CASE STUDY *Lakeside Energy from Waste Centre, London*

This is one of many case studies similar to the Western Sydney Energy and Resource Recovery Centre proposal.

The Lakeside Energy from Waste centre opened in 2010 at Colnbrook approximately 26 kilometres from the London CBD.

Lakeside Energy from Waste Ltd operates the plant as a joint venture between Grundon Waste Management and Viridor. The plant converts over 410,000 tonnes of residual waste each year into electricity.

The site is located in the village of Colnbrook, 1 kilometre from London's Heathrow Airport, and is approximately 26 kilometres from the London CBD.

Proximity to residential areas

Lakeside is approximately 400 metres from the nearest home in the Village of Colnbrook, Berkshire, UK.

How does the community benefit?

The Lakeside Energy from Waste facility helps its customers to meet their own landfill diversion targets, and avoid the rising costs of Landfill Tax.

There is an education center adjacent to the Lakeside Energy from Waste center, where schools and other groups can learn about sustainable waste management and energy from waste.

What sort of waste is managed?

Lakeside processes 410,000 tonnes of municipal and non-hazardous business waste each year.

Lakeside has been sending its Incinerator Bottom Ash (IBA) for reprocessing since 2010, where metals are segregated for recycling and the remaining material is recycled for use in roadbuilding and construction projects.

Since 1st Sep 2015, Lakeside has been sending the Air Pollution Control residue (a by-product of the flue gas treatment) to process into a high quality, lightweight aggregate.

What happens on site?

The Lakeside centre operates two mass burn combustion lines treating municipal and non-hazardous business waste.

The site burns waste at a very high temperature to heat water. This creates steam, which turns a turbine, and the turbine generates green electricity, which is distributed to the National Grid.

Main residues comprise incinerator bottom ash (IBA) and air pollution control residue (APCr). Viridor Energy has contracted Day Aggregates to recycle the incinerator bottom ash and Carbon8 to recycle air pollution control residue for the Lakeside centre.

Key Statistics:

Material to be processed

Municipal and non-hazardous business waste.

Waste management capacity

410,000
tonnes per year

Energy produced

The Lakeside centre produces 37MWe gross of renewable electricity of which, approximately 26MWe (estimated by Arup) is distributed to the National Grid.

Electricity to
56,000 homes

Reporting of emissions data

Air emission data obtained for continuous monitoring as well as stack test emissions reported for regulatory compliance.

Meeting European standards

All exhaust gases are filtered and cleaned before they leave the stack, ensuring that all emissions comply with all UK and European pollution control standards and the site is safe.

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CASE STUDY *Duiven Energy from Waste plant, The Netherlands*

This is one of many case studies similar to the Western Sydney Energy and Resource Recovery Centre proposal.

The Duiven Energy from Waste facility in The Netherlands is owned and operated by AVR and will be the first Energy from Waste facility to store carbon dioxide (CO2). CO2 recovery and reuse will commence in 2019.

It includes a large-scale CO2 capture system and will supply the nearby horticulture and greenhouse farming communities. The plant is a significant step to a better environment, contributing directly to the CO2 reduction in the Netherlands and in reaching the nation's climate targets.

The site is located in the Duiven industrial area, near the German border, close to Arnhem Central Railway Station, the 9th busiest station in The Netherlands.

Proximity to residential areas

The nearest homes are in Westervoort, that is 1.3 kilometres from the facility.

How does the community benefit?

The Duiven facility works closely with industry partners, organisations and authorities to generate awareness and strive for positive change on managing waste.

The facility supplies recycled CO2 to nearby farming communities, which means they don't need to burn natural gases to produce the CO2 they need for horticulture. This creates significant savings on fossil fuels.

The captured CO2 is used by farmers to grow vegetables, soft fruit, flowers and other plants.

What sort of waste is managed?

The facility converts thousands of tonnes of residual household and business waste into energy, which otherwise would have gone to landfill.

What happens on site?

When the waste arrives, it is weighed, mixed and maintained in a storage pit under negative air pressure (this means waste odours cannot leak out).

The combustion process produces steam to create electricity using a turbine generator on site.

