EPBD Recast Article 14
Heating Systems Inspections

National Equivalence Report

IRELAND

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1. Introduction – Overview of EPBD and EPBD Recast Requirements

1.1 EPBD Article 8 – Inspection of Boilers

The EPBD Article 8 – Inspection of Boilers requires member states to establish a regular inspection of boilers fired by non-renewable liquid or solid fuel of an effective rated output of 20kW to 100kW. Such inspection may also be applied to boilers using other fuels.

For heating installations with boilers of an effective rated output of more than 20kW which are older than 15 years a one-off inspection of the whole heating installation is required. The inspection shall include an assessment of the boiler efficiency and the boiler sizing compared with the heating requirements of the building.

Boilers of an effective rated output of more than 100kW shall be inspected at least every two years. For gas boilers, this period may be extended to four years.

As an alternative to the above member states may opt to take measures to ensure the provision of advice to users concerning the replacement of boilers, other modifications to the heating system and alternative solutions to assess the efficiency and appropriate size of the boiler. The overall impact of this approach shall be broadly equivalent to that arising from, the provisions set out above.

1.2 EPBD Recast Article 14 – Inspection of Heating Systems

The EPBD Recast Article 14 – Inspection of Heating Systems requires member states to establish a regular inspection of the accessible parts of systems used for heating buildings, such as the heat generator, control system and circulation pump(s) with boilers of an effective rated output for space heating purposes of more than 20kW. The inspection shall include an assessment of the boiler efficiency and the boiler sizing compared with the heating requirements of the building. The assessment of the boiler sizing does not have to be repeated as long as no changes were made to the heating system or as regards the heating requirements of the building in the meantime.

The inspection frequency may be reduced or lightened where an electronic monitoring or control system is in place. The inspection frequency may be adjusted to reflect the type and effective rated output of the heating system whilst taking into account the inspection costs and the estimated energy costs savings that may result from the inspection. Heating systems with boilers of an effective rated output of more than 100kW shall be inspected at least every two years.

As an alternative to the above member states may opt to take measures to ensure the provision of advice to users concerning the replacement of boilers, other modifications to the heating system and alternative solutions to assess the efficiency and appropriate size of the boiler. The overall impact of this approach shall be equivalent to that arising from, the provisions set out above.

These requirements are summarised in the table below.

	EPBD Article 8 **Inspection of Boilers**	**EPBD Recast Article 14** **Inspection of Heating Systems**
Scope	Boilers with an effective rated output for space heating purposes of more than 20kW.	Accessible parts of heating system such as heat generator, control system and circulation pump(s) with an effective rated output for space heating purposes of more than 20kW.

	EPBD Article 8 Inspection of Boilers	EPBD Recast Article 14 Inspection of Heating Systems
Frequency	20kW – 100kW not specified, greater than 100kW at least every 2 years. For gas boilers this period may be extended to 4 years.	20kW – 100kW not specified, greater than 100kW at least every 2 years. For gas boilers this period may be extended to 4 years.
Assessment	Boiler efficiency and sizing –one-off inspection of the whole heating installation for boilers over 15 years.	Boiler efficiency and sizing –one-off assessment for all boilers provided no change to heating system or heating requirements.
Fuels	Mandatory for non-renewable or solid fuels. May also be applied to other fuels.	All fuels.
Effective date	4 January 2006. Member States may, because of lack of qualified and/or accredited experts, have an additional three year period.	9 January 2013 for buildings occupied by public authorities and to other buildings from 9 July 2013 at the latest.

1.3 Notification to EU Commission of Proposed Approach for Ireland

In September 2012, Ireland notified the EU Commission of its decision to avail of the alternative approach provided for under Article 14(4) of the EPBD Recast. Ireland similarly availed of this alternative approach under Article 8(b) of the original EPBD.

As set out in the notification, the proposed approach continued to centre on the delivery of an effective information campaign aimed at encouraging regular inspection and maintenance of residential and commercial boilers and the replacement of inefficient boilers or heating installations. This campaign is complemented by a range of additional interventions which aim to drive significant purchase and behaviour change, particularly in respect of appliance replacement. This approach is set within a goal of accelerating market change in favour of more energy efficient products and practices relating to boilers / heating systems in Irish buildings. The focus continues on establishing a well-structured set of initiatives, led by government bodies, but with a partnership approach aligning with the business interests of energy efficiency product and service providers, especially key influencers, in the boilers / heating systems sector.

The remit of the present document is to provide the Commission with additional material on how the requirements of the EPBD Recast Article 14 will be met in Ireland including an assessment of the achievement of equivalence, or better, of the actions undertaken, relative to what would have applied under EPBD Article 14 paragraphs 1,2 and 3.

In addition to the information campaign, this report includes other relevant policy and actions not envisaged at the time of the original notification, and which are progressively reducing the numbers of older or inefficient fossil fuel fired boilers and heating systems.

2. Overview of Baseline Study

In July 2004, the Sustainable Energy Authority of Ireland (SEAI) commissioned a review of the options for meeting the EPBD Article 8 requirements in Ireland. The methodologies used together with the underlying assumptions and the proposed recommendations continue to be representative of the position with regard to heating systems in Ireland and has been used as the basis for the development of a hypothetical regular inspection scheme and the assessment of the proposed alternative measures in terms of equivalence. Specific sections are abstracted and abridged below to present a context for the approach taken by Ireland in respect of EPBD Recast Article 14.

The complete report of this study, completed in January 2006 is provided as a separate annex to this report.

2.1 Approach

The study approach can be summarised as follows:

- Exercise to estimate boiler size and a breakdown of the boiler population by user sector, fuel used and age.
- Review of a number of other facets to the introduction of EPBD Article 8 in Ireland, largely based on interviews with representatives of the industry in Ireland (including manufacturers, service technicians and fuel suppliers).
- A summary of the approach to EPBD Article 8 being adopted by three other EU Member States in Autumn 2004.
- Examination of the requirements of the EPBD Article 8 Option (a) approach, and the possible interpretations of its requirements.
- Discussion of the EPBD Article 8 Option (a) Measures, each in turn, and in variations or Scenarios where relevant.
- Consideration of the parameters of the EPBD Article 8 Option (b) approach and their possible equivalence to EPBD Article 8 Option (a).
- Examination of the measures in an EPBD Article 8 Option (b) approach including a mapping of equivalence insofar as possible to the same measures and their Scenarios in EPBD Article 8 Option (a).
- Exploration of ideas arising through the trawl of the industry and the thoughts of the study team, as to other measures of merit.
- Summary of the research findings, and the pros and cons associated with the scenarios examined.

2.2 Research Methodology

To implement the above approach, the study was based on a number of work modules, summarised below:

- Secondary information was reviewed, in particular with a view to characterising the population of boilers.
- Face-to-face interviews were held with nine leading Irish boiler manufacturers and importers which provided data and confirmed the main assumptions adopted for this study.
- Face-to-face meetings were held with representatives of the national gas utility, a major insurance company and training bodies.

- Follow-up telephone conversations were conducted with most of the above organisations to clarify and expand upon significant issues arising.
- To obtain information on current boiler service practices, a postal survey was undertaken of 205 boiler servicing personnel or inspectors.
- The research on the approaches being adopted in other Member States was conducted firstly on the Internet, with subsequent telephone interviews with the person responsible for the implementation of EPBD Article 8.

3. Summary Study Findings – Setting a Baseline

The following are the summary findings of a study commissioned to establish the baseline distribution profile in 2005 of boilers in Irish buildings by fuel, size / output, age, the prevailing practice and potential in respect of inspection/servicing/ maintenance of boilers, and the potential energy and CO_2 saving impacts under differing scenarios.

- Out of a total of 1.25 million boilers, there were 693,000 boilers of over 20 kW and comprising 580,000 oil boilers, 100,000 gas boilers and 13,000 solid fuel boilers.
- Total energy consumption by all boilers estimated at 24,000 GWh, accounting for 5.8 Mt CO_2 emissions.
- Of boilers within the remit of EPBD Article 8, approximately 87% of commercial boilers and 49% of domestic boilers receive a maintenance servicing annually.
- The numbers to target for regular inspection and servicing in these cases were therefore respectively 13% of commercial boilers and 51% of domestic boilers.
- No explicit targets are set in Article 8 for energy efficiency or emissions improvements. Indeed inspection *in itself* will not achieve such improvements. It is the act of maintenance servicing that achieves the improvement (whether stimulated by an inspection, an information campaign, or other means).
- A scenario exercise assessed the hypothetical maximum national savings from an estimated 2.5% average seasonal efficiency improvement arising from servicing boilers ever two years.
- This was calculated per annum at **417 GWh gross or 108,000 tCO_2**, and excludes energy consumption in transport to provide the service.
- It is difficult to assess the conversion rate of inspection advice findings into action in the form of maintenance servicing.
- It has been assumed that the conversion rate is 50%, equating to a potential impact under Option (a) of **208 GWh and 54,200 tCO_2** per annum. These figures thus represent the **baseline** against which equivalence is to be assessed.

3.1 Boiler Population

The size of the Irish market for boilers was researched and in particular an attempt was made to identify the number of boilers with a rated output of 20kW or more. 2005 was used as the baseline year as the EPBD implementation was scheduled from 2006 to 2009.
The findings were as follows:

- In 2005, in the relevant categories (i.e. >20kW for oil / solid fuel and >100kW for gas), there were approximately 580,000 oil-fired boilers; 1,000 gas-fired boilers and 13,000 solid-fuel fired boilers in Ireland;

- Less than 10% of these are in the 'commercial' sector (i.e. public and private non-industrial sectors), the balance are in households;
- The total boiler population in Ireland was estimated to be at least 1.25M (domestic and commercial). The requirements of the EPBD apply to 48% of these;
- The boilers in the main urban centres are least affected given these are now supplied with natural gas and under the Directive inspection is only required if they are >100kW and even then inspection is only required every 4 years;
- A large number of the boilers over 20kW in Ireland are oil-fired boilers in households, which are just over the threshold of 20kW;
- There are between 90,000 and 100,000 boilers that are both over 20kW and over 15-years old (a specific category in the Directive). Of these, 91% are estimated to be oil-fired, with 5% gas-fired and 4% solid-fuel fired;
- Households in Ireland with oil-fired boilers increasingly use kerosene (estimated at 80% in 2005), which burns more cleanly than gas-oil, and requires far less servicing to retain clean, reliable and efficient operation.
- The Irish market differs from other European markets with respect to the higher percentage of oil fired boilers and also the higher market penetration of kerosene.

The review identified historical market data and extrapolated trends. Where possible the boiler population was broken down by fuel type, by size and by age. The review attempted to identify the number of boilers over 15 years old in 2006 due for upgrade or replacement.
It was estimated that, out of a total of 1.25 million boilers, there were 693,000 boilers over 20kW. This comprised 580,000 oil boilers, 100,000 gas boilers and 13,000 solid fuel boilers.

Estimated Total Domestic and Commercial Boiler Population by Size (2005)						
Fuel	**Total (All sizes)**	**< 20kW**	**20-40kW**	**40-100kW**	**> 100kW**	**Total > 20kW**
Oil	677,500	97,500	575,000	3,500	1,500	580,000
Gas	508,000	408,000	97,000	2,000	1,000	100,000
Solid Fuel	65,000	52,000	13,000	NIL	NIL	13,000
Total	1,250,500	557,500	685,000	5,500	2,500	693,000

The EPBD specifically targeted heating systems with boilers over 15 years old as they may be expected to be the least efficient and to emit the most carbon dioxide. The determination of the boiler population over 15 years was made on the basis of the original boiler stock in 1991, plus the total boiler sales in the interim, less the estimated 2005 boiler population, making allowances for attrition. The resulting estimate of the age profile of boilers exceeding 20kW rated capacity is shown below. In 2005 there was an estimated 93,500 boilers with a rated output greater than 20kW over 15 years old.

Estimated Total Domestic and Commercial Boiler Population >20kW (2005)					
Fuel	**Total (All ages)**	**Aged 0-5 years**	**Aged 5-10 years**	**Aged 10-15 years**	**Aged over 15 years**
Oil	580,000	195,000	175,000	125,000	85,000
Gas	100,000	45,000	30,000	20,000	5,000
Solid Fuel	13,000	2,500	3,000	4,000	3,500
Total	693,000	242,500	208,000	149,000	93,500

3.2 Regulatory and Institutional Context

The regulatory and institutional landscape relevant to the EPBD in Ireland was reviewed including existing servicing, inspection and documentation procedures. In addition the approach adopted in three other EU Member States was also reviewed. It was found that:

- There are existing minimum performance efficiency standards for new boilers in Ireland, as a result of an earlier EU Directive on boiler energy efficiency;
- There were no mandatory standards for boiler inspection or performance in Ireland in 2004;
- There were no regulations in Ireland governing the qualifications of personnel engaged in boiler installation and servicing in 2004;
- Some training was available from Bórd Gáis, from Institutes of Technology (especially in Dublin and Cork), from FÁS and from a private company;
- There was an estimated 350 boiler-servicing technicians operating in Ireland. Most were self-employed or worked for small firms;
- There was an estimated core of approximately 200 technicians. An unknown number of people carry out servicing work part-time. In addition, a number of people trained in boiler servicing chose to work in other areas instead, particularly boiler installation;
- When assessing risk, insurance companies ask if organisations have boilers but do not normally inspect the boiler, nor does the presence of a boiler affect the premium.

The leading boiler manufacturers assisted with drafting a questionnaire (see full report in Appendix) which was subsequently circulated to registered service agents. 205 questionnaires were circulated and 56 responses (27%) were received back. The survey findings relate to all domestic heating boilers and to industrial and commercial boilers, particularly the smaller and intermediate sizes and with less certainty to the small number of very large boilers (of > 100kW capacity) that for purely commercial reasons are already intensively monitored and serviced at greater frequency than would arise out of EPBD or EPBD Recast.

The main questionnaire findings were as follows:

- The average time between inspections for a household is approximately three years;
- The single biggest source of training on boiler inspection is the manufacturer – many technicians have attended more than one short training course over the years;
- A short (normally one-page) report is usually provided to the customer at the end of the boiler inspection;
- A technician typically services four or five boilers in one (full capacity) day;
- 28% of services were distress calls;
- It is suspected that many new boilers installed in Ireland were not commissioned in accordance with the manufacturer's recommendations. This results in a loss of efficiency (perhaps more than 7.5%) until the boiler is serviced for the first time;
- Two-thirds of clients follow the advice of the service technician immediately, with a further 20% following the advice 'within a year'. However it is possible that this is driven by concerns regarding reliability or breakdown rather than efficiency;
- Domestic boilers have fewer annual operating hours (typically 2,000 duty hours) and so need less frequent servicing;
- Commercial boilers tend to be better maintained and six-monthly servicing is a typical practice for larger commercial boilers in continuous use (hospitals, etc.);

- Boilers fired by gas oil require servicing every 2 – 3 years while boiler burning kerosene may only need to be serviced every 5 years;
- Based on extensive discussions with service technicians and manufacturers it is estimated that a gas-oil boiler will burn 4-5% less efficiently after 2 seasons or 2000 hours (without service), i.e. an efficiency loss of 2 – 2.5 % per annum, while a corresponding figure for a kerosene boiler is likely to be 0.75% and for a natural gas boiler 0.5%;
- The average level of annual servicing is estimated at 49% for domestic boilers and 87% for commercial boilers;
- Average commercial fuel usage is approximately 15 times the domestic boiler usage whereas the introduction of a mandatory inspection regime would mainly impact on domestic boiler users.

3. Hypothetical Regular Inspection Scheme

The focus of the hypothetical regular inspection scheme is on oil boilers, as scope for incremental efficiency improvements is greater than that for gas. Incremental cost / benefits and impacts for boilers not regularly serviced were considered as part of the analysis.

Estimated Boiler Servicing Patterns (2005)								
Boiler Type	**% Service Calls**	**% of Boilers**	**Annual**	**Up to 3 Yearly**	**< 20kW 3 yearly**	**Weighted Average Per Annum > 20kW**	**Weighted Average Potential not serviced annually**	**Potential Number of Oil Boilers**
Commercial Boilers (all > 20kW)	15%	7.4%	80%	20%	0%	86.6%	13.4%	4,355
Residential Boilers	85%	92.6%	33%	47%	20%	48.5%	51.5%	281,908

On the basis of the figures provided in the 2005 study, of boilers over 20kW and therefore within the remit of the EPBD Recast, on a weighted average basis, approximately 86.6% of commercial boilers and 48.5% of domestic boilers receive a maintenance servicing annually. The numbers to target for regular inspection and servicing in these cases are therefore respectively 13.4% of commercial and 51.5% of domestic boilers. The inspection regime would also incorporate all (building) heating systems with large boilers (>20kW) and that are more than 15 years old. This largely precludes gas fired appliances (except those older than 15 years or greater than 100kW in size). Moreover given that solid fuel accounted for almost 80% of the domestic heating market in Ireland in 1990, with progressive installation of oil and gas fired appliances in the meantime, less than 8% of the boiler population was more than 15 years old in 2005.

Commercial Boilers (2005) 86.6% receive on average an annual service (inspection, cleaning, tuning) Boilers receiving the least servicing are the smallest	
Average consumption per oil boiler (litres)	33,950
Average consumption for small oil boiler Generally less frequently serviced (litres)	6,790
Average boiler efficiency decline per year	4%
Peak boiler efficiency	82%
For boilers not currently receiving regular service:	
Average boiler efficiency gain per biennial service	4%
Average fuel savings per biennial service (litres)	425
Price of commercial oil (€/litre)	0.40
Annual value of fuel saved (€)	170
Average cost per service (€)	300
Annual cost per biennial service (€)	150
Average net cost saving to business (€)	20
Average payback period within biennial cycle	21 (months out of 24)
Ultimate potential savings:	
Number of boilers	4,355
Total fuel savings (million litres)	1.849
Total fuel savings (toe)	1,646
Annual value of fuel saved (M€)	0.740
Calorific value of oil (kWh/litre)	10.35
Total calorific value of oil (GWh)	19.14
CO2 emission factor for oil (g/kWh)	260
CO2 emissions abated per annum (tonnes)	4,976
National costs:	
Total average annual costs of service (M€)	0.653
Attributed costs per tonne CO_2 abated (€/tonne)	131

Residential Boilers (2005) 55% (48.5% >20kW, 6.5% <20kW) receive on average an annual service (inspection, cleaning, tuning)	
Average consumption per oil boiler (litres)	2,180
Average boiler efficiency decline over two years	2.5%
Peak boiler efficiency	82%
For boilers not currently receiving regular service:	
Average boiler efficiency gain per biennial service	2.5%
Average fuel savings per biennial service (litres)	135
Price of commercial oil (€/litre)	0.45
Annual value of fuel saved (€)	61
Average cost per service (€)	100
Annual cost per biennial service (€)	50
Average net cost saving to business (€)	11
Average payback period within biennial cycle	20 (months out of 24)
Ultimate potential savings:	
Number of boilers	281,908
Total fuel savings (million litres)	38.058
Total fuel savings (toe)	343,869
Annual value of fuel saved (M€)	17.126
Calorific value of oil (kWh/litre)	10.35
CO2 emission factor for oil (g/kWh)	260
Total calorific value for oil (GWh)	397.8
CO2 emissions abated per annum (tonnes)	102,413
National costs:	
Total average annual costs of service (M€)	14.095
Attributed costs per tonne CO_2 abated (€/tonne)	136

No explicit targets are set in EPBD Recast Article 14 for energy efficiency or emissions improvements. Indeed inspection in itself will not achieve such improvements. It is the act of maintenance servicing that achieves the improvement (whether stimulated by an inspection, an information campaign, or other means).

Nevertheless a scenario exercise was conducted to assess the hypothetical maximum national savings that would derive from an estimated 2.5% average seasonal efficiency improvement arising from servicing boilers every two years. This was calculated per annum at 417 GWh gross or 108,400 tCO_2, and excludes energy consumption in transport to provide the service. It should be noted that this regime represents little or no net cost saving to a household in many cases. This was a key influence in adopting the original approach taken under EPBD Article 8(b) and in continuing with this approach under EPBD Recast Article 14(4) as well as the fact that the alternative approach would have the added benefit of promoting the benefits of safety and reliability as much as energy efficiency.

Combined Commercial and Residential Oil Boilers (2005) Applies to residual boilers not regularly serviced at present				
	25%	**50%**	**75%**	**100%**
Number of boilers	71,566	143,131	214,697	286,263
Total fuel savings (million litres)	10.071	20.142	30.212	40.283
Annual value of fuel saved (M€)	4.509	9.018	13.526	18.035
Calorific value of oil (kWh/litre)	10.35	10.35	10.35	10.35
CO_2 emission factor for oil (g/kWh)	260	260	260	260
Total calorific value of oil (GWh)	104.23	208.47	312.69	416.93
CO_2 emissions abated per annum (tonnes)	27,101	54,201	81,302	108,402
National Costs				
Total average annual costs of service (€)				14.749
Attributed costs per tonne CO_2 abated (€/tonne)				136

BASELINE ASSUMPTION

The maximum savings arising from the hypothetical regular inspection scheme are therefore 417GWh and 108,402 tonnes CO_2. It has been assumed that the conversion rate is 50%, equating to a potential impact under EPBD Recast Article 14(1) to (3) of 208.5 GWh and 54,200 tCO_2 per annum. These figures thus represent the baseline against which equivalence is to be assessed.

This is the baseline for assessment of the EPBD Recast Article 14(4) actions as implemented in Ireland.

4. Detailed Analysis of Actions Implemented

EPBD Article 8 and EPBD Recast Article 14 enables member states to opt to take measures to ensure the provision of advice to users concerning the replacement of boilers, other modifications to the heating system and alternative solutions to assess the efficiency and appropriate size of the boiler. The overall impact of this approach shall be equivalent to that arising from a regular inspection scheme.

An aligned set of actions contributing to improving boiler and heating system efficiency in the Irish building stock is in place. These consist of actions yielding energy savings and CO_2 abatement of a direct nature from capital investment in high efficiency systems, plus actions of an indirect nature that influence such capital upgrading works or influence improvements to operational heating system efficiency, notably boiler maintenance servicing.

This section of the report deals with the individual actions taken to date, quantifies the energy savings arising and clearly demonstrates how, as an integrated suite of measures, they are equivalent or superior to a mandatory inspection programme.

4.1 National Promotion Campaigns Encouraging Regular Servicing or Replacement

Description

During the period 2006 – 2009 extensive multi-media consumer awareness and advice campaigns, entitled 'Power of One' were conducted (see www.powerofone.ie) which included a range of messages on home energy saving, including boiler servicing and management. Since 2008, in pursuit of the original Article 8 requirements and from 2011 having regard to the provisions of EPBD Recast Article 14, Ireland has run national promotional / advertising campaigns in relation to regular servicing of boilers, using websites and popular and trade media. The campaign has been a partnership between SEAI and key heating industry stakeholders, viz. Bord Gáis Energy (BGE) (natural gas), OFTEC (oil) and Irish Liquid Petroleum Gas Association (ILPGA) (LPG). The campaign has had as its core message the encouragement of regular maintenance of residential and commercial boilers and the replacement of inefficient boilers or heating installations. In collaboration with industry stakeholders, the campaign has encompassed all major media streams including television, radio and national newspaper advertising, as well as web advertising and promotional literature. The campaign directed consumers to a portal web page at www.seai.ie/boilers which in turn linked directly to the web sites and panels of specialist boiler maintenance service providers maintained by the three key stakeholders.

A more holistic message than energy efficiency alone was carried in the campaign. Specifically, it has promoted the benefits of safety and reliability as well as energy efficiency/ cost savings. This is because of known consumer perceptions from the baseline study and the weakness, in economic terms, of an energy efficiency message alone.
As an example of boiler campaign statistics, the campaign in 2011 had reached daily and Sunday newspapers each with a readership of 3.6 million, broadcast listenership of 3.1 million and online advertising achieved 100,000 visits. The campaign led to an increase of over 20% in visits to the relevant web pages, and the residual effect was sustained for a significant period after the primary campaign ceased.

Outcome

Following the establishment of the baseline practice and behaviour, the effectiveness of the various promotional campaigns has been measured through Omnibus quantitative research. The following table summarises the changing consumer attitudes and behaviours to boiler servicing frequency relative to a pre-2010 baseline demonstrating a significant shift to the frequency of servicing towards more efficient practice. On average 71% of boilers were serviced annually in 2011 compared to 63% in 2010 and 58% before 2010.

Servicing Frequency	Every Year	Every 2 Years
Pre 2010	49%	18%
2010	57%	11%
2011	64%	14%

This is a considerable improvement on the 2005 baseline where an estimated 48.5% of residential boilers were serviced annually. The baseline analysis indicated a potential for a further 281,908 domestic boilers to be serviced every second year.

Estimated Energy Savings

The following table provides the estimated total (domestic and commercial) boiler population, by fuel (2005).

Estimated Total Domestic and Commercial Boiler Population by Fuel (2005)			
Fuel	**Total**	**Domestic**	**Commercial**
Oil	680,000	647,500	32,500
Gas	508,000	490,000	18,000
Solid Fuel	65,000	65,000	0
Total	1,253,000	1,202,500	50,500

In order to estimate the impact of the information campaign and alternative measures the pre 2010 and 2011 servicing frequency statistics were applied to the domestic boiler population.

Estimated Total Domestic Boilers Serviced Every 2 Years				
Fuel	**Total**	**Pre 2010**	**2011**	**Pre 2010 to 2011 Increase**
Oil	647,500	375,550	459,725	84,175
Gas	490,000	284,200	347,900	63,700
Solid Fuel	65,000	37,700	46,150	8,450
Total	1,202,500	697,450	853,775	156,325

The calculated pre 2010 to 2011 increase in domestic boilers serviced every 2 years is 156,325 equating to 220GWhs or 57,211 tonnes CO_2. The impact of the 2012 boiler information campaign is not yet available and will be included in the next report.

4.2 Building Regulations Part L Provisions on Minimum Boiler Seasonal Efficiency

Description

The Department of the Environment, Community and Local Government published a revision to the Irish building regulations governing the conservation of fuel and energy in dwellings

(Part-L) in December 2007. The revision included a provision that from 31 March 2008 all oil or gas boiler installations in new dwellings must have a minimum seasonal efficiency of 86%. In addition, all replacement oil or gas boilers in existing dwellings must also have a minimum seasonal efficiency of 86% unless such an installation is impractical. In effect, this means that the vast majority of all boiler installations from the 31st March 2008 will be high efficiency condensing boilers.
The Irish building regulations governing the conservation of fuel and energy in dwellings (Part-L) were further updated in May 2011. From 1 December 2011 all oil or gas boiler installations in new dwellings must have a minimum seasonal efficiency of 90%. In addition, all replacement oil or gas boilers in existing dwellings must also have a minimum seasonal efficiency of 90% unless such an installation is impractical.

Outcome
The Central Statistics Office www.cso.ie publishes statistics on the number of new and existing building projects where building regulations apply. A commencement notice is a notification to a building control authority that a person intends to carry out either works or a material change of use to which the building regulations apply. There were 34,411 commencement notices issued for residential units in the period April 2008 to November 2011 where the minimum boiler seasonal efficiency was 86% and 2,590 residential units from December 2011 to July 2012 where the minimum boiler seasonal efficiency was 90%. The statistics for August 2012 onwards are not yet available.

Estimated Energy Savings
The following table does not include replacement boilers in existing homes.

Estimated Building Regulations Part L Impact on Minimum Boiler Seasonal Efficiency							
Fuel	**Efficiency 2005**	**Minimum Efficiency**	**Average Fuel Savings (litres)**	**Average Value of Fuel Saved**	**Number of Boilers**	**Total GWhs Saved**	**Total tonnes CO_2 Abated**
Building Regulations Part L 2008	82%	86%	272	€122	34,411	96.87	25,186
Building Regulations Part L 2011	82%	90%	544	€244	2,590	14.58	3,791
Total					37,001	111.45	28,977

Calorific value of oil – 10.35kWh/litre
CO2 emissions factor for oil – 260g/kWh

The estimated building regulations Part L impact on minimum boiler seasonal efficiency equates to direct annual energy and CO_2 savings of 111.45 GWhs and 28,977 tonnes respectively.
The regulations set a requirement for a minimum contribution of 10kWh/m^2 from renewable energy technology in new homes thus further reducing the fossil fuel consumption and associated emissions.
There is also a requirement to provide the home owner with instructions on how to operate the systems installed in the house effectively, specifically including the following:

- Information regarding the importance of servicing for boilers and establishing a schedule for same;
- Information on how to make adjustments to the time and temperature control settings; and
- Information on the routine maintenance required to enable the operating efficiency of the systems to be maintained at a reasonable level.

4.3 Greener Homes Scheme of grants for renewable energy heating installations

Description

The Greener Homes scheme was established in 2006 to support homeowners wishing to install renewable energy heating technologies, including wood pellet/chip stoves and boilers, solar panels and geothermal heat pumps. The Greener Homes scheme was open to any individual intending to retrofit a new renewable energy heating system in their home. Homeowners selected products and installers from the registered product and installer lists maintained by SEAI. The following table provides a breakdown of the applications by year:

Year	Number of Installations
2006	1,338
2007	8,382
2008	9,643
2009	7,311
2010	4,831
2011	1,498
Total	33,065

The grant scheme was closed to new applications in May 2011.

