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Title	Burning peat in Ireland : an electricity market dispatch perspective
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Publication Date	2009-08
Publication information	Energy Policy, 37 (8): 3035-3042
Series	Electricity Research Centre(ERC)
Publisher	Elsevier
Link to publisher's version	<a href="http://dx.doi.org/10.1016/j.enpol.2009.03.049">http://dx.doi.org/10.1016/j.enpol.2009.03.049</a>
This item's record/more information	<a href="http://hdl.handle.net/10197/2301">http://hdl.handle.net/10197/2301</a>
DOI	<a href="http://dx.doi.org/10.1016/j.enpol.2009.03.049">http://dx.doi.org/10.1016/j.enpol.2009.03.049</a>

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## **BURNING PEAT IN IRELAND: AN ELECTRICITY MARKET DISPATCH PERSPECTIVE**

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**Abstract:** This paper examines peat power production in Ireland under the three pillars of energy policy – security, competitiveness and environment. Peat contributes to energy security - as an indigenous fuel, it reduces dependency on imports. During a period of low capacity margins, the operation of the peat plants is useful from a system security perspective. Peat generation is being financially supported by consumers through an electricity levy. The fuel also has high carbon intensity. It is not politically viable to consider peat on equal economic criteria to other plant types because of history and location. This paper reviews electricity generation through combustion of peat in Ireland, and quantifies the costs of supporting peat utilising economic dispatch tools, finding the subsidy is not insignificant from a cost or carbon perspective. It shows that while peat is beneficial for one pillar of energy policy (security), the current usage of peat is not optimal from a competitiveness or environmental perspective. By switching from the current 'must-run' mode of operation for peat to the 'dispatched' mode used

for the other generation, significant societal savings (in the range of €21m per annum) can be achieved, as well as reducing system emissions by approximately 5% per year.

**Keywords:** Government Policy, Peat Energy

## **1. Introduction**

The burning of peat for electricity in Ireland and the related policies for its support illustrate a number of interesting aspects about the complexity and interactions between the three pillars of energy policy, namely: security of supply, cost competitiveness, and the environment. This paper considers how peat-fired electricity generation is treated within the electricity market as a basis for considering energy policy at a national level. Peat is treated as a sub-category within brown coal and is defined as combustible soft, porous or compressed, fossil sedimentary deposit of vegetal origin with high water content (up to 90% in the raw state), easily cut, of light to dark brown colour (IEA, 2007). Peat used in electricity generation has a calorific value of 7.787GJ/t. Over 90% of peatlands are in the temperate and cold belt in the Northern Hemisphere. Peatlands cover 16.2% of the land mass of the island of Ireland and 17.2% of the area of the Republic of Ireland. This percentage is only exceeded in global terms by three countries: Finland, Canada and Indonesia (World Energy Council, 2001). Finland was the leading producer of peat for energy purposes in 2005 (8.74 Mt in 2005) and provisional figures for 2006 indicate significant growth to 12.07 Mt (IEA, 2007). The second in rank within the EU and globally was Ireland with 3.96 Mt production in 2005. These two countries, Finland and Ireland together accounted for 67% of global peat production in 2005.

Bord na Móna is an Irish state owned company that was established in 1946 to manage the peat harvesting activities. While there is private harvesting of peat for use in domestic heating, Bord na Móna is the only producer of peat for electricity production in Ireland (Foss et al., 2001).

Total peat production in Ireland peaked in 1995 at 8.0 Mt. Total production in 2006 was 3.7 Mt of which 85% was milled peat (O' Leary et al., 2007). The remainder was sod peat, produced by

the private sector for use in residential heating. Due largely to the different levels of moisture content, milled peat has a calorific value of 7.8 Gigajoule per tonne (GJ/t), compared with 13.1 GJ/t for sod peat and 18.5 GJ/t for peat briquettes (Howley et al., 2007). Bord na Mona's current resources of 70Mt equate to 19 years supply at current production rates. The additional 15 Mt of peat not owned by Bord na Mona are being worked by companies and private individuals (McGettigan and Duffy, 2001).

