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ESG Analysis

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The Socioeconomic and Environmental Impact of Large-Scale Diamond Mining

A report by Trucost for the Diamond Producers Association



Prepared by Trucost

May 2019

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About Trucost

Trucost is part of S&P Global. A leader in carbon and environmental data and risk analysis, Trucost assesses risks relating to climate change, natural resource constraints, and broader environmental, social, and governance (ESG) factors. Companies and financial institutions use Trucost intelligence to understand their ESG exposure to these factors, inform resilience, and identify transformative solutions for a more sustainable global economy. S&P Global's commitment to environmental analysis and product innovation enables its team to deliver essential ESG investment-related information to the global marketplace. For more information, visit www.trucost.com.

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Acknowledgements

Trucost acknowledges the invaluable contributions of data and information by the participating DPA members, ALROSA, De Beers Group, Petra Diamonds and Rio Tinto, and the advice and support of the DPA in managing the project. Trucost also thanks the Wage Indicator Foundation (Wageindicator.org) which provided living wage benchmark data for this study.

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EXECUTIVE SUMMARY

Context and Objectives

The Diamond Producers Association (DPA) is the representative organisation of seven of the world's largest diamond producers, established to maintain demand for, and confidence in diamonds, by promoting the integrity and reputation of the diamond industry and sharing best practices. The membership of the DPA includes ALROSA, De Beers Group, Dominion Diamond, Lucara Diamond, Murowa Diamonds, Petra Diamonds, and Rio Tinto.

In 2017, the DPA engaged Trucost, part of S&P Global, to undertake a world-first comprehensive analysis of the total value contribution of the DPA members, considering all material socioeconomic and environmental benefits and impacts. The study sought to capture not only the economic benefits of diamond mining, which are well understood, but also the social and environmental benefits and impacts associated with the production process. The Trucost Total Value methodology seeks to quantify and capture the full value of these benefits and impacts to provide an assessment of the value created by the DPA members.

The aims of the study are to:

- Understand the material socioeconomic and environmental benefits and impacts of diamond production.
- Leverage this understanding to identify opportunities to minimise the impacts of the industry whilst maximizing the positive value created.

Together the DPA members employ modern large-scale mining techniques to produce 75% of the world's annual diamond production. This report measures the benefits and impacts of the DPA member mining operations

Methodology

The study was conducted across four key phases:

1. **Scoping and Sampling Design:** Detailed preparatory research to identify the most important socioeconomic and environmental indicators for inclusion in the study and to identify a target sample of DPA member sites for inclusion in the data collection process. The target sample represented the full range of countries, mining systems and scales of production employed by the DPA members. A total of 21 environmental and socioeconomic indicators were selected for inclusion in the study.
2. **Data Collection with DPA Members:** A detailed survey was undertaken with representatives of ALROSA, De Beers Group, Petra Diamonds and Rio Tinto to gather information on a comprehensive set of indicators including workplace health and safety, human resources, procurement, taxation, fuel and energy use, water use, waste management and financial performance. The scope of

analysis was defined as the operations of DPA member mines and the centralised support services provided remotely to the mine sites, such as human resources, finance and marketing support. Primary data gathered from the DPA members was supplemented with secondary information from a range of sources including scientific research papers, life cycle assessment databases and industry reports.

3. **Data Processing and Verification:** Data gathered from the DPA members were cleaned, normalised and, where necessary, supplemented with robust modelling and extrapolation techniques to produce a comprehensive database of socioeconomic and environmental metrics for the DPA members.
4. **Data Analysis and Valuation:** The databases for each DPA member were analysed to quantify the biophysical or economic changes associated with each indicator, such as the taxes and royalties paid to local governments or the area of land protected under biodiversity conservation programs. These changes were then valued using Trucost's proprietary natural and social capital valuation approaches, which have been employed in over 100 studies over the past 15 years.

The data collected from DPA members, along with Trucost's analysis, were rigorously evaluated and quality checked in line with the Trucost quality assurance process. To the best of Trucost's knowledge, all data and analysis presented in this report were accurate and reflects the activities of the DPA members.

This public report is a summary of a more detailed analysis and report prepared by Trucost for internal use by the DPA and its members.

Net socioeconomic and environmental benefits totalled \$16B or \$482 per carat of polished diamond produced in 2016

Key Findings

The study finds that in 2016 the DPA members created net benefits of \$16 billion, with socio-economic and environmental benefits outweighing environmental and socio-economic impacts by almost 1700%. Since the environmental and socioeconomic impacts and benefits accrue to different stakeholder groups, with differing preferences and priorities, it may not be appropriate to trade-off benefits in one area against impacts in another. However, combining the total environmental and socioeconomic impacts and benefits of the DPA members can be useful in understanding the scale of these potential trade-offs.

The most important benefits generated by DPA members in 2016 were linked to the direct and indirect benefits of local procurement of goods and services (\$6.8B / \$206 per polished carat, or 40% of total benefits) and the payment of wages and benefits to employees and contractors (\$3.9B / \$116 per

polished carat, 23% of total benefits). The creation of highly remunerated employment opportunities represents a key contribution of the DPA members to local livelihoods in communities surrounding the mine sites.

The most significant impacts of the DPA members in 2016 were linked to greenhouse gas emissions (160 kg CO₂e¹ per polished carat in 2016, or 65% of total impacts) from the use of fossil fuels and electricity, and the production of mining and industrial waste (11% of total impacts).

Employees and Contractors

Diamond mining is a labour-intensive activity, requiring a large workforce of skilled workers often deployed in remote environments. In total, DPA members employed over 77,000 employees and contractors in 2016, mostly in Australia, Botswana, Canada, Lesotho, Namibia, Russia, South Africa and Tanzania. Key benefits and impacts accruing to DPA member employees and contractors include:

In total, DPA members employed over 77,000 employees and contractors in 2016

- **Salaries and Benefits:** Total direct and indirect benefits associated with the payment of wages and other benefits to employees and contractors totalled \$3.9B or \$116 per polished carat in 2016. DPA members universally paid wages in excess of local living wage rates, with the average DPA member employee or contractor receiving 66% more than the national average wage and almost five times more than their country's respective living wage benchmark.
- **Workplace Safety:** Workplace safety incidents on DPA member sites were found to be below average rates in other

industrial sectors (see Figure 5) and the goal of a zero-harm workplace has been adopted by all DPA members. A total of nine workplace fatalities and 118 lost time injury incidents were identified across the 77,000 individuals employed by the DPA members globally in 2016. This equates to over 1.1 million hours worked per lost time injury across the workforce.

- **Gender Wage Gap:** The gender wage gap (the difference between the average remuneration of men and women across all roles - not only within the same pay grade) among the DPA member workforce was estimated at 24%. This rate is lower than the average rate of 28% in the countries of operation of the DPA members, however performance across countries is mixed.
- **Overtime:** DPA member employees were estimated to have worked an average of 48 minutes of overtime each per week in 2016, totalling 3.1 million hours across the DPA members.

¹ Carbon Dioxide Equivalent

- **Insufficient Income, Forced Labour and Child Labour:** No incidences of insufficient income, forced labour or child labour were identified in the DPA member workforce. DPA members adhere to labour Codes of Conduct and have policies and protocols related to these issues. Many members are third-party audited and already publish these statistics as part of their ongoing annual sustainability reporting.

Economy

As a high value natural resource, the production of diamonds represents an important contributor to the economies of many diamond producing nations. Key contributions include employment and procurement of goods and services in remote communities, social programs, payment of taxes and royalties to governments, investments in infrastructure and the distribution of profits to public and private shareholders. Key benefits of the DPA members to local and national economies are illustrated in the following indicators:

DPA member local purchasing programs created \$6.8B or \$206 per carat in benefits for local economies

- **Local Purchasing:** All DPA members support local business development and the growth of small and medium enterprises through local sourcing of goods and services required to run their operations. The direct and indirect benefit of local purchasing strategies totalled \$6.8B or \$206 per polished carat in 2016.
- **Social Programs:** Benefits associated with a selection of social programs operated by the DPA members totalled \$292M or \$9 per polished carat in 2016; this included programs targeting healthcare provision, training and skills development, small to medium sized enterprise development, and charitable activities, but does not represent an exhaustive analysis of all programs implemented by the DPA members.
- **Revenue for Governments and Indigenous Communities:** Revenue to governments and indigenous communities total over \$3.1 B or \$93 per polished carat and represent an important source of income to many country and local governments.
- **Infrastructure Investment:** Total direct infrastructure investment was estimated at \$42M or \$1 per polished carat in 2016. It is noted that this includes only investment occurring in 2016 and not the total investment value of projects commenced in 2016 that may proceed over several years.
- **Profits Retained and Distributed to Private Shareholders:** Profits of \$486M or \$15 per polished carat were distributed to private shareholders of the DPA members in 2016 and \$2.2B or \$66 per polished carat was retained or reinvested in the DPA member businesses.

