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The Contribution of Community Based Initiatives to Climate Change Mitigation

Exemplary GHG Accounting for Repairing and Sharing Initiatives in Berlin

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List of Abbreviations

CBI	Community Based Initiatives
CC	Collaborative consumption
CO_2e	Carbon dioxide equivalents
EF	Emission factor
GHG	Greenhouse gas
GPPA	Green House Gas Protocol for Project Accounting
KB	Kreuzberg
HWRC	Household Waste Recycling Centre
PCF	Product Carbon Footprint
RC	Repair Café
RI	Repair Initiative
SB	Schöneberg

Abstract

Though global warming is continuing, international agreements still require a lot of effort to be translated to the local level. However, the influence of community based initiatives on mitigation remains under-researched, especially in the field of sharing and repairing products.

Therefore, I conducted a GHG accounting with the help of the "GHG protocol for Project Accounting", exemplarily for two Repair Cafés and one All-Sharing Shop in Berlin. I calculated the emission reduction that results from the difference between the initiatives' major activity to a baseline scenario (the purchase of the repaired or lent product).

The Repair Cafés avoided about 1 tonne CO_2e in 2014 each, whereas Leila reduced about 9 tonnes CO_2e per year, representing about 60% and 85% respectively of all replaced products by the initiatives. From both a survey and evaluated literature, I can assess it to be probable that CBIs facilitate behaviour change in favour of mitigation by providing beneficial alternatives to consumption (like saving money or acquiring new skills).

The results have to be evaluated including restricting factors that have occurred due to a lack of data. Only one part of all products repaired/lent by the initiatives could be included in the account due to missing emission factors for products. The substitution factor is based on assumptions, such as only one lending/reparation of an item per person. The protocol has provided helpful guidance in the context of CBIs that repair and lend products by requiring certain principles on the on hand, and by allowing flexibility that makes its application into practice possible on the other hand.

The GHG accounting in this thesis generated a rough estimate on the contribution to mitigation by repair initiatives and sharing shops, but would require further research for better quality of results and for the assessment of wider influences in favour of sustainability.

1. Introduction

1.1 Climate change as a global and local challenge

In December 2015 at the 21st Conference of the Parties in Paris, governments and other stakeholders from all over the world, came together to achieve a new binding agreement on climate change.

> 195 nations signed to limit "global net temperature rise this century well below 2 [°C] and [...] [to] drive efforts to limit the temperature increase even further to 1.5 [°C] above pre-industrial levels. The 1.5 [°C] limit is a significantly safer defence line against the worst impacts of a changing climate. [...] The Paris Agreement for the first time brings all nations into a common cause based on their historic, current and future responsibilities." (UNFCCC, 2015)

It was therefore heralded as a "historic turning point" by the German minister for the environment (BMUB, 2015).

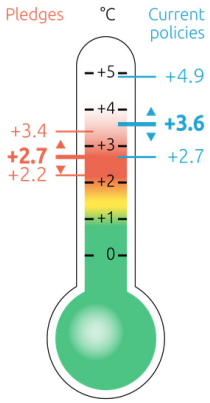


Figure 1: Effect of current pledges and policies on global temperature. 'Pledges' include all INDCs submitted by 7 December. (Climate Action Tracker, 2015)

However, the global level of greenhouse gas emissions (GHG) is still increasing (NOAA, 2015). Pledges for mitigation made by countries associated with the Paris agreement mentioned above are not sufficient to limit temperature rise to 2°C above pre-industrial levels until 2100, but will rather lead to a global warming of 2.7 °C (see Figure 1) (Climate Action Tracker, 2015). Not even the EU targets to reduce 40% of its emissions by 2030 (European Commission, 2015) is consistent with limiting warming to 2 °C, as "it would require many other countries to make a comparably greater effort and much deeper reductions" (Climate Action Tracker, 2015). Furthermore, current national policies worldwide will induce a global net

temperature rise of 3.6°C by the end of the century (Climate Action Tracker, 2015). It is therefore important to put the pledges of the Paris Agreement into practice and quickly launch concrete measures exceeding current policies.

Limiting the global warming to 2 °C by the end of the century would imply limiting GHG emissions per year and capita to 2 tonnes (PKKD, 2011, p. 8). However, the amount of carbon per capita currently emitted on average globally, greatly extents this necessity by about 5 tonnes. Germans for example, emitted 10.6 tonnes per person in 2005 (Schächtele & Hertle, 2007, p. 6).

Yet, if emission trends continue, there is a high risk that the Earth System will be destabilized and affected in its functioning to a degree that threatens its resilience, meaning its ability to overcome increasing human pressures and shocks (World Bank, 2013). It will thus be much less hospitable to the development of human societies (Steffen, et al., 2015, pp. 1259855-1). The concept of planetary boundaries (PB) identifies different "levels of anthropogenic perturbations below which the risk of destabilization of the earth system is likely to remain low" (Steffen, et al., 2015, p. 736) (see Figure 2). Genetic diversity, as much as nitrogen and phosphorus flows have admittedly extended the safe operating space. Climate change and biosphere integrity are connected to all other PBs: They provide overarching systems, but are at the same time regulated by the other boundary processes (Steffen, et al., 2015, pp. 1259855-8). Changes within these PBs may therefore threaten the stability of the whole earth system (Steffen, et al., 2015, pp. 1259855-8).

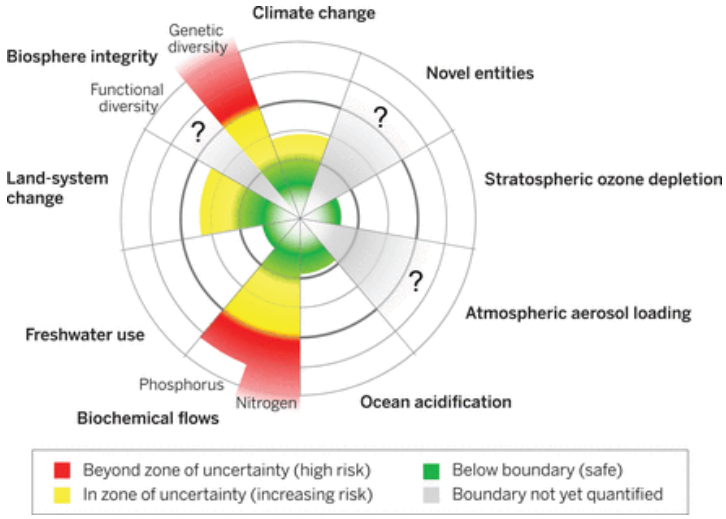


Figure 2: Current planetary boundaries, indicating the risk of the destabilization of the earth systems (Steffen, et al., 2015)

1.2 Placement of research on global warming in geography

Within the geographical research, global warming can be seen as one major phenomenon of Global Change. Its impacts and environmental, social and economic crises exacerbate and reinforce its dynamics mutually (WBGU 2011, p. 66). The term 'global change' summarizes alterations on global scale that are caused by the interplay between human activities and processes in the natural environment. Massive, worldwide changes in the human environment and living conditions have already occurred in the last century and will continue with same or increasing dynamics in the future (Mauser, 2011, p. 1171). This Bachelor thesis in Geography thus contributes to research on Global Change, as it deals with local, bottom-up answers and strategies to mitigate climate change.

Accordingly to the 'German Advisory Council on Global Change', the challenge of dealing with climate change is a key to understanding the complex global transformation processes. The council stresses that only through the interplay between moral, institutional, economical and technological processes can successful transformations be initiated. Interdisciplinary explanation patterns are necessary to find a way overcoming blockades (WBGU, 2014, p. 109). Geography as a bridging and integrating discipline provides a holistic perspective as much as high problem solving competence. It could therefore crucially contribute to research on environmental problems and climate change (Wardenga & Weichhart, 2011, p. 1086).

Related topics to climate change tie in with different geographical research areas: The German Power Shift and extension of renewable energies for example poses questions for spatial planning and participation. A more decentralized manner to produce energy as well as resource scarcity influences existing balances of power and geopolitical interests. Use of energy is also an important issue in debates of global justice and catch-up development (Sennekamp & Glaser, 2011, p. 333 f.). Regarding the spatial dislocation of impacts of global warming, climate change may become one of the biggest political challenges for societies in the 21st century (Mauser, 2011, p. 1171).

1.3 Community based initiatives in the field of mitigation

The transformation to a low-carbon society is highly challenging and implies enormous time constraints. Until now the Paris agreement can be considered as the overarching achievement of *top-down* strategies. Anyhow, the translation into concrete measures, like mitigation targets on different scales, does not yet accord with limiting global temperature rise to at the most 2°C by 2100 (see section 1.1). Mostly problematic is the gap between knowledge and action. Path-dependency, innovation blockades and institutional routines lock in new insights and paralyze momentum to action (WBGU, 2011, p. 255). Nevertheless, "global greenhouse gas emissions need to shrink to net zero some time [sic] between 2080 and 2100" (UNEP, 2014).

Important complementary measures with high emission reduction potential come *bottom-up* from actors such as regions, cities and companies (UNEP, 2014). In the course of a transition towards a low carbon future, community-based initiatives (CBIs), commonly also called grassroots or transition initiatives, play a vital role. They do not only raise environmental awareness, but as well provide practical alternatives and broaden the scope of action for individuals (Seyfang & Haxeltine, 2012, p. 383).

CBIs and their aims are defined as follows in this thesis:

> "Networks of activists and organisations generating novel bottom-up solutions for sustainable development and sustainable consumption [...] that respond to the local situation and the interests and values of the communities involved. In contrast to mainstream business greening, grassroots initiatives operate in civil society arenas and involve committed activists experimenting with social innovations as well as using greener technologies" (Seyfang & Smith, 2007, p. 585). They "aim to reduce dependency on non-renewable energy and [...] greenhouse gas carbon emissions, over time by creating fulfilling low carbon livelihoods in localised economies." (North & Longhurst, 2013, p. 1424)

CBIs thus make climate change tangible and provide alternatives to current paths. They give people a possibility to contribute to and shape the change to a low carbon future, giving them a feeling of empowerment. Creative solutions offer advantages

and direct outputs (Seyfang & Smith, 2007, p. 589) that may motivate intrinsically to behaviour change. The initiatives know the local conditions, can experiment on small scale in their niches, and thus make a quick implementation of possible innovations (Seyfang & Haxeltine, 2012, p. 384).

CBIs vary according to their form of organisation, their activities, motivation and networks. They can be cooperatives, voluntary associations, informal community groups or social enterprises. Activities include renewable energies, urban agriculture and food waste reduction, low carbon transport or a more sustainable housing and provision of goods and materials (Middlemiss & Parrish, 2010; Seyfang, 2010; North & Longhurst, 2013). They can unite political activists, scientists, citizen initiatives and hobbyists. Their motivation can be external and focus on the development of alternatives and internally alimented by the interaction of its members (Ornetzeder & Rohracher, 2013, p. 862).

Research on CBIs (cp. Figure 3) often has been undertaken with a focus on innovativeness and the question of what success means to them (Ornetzeder & Rohracher, 2013; Feola & Nunes, 2014). Embedded in a growing debate on how a transition to a sustainable society may take place (Middlemiss & Parrish, 2010; Heiskanen, et al., 2010), the question of their contribution to change is still not answered. Until now, their up-scaling potential remains unknown, especially in regard to mitigation measures (Seyfang & Smith, 2007; Seyfang & Haxeltine, 2012; North & Longhurst, 2013).

The German Advisory Council on Global Change recommends research on CBIs. They assume that initiatives can be change agents[1] and lead to a transition to a sustainable society. Knowledge of their effects would enhance political and social awareness and may even lead to higher financial support from external sources. It may furthermore provide information on how or if CBIs could be implemented in climate action plans. For CBIs themselves, it may be a possibility to improve their work and save resources. Scientific evidence on their contribution could also improve management and strategies to upscale their impacts and support reduction targets (WBGU, 2011, p. 255f.).

[1] change agents: “strategic actors who are (sometimes unconscious) pioneers of social change, spreading and awareness of the chances it offers” (WBGU, 2011, p. 243)

However, it is difficult to assess the impact of initiatives within the existing complex social-political settings of the transition processes. How CBIs evolve and intertwine, if and how they can be supported, accelerated or enlarged, and how they can be understood and as such evaluated, exist as only rudimentarily knowledge (Smith & Seyfang, 2013, p. 827). Their effect on climate change mitigation and on the provision of alternative solutions has sparsely been assessed (O'Hara, 2013, p. 6). Limited resources and few data collection possibilities especially constrain, not only research, but as well power to demonstrate their importance (Middlemiss & Parrish, 2010, p. 7566; Feola & Nunes, 2014, p. 233).

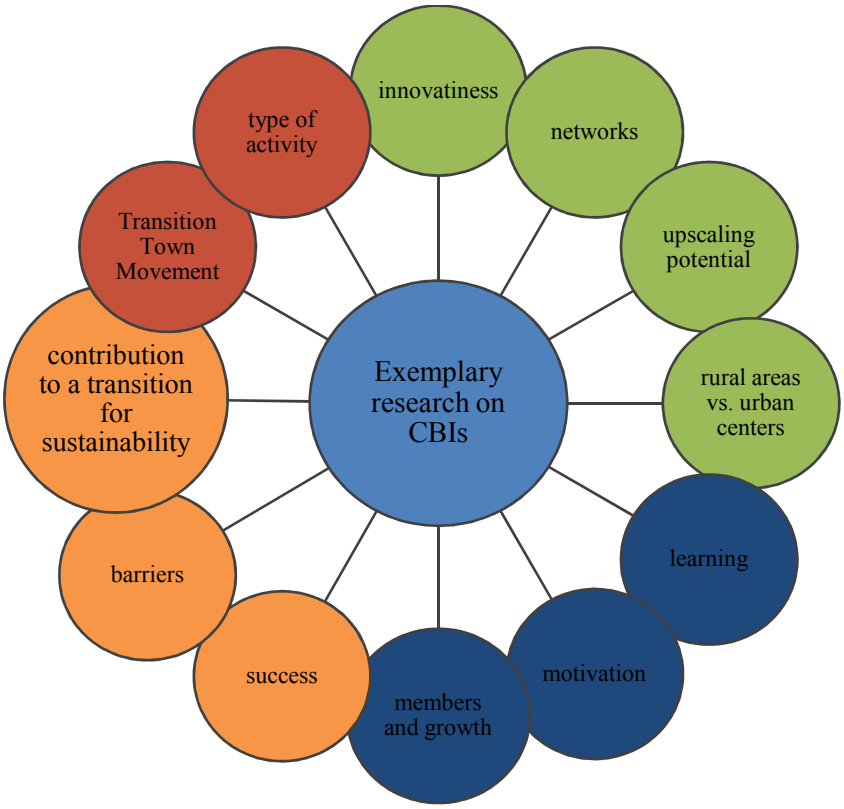


Figure 3: Summary of research on CBIs (own figure according to Feola & Nunes, 2014; North & Longhurst, 2013; Seyfang & Haxeltine, 2012; Smith & Seyfang, 2013)

To summarize, climate change has become a global challenge and current emissions trends are not sufficiently limiting to meet the target of limiting global warming to 2°C. On the one hand, international agreements take a long time to be ratified. On the other hand, bottom-up activities have already begun. However, success of bottom-up activities on the community level and the significance of their impacts on carbon reductions, as much as their contribution to a transition towards a low-carbon society, remain to be seen.

To address this research gap, I estimate the GHG reduction potential for a sample of

CBIs. I focus on CBIs active in repairing and sharing of products in the city of Berlin in Germany. The following paragraphs will provide insight into the mitigation potential of production and consumption of products.

1.4 Mitigation potential of the production and consumption of products

Energy- and resource-intensive consumption of private households is an important source of GHG emissions (Mont, 2004, p.135). It makes up about 40% of all GHG emissions in Germany. The purchase of products accounts for 2.8 tonnes CO_2 equivalents per capita and year in Germany[2] (see Figure 4) (PKKD, 2011, p. 5). However, consumption of products is rarely included in individual carbon footprint calculators[3] (Schächtele & Hertle, 2007, p. 12).

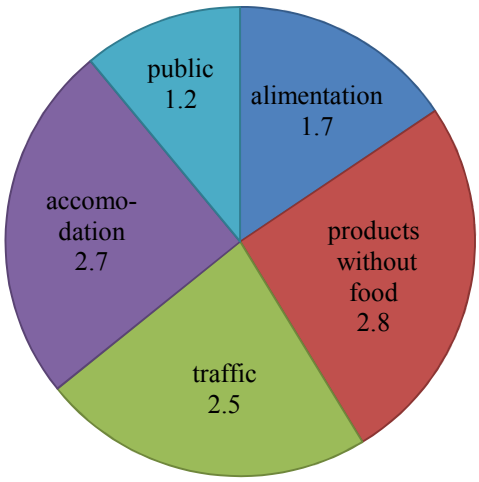


Figure 4: Average carbon footprint of Germans per year in tonnes of CO_2e
(own figure, accordingly to PKKD, 2011, p.5, data from Schächtele & Hertle, 2007)

In Berlin's feasibility study 'climate neutral Berlin 2050', the purchase of energy-saving appliances and the behaviour change of consumers is stated as important in reducing emissions up to 50% by mid-century (Reusswig, et al., 2014, p. 15). Since the amount of old inefficient products in private households is high, the reduction potential is assessed to be highest in the use-phase of appliances – assuming a rebound effect[4] will not occur. A betimes substitution of average white goods, for

[2] Based on Federal Statistic Office 2006: products and services, consumption for traffic, upstream processes included, export excluded (Schächtele & Hertle, 2007, p. 85)
[3] Included for example in those calculators: Ecospeed, Energiediät, LFU, FH Bielefeld or Proclim (Schächtele & Hertle, 2007, p. 12)
[4] *Rebound effect*: Measures that contribute positively to sustainability on isolated consideration but can generate effects with negative influence on sustainability matters in other dimensions, other areas of action or other (part-) systems (Paech, 2005, p. 111).

example, pays itself off in terms of GHG emissions. But if the portion of CO_2e emitted by the production of an item is high, such as in the case of computers, products should only be replaced at the end of their normal lifespan to reduce rebound effect (Reusswig, et al., 2014, p. 73).

In summary, "it seems that although improving efficiency of products and processes makes environmental sense, it is not enough in order to combat the scale of problems we face. Special attention should be given to current consumption levels and patterns [to avoid a rebound effect]." (Mont, 2004, p. 136) However, strategies aiming at a reduction or the abstinence of consumption (so called *sufficiency*[5]) are rarely included in climate action plans on municipal or regional scales (Schmitt, et al. 2015, p.35).

On the one hand, markets are demand driven and thus a certain power is inherent in consumers, giving them the possibility to spur a transition to sustainable low carbon production and consumption. This potential is still underestimated (Grin, et al., 2010, p. 331).
On the other hand, the consumption is also driven by market forces: the discussion of 'planned obsolescence' has recovered in importance in recent years. In popular media coverage, the term is equivalent to a shortening of product lifetime on purpose through the fitting of weak spots by the producers (Prakash, et al., 2015, p.14). In science, it is assumed that manufacturers are geared to product lifetimes as it is a projectable parameter and influenced by other factors such as use, care, technological modernisation and fashion. Service and the possibility to repair and availability of spare parts additionally determine the lifespan of products. So called psychological obsolescence describes the tendency of consumers to replace still functioning products, which generates high resource consumption (Prakash, et al., 2015, p.14f.).

In this thesis repairing and lending by CBIs are investigated as activities that provide alternatives to normal consumption routines and the disposal of products. They prolong product life spans and increase frequency or period of product use (see Figure 5). Thereby resource efficiency of products can be further increased. However, if those activities result in GHG reductions or not, is rather a question of

[5] The development and discussion of those kinds of strategies can be read for example in debates on de-growth (e.g. Seidl & Zahrnt, 2010; Paech, 2013), green growth (e.g. Beckenbach, et al., 2012) or circular economy (e.g. Pauli, 2010).

GHG payback periods that vary for different product groups, as explained above. This aspect will not be covered in the calculations.

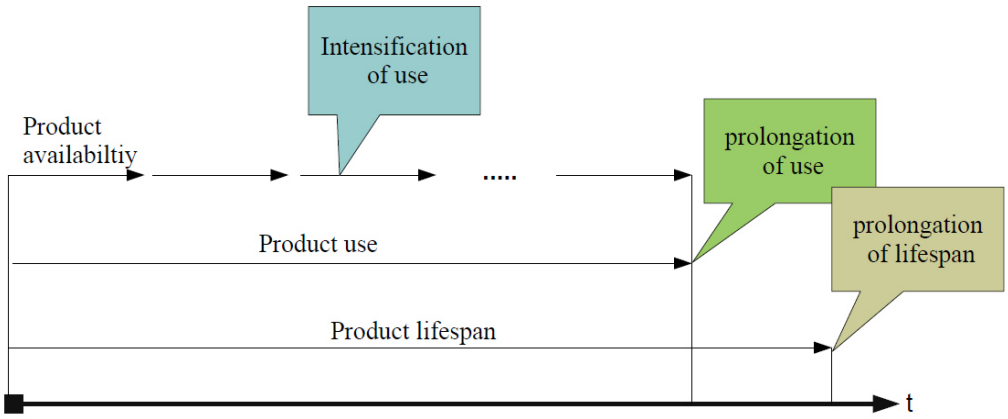


Figure 5: Comparison of increased product efficiency resulting from systems of use not necessarily based on property of goods (own figure, based on Paech 2005, p.341). Sharing mainly implies an intensification and prolongation of use, maybe a prolongation of lifespan. Repairing leads to prolongation of lifespan and makes prolongation of use possible. It could be the case that repaired items are used more frequently, because their performance has improved or additional functions could be recovered.

1.5 CBIs active in sharing and repairing in Berlin

Repair Initiatives

CBIs active in repairing, (in the following called Repair Initiatives (RIs)), organise gatherings, where broken every-day-appliances can be repaired collectively and technical support is provided. Devices repaired mostly cover electrical or mechanical household appliances and consumer electronics, wherefore particular skills are needed; but can also include items like cloths, bicycles or toys (Reperatur-Initiativen, 2016). RIs also undertake product modification, e.g. to improve the fit of clothing or to improve performance of computers. This includes upcycling of waste electrical equipment and reuse of sub-assemblies into new applications (Charter & Keiller, 2014, p. 7). RIs set up appropriate infrastructure usually financed only by voluntary donations, as “in developed countries it is hard to find repair shops for, say, a TV set, or a vacuum cleaner. These are scarce because people prefer to buy new ones, which is probably cheaper than repairing the old unit.” (Munier, 2005, p. 72) The gatherings are non-commercial, based on volunteer work. They aim at reducing waste and spare resources, and test sustainable lifestyles in practice. RIs aim at undermining strategies of planned obsolescence by prolonging the use of items. The vision is not

to provide repairing service for free, but to encourage people to help themselves. Interested participants and volunteering tinkerers can share their experience and learning while having coffee and cake. Thus, RIs also strengthen neighbourhood communication (Reperatur-Initiativen, 2016).

Figure 6: RC in Friedrichshain (Fehrbellinerstraße) (own picture)

Figure 7: logo of 'Stichting Repair Café' (figure from their homepage)

The first RI, called Repair Café (RC), was organised in 2009 in Amsterdam by Martine Postma. In 2011 she founded the Dutch NGO 'Stichting Repair Café' that builds a worldwide network and provides support to local groups that wish to start their own RC (Stichting Repair Café, 2016). In Germany more than 300 RIs exist that are supported by the foundation 'anstiftung' (Stiftungsgemeinschaft anstiftung&ertomis, 2016; Reperatur-Initiativen, 2016). The established 'fixing economy', including car repair for example, has been accomplished by new organisations helping to repair and maintain consumer products (Charter & Keiller, 2014, p. 3). A survey on RCs conducted in 2014 worldwide has shown that 95% have operated for two years or less (Charter & Keiller, 2014, p. 4).

Figure 8: RCs and Leila in Berlin (own map based on Open Street Map, data fro**m repaircafe.org)**

In Berlin, currently 19 RCs exist since 2013 (cp. Figure 8) that are part of the RC foundation (Stichting Repair Café, 2016). Another RI (called 'Reperatur Café') was initiated in 2012 by the association 'Murks? Nein Danke!'. For this thesis, I will investigate the following RCs, as these provided the most reliable and best quality data (see section 2.3.4).

- RC Kreuzberg (Alexandrinenstraße): Is part of the organising association Kunststoffe e.V. and exists since 2013 (Kunststoffe e.V., 2016; BUND Berlin, 2013)
- RC Schöneberg (Crellestraße): Maintenance by 'Friends of the Earth' (BUND), exists since June 2014 (BUND Berlin, 2016).

Sharing Initiatives

The number of sharing shops in Europe is continuously increasing. Examples can be found in Vienna, Bologna, Heidelberg, Graz and London (Leila all-sharing-shop, 2016). The initiatives lend a variety of goods that are then used longer or more frequently (cp. Figure 5). They promote the idea of shared use and collaborative consumption[6] (CC), including a just distribution of goods that are nowadays

[6] *Collaborative consumption* " is people coordinating the acquisition and distribution of a resource for a fee or other compensation. [...] But this definition of collaborative consumption excludes sharing activities [...] because there is no compensation involved. [...] The definition also excludes gift giving which involves a permanent transfer of ownership." (Belk, 2014, p. 1597) "Borrowing and lending are borderline cases of sharing that generate an expectation that the object or some equivalent will be returned." (Belk, 2014, p. 1596)

available in abundance. Community shops can foster social exchange and become places of education and networking (GeLa e.V., 2016). Additional possibilities are provided by the internet platforms 'fairleihen.de' (especially for people living in Berlin), 'frents.com' and 'Leihdirwas.de'.

Another CBI investigated in this thesis is the first borrowing shop in Berlin, Prenzlauer Berg (Fehrbellinerstraße), called 'Leila all-sharing-shop'. It has existed since 2010 and is a project of the network 'Transition Town[7] Pankow'. To borrow, people must be members of the initiative and donate at least one product the shop. A voluntary membership fee of one to three Euros is paid monthly to the supporting association 'GeLa e.V'. An additional fine is charged, if the deadline for returning goods is exceeded, and for some products, an extra deposit needs to be disbursed (Leila all-sharing-shop, 2016).

Figure 9: impression from the virtual tour and logo of Leila **(Leila all-sharing-shop, 2016)**

1.6 Research questions

As mentioned in section 1.3, CBIs are still under-researched – especially their impact on climate change mitigation. Investigations into initiatives active in providing goods and materials are even scarcer. In this thesis, I will therefore analyse the contribution of CBIs active in repairing and sharing to climate change mitigation, and thus how they share into a transition to a more sustainable society.

