

# **GROWN DIAMONDS: UNLOCKING FUTURE OF DIAMOND INDUSTRY BY 2050**

*A report by Frost & Sullivan*

*December 2014*

## Table of Contents

Table of Contents.....	2
Background.....	3
1 Introduction .....	4
2 Rough Earth-mined Diamonds Production Outlook .....	5
3 Increasing Supply-Demand Gap and its Impact.....	12
4 Rough Grown Diamond: Future Outlook.....	17
5 Grown Diamonds: Opportunities for Economic Growth.....	22
6 Analyst Opinion .....	27

## Background

### Analyzing the Demand-Supply for Diamond Industry

*In 2013, Frost & Sullivan had published a report “Grown Diamonds – Shaping Future of Diamond Industry”. The report focused on technology impact assessment of the recent enhancements in the innovative technology of growing diamonds and it received significant industry interest. There have also been other studies analyzing the potential market size, value chain and consumer perception for Grown Diamonds.*

*The Diamond Industry is well established and has a strong value chain of key players. It supports economic development and employment in many countries and often its supply chain spans multiple geographies. Moreover, as an industry it has seen rapid growth in the past two decades with a rising demand and diamonds are globally acknowledged as the most treasured precious stones.*

*This report intends to look closely at the supply chain and some other elements of the diamond industry and analyze the demand and supply curve for this industry. It also looks at various impact areas of the diamond industry such as employment, economic growth, etc. The report then delves into the Grown Diamond industry and how it fits in the industry to possibly resolve some of the supply side issues the industry could potentially encounter.*

*This report is a result of extensive Frost & Sullivan analysis based on key industry reports, publicly available secondary information, internal research and analysis.*

## 1 Introduction

### Grown Diamonds and Mined Diamonds

Diamond industry is global in nature with its supply chain pipeline moving from one country to the other, benefitting each country & its economy. Traditionally the diamond industry has had a single source of supply in the form of diamond mining. However, this process is quite lengthy, rigorous and depends on a finite resource. Diamond mines have a life depending on geographical location of the mine and the type of mining employed. These constraints have not surfaced as a threat globally as yet, but represent a long term problem in the form of depleting raw materials sources.

However, a significant breakthrough, during this period, is a new industry that has pioneered the ability to grow colorless Ila quality diamonds (rare quality which is less than 2% of global rough diamond production from mines) by creating diamond-growing conditions in semiconductor grade facilities, above the earth's surface. These facilities are often referred to as 'Greenhouses' for diamond growth. Similar to any other Greenhouse, they provide the ideal environment for diamond growth by replicating nature-like favorable conditions to allow growth.

Mined diamonds is a finite resource considering the extreme and rare occurrence of natural surroundings in which it can be formed. This puts a question on the sustainability of the industry itself where the primary source can be seen as declining. All the same it should be kept in mind that there are various other non-gem or high tech applications where diamonds can also be used.

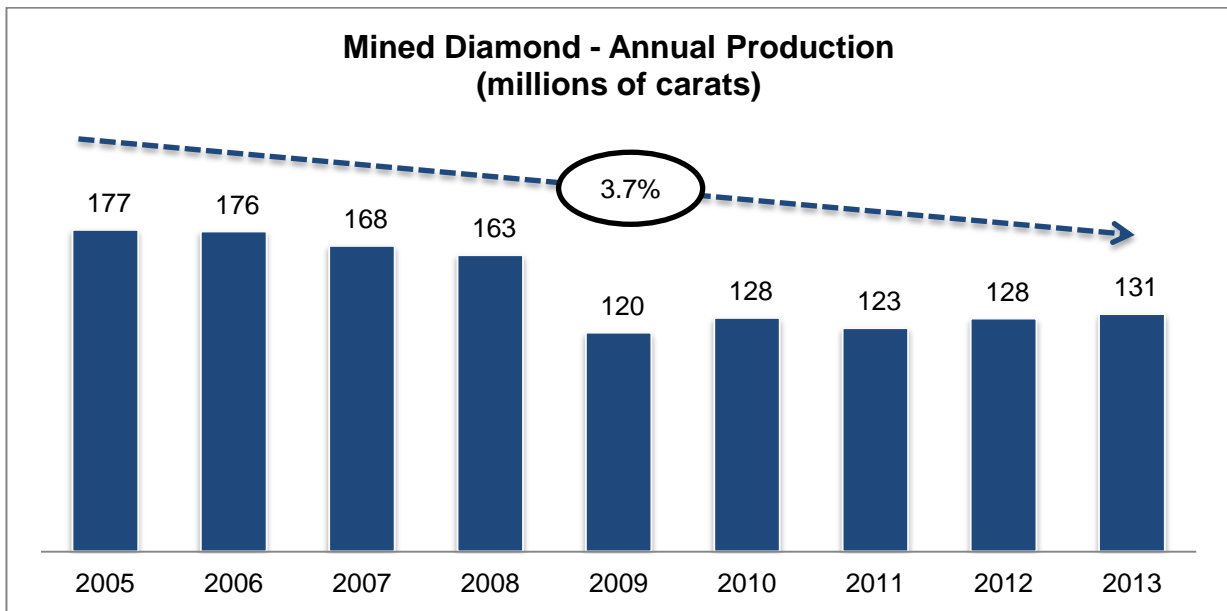
This report analyzes the demand curve till 2050 and also matches it to the supply side trying to identify potential risks or gaps. Here, grown diamonds are analyzed to understand the possibility they represent for the industry from the supply side. Also, other kinds of impact by Grown Diamonds such as that on the diamond industry value chain, economic growth of countries involved and employment generation have also been considered.

## 2 Rough Earth-mined Diamonds Production Outlook

### Global Production has fallen in last 10 years

Rough Diamond production globally has come a long way from producing its first 1 million carat annually in 1872 to reaching a peak of 176.7 million carat in 2006<sup>1</sup>. Since then, the global annual production has fallen by 20-30% off this peak. In 2013, the global rough diamond production from mines was 131 million carats. The world produced more diamonds in that last twenty years than in all of history.

**Figure 1 – Annual Production of Mined Diamonds (2005- 2013)<sup>2</sup>**



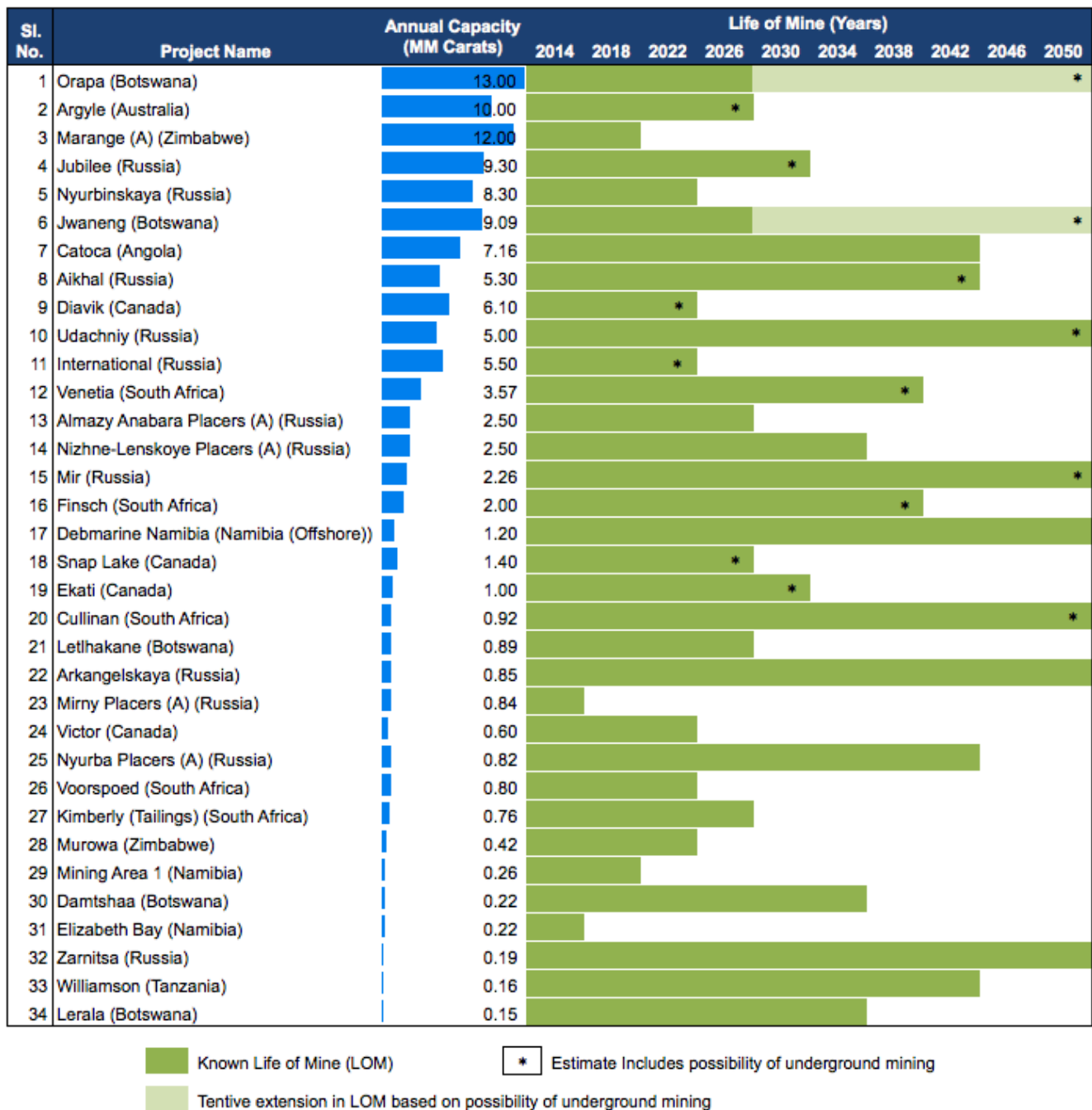
### Existing Mines: Facing end of life and depletion

