings for relatively low cost.

4. **Consider "no regrets" upgrades:** Simple, widely applicable upgrades like LED Lighting can offer predictable energy and maintenance cost reductions and improved functionality, with minimal future downside risk.

5. **Leverage major events:** For new sites or major redevelopments, significant opportunities exist to embed efficiency inherently, such as through optimal Packhouse site layout design or adopting Future Orchard Planting Systems (FOPS).

6. **Explore electrification:** Electrifying processes currently reliant on fossil fuels (e.g., irrigation pumps, mobile machinery, passenger vehicles, freight transport) can reduce emissions while potentially lower operating costs. Capital cost requirements may not be cost effective for every application, but where it is, it can be an investment that sets your business up for future success.

7. **Consider monitoring and automation:** Orchard technologies like monitoring systems and autonomous vehicles/drones can enhance precision, reduce waste (water, fertiliser, fuel), lower labour costs, and improve overall energy efficiency. Seek to find the right balance of cost, reliability, and sophistication to suit the scale and nature of your orchard operation.

8. **Develop an energy strategy:** Before investing major capital in any particular opportunity, take the time to consider your operation as a whole, and develop an overarching strategy for how you want to be using energy now and in the future. The simple act of doing this may significantly change your opinion of what is and is not important for your site. Your energy strategy should align with your specific business goals, site conditions, any expansion plans, and investment capacity. A phased approach, potentially starting with high-impact, cost-effective opportunities, may be most practical.

9. **Seek information and support:** Engage with industry partners, suppliers, and resources mentioned in the report (e.g., EECA guides, case studies, supplier links, PFR, NZAPI, SNZ field days and DETA) to learn more. Also consider low-rate green loans that are offered by several major banks to support sustainability-focused initiatives.

Scope of Activities Covered by Technology Scan

This diagram summarises the energy intensive activities and areas generally included within the scope of this technology scan. Activities were investigated for opportunities to save energy, costs and emissions, and were split into three groupings: Orchard, Orchard & Packhouse, and Packhouse.

Out of Scope items include worker flights and commuting, air and sea freight of produce, and cold storage. Cold storage was excluded as this has been addressed elsewhere by EECA, particularly via their Good Practice Guide – Industrial Refrigeration.

→ EECA | Good Practice Guide - Industrial Refrigeration

Orchard Scope covers tasks necessary for the cultivating and growing of fruit and traditionally relies more heavily on fossil-fuels for orchard vehicles and machinery.

Orchard Scope

- Planting
- Pest and Disease Management
- Weeding and Mowing
- Fertilisation
- Pruning and Thinning
- Irrigation
- Harvesting

Orchard & Packhouse Scope covers items that can be of relevance to both categories, consisting mainly of moving goods and people as well as accommodation for workers.

Orchard & Packhouse Scope

- Lighting
- Fleet Vehicles
- Transport Orchard to Packhouse
- Transport Packhouse to Port
- Accommodation

Packhouse Scope covers activities performed in the packhouse to prepare fruit for market.

Packhouse Scope

- Receiving and Initial Processing
- Staff Handwash and Showers
- Labelling and Weighing
- Washing and Cleaning
- Sorting and Grading
- Packaging
- Loading for Distribution
- Move to Cold Storage

Out of Scope

- Cold Storage
- Worker Flights and Commuting
- Air and Sea Freight of Produce

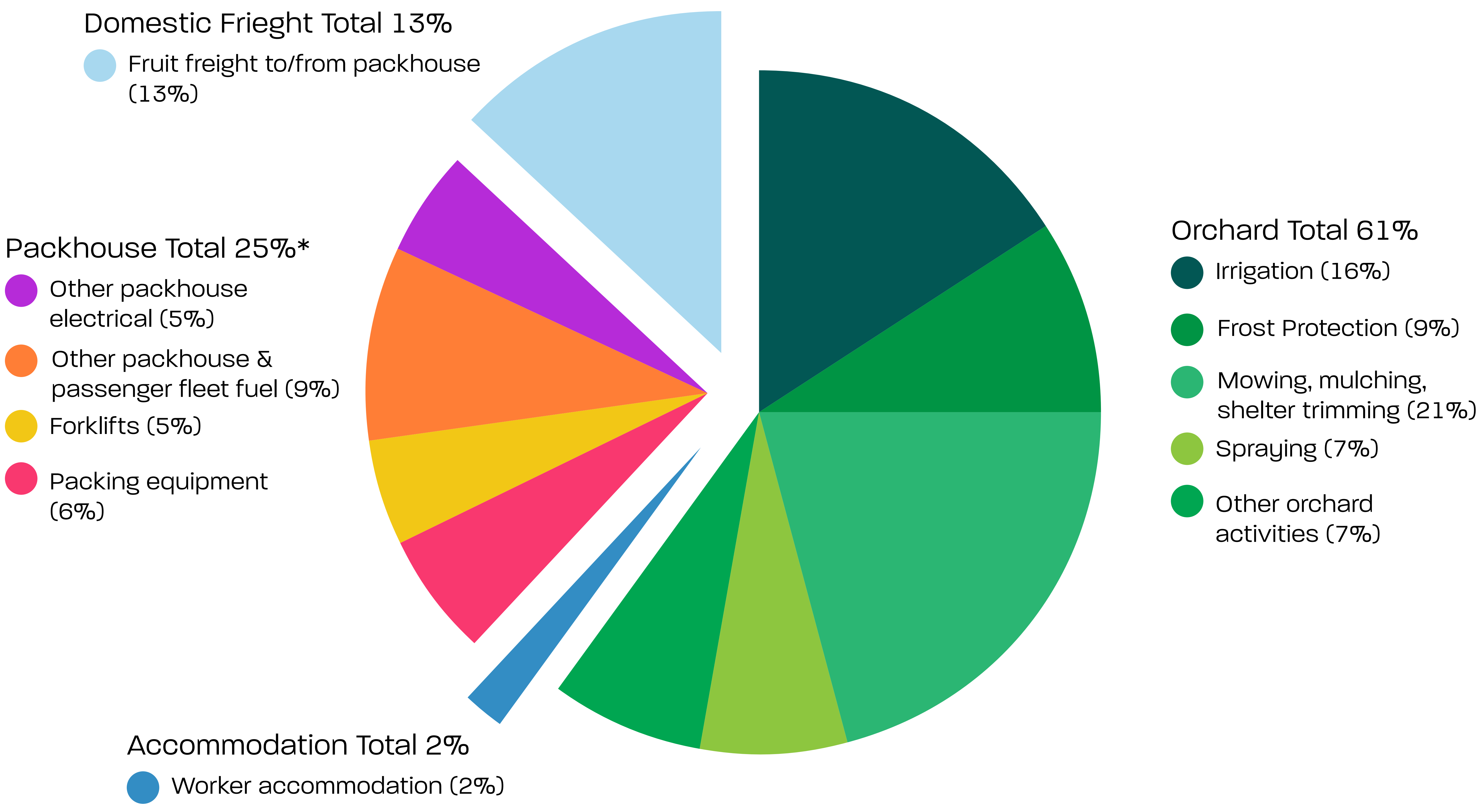
Where Energy is Typically Used

This graphic provides a nominal breakdown of typical energy use (both electrical and thermal) for the activities included within the Technology Scan scope.

The purpose of the graphic is to provide a general indication of where energy is typically used across the industry, which is helpful for prioritising opportunities and providing a reference point for discussion.

It should be noted that actual energy use for activities is highly dependent on a range of factors such as fruit type, equipment used, size and location of the orchard or packhouse, domestic freight requirements, etc. For example, orchards that rely heavily on diesel irrigation pumps may have a considerably higher percentage of their energy use be due to irrigation.

Also note that cool stores are out of scope which would otherwise account for a high portion of packhouse energy use in many cases.



* Excludes coolstores refrigeration

Global Best Practice

Orchards

- Precision orchard management: utilising technologies like sensors, drones, and GPS for targeted irrigation, fertilisation, and pest control, optimising resource use and boosting fruit yield and quality.
- Integrated Pest Management (IPM): reducing pesticide applications by using biological controls, resistant varieties, and monitoring, lowering fuel use for spraying and energy for pesticide production.
- Soil and water conservation: implementing cover crops, reduced tillage, and efficient irrigation systems to maintain soil health, prevent erosion, and conserve water.

Packhouses

- Heat recovery: from refrigeration and compressors for hot water.
- Automation and artificial intelligence (AI): implementing AI and robotics for sorting, grading, and packing to improve efficiency, and to reduce labour and waste.
- LED lighting.

Transport

- Decarbonised transport: electric vehicles, renewable diesel.

Key Global Markets - Differences between regions

Australia

- Solar panel installation has a high uptake on commercial buildings including packhouses due to the high suitability of the Australian climate for solar generation.
- AgTech encompasses innovations in agriculture aimed at improving efficiency, profitability, sustainability, and resilience. It includes devices, sensors, robotics, automation, and artificial intelligence and its uptake is being encouraged by government bodies such as Agriculture Victoria. Energy Smart Farming provides a variety of case studies. Energy Smart Funding Case Studies

Italy

- Integration of agrivoltaic systems, supported by government funding initiatives, including grants covering up to 40% of project costs and long-term feed-in tariffs for electricity production.

