PEP Reports 148B and 148C with **iPEPSyngas Module**

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October 2017

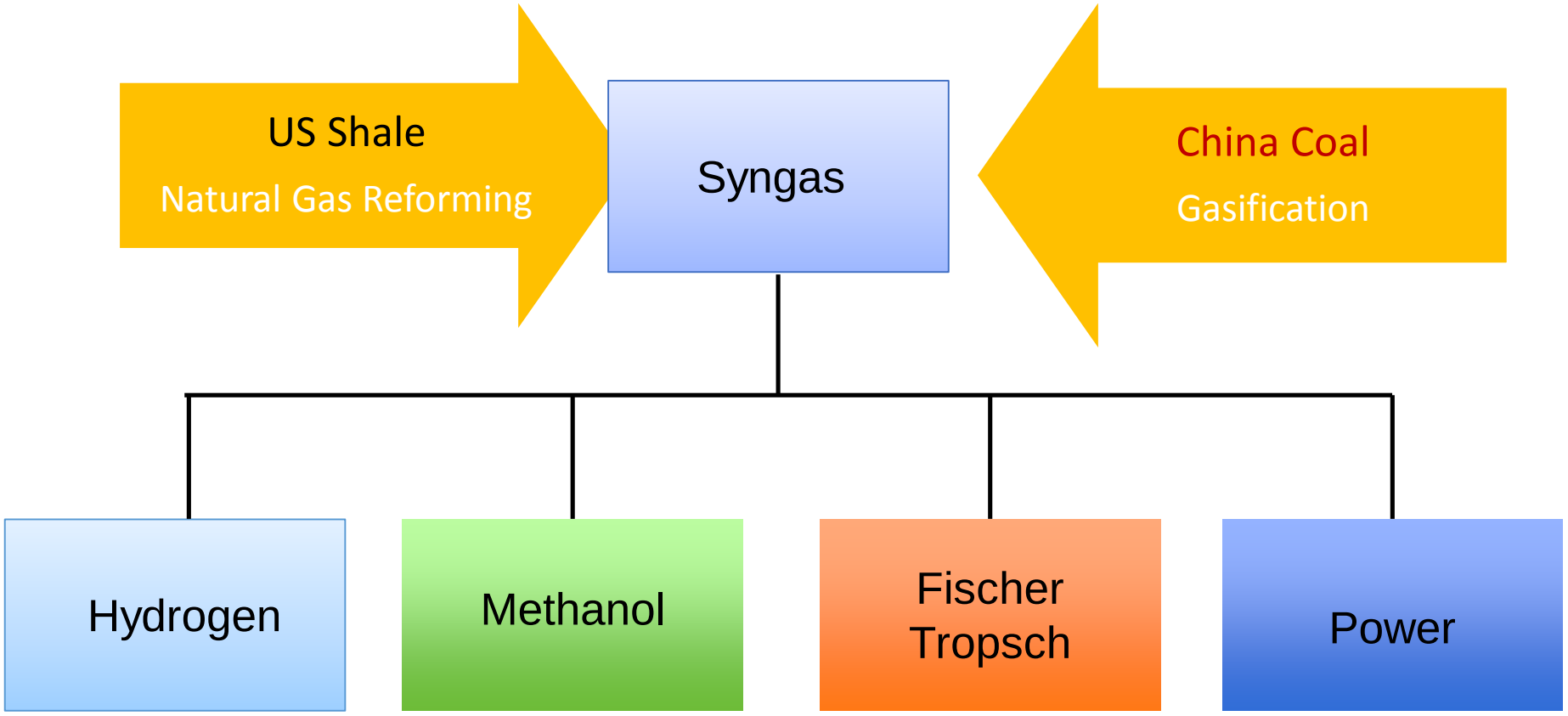
Process Economics Program

IHS Markit

Synthesis Gas (Syngas) Introduction

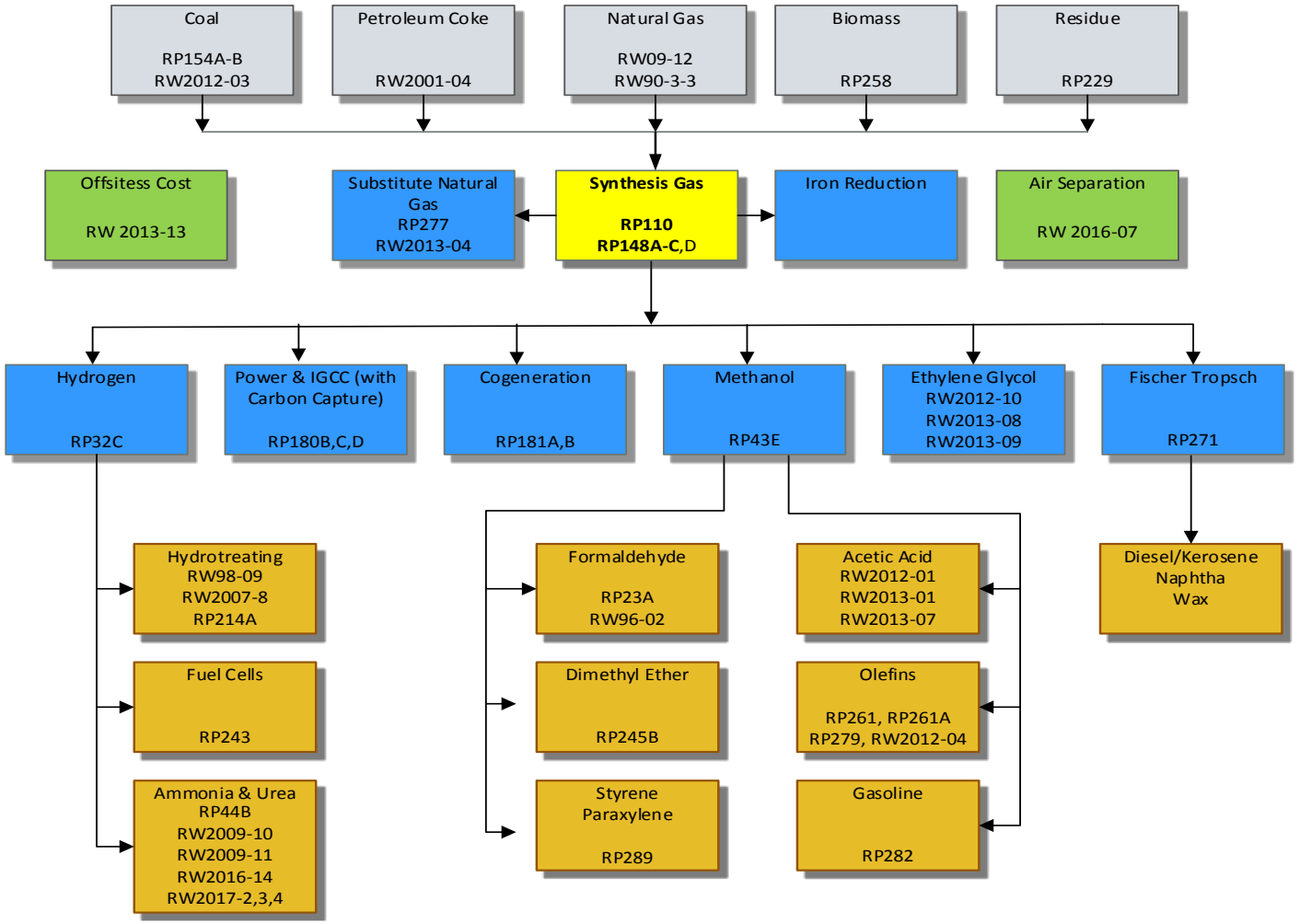
- Syngas is a gaseous mixture of mainly hydrogen and carbon Monoxide, but most of time with some carbon dioxide.
- Syngas are produced by gasification of coal, petroleum coke, biomass, and oil residue or reforming of natural gas,
- Syngas is the key chemical intermediate for a wide range of clean fuels and C1, C2, and C3 based high value chemicals.
- The increasing natural gas supply in North America and increasing coal gasification capacity in China will compete as the dominant feedstock for syngas production in the next 5-10 years.
- Syngas production economics of coal gasification vs. natural gas reforming is the key factor in deciding the competitiveness of the chemicals and fuels from the two feedstocks.
- What will India do?

