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Policy Brief: Improving the energy performance of motor-driven systems

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Food and Rural Affairs

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A Policy Brief for improving the energy performance of motor-driven systems

Evidence, analysis, targets and indicative standards

Overview

1. This Policy Brief represents the outcome of the public consultation on motor-driven systems, which was carried out earlier this year. This is in accordance with the announcement in the Energy White Paper of 23 May 2007 where the Government said it would publish a series of consultation papers setting out its analysis of how the performance of energy using products will need to improve over the next 10–20 years, including proposals for product standards and targets to phase out the least efficient products[1]. This forms part of a wider annual review and policy development process, supporting delivery of the Government's objectives for energy and sustainable consumption and production.

2. To achieve the product standards and targets, a range of measures and approaches is required. These may include: international agreements; European and domestic legislation; and voluntary action through the supply chain to enhance markets for the most cost-effective energy efficient goods and services. In the Energy White Paper, the Government announced a range of policies to support delivery.

3. We believe that the standards will provide suppliers, manufacturers and service providers with a benchmark to improve the performance of products they provide. In addition, we are encouraging industry to deliver improvements in product standards.

4. This Policy Brief addresses in-use energy consumption and carbon emissions associated with the following motor-driven products and systems: electric motors (in industrial and commercial applications in sizes up to 400 kW), variable speed drives, pumps (centrifugal, in clean water applications), pumping systems (industrial and commercial applications), fans and fan systems (industrial and commercial applications).

5. While electric motors provide the motive power for motor-driven systems within industrial and commercial installations, their applications are very diverse and include: fans, pumps, air compressors, refrigeration and air-conditioning compressors, lifts, conveyors and machine tools. Pump and fan applications account for the greatest energy consumption at 32% and 22% respectively. This is followed by air compressor applications (8%), refrigeration applications, air-conditioning applications and a mix of others, such as materials handling (lifting, conveying) and specialist machines.

6. Air-conditioning and refrigeration products use electric motors as components to drive compressors and fans that they incorporate and the motors account for up to 95% of the energy consumed by these products. Separate Policy Briefs have been developed for these products namely, 'Improving the energy performance of air-

[1] See Energy White Paper (23 May 2007), para. 2.102.

conditioning products' and 'Improving the energy performance of commercial refrigeration products'. Modelling suggests that these products collectively account for about 25% of the energy consumed by the motor systems considered in this Policy Brief. This overlap must be taken into account when estimating energy savings projections.

7. It is possible to apply performance standards to the individual components of motor systems such as the electric motor, pump, fan or compressor. However, acceptable performance measurement methodologies and performance information are only available for some of these products, namely induction motors[2] and a sample is presented here. For one class of clean water pumps a performance metric based on an average duty is presented. When suitable performance metrics for the other products (eg fans) are developed these too will be presented in future versions of this Policy Brief.

8. Indicative performance standards for a sample of electric motors are outlined in the Appendix. In addition, for pumps, an indicative performance standard is included in the Appendix and this is based on an approach being developed for the EU's Framework Directive on the Eco-design of Energy-using Products (EuP). Currently there is insufficient data available to recommend an indicative performance standard for fans, though an approach similar to that for pumps will be pursued.

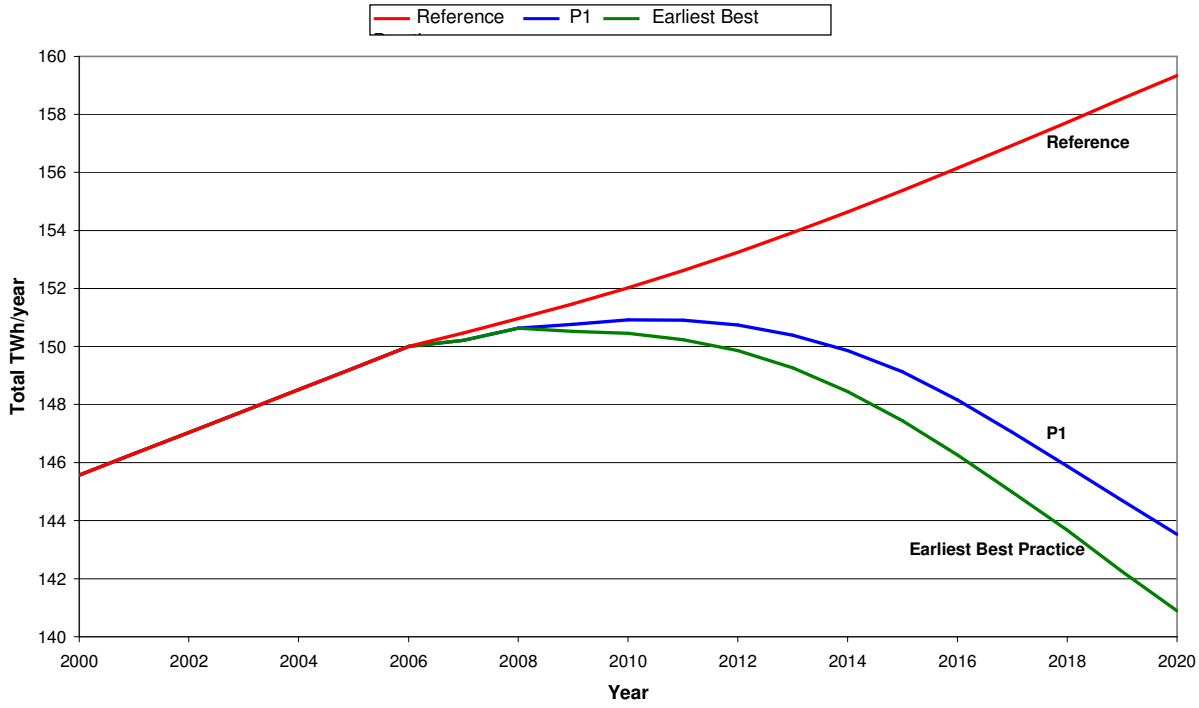
9. It must also be noted that the performance of the components within a motor-driven system are significantly influenced by the way in which they are selected and combined to comprise the whole system; indeed the majority of the available savings will come from the optimum design of such systems. Many of these are specific to particular applications and will benefit from any voluntary supply chain initiative to encourage best practice design, installation and operation. To develop performance standards for such systems, it is first necessary to develop suitable performance test methodologies and metrics on which such standards can be based.

How we expect motor-driven systems to contribute to future energy consumption

10. The following graph shows the Government's projections for energy use by motor-driven systems.

[2] Throughout this Policy Brief, 'induction motor' refers to squirrel cage AC induction motors.

Total in-use energy consumption of installed UK motor-driven systems (see scope in paragraph 4)



11. The Reference[3] projection takes into account underlying trends in markets and technologies, and the estimated or implicit impacts of historical and current policy measures. It does not, as yet, take account of the impact of policies announced in the Energy White Paper of 23 May 2007, which are still being developed and are not targeted at specific products. The intention is to revise these projections once it becomes clearer how these new policy measures will affect motor-driven systems.

12. The Earliest Best Practice (EBP) projection shows what would happen if all new UK sales were based on the most resource efficient options, taking into account design and production cycles, but not taking account of price or other market barriers.

13. The P1 projection sets a target level of ambition that the Government is proposing could be delivered at a reasonable cost, taking into account such things as current UK and global performance benchmarks, economies of scale and the capacity of the supply chain to take coherent action to deliver more energy efficient products[4].

[3] The Reference line or 'REF' is included as a baseline against which progress towards absolute consumption targets can be monitored. It also permits us to measure the impact of market changes in response to published targets and delivered policy measures, and to assess the need for additional action. REF is updated to estimate the aggregate impact of existing policy measures, superimposed on underlying market trends, on the supply, sales and use of motors and motor-driven products and systems – and, therefore, on non-domestic energy consumption. The effectiveness of market transformation policy, taken as a whole, may be assessed as the extent to which it modifies REF.

