INSPIRE
Infrastructure for Spatial Information in Europe

D2.8.III.20 Data Specification on Energy Resources – Draft Guidelines

Title	D2.8.III.20 INSPIRE Data Specification on *Energy* Resources – Draft Guidelines
Creator	INSPIRE Thematic Working Group *Energy* Resources
Date	2012-02-24
Subject	INSPIRE Data Specification for the spatial data theme *Energy* Resources
Publisher	INSPIRE Thematic Working Group *Energy* Resources
Type	Text
Description	This document describes the INSPIRE Data Specification for the spatial data theme *Energy* Resources
Contributor	Members of the INSPIRE Thematic Working Group *Energy* Resources
Format	Portable Document Format (pdf)
Source	
Rights	Restricted to TWG members, DT DS and CT
Identifier	D2.8.III.20_v2.9
Language	En
Relation	Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE)
Coverage	Project duration

Change Log

Version	Changed Sections	Changes made
2.9	"all"	Changes in all sections based on the input and resolutions from the LMO/SDIC consultation
	Executive Summary	Minor update to consultation and testing reference
	2.2	Update of informal description
	2.4	Added new and updated existing terms and definitions
	5.2	Profound revision of existing application schema's. Update of ER UML model and related narrative parts. The *EnergyStatistics* application schema was added in order to provide link with the Statistics domain
	11	Update of portrayal based on the changes in Chapter 5
	Annex B	Reduction of use cases and update to the new template

Foreword
How to read the document?

This document describes the *"INSPIRE data specification on Energy Resources – Guidelines"* version 2.9 as developed by the Thematic Working Group (TWG) *Energy Resources* using both natural and a conceptual schema language.

The data specification is based on a common template used for all data specifications and has been harmonised using the experience from the development of the Annex I data specifications.

This document provides guidelines for the implementation of the provisions laid down in the draft Implementing Rule for spatial data sets and services of the INSPIRE Directive.

This document includes two executive summaries that provide a quick overview of the INSPIRE data specification process in general, and the content of the data specification on *Energy Resources* in particular. We highly recommend that managers, decision makers, and all those new to the INSPIRE process and/or information modelling should read these executive summaries first.

The UML diagrams (in Chapter 5) offer a rapid way to see the main elements of the specifications and their relationships. The definition of the spatial object types, attributes, and relationships are included in the Feature Catalogue (also in Chapter 5). People having thematic expertise but not familiar with UML can fully understand the content of the data model focusing on the Feature Catalogue. Users might also find the Feature Catalogue especially useful to check if it contains the data necessary for the applications that they run. The technical details are expected to be of prime interest to those organisations that are/will be responsible for implementing INSPIRE within the field of *Energy Resources.*

The technical provisions and the underlying concepts are often illustrated by examples. Smaller examples are within the text of the specification, while longer explanatory examples and descriptions of selected use cases are attached in the annexes.

In order to distinguish the INSPIRE spatial data themes from the spatial object types, the INSPIRE spatial data themes are written in *italics.*

The document will be publicly available as a 'non-paper'. It does not represent an official position of the European Commission, and as such cannot be invoked in the context of legal procedures.

Interoperability of Spatial Data Sets and Services – General Executive Summary

The challenges regarding the lack of availability, quality, organisation, accessibility, and sharing of spatial information are common to a large number of policies and activities and are experienced across the various levels of public authority in Europe. In order to solve these problems it is necessary to take measures of coordination between the users and providers of spatial information. The Directive 2007/2/EC of the European Parliament and of the Council adopted on 14 March 2007 aims at establishing an Infrastructure for Spatial Information in the European Community (INSPIRE) for environmental policies, or policies and activities that have an impact on the environment.

INSPIRE will be based on the infrastructures for spatial information that are created and maintained by the Member States. To support the establishment of a European infrastructure, Implementing Rules addressing the following components of the infrastructure are being specified: metadata, interoperability of spatial data themes (as described in Annexes I, II, III of the Directive) and spatial data services, network services and technologies, data and service sharing, and monitoring and reporting procedures.

INSPIRE does not require collection of new data. However, after the period specified in the Directive[1] Member States have to make their data available according to the Implementing Rules.

Interoperability in INSPIRE means the possibility to combine spatial data and services from different sources across the European Community in a consistent way without involving specific efforts of humans or machines. It is important to note that "interoperability" is understood as providing access to spatial data sets through network services, typically via Internet. Interoperability may be achieved by either changing (harmonising) and storing existing data sets or transforming them via services for publication in the INSPIRE infrastructure. It is expected that users will spend less time and efforts on understanding and integrating data when they build their applications based on data delivered within INSPIRE.

In order to benefit from the endeavours of international standardisation bodies and organisations established under international law their standards and technical means have been utilised and referenced, whenever possible.

To facilitate the implementation of INSPIRE, it is important that all stakeholders have the opportunity to participate in specification and development. For this reason, the Commission has put in place a consensus building process involving data users, and providers together with representatives of industry, research and government. These stakeholders, organised through Spatial Data Interest Communities (SDIC) and Legally Mandated Organisations (LMO)[2], have provided reference materials, participated in the user requirement and technical[3] surveys, proposed experts for the Data Specification Drafting Team[4] and Thematic Working Groups[5] and participated in the public stakeholder

[1] For all 34 Annex I,II and III data themes: within two years of the adoption of the corresponding Implementing Rules for newly collected and extensively restructured data and within 5 years for other data in electronic format still in use

[2] The current status of registered SDICs/LMOs is available via INSPIRE website: *http://inspire.jrc.ec.europa.eu/index.cfm/pageid/42*

[3] Surveys on unique identifiers and usage of the elements of the spatial and temporal schema,

[4] The Data Specification Drafting Team has been composed of experts from Austria, Belgium, Czech Republic, France, Germany, Greece, Italy, Netherlands, Norway, Poland, Switzerland, UK, and the European Environmental Agency

[5] The Thematic Working Groups of Annex II and III themes have been composed of experts from Austria, Belgium, Bulgaria, Czech Republic, Denmark, Finland, France, Germany, Hungary, Ireland, Italy, Latvia, Netherlands, Norway, Poland, Romania, Slovakia, Spain, Sweden, Switzerland, Turkey, UK, the European Commission, and the European Environmental Agency

consultations on draft versions of the data specifications. These consultations covered expert reviews as well as feasibility and fitness-for-purpose testing of the data specifications[6].

This open and participatory approach was successfully used during the development of the data specification on Annex I data themes as well as during the preparation of the Implementing Rule on Interoperability of Spatial Data Sets and Services[7] for Annex I spatial data themes.,

The development framework elaborated by the Data Specification Drafting Team aims at keeping the data specifications of the different themes coherent. It summarises the methodology to be used for the data specifications and provides a coherent set of requirements and recommendations to achieve interoperability. The pillars of the framework are five technical documents:

- The Definition of Annex Themes and Scope[8] describes in greater detail the spatial data themes defined in the Directive, and thus provides a sound starting point for the thematic aspects of the data specification development.

- The Generic Conceptual Model[9] defines the elements necessary for interoperability and data harmonisation including cross-theme issues. It specifies requirements and recommendations with regard to data specification elements of common use, like the spatial and temporal schema, unique identifier management, object referencing, a generic network model, some common code lists, etc. Those requirements of the Generic Conceptual Model that are directly implementable will be included in the Implementing Rule on Interoperability of Spatial Data Sets and Services.

- The Methodology for the Development of Data Specifications[10] defines a repeatable methodology. It describes how to arrive from user requirements to a data specification through a number of steps including use-case development, initial specification development and analysis of analogies and gaps for further specification refinement.

- The "Guidelines for the Encoding of Spatial Data"[11] defines how geographic information can be encoded to enable transfer processes between the systems of the data providers in the Member States. Even though it does not specify a mandatory encoding rule it sets GML (ISO 19136) as the default encoding for INSPIRE.

- The "Guidelines for the use of Observations & Measurements and Sensor Web Enablement-related standards in INSPIRE Annex II and III data specification development" provides guidelines on how the "Observations and Measurements" standard (ISO 19156) is to be used within INSPIRE.

The structure of the data specifications is based on the "ISO 19131 Geographic information - Data product specifications" standard. They include the technical documentation of the application schema, the spatial object types with their properties, and other specifics of the spatial data themes using natural language as well as a formal conceptual schema language[12].

A consolidated model repository, feature concept dictionary, and glossary are being maintained to support the consistent specification development and potential further reuse of specification elements. The consolidated model consists of the harmonised models of the relevant standards from the ISO

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[6] For Annex II+III, the consultation phase lasted from 20 June to 21 October 2011.
[7] Commission Regulation (EU) No 1089/2010 implementing Directive 2007/2/EC of the European Parliament and of the Council as regards interoperability of spatial data sets and services, published in the Official Journal of the European Union on 8th of December 2010.
[8] *http://inspire.jrc.ec.europa.eu/reports/ImplementingRules/DataSpecifications/D2.3_Definition_of_Annex_Themes_and_scope_v3.0.pdf*
[9] *http://inspire.jrc.ec.europa.eu/reports/ImplementingRules/DataSpecifications/D2.5_v3.3.pdf*
[10] *http://inspire.jrc.ec.europa.eu/reports/ImplementingRules/DataSpecifications/D2.6_v3.0.pdf*
[11] *http://inspire.jrc.ec.europa.eu/reports/ImplementingRules/DataSpecifications/D2.7_v3.2.pdf*
[12] UML – Unified Modelling Language

19100 series, the INSPIRE Generic Conceptual Model, and the application schemas[13] developed for each spatial data theme. The multilingual INSPIRE Feature Concept Dictionary contains the definition and description of the INSPIRE themes together with the definition of the spatial object types present in the specification. The INSPIRE Glossary defines all the terms (beyond the spatial object types) necessary for understanding the INSPIRE documentation including the terminology of other components (metadata, network services, data sharing, and monitoring).

By listing a number of requirements and making the necessary recommendations, the data specifications enable full system interoperability across the Member States, within the scope of the application areas targeted by the Directive. Once finalised (version 3.0), the data specifications are published as technical guidelines and provide the basis for the content of the Implementing Rule on Interoperability of Spatial Data Sets and Services[14]. The content of the Implementing Rule is extracted from the data specifications keeping in mind short- and medium-term feasibility as well as cost-benefit considerations. The requirements included in the Implementing Rule will be legally binding for the Member States according to the timeline specified in the INSPIRE Directive.

In addition to providing a basis for the interoperability of spatial data in INSPIRE, the data specification development framework and the thematic data specifications can be reused in other environments at local, regional, national and global level contributing to improvements in the coherence and interoperability of data in spatial data infrastructures.

[13] Conceptual models related to specific areas (e.g. INSPIRE themes)

[14] In the case of the Annex II+III data specifications, the extracted requirements will be used to formulate an amendment to the existing Implementing Rule.

Energy Resources – Executive Summary

Purpose
The INSPIRE Directive (2007/2/EC, 14.03.2007) defines the spatial data theme Energy Resources as the: "**Energy Resources including hydrocarbons, hydropower, bio-energy, solar, wind, etc., where relevant including depth/height information on the extent of the resource.**" *Energy Resources* are included in Annex III with the aim to provide an essential thematic frame, allowing exchange of Energy Resources related spatial information across Europe in an interoperable way.

The main purpose of this specification is to allow identification of geographical locations of Energy Resources, providing information about their extent (where possible and relevant). The topic of *Energy Resources* plays a very important role nowadays and this data specification reflects all the main aspects of this domain providing a harmonised structure for various energy resource types across the member states as well as links to the other related domains.

Information about location and the potential of Energy Resources can have significant impact on the environment. This impact can be represented by positive as well as negative aspects, therefore appropriate knowledge about the extent, distribution and volumes of the resources plays an important role.

The provision and implementation of this harmonised data specification should significantly contribute to the main priorities, targets and flagship initiatives of Europe 2020 strategy[15] within the mechanisms of establishing a European spatial data infrastructure.

Scope and description
The data specification scope was delineated by the theme definition and further elaborated, taking into consideration reference material and use cases provided by the stakeholders as well as identified by the members of the INSPIRE Thematic Working Group for Energy Resources (TWG ER). In addition contribution received via public consultation and testing of the Data Specification of Energy Resources ver.2 allowed to adjust current structure with the requirements and recommendations expressed by representatives of stakeholders communities.

Detailed interpretation and description of the Energy Resources theme matured to create the core of the data specification with possibilities for extensions for specific sub-domain / national needs. The whole concept of the data specification was based on modelling needs to cover existing and potential Energy Resources. With this, the requirement distinguishing between renewable and non-renewable Energy Resources had to be taken into consideration. This approach generates requirements to cover feature as well as coverage spatial data representations.

A significant part of the detailed information under the domain covered by this theme falls within the private sector therefore aggregations and overview data are the main focus of this data specification. Nevertheless, where possible, this data specification retains the possibility to exchange detailed information on local level.

Energy Resources do not stand autonomously and there are a number of connections to other INSPIRE themes. These connections were discussed during the development process with the main aim to ensure consistency and reduce multiplicities.

Conclusion & Future
The main value of the INSPIRE Energy Resources data specification is in providing the framework for Energy Resources related spatial data exchange. In addition this framework is characterised by its versa-tile yet flexible structure. Data providers are thus able to publish their existing data in the most convenient way and users can easily discover, evaluate and use appropriate data for their specific needs. As soon as new generic or theme specific needs and requirements are identified, appropriate activities within the framework of INSPIRE implementation and maintenance will have to take place.

[15] Europe 2020 Strategy (*http://ec.europa.eu/europe2020/priorities/sustainable-growth/index_en.htm*)

Acknowledgements

Many individuals and organisations have contributed to the development of these Guidelines.

The Thematic Working Group Energy Resources (ER) included:
Martin Tuchyna (European Commission contact point, TWG Facilitator), Diederik Tirry (TWG Editor), Pablo Burgos Casado, Radoslav Chudy, Søren Elkjær Kristensen, Gijs Remmelts, Chris Rhodes, Peter Semrad, Marta Szabo, Marcel Suri and Lisa Thomas.

Other contributors to the INSPIRE data specifications are the Drafting Team Data Specifications, the JRC data specifications team and the INSPIRE stakeholders - Spatial Data Interested Communities (SDICs) or Legally Mandated Organisations (LMOs).

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Table of contents

1 Scope

This document specifies a harmonised data specification for the spatial data theme *Energy Resources* as defined in Annex III of the INSPIRE Directive.

This data specification provides the basis for the drafting of Implementing Rules according to Article 7 (1) of the INSPIRE Directive [Directive 2007/2/EC]. The entire data specification will be published as implementation guidelines accompanying these Implementing Rules.

2 Overview

2.1 Name

INSPIRE data specification for the theme Energy Resources.

2.2 Informal description

Definition:

Energy resources including hydrocarbons, hydropower, bio-energy, solar, wind, etc., where relevant including depth/height information on the extent of the resource. [Directive 2007/2/EC]

Description:

Energy resources within the INSPIRE context are features defining an inferred or observable spatial extent of a resource that can be, or has been, used as a source of energy [DER 2011]. Considering the INSPIRE definition as well as scope of the remaining INSPIRE themes, Energy Resources are covering both subcategories of primary energy resources: non-renewable and renewable resources. Ensuring the domain consistency a set of common base Energy Resource types is introduced within this data specification.
Considering different viewpoints for representing energy resources this data specification is supporting both discrete and continuous features representations depending on the chosen universe of discourse. The concept of energy resources provides focus to the resource type aspect, documenting of relevant classifications, extent/distribution/potential of the resources, their quantification as well as unified approach for units of measurement. In addition support for the energy resources statistics will provide the opportunity to monitor the energy situation at country level as well as at international level.
Data specification on Energy Resources provides a generic and modular framework for harmonisation of spatial data exchange within the energy related domains and provides important bridge for communicating and networking with new domains.

Data Specification Objective:

The INSPIRE Data Specification on Energy Resources provides an answer to the need for establishing a harmonised framework allowing the exchange of Energy Resources related spatial information across Europe and, where possible, at the wider international level.

Despite the occurrence of economic recessions, global energy consumption is increasing the dependency of society on energy as a whole. Whilst trying to find solutions as to where and how to investigate for further alternative energy resources, it is important to keep in mind the need to deal with these requirements responsibly with appropriate initiatives and actions.

With the availability of non-renewable energy resources in decline and with limited utilisation of renewable energy resources, this underlines the importance for establishment of appropriate activities ensuring an effective utilisation of energy resources.

The data specification for Energy Resources provides the mechanism for exchanging and comparing energy resources related information where it can be defined within a spatial context. This context can help to identify wider and more complex dependencies placed upon energy resources and their related activities in different countries as well as providing a synthetic overview of the state of play of energy resources within the wider context.

Data Specification Process:

This Data Specification had to be defined following the requirements of the INSPIRE Directive as well as Commission Regulation implementing Directive 2007/2/EC of the European Parliament and of the Council as regards the interoperability of spatial data sets and services.

Data Specification framework documents, user requirements and use cases defined by stakeholders as well as TWG ER members, ongoing standardisation activities, including related projects, initiatives, stakeholders consultation and testing and best practices from national, cross-border and international also played an important role in the creation of this data specification.

The INSPIRE data specification on *Energy Resources* has been prepared following the participative principle of consensus building process. The stakeholders, based on their registration as SDICs or LMOs[16] had the opportunity to bring forward user requirements and reference materials, propose experts for the Thematic Working Groups (TWGs) responsible for the specification development, and to participate in the consultation (review) and testing of the data specifications.

TWG ER was composed of experts from Belgium, Hungary, Netherlands, Norway, Spain, Slovakia, United Kingdom and the European Commission.

The specification process took place according to the methodology detailed for INSPIRE respecting the requirements and the recommendations of the INSPIRE Generic Conceptual Model, which is one of the elements that ensures coherent approach and cross theme consistency with other themes in the Directive.

The TWG ER has established connection with other initiatives within the field, such as the Expert Group on Resource Classification of the United Nations Economic Commission for Europe[17], EuroGeoSurveys[18] and EuroGeoSource project[19] as well as related INSPIRE TWGs.

Scope of the Energy Resources Theme:

In order to delineate the scope of energy resources, established relevant legislative framework was taken into the consideration. This approach was chosen in order to reuse where possible already established information exchange agreements with aim to reduce any additional burden on the related communities.

Based on the above most relevant guiding reference with regard to Energy Resources in Europe is the Energy Statistics Regulation EC 1099/2008 which provides generic domain coverage and a basis for

[16] INSPIRE Stakeholders (*http://inspire.jrc.ec.europa.eu/index.cfm/pageid/42*)
[17] UNFC (*http://unece.org/energy/se/reserves.html*)
[18] EuroGeoSurveys (*http://www.eurogeosurveys.org/*)
[19] EuroGeoSource (*http://www.eurogeosource.eu/*)

the extent of the theme scope for the primary energy resources. Energy statistics are often used to communicate energy resources related information to the various communities.

Based on the above scope delineation it is possible to distinguish two energy forms:

- ***Primary energy:*** *is an energy form found in nature that has not been subjected to any conversion or transformation process.* Primary energy can be *non-renewable* or *renewable*.
- ***Secondary energy (Energy Carriers):*** *Primary energy sources are transformed by energy conversion processes (via Energy systems) to more convenient forms of energy (that can directly be used by society), such as electrical energy, refined fuels, or synthetic fuels such as hydrogen fuel.*

Within the INSPIRE context only Primary Energy Resources are considered as relevant, but connection via statistics allows links to be made to the secondary energy form.

The theme “Energy Resources” refers to geographical areas that have been, are currently, or will be in the future mapped to indicate the presence and (potential) availability of Energy Resources. The mapping of these areas is the result from both public and private initiatives and can be conducted at pan-European, national and local level. The concept of Energy Resources provides focus to the resource aspect and the extent/distribution of the resources.

Energy Resources may be located in terrestrial, aquatic and/or marine environments, and may be under either public or private ownership. This theme covers the entire lifecycle of Energy Resources, irrespective of its viability in terms of economic, social and technological aspects. It takes into account resources that are depleted due to exploitation in the past and resources currently not viable but may become so in the future.

The central concept of this theme is to provide means for distributing and exchanging information on the spatial extent and type of previous, current or potential sources of energy. With this, the requirement distinguishing between renewable energy and waste resources on the one hand and non-renewable resources on the other hand had to be taken into consideration:

- **Non-renewables**: Natural resources which, due to long-term formation, cannot be produced, grown, generated, or used on a scale which can sustain its consumption rate. These resources exist in a fixed amount, or are consumed much faster than nature can replenish them.

- **Renewables and waste**: Renewable Energy Resources are derived from natural processes that are replenished constantly. They are widely abundant all over the Earth, but their energy intensity per unit area is typically smaller compared to non-renewable resources. In their various forms, they cover energy needs in all sectors: power generation, hot water and space heating, and transport fuels. Waste is a fuel consisting of many materials coming from combustible industrial, institutional, hospital and household wastes such as rubber, plastics, waste fossil oils and other similar commodities. It is either solid or liquid in form, renewable or non-renewable, biodegradable or non-biodegradable.

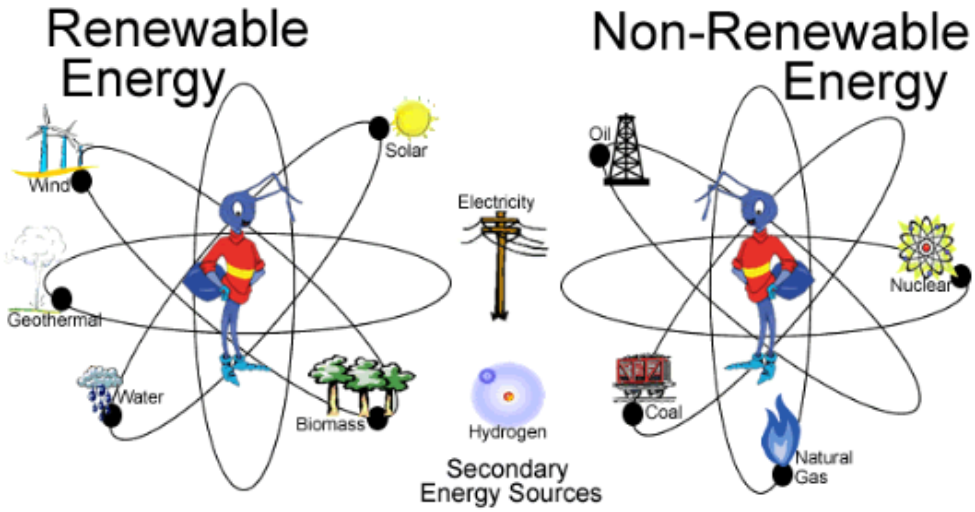


Figure 1 - Renewable and Non-Renewable Energy Types[20]

There are different approaches to describe spatial features representing various types of Energy Resources. On the one hand the occurrence of Energy Resources can be considered as discrete, well-defined features, on the other hand properties of Energy Resources, and in particular renewable energy, can be assessed in a continuous way within a domain of interest. As a consequence of these two different approaches it generated a requirement to cover both feature as well as coverage spatial data representations.

Knowing the spatial representation and location of energy resources will allow data providers to provide information about the resource type, quantification as well as level of resource utilisation to data users..

To meet this requirement Energy Resources have been modelled via four application schemas providing a description of the semantic structure of the dataset:

- The *EnergyResourcesBase* application schema provides a base set of common Energy Resource classes including coded values for the classification of Energy Resources that fall within the scope of this theme.
- The *EnergyResourcesVector* application schema provides the means for modelling discrete spatial features representing fossil fuels and renewables & waste resources.
- The *EnergyResourcesCoverage* application schema provides a simple scheme for assessing the variation of energy potential of renewable and waste resources.
- The *EnergyResourcesStatistics* application schema is a scheme specifically elaborated for exchanging aggregated data (statistical information) on the quantification of energy resources. It is expected that detailed information on the amount of resources is to a large extent private commercial information.

These application schemas contain definitions and descriptions of all the main energy resource types. A detailed description of the application schemas is provided in chapter 5.

Exclusions and anomalies within the theme scope:

The following features, which have correlations with other INSPIRE themes, have been assessed for inclusion within this theme but, following discussions with the relevant Thematic Working Group, it was

[20] U.S. Energy Information Administration
(http://www.eia.doe.gov/kids/energyfacts/sources/whatsenergy.html)

concluded that, to avoid duplication they would not be covered within this theme if it was more relevant for the features to be included elsewhere. More information can be obtained within Chapter 5.

- Secondary Energy Resources, e.g. electricity, are not included within this theme.
- The technical constructions for abstraction, transport and treatment, these are largely covered by Production and industrial facilities.
- Energy use e.g. petrol consumption is not included within this theme.
- Uranium and Thorium as energy resource types are modelled within the Mineral Resources data specification. These elements are exploited together with other minerals and therefore more relevant to the Mineral Resources Data Specification.
- Basic data for wind and temperature distributions are modelled within the Atmospheric Conditions data specification
- Hydro-power plants is a candidate type inherited from the Annex I Hydrography specification. It was decided that this feature is not within the scope of this theme.
- Aerothermal energy resource is covered by the Atmospheric Conditions theme.
- Although an energy resource type of biogas can be derived from a landfill feature type (currently modelled within Production and Industrial Facilities), biogas retained within the Energy Resources code lists in order that it is possible to define a future area of interest with an estimation of the energy production value.
- Smart grids have been assessed but regarded as not relevant for this theme.
- Storage of energy resources based on natural constructions (lakes for hydro, or empty natural reservoirs) are considered within the scope of Energy Resources.

2.3 Normative References

[Directive 2007/2/EC] Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE)

[ISO 19107] EN ISO 19107:2005, Geographic Information – Spatial Schema

[ISO 19108] EN ISO 19108:2005, Geographic Information – Temporal Schema

[ISO 19108-c] ISO 19108:2002/Cor 1:2006, Geographic Information – Temporal Schema, Technical Corrigendum 1

[ISO 19111] EN ISO 19111:2007 Geographic information - Spatial referencing by coordinates (ISO 19111:2007)

[ISO 19113] EN ISO 19113:2005, Geographic Information – Quality principles

[ISO 19115] EN ISO 19115:2005, Geographic information – Metadata (ISO 19115:2003)

[ISO 19118] EN ISO 19118:2006, Geographic information – Encoding (ISO 19118:2005)

[ISO 19123] EN ISO 19123:2007, Geographic Information – Schema for coverage geometry and functions

[ISO 19135] EN ISO 19135:2007 Geographic information – Procedures for item registration (ISO 19135:2005)

[ISO 19138] ISO/TS 19138:2006, Geographic Information – Data quality measures

[ISO 19139] ISO/TS 19139:2007, Geographic information – Metadata – XML schema implementation

[ISO 19157] ISO/DIS 19157, Geographic information – Data quality

[OGC 06-103r3] Implementation Specification for Geographic Information - Simple feature access – Part 1: Common Architecture v1.2.0

NOTE This is an updated version of "EN ISO 19125-1:2006, Geographic information – Simple feature access – Part 1: Common architecture". A revision of the EN ISO standard has been proposed.

