

# AIOTI – Ontology Landscape

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## AIOTI – Alliance for Internet of Things Innovation

**Vision:** We drive on behalf of our members **business, policy, standardisation, research and innovation development** in the **IoT and Edge Computing** and other converging technologies across the Digital Value Chain to support European digitisation and competitiveness.

**Website:** <https://aioti.eu/>

**Groups:** Digital for Green, Distributed Ledger Technologies, Innovation Ecosystems, Policy and Strategies, Research and Partnership **Standardization** Testbeds, Urban Society (horizontal groups)  
Agriculture, Buildings, Energy, Health, Manufacturing, Mobility and Logistics (vertical groups)

# Semantic Interoperability Expert Group:

## What do we do?



- Value of IoT grows with available information

### ◆ “IoT” today characterized by

- Heterogeneity
- Silos
- Tight coupling
- Multiple representations of the information

### ◆ True IoT characterized by

- Sharing of information
- Federation across silos
- Dynamic use of sources

- Explicit agreement on semantics (= meaning) is vital to the success of IoT  
→ **Semantic Interoperability**

→ Support adoption of semantic technologies

# Semantic Interoperability Expert Group: What do we do?

- Semantics often perceived as “difficult”, “academic”, “for experts only”
  - We are a group of experts from standardization & research
- **Lower barrier for implementing semantic systems**

## ◆ Three Whitepapers:

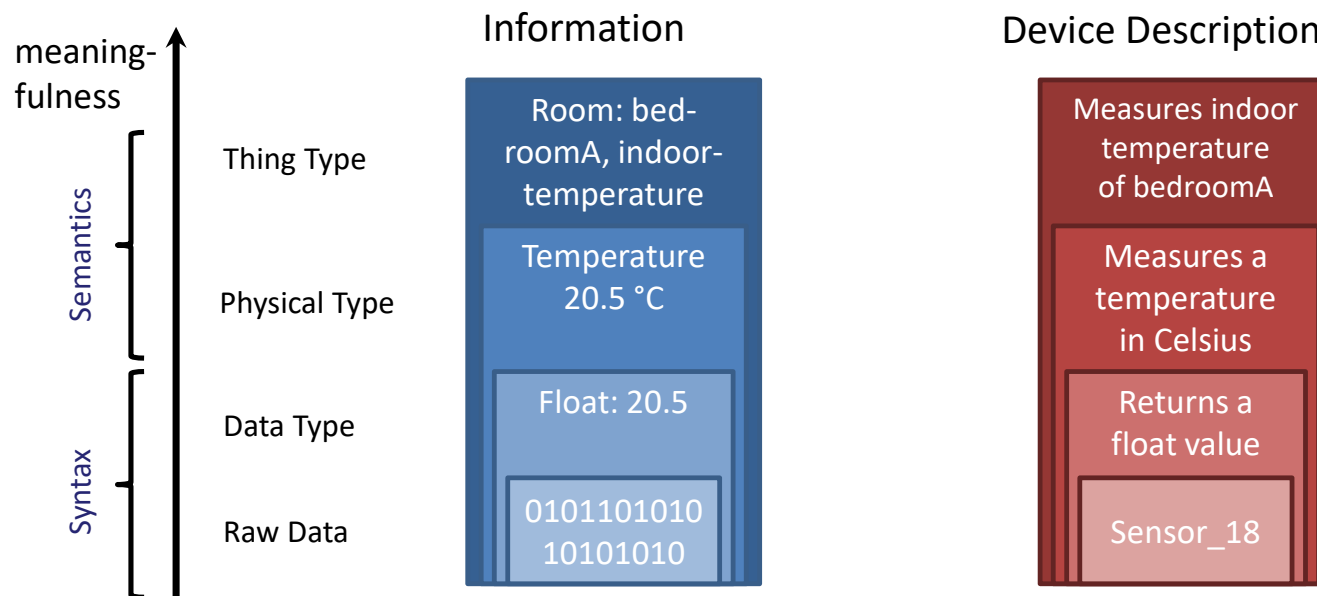
- Semantic Interoperability for the Web of Things: <http://tinyurl.com/58k93m4f>
- Semantic IoT Solutions: A Developer Perspective: <http://tinyurl.com/2p97rhtc>
- Towards Semantic Interoperability Standards based on Ontologies: <http://tinyurl.com/5hx79y5r>

