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The Macro-Economic Implications of Gas Dependence

by

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1. Introduction

Over the coming decade there are likely to be major changes in the structure of the Irish electricity sector. The need to substantially increase output, consequent on economic growth, the liberalisation of the market, and the evolving policy on restricting greenhouse gas emissions will all play roles in driving change. On the basis of information available today it looks likely that all of these forces will result in a continuing increase in our dependence on gas for electricity generation.

If gas supplies were available through many different pipelines and if it were available from many different suppliers this increase in gas dependence would not be a concern. However, the structure of gas transmission leaves gas supplies dependent on a limited number of pipelines. There are also a limited number of sources for gas supply into Europe in the medium term. As a result, there are concerns about the risk of physical interruption due to failure of transmission and the risk that the limited number of suppliers will use their market power to dramatically raise prices in the future.

The risk of undue concentration on gas for electricity generation must be considered in the context of developments in the energy markets of our competitors. While a serious shock to energy prices would have adverse consequences for the economy, its impact would be magnified if Ireland were much more seriously affected than its competitors. Such a differential shock could affect competitiveness and could have a more detrimental impact on medium-term growth than if the shock were shared by all Ireland's EU neighbours. Thus the issue of security of supply must be seen in a wider context, taking account of developments elsewhere in the EU.

If the market price for gas and electricity fully reflected the risks involved in economy-wide dependence there would be no need for the regulatory authorities (The Commission on Energy Regulation, CER, The Department of Natural Resources and Eirgrid) to take specific policy measures to deal with the issue of security of supply. However, it is clear that market prices do not fully reflect the risks from extreme dependence on gas and that, left to itself, the market would deliver an unsatisfactory result from the point of view of national welfare.

In this paper two separate risks from gas dependence have been identified: the risk of physical interruption in supply and the risk of extreme movements in the price of gas. The two risk scenarios have very different probabilities of occurring and very different economic implications. We consider the two of them in turn in Sections 2 and 3.

The issues that arise in considering investment to offset risks from excess dependence on gas in electricity generation are very similar to those that arise in the case of purchase of insurance: What are the risks that are covered by the policy? How likely are the risks to occur? How much will an insurance policy against shocks cost? And who will benefit in the event of a pay out? These issues are considered together in Section 4.

2. Risk of Physical interruption

Firms investing in new plant must consider the risk of physical interruption of gas supply. Any physical interruption in supply would leave a gas-fired generating plant stranded, and the firm would lose significant profits while the plant was down. Thus in a competitive market competing firms will factor some of this risk into their investment decisions in so far as they are liable for the costs of an interruption. However, the potential losses of individual generators are only limited to their medium-run fixed costs for the time that gas is unavailable.

For the economy as a whole a physical interruption in supply of gas would be extremely serious because substitute electricity supplies could not be found in a reasonable time scale. Electricity is an essential ingredient in modern life and this is reflected in the very inelastic demand for electricity.[1] A very extensive interruption of output across the economy would be inevitable from a prolonged interruption of electricity supplies. The social and economic effects would be very severe. While probably less important than the social impact, if the interruption was sustained for more than a few days, the loss of industrial output could not be made good by Irish manufacturing firms supplying from stock and producing more later. Export markets would be lost and a permanent loss of national income would be inevitable.

Even though investors will have a concern to ensure a secure gas supply, the potential costs of a major outage of electricity for the economy as a whole are likely to be massively greater than the costs to the individual generator. If this potential risk is to be adequately dealt with the regulatory authorities can not leave it to market forces but must deal with it directly in the context of energy policy. Already this issue of security of supply was an important factor in the decision to build a second gas pipeline to Britain at an early date.

The costs of an electricity outage will be non-linear in the proportion of the total electricity supply that is lost – the damage done by a loss of electricity will be small for a limited outage but could be massive for a total failure. For example, a loss of 20% of electricity capacity due to a gas outage would be got around through rationing, with regular rotating curtailment of supply, while leaving crucial sectors, such as hospitals, with continuous supply. However, as the loss of capacity rose above 20% the costs and related disruption would be likely to rise. Thus a loss of 80% of electricity capacity due to gas outage would be more than a third worse than the loss of 60%. It is not possible to quantify these economic costs as they would depend on the extent of the loss of electricity capacity, the length of time power was lost and quantification would require much more economic data than are currently available.