[Regulation 1205/2008/EC] Regulation 1205/2008/EC implementing Directive 2007/2/EC of the European Parliament and of the Council as regards metadata

2.4 Terms and definitions

General terms and definitions helpful for understanding the INSPIRE data specification documents are defined in the INSPIRE Glossary[21].

Specifically, for the theme Energy Resources, the following terms are defined:

(1) Primary energy
Energy that has not been subjected to any conversion or transformation process.

(2) Secondary energy (Energy carriers)
Secundary energy is an energy form which has been transformed from primary energy sources. Electricity is one of the most common energy carriers, being transformed from various primary energy sources such as coal, oil, natural gas, and wind.

(3) Non-renewable energy
Natural resources which, due to long-term formation, cannot be produced, grown, generated, or used on a scale which can sustain its consumption rate. These resources exist in a fixed amount, or are consumed much faster than nature can replenish them.

(4) Renewable energy
Any naturally occurring, theoretically inexhaustible, source of energy that is not derived from fossil or nuclear fuel. Renewable energy resources are derived from natural processes that are replenished constantly. They are widely abundant all over the Earth, but their energy intensity per unit area is typically smaller compared to non-renewable resources.

(5) Energy resource
A concentration or occurrence of an energy source which may have been present in the past, is present currently or identified for the future.

2.5 Symbols and abbreviations

EC	European Commission
ER	Energy Resources
GCM	Generic Conceptual Model
IEA	International Energy Agency
OECD	Organisation for Economic Co-operation and Development
TWG	Thematic Working Group

[21] The INSPIRE Glossary is available from http://inspire-registry.jrc.ec.europa.eu/registers/GLOSSARY

2.6 Notation of requirements and recommendations

To make it easier to identify the mandatory requirements and the recommendations for spatial data sets in the text, they are highlighted and numbered.

IR Requirement X	Requirements that are reflected in the Implementing Rule on interoperability of spatial data sets and services are shown using this style.

TG Requirement X	Requirements that are not reflected in the Implementing Rule on interoperability of spatial data sets and services are shown using this style.

Recommendation X	Recommendations are shown using this style.

2.7 Conformance

TG Requirement 1	Any dataset claiming conformance with this INSPIRE data specification shall pass the requirements described in the abstract test suite presented in Annex A.

3 Specification scopes

This data specification does not distinguish different specification scopes, but just considers one general scope.

NOTE For more information on specification scopes, see [ISO 19131:2007], clause 8 and Annex D.

4 Identification information

NOTE Since the content of this chapter was redundant with the overview description (section 2) and executive summary, it has been decided that this chapter will be removed in v3.0.

5 Data content and structure

This data specification defines the following application schemas:

- The *EnergyResourcesBase* application schema provides a base set of common Energy Resource classes including coded values for the classification of Energy Resources that fall within the scope of this theme.
- The *EnergyResourcesVector* application schema provides the means for modelling discrete spatial features representing fossil fuels and renewables & waste resources.
- The *EnergyResourcesCoverage* application schema provides a simple scheme for assessing the variation of energy potential of renewable and waste resources.
- The *EnergyResourcesStatistics* application schema is a scheme specifically elaborated for exchanging aggregated data (statistical information) on the quantification of energy resources. It is expected that detailed information on the amount of resources is to a large extent private commercial information.

IR Requirement 1	Spatial data sets related to the theme Energy Resources shall be made available using the spatial object types and data types specified in the following application schema(s): EnergyResourcesBase, EnergyResourcesVector, and EnergyResourcesCoverage. These spatial object types and data types shall comply with the definitions and constraints and include the attributes and association roles defined in this section.

Recommendation 1	The reason for a void value should be provided where possible using a listed value from the VoidValueReason code list to indicate the reason for the missing value.

NOTE The application schema specifies requirements on the properties of each spatial object including its multiplicity, domain of valid values, constraints, etc. All properties have to be reported, if the relevant information is part of the data set. Most properties may be reported as “void”, if the data set does not include relevant information. See the Generic Conceptual Model [DS-D2.5] for more details.

In addition to the application schemas listed in IR Requirement 1, additional application schemas have been defined for the theme *Energy Resources*. These additional application schemas typically address requirements from specific (groups of) use cases and/or may be used to provide additional information. They are included in this specification in order to improve interoperability also for these additional aspects.

Recommendation 2	Additional and/or use case-specific information related to the theme *Energy Resources* should be made available using the spatial object types and data types specified in the following application schema(s): EnergyResourcesStatistics. These spatial object types and data types should comply with the definitions and constraints and include the attributes and association roles defined in this section.

5.1 Basic notions

This section explains some of the basic notions used in the INSPIRE application schemas. These explanations are based on the GCM [DS-D2.5].

5.1.1 Stereotypes

In the application schemas in this sections several stereotypes are used that have been defined as part of a UML profile for use in INSPIRE [DS-D2.5]. These are explained in Table 1 below.

Table 1 – Stereotypes (adapted from [DS-D2.5])

Stereotype	Model element	Description
applicationSchema	Package	An INSPIRE application schema according to ISO 19109 and the Generic Conceptual Model.
leaf	Package	A package that is not an application schema and contains no packages.
featureType	Class	A spatial object type.
placeholder	Class	A class that acts as a placeholder for a class, typically a spatial object type, that will be specified in the future as part of another spatial data theme. The class should at least have a definition, but may otherwise have a preliminary or no specification (see section 5.1.2).
type	Class	A conceptual, abstract type that is not a spatial object type.
dataType	Class	A structured data type without identity.
union	Class	A structured data type without identity where exactly one of the properties of the type is present in any instance.
enumeration	Class	A fixed list of valid identifiers of named literal values. Attributes of an enumerated type may only take values from this list.
codeList	Class	A code list.
import	Dependency	The model elements of the supplier package are imported.
voidable	Attribute, association role	A voidable attribute or association role (see section 5.1.3).
lifeCycleInfo	Attribute, association role	If in an application schema a property is considered to be part of the life-cycle information of a spatial object type, the property shall receive this stereotype.
version	Association role	If in an application schema an association role ends at a spatial object type, this stereotype denotes that the value of the property is meant to be a specific version of the spatial object, not the spatial object in general.

5.1.2 Placeholder and candidate types

Some of the INSPIRE Annex I data specifications (which were developed previously to the Annex II+III data specifications) refer to types that were considered to thematically belong and which were expected to be fully specified in Annex II or III spatial data themes. Two kinds of such types were distinguished:

- *Placeholder types* were created as placeholders for types (typically spatial object types) that were to be specified as part of a future spatial data theme, but which was already used as a value type of an attribute or association role in this data specification.

  Placeholder types received the stereotype «placeholder» and were placed in the application schema package of the future spatial data theme where they thematically belong. For each placeholder, a definition was specified based on the requirements of the Annex I theme. The Annex II+III TWGs were required to take into account these definitions in the specification work of the Annex II or III theme.

  If necessary, the attributes or association roles in the Annex I data specification(s) that have a placeholder as a value type shall be updated.

- *Candidate types* were types (typically spatial object types) for which already a preliminary specification was given in the Annex I data specification. Candidate types did not receive a specific stereotype and were placed in the application schema package of the future spatial data theme where they thematically belong. For each candidate type, a definition and attributes and association roles were specified based on the requirements of the Annex I theme. The Annex II+III TWGs were required to take into account these specifications in the specification work of the Annex II or III theme.

  If the type could not be incorporated in the Annex II or III data specification according to its preliminary specification, it should be moved into the application schema of the Annex I theme where it had first been specified. In this case, the attributes or association roles in the Annex I data specification(s) that have the type as a value type shall be updated if necessary.

NOTE Once the Annex II+III data specifications have been finalised by the TWGs (version 3.0), all placeholders and candidate types should have been removed. In some cases, this may require one or several of the Annex I data specifications (and the Implementing Rule on interoperability of spatial data sets and services) to be updated.

5.1.3 Voidable characteristics

If a characteristic of a spatial object is not present in the spatial data set, but may be present or applicable in the real world, the property shall receive this stereotype.

If and only if a property receives this stereotype, the value of *void* may be used as a value of the property. A *void* value shall imply that no corresponding value is contained in the spatial data set maintained by the data provider or no corresponding value can be derived from existing values at reasonable costs, even though the characteristic may be present or applicable in the real world.

It is possible to qualify a value of void in the data with a reason using the VoidValueReason type. The VoidValueReason type is a code list, which includes the following pre-defined values:

- *Unpopulated*: The characteristic is not part of the dataset maintained by the data provider. However, the characteristic may exist in the real world. For example when the “elevation of the water body above the sea level” has not been included in a dataset containing lake spatial objects, then the reason for a void value of this property would be ‘Unpopulated’. The characteristic receives this value for all objects in the spatial data set.
- *Unknown*: The correct value for the specific spatial object is not known to, and not computable by the data provider. However, a correct value may exist. For example when the “elevation of the water body above the sea level” *of a certain lake* has not been measured, then the reason for a void value of this property would be ‘Unknown’. This value is applied on an object-by-object basis in a spatial data set.

NOTE It is expected that additional reasons will be identified in the future, in particular to support reasons / special values in coverage ranges.

The «voidable» stereotype does not give any information on whether or not a characteristic exists in the real world. This is expressed using the multiplicity:

- If a characteristic may or may not exist in the real world, its minimum cardinality shall be defined as 0. For example, if an Address may or may not have a house number, the multiplicity of the corresponding property shall be 0..1.
- If at least one value for a certain characteristic exists in the real world, the minimum cardinality shall be defined as 1. For example, if an Administrative Unit always has at least one name, the multiplicity of the corresponding property shall be 1..*.

In both cases, the «voidable» stereotype can be applied. A value (the real value or void) only needs to be made available for properties that have a minimum cardinality of 1.

5.1.4 Enumerations

Enumerations are modelled as classes in the application schemas. Their values are modelled as attributes of the enumeration class using the following modelling style:

- No initial value, but only the attribute name part, is used.
- The attribute name conforms to the rules for attributes names, i.e. is a lowerCamelCase name. Exceptions are words that consist of all uppercase letters (acronyms).

IR Requirement 2	Attributes of spatial object types or data types whose type is an enumeration shall only take values included in the enumeration.

5.1.5 Code lists

Code lists are modelled as classes in the application schemas. Their values, however, are managed outside of the application schema.

5.1.5.1. Obligation

For each attribute that has a code list as its value, a tagged value called “obligation” is specified to define the level of obligation to use values from the list. The tagged value can take the following values:

- *IR* means that only the values defined by the code list shall be used for the attribute. This obligation is also included in the Implementing Rule on interoperability of spatial data and services.
- *TG* means that only the values defined by the code list should be used for the attribute. This obligation is *not* included in the Implementing Rule on interoperability of spatial data and services.

IR Requirement 3	Attributes of spatial object types or data types whose type is a code list with an “obligation” value of “IR” shall only take values that are valid according to the code list’s specification.

Recommendation 3	Attributes of spatial object types or data types whose type is a code list with an “obligation” value of “TG” should only take values that are valid according to the code list’s specification.

5.1.5.2. Governance

The following two types of code lists are distinguished in INSPIRE:

- *Code lists that are governed by INSPIRE (INSPIRE-governed code lists).* These code lists will be managed centrally in the INSPIRE code list register, which is managed and governed by the INSPIRE expert group on maintenance and implementation. Change requests to these code lists (e.g. to add, deprecate or supersede values) are processed and decided upon using the maintenance workflows defined by the INSPIRE expert group.

  INSPIRE-governed code lists will be made available in the INSPIRE code list register at *http://inspire.ec.europa.eu/codeList/<CodeListName>*. They will be available in SKOS/RDF, XML and HTML. The maintenance will follow the procedures defined in ISO 19135. This means that the only allowed changes to a code list are the addition, deprecation or supersession of values, i.e. no value will ever be deleted, but only receive different statuses (valid, deprecated, superseded). Identifiers for values of INSPIRE-governed code lists are constructed using the pattern *http://inspire.ec.europa.eu/codeList/<CodeListName>*/<value>.

- *Code lists that are governed by an organisation outside of INSPIRE (externally governed code lists).* These code lists are managed by an organisation outside of INSPIRE, e.g. the World Meteorological Organization (WMO) or the World Health Organization (WHO). Change requests to these code lists follow the maintenance workflows defined by the maintaining organisations. Note that in some cases, no such workflows may be formally defined.

The tables describing externally governed code lists in this section contain the following columns:

- The *Governance* column describes the external organisation that is responsible for maintaining the code list.
- If the code list is versioned, the *Version* column specifies which version of the code list shall be used in INSPIRE. The version can be specified using a version number or the publication date of a version. The specification can also refer to the "latest available version".
- The *Availability* column specifies from where the values of the externally governed code list are available, through a URL for code lists that are available online, or a citation for code lists that are only available offline.
- In the *Formats* column the formats are listed, in which a code list is available. These can be machine-readable (e.g. SKOS/RDF, XML) or human-readable (e.g. HTML, PDF).
- In some cases, for INSPIRE only a subset of an externally governed code list is relevant. The subset is specified using the *Subset* column.
- For encoding values of externally governed code lists, rules have to be specified for generating URI identifiers and labels for code list values. These are specified in a separate table.

5.1.5.3. Vocabulary

For each code list, a tagged value called "vocabulary" is specified to define a URI identifying the values of the code list. For INSPIRE-governed code lists and externally governed code lists that do not have a persistent identifier, the URI is constructed following the pattern *http://inspire.ec.europa.eu/codeList/<UpperCamelCaseName>*.

If the value is missing or empty, this indicates an empty code list. If no sub-classes are defined for this empty code list, this means that any code list may be used that meets the given definition.

An empty code list may also be used as a super-class for a number of specific code lists whose values may be used to specify the attribute value. If the sub-classes specified in the model represent all valid extensions to the empty code list, the subtyping relationship is qualified with the standard UML constraint "{complete,disjoint}".

5.1.5.4. Extensibility

For each code list, a tagged value called "extensibility" is specified to define which additional values (other than those explicitly specified) are allowed as valid values of the code list. The tagged value can take the following values:

- *none* means that only the values explicitly specified shall / should[22] be used for the attribute.
- *narrower* means that only the values explicitly specified or values narrower than the specified values shall / should be used for the attribute.
- *any* means that, in addition to the values explicitly specified, any other value may be used.

NOTE The "extensibility" tagged value does *not* affect the possibility to update the code list values following the formal maintenance procedure. For example, even for code lists, for which the "extensibility" is set to *none*, it is still possible to add values following the maintenance procedure of

[22] It depends on the level of the "obligation" tagged value on the attribute, whether this is a requirement or recommendation.

the code list. As a result of this update, the code list may include additional valid values, and these additional may be used for attributes having the code list as a type.

5.1.6 Coverages

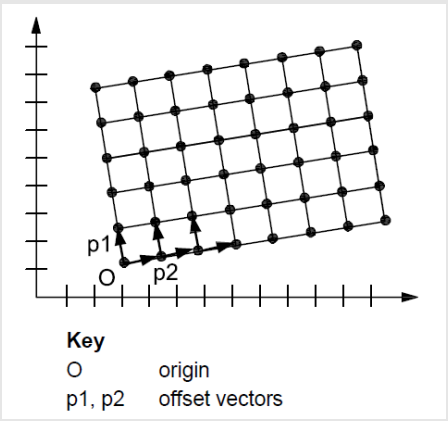
Coverage functions are used to describe characteristics of real-world phenomena that vary over space and/or time. Typical examples are temperature, elevation, precipitation, imagery. A coverage contains a set of such values, each associated with one of the elements in a spatial, temporal or spatio-temporal domain. Typical spatial domains are point sets (e.g. sensor locations), curve sets (e.g. contour lines), grids (e.g. orthoimages, elevation models), etc.

In INSPIRE application schemas, coverage functions are defined as properties of spatial object types where the type of the property value is a realisation of one of the types specified in ISO 19123.

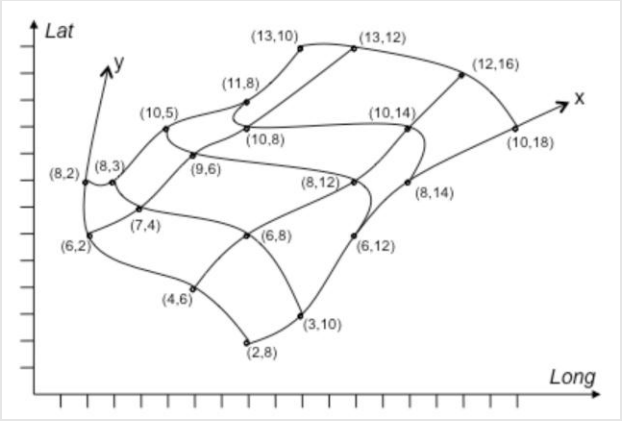
To improve alignment with coverage standards on the implementation level (e.g. ISO 19136 and the OGC Web Coverage Service) and to improve the cross-theme harmonisation on the use of coverages in INSPIRE, an application schema for coverage types is included in the Generic Conceptual Model in 9.9.4. This application schema contains the following coverage types:

- *RectifiedGridCoverage*: coverage whose domain consists of a rectified grid – a grid for which there is an affine transformation between the grid coordinates and the coordinates of a coordinate reference system (see Figure 2, left).
- *ReferenceableGridCoverage*: coverage whose domain consists of a referenceable grid – a grid associated with a transformation that can be used to convert grid coordinate values to values of coordinates referenced to a coordinate reference system (see Figure 2, right).
- *MultiTimeInstantCoverage*: coverage providing a representation of the time instant/value pairs, i.e. time series (see Figure 3).

Where possible, only these coverage types (or a subtype thereof) are used in INSPIRE application schemas.



(Source: ISO 19136:2007)



(Source: GML 3.3.0)

Figure 2 – Examples of a rectified grid (left) and a referenceable grid (right)

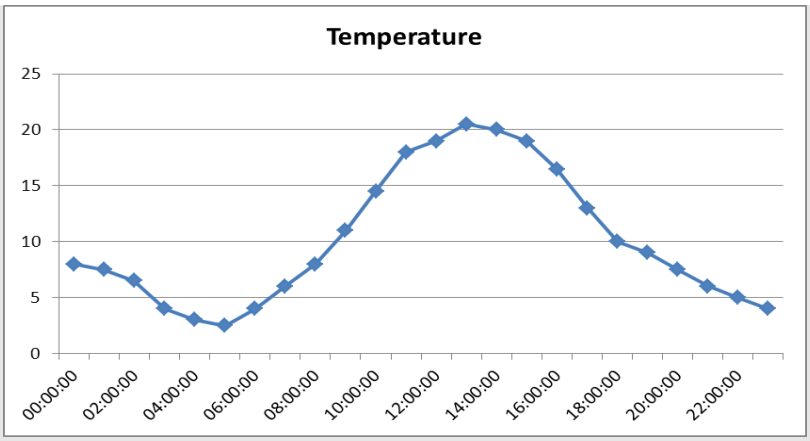


Figure 3 – Example of a MultiTimeSeriesCoverage (a time series)

5.2 Application schemas of Energy Resources

5.2.1 Overview

In this section a brief overview is given of the composition of the Energy Resources model, which is based on four application schema packages.

5.2.1.1. Narrative description

The Energy Resources UML model is structured in four separate application schemas which are created to represent the different viewpoints to model Energy Resources. The *EnergyResourcesVector*, *EnergyResourcesCoverage* and the *EnergyResourcesStatistics* application schemas depend on the *EnergyResourcesBase* application schema, which provides a base set of common Energy Resource classes including coded values for the classification of fossil and renewable Energy Resources. The dependencies between the application schemas are illustrated in Figure 4.

Figure 4 also illustrates the dependencies between the different Energy Resources application schemas and other packages:

- The *Base Types* application schema from the Generic Conceptual Model, and the Annex I theme 'Geographical Names' datatype are used.
- The *EnergyResourcesCoverage* application schema is based on the Generic Coverage (Domain and Range) model defined in the INSPIRE Generic Conceptual Model.

The four Energy Resources application schemas together define a general model that supports the identification and definition of a wide range of spatial objects that represent various types of energy resources. Besides these application schemas another package called *EnergyResourcesCoverage – Extension* was created. This package is purely informative and should help the reader of this document to understand how thematic communities conceptually can define the type of potential energy by extending the empty *PotentialTypeCode* codelist within their thematic domain. A brief explanation of this concept is provided in Annex C.

5.2.1.2. UML Overview

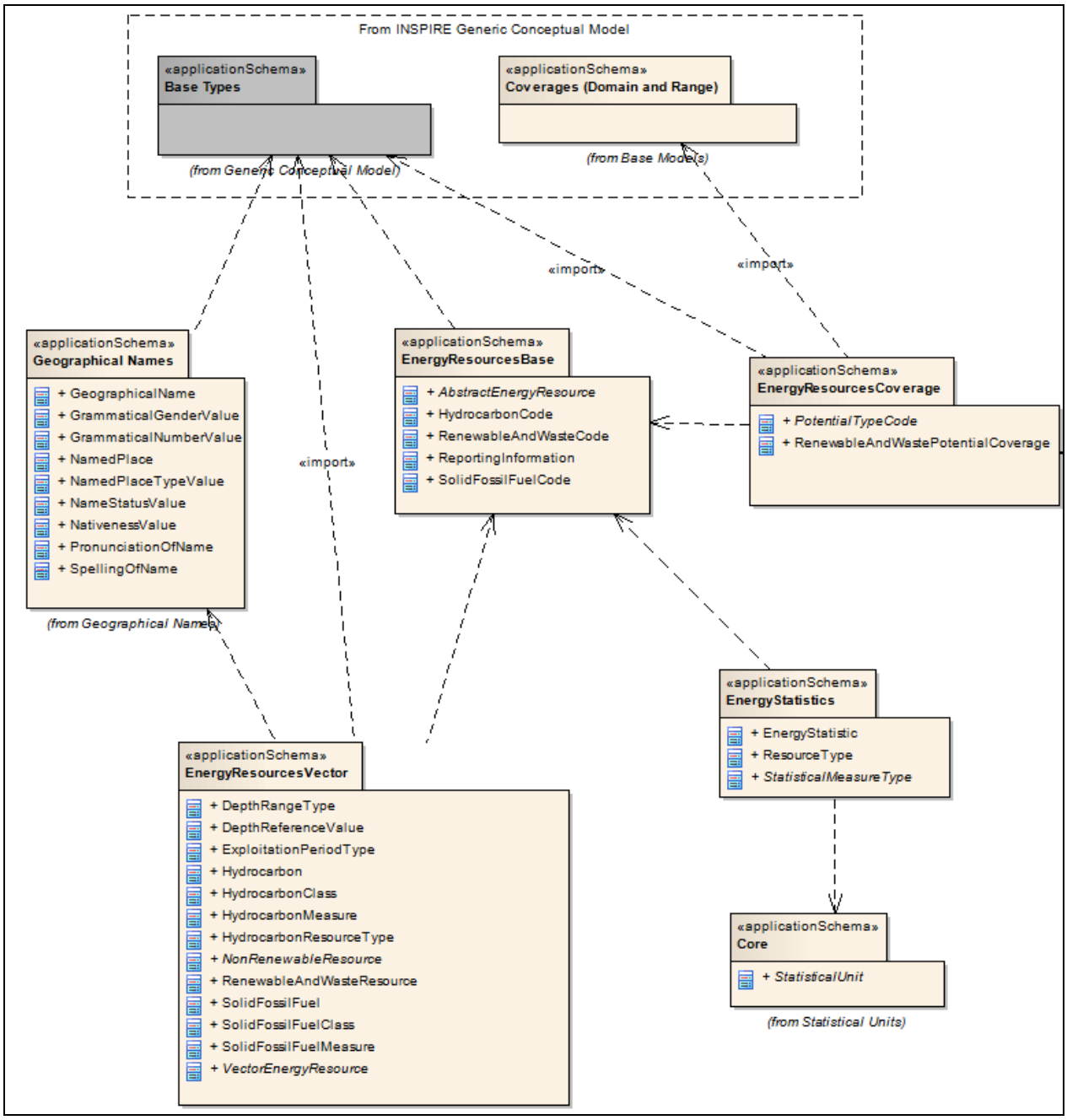


Figure 4 – Package structure of the Energy resources application schemas

5.3 Application schema EnergyResourcesBase

5.3.1 Description

5.3.1.1. Narrative description

The *EnergyResourcesBase* application schema provides a core set of common Energy Resource types that define common classes and characteristics used in other application schemas of the Energy Resources theme.

The base application schema includes coded values for the classification of Energy Resources that fall within the scope of this theme. As there is no unique reference classification for all types of Energy Resources, the coded values are split in three distinct code lists corresponding with primary energy commodities that are defined in Regulation (EC) No 1099/2008 of the European Parliament and of the Council of 22 October 2008 on energy statistics. During the development of the UML model it was discussed and decided with the Mineral Resources TWG that fissile minerals such as Uranium and Thorium, which can be processed into nuclear fuel (applied for the production of nuclear energy), are within the scope of Mineral Resources. The reason for taking this decision is that the prospection and exploration of these minerals is similar to other non-fissile minerals, moreover fissile minerals are often considered as a by-product when mined together with other primary minerals. Finally, the typical key properties of fissile minerals seem to be more in line with other minerals and mineral classification schemes than with other renewable and non-renewable Energy Resources.

