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Accompanying document to the

PROPOSAL FROM THE COMMISSION TO
THE EUROPEAN PARLIAMENT AND COUNCIL

for a directive proposal for stage II petrol vapour recovery during the refuelling of petrol cars at service stations

Impact Assessment

{COM(2008) 812 final}
{SEC(2008) 2938}

1. PROCEDURAL ISSUES AND CONSULTATION OF INTERESTED PARTIES

1.1. Introduction & context

This impact assessment accompanies a legislative proposal that would, if adopted by the Council and European Parliament, bring about a more complete application of controls in the EU to reduce the amount of petrol vapour emitted during the refuelling of cars at service stations.

The proposal has been prepared following commitments made by the Commission in:

– the Thematic Strategy on Air Pollution[1];

– the Commission's proposal to amend Directive 98/70/EC on petrol and diesel quality[2] which aims to facilitate a greater uptake of biofuels and bioethanol in particular by relaxing the vapour pressure requirements of petrol. The Commission recognised that this could lead to greater emissions of volatile organic compounds and indicated that recovery of petrol vapour during the refuelling of cars would be proposed in order to offset these additional emissions.

– a statement accompanying the adoption at second reading of a new directive on ambient air quality[3] in which (i) the Commission recognised the importance of tackling air pollution at source in order to improve air quality; and (ii) signalled several new Community source-based measures including recovery of petrol vapour at service stations.

The proposal is listed in the Commission Legislative Work Programme for 2008 with reference 2008/ENV/006. The preparation of the impact assessment was assisted by an interservice group created on 14 November 2007 to which all DGs were invited to participate.

1.2. Consultation

Consultation of interested parties was undertaken by direct written request for information from identified parties and also by a wider internet based invitation. The period of consultation was open for 8 weeks ending on 25 April 2008.

– The Commission invited key stakeholders to respond directly to a series of questions about the possible introduction of Stage II PVR on 28 February. This invitation was also posted to the Europa web site so that the general public could also be consulted. The consultation was also publicised by "ENDS Daily" on 17 March 2008. Sixteen responses were received spanning Member State regions, environmental agencies, NGOs, equipment suppliers, service station operators, oil

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1 Section 4.2.1.2 on page 9 of COM(2005) 446 of 21 September 2005.

2 Section 3(4) on pages 7 & 8 of COM(2007) 18 of 31 January 2007.

3 Directive 2008/50/EC on ambient air quality and cleaner air for Europe, OJ L152, 11.6.2008, p. 1 – 43.

industry associations and vehicle manufacturers. A summary of these responses is available on line[4].

– Those involved in the manufacture and supply of Stage II equipment supported the introduction of harmonised specifications as did environmental agencies and NGOs. Independent petrol retailers expressed the view that Member States should be allowed to decide for themselves whether to proceed with Stage II PVR. Those who supported Stage II PVR preferred an approach that tackled existing stations progressively so that the larger stations were tackled first as this was more cost effective. Whilst the independent petrol retailers denied any link between benzene exposure (via petrol vapour) and adverse health impacts (leukaemia), the mainstream European downstream oil industry supported the view that service stations built under residential accommodation presented the greatest potential risk and that these stations should be assessed for their suitability to install Stage II controls irrespective of their throughput.

This impact assessment has relied heavily upon two consultancy reports completed on behalf of the European Commission by ENTEC UK Limited[5] and COWI[6] as well as public consultation documents/regulatory impact assessments published in the UK[7] and Western Australia[8] in addition to information from the open literature.

1.3. Impact Assessment Board

The draft impact assessment was submitted to the Impact Assessment Board for its opinion. The Board raised three main issues for which it asked for clarification in the draft text. These are:

– An enhanced explanation as to why EU action was appropriate and necessary;

– Clarification of certain methodological aspects including a treatment of taxation, assumptions used;

– Clarification of the combinations of options particularly in relation to automatic monitoring of petrol vapour recovery equipment and in-service compliance and also further explain comparisons to vehicular measures in the USA.

4 http://ec.europa.eu/environment/air/transport/petrol.htm

5 Stage II Petrol Vapour Recovery – Final Report from contract 070501/2004/379928/MAR/C1, prepared by ENTEC UK Limited on behalf of the European Commission, 17 May 2005. http://ec.europa.eu/environment/air/pdf/entec_report.pdf

6 Analysis of costs associated with the mandatory deployment of Stage 2 Petrol Vapour Recovery, Final report from contract 070307/2007469854/FRA/C3, prepared by COWI on behalf of the European Commission, February 2008. http://ec.europa.eu/environment/air/pdf/cowi_report_stage2_feb08.pdf

7 Final Regulatory Impact Assessment on Petrol Vapour Recovery stage II controls (PVR II), Air and Environment Quality Division, Department for Environment, Food and Rural Affairs, November 2005. http://circa.europa.eu/Members/irc/env/stage2/library?l=/background_documents/pvrstage2-riapdf/_EN_1.0_&a=d

8 Discussion Paper: *Action for Air – Improving air quality through vapour recovery at service stations*, Department of Environment & Climate Change NSW, August 2007. http://circa.europa.eu/Members/irc/env/stage2/library?l=/background_documents/aus-nsw_vapourrecovery/_EN_1.0_&a=d

The draft text has been amended in several areas to take account of the Board's opinion, notably in sections 1.1 (*Introduction & context*); 2.4 (*Subsidiarity & proportionality*); 4 (*Policy options*); 4.1.2 (*Option 2 – ORVR*) and 5.1 (*Assumptions & methodology to estimate costs for Stage II PVR costs*).

2. PROBLEM CHARACTERIZATION AND BASELINE

Volatile Organic Compounds (VOCs) are carbon-based chemicals which evaporate readily into the atmosphere. Once emitted into the air, they are associated with several health and environmental problems:

– poor local air quality (benzene in air);

– formation of ozone and photochemical smog; and

– atmospheric warming and climate change.

Various Community instruments have been developed and implemented to limit VOC emissions. For example, national limits apply on Member States' total emissions of VOCs as embodied in directive 2001/81/EC on national emissions ceilings[9]. There is also legislation to reduce the emissions of VOCs from the use of solvents in industrial installations[10] and to reduce the use of solvents in paints and varnishes[11], to limit the benzene content of petrol (1% v/v)[12] and to restrict the emissions of hydrocarbons from road vehicles[13].

Despite these measures, the impacts of air pollution as assessed by the Thematic Strategy are still significant and the long term objectives for health and the environment, as established in the 6th Environmental Action Programme and the national emissions ceilings directive 2001/81/EC, will not be attained on the basis of current policies even by 2020. The Strategy proposed several measures to help deliver further progress towards the long term objectives including additional controls on the refuelling of petrol cars at service stations.

Petrol vapour emitted during the refuelling of passenger cars is currently unregulated at the Community level although a significant number of Member States have Stage II PVR controls in place. These national regulations vary in scope particularly in terms of the minimum size of petrol station captured, the required vapour collection efficiency and the post-installation compliance regime.

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9 Directive 2001/81/EC on national emission ceilings for certain atmospheric pollutants: OJ L 309, 27.11.2001, p.22.

10 Directive 1999/13/EC on the limitation of emissions of volatile organic compounds due to the use of organic solvents in certain activities and installations: OJ L 85, 29.3.199, p. 1.

11 Directive 2004/42/EC on the limitation of emissions of volatile organic compounds due to the use of organic solvents in certain activities and installations: OJ L 143, 30.4.2004, p. 87.

12 Directive 98/70/EC relating to the quality of petrol and diesel fuels: OJ L 350, 28.12.1998, p. 58.

13 Regulation (EC) N° 715/2007 on the type approval of motor vehicles with respect to emissions from light passenger and commercial vehicles (Euro 5 & Euro 6) and on access to vehicle repair and maintenance information, OJ L 171, 29.6.2007, p. 1.

Since the Thematic Strategy was adopted, the College has also decided to facilitate a greater take-up of biofuels such as bioethanol in the road transport sector. The Commission acknowledged, however, that the blending of some bio-components into petrol can lead to greater emissions of VOCs unless compensating measures are undertaken such as Stage II PVR[2]. Any controls on petrol refuelling must, however, be compatible with the existing Community legislation which regulates the VOC emissions associated with the storage and distribution of petrol from terminals to service stations (so-called "Stage I petrol vapour recovery")[14].

2.1. Health & environmental problems

2.1.1. Benzene in ambient air

Benzene is a VOC and a component of petrol. It is also a known human genotoxic carcinogen and is associated with a heightened risk of illnesses such as leukaemia. A Community air quality standard exists for the protection of public health[15] but there is no known safe level of exposure. Human exposure comes mainly from tobacco smoke, petrol vapour and from vehicle exhaust emissions. The air quality limit value for benzene is expressed as an annual average concentration of 5µg/m^3 that must be met by 1 January 2010.

Given the restrictions on the benzene content of petrol and stricter exhaust limits for road vehicles, there has been an observed decrease in ambient levels of benzene. Moreover, it is likely that most places will comply with the air quality limit value by 2010. However, there may remain problems at heavily trafficked locations and residential areas in the immediate vicinity of petrol service stations.