While it is clear that such a severe disruption would have a very low probability of occurring, the costs if it did occur would be very grave. It is not possible to provide proper quantification of these costs (or of the probability of an interruption) so that those responsible for energy policy will have to use their judgement in determining how much it is worth paying for fuel diversity to avoid the very low probability of severe interruption of electricity supplies.

3. Risk of Major Gas Price Shock

While currently the sources of gas on the EU market are quite diverse, with supplies running out from existing suppliers (e.g. the UK, the Netherlands and Ireland), by 2010 the then fully integrated EU market will be dominated by Russia (Gazprom), Norway, and Algeria. This will be an even more concentrated market than the current OPEC cartel. With a relatively low price elasticity of demand for gas in the medium term, this would confer considerable market power on the small number of major suppliers.[2] This leaves open the possibility that gas prices could be dramatically raised for a sustained period through a voluntary restriction of supply. It is this risk of a future price shock that needs to be considered by Irish energy policymakers.

Unlike the case of a physical interruption, there would be little incentive for individual firms with generating plant to take the risk of a major shock to gas prices into account in their investment decisions. Because all producers in Ireland (and elsewhere) would be faced with

[1] See J. Fitz Gerald, J. Hore and I. Kearney, 2002, "A Model for Forecasting Energy Demand and Greenhouse Gas Emissions in Ireland", ESRI Working Paper No. 146.
[2] Where the supply pipelines pass through a limited number of countries, such as the Ukraine, it could also confer significant market power on these transit countries.

the same increase they could pass it on fully to consumers. While there would be some small reduction in demand due to the higher prices, this would be small and profitability would not suffer dramatically.

It is only if the price rise were expected to be sustained for many years that investment in new plant using alternative fuels would take place, stranding existing gas plant. In the end the suppliers of gas, if acting rationally, would ensure that prices did not remain high for so long that their market was permanently damaged by existing consumers investing in new oil or coal capacity.

Table1: Gas in the Irish and EU Economies

		Ireland	Ireland	Ireland	EU
		2001	2010	2010	2001e
Moneypoint		Open	Open	Closed	
Gas Consumption – Economy	Mtoe	3591	5573	6543	328364
Price	€ a Toe	102	131	131	102
Total Cost of Gas Bought - Economy	€ Million	366	731	858	33504
GNP	€ Million	96746	178572	178572	8816000
Gas as % of GNP		0.38	0.41	0.48	0.38
Electricity, Gas share[3]	%	40	58	79	18

The economy could be more adversely affected by a major shock to gas prices than individual electricity generators. Such a shock would, firstly, affect incomes domestically, in turn affecting consumption, output and employment. Secondly, if Ireland were more affected than other markets by the price shock, then there would be a loss of competitiveness relative to our EU partners. Such a loss would compound the loss of output and income, with an increased incentive for sensitive production to move to other locations that were less affected by the shock.

Thus the possible impact of excess dependence on gas on the economy will depend on the extent of gas dependence in Ireland, and also on our dependence relative to our trading partners. In Table 1 we compare the Irish economy's exposure to gas in 2001 with two variants for 2010: Moneypoint coal-fired electricity generation station open and Moneypoint closed. The price used for 2001 is the import unit value (price) for gas into Ireland as given in the CSO trade statistics. (This does not include transmission charges charged in Ireland.)[4] We also estimate the current exposure of the EU economy using composite data for 1999-2001 and the Irish import price for gas.[5]

These data show that the expenditure on gas used in Ireland today is just under 0.4% of GNP and that, if Moneypoint were to remain open on full power, there would be little change in the economy's exposure to gas up to the end of the decade. However, if Moneypoint were closed by 2010 and replaced by new gas CCGT (Combined Cycle Gas Turbine) stations then Ireland's exposure would rise to almost 0.5% of GNP. This would be somewhat greater than the current average for other EU economies (that have a similar exposure to Ireland today).

[3] The data for Ireland for 2001 are from the Department of Public Eneterprise Energy Balance Sheets. For 2010 they come from ESRI projections. For the EU they are for 2000 and are taken from IEA, 2002, *World Energy Outlook.*

[4] IEA, 2002, *Energy Prices and Taxes*, gives a price for gas for electricity generation in Ireland in 2001 of €158 per TOE.

