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Cemeteries & Crematoria

Cremation Technology

APSE (Wigan 2022)

Please note: All energy costs based on 2021 figures, the variance between the energy sources does still remain similar following energy price rises.

BREEAM Development - Crematoria

BREEAM assessment evaluates the procurement, design, construction and operation of a development against a range of targets based on performance benchmarks.

It focuses on sustainable value across range of categories:

- Energy
- Land use and ecology
- Water
- Health and wellbeing
- Pollution
- Transport
- Materials
- Waste
- Management

BREEAM rating		% score
Outstanding	★★★★★	≥85
Excellent	☆★★★★	≥70
Very good	☆☆★★★	≥55
Good	☆☆☆★★	≥45
Pass	☆☆☆☆★	≥30
Unclassified	☆☆☆☆☆	<30

BREEAM Development - Crematoria

BREEAM inspires developers and creators to improve, innovate and make effective use of resources.

While building to meet BREEAM's enhanced standards will incur a capital cost this should be viewed in the context of the overall value of sustainable development long term.

For Bolsover District Council, the CDS Group are working towards achieving a BREEAM Excellent site (>70%).

The aim and aspirations of Bolsover District Council is to provide a site-wide sustainable development and operation.

The site will be the first UK crematorium to achieve a BREEAM Excellent site-wide.

CDS's aim is to promote sustainability beyond the crematory room.

Decarbonisation in the bereavement sector

Factors for change:

- Social drivers
- Economic (industry led) drivers
- Technology drivers
- Self-regulation
- Regulation

Regulation

The role of the EA/DEFRA in the bereavement sector (cremation)

- Through legislation (Part II activity under EPR)
  - Improving air quality
    - Abatement and withdrawing CAMEO (2027)?
    - Reduction in NOx emissions
    - Reduction in Carbon emissions
    - Reviewing cremation technology
    - Improved emissions monitoring through approved independent MCERTS companies

Cremation Technology/Fuel Available

There are a number of cremation technologies available, using a variety of energy sources:

- Gas
- Electric
- BioLPG
- Hydrogen
- Microwave
- Resomation

Discover what's beneath.

Decarbonisation in the bereavement sector

Year	Non-Domestic Gas - Small (Pence per kWh)	Percentage Change in Gas Prices	Non-Domestic Electricity – Small/Medium (Pence per kWh)	Percentage Change in Electricity Prices
2nd Quarter 2017	2.46	N/A	10.78	N/A
2nd Quarter 2018	2.84	15.4%	11.84	9.8%
2nd Quarter 2019	2.77	-2.5%	13.10	10.6%
2nd Quarter 2020	2.75	-0.7%	14.51	10.8%
2nd Quarter 2021	2.66	-3.28%	14.57	0.4%
2nd Quarter 2022	4.74	78.2%	22.34	53.3%
Difference Between 2017 and 2022	**2.28 p**	**92.7%**	**11.56 p**	**107.2%**

Source: https://www.gov.uk/government/collections/quarterly-energy-prices

Cemeteries & Crematoria

Gas Cremation

Gas Cremation - Overview

Gas cremation is used by >95% of existing crematoria in the UK, primarily sourced by natural gas but some crematoria use LPG due to lack of natural gas supply in the area.

Gas cremation is currently the fastest technology in the market in terms of cremation time.

Gas Cremation – Energy Consumption and Emissions

CDS Derived – Gas and electricity consumption of gas cremators provided by 2 manufacturers, then averaged out with CO2 production.

Cremations per day	Gas usage per cremation (kWh)*	Electricity usage per cremation [inc. rest] (kWh)	CO2/Cremation (Exc. Body and coffin)
1	1359	77	**268kg**
2	763	47	**151kg**
3	564	38	**113kg**
4	483	33	**96kg**
5	424	30	**85kg**
6	348	28	**71kg**

***Average gas consumption stated by cremator manufacturer 300 kWh**

Parameters used

Electricity consumption of gas cremators

Electricity Usage	kWh
E usage/hr during cremation	12kWh/hr
E usage/hr in rest	1.8kWh/hr

Carbon intensity values used to work out CO2 per cremation

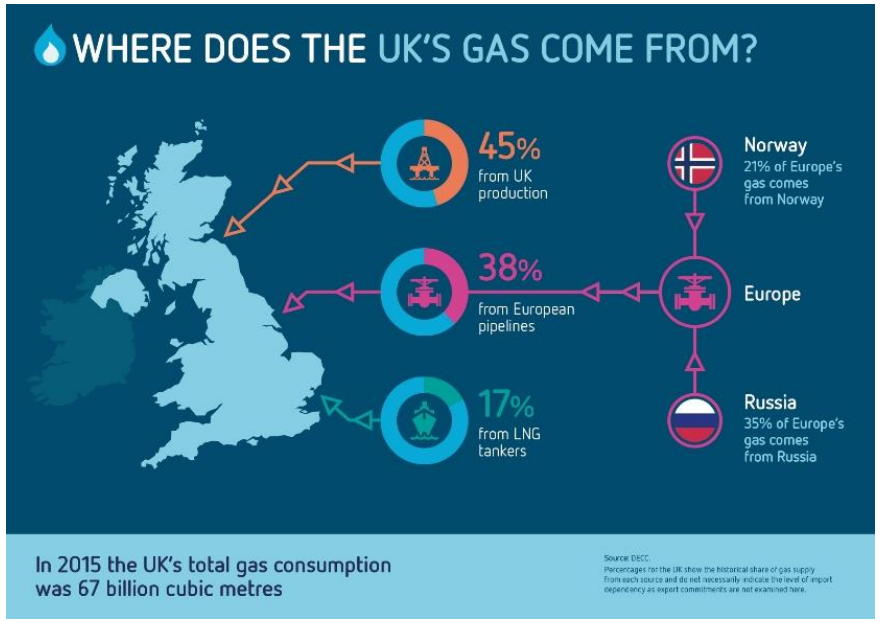
Fuel	Carbon intensity (kgCO2/kWh)
Natural Gas	0.184kg
Electricity	0.231kg

Gas Cremation – Future

The longevity of natural gas for cremation is at risk due to increases in natural gas prices and fuel security which are already being experienced.

A concern is that the UK is a net importer of gas, therefore, the life-cycle and upstream emissions of gas-fired generation are not accounted for as domestic supplies diminish. The transmission distances of gas imports have a significant impact on emissions, the result of higher gas leakages through piping over transmission distances.

The UK is likely to increase its importation of Liquified Natural Gas (LNG), which, due to the energy intensive liquefication process, is more carbon-intensive [0.23-0.27kg CO2/kWh].



