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Solid recovered fuels — Guidance for specification of solid recovered fuels (SRF) for selected uses

PROOF/ÉPREUVE

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO-specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 300 *Solid Recovered Fuels*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

 PROOF/ÉPREUVE

Introduction

Waste-to-energy is a broad term that covers much more than waste incineration. It includes various treatment processes that have different environmental impacts but also offer potential for the progress desired towards a low-carbon and circular economy. Processes that convert waste into solid fuels and generate electricity and/or thermal energy from it can play an increasing role in achieving such goals.

Traditionally, solid fuels recovered from waste have been used as an integrative fuel in incineration or co-incineration plants treating a mix of wastes, so as to improve the energy performance of the plant. There are also some dedicated SRF-EfW plants (e.g. incineration plants and industrial combustion plants recovering thermal and/or electrical energy from the solid recovered fuel alone).

An increasing role as substitutive fuel has occurred over time to allow a reduction of fossil fuel consumption and the impact on climate change and greenhouse gas emission of industrial activities with a high energy consumption. In recent years, the use of solid recovered fuels has expanded to other interesting and promising fields, such as gasification or combined gasification and pyrolysis. Waste gasification and co-incineration of the resulting syngas in a combustion plant, co-processing to power and material recovery in cement kilns and waste incineration in dedicated facilities can be highlighted as best proven techniques to increase the energy efficiency of waste-to-energy processes and optimize their contribution to national and global climate and energy goals.

All the above-mentioned waste-to-energy processes rank differently in the waste hierarchy and have different needs for fuel quality to ensure better plant management as well as compliance with requirements set by national and supranational legislation.

Quite an extensive family of solid fuels can be recovered from waste, with different physico-chemical properties and a quality that is not always well defined. Those produced from non-hazardous waste, classified as SRF (Solid Recovered Fuel), are specifically of interest in this document. The term SRF itself identifies a family of fuels that can differ in origin (input waste streams), composition and quality.

Many barriers still hamper the extensive development of SRFs. As discussed later, a continuing confusion in terminology can be highlighted. Solid fuels recovered from non-hazardous waste are identified in different countries by different terms (e.g. CSS, CDR, CDR-Q, RPF, SBS, CSR,), shipped with different waste codes, and an ambiguous use of the terms RDF and SRF still occurs. SRF is largely produced and traded as waste, different countries labelling it with different waste codes based on local waste legislation. An end-of-waste of SRF is allowed in some countries (e.g. Austria, Italy) if the fuels produced comply with specific and mandatory requirements legally set.

Solid recovered fuels are intended to be classified and specified according to ISO/TC 300 standards. Fuel specification is also the subject of national guidelines, in places addressed to specific end uses of the fuel (e.g. in cement kilns), and of local voluntary commitments on fuel properties between the producer and the end user aimed at ensuring that the latter meets its own technological, economic and environmental needs.

Generic (all solid waste) or specific (SRF) quality requirements are set by national or local regulators (e.g. administrative bodies authorized to issue plant permits), mainly to ensure that waste-to-energy plants at least meet the requirements for environmental and human protection and to regulate the role of waste-to energy plants within the national/regional waste management systems as a whole.

There are still acceptance problems in several countries that need to overcome, for example by reliable data, a high level of information and transparency.

To foster the application of SRFs in existing and new fields and to overcome existing barriers, it is therefore strategically essential for all interested stakeholders to define what quality requirements the SRF meets based on homogeneous, unambiguous and well-accepted criteria.

Solid recovered fuels — Guidance for specification of solid recovered fuels (SRF) for selected uses

1 Scope

This document addresses the provision of background references that are helpful in defining a more detailed specification for SRF according to its specific end use for energy conversion (EfW plants) and to support the SRF market. The aim is to enable all the interested stakeholders – producers, end users, legislators, local authority bodies and standardization bodies – to guarantee that the SRF complies fully with technical, environmental and economic requirements and to facilitate its social acceptability when utilized for energy conversion.

