# Energy production solutions – self-consumption and sale

Below you will find the technical data sheets produced by the "Energy Management" group of the Interreg Upper Rhine ResKuh project in terms of energy production.

There are three fact sheets, covering the following equipment and installations:

**PHOTOVOLTAIC**

**SOLAR WATER HEATER**

**BIOGAS**

You can find other ResKuh technical fact sheets on energy or other project topics on our website: https://agroecologie-rhin.eu/en/reskuh-en/downloads/!

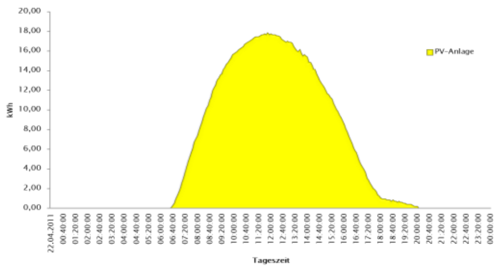
# Photovoltaics in dairy farms

## Reducing costs with solar energy

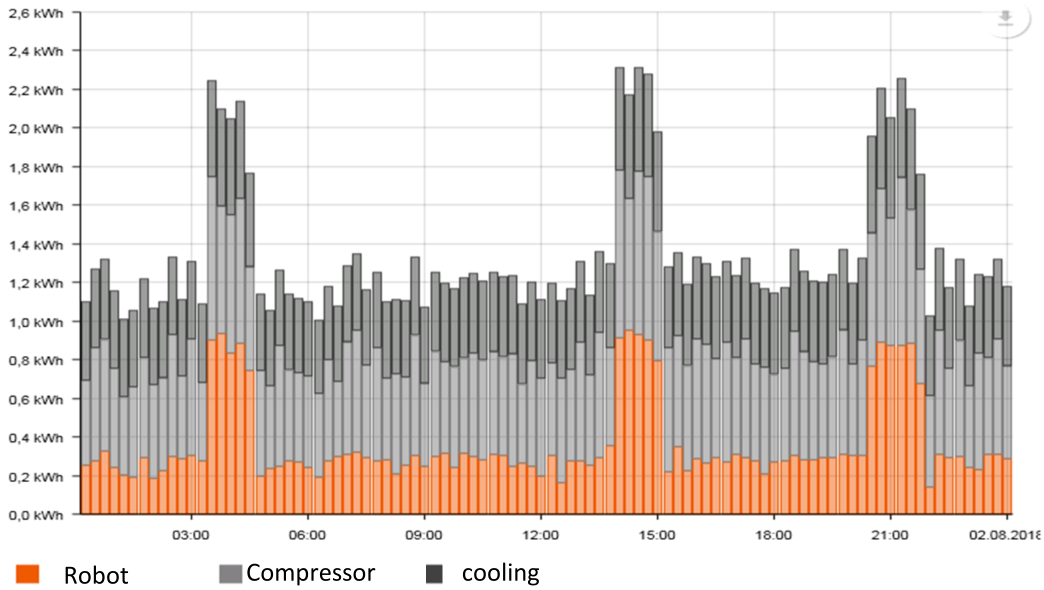
The energy requirements of dairy farming are significant, ranging between 450 and 550 kWh of electricity per cow per year. Electricity is mainly used for milking, cooling milk and cleaning the milking equipment and milk tank. Added to this is the electricity required for lighting the barn, preparing feed and, where applicable, managing manure. Due to increasing automation in dairy farms with milking, feeding and other robots, electricity requirements have risen steadily in recent years. At the same time, the cost per kWh of electricity has increased, prompting farmers to consider ways of reducing costs and consumption.

With the increasing use of electrical appliances, electricity consumption is becoming more evenly distributed throughout the day, making electricity generation and self-consumption more attractive to dairy farmers, as more electricity is needed during the period when a photovoltaic system is generating electricity.

Photovoltaic production over a day




### Energy consumption – example of a milking robot (15-minute cycle)




Daily consumption amounts (with three main washing cycles):

| | |
|---|---|
| Cooling : | 40,79 kWh |
| Compressor: | 53,71 kWh |
| Robot : | 35,48 kWh |

The graph shows a typical day's electricity consumption on a farm for the milking robot itself (DeLaval), the compressor and milk cooling. Electricity consumption for hot water production and vacuum pumps is not shown.

