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- CIRC4Life-H2020-IND-CE-2016-2017/CIRC-2017/TwoStage

A circular economy approach for lifecycles of products and services

Report on Information Logistics Systems development and resulting systems and processes

Deliverable 4.2.

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Summary

This deliverable provides an overview of CIRC4Life informational logistical system including the architecture, the flow of data, the databases as well as the data formats.

The interactions in terms of data between all the CIRC4Life ICT components are described, providing a view of the logistical data flow. This relation is further expanded to all the systems that are developed in other WPs and are related to the ICT Platform. Special attention is paid to the data format and the databases used, taking into consideration the needs of the Circular Economy Business Models, the interoperability of the system within the various systems and the potential scalability for the demonstrations.

This report is an evidence of the development work that has been done to implement the data flow, the storage of the data and allow the interactions of the systems. This is the result of the task 4.2.

Table of Contents

Table of Figures

Acronyms and abbreviations

Abbreviation	Description
CE	Circular Economy
CEBM	Circular Economy Business Model
DoA	Description of Action
EC	European Commission
EoL	End of Life
ICT	Information Communication Technology
JSON	JavaScript Object Notation
JSON-LD	JavaScript Object Notation – Linked Data
KPI	Key Performance Indicator
LD	Large Scale Data
LCA	Life Cycle Assessment
P2P	Peer to Peer
SoA	Service Oriented Architecture
WP	Work Package

1 Introduction

A vital part of the ICT infrastructures and is the information data flows , the data format, data type as well as the architecture used to implement it .

The architecture of the whole ICT platform was described in the Deliverable4.1, and this work is further adapting the architecture, adding also a layer for the exchange of data. This work is the result of Task4.2 which is described as:

"…A vital part of the ICT infrastructures and processes is the information logistical core – managing the information and data exchange between the actors in the overall system. The information logistical system will be open source both in regard to the database systems used, database models and logic and accessible services …"

1.1 Purpose of the document

This report describes the outcome of the work done in T4.2 that set out to design, implement and test the information flow of CIRC4Life. It covers the work done within the development phase and the internal tests of the technical teams prior to the usage by the Industrial Partners of the project.

The report considers the state of the art on the development of similar systems aiming to develop an open source, scalable system that could serve as an enabler for the CEBMs.

1.2 Intended readership

The work presented in this report addresses the need of the following groups:

- The CIRC4Life consortium including the technical and the non-technical partners. The non-technical partners will have a reference on how the CEBM will be supported through the ICT platform whereas the technical partners will have a view of the complete system which will be the reference of the development for the system subcomponents.

- Researchers, scientists and organizations who are interested in Circular Economy and especially on how data can be represented as enablers for Circular Solutions

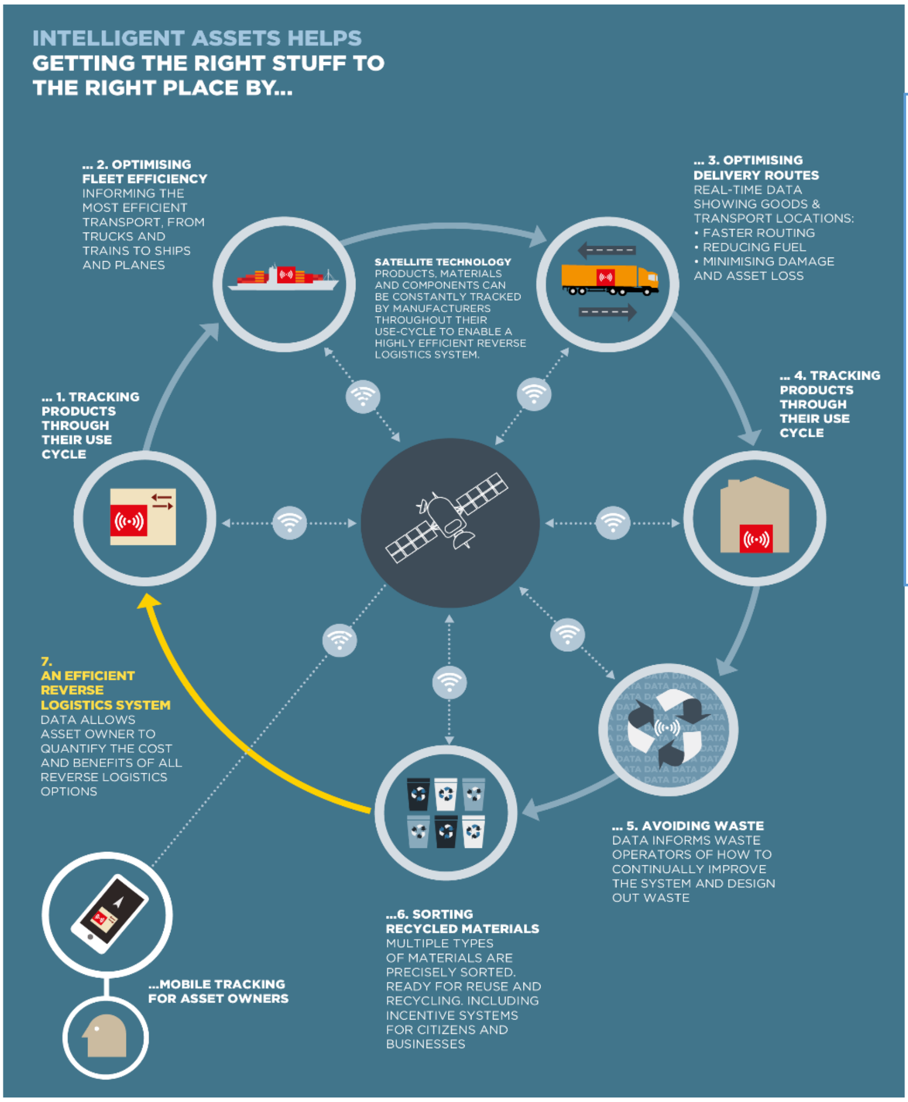
1.3 Relation with other CIRC4Life Work Packages/Deliverables

This deliverable is the core of the logistical data system of the ICT platform that is created in the context of CIRC4Life. It describes the architecture of the ICT platform, the exchange of data as well as the interactions with the systems developed in other tasks and WPs.
In this context, this document considers the data flows of:

- the Impact Assessment Tool (WP1, WP2)
- the ECO-shopping and ECO Account tools (WP3)
- the Traceability Module (WP5)
- the Recycling Module (WP2)
- All the subsystems of WP4

2 ICT platform data logistical system

The CIRC4Life ICT architecture (Tsimiklis, 2018), has described all the vital parts of the ICT platform that will serve the newly created Business Models. The exchange of data between all the components of the architecture is vital of the success and the scalability of the system. As already identified in the literature, data flows are vital for the success of Circular Economy and the scalability of Circular Economy Business Models (Genovese et al., 2017). This integration becomes more relevant as managing Large Scale Data is a success factor for CE (Tien, 2013; Wu et al., 2014). Furthermore, many challenges are described in the design and management of CE information and data (Ritzén and Sandström, 2017).


INTELLIGENT ASSETS HELPS
GETTING THE RIGHT STUFF TO
THE RIGHT PLACE BY...
... 1. TRACKING PRODUCTS THROUGH THEIR USE CYCLE
... 2. OPTIMISING FLEET EFFICIENCY
INFORMING THE MOST EFFICIENT TRANSPORT, FROM TRUCKS AND TRAINS TO SHIPS AND PLANES
SATELLITE TECHNOLOGY
PRODUCTS, MATERIALS AND COMPONENTS CAN BE CONSTANTLY TRACKED BY MANUFACTURERS THROUGHOUT THEIR USE-CYCLE TO ENABLE A HIGHLY EFFICIENT REVERSE LOGISTICS SYSTEM.
... 3. OPTIMISING DELIVERY ROUTES
REAL-TIME DATA SHOWING GOODS & TRANSPORT LOCATIONS:
• FASTER ROUTING
• REDUCING FUEL
• MINIMISING DAMAGE AND ASSET LOSS
... 4. TRACKING PRODUCTS THROUGH THEIR USE CYCLE
... 5. AVOIDING WASTE
DATA INFORMS WASTE OPERATORS OF HOW TO CONTINUALLY IMPROVE THE SYSTEM AND DESIGN OUT WASTE
...6. SORTING RECYCLED MATERIALS
MULTIPLE TYPES OF MATERIALS ARE PRECISELY SORTED. READY FOR REUSE AND RECYCLING. INCLUDING INCENTIVE SYSTEMS FOR CITIZENS AND BUSINESSES
7. AN EFFICIENT REVERSE LOGISTICS SYSTEM
DATA ALLOWS ASSET OWNER TO QUANTIFY THE COST AND BENEFITS OF ALL REVERSE LOGISTICS OPTIONS
...MOBILE TRACKING FOR ASSET OWNERS
DATA

> *"Digital technologies are driving a profound transformation of our economy. Guiding this wave of change by applying circular economy principles could create value, and generate wider benefits for society..."*
> Dame Ellen MacArthur, Founder, Ellen MacArthur Foundation

Figure 1 Data flows in Circular Business Models, Ellen MacArthur Foundation

The importance of managing Large Scale Data and the link to CE was considered in our work for the design of the system. Initially we had considered all the 4Vs (Jagadish, 2015), for the needs of the data that may come to the platform.• Volume—massive amounts of data being generated continually in a volume never before observed; • Variety—distinct and unstructured formats (texting, imaging, videos, voice);• Velocity—high data generation frequency (today it is possible to analyse data before it is stored in a database); and • Veracity—the quality of the data and its proven real-world application.

More specifically we had considered the framework proposed by (Jabbour et al., 2017) to associate the strategies for CE, the key stakeholders and the characteristics of data as shown in table 1, and extended it with the CIRC4Life approach.

Table 1 , Relational matrix illustrating the complexity of linking CE, LD, key-stakeholders and the 4Vs of large-scale data, considering the CIRC4Life approach.

Strategies for CE new business models	Stakeholders (suppliers, producers, consumers)	Essential characteristics of big data (4Vs)	CIRC4Life Approach
Regenerate	Suppliers, in partnership with producers – particularly focal companies – will require new information about a variety of alternatives, renewable and less impactful raw materials.	Veracity of data regarding environmental impact assessment of raw materials (current and potential alternatives)	*A data entry tool should allow to suppliers and producers to add to the system data in an easy way.*
Share	Customers will play a vital role in making information on items that are ready-to-be-shared.	Variety (videos, audio, social media, apps) and velocity of sharing information and opportunities will be key for this kind of circular economy strategy.	*Various data types and formats should be supported, apart from the LCA data.*
Optimise	Producers will be central stakeholders in achieving an optimised, zero waste production and distribution system. Information regarding waste (generated and avoided), and its effects on firm performance will be essential.	Volume and veracity will be key dimensions of this kind of business model for CE. In large-scale production systems, a large volume of data about waste, end-of-use collection, and environmental impacts generated by suppliers will be a major preoccupation for firms. Additionally, veracity is important to plan, for instance, a predictive maintenance scheme based on real-time data according to conditions of machines.	*Producers should be able to input in the system any additional data they have and perform assessment in an easy way.*
Loop	Keeping materials in closed loops will require shared	Velocity, veracity and volume are dimensions that will challenge the loop's model. This is because real	*The Interaction with the Traceability module of ICT is vital.*

	information among all the three stakeholders. Information regarding the traceability of the products during their life cycles and loops will be key.	data about location, condition, and availability will be necessary in order to trace products during journeys through loops. Product monitoring requires a large volume of data. Additionally, veracity about product design characteristics and reliability are essential to maintain a closed loop.	*This should be made available to the end users.*
Virtualise	Understanding consumers' needs and acceptability of virtualised services and products is at the centre of this CE strategy. Producers will need to have reliable data on consumers' preferences.	This strategy will need to monitor consumers' preferences and consumption trends for virtualised products and services. Variety and volume of big data will be particularly useful for organisations.	*The data collected in the ICT platform should offer possibilities of aggregation and further processing.*
Exchange	Producers will play a key role in unlocking this strategy, as they can replace old processes with new ones, which will be more sustainable	A variety of information regarding new trends in technology, production and processes will be necessary. Additionally, the information needs to be accurate and with high levels of veracity.	*Give the possibility of multiple stakeholders to have access to data, with a dedicated access control.*

2.1 ICT Platform data flows

Taking into consideration the above, and the additional feedback received from the CEBMS the CIRC4Life ICT architecture was updated and all the expected data exchange/flows were designed. Figure1 summarizes all the systems and the expected data flow.