This document is intended to provide references for the specification of SRF produced from non-hazardous waste streams and traded to EfW plants as waste. The quality of such SRF is specified through values for relevant fuel properties, appropriate to the subsequent end uses that have an expected growth or an established/well consolidated role in heat and power generation in waste-to-energy systems:

— coal co-combustion in cement kilns

— gasification

— coal co-combustion in power plants.

The SRF can also be used in other end-use applications but these are not addressed in this document.

2 Normative references

There are no normative references in this document.

3 Terms, definitions and abbreviations

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1 Terms and definitions

3.1.1
BAT
best available technique
term used within the European Union for the most effective and advanced stage in the development of activities and their methods of operation which indicates the practical suitability of particular techniques for providing the basis for emission limit values and other permit conditions designed to prevent and, where that is not practicable, to reduce emissions and the impact on the environment as a whole

Note 1 to entry: “Techniques” includes both the technology used and the way in which the installation is designed, built, maintained, operated and decommissioned.

Note 2 to entry: “Available techniques” means those developed on a scale which allows implementation in the relevant industrial sector, under economically and technically viable conditions, taking into consideration the costs and advantages, whether or not the techniques are used or produced inside the Member State in question, as long as they are reasonably accessible to the operator.

Note 3 to entry: “Best” means most effective in achieving a high general level of protection of the environment as a whole.

[SOURCE: Directive 2010/75/EU, Art. 3 (10)]

3.1.2
BAT reference document
term used within the European Union for a document, resulting from the exchange of information drawn up for defined activities, that describes, in particular, applied techniques, present emission and consumption levels, techniques considered for the determination of best available techniques as well as BAT conclusions and any emerging techniques

Note 1 to entry: “BAT conclusions” means a document containing the parts of a BAT reference document laying down the conclusions on best available techniques, their description, information to assess their applicability, the emission levels associated with the best available techniques, associated monitoring, associated consumption levels and, where appropriate, relevant site remediation measures

Note 2 to entry: “Emission levels associated with the best available techniques” means the range of emission levels obtained under normal operating conditions using a best available technique or a combination of best available techniques, as described in BAT conclusions, expressed as an average over a given period of time, under specified reference conditions

Note 3 to entry: “Emerging technique” means a novel technique for an industrial activity that, if commercially developed, could provide either a higher general level of protection of the environment or at least the same level of protection of the environment and higher cost savings than existing best available techniques.

[SOURCE: Diretive 2010/75/EU, Art. 3 (11)]

3.1.3
classification of solid recovered fuels
categorization of *solid recovered fuels* (3.1.18) into classes by focusing on the key properties net calorific value, chlorine and mercury, that are defined by boundary values

Note 1 to entry: The classes are defined by boundary values for the chosen fuel characteristics to be used for trading as well as for the information of permitting authorities and other interested parties.

[SOURCE: ISO 21637, 3.12, modified – Note 1 to entry is added.]

3.1.4
co-incineration plants
term used within the European Union for any stationary or mobile technical unit whose main purpose is the generation of energy or production of material products and which uses *waste* (3.1.19) as a regular or additional fuel or in which waste is thermally treated for the purpose of disposal through the incineration by oxidation of waste as well as other thermal treatment processes, such as pyrolysis, gasification or plasma process, if the substances resulting from the treatment are subsequently incinerated

[SOURCE: Directive 2010/75/EU, Art. 3 (41)]

3.1.5
combustion plant
term used within the European Union for any technical apparatus in which fuels are oxidized in order to use the heat thus generated

[SOURCE: Directive 2010/75/EU, Art. 3 (25)]

3.1.6
composition of solid recovered fuels
breakdown of *solid recovered fuels* (3.1.18) by types of components

Note 1 to entry: This is typically expressed as a percentage of the mass fraction component in the fuel on an as received basis (m % ar).

Note 2 to entry: Examples of components - wood, paper, board, textiles, plastics, rubber.