Nearly all of the world's annual output (99%) of diamonds from mines, alluvial diamond fields and marine operations can be attributed to top nine producer countries - Russia, Botswana, DRC, Australia, Canada, Zimbabwe, Angola, South Africa and Namibia.

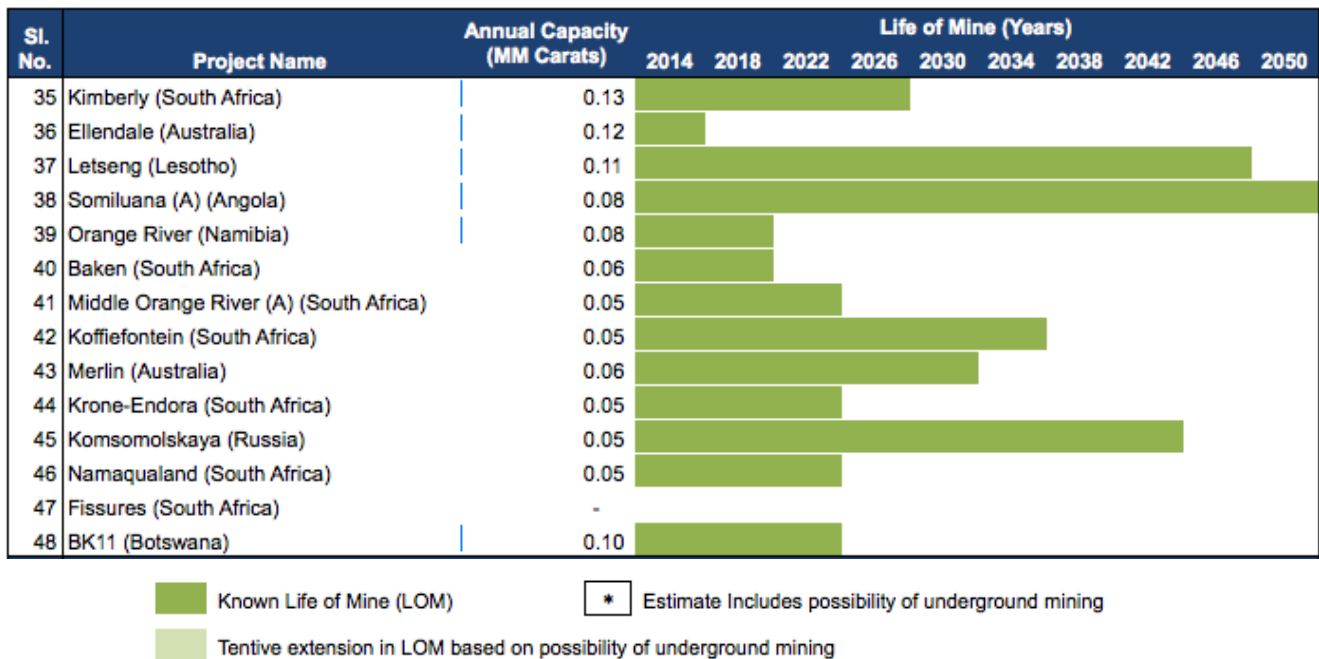
<sup>1</sup> Global Rough Diamond production Since 1870, Gems and Gemology, Summer 2007, Vol. 43, No. 2, Page 98

<sup>2</sup> Kimberley Process Rough Diamond Statistics, [https://kimberleyprocessstatistics.org/public\\_statistics](https://kimberleyprocessstatistics.org/public_statistics)

**Figure 2 – Life of Mines across all key known Mines<sup>3</sup>**



<sup>3</sup> Rough Diamond Supply based on - (1)“Life of Mines” estimates as mentioned by Industry analyst Mr. Paul Zimnisky in his report “Table Toppers”, Mining Journal Special Edition, May 2014. [http://www.mining-journal.com/\\_data/assets/pdf\\_file/0005/561047/Table-toppers-table.pdf](http://www.mining-journal.com/_data/assets/pdf_file/0005/561047/Table-toppers-table.pdf) (2) New Mines estimates derived from “The Global Diamond Report 2013: Journey through the Value Chain”, August 2013, Bain Report. <http://www.bain.com/publications/articles/global-diamond-report-2013.aspx>.  
Key Assumption: All mines were expected to consistently perform at the 2014 Production level (as estimated in “Table Toppers” report mentioned above). Once the “Life of Mine” was over the annual production value was assumed to be zero for all subsequent years. This assumption would provide and optimistic scenario for all mines as normally the production level of mines reduces towards the end of their life



Almost all of the major diamond mines, which have been producing at least 5 million carats of diamonds over past decades, are now past their peak production levels. The only option to extend the life of some of these mines is to go deeper to recover diamonds using underground mining techniques. But underground mines produces fewer diamonds have higher operating costs and short life.

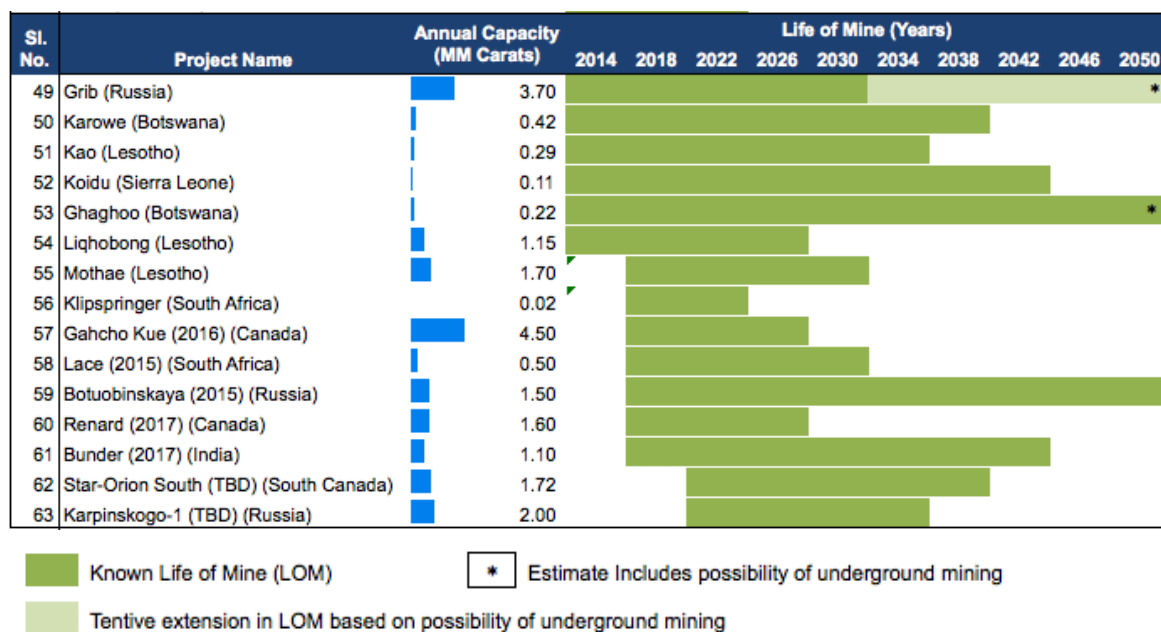
Argyle and Diavik mines are two leading diamond mines estimated to exhaust supplies within the next ten years. The Argyle mine in Australia will be going underground mining way to produced 20 million carats till 2020 before shutting down. The Diavik mine in Canada is already operating as an underground mine and is estimated to reach end of life by 2023. De Beers has planned to invest US\$2 billion to build the Venetia underground mine, which will extend the life of mine from 2022 to beyond 2040. However, the capacity is likely to be less than 5 million carats for the remaining life of mine. Through 2012, De Beers invested more than US\$2 billion to build and operate the Snap Lake mine in Canada. The Snap Lake mine is yet to achieve its production goals and has an estimated life of maximum 20 years.

