

Is it a green or brown job? A Taxonomy of Sustainable Employment

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ABSTRACT

Greening employment is required to avoid multiple ecological crises but so far there exist different notions of what makes a job ecologically sustainable. The article portrays five theoretical perspectives and develops a framework to evaluate the environmental impact of employment in four dimensions: (1) output type: sustainable goods and services as the outputs from work, (2) occupation: green tasks and activities at the workplace, (3) work-lifestyles: working conditions that promote workers' sustainable lifestyles, (4) outcome efficiency: resource-light production processes. It discusses previous approaches in each dimension and proposes improved assessment methods. By connecting the four dimensions, it develops a "Taxonomy of Sustainable Employment" to classify employment into green, mixed and brown jobs. The taxonomy can be applied to evaluate the sustainability of employment and identify effective labour market policies for a just transition.

1. Introduction

Welfare states, the economy, and society of today require employment. However, job preservation is also the main argument against ambitious climate policy – climate action that is needed to avoid disastrous impacts on people and employment itself since "there are no jobs on a dead planet" (ETUC, 2018). The prevention of climate catastrophe and the transgression of other planetary boundaries requires the green mainstreaming of all economic activities, including employment. Although labour (market) policies can support or hinder this transformation, greening work and employment to meet sustainability targets has received only little attention in academia and policymaking. Current policy strategies, such as the European Green Deal, unidirectionally consider the employment effects of sustainability transformations but neglect environmental effect of transforming work. This gap is surprising, as employment – the absence or quest for jobs – fundamentally structures our societies, the economy, and individual lifestyles. While environmental concerns are translated into new indicators and taxonomies in many fields (e.g. green finance), there exists no consistent framework to assess the sustainability of employment.

This paper seeks to close the gap by integrating multiple perspectives on what makes formal, remunerated employment ecologically

sustainable into a common and analytically consistent framework.¹ It identifies four dimensions of sustainable employment and develops a "Taxonomy of Sustainable Employment" to classify employment into green, mixed and brown jobs.

Since the Brundtland report, ecological sustainability has been tightly connected to human needs (WCED, 1987). Therefore, need and need satisfier theories are used in this paper to develop the taxonomy (Brand-Correa et al., 2020). This helps to distinguish needs and wants and thereby detect sustainable and also unsustainable employment patterns (Gough, 2020). Following the Brundtland report of sustainable development, "Sustainable Employment" is defined as paid, formalized work that meets the needs of present or future generations, without compromising the capacities of future or foreign people in other countries to meet their needs. The paper portrays the different strands of research dealing with jobs and the environment (section 2) and identifies four dimensions of sustainable employment (section 3). Based on the dimensions, it proposes a Taxonomy of Sustainable Employment to categorize employment as green, mixed, or brown jobs and discusses further requirements to operationalize the taxonomy (section 4). The paper concludes by summarizing how the results advance research on jobs and the environment (section 5).

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¹ This includes two thematic limitations: First, social sustainability aspects like fair pay, labour standards or preserving of work capacity, that are sometimes labelled "sustainable work" (Becke, 2019; Eurofound, 2022), are not included. Second, the paper excludes the largest part of work: unremunerated work such as unpaid care work. This limitation is intended because formalization and remuneration of jobs institutionalize (un-)sustainability fiercer and is, therefore, the stronger leverage for transformation.

2. Theories of jobs & the environment

Theories of the sustainability of employment start from two directions: From highlighting the synergies between greening the economy and promoting quality jobs on the one hand, and a fundamental critique of the desirability of today's work on the other hand. Within this spectrum, there are five perspectives:

(1) To defeat the incompatibility of environmental protection with economic growth and jobs, the United Nations Environmental Programme (UNEP) was the first to launch an encompassing research program on green jobs. UNEP defines green jobs as employment "that contributes to preserving or restoring the quality of the environment. [...] Jobs that] help to cut the consumption of energy, raw materials, and water through high-efficiency strategies, to de-carbonize the economy and reduce greenhouse gas emissions, to minimize or avoid altogether all forms of waste and pollution, to protect and restore ecosystems and biodiversity." (UNEP, 2008, p. 5). In addition, the ILO argued for fair working conditions as, making "decentness" an additional condition for green jobs to become "sustainable jobs" (International Labour Organisation, 2017).

(2) A related but more fine-grained approach to green jobs is the attempt to measure the greenness of jobs by assessing the greenness of tasks workers deliver in their jobs. UNEP and the ILO describe "green-collar" workers by the type of sector in which workers are employed and the type of products and activities this sector produces (Environmental Goods and Service Sector). Yet already in their first report, the institutions acknowledge that also the tasks themselves matter (UNEP, 2008, p. 11). Current research on green jobs, therefore, distinguishes the output approach ("jobs in businesses that produce goods or provide services that benefit the environment or conserve natural resources") and the process approach ("jobs in which workers' duties involve making their establishment's production processes more environmentally friendly or use fewer natural resources") (Vona et al., 2015, p. 9). Yet, researchers criticized these approaches as imprecise for dichotomously evaluating jobs as "green" or "non-green", while most jobs contain both "green" and "non-green" tasks and should therefore be evaluated on a continuous scale (Vona et al., 2015). More recent publications, therefore, evaluate green jobs by assessing the "greenness-of-jobs" (Janser, 2018). In parallel to green tasks on the demand-side of labour markets, identifying necessary "green skills" of labour market participants ensures that a lack of appropriate skills does not hold back the sustainability transition (Cedefop, 2019).

