Green Rating of Indian Industry

Environmental Rating of Cement Industry

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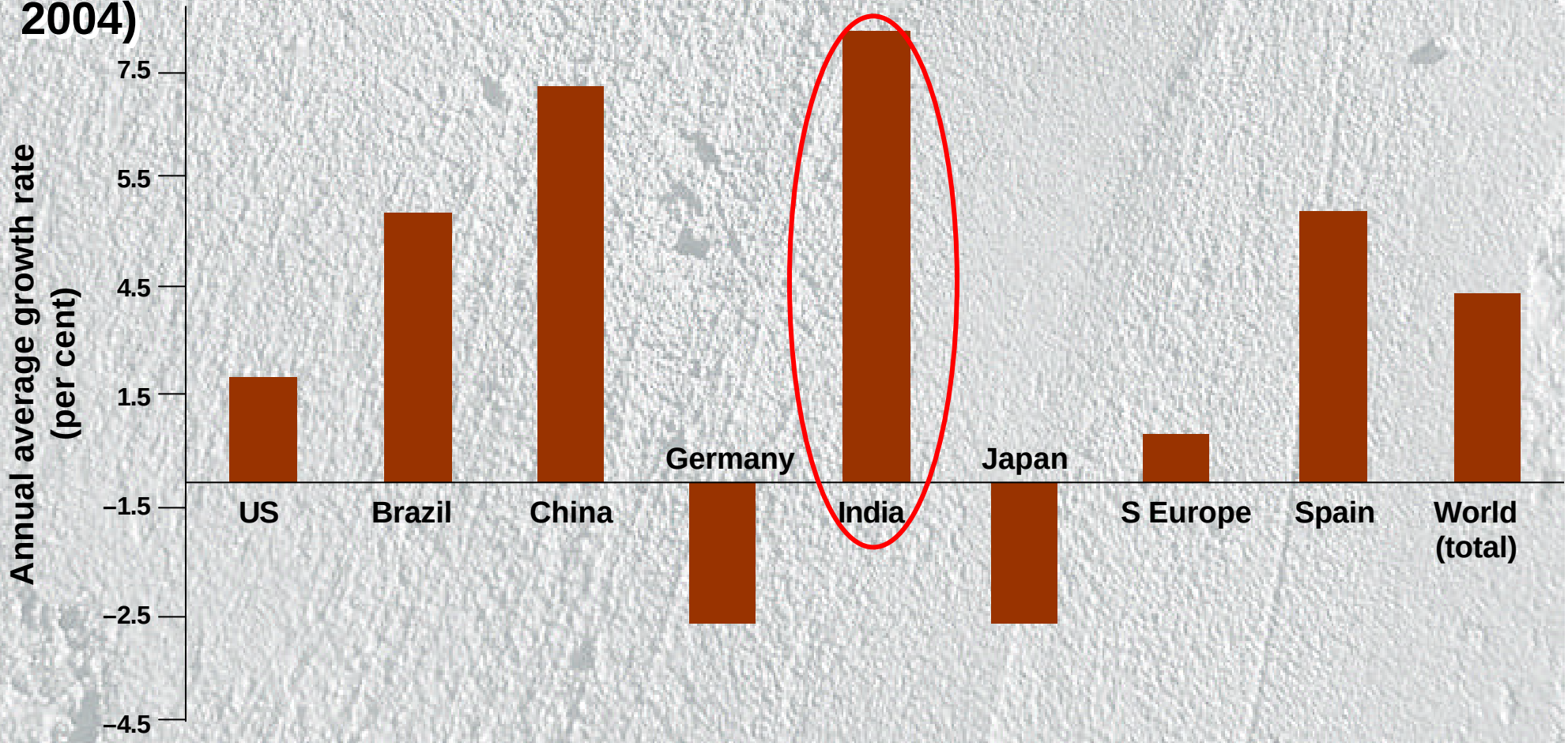
Indian cement industry

Size and growth

- With 163 million tonnes (MT) installed capacity and about 125 MT production, Indian cement industry is the second largest in the world
- It accounts for 6.1% of global production
- China, the global leader, produces about 7 times more than India
- Between 1990 and 2005, Indian cement industry's capacity and production has increased by more than 2.5 times.

The growth rate

- The growth rate of Indian cement industry: roughly at 1.5 times the GDP growth rate – makes it the fastest growing in the world (1993-2004)



- In next five years, it is projected to grow at about 7-8% per annum

Industry structure

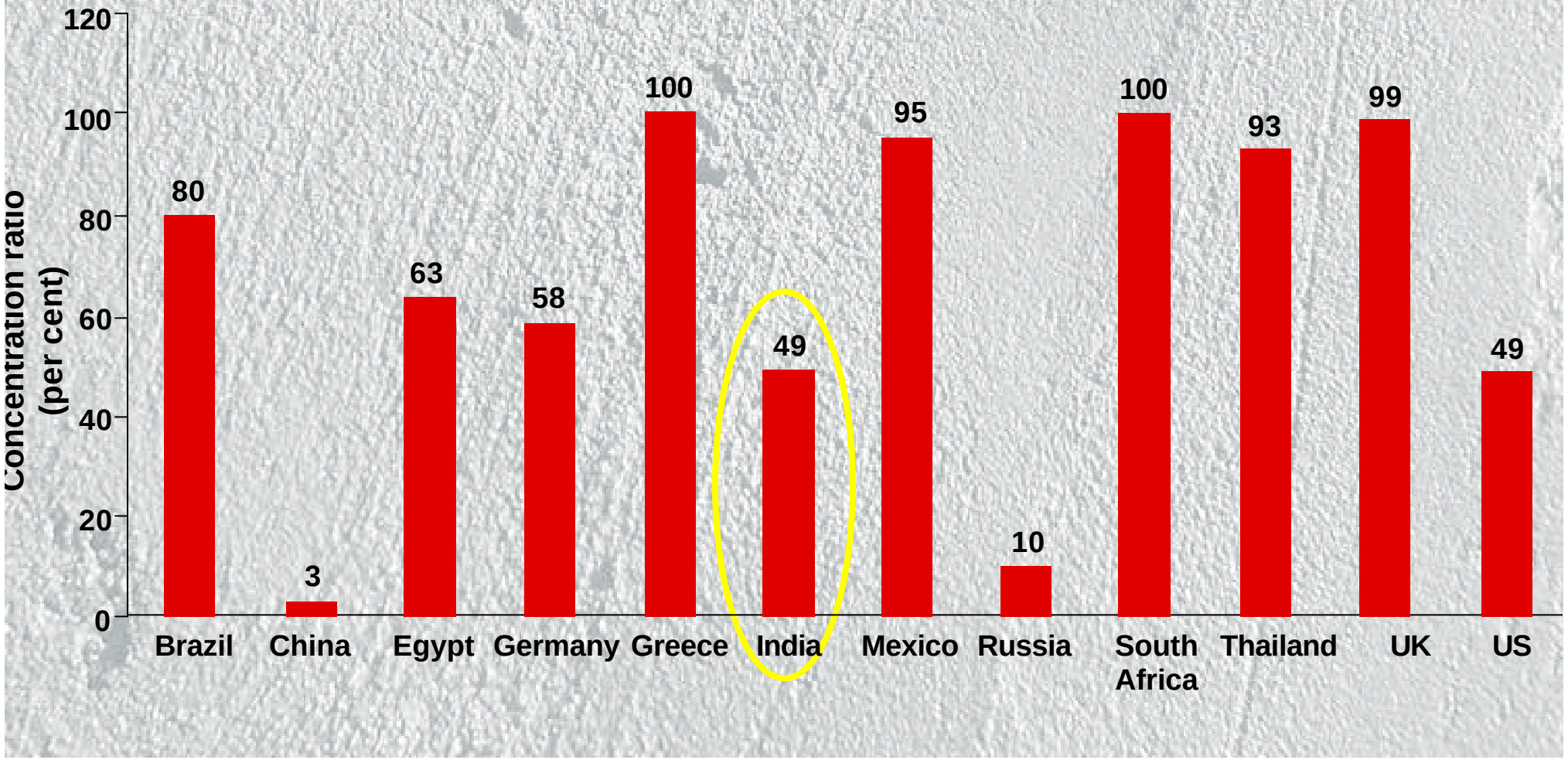
- With more than 400 plants – it is lop-sided in composition
- Capacity of plants varies from 10 tonnes per day (tpd) to 7,500 tpd
- Small plants (mini cement plants) make up three-fourth of the sector in terms of number of plants. But they contribute less than 5% to the total production
- Large plants (128) — of which 68 are million tonne plus plants — account for 94% of capacity and 95% of total production.

Industry structure

- Over the last few years, industry has moved towards consolidation and concentration
- Major players are increasing their market share and MNCs too are increasing their presence
- Concentration ratio in India:
- Top 5 companies account for half the production capacity
- Top 10 companies hold about 73% of the market share

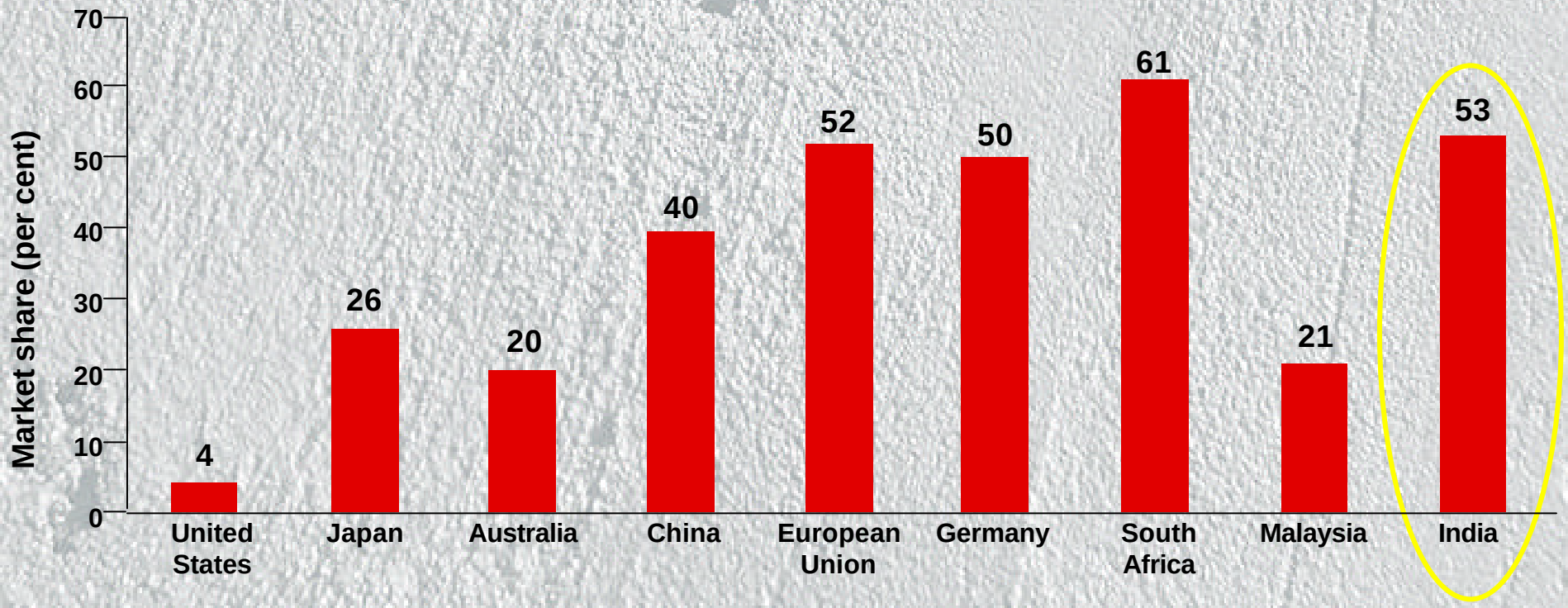
Concentration ratio

Indian cement industry is moderately concentrated – but the trend is towards increasing concentration



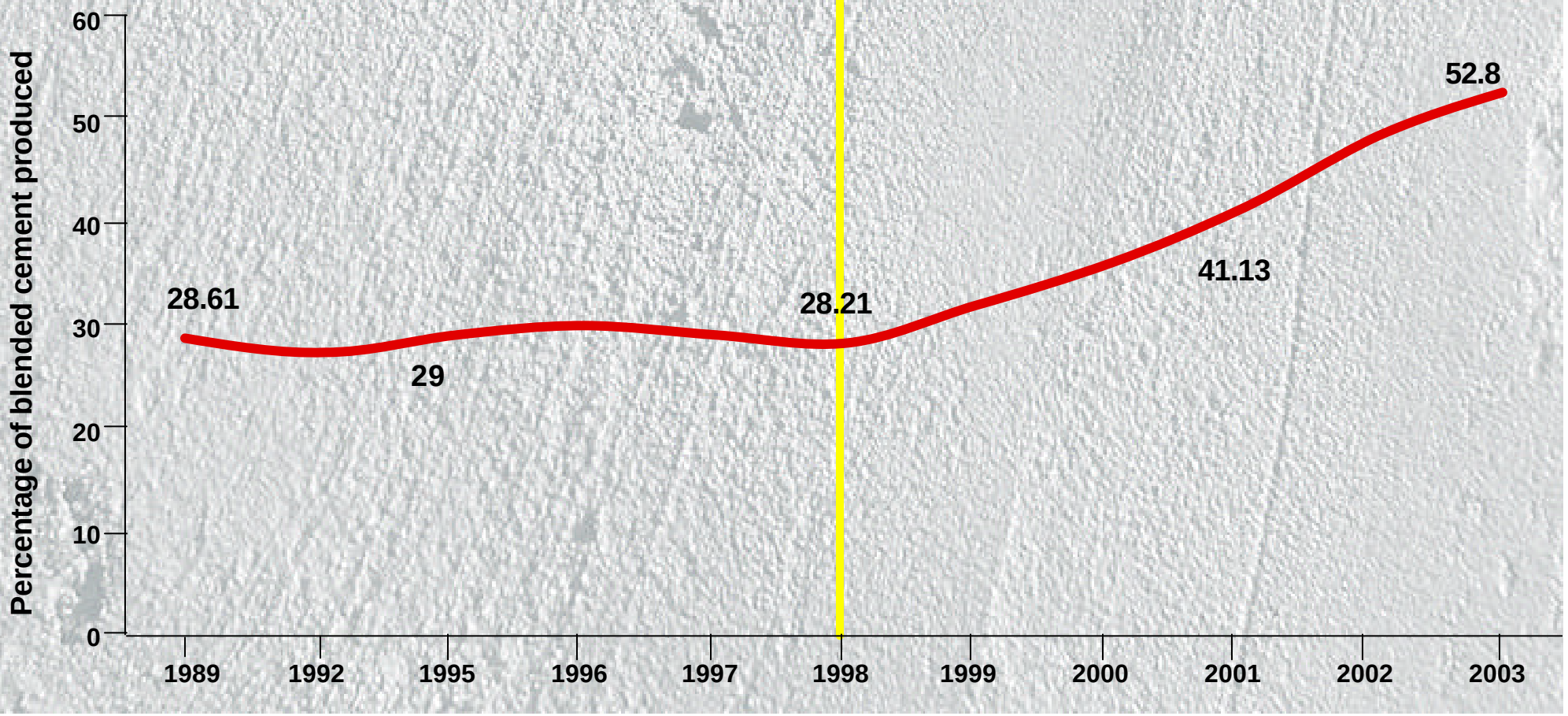
Product profile

- **More than 53% cement produced in India is blended cement — a high penetration rate**



Product profile

From 1998 onwards, the production of blended cement has taken-off in India – it will increase in the future on the back of favourable economics



Cement consumption

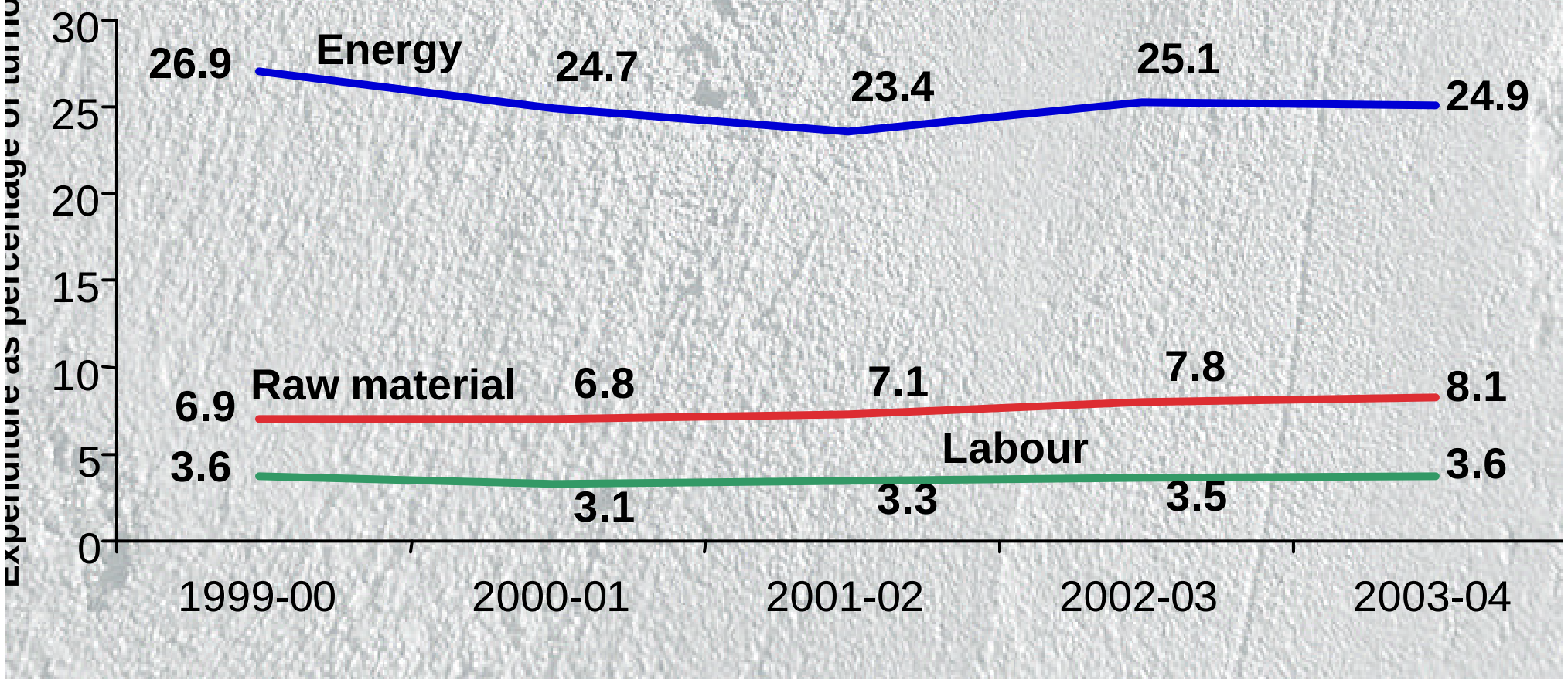
- Current per capita cement consumption in India is low: about 100 kg
- In China and Japan it is above 600 kg and the global average is 270 kg
- Large difference in regional consumption pattern in India – North, South and West consume more than 150 kg/capita; East uses less than 50 kg/capita
- The fact that consumption is low and the Indian economy is growing, ensures a bright prospect for the future growth of this industry

Financial performance

- Has improved significantly in the last few years
- Between 1999-2000 and 2003-04, the average gross profit margin of top 10 Indian companies was similar to that of the top 5 global companies – around 20% of turnover
- The gross profit margin of top 10 Indian companies was in the range of 11.5%-33.0%;
- For top 5 global companies it was in the range of 17.5% - 26.3%.

Production cost analysis

- Energy: 25% - globally competitive
- Raw material: 7.3% - one of the lowest in the world
- Labour: 3.4% - globally competitive

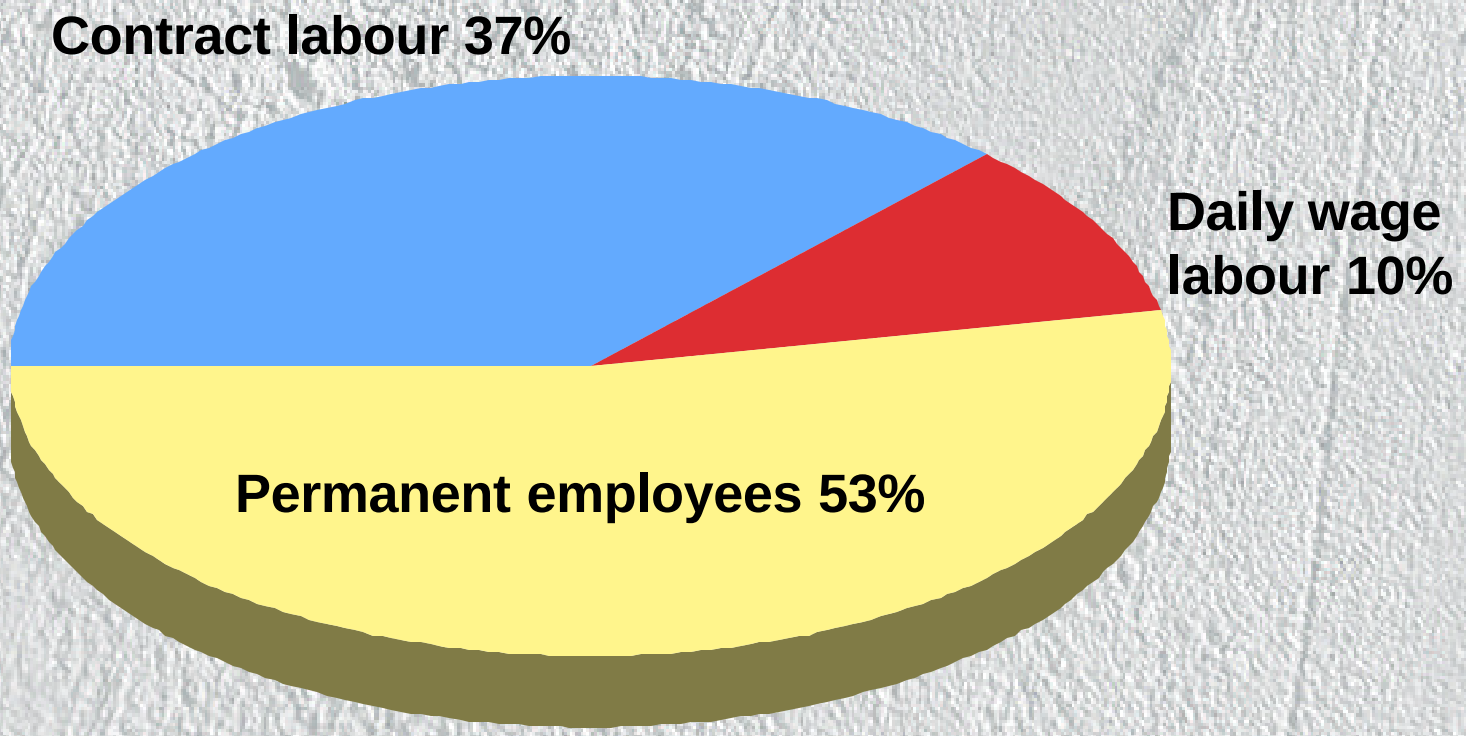


Labour and employment

- On an average it takes about 600 people to produce 1 million tonnes of cement in India – but labour intensity is reducing
- Some modern plants in India use just 275-300 people to produce 1 MT cement - the global average for labour productivity is 550 people/ MT
- In the plants assessed by GRP, the number of people employed reduced from 42,500 in 2000 to 40,100 in 200 — though production increased by 30%
- In the current scenario, the capacity of the cement industry to provide employment is truly limited

