

# On-farm solar milk cooling



## *User Guide & Specifications*



Dear user,

The system for on-farm milk cooling presented in this user guide is based on utilizing milk-cans with an integrated ice-compartment to refrigerate and store milk. The ice is produced daily by a smart solar icemaker that works independently from the electrical grid.

By placing 6 kg ice into the ice-compartment after the milk-can has been filled with a maximum of 30 liters milk, the milk is safe for the next 6 hours under any weather conditions. Additionally, 20 liters of your evening milk can be stored overnight with 8 kg ice in the same milk-can. The 50 kg ice stored in the solar icemaker provides enough ice for at least five days even when the weather is hot or cloudy.

The milk cooling is assured during the various seasons. The removable insulation delivered with every milk-can should be used if ambient temperatures rise above 15°C in order to minimize thermal losses during transport or overnight storage. Thanks to the insulation, the ice can be placed into the milk-can up to 12 hours before milking if you share the icemaker with other users.

Our system can offer you the opportunity to better plan your milking time and to preserve your milk during transport or overnight storage, guaranteeing a high level of quality. This document provides information about how to use and maintain the system. Please, contact us if you have any questions. We are looking forward to hear your suggestions and feedback.

Best regards from our solar milk cooling team.

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## Smart Solar Ice-Maker

*Efficient ice production with solar energy!*



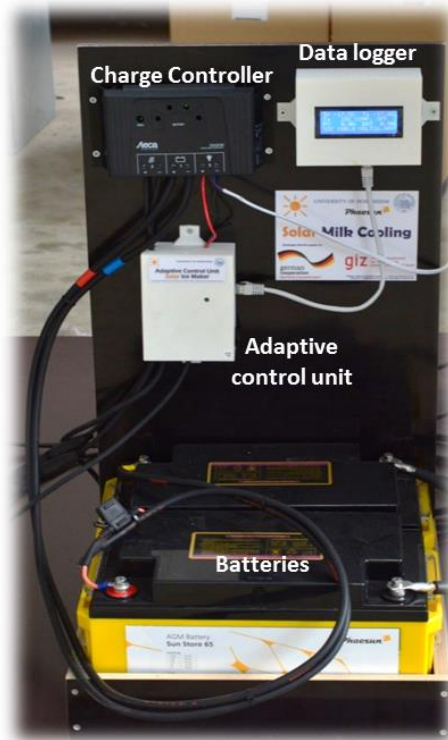
*Model: Uhoh-PF166*

The **smart solar ice-maker** is based on a commercially available DC freezer which is equipped with a control unit (Adaptive control unit charge controller, data-logger and batteries) and powered by PV modules. This means, the production of ice is depending on the availability of solar energy. The smart ice-maker has a volume of 160l and is capable of producing up to 23 kg ice per day. One system includes 25 reusable plastic blocks of 2 kg capacity, an integrated fan and a control panel.

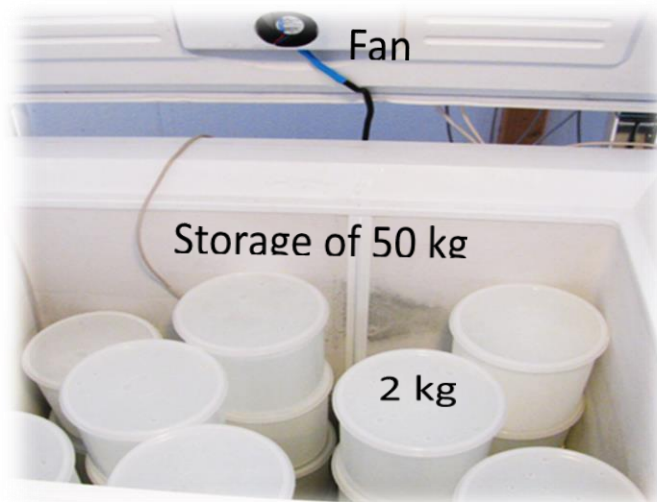
The innovative adaptive control unit allows an intensive and reliable production of ice throughout the year. The smart solar icemaker is equipped with the following features:

- ✓ **Variable compressor speeds depending on solar radiation and state of charge (SOC) of the batteries.**
- ✓ **A fan in the inner chamber in order to increase the freezing rate.**
- ✓ **Energy saving mode used during the night or on rainy days.**
- ✓ **Batteries to increase daily ice production up to 30%.**
- ✓ **Storage of 50 kg ice blocks to assure autonomy for at least 5 days under low radiation or high ambient temperatures**

### Control unit

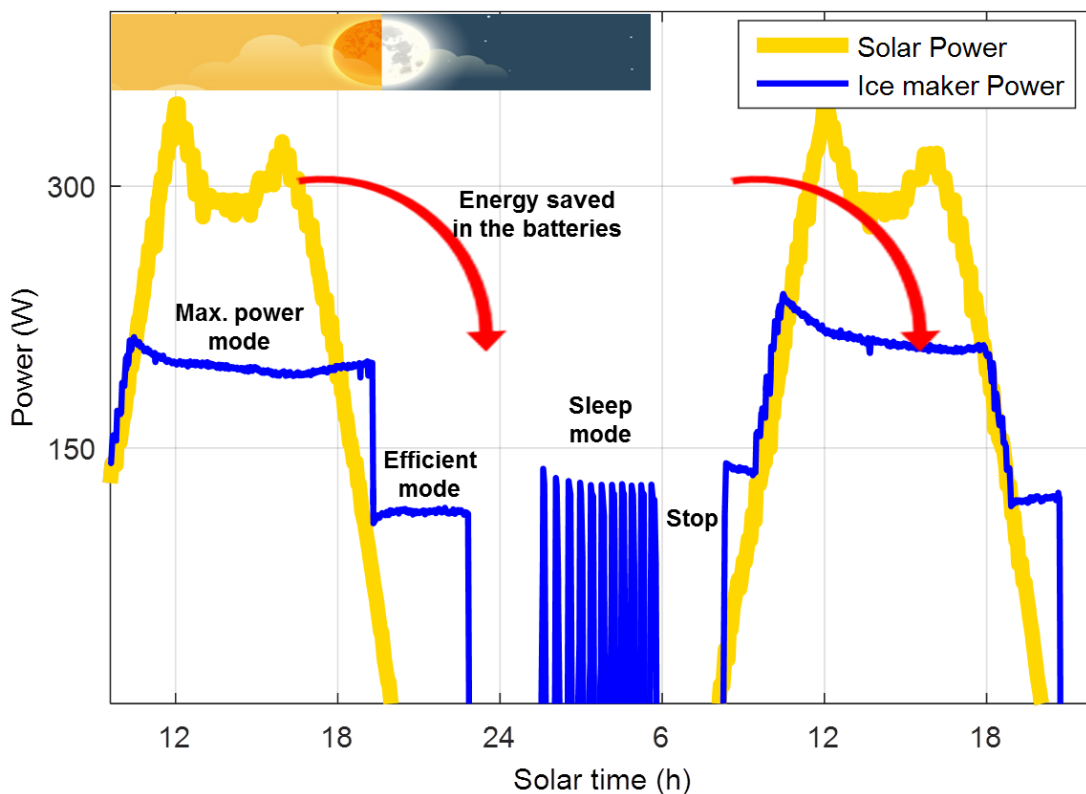


### Inside the smart ice-maker



*The adaptive control unit detects the energy produce by PV modules and commands the freezer to operate at maximum power. After sunset, the freezer keeps on producing ice in an efficient mode with the energy previously stored in the batteries. At the end of the night, the icemaker goes into a sleep mode to keep the ice-blocks frozen and ready for use.*

*The adaptive control unit adjusts the freezing power to the availability of solar energy!*



The daily ice production depends on solar irradiation and mean ambient temperature. Depending on the location and desired ice-output, the system can be operated with 300 Wp and one single battery (65 Ah) or 300 Wp and two batteries (65 Ah each). The expected daily ice production is given in the following table:

**Expected daily ice production in kg/day with 600 Wp and 2 x 65 Ah Battery**

Solar radiation (kWh/m <sup>2</sup> d)	Average Ambient Temperature			
	10 °C	20 °C	30 °C	40 °C
0	-1.2	-2.4	-3.5	-4.7
1	3.8	1.3	-1.0	-3.4
2	8.5	5.3	2.0	-1.5
3	13.0	9.4	4.8	0.3
4	17.6	13.2	8.2	2.2
5	21.9	17.0	11.4	4.8
6	22.4	17.5	12.7	6.7
7	22.9	17.9	13.1	7.0
8	23.0	18.1	13.3	7.3

## Insulated milk can with ice compartment

*Cool down your milk with solar energy!*



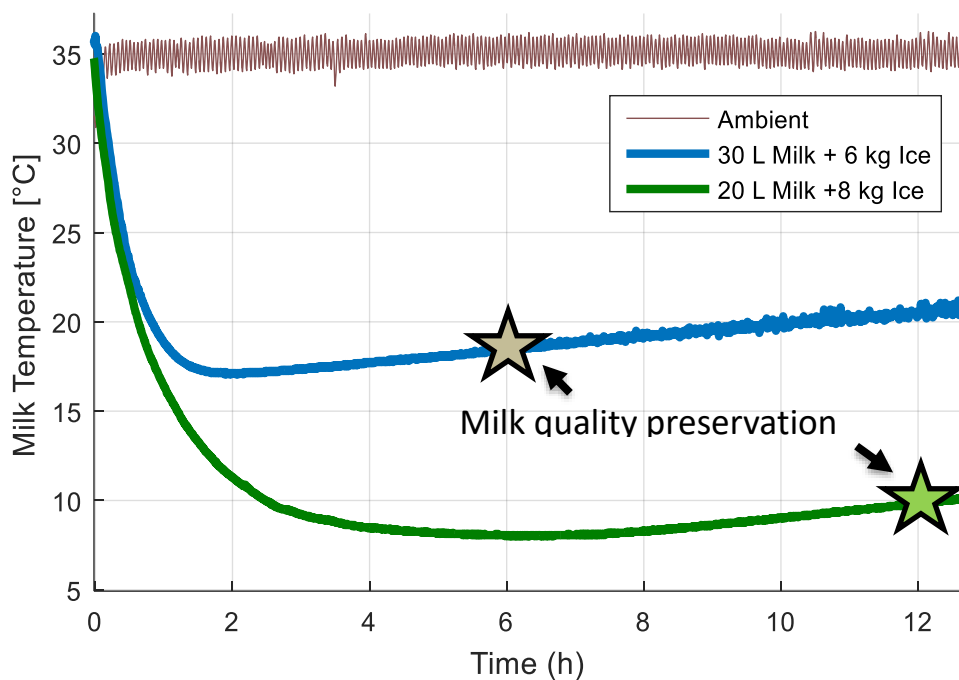
*Model: Uhoh-p2 Stainless Steel 30L*

Insulated milk-cans are used for a flexible milk cooling process on a farm or cooperative level. The milk is cooled down with ice, which is produced by solar energy with a smart icemaker. 2-kg ice-blocks are placed into the ice-compartment right after milking. Afterwards, the milk-can is covered with an insulation to assure milk quality during storage or transportation to the collecting center. The main features are described below:

- ✓ Your morning milk is safe for 6 hours during transportation at temperatures under 20°C.
- ✓ Your evening milk can be stored under 10°C throughout the night.
- ✓ Increase your productivity through regular milking times and no more production losses.
- ✓ Your high quality milk gives you access to price premiums and additional markets.

The insulated milk-can is made of stainless steel with a maximum capacity of 30 liters milk. The ice-compartment has a maximum capacity of 8 kg ice. The milk-can has been designed to operate under two modes as described in the following table.