The first two conceptions of sustainable employment share a common understanding that technological change, eco-efficiency, circular economy, and bioeconomy shall be the key strategies of the sustainability transitions. The environmental policies will affect labour markets and workers have to be supported to adapt to these changes while not questioning consumerism and the productivist model of development (Bottazzi, 2019). However, technological strategies will likely not suffice to avoid climate catastrophe, therefore, additional approaches – including sufficiency, downscaling of and a change in production and consumption patterns – are required (Haberl et al., 2020). The two conceptions highlight only desirable, green, jobs while saying little about the remaining (gradually unsustainable) jobs, or what to do about these jobs considering planetary boundaries. This "carrotism" (Lamb et al., 2020) makes "green jobs" a useful marketing tool to highlight the employment effects of green investments but cannot guide effective transformations.

(3) Labour environmentalism attributes a more active role to workers in the sustainability transition, describing workers as agents of change, that can, due to their position as workers in a company and sector, fight for a just transition. Within that perspective, unions become advocates and important drivers of a just transition (Snell and Fairbrother, 2010). The requirement to exnovate certain industrial sectors raises the question of whether all workers will find employment in green industries and how large the contribution of a servicisation can be

(Bottazzi, 2019). Although labour environmentalists consider employment relationships as a field of transformation, their notions of work remain refined to formal, paid employment, often within well-unionized sectors. Thereby they disregard female-dominated sectors and unpaid work.

(4) Sustainable Work, a concept that is informed by the feminist perspective of "provident economics" (Netzwerk Vorsorgendes Wirtschaften, 2014), draws attention to this blind spot in labour research (Littig, 2018). Scholars of this school define sustainable work more encompassing as "socially necessary work (employment, unpaid care work, community work, cultural work) that furthers the capabilities of today's and future generations" (Barth et al., 2019). Environmental Feminists emphasize the parallel between the exploitation of the (predominantly female) care work and the work of nature (Dengler and Strunk, 2018). Increasing labour productivity is criticized as imposing overproduction and environmental problems (Mair et al., 2020). Assessing the sustainability of formal employment, therefore, requires considering how it affects the "(re)productivity" of all forms of work (Biesecker and Hofmeister, 2010). While this school of thought encourages us to reconsider our evaluation of employment and its productivity, it falls short of empirically applying these findings in the evaluation of actually exiting policies.

(5) Post-work focuses on overcoming work and employment-centeredness. It shares with sustainable work the emphasis on the "social necessity" of some jobs (Aronowitz, 2013). This question was probably raised most prominently by David Graeber (2018) in regards to "bullshit jobs": A bullshit job is "a form of paid employment that is so completely pointless, unnecessary, or pernicious that even the employee cannot justify its existence" (Graeber, 2018). Recently, similar critiques of work were raised from an ecological perspective (Cohen, 2019; Hoffmann and Paulsen, 2020): Batshit jobs – these are jobs that are not only useless but actively destroy the environment (Hansen, 2019). In that perspective, employment is not necessarily (re)productive but consumptive, and eventually destructive (Hoffmann and Paulsen, 2020). For example, just the carbon costs of an hour worked in the French transport sector exceed the French minimum hourly pay (Parrique, 2019, p. 579). This illustrates that there are jobs that are destructive for both the workers and the environment. Considering the distress that unemployment poses to citizens, society, and states, post-work calls for a new (non-)work ethic and is confident that social re-conditioning can establish these values. In its radicalness, post-work certainly evokes utopian thinking (Mair et al., 2020), in a confined form it resembles Keynes' imagination of the norm of the fifteen-hour week in 2030 (Keynes, 1930).

These conceptions illustrate the variety of perspectives on jobs and the environment. All five conceptions describe valuable aspects for assessing the sustainability of employment and greening jobs.

3. Four dimensions of sustainable employment

The different considerations of what makes employment sustainable can be clustered on two scales (see Table 1): The organizational level of analysis (macro – micro) and the immediacy of the environmental effects (direct – indirect). The organizational level ranges from aspects that are valid for a whole industry (macro) to aspects that relate to a single workplace (micro). At the macro-level, sectors and businesses can be categorized, e.g. petroleum refining is rendered fully unsustainable by the requirement of greenhouse gas neutrality. The micro-level evaluates the specific tasks and activities of individuals, e.g. energy-saving consultants might be considered as a green job, independent of the sector they consult. The immediacy of the environmental effects of a job distinguishes whether the brown or green effect results from the workplace (direct), or whether evaluation requires considering the environmental consequences resulting from the interplay between workplaces and the overall socio-economic structures (indirect).

In summary, this results in a 2×2 matrix with "output type" defining

Table 1

Four dimensions of sustainable employment on two scales: level of analysis and type of effect.