Among the top 10 diamond mines in 2014, only Udachniy mine in Russia will still be productive in next 3 decades. Bain and Company’s Global Diamond Industry Report 2013 predicts that mined diamond production will start to decline by 2019, falling by 1.9% per year.

**New Mines: Low Capacity, Short Life and Few in numbers**

In comparison to around 50 active mines available for production today, approximately only 15 new mines are expected to become operational in next 40 years. All these new mines together are expected to add only 18 million carats each year by 2023 in comparison to over 120 million carats produced at present by all mines globally. Of these 15 new mines only 2 mines – Grib (Russia) and Gahcho Kue (Canada) are expected to be able to product close to 4 million carats each year. Grib (Russia) has a life of 19 years and Gahcho Kue (Canada) has a life of 11 years.

**Figure 3 – New Mines: Capacity and Life<sup>4</sup>**



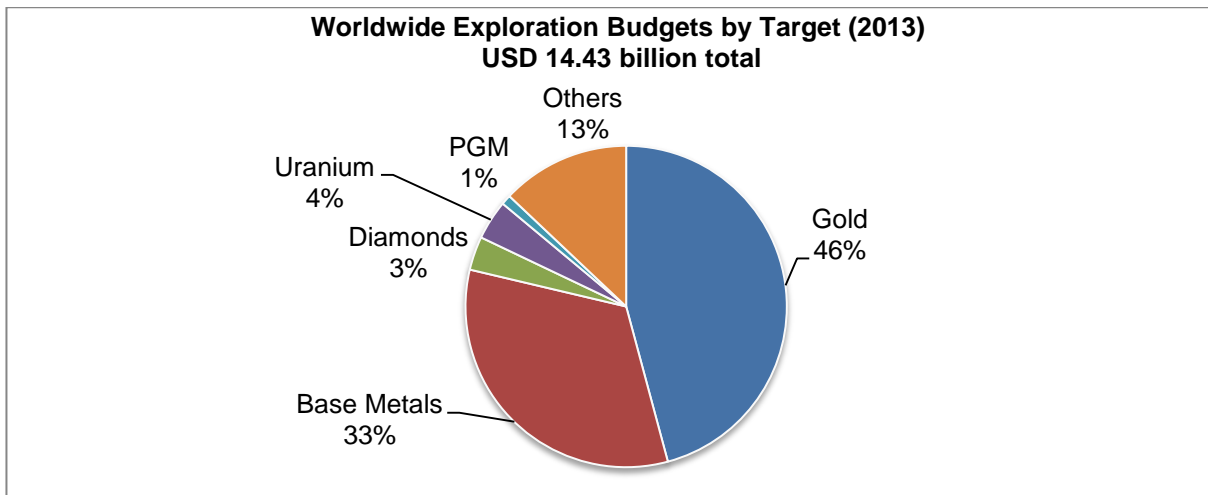
<sup>4</sup> Rough Diamond Supply based on - (1)“Life of Mines” estimates as mentioned by Industry analyst Mr. Paul Zimnisky in his report “Table Toppers”, Mining Journal Special Edition, May 2014. [http://www.mining-journal.com/\\_data/assets/pdf\\_file/0005/561047/Table-toppers-table.pdf](http://www.mining-journal.com/_data/assets/pdf_file/0005/561047/Table-toppers-table.pdf) (2) New Mines estimates derived from “The Global Diamond Report 2013: Journey through the Value Chain”, August 2013, Bain Report. <http://www.bain.com/publications/articles/global-diamond-report-2013.aspx>.  
Key Assumption: All mines were expected to consistently perform at the 2014 Production level (as estimated in “Table Toppers” report mentioned above). Once the “Life of Mine” was over the annual production value was assumed to be zero for all subsequent years. This assumption would provide an optimistic scenario for all mines as normally the production level of mines reduces towards the end of their life.



**Little hope from future new Explorations**

Even with all the technological advancement and development in the field of exploration and mining, the future of Rough Diamond production, from mines, looks bleak. As per DeBeers estimates more than 8,000 kimberlites have been found, but only 67 had enough diamonds to justify the economics of establishing a mine. Of those mines, just seven were major mines like Jwaneng and Orapa in Botswana and Venetia in SA, generating 65% of global rough diamond production by value<sup>5</sup>.

**Figure 4 – Worldwide Exploration Budgets by Target (2013)<sup>6</sup>**

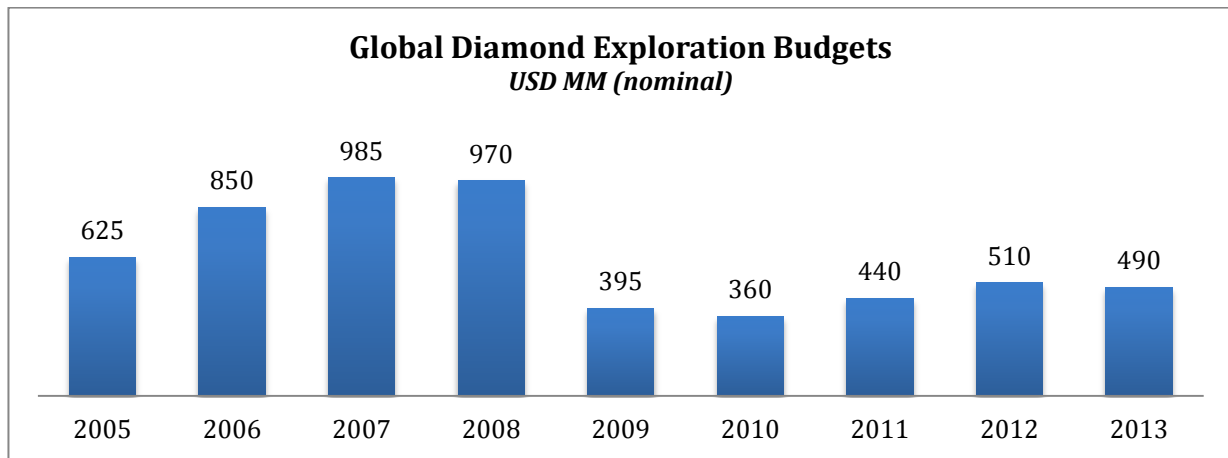


Major diamond producers have reduced exploration budgets while junior exploration companies are facing increased difficulty in obtaining new finance owing to kimberlite feasibility issues. In 2013, 3% of the total budgets for exploration were allocated for Diamond Exploration – as compared with 46% of budgets allocated for gold exploration and 33% for Base Metal explorations. The overall Diamond exploration budgets of mining companies have reduced to half of what it used to be in 2007 and 2008.