The ash and metal products remain at the end of the combustion process – 7% of the metals are recycled, and the mineral bottom ash recycled into sustainable building materials. The CO2 in the flue gas is captured and stored as liquid on site prior to transportation.

Key Statistics:

Material to be processed

Post recycling household and business waste.

Waste management capacity

360,000 tonnes per year

Energy produced

The facility produces 18 MW of electricity and 20 MW of heat which is directly exported to the grid.

At Duiven:

CO2 - 50 kilotonnes (kt) per year

Electricity: 25,000 homes

Heat: 18,000 homes

Reporting of emissions data

The averages per half hour and per day are compared to the standards and are published. The values are registered and reported to the environmental protection agency DCMR or ODRA.

Meeting European standards

The site safely and strictly complies with the EU Industrial Emissions Directive (IED) which imposes strict emission limits for all industrial processes including Waste facilities.

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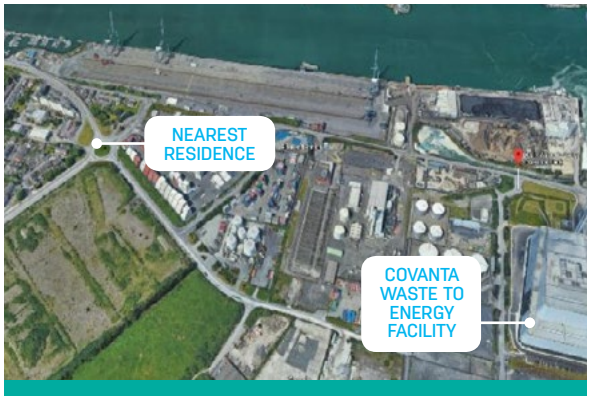
CASE STUDY *The Dublin Energy from Waste facility, Ireland*

This is one of many case studies similar to the Western Sydney Energy and Resource Recovery Centre proposal.

The Dublin Energy from Waste facility operated by Covanta started construction in 2014. It was funded by a public private partnership with Dublin City Council.

It has been operating at full capacity since December 2017. The facility takes waste that cannot be reused or recycled and recovers energy from these materials to generate electricity. This provides a long-term, environmentally responsible waste management solution.



The site, located on Pigeon House road, Dublin, is located less than 3 kilometres from Dublin City Centre, in the Docklands area of Dublin City, close to the mouth of Dublin Port.

Proximity to residential areas

The nearest residential area is Stella Gardens, Irishtown, 1.3 kilometres away. Irishtown is an inner-city suburb close to Dublin City, with historic public housing and modern apartments. The former Irish Glass bottle site, less than 1 kilometre from the site, will soon house 3,000 residential units.

How does the community benefit?

Covanta makes a positive contribution to the community. During construction over 300 jobs were created with more than 50 from the local area. Over 100 positions operate the facility.

Through community-based programs, the centre works with a variety of organizations on local environmental issues. The facility-run initiatives enlist volunteers to help clean up rivers, streets and parks. Also at a local level, the centre supports food pantries, recycling programs, and sports teams.

What sort of waste is managed?

The facility converts thousands of tonnes of residual household and business waste into energy, which otherwise would have gone to landfill.

Each year over 600,000 tonnes of waste is combusted, reducing the volume of waste to landfill by 90%.

What happens on site?

When the waste arrives, it is weighed, mixed and maintained in a storage pit under negative air pressure (this means waste odours cannot leak out).

The combustion process produces steam to create electricity using a turbine generator on site.

The ash and metal products remain at the end of the combustion process. The metals are extracted and recycled, and the final ash is transported for disposal.

Key Statistics:

Material being processed

Municipal and business solid waste.

Waste management capacity

600,000

tonnes per year

Energy produced

60 MW of continuous energy produced providing electricity for

80,000 homes

and can heat up to 50,000 homes

Reporting of emissions data

Emissions are measured and recorded continuously, with results automatically posted to the website in real time (see next page).

Meeting European standards

The facility is licensed by the Environmental Protection Agency under the Industrial Emissions Directive (IED).

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How is air quality measured?

The facility is designed to do better than the EU emissions standards for waste incineration.

The Ireland Environmental Protection Agency's (EPA's) public reporting requirements ensure the facility's performance data is easily accessible.