5.3.1.2. UML Overview

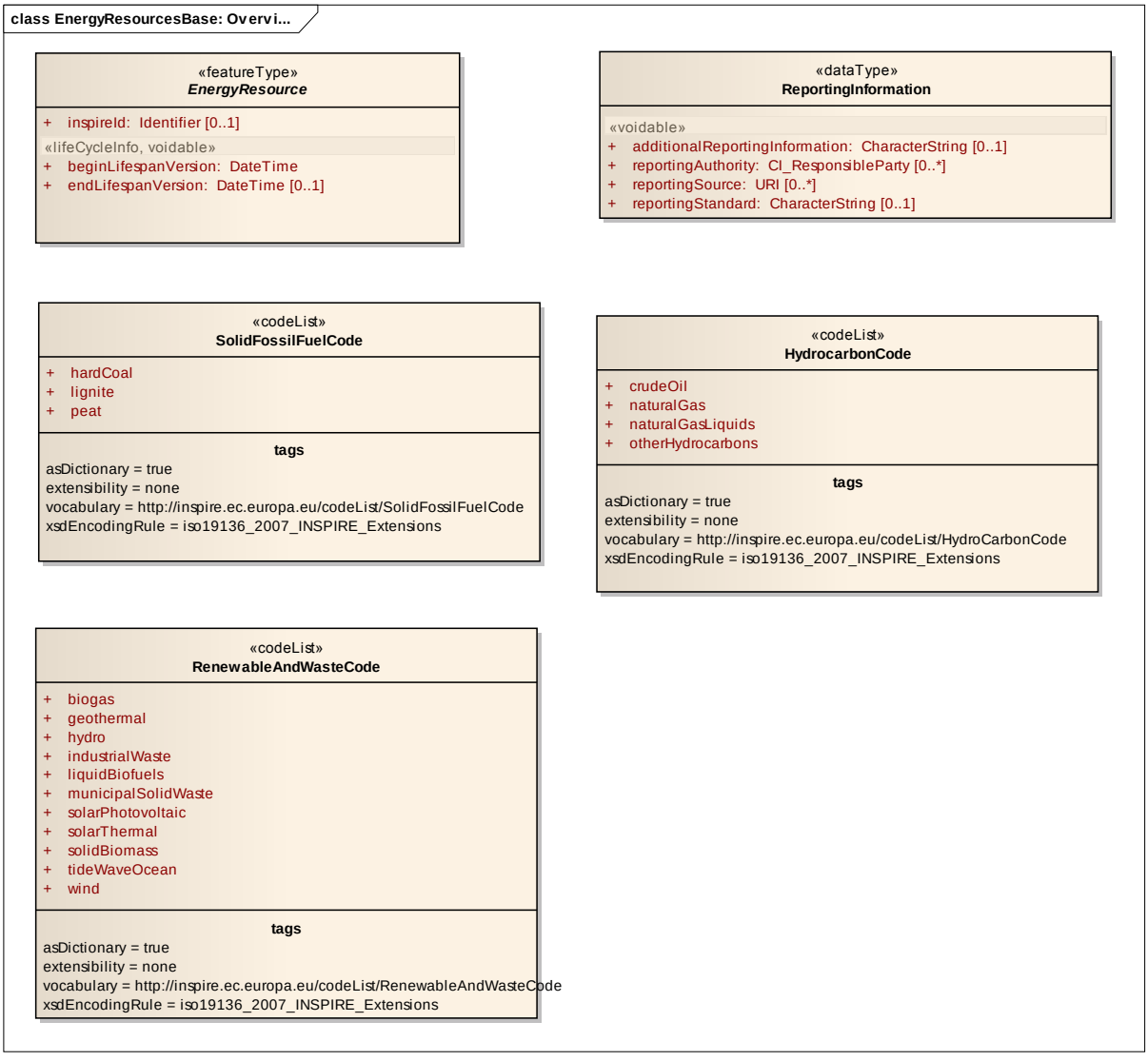


Figure 5 – UML class diagram: Overview of the EnergyResourcesBase application schema

The base application schema as illustrated in Figure 5 basically defines five classes common to all application schemas.
The abstract class *EnergyResource* represents a generic spatial object type that defines the properties which are common to all possible feature types, such as inspire identifier and lifecycle information attributes.

The *ReportingInformation* class supports a proper description of the reporting standards and sources that are applied to classify and/or quantify Energy Resources.

The main categories of Energy Resources are described by 3 distinct code lists: *SolidFossilFuelCode*, *HydrocarbonCode* and *RenewableAndWasteCode*. Each of the 3 code list classes contains a list with the main values of Energy Resource types in a specific subdomain. The use of these code lists will be further explained in section 5.4, 5.5 and 5.6.

Open issue 1: All code list values will be deleted from the UML model in version 3.0 according to the code lists guidelines.

5.3.1.3. Consistency between spatial data sets

The *EnergyResourcesBase* application schema does not require consistency rules.

5.3.1.4. Identifier management

The *EnergyResourcesBase* application schema does not require specific identifier management, though the Energy Resources data specification allows an optional inspireId for all application schemas. This identifier shall, if provided, be maintained by the national or regional authority.

5.3.1.5. Modelling of object references

The *EnergyResourcesBase* application schema does not require modelling of object references.

5.3.1.6. Geometry representation

IR Requirement 4	The value domain of spatial properties used in this specification shall be restricted to the Simple Feature spatial schema as defined by EN ISO 19125-1.

NOTE The specification restricts the spatial schema to 0-, 1-, 2-, and 2.5-dimensional geometries where all curve interpolations are linear.

NOTE The topological relations of two spatial objects based on their specific geometry and topology properties can in principle be investigated by invoking the operations of the types defined in ISO 19107 (or the methods specified in EN ISO 19125-1).

5.3.1.7. Temporality representation

The application schema(s) use(s) the derived attributes "beginLifespanVersion" and "endLifespanVersion" to record the lifespan of a spatial object.

The attributes "beginLifespanVersion" specifies the date and time at which this version of the spatial object was inserted or changed in the spatial data set. The attribute "endLifespanVersion" specifies the date and time at which this version of the spatial object was superseded or retired in the spatial data set.

NOTE 1 The attributes specify the beginning of the lifespan of the version in the spatial data set itself, which is different from the temporal characteristics of the real-world phenomenon described by the

spatial object. This lifespan information, if available, supports mainly two requirements: First, knowledge about the spatial data set content at a specific time; second, knowledge about changes to a data set in a specific time frame. The lifespan information should be as detailed as in the data set (i.e., if the lifespan information in the data set includes seconds, the seconds should be represented in data published in INSPIRE) and include time zone information.

NOTE 2 Changes to the attribute "endLifespanVersion" does not trigger a change in the attribute "beginLifespanVersion".

Recommendation 4 If life-cycle information is not maintained as part of the spatial data set, all spatial objects belonging to this data set should provide a void value with a reason of "unpopulated".

5.3.2 Feature catalogue

Table 3 - Feature catalogue metadata

Feature catalogue name	INSPIRE feature catalogue EnergyResourcesBase
Scope	EnergyResourcesBase
Version number	2.9
Version date	2012-02-24
Definition source	INSPIRE data specification EnergyResourcesBase

Table 4 - Types defined in the feature catalogue

Type	Package	Stereotypes	Section
EnergyResource	EnergyResourcesBase	«featureType»	5.2.2.1.1
HydrocarbonCode	EnergyResourcesBase	«codeList»	5.2.2.3.1
RenewableAndWasteCode	EnergyResourcesBase	«codeList»	5.2.2.3.2
ReportingInformation	EnergyResourcesBase	«dataType»	5.2.2.2.1
SolidFossilFuelCode	EnergyResourcesBase	«codeList»	5.2.2.3.3

5.3.2.1. Spatial object types

5.3.2.1.1. EnergyResource

EnergyResource (abstract)

Name:	Energy Resource
Definition:	A feature defining an inferred or observable spatial extent of a resource that can be, or has been, used as a source of energy.
Description:	SOURCE Adapted from [DER 2011].
Status:	Proposed
Stereotypes:	«featureType»
Identifier:	null

Attribute: inspireId

Value type:	Identifier
Definition:	External object identifier of the spatial object.
Description:	NOTE An external object identifier is a unique object identifier published by the responsible body, which may be used by external applications to reference the spatial object. The identifier is an identifier of the spatial object, not an identifier of the real-world phenomenon.
Multiplicity:	0..1

Attribute: beginLifespanVersion

EnergyResource (abstract)	
Value type:	DateTime
Definition:	Date and time at which this version of the spatial object was inserted or changed in the spatial data set.
Multiplicity:	1
Stereotypes:	«lifeCycleInfo,voidable»

Attribute: endLifespanVersion	
Value type:	DateTime
Definition:	Date and time at which this version of the spatial object was superseded or retired in the spatial data set.
Multiplicity:	0..1
Stereotypes:	«lifeCycleInfo,voidable»

5.3.2.2. Data types

5.3.2.2.1. ReportingInformation

ReportingInformation	
Name:	Reporting information
Definition:	Energy resource reporting information detailing the type of reporting standard or classification schema.
Description:	
Status:	Proposed
Stereotypes:	«dataType»
Identifier:	null

Attribute: additionalReportingInformation	
Value type:	CharacterString
Definition:	All additional reporting information.
Multiplicity:	0..1
Stereotypes:	«voidable»

Attribute: reportingAuthority	
Value type:	CI_ResponsibleParty
Definition:	Organisation responsible for reporting on the estimated and produced energy resources.
Description:	
Multiplicity:	0..*
Stereotypes:	«voidable»

Attribute: reportingSource	
Value type:	URI
Definition:	A link to an external document providing further information about the reporting standard.
Description:	
Multiplicity:	0..*
Stereotypes:	«voidable»

Attribute: reportingStandard	
Value type:	CharacterString
Definition:	Reporting standard for calculating the measurement.
Description:	EXAMPLE SPE (PRMS), UNFC, SEC, etc...
Multiplicity:	0..1
Stereotypes:	«voidable»

5.3.2.3. Code lists

5.3.2.3.1. HydrocarbonCode

HydrocarbonCode	
Name:	Hydrocarbon code
Definition:	Classification value that defines the specialised type of hydrocarbon.
Description:	
Status:	Proposed
Stereotypes:	«codeList»
Extensibility:	none
Identifier:	http://inspire.ec.europa.eu/codeList/HydroCarbonCode

5.3.2.3.2. RenewableAndWasteCode

RenewableAndWasteCode	
Name:	Renewable and waste code
Definition:	Classification value that defines the specialised type of renewable and waste resources.
Description:	
Status:	Proposed
Stereotypes:	«codeList»
Extensibility:	none
Identifier:	http://inspire.ec.europa.eu/codeList/RenewableAndWasteCode

5.3.2.3.3. SolidFossilFuelCode

SolidFossilFuelCode	
Name:	Solid fossil fuel code
Definition:	Additional classification value that defines the specialised type of solid fossil fuels.
Description:	
Status:	Proposed
Stereotypes:	«codeList»
Extensibility:	none
Identifier:	http://inspire.ec.europa.eu/codeList/SolidFossilFuelCode

5.3.2.4. Imported types (informative)

This section lists definitions for feature types, data types and enumerations and code lists that are defined in other application schemas. The section is purely informative and should help the reader understand the feature catalogue presented in the previous sections. For the normative documentation of these types, see the given references.

5.3.2.4.1. CI_ResponsibleParty

CI_ResponsibleParty	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19115:2006 Metadata (Corrigendum)::Citation and responsible party information [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]

5.3.2.4.2. CharacterString

CharacterString	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19103:2005 Schema Language::Basic Types::Primitive::Text [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]

5.3.2.4.3. DateTime

DateTime

DateTime	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19103:2005 Schema Language::Basic Types::Primitive::Date and Time [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]

5.3.2.4.4. Identifier

Identifier	
Package:	INSPIRE Consolidated UML Model::Generic Conceptual Model::Base Types::Base Types [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	External unique object identifier published by the responsible body, which may be used by external applications to reference the spatial object.
Description:	NOTE1 External object identifiers are distinct from thematic object identifiers. NOTE 2 The voidable version identifier attribute is not part of the unique identifier of a spatial object and may be used to distinguish two versions of the same spatial object. NOTE 3 The unique identifier will not change during the life-time of a spatial object.

5.3.2.4.5. URI

URI	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19139 Metadata - XML Implementation::Web environment [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]

5.3.3 INSPIRE-governed code lists

The INSPIRE-defined code lists included in this application schema include the values specified in the tables in this section.

5.3.3.1. Values of code list HydrocarbonCode

Value	Name	Definition	Description	Parent value
crudeOil	Crude oil	Crude oil is a mineral oil of natural origin comprising a mixture of hydrocarbons and associated impurities, such as sulphur. It exists in the liquid phase under normal surface temperature and pressure and its physical characteristics (density, viscosity, etc.) are highly variable. This category includes	SOURCE Adapted from Energy Statistics Regulation EC 1099/2008 .	

		field or lease condensate recovered from associated and non-associated gas where it is commingled with the commercial crude oil stream.		
naturalGas	Natural gas	This data collection applies to natural gas, which comprises gases occurring in underground deposits, whether liquefied or gaseous, consisting mainly of methane. It includes both non-associated gas originating from fields producing hydrocarbons only in gaseous form, and associated gas produced in association with crude oil as well as methane recovered from coal mines (colliery gas) or from coal seams (coal seam gas). It does not include gases created by anaerobic digestion of biomass (e.g. municipal or sewage gas) nor gasworks gas.	SOURCE Adapted from Energy Statistics Regulation EC 1099/2008 .	
naturalGasLiquids	Natural gas liquids	NGL are liquid or liquefied hydrocarbons recovered from natural gas in separation facilities or gas processing plants.	SOURCE Adapted from Energy Statistics Regulation EC 1099/2008 .	
otherHydrocarbons	Other hydrocarbons	Synthetic crude oil from tar sands, shale oil, etc., liquids from coal liquefaction, output of liquids from natural gas conversion into gasoline, hydrogen and emulsified oils	SOURCE Adapted from Energy Statistics Regulation EC 1099/2008 .	

		(e.g. orimulsion). Other hydrocarbons exclude oil shale production.		

5.3.3.2. Values of code list RenewableAndWasteCode

Value	Name	Definition	Description	Parent value
Biogas	Biogas	A gas composed principally of methane and carbon dioxide produced by anaerobic digestion of biomass.	SOURCE Adapted from Energy Statistics Regulation EC 1099/2008 .	
Geothermal	Geothermal	Energy available as heat emitted from within the earth's crust, usually in the form of hot water or steam. This energy production is the difference between the enthalpy of the fluid produced in the production borehole and that of the fluid eventually disposed of. It is exploited at suitable sites: -for electricity generation using dry steam or high enthalpy brine after flashing, -directly as heat for district heating, agriculture etc.	SOURCE Adapted from Energy Statistics Regulation EC 1099/2008 .	
Hydro	Hydro power	Potential and kinetic energy of water converted into electricity in hydroelectric plants. Pumped storage must be included.	SOURCE Adapted from Energy Statistics Regulation EC 1099/2008 .	
industrialWaste	Industrial Waste	Waste of industrial non-renewable origin (solids or liquids) combusted directly for the production of electricity and/or heat.	SOURCE Adapted from Energy Statistics Regulation EC 1099/2008 .	

liquidBiofuels	Liquid biofuels	Liquid biofuels are biogasoline, bio-diesels or other biofuels directly used as fuel.	SOURCE Adapted from Energy Statistics Regulation EC 1099/2008 .	
municipalSolidWaste	Municipal solid waste	Waste produced by households, industry, hospitals and the tertiary sector which contains biodegradable materials that are incinerated at specific installations.	SOURCE Adapted from Energy Statistics Regulation EC 1099/2008 .	
solarPhotovoltaic	Solar Photovoltaic	Sunlight converted into electricity by the use of solar cells usually made of semiconducting material which exposed to light will generate electricity.	SOURCE Adapted from Energy Statistics Regulation EC 1099/2008 .	
solarThermal	Solar thermal	Heat from solar radiation; can consist of: (a) solar thermal-electric plants; or (b) equipment for the production of domestic hot water or for the seasonal heating of swimming pools (e.g. flat plate collectors, mainly of the thermosyphon type).	SOURCE Adapted from Energy Statistics Regulation EC 1099/2008 .	
solidBiomass	Solid biomass	Covers organic, non-fossil material of biological origin which may be used as fuel for heat production or electricity generation.	SOURCE Adapted from Energy Statistics Regulation EC 1099/2008 .	
tideWaveOcean	Tide, wave, ocean	Mechanical energy derived from tidal movement, wave motion or ocean current and exploited for electricity generation.	SOURCE Adapted from Energy Statistics Regulation EC 1099/2008 .	
Wind	Wind	Kinetic energy of wind exploited for electricity generation in wind turbines.	SOURCE Adapted from Energy Statistics Regulation EC 1099/2008 .	

5.3.3.3. Values of code list SolidFossilFuelCode

Value	Name	Definition	Description	Parent value
hardCoal	Hard Coal	Combustible, black, solid organic fossil sediment with a gross calorific value greater than 23865 kJ/kg (5700 kcal/kg) on an ash-free but moist basis. Hard Coal includes anthracite, coking coal and other bituminous coal.	SOURCE Adapted from Energy Statistics Regulation EC 1099/2008 .	
Lignite	Lignite	Combustible mainly brown organic fossil sediment, the lowest rank of coal with a gross calorific value less than 17435 kJ/kg (4165 kcal/kg) and greater than 31% volatile matter on a dry mineral matter free basis. Lignite has a carbon content of between 60% and 70% and is often described as "brown coal".	SOURCE Adapted from Energy Statistics Regulation EC 1099/2008 .	
Peat	Peat	Soft, loose to compressed, natural, combustible sediment of plant origin with a high moisture content (up to 90 % in the raw state), light to dark brown in colour and easily cut. Peat has a carbon content of less than 60%.	SOURCE Adapted from Energy Statistics Regulation EC 1099/2008,Directive 2001/77/EC and from the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.	

5.3.4 Externally governed code lists

The *EnergyResourcesBase* application schema does not contain externally governed code lists.

5.4 Application schema EnergyResourcesVector

5.4.1 Description

5.4.1.1. Narrative description

There are different viewpoints for representing Energy Resources as the majority of them can be modelled both as discrete or continuous features depending on the chosen universe of discourse. The *EnergyResoursesVector* application schema enables the representation of Energy Resources as vector spatial objects.
Energy Resources, and in particular fossil fuels, are spatially delimited by a specific geologic environment with this enabling the creation of fossil fuels. However, due to their subsurface character it is not possible to directly define the exact boundaries of fossil fuels. Therefore, boundaries delimiting subsurface Energy Resources are often defined by human interaction, and consequently rely on the interpretation of a series of scientific and social-economic criteria in order to define the extent of the resource. Furthermore, detailed information on fossil fuels such as their classification can only be gathered through exploration and exploitation projects of which the conditions (including the spatial extent of the activity) are defined by legally managed or regulated areas.

Also many renewable and waste resources are modelled using a similar approach as for non-renewables. Due to their continuous character the delineation of certain types of renewable and waste resources needs human interaction as well to define those areas that are of current and future importance for producing energy.

When applying this application schema it should be realized that strong links exist between the Energy Resources data specifications and the Annex III theme '*Area Management, Restriction and Regulation Zones*'. Geometric objects representing Energy Resources may partially or fully overlapping with geometric objects of the '*Area Management, Restriction and Regulation Zones*' Annex III theme mentioned above, nevertheless an independent geometry is needed since the delimitation and properties of a feature in one theme may change while it remains unchanged in another theme.

5.4.1.2. UML Overview

An overview of the *EnergyResourcesVector* application schema is shown in Figure 6 (key components) and and is further described below.

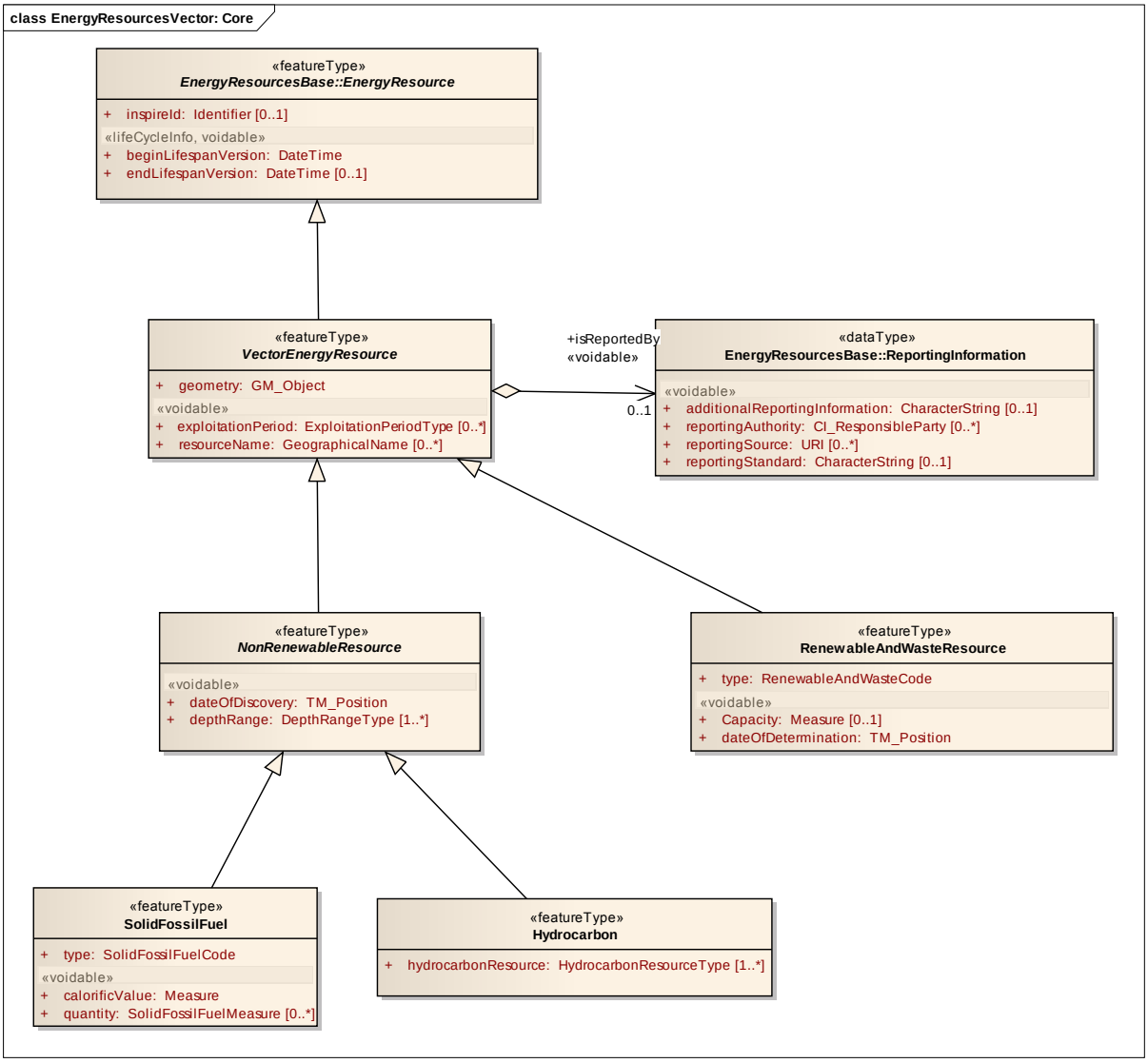


Figure 6 – UML class diagram: Overview of the key components of the EnergyResourcesVector application schema

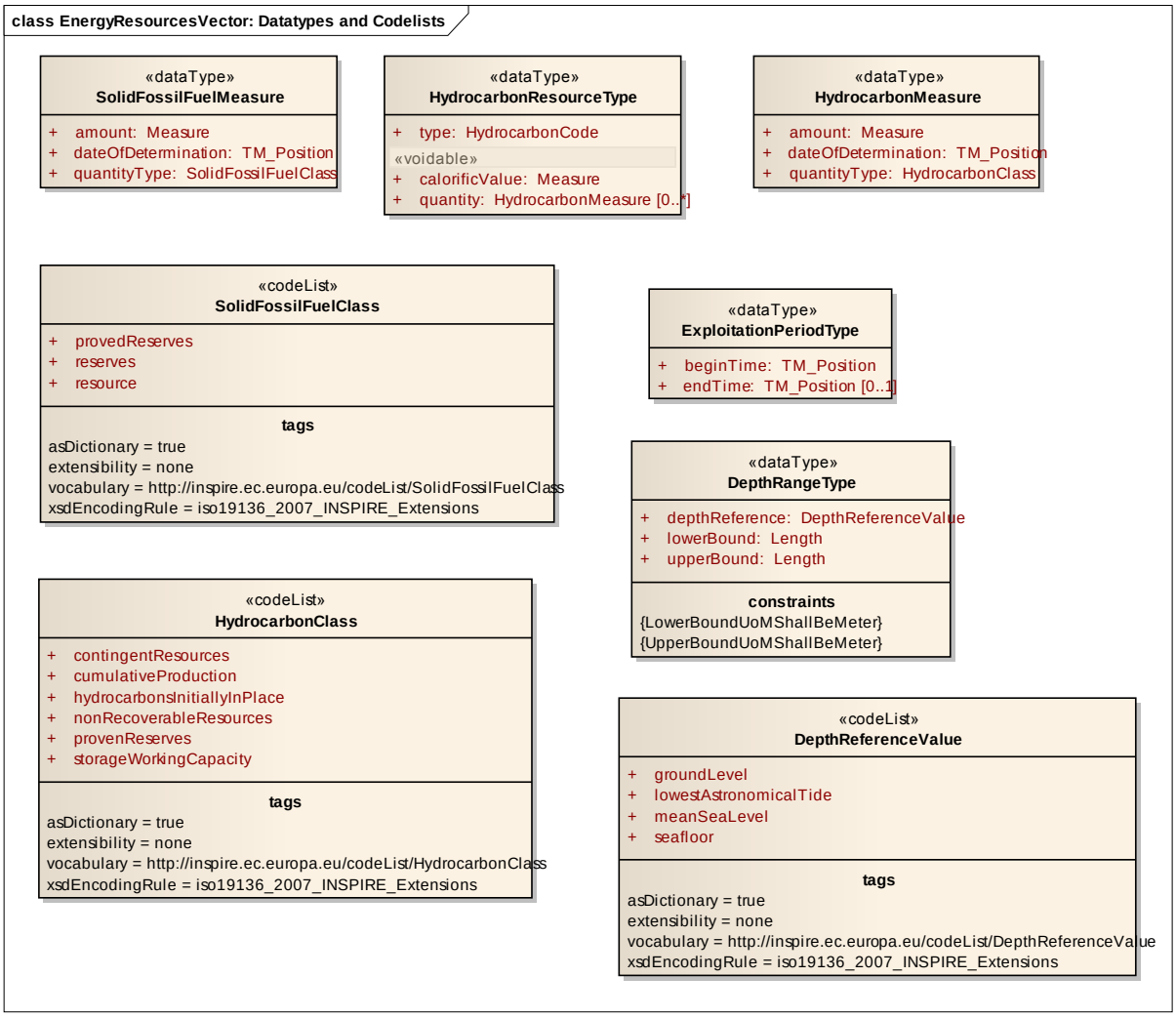


Figure 7 – UML class diagram: Overview of the datatypes and code lists of the EnergyResourcesVector application schema

The *EnergyResourcesVector* application schema has been developed according the Rules for application schemas defined in ISO 19109. The abstract feature type *VectorEnergyResource* is the key spatial object type in this application schema and defines discrete spatial features, representing non-renewable, renewable and waste resources. It inherits common properties such as the Inspire identifier and lifecycle information from the abstract class *EnergyResource* defined in the *EnergyResourcesBase* application schema. Because Energy Resources can be modelled as any kind of 2D or 3D geometry, their geometric representation is expressed by the GM_Object. Type. For harmonisation and interoperability reasons it is recommended to use 2D geometric primitives. A coverage representation of Energy Resources is described in a separate and independent application schema (see section 5.5).

Recommendation 5 When representing Energy Resources as vector features it is recommended to use 2D geometric primitives.

The *VectorEnergyResource* spatial object type also contains common attributes to provide a geographical name of the energy resource concerned, and it also comprises an additional attribute *ExploitationPeriod* to specify the time period of exploitation of the Energy Resource. The spatial object type is further specialized into two main categories of Energy Resources: on the one hand non-renewable resources which are represented by the *NonRenewableResource* featuretype, on the other

hand renewable and waste resources that are represented by the *RenewablesAndWasteResource* class. The abstract *NonRenewableResource* featuretype is once more split up into two spatial object types: *SolidFossilFuel* covers the various types of coal resources in the broadest sense, whereas *Hydrocarbon* combines the different types of natural gas and petroleum resources.

