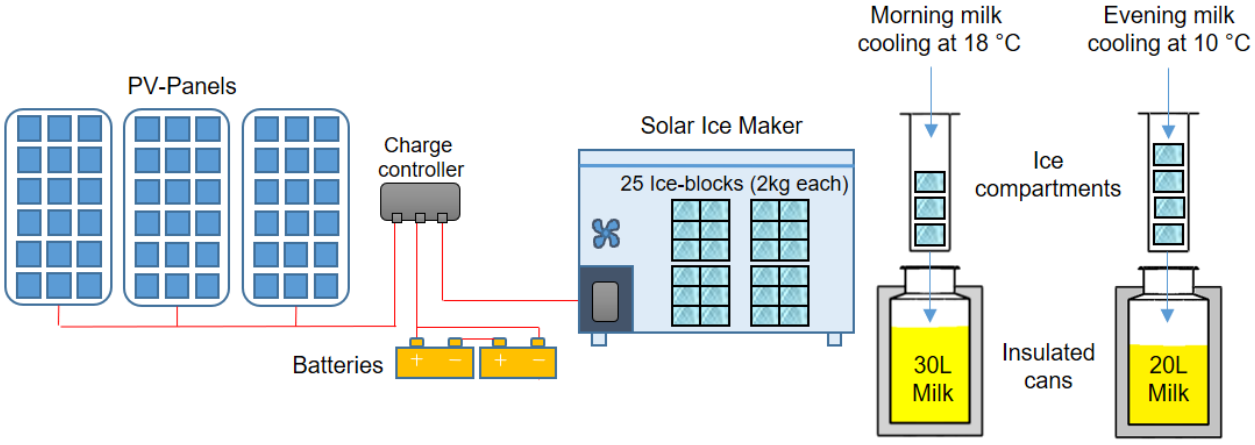
Manual

BOSS Kit Milky Way

Updated on May 2nd 2019

1. Introduction

A solution for on-farm milk cooling has been developed by Phaesun and the University of Hohenheim based on the use of a conventional solar freezer adapted to work as an ice-maker and insulated milk-cans. The milk cans have an integrated ice compartment for the transport of morning milk and the storage of evening milk with a maximum capacity of 30 L milk and 8 kg ice. 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 made in dependence of 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 (Figure 1).



a) b)

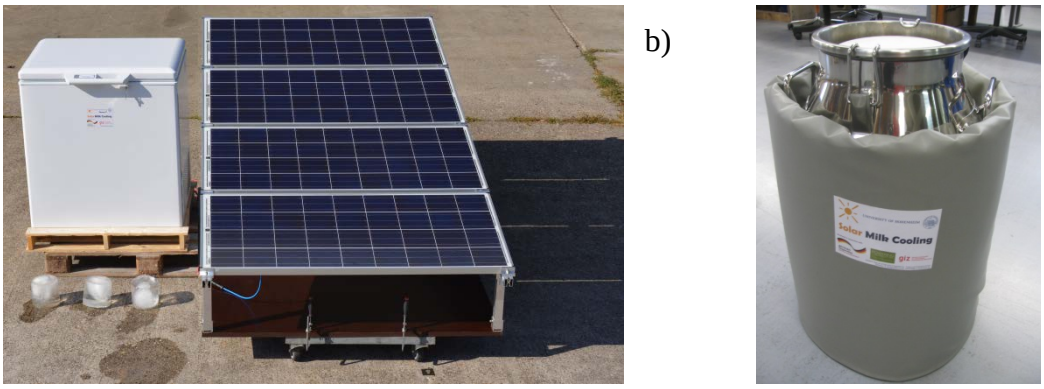


Figure 1. a) Solar Ice-maker connected to the solar panels y b) Insulated milk cans

The following chapters will provide detail information of all the components and how they are assembled.

2. Solar Panels

The document "PN-ASS Assembly Instructions for AluminumSupportStructures.pdf" provides a guide for the assembly of the structure for the solar panels. The shown structure below is an example for an angle of inclination of 10°

3. 

4. 

Figure 1. Mounting of aluminium profiles for 4 solar panels

The connection of the 4 solar panels of 150Wp each is provided with two connections in series and two in parallel, thus ensuring a 24 V and a total of 600 Wp as shown below.

