MKR

Reduce.
Recover.
Reuse.



REFERENCE BOOKLET

# Come and see it running.

## Selected reference plants in daily operation, available at short notice

Digestate evaporators from our first generation to today's DV and MVR series.
Food-waste, residue and agricultural biogas plants in Germany, Switzerland and the Czech Republic.

November 2026

mkr-cleanwater.com

SELECTED REFERENCES

# See our evaporators where they run

Reduce. Recover. Reuse.

MKR Cleanwater develops and builds thermal vacuum evaporators (DV series) and electric MVR evaporators for digestate and slurry. Digestate evaporation started in 2009 with a pilot plant; our evaporators have been running on operating plants since 2013. Behind this is the experience of MKR Metzger, which has built industrial evaporators since 1997, in dozens of projects for cooling lubricants, electroplating, die casting and oil-water separation.

We have realised 20 biogas projects so far. The seven plants in this booklet cover a wide range of substrates, plant types and evaporator models, from our first generation (RT series) to the current DV and MVR series. All are in daily operation.

| Plant | Evaporator | Medium | In operation since |
|---|---|---|---|
| **Food-waste AD plant, Switzerland** | DV4000, 4-stage | Food waste, food-industry residues, rumen contents, pig slurry | 2020 |
| **Food-waste AD plant, western Germany** | 2 × DV line, 3-stage | Food waste, restaurant waste, flotation sludge, grease trap contents | 2019 (line 1), 2020 (line 2) |
| **Peat substitute production, Germany** | MVR15, electric | Washing liquid from separated digestate fibres | 2025 |
| **Agricultural biogas plant, Germany** | DV1000, 3-stage | Liquid fraction, mainly slurry and farmyard manure | 2021 |
| **Food-waste AD plant, Czech Republic** | DV4000, 4-stage | Depackaged food, flotation sludge, restaurant waste, bread, pet food | 2026 |
| **Two biogas plants, northern Bavaria, Germany** | 2 × DV1000, 3-stage | Food-waste digestate and energy-crop digestate with pig slurry | 2017 (line 1), 2018 (line 2) |
| **Poultry farm, north-western Germany** | RT400 | Energy-crop digestate with dry poultry manure | 2015 |

### Visits at short notice

All plants in this booklet can be visited at short notice. We arrange the visit with the operator: you see the evaporator in daily operation and talk to the people who run it.

### Plant size today

**20,000 to over 150,000 m³ of feed per year**

Lines and modules run in parallel, so larger plants are covered by more lines.



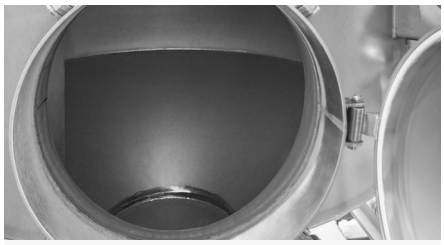
DV4000 modules on their way to the Czech Republic, September 2025.

Our evaporators are built and pre-assembled in Monheim, Bavaria, and leave the workshop as modules: evaporator stages with vapour scrubber, heating module, cooling module and vacuum station.

On site, the modules are set up and connected; installation takes around four weeks. Then follow commissioning and the training of the operating staff.

WHY MKR

# What we do differently, and what you gain



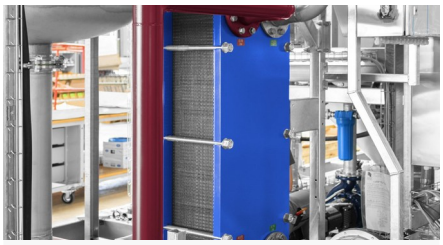
## No brushes in the digestate

No brushes or scraping parts on the heating surfaces, so nothing wears on the heat exchangers. **Nothing to replace there, and no downtime for it.**



## Automatic CIP cleaning

Acid and alkaline cleaning cycles run automatically, at our reference plants weekly or every 240 operating hours. **Clean heating surfaces keep the output up, and cleaning runs without your staff.**



## Low-temperature steam heating

Stage 1 is heated with steam at 65 to 68 °C, not directly with hot CHP water. Under vacuum the digestate boils at 45 to 65 °C. **Far less fouling builds up.**