[SOURCE: ISO 21637, 3.14]

3.1.7
dedicated SRF- EfW plants
any technical unit in which the energy conversion is from the *solid recovered fuel* (3.1.18*)* alone

3.1.8
EfW plants
energy from waste plants like municipal waste incineration (MWI), mono- and co-combustion plants including cement kilns

3.1.9
energy conversion
use of the calorific value of the *solid recovered fuel* (3.1.18) for energy purposes alone or with other fuels

Note 1 to entry: Solid recovered fuels may be an intermediary energy carrier and used directly or indirectly for the energy conversion such as in multi-stage production and use of synthetic gas. Examples of energy conversion processes are incineration, co-incineration, combustion, co-combustion, gasification and pyrolysis, in which energy is used for supplying heat, cooling and/or electric power

[SOURCE: ISO 21637, 3.27]

3.1.10
energy purposes
use of the calorific value within industrial processes or for the supply of heat and electrical power

Note 1 to entry: For industrial processes, the use of solid recovered fuel may contribute to the energy source within the process of producing specific materials, such as cement clinker, bricks and lime.

[SOURCE: ISO 21637, 3.29]

3.1.11
EoW
end-of-waste
term used within the European Union for status of a specified substance or object that ceases to be a *waste* (3.1.19) when it has undergone a recovery, including recycling, operation and complies with specific criteria, to be developed in accordance with the following conditions: (a) the substance or object is commonly used for specific purposes; (b) a market or demand exists for such a substance or object; (c) the substance or object fulfils the technical requirements for the specific purposes and meets the existing legislation and standards applicable to products; (d) the use of the substance or object will not lead to overall adverse environmental or human health impacts

[SOURCE: Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste, art. 6]

3.1.12
gasification plant
any stationary or mobile technical unit whose purpose is converting feedstock fuels into a syngas (synthesis gas) for different final uses

3.1.13
hazardous waste
waste (3.1.19) which has proprieties that may be harmful to human health or the environment

Note 1 to entry: These wastes are categorized by waste streams and hazardous characteristics. The hazardous characteristics relevant to solid wastes are: explosives substances; flammable solids; wastes liable to spontaneous combustion; wastes which, in contact with water emit flammable gases; wastes which oxidizing; organic peroxides; acute poisoning and infectious substances.

Note 2 to entry: Further identification of the waste's status can be determined using the Annex I and Annex III tables of the Basel Convention on the control of transboundarym of hazardous wastes and their disposal.

Note 3 to entry: Additional categories of hazardous waste to those in the Basel Convention Annex I and Annex III may be established by stakeholders to the agreement or at a national level

[SOURCE: ISO 21637, 3.35, modified — Example and Notes 4 and 5 to entry were removed.]

3.1.14
incineration plant
term used within the European Union for any stationary or mobile technical unit and equipment dedicated to the thermal treatment of *waste* (3.1.19), with or without recovery of the combustion heat generated, through the incineration by oxidation of waste as well as other thermal treatment processes, such as pyrolysis, gasification or plasma process, if the substances resulting from the treatment are subsequently incinerated

Note 1 to entry: According to the US Environmental Protection Agency, incinerators are any furnace used in the process of combusting solid waste for the purpose of reducing the volume of the waste by removing combustible matter. A solid waste incineration unit is defined as a distinct operating unit of any facility which combusts any solid waste material from commercial or industrial establishments or the general public (including single and multiple residence, hotels and motels). The term does not include: a) materials recovery facilities (including primary or secondary smelters) which combust waste for the primary purpose of recovering metals; b) qualifying small power production facilities or or qualifying cogeneration facilities which burn homogeneous waste (such as units which burn tires or used oil, but not including refuse-derived fuel) for the production of electric energy or in the case of qualifying cogeneration facilities which burn homogeneous waste for the production of electric energy and steam or forms of useful energy (such as heat) which are used for industrial, commercial, heating or cooling purposes; c) air curtain incinerators provided that such incinerators only burn wood wastes, yard wastes, and clean lumber

