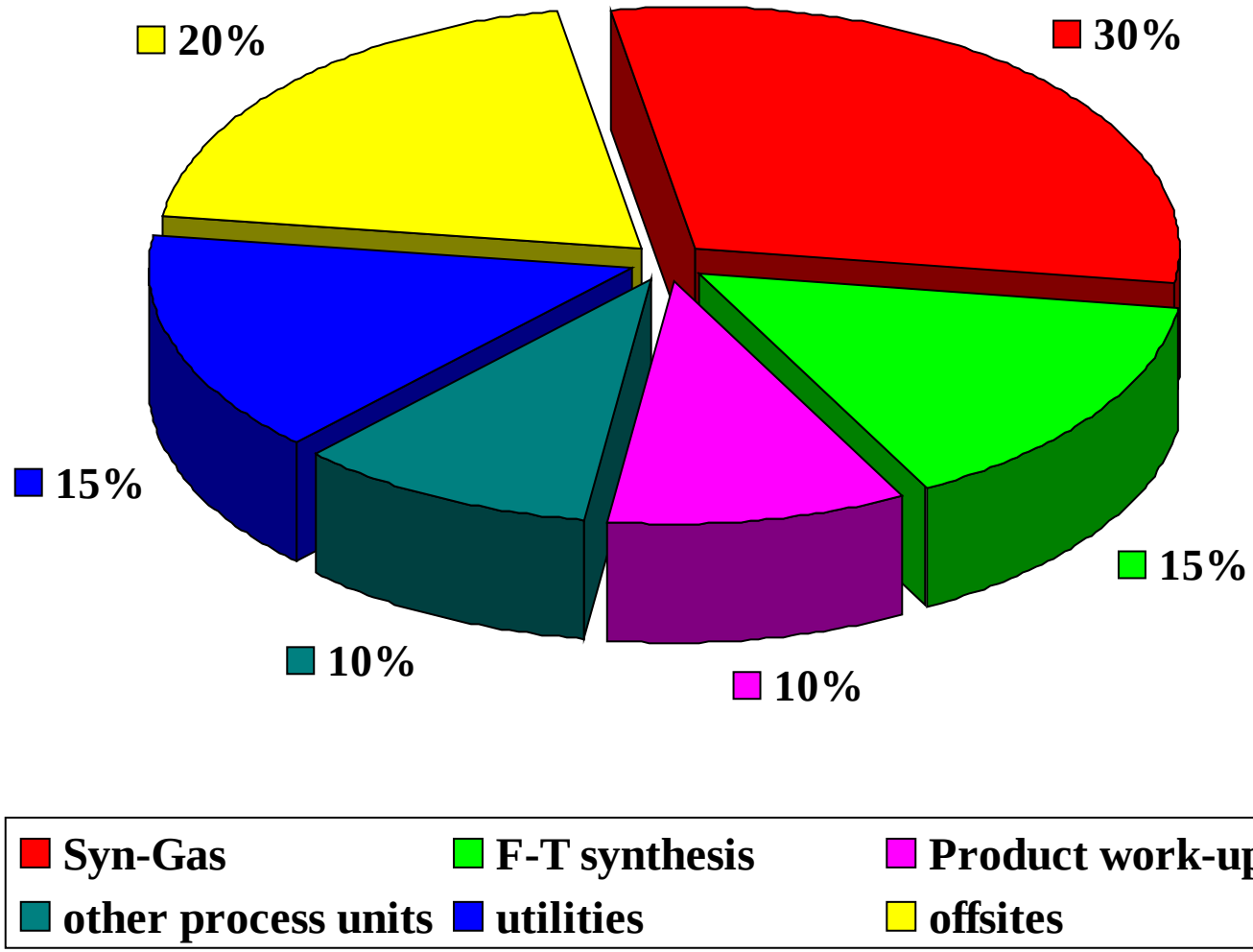
Are Small Scale GTL Plants Economic or Do They Just Require Less Capital

Many new F-T technology providers are touting small scale F-T plants as the answer. In general all they really do is require less capital to build but the actual cost per barrel of installed capacity is typically much larger. But you need gas reserves and gas deliverability to support the GTL plant. If you have little of each you can only build a small scale plant. In addition the operating costs of small scale plants are typically much higher. The obvious reason is that 10 people can run a 2,000 bbl/d plant or a 10,000 bbl/d plant or even a 15,000 bbl/d. The same holds true for utility and gas conditioning modules.

The real economic advantages or break throughs will occur with the commercial introduction of ceramic membrane to make syn-gas and catalyst technology that makes the finished F-T product in the reactor eliminating the costly third step, hydrocracking.

GTL Cost Breakdown



Scale of F-T Reactors

The next 3 charts show the size of a Sasol design 15,000 bbl/d slurry bubble column F-T reactor, a Shell 7,500 bbl/d fixed bed (tube) F-T reactor and a Velocys 125 bbl/d microchannel F-T reactor.

The Sasol 35,000 bbl/d Oryx plant has two F-T reactors costing well over $150 million each.