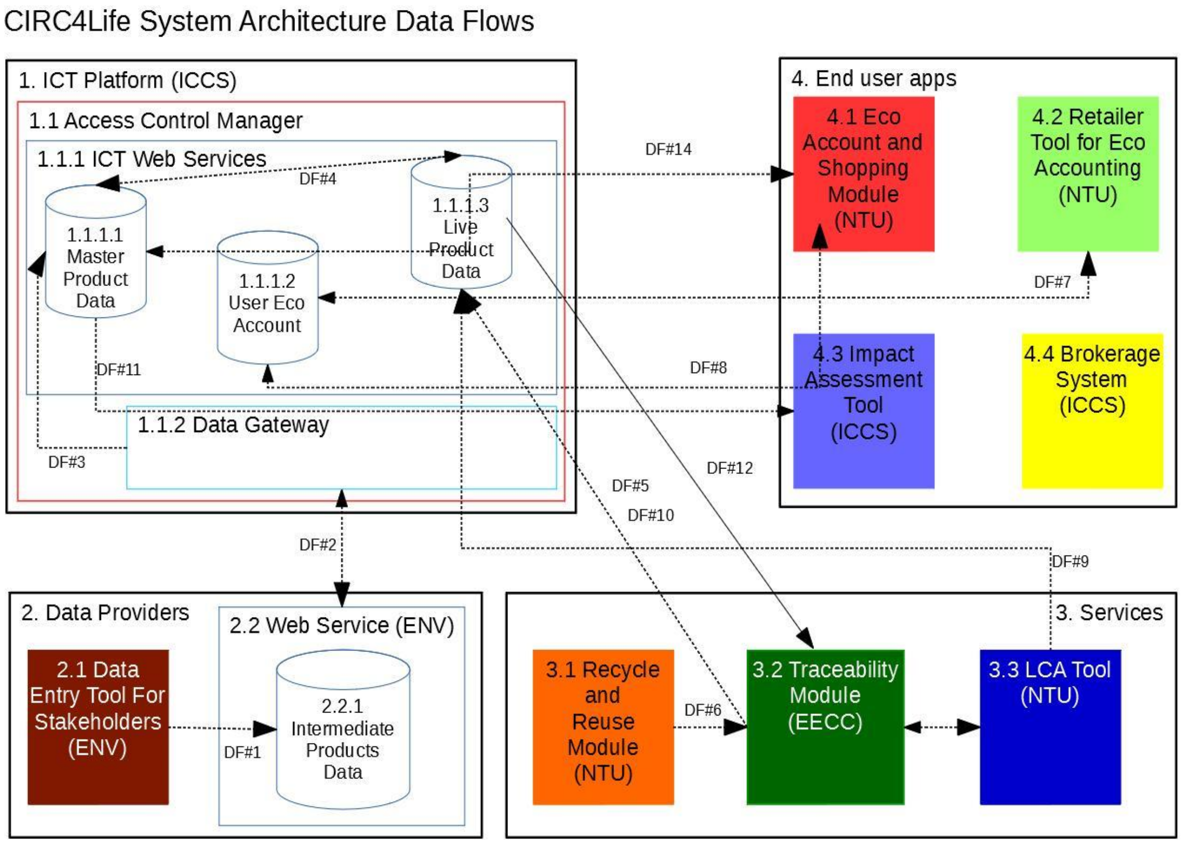

CIRC4Life System Architecture Data Flows
1. ICT Platform (ICCS)
1.1 Access Control Manager
1.1.1 ICT Web Services
1.1.1.1 Master Product Data
1.1.1.2 User Eco Account
1.1.1.3 Live Product Data
1.1.2 Data Gateway
4. End user apps
4.1 Eco Account and Shopping Module (NTU)
4.2 Retailer Tool for Eco Accounting (NTU)
4.3 Impact Assessment Tool (ICCS)
4.4 Brokerage System (ICCS)
2. Data Providers
2.1 Data Entry Tool For Stakeholders (ENV)
2.2 Web Service (ENV)
2.2.1 Intermediate Products Data
3. Services
3.1 Recycle and Reuse Module (NTU)
3.2 Traceability Module (EECC)
3.3 LCA Tool (NTU)
DF#1
DF#2
DF#3
DF#4
DF#5
DF#6
DF#7
DF#8
DF#9
DF#10
DF#11
DF#12
DF#14

Figure 2 CIRC4Life ICT Components and Data Flows

2.2 Data flows relations with other Tasks/WPs

Many of the systems described in the section2.1 are to be developed as part of other tasks of the project with various timelines. The following table gives an overview of the dependency with other tasks as well as the partners that are leading the corresponding tasks.

Table 2 Overview of Modules, Responsible Partners and Related Tasks

Group	Module	Responsible Partner	Related Task
1. ICT Platform	1.1 Access Control Manager	ICCS	T4.3
1. ICT Platform	1.1.1 ICT Web Services	ICCS	T4.5
1. ICT Platform	1.1.2 Data Gateway	ENV	T4.4
2. Data Providers	2.1 Data Entry Tool for Stakeholders	ENV	T4.2
2. Data Providers	2.2 Intermediate Products Data Export Web Service	ENV	T4.2
3. Services	3.1 Recycle and Reuse Module	NTU	T2.3
3. Services	3.2 Traceability Module	EECC	T5.4
3. Services	3.3 LCA module	NTU	T1.2
4. End user applications	4.1 Eco Account and Shopping Module	NTU	T3.3
4. End user applications	4.2 Retailer Tool for Eco Accounting	NTU	T3.2
4. End user applications	4.3 Impact Assessment Tool	ICCS	T1.2
4. End user applications	4.4 Brokerage System	ICCS	T4.7

2.3 Data Flows

All the identified Data Flows are summarized in the Table 3, providing an overview of the source-destination, the expected data format (which is further analyzed in Section 3), the communication protocol and a small description of the transaction.

Table 3 Overview of Data Flows between the CIRC4Life systems

Data Flow	Source	Destination	Data Format	Communication Protocol	Comment
DF#1	2.1 Data Entry Tool for Stakeholders	2.2.1 Intermediate Products Data	JSON	Local Database connector	Data entry UI application saves records to local relational database
DF#2	2.2 Intermediate Products Data Export Web Service	1.1.2 Data Gateway	JSON	HTTP Web Service	Data Gateway service retrieves data entry records
DF#3	1.1.2 Data Gateway	1.1.1 ICT Web Services	JSON	HTTP REST Service	Data Gateway posts validated data entry records to REST endpoint that update Product Master Database.
DF#4	1.1.1.3 Live Product Data	1.1.1.1 Master Product Data	JSON	ICT Platform Internal process	Internal process periodically updates the Master Product Data with live updates received from events
DF#5	3.2 Traceability Module	1.1.1 ICT Web Services	JSON	HTTP REST Service	ICT Platform receives updates/events from traceability module

Data Flow	Source	Destination	Data Format	Communication Protocol	Comment
DF#6	3.1 Recycle and Reuse Module	3.2 Traceability Module	JSON	HTTP REST Service	Recycle module gets information about disposal event
DF#7	4.2 Retailer Tool for Eco Accounting	1.1.1 ICT Web Services	JSON	HTTP REST Service	Retailer tool access to Product Master Date and Eco Account anonymously for purchase history update
DF#8	4.1 Eco Account and Shopping Module	1.1.1 ICT Web Services	JSON	HTTP REST Service	End-user applications access Product Master Data information and Eco Account
DF#9	3.3 LCA Module	1.1.1 ICT Web Services	TBC	TBC	In the current version of the system it is not implemented an interaction between the LCA module and the ICT platform.
DF#10	3.2 Traceability Module	1.1.1 ICT Web Services	JSON	HTTP REST Service	ICT Platform receives the relevant information from events loaded and transformed by the Traceability Module and saves them in Live Product Data.
DF#11	1.1.1 ICT Web Services	4.3 Impact Assessment Tool	JSON	HTTP REST Service	Impact Assessment Tool retrieves product score, material and recycle/re-use information

Data Flow	Source	Destination	Data Format	Communication Protocol	Comment
DF#12	1.1.1 ICT Web Services	3.2 Traceability Module	JSON	HTTP REST Service	Get purchase history in order to provide suggestions for the recycling input
DF#13	3.2 Traceability Module	1.1.1 ICT Web Services	JSON	HTTP REST Service	Consumer and Product ID with recycler evaluation results

Considering the architecture that was presented in Deliverable 4.1, it has been selected a SoA for better coverage of the CEBMs. This approach has a slight differentiation in this deliverable too, as the biggest effort was given on the data flows that will serve the business models within this architecture rather than the P2P connection within the systems. On the other, the P2P possibilities for any system that would like to share data with the platform is feasible, and this can be achieved through the data gateway, which is responsible for any needed data transformation. This functionality is also demonstrated with the Data Entry Tool which may connect directly to the ICT platform.

3 CIRC4Life ICT Platform Software Data Models

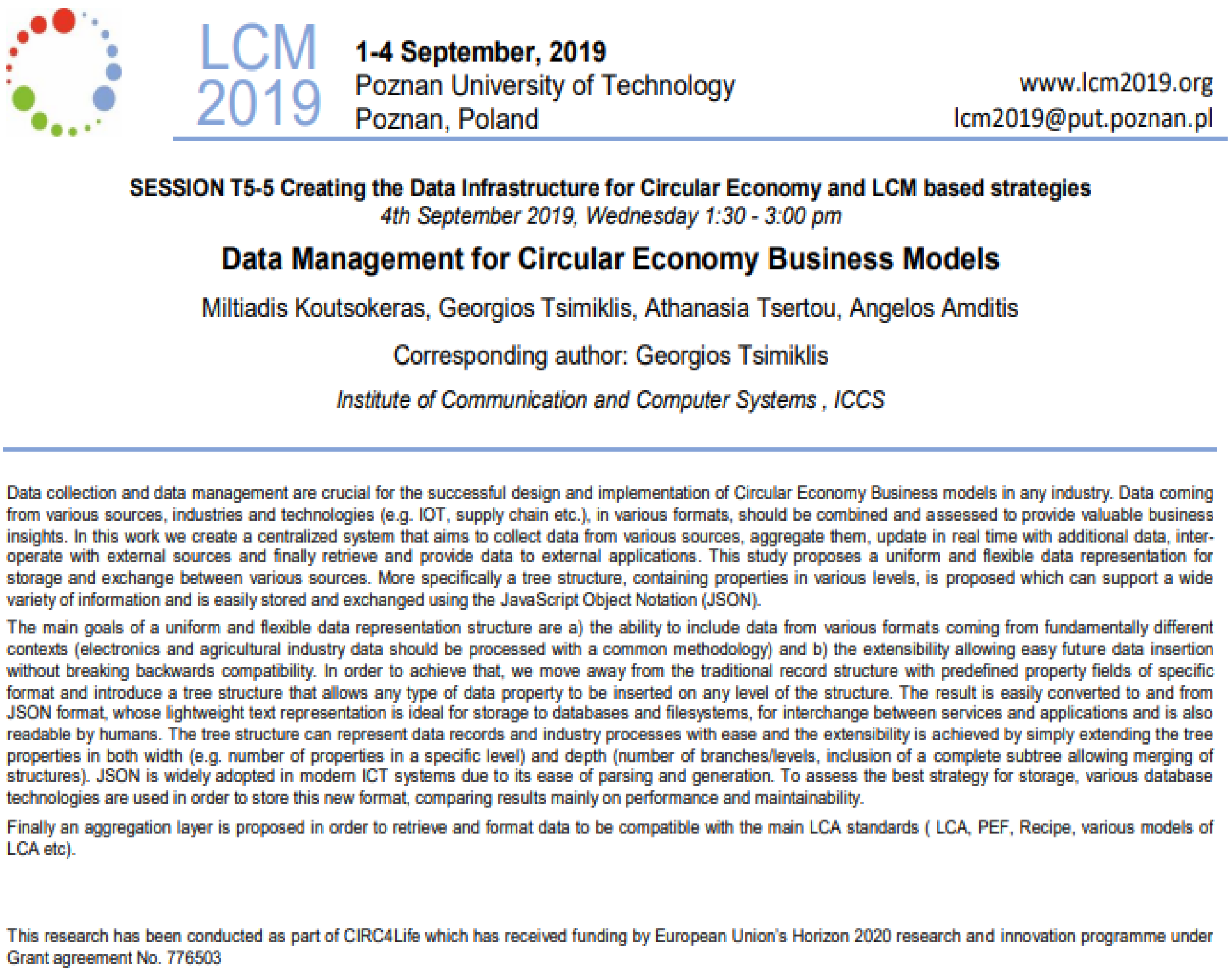
In this section it is described the data persistence layer of the whole ICT platform, an overview of the developed databases, the external databases of the core ICT platform and finally the selected data models.

3.1 Data Persistence Layer

The persistent storage of the ICT Platform consists of a list of MongoDB databases, containing “unstructured”/dynamic data in JSON representation. This choice was made considering the need of generation of big amount of data, without a unique structure and high risk of change due to the innovation brought by the CEBMs. In addition, when it's a question of need of modern application which are generating huge data & generally unstructured data Non-relational database system shows true usability in such case (Kashyap et al., 2016).At the current stage of the system , there is not inserted a big amount of data , however the system is designed with the possibility to upscale by using this architecture .

In a comparative analysis of Non-Relational databases, we can see that the behaviour is highly dependent on the application (Sebastian,2014), whereas MongoDB is currently the most popular document based Non-Relational database (Moniruzzaman et al. ,2013). Furthermore, in a comparison between MongoDB and MySQL, MongoDB provided lower execution times than MySQL in all four basic operations, which is essential when an application should provide support to thousands of users simultaneously. We can choose MongoDB instead of MySQL if the application is data intensive and stores many data and queries lots of data (Győrödi et al.,2015).

On these schema-less databases, the linked relationships between them and external sources is designed with the W3C recommendation, JSON-LD. JSON-LD is a Linked Data format initiative, aiming towards the transformation of WWW to the Semantic Web. The major characteristic is the creation of links between information and the standardization of common properties using shared vocabularies/ontologies like Schema.org, openLCA and GS1 Vocabulary from GS1 SmartSearch.
The JSON-LD Schema defines all possible properties, types and values that is possible to use in a JSON-LD document.



LCM 2019

1-4 September, 2019
Poznan University of Technology
Poznan, Poland

www.lcm2019.org
lcm2019@put.poznan.pl

SESSION T5-5 Creating the Data Infrastructure for Circular Economy and LCM based strategies
4th September 2019, Wednesday 1:30 - 3:00 pm

Data Management for Circular Economy Business Models

Miltiadis Koutsokeras, Georgios Tsimiklis, Athanasia Tsertou, Angelos Amditis

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Data collection and data management are crucial for the successful design and implementation of Circular Economy Business models in any industry. Data coming from various sources, industries and technologies (e.g. IOT, supply chain etc.), in various formats, should be combined and assessed to provide valuable business insights. In this work we create a centralized system that aims to collect data from various sources, aggregate them, update in real time with additional data, interoperate with external sources and finally retrieve and provide data to external applications. This study proposes a uniform and flexible data representation for storage and exchange between various sources. More specifically a tree structure, containing properties in various levels, is proposed which can support a wide variety of information and is easily stored and exchanged using the JavaScript Object Notation (JSON).