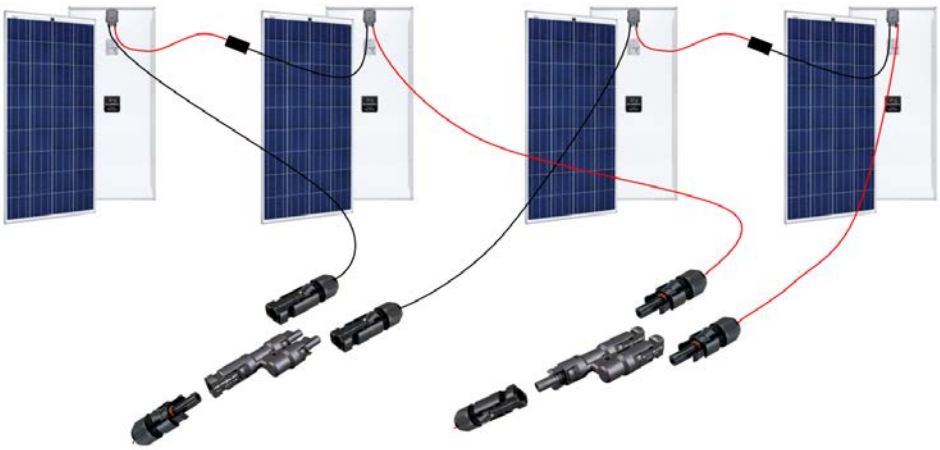


Figure 2. Scheme of serial and parallel connection of PV Panels

5. Battery box

The battery box is provided with two batteries, charge controller, two bulbs, a connection to charge via USB and the socket to plug of the ice-maker.

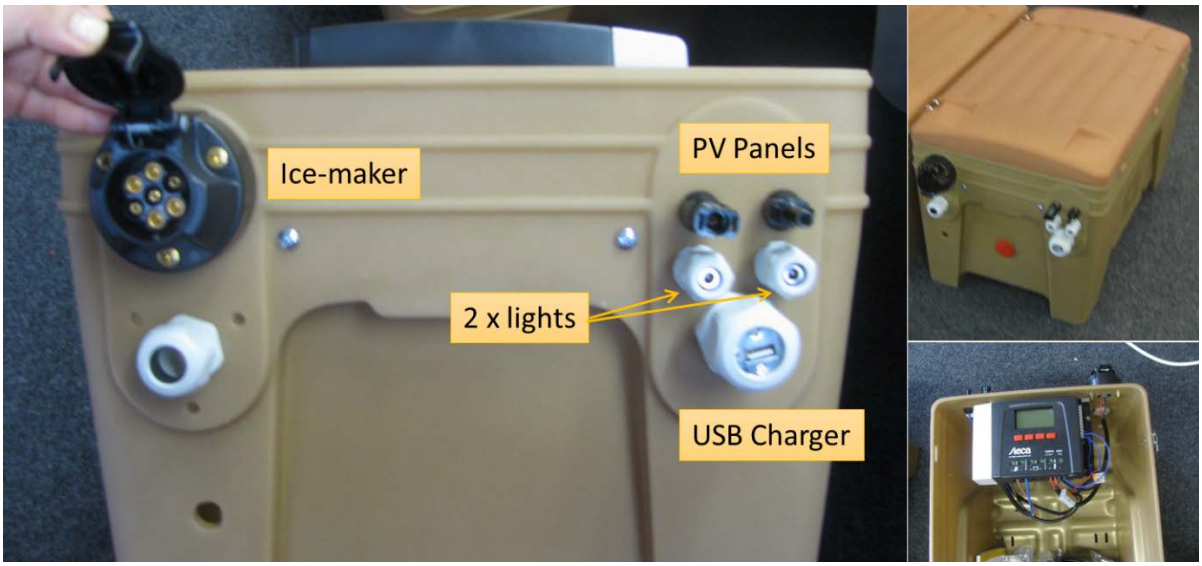


Figure 3. Overview of the plugs of the battery box

The batteries placed inside the box have a nominal voltage of 12 V. These batteries are connected in series for a capacity of 65 Ah at 24 V. The connection of the entire system is shown below:

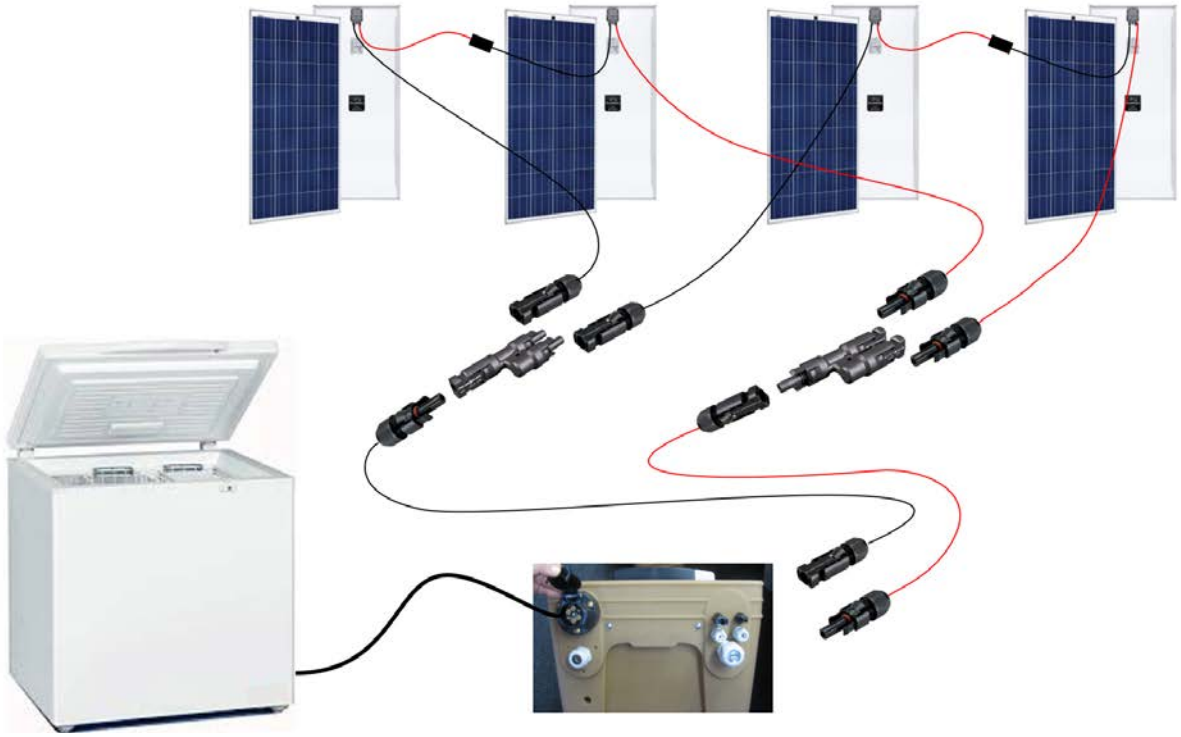
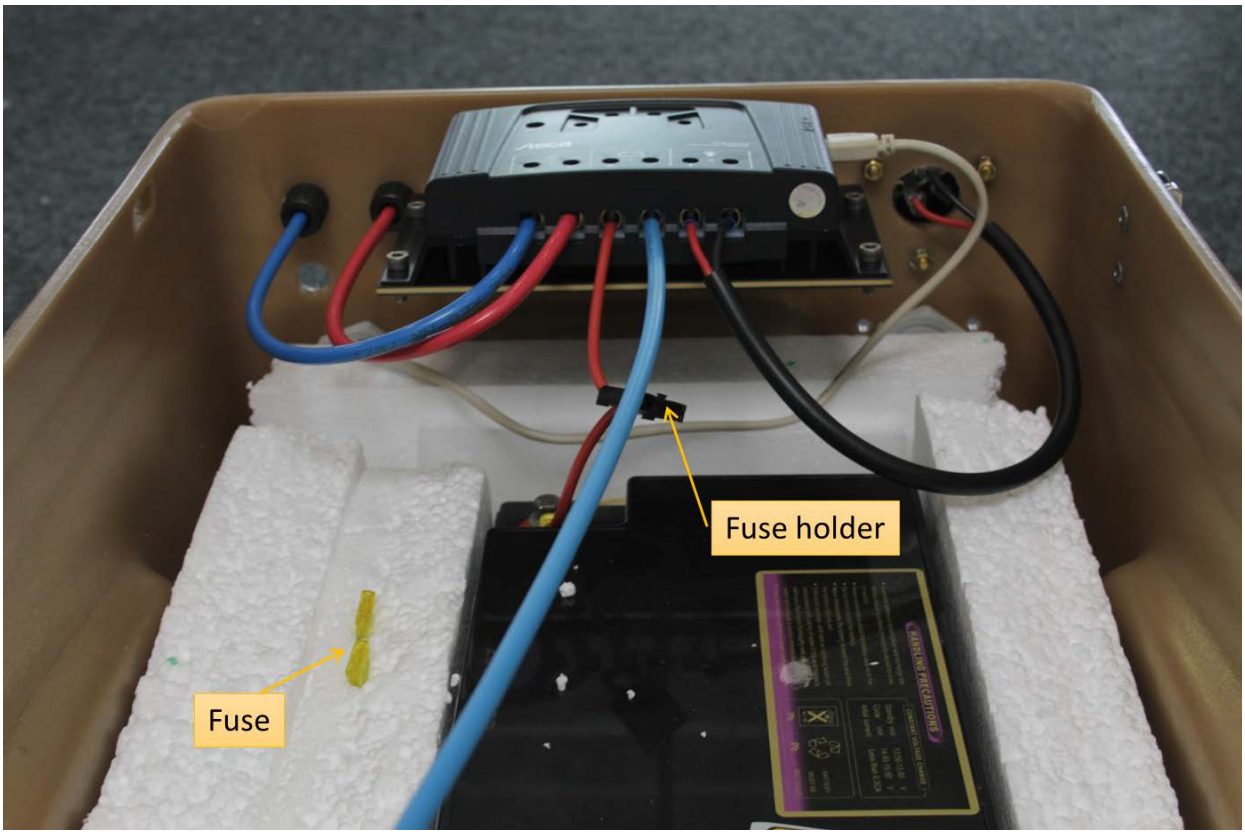


