Capturing Cryogenic Energy for Food Logistics

Natural Gas is liquefied by cooling it to below its boiling point (-162 °C), to ease its transport and logistics handling. However, for onward delivery, the LNG (Liquefied Natural Gas) is warmed up to ambient temperatures, reverting back to gaseous state at the receiving terminals. This stage of operations, where a shift occurs from cryogenic to normal temperatures, presents a viable opportunity to capture the energy released for generic common place uses.

The science involved is to safely capture the cold from the process that prepares the stored Liquid Natural Gas (LNG) for onwards distribution in the gas grid. Regasification or the reheating phase currently loses the energy exchanged by flushing it to air or sea. This energy is recoverable and can be brought into use at dedicated gateways for perishable foods, at port locations. These facilities would bridge the world of cryogenics with the everyday needs of food logistics which operates between – 25 °C to +20 °C. There are also other applications possible from recovering waste energy (or Stranded Cold) from the regasification phase of LNG's life cycle.

The National Centre of Cold-chain Development along with the Ministry of Agriculture and Farmers Welfare, has mooted the idea of combining a series of activities, stemming from the cryogenic phase of handling gas, to build the world's first zero CO2 emission port based cold-chain facility.

CONCEPT BACKGROUND:

- Natural Gas is cooled below its boiling point, -162 °C to transport on ships in liquefied form as LNG (Liquefied Natural Gas). Refrigeration & liquefaction reduces the handling volume 600 times.
- This liquefaction process happens at ship loading terminals and the temperature is maintained during entire transit, including after discharge in shore-side tanks at receiving port terminals.
- At the receiving end, the product undergoes a regasification process before onwards distribution to consumers in gas form (eg. CNG).
- Regasification requires warming up the Liquid gas (LNG) and the cold is lost to environment during this process.
- This regasification or warm-up process can include multiple methods, like heat transfer to a circulating fluid (seawater exchange) or directly to atmosphere (air exchange).
- There is an option to recover this waste energy or 'stranded cold' for use in other applications, including for cold-chain use.

Recovery of Stranded Cold:

1. The heat transfer fluid from regasification process can be directly circulated to enclosed insulated spaces to utilise the captured cold for handling of temperature controlled goods (fruits, vegetables, fish, meat, pharmaceuticals)
2. The captured cold can also be stored as cryogenic form such as Liquid Nitrogen of Liquid Air as energy banks for other selected uses.
3. A combination of both above (direct heat exchange and buffered energy store), is expected to be the best option to utilise the high grade (-162 °C cold) energy source.

Innovative applications:

Various debates and discussions have been undertaken to develop on the concept of recovering waste energy, and a user cluster can be developed around the energy recovered. Such a user cluster is seen to comprise of following applications-

1. At first stage the cold can be applied for cryo-desalination (converting sea water into fresh water through the process of freezing).
2. Cryo-power generation: the degasified LNG expands 600 times, creating pressure. This pressure is used to turn a turbine and produce electricity (no fuel is used to generate electricity).
3. The recaptured cold energy can be piped to closely located (over the fence) cold stores. The cooling will be in lieu of electric powered indoor cooling units, minimizing the cost of refrigeration.
4. Other possible applications include the use the cool energy for freeze drying of horticultural produce (onions, etc.), for air-conditioning of buildings under human occupancy, for generating other cryogenic fluids like liquid nitrogen or dry-ice, etc.
5. The cryogenic fluid (liquid air/nitrogen) can also be used to power refrigeration equipment on road and rail transport.
6. The cryogenic fluid (liquid air/nitrogen) can also be used in the prime drivers (engines) of vehicles like forklifts (engine without fossil fuel).

In summation, the recovered waste/stranded cold can be piped directly for immediate cooling application, and can also be in stored form (as cryogenic fluids) for other operations. All these options present zero pollution applications by capturing waste energy from existing cryogenic uses at LNG terminals.