

The background of the cover is a grayscale photograph of an industrial control panel. It features three large circular gauges at the top, each with a needle and a scale. Below the gauges, there are various pipes, valves, and electrical components, including a prominent cylindrical sensor or actuator. The image is partially obscured by a white diagonal shape on the left side, which contains the text.

Best Available Techniques

Reference
documents

National Direction for Greenhouse Gas
Emissions from Industrial Process Heat

March 2024

EECA
TE TARI TIAKI PŪNGAO
ENERGY EFFICIENCY & CONSERVATION AUTHORITY

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Note

This Best Available Techniques guidance is advisory only. It has been prepared to assist in assessing the industrial process heat technologies that could be adopted by consent applicants and should be read in conjunction with other relevant official guidance documents released by Ministry for the Environment, Ministry of Business, Innovation & Employment, EECA (the Energy Efficiency & Conservation Authority) and regionally specific guidance. It should also be read in conjunction with standards, recognised industry best practice, and other technical publications.

This guidance will be revised periodically, and readers should ensure they are using the latest version. The publication date of the guidance can be found on the cover page. Comments are welcome via email to technicalenquiries@eeca.govt.nz.

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Contents

Authors	2
Note	2
Disclaimer	2
Index to Tables.....	4
1. Introduction	6
1.1 Purpose of this guidance	6
1.2 Structure of this document.....	7
2. Table of low GHG emissions technologies and industrial sectors.....	8
3. Energy efficiency	10
4. Combustion plants.....	18
5. Meat processing industry	29
6. Dairy industry.....	36
7. Food and beverage industry.....	40
7.1 Brewing industry	43
7.2 Ethanol production industry.....	45
7.3 Fish and shellfish processing industry	45
7.4 Fruit and vegetable industry	46
7.5 Grain milling industry	47
7.6 Oil seed processing and vegetable oil refining industry.....	48
7.7 Soft drinks and nectar/juice industry	49
7.8 Starch production industry.....	50
8. Timber processing industry	51
8.1 Wood based panels industry	52
9. Pulp and paper industry	55
9.1 Kraft (sulphate) pulping process	59
9.2 Sulphite pulping process.....	61
9.3 Mechanical pulping and chemimechanical pulping processes.....	63
9.4 Processing of paper for recycling.....	65
9.5 Papermaking and related processes	66
10. Cement, lime and magnesium oxide.....	71
10.1 Cement industry	72
10.2 Lime Industry	75
10.3 Magnesium oxide industry	76
11. Iron and steel	78
12. Aluminium smelting.....	98

13. Chemical manufacturing industry.....	102
14. Plastics	105

Index to Tables

Table 1: Industrial sectors, process steps and low emissions technologies.....	8
Table 2 - Relevant sections of European Commission BAT document – energy efficiency	11
Table 3 - Relevant sections of European Commission BAT document – large combustion plants 20	
Table 4: Relevant sections of US EPA document – industrial, commercial and institutional boilers.....	26
Table 5 - Relevant sections of European Commission BAT document – meat industry	31
Table 6 - Relevant sections of US EPA document – anaerobic digestion	35
Table 7 - Sections of European Commission BAT document - food, drink and milk industries that are relevant to the dairy industry	37
Table 8 - Relevant sections of European Commission BAT document - food, drink and milk industries – general issues relevant to the entire sector	41
Table 9: Links to information in European Commission BAT document relevant to brewing	43
Table 10: Links to information in European Commission BAT document relevant to ethanol production	45
Table 11: Links to information in European Commission BAT document relevant to fish and shellfish processing.....	45
Table 12: Links to information in European Commission BAT document relevant to fruit and vegetable sector	46
Table 13: Links to information in European Commission BAT document relevant to the grain milling sector	47
Table 14: Links to information in European Commission BAT document relevant to oil seed processing and vegetable oil refining.....	48
Table 15: Links to information in European Commission BAT document relevant to soft drinks and nectar/juice	49
Table 16: Links to information in European Commission BAT document relevant to starch production	50
Table 17 - Relevant sections of European Commission BAT document - wood based panels	52
Table 18: Relevant sections of European Commission BAT document - pulp, paper and board: general issues relevant to the entire pulp and paper sector	57
Table 19: Relevant sections of European Commission BAT document - pulp, paper and board: issues relevant to the kraft (sulphate) pulping process.....	59
Table 20: Relevant sections of European Commission BAT document - pulp, paper and board: issues relevant to the sulphite pulping process	61

Table 21: Relevant sections of European Commission BAT document - pulp, paper and board: issues relevant to the mechanical pulping and chemimechanical pulping process	63
Table 22: Relevant sections of European Commission BAT document - pulp, paper and board: issues relevant to processing of paper for recycling.....	65
Table 23: Relevant sections of European Commission BAT document - pulp, paper and board: issues relevant to papermaking and related processes.....	66
Table 24: Relevant sections of US EPA document – pulp and paper manufacturing industry....	68
Table 25: Sections of European Commission BAT document on cement, lime and magnesium oxide production – relevant to cement production	72
Table 26: Relevant Sections of US EPA Document – Cement Industry	73
Table 27: Sections of European Commission BAT document on cement, lime and magnesium oxide production – relevant to lime production	75
Table 28: Sections of European Commission BAT document on cement, lime and magnesium oxide production – relevant to magnesium oxide production	76
Table 29: European Commission BAT Document on iron and steel production	80
Table 30: Relevant sections of US EPA document – iron and steel industry	85
Table 31: European Commission BAT document on ferrous metals processing – Part A: hot and cold forming.....	92
Table 32: European Commission BAT Document on Ferrous Metals Processing – Part B: continuous hot dip coating lines.....	95
Table 33: European Commission BAT document on ferrous metals processing – Part C: batch galvanizing	96
Table 34: European Commission BAT document on ferrous metals processing – Part D: furnaces.....	97
Table 35: European Commission BAT document on non-ferrous metals – sections relevant to non-ferrous metals generally	99
Table 36: European Commission BAT document on non-ferrous metals – sections relevant to aluminium smelting.....	100
Table 38: European Commission BAT document on organic fine chemicals.....	103
Table 39: European Commission BAT Document on Plastics.....	106

1. Introduction

The Climate Change Response Act (CCRA) sets a statutory target for New Zealand to achieve net zero greenhouse gas (excluding biogenic methane) (GHG) emissions by 2050¹. To help achieve this target, an amendment to section 104 of the Resource Management Act (RMA)² requires regional councils to consider the effects of greenhouse gas emissions when assessing resource consent applications for discharges to air. Industries using process heat must now also consider the greenhouse gas emissions from their operations when applying for a discharge to air consent.

On the 27 July 2023, the Government (Ministry for the Environment) implemented a new National Direction for Greenhouse Gases from Industrial Process Heat. As part of this programme of work, EECA (Energy Efficiency and Conservation Authority) is playing a key role in developing guidance for consenting authorities to use when assessing the industrial process heat technologies that could be adopted by consent applicants.

Resource consent applications and emissions plans must include an assessment of the best practicable option to prevent or minimise any adverse effects on climate change from the proposed activity, and other relevant discharges of GHGs from other heat devices (excluding back-up devices) on the same site. Applicants should consider the best available techniques when assessing the best practicable option.

1.1 Purpose of this guidance

The purpose of this guidance is to provide consenting authorities with resources to help them decide whether an applicant should be granted a consent to use fossil fuels to supply industrial process heat (and consequently discharge GHG emissions to air).

Specifically, this guidance identifies relevant best available techniques reference documents that may provide advice in the selection of the best practicable option to prevent or minimise any actual or likely adverse climate change effects from the proposed activity. This guidance also references relevant documents that advise opportunities to reduce process heat requirement prior to the selection of alternative low emissions process heat technologies. This can be done through energy management and auditing as well as potential changes to improve energy efficiency and reduce GHG emissions from existing systems.

¹ The Climate Change Response Act 2002 ('CCRA'), which was amended by the Climate Change Response (Zero Carbon) Amendment Act 2019, now includes a 'net zero' target of national greenhouse gas (excluding biogenic methane) emissions by 2050.

² Which came into force 30 November 2022.

The focus of this guidance is on process heat technologies that are commercially available, or close to being commercially available, and will result in reduced energy consumption and/or reduced carbon emissions.

1.2 Structure of this document

This guidance addresses a range of different technologies and industrial sectors that the consideration of low and zero GHG emissions forms of process heat are relevant to. In addition to industry specific technologies, there are some techniques such as energy efficiency and the use of large combustion plants that are applicable to many industrial sectors. These cross-industry activities are addressed first in this document in Sections 2 to 3, followed by industry specific information. Table 1 identifies the industrial sectors that different technologies apply to.

Relevant best available techniques documents have been identified, and a brief overview of the nature and purpose of the document is provided. Where relevant, specific section references are identified to help direct the reader to useful information. Information on relevant technologies is sorted in order of the different process step categories listed in the left column of Table 1.

2. Table of low GHG emissions technologies and industrial sectors

The following table shows all industrial sectors addressed in this document and identifies process stages and low greenhouse gas (GHG) emissions options that are relevant to each industrial sector. References to the relevant sections in this report are shown at the right of the table.

Table 1: Industrial sectors, process steps and low emissions technologies

Process steps and low GHG emissions options						
Industrial sector	Evaporation/Drying	Sterilisation/ Pasteurisation	Heating, Cooking, Blanching, Melting	Energy efficiency and management	Combustion plants	Report section
Meat	✓	✓	✓	✓	✓	Section 5
Dairy	✓	✓	✓	✓	✓	Section 6
Food & beverages	✓	✓	✓	✓	✓	Section 7
Timber processing	✓		✓	✓	✓	Section 8
Pulp & paper	✓		✓	✓	✓	Section 9
Cement, lime and magnesium oxide	✓		✓	✓	✓	Section 10

Process steps and low GHG emissions options						
Industrial sector	Evaporation/Drying	Sterilisation/ Pasteurisation	Heating, Cooking, Blanching, Melting	Energy efficiency and management	Combustion plants	Report section
Iron and Steel			✓	✓	✓	Section 11
Aluminium smelting			✓	✓	✓	Section 12
Chemical Manufacturing	✓		✓	✓	✓	Section 13
Plastics			✓	✓	✓	Section 14

3. Energy efficiency

Relevant reference document

Reference Document on Best Available Techniques for Energy Efficiency – European Commission, February 2009.

[Access the document](#)

Brief overview of reference document

This document contains generic information and conclusions on techniques for energy efficiency that are considered to be compatible with best available techniques (BAT) for all installations covered by the Integrated Pollution Prevention and Control (IPPC) Directive. This document also gives references to BAT Reference Documents (BREFs) where particular techniques for energy efficiency have already been discussed in detail and can be applied to other sectors. In particular:

- The Large Combustion Plants (LCP) BREF discusses energy efficiency relating to combustion and points out that these techniques may be applied to combustion plants with a capacity below 50 MW.
- The Industrial Cooling Systems (ICS) BREF discusses industrial cooling systems.

Energy efficiency is relevant to all industry sectors and this document contains information on BAT related to processes such as combustion and steam generation, which can be applied to many industries.

Some of the techniques are readily available, established technologies. Other, newer technologies discussed are identified as 'emerging techniques'.

Relevant section references in this document are detailed in Table 2 below.

Table 2 - Relevant sections of European Commission BAT document – energy efficiency

Section reference	Section title	Description where relevant	Reference link
1.3	Definitions of indicators for energy efficiency and energy efficiency improvement	This section provides definitions of indicators for energy efficiency and energy efficiency improvement.	Access section 1.3 of this document
2	Techniques to consider in the determination of BAT	This chapter describes techniques to be considered at the level of an entire installation with the potential to achieve optimum energy efficiency. Relevant section references and headings are provided in the following rows of this table.	Access section 2 of this document
2.1	Energy efficiency management systems (ENEMS)		Access section 2.1 of this document
2.2	Planning and establishing objectives and targets		Access section 2.2 of this document
2.3	Energy-efficient design (EED)		Access section 2.3 of this document
2.4	Increased process integration		Access section 2.4 of this document
2.5	Maintaining the impetus of energy efficiency initiatives		Access section 2.5 of this document
2.8.1	Process control systems		Access section 2.8.1 of this document
2.8.2	Quality management (control, assurance) systems		Access section 2.8.2 of this document
2.9	Maintenance		Access section 2.9 of this document
2.10	Monitoring and measurement		Access section 2.10 of this document

Section reference	Section title	Description where relevant	Reference link
2.11	Energy audits and energy diagnosis		Access section 2.11 of this document
2.12	Pinch methodology		Access section 2.12 of this document
2.13	Enthalpy and exergy analysis		Access section 2.13 of this document
2.14	Thermoeconomics		Access section 2.14 of this document
2.15	Energy models		Access section 2.15 of this document
2.16	Benchmarking		Access section 2.16 of this document
3	Techniques to consider to achieve energy efficiency in energy-using systems, processes, or activities	This chapter sets out techniques to be considered at a level below installation - primarily the level of energy-using systems (for example, compressed air, steam) or activities (for example combustion), and subsequently at the lower level for some energy-using component parts or equipment (for example motors). Relevant section references and headings are provided in the following rows of this table.	Access section 3 of this document
3.1	Combustion		Access section 3.1 of this document
3.1.1	Reduction of the flue-gas temperature		Access section 3.1.1 of this document
3.1.2	Recuperative and regenerative burners		Access section 3.1.2 of this document
3.1.3	Reducing the mass flow of the flue-gases by reducing the excess air		Access section 3.1.3 of this document
3.1.4	Burner regulation and control		Access section 3.1.4 of this document
3.1.5	Fuel choice		Access section 3.1.5 of this document
3.1.6	Oxy-firing (oxyfuel)		Access section 3.1.6 of this document
3.1.7	Reducing heat losses by insulation		Access section 3.1.7 of this document
3.1.8	Reducing losses through furnace openings		Access section 3.1.8 of this document

