Potential Extension of Natural Gas and Related Services in Northern Ireland

Feasibility Study Summary Report

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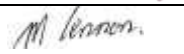
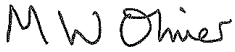
Mick Lennon Fingleton McAdam	Internal Approval		*5th March 2010*
Mark Oliver Fingleton McAdam	Approval for Issue		*5th March 2010*

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1.0 EXECUTIVE SUMMARY

1.1 Terms of Reference

The Department of Enterprise Trade and Investment, (DETI) in conjunction with the Utility Regulator commissioned Fingleton McAdam in August 2009 to carry out a feasibility study and high level cost benefit analysis (CBA) to determine at a strategic level the technical and economic feasibility of bringing gas to towns in the North-West and West of Northern Ireland. The study has focused on the following towns, all of which have a population of greater than 3,000 people: Strabane, Omagh, Magherafelt, Cookstown, Dungannon and Enniskillen. It also considers the potential for large industrial users adjacent to proposed routes.

1.2 Summary

1.2.1 Key findings

The key findings from the feasibility study and CBA analysis are as follows:

- Based on the individual corridors evaluated, the overall net present values (NPVs) are negative (for combined Distribution and Transmission) in every case (Table 1.2.1). Separating out Distribution and Transmission, the results suggest that the Distribution projects for all corridors generate positive NPVs, with the exception of Strabane which is marginally negative based on one set of assumptions. As a result all of the Transmission projects generate negative NPVs which are substantially negative for the longest corridor: Dungannon to Omagh and Enniskillen.

- Following the commercial assessment above, it is necessary in order to complete the full CBA to consider other benefits and costs that arise from the projects, albeit there is no actual income generated or expenditure incurred. The values of two such benefits are quantified (also included under Table 1.2.1):

  - Based on the likely incidence of fuel-switching, the carbon-intensities of various fuels, and the value of CO_2 emissions avoided, the present values of the environmental credit attaching to each corridor are calculated. In all cases, the values of the environmental benefits substantially exceed the positive NPVs on the Distribution projects. Connecting all of the 6 towns (Option 7) produces substantial environmental benefits of between £52m and £104m depending on the assumptions used. Including the environmental credit significantly improves the results for all projects.

  - The level of savings generated for customers who switch to gas have been estimated and are substantial in discounted terms over the forty years. Connecting all of the 6 towns (Option 7) generates a present value for savings to customers of between £65m and £89m depending on the assumptions used. The likelihood is that these increased savings make their way back to the local economy. Depending on what customers chose to do with those savings, they should result in increased economic activity across Northern Ireland.

*Table 1.2-1: Evaluations of Corridors in both Business Models**

Corridor No:	1. Portadown to Dungannon incl. Coalisalnd	2. Portadown to Dungannon and Cookstown	3. Portadown to Dungannon, Cookstown and Magherafelt	4. Portadown to Dungannon and Omagh	5. Portadown to Dungannon, Omagh and Enniskillen	6. NWP to Strabane	7. All Towns
BUSINESS MODEL 1							
NPV of cash flows (£000s) (before environmental credit)							
Distribution: NPV @ 7.5%	4,264	11,468	11,465	8,649	8,869	1,579	16,470
Transmission: NPV @ 6%	-14,330	-21,294	-21,940	-26,125	-40,058	-13,347	-51,073
Total NPV	**-10,066**	**-9,826**	**-10,474**	**-17,477**	**-31,189**	**-11,768**	**-34,604**
IRR of total cash flow (undiscounted)							
Year 40	2.4%	4.4%	4.6%	3.3%	2.2%	-0.5%	3.3%
PV Environmental Credit (£000s)							
(@DR of 3%/3.5%)	13,062	22,721	25,950	24,565	29,147	9,864	51,889
PV Customer Savings (£000s							
Year 40	13,791	22,217	31,557	29,819	39,886	6,906	64,558
BUSINESS MODEL 2							
NPV of cash flows (£000s) (before environmental credit)							
Distribution: NPV @ 7.5%	2,301	8,121	6,934	4,569	3,111	-240	9,480
Transmission: NPV @ 6%	-13,349	-19,364	-19,289	-23,331	-35,834	-12,309	-43,755
Total NPV	**-11,048**	**-11,244**	**-12,355**	**-18,762**	**-32,723**	**-12,548**	**-34,275**
IRR of total cash flow (undiscounted)							
Year 40	2.6%	4.4%	4.5%	3.6%	2.8%	0.7%	4.0%
PV Environmental Credit (£000s)							
(@DR of 3%/3.5%)	20,757	37,634	46,405	45,616	59,874	18,034	103,557
PV Customer Savings (£000s)							
Year 40	17,484	29,373	41,373	39,920	54,631	10,826	89,348

* The study was conducted using two Business Models BM1 and BM2. The primary difference between the two models is the assumed uptake for existing housing which has implications for the design of the distribution system and the level of associated capital/operational expenditure.

- Thus if these projects are to proceed it will be necessary to support the projects financially with some form of a subvention or a cross-subsidy. In regard to the latter, it should be noted that the CBA takes into account the increase in the postalised transmission tariff for customers in the six towns being evaluated. With a cross-subsidy, the postalised transmission tariff would increase for all gas customers across Northern Ireland, to reflect the increased investment (and volumes captured) in the six towns. Thus if the additional transmission revenues which would accrue from other customers across Northern Ireland were taken into account, the transmission projects would (assuming no change in gas demand/volumes) satisfy commercial investment criteria. Thus in this scenario, the transmission tariff increases for everyone in Northern Ireland and existing customers subsidise the new customers in the six towns. The project would not require a subvention in this case. The impact on the demand for gas as a result of the higher tariff has not been considered in this scenario.

There is a second scenario which would assume that the postalised transmission tariff is not increased across Northern Ireland in order to maintain the competitiveness of gas prices. In this event, the transmission projects would need to be supported by a public subvention from Government, if these projects are to proceed. Thus a potential licensee would require a subvention for each project to breakeven based on commercial investment criteria. The decision between the above two options or some combination of the two is a matter for the Utility Regulator. In the event that the second scenario is pursued, the subvention required would be equivalent to the negative NPVs generated based on the commercial assessment of each option (Table 1.2-1A).

*Table 1.2-1A: Level of subventions required to generate a commercial return on Transmission **

Option/Corridor	1	2	3	4	5	6	7
Business Model 1	14,330	21,294	21,940	26,125	40,058	13,347	51,073
Business Model 2	13,349	19,364	19,289	23,331	35,834	12,309	43,755

* The models use 6% as the rate of return that reflects a commercial return on transmission. The subvention is based on assuming no change in the postalised transmission tariff across Northern Ireland.

- The study results are very sensitive to the assumptions made about take-up rates and the capture of large loads. Given the environmental benefits of switching to gas in terms of reduced carbon emissions and the investment required to connect these six towns, it would seem desirable that potential public sector users would connect to gas. This would provide surety to a proportion of the anticipated load captured in the project evaluation.

- Contract customers account for 70% of the total industrial and commercial market captured over the forty years. These are substantial proportions and given that many of these large customers currently use HFO, they may not switch to gas with long contracts unless the current price differential is maintained[1]. The Base Case evaluations exclude potentially very large contract customers identified at Derrylin and Dungannon, for example, and might be considered relatively conservative as a result. It is clear from Sensitivity 3 (higher volumes), that the connection of one or two very large customers can change the viability of the corridors in an overall context. Where contract customers account for a high percentage of the load in a town, it may be necessary to get a commitment from such anchor loads, through some form of take-or-pay contracts, prior to the network extension being implemented. The exact approach would need to be worked out with the Utility Regulator.

[1] Although current future price comparisons reveal that the price differential between natural gas and HFO is 20ppt and that this differential will be maintained for the next four years for which future prices are available.

1.2.2 Other Issues

The study was conducted using two Business Models BM1 & BM2. The primary difference between the two models is the assumed uptake for existing housing which has implications for the design of the distribution system and the level of associated capital / operational expenditure. Business Model BM1 assumes a lower uptake (1.25%) with BM2 assuming 70% of existing housing. The Estimated Annual Consumption (EAC) and customer numbers for each of the towns (at year 40) are shown in Table 1.2-1 below.

Table 1.2-2 EAC & Customer Numbers

Town	Business Model BM1			Business Model BM2		
	No. of Customers	Therms (Million)	GWh	No. of Customers	Therms (Million)	GWh
Dungannon	1,789	4.0	118	5,324	5.7	168
Cookstown	827	3.3	96	4,143	4.9	143
Magherafelt	614	1.1	33	3,160	2.3	68
Omagh	2,039	3.6	104	8,174	6.5	191
Strabane	957	2.8	82	4,710	4.6	135
Enniskillen	1,432	1.5	43	5,876	3.6	105
Total	**7,658**	**16.3**	**476**	**31,387**	**27.6**	**810**

Note – The largest potential load in Dungannon, a brick manufacturing facility, has an EAC of 3.4 million therms. However, the site is not currently in production, and therefore this load is not considered in the base case scenario. The pipeline extension to Derrylin and associated capital / operational expenditure and revenue streams are also not considered in the base case. These are dealt with under Sensitivity 3.

The distribution capital expenditure for the towns also varies depending on the Business Model as can be seen in Table1.2-3 below.