[7] *Transition Town movement*: A civil society movement that aims to address the twin challenges of climate change and peak oil, through local community-based action reducing the dependency on fossil fuels (Seyfang & Haxeltine, 2012, p. 385).

In order to achieve the described aim of this thesis, my research questions are the following two:

RQ1: How can the GHG reductions of CBIs active in repairing and sharing, be estimated?

RQ2: What is the contribution to climate change mitigation by the selected CBIs?

In the next section, a methodology to estimate GHG reductions of the selected CBIs will be developed (chapter 2). I will then present results of the calculations in chapter 3 and discuss those results, together with the methodology applied, in chapter 4. Conclusions and an outlook on CBIs' mitigation potential follow in chapter 5.

2. GHG accounting for mitigation projects

In order to assess the contribution of CBIs active in sharing and repairing to climate change mitigation, a simplified GHG accounting was conducted. In chapter 2.1, I will provide an overview on the method. The "GHG Protocol for Project Accounting" (WRI & WBCSD, 2005) served as a guidance document and framework in this thesis (section 2.2). I will outline the methodology used for the exemplary accounting for CBIs in Berlin in chapter 2.3 and thereby answer RQ1.

2.1 What is GHG accounting?

GHG accounting is also called 'carbon accounting', 'carbon footprint', or 'climate footprint' to give a few examples (Stechemesser & Guenther, 2012, p. 21). Stechemesser who undertook a comprehensive review of 129 publications on GHG accounting in 2012 evolved the following definition for carbon accounting:

> "**Carbon accounting** comprises the **recognition**, the nonmonetary and monetary **evaluation** and the **monitoring** of greenhouse gas emissions on **all levels of the value chain** and the recognition, evaluation and monitoring of the **effects** of these emissions on the carbon cycle of ecosystems." (Stechemesser & Guenther, 2012, p. 35)

Thus carbon accounting can be seen as one part of Life Cycle Assessment (LCA)[8], also known as 'cradle-to-grave analysis', but focussing only on GHG emissions. In difference to a 'cradle-to-gate analysis', LCA also includes the use, disposal or recycling of a product (Pandey, et al., 2011, p.143).

GHG accounting can be applied to products, as well as to official institutional bodies on different spatial scales like nations or cities, as much as for private households, companies, organisations or projects (Stechemesser & Guenther, 2012, p. 25). Several online carbon footprint calculators also exist for individual accountings (see section 1.4).

[8] LCA investigates the range of environmental impacts from all stages of a product, service or process (Pandey, et al., 2011, p.143).

For this thesis I applied two different approaches of carbon accounting: An evaluation of GHG reductions accordingly to activities of the case studies (see sections 2.3.2, 2.3.4 and 2.3.6) which included the Product Carbon Footprints (PCFs) of repaired and shared products based on a literature review (see section 2.3.5). The accounting encompasses the amount of emissions reduced by the CBIs.

Several frameworks with guidelines and requirements for carbon accounting exist (e.g. PAS 2050 (BSI, 2011); OEF (European Commission, 2012); ISO 14064/ 14025/14067 (ISO, 2006); IPCC guidelines for National Greenhouse Gas inventories (IPCC, 2006); cp. Pandey, et al., 2011, p.143). However, the level of standardization is rather low (Ibrahim, et al. 2012, p.2f). Upstream value chain processes are included into the various accounting schemes at different depths. The range of gases assessed in the accountings highly varies: Calculations may only include Carbon or carbon dioxide (CO_2), but may as well include gases ratified in the Kyoto Protocol[9] or all GHGs indicated with the Global Warming Potential (GWP) 100[10] in CO_2 equivalents (CO_2e) (Pandey, et al., 2011, p.136; Stechemesser & Guenther, 2012, p.25). The methodology of carbon accounting is quite controversial due to its data variability and lack of transparency (Pandey, et al., 2011, 137) and may be biased by the initiator (Lippert, 2012). Burritt and Tingey-Holyoak stressed the gap between scientific research in the field of carbon accounting and application by practitioners with rather practical knowledge. They suggest researchers to getting involved and accompany the implementation of developed indicators and tools (Burritt & Tingey-Holyoak, 2012, pp. 41-42). This thesis therefore developed the concept further into a simplified approach (but in a systematic and transparent manner) which will has been applied to three case studies in Berlin. The intention of the presentation of examples is to make them replicable for practitioners.

[9] The Kyoto Protocol is an international agreement linked to the UNFCCC, which commits its Parties to setting internationally binding emission reduction targets. TI was adopted in Kyoto in 1997 and entered into force in 2005. Its first commitment period started in 2008 and ended in 2012 (UNFCCC, 2015). Targets for the first commitment period cover emissions of six main GHGs : carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and Sulphur hexafluoride (SF_6) (UNFCCC, 2016)

[10] GWP 100: "Not all GHGs have equal capacity to cause warming but their strengths depend on radiative forcing it causes and the average time for which that gas molecule stays in the atmosphere. Considering these two together, the average warming it can cause, known as 'global warming potential' (GWP), is calculated mathematically and is expressed relative to that of CO2. Therefore, unit of GWP is carbon dioxide equivalent (CO2-e)." (Pandey, et al., 2011, p.36)

2.2 The 'GHG Protocol for Project Accounting' as a guidance Document

The 'GHG Protocol for Project Accounting' (in the following abbreviated GPPA) was published in 2005 by the GHG Protocol Initiative[11]. This initiative was founded in 1998 by the World Business Council for Sustainable Development (WBCSD) and the World Resources Institute (WRI). Its "mission is to develop internationally accepted greenhouse gas (GHG) accounting and reporting standards and/or protocols and to promote their broad adoption" (WRI & WBCSD, 2005, p. 4).

The GPPA provides a framework to estimate the amount of GHG reduction. It was selected for this thesis, as it fits best to the scale of accounting for CBIs. Its approach is to take GHG of core activities into account, instead of calculating corporate or entity-wide numbers, or in this case an overall footprint of the initiative. As explained above, it is not designed to calculate corporate or entity-wide numbers (WRI & WBCSD, 2005, p. 5). This makes it possible to assess the main impacts, without listing activities that are common to many initiatives, such as paperwork or external communication. These may be complex to assess and can be assumed to have a marginal impact.

This is achieved by calculating emissions reduced due to project activities and comparing it to a defined baseline scenario that represents business-as-usual (see Figure 10). This baseline scenario describes the hypothetical emissions in absence of the activity.

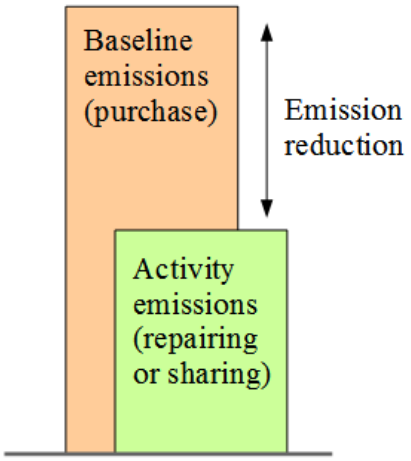


Figure 10: Difference of activity emissions and baseline emissions (own figure)

[11]The protocol available online: http://www.ghgprotocol.org/standards/project-protocol

$$E_{reduct} = E_{act} - E_{base}$$

$$E_{reduct} := Emission\,reductions \quad E_{act} := emissions\,of\,activity \quad E_{base} := emissions\,of\,baseline$$

In the case of initiatives active in repairing and sharing, emissions of activity result from the avoided production, distribution and disposal or recycling of products repaired/lent (see section 2.3.4). Baseline emissions represent the first-hand purchasing of the same items (see section 2.3.5).

CBIs' activities are mostly based on volunteer work, which is rather focussed on the initiative's core aims repairing or sharing. This makes documentation and monitoring processes of their effects more challenging. Due to these constraints for an accounting, the GPPA is a well-suited framework, because its "requirements are extensive [and] there is considerable flexibility in meeting them" (WRI & WBCSD, 2005, p. 5). This involves that the protocol "is not intended to be biased toward any specific programs or policies, [but] the accounting decisions [...] are left to the discretion of its users" (WRI & WBCSD, 2005, p. 5). It does not give guidance for addressing uncertainty or conducting third-party verification. However, its authors highly suggest a maximum of transparency, when justifying necessary decisions and assumptions to ensure quality of calculations. The protocol thus is thought to be a guiding document that allows certain modification to simplify an implication into practice and increase the usefulness of results (WRI & WBCSD, 2005, p. 5).

Accordingly the essential guidance by the GHG protocol is given within the following principles suggested (WRI & WBCSD, 2005, p. 23f.):

1. **Relevance**: Data, methods, criteria and assumptions should only include what is needed for decision making.
2. **Completeness**: All relevant information that may affect the accounting and quantification of GHG should be considered and all requirements should be completed.
3. **Consistency**: Data, methods, criteria and assumptions should always be used in the same manner for different GHG projects to allow meaningful comparison over time.
4. **Transparency**: Clear and sufficient information should be provided for reviewers to assess the credibility and reliability of GHG reduction claims like excludes, assumptions and references.

5. **Accuracy**: Uncertainties in measurements, estimates or calculations should be reduced as much as is practical; bias should be avoided.

6. **Conservativeness**: Assumptions, values and procedures should rather underestimate than overestimate, if uncertainty is high.

In this thesis I developed a systematic concept to measure the contributions to mitigation of CBIs active in repairing and sharing, based on the GPPA (addressing RQ2). Due to the low data availability of the CBIs (see section 2.3.3), the concept is based on several assumptions to make the carbon accounting possible. In this case, all information have been provided for maximum transparency (principle no.4). In the case of CBIs, it was especially challenging to meet the principle of accuracy (no.5). Though calculations should not result in underestimated amounts of GHGs – considering that CBIs may participate in the accounting to raise awareness or financial support (see section 1.4) – the principle of conservativeness (no. 6) represents an overarching premise. Despite the numerous constraints, this approach balances out requirements for the principles and feasibility of the accounting.

2.3 Exemplary GHG accounting for CBIs active in repairing and sharing in Berlin

2.3.1 Structure of the accounting

One important requirement by the GPPA is the principles outlined above and the key idea to calculate reductions of GHG emissions. The structure suggested by the protocol (see Figure 38 in annex A) has been applied in a modified manner in this thesis to simplify the understanding (see Table 1). The following sections follow this structure.

Table 1: Comparison of GPPA structure and sections in this thesis

Section in protocol	Step of procedure	Section in this thesis	Questions to be answered
Define the GHG Assessment Boundary	Define Project activity and primary and secondary effects included	2.3.2	What exactly is defined as the project activity that makes the difference to a baseline scenario? What effects occur and which ones can be included in the accounting based on their significance and data availability?
Select a baseline procedure	Explain the selection of case	2.3.3	Is the data quality good enough for useful results? What assumptions or

	studies, give information on data and its limits		exclusions have been made to the lack of data?
Identify Baseline Candidates	Define substitution factors	2.3.4	What is a suitable baseline scenario? How can the difference to a baseline scenario be translated into substitution factors?
Identify Baseline Candidates, Estimate Baseline Emissions, Monitor and Quantify Reductions	Accounting Baseline Emissions	2.3.5	How can the baseline scenario, the regular purchasing of goods, be measured? What exactly (which part) is substituted by the initiative?
Report GHG Reductions	Accounting GHG Emission Reductions	2.3.6	How can those factors be merged into the calculations of emission reductions?

2.3.2 Defining primary and secondary effects included in the accounting

To decide on the system boundaries and on significant effects included it is necessary to make the investigation feasible, but cover the CBIs' activities best.

The primary effect of repairing and sharing was defined as the replacement of newly produced goods with goods associated with the project activity. This resulted in a reduction of emissions from the production process, from distribution and from a reduction in waste. Repairing can mainly be seen as an intensification of use due to life-time prolonging, whereas sharing results in intensification or prolonging of use due to multiple users (cp. Figure 5).

Further secondary effects have been identified and assessed in their significance:

- Emissions related to the installation and use of infrastructure and further equipment for repairing and sharing, were assumed to be higher for the installation of infrastructure to produce new goods. In order to stay conservative, these higher emissions have consequently been excluded.

- The material and energy used for repairing of goods, includes an increase in emissions. I assumed this to be marginal, as only spare parts need to be purchased or can even regularly be taken from non-repairable goods, which people donate to the initiative. The amount of energy used for repairing was difficult to assess, because RIs only take place once or twice a month and locations are often used in multiple ways. For the selected case-studies data on energy and material input has not been documented and thus is excluded from all case studies.

- I assumed that the transportation of reused or repaired goods by the participants to the place where the activity is performed is equal to the distances customers cover for shopping and the distances covered for the delivery to a disposal site; though waste collection can be expected to be more efficient. In addition, the RIs mostly provide service to their immediate neighbourhood, so that people may use their bicycle or come by foot (see Table 10 in annex A based on own survey).

- Buying new, more efficient products may contribute to higher emission reduction than repairing old devices with a high use of energy. However, this only applies to a few product categories, e.g. for coffee machines (Stratmann & Grießhammer, 2009). Also, the redemption in terms of GHG of new items requires long life-times – often longer than in fact achieved or even possible (e.g. for laptops (Prakash, et al, 2012)). As this complex process is beyond the scope of this thesis, the effect has been excluded.

- The cost of goods provided by the initiatives was expected to be smaller, than those of new products. I presumed that savings are marginal compared to the cost of new products, due to the spare parts needed and financial donations to the initiative. Though possibly more money is spent on the consumption of additional goods leading to a rebound effect and increased emissions (cp. Sorrell, 2007, p. 35), I assumed this effect to be small and exclude it in this thesis.

- Repairing could also lead to additional devices, if for example only one function of a combined music player (e.g. CD and radio) can be repaired; another device with this single function would have been purchased, but later the repaired device breaks and has to be bought again. The same could happen with spare parts purchased for products that cannot be repaired in the end. This effect could not be assessed in this thesis, but was assumed to not occur regularly.

- A potential shorter lifetime of products could not be taken into account for the calculations, because data on the altered life-time of repaired products was not available. Yet, it may occur that the life-time of newly bought products even appears to be shorter; due to obsolescence strategies (Prakash, et al., 2015, p. 98).

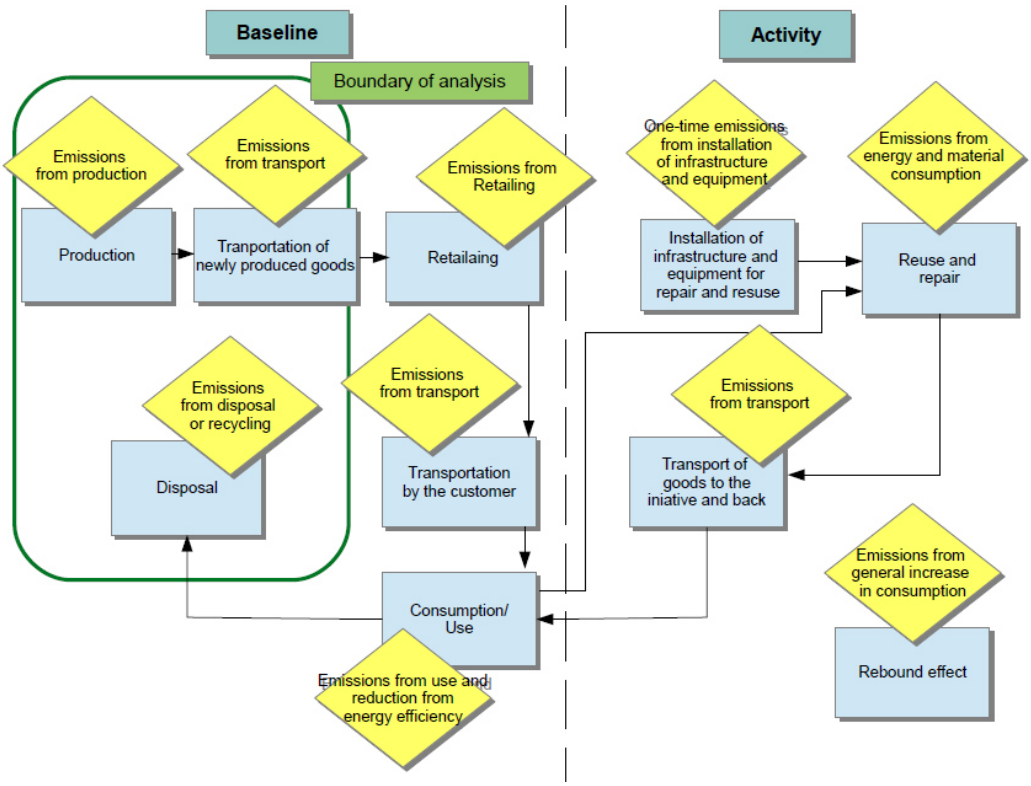


Figure 11: Boundaries of accounting (own figure): comparison of baseline scenario (left side) and project activity (right side). The boundaries of analysis show considered activities (blue boxes) and relating emissions (yellow boxes) that are avoided by the initiative's activity.

2.3.3 Data provided by the initiatives

For the GHG accounting in this thesis I selected three case studies that provided a satisfying set of data required for the calculations: RC KB, RC SB and Sharing Shop Leila (see section 2.3.3).

Data provided by the initiatives (cp. Table 2), comprises products repaired from June 2014 to May 2015 (KB), from June 2014 to July 2015 (SB) and lent in 2014 (Leila). RCs register participants and repaired products with the help of a consent form provided by Repair-Café.org (see Figure 39 annex A). Leila uses a database to keep track of lent items.

The range of products provided by the initiatives highly varies accordingly to their activity. RIs mostly list electronics like kitchen appliances, music equipment and computers. Leila also lends other products like bags, books sports, outdoor and children equipment, tools, toys and housewares. The RC KB cooperates with a company that provides support with repairing smart-phones and online open-source instructions. To strengthen the RC movement, the company additionally offers the

purchase of spare parts at half-price (Kunststoffe e.V., 2016). This extra service probably leads to a higher number of repaired smart-phones in RC KB compared to the other repairing initiatives.

The level of uncertainty in the data provided is high, due to volunteer accountancy: Lists stay incomplete, as some people do not register or do not properly fill out the consent form; hand writing is not possible to decipher; people do not declare, when leaving, if their item was repaired or not. Thus there may be more items repaired, than the initiative is able to document. However, it is still in line with the principle of conservativeness.

Some data entries suggest the plurality of items, like 'cutlery' or 'card boxes'. In this case I took the amount of available objects displayed on Leila's Homepage into account if available, or assume the number '5'. I supposed this number to be conservative average, as most of these entries contain sets of housewares assumable consistent of a higher number of items.

For Leila, data obtained does not include information on whether one item has been lent several times or different items have been lent once. The number of people borrowing is not known either. Data provided by RC KB does not include whether two items were repaired or one person came twice to repair one product. I assigned one unique person (i.e. one action of repair or borrowing) to each item in the list. The assumption was here that participants would not repair or repetitively borrow the same item but rather buy it themselves then (further elaboration in 4.3).

Table 2: Overview on data provided by the initiatives and its use in this thesis

	Time span of data	Information on...	Uncertainty and data gaps	Used for ...
RC KB	June 14 – May 15	repaired products, success of repairing, month	whether the repair was successful not always known; number of participants and visits per participant missing	Accounting GHG emission reductions (number of products repair rate) (2.3.6)
RC SB	June 14 – July 15	repaired products, defaults, success and manner of repairing, name of participants, tinkerer, date	number of visit per product and participant (the name of participant and type of product makes assumptions possible, but gives no certain result, so that this data is not used here); success of reparation not always known	

Leila	2014	Amount and description of lent products, calendar week	Often no exact numbers of products; frequency of lending a product and to how many participants missing	

Data received from beneficiaries of the CBIs via a survey

To gather data beyond the list of items provided by the CBIs, I carried out an additional survey among participants in RCs in Berlin and Leila from July to beginning of September 2015 (cp. Table 3). As the number of participants in the selected case studies would have been low for a statistical evaluation of the data, I decided to broaden the survey to all RIs located in Berlin.

The primary aim was to answer, if the participants would have bought the item in absence of the CBI. I prepared a questionnaire asking for additionally reasons why people come to the CBIs as well as for potential changes of their consumer behaviour due to the activities of the initiatives. For Leila an additional aim of the survey was to receive data on the number of persons borrowing one item. To offer another option to people with limited time or cooperativeness to participate, I shortened the questionnaire to the primary aim of the survey (cp. Table 4 and annex B).

In the face-to-face interviews in RIs the response rate and willingness to answer questions was almost a hundred percent. The feedback rate for questionnaires sent to the initiatives (including Leila) that have been filled out by participants was lower. Unfortunately, the response rate for Leila was very low (7 questionnaires) and the answers included poor elaboration. Therefore, in the case of Leila, the data generated from the survey cannot be taken into account for the calculations. The survey data from RIs has been used for the differentiation between the baseline procedure and the project activity (see 2.3.4). The evaluation of data has been conducted with the program SPSS.

Table 3: Overview on own survey

	Leila	RIs			
Number of initiatives	1	18			
Time span of survey	July and August 2016	July to beginning of September 2016			
Responses	7	133			
Type: short/long questionnaire? filled out or face-to-face?	Long and sent	Long personal 97	Long sent 14	Short personal 4	Short sent 18

Table 4: Overview on data gained with the survey among participants and its use in this thesis

No. of question	Details	Uncertainty and missing of information	Short/long questionnaire	Used for .../Not used because...
1	**products**	Number of further products brought on the same date	Long and short	Not possible to use data for average numbers per date
1	**number of visit**	Total amount of products per visit People did not always remember formerly brought items and on which date	Long and short	Not possible to use data for average numbers per date, Discussion (qualitatively) (section 4.2)
1	**success of repair effort**	few examples, where people did not check out	Long and short	Review of the repair rate (section 2.3.4) (could have been used for the repair rate, but was not calculated per product category in this thesis due to a lack of data)
1	**number of visits necessary to repair a product, or the frequency of borrowing**	Number of items brought on other dates often not filled out for Leila: frequency of lending a product and to how many participants unknown	Long and short	Not possible to use data for average numbers per date or product, Discussion (qualitatively) (section 4.2)
1	**frequency of use**	Estimate by participants	Long and short	Correction of substitution factor (section 2.3.4)
2 and 3	**probability of purchase and reason**	The question seemed not fully clear to the participants: the necessity of a product (e.g. people already have a second gadget, because they need it) or the real fact of buying (they will not buy another one).	Long and short	Substitution factor (section 2.3.4)
4, 6 and 7	**Advantages provided by the initiative**	In general high agreement, the scale may not be optimal main reasons were not requested from the beginning	In short questionnaire asked only for main reasons	Discussion (qualitatively) (section 4.2)

5	**Dislikes about RCs**		Long	Discussion (qualitatively) (section 4.2)
8	**Changed consumption patterns?**	Whether they did not change, because people already acted environmental friendly before or rather because they stick to their behaviour is not known.	Long	Discussion (qualitatively) (section 4.2)
9	**Personal data**	Only age, postal code and occupation known	Long	Discussion (qualitatively) (section 4.2)

2.3.4 Defining the difference between the project activity and a baseline procedure

The GHG protocol suggests comparing a baseline scenario to the project activity. The system boundaries were described in chapter 2.3.2 and the available data in section 2.3.3. To include the primary effects discussed in section 2.3.2 into the calculations, a substitution factor was required, referring to a possible replacement of products brought to the initiatives. This factor was estimated within three steps:

I. First I considered if a product was repaired or not, since this is essential for the saving of GHG emissions. As the dataset on the repair rate is incomplete for many products, I only applied a *repair rate* per product category if the number of products listed under the respective category is higher or equal to ten. For the other cases, the mean value of reparation success across all products has been used. The underlying assumption is that machinery and skills are similar between RIs. The difference in repair rates occured then due to the fact that some devices cannot be repaired, because more specialized tools or knowledge is needed, spare parts are not available, or other barriers for reparation exist.

   Sometimes gadgets cannot be repaired entirely, but the default is detected in a RI. These special cases were taken into account as 'partly repaired'. The same applied to the continuation of repairing at home, to the case when spare parts need to be bought, or when only one function was repaired. As an entire replacement of a product consequently may be possible, the principle of conservative is not infringed.

II. Secondly, I considered the fact that some products are also repaired or lent in society in the absence of the activity (*behaviour of repairing/borrowing*). For example cars are normally too expensive to be disposed when broken and the cost of reparation is usually lower than buying a new one. But, many electronic gadgets are very low in price and repairing could result in higher costs than buying a new product. Repair rates in society also depend on ability to do so and the repairing infrastructure available. Many participants explained during the survey, that there are only few repairing shops. In addition some products are produced with special screws or glued batteries, so that reparation is hindered (see section 1.4).

III. Thirdly I considered whether the beneficiary would have bought the product in the absence of the CBI (*behaviour of consumption*). Sharing Shops mostly lend goods that are not needed on a daily basis, but rather items people use for special occasions (e.g. chocolate fondue) or for a limited time frame (e.g. children equipment). Furthermore, products provided by Leila are often used for leisure time activities or parties; and would maybe not always have been purchased in the absence of the CBI. In RIs everyday commodities are repaired (such as water kettles or radios), as well as products that are only temporarily needed or that serve as a second gadget (e.g. Mini-TV). It was therefore necessary to introduce a parameter, representing the fact that people would not have bought the item repaired or lent. Information from the survey among the beneficiaries was applied here for RCs as this factor depends on the personal attitude of participants. Due to the lack of data (from the list of items, and the survey), I adopted it for Leila.