Netherlands

- Advanced automation and robotics: Dutch packhouses are integrating high-tech automation, including robotic packing lines and automated storage systems, to streamline operations and minimise energy use, with one example being the facility recently built by FruitMasters in Geldermalsen.
- Sustainable building practices: Facilities are being constructed or retrofitted to meet top sustainability standards, such as BREEAM Outstanding incorporating features like solar panels, high quality insulation, and gas-free operations to reduce carbon footprints.
- Smart logistics and energy reuse: Innovations like electric pallet trucks, cross-docking to reduce transport emissions, and utilising residual heat from refrigeration systems for office heating.

California

- Automation: Implementing AI and robotics to optimise orchard management and reduce labour costs.
- Programmable irrigation or fertigation: (precise application of fertilisers using a micro-irrigation system) for specific soil types and plant varieties within a field.
- Renewable diesel: Examples of companies switching orchard fleets from diesel to renewable diesel as well as goods trucking companies electrifying fleets.
- Whole Orchard Recycling (WOR): WOR has been trialled on Californian almond orchards where old trees are ground up and tilled back into the soil to improve soil health, sequester carbon, and enhance water retention.

Israel

- Robotics and smart automation for harvesting, spraying, mowing, sorting, and packing to reduce labour, cut fuel use, and lower energy consumption and emissions.
- Agrivoltaics: While not yet widespread, agrivoltaics for solar electricity is a growing trend in Israeli orchards.

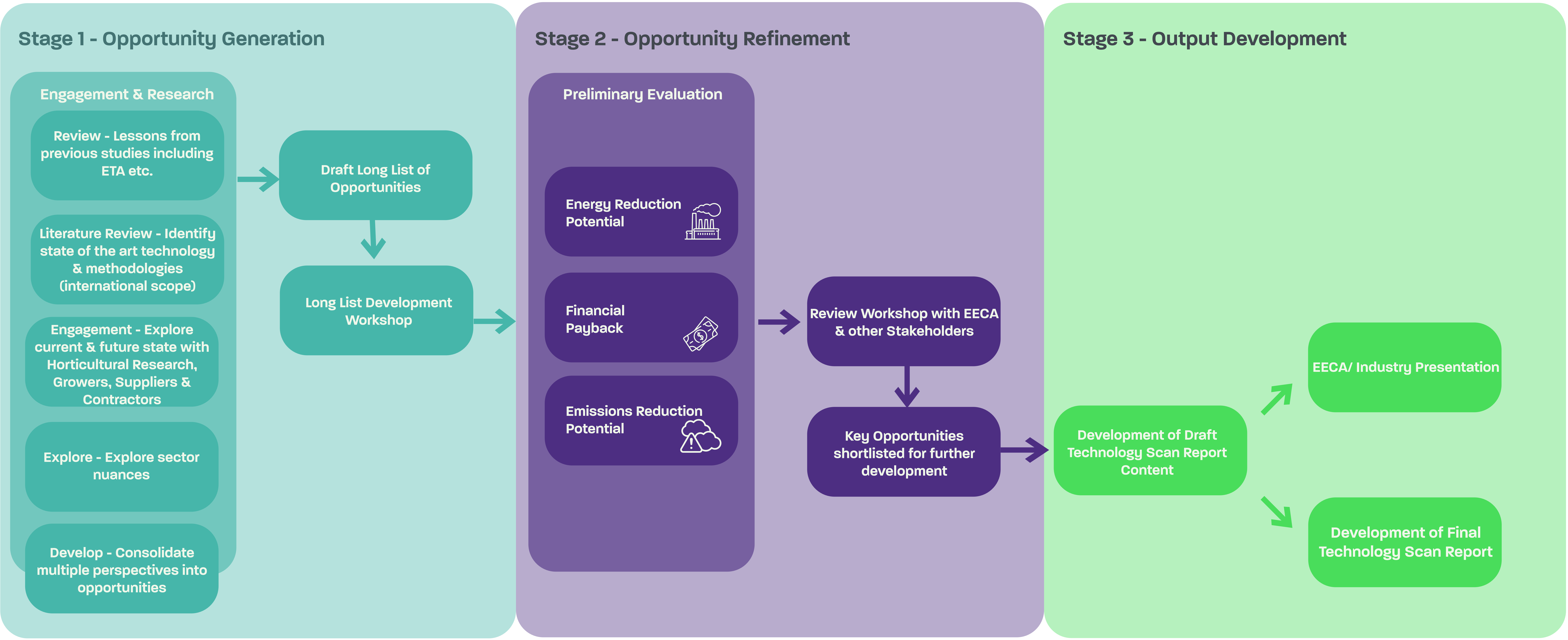
Methodology

This study focuses on reducing energy use from fossil fuels and electricity across New Zealand's orchards and packhouses. It aims to summarise global best practices, including both currently available technologies and those in development, that facilitate cost-effective decarbonisation in the short to medium term.

1. DETA Consulting Ltd (DETA) generated a wide and diverse pool of potential energy reduction technologies and methodologies through our experience in the industry, research, and engagement with a cross section of fruit industry representatives. A long list of 74 opportunities was produced.

2. Each opportunity was systematically assessed based on the evaluation criteria and given a score. The opportunities and scoring were reviewed with EECA and a cross section of fruit industry representatives to deliver the final shortlist of opportunities which would deliver the biggest impact based on the agreed criteria.

3. Chosen technologies were classified into 5 groups where orchard and packhouse operators could focus their efforts in achieving energy savings and decarbonisation. Ideas were elaborated on, key ideas summarised, and suppliers and case studies researched. The findings were then presented in a clear and concise document enabling industry stakeholders to make informed decisions about what opportunities to investigate for themselves.



DISCLAIMER: Typical energy reduction, financial payback, and emission reduction scores were developed for comparing options. Actual values will vary significantly depending on the specific parameters of the site and the existing equipment/technologies. Moreover, only operational greenhouse gas emissions impact has been taken into account, with embedded carbon in equipment and construction omitted.

Assessment/ Evaluation Criteria

Opportunities were scored based on the three criteria described below. The individual criteria scores were then each multiplied by an agreed weighting factor, before being added together to get the total opportunity score.

Energy Reduction

To assess the energy reduction potential of a technology, the relative reduction in energy demand (in kWh or GJ per year) was compared with the older technology it replaces. Where a technology was expected to have an impact on energy use further up or down the supply chain, an estimate of this effect was also included.

Score	Energy Reduction
3	High (>5% of in-scope energy equivalent)
2	Medium (1-5% of in-scope energy equivalent)
1	Low (<1% of in-scope energy equivalent)
	Weighting: 4

Financial Payback

To assess the financial payback of a technology, the typical incremental capital cost of the new technology was divided by the typical annual cost savings it would provide. This generally assumes an opportunity is implemented when old equipment requires replacement.

Score	Financial Payback
3	Short (<5 years)
2	Medium to long (5 to 10 years)
1	Very long or never (>10 years)
	Weighting: 4

Emissions Reduction

To assess the emissions reduction potential of a technology, the relative reduction in greenhouse gas emissions (in kgCO2e per year) was compared with the older technology it replaces. Where a technology was expected to have an impact on emissions further up or down the supply chain, an estimate of this effect was also included.

Score	Reduction
3	High (>5% of in-scope emissions equivalent)
2	Medium (1-5% of in-scope emissions equivalent)
1	Low (<1% of in-scope emissions equivalent)
	Weighting: 2

Example Calculation for Freight Transport Electrification opportunity (Pg.27)

Opportunity Technology *Weighting Factor*	Energy Reduction *4*	Financial Payback *4*	Emissions Reduction *2*	Overall
Freight Transport Electrification	3	1	3	22

Overall Score

(*3*x4) + (*1*x4) + (*3*x2) = **22**

Efficient Orcharding

The cheapest energy is the energy that is not used. Orchard activities represent 61% of this study's energy consumption scope, so improving efficiency of orchard operations can often represent a cost-effective way to significantly reduce overall energy and operating costs. Efficiency can be improved by either reducing energy demand or by increasing fruit yield for a similar amount of energy input required, both of which are considered in this section.

Feature Opportunities

Multi-Row and Multi-Linkage Machinery. Doing more work in a single tractor pass means less fuel is used moving equipment, and more of the fuel is used doing the actual task. This can yield energy, cost and labour savings depending on the specific equipment involved.

Drip Irrigation. On orchards that require high levels of irrigation the energy required for pumping can represent a significant part of the total energy demand, particularly where pumps are powered by diesel. Converting to drip irrigation can reduce water demand and also pumping energy demand.

Monitoring Systems. Sensors, drones, or satellites provide real-time data on soil, weather, and pests, enabling optimised irrigation and frost protection. This reduces energy waste, improves yields, and supports automation, with solutions scalable for small to large orchards.

Future Orchard Planting Systems (FOPS). The FOPS approach uses 2D planar tree structures to maximise sunlight interception, boosting yields (up to double) and reducing energy and nutrient costs per kg of fruit. Best suited for new orchards, it supports automation and lowers long-term labour needs.