Table 1.2-3 Distribution Capital Expenditure

Town	Business Model BM1	Business Model BM2
	Cost (£M)	Cost (£M)
Dungannon	5.8	14.7
Cookstown	3.6	11.9
Magherafelt	3.7	10.2
Omagh	5.9	21.3
Strabane	3.1	12.6
Enniskillen	4.4	15.6
Total	**26.5**	**86.3**

The distribution operational expenditure calculated is based on the town groupings within the various corridors under consideration in the study. These are shown in Table 1.2-4 below.

Table 1.2-4: Distribution Operational Expenditure

No.	Corridor	BM 1 £'000 p.a.	BM 2 £'000 p. a.
1	Portadown - Dungannon	367	467
2	Portadown - Dungannon - Cookstown	412	562
3	Portadown - Dungannon - Cookstown - Magherafelt	463	663
4	Portadown - Dungannon - Omagh	555	705
5	Portadown - Dungannon - Omagh - Enniskillen	608	808
6	Northwest Pipeline - Strabane	499	599
7	All Six Towns	1,608	1,808

The optimum technical and commercial solution for supplying natural gas to the six towns in the West / North-West of Northern Ireland is as follows:

Table 1.2-5: Optimum Gas Supply Solution

Town	Optimum Supply Solution	Capital Expenditure (£M)
Dungannon	28km 250mm dia. Transmission Pipeline from Derryhale AGI, Portadown	15.3
Cookstown	17km 150mm dia. Transmission Pipeline from Dungannon	8.7
Magherafelt	8km 315mm dia. PE 4bar supply from Cookstown	1.4
Omagh	38km 250mm dia. Transmission Pipeline from Dungannon	19.6
Enniskillen	35km 200mm dia. Transmission Pipeline from Omagh	16.1
Strabane	28km 150mm dia. Transmission Pipeline from North-West Pipeline	13.4
Total:		**74.5**
Derrylin (Option)	23km 200mm dia. Transmission Pipeline from Enniskillen	10.2

Note: One contract customer in Derrylin is responsible for the majority of the load. Supply of gas to Derrylin would depend on this potential customer converting to gas.

Given the cost of transmission, the question as to whether any of the transmission lines could be distribution lines instead is worth considering. From a consideration of the various supply options, the technical assessment concluded that the optimum supply solution to provide gas to the towns is 85 bar transmission. Given the costs associated with transmission pipelines, the alternative solutions of 4 & 7 bar distribution supply lines were evaluated. From a consideration of the various supply options, the technical assessment concluded that due the distances between towns and the 40 year load

projections, the optimum supply solution is 85 bar transmission to all towns except Magherafelt.

The selected transmission pipeline routes while, having some difficult terrain (especially Enniskillen / Derrylin corridor) do not present any adverse environmental or construction conditions preventing installation by standard pipelining techniques.

Why promote gas?

The Northern Ireland authorities are keen to develop a natural gas market in Northern Ireland and in particular in the West of Northern Ireland for a number of reasons, including the environmental benefits of switching to gas via reduced carbon emissions, the increased fuel choice and savings for consumers, the diversification of energy sources and to make the province more attractive from the perspective of overall business investment, including foreign investors.

The rationale for extending the gas network is supported by various policies at an EU and UK level and is contained in the Draft Strategic Energy Framework for Northern Ireland, which sets out the four key goals of energy policy, namely competitiveness, security of supply, sustainability and infrastructure.

Gas Tariffs

The 'breakeven' Distribution tariffs generated in the Business Models, with the possible exception of those generated for Strabane, are competitive with current Heavy Fuel Oil (HFO) and gas oil prices. The total value of the savings for customers who switch to gas has been estimated at £89m (BM2) based on the volumes captured in all six towns (Option 7) over a forty year period. The likelihood is that these increased savings make their way back to the local economy, generating increased economic activity across Northern Ireland.

The impact of the roll out of the gas network on the postalised transmission tariff in Northern Ireland is that it increases by between 2.9% (Strabane corridor) and 11.3% (Enniskillen corridor). When all corridors are evaluated as one project, the overall increase in the transmission tariff is 14.7%.

The models do not take account of the impact on the demand for natural gas in the event of 1) an increase in the Transmission tariff or 2) an increase in the price of gas from the increases implied by the carbon credit valuations used. However, it is the case that a carbon tax, while resulting in an increase in all fossil fuel prices, will give natural gas a competitive advantage vis-à-vis oil and coal products.

Evaluation results

The evaluation exercise considers the Distribution and Transmission businesses separately for the seven individual options. Thus any surpluses which arise on the Distribution project would not be expected to be used to make up any shortfalls which arise on the Transmission project.

The results of the evaluation exercise (Table 1.2-1) show that all corridors generate positive NPVs in respect of Distribution in both business models, with the exception of Strabane, which is marginally negative in BM2 (-£240,000). Thus excluding the latter, it can be concluded that the distribution component of each project does not require a subvention, based on the assumed volumes captured and the estimated capital and operating costs.

In regard to the Transmission element all of the corridors generate negative NPVs. The NPVs are substantially negative for the Dungannon to Omagh and Enniskillen corridor (Option 5) at £40m in BM1 and £36m in BM2. The negative NPVs are explained by the very high transmission capital costs for each corridor and the volumes captured, which are

not sufficient to cover the capital and operating expenditures, based on a 6% rate of return. It can therefore be concluded that the transmission component of each project will require a subvention, if the projects are to go ahead.

How can the projects proceed?

There are two scenarios which could be considered for proceeding with these projects. The first assumes that the postalised transmission tariff increases for all customers across Northern Ireland to reflect the increased investment (and higher volumes) arising from the extension to the six towns. If the full increase in the transmission tariff is implemented, the projects would not require a subvention. Existing customers across Northern Ireland would subsidise the new customers in the six towns.

In the second option, the focus is on maintaining competitive gas prices, and thus the transmission tariff is not increased across Northern Ireland. The required level of subvention in this case would have to be sufficient to enable the cash flows including the subsidy to satisfy commercial investment criteria. The transmission element of the project uses 6% as the rate that reflects commercial returns in current licensing agreements. Thus the subventions would be equivalent to the financial deficits generated on the transmission projects in the CBA, before taking into account any non-commercial or external benefits. The decision between the above two options or some combination of the two is a matter for the Utility Regulator. In the event that the second scenario is pursued, the subvention required would be equivalent to the negative NPVs generated based on the commercial assessment of each option (Table 1.2-5).

*Table 1.2-5: Level of Subvention Required for Transmission**

No.	Corridor	Business Model 1 £000	Business Model 2 £000
1.	Portadown- Dungannon	14,330	13,349
2.	Portadown - Dungannon - Cookstown	21,294	19,364
3.	Portadown - Dungannon - Cookstown - Magherafelt	21,940	19,289
4.	Portadown - Dungannon - Omagh	26,125	23,331
5.	Portadown - Dungannon - Omagh - Enniskillen	40,058	35,834
6.	NWP - Strabane	13,347	12,309
7.	All 6 Towns as one single project	51,073	43,755

* Based on a 40 year time horizon and assuming no change in the postalised Transmission Tariff across Northern Ireland.

Environment benefit and cost per tonne of carbon reduced

The inclusion of environmental credits significantly improves the financial viability of the corridors. These credits are based on Government guidelines for valuations for the tonnes of emissions saved and how the cost of carbon should be factored into a CBA.

One measure of the cost of moving to a lower carbon economy, based on a roll out of the gas network, is the cost per tonne of carbon reduced. As BM1 produces the highest subventions, the cost per tonne of carbon reduced is highest in this model. It ranges from

£76/tonne for Corridor 3 (Dungannon, Cookstown and Magherafelt) to £132 for Corridor 5 (Dungannon to Omagh and Enniskillen).

Assessment of non-monetary benefits

The non-monetary benefits focus on the economic case for extending the gas network and the extent to which natural gas facilitates economic development. For the projects which generate negative NPVs, the question arises as to whether these non-quantifiable benefits are sufficient to bridge the gap on the commercial appraisal? Given concerns about the cost of electricity in Northern Ireland however, the availability of gas would provide a competing and competitive fuel source.

Sensitivities

The Business Models are tested for changes in a number of the key assumptions. There are four in total, the results of which are contained in the Summary Tables at the end of Section 1.7:

- A lower Discount Rate for Distribution: 5% versus 7.5% in the Base Case
- A lower Distribution Tariff: 27ppt versus 32ppt
- Higher volumes: based on including the large contract loads at Derrylin and Dungannon and assuming that 90%[2] of contract customers are captured plus 100% of new housebuilding captured compared with 50% in the Base Case.
- Distribution capital expenditure down by 10%

The Business Models are tested for changes in a number of the key assumptions, mostly to do with changes in the assumptions for the Distribution component of the models. A lower discount rate (5%) and a reduction in distribution capital expenditure (-10%) both improve the NPVs on the distribution across all corridors. Conversely, the lower distribution tariff, 27ppt versus 32ppt, reduces the Distribution NPVs and generates negative NPVs for Enniskillen (Option 5), Strabane (Option 6) and All Towns (Option 7) in BM2.

The third test illustrates how sensitive the model is to changes in the very large loads. The connection of one or two very large customers can change the viability of the corridors in an overall context. However, as the Transmission portion of each project remains negative when the higher volumes are assumed, the projects would continue to require a subvention, albeit less than in the Base Case. In BM1 when all town are connected the subvention amounts to £45m compared with £37m under BM2 compared with £51m and £44m respectively in each Base Case.

