CHAPTER – 12
ANALYSIS AND FINDINGS

The research has given answers to the following issues**:**

12.1 ENERGY SCENARIO IN ASIAN SUB-CONTINENT

The proven reserve of various countries is taken from BP Statistics Review 2007. As MMSCMD is the unit extensively followed in natural gas pipeline industry across Asia, these reserves in TCM are converted into MMSCMD by considering 20 years and 330 days as operating time. Based on the data collected on gas availability and demand of each country, the gas supply/ demand is derived as shown in Table 12.1.

Sl. No.	Country	Reserve (Supply)	RPR Ratio	Consumption of 2006	Projected Demand up to 2025	Demand/ Supply gap by 2025	Remarks
		(A)	(B)	(C)	D=C x 1.03[19]	(A – D)	
		MMSCMD	No.	MMSCMD	MMSCMD	MMSCMD	
1	Russian Federation	7220	77.8	1309	2296	4924	Surplus
2	Iran	4262	267.9	319	559	3704	Surplus
3	Qatar	3843	512.3	59	104	3739	Surplus
4	Kazakhstan	455	125.4	61	108	347	Surplus
5	Turkmenistan	433	46	57	101	333	Surplus
6	Indonesia	398	35.6	120	210	188	Surplus
7	Malaysia	376	41.2	122	214	162	Surplus
8	China	371	41.8	168	588	-217	Deficit
9	Uzbekistan	283	33.7	131	229	54	Surplus
10	Kuwait	270	70.8	39	69	201	Surplus
11	India	164	33.9	120	358	-194	Deficit
12	Pakistan	121	26	93	163	-42	Deficit
13	Bangladesh	67	28.6	46	81	-14	Deficit
14	Myanmar	82	40.1	13	22	60	Surplus
15	Thailand	45	12.4	98	172	-127	Deficit
16	Japan	16	7	286	502	-486	Deficit

Table: 12.1 Projected scenario of gas demand / supply of AGG countries

Following gas fields are considered available for supply in AGG:

- Assaluyeh field - Iran 165 MMSCMD
- Daulatabad field - Turkmenistan 150 MMSCMD
- Uzbek Border field - Turkmenisatn 50 MMSCMD
- Karachaganak field -Kazakhstan 100 MMSCMD
- Caspian Block -Kazakhstan 50 MMSCMD
- Chittagong - Bangladesh 20 MMSCMD
- Sitwe- Myanmar 30 MMSCMD

  TOTAL **565 MMSCMD**

Table 12.2 shows the percentage of gas proposed to be utilized from gas surplus countries in the AGG to meet the demand of gas short countries.

S.No.	Gas surplus countries	Net Surplus (2025)	Export (2006)	Unutilized gas	Used for AGG	% of Utilization by AGG
		A	B	C=A-B	D	E=D/C*100
1	Russian Federation	4924	546	4378	0	0
2	Iran	3704	0	3704	165	4.50%
3	Qatar	3739	91	3648	0	0
4	Kazakhstan	347	11	336	150	45%
5	Turkmenistan	333	130	203	200	98.50%
6	Indonesia	188	104	84	0	0
7	Malaysia	162	60	102	0	0
8	Uzbekistan	54	37	17	0	0
9	Myanmar	60	0	60	30	50%
10	Bangladesh				20	
	TOTAL				**565**	

(in MMSCMD)

Table: 12.2 Percentage Utilization of available gas by AGG

12.2 PAST EXPERIENCE OF CROSS–BORDER PIPELINES

Taking the experience of IPI, TAPI, Bakü-Tiflis-Ceyhan Pipeline and Brazil-Bolivia pipeline, the following are the broad conclusions which need to be taken care off while executing AGG.

1. Fructification of cross border pipeline takes minimum 2-3 years

2. Gas reserves will have to be ascertained before venturing into the project

3. Energy policy which is favorable to gas development and reinforces gas market potential

4. Better understanding between sellers, buyers and transit countries through regional co-operation

5. Status of the relations among neighboring countries strongly affects the specific project decision taking

6. Bilateral issues should not be let to come in the way or mix with the project

7. Self-interest of countries can become a hurdle in the cross-border pipeline

8. Higher investments require regional stability

9. Involving private investors in project financing

10. Create a clear and stable investment regime that attracts private (domestic or foreign) investment

11. Create a clear and transparent institutional and regulatory framework for gas production, trade and transit, and consumption

12. Risk sharing among all parties

13. Clear-cut responsibilities of companies purchasing gas, doing construction, Operation & Maintenance, along with selling gas.

