

# PAS 5420:2023

Liquid fuels – Sustainable bioliquid fuels for use in fixed combustion applications for heating, hot water and cooking – Specification



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# Foreword

This PAS was sponsored by OFTEC (Oil Firing Technical Association Ltd). Its development was facilitated by BSI Standards Limited and it was published under licence from The British Standards Institution. It came into effect on 30 April 2023.

Acknowledgement is given to Alan C Black, as the technical author, and the following organizations that were involved in the development of this PAS as members of the Steering Group:

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- BRE Group
- Crown Oil
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- OFTEC (Oil Firing Technical Association Ltd)
- Salford University
- UKIFDA (UK and Ireland Fuel Distributors Association)

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*Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.*

Where words have alternative spellings, the preferred spelling of the *Shorter Oxford English Dictionary* is used (e.g. “organization” rather than “organisation”).

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## Section 1: General

# 0 Introduction

PAS 5420 has been developed to provide the liquid fuel firing industry with an environmental sustainability standard. This PAS sets environmental thresholds and limits for bioliquid fuels for fixed combustion purposes to enable the decarbonization of existing off-gas-grid liquid fuel heating and hot water provision in a controlled and sustainable manner.

PAS 5420 is designed to debar environmentally damaging bioliquid fuel feedstocks and processes from the heating and hot water supply chain. The implementation of PAS 5420 limits future fuel feedstocks to waste-derived sources, and creates and maintains a renewable and sustainable alternative to fossil fuels, drastically reducing carbon emissions from domestic heating to support the UK Government's target of achieving net zero carbon emissions target by 2050.

PAS 5420 defines the acceptable (waste source) feedstock greenhouse gas (GHG) emission parameters necessary to achieve and maintain bioliquid fuel carbon equivalent point of use emissions (CO<sub>2</sub>e ) which do not exceed those values published within Table 12 of SAP 10.2 [1] and Table 32 of SBEM 2022 [2].

# 1 Scope

This PAS specifies requirements for the provision of sustainable bioliquid fuels for use in district and individual heating, hot water and cooking applications.

PAS 5420 is intended to be applied primarily by the liquid fuel supply chain and their auditors. Accordingly, prior industry knowledge and understanding of this context are necessary for those intending to apply the requirements contained in this document

It applies to bioliquid fuels derived from renewable fuel sources produced from non-virgin (waste) feedstocks that result in carbon equivalent lifecycle emissions not exceeding 0.036 kg CO<sub>2</sub>e per kWh when utilized for fixed combustion purposes.

This PAS covers:

- bioliquid fuel types derived from single or multiple waste sources;
- sustainability factors (e.g. fuel type, composition and provenance, and fuel lifecycle); and
- carbon emissions and primary energy usage from production through to point of use.

**NOTE 1** The PAS aligns with the Renewable Energy Directive (RED II) [3], the Building Research Establishment (BRE) Standard Assessment Procedure (SAP), 10.2, Table 12 [1], and the Department for Levelling Up, Housing and Communities (DLUHC) National Calculation Methodology (NCM) Simplified Building Energy Model (SBEM) for non-domestic buildings 2022, Table 32 [2].

This PAS does not cover:

- liquid fossil fuels or blends containing liquid fossil fuels and bioliquid fuels;
- liquid fuels for transportation;
- technical requirements for the application, composition and specification of liquid fuels;
- fuel efficiency for fixed combustion; and
- fuels subjected to post-production/aftermarket combustion-enhancing fuel additives.

The PAS is for use by auditors and distributors of bioliquid fuels.

It might also be of interest to producers, importers and blenders of bioliquid fuels, liquid fuel equipment manufacturers, fuel and fuel equipment trade associations, certification/accreditation bodies and governing bodies.

**NOTE 2** Examples of liquid fuels that might be covered by the PAS are paraffinic liquid fuels conforming to BS EN 15940, such as hydrotreated vegetable oils (HVOs), and fatty acid methyl esters (FAMES) conforming to BS EN 14214.

