

**TA 6066 - REG**  
**Turkmenistan - Afghanistan -  
Pakistan**  
**Natural Gas Pipeline Project**

**Techno-Economic  
Feasibility Study  
Final Report**

**P E N S P E N**<sup>TM</sup>

**April 2005**

# Summary: Introduction



- **TAP Project Techno Economic Feasibility Study**
  - Objectives
  - Status
- **Sixth Steering Committee Meeting in Ashgabat**
  - Eliminated LNG at Gawadar
  - Selected Southern Route
  - Basis for project analysis
  - Preparation of Draft Final Report
- **Seventh Steering Committee Meeting in Islamabad**
  - Presentation of Draft Final Report
- **Eighth Steering Committee Meeting in Islamabad**
  - Presentation of Final Report
  - Next Actions

# Summary: Techno-Economic Feasibility Study Objectives



- **Phase 1: Inception report**
  - Relate gas market data to project for development
  - Identify showstoppers
  - Develop two route corridors: select one
  - Evaluate LNG at Gawadar: discarded
  - Southern Route selected
  
- **Phase 2: Draft Final Report**
  - Purchase satellite data
  - Develop engineering done in Phase 1
  - Conduct field visits
  - Refine cost estimates
  - Perform economic and financial analysis
  - Discuss project viability
  
- **Phase 3: Final Report**

# Summary: Final Report Objectives



- **Address and develop study terms of reference as applied to the project defined in the Inception Report.**
- **Provide a clear indication of overall project viability.**
- **Elaborate recommended pipeline corridor for Southern Route**
  - **Optimal route for development**
  - **Further development in FEED study**
- **Use Framework Agreement as basis for economic and financial analysis**

# Site Visit



- **Team of 4 experts**
  - **Route Survey and Planning Engineer**
  - **Pipeline Construction Engineer**
  - **Environmental Expert**
  - **Social Resettlement Expert**
- **Visits to Pakistan, Afghanistan, Turkmenistan**
- **Meetings with Ministries, ADB, NGOs**
- **4WD and helicopter survey of Pakistan and Baluchistan**
- **Discussed with Ministries, NGOs in Afghanistan**
- **4WD survey in Turkmenistan**
- **No perceived impediment to pipeline construction or operation**

# Pipeline Route



- **No insurmountable geo-technical constraints**
  - Enhanced satellite imagery used
  - Khojak pass
  - Sulaiman range
  - Seismicity and fault lines
- **No identified environmental or social constraints**
  - Further work required at FEED stage
  - Narrowing of the route corridor will focus attention
- **Problems with security**
  - Landmines
  - Insurrection
  - Risk to construction contractors
  - Risk of sabotage to completed pipeline
  - Perception of potential investors

