Annexure

Annexure-A

SEMI-STRUCTURED INTERVIEW SCHEDULE
FOR STUDY ON
STRATEGIC INVESTMENT DECISIONS IN PETROCHEMICAL SECTOR: A COMPARATIVE STUDY OF GCC COUNTRIES

Purpose: Collection of preliminary information about company and its project management and finance departments
Target source: Official or manager responsible for strategic planning, project management or similar functions in the organization at the senior level
Estimated time for interviewing: Flexible schedule ranging from one to two hours

1. Could we start our discussions by talking about the formal and informal systems used for idea generation in your company? (There could be formal systems such as creating a management committee or planning department, setting up management audit system or establishing consultation mechanisms with external experts. The informal systems could be encouraging employees to suggest ideas through a suggestion box scheme, setting up an innovation committee or task force, utilizing the quality circles for generation of new ideas.)

2. Do you attempt to identify project ideas related to the perceived core competencies of your company?

3. Do you identify certain criteria for screening of project ideas? If yes, then are such criteria related to issues such as payback period, compatibility with the core competencies, further earning potential, favorable government policy or personal choice of the CEO and dominant strategists?

4. Could you please describe the process used for short-listing the viable project ideas?

5. Do you apply strategic modeling approach in strategic planning?

6. Does the information derived out of strategic modeling guide the strategic investment decision process?

7. Do you have mechanism in place for scanning the external environment prior to reaching a strategic investment decision? For instance, do you monitor the economic, financial, market, technical environment and perform a social-cost benefit analysis?

8. Which department or function is responsible for managing the process of strategic investment decision in your Company?
9. Which official(s) functionaries are responsible for managing the process of strategic investment decision?

10. What approach is adopted for reaching the final strategic investment decision? For instance, do you use the top- down approach, bottom-up approach or an iterative approach?

11. In what form is the final go-ahead signal given for the implementation of strategic investment decision? (Suggested means for giving the go-ahead could be: creation of a project organization, allocation of budget, putting in place the project structure, or a combination of all these implementation steps)

12. Do you have project planning and project scheduling before implementation?

13. There are several elements included in project implementation such as identification of key return areas, creation of positions and designations, creation of the administrative system, and acquisition and merger of assets. Do you include some or all of these elements in project implementation?

14. Do you have risk management system in place?

15. Do you adopt formal or informal risk assessment techniques?

16. What is the system of assessing the return from project? In terms of quality and in terms of time horizon?

17. What means are adopted to manage/ balance the trade-off between risk and return?

18. What means are adopted for monitoring and control of on-going projects?

19. Do you have contingency planning in place?

20. Would you like to say anything else regarding the issues that we discussed?

Thank you very much for your time and cooperation!

Annexure-B

Material and data presented here have been used for the Comparison of Cost Competitiveness. A summary of cost calculation is presented as section 6.3 of Chapter-6.

1. Basic Assumption of the Production Cost Calculations

The basic assumptions of the production cost calculations used in this section are given bellow. The relevant factors on which fixed costs and variable costs were based are summarized in Tables A1.1 to A1.4

Plant Completion and Production capacity (base case)

To compare cost competitiveness, the 2005 production cost of ethylene and ethylene derivatives were calculated for hypothetical petrochemical plants. For which, it is assumed that construction started in 2002 and commissioned in 2004).

Table A1.1 Premises for fixed cost estimations (for Middle East) (Ethylene, MEG and LLDPE- by feedstock and country)

Country	Saudi Arabia			Qatar	Iran	
ETHYLENE PLANT Feedstock for ethylene	**ETN**	**PPN**	**A-180**	**ETN**	**ETN**	**FR-Nap**
Production Capacity(ETY) *MT/y*	1,200	1,200	800	1,200	1,200	800
Production Capacity(ETY+PPY) *MT/y*	1,226	1,584	1,104	1,226	1,226	591
Construction Cost(ISBL) *$ million*	606	745	611	630	653	423
Construction Cost(OSBL) *$ million*	303	373	306	315	327	212
Total Construction Cost *$ million*	909	1,118	917	944	980	635
Number of operating personnel	74	84	100	74	74	150

