Wiley Rhodes, Newpoint Gas, USA, introduces an end-to-end business model to monetise stranded flare gas and all hydrocarbon emissions.

EVERY LAST DROP

Virtual pipeline (VPL) is a method of transporting natural gas in areas where there is no pipeline infrastructure available, and can be marine or land-based. It is predicated on a modular system of compression or liquefaction, transport to a central processing facility (CPF), and unloading and/or regasification of natural gas.

Integrating natural gas into a VPL is not new: compression and liquefaction of natural gas (into CNG and LNG, respectively) are proven technologies that have been operating successfully around the world for several years. The challenge these technologies have yet to overcome is the fact that both are uneconomical to install and operate on small- to medium-scale projects in remote locations. To focus on methane and ethane misses the revenue potential of the high-Btu value added natural gas (VANG) components.

VANG is used to define the economic properties of the stranded resource being flared. The heating value or Btu of raw natural gas is usually much higher than processed natural gas and therefore contains the 'value added' due to the LPG and NGLs. Accepting the raw gas stream in 'as is' condition reduces the gas processing and gas treating requirements at the gas production site and captures the value added to the gas stream. The higher value gaseous hydrocarbons, which include ethane, propane, butane, pentane, hexanes and heavier hydrocarbons, are retained in the natural gas. The idea behind VANG is to capture the entire gaseous hydrocarbon stream at the source and transport those hydrocarbons to a secure CPF.

Considering natural gas transportation alternatives, all the existing technologies (liquefaction, gas-to-liquids and compression) require preconditioning and the removal of high energy hydrocarbons. Removal of these hydrocarbons, such as LPG and NGLs, reduces the monetary value of the cargo. Why not reverse the procedure and transport the full value of the gas stream to the market for processing and distribution?

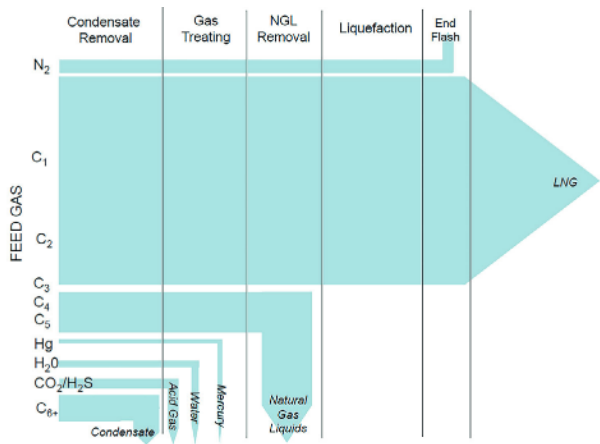


Figure 1. Typical LNG processing.

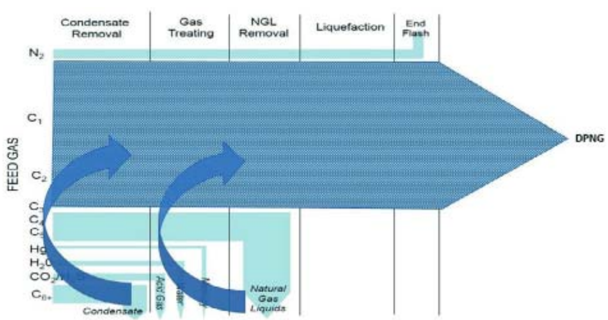


Figure 2. DPNG processing keeps valuable high-Btu components in the product.