[4] These market-based estimates for P1 are cross-compared with the performance improvements that could be envisaged through a set of ambitious but feasible policy options, over and above those included in the Reference line to check their feasibility. Section 3 of this Policy Brief (Policies, risks and measures) describes these along with the associated risks and proposed strengthening initiatives.

14. In theory, delivery of EBP would result in energy use from motor-driven systems falling by about 6% to 140.9 TWh[5] by 2020, relative to 2006. This would represent an energy saving of 18.4 TWh (2.3 MtC, 8.3 $MtCO_2$)[6] over the Reference projections for 2020.

15. The proposed P1 target would result in energy use from motor-driven systems falling to 143.5 TWh by 2020. This would represent an energy saving of 15.8 TWh (1.9 MtC, 7.1 $MtCO_2$)[7] over the Reference projections for 2020.

16. In this product area, we estimate that the P1 target could be achieved through a combination of improvements in product and systems performance. At least one quarter of the P1 target is achievable, according to the modelling if, on average, electric motors and pumps supplied and brought into use each year were to meet the indicative performance standards set out in the Appendix[8]. The remaining savings would arise from increasing the performance of fans, and from improvements in systems performance, for which standards cannot currently be proposed due to a lack of test methodologies and performance metrics. These P1 targets and product standards take into account:

- Benchmark product designs and technologies.
- Underlying market and technology trends.
- The scope for delivering policy benefits at reasonable cost.

17. We estimate this market shift could be delivered at a reasonable cost. For example, there are induction motors available whose performance is a level above that of the existing best in class motor label 'EFF1'. High efficiency circulation pumps are readily available for water circulation systems in buildings. However, their uptake is low, due to a combination of lack of awareness and perceived high cost.

18. If we are on track to deliver this target, we would expect to see substantial shifts in the market, for example:

2010: The minimum efficiency of new induction motors meets the levels that are currently defined as 'high efficiency', (eg equivalent to the 'EFF1' label).
2010: Indicative standards for certain fan and pump products are developed and introduced.
2010: Minimum energy performance levels of ventilation systems in buildings (Specific Fan Power) are set at levels consistent with current best practice.

[5] 1 terawatt-hour (TWh) = 1,000,000,000 kilowatt-hours (kWh).
[6] Carbon emissions for electricity are calculated from Government predictions of the electricity generation mix. Oil and gas are converted using standard Government factors. See MTP Briefing Note BNXS01 at:
www.mtprog.com/ApprovedBriefingNotes/pdf.aspx?intBriefingNoteID=150.
[7] However, some of the energy an appliance uses provides useful heat and when this is reduced, the heating system will have to provide more heat (also known as the heat replacement effect, HRE), so the net carbon reduction taking the HRE into account is 1.6 MtC, 5.8 $MtCO_2$. See MTP Briefing Note BNXS05 for further explanation at:
www.mtprog.com/ApprovedBriefingNotes/pdf.aspx?intBriefingNoteID=151
[8] We recognise that the standards setting approach will need to be flexible otherwise it will not be capable of allowing for the range of motor-driven product and system specifications/applications. For example, particular product groupings may be ruled out or innovation restricted.

2010: Minimum efficiency levels for new pumping systems in buildings attain levels consistent with current best practice performance.
2010: Minimum efficiency levels for new pumping systems and fan systems in other industrial or process applications, such as the water industry or the chemicals industry, attain levels consistent with current best practice performance.
2015: The minimum efficiency of induction motors is improved by one level.

19. Our analysis indicates, in principle, that the P1 target is achievable through normal market mechanisms, supported by policies to be implemented as announced in the Energy White Paper.

20. For that reason, we have consulted with suppliers and manufacturers on the indicative standards set out in the Appendix to build support across the supply chain to act coherently to deliver these.

21. This is in line with the approach taken in the EU's Eco-design of Energy-using Products Framework Directive (EuP), which encourages voluntary actions where appropriate.

22. The Government is committed to working with designers, specifiers, manufacturers and suppliers to overcome barriers that might impede progress, and to promote delivery of these indicative standards more widely in the market. We will, therefore, work with the full range of policies outlined in the Energy White Paper. Where international or domestic measures rely on performance standards, we propose that we should seek to align them with the indicative standards outlined in this Policy Brief. In particular we will:

- Press for EuP measures to adopt performance requirements for electric motors and the other motor-driven products in line with our indicative standards, while acknowledging the Single Market legal base for EuP and recognising that final performance requirements will need to be fully harmonised across the whole of the European Union.
- Encourage, for example through the International Task Force for Sustainable Products (ITFSP), harmonisation of international measurement standards for fans and pumps.
- Support the creation of a UK or international energy labelling initiative or similar measure for pump and fan products.
- Use the indicative standards to identify the most appropriate minimum and/or forward looking standards for use in Government procurement.

23. We set our P1 target and indicative standards based on our current understanding of what is necessary and deliverable. That analysis may change over time, for example, if new efficient technologies enter the market faster than expected; or if consumer trends change; or through international or EU action; or through policies on carbon emissions reduction more generally. We intend to maintain a continued active dialogue with businesses in the supply chain. The aim will be to review progress and to annually update this analysis, the P1 target and the indicative standards for motor-driven systems, among others, following consultation and review.

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1 Status of Policy Brief

24. This Policy Brief is issued as part of an annual process, as announced in the Energy White Paper, to review and update the Government's published analysis, projections, P1 target and indicative standards for more sustainable products. This updated version takes into account the views received following the first consultation and, so far as possible, addresses substantial issues raised.

2 Market overview

25. As set out above, this Policy Brief addresses in-use energy consumption and carbon emissions associated with the following motor-driven products:

- Electric motors (in industrial and commercial applications in sizes up to 400 kW).
- Pumps (centrifugal, in clean water applications).
- Pumping systems (industrial and commercial applications).
- Fans and fan systems (industrial and commercial applications).

26. Over 2.1 million electric motors and associated equipment are supplied into industrial and commercial markets in the UK each year. Within this group, around 0.9 million motors are in the size range 0.75 kW to 400 kW; over 80% of motor-driven systems are powered by motors sized 7.5 kW or smaller. Applications are diverse and on a ranking by energy consumption include pumps, fans, air compressors, refrigeration compressors, air conditioning compressors, and others, including applications such as materials handling (lifts, conveyors and elevators), crushing and grinding, and machine tools. Variable speed drives may be used as controls to realise energy savings in a number of these applications.

27. The largest market for motor-driven equipment is within buildings, followed by the metal products machinery and equipment sector, the chemicals sector, other manufacturing industries and the water industry.

28. Greater energy savings may be achieved through addressing the overall performance of pump and fan systems rather than the individual components, however defining these systems and developing measures to address these is complex and may take some time to achieve.

29. The main energy efficiency measures affecting motor-driven systems are:

- European/CEMEP[9] voluntary motor labelling scheme (induction motors).
- Enhanced Capital Allowance (ECA) scheme (electric motors, integrated motor drives, switched reluctance drives, variable speed drives).
- Building Regulations (fan systems in building ventilation).

[9] European Committee of Manufacturers of Electrical Machines and Power Electronics.

2.1 Trends

30. Sales of large motor-driven equipment have been decreasing with the decline in heavy manufacturing in the UK. However, this has been more than compensated for by significant growth in the building services market (fans and pumps) where higher quantities of smaller equipment are supplied and this is now the dominant market.
At present, motors, pumps, fans and air compressors account for most in-use energy consumption in this sector.

2.1.1 Motors

31. Induction motors[10] dominate the electric motors market. Sales of higher efficiency (EFF1) labelled induction motors (which qualify for ECA) are believed to have reached a plateau at about 17% with the remainder of the market being standard efficiency (EFF2). Strong price competition coupled with a lack of awareness of energy considerations, are thought to be preventing further uptake of high efficiency motors.

32. The next generation of even higher efficiency motors have recently become available on the market. However, uptake is believed to be very low; at present there are no formal methods of distinguishing these products by efficiency ratings.