## More distillate per kWh of heat

Up to four stages use the same heat several times: design value 4.3 l of distillate per kWh th, 4.5 to 4.7 l/kWh measured at full load. **More distillate from less energy.**



## Scrubber built against corrosion

Vapour scrubber with plastic parts (DV) or in super duplex (MVR). Nitrogen is recovered from the vapour, no acid is added to the digestate. **Built for a long service life.**



## Proven on food waste and agricultural media

Reference plants on food-waste and residue digestate and on agricultural digestate with slurry and manure. **You can visit a plant with a medium close to yours before you decide.**



## Test with your own digestate

Laboratory trial, technical centre trial or our MVR test unit at your plant. **You see measured data before you invest.**



## Electric MVR in operation

Fully electric, 22.5 l of distillate per kWh el for the whole plant, with the same core components as our DV evaporators. **Evaporation for sites without waste heat.**



## Our own manufacturing

Heat exchangers, pre-assembled skids and controls, built in our workshop in Monheim. **The evaporation heat exchanger shown here has been in industrial use for more than 20 years.**

TRIALS AND SUPPORT

# From your sample to a plant that runs

Reduce. Recover. Reuse.

### 1 Laboratory trial

We evaporate approx. 2 l of your digestate in our laboratory. The test shows which evaporation ratio is achievable and whether chloride, viscosity or fouling will limit it.

### 2 Technical centre trial

Up to 4 $m^3$ of your medium in our in-house technical centre, within about one week. Data for the design of your plant.

### 3 Test unit on site

MVR test unit, 80 to 100 l/h, rented for at least 4 weeks and run by your trained staff at your plant under real conditions.

### 4 Large-scale DV trial

Media that need a DV evaporator cannot run on the MVR test unit. On request, we test your medium on an existing DV plant.

**50 % credited**

When you order the plant, 50 % of the trial costs are credited. Each step gives you measured data before you decide on the next one.



### Laboratory and practice agree

Before our reference plant in western Germany was built, we evaporated its digestate in our laboratory to a ratio of 1:2.5 in 2018. Since the first line was commissioned in April 2019, the plant has reached around 1:3 in operation. The laboratory test was on the safe side.

We also say no: in several laboratory tests we advised against evaporation or limited the evaporation ratio.

FROM ORDER TO OPERATION

### Pre-assembled modules

Delivery approx. 7 to 9 months ex works, installation approx. 4 weeks, commissioning 1 to 3 weeks. Short installation on site, so your plant routine is disturbed only briefly.

### Training in your language

Your operating staff are trained on site with clear documentation in their own language, including safety instructions.

### Remote monitoring

Remote access to the plant control and evaluation of the operating data after start-up. We see the same data as your staff and can support them without travelling to site.

### Nitrogen and distillate

Ammonium sulphate solution (ASL), pH 5.5 to 6.5; ammonia water as an option is in development. NH4-N in the distillate expected below 30 mg/l.

REFERENCE 01

# Food-waste AD plant, Switzerland

4-stage DV4000 on CHP waste heat, in operation since 2020



Visitor group with Michael Köhnlechner at the DV evaporator, 2024.

## 4.5 to 4.7 l/kWh

distillate per kWh heat at full load of 350 to 370 kW, 2026 (design value 4.3 l/kWh)

## around 30,000 t

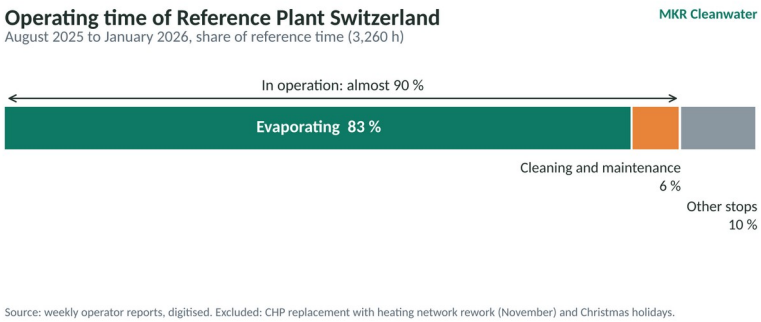
of food waste and food-industry residues a year at the biogas plant

## around 40 m³

of distillate on a full operating day with around 350 kW of heat

Besides food waste and food-industry residues, the biogas plant digests rumen contents from the slaughterhouse and pig slurry. The evaporator runs unattended at night and at weekends; faults are reported to the on-call service.