## ◆ Semantic Tutorial (IoT Week 2021): <http://tinyurl.com/kjrv2uu3>

## ◆ Ontology Landscape: <http://tinyurl.com/y86s82ac>

# Basis: Agreement on Semantic Concepts

- How can we get information on a suitable abstraction level?
  - Higher-level information / knowledge is required
  - Explicit representation of meaning → agreement on semantic concepts
  - Implicit representation would be problematic in large scale, dynamic systems



# Ontology Example

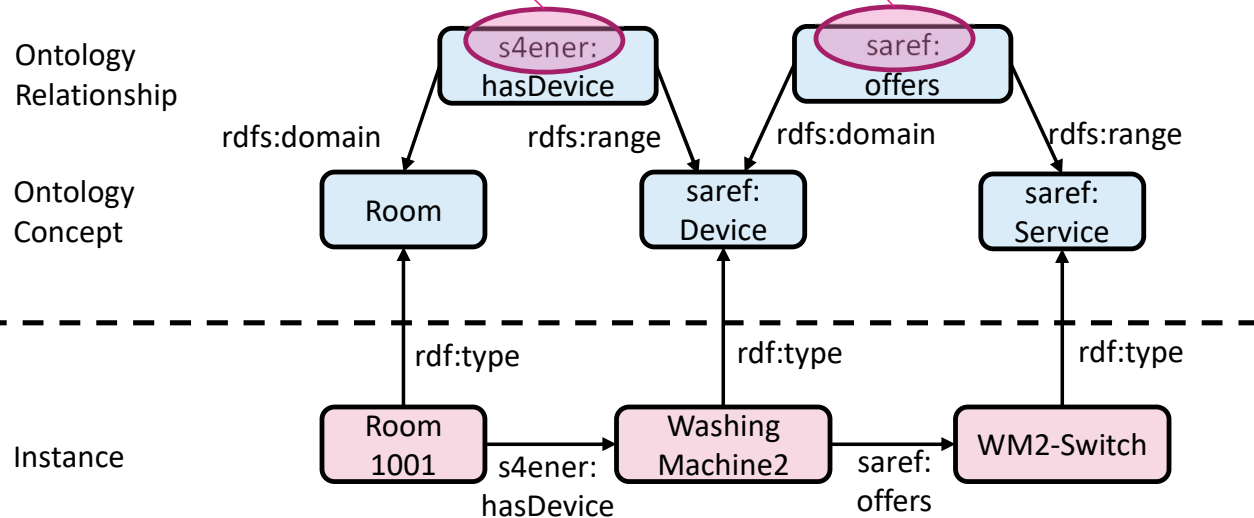
**Ontology** [Gruber 1993]<sup>2</sup>: Ontologies provide a **formal specification** of a **shared conceptualization**, by formally defining **relevant concepts**, their **attributes** and the **relationships between these concepts**.