Labour and employment

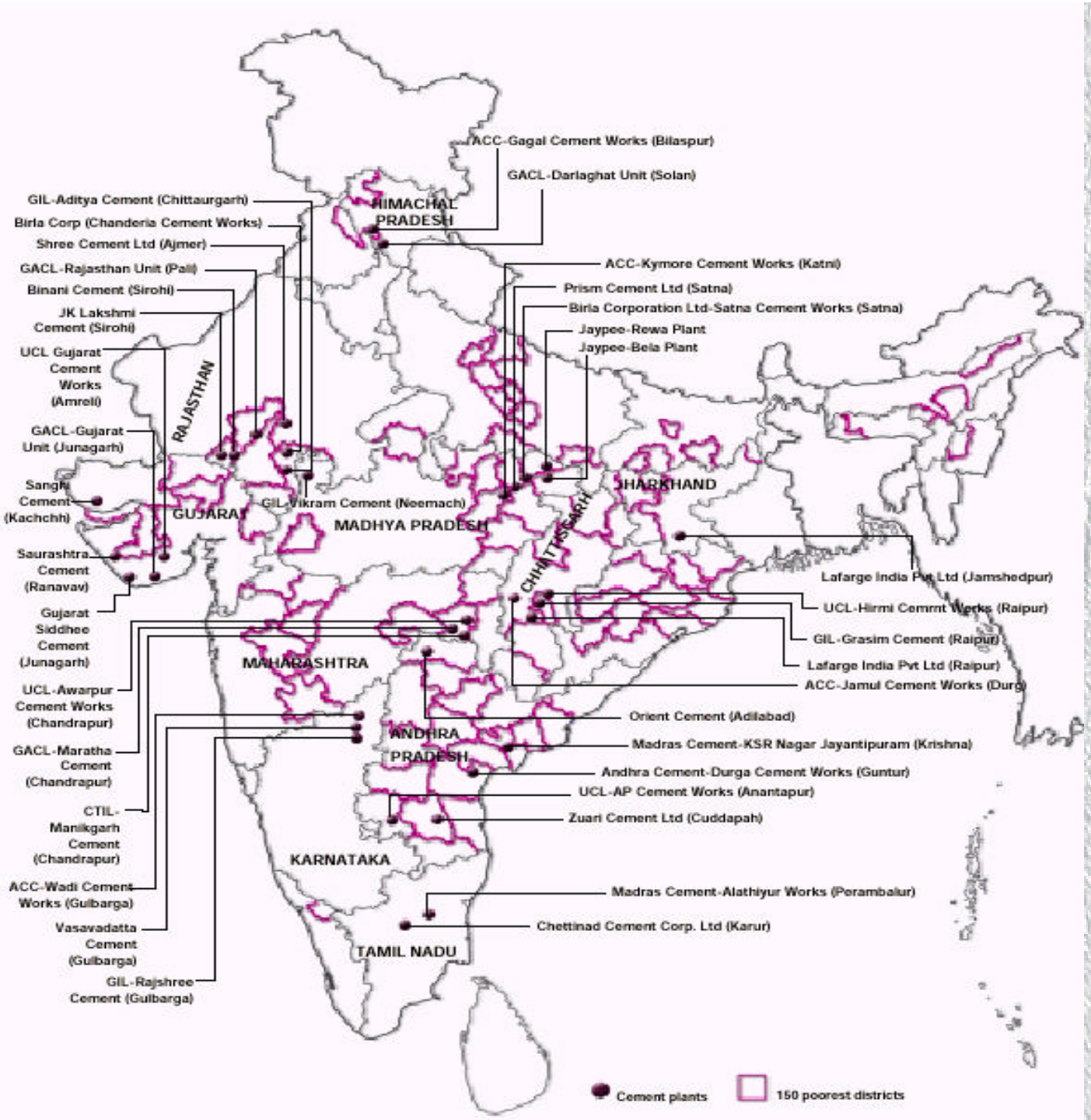
- About half the people employed are on contract or daily wages



- **There is a new trend towards outsourcing cement packagin and loading – area with major occupational health concern**

Location

- The cement plants and their captive limestone mines, are located in areas characterised by poverty and economic backwardness
- About one-third of the plants rated by GRP are located in the 100 poorest districts of India
- More than one-fourth of the 128 large cement plants are located in the 100 poorest districts of India


ACC-Gagal Cement Works (Bilaspur)
GACL-Darlaghat Unit (Solan)
GIL-Aditya Cement (Chittaurgarh)
Birla Corp (Chanderia Cement Works)
Shree Cement Ltd (Ajmer)
GACL-Rajasthan Unit (Pali)
Binani Cement (Sirohi)
JK Lakshmi Cement (Sirohi)
UCL Gujarat Cement Works (Amreli)
GACL-Gujarat Unit (Junagarh)
Sanghi Cement (Kachchh)
Saurashtra Cement (Ranavav)
Gujarat Siddhee Cement (Junagarh)
UCL-Awarpur Cement Works (Chandrapur)
GACL-Maratha Cement (Chandrapur)
CTIL-Manikgarh Cement (Chandrapur)
ACC-Wadi Cement Works (Gulbarga)
Vasavadatta Cement (Gulbarga)
GIL-Rajshree Cement (Gulbarga)
HIMACHAL PRADESH
RAJASTHAN
GUJARAT
GIL-Vikram Cement (Neemach)
MADHYA PRADESH
MAHARASHTRA
ANDHRA PRADESH
KARNATAKA
TAMIL NADU
ACC-Kymore Cement Works (Katni)
Prism Cement Ltd (Satna)
Birla Corporation Ltd-Satna Cement Works (Satna)
Jaypee-Rewa Plant
Jaypee-Bela Plant
CHHATTISGARH
JHARKHAND
Lafarge India Pvt Ltd (Jamshedpur)
UCL-Hirmi Cemrnt Works (Raipur)
GIL-Grasim Cement (Raipur)
Lafarge India Pvt Ltd (Raipur)
ACC-Jamul Cement Works (Durg)
Orient Cement (Adilabad)
Madras Cement-KSR Nagar Jayantipuram (Krishna)
Andhra Cement-Durga Cement Works (Guntur)
UCL-AP Cement Works (Anantapur)
Zuari Cement Ltd (Cuddapah)
Madras Cement-Alathiyur Works (Perambalur)
Chettinad Cement Corp. Ltd (Karur)
Cement plants
150 poorest districts

Rating criteria and weightages

Sustainable industry?

- Cement industry doesn't fulfil the requirements of environmentally sustainable industry
- It uses non-renewable raw materials and energy
- It sources its raw material by mining, which destroys the local ecology
- It produces product that is not recyclable
- Therefore, this rating is not a environmental sustainability rating
- It is a rating to benchmark Indian cement companies with the global best practices

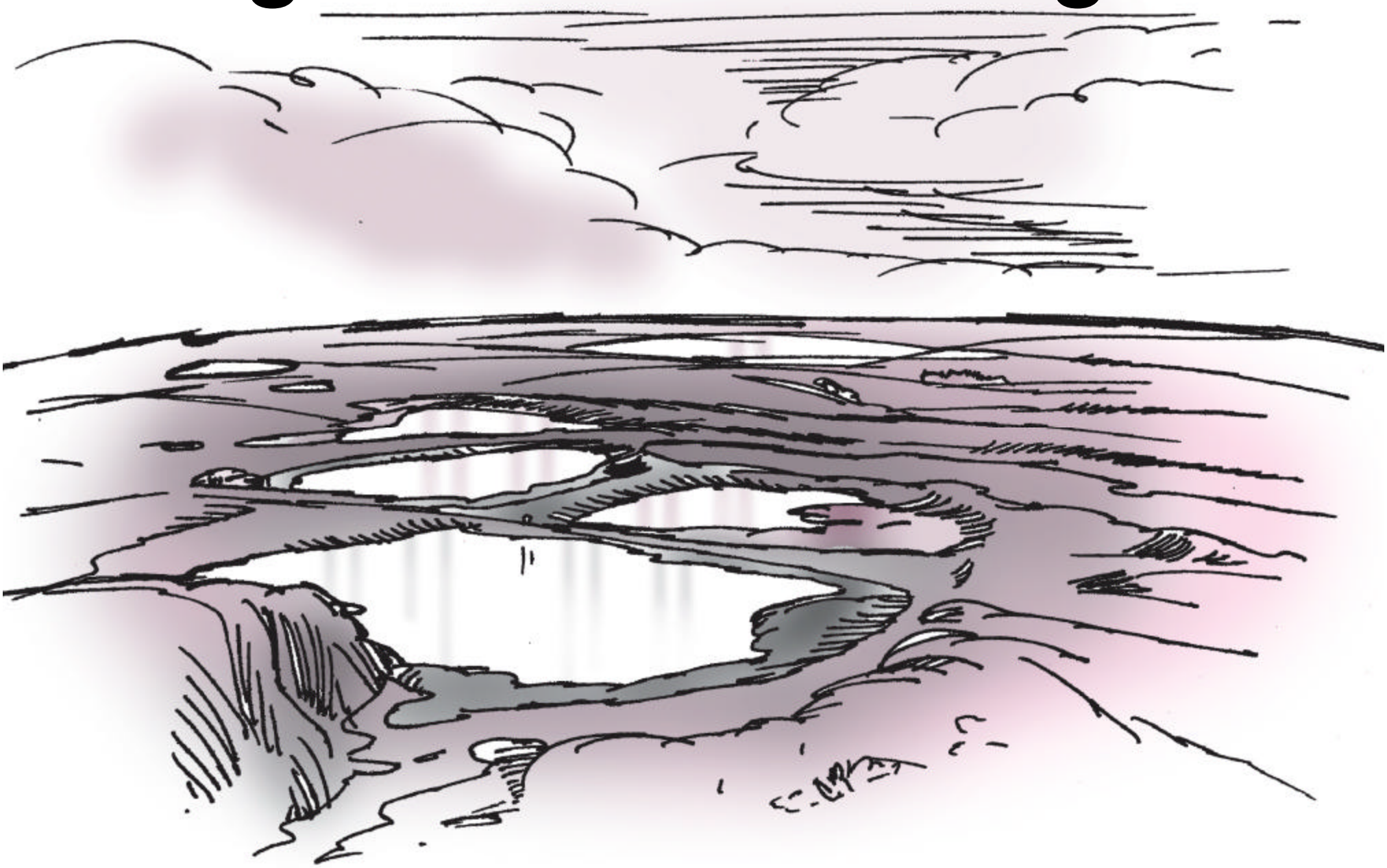
Rating criteria and weightages

A. Corporate policy and management system	**10.00**
❑ Occupational health and safety	4.00
❑ Environment management	3.00
❑ Stakeholder management	3.00
B. Life cycle assessment	**77.50**
❑ Mining	25.00
❑ Production plant and product	52.50
C. Compliance and stakeholder perception	**12.50**
❑ Compliance and PCB perception	2.00
❑ Perception of the local community	7.75
❑ Perception of the GRP surveyor	2.75

Distribution of weightages

Impact category	Weightages
Impact on air quality and atmosphere	47.00
Energy use and waste utilisation	20.00
Impact on land and biodiversity	16.00
Impact on water resources	9.00
Overall performance	8.00

Mining and mine management

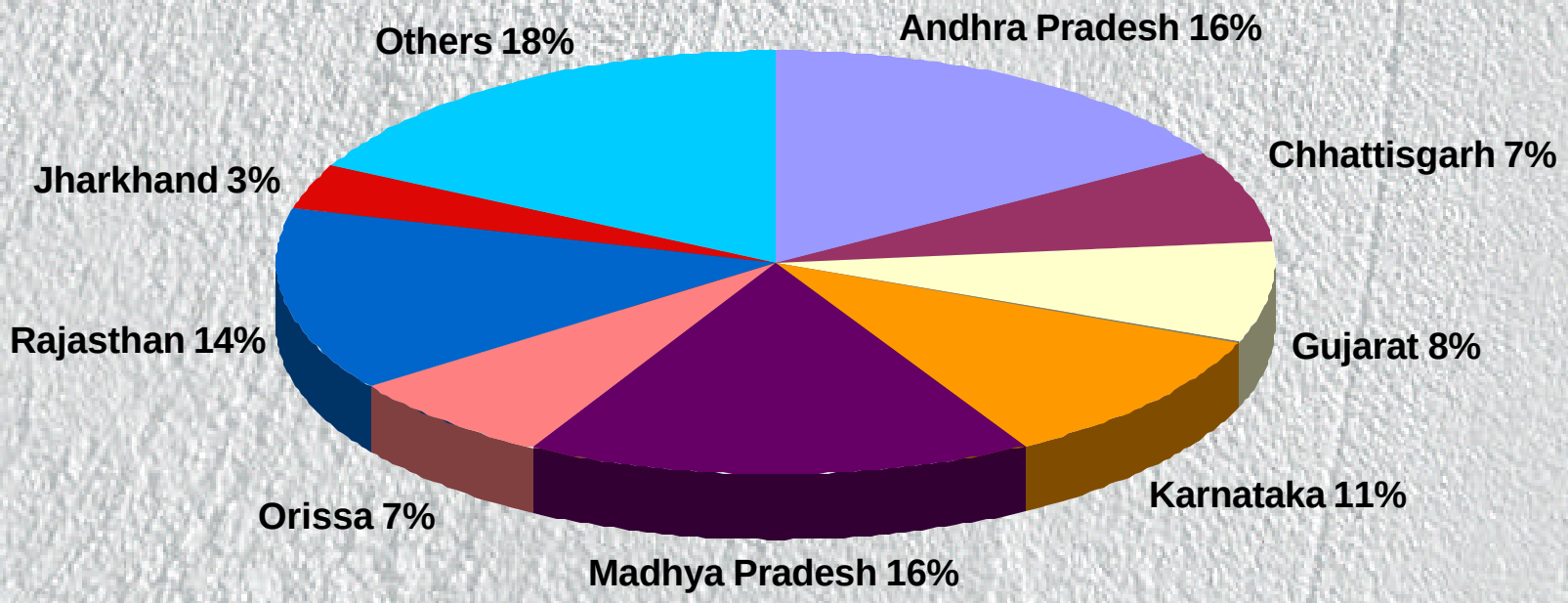


Rating criteria and weightages

Mining	25.00
• Mine characteristic and mining impact	**5.75**
• Mining technology	**4.00**
• Reclamation and rehabilitation	**4.25**
• Impact on water regime	**3.50**
• Afforestation	**2.75**
• Overburden management	**1.50**
• Topsoil management	**1.50**
• Reject handling and dust control	**1.75**

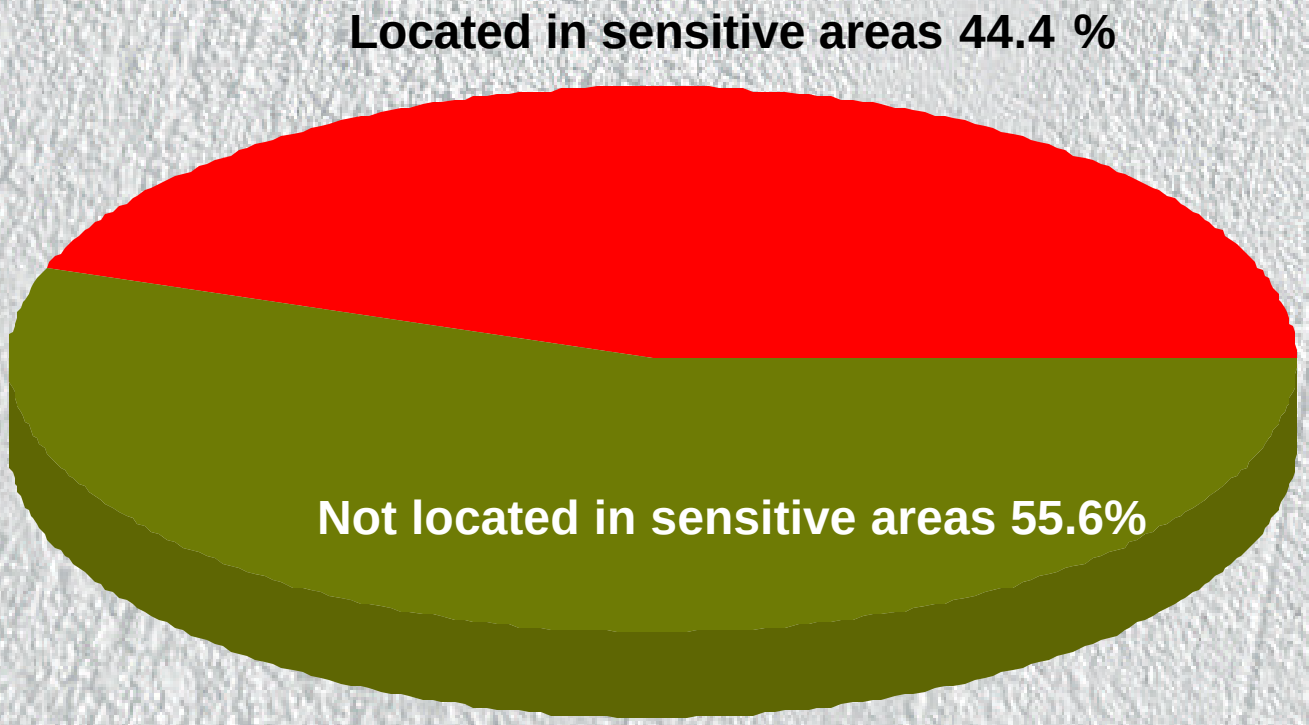
Key issues

- The estimated cement grade limestone reserves in India - more than 90,000 million tonnes
- Some are located in ecologically sensitive areas
- More than 70% reserves are in states with per capita income less than the national average.



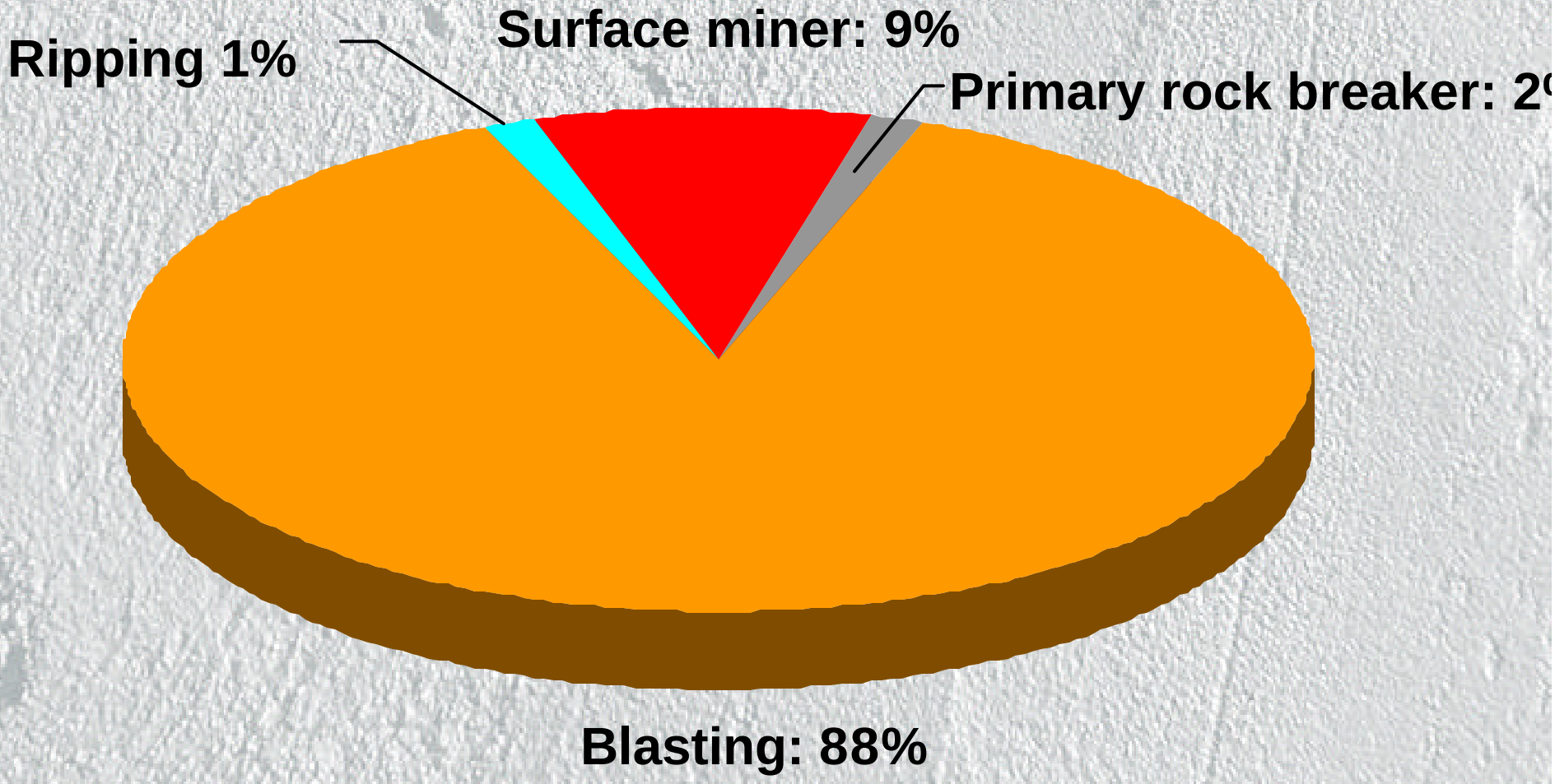
Key issues — location

- Large-scale mining is being done near reserve forests and wildlife sanctuaries in the Himalaya and within the coastal regulation zone and near archaeological sites.
- There is a rush to setup plants and mines in Himachal Pradesh.
- Of the mines assessed by GRP, 44% are located in areas that can be characterised as sensitive



Mining technology

- Limestone mining in India is done predominantly by blasting. About 90% of the limestone is extracted by blasting; less than 10% by surface miner