It replaced a reverse osmosis unit that could not handle this medium.




### How to read this chart

**The bar** is the whole reference time from August 2025 to January 2026, 3,260 hours.

**Green:** the evaporator was evaporating. Orange: planned cleaning and maintenance. Grey: all other stops.

**What it means:** green and orange together, almost 90 % of the time, the evaporator was in operation, unattended at night and at weekends.

### Plant at a glance

**Machine:** DV4000, 4-stage, with vapour scrubber for ASL

**Heat source:** CHP waste heat, 350 to 370 kW at full load

**Medium:** liquid fraction of the digestate

**Distillate:** reused as process water in the depackaging line

**Concentrate and ASL:** taken over by a service provider for fertiliser production

**Cleaning:** CIP weekly

More data: [mkr-cleanwater.com/operating-data](mkr-cleanwater.com/operating-data)

REFERENCE 02

# Food-waste AD plant, western Germany

Two 3-stage DV lines with vapour scrubber for ASL, line 1 since 2019, line 2 since 2020



The evaporator hall. Photo: operator.

The operator started with one line in April 2019 and ordered the second line after the first one had proven itself.

The biogas plant staff look after the evaporators alongside their other duties. In the 2023/24 evaporation season, more than half of the distillate was produced at night and at weekends, with nobody on site.

If heat is briefly unavailable, a line waits in idle mode and carries on as soon as the heat returns, so the evaporator can follow a flexible CHP schedule.

## around 80 m³

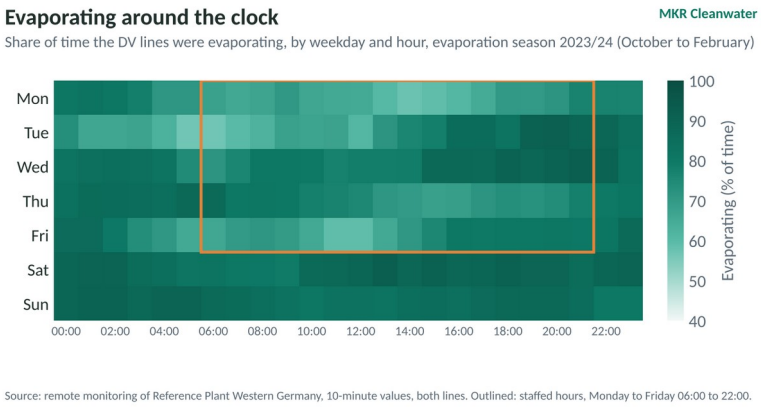
of distillate per day when both lines run at full load, around 40 m³ per line

## at least 88 %

technical availability as defined in VDI 3423 in both evaporation seasons, 2023/24 at least 95 %

## around two thirds

less volume to store and spread: around 3 m³ of digestate becomes around 1 m³ of concentrate




Source: remote monitoring of Reference Plant Western Germany, 10-minute values, both lines. Outlined: staffed hours, Monday to Friday 06:00 to 22:00.

### How to read this chart

**Each cell** is one hour of the week, Monday to Sunday, 0 to 24 h, 2023/24 season, October to February.

**The darker the cell,** the larger the share of that hour in which the lines were evaporating.

**The frame** marks the staffed hours, Monday to Friday 06:00 to 22:00.

**What it means:** outside the frame, with nobody on site, the lines were evaporating 83 % of the time.

### Plant at a glance

**Machine:** 2 × DV line, 3-stage, with vapour scrubber for ASL

**Heat source:** CHP heat

**Medium:** digestate from food waste, restaurant waste, flotation sludge and grease trap contents

More data: [mkr-cleanwater.com/operating-data](mkr-cleanwater.com/operating-data)

**Staff:** on site Monday to Friday in two shifts

**Cleaning:** CIP every 240 operating hours, about every two weeks

**Spare parts:** package kept on site

**Availability:** every minute with an active fault signal counts as downtime, even a lack of heat. 2024/25 was lower because less heat was available.