A recent study from Western Australia undertook personalised monitoring of peoples' exposure to benzene. It showed that time spent commuting and vehicle refuelling represent the highest non-industrial exposure to benzene in non-smokers. Vehicle refuelling comprised between 75-85% of total exposure in the winter and summer respectively[16] even though the benzene content of petrol is only 1% by volume (as in the EU) and individuals were assumed only to spend a few minutes refuelling their vehicles. Similar conclusions have been reached in European studies where individuals had similar time/activity diaries and where individuals spent approximately 60% of their time indoors at home[17].

The French petroleum industries association reported in 2006 on a wide-ranging measurement campaign of benzene concentrations at and around 43 service stations in France[18]. For those service stations constructed under apartment buildings, the

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[14] Directive 94/63/EC on the control of volatile organic compound (VOC) emissions resulting from the storage of petrol and its distribution from terminals to service stations: OJ L365, 31.12.1994, p. 24.

[15] Directive 2000/69/EC relating to limit values for benzene and carbon monoxide in ambient air: OJ L 313, 13.12.2000, p. 12.

[16] A. Horton et al; *Personal monitoring of benzene in Perth, Western Australia: The contribution of sources to non-industrial personal exposure*; Atmospheric Environment 40 (2006) p. 2596-2606.

[17] R. Edwards, M. Jantunen, *Benzene exposure in Helsinki, Finland.* Atmospheric Environment 35(8) 2001 p. 1411-1420 (part of the EXPOLIS project).

[18] L'Union Française des Industries Pétrolières publie une étude relative au bezène mesuré en périphérie des stations services à la demande du Ministère de l'Ecologie et du Développement Durable. March 2006, www.ufip.fr/_fichiers/03_04_2006_%20resume_etude_Bz_limite_prop_stations.pdf

observed concentrations at the petrol dispenser were in the range 10 – 85.7 µg/m^3 (with an average of 31.3 µg/m^3), whilst those at the perimeter of the service station lay in the range 2 – 30.8 µg/m^3 (average equal to 8.2 µg/m^3). Similar measurements made in Malta[19] and Greece[20] also showed that concentrations of benzene can be 7 to10 times the limit value of 5 µg/m^3 at service stations.

Whilst current policies and improved emissions performance of the vehicle fleet may ensure compliance with the benzene air quality limit at most places, there are likely to be elevated concentrations in the immediate vicinity of service stations. This is problematic where residential accommodation is co-located or is situated in close proximity to these stations. In California, where most service stations are fitted with controls to limit petrol vapour emissions during refuelling, the Air Resources Board and the Environmental Protection Agency advise against locating residential accommodation within approximately 90 metres of a service station[21].

2.1.2. Ozone

Once released into the atmosphere VOCs react in the presence of sunlight with nitrogen oxides emitted from combustion processes to form ground level ozone and other components of photochemical smog. Ozone is a transboundary pollutant so that precursors emitted in one country are dispersed and transported in the atmosphere and contribute to the observed ozone in other Member States. Short-term studies show that ozone has adverse effects on pulmonary function, lung inflammation, lung permeability, respiratory symptoms, increased medication usage, morbidity and mortality. There are Community air quality targets[22] to protect against exposure to ozone.

The World Health Organisation recommends a daily maximum 8-hour mean concentration as the principal benchmark for assessing the impact on mortality, with assessment over a full year. Current evidence is insufficient to derive a level for this 8-hour mean below which ozone has no effect on mortality. The ozone directive established a target value for the protection of human health of 120 µg/m^3 as a daily maximum concentration measured over an 8-hour period which is not to be exceeded more than 25 times per calendar year. Member States are obliged to comply as far as possible with this target.

The European Environment Agency undertakes periodic reviews of air quality based upon air quality monitoring data collected and reported to the Commission and the EEA[23]. Although reductions in emissions of ozone precursors appear to have led to lower peak concentrations of ozone in the troposphere, the current target level is frequently exceeded for a substantial part of the urban population of the EEA-32. In

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19 M. Zamitt and A.J. Vella; *Influence of service stations on air quality*; Xjenza 2003, vol. 8, p. 3.

20 P. Spyros et al; *Contribution to ambient benzene concentrations in the vicinity of petrol stations: estimation of the associated health risk*; Atmospheric Environment 41 (2007) p. 1889-1902.

21 Air Quality and Land Use Handbook: A community health perspective; California Environmental Protection Agency & California Air Resources Board, 2005, p. 30. (http://www.arb.ca.gov/ch/landuse.htm)

22 Directive 2002/3/EC relating to ozone in ambient air: OJ L 67, 9.3.2002, p. 14.

23 Air Pollution in Europe 1990-2004, Steinar Larssen et al, European Environment Agency, Copenhagen 2007.

2004, 94% of the urban population experienced exceedances of the 120 μg/m^3 level (the long-term objective for protection of human health), while about 20% of the urban population was exposed to concentrations above the 120 μg/m^3 level for more than 25 days. The target level was exceeded over a wide area and by a large margin.

Several studies have shown that ozone peak values have tended to decrease during the first half of the nineties. However, available data available over the period 1996-2001 shows hardly any variation for the 26th highest maximum daily 8-hour mean. Ozone concentrations in 2004 were reported by 1886 stations across 32 countries and when, in accordance with the ozone directive, concentrations are averaged over 3 years it is clear that the target value was not met in large parts of continental Europe (see Fig 1).

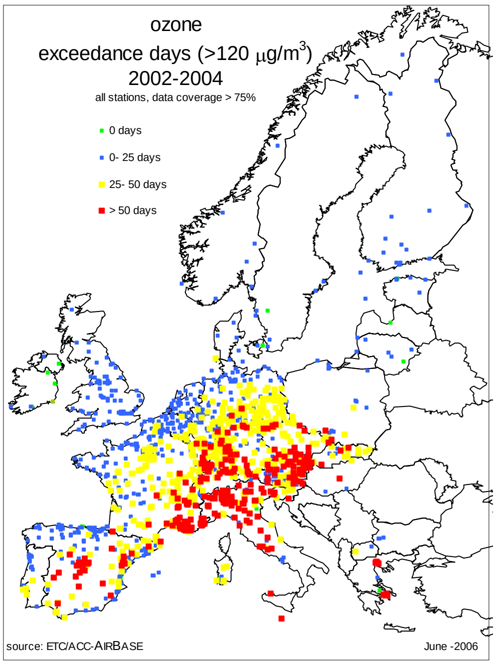

Figure 1: Days exceeding the target value as 3-year average 2002-4. In 2004 urban/suburban background areas provided 44% of stations, rural background areas 24%, traffic sites 18%, 9%, industrial, and 5% not properly classified. [Reproduced by permission of the European Environment Agency]

The reductions in ozone precursor emissions that should result from enforcement of the national emissions ceilings directive 2001/81/EC and international agreements are unlikely to reduce ozone concentrations to below the current target value and long-term objective over the whole of the EEA area. In north-west Europe about 25 exceedance days of the 120 μg/m^3 level are still expected in 2010.

2.1.3. *Ozone as a greenhouse gas*

The calculated global mean radiative forcing of ground level ozone since 1750 is +0.35 Wm^{-2} and ozone is the third most important greenhouse gas after carbon dioxide (+1.66 Wm^{-2}) and methane (+0.48 Wm^{-2})[24]. Although ozone precursor emissions are not directly controlled under the UNFCCC and the Kyoto Protocol, Parties must report on their emissions of VOCs, NOx and carbon monoxide.

2.2. Mixtures of ethanol and petrol

The vapour pressure of a particular liquid VOC is a measure of how easily molecules evaporate and reflects the type and strength of the intermolecular interactions. Where chemically very different compounds are mixed, the intermolecular forces of the pure liquids are disrupted and there is an increased tendency for molecules in the mixture to evaporate. This is called a positive deviation from Raoult's law[25] and is observed when ethanol is mixed with petrol. In fact, the increase in vapour pressure is roughly constant at ~ 7 kPa for ethanol contents in petrol of between 2% and 10% by volume[26]. This compares to the current legislated limit of 60 kPa for the Summer time vapour pressure of petrol sold in the EU.

An increased vapour pressure of petrol will increase the emissions of hydrocarbons during refuelling but it will also increase the evaporative emissions whilst the vehicle is at rest (so called "diurnal" emissions) and those whilst the vehicle is moving (so called "running losses"). These emissions derive from fuel permeation through the plastic and rubber components of the fuel system and breathing losses where petrol vapour is vented from the tank as a function of temperature. Diurnal emissions are captured by the European type approval procedure for passenger cars and light commercial vehicles whilst "running losses" are currently unregulated. Both increase as a function of fuel volatility.

2.3. The baseline

2.3.1. PVR Stage I

Petrol is a complex mixture of hydrocarbons some of which evaporate at ambient temperatures. When petrol is stored at terminals or in underground storage tanks at service stations, petrol vapour fills the head space above the liquid. Petrol vapour is displaced when additional liquid is added to the storage tank. Without any technical intervention, this displaced vapour would be vented directly to the atmosphere.

The Stage I PVR directive 94/63/EC addresses both the storage of petrol at terminals and its distribution by road, rail and inland waterway vessel to service stations. When service stations are refuelled by tanker, the vapour that is displaced from underground storage tanks is returned to the tanker which in turn delivers the petrol vapour back to the refinery or terminal where it can be re-incorporated into the petrol pool and re-supplied to service station operators. Stage I PVR requires certain

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24 P. Forster , V. Ramaswamy, P. Artaxo, T. Bernsten, R. Betts, D.W. Fahey, J. Haywood, J. Lean, D.C. Lowe, G. Myhre, J. Nganga, R. Prinn, G. Raga, M. Schulz and R. Van Dorland, 2007: Changes in Atmospheric Constituents and in Radiative Forcing. In: *Climate Change 2007: The Physical Science Basis. Contribution of Working group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge, United Kingdom & New York.