Mining technology

Blasting has much higher environmental impact – noise, vibration and dust

Mining technology

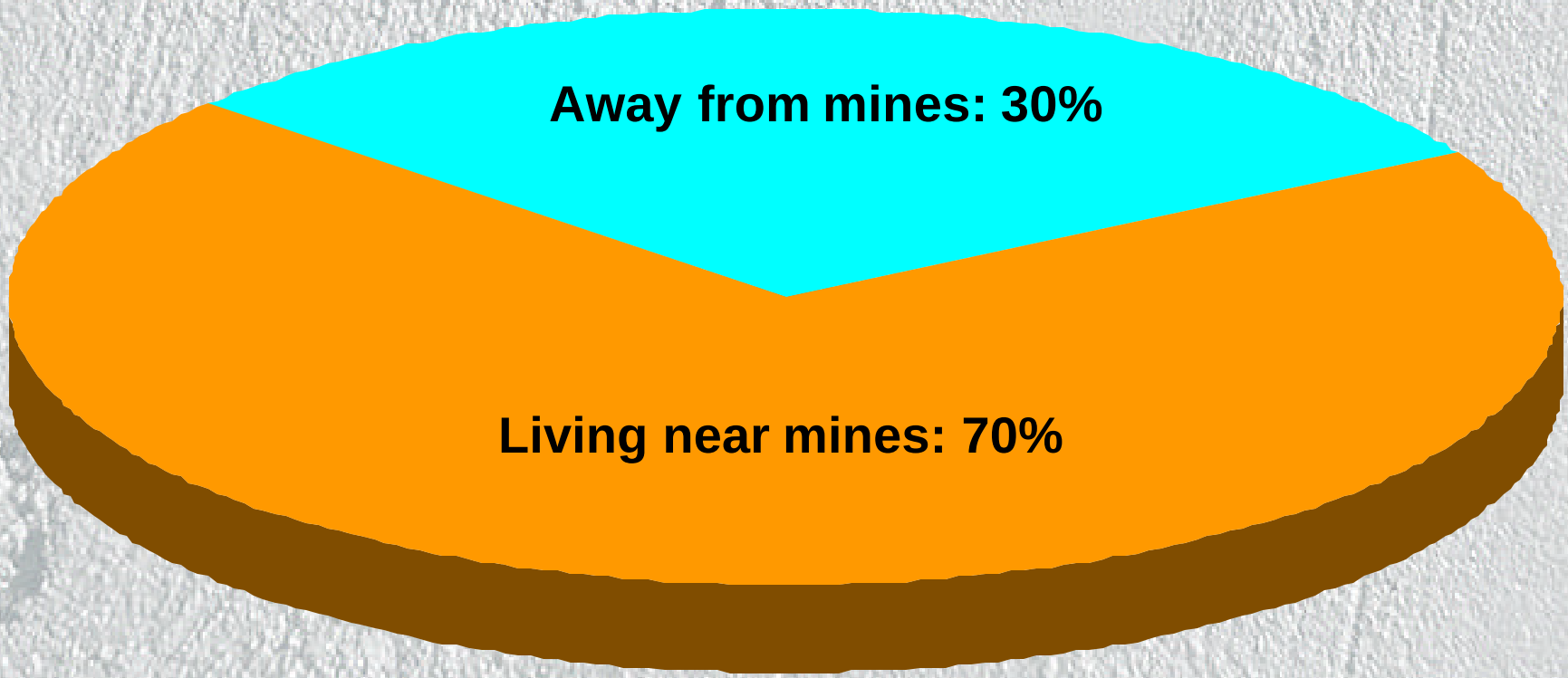
Surface miner – low impact

Mining technology

- Surface miners can be used to mine reserves with about 600 kg/cm^2 compressive strength.
- Of the 36 mines assessed, 10 could have used surface miners, but only five use them.
- Reason: Cost and lack of regulation
- Average cost of mining, including royalty, by surface miners is Rs 47 per tonne limestone compared to Rs 36 per tonne by blasting
- Mining regulators have not insisted on the use of surface miners

Impact on the community

- In India, local communities co-exist with mines
- 70 per cent of the large-scale cement plants have communities residing near their mines (within 1 km radius)



Impact on the community

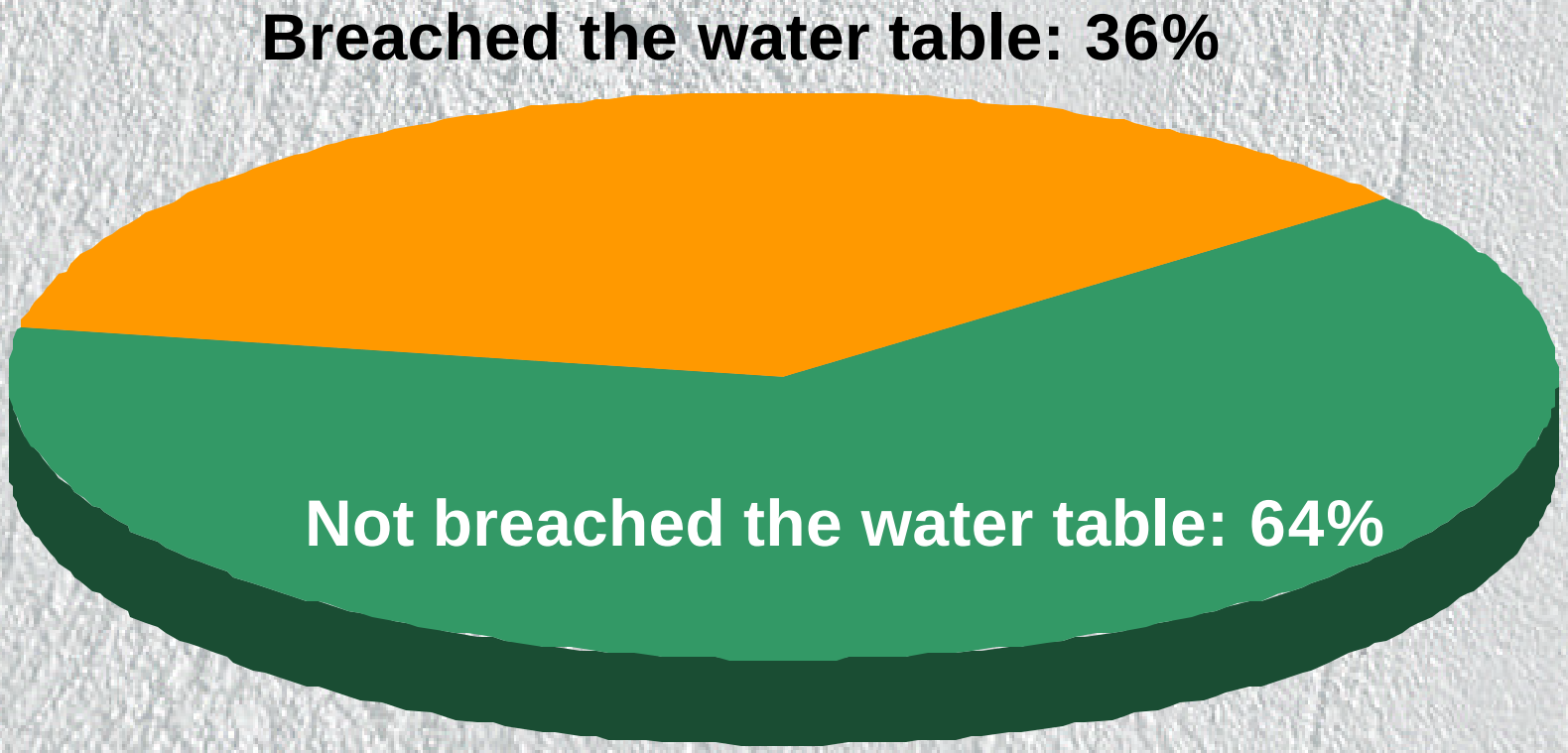
- Most complaints are related to damage to buildings due to blasting. Complaints are also related to dust problems from mining and material transportation from mines.

Water impact

- Cement making and limestone mining is not water intensive. Still, we received several complaints related to groundwater depletion
- We collected and analysed time-series groundwater level data for most mines
- **We concluded:** Wherever, mining has gone below the groundwater table (breached the groundwater table), groundwater levels in the surrounding areas have gone down significantly and hence affected the local community

Water impact

- **Of the 36 mines assessed, as many as 12 mines have breached the groundwater table**



Water impact

Mine management

- For making one tonne of cement, the sector spends Rs 78 on limestone – which is just 3% of the sales
- Captive mines, but no incentive or disincentive for mine management
- Royalty for limestone paid on the quantity used, and not on the quantity mined
- This promotes rejection of low-grade limestone
- We identified 4 plants out of the 36, that were not using limestone with $CaCO_3$ content between 73%-74%
- Four more were not using limestone with $CaCO_3$ content between 70-73%.

Poor overburden management

- Sector generates about 200 kg waste per tonne of limestone excavated
- In 2004, therefore, 25 MT of wastes were generated by the limestone mines of the cement plants
- But, the management of these wastes – overburden – is quite poor

Poor overburden management

Poor topsoil management

- On an average, for every tonne of limestone extracted by the cement sector, 20-50 kg of topsoil is also extracted. Topsoil needs careful management
- Very few plants rated by GRP, had taken proper care of topsoil
- Most plants stated that they preserve it for future use
- But survey results show otherwise – most topsoil is dumped with overburden and some is used for plantations.

Topsoil (mis)management

Plantation

- **Plantation in mines reduces dust, noise and vibration and improves the aesthetics. It is the least one expects from the companies**
- **But…….**
- **The sector performs poorly in plantation**
- **Not even 10% of the areas available in the mines have been properly afforested**
- **None of the mines have plantations around the pit head and very few have it along the haul roads**

Barren mines

Reclamation and rehabilitation

- More than half the plants rated, have not even started reclamation – though in most, some mine pits have been exhausted
- There is complete lack of community-based vision for future use of exhausted mines
- In the plants rated, 64% of the exhausted mines will be converted to water bodies – 160 km^2 of water bodies. But very few have a proper plan for the use of these reservoirs
- In mines, which have already reclaimed their exhausted pits as water reservoirs, water is seldom shared with the local community. In fact, infrastructure for sharing water is absent
- Some of the abandoned water reservoirs, have led to malaria outbreak in the local areas.

Reclamation — water pits

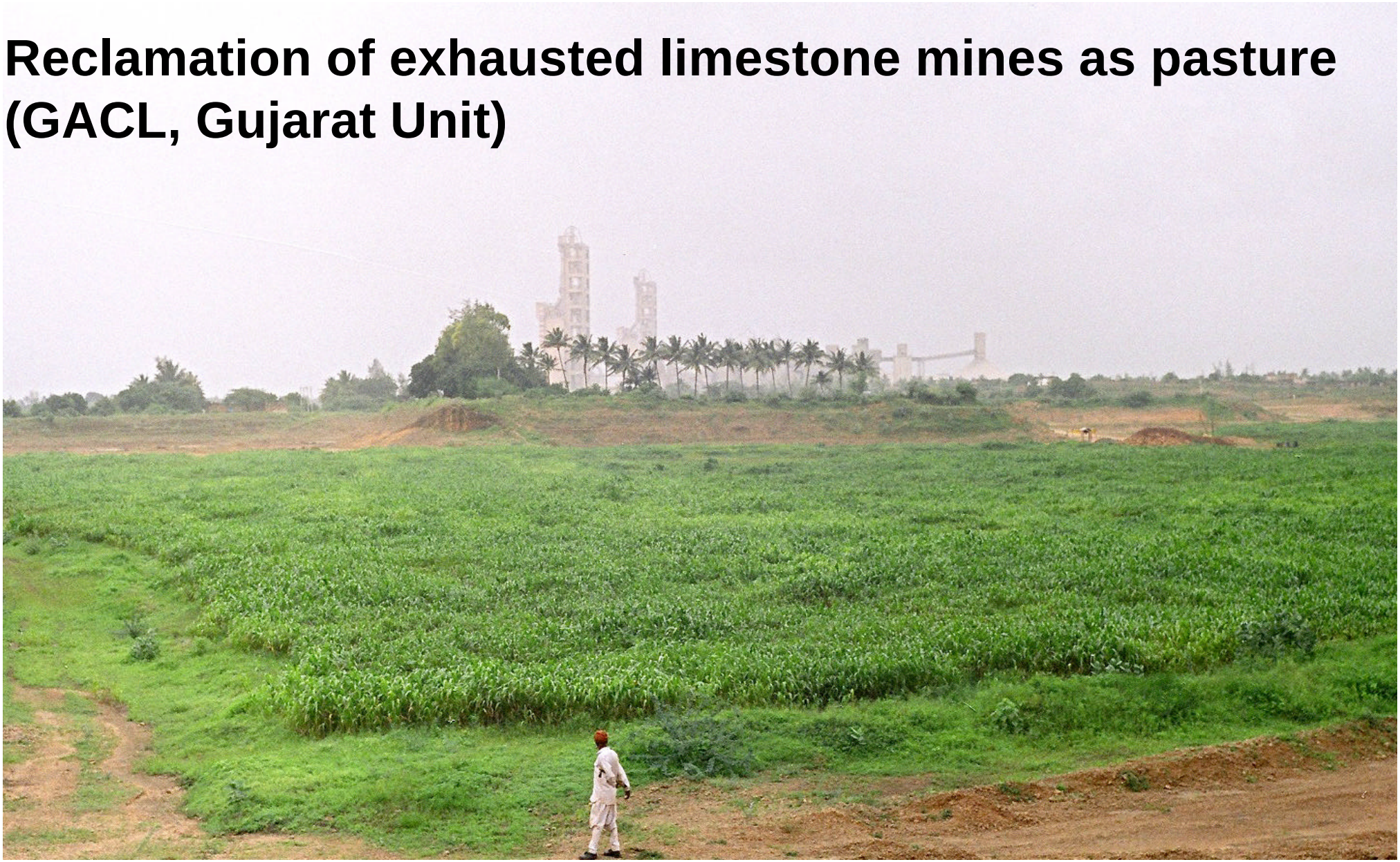
Poor reclamation practices in India

Reclamation

- Water reservoirs are good in water scare areas, but only if there is a proper management plan for its utilisation and sharing.
- As of today, these are just the easiest reclamation options that cement plants have
- But there are plants who have done well in mine reclamation
- Ambuja Cements – Gujarat Unit, has converted part of its exhausted mine into pasture.

But some good reclamation also

Reclamation of exhausted limestone mines as pasture (GACL, Gujarat Unit)

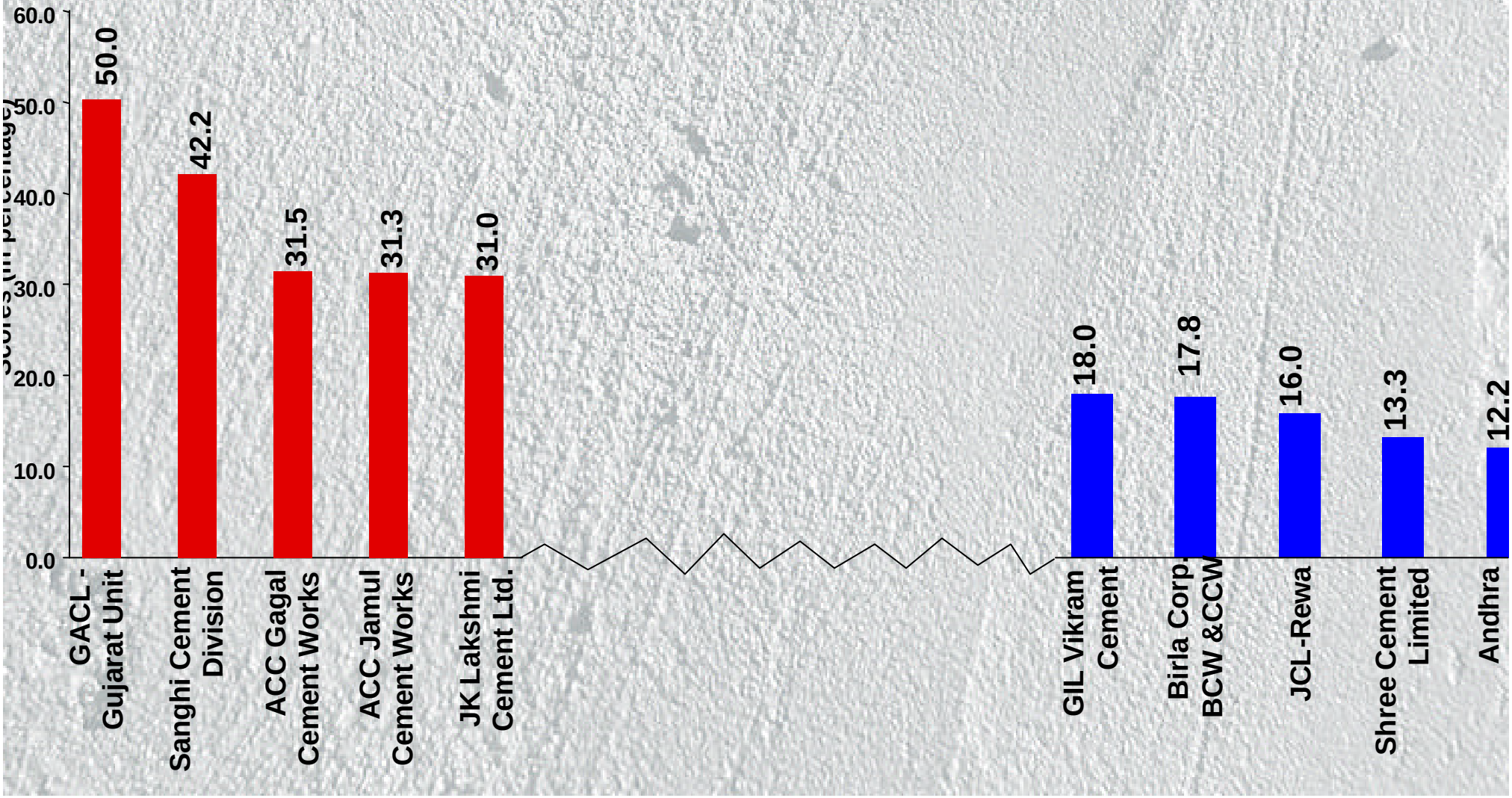


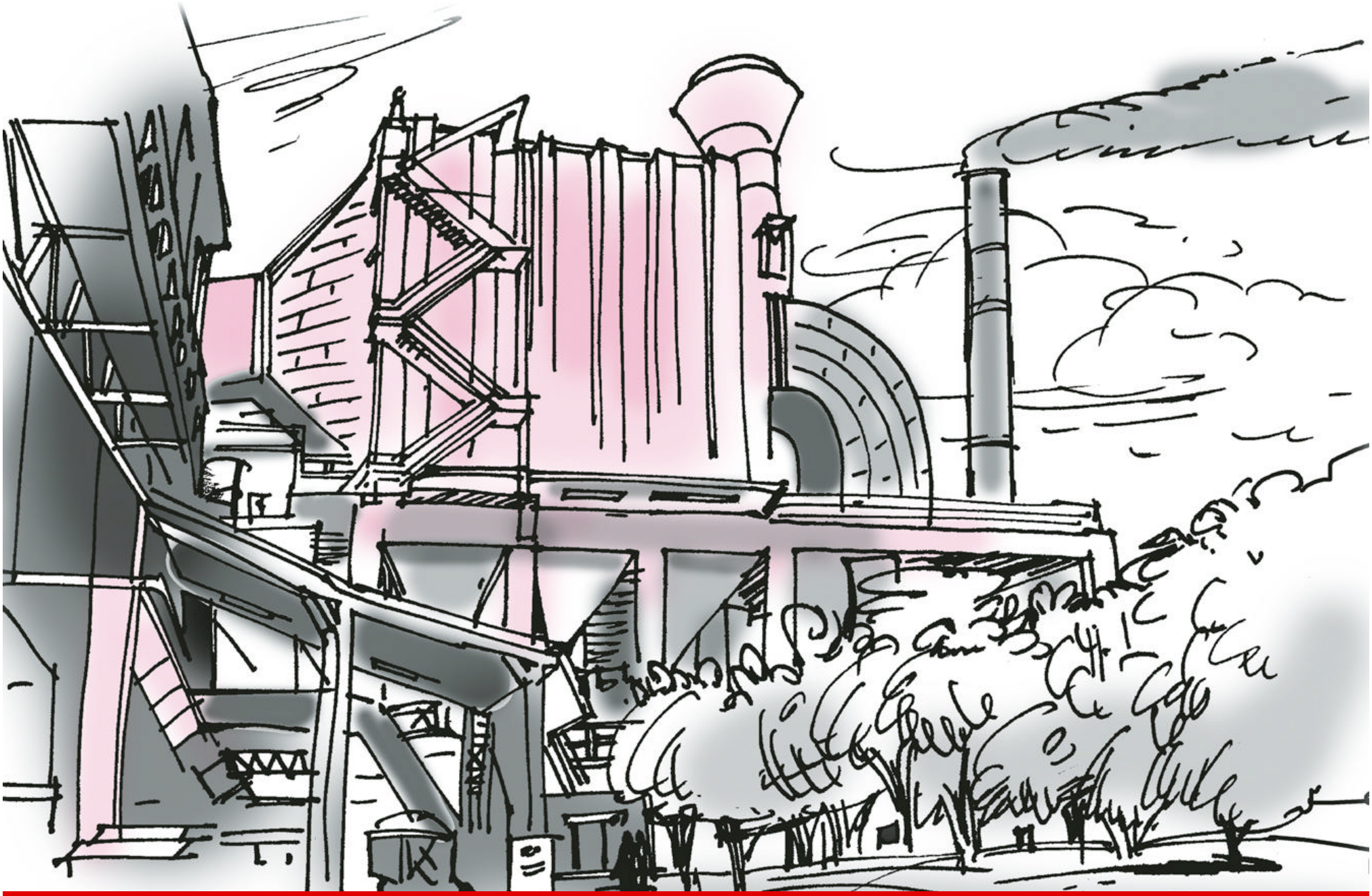
Challenges of mining

- No consultation with the local community when developing mine closure plans
- Low onus on cement plants to manage exhausted mines. For instance, what will happen to the exhausted water pits, once plants are gone, remains unanswered
- The bank guarantee of Rs 20,000 per hectare taken by the government for reclamation is too low for proper reclamation
- This must change
- Regulators will have develop policies that:
  - promote proper mine management
  - promote use of low-grade limestone
  - promote socially-relevant reclamation of exhausted mines

Rating - Mining

Sector average: 24.4%



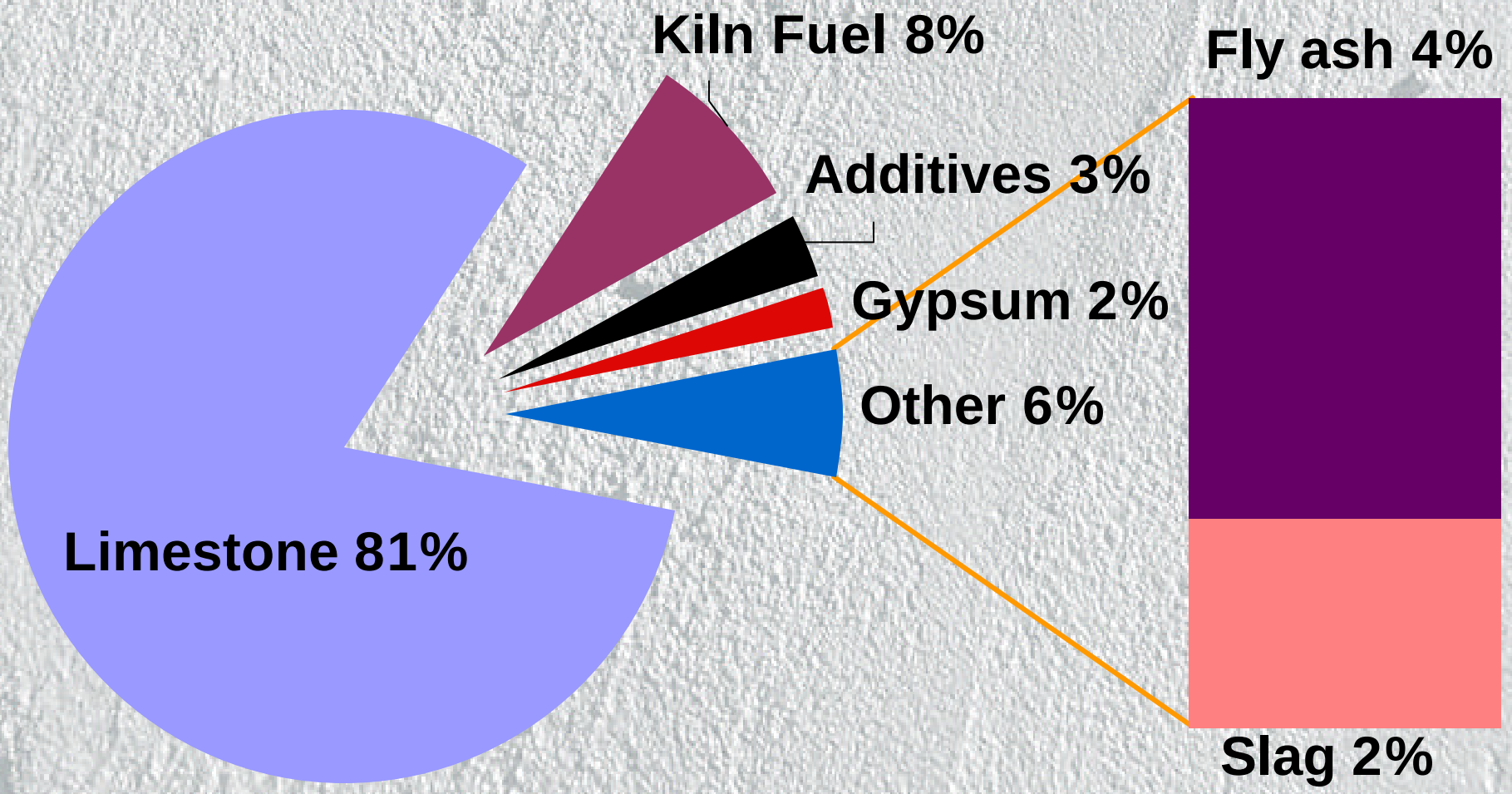


PRODUCTION PLANT AND POLLUTION

Rating criteria and weightages

Production plant and pollution	**52.50**
Raw material consumption & waste utilisation	**7.25**
Production technology	**5.00**
Energy	**7.75**
Water	**4.00**
Stack emission and emission control	**14.75**
Material handling & storage (fugitive emission)	**13.75**

What goes into Indian plants?