The Shell tube reactors in the 140,000 bbl/d Pearl GTL plant are smaller but will have 24 reactors.

The Velocys 1,400 bbl/d GTL Calumet plant has 8 175 bbl/d reactors costing about $1.3 million each

33’ Diameter, 196’ Tall, 2,200 tons can only be delivered via ship/barge at a tide water location

15,000 BBL/D Sasol F-T Reactor

Shell F-T Reactors at Pearl

3-core FT reactor 125 bbl/d

SMALL SCALE GTL PLANTS INDUSTRY LEADERS

The economic advantages or break through's in small scale GTL plants have occurred with the advances in 4 areas:

1. ***Commercial introduction of micro-channel F-T technology;***
2. ***High reactive cobalt catalysts;***
3. ***Mass production of F-T reactors; and***
4. ***Modular construction of the plants*.**

Two companies that are leading the way in this revolution:

- **Velocys PLC based in Houston, Texas**
- **Ventech Engineering based in Pasadena, Texas**

Modular Fabrication

Crude Topping Units ♦ Catalytic Reformers ♦ Naphtha Hydrotreaters ♦ Vacuum Units ♦ Gas Plants ♦ Diesel Production

As a pioneer in defining and utilizing modularization, Ventech employs modularization in the majority of our refinery units.

Ventech's 32-acre fabrication facility is ideal for the assembly and integration of piping, equipment, instrumentation, and electrical components necessary for quick, easy field installations.

- Competitive schedules, the world's fastest
- Capabilities engineered to your business needs
- Mechanical warranties
- Services available for erection, commissioning, and startup

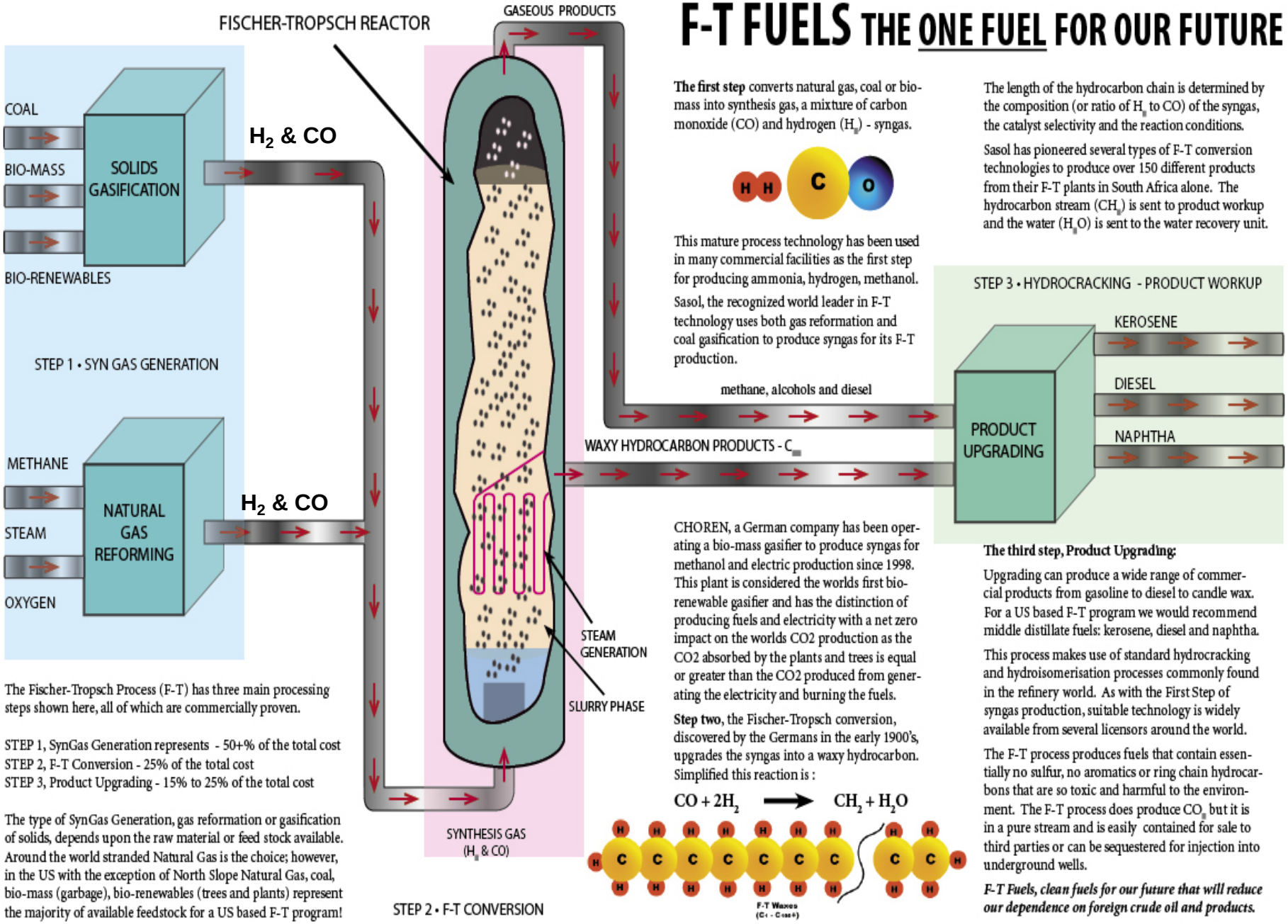
Benefits:
Optimally shorten project schedules, enhanced quality control, fieldwork reduction, elimination of weather delays, improved safety, reduced need for onsite skilled labor and specialized equipment, simplified logistics, and time and cost savings

