

Forecasting Peak Demand & Annual Energy Consumption in the Economic Downturn

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Introduction

SONI, as System Operator, is responsible for operating the transmission system. One aspect is to ensure generation production meets peak demand and energy consumption forecasts. To successfully achieve this SONI require forecasts of these variables to assess the future demand. Required forecasts include an estimate of system Peak Demand (MW) and total Annual Energy Production. Currently SONI use a deterministic forecasting model called "GMASS" to predict future values of these variables. GMASS uses regression analysis over varying historic time frames to create a forecast value for both Peak Demand and Energy Production.

Given that temperature has been found to have the greatest effect on the demand for electricity all demand data is adjusted to a temperature standard known as Average Cold Spell (ACS). Climate condition variation, therefore, are accounted for in the equation. To date external factors affecting energy consumption such as the level of economic activity have merely been used to validate system forecast values. Until recently annual forecasts of energy usage and energy peak demand have been reasonably accurate and produced values close to the observed values. In 2008, however, there has been an increase in the difference between the predicted values and the observed values.

It is important that the System Operator assesses whether the increase in forecast error in 2008 is a random occurrence that is unlikely to occur again or whether it is a longer-term issue affecting energy demand as it has not been factored into the regression tool in previous years. An adjustment to the regression equation employed may now be required.

To assess the accuracy of the forecasts analysis has been carried out using the 8 year medium term regression equation to predict values of energy peak demand in previous years and then these predictions have been compared with the actual observed values in each year. This analysis allows us to identify if the regression tool appears to be forecasting satisfactorily. In addition we will look at the residuals, i.e. the difference between predicted values and observed values of peak demand to ascertain if any of these values appear to be significantly different from the others and hence would require further examination.

Analysis of Regression

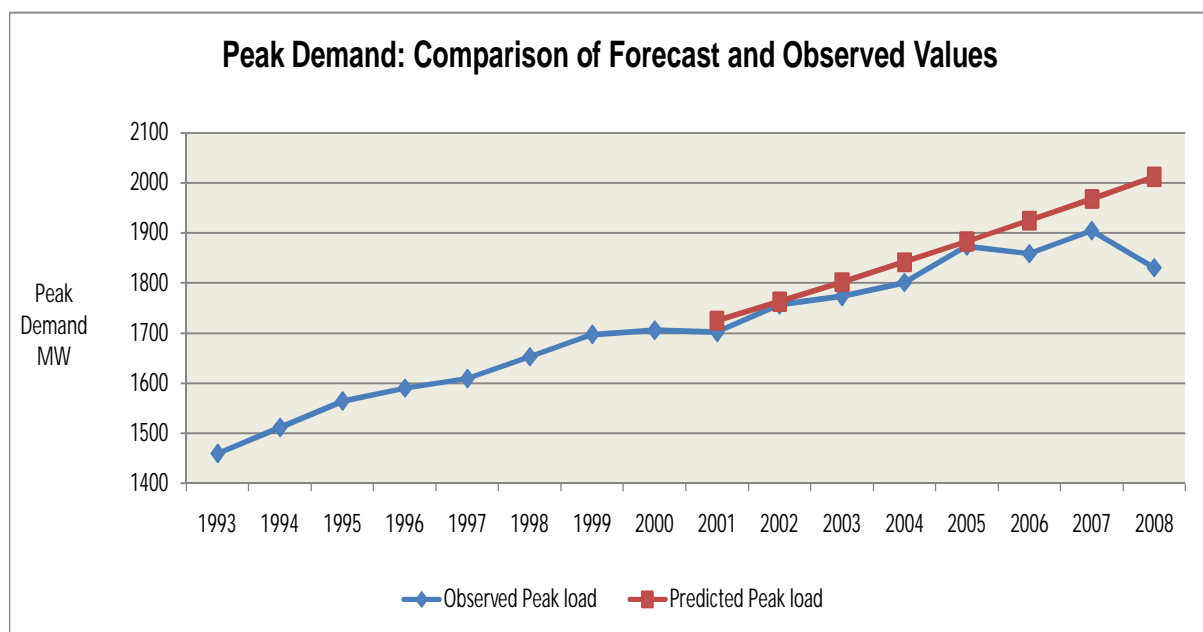
The following chart (Figure 1) represents a forecast made back in 2000 using the 8 year medium term regression equation to predict Peak Demand in the years 2001 to 2008 based on observed Peak Demand values in the preceding years 1993 to 2000.

For the 8 year medium term forecast of load GMASS uses the following regression equation. This is not an industry derived standard equation but has been developed by SONI with experience.

