

FROM WASTE TO CLEAN ENERGY

Sävenäs Waste-to-Energy Plant, Gothenburg





! Electricity and heating to heat and power a standard villa is recovered from one grab of waste.

RECOVERING THE MAXIMUM ENERGY FROM WASTE

Our waste is not wasted. Renova collects and processes waste in the best and most environment-friendly way possible. What is not recovered for new materials or treated to produce biogas, we convert to electricity and heat at our Sävenäs waste-to-energy plant.

We have a permit to receive 550,000 tonnes of waste each year at Sävenäs. About half comes from households and half from business and other activities.

We burn the waste in four furnaces, each with its own cleaning line for flue gases. The energy recovered provides district heating, which we deliver to Gothenburg's network, and electricity to the grid.

Follow the process in the centre spread of this brochure.

WE PRODUCE ELECTRICITY AND HEATING FROM WASTE

The waste-to-energy plant delivers 30 % of the heat for the regional district heating network and the equivalent of 5 % of Gothenburgers' electricity consumption. This means:

- Heating and hot water for around 150,000 apartments
- Electricity for close to 110,000 apartments each year.

RECIPE FOR EFFICIENT COMBUSTION

Our staff ensure an appropriate mix of fuel, air supply and the right temperature for the most efficient combustion possible. Random daily checks are carried out to ensure that the waste coming into the plant is being properly sorted.

24-7 ALL YEAR ROUND

The waste-to-energy plant runs 24/7, all year round. Our communities produce and consume all year round – so the plant can't close for holidays!

In summer, when the heating demand drops, we take the chance to repair and maintain one furnace at a time. We bale combustible waste from businesses and other activities and store it until the heating demand rises. Then the plant runs at full capacity again.

RECYCLING OF SLAG

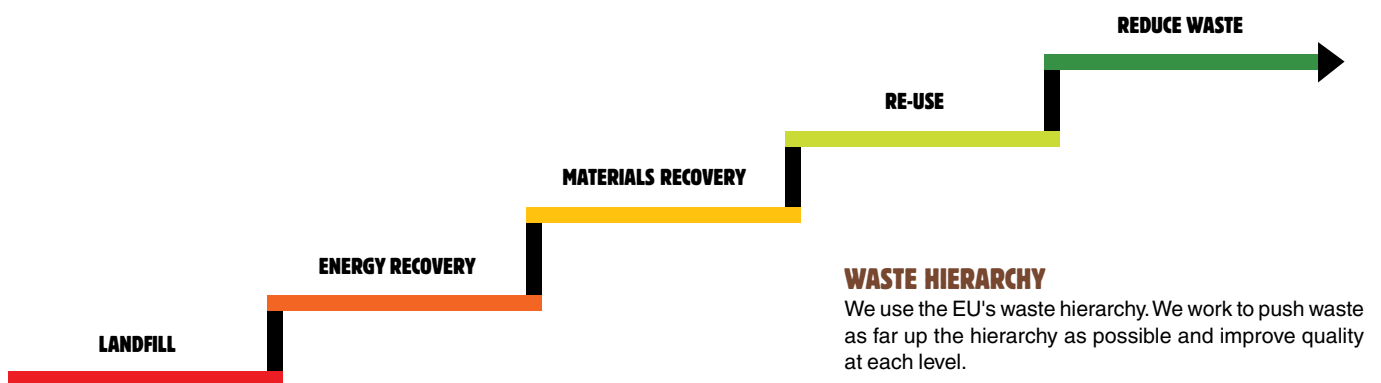
Waste that does not burn comes out of the furnaces as slag. At our Tagene facility, we separate the slag and recover approximately 10,000 tonnes of metals each year. The residue (bottom ash) is recycled as building material.

ONE KILOGRAM OF WASTE BECOMES ...

One kilo of burned waste provides hot water for a 7-minute shower and electricity for 3 hours' computer use.

PUBLIC UTILITY AND A LEARNING ORGANISATION

As in the rest of Sweden and in Europe, we are working to reduce waste and increase reuse and recycling in our region. Efficient combustion with energy recovery has an important role to play locally and globally.