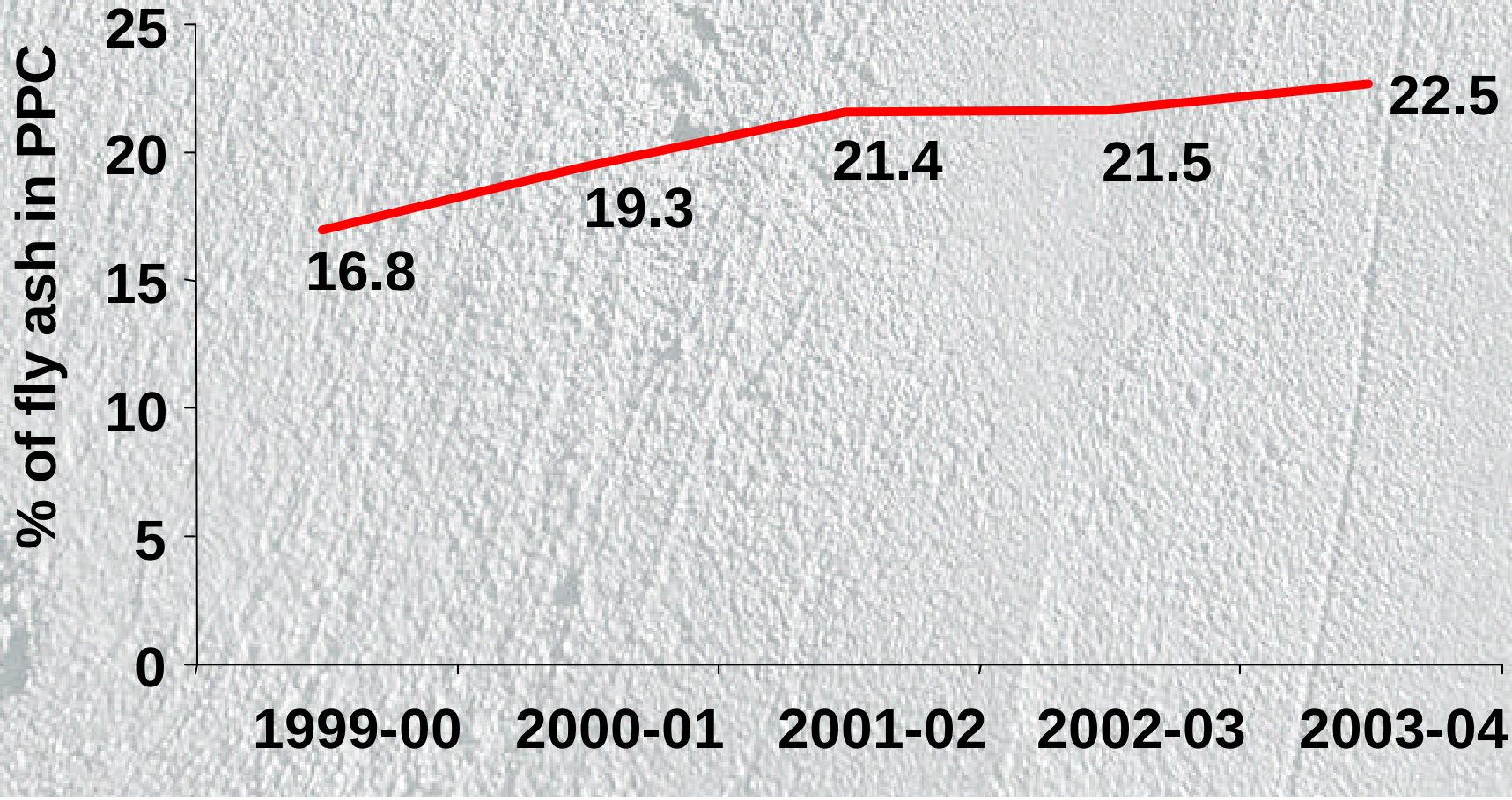


Key findings

- If all the cement manufactured in the country was fly ash-blended, then in 2004, Indian cement industry would have managed to use 40 per cent of the fly ash generated in the country;
- …….but it used only 12 per cent
- The positive part is that it is moving in that direction – economics is driving cement industry towards greater use of fly ash

Key findings

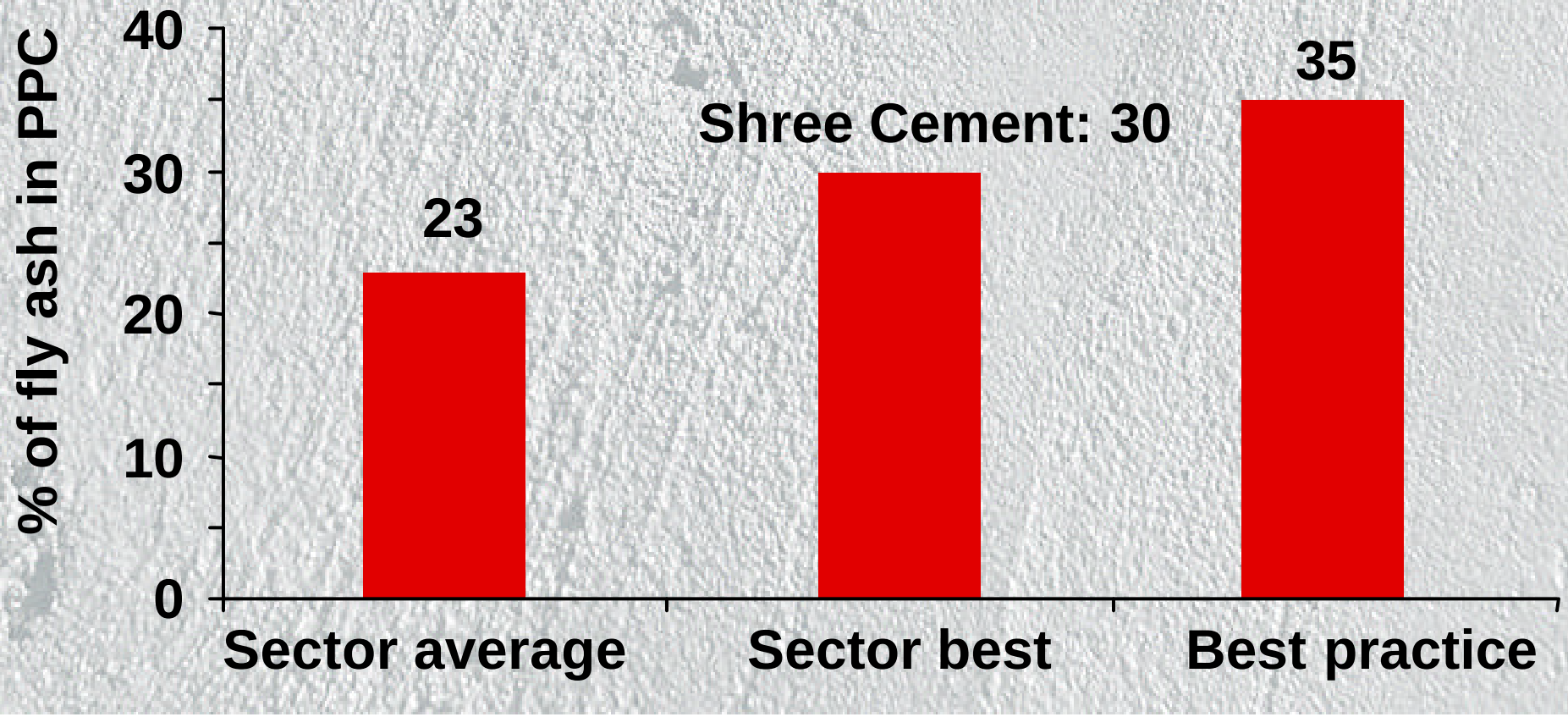
Blended cement production is increasing and so is the percentage of fly ash in PPC



Key findings

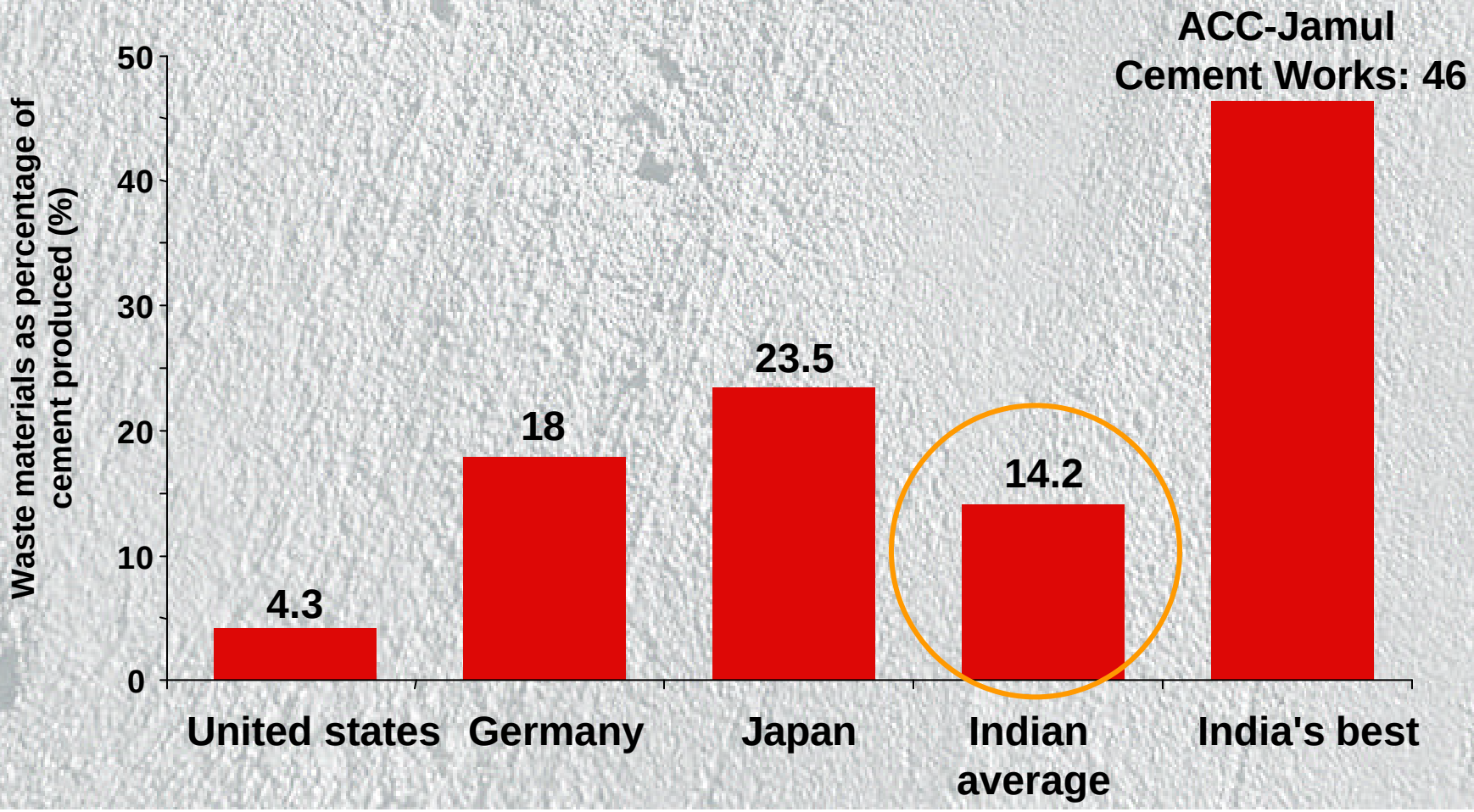
However, there is potential to improve…

- **Average fly ash content is still 23%, It can increase to 35%**



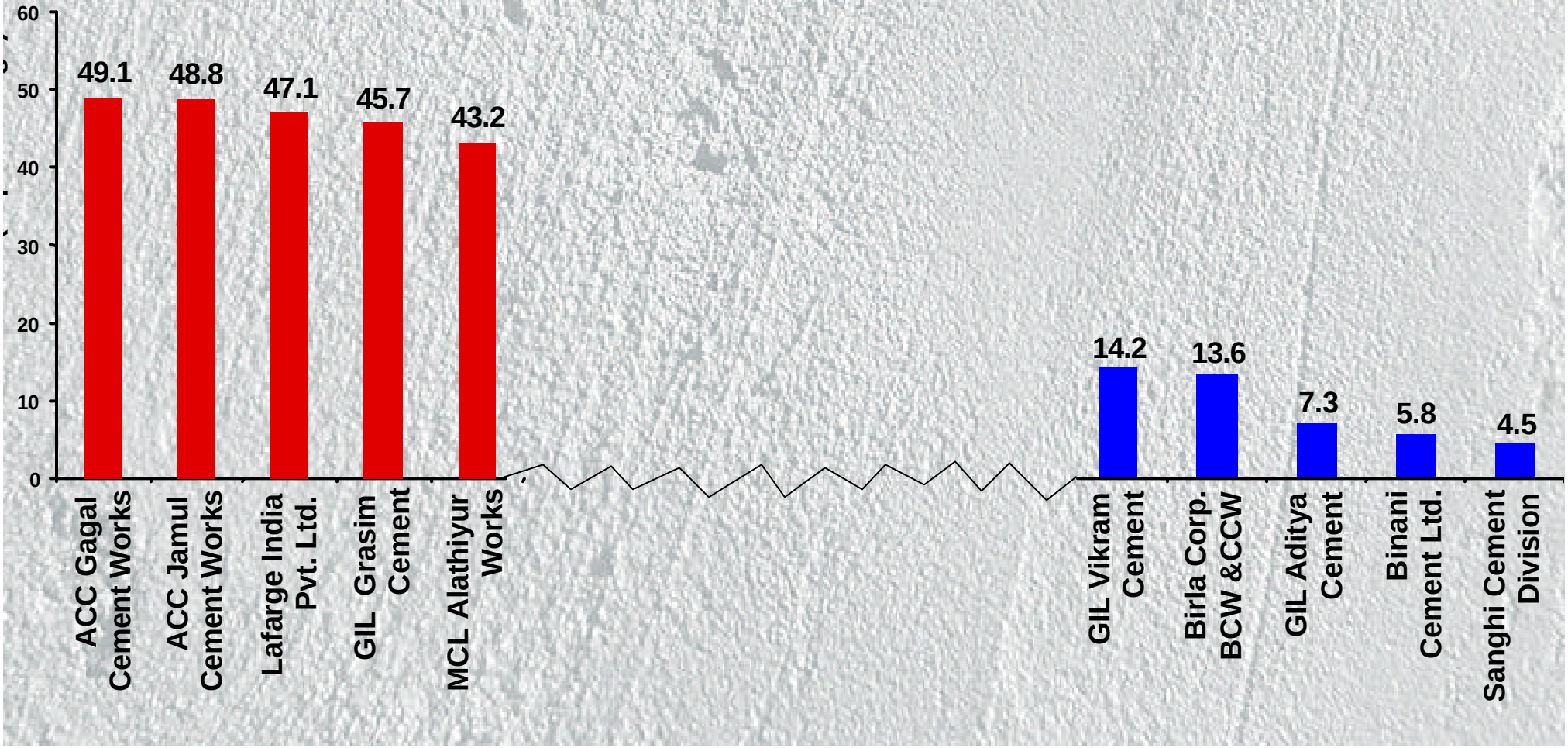
Total waste consumption

In 2003-04, waste materials accounted for 14.2% of cement manufactured in India – relatively low



Rating - Waste Utilisation

Sector average 26.9%



Benchmarking technology

Key findings — Technology

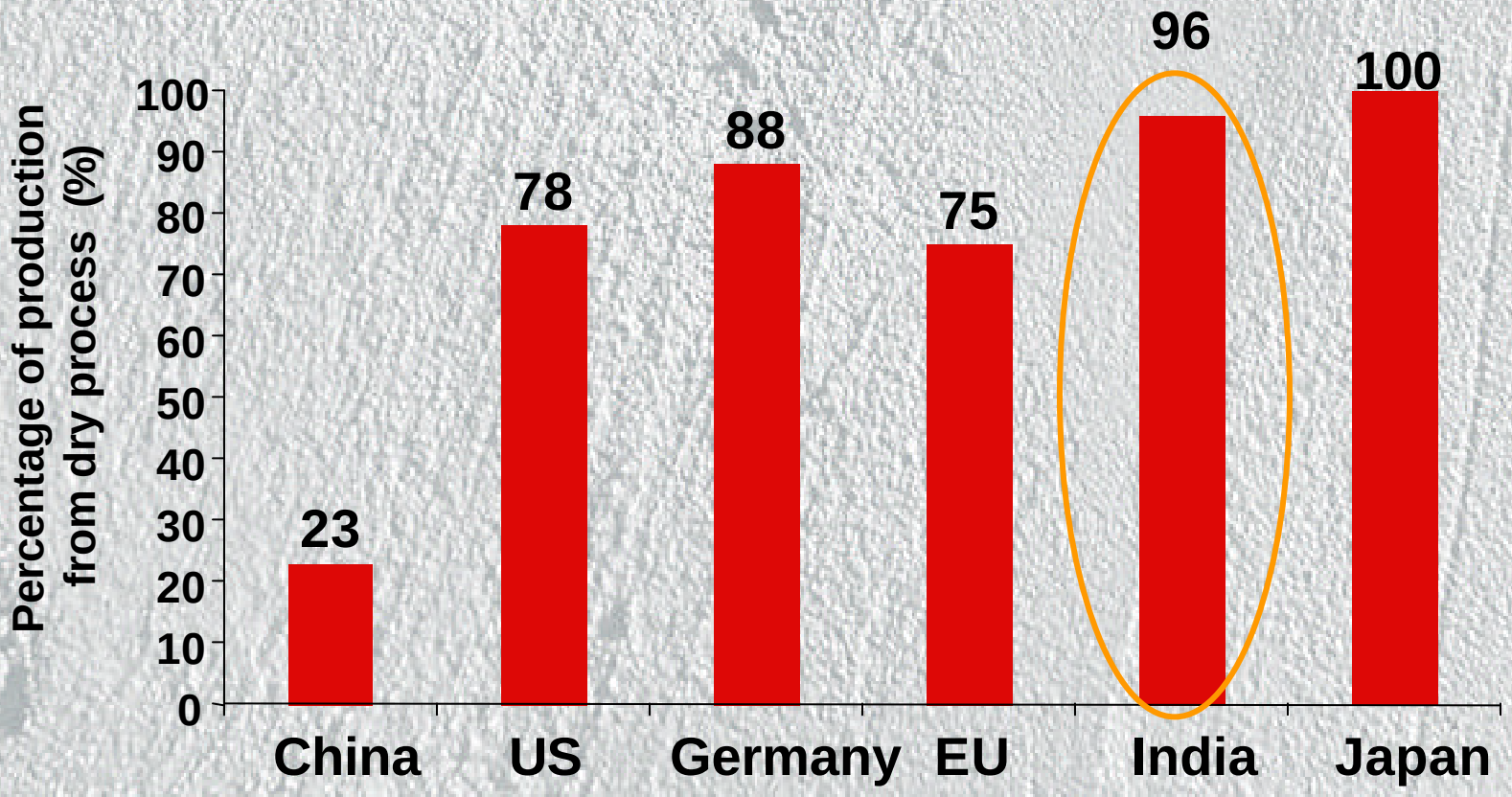
- Most improvements in cement-making technology are geared to reduce energy consumption — with every stage of progression, energy consumption has declined

	Kcal/kg clinker
➢Wet process with internals	1400-1500
➢2-stage cyclone pre-heater	900
➢4-stage cyclone pre-heater plus calciner	750
➢5- stage pre-heater plus calciner	720
➢6-stage pre-heater plus calciner	<700

- Six-stage pre-heater with precalciner considered “state of the art” — but even this technology is still only 70% energy efficient
- A new technology — Fluidised Bed Advanced Cement Kiln System — is being tried in Japan, which has 80% efficiency

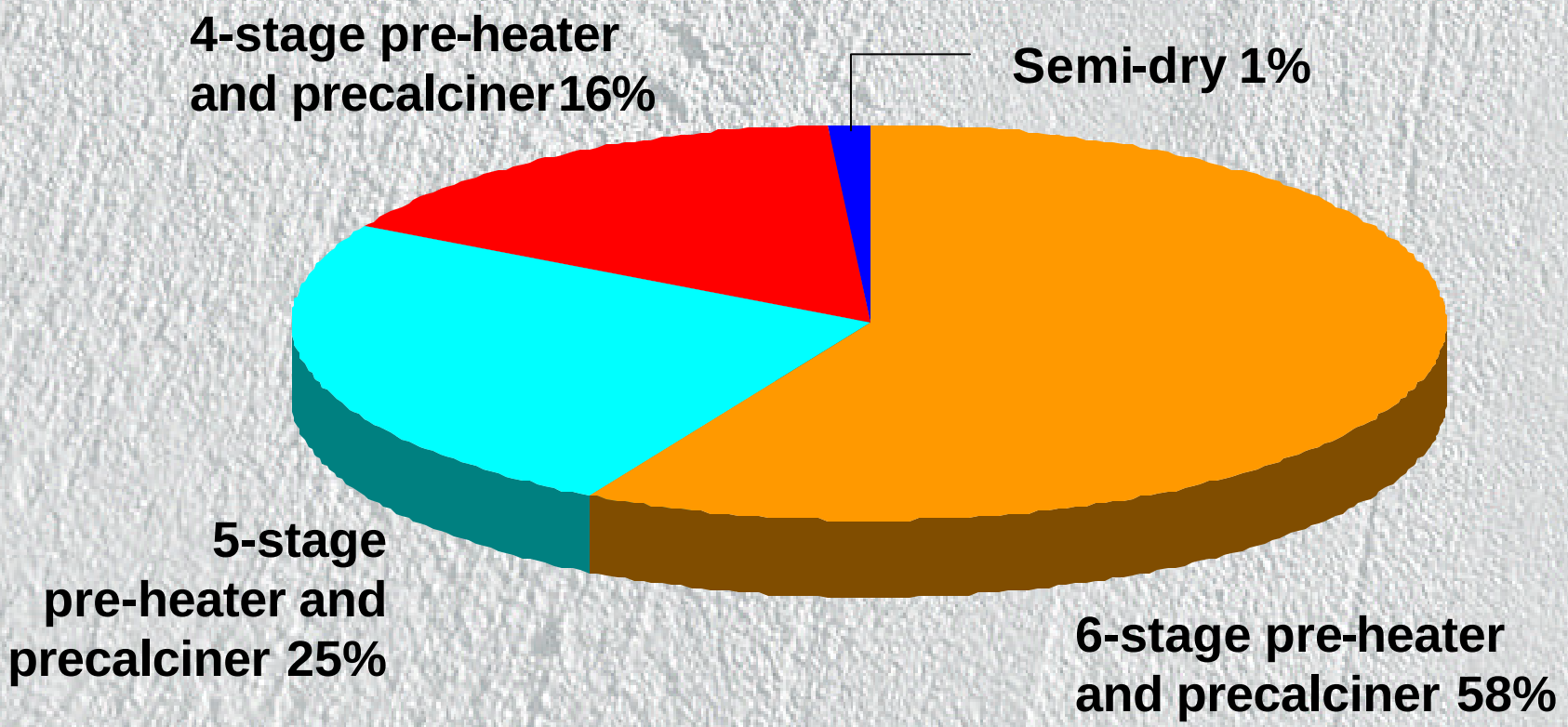
Kiln technology

- **Technology in India's cement industry is one of the best in the world**



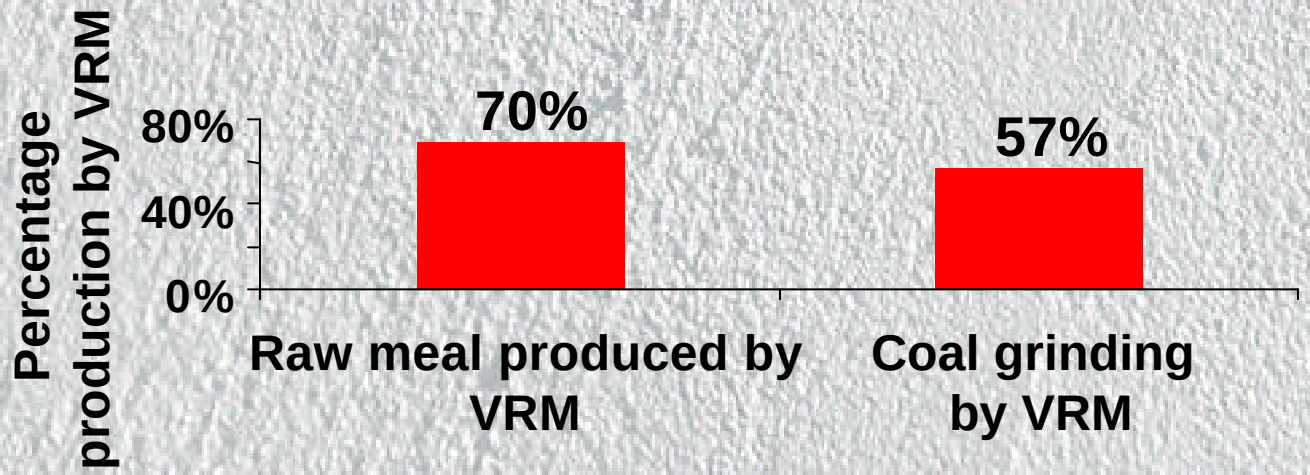
Kiln technology

In the plants rated by GRP, almost 60% of clinker production is by the 6-stage pre-heater with precalciner



