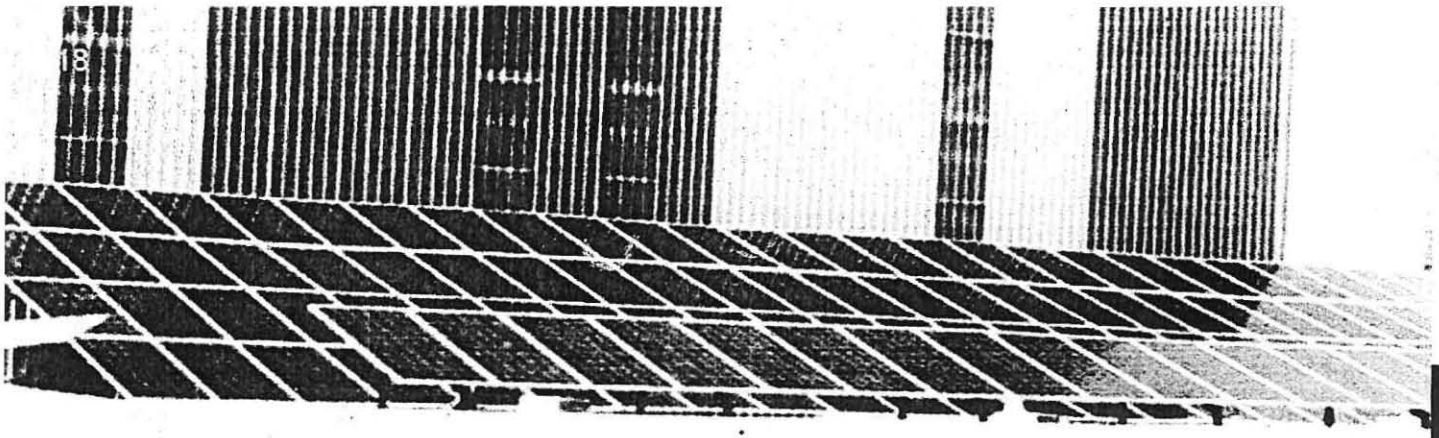

Extensive use of solar energy in dairy value chain reduces operational cost, promotes clean energy

Amit Vyas, MD, Amul India

Meenesh Shah, Chairman, NDDB

Intro Dairy sector

The dairy industry is one of the most complex industries that requires advanced logistic support from the start of milk production till the products reach the customers, also known as last-mile delivery through cold chain. The entire process is an energy intensive value-chain. This includes milk pooling points, collection centers, transportation to factories where milk goes through various processes. As R K Singh, Minister of Power and New & Renewable Energy, said, "Extensive use of solar energy in the dairy value chain can significantly reduce operational cost and promote clean energy."

India has a substantial number of milk producers in the country. It is estimated that the country has more than fifteen million milk procurers that are connected to the large network of dairy cooperatives in the country. As per government data, there are 1.65 lakh village-level dairy cooperatives, 218 district/regional/ taluka unions, and 24 State Dairy Federations/Apex Milk Unions in the country.

Many of the dairy farms and even the dairy factories depend on grid energy for their power needs. With the introduction of smart machineries and the increasing number of dairy innovations, energy demand by this industry is increasing by the day.

The use of solar energy in the dairy segment is limited to hot water supply to the boiler, hot water generator for processing of milk or for CIP cleaning. Although large milk producers adopt these, they are yet to trickle down to retail milk producers who form the critical element of a cooperative milk society. But the scenario is gradually changing.

Solar has found multiple applications in the dairy industry such as solar-energized refrigeration systems for milk cooling, cold storages, packaging rooms etc. In addition, solar energy is utilized in the milk processing units, not only to reduce energy costs, but also to improve overall productivity.

Among the many dairies in India, Amul, the largest cooperative in the country, has pioneered many initiatives through solar power adoption.

