University of Nottingham
Food Systems Institute

Policy Brief 2025
Centre for Food Policy and Foresight

Unlocking a 90% Carbon Reduction in UK Dairy by 2050

Executive Summary

The dairy industry is highly carbon intensive. This policy brief seeks to understand the optimal outcomes for the dairy industry to minimise carbon emissions and contribute towards meeting the UK Government's 2050 net zero goal.

The food sector needs to demonstrate emissions reductions beyond just farm level, throughout manufacturing and distribution. Investment decisions need to be made using evidence to ensure they are sustainable, efficient and align with climate goals. It is vitally important to implement changes to ensure the industry remains compliant with future regulations while still meeting consumer demand.

Currently there is a lack of dairy sector specific decarbonisation guides and a dairy specific scenario based roadmap to reduce emissions and transition to net zero is therefore needed.

The highest energy consumers in the dairy supply chain are transport, pasteurisation and Cleaning-in-Place (CIP), with these prioritised for intervention.

Using a flexible modelling tool, major dairy emissions reductions (up to 90% by 2050) are achievable.

Policy Recommendations

- Prioritise the transition to hydrogen heating in manufacturing and electric transport for distribution
- Encourage adoption of site-specific energy and emissions modelling to determine feasibility and carbon reduction changes
- Implement funding schemes and research to improve wider resource efficiency in the net zero transition (e.g. investment in hydrogen studies and wastewater to energy technologies)
- Introduce subsides or tax incentives for early adoption.

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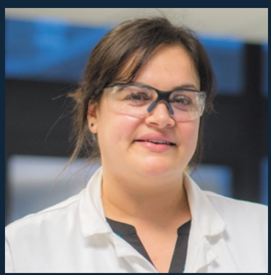

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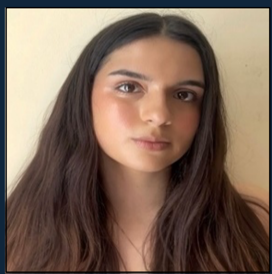

Scenario Modelling Identifies Opportunities

A new quantitative model was developed to simulate the carbon and energy performance of UK dairy manufacturing and distribution. It enabled scenario testing across different fuel types, transport modes and supply chain layouts (Malliaroudaki et al, 2023).

Twelve scenarios were analysed, combining:

- Fuel: oil, natural gas, green hydrogen
- Transport: diesel or electric refrigerated vehicles
- Infrastructure: centralised vs decentralised processing

Energy use per litre of skimmed milk ranged from 365 to 917 kJ, and for cream (330 ml) from 211 to 403 kJ, dependent on the scenario configuration.

Three processing stages consistently consumed the most energy: product transport (up to 38% of total energy use), heat treatment such as pasteurisation (up to 33%), and Cleaning-in-Place systems (CIP, up to 16%). Collectively, these areas provide the greatest opportunity for emissions reduction. For example, switching to electric refrigerated vehicles reduced energy use by 31% for milk and 26% for cream.

Project Benefit

This would support more sustainable and resilient food systems by reducing the sector's climate impact without majorly disrupting production and supply. It directly supports the UK Net Zero Strategy, the Food Strategy and the Hydrogen Strategy and aligns with Sustainable Development Goals 7, 9, 12 and 13.

Meanwhile, transitioning to green hydrogen for thermal processes could cut emissions by up to 90.2% by 2050, particularly when combined with decentralised distribution infrastructure.

While green hydrogen offers major emissions reductions, barriers are presented in terms of scaling hydrogen use due to excessive power consumption, energy losses and, particularly high cost (Ma et al, 2024). However, these factors are likely to decrease over time due to technological advancements and production scale-up. Though alternative hydrogen types (e.g. blue, turquoise) may become viable in future, currently only green hydrogen meets sustainability and net zero alignment criteria (Roy et al, 2025).

The CIP process demands large volumes of heated water and cleaning chemicals that generate high wastewater contents, containing residual chemicals and organic matter, which may be overlooked when focusing solely on emissions reduction (Su et al, 2021).

Additionally, electrolysis for green hydrogen generation requires high purity water which is costly as it requires treatment. However future technological advancements provide the potential for a more sustainable systems; the wastewater from CIP could be used for hydrogen electrolysis to create a circular system (Merabet 2024).

Further Reading

Malliaroudaki et al (2023)
https://www.sciencedirect.com/science/article/pii/S1385894723044650

Ma et al (2024)
https://www.sciencedirect.com/science/article/pii/S0360319923045883

Roy et al (2025)
https://www.sciencedirect.com/science/article/pii/S0360319925011991

Su et al (2021)
https://www.sciencedirect.com/science/article/pii/S0048969721024086

Merabet et al (2024)
https://www.sciencedirect.com/science/article/pii/S0960148124004774

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