<sup>5</sup> Finding new deposits of diamonds 'crucial' <http://www.bdlive.co.za/business/mining/2014/09/15/finding-new-deposits-of-diamonds-crucial>

<sup>6</sup> SNL Metals & Mining's Corporate Exploration Strategies 2013

**Figure 5 – Global Diamond Exploration Budgets<sup>7</sup>**



### **Earth-Mined Diamond Supply estimates by Mines**

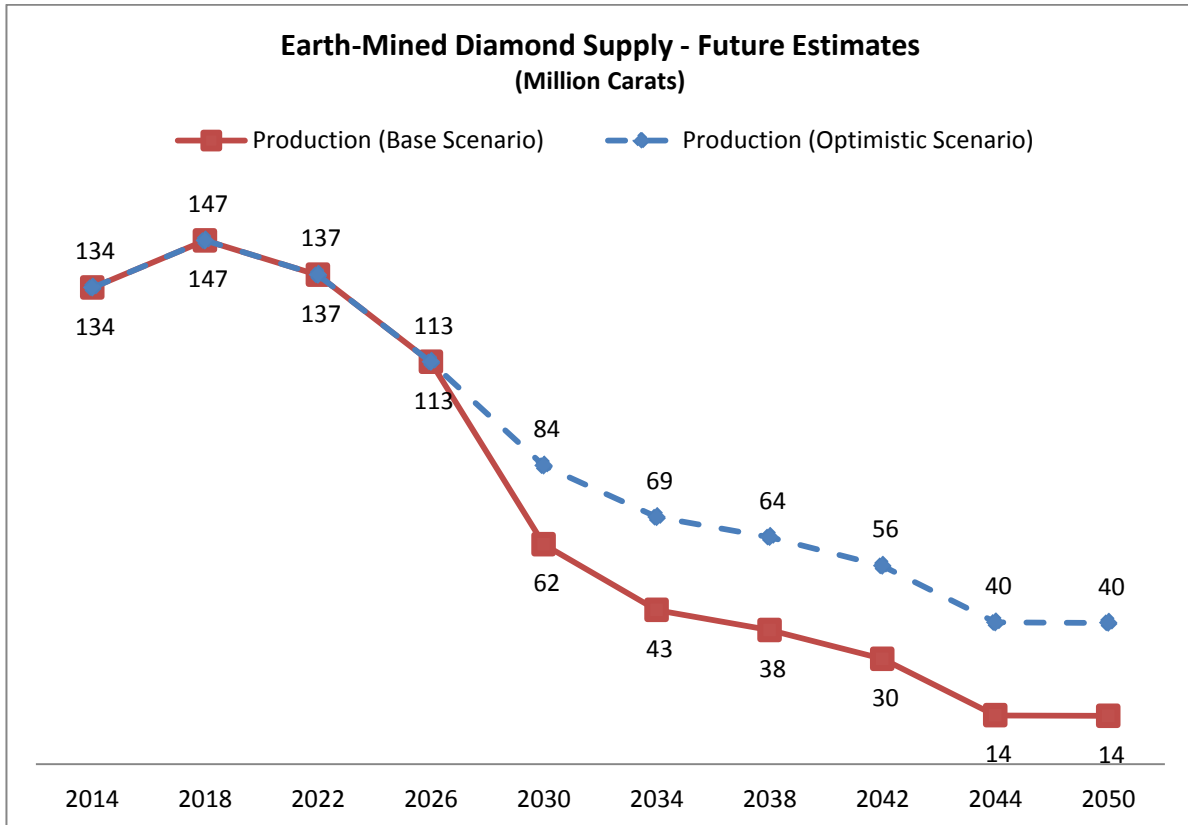
The global mined diamond supply is estimated to drop to 13 million carats in 2050 from the projected 133 million carats in 2014 considering a base case scenario. In order to estimate the production lifecycle of mines in the base case scenario, the primary assumption was that diamond mines would continue to perform consistently at either their best production levels or 2014 production levels. This assumption is intentionally made on the higher side ignoring declining production levels and rising costs of extraction that stump the feasibility of a mine over a period. In case of the optimistic scenario numbers, the estimates for future annual production of each existing and new mine is made with an assumption that even after an open-pit mine goes underground, its annual production will remain same and not reduce. This assumption provides cushion for any year in future when the annual production is higher than our estimate as well as covers the optimistic production scenario for the mines. Also, it is important to note that as mines move underground to sustain production levels, the geology of Kimberlite pipe does not allow them to maintain the same production levels. The Kimberlite pipes are carrot shaped and get very narrow as they go deeper. Approximately 50% of the production at the mines can be lost when mines go underground. This could potentially translate to a loss of about 30–50 million carats per annum of global production over a 20-year period<sup>8</sup>.

<sup>7</sup> SNL Metals & Mining's Corporate Exploration Strategies 2013

<sup>8</sup> <https://www.kpmg.com/Ca/en/industry/Mining/Documents/diamond-q3-2012-november-2012.pdf>

The estimates also include the assumption that the mines Orapa, Jwaneng and Grib will be able to consistently produce the same quantity of rough diamonds annually even after they successfully go underground. The feasibility for underground mining for these mines is yet to be completed.

**Figure 6 – Future estimates for Mined Diamond Supply<sup>9</sup>**

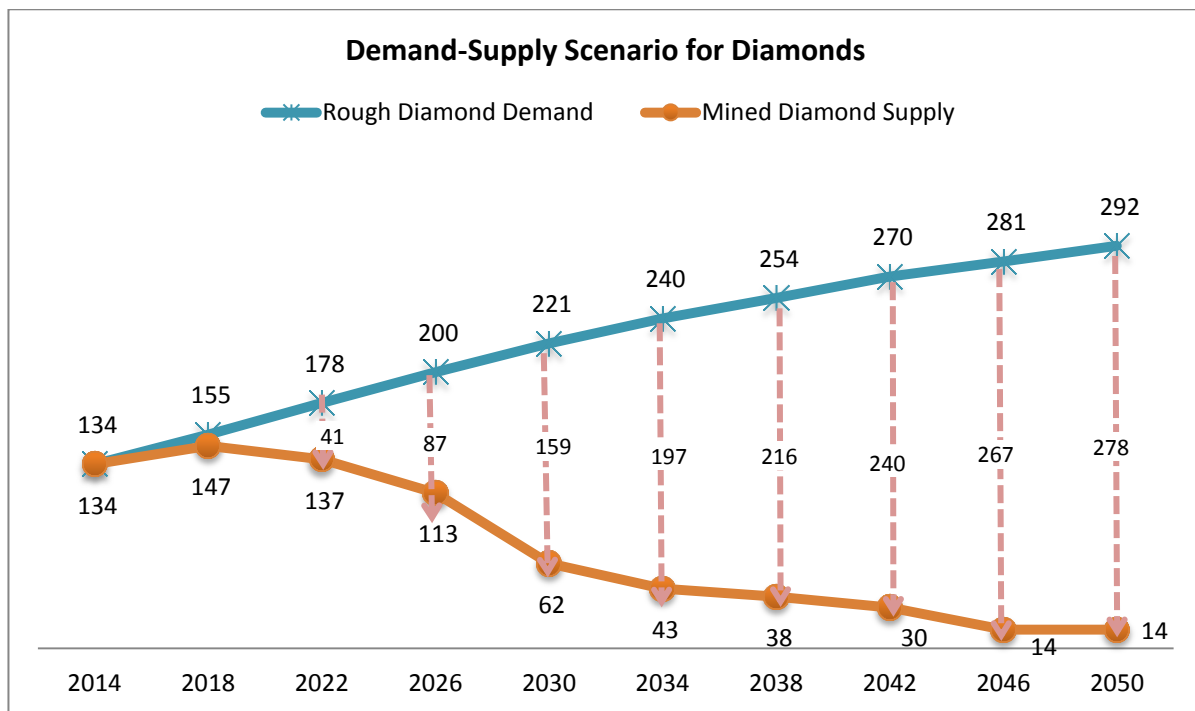


<sup>9</sup> Rough Diamond Supply based on - (1) "Life of Mines" estimates as mentioned by Industry analyst Mr. Paul Zimnisky in his report "Table Toppers," Mining Journal Special Edition, May 2014. [http://www.mining-journal.com/\\_data/assets/pdf\\_file/0005/561047/Table-toppers-table.pdf](http://www.mining-journal.com/_data/assets/pdf_file/0005/561047/Table-toppers-table.pdf) (2) New Mines estimates derived from "The Global Diamond Report 2013: Journey through the Value Chain", August 2013, Bain Report. <http://www.bain.com/publications/articles/global-diamond-report-2013.aspx>

### 3 Increasing Supply-Demand Gap and its Impact

The demand for rough diamond globally has seen a steady rise. The US, which represents the largest share of global jewelry sales, continues to grow consistently in terms of demand. The growing middle class in China and India has given a significant boost to demand of diamond jewelry in recent years. Jewelry growth in China is expected to remain robust with leading retailers such as Chow Tai Fook reporting 32% higher retail revenue over the 2014 Chinese New Year<sup>10</sup>. As per estimates, this steady increase in demand for rough diamonds globally will lead to a shortage of an estimated 248 million carats, by 2050 as shown in the figure below.

