

Water Heating Options for Dairy Farms



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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

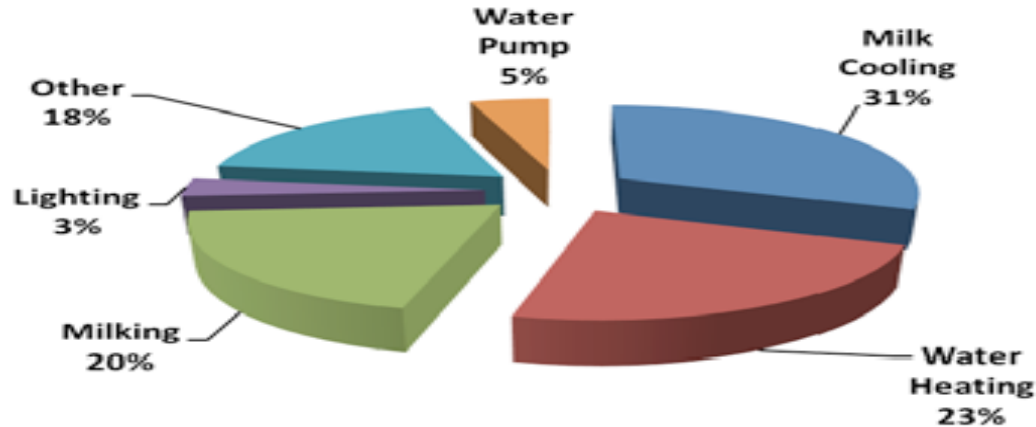


Figure 1. Shows the average component consumption on 60 commercial dairy farms

Cost of electricity = €5.00 per tonne of milk sold

National dairy usage in 2018 was ~ 312 GWh 180,000 T CO₂

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 3rd July, 2019



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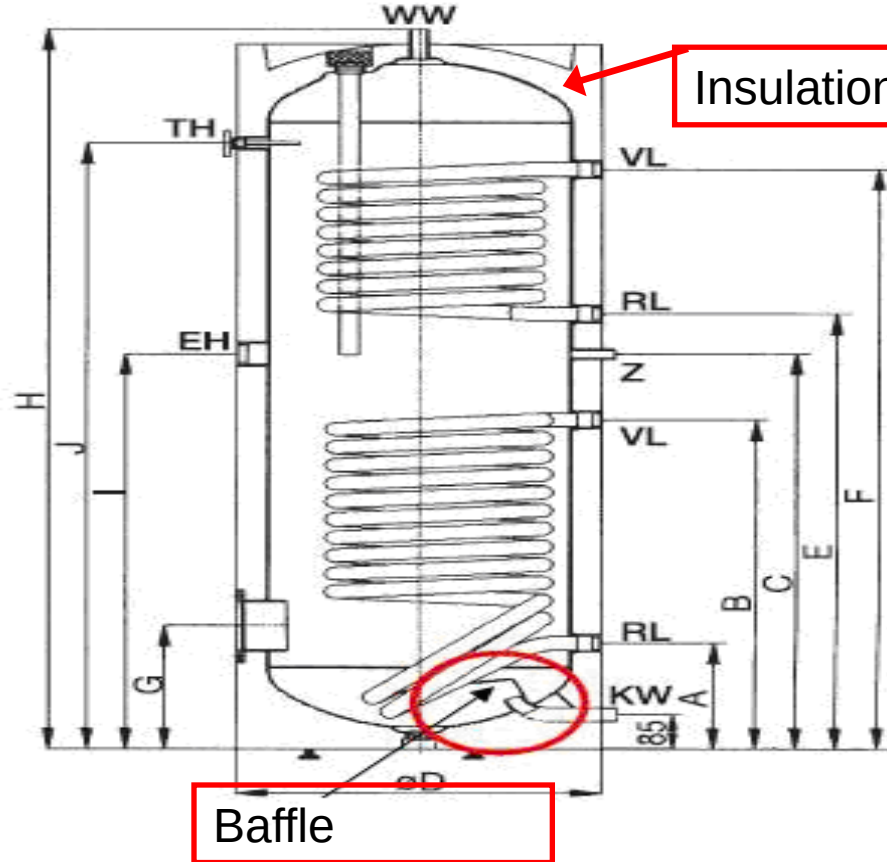
<https://www.teagasc.ie/media/website/publications/2019/Dairy-Farm-Infrastructure-Workbook.pdf>

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 CO₂ 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 CO₂ 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 CO₂ 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

