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ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - APE 7112B
Association à but non lucratif enregistrée à la
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Foreword

This Technical Specification (TS) has been produced by ETSI Technical Committee Smart Machine-to-Machine communications (SmartM2M).

The present document is part 2 of a multi-part deliverable covering SmartM2M; Extension to SAREF, as identified below:

Part 1: "Energy Domain";

Part 2: "Environment Domain";

Part 3: "Building Domain";

Part 4: "Smart Cities Domain";

Part 5: "Industry and Manufacturing Domains";

Part 6: "Smart Agriculture and Food Chain Domain";

Part 7: "Automotive Domain";

Part 8: "eHealth/Ageing-well Domain";

Part 9: "Wearables Domain";

Part 10: "Water Domain";

Part 11: "Lift Domain";

Part 12: "Smart Grid Domain";

Part 13 Maritime Domain.

Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

"**must**" and "**must not**" are **NOT** allowed in ETSI deliverables except when used in direct citation.

1 Scope

The present document presents SAREF4ENVI, an extension of SAREF for the Environment Domain.

2 References

2.1 Normative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found at https://docbox.etsi.org/Reference/.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are necessary for the application of the present document.

[1] ETSI TS 103 264: "SmartM2M; Smart Applications; Reference Ontology and oneM2M Mapping".

[2] ETSI TS 103 548: "SmartM2M; SAREF reference ontology patterns".

[3] ETSI TS 103 673: "SmartM2M; SAREF Development Framework and Workflow, Streamlining the Development of SAREF and its Extensions".

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] ETSI TS 103 410-2 (V1.1.2): "SmartM2M; Extension to SAREF; Part 2: Environment Domain".

[i.2] ETSI TR 103 411: "SmartM2M; Smart Appliances; SAREF extension investigation".

[i.3] ETSI TR 103 781 (V1.1.1): "SmartM2M; Study for SAREF ontology patterns and usage guidelines".

[i.4] Zamorano, J., García, C., González, R, Gallego, J., Pascual, S., Tapia, C., Nievas, M., Sánchez, A., Cardiel, N. Deliverable D4.1: "Photometer sensor (prototype)". STARS4ALL project. March 30th, 2016.

[i.5] "Variación espacial, temporal y espectral de la contaminación lumínica y sus fuentes: Metodología y resultados". Ph.D. thesis. Universidad Complutense de Madrid. February, 2015.

[i.6] ISO 6707-1:2020: "Buildings and civil engineering works -- Vocabulary -- Part 1: General terms".

[i.7] ISO 24161:2022: "Waste collection and transportation management -- Vocabulary".

[i.8] ISO 18606:2013: "Packaging and the environment -- Organic recycling".

[i.9] ISO 59004:2024: "Circular economy -- Vocabulary, principles and guidance for implementation".

[i.10] ISO 27065:2017: "Protective clothing -- Performance requirements for protective clothing worn by operators applying pesticides and for re-entry workers".

[i.11] ISO 5149-1:2014: "Refrigerating systems and heat pumps -- Safety and environmental requirements -- Part 1: Definitions, classification and selection criteria".

[i.12] ISO 10088:2022: "Small craft -- Permanently installed fuel".

[i.13] ISO 8157:2022: "Fertilizers, soil conditioners and beneficial substances -- Vocabulary".

[i.14] ISO 8887-1: "Technical product documentation -- Design for manufacturing, assembling, disassembling and end-of-life processing -- Part 1: General concepts and requirements".

[i.15] ISO 18400-204:2017: "Soil quality -- Sampling -- Part 204: Guidance on sampling of soil gas".

[i.16] Tanenbaum, A. S. (2003): "Computer networks", 4th edition, ed: Prentice Hall.

[i.17] OpenstreetMap Wiki: "Proposal: Key: light source".

[i.18] ISO 21928-2:2023:"Sustainability in buildings and civil engineering works -- Sustainability indicators. Part 2: Framework for the development of indicators for civil engineering works".

3 Definition of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the terms given in ETSI TS 103 673 [3] and the following apply:

ontology: formal specification of a conceptualization, used to explicit capture the semantics of a certain reality

3.2 Symbols

Void.

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

ESCP	École Supérieure de Commerce de Paris
OM	Ontology of units of Measure
OWL	Web Ontology Language
OWL-DL	Web Ontology Language Description Logic
RDF	Resource Description Format
RDF-S	Resource Description Format Schema
SAREF	Smart Applications REFerence ontology
TESS	Telescope Encoder and Sky Sensor
TR	Technical Report
TS	Technical Specification
WGS84	World Geodetic System 1984

4 SAREF4ENVI ontology and semantics

4.1 Introduction

The present document is a technical specification of SAREF4ENVI, an OWL-DL ontology that extends SAREF [1] for the Environment domain.

The present document is a major revision of SAREF4ENVI ontology extension, developed in the context of the STF 641 (https://portal.etsi.org/xtfs/#/xTF/641), using updated reference ontology patterns specified in ETSI TS 103 548 [2] to solve the harmonization needs identified in ETSI TR 103 781 [i.3], with updated development framework and tools defined in ETSI TS 103 673 [3].

ETSI TS 103 410-2 (V1.1.2) [i.1] was created in collaboration with domain experts in the field of light pollution that worked in the STARS4ALL European H2020 project (https://cordis.europa.eu/project/id/688135/). The STARS4ALL project was composed of partners such as Universidad Politécnica de Madrid, Universidad Complutense de Madrid, ESCP Europe, Leibniz Institute of Freshwater Ecology and Inland Fisheries, Instituto de Astrofísica de Canarias, University of Southampton, Europan Crowdfunding Network, and CEFRIEL (Società Consortile a Responsabilita Limitata). As such, V1.1.2 of the present document focused on extending SAREF for photometers to solve the lack of interoperability between sensors that can measure and share information about light pollution. Such extension involves the following use cases (more details can be found in ETSI TR 103 411 [i.2]):

- **Use case 1:** Monitor light pollution in a city, through the data collected by photometers about the magnitude of the light emitted in a given area.
- **Use case 2:** Adjust lampposts light intensity due to high pollution, after identifying the most contaminating lampposts and therefore the areas where more energy is being thrown away.
- **Use case 3:** Register a photometer, in which a new collection of photometers is incorporated into an existing sensor network.

Added in the present document is the covering of the waste management domain, as a collaboration between IMT - Mines Saint-Étienne and the company Compost'Ond, specialized in composting biodegradable waste. The Waste Managment Domain is divided into three modules: Waste, Collection and Treatment. They correspond chronologically to the three stages of waste management systems, from the moment a material becomes waste to the moment it is either transformed into another resource or becomes a final waste:

- The Waste module of the Waste Management Domain covers waste, those who produce it and where, its type, and the containers in which it is disposed before collection.
- The Collection module of the Waste Management Domain covers waste collection, the vehicles used and the journeys made to do so.
- The Treatment module of the Waste Management Domain covers waste processing (pre-treatment, treatment, disposal), the processes that can be used for doing so, the organisations involved, the emissions produced, and the final outputs.

The intention of SAREF4ENVI includes:

- to be the basis for enabling the use of SAREF in the environment domain;
- to exemplify how to enable interoperability between environmental devices in cooperation.

As all the SAREF ontologies, SAREF4ENVI is a dynamic semantic model that is meant to evolve over time. Therefore, the stakeholders in the Environment domain are invited to use, validate and provide feedback on SAREF4ENVI, collaborating with the SAREF ontology experts to improve and evolve SAREF4ENVI in an iterative and interactive manner, so that changes and additions can be incorporated in future releases of the present document.

The prefixes and namespaces used in SAREF4ENVI and in the present document are listed in Table 1.

Table 1: Prefixes and namespaces used within the SAREF4ENVI ontology

Prefix	Namespace
s4envi	https://saref.etsi.org/saref4envi/
saref	https://saref.etsi.org/core/
geo	http://www.w3.org/2003/01/geo/wgs84_pos#
owl	http://www.w3.org/2002/07/owl#
rdf	http://www.w3.org/1999/02/22-rdf-syntax-ns#
rdfs	http://www.w3.org/2000/01/rdf-schema#
xsd	http://www.w3.org/2001/XMLSchema#
skos	http://www.w3.org/2004/02/skos/core#
foaf	http://xmlns.com/foaf/0.1/
org	http://www.w3.org/ns/org#
time	http://www.w3.org/2006/time#
vcard	http://www.w3.org/2006/vcard/ns#

For all the entities described in the present document, it is indicated whether they are defined in the SAREF4ENVI extension or elsewhere by the prefix included before their identifier, i.e. if the element is defined in SAREF4ENVI, the prefix is `s4envi`, while if the element is reused from another ontology, it is indicated by a prefix according to Table 1. Colour codes also help to distinguish the provenance of entities.