**Figure 7 – Rough Diamond: Demand-Supply Gap<sup>11</sup>**



<sup>10</sup> RBC, 'Diamond Digest', 4 March 2014

<sup>11</sup> Rough Diamond Demand for 2014 & 2018 derived from KPMG Commodity Insights Bulletin, August 2014 – Diamond (Q4, 2013 and Q1, 2014). **Assumption:** Rough Diamond Growth Rate gradually faded from 4% (2014-18) to 1% (2042-50).

Rough Diamond Supply based on "Life of Mines" estimates as mentioned by Industry analyst Mr. Paul Zimnisky in his report "The State of Global Rough Diamond Supply -2014". <http://www.kitco.com/ind/Zimnisky/2014-03-10-The-State-of-Global-Rough-Diamond-Supply-2014.html>

International diamond market structure is changing with China making a much larger share of demand than before. China and Hong Kong sales alone have rose to 13% of global diamond jewelry sales with an expected rise to 18% by 2017.

Around 2022, mined diamond industry will see rough diamond demand clocking at 178 million carats (annually) while supply side would fall short by 41 million carats.

It is estimated that the rising demand from China and India together will exceed the size of the US market by 2020<sup>12</sup>. This predicted surge in demand for diamond jewelry from Asia will see a potential struggle to be matched by the supply of diamonds.

### **Effect on Prices**

The ever increasing demand & supply gap potentially poses a strong threat to the diamond industry. Shortage of diamond supply will potentially impact the market economics as well. Steep price increase can be expected if the supply depletion problems are not addressed. Diamond prices are already up 7% in 2014 and are estimated to rise by 5-7% per annum for the next few years<sup>13</sup>. With a predicted fall in diamond production, price rise could become even more aggressive. Further, following sheer economics of demand and supply, mining companies could hold back some stock to maximize life and value of their diamond resources. This could put further pressure on the demand supply gap.

### **Effect on Global Diamond Value Chain**

The effects of the diamond industry on several developing economies in Asia and parts of Africa cannot be underestimated. For instance, diamonds represent 33% of the GDP of Botswana [nearly US \$3.3 billion]<sup>14</sup>. In India, the diamond industry has been a key contributor to the annual growth of the country's gross domestic product (GDP)<sup>15</sup>.

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<sup>12</sup> "The Global Diamond Report 2013: Journey through the Value Chain", August 2013 - Bain Report.  
<http://www.bain.com/publications/articles/global-diamond-report-2013.aspx>

<sup>13</sup> BMO Capital Markets Report - Diamond Prices Report

<sup>14</sup> World Diamond Council:  
[http://www.worlddiamondcouncil.org/download/resources/documents/Fact%20Sheet%20\(The%20Diamond%20Industry\).pdf](http://www.worlddiamondcouncil.org/download/resources/documents/Fact%20Sheet%20(The%20Diamond%20Industry).pdf)

<sup>15</sup> DiamondFacts.org: [http://www.diamondfacts.org/index.php?option=com\\_content&view=article&id=105&Itemid=148&lang=en](http://www.diamondfacts.org/index.php?option=com_content&view=article&id=105&Itemid=148&lang=en)

For a country like India the results of such a drop in supply would be catastrophic, not only resulting in shrinkage of the cutting and polishing industry but also negatively impacting the Jewelry Manufacturing and Retailing industries. There would be a loss in GDP and a multiplier effect in terms of social impact due to a loss of jobs across the supply pipeline.

**Beneficiation:**

With the awareness that Diamonds mines have a limited active life, rough diamond producing countries are looking for ways derive more value from the diamonds coming out of their mines. They are realizing the need to capitalize on cutting and polishing opportunities so that they can expand local employment, and taking advantage of any value-added activities to emerge as a competitive diamond mining & processing destination.

For instance, Botswana intends to demand a greater local allocation of diamonds from De Beers for beneficiation purposes in the remaining two years of the 2012 to 2015 contract period. In addition to this, the Botswana government has begun distributing up to 15 percent of Debswana production outside of De Beers' sales channels. In the long run, the country has indicated that it will demand even greater local allocation of Debswana production - beginning with next sales agreement for the post 2020 period. For this reason, diamond processors in other regions of the world can expect a potential decline in the availability of De Beers produced rough diamonds. Goods polished locally in Botswana have grown from \$28 million in 2005 to just above \$748 million in 2012.<sup>16</sup> De Beers forecasts that over 50 percent of global availability of high quality diamonds will be offered to producer countries in future<sup>17</sup>.

The diamond-producing nations are actively coercing cutting and polishing operators to shift closer to source within the producing nation in order to develop local diamond manufacturing industries. They are offering supply incentives to entice diamond processors and jewelry manufacturers from existing cutting and polishing centres like India, Belgium and Israel.

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<sup>16</sup> [http://www.diamondshades.com/files/1913/7469/8070/De\\_Beers\\_Group\\_2013\\_.pdf](http://www.diamondshades.com/files/1913/7469/8070/De_Beers_Group_2013_.pdf)

<sup>17</sup> Reports to Society 2008, De Beers - [http://www.debeersgroup.com/ImageVaultFiles/id\\_609/cf\\_5/Report\\_to\\_Society\\_08\\_-\\_Economics\\_April\\_2009.PDF](http://www.debeersgroup.com/ImageVaultFiles/id_609/cf_5/Report_to_Society_08_-_Economics_April_2009.PDF)

In general, shrinking processing margins and the beneficiation initiative will lead to greater consolidation of global diamond processing in the coming years.

The trend of beneficiation has started to hurt several cutting and processing centres, particularly India. With around 70% of rough diamond produced being processed here, India is the largest diamond-processing hub in the world. But as a result of falling supply and developments like beneficiation, the industry has lost over 300,000 jobs since 2008<sup>18</sup>.

**Figure 8 – Cutting and Polishing Costs and Jobs across Countries**<sup>1918</sup>

Cutting Centre	Approximate Cutting and Polishing Cost USD/Carat		Approximate Total Cutting and Polishing Jobs	
	2008	2013	2008	2013
Canada	125	140-180	300	50-80
Botswana	45-125	60-120	2200	3750
Namibia	45-125	60-140	1500	970
South Africa	60-100	130-150	1800	1000
US	110	300	100	80-100
Belgium	120	150+	1000	150-200
Israel	47-55	140-300	2000	400
Far East	15-35	20-50	29000	10000
India	6-50	10-50	710,950	410,000

Moreover, processing overcapacity also exists in India at this moment. This is primarily because of greatly reduced production from Australia's Argyle Mine. Zimbabwe's Marange could replace some of this lost production but it will still not be enough to fulfill the current size of the processing industry in India.

### **Vertical Integration across value chain**

#### *Mining Companies integrating into Diamond Retail*

Producing companies are increasingly struggling to tame the ballooning costs of operations as the mines become more mature, and maximize the value earned per carat in order to

<sup>18</sup> Frost and Sullivan Estimates based on RBI Task Force report - <http://www.rbi.org.in/scripts/PublicationReportDetails.aspx?ID=541#a3> and Global Diamond production.

<sup>19</sup> DeBeers Diamond Insights Report

sustain their production - something which they can only be achieved by integrating their production with downstream retail operations, thus by-passing intermediary traders from the value chain. This also allows full control from production worldwide to distribution and pricing of diamonds for consumers.

De Beers and Rio Tinto have both adopted this strategy and are looking at higher margins through branded diamonds. De Beers runs two separate retail businesses - DeBeers Jewelry and its more affordable label - Forevermark which it launched five years ago. Rio Tinto, owner of Argyle mine in Australia, is directly working with retailers such as Chow Tai Fook to develop jewelry collections.

*Branded retail chains: Directly sourcing from mines and owning processing centres*

Similarly, leading diamond brands and retail chains are building closer ties with mining companies in order to ensure an assurance of supply. Tiffany and Co, a leading global luxury jewelry brand, sources rough diamonds directly from producers that it would cut and polish at its manufacturing centers scattered in Southern Africa, Belgium, USA, Cambodia and Vietnam. Tiffany purchases approximately US\$200 million of rough diamonds annually and has supply agreements with the top three diamond producers Rio Tinto, Alrosa and De Beers<sup>20</sup>

Chow Tai Fook, a renowned jewelry chain in China has also set up its own diamond polishing factories to source rough diamonds directly from mining companies. It also has supply agreements with Rio Tinto, Alrosa and De Beers. Chow Tai Fook has four diamond cutting and polishing factories - two in South Africa, one in Botswana, and another in China.