25 *Basic Physical Chemistry*, Walter J. Moore, Prentice Hall International, London 1983, pp 213

26 Joint EUCAR/JRC/CONCAWE Study on: Effects of gasoline vapour pressure and ethanol content on evaporative emissions from modern cars, edited by G. Martini, JRC 2007 (ISBN 978-92-79-05249-1).

underground pipe work to be installed in order that vapour can be returned safely to the tanker.

The smallest petrol service stations with a volumetric throughput of petrol of less than 100 cubic metres (m^3) per annum are exempt from the directive's provisions. Moreover, Member States may also derogate stations with a throughput less than 500 cubic meters per annum so long as there are no adverse health and environmental impacts. However, all service stations, regardless of throughput, must install Stage I PVR equipment if they are located under permanent living quarters or working areas. Any Stage II PVR legislation must be consistent with the Stage I PVR directive as both will apply to the construction and operation of service stations.

2.3.2. *Refuelling emissions*

The total EU inventory of VOC emissions comprises many diverse sources and economic sectors unlike that of other pollutants such as sulphur dioxide which is emitted primarily by the power generation sector. As such, a strategy to reduce significantly overall VOC emissions must necessarily tackle many small sources.

Petrol vapour will occupy the head space in a car's petrol tank so that when the car refuels, petrol vapour is displaced and without any further intervention this vapour is vented to the atmosphere. Spillages and drips from the filler nozzle will also evaporate. Overall emissions of VOC associated with petrol refuelling operations can be estimated on a country basis and these will depend upon the vapour pressure of the fuel, the ambient temperature, the amount of petrol sold each year and whether controls are in operation to limit these emissions. Changes in ambient temperature and vapour pressure can have a significant impact[27]. In May 2005, ENTEC estimated that emissions for the EU27 plus Croatia in 2010 for vehicle refuelling and spillage would be 87.2 ktonnes and 10.4 ktonnes respectively which represent about 1% of total emissions of anthropogenic emissions in 2005. An increase in the regulated vapour pressure from 60 kPa to 70 kPa would increase these emissions to 90.5 and 10.8 ktonnes respectively.

2.3.3. *Service stations*

There are some 110,000 service stations in the EU with a combined turnover of approximately €250 billion and which employ 440,000 people[28]. In response to competition and static margins the sector continues to restructure towards larger and/or unmanned service stations. For example, over the last fifteen years gross retail margins on petrol sold in the UK have been in the range € 5.5 – 7 cents per litre and the UK has witnessed the closure of about half of the 18,000 stations that existed in 1992[29]. Similarly, Denmark has seen a reduction in the number of smaller stations so that in 1990, 22% of all petrol was sold in stations with a petrol throughput of $500m^3$ per annum or less whilst in 2003, such stations accounted for just 8% of petrol sold. The number of service stations in each Member State is presented in Annex II.

[27] See Figure 5.1 of the ENTEC report

[28] European Council for Motor Trades & Repairs. http://www.cecra.eu/en/about/about.php

[29] *Understanding Pump Prices*, UK Petroleum Industries Association, June 2007. www.ukpia.com

Based upon information provided by the European oil industry, ENTEC has derived a size breakdown of service stations in the EU (see Annex II). In many Member States, over 85-90% of stations have an annual throughput of petrol greater than $500m^3$, whilst the average across the EU is about 75%.

2.3.4. *Types of Stage II PVR Controls employed*

Passive and active technical solutions have been developed to reduce the emissions of petrol vapour during refuelling. Both exist on the market today but the passive system has vastly inferior vapour recovery performance and so is not discussed any further. There are two active systems:

(1) A ***Conventional*** system employs a petrol pump filler nozzle consisting of two concentric steel tubes, the outer one of which is kept under vacuum using a vacuum pump. Displaced vapour is actively "sucked" back into the outer nozzle and is transferred to the underground storage tanks of the service station. When a service station receives a fresh delivery of petrol, the vapour contained and displaced from the station's underground storage tanks is captured and stored in the road tanker. It is then returned to the oil refinery or terminal where it can be incorporated into subsequent loads. The key aspect is that petrol vapour that otherwise is displaced and lost from the vehicle is returned "free of charge" to the refinery or terminal where it can be resold. However, if the station is not equipped with VOC Stage I controls, the vapour displaced from underground storage tanks is vented to the atmosphere and the vapour displaced from the vehicle has no economic value.

(2) The ***At Pump*** system is different in that the captured vapour displaced from the vehicle's tank is collected, cooled and condensed into liquid petrol at the petrol dispenser. The liquid petrol is then delivered back to the car's petrol tank as part of the ongoing purchase. This active system does not require any additional underground pipe work at the service station and permits the station operator to resell the petrol vapour otherwise lost to the atmosphere.

(3) **Onboard refuelling vapour recovery** (ORVR) is an emission control system that is placed on board a vehicle. Petrol vapour that is displaced during refuelling is directed towards a large canister containing activated carbon where it is absorbed and prevented from being vented to the atmosphere. The absorbed vapour is subsequently fed to the engine and combusted. ORVR systems have been mandated in the USA for vehicles manufactured from about 1998 onwards. However, in the interim period before all vehicles are fitted with the ORVR equipment, States will continue to apply Stage II PVR controls at service stations. This system is not part of the regulatory type approval regime for vehicles in the European Union.

2.3.5. *National Stage II PVR legislation*

Sixteen Member States have already installed conventional Stage II controls at service stations in various forms (see Annex I). The Community has signed but not ratified the VOC Protocol of the UN ECE Convention on Long Range Transboundary Air Pollution (CLRTAP)[30]. Article 3(b)(ii) of this Protocol requires the parties to implement VOC controls during motor vehicle refuelling. So far, 20 Member States have signed and ratified this protocol whilst a further 7 have signed but not yet ratified. Interestingly, Spain, Bulgaria, Estonia and Finland have ratified but have not implemented Stage II PVR controls nationally. This information is also summarised in Annex I.

2.4. Subsidiarity & proportionality

Ozone is a transboundary pollutant which together with its precursors can be transported over many hundreds of kilometres in the atmosphere. Air pollution problems with such a transboundary dimension must be tackled collectively by the Member States together in order for action to be effective. The current air quality objective for ground level ozone in Community law is widely exceeded and such execeedences are very likely to persist despite the emission reductions of ozone precursor gases in the national emissions ceilings directive 2001/81/EC and the aims of the Thematic Strategy on Air Pollution.

The directive governing the minimum quality of petrol and diesel sold in the EU is based upon Article 95 of the Treaty and applies uniformly across the EU. The Commission has proposed a relaxation of the vapour pressure requirements of petrol in order to promote a greater use of bioethanol[2]. This could however lead to greater emissions of volatile organic compounds even in those countries where Stage II PVR controls are already implemented. As such, Community action is required to address this potential increase in VOC emissions due to its large geographical scope.

In addition, those manufacturing Stage II equipment and those using it have expressed a preference for harmonising technical specifications to improve the functioning of the internal market in such goods. Action is therefore necessary at the Community level. However, only minimum generic parameters need to be established at the Community level so as to overcome the observed obstacles, whilst respecting the varied systems that Member States have already implemented and not stifling new innovative technologies. The most important parameters are the operational efficiency of vapour recovery and the in-service reliability.

3. OBJECTIVES

3.1. 6th Environmental Action Programme – General Objective

A general aim of the proposed measures on Stage II PVR are to enable further progress to be made towards the attainment of the 6th EAP objectives on air quality and air pollution.

The 6th Environmental Action Programme called for the attainment of air quality levels that do not give rise to significant negative impacts on or risks for human

30 Protocol to the 1979 Convention on Long-Range Transboundary Air Pollution concerning the control of emissions of volatile organic compounds or their transboundary fluxes which entered into force on 28 September 2002.

health and the environment[31]. It is also called for a thematic strategy on air pollution with a view to attaining long term objectives of no-exceedence of critical loads and levels for ecosystems and measures to tackle ground level ozone and particulates[32]. Ozone is a priority pollutant that was addressed by the thematic strategy and previously by the national emissions ceilings directive. The analysis undertaken for the strategy concluded that:

– there are approximately 21,000 cases annually of acute mortality and 14,000 respiratory hospital admissions in the 65+ age group;

– there are 21 million days where children and almost 9 million days when adults use respiratory medication

– there are 108 million days when children exhibit cough and lower respiratory symptoms

– there are over 50 million days when adults' activity is restricted

– 827000 km^2 of forest was at risk from damage

– that damage to commercial crops amounted to approximately €2.8 billion annually in 2000.

The Thematic Strategy also proposed new targets to improve protection from ozone but these fell short of the aspirations of the 6th EAP and the long term objectives of the national emissions ceilings directive.

3.2. Specific objectives of the present proposal

The proposed Stage II PVR controls also aim:

– to assist the Member States in their obligation to attain air quality limit values for benzene as stipulated in Community law

– to assist Member States in their obligation to attain as far as possible air quality targets for ground level ozone; and

4. POLICY OPTIONS

Policy options are:

(1) Do nothing.