12.3 PROBABLE OBSTACLES IN IMPLEMENTATION OF AGG

Some of probable obstructions in various phases of the project are as under.

a) Pre –Project Approval Phase

- Rules of the game are required to be clearly defined as many countries will participate in the construction of the pipeline as well as operation thereof. It is essential to create an environment in which the commercial issues of cross-border pipelines are amicably resolved

- Different gas prices at different sources

- Fixation of gas prices may be an important obstruction

- Assurance of firm gas availability throughout the project life. Change of government should not have any impact on this
- Relationship of countries with each other
- More number of countries for one limb could be one of the obstructions\
- Supply countries may pose their own tantrums
- Energy security strategies of participating countries may be different
- Conflict of interest between buyer and seller
- Large investments in cross –border pipelines, investors may like to ensure their return. Confidence building measures for investors are required to be done
- Private sector financing may not be available at initial stage
- Super powers of the world may not like to implement AGG
- LNG lobby may not allow implementation of AGG
- Unstable governments and threat from terrorism
- Cross-border connections require harmonization of national legal and regulatory frameworks, as well gas pricing schedules. Transportation tariff may be a major obstacle
- Sharing of profits etc by participating countries
- The benefits to different countries are of asymptotic nature, thus agreement on cost to be incurred by different countries will have to be agreed by them. Therefore economic, financial viability and distributional consequences are required to be studied carefully
- Evolving of dispute resolution system. Difficulty in agreement of arbitration clause
- Common technical standards for design and construction, operation and maintenance, safety, etc.
- Non-availability of down stream consumer network. The main obstacle in use of natural gas is lack of terminals, long distance pipelines and local

network for transmission of the gas for households as well as for industries.

b) Project Execution Phase

- Technical expertise to deal such a mammoth project
- Different quality of gas
- Large requirement of competent manpower for client, contractor and consultant
- Cross-border pipelines have long history, and are vulnerable to disruption and conflict where transit is associated
- Right of Way (ROW) related problems: As this line will pass through many countries having different rules and regulations in acquisition of land for execution of the pipeline
- Approximate length of the pipeline will be around 14,000 km, probably having pipeline size of 56"/48". Thus the total requirement of steel will be of the order of 70 lakh tonnes, which means almost all the steel mills will be busy for 2 to 3 years in order to supply steel for the project
- Non-availability of contractors having adequate experience in construction, operation and maintenance of pipelines
- Terrain of the pipeline route may pose difficulty in laying the line; therefore route selection is required to be done cautiously
- Custody transfer of gas: Provision of adequate metering system while entering into the country and leaving the country will have to be provided and the problem of gas balancing would have to be tackled. Metering system should be of same type having same accuracy level
- Design related issues and availability of such a huge quantity of line pipe will be a cause of concern for this project

c) Operation Phase

- Cross-border lines are susceptible to disruption and conflict, which may be a cause of concern during operation phase
- Gas reconciliation and balancing

- Capacity utilization needs to ensured, as below capacity utilization will have an impact on project profitability

- Safety and security of pipeline in the respective countries
- Synchronization of maintenance schedule of compressors and pipelines

d) Others

- Since this project will have many countries on board, the coordinating agencies will have to ensure that all parties continue to remain till completion and also thereafter. If all the countries benefit out of the project, they will have incentive to stay and resolve the conflicts amicably

- This project is fraught with the risk of conflicts among participating countries. Thus, a sound Disputes Resolution System is required to be worked out before the project starts

- Gas distribution is a monopoly held by state-owned petroleum companies in many ASEAN countries, thus limiting private sector participation and investment. For example, Indonesia hopes to open up the entire downstream sector with the passage of an oil and gas bill to be passed by the Parliament

- Individual governments must move toward a market-based pricing system and away from practices, such as price intervention and tax distortions, that lead to inefficient pricing of natural gas and gas-related products and services. Natural gas proponents in Indonesia complain that they cannot compete on price until diesel oil and other fuel subsidies are removed.