Environment

Diamond mining is a complex activity requiring energy and resources, which impacts the natural environment. While important, the environmental impacts of the DPA members per unit of economic output were found to be lower than other heavy industries such as the utilities, construction and chemicals sectors (see Figure 7). DPA member mining operations also invest in conservation and rehabilitation and conservation works on the land surrounding the mine, creating potential environmental benefits through the enhancement and protection of natural ecosystems. Key benefits and impacts of the DPA members to the natural environment are illustrated in the following indicators:

**DPA members
conserved over
1,000 square miles
of natural land in
2016, over three
times the land area
used for mining**

- **Biodiversity Conservation:** DPA members collectively protected over 260,000 hectares (more than 1,000 square miles or 854 sq.ft. per polished carat) of land, approximately 3 times the amount of land they utilise, in Australia, Botswana, Canada, Russia, South Africa and Tanzania. This includes, for example, the ALROSA Yakutia Diamonds Live Natural Park and The Diamond Route, a network of eight conservation sites spanning over 200,000 hectares of habitat in South Africa and Botswana which is owned and managed by De Beers Group (De Beers, 2018). DPA member mining operations utilise 84,077 hectares (325 square miles or 272 sq.ft. per polished carat), an area approximately one-third of the total area protected by the DPA members.
- **Greenhouse Gasses:** The DPA member diamond mining operations emitted an average of 160 kg CO₂e per polished carat produced in 2016. Figure 1 presents a comparison of the greenhouse gas emissions associated with the production of natural diamonds, lab grown diamonds and a selection of consumer goods. As shown, the estimated greenhouse gas emissions associated with lab grown diamond production are approximately 3 times (1.8 – 4.6 times) greater than natural diamonds produced by the DPA members in 2016.

Product Comparison

Greenhouse Gas Emissions per Item (kg CO₂e)

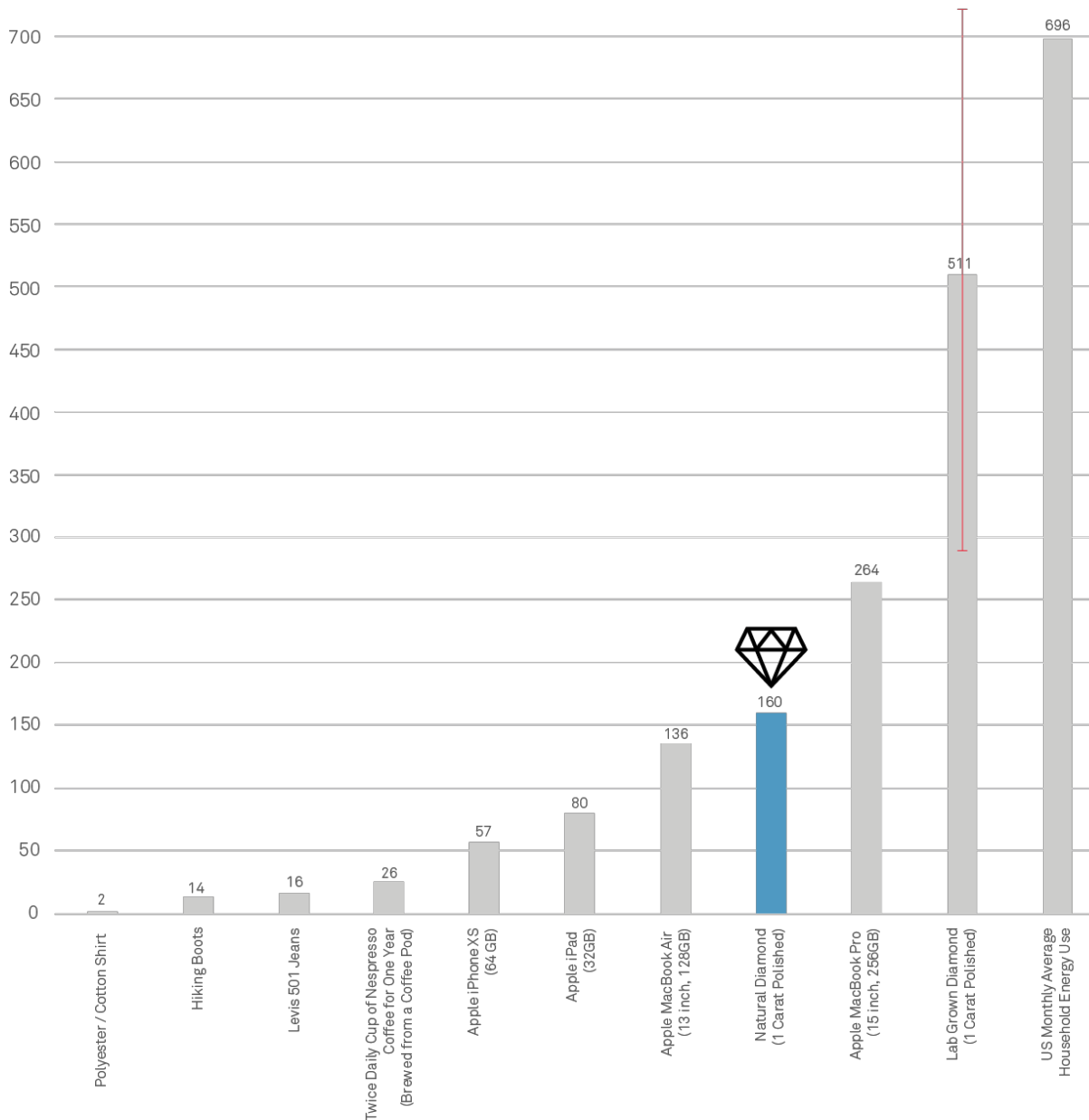


Figure 1 Natural Diamond Impacts in Context: Greenhouse Gas Emissions in the Production of Natural Diamond, Lab Grown Diamond and Selected Consumer Goods (Bates, 2019; Payne, 2019, True Price, 2017; Ila Technologies, 2013; Wernet et al, 2016; Ziminski, 2019; Levi's Strauss and Co, 2015; Apple Inc, 2018a; Apple Inc, 2018b; Apple Inc, 2018c; Apple Inc, 2018d; Cartwright et al, 2011; W.L. Gore and Associates GmbH, 2014; Nespresso, 2018). See Appendix 1 for further information on this comparison.

- Pollution, Land Use and Waste:** The DPA member diamond mining operations produced an average of 4,350 Kg of waste rock residues per polished carat and 1.86 Kg of industrial waste per polished carat, of which 26% (0.5 Kg per polished carat) was recycled. Air, land and water pollution emissions due to energy use and other processes on the mine site also represent a significant impact of diamond mining at 6% of total impacts.

This analysis will serve as a baseline for DPA members to track progress over the coming years.



\$16 billion
in total net benefit
contribution



77,000
employees
and contractors



\$4 billion
contributed to
salaries and benefits



4.8 times
living wage paid to
the average worker



**1.1 million
hours**
worked per one
lost time injury



\$7 billion
direct and indirect
economic benefits of
local purchasing of
goods and services



3 hectares
of land conserved
per hectare used
by mining



\$3 billion
annual payments to
governments and
communities



\$42 million
annual investment
in infrastructure



**160 Kg CO₂e
per carat**
greenhouse gas footprint
per one carat polished
diamond. **69% less**
than the estimated
carbon footprint of lab
grown diamond

Source: Trucost Analysis

INTRODUCTION AND APPROACH

In 2017 the Diamond Producers Association engaged Trucost to undertake a first-of-its-kind analysis of the total value contribution of the DPA members, considering all material socioeconomic and environmental benefits and impacts created by the industry each year. While the direct economic benefits of the sector, such as profits, taxes, salaries and procurement spending, are readily understood and measured by market value it is also possible to value the environmental and social benefits and impacts in order to provide a balanced picture of the total value contribution of the sector.

For the purposes of this study, impacts and benefits are defined as follows:

- **Benefits:** The value of the societal consequences of positive changes in the environment (e.g. biodiversity conservation) and society (e.g. local economic development) associated with the diamond mining operations of DPA members.
- **Impacts:** The value of impacts on environment (e.g. pollution emissions or consumption of water resources) or to people (such as underpayment of wages, or exposure to workplace health and safety risks) associated with the operation of the diamond mining operations of DPA members.

The Trucost analysis therefore considers both the value of economic benefits realised in the market economy, and the value of ‘externalities’ that are not captured by the market but nevertheless create or destroy value for society. An example of a positive externality is the payment of wages to workers in local communities, which not only provides a direct economic benefit, but also stimulates the local economy as workers spend their wages on local goods and services. An example of a negative externality is forced or child labour which create impacts both on the individual and the societies in which they live. The Trucost Total Value methodology seeks to capture the full value of these impacts and benefits to provide a balanced assessment of the value created by the DPA members.

In alignment with the fundamental business objective of all DPA members and to make the data readily comprehensible to the public, the vast majority of data presented in this report are reported as quantities per polished carat.

Methodology

Trucost measured the total benefits and impacts of the diamond mining activities of the DPA members across 21 key socioeconomic and environmental indicators based on data collected for over 150 different metrics from DPA sites representing 70% of the DPA Member’s total rough diamond production. These data were verified by Trucost and then analysed using Trucost’s proprietary natural and social capital quantification and valuation methodologies, which have been employed in more than 100 studies over the past 15 years. More information on Trucost’s methodologies can be found on the Trucost website.