Section reference	Section title	Description where relevant	Reference link
3.2	Steam systems		Access section 3.2 of this document
3.2.1	General features of steam		Access section 3.2.1 of this document
3.2.2	Overview of measures to improve steam system performance		Access section 3.2.2 of this document
3.2.3	Throttling devices and the use of backpressure turbines		Access section 3.2.3 of this document
3.2.4	Operating and control techniques		Access section 3.2.4 of this document
3.2.5	Preheating feed-water (including the use of economisers)		Access section 3.2.5 of this document
3.2.6	Prevention and removal of scale deposits on heat transfer surfaces		Access section 3.2.6 of this document
3.2.7	Minimising blowdown from the boiler		Access section 3.2.7 of this document
3.2.8	Optimising deaerator vent rate		Access section 3.2.8 of this document
3.2.9	Minimising boiler short cycle losses		Access section 3.2.9 of this document
3.2.10	Optimising steam distribution systems		Access section 3.2.10 of this document
3.2.11	Insulation on steam pipes and condensate return pipes		Access section 3.2.11 of this document

Section reference	Section title	Description where relevant	Reference link
3.2.12	Implementing a control and repair programme for steam traps		Access section 3.2.12 of this document
3.2.13	Collecting and returning condensate to the boiler for re-use		Access section 3.2.13 of this document
3.2.14	Re-use of flash steam		Access section 3.2.14 of this document
3.2.15	Recovering energy from boiler blowdown		Access section 3.2.15 of this document
3.3	Heat recovery and cooling		Access section 3.3 of this document
3.3.1	Heat exchangers		Access section 3.3.1 of this document
3.3.2	Heat pumps (including mechanical vapour recompression, MVR)		Access section 3.3.2 of this document
3.3.3	Chillers and cooling systems		Access section 3.3.3 of this document
3.4.2	Trigeneration		Access section 3.4.2 of this document
3.4.3	District cooling		Access section 3.4.3 of this document
3.9	Heating, ventilation and air conditioning (HVAC) systems		Access section 3.9 of this document
3.9.1	Space heating and cooling		Access section 3.9.1 of this document
3.11	Drying, separation and concentration processes		Access section 3.11 of this document

Section reference	Section title	Description where relevant	Reference link
3.11.1	Selecting the optimum technology or combination of technologies		Access section 3.11.1 of this document
3.11.2	Mechanical processes		Access section 3.11.2 of this document
3.11.3	Thermal drying techniques		Access section 3.11.3 of this document
3.11.3.2	Direct heating		Access section 3.11.3.2 of this document
3.11.3.3	Indirect heating		Access section 3.11.3.3 of this document
3.11.3.4	Superheated steam		Access section 3.11.3.4 of this document
3.11.3.5	Heat recovery in drying processes		Access section 3.11.3.5 of this document
3.11.3.6	Mechanical vapour recompression or heat pumps with evaporation		Access section 3.11.3.6 of this document
3.11.3.7	Optimisation of the insulation of the drying system		Access section 3.11.3.7 of this document
3.11.4	Radiant energies		Access section 3.11.4 of this document
3.11.5	Computer-aided process control/process automation in thermal drying processes		Access section 3.11.5 of this document

Section reference	Section title	Description where relevant	Reference link
4	Best available techniques	This chapter presents the techniques that are considered to be compatible, in general, with best available techniques. It provides indications about energy efficiency techniques that can be used as a reference point to assist in the assessment of energy efficiency improvements that are available for the proposed activity. Relevant section references and headings are provided in the following rows of this table.	Access section 4 of this document
4.2	Best available techniques for achieving energy efficiency at installation level		Access section 4.2 of this document
4.2.1	Energy efficiency management		Access section 4.2.1 of this document
4.2.2.1	Continuous environmental improvement		Access section 4.2.2.1 of this document
4.2.2.2	Identification of energy efficiency aspects of an installation and opportunities for energy savings		Access section 4.2.2.2 of this document
4.2.2.3	A systems approach to energy management		Access section 4.2.2.3 of this document
4.2.2.4	Establishing and reviewing energy efficiency objectives and indicators		Access section 4.2.2.4 of this document
4.2.2.5	Benchmarking		Access section 4.2.2.5 of this document

Section reference	Section title	Description where relevant	Reference link
4.2.3	Energy-efficient design (EED)		Access section 4.2.3 of this document
4.2.4	Increased process integration		Access section 4.2.4 of this document
4.2.5	Maintaining the impetus of energy efficiency initiatives		Access section 4.2.5 of this document
4.2.6	Maintaining expertise		Access section 4.2.6 of this document
4.2.7	Effective control of processes		Access section 4.2.7 of this document
4.2.8	Maintenance		Access section 4.2.8 of this document
4.2.9	Monitoring and measurement		Access section 4.2.9 of this document
4.3	Best available techniques for achieving energy efficiency in energy-using systems, processes, activities or equipment	The BAT presented in this section assume that the general BAT in Section 4.2 are also applied to the systems described below, as part of their optimisation. It segments BATs by specific processes, as shown in the following rows.	Access section 4.3 of this document
4.3.1	Combustion		Access section 4.3.1 of this document
4.3.2	Steam systems		Access section 4.3.2 of this document
4.3.3	Heat recovery		Access section 4.3.3 of this document
5.1	Flameless combustion (flameless oxidation)		Access section 5.1 of this document

4. Combustion plants

Relevant reference document

Reference Document on Best Available Techniques for Large Combustion Plants – European Commission, 2017. Note large combustion plants refer to those with a total rated thermal input of 50 MW or more.

[Access the document](#)

Brief overview of reference document

This document concerns the combustion of fuels in installations with a total rated thermal input of 50 MW or more, only when this activity takes place in combustion plants with a total rated thermal input of 50 MW or more.

This document also covers activities that are both upstream (including emissions prevention) and downstream (applying techniques to control the emissions produced). The fuels considered in this document are any solid, liquid and/or gaseous combustible material including:

- solid fuels (for example coal, lignite, peat)
- liquid fuels (for example heavy fuel oil and gas oil)
- gaseous fuels (for example natural gas, hydrogen-containing gas and syngas)
- industry-specific fuels (for example by-products from the chemical and iron and steel industries)

Some of the techniques are readily available, established technologies. Other, newer technologies discussed are identified as ‘emerging techniques’.

Relevant reference document

Reference document on Available and Emerging Technologies for Reducing Greenhouse Gas Emissions from Industrial, Commercial, and Institutional Boilers – US Environmental Protection Agency, October 2010.

This document covers a range of combustion plant sizes.

[Access the document](#)

Brief overview of reference document

This document provides information on techniques and measures that are currently available to control and mitigate GHG emissions from industrial, commercial, and institutional (ICI) boilers. A large number of available technologies are discussed here. However, this paper may not represent all available technologies or measures that can be considered for any given activity to reduce its GHG emissions.

Relevant section references in these documents are detailed in Table 3 and Table 4 below.

Table 3 - Relevant sections of European Commission BAT document – large combustion plants

Section reference	Section title	Description where relevant	Reference link
1.3	Key environmental issues	This section provides an overview of the main environmental issues relevant to large combustion plants.	Access section 1.3 of this document
3.1	Applied common techniques	Techniques are described in this section if they apply to more than one combustion process or type of fuel firing. Further details are provided in Chapters 4 to 9 if the techniques apply to a specific process or to the combustion of a specific fuel performed in specific manner.	Access section 3.1 of this document
3.2	Techniques to consider in the determination of general BAT for the large combustion plant sector	This section describes techniques (or combinations of techniques) and associated monitoring which can achieve a high level of environmental protection in the activities within the scope of this document. The techniques described include both the technology used, and the way the installations are designed, built, maintained, operated and decommissioned. Relevant section references and headings are provided in the following rows of this table.	Access section 3.2 of this document
3.2.1	Environmental management systems		Access section 3.2.1 of this document
3.2.2.7	Techniques to reduce unburnt carbon		Access section 3.2.2.7 of this document
3.2.2.7.1	Combustion optimisation		Access section 3.2.2.7.1 of this document
3.2.2.7.2	Oxidation catalyst		Access section 3.2.2.7.2 of this document
3.2.3	Techniques to increase energy efficiency		Access section 3.2.3 of this document
3.2.3.1	Heat recovery techniques		Access section 3.2.3.1 of this document
3.2.3.3	Cheng Cycle		Access section 3.2.3.3 of this document

Section reference	Section title	Description where relevant	Reference link
3.2.3.4	Combustion air preheating		Access section 3.2.3.4 of this document
3.2.3.5	Advanced material use		Access section 3.2.3.5 of this document
3.2.3.6	Steam double reheating		Access section 3.2.3.6 of this document
3.2.3.7	Feed-water preheating using recovered heat		Access section 3.2.3.7 of this document
3.2.3.8	Advanced control system		Access section 3.2.3.8 of this document
3.2.3.11	Combined-cycle combustion		Access section 3.2.3.11 of this document
3.2.3.12	Topping cycle		Access section 3.2.3.12 of this document
3.2.3.13	Steam turbine and other component upgrades		Access section 3.2.3.13 of this document
3.2.3.14	(Ultra-) Supercritical steam parameters		Access section 3.2.3.14 of this document
3.2.3.15	Flue-gas condenser		Access section 3.2.3.15 of this document
3.2.3.16	Cooling tower air emission discharge		Access section 3.2.3.16 of this document
3.2.3.17	Wet stack		Access section 3.2.3.17 of this document
3.2.3.18	Fuel preheating/drying		Access section 3.2.3.18 of this document
5	Combustion of solid fuels		Access section 5 of this document
5.1.3	Techniques to consider in the determination of BAT for the combustion of coal and/or lignite	This chapter describes techniques to be considered for the combustion of coal and/or lignite. Relevant section references and headings are provided in the following rows of this table.	Access section 5.1.3 of this document
5.1.3.2	Techniques to improve the general environmental performance		Access section 5.1.3.2 of this document

Section reference	Section title	Description where relevant	Reference link
5.1.3.3	Techniques to increase energy efficiency and fuel utilisation		Access section 5.1.3.3 of this document
5.2.3	Techniques to consider in the determination of BAT for the combustion of biomass and/or peat	This chapter describes techniques to be considered for the combustion of peat. Relevant section references and headings are provided in the following rows of this table.	Access section 5.2.3 of this document
5.2.3.3	Techniques to increase energy efficiency		Access section 5.2.3.3 of this document
6	Combustion of liquid fuels		Access section 6 of this document
6.3	Techniques to consider in the determination of BAT for the combustion of liquid fuels	This chapter describes techniques to be considered for the combustion of liquid fuels. Relevant section references and headings are provided in the following rows of this table.	Access section 6.3 of this document
6.3.2.1	Techniques to improve the general performance		Access section 6.3.2.1 of this document
6.3.2.2	Techniques to increase energy efficiency (heavy fuel oil/gas oil in boilers)		Access section 6.3.2.2 of this document
6.3.3.1	Techniques to increase energy efficiency (heavy fuel oil/gas oil in engines)		Access section 6.3.3.1 of this document
6.3.4.1	Techniques to increase energy efficiency (gas oil in turbines)		Access section 6.3.4.1 of this document
7	Combustion of gaseous fuels		Access section 7 of this document

Section reference	Section title	Description where relevant	Reference link
7.1.3	Techniques to consider in the determination of BAT for the combustion of natural gas in boilers / engines / gas turbines	This chapter describes techniques to be considered for the combustion of natural gas in boilers, engines and gas turbines. Relevant section references and headings are provided in the following rows of this table.	Access section 7.1.3 of this document
7.1.3.1.1	General techniques to increase the energy efficiency of natural-gas-fired units		Access section 7.1.3.1.1 of this document
7.1.3.1.2	Specific techniques to increase the energy efficiency of the fuel supply and handling activities		Access section 7.1.3.1.2 of this document
7.1.3.1.2.1	Use of an expansion turbine		Access section 7.1.3.1.2.1 of this document
7.1.3.1.3	Specific techniques to increase the energy efficiency of natural-gas-fired turbines		Access section 7.1.3.1.3 of this document
7.1.3.1.3.2	Flow path optimisation		Access section 7.1.3.1.3.2 of this document
7.1.3.1.3.3	Inlet combustion air cooling		Access section 7.1.3.1.3.3 of this document
7.1.3.1.3.4	Recuperative gas turbine cycle		Access section 7.1.3.1.3.4 of this document
7.3.3	Techniques to consider in the determination of BAT for the combustion of iron and steel process gases	This chapter describes techniques to be considered for the combustion of iron and steel process gases. Relevant section references and headings are provided in the following rows of this table.	Access section 7.3.3 of this document

Section reference	Section title	Description where relevant	Reference link
7.3.3.1.1	General techniques to increase energy efficiency		Access section 7.3.3.1.1 of this document
7.3.3.1.2	Process gas management system		Access section 7.3.3.1.2 of this document
8	Multi-fuel combustion		Access section 8 of this document
8.1.1.3	Techniques to introduce the different fuels into the combustion process		Access section 8.1.1.3 of this document
8.1.1.3.1	Mixing with the main fuel		Access section 8.1.1.3.1 of this document
8.1.1.3.2	Dedicated burners		Access section 8.1.1.3.2 of this document
8.1.1.4.1	Co-firing of biomass and fossil fuels		Access section 8.1.1.4.1 of this document
8.1.3	Techniques to consider in the determination of BAT in solid multi-fuel combustion	This chapter describes techniques to be considered in solid multi-fuel combustion.	Access section 8.1.3 of this document
8.2.3	Techniques to consider in the determination of BAT for the combustion of process fuels from the chemical industry	This chapter describes techniques to be considered with the combustion of process fuels from the chemical industry.	Access section 8.2.3 of this document
10	Best Available Techniques (BAT) Conclusions		Access section 10 of this document
10.1	General BAT conclusions	The fuel-specific BAT conclusions included in Sections 10.2 to 10.7 apply in addition to the general BAT conclusions in this section.	Access section 10.1 of this document

