

# Definitions

“Calculation Consistency is a Requirement”

- **Thermal Efficiency**
  - Products produced? Sold?
  - Power - Included? Excluded? How calculated?
    - Gross power produced?
    - Net power for sale?
- **Carbon Conversion Efficiency**
  - Products produced? Sold?
  - Usually excludes power

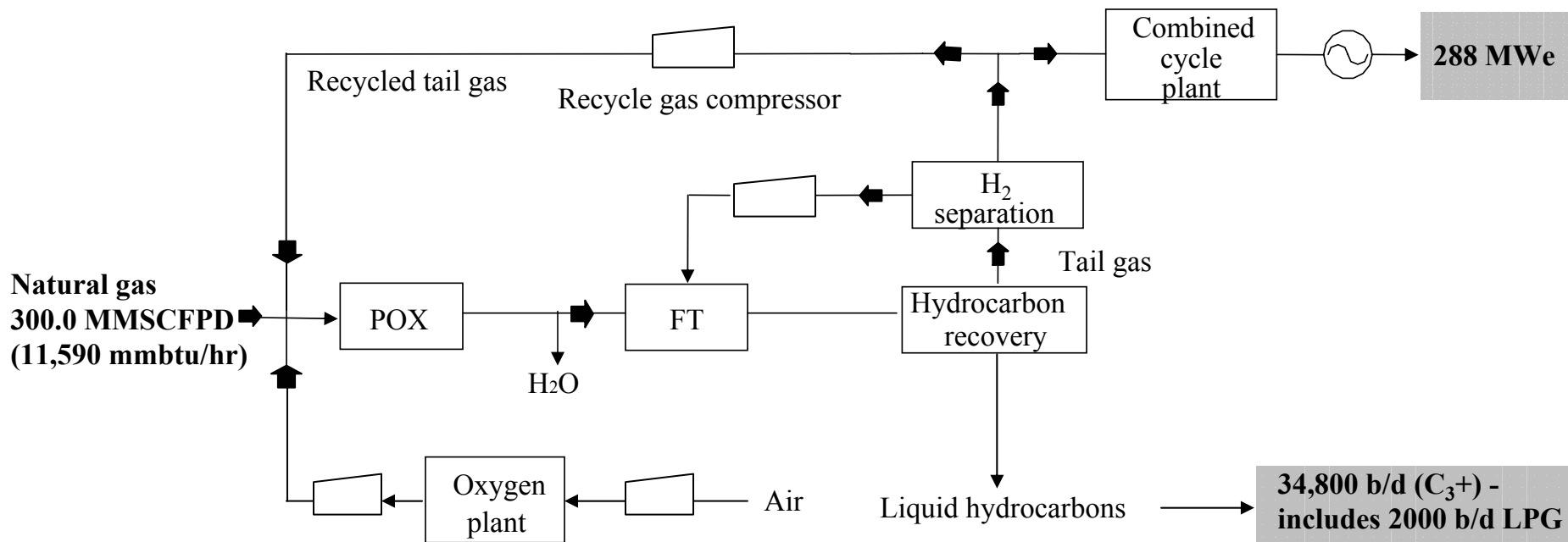
# Definitions

- Thermal Efficiency** = 
$$\frac{\text{Energy Contained in Products Produced (excluding power)}}{\text{Total Energy Fed to Process including any necessary fuel}}$$
- Thermal Efficiency** (including power) = 
$$\frac{\text{Energy Contained in Products Produced and Net Power available for sale to Third Party}}{\text{Total Energy Fed to Process including any necessary fuel}}$$
- Carbon Conversion Efficiency** (power usually excluded) = 
$$\frac{\text{Carbon (wt) in Products Sold/Produced}}{\text{Carbon (wt) Fed to Process including Carbon in any necessary fuel}}$$

# POX w/O<sub>2</sub>

(Rentech Technology)