Outcome

The total number of applications supported under the Greener Homes scheme was 33,065. The following table provides a breakdown of the applications by technology:

Technology	Split by volume
Heat Pump	18%
Biomass	18%
Solar	63%
Wood Gasification	0.5%

The Grants paid amount to almost €75 million which leverages a further €174 million spend by homeowners. By the end of 2010 there were over 1,400 installers registered to install 1,200 registered systems across all technologies.

Estimated Energy Savings

The Greener Homes scheme has been assessed to yield direct annual energy and CO_2 savings of 119 GWh and 28,000 tonnes respectively. A reasonable proportion of the energy consumption in all new dwellings must now be provided by renewable energy sources. The Better Energy Homes scheme continues to support the installation of solar hot water heating systems in existing homes.

4.4 Better Energy Homes (formerly Home Energy Saving) scheme of grants for efficient heating installations

Description

The Better Energy Homes scheme, established in 2009, provides assistance to homeowners to reduce energy use, costs and greenhouse gas emissions and improve the comfort levels within their home. The objectives of the scheme are to:

- Support homeowners in making intelligent choices to improve the energy performance of their home;
- Reduce energy use, costs and greenhouse gas emissions;
- Build market capacity and competence by driving contractor standards and quality;
- Stimulating market innovation.

The incentive is in the form of a Cash Grant. Cash grants are fixed, irrespective of home size, though where actual expenditure is lower than the grant value only the lower amount will be paid. The grants are available to homeowners for the installation of boilers with seasonal heating efficiencies in excess of 90% and advanced heating controls to replace inefficient old systems in existing homes.

Since the introduction of energy supplier targets under the Energy Services / Energy Efficiency Directive, Ireland has operated a programme of energy credits allocated to prescribed works undertaken to published standards. These credits can be accrued by energy suppliers who cause energy efficient works to be completed in homes, among the measures are boiler upgrades, heating controls upgrades and boiler servicing. This credits scheme is anticipated to drive extensive volumes of energy retrofitting and boiler servicing.

Outcome

The following table provides a breakdown of the installations by technology:

Measure	Number of Installations
Cavity	88,328
Roof Insulation	99,114
Dry-lining Insulation	8,399
External Insulation	9,051
High Efficiency Gas Boiler with Heating Controls Upgrade	18,131
High Efficiency Oil Boiler with Heating	12,715
Heating Controls Upgrade only	6,166
Solar Heating	3,136
Integral BER	87,968
Before/After BER	8,367
Total	341,375

Estimated Energy Savings

It is estimated that the direct annual savings attributable to the boilers and heating controls elements are energy and CO_2 savings of 90 GWh and 24,000 tonnes respectively.

4.5 Renewable Heat Deployment scheme for non-domestic heating installations

Description

The Renewable Heat Deployment scheme, introduced in 2007 to run until 2010, with €26 million budget provided support for:

- Automatic Biomass Boilers (wood chips / wood pellets);
- Solar Thermal Collectors;
- Heat Pumps;
- Commercial, agricultural, industrial, services, public sectors, ESCO.

A feasibility study or design appraisal was required as part of the application process. This grant scheme has encouraged the upgrading / replacement of fossil fuel based heating systems with low CO_2 alternative systems- solar heating, heat pumps and biomass boilers and stoves - in non-domestic installations.

Outcome

Approximately 580 installations were completed as a result of the scheme. The breakdown by technology was: boilers fuelled by wood chips and/or wood pellets (40%), solar thermal systems (40%) and heat pumps (20%).

Estimated Energy Savings

The Renewable Heat Deployment scheme has been assessed to yield direct annual energy and CO_2 savings of 410 GWh and 92,000 tonnes respectively.

4.6 Indirect Actions: Boiler Efficiency Databases and Information Dissemination

Further supporting the direct actions set out above, SEAI has also undertaken a number of supporting actions which help further empower consumer purchase decisions and user behaviour.

a. Heating Appliance Register of Performance (HARP)

The Heating Appliance Register of Performance (HARP) database is a product efficiency database for home-heating appliances that are used in Ireland. The database is published by SEAI and is accessible on the SEAI website at www.seai.ie/harp. It is used for the following purposes:

- as a resource in the boiler efficiency promotion campaign above;
- to provide consumers with comparative performance related information for heating appliances to enable them make informed decisions;
- to provide registered Building Energy Rating (BER) assessors with specific product efficiency information which they can use when calculating BERs for dwellings;
- to facilitate compliance with the original Boiler Efficiency Directive; and
- has the potential facilitate the monitoring of market patterns, either in a procurement context or through the Building Energy Rating (BER) system.

In the latter regard, the changing database population will be used as a tool for assessing market trends. Over time, as a result of the marketing potential of the database, the proportion of higher efficiency boilers can be expected to increase. This will be used as a basis to model the distribution of such boilers and estimate the resulting CO_2 savings.

As an example of a positive impact, in part arising from regulatory action (1) above, it is understood that the manufacturers of oil fired boilers may cease manufacturing models other than condensing models during 2011.

b. Triple E register

The online Triple E register of energy efficiency products at www.seai.ie/aca comprises over 9,000 energy technologies including high efficiency boilers and controls. This been developed and maintained as a procurement support resource for organisations in the non-domestic sector – and is the reference point for eligible products under the 'Accelerated Capital Allowance' tax incentive scheme, ultimately driving investment in high efficiency plant and equipment.

c. Building Energy Rating advisory report

Within Ireland's implementation of building energy certification under the original EPBD Article 7 and EPBD Recast Article 11, the Building Energy Rating advisory report to the building owner or user at the point of construction, sale or rental includes the provision of heating system advisory information. In particular, in combination with the rating methodology itself, the report highlights the effect of boiler type and efficiency, controls, response time and fuel type. The BER database provides a tool for monitoring the energy and CO_2 patterns, including boiler efficiency and related patterns and trends, across the accumulating population of buildings receiving BER certificates.

d. Consumer and Business Informational Action

SEAI provides a number of services whereby information on boiler efficiency and the effect efficiency plays in CO_2 emission reductions can be assessed.

In addition to a number of publications specifically aimed at energy efficiency in the home (e.g. "Home Heating Guide") SEAI has been involved in a number of joint initiatives with government bodies. Among these is the publication of the "The Domestic Heating Compliance guide" and the "Guide to the Condensing Boiler Assessment Procedure for Existing Dwellings" in association with the Department of Environment, Community and Local Government.

SEAI also provides on-going information and advice services to both the domestic and non-domestic sectors, the latter including large industry, SMEs and the public sector. Included in these programmes are information and advice highlighting high efficiency technologies and operational and maintenance practices to maximise heating system efficiencies.

e. Training and Competency initiatives

Competency building is important to ensure that a suitably trained and skilled workforce is available to facilitate the implementation plan. The SEAI worked with industry leaders to develop energy efficiency training courses for oil and gas installers and has also worked with the national accreditation authority and relevant bodies to attain national accreditation for these courses.

Since 2005, SEAI has developed nationally accredited training courses for Renewable Energy System installers and has maintained a registered list of installers.

Since June 2009 the national energy regulatory body (Commission for Energy Regulation) has made it a legal requirement that only a competent registered installer known as a Registered Gas Installer (RGI) can perform works on any domestic gas appliance. This includes the installation, removal, repair, servicing, maintenance or replacement of any domestic gas appliance.

All of these actions increase standards of delivery while at the same time increasing consumer confidence in the supply chain, thereby increasing the likelihood of consumers investing in heating servicing and upgrades.

5. Summary of Progress to Date

An aligned set of actions contributing to improving boiler and heating system efficiency in the Irish building stock is in place. The table below summarises actions up to the end of 2010. These consist of actions yielding energy savings and CO_2 abatement of a direct nature from capital investment in high efficiency systems, plus actions of an indirect nature that influence such capital upgrading works or influence improvements to operational heating system efficiency, notably boiler maintenance servicing.

Action	Annual energy saving (GWh)	CO_2 Emissions Abated (Tonnes)	Year commenced
4.1 Multiannual National Media Campaign Promoting boiler servicing and upgraded replacement	220	57,211	2008 On going
5.2 Building Regulations Mandatory minimum boiler efficiency of 86%+ Increased to 90%+ in December 2011	111	28,977	2008
4.3 Greener Homes Scheme Support for installation of solar heating, heat pumps and biomass boilers – 32,000 homes	126	56,800	2006 Concluded 2011
4.4 Better Energy Homes Scheme Support for efficient boiler and controls upgrades – 33,000 of 127,000 homes benefited from boiler and control upgrades	90	24,000	2009 On going
4.5 REHeat scheme Support for installation of solar heating, heat pumps and biomass boilers	500	96,000	2007 Concluded 2010
4.6a Domestic Boiler Efficiency Database Heating Appliances Register of Energy Performance (HARP) and	Indirect	Indirect	2006
4.6b Procurement Support for Business Triple E register of energy efficient products for business sector, including boilers and controls	Indirect	Indirect	On going
4.6c BER Advisory Report Includes the provision of heating system advisory information	Indirect	Indirect	On going
4.6d Information and Advice Highlighting high efficiency boiler technologies and operational and maintenance practices	Indirect	Indirect	On going
4.6e Training Initiatives Training of boiler maintenance and installation technicians	Indirect	Indirect	On going
	1,047	**262,988**	

The annual energy savings in relation to boiler installation and maintenance are difficult to quantify in many instances, but the 1,047 GWh and 262,988 tonnes CO_2 savings attributable to the above direct measures significantly exceed both the realistic (208.5 GWh and 54,200 tonnes CO_2) and hypothetical 417 GWh and 108,402 tonnes CO_2 baselines presented earlier in this report.

6. Future Focus

As outlined in this report, Ireland has taken a number of promotional, regulatory, incentivising and accompanying initiatives in relation to heating system efficiency which are achieving impacts on energy saving and CO_2 abatement to levels significantly higher than would have been realistically achievable under EPBD Recast Article 14 paragraphs 1,2, and 3.

The mandatory minimum boiler efficiency of 90% introduced in December 2011 will provide on-going reductions in energy use. The Better Energy Homes Scheme is expected to continue for some period yet. Activity is currently underway to develop a range of payment support mechanisms including PAYS which is likely to see further investment in retrofitting actions.

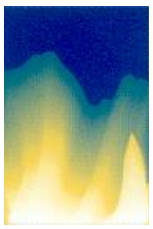
As mentioned previously, energy suppliers who cause energy efficient works to be completed in homes can accrues energy credits towards their mandatory targets. Among the measures are boiler upgrades, heating controls upgrades and boiler servicing. This credits scheme is anticipated to drive extensive volumes of energy retrofitting and boiler servicing.

SEAI will continue to coordinate the national media campaign promoting boiler servicing and upgrade replacement. Consumer and business sector information, advice highlighting high efficiency boiler technologies, operational and maintenance practices, and training of boiler maintenance and installation technicians will be important initiatives in the future.

Appendix 1

Baseline Study

Review of options to meet the requirements of Article 8 of the EU Energy Performance of Buildings Directive in Ireland



National Irish Centre for Energy Rating (NICER)

January 2006

1. Introduction

1.1 The Energy Performance of Buildings Directive

In January 2003, the European Union introduced the Energy Performance of Buildings Directive (EPBD), to be incorporated into the national legislation of Member States by 4th January 2006. The European Commission has stated that the Directive (2002/91/EC) 'will ensure that building standards across Europe place a high emphasis on minimising energy consumption. This will reduce the use of energy in buildings across Europe, without requiring huge additional expenditure, whilst at the same time perceptibly increasing comfort for users'[1].

A paper prepared by the European Commission[2] gives some background to the Directive. It describes the Directive as 'a very important legislative component of energy efficiency activities of the European Union (the then EU 15 Member States) designed to meet the Kyoto commitment (which) responds to issues raised in the recent debate on the Green Paper on energy supply security'. The paper quotes estimates projecting a potential realisable cost saving of 22% by 2010 in terms of the energy consumption of buildings in the EU – this would meet approximately 20% of the EU's commitment under the Kyoto Protocol. It notes, for example, an estimate that some 10 million boilers in EU residential buildings are more than 20 years old, and indicates that replacing these older boilers would save 5% of the heating energy expended in the EU[1].

The EPBD sets out a number of requirements for Member States, of which Article 8 ('Inspection of Boilers') is one. In July 2004, Ireland's energy authority, Sustainable Energy Ireland (SEI), decided to commission a review of the options for meeting the requirements of Article 8 in Ireland. Following a tendering process, a consulting team led by the National Irish Centre for Energy Rating (NICER) was chosen to undertake this review. A kick-off meeting between the consultants and SEI was held on 22 September 2004, with project research undertaken during October and November 2004, and this study report submitted to the SEI in December 2004.

1.2 Article 8 – Text and Interpretation

1.2.1 Text of Article 8

Article 8 of the EPBD states:

[1] European Commission (2003), *Better Buildings – New European Legislation to Save Energy*, available at http://europa.eu.int/comm/dgs/energy_transport/index_en.html
[2] Bowie R. and Jahn A. (2003), *European Union – The new Directive on the energy performance of buildings – Moving closer to Kyoto*, also available at above web address

‘With regard to reducing energy consumption and limiting carbon dioxide emissions, Member States shall either:

(a) Lay down the necessary measures to establish a regular inspection of boilers fired by non-renewable liquid or solid fuel of an effective rated output of 20kW to 100kW. Such inspection may also be applied to boilers using other fuels.

Boilers of an effective rated output of more than 100kW shall be inspected at least every two years. For gas boilers, this period may be extended to four years.

For heating installations with boilers of an effective rated output of more than 20kW that are older than 15 years, Member States shall lay down the necessary measures to establish a one-off inspection of the whole heating installation. On the basis of this inspection, which shall include an assessment of the boiler efficiency and the boiler sizing compared to the heating requirements of the building, the experts shall provide advice to the users on the replacement of the boilers, other modifications to the heating system and on alternative solutions; or

(b) Take steps to ensure the provision of advice to the users on the replacement of boilers, other modifications to the heating system and on alternative solutions, which may include inspections to assess the efficiency and appropriate size of the boiler. The overall impact of this approach should be broadly equivalent to that arising from the provisions set out in (a). Member States that choose this option shall submit a report on the equivalence of their approach to the Commission every two years.’

The Article therefore gives two broad routes to each Member State as regards implementation of Article 8 of the Directive: inspection or the provision of advice.

1.2.2 Interpretation of Article 8

There are some ambiguities in relation to (a) the precise remit of Article 8 of the EPBD and (b) in relation to specific words and terms used. Some of the ambiguities required the formation of working assumptions for the purposes of this study.

(a) Clarification of the Remit of Article 8

- Does Article 8 cover industrial boilers? Given that the title of the Directive refers to ‘buildings’, it is assumed that boilers for manufacturing and industrial processes (including the generation of electricity) do not fall under Article 8 (or under the Directive).

- Is there an upper size limit to the boilers covered by Article 8? The article sets no upper limit of output size.
- Boilers fired by which types of fuel are covered by the Directive? This study assumes that Article 8 applies to oil-fired and solid fuel boilers, subject to specified output and age classifications. It also applies to gas boilers that are (i) over 100kW or (ii) between 20 and 100 kW and over 15 years old.

(b) Working Assumptions required, definition of

– the term 'Regular'

Option (a) of Article 8 states that Member States shall 'lay down the necessary measures to establish a regular inspection of boilers fired by non-renewable or solid fuel …' It does not define either the word 'regular' or the word 'inspection'. These definitions are important not just if Option (a) is chosen as the preferred option, but also if Option (b) is chosen, as a Member State must subsequently demonstrate the broad equivalence of Option (b) to Option (a).

What does 'regular' mean? As the text subsequently advises that two years is the *maximum* inspection interval for oil and solid fuel boilers over 100kW, it would seem unlikely that a maximum interval of *less* than that would be envisaged for smaller, generally less polluting, boilers. Four years is the maximum quoted for *gas boilers* > 100kW.

- the term 'Inspection'

What is covered by the word 'inspection? Taken literally, an inspection does not explicitly incorporate *any* subsequent reporting of findings (verbal or written), or any consequent actions taken (e.g. boiler cleaned, re-set etc.). We develop this further in Section 4.2, and frame a working definition of 'inspection'.

- ***the term 'Broadly Equivalent' (equivalent to what? – CO_2 abatement, cost, or other parameter?)***

Article 8 states that, where Option (b) is the one preferred by a Member State to implement it "The overall impact of this approach should be broadly equivalent to that arising from the provisions as set out in (a)".

First, one needs to decide under what parameter(s) such equivalence should be assessed. - Given that the aim of Article 8 is to reduce energy consumption and limit carbon dioxide emissions, it is considered reasonable to calculate the likely reduction of CO_2 emissions achieved, expressed in tonnes per year.

Second, does the word ‘broadly’ imply a margin of error? If Option (b) achieves a slightly higher or a slightly lower impact than Option (a), then it could still count as being ‘broadly equivalent’. Where does one draw the line for this margin of error, i.e. at what point does the effect become not ‘broadly equivalent ‘ but actually different? Is it at 90% of the effect of Option (a)? - Or at 80%? For the purposes of this study, bearing in mind the difficulty of making accurate measurements, a cut-off point of 80% of the effect of Option (a) was used.

- the term 'Efficiency'

Any reference to “boiler efficiency” is to the Seasonal Efficiency of that boiler based on the Gross (or ‘Higher’) Calorific Value (GCV) of the fuel. This is the best representation of the heating season, as it includes the less efficient frequent start/stops and the warmer temperatures of the earlier and later parts of the heating season, as well as those times when the boiler operates most efficiently, on full load. Efficiency figures based only on boilers working ‘flat out’ on full load, the ‘spot’ figures that might be more popular with boiler suppliers, would not be as suitable for this examination.

- ***the term ‘in an independent manner’***

Inspection and servicing proved to be almost synonymous in the eyes of the public and of service operatives (see discussions in 3.1 and 4.2). We don’t suggest seeking ‘independence’ between those roles: caution may however be advisable when receiving advice from someone who profits more out of equipment sales than servicing.

1.3 Terms of Reference, Approach and Methodology

1.3.1 Terms of Reference

SEI’s Terms of Reference for this study stipulate an assessment of Options (a) and (b) of Article 8 and, for each, to set out the:

- ***“Practicability”,*** i.e. practical and logistical impacts, training, certification, administration and reporting issues involved; and the
- ***“Value-added”,*** i.e. costs, benefits and opportunities – relative to prevailing market practice without such intervention.

Account is to be taken of existing servicing, inspection and documentation procedures applicable to boiler installations in Ireland. The Terms of Reference also request that the study adhere to an objective assessment of the pros and cons associated with both options against the criteria listed, and avoid giving specific advice as to which option should be chosen in Ireland.

The report should provide details of any further work considered to be necessary or desirable in this area.

1.3.2 Approach

In undertaking the study, the general approach used by NICER involved a number of steps.

Firstly, we researched the size of the Irish market for boilers was researched and, in particular, an attempt was made to identify the number of boilers with a rated output of 20kW or more. The year 2005 was taken as the year on which to base our data estimates, as the EPBD is to be implemented from 2006 to 2009. This involved a combination of identifying historical market data and understanding and extrapolating current trends. Where possible, the overall boiler population was broken down by type of fuel used, by size and by age (in particular to try to identify how many boilers would be over 15 years of age in 2006).

The data presented relating to the domestic sector is considered to be robust, probably accurate to 5 - 10%. Data relating to the commercial sector (which has a much smaller number of boilers, but, as will be shown, with considerably higher energy consumption per individual boiler than has the domestic sector) is less robust: there is no readily available data on this sector, and the market is both fragmented and diffuse. The commercial sector data has been built on industry-informed assumptions, to which extrapolations have been applied. When derived in this way, and crosschecked where possible, the data presented is considered likely to be within a 20% margin of error.

Outline of the structure of this report

Section 2
Section 2 presents estimates of boiler size and a breakdown of the boiler population by user sector, fuel used and age.

Section 3
Section 3 reviews a number of other facets to the introduction of Article 8 of the EPBD in Ireland. It is largely based on interviews with representatives of the industry in Ireland (including manufacturers, service technicians and fuel suppliers). These facets, together with the baseline data, help form the assessments of the practicability and value-added of possible intervention scenarios that are explored in Sections 4 and 5.
Section 3 also provides a summary of the approach to Article 8 of the EPBD being adopted by three other EU Member States. As the research was undertaken in Autumn 2004, and the EPBD does not have to be transposed into national legislation until 4th January 2006, not all of these countries had

definitively decided on their approach, but were developing a framework to implement the Article.

Section 4
Section examines the requirements of the Option (a) approach, and the possible interpretations of its requirements, that it sees as generally divided into three distinct “Measures”, 1,2 and 3. The considerations for defining the interpretations are discussed, and it is decided that the Measures should be examined by means of “Scenarios” ranging from lower cost and effect to robust.

Section 5
Section 5 discusses the Option (a) Measures, each in turn, and in variations or Scenarios where relevant. This includes estimates of potential reductions of CO_2 emissions, associated costs and estimates of the number and skills of personnel required to implement each scenario.

Section 6
In Section 5, the parameters of the Option (b) approach are and their possible equivalence to Option (a) is considered.

Section 7
Section 7 examines the Measures in an Option (b) approach. First, it tries to map equivalence insofar as possible to the same measures and their Scenarios in Option A). Next it sets out some possible ways of achieving equivalence with Option (a)

Section 8
Section 8 sets out ideas arising through the trawl of the industry and the thoughts of the study team, as to other measures of merit, perhaps not directly Article 8 specific, but that could lead to CO_2 reduction and better information and management of CO_2 in the boiler sector. It starts by outlining a possible new Measure, Measure 4, that could offer important savings.

Section 9
Section 6 summarises the research findings, and the pros and cons associated with the scenarios examined in Sections 4 and 5. It also briefly describes some supplementary approaches and procedures that might improve the benefits of either Options (a) or (b).

Section 10
Section 10 is a summary of the key findings of the study.

In relation to terminology, the report uses the terms boiler installation, boiler commissioning and boiler servicing, which are defined as:

- *Installation* is the physical procedure of putting the boiler in place and connecting it to its associated water pipes, controls and electric power;
- *Commissioning* is the immediate follow-on from installation. It involves checking all system features to make sure they work and are safe, and then inspecting the boiler, adjusting baffles as necessary, firing the boiler, adjusting combustion conditions and making other required adjustments;
- *Servicing* is similar to commissioning except there is usually little attention to the system, unless there is some problem associated with it. Nozzles will be replaced, the unit will be thoroughly cleaned, any defective parts will be replaced and the boiler will then be fired up and adjusted by means of combustion test equipment.

1.3.3. Methodology

To implement the above approach, the study was based on a number of work modules, as set out below. Elements of these modules fed into different stages of the study (and Sections of this report).

(a) Secondary information was reviewed, in particular with a view to characterising the population of boilers. This included a review of relevant Irish housing and energy statistics and materials produced by manufacturers on their products. Specific sources are cited in Section 2.

(b) Face-to-face interviews were held with several leading Irish boiler manufacturers and importers, including: Grant Engineering Ltd.; Firebird; Gerkros; Waterford Stanley; Taney Distributors; Potterton Myson; C&F Quadrant; Heatmerchants; and Davies Ltd. These contacts provided data and confirmed the main assumptions adopted for this study. Some of these were consulted by frequent subsequent telephone calls.

(c) Face-to-face meetings were held with a number of other industry experts and sources, including Bórd Gáis Éireann, Allianz Insurance, FÁS and the Dublin Institute of Technology.

(d) Follow-up telephone conversations were conducted with most of the above organisations to clarify and expand upon significant arising.

(e) To obtain information on current boiler service practices, a postal survey was undertaken of 205 boiler servicing personnel or inspectors (56 completed questionnaires were returned, of which 50 were usable[3]). A copy of this questionnaire is attached as Annex B to this report. Nine[4] of these respondents were further interviewed by telephone.

(f) The research on the approaches being adopted in other Member States was conducted firstly on the Internet, with subsequent telephone interviews with

[3] All 56 were however used to extrapolate numbers employed
[4] Principally to find information and data relating to the commercial sector

the person responsible for the implementation of Article 8. The research modules, and the project analysis, were conducted closely with Sustainable Energy Ireland.

2. Estimating the Boiler Population in Ireland

2.1 Assumptions in Estimating the Boiler Population

This section provides information on the boiler population in Ireland and on the boiler population to which Article 8 applies. The total boiler population is derived from estimates of the residential and commercial[5] boiler populations. Estimated breakdowns by size, by fuel and by age are then provided.

Some assumptions, established by research for the study, used in these procedures include:

- Domestic boilers range from 10 to 40kW rated outputs. Many commercial boilers would also fall in that range.
- Solid fuel back boilers have an output <20kW
- 80% of solid fuel ranges have an output <20kW
- (All) Boilers of over 40kW rated output are classified as Commercial
- 85% of oil boilers are of over 20kW rated output
- 80% of gas boilers are of under 20kW rated output
- Ref. Table 4, domestic LPG use is about 13% of that of natural gas, the vast bulk of this is cooking, also gas-effect fires. The number of LPG-fired boilers of over 20kW rated output is thus likely to be very low, so they are considered included with (natural) gas boilers and do not receive any separate attention.

2.2 The Domestic Boiler Population

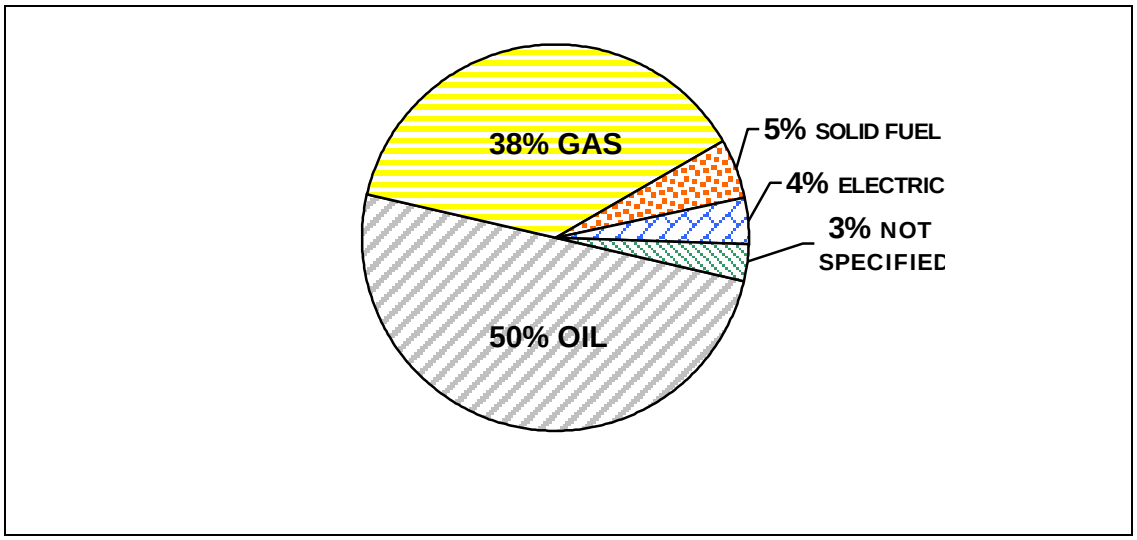
The overall number of housing units with central heating[6] in 2002 was 1.08m, 90% of the national housing stock. With the addition of 68,800 new housing units in 2003[7] and using projected numbers for completions in 2004 and 2005, the number of housing units with central heating[8] at the end of 2005 will be of the order of 1.3m. These centrally heated houses were broken down by fuel type

[5] Commercial boilers relate to non-residential, non-industrial premises. It includes offices, schools, churches, shops, halls, hospitals and nursing homes, hotels, sports and recreational facilities – in the public and private sectors. This is sometimes also called the 'tertiary' sector.
[6] Central Statistics Office, Census 2002, Volume 13 – Housing.
[7] Dept. of Environment, Housing Statistics Bulletin, Quarter 1, 2004.
[8] This assumes all new homes have central heating of some type.

based on the Irish National Survey of Housing Quality[9] and on data supplied by Bórd Gáis Éireann.[10]

In interpreting and extrapolating the data, it is assumed that all homes with gas- and oil- fired central heating have boilers. Industry sources estimated that no more than 20% of solid fuel boilers have outputs of more than 20 kW. They also indicated that most solid fuel boilers/ranges sold in the past 15 years have been dual-fuel-ready, i.e. oil-fired/solid fuel or gas-fired/solid fuel. As dual-fuel appliances may be expected to virtually always use the fuel of convenience, these boilers have been apportioned to oil and gas, as per the manufacturers' estimates. Based on manufacturer and service personnel interviews, it is concluded that the 10% of appliances actually using solid fuel are almost exclusively open-fire back boilers or ranges over 15 years old and are also almost all below 20kW output. Service technicians in particular confirm that use of solid fuel above 20kW is confined to relatively small numbers of farmers burning wood, and that oil-vapourising burners, popular in stoves, have a 10-12 kW output.

