The role of energy efficient and renewable technologies in decarbonising agriculture

Signpost Series - Energy

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## Reminder Key Agricultural Emissions

<table>
<thead>
<tr>
<th>Greenhouse Gas (GHG)</th>
<th>Where from on the farm?</th>
<th>Total: 20.1 Mt of CO2 eq in agriculture of which</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon Dioxide CO₂</td>
<td>Burning of fossil fuels</td>
<td>0.94 Mt of CO₂ eq 5%</td>
</tr>
<tr>
<td>Methane CH₄</td>
<td>Natural bi-product of enteric fermentation</td>
<td>12.97 Mt of CO₂ eq 64%</td>
</tr>
<tr>
<td>Nitrous Oxide N₂O</td>
<td>Naturally produced; emissions can be increased by cultivation &amp; N fertiliser</td>
<td>6.3 Mt of CO₂ eq 31%</td>
</tr>
</tbody>
</table>
### CO₂ Emission Factor 2018

<table>
<thead>
<tr>
<th>Energy Source</th>
<th>CO₂ emission kg/kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grid electricity</td>
<td>0.375</td>
</tr>
<tr>
<td>Natural Gas combustion - Heating</td>
<td>0.205</td>
</tr>
<tr>
<td>Coal - combustion</td>
<td>0.340</td>
</tr>
<tr>
<td>Kerosene</td>
<td>0.257</td>
</tr>
</tbody>
</table>

If I use 4,000 kWh of electricity in the year I’m producing 4,000 x 0.375kg = 1,500kg or **1.5 tonnes** of CO₂.

Kerosene Oil has 10.5 kWh per litre. 1,000 litres = 10,500 kWh. 10,500 x 0.257 = 2,698 kg or **2.7 tonnes** of CO₂.
Possible on-farm energy generation

- Micro-hydro electricity schemes
- Solar panels, ground source heat pumps or wood fuel burners
- Wind turbines
- Growing trees, short rotation forestry, or energy crops such as short rotation coppice or miscanthus as biomass fuel for home supply or sale
- Installing an anaerobic digester to produce methane as fuel for electricity or heat
Why invest in renewable energy

- An opportunity to generate an income through Government incentives
- Makes use of on farm resources from slurry to forestry, straw, wind and rivers.
- Energy generated can be used to generate additional income
- Reduction in GHG emissions
Energy Awareness

- Develop tools to create awareness among staff
- SEAI offer a range of training and supports around energy management and standards.
- Classroom based energy management training for companies
- More effective use of thermostats, time clocks, motion sensors and insulation
- Vehicle checks and maintenance
- Assess on-farm storage facilities, for example, potato stores, to ensure that insulation and natural ventilation is utilised and energy is used efficiently
Lighting – Pig Units

- Lighting accounts for one of the greatest inefficiencies
- Fluorescent lighting and lower energy can reduce costs by up to 80%
- LED allow to match lighting levels and colour to animals needs
- Many units still use tungsten bulbs which are cheap but inefficient at 2 – 4 kWh ppp
- Fluorescent strip lighting can reduce this to 0.8 kWh ppp

3.2 kWh x 0.375 kg of CO2 = 1.2 kg of CO2 ppp
## LED Lighting

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost of LED Lighting and fitting €71 + €4</td>
<td>€75</td>
</tr>
<tr>
<td>Energy used by LED light</td>
<td>25 W</td>
</tr>
<tr>
<td>Energy used by double fluorescent tubes</td>
<td>116 W</td>
</tr>
<tr>
<td>Hours of light per day</td>
<td>14</td>
</tr>
<tr>
<td>Saving in electricity (116W – 25W)</td>
<td>91 W</td>
</tr>
<tr>
<td>At 14 hours per day (14 x 91W)</td>
<td>1274 Wh</td>
</tr>
<tr>
<td>For 365 days</td>
<td>465 kWh</td>
</tr>
<tr>
<td>At 18 cent per kWh / unit of electricity = 465 x 0.18</td>
<td>€84</td>
</tr>
<tr>
<td>Accelerated Capital Allowances (TAX)</td>
<td></td>
</tr>
</tbody>
</table>