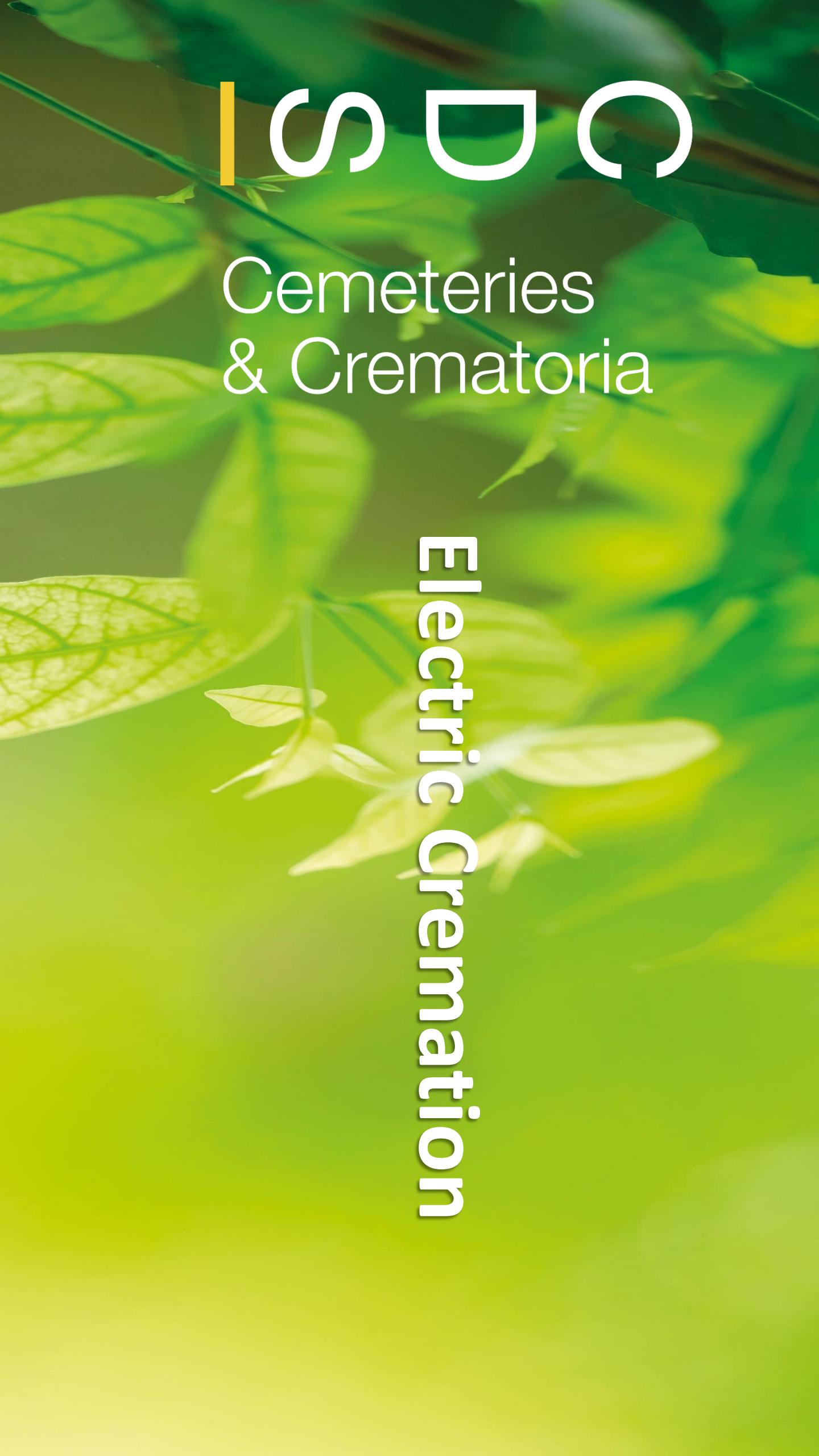
Gas Cremation – Financial Running Costs

CDS Derived – Gas and electricity consumption provided by 2 manufacturers, then averaged out – cost per cremation

Cremations per day	Gas Per cremation (kWh)	Electricity Consumption Per Cremation [inc. rest] (kWh)	Cost per cremation*
1	1359	77	**£82***
2	763	47	**£47***
3	564	38	**£36***
4	483	33	**£31***
5	424	30	**£27***
6	348	28	**£23***

Parameters used

Fuel	Cost/kWh*
Natural Gas	£0.0474
Electricity	£0.2234
*	Adjusted to Sep 2022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Electric Cremation

Electric Cremation

The first UK green energy electric cremator was installed in Memoria's North Oxfordshire site and then in Huntingdon, where Huntingdon Town Council were the first local authority to install green energy electric cremators.

Electric cremation takes on average 120 minutes to complete a process, dependant on the type of coffin used.

Electric Cremation – Installation: Huntingdon

The electric cremator operates as a ‘hot insert’, reaching its optimal temperature within 3 days of initial install and then maintaining that temperature thereafter, therefore requiring electrical energy to maintain the heat. The more electric cremation completed, the lower the average electrical consumption, as the body acts as the fuel to the process.

The long term maintenance costs of electric cremation is thought to be less frequent due to the consistency of temperatures and design of brickwork.

Electric Cremation – Installation: Hambleton

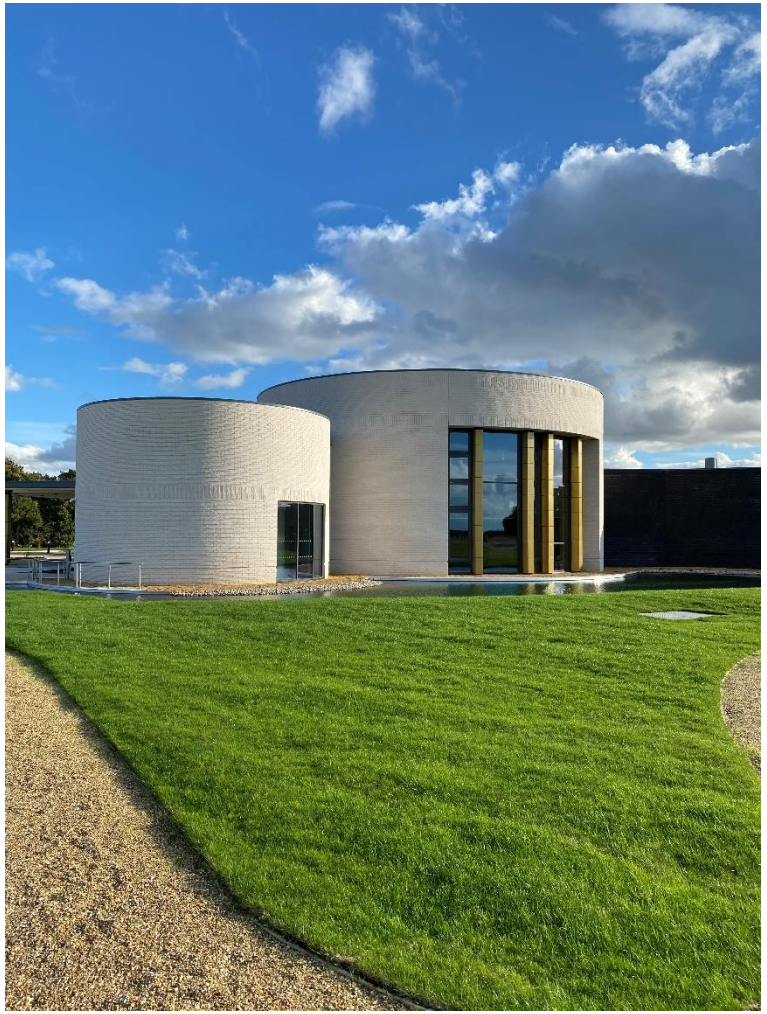
Electric Cremation – Installation: Huntingdon

Discover what's beneath.

Electric Cremation – Installation: Huntingdon

Huntingdon Crematorium first of two DFW electric cremators being installed

Electric Cremation – Huntingdon Crematorium

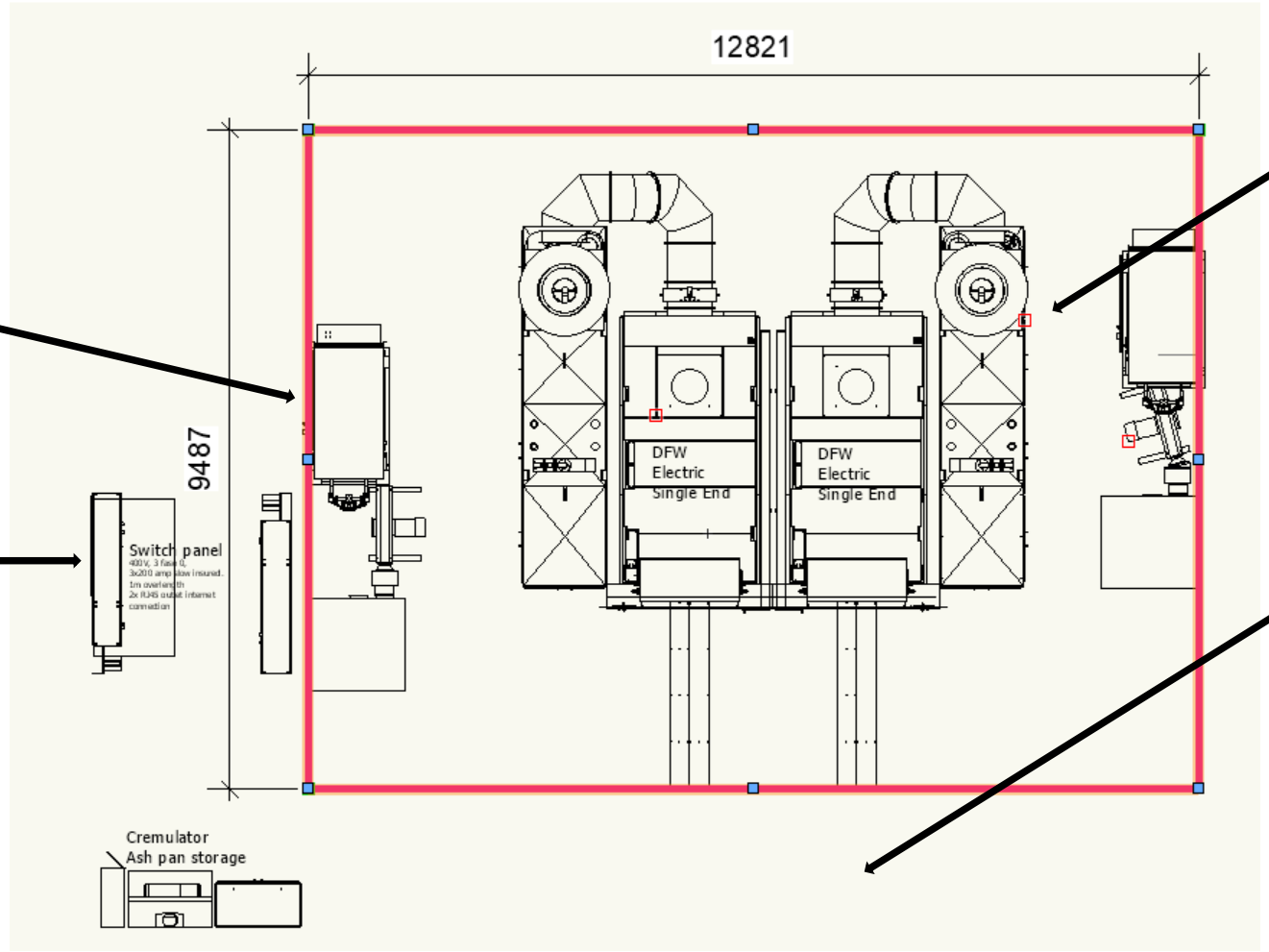


Electric Cremation - Dimensions

Requires separate filters, fans and abatement for each machine.