Based on the evaluations conducted, the extension of the gas network would clearly make a positive contribution to the goals of energy policy in Northern Ireland in terms of improving security of supply, reducing emissions and sustainability.

Ultimately the choice, in the case of projects which require a public subvention, has to be between the range of infrastructural projects that could be undertaken in the North West and West of NI, that generate positive or less negative NPVs.

1.3 Scope & Methodology

The scope of the study includes:

- Survey and evaluation of the potential gas loads for each town
- Selection of the optimum gas supply option for each
- High level distribution & transmission engineering design
- Cost estimates +/- 20% for both transmission & distribution systems

[2] The 90% assumes 100% of large contract loads from Dungannon and Derrylin and 80% of other contract customers.

- Preliminary routing and environmental considerations for transmission pipelines
- High level Cost Benefit Analysis for each of the chosen pipeline route corridors.

The following methodology was adopted to conduct the study:

- Desktop study for the various supply options available
- Survey of each of the towns to establish estimates of gas loads
- Consultation process with all interested parties including large potential customers
- Vantage point survey and environmental / constructability evaluation of each transmission pipeline route
- Transmission and distribution design
- Capital and operational cost estimates derived for both transmission and distribution systems within each of the selected corridors
- Distribution tariff derived for each of selected corridors
- Average postalised transmission tariff evaluated for each corridor
- A Strategic Outline Business Case (SOBC)/cost benefit analysis conducted for each pipeline corridor in accordance with the Northern Ireland Practical Guide to the Green Book[3] where appropriate.
- Sensitivity analysis is carried out to test changes in a number of the more important assumptions.

1.4 Key Assumptions

The followings key assumptions were made in the process of conducting the study:

1.4.1 Business Models

As previously detailed in 1.2.2 the study is conducted on the basis of two Business Models (BM1 & BM2). BM1 assumes a small proportion i.e. 1.25% of total existing households will be connected while BM2 assumes 70% will be connected.

1.4.2 Load Analysis

Existing Housing:

The 2008 estimate for existing housing was extrapolated from 2001 census and 2006 estimates from Northern Ireland Statistics and Research Agency (NISRA). These are summarised in the Table 1.4-1 below:

Table 1.4-1: Estimates of Existing Housing

Town	2008 Estimate	
	Population	Number of Households
Dungannon	12,924	4,778
Cookstown	11,745	4,481
Magherafelt	9,227	3,420
Omagh	21,639	8,270
Strabane	13,937	5,104
Enniskillen	14,648	6,012

The Estimated Annual Consumption (EAC) for each existing household connection is taken as 480 therms.

[3] The Green Book is the name given to the HM Treasury Guide "Appraisal and Evaluation in Central Government" (ISBN 0115601074) which is available together with supplementary guidance on the Treasury website at http://www.hmtreasury.gov.uk/Economic_Data_and_Tools/Greenbook/data_greenbook_index.cfm

New Housing:

The new build assumptions for each town were derived based on a review of historical house building levels over the past five years and following consultation with DOE Planning Service. The 40 year projections are summarised in Table 1.4-2 below.

Table 1.4-2: Estimates of New Housing

Town	New Housing Units
Dungannon	3,125
Cookstown	1,210
Magherafelt	890
Omagh	3,540
Strabane	1,610
Enniskillen	2,470

The Estimated Annual Consumption (EAC) for each new residential connection is 400 therms.

Industrial / Commercial:

From town surveys a list of potential users was compiled. Large I/C load estimates were derived from direct discussions with the potential customers. Carbon allocations for each site were also used to cross check the size of estimated load. Potential I/C customers were divided into categories depending on EAC as summarised in Table 1.4-3 below.

Table 1.4-3: I/C Customer Categories

Customer Category	EAC (therms)
Contract I/C	EAC > 75,000
Large I/C	25,000 < EAC < 75,000
Medium I/C	2,500 < EAC < 25,000
Small I/C	EAC <2,500

Uptake Rates:

As all potential customers will not connect to the natural gas network certain assumptions need to be made about customer uptake or the extent of market penetration. Two potential contract customers have not been considered (refer section 1.2). It is assumed that 80% of the remaining potential contract customers are connected. The following uptake rates over the 40 year period have been assumed for the various business models.

Table 1.4-4: Customer Uptake Rates Estimates

Customer Category	Uptake Rates	
	BM1	BM2
I/C (Contract & Large)	80%	80%
I/C (Medium & Small)	70%	70%
New Domestic	50%	50%
Existing Domestic	1.25%	70%

1.4.3 Network Design

Transmission System

Pipeline sizing for transmission was based on the forecasted 40 year loads. The following criteria were used in deriving the optimum pipe diameter.

- Minimum Inlet Pressure: 50bar
- Minimum Terminal Pressure: 22bar
- Gas Velocity: 11 – 15 m/s

Note: Currently the stated minimum pressure in the South North Pipeline is 35bar.

Distribution System

The pipe sizing for distribution system was based on the projected 40 year loads. The following criteria were used in deriving the optimum pipe diameter.

- Minimum Inlet Pressure: 4 bar
- Minimum Terminal Pressure: 2 bar
- Gas Velocity: 11 – 15 m/s

A 75mbar system was chosen in the town centres as metering & regulation will have to be within buildings.

1.4.4 Capital Expenditure (CAPEX)

The following assumptions were made in deriving the capital cost estimates:

- Budget level of accuracy: +/- 20% (as is appropriate for a Level 1 Study)
- Exchange Rate: €1= £0.85
- Cost base year: 2008/09
- Construction & material rates used are based on current and previous similar projects (no quotations sought)

1.4.5 Operational Expenditure (OPEX)

The following assumptions were made in deriving the distribution operational cost estimates:

- These towns are similar to the towns where distribution licence exists
- Emergency response requirements are as that for current distribution areas
- Marketing & Sales costs are in line with current distribution areas

The annual transmission operational costs were assumed to be equivalent to 1.6% of the capital expenditure which is similar to that used in previous studies.

1.4.6 Cost Benefit Analysis (CBA)

The high level cost benefit analysis (CBA) conducted to determine at a strategic level the technical and economic feasibility of bringing gas to towns in the North West and West of Northern Ireland presents two Business Models (BM1 & BM2). The evaluations are carried out in both models over a forty year time horizon, which reflects the licence period. The results of the evaluations for both models are summarised in the Tables at the end of Section 1.7.

Each business model

- Considers the full economic costs, including capital and operating costs, and the full economic benefits of bringing gas to the selected towns and corridors.
- Calculates the total gas sales volumes, the total number of customers/ connections, transmission and distribution revenues and net cash flows for distribution and transmission separately.
- Values the benefits (gas volumes) by applying the distribution tariff and the average postalised onshore transmission tariff for each corridor to ascertain total revenues over the lifetime of the project.
- Produces separate net present values for the Distribution and Transmission elements of each corridor.
- Identifies and values (where possible) any externalities associated with each selected route/corridor.
- Where monetary values cannot be established for other externalities, the CBA includes a qualitative assessment of such externalities.

1.5 Towns Analysis

1.5.1 Approach

Surveys & Consultation:

The designated towns together with other population centres close to the pipeline corridors were surveyed. A consultation process was entered into with all the public bodies and major stakeholders including potential large industrial customers to evaluate:

- Existing potential customers
- Potential for future I/C and residential development
- Any areas which could facilitate the development of the gas network

Evaluation of Potential Loads:

From the town surveys the total potential gas loads for each were estimated and are summarised in Table 1.5-1 below:

Table 1.5-1: Total Potential Load Estimates

Customer Category / Town	Therms (Million)				GWhr			
	I/C	New Housing	Existing Housing	Total	I/C	New Housing	Existing Housing	Total
Dungannon	7.7	1.3	2.5	**11.5**	227	37	72	**336**
Cookstown	3.9	0.5	2.3	**6.7**	113	14	68	**195**
Magherafelt	1.2	0.4	1.8	**3.4**	35	10	52	**97**
Omagh	3.6	1.4	4.3	**9.3**	105	41	126	**272**
Strabane	3.1	0.6	2.6	**6.3**	91	19	77	**187**
Enniskillen	1.2	1.0	3.1	**5.3**	36	29	91	**156**
Derrylin	9.4	-	-	**9.4**	275	-	-	**275**

Note – The largest potential load in Dungannon, a brick manufacturing facility, has an EAC of 3.4 million therms. However, the site is not currently in production, and therefore this load is not considered in the base case scenario. The pipeline extension to Derrylin and associated capital and operational expenditure and revenue streams are also not considered in the base case. These are dealt with under Sensitivity 3.

Selected Route Corridors:

Based on the transmission supply options as detailed in Section 1.6.1 the towns have been grouped depending on their geographic location within the selected corridor and their dependence on other towns within the chosen corridor being connected to the transmission network. The selected corridors and groupings which are evaluated in the CBA are as follows:

- Corridor 1: Portadown – Dungannon
- Corridor 2: Portadown – Dungannon – Cookstown
- Corridor 3: Portadown – Dungannon – Cookstown – Magherafelt
- Corridor 4: Portadown – Dungannon – Omagh
- Corridor 5: Portadown – Dungannon – Omagh – Enniskillen
- Corridor 6: North-West Pipeline – Strabane
- All Six Towns

The distribution operational costs reflect these groupings within each corridor.