$$\text{Log } L = 0.00956n + 3.160214$$

where L is load and n is year number

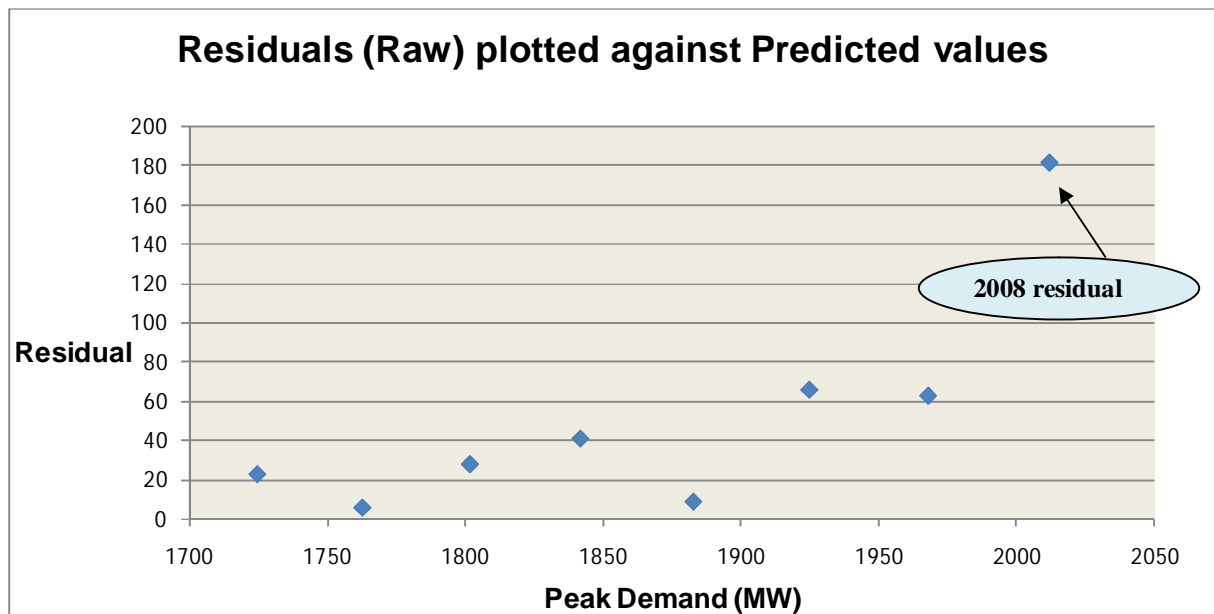
Figure 1: Comparison of Forecasted and Actual Peak Demand using 8 year regression equation



The data in Figure 1 has been adjusted for the Average Cold Spell (ACS). The predicted maximum demand values (red line) which GMASS forecast for 2001 – 2008 can be compared to the actual observed values (blue line) in these years, given that these are now known. As we can see the regression forecast values are very close to the observed values in almost all years and particularly accurate in the first 5 years. The year in which the predicted value differs considerably from the observed value is 2008.

Figure 2 below illustrates this further by showing a plot of residual error values against the Forecasted values. Similarly the same trend can be seen where the residuals appear to be normal (indicated by the rectangular scatter) except for the 2008 residual which lies far out from the other residuals.

Figure 2: Residual errors against Forecasted Values



From both figures above therefore it is evident that the regression is estimating peak demand well until 2008 when there appears to be a sudden difference between the peak demand forecast and that observed.

We see this sudden fall in 2008 also illustrated in Figure3 below which shows the Actual ACS Peak Demand values. A similar trend can be seen when we examine total Energy Production consumed, with a change in 2008 also evident however to a lesser degree as can be seen in Figure 4 below.

Figure 3: ACS Peak Demand

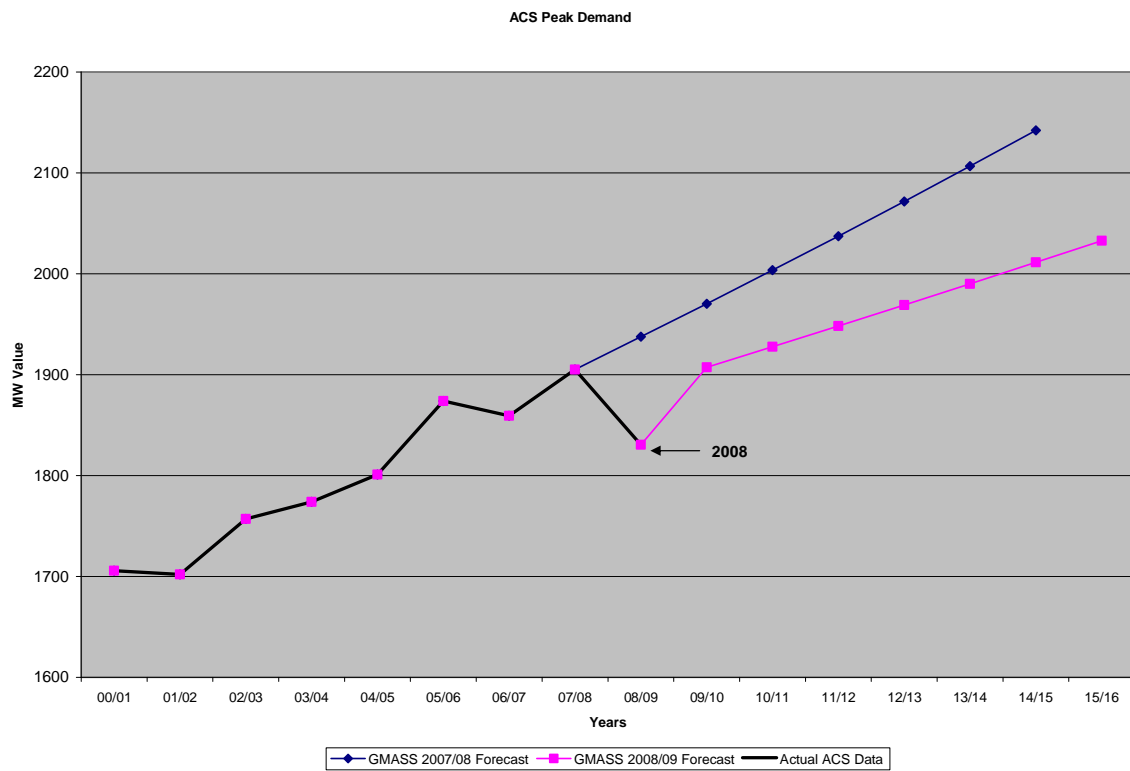
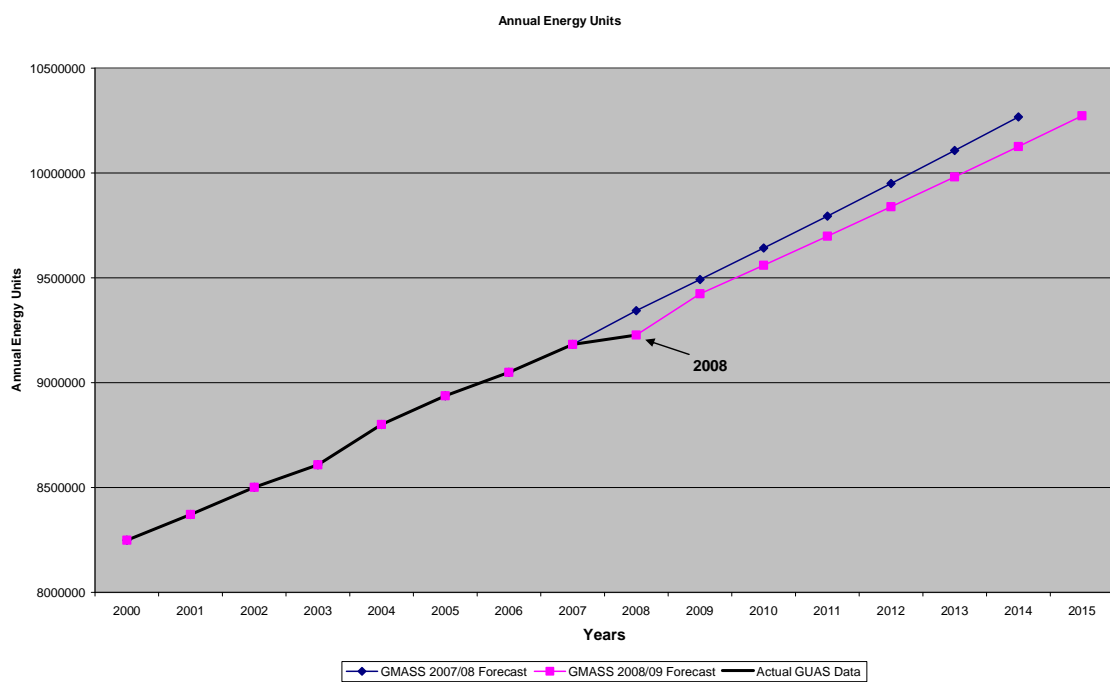