Figure 4. Connection of PV panels, battery box and ice-maker

Please, insert the fuse inside the fuse holder placed in the battery box once all cables have been connected.



6. Solar Ice-maker

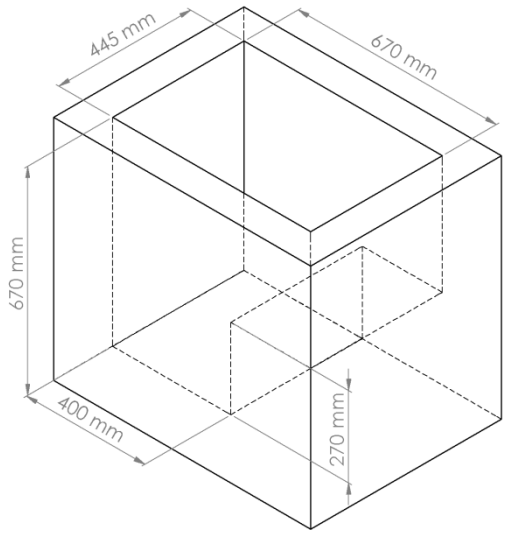
Phaesun and the University of Hohenheim have developed an ice-maker based on a commercially available DC freezer (STECA PF166-H) which is equipped with an adaptive control unit. This means, the production of ice is made in dependence of the availability of solar energy.