33. Other motor technologies such as switched reluctance motors and those that utilise permanent magnets are more efficient than induction motors, especially those rated below 7.5 kW. Most require additional electronic controls to operate, but do offer additional performance capabilities such as variable speed operation. Uptake of these technologies is limited and confined to specialist applications.

34. Reductions in energy use can be achieved by:

- Encouraging sales of the latest generation of high efficiency induction motors.
- Discouraging sales of lower efficiency induction motors.
- Encouraging more widespread uptake of alternative motor technologies.

2.1.2 Pumps

35. Applications for pumps are extremely diverse resulting in a great variety of different pump designs. The efficiency of a pump or pumping system is closely linked to the application to which it is applied; for the majority of the market there are no formal mechanisms to distinguish ‘high efficiency’ pumps or pumping systems. The voluntary European labelling scheme for circulating pumps (used in building heating systems) was launched in 2005, but this lacks widespread recognition within the UK. There has been a recent trend towards smaller pumps and circulators in the building services markets.

36. Price competition remains strong and this has led to pumping systems being sold on the basis of purchase price rather than lifecycle costs, resulting in low installed efficiencies. The evidence we have suggests that the installed efficiency of

[10] Throughout this Policy Brief, ‘induction motor’ refers to squirrel cage AC induction motors.

many pumping systems offers considerable scope for improvement. The use of variable speed drives fitted to pump sets supplied into building services has been rapidly gaining popularity.

37. There is scope for:

- Improving the installed efficiency of pumping systems in many applications.
- Improving the efficiency of some pump types.

2.1.3 Fans

38. Like the pump market, the applications of fans are extremely diverse resulting in a great variety of different fan designs. The efficiency of some fan designs has improved in recent years however the operating efficiency of a fan or fan system is closely linked to the application to which it is applied; for much of the market there are no formal mechanisms to distinguish 'high efficiency' fans or fan systems.

39. The Building Regulations do have a minimum energy performance standard for ventilation systems in buildings ('Specific Fan Power') and consequently have stimulated a high uptake of variable speed drives in these applications.

40. Price competition remains strong and this has led to fan systems being sold on the basis of purchase price rather than lifecycle costs, resulting in low installed efficiencies. The evidence we have suggests that the installed efficiency of many fan systems offers considerable scope for improvement.

41. The ECA scheme has indirectly stimulated the top end of the market where manufacturers of products incorporating fans (heat exchangers, heat pumps, refrigeration equipment) are now specifying higher efficiency fans.

42. There is scope for:

- Further improving the performance of fans in building ventilation systems.
- Improving the installed efficiency of fans in other applications.
- Improving the efficiency of some fan types.

2.1.4 Variable speed drives

43. Strong demand for variable speed drives (VSDs) continues especially on fans where the Building Regulations have contributed to encouraging their uptake within building services, while improved commissioning and control on pumps have encouraged their uptake within in building services. The Integrated Pollution, Prevention and Control (IPPC) Regulations have contributed to their uptake in industrial applications.

44. The new generation of VSD fitted with an 'active front end' is receiving interest in some quarters due to its ability to make compliance with electrical regulations (G5/4) easier and, in some applications, to regenerate power back to the mains supply network.

2.2 Price

45. In general, the market is price sensitive with manufacturers under pressure to offer products at the lowest possible initial cost. This has been a barrier to improving energy efficiency as anything that is perceived to have the potential to add cost, such as the inclusion of best practice components, is treated with caution. However, in many cases the economic barrier is overcome when lifecycle costing information is considered (paybacks within one or two years can often be achieved).

3 Policies, risks and measures

46. In the Energy White Paper, the Government said it would:

- Take steps within the UK to improve the take up of energy efficient products and work internationally, and through the EU, to stimulate global innovation and competition to raise standards and to bring a greater choice and efficient products to UK consumers.
- Deliver on our Gleneagles G8 commitments to promote international co-operation on product labelling and standards and help develop practical standards to reduce standby power.
- Work with the UK supply chain to encourage delivery of more efficient goods and services.
- Publish a series of consultation papers setting out our analysis of how the performance of energy using products will need to improve between now and 2020, including proposals for indicative product standards and initiatives to phase out the least efficient products.

47. As set out above, our analysis indicates, in principle, that the P1 target is achievable through normal market mechanisms, supported by policies to be implemented as announced in the Energy White Paper.

48. In this Section we consider the potential for policy to assist in delivering P1. We identify:

- Policies we believe are already helping to deliver higher environmental performance standards.
- Supporting policies that could assist in delivering P1 in the event that the market fails to deliver it.
- The risks that these policies may not deliver efficiency improvements.
- Further actions that may be necessary to achieve the Government's targets.

49. Figures 3.1, 3.2 and 3.3 illustrate how existing policy instruments could support delivery of more efficient new products - specifically three sizes of induction motor.

50. The graphs plot the data in the Appendix (ie the indicative performance standards for the basket of new products), which correspond to the P1 projection. Also shown on the graphs are equivalent performance values for the Reference and EBP projections. These illustrate the sales-weighted average performance of new products under the different projections.

