Deriving value from wet and gaseous waste streams.

Assessing the real value of “higher value products”
Setting realistic assumption and avoid common pitfalls

Luca Zullo
VerdeNero LLC

luca.zullo@verdenero.com
651-270-6478
My technology works great and my feedstock is a no value waste!

What could possibly go wrong?
Thermodynamics and process economics are not very different

It is never too early to think about economics!
Avoid disconnect between business and technology development

- What are the critical technical benchmarks?
- Is the process mass and energy balance correctly represented in the financial and business plan?
- Do we have an understanding of the impact of technical uncertainties and variability?
- Is the process able to deliver consistent product quality? Are the value assumption representative of the product quality? Do we really know what the market wants?
- Is the margin and return in line with the industry? How do we compare with industry benchmarks?
- Are we focusing to address the technical issues with the largest impact on the business?
- What are the key components of the capital cost?
- What are the trade-offs between capital and operating costs?
- Are we using industry standards % to provide early estimate of unknown quantities?

If you are doomed to fail, fail fast!
Have a RED team to challenge and attack your assumptions
Goals of a techno-economic model

• It is never too early to structure a detailed techno-economic model.
  – Evolve from a conceptual tool to explore risk and uncertainty to a planning one.
  – Stand alone production enterprise

• Evaluate the economic impact of technology options.
  – Identify and assess the impact of uncertainties and/or lack of knowledge. Provide quantitative support in the design of mitigation strategies.
  – Identify critical drivers for the project success.
  – Identify realistic economic and financial goals.

• Assess the impact of external forces outside of the project developer control such as variability in commodities prices and other macro-economic impact factors.
  – Quantification of risk.
  – Avoiding funding pitfalls and providing realistic assessment of the enterprise ability to generate cash.
  – Align investors and founders expectations with those of the project developers.
  – Quantitatively support the business plan and provide clear project metrics to bankers and investors.

• Flexible on business model
  – Include royalties and licenses if you plan to license the technology. You need to make it sure that your licensor will have satisfactory returns.
Typical production cost structure of chemical commodities with mature technologies

Cost of feedstock dominates process economics hence: "Cracking Spread" in oil refining and "Crush Spread" in corn-ethanol

PROCESS SPREAD

Often underestimated or ignored in early evaluations

- Depreciation
- Cost of sales including distribution
- Fixed Costs
- Utilities
- Total Feedstock and consumables
Spread Analysis. Ethanol to higher value chemical.

Values adjusted for inflation. Sources: EIA-DOE, ICIS, Platts

Low oil is not killing the opportunity, but beware of feedstock producer economics!
Understanding the market

• New vs. drop-in molecule
  – Product sold on performance vs. specifications
    ▪ Specification pitfalls
  – Performance improvement of new molecule needs to sufficient to justify the cost of adoption
  – What is the value proposition across the supply chain?
  – Realistic market development time

• Market size
  – Overall market size
  – Impact of new production
  – Market balance
  – Market disposition
    ▪ Consumers/Users profile
    ▪ How the market is being served
  – Competitive dynamics and how they affect the price
  – Incumbent economics

• Impact of logistics, sales and distribution cost
  – Location
  – Domestic vs. Import
    – *Net back price* = *Sale price* – *cost of sales* – *distribution* – *end buyer discount*.

• Feedstock dynamics

• No “green” price premium but ”green” marketing advantage is possible

• Unlike fuels, chemicals are typically not sold in transparent over the counter cash markets, hence the determination of realistic market price is often not trivial
Incumbent economics: what drives their business and margin structure

- Example: Acetone production.
  - **MARGINAL ECONOMICS**: Acetone is co-product of phenol in the Cumene process. Phenol drives the economics which means that acetone producers can sell at 75% of propylene price and go break-even.
  - **IMPACT OF PORTFOLIO**: Because phenol is the profitability driver, they could push the price below current market value to keep market share.
  - **CAPITAL COST ADVANTAGE**: Fully depreciated plants or sunk capital
Waste economics. MSW example

- Is the landfill diversion opportunity really worth $30/ton?

- Not necessarily because landfill margins may allow to reduce the tipping fee to a level to make the diversion not competitive
  - This is the reason why many MSW to Power project eventually failed.

As soon someone can make money out of it is not really a waste. It becomes a commodity!
Market fragmentation. Same molecule. Delivered in many volumes and containers.

Few large and medium consumers > 5000 tpa
Railcar, truck, and ISO container delivery

Several medium consumers 5000 to 1000 tpa
Truck, and IBC containers, small delivery

Paints and Coatings 51.1%

Other (food, packaging, industrial solvents) 9.9%

Printing Ink 15.7%

Many small consumer <<1000 tpa
IBC containers. 55 gals drum
Very small deliveries

Pharmaceuticals 15.3%

Cosmetics 4.1%

Adhesives 4.1%
Chemical Distribution in a Nutshell

Producer price determination

• Use an index as a basis, e.g. ICIS when exist and detract.
  – Index prices are at best indicative of short term spot delivery
  – Index prices from market consultants are typically very optimistic
  – Different index may exist for different products
    ▪ e.g. cost plus when tied to a more transparent commodity

• Cost of sale
  – Commission paid to distributors
  – Typically either a discount on an agreed market price (7% to 10%) or a percentage of the actual gross sale price (4% to 8%)

• Distribution cost
  – Freight and logistics at least $80/ton on average
    ▪ US rail freight typically $50-70/ton
    ▪ Trans-loading costs $20-$40/ton
  – Higher for truck transportation and for smaller delivery systems
  – Repackaging, storage, demurrage, duties, insurance, interests, L/C, RTC leases....

• End user discount
  – Depends on volume and length of contract
    ▪ Large users (>5000 ktpa at least 12 month contract): index minus 20% to 30%
    ▪ Medium users (5000-1000 ktpa): index ~15%
    ▪ Small users (<1000 ktpa): index flat to -10%
Example: n-Butanol pricing

ICIS published price: >$1200/ton
Real net back as low as $650/ton

We conducted a thorough market study for n-Butanol. In general, there are various price tiers within the n-Butanol market. The very large consumers buy at a C3+20 cts/lb feedstock formula or a substantial discount of 20%+ from the ICIS publication. Medium-sized consumers are around ICIS-15% and smaller ones anywhere between ICIS flat and -15%, depending on how much they buy and how informed they are.

VP of large ($9 billion) chemical distributor

Do the economics work here?
Thank you for your attention!

Voyages of discovery are not made by seeing new place but by having new eyes

Marcel Proust