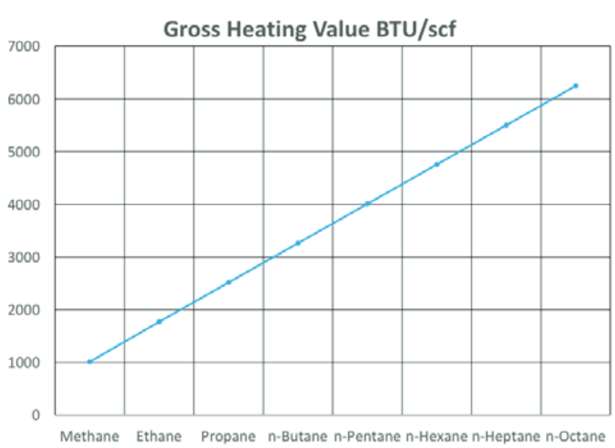


Figure 3. Heating value for natural gas components.[1]

Typical LNG pre-processing

Liquefaction condenses the gas to 1/600 and compression compresses it to 1/300 of its original space requirements. Both proven technologies reduce natural gas space requirements so that a larger quantity can be loaded into a smaller area, but both have limited potential in the market. Every facet of LNG is expensive and CNG has a high weight-to-energy ratio, making it difficult to transport enough gas volume per load to generate a profit (Figure 1).

High-Btu DPNG VANG components

Dense phase natural gas (DPNG^{TM}) is a technical definition associated with a specific product option for flared and stranded gas transport. DPNG combines the value of high-Btu natural gas with the space efficiencies of CNG (Figure 2). It does not include a gas specification but only denotes a pressure of over 2650 psi. In one test case, NGLs and LPG contained an average caloric content of 3972 Btu/ft^3, collecting a multiple of almost 4× when traded on a million Btu basis, and CNG allowed higher volumes of gas to be transported (Figure 3). DPNG and single vessel gas transports produce the revenue to monetise flare and stranded gas without the use of a natural gas pipeline.

As demonstrated in Figure 4, stranded gas and gas flares of less than 100 million ft^3/d are due to the fact that global markets have not discovered an economically viable solution. LNG has a cost to market of US$5.30/million Btu and CNG a cost of US$3.70/million Btu. LNG and CNG contain a low average caloric value of 1.1 million Btu/ft^3, which at US$3.50/million Btu is worth US$3.85/1000 ft^3. With an average of 1.35 million Btu/1000 ft^3, DPNG delivers product to market at a cost of US$2.81/million Btu. This represents a processed product value of US$4.73/million Btu (spec gas, LPG, gasoline feedstock) and a margin of US$1.92/million Btu. The DPNG process yields greater revenue, creating a profitable end-to-end, source-to-market solution.* The formula for calculating DPNG value is as follows:

$$DPNG\ \ Value = Price * Volume \sum_{k=1}^{n} \alpha_k \beta_k$$

where α = volume fraction and β = heating value.

Gas compression, dehydration and loading hydrocarbons

The raw gas stream, when required, is compressed to approximately 1270 psig and sent to a natural gas dehydration unit where the water content of the gas is reduced to 7 lbs/million ft^3 or less. The dried gas then proceeds through a final stage of compression where it

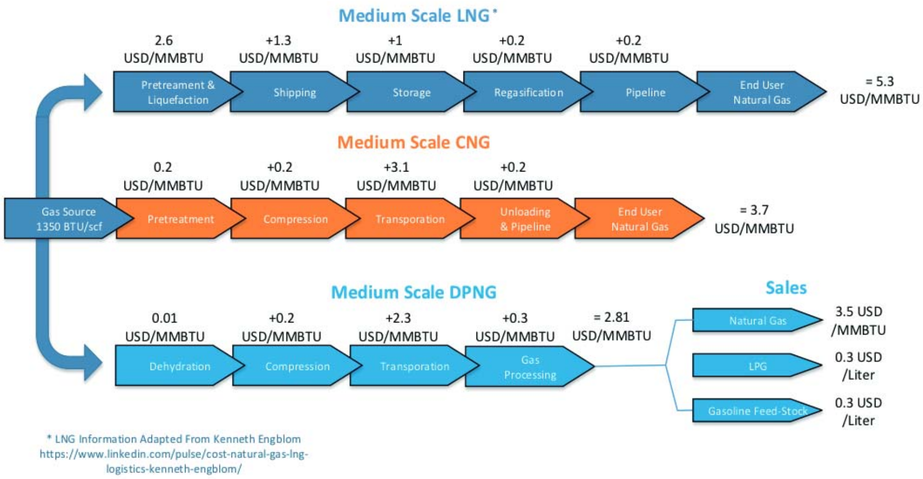


Figure 4. Cost comparison vs energy content.

