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A typology for analysing mitigation and adaptation win-win strategies

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Abstract
A sustainability transition in line with achieving global climate goals requires the implementation of win-win strategies (WWS), i.e. socioeconomic activities that enable economic gains while simultaneously contributing to climate change mitigation or adaptation measures. Such strategies are discussed in a variety of scientific communities, such as sustainability science, industrial ecology and symbiosis and circular economy. However, existing analyses of win-win strategies tend to take a systems perspective, while paying less attention to the specific actors and activities, or their interconnections, which are implicated in win-win strategies. Moreover, they hardly address adaptation WWS. To address these gaps and support the identification and enhancement of WWS for entrepreneurs and policy-makers, we propose a typology of WWS based on the concept of a value-consumption chain, which typically connects several producers with at least one consumer of a good or service. A consideration of these connections allows an evaluation of economic effects in a meso-economic perspective. We distinguish 34 different types of WWS of companies, households and the state, for which 23 real-world examples are identified. Further, contrary to prevailing views on the lack of a business case for adaptation, we do identify real-world adaptation WWS, though they remain underrepresented compared with mitigation WWS. Our typology can be used as an entry point for transdisciplinary research integrating assessment of individual transformative socioeconomic activities and highly aggregated approaches assessing, e.g. the macro-economic effects of WWS.

Keywords Win-win · Green business models · Green entrepreneurs · Typology · Mitigation · Adaptation

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1 Introduction

A sustainability transition in line with green growth requires the implementation of climate win-win strategies (WWS), i.e. socioeconomic activities that enable economic gains, while simultaneously contributing to climate change mitigation or adaptation. Indeed, the 2015 Paris Agreement's reliance on voluntary, rather than binding, contributions underlines the need for such WWS that meet actors' economic interests (Hinkel et al. 2020).

As such, interest in climate WWS is growing. The WWS concept has been widely used for assessing mitigation- and adaptation-related socioeconomic activities for different kinds of actors and aggregation levels (micro- or macro-economic level) in various sectoral, technical and regional contexts. For mitigation, scholars have analysed the individual and social benefits of technological improvements to energy efficiency of residential buildings (Perini and Rosasco 2013) as well as the aggregated economic effects of building stock efficiency measures (Tommerup and Svendsen 2006). Several studies focus on the mobility sector, for example, analysing eco-driving in terms of aggregated economic effects on the household sector at the national level (Barkenbus 2010), and at the micro-level, analysing the potential of a range of mobility WWS (Litman 2017). Studies on energy WWS have focused on household consumption-related measures (Halvorsen et al. 2010) as well as energy generation for fossil-fuel-based power stations (Sarkis and Cordeiro 2009). Analysis in the agricultural sector presents win-wins for 64 different micro-level measures to reduce greenhouse gas emissions (MacLeod et al. 2015). For adaptation, initial studies have assessed the economic and climate-risk reduction wins from coastal urban land reclamation (Bisaro et al. 2019) and nature-based flood defence (Kok et al. 2020).

Given the diverse socioeconomic activities in different sectoral and regional contexts that can give rise to win-win strategies, diverse literatures, e.g. in industrial ecology and symbiosis (Chertow 2000; Lombardi and Laybourn 2012) and circular economy (Bocken et al. 2016), have emerged around the win-win concept in connection with the environment more broadly, including assessing activities that affect pollution, waste and ecological degradation (Bocken et al. 2014). Yet such analyses, based on the underlying assumption that eco-innovations may offer 'competitive advantage' and result in collective environmental benefits, tend to focus on products or processes involved in eco-innovations, without accounting for the particular actors or activities needed to create such WWS. For example, the prominent typology of Dangelico and Pontrandolfo (2010) classifies green products based on life-cycle analysis. While more recent work in industrial symbiosis considers business models that arise in various production-consumption connections (Fraccascia et al. 2016), such approaches take a network perspective, also neglecting the incentives that arise for different actors, i.e. producers and consumers, which are relevant to implementing WWS. Moreover, none of these approaches accommodates many of the climate change adaptation WWS that reduce climate risk, as they largely address only resource efficiency win-wins.

Thus, existing conceptual frameworks are limited in their ability to comprehensively analyse climate WWS in a manner that can provide support to green business developers as well as policy-makers seeking to identify, enhance or scale-up such WWS (Omann et al. 2019). This is important as green business models (GBM), i.e. enterprises that are profitable while also reducing impacts on the environment, are key to a successful implementation of climate WWS (Hinkel et al. 2020). In particular, a shared language that can enable the practical work of identifying and enhancing climate-relevant WWS and green business models is lacking. Such a language can serve as a key entry point for business development of green (climate) entrepreneurs (Nazarkina 2012), for identifying green investment opportunities for climate finance (Ameli et al. 2019) and for developing policy instruments to improve the enabling environments in which such WWS are implemented (Mazzucato and Penna 2016).

This paper addresses these gaps by developing a typology of climate WWS, based on several key concepts not typically applied in the existing literature. First, we focus on the economic effects for the *implementing actor* of a WWS, who strives for an individual *economic win* while simultaneously generating a climate-relevant *ecological win*. By focusing on the implementing actors, we are able to categorise heterogeneous WWS of different socioeconomic actors, i.e. state, companies and households, different actor-specific ambitions and roles and different resulting incentives. This stands in contrast with the economic literature, which often defines economic wins using aggregates, for example, as increases of 'GDP, number of jobs created, consumer benefits, business competitiveness, or average industry performance' (Reddy and Assenza 2009).

Second, our typology is based on the economic activities of implementing actors along *value chains*, a relatively simple concept that enables the analysis of connections of actors, considering their specific economic targets and roles, in the production of one good or service. Here, however, we make one important modification: we also consider final consumption by households or the state at the end of these value chains. Thus, in contrast with value chains where 'the focal [point] … is the end product and the chain is designed around the activities required to produce it' (Peppard and Rylander 2006), we analyse *value-consumption chains* in which consumption is the focal point. By doing so, we are able to analyse both the role of consumption activities and 'profit-oriented' production activities, and their interaction, in leading to different kinds of economic and ecological wins and their different locations along the value-consumption chain. Moreover, we are able to describe how several WWS may be connected along one common value-consumption chain.