		Type of effects	
		workplace effects (direct)	socio-economic effects (indirect)
Level of analysis	sector, company, plant (macro)	1. Output type Does the good or service produced serve human needs, comfort, or wants? Is the satisfier environmentally generalizable?	4. Outcome efficiency Is the environmental harm per produced satisfier lower than for similar satisfiers? Is the environmental harm per hour worked below a justifiable impact-hour-ratio?
	worker, employee (micro)	2. Occupation Does the job description cover green or brown tasks? Do job-related activities harm or benefit the environment?	3. Work-Lifestyles Do time and income effects inhibit a sustainable lifestyle? Does the job encourage unsustainable practices or anti-environmental believes?

the direct effects of the plant, company, or sector (section 3.1), “occupation” describing the direct effects of the tasks and activities of workers (section 3.2). Indirect effects cover the implication of working conditions for workers’ individual (un)sustainable “work-lifestyles” (section 3.3) and the “outcome efficiency” in meeting societal goals at the plant, company, or sector (section 3.4).

For each of the four dimensions, the following sections discuss previous notions of sustainable employment, propose an improved evaluation and definition and describe the implications.

3.1. Output type

3.1.1. Previous approaches

Most studies that assess sustainable employment take a sectoral approach that focuses on the environmental goods and service sector. Considering the work output for the evaluation of sustainable employment is indeed essential. However, existing sectoral approaches face some shortcomings: First, most sectoral perspectives are falsely biased against services. For example, the EU sustainable finance taxonomy excludes relevant pro-environmental services like urban and regional planning for low carbon development (EU Technical Expert Group on Sustainable Finance, 2020). The focus on technical solutions also results in a gender bias, as it precludes female-dominated sectors (ILO, 2018). Second, the sectoral approach is too broad since it includes greenwashed products. For example, the environmental goods and service sectors do not differentiate between small e-cars and unnecessarily resource-intensive e-SUVs (Janser, 2018, p. 80). Third, differences in the purpose of products are not considered because only relative environmental improvements are evaluated. For instance, producing e-ambulances to replace petrol-powered ambulances is to be evaluated differently than making racing cars electronic. This perspective masks that there is a budget of sustainable energy, carbon emissions, etc., and that reducing inefficiency might not suffice to avoid surpassing ecological limits.

3.1.2. Improved evaluation

These shortcomings can be overcome, if it is considered whether work outputs serve human needs, comfort, or wants (Gough, 2020) and whether a generalized use of these work outputs is in line with planetary boundaries (Table 2). Meeting human needs has particular moral importance since unmet needs disable a flourishing life (Doyal and Gough, 1991): Comfort or luxury are of little value when basic needs, like adequate nutrition, are not met. In the past decades, more resource-, energy-, and emission-intensive tools have become a necessity for full participation and survival: need satisfiers have become more unsustainable. For example due to poorer public transport in many regions car ownership is now required to reach the workplace or access health care (Brand-Correa et al., 2020).

Some goods and services actively restore the environment or ensure that environmental goods are not depleting and preserve a healthy environment. These sectors function as a multiplier that enlarges the likelihood that human needs are met within planetary boundaries. Within activities that restore the environment, it does not matter

whether a good or service is serving the needs or only the wants of people, because it does not take away from environmental qualities but enlarges them. Other satisfiers have a negative environmental impact but it is so small that it is generalizable for everyone who needs or wants these goods or services. For example, there is nothing environmentally problematic with luxury massage services, since barely any resources are involved. It is important to distinguish the occasions of use of the product: some products might be generalizable for everyone who needs that product but not for everyone who just wants to enjoy additional comfort of that product or service. Whether a product or service is generalizable or not is time-dependent: With ecological resources and sinks depleting, the line of generalization will gradually shift, making fewer goods and services generalizable. Some goods and services might not be ecologically generalizable but still not immediately surpass environmental limits if only used by a selected group of people.

3.1.3. Definition 1: Output type

Hence, sustainable work outputs are goods or services that directly benefit the environment or constitute ecologically generalizable need satisfiers (green fields in Table 2). Unsustainable work outputs consist of goods and services that use ecological resources in a non-generalizable manner to address people’s luxury or comfort wants (brown fields in Table 2).

3.1.4. Implications

Some sectors’ outputs can easily be identified as sustainable work outputs: For example, composting food waste (restoring ecological systems) or organic horticulture that provides people with food (generalizable need satisfiers). And many social services have little environmental impact (i.e. generalizable) while serving basic needs, e.g. schoolin for education. Some sectors, however, provide generic services (e.g. law consultancy) and their sustainability cannot be assessed by simply considering their work outputs because they serve as inputs and instruments for other goods and services to be produced, sold, or distributed. Hence they fulfill specific roles in administrating and supporting specific goods or services in global values chains (Hoffmann and Paulsen, 2020). Yet, they can be evaluated by considering the value chain up- and down-stream. For example, for multipurpose products the share that is necessary for sustainable work outputs can be classified as sustainable.

3.2. Occupation

3.2.1. Previous approaches

As a response to the finding that some jobs contribute towards greening a company or process from within a company – although the company itself does not produce sustainable work outputs – the tasks of employees received more attention. Mainly based on statistics of the US-American O*NET database, researchers started to assess the greenness of jobs by evaluating the greenness of tasks to be performed in specific professions.