Raw mill and Coal mill

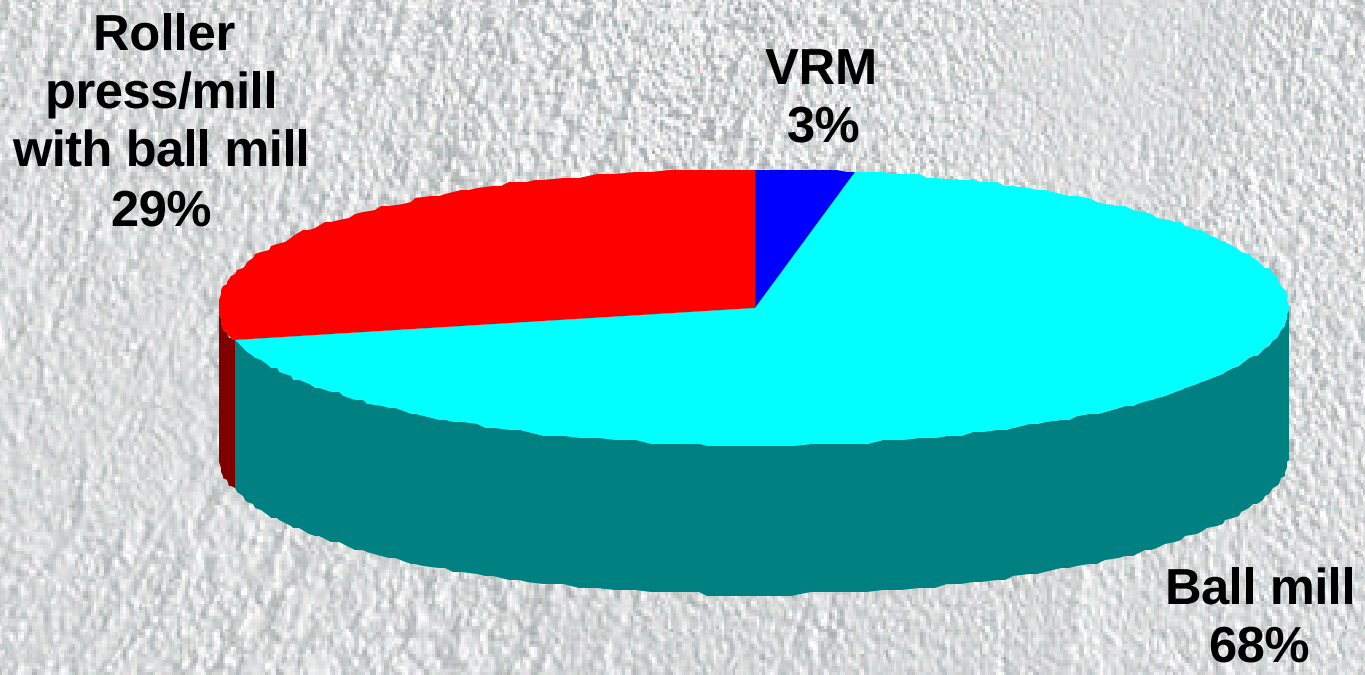
- In Raw mill and Coal mill, the vertical roller mills (VRM) dominate…….
- VRMs are more energy efficient compared to ball mills and use 16.5 kWh/tonne raw meal compared to 22.5 kWh/tonne raw meal used by ball mills
- A Coal mill section with a VRM consumes around 18-20 kWh/tonne coal as compared to 27-29 kWh/tonne in ball mill.



Cement mill

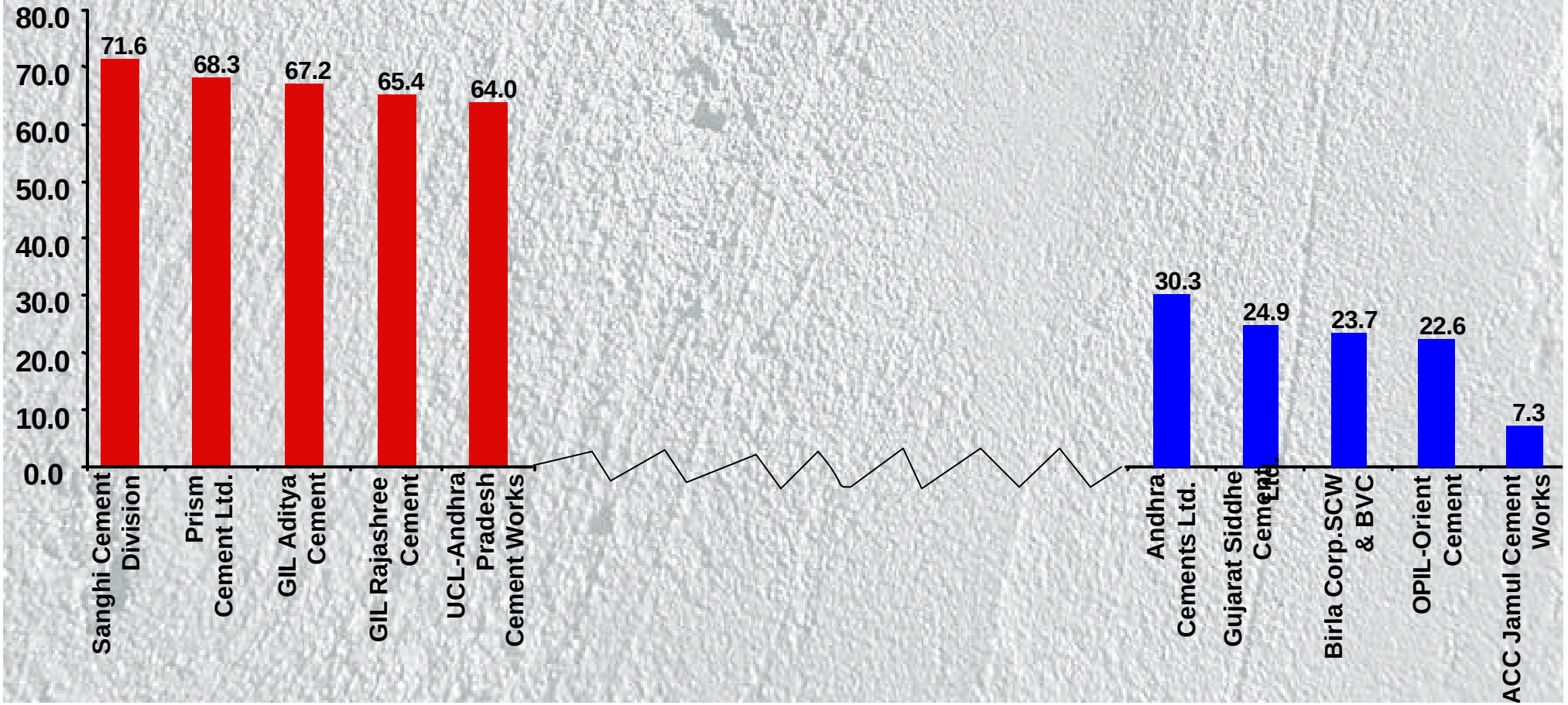
The only section where the sector lags behind in technology…..

- **Cement grinding mill is still dominated by ball mill**
- **Roller press/roller mill in association with ball mill is considere as the most energy efficient — about 29 per cent cement production is from this technology.**



Rating - Technology

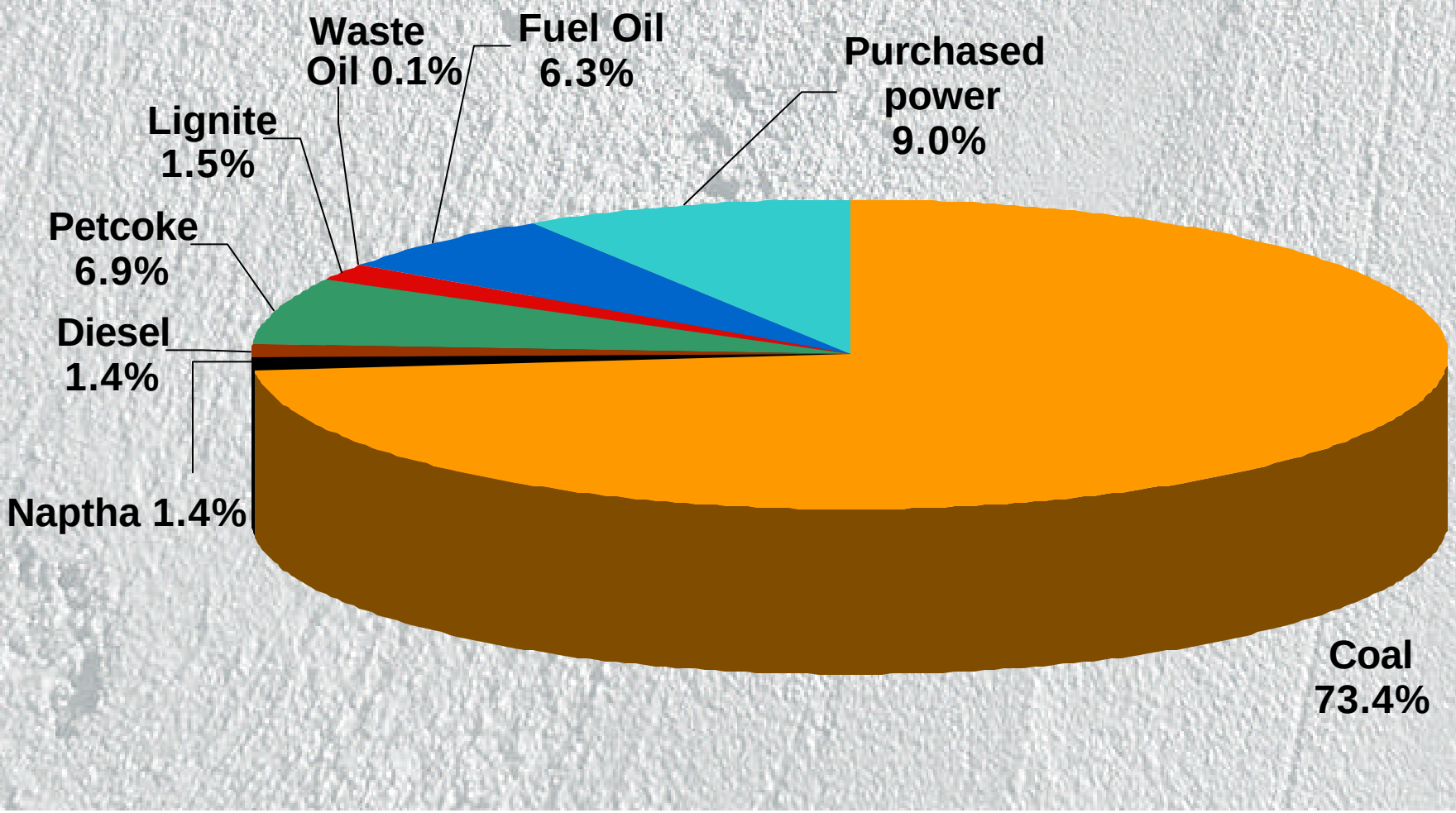
Sector average – 48.7%



Benchmarking energy use

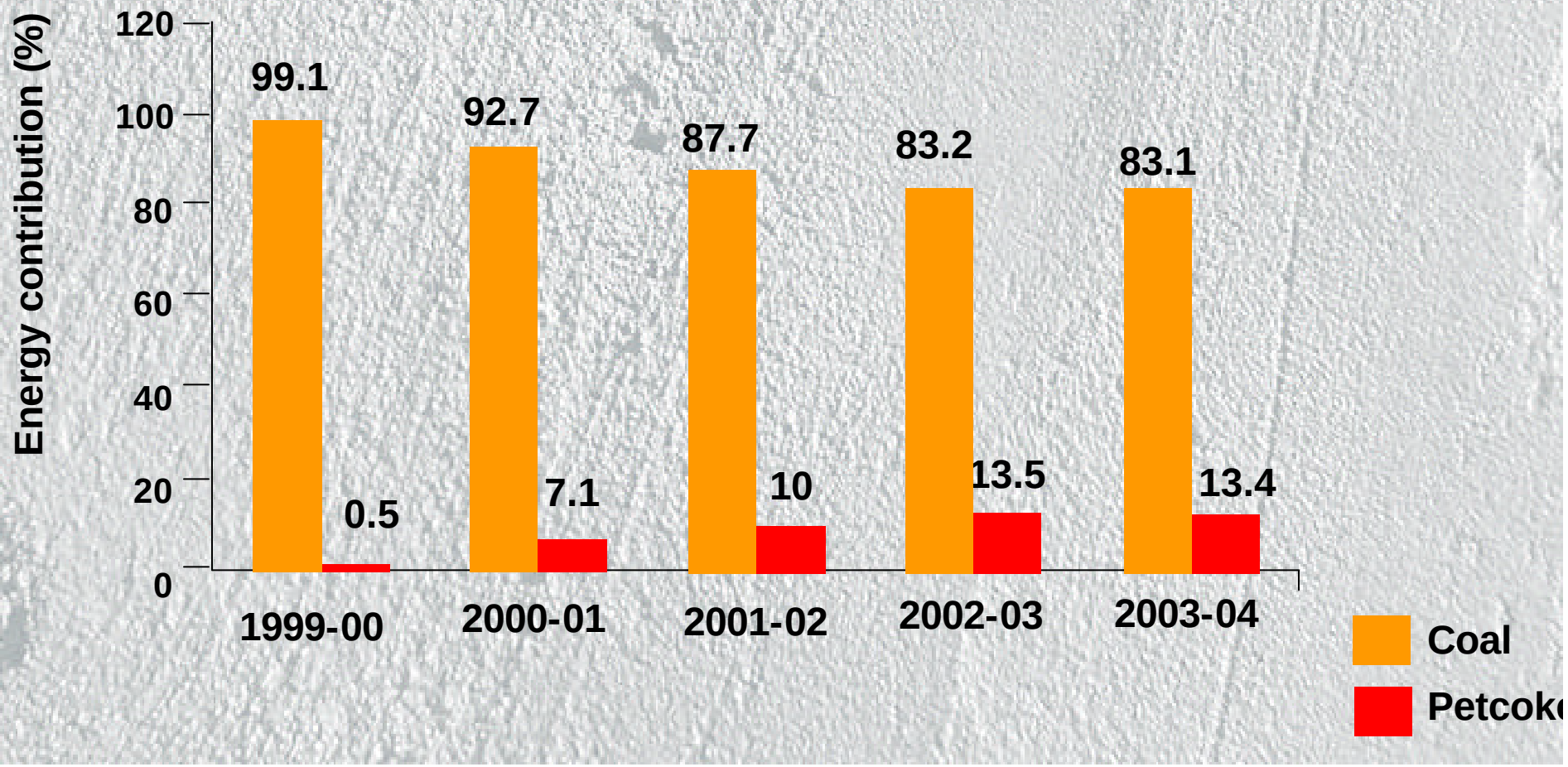
Primary energy composition

More than 73% of the energy needs are met by coal



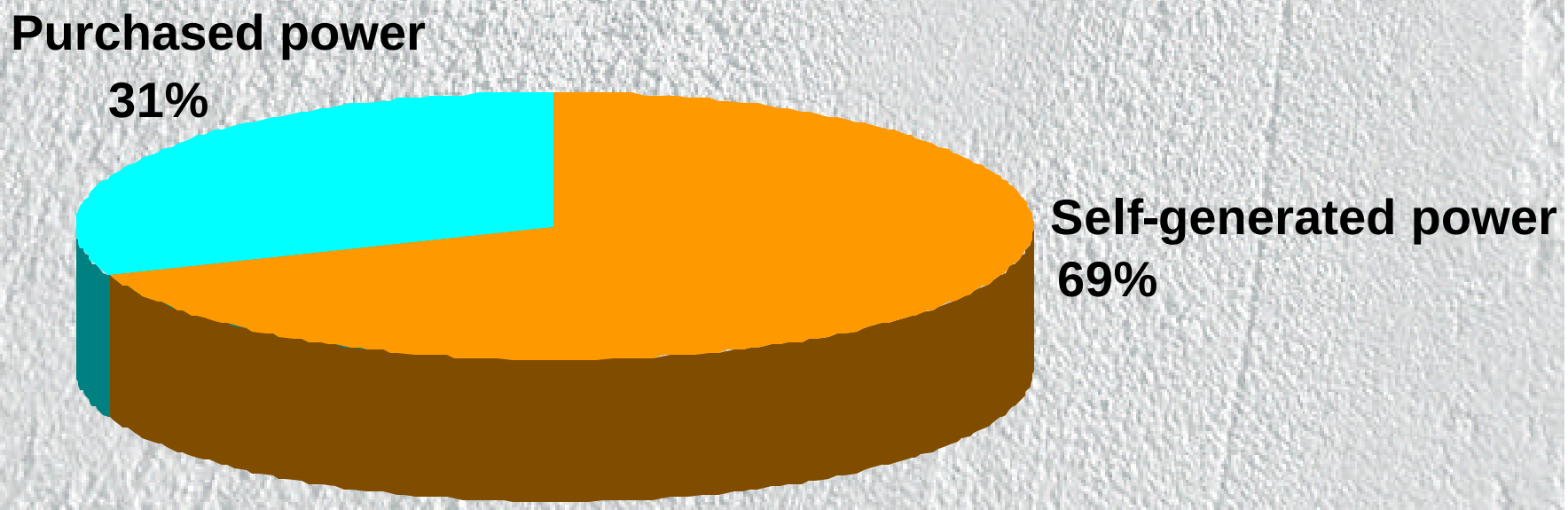
Kiln fuel

…. but use of petcoke (by-product of petroleum refinery) s increasing



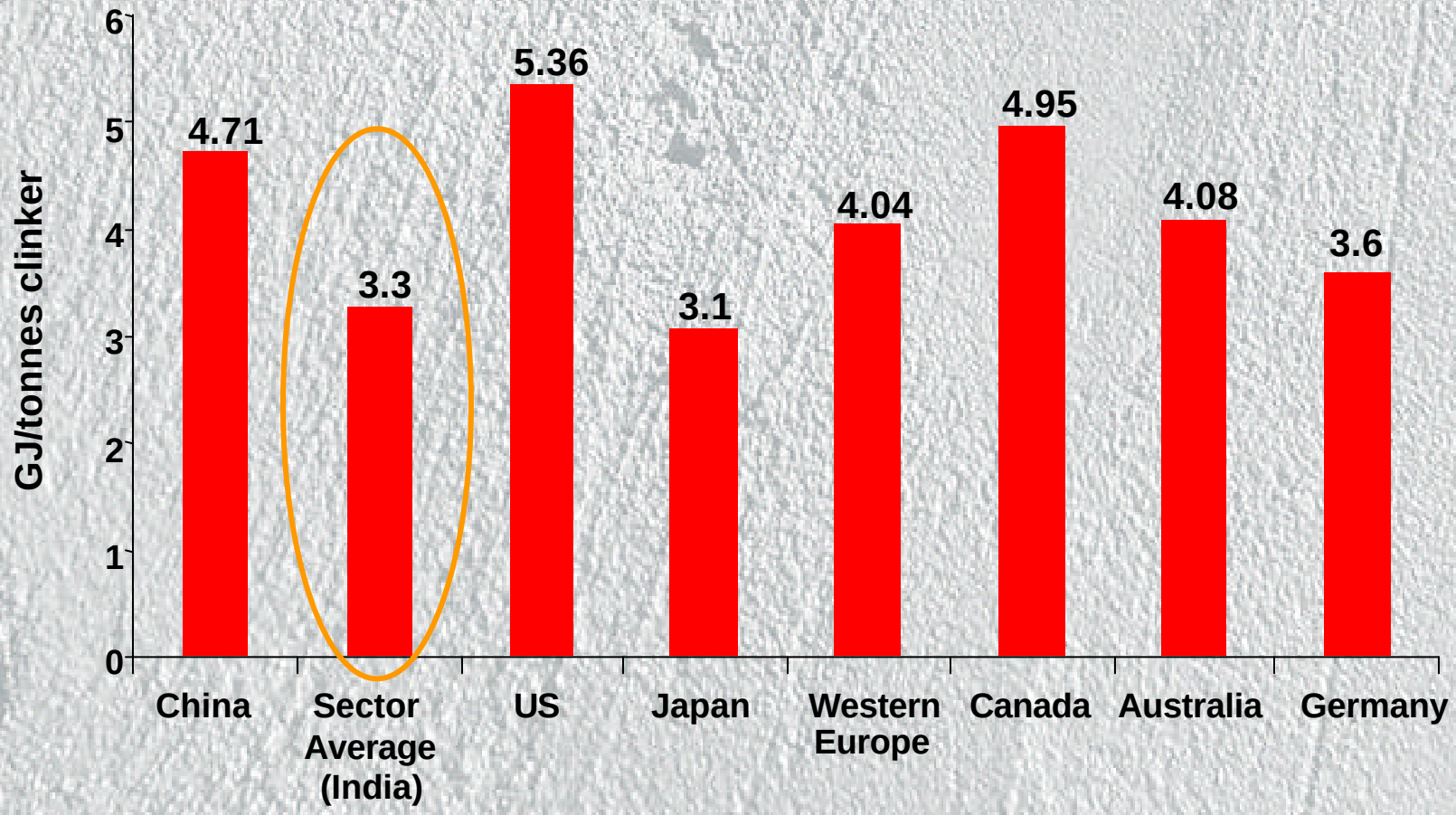
Power

69% of the total power requirement is met from captive plants (DG sets+captive power plants). Many cement plants are in process of installing captive plants