Our typology thus contributes to a meso-economic analysis of potential pathways of the sustainability transition by identifying interdependencies among different types of WWS and their respective political, economic and social environment. *Meso* means in this context *centre stage* between micro and macro and encompasses 'many actors' (Dopfer 2006) instead of only individual actors (micro-level) or aggregates (macro-level). All three approaches are needed for the analysis of the sustainability transition and green growth. Micro-economic approaches are needed for assessing whether economic actors can implement win-win strategies in a cost-efficient way through, e.g. analysing individual consumption choices that affect the viability of a WWS. Macro-economic approaches, such as computational general equilibrium (CGE) models, are used for assessing whether the totality of WWS and GBM contribute to a green growth path or not, due to, for example, the *rebound effect* of energy saving WWS (Druckman et al. 2011), and for analysing the macro-economic enabling environment for WWS and GBM (Paroussos et al. 2019). Meso-economic approaches are essential complements to these approaches, as they are needed to assess where and under which political, economic and social conditions WWS and, in particular, GBM, work in practice. For example, meso-economic analysis of an e-bike sharing green business model in Shanghai finds that this WWS appears to be viable when there are sufficiently motivated 'prosumers' who contribute to bike collection (Ma et al. 2018). Further, meso-economic approaches help identify where fundamental trade-offs must be faced. For example, analysis of e-mobility WWS in megacities shows that required large-scale infrastructure investments may pose problems for the economic win on short- to medium-term time scales (Ma et al. 2018). Taking this meso-economic approach, our typology thus provides a useful tool for stakeholder-based science, in particular, as an entry point to more differentiated research on the viability of WWS and identification of GBM in various socioeconomic contexts, and for policy design to promote these WWS.

The paper is organised as follows. The next section introduces our methodology for analysing WWS, a typology of WWS and presents an elaborated value-consumption chain example. In Sect. 3, we identify and describe real-world examples for 23 different types of WWS. Section 4 discusses our approach and its limits, implications for meso-economic analysis and patterns of observed WWS.

2 Methodology

2.1 Overview and data collection

At the core of our WWS typology is the concept of the value-consumption chain introduced above. We have incorporated a value-consumption chain analysis because it allows us to address the fundamental question: 'Which consumption activities can be addressed through economically viable production processes that, considered together, contribute to mitigating or adapting to climate change?' The value-consumption chain concept thus links consumption and production activities relevant to climate change through focusing on the different actors carrying them out.

For simplification, we denote the use of final products by both households and the state as 'consumption', which differs from the national accounting methodology that distinguishes between state investments and consumption. Further, we include in household consumption the acquisition of capital goods by households (e.g. residential buildings), which also differs from national accounting conventions, which classify such activity as belonging to the commercial sector.

Placing the value-consumption chain at the centre of our analysis gives rise to three key conditions that must be fulfilled for a climate-relevant WWS to be obtained:

i. The value-consumption chain must entail an economic win for the implementing actor (also defined in Sect. 2.2.3);
ii. The value-consumption chain must entail an overall ecological win, addressing either climate change mitigation or adaptation (defined in Sect. 2.2.4).
iii. The value-consumption chain must entail an economic win for the consuming actor, or at least, not an economic loss;

The first condition is crucial to value-consumption chain analysis because it is required for the implementing actor to initiate her or his socioeconomic activity. The second condition is by definition required of any climate-relevant WWS. Further, a specification of the overall ecological win in the value-consumption chain allows us to locate where in the chain, and through which activities, the ecological win manifests itself. The third condition is crucial to the existence of the value-consumption chain because it is what drives production processes, making them viable. Analysing whether all three of these conditions are met in a value-consumption chain brings the analytical focus of WWS to the actor-specific activity level, which is not otherwise addressed in the literature.

Our typology was developed by analysing economically viable socioeconomic activities that have the potential to contribute to a sustainability transition addressing climate mitigation and adaptation goals. Within the transdisciplinary Horizon 2020 project Green-Win, 46 different socioeconomic activities were identified within three action fields, *coastal zone flood* *risk management*, *urban transformations* and *energy poverty eradication and resilience*, and these activities were further supplemented by a review of the literature. Based on thus identified real-world examples of win-win strategies, we developed a 'conceptually-derived' typology which 'defines completely the set of ideal types' of win-win strategies (Doty and Glick 1994). Thus, in Sect. 3 below, we present the typology and illustrate each type through WWS examples identified in Green-Win or in the literature. For some conceptually derived types, real-world examples could not yet be identified, and we discuss this, i.e. the 'empty cells' in Tables 1, 2 and 3 in Sect. 4.

2.2 Typology dimensions

Following the guideline for constructing a typology proposed by Doty and Glick (1994), we define the set of dimensions (criteria) that describe completely each ideal type of a WWS. We identify four essential dimensions in which the WWS differ:

1. Socioeconomic actor,
2. Socioeconomic activity,
3. Economic win and
4. Ecological win.

A further distinction that is helpful in describing WWS is one between different types of goods and services used in the value-consumption chain. While it is not an essential top-level dimension of our typology, it is helpful for more precisely describing different socioeconomic activities that may lead to a WWS. For clarity, we first discuss these different types of goods and services before presenting the dimensions of the typology.

2.2.1 Specifications of goods and services

We use the term *products* to refer to both goods and services and distinguish between three general types of products, two related to mitigation (i.e. the reduction of greenhouse gas emissions) and one to adaptation (i.e. the reduction of climate-related risks) (see Sect. 2.2.4) (IPCC 2013). Products, in general, encompass energy and non-energy resources, preliminary goods, capital goods as well as durable and non-durable consumption goods.

Ecological wins result from innovations concerning the production, use or consumption of products and are related either to 'product features or use, […] [or] to production process improvements or clean technology initiatives' (Pujaria et al. 2003). We follow this and differentiate for mitigation between *sustainably produced products* (SPP) and *sustainably used products* (SUP). The former is a characteristic the product inherits from its production process, while the latter is a characteristic of its utilisation.

SPP, such as renewable energy or recycled paper, encompass energy and non-energy resources, preliminary products, durable and non-durable consumption goods as well as capital goods that are produced with less ecological impacts. Further, services that qualify as SPP are provided with less ecological impacts, typically through utilisation of SUP by the supplier of the service.

SUP like capital or durable consumption goods have lower environmental impacts during their utilisation, such as insulation, renewable energy generation facilities or energy efficient white-ware (e.g. refrigerators). Typically, they are the result of product innovations. Further, services that qualify as SUP enable customers of these services to reduce the environmental impact of their actions. These services are, for example, related to the use of SUP by the customer of the service and/or encompass further process innovations. We note that the categories SPP and SUP are not mutually exclusive. An SUP may also be an SPP, as an SUP may be produced in a 'sustainable' way. Whether or not this is the case, is an empirical question to be addressed by analysing the specific value-consumption chain in question.

For adaptation measures, we consider *adaptation products,* which include capital and durable consumption goods (e.g. dikes) that reduce potential damages from climate change (e.g. increased flood damages from sea-level rise) and services, such as consulting or insurance, that support households, companies or the state in adapting to climate change.