## Example 1 (Refinery Setting C<sub>3</sub>+ Products)

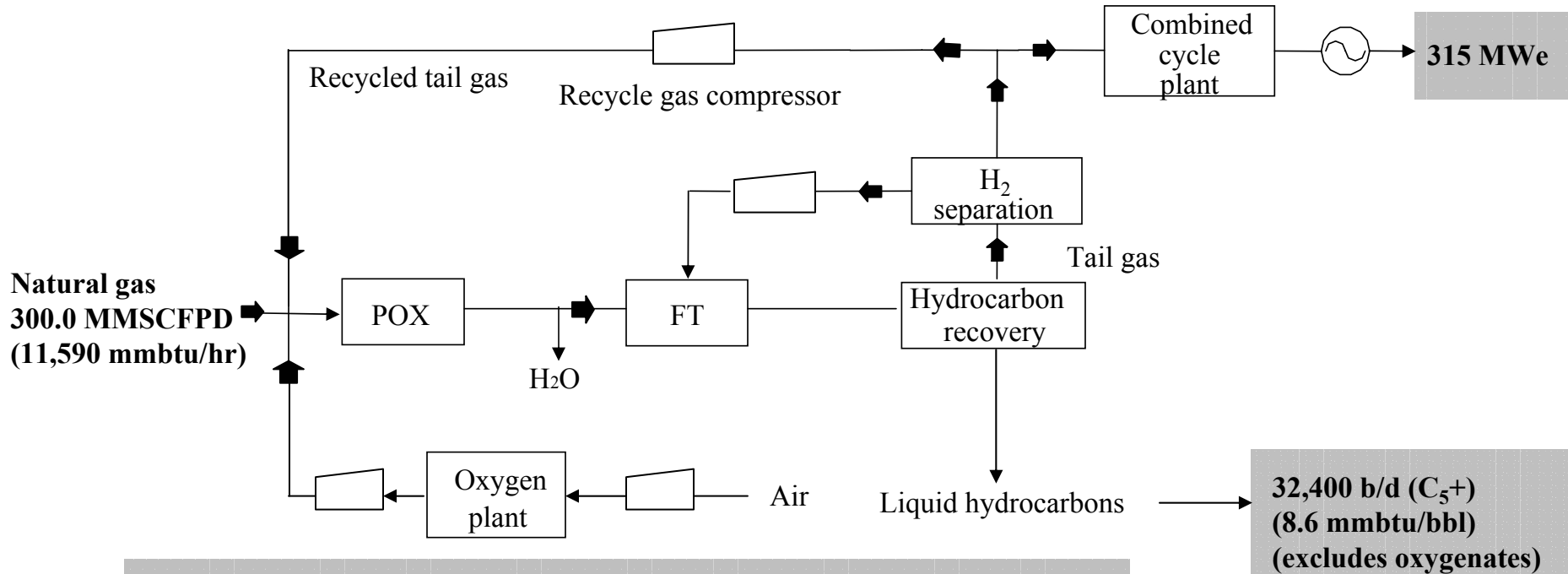


	Products	+ Power	= Total
	(Net)		
Thermal Efficiency =	63%	8%	71%
Carbon Efficiency =	80%		

34,800 b/d (C<sub>3</sub>+) - includes 2000 b/d LPG (8.0 mmbtu/bbl) (excludes oxygenates)

# POX w/O<sub>2</sub> (Rentech Technology)

## Example 2 (GTL/C<sub>5</sub>+ Products ?)



	Products	+ Power	= Total
	(Net)		
<b>Thermal Efficiency =</b>	<b>61%</b>	<b>9%</b>	<b>70%</b>
<b>Carbon Efficiency =</b>	<b>78%</b>		

# Comparison - FT Technologies

## Performance Summary

	Raytheon Study for PdVSA <sup>(1)</sup> (C <sub>5</sub> +)	Shell Estimates <sup>(2)</sup>	POx/O <sub>2</sub> (Rentech) (Chem Systems Report) <sup>(4)</sup> (C <sub>5</sub> +)
<b><i>Thermal Efficiency</i></b>			
Rentech	61%		61%
Syntroleum	44%		
SMDS	64%	62-65% <sup>(2)</sup>	
Others			
- Air-based process		40%	
- O <sub>2</sub> process		55%	
<b><i>Carbon Efficiency</i></b>			
Rentech	70%		78%
Syntroleum	51%		
SMDS	74%	78-82% <sup>(3)</sup>	
Others			
- Air-based process		50-55%	
- O <sub>2</sub> process		70%	
<b><i>(excludes power/water)</i></b>			

<sup>(1)</sup> Feedgas contained 8.5% (vol) CO<sub>2</sub>

<sup>(2)</sup> Source: Shell Gas & Power, presented at the CWC - Global GTL Summit 2001, 28 June 2001 London

<sup>(3)</sup> Current SMDS - Bintulu, Malaysia

<sup>(4)</sup> Chem Systems Report, Stranded Gas Utilization: *Methane Refineries of the Future*, dated January 2001

# Comparison of GTL Technologies

## Cost Summary

Study	Sasol	Shell	Exxon	Syntroleum	Conoco	Rentech
<i>Raytheon Engineers and Constructors, Inc.</i>						
Houston, TX						
Feb. 2000						
Location: USGC						
Location Factor: 1.0						
<b>Case I - 150 MMSCFD</b>						
Total HC Product (BPD)	15,290	17,343	17,000	12,000	—	<b>16,479</b>
TIC \$/daily BBL	\$25,800	\$30,000	\$29,000	\$37,920	—	<b>\$28,450</b>
ROI	14.5%	12.5%	12.9%	11.2%	—	<b>13.7%<sup>(1)</sup></b>
<b>Case II - 500 MMSCFD</b>						
Total HC Yield (BPD)	50,970	57,800	56,700	40,000		<b>54,930</b>
TIC \$/daily BBL	\$20,385	\$26,000	\$24,000	\$31,450		<b>\$23,100</b>
<b>ROI</b>	16.7%	13.2%	14.3%	10.7%		<b>15.4%<sup>(1)</sup></b>

<sup>(1)</sup> No credit for export power