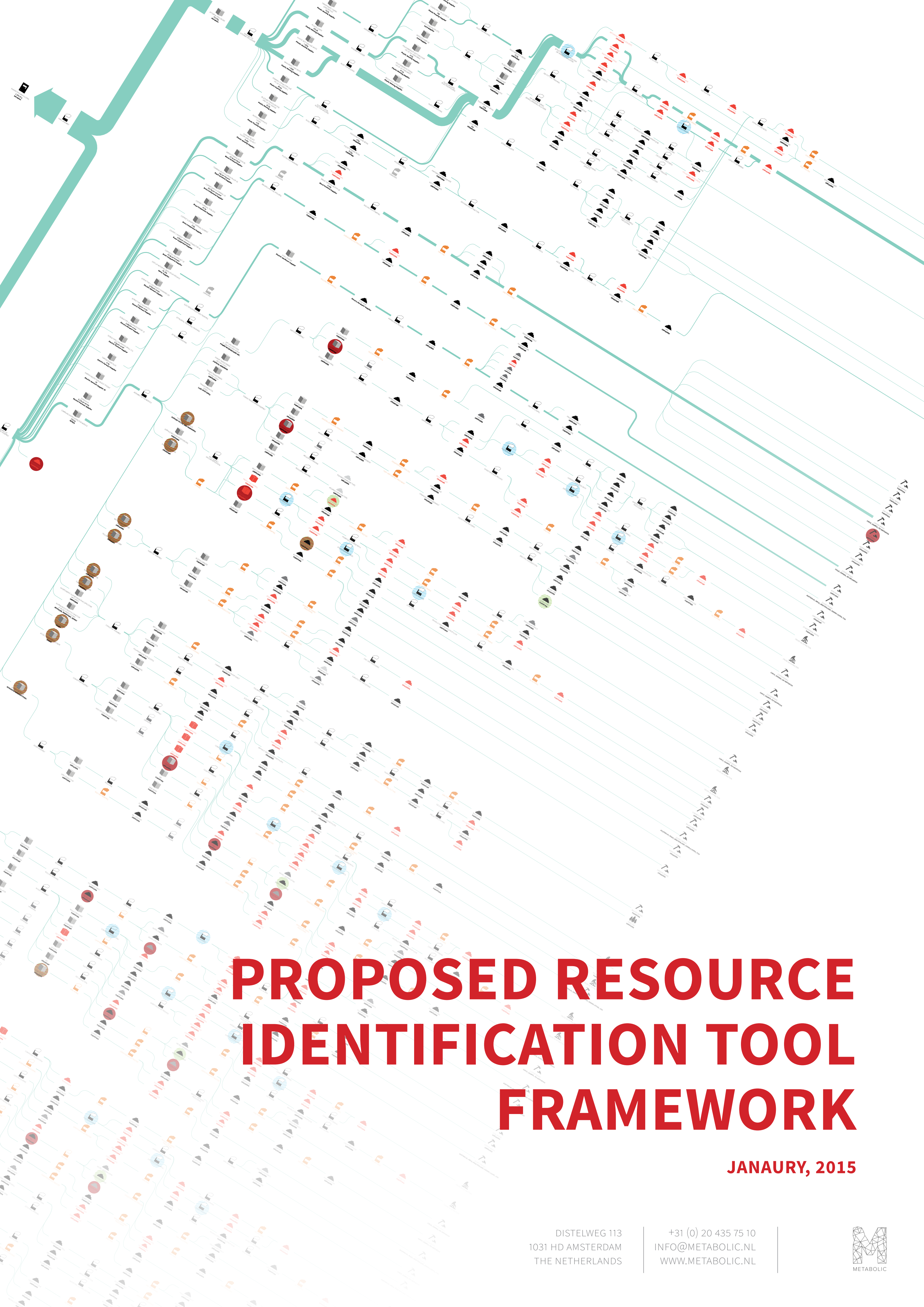


PROPOSED RESOURCE IDENTIFICATION TOOL FRAMEWORK

JANAURY, 2015

DISTELWEG 113
1031 HD AMSTERDAM
THE NETHERLANDS

+31 (0) 20 435 75 10
INFO@METABOLIC.NL
WWW.METABOLIC.NL

METABOLIC

CONTENTS

1. EXECUTIVE SUMMARY 3

2. INTRODUCTION 4
    2.1 PROJECT BACKGROUND 4
    2.2 WHAT IS THE RIT 5
    2.3 USING THE RIT FRAMEWORK 7

3. COMPREHENSIVE RIT FRAMEWORK 8
    3.1 PROPOSED ASSESSMENT AREAS 10
    3.2 INDICATORS 20
    3.3 DATA COLLECTION METHODS 37
    3.4 DATA COLLECTION REQUIREMENTS AND FEASIBILITY 39
    3.5 FINAL RECOMMENDATIONS FOR FAIRMETER PILOT DATA COLLECTION 44

4. FEASIBILITY ASSESSMENT OF RIT FORMAT 45
    4.1 SUPPLY CHAIN ANALYSIS OF DSRM4.0 45
    4.2 QUALITATIVE PERFORMANCE ASSESSMENT OF DSRM4.2 46
    4.3 SUPPLIER INTERVIEWS 47

5. IMPLEMENTATION PLAN FOR THE FAIRMETER RIT 49
    5.1 PRIORITIES AND QUICK WINS 50
    5.2 DEVELOPMENT STRATEGY 51

6. CONCLUSIONS AND FINAL RECOMMENDATIONS 54

1. EXECUTIVE SUMMARY

Businesses increasingly integrate sustainability objectives into their core operations, both as a matter of principle and of strategy. As the low hanging fruit of simple eco-efficiency measures has become exhausted, the rhetoric in the sustainability field has turned to more challenging, but also more rewarding, potential benefits. Two recent themes have emerged as central in this discourse: "fairness" and "circular economy."

Achieving either of these objectives requires increased supply chain data transparency. The idea of a Resource Identification Tool (RIT) for products has been suggested as a possible means of achieving increased insights on the design, materials sourcing, manufacture, use, and end of life handling of products. Both the objectives of Fairness and Circularity could potentially be assisted by such a tool.

As part of the Green Deal FairMeter, the Dutch Ministry of Infrastructure and the Environment has supported the development of a framework for a RIT, to be piloted in the procurement of the next generation of smart meters, with the goal of making them as "fair" as possible.

To help facilitate the data collection and assessment of "fairness," we have proposed an indicator and data framework for a RIT. This framework is a first draft of what a final RIT would likely contain. While the framework has been developed to specifically apply to smart meters (and has been evaluated using the DSRM4.2 smart meter), it is also intended to be general enough so that it could ultimately be applied to other product types. As a next step, further evaluation and refinement of the framework would need to first take place over the course of the development of the smart meter procurement phase.

In our evaluation of the feasibility of the framework, we have seen that collecting high value data from the supply chain will be quite difficult. The types of data that would be needed to provide insightful information about fairness and end of life management are not currently collected by suppliers, and are not present in reporting frameworks that are commonly used to evaluate suppliers in the chain.

The main types of data that would be the most valuable to determine the performance of the next generation FairMeter would include:

- Life cycle inventory (LCI) data for each component of the final product
- An extensive Bill of Materials (BOM) and mass breakdown
- Detailed end-of-life handling and processing instructions for material recovery
- Financial information on the value of individual components

In addition to the development of a procurement pilot to collect the necessary data, there are additional next steps that would need to be taken to further develop and implement a functioning RIT.

A number of administrative activities would need to be undertaken, which would help define the final form of the RIT framework. As immediate next steps, we would recommend the following:

- Conduct a peer review of the proposed framework
- Finalize the assessment areas of the framework for the FairMeter PrestatieLadder.
- Determine and apply a scoring framework to the final assessment areas within the updated PrestatieLadder
- Establish a working group that would oversee the technical implementation of the RIT

Alongside the design and refinement of the RIT framework, a technical implementation plan would need to be developed. The immediate next steps in this implementation plan would include the following:

- Decide on the method of data collection (tracking versus tracing approach) for the RIT
- Design data collection and data entry protocols and guidelines for suppliers
- Design a comprehensive software back-end for data collection, storage, and analysis

2. INTRODUCTION

The Kenncott's Bingham Canyon Mine is one of the largest copper mines in the world, producing approxiamtely 18,7 million tonnes annually.
Image (CC) arbyreed

This report describes an initial data framework for a Resource Identification Tool (RIT) whose function would be to dynamically track key information about products and their components throughout the product supply chain. In this report we have developed a generic data framework for the RIT, however the focus of the framework has been largely steered by the goals of the smart meter procurement process (a focus on the assessment areas of Fairness and Circular Economy). Other aspects of the framework that lie outside of the immediate goals have been developed at a sketch level, and would still require to be built out to a fuller extent. The current results of the RIT framework as a whole still require further development and refinement over the course of operating a pilot program.

2.1 PROJECT BACKGROUND

At the 2013 Innovatie Estafette, a Green Deal was signed between the government and several Dutch network providers focused around the development and roll out of a Fair Meter throughout the domestic and small business sectors in the Netherlands by 2020. A second goal of the Fair Meter Green Deal was to ensure that the development of the Smart Meter would also take into account such issues as material scarcity, conflict materials, transparency about resource use throughout the chain, and opportunities for material recovery and reuse at end of life, among others. This study has been completed as a first step towards achieving this second objective. In this work we have developed a data framework for a Resource Identification Tool (RIT), which will be applied to the new Fair Meter development as a case study and used for procurement efforts for the upcoming generation of smart meters, which will take place over the course of 2015 for network providers Alliander and Stedin. The framework of this Resource Identification Tool can then potentially be applied to other product value chains, with the ultimate goal of stimulating a transition to a more circular economy.

The development of a cross-sectoral Resource Identification and Tracking Tool (sometimes referred to as a "resource passport") has been on the EU-level political agenda since the publication of "A Resource Efficient Europe" by the EU Commission in 2011. This direction has been further supported by the European Resource Efficiency Platform (EREP), (1) which recently published recommendations for product- level materials tracking to facilitate recycling and the closing of loops (Final Recommendations, EREP 31-03-2014).

A recent report published by Royal Haskoning DHV (RH-DHV) evaluated the feasibility of developing such a product-based "resource label."(2) Though the study concluded that a universal, cross-sectoral "resource passport" system is not seen as desirable by the market, starting with per value chain pilots was deemed highly useful. The development of the Resource Identification Tool for the Fair Meter can be seen as one such value chain pilot.

Despite the conclusions drawn by RH-DHV, not all companies resist the idea of a cross-sectoral resource tracking tool, and many of the difficulties of developing such a tool are technically resolvable. The conclusions of the RH-DHV report may come from the fact that the functional definition of a Resource Identification Tool has remained very abstract. Without clear detailing of how the tool would actually function, it is difficult to imagine how such a tool could successfully resolve difficulties around data collection and IP, which are some of the main concerns that companies expressed.

2.2 WHAT IS THE RIT

WHAT IS THE RESOURCE IDENTIFICATION TOOL (RIT)?

Much of the literature about the RIT and similar initiatives remains abstract. Before we can detail how we would go about designing such a tool, we must begin by concretely explaining what we believe a RIT would look like, the functions that it would have, and at least some of the key performance requirements that it would need to adhere to.

The need for a RIT and its added value derive from the structural lack of transparency in the global supply chain. Our economy is global. Resource extraction, processing, and manufacturing occur in a vastly distributed network of companies around the world. An average car is made up of 1.800 individual parts and requires between 4.500 and 4.800 welds for assembly.

An example of a product (an automobile) broken-down into its individual components. (Image source: http://www.autohouston.net)

---

1. http://ec.europa.eu/environment/resource_efficiency/documents/erep_manifesto_and_policy_recommendations_31-03-2014.pdf
2. Royal Haskoning Report

Each of these parts often has further sub-components that are made of many different individual materials. Because of the complexity of this whole system, Original Equipment Manufacturers (OEMs) have very poor insight into the origins of the materials that end up in their products. This makes it difficult to:

- Track environmental impacts over products' life cycles
- Maintain accountability for upstream working conditions and human rights violations
- Influence upstream design choices
- Make appropriate decisions for end-of-life treatment of the product and maximize the value of possible inter-sectoral cascades and recovered materials

Though a car is a complex product, arguably electronics can be even more complex. A typical RAM package of only 1 gigabyte has approximately ten billion transistors and 8 billion memory capacitors. Each of these transistors and capacitors is technically a component, and this is just one part of the electronic device (the memory).

To collect data along this chain, the RIT would need the capacity to seamlessly add and store data at each facility across the product's supply chain through a largely automated process. Information about specific materials will need to be correctly applied to processes and components through a series of relational databases.

The end result would be a complete overview of a product's material contents with a great deal of auxiliary performance data. This product overview would help make key decisions about product design, production, use, and end-of-life.

WHAT WILL THE RIT DO?

To understand the potential functioning of a RIT system, we can take the example of an end-of-life Fair Meter. Upon disposal, this Meter would end up at a collection facility where it would be scanned. The tagging system embedded in the product, would bring up an online data interface displaying the product's details, including among others:

- Date of manufacture
- Recommendations for optimal end-of-life handling, including
- Reuse and remanufacture options and pricing
- Component harvesting options and pricing
- Disassembly guidelines
- Recycling guidelines
- Total material contents and residual value
- Environmental footprint data for the product
- Supplier data for the product with reverse logistics information

This data would ideally be connected to real-time price information for product re-use, component re-use, and materials recovery. An automatic scanning process would sort the product for further processing or shipping based on an optimization algorithm for maximum value extraction at that moment in time.

This algorithm would optimize not only for financial value, but for environmental impact reduction as well. For example, if the reuse value of the product is slightly lower than the recycling value, the algorithm would still select reuse because of the systemic avoidance of impact in creating a new product. At first such scanning facilities would only be available in select locations (as part of the reverse logistics procedures of OEMs). Eventually, with broader adoption, all recycling facilities could be equipped with such scanners.

The RIT would also have valuable functions before end-of-life. It would allow parties along the chain to gain insight into problematic materials or suppliers along their value chain, for example, materials sourced from conflict zones. This would allow companies to put pressure on their suppliers to change their practices, or outright exclude such suppliers from their chain. The RIT would also provide highly accurate LCA data per product for effective total impact accounting. All of this data could be used for product optimization and marketing by OEMs. Taking this into account, the RIT can serve as a mechanism for systemic change: an informational feedback loop that would stimulate the development of cross-sectoral collaboration and product innovation.

At the same time, there are declining benefits for the collection of certain kinds of data: the kind of information collected by the RIT should be balanced with the administrative burden of collecting that information. The design of this tool should ideally start with the most essential pieces of information and eventually be expanded to include other data types. A great deal of focus should also be placed on the automation potential for collecting data. This can be achieved by, for example, integrating the RIT system with existing enterprise management software or supply chain tracking tools.

HOW WILL THE RIT WORK?

Ultimately, a functioning RIT, as described above, would consist of the following primary elements:

- A system for inputting data per material and component throughout the supply chain (either a hardware/software combination with tagging capability on the product and component level, or just a software interface for manual data collection linked to standard product ID systems like bar codes)
- A user interface displaying key conclusions and data about the product at any step of the supply chain

The basic functioning of the RIT as described in the previous section can be achieved through the structured collection of data throughout the product's supply chain. A successful RIT will naturally be complex. However, the goal is to make this complexity invisible, and to have the people and organizations who need to use the RIT have easy and clear value from its use, even before a whole ecosystem of innovations develops around it.

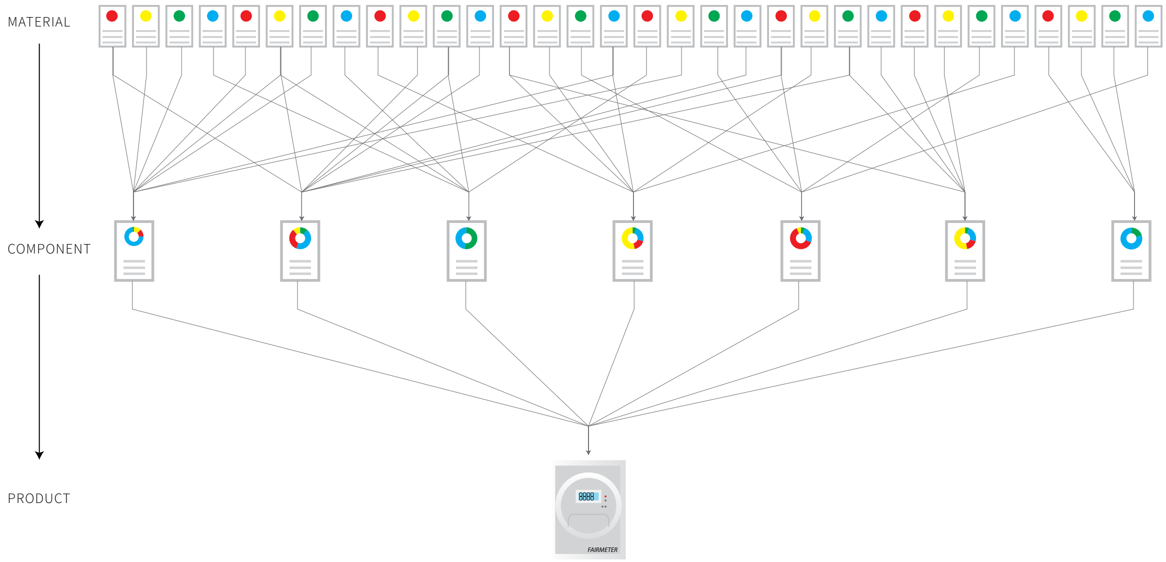
To function properly the RIT would need at least the following components:

- Sophisticated software back-end with a carefully designed data structure
- A secure data interface that would selectively provide information to key users along the chain while shielding key proprietary information (protecting IP)
- A 3rd party data verification process
- Tagging and scanning hardware and / or data entry procedures for materials, components, and final products
- Technical and financial data on best practices for reuse, remanufacture, disassembly, and recycling of materials, components, and products
- Environmental and social impact data for all steps and activities along the chain
- Simple processes for data entry that don't burden parties along the value chain, ideally integrating with existing data systems

2.3 USING THE RIT FRAMEWORK

The data framework we have proposed in chapter 3 of this report will need to be further built out and evaluated prior to use. The framework itself only describes what kind of data would need to be collected and what its uses could be. To actually implement the RIT, the hardware and software components would need to be selected or developed, ideally over the course of a pilot with a specific sector. The suggested indicators would also need to be further developed. Additional detail on the implementation of the RIT is described in section 5 of this report.

The FairMeter procurement process will serve as a partial pilot for the implementation of the RIT with a focus on a few key data streams relating to fairness and circularity.



A conceptual overview of how a resource identification tool works to gather data on components and materials through the chain

3. COMPREHENSIVE RIT FRAMEWORK


A typical assortment of components found in almost any electronic equipment.
Image (CC) Alexandra Cárdenas

We have proposed a tiered structure for the RIT, which is summarized in the table on the following page.