Diagrams are to be interpreted using the Chowlk notation [3], clause 9.7.2.

Figure 1 provides a symbol legend for SAREF4ENVI diagrams.

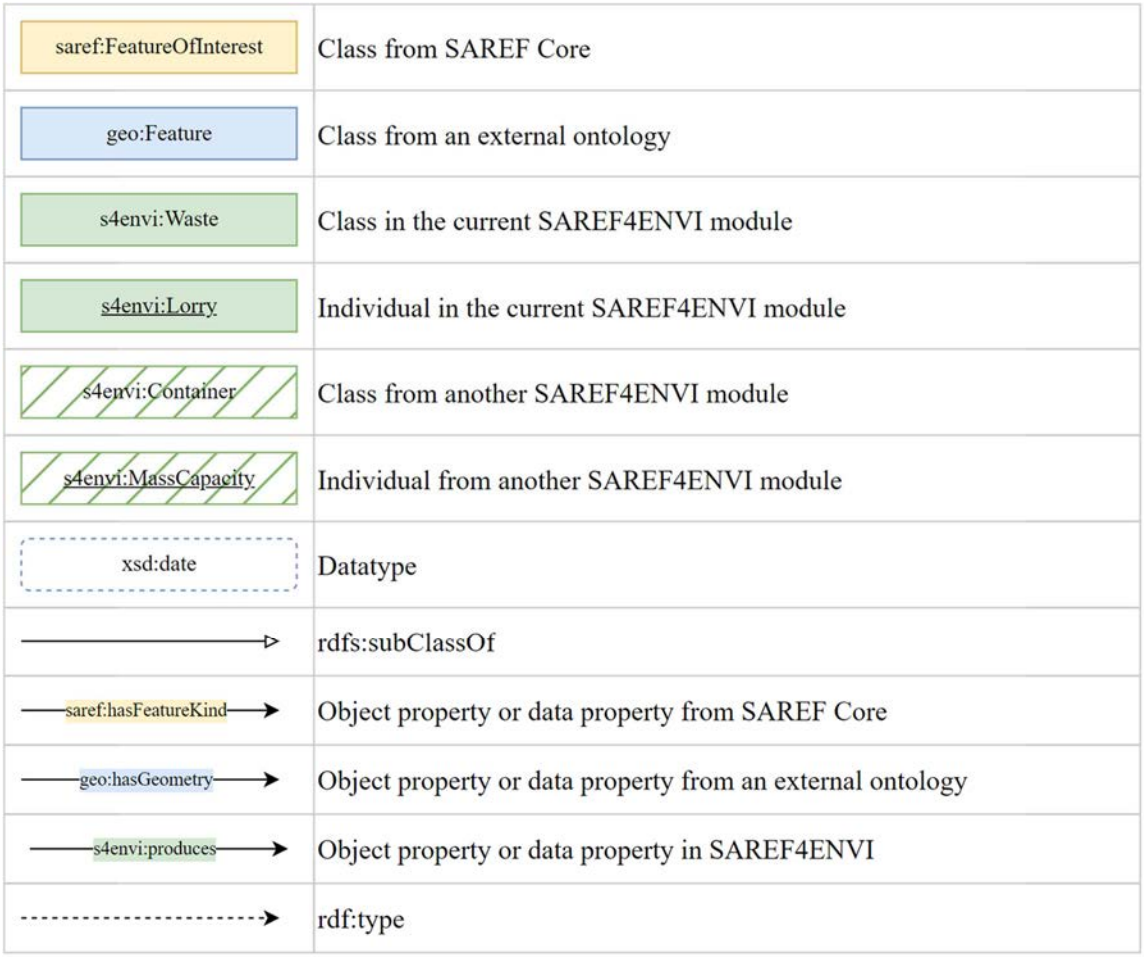

Figure 1: Symbol legend for diagrams in the present document

5 General additions to SAREF

5.0 Overview

The present clause describes general additions to SAREF Core, not specific to the automotive domain.

These additions could be incorporated in future versions of SAREF Core.

5.1 Digital Representations

5.1.0 Overview

Figure 2 describes how features of interest or feature kinds can have a digital representation accessible through some service.

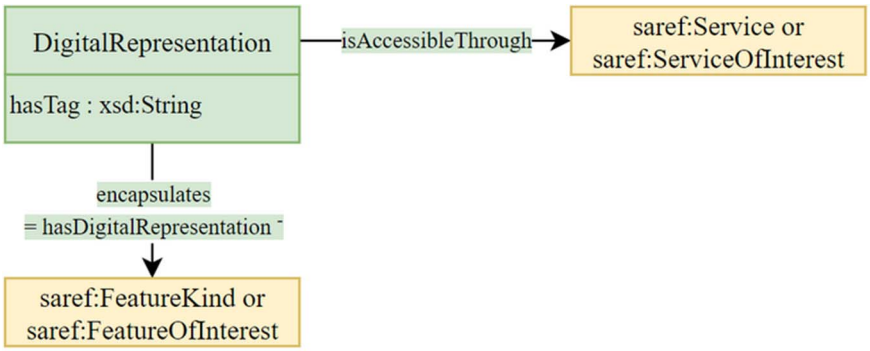

Figure 2: Digital Representations of Features of Interest or Feature Kinds

5.1.1 Property `s4envi:encapsulates`

Is a: `owl:FunctionalProperty`, `owl:ObjectProperty`

Domain: `s4envi:DigitalRepresentation`

Range is union of: `saref:FeatureKind`, `saref:FeatureOfInterest`

A relation between a digital representation and the physical objects it represents.

5.1.2 Property `s4envi:hasDigitalRepresentation`

Is a: `owl:InverseFunctionalProperty`, `owl:ObjectProperty`

Domain is union of: `saref:FeatureKind`, `saref:FeatureOfInterest`

Range: `s4envi:DigitalRepresentation`

A relation between a physical object and the digital representation in which it is encapsulated.

5.1.3 Property `s4envi:isAccessibleThrough`

Is a: `owl:FunctionalProperty`, `owl:ObjectProperty`

Domain: `s4envi:DigitalRepresentation`

Range is union of: `saref:Service`, `saref:ServiceOfInterest`

The relation between a digital representation and the service which it is accessible through.

5.1.4 Property s4envi:hasTag

Is a: owl:DatatypeProperty

Range: xsd:string

A relationship stating the tags that can be assigned to an entity (e.g. a digital representation).

5.1.5 Class s4envi:DigitalRepresentation

A digital representation encapsulates a physical object accessible via Web services.

5.2 Communication interfaces and communication protocols

5.2.0 Overview

Figure 3 describes how SAREF4SYST can be leveraged to describe communication interfaces of devices or device kinds, and communication protocols.

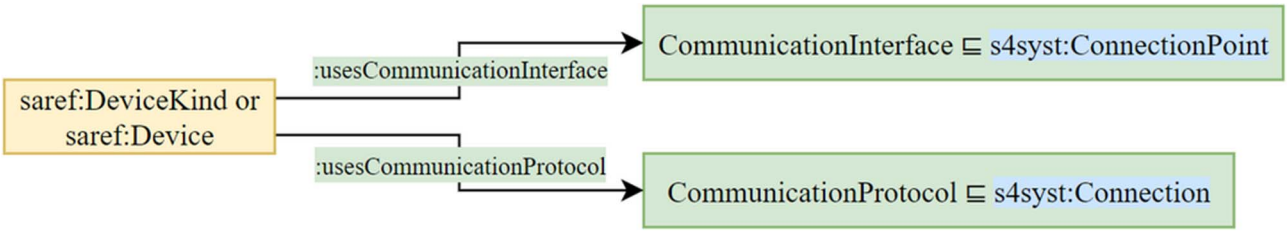

Figure 3: Communication interfaces and communication protocols

5.2.1 Class s4envi:CommunicationProtocol

A protocol is an agreement between the communicating parties on how communication is to proceed. (Definition taken from [i.16].)

5.2.2 Class s4envi:CommunicationInterface

An interface defines which primitive operations and services the lower layer makes available to the upper one, when referring to network layers. (Definition adapted from [i.16].)

5.2.3 Property s4envi:usesCommunicationInterface

Is a: owl:ObjectProperty

Is sub-property of: s4syst:connectsAt

Domain is union of: saref:Device, saref:DeviceKind

Range: s4envi:CommunicationInterface

A relation between a device and the communication interface it uses.

5.2.4 Property s4envi:usesCommunicationProtocol

Is a: owl:ObjectProperty

Is sub-property of: s4syst:connectedThrough

Domain is union of: saref:Device, saref:DeviceKind

Range: `s4envi:CommunicationProtocol`

A relation between a device and the communication protocol it uses.

5.3 General Purpose Properties

5.3.0 Overview

Figure 4 describes some general purpose properties, which are instances of `saref:Property`.