[5] For Ireland GNP is considered more appropriate whereas the figure shown for the EU is GDP.

For electricity the situation would be rather different, with the proportion of electricity produced from gas rising from 40% to nearly 60%, if Moneypoint remained open, or to 80% if it were closed. The latter figure would be very much higher than the exposure of the EU as a whole[6], leaving those sectors that are particularly dependent on electricity very exposed to a gas price shock.

What is the economic significance of the likelihood that by 2010 Ireland will become considerably more gas dependent than the EU average for electricity, and somewhat more gas dependent for the economy as a whole?

If gas prices were to rise suddenly by, for example, 200% to three times their current level, and if the higher price were sustained for a number of years this would have a quite noticeable effect on the Irish economy. With gas usage currently costing 0.4 percentage points of GNP before such a price rise (Moneypoint open), the immediate cost to the economy of such a price shock would be an additional 0.8 percentage points of GNP, taking the cost of gas to a total of 1.2 percentage points of GNP. This would mean a net cost to the Irish economy of 0.8% of GNP paid to the foreign suppliers of gas. Such a negative shock would have knock on effects as the economy adjusted to the inflationary shock. However, provided that Irish exposure was the same as the exposure of our EU competitors, here taken to be the EU, then there would be no relative loss of competitiveness.

However, if European exposure to gas were to remain the same as today and if Moneypoint were to close, as shown in Table 1, the shock to Ireland's economy would amount to just under one percentage point of GNP[7] compared to just under 0.8 percentage points[8] for our competitors. While not a dramatic change, this would still represent a loss of competitiveness compared to our competitors that would enhance the negative output and employment effects.

In the case of businesses and households that are particularly dependent on electricity, the effects of the shock could be more adverse. In the case of businesses, the loss of competitiveness relative to similar electricity-using businesses abroad could be significantly greater, given the much greater gas dependence of the electricity sector in Ireland compared to the rest of the EU. Thus the income loss as a result of the price shock would be compounded by an enhanced incentive to relocate electricity intensive output elsewhere.[9]

There is a range of different strategies that could be adopted to reduce dependence on gas. In this note we concentrate on only one of these possibilities – the maintenance of the coal-fired Moneypoint generation station as a major supplier of electricity into the next decade. However, the issues discussed here apply to the consideration of many of the alternative strategies that might be adopted, and the case of Moneypoint serves as a useful illustration of the complex issues facing the Irish regulatory authorities in determining the appropriate policy to ensure security of energy supplies into the future.

Because of EU regulations on emissions of polluting gases (other than greenhouse gases) the Moneypoint station will require the fitting of flue-gas desulphurisation technology if it is to be permitted to operate after 2008. In addition to the capital cost[10] there would also be a loss of efficiency and higher running costs compared to the current situation.

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[6] IEA, 2002, *World Energy Outlook,* suggests that in 2010 30% of EU electricity will come from gas.

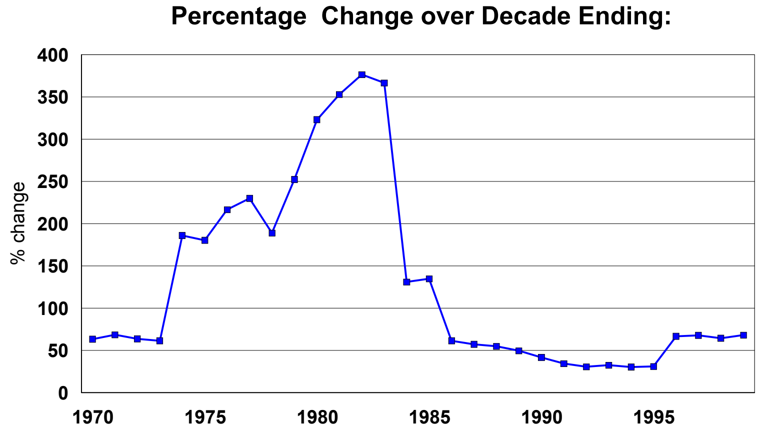
[7] The share of gas in GNP at gas prices before the shock would be 0.48% and with a 200% rise in gas prices this would rise to 1.44% (0.48*3) – an increase of just under one percentage point.