Space for switch panels required.

20 tonne in weight, per machine.

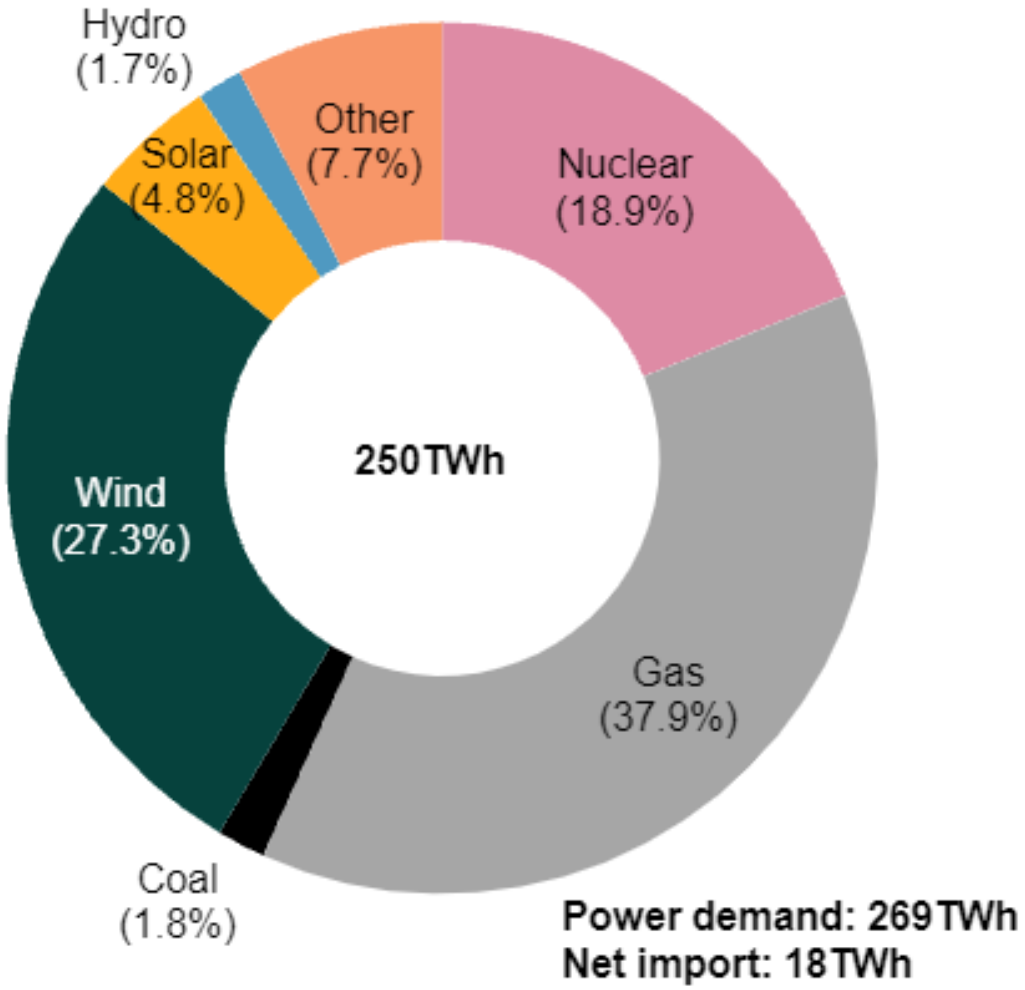


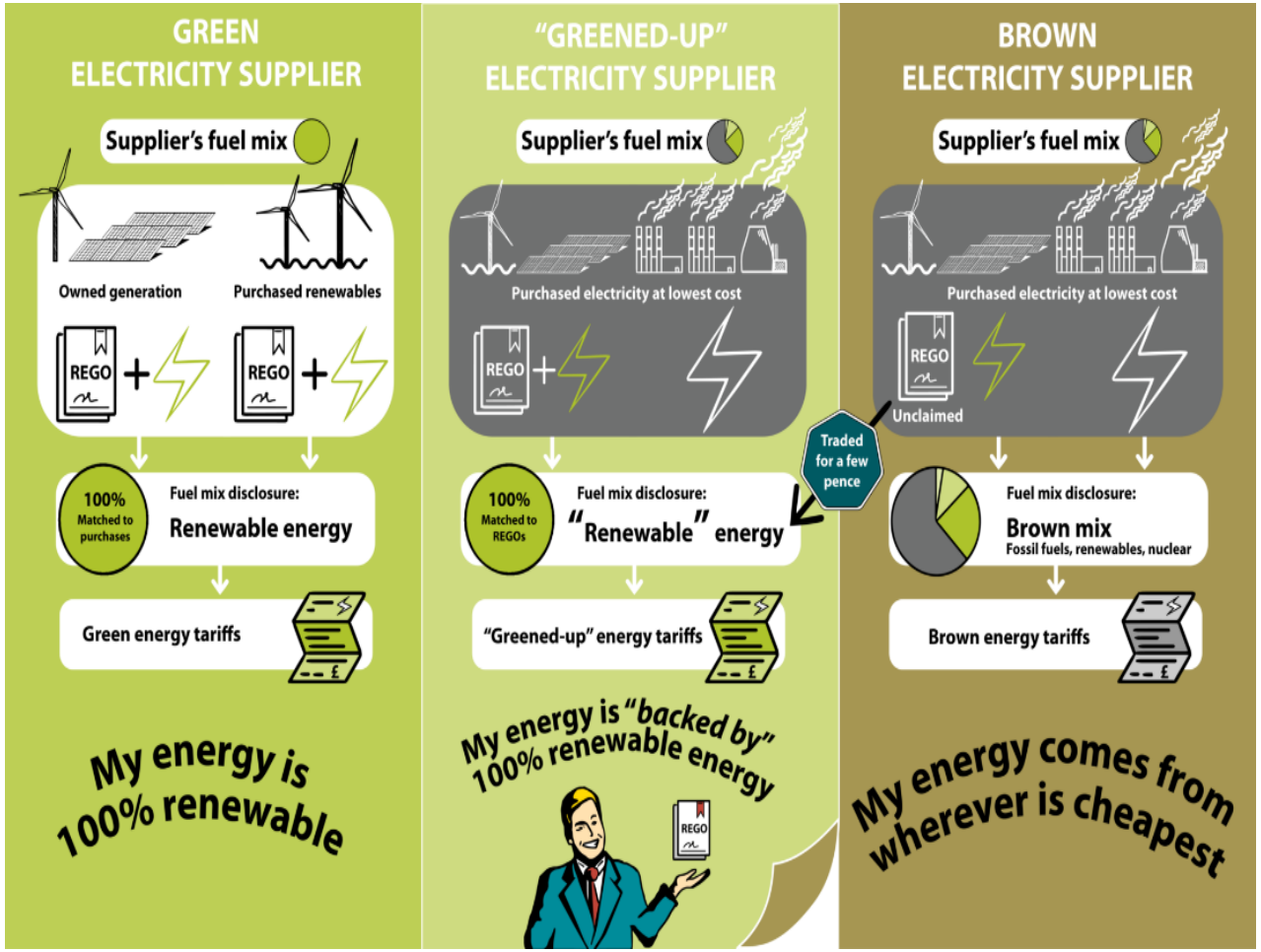
The machines and heat exchange (coolers) are larger in size.

Clearance is required for the AIM system and the 2m for raking is **not** included in this drawing.

There is a double-ended electric cremator now available on the market.

Electric Cremation - Emissions





"REGO" – Renewable energy guarantees of origin

Electric Cremation - Emissions

DFW electric cremations expected consumption figures and estimated CO2 per cremation:

Cremations per day	kWh/hr	CO2 per cremation (grid electricity, exc. Body and coffin)	CO2 per cremation (green electricity tariff, exc. Body and coffin
1	20	**111kg**	**0kg**
2	18	**50kg**	**0kg**
3	15	**28kg**	**0kg**
4	14	**19kg**	**0kg**
5	13	**14kg**	**0kg**
6	12	**11kg**	**0kg**

Carbon intensity values used to work out CO2 per cremation:

Fuel	Carbon intensity (kgCO2/kWh)
Electricity	0.231

CO2 emissions have been modelled by calculating the annual kWh using the kWh/hr divided by the number of annual cremations.

