

# Water Heating Options for Dairy Farms



**Dr. John Upton**  
**Milk Quality Symposium 2019**

# Content of presentation

1. **Energy requirements of water heating**
2. **Providing sufficient quantities of hot water**
3. **How to be cost efficient**
4. **How to be environmentally efficient**

# Dairy Farm Energy Consumption

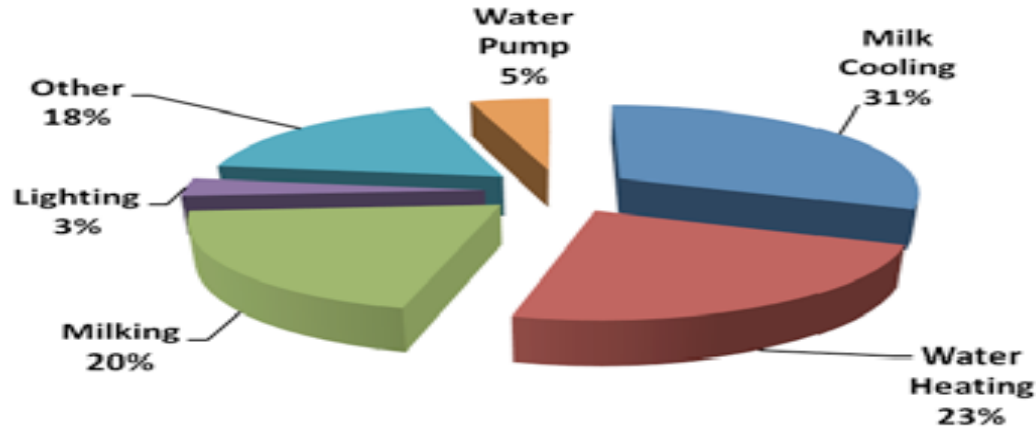


Figure 1. Shows the average component consumption on 60 commercial dairy farms

**Cost of electricity = €5.00 per tonne of milk sold**

**National dairy usage in 2018 was ~ 312 GWh 180,000 T CO<sub>2</sub>**

# Water Heating Requirements

- **Ensure adequate supply at the correct temperature**
- **10 Litres of hot water required per cluster for machine washing – Generally at 80 degrees C, check cleaning product advice**
- **Allow for heating 2% of bulk tank volume for tank washing – Generally at 70 degrees C, check cleaning product advice**

**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**

# Dairy farm infrastructure workbook

## Dairy Farm Infrastructure Workbook

Moorepark'19 Irish Dairying - Growing Sustainably

Wednesday 3<sup>rd</sup> July, 2019



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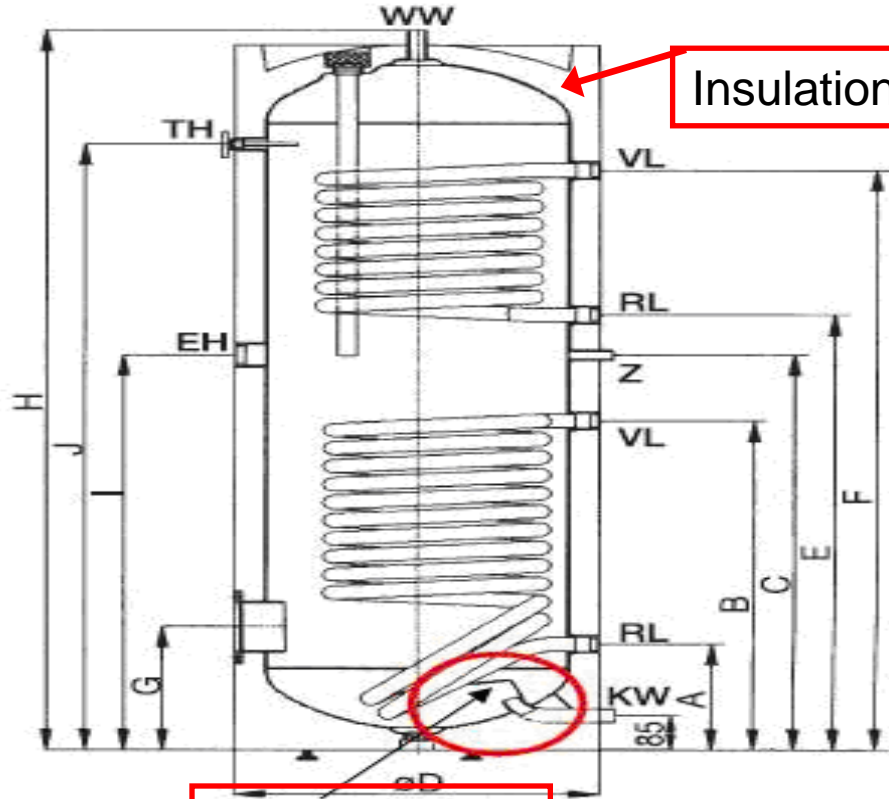
<https://www.teagasc.ie/media/website/publications/2019/Dairy-Farm-Infrastructure-Workbook.pdf>