Country	Saudi Arabia		Qatar		Iran	
DOWNSTREAM PRODUCT PLANT	**MEG**	**LLDPE**	**MEG**	**LLDPE**	**MEG**	**LLDPE**
Capacity *MT/y*	600	400	600	400	600	400
Construction Cost(ISBL) *$ million*	245	153	254	165	264	165
Construction Cost(OSBL) *$ million*	122	76	127	83	132	83
Total Construction Cost *$ million*	367	229	382	248	396	248
Number of operating personnel	44	45	44	45	44	45

Country		Saudi Arabia	Qatar	Iran
COMMON FACTOR FOR THE COUNTRY				
Location factor vs USA	*ratio*	1.02	1.06	1.10
Year of construction awarded	*year*	2002	2002	2002
Year for cost calculation	*year*	2005	2005	2005
Depreciation	*year*	20	15	15
Interest for initial investment	%	4	4	6
Interest for working capital	%	2	2	7.5

ETY: Ethylene, PPY: Propylene, A-180: Trade name of NLG in Saudi Arabia, FR-Nap: Full range naphtha ISBL: in side battery limit, OSBL: outside battery limit; MT/y million ton per year

Table A1.2 Premises for fixed cost estimations (for USA, Japan & China) (Ethylene, MEG and LLDPE- by feedstock and country)

Country		USA			Japan	China
ETHYLENE PLANT Feedstock for ethylene		**ETN**	**PPN**	**N. Gasoline**	**FR-Nap**	**FR-Nap**
Production Capacity(ETY)	*MT/y*	800	800	800	800	800
Production Capacity(ETY+PPY)	*MT/y*	818	1,056	1,104	1,182	1,182
Construction Cost(ISBL)	*$ million*	447	550	599	713	4
Construction Cost(OSBL)	*$ million*	224	275	300	356	238
Total Construction Cost	*$ million*	671	825	899	1,069	713
Number of operating personnel		39	43	39	48	180

Country		USA		Japan		China	
DOWNSTREAM PRODUCT PLANT		**MEG**	**LLDPE**	**MEG**	**LLDPE**	**MEG**	**LLDPE**
Capacity	*MT/y*	600	400	300	400	300	400
Construction Cost(ISBL)	*$ million*	240	150	168	171	112	114
Construction Cost(OSBL)	*$ million*	120	75	84	86	56	57
Total Construction Cost	*$ million*	360	225	253	257	168	171
Number of operating personnel		38	32	38	33	90	65

Country		USA	Japan	China
COMMON FACTOR FOR THE COUNTRY				
Location factor vs USA	*ratio*	1.00	1.14	0.76
Year of construction awarded	*year*	2002	2002	2002
Year for cost calculation		2005	2005	2005
Depreciation	*year*	15	15	15
Interest for initial investment	%	5	7	7
Interest for working capital	%	3	6	7.5

ETY: Ethylene, PPY: Propylene, N-gasoline: Natural Gasoline as NLG called in USA, FR-Nap: Full range naphtha; ISBL: in side battery limit, OSBL: outside battery limit; MT/y million ton per year

Table A1.3 Major unit requirements ethylene by feedstock (Common for all countries)

Materials		Ethane	EP Mix 70:30	EP Mix 50:50	Propane	L-Nap	FR-Nap
Unit energy consumption *k-cal/kg-ETY*		3,100	3,370	3,550	4,000	4,800	4,900
Unit requirement of raw material *t/t ETY*		1.225	1.405	1.558	2.140	2.564	2.898
Product	ETY	1.000	1.000	1.000	1.000	1.000	1.000
Co/by Product	PPY	0.022	0.081	0.130	0.320	0.380	0.478
By Product	H2	0.067	0.062	0.059	0.044	0.037	0.029
	Methane	0.083	0.166	0.237	0.508	0.475	0.438
	C4's	0.028	0.040	0.050	0.088	0.216	0.281
	C5 cut	-	-	-	-	0.102	0.110
	Pyrolysis gasoline	0.023	0.052	0.077	0.172	0.272	0.403
	C9 & Fuel Oil	0.003	0.004	0.005	0.008	0.082	0.159