**NOTE 3** The bioliquid fuels described within this standard are not suitable for use in appliances which incorporate vaporizing sleeve burners.

## 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes provisions of this document.<sup>1)</sup> For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

### Standards publications

BS EN 14214, *Liquid petroleum products – Fatty acid methyl esters (FAME) for use in diesel engines and heating applications – Requirements and test methods*

BS EN 15940, *Automotive fuels – Paraffinic diesel fuel from syntheses or hydrotreatment – Requirements and test method*

BS EN 16214-1, *Sustainability criteria for the production of biofuels and bioliquids for energy applications – Principles, criteria, indicators and verifiers – Part 1: Terminology*

### Other publications

[N1] BUILDING RESEARCH ESTABLISHMENT LTD (BRE). *CO<sub>2</sub> and primary energy factors for SAP*, Standard Assessment Procedure 10 Technical Paper S10TP-15. London: BRE, November 2020.

<sup>1)</sup> Documents that are referred to solely in an informative manner are listed in the Bibliography.



## 3 Terms, definitions and abbreviated terms

### 3.1 Terms and definitions

For the purposes of this PAS, the terms and definitions given in BS EN 16214-1 and the following apply.

#### 3.1.1 auditor

auditable control process verifying organization, body or assurance scheme

#### 3.1.2 bioliquid

liquid fuel produced from waste source material

**NOTE 1** *An example of this is used cooking oil certified under RED II [3].*

**NOTE 2** *This means waste material which, after process treatment, contains properties that enable combustion, and which satisfies the requirements of BS EN 15940 or BS EN 14214.*

#### 3.1.3 carbon (dioxide) equivalent emissions (CO<sub>2</sub>e)

amount of environmental impact total greenhouse gas emissions

#### 3.1.4 common industry collation point

organization or body which collates and summarises audited data on an annual basis in support of inclusion of bioliquid fixed combustion fuel emission data in national carbon and greenhouse gas calculation methodologies

**NOTE** *Examples of the calculation methodologies include SBEM [2] and SAP [1].*

#### 3.1.5 distributor

supplier of liquid fuels to end users

#### 3.1.6 greenhouse gas

gases given off as a consequence of combustion which are identified as having a negative impact on the environment

#### 3.1.7 liquid fuel

energy sources capable of being transported, stored and combusted while in their natural liquid state

#### 3.1.8 sustainability statement

published statement declaring the greenhouse gas CO<sub>2</sub> emissions associated with the production of the fuel

**NOTE 1** *Attention is drawn to the Renewable Energy Directive [3].*

**NOTE 2** *This may also be referred to as a Renewable Fuel Declaration or as Proof of Sustainability.*

### 3.2 Abbreviated terms

For the purposes of this PAS, the following abbreviated terms apply.

BRE	Building Research Establishment
CO <sub>2</sub> e	carbon dioxide equivalent
DLUHC	Department for Levelling Up, Housing and Communities
FAME	fatty acid methyl ester
FA/UCOME	fatty acid/used cooking oil methyl ester
GHG	greenhouse gas
HVO	hydrotreated vegetable oil
MJ	megajoule
NCM	National Calculation Methodology
OFTEC	Oil Firing Technical Association Ltd
PE	primary energy factor
POS	proof of sustainability
RED	Renewable Energy Directive
SAP	Standard Assessment Procedure
SBEM	Simplified Building Energy Model
UCOME	used cooking oil methyl ester

## Section 2: Distributors

# 4 Requirements

### 4.1 Sustainability statement

Bioliqum fuels intended for use in fixed combustion applications shall have a total GHG value not exceeding 10 g/MJ CO<sub>2</sub>e in terms of transport, processing and distribution combined.

*NOTE Attention is drawn to RED II [3] in respect of the legal obligation to make a biofuels sustainability statement publicly available.*

### 4.2 SAP emissions – bioliqum fuels

Bioliqum fuels intended for fixed combustion applications shall be evaluated in accordance with BRE methodology S10TP-15 [N1].