The main goals of a uniform and flexible data representation structure are a) the ability to include data from various formats coming from fundamentally different contexts (electronics and agricultural industry data should be processed with a common methodology) and b) the extensibility allowing easy future data insertion without breaking backwards compatibility. In order to achieve that, we move away from the traditional record structure with predefined property fields of specific format and introduce a tree structure that allows any type of data property to be inserted on any level of the structure. The result is easily converted to and from JSON format, whose lightweight text representation is ideal for storage to databases and filesystems, for interchange between services and applications and is also readable by humans. The tree structure can represent data records and industry processes with ease and the extensibility is achieved by simply extending the tree properties in both width (e.g. number of properties in a specific level) and depth (number of branches/levels, inclusion of a complete subtree allowing merging of structures). JSON is widely adopted in modern ICT systems due to its ease of parsing and generation. To assess the best strategy for storage, various database technologies are used in order to store this new format, comparing results mainly on performance and maintainability.

Finally an aggregation layer is proposed in order to retrieve and format data to be compatible with the main LCA standards (LCA, PEF, Recipe, various models of LCA etc).

This research has been conducted as part of CIRC4Life which has received funding by European Union's Horizon 2020 research and innovation programme under Grant agreement No. 776503

Figure 3 Abstract for presentation during LCM2019 conference

This work was presented during the 9th International Conference of Life Cycle Management (LCM2019) , taking a positive feedback from the experts in the field as well as valuable inputs for the final development .

3.2 Databases

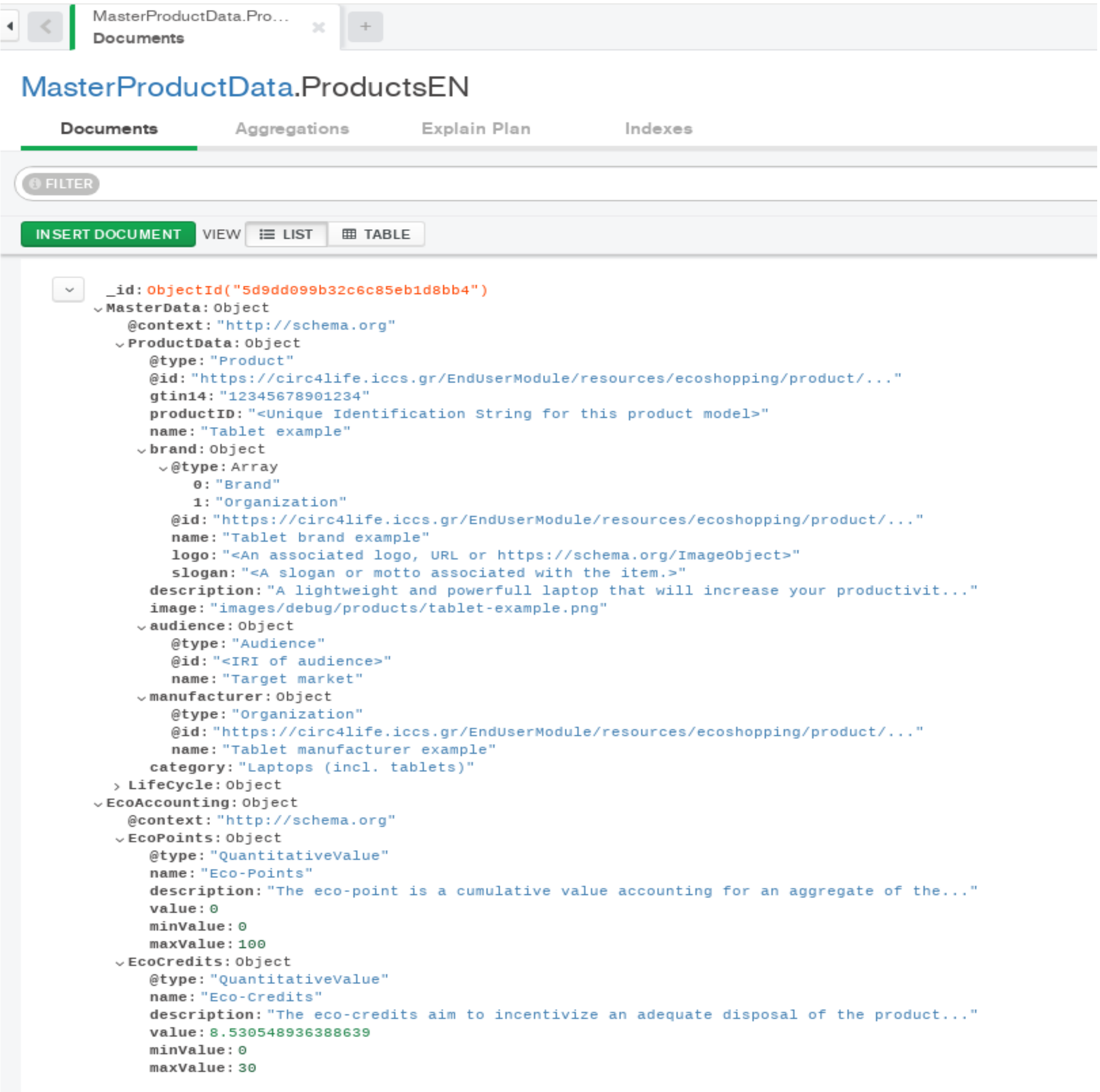
The ICT Platform Core system contains the following databases in a MongoDB server instance.

- Products Master Data
- User Eco-Account
- Live Product Data

The JSON representation of MongoDB records is suitable for applying the JSON-LD linked data design to the unstructured nature of MongoDB. The data can be linked into node graphs (friend of a friend), end to end relationships (individual product to materials) and use a common metadata model: a Resource Description Framework (RDF).

3.2.1 Products Master Database:

In JSON-LD format, a product or material entity can be represented by the Product and IndividualProduct classes as defined in shema.org . Individual Product can be used in cases of a uniquely identifiable item, e.g. a tablet with a specific serial number. Product describes a more general item, e.g. a laptop model of a brand. Several properties of the product can be referenced instead of including in each JSON document to avoid duplication (e.g. manufacturer or material). A list of manufacturers should be kept once and have unique entries and material are simply other products that can be used as components of another product. This process allows the reduction of volume of data, once the system will be upscaled.

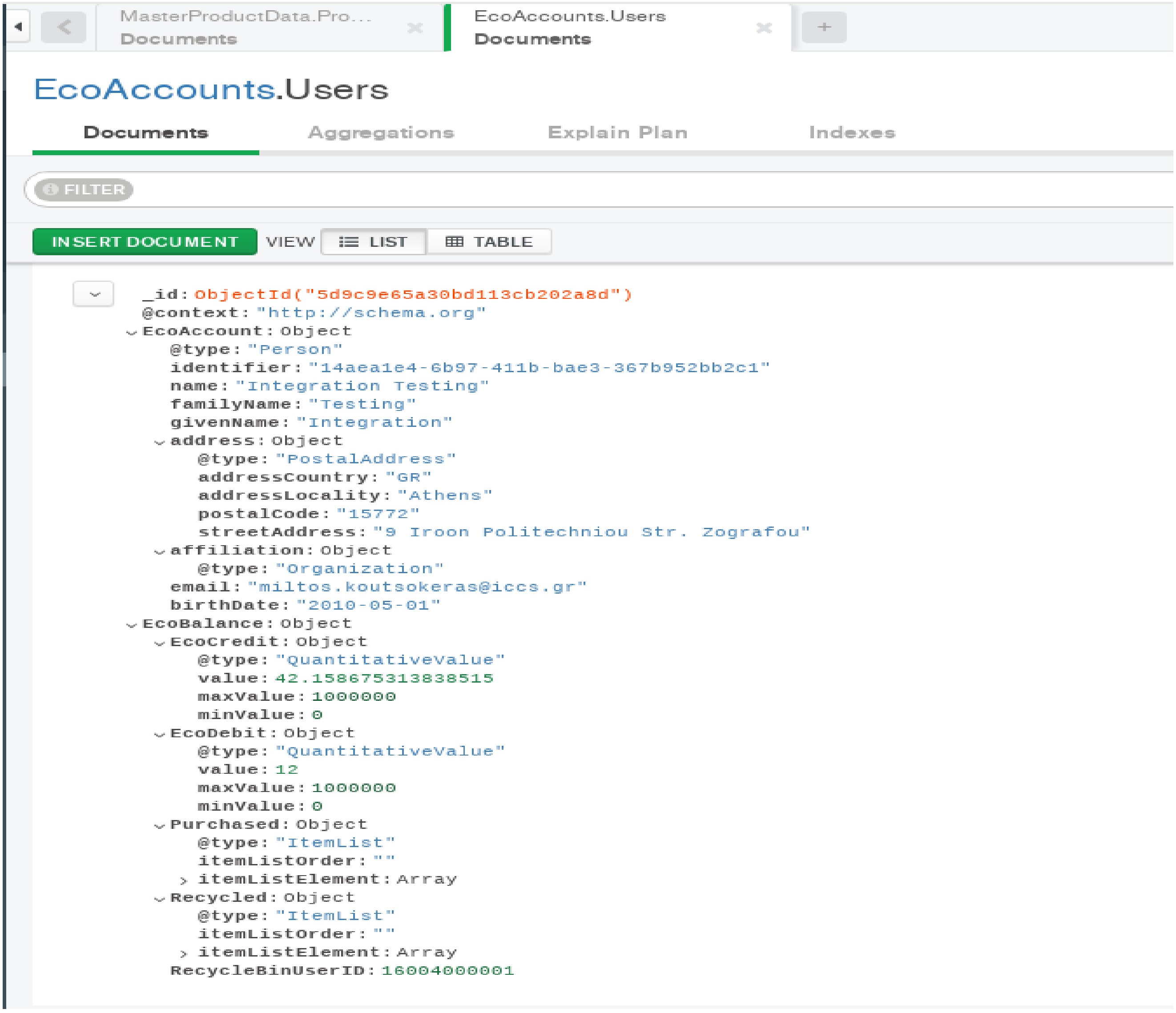


```
_id: ObjectId("5d9dd099b32c6c85eb1d8bb4")
MasterData: Object
  @context: "http://schema.org"
  ProductData: Object
    @type: "Product"
    @id: "https://circ4life.iccs.gr/EndUserModule/resources/ecoshopping/product/..."
    gtin14: "12345678901234"
    productID: "<Unique Identification String for this product model>"
    name: "Tablet example"
    brand: Object
      @type: Array
        0: "Brand"
        1: "Organization"
      @id: "https://circ4life.iccs.gr/EndUserModule/resources/ecoshopping/product/..."
      name: "Tablet brand example"
      logo: "<An associated logo, URL or https://schema.org/ImageObject>"
      slogan: "<A slogan or motto associated with the item.>"
    description: "A lightweight and powerfull laptop that will increase your productivit..."
    image: "images/debug/products/tablet-example.png"
    audience: Object
      @type: "Audience"
      @id: "<IRI of audience>"
      name: "Target market"
    manufacturer: Object
      @type: "Organization"
      @id: "https://circ4life.iccs.gr/EndUserModule/resources/ecoshopping/product/..."
      name: "Tablet manufacturer example"
    category: "Laptops (incl. tablets)"
  LifeCycle: Object
EcoAccounting: Object
  @context: "http://schema.org"
  EcoPoints: Object
    @type: "QuantitativeValue"
    name: "Eco-Points"
    description: "The eco-point is a cumulative value accounting for an aggregate of the..."
    value: 0
    minValue: 0
    maxValue: 100
  EcoCredits: Object
    @type: "QuantitativeValue"
    name: "Eco-Credits"
    description: "The eco-credits aim to incentivize an adequate disposal of the product..."
    value: 8.530548936388639
    minValue: 0
    maxValue: 30
```

Figure 4 MongoDB instance from Master Product Data Database

3.2.2 User Eco-Account Database

In JSON-LD format, the Eco-account is actually a Person linked with his Eco-balance or any other properties the CIRC4Life system may require. You can easily extend it with any other properties from schema.org or other related to CEBMs.



```
_id: ObjectId("5d9c9e65a30bd113cb202a8d")
@context: "http://schema.org"
⌄ EcoAccount: Object
    @type: "Person"
    identifier: "14aea1e4-6b97-411b-bae3-367b952bb2c1"
    name: "Integration Testing"
    familyName: "Testing"
    givenName: "Integration"
  ⌄ address: Object
      @type: "PostalAddress"
      addressCountry: "GR"
      addressLocality: "Athens"
      postalCode: "15772"
      streetAddress: "9 Iroon Politechniou Str. Zografou"
  ⌄ affiliation: Object
      @type: "Organization"
    email: "miltos.koutsokeras@iccs.gr"
    birthDate: "2010-05-01"
⌄ EcoBalance: Object
  ⌄ EcoCredit: Object
      @type: "QuantitativeValue"
      value: 42.158675313838515
      maxValue: 1000000
      minValue: 0
  ⌄ EcoDebit: Object
      @type: "QuantitativeValue"
      value: 12
      maxValue: 1000000
      minValue: 0
  ⌄ Purchased: Object
      @type: "ItemList"
      itemListOrder: ""
    › itemListElement: Array
  ⌄ Recycled: Object
      @type: "ItemList"
      itemListOrder: ""
    › itemListElement: Array
    RecycleBinUserID: 16004000001
```

Figure 5 MongoDB instance from users Eco Account

3.2.3 Live Product Data Database

Traceability data, i.e. real time information about important events occurring to an individual product, is collected through online services, so called capturing applications, provided by the European EPC Competence Centre (EECC). These applications transform the data retrieved from project partners into standardised EPCIS events, which are in turn stored in an EPCIS repository which is also developed and deployed as SaaS by EECC. The data from this repository is not only available through the standardised EPCIS SOAP query interface, but also through CIRC4Life specific accessing applications which aggregate and transform the data into the JSON-LD format mentioned above and discussed in detail in section 4 below. EECC has created an “ECO extension for EPCIS”. By means of this extension to the standard, the Traceability Module tracks ecological impacts associated with possibly any step along the value chain of a product. The accessing applications provide a convenient view on total impacts, e.g. total travel distances. With this overall system architecture in mind, the ICT Platform services should not maintain a copy of all the traceability information. Everything related to traceability of individual products can be queried online from the Traceability Module.