Future Opportunities

High Yield / Low Input Cultivars. Plant & Food Research and Prevar are increasingly focusing new fruit cultivar development on high yields with lower inputs, reducing energy and chemical use (e.g., for irrigation and spraying) for better sustainability and profitability. One of the first of these more resilient varieties is Prevar's GoodnessMe® apple with double gene scab resistance, which was recently launched in European markets.

→ Plant and Food | Goodness Me

Other Notable Opportunities

Irrigation Pumps Sizing and Variable Speed Drives (VSD). Irrigation systems and pumps should be properly designed and specified to ensure efficient long-term operation. In most applications VSDs will be included in the design by default to allow efficient operation across the required range of flowrates.

Hydraulic Ram Pump for Irrigation. A ram pump uses water flowing downhill to pump a small portion uphill without electricity, operating continuously when there is adequate water. Viable for orchards in hilly areas with reliable streams and modest water needs (Ram pumps up to 5,400 L/h capacity are available in NZ from Quality Engineering Ltd. Ideal for niche applications.

Maintenance and Good Practices. All equipment should be well maintained, with particular focus on high energy demand equipment such as tractors, irrigation systems and frost fans, to ensure optimal running efficiency. Irrigation systems should be checked regularly for leaks, and to ensure flow and pressures are within 10% of the operating design conditions. Consider EECA's orchard efficiency checklist.

→ EECA | Orchard Efficiency Checklist

Multi-Row and Multi-Linkage Machinery

Using orchard machinery and equipment that can service multiple rows at the same time or perform multiple tasks in one pass, can significantly reduce vehicle fuel and labour. For many activities a large part of the fuel use is for moving the tractor so reducing tractor movements has major benefit in fuel consumption.

Commonly available examples include:

- Simultaneous mulching and mowing using tractors with front and back linkages.
- Carrying bins on both front and back of tractor to reduce trips required.
- Tower / over-the-row sprayers to cover three rows in a pass.

Where is this most viable?

- Larger orchards where utilisation hours justify investment in higher efficiency equipment.
- Terrain where it is easy to manoeuvre multi-row or multi-linkage setups.
- Orchards where frequent passes are required for spraying, mowing, or thinning.

Pros:

- Significant reduction (eg 20 to 50% reduction) in fuel use for the specific tasks where these solutions are used.
- Reduced labour costs as more work can be done in less time.
- May reduce soil compaction issues, though reduced vehicle movements are offset by heavier vehicle loaded weight.

Cons:

- More complex and expensive equipment.
- Skilled operators required as precision is required to avoid overlap, missed areas or damage.
- Less suitable for older or irregularly spaced plantings or orchards with difficult terrain.

TRS 03 Sprayer. Credit: TRS Equipment

Case Studies and Examples

→ Jeremy Walsh Viticultural Management spraying three complete vineyard rows in one pass using R-Series sprayers from TRS.

Supplier / Supporting Links

→ Vertical Spraying Solutions
→ Farmgard | Front rear mount mulchers
→ Landlogic | Over the row vineyard sprayer
→ TRS Equipment | Over the row orchard sprayer

Energy Reduction: 2 | Financial Payback: 2 | Emissions Reduction: 2 | **Total: 20**

Drip Irrigation

Drip irrigation is designed to slowly release water in a drip or trickle directly to tree roots using low-pressure systems, reducing evaporation, runoff, and pumping energy. Modern drip systems can be automated and integrated with soil moisture sensors, weather data, and smart controllers, allowing growers to fine-tune irrigation schedules and reduce unnecessary pumping.

Drip irrigation is commonly used on New Zealand orchards though can be challenging to successfully implement in orchards that have heavy clay or sandy soils.

Drip irrigation also allows precise fertiliser delivery to roots via fertigation, where liquid fertiliser is pumped through the system. This targets nutrients efficiently, reducing waste and costs for growers.

Where is this most viable?

- Regions where water can be scarce at times or expensive to access, and water restrictions can be enforced.
- Areas prone to erosion.

Pros:

- Reduced irrigation pumping energy demand (>30% reduction) due to lower water pressure and volumes required than for spray irrigation.
- Increased water efficiency as precise and slow delivery means the right amount of water is dispersed at the right time with no run-off and minimal waste.
- Lowered risk of plant disease because water is delivered at the base and doesn't touch the foliage.
- Potential integration with sensors, smart irrigation and fertigation systems.
- Allows use of recycled or recovered water whereas spray systems are regulated to use potable water.
- Suitable for all terrain types.

Cons:

- Installation and initial cost can be expensive, particularly for large or established orchards.
- Emitter/dripper can clog so requires filtered water and flushing.
- Unlike overhead sprinklers, drip systems do not provide frost mitigation.
- Requires a better understanding of irrigation scheduling and system maintenance.
- Plastic piping systems can be susceptible to rodent damage.

Cherry orchard drip irrigation. Credit: Irrigation Services

Case Studies and Examples

→ [Irrigation Services | Pisa View Trust - cherry orchard drip irrigation]
→ [Smart Irrigation | Blyth Orchard - apple orchard drip-micro irrigation]

Supplier / Supporting Links

→ [Thinkwater | drip irrigation]
→ [Irrigation Services]

Energy Reduction: 2 | Financial Payback: 2 | Emissions Reduction: 3 | **Total: 22**

Monitoring Systems

Monitoring systems using sensors, drones, or satellites can collect real-time data on soil moisture, temperature, humidity, and pest risks - enabling growers to optimise both energy use and crop yields.

Solutions range from simple, budget-friendly tools for small orchards to advanced, integrated systems for larger operations. Real-time alerts and remote control can be accessed via mobile apps or dashboard.

For irrigation, small orchards can automate watering with soil moisture sensors and smart controllers that respond to crop needs. Larger operations may add evapotranspiration models and weather forecasts for even greater precision.

For frost protection, temperature and humidity sensors can trigger frost fans or sprinklers only when necessary, reducing energy waste.

Where is this most viable?

- Basic monitoring tools are usually viable for small orchards.
- Larger operations and/or those with high-value crops (e.g. golden kiwifruit, cherries, berries) can justify investing in more advanced, costly systems to maximise efficiency and returns.
- Regions with variable climates where frost risk or drought conditions fluctuate seasonally.

Pros:

- Achieves significant energy savings by optimising irrigation and activating frost protection only when needed.
- Monitoring systems, from basic to advanced, are available to suit orchards of all sizes and types.
- Improves crop health and yield through consistent conditions and early detection of diseases or weather changes.
- Remote monitoring and automation reduce labour and improve convenience.

Cons:

- Potentially high initial costs for sensors and software require careful system selection.
- Complex systems may need significant training for data interpretation.
- Remote areas may lack adequate cellular networks for real-time access.
- Sensors typically require regular maintenance and recalibration for accuracy.

Energy Reduction: 2 | Financial Payback: 2 | Emissions Reduction: 3 | **Total: 22**

Digital Crop Estimate. Credit: Fruitometry

Case Studies and Examples

→ Harvest | kiwifruit orchard monitoring system

Supplier / Supporting Links

→ Vantage NZ | precision soil mapping, moisture monitoring, targeted spraying, and yield tracking
→ Fruitometry | vehicle-mounted counting and analyisis of fruit for kiwifruit orchards
→ Croptide | advanced crop and irrigation monitoring
→ Green Atlas Catrographer | vehicle-mounted counting and mapping of flower, fruit, weed, and tree structure
→ Motorola IRRInet System | remote control & monitoring for irrigation
→ Hortau | precision irrigation management with real-time soil moisture monitoring and AI-driven analytics

Future Orchard Planting Systems (FOPS)

FOPS Is a 2D growing system developed and refined by Plant & Food Research (PFR) since the early 2010s.

By training trees into tall, planar (2D) forms and narrowing row spacing, FOPS allows trees to intercept more of the available sunlight (e.g. 80%) with minimal shading. This improves fruit yield (up to double), quality and consistency – often without significantly increasing nutrient or water use per hectare. As a result, the energy and nutrient cost per kg of fruit is much less than in traditional systems.

FOPS uses narrower rows than traditional 3D growing systems (e.g. 2.2 m vs 3.5 m for apples), but wider spacing within rows (e.g. 2.4 m vs 1.5 m for apples), maintaining similar trees densities while converting sunlight into fruit more efficiently.

Where is this most viable?

- Fruit types available: apple, pear, summerfruit, others in development.
- New orchards or replanting.
- Requires innovative growers willing to learn and implement new systems.

Pros:

- Large on-orchard energy reduction (e.g. 30%) per kg of fruit produced, due to yield increase, less grass growth, fewer harvest picks required.
- Step change improvement in profitability per hectare.
- Large on-orchard energy reduction (e.g. 30%) per kg of fruit produced, due to yield increase, less grass growth, fewer harvest picks required.
- Better water efficiency: PFR research shows more apples per unit of water.
- Efficient harvesting: The 2D structure supports the use of modern harvest platforms, improving efficiency.
- Lower long-term labour costs: Easier pruning, less mowing and other activities.
- Automation-ready: 2D planar systems like FOPS simplify tasks and support future automation.

Cons:

- Requires learning a new growing system.
- High initial costs, mainly for trellis infrastructure.
- Labour-intensive setup in the first two years to train upright branches.