(2) Install Onboard Refuelling Vapour Recovery (ORVR) in passenger cars and light commercial vehicles.

(3) Install PVR Stage II equipment at

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[31] Article 7(1) of Decision N° 1600/2002/EC of the The European Parliament and of the Council laying down a the Sixth Community Environmental Action Programme. OJ L 242, 10.9.2002, p. 1.

[32] Article 7(2)(f) of the Sixth Environmental Action Programme.

(a) All new and substantially refurbished service stations with a throughput greater than 500 m^3 of petrol per annum.

(b) Option (a) and larger existing stations (i.e. with a throughput in excess of 3000 m^3 per annum) by end of 2020

(c) Option (b) and service stations situated in or under residential accommodation.

(d) Automatic monitoring of all stage II equipment that would restrict petrol sales if the equipment is not functioning correctly (to be applied in conjunction with all above options).

4.1. Options discarded at an early stage

4.1.1. 1 – Do Nothing

Target values and long term objectives for the concentration of ozone in ambient air exist in Community legislation but are widely exceeded in the European Union. Ozone is a particularly difficult pollutant to tackle given that it is formed *in situ* in the atmosphere and that its precursors and ozone itself are transported across national borders. The Commission has also recognised the potential worsening of ozone pollution from increased emissions of VOCs due to an increased use of biofuels. Some of those Member States with significant ozone problems have yet to introduce Stage II whilst others have not implemented commitments made internationally to do so. It is also likely that there will be exceedences of the benzene air quality limit value in the vicinity of service stations when the air quality limit value for benzene enters into force in 2010 (with possible delay until 2015). Given this, and the fact some equipment suppliers and users have pointed to the expected benefits of harmonised minimum technical standards for the functioning of the internal market, the "Do Nothing" option is not realistic.

4.1.2. Option 2 – ORVR

There are several key issues associated with On-board Refuelling Vapour Recovery that must be assessed when considering this as a serious policy option:

(1) Adaptation of vehicle design.

Light duty petrol vehicles manufactured for the European market contain a *small* carbon canister to prevent emissions of petrol vapour whilst the vehicle stands at rest (so called "diurnal" emissions). These vapours are absorbed into the canister and released to the engine when the vehicle is underway. ORVR systems require a *larger* canister than currently installed in European cars as well as appropriate piping, valves and vapour controls systems. Naturally, the design of European vehicles would have to be adapted if this option was chosen which would require a change to European type-approval legislation. However, no detailed study has been undertaken to assess the technical feasibility and costs of such systems particularly for smaller cars where space constraints are important.

(2) Timescale

Any introduction of ORVR systems could only be applied to new vehicles. It would not be possible to retrofit/re-engineer the vapour systems of existing vehicles. As such, the effectiveness of any ORVR system would depend upon the rate that new ORVR-equipped vehicles entered the fleet. If one considers that vehicle manufacturers require 3 to 5 years lead time to redesign vehicle systems and that the a further 15 years is required for vehicle fleet renewal, then the full benefit of the ORVR system can only be delivered some 20 years after any new regulation is adopted.

(3) Costs & performance

No detailed analysis of ORVR costs has been undertaken for this impact assessment. However, earlier studies such as that performed by the UK[33] showed the cost effectiveness of ORVR to be around 35% worse than for conventional Stage II petrol vapour controls applied to service stations (see below). Costs are associated with the design and development of ORVR and the actual costs of the additional equipment that would be fitted to each car. Fuel dispensers and conventional Stage II equipment have the advantage of having been standardised and can be purchased "off the shelf". The UK's RIA indicates that the efficiency of vapour recovery is likely to be greater for Stage II PVR than for ORVR[34].

Both the EU and the USA have regulatory controls on the permitted level of hydrocarbon emissions from a motor vehicle at rest. The permitted limits in the USA are much stricter than those in the EU which necessitates the inclusion of a large carbon canister in the fuel system to adsorb the hydrocarbons until the vehicle is driven and the hydrocarbons can be combusted in the usual manner. The additional adaptation of the fuel system required in the USA to implement ORVR was probably less onerous therefore (compared to the current position in the EU) because of the stricter diurnal emissions limits in the USA. This may explain why the US regulators have opted for ORVR rather than nationwide Stage II PVR controls. In addition, there have been concerns over the ability of small gas stations in the USA to deliver reliable implementation of Stage II controls.

For the reasons above, ORVR option has not been taken any further at this stage. Nonetheless, diurnal evaporative emissions of petrol vapour from vehicles at rest and running losses are also significant sources of VOCs. These will not be addressed by Stage II controls at service stations but can be reduced by an order of magnitude by a large carbon canister fitted to the vehicle's fuel system. These benefits alone could justify the mandatory installation of large carbon canisters at a later date and the Commission is committed to assessing whether the existing type approval test cycle for diurnal emissions ought to be harmonised with those in the US and elsewhere[35]. If an when such a tightening of the regulated limits on evaporative emissions is considered, the incremental step of proceeding to "full" ORVR could also be considered as a complement or replacement for Stage II PVR controls at service

33 Chem Systems Ltd. "Gasoline Vapour Recovery Costs", Report prepared for the UK Department of the Environment, 1994.

34 Page 7 ("*Carbon Cannisters*") of the UK's Regeulatory Impact Assessment, November 2005.

35 Communication on the application and future development of Community legislation concerning vehicle emissions from light duty vehicles and access to repair and maintenance information (Euro 5 and 6): 2008/C 182/08: OJ C 182, 19.7.2008, p. 17.

stations. Naturally any decision would be preceded by an impact assessment that would consider the costs and benefits particularly those costs/benefits of Stage II controls still to be incurred.

5. ASSESSMENT OF PVR STAGE II OPTIONS

5.1. Assumptions and methodology to estimate costs for Stage II PVR costs

The approach taken to assess the costs for introducing mandatory Stage II PVR controls yields the following information: (i) total cost; (ii) annualised costs; (iii) amount of petrol vapour abated; (iv); the economic value of petrol vapour recovered; (v) cost effectiveness based on annualised costs. The methodology is described in more detail in the COWI report prepared from the Commission. It takes information about the size and number of petrol service stations and determines the magnitude of the unabated emissions and the emissions after installing Stage II PVR controls where these have yet to be installed. A spreadsheet model was developed by the consultants to make these calculations. This model also allows a sensitivity analysis of the results to certain assumptions to be made.

The Studies undertaken by ENTEC and COWI clearly show that the key parameters influencing the analysis are (i) cost data for Stage II equipment, (ii) lifetimes of service station equipment; (iii) the efficiency of Stage II equipment; and (iv) the economic value of the recovered petrol product. These are discussed more fully below. In all cases the same assumptions were used throughout to compare the various options.

5.1.1. Cost elements for individual service stations

Relevant cost elements in this analysis are the necessary additional or incremental (annualised) costs of introducing PVR Stage II controls over and above those associated with the new build or refurbishment. For example, there will need to be new dispensers and associated equipment for a new construction or major refurbishment regardless of whether PVR Stage II controls are applied. Only the cost differences directly associated with Stage II PVR are included in the analysis.

The key cost elements of introducing Stage II are:

– Capital costs for above-ground equipment, including appropriately equipped dispensers containing vapour return pumps, as well as vapour recovery nozzles, coaxial hoses and other equipment;

– Capital costs for installing the required below-ground pipe work, including a vapour return line to the underground storage tank (only for conventional technology);

– Additional costs of digging up petrol station forecourts at existing petrol stations where installation is not undertaken as part of a planned knock-down and rebuild programme (only for conventional technology);

– Additional ongoing maintenance and testing costs of PVR Stage II equipment as compared to standard equipment. In particular, the requirement for a regular check on the volumetric ratio - with associated adjustments if required - is considered to be essential to ensuring that a reasonable hydrocarbon efficiency is maintained;

– Costs of powering the additional Stage II equipment; and

– Savings due to the economic value of fuel recovered.

This basically leads to the following more or less distinct cases/scenarios for calculating the additional or incremental costs of installing PVR Stage II equipment:

- Scheduled work at an existing site, where

– the incremental costs are due to PVR Stage II equipment only *within* new dispensers (since work is scheduled, and the costs of new dispensers per se are excluded), *or* where

– there are incremental costs due to scheduled installation of underground pipe work

- Unscheduled work at an existing site, where

– the incremental costs are due to retrofitting PVR Stage II equipment (to existing dispensers) only, or where

– there are incremental costs due to unscheduled installation of underground pipe work

- Unscheduled work at an existing site, where

– the incremental costs are due to new PVR Stage II equipment and new dispensers, or where

– there are incremental costs due to unscheduled installation of underground pipework

The actual values assumed are that 15 % of service station sites have the necessary existing pipe work already installed, and that 40 % of existing sites would be able to retrofit dispensers in the case of unscheduled refurbishments.

5.1.2. *Actual cost data used*

The cost data presented in this assessment is based upon that from the DEFRA regulatory impact assessment following an evaluation by the Commission's consultant which considered them to be more comprehensive, more recent and more transparent particularly after having been subjected to extensive public consultation in the UK. DEFRA estimates are, however, based on UK information, which mean that these might differ from those in the rest of the EU and those presented by ENTEC in its report to the Commission. In particular, the DEFRA regulatory impact assessment provided costs data on the "At Pump" system and also assumed that there is a significant fraction of stations where dispensers could not be retrofitted, but would need to be replaced (in the case of unscheduled refurbishments of existing sites), whereas the ENTEC study does not include this assumption. Retrofitting dispensers is significantly cheaper than replacing the dispenser due to non scheduled refurbishment and DEFRA estimates are therefore about twice as high as the ENTEC estimates.

