The True Price of Diamonds

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ABN·AMRO

True pricing can help the diamond sector improve its societal impact

The pictures on top show the three ways to produce diamonds for which this report provides the true price. The picture below shows the processing step, which is also included in the analysis.

Businesses in the diamond sector have positive and negative effects on society.

Diamonds are both a precious consumer good in the form of jewellery and a valuable industrial resource.

Diamond production provides a livelihood to workers along the value chain and has helped the economic development of regions in which diamonds are mined and processed.

In addition to its positive effects to society, the diamond sector is also associated with a number of negative effects on people and the planet.

One important driver of negative effects in both mining and laboratory production of diamonds is energy consumption, leading to amongst other climate change and air pollution. Negative social effects include unsafe working conditions and underpayment.

This report provides a perspective for businesses to understand and improve their impact on society. A sustainable business strives for three goals: (1) long term value creation for shareholders, (2) creating positive value for its other stakeholders and (3) minimizing harm to society.

This report focuses on the last goal. To do so, it applies the *true price* methodology. The *true price* is the *market price* of a product plus the *true price gap*. The true price gap contains all direct external costs that are not part of the price tag but are paid nonetheless – for instance by local communities (air and water pollution), by future generations (climate change) or by employees (health and safety risks). Such external costs are harmful to society and also pose risks to businesses. The true price method provides businesses with insight to improve their societal impact by reducing its true price gap.

This report calculates the true price gap for diamonds (1) from large-scale mining, (2) from artisanal mining, and (3) from laboratory production. The external costs from the processing step are also included.

This report also explores various ways in which the true price gap can be improved.

Note that publicly available data on the diamond sector is scarce. Numbers have been collected and combined from different sources, including some several years old. Reported values of the true price gap carry significant uncertainty.

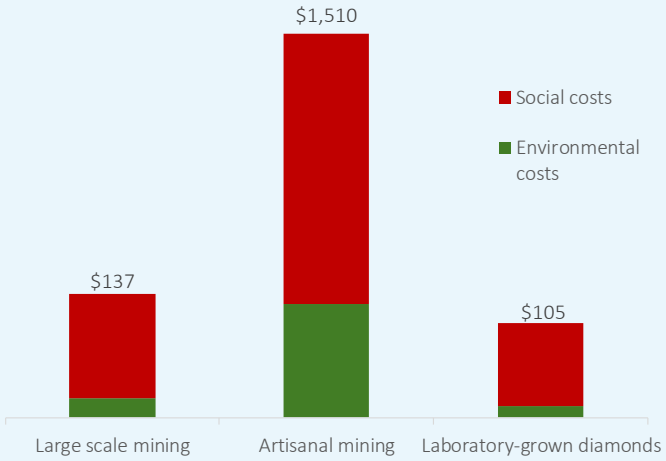
Artisanal diamond mining faces the largest challenge

The figure on the right shows the true price gap for all three types of diamond production assessed.

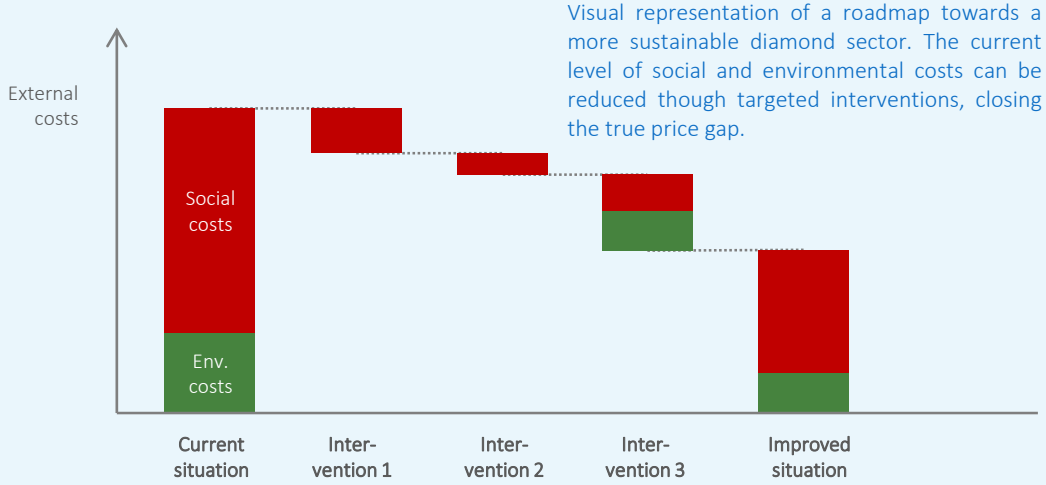
Artisanal production has by far the largest true price gap. This is mainly due to health and safety incidents and insufficient income, coupled with low labour productivity (so that the external costs are shared over a low number of carats).

Much of the social costs that are shared between the three types of production are from the processing step, where serious health risks (due to 'diamond lungs'), underpayment, child labour and forced labour occur.

Between laboratory production and large scale mining, the former has the lowest true price gap, mainly because the effective energy use is lower.



True price gap for diamond production and processing. All figures are in USD per carat of polished diamond for use in jewellery.