12.4 GEO-POLITICS OF ASIAN COUNTRIES PARTICIPATING IN AGG

The geography of the Asian countries is conducive for laying pipeline. However, the current situation in Afghanistan as well as Balochistan region of Pakistan is another matter which needs to be dealt with by the respective governments. The political and economic compulsions in these two regions are a matter of concern. Further, the countries which are gas rich they have to decide for economic growth, while the other group which starving for gas have to take risk and invest in the gas rich countries. Moreover, the political relations of India with Pakistan, Iran with the US, Russia and China, China and India, Bangladesh and India will matter a lot for fructification of this project. The role of the US will also be very important. There is history of trade conflicts exists between India, Bangladesh, Myanmar and China and hence this issue needs more attention with respect to implementation of AGG limb passing through these countries. Thus geopolitics plays a dominant role in cross-border

projects, besides interest of western powers. All efforts are needed to bring in regional stability.

12.5 IMPACT OF AGG ON ENVIRONMENT

Natural gas is the energy of the future for the entire world including Asian countries in view of:

1) Reduced hazards to living organisms, plants, human life including nonliving structures

2) Abundant availability and

3) Cost economics

Natural gas would contribute much more to reduce green house effect in Asian Countries. It may also become one of the pre-dominant compulsions for Asian countries to give birth to AGG.

Details of our study on the environmental benefits of using natural gas in lieu of coal in the proposed AGG are calculated as shown in Table 12.3 to 12.5.

Country	**Gas Consumption per day from AGG (SCM)**	**Gas Consumption per day (billon BTU)**	**CO2 Emission per day in case of Coal (ton)**	**CO2 Emission per day in case of Gas (ton)**	**% Reduction in CO2 emission**
India	140,000,000	5,555	527091	295070	44%
China	280,000,000	11,111	1054278	590194	
Pakistan	95,000,000	3,769	357625	200201	

Note: 1 billion BTU = 25200 SCM

Table 12.3 Reduction in CO2 Emission

Country	Gas Consumption per day from AGG (SCM)	Gas Consumption per day (billon BTU)	CO Emission per day in case of Coal (ton)	CO Emission per day in case of Gas (ton)	% Reduction in CO2 emission
India	140,000,000	5,555	524	100	81%
China	280,000,000	11,111	1049	201	
Pakistan	95,000,000	3,769	356	68	

Table 12.4 Reduction in CO Emission

Country	Gas Consumption per day from AGG (SCM)	Gas Consumption per day (billon BTU)	NO Emission per day in case of Coal (ton)	NO Emission per day in case of Gas (ton)	% Reduction in CO2 emission
India	140,000,000	5,555	1152	232	80%
China	280,000,000	11,111	2305	464	
Pakistan	95,000,000	3,769	782	157	

Table 12.5 Reduction in NO Emission

12.6 TECHNO-COMMERCIAL ANALYSIS OF AGG

During techno-commercial analysis of AGG selection of optimum route and their commercial analysis were studied.

The analysis leads to the following results:

1) Optimum Length of AGG: 13825 km
2) Total estimated cost of AGG : $44996 million (approximately Rs 2,25,000 crores)
3) Calculated IRR for the entire project :12%
4) Techno-Commercial Viability : Yes
5) Order of Transportation Charges : approximately 1.5 US$/MMBTU
6) Total Gas flow from Source to Demand centers: 565 MMSCMD