However, the existing approaches face three shortcomings: First,

Table 2

Output type: Assessment of products and services according to their satisfier purpose (need, comfort, luxury) and the environmental impact of the good or service (benefitting the environment, generalizable, non-generalizable, irreversibly destructive) resulting in three categories: sustainable work outputs (green), mixed (yellow), unsustainable work outputs (brown). Examples for illustration.

satisfiers	Luxury	Local environmental protection holiday camp	Arts, theatres, massages	Villas for housing	Holidays on the Maldives
	Comfort	conversion of a former industrial site to a municipal park	E-bikes for daily commute from the suburbs to the city	E-cars for daily commute in the city	SUVs
	Need	composting food waste	Organic horticulture	Road construction in sparsely populated areas	Emergency helicopter flights
		Restore ecology or prevent erosion of the environment	Generalizable without surpassing environmental limits	Not generalizable for all that have the need or want the comfort/luxury	Irreversibly destroying the environment
(zero/low) environmental harm (high)					

their focus on technical green tasks exhibits the same gender blindness and techno-bias as existing sector-based definitions of green jobs. Second, the existing studies measure only the greenness but not the brownness of tasks. A job that neither harms nor benefits the environment is rated less green than a job that mainly consists of environmental destruction but also includes some minor pro-environmental tasks. This leads to an inconsistent ordering of jobs on the greenness scale and promotes wrong solutions for the environment: For the environment, it is much more important to stop damaging activities than repairing the damages afterwards, particularly since some environmental destruction, e.g. biodiversity loss, is not reversible. Third, measuring only the tasks of employees misses a large share of environmentally relevant activities at work, for example, transport (e.g. business flights), nutrition (e.g. canteen food), recycling facilities, and green procurement. Activities at work form leverage for environmental impact, for example, employees can take trains instead of flying (Süßbauer and Schäfer, 2018).

3.2.2. Improved evaluation

Hence, the second dimension of the taxonomy shall assess the share of green and brown tasks and activities of a specific occupation. In many jobs, negative environmental consequences are not only an unintended side-effect but an essential part of the purpose of the jobs (e.g. marketing experts that encourage unnecessary consumption). Hansen (2019) considers this “batshit” side of many workplaces a “contradiction [that] arises when making a living is also a part of unmaking life” (Hansen, 2019). The environmental impact of the activities should be attributed to the occupation because employees have – different than private consumption – little or no mandate to decide about tasks and activities at work. Time-use studies apply exactly that approach and exclude the footprint of hours worked and in education when calculating individual consumption footprints (Smetschka et al., 2019). In addition, specific activities beyond work hours might be required to successfully participate at work. For example, the means of commuting to work (e.g. car, bike, public transport) depend on the location of the workplace and the position of working times. The responsibility for environmental consequences of these work-preparing activities depends on the quality of offered options, the built environment, other obligations of the employees (e.g. care duties), and the negotiation power between employer and employees.

3.2.3. Definition 2: Occupation

Sustainable occupations entail no brown and at least some green tasks and activities. Unsustainable occupations cover no green and some brown tasks or activities. Green tasks and activities in this respect are the times employees spend on improving, restoring, protecting the environment or time that is devoted towards enabling or promoting this. Brown tasks and activities are the times people spend on inhibiting environmental protection, furthering unsustainable solutions, or performing activities that themselves have a large negative impact on the environment.

3.2.4. Implications

In official labour market statistics, there is no information on activities at work and little information about the purpose of the tasks performed. Such data would have to be gathered from the self-assessment of the employees, for example by letting them list each activity and task at work and rate whether it contributes towards the protection or rather the destruction of the environment. Of course, such self-assessment can only be a proxy with potential pitfalls as a person might not see the purpose and environmental impact because of the fragmentation of tasks. Research on the perceived usefulness of jobs finds some support for this Marxist hypothesis of alienation amongst workers with simple and routine manual tasks being ranked most frequently as a “socially useless job” (Dur and Lent, 2019). However, it could indeed be the case that the jobs are useless, for example as they just contribute to the manifestation of a treadmill of production (Wiese and Mayrhofer, 2020).

Particularly when it comes to assessing the environmental impact of tasks, employees are the experts on the work processes and the implications of their work. If they cannot detect any pro-environmental consequence, that is a good indication that there is in fact none. Indeed, they are likely to be too optimistic about the greenness of their tasks and activities at work: In order to bridge the cognitive dissonance of the desire to make a positive contribution to the world and being trapped in a harmful job, employees might adapt their perception of their jobs when not being able to change their profession. Furthermore, people might greenwash their activities because they are insufficiently informed of the actual changes required to avoid environmental catastrophe.

3.3. Work-lifestyles

3.3.1. Previous approaches

Although there is rich research on sustainable lifestyles and the influence of work patterns, existing measurement methods of sustainable employment fully neglect the influence of jobs on the (un)sustainability of lifestyles. On the one hand, this is surprising because working conditions determine lifestyles and the viability of sustainable lifestyles is intensively researched. On the other hand, this neglect is no surprise because existing measurement approaches of sustainable employment only assess the greenness, not the brownness of jobs, and the consequences of jobs for lifestyles only establish a sufficient criterium for brown, not for green jobs: Working conditions cannot be a prerequisite for sustainable lifestyles, as other systems of provisioning (e.g. social benefits or pensions) can also enable sustainable lifestyles. Whereas, for people that are given no other means of income, employment is a prerequisite that can inhibit a sustainable way of life.

