

Inefficient Bypass of the NTS Estimating the Cost of Bypass Pipelines

Background

At the 7th July NTSCMF, attendees were asked to share with NGG any ideas and / or pipeline construction costs which could be used to estimate the cost of building bypass pipelines that might result in the inefficient bypass of the NTS. Kinsale Energy sourced details of a pipeline which Gas Network Ireland is currently constructing in Scotland. The pipeline is 50 km long and its diameter is 914 mm and they estimate that it will cost €92.9 million to build (equivalent to about £80 million). Vermillion sourced data on German pipeline construction costs and deduced that the German costs are similar in magnitude to the cost of the GNI pipeline. Kinsale Energy also reverse engineered NGG's Option 2 formula from its 2015 NTS GCD11 Discussion Document and estimated that it would cost NGG about £83 million (in 2015 values) to construct a similar pipeline.

National Grid NTS have advised that over 40 sites are availing of the shorthaul service and that this number includes two Interconnector Points. The data necessary to identify the other sites is not publicly available other than they can only be Direct Connects since it is not permitted to shorthaul gas either to or from storage facilities or to DNs. However, an approximation of the shorthaul rate to Direct Connect sites can be made by assuming that a site's obligated capacity and its MNEPOR are similar and that the distance to the nearest entry point is as provided in the Distance Matrix.

Using these approximations, 36 Direct Connect sites were identified as being likely to avail of the shorthaul tariff. By reverse engineering the 2015 shorthaul formula, this paper estimates the cost of constructing bypass pipelines to each of these sites from the nearest entry point.

The Two Shorthaul Formulas

The Optional NTS Commodity Tariff was introduced in 1998 to incentivise the use of the NTS by large sites located near to entry terminals that might otherwise build and operate dedicated pipelines thereby resulting in the inefficient bypass of the NTS. Users may use the NTS Optional Commodity charge as an alternative to both the NTS Entry / Exit SO and TO Commodity charges. The shorthaul formula has not been updated since 1998 and is as follows:

$$p/kWh = 1230 \times M^{-0.834} \times D + 363 \times M^{-0.654}$$

Where: **D** is the direct distance of the site or non-National Grid NTS Pipeline to the elected Entry Terminal in km;

M is the Maximum NTS Exit Point Offtake Rate (MNEPOR) at the site, converted into kWh/day; and

^ means 'to the power of.'

In their 2015 NTS GCD11 Discussion Document, National Grid NTS sought to update the shorthaul formula to reflect the increase in pipeline construction and operating costs since the formula was first introduced. National Grid NTS proposed three formulae for consideration by industry with the following being that described as Option 2:

$$p/kWh = 1247 \times M^{-0.78} \times D + 1422 \times M^{-0.708}$$

The MNEPOR of sites and the direct distance from entry points to user sites is not publicly available so, for the purposes of this paper, the obligated capacities taken from the "Forecast Con. Capacity - Exit" tab and the distances from the "Distance Matrix" tab included in the Transmission Services CWD Model are used for M and D respectively.

Reverse Engineering the Shorthaul Formula

The shorthaul formula was essentially derived in five steps, as follows:

1. The cost of building hypothetical pipelines for a range of flowrates and distance was estimated and tabulated;
2. The annuitized cost of each hypothetical pipeline was then calculated assuming a ten year project life and a 10% project discount rate;
3. The annual cost of operating each pipeline was then estimated and added to the annuitized cost to give the "**Annual Cost**";
4. The Annual Cost was then converted into a unit cost in p/kWh by dividing by (MNEPOR * 365 * 0.75); and then
5. Curve fitting techniques were used to derive a shorthaul formula to best fit the table of unit costs.