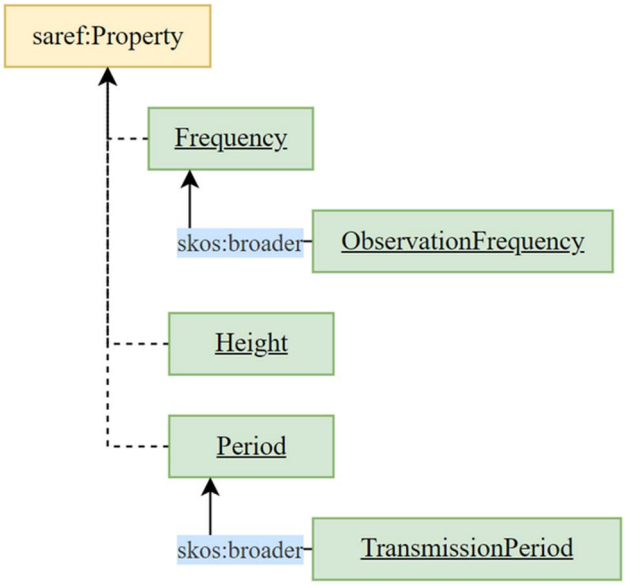

Figure 4: General Purpose Properties

5.3.1 Property `s4envi:Frequency`

An individual representing the property frequency.

5.3.2 Property `s4envi:ObservationFrequency`

Broader property: `s4envi:Frequency`

The frequency at which a sensor makes observations.

5.3.3 Property `s4envi:Height`

An individual representing the property height.

5.3.4 Property `s4envi:Period`

An individual representing the property period.

5.3.5 Property `s4envi:TransmissionPeriod`

Broader property: `s4envi:Period`

The period of information transmission by a device.

6 Application of the SAREF patterns

6.0 Overview

The present clause describes different applications of SAREF patterns, in conformance to ETSI TS 103 548 [2].

6.1 Lighting Domain

6.1.0 Overview

From the Lighting Domain, the present document describes light properties, lights, light points, lampposts, and photometers.

6.1.1 Property class `s4envi:LightProperty`

6.1.1.0 Definition

An aspect of light that can be observable by a sensor.

6.1.1.1 `s4envi:Color`

Is instance of: `s4envi:LightProperty`

Color of the emitted light. It might be indicated by named colors or using other type of color values like hexadecimal for RGB, color temperature, etc.

6.1.1.2 `s4envi:Fluorescence`

Is instance of: `s4envi:LightProperty`

An individual representing the light property fluorescence.

6.1.1.3 `s4envi:Illuminance`

Is instance of: `s4envi:LightProperty`

An individual representing the light property illuminance.

6.1.1.4 `s4envi:Irradiance`

Is instance of: `s4envi:LightProperty`

An individual representing the light property irradiance.

6.1.1.5 `s4envi:LightAbsorption`

Is instance of: `s4envi:LightProperty`

An individual representing the light property light absorption.

6.1.1.6 `s4envi:LightMagnitude`

Is instance of: `s4envi:LightProperty`

An individual representing the light property light magnitude.

6.1.1.7 s4envi:Luminescence

Is instance of: s4envi:LightProperty

An individual representing the light property luminescence.

6.1.1.8 s4envi:Phosphorescence

Is instance of: s4envi:LightProperty

An individual representing the light property phosphorescence.

6.1.1.9 s4envi:ReflectionOfLight

Is instance of: s4envi:LightProperty

An individual representing the light property reflection of light.

6.1.1.10 s4envi:ScatteringOfLight

Is instance of: s4envi:LightProperty

An individual representing the light property scattering of light.

6.1.2 Light

6.1.2.0 Overview

Figure 5 describes lights and their different properties.

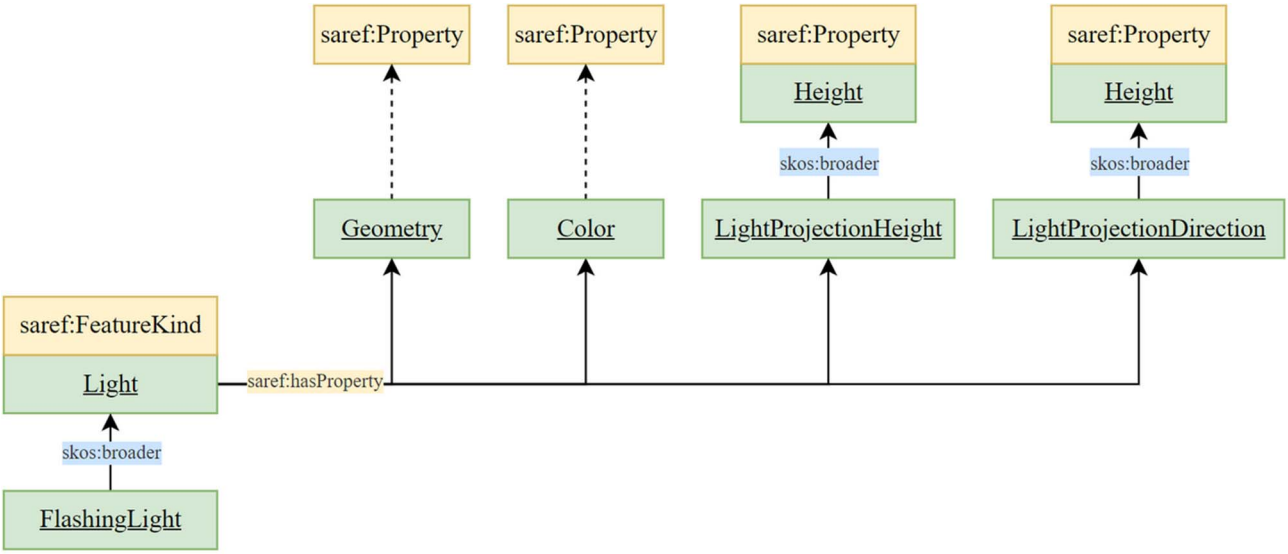

Figure 5: Light

6.1.2.1 Feature kind s4envi:Light

6.1.2.1.0 Definition

A light source, which may be a lantern, a street light, a floodlight, a signal lamp or any other device whose primary purpose is the generation of light. (Definition taken from [i.17].)

6.1.2.1.1 Property `s4envi:Geometry`

Is property of: `s4envi:Light`

The shape of a light emission. It may be described by individuals like "spherical", "cylindrical", etc. even though it is open to more complex representation of geometries using other vocabularies.

6.1.2.1.2 Property `s4envi:LightProjectionHeight`

Broader property: `s4envi:Height`

Is property of: `s4envi:Light`

The height from which a light is projected.

6.1.2.1.3 Property `s4envi:LightProjectionDirection`

Is property of: `s4envi:Light`

The direction in which a light is projected.

6.1.2.1.4 Feature kind `s4envi:FlashingLight`

Broader feature kind: `s4envi:Light`

A light source that has flash.

6.1.3 Light Point

6.1.3.0 Overview

Figure 6 describes light points and their different properties.

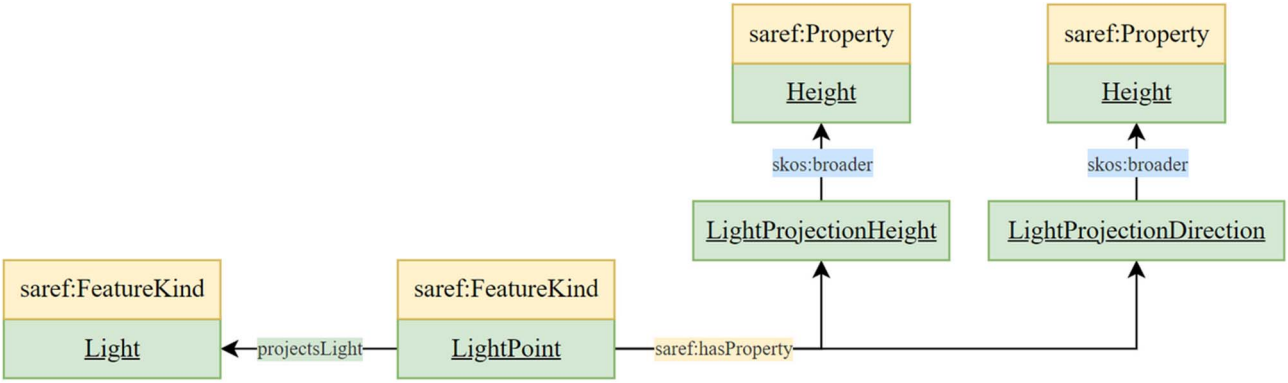

Figure 6: Light Point

6.1.3.1 Feature kind `s4envi:LightPoint`

6.1.3.1.0 Definition

A spatial point from where a light is projected. It might belong to a lamppost.