Air emission levels are measured and recorded by a continuous emissions monitoring system. The data is collected from inside the air stack, which is then published on the Covanta Dublin website

What data?

The raw data is published on the Covanta Dublin website in real time, providing the public with constant updates on air quality. This is important - it means people can see the information quickly.

This data is then checked and verified, with some alterations where, for example, something has been incorrect.

Many of the in-stack air measurements cannot be measured in real time and are tested periodically, with the results then published.

The air pollution control system uses the best available technology.

Water management at the facility

The facility operates on a completely waste water-free basis.

Most of the water used in the centre comes from rain water.

The facility is adjacent to a water treatment plant which also provides the water needed for operations.

How do emissions from this facility perform?

The centre successfully operates according to all EU air quality standards. Air emission levels are measured by the facility's Distributed Control System.

This includes readings from both stacks for:

- Total dust
- Hydrogen Chloride
- Carbon Monoxide
- Sulphur Dioxide and Oxides
- Nitrogen oxides
- Gaseous and vaporous organic substances expressed as Total Organic Carbon

A weekly emissions table is published showing the daily averages from the continuous monitoring of various substances. Following are examples of reporting found at www.dublinwastetoenergy.ie/About-the-facility/emissions-data.

Boiler One

MEASURED EMISSION	TOTAL DUST	TOC	HCL	SO2	CO	NOX
Limit	10	10	10	50	50	200
Unit	mg/Nm3	mg/Nm3	mg/Nm3	mg/Nm3	mg/Nm3	mg/Nm3
17 April 2019	0.34	0.15	0.04	0.01	7.17	127.00
18 April 2019	0.40	0.50	0.07	0.43	11.20	116.43
19 April 2019	0.35	0.16	0.04	0.15	7.08	120.24
20 April 2019	0.32	0.22	0.04	0.15	7.39	124.57
21 April 2019	0.32	0.20	0.05	0.50	7.26	122.76

Boiler Two

MEASURED EMISSION	TOTAL DUST	TOC	HCL	SO2	CO	NOX
Limit	10	10	10	50	50	200
Unit	mg/Nm3	mg/Nm3	mg/Nm3	mg/Nm3	mg/Nm3	mg/Nm3
17 April 2019	0.34	0.18	0.06	1.79	5.83	117.07
18 April 2019	0.33	0.22	0.13	0.90	5.49	107.29
19 April 2019	0.30	0.21	0.11	0.33	5.07	110.68
20 April 2019	0.30	0.21	0.09	0.37	5.19	113.54
21 April 2019	0.31	0.20	0.11	1.20	4.85	116.06

Cleaning the gases

The waste is stored under negative pressure to capture any odours. This means that air does not exit the centre, it is drawn into the centre. The waste is fed into the combustion process that also destroys odours.

The flue gas that is produced during the combustion process is cleaned. This is a three step process as described below.

Step One:

The flue gas is fed into the SemiDry reactor at a temperature of around 170°C. It is injected with dry hydrated lime, water and activated carbon. The particles of calcium hydroxide react with the pollutants in the flue gas. This creates particulate matter that is removed in step 2. The activated carbon neutralizes traces of mercury and dioxins or furans.

Step Two:

Particulate matter is removed by passing the flue gas through a bag house filter.

Step Three:

Water is used in a wet scrubber to reduce the flue gas temperature. This absorbs and neutralizes the remaining acid gases, before the scrubbed gas is released into the atmosphere.

All steps of this process are safe and are continuously monitored by operators working in the control room.

99.99% of the gas volume leaving the stack are gases common to air, including oxygen, hydrogen, nitrogen and water vapour.

CASE STUDY *The Leeds Recycling & Energy Recovery Facility, England*

This is one of many case studies similar to the Western Sydney Energy and Resource Recovery Centre proposal.

The Leeds Recycling and Energy Recovery Facility opened in 2016. The centre removes recyclable waste from general rubbish bins and recovers energy from what is left over.

Leeds City Council worked with an internationally renowned architect to deliver a modern timber framed building with sustainable features that enhance the biodiversity on site. The site is a positive landmark for the Industrial Estate, and the Aire Valley region of Leeds.

The site is located on Newmarket Approach, in the Cross Green Industrial Estate in Leeds. It is 2.4 kilometres away from the St James University Hospital.