# 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 – 6 kg CO<sub>2</sub> per 100 L**



# Water Tanks



Element

# 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

- **Not restricted by night rate electricity**
- **Available either tanked or instant**
- **Ensure system can deliver required volume quickly**
- **Higher capital cost ( approx €3,500 for a 500 L hot water capacity)**
- **Reduced heating times, 1.5 hours to heat 500 L from 10 to 80 degrees**
- **Lower emissions – 3 kg CO<sub>2</sub> 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<sub>2</sub> per 100 L**



# Water Heating Running Costs

System type	Cost per 100 Litres
Day rate electricity	€2.10
Night rate electricity	€0.94
Gas fired system	€0.91
Oil fired system	€0.72

- **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**

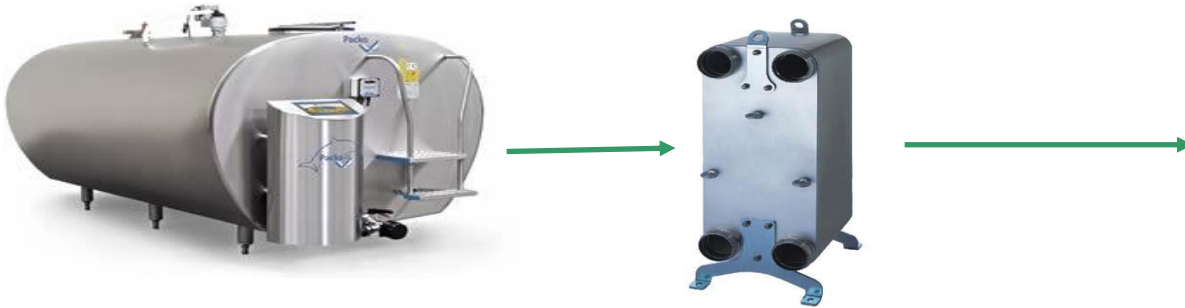
# Simple efficiency measures

- **Test water for hardness – install a water softener 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**



# Options to increase efficiency - Heat Recovery

- Heat energy is removed from milk during cooling
- Energy transferred to a tank of water
- Retrofitting is possible



# Heat Recovery

- HR can meet 30-50% of water heating load
- Payback varies depending on parlour size, hot wash frequency and bulk tank size
- Check payback on case by case basis
- TAMS grant available



# Solar Photovoltaic (PV)

- Generates renewable electricity from the sun
- TAMS grant for 6 kWp system
- Saves ~ 3 tonnes CO<sub>2</sub> per year
- System cost ~ €7,500
- 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:



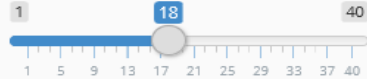
Morning Milking Time:

7:00

Evening Milking Time:

17:00

Number of Milking Units:



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

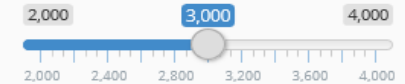
- Dairy Energy Decision-Support Tool

## On-farm Technology Investments

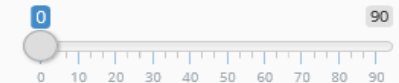
Select Potential Technology:

- Variable Speed Drive (VSD)
- Heat Recovery
- Solar Water Heating
- Solar PV
- Wind Turbine

Investment Cost:



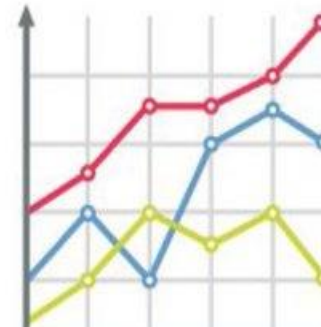
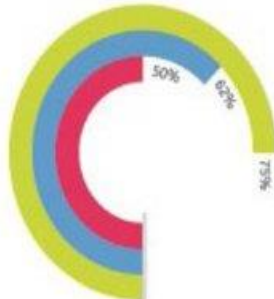
Level of Grant Aid (%):



Rate of Inflation (%):