IR Requirement 5	For each Energy Resource spatial object in the *EnergyResourcesVector* application schema, information regarding the type of Energy Resource shall be provided.

All three non-abstract spatial object types (*SolidFossilFuel, Hydrocarbon and RenewablesAndWasteResource)* contain complex attributes to further define the subtype and, if data are available, to document the calorific value and quantification of the Energy Resources in terms of volume, mass or capacity. It needs to be emphasized that these classes do not represent natural resources only, but also cover storage facilities, both natural (depleted reservoirs) as man-made (caverns, mainly in rocksalt). The facilities can occur both on the surface (e.g. two lakes that represent a pumped storage facility) or underground.

The different methods and approaches for quantifying resources are the main reason for defining three distinct vector spatial object types. While renewable and waste resources can only be quantified by expressing the capacity of the facility extracting the energy resource, the present amount of non-renewable resources is subject to a domain-specific approach. The datatypes *SolidFossilFuelMeasure* and *HydrocarbonMeasure* define the properties that are needed for identifying the level and estimating the amount of the fossil fuels. With regard to Hydrocarbons, an additional datatype *HydrocarbonResourceType* has been introduced to support the fact that oil and gas might occur in one and the same reservoir.

Usually, information on the subtyping and quantification of Energy Resources are dependent on the type of reporting standards that are applied within the subdomain. As there is high variety of reporting standards, each of them with specific characteristics, there is no common reporting standard proposed within the *EnergyResourcesBase* application schema. Moreover, in some cases it is even not possible to map the values between different reporting standards. Therefore, it is sufficient within the scope of the Energy Resources data specification to document in the *ReportingInformation* datatype the name and the source of the reporting standard and to specify the authority that is responsible for the reporting figures.

Certainly, within the domain of non-renewable resources, the quantification of resources as illustrated in Figure 8 is dependent on different stages within an exploration project or an exploitation activity. For this reason reporting standards foresee different sublevels within a resource that provide a clear overview of the real and potential amount of resources that can be extracted from a coal, oil or gas field.

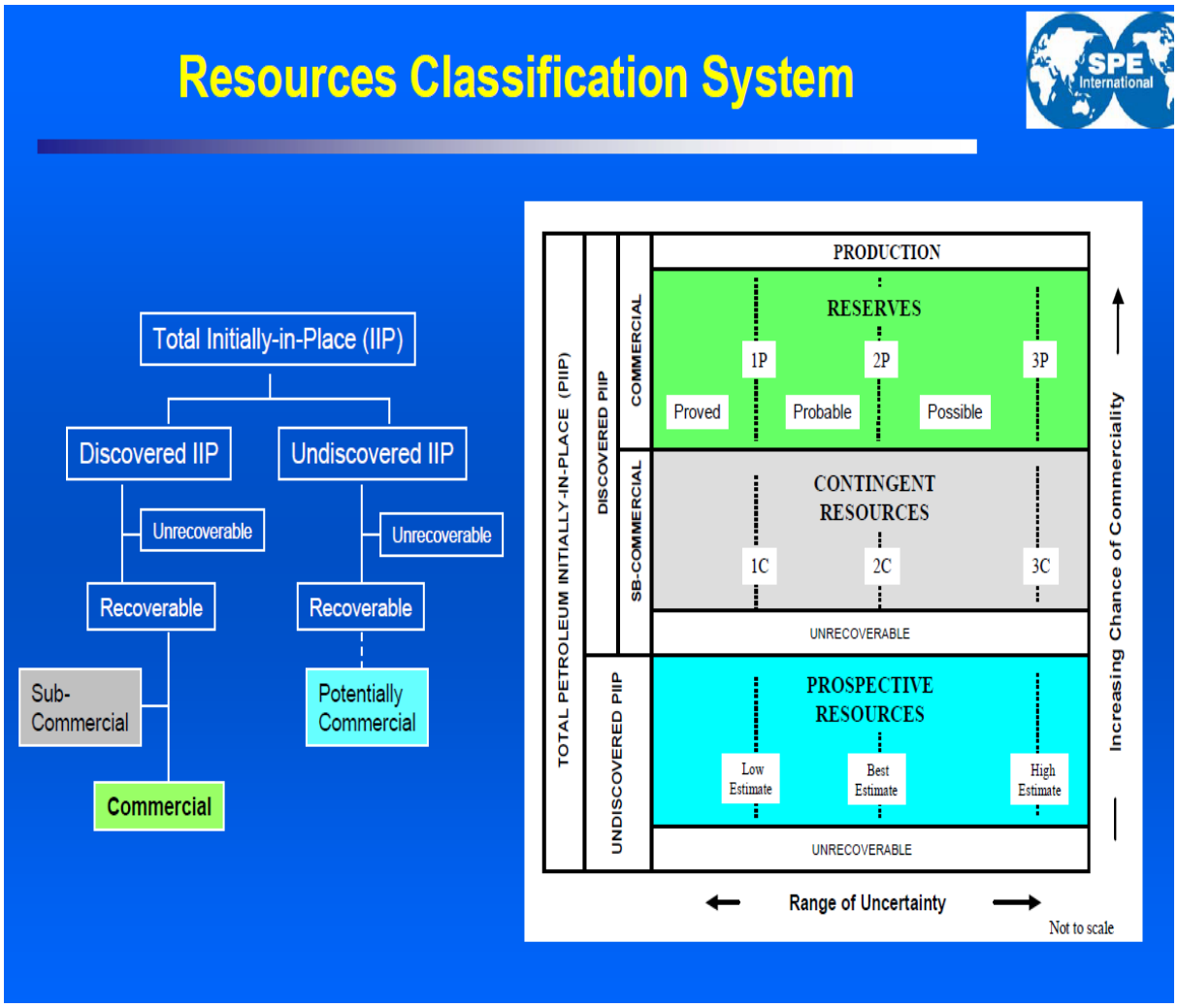


Figure 8 – Example of the international SPE classification for non-renewable resources

Recommendation 6	If applicable, it is strongly recommended to provide reporting information on the quantity of Energy Resources by defining the reporting standard that was applied and provide measures for the amount of each level of the Energy Resource.

The most common units employed to express quantities of energy resources are those relating to volume, mass and capacity. The actual units employed vary according to member state and local conditions and reflect historical practice in the member state. The internationally recognised units which cover almost all of the measurements of fuel and energy quantities are the cubic metre, tonne (metric ton) and joule (Energy Statistics Manual, OECD/IEA, 2005). They are derived from the metre, kilogramme and second included in the Système International d'Unités (SI) and serve as an international basis for science, technology and commerce.
Within the scope of this data specification, it is recommended to apply common units of measures: tonnes for masses, m^3 for volumes, MWe for electrical generation capacity and MWt for heat generation capacity to increase data harmonization and semantic interoperability. Please note that a unit converter is provided on the IEA website (*www.iea.org*). Figure 9 shows an example of a conversion table for volume measures.

To: / From:	gal U.S. multiply by:	gal U.K.	bbl	ft^3	l	m^3
U.S. gallon (gal)	1	0.8327	0.02381	0.1337	3.785	0.0038
U.K. gallon (gal)	1.201	1	0.02859	0.1605	4.546	0.0045
Barrel (bbl)	42.0	34.97	1	5.615	159.0	0.159
Cubic foot (ft^3)	7.48	6.229	0.1781	1	28.3	0.0283
Litre (l)	0.2642	0.220	0.0063	0.0353	1	0.001
Cubic metre (m^3)	264.2	220.0	6.289	35.3147	1 000.0	1

Figure 9 – Example of an volume conversion table (Source: Energy Statistics Manual, OECD/IEA, 2005)

5.4.1.3. Consistency between spatial data sets

The distinction between *Energy Resources* and *Area Management, Restriction and Regulation Zones* is not always made. When information on the boundaries of the natural resource is missing, a feature representing an Area Management, Restriction and Regulation Zone can be used to represent an Energy Resource at the same time. In this rare case the same spatial object is used to provide information on both themes.

IR Requirement 6	To ensure consistency of spatial data, the geometries of spatial objects coincident to a boundary of an Area Management, Restriction and Regulation Zone shall be consistent.

5.4.1.4. Identifier management

The *EnergyResourcesVector* application schema does not require specific identifier management, though the Energy Resources data specification allows an optional inspireId for all application schemas. This identifier shall, if provided, be maintained by the national or regional authority.

5.4.1.5. Modelling of object references

The *EnergyResourcesVector* application schema does not require modelling of object references.

5.4.1.6. Geometry representation

IR Requirement 7	The value domain of spatial properties used in this specification shall be restricted to the Simple Feature spatial schema as defined by EN ISO 19125-1.

NOTE The specification restricts the spatial schema to 0-, 1-, 2-, and 2.5-dimensional geometries where all curve interpolations are linear.

NOTE The topological relations of two spatial objects based on their specific geometry and topology properties can in principle be investigated by invoking the operations of the types defined in ISO 19107 (or the methods specified in EN ISO 19125-1).

5.4.1.7. Temporality representation

The application schema(s) use(s) the derived attributes "beginLifespanVersion" and "endLifespanVersion" to record the lifespan of a spatial object.

The attributes "beginLifespanVersion" specifies the date and time at which this version of the spatial object was inserted or changed in the spatial data set. The attribute "endLifespanVersion" specifies the date and time at which this version of the spatial object was superseded or retired in the spatial data set.

NOTE 1 The attributes specify the beginning of the lifespan of the version in the spatial data set itself, which is different from the temporal characteristics of the real-world phenomenon described by the spatial object. This lifespan information, if available, supports mainly two requirements: First, knowledge about the spatial data set content at a specific time; second, knowledge about changes to a data set in a specific time frame. The lifespan information should be as detailed as in the data set (i.e., if the lifespan information in the data set includes seconds, the seconds should be represented in data published in INSPIRE) and include time zone information.

NOTE 2 Changes to the attribute "endLifespanVersion" does not trigger a change in the attribute "beginLifespanVersion".

Recommendation 7 If life-cycle information is not maintained as part of the spatial data set, all spatial objects belonging to this data set should provide a void value with a reason of "unpopulated".

Within the *EnergyResourcesVector* application schema a series of attributes may contain measures quantifying the (potential) amount of energy available. If such values are provided, the measures should correspond to **annual average** values.

Recommendation 8 If applicable, it is strongly recommended to provide measure values corresponding to annual averages of (potential) energy.

5.4.2 Feature catalogue

Table 3 - Feature catalogue metadata

Feature catalogue name	INSPIRE feature catalogue EnergyResourcesVector
Scope	EnergyResourcesVector
Version number	2.9
Version date	2012-02-24
Definition source	INSPIRE data specification EnergyResourcesVector

Table 4 - Types defined in the feature catalogue

Type	Package	Stereotypes	Section
DepthRangeType	EnergyResourcesVector	«dataType»	5.2.2.2.1
DepthReferenceValue	EnergyResourcesVector	«codeList»	5.2.2.3.1
ExploitationPeriodType	EnergyResourcesVector	«dataType»	5.2.2.2.2

Type	Package	Stereotypes	Section
Hydrocarbon	EnergyResourcesVector	«featureType»	5.2.2.1.1
HydrocarbonClass	EnergyResourcesVector	«codeList»	5.2.2.3.2
HydrocarbonMeasure	EnergyResourcesVector	«dataType»	5.2.2.2.3
HydrocarbonResourceType	EnergyResourcesVector	«dataType»	5.2.2.2.4
NonRenewableResource	EnergyResourcesVector	«featureType»	5.2.2.1.2
RenewableAndWasteResource	EnergyResourcesVector	«featureType»	5.2.2.1.3
SolidFossilFuel	EnergyResourcesVector	«featureType»	5.2.2.1.4
SolidFossilFuelClass	EnergyResourcesVector	«codeList»	5.2.2.3.3
SolidFossilFuelMeasure	EnergyResourcesVector	«dataType»	5.2.2.2.5
VectorEnergyResource	EnergyResourcesVector	«featureType»	5.2.2.1.5

5.4.2.1. Spatial object types

5.4.2.1.1. Hydrocarbon

Hydrocarbon

Name:	Hydrocarbon
Subtype of:	NonRenewableResource
Definition:	Hydrocarbons cover various types of natural gas and petroleum resources.
Description:	
Status:	Proposed
Stereotypes:	«featureType»
Identifier:	null

Attribute: hydrocarbonResource

Value type:	HydrocarbonResourceType
Definition:	Type and amount of hydrocarbon resources in a single accumulation or reservoir.
Multiplicity:	1..*

5.4.2.1.2. NonRenewableResource

NonRenewableResource (abstract)

Name:	Non-renewable resource
Subtype of:	VectorEnergyResource
Definition:	Natural resources which, due to long-term formation, cannot be produced, grown, generated, or used on a scale which can sustain its consumption rate. These resources exist in a fixed amount, or are consumed much faster than nature can replenish them.
Status:	Proposed
Stereotypes:	«featureType»
Identifier:	null

Attribute: dateOfDiscovery

Value type:	TM_Position
Definition:	The date the non-renewable energy source was discovered.
Multiplicity:	1
Stereotypes:	«voidable»

Attribute: depthRange

Value type:	DepthRangeType
Definition:	The range between the deepest (lower bound) and most shallow (upper bound) aspect of the deposit body, where the depth is true vertical depth below the Earth's surface or average sea level.
Multiplicity:	1..*

NonRenewableResource (abstract)	
Stereotypes:	«voidable»

5.4.2.1.3. RenewableAndWasteResource

RenewableAndWasteResource	
Name:	Renewable and waste resource
Subtype of:	VectorEnergyResource
Definition:	A feature defining an inferred or observable spatial extent of a resource that can be, or has been used as a source of renewable energy or waste.
Description:	Renewable energy is energy that is derived from natural processes that are replenished constantly. Waste is a fuel consisting of many materials coming from combustible industrial, institutional, hospital and household wastes such as rubber, plastics, waste fossil oils and other similar commodities. It is either solid or liquid in form, renewable or non-renewable, biodegradable or non-biodegradable.
Status:	Proposed
Stereotypes:	«featureType»
Identifier:	null
Attribute: Capacity	
Value type:	Measure
Definition:	Energy capacity of a renewable energy resource within the spatial extent.
Description:	NOTE the unit of measure to be used is MWe for electrical generation capacity and MWt for heat generation capacity.
Multiplicity:	0..1
Stereotypes:	«voidable»
Attribute: dateOfDetermination	
Value type:	TM_Position
Definition:	Date of determining the capacity of resource.
Multiplicity:	1
Stereotypes:	«voidable»
Attribute: type	
Value type:	RenewableAndWasteCode
Definition:	The type of renewable energy or waste resource.
Multiplicity:	1
Obligation:	Implementing Rule (requirement)

5.4.2.1.4. SolidFossilFuel

SolidFossilFuel	
Name:	Solid fossil fuel
Subtype of:	NonRenewableResource
Definition:	Solid fuels cover various types of coals and products derived from coals.
Description:	
Status:	Proposed
Stereotypes:	«featureType»
Identifier:	null
Attribute: calorificValue	
Value type:	Measure
Definition:	Each non-renewable energy resource is characterised by its own calorific value, *i.e.* the quantity of energy available in a unit of mass.
Description:	NOTE the unit of measure to be used is MJ/tonne

SolidFossilFuel	
Multiplicity:	1
Stereotypes:	«voidable»

Attribute: quantity

Value type:	SolidFossilFuelMeasure
Definition:	Amount of resource according specific categorisation.
Multiplicity:	0..*
Stereotypes:	«voidable»

Attribute: type

Value type:	SolidFossilFuelCode
Definition:	Type of solid fossil fuel.
Multiplicity:	1
Obligation:	Implementing Rule (requirement)

5.4.2.1.5. VectorEnergyResource

VectorEnergyResource (abstract)	
Name:	Vector Energy Resource
Subtype of:	EnergyResource
Definition:	A vector feature defining an inferred or observable spatial extent of a resource that can be, or has been, used as a source of energy.
Status:	Proposed
Stereotypes:	«featureType»
Identifier:	null

Attribute: exploitationPeriod

Value type:	ExploitationPeriodType
Definition:	The exploitationPeriod defines the start and, if applicable, the end date of the application
Description:	NOTE For several reasons there might be more than 1 exploitation period
Multiplicity:	0..*
Stereotypes:	«voidable»

Attribute: geometry

Value type:	GM_Object
Definition:	Geometric representation of spatial extent covered by this energy resource.
Multiplicity:	1

Attribute: resourceName

Value type:	GeographicalName
Definition:	The name of the energy resource
Description:	NOTE For non-renewable energy sources this name is the official name, as it's registered in the national register governed by geological survey or other national authority in charge.
Multiplicity:	0..*
Stereotypes:	«voidable»

Association role: isReportedBy

Value type:	ReportingInformation
Definition:	Reporting information on the typology and quantification of the energy resource.
Multiplicity:	0..1
Stereotypes:	«voidable»

5.4.2.2. Data types

5.4.2.2.1. DepthRangeType

DepthRangeType	
Name:	Depth Range Type
Definition:	The range between the deepest (lower bound) and most shallow (upper bound) aspect of the deposit body, where the depth is true vertical depth below the Earth's surface or average sea level.
Status:	Proposed
Stereotypes:	«dataType»
Identifier:	null
Attribute: depthReference	
Value type:	DepthReferenceValue
Definition:	Reference level that was chosen to determine the vertical depth.
Multiplicity:	1
Obligation:	Implementing Rule (requirement)
Attribute: lowerBound	
Value type:	Length
Definition:	True vertical depth from the earths crust or mean sea level to the deepest vertex of the deposit body.
Multiplicity:	1
Attribute: upperBound	
Value type:	Length
Definition:	True vertical depth from the earths crust or mean sea level to the shallowest vertex of the deposit body.
Multiplicity:	1
Constraint: LowerBoundUoMShallBeMeter	
Natural language:	Value of lowerbound is expressed in meters
OCL:	inv: self.lowerbound.uom.uomSymbol='m'
Constraint: UpperBoundUoMShallBeMeter	
Natural language:	Value of upperBound is expressed in meters
OCL:	inv: self.upperBound.uom.uomSymbol='m'

5.4.2.2.2. ExploitationPeriodType

ExploitationPeriodType	
Name:	Exploitation Period Type
Definition:	Exploitation period of the energy resource.
Status:	Proposed
Stereotypes:	«dataType»
Identifier:	null
Attribute: beginTime	
Value type:	TM_Position
Definition:	The time when the exploitation started.
Description:	This is both for renewable and non-renewable energy sources. For non-renewable energy resources exploitation starts with certain mining activities. In the case of renewable energy resources, it starts with the extraction of energy using specific equipment.
Multiplicity:	1

ExploitationPeriodType

Attribute: endTime

Value type:	TM_Position
Definition:	The time when the exploitation has ended.
Description:	This is both for renewable and non-renewable energy sources. For non-renewable energy resources exploitation ends with stopping the mining activities. In the case of renewable energy resources, it ends when specific equipment is no longer used for extraction of renewable and waste energy.
Multiplicity:	0..1

5.4.2.2.3. HydrocarbonMeasure

HydrocarbonMeasure

Name:	Hydrocarbon measure
Definition:	Amount of resource according to specific categorisation.
Status:	Proposed
Stereotypes:	«dataType»
Identifier:	null

Attribute: amount

Value type:	Measure
Definition:	Amount.
Description:	NOTE the unit of measure to be used is m^3 for natural gas assuming reference gas conditions (15° C; 101,325 kPa) and 10^3 tonnes for oil.
Multiplicity:	1

Attribute: dateOfDetermination

Value type:	TM_Position
Definition:	Date of determining the quantification of resource.
Multiplicity:	1

Attribute: quantityType

Value type:	HydrocarbonClass
Definition:	Level of resource.
Description:	The resource categories proposed are common categories to most classification schemes, representing an aggregated quantity at the level of: • the production, • the total amount initially in place • the reserves, • the contingent resources and • unrecoverable.
Multiplicity:	1
Obligation:	Implementing Rule (requirement)

5.4.2.2.4. HydrocarbonResourceType

HydrocarbonResourceType

HydrocarbonResourceType

Name: Hydrocarbon resource type
Definition: Type and amount of resource according to specific categorisation.
Status: Proposed
Stereotypes: «dataType»
Identifier: null

Attribute: type

Value type: HydrocarbonCode
Definition: Type of hydrocarbon.
Multiplicity: 1
Obligation: Implementing Rule (requirement)

Attribute: calorificValue

Value type: Measure
Definition: Each non-renewable energy resource is characterised by its own calorific value, *i.e.* the quantity of energy available in a unit of mass.
Description:
NOTE the unit of measure to be used is MJ/tonne for oil and KJ/m³ for natural gas assuming reference gas conditions (15°C; 101,325 kPa)
Multiplicity: 1
Stereotypes: «voidable»

Attribute: quantity

Value type: HydrocarbonMeasure
Definition: Amount of resource according to specific categorisation.
Multiplicity: 0..*
Stereotypes: «voidable»

5.4.2.2.5. SolidFossilFuelMeasure

SolidFossilFuelMeasure

Name: Solid fossil fuel measure
Definition: Amount of resource according to specific categorisation.
Status: Proposed
Stereotypes: «dataType»
Identifier: null

Attribute: amount

Value type: Measure
Definition: Amount.
Description: NOTE the unit of measure to be used is 10^3 tonnes.
Multiplicity: 1

Attribute: dateOfDetermination

Value type: TM_Position
Definition: Date of determining the quantification of resource.
Multiplicity: 1

Attribute: quantityType

Value type: SolidFossilFuelClass
Definition: Level of resource.
Multiplicity: 1
Obligation: Implementing Rule (requirement)

5.4.2.3. Code lists

5.4.2.3.1. DepthReferenceValue

DepthReferenceValue	
Name:	Depth Reference
Definition:	code list for the reference level that has been considered to capture its true vertical depth.
Status:	Proposed
Stereotypes:	«codeList»
Extensibility:	none
Identifier:	http://inspire.ec.europa.eu/codeList/DepthReferenceValue

5.4.2.3.2. HydrocarbonClass

HydrocarbonClass	
Name:	Hydrocarbon Class
Definition:	Codelist listing different levels of hydrocarbon resources.
Status:	Proposed
Stereotypes:	«codeList»
Extensibility:	none
Identifier:	http://inspire.ec.europa.eu/codeList/HydrocarbonClass

5.4.2.3.3. SolidFossilFuelClass

SolidFossilFuelClass	
Name:	Solid Fossil Fuel Class
Definition:	Codelist listing different levels of solid fossil fuel resources.
Status:	Proposed
Stereotypes:	«codeList»
Extensibility:	none
Identifier:	http://inspire.ec.europa.eu/codeList/SolidFossilFuelClass

5.4.2.4. Imported types (informative)

This section lists definitions for feature types, data types and enumerations and code lists that are defined in other application schemas. The section is purely informative and should help the reader understand the feature catalogue presented in the previous sections. For the normative documentation of these types, see the given references.

5.4.2.4.1. EnergyResource

EnergyResource (abstract)	
Package:	INSPIRE Consolidated UML Model::Themes::Annex III::Energy Resources::EnergyResourcesBase [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	A feature defining an inferred or observable spatial extent of a resource that can be, or has been, used as a source of energy.
Description:	SOURCE Adapted from [DER 2011].

5.4.2.4.2. GM_Object

GM_Object (abstract)	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19107:2003 Spatial Schema:: Geometry::Geometry root [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]

5.4.2.4.3. GeographicalName

GeographicalName

GeographicalName	
Package:	INSPIRE Consolidated UML Model::Themes::Annex I::Geographical Names::Geographical Names [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	Proper noun applied to a real world entity.

5.4.2.4.4. HydrocarbonCode

HydrocarbonCode	
Package:	INSPIRE Consolidated UML Model::Themes::Annex III::Energy Resources::EnergyResourcesBase [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	Classification value that defines the specialised type of hydrocarbon.
Description:	

5.4.2.4.5. Length

Length	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19103:2005 Schema Language::Basic Types::Derived::Units of Measure [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]

5.4.2.4.6. Measure

Measure	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19103:2005 Schema Language::Basic Types::Derived::Units of Measure [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]

5.4.2.4.7. Measure

Measure	
Package:	INSPIRE Consolidated UML Model::Themes::Annex III::Production and Industrial Facilities::ProductionAndIndustrialFacilities [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	Declared or measured quantity of any kind of physical entity.

5.4.2.4.8. RenewableAndWasteCode

RenewableAndWasteCode	
Package:	INSPIRE Consolidated UML Model::Themes::Annex III::Energy Resources::EnergyResourcesBase [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	Classification value that defines the specialised type of renewable and waste resources.
Description:	

5.4.2.4.9. ReportingInformation

ReportingInformation	
Package:	INSPIRE Consolidated UML Model::Themes::Annex III::Energy Resources::EnergyResourcesBase [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	Energy resource reporting information detailing the type of reporting standard or classification schema.
Description:	

5.4.2.4.10. SolidFossilFuelCode

SolidFossilFuelCode	
Package:	INSPIRE Consolidated UML Model::Themes::Annex III::Energy Resources::EnergyResourcesBase [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	Additional classification value that defines the specialised type of solid fossil fuels.
Description:	

5.4.2.4.11. TM_Position

TM_Position	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19108:2006 Temporal Schema::Temporal Reference System [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]

5.4.3 INSPIRE-governed code lists

The INSPIRE-defined code lists included in this application schema include the values specified in the tables in this section.

5.4.3.1. Values of code list DepthReferenceValue

Value	Name	Definition	Description	Parent value
groundLevel	ground Level	The Earth's surface		
lowestAstronomicalTide	lowest Astronomical Tide	The lowest tide level that can be predicted to occur under average meteorological conditions and under any combination of astronomical conditions.	SOURCE [DFDD]	
meanSeaLevel	mean Sea Level	The average height of the sea at a tide station measured from a fixed predetermined reference level.	SOURCE [DFDD].	
seafloor	seafloor	The bottom of a sea or ocean.		