Figure 3.1 Average efficiency for new, 4 kW, 4-pole, induction motors

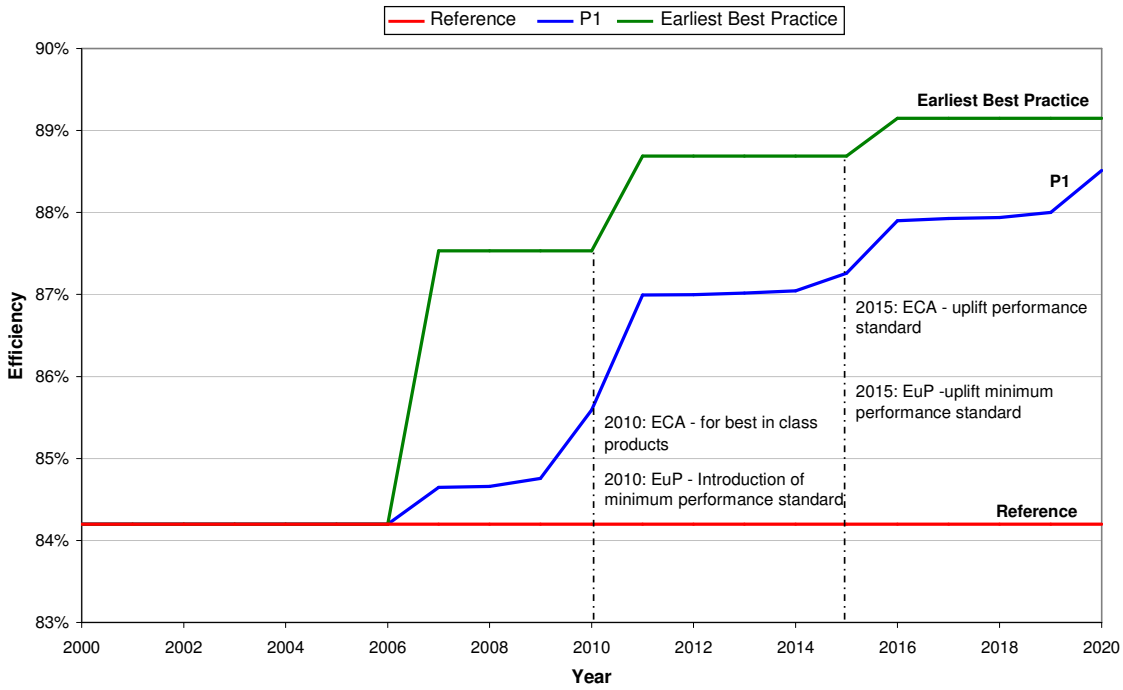


Figure 3.2 Average efficiency for new, 11 kW, 4-pole, induction motors

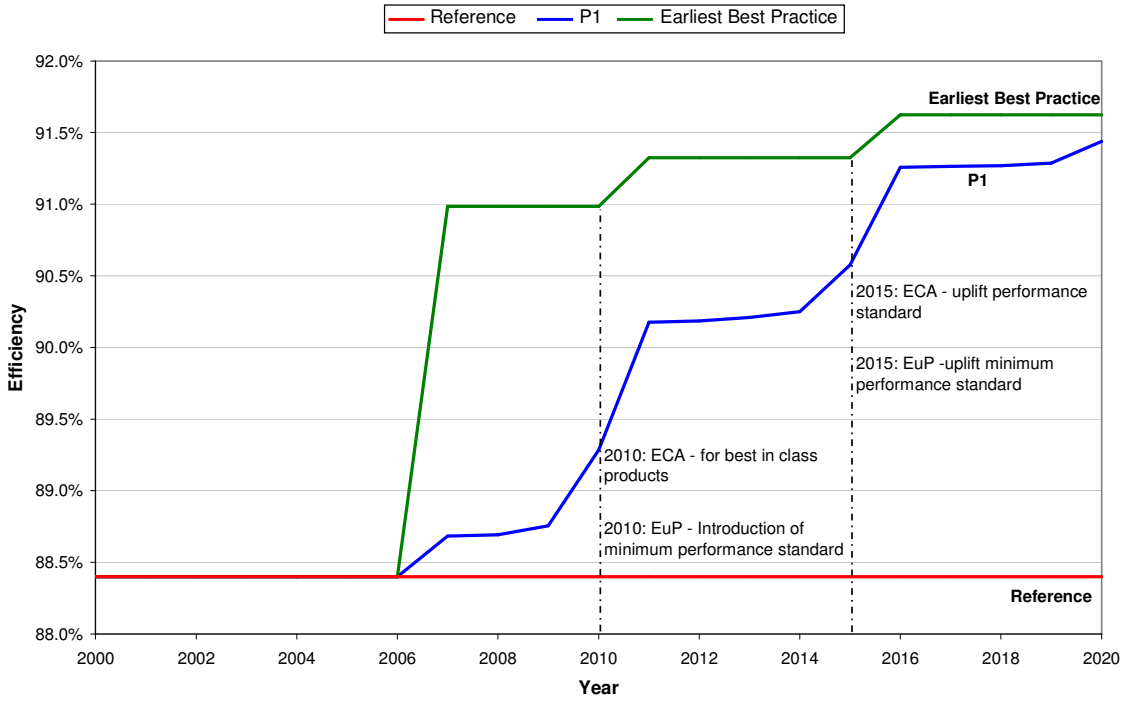
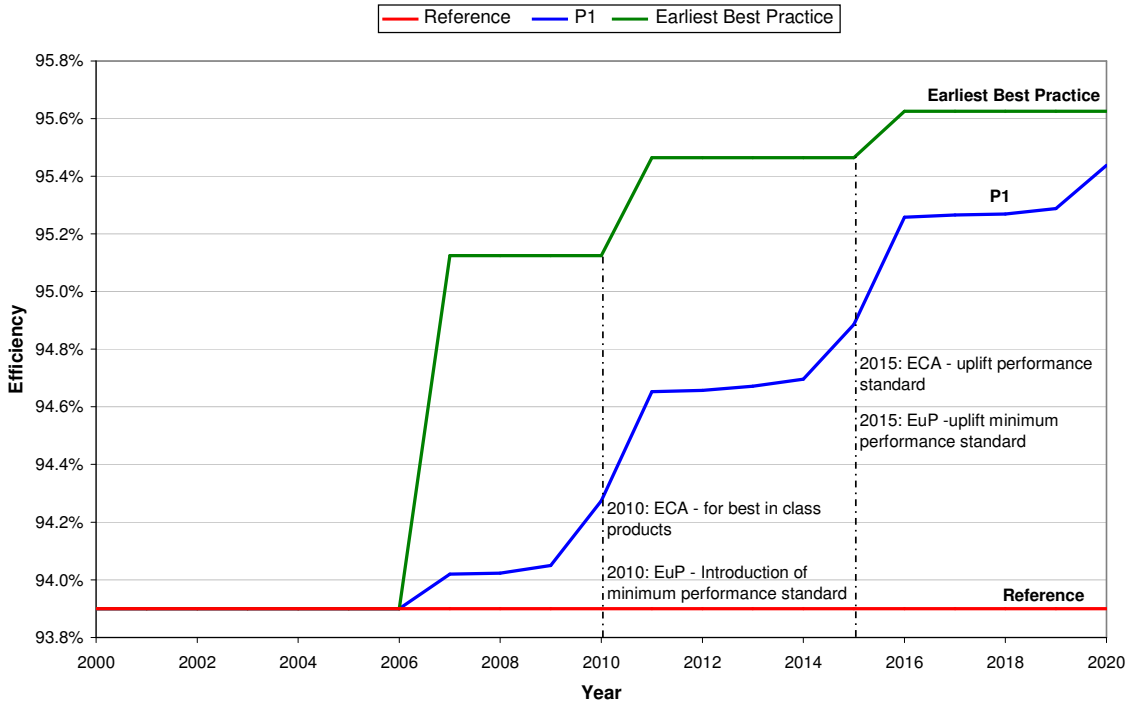


Figure 3.3 Average efficiency for new, 90 kW, 4-pole, induction motors



51. Figures 3.4 and 3.5 illustrate how key existing policy instruments could support delivery of two different sizes of clean water pump.

Figure 3.4 Average efficiency for new, end-suction, close-coupled, clean water pump with duty 25 m^3/hour at 32 m

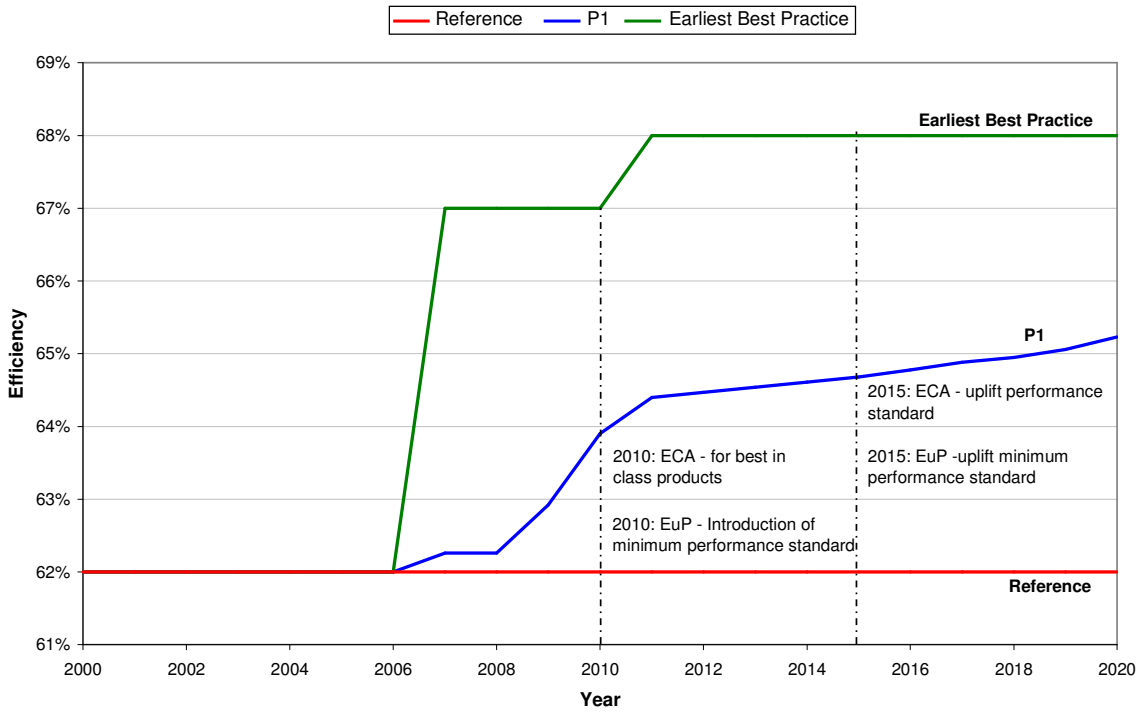
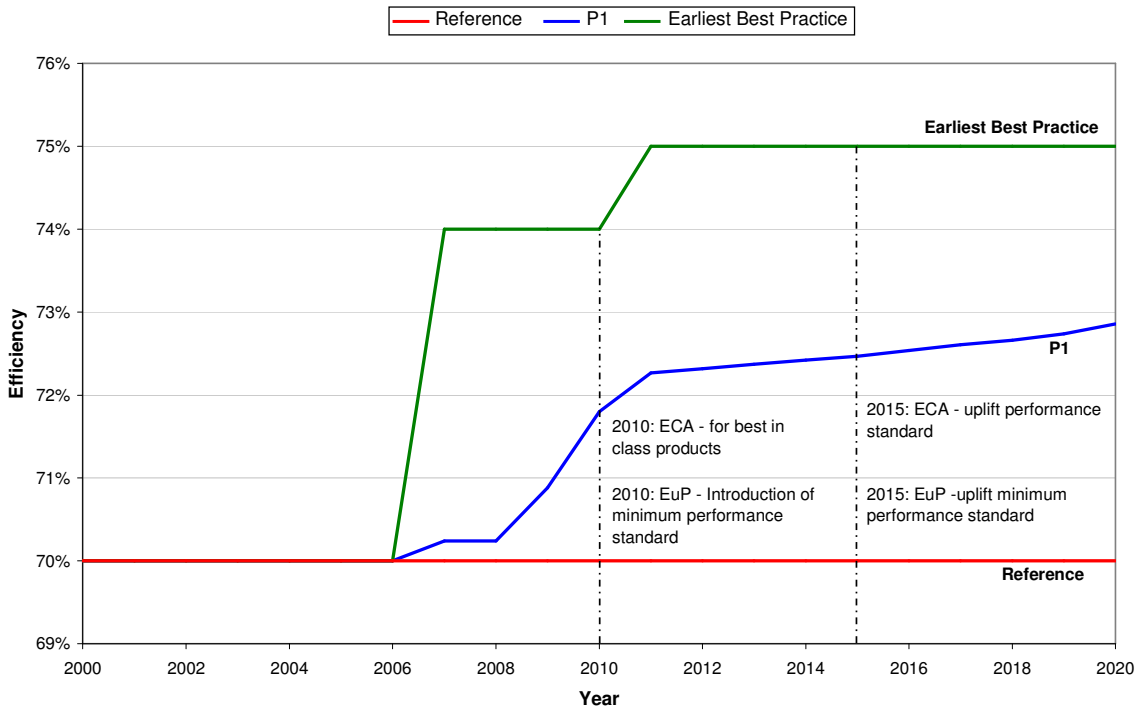