A Wealth of Data

Trucost conducted detailed surveys to gather information across a broad set of indicators including workplace health and safety, human resources, procurement, taxation, fuel and energy use, water use, waste management, and financial performance. Primary data gathered from DPA members were supplemented with secondary information from a range of sources including scientific research papers, life cycle assessment databases and industry reports.

A Comprehensive Sample

The data sample included operations from four companies in six countries. All four types of diamond mining were covered in the sample, including open cut, underground, alluvial and marine mining, representing 70% of DPA members' rough diamond production. Together, DPA members represent the 75% of total global diamond production.

Socioeconomic and Environmental Indicators

Table 1 lists the 21 indicators included in the study. Full details of the Trucost quantification and valuation methodology and the metrics used as inputs to each indicator are provided in a Technical Appendix available from the DPA on request.

Table 1 Economic, Social and Environmental Indicators

Indicator	Description
Socioeconomic Indicators	
Salaries and Benefits	Payment of salaries and the monetary value of in-kind benefits, to employees and contractors of the DPA members in 2016.
Taxation and Royalties	Taxes and royalties paid to governments in 2016.
Local Procurement	Spending on good and services purchased from local businesses (in the same country as the mine) in 2016.
Infrastructure Investment	Investment in infrastructure projects associated with DPA member mines in 2016.
Social Programs	Various indicators including programs related to healthcare, training and skills development, local economic development, and charitable donations or other in-kind contributions to social causes.
Profits to Private Shareholders	Value of profits distributed to private shareholders via dividends and other mechanisms in 2016.
Profits to Government Shareholders and Communities	Value of profits distributed to government shareholders via dividends and other mechanisms, and to communities via participation agreements in 2016.
Retained and Reinvested Profits	Value of profits retained and/or reinvested by the company in 2016.
Insufficient Income	Payment of salaries at rates below the national living wage benchmark. The living wage benchmark is the minimum income necessary to meet typical expenses for accommodation, food, basic services, education, healthcare and transport.
Workplace Safety Incidents	Incidence of lost time injuries incurred by DPA member employees in the conduct of their work in 2016.
	Incidence of work-related fatality among employees of the DPA members in 2016.
Gender Wage Gap	Average difference in the remuneration of males and females in the DPA member workforce across all role categories.
Child Labour	Incidence of labour by children (aged below the legal working age) at DPA member sites in 2016.
Forced Labour	Incidence of forced or bonded labour at DPA member sites in 2016.
Overtime	Hours worked by DPA member employees beyond the national standard working week in 2016.
Environmental Indicators	
Biodiversity Conservation	Area of natural landscape protected from development or conversion to alternative uses.
Air, Land and Water Pollution	Direct and indirect (via fuel combustion) emissions of hazardous chemicals and heavy metals to air, land and water in 2016.

Climate Change	Direct and indirect emissions of greenhouse gasses contributing to climate change in 2016.
Water Consumption	Consumption of water resources in 2016.
Waste	Quantity of industrial wastes disposed via landfill, recycling or incineration, and waste rock produced in 2016.
Land Use	Use of natural land by mine sites and support facilities in 2016.

KEY FINDINGS: CONTRIBUTIONS AND IMPACTS OF THE DPA MEMBERS

Net socioeconomic and environmental benefits² created by the DPA members in 2016 totalled \$16B or \$482 per carat of polished diamond produced. This equates to \$513 per carat in socioeconomic and environmental benefits and \$31 per carat in socioeconomic and environmental costs. Since the environmental and socioeconomic impacts and benefits accrue to different stakeholder groups, with differing preferences and priorities, it may not be appropriate to trade-off benefits in one area against impacts in another. However, combining the total environmental and socioeconomic impacts and benefits of DPA members can be useful in understanding the scale of these potential trade-offs.



\$482

Net Benefit per Carat

The following section provides an in-depth review of the environmental and socioeconomic impacts and contributions of the diamond industry across three key themes: employees and contractors, economy and environment.

Employees and Contractors

- In total, DPA members employed over 77,000 employees and contractors at mines in Australia, Botswana, Canada, Namibia, Russia, South Africa, Lesotho and Tanzania and operations in several other countries during 2016. This is comparable to Fortune 500 companies such as The Coca-Cola Company, Hewlett Packard Enterprise, Alphabet, Nordstrom and Nike Inc., and approximately 75% of the total employment of Alibaba Group.³
- Diamond producers are a source of high-paying jobs in the countries where they operate. DPA members universally paid wages in excess of local living wage rates, with the average DPA member employee or contractor receiving more than 65% above the national average wage and almost 5 times the country living wage benchmark.
- Direct and indirect benefits associated with the payment of wages and other benefits to employees and contractors averaged \$116 per polished carat (or \$3.9B in total) in 2016.
- No incidences of underpayment of living wages, forced labour or child labour were identified at DPA member sites.

² Total monetary value of impacts subtracted from the total monetary value of benefits

³ The Coca Cola Companies: 61,800 employees, Hewlett Packard Enterprise: 66,000 employees, Alphabet: 80,110 employees, Nordstrom: 76,000 employees, Nike Inc: 74,400 employees (Fortune, 2019), Alibaba Group, 2019)

- Workplace health and safety incident rates on DPA member sites were found to be below the average in other industrial sectors and the goal of a zero-harm workplace has been adopted by all DPA members (See Figure 4 and Figure 5). A total of nine workplace fatalities and 118 lost time injury incidents were identified across the 77,000 individuals employed by the DPA members globally.

Diamond mining is a labour-intensive business, requiring a large workforce of skilled workers often deployed in remote and inhospitable environments. Diamond mining operations provide opportunities for skilled and highly remunerated work in remote locations, but also expose workers to risks to health and wellbeing in the course of their work. This creates the potential for important benefits, but also potential impacts, for the people working in DPA member operations. The DPA members have implemented active policies and procedures to mitigate risks – this is reflected in the low rates of workplace safety incidents among the DPA members compared to other sectors (See Figure 4 and Figure 5).

Table 2 DPA Member Benefits and Impacts for People

Indicator	Impact/Benefit	Per Polished Carat 2016
Salaries and Benefits	Benefit	Direct Payments: \$60.6 Indirect Multiplier: \$56
Insufficient Income	Impact	None
Child Labour	Impact	None
Forced Labour	Impact	None
Overtime	Impact	0.09 hours ⁴
Workplace Injuries	Impact	0.000004 cases ⁴
Workplace Fatalities	Impact	0.0000003 cases ⁴
Gender Wage Gap	Impact	24%

⁴ 118 workplace injuries in total. 9 workplace fatalities in total. 3.1 million hours of overtime in total

Salaries and Benefits

The direct and indirect benefits of salaries and wages paid to DPA member employees are significant, at \$116 per polished carat (\$3.9B in total) and accounting for 23% of the total benefits of DPA member's mining activities overall. This includes the payment of salaries and in-kind benefits such as housing, meals and transport, and the economic multiplier effects of the spending of wages in the economy. Payment of wages to workers living in the local community helps to stimulate spending and demand with local businesses and contributes to the growth of the local economy – this is known as an economic multiplier effect.

DPA members on average paid significantly higher wages than the national average in the countries in which they operate. No cases were identified where employees or contractors were paid below the national living wage as calculated by the Wage Indicator Foundation.⁵ DPA employees and contractors are paid an average of 66% more than the national average wage and almost five times more than the living wage benchmark in the country in which they are employed.

⁵ A living wage is the minimum amount sufficient to enable workers and families to afford a basic, but decent, life style that is considered acceptable by the society in which they live – a living wage should enable a family to not only live above the poverty line but also to participate in social and cultural life (Anker, 2011).

