Oiconomy Pricing Scientific Justifications

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Contents

1. General Introduction

The Oiconomy Pricing system documents consists of:

- The Oiconomy Standard (O.S.), describing the system, included sustainability aspects, assessment criteria and measurement requirements. The O.S. contains the compliance criteria for certification purposes and guidance to the system.
- The Oiconomy Pricing Foundation Database (O.F. Database), containing all background data and assumptions.
- The Oiconomy Pricing Tool (O.P.T.), a questionnaire, guiding practitioners along all sustainable aspects and leading to the ESCU scores for the assessed product.
- This Science document, with explanation, scientific justification and references.

Oiconomy methodology

All aspects, including all product supply chain-relevant SDG's, are divided in 10 categories, together comprehensively comprising all PPP sustainability aspects and all product supply chain-relevant U.N. sustainable development goals.

As sustainability indicator, a virtual monetary unit is introduced, the "Eco Social Cost Unit" (ESCU) representing the cost distance to a fully sustainable product and equal to the prevention cost based externalities embedded in the product.
All ESCU scores are the product of a quantitative factor and a price factor.
The O.S. and O.P.T. guide the practitioner through all aspects and all stages of activities related to the product, requiring to determine their foreground quantitative aspect and challenging the practitioner to also determine the foreground mitigation price factor and expected mitigation percentage.
Mitigation data need to be based on demonstrable investment proposals or cost calculations.
For both the quantitative and price factors, the system provides background data, which are automatically allocated from the included database when demonstrable foreground data are lacking.

Background quantitative data are obtained from a wide range of globally available databases and science. The Oiconomy Pricing System is designed to gradually improve the background data from anonymized results from the system itself and scientific research.
Background data are determined by means of the following 5-step procedure, derived from the EcoCost methodology (Delft University of Technology, 2022) (https://www.ecocostsvalue.com) and described in (Croes & Vermeulen, 2015):

1. Definition of the impact category or subcategory considered, together with the characterization factor, the indicator characterizing the relative weight within the category.
2. Determination of the specific standard or target to be achieved.
   a) Assessment of available effective international standards and conventions, based on international standards or no-effect levels.
   b) Without such effective international standard or no-effect level, 80% reduction of the issue (relative to 1998 conditions) or, if concrete measurement of that reduction level is not feasible, at the benchmark made by the average level or methods or practices of the 20% best performers (usually countries).
   c) Where no such concrete target can be defined, the distance to perfect governance on the aspect, from which a Reducing Multiplication Factor (RMF) is calculated, which is applied to a worst case. The method for the determination of the RMF was developed for the aspect of

corruption (Croes & Vermeulen, 2019) and is based on a range more than 60 criteria derived from generally recognized management certification standards such as ISO 22000, ISO 14040 and ISO 45001 (ISO, 2005, 2006, 2018).
Because in a series of real case test rounds in volunteering companies, this proved too difficult for small and some medium sized (SME's), separate shorter, simpler and more aspect specific questionnaires were developed. The O.P.T. directs large companies and companies with experience with good management standards to the complete questionnaires and SME's to the more simple questionnaires.
All questionnaires consist of 4 sections, divided in Plan – Do – Check – Act criteria. The scores of the 4 sections are multiplied, leading to a complete assessment (e.g. with a zero score on the management review (demonstrable top management commitment), the worst case remains assumed).

Background data provided by the O.F. are as much as possible based on global targets. For each individual actor, the foreground data must be based on the zero impact target (local and global).

3. An inventory of the major available preventative measures.
4. Determination of the costs and net effects of the available preventative measures and sorting these by the costs per one unit of the characterization factor, with the lowest on top.
5. Assessment of which preventative measures are required to globally reach the target starting from the top of the cost-sorted measures. The last and most expensive preventative measure to be employed shows the marginal preventative costs. ESCU's for issues with location dependent impact, the highest costs of major preventative measures, multiplied with a reducing impact dependent multiplication factor is allocated.

Marginal preventative costs for are depicted in figure 1.

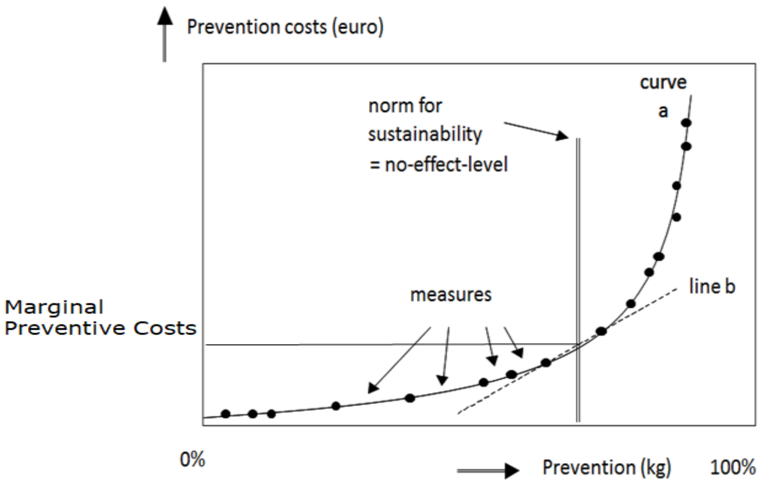

Figure 1. Marginal Preventative costs - EcoCost system (Vogtländer, Bijma and Brezet, 2002, p.60).

Curve a in figure 1 presents the costs of the available preventive measures from low to high costs. From an economic point of view, the cheapest measures for prevention of emissions are taken first and the most expensive last. At crossing point with the line for the no-effect level enough measures are employed to achieve the necessary impact mitigation indicating the "marginal preventative costs". Although the developers of this system, only took Dutch and European marginal costs into account, the Oiconomy Pricing Tool considers these globally applicable, justified by the following arguments:

- Where the Ecosystem only works with background price factors, the O.P.T. gives practitioners the opportunity to demonstrably present their foreground price factors.
  Companies especially are challenged to calculate their specific foreground data, e.g. by investment calculations, as the first step of actual implementation of the
- Developing, low-income countries gradually evolve to high cost countries.
- Preliminarily, most of the considered supply chains are ending at high income countries' consumers.

2. Category: Pollution and Climate.

2.1 Introduction

Although the climate aspect is usually considered separately and often even presented as the only sustainability issue to be addressed, in the O.S., the warming potential is considered as only one aspect in the category of pollution.

Polluting emissions may occur in four separately covered stages, all covered by the O.S.: 1: From organizations' operations, 2: As industrial waste; 3: As result of the use of the product and 4: At end-of life disposal.

Category related Sustainable Development Goals

Goal 3: Ensure healthy lives and promote well-being for all at all ages.
Goal 7: Ensure access to affordable, reliable, sustainable and modern energy.
Goal 13: Take urgent action to combat climate change and its impacts.
Goal 14: Conserve and sustainably use the oceans, seas and marine resources.
Goal 15: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.

Subcategories:

The aspect of **Pollution** is divided in 5 subcategories: Types A,B,C,D and E (see below for further details).

- Type A: Emission of bulk gasses (including fine dust) , causing issues like climate change, acidification and eutrophication.
- Type B: Hard to measure agricultural emissions.
- Type C: Quantitatively measurable chemical emissions.
- Type D: Thermal Pollution, limited to organizations in power production.
- Type E: Incident caused emissions.
- Use-Pollution

This LCA- aberrant subcategorization was developed to enable foreground assessment of preventative costs for all causes of pollution.
In addition, here discussed is the category of **use-pollution** by emissions caused by the use of the product.

Characterization factor

All data on polluting emissions are obtained from the EcoCost/Value system. Justification for the data can be found in (Delft University of Technology, 2022). ESCU's for pollution are equal to EcoCosts.

EcoCosts represent the marginal preventative costs for the impact as characterized by a leading indicator. Every midpoint (or subcategory) is characterized by one leading indicator. For this leading indicator, the same 5 step procedure is followed as described above. The EcoCosts for all other emissions within the subcategory are determined by the product of the EcoCosts for the leading indicator and the impact-based characterization factor of the concerned chemical. As an example, the EcoCost of emission of methane are calculated as about 30,5 times the EcoCosts of CO_2. In practice, preventative costs of CH4 emissions may be different, because very different preventative measures are required. This is one of the reasons that the O.S. challenges the practitioner to determine the product specific (foreground) preventative measures and -costs for impact mitigation.

EcoCosts are available for emissions of individual chemicals, but also for a large range of materials in the Idemat-database. If no quantitative data are available or if even the supplier or country is unknown, the O.P.T. uses data from the Idemat database. The practitioner loses the possibility to correct for double counting preventative costs for pollution and depletion (see O.S. 12.2.13 and O.P.T.-sheet Def-Instr. – I 10).

Background data

- Two types of background data are available.
  All-background data: For materials from unknown or not cooperating suppliers, for which neither quantitative nor price- data are available, all-background ESCU's for emissions are available, obtained from the EcoCost – Idemat database www. ecocostvalue.com.
- Background price data. Where data on emission quantities are available, but no foreground prevention costs, calculations are based on foreground emission quantities and background price factors from the EcoCost system

Foreground data

ESCU calculations are based on foreground emission quantities and foreground price factors.
If the expected mitigation is lower than 100%, for the remaining emissions, the background price factors are used.

2.2 Subcategory: Type A Pollution: Bulk Gasses & Climate change

Introduction

Bulk emission of gasses is the major cause of various issues, such as climate change, acidification, eutrofication, ecotoxicity, human toxicity and smog.

Indicators

The characterization factors and leading chemicals are used following the EcoCost system. (Be aware: the EcoCosts and background ESCU's of for instance CH4 are calculated as 30,5 times the impact of the same amount of CO2. Only foreground data can provide the real product- and emission-specific ESCU's for CH4 mitigation).

The leading indicators are based on the impact of the following chemical emissions:

Global Warming Potential – CO_2
Acidification – SO2
Eutrophication – Phosphate
Ecotoxicity – Zn
Winter Smog – Dust (2,5mm)

Summer Smog – Ethene, CxHx
Human toxicity - Carcinogens – PAH

The following list of gaseous emission is considered.

CO_2 (carbon dioxide)
CFC's (Chlorofluorocarbon compounds)
NH_3 (Ammonia)
NO_x or NO_2 (Nitrogen dioxide)
NO (Nitrogen monoxide)
N20 (Dinitrogen monoxide)
SO_2 (Sulfur Dioxide)
CO (Carbon monoxide)
Lead
Mercury
Methane
Particulates < 10 um (mobile source)
Particulates < 10 um (stationary source)
Particulates < 2,5 um
Carcinogenic particles
Radioactive particles
Non carcinogenic Volatile Organic Compounds (VOC's)
Other gaseous substances

Targets

Internationally determined no- (or acceptable-) effect levels

Background calculations

Following the EcoCost system, all chemicals are measured by the product of the preventative costs of the leading indicator for the issue and the impact based characterization factor for the specific chemical (the relative impact compared to that of the leading indicator). ESCU's are calculated by:
ESCU's = $\sum$ (Qc x $EcoCosts_c$), where:

$\sum$ is the sum of all the following for all emitted gasses.
Qc is the quantity of the emitted chemical per unit of product.
$EcoCosts_c$ is the background Ecocosts for the chemical.

Note that in the O.S., where a gas emission affects several aspects, the highest costs of prevention was taken instead of the aggregate for all affected aspects, because for gaseous emissions the prevention is almost always mitigation of the emission itself, affecting all aspects by the same prevention measure.

Global Warming – CO2

The calculation of the 0.116 euro/kg CO is based on the replacement of electricity by a coal fired power plant, by renewable energy from an offshore wind farm as marginal measure.
For the eco-costs 2022, the results of a tender for the Dutch 'Borssele 1+2' windfarm (94 windmills of 8 MW) were taken as a norm: 7.27 euro cent per kWh excluding the electricity cable to the shore. For 'Borssele 1+2' the costs of the cable is 1.4 euro cent per kWh. Since the future windfarms have more than double distance to the coast, a price norm for the connection to the shore is set to 2.8 euro cent per kWh. Therefore, the costs of this type of renewable electricity is 10.07 euro cent per kWh. The

Danish ‘Horns Rev3’ windfarm costs 10.30 cents per kWh. This electricity is supposed to replace electricity from a coal fired power plant. The marginal costs of electricity from coal is estimated at 1.40 euro cent per kWh (derived from 55 euro per ton coal and an efficiency of a modern power plant of 45%). The CO_2 emissions are 0.75 kg/kWh. This results in (0.1007 – 0.0140) / 0.75 = 0.116 euro/kg CO_2.

Note 1. For nuclear power, see the section on electricity.

Note 2. The intention of the O.P.T. is that also energy suppliers provide their foreground ESCU’s.

Acidification - SO2

The eco-costs 2022 of acidification: 8.75 euro / kg SO_2 equivalent (= 6.68 euro / mol H^+ eq). These eco-costs are related to the current revealed preference of Ultra Low Sulphur Diesel Production in the EU of 10 ppm. For acidification, the latest development of diesel desulphurization has been applied as revealed preference which costs 0.036 $/gal from 600 ppm -> 5 ppm.
This stems from 0.0104 euro per kg diesel (1 gallon = 3.785 litre, 1 litre = 0.83 kg, 1.13 US$ = 1 euro) for 0.595 g Sulphur per kg diesel, resulting in 17.51 euro per kg Sulphur or 8.75 euro per kg SO_2.

Eutrophication - Phosphate

The eco-costs 2022 of eutrophication: 4.70 euro / kg PO_4 equivalent (= 14.40 euro / kg P eq).
These eco-costs of eutrophication in water are related to the costs of sustainable manure treatment. The price in the EU is about 4.7 euro/kg PO_4.
Note: To avoid double counting, the lowest of acidification and eutrofication impact of NH_3 and NO_2 emissions in air and water have been set to zero.

NH_3 via air is allocated to eutrophication due to the big issue of eutrophication of protected natural areas in EU. The marginal prevention measure for NH_3 is an air scrubber for cattle stables; the prevention costs are 17.2 euro/kg NH_3 (De Pue, 2019).

NO_x in air is also allocated to eutrophication. The prevention costs of NO_x through air scrubbers is 6.37 euro per kg, because of the molecular weight ratio of 2.7 for both substances.

<u>Ecotoxicity - Cu</u>

The eco-costs 2022 of ecotoxicity: 340 Euro/ kg Cu equivalent.
The ‘leading indicator substance’ (the most important emission in the list) is Copper, since the emissions of Copper in our society and its ecotoxicity are quite high.
The prevention costs were 55 euro / kg Copper, derived from the water treatment costs in big municipal water treatment facilities. The water treatment costs of smaller industrial systems are, however, a factor 6 higher (Bijstra et al. 2018).

Photochemical oxidant formation ("Summer Smog") – Ethene, CxHx

The eco-costs 2022 of summer smog: 5.35 Euro/ kg NO_x equivalent = 9.08 euro/kg C_2H_4 eq.
NO_x emissions (primarily from cars and trucks) and Volatile Organic Compounds (VOC) from the chemical industry are the main causes of Summer Smog.
There is a revealed preference now for NO_x emissions (the last, and most expensive measure of the prevention curve) related to new strict norms in Europe for reduction of NO_x emissions by cars (and trucks) in cities: Euro 6D. The revealed preference is that all vehicles should have AddBlue Selective Catalytic Reduction (SCR) filter.

For an average middle class European car (e.g. Opel Insignia or Peugeot 508) the prevention of these emissions requires injection of 1 litre AdBlue (32.5% urea in demineralized water) per 1000 km. The costs of AdBlue at a fuel station is 60 euro cents, so the prevention costs is 0.6 / (0.18×4.0x0.9) = 0.92 euro per kg NOx, where 0.9 is the filter efficiency. For background information on the factors 0.18 and 4.0, see (Baldino et al 2017). The investment costs of the filter itself is estimated at 1750 euro (AutoBild 2019). When we assume a life span of 250.000 km , an amount of 0.65 x 250 = 162 kg NOx is reduced, resulting in prevention costs of 1750/162 = 10.80 euro per kg NOx. The SCR filter plus the AdBlue has 10.80 + 0.92 = 11.72 euro/kg NOx prevention costs in total.

Avoiding double counting:
We have to allocate the 11.72 euro per kg NOx to 2 midpoints: eutrophication (see above) and summer smog. In eutrophication the contribution is 6.37 euro per kg NOx. So 11.72 – 6.37 = 5.35 euro per kg should be allocated to summer smog.

Winter smog - Dust (2,5mm)/Fine dust PM 2.5

The eco-costs 2022 of fine dust PM 2.5: 35 euro / kg fine dust PM2.5 equivalent.
The PM2.5 midpoint data are from the UNEP/SETAC report (Fantke et al., 2016).

The factor of 35 euro / kg PM 2.5 equivalent has been based on data for fine dust filters of cars (case: Volvo V70), and the jump from Euro 3 to Euro 5. The emission reduction is 0.05 g/km, with a life time of 300.000 km. The price of a filter is 525 euro.

Human toxicity (cancer and non-cancer)

The eco-costs 2022 of human toxicity, **carcinogens**: 3754 Euro/ kg Benzo(a)pyrene equivalent.
The eco-costs of human toxicity is characterized the DALY (Disability Adjusted Life Years), where 1 Case for cancer in the UseTox Tables equals 11.5 DALY.
In medical science, the DALY is used to make comparisons in terms of prevention costs.
Although the DALY cannot be used as tool for medical decision making on the level of the individual patient (Cleemput et al., 2011), it is often used for general guidance for higher level policy decisions.
For medical cure in hospitals, such as the price of a kidney dialysis, Zorginstituut Nederland (2015) proposes 80.000 euro per DALY in the Netherlands, see also (Mohnen et al. 2019) for costs of kidney patients.

Applying the factor 11.5 DALY per Case and 80.000 euro/DALY to the tables (11.5 x 80.000 = 920.000 euro per DALY), you will find 3754 Euro/ kg Benzo(a)pyrene equivalent.

The eco-costs of human toxicity, **non-cancer**: 25500 euro/kg Mercury.
This is also based on the DALY, where one case of illness in the non-cancer UseTox tables is equivalent to 2.5 DALY (2.5 x 80.000 = 200.000 euro per DALY)

Foreground calculations

These must always be based on demonstrable foreground quantitative emission data.
Without a foreground determination of the price factor, the ESCU’s are calculated as the product foreground Quantity and the O.P.T. provided background price factor.
A foreground price factor must be based on a demonstrable investment or cost calculation of impact mitigation for the specific product, including a realistic expectation of the percentage of impact mitigation. For the remaining impact, the O.P.T. allocates ESCU’s based on the EcoCost system based

background price factors.
The foreground ESCU's are calculated with the following formula:
ESCU's = $\sum$ (Qc x ($EM\%_c$ x MC_c + (1- $EM\%_c$) x $EcoCosts_c$), where:

$\sum$ is the sum of all the following for all emitted gasses.
Qc is the quantity of the emitted chemical per unit of product.
$EM\%_c$ is the Expected mitigation % of the chemical.
MC_c is the foreground costs to achieve the expected mitigation %.
$EcoCosts_c$ is the background Ecocosts for the chemical.