The merging of those three steps results in the *substitution factor:*

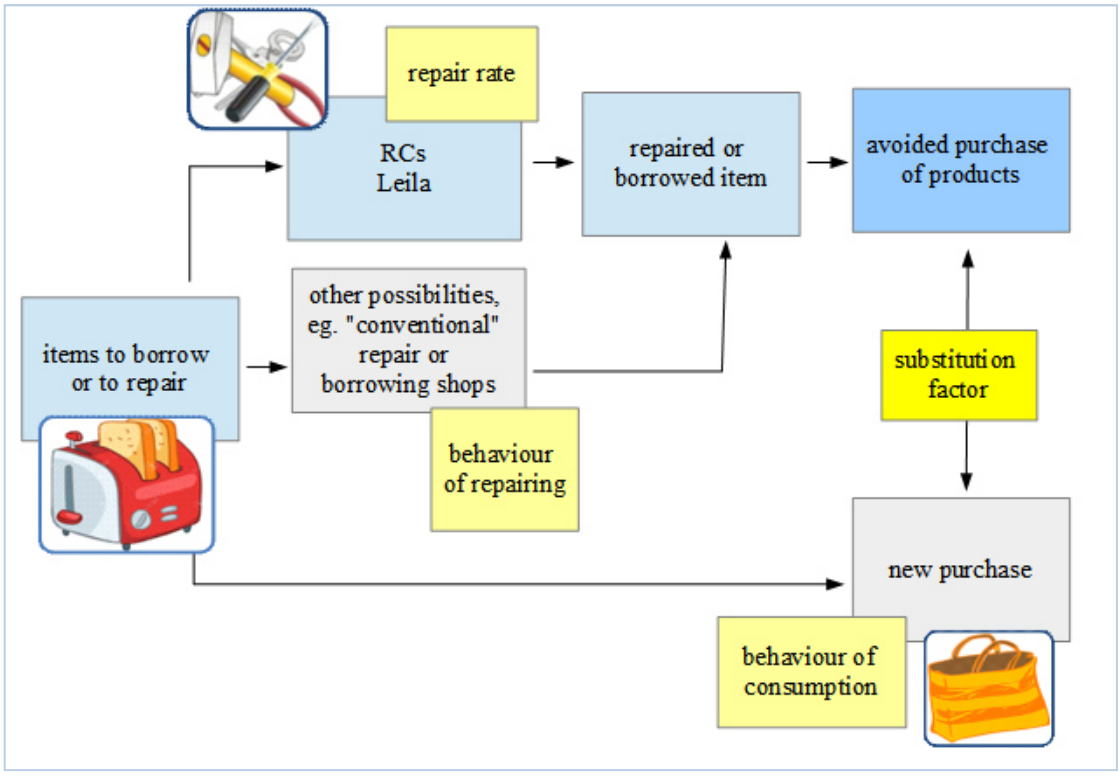


Figure 12: composition of the substitution rate (own figure)

I jointed steps II and III in this thesis to a factor of *behaviour of substitution* due to the lack of data, since they often determine each other (cp. column 3 in Table 5). Therefore, I first used the information obtained from participants, whether they would have bought the product or not in absence of the initiative. Then, I modified this factor depending on their reasons (III), on the frequency of use of the product (III) and on assumptions on repairing/lending in society (II) (see Table 13 in annex C).

The substitution rate consists of a multiplication of the factors above:

Substitution factor = repair rate (I) * behaviour of substitution (II and III)

Example

Substitution Rate for a partly repaired toaster that definitively would have been repurchased new or used: *0.51*0.8 = 0.41*

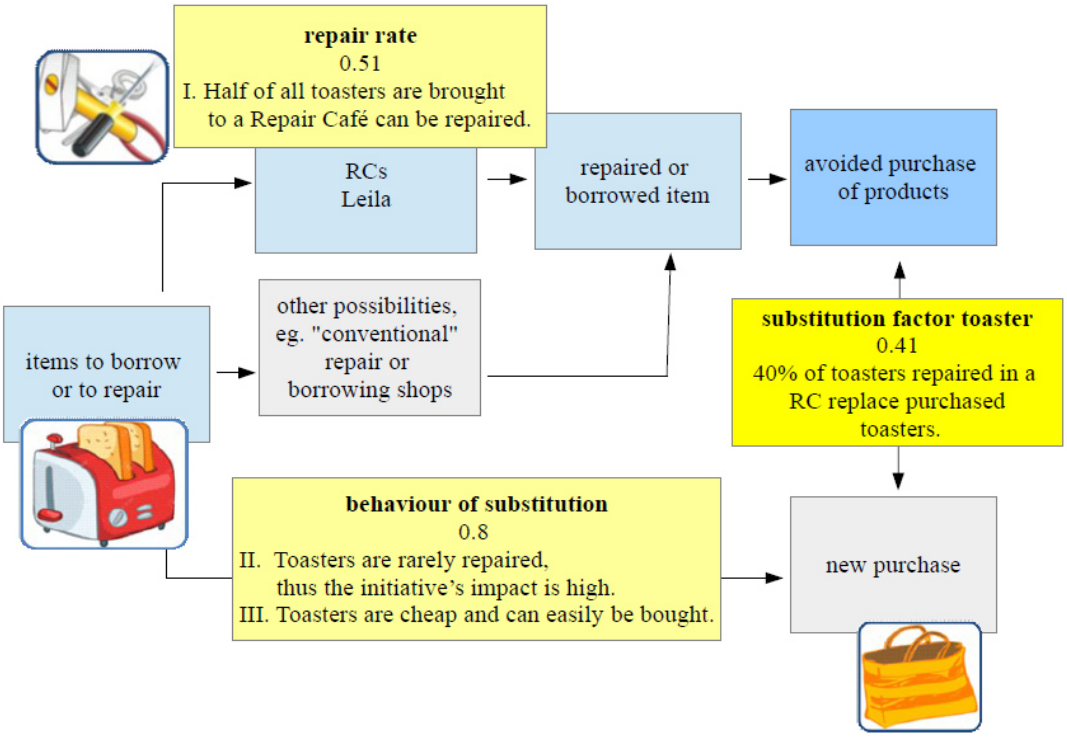


Figure 13: Composition of the Substitution Rate for a partly repaired toaster that definitively would have been bought new or used (own figure)

Table 5: Composition of substitution rate: substitution rate = repair rate * behaviour of substiution

Step	Question	Assumptions on criteria that may define the steps	Source	Sample	Factors	What does the factor mean?
Repair rate						
1 Repair rate	Repaired or not?	Same skills and tools per RI, but some products are more difficult to repair than others	data from RCs KB and SB (2014/15)	Product category if n>=10, otherwise average of all products	Repaired 1 Partly 0.5 Not repaired 0 Average 0.57	Percentage of products repaired; only a reparation makes the non-replacement possible
Behaviour of substitution (RCs + Leila)						
2 Behaviour of repairing/ borrowing in society	What is repaired/ lent in society anyway?	- Difficulty to repair - Equipment needed (oscillo-scope, sewing machine, ...) - access to RCs, Sharing Shop or other person - cost of repair vs. cost of item - necessity and frequency of use - personal value of object - degree of deterioration	Assumptions (used for corrections of 3 Behaviour of consumption)	Product category	Examples: Bicycle 0.1 Laptop 0.4 Toaster 0.7	Impact of the initiative is high, if products would not have been repaired or lent anyway in society
3 Behaviour of consumption	Would people have bought it otherwise ?	- cost of item - necessity and frequency of usage - possibility to buy - newer technology on market - quality and life-time of newly bought products - space - personal value (cp. Prakash, et al., 2015, p.32)	Questionnaires for RIs (if people would have bought it and reasons, frequency of use) In case of data gaps, assumptions based on criteria for product groups without data	Product category	definitively 1 probably 0.7 probably not 0.3 definitively not 0	Impact of the initiative is high, if products would have been purchased otherwise (in the case that a reparation or lending was not possible)

2.3.5 Accounting of baseline emissions

As described above, the baseline scenario was defined as the action of the participants in absence of the CBI. I expected that to some extend new products would have been purchased. Thus, an estimation of the emissions associated to the production of the different items was required. For this I used the Product Carbon Footprint (PCF). In my thesis, I adopted the definition of PCF as laid out by the German PCF pilot project[12]:

> "The **Product Carbon Footprint** is defined as the balance of greenhouse gas emissions among the whole lifecycle of a product in a defined application."
> (PKKD, 2011, p. 8)

This thesis is constraint by low data availability of lent and repaired items (explained in 2.3.3). In addition, the quantity and quality of product EFs found in literature is not satisfying for a good validity of results due to a lack of standardization (cp. section 2.1).

A number of databases providing EFs were assessed, covering a wide variety of factors: e.g. Ecoinvent; Carbon Trust (Footprint Expert), GHG Inventory (UNFCCC), ELCDIII (EPLCA), ProBas/GEMIS (Umweltbundesamt); DCFCCarbonFactors (Defra); BaseImpact (ADEME); SimaPro (ESU); thinkstepGabi (PE international); CEDA 3.0 (Leiden University), GEMIS (IINAS), Athena LCA (cp. Table 11 in annex A for sources). For consumer products that are provided by the initiatives just costly databases are available. Therefore, EFs were identified via literature reviews. Table 14 in annex B exemplarily presents gathered data on EFs for bags and boxes including information on source, amount of emissions per life cycle phase, unit, scope, methodology and my comments of assessment[13].

[12] PCF Pilot Project Germany: Carried out by WWF, Öko-Institut, Potsdam Institute for Climate Impact Research and THEMA1 with the aim to use experiences from different companies and branches and develop a consistent convention for interpretation. GHG emissions have been assessed as well in their interrelation with other environmental impacts (PCF, 2009, p. 6).
[13] The entire table can be found in the digital version and attached in bigger size.

EFs greatly differ in their assessed boundaries, implicated GHG, quality verification and/or spatial scope:

a. For many product categories and numerous products, EFs were lacking from the sources accessible for this thesis (e.g. tools, music equipment and toys) (cp. Table 6). To fill this gap, some EFs have been based on the material a product consists of, while others only include spare parts (e.g. emissions of bulbs instead of entire lamps, a cable instead of the whole cable box). If possible, I assumed a similar item with existing data to use an analogical carbon footprint (same material, weight or size). Products for which data could not be gathered is presented in the results but without their carbon footprint. This is in line with the principle of a conservative estimation (see section 2.2).

Table 6: Availability of Product Carbon Footprints for different product categories

Many PCFs available:	No PCFs available:
❖ Computer equipment	❖ tools: gardening, painting, electrical and non-electrical
❖ White goods	❖ music equipment
❖ TV	❖ Toys

b. Many PCFs are provided by companies selling the products they investigate (e.g. (decathlon, 2013; tesco, 2012 canon, 2004; apple, 2016). Sometimes the accountings are undertaken by external companies (e.g. Carbon Trust for Tesco, AIR for Picture) by applying standards from other stakeholders e.g. public institutions like the French Environmental Ministry ADEME. The data is therefore potentially biased. GHG quantities reported in scientific or institutional sources (such as e.g. Öko-Institut e.V., 2013, Fraunhofer IZM, 2007, Japan Environmental Management Association For Industry, 2012) are in most cases higher than data provided by companies (see Table 15 in annex B), as the example of a backpack explains: The PCF Project[14] estimated 35.3kg CO_2e for a sports bag (with a range from 26.6kg CO_2e to 71.8kg CO_2e) (PCF, 2009, p. 41). The company 'Decathlon' indicates a carbon budget of 10.3kg CO_2 for a similar bag. The company 'Picture' calculates only 3.25kg CO_2 (not CO_2e in both cases) for its backpack made of 100% recycled polyester on its websites[15]. The

[14] composed of a consortium of researchers (PCF, 2009), http://www.pcf-projekt.de/main/platform- initiators/overview/
[15] www.quechua.de/tasche-trekking-100-id_40914 and

transparency of methods and boundaries applied by the companies is often very low. If possible, I avoided data provided by companies or dependent institutions. However, in case of a lack of other sources I selected them and added comments on the validity of the factors used in Table 15 to ensure transparency. EFs provided by companies often include products that are especially eco-friendly and thus emit less GHG than their production of their counterparts provided by the initiative. This was not a criterion of exclusion, because it does not contradict the principle of conservativeness.

c. As described above, for some products multiple sources for EFs could be found (e.g. computer equipment, white goods, TVs). Even between the results of more independent sources, the amount of product emissions shows large discrepancies, as also noted by other authors (e.g. Liu, et al, 2011; Vasan & Pecht, 2014; Andrae & Andersen, 2010). In the case of laptops – a range between 50 to 450 kg CO_2e was reported (see Figure 14) (Liu, et al., 2011, p.502).

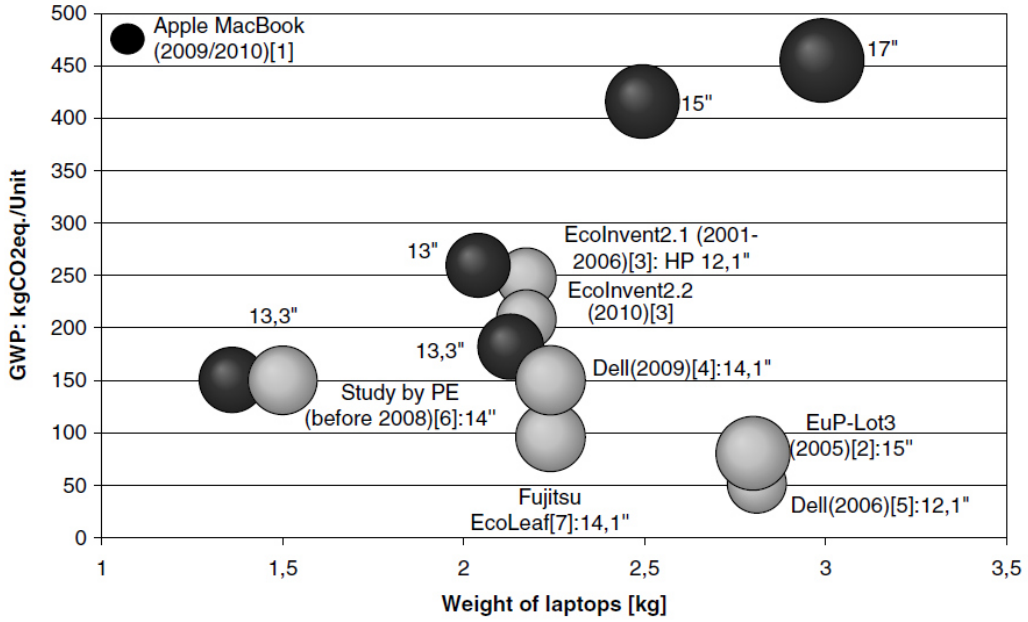


Figure 14: GWP 100 of laptops in the manufacturing stage, the black balls represent the Apple MacBook 2009/2010 of different inches, the grey balls indicate various producers or studies (Liu, et al., 2011, p.502)

Interestingly, the factors generated by Apple (black balls in the Figure 14) are considerably higher than the ones from the EU study "Lot 3". The amount calculated in that study is one of the lowest of all laptops assessed by Liu et al., though investigations were carried out by research institutes on behalf of the European Commission and are assumably less biased. For a study by Öko-Institut

www.picture-organic-clothing.com/de/collection/world-expedition/

the “EuP Lot 3” factor for laptops was applied for netbooks, too. For this thesis, in the case of multiple sources for EFs I chose the most plausible, reliable and transparent one.

d. The identified literature sources on EFs also show a high irregularity concerning the unit of GHG (see section 2.1): The accounting standard “bilan carbone”, published by ADEME, reports kg CO_2e (Jayr, et al., 2011). Anyhow some companies applying this standard to their products provide numbers only in kg CO_2. Moreover, the company ‘Canon’ switches in their unit indications: They use CO_2 in their environmental report but declare in other documents that the amount counted is assessed in CO_2e. Though mistakes may have been made in the reporting, one cannot entirely exclude that errors have already been made in the accounting. I chose to also include data provided in CO_2e in the calculations (which may only represent CO_2 amounts) as this is in line with the principle of conservativeness.

e. In this thesis, only the emissions of raw material extraction, production, transport to the shop and disposal and/or recycling have been included into the accounting (see 2.3.2). I used sources for EFs, where the amount of GHG from transport and use by the customer was not included in the factor or could be excluded (as many studies report emissions of different life cycle phases). For some EFs used, this was not the case, but does not falsify the results or contradict the principle of conservativeness. This is because it only applies to products with no need of energy (such as housewares or a helmet) or extra transport (that is not included in regular shopping).

Figure 15: product value chain and possible assessments (own figure, after PKKD, 2011, p.6)

f. It is not always clear, what kind of GHG emissions are exactly included in EFs because boundaries sometimes are not outlined and specified. Two main methods to define them are commonly used:

I. Emissions resulting from a particular product or service provided by an organisation are classified accordingly to responsibilities and control of an emitter into (Stechemesser & Guenther, 2012, p. 33):

- upstream emissions
- organisational emissions
- downstream emissions

Figure 16: Emissions related to the lifecycle of a product (own figure)

II. Furthermore emissions can be classified into direct and indirect emissions, such as the combustion of fuels or electricity generation. A more specific approach defines three scopes or tiers of analysis (Pandey, et al., 2011, p.145):

- Scope 1 identifies all direct onsite emissions.
- Scope 2 represents indirect greenhouse emissions released by purchasing energy.
- Scope 3 comprises all other indirect emissions for example from disposal, transport, etc.

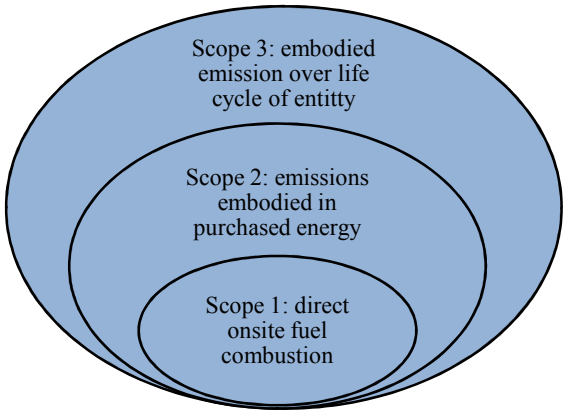


Figure 17: Classification of scopes for product emissions (own figure after Pandey, et al., 2011, p.145)

Scope 3 is most difficult to assess as it has more vaguely defined boundaries, but often represents the largest quantity of emissions. It requires a thorough analysis of all relevant factors and is therefore often kept optional by most accounting standards (Pandey, et al., 2011, p.145).

In this thesis, data sources including all three scopes of analysis were preferred in case of several options available. Specifications on PCF boundaries or the level of information in the literature source have been reported for each EF (see Table 14).

Anyhow, limited scope analysis does not contradict the principle of conservativeness, as it results in underestimated emission reductions by the CBIs.

Summarizing, little data availability made it necessary for the final calculations to allocate products into categories. The classification according to exemplary emission and substitution factors should be done in a conservative way. The product cluster includes products with assumably similar EFs (cp. Table 7). In a second step, I decided whether an additional substitution factor was necessary or not. The EF of a toaster can serve as an exemplary factor for devices like waffle or donut makers. However, it is more probable that a toaster will be replaced, when it cannot be repaired, than the waffle or donut maker, because in general it is used more frequently. It was therefore grouped in a different row than the other two products. For products without an EF, the substitution factor was not needed.

Table 7: Subset of table of final GHG emission calculations (table 15 in annex C): example for the subdivision of factors used. The table is ordered from left to right. Clusters (like kitchen appliances) contain different EFs (e.g. toaster) that include other products with assumably similar carbon footprints. If these products differ in their repair rates or factors on behaviour of substitution, they are located one row below (e.g. waffle iron). If no data on the carbon footprint of a product was available and it could not be ranged similar to another product, it was classified as "without factor" and counted in absolute numbers (not in emission reduction).

Products			**Factors for calculations**					
Cluster	**product group**	**other products included in group**	**EF**	**comment**	**Repair Rate**	**comment**	**behaviour of substitution**	**comment**
kitchen appliances	toaster		5.22	factor for production seems to be very low	0.51		0.80	
		waffle iron, donut maker, pancake maker, popcorn maker, sandwich maker	5.22	factor for production seems to be very low	0.51		0.60	
	...	...	...	...	...	...	...	...
	without factor	milk frother, soda stream			0.51		0.73	average factor for kitchen appliances

2.3.6 Accounting GHG emission reductions

Having explained the factors needed for the calculations in sections 2.3.3 to 2.3.5, it is now possible to understand the calculation of emissions avoided by the activity of the initiative. For the case of RIs, the repair rate was included as an additional factor (cp. section 2.3.4). Following the rationale of the GPPA, the emission reduction has been calculated as the difference of GHG emitted by the initiative and a baseline scenario (WRI & WBCSD, 2005, p. 77):

$$Emission_{reduction} = Emission_{activity} - Emission_{baseline}$$

Since I assumed zero emissions from project activity (cp. chapter 2.3.2), emission reductions are equal to baseline emissions in this case.

Emissions reduced $_{RIs}$ ***= EF * behaviour of substitution * repair rate***
Emissions reduced $_{Leila}$ ***= EF * behaviour of substitution***

In the example of toasters, the reduced emission therefore amounts to (Prakash, et al., 2011, p. 17):

5.22 kg CO_2e * 0.51 * 0.8 = 2.13 kg CO_2e

The results of calculations for each case study initiative are provided in the next chapter.

3. Results

3.1 Applicability of the GHG protocol for project accounting in this context

To answer the first research question, this analysis has shown the GPPA provides a sufficient basis for GHG accountings in the context of CBIs providing goods. Whether the results obtained within this work are satisfying to thoroughly recommend the GPPA in this context, will be discussed in chapter 4.1.

The main idea – to compare the project activity with a baseline scenario – is a great advantage for organisations with limited capacity for bookkeeping. It facilitates the framework's implementation into practice as it does not require investigating the initiative's single activities that emit GHG. By only including the significant effects into the analysis the effort required is reduced.

The proposed principles are valuable in this field of research, as a high level of transparency and using consistent working methods enable repetition. In the case that the interest by external researchers is limited, the methodology applied in this thesis gives CBIs the possibility to undergo the same process on their own. A further simplification may then be appropriate to decrease efforts for the accounting to a reasonable level (see section 4.4). The methodology may be improved for similar accountings in the event of higher data availability (see chapter 4.3).

3.2 Results of the GHG accounting

The GHG accounting in this thesis helped to answer RQ2: "How high is the contribution to climate change mitigation by the selected CBIs?"

The amount of emissions avoided, from products included in the accounting per year, has turned out to be six to seven times higher for Leila, than for the other two case studies (see Figure 18): 9324kg CO_2e saved for 366 products replaced. RC KB avoided 1065kg CO_2e with 28 replaced products. RC SB achieved 1641kg CO_2e savings per year (by 43 products). This is 26kg CO_2e on average for a re-use and 38kg CO_2e per repaired product.

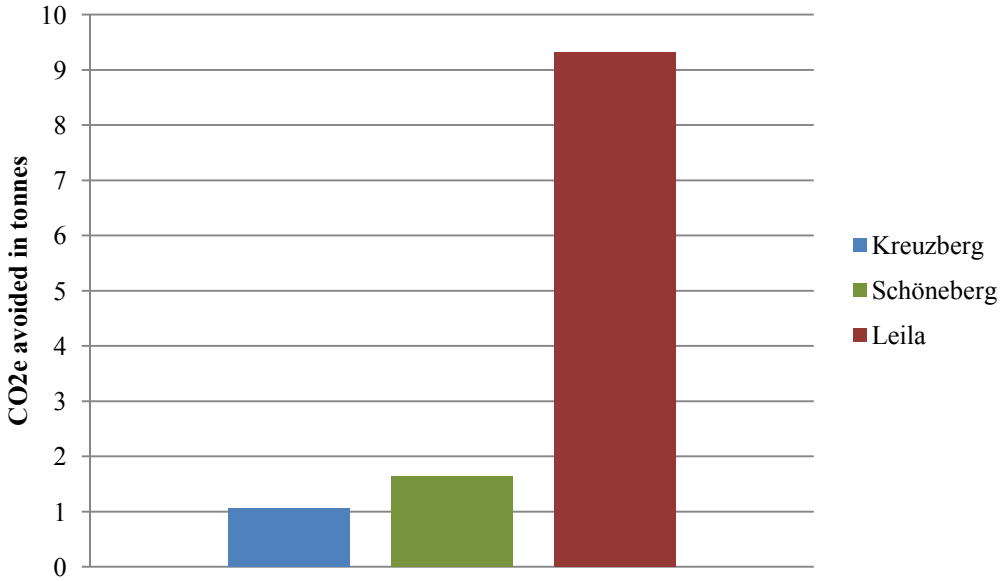


Figure 18: **Portion of GHG emissions avoided per year by CBIs included in the accounting.** The amount of GHG included in the accounting represents only one part of products brought to RCs KB and SB and lent by Leila. For the other part, emission factors have not been available or data has not been accounted (e.g. in the case of gifts at Leila). The portion is based on the assumption that a product is not lent/repaired several times by one person.

In Figure 19 we can compare that the amount of emissions depicted above represents varying ratios of products replaced: For Leila 85% of products replaced are included in the accounting; whereas the portion is only 59% for KB and 61% for SB.

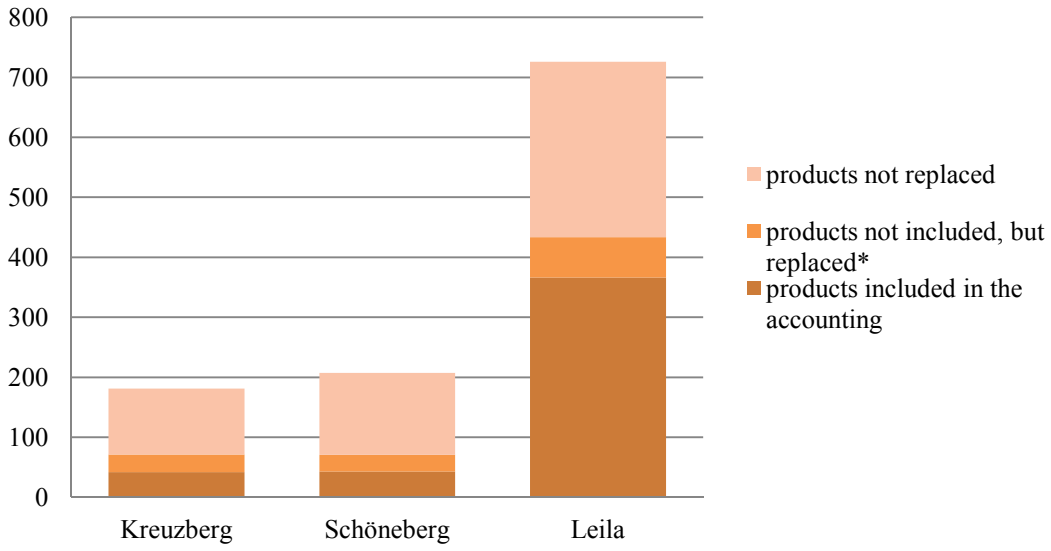


Figure 19: Composition of the number of products brought to the initiatives per year. The part of products included in the accounting has been translated to GHG emissions avoided (shown in Figure 18). For the products not included, EFs have not been available or data has not been accounted by the initiatives (e.g. in the case of gifts at Leila: estimate on website[16] ~9300 products until now). Products not replaced are composed of not repaired products and items people would not have bought in the absence of the activity. The portion is based on the assumption that a product is not lent/repaired several times by one person.

[16] http://madame.leila-berlin.de/index.php?id=17 (assessed 24/04/2016), will soon move to http://leila.innovationspolitik.de/der-laden/ueber-uns/ and loose information used in this thesis, ask for information (e.g. statistics) here: hallo(at)leila-berlin.de

The number of items lent or brought to be repaired does not entirely replace the purchase of a similar product: The amount of products lent by Leila in 2014 (726, additional gifts not included) is almost double to the calculated number of products replaced (433). About one third can be substituted by the two RCs (71 of 181 products brought to RC KB, 72 of 209 for RC SB per year).

