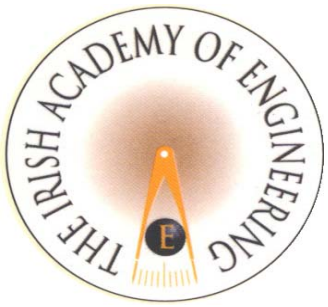

Oireachtas Joint Committee on Climate Change and Energy Security

3rd March 2010

The Irish Academy of Engineering

The Irish Academy of Engineering is an all-Ireland body, concerned with long-term issues where the engineering profession can make a unique contribution to economic, social and technological development.

Its members are Irish engineers of distinction, drawn from a wide range of disciplines and membership currently stands at approximately 120.

Drawing on the experiences and knowledge of its distinguished members, The Academy works to facilitate communication and dialogue on engineering-related matters. It publishes reports and analyses, some jointly with other learned and professional bodies.

The Irish Academy of Engineering,
22 Clyde Road, Ballsbridge, Dublin 4
Tel: 00353 1 665 1337
academy@engineersireland.ie
www.iae.ie

Oireachtas Joint Committee on Climate Change and Energy Security

Introductory Remarks

The Irish Academy of Engineering (IAE) wishes to thank the Committee for its invitation to engage in this discussion and is pleased to respond to all the committee's questions. Indeed we would hope that this is the start of a useful dialogue which will inform the committee in its important policy development role.

What is the Irish Academy of Engineering?

The Irish Academy of Engineers has a membership of approximately one hundred and twenty experienced Irish engineers drawn from a wide range of disciplines. Using the experiences and knowledge of its members, the Academy focuses on issues where the engineering profession can make a unique contribution to economic, social and technological development.

The Academy is an all island body and does not have any political or commercial affiliations.

Its aim is to facilitate communication and dialogue on engineering related matters and with this in view it publishes reports, the most recent of which is Infrastructure for an Island population of eight million. This was presented to the Taoiseach last week.

The Energy Standing Committee

The Academy has a standing Committee on Energy of which I am chairman. In June 2009 it published its latest report on Irish energy issues which focussed significantly on competitiveness. Copies of the report have been supplied to the Committee and we will be pleased to expand on any issues which Committee members wish to raise. The report also contains a list of Committee members and advisors. With me today is Mr. Tony Barry, committee member and retired chairman and CEO of CRH Ltd. Also Mr. Don Moore, Executive Director of the IAE.

Climate Change

Climate Change policy currently exercise some of the finest minds all over the world with the result that an avalanche of data, theory and policy suggestions is becoming very difficult for policy makers to make sense of. The Academy has already published a report (launched in November 2009 by Minister John Gormley) on *adapting* to climate change. The Academy does not generally provide advice on climate science as this is outside of its area of technical competence.

Committee members will be well aware of the impact of energy consumption on carbon emissions and the many policy issues surrounding this which I hope we can deal with in sufficient detail. The IAE is keenly aware of the balance that needs to be struck between:

- Cost/price of energy and its impact on employment
- Environmental Impact
- Supply security

Given the immense technological, financial and resource availability uncertainties surrounding these issues, there is no one "right" answer.

As a general principle the IAE would caution strongly against "betting the farm" on any particular forecast or technology. A conventional generating plant for example commissioned in 2020 is very likely to remain operational past 2050. A nuclear plant possibly past 2080. The investment decisions we take during the coming decade on future energy policy will have a very direct relevance not just to our children but to our great grandchildren. How much of what we assume today about 2050 is likely to be correct? Think of the assumptions we made in 1960 about 2000 and perhaps some degree of humility is appropriate.

Against such uncertainties the Academy strongly recommends that we retain a flexible approach to the future. For example, we should accept that projections of future energy demand are almost certainly going to be wrong! Based on our experience we can be pretty sure about this. This does not mean that we shouldn't plan, but we need a plan that permits us to change course and adjust as circumstances change.

In terms of technology the world will need all available technologies to meet future energy demand. The IAE recommends that Ireland remains open to all such technologies, adopts or rejects technologies based on evidence-based research, and refrains from "emotional" policy making.

Selected Issues

I am conscious of the Committee's recent report consolidating the many inputs it has received. I appreciate how difficult this must have been considering the variety of interests that you must cater for. Based on the report we understand that the Committee's deliberations are very much focussed on the post 2020 period. The Academy report on the other hand covers a number of short term issues in addition to those of interest to the Committee; I have deliberately not focussed on these but will be pleased to respond to any of them as required.

The Irish Economy

In little more than two years the Irish economy has plunged from being the OECD country with the highest growth rate to being the one experiencing the greatest economic contraction. Ireland now has to deal with three economic crises simultaneously:

- As a country that exports more of its GDP than almost any other country in the world, we are uniquely vulnerable to the international economic downturn. The "business model" that depended on attracting ever increasing foreign direct investment (FDI) for export growth, growth in indigenous industries to service both foreign companies located in Ireland as well as world markets and construction activity for employment creation, is now clearly broken and needs to be radically updated.