High Level Distribution Design:

The distribution system will consist of in the majority a 4bar system with 75mbar system being required in town centres. The distribution mains are routed to supply the major I/C loads. Residential loads were taken into account in the sizing of mains but not in the routing of the main spine of the distribution system. In order to obtain a cost of supplying residential loads a length of main was apportioned to each connected customer based on existing systems.

1.5.2 Load Analysis

Table 1.5-2 below summarises the EAC and customer numbers within the two Business Models being considered in the study.

Table 1.5-2: Estimated Annual Consumption

Customer Category	BM 1			BM 2		
	No. Customers	Therms (Million)	GWh	No. Customers	Therms (Million)	GWh
Dungannon						
I/C	162	3.4	99	162	3.4	99
New Housing	1,563	0.6	18	1,563	0.6	18
Existing Housing	64	0.03	0.9	3,599	1.7	51
Year 40 Totals	**1,789**	**4.0**	**118**	**5,324**	**5.7**	**168**
Cookstown						
I/C	162	3.0	88	162	3.0	88
New Housing	605	0.2	7	605	0.2	7
Existing Housing	60	0.03	0.8	3,376	1.6	47
Year 40 Totals	**827**	**3.3**	**96**	**4,143**	**4.9**	**143**
Magherafelt						
I/C	123	0.9	27	123	0.9	27
New Housing	445	0.2	5	445	0.2	5
Existing Housing	46	0.02	0.6	2,592	1.2	36
Year 40 Totals	**614**	**1.1**	**33**	**3,160**	**2.3**	**68**
Omagh						
I/C	157	2.8	82	157	2.8	82
New Housing	1,770	0.7	21	1,770	0.7	21
Existing Housing	112	0.05	1.6	6,247	3.0	88
Year 40 Totals	**2,039**	**3.6**	**104**	**8,174**	**6.5**	**191**
Strabane						
I/C	84	2.5	72	84	2.5	72
New Housing	805	0.3	9	805	0.3	9
Existing Housing	68	0.03	1.0	3,821	1.8	54
Year 40 Totals	**957**	**2.8**	**82**	**4,710**	**4.6**	**135**
Enniskillen						
I/C	116	0.9	27	116	0.9	27
New Housing	1,235	0.5	14	1,235	0.5	14
Existing Housing	81	0.04	1.1	4,525	2.2	64
Year 40 Totals	**1,432**	**1.5**	**43**	**5,876**	**3.6**	**105**

1.5.3 Distribution Capital & Operational Expenditure

Distribution Capital Expenditure

The distribution capital expenditure is based on 2009 rates with a +/-20% margin of error. The cost for service connections is based on the estimated main length, diameter and the class of metering required for each customer category.
The total distribution system capital expenditure estimate for all towns are summarised in the Table 1.5-3 below. These costs include 4bar and 75mbar mains, district pressure reduction units and service connection costs. The major difference between cost in BM1 and BM2 is the inclusion of existing housing as detailed earlier.

Table 1.5-3: Distribution Capital Expenditure

Town	Business Model BM1	Business Model BM2
	Cost (£M)	Cost (£M)
Dungannon	5.8	14.7
Cookstown	3.6	11.9
Magherafelt	3.7	10.2
Omagh	5.9	21.3
Strabane	3.1	12.6
Enniskillen	4.4	15.6
Total	**26.5**	**86.3**

Distribution Operational Expenditure

The distribution operational expenditure calculated is based on the town grouping within the various corridors under consideration in the study. These are as detailed in Section 1.5.1 earlier. The costs are dependent on factors such as distance between each town, response / on-call repair crew requirements, location of depot, sales and engineering requirements. The estimates for operational expenditure for each town are shown in Table 1.5-4 below.

Table 1.5-4: Distribution Operational Expenditure

No.	Corridor	BM 1 £'000 p.a.	BM 2 £'000 p.a.
1	Portadown - Dungannon	£367	£467
2	Portadown - Dungannon - Cookstown	£412	£562
3	Portadown - Dungannon - Cookstown - Magherafelt	£463	£663
4	Portadown - Dungannon - Omagh	£555	£705
5	Portadown - Dungannon - Omagh - Enniskillen	£608	£808
6	Northwest Pipeline - Strabane	£499	£599
7	All Six Towns	£1,608	£1,808

1.6 Transmission Networks

1.6.1 Route Corridor Selection

Environmental, Planning and Construction Considerations

The initial step in corridor selection was to conduct a desk top study using 1:250,000 mapping to establish the various supply options for each town. This evaluation considered proximity to existing transmission networks, proposed future developments and possible alternatives that may have been considered in previous studies. The criteria used to establish the optimum route corridor were:

- Load and supply pressure requirements for each town
- Shortest feasible transmission pipeline distance
- Location and suitability of the offtake connection
- Capacity and supply pressure of existing network

Other key issues considered were Environmental and Planning Legislation, and ease of construction. This involved gathering information on the following issues for the desktop study:

- Centres of population and proposed zones of future development;
- Statutory national and international designated sites (such as AONB, ASSI, SPA, SAC, etc);
- Engineering considerations (suitability of road network for pipeline routing. Rivers, railways and other major pipelines to be crossed, difficult ground conditions, etc);
- Geology, hydrology, soils and land use;
- Mineral extraction and known areas of landfill and contaminated land;
- Landscape and topography;
- Nature conservation;
- Archaeology
- The proposed start and finish points.
- The use of the existing road network if suitable.
- Avoidance as far as practical of major environmental, amenity and engineering features.
- Avoidance of potentially difficult construction areas (e.g. steep sided slopes, complex river crossings, poor ground conditions, etc).
- Avoidance of main population centres as far as is practicable.
- The shortest distance between the start and finish points.

The choice of suitable corridors was finally established following a desktop study of the data obtained and roadside surveys from public vantage points. It excluded consultation with any of the relevant authorities. Environmental Constraint Maps were prepared accompanied by detailed archaeological desktop studies/maps showing the wide ranging and local features within the preferred corridor.

Within the preferred corridor a route was then chosen to avoid developed areas, give clearance to individual properties and avoid natural features and protected areas as much as possible. Crossings within the sections were identified and other salient points noted. The supply routes are described below and shown on Fig 1.6.1 at end of this Section.

Route Description

The preliminary route proposed commences at the Derryhale AGI, which is to be supplied from the existing North-South pipeline. The route progresses northwest for a distance of 28 km to Dungannon AGI, situated to the north of Dungannon town. From here, a 17 km section continues north to Cookstown AGI. A 12.5 km 4 bar PE 100 pipeline will serve the town of Magherafelt from the Cookstown AGI.

From the Dungannon AGI, a 38 km section continues west towards the Omagh AGI, located to the south of the town. The pipeline continues for 35 km to the Enniskillen AGI, and then progresses to the Derrylin AGI, a further distance of 23 km.

An additional 28 km pipeline will commence at a hot-tap tee on the existing North-West pipeline, to serve the town of Strabane.

Portadown to Dungannon (approx. 28km)
BGE / the Utility Regulator currently plan to extend the transmission system westward with 250mm diameter spur line from the South-North Pipeline (Kernan AGI) to Derryhale outside Portadown. The optimum option for supplying Dungannon is a 28km 250mm diameter transmission line from Derryhale AGI. Factors affecting this route are:

- The M1, two A class roads, five B class roads, twenty three C class roads,
- A major river crossing of the Blackwater and approximately twenty three minor river and stream crossings.

Dungannon to Cookstown (approx. 17km) and Magherafelt (approx.12.5km)
The optimum supply route for Cookstown is 150mm diameter transmission spur line from Dungannon AGI an approximate distance of 17km.

The optimum supply option for Magherafelt is 8 km 315mm PE 4bar supply routed along the A29 via Moneymore from Cookstown AGI. This also has the added advantage of being able to supply a large I/C load (Northstone) on route. Factors affecting the route are:

- The developed area and the steep river valley in the vicinity of Newmills.
- One medium sized river crossing of the Ballinderry River near Cookstown and approximately seven smaller river and stream crossings
- Three B class road and eleven C class road crossings.
- The route along the steep river valley at Donaghy will need careful consideration.

Dungannon to Omagh (approx.38km)
The only supply option currently available is the continuation of the 250mm transmission line from Dungannon. The overall length from Dungannon is 38km. Factors affecting this route are:

- One A class road, two B class roads and forty-one C class road crossings.
- Thirty one river and stream crossings of which six have significant flows and wide channels.
- Six stretches of bog land some of which are extensive.
- Steep sections through Esker and Cranlome Hill.
- Three local conservation areas along the Torent river valleys at Donaghmore and south of Parkanour Forest Park and along the river valley south of Crockrawer

Omagh to Enniskillen (approx. 35km)
The optimum solution at this time would be a 58km pipeline from Omagh to Derrylin via Enniskillen. Factors affecting this route are:

- One A class road, two B class roads twenty-six C class road crossings.
- Approximately twenty small river and stream crossings and one larger river crossing of the Quiggery Water.
- The route travels through two major sections of peat land at the Enniskillen end and there are other small areas of bog en-route, these will require a detailed assessment pre-construction.
- The agricultural land along the route is generally of average quality with sloping hills and areas of upland bog.

Enniskillen to Derrylin (approx. 23km)

The optimum solution at this time would be a 58km pipeline from Omagh to Derrylin via Enniskillen. Factors affecting this route are:

- The main crossing of the Upper Lough Erne river
- Four A class roads crossings, one B class road, and ten C class road crossings.
- Fifteen small stream / river crossings and two medium sized river crossings.