In terms of its energy content, measured in million tons of oil equivalent, energy supply from peat declined in absolute terms over the period 1990-2006 by 49%, with its share of total primary energy supply declining from 14.5% in 1990 to 4.4% in 2006 (O' Leary et al., 2005). The declines were more noticeable in the residential heating sector, as people move away from solid fuel usage to natural gas and oil. Peat usage for electricity generation declined at a slower rate, dropping by 26.4% in the period 1990-2006. Its share of the overall fuel mix declined from 19.5% in 1990 to 8.5% in 2006. During this period, 8 old peat stations were closed, totalling 232MW, and these were replaced by 343MW of newer plant. These are the Edenderry Power, West Offaly Power and Lough Ree Power stations. These three stations are supported by a Government imposed Public Service Obligation (PSO) whereby costs incurred by the generator above those incurred by a comparable Best New Entrant (BNE) plant (operating with the most cost-efficient fuel) are recovered via a PSO levy on all electricity consumers. The peat PSO is set to run through the compliance period (15 years of the peat purchase agreements) and was justified by Government for security of supply and fuel diversity reasons. Edenderry Power is based on bubbling fluidised bed technology, has a gross output of 117.5 MW and a net efficiency of 38%. The Electricity Supply Boards's (ESB) Lough Ree (90MW) and West Offaly (135.7MW) power stations (using circulating fluidised bed technology) came online in 2004 and 2005, respectively. All have peat purchase agreements in place totalling just over 3 Mt of peat per annum for 15 years (with expected lifetimes of around 30 years). To meet this, the system operator is obliged to ensure sufficient dispatch levels of the plants that corresponds to a minimum "must run" of around 85%. Based on a calorific value of peat of 7.787 GJ/t and each

of the plant's thermal efficiencies, these plants will emit 2.65Mt of CO<sub>2</sub> per annum. Running base loaded the peat generation can serve up to 6.6 % of the total system demand over the year.

The PSO is imposed by the Commission for Energy Regulation under a 2002 Order from Government. This requires ESB to meet certain obligations by means of a levy on final electricity customers. The obligations to be met are: To ensure Ireland has reasonable self sufficiency by ensuring that a certain percentage of its generation is met by indigenous peat, to promote renewable energy sources, and to provide enough peaking plant for the system. CER determines the amount of the levy on an annual basis, based on estimates provided by ESB. This is made up of support for renewables, peat and peaking plant, as well as administration charges and corrections for over or under estimating the previous year's charges. The PSO has varied over the past 6 years, from a high of €103.3m in 2005, to €1.8m in 2008 – indeed in 2008, no additional charge has been added to electricity bills due to the small size of the PSO. The low amount of the past year's levy is due to increasing amounts of renewables not needing support and also overestimating previous year's levies. However, in each year, the support needed for peat energy was still a significant amount. CER (2007) indicated that the level needed to support peat for the first 9 months of 2008 was €46m – approximately €60m for the year, which is in the region of the support required for peat in previous years. Therefore, while the PSO amount in total is small, or almost zero, there is still significant support needed for peat stations to fulfil their peat purchase agreements.

In terms of emissions generated by peat, the global warming effects of the peat fuel cycle are complex. There does not appear to be a consensus, as it is not clear how to take into account the full life-cycle, as shown in the EU ExternE study (Connolly, Rooney, 1998) – if the usage of bogs after peat is removed is taken into account, total peat emissions may be lower, if its replanted, or higher, if the removal of the carbon sink that was the bog is taken into account. Therefore, in this work, the emissions due to peat are considered to be the emissions due to burning of peat, i.e. it is treated the same as if it were black coal, oil or gas, except it has a higher carbon content than any of those fuels. Emissions can be reduced from peat generation in

two main ways – co-firing and carbon capture and sequestration (CCS). Based on the findings of (SEI, 2005a), which examined CCS using Enhanced Gas Recovery from the peat plants, it was decided that the costs are currently too high to be considered for this work, which examines the short term (next 10-15 years). However, applying CCS in the long term, which may become economic at carbon prices above €60/ tonne, would reduce total Irish emissions by 1.3%.

Co-firing is considered more realistic in the short term, and is considered in this work. The Edenderry power plant has recently received a license to allow “the option of co-fuelling the plant using biomass and meat and bone meal (MBM) up to a maximum of 10% each by volume (80 – 100,000 tonnes per annum)” (IPPC License no.654). When considered from a life cycle point of view, it is considered that burning biomass and MBM are carbon neutral, and therefore reduce emissions from peat plants. There is much debate as to whether this is the case, as shown for example in (Brannlund *et al.*, 2008) which shows that change of land use could have an effect on emissions, or (Schneider and McCarl, 2003) which argue they reduce net greenhouse gas emissions. The approach taken here is that it would be expected that the crops used, or the waste products from meat would be produced in Ireland, and therefore would not change the land use – i.e. MBM is a waste product which would need to be disposed of anyway, and therefore using this instead of peat would reduce emissions.

According to a Sustainable Energy Ireland (SEI) study on cofiring with biomass (SEI 2005), the current theoretical co-firing potential of Edenderry (i.e. maximum amount of fuel that could be co-fired when generating with fluidised bed technology) is 1,140 GWh<sub>fuel</sub> (50% of total fuel use) and the technical potential (i.e. maximum amount that can be used with current plant) 460 GWh<sub>fuel</sub> (20% of total fuel use). In the future, after modification investments, the technical co-firing potential could increase to 690 GWh<sub>fuel</sub> (30% of total fuel use). In the future West Offaly Power could technically co-fire other fuels with biomass to generate approximately 800 GWh per year and Lough Ree Power approximately 550 GWh per year. In both plants the maximum share of biomass-based fuel would be limited to 30% of the total fuel use.