Section reference	Section title	Description where relevant	Reference link
10.1.1	Environmental management systems		Access section 10.1.1 of this document
10.1.3	General environmental and combustion performance		Access section 10.1.3 of this document
10.1.4	Energy efficiency		Access section 10.1.4 of this document
10.2.1	BAT conclusions for the combustion of coal and/or lignite		Access section 10.2.1 of this document
10.2.2	BAT conclusions for the combustion of solid biomass and/or peat		Access section 10.2.2 of this document
10.3	BAT conclusions for the combustion of liquid fuels		Access section 10.3 of this document
10.4.1	BAT conclusions for the combustion of natural gas		Access section 10.4.1 of this document
10.4.2	BAT conclusions for the combustion of iron and steel process gases		Access section 10.4.2 of this document
10.5	BAT conclusions for multi-fuel-fired plants		Access section 10.5 of this document
10.6	BAT conclusions for the co-incineration of waste		Access section 10.6 of this document
10.7	BAT conclusions for gasification		Access section 10.7 of this document
10.8	Description of techniques		Access section 10.8 of this document
10.8.2	Techniques to increase energy efficiency		Access section 10.8.2 of this document

Section reference	Section title	Description where relevant	Reference link
11	Emerging techniques	The techniques outlined in this chapter are all emerging techniques. Relevant section references and headings are provided in the following rows of this table.	Access section 11 of this document
11.1.1	High-temperature and -pressure super critical coal plant		Access section 11.1.1 of this document
11.2.4.2	Oxy-fuel combustion		Access section 11.2.4.2 of this document
11.5.2	Fuel cell applications		Access section 11.5.2 of this document
11.6.1.3	Oxy-combustion		Access section 11.6.1.3 of this document
11.6.1.6	Closed-loop steam cooling		Access section 11.6.1.6 of this document

Table 4: Relevant sections of US EPA document – industrial, commercial and institutional boilers

Section reference	Section title	Description where relevant	Reference link
V.	Summary of measures to reduce GHGs	Summary of the GHG emission reduction measures for existing industrial, commercial and institutional (ICI) boilers presented in this document. The summary table includes emission reduction potential, energy savings, costs, and feasibility of each measure.	Access section V. of this document
VI.	Energy efficiency improvements	This section presents the efficiency improvement measures identified for ICI boilers. The majority of the identified options focus on measures that are common from the perspective of applicability, availability, and owner/operator experience. Details of individual techniques are provided in the following rows of this table.	Access section VI. of this document
VI.1	Operating and maintenance (O&M) practices		Access section VI.1 of this document

Section reference	Section title	Description where relevant	Reference link
VI1.1	New burners/upgrades		Access section VI1.1 of this document
VI1.2	Improved combustion measures		Access section VI1.2 of this document
VI.2	Air preheat and economizers		Access section VI.2 of this document
VI.3	Turbulators for firetube boilers		Access section VI.3 of this document
VI.4	Boiler insulation		Access section VI.4 of this document
VI.5	Minimisation of air infiltration		Access section VI.5 of this document
VI.6	Boiler blowdown heat exchanger		Access section VI.6 of this document
VI.7	Condensate return system		Access section VI.7 of this document
VI.8	Refractory material selection		Access section VI.8 of this document
VI.9	Minimization of gas-side heat transfer surface deposits		Access section VI.9 of this document
VI.10	Steam line maintenance		Access section VI.10 of this document
VII.	Energy programs and management systems	Industrial energy efficiency can be enhanced by effective management of the energy use of operations and processes.	Access section VII. of this document
VII.1	Sector-specific plant energy performance benchmarks		Access section VII.1 of this document
VII.2	Industry energy efficiency initiatives		Access section VII.2 of this document
IX.	Other measures to reduce GHG emissions	As detailed in the following rows.	Access section IX. of this document
IX.1	Alternative fuels – biomass		Access section IX.1 of this document
IX.2	Co-firing		Access section IX.2 of this document

Section reference	Section title	Description where relevant	Reference link
IX.3	Fuel switching		Access section IX.3 of this document

5. Meat processing industry

Relevant reference document

Reference Document on Best Available Techniques in the Slaughterhouses and Animal By-products Industries – European Commission, May 2005.

[Access the document](#)

Brief overview of reference document

This document provides a summary of best available techniques (BAT) relevant to the meat processing industry. It is specifically relevant to slaughterhouses with:

- a carcass production capacity greater than 50 tonnes per day
- installations for the disposal or recycling of animal carcasses and animal waste with a treatment capacity exceeding 10 tonnes per day.

The document provides benchmark data on environmental matters such as energy consumption as well as emissions levels. It also identifies around 250 techniques that can be utilised to improve the performance of operations in the meat processing sector. These techniques are for reducing energy consumption and emissions, as well as more general performance improvements.

Some of the techniques are readily available established technologies and other, newer technologies discussed are identified as 'emerging techniques'.

Relevant reference document

Documentation for Greenhouse Gas Emission and Energy Factors Used in the Waste Reduction Model (WARM) Management Practices Chapters May 2019 - U.S. Environmental Protection Agency (EPA) Office of Resource Conservation and Recovery: October 2019.

[Access the document](#)

Brief overview of reference document

This document provides information on technologies that can be used to reduce greenhouse gas (GHG) emissions from a range of processes and sectors. There is a section on anaerobic digestion which is relevant to the meat processing industry for reducing emissions (by using biogas produced from anaerobic digestion as process heat). This chapter describes the development of anaerobic digestion emission factors for EPA's Waste Reduction Model (WARM). Included are estimates of the net GHG emissions from anaerobic digestion of yard trimmings, food waste, and mixed organics waste.

The document also includes sections addressing the energy impacts and the environmental impacts associated with the use of the various processes described.

Relevant section references in these documents are detailed in Table 5 and Table 6 below.

Table 5 - Relevant sections of European Commission BAT document – meat industry

Section reference	Section title	Description where relevant	Reference link
1.3	Key environmental issues	This section provides an overview of the main environmental issues relevant to slaughterhouses and animal by-products installations, particularly in relation to air, water and energy consumption.	Access section 1.3 of this document
3	Current consumption and emission levels	This section provides information on current consumption and emission levels. These are generally per tonne of carcass produced or per tonne of by-product treated, as relevant. This information shares opportunities for improvement in environmental performance for plants operating at the higher levels in the range.	Access section 3 of this document
4	Techniques to consider in the determination of BAT	This chapter describes the techniques most relevant for determining BATs and provides background information on the BATs presented in Chapter 5. This chapter covers ‘process integrated’ techniques such as prevention and control of emissions, minimising consumption, re-use and recycling procedures. Each technique is listed with a description of the technique, environmental benefits, operational data, financial impact, applicability, driving force(s) for implementation, example plants and reference literature. Relevant section references and headings are provided in the following rows of this table.	Access section 4 of this document
4.1.3	Use of a planned maintenance programme		Access section 4.1.3 of this document
4.1.4	Dedicated metering of water consumption		Access section 4.1.4 of this document
4.1.5	Separation of process and non-process water		Access section 4.1.5 of this document

Section reference	Section title	Description where relevant	Reference link
4.1.8	Use of pressure cleaning throughout the installation		Access section 4.1.8 of this document
4.1.9	Fit cleaning-hoses with hand-operated triggers		Access section 4.1.9 of this document
4.1.10	Supply of pressure-controlled water and via nozzles		Access section 4.1.10 of this document
4.1.12	Dry cleaning of installations and dry transport of by-products		Access section 4.1.12 of this document
4.1.16	Implement energy management systems		Access section 4.1.16 of this document
4.1.17	Energy management at a red meat plant		Access section 4.1.17 of this document
4.1.22	Heat recuperation from refrigeration plants		Access section 4.1.22 of this document
4.1.23	Use of thermostatically controlled steam and water blending valves		Access section 4.1.23 of this document
4.1.24	Rationalisation and insulation of steam and water pipework		Access section 4.1.24 of this document
4.1.25	Isolation of steam and water services		Access section 4.1.25 of this document

Section reference	Section title	Description where relevant	Reference link
4.1.41	Replacement of boiler fuel with tallow		Access section 4.1.41 of this document
4.1.42.1	Management of quantities of water and detergents consumed		Access section 4.1.42.1 of this document
4.1.43.14	Anaerobic pretreatment using down-flow or up-flow reactors		Access section 4.1.43.14 of this document
5	Best Available Techniques (BAT)	This section presents techniques, including emission and consumption levels associated with the use of BAT, that are appropriate to the sector, and could reflect the current performance of some installations within the sector. The general BAT in this chapter should be used as a reference point to assess the current performance of an existing installation, or to assess a proposal for a new installation. They aim to give information for the guidance on achievable emission and consumption levels when using specified techniques. Relevant section references and headings are provided in the following rows of this table.	Access section 5 of this document
5.2.1	Additional BAT for the slaughter of large animals		Access section 5.2.1 of this document
5.2.2	Additional BAT for the slaughter of poultry		Access section 5.2.2 of this document
5.3.1	Additional BAT for fat melting		Access section 5.3.1 of this document
5.3.2	Additional BAT for rendering		Access section 5.3.2 of this document

Section reference	Section title	Description where relevant	Reference link
5.3.3	Additional BAT for fish-meal and fish-oil production		Access section 5.3.3 of this document
5.3.4	Additional BAT for blood processing		Access section 5.3.4 of this document
5.3.8	Additional BAT for biogas production		Access section 5.3.8 of this document
6.1	Bio-refining of animal by-products to produce soil improvers and fertilisers		Access section .6.1 of this document
6.2	Biotechnological treatment of animal by-products in order to increase energetic valorisation		Access section 6.2 of this document

Table 6 - Relevant sections of US EPA document – anaerobic digestion

Section reference	Section title	Description where relevant	Reference link
3.1	A summary of the GHG implications of anaerobic digestion	This section provides a summary of the GHG implications of anaerobic digestion.	Access section 3.1 of this document
3.2	Calculating the GHG impacts of anaerobic digestion	This section reports on the various stages of an anaerobic digestion operation that contribute to anaerobic digestion energy and emission factors. These include pre-processing and digester operations, and biogas collection and utilisation.	Access section 3.2 of this document
3.2.4	Biogas collection and avoided emissions		Access section 3.2.4 of this document
5.1	A Summary of the GHG implications of combustion	This section provides a summary of the GHG implications of combustion of biogas.	Access section 5.1 of this document

6. Dairy industry

Relevant reference document

Best Available Techniques (BAT) Reference Document for the Food, Drink and Milk Industries – European Commission, 2019.

[Access the document](#)

Brief overview of reference document

This document provides a summary of best available techniques (BAT) relevant to the food, drink and milk industries. Some techniques are relevant across all of these sectors, while Section 5 of the document relates specifically to the dairy sector.

The document provides benchmark data on environmental matters such as energy consumption as well as emissions levels. It identifies techniques that can improve the general performance of operations in the dairy sector, and specifically for reduction in energy consumption and emissions.

Some of the techniques are readily available established technologies and other, newer, technologies discussed are identified as ‘emerging techniques’.

Relevant section references in this document are detailed in Table 7.

Table 7 - Sections of European Commission BAT document - food, drink and milk industries that are relevant to the dairy industry

Section reference	Section title	Description where relevant	Reference link
1.7.1	Key environmental issues	This section provides an overview of the main environmental issues relevant to the food, drink and milk industries, particularly in relation to air, water and energy consumption.	Access section 1.7.1 of this document
2.1.2	Energy consumption	This section provides general information on energy consumption in the food, drink and milk industries. This includes the generation of thermal energy (typically from a boiler).	Access section 2.1.2 of this document
2.3.2	Techniques to increase energy efficiency	This section covers various techniques that may be used to increase energy efficiency in the sector and provides details of particular technologies as noted in the following rows of this table.	Access section 2.3.2 of this document
2.3.2.1.1	Heat recovery		Access section 2.3.2.1.1 of this document
2.3.2.1.2	Use of the biogas generated		Access section 2.3.2.1.2 of this document
2.3.2.1.5	Insulation of pipes, vessels and equipment		Access section 2.3.2.1.5 of this document
2.3.2.1.8	Energy efficiency plan		Access section 2.3.2.1.8 of this document
2.3.2.1.10	Combustion regulation and control		Access section 2.3.2.1.10 of this document
2.3.2.2	Techniques related to steam systems		Access section 2.3.2.2 of this document
2.3.3.5	Techniques related to steam systems	This section heading is the same as 2.3.2.2, although the detail is more focused on reducing water consumption, which in turn leads to reduced energy consumption.	Access section 2.3.3.5 of this document
5.3.1	Current consumption and emission levels – energy consumption	This section provides an overview of energy consumption in the dairy sector. It notes the main uses of energy as being thermal energy for the generation of steam and hot water. Specific energy consumption of the main categories of dairy products are provided.	Access section 5.3.1 of this document

Section reference	Section title	Description where relevant	Reference link
5.4	Techniques to consider in the determination of BAT	This chapter describes various techniques that are most relevant for determining BATs in the dairy sector. It provides information for various techniques including a description of the technique, environmental benefits, operational data, financial impact, applicability, driving force(s) for implementation, example plants and reference literature. Relevant section references and headings are provided in the following rows of this table.	Access section 5.4 of this document
5.4.1.2	Use of computer-controlled milk transfer, pasteurisation, homogenisation and cleaning-in-place (CIP) equipment		Access section 5.4.1.2 of this document
5.4.2.3	Sterile water use in homogeniser		Access section 5.4.2.3 of this document
5.4.2.4	Use of continuous pasteurisers		Access section 5.4.2.4 of this document
5.4.2.5	Regenerative heat exchange in pasteurisation		Access section 5.4.2.5 of this document
5.4.2.6	Hibernation for pasteurisers and sterilisers		Access section 5.4.2.6 of this document
5.4.2.7	Ultra-high temperature process of milk without intermediate pasteurisation		Access section 5.4.2.7 of this document
5.4.2.8	Multistage drying in powder production		Access section 5.4.2.8 of this document

Section reference	Section title	Description where relevant	Reference link
5.4.2.9	Precooling of ice-water		Access section 5.4.2.9 of this document
5.4.2.10.2	Use of ultrafiltration for protein standardisation of cheese milk		Access section 5.4.2.10.2 of this document
5.4.3.3	Reuse and recycling of water		Access section 5.4.3.3 of this document
17.4	BAT conclusions for dairies	This section provides a summary of BAT conclusions in relation to various techniques that can reduce energy consumption and/or emissions in the dairy sector, and indicative environmental performance levels for specific energy consumption.	Access section 17.4 of this document

7. Food and beverage industry

Relevant reference document

Best Available Techniques (BAT) Reference Document for the Food, Drink and Milk Industries – European Commission, 2019.