US Shale vs. China Coal

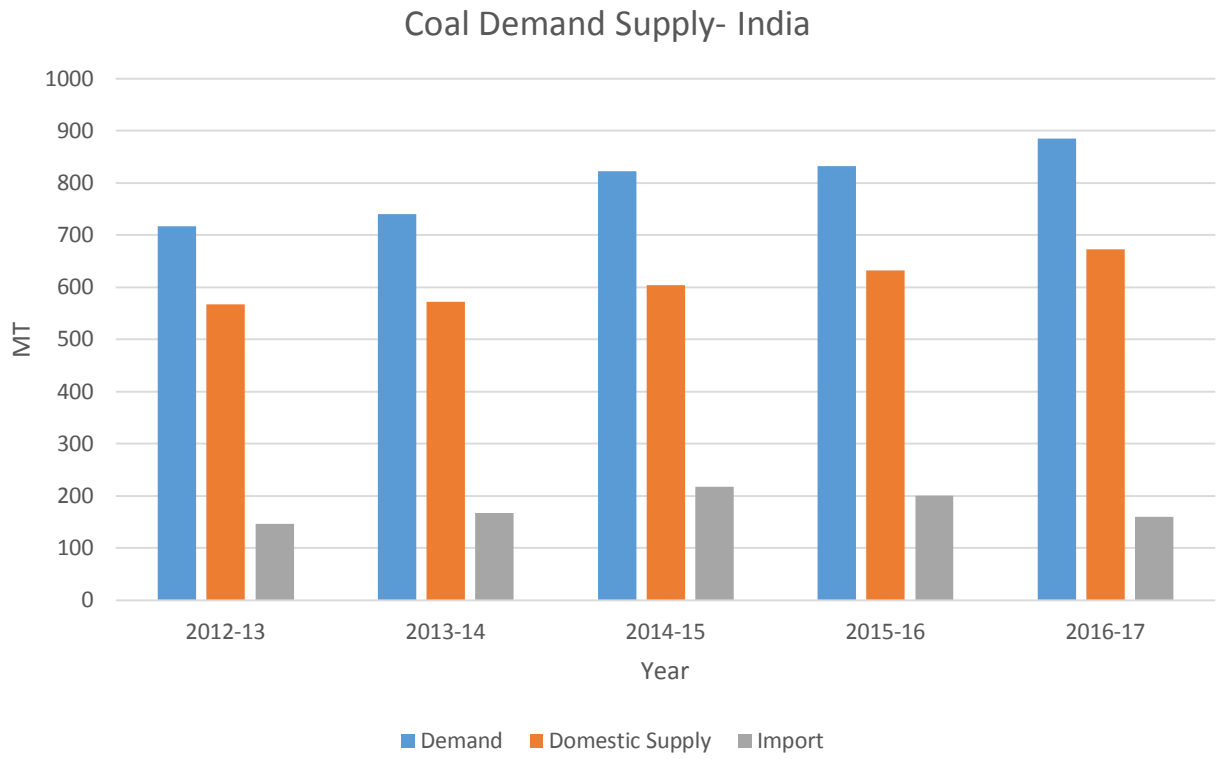


- **Industry needs a quick way to compare syngas production costs from natural gas vs. coal.**
- **Refinery is interested in monetizing petroleum coke**

Process Economics Program - Syngas Value Chain Portfolio



India Coal Summary



Source IHS Markit, Ministry of Coal

India - Typical quality specifications of thermal coal

Parameter	Specifications
Ash Content	25 - 50%
Moisture Content	7 - 18%
Volatile Matter	19 - 31%
Sulphur Content	0.1 – 1.0%
Gross Calorific Value (kCal/kg)	3,100 - 4,900

Source: IHS Markit, MoC

What PEP Offers:

A two-report bundle with an interactive process economics module:

- Report 148B: Syngas Production from Natural Gas Reforming
- Report 148C: Syngas Production from Coal or Petroleum Coke Gasification
- iPEP Syngas Interactive Data Module

The two reports provide basis, methodology, and detailed process design and economics assessment of various production processes.

The iPEP module allows a user to quickly extract and compare production economics of various technologies and feeds.

Syngas Interactive Data Module- included with PEP 148B and 148C

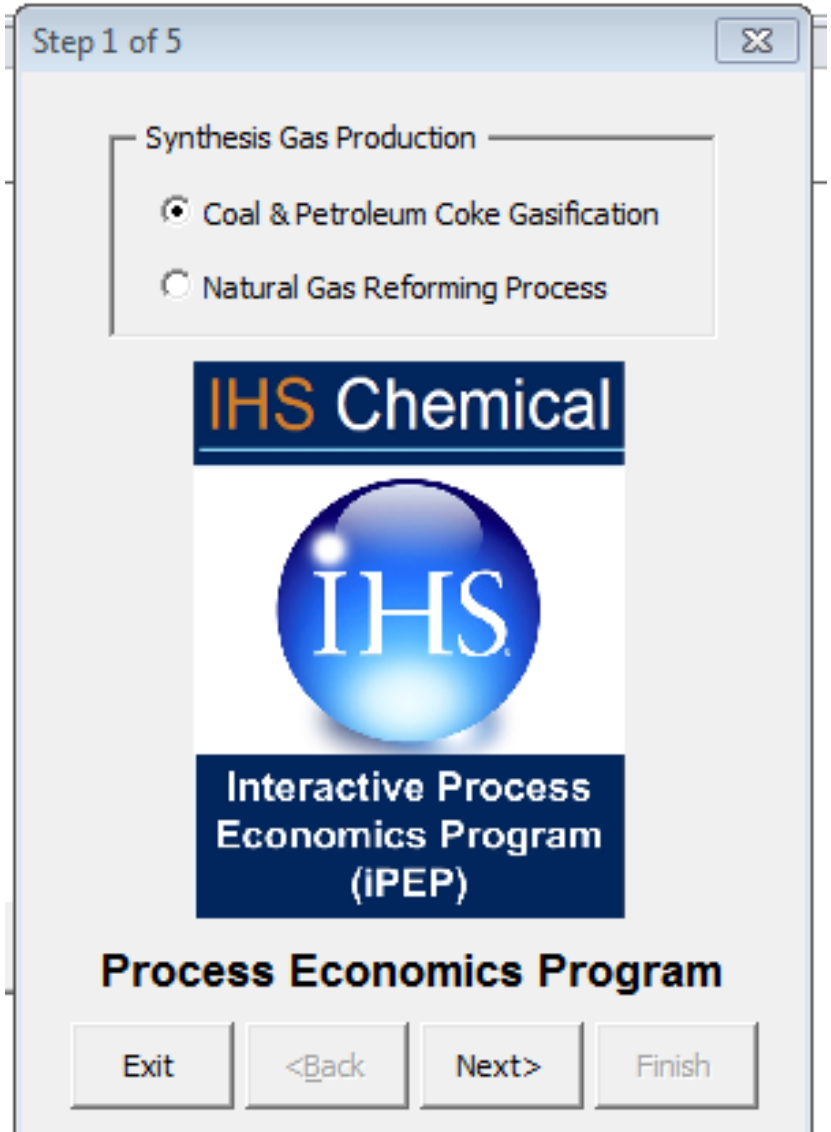
Features

- Syngas production from natural gas, coal and petroleum coke
- Include 4 natural gas reforming technologies from various licensors
- Include 5 leading entrained flow gasifiers with choice of operating pressures, 3 grades of coal or petroleum coke