Figure 4: Annual Energy Production



The reason for the smaller decline in energy is that the economic downturn came in the second half of 2008. If we were to adjust the 2008 figures for the complete year to represent the decline that happened in the second half of 2008, the Energy Production drop would be considerably more and consistent with the observed drop in Peak Demand represented in Figure 3.

It should also be noted that on top of the economic downturn, there was an added factor of an unprecedented electricity price in Northern Ireland as explained later.

Given the drastic changes in the global economy in 2008 it would seem logical that Peak Demand and Energy Production would react in some way to these. The economic factors are discussed in more detail in the next section. On the assumption that economic factors influence electricity demand it would also seem logical to account for these unprecedented economic conditions in the forecast of future Peak Demand and Energy Production.

Economic Factors

The global economy has weakened rapidly in 2008. The US, UK, euro-zone and Japan have all experienced recessionary conditions. Housing markets collapsed with prices plummeting, unemployment rates have risen sharply and business and consumer confidence is at a low. Governments and central banks have implemented numerous measures to help stimulate the economy but the economic outlook continues to be bleak.

On a GDP basis the UK economy is predicted to contract by 3% in 2009 before experiencing a modest recovery in 2010. The Irish Government recently announced in their April 2009 budget that they estimate that GDP in ROI could fall by up to as much as 8% in 2009. Outside the boarder areas Northern Ireland is feeling the same pressure as other economies.

The main areas of the NI economy which have suffered include the retail sector, the manufacturing sector, which is experiencing a huge slowdown, and the construction industry. In Northern Ireland the service sectors output fell by 3.5% in Q3 2008 compared to the same quarter in 2007 and this decline is continuing. Manufacturing output showed zero change in Q3 2008 however in the first quarter of 2009 a substantial number of jobs losses in the manufacturing sector have been announced. Average house prices are continuing to fall after dropping by 28% in 2008 and retail and wholesale output was 6.8% lower in the third quarter of 2008 compared with the previous year. These trends have caused a rise in unemployment.

Overall consumer confidence weakened as indicated by the number of new car registration which was 37% lower in the third quarter of 2008 compared to the same quarter in 2007. In the "First Trust Bank Economic Outlook & Business Review, March 2009" it is forecast that the NI economy will contract with the rest of the UK economy during 2009 before experiencing a similar recovery during 2010. That said

however, it is believed that NI is in a better position to deal with the recession compared to many other UK regions. As of March 2009 GDP in NI is forecast by the First Trust Bank to fall by 1.5% in 2009 before steadying out to 0.0% in 2010 and this compares to a drop of 0.25% in 2008. The First Trust Bank also expects Industrial output to fall by 1% in 2009 and 0.5% in 2010. There are a number of reasons why NI is expected to be less impacted by the current economic downturn, these include;

- A favourable euro/sterling exchange rate, as well as lower VAT rate, consumers in ROI now make increased purchases of goods from NI.
- NI has a higher share of public sector jobs than other regions of the UK, these jobs are less likely to be at risk
- The financial services sector which has suffered severely in recent times is under represented in NI, as is the business services sector, so the region is less exposed to these effects
- Some NI sectors such as food production are expected to remain strong

The "Ulster Bank NI Quarterly Review" published in February 2009 stated "manufacturing output remained flat in Q3 2008 but is expected to decline sharply in Q4 2008 and in 2009." This would align with the trends in Peak Demand and Energy Production that have been seen since October 2008. This review also concludes that "Given the scale of downturn in Q4 2008 it would not be surprising if NI manufacturing output dropped even further".

Electricity Prices

It is generally agreed that the demand for electricity is price inelastic. This means that the quantity of electricity demand does not respond significantly to a change in price. This is common with commodities such as electricity that do not have a close substitute.

