BOSS – Business Opportunities with Solar Systems

Battery-free Fridge

To support rural development and especially the commercial sector in non-electrified areas the Phaesun BOSS-solutions were developed. The term BOSS (business opportunities with solar systems) stands for photovoltaic (PV) technologies which can be used to generate income. These systems are the long-term cost efficient and low emission alternative to the electricity production by diesel generators. The aim of this project was to develop solutions for the operation of a battery-free fridge to sell cold drinks in a shop and for a grain mill operated with solar power. Both systems were planned for Mauritania.

For the fridge Steca PF166 tests in Memmingen and calculations for the city Atar in Mauritania were made. To run the fridge directly from the solar panel an electronic unit developed by Danfoss was installed which decreases the starting current of the compressor by a soft start function. Instead of a battery a cold storage of water or cooling elements with Phase Change Material (PCM) inside the fridge is necessary to reduce the warming of the content in the night. The temperature of the content should always equate 2 to 8 °C.

In the calculations it is assumed that the compressor runs continuously until the content reaches the adjusted temperature of 2 °C. But caused by the temperature sensor which regulates the compressor and is installed between the evaporator pipes the compressor stops often and the content does not reach 2 °C. To improve the cooling of the content the temperature sensor should be fixed on a warm element inside the fridge. Then the compressor should run continuously and the solar power is used more efficient.

For the solar system an East-West orientation with an inclination angle of 60° was considered in the software INSEL. But the effort of two modules orientated to East-West instead of one module orientated towards South is too big compared to the benefit. It was decided to use one PV module with 120 W_p power, inclined by 20° and South orientated.

With this solar system an average daily runtime of the compressor of 6.43 hours in 2012 is reached. On six days per year the irradiation is too low to supply the compressor and on five days per year the compressor is able to run for 9 hours. In the calculations of the cold storage a period of 41 h without energy supply was considered. The hottest ambient temperature during sunshine averaged 40 °C in August 2012. For this period of 41 h about 64 l water or 13 l PCM are necessary to keep the temperature below 8 °C, assumed no new drinks are put inside.

The filling of the fridge in the beginning should happen within some days because not the whole content can be cooled in one sunshine period. In Mauritania with high ambient temperatures just 8 l fluid can be cooled in 7 hours.

If an additional price of 0.12 € is taken for one drink and 20 to 72 drinks are sold in one day the investment of 1191 € is paid back within 496 to 138 days.

Solar Grain Mill

A stone mill from Widu Mühlenbau was found for the project solar grain mill. There was no manufacturer found in the given time who wants to operate his mill with DC motor and fluctuating voltage directly from a solar generator. Unfortunately the mill was manufactured with a three-phased motor with 1.1 kW power instead of the ordered single phase motor therefore the measurement was done for this motor but the system was planned as if it is a single phase motor.

The quality of the flour is good and the fineness is adjustable but the grinding lasts too long. The manufacturer declares that about 48 kg/h can be ground. He will test the grinding when he changes the motor.

From measurement and calculation it was found that the starting power of the motor is quite high with 8.9 kW, while the operation power equates to 162 W. The system was planned with a solar generator of 200 W_p, battery of 65 Ah and inverter with 6 kVA at maximum during 5 sec. The inverter and the battery have to provide the starting power and the battery stores energy for short time during the day.

With this system the costs were calculated depending on the operation hours per day and the irradiation. It is determined by the operation time how many modules are necessary because they cover the energy consumption during the day. The higher the irradiation the lower the system costs and the higher the operation time the higher the costs. With a daily mean irradiation of 4 kWh/m²/d the system costs 5511 € with 3 h operation and 6100 € with 6 h operation per day. If 15 to 25 kg/h grain are ground and 0.1 to 0.18 €/kg is obtained for grinding the investment amortises within 1225 to 226 days.

To operate the grain mill without battery a three-phased motor and a frequency converter with DC input and MPP tracker could be used. These converters can be connected directly to the PV generator. So far no information is available about this product but the possibility should be considered in future.

Small decentralised grain mills can support rural economic because people do not have to transport their grain to the next city and can grind to an affordable price.