5.4.3.2. Values of code list HydrocarbonClass

Value	Name	Definition	Description	Parent value
contingentResources	contingent Resources	Contingent resources are those quantities of	Contingent resources are those quantities	

		energy resources estimated, as of a given date, to be potentially recoverable from known accumulations using established technology or technology under development.	which are (believed to be) present at the time of estimation. These quantities are not (yet) commercial. Maturing of the project to produce this quantity, or technical abilities or economic factors may convert these contingent resources into reserves.	
cumulativeProduction	cumulative Production	The cumulative production from a hydrocarbon resource accumulation		
hydrocarbonsInitiallyInPlace	hydrocarbons Initially In Place	The total amount of a hydrocarbon resource initially present in an accumulation	Hydrocarbons initially in place (HCIIP – or GIIP for gas, or STOOIP for oil) is the quantity estimated to be initially present in an accumulation. The HCIIP is calculated in order to make a business case for exploration. In most cases after successful drilling of the field, a number of adjustments will be made to the HCIIP based on new data acquired when drilling the field (such as well test data, the depth of the lower boundary - gas water contact). As it is a volumetric calculation based on a number of assumptions the HCIIP may be re-evaluated over time as more data become available.	

nonRecoverableResources	non Recoverable Resources	Unrecoverable resources, whether discovered or not, are either technically impossible or not economic to produce.		
provenReserves	proven Reserves	Reserves are estimated remaining quantities of oil and gas and related substances anticipated to be economically producible, as of a given date, by application of development projects to known accumulations.	Reserves are those quantities which are expected to be present at the time of estimation (by pressure measurements, production test, production behaviour) and commercially producible. They may be called remaining reserves (as they may be less than the initial reserves as a part was produced). Proven reserves are that part of the reserves for which the presence is 90 % certain.	
storageWorkingCapacity	storage Working Capacity	Total gas storage capacity, minus the cushion gas. The cushion gas is the total volume of gas required as a permanent inventory to maintain adequate underground storage reservoir pressures and deliverability rates throughout the output cycle.	NOTE It concerns pumped storage (in underground storages; both natural (depleted reservoirs) and man-made (caverns, mainly in rocksalt)).	

5.4.3.3. Values of code list SolidFossilFuelClass

Value	Name	Definition	Description	Parent value
provedReserves	proved Reserves	Reserves that are not only considered to be recoverable but can also be		

		recovered economically. This means they take into account what current mining technology can achieve and the economics of recovery. Proved reserves will therefore change according to the price of coal; if the price of coal is low proved reserves will decrease.		
reserves	reserves	Reserves can be defined in terms of proved (or measured) reserves and probable (or indicated) reserves. Probable results have been estimated with a lower degree of confidence than proved reserves.		
resource	resource	The amount of coal that may be present in a deposit or coalfield. This does not take into account the feasibility of mining the coal economically. Not all resources are recoverable using current technology.		

5.4.4 Externally governed code lists

The *EnergyResourcesVector* application schema does not contain externally governed code lists.

5.5 Application schema EnergyResourcesCoverage

5.5.1 Description

5.5.1.1. Narrative description

Another viewpoint to spatially describe Energy Resources is to assess the variation of an Energy Resource property within a domain of interest. This viewpoint is particularly applied for the representation of the energy potential of renewable and waste resources, and relies to a large extent on the availability of a natural resource only and not on any legal or socio-economic criteria.

The *EnergyResourcesCoverage* application schema defines the specification for the provision of data describing the energy potential within a domain of interest. Within the scope of this data specification

the use of the *EnergyResourcesCoverage* application schema is restricted to the representation of continuous phenomena, such as wind speed, solar radiation, geothermal gradient etc…
However, the *EnergyResourcesCoverage* application schema should not be used as an alternative representation of discrete objects like coal deposits, oil fields, or any other delineation of spatial features, nor to represent properties of subsurface non-renewable energy sources. Therefore, the use of this application schema is restricted to renewable and waste resources, the potential of which can vary over time and space.

The *EnergyResourcesCoverage* application schema has been developed according the Rules for application schemas defined in ISO 19109 and depends on the common model for Coverages included in the Generic Conceptual model. The coverage representation should be applied in order to present the variation of energy-related properties based on a gridded domain.

5.5.1.2. UML Overview

The *EnergyResourcesVector* application schema is presented in Figure 10 and described below.

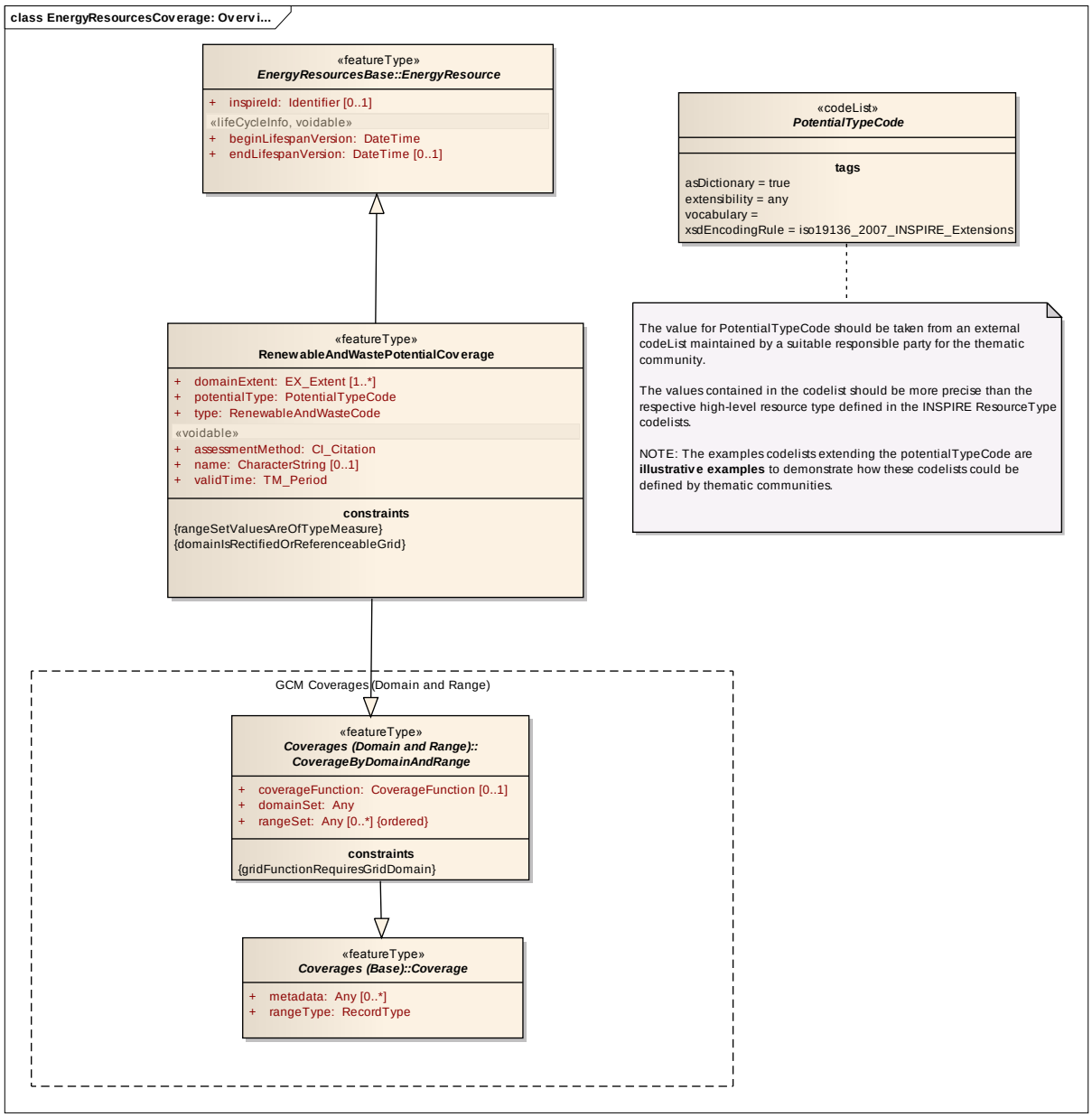


Figure 10 – UML class diagram: Overview of the EnergyResourcesCoverage application schema

The *EnergyResourcesCoverage* application schema defines a model for gridded coverage types based on ISO 19123.

The feature type *RenewableAndWasteCoverage* is the single spatial object type in this application schema for modelling a gridded coverage that represents the potential of a renewable energy resource. It inherits common properties such as the Inspire identifier and lifecycle information from the abstract class *EnergyResource* defined in the *EnergyResourcesBase* application schema.
At the same time other properties are inherited from the abstract *CoverageByDomainAndRange* featuretype (GCM) and correspond to the basic properties of coverages as defined in ISO 19123. Besides the inherited properties additional attributes are defined:

- for providing a coverage name (attribute *name*),
- for describing the extent of the spatio-temporal domain (attribute *domainExtent*),
- for documenting the method used to assess the energy potential (attribute *assessmentMethod*),
- for defining the time period during which the data is usable and for indicating the main type of energy resource (attribute *validTime*).

In cases like modelling wind and geothermal energy it is important to know at which height respectively depth the wind speed and earth crust temperature have been modelled into a coverage representation. This information can be provided by using the *domainExtent* attribute allowing for describing the temporal, vertical and geographic extent of a coverage.

Recommendation 9	It is recommended to describe at least EX_GeographicExtent information through the DomainExtent attribute.

IR Requirement 8	EX_VerticalExtent information shall be provided through the *domainExtent* attribute for coverages having a vertical domain (for example potential of geothermal energy, of wind energy,…).

Detailed information on the type of potential power (*PotentialType* attribute) needs to be provided by selecting a coded value from the *PotentialTypeCode* code list. This code list has been left empty on purpose, and the values should be taken from external code lists that extend the *PotentialTypeCode* code list. The external code lists should be maintained by a suitable responsible organisation for the thematic domain. Illustrative examples how the codelist can be extended for a certain number of subdomains are provided in Annex C.

The rangeset of the coverage needs to correspond with the type of potential power defined (e.g. diffuse solar irradiance, wind speed….) and is composed of a finite range of attribute values which are of type Measure (e.g. 1000 Wm^2).

The domain of the coverage shall be limited to rectified or referenceable grids, which means it can be spatially referenced through a coordinate reference system. Each grid cell that is part of the domain shall correspond with a value representing the amount of potential energy modelled or calculated for a specific Energy Resource type.

When providing data according to the specified application schema, it is of paramount importance that the methodology followed for modelling and generating the coverage is documented. This type of information is essential to interpret the provided information correctly.

The *EnergyResourcesCoverage* application schema only intends to provide a generic pattern for Coverage representations of the energy potential of renewable and waste resources. For using it properly, additional code lists specifying the potential type need to be elaborated and made public, either by member states or thematic communities.

IR Requirement 9	For each Energy Resource spatial object in the *EnergyResourcesCoverage* application schema, information regarding the type of renewable or waste resource shall be provided.

5.5.1.3. Consistency between spatial data sets

The *EnergyResourcesCoverage* application schema does not require consistency rules.

5.5.1.4. Identifier management

The *EnergyResourcesCoverage* application schema does not require specific identifier management, though the Energy Resources data specification allows an optional inspireId for all application schemas. This identifier shall, if provided, be maintained by the national or regional authority.

5.5.1.5. Modelling of object references

The *EnergyResourcesCoverage* application schema does not require modelling of object references.

5.5.1.6. Geometry representation

The geometry representation for Energy Resources coverages is identified by the data structures defined for rectified or referenceable grids in this specification.

5.5.1.7. Temporality representation

The application schema(s) use(s) the derived attributes "beginLifespanVersion" and "endLifespanVersion" to record the lifespan of a spatial object.

The attributes "beginLifespanVersion" specifies the date and time at which this version of the spatial object was inserted or changed in the spatial data set. The attribute "endLifespanVersion" specifies the date and time at which this version of the spatial object was superseded or retired in the spatial data set.

NOTE 1 The attributes specify the beginning of the lifespan of the version in the spatial data set itself, which is different from the temporal characteristics of the real-world phenomenon described by the spatial object. This lifespan information, if available, supports mainly two requirements: First, knowledge about the spatial data set content at a specific time; second, knowledge about changes to a data set in a specific time frame. The lifespan information should be as detailed as in the data set (i.e., if the lifespan information in the data set includes seconds, the seconds should be represented in data published in INSPIRE) and include time zone information.

NOTE 2 Changes to the attribute "endLifespanVersion" does not trigger a change in the attribute "beginLifespanVersion".

Recommendation 10	If life-cycle information is not maintained as part of the spatial data set, all spatial objects belonging to this data set should provide a void value with a reason of "unpopulated".

Within *EnergyResourcesCoverage* application schema a range of attributes are defined that represent continually varying real world phenomena like wind speed, solar irradiation etc.... The scope of these data specifications is not to have information on potential of Energy Resources for a specific point in time, but rather to have long term averages for a certain period. To represent this period information, a temporal attribute *ValidTime* was added to the *RenewableAndWasteCoverage* featuretype. The ValidTime specifies the time window for which measurements have been captured to calculate the average energy potential corresponding to that period.

IR Requirement 10 Temporality information on Energy Resource Coverages shall be provided using the *ValidTime* attribute.

Recommendation 11 It is strongly recommended to provide range values corresponding to annual averages of potential energy sources.

Recommendation 12 It is encouraged to provide range values corresponding to seasonal or monthly averages of potential energy sources when values may fluctuate considerably within a period of one year.

5.5.2 Feature catalogue

Table 3 - Feature catalogue metadata

Feature catalogue name	INSPIRE feature catalogue EnergyResourcesCoverage
Scope	EnergyResourcesCoverage
Version number	2.9
Version date	2012-02-24
Definition source	INSPIRE data specification EnergyResourcesCoverage

Table 4 - Types defined in the feature catalogue

Type	Package	Stereotypes	Section
PotentialTypeCode	EnergyResourcesCoverage	«codeList»	5.2.2.2.1
RenewableAndWastePotentialCoverage	EnergyResourcesCoverage	«featureType»	5.2.2.1.1

5.5.2.1. Spatial object types

5.5.2.1.1. RenewableAndWastePotentialCoverage

RenewableAndWastePotentialCoverage

Name:	Renewable And Waste Potential Coverage
Subtype of:	CoverageByDomainAndRange, EnergyResource
Definition:	Feature type that acts as a function to return an energy potential property value from its range for any direct position within its spatial, temporal or spatiotemporal domain.
Description:	SOURCE Adapted from "Coverage" [ISO 19123:2005].
Status:	Proposed
Stereotypes:	«featureType»
Identifier:	null

Attribute: assessmentMethod

Value type:	CI_Citation
Definition:	A citation to the method used to assess the energy resource potential.

RenewableAndWastePotentialCoverage

Multiplicity: 1
Stereotypes: «voidable»

Attribute: domainExtent

Name: Domain extent.
Value type: EX_Extent
Definition: The attribute domainExtent shall contain the extent of the spatiotemporal domain of the coverage. The data type EX_Extent, is defined in ISO 19103. Extents may be specified in both space and time.
Description: NOTE 1 The domain extent shall be specified at least in space by using EX_BoundingPolygon, EX_GeographicBoundingBox or EX_GeographicDescription.

NOTE 2 In specific case information is needed on the vertical extent e.g. wind power potential.
SOURCE Adapted from [ISO 19123:2005].
Multiplicity: 1..*

Attribute: name

Value type: CharacterString
Definition: Name of the coverage.
Description: EXAMPLE The name of the catchment area for which a coverage has been extracted to represent Hydroelectric potential.
Multiplicity: 0..1
Stereotypes: «voidable»

Attribute: potentialType

Value type: PotentialTypeCode
Definition: There are various types of potential energy, each associated with a particular type of power.
Description: NOTE Most detailed classification must be provided.
Multiplicity: 1
Obligation: Implementing Rule (requirement)

Attribute: type

Value type: RenewableAndWasteCode
Definition: Type of renewable and waste resource to which the measured phenomenon is applicable.
Description: NOTE Most detailed classification must be provided.
Multiplicity: 1
Obligation: Implementing Rule (requirement)

Attribute: validTime

Value type: TM_Period
Definition: The ValidTime specifies the time window for which measurements have been captured to calculate the average energy potential corresponding to that period.
Multiplicity: 1
Stereotypes: «voidable»

Constraint: domainIsRectifiedOrReferenceableGrid

Natural language: domain is a grid (rectified or referenceable)
OCL: inv: domainSet.oclIsKindOf(CV_RectifiedGrid) or inv: domainSet.oclIsKindOf(CV_ReferenceableGrid)

RenewableAndWastePotentialCoverage	
Constraint: rangeSetValuesAreOfTypeMeasure	
Natural language:	rangeSet values are of type Measure
OCL:	inv: rangeSet.forAll(oclIsKindOf(Measure))

5.5.2.2. Code lists

5.5.2.2.1. PotentialTypeCode

PotentialTypeCode (abstract)	
Name:	Potential Type Code
Definition:	Classification value that defines the specialised type of potential energy from renewable and waste resources.
Status:	Proposed
Stereotypes:	«codeList»
Extensibility:	any
Identifier:	

5.5.2.3. Imported types (informative)

This section lists definitions for feature types, data types and enumerations and code lists that are defined in other application schemas. The section is purely informative and should help the reader understand the feature catalogue presented in the previous sections. For the normative documentation of these types, see the given references.

5.5.2.3.1. CI_Citation

CI_Citation	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19115:2006 Metadata (Corrigendum)::Citation and responsible party information [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]

5.5.2.3.2. CharacterString

CharacterString	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19103:2005 Schema Language::Basic Types::Primitive::Text [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]

5.5.2.3.3. CoverageByDomainAndRange

CoverageByDomainAndRange (abstract)	
Package:	INSPIRE Consolidated UML Model::Generic Conceptual Model::Base Models::Coverages::Coverages (Domain and Range) [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	coverage which provide the domain and range as separate properties

5.5.2.3.4. EX_Extent

EX_Extent	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19115:2006 Metadata (Corrigendum)::Extent information [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]

5.5.2.3.5. EnergyResource

EnergyResource (abstract)

EnergyResource (abstract)	
Package:	INSPIRE Consolidated UML Model::Themes::Annex III::Energy Resources::EnergyResourcesBase [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	A feature defining an inferred or observable spatial extent of a resource that can be, or has been, used as a source of energy.
Description:	SOURCE Adapted from [DER 2011].

5.5.2.3.6. RenewableAndWasteCode

RenewableAndWasteCode	
Package:	INSPIRE Consolidated UML Model::Themes::Annex III::Energy Resources::EnergyResourcesBase [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	Classification value that defines the specialised type of renewable and waste resources.
Description:	

5.5.2.3.7. TM_Period

TM_Period	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19108:2006 Temporal Schema::Temporal Objects [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]

5.5.3 INSPIRE-governed code lists

The INSPIRE-defined code lists included in this application schema include the values specified in the tables in this section.

5.5.3.1. Values of code list PotentialTypeCode

Value	Name	Definition	Description	Parent value

5.5.4 Externally governed code lists

The *EnergyResourcesCoverage* application schema does not contain externally governed code lists.

5.6 Application schema EnergyStatistics

5.6.1 Description

5.6.1.1. Narrative description

Detailed, complete, timely and reliable statistics are essential to monitor the energy situation at a country level as well as at an international level. Energy statistics are conceived as an instrument for collecting and representing information on the supply, trade, stocks, transformation and demand of

energy resources and products. In other words, energy statistics provide detailed and reliable data on the different parts of the production and consumption chain.

As such the scope of Energy statistics is much wider than the scope defined in the Energy Resources data specification. Nevertheless, there is a need to support the exchange of aggregated information since a lot of spatial data about Energy Resources are privately held and not available within the context of INSPIRE.

The *EnergyStatistics* application schema provides a generic pattern for exchanging aggregated data based on statistical units. The primary objective of this application schema is to enable the representation of aggregated data dealing with the quantification of primary energy commodities in terms of available in-place resources or in terms of production statistics of energy extracted from primary energy resources. Within this respect it needs to be emphasized that the application schema also might support other types of energy statistics, such as statistics on secondary energy resources, although this goes beyond the scope of the current application schema.

Furthermore, the *EnergyStatistics* application schema aims to be generic and is not restricted to a specific type of statistical unit. It supports statistical units as vector geometries and grid cells.

5.6.1.2. UML Overview

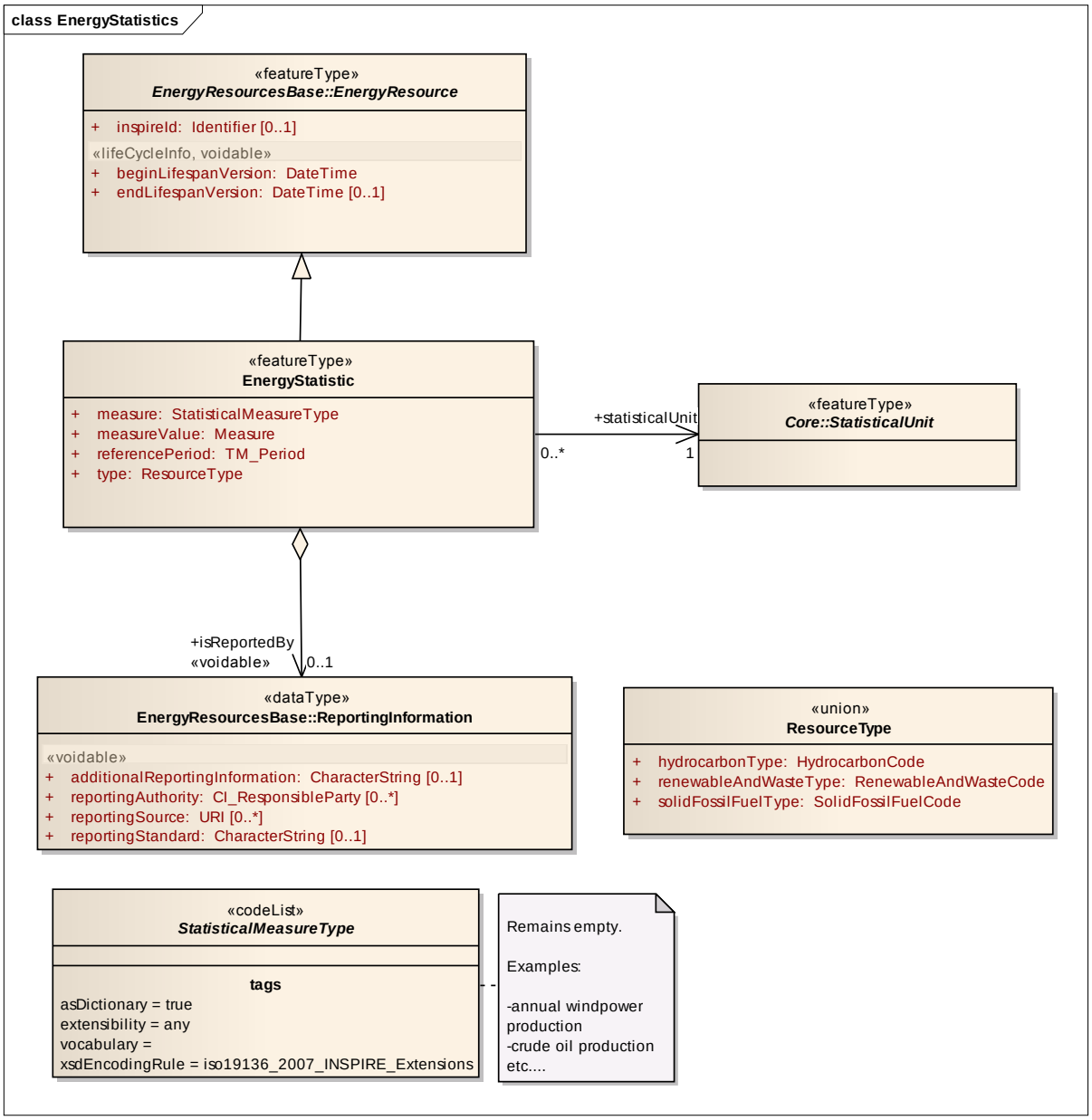


Figure 11 – UML class diagram: Overview of the EnergyStatistics application schema

The *EnergyStatistics* application schema as shown in Figure 11 has been developed according to the Rules for application schemas defined in ISO 19109. The feature type *EnergyStatistic* is the key featuretype in this application schema and represents aggregated data on Energy Resources, in the format of a statistical value. In order to geographically locate aggregated data the *EnergyStatistic* class is linked to the spatial object type *StatisticalUnit,* which is managed by the Statistical Units theme and defines the spatial unit for disseminating or using statistical information. Figure 11 shows the *EnergyStatistics* application schema structure and visualizes how energy-related statistics are linked, through an association, to a the abstract class StatisticalUnit as it is defined in the Statistical Unit – Core application schema. The Core application schema of Statistical Units allows to further specialize the type of statistical unit (grid, urban audit, NUTS, region, etc…).

Similar to the previous listed application schema's, the *EnergyStatistic* featuretype inherits common properties such as the Inspire identifier and lifecycle information from the abstract class *EnergyResource* defined in the *EnergyResourcesBase* application schema.
In addition the *EnergyStatistic* featuretype is characterized by 4 properties:

The *type* attribute allows for defining the subdomain of Energy Resources to which the statistic applies.

The *measure* attribute contains the value of the corresponding code list variable, which describes the type of statistical information provided e.g. annual wind power production. This code list i.e. *StatisticalMeasureType* has been left empty on purpose, and the values should be taken from external code lists that extend the *StatisticalMeasureType* code list. The external code lists should be maintained by a suitable responsible organisation for the thematic domain.

Consequently, the *measurevalue* attribute contains the actual statistical value (e.g. 10 GWh)

Finally, the *referencePeriod* attribute allows for defining the time period to which the statistical information refers.

Usually, information on the calculation of energy statistics are dependent on the type of reporting standards and/or classification schemes that are applied within a certain subdomain. As there is a high variety of calculation methods, each of them with specific characteristics, there is no reference method proposed within the *EnergyStatistics* application schema. Therefore, it is recommended within the scope of the Energy Resources data specification to document in the *ReportingInformation* datatype the name and the source of the calculation method or reporting standard, and to specify the authority that is responsible for the reporting figures.

Recommendation 13	If applicable, it is recommended to provide additional reporting information on statistical values by documenting the reporting standard, source and defining the responsible authority.

Concerning units of measure it is recommended to apply common units of measures to express quantities of resources: tonnes for masses, m³ for volumes, MWh for production of electricity. To enable the comparison between energy resources it is highly recommended to convert quantities into tonne of oil equivalent (toe) defined as 41.868 gigajoules. Many organisations use this unit but the terajoule is increasingly used in accordance with the recommendations by the International Standards Organization (ISO). Please note that a unit converter for volume, mass and energy is provided on the IEA website (*www.iea.org*). An example of a conversion table is provided in Figure 12.

To: / From:	TJ multiply by:	Gcal	Mtoe	MBtu	GWh
Terajoule (TJ)	1	238.8	2.388×10^{-5}	947.8	0.2778
Gigacalorie	4.1868×10^{-3}	1	10^{-7}	3.968	1.163×10^{-3}
Mtoe*	4.1868×10^{4}	10^{7}	1	3.968×10^{7}	11630
Million Btu	1.0551×10^{-3}	0.252	2.52×10^{-8}	1	2.931×10^{-4}
Gigawatt-hour	3.6	860	8.6×10^{-5}	3412	1

Figure 12 – Example of an energy conversion table (Source: Energy Statistics Manual, OECD/IEA, 2005)

5.6.1.3. Consistency between spatial data sets

The *EnergyStatistics* application schema does not require consistency rules.

5.6.1.4. Identifier management

The *EnergyStatistics* application schema does not require specific identifier management, though the Energy Resources data specification allows an optional inspireId for all application schemas. This identifier shall, if provided, be maintained by the national or regional authority.

5.6.1.5. Modelling of object references

The *EnergyStatistics* application schema does not require modelling of object references.