ETY: Ethylene, PPY: Propylene, EP Mix: Ethane-Propane Mix, FR-Nap: Full range naphtha; L-Nap: Light naphtha

Table A1.4 **Major unit requirements ethylene by feedstock (Common for all countries)**

MEG			
Material		**Unit**	**requirement**
Feedstock	Ethylene	t/t	0.640
	Oxygen	t/t	0.680
Utilities	Cooling Water	t/t	219.1
	Steam MP	t/t	0.280
	Steam HP	t/t	1.400
	Boiler Feed water	t/t	0.219
	Electricity	Kwh/t	171.5
Co-Product credits	DEG	t/t	0.090
	TEG	t/t	0.006

Steam MP: Middle pressure steam
Steam HP: High pressure steam
DEG: Di ethylene glycol
TEG : Tri ethylene glycol

LLDPE			
Material		**Unit**	**requirement**
Feedstock	Ethylene	t/t	0.943
	Butane-1	t/t	0.090
Utilities	Cooling Water	t/t	57
	Steam MP	t/t	0.4
	Electricity	Kwh/t	399

PP			
Material		**Unit**	**requirement**
Feedstock	Propylene	t/t	1.012
	Cooling Water	t/t	100
	Steam MP	t/t	0.3
	Electricity	Kwh/t	315

MEG: mono ethylene glycol
LLDPE: linear low density polyethylene
PP: polypropylene

Selection of Ethylene Feedstock

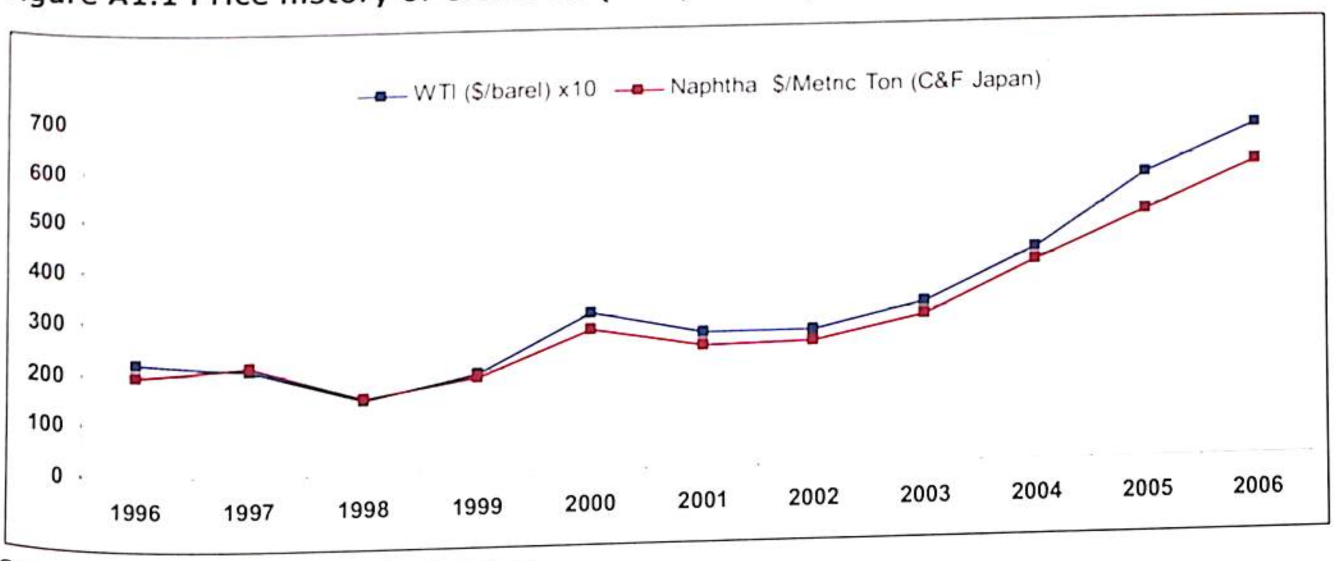
Table A1.5: Selected feedstock by country for ethylene cost calculation