When the bioliqum fuel has been evaluated:

- the CO<sub>2</sub>e value shall not exceed 0.036 kg CO<sub>2</sub>e per kWh; and
- the primary energy factor (PE) value shall not exceed 1.180 (kWh per kWh).

*NOTE 1 Refer to Annex A, Table A.1, which shows liquid fuel comparative PE and CO<sub>2</sub>e values at the date and time of printing of this document.*

*NOTE 2 Liquid fuels which satisfy 4.2 need technical evaluation for suitability for fixed combustion applications following the OFTEC HVO Handbook [4].*

### 4.3 Fuel standards

The bioliqum fuel shall conform to BS EN 15940 (HVO) or BS EN 14214 (FA/UCOME).

*NOTE The application of post-production/aftermarket fuel combustion-enhancing additives and/or fossil or non-waste derived fuels is prohibited.*

### 4.4 Quality assurance and control

The distributor shall operate a quality assurance and auditable control process which enables supply chain verification.

## 5 Auditing

### 5.1 General

Audits shall be conducted at least annually and shall consist of the steps outlined in 5.2 to 5.4.

### 5.2 Verification

Verification shall include:

- certification of HVO against BS EN 15940 (see Annex A) or certification of FA/UCOME against BS EN 14214; and
- biofuels sustainability statement (See 4.1).

**NOTE** Certification can be first, second or third party.

### 5.3 Distributor pre-purchase checks

Prior to the purchase of bioliquid fuels, the distributor shall obtain certifications as per 5.2 and proof of sustainability from their supplier or quality assurance scheme.

The distributor shall retain certifications and proof of sustainability as part of their auditable internal quality assurance process.

**NOTE** The OFTEC HVO Handbook [4] should be used as a technical reference regarding the process of evaluating the technical suitability of liquid fuels for use in fixed combustion applications.

### 5.4 Distributor fuel purchase records

All distributor purchases of bioliquids for use in fixed combustion heating, hot water and cooking applications shall be verified by audit.

Audit procedures shall capture and record:

- total volumes of named bioliquid purchased for resale per annum; and
- average total GHG CO<sub>2</sub>e g/MJ per annum for each bioliquid fuel purchased (see Clause 4.1).