2.2.2 Dimension 1 and 2: actors and actor-specific activities

For actors, we distinguish between *companies*, *households* and the *state*, whereby we assign each of them specific general activities, following their individual target: companies *produce*, households *consume,* and the state makes *expenditures* and *conducts policy.* Our focus is on activities related to the real sector and we do not consider activities related to the financial sector, such as financial investment, funding or borrowing.

We take into account different types of ecological wins that may result from socioeconomic activities. For the characterisation of such activities, we specify categories of actions for all actor types: four for companies, and three for consumers and for states, respectively.

- The four action categories for companies are *production input*, *production process*, *production output*, and *production recirculation*.
- The three action categories for households are *consumption input*, *consumption process*, and *consumption output*.
- The three action categories for states are *expenditure input*, *expenditure process*, and the conduct of *policy*.

The *production* of goods and services, i.e. products, consists of a *process* that uses *inputs* and generates *outputs* (Hitt et al. 2011). We choose this demarcation to describe the different ecological wins and discuss their origins and the location in which ecological wins manifest along the value-consumption chain (Hohmeyer and Koschel 1995, presented in Rennings 2000).

Companies can use process innovations for making their outputs more sustainable, i.e. leading to SPP as described above. These process innovations can relate to the inputs of the production process and to its conduct.

Production input-related company WWS refer to the utilisation of SPP in a company's production, which are manufactured (or extracted) upstream in the value chain. Companies decide on production *inputs*, such as energy and non-energy resources and preliminary goods and services. Eco-innovations on the input level may, for example, involve substituting traditional products for SPP, and thus lead to a substitution of 'ecologically harmful inputs' (ibidem).

Production process-related company WWS refer to process innovations that reduce the ecological footprint of the production process. Within the production *process,* specific technologies, capital goods, services and methods are applied. For mitigation-related ecological wins, the output of the company under consideration receives its ecological characteristics from the processes within the company through, for example, utilisation of SUP, such as energy efficient machinery (Bocken and Allwood 2012). This ecological effect will be passed down the value-consumption chain. For adaptation, ecological wins that arise from a production process WWS result from the utilisation of *adaptation products*. These wins remain in the company under consideration and reduce potential climate change-related impacts on the company.

Production output-related company WWS refers to product innovations (sustainable innovations as discussed in Boons et al. (2013)) related to new or adapted SUP (e.g. electrical vehicles or rooftop PV solar equipment). Companies can use product innovations for making their products more sustainable in their subsequent use, i.e. SUP. Ecological wins from product innovation arise downstream from production in the value-consumption chain, where these SUP are applied. Such SUP also include services that exhibit positive ecological effects for the user of the service, thus realising its ecological impact through enabling other socioeconomic actors (i.e. SUP service users) to implement a win-win strategy.

Finally, *production recirculation* encompasses the re-use of by-products or waste from production processes or consumption. Thus, production recirculation-related company WWS refer to the utilisation of end-of-pipe technologies or recycling and waste disposal.

Households *consume* durable and non-durable goods and services, and they generate waste. We distinguish between three consumption categories leading to household WWS (see Table 2). *Consumption input-related* activity refers to the consumption of SPP, primarily non-durable goods, e.g. renewable energy, as well as services. Consumption process-related activity refers to the use of SUP (durable goods, e.g. renewable energy production facilities and services) and adaptation products (durable goods as well as adaptation services). We thus distinguish between mitigation-related and adaptation-related ecological wins that result from this kind of activity. *Mitigation-related* positive ecological effects result from a reduction of resource needs during use of a specific durable good, such as energy-efficient heating or lighting (Poortinga et al. 2003), green roofs (Oberndorfer et al. 2007) or the enablement of energy generation through rooftop PV-solar or micro-wind turbines (Bahaj et al. 2007). *Adaptation-related* ecological effects result from the utilisation of adaptation products, which include durable goods, such as protection devices against floods (Osberghaus 2015), or services that help actors adapt to climate change. *Consumption output-related* activity refers to the avoidance of waste, its reintroduction back into production processes or waste disposal.

Distinguishing between these three consumer activities is relevant due to different resulting ecological wins. SPP such as non-durable goods and sustainably produced durable goods receive their positive ecological characteristics, e.g. lower resource and energy consumption, from production processes upstream in the value-consumption chain. In contrast, SUP have ecological effects, e.g. reducing greenhouse gas emissions, during their use.

The state makes *expenditures* that, similar to household activities, consist in purchasing non-durable and durable consumption goods, capital goods, such as infrastructures, and services. *Expenditure input-related* activities refers to the state consumption of SPP (e.g. renewable energy or recycling paper), typically in the course of public procurement. Ecological wins arise upstream from the state in the production of these SPP. *Expenditure process-related* activity refers to the purchase of SUP as well as adaptation products (typically capital goods or adaptation services). Ecological wins arise from the use of these SUP (e.g. cars, infrastructure, consultancy services) or adaptation goods, typically capital goods, such as dikes.

Further, the state conducts *policy. Policy-related* activities strive for ecological wins resulting from activities other socioeconomic actors perform based on the policy instruments implemented by the state. We note that policy can be further distinguished according to different types of policy instruments used, i.e. regulation, economic incentives (e.g. support schemes) or communication. Such distinctions are useful for assessing the efficiency of different instruments in enabling a WWS in a given context, for example, whether regulation or support schemes are more cost-efficient in inducing green growth through increased renewable energy production. However, for reasons of space we will not discuss this in further detail. Rather, our typology provides an entry point for such analysis (see Sect. 4).

2.2.3 Dimension 3: actor-specific economic wins

Each economic *win* reflects an improvement of economic parameters compared with the status quo resulting from the implementing actor's activity. By the additional specification *driven*, we indicate that each activity is driven by the intended economic win the actor strives for.

Company economic wins Companies generally undertake activities in order to achieve positive business effects (Lüdeke-Freund et al. 2017). Positive business effects result in an increase in companies' profits, whereby the economic win can result from a decrease of costs or an increase of revenues (Lüdeke-Freund et al. 2017). We therefore distinguish between *cost-reduction-driven* win-win strategies and *revenue-increase-driven* win-win strategies of companies.

Cost reduction results from activities related either to the *inputs* of the company under consideration or to the *processes* of value generation. The former is associated with usage of less costly inputs, the latter relates to *process* innovations that enable a reduction of production costs, including product innovations that in turn lead to less costly production processes. Further, costs can be reduced through recirculation of production waste (see Table 1). Activities aimed at cost reduction rely on the consumer not being made worse-off by the eco-innovation and thus continuing to consume the product at least at similar price levels and quantities.

Revenue increase results from sales of products, induced by receiving higher prices or selling more. This is relevant for a company that through eco-innovation aims to either increase sales of an existing product or introduce a new product to the market. Activities aimed at revenue increase assume that the final product of the company under consideration will be now preferred by the final consumer: either the product of the company has a lower price (compared with competitors) or consuming the product causes a higher utility—in this case due to its ecological characteristics—for the customer.

