



# Patent Filings & Innovation Trends – Green Cement

**2006 – 2017**



This report is commissioned to examine the global innovation & patenting trends in the domain of Green Cements, in particular based on study of patent filings after 2006.



## Executive Summary

This report is commissioned to examine the global innovation & patenting trends in the domain of Green Cements, in particular based on study of patent filings after 2006.

Patenting activity is very significant across environment friendly green cements. Looking at sheer number of filings happening in this domain by enterprises of all sizes, universities and researchers, it becomes much vital to have a keen evaluation of the patenting activity to understand the innovation trends.

The initial research aims to give the readers a clear insight regarding the comparative patenting activity among different players in the domain. A closer look at the patenting activity demonstrates a constant rise in the filing specifically after 2010 wherein a steep rise globally can be observed.

This motivated us to take a deeper dive and analyze critically the raw materials for manufacturing and properties attained by green sand. Further, country-wise (CN, US, IN, EP, CA, and JP etc.) patent filing trends in green cement were also evaluated while also revealing the major players in each category.

Finally, a few prominent recommendations were identified for the players in cement sector that shall help them evaluate the scope of their innovation & opportunities of expansion.



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## 1. INTRODUCTION

With the ever rising population of the world, the need to habitation has exponentially increased. The construction and real estate business is booming and various building materials are available in the market. As a result the natural resources are depleting and we are unintentionally killing our mother earth. Since ages, human race has been using concrete to build empires and forge civilizations. Concrete is the second most used material in the world, trailing only water. According to the U.S. Geological Survey, domestic production of Portland cement increased to more than 80 million tons in 2014 and 4.5 billion tons worldwide. Most of that production is in China, which consumed more cement in the last four years than the United States has in 100 years. The cement industry accounts for more than 5% of global carbon dioxide emissions. The majority of these emissions are due to the de-carbonation of limestone and the energy required to heat materials in a rotating kiln to temperatures exceeding 2,600 degrees Fahrenheit. According to the U.S. Department of Energy, domestic cement production accounts for 2.4% of energy consumption, which is lower than iron and steel mills at 11% and paper mills at 15%. The time is high that we start looking for environment friendly solutions to our building needs. Green cements can be a good replacement of the traditional cements. This study discusses some of the recent patent and technology trends in green cements. However, before we start analyzing or evaluating the trends and activities in this domain, it is imperative to understand the various terminologies, evaluation parameters for patenting activity, etc. used in this study:

### 1.1. Evaluation Parameters for Studying Patenting Activities

Patent activity herein is a measure of innovation and globalization in terms of patent applications for the period 2006 onwards. Patent applications are counted in terms of first filings and foreign filings. First filings are an indicator of innovation and inventive activity, while foreign filings are an indicator of an intention for international trade and of globalization.

Further, all the data presented here is restricted till 2015 as patent applications having their first filing data in 2016-2017 might not be published yet (there is a 18 months lag between filing and publication of patent applications).

### 1.2. Relevance Criteria for Screening and Shortlisting documents

As a first step, all those documents were screened that discussed manufacturing processes, machines, properties or raw materials used for green cement. The screened documents were then manually analyzed to shortlist documents that that disclosed:

1. Raw materials for manufacturing green cement;
2. Properties of green cement

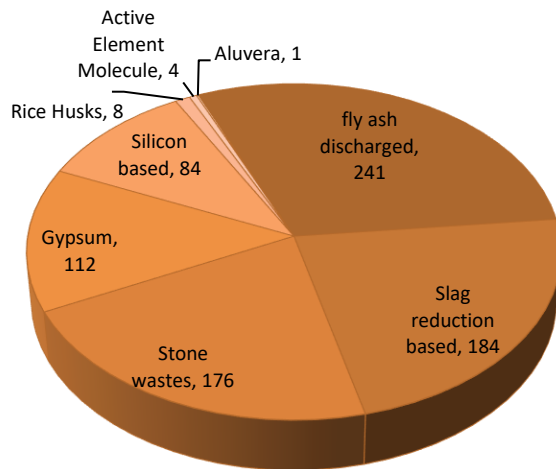
The shortlisted documents were further analyzed in details to identify more relevant information.