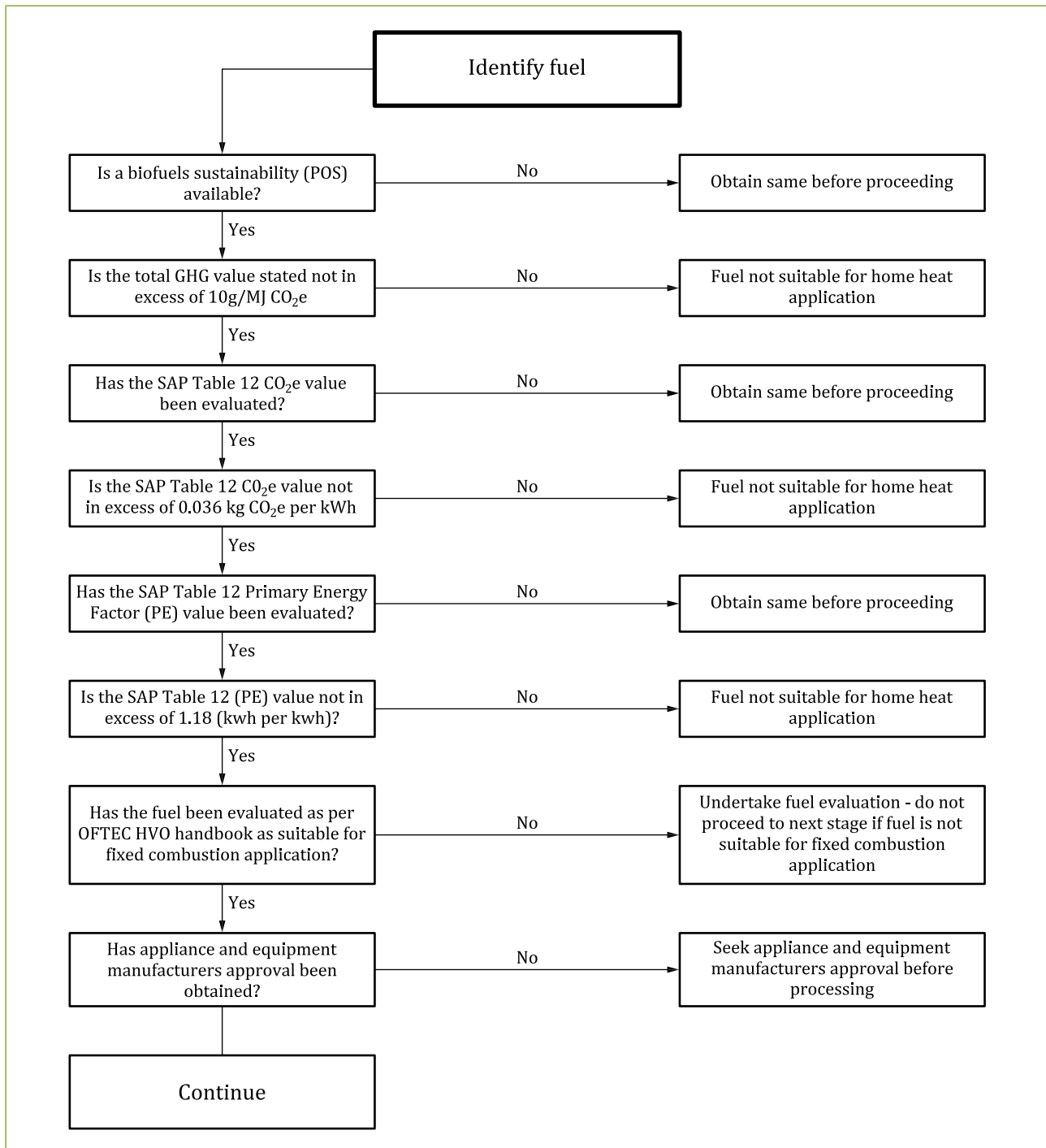
**NOTE 1** New alternative bioliquid fuels not currently cited within this PAS which might become available in the future need to be verified against appropriate technical and sustainability standards.

**NOTE 2** Audit data provided to OFTEC or other common industry collation point is for the purposes of annual submission to BRE for future BRE review and revisions of Annex A, Table A.1, carbon equivalent emission (CO<sub>2</sub>e) and primary energy factors (kWh/kWh) as contained in SAP [1].

## 6 Bioliqum fuel evaluation process

Figure 1 sets out the process that shall be followed in specific order for the evaluation of liquid fuels to determine their suitability for industry use in accordance with the scope of this PAS.

**Figure 1** – Fuel evaluation process flowchart



## Section 3: Auditors

### 7 Audit reporting

The auditors shall collate and summate all audited data collected in accordance with 5.4 from distributors purchase records and shall provide the same to OFTEC on an annual basis.

## Annex A (informative)

### Standard Assessment Procedure 10.2 Table 12 [1]

Extract of Table 12 from SAP 10.2 [1] demonstrating comparative CO<sub>2</sub>e emissions and PE for liquid fuels which have been evaluated in accordance with SAP 10 Technical Paper S10TP-15 [N1] (modified).

**Table A.1** – Fuel prices, emission factors and primary energy factors

Fuel	Standing charge	Unit price pence/kWh	Emissions kg CO <sub>2</sub> e per kWh	Primary energy factor	Fuel code
<b>Liquid fuels:</b>					
• heating oil (kerosene)	–	4.94	0.298	1.180	4
• bioliquid HVO from cooking oil <sup>A)</sup>	–	6.79	0.036	1.180	71
• bioliquid FAME from animal/vegetable oil <sup>B)</sup>	–	6.79	0.018	1.180	73
• B30K <sup>C)</sup>	–	5.49	0.214	1.136	75
<p><sup>A)</sup> For appliances that specifically use bioliquid HVO to BS EN 15940, certified as wholly derived from waste/used cooking oil.</p> <p><sup>B)</sup> For appliances that specifically use bioliquid FAME to BS EN 14214, certified as wholly derived from waste animal fats/used cooking oil.</p> <p><sup>C)</sup> For appliances that specifically use a blend of 30% bio-liquid FAME<sup>B)</sup> and 70% kerosene (B30K).</p> <p><b>NOTE</b> Copyright is claimed in this table. Reproduction of this table and making products from it might infringe that copyright. Details of the copyright owner can be found in the Foreword.</p>					