Any data that can affect the total Eco Score (Eco Points, Eco Credits) of the products are stored in the Live Product Data Database. This is done in order to avoid updates and retrievals in the database, given the Master Product Database is used to serve the End User Applications.

3.3 External Databases

These databases are not part of the ICT Platform system, the data is imported from them:

3.3.1 Intermediate Products Data:

This database contains the data records inserted with the Data Entry Tool for Stakeholders (ENV). More details of this database are presented in section 4.

4 Data Models

In the following paragraphs each data model used in the persistence layer or exchanged between system modules is described in detail. Each data model is accompanied with its JSON-LD and JSON Schema, where those apply.

A complete view of all the files described in this section can be found in Annex I and Annex II.

***NOTE**: All JSON-LD objects below are validated with Google's Structured Data Testing Tool. The main vocabulary used is Schema.org*

All JSON Schemas referenced below are generated from their corresponding JSON-LD with the help of JSON Schema Tool. The initial tool output is modified manually to create references between schemas.

The JSON Schemas can be used to generate source code for various programming languages with the help of various tools: quicktype, jsonschema2pojo.Integrating these tools in the build system allows the automatic generation of source code changes after any Data model change. The generated source code encapsulates the properties of the documents and provides automatic validation of data passed to them.

The example documents referenced below contain example information wrapped with < and >. The property values that are not wrapped, are constants required by the JSON-LD schema, like:
"@type": "Person".

4.1 Product Master Data Models

In JSON-LD format, a product data model encapsulates all information that uniquely identifies a single market product using the class type http://schema.org/Product and also custom classes for describing the life cycle and Eco-accounting properties related to a product. The data model consists of the following main components:

- ***MasterData*** including the product's general and life-cycle properties.
- ***MasterData.ProductData*** these are non-volatile data properties that should be published once for each product. This is the read-only part of a product record: no ICT platform processing should result in changes inside this part of the record after the its creation. Only external authorities on products should allow this. These properties come from the Data Entry Tool.
- ***MasterData.LifeCycle*** These properties come from the Data Entry Tool .
- ***MasterData.LifeCycle.Impact Assessment Methods*** Product Impact Assessment Methods and their corresponding properties.
- ***MasterData.LifeCycle.Resources*** Product Life-cycle resources properties, including product type standardized key codes, detailed materials list and recyclability properties.
- ***MasterData.LifeCycle.Comments*** Free text associated with this product record.
- ***EcoAccounting*** including the product's Eco-points and Eco-credits. This is the volatile part of a product Master Data record. Updates from outside service to the MasterData component properties should result in a re-calculation of the Eco-accounting values for each modified product.

- ***EcoAccounting.EcoPoints*** is a cumulative value accounting for an aggregate of the ecological impacts throughout product life cycle.
- ***EcoAccounting.EcoCredits*** value aim to provide incentive for an adequate disposal of the products after their end-of-life.

In the figure 3 we can see a JSON-LD description of a brand with example data.

```
{
        "@context": "http://schema.org",
        "@type": [
                "Brand",
                "Organization"
        ],
        "@id": "<IRI of owner of this product, ideally in JSON-
LD same as http://schema.org/Brand or
http://schema.org/Organization.>",
        "name": "<Brand name>",
        "logo": "<An associated logo, URL or
https://schema.org/ImageObject>",
        "slogan": "<A slogan or motto associated with the
item.>"
}
```

Figure 6 Example of JSON-LD of a brand description

Whereas the corresponding JSON schema can be found in figure 4.

```
{
        "definitions": {
                "Brand": {
                        "$schema": "http://json-schema.org/draft-07/schema#",
                        "$id": "SchemaOrg_Brand",
                        "type": "object",
                        "title": "The Brand Schema",
                        "required": [
                                "@context",
                                "@type",
                                "@id",
                                "name",
                                "logo",
                                "slogan"
                        ],
                        "properties": {
                                "@context": {
                                        "$id": "#/properties/@context",
                                        "type": "string",
                                        "title": "The @context Schema",
                                        "default": "http://schema.org",
                                        "examples": [
                                                "http://schema.org"
                                        ],
                                        "pattern": "^(.*)$"
                                },
                                "@type": {
                                        "$id": "#/properties/@type",
                                        "type": "array",
                                        "title": "The @type Schema",
                                        "items": {
                                                "$id":
"#/properties/@type/items",
                                                "type": "string",
                                                "title": "The Items Schema",
                                                "default": "Brand",
                                                "examples": [
                                                        "Brand",
                                                        "Organization"
                                                ],
                                                "pattern": "^(.*)$"
                                        }
                                },
                                "@id": {
                                        "$id": "#/properties/@id",
                                        "type": "string",
                                        "title": "The @id Schema",
                                        "default": "",
                                        "examples": [
                                                "<IRI of owner of this product,
ideally in JSON-LD same as http://schema.org/Brand or
http://schema.org/Organization.>"
                                        ],
                                        "pattern": "^(.*)$"
                                },
                                "name": {
                                        "$id": "#/properties/name",
                                        "type": "string",
                                        "title": "The Name Schema",
                                        "default": "",
```

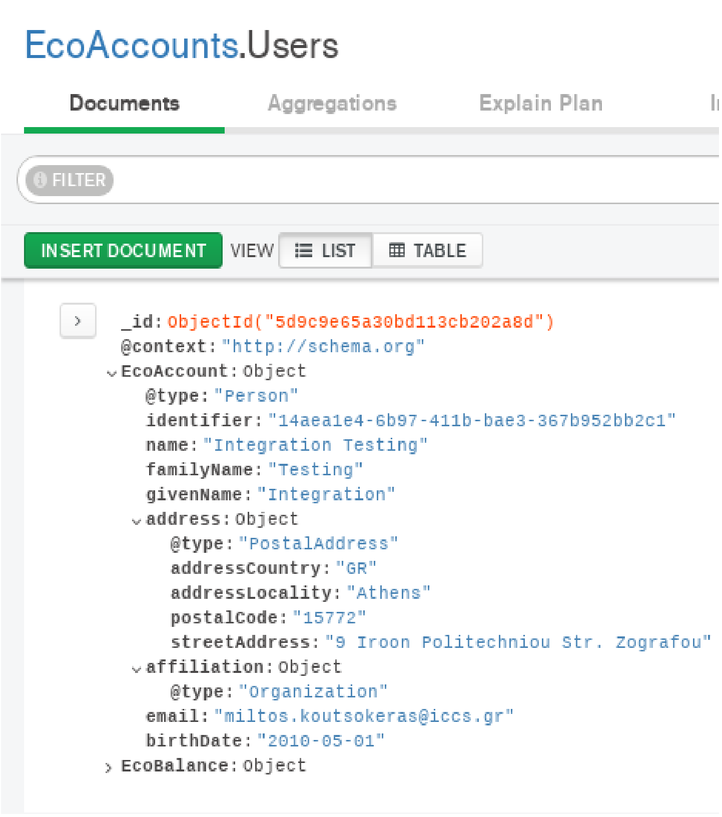
Figure 7 Example of JSON schema of the brand

4.2 User Eco-account models

In JSON-LD format, the Eco-account is actually a *https://schema.org/Person* linked together with his Eco-balance or any other properties may be potentially requested by the end user applications. This can be easily expanded with any other properties from *https://schema.org/.* The data model is broken into 2 main parts:

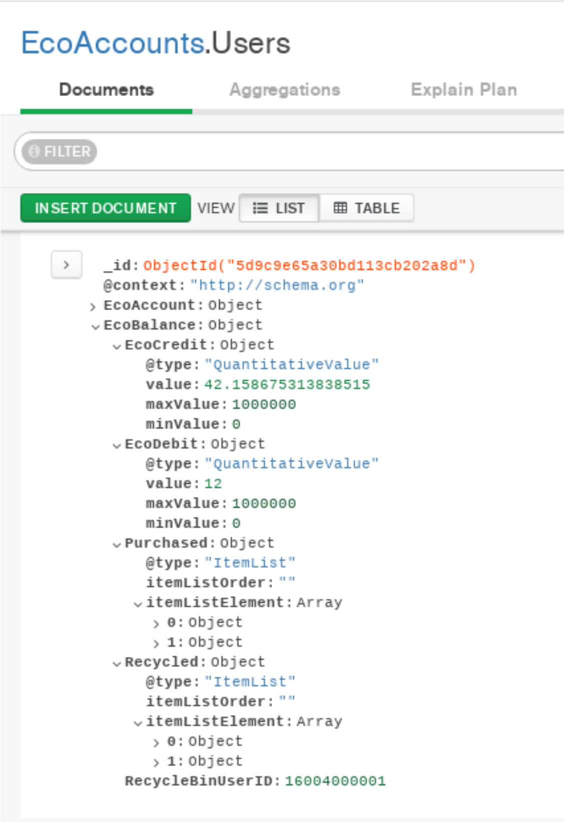
- EcoAccount uniquely identifies the person this account belongs to. This is the part of the structure that directly maps to *https://schema.org/Person*.

- EcoBalance contains the account's Environmental Footprint properties. According to Deliverable 1.3, the main properties of the EcoBalance are the EcoCredit and EcoDebit values, calculated from a single EcoPoint value of a specific product.



```
_id: ObjectId("5d9c9e65a30bd113cb202a8d")
@context: "http://schema.org"
EcoAccount: Object
  @type: "Person"
  identifier: "14aea1e4-6b97-411b-bae3-367b952bb2c1"
  name: "Integration Testing"
  familyName: "Testing"
  givenName: "Integration"
  address: Object
    @type: "PostalAddress"
    addressCountry: "GR"
    addressLocality: "Athens"
    postalCode: "15772"
    streetAddress: "9 Iroon Politechniou Str. Zografou"
  affiliation: Object
    @type: "Organization"
  email: "miltos.koutsokeras@iccs.gr"
  birthDate: "2010-05-01"
EcoBalance: Object
```

Figure 8 User's ECO Account



```
_id: ObjectId("5d9c9e65a30bd113cb202a8d")
@context: "http://schema.org"
EcoAccount: Object
EcoBalance: Object
  EcoCredit: Object
    @type: "QuantitativeValue"
    value: 42.158675313838515
    maxValue: 1000000
    minValue: 0
  EcoDebit: Object
    @type: "QuantitativeValue"
    value: 12
    maxValue: 1000000
    minValue: 0
  Purchased: Object
    @type: "ItemList"
    itemListOrder: ""
    itemListElement: Array
      0: Object
      1: Object
  Recycled: Object
    @type: "ItemList"
    itemListOrder: ""
    itemListElement: Array
      0: Object
      1: Object
  RecycleBinUserID: 16004000001
```

Figure 9User's Eco Balance

The examples of the of the JSON-LD and corresponding JSON schemas are found in Annex I and Annex II respectively.

4.3 Live Product Data model

This data model is an extension of the Product Master Data Model with all the additional data that are collected from the Traceability Model.

5 Data Entry Tool

The data entry tool was designed and developed in order to allow the insertion of data in the ICT platform following a dynamic format. The end users (CEBMs owners or industry partners) have the possibility to enter data to the ICT platform , either related to the LCA attributes of their products or descriptive generic data for the products .
Considering the need for complex data and formats a modular approach was used at the development allowing the insertion of multiple types of data.