[Access the document](#)

Brief overview of reference document

This document provides a summary of best available techniques (BAT) relevant to the food, drink and milk industries. Relevant techniques are described across a range of food and beverage sectors, each with its own section in the document.

The document provides benchmark data on environmental matters such as energy consumption as well as emissions levels. It identifies techniques that can be improve the general performance of operations in the food and beverage sector, and specifically for reduction in energy consumption and emissions.

Some of the techniques are readily available established technologies and other, newer, technologies discussed are identified as ‘emerging techniques’.

Relevant section references in this document are detailed in Table 8. This table provides information relevant to the entire food and beverage sector. Subsequent tables provide specific information relevant to specific food and beverage sub-sectors (for example, Table 9 is relevant to brewing).

Relevant section references in this document are detailed in the tables below.

Table 8 - Relevant sections of European Commission BAT document - food, drink and milk industries – general issues relevant to the entire sector

Section reference	Section title	Description where relevant	Reference link
1.7.1	Key environmental issues	This section provides an overview of the main environmental issues relevant to the food, drink and milk industries, particularly in relation to air, water and energy consumption.	Access section 1.7.1 of this document
2.1.2	Energy consumption	This section provides general information on energy consumption in the food, drink and milk industries. This includes the generation of thermal energy (typically from a boiler).	Access section 2.1.2 of this document
2.3.2	Techniques to increase energy efficiency	This section covers techniques that may be used to increase energy efficiency in the sector, and provides details of particular technologies as noted in the following rows of this table.	Access section 2.3.2 of this document
2.3.2.1.1	Heat recovery		Access section 2.3.2.1.1 of this document
2.3.2.1.2	Use of the biogas generated		Access section 2.3.2.1.2 of this document
2.3.2.1.5	Insulation of pipes, vessels and equipment		Access section 2.3.2.1.5 of this document
2.3.2.1.8	Energy efficiency plan		Access section 2.3.2.1.8 of this document
2.3.2.1.10	Combustion regulation and control		Access section 2.3.2.1.10 of this document
2.3.2.2	Techniques related to steam systems		Access section 2.3.2.2 of this document
2.3.3.5	Techniques related to steam systems	This section heading is the same as 2.3.2.2, although the detail is more focused on reducing water consumption, which in turn leads to reduced energy consumption.	Access section 2.3.3.5 of this document
17	Best Available Techniques (BAT) conclusions		Access section 17 of this document
17.1	General BAT conclusions		Access section 17.1 of this document

Section reference	Section title	Description where relevant	Reference link
17.1.3	General BAT conclusions – energy efficiency	This section provides a summary of techniques that can be applied to reduce energy consumption in the grain milling sector. This includes developing an energy efficiency plan and common techniques such as burner regulation and control and heat recovery.	Access section 17.1.3 of this document

7.1 Brewing industry

Table 9: Links to information in European Commission BAT document relevant to brewing

Section reference	Section title	Description where relevant	Reference link
4.3.1	Current consumption and emission levels – energy consumption	This section provides an overview of energy consumption in the brewing sector. It notes the main uses of energy as being thermal energy for the generation of steam and hot water.	Access section 4.3.1 of this document
4.4	Techniques to consider in the determination of BAT	This chapter describes various techniques that are most relevant for determining BATs in the brewing sector. It provides information on various techniques, including a description of the technique, environmental benefits, operational data, financial impact, applicability, driving force(s) for implementation, example plants and reference literature. Relevant section references and headings are provided in the following rows of this table.	Access section 4.4 of this document
4.4.1.1	Mash infusion process		Access section 4.4.1.1 of this document
4.4.1.2	Mashing-in at higher temperatures		Access section 4.4.1.2 of this document
4.4.1.3	Heat recovery from wort kettle vapour		Access section 4.4.1.3 of this document
4.4.1.4	Increase of the degree of high-gravity brewing		Access section 4.4.1.4 of this document
4.4.1.5	Integrated energy system in the CO ₂		Access section 4.4.1.5 of this document

Section reference	Section title	Description where relevant	Reference link
	recovery plant		
4.4.1.6	Decrease of evaporation rate during wort boiling		Access section 4.4.1.6 of this document
4.4.2.1	Reuse of hot water from wort cooling		Access section 4.4.2.1 of this document
17.3	BAT conclusions for brewing	This section provides a summary of BAT conclusions in relation to techniques that can reduce energy consumption and/or emissions in the brewing sector, and indicative environmental performance levels for specific energy consumption.	Access section 17.3 of this document

7.2 Ethanol production industry

Table 10: Links to information in European Commission BAT document relevant to ethanol production

Section reference	Section title	Description where relevant	Reference link
6.3.1	Current consumption and emission levels – energy consumption	This section provides an overview of energy consumption in the ethanol production sector. It notes the requirement for thermal energy for heating processing lines and buildings associated with the distillation process.	Access section 6.3.1 of this document

7.3 Fish and shellfish processing industry

Table 11: Links to information in European Commission BAT document relevant to fish and shellfish processing

Section reference	Section title	Description where relevant	Reference link
7.3.2	Current consumption and emission levels – energy consumption	This section provides an overview of energy consumption in the fish and shellfish processing sector. It notes the requirement for energy to produce steam and hot water for process and cleaning applications.	Access section 7.3.2 of this document

7.4 Fruit and vegetable industry

Table 12: Links to information in European Commission BAT document relevant to fruit and vegetable sector

Section reference	Section title	Description where relevant	Reference link
8.3.1	Current consumption and emission levels – energy consumption	This section provides an overview of energy consumption in the fruit and vegetable sector. It notes that processes involving heating, cooling, drying, evaporation, sterilisation, pasteurisation and blanching consume significant energy.	Access section 8.3.1 of this document
8.4	Techniques to consider in the determination of BAT	This chapter describes techniques that are most relevant for determining BATs in the fruit and vegetable sector. It provides information for techniques including a description of the technique, environmental benefits, operational data, financial impact, applicability, driving force(s) for implementation, example plants and reference literature. Relevant section references and headings are provided in the following rows of this table.	Access section 8.4 of this document
8.4.1.1	Cooling fruit and vegetables before freezing		Access section 8.4.1.1 of this document
8.4.2.2	Water recycling	The detail is more focused on reducing water consumption, which in turn leads to reduced energy consumption.	Access section 8.4.2.2 of this document
17.7	BAT conclusions for fruit and vegetable sector	This section provides a summary of BAT conclusions in relation to techniques that can reduce energy consumption and/or emissions in the brewing sector, and indicative environmental performance levels for specific energy consumption.	Access section 17.7 of this document

7.5 Grain milling industry

Table 13: Links to information in European Commission BAT document relevant to the grain milling sector

Section reference	Section title	Description where relevant	Reference link
9.3.1	Current consumption and emission levels – energy consumption	This section provides data on specific energy consumption (MWh/tonne of products) in various grain milling installations.	Access section 9.3.1 of this document
17.8.1	BAT conclusions for grain milling – energy efficiency	This section provides indicative environmental performance levels of energy consumption in MWh/tonne of product.	Access section 17.8.1 of this document

7.6 Oil seed processing and vegetable oil refining industry

Table 14: Links to information in European Commission BAT document relevant to oil seed processing and vegetable oil refining

Section reference	Section title	Description where relevant	Reference link
11.3.1	Current consumption and emission levels – energy consumption	This section provides an overview of energy consumption in the oil seed processing and vegetable oil sector. It notes that heating, cooling, drying, milling, pressing, evaporation and distillation are the major energy-consuming steps.	Access section 11.3.1 of this document
11.4	Techniques to consider in the determination of BAT	This chapter describes various techniques that are most relevant for determining BATs in the oil seed processing and vegetable oil sector. It provides information for various techniques including a description of the technique, environmental benefits, operational data, financial impact, applicability, driving force(s) for implementation, example plants and reference literature. Relevant section references and headings are provided in the following rows of this table.	Access section 11.4 of this document
11.4.1.1	Generation of an auxiliary vacuum		Access section 11.4.1.1 of this document
12.3.1	Current consumption and emission levels – energy consumption: specific to olive oil processing and refining	This section notes specific energy consumption values between 0.29 MWh and 13.11 MWh per tonne of products have been reported from three installations.	Access section 12.3.1 of this document
17.10	BAT conclusions for oil seed processing and vegetable oil sector	This section provides a summary of BAT conclusions in relation to techniques that can reduce energy consumption and/or emissions in the oil seed processing and vegetable oil sector, and indicative environmental performance levels for specific energy consumption.	Access section 17.10 of this document

7.7 Soft drinks and nectar/juice industry

Table 15: Links to information in European Commission BAT document relevant to soft drinks and nectar/juice

Section reference	Section title	Description where relevant	Reference link
13.3.1	Current consumption and emission levels – energy consumption	This section provides an overview of specific energy consumption in the soft drinks, nectar and juice sector.	Access section 13.3.1 of this document
13.4	Techniques to consider in the determination of BAT	This chapter describes techniques that are most relevant for determining BATs in the soft drinks, nectar and juice sector. It provides information for various techniques including a description of the technique, environmental benefits, operational data, financial impact, applicability, driving force(s) for implementation, example plants and reference literature. Relevant section references and headings are provided in the following rows of this table.	Access section 13.4 of this document
13.4.1.2	Single pasteuriser for nectar/juice production		Access section 13.4.1.2 of this document
13.4.1.3	Hydraulic sugar transportation		Access section 13.4.1.3 of this document
13.5.1	Optimised juice pasteurisation		Access section 13.5.1 of this document
17.11	BAT conclusions for soft drinks and nectar/juice	This section provides a summary of BAT conclusions in relation to techniques that can reduce energy consumption and/or emissions in the soft drinks, nectar and juice sector and indicative environmental performance levels for specific energy consumption.	Access section 17.11 of this document

7.8 Starch production industry

Table 16: Links to information in European Commission BAT document relevant to starch production

Section reference	Section title	Description where relevant	Reference link
14.3.1	Current consumption and emission levels – energy consumption	This section provides an overview of specific energy consumption in the starch production sector.	Access section 14.3.1 of this document
14.4	Techniques to consider in the determination of BAT	This chapter describes techniques that are most relevant for determining BATs in the starch production sector. It provides information for various techniques including a description of the technique, environmental benefits, operational data, financial impact, applicability, driving force(s) for implementation, example plants and reference literature. Relevant section references and headings are provided in the following rows of this table.	Access section 14.4 of this document
14.4.1	Techniques to increase energy efficiency		Access section 14.4. 1 of this document
17.12	BAT conclusions for the starch production sector	This section provides a summary of BAT conclusions in relation to various techniques that can be applied to reduce energy consumption and/or emissions in the starch production sector and indicative environmental performance levels for specific energy consumption.	Access section 17.12 of this document

8. Timber processing industry

Relevant reference document

Best Available Techniques (BAT) Reference Document for the Production of Wood-based Panels, European Commission 2016.

Access the document

Brief overview of reference document

This document provides a summary of best available techniques (BAT) relevant to the production of wood-based panels. Specifically, the document addresses processes and activities involved in the manufacture of wood-based panels by dry or wet processes, including the production of:

- particleboard (PB)
- oriented strand board (OSB)
- medium density fibreboard (MDF), including low density fibreboard (LDF) and high-density fibreboard (HDF), produced in a dry process
- fibreboard, including rigidboard (RB) and flexboard (FB), produced in a dry process
- fibreboard, including softboard (SB) and hardboard (HB), produced in a wet process.

The document provides benchmark data on environmental matters such as energy consumption as well as emissions levels. It also identifies techniques that can be applied to improve the general performance of operations in the wood panel production sector, and specifically the reduction in energy consumption and emissions.

Some of the techniques are readily available established technologies and other, newer, technologies discussed are identified as 'emerging techniques'.

Relevant section references in this document are detailed in Table 17 below.

8.1 Wood based panels industry

Table 17 - Relevant sections of European Commission BAT document - wood based panels

Section reference	Section title	Description where relevant	Reference link
2.2	Drying of wood particles and fibres	This section provides an overview of the main issues relevant to drying wood particles and fibres, particularly in relation to energy consumption.	Access section 2.2 of this document
2.2.3	Refining of fibres for MDF and other fiberboards	This section provides an overview of the main issues relevant to refining of wood fibres, particularly in relation to energy consumption.	Access section 2.2.3 of this document
2.3.2.1	Environmental issues related to pressing	This section provides an overview of the main issues relevant to pressing wood fibres, particularly in relation to energy consumption.	Access section 2.3.2.1 of this document
2.6	Energy production	This section provides an overview of energy production in the wood-based panel production industry.	Access section 2.6 of this document
3.1.4	Energy consumption	This section provides information on typical energy consumption for key process steps in the wood-based panel production industry.	Access section 3.1.4 of this document
4	Techniques to consider in the determination of BAT	This chapter describes the techniques that are most relevant for determining BATs. It provides background information for the conclusions on the determination of BATs presented in Chapter 4. This chapter covers environmental management systems, process-integrated techniques and end-of-pipe measures. Each technique is listed along with details including a description of the technique, environmental benefits, operational data, financial impact, applicability, driving force(s) for implementation, example plants and reference literature. Relevant section references and headings are provided in the following rows of this table.	Access section 4 of this document
4.2.2.1	Management of the drying operation		Access section 4.2.2.1 of this document

Section reference	Section title	Description where relevant	Reference link
4.2.2.2	Recirculation of waste gases		Access section 4.2.2.2 of this document
4.2.2.3	Combined heat and dryer systems for particleboard and oriented strand board (OSB)		Access section 4.2.2.3 of this document
4.2.4.7	Incineration of press waste gases in an onsite combustion plant		Access section 4.2.4.7 of this document
4.6	Techniques to increase energy efficiency	This section provides information on techniques to increase energy efficiency. Relevant section references and headings are provided in the following rows of this table.	Access section 4.6 of this document
4.6.1	Recovery of energy in hot air emissions		Access section 4.6.1 of this document
4.6.2	Combustion control		Access section 4.6.2 of this document
4.6.3	Dewatering of bark and sludge	This section describes the pretreatment of fuels by lowering the water content of biomass fuels through the use of mechanical dewatering equipment.	Access section 4.6.3 of this document
4.6.5	Heat recovery from steam during refining		Access section 4.6.5 of this document
4.8.2	Optimisation of fuel quantity by the collection of wood fines and dust		Access section 4.8.2 of this document
4.8.4	Reuse of internal collected wood residues in production		Access section 4.8.4 of this document

Section reference	Section title	Description where relevant	Reference link
5	BAT conclusions – energy management and energy efficiency	This section provides a summary of BAT conclusions in relation to techniques that can reduce energy consumption and/or emissions in the wood based panels sector and indicative environmental performance levels for specific energy consumption.	Access section 5 of this document
5.1.5	Energy management and energy efficiency		Access section 5.1.5 of this document
6.1	Superheated steam dryers	This is an emerging technology.	Access section 6.1 of this document
6.2	Recovery of organic compounds from wood	This is an emerging technology.	Access section 6.2 of this document

9. Pulp and paper industry

Relevant reference document

Best Available Techniques (BAT) Reference Document for the Production of Pulp, Paper and Board, European Commission 2015.