Over the past 18 months in Northern Ireland the price of electricity both for domestic, commercial and industrial users has been increasing at an unprecedented rate. For example the average domestic tariff experienced two significant price increases during 2008 beginning with a 14% increase in July 2008 and followed by a 33% increase in October 2008.

The October 2008 price increase does coincide at a time when a substantial fall in energy units consumed was recorded and there is a possibility that this increase in electricity prices did actually have an effect on the demand for electricity.

However, this also coincided at a time when the economic downturn was beginning to become more apparent. It is impossible for these two factors to be separated out to see what effect this significant rise may have had on demand, but it can be assumed that it did have an impact.

Economic Recovery

In terms of when the economic trends will reverse and GDP will rise is open to much debate at present. The general view is that the economy will flatten out at some stage during 2010 and economists are hesitant to project further ahead than this. Previous experience of recessions might lead some to think the recovery will be slow however the degree of government intervention which is currently being levied in order to stimulate the economy has not been applied in past recessions. It is hoped that the government stimulus plans will lead to a faster economic recovery. In the US CNN on 30th March 2009 outlined that PJM, the biggest power grid in North America, forecast a 1.4 percent drop in peak demand in summer 2009 compared with 2008, based on normal weather conditions. Demand in the 13 mid-Atlantic and Midwest states that PJM serves should rebound in 2010 but not surpass levels seen in 2008 until 2011. PJM projected peak demand growth would return to a more normal 1.7 percent per year over the next decade.

For now, given the high degree of uncertainty over the future we feel the best approach is to consider three alternative possible scenarios for the economy and for each of these derive an estimate of Peak Demand and total Energy Production. The three scenarios will consist of a Pessimistic, Realistic and Optimistic view for both the ACS Peak Demand and Annual Energy Production and the figures will be adjusted so that these take account of current and predicted economic conditions.

ACS Peak Demand Scenarios

1. Realistic View – ACS Peak Demand

In this scenario it will be assumed that the reduced level of electricity ACS Peak Demand that has been experienced in the last quarter of 2008 will continue to fall throughout 2009. Given that GDP is forecast to fall by 1.5% in 2009, the forecasted ACS Peak Demand in this year will be approximately 2% lower than in 2008 with the 2010 forecast anticipated to stabilise by staying at the same level as the 2009 forecast to reflect the expected stabilisation with a 0% growth in GDP in 2010. A 0.5% increase in ACS Peak Demand is forecast in 2011 to align with the expected recovery in 2011 onwards. The percentage year on year adjustments for other years are shown in Table 1 and it is not expected that the 2008 ACS Peak Demand figure will be exceeded until beyond 2012. A modest year on year growth rate of 1.50% is predicted from 2013 onwards which is slightly less than that observed in recent years.

2. Optimistic View – ACS Peak Demand

This view will assume that the various stimulus plans currently being applied will allow the economy to recover faster than some expect and hence growth would be higher than in the realistic view above. In this scenario we will assume that in 2009 some confidence will have returned to the economy and that the period of decline will be nearing an end. The ACS Peak Demand forecast in 2009 will therefore be approximately the same as that recorded in 2008 to reflect the expectation that the economy is levelling out. The forecast for 2010 will be slightly higher than 2009 showing a growth of approximately 0.5%. Growth will then continue at an increased rate for the future years. The percentage year on year adjustments for other years are shown in Table 1 and due to the levelling out in 2009 it is expected that the 2008 ACS Peak Demand figure will be exceeded in 2011 with a predicted year on year growth rate stabilising at 1.80% from 2013 onwards.

3. Pessimistic View – ACS Peak Demand

This view will assume that the economy does not recover as fast as hoped and actually falls deeper into recession throughout 2009 and 2010 causing recovery to be much later towards 2012. ACS Peak Demand will be forecasted to be much lower than in realistic scenario. The forecast ACS Peak Demand for 2009 will be approximately 3% lower than in 2008 given the expected fall in GDP. Furthermore in this scenario we consider the case that the economy has not yet bottomed out and further drops in economic output are experienced in 2010, leading to another fall in ACS Peak Demand in 2010 before experiencing a very small increase in 2011. The percentage year on year adjustments for other years are shown in Table 1 and it would be around 2014 before 2008 ACS Peak Demand levels would return with a predicted year on year growth rate stabilising at 1.20% from 2015 onwards as it is predicted in this scenario that the return to a stable year on year growth rate will be over a longer period.

Forecast of Future ACS Peak Demand

Figure 5 below shows the predicted values of ACS Peak Demand in future years under three various scenarios. The blue line depicts the forecast values if the Realistic Scenario discussed above were to occur. The brown line depicts the Optimistic Scenario outlined above where the economy recovers sooner than some expect. The green line forecasts possible future peak demand values if economic conditions were to be possibly worse than expected as outlined in the Pessimistic Scenario above.