We have proposed five overarching assessment categories, which build upon and reorganize the areas originally proposed in the FairMeter PrestatieLadder. These high-level assessment categories are:

- Fairness
- Circularity
- Footprint
- Product Performance
- Transparency

Each of these categories has several assessment areas; which are described later in this document.

The exact scoring of these assessment areas can be determined by the users (in this case, Alliander and Stedin). For the example in the table above, it is possible to set the threshold for a passing score at the state where 100% of suppliers have responded to surveys in detail and 100% of identified smelters are certified by CFSI. It is also possible to set much more lenient scoring where the first focus is on data collection.

As discussed in our previous report, the definition of the term “fair” is quite variable depending on its exact context of use. To further specify their desired interpretation of the term, Stedin and Alliander developed the “FairMeter Prestatie Ladder,” a scoring scheme to describe several dimensions of fairness that they consider important. We have used this performance ladder as a basic guideline for the proposed framework for the RIT.

The data framework consists of several tiers. The highest two tiers are the assessment structure, which add to and reorganize the scoring areas of the Prestatie Ladder. In the first tier, we have defined five high-level assessment categories (for example, fairness). In the second tier, we have described several assessment areas that fit under each category (for example, presence of undocumented conflict minerals). In the tier below are the indicators, which are used to actually calculate scores for the assessment areas (for example, % of smelters in the product supply chain that are not certified "conflict-free" by the Conflict Free Sourcing Initiative, CFSI). Finally, the last tier contains the data collection framework that describes the type of data that needs to be collected at which steps along the supply chain in order to suitably calculate each indicator.

As discussed previously, the objective with this work is to suggest a fully integrated reporting structure that can eventually be used for multiple applications of the RIT (for example, circular end-of-life management). Initially, the framework will be used only to collect data and assess performance on the narrower scope of assessing "fairness" and "circular economy".

3.1 PROPOSED ASSESSMENT AREAS

The FairMeter PrestatieLadder takes a relatively broad approach to the definition of "fair," including a number of parameters within the scope of ecological impacts, product performance, data privacy, and circularity in addition to those that are suggested by the common use of the term. In most applications (such as the FairPhone, FairMaus), the primary association with the term "fair" is limited to an evaluation of conflict minerals and fair labor conditions.

Our recommendation is to keep a broad scope of indicators for the ultimate structure of the RIT, but to disambiguate the areas of assessment into different sub-categories further than has been done thus far in the Prestatie Ladder. In particular, we are recommending to define the "fairness" criteria primarily according the common interpretation of the term "fair": focusing on human impact areas of high concern (conflict minerals, labor conditions). Making clearer divisions between categories of concern will make it easier to prioritize which actions should be taken first and which data collection areas are of the highest priority. In particular, it will make it easier to focus purely on data collection and re-design criteria that primarily impact the Fairness parameter in the first stages of the process.

Based on the areas of concern already identified in the PrestatieLadder, as well as other common dimensions for assessing product sustainability, we propose the following five final scoring categories for the FairMeter RIT:

1. Fairness
2. Circularity
3. Footprint
4. Performance (Product)
5. Transparency

Within each of these categories, we propose several indicators that can be independently weighted to indicate their relative importance. Despite separating Fairness into its own category, rather than having it be the overarching assessment category for the whole tool, we maintain that it is important to evaluate all of these indicators together in order to keep an eye on trade-off impacts. For example, it is possible to improve a score on Fairness while decreasing scores on Circularity and Performance. Any scoring mechanism should provide insights on the best course of action that minimizes undesirable trade-offs.

TIER 1	**TIER 2**	**TIER 3**	**TIER 4**
assessment category	***assessment area***	***indicators***	***data collection framework***
Conflict Minerals	Presence of uncertified conflict minerals in the product	Percent of suppliers successfully surveyed to identify smelters in the chain	List of smelters provided by suppliers
		Percent of relevant smelters identified as "conflict-free" certified smelters	List of CFSI (Conflict Free Sourcing Initiative) certified smelters
		Presence of gold, tin, tungsten, tantilum in the final product	Final bill of materials
		Percentage of gold, tin, tungsten, tantalum in the final product coming from identified "conflict-free" smelters	Bill of materials for the materials used during the manufacturing process
		Presence of gold, tin , tungsten, tantalum in the production process of every component.	Bill of materials for the materials used during the manufacturing process of individual components
		Other documented efforts to eliminate conflict minerals from the supply chain	Management and production protocols, formal agreements and other evidence of efforts to eliminate conflict minerals from the supply chain

An example of an assessment category, illustrating how the information in the tables is organized.

In this section we describe the general contents of the five proposed scoring areas for the final RIT framework. The data collection framework is much more detailed. The data collected in that framework feeds into these final categories.

1. FAIRNESS

This scoring category focuses on human impacts throughout the supply chain including: the presence of conflict minerals, the health and safety of working conditions, fair wages and equitable treatment of laborers, and the inherent presence of toxins or hazards that can impact humans throughout the supply chain. It is a human-focused category; environmental toxicity is looked at in more detail in the Circularity Assessment.

FAIRNESS

SUB-CATEGORY	ASSESSMENT AREA	INDICATORS	DATA COLLECTION
Conflict Minerals	The presence of uncertified conflict minerals in the product	The fraction (%) of suppliers successfully surveyed to identify smelters in the supply chain	List of smelters provided by suppliers
		The fraction (%) of identified “conflict-free” certified smelters (by the Conflict Free Sourcing Initiative	List of CFSI (Conflict Free Sourcing Initiative) certified smelters
		Presence of gold, tin, tungsten, tantalum in the final product	Final bill of materials
		Fraction (%) of gold, tin, tungsten, tantalum in the final product coming from identified “conflict-free” smelters	Bill of materials for the materials used during the manufacturing process
		Presence of gold, tin, tungsten, tantalum in the production process of subcomponents or the final product	Bill of materials for the materials used during the manufacturing process of individual components
		Other documented efforts to eliminate conflict minerals from the supply chain	Management and production protocols, formal agreements and other evidence of efforts to eliminate conflict minerals from the supply chain
Worker Health and Safety	Provision of healthy and safe working conditions throughout the supply chain	Percentage of suppliers formally bound to abide to ILO conventions[3] 155, 161, 176 and 187.	Data on states which have ratified the relevant ILO conventions; Local legislation and / or formal agreements related to these conventions, which have been signed by suppliers.
		Percentage of suppliers which are BS OHSAS 18001 certified[4,5]	Survey data provided by suppliers; Copies or other proof of BS OHSAS certification
		Number of health and safety topics covered in formal agreements with trade unions.	Survey data provided by suppliers; Copies or other proof of formal agreements

---

[3] ILO:http://ilo.org/global/standards/subjects-covered-by-international-labour-standards/occupational-safety-and-health/lang--en/index.htm
[4] OHSAS:http://www.ohsas-18001-occupational-health-and-safety.com/ohsas-18001-kit.htm
[5] An ISO standard on these issues is under development: http://www.iso.org/iso/home/news_index/news_archive/news.htm?refid=Ref1874

FAIRNESS

SUB-CATEGORY	ASSESSMENT AREA	INDICATORS	DATA COLLECTION
Fair Wages & Treatment	Compliance with local labour standards	Percentage of suppliers that have been reported to violate local labor regulations	Statistics of national labor inspections or other relevant institutions and organizations
	Elimination of exploitative labour (child, slave)	Percentage of suppliers formally bound to abide to ILO conventions 138 and 182 on child labour	List of states which have ratified the relevant ILO conventions. Local legislation and / or formal agreements related to these conventions, which have been signed by suppliers
		Percentage of suppliers operating in states which have ratified ILO conventions 82 and 129 on labor inspections.	List of states which have ratified the relevant ILO conventions.
		Percentage of suppliers operating with a workforce including individuals which are younger than 16 years of age.[6]	Statistics of national labor inspections or other relevant institutions and organizations
		Percentage of suppliers formally bound to abide to ILO conventions 29 (including the 2014 Protocol) and 105.[7]	List of states which have ratified the relevant ILO conventions. Local legislation and / or formal agreements related to these conventions, which have been signed by suppliers.
		Percentage of suppliers operating with a workforce including individuals which are engaged in forced labor[8]	Statistics of national labor inspections or other relevant institutions and organizations
	Payment of fair wages	Percentage of suppliers formally bound to abide to ILO conventions 95 and 131.[9]	Local legislation regarding minimum wages for different age groups, economic sectors and industries
		Percentage of suppliers who pays laborers wages which equal or surpass the minimum wage according to the laws of the state in which they operate.	Local legislation regarding minimum wages for different age groups, economic sectors and industries Statistics and data of national labor inspections or other relevant institutions and organizations
		Operations and suppliers identified in which the right to exercise freedom of association and collective bargaining may be violated or at significant risk.	Statistics and data of national labor inspections or other relevant institutions and organizations
		Reported actions to support the right to exercise freedom of association and collective bargaining	Statistics and data of national labor inspections or other relevant institutions and organizations
	Provision fair working conditions	Percentage of suppliers formally bound to abide to ILO conventions 1, 30 and 47 on working time. [10,11]	List of states which have ratified the relevant ILO conventions. Local legislation and / or formal agreements related to these conventions, which have been signed by suppliers.
		Percentage of suppliers formally bound to abide to ILO conventions 171 on night work.	List of states which have ratified the relevant ILO conventions. Local legislation and / or formal agreements related to these conventions, which have been signed by suppliers.

FAIRNESS			
SUB-CATEGORY	***ASSESSMENT AREA***	***INDICATORS***	***DATA COLLECTION***
Toxicity and Hazard	Compliance with RoHS regulations	Fraction (%) of the components of the final product which is certified as ROhS compliant12	RoHS certification of each component of the final product
		RoHS compliance of the final product	RoHS certification of the final product
	Emissions of substances with human toxicity.	Life Cycle Inventory on emissions of substances with human toxicity[13]	Collection and normalization of the emissions associated with the extraction of materials and the manufacturing process
	Toxicity and hazard in the production process	The presence of known mutagens, reproductive toxins, or carcinogens in the production process (in any quantities above 0,1%.14	Type and quantity of each of these kinds of emissions associated with the extraction of materials, manufacturing process and use phase of the final product
	Toxicity and hazard in the final product	Presence of known mutagens, reproductive toxins, or carcinogens in the final product (in any quantities above 0.1%.	Final bill of materials
	Design for elimination of hazard and toxicity	The fraction (%) of processes in product cycle that use state of the art green chemistry processes)[15]	Detailed data regarding all relevant manufacturing processes within the supply chain A database containing state of the art Green Chemistry processes and technologies

Table 1. Fairness assessment category

---

6. For more specific definitions on child labour: file:///C:/Users/Gerard/Downloads/laborinspect_handbk_2003_en.pdf
7. http://ilo.org/global/standards/subjects-covered-by-international-labour-standards/forced-labour/lang--en/index.htm
8. http://www.ilo.org/global/topics/forced-labour/publications/WCMS_321414/lang--en/index.htm
9. http://www.ilo.org/wcmsp5/groups/public/---ed_norm/---declaration/documents/publication/wcms_203832.pdf
10. http://www.ilo.org/travail/areasofwork/WCMS_145675/lang--en/index.htm
11. http://ilo.org/global/standards/subjects-covered-by-international-labour-standards/working-time/lang--en/index.htm
12. For guidelines see: http://www.rohsguide.com/ , for data:
13. http://www.rohsguide.com/rohs-certification.htm
14. Which substances are toxic? ATSDR List:http://www.atsdr.cdc.gov/spl/ ; http://www.atsdr.cdc.gov/toxguides/index.asp
15. Possible reference: http://www.atsdr.cdc.gov/substances/ToxAllResources.asp
Standards?http://www.acs.org/content/acs/en/greenchemistry.html

2. CIRCULARITY

This scoring category focuses on two primary areas of assessment: (1) resource management and (2) ecological impacts (planetary carrying capacity) over the full life cycle of the product. The circular economy is defined as an economy that is “waste free and regenerative by design,” which implies both of these primary areas.

The circularity assessment uses the ecological footprint data to further evaluate and interpret the impacts of resource use. The impacts are evaluated in the economic as well as ecological sense. In contrast to the Circularity indicators, the Footprint indicators in the following assessment category are purely aimed at calculating resource throughput without interpreting the data in terms of their contextual impacts.

CIRCULARITY

CATEGORY	***SUB-CATEGORY***	***ASSESSMENT AREA***	***INDICATORS***	***DATA COLLECTION***
Resource Management	Resource use efficiency	Recycled content use	The fraction (%) of recycled content present in the final product	Final bill of materials
				Percentage of recycled content for each of these materials
		Lifecycle material efficiency	Ratio of the final total weight of the product to the total direct and indirect material used for its manufacture, excluding the material that is produced from recycled or reclaimed items	Final bill of materials
				Bill of direct and indirect material use during manufacturing process
				Percentage of recycled content for each of these materials
		Lifecycle energy efficiency	The ratio of the embodied energy of the Smart Meter to the total energy that the meter is expected to save during its lifecycle.	Total amount of primary energy used during the lifecycle of the product and its components
				Real time (or if this impossible: estimated) energy savings during use phase
		Lifecycle water efficiency	The ratio of the final amount of water used to the total amount of water recycled, reused or produced during the production of the final product.	Life cycle inventory including the volume of water used, reused and produced during all lifecycle phases of the product (m3)

CIRCULARITY

CATEGORY	SUB-CATEGORY	ASSESSMENT AREA	INDICATORS	DATA COLLECTION
Resource Management (continued)	End of Life Resource recovery Potential	Reusability of product and components	The total fraction (%) of components and materials within the total product that can be separated without compromising functionality and structural integrity	Final bill of components of the final product specifying which of these
				Data regarding state of the art recycling technologies associated with relevant components and material flows
			The availability of instructions for reuse	Copies or other documented proof of instructions for recycling and reuse
			The availability of instructions for disassembly	Copies or other documented proof of instructions for disassembly
			Estimated time (months) of functional use of each component remaining at end-of-life	Documentation on the functional and theoretical lifespan of each product
			Total time (seconds) of the disassembly process	Time needed for the disassembly of the final product and its components
		Recyclability of materials	The fraction (%, by mass) of materials in the final product that are theoretically recyclable using existing technologies	Final bill of materials
			The fraction (%) of materials in the final product that are practically recyclable (can actually be recycled considering their configuration in the final product)	Data regarding state of the art recycling technologies associated with relevant material flows
		Design for disassembly, reuse and recycling	Total fraction (%) of components that have been designed following DfD principles	DfR guidelines for products and product groups Data on the Best Available Technologies for recycl
			Total fraction (%) of components in the final product that have been designed according to Design for Recycling (DfR) guidelines[16]	DfR guidelines for products and product groups Data on the Best Available Technologies for recycling
		Compliance with the Directive on Waste Electrical and Electronic Equipment	Is the final product WEEE compliant?[17]	Official WEEE certification of the final product
	Resource depletion	Renewable water, energy and material use	The fraction (%) of the total amount of water (m3) used during the product life cycle coming from renewable sources	LCI data tied to the indicators on direct and indirect water use (See Footprint Assessment Category)
				Data regarding the origins of the water which is used
			The fraction (%) of the final amount of primary energy used during the product life cycle coming from renewable sources	LCI data tied to the indicators on primary energy use,source, and type (See Footprint Assessment Category)
			The fraction (%) of the final amount of materials used during the product life cycle coming from renewable sources	Final bill of materials
				Percentage of renewable materials included in the BOM
		Critical or scarce material use	The fraction (%) of the final amount of materials used during the product life cycle which can be characterized as being a critical material	Final bill of materials
				Percentage of critical materials included in the BOM

CIRCULARITY

CATEGORY	***SUB-CATEGORY***	***ASSESSMENT AREA***	***INDICATORS***	***DATA COLLECTION***
Resource Management (continued)	Water Management	Water stress	Falkenmark Water Stress Indicator[18]	Population served per million cubic meter of yearly runoff (renewable)
		Water recycling and reuse	The fraction (%) of suppliers with an official water management plan in place regarding reuse and recycling	Copies or other documented proof of the water management plan
			The fraction (%) of used water that is recycled or reused on site	Data on the quantity of water which is recycled or reused
	Biotic Resource Use	Total biological resource depletion	Fraction (%) of biotic resources coming from certified sustainable sources.	Final bill of materials
				LCI data tied to the indicators on biotic resource use (See Footprint Assessment Category)
				Copies or other documented proof of relevant certification
	Ecotoxicity	Emissions of ecotoxic substances	Life Cycle Analysis for all releases of substances with ecotoxicity to air, water, and soil over a period of 50 years	List of ecotoxic substances Characterization factors per substance
				The amount of emissions of each of these substances associated with the extraction, manufacturing and use phase of the product
Emissions and Waste	Solid Waste	Solid Waste Management	Fraction (%) of total “waste” materials recycled or reused in high quality applications	Quantity and type of solid waste streams througout the product life cycle
				Destinations and future uses of solid waste streams
			Fraction (%) of total “waste” materials that are downcycled into lower quality applications	Quantity and type of solid waste streams througout the product life cycle
				Destinations and future uses of solid waste streams
			Fraction of total “waste” materials that are disposed of without any form of recovery	Quantity and type of solid waste streams througout the product life cycle
				Destinations and future uses of solid waste streams
			Total monetary value recovered of waste streams	Revenues generated through the selling of waste throughout the supply chain

---

16. http://engineering.dartmouth.edu/~d30345d/courses/engs171/DfRecycling.pdf
17. WEEE: http://ec.europa.eu/environment/waste/weee/legis_en.htm
18. http://www.unep.org/maweb/documents/document.276.aspx.pdf
19. http://www.ghgprotocol.org/files/ghgp/public/Product-Life-Cycle-Accounting-Reporting-Standard-EReader_041613.pdf

CIRCULARITY				
CATEGORY	***SUB-CATEGORY***	***ASSESSMENT AREA***	***INDICATORS***	***DATA COLLECTION***
Emissions and Waste (continued)	Liquid Waste	Wastewater management	The fraction (%) of total suppliers who have their own water treatment facilities on-site	Survey data provided by suppliers or obtained through third party auditing
			The fraction (%) of suppliers who emit heated water into aquatic systems	Recording the ambient temperature of water and the temperature and the mass flow rate of water discharged
			The quality and quantity of discharged wastewater flows	Measurementsregarding the quantity and sampling of water using standard sampling techniques through third party auditing
	Emissions to soil and water	Groundwater pollution	The number of reported incidents in which groundwater pollution occurred within the supply chain	Inspection reports or statistical data provided by local governments / environmental protection agencies
		Pollution of surface waters	The number of reported incidents in which pollution of surface waters has occurred within the supply chain	Inspection reports or statistical data provided by local governments / environmental protection agencies
	Emissions to air	Greenhouse gas emissions	Fraction (%) of suppliers which have actually installed technologies aimed at limiting the emissions of greenhouse gasses	Copies or other documented proof of the management plan on the mitigation of greenhouse gasses
		Other atmospheric emissions	Fraction (%) of suppliers that have protocols or management plans in place aimed at limiting the emissions of VOC's, NOx, SOx, PM and ODS	Data on mitigation technologies used by relevant suppliers
			Fraction (%) of suppliers which have actually installed technologies aimed at limiting the emissions of VOC's, NOx, SOx, PM and ODS	

Table 2. Circularity Assessment category

3. FOOTPRINT

This scoring category provides a snapshot of the overall resource intensity of the production of the product (cradle to gate: extraction, production, transport).