6.1.4 Lamppost

6.1.4.0 Overview

Figure 7 describes lampposts and their relationship to light points and to the light they project.

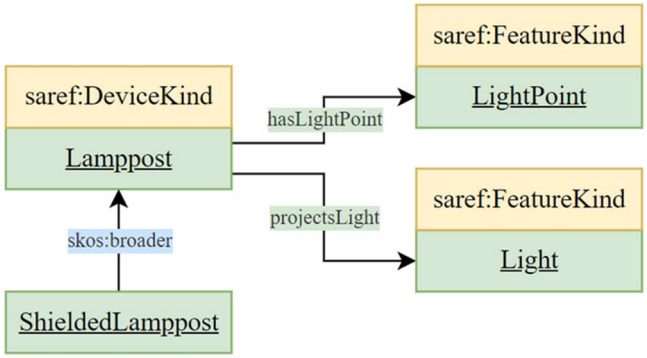

Figure 7: Lamppost

6.1.4.1 Device kind `s4envi:Lamppost`

A tall pole with a light at the top.

`s4envi:Lamppost` belongs to the eponym class `s4envi:Lamppost`. This class groups `s4envi:Lamppost`, narrower device kinds, and devices of this kind.

6.1.4.2 Device kind `s4envi:ShieldedLamppost`

Broader device kind: `s4envi:Lamppost`

A lampost with a shield.

6.1.4.3 Property `s4envi:hasLightPoint`

Is a: `owl:ObjectProperty`

Is sub-property of: `saref:consistsOf`

Domain: `s4envi:Lamppost`

Range: `s4envi:LightPoint`

Links: `s4envi:Lamppost` to `s4envi:LightPoint`

A relation between a lamppost and its light points.

6.1.4.4 Property `s4envi:projectsLight`

Is a: `owl:ObjectProperty`

Domain is union of: `s4envi:Lamppost`, `s4envi:LightPoint`

Range: `s4envi:Light`

Links: `s4envi:Lamppost` to `s4envi:Light`

A relation between a lamppost or a light point and the light (or lights) they might project.

6.1.5 Photometer and TESS

6.1.5.0 Overview

The present clause describes different kinds of sensors relevant to the lighting domain.

6.1.5.1 Sensor kind `s4envi:Photometer`

A photometer, generally, is an instrument that measures light intensity or optical properties of solutions or surfaces.

6.1.5.2 Sensor kind `s4envi:TESS`

Broader sensor kind: `s4envi:Photometer`

The Telescope Encoder and Sky Sensor (TESS) is a Sky Brightness and Cloud detector developed as a device for a remote observatory. A TESS can observe the light magnitude and other properties as ambient temperature and sky temperature.

6.2 Waste Management Domain

6.2.0 Overview

The Waste Managment Domain is divided into three modules: Waste, Collection and Treatment. They correspond chronologically to the three stages in the life of waste for which waste management systems are responsible, from the moment a resource becomes waste to the end of its life, which can occur when it is transformed into another resource or when it becomes final waste.

6.2.1 Waste

6.2.1.0 Overview

The Waste module of the Waste Management Domain covers waste, those who produce it and where, its type, and the containers in which it is disposed before collection.

Figure 8 provides an overview of the Waste module of SAREF4ENVI.

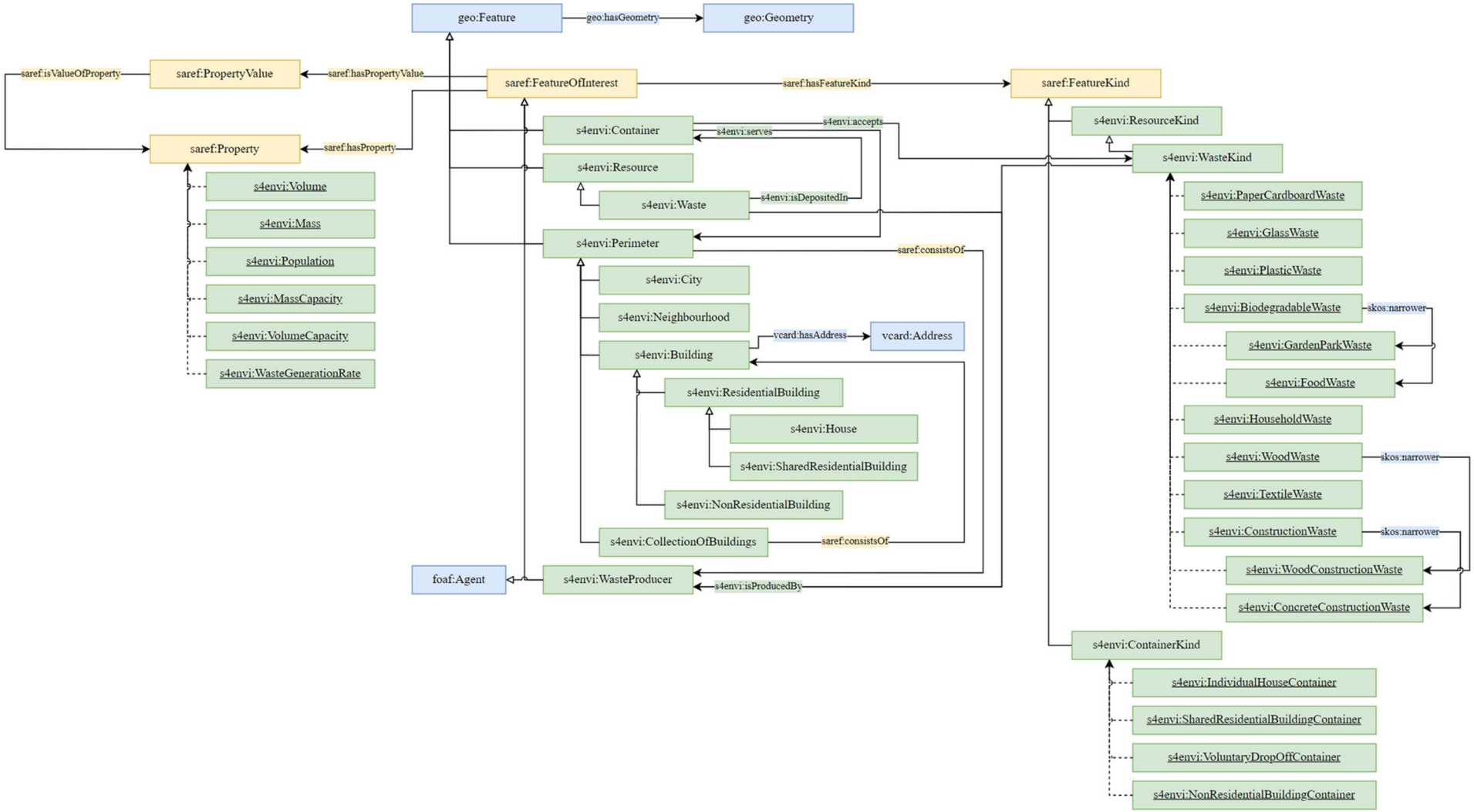

Figure 8: Overview of the SAREF4ENVI Waste module

6.2.1.1 Sub-classes of saref:FeatureOfInterest

6.2.1.1.1 Class s4envi:Container

6.2.1.1.1.0 Definition

Sub-class of: geo:Feature, saref:FeatureOfInterest

Vessel or receptacle used for the temporary holding of waste [i.7], clause 3.2.3.5.

6.2.1.1.1.1 Property s4envi:serves

Is a: owl:ObjectProperty

Domain: s4envi:Container

Range: s4envi:Perimeter

A container is intended to serve one perimeter.

6.2.1.1.1.2 Property s4envi:accepts

Is a: owl:ObjectProperty

Domain is union of: s4envi:Container, s4envi:WasteCollectionVehicleKind, s4envi:WasteProcessingDevice, s4envi:WasteProcessingSite

Range is union of: s4envi:ContainerKind, s4envi:WasteKind

A container, waste processing device, waste processing site or waste collection vehicle kind is intended to accept one or more waste kinds. A waste collection vehicle kind is intended to accept one or more container kinds.

6.2.1.1.2 Class s4envi:Perimeter

Sub-class of: geo:Feature, saref:FeatureOfInterest

Spatial extent considered as containing:

1) the attributee or attributees of a container; or
2) the generator or generators of a waste flux.

6.2.1.1.3 Class s4envi:Building

Sub-class of: s4envi:Perimeter

Construction works that has the provision of shelter for its occupants or contents as one of its main purposes, usually partially or totally enclosed and designed to stand permanently in one place [i.6], clause 3.1.1.3.