Figure 3.5 Average efficiency for new, end-suction, close-coupled, clean water pump with duty 125 m^3/hour at 32 m



52. It is not currently possible to provide equivalent graphs for fans, due to the wide diversity of these products on the market. Data are being collated for these and suitable information will be presented when it becomes available.

3.1 Market analysis, projections and targets

Current status

53. This is our first Policy Brief resulting from the consultation process which addresses how the performance of motor drive systems will need to improve between now and 2020, including proposals for product standards and initiatives to phase out the least efficient products. The intention is to update this analysis on a yearly basis.

54. Tables provided in the Appendix show the average performance level that a sample of motor-driven products will need to achieve to make their contribution, along with improvements in system performance, to realise the P1 target. The tables also provide a metric against which developments in the market can be measured. Additional tables for fan products and other system-based performance metrics will be included in future consultations as further data become available.

55. The intention is to monitor progress against the current projections for technology and market development, to consult on the evidence and, annually, to review and update the published analysis and policy response, including indicative product performance standards for new products supplied to the UK market.

Policy: Publish and update UK market and technology plans annually.
Start date: 2007.
Reference: Announcement in Energy White Paper 2007.
Next deliverables:
- 2008: Monitor market developments, refine models and consult on possible amendments to this Policy Brief.
- 2008: Publish an updated P1 target and indicative product standards.

Acknowledged risks

56. There is a risk that products will develop in a direction that differs from that which was initially expected in the projections (ie P1 target will not be met). To offset this risk, the Government may consider:

- Whether or not a more ambitious P1 target could be set as part of the review process.
- Pursuing measures designed to further accelerate the use of innovative technologies.

57. Weaknesses in knowledge about market and technology trends, the relationship between the performance of products measured under test conditions and what is achieved in real life could all lead to reduced effectiveness of the policy programme.

Strengthening initiatives

- Ongoing: Government will continue to monitor areas to identify where it may be beneficial to strengthen the evidence base on motor-driven systems.

3.2 Engaging the supply chain

3.2.1 Supply chain initiatives

Current status

58. In line with announcements in the Energy White Paper, the Government has asked major UK manufacturers and suppliers to compete to supply motor-driven systems in line with our indicative standards, or where standards do not exist, with standards that will be presented in future versions of this brief[11].

Acknowledged risks

59. The supply chain initiative may not deliver the Government's P1 target or product standards.

[11] see also BNM08: Developing supply chain initiatives to improve pump systems efficiency in the UK; www.mtprog.com/ApprovedBriefingNotes/pdf.aspx?intBriefingNoteID=423)

Strengthening initiatives

- 2008: Government will continue to consider where further actions could be employed to encourage manufacturers and suppliers to work to meet a more ambitious P1 target and product standards. This could help to sustain successful supply chain initiatives.

3.2.2 Metrics: market development

Current status

60. At present there are no tools developed to enable product and system designers and suppliers of pumps and fans to assess energy efficiency performance against the Government's indicative performance standards.

Acknowledged risks

61. Without tools to enable evaluation of performance against the indicative standards, there may be no simple way to assess or report progress.

Strengthening initiatives

- Ongoing: the Government will consider working with manufacturers and suppliers to develop suitable performance metrics and tools (eg test standards, or pump or fan system assessment tools) to enable them to adopt standards at low cost.

3.3 EU and international policy actions, programmes and initiatives

62. Motor-driven products are internationally traded goods where unilateral UK policy actions may have only a limited impact on the design of products placed on the UK market. Therefore, the Government has committed to work at international level to promote international action to bring forward more sustainable products.

3.3.1 International collaboration

Current status

63. The UK is committed to promoting international cooperation on product labelling and standards and, generally, on policy towards more sustainable products.

64. Defra has been instrumental in establishing the International ITFSP[12] which seeks to ensure the harmonisation of policy options with those of other countries to maximise impact in a global market led by the supply chain. Defra operates the secretariat for the ITFSP.

65. Under the ITFSP, a Global Sustainable Product Network (GSPN) was established for motors in 2006. It supported the Standards for Energy Efficiency in

[12] See www.itfsp.org for details.

Electric Motors[13] (SEEEM) initiative to encourage the development of an international set of induction motor performance standards to address the following risks:

- The test standard for induction motors EN60034-2:1999 is no longer regarded as sufficiently accurate for the purposes of defining motor efficiency, especially for the latest best-in-class motors.
- The existing performance labels for induction motors as defined by the voluntary EU/CEMEP motor labelling scheme are no longer able to delineate the latest best-in-class motors.

66. The development of performance labels, or a similar metric, for pumps and fans will also benefit from collaboration at an international, or European, level. In addition, there is a need to develop, internationally, performance measures for fan and pump systems. To do this, there is a need to agree definitions of fan and pump application types.

67. Performance measures for pumps and fans have been recognised as difficult to define; studies being carried out under the EuP Directive (see Section 3.3.2) are likely to result in performance measurement methodologies on which labels or similar measures could be built.

68. A performance metric for fan systems in ventilation systems has been developed through the implementation of the Building Regulations (Part L), namely Specific Fan Power. Similar equivalent measures are required to be developed for:

- Fan systems in other applications (industrial).
- Pumping systems in buildings.
- Pumping systems in other applications, including the water industry and other industrial applications.

Policy: Develop international harmonised measurement standards for motor-driven systems.
Start date: June 2006.
Reference: www.itfsp.org/electric_motors.htm
Next Deliverables:
- 2008: Agreement on international harmonisation of induction motor test standards and performance labels.