Energy Reduction: 3 | Financial Payback: 2 | Emissions Reduction: 3 | **Total: 26**

FOPS system. Credit: Plant & Food Research

Case Studies and Examples

→ Rockit Apples - Current main FOPS system user
→ Forest Lodge Orchards - UFO growing system (UFO is a predecessor to FOPS).

Supplier / Supporting Links

PFR's ongoing FOPS project, supported by MPI, SFFF and industry partners, aims to refine the system and overcome adoption barriers. Field days in Hawke's Bay and Central Otago—promoted via NZAPI and SNZ—let growers see FOPS in action and learn how to apply it.

→ Plant & Food | The Future Orchard

Electric and Autonomous Orcharding

Electric or autonomous orchard vehicles and other equipment have the potential to greatly reduce on-site energy consumption and operating costs. These benefits typically require higher up-front capital costs but pay for themselves in applications where annual run hours are sufficiently high.

Feature Opportunities

Battery-Electric Mobile Machinery. Electric tractors and mowers are ideal for orchard environments, where tasks are repetitive, low-speed, and require precision. These machines offer low energy costs and emissions, reduced noise, and lower maintenance costs.

Electric Pumps. These are a far more energy-efficient and low-emissions alternative to diesel pumps, making them a good opportunity for sites with adequate access to electricity.

Electric Frost Fans. Electric frost fans are a cleaner, quieter, and more efficient alternative to diesel, though their high operating power demands are likely to limit adoption to orchards that have frequent frosts and are close to adequate electricity infrastructure.

Autonomous Vehicles and Machinery. These combine automation with electric or diesel equipment to reduce labour needs and energy use, with options ranging from commercially well proven to emerging prototypes.

Drone Technology. Drones offer efficient, precise crop spraying and monitoring, reducing fuel and chemical use, though their size and regulatory requirements mean most orchards will rely on contracting such work to specialists.

Future Opportunities

A Greener Grid. New Zealand's electricity grid is already among the world's greenest, and it is expected to become increasingly renewable over the coming decade. This enhances the environmental benefits of electrification, making battery-electric machinery an even more compelling choice.

Other Notable Opportunities

Other Orchard Battery-Electric Vehicles and Power Tools. A growing range of battery-electric vehicles and power tools – such as utes, utility terrain vehicles (UTV), pruners and chainsaws – are now available. These reduce fuel use, improve worker comfort, and are well-suited to the stop-start nature of orchard work.

Solar and Battery Integration. Installing solar panels and on-site battery systems can allow orchards to generate much of the electricity required to power their electric machinery. This not only reduces reliance on the grid but also allows for energy storage during peak sunlight hours, enabling overnight charging and backup power during outages. Solar with battery integration typically has relatively long payback, but can be a good solution particularly where access to grid electricity is limited or if done as part of an overall transition to an electric orchard.

→ EECA solar on-farm programme

Battery-Electric Mobile Machinery

Battery-powered mobile machinery, such as tractors and mowers, run on rechargeable batteries, charged via the grid or onsite renewable energy. These machines eliminate diesel use in orchards, cutting operating costs and carbon emissions.

Globally, electric machinery is gaining traction in agriculture, from European vineyards to North American specialty crop farms, driven by stricter environmental regulations and the push for sustainability. Advances in battery technology are reducing costs, improving operating time, and reducing charging times required, making them increasingly practical for diverse orchard operations.

Examples include battery-electric tractors, mowers, electric trailer sprayers (powered by an electric tractor), and electrified harvest/picking platforms.

Where is this most viable?

- Orchards near affordable electricity connections.
- Operations able to charge during off-peak hours.
- Orchards with relatively flat terrain to maximise battery efficiency.

Pros:

- Large (e.g. ~50%) reduction in energy consumption and emissions of the specific equipment. For tractors this can represent a large share of total orchard energy use.
- Reduced energy and maintenance costs (fewer moving parts).
- Often allows for more precise speed and power control, enhancing work quality.
- Electric motors provide near-instant maximum torque and are more suitable for autonomous applications.
- Improves work environment by reducing noise and eliminating diesel fumes.

Cons:

- Battery-electric tractors may require purpose designed electric attachments.
- Higher upfront costs compared to diesel machinery.
- Well planned charging management is required to ensure availability, as charging takes time.
- Electricity supply infrastructure upgrade requirements may be cost prohibitive (depends on specific site location).

Energy Reduction: 3 | Financial Payback: 2 | Emissions Reduction: 3 | **Total: 26**

MKV Electric Tractor. Credit: Monarch

Case Studies and Examples

→ EECA LETF case studies
  * Robson-Williams conversion of old diesel tractor to battery-electric for lifestyle block
  * Lincoln University electric tractor to support solar photo-voltaic (PV) and agriculture co-production.
  * McFetridge battery electric elevating harvest platform.

Supplier / Supporting Links

→ Mean Green Products | electric lawnmowers
→ FJD Dynamic | electric lawnmowers
→ TRS Equipment | electric sprayer trailers
→ Nobili | electric sprayers and mulchers
→ Tuatara | electric UTV/ATV

Electric tractors:

→ Knegt
→ Monarch - electric and autonomous
→ Loxley Innovation - retrofit battery electric tractors
→ John Deere - high horsepower

Electric Pumps

Electric irrigation pumps are significantly more energy-efficient than their diesel counterparts, resulting in lower emissions and reduced operating costs in most situations.

Electric irrigation pumps typically achieve overall efficiency of 75-85%, compared to just 18-35% for diesel pumps, depending on their age and condition.

In some cases where irrigation demand over the year tends to correlate with sunshine hours, on-site solar PV generation, with or without battery storage or grid connection, can become cost effective.

Where is this most viable?

Likely to be viable for some sites, but cost prohibitive for others. Orchards with a combination of the following factors are likely to be most viable:

- Irrigation pumps have reasonably high annual run hours (e.g. 1,500 h/y or greater).
- Reasonable electricity grid access.
- Irrigation pumps are within a few hundred metres of the main electricity supply to the site.
- The orchard will benefit significantly from smart irrigation systems.

Pros:

- Irrigation energy demand cut by more than half and irrigation emissions cut by more than 75% vs using diesel pumps.
- Lower operating and maintenance costs (depending on lines charges and ability to take advantage of demand-flexing incentives).
- Can better enable smart irrigation systems with automation and remote monitoring, potentially improving crop health and reducing water waste.

Cons:

- Electricity supply upgrades or on-site cabling requirements is cost prohibitive on some sites.
- Fixed electric pumps are less mobile than diesel units, though portable electric options are emerging.
- High-capacity pumps may require careful planning to avoid peak electricity charges.

Energy Reduction: 3	Financial Payback: 2	Emissions Reduction: 3	**Total: 26**

Electric pump. Credit: Fraser Gear

Case Studies and Examples

- → Forest Lodge Orchards - Irrigation pump electrification & solar.
- → International examples of solar powered irrigation.

Supplier / Supporting Links

- → Grundfos - irrigation, agricultural & solar pumping solutions
- → Irrigation Services - irrigation system providers
- → Diesel versus electric versus solar - factsheet provided as a joint initiative between Cotton Australia, NSW Irrigators' Council and the NSW Office of Environment and Heritage.
- → Fraser Gear - irrigation & frost protection

Electric Frost Fans

Electric frost fans are an emerging innovation in orchard frost protection, offering a cleaner and potentially quieter alternative to traditional diesel-powered fans.

Electric frost fans are inherently far more efficient than diesel-powered frost fans due to the losses that occur when diesel engines convert chemical energy into mechanical energy. Electric frost fans also have fewer moving parts, lowering maintenance costs.

The main obstacle for widescale adoption of electric frost fans is that they draw a relatively large amount of electricity when running. This often requires expensive electrical infrastructure upgrades which may not be financially justified if annual frost fan operating hours are low.

AGI has indicated they are considering exploring the secondary use of electric frost fans as wind turbines. If such an option did become available it may improve the financial case for electric frost fans for orchards that experience significant wind.

Where is this most viable?

- Where new or replacement frost fans are being considered.
- Orchards that expect to have high frost fan usage.
- Orchards where electricity infrastructure upgrades required are modest.

Pros:

- Frost fan energy use and emissions reduced by >70% and >85% respectively vs using diesel frost fans.
- Lower operating and maintenance costs (depending on lines charges).
- Electric frost fans typically have VSDs that better integrate with smart control systems and remote monitoring, potentially improving crop health and reducing energy waste.
- Potentially less noise than diesel frost fans depending on specific models selected.

Cons:

- Initial investment is typically higher than for diesel models and can be far higher if substantial electrical infrastructure upgrades are required.
- The significantly higher capital cost is often not financially justified due to the low utilisation hours of the equipment.
- Fewer equipment models available compared to diesel.

Energy Reduction: 3 | Financial Payback: 1 | Emissions Reduction: 3 | **Total: 22**

Electric Frost Fan at Peregrine Estate. Credit: QueenstownNZ.co.nz

Case Studies and Examples

With the support of EECA's Technology Demonstration Fund, Forest Lodge imported and installed two electric frost fighting fans in 2020.

→ EECA | Forest Lodge | Electric Fans

→ Peregrine Wines | Electric Frost Fans

Supplier / Supporting Links

→ AGI - Frost fans

Autonomous Vehicles and Machinery

Autonomous tractors, weeding robots, and sowing machines enhance orchard efficiency by integrating advanced automation into some of the most energy-intensive activities.