Proximity to residential areas

The nearest home is approximately 250 metres from Wykebeck's outer boundary, with about 150 residential properties in this area.

How does the community benefit?

This facility works with its local council - Leeds City - to provide educational tours. It has a visitors centre onsite and provides schools and higher education students a waste education program focusing on waste minimisation and recycling activities. They examine how to reduce, reuse and recycle school waste, waste at home or in an office environment.

The Leeds Community Benefit Fund helps to support local initiatives and has provided grants to the local community each year since 2016.

What sort of waste is managed?

The facility uses state-of-the-art technology to remove and sort recyclables before combustion. This process extracts plastics, paper and cardboard, ferrous and non-ferrous metals.

The facility converts thousands of tonnes of household waste into energy, which otherwise would have gone to landfill.

What happens on site?

Household waste is delivered to the facility, shredded and sorted to extract up to 20% of recyclable material from the waste. This includes all recyclable metals.

The combustion process of the residual waste produces steam to create electricity using a turbine generator on site.

Ash and metal products remain at the end of the combustion process. The ash is recycled into construction aggregate, replacing quarried materials used to produce cement and asphalt.

Key Statistics:

Material to be processed

Household post-recycling waste that cannot be reused or recycled.

Waste management capacity

164,000
tonnes per year

Energy produced

The facility produces some 13MW of electricity, directly exported to the English National Grid

Electricity:
22,000 homes in the region

Heat: Has capacity to generate heat for local buildings.

Reporting of emissions data

Emissions are measured and recorded daily, with the results posted monthly to the website.

Meeting European standards

The facility operates safely 24/7, well within both UK and EU standards for emissions to the atmosphere. An environmental permit to operate was received as per The Environmental Permitting (England & Wales) Regulations 2010 in 2013.

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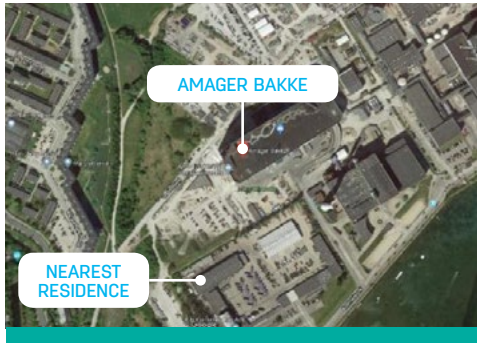
CASE STUDY *Amager Bakke, Denmark*

This is one of many case studies similar to the Western Sydney Energy and Resource Recovery Centre proposal.

Amager Bakke is a combined heat and power, Energy from Waste plant, that opened in 2017.

The facility is supported by five council areas in the Greater Copenhagen area.

This multi-purpose, state-of-the-art plant sets new standards for environmental performance, energy production and waste treatment. It has won awards for its architectural design and for providing leisure facilities and local activities for the community.



The facility is located on the outskirts of Copenhagen, near the airport and 3.5km from Copenhagen's Town Hall Square.

Proximity to residential areas

The nearest apartment is approximately 200 meters from the site in the area of Margretheholm, a high-density apartment area, shown below.

How does the community benefit?

Copenhagen's citizens benefit the most from this facility. They receive cheap and sustainable electricity, district heating and recycled materials.

The facility's roof has been designed as a public park space and operates as an artificial ski slope in winter and an activity park in summer, providing visitors with hiking trails, playgrounds fitness structures, climbing walls, trail running and more.

What sort of waste is managed?

The facility converts thousands of tonnes of residual household and business waste into energy, which otherwise would have gone to landfill.

What happens on site?

When the waste arrives, it is weighed, mixed and maintained in a storage pit under negative air pressure (this means waste odours cannot leak out).

The combustion process produces steam to create electricity using a turbine generator on site. The facility produces electricity and district heating.

It produces more clean water than it uses. Water is recovered from the flue gas (condensation), resulting in more than 100 million litres of water re-use. The ash and metal products remain at the end of the combustion process. 90% of the metal is reused, and the ash is reused for road and similar construction material.

Key Statistics:

Material to be processed

Household and business waste.

Waste management capacity

560,000
tonnes per year

Energy produced

The facility produces up to 63 MW of electricity directly exported to the local grid, and 157 MW heat production.