	30 liters milk + 6kg ice	20 liters milk + 8kg ice
Cooling temperature	17°C after 90 min.	Under 10°C after 150 min.
Used for	Transport of morning milk	Storage of evening milk
Milk quality preservation	At least 6 hours	At least 12 hours



Cooling performance of the isolated milk-can under 35°C ambient temperature for the two suggested modes

### Specifications:

Dimensions	Ø430mm, 700mm height
Weight milk can, empty	7.5 kg
Weight insulation	2.5 kg
Full weight with 30l milk and 6 kg ice	48 kg
Materials	Stainless steel (milk can) Rubber and aluminum (insulation), Plastic (ice cover)
Max./min. capacity	30 liters milk (limit marked) / 8 liters
Max./min. Ice capacity*	Max. 8 kg / min. 2 kg

\*In addition to ice, 1 liter water can be added into the ice compartment to increase cooling performance

## Handling of the insulated milk-cans

**1)** Please, clean the cans if possible with hot water and dry them before you start milking.

Fill the can right after milking until you reach the 30 liters signal



**2)** Place the ice-compartment inside the can and lock it on both sides. Your milk is now safe from any external contamination.



**3)** Take out 3 ice blocks. Make sure the blocks you have selected are totally frozen. Leave them out for a while until the ice can be extracted easily from the plastic tins.



**4)** Remove the ice from the tins and place 3 blocks (6 kg ice) inside the ice-compartment. Afterwards, please add at least 2 liters of water into the ice-compartment, in order to speed up the cooling effect.





5) Use the cover to close the ice-compartment. Your milk can is ready for transport. A good milk quality is assured for the next 4 hours.



6) For warm weather, cover your milk can with the removable insulation.



7) Fill the used tins again with water and place them back into the solar freezer. After 1 to 3 days, these will be ready again for use. Keep at least 20 tins inside the freezer in order to assure ice availability even when the weather is not sunny.



## Maintenance of the milk cooling system

### Solar panels

Please make sure that the solar panels remain free from dust to keep their efficiency high. Simply use a wet cloth to remove the dust. Since the system operates at a low voltage (24 V), there is no risk of an electric shock.



### Smart ice-maker

The freezer operates better when all tins are always inside. As soon as you have placed ice into the milk-can, you can fill the tins again with fresh water and place them back into the freezer.

We advise that every time you need ice again, you should use those ice-tins, which have been in the freezer the longest. This way you can assure that frozen ice is always available.

Especially during hot days or cloudy winter days, it can happen that tins, which have been placed in the freezer 4 days previously, are still not completely frozen. In this case, you can use 4 ice-tins instead of 3.

Please use the key to lock the freezer to avoid that fresh air enters the inner compartment.



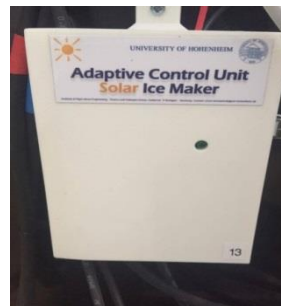
### Adaptive control unit

The adaptive control unit controls the freezer to generate ice during solar radiation hours at -17°C and to keep the ice at 0°C during the night or on rainy days.

The display shows the temperature in the freezer (Tr), the desired temperature (Ts), the ambient temperature (Ta), current at PV, battery and icemaker, State of Charge (SOC), the voltage of the battery and the state of the compressor and the fan (on/off). The display refreshes every 15 seconds and the data is saved on the SD-Card.



The adaptive control unit has a green light that blinks every 15 seconds in synchronization with the display screen.



The system can be turned on and off by using the button on the side of the adaptive control unit.



### Milk-cans with removable insulation

Milk quality can be assured when milk is cooled down fast in clean containers. As soon as the milk-can is back on the farm, old milk residues must be wiped away. The surfaces in contact with the milk should be cleaned with water (hot if possible) and dried, so that no germs can contaminate the following batch of fresh milk.

Using stainless steel containers allows better cleaning of the milk containers, while offering resistance against corrosion and abrasion.



# On-going Projects in the field

Field solar powered milk cooling solution for the higher efficiency of the dairy subsector in Tunisia

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