The cost assumptions for the Conventional and At Pump Stage II PVR systems used in this impact assessment are presented in detail in Annex III.

5.1.3. Investment cycles and life times

According to DEFRA (based on discussions with professional organisations) it can be assumed that the investment cycle in the fuel retail sector is 15 years[36]. At the end of the cycle it is usual for a site to undergo necessary refurbishment including any replacement of or changes to dispensers. It is more cost effective for the retailer to carry out any additional necessary work (such as placement of underground pipe work) at the end of the investment cycle. According to ENTEC there will be different economic lifetimes for above-ground and below-ground equipment respectively; the specific values assumed to be 14 years for all below-ground equipment (equalling the assumed replacement rate of petrol stations), and 5 years for all above-ground equipment. The regulatory impact assessment performed by DEFRA in the UK used an economic lifetime of 15 years for above-ground equipment. This is consistent with the response of the Petrol Retailers Association to the Commission's Public Consultation which referred to 2nd hand use of petrol dispensers some 10 to 15 years after their first sale. Accordingly, this analysis assumes, 15 years for below-ground and above-ground equipment.

5.1.4. Abatement efficiency of Stage II equipment

The cost-effectiveness of Stage II PVR will be better if more vapour is collected i.e. if the system efficiency is greater. However, this has to be balanced against the ability and cost of maintaining a high efficiency in practical use. Whilst ENTEC assumed a recovery efficiency of 80% for petrol vapour captured, in California equipment must perform at 95% or better (similarly for Taiwan, Austria and China) whilst the recent legislation in the UK requires 85% recovery. Other countries have mandated efficiencies in the 80 to 90% range. In addition, it has been pointed out in the public consultation that the regulatory efficiency is linked through to the type-approval/certification process. So that in Germany, the regulated efficiency of 80% is assessed as an average of two tests where the nozzle is placed correctly in the vehicle's neck filler and one where it is placed at 45 degrees (which reduces the effectiveness).

This impact assessment has assumed an efficiency of 85%. This reflects the latest implementation of Stage II controls but also information from the oil industry[37] which stated that the latest generation of Stage II equipment is more reliable and better matched to standardised vehicle tank/neck designs thereby overcoming the observed poor recovery efficiency of earlier Stage II equipment.

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[36] At least for sites with an annual throughput greater than 3000 m^3

[37] Response from CONCAWE, the Environmental and Heath & Safety Organisation representing the EU's oil industry.

5.1.5. *Economic value of recovered product & taxation*

The vapour which is displaced during refuelling resides initially in the petrol tank of the motorist (consumer). So although the consumer effectively loses some petrol this would otherwise be accepted without question by the motorist. The economic value arises because the emitted vapour is recovered and recycled.

When discussing the costs of the two different Stage II systems, the economic value of the displaced petrol vapour must be taken into account. In general terms, the economic analysis of various options takes the approach of maximising social welfare and so the analysis must exclude the level of any taxes levied on the petrol. The economic value of the recovered product is simply the retail price exclusive of any tax.

5.1.5.1. Distributional effects & taxation

However, there are important distributional effects notably from the perspective of the service station operator. The size of these effects varies according to the type of technology used but it can also vary according to national taxation policies.

The simplest situation concerns the Conventional Stage II PVR system. Here the vapour is collected and returned to the oil refinery via the service station's underground storage tank. This vapour will ultimately find its way back into the petrol distribution system where it will be sold and delivered to a service station operator exclusive of duty and VAT. The economic value of the recovered product is simply the retail price of the petrol (excluding duty and VAT) and there are no notable distributional effects or net impacts on national tax revenues.

The At Pump system is more complicated. Here the vapour is cooled, condensed and redirected back to the dispenser where it is dispensed. In some Member States, fuel duty is levied when petrol is first *delivered* to the service station. Hence the vapour that is recovered is resold at the usual forecourt price but no duty and VAT are payable by the service station operator. The selling price thus represents the economic value of the recovered petrol vapour to the operator in this scenario. This is the position in the UK who included this benefit as part of the regulatory impact assessment accompanying the introduction of national Stage II legislation. Some may argue that the Government is deprived of tax revenue from the sale of the recovered petrol and that this represents an equal and opposite cost to society. However, this is unclear given that national authorities have previously already taxed the petrol delivered to the service station and so there is no net impact on national tax revenues.

In other countries, fuel duty may be levied at the point of sale i.e. at the dispenser. As such the recovered vapour will effectively be taxed twice and the economic value of the recovered product will again be the retail price. Here national tax revenues may be increased because of At Pump Stage II PVR equipment.

In the analyses presented here, costs are presented with and without the retail value of the recovered product. Tax is excluded though as described above, this may be an important consideration for service station operators given that tax forms well over 50% of the forecourt price of petrol.

5.2. Benefits

A simplified approach to the calculation of benefits has been taken. This necessarily ignores the important benefits for (1) human health associated with exposure to benzene; and (2) the impacts on forests and the natural environment from exposure to ground level ozone. Only the impacts on health and agricultural crops from ozone have been estimated in monetary terms.

The approach taken builds upon the work on costs and benefits completed in the context of the Clean Air For Europe Programme[38]. Simplified damage cost functions were developed expressed as a monetary figure per tonne of pollutant emitted. Mortality and morbidity have been treated for health. The range of unit values arises because of the different approaches to monetise premature mortality (i.e. using the mean value in a VOLY approach (value of life years) or the mean VSL approach (value of statistical life). For simplicity reasons, a single EU-wide average value has been chosen for the damage cost function for 1 tonne of VOC emitted which is equivalent to € 950 – 2800 per tonne of VOC emitted.

5.3. Option 3(a) – Stage II PVR at new & substantially refurbished stations

This option would apply Stage II PVR controls at new service stations and at existing stations with a throughput of petrol greater than 500 m^3 per annum as part of a planned refurbishment.

Obviously there is little benefit environmentally in installing Conventional Stage II vapour recovery at a service station that is not equipped with Stage I PVR as ultimately any captured vapour will end up being vented to the atmosphere. The VOC Stage I directive 94/63/EC does not apply to stations with an annual throughput of less than 100 m^3. It also allows Member States to derogate stations with a throughput of less than 500m^3 per annum if there are no health or environmental impacts. As such, the Conventional Stage II system can generally only be applied to stations with a throughput of petrol of greater than 500 m^3 per annum.

A summary of the costs, cost effectiveness and monetised benefits for this option are given below for the **At Pump PVR system**.

Petrol vapour abated in 2020 (tonnes)	12 141
Total cost	€ 179.5 m
Annualised cost (2020)	€ 18.7 m
Cost-effectiveness excluding value of recovered petrol	**€ 1540/tonne**
Value of recovered petrol (retail value excluding tax in 2020)	€ 7.6 m
Nett annualised cost including retail value of recovered petrol (2020)	€ 11.1 m

38 "Damages per tonne emission of $PM_{2.5}$, NH_3, SO_2, NOx and VOCs from each EU25 Member State and surrounding areas" AEA Technology March 2005. (as part of the service contract for carrying out cost-benefit analysis of air quality related issues in particular in the Clean Air for Europe Programme.

Cost effectiveness including retail value of recovered petrol	**€ 915/tonne**
Monetised benefits (2020)*	€ 11.5 to 34 m

** This includes only those impacts on human health and agricultural crops from exposure to ground level ozone. It excludes impacts of benzene on human health and the impacts of ozone on forests and the natural environment.*

A summary of the costs, cost effectiveness and monetised benefits for this option are given below for the **Conventional Stage II PVR system**.

Petrol vapour abated in 2020 (tonnes)	12 141
Total cost	€ 209.5 m
Annualised cost (2020)	€ 21.4 m
Cost-effectiveness excluding value of recovered petrol	**€ 1760/tonne**
Value of recovered petrol (retail value excluding tax in 2020)	€ 7.6 m
Nett annualised cost including retail value of recovered petrol (2020)	€ 13.8 m
Cost effectiveness including retail value of recovered petrol	**€1140/tonne**
Monetised benefits (2020)*	€ 11.5 to 34 m

** This includes only those impacts on human health and agricultural crops from exposure to ground level ozone. It excludes impacts of benzene on human health and the impacts of ozone on forests and the natural environment. NB the value of petrol recovered inclusive of tax is not relevant for the Conventional PVR system as the vapour is returned to the oil refinery terminal and not recycled to the petrol dispenser.*

5.4. Option 3(b) – Stage II PVR at new & substantially refurbished stations and larger existing stations with a throughput greater than 3000m3

If new Stage II controls are applied to new and substantially refurbished stations then all existing stations will eventually be fitted with such equipment as each undergoes renewal. This renewal process could be speeded up and may make sense for the largest existing stations which make a proportionately greater contribution to overall emissions. The largest size category of service station considered by the ENTEC and COWI reports covers those stations with a petrol throughput greater than 3000 m^3 per annum based upon available statistics.