2.2.1 Electricity

Introduction

The emissions from power generation differ considerably in the different countries, depending on the mix of power sources and the quality of the power distribution network.
Country specific data for average emissions per KwH from the net were taken from the Idemat_2021_Global_Electricity_Calculation to ESCUs 2022 database at www. ecocostvalue.com. For country unknown, worst case is assumed. Indonesia has the highest ESCU's of the top power using countries together generating 80% of global electricity.
Nuclear energy presents both opportunities and threats. Scientific assessment without emotions is virtually impossible. An international body controls the development and use of nuclear technology. Although nuclear power mitigates GHG emissions and present a temporary solution in a time of a climate crisis, nuclear energy remains unsustainable and therefore, nuclear obtained KwH's are assumed and allocated equal ESCU's to CO2 emission-based KwH's, because also nuclear power has the same preventative measures for GHG emissions as fossil fuels.

Indicator

See directly under Subcategory: Type A pollution.

Targets

Scientifically determined no-effect levels

Background calculations

Country specific data for average emissions per KwH from the net were taken from the Idemat_2021_Global_Electricity_Calculation to ESCUs 2022 database at www.ecocostvalue.com.

For country unknown, the worst case is assumed Indonesia. Indonesia had in 2022 the highest ESCU's of the top power producing countries together generating 80% of global electricity production (KwH's).
Not included yet in the O.P.T. are the power losses at charging and recharging batteries. In the database, a 10% extra ESCU's is assumed.

Foreground calculations

Every organization should be able to demonstrate its power consumption. An unknown power consumption is not accepted by the O.P.T. If the distribution of the total power consumption of a specific product between several products, is unknown, the ESCU's are divided between the products relative to their financial share in the organization's turnover.
Organizations are challenged to determine the specific price factor for their power consumption, e.g. considering:

- Requiring the power supplier to adopt the O.S. and transfer its specific ESCU's.
- Investigate other power suppliers.
- Determine costs self production of renewable power (including distribution and storage).
- Determine all options and costs to mitigate its own power consumption in its specific circumstances.

For power suppliers, the O.P.T. uses the same formula as for bulk gas emissions:
ESCU's = $\sum$ (Qc x ($EM\%_c$ x MC_c + (1- $EM\%_c$) x $EcoCosts_c$), where:
$\sum$ is the sum of all the following for all emitted gasses.
Qc is the quantity of the emitted chemical per unit of product.
$EM\%_c$ is the Expected mitigation % of the chemical.
MC_c is the foreground costs to achieve the expected mitigation %.
$EcoCosts_c$ is the background Ecocosts for the chemical.

For users of power the calculation formula is:
ESCU's = KwH x (EM% x MC + (1- EM%) x $EcoCosts_{country}$), where:
KwH is the amount of kilowatthours per unit of product.
EM% is the expected mitigation %.
MC is the costs to achieve the expected mitigation %
$EcoCosts_{country}$) is the country specific EcoCosts per KwH, provided by the system.

2.2.2 Fuels (industrial use)

Introduction
Burning fossil fuels is globally the largest contribution to global warming. Oil and gas are used in almost every industry, transport; burning of coal power generation is responsible for around 46% of total carbon emissions. Major emitting sectors are (in sequence of quantity): Power generation, transport, manufacturing and construction, buildings and land use change and forestry. (https://ourworldindata.org/emissions-by-sector).
Fossil fuels not only cause climate change by emission of CO_2, but also by emission of methane during their extraction. In addition, burning fossil fuels contributes to acidification and smog by emissions of sulfur- and nitrogen compounds and to eutrofication by emission of ammonia.

Indicator
See directly under Subcategory: Type A pollution.

Targets
Zero emissions

Background calculations
Without a foreground price factor, foreground fuel quantities are multiplied with the system provided ESCU's.
If the distribution between various products of the total fuel consumption of a specific product is unknown, the ESCU's are divided between the products relative to their financial share in the organization's turnover.

Background ESCU's for all commonly used fuels were taken from the Idemat database (Delft University of Technology, 2022). The ESCU's **represent** the total life cycle of fuels including combustion as purchased by the organization.

Foreground calculations

Organizations are challenged to determine the specific price factor for their emissions by fuel burning, e.g. considering:

- Requiring the fuel suppliers to adopt the O.S. and transfer its specific ESCU's.
- Investigate all options to minimize emissions by using the fuels by taking into account both the fuel properties and the used equipment.
- Investigate different fuel suppliers.
- Investigate the use of different fuels, or better change to renewable fuels (including distribution and storage).
- Determine all options and costs to mitigate its own fuel consumption in its specific circumstances.

2.2.3 Commuting

Introduction

Transport globally accounts for about 24% of global CO2 emissions, of which around 45% is by personal road traffic (https://ourworldindata.org/co2-emissions-from-transport), more than half of which is work related by commuting and business trips (Sutton-Parker, 2021).

Indicator

Emissions of CO2 + NOx +SO2

Targets

Zero emissions

Background calculations

The ESCU's for commuting were calculated by multiplication of the average emissions per km for transport means (Otten et al., 2015) and the EcoCosts for emissions at Idemat_2021_Global_Electricity_Calculation to ESCUs 2022. The background commuting distance was calculated as the average commuting distance per day in 13 countries, as reported by (Eurostat Statistic Explained, 2021), multiplied by 233 (working days).
Assumed was (worst case) that all commuting occurs with an average petrol car.

Foreground calculations

Organizations are challenged to demonstrate an accurate bookkeeping of the kilometers and transport means made by their workers for commuting. This can be done by only enter the travelled distances and transport means. The tool will than multiply the travelled distances by an average emission for the transport means. But the organization can also determine the costs for means to mitigate commuting emissions.

2.2.4 Business trips

Introduction:

Transport accounts for about 24% of global CO2 emissions, of which around 45% is by personal road traffic (https://ourworldindata.org/co2-emissions-from-transport), more than half of which is work related by commuting and business trips (Sutton-Parker, 2021).

Indicator

Emissions of CO2 + NOx +SO2

Targets
Zero emissions

Background calculations:
The ESCU's for business trips were calculated by multiplication of the average emissions per km for transport means (Otten et al., 2015) and the EcoCosts for emissions at Idemat_2021_Global_Electricity_Calculation to ESCUs 2022. The background business trip distance was calculated as the average commuting distance per day in 13 countries, as reported b y (Eurostat Statistic Explained, 2021), multiplied by 233 (working days).
Assumed was (worst case) that all business trips occur with an average petrol car.

Foreground calculations:
Organizations are challenged to demonstrate an accurate bookkeeping of the kilometers and transport means made by their business trips. This can be done by only enter the travelled distances and transport means. The tool will than multiply the travelled distances by an average emission for the transport means. But the organization can also determine the costs for means to mitigate commuting emissions.

2.2.5 Transport of goods

Introduction
Transport accounts for about 24% of global CO2 emissions, of which around 42% is for transport of goods (freight) (https://ourworldindata.org/co2-emissions-from-transport).

Indicator
emissions of CO2 + NOx +SO2

Targets
Zero emissions

Background calculations
Without foreground price factors, the number of "tonkilometers" is multiplied by the EcoCosts for emissions for the specific transport means, both at Idemat in (Delft University of Technology, 2022). (Partly) empty return trips shall be included.
Without demonstrable distances, worst case distances and transport means shall be determined and entered in the O.P.T.

To account for differences in "last mile" transport (conventional retailing compared online to retailing), online retailers are required to enter their specific transport data and conventional retailers are requested to determine the average transport data for their consumers. Consumer km's heavily depend on shopping behavior. The default value for supermarkets and similar shops are based on averages of a roundtrip with petrol car of 5 km and a shopping basket of 30 items, and for other shops of a roundtrip of 12,5 km and a shopping basket of 1 item. Data were obtained from (Van Essen et al., 2011; Van Loon et al., 2015).

Foreground calculations
Organizations are assumed and otherwise challenged to be able to demonstrate freight tonkilometers. Organizations are also challenged to determine their costs of mitigation of freight

caused emissions, e.g. by more efficient logistics, low emitting transport means, routes, packaging and product size, transport means, delivery times, load factors, cooperation, reducing returns, etc.).

Idemat indicates the average weight to volume factor (and therewith the average payload) where the data for the listed transport means are based on. However, average payloads may differ from the Idemat listed data. For foreground average payloads, the following ESCU correction applies:

Relative to the average calculated payloads in the closest applicable transport means in the Idemat selection box (included in the O.P.T.) the closest transport means to the used means, the following correction calculation is applied:

Corrected ESCU's = ESCU's x (FAP – IAP)/ 0,7, where:
FAP is the foreground average payload in tons.
IAP is the Idemat listed payload in tons.
0, 7 tons is the payload difference (positive or negative), that causes a 1% difference in fuel economy (Coyle, 2007; Volvotrucks.nl, 2020). Although this calculation only applies to trucks and only for flat journeys in well developed countries, preliminarily the O.P.T. applies it for all means of transport of goods under all circumstances.

2.2.6 Subcategory Use-Pollution

Introduction

Products may cause emissions during their use by:

- Running on electricity
- Running on fossil fuels
- By wear, leakings or evaporation
- By consumption parts (batteries, lubrication oils, replacement parts, washing soaps, paint protective coatings or other chemicals)

The use-sections of the Oiconomy Pricing Tool only request foreground data and only need answered by end-producers.

Indicator

See directly under Subcategory: Type A pollution

Targets

Zero emissions

Background calculations

The properties of a utensil are the determining cause of future pollution. The higher the pollution per time or distance unit of use and the longer the product life, the higher the future pollution.
Therefore the ESCU's caused by the use of a utensil is calculated by the foreground emissions per time- or travelled distance unit, multiplied by the product life and multiplied with the background price factors for the emissions obtained from the EcoCost system (Delft University of Technology, 2022).
Important here is to realize that the product is the utensil, for instance a car, which gets its total lifetime ESCU's for burning fuels allocated. However it that product (the car) becomes a capital good for business purposes (covered by the sections on transport), ESCU's are only allocated for the emissions by the transport related to that other product. This prevents double counting.
In this stage of the O.P.S., most capital goods are not yet included. If, in the future, capital goods are

included, the allocated use-ESCU's must be allocated, depreciated proportionally to organization's financial depreciation methods. However, in that case double counting of pollution ESCU's will become an issue and requires a compensation.

Currently, there are not enough data on use related emissions to create background data for the quantitative factor (emissions per time- or distance unit) on a reasonable amount of products or even product categories.
However, because the use phase of a product is the responsibility of the end-producer, there are no unknown suppliers involved and therefore, the end producers should be able to provide the data and not being able to demonstrate these consequences of the product is not acceptable.

Foreground calculations

As argued above, foreground quantitative data should always be available.
The organization is challenged to also determine methods for product-use emission mitigation and the demonstrate the involved costs, in order to be able to calculate fully foreground ESCU's.

2.3 Subcategory: Type B Pollution - Hard to measure agricultural emissions

Introduction

In agriculture, it is sometimes very difficult or even impossible to measure the exact emissions of added or created chemicals to water, air and soil. In this case, the third part of the methodology applies: determination of the maximum emissions with a governance dependent reducing multiplication factor.

Indicators

The maximum emissions are determined by the quantity of purchased chemicals or by the maximum created chemicals (e.g. ammonia). These are multiplied by the price factor from the EcoCost system (Delft University of Technology, 2022).
Emission impacts are categorized in the following categories and characterized by their relative impact compared with the impact of the leading indicator for the impact category and listed below next to the impact category.

Global Warming Potential – CO2
Acidification – SO2
Eutrofication – Phosphate
Ecotoxicity – Zn
Winter Smog – Dust (2,5mm)
Summer Smog – Ethene
Carcinogens – PAH
Summer Smog – CxHx

In this case, it is not possible to replace the background data by foreground data, because even the emission quantities are unknown.

Targets

Zero emissions or no-effect levels or in this case perfect governance of emission prevention.

Background calculations

If quantitative emission data are lacking, but the nature of the potentially emitted chemicals known, e.g. because they are (almost) impossible to measure, but quantities of purchased agri-chemicals are available, the ESCU's are determined by the total purchased quantities of agri-chemicals, multiplied with a reducing factor for the governance level on prevention of emissions. Without any proof of good governance and due diligence in preventing emissions, the full quantity of purchased amount of chemicals is assumed emitted. As better governance can be demonstrated, the ESCU's are reduced. All-background ESCU's, allocated if even data on purchased agri-chemicals are lacking (e.g. because un unknown supplier is concerned) are obtained from the Idemat database: agricultural products, which is integrated in the O.P.T. This situation is unwanted and continuous pressure should be exercised on suppliers to involve the further tier suppliers and provide ESCU's.

Foreground calculations

In principle, foreground data are not available for category B pollution
All organizations are challenged to analyze their specific emissions and determine their specific costs to mitigate the emissions related to the product and provide, which will place the emissions in the subcategory of type C -emissions.

2.4 Subcategory: Type C Pollution - Measurable chemical emissions

Introduction

The subcategory Type C Pollution assesses the measurable chemical emissions. Some of these are not easy to measure, such as what leaves the chimneys, but usually specialized bodies of analyses are able to measure the types and quantities of emitted chemicals, which shall be executed at average conditions, at least yearly and at process changes that may alter the emissions.

Indicators

The quantity of emissions in water, soil and air of all chemicals listed in the system, per unit of product. The maximum emissions are determined by the quantity of purchased chemicals or by the maximum created chemicals (e.g. ammonia). These are multiplied by the price factor from the EcoCost system (Delft University of Technology, 2022).
Emission impacts are categorized in the following categories and characterized by their relative impact compared with the impact of the leading indicator for the impact category and listed below next to the impact category.

Global Warming Potential – CO2
Acidification – SO2
Eutrofication – Phosphate
Ecotoxicity – Zn
Winter Smog – Dust (2,5mm)
Summer Smog – Ethene
Carcinogens – PAH
Summer Smog – CxHx

Targets

International standards or no-effect levels.

Background Calculations

If emitted quantities are availabe, ESCU's = Q x P, where Q is the quantity of the emitted chemical per unit of product and P is the price to be calculated, equal to the EcoCosts per unit of emitted chemical. The EcoCosts system (Delft University of Technology, 2022), integrated in the O.P.T., provides background data for a wide range of chemicals, which are based on the relative impact compared with the impact of the following leading indicators for the impact categories:

For lacking emitted quantities, e.g. from an unknown further tier supplier, the O.P.T. provides Idemat based background data. This situation is unwanted and continuous pressure should be exercised on suppliers to involve the further tier suppliers and provide ESCU's.

Foreground Calculations

Because applications and conditions differ and because the background values are not based on the prevention of the specific chemical, the specific preventative costs may differ. The practitioner is challenged to investigate the foreground costs of prevention and use these if available and demonstrable.

2.5 Subcategory: Type D Pollution (thermal pollution)

Introduction

Thermal pollution of water does have various impacts. It may for instance affect the biodiversity, oxygen content, microbial growth, fishery, and indirectly water depletion. (El-Sharkawi, 2021; Vallero, 2011)

For thermal pollution of water, no background ESCU's values are yet available.
Currently, this aspect is not included in the Oiconomy Pricing Tool.

Indicators

N/A

Targets

N/A

Background calculations

N/A

Foreground calculations

N/A

2.6 Subcategory: Type E Pollution (incident caused pollution)

Introduction

Type E pollution is caused by emissions at incidents. Companies need as much as possible to prevent incidents and prevent emissions if these still occur. The risks highly depend on the character of the present materials and processes, knowledge of the potential risks and the quality of incident risk management. Therefore, the ESCU's for this subcategory are calculated based on the governance level of preventing incident caused emissions.

Indicators

Emission impacts are categorized in the following categories and characterized by their relative impact compared with the impact of the leading indicator for the impact category and listed below next to the impact category.

Global Warming Potential – CO_2
Acidification – SO_2
Eutrofication – Phosphate
Ecotoxicity – Zn
Winter Smog – Dust (2,5mm)
Summer Smog – Ethene
Carcinogens – PAH
Summer Smog – C_xH_x

Targets

Zero emissions

Background calculations

The ESCU's are calculated as the ESCU's maximum preventative costs, multiplied by a governance level based reducing factor. Currently, only a preliminary background ESCU calculation is included in the Oiconomy Pricing Tool, based on the following reasoning:

"Fire is one of the highest and most polluting incidental risks. Investment and maintenance costs of sprinklers are on average about 3,5% of capital costs () although highly varying by sector. Depreciation costs are within a range of 1,0 - 17,7% of the turnover with an average of 3,5%, which results in prevention costs of 0,014% of the turnover, assuming an average 0,4% capital costs contribution to the product price.

Foreground calculations

Organizations are challenged to make an inventory of potential incidents, their consequences and potential methods to prevent incidents and minimize their consequences if they still might happen. Although the nature of incidents is usually difficult to predict, sometimes risks can be mitigated and preventative costs calculated. (e.g. for driptrays under tanks or an own fire brigade).

3. Category: Depletion.

Introduction
By current mass production and consumption without recycling, materials are depleted.
Minerals are often available in the earth crust in abundance, but growing ever more expensive as the easy extractions are depleted.
Products from nature are depleting vegetable- and animal species.
Almost all types of fresh water resources, like glaciers, rivers and groundwater are depleted especially in dry area's but recently also in other areas, by both too high extraction and by pollution.

Category related Sustainable Development Goals
Goal 2: End hunger, achieve food security and improved nutrition and promote sustainable agriculture.
Goal 7: Ensure access to affordable, reliable, sustainable and modern energy.
Goal 12: Goal 12: Ensure sustainable consumption and production patterns.
Goal 15: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.

Materials are depleted by the use of virgin materials, which is the considered aspect in this subcategory. The target for depletion is zero loss of scarce materials. In addition, uncarefully disposed, the materials may become litter or pollute land, water or air systems, which is the issue in the waste/disposal category. The target for waste/disposal is zero litter and pollution by waste materials.
The aspect of depletion is closely related to the aspect of waste and disposal. One of the major preventative measures against depletion is reuse, refurbishing and recycling, but considered must also be the required processes and transport involved in these processes.

Subcategories
The category of depletion is divided in three subcategories

1. Solid materials (minerals, botanical materials, animals)
2. Fresh water
3. User-depletion, considering the depletion of materials caused by the use of the product.

3.1 Subcategory: Minerals, botanical materials, animals

Introduction
For all scarce materials, except for water and endangered animals, the background data for depletion are obtained from the EcoCost/Value system. Justification for the data can be found in (Delft University of Technology, 2022). ESCU's for pollution are equal to EcoCosts.
The Oiconomy Pricing Tool (O.P.T.) considers waste/end-of-life separately. The aspect of depletion considers the extraction of virgin scarce materials and the aspects of waste and end-of-life consider littering, loss of value and uncontrolled destinations of the materials. These aspects together make a measure of circularity.