SAREF4ENER: an extension of SAREF for the energy domain

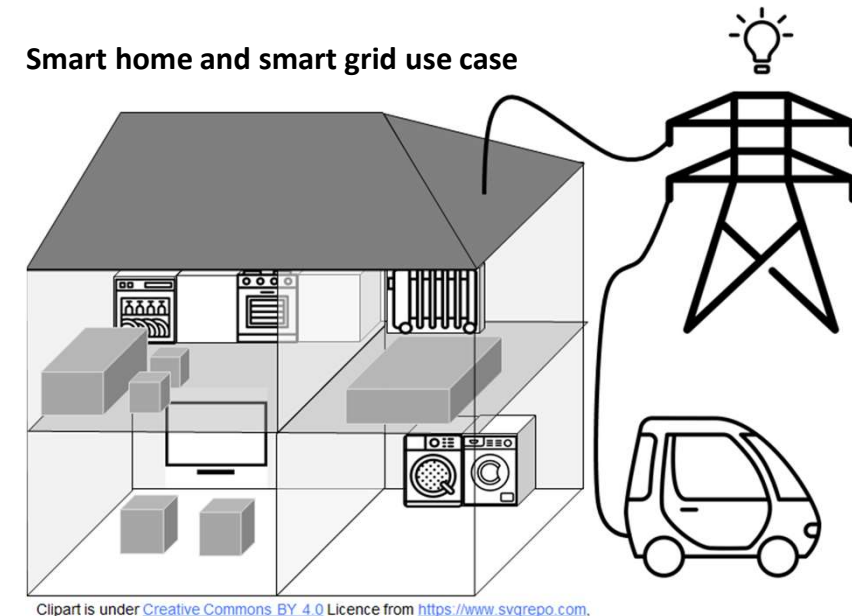
<https://saref.etsi.org/saref4ener/>

Smart Applications REFerence Ontology

<https://saref.etsi.org/>



Smart home and smart grid use case



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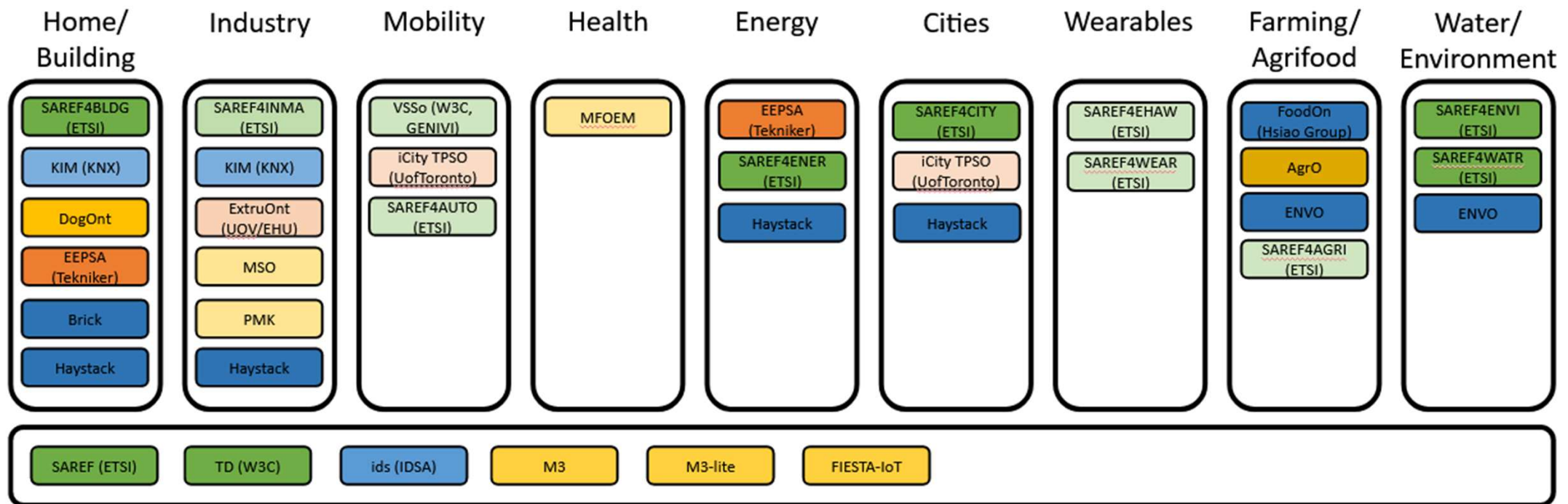
# Goal of the Report

- In December 2021, the first version of the report “Ontology Landscape Release 1.0” has been published, see: <https://aioti.eu/wp-content/uploads/2022/02/AIOTI-Ontology-Landscape-Report-R1-Published-1.0.1.pdf>
- The main objectives of this report are to present:
  - A list of relevant ontologies already defined, subdivided by their domain of interest.
  - For each ontology provide a set of information that allows the users to easily select the ontology that best fits their requirements.
  - The final goal is to create a Landscape with IoT ontologies in analogy to the AIOTI IoT Landscape on standardization.
- Method of collecting information:
  - ✓ Identify relevant ontologies.
  - ✓ Request to ontologies maintainers to provide info compiling a specific template.
  - ✓ Collect the Input received, discuss and approve them with AIOTI Semantic Interoperability Expert Group members