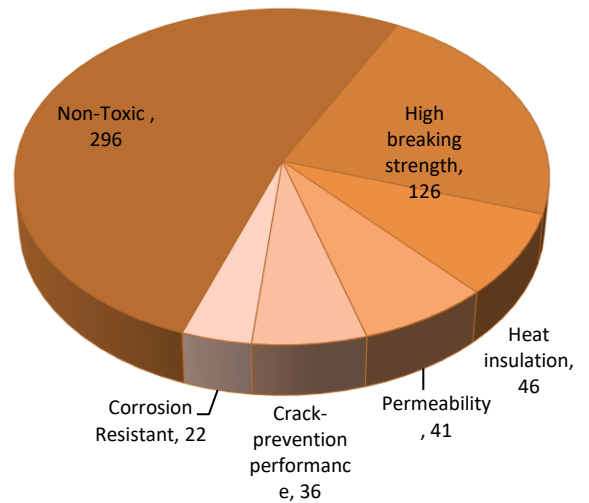
## 2. OVERALL TECHNOLOGY ANALYSIS AND TRENDS

Below table shows the patents categorized in different technology areas in the domain of green cement.

Green Cement	Raw Materials for Green Cement Manufacturing	Silicon based
		Active Element Molecule
		Gypsum
		Slag Reduction based
		Rice Husks
		Stone wastes
		Aluvera
		Fly Ash discharged
	Properties of Green Cement	Non-Toxic
		High breaking strength
		Permeability
		Heat insulation
		Crack-prevention performance
		Corrosion resistant

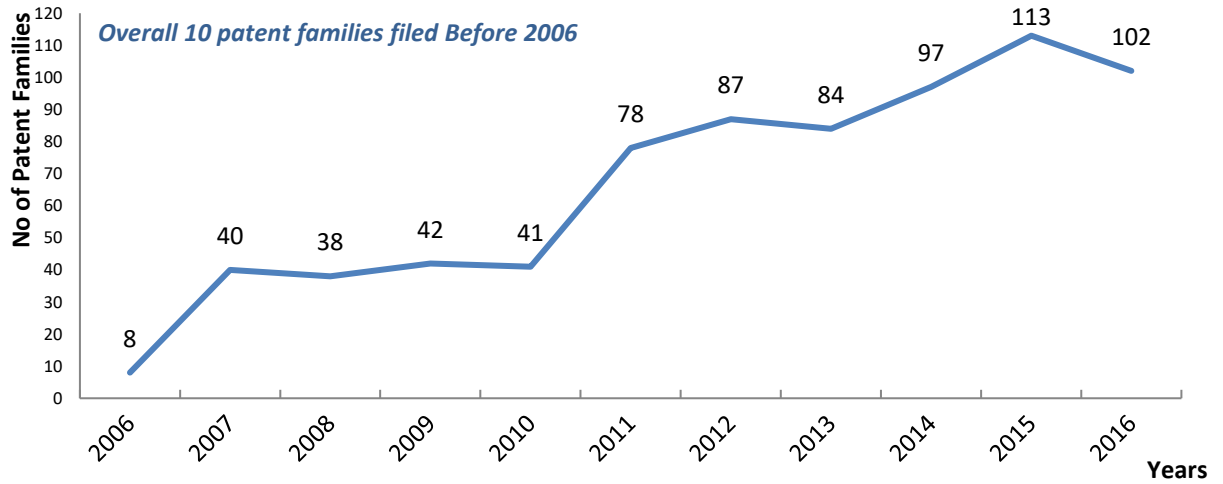


**Raw Materials for Green Cement Manufacturing**



**Properties of Green Cement**

It's noteworthy and interesting that some patents disclose use of **Aluvera** and **Rice Husks** for manufacturing green cements. Also, some players are focusing on manufacturing non-toxic and corrosion resistant cements.