The principle areas of consideration in the context of burning peat for electricity in Ireland in this paper are:

- The public support of the peat power plants is officially justified for reasons of security of supply (SOS).
- There are clear political issues related to labour and employment in the Irish midlands, traditionally an area with relatively high unemployment.
- There are price impacts to consumers due to this support (quantified in the Public Service Obligation (PSO)).
- The peat power plants have considerable emissions of CO<sub>2</sub><sup>1</sup>.
- The peat power plants are beginning to gain licenses to co-fire with biomass
- The peat power plants are grandfathered emissions allocations under the ETS (68.5%<sup>2</sup>).

Although these issues could be categorised as either SOS, environmental or competitiveness concerns, it is interesting to note how they are inherently related. The distinctions are not easy to make, and this is a useful lesson when considering energy policy. Fitzgerald et al. (2005) noted that, “While there is an undoubted argument that peat-fired generating stations provide security through diversifying fuel supplies, it seems most unlikely that this is the most appropriate means of meeting the security of supply objective in a world where greenhouse gas emissions will carry an increasing penalty.”

This paper considers the place of peat-fired electricity generation in Ireland within the modern energy sector context. In doing so it uses economic dispatching tools to consider the level and manner of support for these stations. An assumption is made that these plants are to remain

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<sup>1</sup> Possibilities for carbon capture and sequestration may be feasible for the peat stations in the longer term.

<sup>2</sup> SA/STRE = 0.685 (EPA, 2008)

open, as it is not considered viable, both politically and due to the fact that they do offer some security of supply, that they be closed in the short-term. Therefore, they are examined in terms of short term running costs, i.e. the impact of capital costs is not considered. Two alternatives are examined in terms of the usage of peat power in the country – one considers the current policy of peat as a ‘must run’ plant, due to the PSO, while the other treats peat as conventional plant, and subjects it to the usual economic dispatch. Sensitivities around carbon prices and co-firing are also examined.

It is shown that the current ‘must-run’ method of operation appears sub-optimal when short-run costs are considered; both from a societal perspective (in the range of €20m per annum) and regarding the profit of peat plants themselves. It is also shown that (assuming a €1/tonne CO<sub>2</sub> carbon tax) an emissions reduction of 5% for the entire system is achieved by switching from a ‘must-run’ to a ‘dispatch’ mode of generation. Section 2 examines the operational options for the peat plants in the Irish electricity market, outlining the methodology used in this study. Section 3 examines key results, from a point of view of the 3 pillars of energy policy. Section 4 concludes.

## **2. Methodology – Operational Options for operation of peat generating stations**

This section aims to analyse how peat generation is operated on the system with a view to serving the three stated pillars of energy policy. Two possible operational modes for the day-to-day operation of the peat generation will be examined here.

### **2.1 Operational Modes**

**Must-Run Operation:** this mode of operation is currently employed for the peat generation on the Irish system. It mainly from the fuel purchasing agreements entered into by the generators with the total contracted fuel quantity requiring an annual load factor from the generators of around 85%. To achieve these high running levels peat generators generally have to be



dispatched at base load levels on a day to day basis regardless of the relative economics of the generation merit order.

**Dispatched:** this mode of operation stems from the principles of economic dispatch. This method of operation is used the world over both as the foundation of wholesale electricity markets and as a mode of operation inside utilities or large portfolio generators. In general this approach dispatches onto the system the most economic units first, then the next most economic, and so on until the demand is served in each period. Constraints on the system, e.g. start-up and shut down costs, ramping rates of units, and minimum up and down times are taken into account when dispatching the system.

## **2.2 Methodology – Model used**

In order to assess the relative merits of the operational modes versus the energy policy goals a simulation of the Irish system and market was utilised examining one year of data. This model runs on the PLEXOS electricity modelling software platform and is similarly configured to the model used by the Irish regulatory authorities (All Island Modelling Project, 2008). The model handles both the unit commitment (i.e. optimal dispatching of power plants) and economic dispatch of the Irish system and also replicates the pricing formulation used in the Irish wholesale electricity market (Trading and Settlement Code, 2008). This includes the short run marginal price and uplift. The short run marginal price is the incremental cost of the next MW, and includes fuel cost and carbon cost. All units online are paid at this price, plus an uplift, which is used to spread the costs of starting units and running units at no load over the full day. The model was run both for the “must-run” and “dispatched” mode of operation applied to the peat generation units, over a full year. In addition to this some sensitivities were run in relation to the carbon costs and a scenario was also run to assess the relative merits of co-firing the peat generation with 30% MBM. CCS was not examined here, as it does not look likely to be in operation for some time yet. The fuel prices used in the model are those consistent with those prevailing during mid 2007, and are given in Table 1 – these are taken from (All Island