The regional, national and European waste targets are based on the EU's waste hierarchy. Waste is to be moved up the hierarchy – from landfill at the bottom to reducing or preventing waste at the top (see figure).

The Gothenburg region's waste plan 2020 states that household waste per person in 2020 should not exceed the 2008 level of around 450 to 500 kg per person and year.

A STEP UP FROM THE 1970S

In the 1960s, municipalities in the Gothenburg region joined forces to build the Sävenäs waste-to-energy plant. After the plant opened in 1972, a large part of the region's waste moved up in the hierarchy – from landfill to energy recovery.

In the years since, the plant's efficiency and environmental impact have been improved while continuously delivering energy to the Gothenburg region.

Today, we extract three times the energy from each tonne of waste as when the plant was new.

REDUCES CO2 EMISSIONS

When burning waste replaces oil, natural gas and coal as energy sources, we help reduce CO₂ emissions and the greenhouse effect. This is because two thirds of the waste coming to Renova's Sävenäs plant today is of non-fossil origin.

Around 40 % of the electricity produced is guaranteed renewable, so we get electricity certificates for some of our energy production.

WASTE FROM MANY

Most of the waste burned in Sävenäs still comes from the Gothenburg region. But when we have room, we also receive waste from other regions and countries. This is an environmental win-win when the alternative to energy recovery with us is waste going to landfills.



! Renova's waste-to-energy plant is one of the world's most energy-efficient.

WE BURN WASTE WHILE STEADILY REDUCING EMISSIONS

Since 1980, emissions from the plant have fallen by between 90 and 99 % even though we burn significantly more waste now. Technology development and more stringent regulatory requirements have paved the way for ever-better cleaning. Our communities also now sort more at the source, meaning we get the right waste.

Since 2006, EU legislation on emissions from waste combustion applies. Renova's Sävsnäs plant complies with Sweden's and the EU's environment standards by a very good margin.

SORTING AND RECYCLING ARE IMPORTANT

Hazardous waste needs to be separated out before it reaches the waste-to-energy plant. Different substances in hazardous waste, such as heavy metals, are a problem for the cleaning stages. Gypsum/Plaster, which contains sulphur, should not be burned either. Food waste is better suited to generating biogas and nutrients for soil. Packaging and recycled paper should be sorted for recycling to new material.

LESS PLASTIC REDUCES CO₂

Carbon dioxide is one of the greenhouse gases that cause global warming.

All combustion produces CO₂. When we use products of fossil origin that are then burned, we add more CO₂ than our environment can process naturally. Sorting out plastic for material reuse instead of burning it in the waste-to-energy plant is one way of reducing CO₂ emissions.

HOW WE CLEAN THE FLUE GASES FROM THE WASTE-TO-ENERGY PLANT IN SÄVENÄS:

1. Particles are trapped in electrostatic precipitator
2. Acidic gases like hydrochloric acid and sulphur dioxide, heavy metals and smaller particles are “scrubbed” out in a wet cleaning stage.
3. Dioxins, other organic pollutants and nitric oxides are reduced in the boilers and cleaning stage, by either filters or catalytic converters.

Follow all the cleaning stages in points 8–15 on the next double spread.

CLIMATE IMPACT

One-third of the CO₂ release from Swedish waste-to-energy plants is of fossil origin.

Three per cent of Sweden's total greenhouse gas emissions come from waste-to-energy plants.

Emissions
(tonnes)

Burned
waste
(k tonnes)

In 20 years, emissions of particles, hydrogen chloride, sulphur dioxide and nitrogen have reduced drastically even though we now burn almost double the waste.