Run Technology Calculator



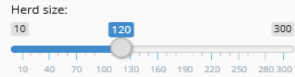


# Solar Photovoltaic Example

## Dairy Energy Decision Support Tool

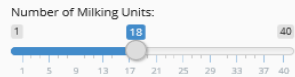
About Technology Calculator Consumption Summary

### Current Farm Setup



Morning Milking Time: 7:00

Evening Milking Time: 17:00



Milk Cooling System:  DX  IB

Water Heating System:  Electric  Oil  Gas

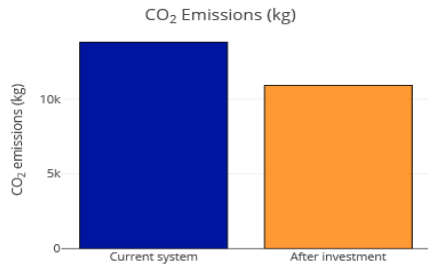
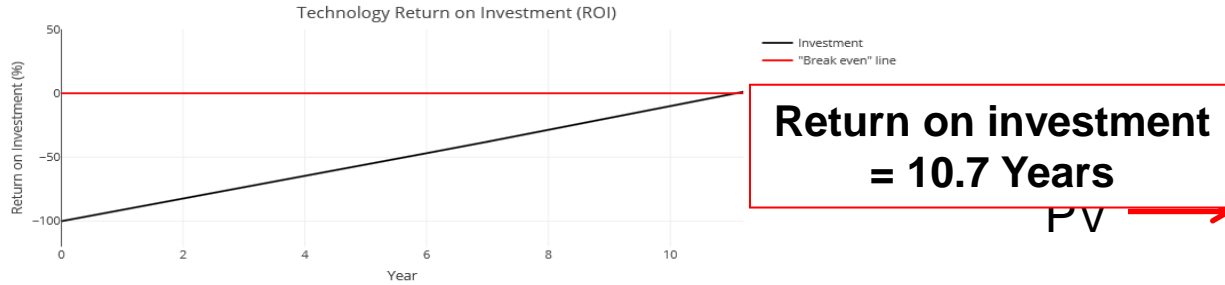
Hot Wash Frequency: Once per day

Milk Collection Interval:  Every two days  Every three days

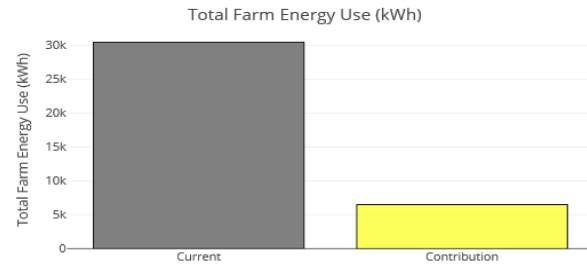
Plate Cooler:  Yes  No

Electricity Tariff:  Flat  Day/Night

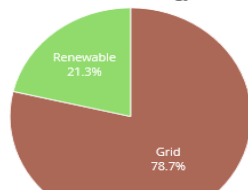
Day Rate Cost (euro/kWh)



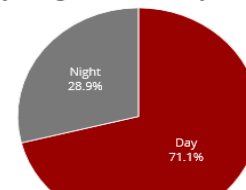
New system will save 57,749 kg of CO<sub>2</sub> in its lifetime



### Grid vs Renewable Energy Use

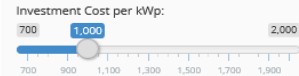


### Day vs Night Time Electricity Use



### On-farm Technology Investments

- Select Potential Technology:
- Plate Cooler
  - Variable Speed Drive (VSD)
  - Heat Recovery
  - Solar Water Heating
  - Solar PV
  - Wind Turbine



Also use renewable system for household electricity?