3.3.2. Improved evaluation

The third dimension shall, therefore, assesses whether a job disables sustainable lifestyles. This can be possible through four mechanisms: Income, in particular hourly wage, can be too low or too high to consume responsibly. The temporal regimes jobs place on employees can rule out sustainable time-use patterns. Everyday practices are acquired at work and might translate into unsustainable behaviour in private life. And, political and moral identity is partially formed at the workplace.

3.3.3. Definition 3: Work-lifestyles

A sustainable work-lifestyle is given when the employment does not inhibit a sustainable lifestyle of the worker and its household through income or time effects, or the training of unsustainable practices or identity. Unsustainable work-lifestyles inhibit a sustainable lifestyle through any of these mechanisms.

3.3.4. Implications

Whether a job promotes or hinders sustainable lifestyles depends on a complex interaction of the worker's characteristics and the local physical or temporal infrastructures. Future methodological development to measure the influence of the four mechanisms for lifestyles should take the following considerations into account: For income effects, three aspects must be distinguished:

First, a lack of income, resulting for example from too low hourly pay, might force people into unsustainable lifestyles. Income required to meet needs sustainably might be higher than what is required to meet needs exploitatively. For example, working-poor households might not have the means to shift to sustainable heating or to afford organic food. The lower income bounds should account for expenditure levels that are required to consume sustainably. This level depends on the expenditure necessary to purchase necessary goods and services on the market and the local availability of free (green) infrastructure.

Second, being able to fulfill a job often requires work-specific expenditure. For example, many employees require a car to reach their workplace and are obliged to wear business or professional attire. Job-based consumption is even encouraged as it is frequently tax-deductible (e.g. secondary apartments at the job location, commuting expenses) or covered by job centers (e.g. driving licenses). In the absence of social security systems that allow members of society to withdraw from the labour market, or to make needs met without a job, employees need to spend income on these goods and services to stay/become employable. This raises required income and expenditure levels. Employment, therefore, has both a productive as well as a consumptive role in society (Hoffmann and Paulsen, 2020). Human labour is essential to production and endogenizing the emissions from the expenditures of workers leads to large differences in the variation of sectoral emissions: For example, the CO₂ emission of the computer service sector increases by 292% (Horen Greenford et al., 2020).

Third, acknowledging that some responsibility for luxury emissions certainly rests with the employees, it is also important to consider the systematic dilemma of excess income. If excess income is not spent, then saving and accumulating excess income will lead to larger inequality and reduced production. While this could milden environmental problems, it would lead to fierce social and economic crises as long as societies are growth- and job-dependent (Wiese and Mayrhofer, 2020). However, if excess income is saved and invested, it will lead to new productive capacities resulting in additional emissions. For example, the emissions from saving/investment of the wealthiest income decile in Austria are about the same size as emissions from their leisure activities, including holidays (Frascati, 2020). Employees can to some extent decide what to spend their excess income on and there is a large impact variation whether income is spent on high-emission private jets or small, pricy art pieces. Yet, jobs that generate excess income are co-responsible for the luxury emission and excess investments enabled by excess income. To keep consumption within consumption corridors (Fuchs et al., 2021), researchers, therefore, call for salaries to be kept within a minimum and also a maximum threshold (Buch-Hansen and Koch, 2019).

Time, not only income, matters for the realizability of sustainable lifestyles. Jobs shape schedules and structure temporal institutions and societal tempi (Levine, 1997). A lack of disposable time due to time committed to employment can lead to time-saving – yet resource-intensive – devices (e.g. dryers, ready-made meals) (Schor and Jorgenson, 2019). Employment can also lead to reduced sleeping time – time-use that is particularly resource-light (Druckman and Gatersleben, 2019). Or it can change the pattern in which free time is used, for example visiting friends by plane instead of going by train, because work schedules do not allow longer travel times. Jobs also lead to a gendered division of labour, resulting in more pay and more time available for men – having implications for total emissions because of gender differences in the activities and their environmental impact of free time (Smetschka et al., 2019). Taking into account that sustainable lifestyles require more time, many researchers advocate a reduction of work hours (Zwickl et al., 2016). However more free time can also increase environmental impact by a recomposition of time and consumption patterns (Antal et al., 2020). Overall, a reduction of employment times will result in lower total emissions when the additional hours spent outside of employment have a lower environmental footprint than the hour spent at work (Parrique, 2019, p. 577).