6.2.1.1.4 Class s4envi:NonResidentialBuilding

Sub-class of: s4envi:Building

Building for any use other than residential.

6.2.1.1.5 Class s4envi:ResidentialBuilding

Sub-class of: s4envi:Building

Building for residential use.

6.2.1.1.6 Class s4envi:House

Sub-class of: s4envi:ResidentialBuilding

Building designed as one dwelling [i.6], clause 3.1.4.5.

6.2.1.1.7 Class s4envi:SharedResidentialBuilding

Sub-class of: s4envi:ResidentialBuilding

Building containing more than one dwelling.

6.2.1.1.8 Class s4envi:City

Sub-class of: s4envi:Perimeter

Inhabited and urbanised place.

6.2.1.1.9 Class s4envi:CollectionOfBuildings

Sub-class of: s4envi:Perimeter

Multiple buildings, not necessarily grouped spatially and not necessarily sharing any characteristics.

6.2.1.1.10 Class s4envi:Neighbourhood

Sub-class of: s4envi:Perimeter

Any spatial subpart of a city.

6.2.1.1.11 Class s4envi:Resource

Sub-class of: geo:Feature, saref:FeatureOfInterest

Useful substances and objects.

6.2.1.1.12 Class s4envi:Waste

6.2.1.1.12.0 Definition

Sub-class of: s4envi:Resource

Substances or objects which are discarded, are intended to be discarded or are required to be discarded in accordance with national laws. Waste is a potential resource or commodity that could be turned into a useful product, recycled or recovered [i.7].

6.2.1.1.12.1 Property s4envi:isDepositedIn

Is a: owl:ObjectProperty

Domain: s4envi:Waste

Range: s4envi:Container

Waste is deposited in one container.

6.2.1.1.12.2 Property s4envi:isProducedBy

Is a: owl:ObjectProperty

Domain is union of: s4envi:Waste, s4envi:WasteKind

Range: s4envi:WasteProducer

Waste is produced by a waste producer. A waste kind is produced by a given waste producer at a given waste generation rate.

6.2.1.1.13 Class s4envi:WasteProducer

Sub-class of: foaf:Agent, saref:FeatureOfInterest

Person or organisation which produces waste from their own activities [i.7], clause 3.2.1.6.

6.2.1.2 Categories of saref:FeatureKind

6.2.1.2.1 Category of Feature Kind s4envi:ContainerKind

6.2.1.2.1.0 Definition

Sub-class of: saref:FeatureKind

Category of container.

6.2.1.2.1.1 s4envi:IndividualHouseContainer

Is instance of: s4envi:ContainerKind

Individual container attributed to a house.

6.2.1.2.1.2 s4envi:NonResidentialBuildingContainer

Is instance of: s4envi:ContainerKind

Container attributed to a non-residential building.

6.2.1.2.1.3 s4envi:SharedResidentialBuildingContainer

Is instance of: s4envi:ContainerKind

Shared container attributed to a residential building.

6.2.1.2.1.4 s4envi:VoluntaryDropOffContainer

Is instance of: s4envi:ContainerKind

Container not attributed to a building but rather located in a public area. Relies on the user voluntarily making the trip to the container to dispose of their waste.

6.2.1.2.2 Category of Feature Kind s4envi:ResourceKind

Sub-class of: saref:FeatureKind

Category of resource.

6.2.1.2.3 Category of Feature Kind s4envi:WasteKind

6.2.1.2.3.0 Definition

Sub-class of: s4envi:ResourceKind

Category of waste.

6.2.1.2.3.1 s4envi:BiodegradableWaste

Is instance of: s4envi:WasteKind

Waste that is biodegradable, such as food waste or waste from green spaces.

6.2.1.2.3.2 s4envi:FoodWaste

Is instance of: s4envi:WasteKind

Food that is discarded along the food chain [i.7], clause 3.1.2.7.

6.2.1.2.3.3 s4envi:GardenParkWaste

Is instance of: s4envi:WasteKind

Tree trunks and branches, plant parts and trimmings generated during the maintenance and pruning of trees and plants [i.7].

6.2.1.2.3.4 s4envi:ConcreteConstructionWaste

Is instance of: s4envi:WasteKind

Waste from discarded products and materials made of concrete, and which arises from construction, renovation or demolition activities [i.7], clause 3.1.2.4.

6.2.1.2.3.5 s4envi:ConstructionWaste

Is instance of: s4envi:WasteKind

Waste which arises from construction, renovation or demolition activities [i.7], clause 3.1.2.4.

6.2.1.2.3.6 s4envi:WoodConstructionWaste

Is instance of: s4envi:WasteKind

Waste from discarded products and materials made of wood, including pallets, crates, boxes, furniture and planks [i.7], clause 3.1.2.33 and which arises from construction, renovation or demolition activities [i.7], clause 3.1.2.4.

6.2.1.2.3.7 s4envi:GlassWaste

Is instance of: s4envi:WasteKind

Waste from discarded products and materials made of glass.

6.2.1.2.3.8 s4envi:HouseholdWaste

Is instance of: s4envi:WasteKind

Waste, but not hazardous waste, that arises from the domestic use of a private dwelling [i.6], clause 3.8.17.

6.2.1.2.3.9 s4envi:PaperCardboardWaste

Is instance of: s4envi:WasteKind

Waste from discarded products and materials made of paper and carboard.

6.2.1.2.3.10 s4envi:PlasticWaste

Is instance of: s4envi:WasteKind

Discarded material which contains as an essential ingredient a high polymer [i.7], clause 3.1.2.28.

6.2.1.2.3.11 s4envi:TextileWaste

Is instance of: s4envi:WasteKind

Waste from discarded products and materials made of textile.

6.2.1.2.3.12 s4envi:WoodWaste

Is instance of: s4envi:WasteKind

Waste from discarded products and materials made of wood, including pallets, crates, boxes, furniture and planks [i.7], clause 3.1.2.33.

6.2.1.3 Property s4envi:Mass

An individual representing the property mass.

6.2.1.4 Property s4envi:MassCapacity

Maximal capacity of a container in terms of mass.

6.2.1.5 Property s4envi:Population

Total number of people living within a perimeter.

6.2.1.6 Property s4envi:Volume

An individual representing the property volume.

6.2.1.7 Property s4envi:VolumeCapacity

Maximal capacity of a container in terms of volume.

6.2.1.8 Property s4envi:WasteGenerationRate

Rate at which waste is generated by a waste producer.

6.2.2 Collection

6.2.2.0 Overview

The Collection module of the Waste Management Domain covers waste collection, the vehicles used and the journeys made to do so.

Figure 9 provides an overview of the Waste Collection module of SAREF4ENVI.

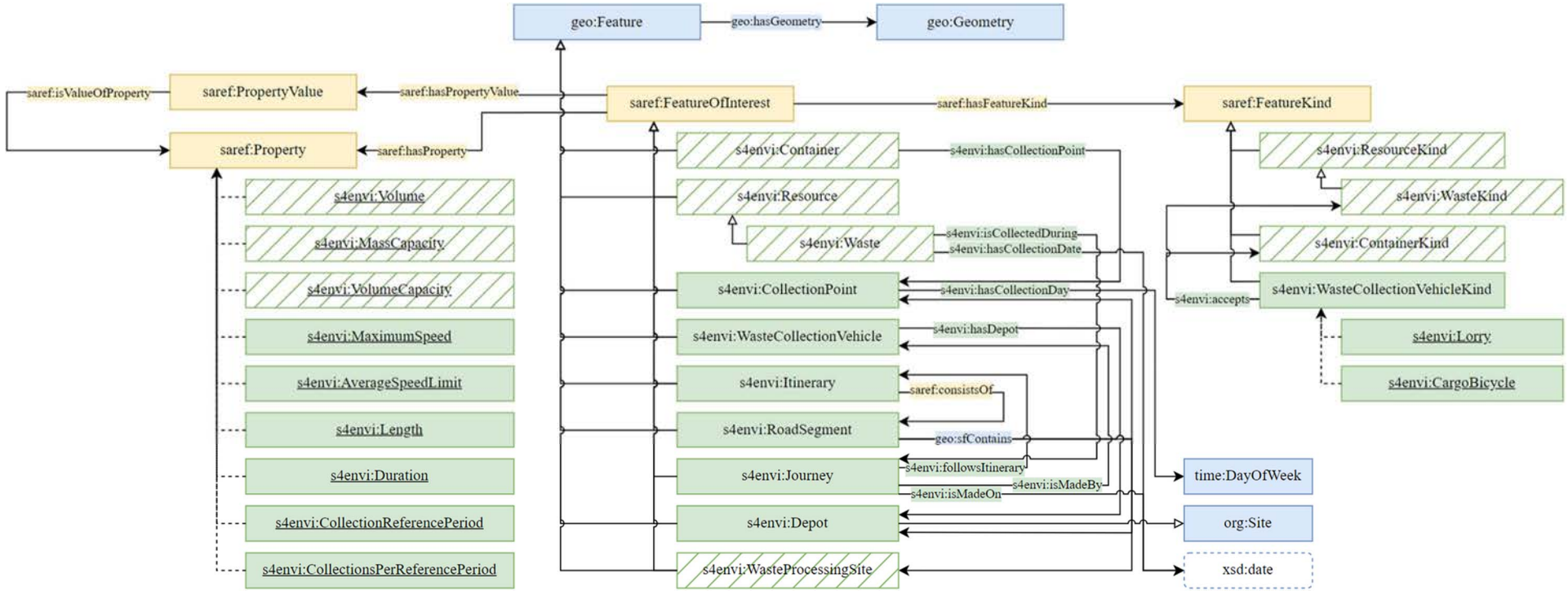

Figure 9: Overview of the SAREF4ENVI Collection modul

6.2.2.1 Sub-classes of saref:FeatureOfInterest

6.2.2.1.1 Class s4envi:CollectionPoint

6.2.2.1.1.0 Definition

Sub-class of: geo:Feature, saref:FeatureOfInterest

Point where waste is collected by refuse collection vehicle [i.7], clause 3.2.3.19.