# Pipeline Design



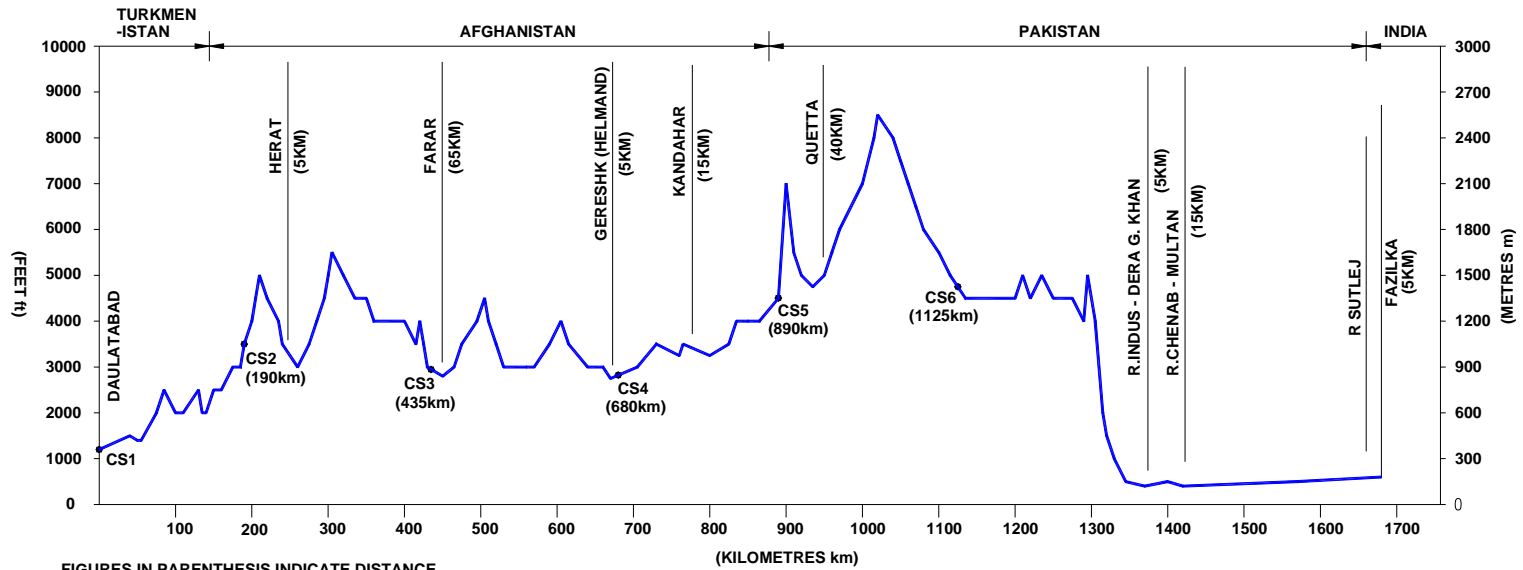
- Design code ASME B31.8
- Single 56" pipeline for 2010 high rate flow (31.4 bcm / y)
- Length 1,680km
- API grade 5L X70: 20.6mm wall thickness
- Design pressure 100 barg
- Normal operating pressure 95 barg
- 6 compressor stations: 3 x 30 MW each
- Capital cost \$3.3 billion
- Operating cost \$28.4 million/year

# Pipeline Route





# Pipeline Route Profile



FIGURES IN PARENTHESIS INDICATE DISTANCE TO THE TOWN FROM OFFTAKE LOCATION.

**T.A.P. ROUTE PROFILE: TOTAL LENGTH 1680KM**

- = Compressor Station Locations

# Supporting Information



- **Pipeline crossings, facilities**
- **Pipeline construction**
- **Pipeline operations and maintenance**
- **Pipeline communications system**
- **Medical requirements**
- **Insurance requirements, customs issues**
- **Environmental impact assessment**
- **Social impact assessment**

# Environmental Mitigation



- **Route**
  - Kyzyljarsky Zakaznik
  - Avoidance of sensitive or valuable land
- **Land acquisition**
  - Minimise land take
  - Effective reinstatement
- **Construction**
  - Minimise nuisance and disruption
  - Minimise impact of workforce on communities
- **Operation**
  - Emissions
  - Health and safety
  - Environmental management

# Social Impact Policy

- **Detailed socio-economic study**
- **Information programme**
  - Entitlements
- **Eligibility**
- **Consultation and participation**
- **Valuation and compensation**
- **Mechanisms for dispute resolution**
- **Mitigation of negative aspects**

# Project Management



- **Implementation schedule**
  - Starts 2005
  - Operational in 2010

- **Basis for Cost Estimates**

| <b>Item</b>  | <b>Southern Route</b>   |
|--|-------------------------|
| <b>Size / dia inches</b>                           | <b>56"</b>              |
| <b>Wall thickness / mm</b>                         | <b>20.6</b>             |
| <b>Length / km</b>                                 | <b>1,680</b>            |
| <b>No. of compressor stations (3 x 30MW)</b>       | <b>6</b>                |
| <b>No. of Border Metering Stations</b>             | <b>3</b>                |
| <b>No. of Meter offtakes</b>                       | <b>0 <sup>(1)</sup></b> |
| <b>No. of scraper receiver / launcher stations</b> | <b>10</b>               |
| <b>No. of Block valves</b>                         | <b>53</b>               |
| <b>No. of Bridges for Major River Crossings</b>    | <b>3</b>                |

<sup>(1)</sup> Offtakes assumed to be by others although tie-in at Multan is included.