Access the document

Brief overview of reference document

This document provides a summary of best available techniques (BAT) relevant to the production of pulp, paper and board. Specifically, the document addresses the following processes and activities:

- chemical pulping
 - kraft (sulphate) pulping process
 - sulphite pulping process
- mechanical and chemimechanical pulping
- processing paper for recycling with and without deinking
- papermaking and related processes
- all recovery boilers and lime kilns operated in pulp and paper mills.

The document provides benchmark data on environmental matters such as energy consumption as well as emissions levels. It also identifies techniques that can improve the general performance of operations in the pulp, paper and board production sector, and specifically the reduction in energy consumption and emissions.

Relevant section references in this document are detailed in Table 18. This table provides information relevant to the entire pulp and paper sector. Subsequent tables provide specific information relevant to specific pulp and paper sub-sectors (for example, Table 19 is relevant to kraft pulping process).

Some of the techniques are readily available established technologies and other, newer, technologies discussed are identified as ‘emerging techniques’.

Relevant reference document

Available and Emerging Technologies for Reducing Greenhouse Gas Emissions from the Pulp and Paper Manufacturing Industry – US Environmental Protection Agency, October 2010.

[Access the document](#)

Brief overview of reference document

This document provides information on control techniques and measures that are currently available to mitigate greenhouse gas (GHG) emissions from the pulp and paper industry. The primary GHGs emitted by the pulp and paper manufacturing industry include carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O), and the control technologies and measures presented here focus on these pollutants. A large number of available technologies are discussed here. However, this paper may not represent all available technologies or measures that that can be considered for any given activity to reduce its GHG emissions.

Relevant section references in these documents are detailed in the tables below.

Table 18: Relevant sections of European Commission BAT document - pulp, paper and board: general issues relevant to the entire pulp and paper sector

Section reference	Section title	Description where relevant	Reference link
1.7	Main environmental issues of the production of pulp and paper	This section provides an overview of energy consumption and emissions generated in relation to pulp and paper production.	Access section 1.7 of this document
2.5	Energy consumption in pulp and paper mills	This section provides an overview of energy used in the production of pulp and paper, and notes that the main uses of heat energy are for processes such as heating the cooking liquor, and evaporation. The section also notes trends relevant to energy consumption in this sector.	Access section 2.5 of this document
2.9	Techniques to consider in the determination of BAT common to all mills	This section describes techniques and associated monitoring that can potentially achieve a high level of environmental protection in the activities within the scope of this document. The techniques described include both the technology used and the way in which the installations are designed, built, maintained, operated, and decommissioned. It covers environmental management systems, process-integrated techniques, and end-of-pipe measures. It also considers waste prevention and management, including waste minimisation and recycling procedures, as well as techniques that reduce the consumption of raw materials, water and energy by optimising use and reuse. Relevant section references and headings are provided in the following rows of this table.	Access section 2.9 of this document
2.9.5	Energy efficiency analysis, energy management and energy audits		Access section 2.9.5 of this document
2.9.6.1.1	Heat recovery from radial blowers used in vacuum systems		Access section 2.9.6.1.1 of this document
2.9.6.1.2	Use of thermo-		Access section 2.9.6.1.2 of this document

Section reference	Section title	Description where relevant	Reference link
	compressors		
2.9.6.1.3	Insulation of steam and condensate pipe fittings		Access section 2.9.6.1.3 of this document
2.9.6.1.4	Drying of biofuel and sludge utilising excess heat		Access section 2.9.6.1.4 of this document
2.9.6.1.5	Further measures for reducing thermal energy use		Access section 2.9.6.1.5 of this document
2.9.8	Prevention, minimisation, recycling and treatment of process residues – minimising solid waste to landfill	This section includes information on organic waste and residues from the production of pulp and paper (bark, wood residues, residual fibres) that can be recovered and incinerated on site to generate heat.	Access section 2.9.8 of this document
2.9.11.2.2	Anaerobic biological wastewater pretreatment (to produce biogas)		Access section 2.9.11.2.2 of this document
8.1	General BAT conclusions for the pulp and paper industry	Introduction to conclusions on relevant process-specific BATs as referred to in the following rows.	Access section 8.1 of this document
8.1.1	Environmental management system		Access section 8.1.1 of this document
8.1.4	Energy consumption and efficiency		Access section 8.1.4 of this document

9.1 Kraft (sulphate) pulping process

Table 19: Relevant sections of European Commission BAT document - pulp, paper and board: issues relevant to the kraft (sulphate) pulping process

Section reference	Section title	Description where relevant	Reference link
3.1.11	Kraft process - chemical and energy recovery system	This section provides an overview of the recovery system in a kraft mill, in relation to organic by-products that can be used to provide energy.	Access section 3.1.11 of this document
3.2.2.3	Current consumption and emission levels energy consumption	Overview of energy consumption in the kraft process.	Access section 3.2.2.3 of this document
3.3	Techniques to consider in the determination of BAT	This section provides information on techniques to consider that are relevant to the kraft pulping process. Relevant section references and headings are provided in the following rows.	Access section 3.3 of this document
3.3.3	Modified cooking before bleaching		Access section 3.3.3 of this document
3.3.16.1	Incineration of strong and/or weak malodorous gases in the recovery boiler		Access section 3.3.16.1 of this document
3.3.16.2	Incineration of collected malodorous gases (strong and weak gases) in the lime kiln		Access section 3.3.16.2 of this document
3.3.16.3	Incineration of collected strong malodorous gases in a dedicated Non-condensable odorous gases (NCG) burner equipped with scrubbers for SO ₂		Access section 3.3.16.3 of this document

Section reference	Section title	Description where relevant	Reference link
	removal		
3.3.18.1	Optimised combustion control and control of the NOX-influencing factors		Access section 3.3.18.1 of this document
3.3.18.2	Optimised black liquor recovery boiler air systems		Access section 3.3.18.2 of this document
3.3.21.1	Selection of fuels, optimised combustion, and control of the kiln operation		Access section 3.3.21.1 of this document
3.3.23	Substitution of fossil fuels used in the lime kiln		Access section 3.3.23 of this document
3.3.27	Measures for increased energy efficiency		Access section 3.3.27 of this document
3.4.1	Enhanced generation of electricity, biomass-based products and the utilisation of excess heat	This is an emerging technique.	Access section 3.4.1 of this document
3.4.2	Gasification of black liquor	This is an emerging technique.	Access section 3.4.2 of this document
8.2.4	Energy consumption and efficiency	BAT conclusions on energy consumption and efficiency – Kraft pulping process.	Access section 8.2.4 of this document

9.2 Sulphite pulping process

Table 20: Relevant sections of European Commission BAT document - pulp, paper and board: issues relevant to the sulphite pulping process

Section reference	Section title	Description where relevant	Reference link
4.1.4	Sulphite pulping process - chemical and energy recovery system		Access section 4.1.4 of this document
4.2.2.3	Energy consumption	Overview of energy consumption in the sulphite pulping process.	Access section 4.2.2.3 of this document
4.3	Techniques to consider in the determination of BAT	This section provides information on techniques to consider that relate to the sulphite pulping process. Relevant section references and headings are provided in the following rows of this table.	Access section 4.3 of this document
4.3.2	Extended modified cooking before bleaching		Access section 4.3.2 of this document
4.3.13	Evaporation of effluents from the hot alkaline extraction stage and incineration of the concentrates in a soda boiler		Access section 4.3.13 of this document
4.3.15	Anaerobic treatment of the condensates and the high chemical oxygen demand (COD) load in the effluent from the bleach plant		Access section 4.3.15 of this document
4.3.18	Optimising the recovery boiler by controlling the firing conditions		Access section 4.3.18 of this document

Section reference	Section title	Description where relevant	Reference link
4.3.24	Reduction of energy consumption (energy efficiency)		Access section 4.3.24 of this document
8.3.3	Energy consumption and efficiency	BAT conclusions on energy consumption and efficiency for the sulphite pulping process.	Access section 8.3.3 of this document

9.3 Mechanical pulping and chemimechanical pulping processes

Table 21: Relevant sections of European Commission BAT document - pulp, paper and board: issues relevant to the mechanical pulping and chemimechanical pulping process

Section reference	Section title	Description where relevant	Reference link
5.1.4	Thermomechanical pulping (TMP)	Overview of the thermomechanical pulping (TMP) process.	Access section 5.1.4 of this document
5.2.2.7	Energy use	Overview of energy use in mechanical pulping and chemimechanical pulping.	Access section 5.2.2.7 of this document
5.3	Mechanical pulping and chemimechanical pulping - techniques to consider in the determination of BAT	This section provides information on techniques to consider that are relevant to the mechanical pulping and chemimechanical pulping processes. Relevant section references and headings are provided in the following rows of this table.	Access section 5.3 of this document
5.3.4	Minimisation of the disposal of process residues and sludge to landfill by efficient dewatering and incineration with energy recovery		Access section 5.3.4 of this document
5.3.9	Extensive recovery of secondary heat from thermomechanical pulping (TMP) and chemithermomechanical pulping (CTMP) refiners and reuse of recovered steam in paper or pulp drying		Access section 5.3.9 of this document
5.3.10	Emission-optimised incineration of solid		Access section 5.3.10 of this document

Section reference	Section title	Description where relevant	Reference link
	waste and energy recovery		
5.4.1	New energy-efficient TMP processes	This is an emerging technique.	Access section 5.4.1 of this document
5.4.2	New energy-efficient bleached CTMP processes	This is an emerging technique.	Access section 5.4.2 of this document
8.4.2	Energy consumption and efficiency	BAT conclusions on energy consumption and efficiency for mechanical pulping and chemimechanical pulping.	Access section 8.4.2 of this document

9.4 Processing of paper for recycling

Table 22: Relevant sections of European Commission BAT document - pulp, paper and board: issues relevant to processing of paper for recycling

Section reference	Section title	Description where relevant	Reference link
6.2.2.4	Energy demand	Overview of energy use in processing of paper for recycling.	Access section 6.2.2.4 of this document
6.3	Processing of paper for recycling - techniques to consider in the determination of BAT	This section provides information on techniques to consider in respect of the processing of paper for recycling. Relevant section references and headings are provided in the following rows of this table.	Access section 6.3 of this document
6.3.7	Anaerobic biological wastewater pretreatment		Access section 6.3.7 of this document
6.3.10	Examples of energy-saving techniques		Access section 6.3.10 of this document
6.3.10.1	High consistency pulping for disintegrating paper for recycling into separated fibre	Achieved environmental benefits include power savings due to a lower water content in the pulper and decreased agitation speed.	Access section 6.3.10.1 of this document
6.3.14	Environmentally sound residue utilisation and energy recovery		Access section 6.3.14 of this document
8.5.3	Energy consumption and efficiency	BAT conclusions on energy consumption and efficiency for processing paper for recycling.	Access section 8.5.3 of this document

9.5 Papermaking and related processes

Table 23: Relevant sections of European Commission BAT document - pulp, paper and board: issues relevant to papermaking and related processes

Section reference	Section title	Description where relevant	Reference link
7.2.2.4	Energy demand	Overview of energy use in papermaking and related processes.	Access section 7.2.2.4 of this document
7.3	Papermaking and related processes - techniques to consider in the determination of BAT	This section provides information on techniques to consider in respect of the papermaking and related processes. Relevant section references and headings are provided in the following rows of this table.	Access section 7.3 of this document
7.3.1	Water management and minimising water usage for different paper grades	This section covers some basic water reduction solutions which could lead to lower water consumption. Lower water volumes usually also mean a lower heat load to the receiving water body.	Access section 7.3.1 of this document
7.3.2	Control of potential negative side effects from closing water circuits	This measure should be read together with Section 7.3.1 above.	Access section 7.3.2 of this document
7.3.8	Measurement and automation		Access section 7.3.8 of this document
7.3.15	Energy saving in papermaking		Access section 7.3.15 of this document
7.3.15.1	Optimisation of dewatering in the press section of the paper machine (wide nip press)		Access section 7.3.15.1 of this document

Section reference	Section title	Description where relevant	Reference link
7.3.15.3	Steam condensate recovery and use of efficient exhaust air heat recovery systems		Access section 7.3.15.3 of this document
7.4.3	Heat recovery with heat pumps		Access section 7.4.3 of this document
8.6.4	Energy consumption and efficiency	BAT conclusions on energy consumption and efficiency for papermaking and related processes.	Access section 8.6.4 of this document

Table 24: Relevant sections of US EPA document – pulp and paper manufacturing industry

Section reference	Section title	Description where relevant	Reference link
II.	Control measures and energy efficiency improvements for direct GHG emission sources	The control measures and energy efficiency options that are currently available for pulp and paper mill processes are listed in a table in this section. Categories of individual measures are listed in the rows below.	Access section II. of this document
II.A	Power boilers, chemical recovery furnaces, and turbines		Access section II.A of this document
II.A.1	Control measures and energy efficiency options for boilers		Access section II.A.1 of this document
II.A.2	Control measures and energy efficiency options for chemical recovery furnaces and combustion units		Access section II.A.2 of this document
II.B	Natural gas-fired dryers and thermal oxidizers		Access section II.B of this document
II.C	Kraft and soda lime kilns		Access section II.C of this document
III.	Additional energy efficiency improvements	This section discusses general energy efficiency measures that could be utilised by energy-using equipment at pulp and paper mills (for example, equipment that uses electricity, steam heat, or heat recovered from another process). This excludes processes that directly emit GHG.	Access section III. of this document
III.A	Energy efficiency improvements in steam systems		Access section III.A of this document