Characterization factor and Indicator

The impact category is depletion of scarce materials, the characterization factor the economic price and the indicator the amount of used virgin scarce material.

Targets

Zero depletion.

Background calculations

The EcoCosts for depletion are equal to the market value of the extracted material, and therefore increases with the scarcity of the material and the ESCU's are calculated as:
ESCU's = $(Q_m - Q_R) \times P_m + RC$, where:

Q_m is the quantity of virgin (and therefore freshly extracted and withdrawn from the earth's/nature's supply) material used in one unit of product.
P_m , the price factor, for metals and most other materials taken from the EcoCost system (Delft University of Technology, 2022), and included in the O.P.T. For water a methodology, slightly adapted from EcoCosts at the Utrecht University, is used. Below these two methodologies are summarized.
Q_r is the amount of the material that is demonstrated recycled.
RC is the costs of recycling, including ESCU's.

(Source and site for more information: https://www.ecocostsvalue.com/eco-costs/eco-costs-resource-scarcity/). "The original eco-costs of materials depletion was based on a combination of recycling and "deeper digging" in combination with mining of ores with a lower concentration (which is more expensive), as prevention measures for depletion. This method had 3 disadvantages: (1) for many critical materials the recycling rates are limited, caused by 'diffusion' (2) the time frame for materials depletion is long term, 100 years – 1000 years or more, which makes it likely that new reserves are discovered or a substitution is developed (3) the long time periods make it less relevant for the short term, e.g. 10 – 30 years

The new eco-costs of metals depletion (as of the eco-costs 2017 V1.3), however, are calculated in a different way. It is related to the short time supply risk of metals, in line with the philosophy of the European union of the Critical Raw Materials (CRM) and the Supply Risk Index of the British Geological Survey. The basic idea is that metals can suddenly become scarce, caused by geopolitical unrest or other supply problems (strikes, serious accidents), that cause shortages in the balance of supply and demand. The result is heavy price fluctuations (IEA 2021). From business point of view, these sudden price jumps are disruptive for existing markets and are suddenly eroding the profitability of products. From governmental point of view, a sudden price jump may cause economic recession. The eco-costs of metal scarcity are equal to a sudden, unexpected, price increase compared to the 10 years average price of the past. Eco-costs are defined as a financial risk: the so called 'Value at Risk' at a 95% threshold, the VAR(95). It means that there is a chance of 5% that this price jump exceeds the eco-costs in the coming year, compared to the average price in the last 10 years. Or the other way around: there is a 95% chance that the price jump is less than the eco-costs. Eco-costs are therefore a business supply risk, where the price jump exceeds the eco-costs every 20 years (i.e. 5% probability for each individual year). The VAR(95) has been calculated from historical data for the period 1946 – 2015". For details on the calculation and assumptions see ((J. Vogtländer et al., 2019); https://www.ecocostsvalue.com/eco-costs/eco-costs-resource-scarcity/).

In a well-functioning Oiconomy Pricing system, all quantities of depleted materials will be included in the obtained supplier-ESCU's. Without complete supplier-ESCU's, the product shall be analyzed and broken down into materials/pieces that can be found in the Idemat Database (Delft University of

Technology, 2022), also included in the O.P.T. In addition, for each material with lacking ESCU's LCA's shall be studied to include excipients and processing aids that do not appear from the analysis of the used materials. At lacking supplier data, always the worst case shall be assumed (e.g. that processing aids are not recycled). It speaks for itself that this is not the intention of the Oiconomy Pricing System and maximum pressure should be put on suppliers to join the system and provide ESCU's.
The Oiconomy Pricing system puts the responsibility of completing lacking data at all stages of the supply chain, which means that in theory, every actor in the supply chain should require data from further tier actors.

Foreground calculations

At full availability of supplier-ESCU's, only for self-added virgin materials ESCU's are allocated.

3.2 Subcategory: Fresh Water depletion

Introduction

The scarcity of fresh water is location dependent. The marginal preventative measure against depletion of local fresh water is the very expensive seawater desalination and pumped transport to the location, both with renewable energy. In many cases, cheaper options are available, such as crop choice, planting in pits, evaporation mitigation, soil improvement, local rainwater harvesting, reuse of water, drip technology, desalination of brackish water and long distance transport of available fresh water. The practitioner is challenged to determine his foreground mitigation options, but without demonstration of other options, ESCU's are allocated based on the marginal measure.

Characterization factor and indicator

The impact category is depletion of scarce fresh water and the indicator is the quantity of used fresh water. The characterization factor depends on the local scarcity of water.

Target

An Aqueduct Atlas Baseline Water Depletion factor <0,1

Background calculations

ESCU's = Max{(BWD – 0,1) x Q x (WDC + CT),0} , where:
Q = The quantity of lost fresh water as defined above.
EL = The elevation of the location of water use in meters.
DL = The shortest distance to a sea with open connection to an ocean of the location in kilometers.
BWD = The Aqueduct Atlas **B**aseline **W**ater **D**epletion factor (https://www.wri.org/applications/aqueduct/water-risk-atlas).
CT = The **c**osts of **t**ransport (pumping) the water from sea to the location with renewable energy, which is calculated, using EL and DL and the data for horizontal and vertical transport in (Zhou & Tol, 2005).
WDC = is the sea**w**ater **d**esalination **c**osts with renewable energy: **WDC = MIN(D_WNR + DPC x CSP).**
D_WNR = the ESCU's for desalination with not renewable energy of 1 m3 of seawater and can be found in O.F.-07 Scarce Resources.
DPC = the **R**equired **P**ower **C**onsumption for 1 m3 of desalinated water is obtained from http://www.lenntech.nl/kostenberekening-ontziltingsinstallatie.htm (corrected for renewable energy)
CSEP is the country specific ESCU allocation for 1 kwH of power and can be found in O.F.-05 Energy resources.

The country specific WDC in O.F.-07, column Q, is calculated based on the country specific average energy mix; If self-use of renewable energy can be demonstrated, WDC can be calculated with the data in O.F.-07 Scarce Resources.
The formula also shows that If BWD <= than 0,1, the water is not considered scarce and the ESCU's zero. Literature shows values of both 0,1 and 0,2 for locations without water scarcity.

Water Reuse.

One potential mitigation is reuse of the already used water. Examples: Before-used water can be used for irrigation in agriculture, parks or gardens, toilet flushing, industrial processing, surface cleaning of roads or environmental restoration. If water is reused, the ESCU's are divided by 2 for both first and next user. Preliminarily, it is assumed that water is not reused more than 1 time.

Foreground calculations

The organization is challenged to determine and demonstrate its own specific costs to mitigate its product related water depletion. In that case, in the above formula for background ESCU's, WDC + CT (the costs of seawater desalinization + transport) is replaced by the actual demonstrated costs for the percentage of water depletion mitigation. For the remainder of depletion, the background calculations apply.

3.3 Subcategory: User Depletion

Introduction

Several products by their use deplete materials, such as fuels, batteries, tires, lubrication oils, maintenance, repairs, brakes, water, cleaning agents, tools.

The properties of a utensil are the determining cause of future pollution. The higher the pollution per time or distance unit of use and the longer the product life, the higher the future pollution.
Therefore the ESCU's caused by the use of a utensil is calculated by the foreground emissions per time- or travelled distance unit, multiplied by the product life and multiplied with the background price factors for the emissions obtained from the EcoCost system (Delft University of Technology, 2022).
Important here is to realize that the product is the utensil, for instance a car, which gets its total lifetime ESCU's for burning fuels allocated. However it that product (the car) becomes a capital good for business purposes (covered by the sections on transport), ESCU's are only allocated for the emissions by the transport related to that other product. This prevents double counting.
In this stage of the Oiconomy Pricing system, most capital goods are not yet included. If, in the future, capital goods are included, the allocated use-ESCU's must be allocated, depreciated proportionally to organization's financial depreciation methods. However, in that case double counting of pollution ESCU's will become an issue and requires a compensation.

Depletion data on used fuels and transport of goods are included in the ESCU's for pollution, where totals from the EcoCost system were taken. Not included yet are depletion ESCU's for commuting and business trips with passenger cars.

Impact category and Indicator

The impact category is depletion of scarce materials, the characterization factor the economic price and the indicator the amount of used virgin scarce material.

Target

For fresh water, An Aqueduct Atlas Baseline Water Depletion factor <0,1.
For other materials, zero depletion.

Background calculations

Currently, there are not enough data on use related depletion to create background data on a reasonable amount of products or even product categories.
However, because the use phase of a product is the responsibility of the end-producer, there are no unknown suppliers involved and therefore, the end producers should be able to provide the data and contribute to the required research.

Foreground calculations

The use-sections of the Oiconomy Pricing Tool only request foreground data.
Above, in the section about depletion, explained was that first ESCU's for depletion are allocated at the point of first use and subtracted again when recycling can be demonstrated at the bottom end of the life cycle. For Use-Depletion, because the calculations of both are simultaneous, ESCU's for demonstrated recycling are directly subtracted.

4. Category: Disposal/Waste

Introduction

In the lifecycle of a product, three stages of existing of waste can be distinguished: the production, the use, and at end-of-life. these three stages are considered separately in the O.S. and the O.P.T. The Oiconomy Pricing Tool allocates ESCU's for both depletion of virgin materials (see category depletion) and for disposal consequences (transport, processing, littering, landfill). This category only considers the latter. In addition, uncarefully disposed, the materials may become litter or pollute land, water or air systems, which is the issue in the waste/disposal category.

The three most important prevention measures for prevention of litter and pollution by waste in the industrial environment :

1. Prevention of the existence of waste.
   1.1. Prevention of redundancy and good coordination of demand, supply and logistics.
   1.2. Prevention of failures and reject.
2. Only use of recyclable tools, solvents and other excipients.
   2.1. A perfect system, at minimal addition of impact, for collection, cleaning/dismantling/processing, and sufficient reuse/recycling destinations.

In practice, a fully circular society, with nature as the example, is impossible. It would for instance mean that all materials are recycled without transport and processing and without loss of quality. It would mean that for instance all nutrients from human excretions are returned to the locations of origin. It would mean that people only live at the locations where they can feed themselves. Fortunately, a fully circular economy is not necessary, e.g. because the earth receives huge amounts of free energy from the sun, which may be used for transport and processing and with the aid of that energy many of the other issues can be overcome.

To date, recycled material is often presented as 100% sustainable. Seldom is accounted for the future disposal and re-recycleability of the reworked material. Potential downcycling and potential waste processing impacts are seldomly accounted for and weighted against for instance landfill or incineration.

Category related Sustainable Development Goals

Goal 9: Build resilient infrastructure, promote sustainable industrialization and foster innovation.
Goal 12: Ensure sustainable consumption and production patterns.

Subcategories

- Waste flows from Production
- Waste flows from the use of the product (Note: still missing, also in the tool.)
- Waste flows at end-of-life

Impact category and indicator

The impact category is litter and pollution by waste materials; The indicator is the quantity of materials for which no sustainable disposal can be demonstrated.

4.1 Subcategory Waste from Production

Introduction

The amount of production-existing waste highly depends on the character of the raw materials (e.g. not all parts of food produce are edible), design issues, production and logistic errors, human, equipment and maintenance failures, shelf-life and quality issues and supply-demand imbalances. Therefore, waste quantities are highly variable and unpredictable.

Impact category and Indicator

In a fully developed circular economy, all material flows are not only recycled, but also not “downcycled”, and keep their value, or have enough positive impact for compensating their full upstream ESCU’s. Therefore, the O.P.T. divides the ESCU’s between origin and destination product according relative to their value.
In the section of depletion, ESCU’s for depletion of materials are calculated as the value of the virgin materials. In the sections of waste/disposal and end-of-life, ESCU’s are recovered by the market value of the demonstrably recycled materials, augmented with ESCU’s for collection and processing. This way, in a fully developed Oiconomy Pricing System, with a zero value of the waste material, all depletion ESCU’s are allocated to the first product-user and the next user zero depletion-ESCU’s. However, if the material has a residual value, an equal amount of ESCU’s are allocated to the destination product and subtracted from the original product. If transport and processing costs for reworking waste are higher than the original extraction costs, the paid price and ESCU’s for the waste will gradually mitigate with every new use of the material.

Targets

Zero litter and zero loss of value of materials

Background calculations

Very generic background average quantities of waste from production could be derived from (CBS, 2019; Kalisz et al., 2022; Ndlovu et al., 2017; ICF Consulting; The American Petroleum Institute, 2000). Because of lack of more granular data, the tool uses these averages as background data in an indiscriminate way, assuming the same waste percentage for all materials.

ESCU's for depletion are obtained from the EcoCost system (Delft University of Technology, 2022). Transport and processing ESCU's are derived from (bouldercounty.gov, 2022; PRO Europe, 2022). Transport and processing costs of both sources may not be based on the same calculation principles. The transport and processing costs, taken from PRO Europe consider packaging waste at European consumer level, which should develop to all materials at industrial level. The Boulder data consider USA data on materials on industrial level.
ESCU's are subtracted for demonstrable amounts of KwH's and for demonstrable amounts of recovered methane from landfills, for which background data are taken from the EcoCost system (Delft University of Technology, 2022).

Foreground calculations

The tool offers the practitioner the opportunity to enter foreground quantities of waste flows for each material. In addition, in case of foreground data, the tool accounts for quantities that are recycled, incinerated with energy recovery or land filled/fermented with methane recovery.
For demonstrably recovered electricity ESCU's are subtracted depending on the countries' specific emissions for power, taken from the Idemat_2021_Global_Electricity_Calculation to ESCUs 2022 database at www. ecocostvalue.com. For demonstrably recovered methane, ESCU's are subtracted based on the relative global warming potential of methane relative to CO_2, taken from (Delft University of Technology, 2022).

4.2 Subcategory Waste in User phase

Introduction

(Note: still missing, also in the tool.)

4.3 Subcategory Waste at End-of-Life

Introduction

The main issues at the end-of-life stage of a product are:
1. A product life shorter than necessary, or redundancy. The consumer buys too much and is tempted to that behavior e.g. by advertising, low quality, low prices, lack of repair and refurbishment opportunities, fashion and social group behavior.
2. Litter, landfill, depletion of materials, pollution, caused by the design of the product and the lack of facilities and opportunities for sustainable disposal.
3. In many countries, the costs of sustainable disposal is an externality, paid by the society and not included in the price of the product and not assessed and organized before the product is introduced into the market.

Impact category and Indicator

Litter and pollution by the waste flow existing at end-of-life disposal.

Targets

Zero litter and pollution by end-of-life disposed materials.

Background and Foreground calculation

The Oiconomy Assessment Tool allocates disposal ESCU's for the following shortcomings:

1. Any disposed material for which no sustainable destination can be demonstrated.
   Background ESCU's are allocated for all materials for which no sustainable destination can be demonstrated, but ESCU's, equal to the obtained price (for the waste) are subtracted for quantities that are either self-retained and recycled or reused, or demonstrably externally recycled.
2. Redundancy. A product life curve shall be made, showing the most common product life (CPL) (the moment of maximum amounts of products reaching end-of-life) and the moment that 80% of the product (80%PL) has reached end-of-life. A "redundancy factor" is determined as 80%PL/CPL. Without actual determination of this factor, a default value of 2,0 is assumed, without further justification.
   The ESCU's for depletion, transport and processing are multiplied by the redundancy factor.
   By means of the determination of a governance quality based reducing multiplication factor (RMF) the obtained ESCU value can be mitigated.

5. Category: Land Use.

Introduction

Common characterization factors in land use assessment are indicators on species richness (De Baan et al. 2012; Lindeijer 2000; Teixeira et al. 2015; Vogtländer et al. 2000; Weidema 2001) and impacts on ecosystem services (Milà i Canals et al. 2012; De Baan et al. 2012; Thoma et al. 2015). literature shows a fierce debate if the most sustainable way towards sustainable land use is via "land sparing" or via "land sharing" (Fischer et al., 2014). Advocates of land sparing argue that high yields by intensive agriculture saves land for high quality biodiversity elsewhere and believe in technology, business as usual in developed countries and closing the yield gap in development countries. Advocates of land sharing and organic agriculture prefer more biodiversity on all land (e.g. Balmford et al. 2005; Phalan et al. 2011; Fischer et al. 2014; Tscharntke et al. 2012). More recently a third option is discussed, that of "sustainable intensification (SI)" (Godfray, 2015; Petersen & Snapp, 2015; Pretty, 1997; Rockström et al., 2017; Tilman et al., 2011), which should develop towards intensive, land sparing agriculture while reducing the environmental impact. A meta analysis by Tuomisto shows that organic farming in Europe has generally lower environmental impacts per unit of area than conventional farming, but due to lower yields and the requirement to build the fertility of land, not always per product unit of product. (Balmford et al., 2018), a large group of scholars in the field, argue that land use assessment should cover a wide range of aspects, like biodiversity, yield, pollution and soil carbon content, which therefore is also the goal of the O.S.

Because the O.S. measures sustainability of products, it covers both "land use" and "land degradation". (Pollution, including CO2 emissions, is covered in the relevant section).
Land use is characterized by the yield and land degradation by biodiversity.
Land use, the aspect considered in this section, makes the organization responsible for providing (products, biodiversity, or both).
50% of habitable land is used for agricultural purposes and 37% is forestry, 30% of which is used as production forestry. Only 1% is urban and build-up area. Therefore, considering land use aspects, the O.S. calculations of background ESCU's is based on agricultural purposes.

Category related Sustainable Development Goals

Goal 2: End hunger, achieve food security and improved nutrition and promote sustainable agriculture.
Goal 7: Ensure access to affordable, reliable, sustainable and modern energy.
Goal 11: Make cities inclusive, safe, resilient and sustainable.
Goal 12: Ensure sustainable consumption and production patterns.

Subcategories

- Land use for agricultural or forestry-for -food purposes
- Land use for non-food forestry products
- Land use for livestock derived products
- Land use for non-agricultural or non-forestry products.

5.1 Subcategory: Land use for agricultural or forestry-for-food purposes

Introduction

See above: general introduction Land Use

Impact category and indicator

The impact category is loss of valuable ecosystems by inefficient land use and the indicator the distance between the yield and the average crop yield in FAOSTAT (FAO, 2019).
The characterization factor is the distance to an average crop yield, obtained from FAOSTAT (www.fao.org/faostat/en/#data/QC).
In case of a yield gap, e.g. for organic agriculture, extra land is required to compensate for the loss of yield. Therefore, ESCU's need to be allocated for restoration and maintenance of an extra piece of land which should be unproductive and of little biodiversity value. Because this will usually be arid, a continuous flow of considerable amounts of water is required for sustainable arable land.