# Project Management



- **Capital Cost Estimates**

| Item                                     | Total        | Total Local Costs |            | Total Foreign Costs |            |
|--|--------------|-------------------|------------|---------------------|------------|
|  | \$ Millions  | \$ Millions       | Percent    | \$ Millions         | Percent    |
| Line Pipe                                | 1,238        | 0                 | 0%         | 1,238               | 100%       |
| Construction incl ROW & land purchase    | 661          | 661               | 100%       | 0                   | 0%         |
| Compressor stations                      | 593          | 161               | 27%        | 432                 | 73%        |
| Metering facilities                      | 57           | 16                | 28%        | 41                  | 72%        |
| Block Valve / Launcher Receiver stations | 49           | 11                | 22%        | 38                  | 78%        |
| Associated Infrastructure                | 128          | 128               | 100%       | 0                   | 0%         |
| Engineering & Project Management         | 179          | 32                | 18%        | 147                 | 82%        |
| Insurance                                | 30           | 0                 | 0%         | 30                  | 100%       |
| Contingency (@ 12.5%)                    | 367          | 127               | 35%        | 240                 | 65%        |
| <b>Totals</b>                            | <b>3,302</b> | <b>1,135</b>      | <b>34%</b> | <b>2,167</b>        | <b>66%</b> |
| Length /km                               | 1,680        |                   |            |                     |            |
| Equivalent Rate per inch dia./metre      | \$22.71      |                   |            |                     |            |

# Project Management



- Operating Cost Estimates

| Item             | Total        | Total Local Costs |            | Total Foreign Costs |           |
|------------------|--------------|-------------------|------------|---------------------|-----------|
|                  | \$ Millions  | \$ Millions       | Percent    | \$ Millions         | Percent   |
| Spares/Equipment | 0.14         | 0.07              | 50%        | 0.07                | 50%       |
| Maintenance      | 0.51         | 0.08              | 16%        | 0.43                | 84%       |
| Utilities        | 20.41        | 20.41             | 100%       | 0.00                | 0%        |
| Manpower         | 2.75         | 2.59              | 94%        | 0.16                | 6%        |
| Insurance        | 0.50         | 0.00              | 0%         | 0.50                | 100%      |
| Overheads        | 4.07         | 4.07              | 100%       | 0.00                | 0%        |
| <b>Total</b>     | <b>28.38</b> | <b>27.22</b>      | <b>96%</b> | <b>1.16</b>         | <b>4%</b> |



# Economic Analysis - 1



- **ADB guidelines**
- **Framework Agreement**
- **Basis for analysis**
  - **Is a commercially financed project viable?**
  - **Establish minimum rate of return (ROR)**
  - **Establish minimum revenue flows from ROR**
  - **Test for sensitivity – India? – Entry price?**
  - **Include environmental costs**

## Economic Analysis - 2



- **Market entry price \$2/MMBTU (\$71/MCM)**
- **Gas purchase price in Dauletabad – unknown**
- **Assumptions made: zero cost - \$20/MCM - \$40/MCM**
- **Transit fee – treated as a tax**
- **Discount rate – 17.5% - commercial finance**
- **Start-up date – 2010**
- **Share of TAP throughput for India?**