Strabane

The optimum supply option is a 28 km 150mm diameter pipeline from the North-West Pipeline. Factors affecting the route are:

- Three A class road crossings and twenty six C class road crossings.
- Three small river and stream crossings and one larger river crossing of the River Faughan.


FIGURE 1.6.1
POTENTIAL TRANSMISSION ROUTES
LEGEND:
Existing Pipelines
Proposed 2010 Pipelines
Potential Routes
Potential 4 Bar Feeder Main
PIPELINE LENGTHS:
Portadown to Dungannon: 28km
Dungannon to Cookstown: 17km
Cookstown to Magherafelt: 8km
Dungannon to Omagh: 38km
Omagh to Enniskillen: 35km
Enniskillen to Derrylin: 23km
Strabane to North-West Pipeline: 28km
NORTH-WEST PIPELINE
SOUTH-NORTH PIPELINE
STRABANE
MAGHERAFELT
COOKSTOWN
OMAGH
DUNGANNON
PORTADOWN
ENNISKILLEN
DERRYLIN
DONEGAL
TYRONE
FERMANAGH
LEITRIM
MONAGHAN
ARMAGH
DOWN
ANTRIM
LONDONDERRY
INISHOWEN
BELFAST
LOUGH NEAGH
NORTH CHANNEL
IRISH SEA
N

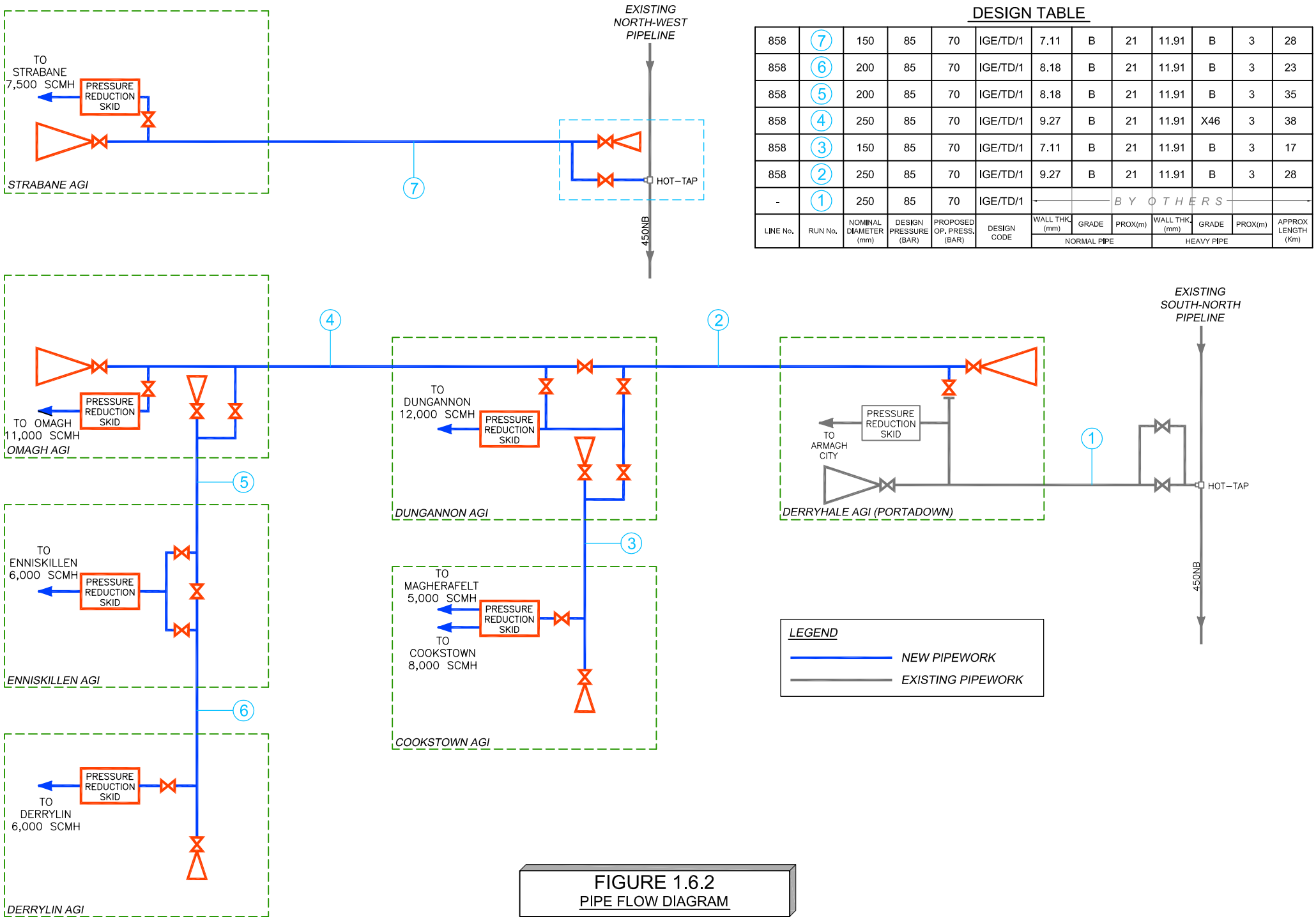
1.6.2 Network Design

The transmission system is designed in accordance with the parameters set out in Section 1.4.3. The Pipeline Flow Diagram (PFD) of the transmission system is shown on Fig. 1.6.2 over page.

The pipeline design caters for the full extent of the total 40 year potential load estimate, including an onward connection from Enniskillen to Derrylin.

Currently the South-North Pipeline (SNP) has design minimum operating pressure of 35bar. In order to optimise the pipelines sizes this minimum pressure will have to be increased to 40bar by year 9 with further increases up to 50bar by year 40 to achieve a required minimum outlet pressure of 22bar at Derrylin. At this time it is not possible to predict what the operational requirements of the network will be in Year 9 or if the minimum operating will remain as low as 35bar. For the purposes of this study, given the time duration of nine years it is accepted that no additional reinforcements (i.e. additional compression) will be required to supply the proposed networks.

For a 150mm nominal diameter (6 inch) pipeline serving Strabane, a minimum inlet pressure of 30bar is required at the NWP offtake. This pressure is achievable in the NWP at the offtake without further reinforcement. However, if allowance is to be made for a future connection of Letterkenny from this pipeline, a 40 bar inlet pressure or a 200 mm diameter pipe will be required.



DESIGN TABLE

LINE No.	RUN No.	NOMINAL DIAMETER (mm)	DESIGN PRESSURE (BAR)	PROPOSED OP. PRESS. (BAR)	DESIGN CODE	NORMAL PIPE WALL THK. (mm)	NORMAL PIPE GRADE	NORMAL PIPE PROX(m)	HEAVY PIPE WALL THK. (mm)	HEAVY PIPE GRADE	HEAVY PIPE PROX(m)	APPROX LENGTH (Km)
858	7	150	85	70	IGE/TD/1	7.11	B	21	11.91	B	3	28
858	6	200	85	70	IGE/TD/1	8.18	B	21	11.91	B	3	23
858	5	200	85	70	IGE/TD/1	8.18	B	21	11.91	B	3	35
858	4	250	85	70	IGE/TD/1	9.27	B	21	11.91	X46	3	38
858	3	150	85	70	IGE/TD/1	7.11	B	21	11.91	B	3	17
858	2	250	85	70	IGE/TD/1	9.27	B	21	11.91	B	3	28
-	1	250	85	70	IGE/TD/1	BY OTHERS						

FIGURE 1.6.2
PIPE FLOW DIAGRAM

1.6.3 Budget Estimates and Schedules

Estimated Capital Expenditure

The transmission capital expenditure budget estimate +/-20% based on preliminary routing and the selected design is shown in Table 1.6-1 below.

Table 1.6-1: Transmission Capital Expenditure

Pipeline	Expenditure (£M)
Derryhale AGI - Dungannon	£15.3
Dungannon - Cookstown	£8.7
Cookstown - Magherafelt**	£1.4
Dungannon - Omagh	£19.6
Omagh - Enniskillen	£16.1
North West Pipeline - Strabane	£13.4
Total	**£74.6**
Enniskillen - Derrylin (Option)	£10.5
** 4 barg Supply Main	

Operational Expenditure

As detailed previously in section 1.4.5 the operational cost were derived as percentage (1.6%) of the capital cost.

Table 1.6-2: Transmission Annual Operational Expenditure

Pipeline	Expenditure (£000)
Derryhale AGI - Dungannon	£245
Dungannon - Cookstown	£139
Cookstown - Magherafelt**	£23
Dungannon - Omagh	£313
Omagh - Enniskillen	£258
North West Pipeline - Strabane	£215
Enniskillen - Derrylin (Option)	£168
** 4 barg Supply Main	

Project Schedules

Cross-country transmission pipeline projects generally evolve through 3 key stages, design, planning and construction. Fingleton McAdam's experience of gas pipelines is that each stage in this process takes approximately 9 - 12 months, with an overall project schedule of 3 years. However significant time savings may be made through careful planning/design.

1.7 Cost Benefit Analysis (CBA)

1.7.1 CBA Principles

The CBA follows closely the principles, guidelines and requirements for project appraisal set out by HM Treasury Green Book Guidelines (2003) and in the Northern Ireland Practical Guide to the Green Book. As previously noted, two business models are presented, Business Model 1 (BM1) and Business Model 2 (BM2) evaluating the selected corridors over a forty year time horizon. The results of the evaluations for both models are summarised in the Tables at the end of Section 1.7.