FOOTPRINT

CATEGORY	ASSESSMENT AREA	INDICATORS	DATA COLLECTION
Energy	Total primary energy	Total amount of primary energy (MJ) used for the extraction of materials and the production and transport of the final product and its individual components.	Life cycle inventory (functional unit: primary energy use. Scope: extraction and production phases)
Abiotic Resources	Total direct material use	Total mass of abiotic materials present in the final product	Bill of materials
	Total indirect material use	Total mass of abiotic materials which has been used to extract, produce and transport the final product and its individual components	Life cycle inventory (functional unit: mass (kg) of abiotic material. Scope: extraction and production phases)
Biotic Resources	Total direct biotic resource use	Total mass of biotic materials present in the final product.	Bill of materials
	Total indirect biotic resource use	Total mass of biotic materials which has been used to extract, produce and transport the final product and its individual components.	Life cycle inventory (functional unit: mass (kg) of biotic materials. Scope: extraction and production phases)
Water	Total direct water use	Total volume of water (m^3) used during the production , assembly and transport of the final product and its individual components	Life cycle inventory (functional unit: volume (m^3) of water. Scope: production phase)
	Total indirect water use	Total volume of water (m^3) used during the extraction and transportation of materials used for the production process	Life cycle inventory (functional unit: volume (m3) of water. Scope: extraction phase)
Emissions	Total air emissions (greenhouse gasses)	Total scope 1 greenhouse gas emissions (kg. CO2 eq.) of the final product and per component	Life cycle inventory (functional unit: kg CO2 eq. Scope: direct emissions during the extraction and production phase)
		Total scope 2 greenhouse gas emissions (kg. CO2 eq.) of the final product and per component	Life cycle inventory (functional unit: kg CO2 eq. Scope: indirect emissions from purchased electricity, heat or steam during the extraction and production phase)
		Total scope 3 greenhouse gas emissions (kg. CO2 eq.) of the final product and per component	Life cycle inventory (functional unit: kg CO2 eq. Scope: other indirect emissions during the extraction and production phase)
	Total air emissions (other)	Total VOC emissions (kg)[20]	Life cycle inventory (functional unit: kg VOC. Scope: direct emissions during the extraction and production phase)
		Total SOx emissions over the lifecycle (kg. SOx)	Life cycle inventory (functional unit: kg SOx. Scope: direct emissions during the extraction and production phase)
		Total NOx emissions over the lifecycle (kg. NOx)	Life cycle inventory (functional unit: kg NOx. Scope: direct emissions during the extraction and production phase)
		Total ODS emissions over lifecycle (kg)	Life cycle inventory (functional unit: kg ODS. Scope: direct emissions during the extraction and production phase)
		Total Particulate Matter (PM) emissions (ppm)[21]	Life cycle inventory (functional unit: PM emissions in ppm. Scope: direct emissions during the extraction and production phase)

4. PRODUCT PERFORMANCE

This scoring category evaluates the product based on more standard performance criteria such as: price, quality, longevity, ease of use, protection of user data. Evaluating performance on these areas simultaneously with the others is important to ensure that product quality is not being excessively compromised for gains in the other areas.

PRODUCT PERFORMANCE			
CATEGORY	**ASSESSMENT AREA**	**INDICATORS**	**DATA COLLECTION**
Economic Performance	Total Product Cost	Discounted Net present value per meter	Life cycle costs, Life cycle benefits, Determine the discount rate
Ecological Performance	Energy savings	Energy savings facilitated by the product over its total life span (MJ of primary energy)	Total energy use of individuals and organizations using the product Total energy use of individuals and organizations not using the product / before the product was used
Longevity	Total product longevity	Effective lifetime of components and materials in years (including reuses)	Survey data on the lifetime of the final product Survey data on the reuse destination and lifetime of materials and components
User data protection	Privacy protection	Presence of a formal agreement / contract regarding sharing of data with third parties	A signed copy of the agreement
		Percentage of users expressing dissatisfaction about privacy concerns	Survey data regarding the (dis)satisfaction of users

Table 4. Product Performance Assessment Category

---

20. VOCs as defined by the EPA -http://www.epa.gov/iaq/voc.html
21. PM as defined by the EPA http://www.epa.gov/pm/

5. TRANSPARENCY

The transparency category evaluates how much information has been provided on a product in order to make an accurate evaluation of the other categories. It also holds essential descriptive product data (such as final bill of materials, disassembly and reuse instructions,etc.)

TRANSPARENCY			
CATEGORY	**ASSESSMENT AREA**	**INDICATORS**	**DATA COLLECTION**
Product Transparency	Materials used in the production process	Provided list with hazardous substances	Bill of materials
		Provided list with conflict materials	Bill of materials
Process Transparency	Supply chain transparency	Overview of the supply chain provided (yes/no)	Overview of the supply chain provided by the producer
		Percentage of supplier responses	Surveys that have been filled in by suppliers
		Quality of supplier responses	A report on the comprehensiveness of responses by suppliers
		Information provided on labour conditions through the supply chain (yes/no)	Surveys that have been filled in by suppliers
	Transparency regarding data	Information on data use and storage practices	Survey data provided by the producer of the meter
		Percentage anonymized data used for analysis purposes	Survey data provided by the producer of the meter
		Percentage of data shared with third parties ; data use is transparently defined by grid operators and energy companies	Survey data provided by the producer of the meter and relevant energy companies

Table 5. Transparency Assessment Category

3.2 INDICATORS

In this section we provide a description of the proposed indicators and data collection protocols for the priority assessment areas that have been identified. These priority areas include Fairness (Conflict Minerals, and Toxicity and Hazard), and Circularity (Resource Management, Ecological Impact, and Emissions and Waste).

SCORING CATEGORY: FAIRNESS

SUB CATEGORY: CONFLICT MINERALS

ASSESSMENT AREA: THE PRESENCE OF UNCERTIFIED CONFLICT MINERALS IN THE PRODUCT

Tantalum, tin, gold and tungsten are used widely in the electronics industry due to their electrical properties which are necessary for the functionality of electronic products. However, the extraction of those four minerals has been fueling wars and human rights violations in specific areas of the word, such as the African Great Lakes Region and adjacent zones. These areas are the most significant reserve banks of these minerals worldwide. As such the electronics industry has been pushed to apply new reporting policies to their suppliers in order to promote transparency and consumer awareness regarding the use of "conflict minerals," both as a result of national legislation as well as voluntary industry initiatives.

An influential piece of legislation in this regard is the Dodd-Frank Wall Street Reform and Consumer Protection Act (or simply: the Act) which obliges all publicly-traded companies operating under the arrangement of the United States' laws to report the use of conflict minerals to the Securities and Exchange Commission (SEC). Under this law conflict minerals are defined as tantalum, tin, tungsten, and gold mined in the Democratic Republic of Congo (DRC) or surrounding countries. Companies must report whether their resources are "DRC Conflict Free" or "Not Found to be DRC Conflict Free," in which case, companies are required to conduct due diligence to determine if their minerals from DR Congo are from conflict-free mines. Companies using conflict minerals must disclose the mine of origin and the smelter used to process the minerals. Besides reporting to the SEC, the law states that companies must also publish this information on their website.

The European Union has been following the proceedings over the Dodd-Frank Act and US debate to shape its own recommendations on conflict minerals legislation. In March of this year, the EU took a first big step in announcing a formal proposal (21) to "stop profits from the trade of minerals fueling conflicts around the globe". Like the Dodd-Frank Act, the EU proposal focuses on only four minerals: tantalum, tin, tungsten and gold. However, the EU proposal does not limit the sourcing to the Democratic Republic of Congo and surrounding countries. It recognizes that conflict minerals can be found throughout the world. In addition, the EU takes a broader definition of the term "conflict minerals" than only defined as minerals that are traded with the revenues supporting armed groups to finance their war. (22) Another key difference with the Dodd-Frank Act is the fact that the reporting as proposed by the EU is completely voluntary and focuses on self-assessment. Furthermore, rather than starting at the brand (e.g. phone company) level, the EU proposal focuses on self-certification of direct importers and smelters of the 3T's and Gold because they are closer to the source of the minerals. Lastly, instead of simply categorizing minerals as conflict-related or conflict-free, the OECD Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas provides detailed recommendations to help companies respect human rights and avoid contributing to conflict through their mineral purchasing decisions and practices. In other words, the process is prioritized over the results. Although this formal proposal is quite elaborate, there is no formal legislation regarding conflict minerals within the European Union.

Aside from governmental legislation and policies, there are initiatives such as the Conflict Free Smelter Initiative (CFSI) which is part of the Electronics Industry Citizenship Coalition (EICC) and the Global eSustainability Initiative (GeSI) work groups that certify smelters as "Conflict-free" through a protocol that is developed specifically for this purpose.

---

21. http://trade.ec.europa.eu/doclib/docs/2014/march/tradoc_152227.pdf
22. See examples in reports from Colombia, Venezuela, and Indonesia.

Indicators:

The policies, legislation, and industry-led initiatives that have just been discussed provide a number of useful building blocks for the development of six indicators, which can be used as a proxy for the extent to which conflict minerals are present within the final product. In order to assess performance on these indicators, most suppliers in an electronic product supply chain would be required to submit the required data, either by including the information in a database linked to their product (material, sub-component, component), or by filling out a supply chain survey sent by the OEM. These indicators, as well as the data collection that is necessary to enable their use, are briefly discussed below.

1. *The fraction (%) of suppliers successfully surveyed to identify smelters in the supply chain.*

- This indicator is expressed as the percentage of the relevant suppliers who are able to answer the surveys from the total number of relevant suppliers surveyed. Suppliers who are not able to respond to this survey and those stating that it is impossible to track the origins of any of the involved conflict minerals, are considered to have limited due diligence for their smelters. As the only elements of a smart meter that are not likely to contain conflict minerals are blank PCBs, plastics (housing, brackets), and packaging there is a need to survey almost all the suppliers in the smart meters' supply chain to record their due diligence regarding identification and control of the smelters further up the chain.

Data collection

- Data should be collected through surveys addressed to every supplier involved in the supply chain who is producing subcomponents that might include any of the conflict minerals, the materials included in these subcomponents and the materials that are used for their fabrication. The surveys should focus on the type of suppliers that suppliers in higher tiers collaborate with, and the type and quantity of components these lower tier suppliers produce. Information should also be collected on the level of access to information higher tier suppliers obtain from lower tier suppliers regarding their material sources and production process and labor practices. The due diligence procedures of higher tier suppliers as well as lower tier smelters and refiners,need to be made available.

Since conflict minerals are used for the production of most of the subcomponents produced in electronics, industry surveys should be addressed to all the involved suppliers excluding those who fabricate blank PCBs, plastic casings, packaging and those involved in the transfer and logistics of the electronics supply chain.

2. The fraction (%) of relevant identified "conflict-free" certified smelters (by the Conflict Free Sourcing Initiative

- This indicator is expressed as the percentage of the smelters identified as "conflict-free" in the CFSI database relative to the total number of smelters identified by suppliers through the surveys discussed above. Thus, building on the previous indicator, the information collected for the calculation of this second indicator provides more insight in the practices of those smelters that have been responding to surveys. However, since those smelters that did not respond to these surveys are excluded here, the population which the indicator deals is likely to be somewhat more limited. This indicator should therefore be jointly evaluated with indicator 1, as described above.

Data collection

- The CFSI's online list of compliant smelters and refiners (24) can be used to identify those relevant suppliers (smelters and refiners) within the supply chain, which adhere to the CFSI's requirements and posses official CFSI certification.

3. Presence of gold, tin, tungsten, tantalum in the final product

- This indicator is expressed as a "Yes" or "No" answer. The final product is said to contain these metals if any of the conflict minerals are present in the final product or any of its subcomponents in their pure form, or processed as an alloy.

Data collection

- Data regarding the presence of any of the conflict minerals should be collected for every subcomponent of the final

---

23. CFSI's template
24. http://www.conflictfreesourcing.org/conflict-free-smelter-refiner-lists/

product from the manufacturers of the subcomponents through tracking or tracing. Where tracing is impossible, the tracking of materials can be pursued through supplier surveys. The resulting bill of materials for each of the subcomponents of the final product should then provide an oversight of all minerals (including the conflict minerals) present in the product. and preferably also list the fraction of the mass of the component (and ultimately the final product) composed of these minerals. These data can also be used to identify specific components of concern for redesign or replacement efforts in future product iterations.

4. Fraction (%) of gold, tin, tungsten, tantalum in the final product coming from identified "conflict-free" smelters

- This indicator is expressed as the percentage of gold, tin, tungsten and/or tantalum that is found in the final product, which has been sourced from smelters and refiners that are identified as "conflict-free" by the CFSI relative to the total amount of conflict minerals that are found in the final product. The percentage must be calculated separately for each conflict mineral.

Data collection

- The data that needs to be collected for this indicator is partially the same as the data needed for the calculation of the third indicator, regarding the presence of conflict minerals in the final product. The only difference here is that the percentage of tin, tungsten, tantalum, or gold present in the final product must be traced back to a specific smelter or refiner within the supply chain. This data needs to be collected at the level of the relevant smelters within the supply chain, because the mixing of minerals of different sources at the smelters makes it impossible to trace back the origins of minerals beyond this point in the supply chain. The data should include the origin of the minerals and the locations where minerals are consolidated, traded, processed, refined, and exported.

5. Presence of gold, tin, tungsten, tantalum in the production process of subcomponents or the final product.

- This indicator is expressed as a "Yes" or "No" answer. Production processes are said to contain these minerals if any of the conflict minerals are present and/or used in any of the production processes of the subcomponents or the final product, in their pure form or as an alloy.

Data collection

- Data regarding the use of conflict minerals or any derivative during production must be collected in every production process step of every subcomponent of the final product. This can be achieved through the tracking of conflict minerals through supplier surveys or external auditing. The data collected should result in a bill of materials for the production processes of the final product and each of its subcomponents.

6. Other efforts to eliminate conflict minerals from the supply chain

- This indicator is expressed as a "Yes" or "No" answer. A supplier is said to engage in other efforts to eliminate conflict minerals from the supply chain only when he provides documented proof of such efforts. An effort to eliminate conflict minerals from the supply chain is defined here as any action aimed at the documentation and reduction of use of conflict minerals, either by introducing new minerals as substitutes or by excluding smelters that cannot be identified as "conflict-free" smelters.

Data collection

- Documented data can be requested from relevant suppliers. The use or intention of use of existing frameworks such as the CFSI or the Mineral Tracking and Certification Scheme (25) as established at the International Conference on the Great Lakes Region (ICGLR) can be requested and used as proof of intention throughout the supply chain. Other formal and legally binding agreements or management protocols dealing specifically with the documentation and elimination of conflict minerals from the supply chain can also be collected.

---

25. http://www.oecd.org/investment/mne/49111368.pdf

SUB CATEGORY: TOXICITY AND HAZARD ASSESSMENT AREA: COMPLIANCE WITH ROHS REGULATIONS

The primary goal of this area of assessment is to evaluate whether or not the final product is fully compliant with RoHS regulations. The RoHS directive aims to restrict certain dangerous substances commonly used in electronic and electronic equipment. The original RoHS Directive was adopted on January 27, 2003. However, the European Parliament and Council revised this legislation June 8, 2011. Today, this revised directive is often referred to as “RoHS II”. RoHS II is an “open scope” Directive. This means that the Directive will apply to all Electric and Electronic equipment (EEE) products that are “dependent on electric current or electromagnetic fields for at least one intended function. This means that eventually, the ROhS requirements will be extended to all EEE, including cables and spare parts, excluding some military and medical equipment are exempt from RoHS compliance. (26, 27, 28) This transition will be completed in 2019.

Any ROhS compliant (29) component is tested (30) for the presence of Lead (Pb), Cadmium (Cd), Mercury (Hg), Hexavalent chromium (Hex-Cr), Polybrominated biphenyls (PBB), and Polybrominated diphenyl ethers (PBDE). For Cadmium and Hexavalent chromium, there must be less than 0.01% of the substance by weight at raw homogeneous materials level. For Lead, PBB, and PBDE, there must be no more than 0.1% of the material, when calculated by weight at raw homogeneous materials. A homogenous material is defined as a material that cannot be mechanically disjointed into different materials. Lastly, any RoHS compliant component must have 100 ppm or less of mercury and the mercury must not have been intentionally added to the component.

The RoHS directive does not apply to components: it applies to final products. So it is the manufacturers responsibility to ensure that all individual components of the final product are compliant. RoHS II is a CE Mark Directive. This means that each product covered by RoHS must have technical testing and accompanying documents, a declaration of conformity, and the CE marking affixed to the product. The format of the declaration of conformity is outlined in Annex VI of the Directive. The CE mark for RoHS products entered into force on 2 January 2013.

Indicators:

The RoHS II directive and the certification requirements tied to it form the basis for the following indicators:

1. Fraction (%) of the components of the final product which is certified as ROhS compliant

- This indicator is expressed as the percentage of the total number of components of the final product which is certified as being compliant with RoHS guidelines.

Data collection

- Calculate the total percentage of components which are certified under RoHS. (see a more detailed description in the following indicator)

2. Is the final product considered to be RoHS compliant?

- This indicator is expressed as a “Yes” or “No” answer. The final product can only be certified as RoHS compliant when all components included within the final product are certified for compliance with RoHS.

Data Collection:

- In order to ensure that products are RoHS compliant, careful testing and documentation must be done in accordance with RoHS Directive regulations. The necessary data can be supplied by RoHS consultants, laboratory testing, XRF analyzer results, or a combination of these means.

- Depending on the position in the supply chain suppliers and producers of certain product can either use one or more of the methodologies to collect their own data, or ask lower tier suppliers to do so and provide the RoHS certification resulting from the process.