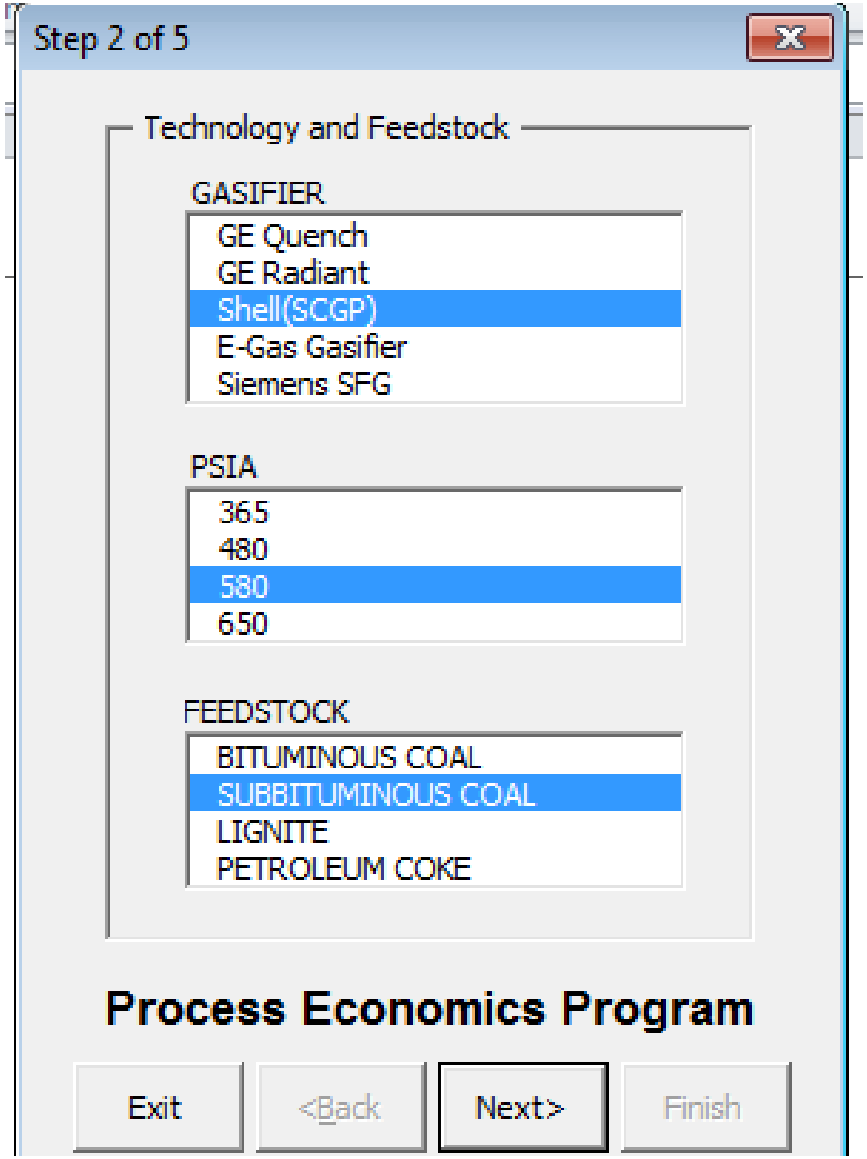
Benefits

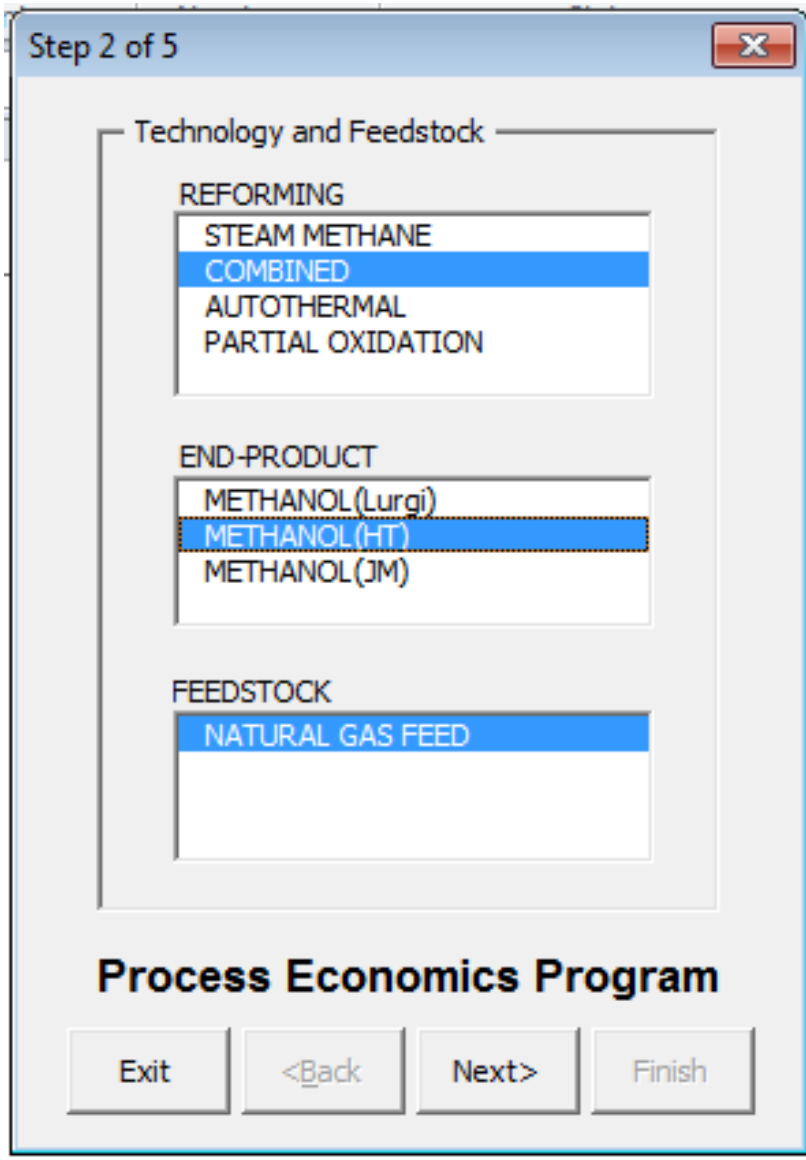
- Quick direct economics comparison between natural gas reforming and coal gasification, useful for competitiveness analysis
- Allow assessment of petroleum coke monetization
- Compare economics of four natural gas reforming technologies from various licensors
- Maximum flexibility in comparing various gasifier/coal grade or petroleum coke combinations at different operating conditions