It stands to reason therefore that, since the shorthaul formula is an approximation of the unit costs calculated in step 4, the Annual Cost of a bypass pipeline can be approximated as the shorthaul rate multiplied by (MNEPOR * 365 * 0.75) where 0.75 is the assumed load factor. Therefore, for a 50 km pipeline with an MNEPOR of 500 GWh per day (similar to the GNI pipeline):

- The shorthaul rate to the site would be 0.0112 p/kWh when calculated with the Option 2 shorthaul formula;
- The Yearly Cost would be 0.0112 p/kWh * 500,000,000 * 365 * 75% which equals £15.3 million;
- The annual cost of operating the pipeline was assumed in 1997 to be about 20% of the Yearly Cost which gives an operating cost in 2015 of about £3.1 million per annum; and
- The resultant annuitized capital cost of the pipeline is therefore £12.2 million per annum; and
- The implied cost of building 50km km of 914 mm Diameter pipeline to NTS standard in 2015 is about £83 million.

Identifying Sites availing of the Optional Commodity Charge

The Distance Matrix included in the Transmission Services CWD Model lists 26 entry points to and 221 exit points from the NTS:

- Of the **26 entry points**, 6 are classed as Beach Terminals, 2 as LNG import Terminals, 1 as an Interconnector Point, 4 as Onshore Fields and 13 as Storage Entry Points. However, since it is not permitted to shorthaul gas from storage facilities and Canonbie, Hatfield Moor and Wytch Farm are not material, only 10 entry points were considered as being sources of shorthaul gas.

- Of the **221 exit points**, 75 are classed as Direct Connects, 124 as GDNs, 3 as Interconnector Points and 19 as Storage Exit Points. However, since it is not permitted to shorthaul gas to either storage facilities or to DNs, only 78 exit points were considered as being destinations for shorthaul gas, 3 of which are interconnector points.
- For each of the 75 Direct Connect sites, the nearest of the 10 entry points to the site was identified and the shorthaul tariff for each shorthaul route was calculated with the 1998 shorthaul formula using the site's obligated capacity as M and its distance (from the Distance Matrix) to the nearest entry point as D.
- The 75 sites were then ranked in order of increasing shorthaul tariff and 36 of the sites were identified as having a shorthaul tariff less than the combined NTS Entry / Exit SO and TO Commodity charges. The shorthaul tariff was also expressed as a percentage of these commodity charges and the maximum shorthaul amount payable at each site was calculated as the product of the shorthaul tariff and the Historical flows at the site. The results of these calculations can be found in Table 1.
- The shorthaul tariff was also calculated for each of the 36 sites using the 2015 formula and the Annual Cost, operating cost and Construction Cost of hypothetical bypass pipelines to each site was determined using the reverse engineering approach described above. The results of these calculations are also included in Table 1.

National Grid NTS have advised that only about 60% of gas flows to eligible exit points avail of the NTS Optional Commodity charge. Hence, about £28 million would be paid by these sites by way of the shorthaul tariff as compared to the £298 million that National Grid estimate that the sites would have to pay to fund the construction and operation of the bypass pipelines (NB both figures are on an annual basis). To put this in perspective, the £28 million is less than 50% of what it would cost just to operate the bypass pipelines. The total cost of constructing these bypass pipelines is in excess of £1.6 billion.

Interconnection Points

The MNEPOR (or the obligated capacity alternative) of each Interconnection Points is of such size as to enable the economic shorthauling of gas from all 13 of the qualifying entry points to each of the Interconnection Points. The shorthaul tariff for each shorthaul route was calculated using the current shorthaul formula and the shorthaul amount paid by users of each route was calculated as the product of this tariff and the Historical flows to the Interconnection Point. However, since the gas shorthauled to the Interconnection Points will have been sourced from several entries, the shorthaul amount calculated in this way overstates the actual amount that will have been paid for each shorthaul route. The shorthaul tariff was also calculated using the 2015 formula from which the Annual Cost, operating cost and Construction Cost of hypothetical pipelines from all entries was derived and the results of these calculations are included as Table 2 and Table 3.

The maximum quantity of gas that can be shorthauled along any route cannot exceed the quantity which entered the NTS through an entry point. Table 4 is similar to Table 3 but the amount paid by users reflects the quantities flowed through the entry points. This shows that only about £10,000 would be paid to shorthaul gas from Wytch Farm to Moffat compared to the £25 million payable based on the Moffat historical flows.