- We have a bankrupt banking industry as a result of our own misguided domestic policies.

- We have an unsustainable public sector deficit which again is a problem with a purely domestic origin.

Few countries (not even Greece!) have to simultaneously cope with three such crises.

Most economic commentators agree that the first step in fixing the Irish economic model is to restore our international competitiveness. The IAE is of the opinion that our very survival depends on this and for this reason has focussed on energy competitiveness in its recent report. Relevant charts showing the current competitiveness position of Ireland's electricity industry are attached.

It is a matter of considerable concern to the IAE that much of the energy policy currently being implemented originated "pre-crisis". The Academy has called urgently for:

- Updated impartial techno-economic analyses to be carried out to underpin future policy development.

- Such analyses to be based on realistic assumptions concerning future energy demand.

- Up to date information on price and availability of primary energy be factored into these studies.

The Academy understands that EirGrid has commenced technical studies in this area and looks forward to these being published in the near future.

We would be pleased to discuss this issue further with the Committee

International Climate Change obligations

Europe, as the world's largest trading block, has led the world's climate change policy debate. It has consistently been a "first mover" in introducing carbon abatement mechanisms and has occupied the "moral high ground" even at the potential expense of reducing its international competitiveness. As a member of the EU, Ireland has met its international obligations even though Ireland will be potentially more seriously disadvantaged than other EU member states by such policies given the openness of our economy.

At the recent Copenhagen summit the EU led the way in proposing major carbon abatement policies and offering to increase its own contribution if other trading partners would agree to new targets.

Europe however received a rude shock at Copenhagen; indeed it suffered the humiliation of being excluded from the room when other countries took the somewhat aspirational decisions made at the summit.

There is an important lesson here for Ireland. The EU does not after all lead the world on climate change. That is the prerogative of the US, China and a group of developing countries with rapidly growing economies and populations. These countries do not share Europe's climate change ambitions and will not implement the kind of economically restrictive policies envisaged by Europe. It is perfectly possible during the next decade of potential economic pain for many countries that climate change will drift down the international policy agenda and that little or no progress will be made in agreeing carbon abatement targets.

The IAE is of the opinion that Ireland should not seek to make national economic sacrifices "to save the planet" in the absence of agreed international action. As a responsible member of the international community Ireland must be prepared to share the climate change burden with its trading partners but should not unilaterally contemplate damaging its competitiveness in the absence of agreed international carbon abatement programmes. In particular it is not appropriate for Ireland to legislate for targets in advance of international agreements.

The possibility of the EU itself either failing to meet its self imposed targets or indeed losing interest in offering world leadership on the issue should not be ruled out. Ireland must retain sufficient policy flexibility to be able to adjust to such a scenario during the next decade.

As a consumer of less than 0.1% of the world's energy, and given the urgent domestic policy problems we face, the IAE believes that, while complying with all our international carbon abatement obligations, **we should leave the leadership of the climate change debate to other countries that are better positioned than we are to influence the outcome**.

Electricity production technologies

As a general principle the IAE believes that Ireland should be open to all production technologies including renewables, carbon capture and storage and nuclear.

- **Onshore wind** is now a proven technology but suffers significantly from intermittency problems. These problems are relatively easily solved at low wind penetrations but are much more serious and costly at high penetrations. The IAE is not convinced that Ireland should set itself a target of 40% of electricity[1] generation from renewables (primarily wind) by 2020 and wants to see proper techno-economic studies (based on various demand and primary fuel price scenarios) carried out to demonstrate the benefits or otherwise of this policy.

- **Electricity storage and interconnection** would undoubtedly assist in solving the intermittency problem associated with renewables. However these solutions also have very considerable capital investment requirements and the overall power system costs must be properly modelled in order to reach valid conclusions on these issues.

- There is an important **constraint on the use of interconnectors** with the UK and that is the lack of alignment of market rules in both jurisdictions. Such a rules mismatch has resulted in an average of 14% utilisation on the Moyle interconnector in 2008. This is a critical issue meriting immediate further study. The Academy has recommended that the E-W interconnector be *deferred* pending confirmation of the removal of such barriers. The Academy perceives this issue as one of normal commercial prudence in the face of a €500m investment.

- **Offshore wind** is technologically proven but remains exceedingly expensive in capital cost terms. It is not yet evident that its introduction at a large scale is possible due to restricted installation facilities. This technology will be pioneered in the UK (England) over the next decade and Ireland should observe developments. Unlike England, Ireland has sufficient on shore sites to allow a significant further expansion of wind power without moving to expensive offshore facilities.

- At present Ireland is developing its **on-shore wind resource on a geographically random basis**. This has major implications for transmission connections. Despite the production of Grid25 by EirGrid, the IAE remains sceptical of the social acceptability of such large scale transmission development especially in the West of the country and is concerned at the very high cost associated with it. The Academy believes that a more interventionist approach on

[1] Second Carbon Budget Oct 2008 Minister for Environment.

siting wind power developments is necessary in order to reduce transmission costs and permit realistic expansion of the technology.