# Solar Photovoltaic Example 40% grant

## Dairy Energy Decision Support Tool

About Technology Calculator Consumption Summary

### Current Farm Setup

Herd size: 120

Morning Milking Time: 7:00

Evening Milking Time: 17:00

Number of Milking Units: 18

Milk Cooling System:  DX  IB

Water Heating System:  Electric  Oil  Gas

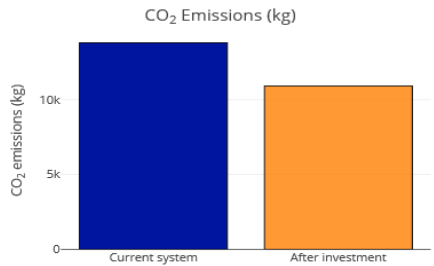
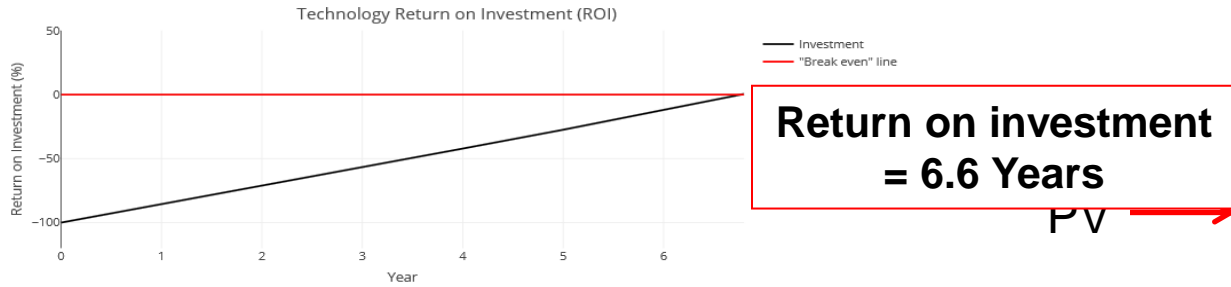
Hot Wash Frequency: Once per day

Milk Collection Interval:  Every two days  Every three days

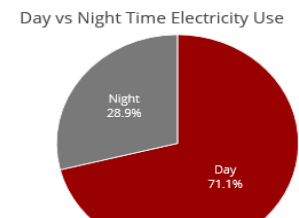
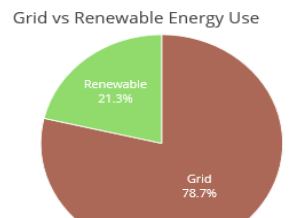
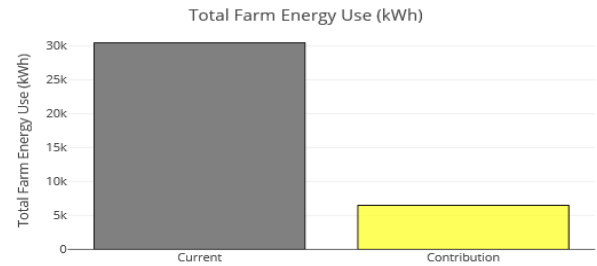
Plate Cooler:  Yes  No

Electricity Tariff:  Flat  Day/Night

Day Rate Cost (euro/kWh)



**New system will save 57,749 kg of CO<sub>2</sub> in its lifetime**



### On-farm Technology Investments

- Select Potential Technology:
- Plate Cooler
  - Variable Speed Drive (VSD)
  - Heat Recovery
  - Solar Water Heating
  - Solar PV
  - Wind Turbine

Solar PV Size (kWp): 6

Investment Cost per kWp: 1,000

Level of Grant Aid (%): 40

Rate of Inflation (%): 10

Feed in Tariff (euro/kWh): 0.5

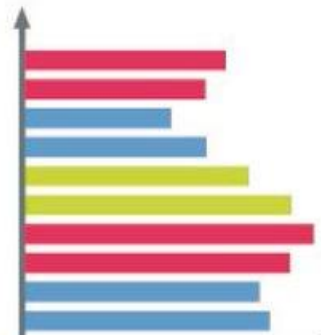
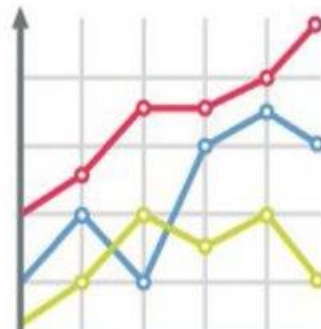
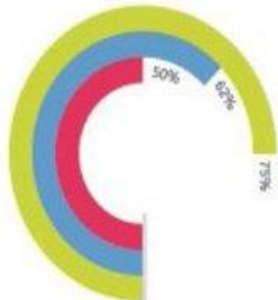
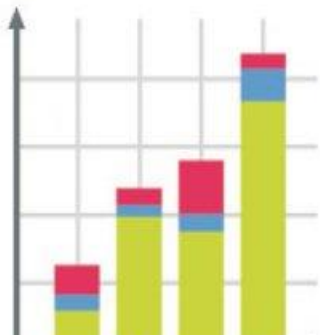
Also use renewable system for household electricity?