500

500

450

450

400

400

350

350

300

300

250

250

200

200

150

150

100

100

50

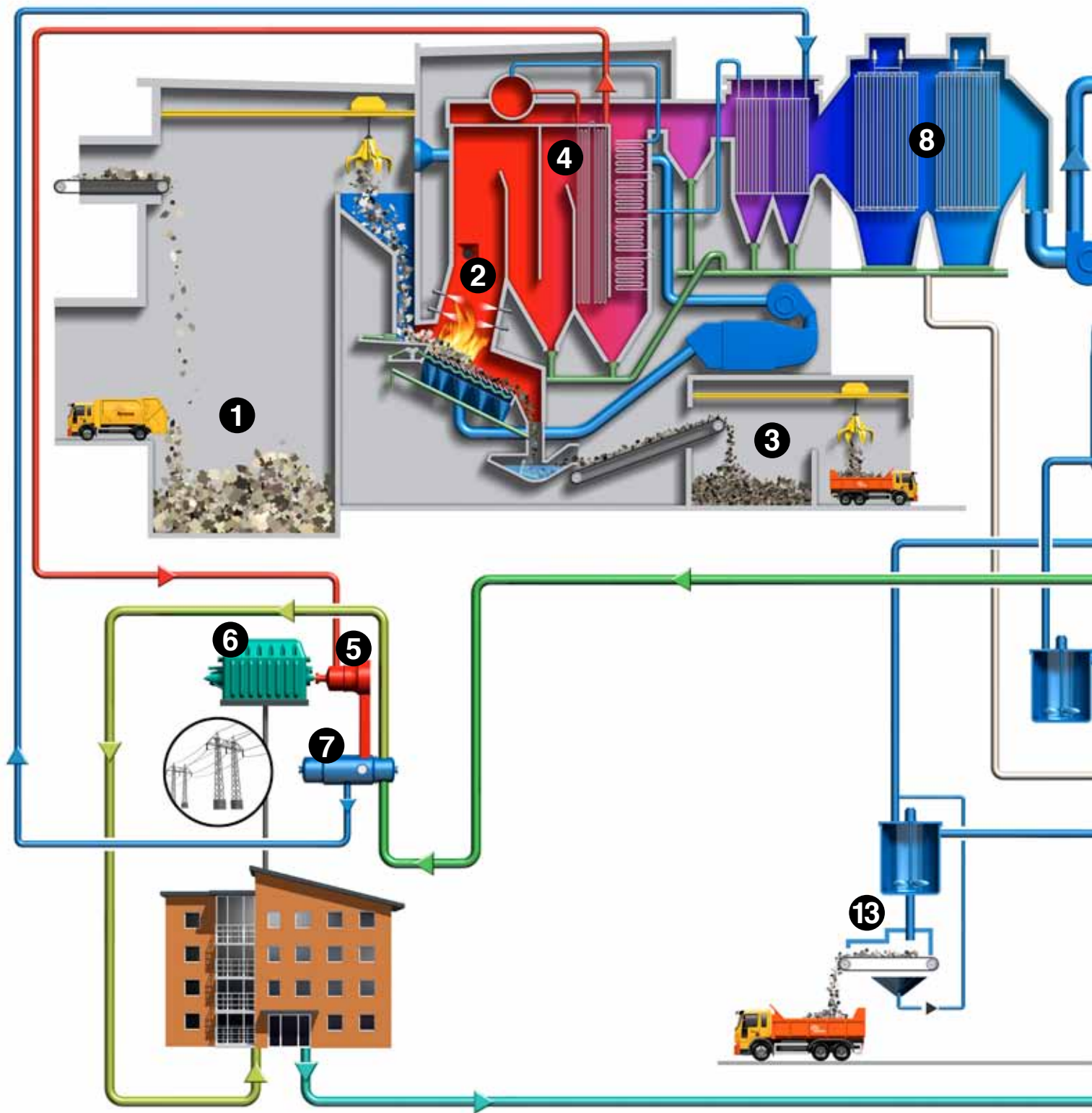
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Year	Particles (tonnes/ year)	Hydrogen chloride (tonnes/ year)	Sulphur dioxide (tonnes/ year)	Nitrogen (tonnes/ year)	Burned (k tonnes/ year)
1992	8.6	31.3	287	490	283.4
1993	14	62.5	293	239	291.1
1997	6.8	44	431	206	381.4
1999	4.7	29	407	190	373.1
2000	2.6	10	90	168	368.1
2001	3.2	10	68	144	352.1
2002	3.4	11	106	163	419
2003	3.0	4.1	30	158	401.9
2004	3.3	5.0	36	162	433.7
2005	4.7	5.4	36	156	436.3
2006	4.7	1.9	49	176	438
2007	3.1	1.4	29	168	444.1
2008	2.4	0.8	22	169	453
2009	2.0	0.8	59	164	446.5
2010	0.8	1.1	46	181	539.1
2011	0.6	0.6	9	179	535.8
2012	0.7	0.6	8	184	542.5

1992

2012

WHERE YOUR WASTE BECOMES POWER AND HEATING.