Similarly, some retailers do not want to use diamonds sourced from countries they are not comfortable doing business with. Therefore, going directly to source can help safeguard integrity of supply chains.

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<sup>20</sup> Tiffany and Co. – US Securities and Exchange Commission (SEC) filings



## 4 Rough Grown Diamond: Future Outlook

Grown diamonds or Cultured Diamonds are a new source of diamonds, which have been grown above the Earth under sustainable conditions. These are real diamonds and are chemically, optically, physically identical to mined diamonds. The only difference between grown diamonds and mined diamonds is their point of origin.

Recent advancements in the microwave plasma technology and years of dedicated research on diamond growing techniques have made it possible to grow high-quality diamonds. A significant achievement in grown diamond technology is the ability to grow colorless Type IIA diamonds which are the purest diamond found below earth and constitute only 2% of the total mined diamond production.

Grown Diamonds have found their application several hi-tech and scientific areas. They are considered as a promising breakthrough in fields like semi-conductor, electronics and quantum computing as well as medical, optical and mechanical applications. Though in limited volume, they have already gone commercial in several industries including the Gems and Jewelry Industry as diamonds that are Origin-guaranteed, Eco-friendly and Sourced through a transparent chain of custody.

### **Growing Diamond: Nature gets to decide the outcome**

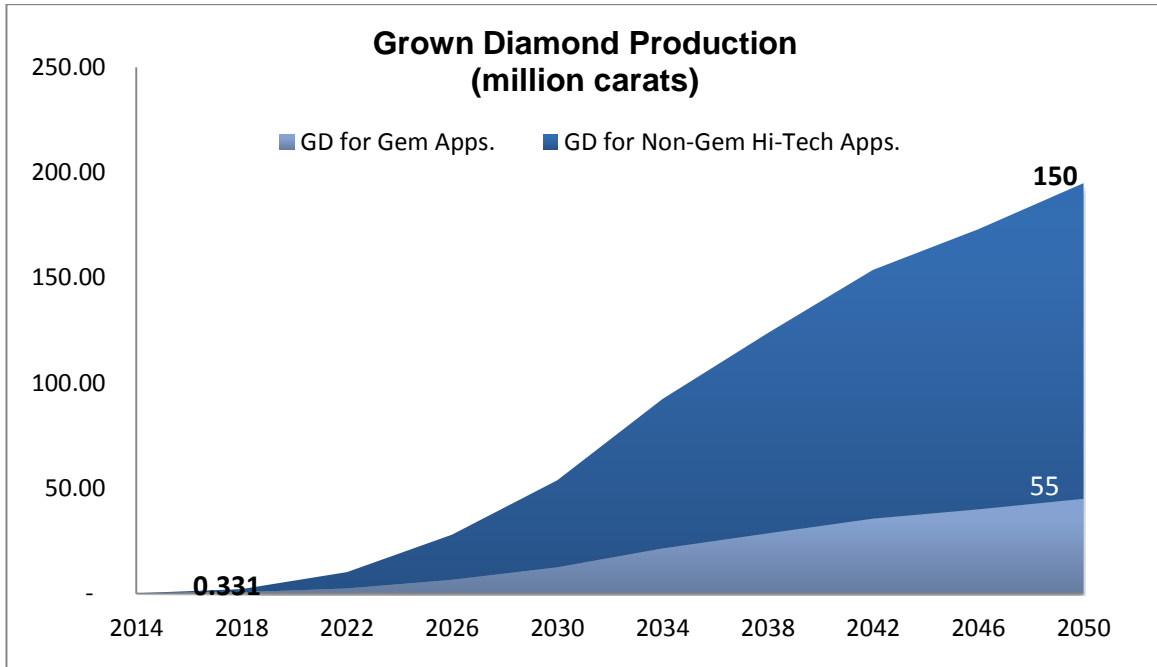
As much as mankind can research and master the technology of “Diamond Growing Greenhouses”, the growth process stays beyond human control following nature’s laws just like growth of any other plant in a greenhouse.

The role of humans is limited to creation of an environment in which diamond growth is possible. Once the Diamond seed is placed and growth conditions established, nature takes control of the growth process. As a result it is practically impossible to grow two absolutely identical diamonds.

This constraint on the ability to grow diamonds along with the scale of investment required limits the growth in production of grown diamonds.

**Grown Diamond Production Forecast**

**Figure 9 – Grown Diamond Production Forecast (2015-2050)<sup>21</sup>**



Diamonds have fantastic properties, from dispersion of light to hardness to radiation hardness. The inconsistency of diamonds that are mined made it impossible for diamonds to be used for many of these properties that it had. However, grown diamonds change this fact. The ability to maintain growing environments capable of achieving the highest purity in diamonds enables grown diamonds to have wider applications than mined diamonds. The target markets for grown diamonds can be broadly segregated into two parts:

1. Gem or Luxury Market
2. Non-Gem or High tech applications

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<sup>21</sup> 1) Grown Diamond Market Share (2014 and 2018) as percentage of Global Diamond Demand derived from “The Diamond Growing Greenhouses-Grown Diamonds In The Gems & Jewelry Industry - Market Assessment”, Frost and Sullivan.  
 2) Rough Diamond Demand for 2014 & 2018 derived from KPMG Commodity Insights Bulletin, August 2014 – Diamond (Q4, 2013 and Q1, 2014)  
 3) Grown Diamond for Gem Application assumed to be 30% of total Grown Diamond Production. Remaining 70% goes to non-gem hi-technology applications  
 4) Growth rate of Grown Diamonds assumed based on technology adoption lifecycle (Diffusion of innovation) concept.  
 5) Cumulative Annual Growth Rate (CAGR) for Total Grown Diamonds Production: 65% (2014-18), 45% (2018-22), 29% (2022-26), 18% (2026-30), 12% (2030-34), 9% (2034-38), 7% (2038-42), 5% (2042-46) and 3% (2046-50)

It is pertinent to note here that only a part of grown diamond production will be available for application in gem or luxury market. The production capacity for Grown Diamonds (including gem and non-gem application) is expected to grow exponentially for next 10-15 years. The present scale (2014) of grown diamond production is estimated to be about 360,000 carats. By 2018 grown diamond production globally will reach close to 2 million carats and by 2026 it is expected to cross 20 million carats. It will take grown diamonds another 25 years to reach production capacity of more than 100 million carats.

Over the next 30 years grown diamonds will become a dominant player in high technology applications and can prove to be a very significant diamond source for the luxury world. By 2030, 34 million carat of gem quality Grown Diamonds can be supplied to the hi-technology verticals like semiconductor & electrical industry, sophisticated medical instrumentation etc. These are some of the diamond consumption areas that remain un-serviced today by the mined diamond industry as there are no spare gem-quality supplies (at an affordable price) to extend to the non-gem industries.

Thus Grown Diamonds, which can deliver a steady & high gem quality diamond supply also have a huge market in non-gem applications.