---

26. Permanent exclusions from RoHS include the following: military equipment, space equipment, equipment designed to be part of another piece of equipment falling outside the scope of RoHS, large scale industry tools, large scale fixed installations, means of transport for persons or goods, non-road mobile machinery, active implantable medical devices, photovoltaic panels, equipment for research and development only available business to business. As noted above, the European Commission adopts a very narrow interpretation of the categories of products to which these exclusions apply.
27 http://www.export.gov/europeanunion/weeerohs/rohsinformation/index.asp
28 http://www.rohscompliancedefinition.com/
29 http://www.rohscompliancedefinition.com/rohs-compliance-faq.html
30 http://www.rohscompliancedefinition.com/rohs-compliance-xrf.html

SUB CATEGORY: TOXICITY AND HAZARD ASSESSMENT AREA: EMISSIONS OF SUBSTANCES WITH HUMAN TOXICITY

This evaluation area is meant to evaluate the emissions of substances with human toxicity throughout the production chain. Here we are not considering "potential" emissions, but rather actual emissions of substances with human toxicity which occur during the production of the subcomponents and the final product.

Indicators:

The following indicators are used to calculate emissions of substances with human toxicity.

1. The results of a Life Cycle Analysis for all releases of substances with human toxicity to air, water, and soil over a period of 50 years

- This indicator is defined as the impact of the total amount of emissions of different types of substances which are toxic to humans, over the entire life cycle of the product.

Data Collection:

- In order to calculate this indicator, data needs to be collected on the type and quantity of each emitted chemical per product chain step, so from the extraction and production phases as well as the end of life treatment of the product and its components. There are several possible means to assess which chemical substances are toxic to humans and relevant for inclusion in this life cycle inventory. One option is the consultation of experts, who can determine which substances should be taken into account on the basis of detailed information on all production processes within the supply chain. Another starting point for these decisions is provided by organizations such as the United States Environmental Protection Agency (EPA) Toxic Release Inventory Program (31) or the Occupational Safety and Health Administration (OHSA) Occupational Chemical Database . (32)

- Subsequently all emissions per product chain step need to be normalized so that they reflect the emissions associated with one unit of production.

- Lastly, the types and quantities of emissions per product should be multiplied with the appropriate characterization factors in order to asses the impact of the total emissions. The USEtox database, a toxicity model developed by the United Nations Environmental Department (UNEP) and the Society for Environmental Toxicology and Chemistry (SETAC) contains a set of characterization factors for human toxicity and freshwater ecotoxicity in life cycle impact assessment (2008)(33) for over 3,000 organic chemicals, and would be recommended as a source for this kind of data.

SUB CATEGORY: TOXICITY AND HAZARD ASSESSMENT AREA: TOXICITY AND HAZARD IN PROCESSES

This assessment area is used to evaluate the inherent toxicity and hazard of the materials in the life cycle production process of the product. It does not take into consideration the actual potential for exposure to the toxic or hazardous materials: the focus is on minimization of total potential risk through aiming for the elimination of inherent hazard.

Indicators:

The following indicators are used to calculate toxicity and hazard in processes.

1. The presence of known mutagens, reproductive toxins, or carcinogens in the production process (in any quantities above 0,1%. (Y/N)

- This indicator is expressed as a "Yes" or "No" answer. When a mutagen, reproductive toxin or carcinogen is present in a concentration (parts per million) which is higher than the allowable safe concentration, they are said to be present in the production process.

- The OHSA laboratory standard defines a mutagen as "chemicals that cause permanent changes in the amount or structure of the genetic material in a cell".

---

31. http://www2.epa.gov/toxics-release-inventory-tri-program/tri-listed-chemicals
32. https://www.osha.gov/chemicaldata/index.html
33. http://toxnet.nlm.nih.gov/cpdb/pdfs/Setac.pdf

Reproductive toxins are defined as “chemicals that affect the reproductive capabilities including adverse effects on sexual function and fertility in adult males and females, as well as adverse effects on the development of the offspring”. The definition of carcinogens is “a substance or a mixture of substances which induce cancer or increase its incidence”. A more elaborate definition on mutagens, teratogens and carcinogens can also be found in the OHSA laboratory standard, including the different catories within these definitions according to which a substance can be classified.

- In line with OHSA guidelines (34), a substance is said to be a mutagen when it contains a mutagen chemical in a concentration equal to or larger than 0.1%. A substance is said to be a carcinogen when it contains a carcinogen chemical in a concentration equal to or larger than 0.1%. A substance is defined as being a reproductive toxins when it contains a reproductive toxic chemical in a concentration equal to or larger than 0.1%. The OHSA categorization contains an additional category which deals with the effects on or via lactation, which also contains a 0,1% categorization boundary.

Data Collection:

- Aside from defining the relevant substances and concentration thresholds, the OHSA can also provide a list of Particularly hazardous substances (35) which includes most of the known carcinogens and teratogens and mutagens. Aside from the list and categorization guidelines, detailed data on the chemicals and substances used during each phase of the production process, either as an input to the final product or a means to produce subcomponents or the final product.

SUB CATEGORY: TOXICITY AND HAZARD ASSESSMENT AREA: TOXICITY AND HAZARD IN THE FINAL PRODUCT

This assessment area is used to evaluate the inherent toxicity and hazard of the materials in the final product. It does not take into consideration the actual potential for exposure to the toxic or hazardous materials: the focus is on minimization of total potential risk through aiming for the elimination of inherent hazard.

Indicators:

The following indicators are used to calculate toxicity and hazard in the final product.

1. Presence of known mutagens, reproductive toxins, or carcinogens in the final product (in any quantities above 0.1%. (Y/N)

- This indicator is expressed as a “Yes” or “No” answer. When a mutagen, reproductive toxin or carcinogen is present in a concentration (parts per million) which is higher than the allowable safe concentration, they are said to be present in the production process.

- The OHSA laboratory standard (36) defines a mutagen as “chemicals that cause permanent changes in the amount or structure of the genetic material in a cell”. Reproductive toxins are defined as “chemicals that affect the reproductive capabilities including adverse effects on sexual function and fertility in adult males and females, as well as adverse effects on the development of the offspring”. The definition of carcinogens is “a substance or a mixture of substances which induce cancer or increase its incidence”. A more elaborate definition on mutagens, teratogens and carcinogens can also be found in the OHSA laboratory standard, including the different categories within these definitions according to which a substance can be classified.

- In line with OHSA guidelines, a substance is said to be a mutagen when it contains a mutagen chemical in a concentration equal to or larger than 0.1%. A substance is said to be a carcinogen when it contains a carcinogen chemical in a concentration equal to or larger than 0.1%. A substance is defined as being a reproductive toxins when it contains a reproductive toxic chemical in a concentration equal to or larger than 0.1%. The OHSA categorization contains an additional category which deals with the effects on or via lactation, which also contains a 0,1% categorization boundary.

---

34. https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10106
35. http://web.pdx.edu/~cooperc/CHP-Web/OSHA_Haz_List_.pdf, http://www.safety.duke.edu/ohs/Documents/PHS_by_CAS.pdf
36. https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10106

Data Collection:

- Aside from defining the relevant substances and concentration thresholds, the OHSA can also provide a list of Particularly hazardous substances (37) which includes most of the known carcinogens and teratogens and mutagens. Aside from the list and categorization guidelines, detailed data on the chemicals and substances used during each phase of the production process, either as an input to the final product or a means to produce subcomponents or the final product.

SUB CATEGORY: TOXICITY AND HAZARD ASSESSMENT AREA: DESIGN FOR ELIMINATION OF HAZARD AND TOXICITY

In recent decades, many green chemistry processes have been developed for the production of electrical and electronic components. A green chemistry process is one which aims to eliminate all forms of inherent hazard (toxicity, corrosivity, flammability) by using preferentially benign substances (for example, using water as a solvent). A second objective of green chemistry based processing is the improved eco-efficiency.

Indicators:

The US Environmental Protection Agency has adopted the “12 principles of green chemistry” (38) which can be used as a basic guideline for the design of production processes related to electrical and electronic components. These guidelines will provide the basis for the following indicator.

1. The fraction (%) of processes in product cycle that use state of the art green chemistry processes.

- A production process is defined here as “any mechanical, electrical or chemical process used to transform inputs (e.g. raw materials or subcomponents” into an output demanded by the market (e.g. a refined material, component or final product)”. This indicator is not related to the scale or impact of production processes, or the relative importance of one process versus another in this regard. It simply lists the fraction of the total number of individual production process within the entire supply chain which is designed in accordance with the 12 aforementioned green chemistry principles. This is largely a pragmatic choice: it would be quite time consuming to create a weighted average based on the relative importance of each production process. However: if such data is available (for example from the conduction of the Life Cycle Assessment with regard to emissions of substances with human toxicity), it is recommended that the relative importance of each process is taken into account.

Data Collection:

- Data on all the relevant production processes within the supply chain and the way in which they are conducted needs to be recorded through supplier surveys or direct auditing of these processes. This data should be compared to a database which contains the state of the art green chemistry processes, best practices and alternative green manufacturing techniques. To our knowledge such a database has not been build with a specific focus on electric and electronic equipment. Thus such a database would need to be developed custom for this kind of indicator. Ideally these processes would be ranked on the basis a scoring system which could for example be based on the extent to which all 12 of the green chemistry principles as listed by the EPA are taken into account in the process in question. These scores as well as the practices included in the database would need to be updated regularly.

- Although a specific database has not been developed there are several resources and institutions which would provide good starting points for this process. The Sandestin Declaration complements the 12 green chemistry principles with 9 green engineering principles. (39) Although these principles have not been used directly with regard to the indicator discussed above, they too could be guiding the development of a database regarding state of the art production processes. Organizations such as the American Chemical Society (40), The Royal Society of Chemistry (41) and the Green Chemistry and Commerce Council (42) provide more in-depth knowledge on green chemistry principles and practices, examples of business cases developed around these principles, and sometimes a platform for knowledge sharing and development and best practices in different industries and economic sectors.

---

37. http://web.pdx.edu/~cooperc/CHP-Web/OSHA_Haz_List_.pdf http://www.safety.duke.edu/ohs/Documents/PHS_by_CAS.pdf
38. http://www2.epa.gov/green-chemistry/basics-green-chemistry#twelve
39. http://www.acs.org/content/acs/en/greenchemistry/what-is-green-chemistry/principles/sandestin-declaration.html
40. http://www.acs.org/content/acs/en/greenchemistry/industry-business.html
41. http://www.rsc.org/
42. http://www.greenchemistryandcommerce.org/about-gc3/what-is-the-gc3

SCORING CATEGORY: CIRCULARITY

SUB CATEGORY: RESOURCE USE EFFICIENCY
ASSESSMENT AREA: RECYCLED CONTENT USE

Many products nowadays are labeled as “recycled content”, which indicates that these items have been produced with recovered materials. However, regardless of such labels, the amount of recycled content varies widely between different products and includes both recycled and reclaimed material. The purpose of this assessment area is to more accurately evaluate the environmental performance of the product in this regard. In order to do so, it is necessary to define the specific amount of recycled content which is included in the final product.

Indicators:

The following indicators are used in evaluating recycled content use

1.The fraction (%) of recycled content present in the final product

- Following the definition of recycled content as proposed in the Cradle2Cradle certification scheme of McDonough and Braungart, recycled content is defined as: “The proportion, by mass, of recycled material within a product that has been recovered or diverted from the solid waste stream, either during the manufacturing process (pre-consumer/post-industrial) or after consumer use (post-consumer).” (43)

Data Collection

- Data regarding recycled content in the final product should be collected for every subcomponent that is labeled as a “recycled content” item. There are different certification scheme for products that assess that claim, such as the Cradle2Cradle certification scheme mentioned earlier or the SCS certification program (44), which review manufacturing data, processes, and chain of custody procedures. The collection of this data is necessary for every subcomponent of the final product. When this data is collected it can be used in combination with the final Bill of Materials (BOM) of the product to calculate the percentage of the content that is finally produced from recycled or reclaimed material.

SUB CATEGORY: RESOURCE USE EFFICIENCY
ASSESSMENT AREA: LIFE CYCLE MATERIAL EFFICIENCY

For the production of each product there is a specific amount of direct material use. This includes material involved in the manufacturing process, which is processed, refined and finally assembled to form the final product during attributable processes. During these processes there is an excess amount of material that is cut off, melted or dissolved that never reach the final product, although it has been used in the production process: the indirect material use. Furthermore, there is an amount of indirect material involved in processes which are not directly attributable to the final product such as materials used to build the capital needed for the production process. This assessment area aims to define the efficiency of material use for the final product produced, by measuring the total amount of direct and indirect materials used during attributable and non-attributable processes involved in the manufacturing of the final product. Because the impact of material use is less for recycled content as opposed to virgin materials, the use of materials that originate from recycled or reclaimed items should be excluded from this assessment.

Indicators:

The following indicators are used in evaluating the life cycle material efficiency of the product.

1. Ratio of the final total weight of the product to the total direct and indirect material used for its manufacture, excluding the material that is produced from recycled or reclaimed items. Or:

- ME = W / ((D+R) - R)

Where:

- ME = Life Cycle Material Efficiency
- W = Total weight of the final product (Kg)
- D = direct material use (Kg)

---

43. http://www.c2ccertified.org/images/uploads/C2CCertified_Product_Standard_V3_121112.pdf
44. http://www.scsglobalservices.com/recycled-content-certification

- I = indirect material use (Kg)
- R = recycled content (Kg)

Data Collection

- Data regarding the direct and indirect material used during attributable and non-attributable processes for the manufacturing of each subcomponent of the final product, including the final product itself must be collected from all the suppliers throughout the supply chain. This could be done through supplier surveys. In these surveys suppliers should report the materials used during attributable processes such as mining and extraction of material preprocessing, intermediate material preprocessing, material use for transportation and distribution of intermediate and final products. Furthermore, suppliers should report on material use for non-attributable processes such as capital goods, overhead operations, corporate activities, transportation of the final products to retail centers . (45) The recycled content of each of the subcomponents should also be recorded as discussed with regard to and excluded from the final amount of material used.

SUB CATEGORY: RESOURCE USE EFFICIENCY
ASSESSMENT AREA: LIFE CYCLE ENERGY EFFICIENCY

Smart Meters are installed to households to provide up-to-date information about the energy consumption of the household to the utility companies and to the user. This information allows utility companies to give an end to estimated bills and refine their pricing policies while allowing the users to regulate and optimize their energy use reducing their bills and carbon emissions. As such a Smart Meter is expected to save a significant amount of energy during its life cycle. On the other hand, a Smart Meter requires a specific amount of energy to be produced, which is called the embodied energy. The purpose of this assessment area is to evaluate the efficiency of the Smart Meter in terms of energy savings.

Indicator:

The following indicators are used to evaluate life cycle energy efficiency of the product.

1. The ratio of the embodied energy of the Smart Meter to the total energy that the meter is expected to save during its life cycle. Or:

- EEf = EE / ES

Where:

- EEf = Life Cycle Energy Efficiency
- EE = Embodied Energy (MJ)
- ES = total energy saved during operation (MJ)

Data Collection

- The data needed to calculate the embodied energy of the final product must be collected from the suppliers of each subcomponent of the product, possibly through surveys. This data should report accumulated energy consumption during attributable and non-attributable processes taking place for the production of the subcomponents and the final product as described in the Life Cycle Material Efficiency indicator . The energy savings that are expected during the use of the Smart Meter can be derived from recorded data from installed meters or be estimated (for example on the basis of average household energy consumption).

SUB CATEGORY: RESOURCE USE EFFICIENCY
ASSESSMENT AREA: LIFE CYCLE WATER EFFICIENCY

As with materials and energy, the production of each product requires the use of a specific amount of water, directly and indirectly. The main use of water takes place during raw material extraction, material processing and fabrication processes, while the total amount of water used per product includes water use for transportation and other relevant attributable and non-attributable processes. At the same time, in many production steps, a fraction of the used water is either recycled or directly reused after use while in some production steps production of water is also taking place. The aim of this assessment area is to evaluate the overall efficiency with which water is used during the production process, taking into account all uses, reuses and recycling processes within the supply chain.

---

45. Green House Gas protocol, World Resource Institute

Indicator:

The following indicators are used to evaluate life cycle water efficiency of the product.

1.The ratio of the final amount of water used to the total amount of water recycled, reused or produced during the production of the final product. Or:

- WE = U / (WS + WR + WP)

Where:

- WE = Life Cycle Water Efficiency
- U = water used (m3)
- WS = water saved (m3)
- WR = water recycled (m3)
- WP = water produced (m3)

Data Collection

- As with material and energy use, relevant data regarding direct and indirect water use, water recycling, reuse and water production practices must be collected for every sub-component of the final product from each supplier. Here too, the data should cover both direct and indirect water use during attributable and non-attributable processes. Aside from the quantities of water being used and produced in every step of the production process, it is also necessary to collect data on the origins of the water being used. This way the fraction of water which is recycled or reused can be assessed.

SUB CATEGORY: END OF LIFE RESOURCE RECOVERY ASSESSMENT AREA: WASTE ELECTRICAL AND ELECTRONIC EQUIPMENT (WEEE) COMPLIANCE

The WEEE directive has been developed to set targets for the collection, recycling, and recovery of waste electrical and electronic components.

Indicators:

The following indicators are used to evaluate waste electrical and electronic equipment (WEEE) compliance.

1. Is the final product (Fair Meter) considered fully WEEE compliant? (Yes / No)

2. Are clearly described refurbishment, treatment, and reuse information available? (Yes / No)

Data Collection

- The final device needs to be certified for compliance with WEEE criteria. (It is recommended to further investigate the regulations for more specific information)

SUB CATEGORY: RESOURCE DEPLETION ASSESSMENT AREA: RENEWABLE WATER, ENERGY AND MATERIAL USE

Within this assessment area the aim is to evaluate the extent to which finite resources are depleted during the product life cycle. In this way the information provided within the Footprint scoring category can be complemented; aside from the quantity of water, energy and materials this assessment allows an evaluation of the availability of these resources on the long term. Renewable resources can be defined as resources which can replenish or regenerate over time, either through biological reproduction or other naturally occurring processes. Renewable resources can, in principle, be extracted from the environment indefinitely as long as the rate of their extraction is equal to, or smaller than, their regeneration rate. For this reason the use of renewable resources as opposed to non renewable ones can be seen as an indication for less resource depletion throughout the lifecycle of the product. The following indicators have been developed following this line of reasoning:

Indicators:

The following indicators are used to evaluate renewable water, energy, and material use.

1. The fraction (%) of the total amount of water (m3) used during the product life cycle coming from renewable sources.

2. The fraction (%) of the final amount of primary energy used during the product life cycle coming from renewable sources.