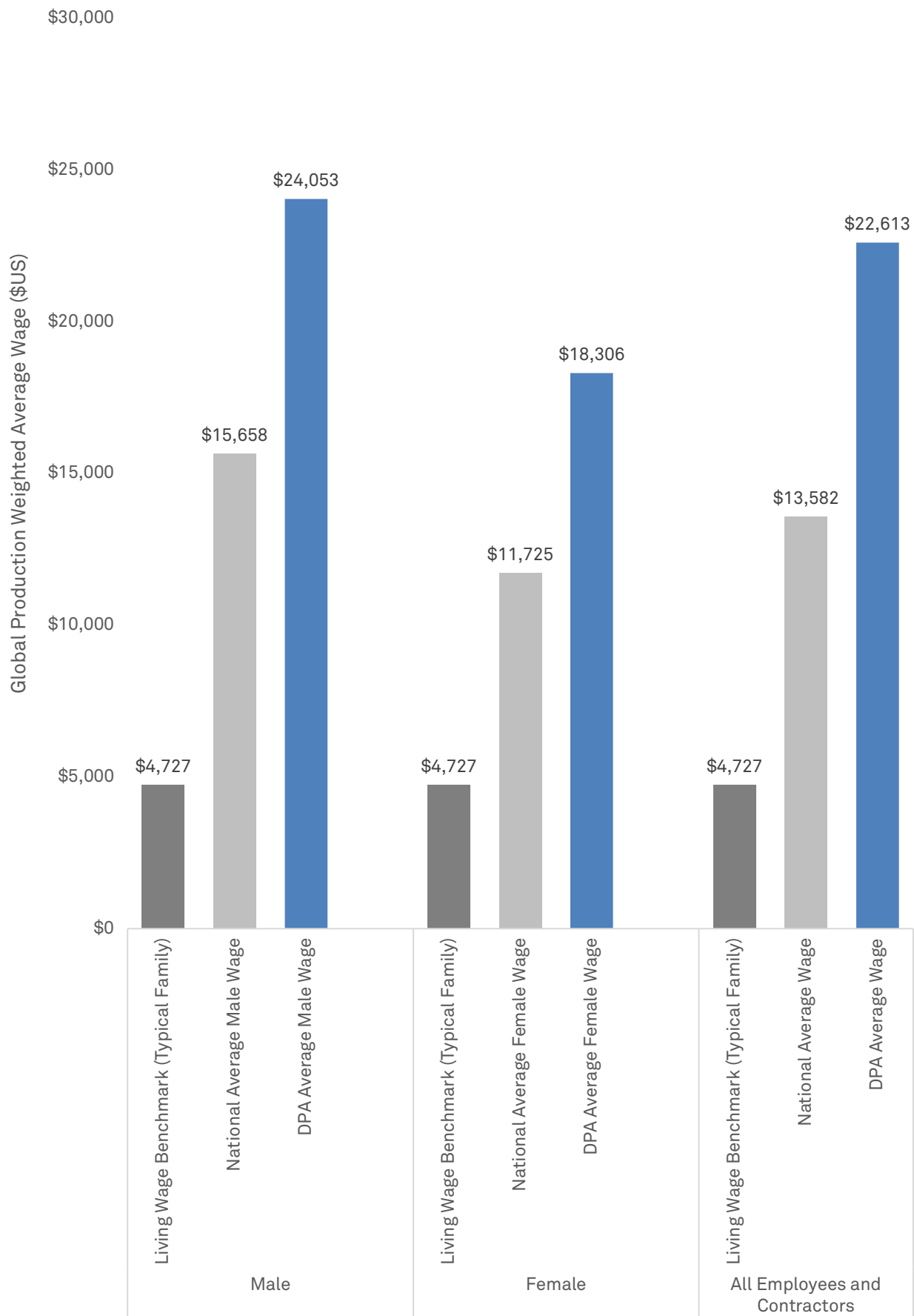


Figure 2 Comparison of Average DPA Wages to Living Wage Benchmarks and Country Average Wages (ILO, 2018a; Wage Indicator Foundation, 2018; Trucost Analysis)

Forced Labour and Child Labour

Child labour and forced labour were not detected among the DPA members. Each company has established codes of conduct and auditing procedures in place to prevent these issues. Child and forced labour are defined as follows:

- **Child Labour:** The International Labour Organisation (ILO) defines child labour as work undertaken by children that is mentally, physically, socially or morally dangerous and harmful to children, and interferes with their schooling (ILO, 2018b).
- **Forced Labour:** The ILO defines forced labour as situations in which persons are coerced to work through the use of violence, intimidation, accumulated debt, retention of identity papers and other means (ILO, 2018c).

Examples of policies implemented by the DPA members to address forced labour, child labour and other socially harmful business practices, not only in their operations but throughout their downstream pipeline, include the Responsible Jewellery Council's Code of Practices, the ALROSA ALLIANCE Guidelines on Responsible Business Practices, the De Beers Best Practice Principles Assurance Programme, the Petra Human Rights Policy and the Rio Tinto Human Rights Policy and Supplier Code of Conduct.

Gender Wage Gap

In socioeconomic analysis the gender wage gap indicator represents the difference between the average remuneration of men and women across all roles. This gap can be explained in part by differences in education level, qualification, work experience, occupational category or hours worked, with the remainder attributed to conscious or unconscious bias. The presence of a gender pay gap does not necessarily imply a difference in pay between male and female workers in the same role, but rather a difference in the average wages paid to male and female workers across the workforce.

For the DPA as a whole the average gender pay gap is 24%, which is less than the 28% average in the countries in which the DPA operates. However, there are significant variations in the gender pay gap by country with the DPA gender pay gap below the national average in some countries and higher than the national average in other countries. As shown in Figure 3, the gender pay gap among the DPA members is comparable to the Professional Services (22%) and Information and Communication Technology (25%) sectors, and significantly less than other heavy industries such as Energy (31%) and Basic and Infrastructure (35% - including manufacturing, mining and engineering) (World Economic Forum, 2016). All DPA members report programs to reduce the gender wage gap over time. These efforts extend to contractors and local business development programs that members have been established by the DPA members.

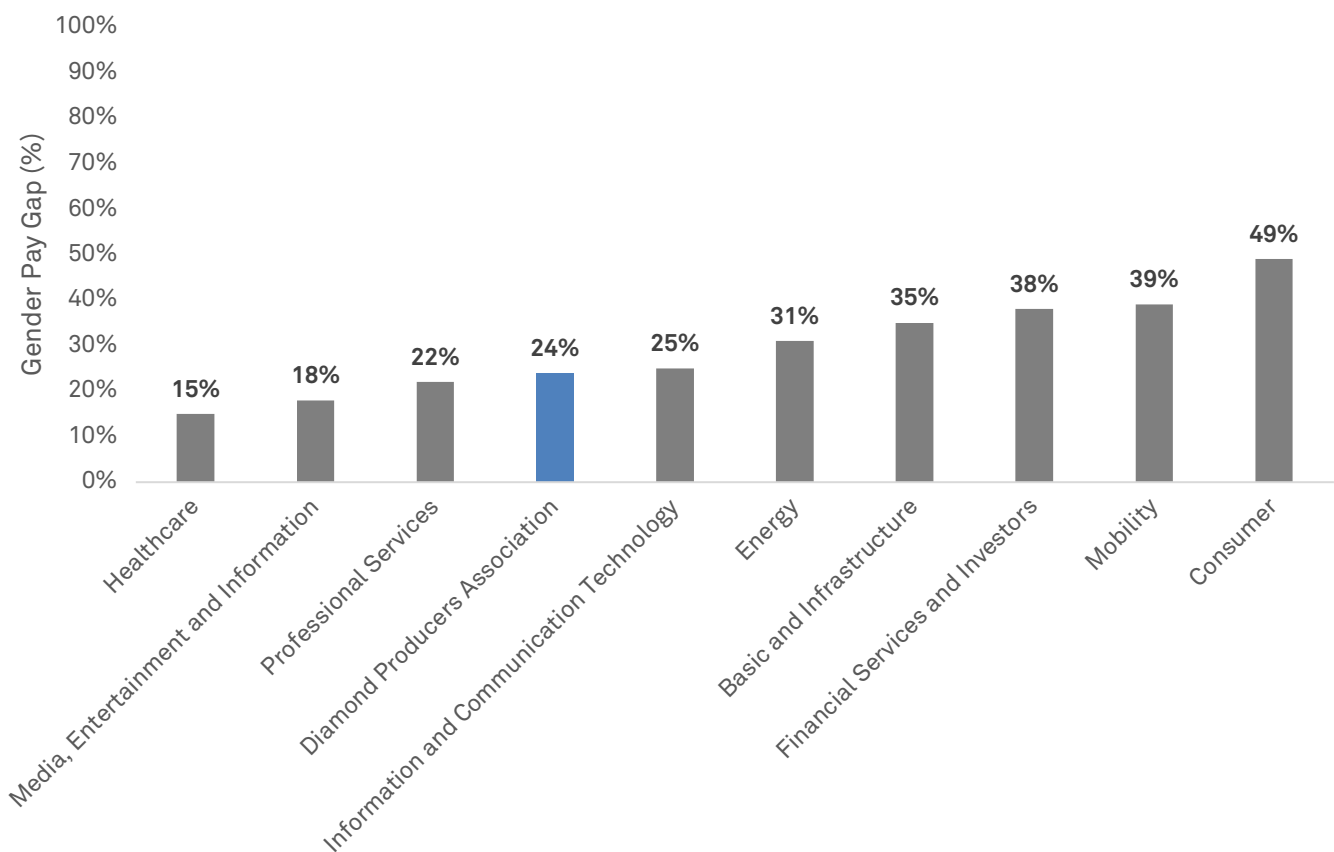


Figure 3 Gender Pay Gap by Sector (Trucost Analysis; World Economic Forum, 2016)

Examples of programs established by the DPA members to promote female advancement include:

- Petra's Women in Mining Committee creates a platform for women to identify challenges in the workplace and advise senior management on policies, procedures, and practices related to attracting, retaining, and providing career development opportunities for women in the workforce.
- Dominion Diamond hosted a Women in Mining strategy session in 2016 which brought representatives from industry, government, indigenous communities, and members of the public together to understand how best to support increased opportunities for women in mining in northern Canada (Dominion Diamond Corporation, 2017).
- As part of its partnership with UN Women, De Beers Group has made commitments across 4 key areas (from leadership to governance) aimed at ensuring women have equal opportunities at all levels of business. Additionally, more than one third of the participants in De Beers' Zimele and Tokafala business development programs are women-owned or co-owned (De Beers Group, 2019; UN Women, 2018).