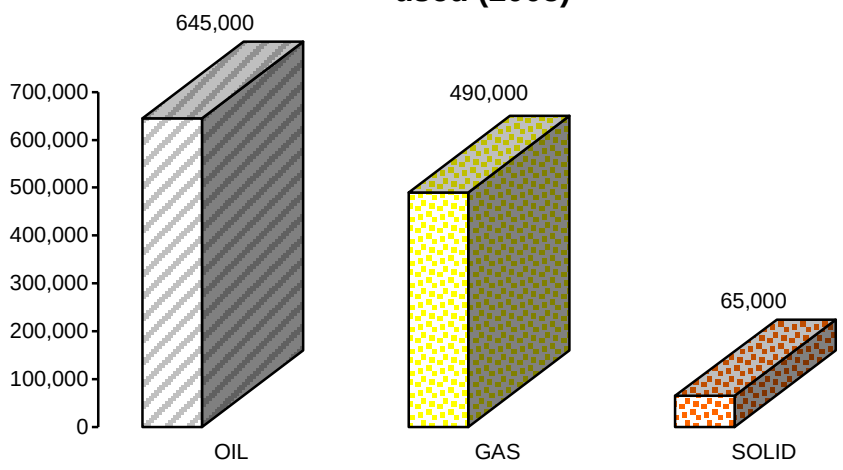
Figure 1: Estimated Domestic Boiler Population, % share by fuel used (2005)



The absolute numbers underlying Figure 1 are shown in Table 1, below, which represent only the domestic boilers relevant to Article 8 (therefore not including electric boilers, storage heating and other unspecified heating generators and systems).

[9] Watson D. and Williams J., Chapter 6, "Heating the accommodation", Irish National Survey of Housing Quality, 2001-2002 ESRI, November 2003
[10] Unpublished BGE data supplied to study team

Figure 2: Estimated Domestic Boiler Population, by fuel used (2005)



2.3 The Commercial Boiler Population

Information on commercial boiler sales is less comprehensive than that for the smaller domestic boilers. This is due partly to the fact that commercial boilers vary in size up to 1MW and are sold by many agents. Also, as no boilers over 90kW are manufactured in Ireland, primary data is difficult to obtain.

The commercial boiler population data is drawn from a variety of sources including: Sustainable Energy Ireland; boiler importers/suppliers; the Departments of Health and Children, Education and Science and Environment, Heritage and Local Government; the Irish Hotels Federation, Fáilte Ireland, the Office of Public Works and fuel suppliers. For the purpose of this study, we define as "Commercial" all boilers used in non-domestic premises (this includes public buildings), excluding those used in industrial manufacturing processes[11]. The education, health, hospitality and public administration sectors were examined individually, as the largest users of such space-heating boilers.

The total number of oil- or gas- heated commercial premises[12], not including home offices or industrial manufacturing concerns, is of the order of 56,000. Some 18,000 are natural gas users, all of them in 'the gas (-served) areas'. The balance of 38,000 commercial premises is split between oil, LPG, and electric heating (and a very small number of solid fuel heated premises), the vast majority of these being oil.

[11] Boilers that provide space-heating and normal hot water mainly for personal use are included, boilers with primary purpose to provide process heat or steam, with a secondary role of space heating and hot water, are excluded.
[12] Unpublished BGE data supplied to study team

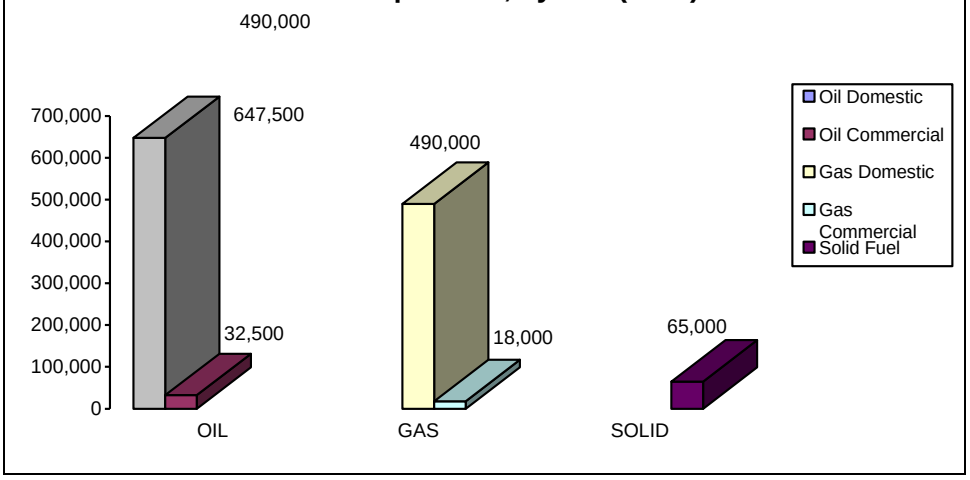
A second and accuracy-checking approach to quantifying commercial boiler numbers starts from the fact that the 2003 breakdown of fossil fuel usage for commercial premises was 70% oil and 30% gas (inc. LPG)[13]. By extrapolation, if 18,000 commercial natural gas users consume 30%, that suggests a further 42,000 (70%) consume oil, giving a total of 60,000 commercial premises burning fossil fuels alone, rather than the 56,000 indicated above (and that includes electricity and LPG users). It is our view that the penetration of gas for commercial heating in gas-supplied areas is greater than that of oil in other, non-gas areas[14]. This suggests the numbers of oil boilers will be overestimated by direct gas extrapolation. The number of commercial premises may be further reduced by 5% to exclude electrically heated premises, bringing the total down to 53,200. Then, subtracting the gas users, this leaves 35,200 oil users.
(A third, rougher and less reliable crosscheck is to hypothesise that the gas/oil ratio of the domestic sector applies also to commercial. This ratio, 645,000: 490,000 boilers, or 57:43, results in 24,000 commercial oil users outside the gas area. Many large fuel users have multiple boilers per site/premises, and there are undoubtedly some oil boilers within the gas area, so the number of oil boilers must be a minimum of 24,000).

Based on the three different approaches, estimates of 18,000 natural gas and 35,200 oil boilers are used.

2.4 Total Boiler Population

The total relevant boiler population is the combined total of domestic and commercial market boilers. The total boiler population (rounded to nearest 5,000) relevant to Article 8 of the EPBD is shown in Figure 3 below.

Figure 3: Estimated Total (Domestic and commercial) Boiler Population, by fuel (2005)



[13] Statistics unit, Department of Communications, Marine and Natural Resources

[14] Because gas boilers are available in smaller sizes than oil boilers, gas likely takes a larger share in gas areas than oil in non-gas areas; smaller oil boilers suggest more of them in relation to fuel usage

2.5 Breakdown of Total Boiler Population by Size

To determine the split of boiler sales by size, we largely used sales data provided by boiler manufacturers/suppliers, informed by our consultations with expert industry informants. These contacts provided data and confirmed the main assumptions adopted for this study. The number of boilers of more than 40kW rated output is derived primarily from supplier sales data and by reference to the total number of commercial customers. In the case of gas, the numbers are taken from Bórd Gáis Éireann, and in the case of oil, crosschecked with the industry team of SEI.

It is considered that any boiler using 50,000kWh or more per year is very likely to have a rated output of more than 20kW. This assumption was applied to the gas sector, where consumption figures are available: from this we can say that 4,100 (23%) of the gas boilers[11] in the commercial sector are over 20kW in size. For oil, however, where consumption figures are not as readily available[15] as for gas, manufacturers' records and estimates of the size breakdown of their sales were used. This led to the estimate that 30,000 of the 35,200 in use are over 20kW, with the observation that, based on the arguments above, this figure may be on the high side.

Table 1 shows that approx. 700,000 boilers fall under the terms of Article 8 of the EPBD. Over 80% of these are oil boilers, reflecting the strong historic market share of oil boilers and the fact that most of these boilers in Ireland fall within the 20-30kW range.

Table 1: Estimated Total Boiler Population (Domestic and Commercial), by Size (2005)[16]

Fuel	Total (All sizes)	Under 20kW	20-40 kW	40-100 kW	Over 100 kW	Total > 20 kW
Oil	677,500	97,500	575,000	3,500	1,500	580,000
Gas	508,000	408,000	97,000	2,000	1,000	100,000
Solid Fuel	65,000	52,000	13,000	NIL	NIL	13,000
Total	1,250,000	557,500	685,000	5,500	2,500	693,000

Note: Annexe A contains explains with an example greater detail of the deduction of the gas figures above.

2.6 Boiler Population over 20kW, by Fuel and Age

[15] For natural gas there has been only one supplier, but oil may be purchased from any of some 400 distributors, and buyers do not necessarily buy from one supplier only.

[16] Source: Data provided by boiler manufacturers and interviews with industry experts. Refer also to the assumptions in 2.1

Article 8 specifically targets heating systems with boilers over 15 years old as they may be expected to be the least efficient and to emit the most CO_2.

Based on manufacturers' estimates of boiler sales for each fuel type and natural attrition rates, we can estimate the age profile of the boiler population less than 15 years old. Statistics regarding the total numbers of boilers in use for various fuels in 1991 will, when replacement units are deducted, give a better picture of the year 2005 total number of boilers over 15 years old.

The aggregate boiler sales figures for the 15 year period (1991 to 2005 inclusive) must be further broken down on the basis of new and replacement boilers, from which may be inferred the number of boilers over 15 years old still in use. Suppliers' and installers' estimates of the split between new and replacement sales/installations are relied on for this breakdown.

The determination of the boiler population over 15 years is made on the basis of the original boiler stock in 1991, plus the total boiler sales in the interim, less the estimated 2005 boiler population, making allowance for attrition.
The resulting estimate of the age profile of boilers exceeding 20kW rated capacity is shown in Table 2. An estimated 93,500 boilers fall into the specifically targeted > 15 years old and > 20kW rated output category.

Table 2: Estimated total boiler population by age, domestic and commercial, that is over 20kW rated output (2005)[17]

Fuel	Total by Fuel	Aged 0 - 5 Years	Aged 5-10 Years	Aged 10-15 Years	Aged over 15 Years
Oil	580,000	195,000	175,000	125,000	85,000
Gas	100,000	45,000	30,000	20,000	5,000
Solid	13,000	2,500	3,000	4,000	3,500
Total by Age	693,000	242,500	208,000	149,000	93,500

To assess the attrition numbers, i.e. boilers being permanently scrapped or retired, it is assumed that the replacement of boilers less than 15 years old, together with the phenomenon of fuel-to-fuel replacement (e.g. oil to gas) are the main influences. Bórd Gáis provided estimates for the numbers of oil to gas replacements during the past 15 years. Waterford Stanley provided estimates for the other main replacement market, i.e. from solid fuel to oil or gas.

On the basis that over 90,000 oil and solid fuel boilers are aged over 15 years, there are grounds for considering that the impact of a once-off system of inspection, if it led to upgrade or replacement, could be environmentally significant. Accordingly, this option is explored in Section 4.7.

[17] Source: Data provided by boiler manufacturers and interviews with industry experts.

2.7 Commercial and Residential sectoral Fuel Usage

Article 8 of the EPBD discusses fuel used by boilers only in terms of oil and gas. The CO_2 emissions associated with burning various fuels are shown below: gas-oil and kerosene are very close, but gas-oil burns 'dirty', producing far more soot, dirtying the boiler, reducing its efficiency and thereby requiring an ever - increasing amount of oil to produce the same amount of heat. Further detail of the type of oil used is therefore important in assessing CO_2 emissions in Ireland.

Table 3 CO_2 emissions from fuels used to fire boilers in Ireland[18]

Fuel	gm. CO_2 per kWh produced
Gas-oil ("diesel")	263.9
Kerosene	257
LPG (liquid petroleum gas)	229.3. less than 2% of total boiler fuels
Natural Gas "NG"	197.8
Solid fuels: Turf Wood	Still widely used in some areas, but outputs very small, <20kW, scarcely really 'boilers' A small number of units > 20kW exist, but considered renewable, with 0 CO_2

This factor, the use of two differing grades of oil for boilers in Ireland (as in the UK), is different to that in mainland Europe. Kerosene[19] is the main domestic heating oil used in Ireland, and gas-oil is the main source for commercial heating (some kerosene is probably used in smaller commercial installations). The switch from gas-oil to Kerosene has been dramatic: kerosene accounted for 74% of domestic heating oil in 2003 against only 37% in 1993. This trend continues, as virtually all domestic oil boilers now sold are kerosene-fired[20]. Mainland Europe uses gas-oil exclusively for both the domestic and commercial sectors, while the UK oil-burning sector is similar to that of Ireland.

Table 4 shows that:

- Commercial sector oil use is approximately 80% of the residential figure; and
- The commercial sector mainly burns heavier fuels[21].

[18] "Emissions", www.sei.ie

[19] Kerosene is a very slightly 'more refined' product than gas-oil. Whitegate began production of it about 1993. It has a lower viscosity (2.0 cSt or 28 second) than gas-oil (3.0 cSt or 35 second) and is almost clear in colour. It burns cleaner than, and causes virtually no 'sooting' compared to gas-oil, in a properly commissioned boiler. It can be used in indoor-mounted boilers, unlike gas-oil, so waste heat is minimized and space maximized.

[20] SEI's expanded Energy Balance 2004 shows kerosene at 76.4%: 80% is assumed for end 2005.

[21] In general, the heavier the grade of oil (i.e. the higher its viscosity), the less cleanly it burns and the cheaper it is.

Table 4: Oil breakdown by grade used and by sector, ktoe (2003)[19]					
Category	Fuel oil	Light oil	Gas oil	Kerosene	Total
Residential	-	-	321	710	1031
Commercial	3	224	571	-	809

The two points above show that the commercial sector is a significant user of the heavier and more polluting grades of oil (the heavier the oil, the more difficult it is to burn and the more the burning equipment needs cleaning). However, this has little influence on the CO_2 emissions only.

Two further observations are to be noted here, the first relating to the relative weightings of the commercial v. domestic sectors and the second to the baseline inspection and maintenance practices applying to them in Ireland. Both are important inputs to the scenario explorations of Sections 4 and 5.

Firstly, when the data for 2003 in Table 4 is compared to the number of boilers shown in Table 1, adjusted to 2003, it indicates that the average annual oil consumption per commercial oil boiler (at 30,302 litres or 313,600 kWh) is 14-15 times that of the average domestic boiler (at 2,032 litres or 21,000 kWh). This weighting needs to be taken into account in assessing the comparative impacts of any measures taken in the scenarios explored in Sections 4 and 5.

Secondly, the questionnaire to service technicians (see Section 3.3) indicates that they spend some 15% of their time servicing commercial boilers, which account for 7% of boilers over 20kW. As the larger commercial boilers (all of those burning light fuel oil and many of those burning gas-oil) are normally serviced by specialist maintenance companies (not covered by the survey), perhaps 20% or more of total service time is spent on servicing commercial boilers, although they represent less than 5% of total boilers (including those less than 20 kW). This is consistent with the further survey finding that commercial boilers are serviced far more frequently than domestic boilers. It suggests that regular inspection of many commercial boilers already takes place in Ireland.

The average annual fuel consumption per domestic oil boiler above supports the view that many such domestic boilers in Ireland might not require a service (and could not justify one on a cost/return basis) more frequently than at three-year intervals. This interval may fall if per-household consumption of oil rises gradually as the country becomes better off. To place this consumption in another context, it would drive a car, averaging 40 mpg on diesel, about 30,000km (19,000 miles) per year.

Table 5 shows the comparative national consumption of natural gas and LPG in the residential commercial sectors in 2003.

Table 5: Natural gas and LPG breakdown by sector, ktoe (2003)[22]			
Category	Natural gas	LPG	Total
Residential	539	71	610
Commercial	303	11	314

When considered with the number of boilers shown in Table 1, this indicates that the average consumption of the commercial gas boiler, at 214,800 kWh, is almost 15 times that of the residential gas boiler, at 14,600 kWh, a result consistent with that found for oil.

For both commercial and residential, the average gas boiler usage is significantly lower than the average for oil. One might suspect that this arises out of the over-estimation of gas boiler numbers. That data is, however, considered robust, so such explanation is very unlikely.

The more likely, and intuitively acceptable, explanation is:
Higher efficiency due younger age – the gas boiler population, commencing less than 20 years ago with most installed in the more recent years, is younger than oil, and would therefore have a higher average efficiency.
Serving more efficient buildings –gas boilers are, on average, installed proportionately more in newer buildings: these buildings benefit from increasingly improved thermal performances prescribed by successive versions of the Building Regulations from the early 1980's on, and so require less heating than average.
Size and type of premises served – gas serves proportionately more urban buildings than does oil: these are on average smaller, with more of terraced and semi-detached, than the oil-served sector, which also serves far more single houses and bungalows.

To conclude this Section, based on their

- Per unit fuel consumption
- Overall population
- Higher average efficiencies
- Lower loss of efficiency with prolonged use

the potential for Article 8 to impact on energy savings and CO_2 abatement is far more dependent on any measures taken for oil or solid fuel boilers than for gas boilers. This is indeed implicit in the wording of the article itself. Accordingly, the exploration of scenarios in Sections 4 and 5 focuses mainly on oil boilers. No particular account is taken of the 13,000 solid-fuel boilers of over 20 kW output thought to be in use. Their importance is thought to be small, diminishing and not to merit specific targeting, due to a combination of:

- Relatively small numbers

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- Inexorably declining numbers due to the march towards greater convenience
- An unknown and probably high proportion of them use renewable biomass (according to boiler service personnel)
- Difficulty in targeting them

3. Context for Implementing EPBD Article 8 in Ireland

3.1 The Energy and CO2 Significance of buildings

1. Energy use in residential and commercial/public sector buildings in Ireland in 2003 represented approximately 44% of national energy demand, composed of 26% by housing and 18% by non-residential buildings.

2. Applying retail prices for the last quarter of 2004 to the above, expenditure on energy in buildings in Ireland today exceeds a total of €3.4 billion (€1.9 billion in housing, €1.5 billion non-residential). In the context of EPBD Article 8, it should be noted that less than half of this expenditure is accounted for by fuel, electricity comprising the larger part.

3. Energy use in the building sector, residential and commercial, was responsible for almost 20 million tonnes of CO2 in 2003. Direct emissions from fuel combustion in domestic and commercial boilers accounted for over 9 million tonnes of this.

4. The impacts of the interventions set out in Article 8 will be considered.

3.2 Regulatory and Institutional Landscape relevant to Article 8

3.2.1 Regulation

There are no mandatory standards or regulations with regard to boiler inspection in Ireland. For performance, however, EU Directive EC 92/42 has been implemented. It sets out the minimum performance criteria for new hot water boilers fired on liquid or gas and was implemented in Ireland through Statutory Instruments (S.I. no. 260 of 1994 and no. 72 of 1995) referencing Irish Standard IS EN 304 (1993) for oil boilers and IS EN 297 (1994) for gas boilers of less than 70kW input. The type of boiler sold changed from cast-iron shell to higher efficiency and then to further improvements in efficiencies driven by the Directive, so that manufacturers say that the average efficiency improved at least 25% between the late 1980's and the late 1990's. The Directive applied only to new boilers, so that the improved efficiencies are reflected in the boiler population on

a gradual basis. Present-day boilers are generally far more efficient than those over 15 years old[23]. Assumptions of efficiencies based on age are included in the scenario explorations.

A set of guidance notes on boiler inspection (other than by the manufacturer) is included in IS EN 12953 (2000) but this applies to large shell boilers only. The Building Regulations (2002) – Part L and Technical Guidance Document L, is concerned with Energy Conservation, mainly as Building Design and Construction affect it. Part J and Technical Guidance Document J in turn relate to Heat Producing Appliances, and includes flueing and other safety provisions, but makes no reference to the inspection or performance of boilers with respect to energy efficiency.

There are no regulations in Ireland governing the qualifications of personnel engaged in boiler installation and servicing. While various bodies such as Bórd Gáis Éireann (BGE) and OFTEC[24] operate registration schemes and promote good practice, there is no restriction on who may install or service a gas, oil or solid fuel boiler (except that some control is exercised by BGE in that it requires any installations carried out by non-authorised installers to be subject to a safety inspection at a cost of €100). In recent (end-2004) discussions on new legislation for the gas market, the Commission for Energy Regulation is suggesting that only 'competent persons' (to be defined) would be permitted to work on gas installations. If such a measure was implemented, it is intended that it be overseen by an independent body (this would relate only to gas, i.e. not to oil or solid fuel boilers). Article 10 of the EPBD requires that "Member States shall ensure that the…inspection of boilers are carried out in an independent manner by qualified and/or accredited experts". One could debate the nuances of 'independent', but, at the very least it would appear to mean that inspectors should not have any commercial interest in sale and installation: as we shall see later when we examine the numbers of inspectors required, that would increase the number of new recruits required for inspection.

Further, while it is not yet a legal provision, it is to be noted that Article 7 of the EPBD requires the assessment and reporting of the energy performance of buildings (both new and 'second-hand') when they are put on the market for sale or rent. This assessment in turn requires an assessment of the efficiency of the boiler and heating system, to be based either on their specification or a survey - i.e. inspection. The requirements of Articles 7 and 8 may thus overlap at times, and this should be taken into account to avoid cost duplication.

Most of the information mentioned above is not directly connected to the EPBD, but it sets the context in which it will be implemented in relation to boilers, and may help provide elements of 'enabling infrastructure' for the options facing Ireland in implementing Article 8 of the EPBD.

[23] See explanatory note on boiler efficiencies, page 22
[24] OFTEC – Oil Firing Technical Association

3.2.2 Training

The number of Boiler Service Technicians listed in the Golden Pages runs to some 260 nationwide. Approximately 10% of the listings are companies and according to the survey findings (see P.18), they employ on average five technicians each. This would give a total number of practicing technicians (relating to oil and gas) of approximately 350. Based on the estimates below of the numbers of apprentices graduating annually, it is concluded that many people qualified to perform boiler servicing choose to do other work, particularly installation that enjoys higher demand and pay at present.
Training courses for installers and service agents, to provide the necessary skills to standards recognised by FETAC[25], are available through the Institutes of Technology, FÁS and Bórd Gáis but these are limited in capacity, particularly in gas installation and servicing. A private sector training company also established a presence in Dublin in 2004 and Bórd Gáis Éireann and FÁS were working with this company in Autumn 2004 to reduce waiting lists of people seeking Gas Installer Domestic (GID) training, and to provide oil boiler commissioning and servicing courses.

The cost of the training courses ranges from €900 to €1,500, depending on whether they are delivered by public or private sector training bodies.

Figure 4: Note on Gas and Non-Gas Areas in Ireland
Ireland may be divided into 'gas', where piped Natural Gas is available, shown by the blue lines on the map, and 'non-gas, fuel supply areas. In the gas area, almost all new heating installations since the early 1990s use gas, and gas- has frequently replaced oil-fired boilers. A consequence of this is a need for more gas- and fewer oil- service technicians in that area.

[25] FETAC – "Further Education and Training Awards Council"

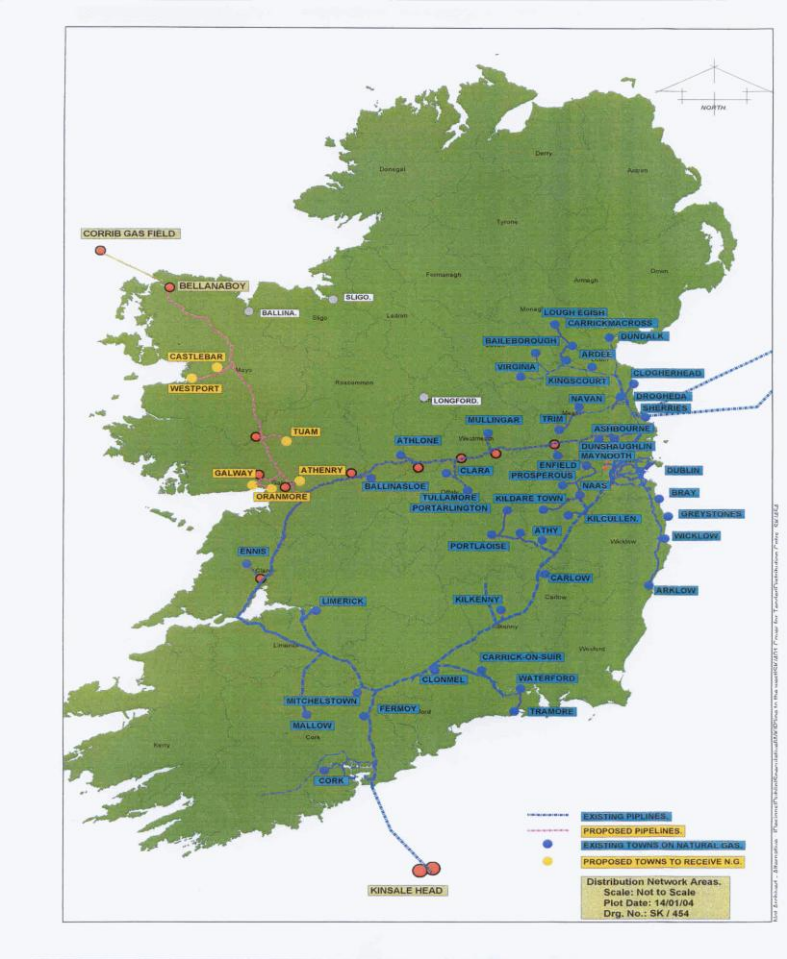


Figure 4. Map of the Republic of Ireland showing main natural gas lines in blue

Standards governing installation of gas boilers have been drawn up by the National Standards Authority of Ireland (Gas Technical Standards Committee 2) and their implementation by the Gas Regulator awaits the passing of legislation.

Gas technicians

The current situation in training of gas installers and service agents is as follows:

- Bórd Gáis training facilities can handle one course for 10 people every six weeks or 100/year due to other training commitments to the gas industry.
- FÁS have a facility in Cork for training 100 gas installers yearly to the new GID (Gas Installer Domestic) standard.
- FÁS intend to provide a similar capacity for GID training at their renovated centre in Ballymun.
- ERS currently has capacity for 150 per annum for GID training.
- Bórd Gáis operates a panel of 50 trained gas boiler service agents.

- Some 260 gas operatives are currently seeking GID training.

Oil technicians

Training for oil boiler service technicians is less well structured than in the gas servicing area. Several reasons are put forward for this. Chief among these are the lack of any single body with influence, equivalent to Bórd Gáis in the gas sector. A further reason may be that the courses of training required for oil boiler commissioning and servicing which boiler manufacturers generally accept are designed by OFTEC and these are seen by some in the field as having relatively low market recognition in Ireland.

The Institutes of Technology, particularly those in Dublin and Cork, have integrated Oil Boiler Servicing modules in the senior cycle of their plumbing apprenticeship courses. Over 600 apprentices graduate annually from the institutes and this should provide a good supply of labour in the oil boiler-servicing field, albeit that refresher courses would be essential.

This issue is now being addressed to some degree at least by the co-operation of FÁS in running the OFTEC 101 and 105 courses. Capacity in oil boiler service training is limited to FÁS in Cork at present and would need to increase in the event of a mandatory inspection regime being implemented. In the event of ongoing demand, and the absence of barriers to new players, private sector supply of training would be expected to emerge.

3.2.3 Other Institutional Capacity

While capacity for the measurement and monitoring of the effectiveness of inspection and servicing of boilers would have existed to some degree in SEI when it was the Irish Energy Centre, this is no longer the case. If a mandatory implementation of Article 8 was decided, - Option (a) – an administrative body, including a quality assurance/inspection arm, would be required to monitor its fair and effective implementation. This body, whether part of SEI or of another state body or contracted to a private venture, would have a ‘secretariat’ and inspection manpower requirement of its own, not now available in SEI or elsewhere, and it would seem to require statutory sanction to exercise its functions.

The views of leading insurance companies were sought through interviews with Allianz and Hibernian, the two largest companies in home and commercial premises insurance. These companies employ risk assessors and inspectors but their interest in boiler installations is confined to the safety aspects of steam boilers that are subject to annual inspection and certification. The insurance industry hasn't any spare capacity for inspection of hot water boilers, which it regards as low risk and therefore essentially outside its remit.

In the event that Option (b), implementation of an advisory/promotional scheme, was chosen to implement Article 8, it should not require the establishment of a

statutory authority. The much smaller number of personnel involved might be additional to SEI resources or subcontracted. To ensure the quality of the implementation, it seems that form of pre-qualification and registration of technicians and operatives would be advisable for the public interest.

3.3 Servicing, Inspection and Documentation Procedures

3.3.1 Survey numbers and returns

For the study team's survey of service agents, the leading boiler manufacturers Firebird, Grant and Waterford-Stanley provided comments on a draft version of the questionnaire that helped form a final version for issue, and passed that final version to their registered service agents. The total number of questionnaires mailed was 205[26], 56 responses were received (27.3%)[27] and nine of the respondents were phoned to further discuss their answers. 5 were omitted from all but the employment examination due ambiguous answers, so that the analysis of the responses is based but on 50. The sub-set of gas - only service technicians' responses was 9 out of 50. The rate of return, and the attention given to completing questionnaires, suggests a pool of skilled and committed service personnel. Discussions with the manufacturers at various stages of the exercise helped develop a greater understanding of issues and ability to interpret the findings.