1. Combustible waste is emptied into a bunker. Two large grabs feed the furnaces with the waste as fuel.

2. The temperature in the furnace is approximately 1000 °C. The waste burns without adding other fuel. Air and flue gases are blown in to achieve efficient, controlled combustion.

3. Non-combustible material in the waste collects as slag at the bottom of the furnaces. The slag is transported to Renova's Tagene facility, where it is sorted and recycled.

4. The combustion heats water which is piped into the boilers. There, the water turns to steam.

5. The hot steam is piped to a turbine.

6. The turbine drives a generator to produce electricity.

7. In the condenser, the steam meets the district heating water in a heat exchanger and heats it to approximately 100 °C. Once the steam has given off its heat, it becomes water again. The water is piped back to the boilers to heat up again.

8. The flue gases are cleaned before emission. The first stage is an electrostatic precipitator that catches 99 % of dust particles.

9. In the wet cleaning stages (the green cylinders) acidic gases, heavy metals and residual particles are scrubbed out.

10. The flue gases from the newest boiler pass through a catalytic converter that reduces dioxins and nitric oxides. For the other three boilers, the gases are instead directed through a bag filter to remove dioxins. Nitric oxides are already reduced in the boiler.

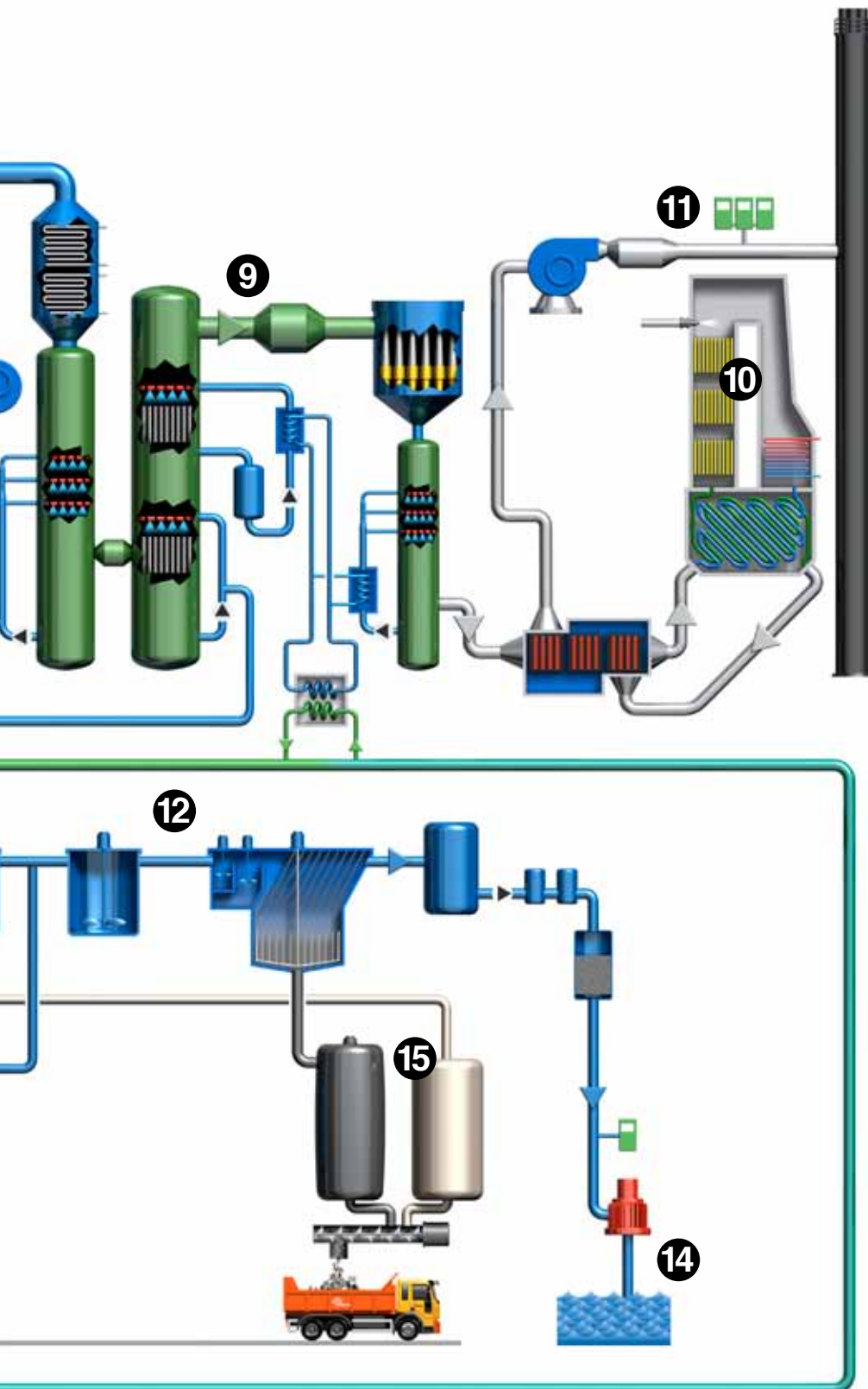
11. Now the flue gases are cleaned and can be released through the 126 m high chimney.