Target

The land sparing target is zero cause of further loss of valuable ecosystems or "land degradation neutrality" as set at the RIO conference on sustainable development (United Nations, 2012).
The O.S. seeks a balance between land sparing and land sharing by striving towards sustainable intensive agriculture. According to (Balmford et al., 2018), For Land assessment, all involved aspects should be accounted for. Therefore, the O.S. allocates ESCU's for both below-average yields (category land use), emission of harmful chemicals (category pollution) and for biodiversity below 80% of locally natural biodiversity (category land degradation/biodiversity).

Background calculations

ESCU's =Q x (1-CY/AY) x EWC, where
AY = Average Yield
CY = actual Crop Yield (or product yield)
EWC = extra water costs for growing crops in arid conditions
Q = quantity of occupied hectares

The background extra water costs are calculated as follows:
Corn is a globally common staple crop, growing under reasonably arid conditions. The world average corn yield (FAOSTAT) in 2014 is 5,615 tons/ha.
To compensate the yield gap, we propose the costs of "growing corn on a new piece of arid land,

irrigated with desalinated seawater". The involved extra costs consist of the costs of seawater desalination + the costs of water transport to the arid location + the yearly interest for the purchase of arid land + the costs of ESCU's for emissions for the energy required for desalination and transport. We assume other agricultural activities equal to standard, without extra costs. Because desalinated water is very expensive, water saving irrigation techniques like subsurface drip technology will surely be economic, and are therefore assumed to be used and reduce water use by 40% (Budiharta et al., 2014; Lamm & Trooien, 2003), but not to need more energy and maintenance than conventional irrigation.
As interest rates we take 5% for high income countries and 13 % for low income countries.
For the average transport distance from sea to suitable arid areas we assume 1000 km horizontal at € 0,055/ m3.100 km. and 400 meters vertical at € 0,046/m3.100m distance (Zhou & Tol, 2005).

The globally average water footprint for corn (Mekonnen & Hoekstra, 2010) is 1222 m3/ton, in arid regions with only 50% green water availability resulting in a need of 611 m3/ton of extra water.
Costs of seawater desalination: € 0,66/m3, including ESCU's for 4 KwH/m3 related emissions, excluding transport (Lenntech, 2017). For the purchase of arable land we assume € 100/ha., the highest of the price range of arid land in South Africa of € 10 - € 100/ha.
Table 1 shows the calculation of ESCU's for land use, resulting in the very high ESCU sum of € 6022/ha.y. However this only applies to the proportion of land wasted by inefficient land use, by multiplication by a land use efficiency factor (EF): EF = (FAY-AY)/FAY, where AY is the actually achieved 5-year average yield and FAY the FAOSTAT listed average yield for the country (or region if reliable data are available). For example, for an efficiency loss of 20%, 0,2 x 6022 = 1204 ESCU's/ ha.y need to be allocated for, or in the case of corn 80% of 5.615 kg of corn = € 0,27/kg.

As default value at lacking yield data, 50% of the average yield is assumed (the lowest % mentioned in literature for the relative yield of organic crops).

Balancing for double counting
With the same amount of water as required for a commercial crop, without any crop bare land in most cases a rich biodiversity would emerge. Although not the same as locally natural, this means that simple aggregation of ESCU's for land use and biodiversity would be a case of double counting. In addition, considering the following:

- Nature with 100% biodiversity and no commercial use (zero yield) obtains zero ESCU's.
- Built land with 100% yield and zero biodiversity obtains full biodiversity ESCU's.

Therefore, the full biodiversity ESCU's is also the maximum allocation for the aggregation of both.

Because the O.S. wants to lead towards an equilibrium of bott aspects, the ESCU's for land use and biodiversity are divided over both aspects as follows:

For land use: ESCU's/ha = (Min(FBE; UE) x (UE/ (UE + BE).
For biodiversity: ESCU's/ha = BE x (BE/ (OE + BE).
FBE represents full biodiversity ESCU's
UE represents the ESCU's for land use.
BE represents the ESCU's for biodiversity.

To obtain the ESCU's per unit of product, both values are divided by the yield/hectare.

Table 1. The calculations for growing 5,615 tons of corn on 1 hectare of arid land (50% green water), 1000 km from sea and at 400 m altitude, with seawater desalinated water and using a Subsurface Drip Irrigation system (SDI) (40% water use reduction):

Action	Calculation	Result (€/ha.y)
Water desalination, including ESCU's for emissions	0,6 (40% reduction for SDI) x 5,615 x 611 x 1,00 (ESCU's for 1 m3 water)	2058
Water transport	0,6 x 5,615 x 611 x (1000/100) x 0,0552 + 0,6 x 5,615 x 611 x (400/100) x 0,046	1515
ESCU's for pumping emissions.	(0,6 x 5,615 x 611) x 0,00455 (kwh/m3.m) x 400 (vertical) x 0,1546 (ESCU's/kwh) + (0,6 x 5,615 x 611) x 0,00546 (kwh/m3.m) x 1000 (horizontal) x 0,1546 (ESCU's/kwh)	2317
Financing Land + subsurface drip irrigation system (SDI)	100 x 0,13 (interest arid land) + 604 x 0,13 (interest SDI) + 604/15 (depreciation SDI)	132
Total		**6022**

(Idemat 2018 lists for transport of liquids (weight/volume ratio = 1) € 0,01/m3.km, assuming return freight available, and neglecting the vertical transport, results in 0,6 x 5,615 x 611 x € 0,01 x 1000 = € 20585 for the ESCU's for road transport of the water, showing the unsustainability of this solution. SDI is "Subsurface Drip Irrigation"

Foreground calculations

Organizations are challenged to determine their foreground costs of mitigation of inefficient land use without loss (or rather under simultaneous increase) of biodiversity.

Note that the background preventative measure against loss of more valuable ecosystems is based on compensation elsewhere, which means that the options to demonstrate lower specific foreground preventative costs are to either find another way to increase his own land use efficiency, self-convert and use a piece of arid land, or finance distant farmers to do so in a verified and demonstrable way. Because in practice at many locations cheaper conversion will be possible, e.g. because brackish water is available and can be desalinated at much lower costs and shorter distance than 1000 km. at lower altitude than 400 meters. there are ample possibilities for lower costs.

If for instance ESCU's for transport (pumping) KwH's are calculated based on exclusive use of PV, like we, following Vogtlander also did for the desalination, the Land use ESCU's/ha.y. become € 4748, and the break-even point at 559/4748 = 11,8%.

The best way however is to produce sparing both land and biodiversity on the self-exploited land. The O.S. allocate ESCU's first per hectares and thereafter divides the score by the yield. Therefore, the higher the yield, the lower the ESCU's per unit of product. The ESCU calculations are equal to those for background cases but based on demonstrable foreground data.

5.2 Subcategory: Land use for non-food forestry products

All above explanations apply for non-food forestry products, with the following additional details:

Additional details

For forestry products, a carbon sequestration bonus compensation is added in two cases:

- Forestry for which a positive long-term balance of carbon sequestration and harvesting can be demonstrated.
- For non-food forest products for which a lifetime > 50 years can be demonstrated.

5.3 Subcategory: Land use for livestock derived products.

Introduction

Section in development – (Insufficient data investigated): Need of statistics for reference yields per hectare without foreign nutrients.

5.4 Subcategory: Land use for non-agricultural products

Introduction

Agriculture and forestry make is by far the largest contribution to land use. 50 % of habitual land on earth is used for agriculture, 37% for forestry, 11% is shrubland and only 1% is urban and built-up land. This means that most other land use than agriculture and forestry is insignificant. For exceptions, e.g. for mining, roads, rail, airports, harbors or defense purposes, the O.S. only requires calculation for non agricultural or forestry products with a yield > € 100.000 /ha or land use > 100 ha.

Impact category and Indicator

Loss of valuable ecosystems

Targets

Restoration and maintenance of valuable ecosystems either on the own premises or elsewhere

Background calculations

Determination of the ESCU's per hectare following the above described method and dividing by the amount of units.

Foreground calculations

Not applicable.

6. Category: Ecosystem Degradation and Biodiversity

Introduction

Many human activities, and especially agriculture go at the expense of biodiversity. Loss of Biodiversity is one of the major sustainability issues, endangering climate, food supply.
The O.S. challenges the partitioner to determine biodiversity, characterized by the relative count of vascular plants to the locally natural count. Because this count depends on the size of the investigated piece of land, the O.S. requires to sample 10 randomly chosen pieces of 10 m2 in each hectare of occupied land.

Category related Sustainable Development Goals

Goal 2: End hunger, achieve food security and improved nutrition and promote sustainable agriculture.
Goal 6: Ensure access to water and sanitation for all.
Goal 14: Conserve and sustainably use the oceans, seas and marine resources.
Goal 15: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.

Subcategories

- Land Degradation and Biodiversity
- Sea Degradation

6.1 Subcategory: Land Degradation and Biodiversity

Data sources and characterization factor

Background data on the biodiversity of the different ecosystems in use are available and incorporated in the O.S. from the EcoCost system. These data are based on the costs of restauration per hectare back to the locally natural ecosystem. The characterization factor is the number of vascular plant species per hectare.

Impact category and indicator

The impact category is biodiversity and the indicator is following:

Targets

The locally natural number of vascular plant species, for which currently no data are available.

Background calculations

ESCU's =Q x (1-CY/AY) x RC, where
AY = Average Yield
CY = actual Crop Yield (or product yield)
RC = restoration costs per hectare
Q = quantity of occupied hectares

The 2018 gross cost of nature and landscape management (excluding purchase of land) for 498956 ha. in the Netherlands was € 1160 million (CBS et al., 2021), which is € 2325/ha., including a great variety of landscapes, but excluding water-ecosystems. Average European one-off costs per year on land conversion (excluding purchase of land) were estimated € 1028/ha.y (Verburg et al., 2012). This makes a total costs of land restoration and maintenance estimated at € 3353/ha.y.

For background calculations, (Vogtländer et al., 2004, page 50; Vogtländer, 2001, page 228) provide data on the species richness for different types of land (in the Netherlands), which for the O.S. were turned into percentages of the natural species richness. Assuming that these percentages are a good indication for global biodiversity, these data were multiplied by the costs of restoration and maintenance per land type.

The EcoCost system provides a methodology based on the formula: EcoCosts = X x RC x $Q/Q_{threshold}$.
RC = the restauration costs per unit of land.
X = the amount of units of land.
Q = the diversity (amount) of vascular plant species measured in a unit of land.
$Q_{threshold}$ = the diversity of vascular plants of the locally natural ecosystem.

Foreground calculations

ESCU calculations are equal to background calculations, but:
Companies are challenged to determine their foreground biodiversity. This needs to be executed by a qualified expert. In addition, because the counted diversity increases with the size of the sampled land, the measurement must be standardized.
Preliminarily, the average is taken from 4 randomly taken samples of 10m2 in each hectare.

6.2 Subcategory: Sea Degradation

(Section in development)

Introduction

Preliminarily, for activities in coral ecosystems, a distance of 10 km around corals was taken, without justification.

Impact category and Indicator:

n/a

Targets

n/a

Background calculations

Background data available in (Bayraktarov et al., 2019) and (Balmford et al., 2004).

Foreground calculations

n/a

7. Category: Human Health (in the surrounding environment or in traffic)

Introduction

Human health aspects are about the health and safety of others than working for the organization and caused by the presence of the organization (surroundings, traffic). See for the last the section “Subcategory: Occupational Health and Safety”, (8.8) under Labour.
Usually the involved people are living in the surrounding of the organization’s premises or affected by organization related traffic.
No data could be found on the preventative costs for this aspect. Therefore, we assume that these are related to occupational health and safety issues and may even be included in the occupational health and safety (OSH) governance of the organization.
Therefore, the calculation of the ESCU’s is equal to OSH ESCU calculation, however with a new reducing governance dependent multiplication factor.

Category related Sustainable Development Goals

Goal 3: Ensure healthy lives and promote well-being for all at all ages.

Subcategories:

Human Health: health and safety issues affected by the near presence of the organization or traffic related to the organization. Human Health & Safety: health and safety issues affected by the near presence of the organization or traffic related to the organization.
User Health: health and safety issues by the use of the product.

- Human Health & Safety (HHS)
- User Health & Safety (UHS)

7.1 Subcategory: Human Health & Safety (HHS)

Introduction

No specific data are available on the prevention costs HHS and prevention measures will heavily depend on the activities, materials, location, management and workers.

Impact category and characterization factor

The impact category is harm to outside people. The characterization factor is the product of the maximum preventative costs and a reducing multiplication factor determined by the measurement of organization’s quality of governance on HHS (see general methodology).

Targets

Zero harm caused by the near presence caused by the near presence or traffic related to the organization to people outside the organization.

Background calculations

The following formula is used: ESCU’s = HHSMax x RMF x M%, where:
HHSMax represents the maximum costs, which is preliminarily assumed equal to those for Occupational Health and Safety (OHS), which is a Utrecht University percentage (10%) of the wage sum.
RMF is the reducing multiplication factor, determined by entering yes or no compliance to a series of criteria.
M% is the issue mitigation percentage. For the remaining percentage, the background ESCU’s are calculated and added.

Foreground calculations

Organizations are challenged to determine their burdens to people outside their premises and demonstrate the related costs of prevention.
The calculation formula is equal to that for background ESCU calculations, however with the foreground prevention costs instead of HHSMAx.

7.2 Subcategory: User Health & Safety (UHS)

Introduction

Use-health considers the safety of the product.
No specific data are available on the prevention costs HHS and prevention measures will heavily depend on the activities, materials, location, management, and workers.

Impact category and Indicator

The impact category is harm to people due to the use of the product.

Targets

Zero harm to users of the product.
For noise the Dutch standards are applied:

Norm (dB(A))	Period of the day (hour)		
	07.00 - 19.00	19.00 - 23.00	23.00 - 07.00
$L_{Ar,LT}$ at facade of noise-sensitive buildings	50	45	40
$L_{Ar,LT}$ in noise- sensitive rooms with people	35	30	25
L_{Amax} at facade of noise-sensitive buildings	70	65	60
L_{Amax} in noise- sensitive rooms with people	55	50	45

L_{ArLT} = Long term average noise level at facades of noise-sensitive buildings
L_{Amax} = Maximum noise level

Background calculations

The use-sections of the Oiconomy Pricing Tool only request foreground data, which the organization theoretically should be able to demonstrate, because no suppliers are involved, because the use phase of a product is the responsibility of the end-producer and there are no unknown suppliers involved.

The following formula is used: ESCU's = UHSMax x RMF x M%, where:
UHSMax represents the maximum costs, derived as follows:
Little data could be found on the expenditures on safety measures on prevention of public health. After a period, many safety measures become mandatory and standard. For collision safety-measures of light duty vehicles, some cost-indication could be found of yearly 0,4% of the invested capital for 24% collision reduction, which makes, faulty assuming linear extrapolation, 1,6% for avoiding of collisions. The mandated safety features are estimated at about 2% of the investment.
Cost–Benefit Analysis of Four Large Truck Advanced Safety Technologies
RMF is the reducing multiplication factor, determined by entering yes or no compliance to a series of criteria.
M% is the issue mitigation percentage. For the remaining percentage, the background ESCU's are calculated and added.

Foreground calculations

Organizations are challenged to investigate all possible harm that product-uses could cause and determine the foreground costs to prevent any harm.
The ESCU calculation formula remains the same, however with the foreground prevention costs instead of UHSMax.

8. Category: Labour

Introduction

Labour related issues belong to the most concerning issues in the supply chain of products. A multiple of issues are covered by the O.S. as listed below in the section of subcategories.

Category related Sustainable Development Goals

Goal 1: End poverty in all its forms everywhere.
Goal 3: Ensure healthy lives and promote well-being for all at all ages.
Goal 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.
Goal 5: Achieve gender equality and empower all women and girls.
Goal 8: Promote inclusive and sustainable economic growth, employment and decent work for all.
Goal 10: Reduce inequality within and among countries.

Subcategories

- Remuneration
- Inequality
- Overtime
- Health Insurance
- Personnel Development
- Various Labour related aspects
- Occupational Health and Safety
- Labour Conditions
- Child Labour

8.1 Subcategory: Remuneration

Introduction

The O.S. strives for a sustainable economy by means of a free market, functioning within moral and convention-based boundaries. Poverty is one of the major sustainability aspects and Sustainable Development nr. 1., but also the one most affecting other aspects. Global population growth, climate, conflict, health and safety conditions, erosion, forest clearing, pollution and many other conditions, all are strongly (positively or negatively) interrelated to poverty. Therefore, the O.S. includes criteria on fair pay of both fair wages (this section) and fair transactions (see "economic"). The most commonly applied indicator for a "Fair minimum wage" is the living wage. However, for our purpose of what is "Fair minimum wage", the living wage has the following limitations:

1. It was developed as an indicator of poverty (Anker, 2005); not as an indicator for what is fair.
2. It is insufficiently suited to be applied in middle and high income countries.
3. It insufficiently accounts for a sustainable family size of 2 children per woman.
4. It insufficiently takes into account the full life time of people.
5. It requires thorough research and continuous maintenance in every country in the world.

Therefore, for the Oiconomy Pricing system a new indicator, suited and easy to calculate for all countries was developed at the Utrecht university (Croes & Vermeulen, 2016b).

The Fair Minimum Wage **(FMW)** is the maximum of the legal minimum wage and a calculated minimum (which is also called "FMW"). **The FMW is determined as a percentage of the Gross National income per capita (GNI/cap), bottom truncated by an absolute minimum for the lowest income countries.** The percentage of the GNI/cap is determined by the average in the 20% most sustainable countries, determined by the Sustainable Development Index – Human Development (SSI -HW) (Croes & Vermeulen, 2016a, 2016b). Because this index is not maintained any more and the original papers also showed that the Human Development Index (UNDP, 2010) gives the same result, currently the HDI is currently used as indicator of the top 20% countries. The percentage was, based

on 2011 data and the 2011 group of best performing countries, determined at 44,89% of the GNI/cap.
The absolute minimum is determined by application of various ILO conventions on workhours, and holidays, resulting in a work-year of 1864 hours, a sustainable fertility rate of 2 children per woman, a thereof derived labour working life and labour partition rate, average life expectancy in the top 20% performing countries, and the WorldBank moderate poverty line of $3,20 /day.capita.
In October 2022 the moderate poverty line was raised to $ 3,65 and integrated in the O.P.T. in may 2023.
Calculation formulas and a precise description can be found in (Croes & Vermeulen, 2016b). The method includes pensions (accounting for a lifetime income. (Either institutionalized by means of countries or lifetime parental and children's care for each other). The absolute FMW anno 2022 is € 2.181,71/ year and € 1,17/hour.

Indicator

The impact category is unfair wages and the indicator the distance of paid wages from the fair minimum wage. See above for a short explanation.

Targets

A fair minimum wage (FMW) for every worker as defined by (Croes & Vermeulen, 2016b).
Fair overtime work payment (the maximum of 50% and the local legal premium).
All hours > Min(legal standard workweek hours; 40) are considered overtime.