## Photovoltaics and Selfconsumption

To calculate the possible self-consumption, the amount of electricity generated by the photovoltaic system at a given moment is compared with the amount of electricity demanded by the business/household at the same moment. By comparing the two values, it is possible to calculate the self-consumption. Table 1 shows the self-consumption rates of photovoltaic systems in relation to the annual consumption of different consumption profiles (taken from KTBL 110).

| **Table 1** | **Electricity generation relative to electricity consumption, in %.** | | | | | |
|---|---|---|---|---|---|---|
| Consumption profile | 25% | 50% | 75% | 100% | 125% | 150% |
| | Selfconsumption rate | | | | | |
| Housing | 88 | 66 | 51 | 42 | 36 | 31 |
| dairy cows - parlour | 81 | 57 | 44 | 37 | 31 | 28 |
| dairy cows - robot | 82 | 61 | 47 | 38 | 32 | 28 |
| Above-ground production | 91 | 71 | 56 | 46 | 39 | 34 |
| Biogas | 89 | 67 | 52 | 42 | 35 | 30 |
| Horticulture | 64 | 42 | 31 | 26 | 22 | 19 |

## Profitability of self-consumption

The total costs per kWh produced consist of the production costs spread over the useful life, including interest, as well as the costs associated with annual consumption.

Ex. : 95.04 kWp installation, €83,403 investment excluding VAT, 3% financing over 20 years

| **Annual costs (full costs)** | | **7.555 €** |
|---|---|---|
| annuities | (Capital 4.170 € + interest 1.251 €) | 5.421 € |
| operating costs | (maintenance , insurance, etc) | 2.134 € |
| Annual electricity generation | (1.050 kWh/kWc) | 99 765 kWh |
| **Cost/kWh generated** | | **7,57 c€** |
| **Annual revenue** | | **13.290 €** |
| Electricity sold | (71.852 kWh * 0,0719 €/kWh) | 5.468 € |
| Self-consumed electricity | (27.943 kWh * 0,2 €/kWh) | 5.589 € |
| Total costs per year | | 7.555 € |
| **Annual surplus / profit from the PV installation** | | **3.196 €** |

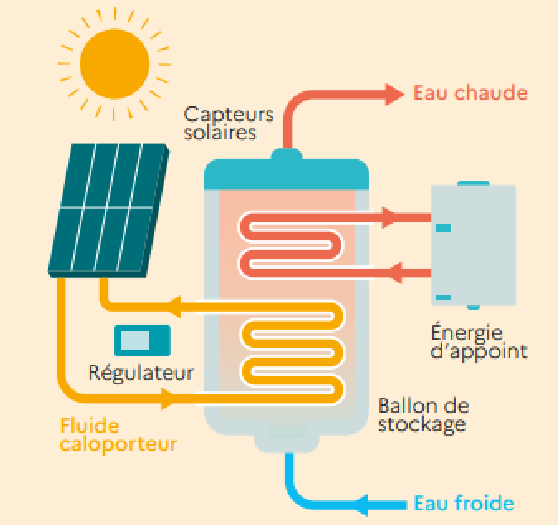
In this example, using his own electricity costs the farmer 7.57 c€ per kWh. His current electricity costs are 20 c€ per kWh. He can save around 12.43 c€ per kWh of photovoltaic electricity that he uses himself. With 28% self-consumption, or 27,934 kWh, his current electricity costs are reduced by 3,472 €.

# Production of hot water by solar water heater

In dairy farming, with 25 to 30% of electricity consumption, the production of hot water for washing is the second largest item, after the operation of the milk tank.

## Functioning

**A solar water heater is a system that stores energy from the sun to preheat water.**




(Source : ADEME)

It is generally composed (*) of:

**- Thermal collectors:** tubes arranged under a black-coated plate and placed under sealed glass in a box, fixed to the roof (ideally south-facing, 45° inclination) or on the facade, which convert solar radiation into heat.

- **Heat transfer fluid:** a mixture of water and antifreeze (e.g., glycol water) that circulates through the collectors and heats up.
- **Vertical storage tank** containing domestic hot water heated to between 50 and 80°C thanks to the heat transferred via a coil.

(*) Other types of collectors exist (unglazed for hot climates or vacuum-sealed, more efficient and more expensive) and tanks (horizontal, less efficient).

**Please note:**

- Collector surfaces and solar autonomy vary depending on the region. In Alsace, annual sunshine is less than 2,000 hours.
- Solar energy covers 40 to 70% of needs. Supplementing with another energy source is essential.

## Sizing

To properly size your solar system and ensure optimal operation, it's essential to first assess your actual annual domestic hot water needs. A measurement campaign estimates the maximum daily demand that may occur on the farm by combining regular (milking machine, milk tank, etc.) and seasonal (calf feeding, crawl space) consumption.

As a general rule, for a 500L tank, approximately 6 to 8 m² of solar collectors are required.

## Focus on the storage balloon

The size of the tank must match the needs, because if it is oversized, the backup consumption is higher to heat and maintain the temperature of underused water.

The tank should, if possible, be installed as close as possible to the hot water draw-off points (to prevent wasted water that cools) and the collectors (to limit heat loss and reduce the cost of the primary circuit) in a heated or at least insulated room (to reduce water cooling). The piping must also be very well insulated.

Stainless steel, thermovitrified, or double-enameled tanks are more resistant to corrosion. If the water is hard, a tank with an enameled or smooth exchanger, on which scale deposits are less likely, will be more suitable.