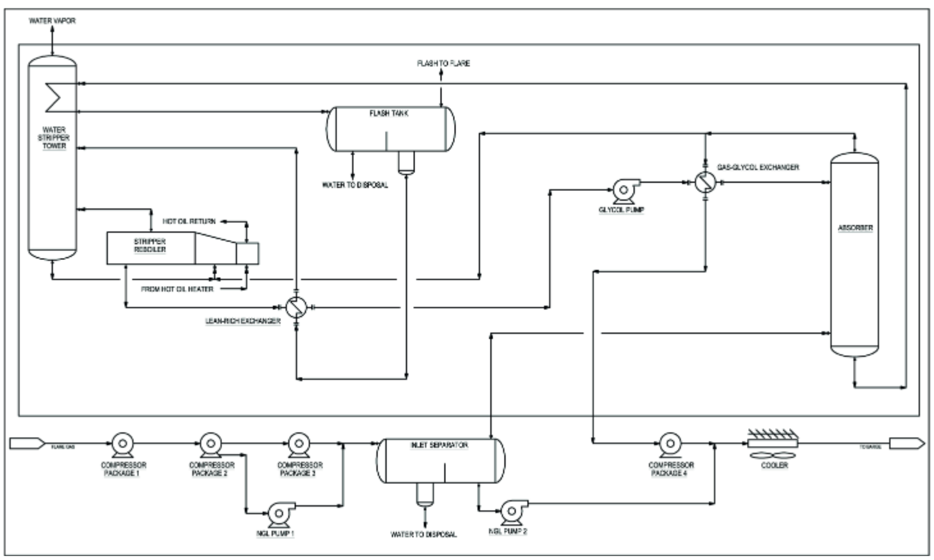


Figure 5. DPNG – compression, dehydration and loading system.

reaches a minimum pressure of 3100 psig and is loaded into the high-pressure DPNG transportation vehicle or vessel (TVV). Any NGLs that are generated during compression are pumped back into the high-pressure stream and loaded into the TVV (Figure 5). Owing to the fact that the hydrocarbons are transported in the single dense phase, all LPG, NGLs and heavy hydrocarbons are dissolved into the high-pressure gas TVV.

Transportation of high pressure hydrocarbons

Several unique technologies exist in marine and road transportation for high-pressure gas. For marine transport, these include a self-propelled barge or a standard barge using tugs and high-pressure storage using a close-packed long pipe design. For road transport, methods include using 40 ft modules with the vessels constructed from steel, composite/steel hybrid, or entirely composite. Each of these vessels has different advantages and disadvantages. In general, the steel construction offers the lowest capital cost, but the weight is high when compared to other hybrid and composite construction options. The most cost-effective modules use composite vessel technology, and several manufacturers have had their models approved by the US Department of Transportation. A 40 ft module with a capacity of 360 000 ft^3 at 3600 psig has proven the most cost-effective in most situations. However, each model of the vessel by each manufacturer must be evaluated to ensure that the right equipment is chosen for each project.

Discharge of high pressure hydrocarbons

The gas is unloaded into a pipeline or gas processing facility (GPF). As an example, if the inlet to the GPF is 950 psig, the discharge gas must be continuously controlled to keep to the correct pressure. As the gas is unloaded from the high-pressure TVV, the pressure will eventually decrease until it is less than 950 psig. When the discharge rate of the gas is too low or the pressure equalises, one stage of compression will be required. As the pressure drops further, a second stage of compression will be brought online to compress the gas to the required pressure. The TVV will be unloaded until about 65 psig remains. This equals a total capacity of 98% of the design capacity of the TVV and results in a reduction in recompression requirements at the unloading site.