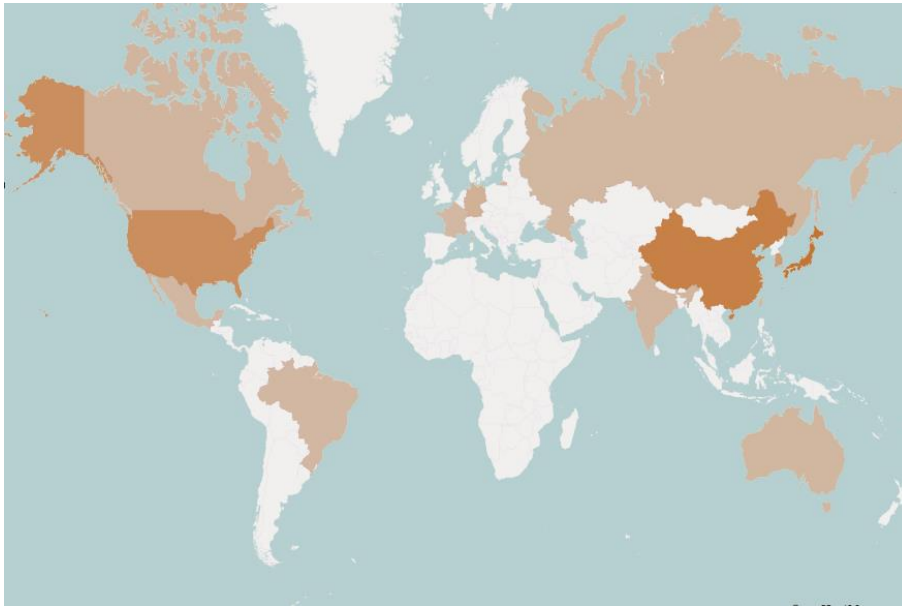
Above chart shows the patent filing trend of green cement. There appears a significant dip in the number of filings in year 2012-2013 and a consistent rise after 2014 which suggests a possibility of commercialization of the technology during that period.



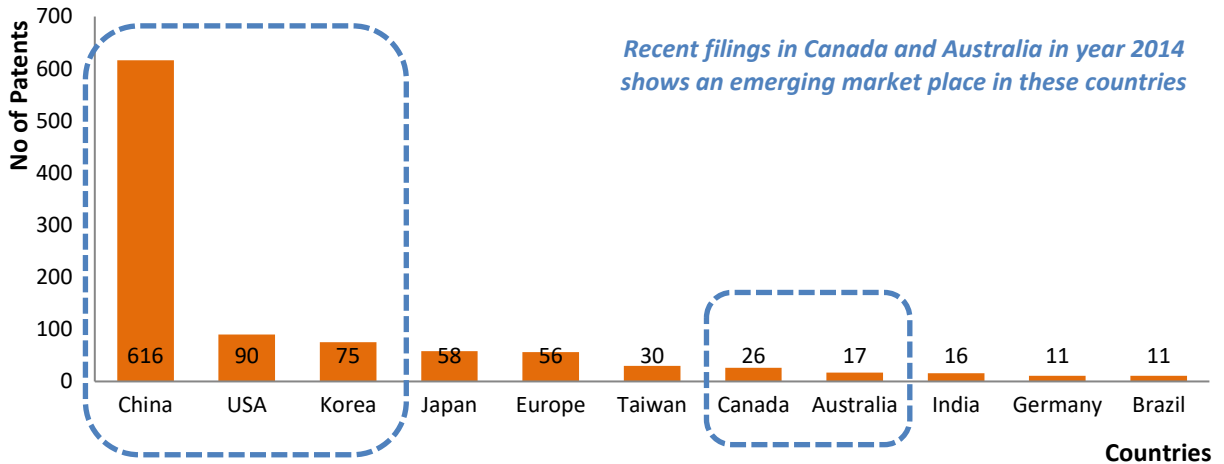
### 3. OVERALL GEOGRAPHICAL COVERAGE OF PATENTING ACTIVITIES

#### 3.1. Share of favourable markets in Patenting Activities

The chart below shows the number of patent families published in different jurisdictions. The technology is being protected in these countries which may denote that the innovators are seeking these geographies as most favorable market for their invention.