12. The pollutants in the water from the wet cleaning stage are removed. Raising the PH separates out metals and other particles.

13. Sulphur is removed in a separate process. The residual product is a kind of gypsum, a stable product that does not leach. It goes to landfill.

14. The cleaned water is somewhat saline. So it cannot be discharged directly into fresh water. Instead, it is piped along Säre Stream out into the Göta River.

15. The sludge with pollutants from the water cleaning and particles from the electrostatic precipitator and bag filter are mixed to a cement-like material, a stable product that does not leach. It goes to landfill.



RESEARCH FOR INCREASED RECYCLING AND ENERGY EFFICIENCY

Exciting developments are occurring in the area of energy recovery. Renova is actively involved in R&D. Extracting even more of the metals and in some cases also the nutrient phosphorus from the slag and ash is one area with great potential.

Today, pieces of metal are separated out and recycled from the slag, the residue after the waste is burned. Even the fly ash contains many different metals, but in chemically bonded form with other substances. Trials are in progress to scrub out zinc and copper from the ash.

Hopefully, this will lead to the recovery of valuable metals and ash that is less polluted.

The ash also contains the nutrient phosphorus. It remains difficult to extract phosphorus in a pure enough state for reuse, but experiments continue.

INCREASED ENERGY EFFICIENCY

We are also working to increase energy efficiency in our waste-to-energy plant to recover as much energy as possible.

This includes participating in R&D for new materials for our equipment that can withstand higher temperatures and thus increase efficiency.

LEADING-EDGE COLLABORATIONS

Renova is involved in many different types of R&D collaborations:

WASTE REFINERY – a Swedish Excellence Centre for optimum conversion of waste material

SWEDISH WASTE MANAGEMENT R&D INITIATIVES – projects within the industry association

THERMAL ENGINEERING RESEARCH INSTITUTE – R&D in fuel-based heat and power production

HTC – the Swedish Competence Centre for high-temperature corrosion

FRIST – Forum for Risk Investigation and Soil Treatment (Chalmers University and others)

POWRES – interdisciplinary waste R&D in Sweden (research school, Chalmers and other Swedish universities)

We also participate in projects where suppliers such as Gotaverken Miljö and Siemens are able to test new technologies *in situ*.

SCHOLARSHIP FOR RESEARCHERS

Students at universities can conduct research projects with us. Each year we also award environment scholarships to doctoral students and young researchers at Chalmers University and Gothenburg University for research on environmental issues related to Renova's activities.



! Extracting metals from ash is one of several exciting research areas for Renova. Picture from the lab in the waste-to-energy plant.