The facts, estimates and observations in this section are based on the questionnaire- and telephone- findings.

The questions asked were a mix of open and closed, with encouragement to comment. The objectives of the questionnaire included:

- Ensuring that those at the 'coal-face' were given an opportunity to express their views on a matter of interest
- Gathering data
- Verifying or modifying data gathered elsewhere
- Verifying or modifying opinions
- Seeking any issues in the industry not otherwise identified.

The findings below relate to all domestic heating boilers and, to industrial and commercial boilers, particularly the smaller and intermediate sizes and with less certainty to the small numbers of very large boilers (of > 100kW capacity) that for purely commercial reasons are already intensively monitored and serviced at

[26] Some mailing overlapped, so the net number is less than 205 and the return rate greater than shown.
[27] Of these, ten were either incomplete or seemed to have had questions misinterpreted by respondents. These were not included in the data analysis.

greater frequency than would arise out of Article 8. Solid fuelled boilers are included, but are not separately discernible due to their small numbers.

3.3.2 Survey Findings

3.3.2.1 Numbers and Structure

The responses to a survey tend to come from those committed to their profession. Anecdotal evidence from manufacturers and suppliers (BGE) suggests the 'professional core' of enterprises may not be much greater than the 205 contacted for this survey.

45 of the 56 respondents are self-employed. Of the remainder, one respondent's company employs 25, one employs 12, one 10, one 8, two have 4, one has 3 and two have 2 – a total of 127. Extrapolating to the numbers in the full lists -, it is the best information available – suggests a total of about 500. This suggests, albeit not statistically very robust, from the summation of manufacturers[28] and suppliers (BGE) lists of service personnel and allowing for some duplication, a total of some 500 personnel dedicated to boiler service, about 2/3rd of whom are self-employed. (Anecdotally, this can be reconciled with an industry perception that there are about 200 dedicated full-time service personnel, with another 300 or more part-time: if others who service, including those who normally install, are included, the 500 equivalent full-time arrived at through the questionnaire seems reasonable).

From the Training subsection below, it is clear that there is a sizeable number of people in the installation sector who have had some training in servicing, and it is very likely that they constitute the great majority of the servicing that we haven't accounted for by the questionnaires.

There are others, possibly not trained, offering service (ref. 3.2.2.3 below).

3.3.2.2 Frequency

Service technicians confirm that operators of commercial boilers make arrangements for regular servicing, at intervals as low as six months where there are "high" operating hours. 'High' was not defined, and may be a topic in itself. Poor settings and boilers far too large for the duty – almost surely the majority of boilers in Ireland – exacerbate the build-up of dirt etc. and produce the effects of 'high' running hours even with relatively short run-time. Service personnel would probably consider more than 12 hours per day, during 6 months per year, as 'high'.

[28] As the availability of trained personnel is vital to manufacturers, and they put much effort into filling out their lists, it is thought that the sum of all of them is close to the total of such personnel actually available.

For the domestic sector, the reasons given for service calls[29] were:

- Contract arrangement – 18%;
- Regular customer, non-contract – 54%;
- 'Distress' (i.e. not functioning) – 28%.

It might be thought that consumers requesting distress call-out are less responsible and take less care of their equipment, and indeed some may be so. Distress calls arise however for two general reasons (a) equipment failure, e.g. a water pump, and this could arise for a boiler that has just been serviced, and, (b) failure of burner to fire due to lack of service. Apart from a general industry impression that the average intervals for (a) may be 6 years or more and for (b) perhaps 4 years or more, there is no breakdown available between these causes and no conclusions may therefore be drawn as to excess fuel use and pollution in the distress sector. Distress calls are also, in some cases, to an unknown extent, additional to normal servicing.

In the commercial sector, industry and insurance sources suggest that 80% of customers have contract maintenance arrangements on at least an annual, if not a more frequent basis. Of the remaining 20%, there are large energy users who employ their own maintenance staff, as well as a percentage, regarded in the industry as very small, who only intervene on failure of equipment.

The responses to the question "frequency of service (months)" indicated that some respondents were mixing up the actual frequency and the recommended frequency. However, from discussion with respondents and industry figures, one can assume, in current practice for domestic oil boilers, intervals between service of 1 year for contract, 2 years for regular customer, and 6 years for distress. The average of these, using the percentages above, is 35 months, - say 3 years. The contractor initiates a proportion of 'regular customer' call-outs by means of a reminder. This may be more common for small industrial/commercial customers.

Table 6 Summary of the current frequency of various boiler inspection calls

Domestic sector. Type of service call	Period between calls (approx.) months	Percent of calls, approx.	Customer cost/benefit, comment [30]	Average time between calls
Contract	12	18	Negative cost benefit	

[29] Note that this is an estimated breakdown of calls, not a breakdown of the arrangements that households have.

[30] A typical annual spend of €1200 based on some 2032 l (see 2.7above) of oil at current prices, with an estimated annual saving of 2% per section on efficiency below, equates to an annual saving of perhaps €24, against a possible service charge of € 100. In some rural areas that charge might be as low as €60.

Regular	24	54	Breakeven at best	35 months
Distress	60	28	Unknown, as many such calls are due to equipment failure	
Industrial sector				12 months or less
Majority	12 months	Not known	Not known[31]	
Minority	Less than 12 months			

A factor affecting servicing capacity is that the increasing tendency to burn kerosene rather than gas oil in the domestic sector (and, less markedly, in the more populous smaller industrial commercial boilers), in recent years, reduces 'distress' service demand. Service personnel also confirmed that kerosene has reduced the service requirement in general. The question was not asked, but it could be intuitively anticipated that gas-oil boilers in general are more frequently serviced, and the subject of more distress call-outs, than others.

If the total national boiler population of 1,250,000 (Table 1) is serviced on average every 3 years, by 500 personnel working say 225[32] days per year, then the current practice is that **they each service on average 3.7 boilers per day**.

There are two key baselines that must be derived from the above, to establish a starting point for the additionality of any measures over current practice. They are:

Manpower: it is necessary to be able to calculate how much extra manpower might be required as a result of any measure arising from Options (a) or (b). The fact that there is a great surplus of partly trained personnel available, albeit probably working mainly in installation, suggests that it is safe to assume that any extra servicing requirements can be easily satisfied by a short re-training period. Thus, extra requirements can be calculated as readily fulfilled by provision of short training courses, following which the trained personnel could perform at a minimum 4 services per day for 200 or more days per year.

Boiler emission saving: Key to this is the time between services. 3 years on average has been determined from the responses to the questionnaire: this is used as a basis for estimations in the study.

[31] Anecdotally, in telephone follow-up of questionnaires, boilers of > 100kW were expected to be serviced perhaps twice yearly.
[32] Considered reasonable or slightly low in view of the high proportion of self-employed.

3.3.2.3 Training

The service personnel surveyed had received training from the following training providers (the totals sum to more than 100% as many of them had attended a number of training courses):

- Manufacturer – 73% (many had done more than one such course – e.g. boilers and burners);
- OFTEC – 58%;
- FÁS – 54%;
- Bórd Gáis Éireann – 32%;
- Institutes of Technology – 20%;
- HETAS[33] and Other Training – 15%[34].

All respondents said they would be willing to attend further training.

Service personnel see a clear distinction between those who install (whom they regard as of relatively low skill, on average), and those who service ("I would like to see plumbers refraining from interfering with oil burners").

There are an unknown number of people who service part-time and who have no training whatever.

It is also clear there are substantial numbers that are in theory capable of carrying out inspection and action as required, but who have little or no recent hands on experience. In 3.2.2 above, 600 apprentices per year are mentioned as graduating with a boiler service module, and 260 technicians are confirmed to be seeking accreditation in the gas sector.

Those who operate these service businesses are largely self-employed (see Structure in 3.2.2) and must therefore deploy a wide management capability including social skills and marketing, if even on a small basis: it also takes time to build a client base. In contrast, the bulk of personnel engaged in installation are either employees or, where self-employed, sell their services generally in a simple price-based manner. It is therefore very likely that it is not only the higher earnings now available in the installation sector that attracts such a high proportion of trained personnel into installation in preference to service, but a natural tendency to take the less demanding path of being an employee.

It is difficult to imagine that any shortage in service personnel, arising out of the implementation of a service regime that might result from the implementation of Article 8, could arise for more than a short period. This of course excludes the

[33] The official body recognised by the UK government to approve solid fuel domestic heating appliances, fuels and services

[34] Stated as: 1 HETAS, 1 British Gas, 1 Calor Gas, 1 IDHE, 1DOBETA, 1 Shell UK

inspectors required for the boilers over 15 years old and over 20kW, where a new type of training needs to be established.

3.3.2.4 Procedures in service and inspection

'Inspection' (only), where no action is taken, is virtually unknown[35], although in some cases that may occur, as the householder cannot afford a recommended expenditure at the time. The most prevalent arrangement is a non-contractual one to perform routine cleaning and adjustment (54% of visits), followed by 'distress' calls to remedy a problem (28%): only 18% are contracted calls. In most cases, a printout of efficiency parameters is given to the customer, but without explanation. The controls part of an installation is rarely checked – generally only in case of a fault investigation. The non-contractual call is initiated both by reminder and customer request.
The question was not asked, but, in discussion, it was clear that commercial-industrial establishments usually have formal or informal service arrangements. Technicians almost always use test equipment to adjust combustion: a small, dwindling, number use the older less precise procedure of adjusting by viewing the flame where that is possible.

3.3.2.5 Documentation

73% claim to give reports to customers[36] – the most sophisticated of these is the OFTEC report, although a number of other sample report sheets submitted to us were almost as comprehensive: most seem to merely give the customer a printout from the test equipment[37]. It seems service technicians rarely discuss the report with the customer, many being simply left behind as evidence of work done. It is also evident that they steer clear of the controls portion of the system unless they need to specifically address it due to malfunction. Thus, maintenance improvements are solely limited to the actions of the service technician. Reluctance to give advice other than ensuring that the boiler can literally lash out more than enough heat is traditional in the industry, for understandable reasons ranging from the variability of client circumstances to their perceived inability to understand in the first instance.

3.3.2.6 Domestic and Commercial

The response to the question "How does your service business divide (number of units)" produced an average of 85% domestic, 15% commercial. This 15% represents a much higher proportion than the actual number of commercial units (see Section 2.1). However, from the answers and telephone interviews, service

[35] This could e.g. arise in an unoccupied house, with boiler firing initiated by a frost thermostat and so very rarely used.
[36] Sample of the OFTEC report, and another typical report sheet, are attached as Annex C.
[37] These questions were not asked specifically, but observation of returns and telephone conversations support the conclusions

technicians expect oil boilers over 100kW to be serviced twice annually. As this frequency would then be in the order of 4 to 6 times the domestic boiler service frequency, service activity and revenue from the commercial sector should constitute a seemingly disproportionately high part of the overall business.

3.3.2.7 Productivity and charges

A service technician performs 4-5 domestic services per day at maximum capacity. Charges are typically €90-120 including VAT: boilers that have become very dirty, perhaps say four years without a service, may be charged at approx. €150 due to the need to replace seals and other consumables.

3.3.2.8 Need for service

The 28% of services that are distress calls is an indirect indication only of the numbers of boilers that are 'dirty' and very inefficient, as many of these calls result from parts or equipment failure. The required frequency of service is more a function of operating time, than size: domestic boilers have few annual operating hours. Their propensity to get dirty is complex, depending not only on type of fuel, but also on installation. Gas and kerosene boilers rarely need service from a combustion point of view, and there is anecdotal evidence of boiler salesmen advising customers to switch to them to reduce servicing costs.

Commercial boilers are almost invariably better looked after, and six-monthly servicing is required for larger commercial boilers in continuous use (hospitals etc.). Almost all boilers (of less than 100 kW) installed after 1999 burn kerosene rather than gas oil[38], and burn clean for a longer time as a result.

Boilers fired by gas oil can probably burn about 3000l or more between services without firing problems – approx 2 -3 years for the average householder, kerosene -fired may run without problems for twice as long, of the order of 5 years, gas a bit longer still. For safety reasons, suppliers and manufacturers promote shorter intervals, BGE particularly so for gas.

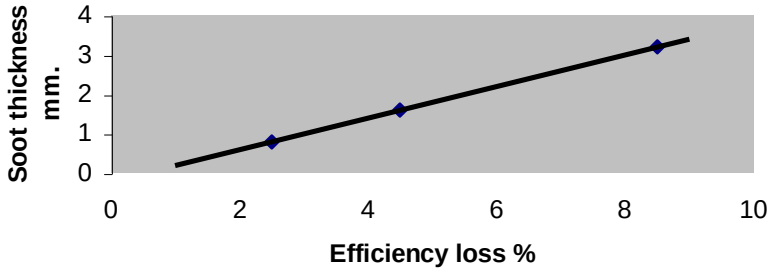
Owners of ranges tend to service most regularly – this may be linked to their owners being wealthier or to the fact that dirty ranges generate noticeable noise and are centrally sited in the home.

3.3.2.9 Efficiency gains available from (a) Servicing, (b) Commissioning and (c) Boiler replacement

[38] Kerosene has approx. 2.0 cSt (28 second Redwood No. 1) and gas oil 3.0 cSt (35 second) viscosity.

Article 8 appears to refer directly only to gains available from servicing, described later as measures 2 and 3 (and perhaps may infer the desirability of replacement, Measure 1, although this is never stated), this section illustrates the relative sizes of the amounts of CO_2 emissions that may be saved by various types of measure that were originated or hypothesised postulated in the study. This is to assist in formulating equivalences that might be considered under Option (b).

Figure 5: Oil boiler efficiency loss v soot build-up, relevant only when burning rich (OFTEC-extrapolated)



(a) Efficiency Gains obtainable through Servicing ('Type B' savings, see Appendix B)

This question is perhaps complicated for the non-technical person who may find the summary in FIG 8 easier to follow. Hereafter, in discussion of Options (a) and (b), this s covered by "Measures" 2 and 3.

The research for this study did not identify any credible reports or studies defining the efficiency gains obtained from the cleaning, replacement of jets and adjustment procedures performed in a service. OFTEC refers to studies[39] that relate soot build-up to loss of efficiency (as a result of increases in flue-gas temperatures), as shown in the extrapolated diagram below. This is however very unrepresentative of the actual situation, as most boilers don't get an opportunity to build so much soot, particularly when kerosene-fired. Manufacturers rarely deliver a gas-oil fired boiler these days, but when they did, and now also for kerosene-fired boilers, they invariably set for 'lean' combustion, i.e. adding more air than is necessary. This precludes the soot build-up that would occur if boilers were set 'rich', with low air in relation to oil consumed.

[39] "Commissioning and servicing oil fired systems", Technical information book 2, Diagram 5.12, OFTEC edition 2 March 2002

Referring to national fuel consumption, and to the oil boiler population, the average use per boiler (also per house) in 2003 was some 2032 litres per year. As domestic oil-burner nozzles are typically sized 0.5-0.6 US gal/hr.[40], the annual firing time for domestic boilers in Ireland lies in the 900-11 hours bracket, and 1000 hours may be taken as typical. Based on extensive discussions with service technicians and manufacturers – and as pointed out above, we have not found any more scientific basis for this data[41] – it is estimated that gas-oil will burn 4-5% inefficiently after 2 seasons or 2000 hours (without service), i.e. an efficiency loss of 2 – 2.5 % per year, while a corresponding figure for kerosene is likely to be 0.75% and for natural gas 0.5%.

(b) Efficiency gains through proper Commissioning

During the course of the study, the study team became persuaded that there are gains through proper commissioning.

According to an American study[42], 'in-situ[43] 'boiler inefficiencies range typically between 2 and 10%. From our comments above, this appears at first to be a very high figure if resulting only from running hours. However, based on the survey responses and on interviews with manufacturers and service technicians, we estimate that over 90% of oil boilers installed in recent years were not commissioned in accordance with manufacturers' recommendations. The result is that a boiler may operate at perhaps more than 7.5%[44] reduced efficiency, until first serviced, and this figure therefore applies to most boilers installed in Ireland – operating or running hour inefficiencies due to dirt build-up etc., the target of Article 8, is additional to such inefficiencies. Moreover, as this is combined with lean burning, there will be little normal indication that anything is wrong, in fact these boilers, even if gas-oil fired, would be slower than normal to build up dirt and they could so continue for many years unless service is necessary due to e.g. a part failure. A paper by CIBSE[45] claims ""A boiler manufactured to operate with a combustion efficiency of 87% could drop to 70% or lower if it is not properly set up". This is a surprisingly high inefficiency for a still functioning boiler, and no evidence is adduced to support it. In the remainder of this study we have conservatively assumed this installation loss to be 5% rather than 7.5%

[40] Heating equipment has traditionally been sized in US measures: 1 gal. US = 3.785 l. 0.6 for kerosene, 0.5 for gas-oil, is the most common nozzle size.
[41] The data is based on personal recollection of actual tests that have however never been tabulated or formulated to plot inefficiency against running time, possibly due to the number of other variables that would have to be taken into consideration.
[42] "Energy efficiency manual", Measure1. 2.1, Donald Wulkinghoff, catalog ref 778, Oikos Books
[43] This term is for actual seasonal efficiency as installed and running v. the target figures for well installed and maintained.
[44] To safeguard their own position, manufacturers ship boilers set lean, also, the tolerance on nozzles is approx. 8%, flue length/bends and resistances are a factor, as is poor siting with respect to wind conditions, and baffles may fall off or out of position in transport. Many are installed over-sized and fire only for short periods, as the manufacturers ship burners adjusted for mid-range or upper limit as the 'default in various cases.
[45]

The comments on poor installation, while anecdotal only, are almost universal within the manufacturing and service communities. The possibilities of savings by remedying installation failings is covered as Measure 4 in 8.1.

FIG8 below summarises the estimated position due to servicing and poor installation based on 1000-hour/year running.

Table 7: Inefficiencies of boilers due to no commissioning, and servicing, by fuel			
Fuel	A. Service-related inefficiency – 2 year service interval	B. Possible installation – related inefficiency	Possible total inefficiency (A+B)
Gas oil	4-5%	5%	9-10%
Kerosene	1.5%	5%	6.5%
Natural Gas	<1%	0[46]	<1%

The first boiler service therefore remedies common installation defects and results in a significant efficiency gain, and reduction of CO_2 emissions[47]. Intuition suggests that boiler services for new boilers may be far fewer than in the past (the service industry, surprisingly, doesn't suggest any increase in demand in recent years, although the boiler population has grown by over 25% in 5 years, all the new boilers are gas or kerosene and first services very likely don't take place for many years – certainly more than 3.

(c) Efficiency gains through replacement of older appliances ('Type A' savings, Appendix B)

No machine can be 100% thermally efficient: cars and power stations range between about 40 and 55% efficient as designed, boilers somewhat more (see below). (There are also further operational inefficiencies due to poor installation or servicing, versus the optimal, as discussed above). The range of designed efficiencies in the boiler population is very considerable, as the optimal efficiency of oil boilers has increased significantly due to improving design over recent years. Boiler efficiencies tend to lie in one of three[48] bands, depending on age, with approx values of:

- Pre-1994: 65%;

[46] Because of the perceived risk to safety if gas appliances are not properly commissioned, it is thought they are in general properly set-up at installation.
[47] Maximum efficiency occurs when CO_2 is slightly high, and minimum CO_2 when efficiency is slightly low. Burners are set between 1.5-2% less than optimum for each, as a best compromise, i.e., at 11.5-12% CO_2
[48] Based on SEDBUK "seasonal efficiencies" using the Gross Calorific Values of fuel

- Moving gradually, from 1994 onward to the late 1990's, to 85%, and
- Post-1999, to 95% for a new design, called 'condensing' boilers (although this has still very small market share in Ireland.

In recent years, virtually all boilers sold are 85% efficient, with just a small number of 95% efficient due to their higher price.

Replacement of a boiler often ensues from a breakdown. Probably more than 80% of major part 'replacements' consists of the burner only, which doesn't convey the major efficiency gain available from replacing the boiler itself. Full boiler replacement normally occurs when it becomes difficult to obtain spares (i.e. for older models).

Applying the efficiency data to the age brackets of oil boilers as per Table 2 in 2.6 allows the construction of a Table below that indicates possible fuel savings by replacing older oil boilers.

Table 8: Estimated savings available through replacement of older appliances, oil-fired only, over 20kW rated output (2005)

Fuel	**Total no. by Fuel**	**Aged 0 - 5 Years**	**Aged 5-10 Years**	**Aged 10-15 Years**	**Aged over 15 Years**
Oil	580,000	195,000	175,000	125,000	85,000
Average efficiency now	77.66%[49]	85%	80%	70%	65%
If replaced by boilers as shown below[50]	CO_2 saved per year, tonnes	CO_2 saved per year, tonnes	CO_2 saved per year, tonnes	CO_2 saved per year, tonnes	CO_2 saved per year, tonnes
A. Bring to 85% efficiency	267,661	-	55,013	117,886	**106,883**
B. Bring to 95% efficiency	565,761	109,696	147,668	175,795	**143,449**

Gas is not included as it is expected that probably most such appliances have 85% efficiency. However, if all those gas boilers that are presently 85% efficient were replaced by condensing boilers at 95% efficiency, the 100,000 boilers affected would save approx. a further 56,254 tonnes CO2 per year.

[49] This reflects the gradually increasing percentage of sales switching to the 85% efficiency boilers e.g., almost 80% of the 5-10 year old boilers are 85% efficient.

[50] We assume that those with less efficient appliances now burn the same average 2023 l/year as those with modern appliances – whereas, to reach the same level of warmth, they would burn more, so the savings, to the extent they may be biased, are understated.

Solid fuel is not included due to small numbers and that anecdotal service-personnel evidence is that they burn renewable timbers.

Maximum effect: It is likely that it would be simpler to administer a replacement scheme where the boiler size does not have to be ascertained, i.e. that could apply also to boilers of less than 20kW output. The CO_2 savings would be considerably more, and the consumer would benefit directly in cash savings. This could be particularly appropriate if the approach used an incentive to achieve replacement. The same efficiency improvements apply to smaller boilers as to the larger ones

3.3.2.10 Influence of the service technician

The survey showed that clients normally follow a service technician's advice to replace a burner or boiler. This is standard behaviour for a layperson when advised by an expert. When a replacement is suggested, the survey indicates the likelihood that:

- 65% of clients make the replacement immediately;
- A further 20% make the replacement within a year;
- 15% of clients do not heed the recommendation (uninterested, can't afford to).

The questions asked here lent themselves to possible misinterpretation, but the gist of it is that, overwhelmingly, customers follow technical service advice when affordable and convenient. From follow-up phone calls, it is clear that acceptance of advice relates solely to matters of reliability, and it is seldom followed for energy saving reasons.

3.4 Approach adopted in other Member States

3.4.1 Countries Reviewed

The brief for the Study required a review of the approach to implementation of Article 8 of the EPBD in a sample of other EU Member States, and it was agreed with SEI that these would be Austria, Denmark and the UK (all regions if different approaches adopted).

In contacting the organisations responsible for implementation in these Member States, a standard set of questions was posed.

Austria and Denmark have mandatory boiler inspection regimes pre-dating the EPBD. The UK has set up a task group, under the aegis of its advisory committee on overall implementation of the EPBD ("DIAG") to examine the options for implementation of Article 8 specifically. This group reported to the UK Department of Environment, Food and Rural Affairs (DEFRA) in March 2004.

3.4.2 Austria

Mandatory inspection of boilers in Austria has been in place for over 20 years. Different regulations apply in its nine provinces, the most common of which require inspection of boilers on the following basis:

- Oil Fired – Annual inspection (including combustion efficiency testing).
- Gas Fired – Inspections every 2 years with safety as the main concern.
- Solid Fuel Fired – Inspection every 4 years with emissions testing.

In addition, boiler installations are required to have a five-yearly check for insurance purposes. Inspection is carried out by Chimney Sweeps with technical training in combustion efficiency testing.

National legislation is being considered that would require mandatory annual inspection and reporting of all boiler installations, including combustion efficiency testing. There is no particular focus on boilers over 15 years old and there are no lower or upper limits to boiler sizes for inspection and testing.

The move to annual inspection of all boilers is causing concern to experts in the energy field in Austria as they feel that non-discriminatory regulation in this case will actually favour the more polluting fuels such as gas-oil (i.e., why should cleaner combustion be treated as strictly as the more polluting combustion of gas-oil?). There is also a suggestion that condensing boilers should receive different treatment.

3.4.3 Denmark

Mandatory inspection exists for oil-fired boilers of all sizes in Denmark on an annual basis. This includes combustion efficiency testing and can be carried by Certified Chimney Sweeps, Independent Service Technicians or Energy Utility Engineers. These inspections are required by fire safety regulations.

Draft Regulations are being prepared to meet the requirements of Option (a) inspection, of Article 8 of the EPBD. As currently drafted, these regulations will require annual inspection and testing of all oil boilers, while larger domestic and commercial gas boilers may be subject to less frequent inspection and testing. Most gas boilers are already subject to an annual safety check and efficiency testing will be carried out at the same time. It is likely that gas boilers over 100kW output will be subject to inspection and testing every four years.

A new regulation requiring once-off inspection and performance check of heating installations over 15 years old is also to be introduced. It is not yet decided who will carry out this work. The people who carry out the boiler inspections lack

knowledge of the other parts of the heating installation, whereas “Energy Consultants” who undertake energy labelling of houses for sale lack in-depth knowledge of boilers.

Monitoring/quality assurance of the schemes is a political issue and it is yet to be decided who will control records and accreditation. No financial incentives are envisaged to support the schemes.

3.4.4 United Kingdom

A consultation group, DIAG[51] representing the energy industry, boiler manufacturers, training specialists and energy consultants, under the auspices of the Building Research Establishment (BRE), reported to DEFRA in March 2004. Its brief was to identify various ‘sub-options’ within options (a) and (b). These were forwarded to the BRE, who are to prepare a preliminary Regulatory Impact Assessment (RIA) that is understood to be almost complete (at end 2005).

The findings of DIAG were:

1. Article 8 Option (b) advice is preferable to Option (a) mandatory inspection, as it allows more flexibility of implementation.

2. Advice, in the form of leaflets that rely directly on the householder or boiler owner taking action, is unlikely to be successful. The response rate to this type of request is very low. “Even in cases where customers only contribute 50% of costs, the uptake on energy efficiency measures is less than 1-2%”.[52]

3. Specific visits to inspect or advise would be expensive to implement.

4. For economy, maximum use must be made of existing regular building visits for other reasons, where inspection or advice can be delivered at the same time. Examples are: annual boiler insurance inspections, Warmfront/EEC assessments, obligatory gas safety checks in rented homes, and surveys for property valuation and the forthcoming Home Condition Report.

5. It is preferable to target only buildings that have boiler installations (approximately only 80% of dwellings). But it may well be easier and cheaper to contact all building/dwelling owners than to identify only those with a boiler.

6. It is not necessary to adopt different approaches for different boiler types. Slightly different approaches are necessary for domestic and commercial boilers.

7. Measurement of the efficiency of installed boilers is not particularly informative, and corrective action is often not feasible. Simple visual inspection of boiler type and age may be more useful.

[51] Website www.diag.org.uk
[52] Item 2, General Conclusions, “Conclusions and Recommendations”.

8. Consideration should be given to the use of actual annual energy consumption data to prioritise those boilers that need inspection. This would be most effective for large boilers that already require detailed energy consumption monitoring.

9. A detailed impact assessment should be carried out to identify the numbers of boilers and likely costs and effectiveness of each option. The assessment should also consider alternative methods of improving energy efficiency where they can be shown to be more cost effective and would still qualify under the terms of the Directive (legal clarification required). – Note that this is essentially identical to the aims of this study for Ireland.

10. A key consideration will be the availability of suitably qualified staff to carry out the work, and training of them.

DEFRA confirmed that this report represented their thinking on Article 8 in Autumn 2004. Scotland and Northern Ireland are likely to follow the DEFRA lead for England and Wales on this matter.

It is to be noted, however, that, as some 86% of the UK domestic central heating market is served by gas, a further 10% by electricity, with the remaining 4% divided between oil and solid fuel[53], the UK approaches Article 8 from a very different standpoint to that of Ireland.

4. Scenarios relating to Option (a) of Article 8

4.1 Issues in Reviewing Option (a) Scenarios

4.1.1 Elements of Option (a)

If EU Member States choose Option (a) of Article 8 of the EPBD, the Directive states that they should:

"lay down the necessary measures to establish a regular inspection of boilers fired by non-renewable liquid or solid fuel of an effective rated output of 20 kW to 100 kW. Such inspection may also be applied to boilers using other fuels.

Boilers of an effective rated output of more than 100 kW shall be inspected at least every two years. For gas boilers, this period may be extended to four years.

For heating installations with boilers of an effective rated output of more than 20 kW, which are older than 15 years, Member States shall lay down the necessary measures to establish a one-off inspection of the whole heating installation. On the basis of this inspection, which shall include an assessment of the boiler efficiency and the boiler sizing compared to the heating requirements of the building, the experts shall provide advice to the users on the replacement of the boilers, other modifications to the heating system and on alternative solutions."