	Exit Points			Optional Commodity Charge		Cost of Bypass Pipeline				
	Obligated Exit Capacity kWh/day	Historical Flows at Exit kWh/day	Distance to Nearest Entry km	p/kWh	% of TOSO	Amount paid by Users	Option 2 OCC	Annual Cost with Annuitised Pipe	Annual Operating Cost	Cost of Construction
DC1	108,300,000	6,623,287	0	0.0020	2%	£48,823	0.0029	£863,705	£172,741	£4,670,224
DC2	73,210,000	1,057,700	0	0.0026	3%	£10,072	0.0038	£770,386	£154,077	£4,165,630
DC3	121,200,056	72,785,150	7	0.0034	4%	£906,341	0.0070	£2,335,218	£467,044	£12,626,990
DC4	38,120,000	12,697,892	1	0.0047	5%	£219,506	0.0081	£841,680	£168,336	£4,551,134
DC5	28,480,000	2,905,176	1	0.0053	5%	£55,709	0.0086	£669,699	£133,940	£3,621,195
DC6	20,040,000	11,454,140	0	0.0061	6%	£254,519	0.0096	£527,725	£105,545	£2,853,516
DC7	40,940,000	24,029,310	5	0.0064	7%	£557,390	0.0126	£1,410,307	£282,061	£7,625,811
DC8	13,276,800	4,334,319	0	0.0080	8%	£126,072	0.0129	£467,947	£93,589	£2,530,285
DC9	43,540,000	14,946,299	9	0.0081	8%	£443,037	0.0175	£2,085,222	£417,044	£11,275,211
DC10	9,750,000	2,980,266	0	0.0106	11%	£114,817	0.0180	£480,573	£96,115	£2,598,556
DC11	91,000,001	7,732,386	37	0.0125	13%	£352,703	0.0318	£7,930,162	£1,586,032	£42,879,974
DC12	57,830,000	36,749,960	24	0.0128	13%	£1,721,054	0.0312	£4,935,010	£987,002	£26,684,585
DC13	67,000,000	46,408,598	37	0.0160	16%	£2,706,142	0.0403	£7,396,873	£1,479,375	£39,996,369
DC14	3,690,000	258,556	0	0.0184	19%	£17,375	0.0319	£321,977	£64,395	£1,740,996
DC15	38,600,000	5,536,770	29	0.0201	21%	£406,422	0.0490	£5,181,261	£1,036,252	£28,016,116
DC16	68,012,169	12,076,753	50	0.0204	21%	£898,588	0.0525	£9,773,567	£1,954,713	£52,847,632
DC17	40,840,000	17,663,742	32	0.0208	21%	£1,343,647	0.0513	£5,730,910	£1,146,182	£30,988,178
DC18	2,583,336	3,267	0	0.0232	24%	£277	0.0410	£290,142	£58,028	£1,568,856
DC19	66,000,000	33,866,070	67	0.0272	28%	£3,357,465	0.0709	£12,814,427	£2,562,885	£69,290,172
DC20	5,520,000	80,702	6	0.0304	31%	£8,948	0.0629	£950,006	£190,001	£5,136,870
DC21	82,000,000	52,401,011	108	0.0352	36%	£6,726,696	0.0944	£21,180,296	£4,236,059	£114,526,097
DC22	1,000,000	12,345	0	0.0432	44%	£1,948	0.0803	£219,914	£43,983	£1,189,121
DC23	45,000,000	5,502,061	84	0.0455	47%	£913,222	0.1179	£14,520,466	£2,904,093	£78,515,066
DC24	42,020,000	22,596,857	87	0.0496	51%	£4,087,408	0.1282	£14,748,003	£2,949,601	£79,745,404
DC25	137,760,000	29,267,580	265	0.0537	55%	£5,733,502	0.1506	£56,791,478	£11,358,296	£307,082,877
DC26	38,660,000	5,025,400	92	0.0561	58%	£1,029,573	0.1449	£15,340,025	£3,068,005	£82,946,585
DC27	11,700,000	669,969	32	0.0569	58%	£139,215	0.1346	£4,310,496	£862,099	£23,307,712
DC28	36,060,000	3,498,548	92	0.0591	61%	£754,734	0.1521	£15,017,386	£3,003,477	£81,202,008
DC29	9,100,000	3,914,012	27	0.0614	63%	£876,600	0.1428	£3,557,402	£711,480	£19,235,585
DC30	48,650,000	12,027,063	126	0.0621	64%	£2,727,333	0.1634	£21,766,188	£4,353,238	£117,694,133
DC31	37,470,000	7,981,283	101	0.0626	64%	£1,824,141	0.1619	£16,604,167	£3,320,833	£89,782,053
DC32	19,300,000	8,065,992	66	0.0732	75%	£2,155,380	0.1816	£9,596,374	£1,919,275	£51,889,516
DC33	16,890,000	152,750	66	0.0817	84%	£45,528	0.2014	£9,314,022	£1,862,804	£50,362,782
DC34	15,380,000	4,986,083	69	0.0914	94%	£1,663,685	0.2249	£9,466,901	£1,893,380	£51,189,427
DC35	19,600,000	5,288,307	86	0.0917	94%	£1,769,364	0.2292	£12,297,744	£2,459,549	£66,496,361
DC36	12,350,000	6,262,078	59	0.0944	97%	£2,157,438	0.2289	£7,740,107	£1,548,021	£41,852,307
Totals ==>						£46,154,672		£298,247,769	£59,649,554	£1,612,685,337