Summary of Optimum Alternatives of AGG Limbs are as shown in Table 12.6

LIMB	GAS SOURCES CONSIDERED	DESIGN GAS FLOW	TOTAL DISTANCE	PROJECT DETAILS	ESTIMATED COST	TRANSPORT CHARGES	TOTAL GAS COST
		MMSCMD	KM		MILLION USD	USD / MMBTU	USD / MMBTU
IRAN PAKISTAN INDIA	IRAN ASSAYULLAH FIELD	165	2625 (UPTO DELHI)	TWIN PIPELINE OF 48 & 56 INCH DIA FROM SOURCE TO 1550 KM AND 56" DIA X 1075 KM. COMPRESSORS - 936 MW	8788	1.14	9.19
TURKMENISTAN-AFGHANISTAN - PAKISTAN - INDIA	DAUALATABAD FIELD IN TURKMENISTAN	150	1950 (UPTO DELHI)	TWIN PIPELINE OF 48 & 56 INCH DIA X 1400 KM , 56" DIA X 550 KM. COMPRESSORS - 936 MW	6926	0.905	9.205
TURKMENISTAN LINK PIPELINE	TURK-UZBEK BORDER FIELD	50	550	48"-250 KM, 42"-200 KM WITH 1 COMPRESSOR OF 33MW	792		
KAZAKHSTAN UZBEKISTAN CHINA	KARACHAGNAK, CASPIAN, TURK-UZBEK BORDER	200	3500	TWIN PIPELINE OF 56", COMPRESSOR-1600 MW	16682	1.47	9.77
INDIA BANGLADESH MYANMAR	DELHI (FROM TAPI), CHITTAGONG (BANGLA)	100	2050	56" X 2050 KM FROM DELHI TO MYANMAR AND COMPRESSORS : 413MW	4627	1.27	9.57
MYANMAR CHINA	IBM P/L AND SITWE (MYANMAR)	100	3150 (UPTO SANGHAI)	56" X 3150 KM, COMPRESSORS : 654 MW	7181	2.08	10.13
TOTAL			**13825 KM**		**44996**		

IRR in all above cases is 12%

Table 12.6 Summary of Analysis of AGG Limbs

12.7 SOFTWARE MODEL FOR TECHNO-ECONOMIC ANALYSIS OF AGG

Pipeline Analysis and Design software has been developed to facilitate analyzing the feasibility, configuration, design and other techno-commercial aspects of various limbs of the AGG .It has been named as PL-ADS “Green Corridor”. The desired outputs are obtained by providing various inputs required by the software on both technical and commercial parameters.

Inputs required for running this software and outputs generated are as given below for technical parameters:

Inputs for Pressure Drop

1. Inlet Pressure Initial (in bars)
2. Flow Rate (in MMSCMD)
3. Base Temperature (in °C)
4. Mean Temperature (in °C)
5. Design Pressure (in bars)
6. Pipe Line Efficiency
7. Grade of Pipe
8. Corrosion Allowance
9. Thinning Allowance

Inputs for Compressor Power

1. Polytropic Efficiency
2. Initial Temperature (in °C)
3. Discharge Pressure (in bars)
4. Compressibility (Z)

Inputs for Fuel Consumption

1. Efficiency (in %)
2. Calorific Value (in kcal/ scm)

Inputs for Mole Fraction of Gas

1. Mole Fraction of N2
2. Mole Fraction of CO2
3. Mole Fraction of H2S

List of Constants

Specific Gravity	0.68
F-Values	
F1	0.72
F2	0.6
F3	0.5
F4	0.4
Ratio of Specific Heats (K)	1.4
Molecular Weight of Air (MWA)	28.7
Standard Pressure (Ps) (in kpa)	101.325
Standard Temperature (Ts) (in °C)	15

Section-wise Inputs

1. Pipe Length (in km)
2. Diameter -D1 (in Inches)
3. Diameter -D2 (in Inches)
4. Tap-off (in MMSCMD)
5. Tap-off Type (Increase or decrease) (in MMSCMD)
6. Mechanical Losses (in %)
7. Remarks

Outputs

1. Outlet Pressure (in Bars)
2. Compression Ratio
3. Compressor Power (in MegaWatts)
4. Fuel Consumption (in MMSCMD)

Inputs for Commercial Analysis are as below:

Project Capital Cost		In US Million
Project construction period	3	Years
Capital phasing	10%	1st year
	40%	2nd year
	50%	3rd year
Project life	30	Years
Flow build up	30%	1st operating year
	50%	2nd year operating year
	80%	3rd operating year
	100%	4th year onwards
Debt	0.7	
Equity	0.3	
Interest Rate	9%	
Installment	10	years
Moratorium	3	years
Depreciation- Stline	9%	
Depreciation- WDV	23.50%	
Simplified Tax Rate	30%	
No. of operating days	330	days / year
Variability of TPT charge	Fixed	For entire project life
Fuel Cost	3	$ /MMBTU

Output generated from Commercial Analysis is as given below:

Transportation charges		USD / MMBTU
IRR on Total Investment		%
IRR or equity		%
Debt Service Coverage ratio		

12.8 PROJECT FINANCING OF AGG

Based on the literature available and project financing, a financing model has been developed. The financing model for various Asian countries forming part of AGG has been developed based on the investment required in each of the countries. A typical financing model for the AGG portion in India for IPI pipeline is as below:

Suppose AGG IPI (India) company would be formed by Indian firms GAIL, ONGC, IOCL, BPCL, HPCL, RIL, and Laying Companies and proposed share holding pattern of the company would be in the following manner.