Conclusion

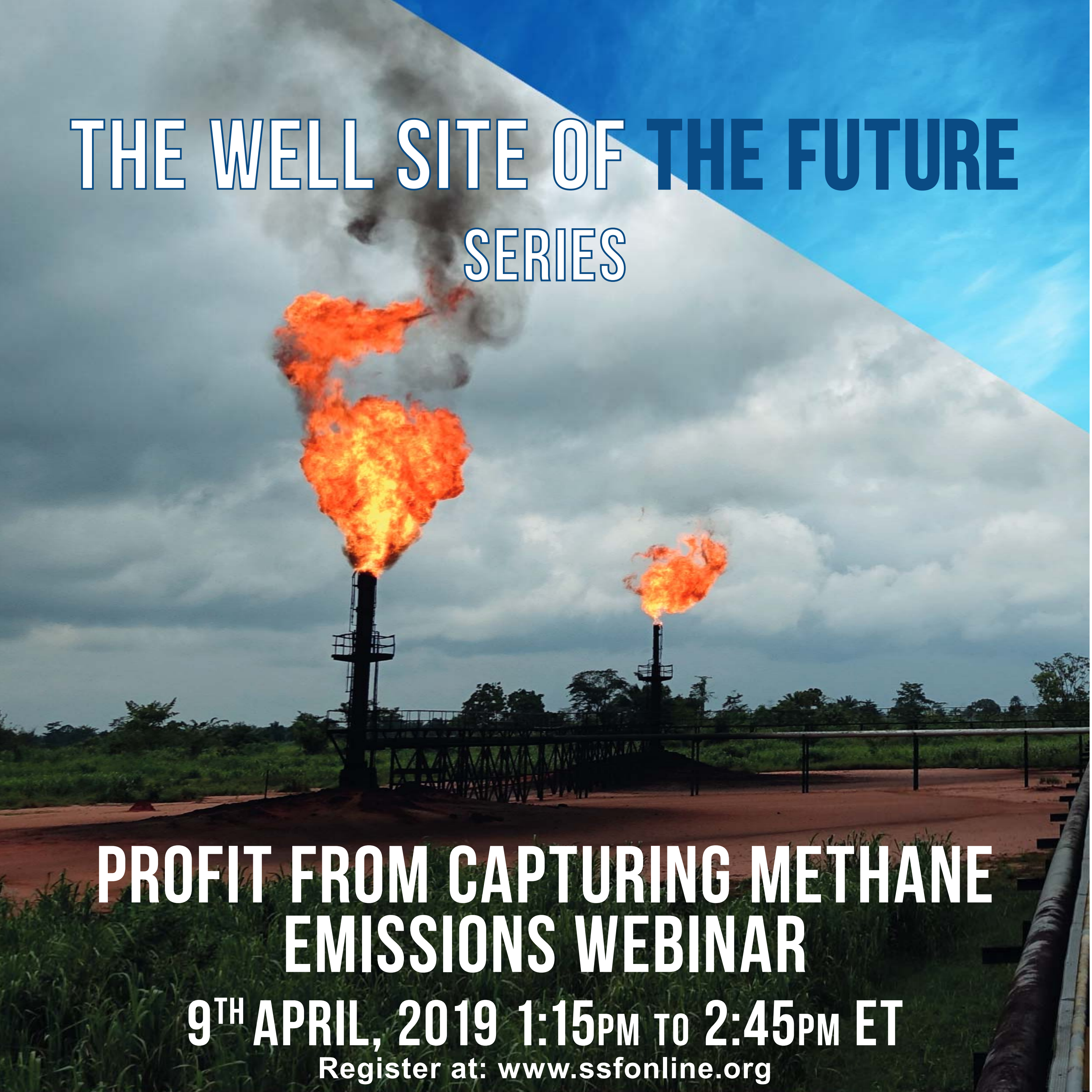
With the development of DPNG through the use of a VPL, flared gas can now be economically captured and transported to market. Utilising this process, exploration and production companies now have the flexibility to venture into areas for future development without the possible production restrictions or revenue loss associated with flaring natural gas.

Reference

1. Data sourced from *Gas Processors Suppliers Association Engineering Data Book*, 13th edition.

Note

*The model excludes the cost of raw natural gas feedstock as this cost varies.



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