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GTL: Why Bigger is not Always Better

The available published information for both Shell and Sasol suggests that their large-scale plants cost more than $100,000 per barrel of daily capacity to construct. Only Shell and Sasol know for sure what their true costs are and, of course, they will vary based on the location and the amount of supporting infrastructure that must be included in the project's total cost.

Shell has received a lot of criticism in the press for the significant cost overruns of their project. The original 2003 estimate of $5 Billion estimate ballooned to $20 Billion (or more depending on who you ask). These numbers are misleading for a number of reasons:

Shell announced an agreement with Qatar in July 2004. The project was not approved for construction by Shell's board until July of 2006. The plant came on line in 2012. Here are some issues Shell had to deal with.

During that time:

- the cost of steel alone almost doubled
- the cost of concrete rose 30%
- the Producer Price Index for Petroleum Support Activities rose from 140 to 200
- the IHS CERA Upstream Capital Costs Index rose from 105 to 230

The project includes:

- 22 offshore wells from two permanent platforms 60 Km offshore
- Two 30 in lines to transport the gas to shore
- A sulfur removal plant to handle 1.6 BCF per day of sour gas
- A natural gas liquids plant to extract 120,000 BPD of NGLs and ethane
- A 170 acre "village" capable of housing the 52,000 workers who were brought in from 50 different countries
- A 140,000 BPD GTL plant that produces a wide variety of specialty products as well as fuels. (The additional refining equipment to make specialty products can add easily be double the cost of refining equipment for fuels only).

Shell has never broken out the cost of the GTL plant from the total project. An "apples to apples" comparison cannot be made.

That said, it is EFT's position that our small modular plant designs can be lower in total installed cost per barrel of daily capacity even though they are significantly smaller.

Here are some of the reasons that support this position:

Location – Plants built in the lower 48 have significant cost advantages over almost any other place on earth. Taking advantage of existing infrastructure (utilities, etc.), shorter distances to transport equipment and readily available work force can make a significant difference in total project cost. Not all US location offer the same benefits, which is why project costs will vary some even with standardized plants.

Different construction strategy – Plants that are custom built at the site are dependent on availability of highly skilled labor and cooperative weather conditions. EFT plants will be mostly shop-built in standardized modules that are shipped to the site for erection and final assembly. This also allows the possibility of re-locating the plant, if necessary. Our approach allows for a certain level of "mass production" which provides further cost reductions and improvements in the overall project schedule.

Lower engineering cost – We "design once and build many," spreading much of the engineering cost over multiple plants. Site-specific engineering and erection costs are also reduced. Foundation requirements are simplified.

Lower labor cost – Labor costs are lower because the bulk of the labor is in a shop where productivity is higher and weather related delays do not exist. Productivity improves even more when multiple plant modules are reproduced in a shop environment. This is of particular importance when skilled labor is not readily available in some remote locations and must be brought in at significant expense. Savings of as much as 20% are common within the modular industry.

Avoiding "diseconomies of scale" – Sometimes making it bigger does not make it better. Example: A fixed-tube reactor, when the shell diameter is under 12 ft, can be built in numerous shell and tube heat exchanger shop around the world. We have identified almost 100 shops in North America alone that are capable of building up to 12 ft diameter. When the diameter gets bigger than 18 feet, as is the case with Shell's reactor, the number of shops that can handle the fabrication (and the weight) drops to a handful and the cost per tube (a measure of unit productivity) goes up, not down. We have received quotes for reactors under 12 ft in diameter and compared them to quotes for reactors in the 18+ ft range. The cost per unit of reactor volume was more than double for the larger reactor (18 ft+ diameter). Additional shipping costs and erection costs also follow extremely large and heavy components.

Lower erection/field costs – Typically, a totally field constructed facility can take 2-3 times longer to assemble versus a modular, shop fabricated facility. Modularization transfers costly, weather dependent field construction man-hours to a less costly, more productive shop environment.

Standard size criteria – EFT's selected reference design sizes are based, in part, on a close fit with the most economical sizes for key components such as Vacuum Pressure Swing Adsorption (VPSA) air separation technology that have already been modularized by major providers such as Praxair, Air Products and others. The same also holds true for other pre-packaged components such as steam and gas turbines for plant power requirements.

FT reactor system– EFT's proprietary fixed bed design and catalyst system has demonstrated several significant cost and operability advantages. The installed cost brings this down further because of an easier to install reactor design/configuration. The high alpha catalyst system increases yield of desired products by as much as 10% over current systems, particularly slurry based system.

In the end, **the only way to know the cost of any project**, at any given site, is to pay a reputable EPC firm to create a FEED (Front End Engineering Design) package that defines the project and cost (usually +/- 5%) <u>for the given location</u>.