Acknowledged risks

69. If new test standards are not agreed the lack of harmonisation will continue. This will act as a barrier to trade, and to agreeing international performance labels and standards.

70. There is a risk that not all trade regions will adopt common test procedures or performance labels for electric motors. The performance of electric motors in the

[13] www.itfsp.org/electric_motors.htm

USA, Canada and Australia already exceeds that of motors in the European Union, which also employs different test methodologies.

71. Some countries have started developing performance standards for fans or pumps, all with varying degrees of accuracy. There is a risk that broad consensus will not be achieved in the development of future test standards.

Strengthening initiatives

- Ongoing: Government will continue to review the effectiveness of these initiatives.
- It may be possible that the GSPN could be run on a more informal basis to continue influencing major international partners.
- The GSPN on motors could be expanded to include fans and pumps, or new GSPNs set up to address these.

3.3.2 Mandatory standards

Current status

72. The Framework Directive on the Eco-design of Energy-using Products (2005/32/EC) (EuP)[14], adopted in 2005, allows the European Commission to set performance requirements for products placed in the EU market. Preparatory product studies are nearing completion for:

- Electric motors (1–150 kW).
- Ventilation fans (non-residential buildings).
- Water pumps (in commercial buildings, drinking water pumping, food industry, agriculture).
- Circulating pumps.

73. The UK is contributing evidence into the preparatory studies and the Government will be pushing for ambitious, but realistic and achievable, standards to be adopted, in line with the indicative standards.

74. The first implementing measures are expected to be adopted by the EU late in 2008. Where necessary UK legislation will follow 12 to 18 months later.

Policy: EU Framework Directive for Eco-design of Energy-using Products.
Start date: 2005 (Framework Directive adopted).
Reference: http://ec.europa.eu/energy/demand/legislation/eco_design_en.htm
Next Deliverables:
- 2010: EuP implementing measure-setting requirements for electric motors, fans and pumps.

[14] See MTP Briefing Note BNXS03 at www.mtprog.com/ApprovedBriefingNotes/pdf.aspx?intBriefingNoteID=389

Acknowledged risks

75. Timing for delivery of standards via EuP is uncertain. Delivery of the UK's preferred standards via EuP is also uncertain since the EuP has a Single Market legal base so any final performance requirements will need to be fully harmonised across the whole of the European Union.

76. There is also a significant risk that current regulatory processes will not be able to respond sufficiently nimbly to a rapidly changing market, leading to ineffective regulation and market drivers.

Strengthening initiatives

- 2008: The Government will consider the value of including a mechanism for regular review and updating of product criteria in the product implementing measure.
- Ongoing: The Government will continue to monitor the effectiveness of the regulatory processes. The current timetable indicates that an implementing measure will not come into force before 2009 with the phase out schedule beginning in subsequent years. The Government will work with the supply chain in an effort to phase in new standards in advance of this measure (see Section 3.2.1 above).

3.3.3 Product information

Current status

77. The existing performance labels for induction motors as defined by the voluntary EU/CEMEP motor labelling scheme are no longer able to delineate the latest best-in-class motors. Many countries, including the USA and Australia have, in addition to their mandatory minimum efficiency performance standards, a series of high efficiency performance labels for their best-in-class motors.

78. The International Electrotechnical Commission (IEC) is currently developing an internationally harmonised labelling standard for induction motors, namely IEC60034-30, which is scheduled for completion in 2008.

79. Europump, the European pump manufacturers association, launched a voluntary labelling scheme in January 2005 for circulating pumps sized up to 2.5 kW. There are no formal product information or labelling schemes in place for fans or other pump products.

Policy: Voluntary labelling schemes for motors and pumps
Start date: 1999
Reference: www.cemep.org/cemep/organization/Ivac/English.pdf
www.iec.ch
www.europump.org
Next Deliverables:
- 2009: Review and endorsement of the IEC induction motor labelling scheme.
- 2009: Review and endorsement of the Europump circulating pump labelling scheme.

Acknowledged risks

80. The lack of reliable or effective information could prevent consumers from making an informed choice and prevent effective competition on energy efficiency issues.

81. There is a small risk that the performance labels for induction motors being developed by the IEC will not synchronise with the minimum performance standards or high efficiency standards as described in existing country standards.

82. The proposed IEC labelling scheme may not specify a test method when applying performance labels; when endorsing the labelling scheme, different countries may apply different test methods, thereby creating the potential for a motor to be placed into a different performance class depending on which test method is applied.

83. Fair comparisons of products are not always easy to achieve, for instance some electric motor products operate at a fixed speed only while others utilise electronic controls and operate at variable speeds to deliver variable duties. In some pump and fan products the electric motor is integral to the whole product and cannot be measured separately.

84. Without information describing the overall system performance of pumps or fans, it will be difficult to promote the better application of fan or pump products and realise the associated energy savings, which could be significant.

Strengthening initiatives

- The Government will consider encouraging collaboration between countries to ensure a common approach when selecting test methods to apply to the IEC induction motor labelling scheme.
- The Government will consider encouraging the development of test standards and performance data that will ensure a fair comparison of products across different technologies that are designed to deliver similar functions.
- The Government will consider encouraging the development of performance metrics which could be used to describe the performance of certain pump and fan systems.

3.3.4 Test methodologies

Current status

85. The revised electric motor test standard IEC60034-2-1 was published in September 2007. When determining motor efficiency, the standard includes different methods to determine motor losses. There is some debate as to which method is the most accurate and, hence, repeatable. There is consensus that the methods are converging with regard to accuracy. However, there is no consensus as to which method should be the preferred one to use.

Policy: International Electrotechnical Commission motor test standard.
Start date: 2007.
Reference:
http://webstore.iec.ch/webstore/webstore.nsf/artnum/038334?opendocument.
Next Deliverables:
2008: Consensus on test methods.

Acknowledged risks

86. There is a risk that a motor may be placed into a different performance class depending on which test method is applied.

Strengthening initiatives

- Government will consider encouraging collaboration between countries to ensure a common approach when selecting test methods to apply to induction motor testing programmes.

3.4 UK policy actions, programmes and initiatives

3.4.1 Public procurement

Current status

87. The Government published its Sustainable Procurement Action Plan (SPAP) in March 2007, re-affirming its commitment to use Government procurement to drive the market for energy efficient products. Alongside the Action Plan, it published updated and extended standards for an increased range of products that are mandatory for Central Government departments. Defra consulted on energy efficient products, which has informed the minimum mandatory standards for this product group in the revised Buy Sustainable Quick Wins (published in July 2008). We are reviewing the approach to setting mandatory standards with the newly formed Centre of Expertise for Sustainable Procurement.

88. Guidance on energy efficiency and energy savings as possible assessment criteria in public sector tendering was published in July 2008 as part of the Energy Services Directive. The Directive also sets out a number of options relating to public sector procurement of energy using products, buildings and energy services, which the Government consulted on during the winter of 2007. The outcome of this consultation will be announced shortly.

89. The NHS (England) published its Sustainable Procurement Action Plan in August 2007. Similar action plans for local authorities are being produced.

90. The Government is also committed to identifying stretching forward-looking standards to provide longer-term signals to business and to encourage innovation, for example, through the use of the 'Forward Commitment Procurement' Model[15].

[15] See www.berr.gov.uk/files/file35312.pdf

Policy: UK Government Sustainable Procurement Action Plan.
Start date: 2007.
Reference:www.sustainable-development.gov.uk/publications/pdf/SustainableProcurementActionPlan.pdf
Next deliverables:
- 2008: Revised Government procurement standards announced.
- 2008: Improving the performance levels for induction motors within Government Procurement Standards to comply with the Energy Technology Criteria List (ECA Scheme).

Acknowledged risks

91. Specifying fixed threshold values in procurement specifications may result in 'lock in' to incumbent technologies by excluding alternative products and lead to innovation being stifled. Outcome-based specifications, along with challenging and progressive threshold values, can help to minimise this.