CASE STUDY

HL: Power of solar in Amul Dairy

Amul, the largest dairy cooperative network not just in India, but globally, has embarked on an energy efficiency drive.

Amul is a brand of the Gujarat Cooperative Milk Marketing Federation (GCMMF), the leading federation of milk producers in the world.

The cooperative has drawn an impressive sustainability roadmap. This outline optimizes the use of natural, renewable resources to enable more than thirty-six million farmer members, grouped in nearly 1,08,574 village-level dairy cooperative societies.

Being led from the top, this endeavor is spearheaded by Mr. Amit Vyas, MD; Mr. Vikramsinh Chavda, Head, Projects, and an entire team of engineers who work closely with the EPC partners.

"We are prioritizing renewable energy usage and have seen reduction in power consumption by 21,00,000 kWh/annum," said Mr. Amit Vyas, MD, Amul, who is presently spearheading the growth as well as the sustainability drive at the dairy.

For GCMMF, the shift to go solar, although slowly, is perhaps a natural extension of its efforts as a responsible corporate.

In what could be termed as the first such large scale solar power project in the country, Zodiac Energy installed 1.4 MW captive

power plant with co-generation at Amul Dairy on a Build, Own, Operate, and Transfer (BOOT) basis. Over the years EPCs such as Thermax and Warree Energies among others have enabled Amul to optimize solar power across applications. For example, in October 2016, Thermax had installed a 560 m^2 parabolic trough collector to allow for the feed-in of solar steam into the factory grid.

Warree, on its part, used sophisticated tools and software to analyze the impact of the solar PVs and how these will be optimized across the federation's dairy partners, i.e., the dairy farmers. The company installed 320 Wp poly crystalline modules at the warehouse facility in Gandhinagar for captive consumption. Thus, solar power has enabled the warehouse to run automated warehousing machines.

Mr. Vyas of Amul acknowledges, "Dairy is a perishable product. Hence, it must be transported under specified temperatures, or else they spoil. Additionally, dairies are launching multiple products to meet new market demands. This further puts pressure on the dairies to scout for renewable energy solutions like solar power to optimize cost."

Amul has pioneered the use of solar energy in the following areas:

Hybrid Thermal Solar Collector for air conditioning at its modern trade store: The system is installed at the company's modern trade store named Amul Green Terrace in Anand. The system (SunX) increases Delta T in the refrigeration cycle. This combined with the increased kinetic energy of the gas molecules and effectively increases the surface area of the condenser. This results in a reduced energy demand of the compressor due to increase in molecular velocity and subsequent volume conversion within the condenser.

With this system, Amul reduced daily Electrical Unit Consumption of VRF System without HSTC System from 202 Units to 134 Units, i.e., 33.66%

Hybrid Thermal Solar Collector for -2 °C Chiller Operation at TFC, Mogar:
The system is installed for -2 Degree Chiller Operation. HTSC system for operation of -2 °C chiller at Chocolate Plant. The system is installed between compressor and condenser, with solar energy pressure of refrigerant is increased and overall electrical load on the chills is reduced. The chilled water generated with this system is used for refiner and tempering machine in chocolate
manufacturing plant.

The HTSC system is unique and patented technology. With this system we can do monthly saving of 5000-6000 units of electric energy. ROI of this system is 2.5 years.

Hybrid Thermal Solar Collector for 7 Degree Chiller Application
Installation of Hybrid Thermal Solar Collector for 7 °C Chiller since May 2022. The operation and functionality of this system is same as above mentioned system installed in -2 Degree Chiller. The chilled water generated with this system is used for refiner and tempering machine in chocolate manufacturing plant.