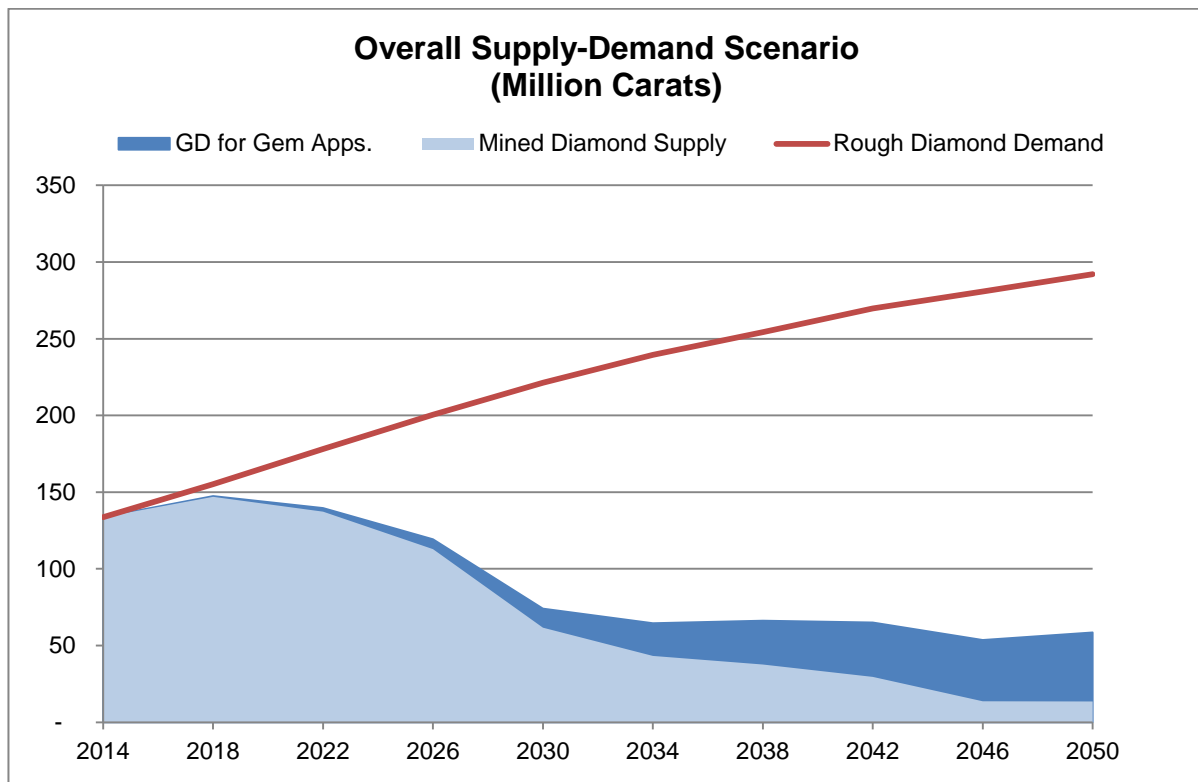
### **Grown Diamond for Gem Applications: Bridging the Supply-Demand Gap**

At a time when, the earth-mined diamond supply is consistently depleting every year, the emergence of Grown Diamond is a security blanket to the industry. As mentioned earlier, Grown Diamonds can not only fill the supply-demand gap for rough diamonds globally, but also expand the market to new application areas and new profile of consumers.

Though Grown Diamonds are yet to contribute significantly to the rough diamond supply of the gem application market (0.3%), it is expected that by 2050, Grown Diamond production for Gem application will be 25% more than Earth-mined Diamond Production. The supply of mined diamond is projected to drop to 43 million carats in 2050 while in the same period, production of Grown Diamonds for Gems & Jewelry sector will rise to 55 million carats (assuming that 70% of the overall 184 million carats Grown Diamond production will be sourced for hi-technology applications).

Diamonds are a luxury product and Grown Diamonds have their own unique selling propositions that can increase the size of a retailers business. Grown Diamonds, with proper disclosures & awareness, will make a compelling diamond category for both trade members and consumers who would prefer an origin-guaranteed, sustainable product that can be offered to them as a choice while shopping for diamonds.

**Figure 10 – Overall Supply Demand Scenario with Grown Diamonds for Gem Applications<sup>22</sup>**



<sup>22</sup> Key Assumptions and Sources:

- 1) Grown Diamond Market Share (2014 and 2018) as percentage of Global Diamond Demand derived from "The Diamond Growing Greenhouses-Grown Diamonds In The Gems & Jewelry Industry - Market Assessment", Frost and Sullivan
- 2) Rough Diamond Demand for 2014 & 2018 derived from KPMG Commodity Insights Bulletin, August 2014 – Diamond (Q4, 2013 and Q1, 2014)
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- 5) Growth rate of Grown Diamonds assumed based on technology adoption lifecycle (Diffusion of innovation) concept.
- 6) Cumulative Annual Growth Rate (CAGR) for Total Grown Diamonds Production: 65% (2014-18), 45% (2018-22), 29% (2022-26), 18% (2026-30), 12% (2030-34), 9% (2034-38), 7% (2038-42), 5% (2042-46) and 3% (2046-50)
- 7) Rough Diamond Supply based on "Life of Mines" estimates as mentioned by Industry analyst Mr. Paul Zimnisky in his report "The State of Global Rough Diamond Supply -2014". <http://www.kitco.com/ind/Zimnisky/2014-03-10-The-State-of-Global-Rough-Diamond-Supply-2014.html>,

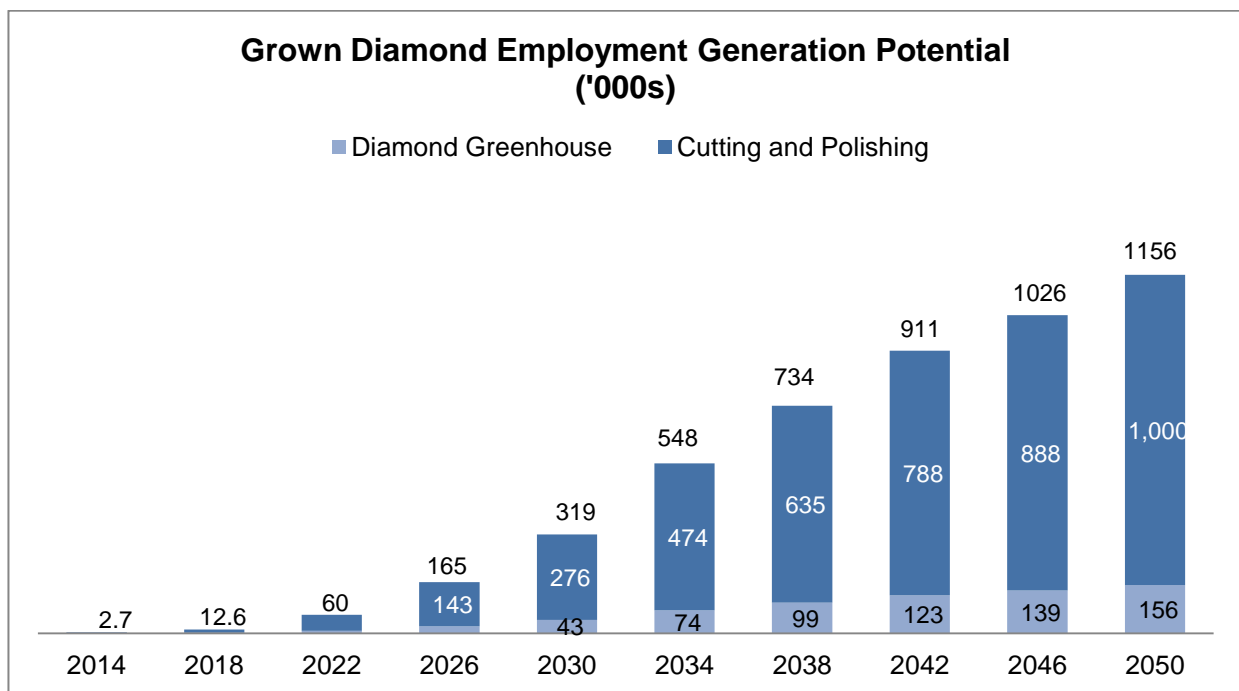
Given the right support to this industry, governments will find they have avoided the possibility of lost jobs, which would have led to a great social burden, and they will be able to expand their economies by having a viable and dependable supply of raw material.

## 5 Grown Diamonds: Opportunities for Economic Growth

### Grown Diamonds: Employment Generation

From creating employment opportunities to increasing foreign exchange reserve, Grown Diamonds offers immense potential for economic growth of any nation by 2050.

**Figure 11 – Grown Diamond Employment Potential<sup>23</sup>**



The global diamond industry employs over 10 million people directly and indirectly all over the world<sup>24</sup>. But as diamond deposits are discovered (and in near future) in more remote and adverse locations, some only accessible by air, diamond mining companies will have to find means to cut costs and streamline their operations. With employment in diamond mining getting tougher, diamond processing sector – directly reliant on the producers – gets directly affected too.