Electric Cremation - Cost

DFW electric cremations expected consumption figures and estimated cost £ per cremation: (to the nearest pound)

Cremations per day	kWh/hr	Costs per cremation* (Grid Electricity)	Costs per cremation* (Green Electricity)
1	20	**£155**	**£197**
2	18	**£70**	**£89**
3	15	**£39**	**£49**
4	14	**£27**	**£35**
5	13	**£20**	**£26**
6	12	**£16**	**£20**

Carbon intensity values used to work out CO2 per cremation:

Fuel	Cost (£/kWh)*
Electricity	£0.2234
Green Electricity	£0.284

**Energy Costs based on September 2022 data.*

Electric Cremation - Emissions

DFW electric cremation data at highly efficient crematorium, doing c. 1,500 cremations per annum through one electric cremator:

Month	Cremation numbers	kWh per cremation	CO2 per cremation (grid electricity)
Jan	90	52.1	**12kg**
Feb	103	30.6	**7kg**
Mar	127	27.4	**6kg**
Apr	89	48.9	**11kg**
May	118	44.7	**10kg**
Jun	113	39.6	**9kg**
Jul	109	59	**14kg**
Average		43.2	**10kg**

Figures are modelled on grid electricity CO2, however this crematorium does operate on a green energy tariff, which would be 0kg of CO2 per cremation (exc. Body and coffin).

Electric Cremation – Efficiency (CO_2)

DFW electric cremation data at highly efficient crematorium, doing c. 1,500 cremations per annum through one electric cremator:

Month	Cremation numbers	kWh per cremation	CO2 per cremation	Total CO2
Jan	90	52.1	**12kg**	1080kg
Feb	103	30.6	**7kg**	721kg
Mar	127	27.4	**6kg**	762kg
Apr	89	48.9	**11kg**	979kg
May	118	44.7	**10kg**	1180kg
Jun	113	39.6	**9kg**	1017kg
Jul	109	59	**14kg**	1526kg
Average		43.2	**10kg**	**Total = 7,265kg**

The same crematorium, modelled on running two electric cremators instead of one (grid electricity)

Month	Cremation numbers	kWh per cremation	CO2 per cremation	Total CO2
Jan	90	292.2	**50kg**	4500kg
Feb	103	234	**39kg**	4017kg
Mar	127	172.5	**28kg**	3556kg
Apr	89	295.4	**50kg**	4450kg
May	118	185.7	**28kg**	3304kg
Jun	113	213.3	**39kg**	4407kg
Jul	109	221.1	**39kg**	4251kg
Average		230.6	**39kg**	**Total = 28,485kg**

Electric Cremation – Efficiency (Costs)

DFW electric cremation data at highly efficient crematorium, doing c. 1,500 cremations per annum through one electric cremator:

Month	Cremation numbers	kWh per cremation	Cost per cremation	Cost for month
Jan	90	52.1	**£11.64**	£1,047.60
Feb	103	30.6	**£6.84**	£704.52
Mar	127	27.4	**£6.12**	£777.24
Apr	89	48.9	**£10.92**	£971.88
May	118	44.7	**£9.99**	£1,178.82
Jun	113	39.6	**£8.85**	£1,000.05
Jul	109	59	**£13.18**	£1,436.62
Average		43.2	**£8.36**	**£1,016.68**

The same crematorium, modelled on running two electric cremators instead of one (grid electricity)

Month	Cremation numbers	kWh per cremation	Cost per cremation	Cost for month
Jan	90	292.2	**£65.28**	£5,875.20
Feb	103	234	**£52.28**	£5,384.84
Mar	127	172.5	**£38.54**	£4,894.58
Apr	89	295.4	**£65.99**	£5,873.11
May	118	185.7	**£41.49**	£4,895.82
Jun	113	213.3	**£47.65**	£5,384.45
Jul	109	221.1	**£49.39**	£5,383.51
Average		230.6	**£51.52**	**£5,384.50**

Electric Cremation

THE ELECTRIC CAR
PAST AND FUTURE

1832 First crude EVs developed

1901 Thomas Edison works to develop better EV batteries

World's first hybrid electric car invented

1900-1912 EVs reach their heyday

1920-1935 Cheap Texas crude oil fuels decline in electric vehicles

1971 Electric lunar rover is first manned vehicle to drive on moon

1973 General Motors unveils prototype for urban EV

1974-1977 U.S. carmaker Sebring-Vanguard produces more than 2,000 CitiCar EVs, which have range of 80-97km

1990-1992 New U.S. environmental regulations renew interest in EVs

1996 GM releases EV1, first mass-produced EV by major automaker

1997 Toyota introduces Prius, world's first mass-produced hybrid

2008 Tesla launches commercial production of Roadster EV

2009-2013 U.S. government installs 18,000 residential, commercial, public chargers

China's BYD Auto releases F3DM, world's first plug-in hybrid

2010 Nissan releases all-electric Leaf

2014 Tesla breaks ground on massive Gigafactory 1 battery plant in U.S. state of Nevada

2016 GM releases Chevy Bolt, its first electric car

Chinese Finance Minister Lou Jiwei says country will totally phase out subsidies for green energy vehicles by 2021

2017

MARCH India's power minister suggests country aims for EV-only sales by 2030

JULY France, U.K. say they will end sales of gasoline, diesel vehicles by 2040

OCTOBER GM says it will launch at least 20 new electric, fuel-cell vehicles by 2023

2020 Tesla targets annual sales of 1 million cars

2025 VW targets annual sales of 2-3 million EVs by this year

BMW wants EVs to account for 15-25% of group sales by this year

2030 Up to 200 million EVs projected to be in circulation

2040 EVs projected to account for 32% of global auto sales

Prius photo by Reuters, others by Getty Images

Sources: International Energy Agency's Global EV Outlook 2017 report, U.S. Department of Energy

Electric Cremation

New (3rd) generation electric cremators are coming to market 2023

- Faster cremation times
- Quicker heat up times
- Improved energy efficiency
- Reduced emissions
- Smaller

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Comparison between gas and electric cremation

Comparison of Gas and Electric – Cost per cremation

Gas Cremation

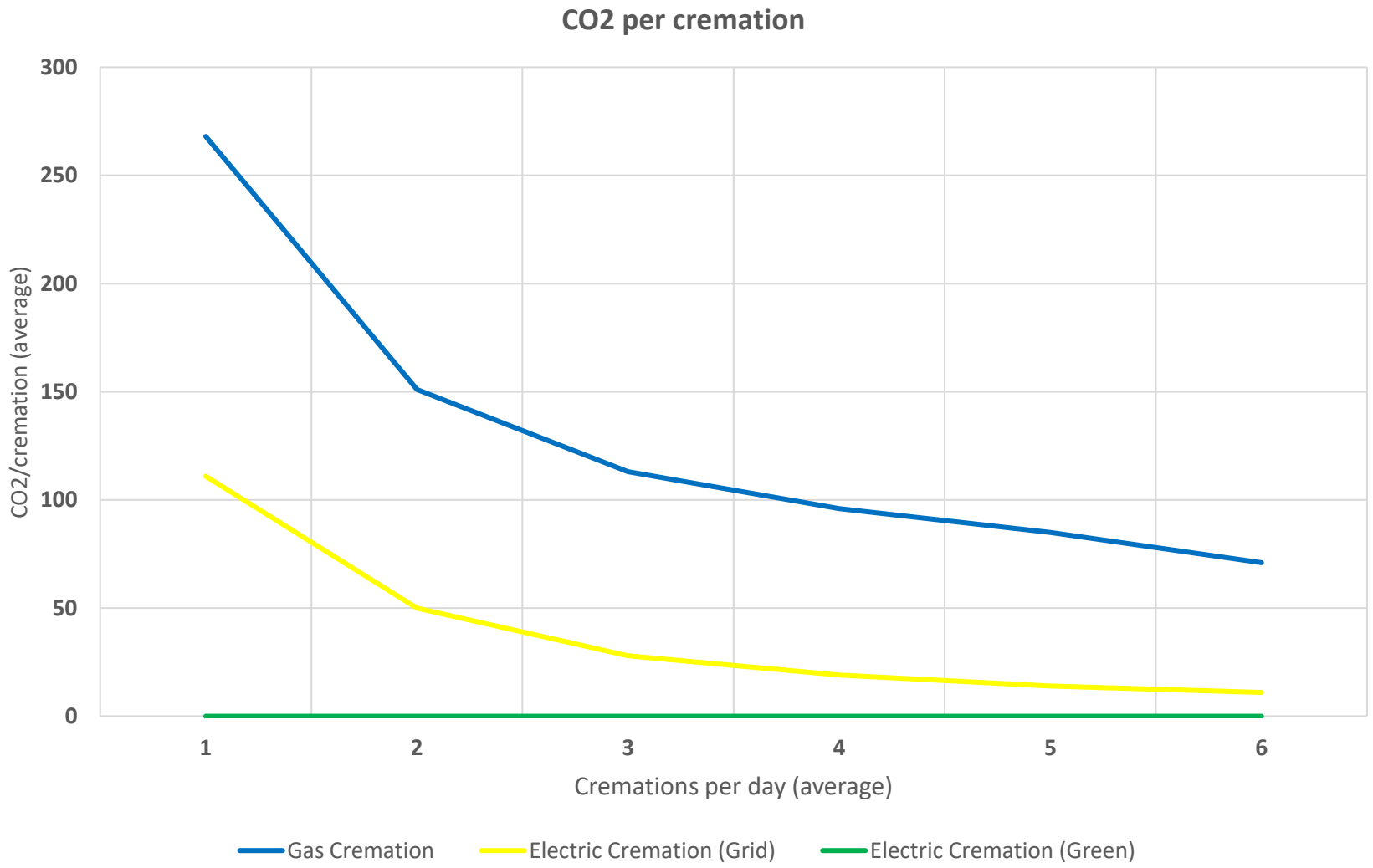
Cremations per day	Gas usage per cremation (kWh)*	Electricity usage per cremation [inc. rest] (kWh)	CO2/Cremation (Exc. Body and coffin)
1	1359	77	**268kg**
2	763	47	**151kg**
3	564	38	**113kg**
4	483	33	**96kg**
5	424	30	**85kg**
6	348	28	**71kg**