Modelling Project, 2008). The gas price shown in the table is an average over the entire year – the model uses prices which change daily. This shows fuel prices only, and does not include the price paid for carbon content of fuel – these are Republic of Ireland prices, but Northern Ireland and Great Britain prices would be similar (with GB slightly lower). CO<sub>2</sub> content is also shown for each fuel. As noted in Section 1, carbon content for peat is assumed to be the actual carbon released when burning peat, as the conclusions from a literature review of life cycle of peat energy were inconclusive.

<b>Fuel</b>	<b>Price (€/GJ)</b>	<b>CO<sub>2</sub> Content (t/GJ)</b>
Coal	2.2	0.0946
Distillate	11.08	0.0741
Heavy Fuel Oil	5.35	0.0774
Gas	5.82	0.0561
Peat	3.4	0.106

**Table 1:** Fuels used: Prices and CO<sub>2</sub> Content

The model itself encompasses the whole of the all-Ireland electricity market area. This includes both Northern Ireland and the Republic of Ireland. The model runs were set up to simulate a year somewhere in the region of 2008-2011. The total installed generation capacity on the system is 10270 MW (consisting of 7782 MW Conventional (i.e. coal, gas, diesel and peat units), 1980 MW Wind, 292 MW Pumped Storage, 216 MW Hydro). The 500 MW direct current interconnector to Great Britain was also modelled. Great Britain was simulated with units aggregated according to fuel type, to give a price for importing on the interconnector. The total demand on the Irish system is around 40 TWh with a system peak demand of 6946 MW.

### **3 Results**

#### **3.1 Economic Issues / Competitiveness**

Typically the level of public support provided to the peat generation each year is set at a level such that the revenue from the sale of energy in the market and the public support revenue is sufficient to cover the capital costs, fixed and variable operation and maintenance costs and fuel costs of the generation.

##### ***3.1.1 System Costs***

Table 2 shows the economic results for the different scenarios examined. The benefit of dispatching peat optimally can be seen for different costs of carbon dioxide emissions and different assumptions on fuel used.

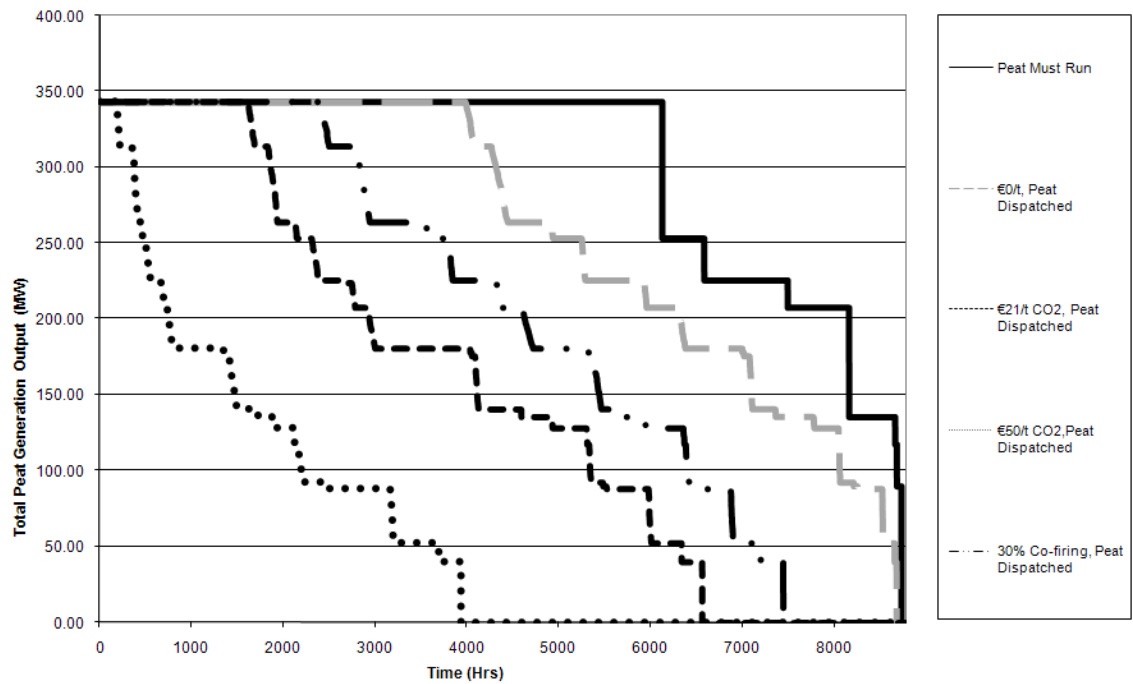
<b>Scenario</b>	<b>Mode of Operation</b>	<b>Energy Produced By Peat (GWh)</b>	<b>Change in Overall System Cost if Peat is Economically Dispatched (€M)</b>
<b>Central Case (21 €/tonne CO<sub>2</sub>)</b>	Must Run	2638	-20.6
	Dispatched	1352	
<b>50 €/tonne CO<sub>2</sub></b>	Must Run	2638	-57.8
	Dispatched	564	
<b>0 €/tonne CO<sub>2</sub></b>	Must Run	2638	-4.4
	Dispatched	2273	
<b>Central Case (21 €/t CO<sub>2</sub>) with 30% Co-firing using Meat and Bone Meal</b>	Must Run	2638	-25.9
	Dispatched	1741	