<sup>23</sup> Cutting and Polishing of 300,000 carats of grown diamonds require 950 workers. 650 carats of grown diamond is produced by 1 machine annually and every machine required 1 qualified engineer or diploma holder to manage and run it

<sup>24</sup> DiamondFacts.org : [http://www.diamondfacts.org/index.php?option=com\\_content&view=article&id=3D132&Itemid=3D169&lang=3Den](http://www.diamondfacts.org/index.php?option=com_content&view=article&id=3D132&Itemid=3D169&lang=3Den)

For example, the Argyle mine is expected to stop producing diamonds after 2020, immediately reducing annual global supply of diamonds by 15%. This mine, which accounts for over 90% of the global supply of pink diamonds, will be largely depleted within the next decade<sup>25</sup>. Majority of diamonds produced from the Argyle mine are small near-gem brown color diamonds. Thus, processing of Argyle stones is a labor-intensive job that can be accomplished in a low-wage country like India. This could potentially pose a threat to the Indian processing industry in terms of employment.

Diamond industry & the allied processing sector needs to recognize that there is now a legitimate & worthy diamond product for those who are worried about losing their source of goods and for businesses to offer to keep people interested in diamonds rather than losing them to the other luxury items that the industry is fighting to compete with. Grown Diamond industry is geared up to increase consumer awareness about Grown Diamonds bearing in mind restraints such as the slow increase in production capacities on the Grown Diamond supply side. Grown Diamonds can be viewed as an alternative diamond supply source for diamond traders and a diverse set of industrial applications that require diamond supply in desirable quantities & of specific quality.

In our earlier report Diamond Growing Greenhouses, it has been highlighted that the potential for traditional cutting and polishing industry looks promising as, based on our research, potentially only a portion of the grown diamond capacity would be utilized for gem quality diamonds. The remaining would be used in high tech and high value-add industries. This would give a good hedge for existing cutters, as diversification would be possible in an industry that has, so far, heavily relied on a single product - gem quality diamonds. Grown Diamond industry would be able to employ nearly 60,000 people in less than a decade.

From diamond growers to retailers, each of the business holds a chance to make a real positive difference to the lives of the communities and peoples they are associated with, both locally and nationally.

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<sup>25</sup> <http://www.mining.com/argyle-pink-diamonds-to-run-out-inside-a-decade-10422/>

**Employment potential in the diamond Cutting and Polishing sector:**

**Figure 12 – Employment Potential through Grown Diamond Processing**

Cutting & Polishing Centre	Share	2014	2050
<b>Engineer/Diploma holders</b>	25%	575	249,950
<b>High-skilled Operators</b>	60%	1,380	599,880
<b>Support Staff</b>	15%	345	149,970

Around 2000 people are presently employed all across the globe for an estimated 300,000 carats of Grown Diamond processing. In less than 4 decades, Grown Diamond industry could potentially employ nearly 999,800 people in order to process 150 million carats of Grown Diamond rough.

Notably, the quality of Grown Diamond is extremely high and the end markets include electronics, semiconductor, research, optics, gems & jewelry and medical among others that would need a highly skilled labor force.

Grown Diamond industry needs a skilled labor force comprising of current available cutting and polishing skills along with next generation skills brought in by Engineers, Scientists and Degree/Diploma holders. Grown Diamonds can create a distinct employment roadmap for the processing country & its local economy by creating high value occupations and skill sets. Specifically for countries like India, where diamond processing is a critical employment stream, Grown Diamond processing can ensure job security to thousands in near future when supply of rough mined diamond starts to drop.

Unlike mined diamonds, Grown Diamonds are not a finite resource but a sustainable resource and all signs point to the fact that demand for Grown Diamonds will continue to thrive in both high technology and the gem trade. This would also ensure that investments, which have been made in the existing cutting and polishing state-of-the-art units across the globe, will not suddenly fall into disuse due to decline of mined rough supply.



**Employment potential in the diamond growing facilities**

**Figure 13 – Employment Generation by Diamond Growing**

Diamond Greenhouse	Share	2014	2050
<b>Phds and Scientists</b>	10%	40	15,630
<b>Engineer/Diploma holders</b>	15%	60	23,445
<b>High-skilled Operators</b>	60%	240	93,780
<b>Support Staff</b>	15%	60	23,445

For an annual production of 150 million carats of Grown Diamonds in 2050, an estimated 150,000 diamond growing machines would be required. This, in turn will help in creating further high value employment and an above ground diamond resource.

An estimated employment for 150,000 machines would mean a minimum employment of about 150,000 people. Diamond Growing facilities are essentially technology-driven innovation centers that employ high-skilled engineers, graduates and researchers & scientists as their principal staff, who are involved in the growing processes.

The leading diamond growers will continue to employ extremely skilled & specialized work force that can support their ever-evolving diamond growth technologies & related research-led work. This would, in time, create a talent pool of highly skilled professionals who can contribute to the diamond industry.

**Employment potential in the ancillary industries**

Grown Diamond industry has ample potential to expand the scope of employment in many ancillary industries that work in tandem with the diamond trade.

Machines manufacturing & systems used in the traditional gem-quality diamond cutting & polishing, will need to evolve to process Grown Diamonds for high technology applications & other commercial applications. The instrumentation sector will have to develop, improve and produce machines that can process Grown Diamond with a polishing quality which is 500 times better than the polishing quality currently achievable for mined diamonds. This will, in

effect, generate ethical and well paid jobs for a skilled employment pool & dedicated technical machine maintenance staff for the machine manufacturers.

Diamond Growing facilities are technology-focused companies who deploy complex equipment that are needed to grow gem-quality diamonds. The mechanical expertise & know-how needed by these companies to maintain and operate these complex machines will further spur employment in the allied mechanical industry.

On the other hand, a steady growth in Grown Diamonds will also add high value for component manufacturers producing mass flow controllers, ultra-high-pressure valves and fittings, PLC (programmable logic controllers) and a whole host of multifarious equipment that are critical for diamond growth. Diamond growing also fosters the need for vendors who have distinguished skills in ultra-high vacuum experience, paving way for contractors with semiconductor facility fabrication skills

And lastly, with high quality Grown Diamonds entering the market, academicians & researchers across the globe will be able to get access to diamonds as per their prescribed scale & quality standards. Already countries around the world – USA, Germany, Belgium, China and Korea, among others– have restarted their diamond application research and development projects, with the Grown Diamond supply which they have been able to access.

It is important to note that these figures have not taken into account the potential increase in employment and creation of new jobs for downstream activities. E.g. in the Gems and Jewelry Industry Jewelry manufacturing and Retailing would be downstream work.

## 6 Analyst Opinion

This report has analysed the supply of diamonds from mined sources till 2050. Various mines across the globe and their life time production values were taken in account to estimate the supply of diamonds from mines. In parallel, the demand was also analysed to understand the growth in demand till 2050 considering various factors such as growing jewelry sales and expected surge in demand from new regions. The following are some of the key conclusions:

### *Falling Supply of Mined Diamonds*

It is an industry acknowledged fact that the supply of mined diamonds has been declining. Moreover, the diamond mining process becomes tougher as the mines age and new mines that are discovered often have shorter life spans and tougher mining conditions. All of this and the slow rate of discovery of new mines points to a potential threat on the source of the diamond industry.

### *Impact of Declining Supply is Widespread*

A fall in supply first directly affects the retail prices for the consumer. Moreover, it also impacts the cutting and polishing industry dependent on the same source often leading to excess capacity going unutilized. The cutting and polishing industry is also threatened by vertical integration that is happening across the value chain in order to improve declining margins and controlling the supply.

### *Grown Diamonds as an Alternate - Limited yet Renewable Source*

Grown Diamonds offer an alternate source for diamond industry. There continue to exist key limitations for the scale of Grown Diamond production which include the scale of investment required in infrastructure, operations, etc. as well as knowledge restraints and technological limitations. However, steady growth in Grown Diamonds supply can not only bridge the supply-demand gap for rough diamonds globally, but also expand the market to new application areas and new profile of consumers.

### **The Last Word**

The diamond industry will soon need to address the question of sustainability of source of raw material keeping in mind all the value chain members and stakeholders in the industry. The key will be build a bridge to meet demand for diamonds and its supply by using alternate sources of raw material such as Grown Diamonds. A decline in mined diamond production & diamond processing capacities also has a direct impact on the millions who are employed within these industry sectors. So the future industry will also need to create & sustain employment and develop new consumption sectors. Considering this, the Mined diamond industry could seek an option of a win-win relationship with Diamond Growers & Grown Diamond industry to strike a balance for all trade members and end-consumers. Different entities in the industry value chain – mining, trade, manufacturing, retailing etc. could also use this knowledge to influence their business decisions in the next few years to come and beyond. Grown diamonds will offer much needed security to all components of the diamond world.

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