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

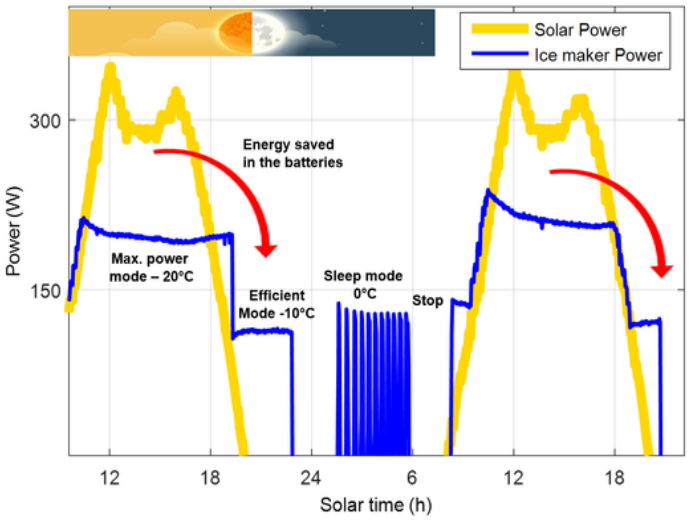
- ✓ Variable compressor speed in dependence of solar radiation and state of charge of the batteries.
- ✓ Operation of a fan in the inner chamber in order to increase freezing rate.
- ✓ Energy saving mode during night and rainy days.
- ✓ Storage of 50 kg ice blocks to assure an autonomy of at least 5 days under low radiation or high ambient temperatures



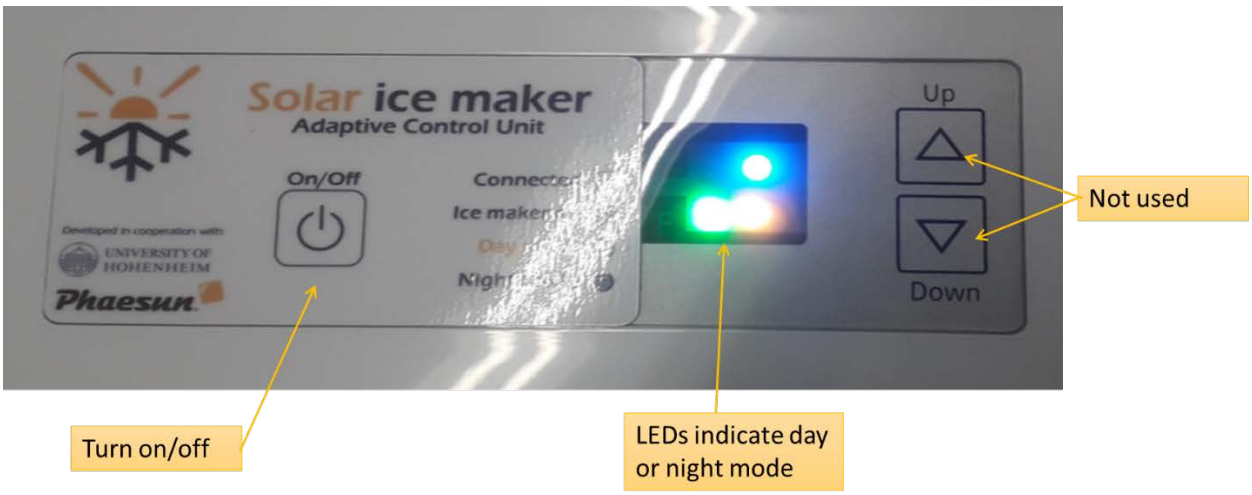
Characteristic	Value	Unit
Energy-Efficiency-Class	A++	
Cooling technology	Vapour compression	
Refrigerant	R-290 (Natural Refrigerant propane)	
Expansion device	Capillary tube	
Compressor speed range	2000 to 3500	min^{-1}
Volume	166	L
Working Voltage	12/24	V
Electrical Power	40 to 100	W
Freezing temperature range	0 to -20	°C
Ambient Temperature	10 to 40	°C
External dimensions	91.7x87.2x70.9	cm
Weight	61	kg