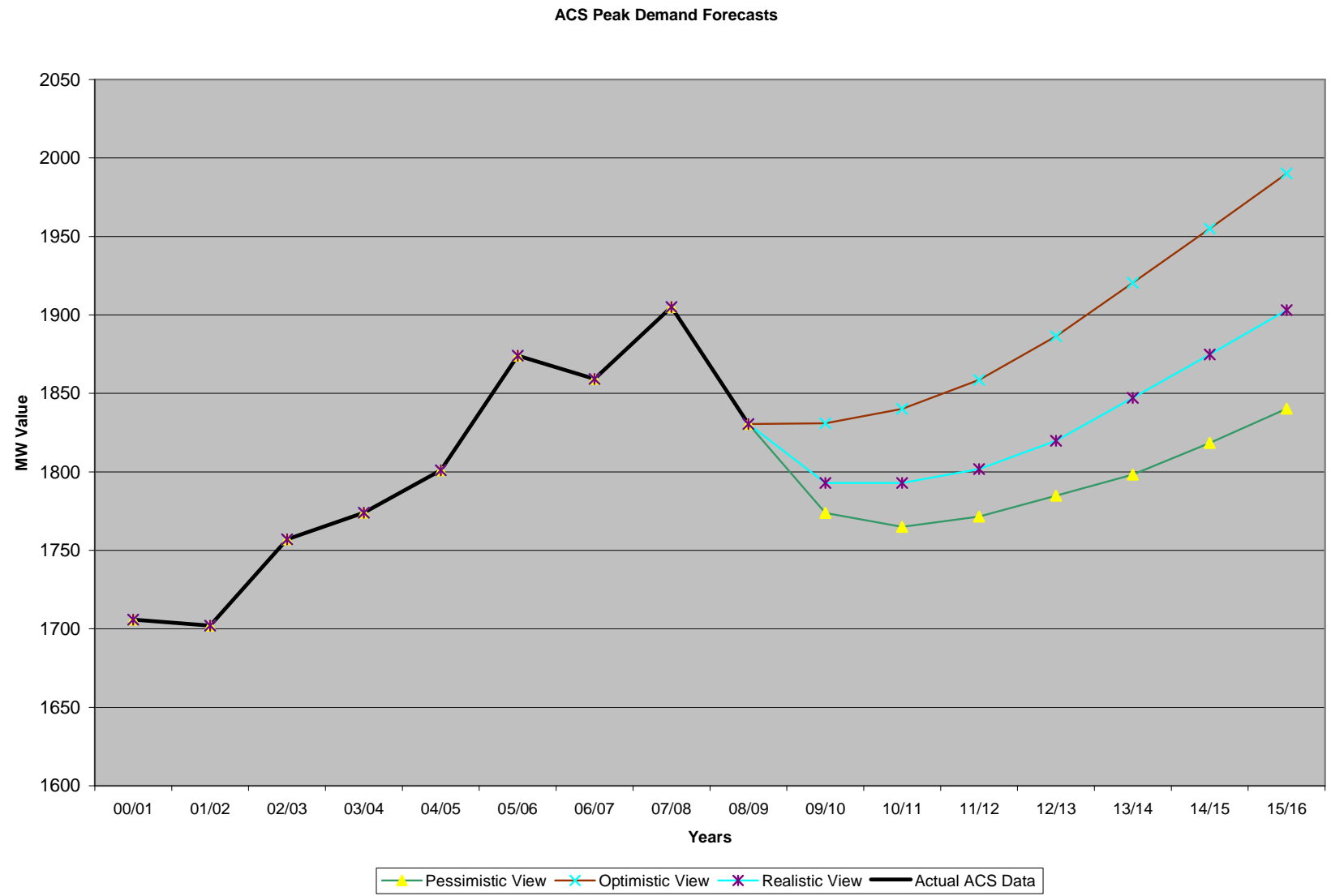
Table 1

	% Growth in ACS Peak Demand Year on Year							
	Actual 2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
2008/09 GMASS Forecast	-3.92%	4.20%	1.07%	1.07%	1.07%	1.07%	1.07%	1.07%
2008/09 Realistic Scenario		-2.06%	0.00%	0.50%	1.00%	1.50%	1.50%	1.50%
2008/09 Optimistic Scenario		0.03%	0.50%	1.00%	1.50%	1.80%	1.80%	1.80%
2008/09 Pessimistic Scenario		-3.10%	-0.50%	0.37%	0.75%	0.75%	1.12%	1.20%

Table 2

	Forecast of ACS Peak Demand (MW)							
	Actual 2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
2008/09 GMASS Forecast	1831	1907	1928	1948	1969	1990	2011	2033
2008/09 Realistic Scenario		1793	1793	1802	1820	1847	1875	1903
2008/09 Optimistic Scenario		1831	1840	1859	1886	1920	1955	1990
2008/09 Pessimistic Scenario		1774	1765	1772	1785	1798	1818	1840

Figure 5: Seven Year Forecast of ACS Peak Demand



Annual Energy Production Scenarios

1. Realistic View – Annual Energy Production

In this scenario it will be assumed that the reduced level of Annual Energy Production that has been experienced in the last quarter of 2008 will continue to fall throughout 2009. Given that GDP is forecast to fall by 1.5% in 2009, the forecasted Annual Energy Production in this year will be approximately 2.6% lower than in 2008 with the 2010 forecast anticipated to stabilise by staying at the same level as the 2009 forecast to reflect the expectation of 0.0% growth in GDP in 2010. A 0.5% increase in Annual Energy Production is forecast in 2011 to align with the expected recovery in 2011 onwards. The percentage year on year adjustments for other years are shown in Table 3 and it is not expected that the 2008 Annual Energy Production figure will be exceeded until beyond 2013. A modest year on year growth rate of 1.50% is predicted from 2013 onwards which is slightly less than that observed in recent years.

2. Optimistic View – Annual Energy Production

This view will assume that the various stimulus plans currently being applied will allow the economy to recover faster than some expect and hence growth would be higher than in the realistic view above. In this scenario we will assume that in 2009 some confidence will have returned to the economy and that the period of decline will be nearing an end. The Annual Energy Production forecast in 2009 will therefore be approximately the same as that recorded in 2008 to reflect the expectation that the economy is levelling out. The forecast for 2010 will be slightly higher than 2009 showing a growth of approximately 0.5%. Growth will then continue at an increased rate for the future years. The percentage year on year adjustments for other years are shown in Table 3 and due to the levelling out in 2009 it is expected that the 2008 Annual Energy Production figure will be exceeded in 2012 with a predicted year on year growth rate stabilising at 1.80% from 2013 onwards.