## Annex B (informative)

### Product data sheet

Table B.1 is an example of a typical UK HVO producer's product data sheet.

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**Table B.1** – Product data sheet

Parameter	Test method	Units	Specification	Typical value
Appearance	ASTM D4176-2	–	Clear and bright	Clear and bright
Density	EN ISO 12185	kg/m <sup>3</sup>	0.770–0.790	0.780
Viscosity	EN ISO 3104	mm <sup>2</sup> /s	2.0–4.0	2.8
Sulfur content	EN ISO 20884	mg/kg	5 max.	<5
Flashpoint	EN ISO 2719	°C	61 min.	>70
Cloud point Summer Winter	EN 23015	°C	– –15 max. –34 max.	– <–15 <–34
Summer Winter	–	–	–15 max. –34 max.	<–15 <–34
Water content	EN ISO 12937	mg/kg	200 max.	40
Ash content	EN ISO 6245	% m/m	0.001 max.	<0.001
Initial boiling point	EN ISO 3405	°C	180 min.	>180
Recovered at 250°C	EN ISO 3405	% v/v	<65	<20
Recovered at 350°C	EN ISO 3405	% v/v	85 min.	>98
95% recovered at	EN ISO 3405	°C	360 max.	>95
Cetane number	EN 15195	–	70 min.	80
Cetane index	EN ISO 4264	–	70 min.	80
CFPP	EN 116	°C	–15....	–34
Carbon residue (on 10% distillation residue)	EN ISO 10370	% m/m	0.1 max.	<0.01
Oxidation stability	EN ISO 12205	g/m <sup>3</sup>	25 max.	<5
Copper strip corrosion 3h/50°C	EN ISO 2160	–	1 max.	1a
Net heat of combustion	ASTM D4809	MJ/kg	42 min.	44

Table B.1 – Product data sheet (*continued*)

Parameter	Test method	Units	Specification	Typical value
Particulate matter	EN 12662	mg/kg	10 max.	<1
Lubricity/HFRR	EN ISO 12156-1	mm	400 max.	350
Renewable diesel	–	% v/v	100	100
Fatty acid methyl ester	–	% v/v	0	0
Total aromatics	EN 12916	% wt	1.1 max.	<1
Polycyclic aromatics (PAH)	SS 155116	% v/v	0.02 max.	<0.02



## Bibliography

### Standards publications

For dated references, only the edition cited applies.  
For undated references, the latest edition of the referenced document (including any amendments) applies.

### Standards publications

ASTM D4809, *Standard Test Method for Heat of Combustion of Liquid Hydrocarbon Fuels by Bomb Calorimeter (Precision Method)*

ASTM D4176-2, *Standard Test Method for Free Water and Particulate Contamination in Distillate Fuels (Visual Inspection Procedures)*

EN 116, *Diesel and domestic heating fuels – Determination of cold filter plugging point – Stepwise cooling bath method*

EN 12662, *Liquid petroleum products – Determination of total contamination in middle distillates, diesel fuels and fatty acid methyl esters*

EN 12916, *Petroleum products – Determination of aromatic hydrocarbon types in middle distillates – High performance liquid chromatography method with refractive index detection*

EN 15195, *Liquid petroleum products – Determination of ignition delay and derived cetane number (DCN) of middle distillate fuels by combustion in a constant volume chamber*

