Water Heating Options for Dairy Farms

Dr. John Upton
Milk Quality Symposium 2020

Teagasc
AGRICULTURE AND FOOD DEVELOPMENT AUTHORITY

Irish milk production energy requirements

- **Electricity consumed = 42 kWh/tonne milk produced (Upton et al., 2013)**

- **Projected that by 2020 Ireland will produce up to 8.8 billion litres; this will require ~ 378 GWh of electricity**

- **Electricity related CO_2 emissions may be 182,000 tonnes by 2020 unless mitigation strategies are implemented**

- **Requirement to improve efficiency by 30% and reduce primary energy use by 30% by 2030**
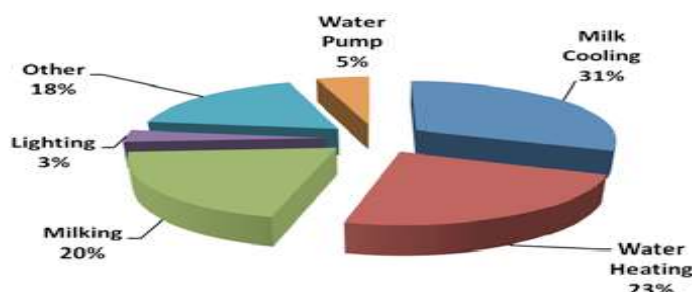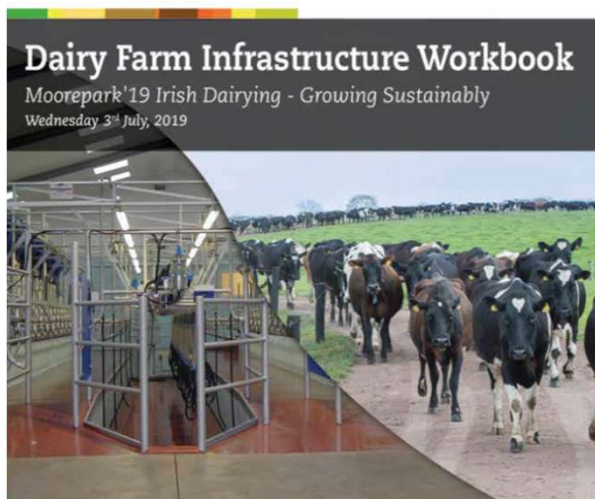
Dairy Farm Energy Consumption

Figure 1. Shows the average component consumption on 60 commercial dairy farms

Cost of electricity = €5.00 per tonne of milk sold

Max = €9.00 Min = €2.50

Dairy farm infrastructure workbook

https://www.teagasc.ie/media/website/publications/2019/Dairy-Farm-Infrastructure-Workbook.pdf

Water Heating Requirements

•<u>Ensure adequate supply at the correct temperature</u>

- 10 Litres of hot water required per cluster for machine washing – Generally at 80 degrees C, check wash trough size

- Allow for heating 2% of bulk tank volume for tank washing – Generally at 70 degrees C, check user manual

E.g. 16 unit parlour requires 160 L hot water per wash
- 8,000 L bulk tank requires 160 L hot water per wash
- 320 L required if washing both on the same day

Electrical water heating

- Low capital cost (approx €1,500 for a system of 500 L capacity)

- Best blend of capital and running costs up to 300 L per day

- Restricted by night rate electricity to keep running costs low

- Long heating times, approx 8 hours to heat 300 L from 10 to 80 degrees with 3 kW element

- Higher emissions – 5.5 kg CO_2 per 100 L

Night Rate Electricity

- Day rate = €0.18 / kWh

- Night Rate = €0.085 / kWh

- Free installation, small standing charge

- Use timers with battery back up

- Night rate from 12 midnight to 9am – summer
  - 11 pm to 8am – winter time

Oil fired water heating

- Reduced heating times, 1.5 hours to heat 500 L from 10 to 80 degrees with 26 kW oil boiler

- Not restricted by night rate electricity

- Higher capital cost (approx €3,500 for a 500 L hot water capacity)

- Available either tanked or instant

- Ensure system can deliver required volume quickly

- Lower emissions – 3 kg CO_2 per 100 L

LPG fired water heating

- Not restricted by night rate electricity

- Higher capital cost

- Typically installed as instant heaters

- Ensure system can deliver required volume quickly

- Lower emissions – 2.4 kg CO_2 per 100 L


Water Heating Running Costs

System type	Cost per 100 litres hot water	CO_2 emissions per 100 litres
Day rate electricity	€2.10	5.5 kg
Night rate electricity	€0.94	5.5 kg
Gas (LPG) fired	€0.87	2.4 kg
Oil (Kerosene) fired	€0.56	3 kg

•Oil and gas systems worth considering from a financial point of view where daily use exceeds 300 L of hot water per day

•Convenience also affects decision making around system choice - Prices correct on 08/12/2020

Options to increase efficiency - Heat Recovery

- **Heat energy is removed from milk during cooling**

- **Energy transferred to a tank of water**

- **Can reduce water heating costs by 40-50%**

- **Retrofitting is possible**

- **TAMS grant available**
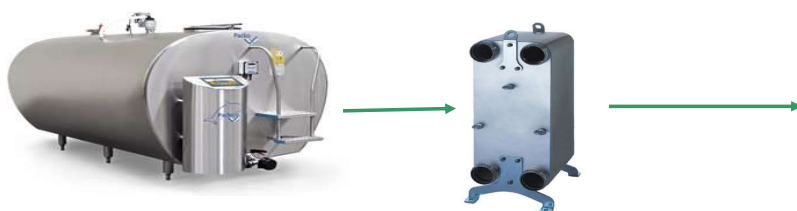
Simple efficiency measures

- **Test water for hardness – install a water softer for heating system if result is over 300 mg/L calcium carbonate**

- **Use best quality insulation**

- **Time system to reduce standing losses**

- **Service gas and oil systems annually**

Solar Photovoltaic (PV)

- Generates renewable electricity from the sun
- TAMS grant for example 6 kWp system (Max 11 kWp)
- Important to size systems for self consumption
- Saves ~ 3 tonnes CO_2 per year for 6 kWp system
- Qualifies for accelerated capital allowances
- Water heater can be used for storage of excess electricity

Decision support for energy efficiency projects

Current Farm Setup

Herd size:
10 — 120 — 300
10 40 70 100 130 160 190 220 250 280300

Morning Milking Time:
7:00

Evening Milking Time:
17:00

Number of Milking Units:
1 — 18 — 40
1 5 9 13 17 21 25 29 33 37 40

Milk Cooling System:
◉ DX ○ IB

Water Heating System:
◉ Electric ○ Oil ○ Gas

Hot Wash Frequency:
Once per day

Milk Collection Interval:
◉ Every two days
○ Every three days

Energy Optimisation Tool
https://messo.shinyapps.io/AEOP_/

On-farm Technology Investments

Select Potential Technology:
◉ Variable Speed Drive (VSD)
○ Heat Recovery
○ Solar Water Heating
○ Solar PV
○ Wind Turbine

Investment Cost:
2,000 — 3,000 — 4,000
2,200 2,400 2,800 3,200 3,600 4,000

Level of Grant Aid (%):
0 — 90
0 10 20 30 40 50 60 70 80 90

Rate of Inflation (%):
1 — 10
1 2 3 4 5 6 7 8 9 10

Run Technology Calculator

Summary

- **Calculate volumes required – ensure that water heating system can deliver the quantities required rapidly**

- **Chose a cost efficient system with low running costs and low CO_2 emissions**

- **Use dairy energy decision support tool to help with decision making**

Thank You