## Installation

The work must be carried out by certified installers using equipment that meets European standards to ensure the quality and productivity of the installation. For solar thermal systems, professionals with the right skills are certified as "Recognized Environmental Guarantor" (RGE). They are subject to certifications issued by Qualibat and Qualit'ENR.

## Investment cost

The cost of a solar installation can vary widely depending on the location, the number of panels, and the size of the farm. It ranges from €900 to €1,700 excluding VAT per m² of collectors, including installation.

## Lifespan and maintenance

Under optimal conditions (well-designed, well-used, and regularly maintained), the components of an individual solar water heater have a lifespan of up to:

- 20-30 years for the collectors, with annual inspections, particularly of the condition of the heat transfer fluid
- 15-20 years for a tank, with regular monitoring and cleaning every 3 years to remove scale
- approximately 10 years for the circulator, temperature sensors, and control system

(sources : ADEME “La production d’eau chaude en élevage laitier et en élevage de veaux de boucherie”, “Le solaire thermique“, “Economies d’énergie sur l’exploitation agricole“)

# Producing biogas on the farm: individual methanization

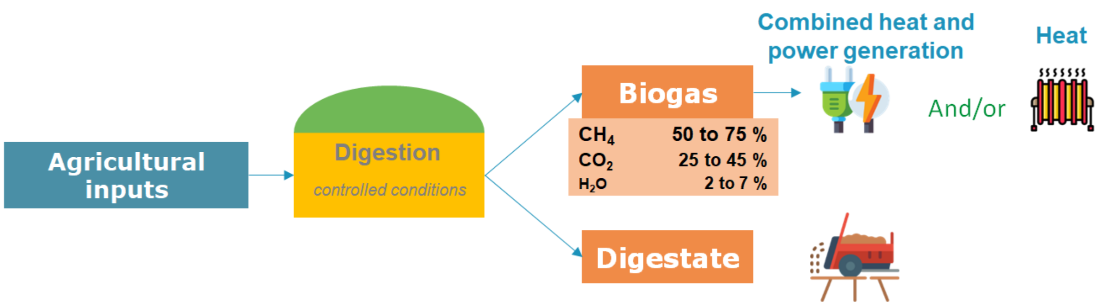
Methanization is the natural process by which bacteria naturally present in animal waste break down biomass to produce biogas, a renewable, local energy derived from local resources.

## How it works

An on-farm methanization site operates on the basis of **effluent from livestock farming**, to which can be added **external plant supplies** such as energy crops, grass or crop residues.

The products of the anaerobic digestion process are :

- **Biogas :** valorized via cogeneration of electricity and heat
- **Digestate :** spread as fertilizer or soil improver




**Electrical efficiency** ≈ 42 % : the electricity generated can be used by the company itself or sold to the grid.
**Thermal efficiency** ≈ 42 % : the heat produced can be consumed internally or by heat consumers near the site

## Types of on-farm methanization

### Micro methanization

Installed power less than 80 Kw
Farm effluents and waste
3,000 to 6,000 t per year

### On-farm methanization

Installed power greater than 80 kW
Livestock effluents, cereal by-products, energy crops
More than 6000 t per year

Various on-farm anaerobic digestion technologies are available (slurry pit cover, digestion pit, etc.), enabling the system to be adapted to the type of farm involved.

Credit : Nénufar

Biogas recovery by covering the slurry pit

## Services rendered

**Valorization of heat for self-consumption**: heating of buildings, production of drinking water, pasteurization of milk, heating of fodder, etc.

**Valorization of electricity** for self-consumption or sale on the grid

**Nitrogen autonomy**: digestate contains around 6 kg of N / t of raw digestate and helps to promote nitrogen autonomy on farms thanks to its high mineral nitrogen content.

## Methanization and greenhouse gases

Methane is a gas whose greenhouse effect is 25 times greater than that of CO2. Direct incorporation of effluent rather than storage limits methane emissions into the atmosphere.

The heat then produced by the cogeneration engine replaces the fossil gas or fuel oil usually used in industrial processes or to heat buildings.

The energy produced by the methanization process therefore replaces fossil fuels and, by reducing greenhouse gases, helps combat global warming.

Credit : CAA

## Carbon storage in soils

Crédit : CAA

The easily degradable fraction of the carbon contained in methanized organic matter helps to form the biomethane molecules valorized via cogeneration. The fraction that is difficult to degrade is found in the spread digestate.

The long-term stable carbon stored in the soil is therefore similar between a process with and without methanization.

## Investment

The level of investment in an on-farm methanizer depends on the installed capacity of the cogeneration plant, and ranges from € 5,000/kWe to € 15,000/kWe for installations between 35 and 500 kWe.

## Compensation

If it is not self-consumed on the farm, electricity can be sold through private contracts or collective self-consumption.