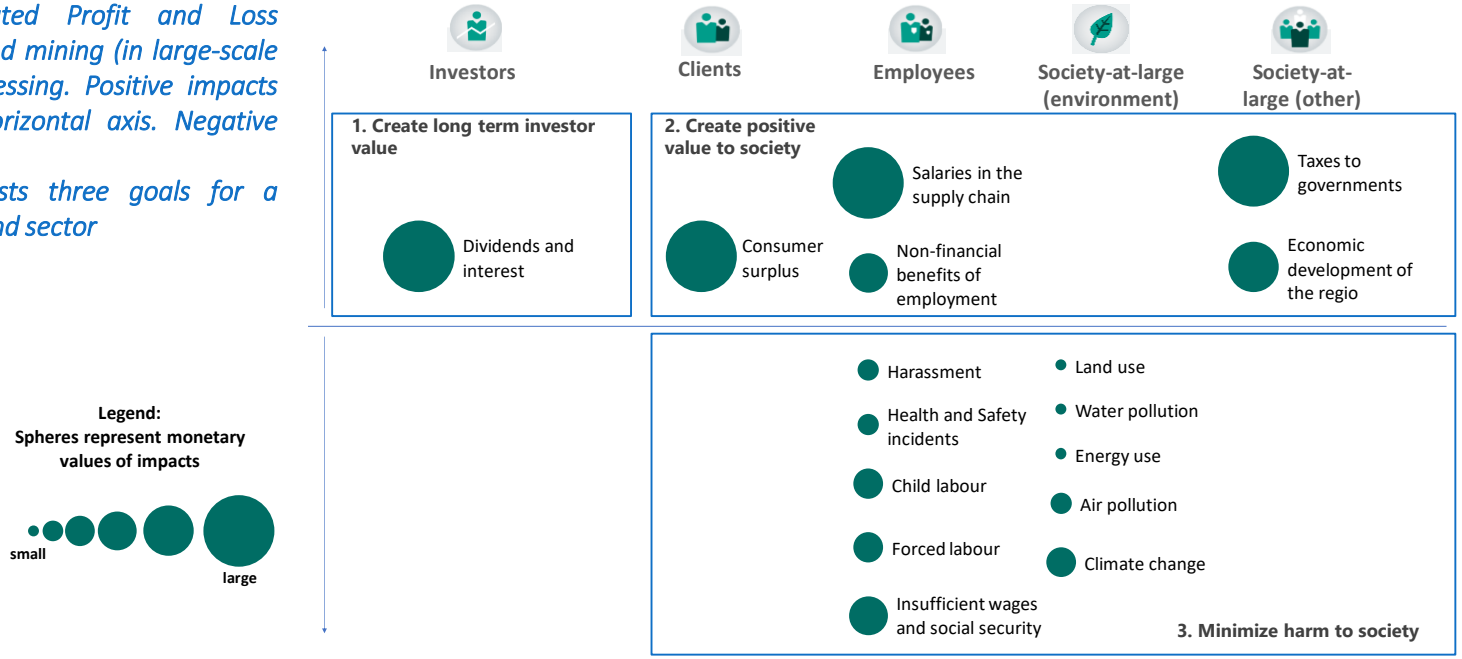
Visual representation of a roadmap towards a more sustainable diamond sector. The current level of social and environmental costs can be reduced though targeted interventions, closing the true price gap.

External costs are not a given. If the sector works together, many of these negative impacts can be mitigated. See schematically depicted in the figure above. A joint effort to draft a complete assessment of externalities can be input for a roadmap towards an increasingly sustainable sector. We assess four measures to close the true price gap and their estimated potential for positive societal impact:

1. Reduce underpayment in polishing industry – with potential impact of USD 35m
2. Increase trace-ability – with potential impact of USD 65m
3. Support human health in areas prone to HIV and TBC – with potential impact of USD 100m
4. Reduce the use of coal for electricity in China – with potential impact of USD 780m

A framework to realize a sustainable diamond sector

Indicative Integrated Profit and Loss account of diamond mining (in large-scale mines) and processing. Positive impacts are above the horizontal axis. Negative impacts below.
The figure suggests three goals for a sustainable diamond sector



Realizing a sustainable diamond sector requires managing its positive and negative effects on society. Diamonds are a precious consumer good but also a valuable industrial resource. The diamond industry thus creates value for shareholders. Diamond production also provides a livelihood to workers along the value chain and has helped the economic development of regions in which diamonds are mined and processed. In addition, economic activity of miners and traders help develop their regions.[1)]

In addition to its positive effects to society, the diamond sector is also associated with a number of negative effects on people and the planet. These are costs that are made during the production, but not paid for by the consumers or the companies in the value chain. Examples include health and safety incidents, destruction of natural landscapes and contribution to climate change.

A sustainable diamond sector can be realized by pursuing three goals:

(1) Long term value creation for shareholders,

(2) Create positive value for its other stakeholders; and

(3) Minimize harm to society, fulfilling responsibility as a corporate citizen.

The total impact of diamond production can be explored using the so-called Integrated Profit and Loss account[2)].

This report focusses on goal #3. True prices are a way to represent external costs. Information on true prices (first part of the report) can be used to identify improvement levers to reduce external costs and increase sustainability (second half of this report). This report limits itself to diamonds produced for jewellery.

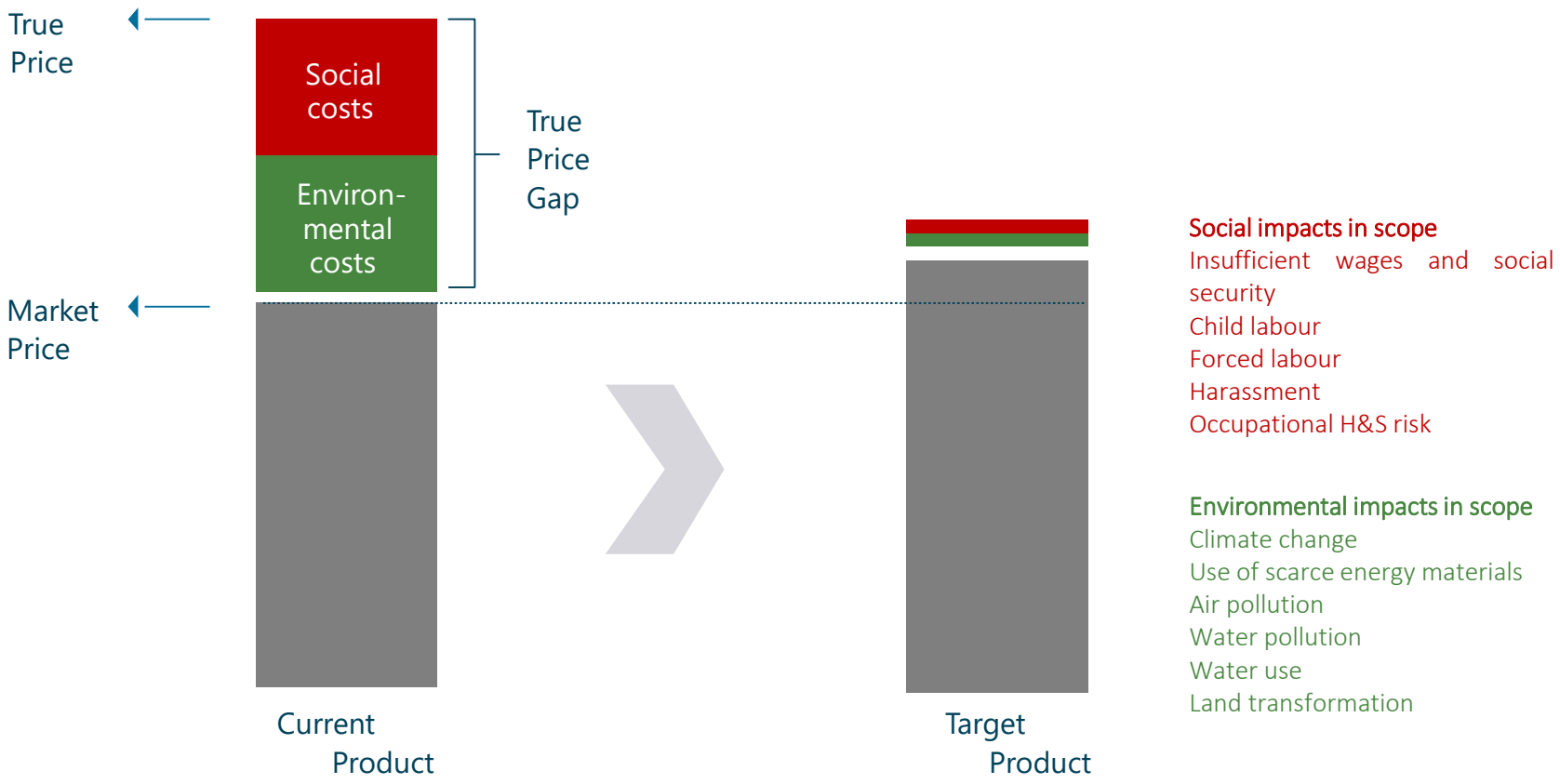
1) See for instance SGCCI, (2017) for Surat, Gujarat in India, where almost 25% of the employment is in the diamond industrt and Kamrany and Gray (n.d.) and Lewin (2011) for Botswana. 2) The Integrated Profit and Loss account was developed by True Price as an extension of the 'ordinary' profit and Loss account that companies publish every year. In addition to financial capital creation, it assesses value creation in a wider sense in line with the recommendations of the International Integrated Reporting Council. True Price has recently assessed the mortgage provision and cocoa trade finance activities at ABN AMRO. See here for a brief report.