Maximum of the patents have been filed in **China, USA and Korea**. It shows that these are the market place for Green cement.





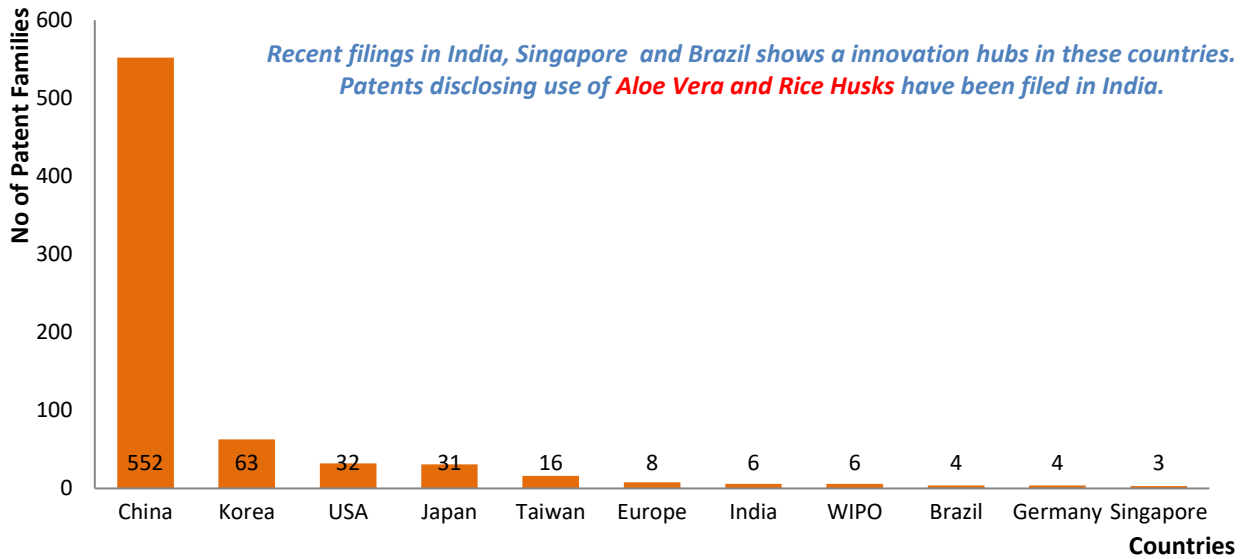


### 3.2. Share of active innovation countries in Patenting Activities

The chart below shows the number of patent families first filed in different jurisdictions. The technology is being first protected in these countries which may denote that the innovations are originating in these countries.



Around **75% of the patents filed in China**. It means China is the innovation hub.