# Summary

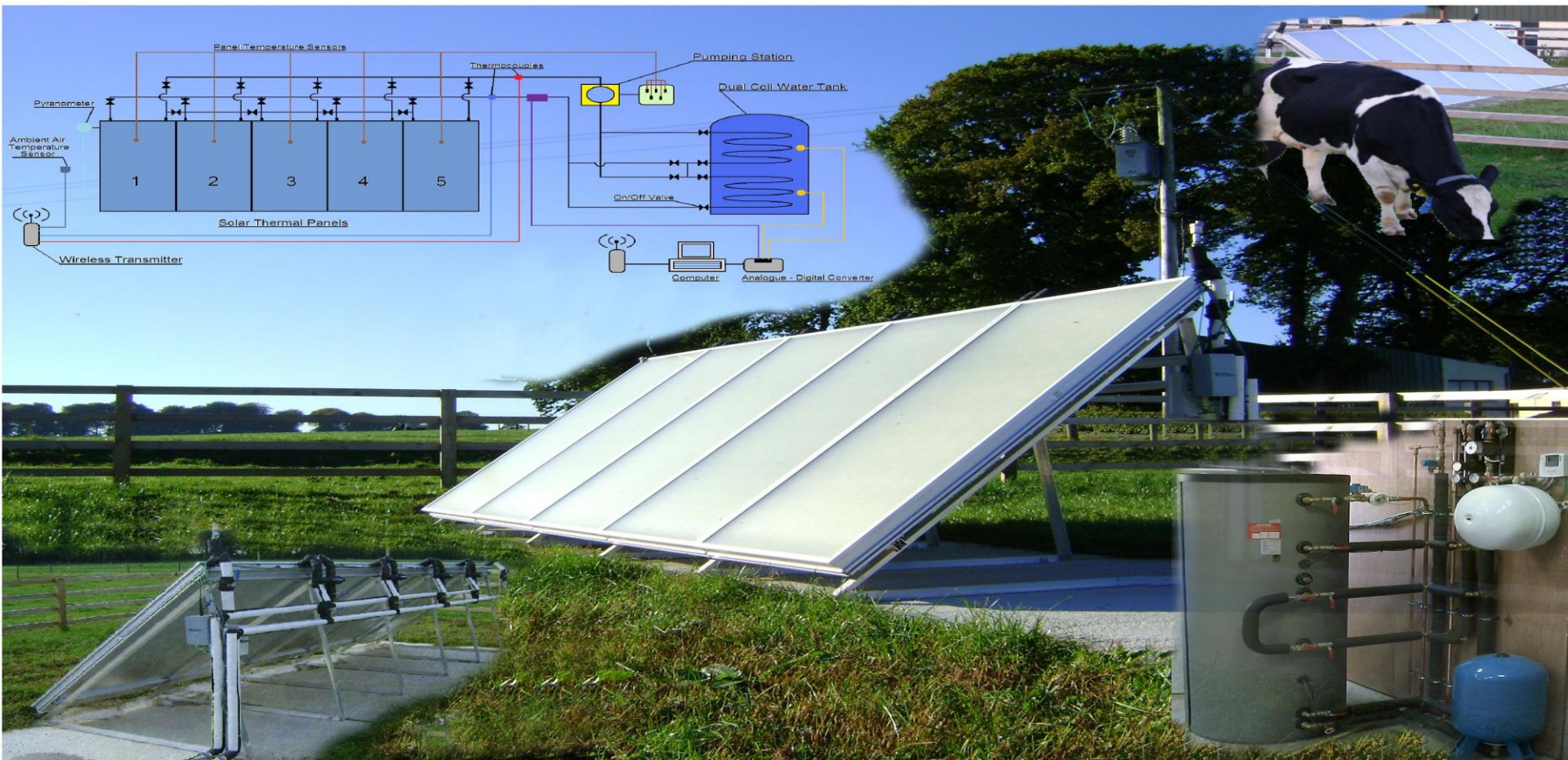
- **Calculate volumes required – ensure that water heating system can deliver the quantities required rapidly**
- **Chose an efficient system with low running costs and low CO<sub>2</sub> emissions**
- **Use dairy energy decision support tool to help with decision making**



**Thank You**



# Solar Thermal



# Solar Thermal

- **Solar thermal system can meet on average 40% of water heating load**
- **The solar tank should be used as a buffer tank only. A second tank to heat the water to 80 degrees is required**
- **The solar tank should pre feed the final temperature water tank**
- **No grant support for solar thermal, paybacks of 10 years**

# Irish milk production energy requirements

- **Electricity consumed = 42 kWh/tonne milk produced (Upton et al., 2013)**
- **7.3 billion Litres of milk produced in 2017 (CSO 2018)**
- **Total electricity required in 2017 was ~ 312 GWh**
- **Projected that by 2020 Ireland will produce up to 8.8 billion litres; this will require ~ 378 GWh of electricity**
- **Electricity related CO<sub>2</sub> emissions may be 182,000 tonnes by 2020 unless mitigation strategies are implemented**