Household economic wins Households consume goods and services, which generate utility (Neary and Roberts 1980). We distinguish between two consumption activities that generate economic wins, whereby the first influences the utility directly and the second indirectly. A household can substitute less-preferred goods by more-preferred ones. This increases household utility directly and reflects a *utility-increase-driven* strategy. In contrast, a household can strive for a reduction of costs associated with the consumption of one good through either a decrease of quantity or a substitution for a less expensive good. Both enable an expansion of all other consumption quantities and therewith an indirect utility increase. We label such strategies *cost-reduction driven*.

State economic wins We focus only on one economic win the state can strive for, namely *cost reduction*.

Cost reduction refers to economic wins that follow from strategies of the state striving for the reduction of (budget) costs or cost reductions resulting from policy design and implementation, e.g. regulation and law making.

In principle, the state can also pursue a strategy of 'economic growth', itself an economic win. In the climate-related WWS domain, such a strategy is known as green growth, which we understand as making 'growth processes resource-efficient, cleaner and more resilient without necessarily slowing them' (Hallegatte et al. 2012). However, whether or not such an economic win materialises depends on macro-economic factors, including the indirect effects of investments, R&D, technological learning and learning-by-doing. Here, we do not consider the macro-economic perspective and therefore, we do not analyse such WWS.

2.2.4 Dimension 4: ecological wins

Each ecological *win* reflects an improvement of ecological (mitigation or adaptation) parameters compared with the status quo resulting from the implementing actor's activity.

We focus on *ecological wins* that relate to climate change. In this context, we define *mitigation-related ecological wins* as positive ecological effects that reduce climate change through greenhouse gas emission reductions and *adaptation-related ecological wins* as effects that reduce the negative impacts of climate change (IPCC 2013).

Finally, we note that further distinctions are possible within each of the four essential dimensions described here. Such further distinctions concern, for example, the time horizon of an economic and ecological win, or the type of policy instrument applied by state actors. However, due to space limitations we cannot go into each of these and limit ourselves to the categories that comprehensively cover the 46 socioeconomic activities identified in Green-Win and relevant literature and the related conceptually derived classes.

2.3 The value-consumption chain: Economic and ecological connection of win-win strategies

Before presenting each type derived from the above presented 4 dimensions though WWS examples, we first present an elaborated example of a value-consumption chain to illustrate its applicability in identifying WWS and their interconnections.

As defined above, for a particular WWS, one economic win arises for the implementing actor, whereas the ecological win can arise anywhere along the value-consumption chain: in the activities of the implementing actor, or upstream (i.e. in activities that precede those of the implementing actor) or downstream (i.e. in activities that follow those of the implementing actor) in the value-consumption chain.

A specific WWS typically induces at least one further socioeconomic activity—connected along a common value-consumption chain—that for their part is also a WWS. If two socioeconomic activities conducted by two independent actors are connected along a value-consumption chain, and these activities generate economic wins for both implementing actors and the consumer (or do not make the consumer worse off), and simultaneously enable an ecological win somewhere along the value-consumption chain, then both are win-win strategies.

Figure 1 presents an example of such interconnections of WWS based on a case study in the Green-Win project. The WWS under consideration concerns a company distributing organic coffee roasted with biogas instead of fossil fuel energy. Looking upstream from the company in the value-consumption chain, the company purchases roasted coffee from local farmers; coffee farmers use biogas for the roasting process, which is generated by livestock farmers; these livestock farmers generate biogas from manure using biogas bags, which are in turn produced by a manufacturing company. Looking downstream from the company in the value-consumption chain, households consume the final product—coffee.

As shown in Fig. 1, two ecological wins take effect. First, an ecological win occurs in the activities of the livestock farmers, who generate biogas from manure, and thus reduce methane emissions from farm waste. Second, an ecological win occurs in the activities of the coffee roasters, whose production process involves a sustainably produced fuel (i.e. an SPP). We can thus identify five WWS, four for companies, and one for households. For companies, we see four *revenue-increase-driven WWS*. The one at the beginning of the value-consumption chain, the production of biogas bags, is a production output-related WWS (Type [8], see below). The next one, the use of manure to generate biogas, is production recirculation-related (Type [11], see below). The production of organic coffee is based on a process innovation — substitution of conventional fuels by biogas — and is thus production input-related (Type [3], see below). The eventual distribution of coffee is also production input-related (Type [3], see below). Households follow a utility-increase-driven WWS of Type [13], see below.

This example illustrates the focus on the identification of actors and activities in (interconnected) WWS that is enabled by value-consumption chain analysis. Next, we present the full WWS typology through identified real-world examples. In our examples, we further point out where other WWS are interconnected through the value-consumption chain. We then discuss the implications of value-consumption chain analysis for WWS identification and enhancement and our findings regarding real-world WWS examples.

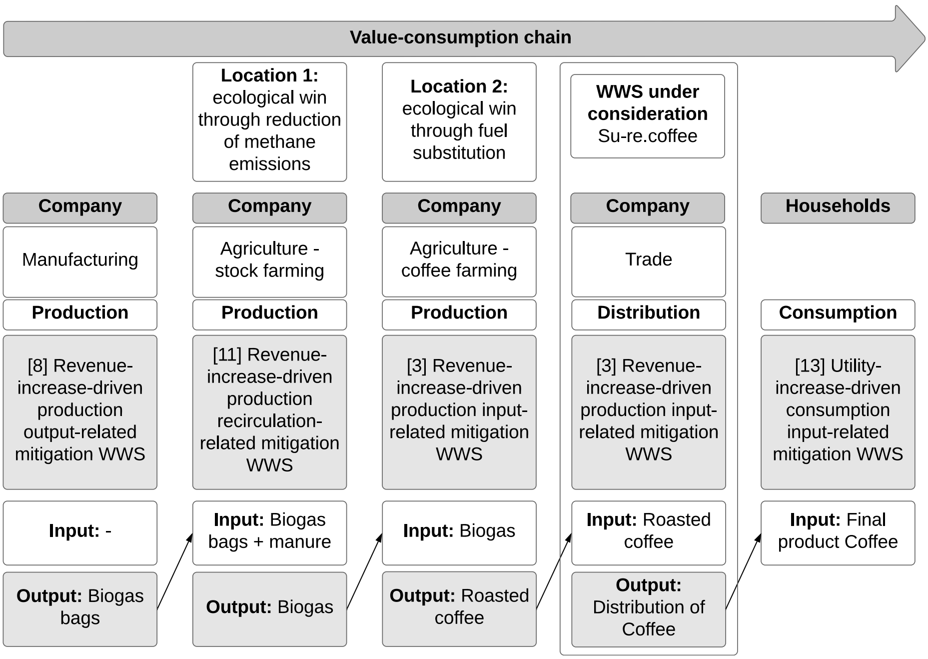

Fig. 1 Example connection of WWS along value-consumption chain

3 Results: typology of win-win strategies

3.1 Company win-win strategy types

Table 1 presents win-win strategies in which a company is the implementing actor. Each company WWS type is characterised according to its specifications along the other three essential dimensions: actor specific activities, intended economic win, and intended ecological win (i.e. whether this ecological win is mitigation- or adaptation-related). This gives rise to 16 types of company WWS.