5.6.1.6. Geometry representation

The geometry representation for *EnergyStatitistics* support different geometrical representations and is described by the geometry descriptor in the *Statistical Units* application schema.

5.6.1.7. Temporality representation

The application schema(s) use(s) the derived attributes "beginLifespanVersion" and "endLifespanVersion" to record the lifespan of a spatial object.

The attributes "beginLifespanVersion" specifies the date and time at which this version of the spatial object was inserted or changed in the spatial data set. The attribute "endLifespanVersion" specifies the date and time at which this version of the spatial object was superseded or retired in the spatial data set.

NOTE 1 The attributes specify the beginning of the lifespan of the version in the spatial data set itself, which is different from the temporal characteristics of the real-world phenomenon described by the spatial object. This lifespan information, if available, supports mainly two requirements: First, knowledge about the spatial data set content at a specific time; second, knowledge about changes to a data set in a specific time frame. The lifespan information should be as detailed as in the data set (i.e., if the lifespan information in the data set includes seconds, the seconds should be represented in data published in INSPIRE) and include time zone information.

NOTE 2 Changes to the attribute "endLifespanVersion" does not trigger a change in the attribute "beginLifespanVersion".

Recommendation 14	If life-cycle information is not maintained as part of the spatial data set, all spatial objects belonging to this data set should provide a void value with a reason of "unpopulated".

5.6.2 Feature catalogue

Table 3 - Feature catalogue metadata

Feature catalogue name	INSPIRE feature catalogue EnergyStatistics
Scope	EnergyStatistics
Version number	2.9
Version date	2012-02-24
Definition source	INSPIRE data specification EnergyStatistics

Table 4 - Types defined in the feature catalogue

Type	Package	Stereotypes	Section

Type	Package	Stereotypes	Section
EnergyStatistic	EnergyStatistics	«featureType»	5.2.2.1.1
ResourceType	EnergyStatistics	«union»	5.2.2.2.1
StatisticalMeasureType	EnergyStatistics	«codeList»	5.2.2.3.1

5.6.2.1. Spatial object types

5.6.2.1.1. EnergyStatistic

EnergyStatistic

Name:	Energy Statistic.
Subtype of:	EnergyResource
Definition:	Set of measures to aggregate values on the availability or production of energy resources.
Status:	Proposed
Stereotypes:	«featureType»
Identifier:	null

Attribute: measure

Name	Measure
Value type:	StatisticalMeasureType
Definition:	What the distribution measures.
Description:	NOTE: for comparing different types of energy resources the unit of measure is tonnes of oil equivalent (toe). Otherwise the commodity units of measure should be applied: 10^3 tonnes for solid fossil fuels and oils, m^3 for natural gas, GWh (electriciy) and TJ (Heat) for renewables and waste EXAMPLE: proved coal reserves by country, wind energy capacity by region, etc...
Multiplicity:	1
Obligation:	Technical Guidance (recommendation)

Attribute: measureValue

Name	Value
Value type:	Measure
Definition:	The value for the defined variable.
Multiplicity:	1

Attribute: referencePeriod

Name	Period of reference
Value type:	TM_Period
Definition:	The time period to which the data is supposed to give a picture of the area of interest.
Multiplicity:	1

Attribute: type

Value type:	ResourceType
Definition:	Type of energy resource to which the measured potential is applicable.
Multiplicity:	1

Association role: statisticalUnit

Value type:	StatisticalUnit
Multiplicity:	1

Association role: isReportedBy

Value type:	ReportingInformation

EnergyStatistic	
Definition:	Reporting information on the provided statistic.
Multiplicity:	0..1
Stereotypes:	«voidable»

5.6.2.2. Data types

5.6.2.2.1. ResourceType

ResourceType	
Name:	Resource type
Definition:	Choice to specify either a solid fossil fuel, a hydrocarbon or a renewable or waste resource i.e. the type of resource to which the statistic applies. NOTE only one option can be chosen.
Status:	Proposed
Stereotypes:	«union»
Identifier:	null

Attribute: hydrocarbonType	
Value type:	HydrocarbonCode
Definition:	Type of hydrocarbon
Multiplicity:	1
Obligation:	Technical Guidance (recommendation)

Attribute: renewableAndWasteType	
Value type:	RenewableAndWasteCode
Definition:	Type of renewable energy and waste.
Multiplicity:	1
Obligation:	Technical Guidance (recommendation)

Attribute: solidFossilFuelType	
Value type:	SolidFossilFuelCode
Definition:	Type of solid fossil fuel.
Multiplicity:	1
Obligation:	Technical Guidance (recommendation)

5.6.2.3. Code lists

5.6.2.3.1. StatisticalMeasureType

StatisticalMeasureType (abstract)	
Name:	Statistical measure type
Definition:	Kind of information that the statistical data represents.
Description:	
Status:	Proposed
Stereotypes:	«codeList»
Extensibility:	any
Identifier:	

5.6.2.4. Imported types (informative)

This section lists definitions for feature types, data types and enumerations and code lists that are defined in other application schemas. The section is purely informative and should help the reader understand the feature catalogue presented in the previous sections. For the normative documentation of these types, see the given references.

5.6.2.4.1. EnergyResource

EnergyResource (abstract)

EnergyResource (abstract)	
Package:	INSPIRE Consolidated UML Model::Themes::Annex III::Energy Resources::EnergyResourcesBase [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	A feature defining an inferred or observable spatial extent of a resource that can be, or has been, used as a source of energy.
Description:	SOURCE Adapted from [DER 2011].

5.6.2.4.2. HydrocarbonCode

HydrocarbonCode	
Package:	INSPIRE Consolidated UML Model::Themes::Annex III::Energy Resources::EnergyResourcesBase [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	Classification value that defines the specialised type of hydrocarbon.
Description:	

5.6.2.4.3. Measure

Measure	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19103:2005 Schema Language::Basic Types::Derived::Units of Measure [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]

5.6.2.4.4. RenewableAndWasteCode

RenewableAndWasteCode	
Package:	INSPIRE Consolidated UML Model::Themes::Annex III::Energy Resources::EnergyResourcesBase [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	Classification value that defines the specialised type of renewable and waste resources.
Description:	

5.6.2.4.5. ReportingInformation

ReportingInformation	
Package:	INSPIRE Consolidated UML Model::Themes::Annex III::Energy Resources::EnergyResourcesBase [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	Energy resource reporting information detailing the type of reporting standard or classification schema.
Description:	

5.6.2.4.6. SolidFossilFuelCode

SolidFossilFuelCode	
Package:	INSPIRE Consolidated UML Model::Themes::Annex III::Energy Resources::EnergyResourcesBase [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	Additional classification value that defines the specialised type of solid fossil fuels.
Description:	

5.6.2.4.7. StatisticalUnit

StatisticalUnit (abstract)	
Package:	INSPIRE Consolidated UML Model::Themes::Annex III::Statistical Units::Core [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	Unit for dissemination or use of statistical information.
Description:	SOURCE [INSPIRE Directive:2007]. EXAMPLE grid cell, point, line, polygon. NOTE Spatial features of any INSPIRE application schema can be considered as a statistical unit, because all can be used as spatial reference. This class is provided to represent features that are used only to disseminate statistical information and that are not included in another INSPIRE application schema.

5.6.2.4.8. TM_Period

TM_Period	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19108:2006 Temporal Schema::Temporal Objects [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]

5.6.3 INSPIRE-governed code lists

The INSPIRE-defined code lists included in this application schema include the values specified in the tables in this section.

5.6.3.1. Values of code list <StatisticalMeasureType>

Value	Name	Definition	Description	Parent value

5.6.4 Externally governed code lists

The *EnergyStatistics* application schema does not contain externally governed code lists.

6 Reference systems

6.1 Coordinate reference systems

6.1.1 Datum

IR Requirement 11	For the coordinate reference systems used for making available the INSPIRE spatial data sets, the datum shall be the datum of the European Terrestrial Reference System 1989 (ETRS89) in areas within its geographical scope, and the datum of the International Terrestrial Reference System (ITRS) or other

geodetic coordinate reference systems compliant with ITRS in areas that are outside the geographical scope of ETRS89. Compliant with the ITRS means that the system definition is based on the definition of the ITRS and there is a well-established and described relationship between both systems, according to EN ISO 19111.

6.1.2 Coordinate reference systems

IR Requirement 12 INSPIRE spatial data sets shall be made available using one of the three-dimensional, two-dimensional or compound coordinate reference systems specified in the list below.

Other coordinate reference systems than those listed below may only be used for regions outside of continental Europe. The geodetic codes and parameters for these coordinate reference systems shall be documented, and an identifier shall be created, according to EN ISO 19111 and ISO 19127.

1. Three-dimensional Coordinate Reference Systems
   - Three-dimensional Cartesian coordinates
   - Three-dimensional geodetic coordinates (latitude, longitude and ellipsoidal height), using the parameters of the GRS80 ellipsoid

2. Two-dimensional Coordinate Reference Systems
   - Two-dimensional geodetic coordinates, using the parameters of the GRS80 ellipsoid
   - Plane coordinates using the Lambert Azimuthal Equal Area projection and the parameters of the GRS80 ellipsoid
   - Plane coordinates using the Lambert Conformal Conic projection and the parameters of the GRS80 ellipsoid
   - Plane coordinates using the Transverse Mercator projection and the parameters of the GRS80 ellipsoid

3. Compound Coordinate Reference Systems
   - For the horizontal component of the compound coordinate reference system, one of the two-dimensional coordinate reference systems specified above shall be used.
   - For the vertical component on land, the European Vertical Reference System (EVRS) shall be used to express gravity-related heights within its geographical scope.
   - Other vertical reference systems related to the Earth gravity field shall be used to express gravity-related heights in areas that are outside the geographical scope of EVRS. The geodetic codes and parameters for these vertical reference systems shall be documented and an identifier shall be created, according to EN ISO 19111 and ISO 19127.
   - For the vertical component in the free atmosphere, barometric pressure, converted to height using ISO 2533:1975 International Standard Atmosphere shall be used.

6.1.3 Display

IR Requirement 13 For the display of the INSPIRE spatial data sets with the View Service specified in D003152/02 Draft Commission Regulation implementing Directive 2007/2/EC of the European Parliament and of the Council as regards Network Services, at least the two dimensional geodetic coordinate system shall be made available.

6.1.4 Identifiers for coordinate reference systems

IR Requirement 14 For referring to the non-compound coordinate reference systems listed in this Section, the identifiers listed below shall be used.

For referring to a compound coordinate reference system, an identifier composed of the identifier of the horizontal component, followed by a slash (/), followed by the identifier of the vertical component, shall be used.

- ETRS89-XYZ for Cartesian coordinates in ETRS89
- ETRS89-GRS80h for three-dimensional geodetic coordinates in ETRS89 on the GRS80 ellipsoid
- ETRS89-GRS80 for two-dimensional geodetic coordinates in ETRS89 on the GRS80
- EVRS for height in EVRS
- LAT for depth of the sea floor, where there is an appreciable tidal range
- MSL for depth of the sea floor, in marine areas without an appreciable tidal range, in open oceans and effectively in waters that are deeper than 200m
- ISA for pressure coordinate in the free atmosphere
- PFO for Pressure coordinate in the free ocean
- ETRS89-LAEA for ETRS89 coordinates projected into plane coordinates by the Lambert Azimuthal Equal Area projection
- ETRS89-LCC for ETRS89 coordinates projected into plane coordinates by the Lambert Conformal Conic projection
- ETRS89-TMzn for ETRS89 coordinates projected into plane coordinates by the Transverse Mercator projection

6.2 Temporal reference system

IR Requirement 15 The Gregorian calendar shall be used for as a reference system for date values, and the Universal Time Coordinated (UTC) or the local time including the time zone as an offset from UTC shall be used as a reference system for time values.

6.3 Theme-specific requirements and recommendations on reference systems

There are no theme-specific requirements or recommendations on reference systems.

7 Data quality

This chapter includes a description of the data quality elements and sub-elements as well as the corresponding data quality measures that should be used to evaluate and document data quality for data sets related to the spatial data theme *Energy Resources* (section 7.1).

It may also define requirements or recommendations about the targeted data quality results applicable for data sets related to the spatial data theme *Energy Resources* (sections 7.2 and 7.3).

In particular, the data quality elements, sub-elements and measures specified in section 7.1 should be used for

- evaluating and documenting data quality properties and constraints of spatial objects, where such properties or constraints are defined as part of the application schema(s) (see section 5);
- evaluating and documenting data quality metadata elements of spatial data sets (see section 8); and/or
- specifying requirements or recommendations about the targeted data quality results applicable for data sets related to the spatial data theme *Energy Resources* (see sections 7.2 and 7.3).

The descriptions of the elements and measures are based on Annex D of ISO/DIS 19157 Geographic information – Data quality.

7.1 Data quality elements

No data quality requirements are defined for the spatial data theme Energy Resources.

7.2 Minimum data quality requirements

No minimum data quality requirements are defined for the spatial data theme Energy Resources.

7.3 Recommendation on data quality

No minimum data quality recommendations are defined.

8 Dataset-level metadata

This section specifies dataset-level metadata elements, which should be used for documenting metadata for a complete dataset or dataset series.

NOTE Metadata can also be reported for each individual spatial object (spatial object-level metadata). Spatial object-level metadata is fully described in the application schema(s) (section 5).

For some dataset-level metadata elements, in particular those for reporting data quality and maintenance, a more specific scope can be specified. This allows the definition of metadata at sub-dataset level, e.g. separately for each spatial object type. When using ISO 19115/19157/19139 to encode the metadata, the following rules should be followed:

- The scope element (of type DQ_Scope) of the DQ_DataQuality subtype should be used to encode the reporting scope.

  NOTE The reporting scope can be different from the evaluation scope (see section 7).

- Only the following values should be used for the level element of DQ_Scope: Series, Dataset, featureType.

  NOTE The value featureType is used to denote spatial object type.

- If the level is featureType the levelDescription/MDScopeDescription/features element (of type Set< GF_FeatureType>) shall be used to list the feature type names.

Mandatory or conditional metadata elements are specified in Section 8.1. Optional metadata elements are specified in Section 8. The tables describing the metadata elements contain the following information:

- The first column provides a reference to a more detailed description.
- The second column specifies the name of the metadata element.
- The third column specifies the multiplicity.
- The fourth column specifies the condition, under which the given element becomes mandatory (only for Table 2 and Table 3).

8.1 Common metadata elements

IR Requirement 16	The metadata describing a spatial data set or a spatial data set series related to the theme **Energy Resources** shall comprise the metadata elements required by Regulation 1205/2008/EC (implementing Directive 2007/2/EC of the European Parliament and of the Council as regards metadata) for spatial datasets and spatial dataset series (Table 2) as well as the metadata elements specified in Table 3.

Table 2 – Metadata for spatial datasets and spatial dataset series specified in Regulation 1205/2008/EC (implementing Directive 2007/2/EC of the European Parliament and of the Council as regards metadata)

Metadata Regulation Section	Metadata element	Multiplicity	Condition
1.1	Resource title	1	
1.2	Resource abstract	1	
1.3	Resource type	1	
1.4	Resource locator	0..*	Mandatory if a URL is available to obtain more information on the resource, and/or access related services.
1.5	Unique resource identifier	1..*	
1.7	Resource language	0..*	Mandatory if the resource includes textual information.
2.1	Topic category	1..*	
3	Keyword	1..*	
4.1	Geographic bounding box	1..*	
5	Temporal reference	1..*	
6.1	Lineage	1	
6.2	Spatial resolution	0..*	Mandatory for data sets and data set series if an equivalent scale or a resolution distance can be specified.
7	Conformity	1..*	

8.1	Conditions for access and use	1..*	
8.2	Limitations on public access	1..*	
9	Responsible organisation	1..*	
10.1	Metadata point of contact	1..*	
10.2	Metadata date	1	
10.3	Metadata language	1	

Table 3 – Mandatory and conditional common metadata elements

INSPIRE Data Specification Energy Resources **Section**	**Metadata element**	**Multiplicity**	**Condition**
8.1.1	Coordinate Reference System	1	
8.1.2	Temporal Reference System	0..*	Mandatory, if the spatial data set or one of its feature types contains temporal information that does not refer to the Gregorian Calendar or the Coordinated Universal Time.
8.1.3	Encoding	1..*	
8.1.4	Character Encoding	0..*	Mandatory, if an encoding is used that is not based on UTF-8.
8.1.5	Data Quality – Logical Consistency – Topological Consistency	0..*	Mandatory, if the data set includes types from the Generic Network Model and does not assure centreline topology (connectivity of centrelines) for the network.

8.1.1 Coordinate Reference System

Metadata element name	**Coordinate Reference System**
Definition	Description of the coordinate reference system used in the dataset.
ISO 19115 number and name	13. referenceSystemInfo
ISO/TS 19139 path	referenceSystemInfo
INSPIRE obligation / condition	mandatory
INSPIRE multiplicity	1
Data type(and ISO 19115 no.)	186. MD_ReferenceSystem

Domain	To identify the reference system, the referenceSystemIdentifier (RS_Identifier) shall be provided. NOTE More specific instructions, in particular on pre-defined values for filling the referenceSystemIdentifier attribute should be agreed among Member States during the implementation phase to support interoperability.
Implementing instructions	
Example	referenceSystemIdentifier: code: ETRS_89 codeSpace: INSPIRE RS registry
Example XML encoding	<gmd:referenceSystemInfo> <gmd:MD_ReferenceSystem> <gmd:referenceSystemIdentifier> <gmd:RS_Identifier> <gmd:code> <gco:CharacterString>ETRS89 </gco:CharacterString> </gmd:code> <gmd:codeSpace> <gco:CharacterString>INSPIRE RS registry</gco:CharacterString> </gmd:codeSpace> </gmd:RS_Identifier> </gmd:referenceSystemIdentifier> </gmd:MD_ReferenceSystem> </gmd:referenceSystemInfo>
Comments	

8.1.2 Temporal Reference System

Metadata element name	**Temporal Reference System**
Definition	Description of the temporal reference systems used in the dataset.
ISO 19115 number and name	13. referenceSystemInfo
ISO/TS 19139 path	referenceSystemInfo
INSPIRE obligation / condition	Mandatory, if the spatial data set or one of its feature types contains temporal information that does not refer to the Gregorian Calendar or the Coordinated Universal Time.
INSPIRE multiplicity	0..*
Data type(and ISO 19115 no.)	186. MD_ReferenceSystem
Domain	No specific type is defined in ISO 19115 for temporal reference systems. Thus, the generic MD_ReferenceSystem element and its reference SystemIdentifier (RS_Identifier) property shall be provided. NOTEMore specific instructions, in particular on pre-defined values for filling the referenceSystemIdentifier attribute should be agreed among Member States during the implementation phase to support interoperability.
Implementing instructions	
Example	referenceSystemIdentifier: code: GregorianCalendar codeSpace: INSPIRE RS registry

Example XML encoding	<gmd:referenceSystemInfo> <gmd:MD_ReferenceSystem> <gmd:referenceSystemIdentifier> <gmd:RS_Identifier> <gmd:code> <gco:CharacterString>GregorianCalendar</gco:CharacterString> > </gmd:code> <gmd:codeSpace> <gco:CharacterString>INSPIRE RS registry</gco:CharacterString> </gmd:codeSpace> </gmd:RS_Identifier> </gmd:referenceSystemIdentifier> </gmd:MD_ReferenceSystem> </gmd:referenceSystemInfo>
Comments	

8.1.3 Encoding

Metadata element name	**Encoding**
Definition	Description of the computer language construct that specifies the representation of data objects in a record, file, message, storage device or transmission channel
ISO 19115 number and name	271. distributionFormat
ISO/TS 19139 path	distributionInfo/MD_Distribution/distributionFormat
INSPIRE obligation / condition	mandatory
INSPIRE multiplicity	1
Data type (and ISO 19115 no.)	284. MD_Format
Domain	See B.2.10.4. The property values (name, version, specification) specified in section 9 shall be used to document the default and alternative encodings.
Implementing instructions	
Example	name: **Energy Resources** GML application schema version: version **2.9**, GML, version 3.2.1 specification: D2.8.**III**.**20** Data Specification on **Energy Resources** – Draft Guidelines
Example XML encoding	<gmd:MD_Format> <gmd:name> <gco:CharacterString> **Energy Resources** GML application schema </gco:CharacterString> </gmd:name> <gmd:version> <gco:CharacterString>**2.9**, GML, version 3.2.1</gco:CharacterString> </gmd:version> <gmd:specification> <gco:CharacterString>D2.8.**III**.**20** Data Specification on **Energy Resources** – Draft Guidelines</gco:CharacterString> </gmd:specification> </gmd:MD_Format>
Comments	

8.1.4 Character Encoding

Metadata element name	Character Encoding
Definition	The character encoding used in the data set.
ISO 19115 number and name	
ISO/TS 19139 path	
INSPIRE obligation / condition	Mandatory, if an encoding is used that is not based on UTF-8.
INSPIRE multiplicity	0..*
Data type (and ISO 19115 no.)	
Domain	
Implementing instructions	
Example	-
Example XML encoding	<gmd:characterSet> <gmd:MD_CharacterSetCode codeListValue="8859part2" codeList="http://standards.iso.org/ittf/PubliclyAvailableStandards/ISO_19139_Schemas/resources/Codelist/ML_gmxCodelists.xml#CharacterSetCode">8859-2</gmd:MD_CharacterSetCode> </gmd:characterSet>
Comments	

8.1.5 Data Quality – Logical Consistency – Topological Consistency

Metadata element name	Data Quality – Logical Consistency – Topological Consistency
Definition	Correctness of the explicitly encoded topological characteristics of the dataset as described by the scope
INSPIRE obligation / condition	Mandatory, if the data set includes types from the Generic Network Model and does not assure centreline topology (connectivity of centrelines) for the network.
INSPIRE multiplicity	0..*
Comments	See clauses on topological consistency in section 7 for detailed information. This metadata element is mandatory if connectivity is not assured for network centrelines in the dataset. In this case the *Connectivity tolerance* parameter – as described in section 7 – must be provided in order to ensure automatic and unambiguous creation of centreline topology in post-process.

NOTE See section 8.2 for further instructions on how to implement metadata elements for reporting data quality.

8.2 Metadata elements for reporting data quality

Recommendation 15 For reporting the results of the data quality evaluation, the data quality elements, sub-elements and (for quantitative evaluation) measures defined in chapter 7 should be used.

The scope for reporting may be different from the scope for evaluating data quality (see section 7). If data quality is reported at the data set or spatial object type level, the results are usually derived or aggregated.

Recommendation 16 The metadata elements specified in the following tables should be used to report the results of the data quality evaluation. At least the information included in the row "Implementation instructions" should be provided.

The first table applies to reporting quantitative results (using the element DQ_QuantitativeResult), while the second table applies to reporting non-quantitative results (using the element DQ_DescriptiveResult).

NOTE These tables may need to be updated once the XML schemas for ISO 19157 have been finalised.

Metadata element name	**See chapter 7**
Definition	See chapter 7
ISO/DIS 19157 number and name	3. report
ISO/TS 19139 path	dataQualityInfo/*/report
INSPIRE obligation / condition	optional
INSPIRE multiplicity	0..*
Data type (and ISO/DIS 19157 no.)	Corresponding DQ_xxx subelement from ISO/DIS 19157, e.g. 12. DQ_CompletenessCommission
Domain	Lines 7-9 from ISO/DIS 19157 7. DQ_MeasureReference (C.2.1.3) 8. DQ_EvaluationMethod (C.2.1.4.) 9. DQ_Result (C2.1.5.)
Implementing instructions	39. nameOfMeasure NOTE This should be the name as defined in Chapter 7. 42. evaluationMethodType 43. evaluationMethodDescription NOTE If the reported data quality results are derived or aggregated (i.e. the scope levels for evaluation and reporting are different), the derivation or aggregation should also be specified using this property. 46. dateTime NOTE This should be data or range of dates on which the data quality measure was applied. 63. DQ_QuantitativeResult / 64. value NOTE The DQ_Result type should be DQ_QuantitativeResult and the value(s) represent(s) the application of the data quality measure (39.) using the specified evaluation method (42-43.)
Example	See Table E.12 — Reporting commission as metadata (ISO/DIS 19157)
Example XML encoding	

Metadata element name	**See chapter 7**
Definition	See chapter 7
ISO/DIS 19157 number and name	3. report
ISO/TS 19139 path	dataQualityInfo/*/report
INSPIRE obligation / condition	optional
INSPIRE multiplicity	0..*
Data type (and ISO/DIS 19157 no.)	Corresponding DQ_xxx subelement from ISO/DIS 19157, e.g. 12. DQ_CompletenessCommission

Domain	Line 9 from ISO/DIS 19157 9. DQ_Result (C2.1.5.)
Implementing instructions	67. DQ_DescripitveResult / 68. statement NOTE The DQ_Result type should be DQ_DescriptiveResult and in the statement (68.) the evaluation of the selected DQ sub-element should be expressed in a narrative way.
Example	See Table E.15 — Reporting descriptive result as metadata (ISO/DIS 19157)
Example XML encoding	

Open issue 2: For reporting compliance with minimum data quality requirements and recommendations specified in section 7, the INSPIRE conformity metadata element should be used. However, since this issue is part of the larger discussion on the Abstract Test Suite and the definition of conformance classes for the data specification, detailed instructions on how to provide metadata on compliance with minimum data quality requirements and recommendations will only be provided for v3.0.

8.3 Theme-specific metadata elements

No mandatory theme-specific metadata elements are defined for this theme.

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Recommendation 17 The metadata describing a spatial data set or a spatial data set series related to the theme *Energy Resources* should comprise the theme-specific metadata elements specified in Table 4.

Table 4 – Optional theme-specific metadata elements for the theme *Energy Resources*

Section	Metadata element	Multiplicity
8.3.1	Maintenance Information	0..1

8.3.1 Maintenance Information

Metadata element name	Maintenance information
Definition	Information about the scope and frequency of updating
ISO 19115 number and name	30. resourceMaintenance
ISO/TS 19139 path	identificationInfo/MD_Identification/resourceMaintenance
INSPIRE obligation / condition	optional
INSPIRE multiplicity	0..1
Data type(and ISO 19115 no.)	142. MD_MaintenanceInformation

Domain	This is a complex type (lines 143-148 from ISO 19115). At least the following elements should be used (the multiplicity according to ISO 19115 is shown in parentheses): – maintenanceAndUpdateFrequency [1]: frequency with which changes and additions are made to the resource after the initial resource is completed / domain value: MD_MaintenanceFrequencyCode: – updateScope [0..*]: scope of data to which maintenance is applied / domain value: MD_ScopeCode – maintenanceNote [0..*]: information regarding specific requirements for maintaining the resource / domain value: free text
Implementing instructions	
Example	
Example XML encoding	
Comments	

8.4 Guidelines on using metadata elements defined in Regulation 1205/2008/EC

8.4.1 Conformity

The *Conformity* metadata element defined in Regulation 1205/2008/EC allows to report the conformance with the Implementing Rule for interoperability of spatial data sets and services or another specification. The degree of conformity of the dataset can be *Conformant* (if the dataset is fully conformant with the cited specification), *Not Conformant* (if the dataset does not conform to the cited specification) or *Not evaluated* (if the conformance has not been evaluated).