In addition to these material aspects of pay and work times of employment on sustainable lifestyles, employment also shapes lifestyles more subtly: At work people acquire new knowledge and skills that translate into private behaviour. For example, employees might learn about the environmental implications of certain products and activities because they are asked to pay attention to them on the job. Workplaces also introduce new practices and train behaviour, and this will likely spill over to private life and shape practices and norms at home. For example, recycling habits that are trained at work might be applied to private life and sustainable food information in canteens can lead to more sustainable eating at home (Verfuert et al., 2021). Studies suggest that habits are formed at work and translate into private life – not vice versa (Mira et al., 2013). Even being forced to participate in ecologically harmful activities at work can lead to an unwillingness to engage in pro-environmental activities in private life: For instance, when the environmental effects of a change of private lifestyles are perceived as negligible compared to the environmental impact caused during work-times, motivation for pro-environmental behaviour might be hard to keep up.

Engaging in environmentally harmful activities or brown tasks at work could even lead to profound cognitive dissonance. To reduce the psychological burden of cognitive dissonance, people that see no option to switch to more ethical jobs or change their activities at the workplace, might adapt their beliefs to anti-environmentalism, e.g. become climate delayers or deniers. Workplaces also influence employees' political beliefs as institutions of learning and information exchange. The

information and experiences made at work influence employees' perception of reality and thereby shape their voting behaviour. For example, the fear of losing one's job in the fossil sector can crowd out voters' wish to protect the environment, and the existential threat to keep one's job can trump people in an unbiased appraisal of what the government is supposed to do.

3.4. Outcome efficiency

3.4.1. Previous approaches

Noting that products largely vary in the amount of energy and resources required for production and the pollution the process causes, the sustainability of the production process gained more attention for assessing sustainable employment. The process perspective is raised by many researchers (Barth et al., 2019) and has been added to the statistical measurement of green jobs. For example, the US-American Bureau of Labor Statistics applies next to the output approach a "process approach, which identifies establishments that use environmentally friendly production processes and practices and counts the associated jobs" (U.S. Bureau of Labor Statistics, 2020). It assesses the differences in production technologies and is therefore applicable to all sectors of the economy – not only environmental goods and service sectors.

However, the existing approaches do not connect the level at which the environmental problems emerge (usually macro-level e.g. climate change) with the required change at the micro-level (e.g. firms, companies). Even the most efficient production method might not establish the required change needed to avoid environmental catastrophes. Only few environmental impacts constitute an environmental problem in itself (e.g. nuclear waste). Most only result in environmental problems when certain scales are transgressed (e.g. land use, GHG emissions). Existing process approaches miss the fact that the size of a sector and the economy matter for the environment.

3.4.2. Improved evaluation

Taking these considerations on board and integrating them into an improved measurement of the dimension requires that we assess the environmental impact of the production process in terms of the two societal functions it holds: to deliver the required goods and services to society (satisfiers) and to provide employment for workers (work hours). This results in two aspects: 1) The environmental harm of the production process per satisfier. The satisfiers measure the use-value of the product or services produced, taking into account the different lifespans of products. 2) The environmental harm of the production process per volume of employment provided. Although one can question whether organizing need satisfaction, such as access to health care, through (income from) employment is still adequate or whether we should seek post-work solutions (Hoffmann and Paulsen, 2020), currently for most people jobs are still a necessity, and socio-economic systems like welfare states depend on the employment volume.

3.4.3. Definition 4: Outcome efficiency

Sustainable outcome efficiency is given if the environmental harm per satisfier use caused in the production process is lower than the average for alternative production and, at the same time, the environmental impact per hour worked is up to the maximum ratio, for the country, of maximum allowed environmental harm and minimum desired employment volume. If the values are above the average harm-per-satisfier-ratio and beyond the maximum harm-per-work-hour-ratio, then outcome efficiency is unsustainable.

3.4.4. Implications

This approach to assessing the dimension has three implications: First, shifting jobs from sectors with a high environmental impact per hour worked e.g. manufacturing to sectors with lower impact e.g. services can green the economy. Dematerialization through services (Heiskanen and Jalas, 2000) and tertiarization (Horen Greenford et al.,

2020) can positively contribute to keeping employment within planetary boundaries. However, this is only the case if employment in green services replaces existing jobs and does not come on top of resource-intensive jobs. In the past, tertiarization has been a key element of economic growth and therefore failed to reduce environmental burden (Fix, 2019). Servicing is only beneficial to the environment when it takes place in resource-light sectors that are unconnected to resource-intensive sectors, e.g. care and culture, and if it replaces more environmentally harmful employment.

Second, adding up the hours worked their environmental impact allows us to calculate the theoretical length of a "sustainable workweek" (Frey, 2019). On average, work hours beyond that length contribute to overproduction. In practice, some sectors have higher impacts per hour worked than others (Hoffmann and Paulsen, 2020) and are hence less (environmentally) affordable. For example, one work-hour in education requires less energy and resource than in steel production. Servicing that replaces energy- and resource-intensive jobs can improve the situation, although the favourableness of service sectors depends on the value chains (Hardt et al., 2021). Society could even financially gain through a selective work time reduction for ecologically harmful sectors – even if they fully compensate workers for the hours not worked. This is the case when the environmental costs per hour worked exceed the hourly pay in that sector. In addition, this implies that if everyone should have access to a job, redistribution of work hours from the overworked to the underworked is required to keep employment within planetary boundaries.