REFERENCE 03

# Peat substitute production, Germany

Electric MVR15 for washing liquid from digestate fibres, in operation since 2025






The MVR15 in the hall at the operating site (left) and a look inside (right), 2026.

Separated digestate fibres from the screw press are washed and conditioned into a peat substitute. An electric MVR15 evaporates the washing liquid, which looks like thin digestate or slurry. The distillate goes back into the washing loop; the concentrate keeps the nutrients and solids, so the loop is closed.

The MVR replaced an ultrafiltration and reverse osmosis concept that did not work on this medium, and shortened the process chain. For sites without waste heat, this is the plant to see the MVR in daily operation.

REFERENCE 04

# Agricultural biogas plant, Germany

3-stage DV1000 for partial-stream zero liquid discharge (ZLD), in operation since early 2021



The DV1000 on the agricultural biogas plant.

On an agricultural biogas plant fed mainly with slurry and farmyard manure, a 3-stage DV1000 evaporates the separated liquid phase. ASL is recovered as mineral fertiliser and the concentrate is dried together with the solids, so no liquid is left from this partial stream.

| approx. 180 kW | 3.4 to 3.7 l/kWh | 5,000 m³/a |
|---|---|---|
| heat demand | distillate per kWh heat | less volume to store per year |

Both plants on our website: [mkr-cleanwater.com/references](mkr-cleanwater.com/references)

REFERENCE 05

# Food-waste AD plant, Czech Republic

4-stage DV4000 on CHP waste heat, commissioned in 2026





Evaporator stage with vapour scrubber (left) and the evaporator line in the new hall (right).

The biogas plant digests a mixed feedstock: depackaged food, flotation sludge, restaurant waste, bread, pet food and other food waste.

The 4-stage DV4000 was delivered in pre-assembled modules in September 2025 and installed in a new hall. The distillate is needed on site, in the depackaging line and for mixing the feed.

### Video: from assembly to commissioning

Thermal vacuum evaporator DV4000 4S on our YouTube channel.

youtube.com/watch?v=3CTrseZqNfA

### Plant at a glance

**Machine:** DV4000, 4-stage, with vapour scrubber for ASL

**Heat source:** CHP waste heat

**Medium:** liquid fraction of the digestate

**Distillate:** used on site for depackaging and feed mixing

**Training:** on site, with clear documentation in Czech, including the safety instructions

**Monitoring:** remote, with evaluation of the operating data

**Operating data:** first data will follow in 2027

REFERENCE 06

# Two biogas plants, northern Bavaria

Two 3-stage DV1000 lines at one site, line 1 since 2017, line 2 since 2018



Line 1, with the space reserved for line 2.

Two DV1000 lines at one site treat digestate from two biogas plants: one plant runs on food waste, the other is a classic energy-crop plant with pig slurry.

The operator started with line 1 in 2017 and ordered line 2 after the first line had proven itself; it followed in 2018. Both lines are in operation.



Line 2 during installation, 2018.

### Plant at a glance

**Machine:** 2 × DV1000, 3-stage, each with vapour scrubber for ASL

**Heat source:** CHP waste heat from both biogas plants

**Medium:** food-waste digestate and energy-crop digestate with pig slurry

**Design values per line:** 1,320 l/h feed, up to 660 l/h distillate at 190 kW of heat

REFERENCE 07

# Poultry farm, north-western Germany

RT400 on energy-crop digestate with dry poultry manure, in operation since 2015



The RT400 in the plant room, 2015.

The RT400 evaporates digestate from an energy-crop biogas plant with dry poultry manure, heated by the CHP unit.

It has been in operation since 2015 and belongs to the first generation of our evaporators.

### Plant at a glance

**Machine:** RT400, first generation

**Heat source:** CHP unit

**Medium:** energy-crop digestate with dry poultry manure

WHAT WE LEARNED

## From the RT series to today's DV and MVR

Our first evaporator generation, the RT series, kept its heating surfaces clean with brushes.