We present 11 types of company WWS through a real-world example identified either in the Green-Win project or from the literature. Real-world examples were not identified for the remaining five WWS types, all of which are adaptation-related, and we discuss this in Sect. 4. Each example is described according to the key conditions identified in Sect. 2, namely, that (i) an economic win is required for the implementing actor; (ii) an ecological win is required somewhere along the value-consumption chain; and (iii) an economic win, or at least not an economic loss, is required for the consuming actor (here, the household).

[1] Cost-reduction-driven production input-related mitigation WWS

Real-world example: a construction company employs an SPP for the construction of a building. Such an SPP has been produced, for example, in India, where fly-ash bricks are cheaper to make and produce less waste and fewer GHG emissions compared with traditional clay bricks (Tàbara et al. 2019).

The *company economic win* results from the company reducing its production costs. The *consumer economic win* is achieved as households purchasing buildings are at least as well off, or even better off, purchasing flats from the company using the SPP than from a company using traditional clay-bricks. The WWS under consideration creates three different ecological wins upstream the value consumption chain: The first results from a substitution of clay by fly-ash as input of the production process of brick producers, which conserves top soil and relates to a further WWS of Type [1]. Secondly, less energy input is required in the production process of the bricks, which reduces emissions and creates a WWS of Type [4]. Thirdly, related to a recirculation WWS of Type [10], a further use of the fly-ash takes place.

[2] Cost-reduction-driven production input-related adaptation WWS

Real-world example: Illova Sugar, Africa's largest sugar producer, purchases additional production inputs beyond its own estates from farmers that have made their production climate resilient through conducting climate risk assessment, supported by a partnership between the Climate Resilient Infrastructure Facility and Illova Sugar, and through taking adaptation measures, such as individual flood protection measures. Here, the adaptation product is upstream in the value-consumption chain, encompassing adaptation goods (flood protection infrastructure) and services (climate risk assessment) that reduce climate risk for farmers (see Type [5]), and which can also lower the overall cost of the SPP to the company (Tàbara et al. 2019).

The *company economic win* results for Illova Sugar, as it acquires production inputs at lower aggregate cost due to its input supply chain being more climate resilient. Further, an economic win is also produced upstream for the farmers who in their own interconnected WWS implement adaptation goods and services into their production. The *consumer economic win*

Table 1 Company win-win strategies

Actor	Economic win	Ecological win	Socioeconomic activities			
			Production input Process innovation	Production process Process innovation	Production output Product innovation	Production recirculation
Companies	Cost reduction	Mitigation	[1] Cost-reduction-driven production input-related mitigation WWS	[4] Cost-reduction-driven production process-related mitigation WWS	[7] Cost-reduction-driven production output-related mitigation WWS	[10] Cost-reduction-driven production recirculation-related mitigation WWS
		Adaption	[2] Cost-reduction-driven production input-related adaption WWS	[5] Cost-reduction-driven production process-related adaption WWS		
	Revenue increase	Mitigation	[3] Revenue-increase-driven production input-related mitigation WWS	[6] Revenue-increase-driven production process-related mitigation WWS	[8] Revenue-increase-driven production output-related mitigation WWS	[11] Revenue-increase-driven production recirculation-related mitigation WWS
		Adaption			[9] Revenue-increase-driven production output-related adaption WWS	

results from consumers purchasing sugar being at least as well off, and no worse off, than purchasing from a traditional producer. The *ecological win* results from the reduction of climate risk upstream in the value-consumption chain with the adaptation of smallholder farmers in Malawi, Mozambique, Swaziland, South Africa, Tanzania, Zambia.

[3] Revenue-increase-driven production input-related mitigation WWS

Real-world example: a coffee distributer in Bali purchases coffee—an SPP—from local farmers that is roasted with biogas instead of electricity or fossil fuels (Tàbara et al. 2019).

The *company economic win* results from the company increasing revenue through sales to customers who value the ecological characteristic of the product. The *consumer economic win* results as a utility increase for households purchasing a sustainably produced product. The *ecological win* arises upstream in the value-consumption chain, as the ecological footprint from carbon emissions of the coffee production is lower than that of conventional coffee production, due to the process innovation WWS implemented by the coffee roasters (see Type [3]).

[4] Cost-reduction-driven production process-related mitigation WWS

Real-world example: Starbucks reduces water and energy use during production processes by up to 30% (FC 2018).

The *company economic win* results from reducing costs by using less resources in the production process. Concerning the *consumer economic win,* consumers purchasing the company's products are at least as well off, and no worse off, than before. They may even realise a utility increase from purchasing a (relatively compared with other) more sustainably produced product. The *ecological win* arises at the value-consumption chain position of the implementing actor because of the water and energy savings.

[5] Cost-reduction-driven production process-related adaptation WWS

Real-world example: a company implements insulation of machinery and buildings, or workplace management practices, e.g. not working at peak temperature times, that secures its own production against climate-related damages from heat, such as machinery depreciation or low labour productivity (Haines et al. 2009; Zander et al. 2015).

The *company economic win* results as the company reduces its production costs by reducing the expected damages from extreme heat events. The *consumer economic win* results as consumers purchasing the company's products are at least as well off, and no worse off, than purchasing from a traditional producer. The *ecological win* arises at the value-consumption chain location of the implementing actor. The insulation is here an adaptation good, and may be produced through connected upstream WWS (see Type [8]), while the changes in workplace management practices are adaptation services.

[6] Revenue-increase-driven production process-related mitigation WWS

Real-world example: in 2014, Coca-Cola company announced investing in improving the energy efficiency of its coolers and vending machines, the largest contributors to the company's energy usage. This process innovation utilises SUP (here, energy-efficient machinery) that reduce the usage of energy in the company's value chain. Coca Cola targets consumers by conveying the message that the beverage is produced more sustainably, thus aiming to increase sales and generate revenues (WWF 2014).

The *company economic win* results as the company increases its revenue by selling their output to customers who prefer it to competing products due to its lower energy input requirements and GHG emissions. The *consumer economic win* results as purchasing the product increases their utility. The *ecological win* arises at the value-consumption chain position of the implementing actor through using an SUP. The SUP may be produced upstream in the value-consumption chain (see Type [8]).