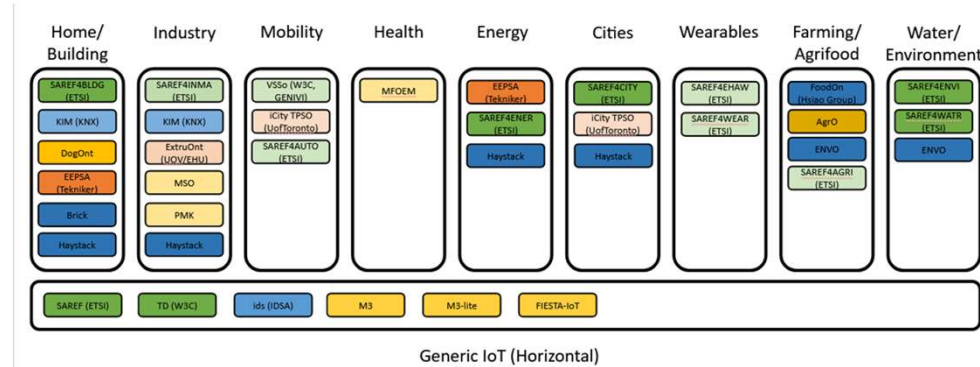
# Content of the Report

**35** ontologies subdivided in **10** different domains.



Generic IoT (Horizontal)

# Content of the Report



## Sustainability & Maintainability Level

Technology Readiness Level (TRL)	TRL / Level	Level 1 Single Maintainer / Project	Level 2 Organization	Level 3 Group of Organizations	Level 4 Standardization Body
	4				
	5				
	6				
	7				
	8				
	9				

Colour code defined to express Technology Readiness Level (TRL) and Sustainability & Maintainability Level

# Some Example Ontologies in Detail

Acronym	SAREF	TRL	6	
Name	Smart Applications REfERENCE Ontology	Main Areas	Generic IoT	
Technical Specification			<a href="https://www.etsi.org/deliver/etsi_ts/103200_103299/103264/03.01.01_60/ts_103264v030101p.pdf">https://www.etsi.org/deliver/etsi_ts/103200_103299/103264/03.01.01_60/ts_103264v030101p.pdf</a>	
URI of Ontology File			<a href="https://saref.etsi.org/core/">https://saref.etsi.org/core/</a>	
License			<a href="https://forge.etsi.org/etsi-software-license">https://forge.etsi.org/etsi-software-license</a>	
Maintainer			ETSI	
Complete Survey Information			<a href="https://drive.google.com/file/d/1J1wk0FCjtOjrMiCt9RPYmN9mP9-Wpl0x/view">https://drive.google.com/file/d/1J1wk0FCjtOjrMiCt9RPYmN9mP9-Wpl0x/view</a>	
Short Description		The Smart Applications REfERENCE ontology (SAREF) is intended to enable interoperability between solutions from different providers and among various activity sectors in the Internet of Things (IoT), thus contributing to the development of the global digital market.		

# Some Example Ontologies in Detail

Acronym	ids	TRL	7	
Name	International Data Spaces Information Model	Main Areas	Generic IoT (Horizontal)	
Technical Specification		Namespace: <a href="https://w3id.org/idsa/core">https://w3id.org/idsa/core</a> Repository: <a href="https://github.com/International-Data-Spaces-Association/InformationModel/">https://github.com/International-Data-Spaces-Association/InformationModel/</a>		
URI of Ontology File		<a href="https://w3id.org/idsa/core">https://w3id.org/idsa/core</a>		
License		Apache 2.0		
Maintainer		Sebastian Bader, Fraunhofer IAIS		
Complete Survey Information		<a href="https://drive.google.com/file/d/1-c8JonwqH22gNqPdFY3UNc3FSE-Fm6kO/view">https://drive.google.com/file/d/1-c8JonwqH22gNqPdFY3UNc3FSE-Fm6kO/view</a>		
Short Description	The Information Model is an RDFS/OWL-ontology covering the fundamental concepts of the International Data Spaces (IDS), i.e. the types of digital contents that are exchanged by participants by means of the IDS infrastructure components.			