6.2.2.1.1.1 Property s4envi:hasCollectionDay

Is a: owl:ObjectProperty

Domain: s4envi:CollectionPoint

Range: time:DayOfWeek

A collection point can be assigned one or more collection days.

6.2.2.1.2 Class s4envi:Depot

Sub-class of: geo:Feature, org:Site, saref:FeatureOfInterest

Site where waste collection vehicles are parked when not in use.

6.2.2.1.3 Class s4envi:Itinerary

Sub-class of: geo:Feature, saref:FeatureOfInterest

Set of road segments that make up the route taken by a waste collection vehicle, from its depot to the collection points on its round and finally to a waste processing site.

6.2.2.1.4 Class s4envi:Journey

6.2.2.1.4.0 Definition

Sub-class of: saref:FeatureOfInterest

Trip that has been made by a waste collection vehicle in reality, following an itinerary, to collect waste from collection points and take it to a waste processing site.

6.2.2.1.4.1 Property s4envi:followsItinerary

Is a: owl:ObjectProperty

Domain: s4envi:Journey

Range: s4envi:Itinerary

A journey follows a defined itinerary.

6.2.2.1.4.2 Property s4envi:isMadeBy

Is a: owl:ObjectProperty

Domain: s4envi:Journey

Range: s4envi:WasteCollectionVehicle

A journey is made by one waste collection vehicle.

6.2.2.1.4.3 Property s4envi:isMadeOn

Is a: owl:DatatypeProperty

Domain: s4envi:Journey

Range: xsd:date

A journey is made on a given date.

6.2.2.1.5 Class s4envi:RoadSegment

Sub-class of: geo:Feature, saref:FeatureOfInterest

Route taken by a waste collection vehicle between:

1) its depot and the first collection point on its round;
2) collection point n and collection point n+1 on its round; or
3) the last collection point on its round and a waste processing site.

6.2.2.1.6 Class s4envi:WasteCollectionVehicle

6.2.2.1.6.0 Definition

Sub-class of: geo:Feature, saref:FeatureOfInterest

Purpose-built vehicle for the collection and transport of waste, whereby the refuse is transferred by differential air pressure, a lifting device, mechanical means or hand [i.7], clause 3.2.2.6. In the case of human-powered waste collection vehicles, they are not necessarily purpose-built for the collection and transport of waste.

6.2.2.1.6.1 Property s4envi:hasDepot

Is a: owl:ObjectProperty

Domain: s4envi:WasteCollectionVehicle

Range: s4envi:Depot

A waste collection vehicle is assigned one depot.

6.2.2.2 Category of Feature Kind s4envi:WasteCollectionVehicleKind

6.2.2.2.0 Definition

Sub-class of: saref:FeatureKind

Category of waste collection vehicle.

6.2.2.2.1 s4envi:CargoBicycle

Is instance of: s4envi:WasteCollectionVehicleKind

Human-powered vehicle in the form of a bicycle (mechanical or electrical) featuring a storage area for transporting loads.

6.2.2.2.2 s4envi:Lorry

Is instance of: s4envi:WasteCollectionVehicleKind

Electric, gas-powered or internal-combustion engine vehicle featuring a rear storage area for transporting loads.

6.2.2.3 Property s4envi:AverageSpeedLimit

Mean speed limit for a road segment or an itinerary.

6.2.2.4 Property s4envi:CollectionReferencePeriod

To be used in conjunction with s4envi:CollectionsPerReferencePeriod to describe the frequency at which waste is collected from a collection point. Waste is collected from a collection point X times every Y [time unit], where X is the unitless value of s4envi:CollectionsPerReferencePeriod, Y is the value of s4envi:CollectionReferencePeriod and [time unit] is the unit of measurement of Y. For example, waste that is collected from a collection point 3 times every 2 weeks would have X = 3, Y = 2 and a [time unit] of 'week'.

6.2.2.5 Property s4envi:CollectionsPerReferencePeriod

To be used in conjunction with s4envi:CollectionReferencePeriod to describe the frequency at which waste is collected from a collection point. Waste is collected from a collection point X times every Y [time unit], where X is the unitless value of s4envi:CollectionsPerReferencePeriod, Y is the value of s4envi:CollectionReferencePeriod and [time unit] is the unit of measurement of Y. For example, waste that is collected from a collection point 3 times every 2 weeks would have X = 3, Y = 2 and a [time unit] of 'week'.

6.2.2.6 Property s4envi:Duration

Duration in time of a journey.

6.2.2.7 Property s4envi:Length

Length in distance of a journey or an itinerary.

6.2.2.8 Property s4envi:MaximumSpeed

Highest speed at which a waste collection vehicle can go.

6.2.2.9 Property s4envi:hasCollectionPoint

Is a: owl:ObjectProperty

Domain: s4envi:Container

Range: s4envi:CollectionPoint

A container can be assigned a collection point.

6.2.2.10 Property s4envi:isCollectedDuring

Is a: owl:ObjectProperty

Domain: s4envi:Waste

Range: s4envi:Journey

Waste is collected during a journey.

6.2.2.11 Property s4envi:hasCollectionDate

Is a: owl:DatatypeProperty

Domain: s4envi:Waste

Range: xsd:date

Waste has one collection date, the date on which it was initially collected.

6.2.3 Treatment

6.2.3.0 Overview

The Treatment module of the Waste Management Domain covers waste processing (pre-treatment, treatment, disposal), the methods that can be used for doing so, the organisations involved, the emissions produced, and the final outputs.

Figure 10 provides an overview of the Waste Treatment module of SAREF4ENVI.