True pricing can help the diamond sector reduce its external costs

The *true price* is the *market price* of a product plus the *true price gap*. The true price gap contains all direct external costs that are not part of the price tag but are paid nonetheless – for instance by local communities (air and water pollution), by future generations (climate change) or by employees (health and safety risks). Such external costs are harmful to society and also pose risks to businesses.

The aim of true pricing is not to increase the market price, but rather to reduce the true price of products by closing the gap. This can be done by creating transparency about the true price gap to enable innovative ways of production.[1)] The true price method provides businesses with insight to improve their societal impact by reducing its true price gap.

As the jewellery diamond sector as a whole has diverse market prices, we focus on the true price gap in this report.



Social impacts in scope
Insufficient wages and social security
Child labour
Forced labour
Harassment
Occupational H&S risk

Environmental impacts in scope
Climate change
Use of scarce energy materials
Air pollution
Water pollution
Water use
Land transformation

1) See e.g., Creating shared value in the rose supply chain for example of previous work of True Price (together with Hivos).

Key results: social impacts dominate artisanal diamonds and processing step

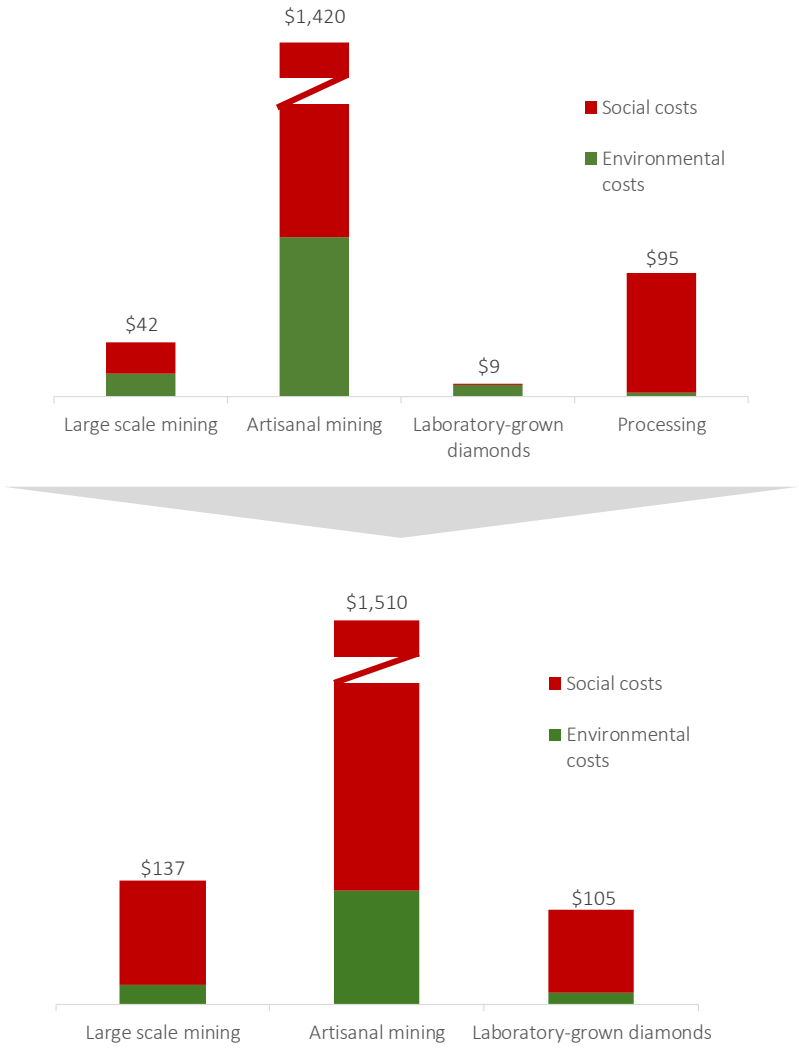
The figures on the right show the true price gap for three types of diamonds: large-scale mining, artisanal mining and laboratory-grown. The first figure assesses the processing step independently, while the second figure combines the impact of producing rough diamonds and the processing step, which we assume to be similar for each type of diamond. See the Appendix for details of the production types assessed.

The first key message from the true price analysis is that social externalities in artisanal production and the processing step are most severe. In particular health and safety incidents contribute strongly to the true price gap of artisanal diamonds. This is driven mainly by a much higher incident rate (up to 90 times higher[1]) and lower labour productivity than in large scale mining.