The CBA comprises an assessment of needs, objectives, options, costs, benefits, and other non-quantifiable factors relevant to the individual pipeline projects. Armed with all of this information, the strategic outline business case (SOBC) is presented for the gas pipelines/corridors under consideration. A number of sensitivities are also examined to test changes in the key assumptions. The results of the sensitivities - four in total - are also summarised in the Tables at the end of Section 1.7.

1.7.2 The Strategic Context

In a European context, many countries have adopted national programmes aimed at reducing emissions. At the EU level various policies and measures have been adopted through the European Climate Change Programme, including achieving a target of 20% of total EU primary energy use through renewable energy and reducing greenhouse gas emissions by at least 20% by 2020. Reducing greenhouse gas emissions and increasing the use of renewable energies will generate a more diversified energy supply for Europe.

In an environment of traditionally high energy costs in Northern Ireland (relative to the UK and EU), there is an ever increasing focus of policy on energy efficiency and emissions reduction. The Draft Strategic Energy Framework for Northern Ireland[4] sets out four key energy goals which are considered critical to tackling energy efficiency and emissions reduction, namely competitiveness, security of supply, sustainability and infrastructure.

The Utility Regulator echoes the Draft Strategic Energy Framework for Northern Ireland in its Corporate Strategy (2009-2014) when reaffirming its aim to expand the gas industry.[5] The Utility Regulator believes that the attractiveness of natural gas is likely to increase as fuel prices become more related to the level of carbon emissions. It also acknowledges the economic reasons for promoting gas, such as increased fuel choice and savings for consumers in Northern Ireland and the diversification of energy sources, which would generate competition. This should put downward pressure on the price of all energy supplies, an important aim for Northern Ireland, where the cost of energy remains a major concern.

Northern Ireland has benefited from an exemption from the Climate Change Levy for natural gas since it was introduced in April 2001. The exemption has encouraged non-domestic customers to switch to gas with obvious environmental benefits. With the exemption due to end in March 2011 a further extension would encourage greater switching to gas, thereby reducing emissions further.

[4] http://www.detini.gov.uk/cgi-bin/downutildoc?id=2470
[5] http://www.niaur.gov.uk/uploads/publications/Corporate_Strategy_2009-14.pdf

1.7.3 Costs and Benefits – quantifiable

The main costs comprise the Distribution and Transmission capital and operational expenditures. Both the Distribution capital and operational expenditure are higher for Business Model 2 as detailed earlier.

The direct benefits comprise the Distribution and Transmission transportation revenues generated by the gas volumes captured over a forty year period.

Distribution tariffs

The evaluation models derive the 'breakeven' Distribution tariff for each corridor which allows the licensee to recover all of the costs associated with each town as it is connected to the network. The 'breakeven' tariffs calculated for each option range between 15-26 pence per therm (ppt) in BM1 and 22-33ppt using BM2. All seven options evaluated in both models, with the exception of Strabane in BM2, produce lower Distribution tariffs compared with the current weighted average conveyance charge of 32ppt based on current licences for gas distribution in Northern Ireland. The models assume a distribution tariff of 32ppt, on the basis that the profile of customers for existing licence holders would not differ substantially for a new potential licence holder. On the basis of 32ppt, Strabane is a marginal case.

Thus all corridors, except Strabane (in BM2) generate positive NPVs on Distribution alone, reflecting the gap between the calculated 'breakeven' distribution tariffs and the tariff of 32ppt used in the models. However should the volumes captured be overstated, the Distribution Tariffs would be higher, although variable distribution costs would decline somewhat.

Based on an analysis of a 'viable' gas tariff, the 'breakeven' gas distribution tariffs were found to generate natural gas prices which are competitive with gas oil in all options. Moreover, based on the pattern of future prices published, the differentials between the cost of natural gas and gas oil and fuel oil prices looks set to hold steady over the next four years.

Postalised Transmission tariffs

The Transmission revenues are derived using the average postalised transmission tariff for NI after the investment in each corridor is taken into account. The net result is that the postalised transmission tariff across Northern Ireland increases by between 2.9% (Strabane corridor) and 11.3% (Enniskillen corridor). When all corridors are evaluated as one project, the overall increase in the tariff is 14.7%. The impact on gas demand in the event of an increase in the Transmission tariff is not taken into account in this study.

External benefits captured by the project

External benefits captured by the project comprise the environmental benefits which arise from switching to natural gas. These are estimated by quantifying the CO2 savings that one could expect from customers switching from other fuels to natural gas, based on published emissions factors for various fuels. The savings are based on Government guidelines as to how the cost of carbon should be factored into a CBA. The present values of these flows are calculated, based on a discount rate of 3.5% for the first 30 years and 3% thereafter. The Summary Tables show the NPVs generated by the environmental benefits for each corridor. In all cases, the value of the environmental benefits substantially exceeds the positive NPVs on the Distribution projects. Connecting all of the 6 towns (Option 7) produces substantial environmental benefits, equivalent £104m (BM2) in discounted terms over the forty years.

An important benefit of extending the gas network is the savings generated for customers who switch to gas. The level of savings for customers has been estimated

over the forty years from a comparison of the cost of oil versus gas for industrial and commercial customers and households. The Summary Tables show the substantial NPVs generated by calculating the savings derived for customers who switch to gas along each corridor. Connecting all of the 6 towns (Option 7) generates an NPV for savings to customers of £89m (BM2).

1.7.4 Non-monetary Costs and Benefits

Lowering business costs and increasing competitiveness
With energy prices in Northern Ireland traditionally amongst the highest in Europe, the additional fuel choice with the introduction of gas could lead to more competitive energy pricing, thus helping to lower business overhead costs and increasing the competitiveness of Northern Ireland businesses. This issue is particularly pronounced in the West and North West, according to Invest Northern Ireland, where the restricted fuel choice means there is little or no alternative to electricity. Indeed for Northern Ireland companies to compete in the international arena competitive reductions in the cost of energy are essential. The latter would also make the region more attractive to foreign investors.

Other economic benefits from rolling out the gas network comprise the opportunities it generates for embracing new skills and new technologies as businesses switch to gas and as new businesses are established. There is also the potential to increase renewable energy by providing a network which could cater for biogas in the future.

Extending the gas network also provides an effective way of helping to combat fuel poverty. Sharp rises in fuel prices over recent years has led to an increase in the number of households in fuel poverty. According to research from the charity National Energy Action in the UK, there were over 5 million households across the UK living in fuel poverty as of March 2009. This was more than double the number in 2003. Northern Ireland has the highest rate of fuel poverty in the United Kingdom, with 1 in 3 households suffering its effects[6]. The roll out of the natural gas network can help low income households by addressing high fuel costs and poor energy efficiency.

Savings to customers
The benefits of switching to gas include the customer savings, already quantified above. The likelihood is that these increased savings make their way back to the local economy. Depending on what customers chose to do with those savings, they should result in increased economic activity across Northern Ireland.

Changing profile of Northern Ireland's enterprise base
There is an important emphasis in the Gas to the West Study (2004)[7] on the extent of low value manufacturing industries in the West of Northern Ireland which are considered vital to the health of the local economies. The suggestion is that "all will need access to natural gas to remain viable in the long term". However, there is a separate issue about the long term viability of these industries for other reasons to do with competition from lower cost locations. It is not clear that access to gas alone would have prevented the loss of jobs in the textile industry, for example.

The availability of gas provides large scale energy intensive industries with opportunities for Combined Heat and Power (CHP) applications, thereby allowing

[6] Ending Fuel Poverty, A Strategy for Northern Ireland, Department of Social Development, November 2004.
http://www.dsdni.gov.uk/ending_fuel_poverty_-_a_strategy_for_ni.pdf
[7] Gas to the West study: An Evaluation of the Economic Case and Social and Environmental Benefits – Leveraging a Critical Infrastructure Investment to Maximum Social and Environmental Benefits, Transition Management, February 2004.

excess power to be sold back into the electricity grid. However with the changing profile of the enterprise base of Northern Ireland[8] , the type of large, heavy energy-using industry, for whom a supply of natural gas would be an important locational factor, is increasingly unlikely to locate in Northern Ireland in the future. In an increasingly developed economy, the focus is more likely to be on increasing high value added manufacturing and internationally traded services as well as domestically traded services. However a reliable competitively priced energy supply is also likely to be as important to the new types of enterprises choosing to locate in NI today, as indeed would other infrastructure such as broadband, waste and transport.

1.7.5 Optimising the Gas Network in the West and North West of NI

The predominant difference between the results under both models has to do with the volumes assumed, which are almost 50% higher in BM2 than in BM1 (Option 7). The volumes drive other differences between the models, notably the distribution capital and operating costs, the environmental credit calculated and the estimated value of the customer savings.

The evaluation exercise considers the Distribution and Transmission businesses separately for the individual options. Thus any surpluses which arise on the Distribution project would not be expected to be used to make up any shortfalls which arise on the Transmission project.

The results of the evaluation exercise show that all corridors generate positive NPVs in respect of Distribution in both business models, with the exception of Strabane, which is marginally negative in BM2 (-£240,000). Thus the design of the Distribution system for each corridor in each model (except Strabane, BM2) more than covers its distribution capital and operational costs, based on the projected volumes captured and the Distribution tariff of 32ppt used in the CBA.