These technologies go beyond simple electrification by eliminating the need for human operators. This dual benefit reduces labour costs and enables lighter, far more energy-efficient equipment, as it no longer needs to support an operator's weight.

Technologies range from commercially available equipment and accessories, through to cutting-edge prototypes that are still being trialled and refined.

Where is this most viable?

Viability criteria vary depending on the specific task being automated, but common features include:

- Orchards with flat to gently rolling terrain without large ruts or livestock.
- Large orchards or where multiple growers cooperate to share a unit to maximise its utilisation.
- Orchards with 2D planar growing systems generally better accommodate fruit imaging and picking due to fruit being more uniformly presented and visible.
- New orchards designed specifically for autonomous equipment.

Pros:

- Potentially >90% reduction in energy use, emissions and labour for common repetitive tasks such as mowing and weed spraying.
- High precision so only targets necessary areas.
- Ability to work continuously and consistently for long periods, in some cases at night.
- Rapidly developing artificial intelligence and robotics technology are likely to lead to major developments over the coming decade that offer significant first mover advantage to early adopters.

Cons:

- May require a major change to how an orchard runs to get maximum benefit of the technology. Requires learning.
- These are rapidly emerging and evolving technologies, some of which may not be fully proven yet in commercial use. Less proven equipment carries increased risk of downtime or other problems.
- Difficult to make confident long-term investment decisions when technologies are evolving rapidly.

Energy Reduction: 3 | Financial Payback: 2 | Emissions Reduction: 3 | **Total: 26**

Govor autonomous electric mower Credit: Agovor

Case Studies and Examples

The ZAG Zespri Innovation Fund recently trialled Govor, a commercially available lightweight electric autonomous towing machine which has modular towing attachments for weed spraying and for mowing. (Report yet to be released publicly).

- → Burro | 45 South Cherry Orchard | multifunctional autonomous vehicles
- → EECA LETF case studies

Supplier / Supporting Links

- → Govor - autonomous towing machine
- → Burro - multifunctional autonomous vehicle
- → Oxin - autonomous & multitasking robotic tractor
- → Prospr - autonomous multi-purpose hybrid vehicle platform with intelligent spraying
- → Ecorobotix Crop Care - AI-powered targeted spot spraying technology
- → Washington State and Oregon State Universities - developing robotic solutions for pollination, fertilisation and pruning

Drone Technology

Drone technology can be used in multiple ways on orchards, most commonly for targeted crop spraying and for mapping and monitoring crop condition, supporting precise, sustainable management.

Using drones for these tasks allows one operator with a drone to cover large areas of orchard in a shorter time and with less fuel and chemical use than traditional ground-based methods.

Once an orchard is mapped the drone can then operate semi-autonomously, though the operator is required to maintain supervision throughout the operation.

Agricultural spraying drones include some of the largest commercially available drones, that can be as much as 3 m across and carry payloads of up to 70 kg of liquid. Operating these large drones requires a range of training and certifications to ensure compliance with Civil Aviation Authority regulations. For that reason most orchards are likely to contract out drone work to specialist contractors.

Where is this most viable?

- Irregularly shaped orchards or where terrain is challenging for ground based machinery.
- Disease prone or sensitive crops that would benefit from drone monitoring of crop health.
- Orchards without netting above the canopy.
- Where targeted spraying is required.

Pros:

- Large reduction in energy use and emissions for the crop spraying tasks it is used for.
- Reduced labour costs.
- Less machinery moving through the orchard reduces soil compaction and damage to plants.
- Mapping and monitoring increase visibility of operations and allows for data analysis of product quality, pruning effectiveness, and the impacts of new or different activities/fertilisers.
- Precise application can reduce the amount of fertiliser or spray needed.

Cons:

- Not suitable for orchards with netting above canopy.
- Significant establishment cost and high level of training and operator skill required.
- Weather dependent operation.
- Requires supervision from a skilled operator even during semi-autonomous operation for regulatory compliance.
- New technology still establishing best practices and applications in NZ orcharding.

Energy Reduction: 2 | Financial Payback: 2 | Emissions Reduction: 3 | **Total: 22**

XAG drone spraying at Felton Road. Credit: Felton Road

Case Studies and Examples

→ XAG drones used for spraying at Felton Road.
→ XAG drones applying pesticides in a pomelo orchard in China. - 78% water savings, 33 ha sprayed in one day

Supplier / Supporting Links

→ Aerolab – training and support for establishing an agricultural drone operation.
→ DJI - a global leader in agricultural drones
→ Aerofarm – agricultural drone services for spraying, spreading, and field mapping, and supplier of drones with up to 70 kg payload.

Packhouse Efficiency

The most cost-effective opportunities to reduce operating costs, energy use, and emissions often involve using energy more efficiently. This is certainly true for packhouse operations, which represent 25% of this study's energy consumption scope, and is the focus of this section.

Feature Opportunities

LED Lighting. Although it may be less interesting than high-tech fruit grading equipment or the latest packing machine, upgrading to LED lighting commonly represents a simple and predictable opportunity to permanently reduce energy and maintenance costs for a packhouse.

Packhouse Site Layout. New sites and major site expansions offer a crucial opportunity to permanently embed inherent efficiencies into the site operations. This involves careful design of the site layout to optimise fruit and forklift movements, which can greatly reduce forklift requirements and minimise fruit handling.

Future Opportunities

Efficient Hot Water Production. Hot water use is relatively minor at most packhouses currently, but the apple industry is investigating hot water washing of fruit to improve long term product quality. If this becomes a common practice, then apple packhouses may have to provide significant quantities of hot water for this. Key opportunities for efficient hot water production are below. Note that these will only likely be viable if there is hot water demand over a significant part of the year to justify the capital expense of these systems:

- Utilising waste heat recovery from site refrigeration systems. Depending on the design of the refrigeration system it may be possible to recover 15 to 25% of the total cooling load as hot water at temperatures up to 60°C with effectively no ongoing operating cost.
- Air-sourced hot water heat pump. Air-sourced hot water heat pumps are seeing increasing adoption across industrial and commercial sites for potable water heating duties as they typically have a coefficient of performance (COP) of 3 to 4, which means that operating costs are typically around 25-35% of an electric resistance heater, or 50-70% of an LPG hot water heater.

→ EECA | Good Practice Guide - Industrial Refrigeration

Other Notable Opportunities

Maintenance and Good Practices. A poorly maintained or operated site can significantly increase energy costs. Packhouses should prioritise good maintenance and operating practices, including:

- Preventative maintenance practices.
- Implementing a compressed air leak detection and repair plan.
- Having heating ventilation and air conditioning (HVAC) setpoints reviewed regularly and set appropriately, and minimising unnecessary use.
- Minimise air infiltration into temperature controlled spaces (may include rapid roll doors in high use duties).

Coolstore Operations. Though not included within the scope of the present review, coolstore refrigeration systems are extremely important to many packhouses and often represent the vast majority of site energy consumption.

→ EECA | Packhouse and Coolstores Sector Pathway
→ EECA | Packhouse and Coolstores Efficiency Checklist
→ EECA | Refrigeration Energy Efficiency Checklist

LED Lighting

Switching to LED lighting is a highly effective way to cut energy costs in packhouses that are still using older lighting systems in high use applications. For those yet to make the transition, this upgrade offers a significant, cost-efficient opportunity to reduce operational expenses.

An important co-benefit of LED lighting in the context of packhouses is that LED lights can be selected to provide optimal light levels for grading activities, which may provide material production benefits for some sites.

LED lighting replacements are usually done either by progressively replacing old fluorescent or other lighting types as they fail, as part of a maintenance programme, or by carrying out a larger capital project to replace entire areas of lighting at one time. The advantage of the latter is that it lends itself to carrying out a wider reassessment of lighting needs, including potential installation of daylight or motion sensors to automatically reduce unnecessary use of lighting.

Good quality LED lighting not only uses less electricity than older lighting technologies, it also has far longer operating life, which can represent a significant maintenance cost saving, particularly for lighting that requires heights access equipment to replace.

Where is this most viable?

- Lighting that has high run hours.
- Lighting for fruit grading or repacking tables.
- Old lighting systems that use particularly inefficient technologies.
- Areas where lighting is on for large periods of time unnecessarily.