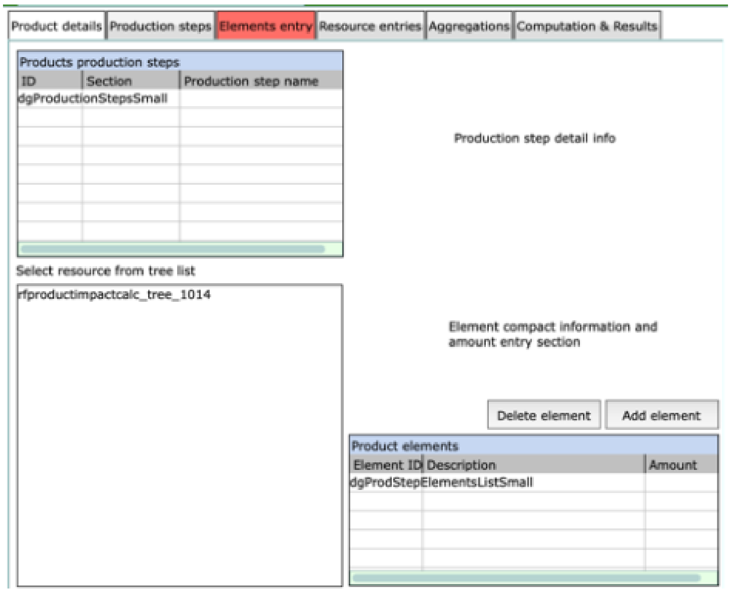
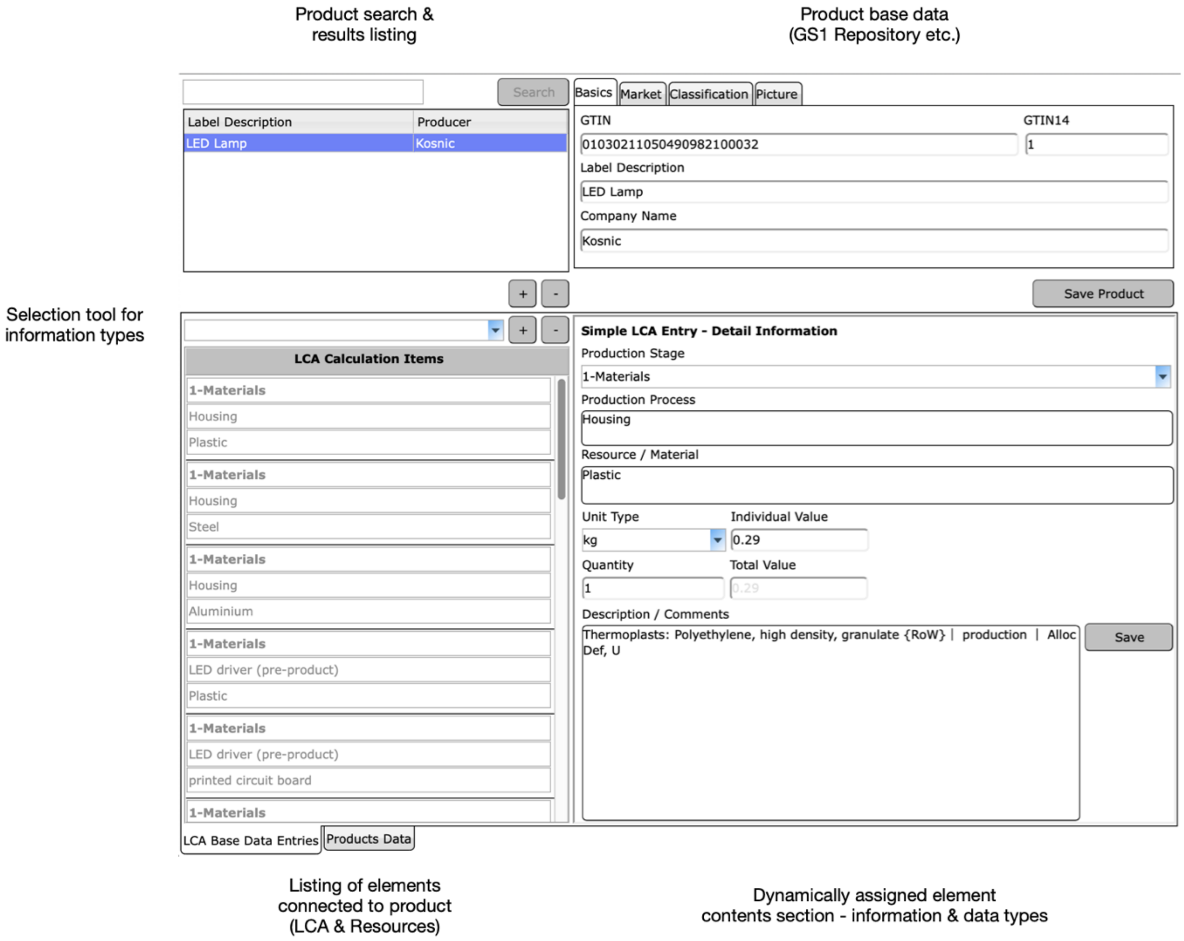


Figure 10 Data entry Tool, User Interface

This tool was further exploited for task 4.4 as described in D4.3. The results from this development work is described in more detail in D4.3 covering the development approaches, results and future development plans for both the interoperability system and its management structures.



Label Description	Producer
LED Lamp	Kosnic

GTIN: 01030211050490982100032
GTIN14: 1
Label Description: LED Lamp
Company Name: Kosnic

1-Materials
Housing
Plastic
1-Materials
Housing
Steel
1-Materials
Housing
Aluminium
1-Materials
LED driver (pre-product)
Plastic
1-Materials
LED driver (pre-product)
printed circuit board
1-Materials

Simple LCA Entry - Detail Information
Production Stage: 1-Materials
Production Process: Housing
Resource / Material: Plastic
Unit Type: kg
Individual Value: 0.29
Quantity: 1
Total Value: 0.29
Description / Comments: Thermoplasts: Polyethylene, high density, granulate {RoW} | production | Alloc Def, U

Figure 11 Data Entry Tool Extended User Interface

The resulting data and information entry toolset developed has the following main characteristics:

- Ability to handle increased number of data over time in one unified data structure and one common approach of management.
- Modular user interface that adapts dynamically according to the needs of the user for information access.
- Information types can include connectivity information for external qualified services and databases, allowing one entry point for multiple information and services providers.
- The interoperability layer and end-user system can function as a escrow system for a products vital data over time – dynamically adding new types of information and connectivity information over the products use phases and technical lifetime.

As a part of the development work web services where developed allowing the interaction with the interoperability layer from the ICT platform. The web services collect the different datasets for a product and delivers them in a sorted and grouped manner (See ANNEX III) .

5.1 Intermediate Product Data record

Each Product Record created by the data entry Tool is expected to consist of the following information:

Product information: Basic product properties based on the GS1 Registry . These properties map to schema.org Product class as follows:

Table 4 Mapping between the GS1 Registry Attributes and the schema.org definitions

GS1 Registry	schema.org Product class
GTIN	gtin14
Name	name
Brand	brand
Label description	description
Medium resolution image URL	image
Target market	audience
Company name	manufacturer
Product classification	category

Lifecycle Assessment information (Materials, resources, comments, Eco-Points etc) : Additional information related to the products that may be used for the calculation of Eco-Points, Eco-Credits or for the display of relevant info by the end-User Applications .

This data model should contain the initial information to import in a Product Master Data record. The Data Gateway Module will be responsible for the data transformations in order to match the Product master Data Record in a unique data format.

6 Conclusions

The CIRC4Life information flow system is developed and deployed in the servers of ICCS in Greece and ENV in Sweden. The Traceability Module is deployed with a SaaS architecture on EECC servers in Germany. The functionalities are tested within the technical partners of the task and the system is ready for testing by the Industrial Partners.

The feedback collected during the End to End tests, will be used to refine the system and make any small update needed to facilitate the demonstrations and the correct application of the CEBMs. Furthermore, the Webservices/APIs are still under development and this make slightly affect the aforementioned design. Any potential change of the above, will be reported in deliverable 4.4.

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Appendix I, JSON-LD

Brand

```
{
        "@context": "http://schema.org",
        "@type": [
                "Brand",
                "Organization"
        ],
        "@id":  "<IRI  of  owner  of  this  product,  ideally  in  JSON-LD  same  as
http://schema.org/Brand or http://schema.org/Organization.>",
        "name": "<Brand name>",
        "logo": "<An associated logo, URL or https://schema.org/ImageObject>",
        "slogan": "<A slogan or motto associated with the item.>"
}
```

ECO Account

```
{
        "@context": "http://schema.org",
        "EcoAccount": {
                "@type": "Person",
                "identifier": "<Unique Identifier Here>",
                "url":  "<Public  or  Private  URL  of  web  page  that  displays  this
account>",
                "name": "<Full name>",
                "familyName": "<Last name>",
                "givenName": "<First name>",
                "address": {
                        "@type": "PostalAddress",
                        "addressCountry": "<2-letter country code, e.g. GR>",
                        "addressRegion": "<Address region, e.g. Attica>",
                        "addressLocality": "<City name, e.g. Athens>",
                        "postalCode": "<Postal code number>",
                        "streetAddress": "<Full street address, name, number, town>"
                },
                "affiliation": {
                        "@type": "Organization",
                        "name": "<Affiliated organization name>",
                        "url": "<Affiliated organization Website address>"
                },
                "gender": "<Sex gender, https://schema.org/Male>",
                "telephone": "<Telephone number>",
                "email": "<Email address, e.g. user@example.com>",
                "birthDate": "<Date formatted as ISO 8601 YYYY-MM-DD, e.g. 1985-01-
14>",
                "image": "<URL of account image>"
        },
        "EcoBalance": {
                "RecycleBinUserID": 16004000001,
                "EcoCredit": {
                        "@type": "QuantitativeValue",
                        "value": 5,
                        "unitCode": "<Unit of measurement if applies>",
                        "maxValue": 1000000,
                        "minValue": 0
                },
                "EcoDebit": {
                        "@type": "QuantitativeValue",
                        "value": 10,
                        "unitCode": "<Unit of measurement if applies>",
                        "maxValue": 1000000,
                        "minValue": 0
                },
                "Purchased": {
                        "@type": "ItemList",
                        "itemListOrder": "https://schema.org/ItemListUnordered",
                        "itemListElement": [
                                {
                                        "@type": "IndividualProduct",
                                        "@id": "<See file IndividualProduct.json>"
                                },
                                {
                                        "@type": "IndividualProduct",
                                        "@id": "<See file IndividualProduct.json>"
                                }
                        ]
                },
                "Recycled": {
                        "@type": "ItemList",
                        "itemListOrder": "https://schema.org/ItemListUnordered",
                        "itemListElement": [
                                {
                                        "@type": "IndividualProduct",
                                        "@id": "<See file IndividualProduct.json>"
                                },
                                {
                                        "@type": "IndividualProduct",
                                        "@id": "<See file IndividualProduct.json>"
                                }
                        ]
                }
        }
}
```

Individual Product

```
{
        "@context": "http://schema.org",
        "@type": "IndividualProduct",
        "@id": "<This is a subclass of Product.json, contains all of its properties
and add one more: serialNumber>",
        "serialNumber": "<The product identifier, such as ISBN>",
        "purchaseDate": "<Date of purchase, Date formatted as ISO 8601 YYYY-MM-DD,
e.g. 1985-01-14>"
}
```

Product

```
{
        "@context": "http://schema.org",
        "@type": "Product",
        "@id": "<IRI of product>",
        "gtin14": "<The GTIN-14 code of the product>",
        "productID": "<Unique Identification String for this product model>",
        "name": "<Name of the product>",
        "brand": {
                "@type": "Brand",
                "@id": "<See file Brand.json>"
        },
        "description": "<Label description>",
        "image": "<images/product-example.png>",
        "audience": {
                "@type": "Audience",
                "@id": "<IRI of audience>",
                "name": "<Target market>"
        },
        "manufacturer": {
                "@type": "Organization",
                "@id": "<See file Manufacturer.json>"
        },
        "category": "<Product categorization/classification>",
        "material": "<Product main material>"
}
```

Product Master Data Record

```
{
        "MasterData": {
                "@context": "http://schema.org",
                "ProductData": {
                        "@type": [
                                "Product",
                                "IndividualProduct"
                        ],
                        "@id": "<See file Product.json>"
                },
                "LifeCycle": {
                        "Impact Assessment Methods": {
                                "TODO": "@NTU This requires your input."
                        },
                        "Resources": {
                                "@context": "http://schema.org",
                                "HSkey": {
                                        "value": 847130,
                                        "description": "Product Harmonized System 6
digit code (e.g. for laptops the code is 847130) as described in
http://www.wcoomd.org/en/topics/nomenclature/overview/what-is-the-harmonized-
system.aspx."
                                },
                                "UNUkey": {
                                        "value": 303,
                                        "description": "Product UNU-KEY code (e.g.
for laptops the code is 0303) as described in https://unu.edu/projects/e-waste-
quantification.html#outputs"
                                },
                                "Recyclability": {
                                        "Lifetime": {
                                                "years": {
                                                        "@type": "QuantitativeValue",
                                                        "name": "Years",
                                                        "description": "Years of
product usage.",
                                                        "value": 2,
                                                        "unitCode": "C62",
                                                        "unitText": "No unit"
                                                },
                                                "months": {
                                                        "@type": "QuantitativeValue",
                                                        "name": "Months",
                                                        "description": "Additional
months of product usage.",
                                                        "value": 7,
                                                        "unitCode": "C62",
                                                        "unitText": "No unit"
```

```
                                              }
                                      },
                                      "Parameters": {
                                              "WeightOfExergy": {
                                                      "@type": "QuantitativeValue",
                                                      "name": "Exergy factor",
                                                      "description":  "Weight  for
product materials exergy (A or D factor).",
                                                      "value": 0.00006224,
                                                      "unitCode": "C62",
                                                      "unitText": "No unit"
                                              },
                                              "WeightOfEoLState": {
                                                      "@type": "QuantitativeValue",
                                                      "name": "EoL factor",
                                                      "description":  "Weight  for
End of Life state factor (B factor).",
                                                      "value": 4.706,
                                                      "unitCode": "C62",
                                                      "unitText": "No unit"
                                              },
                                              "WeightOfLifetime": {
                                                      "@type": "QuantitativeValue",
                                                      "name": "Eco-points",
                                                      "description":  "Weight  for
Lifetime Factor, LCIA result (C factor).",
                                                      "value": 15.0,
                                                      "unitCode": "C62",
                                                      "unitText": "No unit"
                                              },
                                              "OrganicChemicalExergy": {
                                                      "@type": "QuantitativeValue",
                                                      "name": "Organic Urban Waste
Chemical Exergy",
                                                      "description": "The chemical
exergy is a physical measure of its calorific value.",
                                                      "value": 0.0,
                                                      "unitCode": "C62",
                                                      "unitText": "No unit"
                                              },
                                              "OrganicMass": {
                                                      "@type": "QuantitativeValue",
                                                      "name": "Organic Urban Waste
Mass",
                                                      "description": "Organic Urban
Waste Mass in grams.",
                                                      "value": 0.0,
                                                      "unitCode": "GRM",
                                                      "unitText": "g"
                                              }
                                      },
                                      "EoLState": {
                                              "__CustomEnum__": [
                                                      {
                                                              "name": "Working",
                                                              "value": 1.0
                                                      },
                                                      {
                                                              "name": "Re-usable",
                                                              "value": 0.5
                                                      },
                                                      {
```

```
                                                                "name": "Broken",
                                                                "value": 0.0
                                                        }
                                                ],
                                                "name": "End of Life state",
                                                "description":  "The  product's  state
at the time of End of Life.",
                                                "value": 1.0
                                        }
                                },
                                "Material List": [
                                        {
                                                "info": {
                                                        "@type": "Product",
                                                        "@id":       "<See       file
Product.json"
                                                },
                                                "factors": {
                                                        "mass": {
                                                                "@type":
"QuantitativeValue",
                                                                "name": "Mass",
                                                                "description":
"Material mass in grams.",
                                                                "value": 1.1,
                                                                "unitCode": "GRM",
                                                                "unitText": "g"
                                                        },
                                                        "rarity": {
                                                                "@type":
"QuantitativeValue",
                                                                "name": "Rarity",
                                                                "description":
"Material rarity factor (Energy density in kJ/g).",
                                                                "value": 1.2,
                                                                "unitCode": "NA",
                                                                "unitText": "kJ/g"
                                                        },
                                                        "recyclabilityfactor": {
                                                                "@type":
"QuantitativeValue",
                                                                "name":
"Recyclability",
                                                                "description":
"Material Recyclability factor (1.0 for working products).",
                                                                "value": 1.3,
                                                                "unitCode": "C62",
                                                                "unitText": "No unit"
                                                        }
                                                }
                                        },
                                        {
                                                "info": {
                                                        "@type": "Product",
                                                        "@id":       "<See       file
Product.json"
                                                },
                                                "factors": {
                                                        "mass": {
                                                                "@type":
"QuantitativeValue",
                                                                "name": "Mass",
                                                                "description":
"Material mass in grams.",
                                                                "value": 2.1,
                                                                "unitCode": "GRM",
                                                                "unitText": "g"
                                                        },
                                                        "rarity": {
                                                                "@type":
"QuantitativeValue",
                                                                "name": "Rarity",
                                                                "description":
"Material rarity factor (Energy density in kJ/g).",
                                                                "value": 2.2,
                                                                "unitCode": "NA",
                                                                "unitText": "kJ/g"
                                                        },
                                                        "recyclabilityfactor": {
                                                                "@type":
"QuantitativeValue",
                                                                "name":
"Recyclability",
                                                                "description":
"Material Recyclability factor (1.0 for working products).",
                                                                "value": 2.3,
                                                                "unitCode": "C62",
                                                                "unitText": "No unit"
                                                        }
                                                }
                                        }
                                ]
                        },
                        "Comments": "@ENV This is free text coming from the GUI form
widget"
                }
        },
        "EcoAccounting": {
                "@context": "http://schema.org",
                "EcoPoints": {
                        "@type": "QuantitativeValue",
                        "name": "Eco-Points",
                        "description": "The eco-point is a cumulative value
accounting for an aggregate of the ecological impacts throughout product life
cycle.",
                        "value": 0,
                        "minValue": 0,
                        "maxValue": 100
                },
                "EcoCredits": {
                        "@type": "QuantitativeValue",
                        "name": "Eco-Credits",
                        "description": "The eco-credits value aim to provide
incentive for an adequate disposal of the products after their end-of-life.",
                        "value": 24,
                        "minValue": 0,
                        "maxValue": 30
                }
        }
}
```