Looking at the Transmission element, none of the corridors in either model cover their capital and operational costs. All corridors return substantially negative NPVs on the Transmission element, with Option 7 generating a deficit of £51m using BM1 (and £44m using BM2).

Proceeding with these projects may or may not require a subvention. This is a matter for the Utility Regulator and will depend on whether postalised transmission tariffs are increased for all customers across Northern Ireland or whether the increase in the tariff as a result of the investment is not passed on to gas customers. In the event that tariffs are not increased, the level of subvention required is determined from the discounted commercial net cash flows and excludes any external benefits which do not accrue to the licence holder. Thus taking account of the commercial costs and benefits/ revenues generated by each corridor, the transmission projects would need to be supported by a public subvention if these corridors were to proceed. The required level of subvention is to be sufficient to enable the cash flows including the subsidy to satisfy commercial investment criteria. The transmission element of the project uses 6% as the rate that reflects commercial returns in current licensing agreements.

Thus any potential licensee who can achieve the volumes as captured in the models and keep the costs in line with those estimated in the models will earn 6% as the rate of return that reflects commercial returns, assuming a subsidy is provided. Higher

[8] According to *'Ireland North and South - A Statistical Profile'*, Central Statistics Office, Dublin, (2008), manufacturing accounted for 15% of the gross value added in the economy in 2005 compared with 19% in 2001. The corresponding proportions in the Republic of Ireland were 25% in 2005 compared with 32% in 2001.

volumes and/or lower costs would result in a lower subvention, assuming a 6% rate of return. Thus the subventions are equivalent to the financial deficits generated on the Transmission component of each project, before taking into account any non-commercial or external benefits and assuming that the postalised tariff is not increased across Northern Ireland.

The inclusion of environmental credits significantly improves the financial viability of the corridors. The improved viability reflects the valuations placed on carbon emissions saved, according to Government guidelines on how the cost of carbon should be factored into a CBA. However, it is the case that a carbon tax, while resulting in an increase in all fossil fuel prices, will give natural gas a competitive advantage vis-à-vis oil and coal products. As previously highlighted, these models do not take into account the impact on demand for natural gas of the price increases that are implied by the carbon credit valuations used.

Although the environmental benefits quantified do not comprise part of the commercial appraisal, it is possible to derive the cost per tonne of carbon reduced, based on the subvention required. This is one measure of the cost of moving to a lower carbon economy, based on a roll out of the gas network. As BM1 produces the highest subventions, the cost per tonne of carbon reduced is highest in this model. It ranges from £76/tonne on the Magherafelt corridor (Option 3) to £132/tonne on the Enniskillen corridor (Option 5) (see Summary Tables).

Extending the gas network in Northern Ireland would mean some contribution by the Northern Ireland economy to the challenges posed by global warming but at a cost, equivalent to the subvention or the calculated cost per tonne of carbon reduced for achieving reductions in carbon emissions. For all six towns (Option 7) the latter amounts to almost £92/tonne in BM1 and almost £43/tonne in BM2.

The non-monetary benefits focus on the economic case for extending the gas network and the extent to which natural gas facilitates economic development. For the projects which generate negative NPVs, the question arises as to whether these non-quantifiable benefits are sufficient to bridge the gap on the commercial appraisal? However, given concerns about the cost of electricity in Northern Ireland, it is the case that the availability of gas would provide a competing and competitive fuel source.

1.7.6 Sensitivities

Four sensitivities were carried out to examine the impact of changes in a number of the key assumptions:

A lower Discount Rate for Distribution: 5% versus 7.5% in the Base Case
As would be expected, the lower discount rate of 5% increases the NPVs on the Distribution for each project. Under Option 7 the NPV on the Distribution increases to almost £29m from £16m in the Base Case for BM1. There were no changes to the Transmission element of the projects.

In capital budgeting, the assumed discount rate represents the cost of capital which will vary depending on the risk associated with a project. In the Base Case 7.5% is the rate of return that reflects commercial returns on gas distribution projects, as set down by the Utility Regulator. The lower discount rate of, say 5%, would imply a lower level of risk is assumed for the project and hence the lower NPVs are generated.

A lower Distribution Tariff: 27ppt versus 32ppt
The lower Distribution Tariff of 27ppt, although still ahead of the 'breakeven' tariff under BM1, reduces the NPVs on the Distribution for all corridors. When all towns are connected (Option 7) the NPV is reduced from £16m to £9m (BM1).

Five of the corridors in BM2 have a breakeven distribution tariff of 27ppt or more. Hence two of them, Dungannon (Option 1) and Omagh (Option 4), almost breakeven on Distribution using a 7.5% discount rate. In the other three corridors, Enniskillen (Option 5), Strabane (Option 6) and all towns (Option 7), the NPVs on distribution are negative and of the order of -£2m for Option 5 and 6.

The Distribution projects will continue to return positive NPVs if the Distribution Tariff used in the CBA remains above the 'breakeven' tariff. There were no changes to the Transmission element of the projects in either model.

Higher volumes -based on including the large contract loads at Derrylin and Dungannon and assuming that 90%[9] of contract customers are captured plus 100% of new housebuilding captured compared with 50% in the Base Case.
It is clear from the evaluation exercise that the study results are very sensitive to the assumptions made about take-up rates and the capture of large loads. The third sensitivity produces significantly more positive results, when the large loads identified at Derrylin and Dungannon are captured as contract customers and when the penetration of new housebuilding is doubled compared with the Base Case. The results are generated, notwithstanding the additional transmission capital expenditure to connect Derrylin (£10.5m.). As a result the total load captured increases by as much as 104% on the Enniskillen corridor (Option 5) and by 63% overall when all towns are connected (Option 7) using BM2. The corresponding increases under BM1 are 160% and 94% respectively.

For the first time, some of the corridors show overall positive NPVs, notably all corridors except Omagh and Strabane in both business models. In every case the distribution NPVs increase substantially compared with the Base Case, while the Transmission NPVs are less negative.

[9] The 90% assumes 100% of large contract load at Dungannon and Derrylin and 80% of other contract customers.

Ship-or-Pay

This sensitivity illustrates how sensitive the model is to changes in the very large loads. The connection of one or two very large customers can change the viability of the corridors in an overall context. Where contract customers account for a high percentage of the load in a town, it may be necessary to get a commitment from such anchor loads, through some form of take-or-pay contracts, prior to the network extension being implemented. The exact approach would need to be worked out with the Utility Regulator.

Given the environmental benefits of switching to gas in terms of reduced carbon emissions and the investment required to connect these six towns, it would be seem desirable that potential public sector users would connect to gas. This would provide surety to a proportion of the anticipated load captured in the project evaluation.

Distribution capital expenditure down by 10%

The 10% reduction in Distribution capital expenditure marginally improves the overall NPVs for the Distribution projects. When all the towns are connected (Option 7) the Distribution NPV increases from £9.5m in the Base Case for BM2 to £10.3m in BM2. The impact in BM1 is to increase the NPV on Option 7 to £17.3m from £14.5m. There is no impact on the Transmission project, with the result that the overall project NPV increases across all corridors in both models.

Summary Table of CBA Results for Business Model 1

COST-BENEFIT ANALYSIS PIPELINE CORRIDOR:	1	2	3	4	5	6	7
Total Volumes (000 therms)	**137,057**	**251,949**	**288,736**	**255,526**	**300,524**	**96,932**	**549,134**
Residential Connections #	**1,627**	**2,292**	**2,783**	**3,508**	**4,824**	**873**	**6,854**
New housing	1,563	2,168	2,613	3,333	4,568	805	6,423
Existing housing	64	125	171	176	257	68	431
Transmission Tariff (ppt) *average charge per unit:*/year	**2017/18**	**2017/18**	**2017/18**	**2017/18**	**2017/18**	**2017/18**	**2017/18**
- Residential and Small I/C	9.330	9.470	9.482	9.716	10.060	9.302	10.378
- Large I/C	8.141	8.264	8.275	8.478	8.779	8.117	9.058
Distribution Tariff (ppt)	20.47	15.27	17.34	19.40	20.91	26.04	20.85
Used in CBA	32.00	32.00	32.00	32.00	32.00	32.00	32.00
Total Transmission & Distribution Revenues							
- over 40 yrs (£000s)	**55,413**	**102,131**	**117,195**	**104,240**	**123,700**	**39,086**	**227,371**
Total Distribution & Transmission Capital and Opex Expenditure							
- over 40 yrs (£000s)	**42,964**	**62,538**	**70,829**	**87,226**	**119,962**	**40,788**	**191,210**
NPV of cash flows (£000s): (before environmental credit)							
Distribution: NPV @ 7.5%	4,264	11,468	11,465	8,649	8,869	1,579	16,470
Transmission: NPV @ 6%	-14,330	-21,294	-21,940	-26,125	-40,058	-13,347	-51,073
Total NPV	**-10,066**	**-9,826**	**-10,474**	**-17,477**	**-31,189**	**-11,768**	**-34,604**
IRR of total cash flow (undiscounted)							
Year 40	2.4%	4.4%	4.6%	3.3%	2.2%	-0.5%	3.3%
NPV Environmental credit (£000s)							
Year 40 (@DR of 3%/3.5%)	13,062	22,721	25,950	24,565	29,147	9,864	51,899
Total Project NPV (£000s) after environmental credit							
Year 40	2,996	12,894	15,475	7,088	-2,042	-1,904	17,295
Project IRR (after environ credit):							
Year 40	5.6%	7.3%	7.5%	5.9%	4.7%	3.6%	6.1%
NPV Customer savings (£000s)							
Year 40	13,791	22,217	31,557	29,819	39,886	6,906	64,558
Total Project NPV (£000s) after environmental credit and customer savings							
Year 40	16,787	35,111	47,033	36,907	37,845	5,001	81,853
Level of Subvention (£000s)	**14,330**	**21,294**	**21,940**	**26.125**	**40,058**	**13,347**	**51,073**
Cost per tonne of carbon saved (£s)	103.05	83.86	76.44	101.29	132.16	127.61	91.91