Table 1: DC Sites for which the Optional Commodity Charge may be practical option

Assumed MNEPOR of Exit Point ==> 651,676,940 kWh/day
 Historical Flows at Exit Point ==> 234,219,897 kWh/day

Entry Point	Distance to Bacton km	Optional Commodity Charge			Cost of Bypass Pipeline			
		p/kWh	% of TOSO	Amount paid by Users	Option 2 OCC	Annual Cost with Annuitised Pipe	Annual Operating Cost	Cost of Construction
Beach Terminals								
Teesside	388.66	0.0215	22%	£18,351,480	0.0655	£116,771,458	£23,354,292	£631,406,626
Barrow	522.96	0.0287	29%	£24,508,284	0.0878	£156,617,364	£31,323,473	£846,861,411
Easington (not incl. Rough)	252.88	0.0142	15%	£12,126,828	0.0429	£76,486,445	£15,297,289	£413,577,506
St Fergus	825.16	0.0449	46%	£38,362,239	0.1381	£246,278,071	£49,255,614	£1,331,674,786
Theddlethorpe	208.61	0.0118	12%	£10,097,329	0.0355	£63,351,834	£12,670,367	£342,556,036
Bacton UKCS	0	0.0006	1%	£533,883	0.0008	£1,458,650	£291,730	£7,887,214
Onshore Fields								
Canonbie	494.21	0.0271	28%	£23,190,279	0.0830	£148,087,433	£29,617,487	£800,738,365
Hatfield Moor (onshore)	224.39	0.0127	13%	£10,820,742	0.0381	£68,033,654	£13,606,731	£367,871,572
Burton Point	372.14	0.0206	21%	£17,594,143	0.0627	£111,870,085	£22,374,017	£604,903,922
Wytch Farm	426.36	0.0235	24%	£20,079,786	0.0717	£127,956,794	£25,591,359	£691,887,976
Interconnection Points								
Bacton IP		0.0006	1%	£533,883	0.0008	£1,458,650	£291,730	£7,887,214
LNG Import Terminals								
Isle of Grain	216.9	0.0123	13%	£10,477,373	0.0369	£65,811,421	£13,162,284	£355,855,516
Milford Haven	536.72	0.0294	30%	£25,139,093	0.0901	£160,699,864	£32,139,973	£868,936,302

Table 2: Cost of bypass pipelines built to shorthaul gas to the Bacton Interconnection Point