The second key message is that laboratory-grown diamonds have a smaller true price gap than natural diamonds, both in terms of social and environmental impact. Although growing diamonds in a lab is an energy-intensive process, the energy-related costs per carat are lower than for mined diamonds.[2]

For large-scale mined and laboratory-grown diamonds, we find that for some environmental externalities, direct sources from the sector (e.g., annual reports) and research reports offer different values for energy use. We present the true price gap based on direct sources here.

As the social impacts of the processing step add a large true price gap to both large scale mining and laboratory-grown diamonds, their true price gaps are relatively closer together in the second figure.



True price gap for diamond production and processing. The figure on top shows the true price gap for the processing step independently, while the bottom figure combines the impact of producing rough diamonds and the processing step. All figures are in USD per carat of polished diamond for use in jewellery. Note that numbers may not add up do to rounding.

1) Calys-Tagoe et al (2015); 2) Alrosa (2016).

Large scale mining: main impacts on climate change and underpayment

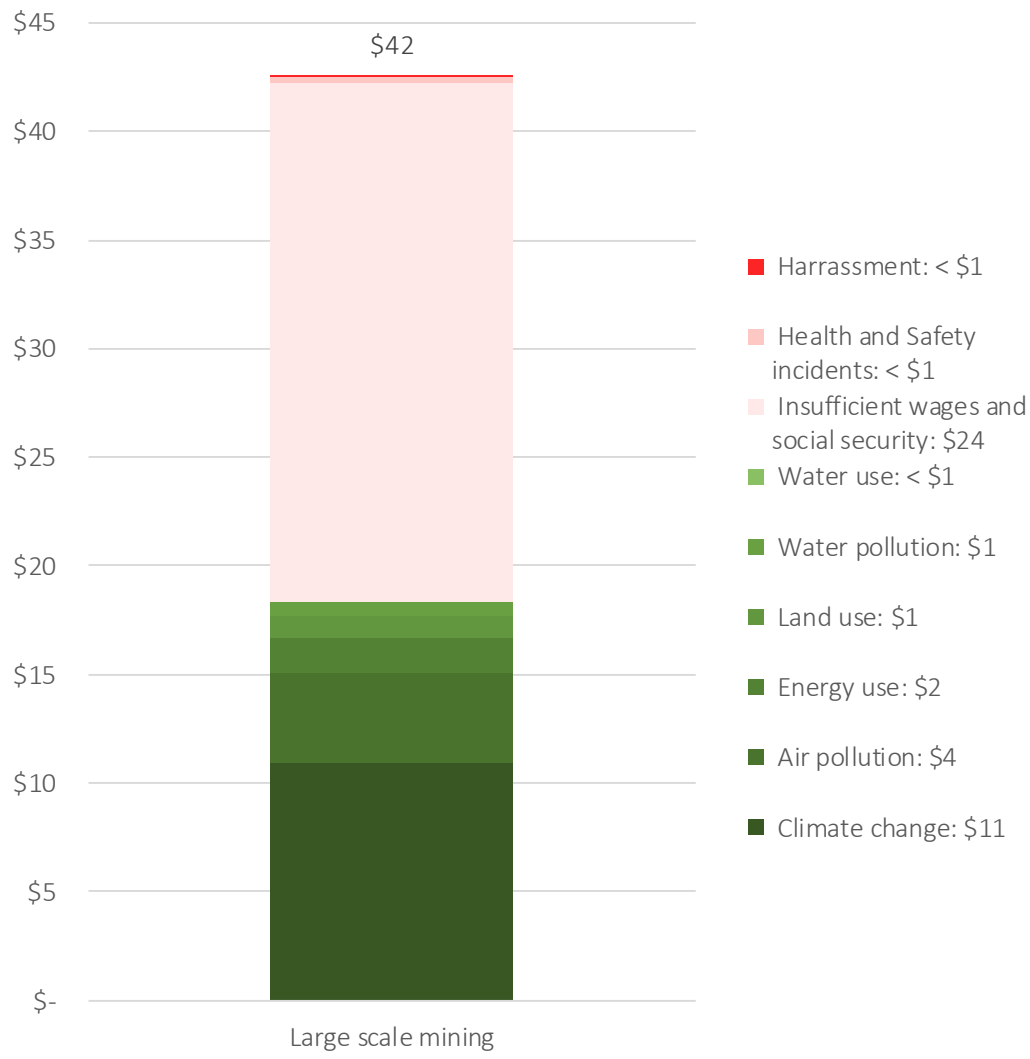
The mining step has a true price gap of ~42 USD per carat polished diamonds, using values reported by ALROSA and Rio Tinto for energy use. Approximately 58% of this is from natural externalities and 42% from social externalities.

The most significant impacts are the contribution to climate change, air pollution and underpayment of workers.

Greenhouse gas emissions are estimated at ~100 kg CO2-eq/carat polished diamonds, from several kinds of fuel and electricity to operate the mine. This translates to a true price contribution of 11 USD/polished carat. Energy use also impacts the future availability of energy materials and pollutes air and water. Indeed, the second largest environmental impact is air pollution through sulphur oxides, contributing 4 USD/polished carat.

Land transformation in the sector as a whole is very large, and landscapes can be changed very strongly. Due to the amount of carats per mine, the impact expressed per carat of polished diamonds is relatively modest.

Underpayment relates to employees receiving wage below the so-called living wage required for a decent standard of living.[1)] Note that the living wage can be significantly above the legal minimum wage. Gem Diamonds for instance report that their lowest employees earn 11% above the legal minimum wage in Botswana, or ~109 USD/person/month. This is still much below the living wage, estimated at 560 USD/person/month.[2)] Our estimate for the total impact of underpayment for a carat of polished diamond is around 24 USD.



True Price gap for large scale mining [USD/ct polished diamond]. Note that numbers may not add up do to rounding.

1) The living wage can be significantly above the legal minimum wage. See the Global Living Wage Coalition for a comprehensive discussion (link). 2) WageIndicator Foundation (2013)

Artisanal mining: main impacts health & safety and underpayment

Artisanal mining has a very high true price gap of almost 1,420 USD/carat polished diamond.

Almost all of this is from social impacts (91%), with land transformation as the main environmental impact.

The key drivers of the high true price gap are unsafe working conditions and a low pay of workers, but also low labour productivity: 27 unpolished carats/person/year (or around 10 carats of polished diamond person per year). This means that the total social costs are distributed over a relatively low volume.