Section reference	Section title	Description where relevant	Reference link
III.C	Energy efficiency improvements in chemical pulping		Access section III.C of this document
III.C.1	Digesters (chip cooking)		Access section III.C.1 of this document
III.C.2	Pulp washing		Access section III.C.2 of this document
III.C.3	Bleaching		Access section III.C.3 of this document
III.D	Energy efficiency improvements in mechanical pulping		Access section III.D of this document
III.D.1	Mechanical pulping		Access section III.D.1 of this document
III.D.2	Repulping of market pulp		Access section III.D.2 of this document
III.D.3	Secondary (recovered) fibre processing		Access section III.D.3 of this document
III.E	Energy efficiency improvements in papermaking		Access section III.E of this document
III.E.1	Paper machines – forming and pressing sections		Access section III.E.1 of this document
III.E.2	Paper machines – drying section		Access section III.E.2 of this document
III.F	Energy efficiency improvements in facility operations		Access section III.F of this document
III.F.1	Energy monitoring and control systems		Access section III.F.1 of this document
III.F.7	Process integration pinch analysis		Access section III.F.7 of this document

Section reference	Section title	Description where relevant	Reference link
III.G	Emerging energy efficiency technologies	This section identifies emerging energy efficiency technologies.	Access section III.G of this document
III.G.1	Raw material preparation		Access section III.G.1 of this document
III.G.2	Chemical pulping		Access section III.G.2 of this document
III.G.3	Pulp washing		Access section III.G.3 of this document
III.G.4	Secondary fiber processing		Access section III.G.4 of this document
III.G.6	Paper machines – drying section		Access section III.G.6 of this document
IV.	Energy programs and management systems	This section provides information on various energy efficiency programmes and systems that can reduce energy use and GHG emissions.	Access section IV. of this document
IV.A	Sector-specific plant energy performance benchmarks		Access section IV.A of this document
IV.B	Industry energy efficiency initiatives		Access section IV.B of this document

10. Cement, lime and magnesium oxide

Relevant reference document

Best Available Techniques (BAT) Reference Document for the Production of Cement, Lime and Magnesium Oxide - European Commission 2013.

[Access the document](#)

Brief overview of reference document

This document provides a summary of best available techniques (BAT) relevant to the production of cement, lime and magnesium oxide.

The document provides benchmark data and information concerning the environmental performance such as energy consumption as well as emissions levels of installations within the cement, lime and magnesium oxide sector.

Relevant section references in this document are detailed in separate tables for the cement, lime and magnesium oxide manufacturing processes.

Some of the techniques are readily available established technologies and other, newer, technologies discussed are identified as 'emerging techniques'.

Relevant reference document

Available and Emerging Technologies for Reducing Greenhouse Gas Emissions from the Portland Cement Industry – US Environmental Protection Agency, October 2010.

[Access the document](#)

Brief overview of reference document

This document provides information on control techniques and measures that are currently available to mitigate greenhouse gas (GHG) emissions from the cement manufacturing sector. The primary GHG emitted by the cement industry is carbon dioxide (CO₂), and the control technologies and measures presented in this document focus on this pollutant.

Relevant section references in these documents are detailed in the tables below.

10.1 Cement industry

Table 25: Sections of European Commission BAT document on cement, lime and magnesium oxide production – relevant to cement production

Section reference	Section title	Description where relevant	Reference link
1.2.4.3	Use of wastes as fuels		Access section 1.2.4.3 of this document
1.3.3.1	Thermal energy demand		Access section 1.3.3.1 of this document
1.3.3.3	Consumption of waste fuels		Access section 1.3.3.3 of this document
1.4	Cement industry - techniques to consider in the determination of BAT	This section describes techniques, and associated monitoring, that can potentially achieve a high level of environmental protection in the activities within the scope of this document. The techniques described include both the technology used and the way in which the installations are designed, built, maintained, operated and decommissioned. It covers environmental management systems, process-integrated techniques, and end-of-pipe measures. It also considers techniques that reduce the consumption of raw materials, water and energy by optimising use and reuse. Relevant section references and headings are provided in the following rows of this table.	Access section 1.4 of this document
1.4.2.1	Reduction of thermal energy use		Access section 1.4.2.1 of this document
1.4.2.1.1	Kiln systems		Access section 1.4.2.1.1 of this document
1.4.2.1.2	Raw material properties		Access section 1.4.2.1.2 of this document
1.4.2.1.3	Fuel properties		Access section 1.4.2.1.3 of this document
1.4.2.1.4	Gas bypass system		Access section 1.4.2.1.4 of this document
1.4.2.1.5	Reduction of the clinker content of cement products		Access section 1.4.2.1.5 of this document

Section reference	Section title	Description where relevant	Reference link
1.4.2.3	Process selection		Access section 1.4.2.3 of this document
1.4.2.4	Energy recovery from kilns and coolers		Access section 1.4.2.4 of this document
1.4.3.1	Process control optimisation		Access section 1.4.3.1 of this document
1.4.3.3	Use of wastes as fuels		Access section 1.4.3.3 of this document
1.4.12	Environmental management tools		Access section 1.4.12 of this document
4.2	BAT conclusions for the cement industry	A summary of BAT conclusions for the cement industry.	Access section 4.2 of this document
4.2.3	Energy consumption and process selection	A summary of information on energy consumption and process selection for the cement industry.	Access section 4.2.3 of this document

Table 26: Relevant Sections of US EPA Document – Cement Industry

Section reference	Section title	Description where relevant	Reference link
IV.	Summary of control measures	This section provides a summary of control measures that can be utilised to reduce GHG emissions from the cement industry, focusing on CO ₂ emissions.	Access section IV. of this document
V.	Energy efficiency improvements to reduce GHG emissions	The cement manufacturing process is highly energy intensive. This section details potential improvements to improve energy efficiency. Specific process steps are detailed in the following rows.	Access section V. of this document
V.B	Energy efficiency improvements in clinker production		Access section V.B. of this document
	Process control and management systems		Access section V.B. of this document
	Replacement of kiln seals		Access section V.B. of this document
	Kiln combustion		Access section V.B. of this document

Section reference	Section title	Description where relevant	Reference link
	system improvements		
	Use of fluxes and mineralizers to reduce energy demand		Access section V.B. of this document
	Kiln/preheater insulation		Access section V.B. of this document
	Refractory material selection		Access section V.B. of this document
	Grate cooler conversion		Access section V.B. of this document
	Suspension preheater low pressure drop cyclones		Access section V.B. of this document
	Conversion to multistage preheater		Access section V.B. of this document
	Conversion of long dry kiln to preheater /precalciner kiln		Access section V.B. of this document
	Oxygen enrichment		Access section V.B. of this document
	Air mixing technology		Access section V.B. of this document
VIII.	Oxy-combustion		Access section VIII. of this document
IX.	Other measures to reduce GHG emissions		Access section IX. of this document
	Fuel switching		Access section IX. of this document
	Alternative fuels – biomass		Access section IX. of this document
	Hybrid solar plants and wind turbines		Access section IX. of this document
	Syngas co-production		Access section IX. of this document

10.2 Lime Industry

Table 27: Sections of European Commission BAT document on cement, lime and magnesium oxide production – relevant to lime production

Section reference	Section title	Description where relevant	Reference link
1.4.12	Environmental management tools		Access section 1.4.12 of this document
2.3	Lime industry - current consumption and emission levels	Brief overview of main use of energy and source of emissions in the lime industry.	Access section 2.3 of this document
2.3.2.1	Use of energy	Overview of the use of energy in the key process steps of lime production.	Access section 2.3.2.1 of this document
2.4	Techniques to consider in the determination of BAT	This section describes techniques and associated monitoring that can potentially achieve a high level of environmental protection in the activities within the scope of this document. The techniques described include both the technology used and the way in which the installations are designed, built, maintained, operated and decommissioned. It covers environmental management systems, process-integrated techniques and end-of-pipe measures. It also considers techniques that reduce the consumption of raw materials, water and energy by optimising use and reuse. Relevant section references and headings are provided in the following rows of this table.	Access section 2.4 of this document
2.4.2	Reduction of energy consumption (energy efficiency)		Access section 2.4.2 of this document
2.4.3	Process control optimisation		Access section 2.4.3 of this document
2.4.4	Choice of fuels (including waste fuels)		Access section 2.4.4 of this document
2.4.6.1.1	Process optimisation		Access section 2.4.6.1.1 of this document

Section reference	Section title	Description where relevant	Reference link
4.3	BAT conclusions for the lime industry	A summary of BAT conclusions for the lime industry.	Access section 4.3 of this document
4.3.3	Energy consumption and process selection	A summary of information on energy consumption and process selection for the lime industry.	Access section 4.3.3 of this document

10.3 Magnesium oxide industry

Table 28: Sections of European Commission BAT document on cement, lime and magnesium oxide production – relevant to magnesium oxide production

Section reference	Section title	Description where relevant	Reference link
1.4.12	Environmental management tools		Access section 1.4.12 of this document
3.3	Magnesium oxide industry - current consumption and emission levels	Brief overview of main use of energy and source of emissions in the magnesium oxide industry.	Access section 3.3 of this document
3.3.2	Energy consumption	Overview of the use of energy in the key process steps of magnesium oxide production.	Access section 3.3.2 of this document

Section reference	Section title	Description where relevant	Reference link
3.4	Techniques to consider in the determination of BAT	This section describes techniques and associated monitoring that can potentially achieve a high level of environmental protection in the activities within the scope of this document. The techniques described include both the technology used and the way in which the installations are designed, built, maintained, operated and decommissioned. It covers environmental management systems, process-integrated techniques and end-of-pipe measures. It also considers techniques that reduce the consumption of raw materials, water and energy by optimising use and reuse. Relevant section references and headings are provided in the following rows of this table.	Access section 3.4 of this document
3.4.3	Reduction of energy consumption (energy efficiency)		Access section 3.4.3 of this document
3.4.4	Process control optimisation		Access section 3.4.4 of this document
4.4	BAT conclusions for the magnesium oxide industry	A summary of BAT conclusions for the magnesium oxide industry.	Access section 4.4 of this document
4.4.2	Energy consumption	A summary of information on energy consumption for the magnesium oxide industry.	Access section 4.4.2 of this document

11. Iron and steel

Relevant reference document

Best Available Techniques (BAT) Reference Document for Iron and Steel Production - European Commission 2013.

[Access the document](#)

Brief overview of reference document

This document provides a summary of best available techniques (BAT) relevant to iron and steel production.

The document provides benchmark data and information concerning the environmental performance of installations within the sector. It also outlines consumption and nature of raw materials, water consumption, use of energy and the generation of waste. This information includes the environmental performance levels (for example, emission and consumption levels) which can be achieved by using the techniques, associated monitoring, costs, and the cross-media issues associated with the techniques.

Some of the techniques are readily available established technologies and other, newer, technologies discussed are identified as 'emerging techniques'.

Relevant reference document

Available and Emerging Technologies for Reducing Greenhouse Gas Emissions from the Iron and Steel Industry – US Environmental Protection Agency, September 2012.

[Access the document](#)

Brief overview of reference document

This document provides information on control techniques and measures that are currently available to mitigate greenhouse gas (GHG) emissions from the Iron and Steel manufacturing sector. The primary GHG emitted by the Iron and Steel industry is carbon dioxide (CO₂), and the control technologies and measures presented in this document focus on this pollutant.

Relevant reference document

Best Available Techniques Reference Document for the Ferrous Metals Processing Industry - European Commission December 2001.

[Access the document](#)

Brief overview of reference document

This document provides a summary of best available techniques (BAT) relevant to the ferrous metals processing industry.

The document provides benchmark data and information concerning the environmental performance of installations within the sector. It also outlines consumption and nature of raw materials, water consumption, use of energy and the generation of waste. Industry sub-sectors addressed include:

- Hot and cold forming
- Continuous coating
- Batch galvanising

A fourth section of the document (Part D) relates specifically to furnaces.

Some of the techniques are readily available established technologies and other, newer, technologies discussed are identified as 'emerging techniques'.

Relevant section references in these documents are detailed in the tables below.