Quickly Generate and Compare Syngas Production Economics from Coal Gasification and Natural Gas Reforming

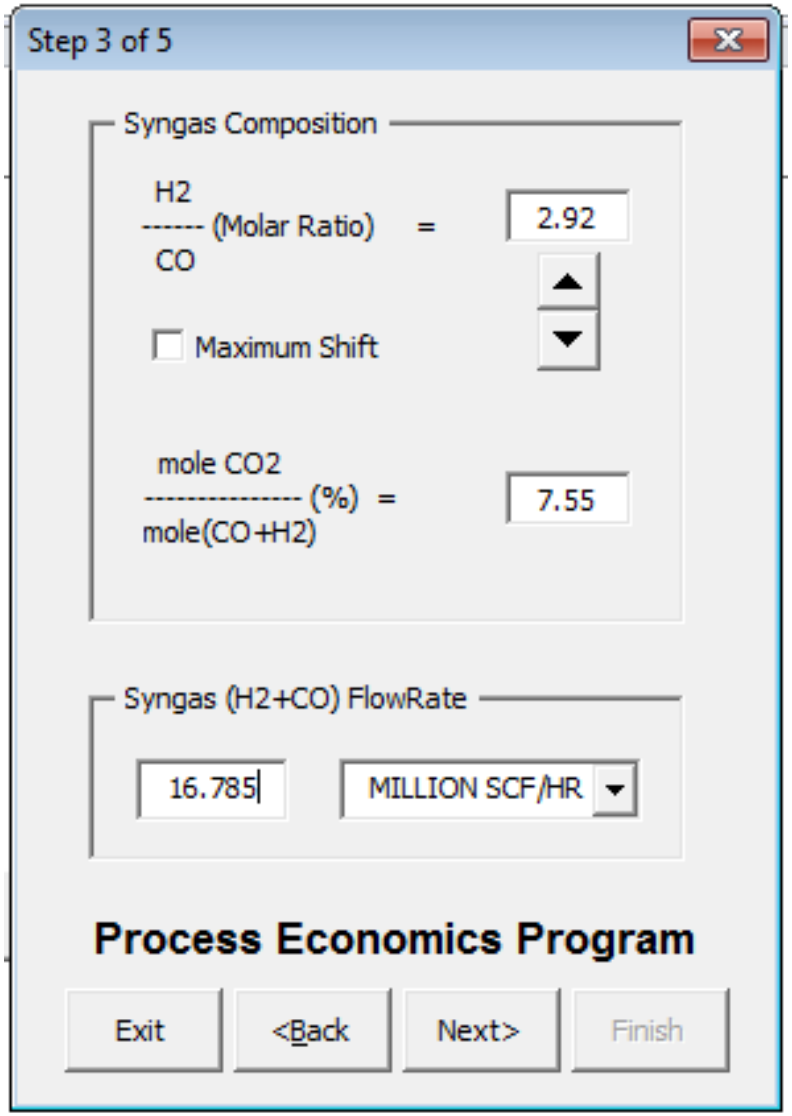


Coal Gasification: selection of gasifiers / coal grades and petcoke
Natural Gas- choice of reforming technologies / licensors





Can specify a wide range of syngas composition and quantity depending on end product requirements



Typical Syngas Ratio (H_2/CO) for Intended End-Products

Intended product	Typical H_2 / CO Ratio
Hydrogen	Maximum H_2
Methanol	$(H_2\text{-}CO) / (H_2+CO_2) = 2.05$
Fischer-Tropsch Synthesis	H_2 / CO = 2.0
Ammonia	N2:H2= 3