Country	Ethane	EP Mixture	Propane	Naphtha
Saudi Arabia	**X**	**X (EP=50:50)**	**X**	**X (natural gasoline)**
Qatar	**X**			
Iran	**X**			**X Full range Naphtha**
USA	**X**	**X (EP=70:30)**	**X**	**X (natural gasoline)**
Japan				**X Full range Naphtha**
China				**X Full range Naphtha**

Crude Oil Market Price

The market price of feedstock hydrocarbon changes on the crude oil market price. The market price of West Texas Intermediate (WTI) has been soaring since 2000 when it exceeded $ 20/barel. The price further exceeded $50/barel in mid 2004 and reached $70/barel in August 2005 and once exceeded $ 75/barel in April 2006. Figure A1.1 shows historical data of the WTI market price and naphtha price in Japan from 1996 through 2006.There is a strong linear correlation between the WTI crude oil market price and naphtha price (Japan Naphtha = 9.1 x WTI).

Figure A1.1 Price history of Crude Oil (WTI) and Japan Naphtha



Source: CMAI Prices & Economics Database

Feedstock Price (Ethane, Propane, Naphtha):

Table A1.6: Prices of ethylene feedstock in Saudi Arabia

Year	Propane Factor "A"	Butane Factor "B"	Natural Gasoline Factor "C"	
2002	0.621	0.655	0.658	***Propane Price*** = A (Naphtha Price- transportation cost) ***Butane Price*** = B (Naphtha Price- transportation cost) **Natural Gasoline *Price*** = C (Naphtha Price- transportation cost) *Naphtha price: Naphtha price (C&F Japan), average of PLATTS/ARGUS*
2003	0.632	0.660	0.666	
2004	0.643	0.665	0.674	
2005	0.654	0.670	0.682	
2006	0.665	0.675	0.690	
2007	0.687	0.680	0.698	

Source: Supreme Council of Petroleum & Mineral Affairs, Saudi Arabia

Naphtha and Light NGL Price

Saudi Arabia supplies light NGL (A-180) recovered from crude oil associated gas, or a distillate fraction of A-180, to its domestic petrochemical producers. Many Japanese and other Asian petrochemical firms so strongly prefer the quality of A-180 over naphtha as to be prepared to pay an approximately $15/t premium. Since 2002, Saudi Arabian domestic supply price of A-180 has been determined based on the price of naphtha at Japanese ports in the same manner with the price formula applicable to propane/butane as discussed in this section earlier.

Qatar does not consume naphtha and light NGL as ethylene feedstock because it is self sufficient in ethane so far.

Although Iranian petrochemical producers currently consume mainly naphtha feedstock, the large new petrochemical plants will use ethane as the feedstock. The cost for Iran was calculated based on both ethane and naphtha. The supply price of naphtha is set at the FOB naphtha price at Middle Eastern shipping port less 10%.

In USA, light NGL associated with natural gas production is supplied either to gasoline pool or petrochemical production at openly traded price. The price history of naphtha in Japan and ethane and natural gasoline in USA shows that these three types of petrochemical feedstock follow very similar trends. The history of the price ratio between naphtha in Japan and ethane/natural gasoline in the USA shows that the price of petrochemical feedstock in USA increased very gradually as compare to Japan.

Most of Asian petrochemical producers use naphtha as feedstock. The openly traded price of naphtha is determined based on the price (C&F) of naphtha imported from the Middle East to Japanese port adjusted by differences in ocean freight to domestic ports. Although transfer prices between domestic refineries upstream and petrochemical producers downstream are not published, it is assumed that in most cases the transfer price is based on an open market price. In this cost calculation, inland transportation expenses and taxes are not incorporated into naphtha price for each particular producer.