Summary Table of CBA Results for Business Model 1 - Sensitivities

Sensitivity	1	2	3	4	5	6	7
1. Lower DR on Distribution = 5%							
NPV of cash flows (£000s) (before environ. credit)							
Distribution: NPV @ DR = 5%	7,514	18,576	19,386	15,078	16,333	3,095	28,963
Transmission: NPV @ DR = 6%	-14,330	-21,294	-21,940	-26,125	-40,058	-13,347	-51,073
Total NPV	-6,817	-2,718	-2,554	-11,048	-23,725	-10,252	-22,111
IRR of total cash flow (undiscounted)							
Year 40	2.4%	4.4%	4.6%	3.3%	2.2%	-0.5%	3.3%
2. Lower Distribution Tariff 27ppt							
NPV of cash flows (£000s) (before environ. credit)							
Distribution: NPV @ DR = 7.5%	2,414	8,040	7,556	5,217	4,870	254	9,086
Transmission: NPV @ DR = 6%	-14,330	-21,294	-21,940	-26,125	-40,058	-13,347	-51,073
Total NPV	-11,916	-13,254	-14,384	-20,908	-35,188	-13,094	-41,987
IRR of total cash flow (undiscounted)							
Year 40	1.2%	3.2%	3.3%	2.3%	1.3%	-2.0%	2.3%
3. Higher volumes: 90% of contract customers (add back in large contract loads in Dungannon and Derrylin) plus 100% of new housebuilding							
Volumes over 40 years increased to	273,300	404,350	446,163	416,072	780,700	113,038	1,066,600
% change from Base Case BM1	99%	60%	55%	63%	160%	17%	94%
NPV of cash flows (£000s) (before environ. credit)							
Distribution: NPV @ DR = 7.5%	15,655	23,954	24,158	21,248	49,536	2,583	59,568
Transmission: NPV @ DR = 6%	-10,550	-17,024	-17,540	-21,554	-35,733	-12,727	-44,727
Total NPV	**5,104**	**6,931**	**6,618**	**-305**	**13,803**	**-10,144**	**14,841**
IRR of total cash flow (undiscounted)							
Year 40	9.3%	9.0%	8.8%	7.0%	8.6%	1.2%	8.3%
4. Distribution capex down by 10%							
NPV of cash flows (£000s) (before environ. credit)							
Distribution: NPV @ DR = 7.5%	4,452	11,771	11,899	9,002	9,362	1,677	17,265
Transmission: NPV @ DR = 6%	-14,330	-21,294	-21,940	-26,125	-40,058	-13,347	-51,073
Total NPV	-9,879	-9,523	-10,041	-17,123	-30,696	-11,670	-33,809
IRR of total cash flow (undiscounted)							
Year 40	2.5%	4.5%	4.7%	3.3%	2.2%	-0.4%	3.4%

Summary Table of CBA Results using Business Model 2

COST-BENEFIT ANALYSIS PIPELINE CORRIDOR:	1	2	3	4	5	6	7
Total Volumes (000 therms)	**177,790**	**330,894**	**397,019**	**366,962**	**463,183**	**140,179**	**822,590**
Residential Connections #	**5,172**	**9,163**	**12,207**	**13,206**	**18,980**	**4,637**	**30,652**
New housing	1,563	2,168	2,613	3,333	4,568	805	6,423
Existing housing	3,609	6,995	9,595	9,874	14,413	3,832	24,230
Transmission Tariff (ppt) *average charge per unit:*/year	**2017/18**	**2017/18**	**2017/18**	**2017/18**	**2017/18**	**2017/18**	**2017/18**
- Residential and Small I/C	9.330	9.470	9.482	9.716	10.060	9.302	10.368
- Large I/C	8.141	8.264	8.275	8.478	8.779	8.117	9.049
Distribution Tariff (ppt)	26.88	22.33	25.02	26.95	29.22	32.69	27.29
Used in CBA	32.00	32.00	32.00	32.00	32.00	32.00	32.00
Total Transmission & Distribution Revenues							
- over 40 yrs (£000s)	**72,248**	**134,870**	**162,114**	**150,727**	**192,115**	**56,948**	**343,229**
Total Distribution & Transmission Capital and Opex Expenditure							
- over 40 yrs (£000s)	**55,390**	**85,212**	**101,743**	**117,245**	**163,169**	**53,256**	**256,140**
NPV of cash flows (£000s): (before environmental credit)							
Distribution: NPV @ 7.5%	2,301	8,121	6,934	4,569	3,111	-240	9,480
Transmission: NPV @ 6%	-13,349	-19,364	-19,289	-23,331	-35,834	-12,309	-43,755
Total NPV	**-11,048**	**-11,244**	**-12,355**	**-18,762**	**-32,723**	**-12,548**	**-34,275**
IRR of total cash flow (undiscounted)							
Year 40	2.6%	4.4%	4.5%	3.6%	2.8%	0.7%	4.0%
NPV Environmental credit (£000s)							
Year 40 (@DR of 3%/3.5%)	20,757	37,634	46,405	45,616	59,874	18,034	103,557
Total Project NPV (£000s) after environmental credit							
Year 40	9,709	26,390	34,051	26,854	27,151	5,485	69,282
Project IRR (after environ credit):							
Year 40	6.5%	8.0%	8.3%	7.1%	6.3%	5.4%	7.6%
NPV Customer savings (£000s)							
Year 40	17,484	29,373	41,373	39,920	54,631	10,826	89,348
Total Project NPV (£000s) after environmental credit and customer savings							
Year 40	27,193	55,763	75,424	66,774	81,782	16,311	158,631
Level of Subvention (£000s)	**13,349**	**19,364**	**19,289**	**23,331**	**35,834**	**12,309**	**43,755**
Cost per tonne of carbon saved (£s)	64.21	49.99	41.04	52.28	62.00	69.27	42.99

Summary Table of CBA Results for Business Model 2 - Sensitivities

Sensitivity	1	2	3	4	5	6	7
1. Lower DR on Distribution = 5%							
NPV of cash flows (£000s) (before environ. credit)							
Distribution: NPV @ DR = 5%	5,625	15,538	15,301	11,669	11,628	1,441	24,657
Transmission: NPV @ DR = 6%	-13,349	-19,364	-19,289	-23,331	-35,834	-12,309	-43,755
Total NPV	**-7,725**	**-3,826**	**-3,988**	**-11,661**	**-24,206**	**-10,867**	**-19,097**
IRR of total cash flow (undiscounted)							
Year 40	2.6%	4.4%	4.5%	3.6%	2.8%	0.7%	4.0%
2. Lower Distribution Tariff 27ppt							
NPV of cash flows (£000s) (before environ. credit)							
Distribution: NPV @ DR = 7.5%	54	3,922	1,967	49	-2,477	-1,987	-575
Transmission: NPV @ DR = 6%	-13,349	-19,364	-19,289	-23,331	-35,834	-12,309	-43,755
Total NPV	**-13,296**	**-15,442**	**-17,322**	**-23,282**	**-38,310**	**-14,296**	**-44,329**
IRR of total cash flow (undiscounted)							
Year 40	1.3%	3.1%	3.2%	2.5%	1.8%	-0.7%	2.9%
3. Higher volumes: 90% of contract customers (add back in large contract loads in Dungannon and Derrylin) plus 100% of new housebuilding							
Volumes over 40 years increased to	314,033	483,295	554,446	527,508	943,359	156,285	1,340,056
% change from Base Case BM2	77%	46%	40%	44%	104%	11%	63%
NPV of cash flows (£000s) (before environ. credit)							
Distribution: NPV @ DR = 7.5%	13,692	20,608	19,627	17,168	43,778	765	52,578
Transmission: NPV @ DR = 6%	-9,569	-15,094	-14,889	-18,759	-31,509	-11,688	-37,408
Total NPV	**4,123**	**5,513**	**4,737**	**-1,591**	**12,269**	**-10,924**	**15,170**
IRR of total cash flow (undiscounted)							
Year 40	8.7%	8.4%	8.1%	6.8%	8.2%	1.8%	8.1%
4. Distribution capex down by 10%							
NPV of cash flows (£000s) (before environ. credit)							
Distribution: NPV @ DR = 7.5%	2,489	8,424	7,368	4,922	3,603	-141	10,275
Transmission: NPV @ DR = 6%	-13,349	-19,364	-19,289	-23,331	-35,834	-12,309	-43,755
Total NPV	**-10,860**	**-10,941**	**-11,921**	**-18,409**	**-32,231**	**-12,450**	**-33,480**
IRR of total cash flow (undiscounted)							
Year 40	2.6%	4.5%	4.6%	3.6%	2.9%	0.7%	4.1%