Strengthening initiatives

- 2008: The Government will consider including standards specifically for the procurement of motor-driven systems, where applicable, within its formal procurement guidelines that are at, or above, the indicative standards in the Appendix.
- Strengthened leadership and scrutiny of performance on sustainable procurement throughout Government as set out in the SPAP.
- Transforming Government procurement agenda will build procurement capabilities and capacities within Departments and improve delivery of agreed policies.

3.4.2 Product information

92. There are no mandatory energy labelling schemes for motors and motor-driven equipment in the UK.

3.4.3 Building Regulations

Current status

93. The Building Regulations, Part L (Conservation of Fuel and Power) gives energy performance requirements in new and refurbished buildings. It also implements some of the requirements of the Energy Performance of Buildings Directive, published in January 2003, of which the principal objectives are:

- To promote the improvement of the energy performance of buildings within the EU through cost-effective measures.
- To promote the convergence of building standards towards those of Member States which already have ambitious levels.

94. Within Part L, the Specific Fan Power measure defines the minimum efficiency performance of mechanical ventilation systems in buildings, which includes the performance of some fans.

95. Energy use by pumps within public and commercial buildings exceeds that of all other pumping applications within the UK, their primary applications include heating, ventilation and cooling (HVAC), and pressure boosting applications. There remains considerable scope to uplift their performance through minimum performance requirements associated with the Building Regulations. Standards defining the performance of pumps and pump systems in the different primary applications within buildings do not exist at present.

Policy: Building Regulations - Conservation of Fuel and Power- (Part L in England and Wales and equivalent in Scotland and Northern Ireland).
Start date: 2006.
Reference:
http://www.communities.gov.uk/planningandbuilding/buildingregulations/legislation/
Next Deliverables:
- 2010: Consider introduction of minimum performance levels for pumping systems in buildings.
- 2010: Consider improving the minimum Specific Fan Power levels for mechanical ventilation systems.

Acknowledged risks

96. The Building Regulations are applicable to new or refurbished buildings. Fan and pump systems within buildings enjoy a relatively long life, consequently systems within existing building stock may not be refurbished or improved for 20 years or more, resulting in little opportunity for their improvement.

Strengthening initiatives

- The Government will continue to look at ways to ensure that:
  - Alternative ways are found to encourage the improvement of fan or pump systems within the existing building stock.
  - Performance levels are in line with the P1 targets.

3.4.4 The Enhanced Capital Allowance scheme

Current status

97. The ECA scheme is a key part of the Government's programme to manage climate change, and encourages businesses to invest in energy saving plant or machinery. The ECA scheme provides businesses with 100% first-year tax relief on their qualifying capital expenditure. To qualify the equipment must be specified on the Energy Technology List (ETL), which is managed by the Carbon Trust on behalf of Government. The scheme allows businesses to write off the whole cost of the equipment against taxable profits in the year of purchase.

98. The 'Motors and Drives' product category within the ECA scheme includes the following four technology classes:

- Single speed motors (induction).

- Variable speed drives.
- Switched reluctance drives.
- Integrated motor drive units (induction).

99. Penetration of the market by existing high efficiency motors (induction) is believed to have reached a plateau at about 17%. At the same time, the current criteria defining 'high efficiency motors' (ie to CEMEP EFF1) is no longer representative of the best-in-class motors now available. There is potential scope to upgrade the minimum performance criteria for single-speed motors to encompass currently available, best-in-class motors. Generally speaking, high efficiency motors cost more to buy, which dissuades customers from purchasing them. Therefore, a balance needs to be struck between encouraging improvement in high-end motor efficiency and influencing their uptake in the market.

100. The existing performance labels for induction motors as defined by the voluntary EU/CEMEP motor labelling scheme are no longer able to delineate the latest best-in-class motors. Therefore, examination needs to be given to driving up the efficiency of so called standard motors (CEMEP EFF2) and high efficiency motors (CEMEP EFF1).

101. There are other emerging motor technologies whose efficiencies equal, or exceed, that of standard induction motors. Examination of these technologies is to be progressed.

Policy: Enhanced Capital Allowance Scheme.
Start date: 2001.
Reference: www.eca.gov.uk/etl
Next Deliverables:
- 2008: Technical review of single-speed motors.
- 2008: Examination of ETL candidate motor technologies.

Acknowledged risks

102. The electric motor products included in the ECA scheme are internationally traded and most are manufactured outside of the UK. There may be a time delay required to allow industry to adapt to new performance levels, should they be proposed in 2008.

103. Few performance criteria exist for other motor technologies (eg permanent magnet motors) making it more complex to specify performance levels for the ECA scheme.

Strengthening initiatives

- The Government will consider encouraging the development of the international motors labelling scheme described in Section 3.3.3.
- There are emerging motor technologies with energy efficiencies that equal or exceed those of equivalent induction motors. The Carbon Trust is expected to examine such technologies for future ECA scheme consideration.

- There are emerging drive and control technologies that can improve the overall performance of motor technologies. The Carbon Trust is expected to examine such technologies for future ECA scheme consideration.

3.4.5 Industry voluntary initiatives: minimum performance standards for specific industrial processes

Current status

104. The range of applications to which electric motors are applied is both large and diverse, and even within fan and pump applications the range remains large. Consequently, it is difficult to define performance metrics for fan or pump systems in a generic way. Certain industrial applications are known to be significant energy users, (eg pumping systems within the water supply and sewerage industry). Definition of performance metrics for these application types with a view to introducing voluntary minimum performance standards will lead to significant energy savings.

Policy: Industry Voluntary Initiatives.
Start date: 2008.
Next Deliverables:
- 2008: Utilities industries agreement to improve the performance of fans and pumps in water supply and sewage processing applications.
- 2008: Other industrial sectors, such as the chemicals industry, agreement to improve the performance of fans and pumps in their applications.

Acknowledged risks

105. Test standards and benchmark information defining the performance of fan and pump systems in many different industrial applications do not exist at present.

106. There is a risk that UK industry (in specific sectors) may not be prepared to agree to voluntary standards. Outside the Building Regulations there is currently no mechanism available for mandatory performance standards for systems as opposed to products.

Strengthening initiatives

- The Government may consider facilitating development of test standards and benchmark information for fan and pump applications in specific industrial applications.
- The Government will consider whether to develop incentives for industry to develop and participate in Voluntary Initiatives.

3.5 Other policies with potential to impact on motor-driven systems

3.5.1 Smart metering

107. The Energy White Paper set out a number of policies on energy billing and metering, designed to reduce energy consumption. The Department for Business,

Enterprise and Regulatory Reform (BERR, formerly the DTI) recently consulted on the implementation of these policies (the consultation period closed on 31 October 2007). In summary, these are:

- To promote awareness of domestic energy use through a requirement on energy suppliers to present consumption data (preferably in graphical form) on consumers' bills to allow them to compare different periods of energy consumption.
- To provide real-time display units to certain customers so that they can see in real time, and in a way that is relevant to them, how much electricity they are consuming.
- To require the installation of smart meters for business customers above a certain energy usage threshold, where it has been proven to be cost-effective.

108. The Energy White Paper also set out the Government's expectation that smart metering would be introduced in the remainder of the business sector and the domestic sector over the next decade.

3.5.2 Promoting energy/carbon savings in industry and commerce

109. Climate Change Agreements (since 2001) and the EU Emissions Trading Scheme (since 2005) have required industry to improve its energy performance and reduce emissions. This encourages, for example, savings due to the more efficient use of lighting and commercial refrigeration. There are various products and systems that use motors (eg pumps and fans) that will contribute to the savings required. The Carbon Reduction Commitment (CRC), a mandatory emissions trading scheme aimed at the large non-energy intensive sector, is expected to start in 2010. The CRC will incentivise energy saving measures across 5,000 of the larger commercial and public sector organisations – including retail premises, hotels and offices. As the CRC will cover indirect energy usage by these organisations, it should be expected to add to demand for energy efficient motors in the commercial sector. Innovation in industrial products in this area may stimulate enhancements in the design and manufacture of domestic products.