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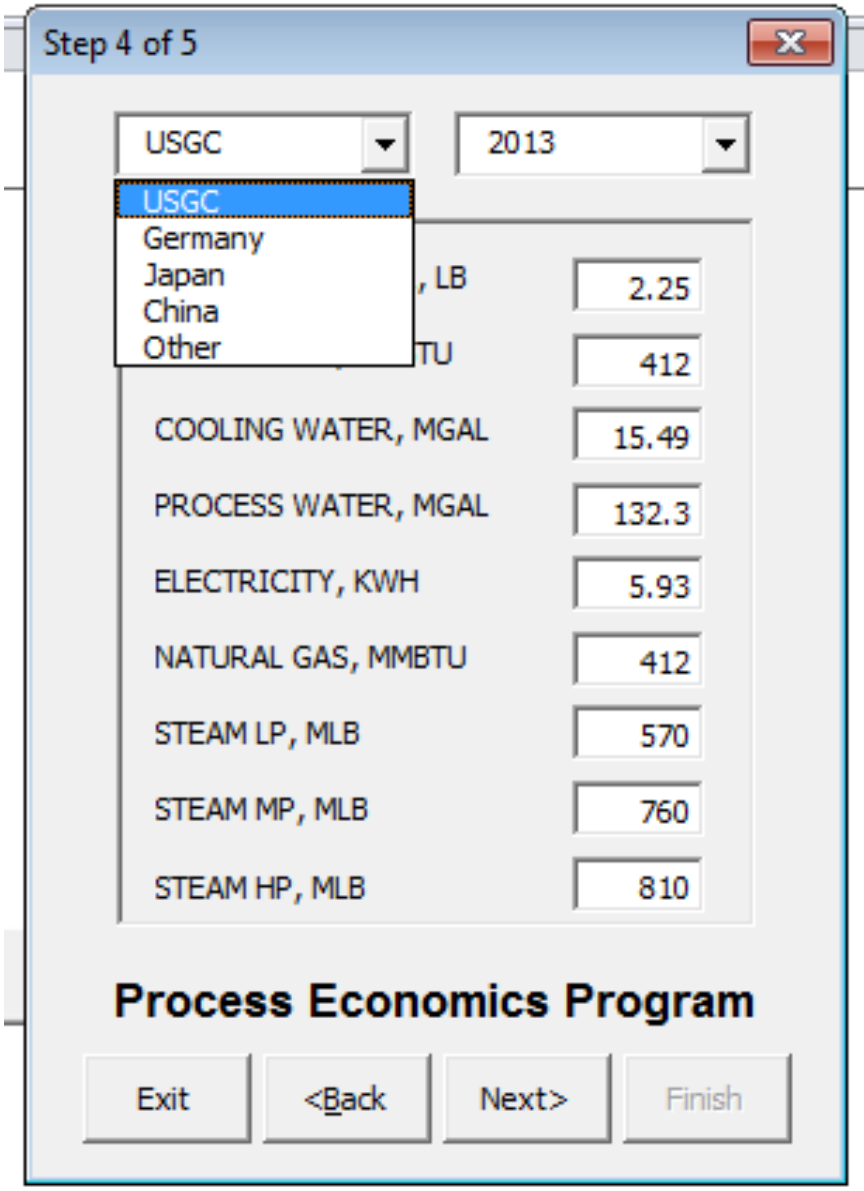
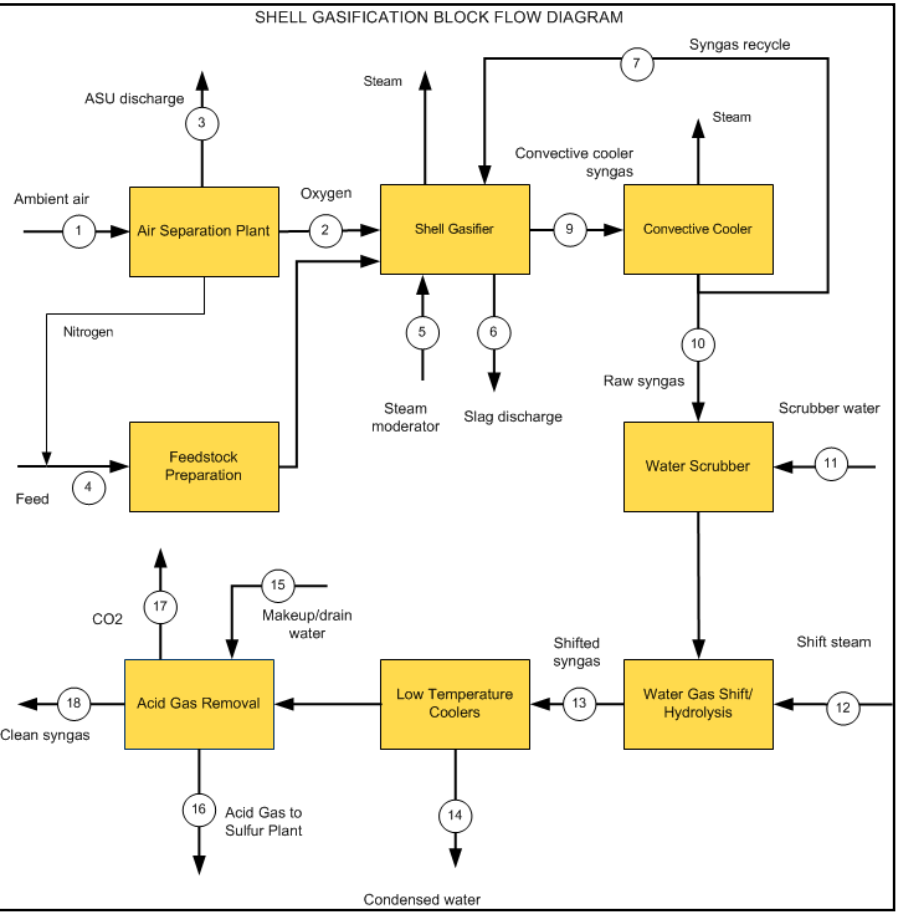
Selection of plant location with built-in feedstock and utility price, but can be over-written by client's numbers