ECONOMICAL AND EFFICIENT TRANSPORT



! Renova's first mass-produced electric-hybrid collection truck. It runs on electricity only up to 20 km/h, which is perfect for the vehicle's pattern of short distances with many stops. Energy consumption is 30–35 % lower than a conventional refuse collection vehicle.

24/7 all year round, waste is delivered to the Sävenäs waste-to-energy plant. Most is transported in Renova's own vehicles. Transport that is as environment-friendly as possible is important to us. We are drivers in the development of vehicles and renewable fuels.



Our permit for the waste-to-energy plant under Sweden's Environment Code includes requirements on transport to the plant.

For many years, Renova has been working with vehicle manufacturers and other partners to develop as efficient and environment-friendly vehicles as possible. For example, we were first in the world to introduce an electric-hybrid collection vehicle powered by electricity and diesel that loads and compresses waste using only electricity. We also have a number of heavy vehicles using MD technology. The engine runs on both biogas(methane) and diesel.

A truck with trailer powered by liquid biogas (LBG) transports slag from the waste-to-energy plant to sorting at the Tagene facility. Being able to deliver vehicle gas in liquid form makes it possible to use biogas for fuel-hungry heavy vehicles.

FOSSIL FUELS BEING PHASED OUT

In 2013 nearly 80 % of fuel for our heavy vehicles was from renewable sources. Our aim is to phase out fossil fuels completely within a few years.

Our transshipment facilities in the Gothenburg region are important in reducing the environmental impact from transport to the Sävenäs plant. There, collection vehicles deposit waste collected from close by. It is then reloaded and shipped to the waste-to-energy plant in container trucks. A container truck carries the load of 8-9 collection vehicles, substantially reducing emissions.

Smart route planning for all vehicles is done using software, and regular training of all drivers in eco-driving also help make Renova's shipments efficient and greener.

FOOD BECOMES BIOGAS WHICH BECOMES VEHICLE FUEL

More and more households are sorting food waste at the source. At our pre-treatment facility for biological waste in Marieholm, food waste becomes the raw material for biogas production.

One person generates approximately 100 kg of food waste annually. From this, we can produce biogas sufficient to drive a car 133 km, for example.

WE DO MORE IN WASTE AND RECYCLING

Renova is a publicly-owned enterprise providing a wide range of waste-related services. We collect and treat all types of waste and recycling materials. We train, act as advisers and provide waste management services. Our vision is to drive development in the transition to sustainable growth in our region.

WHAT WE DO:

- Training, advice and study visits.
- Collection and shipment of all types of waste and recyclable materials
- Environment-friendly waste management
- Services such as waste room management, washing of bins, vehicle repairs

Our customers include both public and private enterprise and organisations.

The Renova group consists of Renova AB and Renova Miljö AB. The group is owned by the municipalities of Ale, Gothenburg, Härryda, Kungälv, Lerum, Mölndal, Partille, Stenungsund, Tjörn and Öckerö.