[7] Cost-reduction-driven production output-related mitigation WWS

A PV equipment supplier, Senec, introduced a new PV power regulation unit for installations that want to combine self-use, storage and feed-in to the grid. One of the key innovations is that the product only contains a single AC/DC converter instead of a pair of them as has been state of the art. This innovation improves the performance of the unit while saving production costs (SENEC 2019).

The *company economic win* results as the company reduces its production costs through new product development. The *consumer economic win* results as purchasing the product increases their utility, or at least makes them no worse off compared with purchasing the equivalent traditional product. The *ecological win* arises downstream in the value-consumption chain at the position of the consuming actor through using the new PV power regulation unit, an SUP.

[8] Revenue-increase-driven production output-related mitigation WWS

Real-world example: a company in Austria produces and sells solar low-cost plug-and-play photovoltaic modules, which can be used by households to produce electricity at very low operational cost. These modules are attractive for households living in rental units, as they can be plugged into normal electric sockets and thus the cost of moving them to new locations is minimal (Tàbara et al. 2019). It is important to understand that for module operation, regulations are needed for allowing households to plug such units in (see Type [22]).

The *company economic win* results from the company increasing its revenues by selling these modules to consumers who wish to reduce their own costs and environmental impacts. The *consumer economic win* results as households increase their utility by reducing their GHG emissions and costs from electricity consumption. The *ecological win* takes place downstream from the implementing actor in the value-consumption chain, with households that implement a WWS that substitutes traditional energy use for electricity produced from the PV modules (see Type [13]).

[9] Revenue-increase-driven production output-related adaptation WWS

Real-world example: a start-up company located in Istanbul (Turkey) produces building blocks that can be used for constructing green façades, i.e. façades that can carry and sustain living plants. The building block is an adaptation good because it can contribute to reducing urban heat-island effect, thus reducing the expected damages from extreme heat events in cities (Tàbara et al. 2019).

The *company economic win* results from the company increasing its revenue by selling products into a growing market for products associated with urban sustainability. The *consumer economic win* results from consumers increasing their utility by purchasing an adaptation good, i.e. a good that contributes to the public good of reduced heat-island effect. The *ecological win* results downstream in the value-consumption chain with the positive effect of the use of building blocks for facade construction on reducing urban heat-island effect.

[10] Cost-reduction-driven production recirculation-related mitigation WWS

Real-world example: cement production uses scrap tires (Nakomcic-Smaragdakis et al. 2016). The *company economic win* results from the cost reduction achieved by replacing fossil fuels and steel in cement production. The *consumer economic win* results from a safe and cheap recycling of scrap tires. The *ecological win* arises at the location of the implementing actor from replacing fossil fuels and steel in cement production.

[11] Revenue-increase-driven production recirculation-related mitigation WWS

Real-world example: Kazmock, a company in the Netherlands, makes use of depreciated conveyor belt material to produce high-end luggage for consumers (Fraccascia et al. 2016). The company increases revenue by producing high-end consumer products that are also desirable for their reduced ecological footprint, which is achieved through making use of recycled materials.

The *implementing actor economic win* results from the company increasing its revenue by selling products to consumers who value the sustainability-oriented production recirculation. The *consumer economic win* results from the consumers increasing their utility by purchasing a recirculated product. The *ecological win* is at the location of the implementing actor, generated from a reduction of GHG-emission through applying waste management technologies.

3.2 Household win-win strategy types

Table 2 presents win-win strategies for households. As for companies, types of WWS are identified for the different values of three essential dimensions: socioeconomic activity, economic win, and ecological win. This gives basically 12 types of household WWS.

Each example is again described according to the three key conditions identified in Sect. 2. However, because the implementing actor is also the consuming actor, i.e. the household, an economic win for the household satisfies both conditions (i) an economic win for the implementing actor; and (iii) an economic win for the consuming actor. Therefore, we only describe the household economic win and the ecological win, which may nevertheless occur anywhere along the value-consumption chain.

Real-world example: WWS are identified for seven types. Here, once again, all five WWS for which a real-world example could not be identified are adaptation related. We discuss this in Sect. 4.

[12] Cost-reduction-driven consumption input-related mitigation WWS

Real-world example: a common example is the consumption of regionally produced products, such as renewable energy in the form of electricity or heat from local power generation. The *household economic win* arises from the lower costs in using the SPP, when such SPP are indeed less costly. The *ecological win* arises from production processes upstream from the household in the value-consumption chain, e.g. in electricity production (see Type [6]).

Table 2 Household climate-related win-win strategies

Actor	Economic win	Ecological win	Socioeconomic activities		
			Consumption input	Consumption process	Consumption output
Households	Cost reduction	Mitigation	[12] Cost-reduction-driven consumption input-related mitigation WWS	[14] Cost-reduction-driven consumption process-related mitigation WWS	[17] Cost-reduction-driven consumption output-related mitigation WWS
		Adaption		[15] Cost-reduction-driven consumption process-related adaption WWS	
	Utility increase	Mitigation	[13] Utility-increase-driven consumption input-related mitigation WWS	[16] Utility-increase-driven consumption process-related mitigation WWS	[18] Utility-increase-driven consumption output-related mitigation WWS
		Adaption			

[13] Utility-increase-driven consumption input-related mitigation WWS

Real-world example: examples of this WWS encompass all consumption decisions of households striving for higher utility because of the positive ecological characteristics of non-durable SPP, like organically grown food. The *household economic win* arises from the utility increase for households of using the SPP. The *ecological win* arises from production processes upstream from the household in the value-consumption chain (see Type [6]).

[14] Cost-reduction-driven consumption process-related mitigation WWS

Real-world example: a household uses car sharing services or public transport (both SUP) instead of buying and using their own cars. The *household economic win* arises from transport cost reduction for households from using the SUP. The *ecological win* arises from the reduced fossil fuel use at the value-consumption chain position of the implementing actor, i.e. the household, induced by its utilisation of SUP. Other examples include energetic retrofitting residential buildings or self-generation of renewable electricity.

[15] Cost-reduction-driven consumption process-related adaptation WWS

Real-world example: a household builds or retrofits a building that improves its resilience against climate change-related impacts, e.g. increased intensity and frequency of storms. Adaptation goods such as flood barriers or raised housing foundations are utilised to reduce expected damages. The *household economic win* arises from cost reduction for households from reduced expected climate-related damages. Key to realising this economic win is that the costs of the retrofitting must be less than the expected benefits in avoided damages from carrying out the adaptation measure. The *ecological win* arises at the location of the implementing actor from reduced climate change impacts.

Other examples include the use of adaptation services, i.e. insurances against climate-related damages that reduce potential future climate-related damage costs of households, by transferring risk of large losses to the insurance policy issuer.