Appendix II, JSON-Schema

Brand

```
{
        "definitions": {
                "Brand": {
                        "$schema": "http://json-schema.org/draft-07/schema#",
                        "$id": "SchemaOrg_Brand",
                        "type": "object",
                        "title": "The Brand Schema",
                        "required": [
                                "@context",
                                "@type",
                                "@id",
                                "name",
                                "logo",
                                "slogan"
                        ],
                        "properties": {
                                "@context": {
                                        "$id": "#/properties/@context",
                                        "type": "string",
                                        "title": "The @context Schema",
                                        "default": "http://schema.org",
                                        "examples": [
                                                "http://schema.org"
                                        ],
                                        "pattern": "^(.*)$"
                                },
                                "@type": {
                                        "$id": "#/properties/@type",
                                        "type": "array",
                                        "title": "The @type Schema",
                                        "items": {
                                                "$id": "#/properties/@type/items",
                                                "type": "string",
                                                "title": "The Items Schema",
                                                "default": "Brand",
                                                "examples": [
                                                        "Brand",
                                                        "Organization"
                                                ],
                                                "pattern": "^(.*)$"
                                        }
                                },
                                "@id": {
                                        "$id": "#/properties/@id",
                                        "type": "string",
                                        "title": "The @id Schema",
                                        "default": "",
                                        "examples": [
                                                "<IRI of owner of this product,
ideally in JSON-LD same as http://schema.org/Brand or
http://schema.org/Organization.>"
                                        ],
                                        "pattern": "^(.*)$"
                                },
                                "name": {
                                        "$id": "#/properties/name",
                                        "type": "string",
                                        "title": "The Name Schema",
                                        "default": "",
                                        "examples": [
                                                "<Brand name>"
                                        ],
                                        "pattern": "^(.*)$"
                                },
                                "logo": {
                                        "$id": "#/properties/logo",
                                        "type": "string",
                                        "title": "The Logo Schema",
                                        "default": "",
                                        "examples": [
                                                "<An associated logo, URL or
https://schema.org/ImageObject>"
                                        ],
                                        "pattern": "^(.*)$"
                                },
                                "slogan": {
                                        "$id": "#/properties/slogan",
                                        "type": "string",
                                        "title": "The Slogan Schema",
                                        "default": "",
                                        "examples": [
                                                "<A slogan or motto associated with
the item.>"
                                        ],
                                        "pattern": "^(.*)$"
                                }
                        }
                }
        }
}
```

Eco Account

```
{
        "definitions": {
                "EcoAccountRecord": {
                        "$schema": "http://json-schema.org/draft-07/schema#",
                        "$id": "http://example.com/root.json",
                        "type": "object",
                        "title": "The Eco-account record Schema",
                        "required": [
                                "@context",
                                "EcoAccount",
                                "EcoBalance"
                        ],
                        "properties": {
                                "@context": {
                                        "$id": "#/properties/@context",
                                        "type": "string",
                                        "title": "The @context Schema",
                                        "default": "http://schema.org",
                                        "examples": [
                                                "http://schema.org"
                                        ],
                                        "pattern": "^(.*)$"
                                },
                                "EcoAccount": {
                                        "$id": "#/properties/EcoAccount",
                                        "type": "object",
                                        "title": "The Ecoaccount Schema",
                                        "required": [
                                                "@type",
                                                "identifier",
                                                "url",
                                                "name",
                                                "familyName",
                                                "givenName",
                                                "address",
                                                "affiliation",
                                                "gender",
                                                "telephone",
                                                "email",
                                                "birthDate",
                                                "image"
                                        ],
                                        "properties": {
                                                "@type": {
                                                        "$id":
"#/properties/EcoAccount/properties/@type",
                                                        "type": "string",
                                                        "title": "The @type Schema",
                                                        "default": "Person",
                                                        "examples": [
                                                                "Person"
                                                        ],
                                                        "pattern": "^(.*)$"
                                                },
                                                "identifier": {
                                                        "$id":
"#/properties/EcoAccount/properties/identifier",
                                                        "type": "string",
                                                        "title":   "The   Identifier
Schema",
                                                        "default": "",
                                                        "examples": [
                                                                "<Unique  Indentifier
Here>"
                                                        ],
                                                        "pattern": "^(.*)$"
                                                },
                                                "url": {
                                                        "$id":
"#/properties/EcoAccount/properties/url",
                                                        "type": "string",
                                                        "title": "The Url Schema",
                                                        "default": "",
                                                        "examples": [
                                                                "<Public  or  Private
URL of web page that displays this account>"
                                                        ],
                                                        "pattern": "^(.*)$"
                                                },
                                                "name": {
                                                        "$id":
"#/properties/EcoAccount/properties/name",
                                                        "type": "string",
                                                        "title": "The Name Schema",
                                                        "default": "",
                                                        "examples": [
                                                                "<Full name>"
                                                        ],
                                                        "pattern": "^(.*)$"
                                                },
                                                "familyName": {
                                                        "$id":
"#/properties/EcoAccount/properties/familyName",
                                                        "type": "string",
                                                        "title":   "The   Familyname
Schema",
                                                        "default": "",
                                                        "examples": [
                                                                "<Last name>"
                                                        ],
                                                        "pattern": "^(.*)$"
                                                },
                                                "givenName": {
                                                        "$id":
"#/properties/EcoAccount/properties/givenName",
                                                        "type": "string",
                                                        "title":    "The    Givenname
Schema",
                                                        "default": "",
                                                        "examples": [
                                                                "<First name>"
                                                        ],
                                                        "pattern": "^(.*)$"
                                                },
                                                "address": {
                                                        "$id":
"#/properties/EcoAccount/properties/address",
                                                        "type": "object",
                                                        "title":     "The     Address
Schema",
                                                        "required": [
                                                                "@type",
                                                                "addressCountry",
                                                                "addressRegion",
                                                                "addressLocality",
                                                                "postalCode",
                                                                "streetAddress"
                                                        ],
                                                        "properties": {
                                                                "@type": {
                                                                        "$id":
"#/properties/EcoAccount/properties/address/properties/@type",
                                                                        "type":
"string",
                                                                        "title":  "The
@type Schema",
                                                                        "default":
"PostalAddress",
                                                                        "examples": [

        "PostalAddress"
                                                                        ],
                                                                        "pattern":
"^(.*)$"
                                                                },
                                                                "addressCountry": {
                                                                        "$id":
"#/properties/EcoAccount/properties/address/properties/addressCountry",
                                                                        "type":
"string",
                                                                        "title":  "The
Addresscountry Schema",
                                                                      "default":
"",
                                                                      "examples": [
                                                                              "<2-
letter country code, e.g. GR>"
                                                                      ],
                                                                      "pattern":
"^(.*)$"
                                                              },
                                                              "addressRegion": {
                                                                      "$id":
"#/properties/EcoAccount/properties/address/properties/addressRegion",
                                                                      "type":
"string",
                                                                      "title":  "The
Addressregion Schema",
                                                                      "default":
"",
                                                                      "examples": [

        "<Address region, e.g. Attica>"
                                                                      ],
                                                                      "pattern":
"^(.*)$"
                                                              },
                                                              "addressLocality": {
                                                                      "$id":
"#/properties/EcoAccount/properties/address/properties/addressLocality",
                                                                      "type":
"string",
                                                                      "title":  "The
Addresslocality Schema",
                                                                      "default":
"",
                                                                      "examples": [

        "<City name, e.g. Athens>"
                                                                      ],
                                                                      "pattern":
"^(.*)$"
                                                              },
                                                              "postalCode": {
                                                                      "$id":
"#/properties/EcoAccount/properties/address/properties/postalCode",
                                                                      "type":
"string",
                                                                      "title":  "The
Postalcode Schema",
                                                                      "default":
"",
                                                                      "examples": [

        "<Postal code number>"
                                                                      ],
                                                                      "pattern":
"^(.*)$"
                                                              },
                                                              "streetAddress": {
                                                                      "$id":
"#/properties/EcoAccount/properties/address/properties/streetAddress",
                                                                      "type":
"string",
                                                                        "title":  "The
Streetaddress Schema",
                                                                        "default":
"",
                                                                        "examples": [

        "<Full street address, name, number, town>"
                                                                        ],
                                                                        "pattern":
"^(.*)$"
                                                                }
                                                        }
                                                },
                                                "affiliation": {
                                                        "$id":
"#/properties/EcoAccount/properties/affiliation",
                                                        "type": "object",
                                                        "title":   "The   Affiliation
Schema",
                                                        "required": [
                                                                "@type",
                                                                "name",
                                                                "url"
                                                        ],
                                                        "properties": {
                                                                "@type": {
                                                                        "$id":
"#/properties/EcoAccount/properties/affiliation/properties/@type",
                                                                        "type":
"string",
                                                                        "title":  "The
@type Schema",
                                                                        "default":
"Organization",
                                                                        "examples": [

        "Organization"
                                                                        ],
                                                                        "pattern":
"^(.*)$"
                                                                },
                                                                "name": {
                                                                        "$id":
"#/properties/EcoAccount/properties/affiliation/properties/name",
                                                                        "type":
"string",
                                                                        "title":  "The
Name Schema",
                                                                        "default":
"",
                                                                        "examples": [

        "<Affiliated organization name>"
                                                                        ],
                                                                        "pattern":
"^(.*)$"
                                                                },
                                                                "url": {
                                                                        "$id":
"#/properties/EcoAccount/properties/affiliation/properties/url",
                                                                        "type":
"string",
                                                                     "title":  "The
Url Schema",
                                                                     "default":
"",
                                                                     "examples": [

        "<Affiliated organization Website address>"
                                                                     ],
                                                                     "pattern":
"^(.*)$"
                                                             }
                                                     }
                                             },
                                             "gender": {
                                                     "$id":
"#/properties/EcoAccount/properties/gender",
                                                     "type": "string",
                                                     "title": "The Gender Schema",
                                                     "default": "",
                                                     "examples": [
                                                             "<Sex         gender,
https://schema.org/Male>"
                                                     ],
                                                     "pattern": "^(.*)$"
                                             },
                                             "telephone": {
                                                     "$id":
"#/properties/EcoAccount/properties/telephone",
                                                     "type": "string",
                                                     "title":    "The    Telephone
Schema",
                                                     "default": "",
                                                     "examples": [
                                                             "<Telephone number>"
                                                     ],
                                                     "pattern": "^(.*)$"
                                             },
                                             "email": {
                                                     "$id":
"#/properties/EcoAccount/properties/email",
                                                     "type": "string",
                                                     "title": "The Email Schema",
                                                     "default": "",
                                                     "examples": [
                                                             "user@example.com"
                                                     ],
                                                     "pattern": "^(.*)$"
                                             },
                                             "birthDate": {
                                                     "$id":
"#/properties/EcoAccount/properties/birthDate",
                                                     "type": "string",
                                                     "title":    "The    Birthdate
Schema",
                                                     "default": "",
                                                     "examples": [
                                                             "1985-01-14"
                                                     ],
                                                     "pattern": "^(.*)$"
                                             },
                                             "image": {
```

```
                                                        "$id":
"#/properties/EcoAccount/properties/image",
                                                        "type": "string",
                                                        "title": "The Image Schema",
                                                        "default": "",
                                                        "examples": [

        "https://example.com/user.png"
                                                        ],
                                                        "pattern": "^(.*)$"
                                                }
                                        }
                                },
                                "EcoBalance": {
                                        "$id": "#/properties/EcoBalance",
                                        "type": "object",
                                        "title": "The Ecobalance Schema",
                                        "required": [
                                                "RecycleBinUserID",
                                                "EcoCredit",
                                                "EcoDebit",
                                                "Purchased",
                                                "Recycled"
                                        ],
                                        "properties": {
                                                "RecycleBinUserID": {
                                                        "$id":
"#/properties/EcoBalance/properties/RecycleBinUserID",
                                                        "type": "integer",
                                                        "title":                  "The
RecycleBinUserID Schema",
                                                        "default": 0,
                                                        "minimum": 0,
                                                        "maximum": 99999999999,
                                                        "examples": [
                                                                16004000001
                                                        ]
                                                },
                                                "EcoCredit": {
                                                        "$id":
"#/properties/EcoBalance/properties/EcoCredit",
                                                        "type": "object",
                                                        "title":    "The    Ecocredit
Schema",
                                                        "required": [
                                                                "@type",
                                                                "value",
                                                                "unitCode",
                                                                "maxValue",
                                                                "minValue"
                                                        ],
                                                        "properties": {
                                                                "@type": {
                                                                        "$id":
"#/properties/EcoBalance/properties/EcoCredit/properties/@type",
                                                                        "type":
"string",
                                                                        "title":  "The
@type Schema",
                                                                        "default":
"QuantitativeValue",
                                                                        "examples": [
        "QuantitativeValue"
                                                                        ],
                                                                        "pattern":
"^(.*)$"
                                                                },
                                                                "value": {
                                                                        "$id":
"#/properties/EcoBalance/properties/EcoCredit/properties/value",
                                                                        "type":
"integer",
                                                                        "title":  "The
Value Schema",
                                                                        "default": 0,
                                                                        "examples": [
                                                                                5
                                                                        ]
                                                                },
                                                                "unitCode": {
                                                                        "$id":
"#/properties/EcoBalance/properties/EcoCredit/properties/unitCode",
                                                                        "type":
"string",
                                                                        "title":  "The
Unitcode Schema",
                                                                        "default":
"",
                                                                        "examples": [

        "<Unit of measurement if applies>"
                                                                        ],
                                                                        "pattern":
"^(.*)$"
                                                                },
                                                                "maxValue": {
                                                                        "$id":
"#/properties/EcoBalance/properties/EcoCredit/properties/maxValue",
                                                                        "type":
"integer",
                                                                        "title":  "The
Maxvalue Schema",
                                                                        "default": 0,
                                                                        "examples": [

        1000000
                                                                        ]
                                                                },
                                                                "minValue": {
                                                                        "$id":
"#/properties/EcoBalance/properties/EcoCredit/properties/minValue",
                                                                        "type":
"integer",
                                                                        "title":  "The
Minvalue Schema",
                                                                        "default": 0,
                                                                        "examples": [
                                                                                0
                                                                        ]
                                                                }
                                                        }
                                                },
                                                "EcoDebit": {
                                                      "$id":
"#/properties/EcoBalance/properties/EcoDebit",
                                                      "type": "object",
                                                      "title":    "The    Ecodebit
Schema",
                                                      "required": [
                                                              "@type",
                                                              "value",
                                                              "unitCode",
                                                              "maxValue",
                                                              "minValue"
                                                      ],
                                                      "properties": {
                                                              "@type": {
                                                                      "$id":
"#/properties/EcoBalance/properties/EcoDebit/properties/@type",
                                                                      "type":
"string",
                                                                      "title":  "The
@type Schema",
                                                                      "default":
"QuantitativeValue",
                                                                      "examples": [

        "QuantitativeValue"
                                                                      ],
                                                                      "pattern":
"^(.*)$"
                                                              },
                                                              "value": {
                                                                      "$id":
"#/properties/EcoBalance/properties/EcoDebit/properties/value",
                                                                      "type":
"integer",
                                                                      "title":  "The
Value Schema",
                                                                      "default": 0,
                                                                      "examples": [
                                                                              10
                                                                      ]
                                                              },
                                                              "unitCode": {
                                                                      "$id":
"#/properties/EcoBalance/properties/EcoDebit/properties/unitCode",
                                                                      "type":
"string",
                                                                      "title":  "The
Unitcode Schema",
                                                                      "default":
"",
                                                                      "examples": [

        "<Unit of measurement if applies>"
                                                                      ],
                                                                      "pattern":
"^(.*)$"
                                                              },
                                                              "maxValue": {
                                                                      "$id":
"#/properties/EcoBalance/properties/EcoDebit/properties/maxValue",
                                                                      "type":
"integer",
                                                                     "title":  "The
Maxvalue Schema",
                                                                     "default": 0,
                                                                     "examples": [

        1000000
                                                                     ]
                                                              },
                                                              "minValue": {
                                                                     "$id":
"#/properties/EcoBalance/properties/EcoDebit/properties/minValue",
                                                                     "type":
"integer",
                                                                     "title":  "The
Minvalue Schema",
                                                                     "default": 0,
                                                                     "examples": [
                                                                             0
                                                                     ]
                                                              }
                                                      }
                                              },
                                              "Purchased": {
                                                      "$id":
"#/properties/EcoBalance/properties/Purchased",
                                                      "type": "object",
                                                      "title":    "The    Purchased
Schema",
                                                      "required": [
                                                              "@type",
                                                              "itemListOrder",
                                                              "itemListElement"
                                                      ],
                                                      "properties": {
                                                              "@type": {
                                                                     "$id":
"#/properties/EcoBalance/properties/Purchased/properties/@type",
                                                                     "type":
"string",
                                                                     "title":  "The
@type Schema",
                                                                     "default":
"ItemList",
                                                                     "examples": [

        "ItemList"
                                                                     ],
                                                                     "pattern":
"^(.*)$"
                                                              },
                                                              "itemListOrder": {
                                                                     "$id":
"#/properties/EcoBalance/properties/Purchased/properties/itemListOrder",
                                                                     "type":
"string",
                                                                     "title":  "The
Itemlistorder Schema",
                                                                     "default":
"",
                                                                     "examples": [

        "https://schema.org/ItemListUnordered"
```

```
                                                                        ],
                                                                        "pattern":
"^(.*)$"
                                                                },
                                                                "itemListElement": {
                                                                        "$id":
"#/properties/EcoBalance/properties/Purchased/properties/itemListElement",
                                                                        "type":
"array",
                                                                        "title":  "The
Itemlistelement Schema",
                                                                        "items": {

        "$ref": "IndividualProduct.schema.json#/definitions/IndividualProduct"
                                                                        }
                                                                }
                                                        }
                                                },
                                                "Recycled": {
                                                        "$id":
"#/properties/EcoBalance/properties/Recycled",
                                                        "type": "object",
                                                        "title":    "The    Recycled
Schema",
                                                        "required": [
                                                                "@type",
                                                                "itemListOrder",
                                                                "itemListElement"
                                                        ],
                                                        "properties": {
                                                                "@type": {
                                                                        "$id":
"#/properties/EcoBalance/properties/Recycled/properties/@type",
                                                                        "type":
"string",
                                                                        "title":  "The
@type Schema",
                                                                        "default":
"ItemList",
                                                                        "examples": [

        "ItemList"
                                                                        ],
                                                                        "pattern":
"^(.*)$"
                                                                },
                                                                "itemListOrder": {
                                                                        "$id":
"#/properties/EcoBalance/properties/Recycled/properties/itemListOrder",
                                                                        "type":
"string",
                                                                        "title":  "The
Itemlistorder Schema",
                                                                        "default":
"",
                                                                        "examples": [

        "https://schema.org/ItemListUnordered"
                                                                        ],
                                                                        "pattern":
"^(.*)$"
                                                                },
                                                                "itemListElement": {
                                                                        "$id":
"#/properties/EcoBalance/properties/Recycled/properties/itemListElement",
                                                                        "type":
"array",
                                                                        "title":  "The
Itemlistelement Schema",
                                                                        "items": {

        "$ref": "IndividualProduct.schema.json#/definitions/IndividualProduct"
                                                                        }
                                                                }
                                                        }
                                                }
                                        }
                                }
                        }
                }
        },
        "$ref": "#definitions/EcoAccountRecord"
}
```