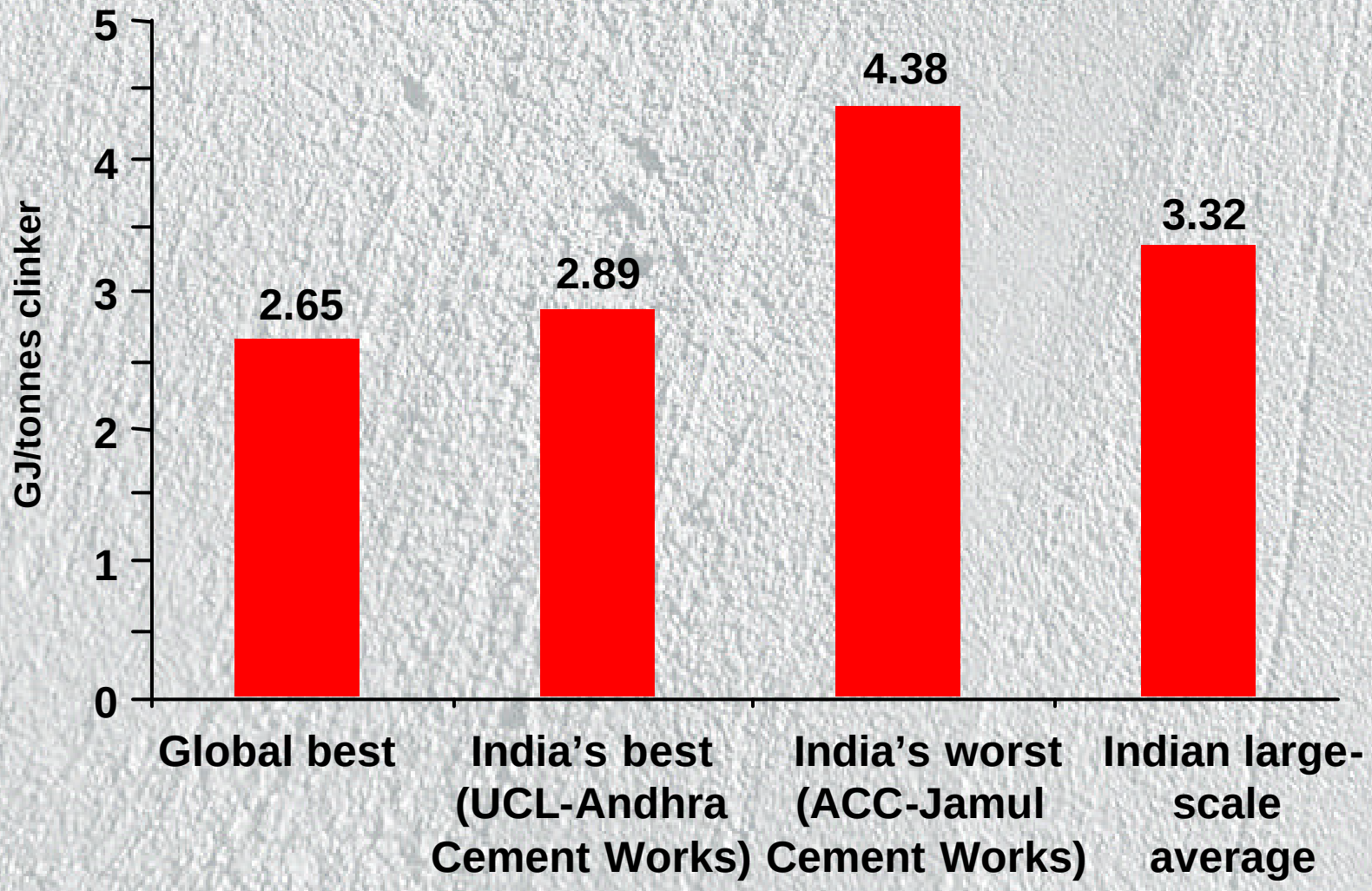
Thermal energy in kiln

ndian large-scale sector more energy efficient compared to China, JS and Canada



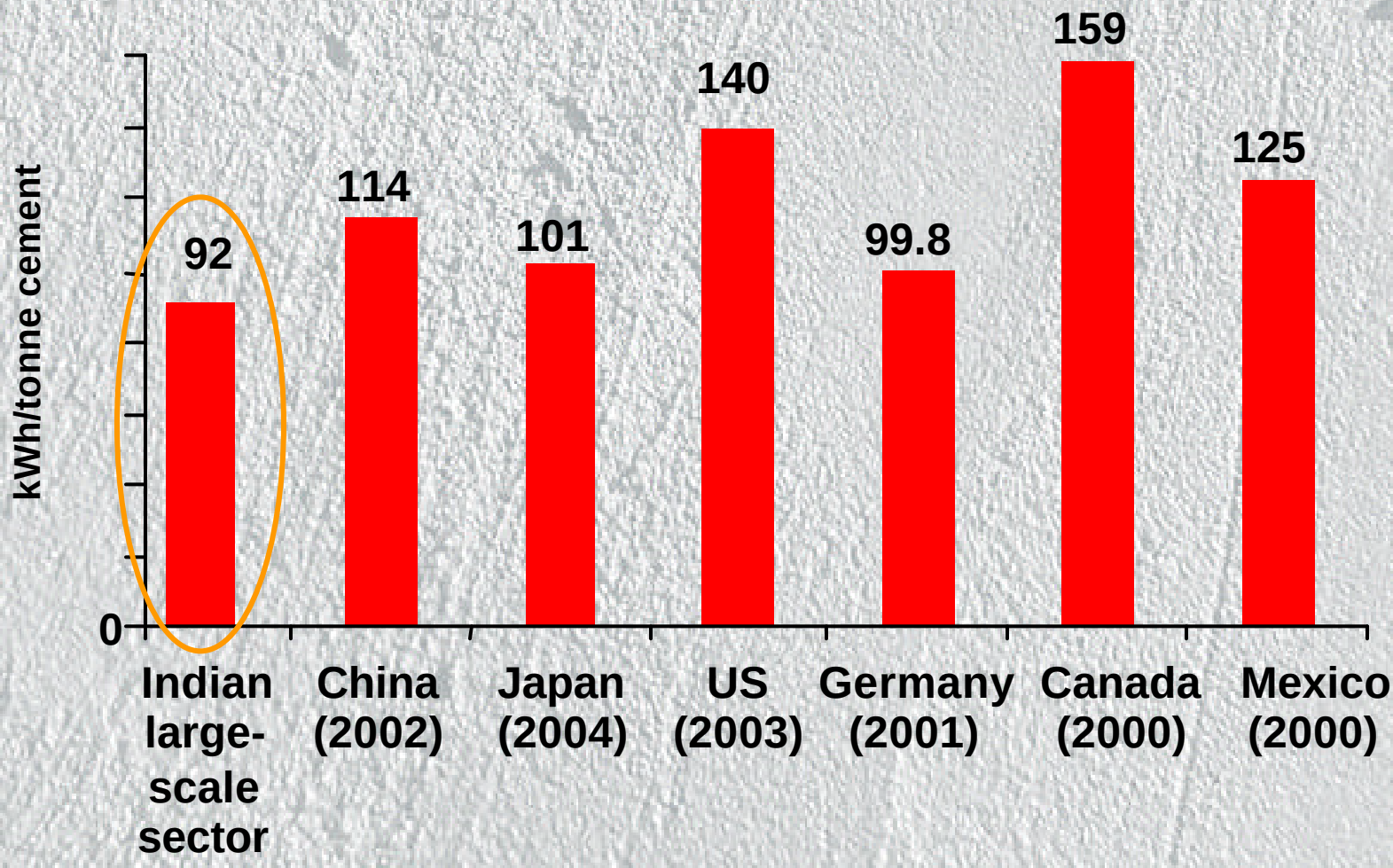
Benchmarking

ndian average still 25% higher than the global best practice



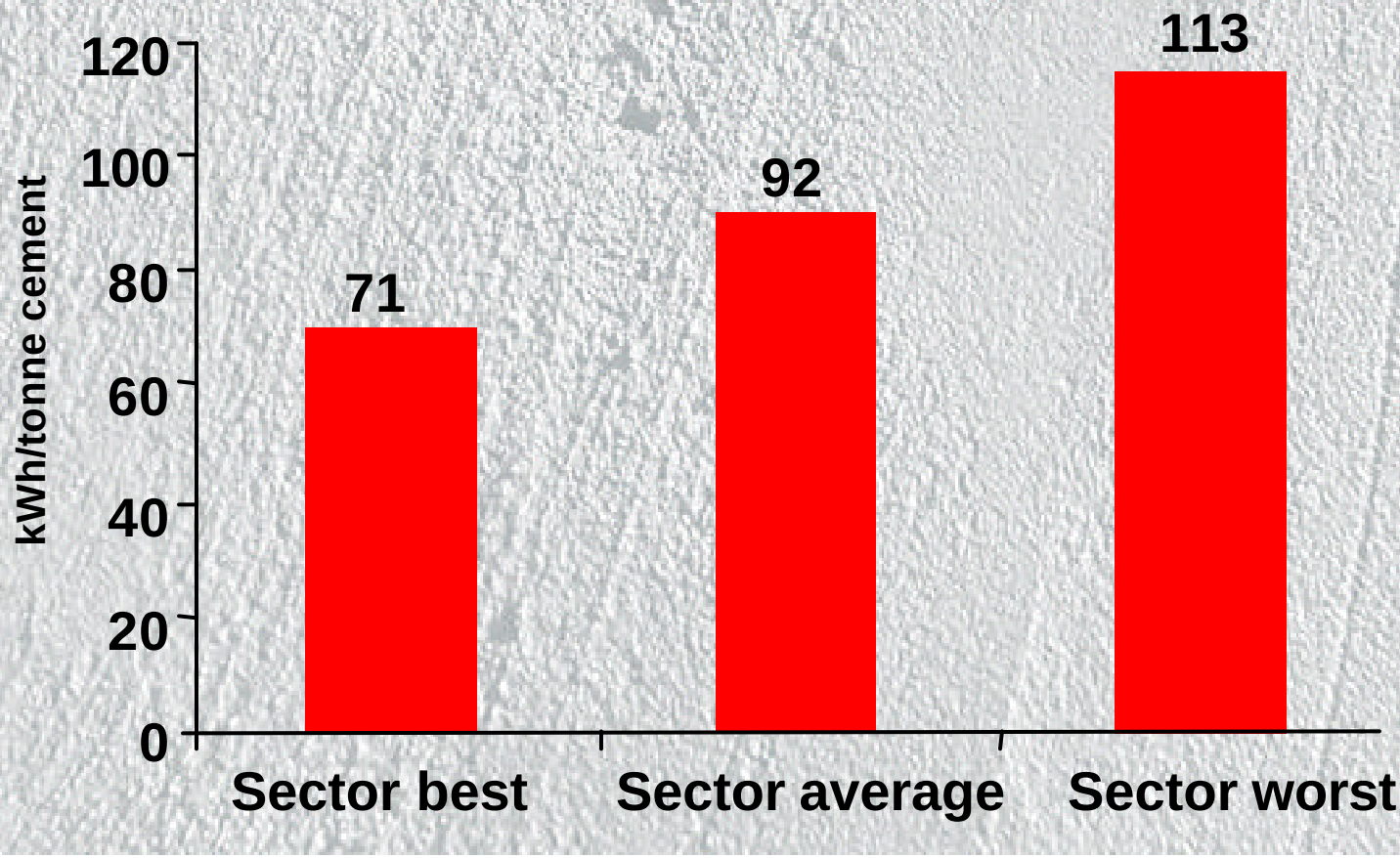
Power consumption

Specific power consumption in large-scale Indian plants is one of the lowest in the world – 92 kWh/tonne cement



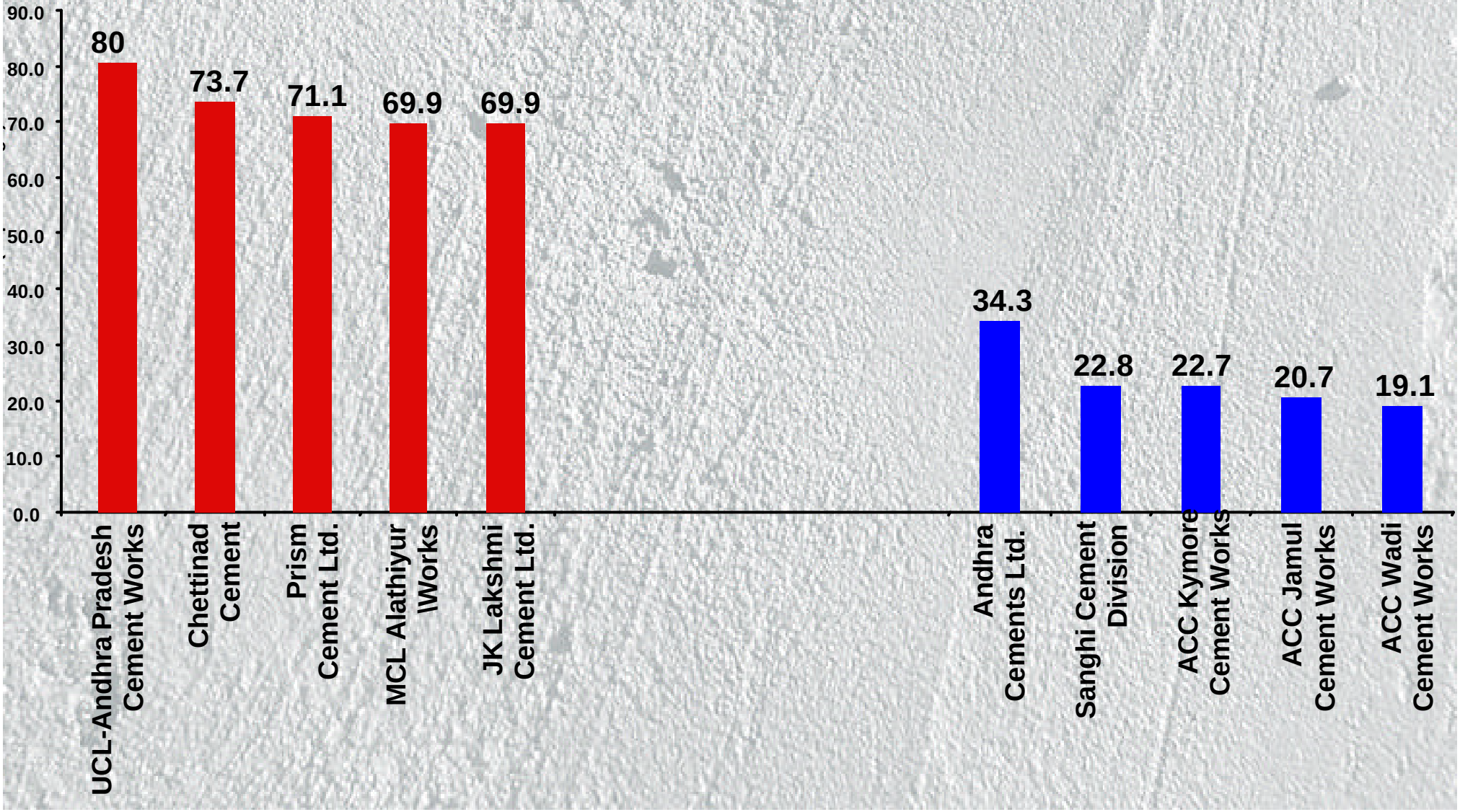
Benchmarking

- There is big difference in the power consumption of the best and worst cement plant



Rating - energy

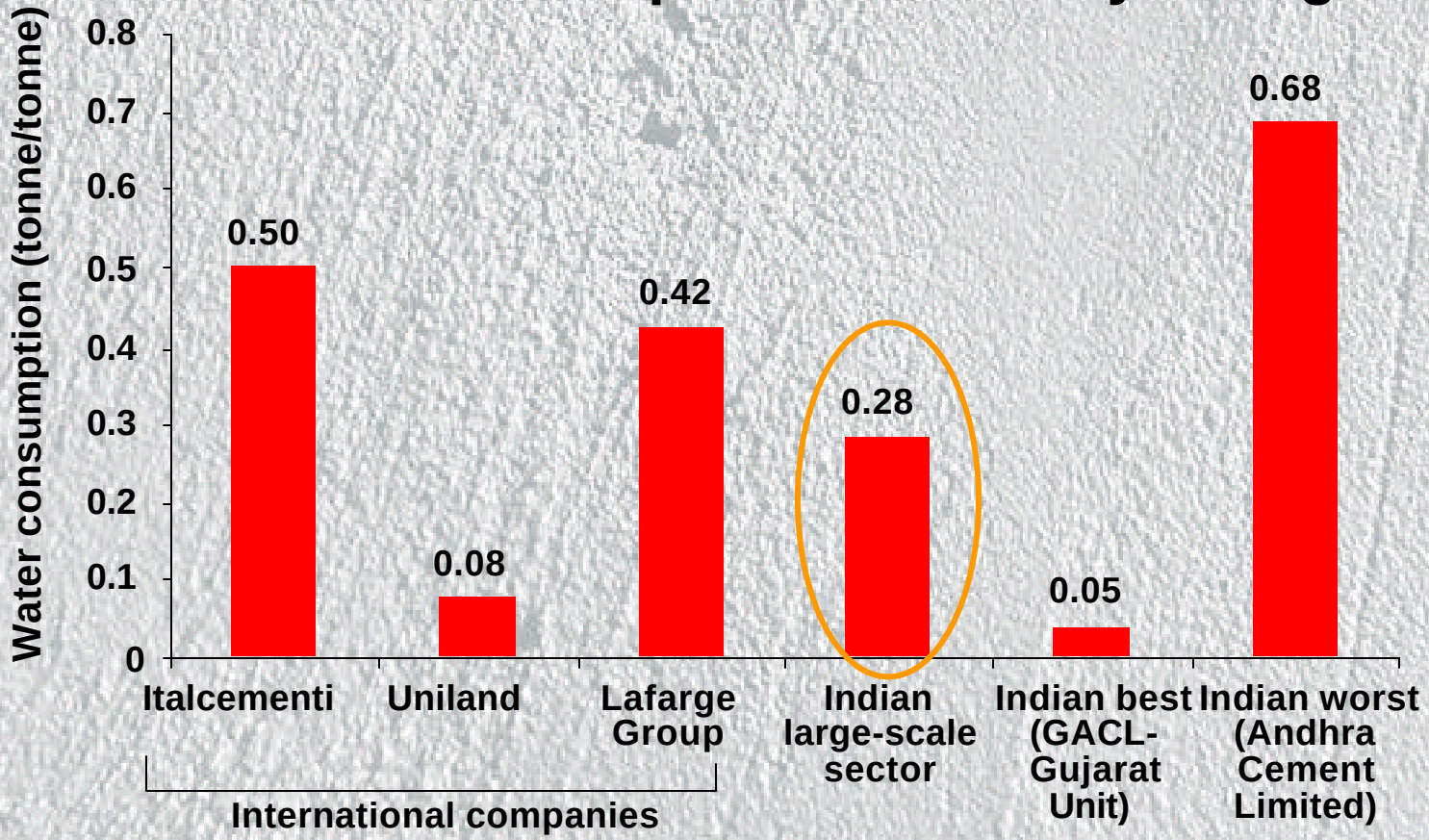
Sector average – 54.6%



Benchmarking Water Use

How much is consumed?

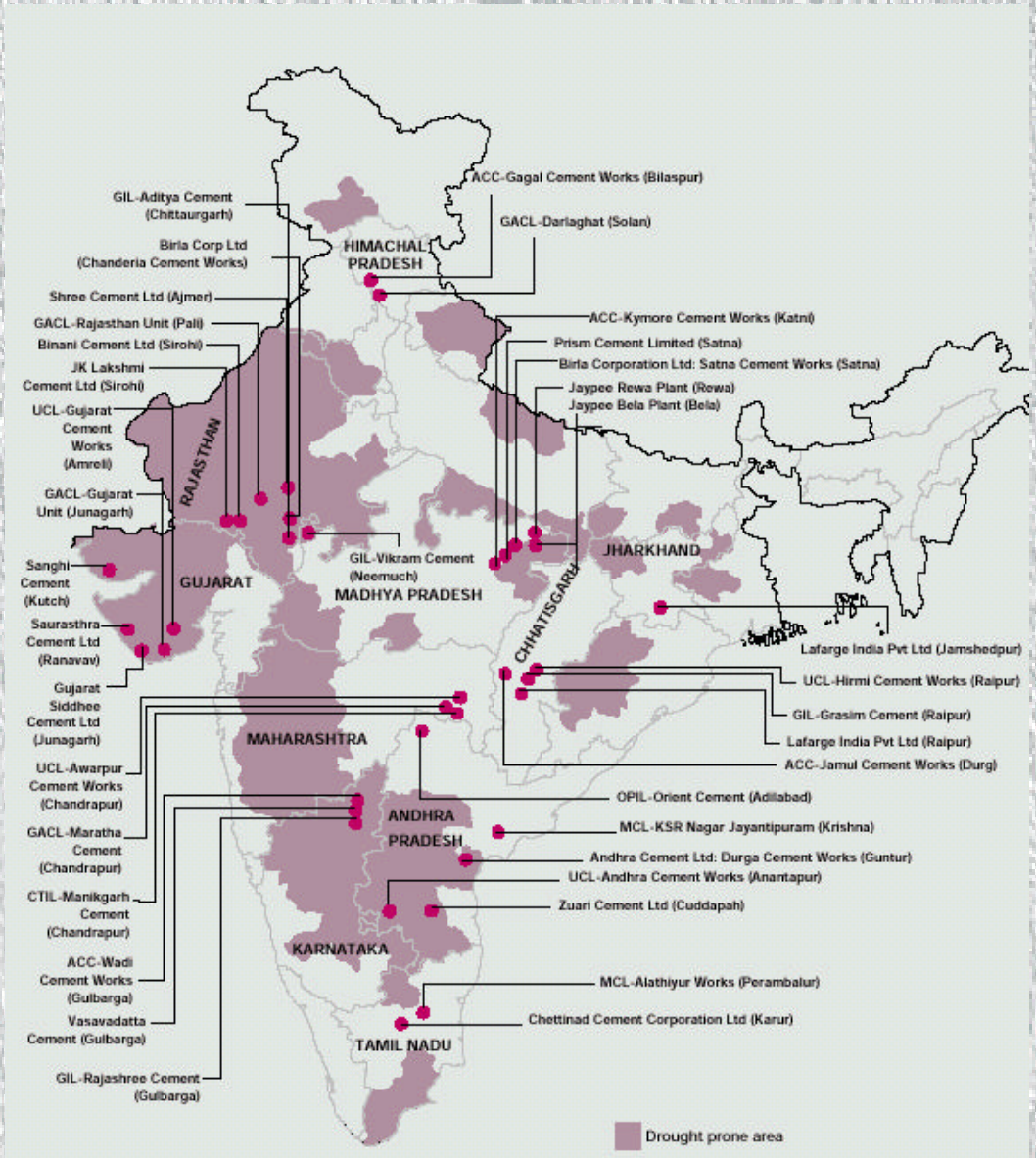
- Overall, the plants rated by GRP consume around 0.5 tonne water per tonne of cement.
- The process water consumption, however, is 0.3 tonne per tonne cement – which compares favourably with global practice



How much is consumed?