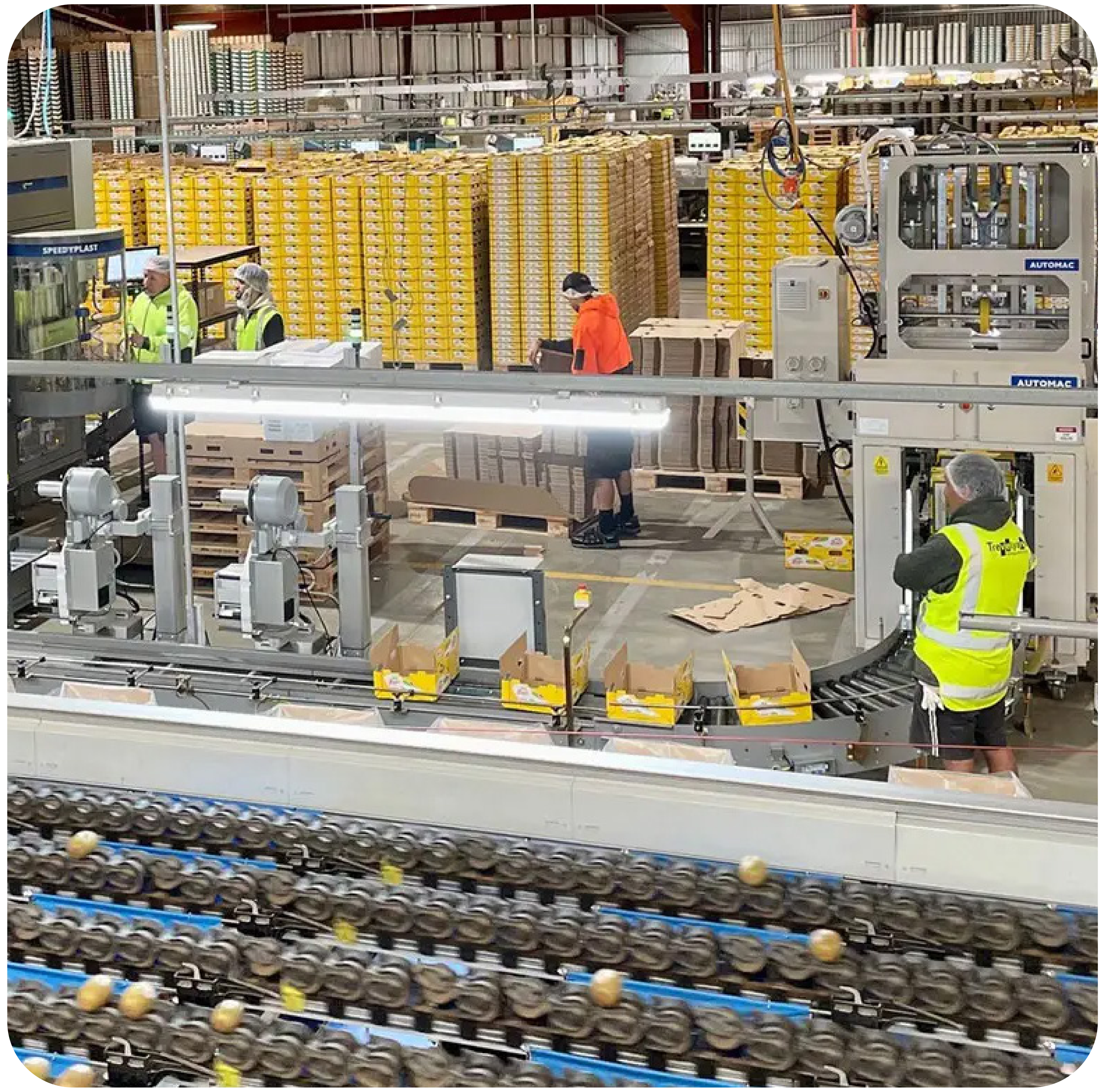
Pros:

- Large reduction in electricity demand for lighting (typically >50%).
- Reduced maintenance costs due to longer operating lives (50,000 h typical).
- Improved light levels for fruit grading.

Cons:

- Best final solution may require replacing large areas of lighting at once even when some of the existing lighting may have recently been replaced.
- Financial payback can be poor for lighting that runs for only a few hours per day on average.

Energy Reduction: 2 Financial Payback: 2 Emissions Reduction: 2 **Total: 20**



Trevelyan's Packhouse. Credit: EECA

Case Studies and Examples

→ Trevelyan's - Packhouse LED lighting upgrade project

Supplier / Supporting Links

→ Nugreen - lighting specialists who also offer Lighting as a Service

Packhouse Site Layout

For new packhouse sites or major redevelopments the importance of carefully designing the site layout should not be underestimated. Key concerns are to optimise fruit handling as well as bin and pallet movements, to minimise forklift activity required. This may also involve the strategic use of conveyors to transport fruit along key routes of travel.

A new packhouse with a well-designed layout may require less than one third as many forklifts that an older sprawling site of similar capacity would require. This represents substantial cost savings in terms of energy use, leasing costs, maintenance and labour, while also reducing risk of product damage.

Where is this most viable?

- Greenfield site developments or where major redevelopments are required
- Where certain forklift routes are heavily used

Pros:

- Large (eg >50%) reduction in forklift activity required, cutting forklift energy, emissions and labour proportionally.
- Significant reduction in health and safety risk on site from forklift and other vehicle movements.
- Less fruit handling may offer product quality benefits in some cases.

Cons:

- Only applicable to new sites or sites undergoing major redevelopment.
- Significant design input required early on in process to maximise benefit.

Packhouse. Credit: MPAC

Case Studies and Examples

→ [MPAC's state-of-the-art packhouse facility at the Tauriko Business Estate, Tauranga]

Energy Reduction: 2 | Financial Payback: 3 | Emissions Reduction: 2 | **Total: 24**

Packhouse Electrification Opportunities & Renewable Energy

Most packhouse operations are heavily electrified already, but there will usually be some activities that still rely on fossil fuels. Electrification of those activities is the focus of this section, along with options for sourcing electricity that is more renewable than standard grid electricity.

Feature Opportunities

Battery-Electric Passenger Fleet Vehicles. Transitioning high-use, locally driven leased passenger vehicles to electric vehicles (EVs) can significantly reduce energy use, emissions, and operating costs with relatively low capital expense. Despite the recent addition of Road User Charges to EVs, for appropriately selected vehicles doing >25,000 km/y this will usually be cost effective.

Solar Electricity Generation. Behind-The-Meter (BTM) solar PV systems, installed on packhouse roofs or ground-mounted arrays, will typically reduce electricity costs and emissions by 5-15%, especially for sites with high summer demand. Solar arrays can either be owned by the packhouse operator or by a third party who sells the electricity produced to the packhouse via a Power Purchase Agreement (PPA).

Future Opportunities

A Greener Grid. New Zealand's electricity grid is already among the world's greenest, and it is expected to become increasingly renewable over the coming decade, reducing emissions from packhouse electricity use.

Other Notable Opportunities

Battery-Electric Forklifts. . Most sites are now using battery-electric forklifts for most forklift duties as they use less than half the energy of diesel or LPG models, cutting operating costs significantly, and being especially beneficial where exhaust fumes risk fruit ripening. Higher capital costs require moderate run hours for economic viability, and fast-charging models need staggered charging to avoid peak demand charges.

Sleeved Solar PPA. Off-site sleeved Power Purchase Agreements (PPAs), such as those offered by Lodestone, allow packhouses to source all electricity from renewable sources with Renewable Energy Certificates (RECs), meeting Science Based Targets initiative (SBTi) emission reduction targets (if relevant) without on-site infrastructure. This eliminates capital costs for solar arrays, providing cost-effective, scalable renewable energy, though benefits depend on contract terms and grid pricing.

Battery-Electric Passenger Fleet Vehicles

For sites that lease their passenger fleet vehicles, a good opportunity to reduce energy use, emissions and operating costs for relatively minor capital expense can be to transition the highest use vehicles to equivalent EVs. While the introduction of Road User Charges (RUC) has impacted electric vehicle (EV) economics, for high use vehicles with mostly local travel, the switch generally remains cost-effective, depending on the models chosen.

How and where EVs will be charged is a key topic to work through. Slow chargers have relatively low installed capital cost and minor impact on site electrical loads, while fast chargers can have much higher installed capital cost and can impact significantly on electricity lines charges. An optimal solution for an EV fleet will commonly involve multiple slow chargers used primarily overnight, as well as one or two fast chargers for occasional on-demand charging when required.

Where is this most viable?