**Table 2:** Economic results for different scenarios examined

The key finding from the system simulation runs is that in all scenarios the overall (short run) system costs improve when the mode of operation is switched from must run to dispatched. For the central scenario the overall cost of energy supply and carbon dioxide emissions for the system reduces by €20.6M (about 1.25% of total fuel and carbon costs for the system). This significant change is the best indicator for the actual total social cost of adopting a must run approach to the peat plant. It can be seen that as the CO<sub>2</sub> costs increase the social cost of adopting a must run approach also increases significantly (from €20.6M with €21/tonne CO<sub>2</sub> to €57.8M with €50/tonne). By adopting co-firing to a level of 30% using Meat and Bone-Meal (MBM), (which, due to its nature as a waste product, does not have a cost associated with it) it

can be seen that peat is used more, while the societal savings are greater (€25.9M compared to €20.6M). Co-firing with MBM to 30% may not actually be possible due to lack of availability. However, due to the fact that it is considered not to have a cost here, it can be thought of as the 'best-case' material for co-firing. Other likely renewable sources, such as energy crops or wood residue, while also having no carbon costs associated, would have a fuel cost and therefore decrease the usage of the peat stations compared to a case with co-firing with MBM. Examining the short run marginal price of the system in the simulations, it is seen that there is an average reduction in price over the year of €1.51/MWh (from €66.88/MWh to €65.37/MWh) when moving from must-run to dispatched mode of operation. This is the equivalent of approximately €60m being added to the total energy bill for the year, due to the PSO (in the central case), assuming the prices paid for energy are marginal prices ( $€1.51 * \sim 40TWh = \sim €60M$ ).

It can be seen that the annual energy produced over the year from the peat generation in the must-run mode of operation is 2638 MWh. This roughly corresponds to an annual load factor of 85%, roughly equal to the 3Mt of peat contracted. The load duration curves shown in Figure 5 summarise the running levels of the peat generation under various scenarios tested. These show the amount of hours that the 3 peat plants are producing above the indicated level of production. It can be seen that for the central case, with 21 €/tonne of CO<sub>2</sub> carbon costs, the dispatched mode of operation resulted in an approximate halving of the annual output from the peat generators. As carbon prices increase, peat generation is used less frequently, as expected. It should be noted that, with 0 €/tonne CO<sub>2</sub> costs, peat generation is not changed significantly whether dispatched economically or must run, showing that it is the carbon cost which is having greatest impact on operation of these plants.



**Figure 1:** Load duration curves for peat generators under different scenarios

### 3.1.2 Peat Generation Economics

Table 3 summarises the results as regards the operation of the peat stations. The short run profit here is found by subtracting the fuel and carbon cost from the revenue. The revenue is the short run marginal price multiplied by the production by the plant. The first point to note from the simulations is that in almost all cases the peat plant makes a positive short run profit in the market place – these figures do not include the PSO. This is due to the fact that peat plants are rarely the marginal unit – these are usually either open cycle gas turbine or closed cycle gas turbines. As can be seen, as carbon prices increase, peat plant will more often be marginal, or sometimes more expensive than marginal, and therefore does not make a profit when must run at €50/t of CO<sub>2</sub>. It would be expected that all plants (except marginal plant) make a short term profit if economically dispatched, but this shows that, even when operated as must run, peat can make a short run profit. As stated earlier, only short run costs are considered here, as it does not seem politically viable that the peat plants would be shut down, and therefore capital costs on

the system are not included. Also, peat plants are already built, therefore the capital costs that have been incurred are sunk costs. Since the peat plants and related contracts are part of state owned companies, it is unlikely that the plants could be shut down while externalising the unrecovered capital costs outside of the Irish societal structure. The results above indicate that such an option, were it available, is not desirable anyway, as the peat generation, since it is already in existence, has an active and positive contribution to make to the Irish electricity system.