[53] http://www.powerwatch.org.uk/energy/graham.asp

Option (a) therefore sets out different requirements relating to:

- Boilers between 20kW and 100kW;
- Boilers over 100kW which are not gas-fired;
- Boilers over 100kW which are gas-fired;
- Boilers that are over 20kW and also aged over 15 years.

The dimensions to Option (a) are depicted graphically in Table 9.

<table>
<tr><th colspan="5">Table 9: Summary of Article 8 Option (a) requirements</th></tr>
<tr><th>Boiler Size</th><th>Natural Gas</th><th>Oil (Gas-oil or Kerosene)</th><th>Solid Fuel</th><th>Units over 15 Years Old</th></tr>
<tr><td>Over 20kW and under 100 kW</td><td>N/A</td><td colspan="2">“Measure 2”
Regular inspection</td><td rowspan="3">“Measure 1”
One-off inspection of heating installation and provision of advice to users</td></tr>
<tr><td rowspan="2">Over 100 kW</td><td colspan="3">“Measure 3”</td></tr>
<tr><td>Inspection at least every 4 years</td><td colspan="2">Inspection at least every 2 years</td></tr>
</table>

Article 8 may be broken down as above into three ‘measures’ that each requires a plan. The study attempts to estimate the range of effects that might ensue from such plans for an Option (a) approach, and then to formulate Option (b) approaches that might offer equivalent effect, by mirroring them in an optional regime– equivalence may also be achievable by other measures apart from mirroring, and some such measures will also be advanced.

4.1.2 Defining Scenarios under Option (a)

Measure 1 is discussed in Section 5.1. This measure applies to boilers over 15 years old regardless of the approach adopted for boilers under 15 years old, if Option (a) is pursued. Based on two possible interpretations of the requirement for an ‘inspection’[54], two scenarios, A and B, are examined.

Measure 2 also requires interpretation and further definition. Section 4.2 sets out our understanding of the phrase ‘regular inspections’ that is key to Option (a). Sections 5.2.1 to 5.2.4 describe and explore four scenarios, where the frequency of service is varied in years and also according to fuel type. These range in ‘severity’ from a case that might reasonably considered on the basis of the rate at which boilers get dirty, but that would have the effect of increasing CO2 emissions in Ireland, through three other scenarios ranging from a minimal

[54] Note: this is more comprehensive, and requires different skills, than the normal boiler service, and would cost an estimated € 200 as against € 100 for the latter

improvement over the current frequency of service, to a maximal state where all relevant boilers are serviced every year.
Finally, Measure 3 considers large (industrial/commercial) boilers over 100kW are considered in Section 5.3.

4.1.2 Cost considerations

A key issue for all measures and their scenarios is the additionality of any impact to estimated current practice. To make valid comparisons, costs and benefits both public and private are examined for each measure and scenario. The assumption is that expenditure in this area is currently at or near nil.

Public costs are of the following type

- Establishment capital costs of a 'Secretariat', possible commissioning of database, office equipment, initial launch publicity
- Ongoing, yearly, overhead costs of salaries, space rental, telephones etc.
- Costs of providing training as necessary: while these costs are outllined in the study, in practice trainees might pay a fee, described as an "Industry cost", that would totally fund the training programme, at no cost to the exchequer
- Ongoing promotional costs, hard, paid ads etc., and soft PR type opportunities, the costs of any incentives

These costs are very discretionary, and:

- Have the central overhead or 'Secretariat' component shared between all three measures, that should be less than their individual sum
- Arise irrespective of whether Options (a) or (b) are chosen
- May differ considerably in magnitude and emphasis depending on approach
- Might ideally be considerably flexible, particularly in the case of Option (b) where the flow from the promotional cost tap would be adjusted according to success.

The Secretariat is the administration overhead that can range from as low as €0.25M for the Measure 2 lower option (b), upwards – adding further tasks willl generally add of the order of €100 – 200,000 for each task. The possible public Secretariat costs are generally:

- Equipment, database, initial expenses from € 0.25 to 1M
- Overhead, from € 0.25 up to € 1M annual operating cost depending on responsibilities
- Promotional budget from € 0.3M to € 2.5M annually
- Training costs could exceed € 1M per year in such cases, but could probably be largely funded through fees.

As mentioned a number of times, even with good market research, the real cost of achievement is impossible to predict – one can predict the existence of a secretariat at a particular cost, but success is a different matter,

Public benefit

The public benefit is the tonnes CO_2 emissions savings as calculated.

It is possible to view the public benefit of the measures as discrete isolated elements, but the common, shared nature of the overhead suggests it wouldn't be realistic to completely separate their public costs.

Private costs

The private costs consist of:

- Possible extra inspection cost for Measure 1, boilers > 15 years old and > 20kW, (except to the extent that a policy chosen for this measure might obviate the need for inspection by replacement)
- Comparing the current notional service cost per year, of € 33 (€ 100 for a service every 3 years) to the same cost over a different number of years service frequency

The study doesn't consider replacement costs as a private cost, as replacement would be entirely voluntary, but they are tabulated to give a sense of their magnitude (Table 14).

The study assumes a 1:1 relationship between percentages of fuel used and saved and the CO_2 arising from it (specific of course to each fuel). While the relationship is more complex than that, this assumption is that normally used and is sufficiently accurate to be acceptable. As mentioned throughout the study, no CO_2 benefits are presumed to accrue from solid fuel appliance replacement or servicing, as questionnaire respondents that were phoned advised them as large timber-burning farm-based boilers, i.e. renewables, albeit their servicing requirements for practical purposes are relatively frequent.

4.1.3 Challenge of Identifying Relevant Boilers

A practical problem with all of the scenarios under Article 8 Option (a), and indeed in assessing progress under (b), is that there is no central record of boilers in Ireland. How then can households and organisations be notified that they need to have a mandatory boiler inspection, under any of the Option (a) scenarios? How can the authorities know what action, if any, has been taken as a result of e.g. promotion? Also, Article 8 refers to boilers over 20kW and many households and organisations will not know if their boiler is under or over this threshold. Various ways may be envisaged as to how one could build a database of the Irish boiler population over time but this is an onerous task.

A mandatory regime suggests the following questions:

- How does a household know what size and age a boiler is?
- How can relevant authorities know whether a household or business is complying or not?
- What is the process of enforcement (and what happens to those who do not comply)?

The first two questions above also arise for Option (b) - how can the householder/business know whether they need take action, how will the authorities know what, if any, voluntary action has been taken?

It may be assumed that a good searchable boiler-identity website, if made available, would enable the identification of the size and age of a boiler: there would be, however, considerable numbers who might either not have access to it or be unable to use it properly, no matter how apparently 'simple' to the cognoscenti. The only way to be sure of boiler detail is by a visit of a competent person where necessary. A force acting against identification of detail could be that, as the reward for identifying your boiler as being over 15 years old, in effect a cost penalty of an inspection (costing say €100[55]), there is not only no incentive to do so, but a disincentive. Indeed, the only people with an incentive to report their boiler details accurately are those with boilers of under 20kW and 15 years, i.e. those who are thereby excluded from the effects of Article 8.

Backed by a help line, a database would be more costly and be more effective. A proportion of the population – perhaps between 20% and 50%[56] - would require an inspection by a third party.

On the issue of how 'the authorities' will know about compliance or not, the arguments are similar: only with inspection by service technicians, and a report, linked to a central database of boilers, can this be established.

Some possible means of addressing this issue are considered in Section 5.5.

4.1.4 Distinction between Commercial and Residential Boilers

Referring to Section 2.2 for examination of commercial boilers "estimates of 18,000 natural gas and 35,200 oil boilers are used", and, with Table 1, a table of commercial boilers by size may be constructed. Note that the "under 40kW" numbers is a residual from the other figures. The split in commercial boilers

[55] For boilers over 15 years old, Article 8 requires a far more demanding assessment, of the whole heating system, not just the boiler, as well as (separate) home energy rating and boiler sizing calculations: there are very few people qualified to do this, and € 200 is a very conservative cost estimate.

[56] A final guesstimate could be made depending on Internet penetration in the home at the time

between less than 20 kW and 20 - 40 kW is not known. The unit fuel usage may be higher than for domestic boilers, but is unlikely to be significantly so. This is because there is a well established over sizing tradition in the industry in Ireland – where a duty and load seems substantial, the boiler size is almost invariably increased so it can readily heat from a standing start. Therefore, in the up to 40kW category, where the study assumes the pragmatic domestic/commercial divide to lie (i.e. few domestic boilers are of over 40kW capacity), it is assumed that domestic and commercial may be treated in the same manner as far as all calculations are concerned.

Commercial boilers of between 40 – 100 kW size are definitely of interest, but while interesting to the study, they are not referred to in Article 8. They are included in the statistics and examinations of all the 20 – 100 kW boilers in the study, and there is no data or information at present on which to base a separate treatment for them, although that would be desirable. The arguments and options for replacement of them are in line with those for the domestic sector. These are the more serious commercial boilers, in contrast to the newsagent shop with accommodation over kind that features perhaps considerably for the commercial boilers less than 40 kW.

If we take the two categories of larger boiler, i.e. <40 kW< 100 kW, and > 100kW, it is tempting to apply the 80/20 rule to their 7,500 and 2,500 estimated populations respectively. This line of approach is taken further in the examination of Measure 8.1.

Table 10. Estimated total commercial boiler population split by size and fuel used

Fuel	Total all sizes	Under 40kW	40 – 100 kW	Over 100 kW
Oil	35,200	30,200	3,500	1,500
Gas	18,000	15,000	2,000	1,000
Solid fuel	-	-	-	-
Total	53,200	45,200	7,500	2,500

.

Article 8 of the EPBD does not make any distinction between boilers in people's homes or boilers used by commercial or other organisations. However, there is a case for making such a distinction, for a number of reasons:

- The consumption per boiler is 15 times higher in the commercial than the domestic sector (section 2.4). The total oil consumption of the commercial sector is about 80% of that of the domestic sector.
- Running hours are longer (daily) as heating is part of the commercial need (for worker comfort, for shoppers etc.)
- Based on our survey, commercial boilers are better maintained than domestic boilers, with most having servicing contracts or arrangements.

- Again based on the survey, commercial boilers tend to be much older than domestic boilers[57] partly resulting no doubt from their good maintenance
- Few of the larger commercial boilers burn kerosene[58] (because many of them are too big, i.e. > 50 or 60kW[59], or older), but the percentage isn't known.
- As a continuity and security measure, many commercial users operate two or more boilers, together and/or in standby.

4.2 Defining 'Regular Inspections'

4.2.1 Defining 'Inspections'

Under Option (a), boilers over 20kW must be subject to regular inspection and, for boilers over 15 years old, the whole heating installation must be inspected. What does a boiler 'inspection' mean?

It is to be noted that Article 8, Option (a), is confined to "inspection" only, and does not extend to measurement, testing or adjustment. Moreover, for boilers/heating systems no more than 15 years old, there is no specified requirement for the giving of advice in the EPBD. Recital 19 of the EPBD refers to boiler maintenance, including adjustment, but maintenance is not a requirement of Article 8. Also, whether option (a) or (b) is adopted, there is no obligation on either the owner or user of the building to act on any advice given or to even read it.

The elements of a normal boiler service are:

(i) Open access covers, examine parts and clean as necessary. This may reveal the need for more measures, e.g. replacement of seals, or pump problems in some cases. Replace nozzle, check fan and flue
(ii) Fire up boiler to temperature, and run for 10 minutes
(iii) Take readings to guide and adjust settings per boiler manufacturer's recommendations, using combustion test equipment, until the desired flue gas CO_2 level is obtained,
(iv) Test oil pump pressure
(v) Prepare report (often meaning attach test printout to the client bill – see example in Annex C) and present to client.

[57] Well-maintained boilers are likely to have fewer problems. There is less 'low-hanging fruit' in this sector than in the domestic one. Low oil prices from the mid-1980's have led to less focus on such a non-core current cost, while capital expenditure traditionally places energy saving among the lowest priorities.
[58] The national fuel statistics from SEI, referred to in Table 3a, shows "0" for the use of kerosene in this sector. However, this study regards it as a matter of classification: that small businesses purchase small kerosene-burning boilers just as does the domestic sector.
[59] While kerosene boilers of 100kW are now available, 60kW was an upper limit in past years

Two questions that arise from this definition of a typical boiler *service* are:

- What elements of boiler servicing are needed, at a minimum, to comply with 'inspection'?
- Is a report an essential part of it?

***Minimum Complying Procedure**:*

It could be argued that ***viewing the flame***, without using any test equipment, could suffice. This would be a retrograde approach as it rolls back attempts to make boiler servicing more professional than in the past. It also provides no data on emissions with which to measure progress.

Alternatively, one could fire up a boiler and simply check test read-outs, omitting the cleaning, nozzle replacement and adjustment of combustion steps. This does not seem sensible as, by requiring the combustion analysis, it will cost more than a visual inspection and almost as much as a full service. If any action was to be taken, another combustion test would be needed after adjustment and the overall time and cost of the job would increase.

Further, as outlined in Section 3.3, inspection only is unusual if not indeed unknown in Ireland. It would include all the service actions now taken except the remedial ones. If Article 8 were implemented without the remedial service actions, it would decrease the CO_2-reducing actions being taken, unless customers paid out a second time for a normal service. As this is clearly not the intention, we define 'inspection' under Article 8 as consisting of the elements outlined above and constituting a normal boiler service today.

Is a report an inherent part of an inspection?

The group examining options for the UK stated[60] "Neither of the options places any requirement on the owners of buildings to react to the inspection report or advice.... the impact of Option (a) relative to Option (b) rests on an assessment of the extent to which installation specific advice given in an inspection report is more persuasive than general advice." Note that they presume there is a report, and this seems a reasonable presumption as:

- To have the possibility of action being taken on foot of the inspection, a written report of the findings of the inspection is useful if not prerequisite;
- Without a written report of some kind, there is no record that any inspection has taken place;
- Even a written report does not imply that the user has to actually take any subsequent action, so there is no disincentive to receiving the report from the user's perspective.

[60] *Implementation of Article 8 of the Energy Performance of Buildings Directive", page 3

Therefore, a written report is considered to be part of this 'inspection'. From the survey, it is established that over 90% of service technicians (who responded to the survey) already supply a report. It is concluded that a report, to include at least a defined minimum of information, should be included in the definition of inspection.

"Inspection", in this study, therefore means:
Carrying out the procedures of a service as described above, and delivering a report of the boiler performance.

4.2.2 Defining 'Regular', and the pros and cons of various frequencies

Article 8 does not specify the frequency of inspections except in the case of boilers over 100kW. For these, a maximum interval of 2 years is allowed for non-gas fired boilers, extending to 4 years if the boiler is fired on gas.

There will be a trade-off between the benefits from more regular inspections and the costs involved. The shorter the interval between inspections, the greater the environmental benefit but the greater the cost.

The service interval should ideally be related to running hours rather than years: as very few boilers can or do clock their running hours (although more common for very large boilers, and included recently as standard for some smaller units), this is impractical. Reference can be made to "an average heating season" for domestic users, while drawing the attention of hospitals, hotels etc. that their duty may equate to two or more such seasons per year.

In deciding what the appropriate intervals for inspection should be, the following are some pertinent considerations:

Six-month intervals

- Boilers in continuous use, say due to summer hot water load, may require 6 monthly servicing. Many hospitals, nursing homes and hotels already service their boilers on a six monthly basis
- Very large users can emit a considerable amount of excess CO_2 in 6 months if their equipment is not well serviced.

One -year interval

- Gas-oil boilers get dirty (sooted) most quickly, probably losing about 2% efficiency per heating season (per year, but counted as 2 seasons per year if in continuous use)
- Natural gas are slow to get dirty, as are, to a lesser extent, kerosene and LPG boilers – dirt is scarcely perceptible for 4 seasons or more

- Article 8 Option (a) stipulates that oil boilers > 100kW require inspection at least every 2 years. It would be illogical that more frequent mandatory inspection, e.g. every year, would be imposed for smaller boilers
- Virtually all manufacturers have always advised a one-year interval for service, irrespective of fuel, although the service requirement has greatly diminished due to cleaner fuels: they are unlikely to support any longer interval (unless accompanied by other more attractive measures for them)

Two-year intervals

- Over one third of boilers are already serviced annually (per section 3) - would implementation of the Directive based on two-yearly testing serve only to prejudice this?
- Domestic oil burning averaging only 2,032 litres per year suggests that a two-year interval would not be too long for any category including the 'worst', gas-oil boilers.

4-year intervals

- Kerosene could be regarded as falling a little short of gas[61] in terms of cleanliness of burning. It produces some 25% more CO_2 emissions per kWh produced than does gas. A four-yearly frequency might suffice for kerosene-fired (oil) boilers.
- (On the other hand) For safety, 4 years is a long inspection interval: BGE actively encourages a 1-year safety inspection for gas boilers.

There are, therefore, a variety of arguments for different intervals to be adopted for boiler inspection, consequently it would perhaps not be wise to be too prescriptive. An ideal situation could be to have different time intervals dependent on fuel used. Our scenarios choose three sets of intervals for examination, to reflect a cross section of those arguments.

4.2.3 Annual fuel usage and costs per boiler

Section 2.7 detailed how 2032l/year was the 2003 domestic oil boiler average. The gradual move to kerosene is increasing this litre volume, because, to produce the same heat, more kerosene by volume would be required, than gas oil. 2180l could be a suitable figure for 2005. One might, on the other hand, argue, that we should assume an average HEAT input per house, in which case any less efficient appliances would burn a greater volume. To avoid unnecessary confusion by making repeated small adjustments of that nature, that would not be warranted by the inherent accuracy of the data available, 2032 litres of gas oil is

[61] Kerosene is not used for home heating in mainland Europe due storage considerations. It is also of small import in the UK, as explained in 3.4.4. The wide use of kerosene in Ireland might be expected to carry through to some differences in analysis and policy consideration.

used[62] as the basis for calculating the amounts of CO_2 used and the reductions that can be obtained, in the following pages.

The private buyer price used[63] for fuels is

- Gas-oil 53.4 c/litre
- Kerosene 54.4 c/litre
- Natural gas (priced as >18,000kWh/yr.usage @ 4c/kWh, equivalent to 42.2 c/litre (no effect on standing charges)

.

4.2.4 Calculations of CO2 savings

There are two types of saving in question in this study,

- Savings by replacing boilers of one efficiency level with another efficiency level – Type A savings, and
- Type B, savings derived from the cleaning effect of servicing.

They are calculated as shown in Appendix B

5. Examination of Option (a) measures

5.1 Measure 1, Boilers over 20kW *and* over 15 years old

The Article 8 requirement for a once-off inspection of boilers over 20kW and over 15 years old is unambiguous. It arose from the realisation that there is a population of older boilers that are significantly less efficient than modern designs: the time cut-off of 15 years derives from this. In Ireland, the sale of such boilers continued into the late 1990's, albeit as a declining proportion. Unlike the other measures called up in Article 8, this measure is presumably intended to expire when this population has been retired. Another feature that distinguishes it is that, if implemented as apparently set out, it would require a special and new category of inspector to fulfil it as outlined below. This type of inspector could be a 'hands-off' person, who, in contrast to the service personnel of measures 2 and 3, would not get his/her hands dirty. For this type of inspector, three scenarios are examined under the heading "A" as follows – the numbers who will voluntarily respond to the findings of the inspection are estimated at the three different levels of **replacement** by modern boiler – as undoubtedly the advice would almost undoubtedly stress that desirability.
However, if this inspection also includes a full service, then scenario "B" applies, it assumes 0% replacement and that the savings arising from servicing/cleaning of this group of boilers. A hands- off inspectorate leans towards A, while hands-on leans towards B.

[62] Based on heat equivalence, the maximum error arising from calculating CO_2 emissions between 100% gas oil base and 100% kerosene base is 2.7%
[63] SEI fuel cost comparison Jan 2006

In practice, unless options set out under Option (b) are chosen, the Option (a) outcome will be some combination of A and B – there are so many possible combinations that this is not pursued.

5.1.1 Type A Inspection, does not include a service

The savings here are of type A – savings by replacing with higher efficiency boilers (see Appendix B)

Inspection skills The skills required for this, Measure 1, part of Option (a) are extra to those required for Measures 2 and 3 - i.e., a **Service Technician** who has not attained, for gas, Installer 3 (GI3) level or equivalent, or for oil, Technician (OFT) 50 or equivalent, may not have the requisite skills to assess the overall heating system. Of those who have (such skills), few would be able to properly assess the heating demand of the premises (in order to correctly size a boiler), - all of these abilities are required for this "over 20kW and over 15 years old" category. (This of course also applies to installers). An **Energy Consultant**, on the other hand (e.g. the sort of person who may in the future assess building energy performance for certification or labelling purposes, under Article 7 of the Energy Performance of Buildings Directive), would thereby be fit to perform the latter part (heat loss calculations), but might not have the skills to examine the boiler and heating system in sufficient detail. For these heating systems that are over 20 kW and also over 15 years old, the observation of our Danish respondent[64] about skills levels (see next section) thus applies equally to Ireland: "People who carry out boiler inspections lack knowledge of the other parts of the heating installation, whereas "Energy Consultants" who undertake energy labelling of houses for sale lack in-depth knowledge of boilers".

Given the requirement for inspecting boilers over 20kW and over 15 years, and that a new group of specially-trained inspectors will be required, training sufficient manpower for this task will be an important requirement if Option (a) is selected. The detail of the inspection suggests an output of 2 per day per inspector, or 50 annually based on 225 working days. This makes no allowances for sickness, inefficiencies etc.

Identifying boilers over 15 years also represents a real challenge as many households and organisations may not know the age of their boiler (e.g. if they have moved into a house or premises in recent years). Given that verification that their boiler is over 15 years and 20kW will generate a possible cost to them, (by confirming the requirement for a system inspection), there is a disincentive for organisations or households to volunteer this information.

[64] See 2.4.2

The costs, benefits and logistical implications of this section of Article 8 (i.e. requirements for boilers over 20kW and over 15 years old) form part of the review of the different Option (a) scenarios in the following sections.

Costs:

As mentioned previously, the administration of Article 8 will incur a public cost for a Secretariat, whichever approaches and options are chosen. Specific private costs that arise in dealing with boilers over 15 years old are estimated as follows:

It is estimated that there are 85,000 oil boilers over 20kW and over 15 years old at the end of 2005 (see Table 2), the old 'stock'. A further 25,000 boilers will be reaching the 15 year threshold each year thereafter. The corresponding figures for gas are – stock of 5,000 over 15 years old with another 4,000 arising per year, and for solid fuel those figures are 3,500 and 800 respectively. The total is then 93,500 old stock, and an extra 29,800 arising each year into the programme. The activity level depends on the time period allowed for an inspection to take place. Note, when the inefficient older boiler stock is fully replaced, there would be little justification to continue with this measure.

Table 11 Numbers of Inspectors required, costs

Period, years	4	3	2	1
No. of boilers	48,500	53,175	60,967	76,550
No. of inspectors	108	118	136	170
Industry cost, training, €	324,000	354,000	405,000	510,000
(Extra) private cost, where applicable, €	100	100	100	100

The additional private cost of an inspection the estimated inspection cost €200, less the €100 service charge on average every 3 years, i.e. € 100.

This measure might continue until say 2015 at the latest, by which time the less efficient (65%, Section 3.3.2.9 (c)) boilers should be eliminated.

The private costs that Article 8 imposes for this group of boilers are inspection only, as any actions taken as a result of inspection are optional: the costs and benefits of typical actions for the individual are shown in Table 12 below

Table 12: Average optional private cost and benefit to consumer in replacing e.g. boiler > 15 years old and > 20kW by modern wall-hung boiler

Fuel	Cost €	Annual saving € (oil 54c/l, gas 40c/l), annual burn 2032l	Simple payback, years
Oil			
Standard (85% eff.)	1500	258	5.8
Condensing (95%)	2100	347	6
System (condens. + further 10% gain)	> 6000	382	> 15
Gas			
Condensing (95%)	1400	86	16.3

Benefits

Throughout the study it is assumed that at CO_2 savings and efficiency improvements are directly linked on a 1:1 basis, and it is reasonable for practical purposes to assume that a 1% improvement in efficiency produces a 1% reduction of CO_2 emission. As CO_2 is produced directly by combustion of fuel, and the amount is known for each fuel, if the fuel reduction is known, then CO_2 is reduced by the same percentage

Although inspection would be mandatory under Option (a), compulsion ends there, there is no requirement for any action to ensue – therefore to predict the fuel savings, assumptions must be made as to what percentage of inspections might result in action, and indeed what kind of action that would be. This is clearly a matter of taking a view: are there any grounds on which such guesstimates might be based?

There are no definitive or scientific grounds; the evidence is more loosely based. It is known, for instance, that an effective national promotional campaign can achieve at best 5-10% success (in terms of the number of people who will take action). 10% is a very high response to any marketing campaign. This can of course be greatly increased by well-chosen grants or other incentives. Also, the service technician questionnaires indicate that service technicians estimate that an average of 65% of customers accept their advice and replace boilers immediately when so advised, however, and an important caveat, is that this is invariably advice relating to continued operation and reliability - non-availability of parts, inability to repair etc. – and rarely for energy economy. The 'flavour' from these technicians, and the experience of energy conservation campaigns both in Ireland and wider afield, is that, although consumers are well disposed to energy conservation and reduction of pollution, they are very slow to take even the simplest and cheapest of actions, unless they have a particular problem, or are offered an inducement.

Note on the above table:

The paybacks may not seem very impressive at first glance, but are based on averages including the many people who operate quite frugally and at low comfort levels. It is known that average temperatures in houses are continually rising, so the paybacks will shorten over time.

Rather than use the above figures in promotion, illustrations based on the higher spends of some households would be far more powerful, showing much shorter paybacks – e.g. a table based on annual fuel spends of € 2500, €2000 and €1500 would show paybacks of 2.6, 3.3 and 4.4 years respectively for condensing boilers.

There is no doubt that where an expert advises a course of action, it results in a far greater response than may be expected from a promotional campaign alone.

Based on the above parameters, this study assumes that exercise of Option (a), by means of national promotion and active encouragement of service personnel, would result in 10% replacement of the older boilers, per year, over and above their natural rate of replacement. As an ongoing exercise, whereby a further cohort of boilers fits the parameters each year, and as the focus would be on this sector, the 10% rate is applied to (refer to Table 2) boilers 10-15 years old added to those over 15 years old, i.e. 210,000 oil and 25,000 gas boilers, giving an annual replacement of 21,000 oil and 2,500 gas. The reasoning behind this assumption is strengthened by the fact that there is an increasing scarcity of spares for such older boilers and therefore good retirement arguments. It is assumed that there would be no tangible system replacement. Also, as even the older gas boilers have a probable 85% efficiency, their replacement is not included in benefits, the benefits are calculated solely on 21,000 annual oil replacements, and it is further assumed that a quarter of these would be by the highest efficiency, i.e. condensing, boilers. Good marketing, including adding to publicised SSIA fund spending options, would help underpin this achievement, perhaps even better it.

Setting out the lower, medium and higher scenario benefits, the 10% figure or 21,000 boilers per year is taken as the medium, with low and high attainment assumed set at 7.5% and 12.5% respectively.

Table 13. Measure 1, A, Option (a): Benefits of replacement of boilers >15 years old and > 20kW, domestic sector only

Public benefit scenarios **Reduction of yearly CO_2 emissions, tonnes**. The lower benefit is 7.5%, i.e. 15,750 boilers/year, medium is 10% or 21,000 boilers/year, higher is 12.5%, 26,250: in both cases, a 75/25 split in efficiency gain from 65% to 85%/95%, is assumed				
	Savings, tonnes CO_2/year			
	Lower	**Medium**	**Higher**	
Oil boilers only	21,498	28,665	35,830	The measure could have a duration of approx. 10 years
Gas boilers		-	-	No CO_2 saving
SF boilers		-	-	No CO2 saving
Private benefit				
	The benefits are received only by those who take action to replace, and are shown above in Table 14			

Logistical and Practical Implications

Oil and Solid Fuel: The numbers outlined under the Costs heading above show a need for inspection of approximately 55,000 boiler systems per year for the first three years, with a drop in the number to be inspected thereafter. This represents a need for 100 specialists that do not currently exist (assuming two inspections per day, 225 days per year each). The training requirement is therefore for, say, 120 persons (assuming some drop-out etc.) at an assumed training cost of €3,000 each. This gives a total required training cost of some €360,000.

Gas: Chapter 2 showed that some 5,000 units will exist in 2005, to which an average of 4,000 per year will be added over the following years. To fulfil the requirement of a system inspection in three years, 5,700 boilers per year will have to be inspected. This would require approximately eleven trained personnel. It should be possible for BGE to source and train this number of suitably qualified personnel from the existing pool of gas service technicians.

5.1.2 Type B Inspection, includes boiler service

The savings here are type B, i.e. savings from increased frequency of servicing and cleaning (see Appendix XXX). This is a variant of Measure 2. Therefore, if it is to be considered at all it must be more stringent than the Measure 2 adopted, as the sector is singled out for special attention. The key figure required here is “n”, the servicing gain in years over current practice. If n is positive, there is a gain, if 0, there’s no gain, and if n is negative, the measure increases the CO_2 emissions.
Thus, with n for current practice of approx. 3 years, there will only be a reduction of emissions if boiler owners are given only 2 years or less to have the inspection.