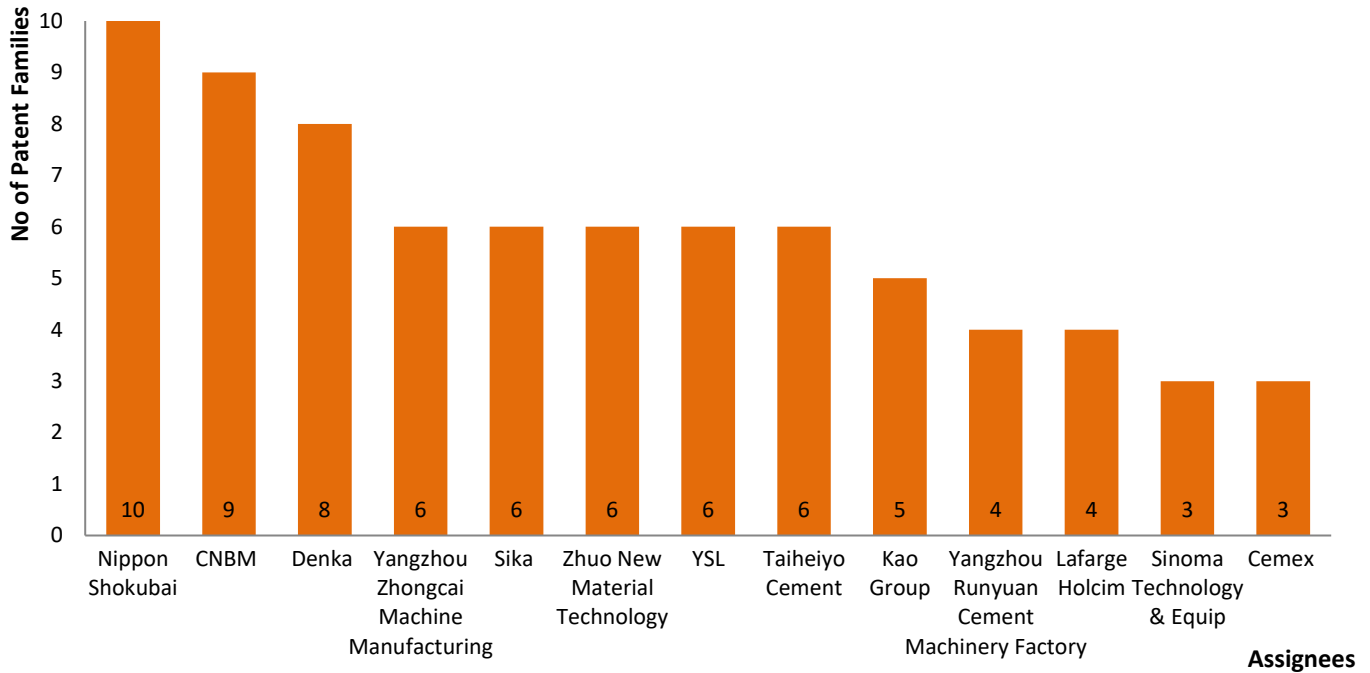




## 4. ACTIVE PLAYERS AND INNOVATORS

### 4.1. Active patent assignees in this area

The chart shows the major players in the technology domain related to Green Cement.



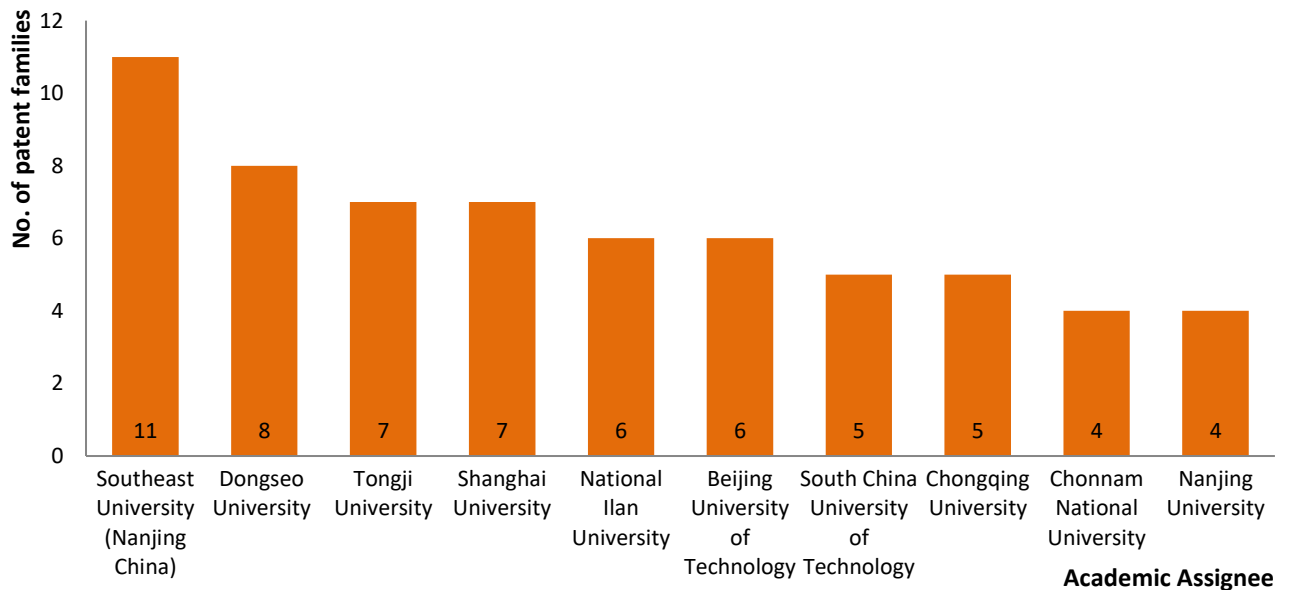
Around 18% assignees are OEMs and suppliers, 22% are universities and academic and 60% are individual innovators. It is evident that majority of the filing is done by individuals. Thus there lies a great opportunity to procure / license-in the technology from individual innovators.