Electric Cremation (Grid)

Month	Cremation numbers	kWh per cremation	CO2 per cremation (grid electricity)
Jan	90	52.1	**12kg**
Feb	103	30.6	**7kg**
Mar	127	27.4	**6kg**
Apr	89	48.9	**11kg**
May	118	44.7	**10kg**
Jun	113	39.6	**9kg**
Jul	109	59	**14kg**
Average		43.2	**10kg**

**All values exclude the CO2 emissions from the body and the coffin which would be between an additional 25kg and 50kg dependant on coffin, body size and gender.*

Comparison of Gas and Electric – CO2 per cremation



Comparison of Gas and Electric – Cost per cremation

Gas Cremation

Cremations per day	Gas Per cremation (kWh)	Electricity Consumption Per Cremation [inc. rest] (kWh)	Cost per cremation
1	1359	77	**£82**
2	763	47	**£47**
3	564	38	**£36**
4	483	33	**£31**
5	424	30	**£27**
6	348	28	**£23**

Electric Cremation

Cremations per day	kWh/hr	Costs per cremation (Grid Electricity)	Costs per cremation (Green Electricity)
1	20	**£155**	**£197**
2	18	**£70**	**£89**
3	15	**£39**	**£49**
4	14	**£27**	**£35**
5	13	**£20**	**£26**
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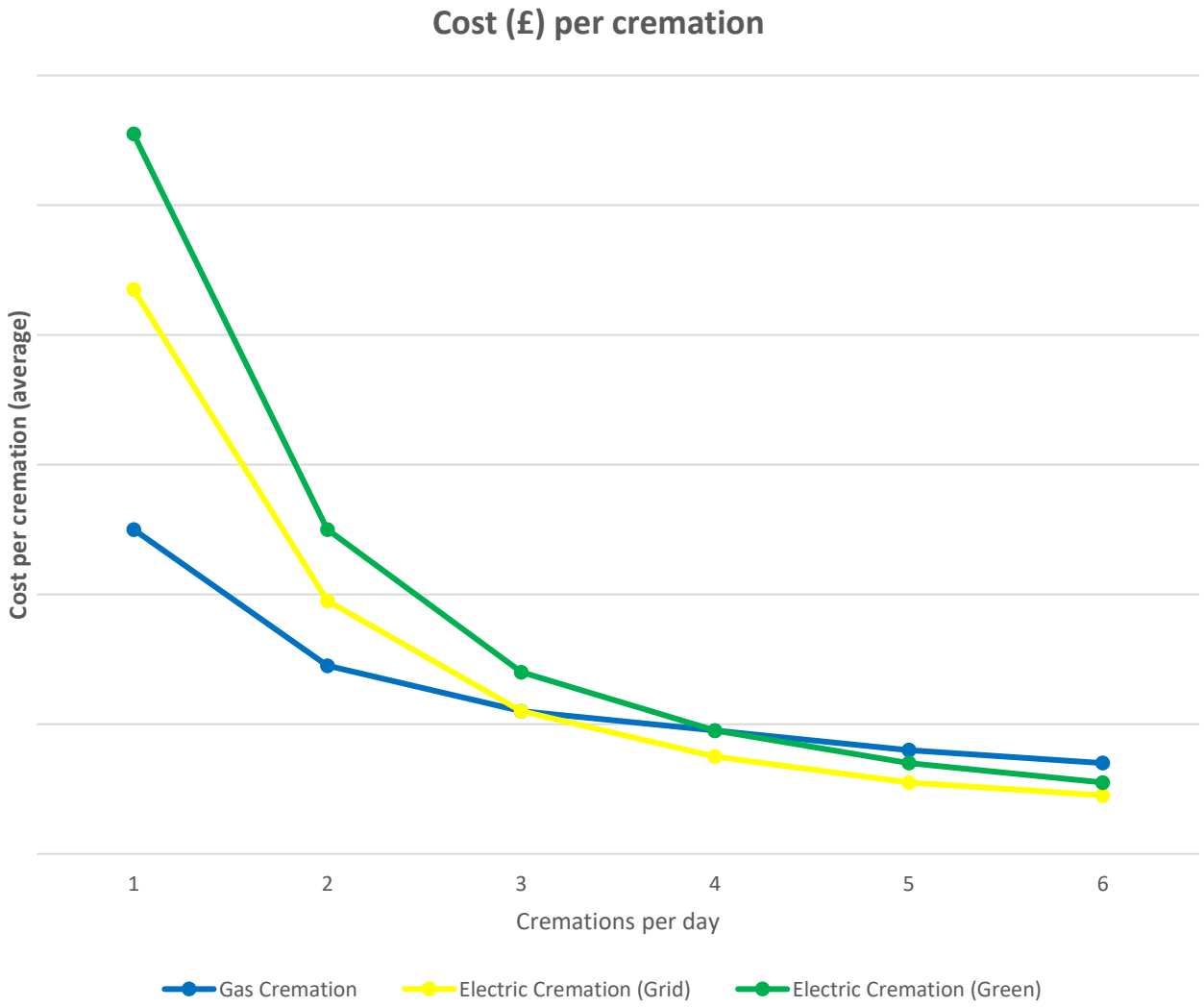
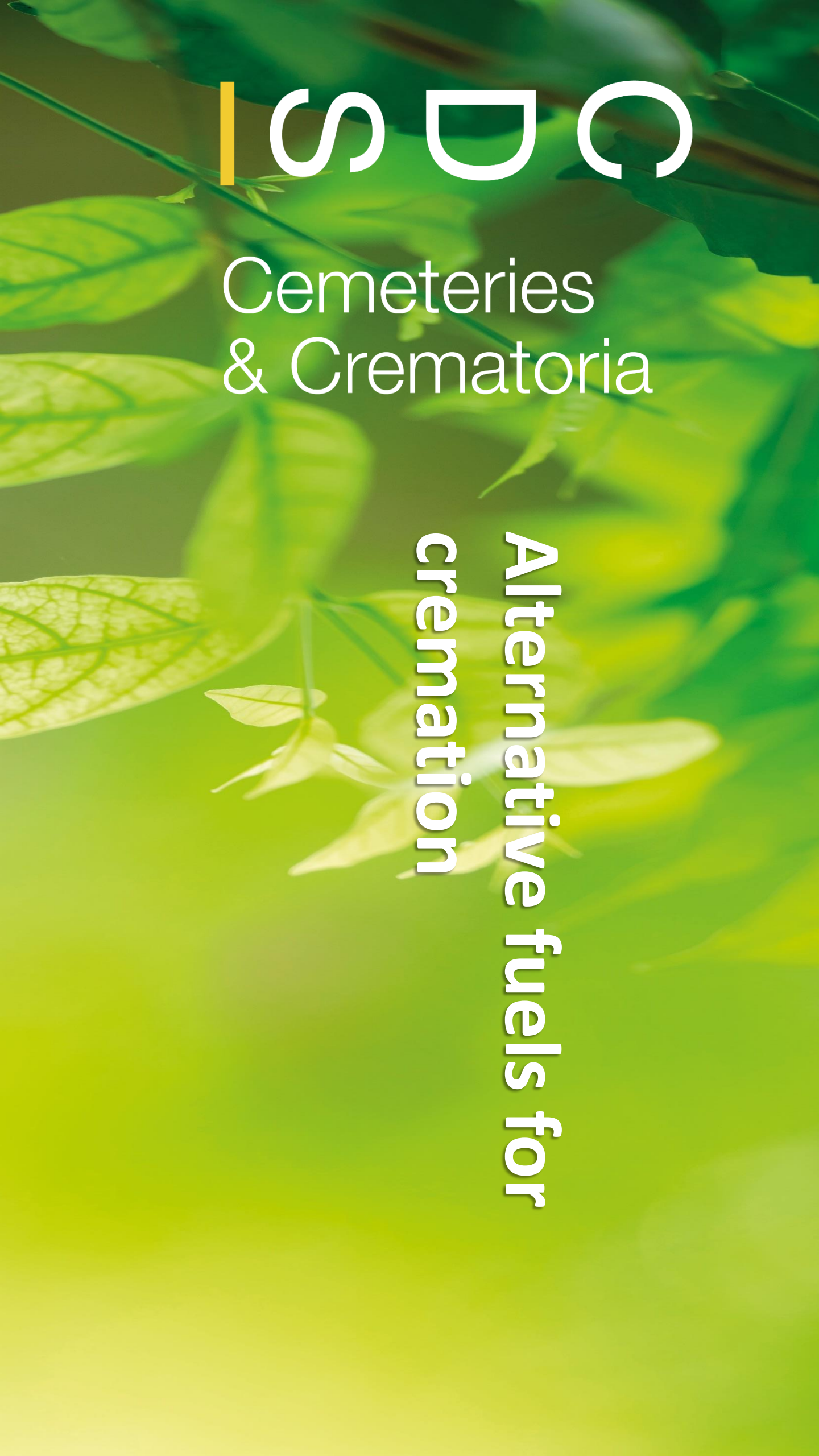
Comparison of Gas and Electric – Cost per cremation

