Modular Gasification

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Modular thinking - observations

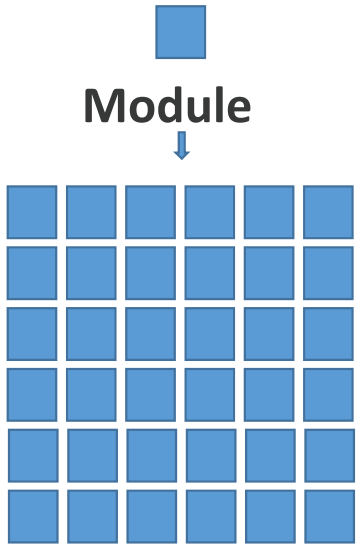
- Modular is often assumed to mean "small". Are these (below) modular ?
  - Great Plains Synfuel Plant – 14 Lurgi Gasifiers, each unit processes ~1300 ton/day lignite.[1] Each unit is 40 feet tall, processes ~ 220MWth eq. of coal.
  - The largest reciprocating engine power plant (2015) is 573 MW, using 38 engines.[2]

    If you wanted to operate this plant on gasified coal, should you build 38 gasifiers, or three?
    If you had a customer who wanted 20MW, what would you provide for a gasifier?

1 Great Plains Synfuels Plant, Factsheet, https://www.basinelectric.com/files/pdf/Fact-Sheets-Media-Kit/DGC-talking-points.pdf, coal rate based on 7100BTU/lb lignite
2 World's Largest Internal Combustion Engine Power Plant Inaugurated 04/29/2015 | Aaron Larson . Power Magazine http://www.powermag.com/worlds-largest-internal-combustion-engine-power-plant-inaugurated/

Why modular?

- **Existing practice to develop *large** gasification has been challenging:**
  - Financing first of a kind – costly!
  - Limited experience at large scale – technical improvements are costly.
  - Limited flexibility – you get what you built, for a long time.
- **Modular development offers possible advantages**
  - Single-module deployment provides experience, easier financing
  - Achieve scale by aggregation (right)
  - Flexible size and operation possible – binary additions/upgrades



AGGREGATION APPROACH

**"large"* means utility scale

Modular development and deployment – pathway and problems

- **A proposed pathway:**
  - Smaller module deployment will provide experience and profitable products (i.e., it will make money, it is not just a pilot to get to another larger device).
  - Large unit numbers achieve "economy of number"; mass manufacturing.
  - Aggregation will follow to create large-scale impact.

$$Unit\ Cost\ of\ Product \sim \frac{Capital\ Cost + Operating}{Unit\ Output}$$

Desired, but unlikely: ***Capital ~ Output***
Example of hot water tank: can't shrink thermostat

- **A real problem:**
  - Profitable at "small-scale" is challenging!

"Profit problem"

Solutions to the profit problem

Repeat unit engineering examples:
- Turbine combustors, fuel injectors
- Fluid bed air distributors
- Fuel cells
- Reciprocating engines
- Catalyst beds
- …..
- …..
- NOT gasifiers (?)

- **Solution #1**
  - The small module **IS** a pilot, forget about making it profitable.
  - Scale-up by aggregation (repeat unit engineering) is acceptable.
  - Does not achieve substantial experience with modules, mass manufacturing
- **Solution #2**
  - Focus on high-value applications for the small module
  - E.g., make fuel in Alaska, Rare Earth by-product, etc.
  - Does not achieve substantial experience with modules, mass manufacturing
- **Solution #3**
  - Establish a module size that is profitable – or, an aggregate size of one process.

Make diamonds!

$$Unit\ Cost\ of\ Product \sim \frac{Capital\ Cost + Operating}{Unit\ Output}$$