Many early evaporators in the industry, not only ours, were built for biogas plants with 5,000 to 10,000 $m^3$ of digestate a year. At that size, the effort of running an evaporator, from daily operation and maintenance to spare parts, weighs on a small volume. Where the German feed-in tariff (EEG) also expired, several plants stopped evaporating or shut down.



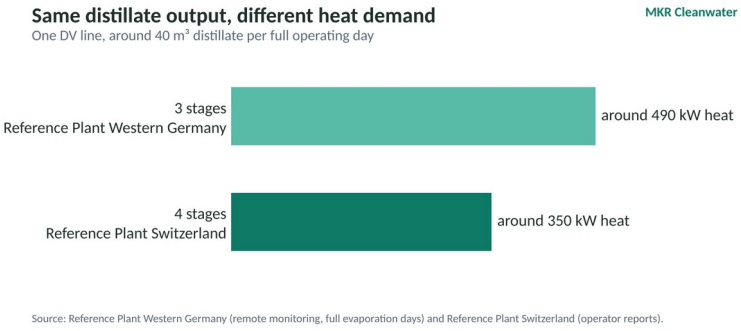
RT400 units in production, first generation.

| | First generation (RT series) | DV and MVR series today |
|---|---|---|
| **Heating surfaces** | kept clean with brushes | no brushes in the digestate, automatic CIP cleaning |
| **Typical plant size** | 5,000 to 10,000 $m^3$ of digestate a year | 20,000 to over 150,000 $m^3$ of digestate a year |
| **Scaling** | single small units | lines and modules running in parallel |

How today's DV and MVR series work: [mkr-cleanwater.com/technologie](mkr-cleanwater.com/technologie)

# Operating data and evidence

Since 2013 we have documented dozens of laboratory evaporation tests for more than 30 clients in eight countries, on food-waste and residue digestate, energy-crop digestate, slurry, poultry-manure digestate and RO concentrate. In addition, there are 504 samples from 19 operating plants with 2,514 measured values for distillate and ammonium sulphate solution.