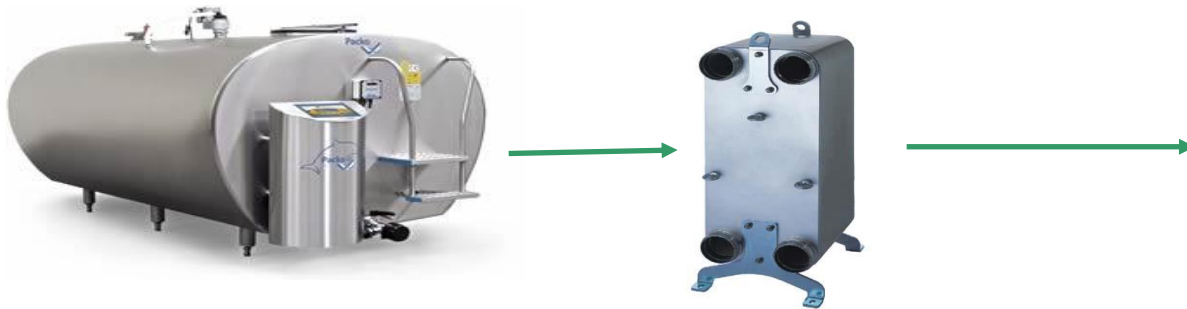
Simple efficiency measures

- 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)

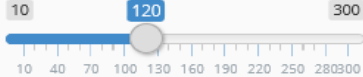
- Generates renewable electricity from the sun
- TAMS grant for 6 kWp system
- Saves ~ 3 tonnes CO₂ per year
- System cost ~ €7,500
- Qualifies for accelerated capital allowances
- Water heater can be used for storage of excess electricity



Decision support for energy efficiency projects

Current Farm Setup

Herd size:



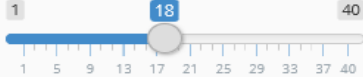
Morning Milking Time:

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

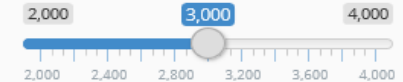
- Dairy Energy Decision-Support Tool

On-farm Technology Investments

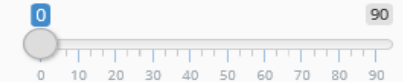
Select Potential Technology:

- ☒ 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

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

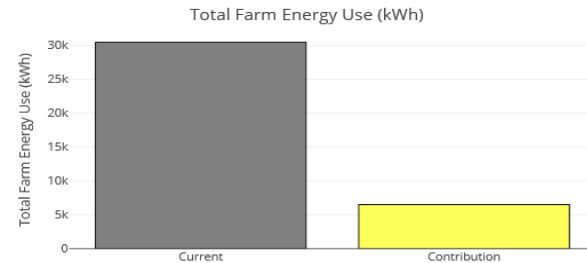
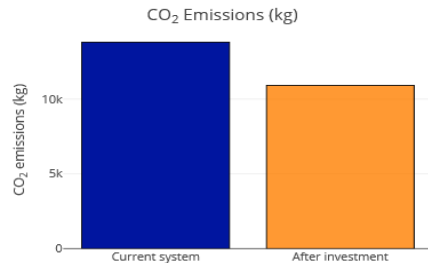
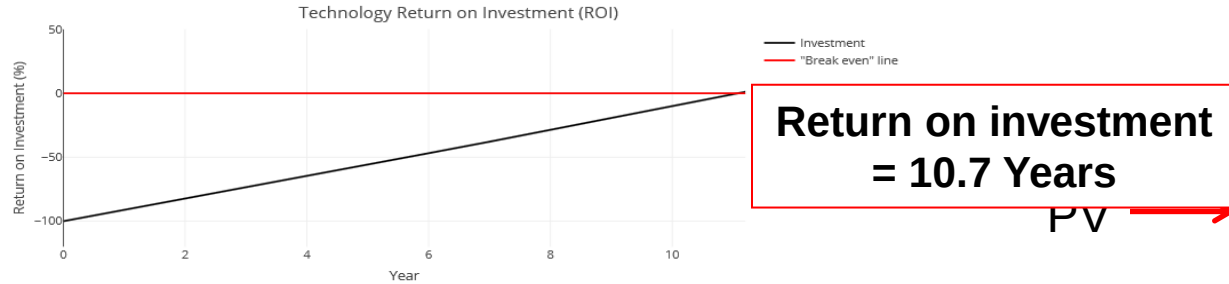
Hot Wash Frequency: Once per day