Health and Safety impacts are by far the largest impact at ~980 USD/polished carat. Benedict et al (2015) report that fatal incidents are 90 times more likely to occur than in large-scale mining. This mainly relates to incidents where workers fall to death. Non-fatal, but serious, incidents are also a factor 6-7 more likely.

We have used incident rates of 1 fatal incident per 185 working years and 1 other incident per 18 working years.

Income of artisanal miners is low. Values as low as 1.25 USD/worker/day have been reported in Sierra Leone.[1)] This is far below the living wage, especially when taking into account that workers have to support a family. A critical point is that, however low the income is, it is often better than alternatives, and therefore driving for example farmers into mining[2)]. In total, the impact of underpayment and lack of social security is USD 290/polished carat.

True Price gap for artisanal mining [USD/ct polished diamond]. Note that numbers may not add up do to rounding.

1) Study by Vlassenroot and Bockstael (2008); 2) The Economist (2016)

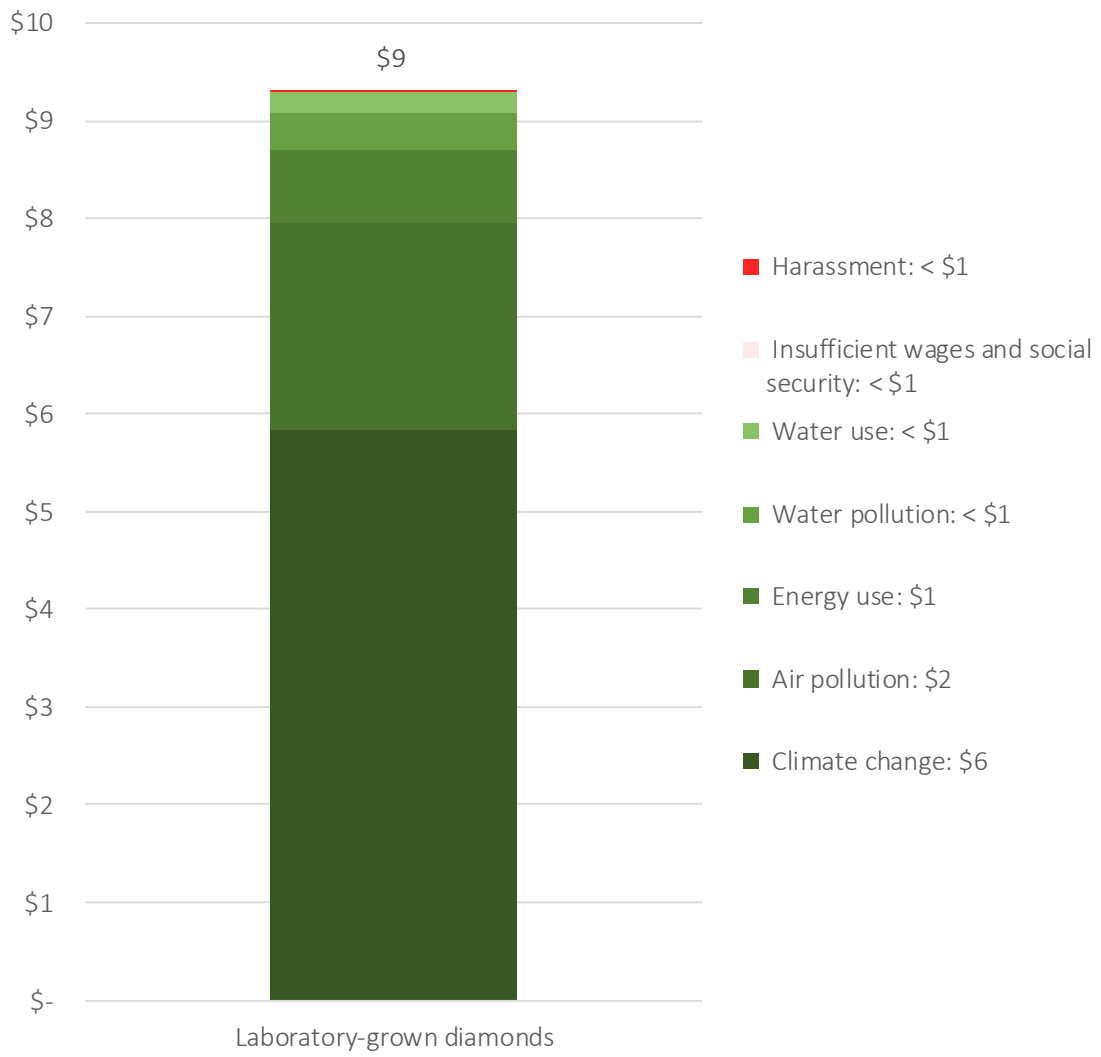
Laboratory-grown diamonds: relatively low true price, mainly driven by energy

Most laboratory-grown diamonds are very small and for industrial use, although a small share makes it to the retail jewellery market.[1)]

Energy use related external costs (climate change, air pollution, use of scarce energy materials) are the bulk of the external costs and are assessed at roughly 9 USD/polished carat.

Growing diamonds in the lab is an energy-intensive process. Growing 1 carat of rough diamonds requires 26 kWh of energy according to companies in the sector (Gemesis diamond and Apollo Diamonds).[2)] Large scale mining however, has still a relatively higher energy use per carat of rough diamonds (57 kWh).

Most laboratory-grown diamond production takes place in the Chinese provinces of Nanyang and Zhengzhou.[3)] Companies in the region (Zhongnan Diamond, Henan Huanghe Whirlwind and Zhengzhou Sino-Crystal Diamond)[4)] report that on average their workers earn well above the living wage of ~500 USD/month. We have not been able to assess whether this holds for *all* workers, but even if a share of them earns below the living wage, the contribution to the true price gap is less than a cent per carat. This is directly related to the very high labour productivity: an estimated 70% of the world's laboratory-grown diamonds are produced by less than 10,000 workers.



True Price gap for laboratory-grown diamonds [USD/ct polished diamond]. Note that numbers may not add up do to rounding.

1) Linde at al (2015); 2) Ali (2011); 3) and 4) Research and Markets (2017)

Processing step: underpayment, child and forced labour significant

The true price contribution of the processing step adds ~95 USD/polished carat.