3. The fraction (%) of the final amount of materials used during the product life cycle coming from renewable sources.

- Although the definition of renewable resources as provided above is quite straightforward, its use for calculating these three indicators may not always be simple. In fact the Food and Agricultural Organizations (FAO) definition of a renewable water resource as included in the Aquastat Database Glossary covers a whole page, and would be far too elaborate to include in the report. Rather than proposing a theoretical definition here, we propose to develop a definition not only from a theoretical point of view but also incorporating pragmatic issues regarding the feasibility of measurements and the collection of data. In doing of so it is recommended to build on the definitions and research of institutions such as the FAO, the United Nations Environmental Programme and the Organisation for Economic Co-operation and Development where possible.
- For the purpose of defining renewable energy we propose to follow the International Energy Agency which states that "Renewable energy is derived from natural processes that are replenished constantly. In its various forms, it derives directly or indirectly from the sun, or from heat generated deep within the earth. Included in the definition is energy generated from solar, wind, biomass, geothermal, hydro power and ocean resources, and biofuels and hydrogen derived from renewable resources".
- It is difficult to expand the definition of a renewable material beyond that of a renewable resource as presented above. As with water the renewability of a material is context specific and whether a used material is actually renewable also depends on the extraction rate. Even organic materials such as for example wood, are not necessarily renewable: when wood harvesting occurs at rates which outpace the regeneration rate of the resource stock: in other words the time in which wood grows back in the ecosystem from which it was harvested. For the purposes of calculating the third indicator we define renewable materials as any material that can be replenished in a reasonable time using biological processes.

Data collection:

- For the calculation of the three indicators mentioned above, two kinds of data are required: the total amount of water, primary energy and materials used throughout the product's life cycle on the one hand, and the origins of these materials on the other. This data should be provided by the relevant suppliers on the basis of supplier surveys. Where suppliers claim to obtain water, energy or materials from a renewable source, documented evidence and where possible certifications tied to the resource should also be provided. Where the renewability of water, energy or materials used is ambiguous it might be necessary to arrange an audit by a third party or rely on the judgments of expert on the issue and industry in question.

SUB CATEGORY: RESOURCE DEPLETION
ASSESSMENT AREA: CRITICAL OR SCARCE MATERIAL USE

With this assessment area another dimension of the issue of resource depletion is explored, specifically with regard to the use of raw materials. It is aimed at assessing the criticality of a material. Although the exact definitions used by different institutions and scientists vary somewhat, critical materials are defined here as materials which are characterized by a high supply risk, and a high economic importance for the industry in question. The following indicator aims to take these issues into account:.

Indicators:

The following indicators were used to evaluate critical or scarce material use.

1. The fraction (%) of the final amount of materials used during the product life cycle which can be characterized as being a critical material.

- Defining which materials are critical is not straightforward. Supply risks can stem from more than absolute scarcity alone: the concentration of material resources, geopolitical developments, the economic feasibility of extraction and a number of other factors can be just as important. Similarly the economic and strategic importance of materials depends not only on their value, but also the extent to which they can be substituted by materials with similar properties and in general the function these materials fulfill within the product. Therefore it is not possible to, up front, provide a comprehensive list of all the critical materials used throughout the Smart Meters life cycle.

Data collection:

- Nevertheless there are a few sources which might provide a useful starting point for such a critical materials list, such as the European Commissions Report on Critical Materials for the EU. Several publications of the United States Geological Survey and the United States Department of Energy's Critical Materials Strategy. Although a list of critical materials can be composed based on such publication, the list would never be comprehensive: criticality is a relative concept which relies on changing factors such as availability and total supply risk and substitutability. Therefore it is recommended that any list of critical materials is regularly reviewed, and updated on the basis of state of the art research and expert consultations. Aside from determining which materials are critical, the calculation of this indicator also requires data regarding the quantity and type of materials used throughout the product life cycle.

SUB-CATEGORY: WATER MANAGEMENT
ASSESSMENT AREA: WATER STRESS

This assessment area is meant to evaluate the extent to which the use of freshwater for human consumption and production is under pressure in the areas in which part of the production and supply chain of the Smart Meter is located. By evaluating the extent to which water stress occurs in these areas, a contextualization for other assessment areas such as water recycling and reuse and renewable water use can be provided.

Indicators:

The following indicators have been used to evaluate water stress

1. The Falkenmark Water Stress Indicator, or:

- WSI = W / P

Where:

- WSI = the Falkenmark Water Stress Index
- W = the total volume (m3) of the fraction of freshwater runoff which is available for human use within an area
- P = the total population depending on this water within that same area

- When the total annual amount of water available to the population in an area is bigger than 1700 m3 per capita, an area is seen as not experiencing water stress, whereas an amount of 1000 to 1700 m3 per capita indicates water stress and 500 to 1000 m3 indicates water scarcity. An area is characterized by absolute water stress when the amount of annual runoff available per capita is less than 500 m3. (46)

Data collection:

- Two kinds of data need to be collected in order to be able to calculate the Falkenmark Water Stress Indicator for an area. Firstly it is necessary to calculate the annually available volume of water in an area. It should be noted that this amount of available water consists solely of the fraction of the runoff of freshwater which is annually available for human uses. The second data necessary is the total population dependent on this amount of available water. At a national level the Falkenmark Water Scarcity Index has been calculated for a wide range of countries and data is usually readily available (e.g the Vital Water Graphics published by the United Nations Environment Programme and GRID-Arendal) (47). At a regional or local level it might be necessary to collect and calculate the data for that specific area.

---

46. http://www.sustainabilityconsortium.org/wp-content/themes/sustainability/assets/pdf/whitepapers/2011_Brown_Matlock_Water-Availability-Assessment-Indices-and-Methodologies-Lit-Review.pdf
47. http://www.unep.org/dewa/vitalwater/article77.html

SUB-CATEGORY: WATER MANAGEMENT
ASSESSMENT AREA: WATER RECYCLING AND REUSE

The purpose of this assessment area is to move beyond evaluating the extent to which water resources are depleted throughout the product life cycle as a whole (renewable water use) and the impact of water use on local resources (the water stress index). The assessment area provides an indication of the practices and efficiency with which water is used at the level of individual factories, smelters and refineries.

Indicators:

The following indicators have been used to evaluate water recycling and reuse:

1. The fraction (%) of suppliers with an official water management plan in place regarding reuse and recycling.

- This indicator is not aimed at assessing the actual impacts of such management plans, or the extent to which these plans are comprehensive. Rather it provides a crude first indication regarding those suppliers which do and those which do not prioritize effective water management during their operations. A second indicator is needed to be able to evaluate the effectiveness of the management plans of suppliers.

2. The fraction (%) of used water that is recycled or reused on site.

- This indicator is aimed at estimating the actual effect of site-specific water management plans. The main difference with the assessment of life cycle water efficiency is the fact that the indicator is calculated at the scale of individual production and mining facilities of suppliers rather than the product life cycle as a whole.

Data collection:

- For the first indicator only one kind of data needs to be collected; suppliers should provide documented evidence of the water management plans in place at their respective facilities. If this is desired additional information on the specific content of these plans could be collected through surveys on supplier interviews. To determine the fraction of used water which is recycled or reused, data needs to be gathered on the direct water use at the specific mining and production locations. Furthermore data regarding the site-specific volume of water which is recycled and reused must also be made available by suppliers. Both kinds of data could be made available by suppliers (e.g. through surveys, or water management reports). Another option (which could be useful when the data provided by suppliers is incomplete or seems untrustworthy) would be third party auditing of the sites in questions, in which the necessary data is gathered.

SUB-CATEGORY: BIOTIC RESOURCE USE
ASSESSMENT AREA: TOTAL BIOLOGICAL RESOURCE DEPLETION

Within the definitions regarding renewable material use as presented above, most biotic resource are categorized as renewable. However, as with renewable water use it is necessary to look at the use of biotic resources not just at the level of the product life cycle but also take into account the context in which a renewable resource is used and the rate at which it is depleted. When renewable resources are extracted from the environment at an unsustainable rate, or in an unsustainable manner, this can have profound impact upon the ecosystem of which they are apart. This assessment area is aimed at taking such ecological impacts into account.

Indicators:

The following indicators have been used to evaluate total biological resource depletion

1. Fraction (%) of biotic resources coming from certified sustainable sources.

- This indicator is designed to take the ecological impacts associated with biotic resource use into account in an indirect manner, by looking at the extent to which the biotic resources used by suppliers are coming from certified sustainable sources. Examples of such certification schemes are the Forest Stewardship Council (48) and the Marine Stewardship Council (49). For some other sectors, such as for example the rubber industry (50), standards

---

48. https://ic.fsc.org/
49. http://www.msc.org/
50. http://www.rubberstudy.com/news-article.aspx?id=5057&b=default.aspx

and certification schemes are still under development.

Data collection:

- Three kinds of data are required for the calculation of this indicator: (1) the complete list of biotic resources used during the extraction and production processes associated with the Smart Meter, a valid available certification scheme which can serve as proof for showing that the resource in question is extracted in a sustainable manner and (3) documented proof of meeting the requirements of these schemes, and obtaining official certification, from relevant suppliers. Where resource certification schemes are not well known, it may be necessary to consult experts. Data regarding the quantity and origins of biotic resources that are used throughout the product life cycle, should be provided by relevant suppliers.

SUB-CATEGORY: ECOTOXICITY

ASSESSMENT AREA: EMISSIONS OF ECOTOXIC SUBSTANCES

This assessment area is meant to evaluate the emissions of substances with ecological toxicity throughout the production chain. Here we are not considering "potential" emissions, but rather actual emissions with ecotoxicity which occur during the production of the subcomponents and the final product.

Indicators:

The following indicators have been used to evaluate emissions of ecotoxic substances

1. The results of a Life Cycle Analysis for all releases of substances with ecotoxicity to air, water, and soil over a period of 50 years

- This indicator is defined as the impact of the total amount of emissions of different types of substances which are ecotoxic, over the entire life cycle of the product.

Data Collection:

- In order to calculate this indicator, data needs to be collected on the type and quantity of each emitted substance chemical per product chain step, so from the extraction and production phases as well as the end of life treatment of the product and its components. There are several possible means to assess which chemical substances are ecotoxic and relevant for inclusion in this life cycle inventory. One option is the consultation of experts, who can determine which substances should be taken into account on the basis of detailed information on all production processes within the supply chain. Another option would be to take the USEtox data base (51) , which includes characterization factors for ecotoxicity as a starting point. Subsequently all emissions per product chain step need to be normalized so that they reflect the emissions associated with one unit of production. Lastly, the types and quantities of emissions per product should be multiplied with the appropriate characterization factors in order to asses the impact of the total emissions. As mentioned earlier the USEtox database characterization factors for ecotoxicity in life cycle impact assessment can be used as a source for this kind of data.

SUB-CATEGORY: SOLID WASTE

ASSESSMENT AREA: SOLID WASTE MANAGEMENT

Many materials can be classified as waste, and still retain value for use in other applications. This assessment area looks at the actual management practices of suppliers for their solid waste streams, and the level of quality that is preserved as these materials leave the facilities. The WEEE directive (52) in Europe sets recycling targets for member states for different kinds of products and has done quite a lot to improve electronic recycling rates.

Indicators:

The following indicators have been used to evaluate solid waste management

1. Fraction (%) of total "waste" materials recycled or reused in high quality applications.

- The applications for high value reuse will have to be determined on a case by case basis as the form and quality of the waste material can differ greatly. For example, re-polymerization of plastics to get it back to the original quality such that it would be able to replace virgin polymer counts as reuse in a high quality application. In general, when recycled plastic is able to replace virgin plastic while satisfying the same functional requirements as the original

---

51. http://www.usetox.org/
52. http://eur-lex.europa.eu/legal-content/EN/ALL/;ELX_SESSIONID=d27yJ2lT3M1fMr0pgb0pXr6DQJhyC52pK4vH1GzKf3QLvp7yYLng!1058450515?uri=CELEX-:32002L0096

application like strength, flexibility, temperature resistance, stiffness, corrosion resistance etc., it can be classified as a high quality application. When used components are refurbished and used in new products, its economic value increases. This is a perfect example of recycling and reusing (or upcycling) in higher quality applications.

2. Fraction (%) of total "waste" materials that are downcycled into lower quality applications (including incineration with energy recovery).

- A material is downcycled if it loses its original functionality and needs to be used in a lower value application. For example, most of the times, recycling of components and parts degrades the material and makes it unfit for replacement of the original part without addition of new virgin material to reinforce it. This type of recycling is classified as downcycling.

3. Fraction of total "waste" materials that are disposed of without any form of recovery (including landfill and incineration without energy recovery).

- When materials cannot be recycled, they end up in the landfill or are incinerated (without energy recovery. This is the traditional linear economy model of 'take, make and waste'.

4. Total monetary value recovered of waste streams (€/kg)

- This indicator is calculated by summing up the revenue generated due to sale of waste stream to other industries and the cost of virgin material and products that have been avoided due to reuse of existing parts and use of recycled material.

Data Collection

- Data collection for these indicators will involve the tracking of all waste streams that exit production processes through the chain (this should also include resource extraction steps such as mining). Data collection should focus on the type, quantity and future uses of these waste streams. Collection of this data would be most useful in a database where figures can be updated over time, and could be achieved through supplier surveys or alternatively third party audits. As a first step, each producer (supplier) in the chain will have to allocate waste based on the particular component(s) that are being produced for Fair Meter. They can either isolate the relevant production process, or allocate a fraction of waste outputs according to some fraction of use that is sensible.
- Of this total figure, a table can be made showing where each waste sub-fraction is being sent to, and:
  - What the estimated quality retention is (basically what we mean to say here, is that the complexity within the waste product is retained in following applications. (Difficult to gauge)
  - What the total monetary return is per kg of waste. (This includes both receiving payment for waste products (+), and being charged for disposal (-))
- It would be useful to complement this data with protocols and management plans in place regarding the solid waste management at relevant production and extraction facilities. The most important analysis that needs to be made in order to calculate the indicators above, is whether a waste stream is recycled or reused in high quality applications, downcycled or disposed of. For cases in which it is difficult to this type of analysis internally, expert consultation should be considered.

SUB-CATEGORY: LIQUID WASTE
ASSESSMENT AREA: WASTEWATER MANAGEMENT

This assessment area is meant to evaluate the disposal practices, types and intensity of pollution to water throughout the supply chain. Types of pollution that we are interested in here are: thermal pollution, organic contaminants, inorganic contaminants, macroscopic pollution. A number of indicators have been developed in relation to these issues.

Indicators:

The following indicators have been used to evaluate wastewater management

1.The fraction (%) of total suppliers who have their own water treatment facilities on-site.

- This indicator is the crudest of the proposed indicator with regard to wastewater management. It is intended to provide a first proxy for the wastewater management practices at the facilities of relevant suppliers. The rationale behind this is that those facilities that actually have their own on-site wastewater treatment facility will generally emit less heated and polluted wastewater directly into the surrounding environment. The indicator is not meant to assess the quality of wastewater treatment in any way.

2. Fraction (%) of suppliers who emit heated water into the environment

- Heated water is defined here as any flow of discharge water with a temperature above the ambient water temperature of the body in which it is discharged.

3. The quality and quantity of discharged wastewater flows.

- Quality of water needs to adhere to national effluent discharge guidelines like the Effluent Limitation Guidelines (ELG) (53) in the U.S. and EU's a) Directives on urban waste water treatment (54) and on nitrates pollution (55) and b) Water Framework Directive. These directives and guidelines regulate the biological oxygen demand, chemical oxygen demand, Nitrogen levels, Phosphorus levels and other relevant concentrations of substances in the water. The actual allowed concentration of effluents depend on the country in which discharge is taking place (only relevant where EU Frameworks are concerned) and the application of the water source the effluents are discharged into. Both in EU and US legislation, industry specific guidelines are available. If wastewater disposal takes place in an EU country, the quality indicator can be based on the aforementioned directives; for locations within the United States the ELG can for the basis of quality measurements. For facilities located in neither of these countries we propose to (1) use the Effluent Limitation Guidelines as a guideline basis for quality measurement, in nations where national standards are absent or significantly less rigorous or (2) use national guidelines where these are comparable to the ELG. In this way the indicators calculation should not differ too significantly for different supplier locations.

Data Collection:

- Supplier surveys can be used to determine the presence or absence of on-site water treatment facilities. Determining the percentage of suppliers emitting heated water can be combined with a wider quality check, in which both the quantity and quality of discharge flows need to be measured. All standards included in the aforementioned EU/US regulations or comparable national guidelines which are in pace should be taken into account. The quality measurements could be outsourced to a third (local) party specialized in this kind of auditing as long as the type of data being gathered is comparable across the supply chain.

SUB-CATEGORY: EMISSIONS TO SOIL AND WATER ASSESSMENT AREA: GROUNDWATER POLLUTION

The aim of this assessment area is to provide a more context specific evaluation of the solid and liquid waste flows associated with the extraction of materials, and the production of subcomponents and the final product. In order to achieve this an indicator has been developed with regard to the occurrence of local groundwater pollution throughout the supply chain.

Indicators:

The following indicators have been used to evaluate groundwater pollution.

1. The number of reported incidents in which groundwater pollution occurred within the supply chain

Data collection:

In relation to this indicator only one kind of data needs to be collected, namely: reports of site-specific inspections and statistical data regarding groundwater pollution when this is available. The data could in principle be provided by local governments or related organizations (e.g. environmental protection agencies). Where this is not possible, for example because the enforcement of laws with regard to environmental pollution by local governments or affiliated organizations is lacking or absent, other data sources could be used such as NGO reports or articles and research by local activists or journalists.

SUB-CATEGORY: EMISSIONS TO SOIL AND WATER ASSESSMENT AREA: POLLUTION OF SURFACE WATERS

The aim of this assessment area is to provide a more context specific evaluation of the solid and liquid waste

---

53. http://water.epa.gov/scitech/wastetech/guide/
54. http://ec.europa.eu/environment/water/water-urbanwaste/index_en.html
55. http://ec.europa.eu/environment/water/water-nitrates/index_en.html

flows associated with the extraction of materials, and the production of subcomponents and the final product. In order to achieve this an indicator has been developed with regard to the occurrence of the pollution of local surface waters throughout the supply chain.

Indicators:

The following indicators have been used to evaluate pollution of surface waters

1. The number of reported incidents in which pollution of surface waters has occurred within the supply chain.

Data collection:

- In relation to this indicator only one kind of data needs to be collected, namely: reports of site-specific inspections and statistical data regarding the pollution of surface waters when this is available. The data could in principle be provided by local governments or related organizations (e.g. environmental protection agencies). Where this is not possible, for example because the enforcement of laws with regard to environmental pollution by local governments or affiliated organizations is lacking or absent, other data sources could be used such as NGO reports or articles and research by local activists or journalists.

SUB-CATEGORY: EMISSIONS TO AIR
ASSESSMENT AREA: GREENHOUSE GAS EMISSIONS

This assessment area is not meant to measure the actual emission of greenhouse gases (GHG). This should be done as a part of the footprint analysis depicted in table XX. Instead the aim is to assess whether suppliers have take measures to limit these emissions. Therefore the following indicator is taken into consideration:

Indicators:

The following indicators have been used to evaluate greenhouse gas emissions.

1. Fraction (%) of suppliers that have protocols or management plans in place aimed at limiting the emissions of greenhouse gasses.