Milk Collection Interval: ☒ Every two days ☐ Every three days

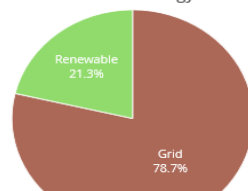
Plate Cooler: ☐ Yes ☒ No

Electricity Tariff: ☐ Flat ☒ Day/Night

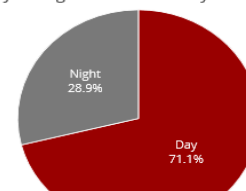
Day Rate Cost (euro/kWh)



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

Solar PV Size (kW): 6

Investment Cost per kWp: 1,000

Level of Grant Aid (%): 0

Rate of Inflation (%): 10

Feed in Tariff (euro/kWh): 0.5

Also use renewable system for household electricity?

12:11

27/03/2018

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

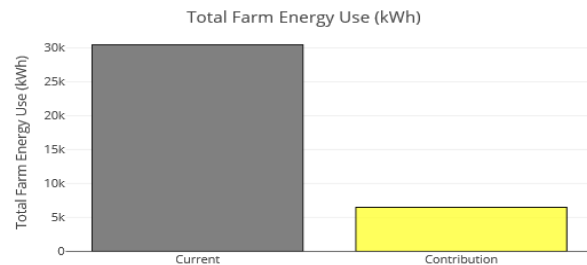
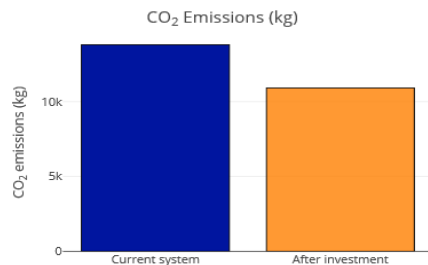
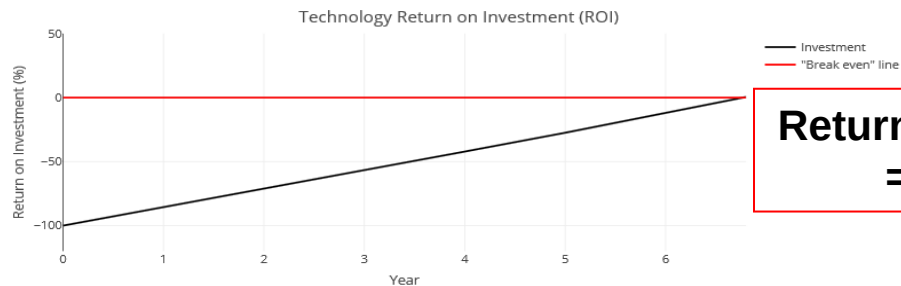
Hot Wash Frequency: Once per day

Milk Collection Interval: ☒ Every two days ☐ Every three days

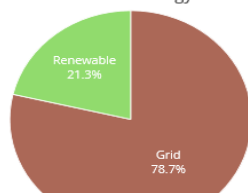
Plate Cooler: ☐ Yes ☒ No

Electricity Tariff: ☐ Flat ☒ Day/Night

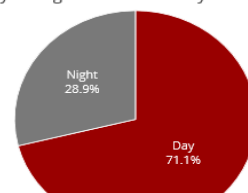
Day Rate Cost (euro/kWh)



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

Solar PV Size (kWp): 6

Investment Cost per kWp: 1,000

Level of Grant Aid (%): 40

Rate of Inflation (%): 1

Feed in Tariff (euro/kWh): 0.5

Also use renewable system for household electricity

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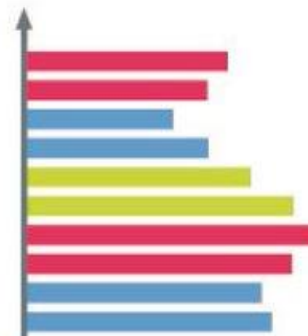
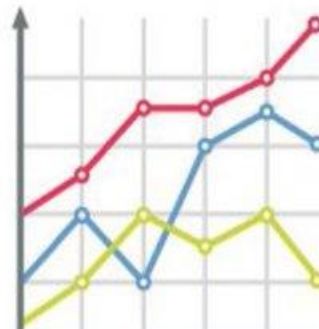
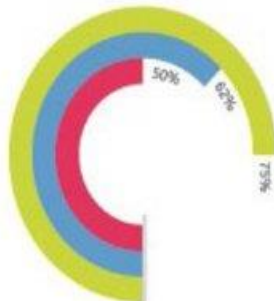
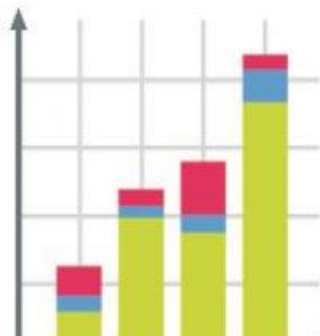
27/03/2018