Workplace Safety

Workplace safety incidents are reported by DPA members and create a significant social cost for communities. A total of nine workplace fatalities were reported for the calendar year 2016. By comparison, there were four fatal incidents in 2013 and 2014, three cases in 2015 and ten cases in 2010. The DPA members have committed to, and are working toward, a goal of zero workplace fatalities across all DPA member sites.

Figure 4 presents a comparison of sector average fatality frequency rates across a selection of key sectors. The Fatal Injury Frequency Rate (FIFR) among DPA members, at 0.004 fatal injuries per 200,000 work hours, falls within the mid-range of comparator sectors, at a higher rate than the power sector at 0.003 and lower than the transportation sector at 0.014 fatalities per 200,000 work hours. DPA members are working to improve safety with a goal of achieving zero workplace fatalities across the DPA sites.

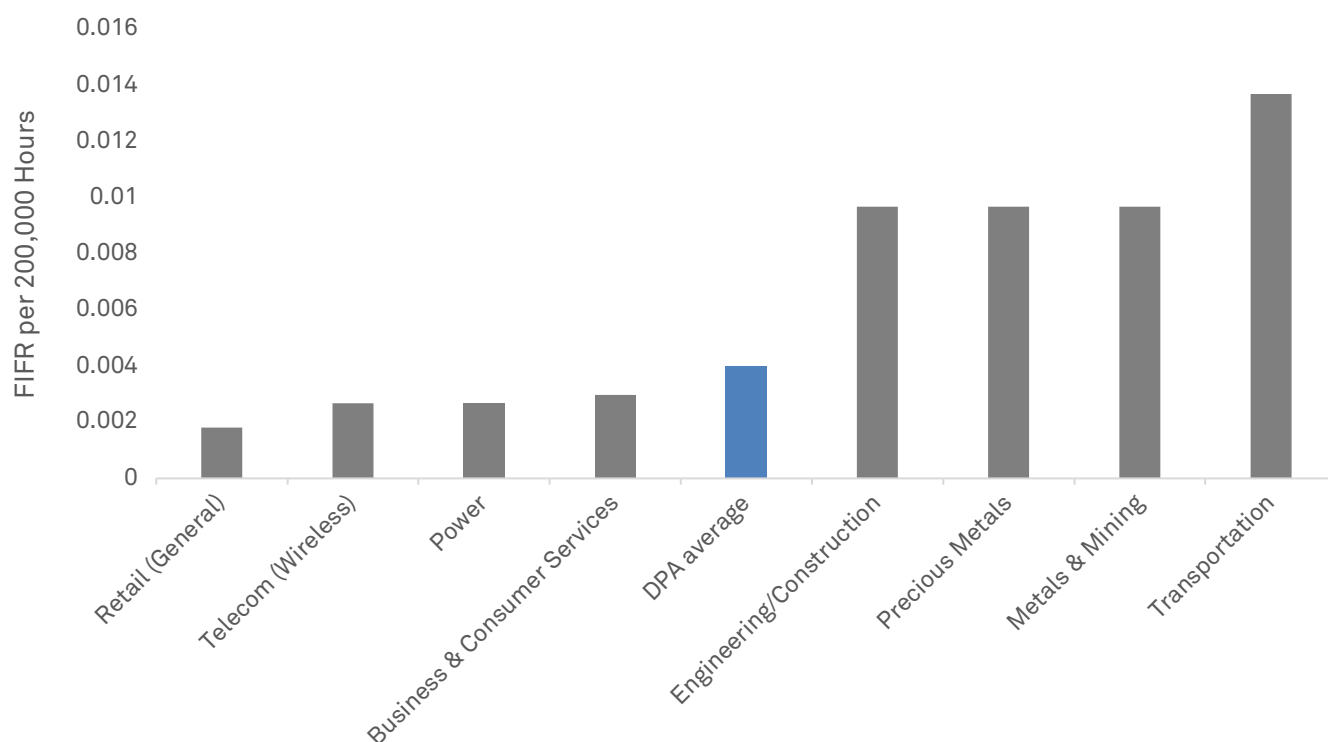


Figure 4 Comparison of FIFR among the DPA members vs key comparator sectors (Adapted from BLS (2018a); Trucost Analysis)

A total of 118 lost time workplace injuries were identified at DPA member sites in 2016. Figure 5 compares the Lost Time Injury Frequency Rate (LTFIR) among DPA members with a series of comparator sectors. Injury rates among DPA members were found to be lower than other sectors, at 0.5 injuries per 200,000 work hours compared to 1.2 injuries in the telecommunications sector to 8.7 injuries per 200,000 work hours in the engineering and construction sector.

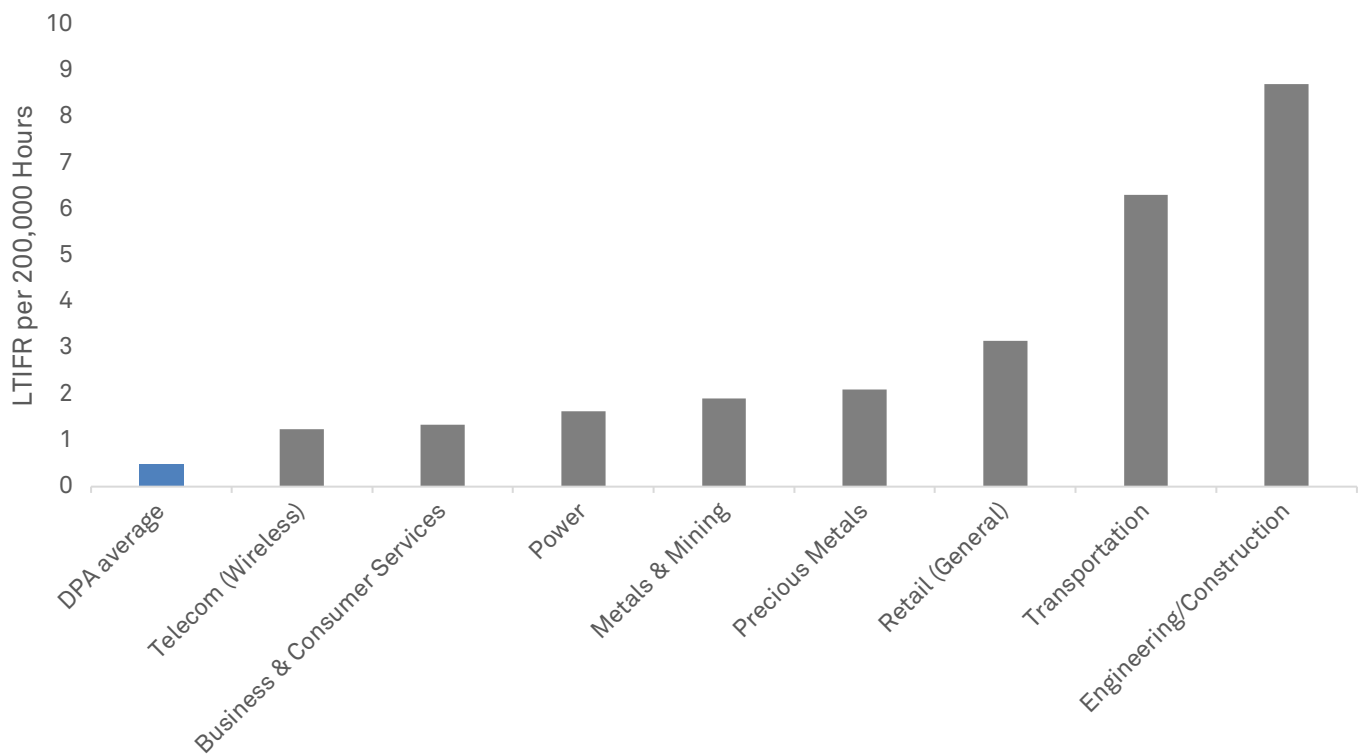


Figure 5 Comparison of LTIFR among the DPA members vs key comparator sectors (Adapted from BLS (2018b); Trucost Analysis)

Key examples of policies and initiatives implemented by DPA members to improve health and safety include the ALROSA health and safety policy (ALROSA, 2018), the De Beers Group Good to Great programme, the Petra Mining Occupational Safety and Health initiative (in cooperation with the South African Chamber of Mines), and the Rio Tinto Critical Risk Management programme.

Overtime

A total of 3.1 million hours of overtime were reported among the DPA members equating to approximately 40 hours of overtime per employee or contractor over a year, or approximately 48 minutes per week.

Economy

- As a high value natural resource, the production of diamonds represents an important contributor to the economies of many producing nations.
- DPA members purchased \$4B in goods and services from local suppliers in 2016, contributing \$6.8B in direct and indirect economic benefits for local communities and businesses in the countries in which they operate.
- Another important benefit for local communities is the development of infrastructure. The DPA members invested an average of \$1 per polished carat in infrastructure in 2016.

As a high value natural resource, the production of diamonds represents an important contributor to the economies of many producing nations. Such contributions include the payment of taxes and royalties to governments, employment and procurement of goods and services in remote communities, investments in infrastructure and the distribution of profits to public and private shareholders.