Deducing from the portion of products included and not included, as discussed above, I received a respective amount of GHG emissions avoided by all replaced products (see Table 8):

Table 8: Extrapolation of emissions avoided from products included in the accounting to emissions that would result from all products replaced[17]

	Emissions avoided per year in kg CO_2e	Amount of products included	Amount of products replaced	**Extrapolation of GHG avoided per year in kg CO_2e**
Leila	9324	366	433	**11031**
KB	1065	42	71	**1800**
SB	1641	43	71	**2710**

For a later comparison and evaluation of the case studies (see section 4.1), it is interesting to analyse the input into the initiatives in terms of invested time. Leila is open at least 24 hours per month, whereas monthly meetings take place for four hours in KB and for three hours in SB. Data received from RC SB additionally revealed that 14.86 participants and 6.5 tinkerers take part in monthly meeting on average. The amount of GHG emissions saved per hour for Leila (32kg CO_2e) lies in between the results for KB (22kg CO_2e) and for SB (46kg CO_2e) (cp. Figure 20). More products are tried to be repaired at RCs per hour (3.8 and 5.8) than are lent by Leila (2.5), though the amount of products replaced is similar (1.5, 2.0 and 1.5). For further outcomes per month see Table 18 to Table 20, in Annex C.

[17] Emissions extrapolated = emissions avoided* reciprocal value of ratio, e.g. for Leila: 11301 = 9324* (433/366)

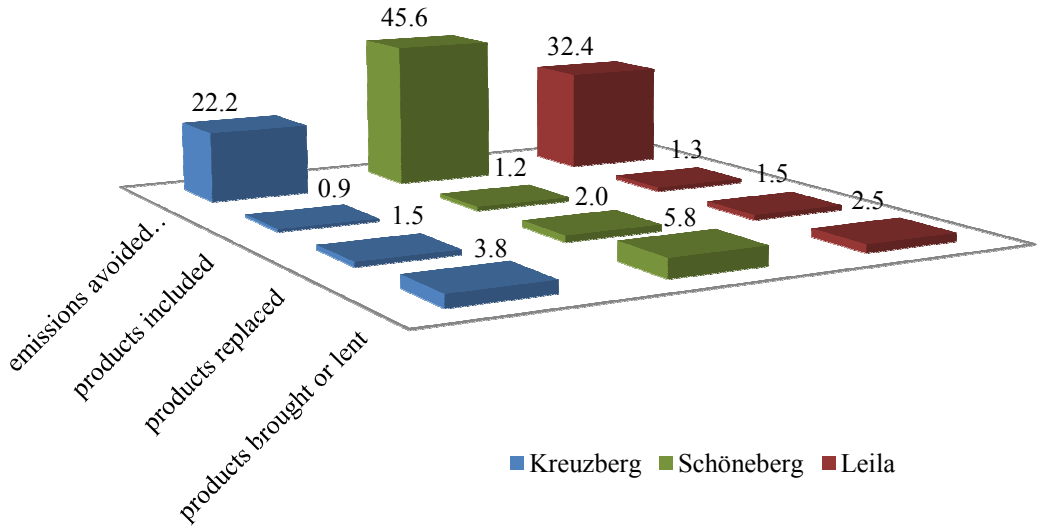


Figure 20: Comparison of emissions avoided and amount of products replaced by the CBIs per opening hour. The amount of products included in the accounting (thus GHG emissions avoided) is one part of products brought/lent. For the other part, emission factors have not been available or data has not been accounted. Products not replaced include not repaired products or items people would not have bought in the absence of the activity. The portion is based on the assumption that a product is not lent/repaired several times by one person.

Figure 21 gives an overview on the kinds of products lent and brought to be repaired. About one third of items attempted to be repaired at RCs consist of music equipment. One fifth of products brought to RCs are kitchen appliances. Many telephones (17%) are brought to RC KB and a lot of computers and equipment (17%) to RC SB. The major categories of products lent at Leila's are tools (21%), toys (13%) and sports equipment (11%).

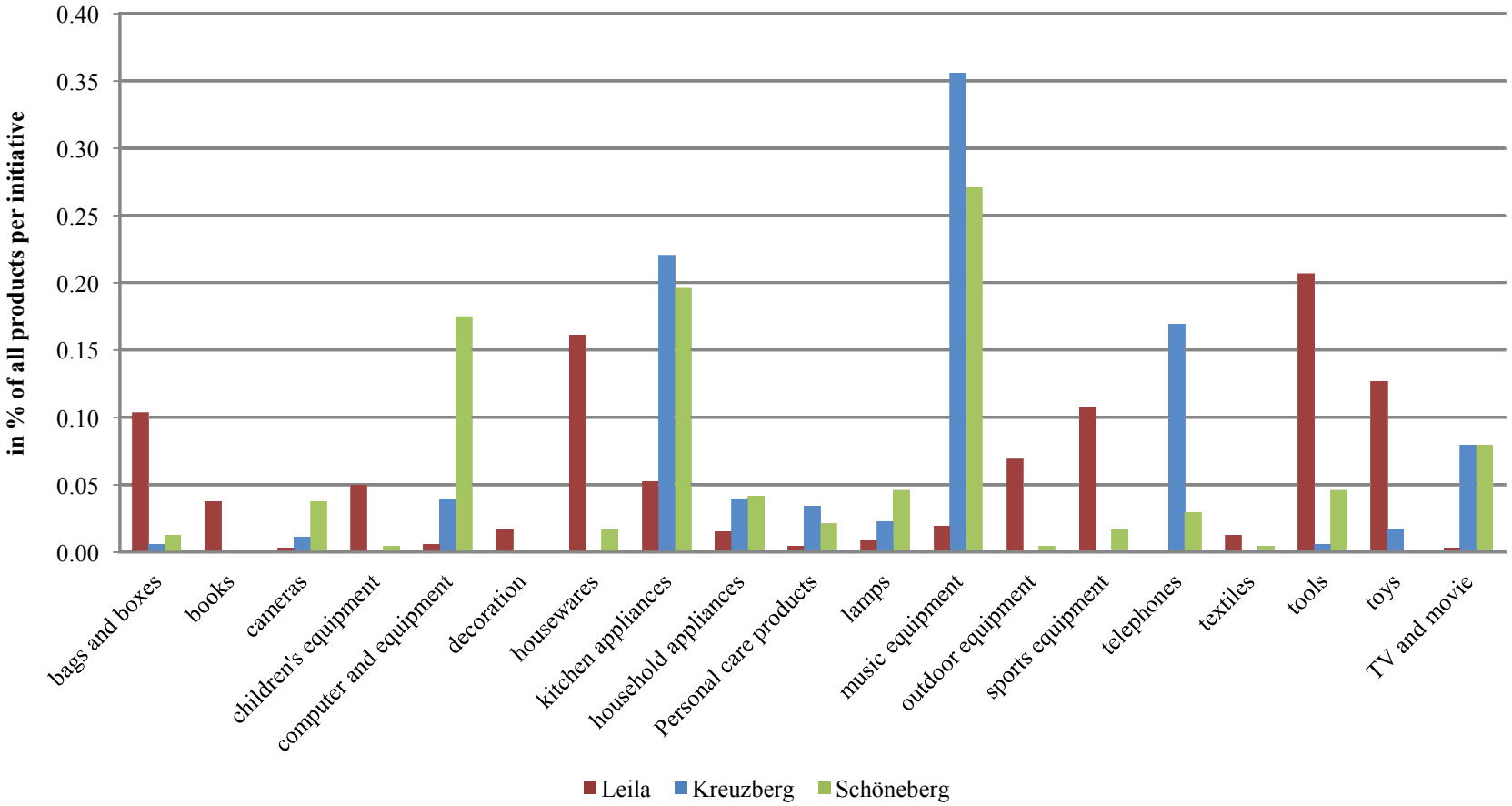


Figure 21: Ratio of product categories brought to RCs or lent by Leila. The portions are related to all products brought or lent and calculated per initiative.

Having a closer look on replaced products (see Figure 22 to **Figure 24**), the amount of brought/lent products and the number of finally replaced ones vary per product category. Replacement rates for each product category are defined by repair rates (for RCs only) and factors representing the behaviour of substitution (cp. section 2.3.4). They are higher for Leila, since the multiplication with a repair rate was not necessary. However, the amount of products replaced also depends on the number of items brought in to be repaired. In figures 22 to 24, I highlight this by presenting the five product categories with highest number of replaced items.

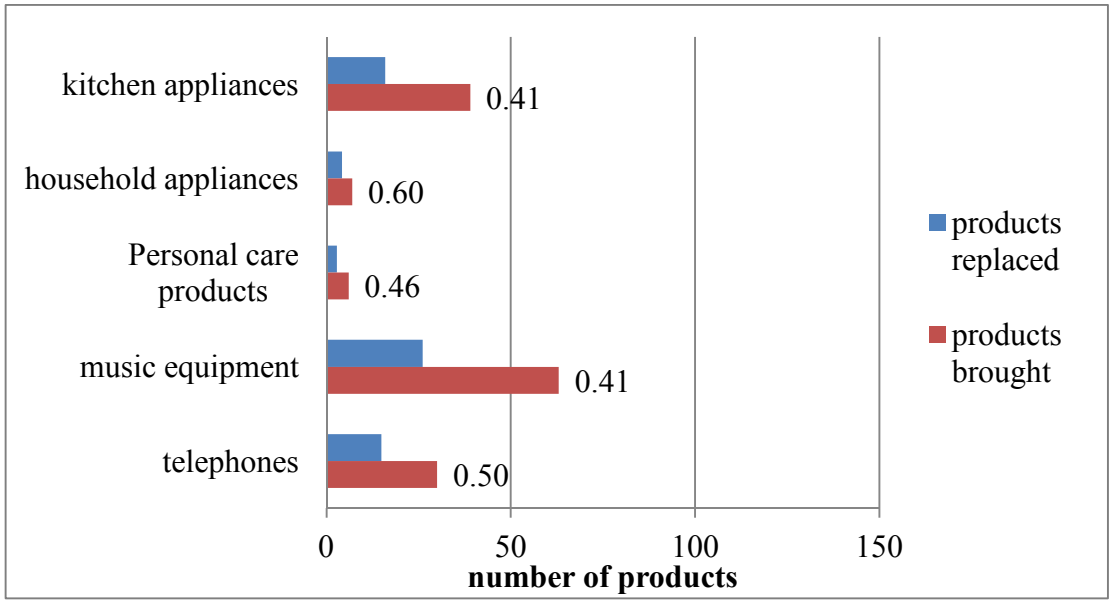


Figure 22: **The five categories of most replaced products in RC KB**. The amount of products replaced per products brought or lent constitutes the substitution factor (named behind the bars).

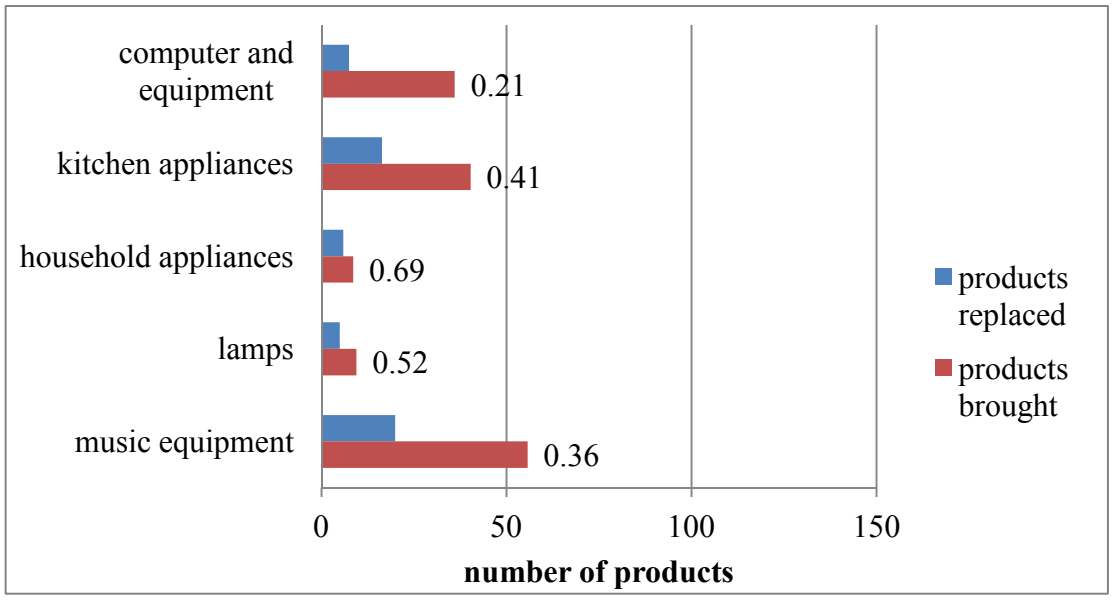


Figure 23: The five categories of most replaced products in RC SB. The amount of products replaced per products brought or lent constitutes the substitution factor (named behind the bars).

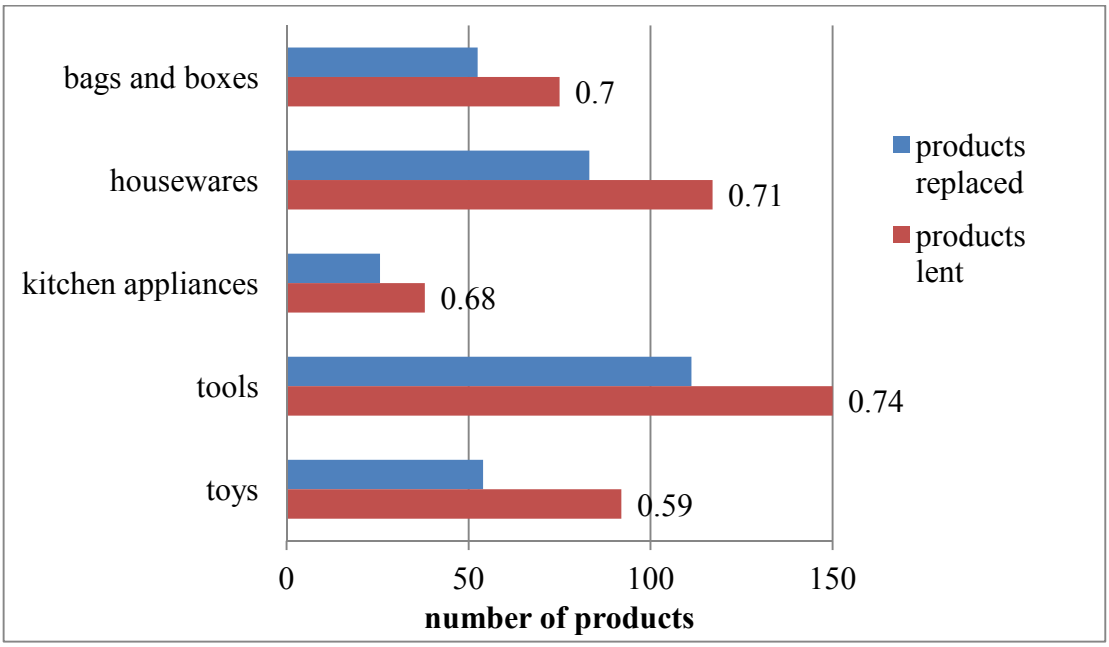


Figure 24: The five categories of most replaced products by Leila. The amount of products replaced per products brought or lent constitutes the substitution factor (named behind the bars).

In RCs household appliances, personal care products and computers with equipment play an important role for reparation, next to kitchen appliances. Product categories may be among the TOP 5 replaced items, though replacement rates are higher for others. In the case of Leila mostly bags and boxes, housewares and kitchen appliances have been replaced. Table 17 in Annex C contains substitution factors for all product categories.[18]

The part of RQ2 that refers to GHG emissions and product purchase avoided has now been answered. Chapter 3.3 will elaborate possible broader effects of the initiatives to climate change mitigation.

[18] In Table 17, the substitution factors result from an average per product category that has not been weighted by the amounts of different products within a category (with varying substitution factors).The substitution factors displayed here are based on weighted portions from the amount of replaced and brought products separately calculated for each category.

3.3 Additional findings from the survey

This chapter presents results from the survey undertaken in different RIs in Berlin over the course of two months. For Leila, no additional outcomes could be assessed due to a low number of completed questionnaires.

3.3.1 Changes of consumption patterns

About half of the participants in the survey, believed their consumption patterns have changed because of the possibility to repair products in RIs.

Three fourth of beneficiaries say they have already bought few products or buy fewer products thanks to the initiative's activity. One fifth has not been influenced. About 77% of participants pay attention to quality and durability of products they buy – some of them thanks to the initiative's activity. 19% does not look after these product characteristics. About 40% looks out on how well products can be repaired or recycled, whereas almost 60% does not. Many participants in the survey assessed this to be very difficult for consumers.

3.3.2 Attributes of participants in Repair Cafés

One third of people coming to the RIs are older than 60 years (cp. Figure 25). About 60% of participants are between 30 and 60 years old. Less than 10% are younger than thirty years.

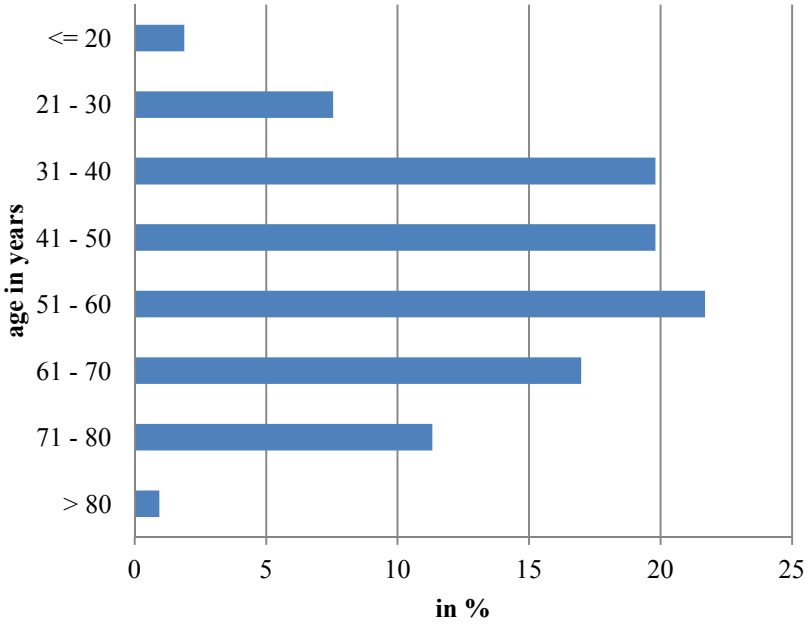


Figure 25: Age structure of RC participants

Half of the participants currently have a job (cp. Figure 26). 11% stated that they were jobless and 4 % students. One third of participants were retired at the time of the survey.

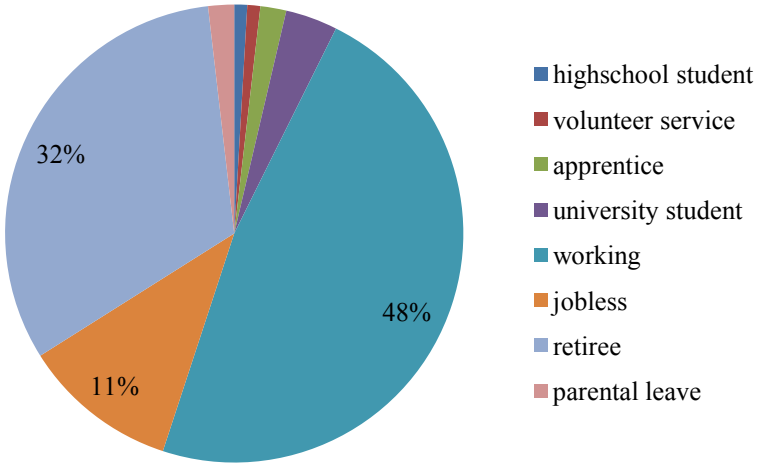


Figure 26: Occupation of RC participants

Most people live in Kreuzberg and other inner city districts (for detailed information see Table 10 in annex A). They mostly visit the closest RI.

3.3.3 Benefits Provided by CBIs

In order to assess advantages of RIs and reasons why people avail them of the opportunity of attending RC meetings, I tested the level of agreement to different statements (cp. Figure 27). Almost all participants approved that repairing is good for the environment and that they do not like buying things again. Most people save money thanks to RIs. Participants believed they can learn something (89%), have fun (89%) and meet people (87%) at RIs. 72% of participants have had experience with things breaking shortly after purchase. Aiming to assess awareness of climate change, I found the agreement to be lower, but still 69% repair to avoid GHG emissions. Only one third declared repairing to be more convenient than buying.

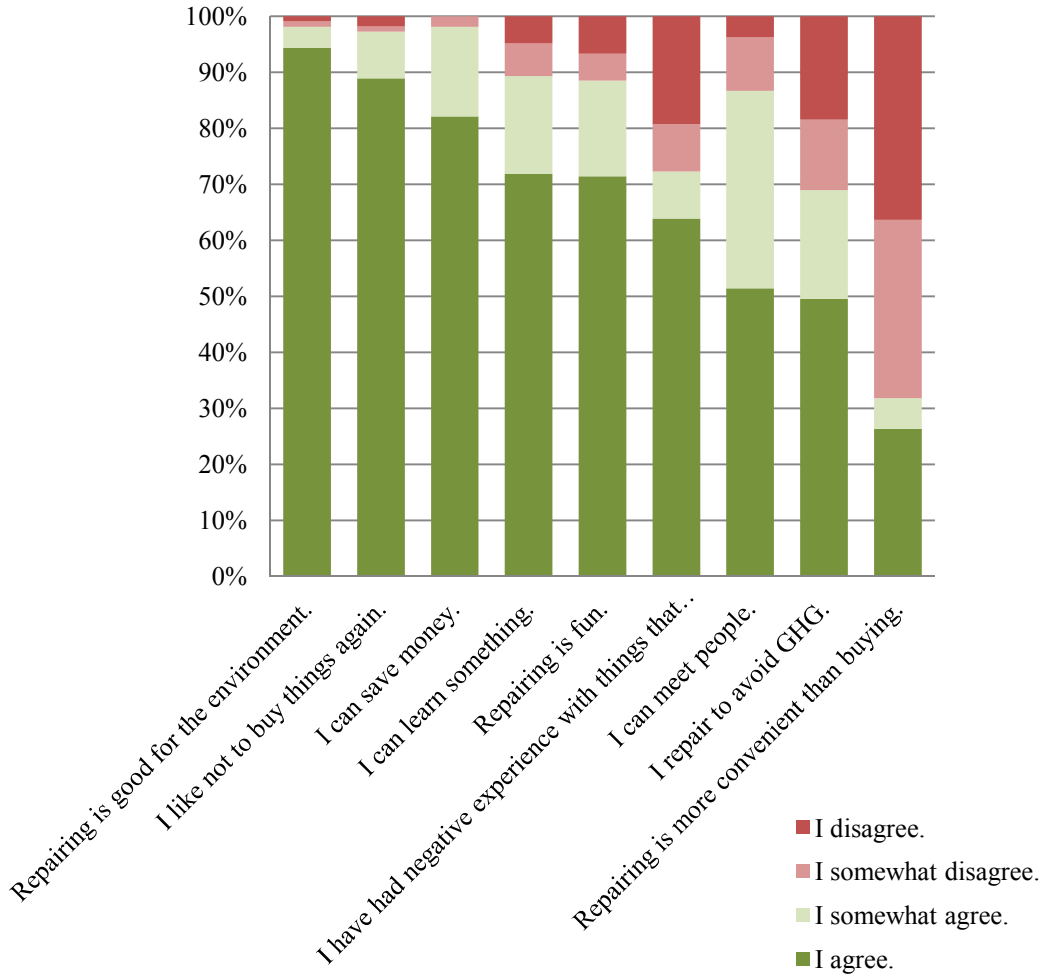


Figure 27: **Advantages of RCs and reasons for coming.** The bars are extrapolated to 100% in order to make comparison of the level of agreement possible.

Having a closer look on people's agreement, Figure 28 reveals the main reasons and advantages provided by RIs. I asked participants to mark the two advantages most important to them: More than one fourth comes mainly for environmental reasons. For 22%, they dislike to buy things again is the most motivating factor. One fifth of survey participants thought the financial benefit resulting from repairing of items is a main reason to come. 10% especially like to acquire new skills, whereas only 4% indicated the fun of repairing as a major motivation. For about the same amount of participants, meeting people is a relevant factor to go to a RI. 2% of participants are mostly motivated by the mitigation opportunity.

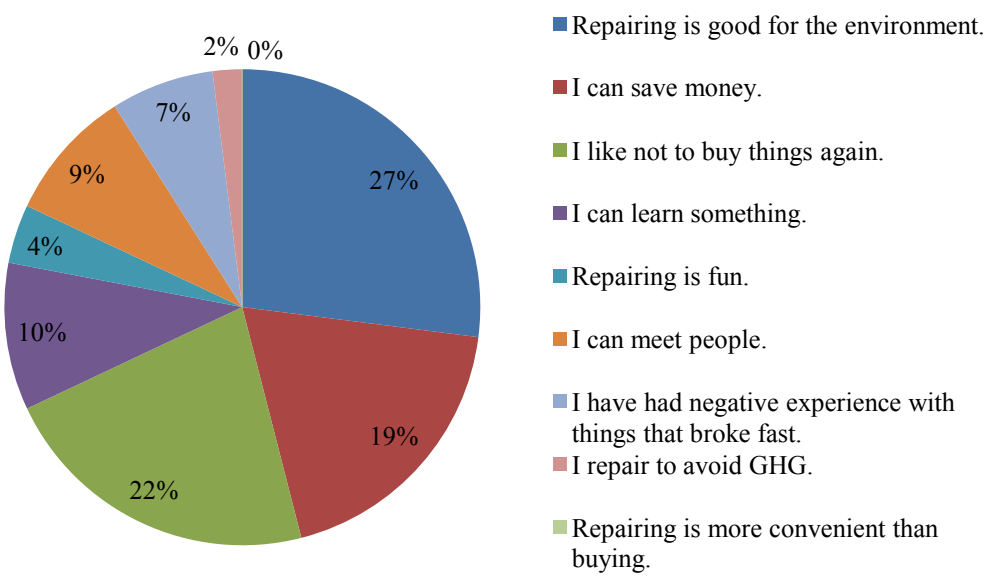


Figure 28: Main reasons to come to a RC. Figure 27 reveals high agreement to almost all statements. Therefore, people were asked for their two main reasons for coming to receive a clearer picture on their motivation. As this extra task has not been implemented in the questionnaire from the beginning, 20 participants have not been asked to mark the main reasons.