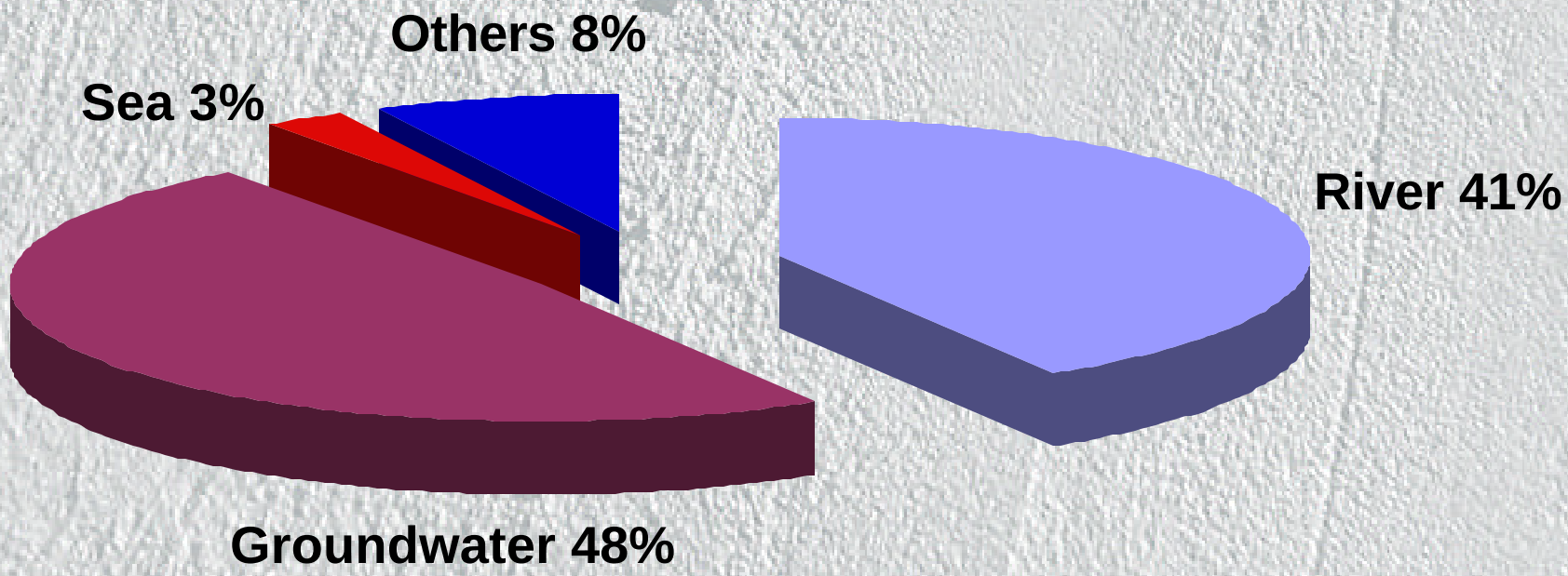
- Though specific water consumption seems quite low – the total water consumption is quite high – due to the quantum of product
- In 1999-00, 34 MT of water was consumed by the plants rated by GRP.
- This increased to 39 MT in 2003-04.
- This is a very high amount considering:
  1) Where the plants are located?
  2) How they source this water?

Located in water stressed areas



Sourcing from groundwater

- Groundwater including impounded water is a major source for the sector
- Plants located in water stressed areas mostly use groundwater

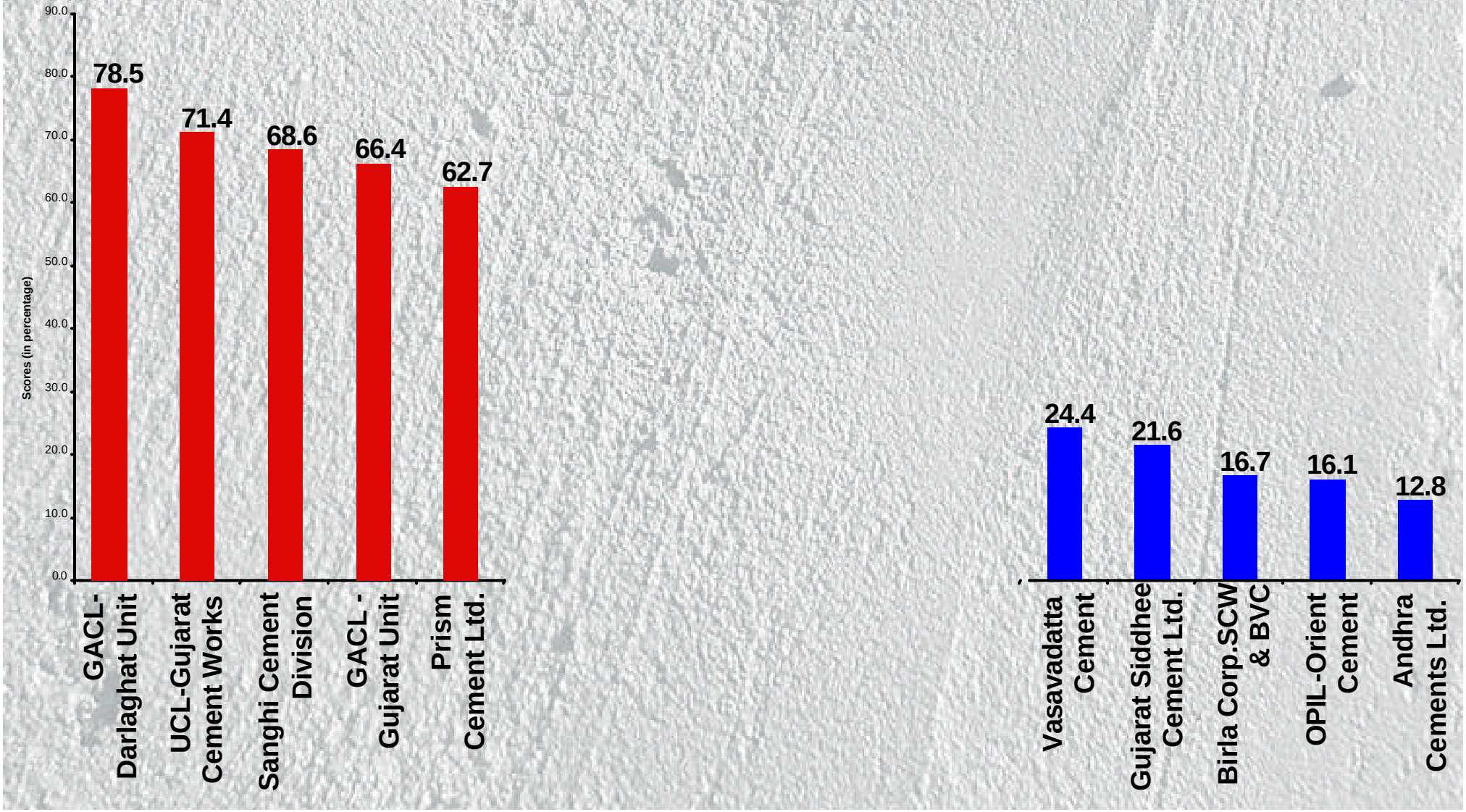


But solutions exist

- Even if only one-fourth the area available in the plant and mines is used for rainwater harvesting, all plants can meet their annual water requirement, with some to spare for the community
- But most plants have not undertaken proper rainwater harvesting
- Exhausted pits - only ‘rainwater harvesting’
- But there are some good practices as well
- Two plants located in the water-scarce coastal belt use sea water; two plants recycle sewage for process use

Rating - water

Sector average – 40.0%



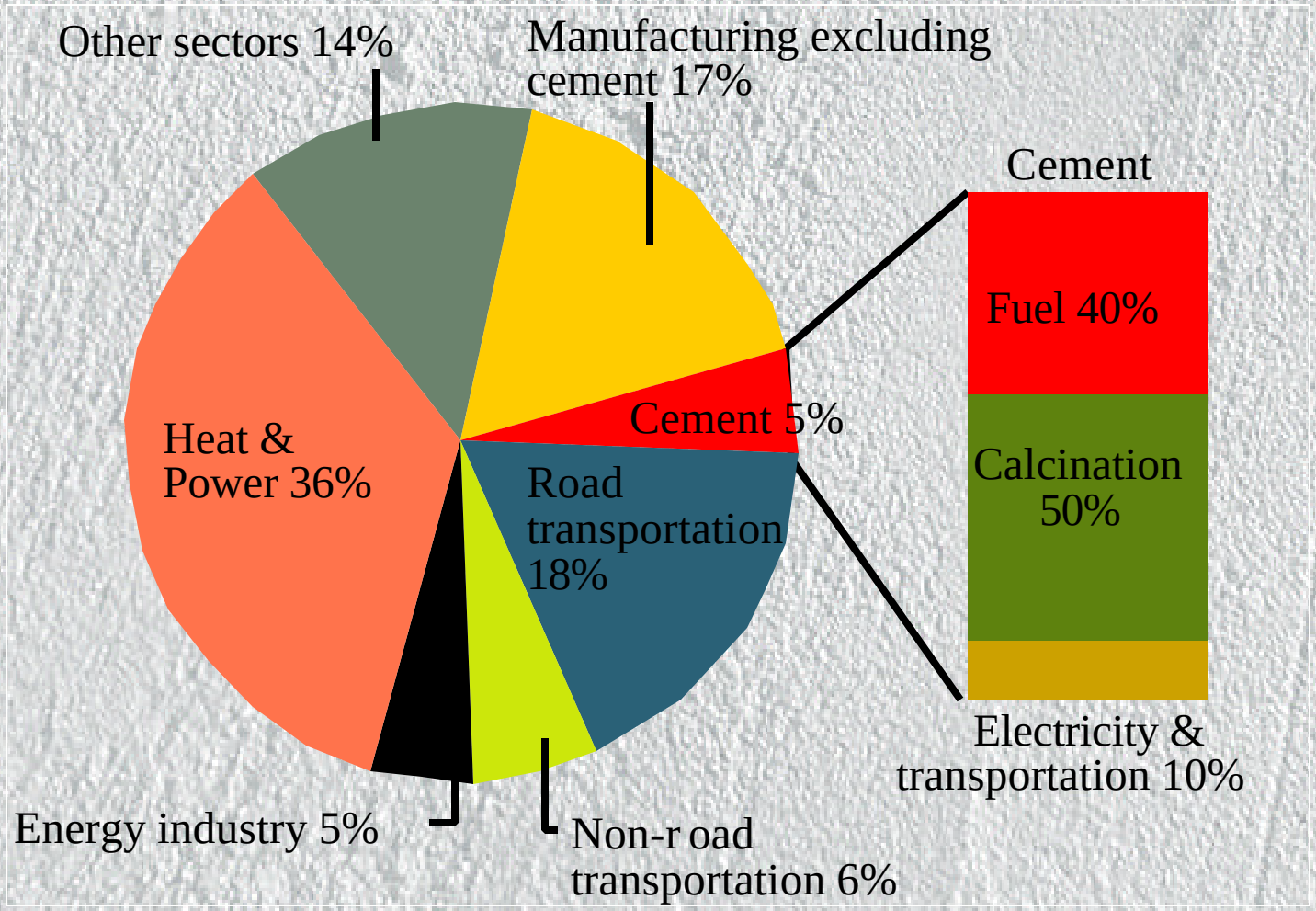
Stack emission and emission contro

Emissions vis-à-vis regulations

Emissions	Concentration (mg/Nm^3)	Load (kg/tonne clinker)	Regulations in India
NO_x (as NO_2)	< 200-3000	<0.4-6	Not Regulated
SO_2	<10-3500	<0.02-7	Not Regulated
Dust (Particulates)	5-200	0.01-0.4	Standard: 100-150 mg/Nm^3
CO	500-2000	1-4	Not Regulated
CO_2	400-520 g/Nm^3	800-1040	Not Regulated
TOC	5-500	0.01-1	Not Regulated
HCl	<1-25	<2-50 g/t	Not Regulated
PCDD/F	<0.1-0.5 ng/Nm^3	<200-1000 ng/t	Not Regulated
HEAVY METALS			
Sum total of Hg, Cd, Tl	< 0.0001-0.1 (mainly Hg)	20-600 mg/t	Not Regulated
Sum total of As, Co, Ni, Se, Te	<0.001-0.1	2-200 mg/t	Not Regulated

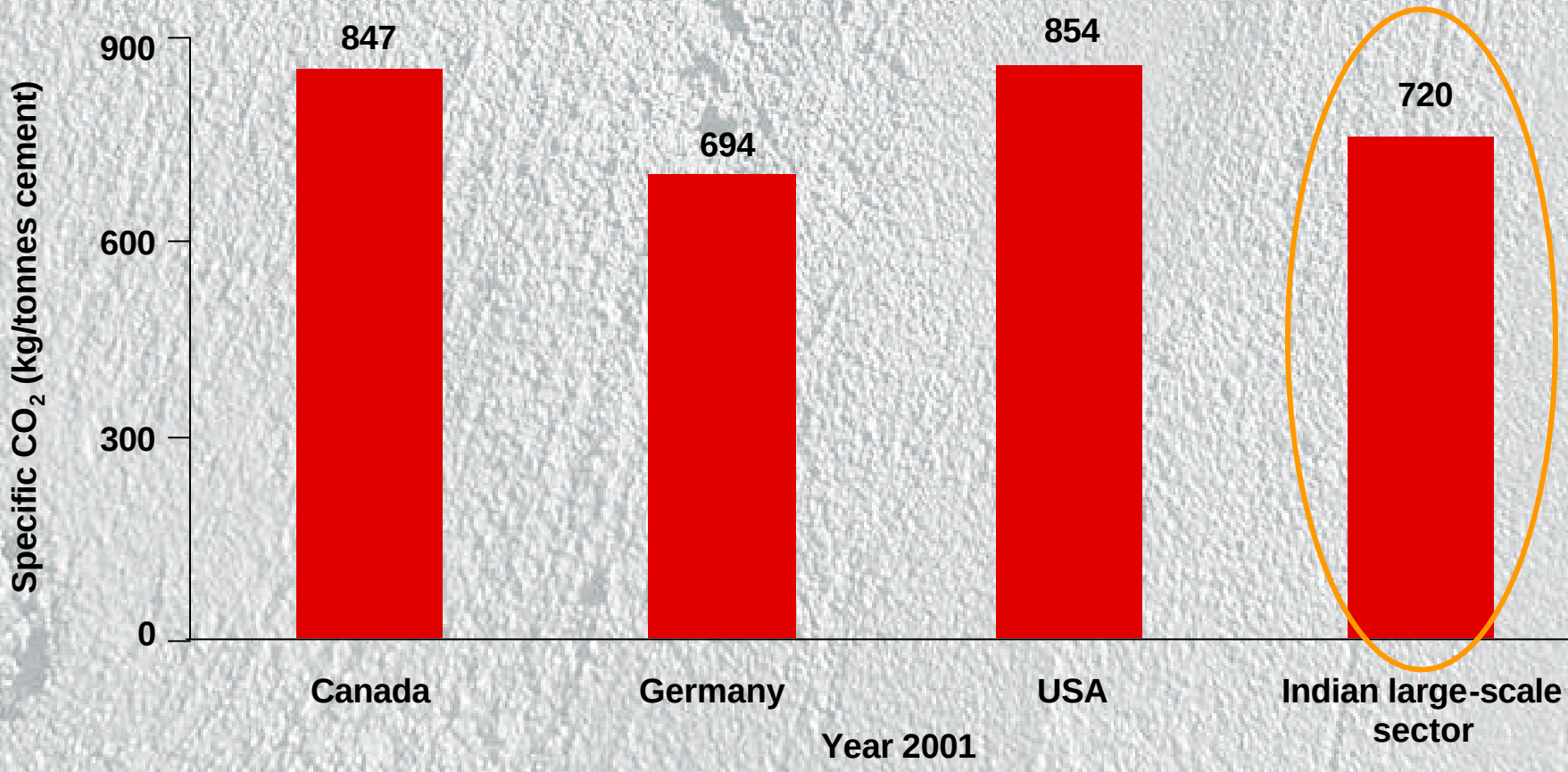
CO_2 emissions

Cement industry accounts for about 5% of global anthropogenic CO_2 emissions



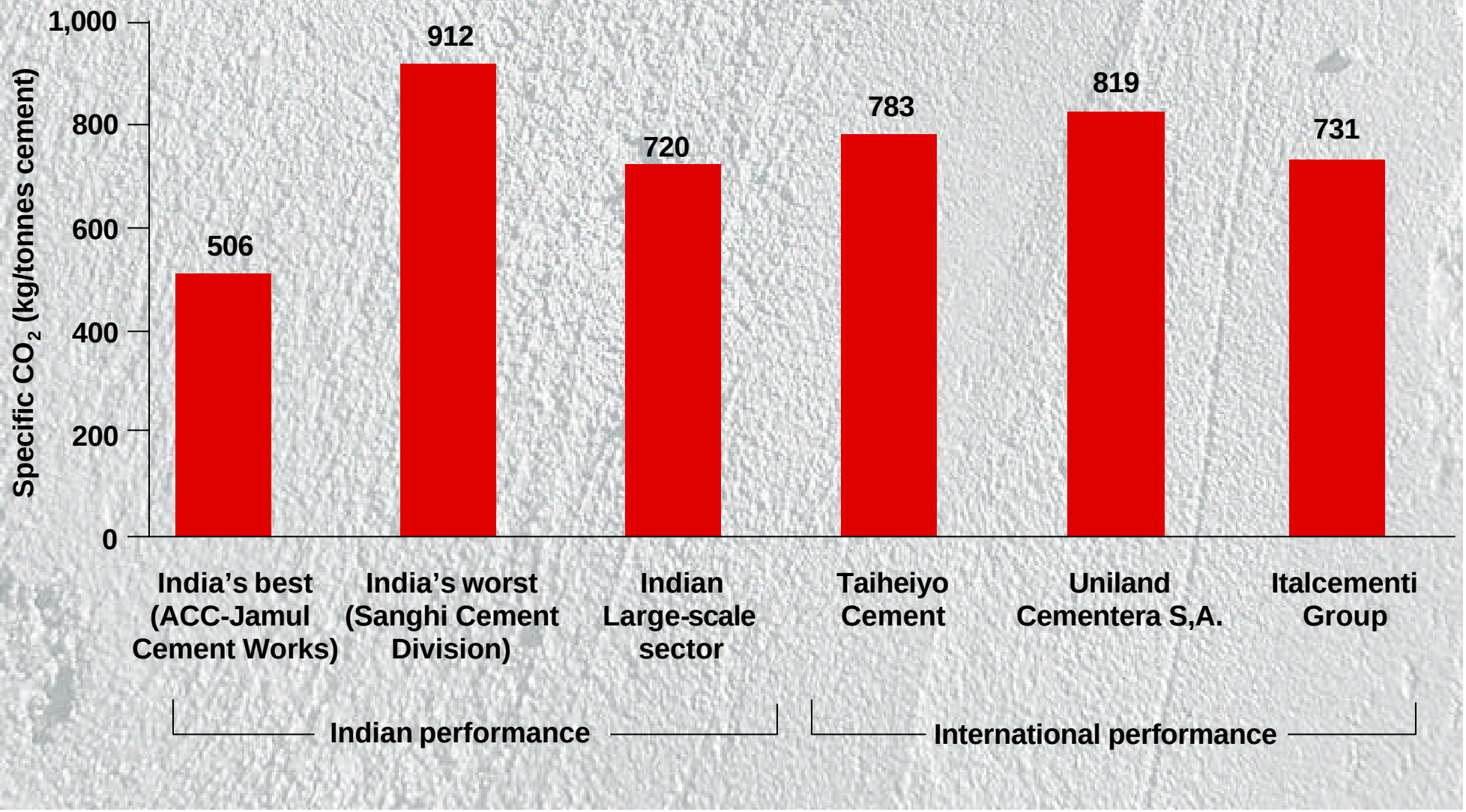
Benchmarking CO_2 emissions

With 720 kg CO_2 emissions per tonne cement, Indian cement industry is one of the lowest CO_2 emitters in the world
Primarily due to high production of blended cement and better energy efficiency