- Total length = 1075 km
- Total cost =US$ 2135 Million
- Equity (40%) = US $ 854 Million
- Debt (60%)= US $ 1281 Million

*** 1 Share = US$ 1**

	Category	No of shares held	%of shareholding
A	**Promoter's holding**		
1	Gail (India)Ltd	85,400,000	10 (US$ 85.4 Million)
2	BPCL	51,240,000	6 (US$ 51.24 Million)
3	IOCL	51,240,000	6 (US$ 51.24 Million)
4	HPCL	51,240,000	6 (US$ 51.24 Million)
5	RIL	85,400,000	10 (US$ 85.4 Million)
6	ONGC	51,240,000	6 (US$ 51.24 Million)
7	LAYING COMPANIES	51,240,000	6 (US$ 51.24 Million)
	Sub total		**50%(US$ 427 Million)**
B	**Non-promoters holding**		
1	Institutional investors	42,700,000	5% (US$ 42.7 Million)
2	Mutual funds	42,700,000	5% (US$ 42.7 Million)
3	Banks	42,700,000	5% (US$ 42.7 Million)
4	Insurance companies	42,700,000	5% (US$ 42.7 Million)
5	FII'S	42,700,000	5% (US$ 42.7 Million)
	Sub total		**25%(US$213.5 Million)**
C	**Others**		
1	Indian public	128,100,000	15%(US$ 128.1 Million)
2	Private corporate body	51,240,000	6%(US$ 51.24 Million)
3	NRI'S	17,080,000	2%(US$ 17.08 Million)
4	Any other(trusts)	17,080,000	2%(US$ 17.08 Million)
	Sub total		**25%(US$213.5 Million)**
	GRAND TOTAL	**854,000,000**	**100%(US$ 854 Million)**

Table 12.7: Equity Pattern of AGG-IPI (India) Ltd.

	Category	Total fund	Percent of total fund
A	**Foreign fund**		
1	Asian development bank	US$ 384.3 Million	30%
2	World bank		
2.a	IBRD	US$ 89.67 Million	7%
2.b	IDA	US$ 51.24 Million	4%
2.c	IFC	US$ 128.10 Million	10%
2.d	MIGA	US$ 89.67 Million	7%
2.e	ICSID	US$ 76.86 Million	6%
B.	**International bond**	US$ 76.86 Million	6%
C.	**Domestic fund**		
	Local commercial banks		
a.	ICICI	US$ 51.24 Million	4%
b.	HDFC India Ltd.	US$ 51.24 Million	4%
c.	ABN AMRO Bank (India) Limited	US$ 51.24 Million	4%
D.	**Domestic Bond**	US$ 76.86 Million	6%
E.	**Government guaranteed official loans from multilateral institutes**	US$ 76.86 Million	6%
F.	**Specialized energy funds from government**	US$ 76.86 Million	6%
	TOTAL	**US$ 1281 Million**	100%

Table 12.8: Debt Patterns of AGG-IPI (India) Ltd.

Financing of the next clusters of pipeline projects are likely to be:

- Through a “hybrid” structure that uses existing financing techniques
- Where government support comes from both the host and exporting countries
- Where credible, practical solutions have been adopted to address the key industry problems.

- Major gas projects and investments, such as trans-border pipelines, require innovative and specifically tailored institutional and Policy frameworks.