[16] Utility-increase-driven consumption process-related mitigation WWS

Real-world example: a household purchases any of alternative vehicles, low-energy houses and similar durable, energy consuming goods, all of which are SUP. The *household economic win* arises from the utility increase it experiences employing these SUP and the related GHG emission reductions. The *ecological win* results from energy and emission reductions and takes place at the position of the implementing actor, i.e., household consumption.

[17] Cost-reduction-driven consumption output-related mitigation WWS

Real-world example: a household turns used durable goods or residual waste from non-durable goods into downstream applications, for example, processing biodegradable household waste for composting their garden. The *household economic win* results from a cost reduction for the households through reduced fees for public waste collection and reduced need for fertiliser for their garden. The *ecological win* results from a reduction of waste and a reduction of fertiliser use, which saves emissions during the fertiliser production.

[18] Utility-increase-driven consumption output-related mitigation WWS

Real-world example: a household turns used durable goods or residual waste from non-durable goods into downstream applications, for example, processing biodegradable household waste for composting their garden. The *household economic win* results from a utility increase for the households through the satisfaction the household obtains from conducting recycling. The *ecological win* results from a reduction of waste and a reduction of fertiliser use, which saves emissions during the fertiliser production.

3.3 State win-win strategy types

Table 3 presents win-win strategies for the state. As above, types of WWS are identified for the different values of the dimensions: socioeconomic activity, economic win, and ecological win. This gives six types of state WWS.

Each example is again described according to the key conditions identified in Sect. 2. Here, the consuming actor may be the state itself, which thus requires only describing the state economic win, as this covers both conditions (i) an economic win for the implementing actor; and (iii) an economic win, or at least no economic loss, for the consuming actor. However, the consuming actor may also be households affected by state policy. Examples of this kind we describe along all three key conditions, namely, that (i) an economic win is required for the implementing actor; (ii) an ecological win is required somewhere along the value-consumption chain; and (iii) an economic win, or no economic loss, is required for the consuming actor.

We note that WWS examples are identified for five types, with the one type for which no example could be identified being adaptation-related. We discuss this in greater detail in Sect. 4.

[19] Cost-reduction-driven expenditure input-related mitigation WWS

Real-world example: in the UK, the state procures less costly recycling paper, an SPP, for use by its administration. The *state economic win* arises from lower costs from using the less costly paper (Walker and Brammer 2009). The *ecological win* takes effect upstream in the value-consumption chain through paper production of a company implementing its own WWS (see Type [10]).

[20] Cost-reduction-driven expenditure process-related mitigation WWS

Real-world example: the state implements energy retrofitting of administrative buildings requiring use of improved insulation, an SUP, and thus reduces energy consumption (Ardente et al. 2011). The *state economic win* results from lower energy costs for state-operated buildings. The *ecological win* results at the location of the implementing actor from the reduced GHG-emissions associated with state consumption activities.

[21] Cost-reduction-driven expenditure process-related adaptation WWS

Real-world example: in the Netherlands, Germany and the UK, the state undertakes expenditure activities for building dikes and sand dunes to increase coastal flood protection that accounts for increasing flood risk from future sea-level rise (Bisaro et al. 2019). The *state*

Table 3 State win-win strategies

Actor	Economic win	Ecological win	Socioeconomic activities		
			Expenditure input	Expenditure process	Policy
State	Cost reduction	Mitigation	[19] Cost-reduction-driven expenditure input-related mitigation WWS	[20] Cost-reduction-driven expenditure process-related mitigation WWS	[22] Cost-reduction-driven policy-related mitigation WWS
		Adaption		[21] Cost-reduction-driven expenditure process-related adaption WWS	[23] Cost-reduction-driven policy-related adaption WWS

economic win results from a reduction of costs for the state from reduced expected damages of coastal flooding. The *household economic win* results from reduced flood risk. Here adaptation goods, i.e. dikes or sand dunes, are utilised. The *ecological win* arises from a reduction of expected damages from coastal flooding under sea-level rise.

[22] Cost-reduction-driven policy-related mitigation WWS

Real-world example: the German feed-in tariff for renewables is a scheme in which electricity consumers pay feed-in tariffs to producers of renewably generated electricity via electricity providers (Jacobs 2017). This scheme triggers WWS of type [8] for renewable electricity producers. The state economic win results from the fact that this scheme does not use public budgets. The ecological win results from the build-up of a renewable electricity sector and the renewably generated electricity.

[23] Cost-reduction-driven policy-related adaptation WWS

Real-world example: in Hamburg, Germany, the state implements policies that include regulations requiring private adaptation measures in companies and households located in the new district of Hafen City (Bisaro and Hinkel 2018). The *state economic win* results from reduced costs to the state for spending on support schemes, e.g. emergency response and recovery, that result from damages from climate-related weather extremes, e.g. heat waves or flooding. An economic win arises because private adaptation measures reduce these damage costs by ensuring companies and households are prepared for such events, thus reducing aggregated costs—i.e. the sum of discounted private spending and governmental costs associated with potential climate damages. The *household economic* win arises because such private adaptation measures generally have positive benefit-cost ratios, particularly over mid to long-term time horizons. The *ecological win* arises from reduced aggregate climate damages.

4 Discussion

4.1 Benefits of the meso-economic approach and directions for future research

Our typology has been developed through applying a *value-consumption chain* concept, extending the standard value chain concept to include consumption. The approach has two defining features. First, considering consumption as a part of the value chain highlights that the ultimate aim of a value chain is to bring benefits to consumers. In this view, key for understanding a WWS is thus identifying how a *sustainably produced*, *sustainably used* or *adaptation* product can increase the utility of a household or reduce its costs. The value-consumption chain concept extends analysis to include consumption decisions, such as *utility increase* or *cost reduction*, and thus helps determine whether related business models are viable and identify related policies (e.g. regulations and support schemes) for the sustainability transition.

Second, the approach forces the analyst to think through the interconnections of WWS along a value-consumption chain, which in turn enables an assessment of economic effects in a meso-economic perspective. When analysing WWS, a meso-economic approach has to first analyse how an (intended) implementation of a WWS impacts all actors in the related value-consumption chain, directly or indirectly. With regard to the example presented in Sect. 2.3 (distribution of organic coffee roasted with utilisation of biogas instead of fossil energy), a meso-economic analysis would assess the potential changes of revenues for biogas-bag manufacturers, coffee farmers, and also fossil-energy generators and conventional coffee producers, and households that change their consumption patterns. Neither an analysis of only the coffee distributor and how she implements her WWS, nor an aggregated (macro) approach would be able to depict the economic and social effects for all actors involved. The approach thus emphasises an analysis of the different connections between WWS and their interdependence in the value-consumption chain.