Figure 29 shows further motivation of participants from an open answer category additionally to the ones displayed in Figure 28. Additional to environmental reasons, people appreciated RIs as a critique of throw-away-society and alternatives to current consumption possibilities. Support and the possibility to repair a product no longer available are further important aspects to the participants.

Only 34 of 133 participants disliked something, mostly based on organizational aspects, such as waiting time (cp. Figure 40 in annex C).

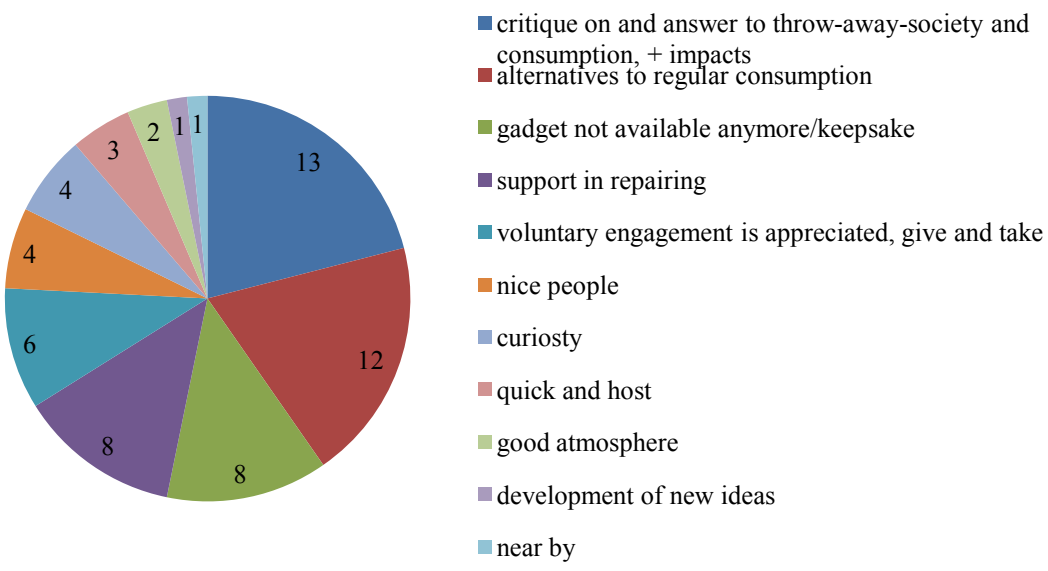


Figure 29: Further reasons why people come to a RC. These reasons reveal from the option of an open answer category after categories preset (cp. figure 27 and 28). The numbers stand for the frequency named.

Relevant in this context is people's estimate on a possible new purchase of the product brought. 68% believed they would have bought the product repaired or not repaired at a RI. 10 % thought a replacement probably would not have happened. 22% tried to repair items they would not have bought new (or used).

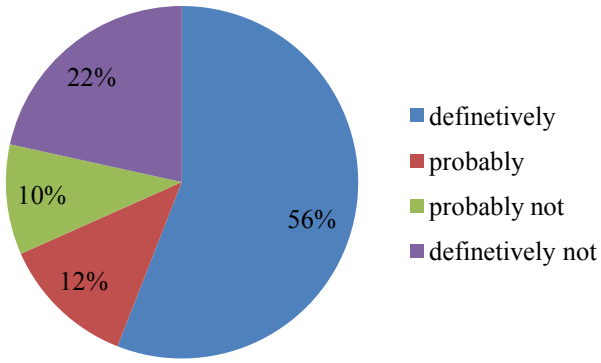


Figure 30: Answers on the question "Would you have bought this item if it was not repaired?"

Figure 31 reveals that only a fifth has to come more than once to get their item repaired. This contradicts to the assumption on not bringing an item several times to be repaired made in chapter 2.3.4 (further elaboration in the discussion).

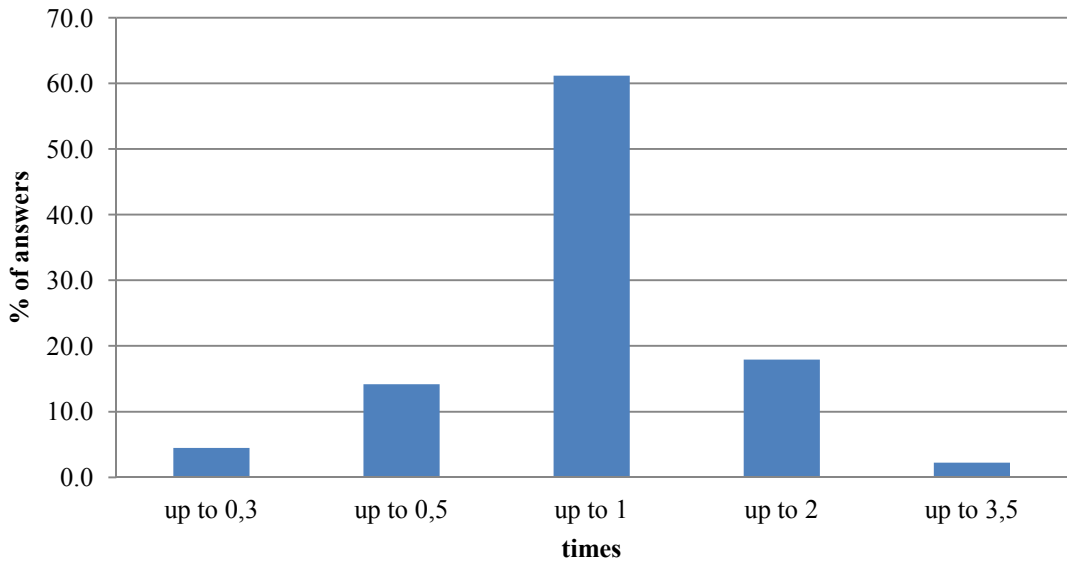


Figure 31: **Answers to the question "How often did you have to come/do you still have to come to repair the item?**". People were asked the question per item brought. Less than 1 represents the fact that several items have been repaired in one meeting.

Three fourth of people asked in the survey visited the RI for the first time (Figure 32). It was the second meeting for 11% of participants, and the third for 7% of participants. Only few people had come more than three times.

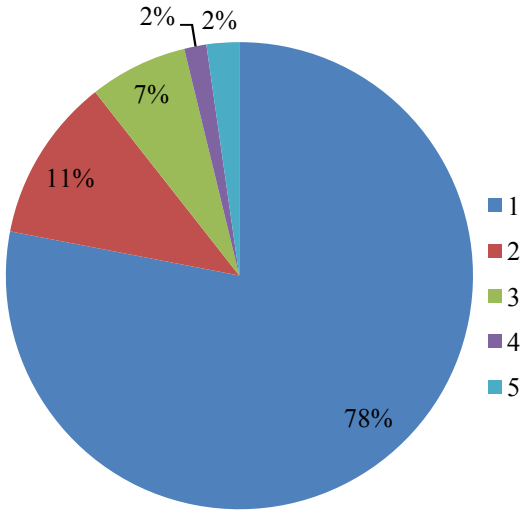


Figure 32: **Number of Visit at RC.**
People were asked for the number of visit an item was brought. Displayed here is only the highest number mentioned.

4. Discussion

In the last chapters, I revealed that the GPPA is suitable to identify the contribution to climate change mitigation of CBIs active in repairing and sharing. Results from the GHG accounting show, the RCs and the sharing shop Leila reduce a considerable amount of GHG emissions. How one can interpret those results, and what they include will be discussed in the next chapter 4.1. The results from the survey will be embedded in possible contributions by CBIs to mitigation and sustainability in chapter 4.2. I will assess the methodology of GHG accounting in this context in section 4.3. I will then draw criticism on the survey procedure and on the questionnaire used (4.2 and 4.3). Chapter 4.4 gives an outlook on further research, possibilities of monitoring and support of CBIs in society.

4.1 Discussion of results from GHG accounting

The amount of GHG emissions avoided by the initiatives is not immensely high in comparison to what is emitted by their participants: about 10.6 tonnes per year and person (in Germany) (PKKD, 2011, p. 5). However, this implies that the reductions achieved by Leila would, for example, equal out all GHG emitted by one organizer. RCs avoid about half the amount of emissions resulting from the purchase of products per person (2.8 tonnes).

Advantages of carbon accountings have generally been questioned by groups supported by the Climate Challenge Fund (cp. section 4.1). They queried the merit of carbon evaluation and significant efforts undertaken being concerned that this focus would be at the expense of changing behaviours (a major aim of many initiatives). Nevertheless, carbon budgets have been assessed to raise further awareness of CO_2 emissions and climate change within communities (Hilliam, et al., 2015a, pp. 36, 41). Tansey argues that the introduction of footprints and their use would set the foundation for creating policies encouraging projects like borrowing shops, re-use centres and RIs (Tansey, 2014, p. 6).

During my investigations I observed that RIs can be very different in their location, participants and objectives. Some of them mainly focus on efficient repairing with little waiting times. As RC KB and RC SB seemed like this to me, results are probably higher than for others that rather serve as a meeting point for their

neighbourhood. Locations of RIs in Berlin range from neighbourhood centres to a small museum. This implies that people – if they try several RIs – can potentially encounter an initiative meeting their diverse demands and preferences (cp. Figure 28). Especially interesting would also be to see if the amount of emissions avoided varies among different types of RCs with other habits, rules, locations or clientele. Also, an investigation of CBIs active in other fields[19] and a comparison to my case studies may reveal meaningful results. However, this was beyond the scope of my thesis.

Coverage of results

The main aim of this thesis was to make the contribution to climate change mitigation of CBIs active in repairing and sharing assessable. For three case studies I have shown that there is a considerable reduction potential. This contribution to mitigation is not a direct amount of emissions reduced by the initiative's activity, but depends on the amount of products replaced (cp. Figure 19). The replaced products included in the accounting should always be assessed together with further products replaced to not underestimate the initiative's impact. In the event that satisfying EFs were not available, neither for the product, nor for representative similar items, products have been excluded from calculations.

In chapter 3.2 the extrapolation of the results has been presented including all products replaced. I translated the portion of products included and not included to the amount of emissions avoided (cp. Figure 20 and Table 8). This calculation makes it possible to receive a rough estimate on emissions avoided by all replaced products, but drastically lowers the quality of results. EFs for products not included may highly vary from the ones used.

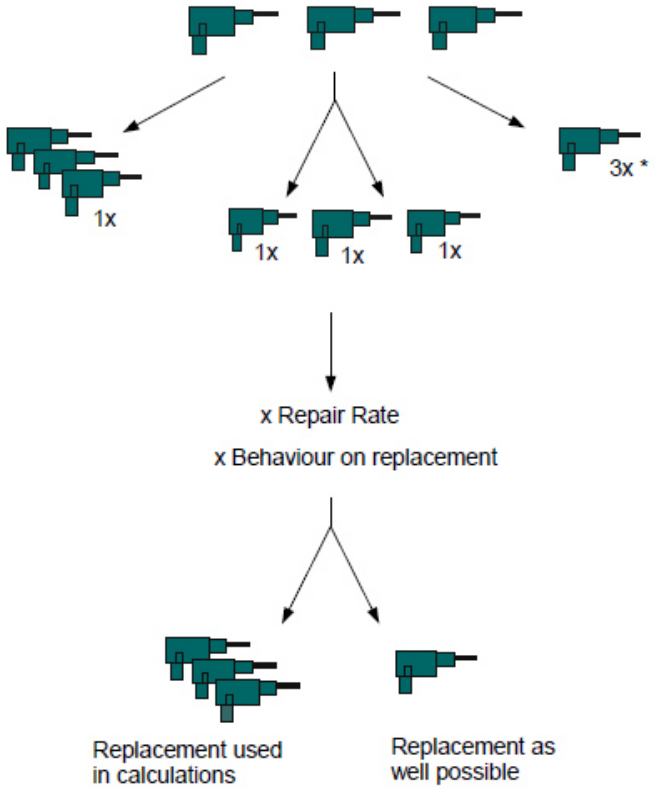
Another amount that is not included in the GHG results is the 'give-aways' from Leila. Also, recommendations given by tinkerers who possibly have contributed to the reparation of the items at home or at a professional service were not considered. Further, GHG saved by lending of repairing tools (RC SB) have not been included into the assessment. Additionally complete registration processes cannot be guaranteed, so more products than listed may have been replaced.

[19] The research project TESS includes such an investigation. Results have not been published yet, but may be available in due course on its website: http://www.tess-transition.eu/

Assumption on repairing/borrowing activities in the list by unique persons

As seen in the last chapter, emissions avoided seem to be about six to seven times higher for the sharing shop than for the selected RCs. The inclusion of equalizing aspects would lead to a convergence of the reduced emissions over the selected initiatives.

For Leila, I assumed every product listed was borrowed by a unique person and not repeating borrowed by the same person. Otherwise I supposed people would not make the effort to borrow. However, in reality the same item could have been repeating borrowed by the same person (see Figure 33). The list provided does not contain the number of products lent, but the frequency of lending a certain type of product. The case that a product was repeating borrowed by different persons[20] is thus not relevant for substitution.



* Times people come to Repair Cafés to repair one item is limited, because there can either be found a solution or not. Times people borrow one item at Leila's is not limited. The difference might thus probably be higher for Leila.

Figure 33: Possibilities of replacement for three drilling machines listed

[20] Statistics from Leila's website lead to the assumptions that one product has been lent three times on average (Leila all-sharing-shop, 2016).

The same problem appears for RCs: Data (except for SB) does not reveal how often people have to come to repair one item. If there is the same kind of product listed in two following meetings, it cannot be extracted, whether it was the same product brought twice or two different products.

With the assumption made, the amount of emissions avoided by the initiatives is higher than it would be with a correct factor in the case of available information. This contradicts the principle of conservativeness. Results should therefore always be presented with this restriction they are based on. However, Figure 31 shows that only in few cases people have to come more than once to repair their item. Also, the variance from the assumption made is probably rather low for Leila as the frequency of lending (until people buy the item) is limited. The variation of results is likely to be lower for RCs than for Leila, because a trial of reparation lasts up to a limited number of times (in contrary to unlimited times of borrowing an item).

Organisational efficiency

Figure 21 has revealed that emissions avoided and products replaced are about the same size for the different initiatives. Completing this argument, the amount of personnel involved per hour should be taken into account, too. In SB, on average six to seven tinkerers spent their time helping others to repair broken items. This RC involves a further cook and other organisers. In KB eight tinkerers, one volunteer, one organiser and one office worker make run the RC (Garrote Gash, 2015)[21]. The results conform to RCs worldwide where nine volunteers attend each session (not including organisers) (Charter & Keiller, 2014, p. 4). For Leila, about ten people manage the lending of products (Wolfert, 2015). Concluding we can say that the personnel involved are about the same for all initiatives. Including this information, would not lead to a convergence of the results over the initiatives, in contrast to the evaluation per hour. However, a thorough interpretation of effectiveness and performance is not feasible, because financial means and infrastructure, such as the location and tools, are not assessed. Leila uses an extra studio; the rooms where the RCs take place are the office of the NGO *friends of the earth* (SB) and the founder's artist workshop (KB) (Garrote Gash, 2015). Worldwide 75% of RCs hold session at fixed venue (Charter & Keiller, 2014, p. 4). Calculating the amount of emissions

[21] I conducted a face-to-face interview for the research project TESS (Towards European Societal Sustainability) within an internship at Potsdam Institute for Climate Impact Research.

avoided per participant would be interesting to compare with the entire carbon footprint of Germans (see section 1.3). In my thesis, this is not applicable due to missing data for all initiatives. Known is only that 17 people take part per meeting in KB (Garrote Gash, 2015) and 15 in SB (calculated from data obtained). Leila has more than 700 members (Leila all-sharing-shop, 2016), whereas 100-200 are estimated by the founder to be active participants (Wolfert, 2015).

Another aspect of organisational efficiency that may affect the results and effectiveness is the time the initiatives already exist: Leila was established in 2010, whereas RC SB exists since 2014 and RC KB since 2013. The survey of RCs by Charter and Keiller revealed that 95% of participating RCs around the world have operated for two years or less (Charter & Keiller, 2014, p. 4).

Avoided waste

Besides the calculated GHG reductions, waste is also avoided by the selected initiatives, however to different extents: Probably people borrow only what they do not need on high frequency. For products used in everyday-life the effort may be too high. In contrast, products people bring to repair are used regularly and mostly would have been bought again (see Figure 40). In addition, more possibilities exist for a different use of not needed items, than for broken ones. Not wanted products can for example be brought to Leila, be sold or be given to others. Repairing in common shops is often not possible or affordable. Concluding, Leila's impact seems to be mainly the avoidance of new purchase. In the case that people have to buy fewer items because product life times are prolonged, RCs as well avoid a lot of waste. Accordingly to the RC foundation 200.000 kg of waste were avoided in 2014 by 700 RCs (Stichting Repair Café, 2014). The Restart Project, a social enterprise located in London, states to have retrieved 750 kg of electronic waste since 2012[22] by hosting 55 'Repair Parties' (14 kg per party) (restart, 2016). This cannot be observed directly by having a look at replaced products. For the evaluation of the initiatives' environmental impact it is a crucial point.

[22] The issue date of the web article is not known, but was accessed by Charter and Keiller on 27th June 2014 and includes sources from 2014.

Comparison with other studies

a) Climate Challenge Fund case studies, 2015

The results obtained in this thesis can be compared with case studies investigated for a review of the Climate Challenge Fund (CCF) by Scottish Government in 2015. I chose the three CBIs active in reuse or recycling of their study.

Compared to these, the amount of emissions avoided by Leila and the two RCs seems to be low (cp. Table 6): The Concrete Garden and Eco Drama's Magic Van Tour reduce 47 and 118 tonnes of CO_2 per year (Hilliam, et al., 2015b, pp. 4-11,36-39). The Bike Revolution's activities result in a little higher amount (10 tonnes CO_2) than for Leila (9 tonnes CO_2), but are a lot higher than for RCs with comparable practices (about 1 tonne CO_2e). Table 6 shows that activities included in the accounting extend one major activity and include secondary effects (such as behaviour change). The three case studies have received high funding (£130,295 - 450,000) (Hilliam, et al., 2015b, pp. 4-11,36-39) and are partly run by professional staff (Hilliam, et al., 2015a, p. 23). Leila attempted to apply for financial support from local government, but did not succeed (Tansey, 2014, p. 6). The RC foundation raised $525,000 through a 3-year grant from the Dutch Ministry of Infrastructure, support from foundations and small donations (Tansey, 2014, p. 21 and McGrane, 2012). In my perspective, the performance of my case studies seems to be in line with the other initiatives, as they realize only one activity and have limited personal and financial means.

Table 9: Comparison of case studies assessed in the Review of the CCF **(Hilliam, et al., 2015b, pp. 4-11,36-40)**

Case Studies Climate Challenge Fund Review 2015, Appendix C, Scottish Government Social Research Dr Alex Hilliam, Stuart Moir, Lauren Scott, Tessa Clark and Ian Smith			
project name	Concrete Garden: Growing together	Eco Drama's Magic Van Tour	Bike Revolution (Outfit Moray)
CO_2 emission reduction in tonnes per year	46.67	118.34[23]	10.15

[23] Not completely clear in text, whether the emission reduction (10,065 tonnes CO2e) was for the review duration (3 years) or the time the project lasts (9 years) taken into account here.

What is included?	food growing, avoiding food miles, reducing food waste, reusing rubber tyres, clothes swapping/reuse	behaviour change of schoolchildren relating to transport (active travel to school more than once a week), energy (not putting home video games consoles on standby after use), recycling (of paper/card, metals, glass, plastic and packaging)	bike refurbishment, metal recycled, car miles reduced
duration of funding	3 years	3 years	2 years
value in pound	high (130,295-450,000)	high (130,295-450,000)	high (130,295-450,000)

b) Waste & Resource Action Programme

The registered UK charity and company WRAP investigated that the

> "reuse of key household products, such as clothes, household appliances and electrical equipment, could reduce UK greenhouse gas emissions by an average 4 million tonnes CO_2 eq per year between now and 2050" (WRAP, 2011a, p. 1).

WRAP accounts the potential to reduce the UK carbon footprint up to 15%, by changing how we design, make, buy and dispose of electrical and electronical equipment (WRAP, 2016). This could add £800 million GDP to the UK economy (WRAP, 2016).

However, only 7% of products in the UK are re-used (WRAP, 2016). More than 60% of waste of electrical and electronical equipment (WEEE) items collected at Household Waste and Recycling Centres (HWRCs) in the UK were assessed as suitable for re-use following minor repair (WRAP, 2012, p. 1)[24]. WEEE is often repaired in RCs (cp. Figure 22). One third of respondents at HWRCs as well consider their electronical and electric item to be in full working order.

"40% of WEEE items collected at HWRCs are televisions" (WRAP, 2012, p. 2). Net GHG savings following repair are 66 kg CO_2e per TV (WRAP, 2011b, p. 3f.). Comparing this to my calculations, the amount of emissions reduced is underestimated in this thesis. RC SB avoided 65 kg CO_2e with the reparation of 4 TVs (chosen EF for TV: 239.67kg CO_2e). The WRAP study is probably based on another EF and different substitution accountings for the reuse network. They explain

[24] Studies in 2011 come to the different result of 23% of WEEE immediately resalable or resalable following viable repair and refurbishment, with resale value up to £220 million (WRAP, 2011c, p. 1).

for example that "preparation for re-use" applies to products regarded as waste before (cp. methodology for more information: WRAP, 2011a).

c) Survey by Charter and Keiller in 2014

Which product categories are the most frequently brought to RCs and to Leila depends on factors named in Table 5 (e.g. frequency of use, price or transport). Surpisingly these categories vary amongst RCs worldwide as revealed by a survey by Charter and Keiller in 2014[25]. *Small kitchen appliances* are frequently brought (86% of respondents) (Charter & Keiller, 2014, p. 6) – conform to the findings from RC KB and RC SB. *Clothing and textiles* (69%), as much as *bicycles* (65%) are more often brought to RCs in the survey than to my case study initiatives (cp. Figure 35). This suggests that RCs equipped with specialized infrastructure for bicycle repair have taken part in the survey. Though RC KB provides bicycle repair, only four bicycles were brought to the initiative from June 2014 to July 2015. In Berlin, RC SB II specialises in bicycles (and mechanical technique) and does not repair electronics (Repair Café Fahrräder, 2016).

According to the survey by Charter and Keiller *lighting* is often and always (76%) brought to RCs (Charter & Keiller, 2014, p. 6). The category makes up 2% of all products brought to KB and 5% in SB, but also only comprises one type of product. *CD and DVD players* are frequently (59%) brought to RCs that participated in the survey from Charter and Keiller and also to the RCs KB and SB (comparable: *music equipment* 36% (KB) and 27% (SB) of all products, *TV and movie* 8% of all products). Over half of products disposed at HWRCs are consumer products (TVs, radios, DVD players etc.) that are frequently repaired in RCs. WEEE has the greatest economic potential on a £/tonne basis. This may be due to replacement with newer items (WRAP, 2011c, p. 2).

[25] Organisers, founders and volunteers from RCs and Hackerspaces were invited to participate in online surveys (www.surveyhizmo.com) in May 2014. "Hackerspaces are physical places where people with interest in technology can meet and work on their projects." (Charter & Keiller, 2014, p. 3) Those can be coding or software development, making or fixing electrical and electronical items, upcycling or art projects (Charter & Keiller, 2014, p. 11). Invitations for RC members were sent from Martine Postma (founder of the RC foundation) in the Netherlands, via the respective National Network organiser in Germany and Belgium, and via email from The Centre for Sustainable Design in other countries. 158 responses (70% founders and/or organisers, 23% volunteers) were received from 144 RCs in 9 countries. 31 responses were sent in from German RCs. (Charter & Keiller, 2014, p. 4).

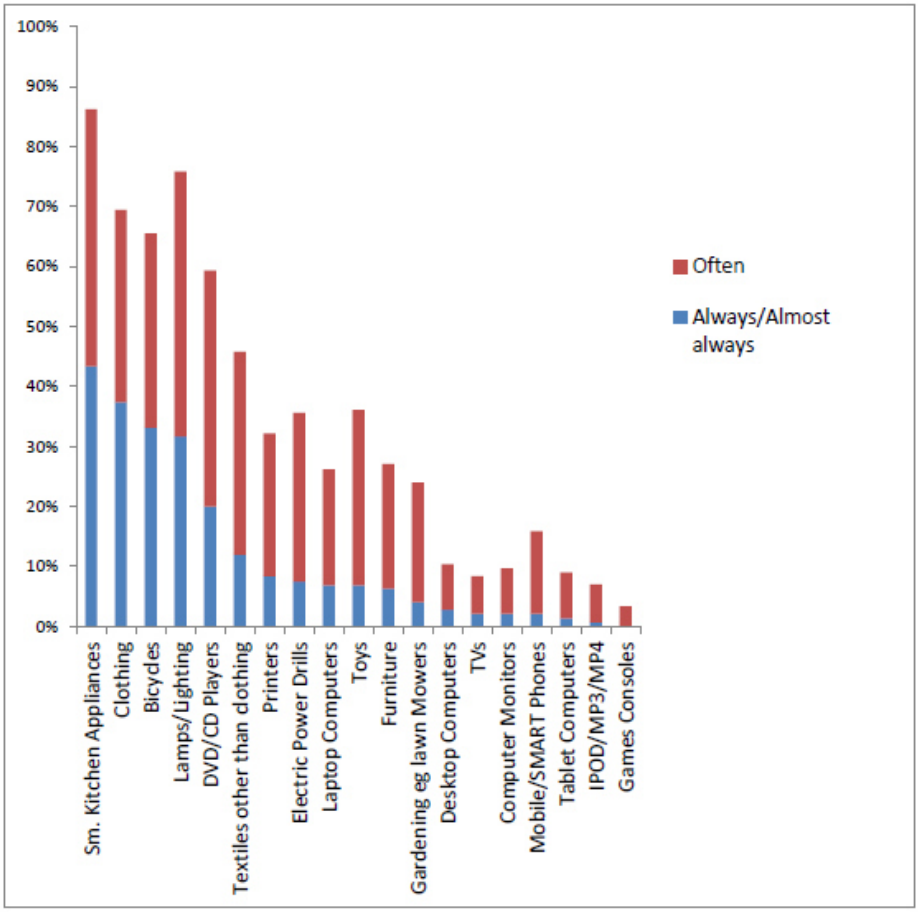


Figure 34: Results of an online survey in May 2014 on RCs and Hackerspaces inviting organisers and volunteers around the world to participate: Responses to the question 'How frequently are the following items brought to your RC for repair?' Responses were given on a five point Likert scale from Always to Never (Charter & Keiller, 2014, p. 6).