Individual Product

```
{
        "definitions": {
                "IndividualProduct": {
                        "$schema": "http://json-schema.org/draft-07/schema#",
                        "$id": "SchemaOrg_IndividualProduct",
                        "type": "object",
                        "extends": {
                                "$ref": "Product.schema.json#/definitions/Product"
                        },
                        "title": "The IndividualProduct Schema",
                        "required": [
                                "serialNumber",
                                "purchaseDate"
                        ],
                        "properties": {
                                "serialNumber": {
                                        "$id": "#/properties/serialNumber",
                                        "type": "string",
                                        "title": "The Serialnumber Schema",
                                        "default": "",
                                        "examples": [
                                                "<The  product  identifier,  such  as
ISBN>"
                                        ],
                                        "pattern": "^(.*)$"
                                },
                                "purchaseDate": {
                                        "$id": "#/properties/purchaseDate",
                                        "type": "string",
                                        "title": "The Purchasedate Schema",
                                        "default": "",
                                        "examples": [
                                                "<Date of purchase, e.g. Tue Jul 09
00:00:00 EEST 2019>"
                                        ],
                                        "pattern": "^(.*)$"
                                }
                        }
                }
        }
}
```

Product

```
{
        "definitions": {
                "Product": {
                        "$schema": "http://json-schema.org/draft-07/schema#",
                        "$id": "SchemaOrg_Product",
                        "type": "object",
                        "title": "The Product Schema",
                        "required": [
                                "@context",
                                "@type",
                                "@id",
                                "gtin14",
                                "productID",
                                "name",
                                "brand",
                                "description",
                                "image",
                                "audience",
                                "manufacturer",
                                "category",
                                "material"
                        ],
                        "properties": {
                                "@context": {
                                        "$id": "#/properties/@context",
                                        "type": "string",
                                        "title": "The @context Schema",
                                        "default": "http://schema.org",
                                        "examples": [
                                                "http://schema.org"
                                        ],
                                        "pattern": "^(.*)$"
                                },
                                "@type": {
                                        "$id": "#/properties/@type",
                                        "type": "string",
                                        "title": "The @type Schema",
                                        "default": "Product",
                                        "examples": [
                                                "Product"
                                        ],
                                        "pattern": "^(.*)$"
                                },
                                "@id": {
                                        "$id": "#/properties/@id",
                                        "type": "string",
                                        "title": "The @id Schema",
                                        "default": "",
                                        "examples": [
                                                "<IRI of product>"
                                        ],
                                        "pattern": "^(.*)$"
                                },
                                "gtin14": {
                                        "$id": "#/properties/gtin14",
                                        "type": "string",
                                        "title": "The Gtin14 Schema",
                                        "default": "",
                                        "examples": [
                                                "<The GTIN-14 code of the product>"
                                        ],
                                        "pattern": "^(.*)$"
                                },
                                "productID": {
                                        "$id": "#/properties/productID",
                                        "type": "string",
                                        "title": "The Productid Schema",
                                        "default": "",
                                        "examples": [
                                                "<Unique Identification String for
                        this product model>"
                                        ],
                                        "pattern": "^(.*)$"
                                },
                                "name": {
                                        "$id": "#/properties/name",
                                        "type": "string",
                                        "title": "The Name Schema",
                                        "default": "",
                                        "examples": [
                                                "<Name of the product>"
                                        ],
                                        "pattern": "^(.*)$"
                                },
                                "brand": {
                                        "$ref":
                        "Brand.schema.json#/definitions/Brand"
                                },
                                "description": {
                                        "$id": "#/properties/description",
                                        "type": "string",
                                        "title": "The Description Schema",
                                        "default": "",
                                        "examples": [
                                                "<Label description>"
                                        ],
                                        "pattern": "^(.*)$"
                                },
                                "image": {
                                        "$id": "#/properties/image",
                                        "type": "string",
                                        "title": "The Image Schema",
                                        "default": "",
                                        "examples": [
                                                "<images/product-example.png>"
                                        ],
                                        "pattern": "^(.*)$"
                                },
                                "audience": {
                                        "$id": "#/properties/audience",
                                        "type": "object",
                                        "title": "The Audience Schema",
                                        "required": [
                                                "@type",
                                                "@id",
                                                "name"
                                        ],
                                        "properties": {
                                                "@type": {
```

```
                                                        "$id":
"#/properties/audience/properties/@type",
                                                        "type": "string",
                                                        "title": "The @type Schema",
                                                        "default": "Audience",
                                                        "examples": [
                                                                "Audience"
                                                        ],
                                                        "pattern": "^(.*)$"
                                                },
                                                "@id": {
                                                        "$id":
"#/properties/audience/properties/@id",
                                                        "type": "string",
                                                        "title": "The @id Schema",
                                                        "default": "",
                                                        "examples": [
                                                                "<IRI of audience>"
                                                        ],
                                                        "pattern": "^(.*)$"
                                                },
                                                "name": {
                                                        "$id":
"#/properties/audience/properties/name",
                                                        "type": "string",
                                                        "title": "The Name Schema",
                                                        "default": "",
                                                        "examples": [
                                                                "<Target market>"
                                                        ],
                                                        "pattern": "^(.*)$"
                                                }
                                        }
                                },
                                "manufacturer": {
                                        "$ref":
"Manufacturer.schema.json#/definitions/Manufacturer"
                                },
                                "category": {
                                        "$id": "#/properties/category",
                                        "type": "string",
                                        "title": "The Category Schema",
                                        "default": "",
                                        "examples": [
                                                "<Product
categorization/classification>"
                                        ],
                                        "pattern": "^(.*)$"
                                },
                                "material": {
                                        "$id": "#/properties/material",
                                        "type": "string",
                                        "title": "The Material Schema",
                                        "default": "",
                                        "examples": [
                                                "<Product main material>"
                                        ],
                                        "pattern": "^(.*)$"
                                }
                        }
                }
        }
```

```
}
```

Product Master Data Record

Due to the big size of this record it is not provided in this document but is available upon request and will be also available in the deliverable 4.4.