Modularisation Partner: Ventech Engineers

- Full service EPC firm
- Proven world leader in modularisation of process units for the oil and gas industries
- Financial strength allows partnering and co-investing in projects

- Velocys is Ventech's preferred FT partner
- $2 million equity investment in OCG in November 2012
- Ordered reactors for **1,400 bpd** plant

F-T FUELS THE ONE FUEL FOR OUR FUTURE



The Fischer-Tropsch Process (F-T) has three main processing steps shown here, all of which are commercially proven.

STEP 1, SynGas Generation represents - 50+% of the total cost
STEP 2, F-T Conversion - 25% of the total cost
STEP 3, Product Upgrading - 15% to 25% of the total cost

The type of SynGas Generation, gas reformation or gasification of solids, depends upon the raw material or feed stock available. Around the world stranded Natural Gas is the choice; however, in the US with the exception of North Slope Natural Gas, coal, bio-mass (garbage), bio-renewables (trees and plants) represent the majority of available feedstock for a US based F-T program!

The first step converts natural gas, coal or bio-mass into synthesis gas, a mixture of carbon monoxide (CO) and hydrogen (H_2) - syngas.

This mature process technology has been used in many commercial facilities as the first step for producing ammonia, hydrogen, methanol.

Sasol, the recognized world leader in F-T technology uses both gas reformation and coal gasification to produce syngas for its F-T production.

CHOREN, a German company has been operating a bio-mass gasifier to produce syngas for methanol and electric production since 1998. This plant is considered the worlds first bio-renewable gasifier and has the distinction of producing fuels and electricity with a net zero impact on the worlds CO2 production as the CO2 absorbed by the plants and trees is equal or greater than the CO2 produced from generating the electricity and burning the fuels.

Step two, the Fischer-Tropsch conversion, discovered by the Germans in the early 1900's, upgrades the syngas into a waxy hydrocarbon. Simplified this reaction is :

The length of the hydrocarbon chain is determined by the composition (or ratio of H_2 to CO) of the syngas, the catalyst selectivity and the reaction conditions.

Sasol has pioneered several types of F-T conversion technologies to produce over 150 different products from their F-T plants in South Africa alone. The hydrocarbon stream (CH_2) is sent to product workup and the water (H_2O) is sent to the water recovery unit.

The third step, Product Upgrading:

Upgrading can produce a wide range of commercial products from gasoline to diesel to candle wax. For a US based F-T program we would recommend middle distillate fuels: kerosene, diesel and naphtha.

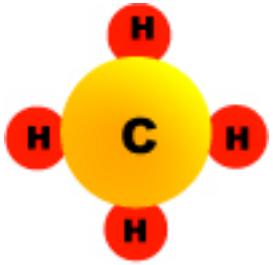
This process makes use of standard hydrocracking and hydroisomerisation processes commonly found in the refinery world. As with the First Step of syngas production, suitable technology is widely available from several licensors around the world.

The F-T process produces fuels that contain essentially no sulfur, no aromatics or ring chain hydrocarbons that are so toxic and harmful to the environment. The F-T process does produce CO_2 but it is in a pure stream and is easily contained for sale to third parties or can be sequestered for injection into underground wells.

F-T Fuels, clean fuels for our future that will reduce our dependence on foreign crude oil and products.

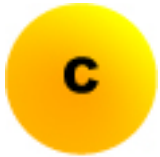
WHAT IS “SYN-GAS”?

In the F-T world syn-gas is carbon monoxide & hydrogen



CH4
methane

OR

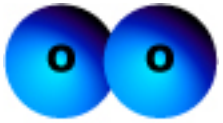


carbon

add

H2O
water
steam

plus



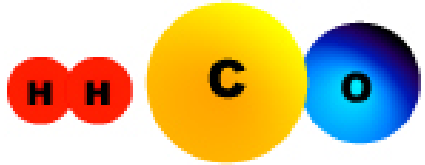
oxygen

OR

N_2 O_2

AIR
(78 % N_2 - 21 % O_2)

plus
heat



H2 + CO
syn-gas

SYNTHETIC DIESEL

F-T DIESEL BURNS
AS CLEAN AS CNG

U.S. EPA*
APPROVED

NON-TOXIC

ZERO SULFUR

ZERO AROMATICS

>70 CETANE

PM_{10} ≤ CNG

*EPA Water Docket, EB 57 located at 401 M Street SW Washington DC, 20460 Reference Docket No. W-98-26 in UNOCAL data file 4.A.a.3, Vol 13