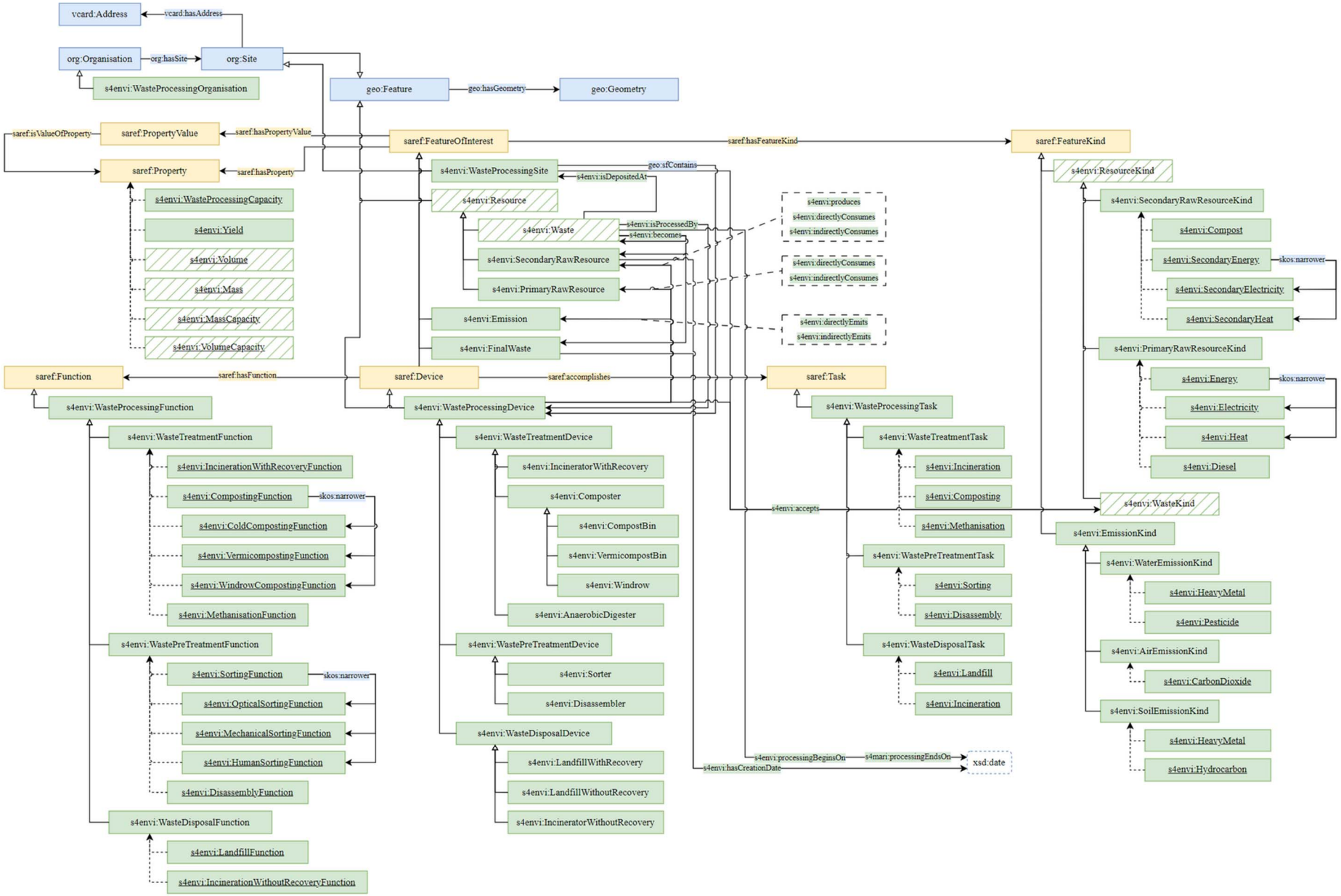

Figure 10: Overview of the Waste Treatment module of SAREF4ENVI

6.2.3.1 Class s4envi:WasteProcessingOrganisation

Organisation in the waste processing industry that has waste processing sites.

6.2.3.2 Sub-classes of saref:FeatureOfInterest

6.2.3.2.1 Class s4envi:Emission

Sub-class of: saref:FeatureOfInterest

Unwanted substance released into the air, water or soil.

6.2.3.2.2 Class s4envi:FinalWaste

Sub-class of: saref:FeatureOfInterest

State of waste that has been processed by a waste disposal device.

6.2.3.2.3 Property s4envi:hasCreationDate

Is a: owl:DatatypeProperty

Domain is union of: s4envi:FinalWaste, s4envi:SecondaryRawResource

Range: xsd:date

Final waste and secondary raw resources have a creation date that corresponds to the date on which their creation was completed.

6.2.3.2.4 Class s4envi:PrimaryRawResource

Sub-class of: saref:FeatureOfInterest, s4envi:Resource

Natural resource or energy that is used as a resource for the first time as input in a process or for creating a solution [i.9], clause 3.3.2.

6.2.3.2.5 Class s4envi:SecondaryRawResource

Sub-class of: saref:FeatureOfInterest, s4envi:Resource

Resource that is obtained from one that has already been processed or used [i.9], clause 3.3.5.

6.2.3.2.6 Class s4envi:WasteProcessingSite

Sub-class of: geo:Feature, org:Site, saref:FeatureOfInterest

Licensed plant in which waste is treated in accordance with the local laws [i.7], clause 3.1.3.20.

6.2.3.3 Categories of saref:FeatureKind

6.2.3.3.1 Category of Feature Kind s4envi:EmissionKind

Sub-class of: saref:FeatureKind

Category of emission.

6.2.3.3.2 Category of Feature Kind s4envi:AirEmissionKind

6.2.3.3.2.0 Definition

Sub-class of: s4envi:EmissionKind

Category of air emission.

6.2.3.3.2.1 s4envi:CarbonDioxide

Is instance of: s4envi:AirEmissionKind

Carbon dioxide, a greenhouse gas.

6.2.3.3.3 Category of Feature Kind s4envi:SoilEmissionKind

6.2.3.3.3.0 Definition

Sub-class of: s4envi:EmissionKind

Category of soil emission.

6.2.3.3.3.1 s4envi:HeavyMetal

Is instance of: s4envi:SoilEmissionKind, s4envi:WaterEmissionKind

Heavy metals are elements that are toxic to human health, animals and plants. Cadmium, mercury and lead are examples of heavy metals.

6.2.3.3.3.2 s4envi:Pesticide

Is instance of: s4envi:SoilEmissionKind

Substance or mixture of substances intended for preventing, destroying, repelling, or reducing any pest or weeds [i.10], clause 3.9.

6.2.3.3.4 Category of Feature Kind s4envi:WaterEmissionKind

6.2.3.3.4.0 Definition

Sub-class of: s4envi:EmissionKind

Category of water emission.

6.2.3.3.4.1 s4envi:Hydrocarbon

Is instance of: s4envi:WaterEmissionKind

Chemical compound consisting of hydrogen and carbon [i.11], clause 3.7.5.

6.2.3.3.5 Category of Feature Kind s4envi:PrimaryRawResourceKind

6.2.3.3.5.0 Definition

Sub-class of: saref:FeatureKind, s4envi:ResourceKind

Category of primary raw resource.

6.2.3.3.5.1 s4envi:Diesel

Is instance of: saref:FeatureKind, s4envi:PrimaryRawResourceKind

Hydrocarbon fuel, or blend thereof, that is liquid at atmospheric pressure and is used in compression-ignition engines [i.12], clause 3.7.

6.2.3.3.5.2 s4envi:Electricity

Is instance of: saref:FeatureKind, s4envi:PrimaryRawResourceKind

Energy in the form of electricity.

6.2.3.3.5.3 s4envi:Energy

Is instance of: saref:FeatureKind, s4envi:PrimaryRawResourceKind

A primary raw resource that can take the form of heat or electricity.

6.2.3.3.5.4 s4envi:Heat

Is instance of: saref:FeatureKind, s4envi:PrimaryRawResourceKind

Energy in the form of heat.

6.2.3.3.6 Category of Feature Kind s4envi:SecondaryRawResourceKind

6.2.3.3.6.0 Definition

Sub-class of: saref:FeatureKind, s4envi:ResourceKind

Category of secondary raw resource.

6.2.3.3.6.1 s4envi:Compost

Is instance of: saref:FeatureKind, s4envi:SecondaryRawResourceKind

Material obtained by decomposition of a mixture consisting principally of various vegetable residues, occasionally with organic materials of animal origin, and having a limited mineral content [i.13], clause 3.2.8.6.

6.2.3.3.6.2 s4envi:SecondaryElectricity

Is instance of: saref:FeatureKind, s4envi:SecondaryRawResourceKind

Electricity recovered from a previous use or from waste.

6.2.3.3.6.3 s4envi:SecondaryEnergy

Is instance of: saref:FeatureKind, s4envi:SecondaryRawResourceKind

Energy recovered from a previous use or from waste [i.18], clause 3.36.

6.2.3.3.6.4 s4envi:SecondaryHeat

Is instance of: saref:FeatureKind, s4envi:SecondaryRawResourceKind

Heat recovered from a previous use or from waste.

6.2.3.4 Class s4envi:WasteProcessingDevice

6.2.3.4.0 Definition

Sub-class of: saref:Device

Device that processes waste.

6.2.3.4.1 Property s4envi:directlyConsumes

Is a: owl:ObjectProperty

Domain: s4envi:WasteProcessingDevice

Range is union of: s4envi:PrimaryRawResource, s4envi:SecondaryRawResource

A waste processing device directly consumes one or more primary or secondary raw resources.

6.2.3.4.2 Property s4envi:directlyEmits

Is a: owl:ObjectProperty

Domain: s4envi:WasteProcessingDevice

Range: s4envi:Emission

A waste processing device directly emits one or more emissions.

6.2.3.4.3 Property s4envi:indirectlyConsumes

Is a: owl:ObjectProperty

Domain: s4envi:WasteProcessingDevice

Range is union of: s4envi:PrimaryRawResource, s4envi:SecondaryRawResource

A waste processing device indirectly consumes one or more primary or secondary raw resources.

6.2.3.4.4 Property s4envi:indirectlyEmits

Is a: owl:ObjectProperty

Domain: s4envi:WasteProcessingDevice

Range: s4envi:Emission

A waste processing device indirectly emits one or more emissions.

6.2.3.4.5 Property s4envi:produces

Is a: owl:ObjectProperty

Domain: s4envi:WasteProcessingDevice

Range is union of: s4envi:FinalWaste, s4envi:SecondaryRawResource

A waste processing device produces one or more secondary raw resources and/or final waste.