Table 3 Economic impacts and contributions of the DPA members (Trucost Analysis)

Indicator	Impact/ Benefit	Per Polished Carat 2016
Local Procurement (incl. Economic Multiplier)	Benefit	US \$206
Taxation and Royalties	Benefit	US \$73
Retained Profits	Benefit	US \$66
Profits to Government Shareholders and Communities	Benefit	US \$20
Profits to Private Shareholders	Benefit	US \$15
Social Programs ⁶	Benefit	US \$9
Infrastructure Investment	Benefit	US \$1

Local Purchasing

Local purchasing of goods and services utilised on DPA mine sites, along with the multiplier effects on local economies, represent the most significant economic benefit of the DPA members at \$6.8B or \$206 per polished carat. All the DPA members surveyed identified local purchasing as an important lever to support the economic development of the regions in which they operate and to develop an effective eco-system in which to operate their mines over several decades. Many have internal targets to maximise locally purchased share of goods and services to support the development of local businesses. Local purchasing not only supports businesses in the local region through demand for goods and services, but also has an economic multiplier effect on the broader local economy. As the incomes of direct suppliers increase, additional spending on goods and services is stimulated creating

⁶ Results presented for social programs represent the combined value of the outcomes of a sample of programs operated by the DPA members.

a multiplier effect that propagates throughout the economy. For example, increased spending in construction to build new infrastructure stimulates additional spending in those sectors that supply the construction project both directly and indirectly, such as raw material producers and engineering services. Trucost utilised national economic accounts to estimate the average economic multiplier in each country context and used this to estimate the indirect economic benefits of local purchasing.

Revenue to Governments and Indigenous Communities

Revenues to governments and indigenous communities, including the payment of taxes and royalties (\$2.4B or \$73 per polished carat) and payment of dividends to government shareholders and communities (via participation agreements) (\$665M or \$20 per polished carat), total over \$3B per annum (or \$93 per polished carat) and represent an important source of income to many country and local governments.

Social Programs

Social programs operated by the DPA members also represent an important positive contribution at \$292M per annum or \$9 per polished carat). This includes programs targeting the following areas:

- Healthcare and health promotion programs, such as the operation of hospitals and the provision of health screening services to employees. Examples include the ALROSA Medical Centre and Children's Rehabilitation Centre (ALROSA) and the Jwaneng and Orapa mine hospitals (De Beers Group).
- Training and education programs, including scholarships, apprenticeships and professional education initiatives.
- Local economic development initiatives to support the growth of small to medium enterprises, resulting in increased local employment. Examples include the Tokafala and Zimele programmes (De Beers Group), the Vukuzenzele agricultural project (Petra Diamonds) and the Amrun project (Rio Tinto).
- Charitable contributions to a range of third-party organisations and direct spending on social programs.
- Spending on conservation and biodiversity preservation initiatives.

DPA member social programs created \$292M or \$9 per polished carat in benefits in 2016

Profits Retained and Distributed to Private Shareholders

Over \$486M (or \$15 per polished carat) in profits were distributed to private shareholders of DPA members in 2016 and \$2.2B (or \$66 per polished carat) in profits were retained or reinvested in DPA member businesses.

Infrastructure Investment

Total direct infrastructure investment was estimated at \$42M (or \$1 per polished carat) in 2016. This includes only investment expenditure occurring in 2016 and not the total investment value of projects commenced in 2016, which may proceed over several years and create value into the future.

Environment

- Greenhouse gas emissions are the most significant impact of the DPA member operations, averaging 160 kg CO₂e per polished carat in 2016. This is the equivalent to the emissions from driving 391 miles in an average passenger vehicle (EPA, 2019). As shown in Figure 1, the estimated greenhouse gas emissions associated with lab grown diamond production are approximately 3 times (1.8 – 4.6 times) greater than diamonds produced by the DPA members in 2016.
- The DPA members protect a total of 263,626 hectares (more than 1,000 square miles or 854 sq.ft. per polished carat) of natural land for conservation, approximately three times the footprint of DPA member mining operations.

Diamond mining is a complex activity requiring energy and resources, generating potential impacts to the natural environment. But DPA members also create environmental benefits through investments in conservation and rehabilitation works in the regions surrounding the mines which enhance and protect natural ecosystems. The environmental sustainability of the diamond sector is dependent on the degree to which environmental risks are managed, whilst maximising benefits to natural landscapes.

Table 4 DPA Member Benefits and Impacts on the Environment

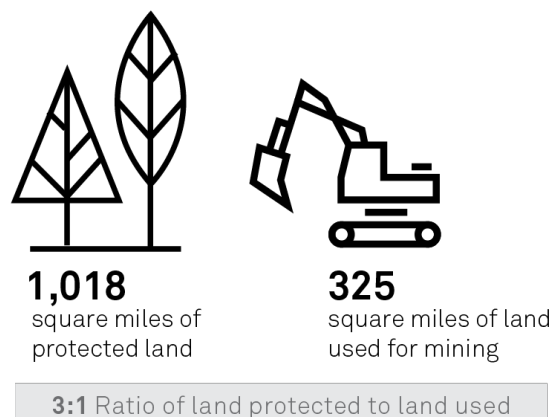
Indicator		Impact/ Benefit	Per Polished Carat 2016
Biodiversity Conservation		Benefit	854 sq.ft
Water Depletion		Impact	7.3 m ³
Air, Land and Water Pollution	Particulate Matter	Impact	0.40 Kg
	Nitrogen Oxides	Impact	0.86 Kg
	Sulphur Dioxide	Impact	0.51 Kg
	Ammonia	Impact	<0.01 Kg
	NMVOC	Impact	0.13 Kg
	1-4 -DB eq	Impact	35.39 Kg
	Phosphorus	Impact	0.04 Kg
Land Use		Impact	272 sq.ft
Waste	Waste Rock	Impact	4,350 Kg
	Industrial Waste	Impact	1.86 Kg
Climate Change		Impact	160 Kg CO ₂ e

Biodiversity Conservation

Biodiversity conservation programs operated by DPA members protected a total of 263,626 hectares of natural land (1,000 square miles or 854 sq.ft. per polished carat) in Australia, Botswana, Canada, Russia, South Africa and Tanzania. This includes the ALROSA Yakutia Diamonds Live National Park and The Diamond Route, owned and managed by De Beers Group, a network of eight conservation sites spanning over 200,000 hectares

of habitat in South Africa and Botswana (De Beers Group, 2018). Total land conserved by DPA members is equivalent to approximately three times the land used for mining. Land reclamation projects are approved in advance by local government and adhere to relevant environmental standards.

Conservation Comparison



Greenhouse Gas Emissions

Reducing greenhouse gas emissions is a priority for the DPA members. Total greenhouse gas emissions per polished carat are estimated at 160 kg CO₂e per polished carat (equivalent to the emissions from driving 391 miles) or 56 kg CO₂e per rough carat (equivalent to the emissions from driving 137 miles) across the DPA members (EPA, 2019). This impact is driven by the use of fossil fuels in vehicles, equipment and machinery (42%) and in the generation and use of electricity (58%). The remote location of the DPA member mines present challenges in reducing fossil fuel use and greenhouse gas emissions, however DPA members have adopted renewable energy to offset some of their fossil fuel energy needs and have programs to reduce energy usage. Efforts include:

- The electricity demands of Argyle Mine (Rio Tinto) in Australia are largely supplied by the Ord Hydro Power Station located at the nearby Lake Argyle, providing a reliable source of low carbon electricity for the site (Rio Tinto, 2015). The adoption of renewable energy at Argyle mine contributed to reducing greenhouse gas emissions per polished carat.
- Diavik Mine in Canada (Rio Tinto and Dominion Diamond Corporation) has installed a 9.2 MW wind farm at the mine site, which supplied 7.6% of the mine's energy requirements, displacing 3.4 million tonnes of diesel in the mining operations and saving \$4.1 million in energy costs in 2016 (Rio Tinto, 2016).

The greenhouse gas footprint of DPA member diamonds is estimated at 160 kg CO₂e per polished carat

Pollution and Waste

Diamond mining and recovery is almost entirely reliant on mechanical processes and does not require the use of large quantities of toxic chemicals, but does require significant quantities of energy, in many cases from fossil fuels. The majority of waste produced by the DPA member diamond mining operations (over 99% by weight) is waste rock (4,350 Kg per polished carat). This waste material is disposed of on site and is eventually reclaimed as part of the landscape during the mine closure and rehabilitation process. The DPA members produced approximately 1.86 Kg per polished carat of industrial waste and 26% by weight, or 0.49 Kg per polished carat, was recycled in 2016.

Environmental Impacts of the Diamond Industry in Context

Figure 6 and Figure 7 place the environmental impacts of the DPA members in context with other commodities and sectors. In Figure 6 it can be seen that the environmental impacts of the diamond sector per million dollars of revenue are 59% less than the costs of mining zinc, 52% less than the costs of mining lead, 21% less than the costs of mining cobalt, and 89% less than the costs of mining cerium (a rare earth used in electronics manufacturing).