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Alternative fuels for
cremation

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BioLPG Cremation

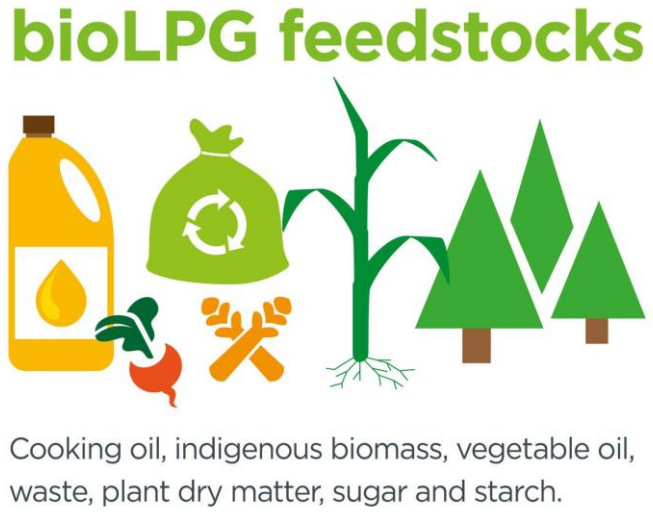
BioLPG Cremation

BioLPG is a co-product of the biodiesel production process.

During manufacturing, the feedstocks undergo a series of complex treatments. They are combined with hydrogen in a process, called hydrogenolysis, which separates and purifies their energy content.

During the refining process, a variety of waste ‘off-gases’ are produced that contain propane or BioLPG.

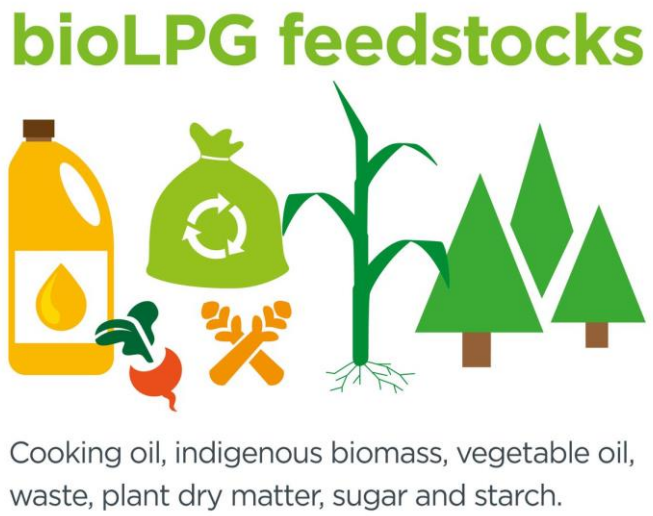
For every tonne of biodiesel, 50 kg of BioLPG is generated from this gas stream. This co-product is then purified to make it identical to conventional propane.



BioLPG Cremation

If Oil Seed Rape is used as a fuel crop for bio diesel (being an oil crop it would be the most efficient) then the following can be derived from data from the Energy Systems Research Unit at University of Strathclyde

Oil Seed Rape Bio Crop	Value	Measure
Production Area	1,000,000.00	Ha
OSR Yield Hectare	3.50	tonnes hectare
Production yield	3,500,000.00	tonnes
Conversion raw material to oil	0.40	%
Oil yield	1,400,000.00	tonnes
Conversion value to diesel	0.97	%
Production Volume	1,358,000.00	tonnes diesel
Conversion to BioLPG	0.05	tonnes
Production Volume	67,900.00	tonnes BioLPG



BioLPG Cremation

To produce the fuel crop (OSR) requires artificial nitrogen fertiliser, nitrogen fertiliser requires natural gas in its production.

The table below illustrates the amount of Nitrogen required and the resulting carbon produced (carbon equivalents CEV) for 1m Hectares of BioDiesel production. This doesn't take account of fuel for cultivation, harvesting, chemical sprays, or transport from field and production plant to end user.

N Fertiliser Use	Value	Measure
Production area	1,000,000	Hectares
Production Yield	3,400,000	Tonnes
Nitrogen per hectare	0.25	Tonnes
Total nitrogen	250,000	Tonnes
CEV	3.4	Tonnes
Carbon production	850,000	Tonnes

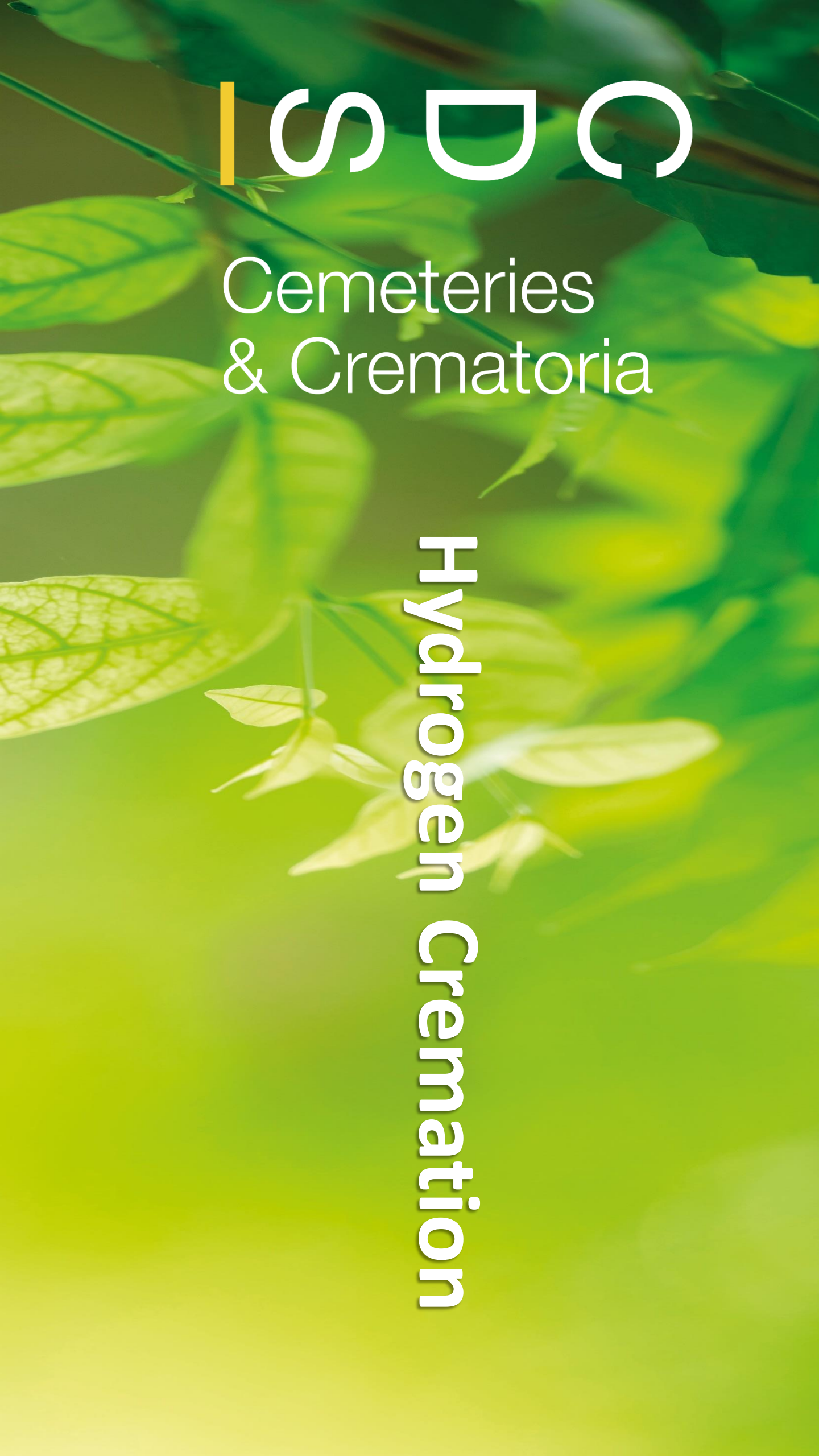
BioLPG Cremation

Food Security and Energy Security

Since Russia invaded Ukraine food security and energy security have never been more critical, replacing food crops with energy crops is unlikely to happen in the UK on any large scale.