3. Pessimistic View – Annual Energy Production

This view will assume that the economy does not recover as fast as hoped and actually falls deeper into recession throughout 2009 and 2010 causing recovery to be much later towards 2012. Annual Energy Production will be forecasted to be much lower than in realistic scenario. The forecast Annual Energy Production for 2009 will be approximately 3.6% lower than in 2008 given the expected fall in GDP. Furthermore in this scenario we consider the case that the economy has not yet bottomed out and further drops in economic output are experienced in 2010, leading to another fall in Annual Energy Production in 2010 before experiencing a very small increase in 2011. The percentage year on year adjustments for other years are shown in Table 3 and it would be around 2014 before 2008 Annual Energy Production levels would return with a predicted year on year growth rate stabilising at 1.20% from 2015 onwards as it is predicted in this scenario that the return to a stable year on year growth rate will be over a longer period.

Forecast of Future Annual Energy Production

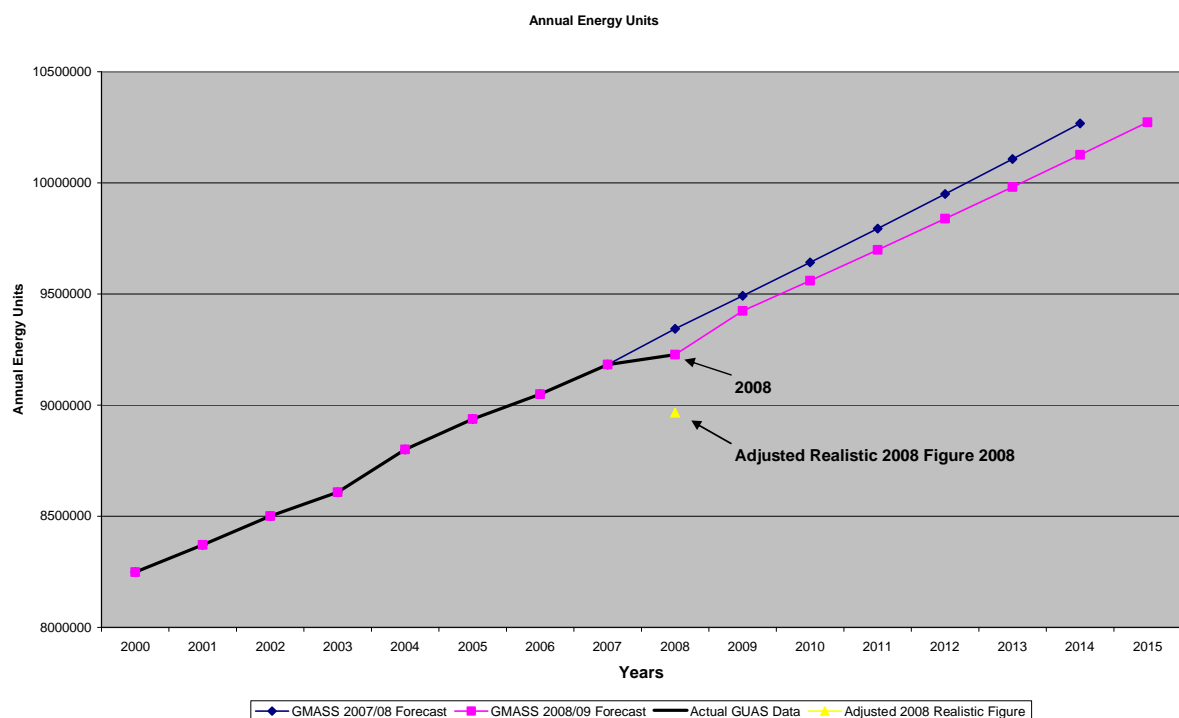
The data for 2008 was adjusted to allow SONI to create a more realistic future forecast based on the assumption that the economic downturn had occurred throughout the whole of 2008 and not just towards the end of the year.

The first 6 months of 2008 were compared to the first 6 months of 2007. This showed a 2.7% increase in sent out units for the first 6 months of 2008.

The last 6 months of 2008 were compared to the last 6 months of 2007. This showed a 2.29% ($\approx 2.3\%$) decrease in sent out units for the last 6 months of 2008.

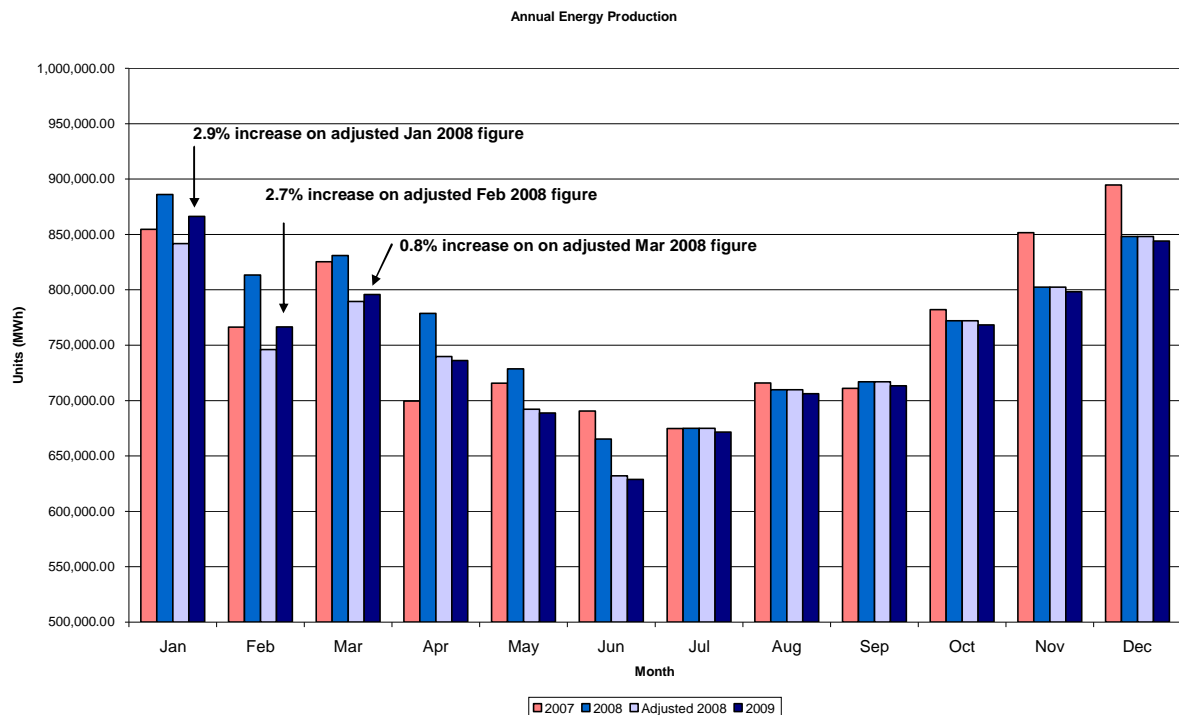
This gave an overall factor of 5% that should be applied to reduce the first 6 months of 2008, with the second 6 months being left unaltered. This results in a more realistic 2008 Annual Energy Unit figure (8965788 MWh) that may have occurred had the economic downturn happened throughout the whole of 2008. This is illustrated in Figure 6 below.