Background calculations

Background ESCU's are calculated as the difference between the lowest wage that can be found and the FMW, applied to the low-paid labour percentage of the product price and accounting for a default percentage of overtime. To determine this, background values need to be found for both the amount of work-hours per unit of product, and the lowest (worst case) wage paid in the country.
This results in the following calculation formula:

ESCU's = LWL% x PP x $\sum$(LWp – FMW), where:
LWL% is the low-skilled labour-hour % of the product price, to be found per sector in WIOD social accounts 2014 (https://www.rug.nl/ggdc/valuechain/wiod/wiod-2016-release).
PP is the **P**roduct's **P**rice.
LWp is the **L**owest **W**age **P**aid to adults in the country as found in Wageindicator.org.
In addition a background standard 33% of the workhours is considered overtime.

Foreground calculations

Foreground ESCU's are calculated as the difference between the demonstrable actual wage and the FMW aggregated for all workers paid below the FMW, as follows:
ESCU's = FWh x $\sum$(PWp – FMW), where:
FWh is the **F**oreground amount of **W**ork**h**ours spent per unit of product.
PWp is the **P**aid **W**age per **P**erson per unit or product.
In addition, added shall be the cost distance to overtime payment, where overtime is defined as:
Overtime ESCU's = Min (LSWW ;40), where:
LSWW is the Legal Standard workweek.

8.2 Subcategory: Overtime

Introduction

According to ILO Conventions No. 1 and No. 30, the rate of pay for overtime shall be not less than one-and-one-quarter times the regular rate (ILO, 2004). Overtime premiums of 50 per cent above the regular wage and higher for weekends are standard in many countries.
Legislation and Practice show a great variation of overtime systems, but in the EU 50% extra payment above standard compensation is the most common legal compensation (Eurofound, 2022).
However, practice is different. Much overtime is not paid at all (Perinelli & Baker, 2010).
Preliminarily, for the Oiconomy, +50% is taken as a fair extra compensation for overtime.
In the Netherlands there is no mandatory premium for shiftwork, but such premium is commonly paid.

Indicator

The distance between actual overtime payment and 50% premium.

Target

Zero overwork without at least 50% premium for overtime.
Premiums shall be equal for all workers with incomes < 4 times the FMW. Workers with an income > 3 times the FMW are considered to be able to negotiate their income themselves. (without justification).

Background calculations

For background ESCU's (allocated if no proper overtime registration can be demonstrated, it is assumed that 50% of the worked hours are overtime, based on (Common Objective, 2018; Kuddo, 2009), which results in the following ESCU calculation:

ESCU's = Max(BWh x BOW% x FMW x BOW% x (OWP-AWP);0), where:

BWH = the background workhours on the product, set to 50% of the product price
FMW is the fair minimum wage.
BOW% is the background amount of overtime hours spent on the product, which is set to 50% (60 hours per week instead of 40).
BOWP is the target minimum overtime percentage, which is set to 50%
BAWP is the actually used overtime percentage, which is set to zero.

Foreground calculations

Foreground ESCU's are calculated equal to the sum required to raise all overtime remunerations of workers with an income > 3 times the FMW to the fair overtime compensation.
For the workers with an income < 3 x FMW applies:

ESCU's = Max (∑ *(*OWPp-AWPp)*;0)*, where:
OW%p is the *actually amount of overtime hours for each worker spent on the product.*
OWPp is the target minimum overtime percentage for workers.
AWPp is the actually used overtime percentage.

8.3 Subcategory: Child Labour

Introduction

Not for all child labour ESCU's are allocated. In short, physically and mentally harmless work answering to defined criteria and not limiting schooltime, by children belonging to the family is not considered a type of child labour that needs ESCU allocation.
Considered conditions, depending on children's age were included:

Maximum workhours/week: For the maximum workhours per week, the Netherlands legislation is taken as target. The maximum workhours depend on age and type of day (schoolday, weekend, holiday. Maxima are set per day, per schoolweek and holiday-week. In the tool, only the maxima per schoolweek are included). Source: (Netherlands Labour Organization, 2022).

Minimum wage, as a percentage of the adult minimum wage, for which the FMW is taken and for the percentages the slightly rounded legal Dutch percentages: (www.uwv.nl/particulieren/bedragen/detail/minimum-jeugd-loon). Maximum weight to be lifted: The maximum weight to be lifted is complex. It depends on the age, gender, person's posture, the frequency of lifting, the height of lifting ,the shape of the load and the distance to the body. The given weights are maxima under ideal conditions. Literature on the diverse conditions can be found in (Charoenporn et al., 2019).

Maximum distance from home: No legislation or standards could be found on the maximum travel distance for children to work. Some could be found on the distance to school, like max. 3 km in India (The Indian Express, 2022), for children up to 14 years. However, in the case of preventing child labour, any organized long distance transport should be prevented, which is a different cause than school commuting. Therefore, a maximum of 3 km was chosen for children up to 14 years old; 10 km for children from 15 – 17 years and unlimited for 18+.

Indicator

Target wage – Paid wage, where in case of the worst form of child labour, the target wage is the FMW for adults.

Targets

Demonstrable Zero Child Labour according to the above definition

Background calculations

Background ESCU's are allocated for child labour, where no absence of child labour can be demonstrated and no foreground data are available. In countries without child labour according to the Unicef statistics (Unicef, 2018), zero ESCU's are allocated.
Because the Unicef child labour statistics on the % of children involved in child labour is not complete for all countries, this statistic could not be used for the development of an governance dependent reducing indicator. Therefore, the Human Development index was taken for the purpose.

ESCU's = HP x (1-HDI) x (FMW - ACW), where:
HP is the most likely but demonstrable amount of Hours (HP) of low skilled labour, worked on one unit of Product. Sources are IO databases, the internet and information and tests at accessible suppliers.
HDI is the Human Development country of the most likely country of the work.
FMW is the Fair Minimum Wage for adults.
ACW is the most likely Average Childrens' hourly Wage (ACW) paid to children in the default country,

without other demonstrable data determined as 30% of the lowest paid hourly wage for adults that can be found at Wageindicator.org for the country.

Foreground calculations

Foreground ESCU's for Child Labour are calculated as the extra costs to improve the conditions to the minimum conditions, or to replace the child by an adult, paid the FMW.
First, a series of conditions is checked that lead to zero ESCU's:

- A relevant certificate.
- No child Labour is known in the country.
- The organization declares that it does not use child labour as detailed defined in the tool and agrees to obtain unannounced audits.

Another considered condition is that the organization uses child labour but the only violation against the defined criteria is underpayment. In that case:
ESCU's = $\sum$(TWc-AWc), where
TWc is the target wage per child.
AWc is the actual wage per child.

Other cases are considered as "worst form on child labour", for which background ESCU's are allocated as described above:

8.4 Subcategory: Inequality

Introduction

Remuneration differences are necessary because they belong to the free market, providing motivation and opportunities. Some rewards however, are harmful because they stimulate decision takers to prevalent their own interests and the financial interest of their shareholders over the interest of sustainability. Reduction of Inequality is Sustainability Development Goal nr. 10. Therefore, the O.S. includes criteria on inequality and ESCU's are allocated for unfair inequality. For this purpose a definition was developed for "Fair Inequality" in (Croes & Vermeulen, 2016a), based on the following principles:

The average ratio between the highest and lowest parliamentary determined wages in the top 20% countries determined by the Sustainable Development Index – Human Development (SSI -HW).
For the highest wage, the wage of the president or prime minister was taken and for the lowest, the legal minimum wage. The obtained ratio (14,1) is applied to governmental organizations. For semi governmental organization, this ratio is augmented with 20%, (following Dutch regulations), resulting in a ratio of 18,3 and for other organizations with another 20%, resulting in a ratio of 23,8, reasonably in accordance with recent developments in various countries (Croes & Vermeulen, 2016a).
This means that (for industry) for any wage lower than 4,2% of the highest wage in the organization, ESCU's are allocated, equal to the amount needed to raise the wage to 4,2% of the highest wage.

Indicator

The impact category is inequality and the indicator the ratio between the highest and lowest income in the organization.

Targets

A maximum inequality ratio than the Fair Inequality Ratio (determined as a factor 23,8 by (Croes & Vermeulen, 2016a), based on the income ratios between of presidents and the minimum wage in the

20% best performing countries, augmented with 2 times 20% via semi governmental organizations to industry.

Background calculations

For Background ESCU's, all low paid wages are assumed equal to the lowest wage found for the country in Wageindicator.org. The highest wage is assumed equal to the highest CEO salary (including bonusses) found on the internet (e.g. year reports) for industry leaders in the sector. A default overtime of 50% is assumed for the highest paid person, based on internet research showing that 50% is the most common %.
In the USA, the median CEO income of companies with $25 – $50 mio revenue is $355.000 (W. Cooper, 2019), which is about $190/hour. The FMW for the USA is $ 13,94. Paying a lowest wage of the FMW, the maximum fair total CEO income with a 40 hour workweek would be 23,8 x US$ 13,94 = $331.772, but with a 60 hour workweek $663.554. Based on these data, the risk of irresponsible income inequality in organizations with a revenue < $ 25 mio is small and are therefore exempted from assessment. For organizations with a revenue > $ 25 mio, ESCU's are calculated as follows:

ESCU's = ∑ (BHI – (WH x FMW)), where:
BHI is the highest hourly total income in the organization, to be determined by searching the internet for the highest CEO income in the sector. For the calculation of the hourly CEO income, for the CEO a background 60 hour workweek is assumed.
WH is the background amount of workhours per unit, to be found per sector in WIOD social accounts 2014 (https://www.rug.nl/ggdc/valuechain/wiod/wiod-2016-release).
FMW is the fair minimum wage. (Extra ESCU's for incomes below the FMW were already allocated in the subcategory of fair wages)

Foreground calculations

Foreground ESCU's are calculated as the amount needed to raise the wages of all workers to 4,2% of the highest wage (including bonusses). Overtime income of both highest paid person and other workers is preliminarily calculated as 1,5 hour for all types of overtime.
The ESCU's are calculated as follows:
ESCU's = FWH x ∑ (FBHI – Wp), where:
FWH is the foreground amount of workhours per unit of product.
FBHI is the foreground highest total income in the organization.
Wp is the wage of each worker in the organization.

8.5 Subcategory: Labour Conditions

Introduction

Considered are 22 criteria/issues on labour conditions (mostly from Dreyer, Hauschild, & Schierbeck, 2010), and collected from ILO conventions, the GRI and ISO 22000).
Assumed is a maximum preventative costs of 8,33% (one month's pay/year) of the product's labour costs. Currently, there is no justification for this percentage, but given the percentages for other aspects, OSH and the gender wage gap, we trust this percentage is in the right order of magnitude. There is neither a characterization factor for the impact of the 22 different issues, nor do we have preventative costs for the individual issues, which is the reason to use the method of the governance level reducing multiplication factor.

Indicator

The maximum preventative costs, multiplied by a governance level determined reducing multiplication factor (RMF).

Targets
Full compliance to the 22 criteria on Labour Conditions.

Background calculations
The ESCU's are calculated as The maximum preventative costs, multiplied by a reducing factor for the quality of governance on the aspect.
ESCU's = LCMax% x BLC% x PP, where:
LCMax% is the maximum preventative costs for optimal labour conditions where non conformances occur, preliminarily set on one month pay per year (= 8,33% of the labour costs).
BLC% is the Background Labour Costs % of the product price, obtained from IO databases for the sector.
PP is the Product Price, estimated based on company-own research.

Foreground calculations
The organization is challenged to determine its own foreground costs to close the distance to optimal labour conditions by means of good governance. ESCU's are calculated as:
ESCU's = LCMax% x RMF x FLC% x PP, where:
LCMax% is the maximum preventative costs for optimal labour conditions.
FLC is the Foreground Labour Cost % x PP.
RMF is the foreground governance level determined reducing multiplication factor.
PP is the Product Price.

8.6 Subcategory: Personnel Development

Introduction
All workers deserve to be able to develop themselves to their abilities, even when that could mean that these workers may use their learnt abilities elsewhere.

As target of expenditures on personnel development, required are the average company expenditures in the group or 20% best performing countries. Preliminary ESCU's are based on USA data. The USA average wage (2013) was $ 44888 (https://www.ssa.gov/oact/cola/AWI.html); The USA average industry direct learning expenditures (2013) were about $1208 (Bouchrika, 2020; Miller, 2014), which is 2,7% of the average wage.

Indicator
Cost distance for personnel development to 2,7% of the wage sum.

Targets
Minimum employer contribution to the development of workers of 2,7% of the wage sum.

Background calculations
Usually, organizations can demonstrate their own contribution to workers' development, but sometimes not from not cooperating first or further suppliers. For those, background ESCU's for personnel development contribution are calculated as follows:
ESCU's = (TPDC-BPDC) x WS% x PP, where:
TPDC is the Target Personnel Development Contribution %.
BPDC is the Background Personnel Development Contribution %, set to zero.
WS% is the Wage Sum % (from sheet preparation).
PP is the Product Price, derived from price research.

Foreground calculations

Preliminarily, ESCU's are calculated as the cost distance to spent expenditures on personnel development to 2,7 % of the wage sum, as follows:
ESCU's = (TPDC-PPDC) x WS% x PP, where:
TPDC is the Target Personnel Development Contribution %.
PPDC is the actually Paid Personnel Development Contribution %.
WS% is the actual Wage Sum % (from sheet preparation).
PP is the actual Product Price.

Sometimes customers or governments provide or pay worker's training instead of the organization itself. If the costs spent by these external organizations can be demonstrated, these may be entered. However, if these costs are entered by the organization, the involved customer may not enter these costs as bonus, because that would be double counting.

8.7 Subcategory: Employment contract time

Not yet included aspect.

8.8 Subcategory: Other Labour related aspects

Introduction

Considered are 7 of worker's contract and payment related issues, such as lack of timely payment, a gender wage gap and paid parental leave:

- Contracts and notification before start and termination.
  See (Bakina, 2021)
- Wages paid at regular intervals of not longer than one month.
- No money, hiring fees taken from workers.
- No parts of remuneration withhold other than legally required.
- Equal pay for equal work and no gender remuneration gap.
  (Eurostat, 2022; ILO, 2020)
- No costs enforced on workers.
  See (D. Cooper & May, 2017)
- Parental leave.
  Maternity rights are set out in the 1992 Pregnant Workers Directive. This EU legislation sets the minimum period for maternity leave at 14 weeks, with 2 weeks' compulsory leave before and/or after confinement and an adequate allowance subject to national legislation (Giulio Sabbati; Martina Prpic; Ulla Jurviste, 2019). Legislations in the USA and OECD countries can be found in (Bipartisan Policy Center, 2020; OECD, 2021).

Because no data are available on the relative impact of these 7 issues and for most of these no costs of prevention could be found, preliminarily, the ESCU's are based on a scoring method. (2 points for perfect governance; 1 point for good governance but incidental violations and 0 points for worse.
The ESCU's are calculated as follows:
ESCU's = (TVLS/14) * MC where:
TVLS is the Total Various Labour aspect Score
14 is the maximum score at perfect governance for all 7 issues.
MC is the maximum Costs. Because background costs could be derived for fixing the gender wage gap, preliminarily, fixing the Gender Wage Gap (GWP) was assumed being the worst case. The global

average factor weighted GWP is 18,8% (ILO, 2017, 2019). At a 50% work share between genders, a raising of the average womans' wage would cost 9,4% of the product's labour costs.

Indicator
Simple governance scoring from 0 to 2 points per issue.

Targets
Zero violations with the above issues, resulting in a maximum governance score of 7 x 2 = 14.

Background calculations
For the background costs the maximum number of violations is assumed, resulting in the Formula: ESCU's = (TVLS/14) x MC. (See above for the explanation of the variables).

Foreground calculations
Preliminarily, the ESCU's are calculated based on the number of violations in the organization, as follows.

8.9 Subcategory: Health insurance

Introduction
In most high performance countries, employers contribute to employees' and their families' health insurance premiums. According to the O.S. system, ESCU's should be calculated as the cost distance to the average employers' a average contribution to the health care insurance premiums in group of the top 20% performing countries. Required data by country are the average health care costs per family and the average employer' contribution.

Countries have very different systems, which makes it very difficult to obtain these data. Some countries have full governmental coverage of health care, paid from the taxes. Because taxes are partly paid by industry, companies still contribute via that tax. Other countries have no or little governmental contribution to the costs and leave that to private insurances. In some of these countries without a proper governmental health care system, employers pay most of the premiums, but leave the unemployed without health insurance, but in other (mostly low income countries), also workers have no or little health insurance. Several countries have, next to their taxation, a separate tariff for health insurance, an average of around 60% is paid by the employer (Deloitte, 2017). In some countries health care contribution is specifically specified, in others part of the greater category of social security (Deloitte, 2017).

Indicator
Cost distance for health insurance contribution to 6% of the wage sum.(see below under background calculations for the justification of 6%).

Targets
Minimum employer contribution of health insurance cost of workers of 6% of the wage sum.

Background calculations
Usually, organizations can demonstrate their own contribution to workers' health insurance, but sometimes not from not cooperating first or further suppliers. For those, background ESCU's for health insurance contribution are allocated.
Total health care expenditures in the top 20% group of countries is around 10% of the GDP/capita (The World Bank, 2017), of which industry pays 60%. If we assume that the added value of products' represents their contribution to the GDP, equal to [1-purchased value ratio], as determined in Pr 21

(Sheet preparation), 6% of the wage sum represents the average health insurance costs, as wages represent the greater part of the added value. The Background ESCU's are calculated as follows:

ESCU's = (THIC-BHIC) x WS% x PP, where:
THIC is the Target Health Insurance Contribution %.
BHIC is the Background Health Insurance Contribution %, set to zero.
WS% is the Wage Sum % (from sheet preparation).
PP is the Product Price, derived from price research.

The assumptions are not completely accurate, because the GDP only includes the value produced inside the country, where preliminarily in the O.S., the purchased value is based on the total of residential and imported items.

Foreground calculations

The organization is demonstrating its foreground workers' health insurance contribution.
ESCU's = (THIC-PHIC) x WS% x PP, where:
THIC is the Target Health Insurance Contribution %.
PHIC is the actually Paid Health Insurance Contribution %.
WS% is the actual Wage Sum % (from sheet preparation).
PP is the actual Product Price.

8.10 Subcategory: Occupational Health and Safety

Introduction

Occupational Health and Safety (OHS) is an internationally recognized aspect, included in the legislation most countries and internationally regulated by various ILO conventions, starting with (ILO, 1981). Still, huge numbers of both fatal and non fatal incidents occur (https://ilostat.ilo.org/topics/safety-and-health-at-work) and only about 16000 companies are ISO 45001 trained and certified (https://qsr.com/services/iso-standards/iso-45001-certification).