V

V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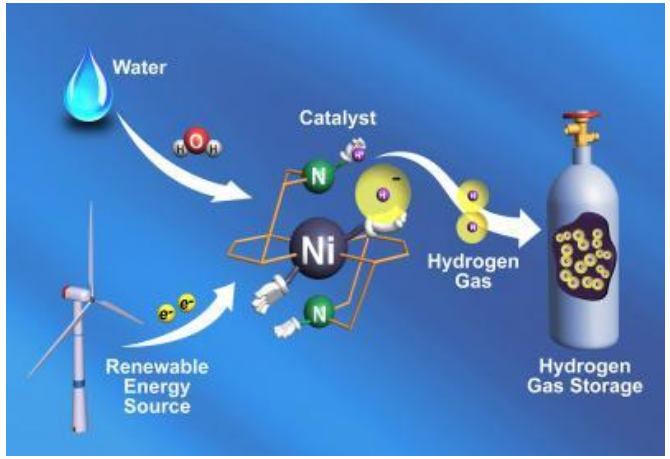
Hydrogen Cremation

Hydrogen Cremation

Green hydrogen is essentially carbon neutral, therefore the prospect of using green hydrogen for cremation fuel is positive, however the costs involved in green hydrogen production is extremely high compared to natural gas.



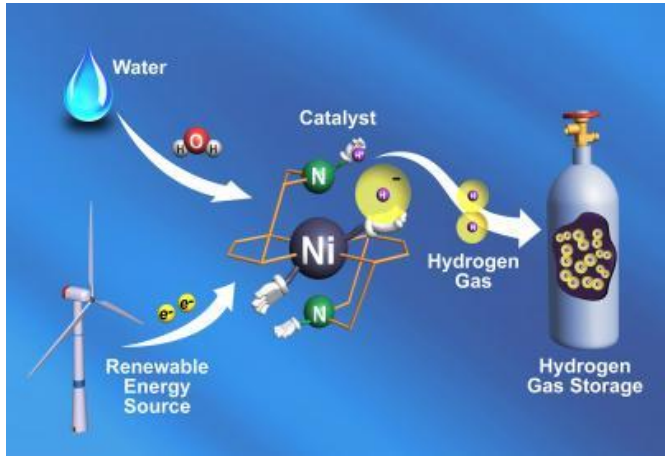
Hydrogen Cremation

There are two principal methods for producing hydrogen gas:

96% of global production is through steam methane reforming (SMR), using fossil fuels (Blue Hydrogen)

And

4% is produced through electrolysis, using a mixture of electricity and water. (Green Hydrogen)

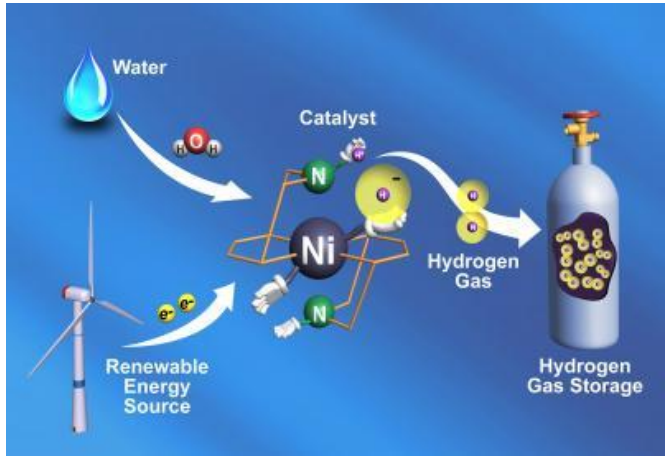


Hydrogen Cremation

Hydrogen has a lower molecular weight, therefore the probability of leakage is higher.

It diffuses easily in air and has a high tendency to leak, which makes it difficult to be contained.

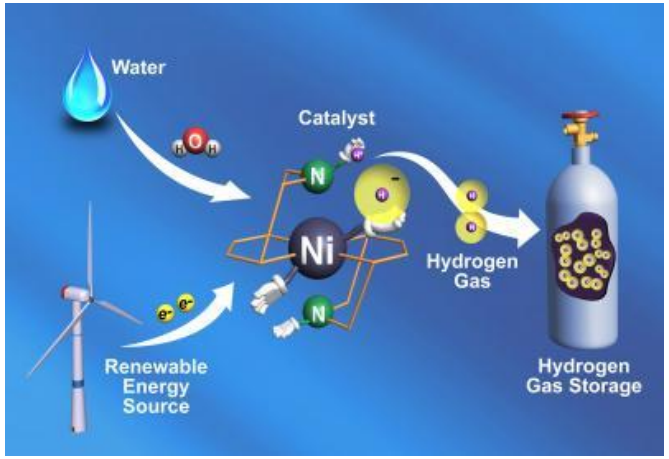
Hydrogen has a wide flammability range from 4 to 75% and a very low ignition energy.



Hydrogen Cremation

Burning hydrogen in pure oxygen produces H2O as a by-product. However in cremation, hydrogen would be burnt in air and some of the ferociously active oxygen atoms combine with nitrogen in the air to form NOx.

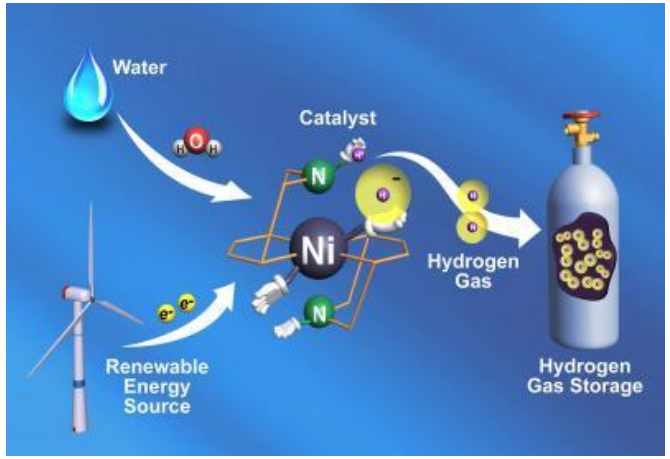
As there is no carbon atoms for the oxygen atoms to combine with, a higher proportion combine with nitrogen from the air to form NOx.



Hydrogen Cremation

For this reason burning hydrogen in air produces up to **six times the NOx emissions** than burning methane (natural gas) in air.

NOx is 300 times more potent than CO2.



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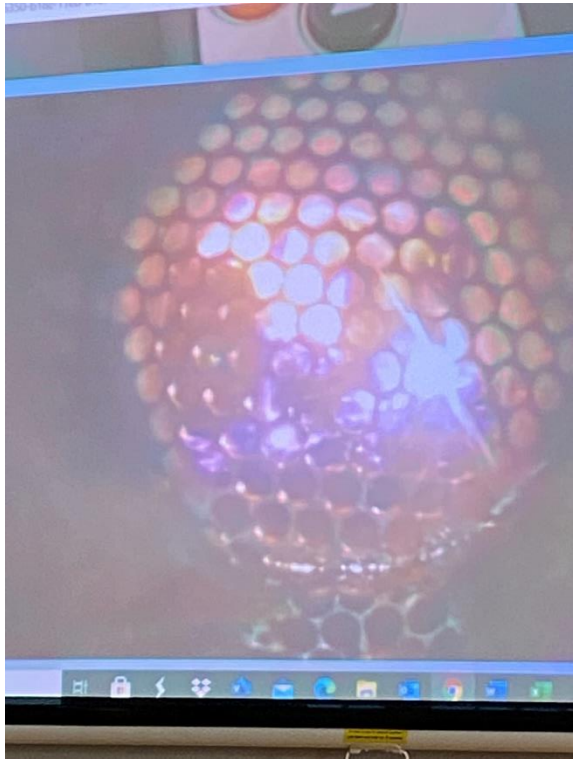
Microwave Technology

Microwave cremation

Mk1 Unit
System Energisation March 2021
Experimental programme concluded
September 2021