- The Green paper of October 2006 proposed a target of obtaining 30% of Ireland's electricity from co-firing of **biomass** in peat stations by 2015. Little progress has been made towards this and the Academy believes that, in the context of the latest EU Directive on renewables of April 2009 and the urgent need to create employment in rural areas this proposal needs to be re-looked at as it may provide a cost effective way to progress towards the EU target

- **Carbon Capture and Storage (CCS)** is not a proven technology but may become so over the next decade. The latest estimates[2] from the Global CCS Institute indicate that an avoided cost of between US$60 and US$100 per tonne of CO2 would be necessary to make the technology economic. It should be noted that UK plans to utilise this technology envisage an Enhanced Oil Recovery (EOR) use for the captured CO2 which is likely to make the process considerably more economic close to North Sea depleted oil fields. While remaining open to this technology it cannot currently be part of a firm technology alternative for Ireland.

- **Nuclear power** is a proven technology. Indeed nuclear and hydro-power are the only proven options for large scale dispatchable carbon free generation. As a consequence there is a resurgence of interest and orders for new nuclear power plants worldwide. At present the all-island grid is too small to accommodate the size of nuclear units now being ordered internationally. However, with an alignment of the markets in Ireland and Britain, increased interconnection, and the likely development of smaller fourth generation nuclear units, nuclear is likely to become a realistic option for Ireland in the longer term. Even if Ireland committed to a nuclear plant now it would probably be 2025 at the earliest before such a plant would be commissioned.

- The Academy believes that the **legal barrier to utilising nuclear technology** in Ireland should be dismantled and that relevant institutions and skills should be established to license such a technology when the time is appropriate. The Academy also believes that an important commercial opportunity exists to participate in the UK nuclear programme once a further interconnector is constructed.

- The Academy commends the Government on its current policy in relation to **Ocean Energy**. While this is not a proven technology, Ireland commands significant wave power resources and should support the R&D required to ultimately commercialise this resource. This technology cannot be currently relied upon for firm planning purposes.

- **Natural Gas fired generation** is the backbone of the Irish electricity generation and plays an increasingly important role in our heating market. At present 98% of Irelands gas supplies is

[2] **Strategic Analysis of the Global Status of Carbon Capture and Storage;** Report 2: Economic Assessment of Carbon Capture and Storage Technologies Final 2009.

delivered through a single pipeline in Scotland. It is essential that the Corrib field onshore facilities are completed as quickly as possible, to reduce this security exposure and that our gas storage facilities are expanded, to cater for both technical and geopolitical risk to gas supply, as Britain becomes increasingly dependent on gas imports.

- There is a view that natural gas and oil are both **fossil fuels** and subject to the same international market forces. A recent ESRI report[3] for example states as a basic assumption: "We assume that natural-gas prices change in proportion to the changes in oil prices". Frankly this is not just incorrect; it is entirely the opposite of current reality.

    - Oil prices have approximately doubled in the past 18 months while natural gas prices have halved.
    - World oil reserves are under pressure while natural gas reserves continue to increase.
    - The International Energy Agency (IEA) in its latest World Energy Outlook (WEO 2009) report states"
      "In Europe, over 70% of gas is sold under long-term contracts with prices indexed mainly to oil, even though oil-based fuels compete less and less with gas. The **growing glut of gas** will increase pressure on gas importers and external suppliers to adopt gas-indexation and could boost spot gas trade, though this would not necessarily lead to lower prices in the longer term. Further EU and national moves to open up gas and power markets to competition could accelerate this trend." (emphasis added)
    - On February 25th 2010 the Financial Times reported:
      "Gazprom has agreed changes to gas contracts with European energy groups to allow up to 15 per cent of sales to be linked to gas prices on the spot market, which are about 25 per cent cheaper than the oil-linked prices specified in long-term contracts.

    All evidence points to a glut of natural gas and low prices on the EU market for at least the next five years with restrained price increases after that. If this assumption is factored into the ESRI study then the results of the analysis are entirely at variance with those published.

    Natural Gas will *not* solve Ireland's carbon emissions problem over the long term and there are indeed significant medium term concerns about security of supply in Europe. Nevertheless it is essential that gas based scenarios are factored into updated analyses of Ireland's energy needs. A plentiful and cheap gas supply over the next decade could form an ideal "bridge" to long term carbon free solutions and greatly reduce the risk associated with early "bets" on capital intensive technologies..

[3] Investment in Electricity Infrastructure in a small Isolated Market – The case of Ireland.

Demand Forecasts

One of the Academy's main criticisms of current policy has been the failure to update economic studies to reflect the greatly reduced energy demand in the economy as a result of the recession. EirGrid has recently revised its estimate for new generation and this now indicates that no further expansion of generation capacity will be required before 2017. In the event of continuing weak economic growth post 2012, a forecast which many economists would support, it is perfectly possible that no net new generation will be required before 2020.