An economic lifetime of 15 years implies that one fifteenth (6.7%) of existing sites will undergo scheduled refurbishment in any given year. Assuming legislation would enter into force in 2013, it could be expected that 47% of existing sites could install PVR Stage II controls by 2020 as a scheduled part of their investment cycle whilst the remainder would require unscheduled refurbishment with proportionately higher costs.

A summary of the costs, cost effectiveness and monetised benefits for this option are given below for the **At Pump PVR system**.

Petrol vapour abated in 2020 (tonnes)	17 769
Total cost	€ 317.4 m
Annualised cost (2020)	€ 31.95 m
Cost-effectiveness excluding value of recovered petrol	**€ 1798/tonne**
Value of recovered petrol (retail value excluding tax in 2020)	€ 11.1 m
Nett annualised cost including retail value of recovered petrol (2020)	€ 20.8 m
Cost effectiveness including retail value of recovered petrol	**€ 1171/tonne**
Monetised benefits (2020)*	€16.9 to 49.7m

** This includes only those impacts on human health and agricultural crops from exposure to ground level ozone. It excludes impacts of benzene on human health and the impacts of ozone on forests and the natural environment.*

A summary of the costs, cost effectiveness and monetised benefits for this option are given below for the **Conventional Stage II PVR system**.

Petrol vapour abated in 2020 (tonnes)	17 769
Total cost	€ 389 m
Annualised cost (2020)	€ 38.4 m
Cost-effectiveness excluding value of recovered petrol	**€ 2160 /tonne**
Value of recovered petrol (retail value excluding tax in 2020)	€ 11.1m
Nett annualised cost including retail value of recovered petrol (2020)	€ 27.2 m
Cost effectiveness including retail value of recovered petrol	**€ 1533/tonne**
Monetised benefits (2020)*	€16.9 to 49.7m

** This includes only those impacts on human health and agricultural crops from exposure to ground level ozone. It excludes impacts of benzene on human health and the impacts of ozone on forests and the natural environment. NB the value of petrol recovered inclusive of tax is not relevant for the Conventional PVR system as the vapour is returned to the oil refinery terminal and not recycled to the petrol dispenser.*

5.5. Option 3(c) – Stage II PVR at all stations located in residential accommodation (scheduled versus unscheduled installations)

In some Member States it is common to find relatively small service stations integrated into residential buildings. This was recognised in the VOC Stage I directive which required PVR controls during petrol deliveries at all such stations irrespective of size. The benefit of these Stage I controls would be maximised if Stage II PVR controls are also installed at the same service stations.

Unfortunately, there are no statistics on the number of service stations integrated into residential accommodation and so it is difficult to quantify total costs for requiring

Stage II controls to be fitted. However, from the COWI study it is possible to derive an approximate estimate of the costs of fitting Stage II controls to a station with one fuel dispenser (4 nozzles) with a throughput of 500 m^3 or less which ought to be a useful surrogate for the cost of installing Stage II PVR at a small service station within residential accommodation.

Illustrative costs associated with a scheduled and unscheduled installation of Stage II PVR are given in the table below.

Cost-effectiveness (€/tonne)	**Conventional**		**At Pump**	
	Scheduled	**Unscheduled**	**Scheduled**	**Unscheduled**
Without retail value of recovered petrol of €0.4 per litre	1890	5452	1500	3370
Including retail value of recovered petrol of €0.4 per litre	1340	4910	960	2820

(1) Assumes 15 year economic lifetime; (2) Assumes price excluding tax of €0.40

In its response to the Commission's public consultation, CONCAWE stated that it was about to publish a report concerning worker exposure to benzene in the downstream oil industry. This report concludes "*that in certain circumstances the contribution of uncontrolled refuelling emissions to ambient benzene concentrations can be significant in terms of the air quality limit value for benzene*" and that "*refuelling emissions can result in general population exposures, at least during certain peak periods, above the air quality limit value. The case of service stations below residential buildings is one of the circumstances in which this situation can occur. The report recommends that service stations in such locations should be assessed for the advisability of introducing Stage II controls.*"

It is clear that the costs for such small stations differ appreciably if the installation of Stage II PVR controls is made as part of the natural economic cycle i.e. as a scheduled refurbishment rather than an unscheduled retrofit. As such, the preferred option would be to insist on installing Stage II PVR when a station is constructed as new or when an existing station undergoes a major refurbishment. In any event, if a new regulation entered into force in 2013, approximately 50% of existing service stations would undergo refurbishment as part of the natural cycle by 2020.

5.6. Option 3(d) – automatic monitoring

The overall cost-effectiveness of Stage II PVR equipment would be maximised if the equipment actually functions correctly once installed. However, in its response to the public consultation, the Umweltbundesamt stated that in the late 1990s up 50% of systems tested in Germany were non-compliant. The ENTEC report also noted that in Denmark 25% of systems and in the Rotterdam area of the Netherlands close to 20% of operators did not undertake the necessary inspections to ensure correct functioning[39].

[39] ENTEC Report pages 22 – 25.

Checking of the performance on installed equipment can be carried out periodically and a period of every one to two years seems to be common. Alternatively, automatic "real-time" monitoring can be required which has the advantages of permitting self-calibration/fine tuning of the equipment whilst in operation and also lengthening the period between inspections and thereby reducing inspection & maintenance costs for the station operator (c.f. an inspection cost of c.a. €200-250 per dispenser).

Since 2003, Germany has mandated automatic monitoring and doubled the period between inspections of Stage II equipped dispensers to two years. German Authorities estimated that the cost to retrofit each dispenser is of the order of €2000. New equipment is likely to be less than this although no firm estimates are available. The European Oil industry points to the fact that the newer generation of Stage II equipment is more reliable and that simpler fault detection procedures are possible at one tenth the cost of "traditional" automatic monitoring.

The justification for automatic monitoring is not clear-cut and such monitoring is not required in many of those Member States where Stage II PVR controls are already in place. What is clear is that those operators who have installed automatic monitoring usually benefit from a longer period between mandatory inspections as part of their operating permit or licence.

5.7. Sensitivity of cost estimates

The COWI study looked at the impacts of changes in assumptions on the calculation of costs. The following table gives a clear indication as to the direction and magnitude of changes in key assumptions for the Option 2(a) (new and substantially refurbished stations):

Cost effectiveness in 2020 (€/tonne)	Conventional	At Pump
15 year lifetime for above ground equipment*	1140	915
10 year lifetime for above ground equipment*	1546	1326
5 year lifetime for above ground equipment*	2787	2574
Collection efficiency of 80%**	1681	1448
Collection efficiency of 90%**	1425	1217
All high cost assumptions	2282	1974
All low cost assumptions	809	677

* Assuming a collection efficiency of 85%; ** using an economic lifetime of 10 years for above ground equipment

5.8. Comparison with cost-effectiveness of other measures

The table below presents the marginal costs of abatement for selected measures to abate VOC emissions from stationary sources. This information is taken from the GAINS integrated assessment model developed by the International Institute of Applied Systems Analysis which contains comprehensive information on air pollution abatement measures and their costs[40]. The cost curve contains many more measures than presented here but shows that Stage II costs fall into the low to mid part of the cost curve.

Technical measure	Abatement cost in €/tonne of VOC
Water based inks in the Packaging Industry	80
Incineration of VOCs in coil coating	220
Hydrocarbon machine in textile dry cleaning	340
Activated carbon absorption in Industrial adhesives application	420
Improved application gunwash in vehicle refinishing	550
Water based inks in screen printing	660
Water based adhesives	695
Inks used in Packaging – enclosure and activated carbon absorption	1000
Stripping and vent gas treatment in PVC manufacture	1150
Wood treatment – activated carbon absorption	1340
Water based inks and enclosure and carbon absorption	1600
Water based inks and enclosure and incineration	1850
Substitution of products in rubber synthesis	2300
Substitution in vehicle refinishing sector	3400
Wood treatment vacuum impregnation & incineration	4000
Substitution of vehicle refinishing paints & incineration	6000
Domestic solvents reformulation	12000
Textile dry cleaning activated carbon absorption	20000
Closed solvent degreasing with HF and activated charcoal absorption	62000

5.9. Administrative costs

Due to the hazardous nature of petrol and petrol dispensing facilities and the legal requirement to apply the Petrol Stage I PVR directive 94/63/EC, the Member States

40 http://www.iiasa.ac.at/rains/gains-online.html?sb=9

are all likely to have in place a system of permitting which authorises the operation of service station activities. As such, the single most important additional administrative activity for the Member States will be the modification and re-issue of all necessary permits and verification of compliance with relevant permit conditions. There will also be savings due to the reduced need to demonstrate conformity with varied national requirements as minimum harmonised specifications should lead to mutual recognition of national standards.

The total one-off costs for permits is the product of the number of service stations affected by the new regulations and the cost for processing and issuing a new permit. A typical charge levied for the modification and re-issue of a permit is of the order of €120 and this is a cost that is recoverable by the permit issuing authority. The reports from ENTEC and COWI identified approximately 17,700 additional service stations that would be affected by any new legislation. The total administrative cost is estimated therefore at €2.1 million.

Compliance certification would also entail additional administrative costs for service station operators. Information from the UK's RIA suggests that these requirements would present an annual cost per station of €150. For, 17,700 stations the total annual cost would be €2.65 million per annum.