2. Fraction (%) of suppliers which have actually installed technologies aimed at limiting the emissions of greenhouse gasses.

- Both indicators are expressed as a “Yes” or “No” answer.

Data collection:

- The data required for the first of these two indicators can be collected through supplier surveys and the provision of documented proof of management plans and protocols that are in place in order to mitigate the emissions of greenhouse gasses by relevant suppliers. A variety of technologies (e.g dry and wet scrubbers) are available for removing or at least limiting these substances from a gas stream, and a list of state of the art technologies capable of realizing these mitigations should be created. With this list it will be possible to determine whether suppliers use technologies aimed at the mitigation of greenhouse gasses at their facilities. Data regarding the use of technologies by suppliers could be achieved through supplier surveys or, alternatively, by third party auditing and site visits.

SUB-CATEGORY: EMISSIONS TO AIR
ASSESSMENT AREA: OTHER ATMOSPHERIC EMISSIONS

This assessment area is meant to evaluate a number of emissions that fall beyond the scope of GHG emissions, namely: Volatile organic compounds (VOCs), nitrogen oxides (NOx), sulfur oxides (SOx), particulate matter (PM), Ozone depleting substances (ODS). As with the previous assessment area on greenhouse gas emissions the goal is not to evaluate actual emissions but rather to see whether suppliers have taken measures to mitigate these emissions. Therefore, here too, the we focus on the following the presence of management plans and the implementation of emission mitigation technologies.

Indicators:

The following indicators have been used to evaluate other atmospheric emissions

1. Fraction (%) of suppliers that have protocols or management plans in place aimed at limiting the emissions of VOC’s, NOx, SOx, PM and ODS.

2. Fraction (%) of suppliers which have actually installed technologies aimed at limiting the emissions of VOC’s, NOx, SOx, PM and ODS.

Data Collection

- The data required for the first of these two indicators can be collected through supplier surveys and the provision of documented proof of management plans and protocols that are in place in order to mitigate the aforementioned emissions by relevant suppliers. A variety of technologies (e.g Selective Catalytic Reduction (SCR)) are available for removing or at least limiting these substances from a gas stream and a list of the most relevant, state of the art technologies capable of realizing such mitigations this should be created. With this list it will be possible to determine whether suppliers use technologies aimed at the mitigation of greenhouse gasses at their facilities. Data regarding the use of technologies by suppliers could be collected through supplier surveys or, alternatively, by third party auditing and site visits.

3.3 DATA COLLECTION METHODS

As defined in this report, the RIT framework requires a few different types of data sources for the evaluation of the proposed indicators:

- Supplier data
- External data sets (existing)
- External data sets (custom made)
- Meta data (overall response of suppliers)
- Product use-phase data

SUPPLIER DATA

As has been mentioned previously, there are generally two approaches that can be taken to collect the supplier data needed for the RIT: tracking or tracing. Data tracking involves collecting data along the supply chain as a product is assembled. Tracing involves traveling back up the supply chain to collect data, generally through surveys. Tracking is theoretically preferable because of the dynamic and more complete nature of the data buildup, but it is also much more organizationally complex to institute.

Within the supplier data category, which comprises most of the necessary data, some sub-sets of information are easier to collect than others. The ease of data collection will also vary across suppliers. For example, many companies can readily access their energy use data. If a company only manufactures one product (a single type of component), then it will be relatively easy for this company to calculate energy demand per component through a simple normalization calculation

What we can see from this list of data is that most information is not covered by existing protocols, and would need to be collected independently. One of the main types of data that would need to be collected to evaluating all assessment areas of the RIT would be an almost full Life Cycle Inventory (LCI). An LCI consists of detailed tracking of all the flows in and out of the product system, including raw resources or materials, energy by type, water, and emissions to air, water and land by specific substance.

This kind of analysis can be extremely complex and may involve dozens of individual unit processes in a supply chain (e.g., the extraction of raw resources, various primary and secondary production processes, transportation, etc.) as well as hundreds of tracked substances. which would need to be compiled from inputs provided by suppliers at almost every step of the supply chain.

Surveys or digital forms for collecting the necessary kind of data will need to be developed for the different kinds of supplier types, which will include at minimum:

- Raw material extraction companies
- Smelters and refiners
- Manufacturers
- Transport and logistics companies

For each type of supply chain partner, the survey questions will need to be adjusted to be relevant to their kind of work. Each survey should also request general information that assists in normalizing the data to common baselines. For example, manufacturing facilities should be asked to indicate their geographical location so that their purchased electricity can be evaluated against the local energy grid mix. The total production volumes of each component at each facility should be requested as a standard measure in order to be able to normalize facility-level data to a per-product level.

As further described in the implementation plan, though the collection of this kind of data is not standard practice in the industry, there are many kinds of existing software which are potentially suited to gather this kind of information. We would strongly recommend either directly using or modifying existing software in collaboration with a software supplier.

EXTERNAL DATA SETS (EXISTING)

In addition to data collected via surveys from individual suppliers, additional information will need to be drawn from existing datasets. Data that would need to be collected using existing datasets would include the following, at minimum:

- National grid reference database
- Critical materials reference list
- Renewable materials reference list
- Material recycling classification list
- CFSI list of certified suppliers
- USEtox database for toxic materials
- Ground and surface water pollution databases, by nation or region

Some of these external datasets can be gathered from international sources. However many of these datasets would need to be collected at a national or possibly regional level. In the majority of cases these datasets are updated annually, and in order to ensure that the best information is made available, the software of the RIT would ideally need to access the latest versions.

Many of these datasets can be imported into a customizable database for the RIT, and accessed via software. As more insightful or useful databases become available in the future, these can be incorporated into the existing framework.

EXTERNAL DATA SETS (CUSTOM-MADE)

Within the framework, there are some specific types of data that would need to come from external datasets that currently do not yet exist to our knowledge. These datasets would need to provide a reference list of best practices for Green chemistry processes. Specifically, this database would ideally cover the following information:

- Material resource efficiency and waste minimization best practices for relevant components
- List of best available process technologies
- List of best available environmentally-benign substances
- Energy and water efficiency best practices
- Best practices in high value reuse, and waste minimization

With this type of dataset, it would be important to update it regularly, to reflect the latest information in technological development, and best practices.

USE PHASE DATA

A significant gap in collecting comprehensive life cycle data of the product, comes from the use phase. The main barriers in collecting use phase data stem from privacy concerns, but also include a lack of technical infrastructure to collect comprehensive data.

The types of information that would need to be collected during the use phase would include:

- Use phase energy consumption
- Use phase energy savings
- Use phase material use
- Use phase emissions
- Disposal, recycling, or reuse channels at end of use

An approach to estimating the use phase data could be to collect general statistical data on the product's performance during the use phase, and reference this against empirical data from a subset of meters that have been tested.

META DATA

In addition to the instances of data that would need to be collected, either via supplier survey, use phase, or external datasets, the RIT would also need to collect metadata; that is an overview of all the data that has been collected, and the different aspects of its overall quality. In the case of the RIT, there are specific types of metadata that would ideally be collected, at a minimum:

- The author, location, and entry date of all data
- The total number of suppliers who have provided data
- The overall quality of the data submitted, such as:
- Degree of completion
- Accuracy of data

3.4 DATA REQUIREMENTS AND COLLECTION FEASIBILITY

In order to generate a final score for each of the assessment areas that have been previously discussed, data needs to be collected from across the supply chain and aggregated to calculate each of the indicators. Though the indicators described in the framework are meant to be assessed on the level of the final product, in an ideal scenario the RIT would contain this data for each sub-component in the product. This component-level information would allow for more detailed treatment of each element at end of life and provide more specific insights on future design improvements and supplier selection.

In this section we evaluate the general data requirements and provide a rough indication of the feasibility of collecting the data needed to evaluate the Fairness and Circularity indicators that were selected as high priority topics by the steering group of this project.

In the table below, we have assessed the general feasibility of collecting the necessary data for the high-priority indicators. Our assessment of feasibility is informed by our previous research into the FairMeter supply chain structure (understanding the materials and processes that exist), and also from interviews made with suppliers who have provided us their own opinion on the feasibility of collecting data, based largely on their current practices and protocols.

DATA REQUIREMENTS AND COLLECTION FEASIBILITY

ASSESSMENT AREA / INDICATOR	***DATA COLLECTION***	***DIFFICULTY OF COLLECTION***
Fairness / Conflict Minerals	List of smelters provided by suppliers	🟨
	List of CFSI (Conflict Free Sourcing Initiative) certified smelters	🟩
	Final bill of materials	🟥
	Bill of materials for the materials used during the manufacturing process	🟥
	Bill of materials for the materials used during the manufacturing process of individual components	🟥
	Management and production protocols, formal agreements and other evidence of efforts to eliminate conflict minerals from the supply chain	🟨
Fairness / Toxicity and Hazard	RoHS certification of each component of the final product	🟨
	RoHS certification of the final product	🟨
	Collection and normalization of the emissions associated with the extraction of materials and the manufacturing process	🟥
	Type and quantity of each of these kinds of emissions associated with the extraction of materials, manufacturing process and use phase of the final product	🟥
	Final bill of materials	🟥
	List of toxic materials	🟨
	Detailed data regarding manufacturing processes	🟥

Levels of difficulty in collection

🟥 High 🟨 Medium 🟩 Low

DATA REQUIREMENTS AND COLLECTION FEASIBILITY

ASSESSMENT AREA / INDICATOR	***DATA COLLECTION***	***DIFFICULTY OF COLLECTION***
Circularity / Resource Use and Efficiency	Final bill of materials	🟥
	Percentage of recycled content for each of these materials	🟨
	Bill of direct and indirect material use during manufacturing process	🟥
	Total amount of primary energy used during the lifecycle of the product and its components	🟨
	Real time (or if this impossible: estimated) energy savings during use phase	🟨
	Life cycle inventory including the volume of water used in the extraction and production phases (m3)	🟥
	Data regarding the source of these water flows	🟥
Circularity / End of Life Resource Recovery	Final bill of materials	🟥
	Data regarding state of the art recycling technologies associated with relevant components and material flows	🟥
	Copies or other documented proof of instructions for recycling and reuse	🟨
	Theoretical lifespan of the final product	🟨
	Lifespan of individual components	🟥
	Time needed for the disassembly of the final product and its components	🟥
	Data regarding state of the art recycling technologies associated with relevant material flows	🟥
	Protocols elaborating on design process of the final product and its components	🟥
	Copies or other documented proof of disassembly and recycling instructions	🟨
	Protocols elaborating on design process of the final product and its components	🟥
	WEEE certification of the final product	🟩
Circularity / Resource Depletion	LCI data tied to the indicators on direct and indirect water use (See Footprint Assessment Category)	🟥
	Data regarding the origins of the water which is used	🟥
	LCI data tied to the indicators on primary energy use	🟥
	Final bill of materials	🟥
	Percentage of renewable materials included in the BOM	🟥
	Percentage of critical materials included in the BOM	🟥

DATA REQUIREMENTS AND COLLECTION FEASIBILITY

ASSESSMENT AREA / INDICATOR	***DATA COLLECTION***	***DIFFICULTY OF COLLECTION***
Circularity / Water Management	Population served per million cubic meter of yearly runoff (renewable)	🟨
	Copies or other documented proof of the water management plan	🟨
	Data on the quantity of water which is recycled or reused	🟥
Circularity / Total Biological Resource Depletion	Final bill of materials	🟥
	LCI data tied to the indicators on biotic resource use (See Footprint Assessment Category)	🟥
	Copies or other documented proof of relevant certification	🟩
Circularity / Ecotoxicity	List of ecotoxic substances	🟨
	The amount of emissions of each of these substances associated with the extraction, manufacturing and use phase of the product	🟥
Circularity / Solid Waste	Protocols for disposal of solid waste and quality retention of materials.	🟥
	Destinations and future uses of solid waste streams	🟥
	Destinations and future uses of solid waste streams	🟥
	Amount of revenues generated through the selling of waste throughout the supply chain	🟥
Circularity / Waste and Emissions	Survey data provided by suppliers	🟨
	Recording the ambient temperature of water and the temperature and the mass flow rate of water discharged	🟥
	Protocols for disposal of solid waste and quality retention of materials	🟥
	Survey data provided by suppliers on the volume (m^3) of discharged water, Sampling of water using standard sampling techniques	🟥
	Inspection reports or statistical data provided by local governments / environmental protection agencies	🟨
	Protocols for greenhouse gas emissions per life cycle step[16]	🟨
	Protocols for these other emissions per life cycle step	🟨

Table 6. Data requirements and collection feasibility

In the sections below, we will discuss the feasibility data collection that have been summarized in the table above.

FAIRNESS

The primary data inputs for assessing Fairness as we have defined include:

For conflict minerals:

- Supplier surveys to identify all relevant smelters in the supply chain (those dealing with suspected conflict minerals)
- CFSI's certified supplier database
- Complete product bill of materials with a mass breakdown of each material, ideally also at a component-level resolution

For hazard and toxicity:

- RoHS compliance certificates per component
- Complete bill of materials
- Toxicity database and characterization factors
- Manufacturing process descriptions (for green chemistry evaluation)

As indicated in the table above, the most difficult type of information to gather in the Fairness assessment category is the detailed bill of materials (BOM) and related mass breakdown. This information would ideally be collected from each supplier along the chain, beginning with the first manufacturer and ending at the final product assembly. A universal tracking system where the BOM data could be stored in a database associated with the product ID (such as a product number related to a specific barcode) would be ideal for this purpose. In this manner, the BOM data would simply accumulate in a central database with the addition of each component during manufacturing. A schematic diagram of the final product would indicate where each component is physically located on the product. Such a collection method would require a coherent data collection format across suppliers in the electronics chain, and a universal scanning and data storage mechanism. As such, this is not likely to be the first method available for this kind of data collection in the early implementation of the RIT. An alternative approach to collecting this information is through supply chain interviews requesting BOM data for each component up through the chain. This data would ideally be collected directly into a database via a digital form to prevent the need for manual collation of survey information. Response rates are initially likely to be low because most suppliers to not have this information on hand.

Though the bill of materials data is essential for getting more fine-grained data on the total fraction of material by mass that is coming from certified conflict-free sources in the final product, it is not absolutely essential in order to complete a basic assessment of the presence of conflict minerals. A minimal version of this assessment can be done through the evaluation of smelters in the chain. Collecting data on the identify of smelters can also be done through a tracking or tracing process. Based on our supplier interviews, responses to this kind of inquiry are also likely to be incomplete, though likely higher than for BOM data.

To conduct a detailed evaluation of product toxicity and hazard, however, the complete bill of materials is essential. As we have found in our tear down analysis of the DSRM4.2, despite RoHS compliance, many components still contain banned materials that have been permitted as a result of exemptions. Other materials of potential concern are not included in RoHS restrictions, and it may be considered desirable to have a more complete overview of inherent product toxicity based on a broader set of criteria. However, due to the relative difficulty of collecting complete BOM data and cross-checking it against lists of toxic materials, limiting the product evaluation to RoHS compliance may be necessary in early stages of the RIT development. This is highly feasible, since it is already required by law.

CIRCULARITY

The primary data inputs for assessing Circularity as we have defined include:

For Resource Management:

- Complete product bill of materials with a mass breakdown of each material, ideally also at a component-level resolution
- Complete bill of direct and indirect material use in manufacturing
- % recycled content included in each component per material type
- % of process wastes recycled
- % of process wastewater recycled
- Product use phase energy demand
- Product use phase energy savings
- Disassembly instructions and disassembly time
- Information on the implementation of DfR and DfD guidelines in component design

- Recycling and Re-use information
- Recyclable materials reference list
- WEEE compliance
- % renewable energy
- % renewable water
- National grid mix reference dataset
- Critical materials reference list
- Renewable materials reference list

For Ecological Impact:
- Documentation of water management plan
- % wastewater recycled
- Complete product bill of materials with a mass breakdown of each material, ideally also at a component-level resolution
- % biotic materials
- Documentation of relevant certification
- List of emissions of ecotoxic substances

For Emissions and Waste
- Documentation of waste flows, including total volumes and documentation of destination (waste collection, sale to third parties)
- Third party (government or agencies) site surveys of water, soil, and air quality
- Direct emissions reference list

Collecting the data necessary for the Circularity assessment area is more challenging than for the Fairness assessment area, due to the quantity and complexity of the data required. In addition to bill of material data disaggregated per component, many of the indicators require Life Cycle Inventory (LCI) data collection from each supplier (inputs and outputs of materials, energy, water, and emissions). These inventory data will need to be normalized to each component in order to be able to accurately aggregate these numbers to the final product. Aside from typical LCI data, various contextual data is needed, such as: % recycled content per material type, % renewable energy in all steps of the chain, treatment of waste flows, types of processes employed in production, etc. Some of the contextual data is non-quantitative in nature, which means that standard formats will need to be developed in order to collect it accurately.

In addition to these kinds of supplier data, many of the indicators in this category require external datasets, some of which will have to be custom-made for the RIT. For example, the evaluation of renewable, critical, and recyclable materials all require external reference lists. Standard reference lists of best practices for green chemistry processes do not exist to our knowledge, and would need to be specially compiled for this tool. All reference lists would need to be updated on an annual basis due to changing technologies and conditions.

The basis for several of the evaluations in this assessment area is the bill of materials. It is in many ways the simplest dataset to collect out of the ones listed, and therefore represents a good starting point for an initial RIT pilot. In combination with some external datasets, the BOM alone can provide key insights on product impact and recycling potential. In addition, once a standard protocol for collecting the BOM data across the chain is in place, it can later be expanded with other types of data. To simplify the development of such a BOM protocol, it can be built on top of existing standards such as RoHS reporting. One key challenge with collecting BOM data is intellectual property (IP). It would be necessary to develop a selective IP screen within the data collection framework that would only show BOM data to a certain level of disaggregation to third parties. The appropriate level of disaggregation would need to be determined by the suppliers participating in the first pilot.

3.5 FINAL RECOMMENDATIONS FOR DATA COLLECTION IN THE PILOT FAIRMETER RIT

Based on our evaluations of the data requirements and the necessary collection process for a product like the upcoming SMR5 smart meter, this section describes our recommendation for the minimum data collection for a FairMeter RIT pilot. Once again, we are focusing only on the priority assessment areas selected by the steering group (a subset of the Fairness and Circularity sections).