Costs and logistics

If 2-year period allowed: The average private cost to owners of boilers in this category, is estimated to be € 67 (this is € 200 for an inspection, € 100 per year over the 2 years, less the current service of € 100 averaged over 3 years, € 33). IF the execution of the inspections is smoothed over the 2 years by e.g. some booking system, then the number of boilers to be inspected each year for the first two years is:
Oil, ½ of the 85,000 stock, i.e. 42,500, plus the 25,000 becoming 15 years old with each successive year, i.e. 67,500 per year for two years, falling to 25,000 per year from the third year on.
Solid fuel is ½ of the 3,500 stock, or 1,750 per year.
Gas is ½ of 5,000, i.e. 2,500, plus 4,000, total 6,500 per year falling to 4,000 from the third year.
Leaving solid fuel aside, 74,000 inspections are required per year, a need for 135 inspectors (plus an extra say 25, making 160). Training could then cost as much as € 480,000.
If the inspection frequency is reduced to 1-year, this entails 19,000 boiler inspections requiring a theoretical number of 216 inspectors, say 250 to be trained, cost € 750,000.

Public benefit

2-year frequency: The calculated CO2 savings are: Oil boilers 9,018 tonnes per year for two years, 3,340 tonnes per year thereafter, (Solid Fuel boilers, 0 if burning of timber only is assumed), Natural Gas, 174 tonnes per year, reducing to 107 tonnes per year from the third year.
The total CO_2 reduction is 9,192 tonnes per year the first two years, 3,447 tonnes per year from year 3.

1-year frequency: If the inspection (that includes a service) interval was reduced to 1 year – and if B is used it seems probable that would be the intention of Article 8 - the results are:

CO_2 savings – oil 29,393 2 t/y falling to 6,680 from the 2nd year, gas 481 tonnes per year falling to 214 tonnes per year from the 2nd year. Total 29,874 tonnes falling to 6,904 tonnes from year 2.

Table 14 Measure 1, B, Option (a): Benefits of 'inspection' of boilers >15 years old and > 20kW, domestic sector only, results only in a service

Public benefit, Reduction, tonnes CO_2/year			
	Lower (2-years)	**Higher (1-year)**	
Oil boilers, Gas boilers, SF boilers	9,192 for first 2 years 3,447 from year 3	29,874 first year, falling to 6,904 from year 2	Reduction of yearly CO_2 emissions, tonnes. The lower benefit results if owners are given 2 years to inspect, the higher if given 1 year. Both ongoing figures would fall gradually as 2 years or 1 year became the normal service interval
Public cost			
	0.48M	0.75M	Training
Private benefit per boiler per year			
Gas oil Natural gas	€ 27.12 € 4.29	€ 54.25 € 8.58	Benefit from more efficient burning
Private cost per owner per year			
	€ 67	€ 167	200-33 for 1 year, 1/2(200) – 33 for 2 years

Observations on the introduction of Measure 1, Type A and B.

If the authorities were to mandate (Option (a)) that boilers and systems > 15 years old and > 20 kW were to be inspected – whether type A or B – within a limited time (e.g. within 3 years), it is conceivable that there would be little action until the closing months or weeks, by which time the inspectors could not complete the required number of inspections. In such a situation, if the consumer can avoid the cost of an inspection, say €200, by replacing the old boiler, and also benefit from fuel savings with added savings that would bring, replacement action might greatly increase.

It has been suggested that it is possible that older, gas-oil boilers will be found mainly on farms. The reasoning here is that most requests to set (replacement) burners for gas oil apparently come from farmers, who may combine their tractor and heating diesel oil purchasing. While this may well be correct, it is considered unlikely that the tractor diesel tank is often sited close enough to the house to supply the heating oil. Even where that might be the case, and there isn't a separate heating oil tank available to accept kerosene, a switch to kerosene diesel might at most involve an additional purchase of an oil tank.

5.2 "Measure 2" Option (a): Boilers between 20 and 100kW size

From Table 9, this measure applies to:

- Oil (gas-oil and kerosene) and solid fuel fired boilers of > 20 kW < 100 kW capacity.

Estimates of the savings in fuel burnt and corresponding reduction of CO_2 emissions depend on relatively ascertainable facts such as fuel used and population of boilers, and assumptions such as, that the average burn of fuel per boiler is evenly distributed across the different types and fuels, and that we can state a definite percentage by which the efficiency of each type is improved by servicing it 'now' instead of next year. The least robust data thus required is that relating to savings due to servicing. No authoritative data on this area has been found. Expert opinion suggests that the following assumptions are the best that can be made:

Table 15: Estimated savings from more frequent servicing, per year	
Fuel used	% efficiency gain per service year
Gas oil	2.5
Kerosene	0.751
LPG	0.75
Natural Gas	0.5
Solid fuel	4

The gain in service years is represented as n, which may be positive, zero or negative.

The combustion of solid fuel is carbon neutral for wood, and the savings from any, very few, coal-fired boilers falling under Article 8 would be minimal, so solid fuels are not relevant here except to note that their servicing requirement is the most intensive.

5.2. Measure 2 scenarios

The current average number of services is 1,250,000 boilers over 3 years, i.e. 416,700 per year, or 3.7/technician per day (Section 3.3.2.2). Note, those boilers that are >15 years old and > 20 kW are not included, as they have been discussed as Measure1. Note also that it is assumed that normal 3-year servicing continues to apply to all smaller boilers under 20kW (97,500 oil, 408,000 natural gas) and to the total of solid fuel irrespective of size, 65,000 making a total of 570,000 boilers that are still serviced 3-yearly, 190,000 services per year, and that have no additionality or effect relevant to Article 8, except in that they continue to have their current service manpower requirement. The population of

boilers that affect CO_2 emissions for the four scenarios of Measure 2, under Article 8, is shown in Table 16 below. It is also to be noted that, by separating the inspection requirement for older boilers from the current practice, as Article 8 requires, the present service cadre would carry out an average of 0.27 fewer services per day: 37 of our present service personnel would thus no longer be required unless more service activity arises from the Scenarios.

5.2.1 Measure 2, Scenario 1 – Minimal effort

The elements of the first scenario reviewed under Option (a) are shown below. Arguments can be advanced for the service intervals selected for this scenario (Section 4.2.2), but it has the surprising result of an increase in CO_2 emissions over the levels arising from the current service regime in Ireland. The reason for that surprise is that the boiler population over 15 years old, most of which is gas oil, is excluded from the calculations of benefits, as the older boilers belong in Measure 1. This scenario is instructive as an illustration, but is not of course used again in any part of the study. The reductions in pollution flowing from year to year at present from the ongoing switch from gas oil to kerosene are cut in this scenario, as the service interval for kerosene boilers is raised.

Table 16: Measurement 2, Option (a): Scenario 1, "Lower"		
Boiler Size	**Natural Gas and Kerosene Boilers**	**Gas-Oil and Solid Fuel Boilers**
Over 20kW and under 100kW, < 15 years old	Inspection every 4 years	Inspection every two years
Number	464,000 kerosene 95,000 natural gas	31,000 gas oil (boilers)

Costs

Section 2.7 (ref. Table 3a) indicates kerosene supplying 80% of the domestic oil boiler market at end 2005 (and probably a similar or higher share in the small to medium commercial market). Applying that to the boiler populations in Table 2 indicates 464,000 kerosene and 116,000 gas oil. The 85,000 boilers over 15 years old are presumed to be virtually all gas oil: they, and the 5,000 older natural gas boilers out of the 100,000 gas population boiler over 20kW are deducted from the above numbers. Solid fuel boilers are omitted, as the indications are that those over 20kW are firing renewable timber.

Manpower: the 559,000 gas or kerosene boilers are serviced every 4 years, 139,750 per year. The 31,000 gas oil boilers are serviced every 2 years, 15,500 per year. The total number of services, including all smaller and solid fuel boilers, is 345,417 per year, i.e. 190,000 services per year, The average intensity of

services would be reduced to 3.1 per day from 3.7.No further manpower is required, 11 persons of the current service pool would be surplus.

Benefits

Thus, "n" for kerosene and gas is –1, and +1 for gas-oil. This Scenario 1 measure in itself would actually **increase** annual CO_2 emissions by 17,040 tonnes.

Note: Scenario 1 serves to indicate how measures that might reasonably be formulated under Article 8 would have an opposite effect to what is desired. It sets the scene for the next scenario, – the service intervals assumed are at the low range of what could be defended. Needless to say, this scenario is not used in any other part of the study as to set targets or otherwise.

5.2.2 Measure 2, Scenario 2 – Lower Scenario

The second scenario identified under Option (a) involves a slightly more rigorous inspection regime than current practice. Natural gas and kerosene boilers are serviced according current practice, while the frequency is increased to every two years for gas oil boilers (also for solid fuel, that have a need for frequent servicing: this affects the manpower required a little, but not the emissions).

Table 17: Measurement 2, Option (a): Scenario 2, "Medium"		
Boiler Size	**Natural Gas and Kerosene Boilers**	**Gas-Oil and Solid Fuel Boilers**
Over 20kW and under 100kW, < 15 years old	Inspection every 3 years	Inspection every two years
Number	464,000 kerosene 95,000 natural gas	31,000 gas oil (boilers)

Costs

The Manpower implications are 391,800 services per year, 3.48 per day. Note, although this compares with 3.7 per day current practice, this latter figure includes the population of older boilers that will fall under a special, different inspection regime: the Scenario 2 regime is slightly more intensive than current practice, but no extra manpower is required.
The extra public costs would be € 17 per year for the 31,000 gas oil users (that have boilers less than 15 years old) – i.e. €100 service spread over 2 instead of 3 years.
There are no other public or private costs other than administration and promotion of the scheme.

Benefits

n= 0 for gas and kerosene, and n = 1 for gas oil. The annual reduction in CO_2 emissions would be 4,142 tonnes.

Logistical and Practical Implications

The logistical and practical implications would be minimal.

5.2.3 Measure 2, Scenario 3 – Medium Scenario

The third scenario under Option (a) assumes an again tighter inspection regime than in Scenario 2. Specifically, it assumes under this scenario that all oil boilers would be inspected on an annual basis, as per Table 9.

Table 18: Measurement 2, Option (a): Scenario 3, "Robust"		
Boiler Size	**Natural Gas and Kerosene Boilers**	**Gas-Oil and Solid Fuel Boilers**
Over 20kW and under 100kW, < 15 years old	Inspection every 2 years	Inspection every year
Number	464,000 kerosene 95,000 natural gas	31,000 gas oil (boilers)

Costs

Manpower: the annual number of all services would increase to 500,500 per year, representing 4.45 per day, and requiring an increase of 101 service personnel, at a public cost for training of 101 x 1,500, total 151,500. The extra private cost would be € 17 per year for those with gas or kerosene boilers, and € 67 for those with gas oil boilers. The assumption is that there would be no change in practice or extra cost for the estimated 570,00 owners of smaller boilers, or for those with older boilers (who may however have to pay more again for their special inspection, as required by Article 8).

Benefits

n= 1 for gas and kerosene, and = 2 for gas oil. The annual reduction in CO_2 emissions would be 29,464 tonnes

5.2.4 Measure 2, - Scenario 4, Robust scenario

Table 19: Measurement 2, Option (a): Scenario 3, "Robust"		
Boiler Size	**Natural Gas and Kerosene Boilers**	**Gas-Oil and Solid Fuel Boilers**

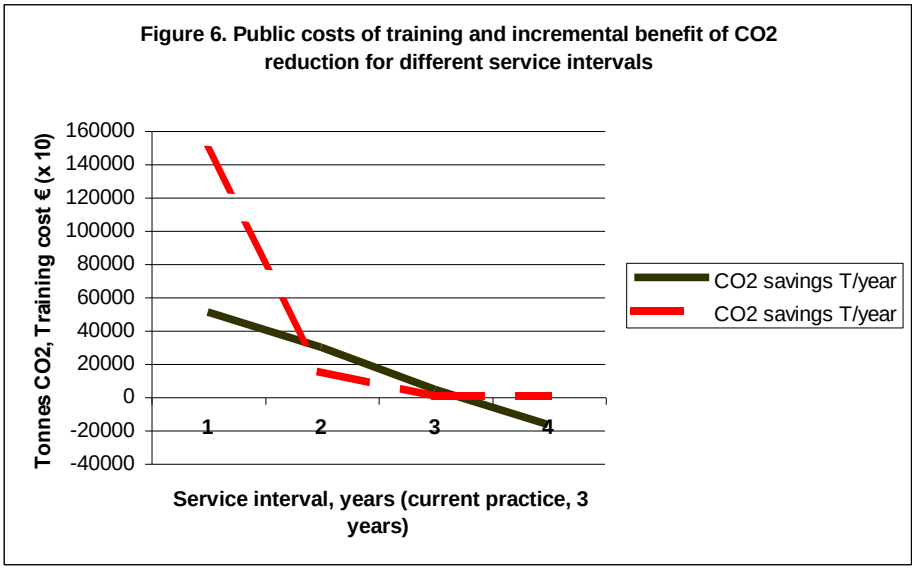
Over 20kW and under 100kW, < 15 years old	Inspection every year	Inspection every year
Number	464,000 kerosene 95,000 natural gas	31,000 gas oil (boilers)

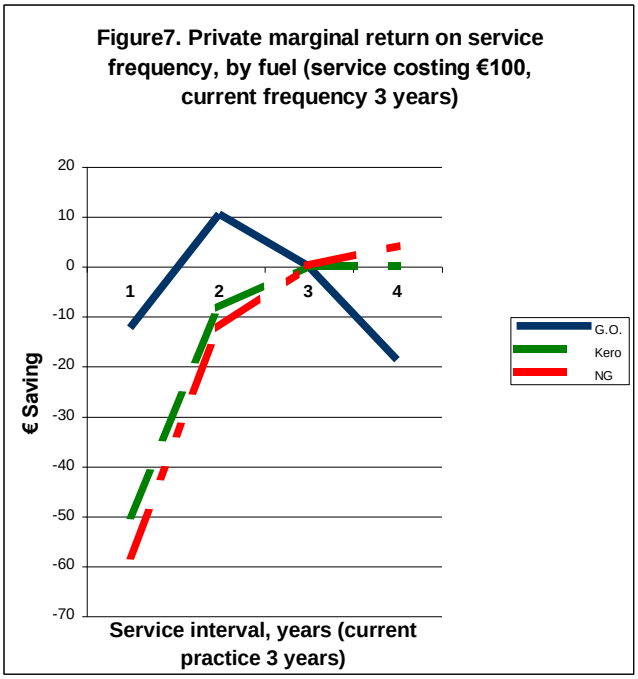
Cost: the manpower requirement would be for 820,000 services per year, in total: the existing service personnel – who would have to carry out 7.3 services per day, could not fulfill this. To return the level of service to the current level average of 3.7 per day would require total service manpower of 985, or 485 extra personnel. The public training cost at € 1,500 each for training would then be € 1,477,500.

The private cost would be € 67 per year for all owners of boilers over 20kW, gas, kerosene and gas oil fired (solid fuel might be either be included or excluded without extra effect either way: again, a separate inspection regime for the 85,000 older boilers of over 20kW is assumed).

The CO_2 emissions reduction would be 50,644 tonnes per year.

Public cost and benefit is examined in Fig. 6 below. It is important to remember that, to enable them to be depicted graphically together, they employ different scales on the vertical axis, and readings of the cost values scale are therefore to be multiplied by 10.





This curve shows how the cost of additional servicing can tip the returns to the consumer into the negative. It suggests that, from a purely private return point of view, 2 years is optimal for gas oil boilers, 3-4 for kerosene and natural gas would be optimal at 4 years or more. The comparison is based on the current 3-year baseline at 0. Thus, the private return on extra servicing – Type B savings – is very low.

5.3. Measure 3 - Boilers over 100kW capacity

Table 20. Estimated total commercial boiler population split by size and fuel used

Fuel	Total all sizes	Under 40kW	40 – 100 kW	Over 100 kW
Oil	35,200	30,200	3,500	1,500
Gas	18,000	15,000	2,000	1,000
Solid fuel	-	-	-	-
Total	53,200	45,200	7,500	2,500

The possible gains in this sector are compared below to those of the generality of domestic boilers as described in Section 2.2.2.9. These boilers break into three groups

- Up to about 40 or 50kW – Treatment quite similar to domestic, slightly higher fuel consumptions and attention to servicing. Throughout the study, they are effectively lumped with domestic.
- From 50 to 100 kW – the better attention, higher fuel usage, profile, increases

- Over 100kW – upwards, enjoy increasing levels of care, as their mission and running cost is significant**.**

Efficiency gain from servicing: it appears this is largely obtained already by a far greater service frequency than for domestic boilers: further savings are likely to be slight.

Efficiency gain from commissioning: larger boilers in this sector tend to be sold by more specialist companies, the transaction is more professional than the domestic one and they are almost always properly commissioned. The larger ones in particular tend to be commissioned with the involvement of highly trained instrument technicians etc., and to have far greater sophistication in their instrumentation than the rudimentary level of smaller boilers.

Efficiency gain from replacement is very difficult to quantify – larger boilers are more individually engineered than the mass-produced domestic boiler, their application is likely to be far more specific. A few of the very largest burn heavier, cheaper fuels, and in some cases, if replacement is considered, it might be that a replacement should not be just a direct, kW for kW, swap, but the duty of the boiler system etc. should be studied, and the replacement properly engineered. Referring to another part of the sector, manufacturer and service personnel interviews suggest there may be a significant number of boilers that are inefficiently configured, in hotels and nursing home applications particularly. Situations where significant improvements are possible are characterised by:

- Relatively high ‘turn-down ratio’ (e.g. winter heating + hot water load divided by summer hot water load) –
- Very old equipment, reasonably well maintained, but lagging modern plant capabilities:
- Changes to buildings have not been matched by adjustments to heating equipment

A typical example is a hotel with boiler plant of 200-300kW, often in a single unit, whereby, to heat hot water in summer, perhaps 3 tonnes of metal has to be heated as well as the required water. Modern practice would suggest 3-4 units or modules that can be fired up together or independently, thereby maximising load efficiency, minimising wear and tear and providing almost guaranteed continuity. The first cost, and the space required, could of course be considerably higher, The move to very high efficiency (condensing) boilers has been very slow in the domestic sector in Ireland, compared to, say, the UK, although their extra cost over conventional boilers continues to decrease. For cost reasons, almost all are gas-fired (these are considerably cheaper to make than the oil-fired version). There is hardly any evidence of their penetration into the commercial/industrial sector, which is very surprising due to the high fuel usages there. An investigation into this is outside the scope of this report, although the answers might better inform policy in this sector. Among the parameters are:

- Physical space availability may be a limitation
- Condensing **gas** boilers are available as a standard product up to about 150kW (from Germany in particular)
- Standard condensing **oil** boilers of over 70 kW are hard to find – perhaps their individual engineering then drives up the costs
- What is available in Ireland tends to follow the UK, where the need for and advantages of a condensing oil boiler would be very limited in contrast to Ireland
- Kerosene-fired boilers are now generally available up to a maximum size of about 100kW (there's no size restriction on gas oil, or natural gas, boilers)

The study has found anecdotal evidence of from 4 to 6 modular boilers being used recently in hotels and apartment blocks: this may suggest a market opening for further penetration by larger modular units. The study suggests it would be useful to examine the boiler situation in hotels, schools, halls, swimming pools, hospitals and nursing homes in a more detailed way (by survey or other method) to establish sizes, turn-down requirement, age and other parameters. In view of the reported decline in the fortunes of the tourism B&B sector, where boiler running hours are likely to exceed general domestic, pattern, this sector might be included, to estimate the benefits of condensing appliances or other measures. Hospitals might also be included, albeit their respective Technical Services Officers may already have assessed those falling under the control of the former Regional Health Authorities.

Article 8 states that all boilers over 100kW and their associated systems must be inspected at least every 2 years. Some establishments with installed capacity over 100kW, and thereby using similar high quantities of fuel, would not be affected by that statement, and there is a strong argument, if the target is to obtain reductions in pollution where reasonably possible, to differentiate between oil boilers (likewise for the few solid fuel units that might qualify) where the threshold might be set at over 50kW, and gas, remaining at 100kW.

Attributes of the industrial/commercial sector

The disciplined culture of the industrial, and to a much lesser extent the commercial, sub-sectors, means they could be considered for the 'pilot' introduction of measures, with households learning from their experience. This is largely due to the organised nature of the sector, i.e. that it is:

- More conscious of and accustomed to using schedules
- Tracks its costs and uses reporting systems
- Has technical staff capable of appraising the detail (industrial sub-sector only)
- Might welcome an initiative that enabled better cost control

- Is accustomed to a compliance burden, so, in contrast to the domestic sector, would find a mandatory regime less problematic
- Has dedicated channels of influence and information, Small Firms Association (SFA), Irish Small & Medium Enterprises Association (ISME) etc.) that would enable dialogue on the details of implementation
- Is accustomed to actions based on investment returns and paybacks - boiler replacement payback periods should be attractive at the current (end-2004) combination of fuel prices and interest rates

It may be useful to bear these in mind if piloting or testing of any measure is considered. However, the industrial sub-sector[65] in particular has made considerable use of technical advice and incentives from SEI and its antecedents and tends to be relatively aware of possibilities for improvement.

This study therefore concludes that the additional improvements available in the industrial/commercial sector in relation to Article 8, except for the hotels etc. outlined above for which special measures may be advisable, are relatively small in comparison to the domestic sector, and thus the concentration in examining options (a) and (b) is concentrated on the domestic sector.

The contrasting **attributes of the domestic consumer** are:

- Less aware of what equipment s/he has
- Less aware of the associated annual spend
- Less inclined to think in cost and return terms
- A short boiler failure is not as 'mission-critical' for them
- More difficult to motivate

In summary:

- Measures that work for the domestic sector are likely to work better for the commercial.
- The commercial sector is more conditioned to an option A approach than is the domestic
- Due to the dominance of kerosene in the domestic, and prominence of gas oil in the commercial, sectors, annual savings available from increased servicing may be similar, and the fuel differences also offer policy alternatives
- Despite dissimilar profiles, both sectors may be roughly equivalent in terms of total savings potential

Conclusions on boilers over 100kW

[65] The authors of this study believe that major energy efficiencies have been, and continue to be, made in the industrial sector above all others, but that, conversely, the commercial sector is the most energy inefficient and unaware sector in Ireland in electricity and heating.

Article 8 requires a service period of at least every 2 years for oil- fired, and 4 for gas-fired, boilers over 100kW. It seems unlikely that this would save any CO2 in Ireland.
More information is needed to tailor services and policies for this sector.

6. Defining scenarios under Option (b)

6.1 Overview of Option (b)

Article 8 of the EPBD allows for an alternative Option (b) to the mandatory inspection Option (a). Under Option (b), EU Member States shall:

'take steps to ensure the provision of advice to the users on the replacement of boilers, other modifications to the heating system and on alternative solutions which may include inspections to assess the efficiency and appropriate size of the boiler. The overall impact of this approach should be broadly equivalent to that arising from the provisions set out in (a). Member States that choose this option shall submit a report on the equivalence of their approach to the Commission every two years'.

As with Option (a), the first consideration here is to make sure the terms and definitions of this Option are clearly understood, so they are examined in the Section 6.2, below.

Then the possibilities of achieving are explored. This is broken into 3 divisions, and they are listed in Section 6.3.

- Measures that are considered worthwhile in themselves, but do not directly address the options (Section 6.4)
- Measures, different to those mandated in Option (a), that might convey equivalence to them (Section 6.5), and
- Matching - attempting to achieve the effects of Measures 1,2 and 3 as mandated in Option (a), by means of the Option (b) approach of advice etc. — ranging from the lower case scenario to the maximal scenario outlined in (b) (Section 6.6).

6.2 Setting Parameters for Option (b) Scenarios

6.2.1 Option (b) Parameters

The minimum requirement must be that all relevant boiler owners/operators in the domestic and commercial sectors have access to advice. It is necessary to define the parameters of an advisory scheme to evaluate the possible effect.

- Is advice to be provided on a pro-active basis?

- Is it a once-off or ongoing advisory service?
- How can ‘broad equivalence’ with Option A be established?

It seems arguable that a good advisory system would require a mix of:

- A source of information, e.g. a booklet
- Media campaign, direct advertising and publicity
- Website for information, with search engine to ascertain boiler details
- Possibly a help-line.

These might vary as to detail, design, content, media spend, and eventually expense, between the three scenarios considered below. The least-cost option will be at the lower end of such activities and their costs.

As the ‘inspection’ regime in Option (a) would be ongoing at chosen inspection intervals, the Option (b) ‘advisory’ regime would also be ongoing, or repeated as necessary.

6.2.2 Minimum Complying Procedure

A minimum action to satisfy the general requirements of Article 8 would be the circulation of an advisory booklet outlining the benefits of boiler servicing and replacement. The circulation of this material could be done in a variety of ways that will be explored in the first Option (b) scenario. An advisory campaign would need to be designed so its circulation gives maximum reach to the target audience, in this case domestic and commercial boiler owners/operators.

Satisfying Article 8 for boilers over 20kW and over 15 years is more problematic. The necessary information can be included in the mail-shot for all boiler owners, but how does the owner know that a boiler is over 15 years old or over 20kW? This was discussed in Section 4.1 and an appropriate website and database with good search facility would make it possible for owners to verify details of their boiler, but there would be error involved (to an extent not predictable in this study) and many owners would not take up this option. The only way to be sure of the age/size of the boiler is to have it visited by a service technician.

Mailing could be associated with suitable events such as Energy Awareness Week (annual) or national information campaigns on behalf of the Department of Environment for example. To meet the requirement of Article 8, the information to be distributed might include advice on the benefits of:

- Boiler inspection, servicing and replacement
- Matching boiler output to heat demand
- Heating system control and maintenance
- The benefits of replacing an old boiler with a new high-efficiency one
- Possible replacement cost parameters.

6.2.3 Determining Broad Equivalence

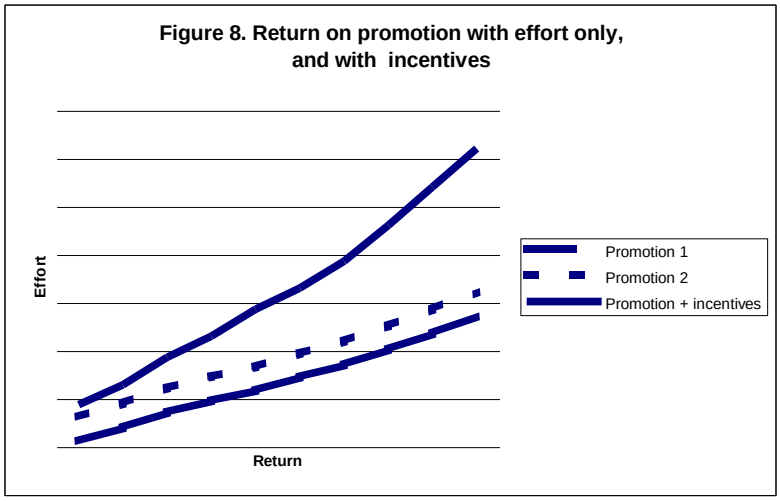
To determine the impact of an advisory campaign, various marketing metrics can be employed such as, response to unsolicited mail, recognition of issues, likely action following recognition, etc., or it could be assessed anecdotally by contact with boiler service technicians. These issues are discussed in Section 5.4.

Appropriate metrics are required to determine the possible equivalence of the advisory Option (b) and mandatory Option (a) scenarios. For the least cost options, a measurement of recognition, possibly recall, might suffice. For more costly scenarios, reduction in emissions would be the primary measure of effectiveness, although it would be difficult to establish equivalence. In all cases and for all scenarios, it could be argued that calculating the litres consumed per boiler, annually, possibly with degree-day adjustment, would be an indicator worthy of consideration.

In collecting information for such an indicator, considerations such as average comfort temperatures[66] would be potentially confounding factors. However, if a time series of such data were available, a discontinuity or change due to Article 8 interventions might be discernible[67].

Implementation of Option (b) measures will follow a "Return on Effort" curve, as depicted graphically below. Here, the lower curves represent two promotional mixes, that yield return as effort is increased (i.e. more money and other resources applied): the third curve shows how an incentive may have a dramatic effect on the gradient, the return for each extra effort. The slope of such a curve and thus the effectiveness of the effort depend on the receptivity of the public (itself a combination of the quality of the measure, as well immediate influences as e.g. cost of fuel, shortage of fuel, signals to the public ref., say, carbon taxes, their access to cash etc.), and the quality of the promotional campaign. By applying stimuli, or 'incentives' – e.g. cash grants for replacement of old equipment, or pushing the market to use only kerosene in almost all oil boilers – the return-to-effort curve may be favourably displaced.
This is simplistic, but is placed here to emphasise that the experience of promoting energy conservation measures is one of very low gradients, to the extent that the return may scarcely justify the effort. In the view of the study team, very low return is likely rather than just possible, unless 'incentives' are carefully added. Incentives may be of the positive kind – tax credit, grant etc. – or negative – fines, penalties.

[66] Average indoor temperatures are rising over time, due possibly to affluence and experience of conditions in work environments.
[67] SEI might consider a temperature sampling technique, analogous to the TAM ratings of TV, based on a sampled number of regular readings logged via telemetry or otherwise.



