

A CLEAN ENERGY FUTURE FOR LIQUID TERMINALS TODAY

Almost everyone in the liquid terminal industry would agree that resolution of the energy trilemma may take up to 20 years. At the same time, investors are starting to distance themselves from the hydrocarbon industry and publicly traded companies have a challenge to satisfy a broad range of investors on a path forward. Therefore; the liquid terminal industry needs a plan to support positive economic results during the energy trilemma transition.

The good news is there are many opportunities to reformulate existing hydrocarbon liquid storage terminals for profit in clean energy. The solutions incorporate emission reductions, storage of products generated through renewable efforts, optimization, and new technologies that take advantage of the existing terminal infrastructure, systems, and locations. The top eight technologies are listed in the Long Duration Energy Storage (LDES) for Liquid Terminal Technologies chart, but the most obvious technology for liquid terminals to embrace was flow batteries, utilizing bulk storage with low or no emissions and supporting Electrical Energy Storage (EES). Flow batteries would truly be a windfall for the tank and terminal industry if it was economical today. However; even with an efficient flow battery solution the equation is not complete without energy generation. The complete solution needs to harness the terminal assets already



in place, store energy, and at the same time capture a renewable means of power generation. The combination of these efforts paints a picture of transition success accepted by the industry and the most aggressive investors.

As a reference point for terminal storage competition, one need not look any further than lithium-ion batteries for EES. When it comes to power generation, solar and wind are the systems to beat. The liquid terminal industry can beat Photovoltaic (PV) solar with batteries in ways such as:

- Long Duration Energy Storage (LDES)
- Lower Electrical Energy Storage (EES) cost
- A lower carbon footprint

- 100% US materials, fabrication, and construction

From an investor perspective there are plenty of selling points, but the big challenge is great economics. The solution lies in relatively new technology formulated to fit the liquid terminal industry. Taking advantage of the location of many terminals and their proximity to industry and power grids are key elements of success. One solution is as simple as waste heat recovery and clean bulk energy storage, a system that can compete with solar, wind, and batteries toe to toe. The additional benefits for applying AT&V's Carbon Reduction Clean Energy Storage (CRCES™) technology include the following:

- Unlimited life cycles



- No cost of future battery replacement risk
- Smaller area required for energy storage
- More local jobs versus batteries deployment
- Efficiency in Long Duration Energy Storage (LDES)
- Faster project timelines
- 20+ year life of unit

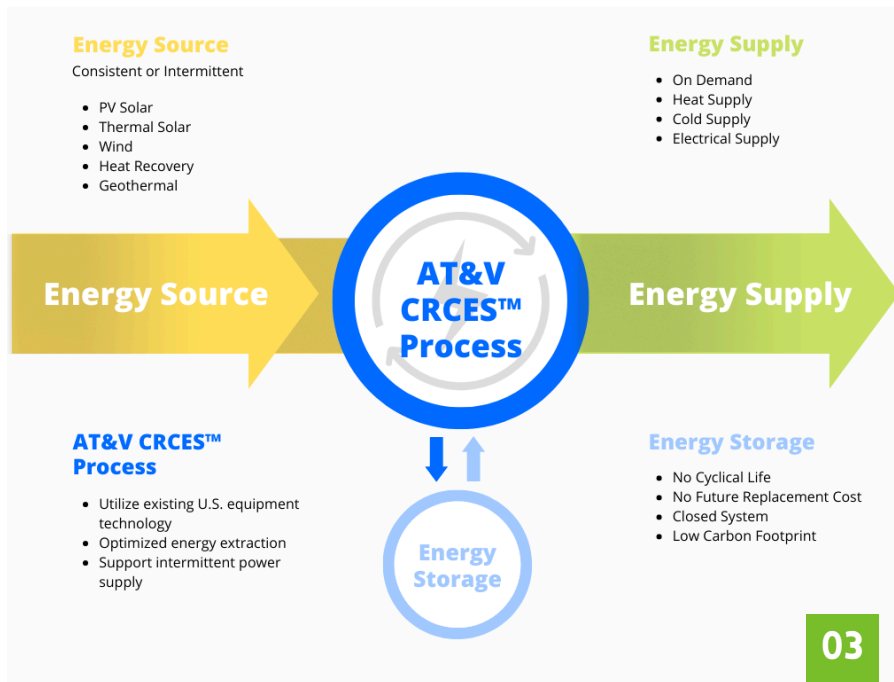
To realize these benefits requires a commitment to work with the power community and industries in the vicinity of the existing liquid terminal. One source of energy will be low-quality waste heat. Most industries have already utilized waste heat in a variety of manners but still have low quality waste heat within their operations. Typical operations consume water, power, chemicals, and land area to expel this low-quality waste heat. The technologies to utilize low-quality waste heat, as well as convert tanks and systems to act as energy storage, are available today. A low-end FEED Study can identify the resources that can be utilized for energy acquisition, storage, and distribution. Terminal companies who embrace the concept are underwriting their future by:

- Promoting a path to clean energy storage with investors
- Adding long-term sources of revenue
- Reducing local industries' consumption of water
- Expanding relationships with local industries
- Stabilizing the power grid with clean energy
- Acquire low-cost energy
- Incorporate good economics
- Show flexibility for future transitions
- Minimize land required for new equipment

Storage of clean energy in liquid hydrocarbon terminals can be accomplished through a number of applications which incorporate technology that has been around for thirty (30) years and others which promote technology that is still incomplete. Review of these applications shows that many do not take advantage of the traditional hydrocarbon terminal's assets. For applications to have a good fit the projects need to accomplish the following:

- Utilize current physical assets
- Support deployment today
- Leverage existing staff and systems

Most clean energy storage is burdened with incomplete technology or limited by rare materials. The CRCES™ technology is available for commercialization today and has the unique benefit of storing energy from low-quality waste heat sources. CRCES™ storage technology can utilize the traditional storage tanks found in liquid terminals with modifications, while full utilization of most tanks can be realized. Not only are the assets of the liquid terminal utilized, but the terminal's current management systems are appropriate to operate the facilities described. Many liquid terminals operate propane facilities or blending, which is of similar complexity to operating the facility supported by CRCES™. In addition, most liquid terminals are located in areas where it is easy to tie into the



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electrical grid, support a substation, generate behind the meter, or work through an electrical broker to sell power.

Energy transition of liquid terminals will start through:

- Aggregating low quality waste heat from local operators for clean energy generation
- Storage of energy from renewable sources for grid stabilization
- Storage of electricity from the grid to support peak shaving and/or backup systems
- Support of ammonia for bunker fuel demand
- Establishing a path to the hydrogen economy

Whether the terminal is driven to have a green initiative or generate additional revenue streams, the solution is at hand.

FOR MORE INFORMATION

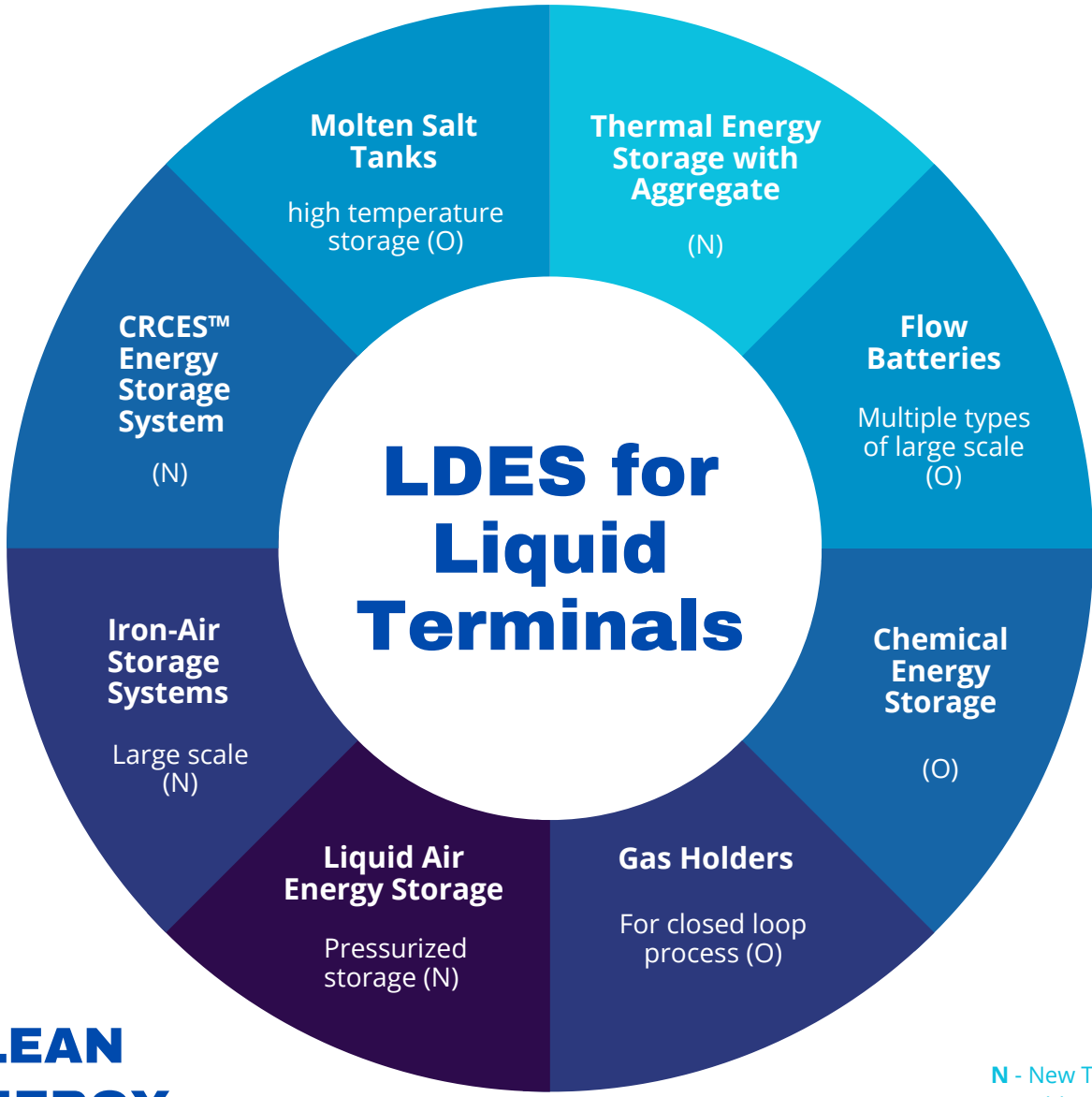
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N - New Technology
O - Old Technology

CLEAN ENERGY STORAGE CONCEPTS

Long-Duration Energy Storage (LDES) for Liquid Terminals Technologies