Due to the decreased number of running hours under the dispatched mode of operation variable costs, i.e. fuel and carbon costs, for the peat plant are significantly less. The dispatched mode of operation also has the benefit of turning on the peat plant at the most appropriate times in the market. In this scenario any time a peat plant is dispatched it automatically is covering its short run costs of generation. In fact it typically is receiving higher revenue per MWh generated than its costs. As a result, an increase in the short run profit earned by the peat generators in the market can be seen for all scenarios. This does not take into account the fact that peat plants, which are generally designed to be base-loaded, will now be operated as mid-merit units as indicated by the load duration curve.. However, studying any potential changes in operation and maintenance costs were considered outside the scope of this study.

Scenario	Mode of Operation	Total Peat Generation Costs (€M)	Reduction in costs if Dispatched (€M)	Energy Market Short Run Profit of Peat (€M)	Increase in Energy Market Short run Profit if Dispatched (€M)
<b>Central Case</b> <b>(21 €tonne CO<sub>2</sub>)</b>	Must Run	144.7		20.6	
	Dispatched	77.4	67.2	22.6	2.0
<b>50 €tonne CO<sub>2</sub></b>	Must Run	223.4		-4.0	
	Dispatched	54.1	169.3	4.8	8.8
<b>0 €tonne CO<sub>2</sub></b>	Must Run	87.8		47.1	
	Dispatched	76.8	49.1	47.6	0.5
<b>Central Case with 30% Co-firing using MBM</b>	Must Run	138.3		27.1	
	Dispatched	89.1	11.1	32.5	5.4

**Table 3:** Peat Generation Economics

Taking Tables 2 and 3 together, the simulations have shown that for the central scenario, the adoption of a dispatched mode of operation results in a system wide saving of around €1M per year (Table 2) and approximately halves the number of running hours of the peat generation. The reduction in running hours results in around €67M reduction in peat and carbon costs and increases the market profit by €2M compared to a must run case (Table 3). These figures can be examined in the context of a PSO support scheme in which peat accounts for €60M of the cost of the scheme, as described earlier. It could be surmised that moving towards a dispatch mode



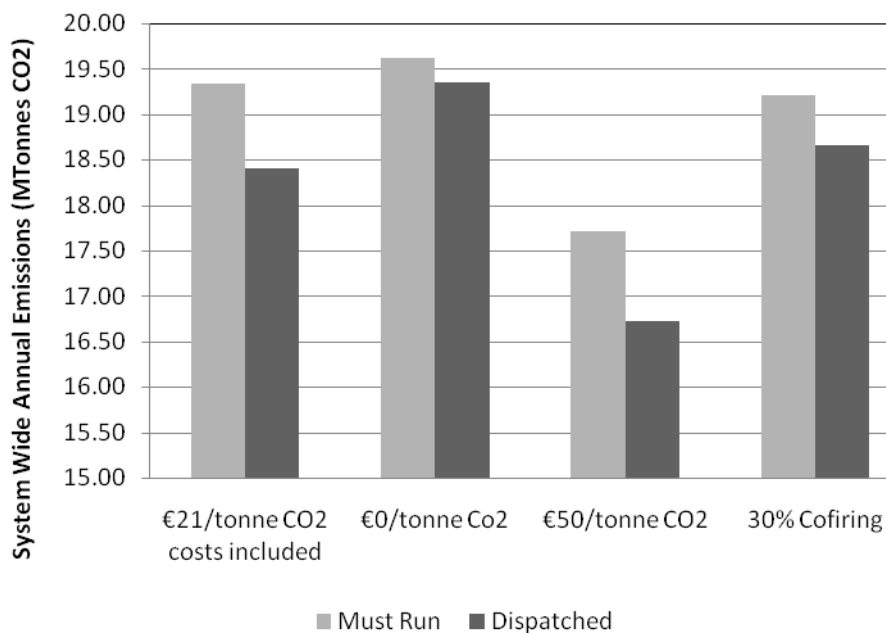
of operation and abolishing the PSO support scheme could lead to an improvement in the peat generation net income of €9M per annum, i.e. €67M(variable costs) + €2M(additional profit) – €60M (PSO) = €9M. If these conditions were to prevail, or if there was a smaller PSO, then it would appear that the above steps could be taken without jeopardising the economic viability of the peat generation. However, an additional complication in the Irish market place at present is the system of grandfathering carbon emissions permits while allowing the full pass through of carbon costs into the electricity market prices. This current system provides a windfall benefit to generators and this benefit also contributes towards the viability of the peat generation this is not included in the costs above. The grandfathering of emissions permits is something which has received a lot of attention at national and international level, with different rules suggested and used for deciding the type and size of permits granted (Bohringer, 2005, Zhang, 1999). These methods of allocating permits impact on the economic and environmental effects of the power system. As grandfathering of carbon emission permits is generally based on historic performance the adoption of the dispatch mode of operation and subsequent halving of the peat generation running hours will have economic implications. A simple estimate of reduction in grandfathered rights can be based on the change in running hours by moving to the dispatched mode of operation and the 21 €/tonne CO<sub>2</sub> carbon costs used in the central scenario. This simple estimate would put the cost of the reduction in carbon permits at around €30 M per annum in the central scenario.