Characterization factor and Indicator

Because of availability of data in the various industry sectors, the assessment of OHS could be developed properly based a characterization factor.
ESCU's were determined by assessment of the quality of governance on OHS and the risks in the industry sector. Determined in the Oiconomy project were the costs of good governance in two major industries, one in the food sector and one in the construction sector. The sector with the highest incident rate in the European Union of these two was the construction sector (Eurostat, 2020a, 2020b). The executed assessment was executed in a OSH certified large construction company in the construction industry. The found costs of good governance was 10% of labour costs. The incident rates of the construction sector were set as leading indicator (characterization factor = 1).

The risk factors or "characterization factors" were determined by the European (8 years average) fatal- and non-fatal incident rates. Characterization factors were calculated for both fatal and non-fatal incidents as follows:

$CF_{sector} = IR_{sector}/IR_{Leading\ sector}$, where:

CF_{sector} is the characterization factor for an industry sector

IR_{sector} is the incident rate of the industry sector in the European union

$IR_{Leading\ sector}$ is the EU incident rate in the leading indicator sector

The average was determined of the characterization factors for fatal and non-fatal incidents, which means that fatal incidents weigh much higher than non-fatals (because the fatal incident rates are much lower). The maximum ÈSCU's per industry sector are calculated by the average of fatal and non-fatal incident rates, multiplied by the value of the leading indicator.

Targets

A governance level, required for ISO 45001 - OHS certification (ISO, 2018).

Background calculations

With a demonstrable O.S. approved OSH certificate, zero ESCU's are allocated.
Without such certificate the ESCU's are calculated as follows:
ESCU's = BRMF x CF x LIC, where:
RMF is the background multiplication factor = 1,0.
CF is the impact characterization factor, determined by the average of fatal and non-fatal incident 8-year statistics in the European Union.
LIC is Leading Indicator Costs, determined at the Utrecht University at 10% of the Labour costs per unit of product. The background labour costs are determined as 50% of the product's price. The background product's price must be estimated by searching the internet and requesting prices at potential suppliers.

Foreground calculations

With a demonstrable O.S. approved OSH certificate, zero ESCU's are allocated.
Without such certificate the ESCU's are calculated as follows:
ESCU's = RMF x CF x LIC, where:
RMF is the governance level determined reducing multiplication factor.
CF is the impact characterization factor, determined by the average of fatal and non-fatal incident 8-year statistics in the European Union.
LIC is Leading Indicator Costs, determined at the Utrecht University at 10% of the foreground labour costs per unit of product.

9. Category: Social responsibilities and Animal Welfare

Introduction

Some social aspects could not be covered in other categories and are covered in this section.
More aspects may be covered in the future for still missing social externalities.

Considered Sustainable Development Goals

Goal 5: Achieve gender equality and empower all women and girls.
Goal 16: Promote just, peaceful and inclusive societies.
Goal 17: Revitalize the global partnership for sustainable development.

Subcategories

- Various Social Responsibilities
- Animal Welfare

- Social responsibilities: user aspects

9.1 Subcategory: Various Social Responsibilities

Introduction

Social issues, currently 27, are covered in this section, divided in 4 groups:
These issues are not covered in other categories either because their character does not belong in that category, or the used methods of assessment or calculation cannot be applied to the relevant issue. Costs of prevention, literally interpreted, are usually low or even zero, because the measure is usually to abstain from an activity, however, at the expense of profitability. Therefore, as for the aspects of corruption and violence and for financial issues, the net operating margin is the closest to the costs involved in abstaining from social irresponsible activities.
Non compliance on a series of economic or financial criteria would result in a very low rating.
An interest difference of about 16,5% between Moody's AAA and junk status of 10-year country credit bonds is not uncommon. Therefore, for financial aspects, the ESCU allocations can be maximized to 16,5% of the 5-year sector average profit margin. Assuming that an organization, not complying to all 27 social responsibilities should not be allowed to make a profit, preliminarily 16,5 % of the sector average profit is allocated. Because no different impact data are available for the different issues, the characterization factor is assumed equal to 1 for all issues, resulting in an ESCU score of 16,5/27 = 0,61% of organizations' net operating margin per issue.

Labour related aspects, not covered in the section of labour,
either occurring in ILO conventions, or very common criteria in national legislations or delivery contracts.

1. Discrimination in personnel policy, advertising or other communication considering sexes, health, handicap, religion, race, origin, age, political conviction, pregnancy or migrants, including unequal gender distribution in the organization's leadership.
2. Lack of efforts to stimulate labour participation of minorities, disabled and underprivileged. However, this standard does recognize the necessity of well qualified personnel for the job. Lack of participation.
3. Physical or mental violence and harassment to persons inside or outside of the organization.
4. Lack of demonstrable involvement of vulnerable groups and lack of avoiding discrimination by gender, race or other, and in low income countries of local suppliers.
5. Payment of suppliers, employees or other workers more than 30 days after delivery or after the agreed limit of the payment date.

Property rights related aspects.

Property, rights have positive and negative effects. They protect ownership and stimulate research and development, but may also slow down sustainable development and by huge profits on essential needs transfer wealth from the poor (consumers) to the rich (shareholders).

6. Illegal use of a brand name, knowledge, domain, design or intellectual property of others, use of origin statements without substantial activities at the relevant location. The strictest legislation of all countries involved in production, trade and consumption applies.
7. Violation of property rights of both tangible goods and intellectual property.

8. The use of property rights based on DNA or properties directly from nature (e.g. natural seeds).
9. The use of property rights for longer than 10 years after first launch in the market on food and health products .
10. The use of property rights on sustainability enhancing developments, longer than 10 years after first launch in the market.
11. Under-market compensation for acquired property and using any pressure to acquire property.
12. Disrespect for not well defined traditional property, e.g. involving indigenous people, or their culture and rights.

Communication related issues

Following criteria are either common legal criteria, common misleading communications, advertising harmful products, common annoyances or incomplete information potentially leading to extra expenses for consumers.

13. Advertising without respect for groups of the society, such as stereotyping, or advertising on media that divide instead of connect, or on media that do not prevent use by others of their media to divide or mislead.
14. Advertising with potential wins, prizes or profits without publishing the chance, or advertising subscriptions with temporary reductions without mentioning the expiration data of the reduction and what cost may be expected after the reduction period. (exception: lotteries and other products that present this chance/risk ratio and the related uncertainty as the product itself).
15. Advertising smoke, health damaging food- or care-products, or pharmacological products (except on medical prescription), without presenting substantial negative side effects as one of the clearest communications. Not intended here is a copy of the package leaflet for prescriptions, but only the major issues (such as cancer by smoke).
16. Use of health claims without reference to published independent and reviewed scientific evidence of their correctness.
17. Use of misinformation about the product or purpose and consequences of use. (communicate your own strength's and not the competitors' weakness).
18. Communicating negative information on competing products and companies.
19. Not consistently communicate the sustainability as it is determined by the use of the Oiconomy standard together with advertising about or including aspects of sustainability.
20. Incomplete, ambiguous, insufficient transparency of vital information, or information that raises expectations not conforming the product, on packaging, information leaflets, contracts, webpages, prospectus and other ways of communication about the product or company.
21. (Risk of) violation of privacy.
    1. Spam, uninvited telemarketing or other methods of violating the privacy of private persons.
    2. Keeping, disclosing or using personal data without a proper reason or without knowledge of the involved persons.
    3. Insufficient protection of personal data, both physically and digital.
22. Advertising that insurance will pay for a product.
23. Lack of easy access and/or follow-up to service desks for complaints and grievances. (The responsible organization keeps waiting times limited, answers in countries’ own language, documents and effectively investigates and solves complaints and incidents and takes measures to prevent repetition).

Issues not belonging in any other category or group

24. Noise (>50 decibels in living areas), vibration, smell, dust, traffic in living areas or other disturbances to people, where this matter is not covered by the section on public health.
25. Earthquake-, land slide, avalanche- or flood risks due to operations, in areas where it may damage others.
26. Damage to cultural heritage.
27. Direct or indirect lobbying with the intention to weaken or delay any sustainable development on aspects discussed in the Oiconomy Pricing system.

Characterization Factor and Indicator

The characterization factors of the 27 different issues are all assumed 1, because there is no objective way to weigh the relative impact of these issues.
The indicator is the Percentage of issues with non-compliances multiplied with the net operating margin and product price.

Targets

Complete compliance to all 27 criteria

Background calculations

ESCU's = PP x 14 x PLNC x BNOM, where:

PP is the product's price
14 is the regularly occurring number of issues (the other 13 are sector-dependent or not very common), which is taken as the worst case.
BNOM is the background average net operating margin of the sector.
PLNC is the assumed % Profit Loss per Non-Compliance.

Foreground calculations

ESCU's = PP x NC x PLNC * FNOM, where:
PP is the product's price
PLNC is the assumed % Profit Loss per Non Compliance.
FNOM is the foreground 5 year average net operating margin of the sector.

9.2 Subcategory: Animal welfare

Introduction

Animal welfare is a very complex aspect with questions like how to define and measure; What is the target; Is species categorization necessary and if yes how to do that? The aspect of animal welfare affects other aspects both positively and negatively. Some examples: Providing more space to farm animals and lower yielding organic agriculture also requires more land, but mitigation of the amount of non-vegetarian consumption saves land and land is a prerequisite to prevent hunger; Livestock's industry over-reliance on human-edible food as animal feed has increased food insecurity and a detrimental impact on biodiversity. Use of antibiotics increase yields and therefore reduce hunger and poverty, but increase the risks of resistant human-pathogenic bacteria. Large scale low cost agriculture keeps food prices low, but increases poverty of large numbers of small scale farmers (UNEP & OIE Global Forum on Animal Welfare, 2020).

Next to environmental aspects and the direct harm-impacts to animals, high animal welfare standards are increasingly experienced as a moral need. People feel uncomfortable to contribute to harm animals and withhold them from their species typical behavior. Therefore the O.S.

subcategorizes animal welfare in the category of “Various **social** aspects”.
Animal welfare is very difficult to measure, nor is a characterization factor available on the relative seriousness of the impacts to animals of the different harms inflicted by mankind. There are also no data suitable to determine the group of 20% best performers.
Therefore, the Oiconomy Pricing System follows its third methodology option for an indicator in its methodology: a reducing governance factor multiplied by the maximum preventative costs.
Available and widely accepted (e.g. by the European Union (Eur-Lex, 2020; Welfare Quality Network, 2009b) are the five freedoms of animal welfare:

Indicator

1. Freedom from hunger and thirst: by ready access to fresh water and a diet to maintain full health and vigor.
2. Freedom from discomfort: by providing an appropriate environment including shelter and a comfortable resting area.
3. Freedom from pain, injury or disease: by prevention through rapid diagnosis and treatment.
4. Freedom to express normal behavior: by providing sufficient space, proper facilities and company of the animal’s own kind.
5. Freedom from fear and distress: by ensuring conditions and treatment which avoid mental suffering.

These five freedoms present very general principles for animal wellbeing. The actual issues vary per species, type of human activity, country, climate and even culture and religion. However, based on these 5 freedoms, standards have been developed describing minimum conditions for specific species of farm animals, e.g. (Animal Health Australia, 2020; Animal Welfare Standards, 2022; Farm Animal Welfare Council, 2009; Textile Exchange (responsible down standard), 2014; Better Life Label - Animal Protection, 2022).

Various standards on animal welfare include criteria on organic agriculture and all organic agriculture labels include criteria on animal welfare, which complicates the specific determination of the preventative costs for animal welfare.
The EU Welfare Quality© project’s welfare assessment protocol, provides a protocol of scoring criteria (based on the 5 freedoms of animal welfare), including derived specific protocols for a number of animal species (Welfare Quality Network, 2009c, 2009b, 2009a, 2012, 2018). This assessment protocol only considers animal welfare criteria and expresses these in a “WQ score”.

These standards do not include criteria on the keeping of animals related to a goal, like for fur, testing, education, breeding tourism and entertainment. On the breeding of animals for fur, the Furfree Alliance published a summary of legislation in European countries (FurFree Alliance, 2015), showing that the matter is quite widely considered immoral and already banned in various countries, like Austria, parts of Belgium, Netherlands in 2024, Croatia, Denmark for foxes, Germany in several states, Slovenia, Switserland and the UK, several states in the USA, Japan, New Zealand.
The European Union also banned testing on animals of cosmetics (The European Parliament and the Council of the European Union, 2009) and in the USA a bill to this goal is pending (USA Congress.gov, 2021). Therefore, the Oiconomy Pricing system considers breeding or keeping animal for fur and testing for cosmetic purposes unsustainable.

(Gocsik et al., 2016) determined the WQ score and involved costs of a series of poultry farms.
A Volwaard en Eerlijk piece of chicken had a 27% higher WQ score than conventional chicken and a 22,6% higher production costs than standard intensive poultry farming. “Extensive outdoor” a 25,4% higher WQ score and 47,6% higher costs. Organic a 21% higher WQ score and a 139% higher costs.

These data demonstrate the huge difference (mainly due to higher feed costs) between the costs of fully organic poultry and farms only complying to animal welfare criteria.

A German research (Institut Agrarpolitik und Landwirtschaftliche Marktlehre Fachgebiet Agrar- und Ernährungspolitik, 2016; Wissenschaftlicher Beirat Agrarpolitik beim BMEL, 2015) on the involved costs to achieve potential legal animal welfare criteria, and also based on the 5 freedoms shows the following costs distance at farm level:

Pork:	28-41 % from the average sales price at farm level.	
Poultry - eggs:	7-18 %	"
Poultry – meat:	9-22%	"
Cows Milk	2-5%	"
Beef	18-27%	"

Standing out is the almost equal costs between the Gocsik determined preventative costs for poultry meat and the maximum of the range for poultry meat in the German research (22,6% and 22%). Because on the aspect, we are looking for the worst case costs to be reduced by the demonstrable governance factor of the specific organization, The German maxima are used as background data. The background ESCU's for all birds and small animals (e.g. rabbits) are assumed equal to chickens; The background ESCU's for all large farm animals other than cows kept indoors are assumed equal to cows for meat and kept outdoors to cows for milk.

Targets

No specific one-indicator assessment of the welfare of an animal is available. Various comprehensive multi-criteria standards are available. Therefore, for this aspect, certification to some standards, meaning 100% compliance to all criteria results in zero ESCU's. Otherwise, the target is optimal governance of animal welfare.

Background calculations

In absence of an O.S. approved certificate covering animal welfare, the ESCU's are determined by:
ESCU's = PP x MPC x RMF x M%, where:
PP is the product's price.
RMF is the Reducing Multiplication Factor determined by a set of PDCA based governance quality determining criteria.
M% is the issue mitigation percentage. For the remaining percentage, the background ESCU's are calculated and added.
MPC is the maximum preventative costs, derived from (Institut Agrarpolitik und Landwirtschaftliche Marktlehre Fachgebiet Agrar- und Ernährungspolitik, 2016; Wissenschaftlicher Beirat Agrarpolitik beim BMEL, 2015). The maxima from the reported range of percentages from the sales price at farm level were used. For other animals, values were assumed equal to a known value for a similar animal (e.g. for all bird meat the value for chickens).

Foreground calculations

The organization is challenged to determine the foreground costs to improve the RMF and therewith the animal welfare. The foreground calculation formula is:
ESCU's = PPP x RMF x IC x M%, where:
PP is the product's price.
RMF is the Reducing Multiplication Factor determined by a set of PDCA based governance quality determining criteria. For the remaining percentage, the background ESCU's are calculated and added.
IC is the improvement costs per unit of product.

M% is the issue mitigation percentage. For the remaining RMF score, the background formula is used.

9.3 Subcategory: Social responsibilities: user aspects

Introduction

Next to pollution, health and safety issues and depletion issues, product use may cause harm or annoyances by their use. Three product-use aspects are currently covered by the O.S.
The use-sections of the Oiconomy Pricing Tool only request foreground data, but even these may not be available.
Currently, there are not enough data on use-related social issues to create background data on a reasonable amount of products or even product categories.
However, because the use phase of a product is the responsibility of the end-producer, there are no unknown suppliers involved and therefore, the end producers should be able to provide the data.

Issues

- Instructions for use
- Product Warranties

9.3.1 Instructions for use

Introduction

Clear and correct instructions for use of products are an important means for the effective achievement of sustainable development. E.g. these criteria may affect product life, energy consumption, product related health and safety issues and sustainable disposal.
Instructions may be provided on the product or packaging or on the internet if clearly referred to on the product.

Indicator

The number of target criteria not met.

Target

Instructions are:

1. Checked and approved by a qualified independent person with the native language.
2. In the right and correct language
3. Complete, nowhere confusing and completely conforming the use of the utensil
4. Up to date
5. Understandable for every normal user.
6. Including how to maintain a long product life
7. Including how to repair the most common wear, failings and damages
8. Mentioning where to obtain spare parts.
9. If danger or complexity is involved or special tools are required, the instructions include advise and addresses about where the product can be repaired or maintained and how to contact.

Background calculations

The actual costs of prevention are not available and will be quite product- and sometimes location-dependent. Without foreground data, the O.S. preliminarily allocates ESCU's as follows:
At zero Non Compliances (NC) to the 9 criteria: ESCU's = 0.

At max 2 NC's: ESCU's = 0,5% of the sector average net operating margin.
At >2 NC's: ESCU=s 1,0 % of the sector average net operating margin.
There is no scientific justification for this calculation of ESCU's.

Foreground calculations

N/a

9.3.2 Product Warranties

Introduction

Product warranties are important because they place the responsibility for the quality of the product on the supplier. They improve product life and quality. Because also sustainability aspects, such as safety, use-depletion and pollution, and energy consumption belong to product's properties, warranties also apply to sustainability properties.

Indicator

Yes or no compliance to the criterion of giving responsible product warranties.

Target

Product Warranties, complying to the legislation of both the countries of production, sales and use, easily accessible for consumers/users in all languages of these countries, easy to contact for complaints and replace failing products.

Background calculations

Without proper responsible warranties, ESCU's are calculated as follows:
ESCU's = 2% of the sector average net operating margin. **There is no scientific justification for this calculation of ESCU's.**

Foreground calculations

N/a

10. Category: Corruption & Conflict

Introduction

Conflict, war, corruption and crime are great dangers to sustainability.
Therefore the O.S. includes criteria on both situations where the activities of an organization may contribute to situations of conflict, violence or corruption, and situations where the transparency and reliability of the organization and its communication may be questioned by the presence of situations of conflict or corruption.

Corruption is an economic issue, detrimental by itself and in addition heavily affecting all other aspects. Most detrimental is corruption of governmental level and by large international companies. Assessment of ESCU's for corruption is an absolute necessity. However, for smaller companies, corruption often is more an unavoidable burden than a revenue model. International companies always have the choice to abandon business and renounce the made profit in a corrupt country and take the risk of cooperation with competitors in avoiding bribes, where small local companies don't.

Measuring involvement in corruption by a specific organization or case is by nature almost impossible. The most recognized indicator on the level of corruption by country is the yearly updated Transparency International Corruption Perception Index (https://www.transparency.org/).