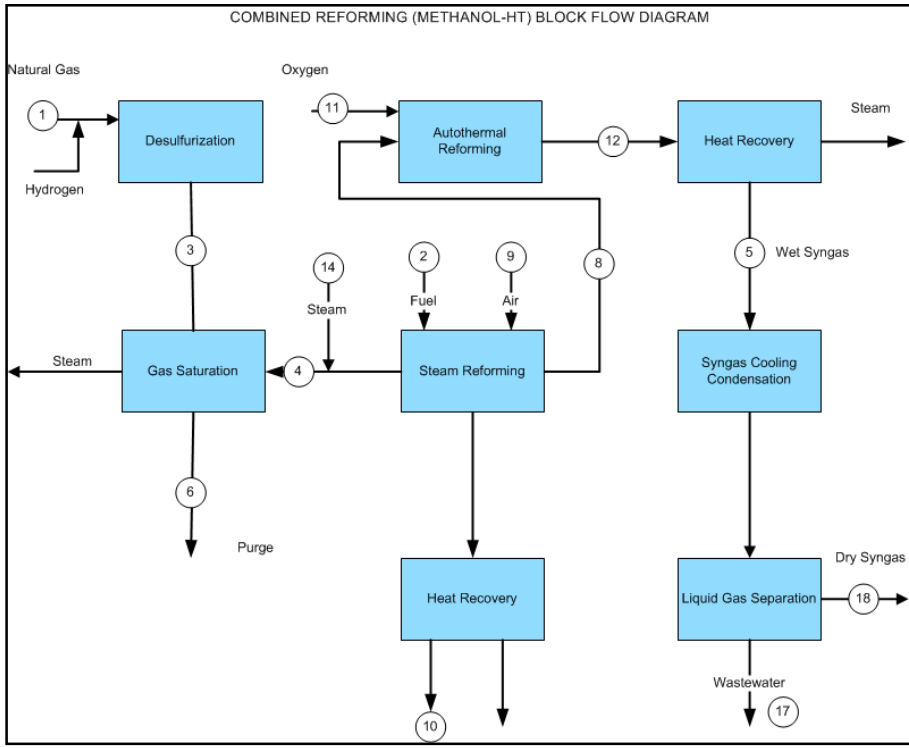


Each process economics module consists of six output files. 1. Process Block Flow with Stream Numbers

Shell Gasification



Haldor Topsoe Combined Reforming



2. Stream table with composition (partial List)

SYNTHESIS GAS FROM SUBBITUMINOUS COAL VIA SHELL(SCGP) GASIFIER (580 PSIA)

		Mol Wt	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
CO		28.01	--	--	--	--	--	--	930,603	--	1,735,199
CO2		44.01	980	--	980	--	--	--	331,262	--	617,670
CH4		16.04	--	--	--	--	--	--	50	--	93
H2		2.02	--	--	--	--	--	--	42,062	--	78,429
H2S		34.02	--	--	--	--	--	--	2,168	--	4,042
O2		32	492,736	492,637	98	--	--	--	--	--	--
H2O		18.02	13,496	--	13,496	--	84,614	--	287,387	--	535,861
COS		60.07	--	--	--	--	--	--	207	--	386
N2		28.01	1,607,343	693	1,606,650	82,499	--	--	102,534	--	191,184
Ar		39.95	27,612	1,482	26,130	--	--	--	1,714	--	3,196
Feed			--	--	--	846,139	--	--	--	--	--
Slag			--	--	--	--	--	39,989	--	--	--
Total	lb/hr		2,142,166	494,812	1,647,354	928,637	84,614	39,989	1,697,987	--	3,166,060
Pressure	psia		15	725	75						580
Temp	F		59	258	59	77	738	212	800		2,552

3. Utility Summary by Process Sections

SYNTHESIS GAS FROM SUBBITUMINOUS COAL VIA SHELL(SCGP) GASIFIER (580 PSIA)

AVERAGE CONSUMPTIONS	UNIT	BATTERY LIMITS TOTAL	SECTION 100	SECTION 200	SECTION 300
COOLING WATER	GPM	96,808	18,151	--	78,657
PROCESS WATER	GPM	449	--	--	449
ELECTRICITY	KW	96,308	79,351	16,265	692
NATURAL GAS	MM BTU/HR	18	--	--	18
STEAM LP	M LB/HR	19	--	--	19
STEAM MP	M LB/HR	86	--	85	1
STEAM HP	M LB/HR	--	--	--	--
STEAM LP	M LB/HR	-3	--	--	-3
STEAM MP	M LB/HR	-237	--	-232	-5
STEAM HP	M LB/HR	-1,285	--	-1,285	--

4. Capital Cost Estimate

SYNTHESIS GAS FROM SUBBITUMINOUS COAL VIA SHELL(SCGP) GASIFIER (580 PSIA)