[8] Derived from Table 1: calculated as (.38*2=0.76 percentage points).

[9] Individual businesses would not have to physically relocate elsewhere. Much more likely would be a situation where output in the firm declines or ceases in Ireland and the market is met from production by more successful firms elsewhere.

[10] The cost of fitting such equipment to a coal-fired station in Eggborough in Britain is put at £70M for two 500 MW units (http://www.british-energy.com/media/press/items/item4.html) This would translate

Figure 1: Change in Real Import Price of Oil



To work out the benefits of undertaking this investment to enhance security of supply in the face of price shocks it is necessary to make some assumptions about the likelihood and magnitude of such shocks in the future. In Figure 1 we show the Irish experience with the real import price of oil.[11] It shows the percentage change in the price over a series of ten year periods ending between 1970 and 1999. As can be seen from the Figure, in 1982 the real price of oil was over 370% of the price a decade previously. By contrast, in 1994 it was only 30% of the price in 1985. While the factors driving gas prices are rather different, they do provide some indication of potential volatility as both oil and gas markets involve long lead times for investment in supply and some degree of market power for producing countries (and firms). Though the past need not be a good guide for future price volatility, it does provide a benchmark against which to consider the value of investing in future security of supply.

If the probability and the magnitude of a future price shock could be estimated then it would be possible to estimate the expected value of the potential benefits from fuel diversity. For example, in a very simplified case, if the probability of a 200% real price rise lasting five years were estimated at 10% and if there were a 90% probability of no change in the real price then it would be possible to value the expected cost of a shock as the weighted average of the no shock situation (probability 90%) and of a 200% real shock (probability of 10%) The calculation would be as follows for the single year cost of such a shock:

Cost = 200*0.1+0*0.9=20

If the price rise were to last for 5 years and prices were then to revert to the base case the cumulative cost would be 20% onto prices for 5 years or 100% of the one year cost of buying gas. Obviously because such a shock would occur in the future the costs would have to be appropriately discounted.

The real world can not be characterised in this simplistic way as involving only two outcomes. In practise there is a very wide range of possible outcomes on price each having a different probability of realisation. In the Box we provide another illustration of a simple working out of the possible cost of a future price shock.

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into around €100 million for Moneypoint. However, detailed costings for Moneypoint would have to be obtained from the ESB.

[11] The CSO unit value index for imports SITC3 is divided by the deflator for GNP.

Box: Illustration of Costs and Benefits of Security of Supply Investment

In the real world there is an infinite range of possible future outcomes for gas prices. In Table 2 we show a purely illustrative example of a possible distribution of outcomes on real gas prices, together with purely illustrative probabilities. Thus the probability of the real price rising by 100% is assumed to be 12.5%. It is here also assumed that the breakeven price for undertaking the investment on purely commercial grounds is the current price level (0% in Table 2). If the price rises above this level then there is a benefit from having Moneypoint available.

Table 2: Illustrative Distribution of Possible Real Gas Prices over the Coming Decade

Cumulative Change in Real Gas Price, %	Probability, %	Probability * Price
-75	10.0	
-50	30.0	
0	20.0	
50	15.0	7.50
100	12.5	12.50
150	7.5	11.25
200	3.5	7.00
250	1.5	3.75
Total		42.00

It is also possible that shocks could include substantial falls in gas prices, though the scope for large percentage price falls is probably more limited than for increases because of the significant short-run costs of gas production and international transmission. However, the costs of the "security of supply policy"are capped at the capital cost of installing flue-gas desulphurisation because, and if prices fall below the breakeven price, there is always the option of closing the plant. Obviously once the investment has taken place the decision on closure would then depend on the running costs of the plant, excluding the sunk capital costs. Provided that the short-run marginal cost for Moneypoint was lower than that for gas fired plant, it would still be profitable to keep it open as it would be paying off some of the original capital costs. The net cost of this security of supply policy would then be less than the full capital cost.