It is most important that realistic new energy demand scenarios are developed for Ireland and that new techno-economic studies are commissioned based on these significantly more conservative assumptions and the recognition that the availability of capital will be restricted in the future and will thus need to be directed to those areas giving the greatest economic and employment potential.

EU Regulations

The first EU energy directive of the decade setting out targets for Ireland was published in 2001[4]. This directive aimed to increase Ireland's electricity production from renewables from 3.6% in 1997 to 13.2% in 2010. This target will be exceeded.

In 2003 the biofuels directive[5] required EU member states to ensure that biofuels accounted for 2% of transport fuels by 2005 and 5.75% by 2010. This directive has been seriously discredited as a badly thought out piece of legislation which considerably damaged the environment in developing countries as well as being a direct contributor to escalating food prices for world's poor. The sale of biofuels in Ireland will come nowhere near these targets and they have in effect been abandoned.

In April 2009a new EU directive[6] on the promotion and use of energy from renewables came into effect setting targets for overall energy consumption (and, with exception of transport, abandoning sectoral targets). Under this directive Ireland is required to increase the contribution of renewables to Gross Final *Energy* Demand from 3.1% in 2005 to 16% in 2020. The directive also requires 10% of energy consumption in transport to come from renewables, including renewable electricity.

The main lesson from this succession of EU regulations is the uncertainty that such a rapid succession of directives (in addition to an equal number of national directives) causes in an industry which is capital intensive and relatively slow-moving in terms of investment. It also means that we should not consider this to be the end of these regulations; there will be more and their future direction post Copenhagen is difficult to predict.

[4] Directive 2001/77/EC
[5] 2003/30/EC
[6] 2009/28/EC

The Academy welcomes the move away from sectoral targets and would point out that the new directive now permits a much more flexible internal target setting arrangement in Ireland and that plans and policies should be revised in this context.

Permitting for infrastructure

There are major problems for all energy industry investors in Ireland in relation to obtaining planning permission for both physical plant and transmission works required to connect such plant to energy networks. This is not confined to the electricity industry, the permitting of the Corrib Gas Field has been little short of a nightmare for its promoters and the country has been very badly served by the processes employed in permitting this critical piece of Irish infrastructure. When during the year the Chairman of Statoil publicly referred to the "*political risk*" of doing business in Ireland his comments would have been perceived by the international investment community as a major barrier to investment in Ireland. Political risk is what the oil industry normally associates with countries like Nigeria or Angola.

The recent decision by An Bord Pleanala to further delay the project which appeared to ignore internationally accepted safety standards prompted a very pointed reply from the Technical Officer at the Department of Communications, Energy and Natural resources. This lack of joined up thinking at Government level creates a perception of unpredictable and capricious decision making, creates enormous political / regulatory risk and is hugely damaging to Ireland's investment prospects.

The IAE has called on a number of occasions for a review and reform of our permitting process which will deliver certainty in decision making within a reasonable period of time. The recent legislation dealing with the permitting of critical infrastructure is most unlikely to solve the problem. This remains a critically important issue.

Energy Conservation

The Academy has noted in its report the view of The International Energy Agency (IEA) that more than 50% of future carbon abatement is likely to be achieved from energy conservation measures. The Academy has also noted the excellent recent report produced for SEI by McKinsey and is strongly supportive of energy conservation measures.

The IAE has recommended a significant stepping up of a grant assisted programme for dwelling insulation. We note the initial step taken in the recent budget and strongly recommend that this programme be ramped up significantly in the future.

Price Impact Analyses

The Academy notes the practice among sophisticated regulatory authorities particularly in North America of demanding detailed price impact analyses in relation to all policy changes and major investment proposals.

The CER should demand from policy and investment proposers that competent price impact analyses are carried out for all such proposals and published for discussion prior to any decision to implement such policies or investments.

Gas Storage

Ireland rates very poorly in terms of gas storage in relation to its EU neighbours. It is uniquely vulnerable given its location on the far western edge of the European gas network, dependent in part on a single piece of infrastructure for importation of more than 90% of its need and 65% dependent on gas for power generation. Gas storage is required for security of supply reasons in the event of an interruption and will be required for operational reasons if further large amounts of "must take" intermittent renewables are connected to the system.

The Academy has found no evidence of any studies examining the impact of using gas fired generation to balance intermittent renewables. It is essential that the physical and cost implications of such a generation portfolio are established without delay.

Increasing Capital Intensity

It is a feature of modern energy systems as they are decarbonised that they become steadily more capital intensive. Technologies such as on-shore wind, carbon capture and storage, nuclear and, particularly, off-shore wind are extremely capital intensive and present investors with a very different risk profile to conventional gas fired generation.

It is notable that the UK authorities have recently acknowledged that the relatively *laissez-faire* market which they have encouraged for the past two decades will not be adequate to incentivise the heavy capital investment required for nuclear and off-shore wind. Already the latter has required a doubling of ROC[7] support in order to make the investment viable.