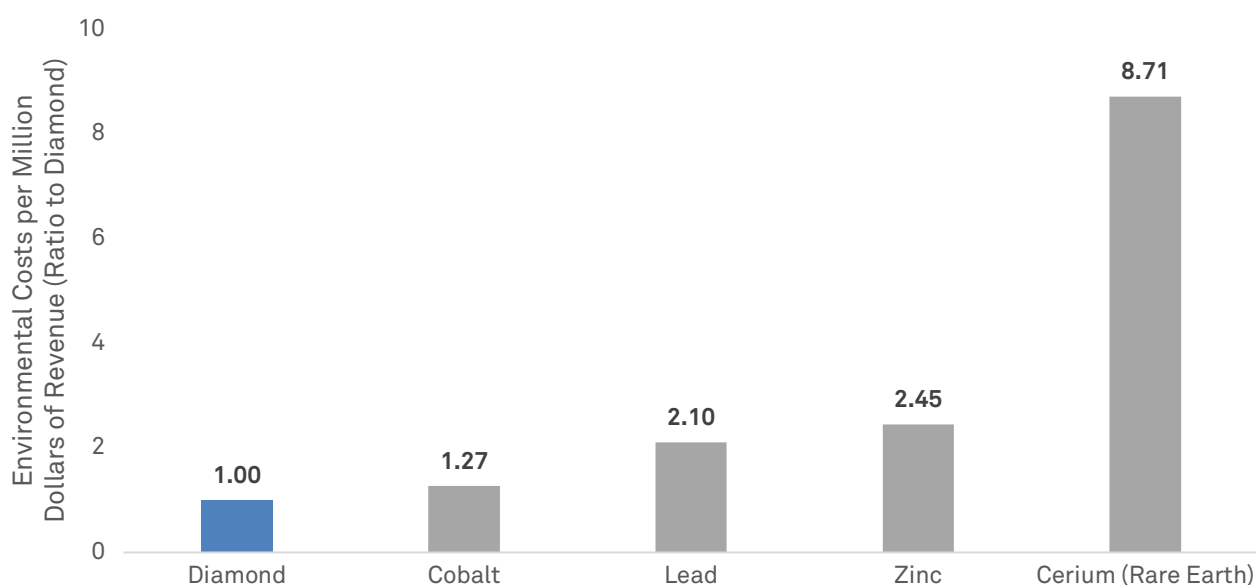


Figure 6 DPA environmental performance in context: Comparison with other mining sectors (Note: Includes environmental costs from greenhouse gas emissions; air, land and water pollution, water consumption and land occupation) (Trucost Analysis, Wernet et al., 2016)

Figure 7 shows that the value of the direct environmental impacts of DPA members per million dollars of production is approximately 49% above the all sector average but creates fewer environmental costs than other heavy industrial sectors such as utilities and construction and materials.

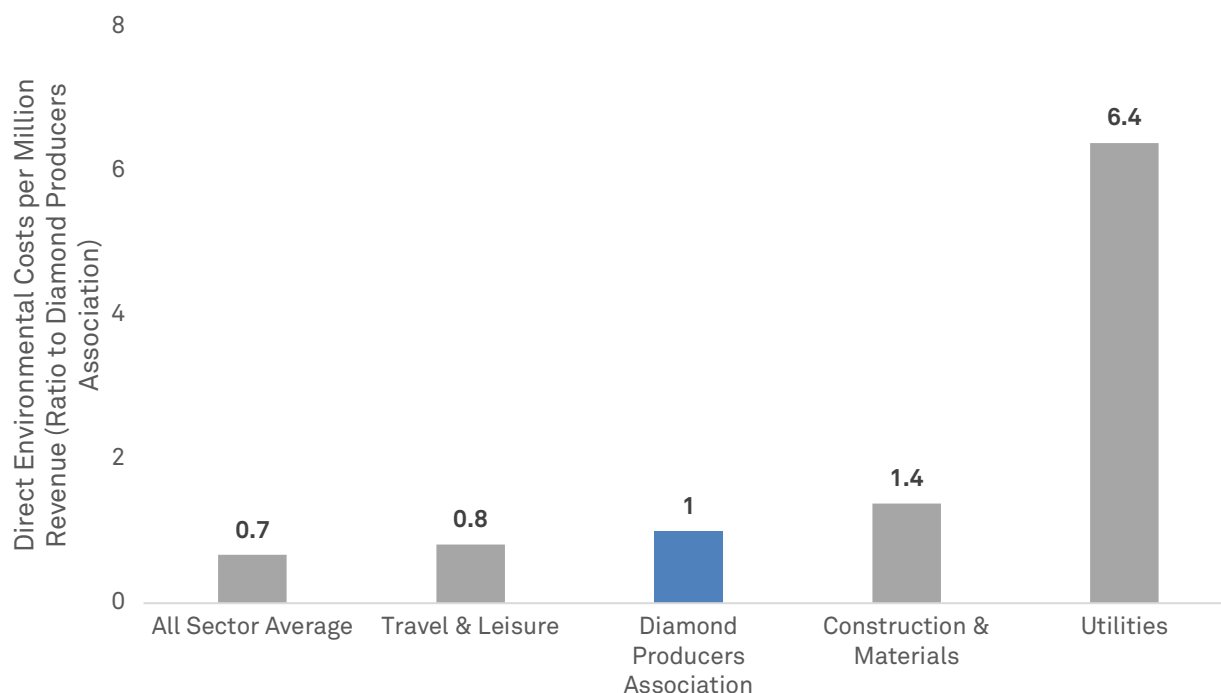


Figure 7 DPA environmental performance in context: DPA environmental impact costs per million of revenue (all environmental indicators) vs selected economic sectors and an all sector GDP weighted average (Trucost Analysis)

Figure 8 presents a comparison of the monetised value of the environmental impacts of producing a one carat polished diamond and a one-way flight between New York City and Los Angeles. The analysis shows the environmental cost of producing a diamond, while significant, is less than two fifths (37%) of that of one seat on the 3,806 km, seven-hour, flight between New York City and Los Angeles. Similarly, the environmental costs of producing diamond is approximately two thirds of that of one seat on the 2,110 km flight from Beijing to Tokyo.

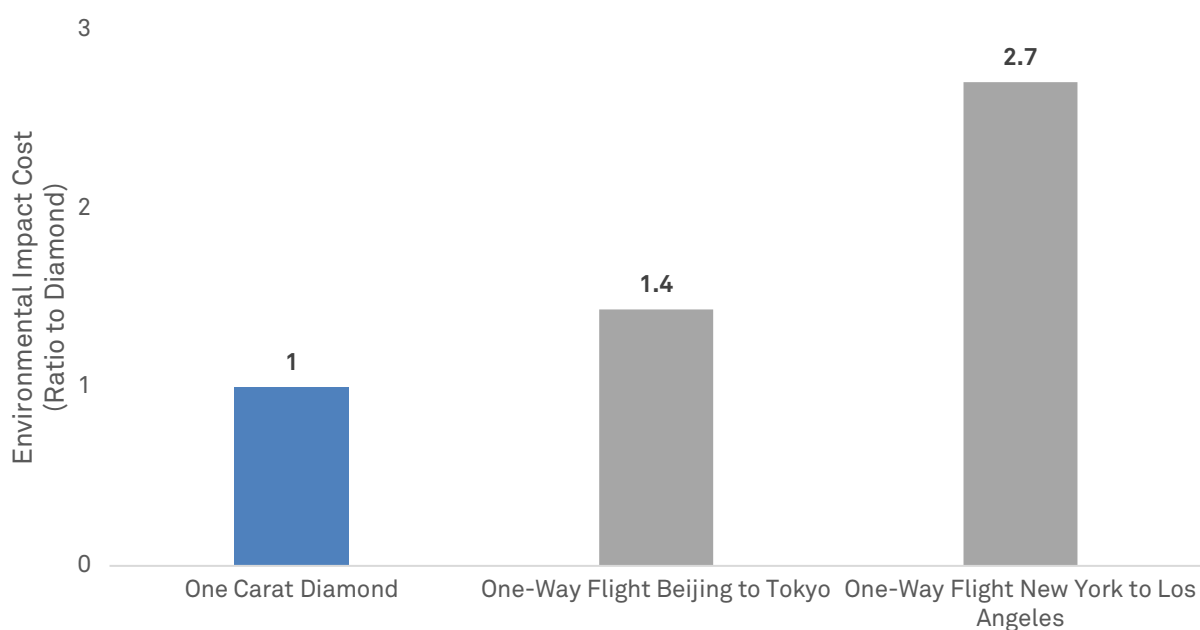


Figure 8 Environmental Impact Comparison: One Carat Diamond vs One Seat on a One-Way Flight New York to Los Angeles (Trucost Analysis, Wernet et al., 2016)

Case Study: Botswana

In the 50 years since independence, Botswana has achieved sustained economic growth of 5.9% per annum, and greatly increased GDP per capita to levels surpassing that of Nigeria, South Africa, Zambia and Ghana (De Beers Group, 2018b). This growth has been underpinned in part by the development of the diamond and other mining industries in the country (Lewin, n.d.). The partnership between De Beers Group and the Government of Botswana, established to utilise the nation's diamond resources with long term development goals in mind, has underpinned Botswana's success and helped the country avoid the 'resource curse' seen in other resource rich countries. Revenue generated by the partnership represented 24% of total Botswanan GDP and 86% of exports in 2014 (De Beers Group, 2014). The economic resources generated from diamond production have supported employment and growth in the broader economy through a focus on local procurement, development programmes for small and medium sized enterprises (such as the Tokafala and Zimele programmes) and investments in capital works and infrastructure. De Beers Group also operates a beneficiation programme that seeks to promote engagement in value added diamond processing activities, directing 20% of rough diamond sales to businesses in Botswana, Namibia, South Africa and Canada in 2015 (DPA, 2018).