Third, the indicators of the process dimensions also imply that increasing labour productivity constitutes a liability – not an asset – to a socio-ecological transition (Cieplinski et al., 2021). Empirical studies find a strong correlation between increasing labour productivity and a worsening energy-labour-ratio at the sectoral level (Hardt et al., 2021). This is not a coincidence: with labour being made relatively expensive and resources relatively cheap, profits can be best made by expanding the production through additional machines, not additional workers. This leads to higher energy and resource consumption for the production process while keeping or lowering hours worked. Therefore, several researchers promote lower labour productivity as a tool for full employment within the earth's carrying capacity (Mair et al., 2020).

4. Taxonomy of Sustainable Employment

The four dimensions comprise different aspects of the environmental sustainability of employment and assess it at different levels: occupation and work-lifestyles at the micro-level of a worker's job. Work outputs and outcome efficiency at the macro-level of companies or sectors. As each job unambiguously belongs to one company or sector, the evaluation for the macro-level can be assigned to the micro-level. Thereby, minimum requirements at the job level for the (un-)sustainability of employment in each dimension can be formulated (definition 1-4). By combining the four definitions as follows, the Taxonomy of Sustainable Employment is constructed which enables us to classify jobs as green, brown or mixed.

Taxonomy of Sustainable Employment

A job qualifies as a "green job" ["brown job"], ...

- 1 ... if it produces **sustainable work outputs** [unsustainable work outputs], else ...
- 2 ... if its task and activities make it a **sustainable occupation** [unsustainable occupation], else ...
- 3 ... if it does not inhibit [does inhibit] **sustainable work-lifestyle of the worker and its household**, else ...
- 4 ... if it entails a **sustainable outcome efficiency** [unsustainable outcome efficiency].
Otherwise, it is a "mixed job".

How the Taxonomy of Sustainable Employment links the definitions of the four dimensions to classify jobs as green, mixed, or brown is illustrated in Fig. 1. The decision system starts with analyzing workplace effects at the macro-level (1), continues counterclockwise with workplace effects at the micro-level (2) and socio-economic effects at the micro-level (3), and ends with socio-economic effects at the macro-level (4). Lexicographically, each step evaluates whether a job can already be categorized as brown or green by that dimension and otherwise continues with the next dimension. For work-lifestyle, promoting sustainable lifestyles is no sufficient criteria for a green job because employment is no prerequisite for sustainable lifestyles (see section 3.3). Some jobs do not meet any of the criteria and therefore neither qualify as green nor brown but remain a “mixed job”.

The categorical classification into green, mixed and brown jobs inevitably leads to information loss of nuances and causes of greenness and brownness within the dimensions. While the nuanced perspective helps identifying opportunities for greening employment, e.g. through labour market policies (Bohnenberger, 2022), the taxonomy is better suited for assessing sustainability transitions of labour markets or specifying political objectives.

Further research is required on how to translate the taxonomy into regionally specific indicators that take into account the local temporal and physical infrastructures, the remaining time scales to combat environmental crises, and the multidimensional nature of

environmental problems. Environmental harm covers several environmental impacts, e.g. energy consumption, GHG-emissions, water use, which entail thresholds at different levels (e.g. global, regional, local) and can be calculated differently by inclusion/exclusion of value-chain effects. The multidimensionality of environmental problems requires a careful selection of impact indicators. Previous approaches treated sectors in isolation but production also depends on input factors (upstream) and financial means flowing back from the sites of consumption (downstream). Considering value-chains is hence crucial to prevent greenwashing of jobs that only persist because dirty production processes were outsourced without changing the footprint of the products produced, or can only exist because they enable their clients to undertake environmental destruction.

While data availability for the two macro-dimensions (work outputs, outcome efficiency) might be better as it depends on rather uniform products/services or employment volume, large data gaps exist for the micro-level, particularly the activities at the workplace, time-use effects of employment, and habitual and political influences jobs. Instead of neglecting these dimensions when assessing the sustainability of employment, this gap can be seen as a research opportunity for acquiring systematic or case-study-based data.