Appendix III, JSON generated from the data entry tool

Service call:
http://envirodata.se:5012/api/C4L_DB/c4l_services/ProductAllEntries?pgtin=01030211050490982100032

```
# Create connection and session to the interoperability database
Do $clib.$objects.doDBStandardOps.$newref() Returns lrefDBStdOps
Do lrefDBStdOps.$GetSession('C4L_DB_RO') Returns loSession
Do loSession.$newstatement() Returns loStatement

# First get the ID for the record... Add the language parameter later and insert it into the search terms.
Begin text block
Text:SELECT id FROM generic_mini WHERE element_name = 'product_masterdata_entry' AND element_index_type = 'GTIN' AND element_index_value = '[pgtin]';
End text block
Get text block lchSQL

Do loStatement.$execdirect(lchSQL)
Do loStatement.$fetchinto(lnID)

# Get the product base data and enter it into the result list...
Begin text block
Text:SELECT value_json from generic_mini
Text:WHERE system_type = 'Product_Master_Data' AND
Text:id = [lnID];
End text block
Get text block lchSQL

Do loStatement.$execdirect(lchSQL)
Do loStatement.$fetch(llTempList,99999,kTrue)

Do lrwProduct_All_Entries.Product_Base_Data.$merge(llTempList) Returns lbStatus

Do llTempList.$clear()

# Get the parameter data not LCA base data
Begin text block
Text:SELECT value_json from generic_mini
Text:WHERE system_type = 'LCA / ecoPoint / ecoCredit' AND
Text:function_code <> 'rfSimple_LCA_Item_Entry' AND linking_index_value = [lnID];
End text block
Get text block lchSQL

Do loStatement.$execdirect(lchSQL)
Do loStatement.$fetch(llTempList,999999,kTrue)

Do lrwProduct_All_Entries.Product_Parameters.$merge(llTempList)

Do llTempList.$clear()

# Get the base data for LCA calculation
Begin text block
Text:SELECT value_json from generic_mini
Text:WHERE system_type = 'LCA / ecoPoint / ecoCredit' AND
Text:function_code = 'rfSimple_LCA_Item_Entry' AND linking_index_value = [lnID];
```

```
End text block
Get text block lchSQL

Do loStatement.$execdirect(lchSQL)
Do loStatement.$fetch(llTempList,999999,kTrue)

Do lrwProduct_All_Entries.Product_LCA_Data_Entries.$merge(llTempList)

Do llTempList.$clear()

# Get entries for EPCIS connectors
Begin text block
Text:SELECT value_json from generic_mini
Text:WHERE
Text:function_code = 'rfEPCIS_Access' AND linking_index_value = [lnID];
End text block
Get text block lchSQL

Do loStatement.$execdirect(lchSQL)
Do loStatement.$fetch(llTempList,999999,kTrue)

Do lrwProduct_All_Entries.Product_EPCIS_Entries.$merge(llTempList)

Do llTempList.$clear()

# Get entries for support resources
Begin text block
Text:SELECT value_json from generic_mini
Text:WHERE
Text:function_code <>'rfProd_Base' AND function_code <>'rfEPCIS_Access' AND function_code <>'rfSimple_LCA_Item_Entry'
Text:AND function_code <>'rfEcoPoints_EcoCredits' AND function_code <>'rfEEE_Category' AND function_code <>'rfLifetime_Estimate'
Text:AND linking_index_value = [lnID];
End text block
Get text block lchSQL

Do loStatement.$execdirect(lchSQL)
Do loStatement.$fetch(llTempList,999999,kTrue)

Do lrwProduct_All_Entries.Product_Support_Resources.$merge(llTempList)

# Create the JSON text and parse away control chars...
Do OJSON.$listorrowtojson(lrwProduct_All_Entries,kUniTypeCharacter) Returns lbinJSON
Do OJSON.$formatjson(lbinJSON) Returns lchJSONFormatted

Do method $RemoveControlCharacters (lchJSONFormatted) Returns lchJSONFormatted

Do $cinst.$sethttpstatus(200,'OK')
Do $cinst.$addhttpresponseheader('content-type','application/json')


# Deliver the result in the form of a JSON object.
Quit method lchJSONFormatted
```

Resulting JSON object from the service specified above.

```
{
  "Product_Base_Data": [
    {
      "element_type": "product_masterdata_entry",
      "gtin": "01030211050490982100032",
      "gtin14": "1",
      "brand": "",
      "label_description": "LED Lamp",
      "image": null,
      "target_market": "",
      "company_name": "Kosnic",
      "classification": "",
      "unique_identifier": "",
      "language_code": ""
    }
  ],
  "Product_Parameters": [
    {
      "element_type": "ecoPoint_entry",
      "ecoPointValue": 120.0,
      "ecoPointFunctionalUnit": "1 Luminaire",
      "ecoPointComments": "120 points is the eco-point value for 40,000 hours service time, which is a optimistic scenario. A range of different working hours are also considered, the associated eco-point values are below. You can define a small dynamic display table showing the changes of eco-point value by changing the working hours. ",
      "ecoPointScenarios": [

      ],
      "language_code": ""
    }
  ],
  "Product_LCA_Data_Entries": [
    {
      "element_type": "simple_lca__individual_entry",
      "stage": "1-Materials",
      "process": "Housing",
      "resource": "Aluminium",
      "unit_type": "kg",
      "quantity": 1.0,
      "individual_value": 1.1,
      "total_value": 1.1,
      "description": "Alloys:Aluminium alloy, AlLi {RoW} | production | Alloc Def, U",
      "language_code": ""
    },
    {
      "element_type": "simple_lca__individual_entry",
      "stage": "1-Materials",
      "process": "Housing",
      "resource": "Steel",
      "unit_type": "kg",
      "quantity": 1.0,
      "individual_value": 2.199,
      "total_value": 2.199,
      "description": "Ferro:Steel, low-alloyed, hot rolled {RoW} | production | Alloc Def, U",
      "language_code": ""
    },
    {
      "element_type": "simple_lca__individual_entry",
      "stage": "1-Materials",
      "process": "Housing",
      "resource": "Plastic",
    "unit_type": "kg",
    "quantity": 1.0,
    "individual_value": 0.29,
    "total_value": 0.29,
    "description": "Thermoplasts: Polyethylene, high density, granulate {RoW}｜ production ｜ Alloc Def, U",
    "language_code": ""
  },
  {
    "element_type": "simple_lca__individual_entry",
    "stage": "1-Materials",
    "process": "LED driver (pre-product)",
    "resource": "Plastic",
    "unit_type": "kg",
    "quantity": 1.0,
    "individual_value": 0.252,
    "total_value": 0.252,
    "description": "Thermoplasts:Polyethylene, high density, granulate {RoW}｜ production ｜ Alloc Def, U",
    "language_code": ""
  },
  {
    "element_type": "simple_lca__individual_entry",
    "stage": "1-Materials",
    "process": "LED driver (pre-product)",
    "resource": "printed circuit board",
    "unit_type": "kg",
    "quantity": 1.0,
    "individual_value": 0.688,
    "total_value": 0.688,
    "description": "Printed wiring board:Printed wiring board, surface mounted, unspecified, Pb containing {GLO}｜ production ｜ Alloc Def, U",
    "language_code": ""
  },
  {
    "element_type": "simple_lca__individual_entry",
    "stage": "1-Materials",
    "process": "LED lighting board",
    "resource": "LED",
    "unit_type": "kg",
    "quantity": 1.0,
    "individual_value": 0.32,
    "total_value": 0.32,
    "description": "Component:Light emitting diode {GLO}｜ production ｜ Alloc Def, U",
    "language_code": ""
  },
  {
    "element_type": "simple_lca__individual_entry",
    "stage": "1-Materials",
    "process": "LED lighting board",
    "resource": "Aluminum",
    "unit_type": "kg",
    "quantity": 0.0,
    "individual_value": 0.012,
    "total_value": 0.0,
    "description": "Alloys:Aluminium alloy, metal matrix composite {RoW}｜ aluminium alloy production, Metallic Matrix Composite ｜ Alloc Def, U",
    "language_code": ""
  },
  {
    "element_type": "simple_lca__individual_entry",
    "stage": "1-Materials",
    "process": "Other plastic members",
    "resource": "Plastic",
    "unit_type": "kg",
      "quantity": 1.0,
      "individual_value": 0.027,
      "total_value": 0.027,
      "description": "Thermoplasts:Polyethylene, high density, granulate {RER} | production | Alloc Def, U",
      "language_code": ""
    },
    {
      "element_type": "simple_lca__individual_entry",
      "stage": "1-Materials",
      "process": "Fasten members",
      "resource": "Steel",
      "unit_type": "kg",
      "quantity": 1.0,
      "individual_value": 0.07838,
      "total_value": 0.07838,
      "description": "deep drawing, steel, 650 kN press, automode | deep drawing, steel, 650 kN press, automode | APOS, S - RoW",
      "language_code": ""
    },
    {
      "element_type": "simple_lca__individual_entry",
      "stage": "1-Materials",
      "process": "Fasten members",
      "resource": "Plastic",
      "unit_type": "kg",
      "quantity": 1.0,
      "individual_value": 0.0016,
      "total_value": 0.0016,
      "description": "extrusion, plastic pipes | extrusion, plastic pipes | APOS, S - RoW",
      "language_code": ""
    },
    {
      "element_type": "simple_lca__individual_entry",
      "stage": "3-Packaging",
      "process": "Board box",
      "resource": "Corrugated board box",
      "unit_type": "kg",
      "quantity": 1.0,
      "individual_value": 1.17,
      "total_value": 1.17,
      "description": "Corrugated board:Corrugated board box {RoW} | production | Alloc Def, U",
      "language_code": ""
    },
    {
      "element_type": "simple_lca__individual_entry",
      "stage": "2-Manufacturing",
      "process": "Energy input",
      "resource": "Electricity",
      "unit_type": "kw/h",
      "quantity": 1.0,
      "individual_value": 4000.0,
      "total_value": 4000.0,
      "description": "Photovoltaic:Electricity, low voltage {RoW} | electricity production, photovoltaic, 3kWp slanted-roof installation, multi-Si, panel, mounted | Alloc Def, U",
      "language_code": ""
    },
    {
      "element_type": "simple_lca__individual_entry",
      "stage": "3-Packaging",
      "process": "Thermoplastic film",
      "resource": "Plastic",
      "unit_type": "kg",
      "quantity": 1.0,
      "individual_value": 0.0003,
        "total_value": 0.0003,
        "description": "Thermoplasts:Packaging film, low density polyethylene {RoW} | production | Alloc Def, U",
        "language_code": ""
      },
      {
        "element_type": "simple_lca__individual_entry",
        "stage": "3-Packaging",
        "process": "Packaging paper",
        "resource": "Graphic paper",
        "unit_type": "kg",
        "quantity": 1.0,
        "individual_value": 0.0004,
        "total_value": 0.0004,
        "description": "Graphic paper:Printed paper, offset {RoW} | offset printing, per kg printed paper | Alloc Def, U",
        "language_code": ""
      },
      {
        "element_type": "simple_lca__individual_entry",
        "stage": "3-Packaging",
        "process": "Plastic form creation",
        "resource": "Plastic form",
        "unit_type": "kg",
        "quantity": 1.0,
        "individual_value": 0.066,
        "total_value": 0.066,
        "description": "polystyrene production, extruded, CO2 blown | Alloc Def, U",
        "language_code": ""
      },
      {
        "element_type": "simple_lca__individual_entry",
        "stage": "4-Transport",
        "process": "Shipping",
        "resource": "Shipping",
        "unit_type": "kg*km",
        "quantity": 1.0,
        "individual_value": 56451.96,
        "total_value": 56451.96,
        "description": "Water:Transport, freight, sea, transoceanic ship {GLO} | market for | Alloc Def, S",
        "language_code": ""
      },
      {
        "element_type": "simple_lca__individual_entry",
        "stage": "5-Use",
        "process": "Use phase",
        "resource": "Electricity",
        "unit_type": "kw/h",
        "quantity": 1.0,
        "individual_value": 4000.0,
        "total_value": 4000.0,
        "description": "Photovoltaic:Electricity, low voltage {RoW} | electricity production, photovoltaic, 3kWp slanted-roof installation, multi-Si, panel, mounted | Alloc Def, U",
        "language_code": ""
      },
      {
        "element_type": "simple_lca__individual_entry",
        "stage": "6-End of Life",
        "process": "Disposal",
        "resource": "Disposal - incineration",
        "unit_type": "kg",
        "quantity": 1.0,
        "individual_value": 7.1744,
        "total_value": 7.1744,
        "description": "Municipal solid waste {RoW} | treatment of, incineration | Alloc Def, U",
      "language_code": ""
    }
  ],
  "Product_LCA_Result_Aggregates": [

  ],
  "Product_LCA_Results_Indicators": [

  ],
  "Product_EPCIS_Entries": [

  ],
  "Product_Support_Resources": [
    {
      "element_type": "ecoPoint_entry",
      "ecoPointValue": 120.0,
      "ecoPointFunctionalUnit": "1 Luminaire",
      "ecoPointComments": "120 points is the eco-point value for 40,000 hours service time, which is a optimistic scenario. A range of different working hours are also considered, the associated eco-point values are below. You can define a small dynamic display table showing the changes of eco-point value by changing the working hours. ",
      "ecoPointScenarios": [

      ],
      "language_code": ""
    }
  ]
}
```