Table 29: European Commission BAT Document on iron and steel production

Section reference	Section title	Description where relevant	Reference link
2.1	Energy management in the steelmaking industry	An overview of the use of energy in the production of iron and steel.	Access section 2.1 of this document
2.5	General techniques to consider in the determination of BAT	This section describes techniques and associated monitoring that can potentially achieve a high level of environmental protection in the activities within the scope of this document. It covers environmental management systems, process-integrated techniques and end-of-pipe measures. It also covers techniques for reducing the consumption of raw materials, water and energy. Relevant section references and headings are provided in the following rows of this table.	Access section 2.5 of this document
2.5.1	Environmental management systems		Access section 2.5.1 of this document
2.5.2	Energy management		Access section 2.5.2 of this document
Sinter plants			
3.2	Current emission and consumption levels	An overview of emissions and consumption of materials and energy within sinter plants.	Access section 3.2 of this document
3.2.2.4	Energy consumption		Access section 3.2.2.4 of this document
3.3	Techniques to consider in the determination of BAT for sinter plants	This section describes techniques and associated monitoring that can potentially achieve a high level of environmental protection in the activities within the scope of this document. It covers process-integrated techniques and end-of-pipe measures. It also covers techniques for reducing the consumption of raw materials, water and energy. Relevant section references and headings are provided in the following rows of this table.	Access section 3.3 of this document
3.3.1	Process optimisation		Access section 3.3.1 of this document
3.3.5.1	Heat recovery from sintering and sinter cooling		Access section 3.3.5.1 of this document

Section reference	Section title	Description where relevant	Reference link
3.3.5.2.2	Recycling of waste gas from the end sinter strand combined with heat exchange		Access section 3.3.5.2.2 of this document
3.3.5.2.3	Recycling of waste gas from part of the end sinter strand and use of waste gas from the sinter cooler		Access section 3.3.5.2.3 of this document
3.3.5.2.4	Recycling of parts of waste gas to other parts of the sinter strand		Access section 3.3.5.2.4 of this document
Pelletisation plants			
4.2	Current emission and consumption levels	An overview of emissions and consumption of materials and energy within pelletisation plants.	Access section 4.2 of this document
4.2.2.4	Energy consumption		Access section 4.2.2.4 of this document
4.3	Techniques to consider in the determination of BAT for pelletisation plants	This section describes techniques and associated monitoring that can potentially achieve a high level of environmental protection in the activities within the scope of this document. It covers process-integrated techniques and end-of-pipe measures. It also covers techniques for reducing the consumption of raw materials, water and energy. Relevant section references and headings are provided in the following rows of this table.	Access section 4.3 of this document
4.3.8	Recovery of sensible heat from the induration strand		Access section 4.3.8 of this document
Coke oven plants			
5.2	Current emission and consumption levels	An overview of emissions and consumption of materials and energy within coke oven plants.	Access section 5.2 of this document
5.2.2.4	Energy demand		Access section 5.2.2.4 of this document

Section reference	Section title	Description where relevant	Reference link
5.3	Techniques to consider in the determination of BAT for coke oven plants	This section describes techniques and associated monitoring that can potentially achieve a high level of environmental protection in the activities within the scope of this document. It covers process-integrated techniques and end-of-pipe measures. It also covers techniques for reducing the consumption of raw materials, water and energy. Relevant section references and headings are provided in the following rows of this table.	Access section 5.3 of this document
5.3.11	Heat recovery coking		Access section 5.3.11 of this document
Blast furnaces			
6.2	Current emission and consumption levels	An overview of emissions and consumption of materials and energy within blast furnaces.	Access section 6.2 of this document
6.2.2.4	Energy and reductant demand		Access section 6.2.2.4 of this document
6.3	Techniques to consider in the determination of BAT for blast furnaces	This section describes techniques and associated monitoring that can potentially achieve a high level of environmental protection in the activities within the scope of this document. It covers process-integrated techniques and end-of-pipe measures. It also covers techniques for reducing the consumption of raw materials, water and energy. Relevant section references and headings are provided in the following rows of this table.	Access section 6.3 of this document
6.3.5	Gas recovery system for top hopper release		Access section 6.3.5 of this document
6.3.10	Increase of energy efficiency in blast furnaces		Access section 6.3.10 of this document
6.3.11	Recovery and use of blast furnace gas		Access section 6.3.11 of this document

Section reference	Section title	Description where relevant	Reference link
6.3.12.5	Direct injection of used oils, fats and emulsions as reducing agents and of solid iron residues		Access section 6.3.12.5 of this document
6.3.13	Energy recovery from top gas pressure		Access section 6.3.13 of this document
6.3.14	Energy savings at the hot stoves		Access section 6.3.14 of this document
Basic oxygen steelmaking and casting			
7.2	Current emission and consumption levels	An overview of emissions and consumption of materials and energy within the basic oxygen steelmaking and casting process.	Access section 7.2 of this document
7.2.2.4	Energy consumption		Access section 7.2.2.4 of this document
7.3	Techniques to consider in the determination of BAT for basic oxygen steelmaking and casting	This section describes techniques and associated monitoring that can potentially achieve a high level of environmental protection in the activities within the scope of this document. It covers process-integrated techniques and end-of-pipe measures. It also covers techniques for reducing the consumption of raw materials, water and energy. Relevant section references and headings are provided in the following rows of this table.	Access section 7.3 of this document
7.3.7	Energy recovery from the basic oxygen furnace (BOF) gas		Access section 7.3.7 of this document
7.3.9	Increased energy efficiency in the steel shop by automatisation		Access section 7.3.9 of this document
7.3.10	Direct tapping from BOF		Access section 7.3.10 of this document
Electric arc furnace steelmaking and casting			

Section reference	Section title	Description where relevant	Reference link
8.2	Current emission and consumption levels	An overview of emissions and consumption of materials and energy within the electric arc furnace steelmaking and casting process.	Access section 8.2 of this document
8.2.2.4	Energy consumption		Access section 8.2.2.4 of this document
8.3	Techniques to consider in the determination of BAT for electric arc furnace steelmaking and casting	This section describes techniques and associated monitoring that can potentially achieve a high level of environmental protection in the activities within the scope of this document. It covers process-integrated techniques and end-of-pipe measures. It also covers techniques for reducing the consumption of raw materials, water and energy. Relevant section references and headings are provided in the following rows of this table.	Access section 8.3 of this document
8.3.1	Electric arc furnace (EAF) process optimisation		Access section 8.3.1 of this document
8.3.2	Scrap preheating		Access section 8.3.2 of this document
Summary information for iron and steel production industry			
9	BAT conclusions for iron and steel production	A summary of BAT conclusions for the iron and steel production industry.	Access section 9 of this document
9.1.1	Environmental management systems	A summary of information on environmental management systems for the iron and steel production industry.	Access section 9.1.1 of this document
9.1.2	Energy management	A summary of information on energy management for the iron and steel production industry.	Access section 9.1.2 of this document
9.2	BAT conclusions for sinter plants		Access section 9.2 of this document
9.3	BAT conclusions for pelletisation plants		Access section 9.3 of this document
9.4	BAT conclusions for coke oven plants		Access section 9.4 of this document
9.5	BAT conclusions for blast furnaces		Access section 9.5 of this document

Section reference	Section title	Description where relevant	Reference link
9.6	BAT conclusions for basic oxygen steelmaking and casting		Access section 9.6 of this document
9.7	BAT conclusions for electric arc furnace steelmaking and casting		Access section 9.7 of this document
11	Emerging techniques	This section outlines a number of relevant emerging techniques with section references shown in the following rows.	Access section 11 of this document
11.1.1	Carbon dioxide mitigation strategies (Ultra-low carbon dioxide (CO ₂) steelmaking project)		Access section 11.1.1 of this document
11.3.1	Super coke oven		Access section 11.3.1 of this document
11.3.3	Alternatives in coke oven gas utilisation		Access section 11.3.3 of this document
11.4.2	Slag heat recovery		Access section 11.4.2 of this document

Table 30: Relevant sections of US EPA document – iron and steel industry

Section reference	Section title	Description where relevant	Reference link
V.	Energy programs and management systems	Industrial energy efficiency can be enhanced by informed management of the energy use by operations and processes. There are formal energy management programs available, both with and without additional cost, as well as facility or industry-specific programs.	Access section V. of this document
V.A	Formal energy programs		Access section V.A of this document

Section reference	Section title	Description where relevant	Reference link
V.B	Energy performance benchmarks on plant and industry-specific basis		Access section V.B of this document
V.C	Industry energy efficiency initiatives		Access section V.C of this document
VI.	Summary of GHG control measures	This section is a summary of the GHG control measures identified as potentially feasible for the iron and steel industry. All measures are energy efficiency measures. Reductions in fuel consumption result in reductions of direct emissions of GHGs at the steel plant, and reductions in electricity usage result in reductions of indirect GHG emissions.	Access section VI. of this document
VII.	Energy efficiency improvement measures for the steel industry	This section describes the energy efficiency measures that may be feasible for GHG control in the iron and steel industry. All measures reduce fuel consumption and, therefore, produce direct and indirect reductions in fuel-associated GHG emissions.	Access section VII. of this document
Sintering at Integrated Iron and Steel Plants			
VII.A.	Sintering at integrated iron and steel plants		Access section VII.A. of this document
	Sinter plant heat recovery		Access section VII.A. of this document
	Emission optimized sintering		Access section VII.A. of this document
	Increasing bed depth		Access section VII.A. of this document
	Improve ignition oven efficiency		Access section VII.A. of this document
Coke-making			
VII.B.	Coke-making		Access section VII.B. of this document
	Coal moisture control		Access section VII.B. of this document
	Programmed heating		Access section VII.B. of this document

Section reference	Section title	Description where relevant	Reference link
	Coke dry quenching		Access section VII.B. of this document
	Additional use of coke oven gas		Access section VII.B. of this document
	Single chamber system		Access section VII.B. of this document
	Non-recovery coke ovens		Access section VII.B. of this document
Blast furnace at integrated iron and steel plants			
VII.C.	Blast furnace at integrated iron and steel plants		Access section VII.C. of this document
	Pulverized coal injection		Access section VII.C. of this document
	Natural gas injection		Access section VII.C. of this document
	Injection of coke oven gas (COG) and basic oxygen furnace (BOF) gas		Access section VII.C. of this document
	Charging carbon composite agglomerates		Access section VII.C. of this document
	Recovery of blast furnace gas		Access section VII.C. of this document
	Hot-blast stove automation		Access section VII.C. of this document
	Recuperator hot-blast stove		Access section VII.C. of this document
	Improvement of combustion in hot stove		Access section VII.C. of this document
	Improved blast furnace control systems		Access section VII.C. of this document

Section reference	Section title	Description where relevant	Reference link
	Blast furnace gas recycling		Access section VII.C. of this document
	Slag heat recovery		Access section VII.C. of this document
Basic oxygen furnace at integrated iron and steel plants			
VII.D.	Basic oxygen furnace at integrated iron and steel plants		Access section VII.D. of this document
	Basic oxygen furnace (BOF) heat and fuel gas recovery		Access section VII.D. of this document
	Improvement of process monitoring and control		Access section VII.D. of this document
	Programmed and efficient ladle heating		Access section VII.D. of this document
Casting			
VII.E.	Casting		Access section VII.E. of this document
	Efficient ladle preheating and tundish heating		Access section VII.E. of this document
	Near net shape casting		Access section VII.E. of this document
Hot Rolling Mills			
VII.G.	Hot rolling mills		Access section VII.G. of this document
	Proper reheating temperature		Access section VII.G. of this document
	Avoiding overload of reheat furnaces		Access section VII.G. of this document
	Hot charging		Access section VII.G. of this document
	Recuperative burners		Access section VII.G. of this document
	Flameless burners		Access section VII.G. of this document
	Insulation of furnaces		Access section VII.G. of this document

Section reference	Section title	Description where relevant	Reference link
	Walking beam furnace		Access section VII.G. of this document
	Controlling oxygen levels and variable-speed drives on combustion air fans		Access section VII.G. of this document
	Heat recovery to the product		Access section VII.G. of this document
	Waste heat recovery from cooling water		Access section VII.G. of this document
Cold rolling mills			
VII.H.	Cold rolling mills		Access section VII.H. of this document
	Heat recovery on the annealing line		Access section VII.H. of this document
	Reduced steam use in the pickling line		Access section VII.H. of this document
Finishing operations			
VII.I.	Finishing operations		Access section VII.I. of this document
	Continuous annealing		Access section VII.I. of this document
General measures for energy efficiency improvements			
VII.J.	General measures for energy efficiency improvements		Access section VII.J. of this document
	Preventive maintenance		Access section VII.J. of this document
	Energy monitoring and management system		Access section VII.J. of this document
Energy efficiency options for electric arc furnace steelmaking			

Section reference	Section title	Description where relevant	Reference link
VII.K.	Energy efficiency options for electric arc furnace steelmaking		Access section VII.K. of this document
	Improved process control (neural networks)		Access section VII.K. of this document
	Bottom stirring/stirring gas injection		Access section VII.K. of this document
	Oxy-fuel burners		Access section VII.K. of this document
	Post-combustion of the flue gases		Access section VII.K. of this document
	Direct current arc furnace		Access section VII.K. of this document
	Scrap preheating		Access section VII.K. of this document
	Scrap preheating, post combustion—shaft furnace (fuchs)		Access section VII.K. of this document
	Engineered refractories		Access section VII.K. of this document
	Airtight operation		Access section VII.K. of this document
	Contiarc® furnace		Access section VII.K. of this document
	Twin-shell furnace		Access section VII.K. of this document
Appendix A.	Emerging techniques for GHG control	The following are emerging technologies.	Access Appendix A. of this document
Appendix A.2.	Near-term technologies		Access Appendix A.2. of this document
	Carbon-free fuel		Access Appendix A.2. of this document

Section reference	Section title	Description where relevant	Reference link
Appendix A.3.	Energy improvement technologies from U.S. Department of Energy (DOE) and DOE partnerships		Access Appendix A.3. of this document
	Minimization of blast furnace fuel rate by optimizing burden and gas distributions		Access Appendix A.3. of this document
	Research, development, and field testing of thermochemical recuperation for high temperature furnaces		Access Appendix A.3. of this document
	Paired straight hearth furnace		Access Appendix A.3. of this document

Table 31: European Commission BAT document on ferrous metals processing – Part A: hot and cold forming

Section reference	Section title	Description where Relevant	Reference link
Hot rolling mills			
A3.1	Hot rolling mills – present consumption and emission levels	An overview of the use of energy and other inputs to hot rolling mill operation.	Access section A3.1 of this document
A4.1	Techniques to consider in the determination of BAT for hot and cold forming – hot rolling mill	An overview of techniques for environmental protection and energy saving relevant to hot rolling mill operation. Relevant section references and headings are provided in the following rows of this table.	Access section A4.1 of this document
A.4.1.3.1	Reheating and heat treatment furnaces-general measures for energy efficiency and low emission operation		Access section A.4.1.3.1 of this document
A.4.1.3.2	Furnace automation /furnace control		Access section A.4.1.3.2 of this document
A.4.1.3.3	Optimised furnace door design		Access section A.4.1.3.3 of this document
A.4.1.3.4	Regenerative burner system		Access section A.4.1.3.4 of this document
A.4.1.3.5	Recuperator and recuperative burners		Access section A.4.1.3.5 of this document
A.4.1.3.6	Oxy-fuel technology		Access section A.4.1.3.6 of this document
A.4.1.3.11	Waste heat boiler		Access section A.4.1.3.11 of this document
A.4.1.3.13	Reduction of energy loss through stock transportation device		Access section A.4.1.3.13 of this document
A.4.1.3.15	Feedstock preheating		Access section A.4.1.3.15 of this document