For a minimum assessment of the selected Fairness criteria, the following data will need to be collected:

- Smelter identification across the supply chain (via surveys)
- External CFSI smelter database
- RoHS certification data for products
- (Bill of Materials with a mass breakdown of each material at a component-level resolution) (because it is a minimum requirement for the Circularity criteria)

For a minimum assessment of the selected Circularity criteria, the following data will need to be collected:

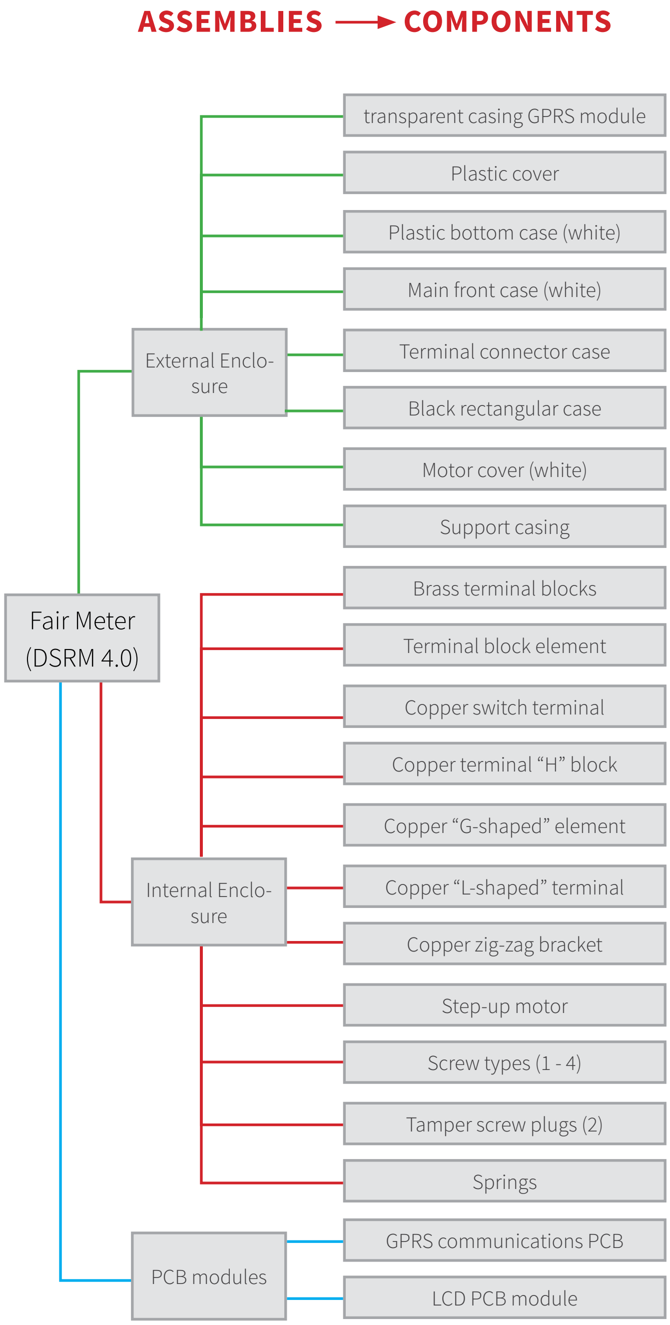
- Bill of Materials with a mass breakdown of each material at a component-level resolution
- Recyclable materials reference list
- National grid mix reference dataset
- Critical materials reference list
- Renewable materials reference list
- WEEE compliance
- Supplier survey to collect additional contextual data (waste management practices, recycled content)

4. FEASIBILITY ASSESSMENT OF RIT FRAMEWORK

The RIT framework that has been described in the previous section has been developed such that it can be applied to a wide range of product value chains. To better understand the scope of the supply chain of a given product, and thereby the types and amount of data that an RIT framework would need to collect, we used a case study on a smart meter.

By conducting a tear down of the DSRM4.0 meter, we were able to construct a sketch of the entire supply chain structure, and identify a number of "hotspots" where key data would need to be collected.

Additionally, we conducted interviews with a selection of suppliers that we identified in the DSRM4.0 meter supply chain. The objective of these interviews was to better understand what types of information could be feasibly collected at a product or material level, and what additional barriers suppliers saw in using a RIT framework.



4.1 SUPPLY CHAIN ANALYSIS OF DSRM4.0

As a foundation for our supply chain analysis, we conducted a tear down of a previous version of the FairMeter (DSRM4.0). In our tear down, we separated and recorded each of the primary assemblies, and where possible, we further separated out individual components. In the case of small scale components (for example, resistors soldered onto a PCB board) we documented the total number and type, but left the full PCB board in tact.

Based on the components that were collected during the tear down, we further analyzed the specific material types, brands, and manufacturer information (if available). Where information wasn't available, we conducted online research to find similar components with the same or similar characteristics. For a full overview of the tear down results, see the technical report from this study, published in October 2014.

Once we had completed a full overview of all components that had been recorded in the tear down, we conducted internet research to trace the supply chain structure and processes back to raw material extraction. In our documentation of the supply chain, we highlighted a number of "red flag" areas, including:

- Process Issues:
- Energy intensive process
- Known labour issues
- Material Issues
- Toxic material
- Conflict material
- Critical material

Shown below is an overview graphic of the supply chain. Many of the supply chain steps have been simplified in order to visually represent the entire chain in one graphic. The main process steps and materials are shown in the below map. It is worth stressing that the actual supply chain is significantly more complex, both in terms of process steps and material types.

4.2 QUALITATIVE PERFORMANCE ASSESSMENT OF DSRM4.0

Based on our construction of the supply chain, we were able to conduct a qualitative analysis of the performance of the DSRM4.0 as a product by examining what it contains. We have provided a rough, qualitative assessment here due to the lack of specific data that we could actually collect about the materials and processes is within the supply chain. Furthermore, the extent to which the supply chain is mapped in this overview graphic underestimates the full scope of the actual chain, considering all known materials and processes. Therefore the results provided in this assessment are indicative of the actual picture.

Nevertheless, a number of useful insights can be drawn from this assessment, including the size and complexity of the chain as a whole. We have estimated that there are 12 families of components found within the DSRM4.0, but approximately 120 unique components can be found altogether. We have observed that many of the same component types are unique, implying that they originate from different suppliers and likely have different material compositions and production processes. Looking over the entire supply chain, we estimate that there are a minimum of 3.000 suppliers.

In terms of the performance of the overall product, there are a number of things that clearly stand out:

- The meter can be considered RoHS compliant, however we have noted that many of the components were exempt from the RoHS framework. Exemptions to RoHS are granted to narrowly-defined applications for which the elimination of the prohibited substance is technically or scientifically impracticable or when the only available substitution produces more negative than positive benefits to the environment, health, or consumer safety.
- There is a very high number of toxic materials throughout the supply chain. Nearly every material chain that we have mapped contains at least one toxic material. In addition to the materials themselves, processes which utilize toxic materials or chemicals are ubiquitous.
- Critical materials are commonly found, but in relatively small quantities. A common example found in this supply chain is in metal plating.
- A very high number of conflict materials have been identified within the supply chain. These mostly exist in the form of tin solder, films, and other plating materials. Because these uses of materials are so widely employed in electronics products, the use of conflict materials is deeply
- Roughly half of the processes that we documented can be classified as 'highly energy intensive', and the majority of the processes are also inherently hazardous.
- Significant labour issues exist throughout the supply chain, and most of them pertain to exposure to workplace hazards. We were unable to accurately depict the level of human and workers rights issues due to a lack of specific information.

In summary the DSRM4.0 meter would score very poorly due to the ubiquity of impacts that we encountered in our analysis of the supply chain. It is clear that the information required to accurately quantify these impacts would be difficult to gather, as it would require a large amount of specific LCI data, that would have to be aggregated from a very large number of suppliers.

4.3 SUPPLIER INTERVIEWS

In addition to mapping the supply chain and assessing the performance of the DSRM4.0 meter, we directly contacted a number of suppliers who manufacture typical components found in the chain. Our interviews aimed to better understand the feasibility of collecting different types of data, the monitoring policies towards suppliers that are in place, and if there are internal or external policies regarding sustainability and fairness.

In our selection of suppliers for interviews, we identified suppliers from different tiers of the supply chain, as well as larger and smaller suppliers. This gave us a better understanding of how different supplier types, in different levels of the supply chain respond to questions about data collection and feasibility.

An overview of our interviews with parties in the supply chain includes:

- Original equipment manufacturers (OEMs)
    - Landis+Gyr
    - General Electric

- 2nd tier suppliers
    - Xemex (PCB module assembly)
    - Telit (antennas and LCDs)

- 3rd tier suppliers
    - Texas Instruments
    - Panasonic (resistors, transistors, integrated circuits and other microelectronics)

- 4th and 5th tier suppliers
    - Terminal manufacturers and smelters.

4.3.1 OVERVIEW OF RESULTS

Below is a summary of the primary takeaways from the interviews with suppliers that we had:

Most of the types of data that are needed in order to be included in the RIT framework are not routinely collected by parties in the industry. Companies do not track per- product bills of materials, nor do they generally have per product information on energy, water, waste, and emissions intensity.

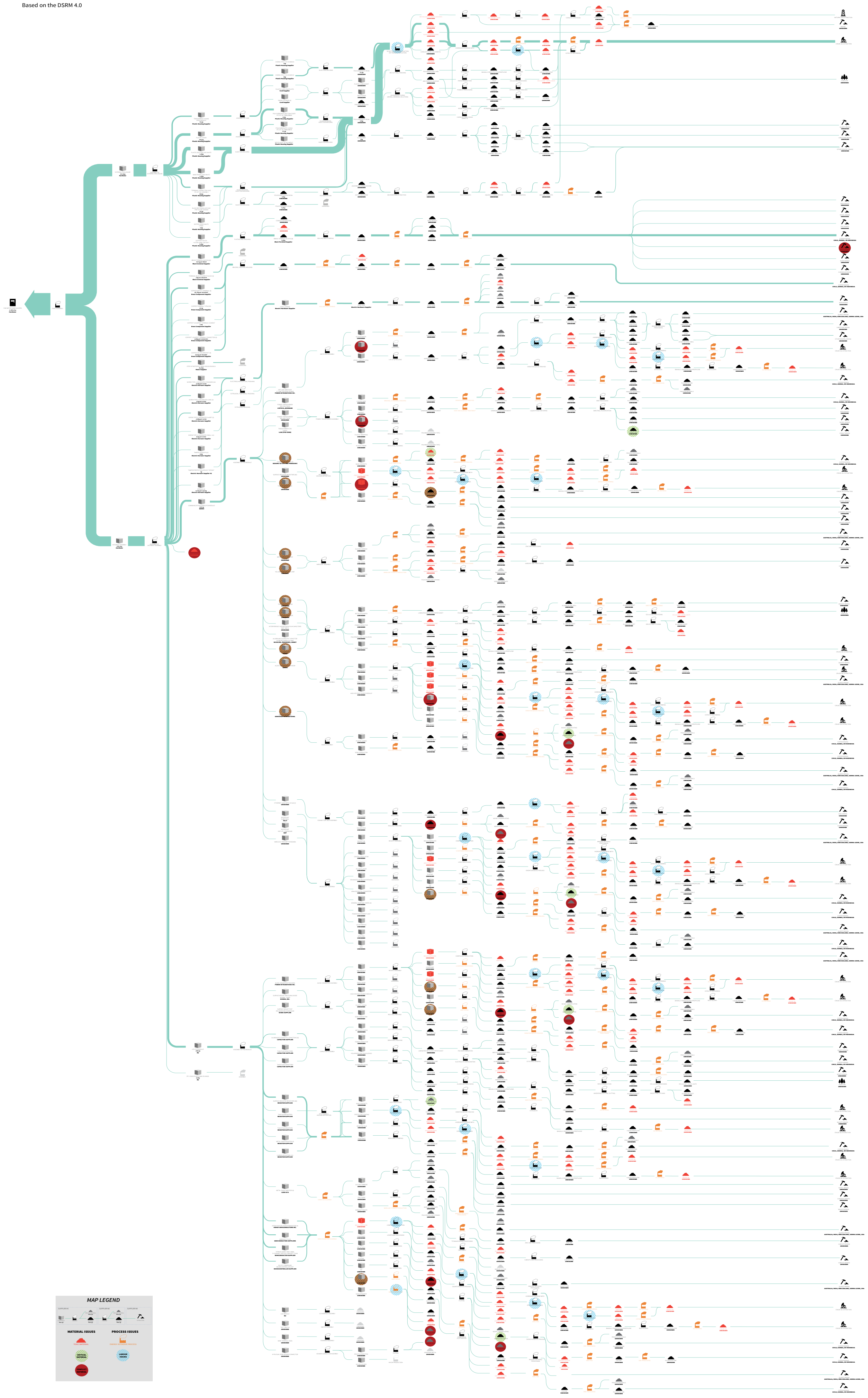
The cost of instituting these kinds of data collection efforts is considered very high. Unless there are legal requirements for collecting this kind of data (such as RoHS, REACH, or the Dodd-Frank Act), the industry is unlikely to be persuaded to independently set up data collection. Maxwell Technologies, in response to the Dodd- Frank Act, has completed a detailed survey process for its supply chain to begin identifying all smelters. They were able to achieve a 70% response rate among their suppliers (though not all responses contained all the relevant information they requested). Within only this part of their supply chain, they identified over 400 smelters, very few of which were certified as “conflict-free.”

Pressure from OEMs and parties further down in the supply chain has, in a limited number of cases, been successful at encouraging some suppliers to collect more detailed data. ON Semiconductor, based in Phoenix, Arizona, USA, for example, has product-level material tracking and detailed metrics for energy, water, and waste. They have also instituted many resource efficiency measures. This is largely in response to pressure from their primary buyers, which include Sony and Samsung.

It will be a challenging and longer-term process to comprehensively institute the necessary data collection and transparency within the electronics sector to apply the objectives of the RIT.

FAIR METER SUPPLY CHAIN OVERVIEW

Based on the DSRM 4.0



5. IMPLEMENTATION OF THE RIT FRAMEWORK

Just one example of how information about products can be transmitted digitally.
Image (CC) Tom Godber

Fully implementing a resource identification system will be a complex process requiring buy-in, commitment, and resources from across a broad range of stakeholders. In this section we will outline the quick wins that can be acted on in the short-term, but also go into detail on the longer-term aspects of a development strategy.

5.1 PRIORITIES & QUICK WINS FOR THE FAIRMETER PROCESS

Because “fairness” is the first priority for Stedin and Alliander, we suggest focusing on the more conventional aspects of “fair” before attempting to branch out further into the circularity and resource efficiency measures that were also identified as important in the FairMeter Prestatie Ladder. Within the assessment framework we present here, we have narrowed the scope of “Fair” to include: conflict minerals, health and safety, fair labor, and toxicity or hazard to humans resulting from the product’s supply chain (described in more detail in the framework overview). To even further narrow these areas of measure, the first focus can be on conflict minerals and fair labor.

As identified in our previous report, it is impossible to exclude any specific classes of components from an evaluation of “fairness,” since every family of components can be made in a way that requires the use of conflict minerals. The only parts of the product that could potentially be exempt from data collection on conflict minerals are: plastics, blank PCB boards, and packaging. However, even these parts of the product’s supply chain would ideally be assessed on fair labor conditions.

There are two broad strategies that can be pursued to remove conflict minerals from a supply chain. The first is to “design them out,” which would involve selecting solder or capacitor types, for example, that do not use conflict minerals. The second is to ensure that all of the minerals of concern that are used come from certified, conflict-free sources. The first strategy is generally inadvisable because it can lead to technological under-performance and potentially dramatic price increases in the end product. To fully assess that approach, a more detailed evaluation of component replacement options would be necessary (which could be done as part of a pilot project with suppliers).

Our recommendation is to pursue the second strategy: aiming to ensure that all materials used are certified conflict-free. While acquiring data for the "conflict" dimension via surveys, other supplier questions regarding labor conditions and other relevant parameters can also be requested. This will involve a standard, time-consuming supply chain survey process. However, based on what we uncovered in our supplier interviews, there may be some short-cuts possible. According to our assessment, the fastest possible ways of moving towards a "fair" product involve:

- Working with more advanced suppliers that are already collecting relevant kinds of information and have strong CSR policies (e.g., ON Semiconductor).
- Working with American-based suppliers who have already taken measures for reporting to the Dodd-Frank Act (e.g., Maxwell Technologies), or large suppliers that sell to the United States and must also conform with Dodd-Frank requirements.

Additional opportunities that could be taken advantage of for beginning to develop the fuller version of the RIT from existing infrastructure include:

- Partnering with CFSI to develop a chain-of-custody tracking system from its certified smelters (so that all certified smelters pass on a certificate to their buyers, that is carried with the products that are manufactured with conflict-free materials)
- Using existing mandated data collection (MSDS, RoHS, REACH) to start building out more detailed product-level information. Using these kinds of existing formats, it is possible to start evaluating more parameters of interest as defined in the RIT, though most data will still not be readily available.

It is clear that almost every micro-electronics product should be assumed to have conflict minerals. It does not seem feasible to exclude certain products based on family of components that are believed to be conflict-free. Through our research, we have seen that certain exceptions can be made however. For example, specific types of resistors or capacitors that are based on non-conflict minerals can be determined up-front.

Generally speaking, the only things that are likely not to have conflict minerals are the following components:

- Blank PCBs
- Plastics (housing, brackets)
- Packaging

5.1.1 QUICK WINS

Some of the main "quick wins" that we see are described below:

- *Specifically target or engage companies in the design process in the supply chain that can prove best practices in material selection, and have strict guidelines for suppliers. These companies are more likely to have already learned what works and what doesn't.*

- *Companies that work or sell to the US, which have to implement the Dodd Frank Act. There isn't European legislation on conflict minerals, only recommendations, which hasn't resulted in companies actively pursuing this data collection. E.g.: ON Semiconductor.*

- *Need to as a first step do research on suppliers and see what they say on sustainability and CSR. Having suppliers that don't understand the motivation or reasoning behind these sustainability measures, and making them start from scratch, would be difficult.*

- *Using RoHS and REACH data as a foundation for initial collection*

- *Material Safety Data Sheets can also be used to harvest a lot of data about components – also on toxicity and hazard (good start to g*etting this information)

5.2 DEVELOPMENT STRATEGY

When considering the long-term development strategy for the RIT, there are several aspects that would contribute to a comprehensive implementation plan. We present and discuss these key activities below.

5.2.1 ADMINISTRATIVE ACTIVITIES

Many of the immediate steps in implementation require coordination around decisions that will steer and support the implementation of technical activities.

1. Finalize the Assessment Areas for the Fair Meter Prestatie Ladder

In this document, we have outlined additional assessment areas and indicators that expand on the original Fair Meter Prestatie Ladder. The work presented in this research specifically includes a more in-depth assessment of Fairness, and includes new assessment areas such as circular economy. Based on feedback from the group regarding which assessment areas should be prioritized, we have expanded on a subset of assessment areas to include a more detailed list of indicators and data collection protocols.

A decision needs to be made on the finalization of the framework for the Prestatie Ladder, specifically which assessment areas ought to be finalized, and which should be left out. The finalized Prestatie Ladder will serve as a basis for how FairMeter conceptualizes issues such as Fairness, and how these issues are evaluated and measured through supply chains.