MNEPOR of Exit Point ==> 530,089,918 kWh/day
 Historical Flows at Exit ==> 160,519,297 kWh/day

Entry Point	Distance to Moffat km	Optional Commodity Charge		Cost of Bypass Pipeline			
		p/kWh	% of TOSO	Annual Cost with Annuitised Pipe	Annual Operating Cost	Cost of Construction	Option 2 OCC
Beach Terminals							
Teesside	186.14	0.0126	13%	£54,146,952	£10,829,390	£292,783,398	
Barrow	200.28	0.0135	14%	£58,155,867	£11,631,173	£314,460,406	
Easington (not incl. Rough)	337.78	0.0222	23%	£97,139,309	£19,427,862	£525,251,672	
St Fergus	356.34	0.0234	24%	£102,401,365	£20,480,273	£553,704,660	
Theddlethorpe	401.06	0.0263	27%	£115,080,198	£23,016,040	£622,261,645	
Bacton UKCS	540.45	0.0351	36%	£154,599,485	£30,919,897	£835,950,333	
Onshore Fields							
Canonbie	46.24	0.0037	4%	£14,483,072	£2,896,614	£78,312,866	
Hatfield Moor (onshore)	316.06	0.0208	21%	£90,981,343	£18,196,269	£491,954,317	
Burton Point	351.31	0.0231	24%	£100,975,280	£20,195,056	£545,993,533	
Wytch Farm	665.77	0.0431	44%	£190,129,702	£38,025,940	£1,028,069,326	
Interconnection Points							
Bacton IP	540.45	0.0351	36%	£154,599,485	£30,919,897	£835,950,333	
LNG Import Terminals							
Isle of Grain	662.21	0.0429	44%	£189,120,385	£37,824,077	£1,022,611,748	
Milford Haven	770.73	0.0498	51%	£219,887,535	£43,977,507	£1,188,975,881	

Table 3: Cost of bypass pipelines built to shorthaul gas to the Moffat Interconnection Point

MNEPOR of Exit Point ==> 530,089,918 kWh/day
 Historical Flows at Exit ==> 160,519,297 kWh/day

Entry Point	Distance to Moffat km	Optional Commodity Charge		Cost of Bypass Pipeline			
		p/kWh	% of TOSO	Annual Cost with Annuitised Pipe	Annual Operating Cost	Cost of Construction	Option 2 OCC
Beach Terminals							
Teesside	186.14	0.0126	13%	£54,146,952	£10,829,390	£292,783,398	
Barrow	200.28	0.0135	14%	£58,155,867	£11,631,173	£314,460,406	
Easington (not incl. Rough)	337.78	0.0222	23%	£97,139,309	£19,427,862	£525,251,672	
St Fergus	356.34	0.0234	24%	£102,401,365	£20,480,273	£553,704,660	
Theddlethorpe	401.06	0.0263	27%	£115,080,198	£23,016,040	£622,261,645	
Bacton UKCS	540.45	0.0351	36%	£154,599,485	£30,919,897	£835,950,333	
Onshore Fields							
Canonbie	46.24	0.0037	4%	£14,483,072	£2,896,614	£78,312,866	
Hatfield Moor (onshore)	316.06	0.0208	21%	£90,981,343	£18,196,269	£491,954,317	
Burton Point	351.31	0.0231	24%	£100,975,280	£20,195,056	£545,993,533	
Wytch Farm	665.77	0.0431	44%	£190,129,702	£38,025,940	£1,028,069,326	
Interconnection Points							
Bacton IP	540.45	0.0351	36%	£154,599,485	£30,919,897	£835,950,333	
LNG Import Terminals							
Isle of Grain	662.21	0.0429	44%	£189,120,385	£37,824,077	£1,022,611,748	
Milford Haven	770.73	0.0498	51%	£219,887,535	£43,977,507	£1,188,975,881	

Table 4: Cost of bypass pipelines built to shorthaul gas to the Moffat Interconnection Point (using entry point historical flows)