The category *tools,* most frequently lent at Leila, conforms to the most popular items lent via the online-sharing platform *fairleihen* in 2015: drilling machine, padsaw and ladder (blog.fairleihen.de, 2015).

The product category also strongly affects the factor *behaviour of substitution* (cp. Figure 22 to Figure 24). Low substitution rates for consumer equipment may be a replacement with newer products:

"Consumer equipment is less likely to be disposed of because it is broken compared to other types of WEEE. Over half at HWRCs [Household Waste Recycling Centres] is thrown away because it is being replaced with a newer item or is no longer wanted." (WRAP, 2011c, p. 2)

4.2 Discussion of results from the survey

Behaviour change

The impact of CBIs for a transition towards a sustainable future may neither be definite nor decisive: "the idea that social change can stem from the grassroots is an ideological position that does not fit comfortably with all worldviews on how change comes about." (Middlemiss & Parrish, 2010, p. 7560). It became clear in the previous chapters that the amount of GHG is not immensely high in comparison to what is emitted generally, e.g. per German. Anyhow, it is probable that if CBIs contribute to a change of behaviour in favour for sustainability, emissions now avoided by the initiatives would be surpassed. Scenarios developed by Quack in 2008 show that behaviour change until 2020 can result in energy savings of 16% to 62% in comparison to status quo in Germany (32.3m to 97m t CO_2e per year and two-person household[26]) (Quack, 2008, p. 32).

According to Paech, alternative forms of property and consumption require consumers to change their routines of use, rhythm of purchase and disposal (Paech, 2005, p. 53). About half of the survey participants confirmed in questions 8 that a change of their consumption patterns had occurred due to the possibility to repair. However, this question was posed slightly ambiguously: The case that participants avoid the purchase of a new product thanks to the initiative lead to the same answer than a general change of consumption routines. It did not define the direction of change, whether towards sustainability or not. The answer "No" did not indicate the characteristics of current consumption. Likewise the question "Do you buy few(er) products?" was answered with "Yes" if a person bought few products before, but as well if the purchase of fewer products resulted from the participation in a RI. The lack of clarity arises because this question was not clearly linked to the question on behaviour change.

Anyhow, an open question asking for reasons why consumption patterns had changed or not revealed that many participants saw themselves as conscious consumers, already aware of sustainability issues. This fact has been supported by

[26] Behaviour change is represented as a changed ratio of defined household types: From 100% to 60% average households, 14% efficient, 9% double-efficient, 9% climate efficient, 9% sustainable households. Emissions resulting from prior production processes abroad are not included here. See their report for more details (Quack, 2008, pp. 5-6).

high agreement to “Repairing is good for the environment” (cp. Figure 27 and Figure 28). Participants may thus be aware that consumption of products fosters resource scarcity and problems of waste (Common & Stadl 2005, p.114f; Gebhardt, et al. 2011, p.999). Regarding the lower importance the respondents gave to reducing GHG emissions when repairing, participants may rather consume less than buy energy efficient gadgets that can shift the problem to other dimensions of the environment. Many participants even seemed surprised by a possible influence of repairing on mitigation.
Social desirability of answers is important to bear in mind here (Baur & Blasius, 2104, p. 625) . High results could mean in this context that participants would like their consumption patterns to change – which also may be influenced by the initiative’s trial to raise awareness.

The same problem of ambiguity also applies to the other aspects on awareness and behaviour of consumption. Participants often added to this question that paying attention on quality/durability and especially on reparability/recyclability of products is hardly possible. Also among RC volunteers, it is widely believed that products are designed and manufactured to fail prematurely (Charter & Keiller, 2014, p. 14). Visiting the initiatives, tinkerers explained that some devices cannot be repaired any longer because special screws hinder the opening of the product or spare parts cannot be changed. “Printers and Electrical tools are considered to be the most frequently in need of repair, because of what respondents believe to be ‘planned or in-built obsolescence’” (Charter & Keiller, 2014, p. 7). The RI “Murks? Nein Danke!” therefore provides information for consumers on its website on the quality of products (Schridde, 2016). Political consumerism characterises consumption decisions that take the conditions of production and further economical activities of manufacturers into account. It aims at increasing the number of sustainable and transparent offers that consumers can influence in the long term. (WBGU, 2014, p. 84 ff.). Organizers and volunteers also believe to get more involved with campaigning to improve product reparability/longevity in the future (Charter & Keiller, 2014, p. 7).

Summarizing the discussion, results represent participant’s perceptions, not ratios of changed behaviour and awareness. Interesting is that repairing is rather associated

with environmental benefits than with GHG reductions. Additional information from psychological research on environmental awareness and on consumption behaviour would be needed to evaluate whether consumption patterns of participants have changed or will change in the future. They depend on several variables and can be verified only in the long term.

Anyhow, it is probably that RCs and Leila make a change of routines easier since they decrease existing barriers (e.g. missing skills or societal etiquette). They re-empower consumers by providing other possibilities of use and possibilities to reduce consumption that are independent from knowledge and resources (mostly not the case for political consumption) (WBGU, 2014, p. 102). The initiatives give environmental-conscious consumers the chance to reduce emissions resulting from the production and disposal of products, complementing decreases in the use phase. The purchase of products per capita and year in Germany results in 2.8 tonnes of CO_2e (compare section 1.4); RIs can thus – together with behaviour change – reduce a major amount of GHG emitted by products in all life cycle phases (Quack & Rüdenauer, 2005, p. 35).

Attributes of RIs participants

The discussion on characteristics of RI participants given above may allow further assessment of behaviour change and the assumptions made. Figure 25 represents the age structure obtained from my survey data which is compared with Berlin inhabitants of the inner city districts (see Figure 35):

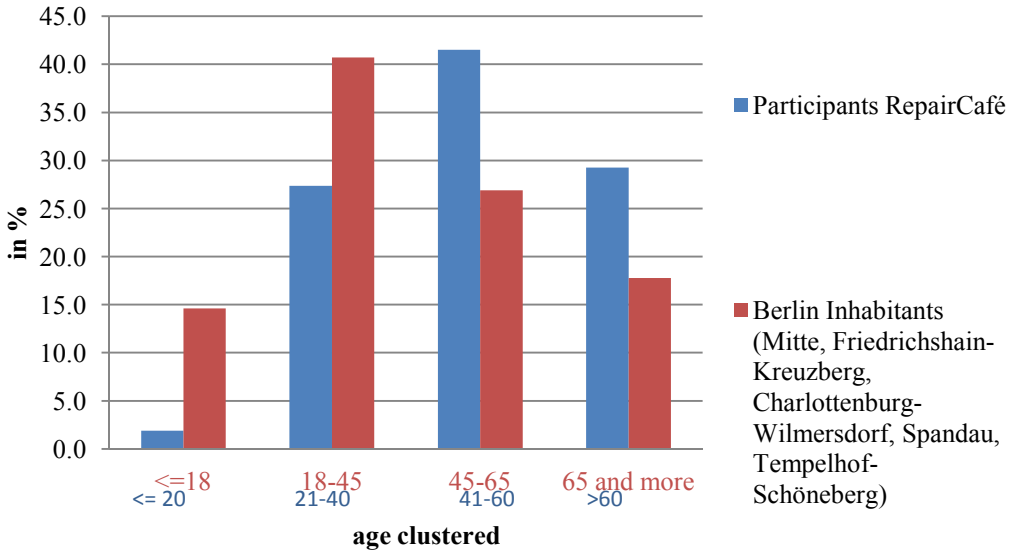


Figure 35: Comparison of age structure of RC Participants and inner Berlin inhabitants (Amt für Statistik Berlin-Brandenburg, 2014)

One can observe that participants of RIs are older on average than people living in selected districts of Berlin. About one third is more than 60 years old, whereas 18% age more than 65 years in Berlin districts. Especially adolescents from about 20 to 40 years are underrepresented in RIs. Participants between 21 and 30 years make up 7.5% in RIs, whereas 12% of Berlin inhabitants are between 18 and 27 years old (Amt für Statistik Berlin-Brandenburg, 2014). For organisers and volunteers of RCs worldwide the same ratio applies: 35% age 55 to 65 years and 21% are older than 65 years (Charter & Keiller, 2014, p. 4).

The high amount of workers and retirees (together 80%) and the small share of high school or university students (together 5%) is conforming to the age structure described above (Figure 25). The rate of jobless participants (11%) is about the same height than the unemployment rate for Berlin (10.4%) (Bundesagentur für Arbeit, 2016). 70% of RC and HC organisers and volunteers have a Bachelor or post graduate degree (Charter & Keiller, 2014, pp. 4, 9).
According to the global study in this context is that in RCs 60% are male organisers or volunteers and 40% are female, whereas in HCs almost everybody is male (90%) (Charter & Keiller, 2014, pp. 4, 9). RCs seem to attract genders almost equally[27].

Motivation and advantages of RIs

The importance of environmental aspects for participants has been highlighted before. This is in line with findings from Hamari et al. saying that intrinsic motivations, such as perceived sustainability, are strong determinant of positive attitudes towards collaborative consumption (CC) (Hamari, et al., 2015, p. 17). Additionally to environmental reasons, drivers to participate may be that 97% and 72% of participants of my survey also agreed on the statements "*I like not to buy things again."* and *"I have had negative experience with things that broke fast."* that alludes to perceived 'planned obsolescence' (cp. Figure 28). For more than 70% of participants of RCs in Berlin their expectation of product longevity has been undercut. Motivation for organisers and volunteers of RCs worldwide to participate is encouraging others to live more sustainably and to fix (Charter & Keiller, 2014, p. 5). Over 80% of RC organisers and volunteers get engaged in RCs to improve a valuable service to the community.

[27] Other genders than female and male have not been assessed in the survey. It cannot be said anything about this here. The sex of participants was not assessed in my survey.

Intensions to participate in CC are less determined by attitudes, but are significantly affected by economic benefits (saving money and time) (Hamari, et al., 2015, p. 17). This is also reflected in my study: on the one hand almost 70% of participants disagree that repairing is more convenient than buying. I assume repairing does not save time, if social contacts are not coupled to a RI. On the other hand, almost all participants agree to save money by reparation. This may also be very motivating for jobless people (11%). Anyhow, nearly half of respondents at Household Waste Recycling Centres believe it would be cheaper to replace than repair their item (WRAP, 2011c, p. 2). RIs thus provide a cheap alternative to standard reparation services.

Organisers and volunteers may have expected financial benefits to make participation attractive: about 70% rather participate to help others save money, than saving money themselves (about 20% agreed) (Charter & Keiller, 2014, p. 5). When launching the RC, they may not have anticipated it to be very profitable, but good for the environment. Sommer and Schad also assess economic capitals as one important precondition to become a change agent (Sommer & Schad, 2014, p. 50). This is in line with 70% of organizers and volunteers holding a Bachelors or Post Graduate degree (Charter & Keiller, 2014, p. 4). Other crucial factors are time and habitual willingness (Sommer & Schad, 2014, p. 51). As more than half of RC volunteers and organisers worldwide age over 55 years, the rate of retirees rich on time may be high.

Enjoyment of the activity, such as having fun or a meaningful way to interact with members of the community, is the strongest determent to participate in CC. It plays an important role in the formation of attitude and in intentions of use (Hamari, et al., 2015, p. 9). Most organisers and volunteers also take part to meet others who share their interests and to make new friends (Charter & Keiller, 2014, p. 5). Participants in my survey agreed repairing was fun and a possibility to meet people. This is even the most motivating factor for some (cp. Figure 28). People from different backgrounds come together, so that discourses are spread leading to a dispersion of the initiative's aims. As participants mainly visit the RIs located close by (see chapter 3.3.2.), the initiatives can serve as a meeting point for neighbourhood, too. They may therefore increase social capital and community cohesion (Heinrichs, 2013, p. 99).

Mont underlines the need for sustainable consumption alternatives to be laden with attractive symbolism (Mont, 2004, p. 152). Crucial for the survival of CC systems is

to “make participation more pleasurable, more communal, and more supportive for the ideological cause by promoting positive buzz” (Hamari, et al., 2015, p. 10). This may reduce barriers to come to a meeting and be an advantage to professional offers. A good manner to do so is creating a café atmosphere by offering coffee and cake.

RIs help people to acquire new skills for self-help (Reperatur-Initiativen, 2016). This can give a feeling of success and foster self-consciousness. About 90% of participants in my survey confirm the learning effect. The initiatives demonstrate self-efficacy – not only by repairing, but also by engaging for sustainability – that may motivate more people to contributing to the repair movement.

North and Longhurst argue “that Transition initiatives embody a collective, progressive politics of responsibilities for climate change and resource crisis that is hopeful, optimistic and generative of possibilities.” (North & Longhurst, 2013, p. 1). This seems also to be the case for RIs, as only few people at all named things they did not like and mostly criticised organizational issues (cp. Figure 40 in annex C). A way to avoid disappointment among participants in sharing shops is to employ systems of trust that allocate resources evenly and monitor the sharing activities (Hamari, et al., 2015, pp. 9-11).

Figure 36 summarizes the different aims and means explained above used by CBIs to contribute to climate change mitigation and sustainability. Anyhow, a complete judgement on their contribution to a transition can only be made after further and more detailed research on this topic including more investigations on the actual behaviour of participants.

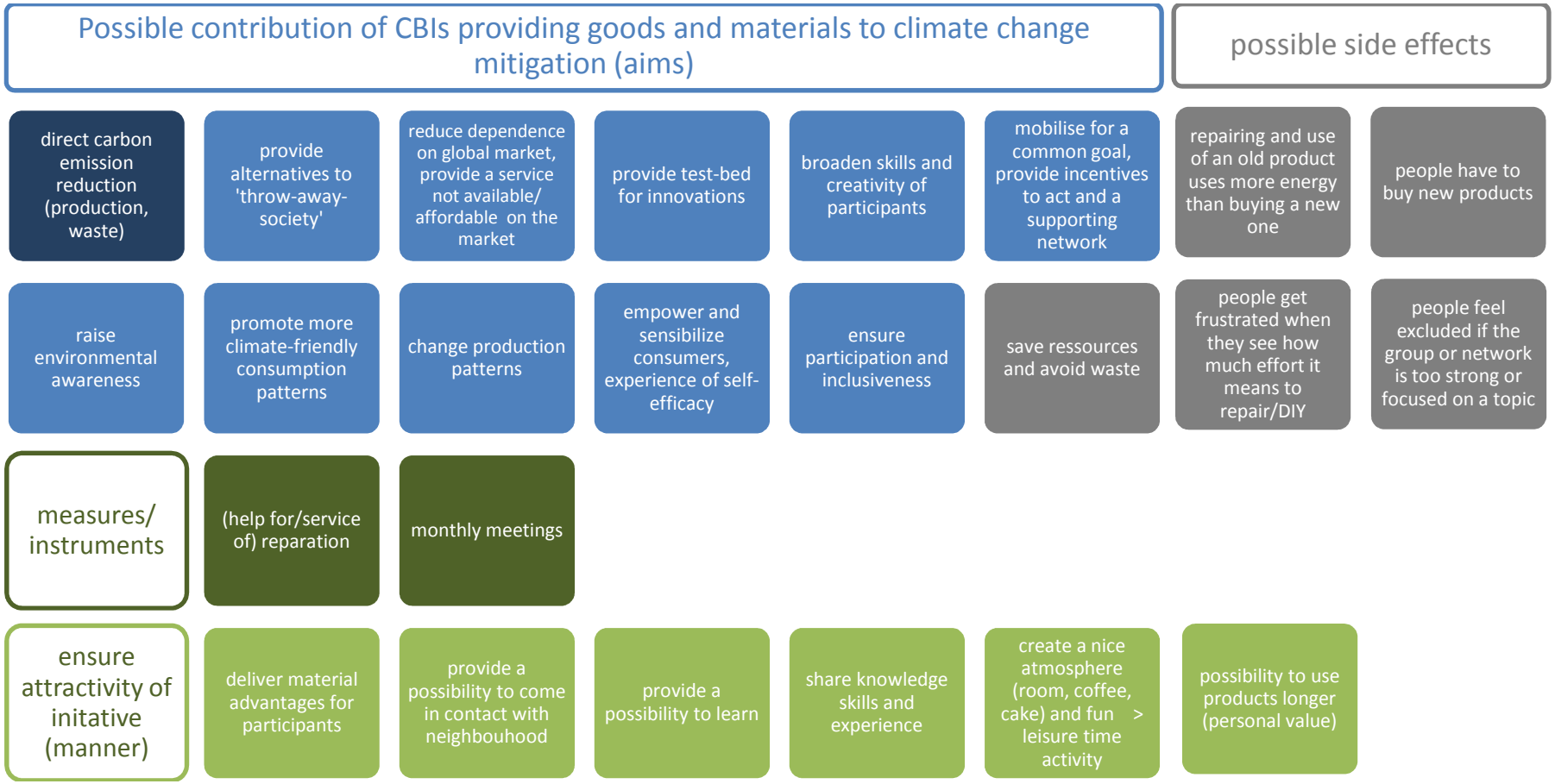


Figure 36: Summary of CBIs' possible contributions to climate change mitigation (based on the conducted interviews: Garrote Gash, 2015 and Wolfert, 2015, see Annex C). Displayed are possible aims (blue), side effects (grey), instruments (dark green) and manners (light green). The boxes with outlines are headings and the filled ones contents. The box in dark blue represents the contribution to mitigation by CBIs that was the focus in this thesis (chapter 3.2), whereas the light blue boxes contain other possible contributions that are partly investigated in this work (chapter 3.3). The case that people have to buy new products could happen if one function of a product was meant to be repaired, but due to the working process the whole product got broken instead. Another possibility would be that one function of a product could be repaired, but the participant would a buy a gadget with the other function only. If then the repaired product breaks the participant needs to buy another appliance with the first function.

4.3 Discussion of methodology

Comparison to baseline

The method proposed by the GPPA can be questioned: It seems to be contradictory that the less people buy in a business-as-usual scenario ("lower carbon baseline"), the lower is the emissions avoided by the CBIs' activity. It shows how strongly results depend on the baseline set, as they only represent the difference made, not the full carbon footprint of the initiative. Correlated to the behaviour of replacement, however, this discrepancy only applies to the case that people bring or borrow things they do not truly need. 68% would have probably or definitively bought the repaired item again (cp. Figure 30). Defining the difference between the baseline scenario and the project activity is in line with the GPPA and has the advantage of simplifying the method. This is especially relevant for the application to CBIs with limited possibilities for documentation (cp. section 3.1).

Substitution factor

The applied method leads to constraints regarding the quality of results through different aspects concerning the *substitution factor*:

1. The first one is the assumption on the *behaviour of substitution* due to a lack of data obtained from the survey and the initiatives. As explained in chapter 4.1, the level of replacement has been overestimated due to the supposition of one unique person borrowing, respectively coming only once to repair an item. However this was transparently reported and should always be displaced together with the results. The introduction of an additional factor (next to the *behaviour of reparation/sharing* and the *behaviour of purchase*) would result in a more appropriate substitution rate and would counterbalance the effect described. This may equal out the difference between results from the sharing shop and the RCs, as seen in chapter 4.1. Satisfying data is thus the precondition to repeat investigations.

2. Another step with high uncertainty is the rate of *behaviour of substitution,* which is based on assumptions (cp. section 2.3.4). An option to achieve a better quality of factors would be the assessment of criteria influencing *behaviour of reparation/sharing* and *behaviour of purchase* (see Table 5), which would have

overburdened the survey and would have been beyond the scope of this thesis. This factor has been used to modify the factor *behaviour of substitution* (as they determine each other). However, given a better data base the two factors could be assessed separately (representing two different decisions). They could then each be multiplied with the repair rate, following the idea of representing branches in a probability tree, where a multiplication is the correct step in this case. The results would be distinctly lower then.

3. The third component of the *substitution factor* is the *repair rate* (cp. Table 17): According to Tansey "it is estimated that 70% of items brought to RCs are fixed" (Tansey, 2014, p. 21). Averaged on all product categories in this thesis, only 57% of items brought can be repaired. This means the repair rate used here is very low in comparison and results obtained may be underestimated. Since no repair rate was applied to the Leila, these changes in the repair rate would also influence results on the difference between the CBIs.

Data availability

Another limitation to the results is the lack of external data on PCFs. This has lead to a limited quantification and transfer of replaced products into emissions avoided (cp. section 3.1). Extrapolations of results revealed a rough estimate on total carbon reductions, but this step involves a large uncertainty (cp. section 4.1). Case studies investigated by the Scottish Government confirmed that data gathering for baseline emissions is challenging. Estimates and guesswork even became necessary for CBIs active in other fields, for which I considered it easier to encounter EFs. This is still more problematic if carbon accountings are done to identify targets, as inaccurate ones are difficult to meet (Hilliam, et al., 2015a, pp. 33-34).

Further, the questionnaire was not detailed and specific enough to receive information on the dates items listed were repaired or lent. The survey did neither reveal the number of persons participating; nor the total number of products people ever lent or brought to the initiative (with the respective date). Also, the response-rate has been lower, when I did not personally conduct the interview (as in the case of Leila). Assumingly organisers had more difficulty to convince people to enter the survey because participants may feel less obliged. A rejection to take part may be

easier, if the person dependent on the survey is not present or known (Baur & Blasius, 2104, p. 649). Another explanation for the dispersion may be that filling out questionnaires requires more time for people to understand the questions. In a conversation, necessary choices when entering the answers into the questionnaire are left to the interviewer.

Meeting the principles required by the GPPA

I have based the methodological approach on the GPPA as I found this a suitable framework for the application to CBIs. A core aspect of this protocol is the consideration of several key principles. In my case, the principles *completeness* and *accuracy* have not always been accomplished in the research due to a lack of data. Given more detailed data sets from surveys and PCFs, this could be improved. Also the principle *conservativeness* could not continuously be applied in my thesis (e.g. by the assumption on repairing/borrowing activities in the list). However, in many aspects this principle has been considered (e.g. for the inclusion of products in the calculations). I assume that the latter weight stronger on the results, which are therefore still underestimated. Anyhow, this is a weakness in this GHG accounting, since the amounts calculated cannot be entitled as minimum avoided emissions achieved by the CBIs. Nevertheless, the aim to derive a first estimate on mitigation potential for the selected CBIs was achieved.

Also due to several necessary assumptions, the principle of *transparency* was strictly taken into account in the methodology. While some of the accounting principles have been infringed at some steps in the approach, this is alleviated by a clear transparency provided through detailed explanation and data tables provided in this thesis. Thus, the reader knows what the accounting and the results encompass reader knows what the accounting and the results encompass. The principles have turned out to be a valuable methodological guidance and should always be followed as best as possible. If documentation and data gathering processes can be carried out with quality standards by the initiatives, efforts for the investigation may be higher but results certainly more accurate.

4.4 Recommendations for future research

Summarizing the above described limitations of my thesis, I recommend repeating this research under different preconditions:

List of included items and data on PCF from external databases

In the case of initiatives active in repairing and sharing, the calculations are based on a high number of newly purchased products. The assessment of this long list of items constitutes complex work for organisations based on voluntary work. The first possibility proposed in this thesis is to simplify primary activities. They can be scaled up in a second step to identify the entire impact of an initiative. For RIs and Leila, evaluating a representative basket of goods repaired on one meeting or lent within one day would be an adequate possibility. A similar approach could be to calculate emissions only for products with PCFs of satisfying quality. Further products would be listed only (like gifts available at Leila's) and not clustered in product categories.

Due to financial limitations for this thesis, costly databases could not be applied. However, gaining access to high quality databases could enlarge the list of items included into the accounting.

Moving beyond GHG emissions

An advantage of the methodology applied is that it permits to include other environmental impacts. It can be extended to various environmental assessments or include the amount of resources saved with the activity. Those impacts could be included in further assessments for comparing GHG savings of the different initiatives.

Surveys among participants

As described in the previous chapters, the conduted survey has not revealed all information needed for the calculations and the questionnaire has been missing specification in some questions. My recommendations are:

- Increase the number of survey participants for sharing shops by either spending time on site or by earlier embedding other media. The questionnaire was embedded in Leila's newsletter, but I did not receive responses. Researchers

could give incentives (such as small prizes) or visit meetings of the initiative (if there is one with a high number of participants).

- The questionnaire should include information that can be used for the substitution rate, such as the relevance of other possibilities of reparation for the items brought, since data on reparation, reuse and purchase activities in society is rather low:

  "Although the relative merits of waste management options further down the waste hierarchy (recycling, energy recovery, landfill) are well studied, the wider environmental and economic impacts of reuse are less understood. This is in part due to the complex nature of reuse activities and consumer behaviours, [...]." (WRAP, 2011a).
- Make a list of all products, participants and tinkerers for each meeting you attend conducting the survey. This may help to include more survey data in factor and effectiveness calculations, as data would be complete for these sessions.
- More attention during the preparation for the questionnaire should be given to the social desirability of responses. In my impression, this applies especially to questions on the purchase of products and estimates on a possible change of consumption patterns.

4.5 Growth potential for CBIs active in repairing and sharing

Though there is only few verifiable data on the expansion of the Sharing Economy[28] in Germany and worldwide, Heinrichs shows the concept gains popularity beyond niche. More than half of Germans have already experienced alternative forms of property and consumption (Heinrichs, 2013, p. 101) and the number of RCs and sharing shops is increasing worldwide (Tansey, 2014, pp. 6, 21). Social media and other information technologies favoured the expansion of the sharing economy (Heinrichs, 2013, p. 105) and iFixit movements[29]. The initiatives seek to acquire new participants and expect the number of repairs to increase in the future (Charter & Keiller, 2014, p. 14). If for example all inhabitants of Berlin would repair one item, already about 90,000 tonnes CO_2e could be saved (calculation is based number on inhabitants from statista, 2016).

[28] Collaborative lifestyle is one aspect of Sharing Economy among redistribution markets and product-service systems (Heinrichs, 2013, p. 103).
[29] They produce open-source online repair guides and sell spare parts (Tansey, 2014, p. 24).

An urban context may be helpful, if greater diversity of political action, denser networks and resources ensure the survival of grassroots initiatives (North & Longhurst, 2013, p. 1423). Social networks are a determining factor for the impact of change agents, too (Sommer & Schad, 2014, p. 51). The founders of RC KB and Leila confirmed this assumption (Garrote Gash, 2015 and Wolfert, 2015). Participants may also get to know initiatives active in other areas, such as food or energy via this network. About 70% of RC organisers and volunteers believe their initiative to tie stronger bonds with other RCs in the future (Charter & Keiller, 2014, p. 8).