Summary

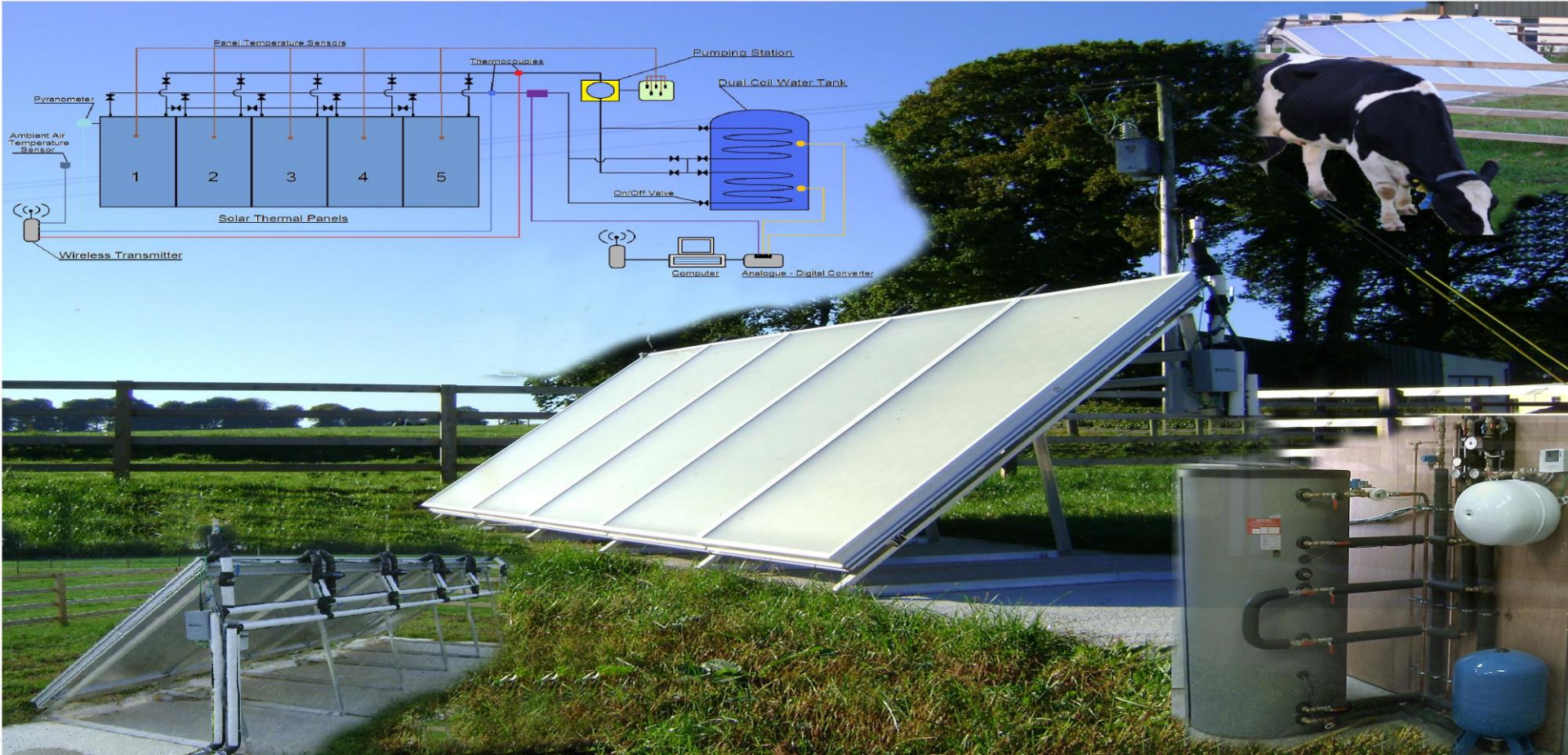
- **Calculate volumes required – ensure that water heating system can deliver the quantities required rapidly**
- **Chose an efficient system with low running costs and low CO₂ emissions**
- **Use dairy energy decision support tool to help with decision making**



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 CO₂ emissions may be 182,000 tonnes by 2020 unless mitigation strategies are implemented**