4 Other potential measures

110. This Section looks towards other measures that may need to be developed to enable the desired average energy performance to be achieved.

4.1 Training, education and awareness

111. Motor-driven systems may be complex; in many instances the interaction of the components with each other within the system can significantly affect the overall system efficiency. Purchasing lowest cost components can have a detrimental effect on the overall system efficiency resulting in high running costs. It is important that specifiers, purchasers and users of motor-driven equipment are aware of the lifecycle costs of systems and make their respective decisions in an informed manner. Ensuring adequate provision of training and education is the responsibility

of all stakeholders of motor-driven equipment. Therefore, the following measure can be foreseen:

- Within the supply chain initiative (see Section 3.2.1), suppliers of motor-driven equipment could provide training and skills development measures for participants.

112. The Government will consider whether to encourage formal training and professional development skills of equipment users.

4.2 Alternative motor technologies

113. Alternative motor technologies to the industry-standard induction motor exist and some, such as those utilising permanent magnets, are starting to gain prominence. Policies and test standards applied to motors need to be designed such that they are technology independent and allow for greater adoption of alternative technologies.

5 Potential impacts

114. This Section provides a partial analysis of the more significant potential impacts of the proposals contained in this Policy Brief.

5.1 Consumer cost/benefit analysis

115. There is considerable economic benefit to be achieved from switching from standard efficiency motors, pumps or fans to high efficiency versions. The same is true when purchasing and configuring whole systems, especially when running hours are high. Although high efficiency motors cost between 10% and 30% more than their standard equivalents, when running hours are sufficiently high this additional purchase cost can be recovered within the first year of operation through reduced running costs.

116. As a great many pump and fan systems are unique by design, it is difficult to place a generic value on them. However, most lifecycle cost calculations do indicate that a payback of between one and two years is realistic for a modest increase in investment. There is a small overhead associated with performing the lifecycle costing analysis of the system, but this is normally borne by the supplier or the specifier.

5.2 Business impacts

117. Electric motors are generally produced by a few large manufacturers most of whom are based outside the EU. However, to be used within the EU, these must conform with EU policies. Other motor-driven systems, such as pumps and fans tend to be produced more locally within the EU, and some manufacturers are based in the UK.

118. Electric motors are increasingly traded in a global market. Different trading blocs use different test standards and procedures to measure motor performance, and base their efficiency labelling systems on these. It is difficult for manufacturers to produce motors to suit the various markets.

119. There are certain industries, such as the water industry, in which motors are operated for large numbers of hours per year. In other areas, such as emergency pumps and ventilators, the number of operating hours can be very small. In these cases, the additional cost of higher efficiency motors form a significant part of the lifecycle costs and are more difficult to justify[16].

120. Motors are supplied to the market in a number of ways; the principal route is through original equipment manufacturers (OEMs) where motors are incorporated within a larger piece of equipment. They are also supplied through the distribution chain to system integrators or as replacement units. To a lesser extent they are supplied directly from the manufacturer to the end user.

5.3 Waste impacts

121. For motor-driven systems, over 90% of the environmental impacts are attributable to in-use energy consumption.

122. There is little information regarding the environmental impacts of the production of motor-driven systems. However, it is thought that these impacts are minimal when compared with the in-use energy consumption and end-of-life impacts. There are no major impacts associated with disposal of motors. Generally, motors larger than 11 kW are repaired when they fail, but for small motors it is often not economic to repair them. Repairing motors typically involves the installation of new bearings, or new copper windings; old bearings and copper wire can be recycled[17].

123. Motors generally comprise valuable metals such as copper, aluminium, steel and cast iron. As a result, these materials are usually recycled. There are no hazardous waste issues associated with the disposal of motors.

124. Pumps generally consist of cast iron, various steels, bronze and, in the case of some smaller pumps, certain plastics, while fans generally comprise cast iron, various steels, aluminium and various plastics.

125. In keeping with motors, and with the exception of the plastic components, pumps and fans tend to be recycled due to the high economic values of the component materials.

126. Motors, pumps and fans do not, in general, fall within the scope of the WEEE Regulations when sold as standalone products to be fitted as part of a system. However, they are also used as components in several product types that are covered by the WEEE Regulations, and in those cases, they will be recycled when those products reach the end of their life.

[16] www.ecomotors.org/files/Motorspresentation1.pdf
[17] http://www.ecomotors.org/files/Motors report 1.1 inception report.pdf

5.4 Health impacts

127. It is commonly accepted that higher efficiency motors, pumps and fans are associated with reduced noise and vibration emissions. This is of greatest interest to fans, primarily in commercial applications, where regulations govern acceptable noise and vibration limits[18]. No additional health impacts have been identified that are associated with better performing motors, pump and fans.

6 Further information

128. The following Market Transformation Programme (MTP) publications (available from www.mtprog.com) are linked to this Policy Brief and present the underlying evidence base of information such as further explanations, definitions, assumptions and important background information:

BNM01	Revising EU motor labelling scheme and MTP actions to increase UK adoption of higher efficiency motors
BNM02	Minimum Efficiency Performance Standards (MEPS) for electric motors
BNM08	Developing supply chain initiatives to improve pump systems efficiency in the UK

[18] For example, European Standard prEN15251: Criteria for the indoor environment, including thermal, indoor air quality, light and noise.

Appendix
Indicative performance standards for motor-driven products and systems

129. Tables A1–A5 show the indicative performance standards for new products supplied to UK end-users. These correspond with the Government's underlying published stock models and projected energy consumption in each sector (the P1 target presented in this Policy Brief).

130. These specifications may be used directly in suitable policy instruments (eg the supply chain initiative) and provide a metric against which developments in the market can be measured.

131. The underlying stock modelling is subject to an ongoing consultation and review process. More detail on the modelling, current market analysis and data downloads are available via the MTP's What-If tool (http://whatif.mtprog.com)

Tables A1, A2 and A3 - Performance specifications, induction motors

Table A1 Target average efficiency for a new, 4 kW, 4-pole motor (S1 duty)

Year	P1
2006	84.2
2007	84.6
2008	84.7
2009	84.8
2010	85.6
2011	87.0
2012	87.0
2013	87.0
2014	87.0
2015	87.3
2016	87.9
2017	87.9
2018	87.9
2019	88.0
2020	88.5

Table A2 Target average efficiency for a new, 11 kW, 4-pole motor (S1 duty)

Year	P1
2006	88.4
2007	88.7
2008	88.7
2009	88.8
2010	89.3
2011	90.2
2012	90.2
2013	90.2
2014	90.2
2015	90.6
2016	91.3
2017	91.3
2018	91.3
2019	91.3
2020	91.4

Table A3 Target average efficiency for a new, 90 kW, 4-pole motor (S1 duty)

Year	P1
2006	93.9
2007	94.0
2008	94.0
2009	94.0
2010	94.3
2011	94.7
2012	94.7
2013	94.7
2014	94.7
2015	94.9
2016	95.3
2017	95.3
2018	95.3
2019	95.3
2020	95.4

Tables A4 and A5 - Performance specifications, clean-water pumps

Table A4 Target average pump efficiency for a new, end-suction, close-coupled, clean-water pump operating with a duty of 25 m^3/hour at 32 m

Year	P1
2006	62.0
2007	62.3
2008	62.3
2009	62.9
2010	63.9
2011	64.4
2012	64.5
2013	64.5
2014	64.6
2015	64.7
2016	64.8
2017	64.9
2018	65.0
2019	65.1
2020	65.2

Table A5 Target average pump efficiency for a new, end-suction, close-coupled, clean-water pump operating with a duty of 125 m^3/hour at 32 m

Year	P1
2006	70.0
2007	70.2
2008	70.2
2009	70.9
2010	71.8
2011	72.3
2012	72.3
2013	72.4
2014	72.4
2015	72.5
2016	72.5
2017	72.6
2018	72.7
2019	72.7
2020	72.9