Our typology thus provides a tool for stakeholder-based science as it (i) focuses on consumption decisions, highlighting the viability of a GBM, and bringing the full set of interconnections of WWS to light; and (ii) provides a language for analysts and stakeholders to examine these interdependencies. Such deeper analysis can support entrepreneurs, investors and policy-makers in identifying WWS and related viable GBM, and informing policy to enhance these.

For example, comparative research on WWS of the same type in different socio-economic contexts can address questions regarding their viability and enabling conditions and what policy instruments can most effectively or efficiently scale up these WWS. One interesting research direction in this regard is to what extent company revenue-driven mitigation WWS are dependent on consumer utility gains from the ‘green’ label, versus other possible drivers, such as the preferences of its funders/investors regarding the company’s sustainability practices. Unpacking the importance of respective drivers of company WWS, i.e. consumer, entrepreneur and investor preferences, could usefully inform entrepreneur business development strategies, such as prioritising green labelling or optimising production processes, with regard to their viability and appropriate financing strategies.

Another potential benefit of applying the approach is that target-oriented formulation of supporting policies becomes more effective. For instance, policy can focus either on consumers through demand-side financial support for purchase (e.g. for E-vehicles), or on producers through supply-side support for production (e.g. tax exemptions or R&D support). Furthermore, policy can implement regulations for energy generation (e.g. CO_2 limits) or energy consumption (e.g. energy efficiency regulations for buildings, white-ware or passenger cars). The typology provides an entry point for evaluating which types of policy instruments are most effective in enabling WWS. For example, for the policy-related adaptation WWS (Type [23]), whereby the state conducts policy to induce private adaptation measures against flood risk, the economic win for the state associated with regulating adaptation measures is based on cost-sharing for adaptation, i.e. flood risk reduction, with the private sector. Which type of policy instrument, e.g. regulation, incentives or communication, is cost-effective in inducing private adaptation is an empirical question that may differ across socio-economic contexts, depending on, for example, governance quality, culture of risk adversity, capacity in the private sector, etc. We provide here a language for addressing such questions empirically.

4.2 Patterns in observed win-win strategies

Another outcome of our analysis is a survey of real-world examples carried out through stakeholder interaction in the Green-Win project and in surveying the literature. Our typology consists of 34 conceivable types of WWS, for roughly two thirds of which (23) we found real-world examples. Of particular interest is the observation that despite a view held by several sustainability scholars and practitioners that the business case for adaptation is difficult to make (Atteridge 2011), we found multiple real-world examples of adaptation WWS of several different types. This is in itself a significant finding, as we have demonstrated that adaptation WWS, and related green business models, are indeed worthy of attention for green investors, rather than being predominantly the domain of grant funding (Pauw 2015). Yet, despite this broader point, we nonetheless observe that adaptation WWS appear to remain underrepresented in real-world WWS, as compared with mitigation WWS, with all 11 WWS types for which a real-world example could not be identified being adaptation related. This includes five company WWS types (Table 1), five household WWS types (Table 2), and one state WWS type (Table 3).

Regarding company and household WWS, which are based on value-consumption chains in which the household is the end consumer, the lack of adaptation-related WWS appears to reflect the much larger presence of climate mitigation, compared with adaptation, in the corporate sphere and Corporate Social Responsibility discourse (Druce et al. 2016). In principle, for households, Type [13] (utility-increase-driven consumption input-related mitigation WWS) should also apply for adaptation. For example, consumers could experience utility increases from buying goods that are produced through climate resilient techniques, such as climate resilient agriculture. A product produced under lower climate risk exposure, such as through the climate resilient supply chains of Illova Sugar discussed under Type [2], would thus be attractive to consumers who value decreased vulnerability of producers in the supply chains for the products they purchase. This would in turn mean that, for companies, a revenue-driven product input-related WWS could be relevant for adaptation: the company would introduce climate resilience in its supply chain precisely to target consumers who value such adaptation products. However, production and labelling of such sustainably-produced adaptation products is far less advanced than for mitigation-relevant products, and there is so far little evidence that they attract consumer demand (CPI 2017).

Another reason why adaptation WWS may be as yet underrepresented in real-world implementation relates to how the benefits of adaptation WWS accrue. Whereas cost-reduction-driven mitigation WWS generally reduce costs through improving resource efficiency and thus reducing cash expenditures, e.g. for business or consumers, cost-reduction-driven adaptation WWS reduce climate risks, and thus the cost reductions they achieve are stochastic. That is, cost reductions from adaptation WWS occur irregularly through avoided damages in extreme events, e.g. flooding or drought. WWS that depend on such stochastic benefits can give rise to psychological, social and financial barriers that impede companies or households from implementing such WWS (Adger et al. 2009).

Our analysis thus shows that indeed, contrary to prevailing views, adaptation WWS are conceptually and empirical viable. Moreover, due to lack of labelling as well as the character of adaptation benefits just described, more attention to company and household adaptation WWS may be warranted.

4.3 Limitations of the study

Our typology enables an identification of where trade-offs and limits to WWS may arise through identifying interconnections between WWS. In particular, the full value-consumption chain example shown in Sect. 2.3 depicts the interconnections to other WWS that can arise from implementing a specific WWS. Moreover, it demonstrates that each of the individual WWS is linked to other WWS upstream and downstream in the value-consumption chain.

One important issue in regard to analysing such trade-offs is the ‘rebound effect’, when activities produce economic wins by cost reductions that may lead to an increase in activities with potentially harmful ecological effects due to the availability of resources freed up, thus negating the overall ecological win (Greening et al. 2000). For example, a household may turn on an indoor heating system more often because insulation has increased its effectiveness, thereby consuming the same amount of resources in the production of heat, while experiencing a warmer house. The rebound effect can thus influence aggregate effects of potential win-win strategies in the macro-economy or a given sector, potentially giving rise to limits or trade-offs in WWS. Evaluating such effects requires, on the one hand, in-depth micro-economic study of the full set of consumption choices of WWS-implementing households, i.e. beyond just those directly relevant to the WWS, and on the other hand, the macro-economic study of the aggregate effect of such choices. It may also involve evaluation of the production choices for WWS-implementing companies for a particular value-consumption chain. Here, in contrast, we have presented a complementary meso-economic perspective, which allows to analyse where in production and consumption processes such trade-offs may arise, through identifying actors and activities implicated in WWS and their interconnections.

We note that our typology thus provides an entry point through identifying interconnections and analysing the limits or trade-offs they give rise to, while the latter ones, however, must be addressed through deeper empirical analysis in order to, for example, quantify such trade-offs and limits. Such effects are the domains of micro- and macro-economic analysis. We hope that our typology provides a language that supports the integration of findings from such analyses into the wider transdisciplinary discussion on the role of win-win strategies in the sustainability transition.

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