[SOURCE: Directive 2010/75/EU (40); US Environmental Protection Agency. Standards of Performance for New Stationary Sources and Emission Guidelines for Existing Sources: Commercial and Industrial Solid Waste Incineration Units; [Technical Amendments] Federal Register / Vol. 83, No. 116 / Friday, June 15, 2018 / Proposed Rules 3.17]

3.1.15
MSW
Municipal Solid Waste
waste (3.1.19) collected and treated by or for municipalities

Note 1 to entry: It typically covers waste from households, including bulky waste, similar waste from commerce and trade, office buildings, institutions and small businesses, as well as yard and garden waste, street sweepings, the contents of litter containers, and market cleansing waste if managed as household waste.

3.1.16
non-hazardous waste
waste (3.1.19) that is other than *hazardous waste* (3.1.13)

3.1.17
specification of solid recovered fuels
list of properties that characterize *solid recovered fuels* (3.1.18)

[SOURCE: ISO 21637, 3.76]

3.1.18
SRF
Solid Recovered Fuel
solid fuel for energy purposes according to ISO 21640, derived from *non-hazardous wastes* (3.1.18)

Note 1 to entry: According to EN 15359, SRF are solid fuels prepared from non-hazardous waste s meeting the classification and specification requirements laid down in this European Standard. "Prepared" means processed, homogenized and upgraded to a quality that can be traded amongst producers and users.

Note 2 to entry: Whether the input material is hazardous or non-hazardous is determined through national laws and Directives or by categorization of the fuel through the Annexes in the *Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal.*

[SOURCE: ISO 21637, 3.75, modified – Original Notes 1-2 to entry were replaced by a new Note 1.]

3.1.19
waste
substances or objects which are discarded or are intended to be discarded

Note 1 to entry: The provisions of national laws can apply.

Note 2 to entry: The Basel Convention on the control of transboundary movements of hazardous wastes and their disposal provides the user with the ability to determine whether a material is deemed to be a hazardous waste or non-hazardous waste. By following the Convention's requirements and Annexes, along with national laws, operators have a clear understanding of the distinction between the different categories of waste.

[SOURCE: Basel Convention on the control of transboundary movements of hazardous wastes and their disposal, 2019]

3.2 Symbols and abbreviated terms

BAT	Best Available Tecnique
CDW	Construction and Demolition Waste
ICW	Industrial and Commercial Waste
H	Hazardous Waste
NH	Non-Hazardous Waste
MSW[a]	Municipal Solid Waste
EoW	End-of-Waste
RDF[b]	Refuse Derived Fuel
SRF[c]	Solid Recovered Fuel
ar	as received
d	dry basis
BD	bulk density, kg/m^3
DM	dry matter, % in mass
NCV	net calorific value, MJ/kg; kcal/kg
M	moisture content, $q_{p,\,net}$, % in mass

A	ash content, % in mass
TC	total carbon content, % in mass

[a]Municipal solid waste is a *waste* (3.1.18) collected and treated by or for municipalities. It typically covers waste from households, including bulky waste, similar waste from commerce and trade, office buildings, institutions and small businesses, as well as yard and garden waste, street sweepings, the contents of litter containers, and market cleansing waste if managed as household waste.

[b]RDF differs from SRF (*solid recovered fuel* as defined in 3.1.17) in that it is not in compliance with standardized classification and specification requirements. RDF includes high calorific fractions, which are coarser fractions from waste streams that contain materials with a high calorific value that have not been processed as extensively as fractions for power plants running on secondary fuels such as SRF.

[c]As defined in 3.1.17.