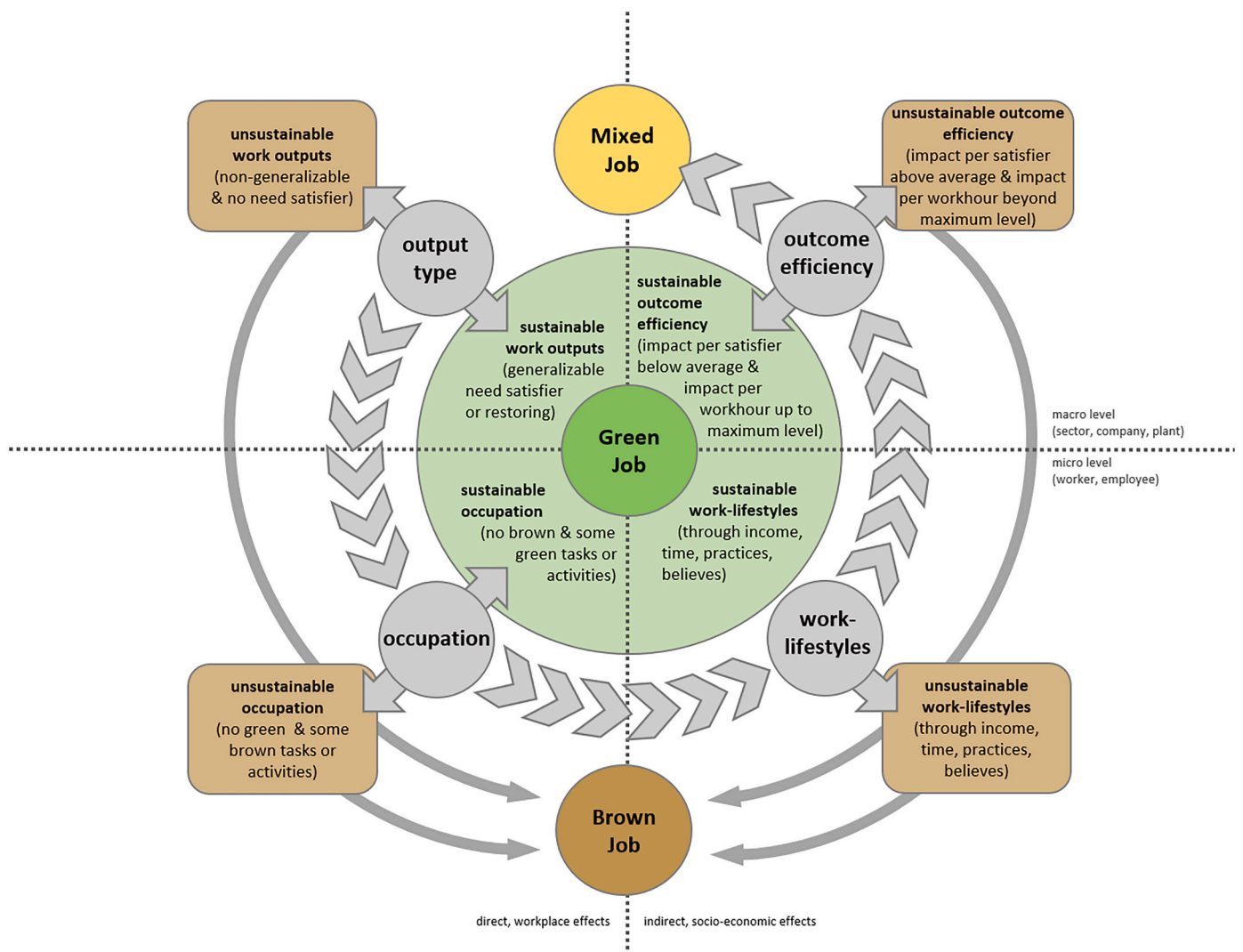


Fig. 1. Taxonomy of Sustainable Employment with decision system to classify jobs as brown, mixed, green.

5. Conclusions

This article explores the ecological sustainability of formal, paid employment. It identifies five theories of “jobs & the environment” and systemizes their proposals for assessing the sustainability of employment by the level of analysis (worker – company/sector) and the immediacy of the effect (workplace – socio-economic). For each of the resulting four dimensions (output type, occupation, work-lifestyles, outcome efficiency), the article discusses previous approaches and proposes an improved evaluation approach. Definitions for the four building blocks are provided and compiled into the Taxonomy of Sustainable Employment which enables categorization into green, mixed, or brown jobs. The four dimensions and the taxonomy can be used to assess the current (un-)sustainability of employment, to identify strategies for greening labour market policies or workplaces, and develop socio-ecological transformation scenarios. Further research is required to operationalize the taxonomy with quantitative indicators.

The article advances existing research, which depicted only selected aspects of sustainable employment, by developing a framework that tabulates the environmental effects of employment at all levels jointly. As a correct assessment of jobs requires that all relevant factors that determine the (un-)sustainability are taken into account, the multidimensionality provides a step to a more accurate outlook on the sustainability of employment. The new evaluation approaches for each of the four dimensions overcome shortcomings of previous approaches: By reference to needs theories, the definition of sustainable work outputs avoids misclassification and greenwashing of goods and services. The occupation approach extends the environmental effects from tasks to job-related activities which have been neglected so far. Considering mechanisms through which jobs shape the (un-)sustainability of lifestyles embeds employment into sustainable consumption patterns. Measuring outcome efficiency not in relative improvements but in reference to absolute limits of environmental harm, aspired employment volume, and use of products and services, ensures that the evaluation of the sustainability of employment meets the requirement of avoiding ecological collapse.

Measurement methods were so far almost entirely developed for identifying only green and not brown jobs. This is a major risk because planetary health will only be reached when green jobs are replacing, not added on top of, brown jobs. The article contributes to this transformation by proposing a taxonomy that identifies both green and brown jobs.

Identifying and overcoming jobs that require making one's living at the expense of future generations raise the quality of work by reducing the burden of performing socially useless or even harmful tasks. Recent numbers indicate that about a quarter of employees are either not sure or do not think their job is socially useful (Dur and Lent, 2019). Relieving people from the necessity of spending a large share of their lifetime on activities that destroy their livelihoods and enabling workers to transform their jobs into sustainable, responsible, and meaningful activities can thus advance decent work.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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