The future trading arrangements in the UK are therefore likely to be modified to incentivise the nuclear and off-shore wind investment. It is not clear how convergence with an Irish trading market might be achieved in the medium term given the different objectives of the Irish authorities. Yet as mentioned earlier, failure to "converge" the two trading arrangements into a single uniform market will mean that investment in interconnection is unlikely to be commercially sound both large scale renewables and nuclear investment will be potentially disadvantaged in the long term .

[7] Renewable Obligation Certificate

A useful preliminary study completed by Pöyry, a specialist Finnish consultant, in mid 2009 concluded as follows:

> "Although much more detailed modelling work needs to be carried out to properly model the behaviour of the grid systems in both countries, our concern at the outset of the study that the very dynamics of variable wind output would challenge the system operators has changed to concern about the economic shape of the market.
>
> While this study was deliberately confined to examining the electricity market, there are clear signals that wind intermittency will challenge the gas markets in both islands and these are worthy of similar analysis.
>
> At the outset of this work, we believed that it was vital to inform the debate about the importance of wind in decarbonising the electricity supply by informed, quantitative analysis. This has proved to be a major challenge, but the richness of the information has surprised even the project team, and while the answers we now have are often complex, we believe that any debate on the role of wind can now be properly informed."

We understand that EirGrid has commissioned Pöyry to carry out a much more detailed study and commend the TSO for its action in this area. We look forward to the results of this study becoming available in the near future.

New technologies —Smart Meters, Electric Vehicles

The Academy has commented on the above technologies in its report. In summary the Academy feels that such technologies will play a significant role in the energy system but only post 2020. The Academy would advise against implementing large and costly capital investment on such infrastructure in the short term until the technology is significantly more developed and until its deployment can be demonstrated to show a return to the customer who will ultimately carry the cost.

Irish Academy of Engineering
Discussion with Oireachtas Joint Committee on Climate Change And Energy Security - Summary

Academy recommendations

1. Ireland should retain a flexible approach to future energy technology investments and considers all technologies based on their techno-economic merits.

2. Policymakers urgently need to update techno-economic energy studies to take account of the dramatic fall in energy demand and the recent significant changes in world energy markets.

3. While meeting its international carbon abatement obligations, Ireland, given its small size and many domestic economic problems, should not seek a leadership role in the international climate change debate and should be conscious that the EU position on climate change is not acceptable to most of the rest of the world.

4. Ireland's permitting system for large infrastructure investment is not fit for purpose as has been demonstrated repeatedly on the Corrib gas project. Recent legislation dealing with strategic infrastructure is most unlikely to alter this situation. This dysfunctional system needs to be re-examined with a view to a radical legislative overhaul.

5. The Academy believes that there is a major opportunity to improve Ireland's carbon emissions at low cost by engaging in a large scale programme to upgrade the insulation of existing Irish dwellings. Investment in such a scaled up programme would also provide an ideal economic stimulus with a positive effect on employment and minimal "leakage" overseas.

6. The IAE strongly recommends that all significant policy changes and investment proposals be accompanied by a comprehensive "Price Impact Analysis" detailing the effect of the proposal on the prices paid by energy consumers. Such analyses should be carried out by the promoters of the proposal, submitted to the CER and published for comment prior to proceeding with such proposals.

7. In order to benefit from increased electricity interconnection with the UK it is essential that the trading rules in the UK and Ireland converge around some common processes and principles. Given that the East-West interconnector is under construction this issue is now urgent.

8. New technologies such as smart metering and electric transport will undoubtedly arrive over the next few decades. However there remain many uncertainties in relation to the adoption of these technologies and the IAE advocates a cautious approach particularly with respect to large scale up-front capital investment.

9. The Academy is greatly concerned at the risks being taken on Natural Gas supply security. The immediate priority is to complete the Corrib project. While the proposed LNG project on the Shannon estuary will also increase security it is imperative that Ireland move quickly to increase gas storage from the very low levels pertaining today.

Electricity Price Competitiveness

The IAE has expressed major concern at the long term decline of electricity price competitiveness in Ireland and has discussed this in its report.

The Academy uses published statistics from Eurostat to make its comparisons. Essentially the Academy is seeking to establish the relative efficiency of the Irish electricity industry compared to its EU counterparts as measured by the price(s) of electricity in each country. It is important to understand the following basis for the Academy figures:

- The Academy figures exclude taxes. Some EU countries tax electricity and this tends to flatter Irish comparisons. While it is certainly relevant to Irish exporters it is not appropriate to take taxes into account when comparing the relevant efficiency of the basic industries. SEI comparisons which are directly relevant to export competitiveness do compare after tax figures.
- SEI comparisons also examine affordability of domestic (household) prices which is a perfectly relevant exercise and requires that corrections for purchasing power parity (PPP) be applied. The Academy does not apply PPP corrections because it is focussed on relative industry efficiency and such corrections are not appropriate.
- Because it is easy for countries to cross subsidise between domestic and industrial electricity prices (sometimes for perfectly valid reasons) the IAE has constructed a composite price index weighted by consumption in each country in accordance with EU methodology. There has been a discussion with SEI on relevant weighting factors as the EU statistics have become more precise since 2007. The resultant trend is shown in Figure 1 below and includes SEI estimates[8] of the index for 2007 – 2009.