4 Compilation, structure and use of data

Background references and data provided in this document have been collected from:

— national/international legislation, standards, guidelines and statistics on waste management;

— sectoral statistics reported in documents or websites (e.g. Global Cement; AITEC, Italian Cement Technical and Economical Association; VDZ, German Cement Works Association; Japan Cement Association; European Recovered Fuel Organisation; German Quality Assurance Association for Solid Recovered Fuels and Recycled Wood (BGS e. V.; Japan RPF Association);

— reference documents on the best available techniques;

— public documents of national producers/end users;

— a review of literature studies;

— international databases (e.g. the ECN Phyllis Database);

— responses sent to questionnaires. Four online surveys were promoted in 2017 by the ISO TC 300/WG2 to collect background information on:

  — profiles of the SRF-RDF produced. Responses (25) were provided from European (88 %: Germany, Italy, Sweden, Spain, Finland) and Japanese (12 %) producers;

  — market, production and use of SRF-RDF. Only a few responses were collected (5) that refer to European countries (Spain, France, Italy, Austria);

  — legislation, standards and guidelines that have an impact on SRF-RDF. Responses (11) were provided by European stakeholders (60%: Germany, France, Italy, Denmark and Serbia) and Asia (40 %, Japan);

  — needs for the classification and specification of SRF-RDF. Responses (15) were provided by stakeholders (end users, producers, authorities, mirror committees) of European countries only (Sweden, Spain, Italy, France, Austria and Germany);

— personal communications (e.g. Italian producers/end users of SRF; Japanese producers of RPF).

Background references on the main characteristics of the end-user plants of interest are provided in Annex C, while the collected background references on provisions in national legislations, standards, plant permits, guidelines, voluntary agreements, results of statistical assessments for typical values, reference data for properties of the produced SRF/RDF, are reported in Annexes A, B and D.

It is highlighted that:

— the background references for fuel specification are presented as reported in the documentary source;

— the use of non-homogeneous units occurs in the documentary sources, in particular in the case of fuel requirements for trace elements;

— the time dating is not necessarily homogeneous, and a geographical origin, largely from European countries, characterizes most of that background reference material, as well as the collected measured values, on which the statistical assessments for typical values in Annex D are based.

In the body of this document, an introductory framework is given in Clause 5. This is aimed at clarifying what this document means by SRF/RDF, what are the most widely used terms and the available rules for the classification and specification of solid recovered fuels, and to provide a brief overview of global markets. For each of the end users of interest, a summary description of technological needs, main requirements for quality achievable from mandatory provisions, guidelines, voluntary specifications, and references for typical values in the solid recovered fuels produced, are then provided in Clauses 6 to 8.