12.9 PROJECT MANAGEMENT OF AGG

AGG will have the following limbs for execution:

- India-Pakistan-India (IPI)
- Turkmenistan -Afghanistan-Pakistan-India (TAPI)
- Turkmenistan Link Pipeline
- Kazakhstan-Uzbekistan-China(KaUzChi)
- India- Bangladesh-Myanmar
- Myanmar-China

The probable project management model for AGG is shown in Exhibit 12.1, where Special Purpose Vehicles will work simultaneously on various limbs:

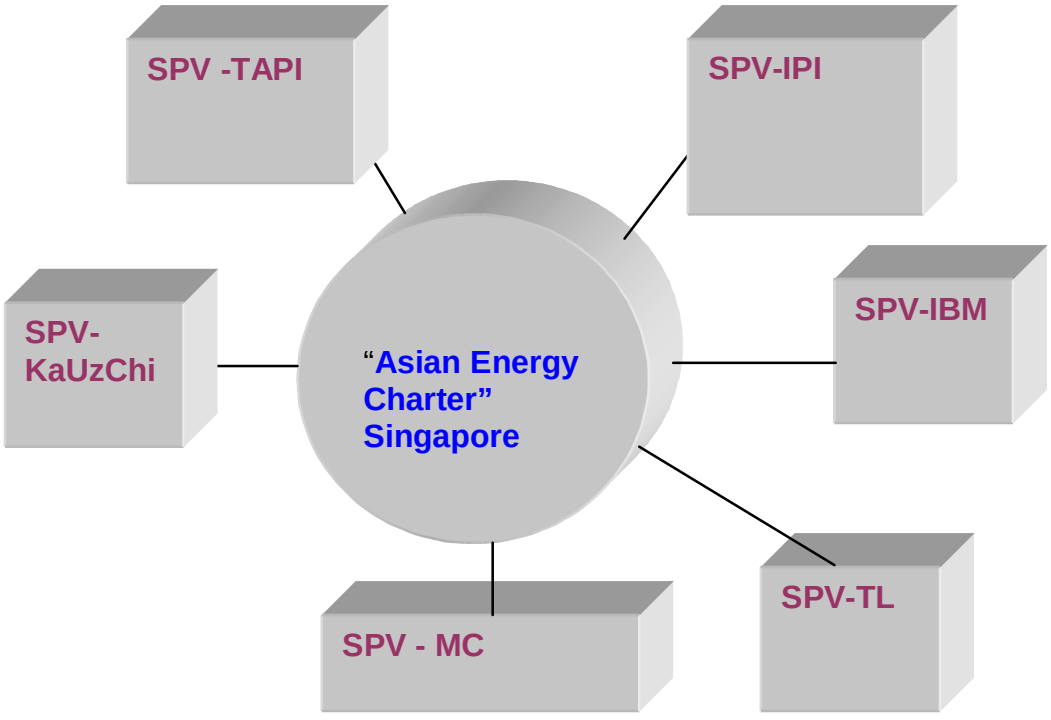

Exhibit 12.1 Asian Energy Charter

IPI	Iran-Pakistan-India
IBM	India-Bangladesh-Myanmar
MC	Myanmar-China
KaUzChi	Kazakhstan-Uzbekistan-China
TAPI	Turkmenistan-Afghanistan-Pakistan-India
TL	Turkmenistan Link Pipeline

All the countries have to have their own structure for implementation of the project. Since, the member countries will have different priorities for participating in this project, country wise structure needs to be developed based on the experience of the other completed cross border projects**.** The country-wise structure will depend upon the model of execution of the project.

In order to execute AGG, a Special Purpose Vehicle will be formed, which will be under control of AEC (Asian Energy Charter)

In the proposed model it is being assumed that construction and operation and maintenance of the portion of the limb in any country will be done by the respective country. This arrangement for construction, operation & maintenance of pipeline would be ideal, considering different countries have different rules and regulations, to deal with security and other related problems. An individual country would be able to take care of the problems according to their own law, but find it difficult to follow the rules and regulations of another country.

The typical country structure for Iran-Pakistan-India limb is as shown in Table 12.9:

Pipeline Section	**Gas Supplier**	**Construction**	**Transporter**	**Operation & Maintenance**	**Gas Custody Transfer (CT) Point**	**Check Metering Point**
Iran- CT point for Pakistan	Iran	Iran	Iran	Iran	Exit point of Iran	Entry Point of Pakistan
CT point for Pakistan- CT point for India	-	Pakistan	Pakistan	Pakistan	Exit point of Pakistan	Entry point of India
India-Bangladesh	India	India	India	India	Exit point of India	Entry point of Bangladesh

Table 12.9 Country Structure of IPI

Since all the countries will be doing their part of execution therefore the following execution methodology is proposed for AGG:

- All countries have their own consultants/ PMCs but their scope and terms and conditions will remain same
- Technical specifications for major procurement packages will remain same like material of line pipe i.e. API X-70 or 80
- Custody transfer methodology and specification will remain the same i.e. the custody transfer of gas from one country to the other will be done at the exit point of preceding country, and type of meter should be Ultrasonic type following AGA – 9 code
- Procurement and construction will be done by respective consultants
- The line will be capitalized country wise, which will decide final tariff/transit fee calculations

Project Monitoring of AGG will be typical monitoring of its own kind, wherein activities will be done at country level of particular limb as well as at corporate level i.e. at AEC level. The Project monitoring process may be carried out through meetings “one to one (OTO)” or “one to many (OTM)” and MIS reports.

The structure shown in Exhibit 12.2 is proposed for monitoring of AGG.

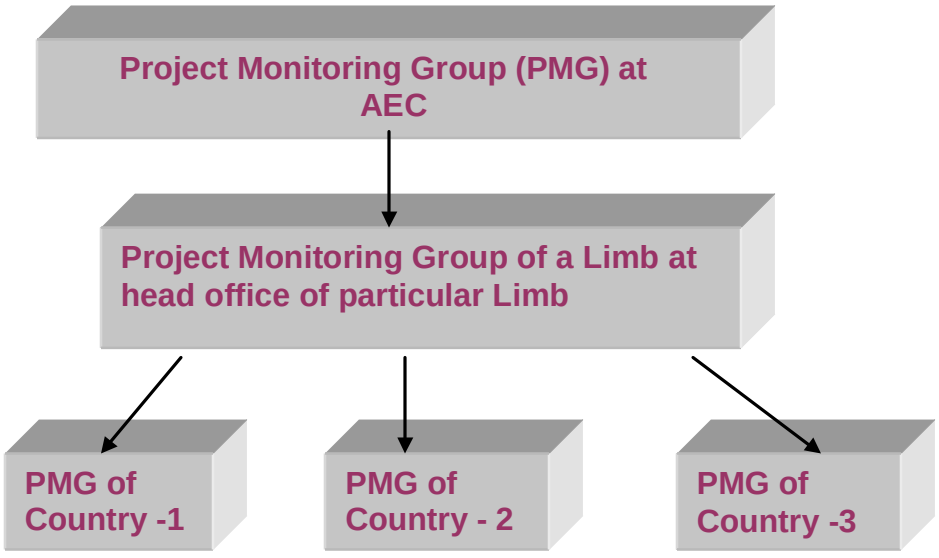

Exhibit 12.2 Structure for AGG Monitoring

As per above diagram the project needs to be monitored at 3 levels.

Level -1: At corporate level of AEC, wherein Project Monitoring Group (PMG) will monitor the projects of all countries with respect to time, cost and quality. They will seek reports as per desired frequency from PMG of particular limb.

Level-2: It would be done at the corporate level of the particular limb. Let's suppose that the corporate office for Iran-Pakistan-India Line is in India, then the monitoring of the total project will be done by PMG located in India.

Level-**3**: It would be done at country level by the company which is executing part of the limb within their country. For IPI line, individual limb monitoring will be done at Iran, Pakistan and India respectively.

Since the contracts and procurement action will be taken up by respective countries, the following issues are required to be sorted out in execution:

- **Procedure to be followed for Contracts and procurement** :
  Since more than 10 countries will participate in the contracts and procurement activities and every country will have their own system of procurement, it is necessary for AEC to finalize a combined procedure for the sake of consistency. This would further make it easier for all countries to avoid differences in their approach

- **Mode of procurement**:
  It needs to be decided what type of tendering mode will be applied, whether ICB (International competitive bidding), LICB (Limited International competitive bidding) ,e-tendering , reverse auction etc. These issues will bother all the countries before taking any procurement action.

- **Taxes and Duties**:
  These components have major impact on the project cost. AEC needs to decide on exemption on movement of goods from one country to other, if the materials are required to transit from one country to another

Based on the literature and experience available, the following Issues also need to be taken care during Project Management of AGG.

- Project Monitoring
- Contract Management
- Construction Management
- Stakeholder Management
- Quality Assurance
- Risk Management
- Project Closure