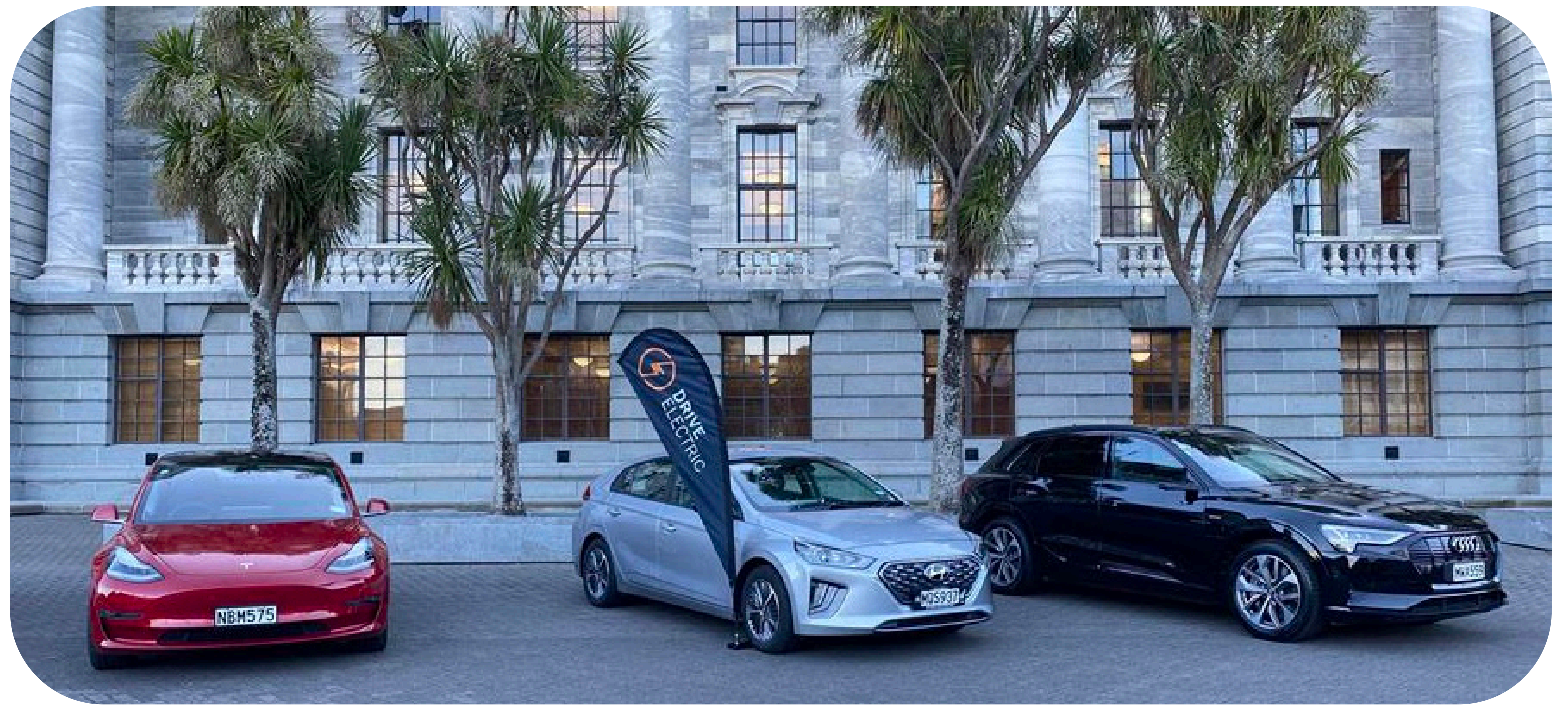
- High use cars (eg average >500 km/wk) that do mostly local travel and can charge overnight. EV ute options are becoming available but few options at present.
- Leased fleet vehicles. Owned EVs can be viable but payback tends to be long.
- Sites with sufficient electrical capacity to add EV chargers.

Pros:

- 60-75% reduction in energy use and >85% reduction in emissions for passenger fleet vehicles (typical).
- Reduced operating costs (excluding lease cost) equivalent to $8 to $15 per 100 km driven, depending on specific vehicles.
- Relatively low capital cost for charging if primarily using slow chargers.
- If fleet vehicles are leased, then there may be no other capital costs incurred.
- Can scale into the opportunity, transitioning the highest use most suitable vehicles first, then others as EVs become increasingly cost competitive.

Cons:

- Can become cost prohibitive if there is insufficient electrical capacity to accommodate the desired EV chargers.
- Education and first-hand experience required to overcome the range anxiety that many new users have.
- Cars allocated to individuals and taken home after hours may require specialised arrangements for reimbursing the user for at-home charging costs.
- Limited (but increasing) options for replacing utes with EV equivalents.
- If vehicles are owned outright then purchase cost of EV is typically higher than purchase cost of equivalent fossil fuel powered vehicles giving long repayment time.



Electric vehilces Credit: Drive Electric

Energy Reduction: 2   Financial Payback: 3   Emissions Reduction: 2   **Total: 24**

Case Studies and Examples

- → Custom Fleet learnings from EV work with The Warehouse Group, Watercare Services, and Queenstown Lakes District Council
- → EECA & Custom Fleet - EV Lease pilot

Supplier / Supporting Links

- → Drive Electric - knowledge hub and tools to assess EV options.
- → EECA's EV vehicle cost comparison including electric van options.
- → Driveline - fleet vehicle leasing
- → Electric vehicle database

Solar Electricity Generation

Solar Photo-Voltaic (PV) electricity generation can be used to reduce packhouse energy costs and emissions associated with purchasing grid electricity. The simplest way to employ this technology is to install Behind-The-Meter (BTM) solar arrays either on building roofs or mounted on the ground.

Solar arrays can either be owned by the packhouse operator or by a third party who sells the electricity produced to the packhouse via a Power Purchase Agreement (PPA) or a Solar As a Service (SAS) agreement. The benefit of a third party owning the solar array is that it eliminates most or all the capital investment required from the packhouse operator.

The highest return-on-investment solar array size is commonly slightly larger in capacity than the normal daytime summer electricity demand of the site. This allows most of the electricity generated to be used by the site, as any surplus sold to the grid is usually sold at relatively low unit prices.

Depending on the specific demand profile of the site, such a solar array commonly provides 5 to 15% of the annual electricity needs of the packhouse site.

Where is this most viable?

- Packhouses that have substantial summer electricity demand.
- Sites where building designs have sufficient strength to accommodate solar arrays on their roofs or available land for ground mounted arrays.

Pros:

- 5 to 15% reduction in ongoing electricity costs and emissions.
- Good optics from a marketing perspective.
- Can scale into the opportunity if desired.

Cons:

- Limited reduction achievable without addition of batteries, which usually require additional reasons for installing to justify, though battery prices are reducing.
- Installing on-site solar worsens the financial benefit of then later contracting for a sleeved solar PPA.

Commercial Solar Array Credit: Supreme Solar

Case Studies and Examples

→ Seeka reported 791 kW of installed solar generation capacity in their 2024 sustainability report, with a target of 1,000 kW in 2025

Supplier / Supporting Links

There are numerous good options for commercial solar, such as:

→ Supreme Solar
→ Sunergise
→ Infratec
→ Lightforce

Energy Reduction: 2 Financial Payback: 2 Emissions Reduction: 2 **Total: 20**

Low Emission Domestic Freight

Domestic freight accounts for approximately 13% of this study's energy consumption scope and encompasses the fuel used to move fruit from the orchard to packhouse and from packhouse to port or to its final destination within New Zealand.

Feature Opportunities

Freight Transport Electrification. Electric freight is now an available option in some parts of New Zealand and appears to be the direction short- and medium haul freight is likely to progressively move toward as electric truck capital costs reduce and range improves. Using battery-electric trucks cuts energy use and emissions of domestic freight by more than half, representing a significant opportunity that is likely to become more and more cost effective in coming years.

Future Opportunities

Hydrogen Freight Trucks. These provide a decarbonisation alternative to battery-electric trucks, offering longer range and faster refuelling for long-haul freight, plus higher payload due to lighter powertrains. Higher capital and operating costs compared to diesel or battery-electric are a drawback. Battery-electric trucks are generally more cost-effective for short- and medium-haul routes, but hydrogen may gain traction where early adopters operate. Cost and infrastructure developments will be key to watch.

Renewable Diesel. This is a direct drop-in replacement for petroleum diesel but made from renewable sources. Renewable diesel is not readily available in NZ but is used extensively elsewhere. If/ when renewable diesel becomes widely available here it is expected to be sold at a significant premium to petroleum diesel but will provide a zero-capital-cost method to greatly reduce freight emissions.

Low Emission Freight Certificates. LEFCs, the development of which are currently being assessed by the Sustainable Business Council, aim to accelerate low-emission truck adoption by improving return on investment and enabling targeted Scope 3 emission reductions for organisations. LEFCs enable freight companies to earn premiums for using low emission vehicles, helping offset their higher costs. The feasibility summary report is due to be released in the 3rd quarter of 2025, with the development of a registry being the next step.

Other Notable Opportunities

Efficiency Checklists. Freight contractors should ensure they are following good efficiency practices, such as those detailed in EECA's Energy Efficiency Checklist for Heavy Freight.

→ EECA | Energy Efficiency Checklist for Heavy Freight

Rail Transport. Rail transport is highly energy-efficient, using about 20% of the fuel required by diesel trucks over the same distance, however fruit transport by rail in New Zealand is rare. The additional handling needed to transfer fruit from truck to rail, combined with the proximity of most fruit packhouses to destination ports, often makes rail cost-ineffective. Long-haul routes, like Central Otago to North Island ports, may offer potential for cost-effective rail use, but viability requires case-by-case assessment.

→ Dept of Transport | Renewable Freight Certificate Assessment Report

Freight Transport Electrification

Though still niche, freight contractors are now operating a small number of battery electric trucks in New Zealand. These offer a step change reduction in energy use and emissions associated with domestic freight.

As battery technology continues to advance, batteries are becoming more energy-dense and capable of faster charging, making battery-electric trucking increasingly viable over short, medium and long-haul routes.

The significantly higher capital cost of battery electric trucks mean contracted electric freight is currently more expensive than traditional diesel freight, however this premium is expected to gradually disappear over coming years as electric truck costs reduce.

Where is this most viable?

- High use routes that provide the high utilisation required for electric trucks to pay off their higher capital cost.
- Scheduled, repeatable routes, that allow for predictable, low cost charging.
- Short to medium haul routes.
- Hilly routes where regenerative braking can provide significant benefit.