Acting on the assumption that infrastructure plays a greater role than attitude for specific behaviour; RIs provide convincing offers for repairing items (WBGU, 2011, p. 256). The inititatives seem to be very successful because they connect to people's everyday life (Sommer & Schad, 2014, p. 54). According to WBGU, effective environmental and climate policies have to create acceptance and legitimisation; they need to make participation possible (WBGU, 2011, p. 71). In my perspective, RIs therefore provide a first approach focussing on the top of waste hierarchies by providing alternatives to consumption and improving repairing skills (Tansey, 2014, p. 14). It has also been shown that new jobs and business models have been created tying in with the ideas of these CBIs (Tansey, 2014, pp. 12,16). To ensure the revival and a growing influence of RIs and sharing shops, governmental support could be helpful for some initiatives. It may secure stamina required to achieve changes in consumption patterns as they need longer time and more comprehensive change in society (Mont 2004, p.136).

Apart from external support, CBIs could improve their impact by strengthening their outreach: RIs or their networks may organise trainings to improve their tinkerers' skills or could focus more on help for self-help. If the capacity is limited, RIs should communicate that people bring only product groups with high chance of successful reparation (like RC KB does on their homepage). They could also reduce to product categories that are difficult or very expensive to repair otherwise. In the case that values or business models adapt to repairing and sharing habits in society in the long term, RIs and sharing shops would still be valuable for sustainability if they could find their niche to complement professional offers.

Only the years ahead can show whether governmental support, wider networks, innate strengths or a combination will be the best way for growth encouraging transition.
However, a challenge for the CBIs may then be as well to find the right balance and keep their attractiveness that results from community based pioneering activities and personal contacts.

5. Conclusion

The calculations have revealed that RIs and sharing shops considerably contribute to climate change mitigation. The amount of GHG reductions was difficult to measure in the case of CBIs active in repairing and sharing due to the long list of products to be included and the consideration of a substitution factor. I have applied and adapted the existing 'Greenhouse Gas Protocol for Project Accounting' (GPPA) to the case of three CBIs in Berlin. I found the GPPA (developed for project accounting) a useful framework, since it offers a simplified approach which can be adapted in a flexible way to the specificities of the case studies characterized by a lack of detailed data. The principles proposed by the GPPA have been considered wherever possible. Unfortunately the principle of conservativeness could not have been fulfilled constantly due to the lack of data, but I expect that it does not result in an overall estimation of results.

The thesis reveals a first estimate on emissions avoided by the activities: The sharing shop Leila reduces about 9 tonnes of CO_2e per year, whereas the two RCs avoid more than 1 tonne each. The GHG emissions represent 85% and about 60% of all products replaced. Results should always be reported as the difference to a defined baseline scenario (the purchase of the repaired or borrowed product) and need to be evaluated with the products replaced that are not included in the carbon budget.
Further contributions by CBIs to climate change mitigation and sustainability can be assumed, but their evaluation was beyond the scope of this thesis. For a wider dispersion in society external support may be helpful for some initiatives.

Especially challenging for this thesis has been missing data from literature reviews and from the initiatives. Restrictions resulted from missing standards for carbon

accountings and from a lack on PCFs from external literature for many repaired/lent products. A survey among RCs in Berlin could not fully fill the gap of information, due to partly low response rates and because it missed some specification in the questionnaire. A further investigation following the examples given here should ensure satisfying data quantity and quality and consider applying the simplifications presented in section 4.4. Though GHG accountings have been controversially discussed due to high efforts before, the estimates given on CBIs' contribution to mitigation can provide a basis for further support of repairing and sharing movements.

Annex A

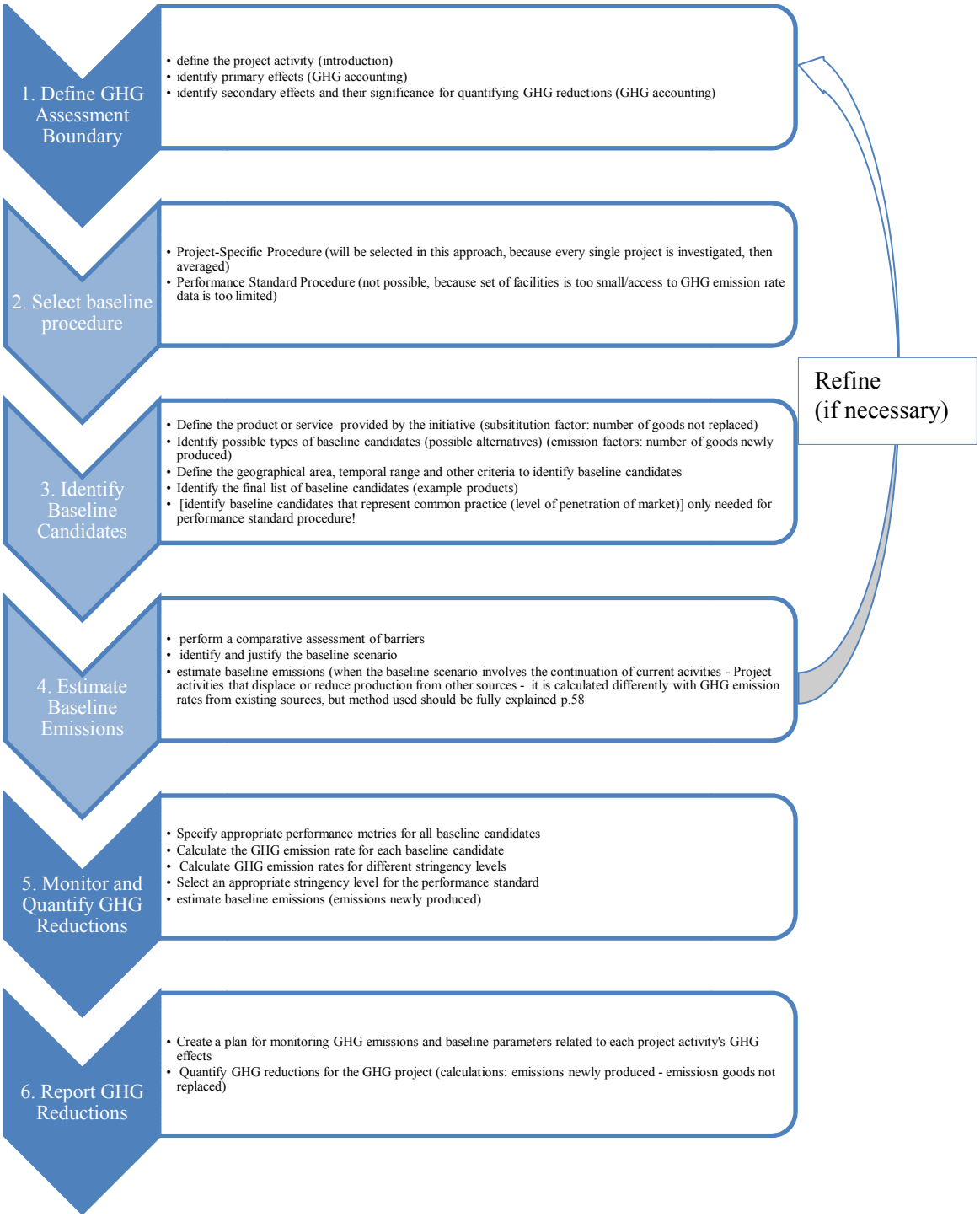


Figure 37 Steps for accounting and reporting GHG reductions from a project according to the GHG Protocol for Project Accounting (WRI & WBCSD, 2005, p. 27). It has been modified for this thesis.

Table 10: Number of participants living in the districts of the RIs. The cells contain the amount that postal codes were named by the participants in the survey among RIs.

Neighbourhood RI is located in (the deeper the blue the more central is the district)	Postal Code (starting with)																								sum
	101	102	103	104	105	106	107	108	109	120	121	122	123	124	125	126	131	132	134	135	140	141	145	146	
Brunnenviertel (13355)	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0	0	0	0	3
Charlottenburg (14059)	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	1	9
Friedrichshain (Rigaer) (10247)	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	3
Friedrichshain (Straßmann) (10249)	0	6	1	0	1	0	0	0	1	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	11
Kreuzberg (Alexandrinen) (10969)	3	0	1	0	0	2	2	0	3	2	0	1	2	1	0	0	0	0	0	1	1	1	1	0	21
Kreuzberg (Urban) (10961)	0	0	0	1	1	0	1	0	6	2	1	0	2	0	0	0	0	0	0	0	0	1	0	0	15
Oberschöneweide (12459)	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
Prenzlauer Berg (10119)	1	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
Schöneberg (10827)	0	0	0	0	0	0	2	7	3	0	2	2	1	0	0	0	0	0	0	0	0	1	0	0	18
Soldiner Kiez (13359)	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	2	0	0	0	0	0	0	5
Spandau (13595/13589)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	5
Tempelhof (Murks) (12109)	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	2
Treptow (12435)	0	0	0	0	0	0	0	0	0	1	0	0	1	2	1	2	0	0	0	0	0	1	0	0	8
sum	4	7	4	7	5	2	5	7	13	6	5	3	6	5	1	2	3	3	1	7	6	4	1	1	108

	district where the RI is located in
	district next to the district where the RI is located in
	mark for other postal codes named by participants
	districts named where no RI is available

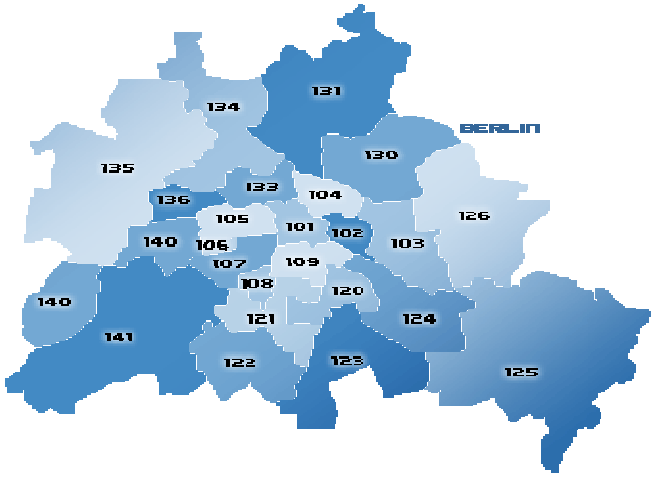


Figure 38: map of postal codes in Berlin **(sicherheitsfirmen-vergleichen.de, 2016)**

Figure 39: Registration sheet for RCs (provided by Stichting Repair Café, 2016.)

Table 11: Assessed databases for this thesis

name of database	name of publisher of database	domain	open/cost	brief description	link
		agriculture, services, goods, mobility,…			
DCFCarbonFactors	DEFRA (Department for Environment Food & Rural Affairs)	electrictiy and heat, transport and fuels, materials, waste, water treatment	open	UK Factors for Company Reporting, suitable as well for other sizes of organization	http://naei.defra.gov.uk/data/data-selector
GHG Inventory	UNFCCC	commercial/institutional, residential, agriculture, forestry, fisheries	open	List of Third-Party-Databases also available	http://www.ghgprotocol.org/Third-Party-Databases
ProBas/GEMIS	Umweltbundesamt/Internationales Institut für Nachhaltigkeitsanalysen und -strategien	materials	open	GEMIS is data/extension to download of ProBas	http://www.probas.umweltbundesamt.de/php/prozessliste.php?topic_id=8589934592
Ecoinvent		all kinds of products and materials	guest, costly		http://www.ecoinvent.org/database/database.html
BaseIMPACTS	ADEME	materials, processes	open (account)	gives all conversion	http://www.base-impacts.ademe.fr/
Athena LCA software	Athena Sustainable Materials Institute	buildings	open (account)	EcoCalculator or ImpactEstimator give different amount of detail	http://calculatelca.com/about-us/athena-sustainable-materials-institute/
thinkstep Gabi	PE international	building materials	30 day testing		http://www.thinkstep.com/software/gabi-lca

Umweltproduktdeklarationen	Institut für Bauen und Umwelt	furniture, carton			http://bau-umwelt.de/hp354/Deklarationen.htm?ITServ=C5972a255X14d2e6d
Environmental Product Declaration	EPD	different materials and product components, but not important for TESS	some products free		http://www.environdec.com/en/EPD-Search/
List of Labels by PCR	EcoLeaf	printer, scanner, camera, data projector, facsimile,	open	factors for limited products	http://www.ecoleaf-jemai.jp/eng/label.html
Emission factor database	carbonfootprint.com	product components, materials	open, 17€/factor	based on Bath Uni and Ecoinvent	http://www.carbonfootprint.com/
TrendtabellenAtmosphaerischerEmissionen1990-2013	UBA (Umweltbundesamt)	all materials	open	low level of differentiation	http://www.umweltbundesamt.de/themen/klima-energie/treibhausgas-emissionen
Sustainability Disclosure Database	Global Reporting Initiative	textiles, perfume, waterfilter, lego, stationery and more		"Sustainability" Reports from different	http://database.globalreporting.org/search
LCA Harmonization	NREL	renewable energy plants			http://www.nrel.gov/analysis/sustain_lcah.html
ELCD	EPLCA - European reference Life-Cycle		downloaded		http://eplca.jrc.ec.europa.eu/ELCD3/
LCA Food Database	LCA Food-conference	food	open	Food Database that links to other	http://www.lcafood.dk/
TEAM/DEAM	pwc	software is based on ecoinvent and more	demoversion for free		http://ecobilan.pwc.fr/en/boite-a-outils/team.jhtml
Bureau Veritas CODDE	EIME	materials and processes, E&E, Textiles, Transport	demo version 30 days	based on ELCD, Ecoinvent and Bureau Veritas CODDE	http://www.codde.fr/en/lca-software.com/195_database.html

SimaPro	ESU	all kinds of products and services	test version, 1.900€/year	extension with Ecoinvent	
Climate Earth	MIET 2.0/CEDA 3.0	all kinds of products	costly		
Universiteit Leiden	E3IOT + CMLCA	all kinds of products	1000 euro		
GHG Reporting Program Data Sets	EPA	industry sectors, especially energy + personal footprint	open	data on different industry sectors	http://www.epa.gov/climatechange/ghgemissions/
emissionfactors.com	ef	transport, composting, waste, hotel nights,…	open	free database with different	http://emissionfactors.com/#about-section
European Database for Corrugated Board Life Cycle Studies	FEFCO and CCBB	paper, cardboard	open	Database document with emissions to air	http://www.fefco.org/technical-documents/lca-database
AusLCI	The Australian Life Cycle Inventory Database Initiative	materials	open		http://alcas.asn.au/AusLCI/index.php/Datasets/Materials
CarbonTrust	Footprint Expert	different products including white goods?	costly		
iLCA2010+ LCI Data Base System	Gruner Sustainability	e.g. electronics and electronics, technologies, health	costly		

Annex B

Table 12: List of RIs in Berlin with date of visit/of survey, address and contact. Grey if not existent or not suitable.

N°	neighbourhood		date visit	date survey	When?	Institution and person in charge
1	Kreuzberg – Alexandrinen straße	10969	06.07.2015, 03.08.2015, 31.08.2015		1st Monday 16-20 registration	Kunststoffe.V., Elisa Garrote
2	Oberschöne weide Reinbeckstraße 9	12459	08.07.2015	05.08.2015 12.08.2015 02.09.2015	1st and 2nd Wednesday, 17-20	Industriesalon Schöneweide e.V., Forum für Industrie-Technik-Kultur
3	Lichtenberg, eigentlich Althohenschön hausen	13055	09.07.2015	23/07/2015		Umweltkontaktstelle , interkulturellergarten@sozdia.de; umwelt@firmaris.de (Paul Dawson, Anne Haertel), http://www.interkulturellergarten.de/
4	Soldiner Kiez Osloerstraße 12	13359	09.07.2015	23/07/2015		
5	Kreuzberg - Urbanstraße 21	10961	02.08.2015	12/07/2015	1st Sunday 12-15	Nachbarschaftshaus http://www.nachbarschaftshaus.de/veranstaltungen/
7	Treptow Plesserstr. 1	12435	10.07.2015	14/08/2015	2nd Friday	Café Grenzenlos
8	Wedding – Müllerstraße 56-58	13349		August holidays, 02.08.2015 03.09.2015	1st Thursday, 15-18	DieWille Birgit Dörr
9	Reinickendorf - Letteallee 82/86	13409		15/07/2015	3rd Wednesday, 15-18	DieWille Birgit Dörr
10	Schöneberg - Crellestraße 35	10827	20.07.2015 17.08.2015		3rd Monday 18-21, registration	BUND repaircafe @ bund-berlin.de http://repaircafe-schoeneberg.de/, Daniel Affelt,
11	Wedding II Brunnen-viertel – Graunstraße 28, Kiezladen Freizeiteck	13355		26/08/2015	4th Wednesday 17-20, registration	repaircafe @ brunnenviertel.de Daniel Affelt
	Spandau – Schönwalder Straße 23, Paul Schneider Haus	13585	Moved, belongs to no. 13		last Monday, 17.30-20	Klimawerkstatt Spandau
12	Spandau Wilhelmstadt Adamstraße 39	13595		13/08/2015	every second Thursday, 17.30-20	Klimawerkstatt and Stadtteilladen Wilhelmsstadt Info @ klimawerkstatt-spandau.de http://www.klimawerkstatt-spandau.de/

13	**Spandau Zufluchtsgemeinde – Westerwaldstraße 16**	**13589**		**27.07.2015 31.08.2015**	**last Monday, 17.30-20**	**Klimawerkstatt and evangelische Zufluchtgemeinde**
14	Prenzlauer Berg - Fehrbelliner Str. 92	10119	02/08/2015		1st Sunday, 15-18	Nachbarschaftshaus am Teutoburger Platz in der Ökowerkstatt
15	Friedrichshain II - Rigaerstraße 86	10247	22/08/2015	25.07.2015 sent, but no response	4th Saturday, 15-17	Zeitprojekt Berlin, Kiezwerkstatt Klaus Abendbrot http://www.zeitprojektberlin.de/
16	Friedrichshain I – Straßmann straße 17	10249	31.07.2015 21.08.2015			http://repaircafefriedrichshain.wordpress.com/ repaircafe @ menschmartin.com, Martin Wagner
17	Charlottenburg – Sophie-Charlotten-Str.30	14059	06/08/2015	03/09/2015	1st Thursday 17-19	Info @ klausenerplatz.de
	Schöneberg - Goebenstraße 12		only bicycles		Mo, Di, Do, Fr: 11-18Uhr; Mi 11-15 Uhr, Sa 11-14 anrufen!	Taisun Illtner
	Friedrichshain III - Revaler Straße 99				opening soon?	repaircaferaw @gmail.com (Mr. Ashleigh Nuttall) https://www.facebook.com/repaircaferaw
	Wilmersdorf - Paretzer Straße 7		summer break		every fourth weekend	Naturfreunde
18	Tempelhof, Murks Werkstatt, Dirschelweg 1	12109		not received in time for August, 03.09.2015	first Thursday 16-18	MURKS Nein Danke!? Bastian Brabec bastian.brabec @gmx.de

Potsdam Institute for Climate Impact Research
Hanne Hagedorn
hagedorn@pik-potsdam.de
Telefon: 0176 9766 0980

Questionnaire Repair Café Where? _____ Date: _____

Your opinion is needed!

Dear visitors of Repair Café,

my Bachelor thesis, which I am writing at Potsdam Institute for Climate Impact Research aims at calculating the reduction of Greenhouse Gas Emissions reached by Repaircafé Kreuzberg. Therefore I need your support!

I would be very happy if you could spend some minutes (5-10 minutes) to fill out this short questionnaire.

Your data is only used in an anonymized manner. For additional questions you can reach me via email (hagedorn@pik-potsdam.de) or on the phone (+49 176 9766 0980).

Thanks a lot for your help!

1. Which items did you repair at Repair Café Kreuzberg (include today, please)?

brought item (one item per line)	Number of visit at Repair Café	Repaired?	How often did/do you have to come to Repair Café to repair that item?	How often do you use that item on average?
				☐ 1xyear ☐ 1xmonth ☐ 1xweek ☐ 1xday ☐ ____________________
				☐ 1xyear ☐ 1xmonth ☐ 1xweek ☐ 1xday ☐ ____________________
				☐ 1xyear ☐ 1xmonth ☐ 1xweek ☐ 1xday ☐ ____________________
				☐ 1xyear ☐ 1xmonth ☐ 1xweek ☐ 1xday ☐ ____________________
				☐ 1xyear ☐ 1xmonth ☐ 1xweek ☐ 1xday ☐ ____________________
				☐ 1xyear ☐ 1xmonth ☐ 1xweek ☐ 1xday ☐ ____________________
				☐ 1xyear ☐ 1xmonth ☐ 1xweek ☐ 1xday ☐ ____________________

	2. Which items listed above did you buy new or used/ would you have bought new or used if it was not possible to repair them at Repair Café (please fill out for all repaired items so far)?				3. Why would you NOT have bought them again? (Multiple selection possible.)			
Item (Please list as above in question 1)	I would have definitively bought	I would have probably bought	I would have probably not bought	I would have definitively not bought	A new product is too expensive for me.	The item is a keepsake or a present.	I do not use the item often enough.	other reasons
	☐	☐	☐	☐	☐	☐	☐	
	☐	☐	☐	☐	☐	☐	☐	
	☐	☐	☐	☐	☐	☐	☐	
	☐	☐	☐	☐	☐	☐	☐	
	☐	☐	☐	☐	☐	☐	☐	
	☐	☐	☐	☐	☐	☐	☐	
	☐	☐	☐	☐	☐	☐	☐	
	☐	☐	☐	☐	☐	☐	☐	
	☐	☐	☐	☐	☐	☐	☐	

4. What do you like about Repair Café?

_____

_____

_____

5. What do you dislike about Repair Café?

_____

_____

6. Why do you come to Repair Café? Which advantages do you benefit from?

	I agree.	I somewhat agree.	I somewhat disagree.	I disagree.	I do not know.
I like not to buy things again.	☐	☐	☐	☐	☐
I can learn something at Repair Café.	☐	☐	☐	☐	☐
It is fun to repair things.	☐	☐	☐	☐	☐
Repairing items is good for the environment.	☐	☐	☐	☐	☐
I can meet people at Repair Café.	☐	☐	☐	☐	☐
I can save money.	☐	☐	☐	☐	☐
Repairing is more convenient than buying things.	☐	☐	☐	☐	☐
I repair items to avoid green house gas emissions.	☐	☐	☐	☐	☐
I made negative experience with items that broke fast.	☐	☐	☐	☐	☐
Others:_____	☐	☐	☐	☐	☐

7. Please mark your two main reasons coming to Repair Café in the table above.

8. Do you think the possibility to repair things has changed your consumption patterns?

□ Yes	□ No	□ I do not know.
In which way/ Why not? _____ _____		
1. Do you therefore buy fewer products? □ Yes □ No □ I do not know. 2. Do you therefore pay more attention to quality and durability of products you bought? □ Yes □ No □ I do not know. 3. Do you therefore pay attention when buying things on how well products can be repaired or recycled? □ Yes □ No □ I do not know.	1. Do you buy fewest products on purpose? □ Yes □ No □ I do not know. 2. Do you pay attention to quality and durability of products you bought? □ Yes □ No □ I do not know. 3. Do you pay attention when buying things on how well products can be repaired or recycled? □ Yes □ No □ I do not know.	

9. Personal data

age								
postal code								
occupation	□ highschool student	□ apprentice	□ university student	□ working	□ unemployed	□ retiree	□ volunteer	□ _____ _____

Potsdam-Institut für Klimafolgenforschung

Hanne Hagedorn hagedorn@pik-potsdam.de Telefon: 0176 9766 0980

Repaircafé Wo?: _____ Datum: _____

Liebe Besucher*innen des Repair Cafés,
im Rahmen meiner Bachelorarbeit untersuche ich wie viele Treibhausgasemissionen durch Repair Cafés eingespart werden. Und dafür brauche ich eure Unterstützung! Ich freue mich sehr, wenn ihr euch kurz Zeit nehmt, um die Fragen zu beantworten. Die Daten werden selbstverständlich ausschließlich anonymisiert verwendet. Bei Rückfragen erreicht ihr mich unter hagedorn@pik-potsdam.de oder 0176 9766 0980.
Vielen Dank fürs Mitmachen!

Welche Gegenstände hast du bereits im Repair Café repariert bzw. heute mitgebracht?

mitgebrachter Gegenstand (ein Gegenstand pro Zeile)	Wie vielter Besuch im Repair Café?	Repariert?	Wie häufig musstest du/musst du noch ins Repair Café kommen, um diesen zu reparieren?	Wirst du den Gegenstand neu oder gebraucht kaufen?/ Hättest du den Gegenstand neu oder gebraucht gekauft, wenn du ihn nicht hättest reparieren können?				Weshalb wirst du ihn erneut kaufen?/ Weshalb hättest du ihn nicht erneut gekauft?	Wie häufig benutzt du diesen Gegenstand im Durchschnitt?
				Hätte ich auf jeden Fall erneut gekauft	Hätte ich wahrscheinlich erneut gekauft	Hätte ich wahrscheinlich nicht erneut gekauft	Hätte ich auf keinen Fall erneut gekauft		
				☐	☐	☐	☐		
				☐	☐	☐	☐		
				☐	☐	☐	☐		

Warum kommst du zum Repair Café? Welche Vorteile bringt es dir?
Bitte kreuze in der Tabelle zwei Gründe an, die dir am wichtigsten sind.