Electricity:
62,500 homes

Heat:
140,000 homes

Water:
100 million litres
of spare water

Reporting of emissions data

Emissions are recorded at every half hour interval over 24-hour period, with an average measure published monthly.

Meeting European standards

Amager Bakke will contribute to Copenhagen's ambitious goal of becoming carbon-neutral by 2025 in a safe manner.

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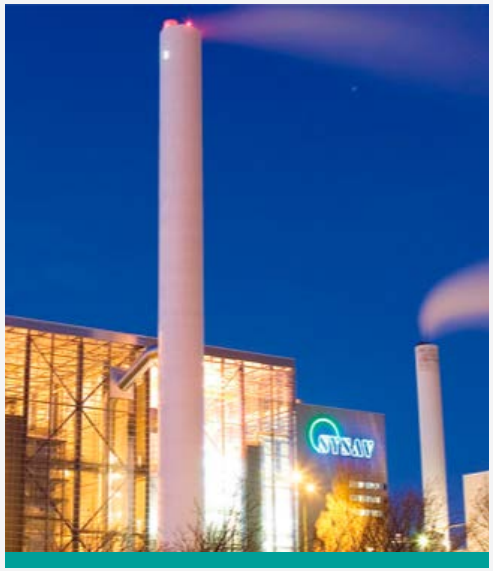
CASE STUDY *The Sysav Energy-from-waste Facility in Malmö, Sweden*

This is one of many case studies similar to the Western Sydney Energy and Resource Recovery Centre proposal.

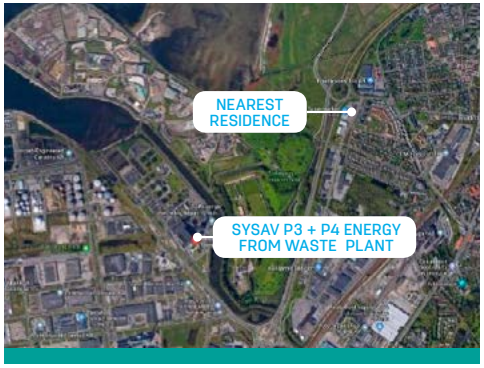


The Sysav Energy from Waste plant in Malmö is one of the most energy-efficient facilities in Sweden. It is one of the world's most advanced plants for combustion of waste and it's gas cleaning systems.

The facility commenced in operation in 1973 and was upgraded with additional boiler capacity in 2003 and 2008, enabling both electricity and district heating to be produced for residents.

Proximity to residential areas

The closest residential area is approximately 1 kilometer from the site, with greenspace separating the residential area from the industrial area.



The facility is located in the industrial dock area near Hamnen, a port city, located on the outer suburbs of Malmö.

How does the community benefit?

Waste that comes into the plant is sorted and recycled. The recycling centre has an educational focus and Sysav has had more than two million visits to its recycling centers across Sweden.

The Sysav group invites the community to take study tours of its facilities and almost 3,100 community members participated in 2017. Over 3,000 school students have participated in the tours.

The site operations team collaborates locally and regionally with universities and colleges on energy and waste research projects.

What sort of waste is managed?

This facility provides sorting, recycling, storage and composting to ensure landfill is only used as a final resort. The centre converts thousands of tonnes of residual household and business waste into energy, which otherwise would have gone to landfill.

What happens on site?

Pre-sorted, combustible, household and industrial waste is received at the plant from the southernmost region in Sweden. The waste is carefully combusted, passing through a heat exchanger, where steam is produced, and generated into electricity.

An advanced cleaning process as part of the new plant, passes the gas particles through a 'scrubbing' process returning the gas to water, which acts as the source for a heat pump, producing and capturing the district heat for the local area.

Key Statistics:

Material to be processed

Household waste along with combustible waste from businesses.

Waste management capacity

630,000
tonnes per year

Energy produced

The facility produces up to 60 MW electricity and up to 135MW of district heating, directly exported to the grid.

Electricity approx:
53,000 homes
District Heating:
70,000 homes

Reporting of emissions data

Daily and monthly air emission reports are provided.

Meeting European standards

The plant is classified as energy recovery in line with the EU policy on waste.

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