5.10. Social & employment aspects

5.10.1. Employment

The impacts of new Stage II controls must be seen against those changes which are already happening in the sector. As noted earlier, there is already a shift towards larger stations with shops and towards unmanned service stations. For the smallest service stations with a throughput of 500 m^3 per annum, the necessary investment costs for a worst case unscheduled installation of Stage II equipment are approximately €16-28,000. This is equivalent to approximately € 0.2-0.5 cents per litre of petrol. Since January 2007, the real cost of petrol has risen by over 60% representing approximately €cents 30 per litre. Operators have been able to pass these costs on to consumers without any noticeable impact on demand for petrol. In general, no significant impact is expected on net income levels of service station operators as costs are likely to be passed onto to consumers.

The current proposal is likely to lead to an increased demand for Stage II equipment and for its inspection and maintenance. The minimum harmonised technical standards should also make it easier for original equipment manufacturers to supply into other Member States from those in which they are established. The impacts of these positive benefits have not been quantified but are likely to safeguard or to augment current employment levels in this manufacturing sector.

5.10.2. Social inclusion, cohesion and environmental equity

Environmental equity promotes the equitable distribution of societal burdens and benefits with specific emphasis on exposure to environmental toxicants[41]. This is

[41] *Air Quality Guidelines – Global Update 2005*. World Health Organisation Europe 2006, p. 136.

consistent with the core principles of social equity and cohesion of the EU's sustainable development strategy[42]. Emerging information suggests that because of the influence of local sources, urban sub-populations exist that have consistently higher exposure to ambient pollution and that these areas of high exposure often coincide with lower socioeconomic position. Moreover, groups of lower socioeconomic position may also be more responsive to air pollution and have lower baseline health status[41].

In relation to industrial emissions to air and water in the UK, Friends of the Earth determined that 82% of carcinogenic emissions are in the 20% most deprived localities[43]. An analysis of the London Congestion charge also identified the asymmetric impacts of air pollution in deprived areas but that in this case the benefit of the congestion charging scheme brought proportionately greater benefits in these deprived areas[44].

Service stations are more likely to be distributed in urban areas and at the side of major roads. As such there is scope for disproportionate impacts particularly in relation to those petrol service stations situated in or close to residential accommodation where the cost of such accommodation is likely to be less costly and attract the more economically disadvantaged. This was recognised in the VOC Stage I directive where petrol vapour from road tanker deliveries has to be recovered at service stations located in residential accommodation irrespective of how large these stations are. Conversely, Stage II PVR controls at service stations close to or under residential accommodation are likely to deliver greater benefits to those in lower socioeconomic groups which is entirely consistent with the principle of environmental equity.

5.11. Workers' health & safety

Those working at or close to service stations constitute a group likely to experience a greater accumulated exposure to benzene than the general public. Such workers will be in a similar position to those who reside in accommodation built above or very close to service stations and who will benefit from the application of Stage II PVR controls at service stations.

6. COMPARISON OF OPTIONS

The table below presents a summary of the costs and cost-effectiveness of the various options where this is possible.

Option	Total cost €m	Emissions abated	Cost effectiveness (€/tonne)	Annualised Costs* *[& benefits]* in

42 Communication from the Commission to the Council and the European Parliament of 25 May 2005 on a draft declaration on guiding principles for Sustainable Development; COM(2005) 218 final.

43 *Pollution and Poverty – Breaking the link*; Friends of the Earth Policy and Research Unit 2005. www.foe.co.uk/resource/reports/pollution_poverty_report.pdf

44 *Congestion Charge has modest impact on the life expectancy of Londoners*; London School of Hygiene & Tropical Medicine, University of London, February 2008. www.lshtm.ac.uk/news/2008/congestioncharge.html.

		(tonnes)	Excluding recovered petrol	Including retail value of recovered petrol	2020 €m
3a (At pump)	179.5	12 141	1540	915	11.1 [*11.5-34.0*]
3a (Conventional)	209.5	12 141	1760	1140	13.8[*11.5-34.0*]
3b (At pump)	317.4	17 769	1798	1171	20.8 [*16.9-49.7*]
3b (conventional)	389	17 769	2160	1533	27.2 [*16.9-49.7*]
3c (At pump)	not calc.	not calc.	Est. 1500	Est. 960	not calc.
3c (conventional)	not calc.	not calc.	Est. 1890	Est. 1340	not calc.
3d	Limited information available				
a – Stage II controls at new and substantially refurbished service stations *b – option (a) plus existing stations with throughput greater than 3000 m^3 per annum by 2020* *c – option (b) plus all stations situated in residential accommodation irrespective of size/throughput* *d – option (c) plus installation of automatic monitoring equipment* **-includes economic value of the recovered petrol (retail price)*					

The preferred option is Option 3(c) which would (i) apply to new and refurbished stations above 500m^3 throughput; (ii) require retrofitting of existing stations above a throughput of 3000 m^3 by 2020; and (iii) require all new or substantially refurbished stations situated under residential accommodation to equip with Stage II controls irrespective of size.

It is clear that obliging the larger existing stations to install Stage II controls before 2020 imposes additional costs but also delivers substantially greater emissions reductions albeit with a slightly worse cost-effectiveness. However, the costs are relatively modest for both options. Option 3(b) has annualised costs in 2020 of 32 and 38 million euros in 2020 for the "at pump" and "conventional" systems respectively before taking into account the value of recovered petrol (€21 to 27 million when the value of recovered petrol is included).

Whilst it is not possible to calculate directly the costs associated with Option 3(c), where all stations in residential accommodation would fit Stage II controls, the illustrative calculation shows that the costs of a scheduled retrofit of a small service station would be similar to the average for all service stations in Options 3(a) and 3(b). The costs of an unscheduled retrofit are substantially higher and do not justify the imposition of a time limit. However, in the 10 years following adoption of any new Directive on Stage II PVR, over two thirds of such stations would have been expected to have undergone a scheduled refurbishment.

Whilst automatic monitoring would certainly guarantee the delivery of the intended benefits in practice, there is uncertainty over the costs of such systems and whether there are not simpler and cheaper systems that can deliver as well. This conclusion was supported by the findings of ENTEC report which determined a 50% worsening in cost-effectiveness for the mandatory inclusion of automatic monitoring[45]. However, given the increased probability of reliable in-service performance there will undoubtedly be less need for periodic inspection of the Stage II equipment which would represent a cost saving.

7. MONITORING AND IMPLEMENTATION

Extensive reporting mechanisms are already in place to monitor ambient air quality and Member States' adherence to Community air quality objectives. Non-compliance with legal air quality requirements is enforced pursuant to existing Treaty provisions. Member States will need to transpose the Stage II directive's provisions once adopted and to bring about their practical implementation and the Commission will need to assess the conformity of those transposing measures. Monitoring of Member States' progress can be gauged from the emission inventory reports that they are obliged to compile and submit to the Commission (and the Convention on Transboundary Air Pollution) pursuant to the national emissions ceilings directive. There are also statistics compiled by national and European oil industry associations which can also assist in evaluating progress. It is thought that the imposition of an additional specific reporting burden may be disproportionate as this would require the compilation of additional statistical information at the national level. In any event, the Commission has the prerogative to ask at any moment how the Member States have implemented Community law.

[45] Table 6.24, p. 55 of the ENTEC report prepared for the Commission (May 2005).

Annex I
Status of Stage II PVR Implementation in the Member States

Country	Details of Stage II PVR controls	Expected compliance with NECD ceiling for VOCs in 2010[46]	Status w.r.t. UNECE VOC protocol *(compliance in respect of Stage II)*
Austria	Controls apply to all service stations by 1998 at the latest	yes	Ratified (yes)
Belgium	*Brussels Region*: Controls apply to all service stations by 2007 except if throughput of petrol is less than 500m^3 per annum and not situated under dwellings; *Flanders*: Controls apply to all service stations greater than 100m^3 petrol throughput per annum. *Wallonia*: Controls apply to all new and existing stations by 2010.	yes	Ratified (yes)
Cyprus	No legislation but stations generally fit appropriate underground pipe work	yes	Non-signatory
Czech Republic	Controls apply to all stations by 2004	yes	Ratified (yes)
Denmark	Controls apply to all stations with petrol throughput greater than 500m^3 by 2000	No	Ratified (yes)
Estonia	No legislation	yes	**Ratified (no)**
Finland	No legislation	yes	**Ratified (no)**
France	Controls apply to all new stations greater than 500m^3 petrol throughput by 2001 and existing stations with throughput greater than 3000m^3 by 2002	No	Ratified (yes)
Germany	Controls apply for all new and existing stations greater than 1000m3 petrol throughput by 1997	yes	Ratified (yes)
Greece	No legislation	yes	Signatory only

46 http://www.eea.europa.eu/highlights/more-eu-member-states-to-miss-2010-air-pollutant-limits