Recommendation 18 The Conformity metadata element should be used to report conceptual consistency with this INSPIRE data specification. The value of Conformant should be used for the Degree element only if the dataset passes all the requirements described in the abstract test suite presented in Annex A. The Specification element should be given as follows:
- title: “INSPIRE Data Specification on <Theme Name> – Draft Guidelines”
- date:
  - dateType: publication
  - date: 2012-02-24

Open issue 3: Conformance testing is still an open issue under discussion.

Instructions on conformance testing and a common abstract test suite (including detailed instructions on how to test specific requirements) will be added at a later stage.

This may also lead to an update of the recommendations on how to fill the conformity metadata element.

8.4.2 Lineage

Recommendation 19 Following the ISO 19113 Quality principles, if a data provider has a procedure for quality validation of their spatial data sets then the data

quality elements listed in the Chapters 7 and 8 should be used. If not, the *Lineage* metadata element (defined in Regulation 1205/2008/EC) should be used to describe the overall quality of a spatial data set.

According to Regulation 1205/2008/EC, lineage "is a statement on process history and/or overall quality of the spatial data set. Where appropriate it may include a statement whether the data set has been validated or quality assured, whether it is the official version (if multiple versions exist), and whether it has legal validity. The value domain of this metadata element is free text".

The Metadata Technical Guidelines based on EN ISO 19115 and EN ISO 19119 specify that the statement sub-element of LI_Lineage (EN ISO 19115) should be used to implement the lineage metadata element.

Recommendation 20 To describe the transformation steps and related source data, it is recommended to use the following sub-elements of LI_Lineage:
- For the description of the transformation process of the local to the common INSPIRE data structures, the LI_ProcessStep sub-element should be used.
- For the description of the source data the LI_Source sub-element should be used.

NOTE 1 This recommendation is based on the conclusions of the INSPIRE Data Quality Working Group to avoid overloading of the overall lineage statement element with information on the transformation steps and related source data.

NOTE 2 In order to improve the interoperability, domain templates and instructions for filling these free text elements (descriptions) may be specified in an Annex of this data specification.

Open issue 4: The suggested use of the LI_Lineage sub-elements needs to be discussed as part of the maintenance of the INSPIRE metadata Technical Guidelines.

8.4.3 Temporal reference

According to Regulation 1205/2008/EC, at least one of the following temporal reference metadata elements shall be provided: temporal extent, date of publication, date of last revision, date of creation. If feasible, the date of the last revision of a spatial data set should be reported using the *Date of last revision* metadata element.

9 Delivery

9.1 Delivery medium

TG Requirement 2 Data conformant to this INSPIRE data specification shall be made available through an INSPIRE network service.

TG Requirement 3	All information that is required by a calling application to be able to retrieve the data through the used network service shall be made available in accordance with the requirements defined in the Implementing Rules on Network Services.

EXAMPLE 1 Through the Get Spatial Objects function, a download service can either download a pre-defined data set or pre-defined part of a data set (non-direct access download service), or give direct access to the spatial objects contained in the data set, and download selections of spatial objects based upon a query (direct access download service). To execute such a request, some of the following information might be required:

- the list of spatial object types and/or predefined data sets that are offered by the download service (to be provided through the Get Download Service Metadata operation),
- and the query capabilities section advertising the types of predicates that may be used to form a query expression (to be provided through the Get Download Service Metadata operation, where applicable),
- a description of spatial object types offered by a download service instance (to be proviced through the Describe Spatial Object Types operation).

EXAMPLE 2 Through the Transform function, a transformation service carries out data content transformations from native data forms to the INSPIRE-compliant form and vice versa. If this operation is directly called by an application to transform source data (e.g. obtained through a download service) that is not yet conformant with this data specification, the following parameters are required:
Input data (mandatory). The data set to be transformed.

- Source model (mandatory, if cannot be determined from the input data). The model in which the input data is provided.
- Target model (mandatory). The model in which the results are expected.
- Model mapping (mandatory, unless a default exists). Detailed description of how the transformation is to be carried out.

9.2 Encodings

9.2.1 Default Encoding(s)

TG Requirement 4	Data conformant to the application schema(s) defined in section 5 shall be encoded using the encoding(s) specified in this section.

9.2.1.1. Default encoding for application schema EnergyResourcesBase

Name: EnergyResourcesBase GML Application Schema
Version: version 2.9, GML, version 3.2.1
Specification: D2.8.**III**.**20** Data Specification on **Energy Resources** – Draft Guidelines
Character set: UTF-8

The GML Application Schema is distributed in a zip-file separately from the data specification document.

9.2.1.2. Default encoding for application schema EnergyResourcesVector

Name: EnergyResourcesVector GML Application Schema
Version: version 2.9, GML, version 3.2.1

Specification: D2.8.**III**.**20** Data Specification on **Energy Resources** – Draft Guidelines
Character set: UTF-8

The GML Application Schema is distributed in a zip-file separately from the data specification document.

9.2.1.3. Default encoding for application schema EnergyResourcesCoverage

Name: EnergyResourcesCoverage GML Application Schema
Version: version 2.9, GML, version 3.2.1
Specification: D2.8.**III**.**20** Data Specification on **Energy Resources** – Draft Guidelines
Character set: UTF-8

The GML Application Schema is distributed in a zip-file separately from the data specification document.

Note that GML allows the encoding of the value side of the coverage (i.e. the range set) either internally to the GML Coverage or in external files by using references. Either option is permitted. For the external file formats used it is suggested that GeoTiff, Tiff or JPEG2000 (without lossy compression) could be applied.

9.2.1.4. Default encoding for application schema EnergyResourcesStatistics

Name: EnergyResourcesStatistics GML Application Schema
Version: version 2.9, GML, version 3.2.1
Specification: D2.8.**III**.**20** Data Specification on **Energy Resources** – Draft Guidelines
Character set: UTF-8

The GML Application Schema is distributed in a zip-file separately from the data specification document.

9.2.2 Alternative Encoding(s)

Recommendation 21 It is recommended that also the encodings specified in this section be provided for the relevant application schemas.

9.2.2.1. Alternative encoding for application schema EnergyResourcesCoverage

Open issue 5: To be completed. Options could be GeoTiff or ESRI ASCII GRID. Or even broader all raster formats supported by GDAL library.

Name: <name of the format>
Version: <version of format>
Specification: <specification reference>
Character set: <character set>

9.2.2.1.1. Encoding rule(s) used

10 Data Capture

For every spatial object type: Capturing rules describing the criteria which spatial objects are part of spatial data sets ("selection criteria") as free text. Typical selection criteria are minimum area or length or functional characteristics like the class of a road.

Data capturing rules are the main element to define the targeted level of detail. For instance, there may be a need for transport networks on two levels of detail (at the European level, scale about 1:1000000 and at the local level, scale about 1:10000) with very similar feature catalogues. However, the data will be very different. This difference is a result of different capturing rules / selection criteria for both levels of detail.

The data capturing processes used by a data provider, i.e. the "how", are not relevant for this component.

If there is no specific guidance with respect to data capture, include the following sentence.

There is no specific guidance required with respect to data capture.

11 Portrayal

This clause defines the rules for layers and styles to be used for portrayal of the spatial object types defined for this theme.

In section 11.1, the *types* of layers are defined that are to be used for the portrayal of the spatial object types defined in this specification. A view service may offer several layers of the same type, one for each dataset that it offers on a specific topic.

Section 11.2 specifies the styles that shall be supported by INSPIRE view services for each of these layer types.

In section 11.3, further styles can be specified that represent examples of styles typically used in a thematic domain. It is recommended that also these styles should be supported by INSPIRE view services, where applicable.

Where XML fragments are used in these sections, the following namespace prefixes apply:

- sld="http://www.opengis.net/sld" (WMS/SLD 1.1)
- se="http://www.opengis.net/se" (SE 1.1)
- ogc="http://www.opengis.net/ogc" (FE 1.1)

IR Requirement 1	If an INSPIRE view services supports the portrayal of data related to the theme **Energy Resources**, it shall provide layers of the types specified in this section.

TG Requirement 5	If an INSPIRE view network service supports the portrayal of spatial data sets corresponding to the spatial data theme **Energy Resources**, it shall support the styles specified in section 11.2.

If no user-defined style is specified in a portrayal request for a specific layer to an INSPIRE view service, the default style specified in section 11.2 for that layer shall be used.

Recommendation 1 In addition to the styles defined in section 11.2, it is recommended that, where applicable, INSPIRE view services also support the styles defined in section 11.3.

11.1 Layers to be provided by INSPIRE view services

Layer Name	Layer Title	Spatial object type(s)	Keywords
ER.SolidFossilFuel	Solid fossil fuel	SolidFossilFuel	Solid Fossil Fuel, Energy, Resource
ER.Hydrocarbon	Hydrocarbon	Hydrocarbon	Hydrocarbon, Energy, Resource,
ER.RenewableAndWasteResource	Renewable And Waste Resource	RenewableAndWasteResource	Renewable, Waste, Energy, Resource,
ER.RenewableAndWastePotentialCoverage	Renewable And Waste Potential Coverage	RenewableAndWastePotentialCoverage	Renewable, waste, potential, Energy, Resource, Coverage

11.1.1 Layers organisation

None.

11.2 Styles to be supported by INSPIRE view services

11.2.1 Styles for the layer ER.SolidFossilFuel

Style Name	ER.SolidFossilFuel.Default
Default Style	yes
Style Title	Solid Fossil Fuel Default Style
Style Abstract	This layer type is for representation of solid fossil fuel data as points, curves and surfaces.
Symbology	The symbol depends on the geometry type. **For point geometry:** Fill colour: 50% GREY RGB 80,80,80 Outline colour: SOLID BLACK

Abstract: The geometry is rendered as a square with a size of 6 pixels, with a 50% grey (#808080) fill and a black outline.
Example:

SLD:

```
  <sld:NamedLayer>
    <se:Name>ER.SolidFossilFuel.Default</se:Name>
    <sld:UserStyle>
      <se:Name>INSPIRE_Default</se:Name>
      <sld:IsDefault>1</sld:IsDefault>
      <se:FeatureTypeStyle version="1.1.0">
        <se:Description>
          <se:Title>Solid Fossil Fuel Default Style</se:Title>
          <se:Abstract>The geometry is rendered as a square with a size of 6
pixels, with a 50% grey (#808080) fill and a black outline.</se:Abstract>
        </se:Description>
        <se:FeatureTypeName>Solidfossilfuel</se:FeatureTypeName>
        <se:Rule>
          <se:PointSymbolizer>
            <se:Geometry>
              <ogc:PropertyName>ER.geometry</ogc:PropertyName>
            </se:Geometry>
            <se:Graphic/>
          </se:PointSymbolizer>
        </se:Rule>
      </se:FeatureTypeStyle>
    </sld:UserStyle>
  </sld:NamedLayer>
```

For curve geometry:

Colour: SOLID BLACK
Width: 1px
Abstract: The geometry is rendered as a solid black line with a stroke width of 1 pixel..
Example:

SLD:

```
  <sld:NamedLayer>
    <se:Name> ER.SolidFossilFuel.Default </se:Name>
    <sld:UserStyle>
      <se:Name>INSPIRE_Default</se:Name>
      <sld:IsDefault>1</sld:IsDefault>
      <se:FeatureTypeStyle version="1.1.0">
        <se:Description>
          <se:Title> Solid Fossil Fuel Default Style </se:Title>
          <se:Abstract>The geometry is rendered as a solid black line with a
stroke width of 1 pixel.</se:Abstract>
        </se:Description>
        <se:FeatureTypeName> Solidfossilfuel </se:FeatureTypeName>
        <se:Rule>
          <se:LineSymbolizer>
            <se:Geometry>
              <ogc:PropertyName>ER.geometry</ogc:PropertyName>
            </se:Geometry>
```

	<se:Stroke/> </se:LineSymbolizer> </se:Rule> </se:FeatureTypeStyle> </sld:UserStyle> </sld:NamedLayer> **For surface geometry:** Fill Colour: 50% GREY RGB 80,80,80 Outline colour: SOLID BLACK Width: 1px Abstract: The geometry is rendered using a 50% grey (#808080) fill and a solid black outline with a stroke width of 1 pixel. Example:  SLD: <sld:NamedLayer> <se:Name> ER.SolidFossilFuel.Default </se:Name> <sld:UserStyle> <se:Name>INSPIRE_Default</se:Name> <sld:IsDefault>1</sld:IsDefault> <se:FeatureTypeStyle version="1.1.0"> <se:Description> <se:Title> Solid Fossil Fuel Default Style </se:Title> <se:Abstract>The geometry is rendered using a 50% grey (#808080) fill and a solid black outline with a stroke width of 1 pixel.</se:Abstract> </se:Description> <se:FeatureTypeName> Solidfossilfuel </se:FeatureTypeName> <se:Rule> <se:PolygonSymbolizer> <se:Geometry> <ogc:PropertyName>ER.geometry</ogc:PropertyName> </se:Geometry> <se:Fill/> <se:Stroke/> </se:PolygonSymbolizer> </se:Rule> </se:FeatureTypeStyle> </sld:UserStyle> </sld:NamedLayer>
Minimum & maximum scales	No scale limits

11.2.2 Styles for the layer ER.Hydrocarbon

Style Name	**ER.Hydrocarbon.Default**
Default Style	yes
Style Title	Hydrocarbon Default Style
Style Abstract	This layer type is for representation of hydrocarbon data as points, curves and

	surfaces.

Symbology	The symbol depends on the geometry type.
	For point geometry:
	Fill colour: 50% GREY RGB 80,80,80
	Outline colour: SOLID BLACK
	Abstract: The geometry is rendered as a square with a size of 6 pixels, with a 50% grey (#808080) fill and a black outline.
	Example:
	 
	SLD:
	`<sld:NamedLayer>`
	`<se:Name>ER.Hydrocarbon.Default</se:Name>`
	`<sld:UserStyle>`
	`<se:Name>INSPIRE_Default</se:Name>`
	`<sld:IsDefault>1</sld:IsDefault>`
	`<se:FeatureTypeStyle version="1.1.0">`
	`<se:Description>`
	`<se:Title>Hydrocarbon Default Style</se:Title>`
	`<se:Abstract>The geometry is rendered as a square with a size of 6 pixels, with a 50% grey (#808080) fill and a black outline.</se:Abstract>`
	`</se:Description>`
	`<se:FeatureTypeName>Hydrocarbon</se:FeatureTypeName>`
	`<se:Rule>`
	`<se:PointSymbolizer>`
	`<se:Geometry>`
	`<ogc:PropertyName>ER.geometry</ogc:PropertyName>`
	`</se:Geometry>`
	`<se:Graphic/>`
	`</se:PointSymbolizer>`
	`</se:Rule>`
	`</se:FeatureTypeStyle>`
	`</sld:UserStyle>`
	`</sld:NamedLayer>`
	For curve geometry:
	Colour: SOLID BLACK
	Width: 1px
	Abstract: The geometry is rendered as a solid black line with a stroke width of 1 pixel..
	Example:
	 
	SLD:
	`<sld:NamedLayer>`
	`<se:Name> ER.Hydrocarbon.Default </se:Name>`
	`<sld:UserStyle>`
	`<se:Name>INSPIRE_Default</se:Name>`
	`<sld:IsDefault>1</sld:IsDefault>`

```
      <se:FeatureTypeStyle version="1.1.0">
        <se:Description>
          <se:Title> Hydrocarbon Default Style </se:Title>
          <se:Abstract>The geometry is rendered as a solid black line with a
stroke width of 1 pixel.</se:Abstract>
        </se:Description>
        <se:FeatureTypeName> Hydrocarbon </se:FeatureTypeName>
        <se:Rule>
          <se:LineSymbolizer>
            <se:Geometry>
              <ogc:PropertyName>ER.geometry</ogc:PropertyName>
            </se:Geometry>
            <se:Stroke/>
          </se:LineSymbolizer>
        </se:Rule>
      </se:FeatureTypeStyle>
    </sld:UserStyle>
  </sld:NamedLayer>
```

For surface geometry:

Fill Colour: 50% GREY RGB 80,80,80
Outline colour: SOLID BLACK
Width: 1px
Abstract: The geometry is rendered using a 50% grey (#808080) fill and a solid black outline with a stroke width of 1 pixel.
Example:

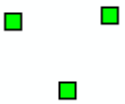
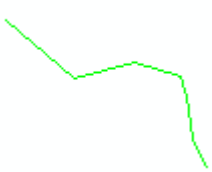
SLD:

```
<sld:NamedLayer>
    <se:Name> ER.Hydrocarbon.Default </se:Name>
    <sld:UserStyle>
      <se:Name>INSPIRE_Default</se:Name>
      <sld:IsDefault>1</sld:IsDefault>
      <se:FeatureTypeStyle version="1.1.0">
        <se:Description>
          <se:Title> Hydrocarbon Default Style </se:Title>
          <se:Abstract>The geometry is rendered using a 50% grey (#808080)
fill and a solid black outline with a stroke width of 1 pixel.</se:Abstract>
        </se:Description>
        <se:FeatureTypeName> Hydrocarbon </se:FeatureTypeName>
        <se:Rule>
          <se:PolygonSymbolizer>
            <se:Geometry>
              <ogc:PropertyName>ER.geometry</ogc:PropertyName>
            </se:Geometry>
            <se:Fill/>
            <se:Stroke/>
          </se:PolygonSymbolizer>
        </se:Rule>
      </se:FeatureTypeStyle>
    </sld:UserStyle>
  </sld:NamedLayer>
```

Minimum & maximum scales	No scale limits

11.2.3 Styles for the layer ER.RenewableAndWasteResource

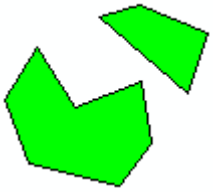
Style Name	**ER.RenewableAndWasteResource.Default**
Default Style	yes
Style Title	Renewable and Waste Resource Default Style
Style Abstract	This layer type is for representation of Renewable and waste resource data as points, curves and surfaces.

Symbology	**For point geometry:**
	Fill colour: LIGHT GREEN RGB 00,255,00
	Outline colour: SOLID BLACK
	Abstract: The geometry is rendered as a square with a size of 6 pixels, with a green (#008000) fill and a black outline.
	Example:
	 
	SLD:
	`<sld:NamedLayer>`
	`<se:Name>ER.RenewableAndWasteResource.Default</se:Name>`
	`<sld:UserStyle>`
	`<se:Name>INSPIRE_Default</se:Name>`
	`<sld:IsDefault>1</sld:IsDefault>`
	`<se:FeatureTypeStyle version="1.1.0">`
	`<se:Description>`
	`<se:Title>Renewable and Waste Resource Default Style</se:Title>`
	`<se:Abstract>The geometry is rendered as a square with a size of 6 pixels, with a green (#008000) fill and a black outline.</se:Abstract>`
	`</se:Description>`
	`<se:FeatureTypeName>RenewableAndWasteResource</se:FeatureTypeName>`
	`<se:Rule>`
	`<se:PointSymbolizer>`
	`<se:Geometry>`
	`<ogc:PropertyName>ER.geometry</ogc:PropertyName>`
	`</se:Geometry>`
	`<se:Graphic/>`
	`</se:PointSymbolizer>`
	`</se:Rule>`
	`</se:FeatureTypeStyle>`
	`</sld:UserStyle>`
	`</sld:NamedLayer>`
	For curve geometry:
	Colour: LIGHT GREEN RGB 00,255,00
	Width: 1px
	Abstract: The geometry is rendered as a green line with a stroke width of 1 pixel..
	Example:
	 
	SLD:

```
 <sld:NamedLayer>
    <se:Name> ER.RenewableAndWasteResource.Default </se:Name>
    <sld:UserStyle>
      <se:Name>INSPIRE_Default</se:Name>
      <sld:IsDefault>1</sld:IsDefault>
      <se:FeatureTypeStyle version="1.1.0">
        <se:Description>
          <se:Title>Renewable and Waste Resource Default Style</se:Title>
          <se:Abstract>The geometry is rendered as a green line with a stroke
width of 1 pixel.</se:Abstract>
        </se:Description>
        <se:FeatureTypeName> RenewableAndWasteResource </se:FeatureTypeName>
        <se:Rule>
          <se:LineSymbolizer>
            <se:Geometry>
              <ogc:PropertyName>ER.geometry</ogc:PropertyName>
            </se:Geometry>
            <se:Stroke/>
          </se:LineSymbolizer>
        </se:Rule>
      </se:FeatureTypeStyle>
    </sld:UserStyle>
  </sld:NamedLayer>
```

For surface geometry:

Fill Colour: LIGHT GREEN RGB 00,255,00
Outline colour: SOLID BLACK
Width: 1px
Abstract: The geometry is rendered using a green (#008000) fill and a solid black outline with a stroke width of 1 pixel.
Example:



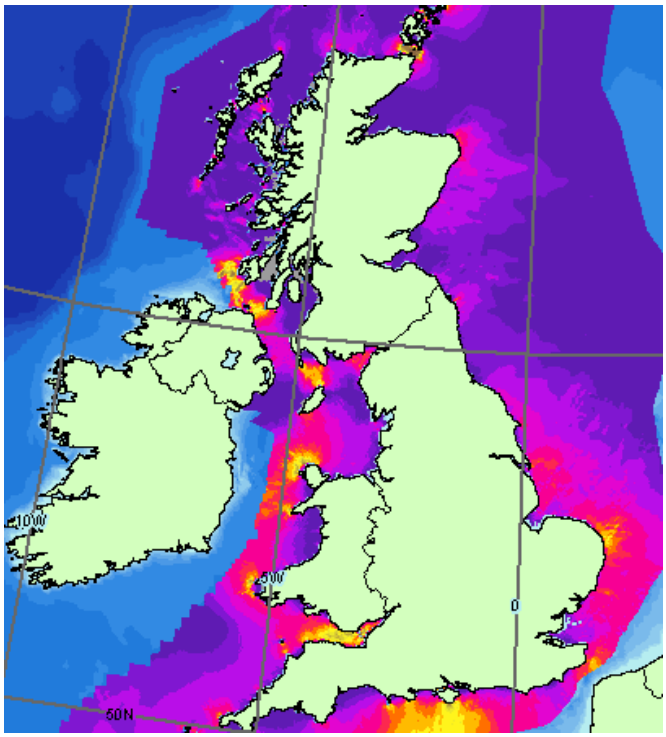
SLD:

```
<sld:NamedLayer>
    <se:Name> ER.RenewableAndWasteResource.Default </se:Name>
    <sld:UserStyle>
      <se:Name>INSPIRE_Default</se:Name>
      <sld:IsDefault>1</sld:IsDefault>
      <se:FeatureTypeStyle version="1.1.0">
        <se:Description>
          <se:Title>Renewable and Waste Resource Default Style</se:Title>
          <se:Abstract>The geometry is rendered using a green (#008000) fill
and a solid black outline with a stroke width of 1 pixel.</se:Abstract>
        </se:Description>
        <se:FeatureTypeName>RenewableAndWasteResource</se:FeatureTypeName>
        <se:Rule>
          <se:PolygonSymbolizer>
            <se:Geometry>
              <ogc:PropertyName>ER.geometry</ogc:PropertyName>
            </se:Geometry>
            <se:Fill/>
            <se:Stroke/>
          </se:PolygonSymbolizer>
        </se:Rule>
      </se:FeatureTypeStyle>
    </sld:UserStyle>
  </sld:NamedLayer>
```

Minimum & maximum scales	No scale limits.

11.2.4 Styles for the layer ER.RenewableAndWastePotentialCoverage

Style Name	**ER.RenewableAndWastePotentialCoverage.Default**
Default Style	yes
Style Title	Renewable And Waste Potential Coverage Default Style
Style Abstract	This layer type is for representation of Renewable and Waste Potential data as colored raster symbolize (values are Measures, expressed in units of Energy)

Symbology	Example:  **Figure 13 - ©Atlas of UK Marine Renewable Energy Resources**
	 SLD Example for potential coverage:
	 `<sld:NamedLayer>`
	`<se:Name> ER.TidalPotentialSurfaceCoverage </se:Name>`
	`<sld:UserStyle>`
	`<se:Name> ER.TidalPotentialSurfaceCoverage.tidalPower </se:Name>`
	`<sld:IsDefault>1</sld:IsDefault>`
	`<se:Raster Symbolizer version="1.1.0">`
	`<se:Description>`
	`<se:Title> Tidal power potential Surface Coverage </se:Title>`
	`<se:Abstract> Grid Coverage is symbolized by a colored raster symbolizer (Values in kW/m2)`
	`</se:Abstract>`
	`</se:Description>`
	`<se:Opacity>1.0</se:Opacity>`
	`<se:OverlapBehavior>AVERAGE</se:OverlapBehavior>`
	`<se:ColorMap>`
	`<se:Categorize fallbackValue="#FFFFFF">`
	`<se:LookupValue>Rasterdata</se:LookupValue>`
	`<se:Value>#9B9C9D</se:Value>`
	`<se:Threshold>0.01</se:Threshold>`
	`<se:Value>#583495</se:Value>`
	`<se:Threshold>0.05</se:Threshold>`

	<se:Value>#6D429A</se:Value> <se:Threshold>0.1</se:Threshold> <se:Value>#8E489C</se:Value> <se:Threshold>0.25</se:Threshold> <se:Value>#B44299</se:Value> <se:Threshold>0.5</se:Threshold> <se:Value>#EC148C</se:Value> <se:Threshold>1</se:Threshold> <se:Value>#EC2D50</se:Value> <se:Threshold>1.5</se:Threshold> <se:Value>#F46F21</se:Value> <se:Threshold>2</se:Threshold> <se:Value>#F7B71B</se:Value> <se:Threshold>3</se:Threshold> <se:Value>#F2EC3B</se:Value> <se:Threshold>4</se:Threshold> <se:Value>#E5E03C</se:Value> <se:Threshold>5</se:Threshold> <se:Value>#D2C53F</se:Value> <se:Threshold>6</se:Threshold> <se:Value>#BDAB3E</se:Value> <se:Threshold>8</se:Threshold> <se:Value>#AD9140</se:Value> <se:Threshold>10</se:Threshold> <se:Value>#997940</se:Value> <se:Threshold>20</se:Threshold> <se:Value>#866240</se:Value> <se:Threshold>40</se:Threshold> </se:Categorize> </se:ColorMap> </se:RasterSymbolizer> </sld:UserStyle> </sld:NamedLayer>
Minimum & maximum scales	No scale limits.

11.3 Other recommended styles

No other styles are recommended.

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Annex A
(normative)

Abstract Test Suite

Any dataset conforming to this INSPIRE data specification shall meet all requirements specified in this document.

Open issue 6: Conformance testing is still an open issue under discussion.