Regardless of which figures one uses it is clear that over a period of a decade Ireland's composite price index has gone from being 10% below EU average prices to being approximately 40% above.

There has been a significant improvement in industrial price competitiveness in 2009 as shown in Figure 2. This has resulted from rebates arising from a sharp drop in natural gas prices being applied mainly to industrial prices. The IAE favours this policy of protecting the exposed sector.

There has been no improvement in household price competitiveness.

Two cost components dominate electricity prices, fuel and capital. Hence the generation technology mix is critical from the point of view of keeping prices competitive. The IAE believes that much more comprehensive studies of future generation technology options are necessary. These should incorporate the significantly reduced demand forecasts resulting from the economic recession and up-to-date assumptions on fuel prices.

[8] Private correspondence with SEI

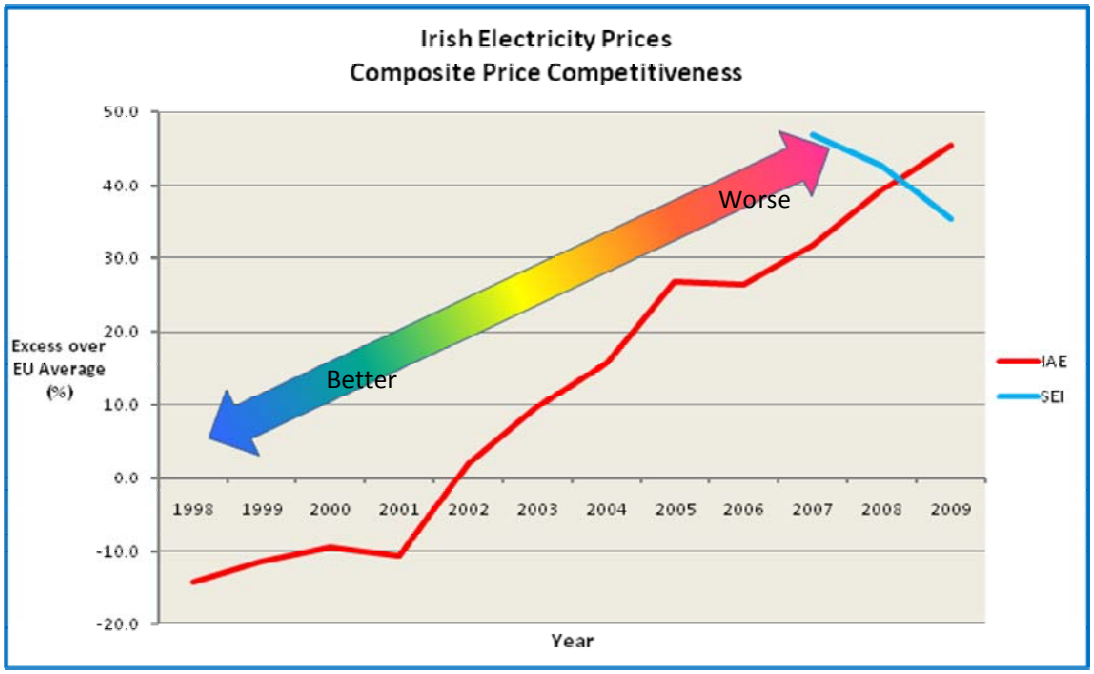