## 4.2. Universities and Academic Assignees

The table below shows the major academic assignees in the technology domain related to Green Cement.

Top Academic	Country	Top Inventors
Southeast University (Nanjing China)	China	Guo Liping (3)   Cai Guanghua (3)   Liu Songyu (3)
Dongseo University	South Korea	Kim Young Min (8)   Lee Kug Jae (8)   Lee Kang Heup (5)
Tongji University	China	Wang Ru (1)   Zhang Jie (1)   Yang Jie (1)
Shanghai University	China	Dongliang Cao (2)   Fucheng Sun (2)   Wenxiong Lu (2)
National Ilan University	Taiwan	Lin Kae-Long (6)   Wu Hsiu-Hsien (2)   Chang Wen-Hsuan (2)
Beijing University of Technology	China	Cui Suping (5)   Wang Hongtao (3)   Gong Xianzheng (3)
South China University of Technology	China	Hu Jiayu (2)   Guo Wenying (2)   Sun Weimin (1)
Chongqing University	China	Qitao Yuan (2)   Li Li (2)   Tinglei Zhang (2)
Chonnam National University	South Korea	Song Jin Kyu (4)   Yang Keun Hyeok (4)
Nanjing University	China	Zhou Hongcang (1)   Zhou Yunqiao (1)   Bai Yuxiang (1)





### 4.3. Active Inventors in this area

The table below shows the major inventors in the technology domain related to Green Cement.

Inventors (with corresponding assignees)	Number of Patents Families
Yang Shengqiang (Yangzhou Zhongcai Machine Manufacturing)	9
Lee Kug Jae (Dongseo University)	8
Kim Young Min (Dongseo University)	8
Yang Yi (Guangxi yunyan special cement building material YSL)	7
Yang Zhuoshu (Zhuo new material technology)	6
Huang Fang (Guangxi yunyan special cement building material YSL)	6
Long Zhimou (Guangxi yunyan special cement building material YSL)	5
Lee Kang Heup (Dongseo University)	5
Li Shaodong (Zhuo new material technology)	5
Marazzani Beat (SIKA)	4

Maximum of Inventors are from Guangxi yunyan special cement building material YSL and Zhuo new material technology and they are focusing on manufacturing of green cement with different raw materials.