Instructions on conformance testing and a common abstract test suite (including detailed instructions on how to test specific requirements) will be added at a later stage.

Annex B
(informative)
Use cases

Energy resources related information is mainly collected or produced to be used within the energy domain as well as for the usage in other domains (contingency planning, impact assessment, landscape planning, identification of EU critical infrastructure, etc.). Following use cases were used in data specification development as examples of real use of Energy Resources related data.

B.1 Energy crisis management

B.1.1 Overview and involved actors

Activities aimed to prevent and manage potential energy crises, with an enhanced Early Warning Mechanism utilising Energy Resources related spatial data.
Main actors:

- Energy resources providers
- Energy resources consumers
- European Commission
- Citizens

B.1.2 Narrative description

An energy crisis is any great bottleneck (or price rise) in the supply of energy resources to an economy. In popular literature though, it often refers to one of the energy sources used at a certain time and place. Energy runs machinery in factories, lights our cities and powers our vehicles. There has been an enormous increase in the demand for energy as a result of industrial development and population growth. Supply of energy is, therefore, far less than the actual demand.

B.1.3 Detailed description

Use Case Description	
Name	Energy crisis management
Primary actor	Energy resources data provider
Goal	Achieve energy resources security
System under consideration	Energy Management System
Importance	High
Description	*In case some countries will reduce or stop providing energy from their own resources, this mechanism will ensure, the negative impact on the countries depending on those resources will be reduced on minimal level.*
Pre-condition	Knowledge on location of existing energy resources
Post-condition	Energy supply is secured via origin supplier or the new one based on deployed scenario
Flow of Events – Basic Path	
Step 1.	In case country providing energy from energy resources located within their jurisdiction will see there are reasons to eliminate or interrupt supply of energy, they will inform the EC about the situation.

Use Case Description	
Step 2.	European Commission will analyse received information and based on available spatial data scenarios for alternative energy supply are prepared.
Step 3.	If the situation is not solved within the time countries can use their backups, the most appropriate implementable scenario have to be deployed.
Flow of Events – Alternative Paths	
	NONE
Data source: Location of Energy Resource	
Description	Identification of places with the technically, technologically and commercially (with profit) exploitable accumulation (occurrence) of whatever phenomenon from which energy is/might be produced or extracted.
Data provider	National energy agencies collecting deposit related data
Geographic scope	EU
Thematic scope	Energy resources
Scale, resolution	Depending on source data
Delivery	Of/on line
Documentation	*http://europa.eu/rapid/pressReleasesAction.do?reference=IP/09/1718* *http://en.wikipedia.org/wiki/Energy_crisis#Crisis_management* *http://www.informaworld.com/smpp/section?content=a919781602&fulltext=713240928#references* *http://www.springerlink.com/content/v2r1k301t426072h/fulltext.pdf*

B.1.4 Requirements from the use case

Analyzing the use case, there is a need to provide the following objects and attributes:

- Energy resource
- Resource Type
- Resource Amount including quanitification and probability
- Energy resource region
- Resource Type
- Reserves in situ

B.1.5 Relationship with other INSPIRE Themes

This use case has some relationships with the following INSPIRE data themes:

- Production and industrial facilities
- Utility and governmental services

B.2 Identification of appropriate underground structures for gas storages.

B.2.1 Detailed description

Use Case Description	
Name	Identification of appropriate underground structures for gas storages.
Primary actor	Planner
Goal	Identification of appropriate storage capacities to cover critical periods with lack of relevant resources.
System under consideration	Energy Management System
Importance	High
Description	Recently some of the EU member states have encountered a phenomenon "gas crisis" when gas supplies at the Slovak-Ukrainian border were cut off. Due to the fact some of them recognized that their underground gas storage capacity, considering wintertime conditions logically coupled with bigger consumption, was too low. It is not always possible to manage reverse flows in the transit or transmission pan-European system and provide enough gas through pipelines where needed. In such cases sufficient gas storage capacity would be convenient backup which might temporarily, how long it depends on storage capacity and concrete strategy, save situation.
Pre-condition	Knowledge on location of gas fields, especially those which sizes comply with intended storage capacity and which status of utilization indicates, that they have already been depleted.
Post-condition	Knowledge on location of gas fields, especially those which sizes comply with intended storage capacity and which status of utilization indicates, that they have already been depleted.
Flow of Events – Basic Path	
Step 1.	Member state is severely affected during wintertime insufficient gas supplies due to an unpredicted cut off.
Step 2.	The EC will analyse underground storage capacity of all affected countries and where it's needed will propose a member state to start looking for convenient geological structures, considering the fact that gas depleted storage type is the most common, where might be enough gas stored – where might be a new underground storage projected/built.
Step 3.	Users/organizations/institutes put in charge work actively with relevant INSPIRE's data.
Flow of Events – Alternative Paths	
	NONE
Data source: Energy resource	
Description	Identification of places with the technically, technologically and commercially (with profit) exploitable accumulation (occurrence) of whatever phenomenon from which energy is/might be produced or extracted. Some of those structures can be after depletion transformed into storages (gas storages, CO2 storages). Geographical position, possibly also spatial extend and attribute as development status (code of utilization) should be at least available, in order data can be used in efficient way.
Data provider	National geological institutes/surveys, possibly energy agencies collect data related to energy resources deposits
Geographic scope	EU

Use Case Description	
Thematic scope	Energy resources
Scale, resolution	Depending on source data
Delivery	off/on line (see examples below)
Documentation	The International Map of Natural Gas Fields in Europe 1 : 2.500.000, consisting of nine map sheets, shows the distribution of natural gas fields and pipeline systems in Europe and adjacent areas covering a total of 64 countries. Important structural units such as sedimentary basins, major faults, orogenic belts and crystalline massifs are also represented on the map, because the distribution of natural gas fields is strongly connected with the geological underground. At the 23rd meeting of the Committee on Gas of the Economic Commission for Europe in 1977, it was decided to revise both the International Map of Natural Gas Fields in Europe (1972) and the Explanatory Notes of the Map (1976).  **Figure B1 - International Map of Natural Gas Fields in Europe 1 : 2.500.000, detail view.** **Source: BGR** The updated version of the map was published in 1984 by the Economic Commission for Europe (ECE) and the Federal Institute for Geosciences and Natural Resources (BGR). Examples of national servers with such information: Denmark *http://www.ens.dk/EN-US/OILANDGAS/DATA/Sider/Forside.aspx* Netherlands *http://www.nlog.nl/en/pubs/maps/other_maps/other_maps.html* Norway *http://www.npd.no/engelsk/cwi/pbl/en/factmap/download/shapes_welcome.htm* United Kingdom *https://www.og.decc.gov.uk/information/index.htm*

B.2.2 Requirements from the use case

Analyzing the use case, there is a need to provide the following objects and attributes:

- Energy resource
- Resource type - Gas Field
- Extent of resource depletion
- Energy resource region
- Resource type - Petroleum System

B.3 County Development Plan (Wind energy resources data usage), Ireland

B.3.1 Overview and involved actors

This use case shows flow of the spatial data (from Wind energy resources point of view) used for the purpose of County Development Plan (CDP) In Ireland.
Main actors:

- Sustainable Energy Authority of Ireland
- County council
- Citizens

B.3.2 Narrative description

Main purpose of CPD is to set out an overall strategy for the proper planning and sustainable development on the County level. CPD is in line with National Spatial Strategy as well as Irish Spatial Data Infrastructure development strategies. Each county has developed their own CDP which covers all aspects of development and land use within that county e.g. commercial, residential and of course wind-farm development. CPD is directly driven by the legislative requirement defined in the Planning and Development Act, 2000.
CDP assessment has to be updated at least every six years.

B.3.3 Detailed description

Use Case Description	
Name	County Development Plan (Wind energy resources data usage) adopted by County Council
Primary actor	Analyst
Goal	Establish sustainable energy structures, technologies and practices on county level in order to achieve the energy efficiency improvement.
System under the consideration	Development Plan Information System
Importance	Medium
Description	Relevant authorities in Ireland collect the wind energy resources spatial data, which are used to perform the analysis for the Environment and Heritage part of the CDP, especially in area of Landscape and Visual Amenity evaluation. Available data are adjusted for the purpose of CDP and provided to County Council. County Council (or another authority) performs analysis of data data and prepare CDP including landscape designation maps containing the results of analysis and synthesis done according the specific methodology based on dedicated legislation. The CDP covers also other aspects such as the identification and location of archaeological monuments, protected views/prospects, protected habitat such as Special Protection Areas (SPAs) and Special Area of Conservation (SACs), protected landscapes (Areas of Outstanding Natural Beauty – AONB) etc, but focus on this use case is to the energy resources scope.

Use Case Description	
Pre-condition	Availability of spatial data to be used for the purpose of CDP
Post-condition	The County Council data sets are available **on-line** (in future complying with INSPIRE standards) comprising data sets of all stages of the processing, basic data, grid data and range data.
Flow of Events – Basic Path	
Step 1.	Relevant authorities responsible for wind energy resources inventories and data provision identify, where necessary collect and collate existing data.
Step 2.	Collected data are adjusted to the desirable structure by (same authority like in step 1, or by the different authority).
Step 3.	Adjusted data are analysed by (same authority like in step 1, or by the different authority) according the methodology based on relevant legislation.
Step 4.	Results of analysis are provided to County Council for preparation of Draft Development Plan.
Step 5.	Evaluation of comments received by Public displays (1^{st}+2^{nd}) .
Step 6.	Adoption by County Council of the Development Plan and Manager's report
Step 7.	CPD publication
Flow of Events – Alternative Paths	
	NONE
Data source: Member State Data Set	
Description	Relevant authorities responsible for wind energy resources manages database with a collection of all relevant wind energy data. This database is available internally and published to some extent in information systems.
Data provider	*The Sustainable Energy Authority of Ireland? *http://maps.seai.ie/wind/*
Geographic scope	Ireland
Thematic scope	Energy resources
Scale, resolution	The highest resolution that the member state can provide.
Delivery	Formats of encoding? (XML, SHP, other?). These data are published in specific information systems on the internet by state administrative services including view services. In future, data should be delivered INSPIRE GML application schema conform, either directly or through OGC web services.
Documentation	*http://www.irishspatialstrategy.ie/* *http://www.irishspatialstrategy.ie/isdi/* *http://www.irishstatutebook.ie/2000/en/act/pub/0030/index.html* *http://www.leitrimcoco.ie/eng/Services_A-Z/Planning_and_Building_Control/Publications/County_Development_Plan.pdf*

B.3.4 Requirements from the use case

Analyzing the use case, there is a need to provide the following objects and attributes:

Wind energy assessment units with:

- Wind speed x (to be defined) meters height above surface [m/s]
- Wind power [W/m2]

B.3.5 Relationship with other INSPIRE Themes

This use case has some relationships with the following INSPIRE data themes:

- Protected sites: identification and location of archaeological monuments

Note: This use case is related to the use case defined in TWG AC-MF "**Use Case on finding best locations for new wind farms**". Despite the connection, scope of both use cases is different. The finality of the use case provided by TWG ER is to optimize spatial planning and spatial development in which wind farms are one of the features to be considered, whereas the use case developed by TWG AC/MF is really to find the best location for wind farms by primarily using meteorological information and secondary looking to the environment (availability of infrastructure, protected areas, etc.…). Nevertheless the use case defined by AC-MF has high relevance for this data specification, therefore it is highly recommended to read also AC-MF use case.

B.4 Potential for photovoltaic power generation in EU countries

B.4.1 Overview and involved actors

Performance of photovoltaic (PV) power plants depends strongly on solar radiation and temperature which are variable across regions. A study has been conducted by European Commission Joint Research Centre (EU JRC) to quantify potential for solar electricity production in member states as one of key pieces of information needed for setting up policy incentives for promoting photovoltaic installations.

Main actors:

- EU JRC, EU member states + regions
- Research and education bodies
- Citizens

B.4.2 Narrative description

Solar renewable energy needs political support mechanisms that aim to promote dissemination of solar energy technology and development of new markets. One of the most used measure to support renewable energies in Europe are preferential feed-in-tariffs which are calculated from information about production potential for each of technologies and payback time of the investment. To set up proper feed-in-tariff for photovoltaics, an information about annual PV production potential is needed. To provide this information a GIS-based study has been conducted, which resulted in maps and statistical information on PV production potential in countries and regions.

B.4.3 Detailed description

Use Case Description	
Name	Potential for photovoltaic power generation in EU countries
Primary actor	Data analyst
Goal	Quantify potential for solar electricity production in member states as one of key pieces of information needed for setting up policy incentives for promoting photovoltaic installations.
System under the consideration	Photovoltaic Geographic Information System (PVGIS)
Importance	High
Description	*For setting up proper financial support incentives for solar photovoltaics, information about production potential of photovoltaic power systems is needed for each region or country.*
Pre-condition	Knowledge on existing solar energy resources

Use Case Description	
	The resulting map and derived statistical information is used in policy making for setting up the incentives for solar photovoltaics.

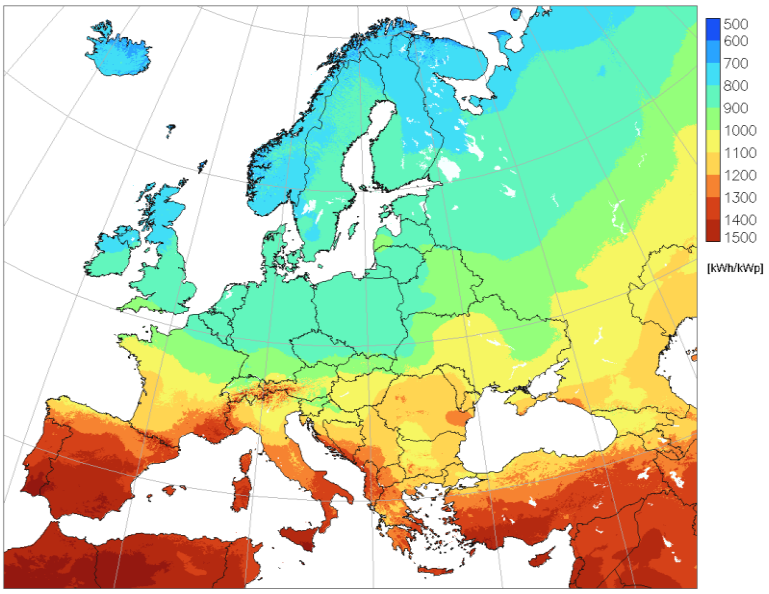

Figure B4 - Illustrative example: Input data source - annual sum of global in-plane irradiation for optimally inclined surface

Post-condition

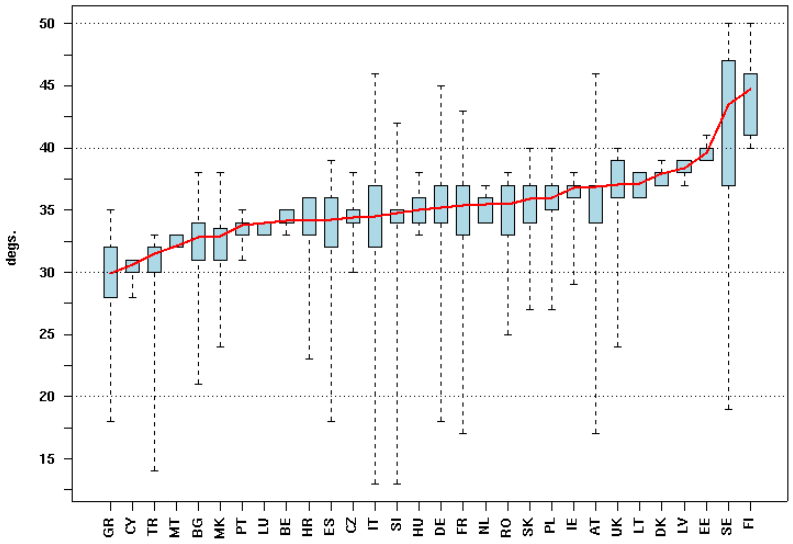

Figure B5 - Illustrative example of the output: Yearly sum of the electricity generated by a typical 1 kWp PV system in EU 27 Member States and 3 Candidate Countries (kWh/kWp) with modules mounted at the optimum angle.

The solid line represents the country's average value. The extremes of the dash lines show the minimum and maximum values in each country. The box plot depicts the 90% of occurrence of values in urban residential areas

Use Case Description	
Flow of Events – Basic Path	
Step 1.	To quantify potential electricity production from a PV system a grid data layers (maps) on annual average global horizontal and in-plane irradiation are needed. These data layers are used for calculation of annual PV electricity production maps across the EU.
Step 2.	The PV production maps are overlaid with a land cover map, namely with the category 1 (at the hierarchical level 1 this class represents urbanised land) to focus the analysis on areas where installations of PV systems are the most likely (places where people live, or close to them).
Step 3.	The map of PV potential in urban areas is statistically summarised at the level of a country and at the level of large administrative region (corresponding to the NUTS level 1 or 2) to provide an aggregated information for decision making. Such maps are statistically analysed to provide info about average PV potential but also about statistical distribution values.
Flow of Events – Alternative Paths	
	NONE
Data source: Global horizontal and in-plane irradiation, CORINE Land Cover, GISCO NUTS	
Description	From renewable energy sources, a data file representing annual potential of global horizontal irradiation and global in-plane irradiation are needed at a medium spatial resolution. In addition the following data are needed: CORINE Land Cover map and GISCO NUTS (administrative regions).
Data provider	JRC, EEA, GISCO
Geographic scope	EU
Thematic scope	Energy resources and other thematic groups
Scale, resolution	regional (cca 1:500 000)
Delivery	Off–line
Documentation	http://dx.doi.org/10.1016/j.solener.2006.12.007

B.4.4 Requirements from the use case

Analyzing the use case, there is a need to provide the following objects and attributes:
globalHorizontalIrradiation

B.4.5 Relationship with other INSPIRE Themes

This use case has relationships with the following INSPIRE data themes:
- Land Cover (CORINE Land Cover 2000 (grid data layer))
- Administrative Units (GISCO administrative units)

Annex C
(informative)
Extension of the EnergyResourcesCoverage application schema

C.1 Description

C.1.1 Narrative Description and UML overview

Energy Resources can be described through a Coverage representation that represents the variation of an Energy Resource property within a domain of interest. Within the scope of this data specification this viewpoint is particularly applied for the representation of potential energy extracted from renewable and waste resources. This Annex tries to clarify the concept how the generic *RenewableAndWasteCoverage* can be further specialised into domain-specific coverages (For example potential solar energy data sets). The reason for further subtyping the generic *RenewableEnergyPotentialCoverage* is twofold:

- Allowing for defining Range Values via domain-specific datatypes: What are the domain-specific values to be represented: wind power density, direct normal solar irradiation, potential Biomass etc…
- Propose common units of energy measures: In order to achieve a greater interoperability among European data sets with regard to energy potential, the definition of common units of measures would be beneficial for each subtype of renewable energy or energy extracted from waste resources.

It should be noticed that the deepening of the application schema is not a theme-independent process. Some natural phenomena such as wind properties, temperature properties, and wave properties can be modelled in application schema's of other Annex II and III themes, as the observations of these natural phenomena are within the scope of these themes.

The figure below depicts again the UML diagram of the coverage application schema. However, the *EnergyResourcesCoverage* application schema only intends to provide a generic pattern for Coverage representations of the energy potential of renewable and waste resources. For using it properly, additional code lists specifying the potential type need to be elaborated and made public, either by member states or thematic communities.

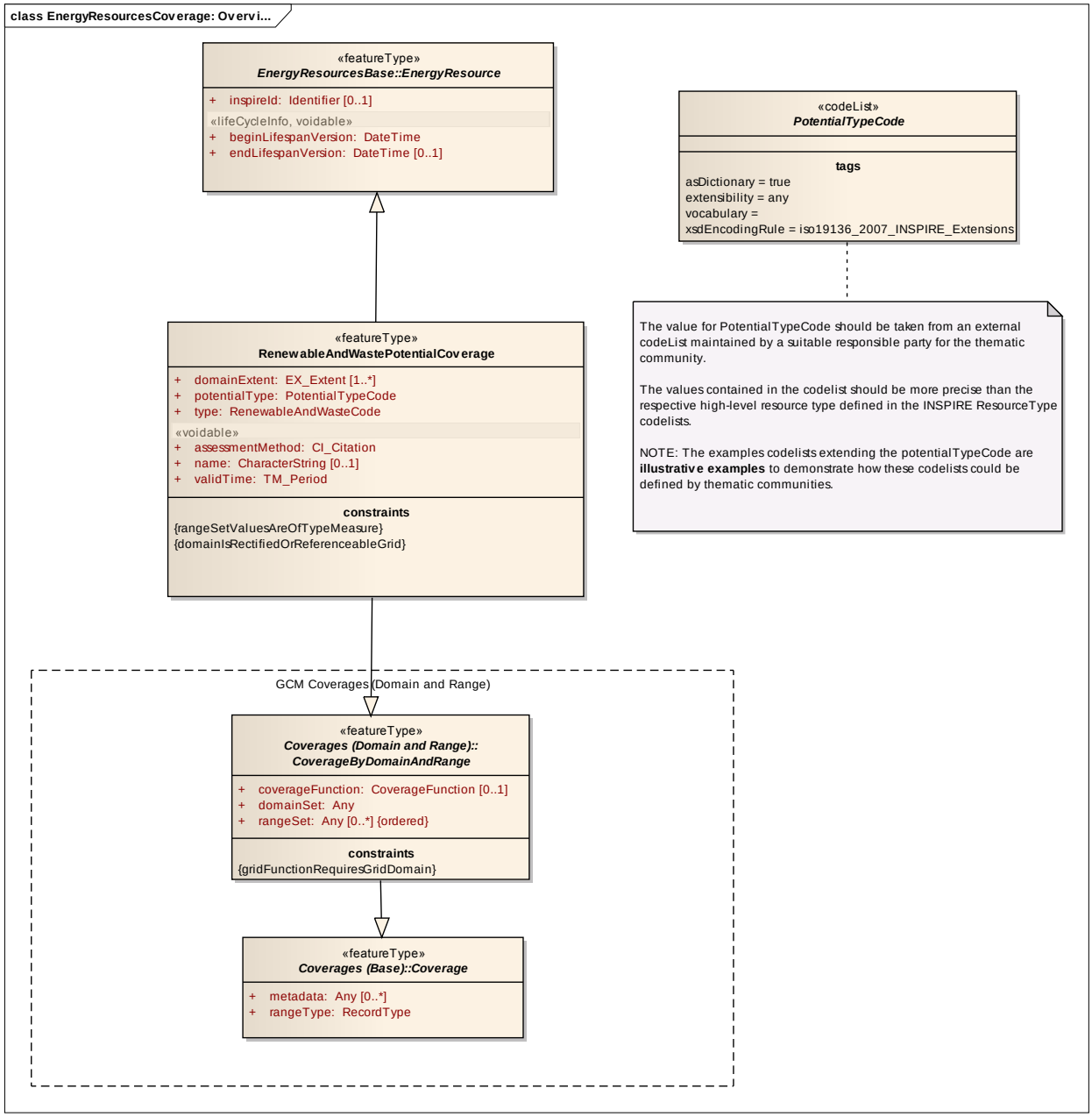

Figure 2 - – UML class diagram: Overview of the EnergyResourcesCoverage application schema

As can be observed from the UML model the modelled PotentialTypeCode codelist has been intentionally left empty. Figure 3 shows the mechanism how the abstract empty code list can be extended into domain-specific values. In this figure examples have been elaborated for the potential of wind, tidal, solar, hydro and geothermal energy. Each code list ensures a unique list of common types of properties corresponding to a specific measure in the subdomain e.g. diffuse irradiance for the potential of solar energy.

Additionally, OCL constraints can be defined on the range*EnergyResourcesCoverage* in order to restrict the possible units of measure of the RangeSet values of the coverage, which are of type Measure. For example an OCL constraint can be added to define that diffuse irradiance should be measured in Wm^2.

By using common unit of measures, a greater harmonisation among European data sets with regard to energy potential shall be established.

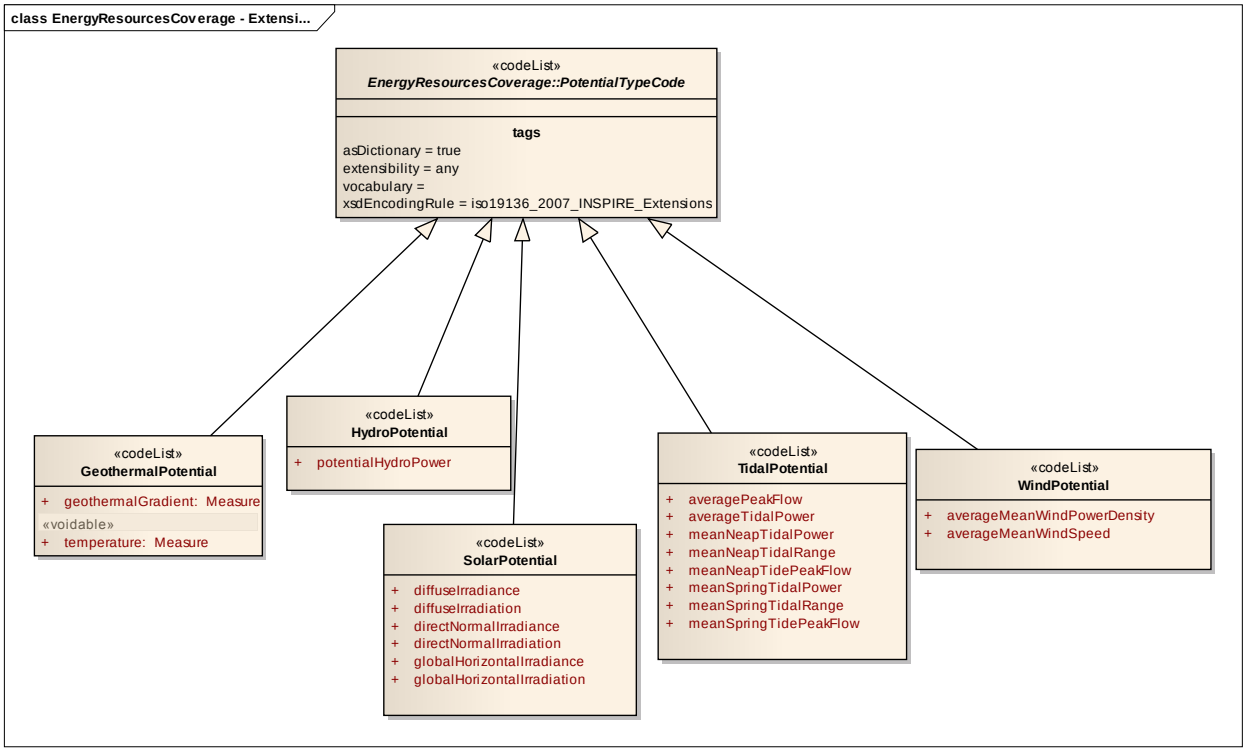

Figure 3 - – Extension mechanism of the PotentialTypeCode code list