Formalizing the indicators and data collection protocols within the Prestatie Ladder will also facilitate many technical implementation steps, including the development of design guidelines, tendering guidelines, and the design of software systems for data collection.

2. Determine and Finalize a Scoring Framework for the Prestatie Ladder

We have identified a comprehensive list of assessment areas, indicators, and data collection protocols. What needs to be further developed is a scoring framework for each of the indicators, which provides an overall score to the final product. The scoring framework would also need to consider weighting factors for indicators which higher or lower importance.

3. Finalize and peer review assessment areas and indicators

After determining the final structure and scoring framework for the Prestatie Ladder, we recommend that it is peer reviewed by experts, and revised as necessary. We recommend that reviewers of the framework not only look into the assessment areas, but also the methods for evaluation and any anticipated difficulties in calculation in practice.

4. Set up a working group to oversee implementation

A working group consisting of suppliers and the original equipment manufacturer (OEM) for the FairMeter should be established. The purpose of this group would be to jointly develop and oversee the technical development and ongoing performance of the RIT. In a non-exhaustive list, some of the key responsibilities that we see may include:

- Create broad buy-in and continued commitment through the supply chain. One possible avenue to explore would be signing a joint intention agreement or manifest with as many suppliers in the chain as possible.
- Ensuring that the RIT system is well functioning, and that the collection and provision of data is streamlined with suppliers' existing data collection protocols.
- Continuous improvement programs with suppliers that aim to improve quality of data over time

5. Set up a Third Party Data Verification Process

An important activity in the overall development process of the RIT is establishing a third-party verification process that would be exclusively in charge of verifying the quality and accuracy of data delivered by suppliers. A part of this 3rd party's responsibility could also include conducting audits on suppliers though the supply chain. We envision this to be established over a longer time period however, and would not be a high priority as an immediate follow up step.

5.2.2 TECHNICAL IMPLEMENTATION ACTIVITIES

The basic functioning of the RIT can be achieved through the structured collection of data throughout the product's supply chain. There are many distinct technical elements that need to function together in order for the RIT system to function properly. A successful RIT will naturally be complex. However, the goal is to make this complexity invisible, and to have the people and organizations who need to use the RIT take easy and clear value from its use. In this section we will highlight the main steps that make up the technical implementation road map.

1. Decide on tracking versus tracing approach (this is largely dependent on which indicators and assessment areas are chosen)

The first decision that should be made before commencing any type of technical design of the RIT is the selecting either a "tracking" or "tracing" method for collecting information. Tracking refers to following a product as it passes down the supply chain towards the consumer, and gathering information on that product at every step of the chain. Tracking would require suppliers to digitally record or somehow 'embed' information on the product as it passes through their processes. Alternatively, tracing is a method that identifies the path back up the supply chain, and collects information at each step back to its ultimate point of origin or extraction. Tracing typically involves distributing surveys up the supply chain, and aggregating the responses from suppliers.

These two approaches have different implications when designing an RIT. For example, if conflict minerals will be the main area of assessment, then a tracking approach starting from CFSI smelters may be the best thing to initiate. A tracking approach would document every material addition to the product as it passes through the supply chain, and would give the OEM the best insight into where within the supply chain conflict minerals are being used. Alternatively, tracing, as applied by Maxwell Technologies could be implemented. Maxwell Technologies, in response to the Dodd- Frank Act, has completed a detailed survey process for its supply chain to begin identifying all smelters. They were able to achieve a 70% response rate among their suppliers (though not all responses contained all the relevant information they requested). Within only this part of their supply chain, they identified over 400 smelters, very few of which were certified as "conflict-free."

2. Design data collection protocols and guidelines for suppliers

As physical products move through the supply chain, there needs to be a clear set of protocols for scanning and entering relevant data about those products into the RIT system. This would require either the design and development of a means to physically "tag" and scan hardware elements and / or procedures for comprehensively documenting materials, components, and final products. In either of these approaches, there are two main types of data that would need to be collected:

- Technical and financial data that provide instructions and best practices for reuse, remanufacture, disassembly, and recycling of materials, components, and products.
- A comprehensive set of environmental and social impact data for the product, for all steps and activities along the supply chain.

In addition to the above data requirements, it might also be necessary to include additional protocols and guidelines to suppliers about how to allocate impacts per product.

We have found from interviews with suppliers that collecting and submitting data on individual components is perceived negatively, largely due to the costs of implementing the system, and time needed to complete the data request to high quality. It is important to keep in mind that the development of these collection protocols should attempt to minimize the burden on parties along the supply chain, and ideally integrate with existing data systems, if available.

One approach to collecting data per product would be to have a detailed data sheet that can be accessed through scanning the product. This could be accomplished through either a barcode or RFID tag. In such a system, each supplier would scan the component ID, presenting a digital data input sheet. The supplier (or OEM, if data is collected via surveys in a tracing system) would be able to add new information regarding that component, and store that new information in a database.

One key consideration of such a system would be the protection of intellectual property (IP) of individual suppliers. In the digital interface where suppliers enter data, there should be an IP screen that ensures that supplier information cannot be accessed by other parties.

3. Design and develop an appropriate software back-end

Arguably the most important aspect of the RIT is the creation of a system that stores and processes the data received from the supply chain. Using a centralized software platform to store the data will greatly facilitate oversight of the records, and allow for aggregation and processing of complex data. A software system would also ideally be able to conduct analytics and score the data according to the indicators that have been developed in the RIT framework.

A software tool would ideally integrate with the OEM's existing ERP system, and facilitate tracking information on products and components through the addition of bar codes or RFID tagging systems. Customized software could be developed to integrate specific auxiliary data sources such as national grid emissions data, toxic materials data, and critical materials data. However, designing and developing a software tool from scratch would require a significant amount of effort and development time

Alternatively, there are numerous platforms that already exist which are capable of storing and organizing the relevant information. Software solutions on the market range from open shell frameworks where the user defines the data structure, to more sophisticated tools that include built-in databases, automated form generation, and algorithmic analysis of data. There are several platforms that include one or more modules for the assessment of: EH&S, NEPA, RoHs, REACH, WEEE, JIG, conflict mineral compliance, environmental risk, waste streams, product BOM, sustainable design, and life cycle impact, among others. Many of the LCA tools are linked to databases containing information on different materials and processes, and include modules that analyze impact for parameters such as emissions and energy use across different steps in the supply chain.

Despite the wide range of solutions currently available, none of them include all of the features required to perform a holistic analysis of a product's fairness. One option is to use a combination of software tools, however storing data across several platforms may become complex and costly. Another approach could be to work a company that has already developed software that includes the right set of features for collecting and analyzing the data. Additional modules that focus specifically on checking against fairness criteria could be added to expand the existing software platform. Additional information can be found on specific software in the Appendix.

6. CONCLUSIONS AND FINAL RECOMMENDATIONS

In this report we have presented and evaluated a RIT framework that can be used to evaluate the performance of next generation smart meters. The framework covers five broad categories of evaluation, wherein we have elaborated on two of the categories; Fairness and Circularity. This framework has been developed as a first draft, and we recommend that it is further built upon and tested during the RIT pilot process as a next step.

- In order for the RIT to function well, a lot of data will be required.
- In practice, very little of this data is typically collected by suppliers
- Most data is difficult to get, however there are some minimum scenarios which include smelter information from CFSI certified sources, and RoHS documentation
- Currently, not many suppliers collect information beyond minimum reporting (if at all), and they perceive it as costly and difficult to implement.

In our evaluation of the data requirements and the necessary collection processes for a product like the upcoming SMR5 smart meter, we have recommended a subset of data that would be required to conduct a minimum assessment of fairness and circularity.

For a minimum assessment of the selected Fairness criteria, we recommend that the following data is collected:

- Smelter identification across the supply chain (via surveys)
- External CFSI smelter database
- RoHS certification data for products
- (Bill of Materials with a mass breakdown of each material at a component-level resolution) (because it is a minimum requirement for the Circularity criteria)

For a minimum assessment of the selected Circularity criteria, we recommend that the following data is collected:

- Bill of Materials with a mass breakdown of each material at a component-level resolution
- Recyclable materials reference list
- National grid mix reference dataset
- Critical materials reference list
- Renewable materials reference list
- WEEE compliance
- Supplier survey to collect additional contextual data (waste management practices, recycled content)

In addition to identifying and evaluating how to collect relevant data in procurement, there are several next steps in implementing the RIT framework can be taken in parallel. Many of the immediate steps in implementation require coordination around decisions that will steer and support the implementation of technical activities.

In terms of administrative activities, we recommend that the following that the following actions are taken:

- Conduct a peer review of the proposed framework
- Finalize the assessment areas of the framework for the FairMeter PrestatieLadder.
- Determine and apply a scoring framework to the final assessment areas within the updated PrestatieLadder
- Finalize the structure and scoring of the framework as an input for the FairMeter PrestatieLadder.
- Establish a working group that would oversee the technical implementation of the RIT

There are many additional areas within the technical implementation plan that should be further investigated, particularly in regard to the format and design of the software. In our research we have found that there are already many existing software that can collect this kind of information. We would strongly recommend investigating the options of using or modifying existing software tools in collaboration with a software developer.

We would recommend the following activities as first steps in the technical implementation plan.

- Decide on the method of data collection (tracking versus tracing approach) for the RIT
- Design data collection and data entry protocols and guidelines for suppliers
- Investigate options for developing a comprehensive software back-end for data collection, storage, and analysis

METABOLIC

Distelweg 113
1031HD Amsterdam
The Netherlands

info@metabolic.nl
+31 20 435 75 10

7. APPENDIX

1. SELECTED INTERVIEW NOTES

UMC (United Microelectronics Corporation)

- UMC manufactures semiconductors and silicon chips
- We spoke with their sales manager, at their Amsterdam office. Their headquarters are located in Taiwan
- His main comment was that they are too far down the supply chain to be relevant (his initial remark). He thought it would be more applicable for parties closer to the end user to be contacted
- Generally, it is possible for them to track Bills of Materials or things that happen within the scope of their company, but outside that (what happens at suppliers) they don't have control over.
- They do not track energy, water, or emissions on a product level. Collecting this data would be very difficult because it's not part of their regular business practices, and that it would just raise their overhead.
- The general feeling was that it would be difficult or impossible to get this information from their suppliers, or for them to even ask because they don't practice it themselves. They can't ask suppliers to do things they don't do themselves. He said it's generally not practiced in the industry.
- Tracking some of the information that we are looking for might be more applicable for industries like food where goods are more sensitive to environmental factors like temperature, or pressure. But he said that their products are very robust.
- In order for a tracking program to be successful, he said that it would have to be implemented in the logistics and shipping chain, because the information would have to be tracked in the containers of material that arrive. He said that it's often very high-paced movement of things: products come in, they get modified, and they get reshipped with another container of other material. They don't practice tracking or passing information.
- They don't use RFID. They get silicon wafers in containers and further process the materials. The barcodes usually contain product ID and description: basic general info, but nothing on material composition or this kind of thing.
- When asked about conflict minerals, he didn't know what they were. He said they always try to avoid banned materials, but don't have active measures implemented for avoiding these materials in their supply chain. So their strategy is avoidance rather than active control.

Maxwell Technologies:

- Maxwell Technologies manufactures energy technologies: ultra-capacitors, super-capacitors, and entire energy management systems on a chip – focused specifically on power, energy storage)
- Maxwell is one of twenty companies in the world certified to provide space technologies (NASA). Known for high- quality)
- We spoke with a representative in their purchasing department, who was actually involved in Maxwell's own conflict materials assessment.
- Not much information is available on how successful the initiative ultimately was. They surveyed 160 direct suppliers, with an average response rate of around 70%, and were able to identify over 400 smelters in just this part of their supply chain. Even from the ones that did respond, the surveys were largely incomplete.
- The further up the chain the information collection went, the less successful they were at getting data.
- For any new suppliers they work with they ask them to read and familiarize themselves with the Dodd Frank Act and the legislation surrounding conflict minerals.
- They have active risk mitigation. For suppliers that don't respond, he claims that they do have corrective measures. If suppliers don't comply with their guidelines they do have risk of discontinuing working relationships. (we doubt that this happens regularly, and certainly not with suppliers for whom they don't have good replacements). They as a company try to work closely with suppliers – probably more so than with other people.
- The only data they get regarding material composition is whatever comes in the MSDS with the product. This

data only pertains to materials that have specific handling or usage precautions (hazardous or toxic materials). This is the only extent of their material tracking. Philip asked if they buy a PCB from a supplier if they get a breakdown of the materials in it (e.g., copper, bisphenol A, etc.), and he said no. They also do not track energy usage or emissions on a per-product level. He assumed they were able to track these parameters or at least derive them on the basis of the overall energy and water use for their

- They usually are not producing just one type of product, so this complicates allocating impacts per product.
- Overhead cost associated with collecting this data is the primary barrier. Would require 1 or 2 FTE per company to continuously track and monitor this information.
- He also mentioned that tracking materials or trying to get some of this information on some of the simpler products, like ultra-capacitors, which have fewer components than their other power management systems, that would probably be easier than for more complex ones. The fewer components the easier it would be to get the data. For some of their more complex products, they have 50 suppliers feeding into one product, and that makes it much harder to get this data.
- One of the reasons they don't practice bill of materials tracking is due to IP. IP is a big barrier. They wouldn't want to have their suppliers think that they are trying to integrate downwards in the value chain and acquire key information about their products.

ON Semiconductor :

- ON is a global company, based in Phoenix, Arizona. Their main clients appear to be SONY, Samsung, Canon. Their OEMs seem to put pressure on them to certify their products – its easier if a big client puts pressure on them to do this)
- Interesting because they actually do track and make available lots of information on their products, including specific bill of materials composition of their subcomponents. The reason that they do BoM tracking is specifically for RoHS compliance, but they go beyond the basic information and collect additional data (percentage composition of all materials in products). They also track halogens, which are not banned by RoHS. They appear to also have tracking for water, fuel, electricity, waste management. They also have detailed data on product composition.
- They also have a take-back and recycling policy for their components, they also have a manufacturing scrap reclaiming center, green partner certification.

2. DATA COLLECTION SOFTWARE

There are a wide range of software tools on the market. Below are just a few examples of existing software tools that could be used to further develop an RIT:

1. 3E Green Product Analyzer (GPA)

- By 3E Company. The 3E GPA (Green Product Analyzer) provides data and information needed to support sustainability and EH&S compliance initiatives, giving EH&S and purchasing staff the detailed information they need about the chemical makeup of products -- information that will enable sophisticated analysis, application and decision support, and ultimately better product sourcing and management.

2. Environmental Knowledge and Assessment Tool (EKAT)

- By CABEM Technologies. The Environmental Knowledge and Assessment Tool (EKAT) is a software tool used to identify, research, and evaluate environmental and pollution prevention options for products and systems. EKAT is designed and built by the team of M2 Technologies, Kansas State University, and CABEM Technologies as members of the National Environmental Evaluation and Remediation Consortium (NEER). EKAT is a suite of integrated modules designed to mitigate safety and environmental risks associated with material, product and system use. EKAT's capabilities include: an environmental screening tool for regulatory requirements and potential issues of concern; estimating emissions from equipment or processes; an indoor air chemical concentration module; National Environmental Policy Act (NEPA) evaluations; and Programmatic Environment, Safety, and Occupational Health Evaluation (PESHE) reports required by the Department of Defense.

3. DataPipe Environment and Waste Modules

- By Knorr Associates Inc. DataPipe Environment and Waste Modules are part of the comprehensive DataPipe EH&S Software. You can purchase the entire system or individual modules. Environmental Modules include: Air Pollution, Emission Source Tests, Form R, Lab Packs, MSDS Generation, NPDES, Ozone Depleting Substances/CFCs, PCB Inventory & Containers, Process Models, Responsible Care, Storage Tanks, Tank Activity, TSCA, Waste Characterization, Waste Receiving, Waste Shipping, Waste Storage, Waste Treatment/Recovery, List of Lists, Permit History, Project Management, Spill Calculator, and Water Quality. It also includes modules for general activities such as Questionnaires and a Tickler/To-Do feature.

4. Product Ecology

- By WSP Digital, Part of WSP Environment & Energy. An online set of tools to help you design greener products. Product Ecology has four key features: Lifecycle Designer - analyses impacts from materials, production and transport through to end-of-life; ecoCompareTM - compares CO2 emissions, waste and water impacts of materials and processes; EcoDesign Quickstarts - checklists and sustainable design strategies; and Compliance Navigator - reviews product designs against specific regulations and standards. It is underpinned by the Ecoinvent database, which has been developed over many years by the Swiss Centre for Life Cycle Inventories.

5. Windchill (formerly InSight Product Analytics)

- By PTC (Parametric Technology Corporation). Windchill, PTC's Product Lifecycle Management (PLM) software enables companies to streamline product development processes and deliver superior physical goods and information products. The core of PTC's solution is built upon delivering a suite of capabilities to enable bill of material (BOM) analysis for environmental performance, cost, and reliability throughout the product lifecycle. Extending the environmental analytics capabilities of InSight, PTC acquired technology from Planet Metrics, Inc. This technology enables manufacturers and retailers to model, analyze and optimize carbon emissions and energy use throughout the entire value chain, from concept to end-of-life. The Planet Metrics software includes an exhaustive, normalized database of environmental profiles and combines both analytics and intuitive heat map displays that make it easy to identify high-impact "hot spots" in materials, packaging, supply chain, transportation, and disposal.

6. Windchill Compliance (formerly InSight Environmental Compliance)

- By PTC (Parametric Technology Corporation). Windchill Compliance, formerly InSight Environmental Compliance and Synapsis Technology's EMARS – is a solution for tracking and improving the environmental performance of your products, parts, materials, and suppliers. It can integrate with your existing supply chain and product development systems or function as a stand-alone system. Windchill Compliance is an easy-to-deploy, scalable, and industry-proven enterprise solution used by leading manufacturers, including Beckman Coulter, Cisco Systems, GE, IBM, Motorola, Sony Ericsson, Visteon, and Xerox. Stay up-to-date with constantly changing compliance requirements, exemptions, and horizon at-risk substances. Supported regulations and standards include: REACH, RoHS, WEEE, ELV, the Joint Industry Guide (JIG), and the Global Automotive Declarable Substance List (GADSL).

7. BOMtracker

- By Actio Corporation. BOMtracker (Bill of Materials Substance Tracking Solution) is a secure, online solution that provides oversight, analysis and substance volume tracking of multilevel BOMs. Rollups of part or substance data can be made across the enterprise, legal entity or location. Regulatory concerns for a part or substance are flagged based upon volume thresholds and regulatory requirements of the final shipment destination of the product. For the electronics industry, BOMtracker automatically creates material declarations in the IPC-1752 Class A, B, C and D and JIG 101 standard in order to alleviate the risk of product recalls and ensure compliance with RoHS, REACH and WEEE.

Actio also offers modules for tracking conflict mineral compliance, and secure material disclosure.