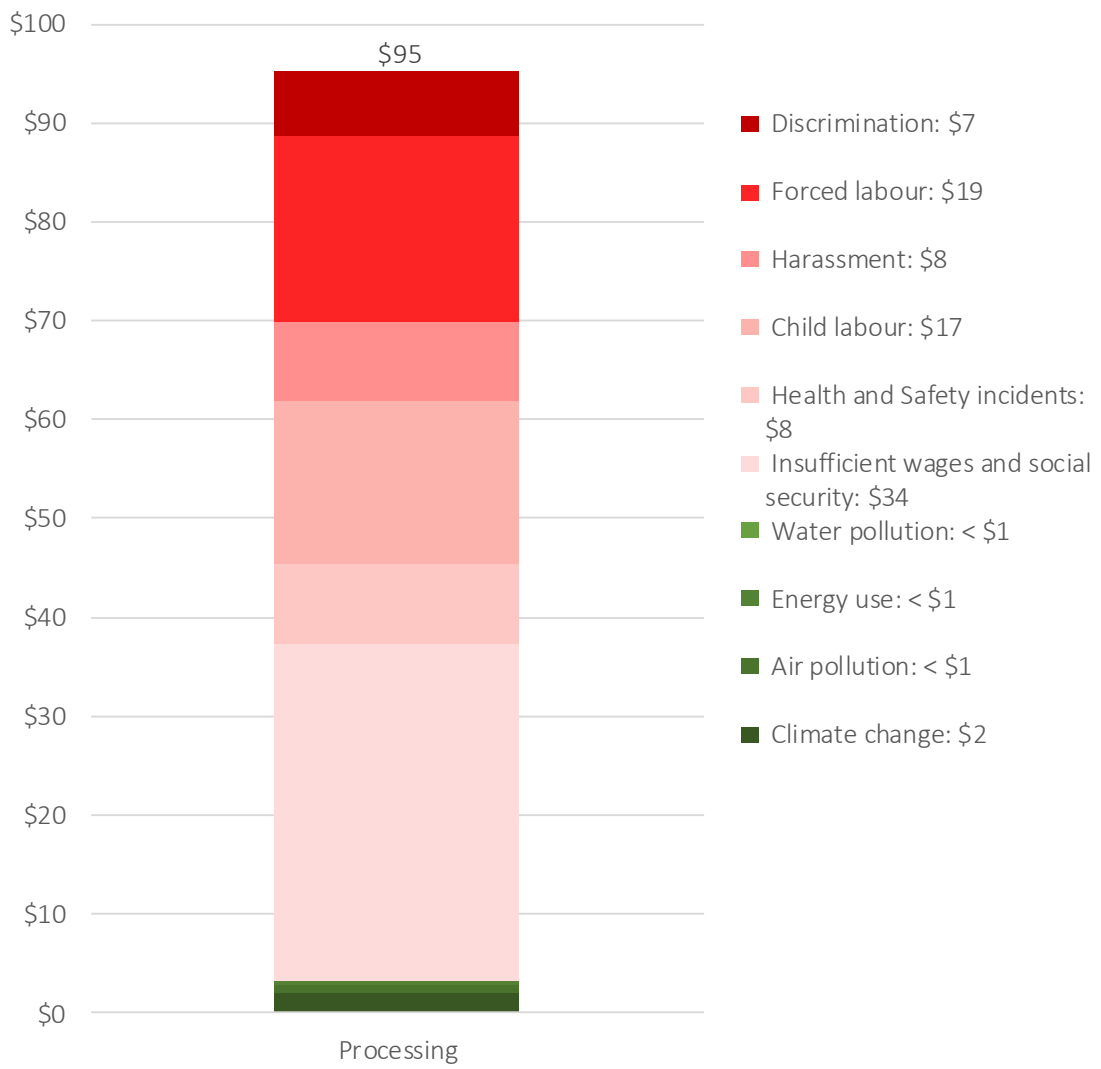
The processing sector where diamonds are cut and polished for use in jewellery is not very demanding in terms of energy and land use – therefore, the true price is almost completely based on social externalities.

Most of the processing takes place in India. Underpayment, child labour and forced labour are relevant.

The living wage in India is 182 USD/worker/month.[1)] About 20% of workers perform skilled expert work and earn well above this,[2)] but 80% of workers are in the low-income group that typically does not earn the living wage. In addition, most workers are unregistered, placing social security out of reach.[3)]

Assessments for the share of child workers and forced workers are hard to make. The regional and national averages in India are respectively 2.2%[4)] and 1.4%.[5)] We assume the average holds because of a lack of data and because the diamond industry is not an industry in which these phenomena occur less than the average.[6)]

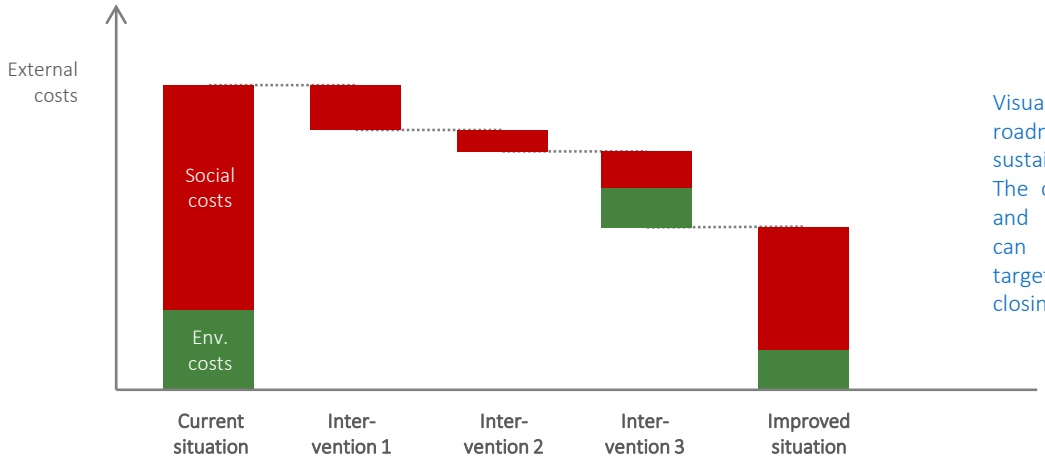
Changing the external costs in processing is an unavoidable step towards a more sustainable product for consumers. Diamonds that are produced in any of the three ways (mined at large scale, artisanal mined and laboratory-grown) need to be cut and polished to make jewellery. Hence, true price gap of processing is part of the true price gap of all types of gem-quality diamonds.



True Price gap for the processing step [USD/ct polished diamond]. Note that numbers may not add up do to rounding.