# Economic Analysis - 3

- **6 market cases**
  - Moderate Pakistan
  - High Pakistan
  - Moderate Pakistan + Moderate India
  - High Pakistan + Moderate India
  - Moderate Pakistan + High India
  - High Pakistan + High India
- **All cases reported**
- **We will look at**
  - Moderate Pakistan
  - High Pakistan

# Economic Analysis - 4



## Moderate Pakistan

### Financial Rate of Return

|                            |       | Gas input price, \$/MCM |       |       |       |
|----------------------------|-------|-------------------------|-------|-------|-------|
|                            |       | \$0                     | \$20  | \$30  | \$40  |
| Gas sales price,<br>\$/MCM | 60    | 18.7%                   | 14.7% | 12.2% | 8.8%  |
|                            | 71.04 | 20.5%                   | 17.0% | 14.9% | 12.3% |
|                            | 80    | 21.7%                   | 18.6% | 16.7% | 14.5% |
|                            | 90    | 23.0%                   | 20.2% | 18.5% | 16.6% |
|                            | 100   | 24.2%                   | 21.6% | 20.1% | 18.4% |
|                            | 110   | 25.4%                   | 22.9% | 21.5% | 20.0% |

## High Pakistan

### Financial Rate of Return

|                            |       | Gas input price, \$/MCM |       |       |       |
|----------------------------|-------|-------------------------|-------|-------|-------|
|                            |       | \$0                     | \$20  | \$30  | \$40  |
| Gas sales price,<br>\$/MCM | 0.211 |                         |       |       |       |
|                            | 60    | 23.4%                   | 18.1% | 14.7% | 10.6% |
|                            | 71.04 | 25.7%                   | 21.1% | 18.3% | 15.0% |
|                            | 80    | 27.5%                   | 23.2% | 20.7% | 17.9% |
|                            | 90    | 29.3%                   | 25.4% | 23.1% | 20.6% |
|                            | 100   | 31.0%                   | 27.3% | 25.3% | 23.0% |
|                            | 110   | 32.6%                   | 29.2% | 27.3% | 25.2% |

### NPV at Discount Rate of 17.5%

|                            |       | Gas input price, \$/MCM |       |        |        |
|----------------------------|-------|-------------------------|-------|--------|--------|
|                            |       | \$0                     | \$20  | \$30   | \$40   |
| Gas sales price,<br>\$/MCM | -116  |                         |       |        |        |
|                            | 60    | 312                     | -594  | -1,047 | -1,502 |
|                            | 71.04 | 790                     | -116  | -569   | -1,023 |
|                            | 80    | 1,177                   | 272   | -181   | -636   |
|                            | 90    | 1,610                   | 704   | 252    | -203   |
|                            | 100   | 2,043                   | 1,137 | 684    | 230    |
|                            | 110   | 2,476                   | 1,570 | 1,117  | 663    |

### NPV at Discount Rate of 17.5%

|                            |       | Gas input price, \$/MCM |       |       |        |
|----------------------------|-------|-------------------------|-------|-------|--------|
|                            |       | \$0                     | \$20  | \$30  | \$40   |
| Gas sales price,<br>\$/MCM | 801   |                         |       |       |        |
|                            | 60    | 1,398                   | 118   | -522  | -1,164 |
|                            | 71.04 | 2,081                   | 801   | 161   | -481   |
|                            | 80    | 2,635                   | 1,355 | 715   | 73     |
|                            | 90    | 3,254                   | 1,973 | 1,333 | 692    |
|                            | 100   | 3,872                   | 2,592 | 1,951 | 1,310  |
|                            | 110   | 4,491                   | 3,210 | 2,570 | 1,929  |

# Financial Analysis - 1

- In accordance with the Framework Agreement
- Risks – field, transport, market, political
- Transit fees - \$1 / 100km / MCM
- Rate of return = normal discount rate = 17.5%
- Tariff assumptions
  - Depreciation
  - Operating costs
  - Return on undepreciated assets
- Full-cost, capacity-offered principle
- Carbon emission v benefits
  - Direct and indirect