Country	Details of Stage II PVR controls	Expected compliance with NECD ceiling for VOCs in 2010[46]	Status w.r.t. UNECE VOC protocol *(compliance in respect of Stage II)*
Hungary	Controls apply to all stations with throughput greater than $100m^3$ by 2003	yes	Ratified (yes)
Ireland	No legislation	yes	Non-signatory
Italy	Controls apply to all petrol stations by 2000	yes	Ratified (yes)
Latvia	Controls apply to all new stations from 2000	yes	Non-signatory
Lithuania	Controls apply to all new stations with a throughput greater than $100m^3$ ($500m^3$ in rural areas) and all stations by 2007.	yes	Ratified (yes)
Luxembourg	Controls apply to all petrol station by January 2005	yes	Ratified (yes)
Malta	No legislation	yes	Non-signatory
Netherlands	Controls apply to all stations with throughput greater than $500m^3$ by 1999	yes	Ratified (yes)
Poland	Controls apply to all service stations with throughput greater than $100m^3$ by 2005	**no**	Non-signatory
Portugal	No legislation	**no**	Signatory only
Slovakia	Controls apply to all stations with a throughput greater than $1000m^3$ from January 2005. Stations with a throughput greater than $100m^3$ but less than $1000m^3$ and located under permanent dwellings or industrial premises must comply by 1 January 2008.	yes	Ratified (yes)
Slovenia	Legislation applies to all new and refurbished stations	yes	Non-signatory
Spain	No legislation	**no**	**Ratified (no)**
Sweden	Controls apply to all stations with throughput greater than $100m^3$ by 1995 though exemptions can be granted for rural stations with a throughput less than $300m^3$.	yes	Ratified (yes)

Country	Details of Stage II PVR controls	Expected compliance with NECD ceiling for VOCs in 2010[46]	Status w.r.t. UNECE VOC protocol *(compliance in respect of Stage II)*
UK	Controls will be applied to all new stations and existing stations with a throughput greater than 3500m^3 from January 2010. New stations with throughputs less than 500m^3 are exempt.	yes	Ratified (yes)
Bulgaria	No legislation but most stations have controls in place	yes	**Ratified (no)**
Romania	No legislation	yes	Non-signatory
Croatia	No legislation	n/a	Non-signatory
European Community	n/a	yes	Signatory only

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Annex II
Numbers of petrol stations by Member State & size

Country	*N° of stations*	*% of stations > 500m³ p.a.*	*Country*	*N° of stations*	*% of stations > 500m³ p.a.*
Austria	2900	-	Latvia*	590	53%
Belgium	3400	-	Lithuania*	625	-
Cyprus*	250	84%	Luxembourg	280	-
Czech Republic	2150	91%	Malta*	80	-
Denmark	2100	91%	Netherlands	3700	-
Estonia*	500	-	Poland	6700	-
Finland	2050	80%	Portugal	2350	-
France	13600	-	Slovakia*	780	94%
Germany	15250	84%	Slovenia*	420	90%
Greece	8200	-	Spain	8700	-
Hungary	1600	-	Sweden	4000	-
Ireland	1850	-	UK	9800	90%
Italy	22500	-	Croatia*	600	

*Information taken from Statistics published by The European Petroleum Industries Association unless otherwise stated. *signifies information taken from Annex A of the ENTEC Report.*

Service station throughput (m^3/yr)	*% of total volume of petrol supplied*	*% of service stations*
< 500	10.7%	26.9%
< 1000	21.5%	41.2%
< 1500	32.2%	55.5%
< 2000	41.4%	64.3%
< 2500	50.5%	73.1%
< 3000	59.6%	82.0%
< 4000	71.7%	88.5%
< 5000	83.6%	95.0%
> 5000	16.4%	5.0%

Annex III
Costs of Stage II Petrol Vapour Recovery

Conventional System

Annual throughput (m^3)	0 - 500	500 - 1000	1000 - 2000	2000-3000	3000+
Assumed number of dispensers	1	2	3	4	6
Number of nozzles per dispenser	4	4	4	4	4
Supplementary materials and labour					
Unscheduled installation of underground pipe work					
Underground pipework	4,860.00	5,265.00	6,075.00	7,290.00	8,910.00
Surround to pipework	405.00	810.00	1,215.00	1,620.00	2,430.00
Tank connections and valves	494.10	988.20	1,490.40	1,992.60	2,972.70
Trench excavation for vapour recovery pipework	5,670.00	6,075.00	6,885.00	8,100.00	12,150.00
Remove pumps and replace	405.00	810.00	1,215.00	1,620.00	2,430.00
Installation of vapour recovery equipment	486.00	972.00	1,458.00	1,944.00	2,916.00
Unscheduled total	*12,320.10*	*14,920.20*	*18,338.40*	*22,566.60*	*31,808.70*
Scheduled installation of underground pipe work					
Underground pipework	1,344.60	1,393.20	1,458.00	1,558.44	1,934.28
Surround to pipework	324.00	567.00	810.00	1,296.00	1,944.00
Tank connections and valves	494.10	988.20	1,490.40	1,992.60	2,972.70
Trench excavation for vapour recovery pipework	0.00	0.00	0.00	0.00	0.00
Remove pumps and replace	405.00	810.00	1,215.00	1,620.00	2,430.00
Installation of vapour recovery equipment	486.00	972.00	1,458.00	1,944.00	2,916.00
Scheduled total,	*2,608.20*	*3,839.40*	*5,094.90*	*6,629.04*	*9,523.98*
Existing pipework at hand					
Underground pipework	0.00	0.00	0.00	0.00	0.00
Surround to pipework	0.00	0.00	0.00	0.00	0.00
Tank connections and valves	494.10	988.20	1,490.40	1,992.60	2,972.70
Trench excavation for vapour recovery pipework	0.00	0.00	0.00	0.00	0.00
Remove pumps and replace	405.00	810.00	1,215.00	1,620.00	2,430.00
Installation of vapour recovery equipment	486.00	972.00	1,458.00	1,944.00	2,916.00
Existing pipework total	*939.60*	*1,879.20*	*2,826.90*	*3,774.60*	*5,645.70*
Costs of PVR Stage 2 equipment					
New dispenser (unscheduled)					
Dispenser	10,484.32	20,968.64	31,452.96	41,937.28	62,905.92
Vapour recovery equipment	2,930.40	5,860.80	8,791.20	11,721.60	17,582.40
Nozzle	2,326.56	4,653.12	6,979.68	9,306.24	13,959.36
New dispenser - total	*15,741.28*	*31,482.56*	*47,223.84*	*62,965.12*	*94,447.68*
New dispenser (scheduled)					
Dispenser	0.00	0.00	0.00	0.00	0.00
Vapour recovery equipment	2,930.40	5,860.80	8,791.20	11,721.60	17,582.40
Nozzle	2,326.56	4,653.12	6,979.68	9,306.24	13,959.36
New dispenser - total	*5,256.96*	*10,513.92*	*15,770.88*	*21,027.84*	*31,541.76*
Retrofit to existing dispenser					
Dispenser	0.00	0.00	0.00	0.00	0.00
Vapour recovery equipment	3,984.16	7,968.32	11,952.48	15,936.64	23,904.96
Nozzle	2,344.32	4,688.64	7,032.96	9,377.28	14,065.92

Retrofit to existing dispenser, total	*6,328.48*	*12,656.96*	*18,985.44*	*25,313.92*	*37,970.88*
Recurring costs (per year - dependent on number of dispensers)					
Maintenance and power costs					
Incremental maintenance and tests	249.13	337.93	426.73	515.53	693.13
Incremental power	7.40	14.80	22.20	29.60	44.40
Total "m&p" costs	256.53	352.73	448.93	545.13	737.53

"At pump" System

Annual throughput (m^3)	0 - 500	500 - 1000	1000 - 2000	2000-3000	3000+
Assumed number of dispensers	1	2	3	4	6
Number of nozzles per dispenser	4	4	4	4	4
Supplementary materials and labour					
System using new technology (Regardless of new, scheduled or unscheduled)					
Installation of vapour recovery equipment	486.00	972.00	1,458.00	1,944.00	2,916.00
New technology total	*486.00*	*972.00*	*1,458.00*	*1,944.00*	*2,916.00*
Costs of PVR Stage 2 equipment					
New dispenser (unscheduled)					
Dispenser	10,484.32	20,968.64	31,452.96	41,937.28	62,905.92
Vapour recovery equipment	2,960.00	5,920.00	8,880.00	11,840.00	17,760.00
Nozzle	2,326.56	4,653.12	6,979.68	9,306.24	13,959.36
New dispenser (unscheduled), total	*15,770.88*	*31,541.76*	*47,312.64*	*63,083.52*	*94,625.28*
New dispenser (scheduled)					
Dispenser	0.00	0.00	0.00	0.00	0.00
Vapour recovery equipment	2,960.00	5,920.00	8,880.00	11,840.00	17,760.00
Nozzle	2,326.56	4,653.12	6,979.68	9,306.24	13,959.36
New dispenser (scheduled), total	*5,286.56*	*10,573.12*	*15,859.68*	*21,146.24*	*31,719.36*
Retrofit to existing dispenser					
Dispenser	0.00	0.00	0.00	0.00	0.00
Vapour recovery equipment	4,440.00	8,880.00	13,320.00	17,760.00	26,640.00
Nozzle	2,344.32	4,688.64	7,032.96	9,377.28	14,065.92
Retrofit to existing dispenser, total	*6,784.32*	*13,568.64*	*20,352.96*	*27,137.28*	*40,705.92*
Recurring costs (per year - dependent on number of dispensers)					
Maintenance and power costs					
Incremental maintenance and tests	249.13	337.93	426.73	515.53	693.13
Incremental power	7.40	14.80	22.20	29.60	44.40
Total "m&p" costs	*256.53*	*352.73*	*448.93*	*545.13*	*737.53*