Figure 6: Realistic 2008 Annual Energy Production



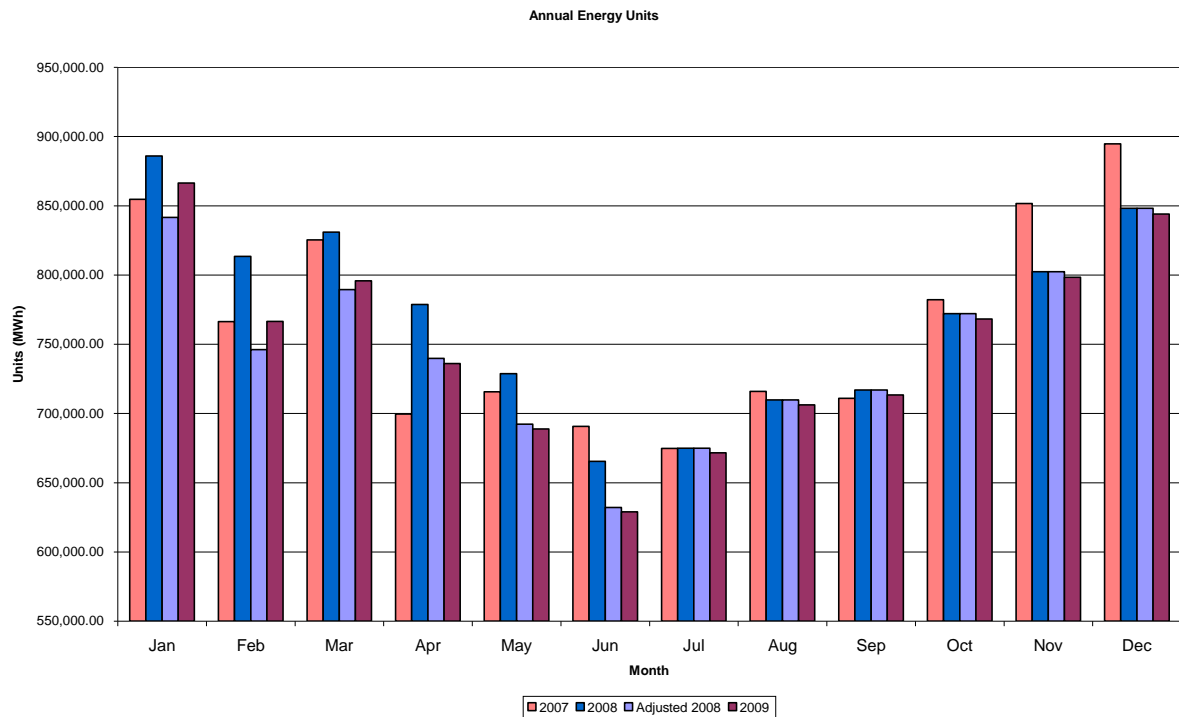
The actual data for the first 3 months of 2009 was compared with the adjusted 2008 figures for the same 3 months. It was observed that in January there was an increase of 2.9% on the adjusted 2008 figure, in February there was an increase of 2.7% on the adjusted 2008 figure and an even further reduction in this month on month % increase in March to 0.8% as seen in Figure 7 below.

Figure 7: Comparison of Actual 2009 Data with the Adjusted 2008 Data



This decreasing trend is predicted to continue until at least the end of 2009 with it levelling out in 2010. To try and account for this a further 0.5% decrease in the April to December 2008 adjusted figures will be applied to give the resultant April to December 2009 monthly figures as shown in Figure 8 below.

Figure 8: Forecasted 2009 Monthly Values



The 2009 figures have then been totalled up to get an Annual 2009 forecast which is then applied to the Realistic, Optimistic and Realistic scenarios as described above.

Figure 9 below shows the resultant forecasted values of Annual Energy Production in future years under the three various scenarios. The blue line depicts the forecast values if the Realistic Scenario discussed above were to occur. The brown line depicts the Optimistic Scenario outlined above where the economy recovers sooner than some expect. The green line forecasts possible future peak demand values if economic conditions were to be possibly worse than expected as outlined in the Pessimistic Scenario above.