CO2 savings 465 x 0.375 kg of CO2 per kWh = **174 kg**
Selecting high efficient pumps, aerators and separators

- Should be considered when specifying or upgrading motors for feed or manure handling
- Fitting a Variable Speed Pump can reduce costs by 30%
- Inefficient motors typically require 6kWh ppp
- Efficient motors 2 kWh ppp
- Saving 4 kWh ppp

4kWh x 0.375 kg of CO2 = 1.5kg of CO2 per pig produced
Insulation of pig units

- Good insulation reduces amount of heat lost and heat coming in.
- Heat lost through the walls of the building requires supplementary heat increasing costs.
- Fitting composite panels containing solid polyurethane insulation, protected from moisture ingress, is recommended.

- Typical insulation 9kWh per pig produced
- Best Practice = 3 kWh
- Saving 6kWh per pig produced

6kWh x 0.375 kg of CO2 = 2.25kg of CO2 per pig produced
Ventilation

- Ventilation is designed to optimise the living conditions of pigs
- Typical finishing building ventilation fans using 7.2 kWh per pig produced (ppp)
- Best practice could achieve 4 kWh ppp
- Saving – 3.2 kWh ppp

\[ 3.2 \times 0.375 \text{ kg of CO2} = 1.2 \text{ kg of CO2 per pig produced} \]
Fit efficient fans

- A single fan in a finishing building will consume its own value in 12 months
- Paying 10% more on a more energy efficient fan will pay for itself in the same time
- Clean dust & debris from fan blades
- Typical finishing building 10 kWh ppp
- Best practice efficient fans 6 kWh ppp
- Saving 4 kWh ppp

$4 \times 0.375 \text{ kg of CO2} = 1.5 \text{ kg of CO2 per pig produced}$
Variable Speed Drives

- SEAI grant aid 40% for VSD – 2017, 2018, 2019 (€1m)
- VSD reduces electricity consumption by 56 – 65%
- Vacuum pumps account for 7.12 Wh per litre of milk produced

<table>
<thead>
<tr>
<th>Year</th>
<th>No of grants paid</th>
<th>CO2 Emissions without VSD</th>
<th>CO2 Emissions with VSD</th>
<th>Annual Co2 Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>2017</td>
<td>48</td>
<td>142</td>
<td>71</td>
<td>71</td>
</tr>
<tr>
<td>2018</td>
<td>69</td>
<td>184</td>
<td>92</td>
<td>92</td>
</tr>
<tr>
<td>2019</td>
<td>111</td>
<td>251</td>
<td>125</td>
<td>125</td>
</tr>
<tr>
<td>overall</td>
<td>228</td>
<td>577</td>
<td>288</td>
<td>288</td>
</tr>
</tbody>
</table>
Heat Pumps

- ASHP to warm under floor heating system
- LPG heated sheds require increased ventilation – higher CO$_2$ and humidity levels
- Underfloor heating system, air exchange unit and back up LPG heater.
Role of biomass production in GHG mitigation.

- Sequestering Carbon in the soil and biomass.
- Mitigation of nitrous oxide via reduced N requirement.
- Reduced emissions associated with fuel usage and manufacture of inputs.
- Substitution of fossil fuels for energy generation and heat production.
MACC – Energy Abatement

Bioenergy Mitigation

1.37 M t CO$_2$e

Abatement Costs €/tCO$_2$e

Carbon Price

Biofuel S. Beet

Biofuel (OSR)

Biomass (Electricity)

Biomass (Heat)

Wood

Biomass

Farm Energy

Potential ktCO$_2$-e saving/year

Dairy Farms

Forestry

Miscanthus and SRC

SRC

Biofuel

Slurry/Grass

0 200 400 600 800 1,000 1,200 1,400 1,600

0

0 200 400 600 800

0 200 400 600 800

0 200 400 600 800

0 200 400 600 800

0 200 400 600 800

0 200 400 600 800
## Biomass heating - SSRH tariff levels
(Cent for each kWh of heat produced)