In the illustration in this box we have simplified the calculations by assuming that where the price falls Moneypoint is closed (represented by a zero in the relevant rows of Table 2). As discussed above, this exaggerates the costs by assuming them to be at the maximum, with no offsetting benefits where the price for electricity is above the short run marginal cost of production in Moneypoint.

Using these assumptions, the benefits of having Moneypoint begin to accrue in the case where real prices rise. The expected value of these benefits is calculated as shown in Table 2 by multiplying the possible real price increases by the probability (in coefficient form) of each event, and summing the result. In the example above the expected value of the benefits would be 42% of the annual cost of the gas. If the price increases were expected to persist for 5 years then the benefits would be calculated as:

Benefit = 42*5 = 210%

In this example the possible gain of 210% of the annual gas price would be compared to the capital cost. If the expected gain were greater than the capital cost then this investment in security of supply could be expected to be profitable. In the real world it would be necessary to treat the possible cost of a fall in price in a more sophisticated way. It would also be necessary to discount the future benefits and costs to bring them to their present value.

The real world is also much more complex for a number of other reasons. There is uncertainty about the future cost of carbon emissions. The higher the future cost of carbon, the more expensive will be solutions that rely on coal (or peat) fired plant to provide security of supply. It will also be necessary to take account of the fact that in the early years, before carbon prices rise, there could be savings from having Moneypoint available because of its low fuel costs, savings that would partly offset the capital costs.

4. The Costs and Benefits of Security of Energy Supply

We have discussed in Sections 2 and 3 the methodology for assessing the costs and benefits of measures to enhance security of electricity supply. Here we summarise the results of applying the methodology: how much would it be worth paying to buy insurance against future shocks? We go on to consider who should pay the cost of buying enhanced security and who should benefit. The determination of who will actually pay and who will actually benefit will be dependent on the regulatory authorities. Matching up those who pay with those who benefit will be important to ensure an "efficient" economic outcome.

4.1 The Costs and Benefits

While the appropriate methodology for determining the costs and benefits of policies to ensure security of energy supply has been outlined here, it is not possible to easily quantify the benefits of fuel diversity: neither the probability of shocks nor their possible magnitudes can be readily estimated and the figures in Table 2 are only used to illustrate the issues involved. As discussed in Section 2, in the case of physical interruption of supply it is exceptionally difficult to assess the potential costs and the probability of such an outcome. In the case of potential price shocks it should be easier to provide some idea of possible magnitudes by testing a range of scenarios.

In carrying out such sensitivity analysis those responsible for energy policy will have to form a view as to the possible magnitudes of future price shocks and their possible likelihood. This, in turn, can be used to estimate the potential economic cost of price shocks and to provide guidance on how much it is worth paying for enhanced fuel diversity in the future. In the end, this will be a matter of judgement and it is not amenable to a deterministic scientific answer.

In practise, there are additional dimensions that will have to be taken into account in reaching a decision on the costs and benefits of different strategies for ensuring security of energy supply. As outlined above, the optimal decision for the electricity sector may not be optimal for the economy as a whole because of the externalities involved. For example, we have discussed above how the Irish economy could find itself more exposed to price shocks than other competing economies. To the extent that this economy-wide exposure has not been taken into account in the numerical examples, the regulatory authorities will need to incorporate it into their decision making processes.

The issue of whether Moneypoint should be kept open can be seen very much as a decision about buying a complicated insurance policy – a "premium" is paid in return for some insulation against future price shocks and against possible interruption of gas supply. This cost or "premium" is made up of the capital sum needed to make the necessary improvements in the plant and any excess running costs for the plant over its life time.[12] At any point, if expectations about the benefits from enhanced security of supply change, it will be possible to close Moneypoint. Thus the cost of this option on providing security of supply (insurance policy) is capped at the capital cost of the initial upgrading of the plant – the cost can not

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[12] Where the "excess" is defined as the running costs of Moneypoint less the costs of the next cheapest generating station

exceed this and may well be less than the full capital cost due to savings on running costs while the price of carbon is still low.

Even with the substantial cost of upgrading Moneypoint, at current fuel prices Moneypoint would still initially be the lowest cost producer on the system. However, the expected rising cost of carbon emissions over the coming decade will gradually erode this favourable position. Uncertainty about the future price of carbon emissions means that there is also considerable uncertainty about how long Moneypoint's favourable status as lowest cost producer will persist and about how much of premium would be required to keep it available once the cost of emitting carbon rises.