7. Matching for Option (a) Measures

A positive aspect of Option (b)

As advertising and promotion is not as reliable or predictable a means to put a message across than a detailed mandated action, it is likely that the Option (b) approach would generally sweep along the smaller boilers with the larger ones specified in Article 8. This is a good effect – savings for each such boiler could be very similar, even the smaller boilers are usually just under the 20kW threshold. It is an important part of Option (b) results and benefits, adding about 23% for oil, and 400% to gas, servicing benefits in reduction of CO_2 over a purely > 20kW Option (a) approach.

A negative aspect of Option (b).

There can be no guarantees, prior to taking action and getting some experience and track record, of any results form promotional campaigns. It is also important to realise that the effort to match the (b) promotional options to the (a) options is purely notional, it is by nature imprecise and options cannot be reliably mapped or mirrored between (a) and (b) – different levels of effort are examined for both options, but inspiring the public to take CO_2 reduction or energy conservation action, even where the personal paybacks are good, is notoriously difficult. The study team is of the opinion that, barring oil shocks such as those of 1973 and 1979, there will be little achieved without incentivisation. On the other hand, it must be pointed out that, the (a) options themselves are so loosely defined in Article 8 that it would be difficult, if not impossible, to know or prove whether any progress was made or equivalence achieved or not.

The question of numbers of service personnel or inspectors has been considered in the Option (a) examination, private costs likewise, and is not repeated here.

7.1 Matching for Measure 1 of Option (a)

The following might arguably be considered to be within Option (a), as it lies on the regulatory side, it doesn't, however, consist of or contain the inspection – in fact it avoids or obviates the need for it - which is the basis of Option (a).

The goal here is the replacement of a population of boilers that operate at the relatively low efficiency of 65%, by modern boilers that are 85% or 95% efficient, depending how much you pay. The old ones are oil boilers only, for practical purposes, and sales of this type were in decline from about 1994, probably ceasing about 1998 (there are anecdotal suggestions that the last stocks of such boilers, no longer saleable in the UK or European mainland due to an EU Directive, were dumped in Ireland where there is no checking on site practice).

Two methods of achieving this are advanced. Perhaps 7.1.1 is closer to an (a), and 7.1.2 to the (b) Option.

7.1.1 Replacement through gas oil restriction

Chapter 2 showed that, in 2002, kerosene supplied 73% of the residential oil heating market (gas-oil 27%). As almost all oil boilers under 70kW sold in recent years burn kerosene, the kerosene share of the oil heating market is virtually 80% in 2005. The remaining 20% gas-oil is used mainly in old boilers, including virtually all those over 15 years old.

The objective here would be to make gas oil the exception. To continue to obtain it, a certificate or identity would be required, based on inspection. In general, all oil boilers under 70kW[68] may be converted to burning kerosene by adjusting pump pressure and switching the burner nozzle. As a number of loads extending up to 200kW would use modular or multi (smaller, for security) boilers to supply that load, it is likely that at least 80% of boiler numbers in the commercial sector are under 70kW and would fall into the kerosene conversion net[69].

Advantages

- Compulsory switch to kerosene would 'flush out' the gas oil, and by definition the older, boilers.
- It would identify ALL (non-gas) commercial boilers – not necessarily all to be replaced as some will be reasonably recent, and those over 70kW are

[68] Kerosene is more chemically aggressive, it could probably be used in general without change of equipment, other than nozzles, up to about 100kW

[69] Technical staff of the Conoco-Philips refinery at Whitegate confirmed to us that increasing the kerosene market at the expense of gas-oil (diesel) to the extent outlined would not cause any refining problems

probably not easily converted, but it presents an opportunity to establish a good commercial database

- Inspection of all commercial boilers would permit focus on the duty cycle, and possible classification as 6-month etc. service interval
- It would also convey ongoing cleaner burning in all oil burners and save perhaps 2% for those now burning gas-oil, on average
- It would reduce the need for a stringent Option (a) approach (and equally an expensive Option (b) alternative), as inspection and service intervals of up to 4 years could be regarded as reasonable (albeit, government might not wish to procure a lighter service regime than exists) – it would in any event have an ongoing servicing benefit.
- Boilers can generally be switched to kerosene by substituting the burner nozzle, reducing pump pressure and re-tuning – i.e. at the cost of a normal service
- It could be a good introductory move prior to advancing on a broader front of measures
- The move would be popular with oil distributors as it would simplify their storage needs and delivery schedules
- It could ease the private cost of the special € 200 inspection requirement, avoiding it by replacement, or the cost might be refunded upon proof of replacement (becoming a state subsidy).

Disadvantages/Issues arising

- Possibility of change in excise revenue to the state
- It would not be unreasonable that (to avoid kerosene-conversion of old inefficient boilers) a class licence would be associated with the move, whereby boilers of less than specified efficiencies could not be supplied with fuel in future – such moves, and even more specific restrictions, are already implemented or being introduced elsewhere in Europe[70].
- Gas-oil, fuel oil and light oil presently used in the commercial sector would be replaced only where practicable, in general where unit size is at or below 1000kW (price and availability are factors, and combustion equipment could need major alteration).

Costs/benefits

The quasi-regulatory approach would add to secretariat costs by perhaps only € 150,000 per year. The benefits are as discussed in 7.1.2.

7.1.2 Replacement through 'Scrappage' Scheme

[70] E.g., from 1/11/ 2004 the exhaust gas losses for all new oil and gas boilers in Germany may not exceed these values: a. > 04 < 25 kW 11 % b. >25 < 50 kW 10 % c. > 50 kW 9 %

The rationale behind this suggestion is to offer an incentive to lead to the retirement of older boilers, as above. It could also be very popular and help soften the impact of increasing regulation. There would be many parameters in establishing such a scheme, e.g.:

- The level of state subvention
- Possible level of industry subvention
- Conditions of subvention
    - Types of boilers that qualify for removal
    - Types of boilers that qualify as replacement
    - Level of subvention different for different boilers, to encourage extra-high efficiency boilers
- Duration of offer
- Administrative and verification details

Advantages

- There could be a positive psychological impact, benefiting all energy conservation and boiler efficiency in particular
- Advice on excess costs and inefficiencies of older boilers is provided along with information on the efficiency of modern ones
- Would lead to good knowledge of older boiler population and parameters (as good sales data is available from the early 1990s onwards)
- Scrappage allowance could be varied to obtain results (e.g. could be speeded up or slowed down or could vary by size). They could also be combined with oil price and efficiency factors to make a payback case
- Scrappage might favour replacement by high-efficiency (net 95%) condensing boilers
- It could be a good way to move the commercial sector
- Although focused presumably on boilers aged over 15 years, some spill-over could occur for newer boilers as the time-progression of boiler efficiencies became more widely recognised – with or without scrappage.

Disadvantages/Issues Arising

- Risk of fraudulent scrappage
- Will not provide full boiler database
- Might best be applied to all oil boilers (i.e. not only those larger than 20kW) as
    - Oil boilers not > 20 kW are close to that level anyway
    - Eliminates the difficulty of owners verifying their boiler size.

Costs

Private costs.

This measure could obviate, or reduce, the need for the special new inspectors listed in Measure 1, likewise save that € 200 inspection fee, by simply replacing the older boiler. It is quite possible that this is the true goal of this measure in Article 8. This would be cost neutral to current practice, from a private point of view. This is to take the view that the resulting replacements pay for themselves as detailed in Table 14 Section 5.1.1.

Public costs

Administrative costs should be minimal – perhaps € 0.1 to 0.2M for supervision and monitoring each year for 5 years (allowing for lead-in to a scheme, and extra time for completion).

Costs specific to scrappage

- Careful consideration would be needed to strike the suitable scrappage subsidy, to consider different levels dependent on size, etc.
- The trade should be expected to respond with some subsidy contribution – the baseline prices on which they offer to contribute would have to be verified either independently before the scheme, or by reference to their records later
- Direct costs to the state would be
    - Subvention € 50, cost € 4.25M for over 20 kW only and up to € 6.775M if smaller boilers included
    - Subvention €100, costs € 8.5M to €13.55M.
    - This may be spread over 3-5 years or more.
    - If smaller boilers included, a subsidy split € 100 v. € 50 for boiler efficiency, and an outcome of 50/50 in the type of change made, the total cost would be € 10.16 – say € 2 per year over 5 years, € 3M year 1, with an admin cost of say (extra) € 0.35M per year.

A possible scenario would be subventions of at least € 50 to €100 each per replacement from government and the Trade, with the state carrying the organisational overhead. A positive approach would see the allowance significantly increased (at least € 100 v. € 50) for choice of the higher efficiency boilers.
Details of the operation of the car scrappage schemes should be examined to learn from them, if this approach is considered.

Public Benefits

By eliminating the population of boilers older than 15 years at end 2005, the public benefit would be **106,880 tonnes CO_2 per year,** and potentially substantially higher as smaller boilers would also be caught unless exempted or e.g. excluded from scrappage – they would bring the saving up to **124,850 tonnes per year.** If the replaced boilers were split 50/50 between the 85% and

95% efficiencies, the savings would lie between 125,166 for > 20kW only, and 146,205 if small boilers included.
If, for reasons of capacity etc. this were managed as a demand (e.g. subsidy for only 25,000 boilers per year, or 5 years to replace by regulation), the gains would arise cumulatively by 1/5th per year, or ranging from some 21,000 tonnes per year to 29,000, cumulatively.
One may add to this the ongoing cohort becoming 15 years old every year to which the efficiency gains apply, for say at least another 5 years, and that will add at least 31,346 tonnes per year and even up to 49,745 – at the end of 5 years the reduction will be from the lowest of **263,610** tonnes per year (only boilers over 20kW, only 85% efficient replacements) to a highest of **373,575** tonnes per year (all sizes, replacement 50/50 by efficiency range). In all cases, the replacements above are OIL boilers ONLY.

7.2 Matching for Measure 2, Option (a) scenarios

The first scenario of Measure 2 in Option (a) is not mirrored because it is purely informative, and its achievement is negative. The second, or lower, scenario, is the first considered below.

7.2.1 Matching Measure 2, – Lower cost scenario

A leafleting campaign, on a yearly or two-yearly basis, would meet the requirements of Article 8. It would be difficult to compare its equivalence with the least cost Option (a) scenario. The impact of both scenarios would be hard to measure, other than in terms of awareness. Anecdotal evidence of boiler service technicians and vendors/installers would offer a low-cost indication of whether action is being taken or not.

Although this scenario is unlikely to achieve much in terms of the stated aim of the EPBD in reducing energy consumption and limiting CO_2 emissions, it could be implemented immediately, allowing a further period of up to three years to examine its results (and the experience of other EU Member States) and to plan to introduce a more effective option.

It would be cheaper to mail all households and businesses rather than trying to identify boilers over 20kW and discriminating by fuel use and age of boiler.

The leaflet or booklet would indicate the potential benefits of boiler servicing in terms of fuel savings on an annual basis, and the potential pay-back on replacement of old inefficient boilers with modern efficient appliances. Safety benefits could also be highlighted.

Table 21: Elements of Option (b): Scenario 1 – Lower cost scenario
Details: ▪ Advisory only

▪ Indicating the need for regular inspection and servicing ▪ Aimed at all homes/commercial premises with boilers ▪ Pointing out the benefits of servicing/replacement
Medium: ▪ Direct mail campaign, leaflets or booklets
Implementation Routes: ▪ Direct mail to all households and organisations ▪ Via utility bill or fuel supplier – 'bill stuffer' ▪ Via Government information campaign.
Cost: ▪ Cost of €250,000 to €500,000 per year ▪ Ongoing administration costs of € 30-40,000 per year
Impact: ▪ Response/subsequent actions by recipients, perhaps at 1-2% level, equating to 2,000 – 4,000 tonnes CO_2 per year reduction ▪ Not measurable but very low in terms of emissions reduction.

Costs

The main cost elements in this scenario are the design, printing and postage of some 1.5 million leaflets or booklets. Taking the least cost route, a simple, A5 size leaflet could be designed and printed in these quantities for €225,000. The least cost postage option, i.e. via An Post – not addressed (to "the householder") for general delivery to all premises on postal rounds, would incur a cost of €300,000. It is assumed that this exercise is repeated annually.

Using energy suppliers' billing and information channels as is already done with Bórd Gáis customers could reduce distribution costs. This route would be unreliable in the case of oil users and a general mail-shot to all homes and commercial premises is seen as being more effective and not wasteful, as over 90% of all homes and over 50% of all commercial premises have boilers.

Other possible means of low cost distribution would be to include leaflets in other Government information campaigns geared to advising the general public of energy and environmental issues, waste strategy (including energy waste) or, as part of a broader campaign to advise of the implications of the Energy Performance of Buildings Directive. In terms of share of costs, a budget figure of €100,000 could be allocated to this item as it represents only part of what would be a comprehensive information campaign.

Benefits

There would be no measurable benefit in terms of emissions from this scenario. Evidence[71] suggests that a response rate of 1-2% is typical for such schemes involving discretional expenditure. For instance, the Bórd Gáis Boiler Servicing promotion achieves a 2% response in terms of service contracts. However, if oil prices rise considerably, or a carbon tax was introduced, the response could rise. A hypothetical result would be annual savings[72] of some 2,200 tonnes CO_2 that would accrue if 1% of all boilers were serviced every 1-year instead of every 3.

Logistics

The main logistical element of this scenario is getting the information to the end user. The least cost option, i.e. as part of a Government information campaign, is also the least problematic as no effort is required to identify the target audience.

Alternative means of distribution might include Local Authority mailing re Domestic Waste Charges or Commercial Water Charges under an Energy and Environmental cover. The possibility of piggybacking on other Energy and Environmental campaigns is likely to increase awareness but resulting action would be unquantifiable.

7.2.2 Matching Measure 2 – Medium Scenario

A more comprehensive approach to the advisory option would see a scheme, also dependent on the publics' response, but with greater resources to attempt to achieve results corresponding to Measure 2, medium scenario.

Table 22: Elements of Matching Measure 2, – Medium Scenario
Details: ▪ Advisory with supporting measures ▪ Aimed at all homes/commercial premises with boilers ▪ Quantifying the benefits of servicing/replacement
Media: ▪ Direct mail campaign, leaflets or booklets ▪ TV and radio promotions ▪ Help line and website
Implementation Routes: ▪ Direct mail to all households and organisations ▪ Via utility bill or fuel supplier – 'bill stuffer' ▪ Via local authorities ▪ Via television and radio ▪ Via help line and website
Cost: ▪ Cost of €1.5m to €2m per year

[71] Bórd Gáis, ESB, SEI.
[72] This is calculated across all boilers including smaller ones as its unlikely the promotional message could be more precisely targeted

▪ Ongoing administration costs of perhaps €80,000 per year
Impact: ▪ Response/subsequent actions by recipients of up to 10% ▪ Calculable reduction in energy consumption ▪ Reduction in emissions calculated as 9,878 tonnes per annum.

Costs

The cost range for this option reflects a choice of measures to be included, from leafleting, advertising and promotion only, to fully resourced hotline and web-based support. In other words, Scenario 2 really covers a range of scenarios, the plural indicating the menu of promotional options, both by channel and intensity (spend), that could be manipulated and, dependant on feedback, increased, diminished, varied etc. The budget could be reassessed periodically, based on results. At any stage it could be decided that progress was inadequate or too expensive, and a decision made to move to another measure or an Option (a) approach.

Costs for Option (b) – Scenario 2 include an annual mail-shot, using individually addressed envelopes, at €700,000. Design and printing costs would be increased to €600,000 for higher quality design and more detailed text (examples of cost/benefit of actions). There would also be a higher administration input, perhaps covering a half-time executive plus contracted web maintenance etc., say €100,000. A budget figure of €250,000 is added for a media campaign bringing the total to ca. €1.7m.

Further optional cost elements for this scenario would include a 'hot-line' advisory service to help end users choose the appropriate actions and a web-based boiler database to help identify boiler type and age. Budget costs for these elements are, say €200,000 set-up and €150,000 annual costs. Integrating these actions in a broader Government information campaign could reduce any or all of the above costs.

Benefits

It is to be expected that a strong media campaign to raise awareness of the advice available to the end user would increase response rates to 2-10%. For the purpose of calculating impact in terms of emission reduction, we assume a 2% response in replacing boilers over 15 years old with standard 85% efficient boilers. Calculated on the same basis as in 4.3, Option 2, this would result in a saving of 2,138 tonnes of CO_2 per annum. Assuming a 10% response in terms of inspection, leading to a 1-year frequency of cleaning of oil boilers for that group, this would result in CO_2 savings of 7,740 tonnes, giving a total CO_2 saving of 9,878 tonnes per annum.

This represents less than half of the estimated savings achieved under Option (a) – Scenario 2 for broadly equivalent cost, but the guess element of results from promotion makes it somewhat comparable.

The likelihood of maintaining this level of saving on a multi-annual basis is uncertain. Increasing expenditure would increase the benefit, but likely with diminishing returns, so that a switch to an Option (a) mandatory regime could be made, or the supplementary approaches discussed in Section XXXX implemented.

Logistics and Practical Implications

The elements of the information campaign for this scenario would need to be co-ordinated and mutually supportive, and other measures such as the hotline would need to be in place to deal with end user response to the information campaign. This could require a lead-in period of 6 months. The development and implementation of a website, with guidance to boiler type, age and typical efficiency could be executed within this time, and hopefully source data from SEDBUK[73] and/or others could be used.

Training of 'hot-line' operators would depend on their level of technical knowledge, but should not require more than 6 weeks. It is assumed that the existing pool of service technicians and installers can accommodate the increase in inspection, servicing and maintenance/replacement of boilers directly resulting from this programme.

7.2.3 Matching Measure 2, Robust scenario

Table 23: Elements of Matching Measure 2, – Robust Scenario
Details: ▪ Advisory with supporting measures ▪ Aimed at all homes/commercial premises with boilers ▪ Quantifying the benefits of servicing/replacement
Media: ▪ Direct mail campaign, leaflets or booklets ▪ TV and radio promotions ▪ Help line and website
Implementation Routes: ▪ Direct mail to all households and organisations ▪ Via utility bill or fuel supplier – 'bill stuffer' ▪ Via local authorities ▪ Via television and radio ▪ Via help line and website

[73] SEDBUK: Seasonal Efficiency of Domestic Boilers in the UK (Database).

Cost:	▪ Cost of € 3 M to € 5 M per year ▪ Ongoing administration costs of perhaps €150,000 per year
Impact:	▪ Response/subsequent actions by recipients of 20% of all older boilers, 20% of all other boilers to 1-year service frequency ▪ Calculable reduction in energy consumption ▪ Reduction in emissions calculated as 49,256 tonnes per annum.

The Robust scenario supposes there is a determination to make a promotional approach yield tangible results to the extent that the budget strings are loosened. It is very similar to the Medium Scenario, except the media spend is raised significantly, possible expensive PR is used (a spread of big-name, role model endorsements), and the older boiler population is particularly targeted. Efforts to involve manufacturers in promotional replacement would be made. Boiler replacement is targeted as the first home for SSIA money. Energy prices would need to remain as firm as they are recently, or become higher, for the results to be delivered.

In this case, the CO_2 savings at 20% are 34,076 and savings due increased servicing, again achieved across the board irrespective of size, at 20% are 15,181 tonnes, making a total of 49,256 tonnes.

7.3 Measures matching Measure 3

The study team are convinced that on the one hand to implement the 2 years for oil and 4 years for gas inspections would not at all increase the frequency at which servicing for large boilers is carried out compared to the present – like the first scenario of 5.2.1, it would likely increase the total CO_2 emissions. There is no factual basis for this view except the strong anecdotal evidence from industry that tells of many industrial boilers being serviced every 6 months.

On the other hand, there is also not enough data on which to base any suggestions of intervals for examination – the use of boilers in the commercial and industrial sector is too diverse for a simplistic catch-all approach that would likely result from the absence of real information about the sector.

There are almost undoubtedly important opportunities for savings, by one means or another, some of which have been discussed in 5.3. To estimate what they might be, and to gather the information needed for an informed decision, could be approached by either, e.g. the once-off examination of boilers as discussed in Section 8, or by boiler registration.

8. Further Measures suggested in the course of the study

8.1 Measure 4, a Once-Off Compulsory Inspection of all boilers

Section 3.3.2.9 (b) drew attention to important savings that could be made, not referred to in Article 8. These savings from commissioning could therefore be regarded as offering equivalence to the Option (a) Measures, and constitute a special measure, Measure 4.

How is Measure 4 to be implemented? A once-off compulsory inspection could deliver Measure 4, as well as form a rigorous planning basis for the future choice of actions from Options (a) or (b). If applied to all boilers and kept up-to-date subsequently, policies and instruments could be tailored and results of actions measured, for best effect.

The inspection could be just that, at a reduced cost of say € 50, or part of a normal service (€ 100). The latter is probably preferable for acceptance, and would impose little or no private burden if given a 3-year introduction.

If once-off compulsory inspection had a lead-in period to full implementation of Article 8 (say three years), akin to the car testing programme, during this time, as routine services occurred, details of each boiler and the name and address of the owner could be noted by the service technician, and passed to a database administrative group. At the end of the lead-in, oil supply might be available only to those registered. The logistics of such a registration scheme (e.g. use of numbered stickers to identify 'registered' boilers, how lists could be provided to oil distributors etc.) would need to be considered.

The regime might be limited to boilers over 100kW. A planned examination of customer accounts could identify boilers over 100kW, and probably also those over 20kW and 15 years old, with a high degree of accuracy. As an alternative to compulsory registration, gas suppliers might be expected to cooperate with such a scheme. The data advantages of a full scheme would however be largely lost.

Advantages of Once-Off Compulsory Inspection

- Enables compilation of a database to provide a basis for policy and action
- Fulfils minimum criteria for management – the ability to measure results
- Leaves open the choice of Measures under Options (a) or (b) for the future
- Lends itself to possible run-time based servicing etc. (particularly relevant for commercial sector) at a future time

- Would tune-up recent installations that have not been properly commissioned, with perhaps an average 5% base efficiency and up to 1.5 % cleaning saving – saving up to 7.5% of CO_2.
- It could save 1.5% CO_2 on other boilers.
- Would serve as basis for further action on
    - Boilers of over 20kW, and
    - Boilers also over 15 years old
- The timeframe for inspection (and registration), and therefore the financial outlay, is flexible.
- Permits (targeted if preferred) advice to those with boilers over 15 years old that their costs are excessive and the regulatory burden on them may increase. It also allows those with boilers now in the 10-14 year old bracket approaching 15 years to be forewarned. In both cases, this could lead to older boilers being replaced.
- The registration of boilers – as it does for cars[74]: enables government to apply constraints and conditions that could lend if desired be used to discriminate in favour of smaller boilers.
- A successful system of once-off inspections would reduce a potential need under Option (a) for a system (legal or otherwise) to deal with non-compliance. The sanction could be the unavailability of legitimate fuel supplies.
- Might usefully be introduced as the only Article 8 measure for the first 3 years on the reasonable basis that it enables targeted policies.

Disadvantages/Issues Arising with Once-off Compulsory Inspection

- Uncertain public reaction to compulsory element.
- In reality, could fuel supplies be stopped to any household?
- If applied only to oil boilers, it might be resented by the oil-side industry, although extension to gas is less warranted.
- Would also affect the approx. 505,000 domestic and commercial boilers under 20kW that are not referred to by Article 8. However, from an energy efficiency perspective, many of these boilers are close to 20kW (probably minimum 14.7kW and most likely to be 17.65 kW), and the final CO_2 benefits of including them would be very beneficial.

Costs/Benefits

There would be no compulsion for households or other boiler owners to act following compulsory inspection.

CO_2 reductions would result from a combination of Measure 1B and Measure 2 type actions – i.e. from the replacement of older boilers, increased servicing savings – plus some tuning benefit (the commissioning issue. Using the lower

[74] As outlined in Section 2.7, the average consumption per oil boiler per year is equivalent to 19,000 miles for a car doing 40 mpg on diesel.

scenario of Measure 1B at 9,192 tonnes per year, the lower scenario of Measure 2, 4,142 tonnes, and if we even assume 1/3rd of the commissioning gains 1/3(65,106), the outcome is a gain of 30,704 tonnes per year. These figures are likely to be on the conservative side – if boiler replacements as per Measure 1A also ensue, as is likely to some degree, the attainment could most likely be above that of a reasonable interpretation of the Option (a) outcomes.
An annual subvention by the state for publicity (estimated at €0.5m) and administration, including building of database (also estimated at €0.5m), and the usual extra € 100,000 for additional operational costs, would total €1.1m per year for a minimum 3-year period to establish good practice.

Labour demand: If proper commissioning were performed on all new boilers (by trained service personnel), as is mandatory in the UK for instance, there would be a demand for about 21,600 commissioning man-days per year at present construction levels[75]. This would correspond to fulltime work for approximately 96 technicians, say 110 – this should be taken up relatively easily by the industry.

8.2 Utilities and Fuel Suppliers to target high consumption

A utility with complete billing information, such as BGE[76], could calculate the normalised consumption (I.e. consumption per m^2), if it had floor area data of each property available. It could then target customers with apparently excess consumption – e.g., initially, over twice the average square metre value. Targeting could range in intensity from strongly focused advisory campaigns, through free audit with advice, or excess consumption surcharge. Customers might participate in providing area information in return for some benefit such as a monitoring/targeting and economy advisory service.

Oil for boilers is however potentially available from many distributors, and, as customers shop around, a distributor cannot be sure of the annual consumption of a customer. Distributors also vary greatly in their level of sophistication and IT applications, so that while some would be able to conduct mailings and otherwise target customers, others would not.
Distributors could be asked to submit customer lists - these would be checked for overlap with each oil customer receiving a unique identity code. Then, if oil distributors reported transactions by identity, the sum of deliveries could be allocated to the correct identities/addresses, by means of software entry and a database. Then, and really only then, high-users could be targeted as for gas, - by a state agency or an agency contracted to do so on behalf of the state.

High users, as defined/re-defined from time to time, could be required to have an inspection that would deliver full boiler and system information to the database.

[75] Based on an assumption of 80,000 new houses, with one technician able to commission seven boilers per day, for 220 days per year.
[76] These possibilities have been discussed with BGE managers

Remedial action might be required: the trigger-points, any subsidies or penalties, would be at government discretion.

Advantages

- Offers high flexibility in targeting
- Can offer a solid basis for further measures
- Even-handed – users 'pay'

Disadvantages/Issues Arising

- Bureaucratic, perhaps elements of 'Big Brother' monitoring your activities
- Would be unpopular with oil distributors[77]
- Oil distributors might be supplied purposed software FOC
- Difficult to normalise the commercial sector
- Targeted customers might receive a run-hour meter FOC, to help them monitor

Cost/Benefits

The main costs would be – preparation of database (say €250,000), embed database reporting with distributors and necessary training (say €300,000), annual admin costs (say € 250,000). By gradual refinement of targeting criteria, most of any benefits available from the domestic sector should be attainable, and with experience, this could also apply to the commercial sector.

To demonstrate equivalence of impact, we would expect the use of a variety of metrics and means ranging through:

- Surveys of boiler owners to ascertain the rate of action, sampled with national extrapolation
- Surveys of service technicians to ascertain workload trends
- Surveys/reports from boiler manufacturers and installers to establish replacement rate (and perhaps more detail)

In such a way, progress to the level of savings estimated in Option (a) – Scenario 2 might be estimated/monitored. Option (a) - Scenario 3 could be achieved by further targeting.

[77] However, they might be reminded that motor garages have to comply with various bureaucratic rules in issuing number plates, and in buying and re-selling cars

8.3 Installation of Run-time Meters on New Boilers, with Retro-fit on Existing Boilers

Operating hours, or run time, is a key determinant of the need for inspection or service. At least one of the Irish boiler manufacturers now fits a run-time meter as standard in boilers.

For new boilers it may be possible through Building Regulations that such a meter be included, to be zeroed at each service. This would enable a possible move later on to management of servicing on operating hours. This should not add more than €15 to the cost of a new boiler (cost and fitting).

For existing boilers, meters for retrofit might be available in bulk for ca. €10-12 each, and fitting might cost €30 or less for volume installation on estates to ca. €50-60 otherwise. Government might consider free or subsidised fitting of meters in return for, say, submission of data for a national boiler database.

Run-time meters might be included for new boilers under Building Regulations.

8.4.3.2 Fit Economisers to Commercial Boilers

Two-stage, and even three-stage, economisers might economically be fitted to many larger commercial boilers.

8.4.3.3 Integration of Databases

Databases arising from Energy Labelling under the same Energy Performance of Buildings Directive, and the database of boilers, could be compatible and interoperable, and perhaps common or integrated.

8.4.3.4 Amend Regulations in Favour of Condensing Boilers

All boilers going into new houses, and at some time also all replacement boilers could be of condensing type (unless wood-pellet or other renewable fuel is used).

8.4.3.5 Ensure Compliance with Building Regulations

Anecdotal evidence suggests that not only are boilers not commissioned properly, but also that rules regarding the installation of controls are frequently breached and that increased compliance would lead to energy efficiency gains.