EN 23015, *Petroleum products – Determination of cloud point*

EN ISO 2160, *Petroleum products – Corrosiveness to copper – Copper strip test*

EN ISO 2719, *Determination of flash point – Pensky-Martens closed cup method*

EN ISO 3104, *Petroleum products – Transparent and opaque liquids – Determination of kinematic viscosity and calculation of dynamic viscosity*

EN ISO 3405, *Petroleum and related products from natural or synthetic sources – Determination of distillation characteristics at atmospheric pressure*

EN ISO 4264, *Petroleum products – Calculation of cetane index of middle-distillate fuels by the four variable equation*

EN ISO 6245, *Petroleum products – Determination of ash*

EN ISO 10370, *Petroleum products – Determination of carbon residue – Micro method*

EN ISO 12156-1, *Diesel fuel – Assessment of lubricity using the high-frequency reciprocating rig (HFRR) – Part 1: Test method*

EN ISO 12185, *Crude petroleum and petroleum products – Determination of density – Oscillating U-tube method*

EN ISO 12205, *Petroleum products – Determination of the oxidation stability of middle-distillate fuels*

EN ISO 12937, *Petroleum products – Determination of water – Coulometric Karl Fischer titration method*

EN ISO 20884, *Petroleum products – Determination of sulfur content of automotive fuels – Wavelength-dispersive X-ray fluorescence spectrometry*

SS 155116, *Petroleum products – Determination of aromatics in diesel fuel – Mono- and dicyclic aromatic compounds and PAH*

## Other publications

- [1] BUILDING RESEARCH ESTABLISHMENT (BRE). *Standard Assessment Procedure (SAP), 10.2*. London: BRE, 2021<sup>2)</sup>.
- [2] DEPARTMENT FOR LEVELLING UP, HOUSING, AND COMMUNITIES (DLUHC). National Calculation Methodology (NCM) Simplified Building Energy Model (SBEM) for non-domestic buildings. April 2022<sup>3)</sup>.
- [3] EUROPEAN UNION. Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources (recast) (Text with EEA relevance). Official Journal of the European Union, 2018<sup>4)</sup>.
- [4] OIL FIRING TECHNICAL ASSOCIATION (OFTEC). *Hydrotreated vegetable oil (HVO) handbook, Issue 1.3*. OFTEC, December 2021<sup>5)</sup>.

## Further reading

DEPARTMENT FOR TRANSPORT (DfT), *Renewable Transport Fuel Obligation (RTFO)*. London: DfT, 2021<sup>6)</sup>.

EUROPEAN COMMITTEE FOR STANDARDIZATION (CEN). PD CEN/TR 16389:2017, *Automotive fuels – Paraffinic diesel fuel and blends with FAME – Background to the parameters required and their respective limits and determination*.

## Useful websites

The UKIFDA Customer Charter is available at [www.ukifda.org/code-of-practice-and-customer-charter/](http://www.ukifda.org/code-of-practice-and-customer-charter/)

<sup>2)</sup> Available at [www.bregroup.com/sap/sap10/](http://www.bregroup.com/sap/sap10/)

<sup>3)</sup> Available at [www.uk-ncm.org.uk/](http://www.uk-ncm.org.uk/)

<sup>4)</sup> Available at [www.gov.uk/eu-withdrawal-act-2018-statutory-instruments/the-renewable-energy-energy-efficiency-and-motor-fuel-emissions-miscellaneous-amendments-eu-exit-regulations-2021](http://www.gov.uk/eu-withdrawal-act-2018-statutory-instruments/the-renewable-energy-energy-efficiency-and-motor-fuel-emissions-miscellaneous-amendments-eu-exit-regulations-2021)

<sup>5)</sup> Available at [www.oftec.org/media/p2gdjxyo/oftec\\_hvo\\_handbook\\_issue1-3\\_dec2021.pdf](http://www.oftec.org/media/p2gdjxyo/oftec_hvo_handbook_issue1-3_dec2021.pdf)

<sup>6)</sup> Available at [www.legislation.gov.uk/ukdsi/2020/9780348213324](http://www.legislation.gov.uk/ukdsi/2020/9780348213324)

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