Pros:

- 50 to 70% reduction in energy use and >80% reduction in emissions for domestic freight (typical).
- Reduced operational costs for electric truck operators due to lower energy and maintenance costs.
- Avoids potential for truck emissions to accelerate fruit ripening when idling at orchard or packhouse.
- Improved operating environment for workers.
- Excellent marketing opportunity.
- Potential funding support for early adopters, e.g via the Low Emissions Heavy Vehicle Fund (LEHVF).

Cons:

- Higher cost to contract than diesel at present but expected to become more competitive over time.
- Higher upfront cost limits rate of adoption to applications where customers are willing to pay a premium. Note: some applications may be eligible for support from LEHVF.
- Requires charging infrastructure at truck depots. Currently there is a lack of public heavy vehicle chargers, but this is set to increase in coming years.
- Batteries add weight, which reduces the payload of an electric truck vs an equivalent diesel truck.
- Slower refuelling than diesel until advancements in technology address this.

Energy Reduction: 3 | Financial Payback: 1 | Emissions Reduction: 3 | **Total: 22**

Electric long range truck Credit: E-trucks

Case Studies and Examples

- → Foodstuffs and EECA - first fully electric refrigerated logistics truck in 2020.
- → Reliance Transport medium-duty electric Scania trucks for containers and freight.
- → Mainfreight electric trucking for Forest Lodge Orchard cherries

Supplier / Supporting Links

- → EECA article - charging forward: trialling battery electric trucks in your fleet.
- → Transport projects co-funded by EECA
- → Ara ake heavy freight total cost of ownership (TCO) tool
- → E-Trucks – supplier of battery-electric heavy vehicles to New Zealand.
- → EECA | Low Emissions Heavy Vehicle Fund

Opportunities List

Scoring Category	Energy Reduction	Financial Payback	Emissions Reduction	Overall
Weighting Factor	4	4	2	/30

Orchard Opportunities

Area	Opportunity type	Opportunity Technology	Energy Reduction	Financial Payback	Emissions Reduction	Overall
Feature Opportunities						
Minimise need for intervention	Efficient Orchard	Future Orchard Planting Systems (FOPS)	3	2	3	26
Orchard tractors & machinery	Electric Orchard	Battery-electric mobile machinery	3	2	3	26
Pumps	Electric Orchard	Electric pumps	3	2	3	26
Orchard tractors & machinery	Electric Orchard	Autonomous vehicles and machinery	3	2	3	26
Pumps/ irrigation	Efficient Orchard	Drip irrigation	2	2	3	22
Monitoring	Efficient Orchard	Monitoring systems	2	2	3	22
Frost protection	Electric Orchard	Electric frost fans	3	1	3	22
Automation	Electric Orchard	Drone technology	2	2	3	22
Orchard tractors & machinery	Efficient Orchard	Multi-row and multi-linkage machinery	2	2	2	20
Other Opportunities						
Pumps/ irrigation	Efficient Orchard	Irrigation efficiency checks	2	3	2	24
Orchard tractors & machinery	Renewable energy	Non-electric renewable fuel tractor options	3	1	3	22
Pumps/ irrigation	Efficient Orchard	VSDs on pumps	2	3	1	22
Fertiliser	Technology change	Biochar	1	3	3	22
Orchard tractors & machinery	Efficient Orchard	Operational efficiency improvements	1	3	2	20
Pumps/ irrigation	Renewable energy	Solar water pump	2	2	2	20
Pumps/ irrigation	Renewable energy	Hydraulic Ram pump for irrigation water	2	2	2	20
Electricity supply	Renewable energy	Orchard solar PV/ agrivoltaics	2	2	2	20
Minimise need for intervention	Nutrient recovery	Whole Orchard Recycling (WOR)	2	2	2	20

Opportunities List

Area	Opportunity type	Opportunity Technology	Energy Reduction	Financial Payback	Emissions Reduction	Overall
Minimise need for intervention	Technology change	Cover planting to reduce herbicide requirements	2	2	2	20
Minimise need for intervention	Orchard design	High yield low input fruit varieties	2	2	2	20
Hail protection	Efficient Orchard	Hail nets	2	2	2	20
Electricity supply	Renewable energy	Grid decarbonisation	1	3	2	20
Frost protection	Electric orchard	Electric heating wires for frost protection	2	1	3	18
Fertiliser/ sprays	Technology change	Low carbon synthetic fertilisers	1	2	3	18
Frost protection	Efficient Orchard	Frost cloth	2	1	2	16
Electricity supply	Renewable energy	Hydropower from irrigation dams	2	1	2	16
Electricity supply	Renewable energy	Wind turbine electricity on site	2	1	2	16
Waste to energy	Renewable energy	Hydrogen generation	2	1	2	16
Minimise need for intervention	Technology change	Sheep grazing	2	1	2	16
Fertiliser	Technology change	Compost	1	2	2	16
Tools	Electric orchard	Battery electric hand tools	1	2	2	16
Pest Control	Other	Biological control	1	2	2	16
Pest Control	Technology change	Use of pheromones	1	2	2	16
Orchard tractors & machinery	Electric orchard	Electrifying orchard mobility	1	2	1	14
Frost protection	Renewable energy	Renewable diesel for frost fans	1	1	3	14
Pumps	Renewable energy	Renewable diesel for diesel powered pumps	1	1	3	14
Waste to energy	Renewable energy	Burning waste for fuel	1	2	1	14
Waste to value	Technology change	Packaging made from pruning waste	1	2	1	14
Waste to value	Technology change	Biosurfactants made from pruning waste	1	2	1	14
Frost protection	Renewable energy	Anti-frost bio-wax candles	1	2	1	14
Orchard tractors & machinery	Energy efficiency	Fuels with cleaning additives for engine efficiency	1	2	1	14
Sequestration	Sequestration	Plant trees in low utilised areas to sequest CO_2	1	1	2	12

Packhouse Opportunities

Area	Opportunity type	Opportunity Technology	Energy Reduction	Financial Payback	Emissions Reduction	Overall
Feature Opportunities						
Forklifts/ fruit handling	Packhouse efficiency	Site layout	2	3	2	24
Fleet vehicles	Packhouse electrification	Fleet vehicle electrification	2	3	2	24
Lighting	Packhouse efficiency	LED lighting for high use areas	2	2	2	20
Electricity supply	Packhouse renewable energy	Solar electricity generation	2	2	2	20
Other Opportunities						
Forklifts	Packhouse electrification	Electrification of forklifts	2	2	2	20
Hot water	Packhouse efficiency	Heat recovery for hot water production	2	2	2	20
Electricity supply	Packhouse renewable energy	Sleeved renewable PPA	1	3	2	20
Lighting	Packhouse efficiency	Light level sensors for lights	1	3	1	18
Lighting	Packhouse efficiency	Seperate lighting circuits for manual screening	1	3	1	18
Compressed air	Packhouse efficiency	Compressed air leak maintenance plan	1	3	1	18
Water pumping	Packhouse efficiency	High efficiency apple washing systems	2	2	1	18
Monitoring	Packhouse efficiency	Monitoring solutions	1	3	1	18
Quality	Monitoring	Near infrared and camera grading	1	3	1	18
Packing machinery	Packhouse automation	Automated packing	1	3	1	18
Packing machinery	Packhouse automation	Automated palletising	1	3	1	18
Packing machinery	Packhouse efficiency	Switch off equipment during breaks	1	3	1	18
Worker accommodation	Accommodation efficiency	Low flow shower heads at orchard accommodation block	1	3	1	18
Worker accommodation	Accommodation efficiency	Turn off lights when not required	1	3	1	18
Worker accommodation	Accommodation electrification	Heat pumps	1	3	1	18
Forklifts/ fruit handling	Packhouse automation	Automated bin tippers	1	2	1	14
Forklifts	Packhouse automation	Autonomous vehicles	1	2	1	14
Electricity supply	Renewable energy	Renewable energy certificates (RECs)	1	1	3	14

Area	Opportunity type	Opportunity Technology	Energy Reduction	Financial Payback	Emissions Reduction	Overall
Electricity supply	Renewable energy	Battery Energy Storage System (BESS)	1	2	1	14
On-site electrical infrastructure	Packhouse efficiency	Improve power factor correction	1	2	1	14
Worker accommodation	Accommodation electrification	Hot water heat pump for accommodation block	1	2	1	14
Worker accommodation	Accommodation efficiency	LED lighting for accommodation block	1	2	1	14
Worker accommodation	Accommodation efficiency	Energy efficient appliances for accommodation block	1	2	1	14
Worker accommodation	Accommodation electrification	Electric appliances for accommodation (replacing gas)	1	2	1	14

Domestic Freight Opportunities

Area	Opportunity type	Opportunity Technology	Energy Reduction	Financial Payback	Emissions Reduction	Overall
Feature Opportunities						
Domestic freight	Low emissions domestic freight	Freight transport electrification	3	1	3	22
Other Opportunities						
Domestic freight	Low emissions domestic freight	Hydrogen trucks	3	1	3	22
Domestic freight	Freight efficiency	Heavy freight efficiency checklist	1	3	2	20
Domestic freight	Low emissions domestic freight	Rail transport	2	2	2	20
Domestic freight	Low emissions domestic freight	Low Emission Freight Certificates	1	1	3	14
Domestic freight	Low emissions domestic freight	Renewable diesel	1	1	3	14