Considered Sustainable Development Goals

16: Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels.
17: Strengthen the means of implementation and revitalize the global partnership for sustainable development.

Subcategories

N.a.

Indicator

The indicator is the maximum costs to stop corruption, multiplied with a reducing factor for the governance of corruption.
The maximum costs to stop corruption is to make corruption-based business unprofitable and therefore equal to the net operating margin.
The reducing multiplication factor (RMF) is determined by assessment to a set of PDCA divided criteria. One of these criteria is an 8 year accountant switch. The EU proposes a maximum 10 year period but leaves legislation and choices to the member countries. In 2013, The Netherlands implemented a mandatory 8 year accountant switch (Gold et al., 2013).

Background calculations

Reliably measuring corruption is almost by definition impossible, because corruption tries to be hidden. However, it is possible to assess the quality of governance against corruption.
The O.P.T. first excludes some demonstrable situations for assessment: risk of partiality by shareholders, company size, countries' Corruption Perception Index score and existing certificates.
For the remaining organizations, the calculation formula is:

ESCU's = PP x BNOM x RMF, where:
PP is the product price.
BNOM is the Average Background Net operating margin of the sector, because taking away the profit is taken as the maximum preventative costs.
RMF is the Reducing Multiplication Factor, determined by measuring the governance level on corruption and conflict.

Foreground calculations

For foreground calculations, the following formula is used:
ESCU's = PP x FNOM x RMF x M%, where:
FNOM is the foreground 5 year average net operating margin of the company, and the other variables the same as for background calculations.
M% is the issue mitigation percentage. For the remaining percentage, the background ESCU's are calculated and added.

11. Category: Economic Responsibilities

Introduction
The economic responsibility (or in O.S. terminology “prosperity”) section is partly still in a preliminary stage, not only in the O.S., but also in science generally. E.g. In a literature search on fair banking, one almost exclusively finds criteria on in which sectors or companies banks invest. No criteria are found on speculation of facilitating speculation, the sustainable use of options and futures, required buffers.
For the O.S., a solid measure for the important aspect of fair transactions could be developed, as a consequence from the fair minimum wage.

Considered Sustainable Development Goals:
Goal 1: End Poverty in all its forms everywhere.
Goal 12: Ensure sustainable consumption and production patterns.
Goal 16: Promote just, peaceful and inclusive societies.
Goal 17: Revitalize the global partnership for sustainable development.

Subcategories:
- Fair Transactions
- Transparency
- Finance related criteria
- Fair Taxes
- Subsidies

11.1 Subcategory: Fair Transactions

Introduction
At the Utrecht university a method was developed to determine a definition of a “fair minimum wage (FMW)”(Croes & Vermeulen, 2016b), based on a relative amount depending on a countries’ wealth (a percentage of the GNI/capita), bottom truncated by an amount based on application of ILO conventions, a sustainable family size of 2 children per woman and the medium World Bank poverty line. See the justification in the section on remuneration.

Wages are only applicable in a employer-employee relation. In addition, all suppliers of sufficient size and development are potential actors in the Oiconomy Pricing system. Still lacking was a system to measure the distance to a fair payment for goods, delivered by “Low Developed Suppliers (LDS)”, such as small farmers, workshops, drivers or other actors without any payroll relation with the organization. In practice, the power difference between medium and large companies in high income countries and an LDS is often too big for an equal negotiation on prices.

The Oiconomy Pricing System (OPS) limits the assessment of fair transactions to transactions with an LDS. The OPS considers customers of LDS’s responsible to see to it that the LDS obtains a price for his product, at least equal to the FMW. Therefore, the organization purchasing from LDS’s shall determine the amount of hours and other costs of the LDS and determine the cost distance between paying him the hourly FMW (after having paid his costs) and the actual paid price.
However, the organization does not need to compensate the distance to the total income of the LDS

if his business does not provide him a full time (1864 hours/year) job, but only for the worked hours.

Impact category and indicator

The impact category is unfair payment for products (materials or services) and the indicator is the distance between the paid amount per worked hour and the fair minimum wage (FMW) as determined by the O.P.T.

Targets

Zero distance between actual payment and the FMW.

Background calculations

The background ESCU calculation formula is: ESCU's = FMW – WCI * DH, where:
FMW is the minimum wage
WCI is the Worst Case Income in the country, as listed in www.WageIndicator.org.
DH is the default amount of worked hours, as found for the industry sector in an IO database as WIOD-SEA (WIOD, 2020).

Foreground calculations

The foreground ESCU calculation formula is: ESCU's = FMW – AWH, where:
FMW is the minimum wage
AWH is the Actual Wage per Hour as calculated by the paid amount divided by the amount of worked hours for one unit of product.

11.2 Subcategory: Transparency

Introduction

The O.S. limits itself to product related transparency. In literature, no criteria on product related transparency could be found. At the Utrecht University, a preliminary set of criteria was developed, limited to product sustainability transparency and product costs transparency.
In order not to harm the consumer or society, the organization should be transparent in:

1. Directly and indirectly to the product related costs, such as the price, taxes, delivery costs, costs and terms of credits, installation costs, replacements to be expected due to wear, maintenance and energy use, disposal costs and the costs of required or advised insurances or subscriptions, taxes and tied sales with other products, contract- and cancellation periods. All these are based on the defined normal use and the year/moment of sales. For case specific costs (e.g. installation costs), averages may be used.
2. All legal communication requirements to the product, all other terms of delivery or conditions for use of the product, and all addresses for redress, return and complaints.
3. The expected product life at normal use, not necessarily equal to the warranty period. "Dependence on use" may be mentioned, but not without an average product life.
4. If applicable, the potential adverse effects of the use of the product to the user, the environment or other people, and the measures the user/customer may take to minimize that impact and the costs of such measures. For financial products, the risks of the product.
5. No communications by the organization contradicting the data demonstrated by ESCU's.
6. Information on the proper disposal of the product and its packaging material at end of life.

Indicator

The aspect is characterized by the measure of demonstrable compliance that the above 6 product transparency criteria.
The indicator is a reducing factor multiplied by the net operating margin of the industry sector.
The factor is a simple either 0, 0,33 or 0,66, depending on the correctness of the information and the percentage if sales/advertising locations where the information is communicated.

Targets

Full compliance to above criteria at all locations of advertising and sales.

Background calculations

ESCU's = PP x BNOM x factor, where:
PP is the product's price.
BNOM is the background net operating margin for the sesctor.
Factor as described above, but as background data, usually 1,0.

Foreground calculations

The organization is challenged to determine and enter the costs to achieve at least 80% of demonstrable compliance.
ESCU's = Costs of 80% demonstrable compliance.

11.3 Subcategory: Finance related criteria

Introduction

This aspect is in development and not yet actively included in the O.P.T.
Most literature and websites on responsible or sustainable finance focus on the issue of responsible financing (usually by banks or insurance companies) and especially in which companies is invested. The Oiconomy Pricing system would be a means for such companies to assess the sustainability of their investments.
However, little literature is yet available on criteria of financial conduct and used tools, while for instance the 2008 financial crisis was caused by irresponsible conduct and misuse of financial tools and a repetition of such crisis is far from impossible. Certain is that financial misconduct may lead to serious harm to large amounts of people and huge governmental support of financial corporations, such misconduct is an externality.

In order to make companies aware of potential finance related types of misconduct, a series of issues were already proposed in the O.P.T., but without ESCU calculations.

Impact category and indicator

N.a.

Targets

N.a.

Background calculations

N.a.

Foreground calculations

N.a.

11.4 Subcategory: Fair Taxes

Introduction

October 2021, the international community agrees that corporate tax rates shall not be lower than 15%. Herewith they agree that corporate tax rates were caused unfair competition.
The 15% minimum was an agreement based on negotiations, differences remain existing.
Fact is that most costs on infrastructure fall required for the production fall on the country of production and countries of head offices or mailbox companies hardly cost anything to the residing country. Therefore, the O.S. considers that fairly paid taxes should be proportional to the workhours on the product in the different countries.

Indicator

The difference between the fair tax and the paid tax.
The fair tax is calculated by the product of the product-workhour share, the Net Operating Margin, and the corporate turnover. The Datafile of the O.P.T. contains an inventory of corporate tax rates by country, taken from various sources but most from (Deloitte, n.d.; Trading Economics, 2022; OECDStat).

Targets

Zero difference between the fair tax and the paid tax.

Background calculations

Currently, anno 2023, The O.P.T. has not enough data to provide a background Tax avoidance average per industry sector. Therefore, for background calculations, only very rough indicative data are used until further research refines these.
Fact is that many international corporate companies pay little or even zero tax, despite of huge income (Koronowski et al., 2022). The OECD average corporate tax revenues as a percentage of GDP in 2018 was 3,1% and globally 3,2% (OECD, 2019).
Assuming that a product's price represents its proportional part of the GDP, and that zero tax regularly occurs and therefore represents the worst case, One very rough way of calculating background ESCU's are therefore as 3,2% of the product's price.
The global average GDP weighted statutory corporate tax rate in 2022 was 25.54% (Tax Foundation, 2022).
However, Average Net Operating Margins by industry sector are available and usually, the industry sector is known, even when the company and country are not.
If it may safely be assumed that the relevant actor in the supply chain has no activities or companies in more than one country (E.g. most small farmers have not), the background ESCU's are calculated as follows.
ESCU's = PP x ANOP x ANOM, where:
PP is Product Price (of the product/material at the relevant supply chain stage).
ANOM is the Average Net Operating Margin for the industry sector.

ASCTR is the (globally) Average Statutory Corporate Tax Rate.

Foreground calculations

$ESCU' = \sum [(WH_{country} / TWH) \times FNOM \times CTR_{country}] \times CT - PCT) \times (PrT/CT)$,where:
$WH_{country}$ is the amount of workhours of the organization in the relevant country.
THW is the total amount or workhours in the organization.
FNOM is the foreground net operating margin.
$CTR_{country}$ is corporate tax rate in the country.
CT is the corporate turnover.
PCT is the paid corporate tax.
PrT is the product turnover.

11.5 Subcategory: Subsidies

Introduction

All subsidies are externalities and confuse the total ESCU value, which is aimed to gradually evolve to the real extra costs for the sustainable version of the product. In addition, subsidies may disturb the free market and it is doubtful that they even distort welfare. However specific sustainability enhancing subsidies are helpful for faster implementation of these (Draper et al., 2021; OECD; WorldBank; WTO; IMF, 2022).
Therefore subsidies count as ESCU's except for those of which clear and intended first goal is sustainability enhancement.

Indicator

The full sum of subsidies relevant for the product.

Targets

Not applicable. F or all subsidies, ESCU's are allocated.

Background calculations

N.a.

Foreground calculations

All subsidies, specifically on products shall directly be allocated as ESCU's.
Subsidies to the organization, relevant for the product shall be allocated as ESCU's proportionally to the product's turnover share of organizations' turnover.

12. Positive impacts Bonus

Introduction

The Bonus section is not an aspect category. It can be understood as an extra stage or option in the production flow in the organization.
Organizations often provide benefits for the society. Therefore, bonus-ESCU's are allocated for benefits, materials or activities with positive impact. They must reduce the sum of other ESCU's and are therefore negative. Inclusion of benefits in the assessment needs to comply with strict rules in order to prevent unjustified use of Bonus-ESCU’s and greenwashing. Therefore, a study to the required criteria was conducted and published. (Croes & Vermeulen, 2020). The outcome resulted in the following criteria:

1. Equal to other ESCU's, Bonus-ESCU's represent "externalities", costs or benefits for others than the actors in the supply chain itself. Therefore, for benefits for the organization itself or its customers, no Bonus-ESCU's are allocated. Bonus-ESCU's may only be allocated for products and activities that the organization is not paid for. Some frequent occurring conditions and criteria are:
    a. Advertising a benefit makes the costs an internality, for which no ESCU’s can be demonstrated.
    b. R&D activities (almost) exclusively intended for environmental or social improvements are positives if the envisioned results are beneficial especially to others than those involved in the economic transaction.
    c. Products of which the utility is (almost) exclusively unburdening (e.g., solar panels) are positives. Only the capacity-raising investments (depreciation + interest) are positives, not the utility itself, unless that positive utility is free of charge. Note that for instance the utility of an electric car, measured by status is not unburdening, because its utility is driving.
2. With a few exceptions, the Bonus-ESCU's are equal to the demonstrable expenditures by the organization for the considered aspect.
3. Bonus-ESCU's are always foreground (calculated by the organization and considering the specific product.
4. Bonus-ESCU’s must be based on demonstrable benefits and may not be based on “absence of negative impact”.
5. Bonus-ESCU’s must consider the aspects, included in the Oiconomy Pricing Standard and the Oiconomy Pricing Tool.
6. Employment is no reason for Bonus-ESCU’s, with the exception of secondary employment in rather closed communities in low income countries. (“secondary employment” is defined as demonstrable and defined amount of employment in the close community of the organization as a direct result of the activities of the organization).
7. A product with evident benefits, for which the organization is paid (e.g. food, pharma, medical devices, solar panels).

Indicator

The demonstrable expenditures on an external benefit

Target

Not applicable

Background calculations

Not applicable

Foreground calculations

Expenditures are spent by the organization and usually not specifically related to one product, unless the organization only produces and sells one product. Therefore,

ESCU's = $E_b \times T_p / T_o$,

Where E_b is the expenditures for the benefit, T_p is the product turnover and T_o is the organization turnover.

References:

Animal Health Australia. (2020). *Animal Welfare Standards*. https://www.animalwelfarestandards.net.au/sheep/

Animal Welfare Standards. (2022). *International Animal Welfare Standards Project*. Www.Animalwelfarestandards.Org. https://www.animalwelfarestandards.org/

Anker, R. (2005). *A new methodology for estimating internationally comparable poverty lines and living wage rates* (No. 72; Working Papers, Issue 72).

Bakina, I. (2021). *Dismissals Guide Andersen in Europe* (Issue March).

Balmford, A., Amano, T., Bartlett, H., Chadwick, D., Collins, A., Edwards, D., Field, R., Garnsworthy, P., Green, R., Smith, P., Whitmore, A., Broom, D. M., Chara, J., & Finch, T. (2018). The environmental costs and benefits of high-yield farming. *Nature Sustainability*, *1*(9), 477–485.

Balmford, A., Gravestock, P., Hockley, N., McClean, C. J., & Roberts, C. M. (2004). The worldwide costs of marine protected areas. *Proceedings of the National Academy of Sciences of the United States of America*, *101*(26), 9694–9697. https://doi.org/10.1073/pnas.0403239101

Balmford, A., Green, R. E., & Scharlemann, J. P. W. (2005). Sparing land for nature: Exploring the potential impact of changes in agricultural yield on the area needed for crop production. *Global Change Biology*, *11*(10), 1594–1605. https://doi.org/10.1111/j.1365-2486.2005.001035.x

Bayraktarov, E., Stewart-Sinclair, P. J., Brisbane, S., Boström-Einarsson, L., Saunders, M. I., Lovelock, C. E., Possingham, H. P., Mumby, P. J., & Wilson, K. A. (2019). Motivations, success, and cost of coral reef restoration. *Restoration Ecology*, *27*(5), 981–991. https://doi.org/10.1111/rec.12977

Better Life Label. (2022). *Better Life Label Dairy cattle - 3 stars*.

Better Life Label - Animal Protection. (2022). *What is the Better Life label?* https://beterleven.dierenbescherming.nl/zakelijk/en/what-is-the-better-life-label/

Bipartisan Policy Center. (2020). *Paid Family Leave in the United States* (Issue February). https://www.proquest.com/dissertations-theses/essays-on-paid-family-leave-united-states/docview/2234774926/se-2?accountid=17242

Bouchrika, I. (2020). 68 Training Industry Statistics: 2021/2022 Data, Trends & Predictions. *Research.Com*.

bouldercounty.gov. (2022). *Hazardous Waste Disposal Costs for Businesses*. Https://Bouldercounty.Gov/Environment/Hazardous-Waste/Disposal-Costs-for-Businesses/. https://bouldercounty.gov/environment/hazardous-waste/disposal-costs-for-businesses/

Budiharta, S., Meijaard, E., Erskine, P. D., Rondinini, C., Pacifici, M., & Wilson, K. A. (2014). Restoring degraded tropical forests for carbon and biodiversity. *Environmental Research Letters*, *9*(11), 114020. https://doi.org/10.1088/1748-9326/9/11/114020

CBS. (2019). *Material Flow Monitor 2016 – Technical Report, Statistics Netherlands, The Hague/Heerlen, The Netherlands.* (Issue december).

CBS, PBL, RIVM, & WUR. (2021). *Kosten en financiering natuur- en landschapsbeheer 1999-2018*. https://opendata.cbs.nl/statline/#/CBS/nl/dataset/70213ned/table?dl=380E

Charoenporn, N., Outama, A., Kaewdok, T., Earde, P., & Kooncumchoo, P. (2019). Maximum acceptable weight of lift in adolescence aged 15 to less than 18 years old. *Advances in Intelligent Systems and Computing*, *826*(August 2018), 778–788. https://doi.org/10.1007/978-3-319-96065-4_81

Common Objective. (2018). *Working hours in the fashion industry*. Https://Www.Commonobjective.Co/Article/Working-Hours-in-the-Fashion-Industry.

Cooper, D., & May, T. K. (2017). *Employers steal billions from workers ' paychecks each year Survey data show millions of workers are paid less*.

Cooper, W. (2019). *https://chiefexecutive.net/ceo-and-senior-executive-compensation-in-private-companies-2018-19/*. ChiefExecutive. https://chiefexecutive.net/ceo-and-senior-executive-compensation-in-private-companies-2018-19/

Coyle, M. (2007). *Effect of Payload on the Fuel Consumption of Trucks*.

Croes, P. R., & Vermeulen, W. J. V. (2015). Life Cycle Assessment by Transfer of Preventative Costs in the Supply Chain of Products. A first draft of the Oiconomy system. *J. Cleaner Prod.*, *102*, 178–187. https://doi.org/10.1016/j.jclepro.2015.04.040

Croes, P. R., & Vermeulen, W. J. V. (2016a). In search of income reference points for SLCA using a country level sustainability benchmark (part 1): fair inequality. A contribution to the Oiconomy project. *Int. J. Life Cycle Assess.*, *21*(3), 349–362. https://doi.org/10.1007/s11367-015-1018-0

Croes, P. R., & Vermeulen, W. J. V. (2016b). In search of Income Reference Points for SLCA using a Country Level Sustainability Benchmark (part 2): Fair Minimum Wage. A Contribution to the Oiconomy project. *Int. J. Life Cycle Assess.*, *21*(3), 363–377. https://doi.org/10.1007/s11367-015-1017-1

Croes, P. R., & Vermeulen, W. J. V. (2019). Quantification of corruption in preventative cost-based S-LCA: a contribution to the Oiconomy project. *Int. J. Life Cycle Assess.*, *24*(1), 142–159. https://doi.org/10.1007/s11367-018-1507-z

Croes, P. R., & Vermeulen, W. J. V. (2020). The assessment of positive impacts in LCA of products. *Int. J. Life Cycle Assess.*

De Baan, L., Alkemade, R., & Koellner, T. (2012). Land use impacts on biodiversity in LCA: a global approach. *Int. J. Life Cycle Assess.*, *april*, 1–15. https://doi.org/10.1007/s11367-012-0412-0

De Pue, D. (2019). *Insights into the spatially differentiated control of ammonia emissions from livestock farming in Flanders* (Issue 1). Ghent University.