With possible structural changes to the carbon permit allocation scheme and possibly the PSO scheme itself, the exact shape of the necessary support scheme for peat generation using the dispatched mode of operation remains unclear. However, the fundamental feature reported here is that there is a clear societal saving in the range of €21M per annum by moving to a dispatch mode of operation. As details around the future mechanism of carbon credit allocation become available, there is no reason that the appropriate changes cannot be made to the peat support scheme to account for the dispatch mode of operation while still ensuring full recovery of fixed and capital costs. While this may mean a continuation of some sort of subsidy for peat plants, it

would also mean a reduction in the size of the subsidy, if needed at all. There would obviously be employment implications, as the peat stations are located in the midlands, which is traditionally one of the areas in Ireland with lower employment figures. Also, the age profile of many of the people involved in harvesting peat is older, and therefore this may cause problems with re-employment. However, these points are outside the scope of this study and are not examined here.

### 3.2 Environmental Implications

From the simulation runs the implications of moving from a must run mode of operation to a dispatched mode of operation were examined from the perspective of system wide CO<sub>2</sub> emissions. While it is understood that peat is one of the highest CO<sub>2</sub> emitting forms of generation, with on average 1.1 tonne of CO<sub>2</sub> emitted per MWh, the actual net CO<sub>2</sub> implications of reducing peat generation output cannot be properly assessed without accounting for the features of the substitute generation and other system issues. The simulations performed here have done this, as when peat is not used, other plant is used to meet demand. Figure 6 below summarises the results with regard to CO<sub>2</sub> emissions.



**Figure 2:** Total CO<sub>2</sub> emissions for different scenarios

It can be seen that a significant decrease in system wide emissions can be gained from moving from the must run mode of operation to the dispatch mode of operation. This is mainly due to the decrease in the running hours of the peat generation. An approximate halving of the running hours for the peat generation in central scenario results in an approximate 5 % reduction in system wide emissions, as shown in the Central Case. It should also be noted that the carbon price affects other plant on the system, as the total emissions change in the must run cases also. It should also be noted that moving to a dispatched mode of operation addresses the apparent contradiction with the PSO on the one hand encouraging clean fuels, but on the other hand supporting a fuel which has high carbon intensity. Table 4 shows the cost of the PSO in terms of carbon emissions, at varying levels of carbon cost.

<b>Cost of CO2 (€/ tonne)</b>	<b>Additional tonnes of CO2 due to PSO</b>	<b>Cost of additional CO2 due to PSO (€)</b>
21	926,434	19,455,119
0	259,671	0
50	989,309	49,465,464
21 (w/ co-firing)	553,597	11,625,539

**Table 4:** Emissions due to PSO

Assuming central scenario conditions, this relatively simple operational change to the peat generation has a similar impact on emissions as 600 MW of installed wind capacity, as shown in (Denny, 2006). This is based on a wind capacity factor of 0.32 and wind generation displacing the average per unit energy emissions of the system of 0.55 tonnes CO<sub>2</sub>/MWh.

It could be easily extrapolated that another 5% reduction in system emissions could be gained by turning the peat generation off all together. However, here it is assumed that the societal cost of the carbon emissions are entirely reflected in the respective carbon costs shown here and as

such the dispatched scenarios reflect the optimal operation of the plant from an economic and environmental perspective.

### **3.3 Security of Supply Implications**

Historically the case for the public support of peat generation was based on the security of supply benefits brought to the system. Peat generation in the Irish context brings security of supply benefits in two ways, physical security and price security.

#### ***3.3.1 Physical Security of Supply***

With Ireland importing over 91% of its primary energy needs in 2006 (Howley et al., 2007), peat as an indigenous fuel source has obvious attractions for the Irish energy sector. In the electricity sector there was been a trend over recent years towards investment in gas fired generation. Overdependence on gas generation is of concern for Ireland due to its remoteness from the centres of production such a Russia and the possible single points of failure in the transmission system which could possibly cut supply to the Irish system. With only 343 MW of peat capacity on the Irish system peat generation clearly will not single handily avoid blackout situations in the event of large gas supply incidents. However, the capacity could provide some emergency supply into the network.