Elements for the case study:
Quote: **"We are prioritizing renewable energy usage and have installed 1 MW solar rooftop PV system and renewable power contributes 2% of total power consumption"**
Amit Vyas, MD, Amul India

Box:
Utilization of solar power

Year	Technology	Total installed capacity (KWp)	Total generation (Million kwh)	% Overall Electrical energy0		
2018-19	Solar rooftop	520	0.36	0.55		
2019-20	Solar rooftop	1000	1.15	1.72		
2020-21	Solar rooftop	1000	1.68	2.19		
2021-22	Solar rooftop	1000	1.64	1.92		
Total capacity at AmulFed Dairy	Solar rooftop	1000	1.64	1.92		

Info boxes:
Amul's sustainability mission for 2030
35 % Reduction in Specific Carbon Emission
50 % Reduction in Ground Water Drawn
20 % Reduction in Chemical Consumption
Carbon sequestering through Forestry initiatives

Highlights 2021-22:
Electricity saving of 21,00,000 kWh/annum
Fuel saving 1,00,000 SCM/annum
CO2 emission reduction by 1800 MT/annum

Impact on energy consumption
FY 2019-20 59.7 kWh/KLFY
2020-21 52.3 kWh/KLFY
2021-22 53.4 kWh/KL

The Association interview:
Meenesh Shah, Chairman, National Dairy Development Board (NDDB)

NDDB is playing an instrumental role in the solar uptake in the dairy segment.
The dairy sector in India has always been at the forefront of adopting modern technologies. Solar power is one of them.

In line with the Government of India policy, to provide long term sustainable, clean, renewable, and viable source energy, NDDB has implemented eighteen installations of **Concentrated Solar Thermal (CST)** in various dairy plants with the financial support from MNRE and UNDP-GEF. The combined financial support from MNRE and UNDP-GEF is about 30% of the estimated project cost in the first fifteen projects across India.

A typical CST project targets to replace 5-15% of the average

daily thermal requirement of each plant with thermal energy from CST. Till date total installed heat output of 213 Lakh KCal/ day (9900 m2 of aperture area) has been installed.

Heat from solar energy can be used in generation of hot water to meet requirement in low heat applications (@ 80-85 Deg. C like can washer, crate washer and cleaning in place (CIP) of dairy plant equipment and boiler feed water based on the dairy plant configuration and requirements.

We understand that solar based thermal storage solutions are being incorporated at the village level. What is the thought process behind this initiative?

NDDB supported farmers of the Mujkuva village and helped them to organize India's first grid connected solar pump irrigators' cooperative enterprise, wherein farmers affiliated with a collective have installed solar pumps into their fields. These farmers use solar energy for irrigation and export the surplus power to the power distribution company through a micro grid established and managed by them. These farmers are thus earning from sale of electricity up to to Rs.5000/ month apart from the savings on energy bills for irrigation. The farmers have also started rationing their water usage to maximize their income through energy sell.

The cooperative was inaugurated by Hon'ble Prime Minister of India on 30th Sep 2018, and its operations and design considerations have inspired the design of Gujarat's innovative **Suryashakti Kisan Yojana,** one of the three components of the **Kisan Urja Surksha evam Utthan Mahabhiyan** scheme of the Government of India.

Can you elaborate on the Mujkuva project?

It started as a pilot project at Mujkuva in 2018-2019. We experimented with the augmentation of existing bulk milk coolers at the village milk collection points through solar PV and thermal storage system (TSS). We observed up to 50 % reduction in power drawn from grid and thermal storage backup. Based on the learnings, a completely off-grid solar PV system solution with TSS, instant milk chiller (IMC) was executed in Assam in 2021. The results of off-grid experimentation are encouraging, as there is near 60% savings on grid power,100% reduction in milk spoilage and overall reduction in operational cost by 50%.

What has been the impact so far?

The pilot became a rationale to solarize operations of village level dairy cooperative societies. With a purpose of propagating the usage of solar energy in dairies and especially helping a village level dairy cooperative society (DCS) from remote villages in conducting uninterrupted milk collection even during the hours of power failure, NDDB piloted the idea of installing roof top solar PV system at the DCS. Grid connectivity and hybrid invertor attached with the system ensures an evacuation of the surplus energy to the grid and earn additional income through net metering.