NEOJOULE

Microwave cremation



An early trial at 30% power – 90mins between images

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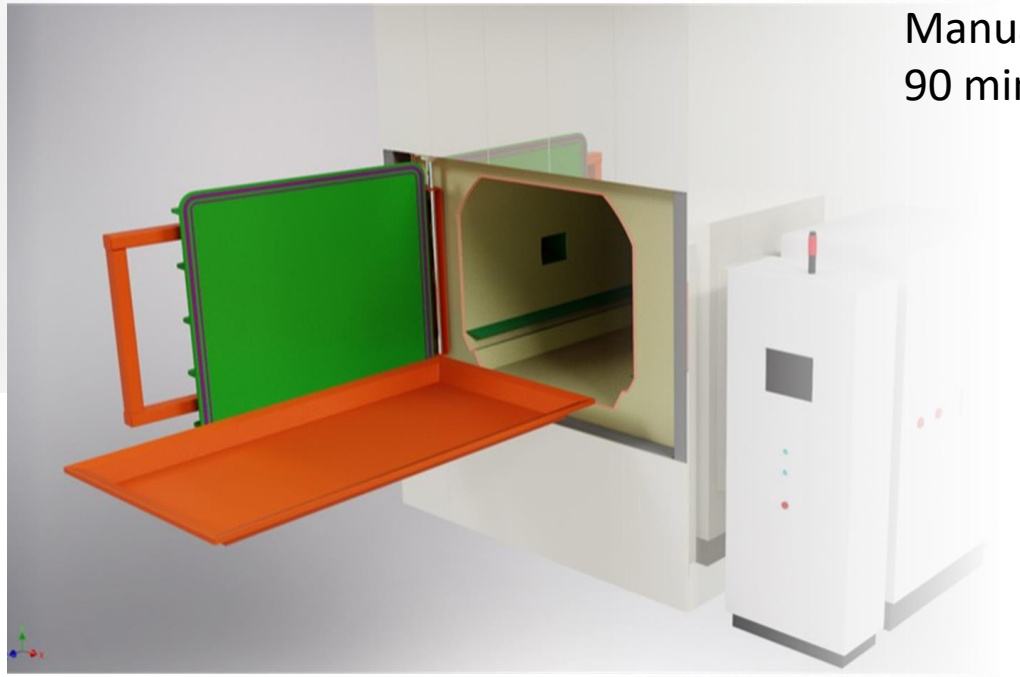
Microwave cremation

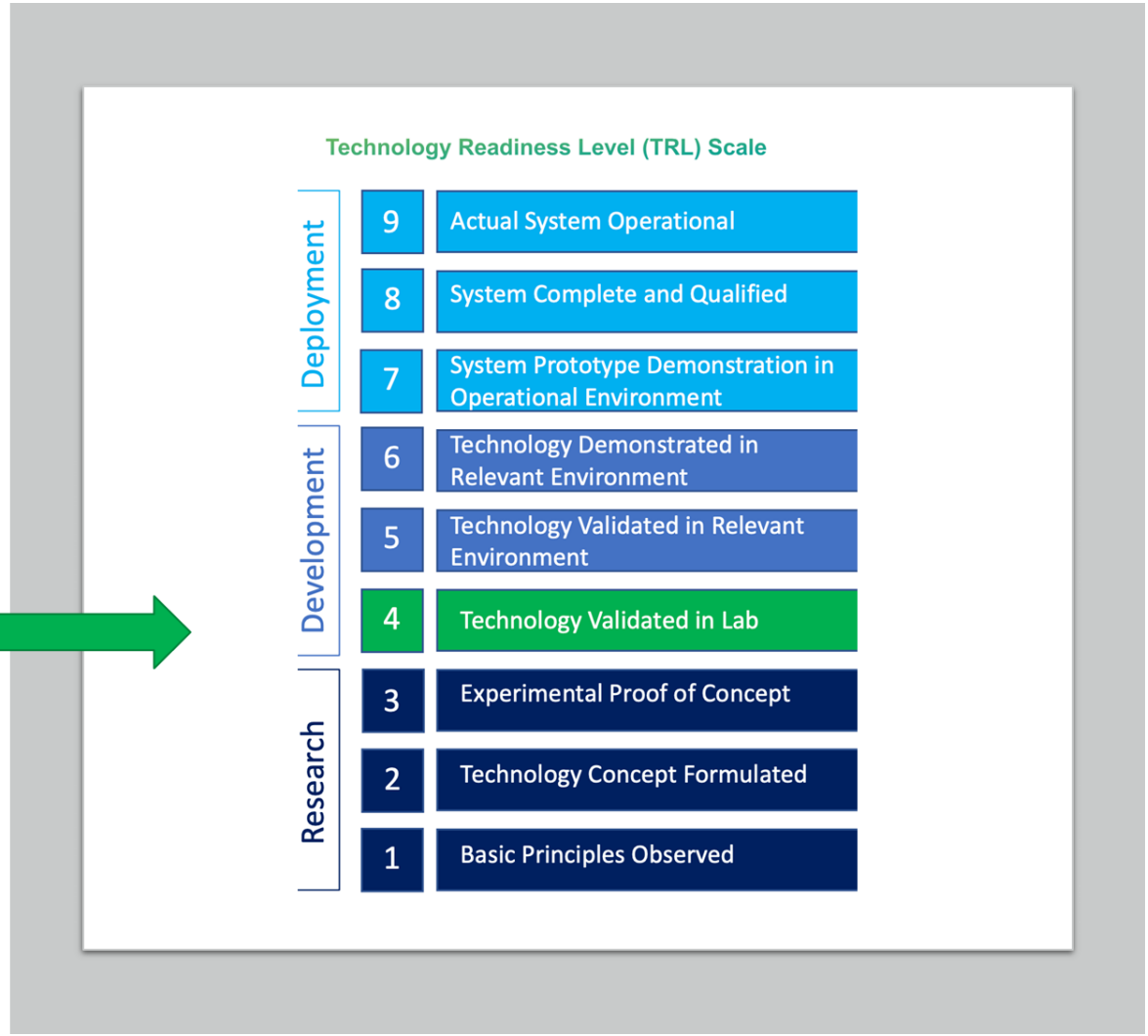


Mk2
1m to 1.7m nominal diameter
Enhanced wave guide cooling and air injection
Flat floor for ease of access
Motorised encoded door
Manual tray system
90 minute cycle

NEOJOULE

Microwave cremation

Current position in development

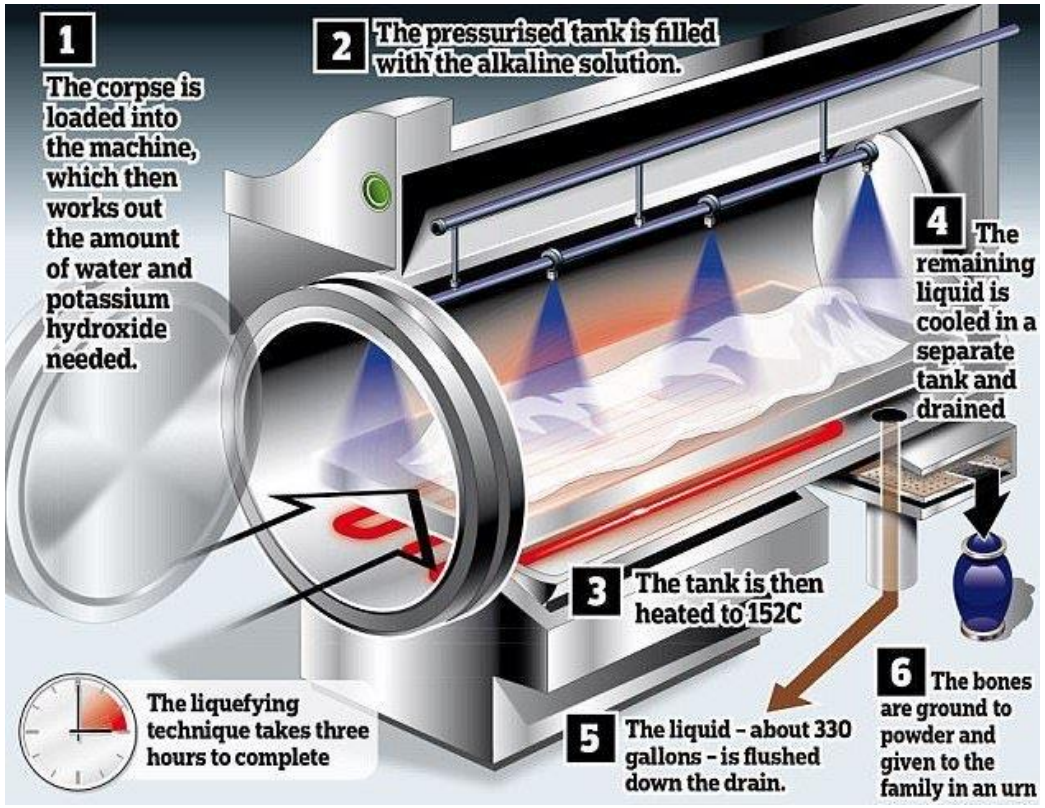


Cemeteries & Crematoria

Resomation

Resomation

Variable	Result
Capital Cost (Average)	A single system cost is - £350k , a dual system cost is £550k
Maintenance Costs (Average)	Unknown
Lifetime	Unknown
Cremation Time	3-3.5 hours (180-210 minutes)
Lead times from purchase	Unknown
Manufacturers	Resomation, Aquamation
Process	The process uses 1200 litres per cycle



Cremation -Using tools and technology to reduce carbon

Emissions*

Cremation Activity	Carbon	NOx
Natural Gas		
Bio-LPG		
Green Energy Electric		
Resomation		
Microwave		

*Excludes Life Cycle Analysis