5 SRF and other waste derived fuels

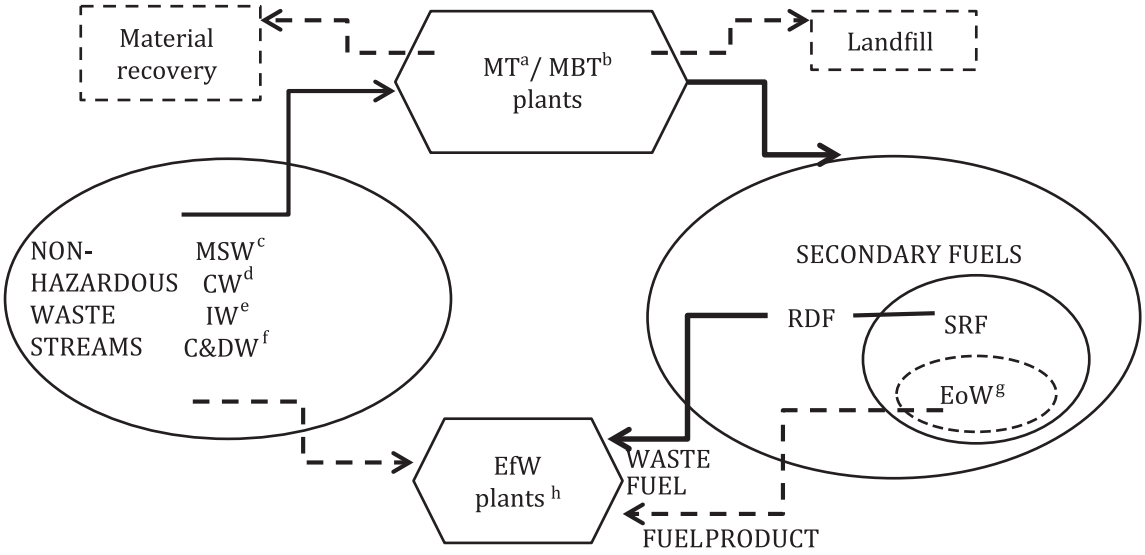
5.1 General

Waste-to-energy is a broad term that identifies a value chain aimed at exploiting the energy potential of waste by means of the generation of electricity and/or heat in different forms of energy-from-waste (EfW) plants.

Within that value chain, waste can follow a “first address” or a “second address” pathway to the EfW plant, as Figure 1 shows schematically. The waste fuels that fall within the field of interest of this document are those referred to as “secondary fuels” in Figure 1 that are:

— produced from non-hazardous (NH) waste streams of urban, industrial or commercial origin, through a treatment process; this means that, if sent to EfW plants as generated, the same input waste streams are excluded;

— traded in national markets or shipped for energy recovery in EfW plants as waste; this means that waste fuels traded as fuel products in all respects, as long as they comply with mandatory requirements legally set to declare their end-of-waste status (the EoW subset in Figure 1), are excluded.



Key

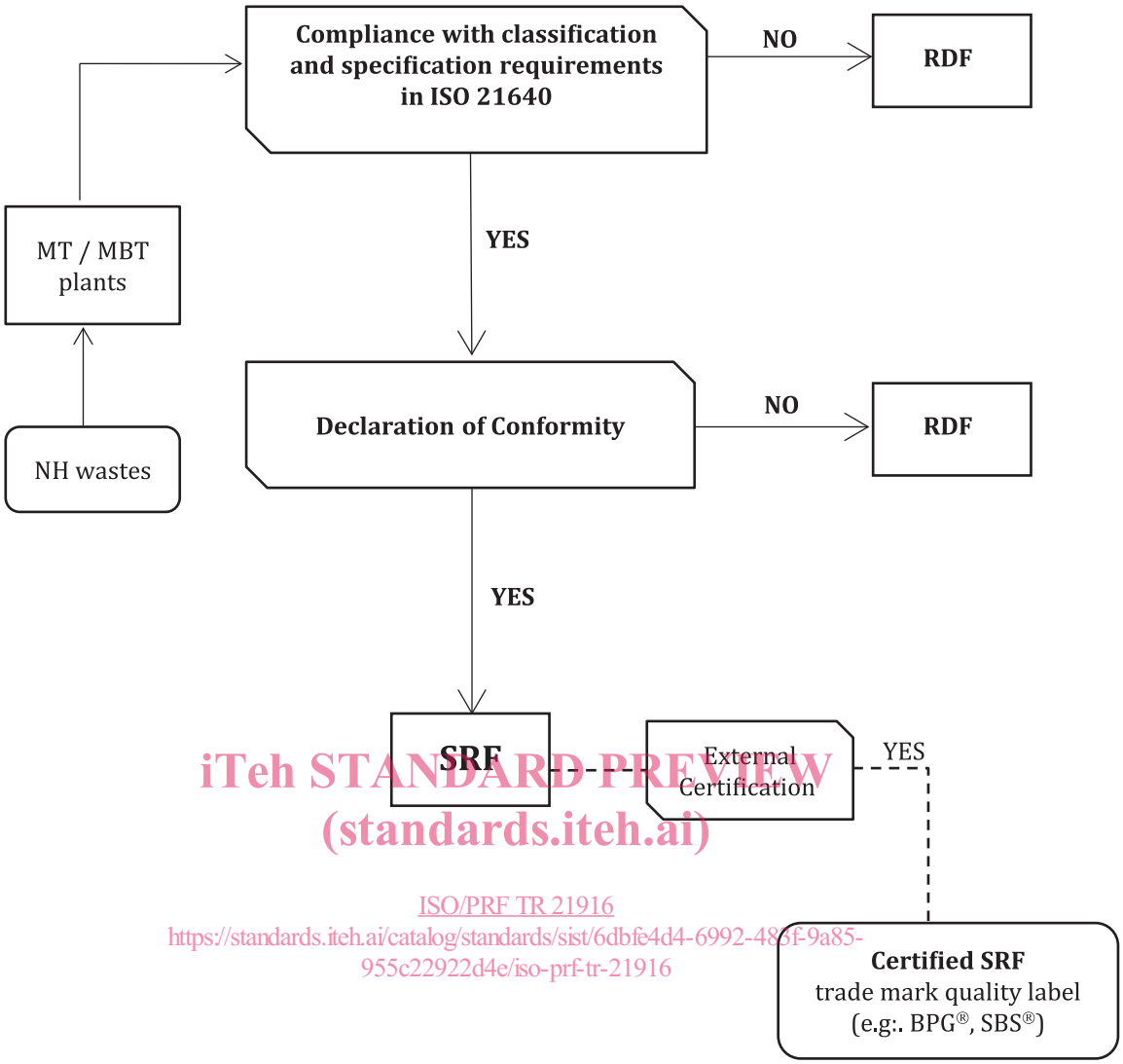
a mechanical treatment plants
b mechanical-biological treatment plants
c municipal solid waste
d commercial waste
e industrial waste
f construction & demolition waste
g end-of-waste (secondary fuel as fuel product, not waste)
h energy from waste plants, including cement and lime kilns