OUR FACILITIES

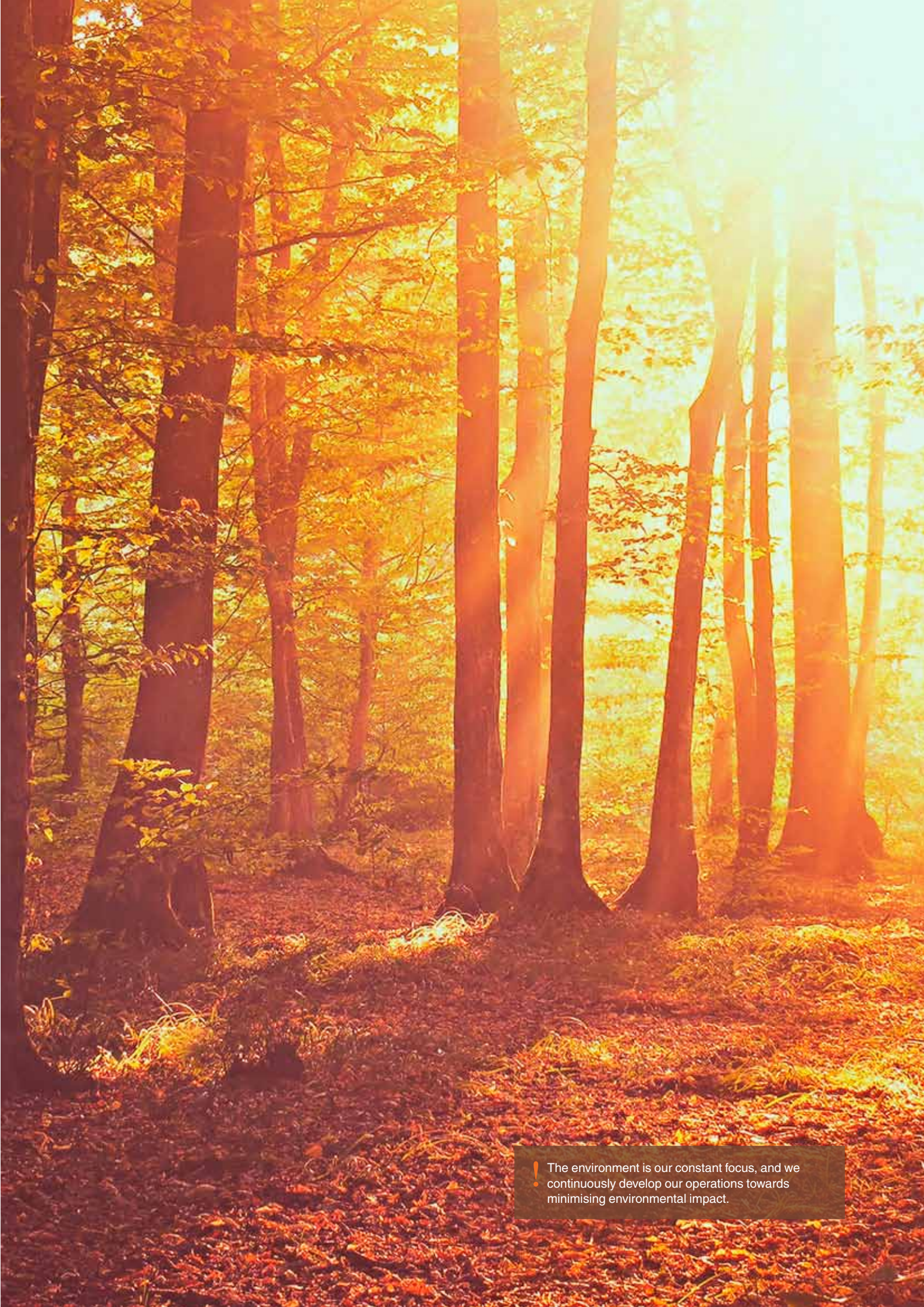
Over 90 % (in volume) of the waste Renova collects is recycled into new materials or energy. We have facilities for:

- Energy recovery (Sävenäs waste-to-energy plant, Gothenburg).
- There is also a preparatory sorting facility, a kiln for pet cremations and a receiving hall for separate processing of high-risk and classified waste in the waste-to-energy plant. Renova's Environment Centre is also located here along with our Environment School for upper-secondary school students. We also organise other types of courses and receive study visits here.

- Treatment of biological waste (Marieholm, Gothenburg). Here, food and catering waste becomes raw material for biogas.
- Sorting and recycling (Högsbo and Skräppekärr, Gothenburg). Here, we sort construction waste and other commercial waste. Interim storage of recyclables is also located here. We also operate recycling centres in several municipalities.
- Reception of hazardous waste (Ringön, Gothenburg).
- Reception of electronics waste (Sävenäs, Gothenburg).
- Transshipment. We have several transshipment facilities in the region where waste is reloaded into higher-capacity vehicles to reduce trips.
- Landfills (Tagene, Gothenburg and Fläskebo, Härryda).

MORE ABOUT US

Learn more about us at: www.renova.se
Follow us on Facebook: www.facebook.com/renovaab



! The environment is our constant focus, and we continuously develop our operations towards minimising environmental impact.