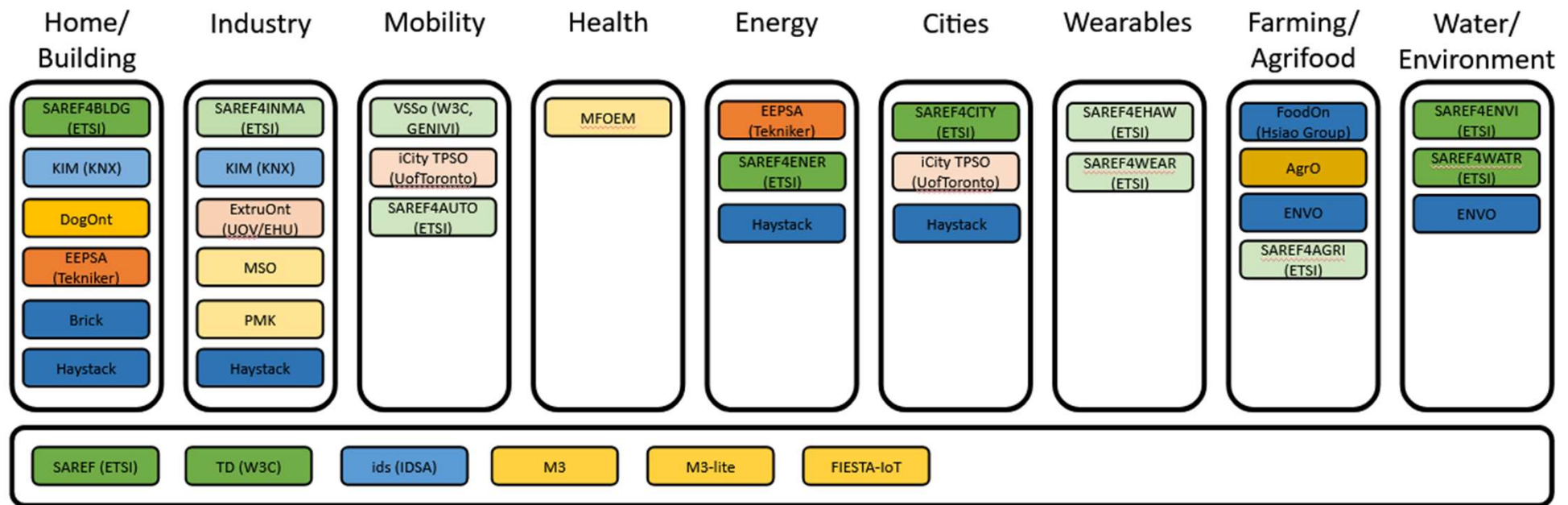


# Some Example Ontologies in Detail

Acronym	iCity TPSO	TRL	4	
Name	iCity Transportation Planning Suite of Ontologies	Main Areas	Mobility, Cities	
Technical Specification		<a href="http://ontology.eil.utoronto.ca/icity/iCityOntologyReport_1.2.pdf">http://ontology.eil.utoronto.ca/icity/iCityOntologyReport_1.2.pdf</a>		
URI of Ontology File		<a href="http://ontology.eil.utoronto.ca/icity/UrbanSystem.owl">http://ontology.eil.utoronto.ca/icity/UrbanSystem.owl</a>		
License		MIT		
Maintainer		Megan Katsumi, Department of Mechanical & Industrial Engineering - University of Toronto		
Complete Survey Information		<a href="https://drive.google.com/file/d/1i1xknFF9wIPCtqtRZXYX4sDTBGC2lSiO/view">https://drive.google.com/file/d/1i1xknFF9wIPCtqtRZXYX4sDTBGC2lSiO/view</a>		
Short Description	The Transportation Planning Suite of Ontologies (TPSO) provides a common set of terms for unambiguously storing and accessing data. The key purpose of the iCity TPSO is to address the challenges of data integration and reuse in the context of transportation planning.			

# How to Use the Ontology Landscape

Based on your domain of interest, check in the main resume table, the ontologies that can be interesting for you



# How to Use the Ontology Landscape

Using the colour code you can start to exclude some of the solutions in the list, based on your requirements (e.g., you can exclude some solutions because not mature enough or because they are not maintained by a large community).

Sustainability & Maintainability Level

Technology Readiness Level (TRL)	TRL / Level	Level 1 Single Maintainer / Project	Level 2 Organization	Level 3 Group of Organizations	Level 4 Standardization Body
	4				
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# Conclusions and Next Steps

- AIOTI Ontology Landscape as useful tool for:
  - stakeholders to choose suitable IoT ontologies
    - divided by their domain of interest
    - based on their maturity level and sustainability
  - ontology developers to give visibility to their ontologies
- Findings
  - Engaging stakeholders to fill in the survey for the ontology landscape has been long and challenging – what can be improved?
  - Certain domains in the ontology landscape are more populated (e.g., Home/Buildings and Industry) than others (e.g., Health and Wearables). Why?
- Please help us with your feedback:
  - Do you share this conclusion?
  - Is it easy to use?
  - What can be improved?

## Contribute to the Ontology Landscape!

**Fill out the online survey:**

<https://ec.europa.eu/eusurvey/runner/OntologyLandscapeTemplate>