NOTE Dashed arrows and boxes identify paths/fuels that do not fall within the field of interest of this document.

Figure 1 — A schematic view of the waste-to-energy value chain

Given the above, all the secondary fuels are assumed to fall under the generic and common name of Refuse Derived Fuel (RDF) and the Solid Recovered Fuel (SRF) are identified as a subset of that large family. Only secondary fuels that meet the classification and specification requirements laid down in a well shared standard can be considered as SRF (see Figure 2). A complementary assumption is that wastes not suitable for re-use, preparation for re-use or for efficient material recovery are intended to be used in MT/MBT plants for the production of SRF.

The meaning of the proposed assumptions is to identify a waste fuel – specifically the SRF - whose added value is to be a more “processed, refined and defined” fuel than a generic RDF not submitted to specific regulations. Therefore, a fuel that is well characterized and known for its properties, that is better able than unregulated RDF to meet the technical and environmental needs related to its specific use for energy recovery, and, in fact, can give results truly complementary to the waste recycling priority, based on the treatment technologies currently available for its production.



NOTE The external certification of SRF mentioned in Figure 2 is a national/company initiative that does not take part in standardization.

Figure 2 — A proposed approach to distinguish between RDF and SRF (adapted from[1])

Countries belonging to the EU have a common reference in in the European standard EN 15359[2] that defines SRF in terms of a solid fuel prepared from non-hazardous wastes to be utilized for energy recovery in incineration or co-incineration plants that meets the classification and specification requirements laid down in that standard. Such a definition is recognized by the European reference document on the best available techniques (BAT) for waste treatment[3]; it explicitly mentions EN 15359 as a reference and assumes that the refuse-derived fuel (RDF) differs from the SRF due to it not being produced in compliance with the specific criteria defined in the European standard.

ISO 21640,[4] developed based on the European standard, confirms that definition of SRF, emphasizes the origin of SRF from wastes that are not more suitable for efficient reuse and recycling of materials and provides shared rules (classification and specification requirements) that can be applied in different countries to identify a secondary fuel as SRF. Therefore, ISO 21640 is here assumed as a reference to distinguish between RDF and SRF (Figure 2).

An overview of national markets clearly showed that secondary fuels can take on different names locally and, above all, how a widespread use of the term RDF occurs that does not always allow a clear identification as a generic, non-standardized, or a standardized solid recovered fuel (an SRF). A list of the most common terms that are locally used to identify secondary fuels and that are referred to in