6.2.3.5 Class s4envi:WasteDisposalDevice

Sub-class of: s4envi:WasteProcessingDevice

Device that disposes of waste.

6.2.3.6 Class s4envi:IncineratorWithoutRecovery

Sub-class of: s4envi:WasteDisposalDevice

Device that performs the task of incineration without energy recovery.

6.2.3.7 Class s4envi:LandfillWithRecovery

Sub-class of: s4envi:WasteDisposalDevice

Device that performs the task of landfill with energy recovery.

6.2.3.8 Class s4envi:LandfillWithoutRecovery

Sub-class of: s4envi:WasteDisposalDevice

Device that performs the task of landfill without energy recovery.

6.2.3.9 Class s4envi:WastePreTreatmentDevice

Sub-class of: s4envi:WasteProcessingDevice

Device that pre-treats waste before the waste undergoes treatment or disposal.

6.2.3.10 Class s4envi:Disassembler

Sub-class of: s4envi:WastePreTreatmentDevice

Device that performs the task of disassembly.

6.2.3.11 Class s4envi:Sorter

Sub-class of: s4envi:WastePreTreatmentDevice

Device that performs the task of sorting.

6.2.3.12 Class s4envi:WasteTreatmentDevice

Sub-class of: s4envi:WasteProcessingDevice

Device that treats waste.

6.2.3.13 Class s4envi:AnaerobicDigester

Sub-class of: s4envi:WasteTreatmentDevice

Device that performs the task of methanisation.

6.2.3.14 Class s4envi:Composter

Sub-class of: s4envi:WasteTreatmentDevice

Device that performs the task of composting.

6.2.3.15 Class s4envi:CompostBin

Sub-class of: s4envi:Composter

Device that performs the task of composting via cold composting.

6.2.3.16 Class s4envi:Windrow

Sub-class of: s4envi:Composter

Device that performs the task of composting via windrow composting.

6.2.3.17 Class s4envi:IncineratorWithRecovery

Sub-class of: s4envi:WasteTreatmentDevice

Device that performs the task of incineration with energy recovery.

6.2.3.18 Category of Task s4envi:WasteProcessingTask

Sub-class of: saref:Task

Single step or a combination of multiple steps in which waste is handled via mechanical, chemical, thermal or biological processes with the aim of recovering material or energetic value and/or reducing the volume and environmental impact of the waste [i.7], clause 3.1.3.19.

6.2.3.19 Category of Task s4envi:WasteDisposalTask

6.2.3.19.0 Definition

Sub-class of: s4envi:WasteProcessingTask

Putting waste in an appropriate facility without the intention of recovery [i.7], clause 3.1.3.3.

6.2.3.19.1 s4envi:Incineration

Is instance of: s4envi:WasteDisposalTask, s4envi:WasteTreatmentTask

Thermal destruction of waste by a process of controlled high-temperature combustion with or without energy recovery [i.7], clause 3.1.3.6. Energy recovery is the process of treating waste products by thermal, chemical or biological processes to recover energy or products for energy production [i.7], clause 3.1.3.5.

6.2.3.19.2 s4envi:Landfill

Is instance of: s4envi:WasteDisposalTask

Deposition of waste into or onto the land as a means of disposal [i.15], clause 3.10.

6.2.3.20 Category of Task s4envi:WastePreTreatmentTask

6.2.3.20.0 Definition

Sub-class of: s4envi:WasteProcessingTask

Represents the task of pre-treating waste: preparing waste for treatment or disposal.

6.2.3.20.1 s4envi:Disassembly

Is instance of: s4envi:WastePreTreatmentTask

Taking apart of an assembled product into constituent materials and/or components [i.14], clause 3.1.3.

6.2.3.20.2 s4envi:Sorting

Is instance of: s4envi:WastePreTreatmentTask

Separating into different categories.

6.2.3.21 Category of Task s4envi:WasteTreatmentTask

6.2.3.21.0 Definition

Sub-class of: s4envi:WasteProcessingTask

Represents the task of treating waste.

6.2.3.21.1 s4envi:Composting

Is instance of: s4envi:WasteTreatmentTask

Aerobic process designed to produce compost [i.8], clause 3.2.

6.2.3.21.2 s4envi:Methanisation

Is instance of: s4envi:WasteTreatmentTask

Process of controlled decomposition of biodegradable materials under managed conditions where free oxygen is absent, at temperatures suitable for naturally occurring mesophilic or thermophilic anaerobic and facultative bacteria species, that convert the inputs to a methane rich biogas and digestate [i.8], clause 3.10.

6.2.3.22 Category of Function s4envi:WasteProcessingFunction

Sub-class of: saref:Function

Represents the functionality of processing (pre-treating, treating, disposing of) waste.

6.2.3.23 Category of Function s4envi:WasteDisposalFunction

6.2.3.23.0 Definition

Sub-class of: s4envi:WasteProcessingFunction

Represents the functionality of disposing of waste.

6.2.3.23.1 s4envi:IncinerationFunction

Is instance of: s4envi:WasteDisposalFunction, s4envi:WasteTreatmentFunction

Function of incinerating.

6.2.3.23.2 s4envi:LandfillFunction

Is instance of: s4envi:WasteDisposalFunction

Function of landfilling.

6.2.3.24 Category of Function s4envi:WastePreTreatmentFunction

6.2.3.24.0 Definition

Sub-class of: s4envi:WasteProcessingFunction

Represents the functionality of pre-treating waste.

6.2.3.24.1 s4envi:DisassemblyFunction

Is instance of: s4envi:WastePreTreatmentFunction

Function of disassembling.

6.2.3.24.2 s4envi:HumanSortingFunction

Is instance of: s4envi:WastePreTreatmentFunction

Function of sorting carrired out by a human.

6.2.3.24.3 s4envi:MechanicalSortingFunction

Is instance of: s4envi:WastePreTreatmentFunction

Function of sorting carried out by using mechanical forces.

6.2.3.24.4 s4envi:OpticalSortingFunction

Is instance of: s4envi:WastePreTreatmentFunction

Function of sorting carried out by using optical sensors.

6.2.3.24.5 s4envi:SortingFunction

Is instance of: s4envi:WastePreTreatmentFunction

Function of sorting.

6.2.3.25 Category of Function s4envi:WasteTreatmentFunction

6.2.3.25.0 Definition

Sub-class of: s4envi:WasteProcessingFunction

Represents the functionality of treating waste.

6.2.3.25.1 s4envi:ColdCompostingFunction

Is instance of: s4envi:WasteTreatmentFunction

Function of cold composting.

6.2.3.25.2 s4envi:CompostingFunction

Is instance of: s4envi:WasteTreatmentFunction

Function of composting.

6.2.3.25.3 s4envi:VermicompostingFunction

Is instance of: s4envi:WasteTreatmentFunction

Function of vermicomposting.

6.2.3.25.4 s4envi:WindrowCompostingFunction

Is instance of: s4envi:WasteTreatmentFunction

Function of windrow composting.

6.2.3.25.5 s4envi:MethanisationFunction

Is instance of: s4envi:WasteTreatmentFunction

Function of methanising.

6.2.3.26 Property s4envi:WasteProcessingCapacity

Maximal capacity of a waste processing site in terms of volume or mass of waste processed per unit of time.

6.2.3.27 Property s4envi:Yield

Ratio of input waste to output resource.

6.2.3.28 Property s4envi:becomes

Is a: owl:ObjectProperty

Domain: s4envi:Waste

Range is union of: s4envi:FinalWaste, s4envi:SecondaryRawResource

Waste becomes either a secondary raw resource, or final waste.

6.2.3.29 Property s4envi:isDepositedAt

Is a: owl:ObjectProperty

Domain: s4envi:Waste

Range: s4envi:WasteProcessingSite

Waste is deposited at a waste processing site.

6.2.3.30 Property s4envi:isProcessedBy

Is a: owl:ObjectProperty

Domain: s4envi:Waste

Range: s4envi:WasteProcessingDevice

Waste is processed by at least one waste processing device.

6.2.3.31 Property s4envi:processingBeginsOn

Is a: owl:DatatypeProperty

Domain: s4envi:Waste

Range: xsd:date

Waste begins being processed on a given date.

6.2.3.32 Property s4envi:processingEndsOn

Is a: owl:DatatypeProperty

Domain: s4envi:Waste

Range: xsd:date

Waste ends beging processed on a given date.

Annex A (informative): Bibliography

- ETSI TS 103 267: "SmartM2M; Smart Applications; Communication Framework".
- ETSI TS 102 689: "Machine-to-Machine communications (M2M); M2M Service Requirements".
- ETSI TS 118 101: "oneM2M; Functional Architecture (oneM2M TS-0001)".
- ETSI TS 118 102: "oneM2M; Requirements (oneM2M TS-0002)".

History

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