#### ***3.3.2 Price Security of Supply***

The benefits of a diversified generation portfolio have been illustrated previously. Some approaches have used financial portfolio theory to illustrate this (Awerbuch, 2006) while others have used diversity indices (Grubb, Butler, Twomey, 2005). The main financial benefits arise from the fact that the price volatility in diverse generation portfolios is less than that in non diversified portfolios. This is due mainly to the fact that various fuel price fluctuations tend not to be perfectly correlated with each other. Peat has some positive attributes from this perspective. Since not traded on international energy markets peat tends to have a low price

correlation with other fuel sources. Table 5 illustrates this feature. It can be seen that peat, while correlated with gas to some extent, is not correlated to coal or oil, and so if coal or oil prices get expensive, peat does give security from a price perspective – however, this benefit could be still kept if peat plant were changed to a dispatched mode of operation. It can also be seen that coal is also not very highly correlated with gas, oil or peat, and so also offers some price security – therefore, the main security benefit of peat should be physical security.

	<b>Gas</b>	<b>Coal</b>	<b>Oil</b>	<b>Peat</b>
<b>Gas</b>	1	0.3	0.75	0.39
<b>Coal</b>	0.3	1	0.28	0.14
<b>Oil</b>	0.75	0.28	1	0.07
<b>Peat</b>	0.39	0.14	0.07	1

**Table 5:** Historic Fuel Price Correlation

### ***3.3.3 Capturing the Benefit of security of supply***

In order to benefit from the security of supply aspects related to peat, both physical and price related, it is important that the peat generation stations remain available to the system. However, it is not necessary that the peat stations generate at full load. As long as the units are available to generate in the event of a physical shortage then physical security of supply benefits are retained. Similarly, as long as the peat generation is available to generate when other fuel market prices spike, the security of supply benefits in relation to price are retained. In some ways peat generation can be thought of providing a cap on the cost of generation for a volume related to the 343 MW of peat capacity running at base load.

It is clear from this that the running level is not an important factor in retention of the security of supply benefits of peat generation, but that the availability of the generation is the key feature. Given this fact, moving from a must run mode of operation to a dispatched mode of operation should have no implications on the security of supply benefits offered by peat generation. Peat would likely not be replaced in the long term, but could be moved to a dispatched mode of

operation in the short term without affecting security of supply. There is also the possibility of mothballing the peat plant to be used again if future market conditions permit. It should also be considered here that there has been a large increase in renewables in Ireland in the past years, with approximately 1000MW now installed – therefore there is already a source of indigenous energy in the country, albeit a variable one.

#### **4. Conclusions**

Using a simulation of the Irish electricity market, this paper examined the role peat generation with respect to the three pillars of energy policy. It was found that overall the existing peat fired generation does have an active and positive role to play in the Irish electricity system. However, it is not necessary that the peat stations generate at full load. The current “must run” mode of operation adopted for peat generation appears sub-optimal. This analysis found that there are significant social cost benefits to moving to a “dispatched” mode of operation for peat, (in the range of €1 M per annum), depending on CO<sub>2</sub> prices. The dispatched mode of operation also offered a 5% (1 million tonnes of CO<sub>2</sub>) reduction in system emissions over the year (assuming a €1 per tonne carbon tax), as well as removing the apparent contradiction of subsidising both renewables for their clean energy and peat, with its high carbon intensity. It was also established that the security of supply benefits of peat generation are retained by moving to the dispatch mode of operation.

There appears to be a societal gain to be made from altering the mode of operation of the peat generation from a must run mode to a dispatched mode. It is likely that such a change would involve a reduction in the quantity of milled peat required to be produced annually. This would have employment implications, not examined here. Adopting a dispatched mode of operation would also require a review of the various contractual and support mechanism surrounding the peat generation. Among these are the current fuel contracts and the PSO mechanism. Any future

changes to the support scheme may also have to account for possible changes in the carbon credit allocation scheme to generators.

## **7. Acknowledgments**

This work has been conducted in the Electricity Research Centre, University College Dublin which is supported by Electricity Supply Board (ESB) Networks, ESB Power Generation, EirGrid, Commission for Energy Regulation, Cylon, Airtricity, Viridian, Bord na Mona, ESB International, SWS, Bord Gáis and Siemens. The views expressed in this work are strictly the authors personal views and do not represent the views of their employers.

The authors acknowledge the useful comments of Richard Tol and Laura Malaguzzi Valeri, both with the Economic and Social Research Institute, Dublin, Ireland and John O'Reilly of Bord na Mona in the preparation of this paper.

This article copyrighted and reprinted by permission from the International Association for Energy Economics. The material first appeared in the proceedings of the 31st IAEE International Conference. This paper extends and updates this analysis.

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