## 5. KEY ASSIGNEES ACTIVITIES IN GREEN CEMENT

### 5.1. Key Assignees and their activities in technical sub-categories of Green Cement

Assignees v/s Technology	Raw Materials for Green Cement Manufacturing							Properties of Green Cement						
	Silicon based	Active Element Molecule	Gypsum	Slag reduction based	Rice Husks	Stone wastes	Aluvera	Fly ash discharged	Non-Toxic	High breaking strength	Permeability	Heat insulation	Crack-prevention performance	Corrosion resistant
Nippon Shokubai	0	0	1	1	0	1	0	7	0	1	1	0	1	1
China National Building Material (CNBM)	0	0	1	1	0	5	0	0	3	2	2	2	2	1
Denka	1	0	1	1	0	0	0	4	1	1	1	0	0	1
Guangxi Yunyan Special Cement YSL	0	0	1	3	0	3	0	4	3	1	0	0	0	0
Taiheiyo Cement	0	0	0	2	0	3	0	3	1	1	0	0	1	0

Major Players seems to be filing in the domain of manufacturing of green cement using fly ash and stone wastes.



## 5.2. Key Assignees and their filing activities in Green Cement domains

Assignees v/s Market Geographies	JP	US	CN	EP	KR	IN	TW	ES	DE	BR	VT	SG
Nippon Shokubai	13	9	8	8	4	4	3	2	2	1	0	0
China National Building Material (CNBM)	0	0	9	0	0	0	0	0	0	0	0	0
Denka	6	2	8	3	3	0	5	0	0	0	1	1
Guangxi Yunyan Special Cement YSL	0	0	6	0	0	0	0	0	0	0	0	0
Taiheiyo Cement	4	0	1	0	1	1	1	0	0	0	0	0

Japan, China and USA seem to have a lot of market opportunities

COUNTRY CODES					
JP	JAPAN	US	USA	CN	CHINA
EP	EUROPE	KR	SOUTH KOREA	IN	INDIA
TW	TAIWAN	ES	SPAIN	DE	GERMANY
BR	BRAZIL	VT	VIETNAM	SG	SINGAPORE



## 6. INSIGHTS & RECOMMENDATIONS

The significance of the intellectual property of green cement inventions is quite evident from the innovation trends witnessed across all sub-categories of domain in major countries and globally. This can also be made from the fact that some countries are making it mandatory to use 'green cement' for new projects. For instance,

- **Dubai Municipality** has declared mandatory to use environment-friendly cement;
- **UK** introduces strict residential construction laws requiring all new buildings to be carbon neutral

There seems to lesser number of filings in manufacturing of green cement with **Aluvera, Active Element Molecule (anti-electromagnetic wave antitoxic toxin-filtering, long-acting antibacterial oxygen-releasing, waterproof flame-retardant) and Rice Husk**. There is a white space in these areas for improvement.

Today green cement production accounts for 3.5% of global cement, but is forecast to grow to over 13% of the market by 2020. Although green cement production will, initially, be confined to developed countries, **China and India** will catch up quickly given their dominance on the world cement scene.

Many governments now require a greater level of environmental awareness in projects they fund, leading to more pressure on construction companies to buy green building materials including cement. There will be some penetration of green cement into the residential housing market. This will increase if more countries follow the UK's lead in adopting strict residential construction laws requiring all new buildings to be carbon neutral.



## 7. REFERENCES

### Databases:

- Questel Orbit – A Leading Commercial Patent Search Database
- Lens.org – A freely available Patent Search Database

### Websites

- International Patent Classification (IPC) Official Publication on World Intellectual Property Organization Website for information on IPCs
- Precast.org

### Research Papers

- A Paper on, “Assessment of Greener Cement by employing thermally treated sugarcane straw ashes”, published June 2017 - By Eduardo Gurzoni Alvares Ferreira et al.
- “Greening cement in China: A cost-effective roadmap” – By Xuewei Liu et al.
- “Physico-chemical and mechanical characterization of high volume fly ash incorporated and engineered cement system towards developing greener cement” – By T.Hemalatha et al.
- “Trends and developments in green cement and concrete technology” – By Mohammed S.Imbabi et al.