1) WageIndicator Foundation (2013); 2) Basu (2013); 3) Hirway (2009); 4) Shah (2014); 5) Global Slavery Index (2016); 6) Miklian (2013)

Improving the sustainability of diamonds



Visual representation of a roadmap towards a more sustainable diamond sector. The current level of social and environmental costs can be reduced though targeted interventions, closing the true price gap.

This report so far mainly focused on the external costs of diamond production and manufacturing. Obviously, the diamond sector also has a strong positive effect on developing economies.

Since the start of the diamond industry in Surat, Gujarat, fifty years ago, the city has grown to a population of over 6 million.[1)] More than 25% of the employment in Surat is due to the diamond industry, and the unemployment rate is practically 0.[2)] Similarly, Botswana has gone through a steep economic growth.[3)]

Roadmap to a sustainable diamond sector

To become a truly sustainable sector, the diamond industry should however focus on declining the harm to society. A joint effort to draft a complete assessment of externalities can be input for a roadmap towards an increasingly sustainable sector. Using the insights offered by the true price analysis of the three types of diamonds, this section identifies and discusses next steps for the diamonds sector. The main areas for improvement are typically the steps in the value chain with the largest externalities, in this case the artisanal mining and processing steps (as it contributes to jewellery from all types of diamonds).

Artisanal mining

The true price gap per carat is by far largest for artisanal diamonds. This is mainly due to unsafe working conditions, low wages and the occurrence of child labour.

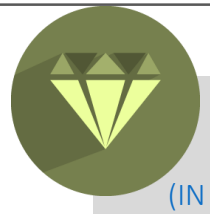
Improving this sector is not is easy. This is due to the highly informal nature of the sector and the fact that diamond mining is an attractive job compared to alternatives – despite the low pay compared to the living wage and its risky nature.[4)] Small-scale best case practices (e.g., My Fair Diamond, Rosy Blue, Diamond Development Initiative) however, show that it is possible. Assisting governments to enforce standards for workers to prevent the relatively high number of (fatal) incidents could reduce the true price gap drastically.

Processing

Underpayment is the largest social impact in the processing step. Providing more factory workers with official contracts with a wage towards the Indian living wage and sufficient social security would be a huge improvement. A larger number of official workers (currently almost 80% of workers in the diamond sector in Gujarat is unregistered)[5)] could also reduce the occurrence of forced labour.

1) Indiaonlinepages (2017); 2) SGCCI, (2017); 3) Kamrany and Gray (n.d.); 4) The Economist (2016); 5) Hirway (2009)

Four interventions could decline total externalities by roughly USD 1 bln



POTENTIAL IMPACT
'REDUCE UNDERPAYMENT'
(IN 10% OF POLISHING INDUSTRY)

~USD 35 M/YEAR

POTENTIAL IMPACT
'INCREASE TRACE-ABILITY'

~USD 65 M/YEAR

POTENTIAL IMPACT
'SUPPORT HUMAN HEALTH
(BEYOND PREVENTING INCIDENTS)'

~USD 100 M/YEAR

POTENTIAL IMPACT
'REDUCING COAL FOR ENERGY
USE IN DIAMOND SYNTHESIS '

~USD 780 M/YEAR

Next to addressing the main issues along the value chain, we offer concrete interventions for the diamonds sector. Applying these will help the move to a more sustainable sector.

1. Reduce underpayment

Underpayment (of employees) and underearning (of small entrepreneurs) is particularly grave for artisanal mining and in the processing step.

Reducing underpayment can start at some of the largest polishers in India. The living wage gap can be closed as soon as workers earn 60% above minimum wage (on average, low-paid workers already earn 25% above the minimum wage). The total impact of this measure is ~USD 35m

2. Increase trace-ability

A main issue for customers throughout the value chain is the lack in trace-ability and transparency of the origin of diamonds. On a small scale, some retailers are already disclosing where diamonds are from.

If better trace-ability could convince 0.1% of consumers to revert their choice from a 'worst-case diamond' to a 'best-case diamond', this could reduce the global true price gap by ~USD 60m.

3. Support human health (beyond preventing incidents), focus on HIV/TBC

Contagious diseases are still a large threat to human health in Sub-Saharan Africa. Some large employers in Southern Africa already pioneer in providing free medicine and protective measures in particular in areas with high rates of TBC and HIV [1)]. However, an estimated 1,100 artisanal miners in Angola and Congo still attract HIV every year. If this can be reduced by 25%, the total health benefits are ~USD 100m.

4. Reduce coal for energy use

Electricity production in China is for 75% generated by coal[2)]. Coal contributes strongly to negative environmental impacts – even stronger than other fossil fuels.

Forced by the strong pollution of the country, the Chinese government has made the reduction of coal dependence a top priority.[3)] As large users, laboratory-grown diamond manufacturers can lead the transition.[4)]

If the coal content of the electricity mix can be reduced from 75% to 70%, at the top-3 producers, this can prevent USD 780m in environmental impacts.

1) For example Botswana Sort diamonds. 2) International Energy Agency. 3) Central Committee of the Communist Party of China (2016); 4) Companies really have the ability to change this. See e.g., National Energy Administration (2017).

Appendix: methodology

This report has assessed three types of diamond production plus processing

Diamond production takes part in global value chains. To calculate the true price, we assessed the main externalities throughout the value chain. At the first step, diamonds are found in nature, or grown in a laboratory.

In this study, we distinguish between three types of diamond production. In all cases, we study diamonds for use in jewellery. We consider only diamonds that are legally traded (with a Kimberly certificate).

1. Large-scale mining

This refers to industrial production of diamonds in large, often open mines around the world. Production is mechanized to a high degree and labour productivity is high (~1,500 carats/person/year on average).[1)]

2. Artisanal mining

This is small-scale production of diamonds. Most artisanal production takes place in Congo and Angola. Compared to large-scale mining, the application of machinery is much lower, leading to a labour productivity as low as 27 carats/person/year.[2)]

3. Laboratory-grown diamonds

This uses chemical vapor deposition (CVD) or high pressure-high temperature (HPHT) techniques. Due to increasing technological advances the total production surged to roughly 4 billion carats[3)] in 2016, mainly produced in China. Most laboratory-grown diamonds are small and for industrial purposes, although a share finds its way to the jewellery market. Labour productivity is very high (up to 300,000 carats/person/year)[4).] Most of the global laboratory-grown diamonds come from China.

In addition, all types of diamonds go through a processing step before they can be used in jewellery.