Ich finde es gut, Dinge nicht neu kaufen zu müssen.	□
Im Repair Café kann ich etwas lernen.	□
Es macht Spaß Dinge zu reparieren.	□
Dinge zu reparieren ist gut für die Umwelt.	□
Durch das Repair Café komme ich mit anderen Menschen in Kontakt.	□
Durch das Repair Café spare ich Geld.	□
Es ist bequemer Dinge zu reparieren als sie zu kaufen.	□
Ich repariere Dinge, um Treibhausgase einzusparen.	□
Ich habe negative Erfahrungen mit Produkten gemacht, die schnell kaputt gingen.	□
Sonstiges:_____	□

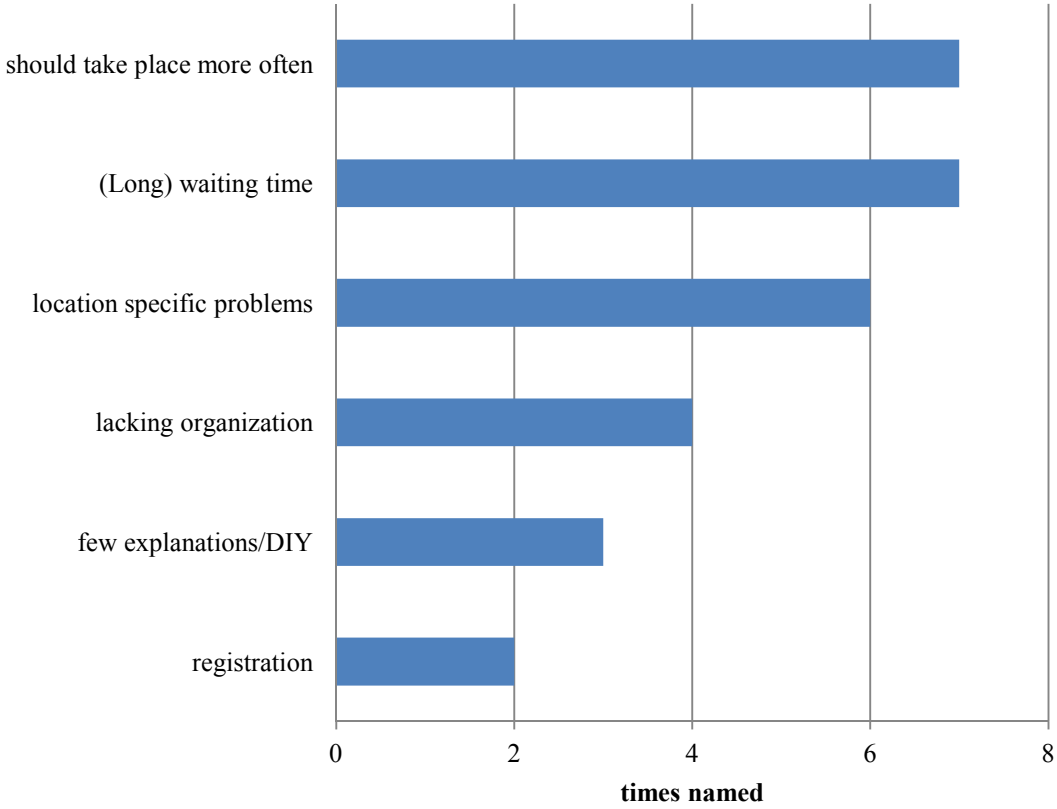


Figure 40: **Things (named more than once) people dislike about Repair Cafés.** This question is evaluated for the sake of completeness, though only 34 of 134 participants specified their answer. It results from an open question on things people like (this part is not evaluated) and dislike, asked for before the reasons why people come in order to make them think about it first without answer categories. The graphic contains the number problems have been mentioned, if higher than one.

Annex C

Table 13: Calculations of 'behaviour on replacement' for exemplary products to show the procedure of decision-making; first part (rows 2-5) and second part (reasons) based on survey, corrections based on assumptions (the whole table can be found on CD of digital version)

	alarm clock	**amplifier**	**answering machine**	**angle grinder**	**backpack**	**bicycle**
definetively (*1)	1.00	2.00	1.00	leer	1.00	2.00
probably (*0,7)	0.70	1.40	leer	leer	leer	leer
probably not (*0,3)	leer	leer	leer	leer	leer	leer
definetively not (*0)	leer	leer	leer	0.00	leer	0.00
sum	1.70	3.40	1.00	0.00	1.00	2.00
substitution rate (blank: just average)	0.85	0.85	1	0	1	0.67
reason 1 (Why would not have bought?)		too expensive				only partly broken or can be repaired
frequency of usage 1 (corresponding to displayed reason)	dayly	dayly	dayly	yearly	weekly	dayly
reason 2						
frequency of usage 2		dayly				dayly
reason 3						
frequency of usage 3						
reason 4						
frequency of usage 4						
needs correction? (low data available, so various user behaviour not included)					0.7	0
needs correction? (explanation)	no, is very important, but people may use their mobile phone instead			baseline: people using those kind of tools may more probable repair things themselves as well	backpacks may be lent and repaired in society, people may have as well several backpacks so do not necessarily buy a new one	bicycles are normally repaired
	alarm clock	**amplifier**	**answering machine**	**angle grinder**	**backpack**	**bicycle**
copy substitution rate with corrections	0.85	**0.85**	**1.00**	**0.00**	0.7	**0.00**
cluster (generated from this list and EF list)	other products	music equipment	telephones	tools	bags and boxes	sports equipment
correspondent EF	-	-	big button telephone	lawn mower	bag	bicycle
cluster for substitution factor? Or other than EF?	other products	music reproducer	answering machine	angle grinder		
substitution factor for cluster	**0.95**				**0.7**	

Table 14: Details included in table on EFs, here presented for the example cluster of bags and boxes. In the digital version of this thesis the whle table can be found.

cluster	item standar	data source	factor description in source and [what is included in 'factor total in source']	EF used in kg CO_2e	comment on factor
bags and boxes	bag	pcf projects 2008	Tchibo sports bag (mainly coated polyester fibre, poly-propylene reinforced bottom, polyester lining, 5 zipper compartments, two net compartments) [PCF]	35.30	
	boxes	Turtlebox	Umzugskarton aus 100% recycelbarem Kunststoff (berechnet aus 600maliger Verwendung, allerdings nur wichtig für Berechnung)	13.80	
	carton (pulp)	SANDRA/EPD	corrugated board box [in factor total, disposal is not included] (300 to 800g/m2, 80% of recycled paper, 60% FSC certified, water base inks, plasticizers free glues 8 to 16g/m2)	1.16	disposal is excluded: but this means the estimate is only more conservative

factor total in source	factor low	factor high	raw materials	Production	distribution to shop	transport by customer	use	disposal	recycling	unit
35.30	26.60	71.80	included in production (not applicable)	32.57	1.52	0.00	not included	3.61	-2.40	kg CO_2e
13.80	no	no	yes	yes	?	?	?	?	?	g CO_2
1182.00	no	no	118.00	1039.00	24.00	no	no	184.00	not included in calculation, but 80%	kg CO_2e/t

boundaries/ scope	methodology	comments	comments on calculations	link/details source
1,2,3	PCF with ISO 14040/14044			
?			I define it as a mistake in the report and estimate they meant CO_2e instead of CO_2. If this is not the case, the calculation is still conservative in its approach.	https://www.turtle-
1,2,3	LCA (Environmental performance declaration)		OBI says weight of one carton is 1 kg for L carton (77 Liter)(http://www.obi.de/decom/product/OBI_Umzugskarton_L/6699987) NEUHAUS-PAPIER says 1,48 kg (80L) (http://www.neuhaus-papier.de/umzugskartons/index.html)	

Table 15: First part of calculation tables showing all clustered products and factors used for calculations. The table can be found in the digital version. I broadened some rows to show exemplarily what type of information they contain. Factors in read seemed very over- or underestimated to me. Blue factors are copied from similar products or the general rate averaged over the category or all products. Grey font was chosen for all products without EFs.

Products			Factors for calculations					
cluster (emission factors)	**product group**	**other products included in group**	**EF**	**comment on factor**	**Repair Rate**	**comment**	**behaviour on replacement**	**comment?**
			in kg CO_2e		for Repair Cafés only		Behaviour of repairing/borrowing combined with behaviour of	
bags and boxes	bag	backpack, suitcase, bicycle bags	35.30		0.57	general rate	0.70	
	boxes	bicycle basket	13.80		0.57	general rate	0.70	copied
	carton (pulp)		1.16	disposal is excluded:	0.57	general rate	0.70	copied
books	book		1.00	transport could not be excluded	not needed		0.30	assumption: books are lent often, but are cheap and easy to buy
	brochure		2.28		not needed		0.30	assumption:
cameras	digital camera	digital camera	5.15	seems to be very low	0.55		0.65	
		video camera	5.15	seems to be very low	0.55	copied from	0.00	
	without factor	tripod			0.55		0.65	copied from digital camera
children's equipment	buggy	car seat, bike trailer, bike seat,	314.22		0.57	general rate	0.50	assumption:
	highchair	plastic stool	23.93		0.57	general rate	0.50	assumption:
	cot	children's grid, diaper changing	405.00		0.57	general rate	0.50	assumption: cots
	bottle heater		5.27	taken from steamer	0.57	general rate	0.50	assumption:
	without factor	breast pump, baby bathtub, foot			0.57	general rate	0.50	assumption:
computer and equipment	desktop PC		138.00	EuP always seeemed to be a very low estimate: desktop PC and monitor together is less than laptop	0.34		0.30	
	monitor	PC parts	56.60	EuP always seeemed	0.34		0.43	
	laptops		213.10	EuP always seeemed	0.34		0.66	
	netbook	tablet	90.00		0.34		0.66	copied
	printer		94.70		0.33		0.90	
	scanner	laminator	65.94		0.33	copied from printer	0.90	copied
	without factor	computer accessories: mouse,			0.34		0.25	
		navigation system			0.34		0.65	
		typewriter, CD-Rom			0.34		0.00	assumption:

decoration	christmas tree		13.48		not needed		0.70	assumption:
	without factor	garland, hawaii flowers, wooden			not needed		0.20	assumption:
furniture	without factor	coatrack			not needed		1.00	
housewares	plate	teapot, cake stand, picnic set (one	0.26	distribution and	0.57	general rate	0.67	
	cups	spatula, acrylic glass holder, picnic set (one part)	0.19	distribution and transport could not be excluded, but factor seems to be	0.57	general rate	0.72	substitution housewares average
		measuring jug	0.19	distribution and	0.57	general rate	1.00	
	glasses		0.10	distribution and	0.57	general rate	0.72	substitution
		champagne glasses	0.10	distribution and	0.57	general rate	0.00	
	glas bowles	punch jar,	0.14	distribution and	0.57	general rate	0.72	substitution
	cutlery	scoop,corkscrew, picnic set (one	0.05	distribution and	0.57	general rate	0.72	substitution
		all-purpose slicer, mango peeler	0.05	distribution and	0.57	general rate	1.00	
		kitchen sieve, food mill	0.05	distribution and	0.57	general rate	1.00	
		tea sieve	0.05	distribution and	0.57	general rate	0.30	
		baking equipment/pan	0.05	distribution and	0.57	general rate	0.72	substitution
	without factor	thermos jug, casserole, chip pan,			0.57	general rate	0.72	average rate for
kitchen appliances	coffee machine	espressomachine	32.00	disposal is excluded: but this means the estimate is only more conservative	0.51		0.80	
	toaster		5.22	factor for production	0.51		0.80	
		waffle iron, donut maker, pancake	5.22	factor for production	0.51		0.60	
	water kettle	water kettle	0.84	distribution could	0.51		1.00	
		espesso cooker	0.84	distribution could	0.51		0.50	
	breadmachine		6.68	factor for production	0.51		1.00	
	steamer	ice cream machine	5.27	factor for production seems to be very low	0.51		0.60	factor for waffle iron
		(hand stick) mixer, coffee grinder, grain mill, kitchen machine, juicer	5.27	factor for production seems to be very low	0.51		0.78	factor for mixer, higher number of products
	microwave	electric oven	8.30	factor for production	0.51		0.48	
	hotplate	fondue (electric), raclette grill,	1.20	factor for production	0.51		0.70	
	without factor	milk frother, soda stream			0.51		0.73	average factor
household appliances	electric iron		1.40	factor for production	0.87		1.00	
	vacuum cleaner	steam cleaner, hand vacuum	48.00		0.87		0.60	
	ventilator	air humidifier, exhauster	39.00		0.87		1.00	
	without factor	fire detector			0.87		0.70	
		sewing machine			0.87		0.70	

Personal care products	hairdryer	hair truing device	4.54	factor for production seems to be very low	0.53		1.00	
		hair cutter: hair cutter, epilator,	4.54	factor for production	0.53		0.85	
	without factor	brush			0.53		1.00	
		electric toothbrush, mouth shower			0.53		0.69	
		heating pad, massage machine			0.53		0.85	
		sunglasses, glasses			0.53		0.90	
		wheelchair, foot splint, crutches			0.53		0.50	
lamps	lamp	torch, red light lamp, halogen	6.00		0.74		0.70	
music equipment	without factor	music reproducer: amplifier,			0.63		0.86	
		music player (combined CD, cassette, radio, HiFi, stereo, tape),		use factor for DVD-player	0.63		0.47	
		effects unit			0.63		0.30	
		headphones			0.63		0.90	
		record player			0.63		1.00	
		voice recorder, walkman			0.63		0.18	
		instruments: guitar, guitar pedal,			0.63		0.86	factor taken
Outdoor equipment	sleeping bag	tent, camping mat, air mattress,	45.30	distribution could	not needed		0.40	assumption:
	ale-bench	chair	57.00	distribution could	not needed		0.40	assumption:
	cooker	cool box, thermal pack	0.30	factor for production	0.57	general rate	0.40	assumption:
	without factor	air pump, water canister			not needed		0.40	assumption:
Sports equipment	bicycle	Bobby car, tricycle, onecycle,	52.80	may be too high for	0.57	general rate	0.30	bicycles are
	ski	cross-country ski, longboard,	45.07		0.57	general rate	0.30	assumption:
	helmet	badminton racket, basket ball,	0.98	helmet made of	0.57	general rate	0.30	assumption: a
	frisbee	ball, swimming flippers, inflatable	0.30	only material, not	0.57	general rate	0.30	assumption: a
	without factor	inlineskates, slackline, stilts,			0.57	general rate	0.30	assumption: a
telephones	big button telefone	big button telefone with cabel	5.26		0.74		0.57	
		answering machine	5.26		0.74		1.00	
	smartphone		40.09		0.74		0.70	
	mobile phone		12.00	distribution and use	0.74		0.30	
textiles	fleece jacket		29.96	factor seems to be	0.57	general rate	0.33	copied from
	men's shirt	dress, costume	0.08	seems to be very	0.57	general rate	0.33	copied from
	cotton shirt		0.04	seems to be very	0.57	general rate	0.33	copied from
	textile		0.07	seems to be very	0.57	general rate	0.33	copied from
	Jeans		11.80		0.57	general rate	0.33	
	leather hat		36.49	It is estimated that	0.57	general rate	0.33	copied from
	without factor	zip			0.57	general rate	0.70	
		dressing doll			0.57	general rate	unknown	highly depends
tools	extension cable	cable, instrument cable, cable	20.46	only the cable, not	0.57	general rate	1.00	

	lawn mower	shredder, Black&Decker, bolt cutter, tile cutter, hand circular			0.57	general rate	0.57	copied from drilling machine
		drilling machine, hammer drill,	178.05		0.57	general rate	0.57	
		angle grinder, polisher	178.05		0.57	general rate	0.00	
	hammer (0,5kg	fruit picker, mitre box, rubber	0.57	seems to be very	0.57	general rate	0.80	copied from axe
	ladder (10kg,		176.00		0.57	general rate	0.80	copied from axe
	axe (1kg; 0,1kg Esche	hedge shears, secateurs, rake,	1.24	seems to be very	0.57	general rate	0.80	
	spade (2,3 kg: 2,2kg	garden fork	3.00		0.57	general rate	0.80	copied from axe
	watering can (360g)	water canister	0.62		0.57	general rate	0.80	copied from axe
	paperhanging table		135.00	factor taken from	0.57	general rate	0.80	copied from axe
	without factor	furniture roll/transport set, roller			0.57	general rate	0.80	copied from axe
toys	board game	puzzle, game case, magic game	0.62	factor seems to be	0.57	general rate	0.60	assumption: toys
	logs of wood (6kg,	wooden ship/teddytruck/toys,	1.50		0.57	general rate	0.60	assumption: toys
	1kg average plastic	baby toy, barbie horse stable (480g), blinking hat, tuning tedy, dressing doll, lego brick box (2x), mask, plastic car/lock/toy	3.50	manufacturing of product not included, but most products are lighter than 1 kg	0.57	general rate	0.60	assumption: toys are generally passed on, but are cheap as well, people like to try different board games, good possibility for visitors as well
	without factor	remote controlled boat, toy duck,			0.57	general rate	0.00	
		lightsaber, quadrocopter			0.57	general rate	0.00	copied from
TV and movie	TV		239.67		0.17		0.40	
	projector		53.50		0.17		0.40	copied from TV
	DVD		6.71	factor seems to be	0.17		0.60	
	video recorder/player	combined video and DVD-player	22.00		0.17		0.34	
	Playstation 3		81.00		0.17		0.34	copied from video (though
	without factor	receiver			0.17		0.30	
		remote control			0.17		0.50	
		movie, TV-usb			0.17		0.50	copied from
other products	without factor	alarm clock, calculator, weather			0.57	general rate	0.95	
		megaphone, ultrasonic instrument, oscilloscope			0.57	general rate	unknown	too many different

Table 16: Example for calculation: selected product categories in the case of Leila (whole table can be found on CD of digital version). . Factors in read seemed very over- or underestimated to me. Blue factors are copied from similar products or the general rate averaged over the category or all products. Grey font was chosen for all products without EFs.

Products			**Factors for calculations**		**Leila**					
cluster (EFs)	product group	other products included in group	EF	behaviour on replacement	amount of products borrowed	amount of products replaced	extra products	products included in calculations	Emission Leila	cluster emission
			in kg CO_2e	Behaviour of repairing/borrowing & behaviour of consumption in society			products replaced not included in emission		in kg CO_2e	in kg CO_2e
bags and boxes	bag	backpack, suitcase, bicycle bags	35.30	0.70	17	11.90		52.50	420.07	537.95
	boxes	bicycle basket	13.80	0.70	8	5.60			77.28	
	carton (pulp)		1.16	0.70	50	35.00			40.60	
books	book		1.00	0.30	26	7.80		8.10	7.80	8.48
	brochure		2.28	0.30	1	0.30			0.68	
cameras	digital camera	digital camera	5.15	0.65	1	0.65		0.65	3.35	3.35
		videocamera	5.15	0.00	0	0.00			0.00	
	without factor	tripod		0.65	1	0.65	0.65			
...	...	...	...	...	...	...	...	...	...	...
music equipment	without factor	music reproducer: amplifier, loudspeaker		0.86	5	4.28	11.97			
		music player (combined [illegible])		0.47	0	0.00				
		effects unit		0.30	0	0.00				
		headphones		0.90	0	0.00				
		record player		1.00	0	0.00				
		voice recorder, walkman		0.18	0	0.00				
		instruments: guitar, guitar pedal, keyboard,		0.86	9	7.70				
...	...	...	...	...	...	...	...	...	...	...
total					726.00	433.32	66.83	366.49	9324.06	
					products totally lent	products replaced	products replaced not included in the calculations	products replaced included in the	emission reduction Leila in kg CO_2e e	

Table 17: Comparison of substitution factors used in calculations; the repair rate was calculated from data received, behaviour on replacement constitutes of information from the survey (*Would you have bought the item if it was not possible to repair/borrow?)* and additional assumptions on general behaviour of repairing/lending in society, partly based on the survey (*Why not?*). The greener a factor, the higher is the substitution.

cluster (EFs)	**substitution factor (with repair rate)**	**behaviour of substitution (substitution factor without repair rate)**
bags and boxes	0.40	0.70
books	not needed	0.30
cameras	0.24	0.43
children's equipment	0.29	0.50
computer and equipment	0.18	0.53
decoration	not needed	0.45
housewares	0.39	0.69
kitchen appliances	0.37	0.73
household appliances	0.70	0.80
Personal care products	0.44	0.83
lamps	0.52	0.70
music equipment	0.41	0.65
Outdoor equipment	0.23	0.40
Sports equipment	0.17	0.30
telephones	0.48	0.64
textiles	0.22	0.38
tools	0.40	0.70
toys	0.21	0.36
TV and movie	0.12	0.48

Table 18: Results for RC KB per product category, per year month and hour

product cluster	RC Kreuzberg				
	cluster emission in kg CO_2e	products replaced included	**extra products replaced**	**all products replaced**	**products brought**
bags and boxes	14.08	0.40	0.00	0.40	1.00
books					
cameras	3.68	0.72	0.00	0.72	2.00
children's equipment					
computer and equipment	138.08	1.29	0.09	1.38	7.00
decoration					
housewares					
kitchen appliances	204.27	15.52	0.37	15.89	39.00
household appliances	101.44	2.96	1.22	4.18	7.00
Personal care products	10.95	2.41	0.37	2.78	6.00
lamps	12.43	2.07	0.00	2.07	4.00
music equipment	0.00	0.00	26.06	26.06	63.00
outdoor equipment					
sports equipment					
telephones	514.28	14.88	0.00	14.88	30.00
textiles					
tools	11.66	0.57	0.00	0.57	1.00
toys	1.20	0.34	0.00	0.34	3.00
TV and movie	53.37	0.78	0.22	1.00	14.00
total per year for Leila and KB, 14 months for SB, category 'others' excluded	**1065.44**	**41.94**	28.33	70.27	177.00
14 month, category 'others' included					
per year, category 'others' excluded					
per year, category 'others' included			**29.41**	**71.35**	**181.00**
per month	88.79	3.50	2.45	5.95	15.08
per hour	22.20	0.87	0.61	1.49	3.77
Replacement Rate			**0.39**		

Table 19: Results for RC SB per product category, per year month and hour

product cluster	RC Schöneberg				
	cluster emission	**products replaced included**	**extra products replaced, cluster**	**all products replaced per year**	**products brought per year**
bags and boxes	42.25	1.20	0.00	1.03	2.57
books					
cameras	16.75	3.22	0.00	2.76	7.71
children's equipment	0.00	0.00	0.29	0.25	0.86
computer and equipment	1228.16	8.36	0.31	7.43	36.00
decoration					
housewares	0.06	1.14	0.82	1.68	3.43
kitchen appliances	171.54	18.31	0.74	16.33	40.29
household appliances	69.08	2.61	4.26	5.89	8.57
Personal care products	6.50	1.43	0.74	1.86	4.29
lamps	34.19	5.70	0.00	4.89	9.43
music equipment	0.00	0.00	23.18	19.87	55.71
outdoor equipment	0.07	0.23	0.00	0.20	0.86
sports equipment	36.12	0.68	0.00	0.58	3.43
telephones	37.09	0.84	0.00	0.72	6.00
textiles	5.64	0.19	0.00	0.16	0.86
tools	185.67	5.04	0.00	4.32	9.43
toys					
TV and movie	81.66	1.25	0.26	1.29	16.29
total per year for Leila and KB, 14 months for SB, category 'others' excluded	1914.78	50.20	30.60		
14 month, category 'others' included	in kg CO_2e			84.35	244.00
per year, category 'others' excluded	**1641.24**	**43.03**	**26.23**	69.92	205.73
per year, category 'others' included				**72.3**	**209.14**
per month	136.77	3.59	2.19	6.03	14.94
per hour	45.59	1.20	0.73	2.01	5.81
Replacement Rate			**0.33**		

Table 20: Results for Leila per product category, per year month and hour

	All-Sharing Shop Leila				
product cluster	**cluster emission**	**products replaced included**	**extra products replaced**	**all products replaced**	**products lent**
bags and boxes	537.95	52.50	0.00	52.50	75.00
books	8.48	8.10	0.00	8.10	27.00
cameras	3.35	0.65	0.65	1.30	2.00
children's equipment	4316.92	15.50	2.50	18.00	36.00
computer and equipment	118.69	1.80	0.25	2.05	4.00
decoration	18.87	1.40	2.00	3.40	12.00
housewares	9.10	73.78	9.36	83.14	117.00
kitchen appliances	125.73	25.70	0.00	25.70	38.00
household appliances	111.00	5.60	3.50	9.10	11.00
Personal care products	0.00	0.00	1.50	1.50	3.00
lamps	25.20	4.20	0.00	4.20	6.00
music equipment	0.00	0.00	11.97	11.97	14.00
outdoor equipment	685.08	16.80	3.20	20.00	50.00
sports equipment	358.28	21.60	1.80	23.40	78.00
telephones					
textiles	12.21	2.64	0.00	2.64	9.00
tools	2913.29	81.62	29.60	111.22	150.00
toys	75.88	54.00	0.00	54.00	92.00
TV and movie	4.03	0.60	0.50	1.10	2.00
total per year for Leila and KB, 14 months for SB, category 'others' excluded	**9324.06**	**366.49**	**66.83**	**433.32**	**726.00**
14 month, category 'others' included	in kg CO_2e				
per year, category 'others' excluded					
per year, category 'others' included					
per month	777.01	30.54	5.57	36.11	60.50
per hour	32.38	1.27	0.23	1.50	2.52
Replacement Rate			**0.60**		

Annex D

For discussion:

Aims[30]	RC	achieved	Leila	achieved	Effects for mitigation
- **Environmental**	**1**				
Reduce GHG emissions	8	8	7	4	Direct effect
More efficient use of natural resources, avoid waste	10	9	9	7	Reduces GHG in production and disposal
Increase environmental awareness of participants/local community/society	7	7	8	3	Awareness for climate change and the need for mitigation
- **Social**	**2**				
Stimulation of social interaction, networking within participants and local community	7	7	9	4	Spread of ideas, exchange of opinions, attractiveness
Inclusion/help for/Integration of a wide diversity of people that benefit (class, ethnicity, gender) including disadvantaged people	7	5	9	7,5	Ensure inclusiveness in societal change
Improve skills of participants and the local community to manage their every-day life	8	7	10	7	Provide alternatives and support creativity to encounter solutions. attractiveness
Social innovation: Support sustainable behaviour and lifestyles, social practices	8	6	8	6	Support climate-friendly life-styles
- **Political**					
Mobilise people for one common political aim (e.g. to promote social/political transformation and influence political agenda, push reforms,…)	7	5	10	5	Mobilise people to act for change
Build/strengthen a network of similar initiatives/communities taking action	7	6	10	7	Movement-building, meet people with similar goals, motivation, improvement
Build/strengthen a network of other (political) actors/organisations/institutions …	5	5	Not important		Bring complementary strategies together; synergies, motivation, new ideas
- **Economical**					
Development/experimental procedure/demonstration of a good working company/model of organisation/strategy	7	6	5	3	Success could be thought in more varying ways

[30] Data from TESS interviews with founders of the initiatives Repair Café Kreuzberg (conducted by myself) and All-Sharing Shop Leila: questionnaires prepared for a wide range of initiatives

	Deliver material advantages for participants (e.g. good quality of products and service for low budget)	8	8	10	10	Attractiveness and inclusiveness of initiative; no need to buy new (often cheaper than repairing)
	Revitalise local economy (e.g. new jobs, revitalise socially disadvantaged areas, improve local economic activities,...) or/and improve economic independence of local community (money spent at site, self-organisation)	7	6	8	8	Keep economy local instead of being dependent on global supply chains, give a feeling of empower for participants
-	**Technological**					
	Develop/improve/spread innovations, products and services to answer to a demand that is not covered by the market	9	8	6	6	Repairing is often too expensive, sharing mostly not offered for smaller products
	Provide possibilities to learn, spread skills/knowledge and/or broaden skills of participants	9	8	9	3	Empower people for DIY, attractiveness of initiative

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