Co-product Cost sharing and By product crediting :

For calculation of olefin production costs, ethylene and propylene are regarded as co-products and sharing the total cost proportionally to quantity of each produced. MEG, di-ethylene glycol (DEG) and tri-ethylene glycol (TEG) are also regarded as co-products. In calculation of by product credit in olefin production costs, the market price or fuel equivalent value of the respective by- products prevailing in the region is used in the unit cost credit calculation. For example, the C4 stream is valued equal to the butane price per ton in open market, prolysis gasoline to naphtha procurement price per ton, and hydrocarbon gas/liquid to the procurement price per MMBtu.

Table A1.7 Prices of material used for calculation of product costs ($/ton)

COUNTRY **Feedstock/ By-product credit prices**		**SAUDI ARABIA**	**QATAR**	**IRAN**	**USA**	**JAPAN**	**CHINA**
Naphtha (MOPJ)		455	455	455	455	455	455
Naphtha (MOPA)		410	410	410	410	410	410
Propane Aramco CP		460	460	460	460	460	460
Feedstock prices at factory fence							
Ethane Price		37	79	62	423	-	-
Propane Price		268	460	414	460	506	506
Naphtha Price		279	-	368	460	455	446
Feedstock and product unit price							
Product	Ethylene FOB	819	819	819	910	910	910
By-product	Methane	36	34	36	362	437	397
	C4 rafinate	274	450	405	455	541	541
	Pyrolysis gasoline	279	410	369	455	455	446
Market Price	MEG	806	806	806	910	875	910
	LLDPE	1,003	1,003	1,003	1,107	1,073	1,107
Co-feedstock	Oxygen for MEG	50	50	40	57	57	57
	Butane-1 for LLDPE	1,251	1,251	1,251	1,201	1,201	1,201

MOPJ/ MOPA: Mean of Platts Japan naphtha assessments which is the reference for all naphtha cargoes trading in North Asia

In Saudi Arabia, despite of supply price of feedstock propane or A-180 being much lower than the feedstock price in other countries, the credit price of product fuel gas (methane or hydrogen) and hydrocarbon liquid fuel are valued equivalent to the fuel value prevailing in the country, which are much lower than the prices in other countries. This means the lower valued by products credit is partially canceling out the merit of a favorable feedstock price.

The summary of feedstock price and by product credit price applied to the respective country for cost competitiveness (at $50/barel WTI crude oil price) is presented in Table 6.4

Derivative Products Cost Calculation Structure:

In products cost calculation the following cost components have been considered:

A. *Direct Production cost*

a. Cash costs

i. Variable cash costs such as feedstock, utilities, energy and auxiliary materials

ii. Fixed cash costs such as direct production costs, including manpower costs and other direct auxiliary expenses

b. Depreciation

B. ***Indirect*** *overhead* ***costs*** *and expenses, including management* *costs* and interest accrued from direct auxiliary expenses

C. *Full production cost =A+B*

The cash costs of ethylene derivatives MEG and LLDPE are calculated based on the cash cost of ethylene as an internal transfer price. The depreciation and amortization and the indirect overhead cost for MEG and LLDPE production also include the depreciation and amortization and the indirect overhead cost for ethylene production.

Different sources for data on production cost components, such as consumption of feedstock and other auxiliary material (catalysts and chemicals), license fee, manpower cost, maintenance cost, depreciation term and rate of interest accrued from borrowed money, are adopted for he production cost calculation.

Author's Profile

Mohammad Washid is a *Petroleum Economist*, specialized in strategic planning, economic analysis and investment decisions in oil, gas and petrochemicals industries. He has extensive corporate, consultancy and academic experience.

He is associated with *University of Petroleum & Energy Studies* (UPES) Dehradun (India) as Associate Dean & Associate Professor, since its inception in 2003. He initiated the first batch of MBA (Oil & Gas Management) and pioneered consulting services for the University.

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He worked with *All India Management Association*, New Delhi (India) for more than 8 years, as a Program Director and Assistant Professor and was also associated with *Robert Kennedy College*, Switzerland as Adjunct Faculty.

Mr. Washid is also active member of number of professional bodies like Gerson Lehrman Group (GLG)'s Energy & Industrial Council, USA.; Energy Institute, UK; Academy of International Business- India Chapter; All India Management Association; Academy of Management, USA

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December, 2007