Closure of the Argyle Mine

The Argyle diamond mine, operated by Rio Tinto in Western Australia, is scheduled to close in 2020 having operated since 1983, first as an alluvial mine, then an open pit mine and since 2013 as an underground mine. In preparation for closure, Rio Tinto has undertaken an extensive stakeholder consultation process to plan for the rehabilitation of the mine site and to support local communities following the closure of the mine. A committee representing the Traditional Owners of the Argyle site has been established to review and advise on all decommissioning and rehabilitation proposals.

Rio Tinto has established the 'Life after Argyle' program to support all permanent and fixed term employees affected by the mine closure to plan for their careers and seek alternative opportunities after the closure of the mine. The program focuses on identifying the skills and achievements of each employee, developing an individual career plan and identifying further training and support needs in the transition to new roles within Rio Tinto and in the local community. This includes redeployment of workers to other Rio Tinto mines in Western Australia and transition of staff to roles in the rehabilitation process.

Case Study: Yakutia (Russia)

ALROSA Group has produced diamonds in the Yakutia region (Sakha Republic) of Russia since 1957, prior to the development of roads and settlements in the area. ALROSA Group undertakes mining operations across 11 kimberlite pipes and 16 alluvial deposits in Yakutia and is the largest taxpayer in the region. In 2016, ALROSA paid taxes and dividends to the government of Yakutia, accounting for 40% of the region's budget. The Agreement on Social and Economic Development of the Republic of Sakha sets forth the terms of cooperation between ALROSA Group and the Government of Sakha through to 2020. This agreement covers support for local communities through regional development, charitable and sponsorship programs which focus on children's wellbeing, education, culture, arts, sports, investments in social infrastructure facilities and non-profit socially significant projects. ALROSA's social programs target the social and economic development of the Yakutia region through the financial support for over 200 public, municipal, state organisations under the Target Fund for Future Generations of the Republic of Sakha (Yakutia) which has received over RUB 4.5 billion from ALROSA Group since 2011. Key social programs supported by ALROSA in Yakutia include:

- Support for employees and their families to participate in wellness and recreation activities.

- Establishment of the ALROSA medical centre and healthcare program in cooperation with 70 leading medical institutions in Russia. Each year, 2,200 individuals receive regular health checks and treatment under this program.

- Funding for the maintenance of cultural and sports facilities and support for over 175 sports clubs and associations benefiting 10,000 adults and children.

- Financing and development of housing projects and preferential home financing for employees.

- Establishment of a rehabilitation centre for physically disabled children.

- Establishment of the Yakutia Diamonds Live National Park, a 32,000 hectare refuge for local flora and fauna.

CONCLUSIONS AND RECOMMENDATIONS FOR ACTIONS

This study represents a world first attempt to quantify and value the benefits and impacts of modern diamond mining. The study finds significant socioeconomic benefits for the employees, communities and governments in the countries where the DPA members operate, but also highlights impacts on the environment and society that should be the focus of continuing efforts to improve the sustainability of the industry.

Based on this analysis, Trucost recommends the following key actions for the DPA members:

- Reducing key impacts of diamond production.
 - Seek opportunities to reduce the environmental impact of diamond mining by considering the adoption of renewable energy and energy efficiency technologies to reduce greenhouse gas emissions and to increase the recycling of waste produced on mine sites.
 - Maintain and expand proactive policies and programs to improve workforce health and safety on mine sites and continue to work towards the goal of zero harm workplaces.
 - While in many cases the DPA members outperform country averages on the gender pay gap, Trucost recommends further action to close the pay gap through measures to increase female representation in the workforce and ensure equal opportunities for female workers to advance to senior positions within organisations.
- Maximising the benefits of the diamond industry.
 - Continue to maintain and enhance efforts to procure local goods and services and to support the growth and development of local industry outside of the mining sector.
 - Maintain and enhance conservation efforts in high biodiversity value areas nearby to DPA member sites. As a possible goal, DPA members could seek to create environmental benefits through conservation and other programs that are of equivalent value to the broader environmental costs of production.
 - Maintain attractive salary and benefit provisions offered to employees and contractors at well above local average and living wages and continue efforts to extend employment opportunities to local communities to maximise the impact of wages on the local economy.
- Understand and communicate benefits
 - Take a structured and data driven approach to measuring and evaluating the benefits created through social programs to aid in future program optimization and to better communicate the positive impact of the DPA members. Aligning impact assessments with the Sustainable Development Goals can help communicate impact and align with Government development agendas.
 - Trucost recommends the DPA study the total value profile of the full diamond value chain to gain a complete appreciation of the value of the industry and to better understand any negative impacts that require further management.

- The DPA members represent the majority of diamond production by volume and value, and do not themselves engage in artisanal mining. However the artisanal diamond mining sector is of great economic and social significance. Artisanal sector workers are known to be at greater risk of unsafe and unfair labour conditions and artisanal operations are likely to be more damaging to the environment. DPA members are already involved in helping lift the artisanal sector, through their support of the Diamond Development Initiative (Diamond Development Initiative, 2019) and programs such as De Beers Group's Gemfair initiative (Gemfair, 2019). Trucost recommends that DPA members continue to contribute to efforts to better understand the environmental and socioeconomic impact of the artisanal diamond sector, and support efforts to improve health, safety and environmental conditions in artisanal mines.

DETAILED METHODOLOGY

A detailed description of the study methodology is available on request from the Diamond Producers Association.

APPENDIX 1. NOTE ON NATURAL DIAMOND GREENHOUSE GAS IMPACT IN CONTEXT ANALYSIS

Figure 1 presents the greenhouse gas footprint of natural diamond in comparison with lab grown diamonds and selected consumer goods. In all cases the greenhouse gas footprint includes emissions from production but excludes any emissions from product use and disposal, to maintain consistency with the scope of the analysis for natural diamond. Greenhouse gas footprints for all products except for lab grown diamond are based on assessments published by the manufacturers (Levi Strauss and Co, 2015; Apple Inc, 2018a; Apple Inc, 2018b; Apple Inc, 2018c; Apple Inc, 2018d, W.L. Gore and Associates GmbH, 2014; Nespresso, 2018) or LCA practitioners (Cartwright et al, 2011). Disclosure on the greenhouse gas and broader environmental impact of lab grown diamond production is poor, with limited quantitative information available in the public domain on energy and material inputs. To overcome this limitation, Trucost prepared an estimate of the greenhouse gas footprint per polished carat due to energy use only, using an average of estimates in the public domain (Table 5). In all cases, greenhouse gas emissions associated with the production of materials and equipment, and the use of energy outside of the lab grown diamond production process, have been excluded. The effect of this scope limitation is likely to underestimate the total greenhouse gas emissions associated with lab grown diamond production. Furthermore, Trucost has excluded energy consumption estimates at the upper and lower extreme (marked with * in Table 5) to avoid skewing the overall average estimated energy requirement per carat. Consequently, the energy consumption data below likely represents a conservative estimate of actual energy use for the production of lab grown diamonds on the market today.

Greenhouse gas emissions from energy use were estimated based on the average emissions per kWh of electricity consumed from the local electricity grid in key lab grown diamond producer countries (Wernet et al, 2016). The following production shares are assumed based on analysis and estimates provided by diamond industry analyst Paul Zimnisky:⁷ USA (10%), Russia (12.5%), China (42.5%), France (1.25%), UK (10%), Singapore (10%), Israel (1.25%), and India (12.5%).

⁷ <http://www.paulzimnisky.com/>

Table 5 Energy Requirements for the Production of Lab Grown Diamonds (Trucost Analysis, Bates, 2019; Payne, 2019; True Price 2017; Ila Technologies, 2013)

Source	Production Greenhouse Gas Emissions per Polished Carat (kg CO ₂ e)		Explanatory Note
	Lower Bound	Upper Bound	
Bates (2019)	650 kWh	1,100 kWh	High Pressure High Temperature process, single stone
	350 kWh	700 kWh	High Pressure High Temperature process, multi stone
	1,000 kWh*	1,700 kWh*	Chemical Vapour Deposition process
Payne (2019)	250 kWh	750kWh	Chemical Vapour Deposition process
True Price (2017)	26 kWh*	Not Available	Unspecified
Ila Technologies (2013)	77 kWh	Not Available	Chemical Vapour Deposition process
Overall Average Energy Requirement (All Available Data) (kWh per Polished Carat)			727 kWh
Adjusted Average Energy Requirement (Excluding upper and lower outlier values (marked with *)) (kWh per Polished Carat)			591 kWh (332 - 850 kWh)
Production Weighted Average Greenhouse gas emissions per kWh (kg per kWh)			0.87 kg/kWh
Production Weighted Average Greenhouse Gas Emissions per Polished Carat (Kg per Polished Carat)			511 kg per Polished Carat (287 – 736 kg per Polished Carat)

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