4.2 Who Pays?

While at an economy-wide level the factors to be taken into account are reasonably clear, the evolving structure of the electricity sector makes it less clear who will or should actually pay the insurance "premium" and who will benefit in the event of a sudden sharp rise in gas prices or an interruption to gas supply. Because of this uncertainty there is the danger that a nationally optimal strategy may not be realised because of inappropriate incentives to the different market participants.

It could be argued that individual consumers could choose whether to pay a premium on their normal tariff and make their own choices about security of supply. However, such an approach would be costly to administer and it seems probable that customers would underinvest in security of supply. The alternative is for the regulator to decide whether Moneypoint is worth keeping open for security of supply reasons. If it is to be kept open then the regulator would guarantee that the capital costs of the new investment could be reclaimed from all consumers.

In the early years, when the price of carbon is low, the owners of Moneypoint should receive a price at or above the current short-run marginal cost of production[13]. This may initially be adequate to pay the long-run marginal cost of a unit of electricity from the plant. However, as it is anticipated that the cost of production in Moneypoint will eventually rise, due to rising carbon prices, the plant would probably eventually become uneconomic if security of supply considerations were not taken into account. If the investment is to be undertaken, the regulator would have to provide a guarantee that the capital costs would be recouped over the lifetime of the project. To the extent that the capital cost had not been recouped in the early years, when the price of carbon is low, it would have to be recouped by use of system charges paid by all consumers.

4.3 Who Benefits?

In planning for the future the reason why consumers (business and households) would want to take out insurance against price shocks (such as buying fuel forward) is precisely to guard against future price uncertainty. This allows the business sector (and households) to plan ahead their own investments. The "insurance policy" on security of supply will lose all value for business if it is not clear that business will benefit from a more stable price regime.

If for example, there were to be a gas price shock in 2010 how would a potentially competitive market react? Given the likely structure of generation, the marginal supplier of electricity to the market would be a gas fired station. In a competitive market that station would charge the full marginal cost of supplying and that price would set a floor for

[13] Determined by the cost of production in the most expensive station supplying base load – probably a gas station.

electricity prices for consumers. The effect would be that that the owners of Moneypoint, with a markedly lower cost of supplying, would make very substantial profits under such a market regime.

If consumers had paid the “insurance premium” over the intervening years to keep Moneypoint open (for example, through paying higher use of system charges) it would seem unfair that the benefit should then accrue to the owner of Moneypoint, even if the owner was still the state. However, even if the regulatory regime ensured that the *quid pro quo* for maintaining Moneypoint in operation was that such excess profits would be paid back to the consumer, there remains the issue of how such a payment should be made.

Generally the economic principles of marginal cost pricing would suggest that consumers should pay the full marginal cost of a unit of electricity. Otherwise more gas will be consumed than is socially optimal. This would normally argue for paying back consumers the profits from Moneypoint as a lump sum, for example as a reduction in the fixed cost element of consumers’ bills.[14]

While this approach might well be logical once the price shock (or supply interruption) had happened, it is not necessarily optimal from the standpoint of today. It is only if there is a commitment that in the event of a price shock the profits from Moneypoint will be used to reduce the unit cost of electricity for all consumers that the same consumers would want to buy such a policy. This would suggest that if there is a pay-out on the “insurance policy” at some future date through gas prices rising dramatically, the benefit from lower cost production by Moneypoint should be used to reduce the marginal cost of electricity to all consumers.

4.4 Conclusions

The conclusion of this analysis is that the regulatory authorities must first assess whether the potential national benefits in terms of security of supply warrant investing in keeping Moneypoint open. If they do believe that it is worth doing so then the regulatory authorities will have to ensure that the incentives are provided to see that the investment takes place. In addition, if the policy of enhancing security of supply is to have a value for the intended potential beneficiaries (consumers), the regulatory authorities will also have to commit in a transparent way to a mechanism that will ensure that consumers will benefit in the event of a price shock (supply interruption). This would become particularly important if Moneypoint were ever to be sold by the current shareholder, the State.

[14] However, it would be very difficult to determine how such a lump sum benefit should be allocated fairly across consumers.