	COST $1,000
BATTERY LIMITS EQUIPMENT, FOB	
REACTORS	341,661
HEAT EXCHANGERS	100,588
PUMPS	11,845
TOTAL EQUIPMENT	454,095
DIRECT INSTALLATION COSTS	195,261
AIR SEPARATION UNIT	58,221
FEED PREPARATION	112,989
GAS CLEANUP UNIT	57,558
INDIRECT COSTS	175,625
UNSCHEDULED EQUIPMENT, 10%	105,375
BATTERY LIMITS, INSTALLED	1,159,122
CONTINGENCY 25%	289,781
BATTERY LIMITS INVESTMENT	1,448,903
OFFSITES INSTALLED	
CLARIFIED WATER	2,085
COOLING WATER	15,022
PROCESS WATER	2,616
BOILER FEED WATER	4,013
STEAM	25,269
TANKAGE	1,363
UTILITIES & STORAGE	35,345
GENERAL SERVICE FACILITIES	148,425
WASTE TREATMENT	72,445
TOTAL	256,215
CONTINGENCY, 25%	64,054
OFF-SITES INVESTMENT	320,269
TOTAL FIXED CAPITAL	1,769,172

5. Variable Costs Summary

SYNTHESIS GAS FROM SUBBITUMINOUS COAL VIA SHELL(SCGP) GASIFIER (580 PSIA)

	UNIT COSTS	CONSUMPTION PER MSCF	¢/MSCF
SUBBITUMINOUS COAL	0.7¢/LB	50.388LB	35.27
AGR SOLVENT	1,000¢/LB	0.00075LB	0.75
SHIFT CATALYST	1,800¢/LB	0.00076LB	1.37
OTHER CHEMICALS			3.74
GROSS RAW MATERIALS			41.13
SLAG DISPOSAL	-0.5¢/LB	-2.3814LB	1.19
SULFUR	7.75¢/LB	-0.11102LB	-0.86
TOTAL BY-PRODUCTS			0.33
COOLING WATER	15.49¢/MGAL	346GAL	5.36
PROCESS WATER	132¢/MGAL	1.6043GAL	0.21
ELECTRICITY	5.93¢/KWH	5.7352KWH	34.01
NATURAL GAS	412¢/MMBTU	1,072BTU	0.44
STEAM LP	570¢/MLB	1.1315LB	0.64
STEAM MP	760¢/MLB	5.1213LB	3.89
STEAM HP	810¢/MLB	--LB	0.00
STEAM LP	570¢/MLB	-0.17865LB	-0.10
STEAM MP	760¢/MLB	-14.113LB	-10.73
STEAM HP	810¢/MLB	-76.522LB	-61.98
TOTAL UTILITIES			-28.26

6. Production Costs at three production capacities

SYNTHESIS GAS FROM SUBBITUMINOUS COAL VIA SHELL(SCGP) GASIFIER (580 PSIA)

CAPACITY(MILLION MSCF/YR)*	**66.20**	**132.40**	**264.80**
INVESTMENT($ MILLIONS)			
BATTERY LIMITS (BLI)	910.60	1,449	2,305
OFFSITES	163.40	320.00	609.00
TOTAL FIXED CAPITAL (TFC)	1,074	1,769	2,914
PRODUCTION COSTS(¢/MSCF)			
RAW MATERIALS	41.13	41.13	41.13
BY-PRODUCTS	0.33	0.33	0.33
UTILITIES	-28.26	-28.26	-28.26
VARIABLE COSTS	13.20	13.20	13.20
OPERATING LABOR, $46.23/HR	12.23	6.12	3.06
MAINTENANCE LABOR, 1.6%/YR OF BLI	22.01	17.51	13.93
CONTROL LAB LABOR, 20% of OPER LABOR	2.45	1.22	0.61
LABOR COSTS	36.69	24.85	17.60
MAINTENANCE MATERIALS, 2.4%/YR OF BLI	33.01	26.27	20.89
OPERATING SUPPLIES, 10% of OPER LABOR	1.22	0.61	0.31
TOTAL DIRECT COSTS	84.12	64.93	52.00
PLANT OVERHEAD, 80% TOTAL LABOR	29.35	19.88	14.08
TAXES AND INSURANCE, 2%/YR OF TFC	32.45	26.72	22.01
PLANT CASH COSTS	145.92	111.53	88.09
DEPRECIATION, 10%/YR OF TFC	162.24	133.61	110.05
PLANT GATE COST	308.16	245.14	198.14
G&A, SALES, RESEARCH	29.03	23.45	19.12
NET PRODUCTION COST	337.19	268.59	217.26
ROI BEFORE TAXES, 15%/YR OF TFC	243.35	200.42	165.07
PRODUCT VALUE	580.54	469.01	382.33

Value Proposition

- The battle between US shale gas and China coal for syngas based chemical production depends on the economics of syngas production from each feedstock.
- The two new detailed reports issued by IHS Chemical on syngas production: PEP148B and 148C with an included interactive iPEPSyngas module can help you to make a quick economics-based comparison of natural gas reforming and coal gasification projects;.
- The report package will also help refineries to assess petroleum coke monetization opportunities.
- With natural gas reforming, it can compare the economics of four technologies from various licensors
- With gasification, it can compare the economics of five entrained flow gasifiers with three grades of coal and petcoke

Meet the Authors

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