8.4.3.6 First, conduct market research and establish metrics

To obtain value for money in promotion, to achieve results whether through Options (a) or (b), and to measure progress, market research and metrics should be the first priority in any action programme.

9. Summary of Study Findings

9.1 Key Findings on Boiler Population

Chapter 2 of the report deals with the population of boilers in Ireland and the population relevant to Article 8 of the European Performance of Buildings Directive. It estimates that:

- In 2005, in the categories relevant to Article 8, there are approximately 580,000 oil-fired boilers; 5,000 gas-fired boilers and 13,000 solid-fuel fired boilers in Ireland;
- Only 10% of these by number are in the 'commercial' sector (i.e. public and private non-industrial sectors), the balance are in households;
- With a total boiler population of some 1.25m (domestic and commercial), in Ireland, Article 8 applies to 48% of these:
- Those least affected by Article 8 are those in the areas now supplied with natural gas, i.e. most of the main urban centres;
- A large number of the boilers over 20kW in Ireland are oil-fired boilers in households, that lie just over the Article 8 threshold of 20kW;
- There are between 90,000 and 100,000 boilers that are both over 20kW and over 15-years old (a specific category in Article 8). Of these, 91% are estimated to be oil-fired, with 5% gas-fired and 4% solid-fuel fired; that category generally has an intrinsic or design efficiency of 65% whereas modern boilers have 85% and 95% efficiencies.
- Households in Ireland with oil-fired boilers increasingly use kerosene (80% in 2005), which burns cleaner than gas-oil, thereby requiring far less service. In their emissions, they are approaching the status of gas, and gas-fired boilers are excluded from the remit of Article unless boilers are over 100kW. The move to kerosene means Irish households differ from their EU mainland counterparts, who (when they use oil) mainly use gas-oil. It is possible that kerosene is lumped with gas oil in the Article, despite its cleaner burning, due to lack of familiarity with it in mainland Europe.
- The bulk of the commercial sector uses boilers similar to domestic in terms of size and fuels, but the larger users, those with boilers over 70kW and particularly those over 100kW that are singled out in the Directive, burn gas oil in the main, a small number burn heavier oils, and in general these large boilers are serviced at a higher frequency suitable to their duty cycle.

9.2 Key Findings on Context for Introducing Article 8 in Ireland

Chapter 3 presented information on the regulatory and institutional landscape relevant to Article 8 in Ireland; existing servicing, inspection and documentation procedures and the approaches being adopted (at this early stage) to Article 8 in three other EU Member States. It found:

- There are standards for new boilers in Ireland, following from an earlier EU Directive on boiler energy efficiency;
- There are no mandatory standards for boiler inspection or performance in Ireland;
- There are no regulations in Ireland governing the qualifications of personnel engaged in boiler installation and servicing;
- Some training is available – from Bórd Gáis, from Institutes of Technology (especially in Dublin and Cork), from FÁS and from a private company;
- There are perhaps 500 boiler-servicing technicians operating in Ireland. Most are self-employed or work for a small firm;
- Insurance companies ask if organisations have boilers in assessing risk but do not normally inspect the boiler, nor does it affect premiums.

A study of the service technicians undertaken for the study found:

- The average time between inspections for a household is of the order of three years;
- The single biggest source of training on boiler inspection is the manufacturer – many technicians have attended more than one short training course over the years;
- A short (normally one-page) report is usually provided to the customer at the end of the boiler inspection;
- A technician typically services four or five boilers in one (full capacity) day;
- Almost all new boilers installed in Ireland are not commissioned in accordance with the manufacturer's recommendations. This results in a loss of efficiency (perhaps more than 7.5%) until the boiler is serviced for the first time;
- Two-thirds of clients follow the advice of the service technician when advising action related to reliability, immediately, with a further 20% following the advice 'within a year'.
- In contrast, advice related to energy conservation is almost always ignored.

The review of the approaches being to Article 8 of the EPBD adopted by a selection of other EU Member States showed:

- In Austria, there has been mandatory inspection of boilers for over 20 years, with variations by region. National legislation is now being considered to introduce mandatory annual inspection and reporting in relation to all boiler installations, to include combustion efficiency testing. This would correspond with Option (a) under Article 8 of the EPBD;
- In Denmark, mandatory annual inspection already exists for all oil-fired boilers. Denmark is also likely to follow the Option (a) route, keeping its annual mandatory testing of oil-fired boilers and introducing mandatory (but less frequent) inspection and testing of gas boilers. A new regulation

will be introduced to require inspection and performance checking of heating installations over 15 years;

- A common approach is likely across the different parts of the UK. Unlike in the other two countries reviewed, this is likely to follow Option (b) of Article 8. The precise nature of the advisory campaigns mounted under Option (b) is still being considered by the Department of Environment, Food and Rural Affairs (DEFRA).

There are important variations in the effects of Article 8 between Member States, e.g.:

- The domestic sector in Ireland (as in the UK) burns its oil relatively cleanly by using kerosene. It therefore requires less service and benefits less from such service, than its domestic counterparts in mainland Europe (where oil boilers use gas-oil).
- However, whereas oil represents just over 50% of boilers in Ireland and gas 41%, gas accounted for 90% of the UK domestic market in 2003 (according to the UK's Department of Trade and Industry) and oil only 9%. Article 8 affects natural gas boilers only if they are over 20kW and 15 years old, or very large, over 100kW. There is accordingly a great difference in the effect of Article 8 between Ireland and the UK.
- Irish regulatory measures for boilers - for installation and operation, and from pollution and safety aspects - are generally less stringent than those of the mainland EU countries surveyed.

9.4 Summary of Measures and scenarios examined to meet Article 8 requirements

The key elements are summarised in Table 26 below.

<table>
<tr><th colspan="6">Table 24 Summary of Measures, and Option (a) and (b) approaches</th></tr>
<tr><th>Measure</th><th>Requirement</th><th colspan="2">Option (a) treatment</th><th colspan="2">Option (b) treatment</th></tr>
<tr><td rowspan="2">1</td><td rowspan="2">All boilers over 15 years old and 20 kW to be serviced regularly</td><td>If inspection means no action essential</td><td>Possible public response of some boiler replacement, some extra cleaning</td><td>Emphasis on replacement – restriction gas oil availability</td><td rowspan="2">A rapid rate of replacement could result.
Savings from replacement are far greater than from servicing</td></tr>
<tr><td>If inspection also means servicing</td><td>Extra servicing and cleaning</td><td>Offer scrappage incentives to replace with modern boilers</td></tr>
<tr><td rowspan="4">2</td><td rowspan="4">(Excluding boilers covered in measure 1) all boilers over 20kW up to 100 kW must have a “regular inspection”</td><td>Scenario 1, Minimal: Gas oil service every 2 years, natural gas and kerosene 4</td><td>CO_2 emissions would RISE</td><td>Nothing chosen as equivalent</td><td></td></tr>
<tr><td>Scenario 2, Lower: Gas oil boilers inspected every 2 years, natural gas and kerosene 3</td><td rowspan="3">Increasing reductions of CO_2 ↓</td><td>Leaflet or booklet to all households, not addressed (to ‘the householder)</td><td rowspan="3">Results from campaigns would be minimal, impossible to predict without piloting at least, and difficult to measure</td></tr>
<tr><td>Scenario 3, Medium
Gas oil boilers every year, natural gas and kerosene 2</td><td>Direct mail, supplemented by media campaign, help line and website</td></tr>
<tr><td>Scenario 4, Robust:
Gas oil, natural gas and kerosene every year</td><td>As above, assisted by some incentives</td></tr>
<tr><td>3</td><td>Over 100kW, gas inspection interval max 4 years, oil 2</td><td colspan="2">Likely to increase CO2, boiler registration or once-off inspection would gather data for policy making</td><td colspan="2">Strong advisory service to the sector, through SEI, with subsidy of consultant studies</td></tr>
</table>

9.5 Strength and weaknesses of Option (a) Measures and scenarios

Table 25: Strengths and Weaknesses of EPBD Article 8 Option (a) Scenarios					
	Impact	**Annual Cost to State**	**Strengths**	**Weaknesses**	**Barriers/ Challenges**
Measure 1 A Inspection	From 21,498 to 35,830 tonnes per year	€ 0.1M extra to Secretariat overhead. Training cost	If replacements are made, savings are robust and ongoing. Replacement seems undoubted, albeit unstated, objective of Article 8	Need to train 108-136 new-type inspectors. Fundamental question of how many will replace due to the inspection, is the weak link. Cost to consumer up to € 67	Difficulty of identifying relevant boilers
Measure 1 B Service	From 9,192 to 29,874 first few years, falling to 3,447 to 6,904	Do.	Compulsory service might in reality lead to replacement, Type A savings, rather than type B – and achieve the same as the B scenario of Measure 1	This is very likely not the action intended by Article 8. Overlaps with Measure 2, and joins with it, but should be special and stand-alone	Difficulty of identifying relevant boilers
Measure 2, Scenario 1 - Lower	4,142 tonnes per year	€ 0.1M extra to Secretariat overhead.		Extra private cost only € 17 per year, benefit € 10 per year, for very few – no change for most The saving is so small, why bother?	Difficulty of identifying relevant boilers
Measure 2, Scenario 1 - Medium	29,464 tonnes per year	€ 0.1M extra to Secretariat overhead.	Just beginning to be a net loss to the individual boiler owner.	Extra private costs € 17 for most, € 67 for few, per year, benefit - € 10 for all	Difficulty of identifying relevant boilers
Measure 2, Scenario 1 - Robust	50,644	€ 0.1M extra to Secretariat overhead. Training cost up to € 1.5M		Extra private costs € 67 for all, benefit - € 50 for most, - € 10 for some, per year. Nearly 500 extra personnel.	Difficulty of identifying relevant boilers
Measure 3	Not known	Not known	No specific actions have been advanced under Option (a). Large savings can be made in many cases, and action would be likely if detailed knowledge was available.	This sector appears to be already making best effort.	Difficulty of identifying relevant boilers. Likely remedies more complex and diverse

9.5 Strength and weaknesses of Option (b) Measures and scenarios

Table 26: Strengths and Weaknesses of EPBD Article 8 Option (b) Scenarios					
	Impact	**Annual Cost to State**	**Strengths**	**Weaknesses**	**Barriers/ Challenges**
Measure 1 A Inspection **Measure 1 B Service**	As much as 236,610 to 373,575 tonnes per year cumulatively over 5 years	€ 3M year 1, € 2M/year thereafter, additional € 0.35 per year admin.	Removes the € 200 inspection charge. Measures 1 and 2 can 'piggyback' each other to an extent. Associate scrappage, SSIA, go for maximal 95% efficiency, effectively 'top of the class'. To manage demand, run for 5 years and allow change/limit scrappage to say 25,000 per year?	Would increase size of installation market considerably – by up to 50% at present – but if housing completions were declining, would take up slack in these trades.	Mobilise industry as car sales industry was mobilised – with the difference that Irish manufacturers can supply most of the extra demand. Controlling dangers of fraud.
Measure 2, Scenario 1 - Lower	> 2,200 tonnes per year, up to perhaps 6,600	€ 0.25 to 0.5 for first year, falling to 0.04 per year after 2-3 years	Very non-invasive. Promoting personal responsibility. Can be optimised from market research. Measures 1 and 2 can 'piggyback' each other to an extent.	There are so many advertising messages coming at everybody that it is very hard to get through.	Its unlikely that awareness and action can be achieved together, so some years required, with changing emphasis in message
Measure 2, Scenario 1 - Medium	> 9,878 tonnes per year	Up to € 1.7M per year		There are so many advertising messages coming at everybody that it is very hard to get through.	Difficulty of identifying relevant boilers, applies to all cases
Measure 2, Scenario 1 - Robust	49,256 tonnes per year	Up to € 5 M per year for 3 years, including incentives	This runs tightly with Measure 1 The industry should match € 1-2 M per year in incentives. Response to incentives can be very strong.		Requires very competent team, market-oriented. Difficulty of identifying relevant boilers, applies to all cases
Measure 3	Not known	Say, € 2M allocation	State would subsidise engineering studies	Would require reviving an SEI capability to manage the fund	Possibility to improve, systemise such studies
Measure 4	30,709 t/y	€ 1,1M per year	Major advantages, see 8.1	Very invasive	Public reaction

Annex A: Example of preparation of data

Subject: establishing data for gas boilers as shown in Table 1 of the Report.

Category	Size < 20kW	Size > 20 kW	Source
Domestic	394,000	96,000	BGE and manufacturers – "< 20 kW is > 80% of total"
Commercial	13,900	4,100	Examination of consumptions v. sizes "23% are > 20 kW"
Totals	407,900	100,100	
Rounded totals	408,000	100,000	As shown in Table 1

Annex B: Questionnaire for Boiler Servicing Survey

Boiler Servicing Survey -

important for anyone who services boilers

Why a survey?

EU governments, including Ireland, will bring a new Directive into force during 2006-2009, to improve the energy performance of buildings and control Carbon Dioxide pollution. The Directive sets out new requirements for houses and other buildings, and for boilers and heating systems. The requirements for boilers and heating systems may be met by inspection, or by providing advice.

Sustainable Energy Ireland (SEI, the national energy authority) has appointed NICER to assess these options. We are examining the servicing of boilers that provide space and water heating in buildings, excluding boilers for industrial processes.

Specialists like yourself can help us build a picture of what is happening now. ***As this is very important to you and your business, PLEASE ANSWER THE QUESTIONNAIRE AND RETURN IT USING THE SELF-ADDRESSED ENVELOPE PROVIDED.***

If you think we are leaving out any important question, please tell us, in the space provided at the end, (or call us at 01 282 1907, or email: info@nicer.ie**).** For the full "Energy Performance of Buildings Directive", or Article 8 that relates to boilers, see www.sei.ie/EPBD

Thanks in advance for your help.

Patrick Duffy, Managing Director, NICER (National Irish Centre for Energy Rating Ltd.)
www.nicer.ie

PRIZE: WIN a Service & Commissioning Combustion Analysis Kit.

On behalf of SEI, one of the replies will be drawn to win a ***Service & Commissioning Combustion Analysis Kit*** (Smoke Gun, Draught Gauge, Electronic Combustion Analyser & separate Remote Printer, in a reinforced carry case) suitable for both oil and gas.

Boiler Servicing Survey

(1) How long have you been servicing boilers?

Less than 5 years ☐
5 – 15 years ☐
More than 15 years ☐

(2) Are you part of a larger company or self-employed?

Self-employed ☐
Larger company
(how many people)? _____

(3) How many boilers would you service?

In a typical working day _____
In a typical working year _____

(4) How does your business divide?

Contract customers _____%
Non-contract customers _____%

Distress call-outs _____%

(5) How does your service business divide?
(Percentage of total units)

Domestic (housing units) _____%
Boiler only _____%
Non-domestic units _____%
Heating System only _____%

Boiler and heating system _____%

(6) Out of all your service visits, how many involve checking;

Combustion efficiency _____%

(7) What types of boilers do you service?
Percentage of total?

Oil _____%
Natural Gas _____%
LPG _____%
Other_____ _____%
(please state)

(8) Frequency of Service (months).

Oil _____
Natural Gas _____
LPG _____
Other _____
(please state)

(9) Please give your best estimate regarding the age of the boilers you service:

Age of Boiler	Age of Oil Boilers	Age of Gas Boilers	Age of Other Boilers
1999 - 2004	%	%	%

1994 - 1998	**%**	**%**	**%**
1989 - 1993	**%**	**%**	**%**
Pre 1989	**%**	**%**	**%**
Total	**100%**	**100%**	**100%**

(10) Does frequency of service vary with age of boiler? YES ☐ NO ☐

(Please comment below).

_____
_____
_____

(11) Please give your best estimate regarding the size of the boilers you service:

Size of Boiler	Size of Oil Boilers	Size of Gas Boilers	Size of Other Boilers
Below 68,000 Btu/h (20kW)	**%**	**%**	**%**
68,000 to 136,000 Btu/h (20 - 40kW)	**%**	**%**	**%**
136,000 to 340,000 Btu/h (40 – 100kW)	**%**	**%**	**%**
Over 340,000 Btu/h (100kW)	**%**	**%**	**%**
Total	**100%**	**100%**	**100%**

(12) Does frequency of service vary with size of boiler? YES ☐ NO ☐

(Please comment below)

_____
_____

(13) What types of servicing do you offer? (Tick all types)

Inspection of boiler ☐
Inspection of heating system ☐
Cleaning of boiler ☐
Written report ☐
Combustion Efficiency testing ☐
Checking Controls ☐
customer?
Fuel supply system ☐

☐

(14) Does your company install:

(a) Boilers YES☐ NO☐

(b) Heating Systems YES☐ NO☐

(15) Do you give any advice or report about the service to the

Advice on replacement, etc.
YES ☐ NO ☐

If 'YES', please attach a blank example, if possible.

(16) Do you fill out any form for yourself/your company YES ☐ NO ☐

No form, but fill out a company timesheet YES ☐ NO ☐

(17) In about what percent of services do you recommend a new boiler? _____%

How would you break down the main reason you give?

Replace to avoid expected problems _____%

Replace to save fuel/money _____%

Any comments?

_____
_____
_____

(18) When you recommend replacing a boiler, about what percent of your customers act on your advice:

Nearly immediately? _____**%** ☐

NOT immediately, but within year? _____%

Not at all? _____%

Any comments?

_____
_____

(19) What training and what qualifications have you for boiler servicing?

"On the job" training primarily ☐

Institute of Technology

Fás ☐
Manufacturer's ☐
Bord Gáis ☐
OFTEC ☐
HETAS ☐
Other ☐

If 'other', please name

_____
_____

(20) Tick if you are registered with servicing/assessing

OFTEC ☐ Bord Gáis ☐ HETAC ☐ Other ☐

If 'other', please name

_____

(21) Would you do further training in

boiler performance?

YES ☐ NO ☐

(22) If you would like to express views on boiler servicing or system servicing, or if you have any suggestions for changes in the market or regulatory measures, please do so here:

Is it OK for us to contact you to discuss your answers or views? Yes ☐ No ☐

If ‘yes’, please provide your: Name _____ Phone no. _____

Please forward the completed questionnaire in the enclosed stamped addressed envelope.

Thanks for your time and effort: please post now, and enter in the draw!

Appendix 2

Baseline Calculation Workbooks

EPBD ARTICLE 8
PRELIMINARY ASSESSMENT
POTENTIAL ADDITIONALITY, RESPONSE AND COST EFFECTIVENESS

STEP 1: PROFILE OF RELEVANT BOILERS

Estimated total boiler population >20kW by fuel and age, 2005

Fuel	< 5 years	5-10 years	10-15 years	>15 years	Total	Oil & Gas
Oil	195000	175000	125000	85000	580000	
Gas	45000	30000	20000	5000	100000	680000
Solid	2500	3000	4000	3500	13000	
Total	242500	208000	149000	93500	693000	

Estimated commercial boiler population >20kW by fuel and age, 2005

Fuel	< 5 years	5-10 years	10-15 years	>15 years	Total	Oil & Gas	% of all boilers	
Oil	9000	9000	7000	7500	32500			32500
Gas	5000	6000	5000	2000	18000	50500	7.4%	18000
Solid	0	0	0	0	0			
Total	14000	15000	12000	9500	50500			

Estimated residential boiler population >20kW by fuel and age, 2005

Fuel	< 5 years	5-10 years	10-15 years	>15 years	Total	Oil & Gas		
Oil	186000	166000	118000	77500	547500			547500
Gas	40000	24000	15000	3000	82000	629500	92.6%	82000
Solid	2500	3000	4000	3500	13000			
Total	228500	193000	137000	84000	642500			

STEP 2: BASE CASE ASSUMPTIONS

BASE CASE ASSUMPTIONS

Only **additionality** is considered, I.e. incremental cost/benefits and impacts for boilers not already being regularly serviced at present

Focus is on **oil** boilers, as scope for incremental efficiency improvements is greater than that for gas

Assumption that survey questionnaire responses on servicing patterns are apportioned similarly between oil and gas

Boiler servicing patterns:	% of service calls	% of boilers	Annual	Up to three yearly	<20kW (3 yearly)	Weighted average per annum for >20kW	Weighted average cope for improvement*	Nos. oil boilers for improvement
Commercial boilers (all > 20 k\	15%	7.4%	80%	20%	0%	86.6%	13.4%	4355
Residential boilers	85%	92.6%	33%	47%	20%	48.5%	51.5%	281908

Above averages are applied as base cases for oil boilers under each SCENARIO below

STEP 3: ASSESSMENT OF IMPACT

Commercial boilers:

87% receive on average an annual service (inspection, cleaning, tuning)

Boilers receiving the least servicing are the smallest

Average annual consumption per oil boiler (litres)	33950	
Average consumption per less serviced oil boiler (litres)	6790	(one fifth of overall sectoral average)
Average boiler efficiency decline per year	2.5%	(based on 2000 hours)
Peak boiler efficiency	82%	
Seasonal system efficiency	65%	
For boilers not currently receiving regular service:		
Average boiler efficiency gain per biannual service	**2.5%**	
Average fuel savings per biannual service (litres)	420	
Price of commercial oil (€/litre)	0.40	
Annual value of fuel saved (€)	168	
Average cost per service (€)	200	
Annual cost per biannual service (€)	100	
Average net cost saving to business (€)	68	
Average payback period within biannual cycle (months out of 24)	14	(months out of 24)

Ultimate potential savings:	**Assuming average boilers**	**Assuming smaller boilers**
No. of boilers	4355	4355
Total fuel savings (million litres)	1.831	0.366
Total fuel savings (toe)	1630	326
Annual value of fuel saved (M€)	0.732	0.146
Calorific value of oil (kWh/litre)	10.35	10.35
CO2 emission factor for oil (g/kWh)	260	260
CO2 emissions abated per annum (tonnes)	4928	986
National Costs:		
Total average annual costs of service (M€)	0.436	0.436
Attributed costs per tonne CO2 abated (€/tonne)	**88**	**442**

Residential boilers:

55% (48.5% >20kW, 6.5% <20kW) receive on average an annual service (inspection, cleaning, tuning)		
Average consumption per oil boiler (litres)	2180	
Average boiler efficiency decline per year	2.5%	
Peak boiler efficiency	82%	
Seasonal system efficiency	65%	
For boilers not currently receiving regular service:		
Average boiler efficiency gain per biannual service	**2.5%**	
Average fuel savings per biannual service (litres)	135	
Price of domestic oil (€/litre)	0.45	
Annual value of fuel saved (€)	61	
Average cost per service (€)	100	
Annual cost per biannual service (€)	50	
Average annual net cost saving to household (€)	11	
Average payback period within biannual cycle (months out of 24)	20	(months out of 24)
Ultimate potential savings:		
No. of boilers	281908	
Total fuel savings (million litres)	38.058	
Total fuel savings (toe)	33869	
Annual value of fuel saved (M€)	17.126	
Calorific value of oil (kWh/litre)	10.35	
CO2 emission factor for oil (g/kWh)	260	
CO2 emissions abated per annum (tonnes)	102413	
National Costs:		
Total average annual costs of service (M€)	14.095	
Attributed costs per tonne CO2 abated (€/tonne)	138	

Combined Commercial & Residential Boilers:

Applies to residual boilers not regularly serviced at present

		THREE SCENARIOS		
		Scenario	**1**	**2**	**3**
Ultimate potential savings:	**100%**	**% realisation**	**25%**	**50%**	**75%**
No. of boilers	286263		71566	143131	214697
Total fuel savings (million litres)	39.889		9.972	19.944	29.917
Total fuel savings (toe)	35499		8875	17749	26624
Annual value of fuel saved (€)	**17.858**		**4.465**	**8.929**	**13.394**
Calorific value of oil (kWh/litre)	10.35				
CO2 emission factor for oil (g/kWh)	260				
CO2 emissions abated per annum (tonnes)	107341		26835	53670	80505
National Costs:					
Total average annual costs of service (M€)	**14.531**				
Attributed costs per tonne CO2 abated (€/tonne)	135				

EPBD ARTICLE 8 IMPLEMENTATION IN IRELAND
ASSESSMENT OF OPTIONS (a) & (b)
EXPLORATION OF SCENARIOS

Estimated total boiler population >20kW by fuel and age, 2005

Fuel	< 5 years	5-10 years	10-15 years	>15 years	Total	Oil & Gas
Oil	195000	175000	125000	85000	580000	
Gas	45000	30000	20000	5000	100000	680000
Solid	2500	3000	4000	3500	13000	
Total	242500	208000	149000	93500	693000	

Estimated commercial boiler population >20kW by fuel and age, 2005

Fuel	< 5 years	5-10 years	10-15 years	>15 years	Total	Oil & Gas		
Oil	9000	9000	7000	7500	32500			32500
Gas	5000	6000	5000	2000	18000	50500	7.4%	18000
Solid	0	0	0	0	0			
Total	14000	15000	12000	9500	50500			

Estimated residential boiler population >20kW by fuel and age, 2005

Fuel	< 5 years	5-10 years	10-15 years	>15 years	Total	Oil & Gas		
Oil	186000	166000	118000	77500	547500			547500
Gas	40000	24000	15000	3000	82000	629500	92.6%	82000
Solid	2500	3000	4000	3500	13000			
Total	228500	193000	137000	84000	642500			

BASE CASE ASSUMPTIONS

Only additionality is considered, I.e. incremental cost/benefits and impacts for boilers not already being regularly serviced
Focus is on oil boilers, as scope for incremental efficiency improvements is greater than that for gas

Boiler servicing patterns:	**% of service calls**	**% of boilers**	**Annual**	**Up to three yearly**	**<20kW (3 yearly)**	**Weighted average per annum for >20kW**	**Weighted average scope for improvement***	**Nos. oil boilers for improvement**
Commercial boilers (all > 20 kW)	15%	7.4%	80%	20%	0%	86.6%	13.4%	4355
Residential boilers	85%	92.6%	33%	47%	20%	48.5%	51.5%	281908

Above averages are applied as base cases for oil boilers under each SCENARIO below

Commercial boilers:

87% receive on average an annual service (inspection, cleaning, tuning)
Boilers receiving the least servicing are the smallest

Average consumption per oil boiler (litres)	33950	
Average consumption per less serviced oil boiler (lit	6790	(one fifth of overall sectoral average)
Average boiler efficiency decline per year	4%	
Peak boiler efficiency	82%	
For boilers not currently receiving regular service:		
Average boiler efficiency gain per biannual service	4%	
Average fuel savings per biannual service (litres)	425	
Price of commercial oil (€/litre)	0.40	
Annual value of fuel saved (€)	170	
Average cost per service (€)	300	
Annual cost per biannual service (€)	150	
Average net cost saving to business (€)	20	
Average payback period within biannual cycle (mont	21	(months out of 24)

Ultimate potential savings:

No. of boilers	4355
Total fuel savings (million litres)	1.849
Total fuel savings (toe)	1646
Annual value of fuel saved (M€)	0.740
Calorific value of oil (kWh/litre)	10.35
CO2 emission factor for oil (g/kWh)	260
CO2 emissions abated per annum (tonnes)	4976

National Costs:

Total average annual costs of service (M€)	0.653
Attributed costs per tonne CO2 abated (€/tonne)	131

Residential boilers:

55% (48.5% >20kW, 6.5% <20kW) receive on average an annual service (inspection, cleaning, tuning)

Average consumption per oil boiler (litres)	2180
Average boiler efficiency decline per year	4%
Peak boiler efficiency	82%
For boilers not currently receiving regular service:	
Average boiler efficiency gain per biannual service	4%

Average fuel savings per biannual service (litres)	136	
Price of commercial oil (€/litre)	0.45	
Annual value of fuel saved (€)	61	
Average cost per service (€)	100	
Annual cost per biannual service (€)	50	
Average net cost saving to business (€)	11	
Average payback period within biannual cycle (mont	20	(months out of 24)

Ultimate potential savings:

No. of boilers	281908
Total fuel savings (million litres)	38.434
Total fuel savings (toe)	34204
Annual value of fuel saved (M€)	17.295
Calorific value of oil (kWh/litre)	10.35
CO2 emission factor for oil (g/kWh)	260
CO2 emissions abated per annum (tonnes)	103426

National Costs:

Total average annual costs of service (M€)	14.095
Attributed costs per tonne CO2 abated (€/tonne)	136

Combined Commercial & Residential Oil Boilers:

Applies to residual boilers not regularly serviced at present

OPTION (a) SCENARIOS

		Scenario	**1**	**2**	**3**
Ultimate potential savings:	**100%**	**% realisation**	**25%**	**50%**	**75%**
No. of boilers	286263		71566	143131	214697
Total fuel savings (million litres)	40.283		10.071	20.142	30.212
Total fuel savings (toe)	0		0	0	0
Annual value of fuel saved (€)	18.035		4.509	9.018	13.526
Calorific value of oil (kWh/litre)	10.35				
CO2 emission factor for oil (g/kWh)	260				
CO2 emissions abated per annum (tonnes)	108402		27101	54201	81302

National Costs:

Total average annual costs of service (€)	14.749
Attributed costs per tonne CO2 abated (€/tonne)	136

OPTION (a)	ASSUMPTIONS/BASIS INPUTS	OUTPUTS	VFM

Scenario 1

Commercial Boilers