## Financial Analysis - 2

- NPV of gas revenues to Turkmenistan: No gas sale price escalation

### Pakistan Moderate

|  |     | Pipeline rate-of-return allowed for ('\$ million) |       |        |          |
|--|-----|---|-------|--------|----------|
|  |     | 10.0%   | 17.5% | 20.0%  | 25.0%    |
| Afghan Transit Fee \$<br>per 1000cm per<br>100km | 0.5 | \$2,465   | \$889 | \$364  | -\$688   |
|  | 0.8 | \$2,284   | \$708 | \$183  | -\$869   |
|  | 1.0 | \$2,162   | \$586 | \$61   | -\$991   |
|  | 1.3 | \$1,980   | \$404 | -\$121 | -\$1,173 |
|  | 1.5 | \$1,859   | \$283 | -\$242 | -\$1,294 |

### Pakistan High

|   |     | Pipeline rate-of-return allowed for (\$ million) |         |         |         |
|---|-----|--|---------|---------|---------|
|   |     | 10.0%  | 17.5%   | 20.0%   | 25.0%   |
| Afghan Transit Fee \$ per<br>1000cm per 100km | 0.5 | \$4,880  | \$3,322 | \$2,803 | \$1,763 |
|   | 0.8 | \$4,620  | \$3,062 | \$2,543 | \$1,503 |
|   | 1.0 | \$4,448  | \$2,890 | \$2,371 | \$1,331 |
|   | 1.3 | \$4,189  | \$2,630 | \$2,111 | \$1,071 |
|   | 1.5 | \$4,016  | \$2,457 | \$1,938 | \$898   |

# Financial Analysis - 3



## Conclusions

- **Project appears robust for all scenarios, except Pakistan Moderate.**
- **Trade-off for Afghanistan: lost tax revenue / transit fee**
- **Affordable gas purchase price from Dauletabad**
  - \$20, \$30, \$40 / MCM?
- **Gas entry price in Pakistan**
  - Now \$2 / MMBTU (\$71 / MCM)
  - But trend is upwards to match LNG imports

# Financial Analysis – 4

## Rates of return for various input and market prices



|                 |        |             |             | Gas input price, \$/MCM |             |                 |                 |
|-----------------|--------|-------------|-------------|-------------------------|-------------|-----------------|-----------------|
| Gas sales price | \$/MCM |             |             | \$40                    | \$58        | \$70            | \$80            |
|                 |        |             | 60          | 10.6%                   | negative    | negative        | negative        |
|                 |        | <b>FIRR</b> | <b>71</b>   | <b>15.0%</b>            | <b>6.5%</b> | <b>negative</b> | <b>negative</b> |
|                 |        |             | 80          | 17.9%                   | 11.2%       | 4.0%            | negative        |
|                 |        | <b>EIRR</b> | <b>88.8</b> | 20.3%                   | 14.7%       | 9.5%            | 2.5%            |
|                 |        |             | 100         | 23.0%                   | 18.3%       | 14.3%           | 10.0%           |
|                 |        |             | 110         | 25.2%                   | 21.0%       | 17.5%           | 14.1%           |

## Sensitivity Results

| Input Price in Turkmenistan |          | Market Price in Pakistan |          | FIRR% |
|-----------------------------|----------|--------------------------|----------|-------|
| \$/MCM                      | \$/MMBtu | \$/MCM                   | \$/MMBtu |       |
| 58                          | 1.63     | 77.5                     | 2.18     | 10.1  |
| 51                          | 1.44     | 71.04                    | 2        | 10.4  |
|                             |          |                          |          |       |
|                             |          |                          |          |       |



# Recommendations



- **Complete the audit of Dauletabad gas reserves**
- **Firm gas price and transit fee variables**
- **Address minefield clearance and security**
- **Move to the next stage of project development**

# Conclusion



- Thank you
- Discussion