Figure 1

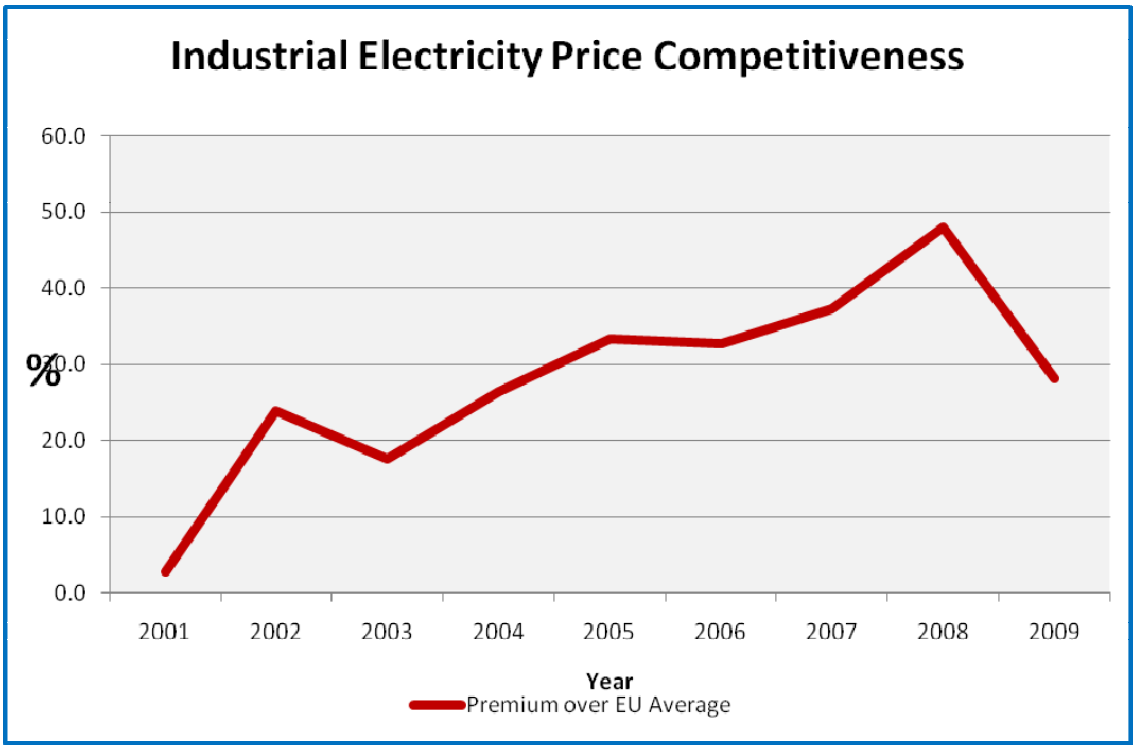

Figure 2

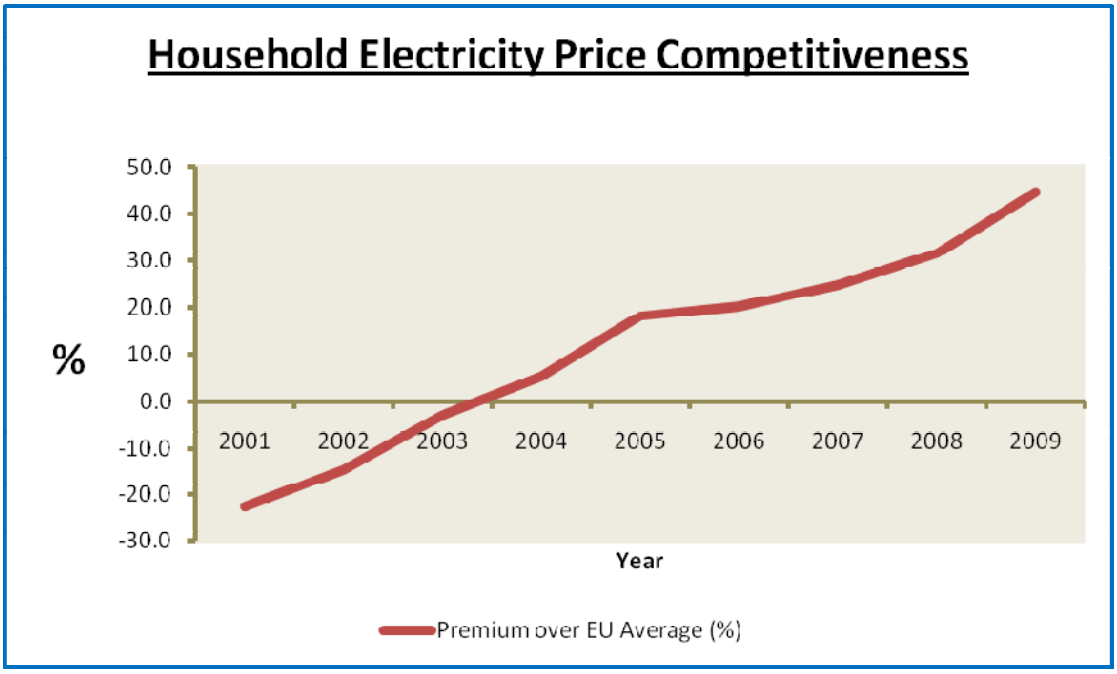

Figure 3

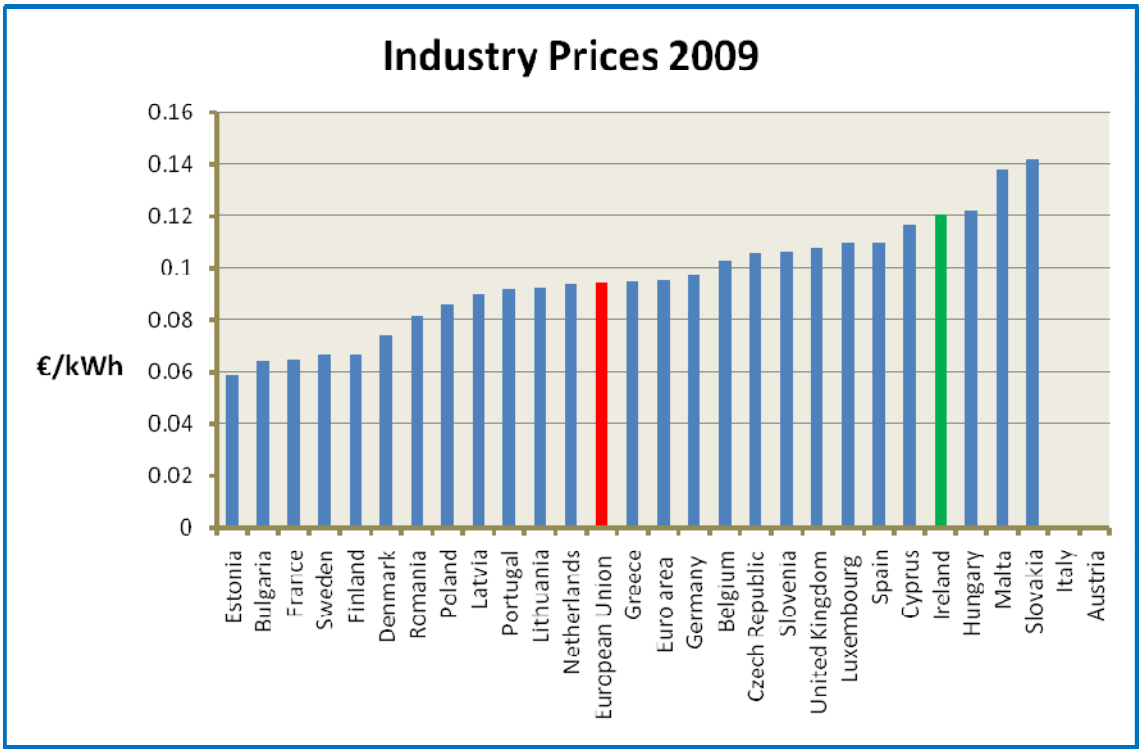

Figure 4

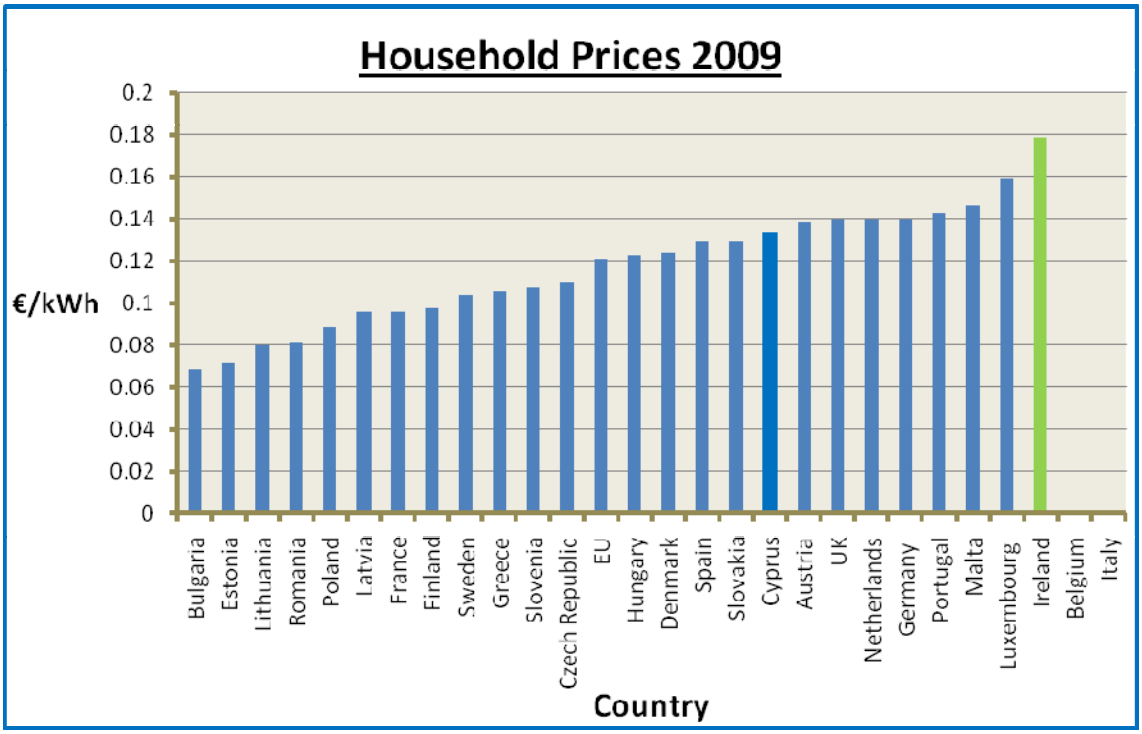
Household Prices 2009
€/kWh
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
Bulgaria
Estonia
Lithuania
Romania
Poland
Latvia
France
Finland
Sweden
Greece
Slovenia
Czech Republic
EU
Hungary
Denmark
Spain
Slovakia
Cyprus
Austria
UK
Netherlands
Germany
Portugal
Malta
Luxembourg
Ireland
Belgium
Italy
Country

Figure 5