Section reference	Section title	Description where Relevant	Reference link
A.4.1.3.16	Heat conservation box/thermal covers		Access section A.4.1.3.16 of this document
A.4.1.3.17	Hot charging/direct rolling		Access section A.4.1.3.17 of this document
A.4.1.7.3	Heat shields on transfer tables		Access section A.4.1.7.3 of this document
A.4.1.7.4	Strip edge heating		Access section A.4.1.7.4 of this document
A.4.1.8.12	On line heat treatment (accelerated cooling)		Access section A.4.1.8.12 of this document
A.4.1.8.13	Thermo mechanical rolling operation		Access section A.4.1.8.13 of this document
A5	Best available techniques for hot and cold forming	An overview of the development and selection of BATs for hot and cold forming.	Access section A5 of this document
A.5.1	Hot rolling mill	Summary of BATs relevant to the hot rolling process.	Access section A.5.1 of this document
Cold rolling mills			
A3.2	Cold rolling mills – present consumption and emission levels	An overview of the use of energy and other inputs to cold rolling mill operation.	Access section A3.2 of this document
A4.2	Techniques to consider in the determination of BAT for hot and cold forming – cold rolling mill	An overview of techniques for environmental protection and energy saving relevant to cold rolling mill operation. Relevant section references and headings are provided in the following rows of this table.	Access section A4.2 of this document
A.4.2.2.26	Acid heating by heat exchangers		Access section A.4.2.2.26 of this document
A.4.2.4.9	Preheating combustion air/use of regenerative or recuperative burners for annealing furnace		Access section A.4.2.4.9 of this document

Section reference	Section title	Description where Relevant	Reference link
A.4.2.4.11	Preheating the feedstock		Access section A.4.2.4.11 of this document
A5	Best available techniques for hot and cold forming	An overview of the development and selection of BATs for hot and cold forming.	Access section A5 of this document
A.5.2	Cold rolling mill	Summary of BATs relevant to the cold rolling process.	Access section A.5.2 of this document
Wire plant			
A3.3	Wire plant – present consumption and emission levels	An overview of the use of energy and other inputs to wire plant operation.	Access section A3.3 of this document
A4.3	Techniques to consider in the determination of BAT for hot and cold forming – wire mill	An overview of techniques for environmental protection and energy saving relevant to wire mill operation. Relevant section references and headings are provided in the following rows of this table.	Access section A4.3 of this document
A.4.3.12.1	Inductive heating of wire		Access section A.4.3.12.1 of this document
A5	Best available techniques for hot and cold forming	An overview of the development and selection of BATs for hot and cold forming.	Access section A5 of this document
A.5.3	Wire plant	Summary of BATs relevant to wire plant operation.	Access section A.5.3 of this document

Table 32: European Commission BAT Document on Ferrous Metals Processing – Part B: continuous hot dip coating lines

Section reference	Section title	Description where relevant	Reference link
B3	Continuous coating lines – present consumption and emission levels	An overview of the use of energy and other inputs to continuous coating lines.	Access section B3 of this document
B4	Techniques to consider in the determination of BAT for continuous coating lines	This section provides information on techniques to consider that are relevant to continuous coating lines. Relevant section references and headings are provided in the following rows of this table.	Access section B4 of this document
B.4.1.4.2	Preheating of combustion air with recovery heat		Access section B.4.1.4.2 of this document
B.4.1.4.3	Preheating the strip with recovery heat		Access section B.4.1.4.3 of this document
B.4.1.4.4	Steam production with recovery heat		Access section B.4.1.4.4 of this document
B.4.1.6.1	Induction electrical furnace - galvannealing		Access section B.4.1.6.1 of this document
B.4.1.10.1	Closed cooling water loop		Access section B.4.1.10.1 of this document
B.4.1.10.2	Reuse of cooling water		Access section B.4.1.10.2 of this document
B5	Best available techniques for continuous coating lines	An overview of BATs for continuous coating lines. Relevant section references and headings are provided in the following rows of this table.	Access section B5 of this document
B.5.1	Galvanizing of sheet		Access section B.5.1 of this document
B.5.2	Aluminizing of sheet		Access section B.5.2 of this document
B.5.3	Lead-tin coating of sheet		Access section B.5.3 of this document

Section reference	Section title	Description where relevant	Reference link
B.5.4	Coating of wire		Access section B.5.4 of this document

Table 33: European Commission BAT document on ferrous metals processing – Part C: batch galvanizing

Section Reference	Section Title	Description Where Relevant	Reference Link
C3	Batch galvanizing – present consumption and emission levels	An overview of the use of energy and other inputs to batch galvanizing.	Access section C3 of this document
C4	Techniques to consider in the determination of BAT for batch galvanizing	This section provides information on techniques to consider that are relevant to batch galvanizing. Relevant section references and headings are provided in the following rows of this table.	Access section C4 of this document
C.4.6.8	Heat recovery from galvanizing kettle heating		Access section C.4.6.8 of this document
C.4.6.9	Efficiency of furnace heating/control		Access section C.4.6.9 of this document
C5	Best available techniques for continuous coating lines	An overview of BATs for batch galvanizing.	Access section C5 of this document

Table 34: European Commission BAT document on ferrous metals processing – Part D: furnaces

Section reference	Section title	Description where relevant	Reference link
D1	Furnaces: thermal efficiency	An overview of the thermal efficiency of furnaces. Specific details are included in sub-sections as detailed below.	Access section D.1 of this document
D.1.1	Regenerative burners		Access section D.1.1 of this document
D.1.2	Recuperators and recuperative burners		Access section D.1.2 of this document
D.6	Heating of process liquors (acid, emulsions).		Access section D.6 of this document
D.9.2	Cooling systems and cooling water treatment		Access section D.9.2 of this document

12. Aluminium smelting

Relevant reference document

Best Available Techniques (BAT) Reference Document for the Non-Ferrous Metals Industries-European Commission 2017.

[Access the document](#)

Brief overview of reference document

This document provides a summary of best available techniques (BAT) relevant to the production of various non-ferrous metals, including aluminium.

The document provides benchmark data and information concerning the environmental performance of installations within the sector. It also outlines consumption and nature of raw materials, water consumption, use of energy and the generation of waste.

Some of the techniques are readily available established technologies and other, newer, technologies discussed are identified as 'emerging techniques'.

Relevant section references in these documents are detailed in Table 35 and Table 36 below.

Table 35: European Commission BAT document on non-ferrous metals – sections relevant to non-ferrous metals generally

Section reference	Section title	Description where relevant	Reference link
2.2	Energy management	This section provides an overview of energy management in the non-ferrous metals industry generally.	Access section 2.2 of this document
2.2.1	Applied processes and techniques	Relevant to the entire non-ferrous metals industry.	Access section 2.2.1 of this document
2.12	Non-ferrous metals industry - techniques to consider in the determination of BAT	This section describes techniques and associated monitoring that can potentially achieve a high level of environmental protection in the activities within the scope of this document. The techniques described include both the technology used and the way in which the installations are designed, built, maintained, operated and decommissioned. It covers environmental management systems, process-integrated techniques and end-of-pipe measures. It also considers techniques that reduce the consumption of raw materials, water and energy by optimising use and reuse. Relevant section references and headings are provided in the following rows of this table.	Access section 2.12 of this document
2.12.1	Environmental management systems		Access section 2.12.1 of this document
2.12.2	Energy management		Access section 2.12.2 of this document
2.12.3	Monitoring and process control		Access section 2.12.3 of this document
2.12.5.2.1	Afterburners/afterburning chambers		Access section 2.12.5.2.1 of this document
11.1	General BAT conclusions	A general summary of BAT conclusions for the non-ferrous metals industry.	Access section 11.1 of this document
11.1.1	Environmental management systems (EMS)		Access section 11.1.1 of this document
11.1.2	Energy management		Access section 11.1.2 of this document
11.1.3	Process control		Access section 11.1.3 of this document

Table 36: European Commission BAT document on non-ferrous metals – sections relevant to aluminium smelting

Section reference	Section title	Description where relevant	Reference link
1.3	Aluminum	This section provides an overview of the production of aluminum, including key environmental issues.	Access section 1.3 of this document
4.2	Current emission and consumption levels		Access section 4.2 of this document
4.2.4.4	Energy consumption (secondary aluminum)		Access section 4.2.4.4 of this document
4.3	Aluminum industry - techniques to consider in the determination of BAT	This section describes techniques and associated monitoring than can potentially achieve a high level of environmental protection in the activities within the scope of this document. The techniques described include both the technology used and the way in which the installations are designed, built, maintained, operated and decommissioned. It covers environmental management systems, process-integrated techniques and end-of-pipe measures. It also covers techniques that reduce the consumption of raw materials, water and energy by optimising use and reuse. Relevant section references and headings are provided in the following rows of this table.	Access section 4.3 of this document
4.3.4.4	Selection of the appropriate secondary melting furnaces		Access section 4.3.4.4 of this document
4.3.4.12.1	Use of metal pumping or a stirring system to improve efficiency and reduce salt usage		Access section 4.3.4.12.1 of this document
4.4	Emerging techniques	This section presents emerging techniques, some of which can lead to reduced energy consumption.	Access section 4.4 of this document
11.3	BAT conclusions for aluminum production including alumina and anode production	A summary of BAT conclusions for the aluminum production industry. Relevant categories are noted in the rows below.	Access section 11.3 of this document

Section reference	Section title	Description where relevant	Reference link
11.3.1.1	Energy		Access section 11.3.1.1 of this document
11.3.4.2	Energy (secondary aluminum production)		Access section 11.3.4.2 of this document

13. Chemical manufacturing industry

Relevant reference document

Reference Document on Best Available Techniques for the Manufacture of Organic Fine Chemicals - European Commission August 2006.

[Access this document](#)

Brief overview of reference document

This document provides a summary of best available techniques (BAT) relevant to the production of organic chemicals, including pharmaceuticals.

This document focuses on the batch manufacture of organic chemicals in multipurpose plants. It addresses the manufacture of a wide range of organic chemicals including:

- dyes and pigments
- plant health products and biocides
- pharmaceutical products (chemical and biological processes)
- organic intermediates
- flavours, fragrances and pheromones
- vitamins
- optical brighteners

The document provides benchmark data and information concerning the environmental performance of installations within the sector. It also outlines consumption and nature of raw materials, water consumption, use of energy and the generation of waste.

Some of the techniques are readily available established technologies and other, newer, technologies discussed are identified as 'emerging techniques'.

Relevant section references in this document are detailed in Table 38 below.

Table 37: European Commission BAT document on organic fine chemicals

Section reference	Section title	Description where relevant	Reference link
2.3.5	Energy supply	Overview of energy supply for the production of organic fine chemicals which comprise mainly steam and electricity.	Access section 2.3.5 of this document
4	Techniques to consider in the determination of BAT	This section describes techniques and associated monitoring that can potentially achieve a high level of environmental protection in the activities within the scope of this document. The techniques described include both the technology used and the way in which the installations are designed, built, maintained, operated and decommissioned. It covers environmental management systems, process-integrated techniques and end-of-pipe measures as well as techniques that reduce the consumption of raw materials, water and energy by optimising use and reuse. Relevant section references and headings are provided in the following rows of this table.	Access section 4 of this document
4.2.1	A 'state of the art' multipurpose plant		Access section 4.2.1 of this document
4.2.10	Pinch methodology		Access section 4.2.10 of this document
4.2.11	Energetically coupled distillation		Access section 4.2.11 of this document
4.2.20	Minimisation of exhaust gas volume flows from distillation		Access section 4.2.20 of this document
4.3.3	Recovery of aromatic solvents and lower alcohols		Access section 4.3.3 of this document
4.3.5.7	Thermal oxidation of volatile organic compounds (VOCs) and co-incineration of liquid waste		Access section 4.3.5.7 of this document

Section reference	Section title	Description where relevant	Reference link
4.3.5.8	Co-incineration of halogenated waste solvents		Access section 4.3.5.8 of this document
4.4	Environmental management tools		Access section 4.4 of this document
5	Best available techniques	A summary of BATs for the organic fine chemicals industry. Relevant section references and headings are provided in the following rows of this table.	Access section 5 of this document
5.1.1.1	Integration of environmental, health and safety considerations into process development		Access section 5.1.1.1 of this document
5.1.2.6	Minimisation of energy consumption		Access section 5.1.2.6 of this document
5.2.2	Re-use of solvents		Access section 5.2.2 of this document
5.3	Environmental management		Access section 5.3 of this document
6.2	Process intensification	This is an emerging technique.	Access section 6.2 of this document
6.3	Microwave assisted organic synthesis	This is an emerging technique.	Access section 6.3 of this document
6.4	Constant flux reactor systems	This is an emerging technique.	Access section 6.4 of this document

14. Plastics

Relevant reference document

Reference Document on Best Available Techniques in the Production of Polymers - European Commission: August 2007.

[Access the document](#)

Brief overview of reference document

This document provides a summary of best available techniques (BAT) relevant to the production of a range of polymers such as polyvinyl chloride, polystyrene, and unsaturated polyesters.

The document provides a range of BAT relevant to polymer production. It addresses environmental management tools, equipment design, maintenance and techniques related to energy and end-of-pipe measures.

Relevant section references in this document are detailed in Table 39 below.

Table 38: European Commission BAT Document on Plastics

Section reference	Section title	Description where relevant	Reference link
2.2	Energy (general processes and techniques applied in the production of polymers)	A brief overview of the use of energy in the production of polymers.	Access section 2.2 of this document
12	Techniques to consider in the determination of BAT for the production of polymers	This section describes techniques and associated monitoring that can potentially achieve a high level of environmental protection in the activities within the scope of this document. The techniques described include both the technology used and the way in which the installations are designed, built, maintained, operated and decommissioned. It covers environmental management systems, process-integrated techniques and end-of-pipe measures. It also covers techniques that reduce the consumption of raw materials, water and energy by optimising use and reuse. Relevant section references and headings are provided in the following rows of this table.	Access section 12 of this document
12.1	Generic techniques		Access section 12.1 of this document
12.1.1	Environmental management tools		Access section 12.1.1 of this document
12.1.12	Recovery of exothermic reaction heat through generation of low pressure steam		Access section 12.1.12 of this document
12.1.15	Re-use of waste		Access section 12.1.15 of this document
12.5.2	Thermal treatment of wastewater		Access section 12.5.2 of this document
13	Best available techniques	A summary of BAT conclusions for the polymer industry.	Access section 13 of this document