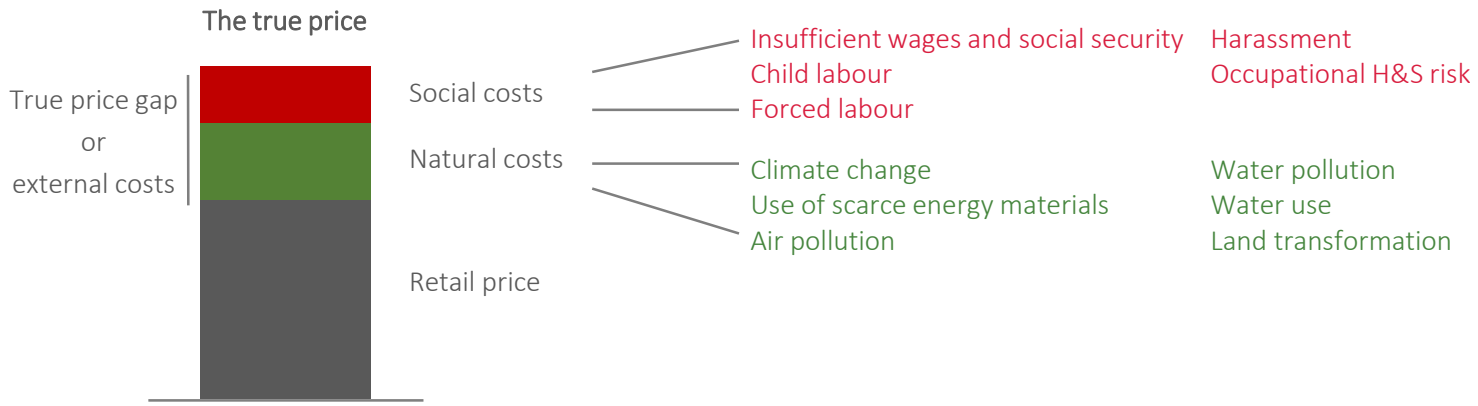
4. Processing

This corresponds to cutting and polishing of diamonds. Over 90% of processing takes place in India. Processing is mainly manual and labour productivity is low (~37 carats of polished diamonds/ person/year)[5)].

In addition to the production and processing of diamonds, the value chain consists of the trading and transportation of diamonds. These steps are again typically similar for all types of diamonds. They do not carry large externalities and are left out of the comparison.

1) Carats unpolished diamonds. Based on production and employee numbers in annual reports of Alrosa, De Beers, Debswana, Gem Diamonds and Rio Tinto. 2) Carats unpolished diamonds. Based on an annual production of ~35m carats (Kimberley Process) by 1.3 m workers(World Diamond Council). 3) Olson (2016); note that some sources name even higher numbers, up to 14 bln carats; 4) Carats unpolished diamonds. Based on employee numbers and estimated production of Zhongnan Diamond, Henan Huanghe Whirlwind and Zhengzhou Sino-Crystal Diamond. 5) Based on ~25m ct polished diamonds (IceX) by 700,000 employees

Background: the true price



The true price is a measure of the price a product– for instance a diamond – would have if one considers the hidden costs. The true price is the market price plus the true price gap. The true price gap consists of all direct external costs along the value chain. External costs are environmental and social costs that are not part of the price tag, but are paid nonetheless – for instance by local communities (air and water pollution), by future generations (climate change) or by employees in the value chain (health and safety risks).

Based on data from the sector (annual reports of producer companies and sector reports) and secondary data (academic sources and NGO's), we have estimated values for five social indicators and six environmental indicators. These indicators are chosen to include the most material externalities of diamond production.

All data are expressed in monetary terms, to make them fully comparable. That is, a U.S. Dollar impact of climate change, can directly be compared to a U.S. Dollar impact on air pollution and even a U.S. Dollar impact on insufficient wages and social security. In addition, all impacts are expressed per carat diamond. We both assess the impact of a carat of raw diamond and a carat of polished diamond for jewellery purposes.

Note that social impacts are naturally expressed on a per Full Time Equivalent (FTE) basis. For example, the occurrence of harassment is mainly found in terms of a percentage of FTE. To express these on a per-carat basis, we divide by the labour productivity. This means that sectors that have a low labour productivity – such as artisanal mining and diamond processing - are most likely to have high social costs per carat.

Note that publicly available data on the diamond sector is scarce. Numbers have been collected and combined from different sources, including some several years old. Reported values of the true price gap carry significant uncertainty.

External costs in scope for this report

	Impact	Description
Environmental Externalities	Climate change	Emission of carbon dioxide and other greenhouse gasses mainly through electricity and other energy use.
	Air pollution	Emission of toxic gasses (e.g., NOx and SOx), mainly related to energy use.
	Use of scarce energy materials	Energy-carrying materials (oil, natural gas, etc.) are scarce resources that are used both as fuels and as source materials in the chemical industry (e.g., for plastics). Their stock is finite. If fossil fuels are used today, their availability to future generations declines (e.g., they have to mine oil from deeper layers, at a higher price).
	Land transformation	Transforming land for mining destroys original habitats, affecting biodiversity. Land transformation can also contribute to climate change, if carbon stored in soil or biomass is emitted. This effect is particularly strong if inland wetland is transformed.
	Water pollution	Pollution of water with acidifying and other toxic pollutants.
	Scarce water use	The use of blue water, reducing the availability of water for human use. Water use is only a relevant impact in regions where water is scarce.
Social Externalities	Insufficient wages and social security	Workers earning below the so-called living wage (that is sufficient for a decent standard of living). Note that the living wage can be above the legal minimum wage. See the Global Living Wage Coalition for a comprehensive discussion (link) Absence of social security (e.g., unemployment savings and sick leave) also contributes to the true price gap.
	Child labour	Occurrence of child labour according to the ILO criteria. Hazardous work and labour by children under 14 years add a larger share to the true price gap.
	Forced labour	Occurrence of forced labour. Forced labour is work with a non-voluntary component and occurs in various forms with differing levels of severity.
	Harassment	(Sexual and non-sexual) harassment of workers, including health effects and treatment costs.
	Health and Safety incidents	Mainly determined from fatal and non-fatal incidents at work. Working in an unsafe working environment adds to the true price gap.
	(Gender) Discrimination	Reflects to the absence of paid maternity leave, and the gender wage gap, where women earn less than men for similar work.

List of sources

Sources: General

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