<table>
<thead>
<tr>
<th>Tier</th>
<th>Lower Limit (MWh/yr)</th>
<th>Upper Limit (MWh yr)</th>
<th>Biomass Heating Systems Tariff (c/kWh yr)</th>
<th>Amount/yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>300</td>
<td>5.66</td>
<td>€16,980</td>
</tr>
<tr>
<td>2</td>
<td>300</td>
<td>1,000</td>
<td>3.02</td>
<td>€20,650</td>
</tr>
<tr>
<td>3</td>
<td>1,000</td>
<td>2,400</td>
<td>0.5</td>
<td>€7,000</td>
</tr>
<tr>
<td>4</td>
<td>2,400</td>
<td>10,000</td>
<td>0.5</td>
<td>€38,000</td>
</tr>
<tr>
<td>5</td>
<td>10,000</td>
<td>50,000</td>
<td>0.37</td>
<td>€148,000</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td>€230,630</td>
</tr>
</tbody>
</table>
SSRH Example

- Poultry Unit
- 400 kW boiler – cost €360,000
- Run 1,700,000 kWh/year (50% load)
- Oil Displaced = 160,500 litres
- Oil Cost pa = €105,930 (0.66 c/litre)
- Wood Chip cost pa = €58,000
- Saving pa = €47,930
- Payback without grant or SSRH = 6.2 years

SSRH extra income = 300 MWh x €56.6 = €16,980 +

700 MWh x €30.20 = €21,140 + = €41,620

700 MWh x €5 = €3,500

Heat Saving from wood chip + SSRH = €89,550 or payback 4 years
GHG savings in poultry unit

- Emission factor oil = 0.257 kg CO$_2$ - per kWh

1.7m kWh x 0.257 = 437 tonnes of CO$_2$
## Value of Straw Compared to Oil

<table>
<thead>
<tr>
<th>Bale Type</th>
<th>Bale Weight</th>
<th>Kilo watt hours (kWh) per bale</th>
<th>Oil equivalent (litres)</th>
<th>Oil Value equivalent (€0.60 c/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 x 4 Round</td>
<td>150kg</td>
<td>690</td>
<td>66</td>
<td>€40</td>
</tr>
<tr>
<td>5 x 4 Round</td>
<td>250kg</td>
<td>1,150</td>
<td>110</td>
<td>€66</td>
</tr>
<tr>
<td>8 x 4 x 4 Square</td>
<td>500kg</td>
<td>2,300</td>
<td>220</td>
<td>€132</td>
</tr>
</tbody>
</table>

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*Image of a straw bale*
PV cuts your Carbon Footprint

- Each kWh of electricity generated by fossil fuels produces around 0.375 kg of carbon dioxide.
- A 20 kW PV system will produce about 20 x 800 kWh per year (16,000 kWh)
- This reduces the carbon footprint of the business by 16,000 x 0.375 kg = 6,000 kg of **6 tonnes of CO₂**
Biogas Plant
## Biogas – 15 year - SSRH tariff levels (Cent for each kWh of heat produced)

<table>
<thead>
<tr>
<th>Tier</th>
<th>Lower Limit (MWh/yr)</th>
<th>Upper Limit (MWh/yr)</th>
<th>Anaerobic Digestion (c/kWh yr)</th>
<th>Amount/yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>300</td>
<td>2.95</td>
<td>€8,850</td>
</tr>
<tr>
<td>2</td>
<td>300</td>
<td>1,000</td>
<td>2.95</td>
<td>€20,650</td>
</tr>
<tr>
<td>3</td>
<td>1,000</td>
<td>1,400</td>
<td>0.50</td>
<td>€2,000</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td>€31,500</td>
</tr>
</tbody>
</table>
Conclusions

- Energy efficiency should be the first fuel on all farms.
- There is a large variation in energy costs on Irish farms. Every farmer can calculate their own energy costs.
- Payback periods on renewables technologies can vary considerably. Paybacks should be calculated.
- Energy crops can mitigate emission production within agriculture and energy.