Delft University of Technology. (2022). *www.ecocostsvalue.com*. https://www.ecocostsvalue.com/

Deloitte. (n.d.). *Corporate Tax Rates 2018-2022*.

Deloitte. (2017). *EU Social Security Survey*.

Draper, P., Freytag, A., Gao, H., & et al. (2021). *Domestic Distortions throurh industrial Subsidies: Reframing the G20's potential Perspective*.

Dreyer, L. C., Hauschild, M. Z., & Schierbeck, J. (2010). Characterisation of Social Impacts in LCA: Part 1: Development of Indicators for Labour Rights - Supplementary Material 1-4. *Int. J. Life Cycle Assess.*, *15*(3), 247–259. https://doi.org/10.1007/s11367-009-0148-7

El-Sharkawi, M. A. (2021). Environmental Impact of Power Plants. *Electric Energy*, 81–90. https://doi.org/10.1201/9781420062205-8

Eur-Lex. (2020). *Animal Welfare*. Animal-Welfare @ Eur-Lex.Europa.Eu. https://eur-lex.europa.eu/EN/legal-content/glossary/animal-welfare.html

Eurofound. (2022). *Overtime in Europe: Regulation and practice*. Publications Office of the European Union, Luxembourg. www.eurofound.europa.eu

Eurostat. (2020a). *Fatal acccidents at work*. Https://Ec.Europa.Eu/Eurostat/Statistics-Explained/Index.Php/Accidents_at_work_statistics#Incidence_rates. https://ec.europa.eu/eurostat/statistics-explained/index.php/Accidents_at_work_statistics

Eurostat. (2020b). *Fatal accidents at work by NACE Rev. 2 activity and sex*. Https://Ec.Europa.Eu/Eurostat/Statistics-Explained/Index.Php/Accidents_at_work_statistics#Incidence_rates. https://ec.europa.eu/eurostat/web/products-datasets/-/hsw_n2_01

Eurostat. (2022). *Gender pay gap statistics* (Issue March).

Eurostat Statistic Explained. (2021). Passenger mobility statistics. *Online*, *December*, 1–11. https://ec.europa.eu/research/foresight/index.cfm

FAO. (2019). *FAOSTAT*. Website. http://www.fao.org/faostat

Farm Animal Welfare Council. (2009). *Farm Animal Welfare in Great Britain: Past, Present and Future* (Issue October).

Fischer, J., Abson, D. J., Butsic, V., Jahi Chappell, M., Ekroos, J., Hanspach, J., Kuemmerle, T., Smith, H. G., & Von Wehrden, H. (2014). Land sparing versus land sharing: Moving forward. *Conservation Letters*, *7*(3), 149–157. https://doi.org/10.1111/conl.12084

FurFree Alliance. (2015). *Overview over national legislation on fur farming in Europe* (Issue February).

Giulio Sabbati; Martina Prpic; Ulla Jurviste. (2019). *Maternity and paternity leave in the EU* (Issue March). http://www.europarl.europa.eu/thinktank

Gocsik, É., Brooshooft, S. D., De Jong, I. C., & Saatkamp, H. W. (2016). Cost-efficiency of animal welfare in broiler production systems: A pilot study using the Welfare Quality® assessment protocol. *AGSY*, *146*, 55–69. https://doi.org/10.1016/j.agsy.2016.04.001

Godfray, H. C. J. (2015). The debate over sustainable intensification. *Food Security*, *7*, 199–208. https://doi.org/10.1007/s12571-015-0424-2

Gold, A., Ewelt-knauer, C., & Pott, C. (2013). 2013 - verplichte roulatie van accountantskantoren - Gold. *Accountantscontrole*, *November*, 448–458.

ICF Consulting; The American Petroleum Institute. (2000). Overview of exploration and production waste volumes and waste management practices in the United States. *American Petroleum Institute, Washington DC*, *May*, 74.

ILO. (1981). C155 - Occupational Safety and Health Convention, 1981 (No. 155). In *ILO conventions*. https://www.ilo.org/dyn/normlex/es/f?p=1000:12100:0::NO::P12100_ILO_CODE:C154

ILO. (2004). *Statutory regulations on overtime in selected countries* (Issue May). www.ilo.org/travail

ILO. (2017). *Measuring the gender wage gap. Turkey case*. https://doi.org/10.1787/9789264281318-15-en

ILO. (2019). *Global Wage Report-2018*.

ILO. (2020). *How big is the gender pay gap in your country?* 55. https://www.ilo.org/global/about-the-ilo/multimedia/maps-and-charts/enhanced/WCMS_650829/lang--en/index.htm

Institut Agrarpolitik und Landwirtschaftliche Marktlehre Fachgebiet Agrar- und Ernährungspolitik. (2016). *Wissenschaftliche Zuarbeit für die Erstellung aktueller Gutachten in den Bereichen Nutztierhaltung und Klimapolitik*.

ISO. (2005). *ISO 22000*. www.ISO.org

ISO. (2006). *ISO 14040. Environmental Management - Life Cycle Assessment - Principles and Framework* (Vol. 2006). www.ISO.org

ISO. (2018). *ISO 45001:2018 Occupational health and safety management systems — Requirements with guidance for use*. https://www.iso.org/standard/63787.html

Kalisz, S., Kibort, K., Mioduska, J., Lieder, M., & Małachowska, A. (2022). Waste management in the mining industry of metals ores, coal, oil and natural gas - A review. *Journal of Environmental Management*, *304*(September 2021). https://doi.org/10.1016/j.jenvman.2021.114239

Koronowski, R., Vela, J., & Rasheed, Z. (2022). *These 19 Fortune 100 Companies Paid Next to Nothing—or Nothing at All—in Taxes in 2021*. Www.Americanprogress.Org. https://www.americanprogress.org/article/these-19-fortune-100-companies-paid-next-to-nothing-or-nothing-at-all-in-taxes-in-2021/

Kostopoulos, E. D., Spyropoulos, G. C., & Kaldellis, J. K. (2020). Real-world study for the optimal charging of electric vehicles. *Energy Reports*, *6*, 418–426. https://doi.org/10.1016/j.egyr.2019.12.008

Kuddo, A. (2009). *Labour Laws in Eastern European and Central Asian Countries: Minimum Norms and Practices* (Issue 0920).

Lamm, F. R., & Trooien, T. P. (2003). Subsurface drip irrigation for corn production: A review of 10 years of research in Kansas. *Irrig.Sci.*, *22*(3–4), 195–200. https://doi.org/10.1007/s00271-003-0085-3

Ledo, A., Heathcote, R., Hastings, A., Smith, P., & Hillier, J. (2018). Perennial-GHG: A new generic allometric model to estimate biomass accumulation and greenhouse gas emissions in perennial food and bioenergy crops. *Environmental Modelling and Software*, *102*, 292–305. https://doi.org/10.1016/j.envsoft.2017.12.005

Lenntech. (2017). *Kostenberekening. Voorbeeld kostenberekening ontziltingsinstallatie*.

Lindeijer, E. (2000). Biodiversity and life support impacts of land use in LCA. *J. Cleaner Prod.*, *8*, 313–319.

Mekonnen, M. M., & Hoekstra, A. Y. (2010). The Green, Blue and Grey Water Footprint of Crops and Derived Crop Products. In *Value of Water* (No. 47; Research Report Series, Vol. 1, Issue 47).

Milà i Canals, L., Rigarlsford, G., & Sim, S. (2012). Land use impact assessment of margarine. *Int. J. Life Cycle Assess.*, *18*(6), 1265–1277. https://doi.org/10.1007/s11367-012-0380-4

Miller, L. (2014). *2014 Training Industry Report* (Issue December).

Mills, A. (2014). Health Care Systems in Low- and Middle-Income Countries _ Enhanced Reader.pdf. *New England Journal of Medicine*, *February 6*.

Ndlovu, S., Simate, G. S., & Matinde, E. (2017). *Waste Production and Utilization in the Metal Extraction Industry*. Google Books. https://books.google.nl/books?hl=nl&lr=&id=XOneDwAAQBAJ&oi=fnd&pg=PR6&ots=N5Qj7apHHp&sig=S4sx9L4gp0omH7AJPJVDxIFOwtM#v=onepage&q&f=false

Netherlands Labour Organization. (2022). *Employment of minors and young adults*. Netherlands Labour Organization. https://business.gov.nl/regulation/employment-young-people/

OECD; WorldBank; WTO; IMF. (2022). *Subsidies, Trade, and International Cooperation*. https://doi.org/10.1007/CBO9781139565332

OECD. (2019). Corporate Tax Statistics. *Corporate Tax Statistics*, *Third Edit*, 1–52. https://www.oecd.org/tax/tax-policy/corporate-tax-statistics-second-edition.pdf

OECD. (2021). *PF2 . 1 . Parental leave systems Definitions and methodology* (Issue October).

Otten, M. B. J., ’t Hoen, M. J. J., & Den Boer, L. C. (2015). *STREAM personenvervoer 2014: Studie naar Transport Emissies van Alle Modaliteiten. Emissiekengetallen 2011*.

Perinelli, B., & Baker, V. A. (2010). *Overtime does not pay. A comparative analyses of wages in 23 countries in times of recession* (Issue December).

Petersen, B., & Snapp, S. (2015). What is sustainable intensification? Views from experts. *Land Use Policy*, *46*, 1–10. https://doi.org/10.1016/j.landusepol.2015.02.002

Phalan, B., Onial, M., Balmford, A., & Green, R. E. (2011). Reconciling Food Production and Biodiversity Conservation: Land Sharing and Land Sparing Compared. *Science*, *333*(September), 1289–1291. https://doi.org/10.1126/science.1208742

Pretty, J. N. (1997). The sustainable intensification of agriculture. *Natural Resources Forum*, *21*, 247–256. https://doi.org/10.1111/j.1477-8947.1997.tb00699.x

PRO Europe. (2022). Participation Costs Overview 2022. *Europe*, *February*.

Reick, B., Konzept, A., Kaufmann, A., Stetter, R., & Engelmann, D. (2021). Influence of Charging Losses on Energy Consumption and CO2 Emissions of Battery-Electric Vehicles. *Vehicles*, *3*(4), 736–748. https://doi.org/10.3390/vehicles3040043

Rockström, J., Williams, J., Daily, G., Noble, A., Matthews, N., Gordon, L. J., Wetterstrand, H., DeClerck, F., Shah, M., Steduto, P., De Fraiture, C., Hatibu, N., Unver, O., Bird, J., Sibanda, L., & Smith, J. (2017). Sustainable intensification of agriculture for human prosperity and global sustainability. *Ambio*, *46*, 4–17. https://doi.org/10.1007/s13280-016-0793-6

Stern. (2022). *Capital expenditures by Industry*. Capital Expenditures by Sector. https://pages.stern.nyu.edu/~adamodar/New_Home_Page/datafile/capex.html

Sutton-Parker, J. (2021). Determining commuting greenhouse gas emissions abatement achieved by information technology enabled remote working. *Procedia Computer Science*, *191*, 296–303. https://doi.org/10.1016/j.procs.2021.07.037

Tax Foundation. (2022). *1980 2022 Corporate Tax Rates Around the World*.

Teixeira, R. F. M., de Souza, D. M., Curran, M. P., Assumpció, A., Michelsen, O., & Milà I Canals, L. (2015). Towards consensus on land use impacts on biodiversity in LCA: UNEP/SETAC Life Cycle Initiative preliminary recommendations based on expert contributions. *J. Cleaner Prod.*, 1–5. https://doi.org/10.1016/j.jclepro.2015.07.118

Textile Exchange. (2014). *Responsible Down Standard 3.0*. http://www.scopus.com/inward/record.url?eid=2-s2.0-84865607390&partnerID=tZOtx3y1%0Ahttp://books.google.com/books?hl=en&lr=&id=2LIMMD9FVXkC&oi=fnd&pg=PR5&dq=Principles+of+Digital+Image+Processing+fundamental+techniques&ots=HjrHeuS_

The European Parliament and the Council of the European Union. (2009). Regulation (EC) No 1223/2009 of the European Parliament and of the Council of 30 November 2009 on cosmetic products. *Official Journal of the European Union*, *1223*.

The Indian Express. (2022). Can’t expect children to walk 3 km to attend school: Supreme Court. *The Indian Express*, *October 17*. https://indianexpress.com/article/india/cant-expect-children-to-walk-3-km-to-attend-school-supreme-court-4836668/

The World Bank. (2017). *Current health expenditure (% of GDP)*.

Thoma, G., Matlock, M. D., Putman, B., & Burek, J. (2015). *A Life Cycle Analysis of Land Use in US Pork Production*. http://research.pork.org/FileLibrary/ResearchDocuments/13-208-Thoma-UofARK.pdf

Tilman, D., Balzer, C., Hill, J., & Befort, B. L. (2011). Global food demand and the sustainable intensification of agriculture. *PNAS*, *108*(50), 20260–20264. https://doi.org/10.1073/pnas.1116437108

Trading Economics. (2022). *Corporate Tax Rate@ Tradingeconomics.Com*. Corporate Tax Rates. https://tradingeconomics.com/dominican-republic/corporate-tax-rate

Tscharntke, T., Clough, Y., Wanger, T. C., Jackson, L., Motzke, I., Perfecto, I., Vandermeer, J., & Whitbread, A. (2012). Global food security, biodiversity conservation and the future of agricultural intensification. *Biological Conservation*, *151*(1), 53–59. https://doi.org/10.1016/j.biocon.2012.01.068

UNDP. (2010). *Human Development Index (HDI) and HSDI*. http://i.unu.edu/media/ourworld.unu.edu-en/article/2608/2010-Human-Sustainable-Development-Index.pdf

UNEP, & OIE Global Forum on Animal Welfare. (2020). *Animal Welfare in the Context of The Sustainable Development Goals (SDGs)* (Issue April).

Unicef. (2018). *Child Labour – Current Status + Progress*. https://data.unicef.org/topic/child-protection/child-labour/

United Nations. (2012). Rio+20 United Nations Conference on Sustainable Development. *United Nations*, *38164*(June), 1–53. https://doi.org/12-38164* (E) 220612

USA Congress.gov. (2021). *Proposed S3357 Humane Cosmetics act of 2021*. https://www.congress.gov/bill/117th-congress/senate-bill/3357

Vallero, D. A. (2011). Thermal Pollution. In *Waste* (pp. 425–443). Elsevier Inc. https://doi.org/10.1016/B978-0-12-381475-3.10028-2

Van Essen, H. P., Schroten, A., Otten, M. B. J., Sutter, D., Schreyer, C., Zandonella, R., Maibach, M., & Doll, C. (2011). *External Costs of Transport in Europe. Update Study for 2008* (Issue September).

Van Loon, P., Deketele, L., Dewaele, J., McKinnon, A., & Rutherford, C. (2015). A comparative analysis of carbon emissions from online retailing of fast moving consumer goods. *Journal of Cleaner Production*, *106*(2015), 478–486. https://doi.org/10.1016/j.jclepro.2014.06.060

Verburg, R. W., Puister, L. F., Michels, R., & Van Duijvendijk, K. (2012). *Estimating costs of nature management in the European Union* (No. 97; WOt-Technical Report). https://doi.org/10.18174/425041

Vogtländer, J. G., Bijma, A., & Brezet, H. C. (2002). Communicating the eco-efficiency of products and services by means of the eco-costs/value model. *J. Cleaner Prod.*, *10*(1), 57–67. https://doi.org/10.1016/S0959-6526(01)00013-0

Vogtländer, J. G., Brezet, H. C., & Hendriks, C. F. (2000). The Virtual Eco-Costs ' 99. *Int. J. Life Cycle Assess.*, *5*(6), 1–10.

Vogtländer, J. G., Lindeijer, E., Witte, J.-P. M., & Hendriks, C. F. (2004). Characterizing the change of land-use based on flora: application for EIA and LCA. *J. Cleaner Prod.*, *12*(1), 47–57.

https://doi.org/10.1016/S0959-6526(02)00022-7

Vogtländer, J., Peck, D., & Kurowicka, D. (2019). The eco-costs of material scarcity, a resource indicator for LCA, derived from a statistical analysis on excessive price peaks. *Sustainability (Switzerland)*, *11*(8). https://doi.org/10.3390/su11082446

Volvotrucks.nl. (2020). *Invloed-transportcycli-en-gewicht-op-brandstofverbruik @ www.volvotrucks.nl*. https://www.volvotrucks.nl/nl-nl/news/kennisbank/brandstof-besparen/invloed-transportcycli-en-gewicht-op-brandstofverbruik.html#:~:text=Een zware rit heeft vanzelfsprekend,het brandstofverbruik van ongeveer 1%25.

Weidema, B. P. (2001). *Physical impacts of land use in product life cycle assessment*. http://www.lca-net.com/files/gaps9.pdf

Welfare Quality Network. (2009a). Assessment protocol for cattle. In *Welfare Quality® Assessment Protocol for Cattle*. http://www.welfarequalitynetwork.net/network/45848/7/0/40

Welfare Quality Network. (2009b). Principles and criteria of good farm animal welfare. In *Welfare Quality® Factsheet*. https://books.google.com/books?id=9qC5BQAAQBAJ&pgis=1

Welfare Quality Network. (2009c). Welfare Quality ® Assessment protocol for pigs(sows and piglets, growing and finishing pigs). In *Welfare Quality® Assessment Protocol for Pigs*.

Welfare Quality Network. (2009d). Welfare Quality Assessment protocol for Poultry. In *Welfare Quality® Assessment Protocol for Poultry* (Issue January). http://www.welfarequalitynetwork.net/network/45848/7/0/40

Welfare Quality Network. (2012). Welfare Quality® assessment protocol for laying hens. In *Welfare Quality® Consortium, Report 589* (Issue May). www.welfarequality.net

Welfare Quality Network. (2018). *WQNetwork Qualification Outline* (Vol. 4).

WIOD. (2020). *World Input Output Database*. http://www.wiod.org

Wissenschaftlicher Beirat Agrarpolitik beim BMEL. (2015). Wege zu einer gesellschaftlich akzeptierten Nutztierhaltung. *Berichte Uber Landwirtschaft*, *93*.

Zhou, Y., & Tol, R. S. J. (2005). Evaluating the costs of desalination and water transport. *Water Resour. Res.*, *41*(3), 1–10. https://doi.org/10.1029/2004WR003749