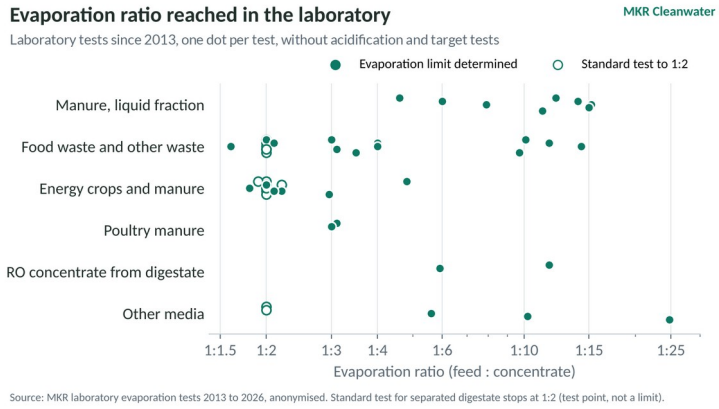



### How to read this chart

**Both bars** show one DV line producing around 40 m³ of distillate per full operating day.

**The length** is the heat it needs: around 490 kW with 3 stages, around 350 kW with 4 stages.

**What it means:** the number of stages follows the heat at your site. More stages make better use of little heat.

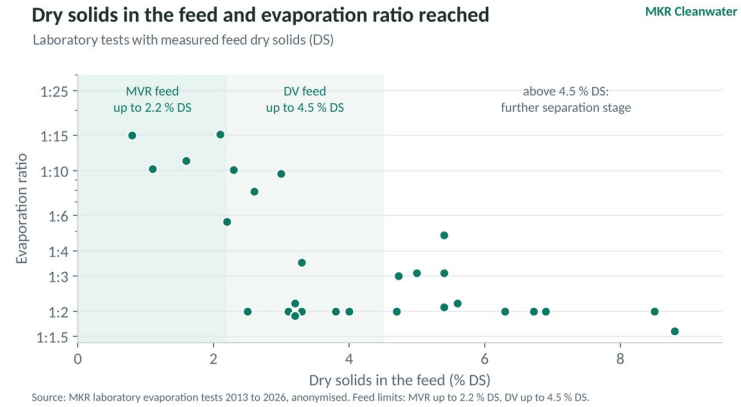



### How to read this chart

**One dot** per laboratory test, grouped by medium. 1:3 means 3 m³ of feed become 1 m³ of concentrate.

**Filled dots:** the limit was reached. Open dots: standard test stopped at 1:2, a test point, not a limit.

**What it means:** thin liquid fractions reached 1:10 to 1:15, food-waste digestate 1:3 to 1:4 in extended tests.




### How to read this chart

**One dot** per laboratory test: dry solids in the feed against the evaporation ratio reached.

**The shaded areas** are the feed limits: MVR up to 2.2 % DS, DV up to 4.5 % DS.

**What it means:** above 4.5 % DS a further separation stage is needed. The laboratory test shows this before the investment.

**More data to come.** We are extending data logging at our reference plants. Further operating data will be published on our website from early 2027.

All measured data with period and data basis: [mkr-cleanwater.com/operating-data](mkr-cleanwater.com/operating-data)

FAQ

# Questions we hear before a project

Reduce. Recover. Reuse.

### We have no CHP and no waste heat. Does evaporation still work?

Yes. The MVR evaporator runs on electricity only, 22.5 l of distillate per kWh el for the whole plant (Reference 03, page 7). Since 2026 the DV evaporator is also available with a heat pump. We check which fits your plant.

### What does it cost to operate?

From 5.50 €/m³ of feed with a DV evaporator, from 8 €/m³ with an MVR. The figure depends above all on your energy prices, and on medium, dry matter and ammonium; we calculate it specifically for your project. These are operating costs only, without the investment. Compare them with what one m³ costs you today for storage, transport and spreading.

### Where do concentrate and ammonium sulphate solution go?

The concentrate keeps phosphorus, potassium and organic matter in a smaller volume, so there are fewer loads. ASL is a mineral nitrogen fertiliser, pH 5.5 to 6.5. Where the nitrogen comes from manure, it can qualify as RENURE. In Switzerland a service provider takes both for fertiliser production.

### Can we discharge the distillate?

NH4-N in the distillate is expected below 30 mg/l. It is reused as process or dilution water; discharge only after site-specific finishing.

### How much staff time does it take?

In western Germany the biogas plant staff look after the evaporators alongside their other duties, and the lines run unattended at night and at weekends. Faults are reported automatically, and cleaning (CIP) runs on its own.

### Our plant is much larger than your references.

Lines and modules run in parallel: DV units with 180 to 600 kW of heat each, MVR modules of up to 4 m³/h each. Plants of 20,000 to over 150,000 m³ of feed per year are covered by more of the same units.

### Why are some early evaporators no longer running?

Small plants, high effort per m³ and expired feed-in tariffs, see page 10. Today's DV and MVR series work without brushes and clean themselves automatically.

### Who supports us in our country?

We work with partners on site in our target markets. Your operating staff are trained on site in their own language, and after start-up we monitor the plant remotely and evaluate its operating data.

### Can we see a plant before we decide?

Yes. All plants in this booklet can be visited at short notice. We arrange the visit with the operator, so you see the evaporator in daily operation and talk to the people who run it.

CONTACT

# Let's look at your plant

Four values are enough for a first assessment:

### 1 Medium and annual volume

What is to be evaporated, e.g. the liquid phase after separation, and how much per year in $m^3$.

### 2 Dry matter of the liquid phase

In %, ideally from a recent analysis.

### 3 Ammonium nitrogen

NH4-N in $kg/m^3$ or mg/l. It determines how much nitrogen ends up in the N product.

### 4 Available heat

Waste heat in kW and its temperature in °C. Without waste heat: MVR, or DV with a heat pump.

**On our website and YouTube**

mkr-cleanwater.com/references all reference plants

mkr-cleanwater.com/operating-data measured operating data and evidence

youtube.com/watch?v=3CTrseZqNfA video: DV4000 from assembly to commissioning

# You are welcome to visit.

One reference plant or a whole tour: call us, and we arrange it with the operators.



## Your contact

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See you on site,