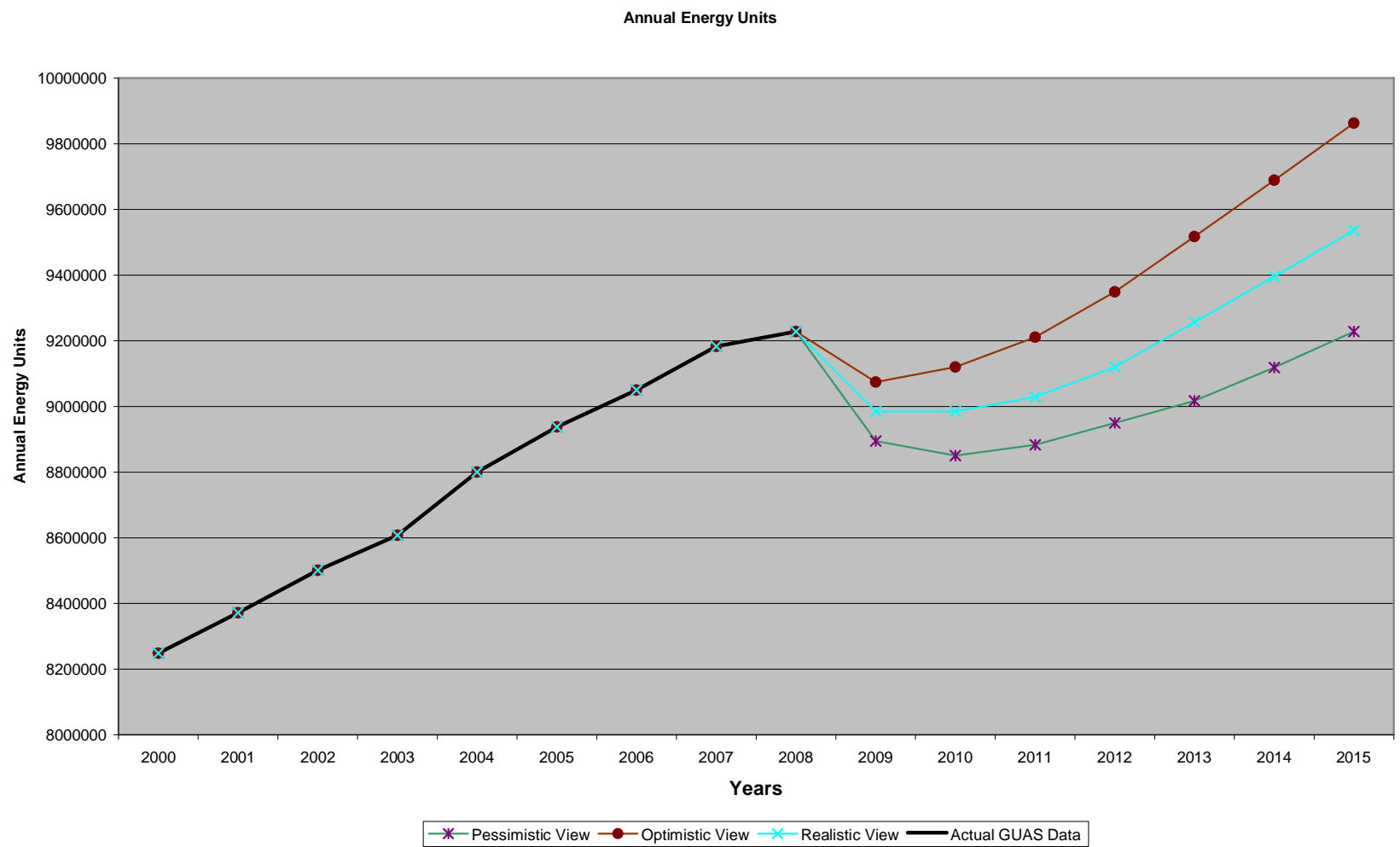
Table 3

	% Growth in Annual Energy Production Year on Year							
	Actual 2008	2009	2010	2011	2012	2013	2014	2015
2008/09 GMASS Forecast	0.49%	4.20%	1.07%	1.07%	1.07%	1.07%	1.07%	1.07%
2008/09 Realistic Scenario		-2.64%	0.00%	0.50%	1.00%	1.50%	1.50%	1.50%
2008/09 Optimistic Scenario		-1.66%	0.50%	1.00%	1.50%	1.80%	1.80%	1.80%
2008/09 Pessimistic Scenario		-3.61%	-0.50%	0.37%	0.75%	0.75%	1.13%	1.20%

Table 4

	Forecast of Annual Energy Production (MWh)							
	Actual 2008	2009	2010	2011	2012	2013	2014	2015
2008/09 GMASS Forecast	9227594	9423614	9560096	9698554	9839017	9981515	10126076	10272732
2008/09 Realistic Scenario		8984383	8984383	9029305	9119598	9256392	9395238	9536167
2008/09 Optimistic Scenario		9074227	9119598	9210794	9348956	9517237	9688548	9862942
2008/09 Pessimistic Scenario		8894540	8850067	8883255	8949879	9017003	9118444	9227866

Figure 9: Seven Year Forecast of Annual Energy Production



Forecast Approval by the Northern Ireland Authority for Utility Regulation (NIAUR)

A draft version of this Demand Forecast document had been submitted to NIAUR for their consideration during April 2009.

On the 15th June 2009 NIAUR confirmed to SONI that they were content for the 'Realistic Scenario' Forecast to be used and that NIAUR will be using it in various processes they carry out, for example, Capacity Payments and Tariffs.

Therefore, going forward, SONI will be using the 'Realistic Scenario' Forecast as approved by NIAUR.

Economic statistics sourced from the following publications:

First Trust Bank Economic Outlook & Business Review, March 2009

Ulster Bank NI Quarterly Economic Review February 2009

Department of Enterprise Trade and Investment in Northern Ireland (DETINI) Quarterly Economic Review Bulletin, Winter 08/09