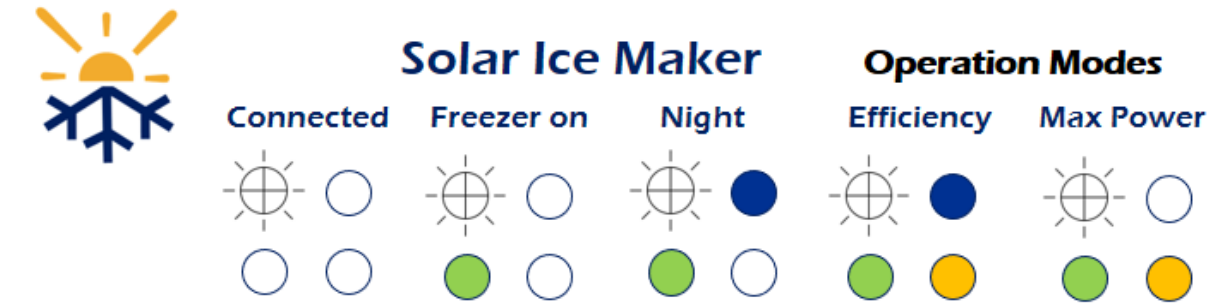


The adaptive control unit detects automatically solar radiation and commands the freezer to operate at maximal power. After sun set the freezer keeps on producing ice in an efficient mode with the energy previously saved in to the batteries. At the end of the night, the ice-maker goes into a sleep mode to keep the ice-blocks frozen and ready to use.



Operation Modes:





Voltage	-	<23.4V	<24.4V	<25.4V	>25.4V
Compressor	OFF	OFF	ON	ON	ON
Temperature	OFF	OFF	0°C	-10°C	-20°C
Fan	OFF	OFF	OFF	ON	ON

Energy consumption:

	Average daily ambient temperature			
Ice output	**10 °C**	**20 °C**	**30 °C**	**40 °C**
0 kg	288 Wh/day	400 Wh/day	586 Wh/day	851 Wh/day
2 kg	438 Wh/day	571 Wh/day	803 Wh/day	1133 Wh/day
4 kg	588 Wh/day	742 Wh/day	1020 Wh/day	1416 Wh/day
6 kg	738 Wh/day	912 Wh/day	1237 Wh/day	1698 Wh/day
8 kg	888 Wh/day	1083 Wh/day	1454 Wh/day	1980 Wh/day
10 kg	1038 Wh/day	1254 Wh/day	1671 Wh/day	2263 Wh/day
12 kg	1188 Wh/day	1425 Wh/day	1888 Wh/day	2545 Wh/day
14 kg	1339 Wh/day	1596 Wh/day	2105 Wh/day	
16 kg	1489 Wh/day	1766 Wh/day	2322 Wh/day	
18 kg	1639 Wh/day	1937 Wh/day		
20 kg	1789 Wh/day	2108 Wh/day		
22 kg	1939 Wh/day	2279 Wh/day		
24 kg	2089 Wh/day			

Performance:

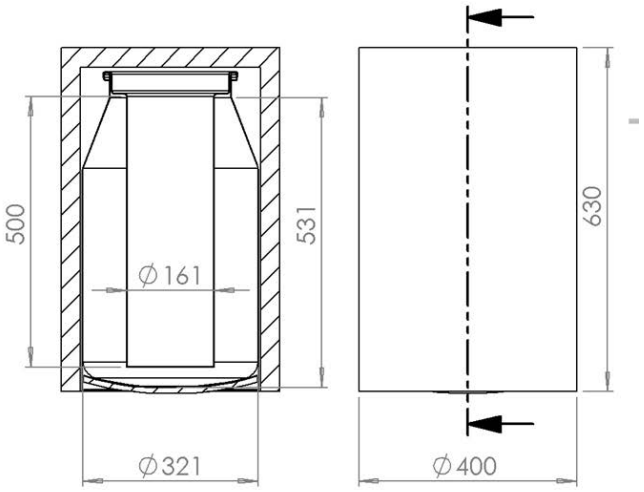
If the system is powered by a solar system, the daily ice production depends on solar irradiation and mean ambient temperature. Depending on the location and desired ice-output, the system can be powered by 600 Wp and two batteries (65 Ah each). The expected daily ice production is shown in following table:

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

Mean Amb. Temp.	***10 °C***	***20 °C***	***30 °C***	***40 °C***
0 kWh/m² day	-1.2 kg	-2.4 kg	-3.5 kg	-4.7 kg
1 kWh/m² day	3.8 kg	1.3 kg	-1.0 kg	-3.4 kg
2 kWh/m² day	8.5 kg	5.3 kg	2.0 kg	-1.5 kg
3 kWh/m² day	13.0kg	9.4 kg	4.8 kg	0.3 kg
4 kWh/m² day	17.6kg	13.2 kg	8.2 kg	2.2 kg
5 kWh/m² day	21.9kg	17.0 kg	11.4 kg	4.8 kg
6 kWh/m² day	22.4kg	17.5 kg	12.7 kg	6.7 kg
7 kWh/m² day	22.9kg	17.9 kg	13.1 kg	7.0 kg
8 kWh/m² day	23.0kg	18.1 kg	13.3 kg	7.3 kg

7. Insulated milk can with ice compartment

Insulated milk-cans are applied for flexible milk cooling at farm or cooperative level. The milk is cooled through ice blocks placed into the ice-compartment right after milking. After it, the milk-can is cover with an insulation to assure milk quality during storage or transportation to the collecting center.



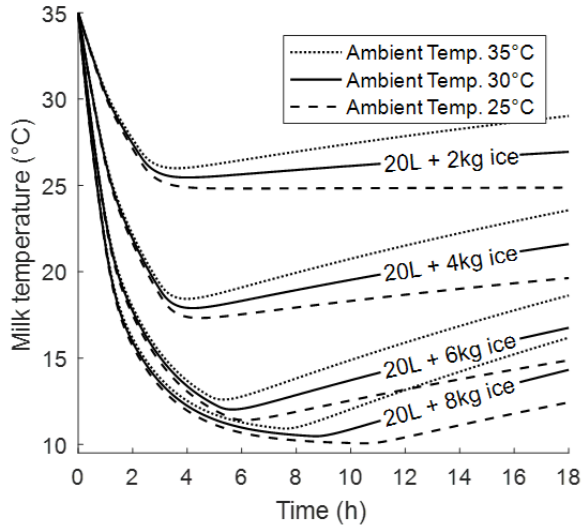
The main features are described below:

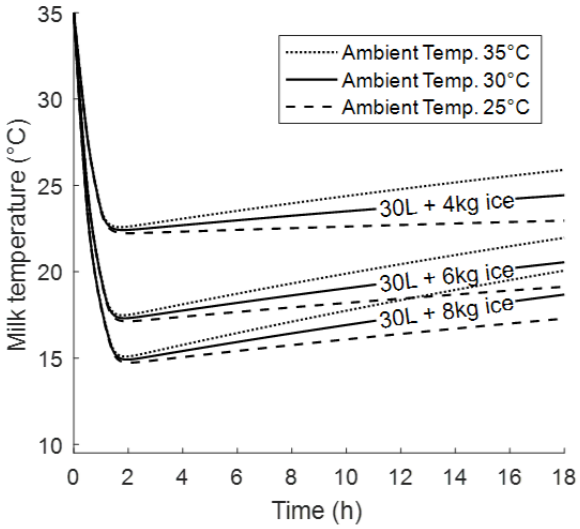
- Your morning milk is safe under 20°C for 6 hours during transportation.
- Your evening milk can be stored under 10°C cover the whole night.
- Increase your productivity by regular milking times and no more production losses.
- Your high quality milk gives you access to price premiums and additional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

The insulated milk-can is made of stainless-steel with a maximum capacity is 30 liter 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 following table.

	30 Liter milk + 6kg Ice	**20 Liter 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 16 hours

Expected cooling curves:





Handling of the insulated milk cans

1) Clean the plastic milk-cans if possible with hot water and keep it dry before you start filling it with milk (Max. 30 Liter milk).

2) Take out 3 ice blocks. Make sure the blocks you have selected are totally frozen. Let them out for a while until they are easy extractable from the plastic tin. Remove the ice from the tins and introduce 3 blocks (6 kg ice) inside the ice-compartment. After it, please add at least 2 liter water into the ice-compartment too in order to improve heat transfer between ice and compartment.

3) Use the cover to close the ice-compartment.

4) Fill the can until you reach about the 30 liters. Then secure the ice compartment and the insulated milk can is ready to be transported.

5) Fill the used tins with water again and put them back in to the ice-maker. After 1 to 3 days, these will be ready again to use. Keep at least 20 tins inside the freezer in order to assure ice availability even under unfavorable weather conditions.