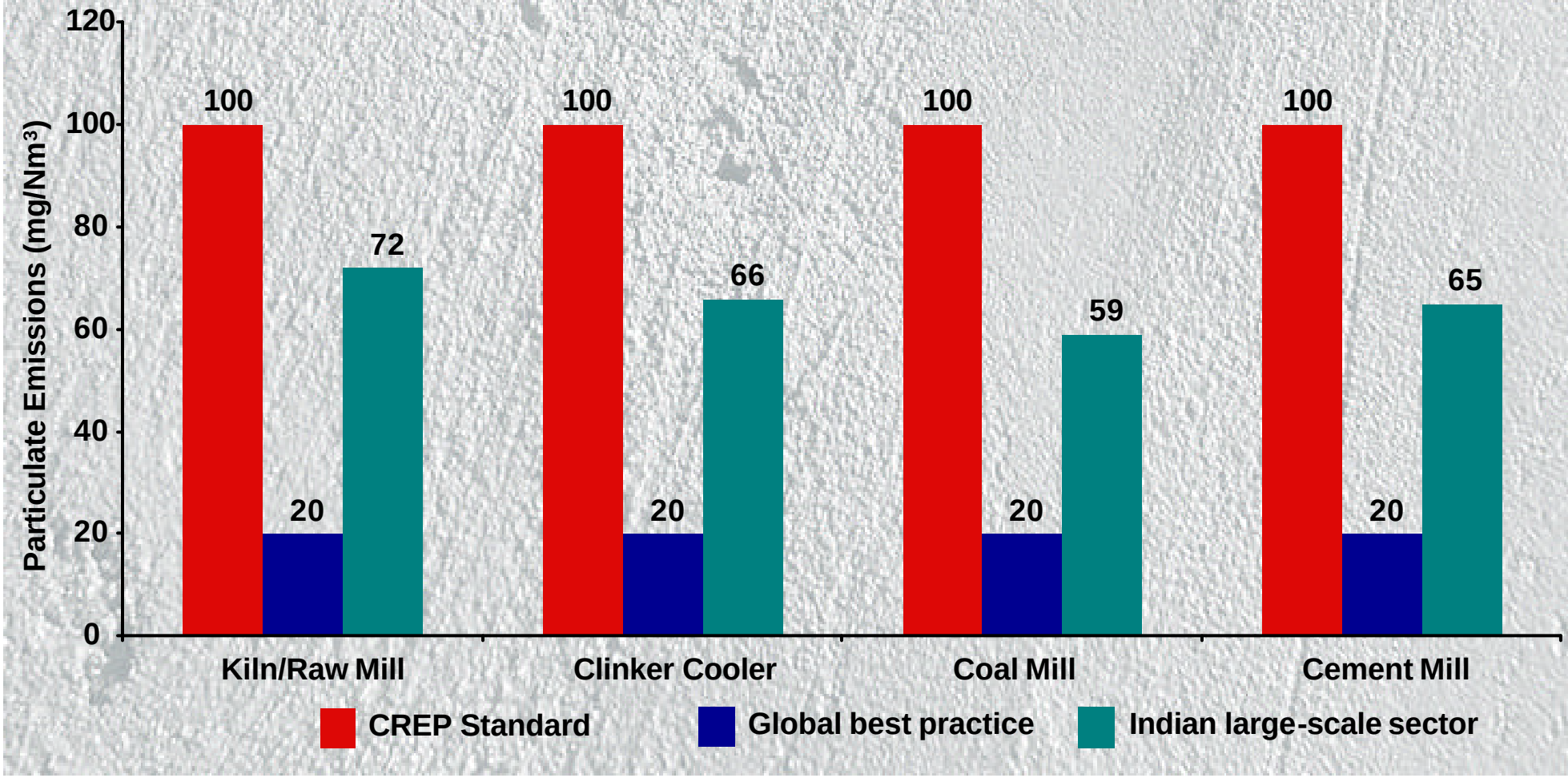
Benchmarking CO_2 emissions

There is a wide difference in CO_2 emissions between Indian plants



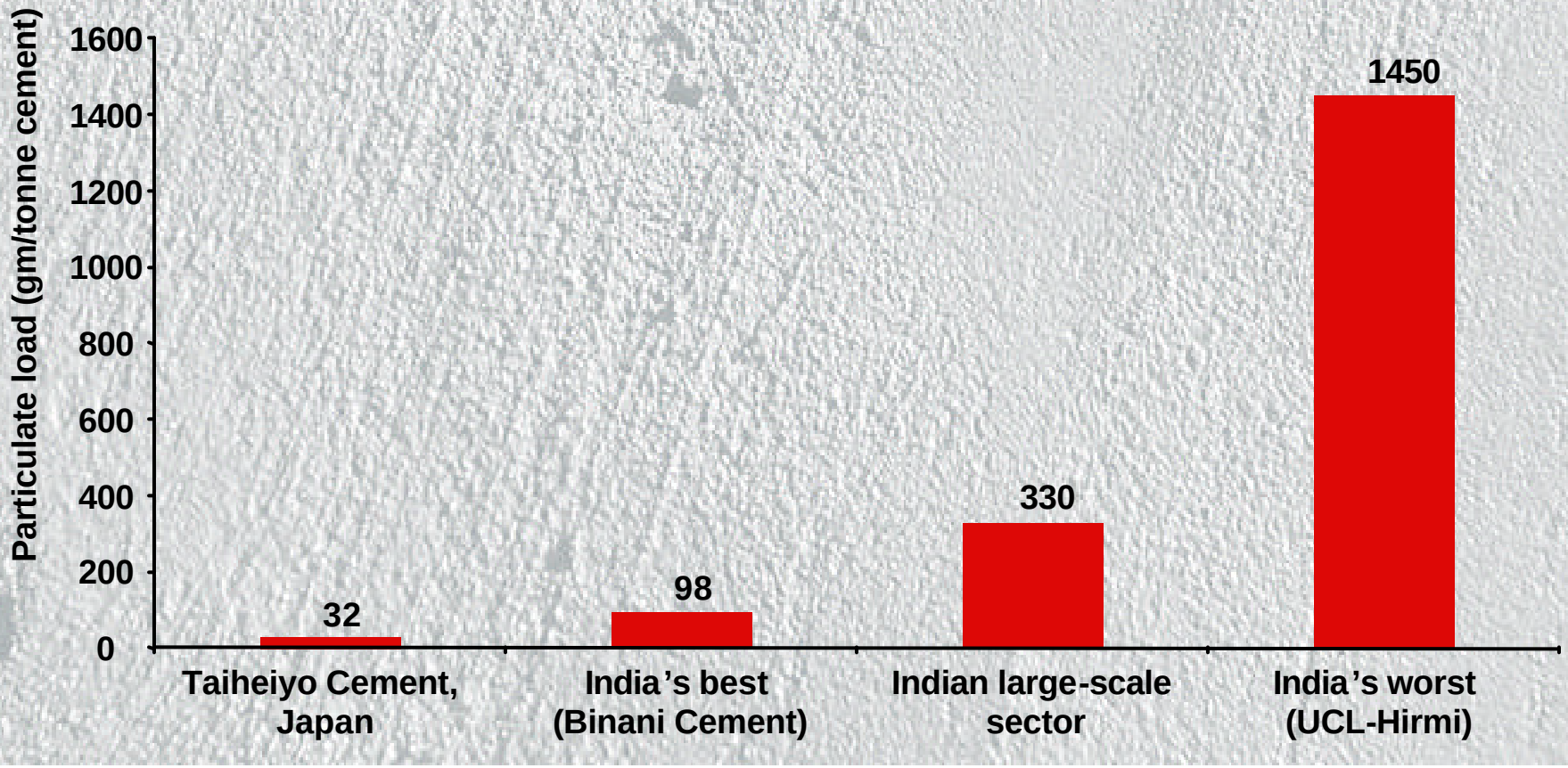
Particulate emissions

n terms of emissions levels, most large-scale plants emit far lower than he existing Indian standard, but far higher than the global best practice



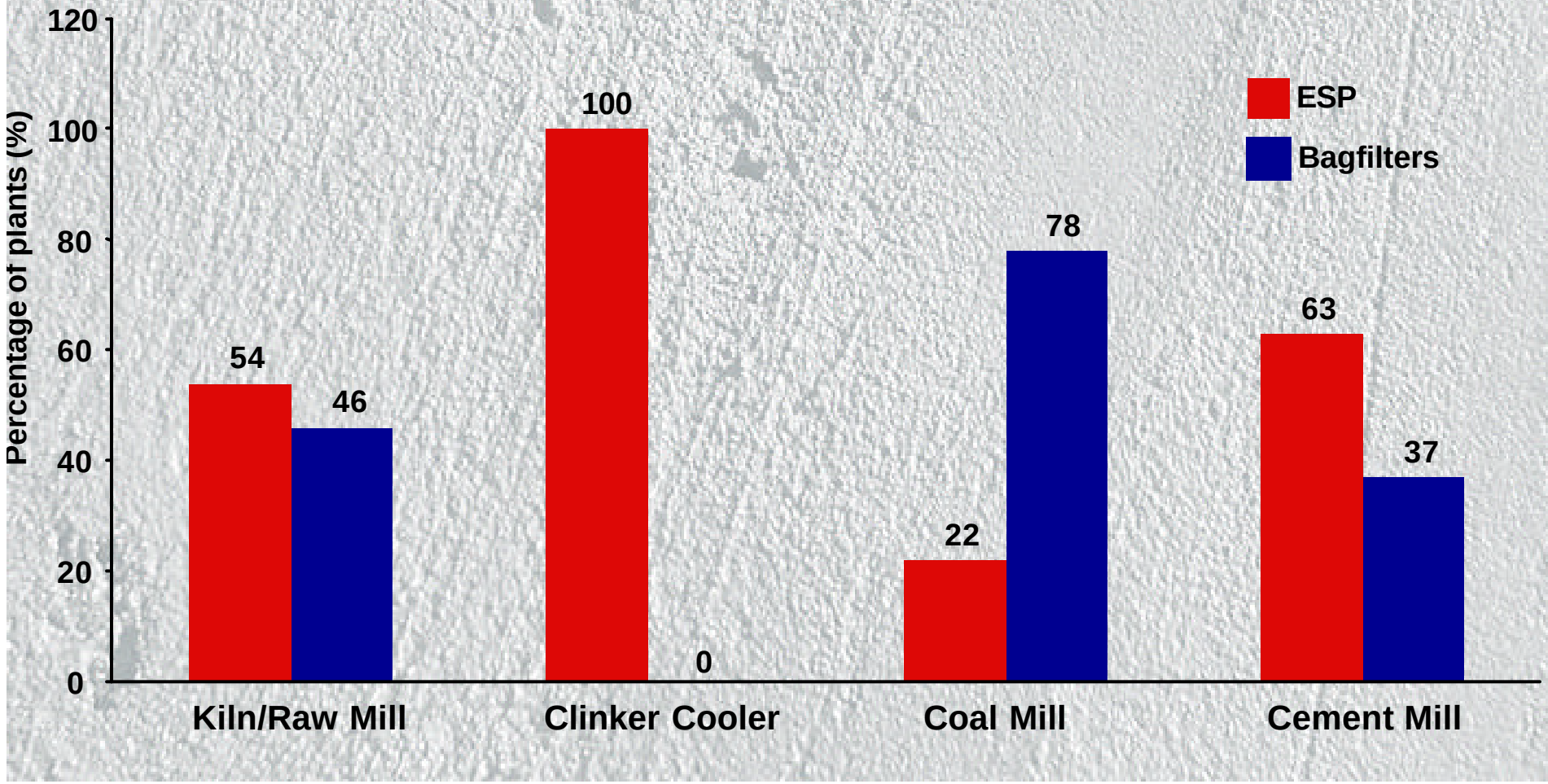
Benchmarking particulate load

- The emission of particulates (330 gm/tonne cement) is quite high in Indian plants compared to the global practices
- Even the best Indian plant emits 3 times more particulates than the best global plants



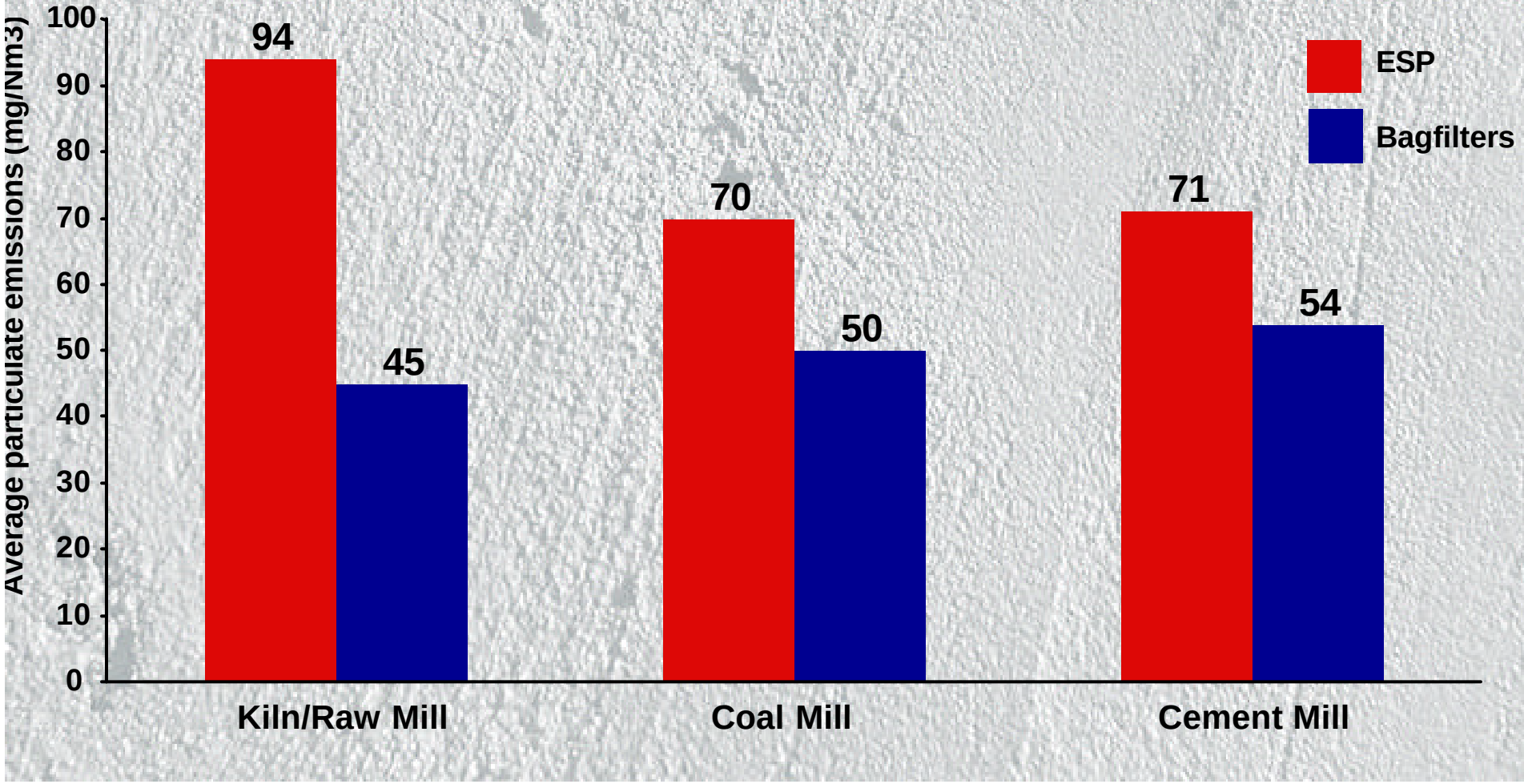
Emission control technology

- **High particulate emissions because majority of plants still using low-efficiency ESPs.**



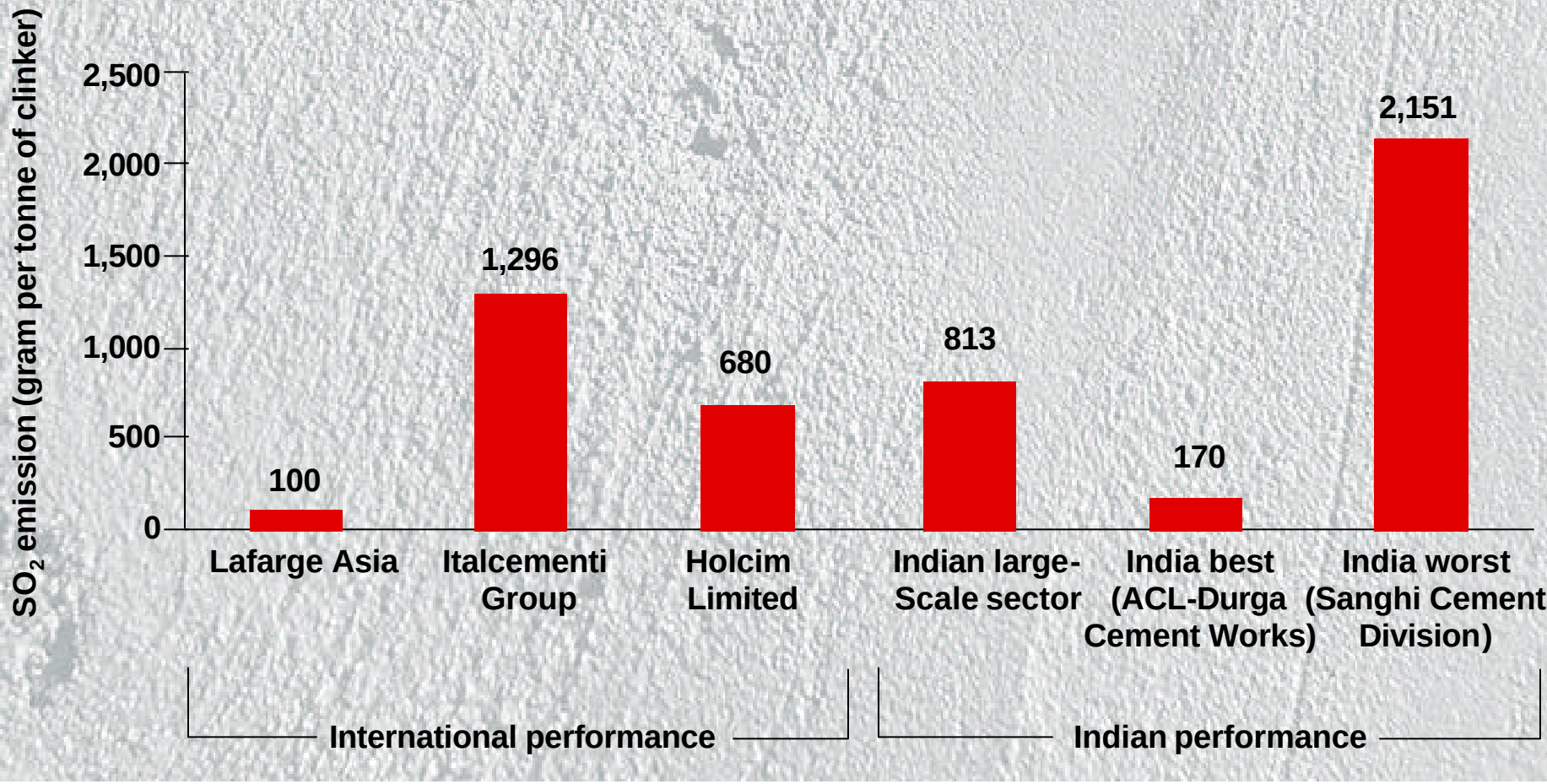
Technology benchmarking

- **In the plants rated by GRP, the emissions control performance of bagfilters are far more superior than ESPs**



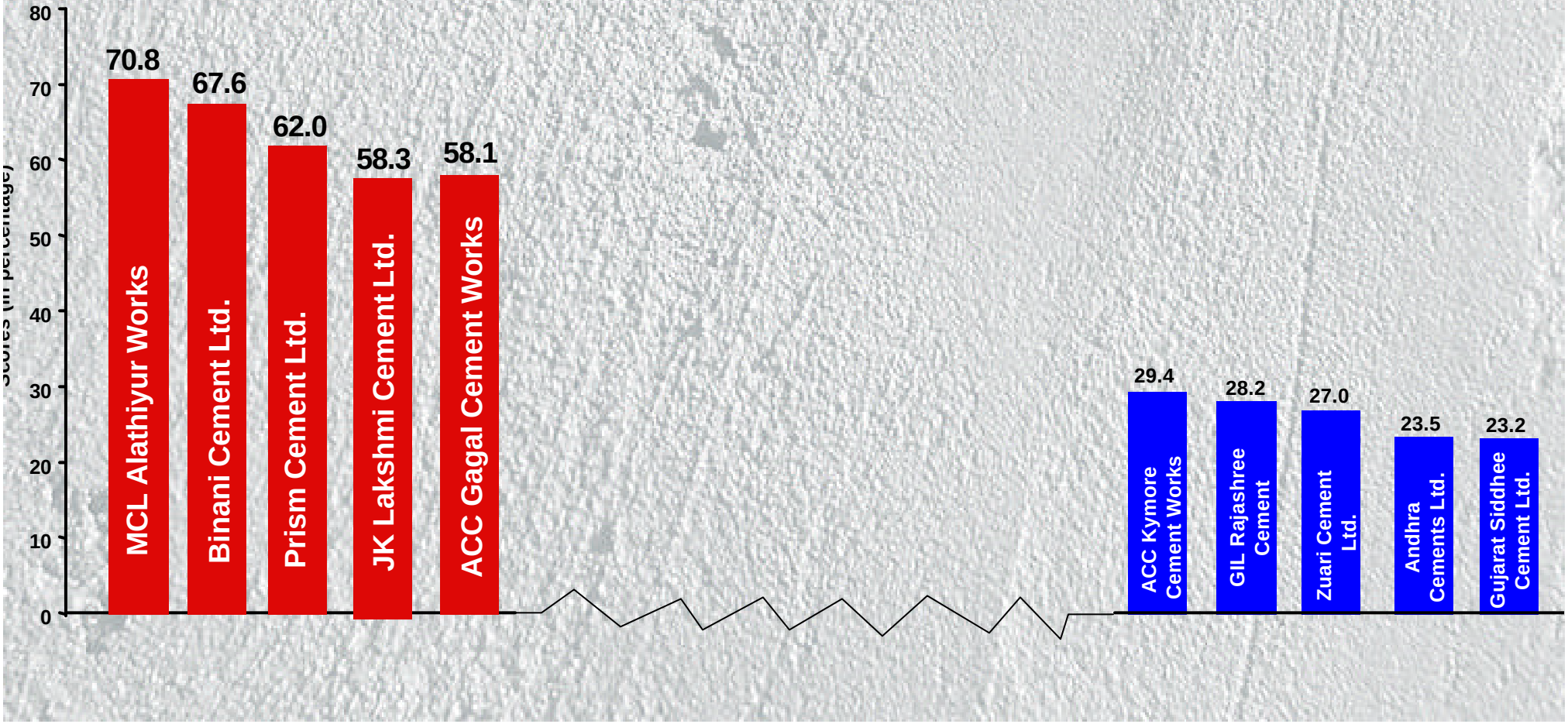
SO_2 emissions — on a higher side

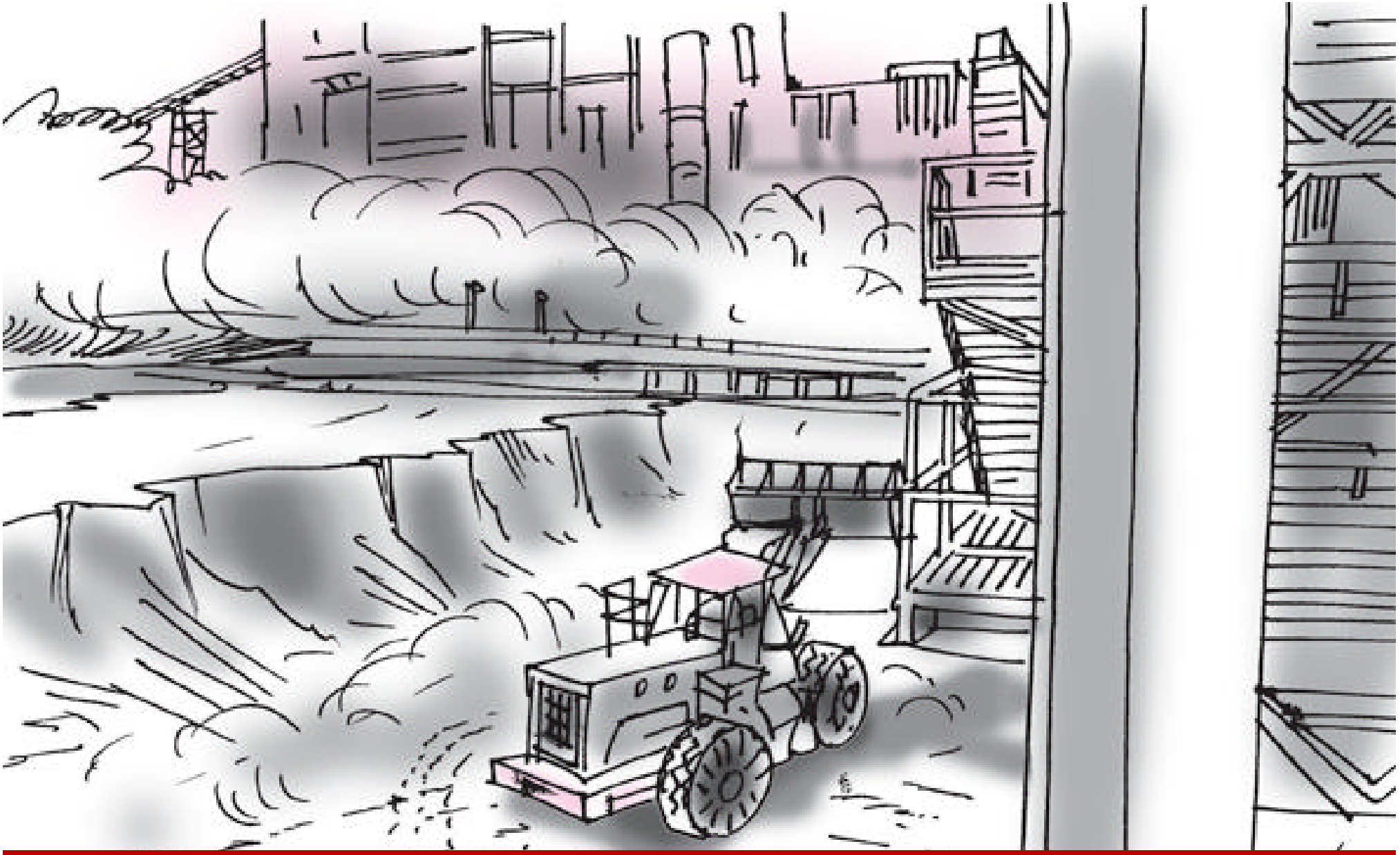
- Estimations done by GRP, indicate that the average SO_2 emissions in Indian plants is about 810 gm per tonne of clinker. This is much highe than some international companies - plants using petcoke have highe SO_2 emissions



Rating - stack emission and control

- **Sector average — 44%**





MATERIAL TRANSPORTATION, HANDLIN
AND STORAGE

Issue in perspective

- In 2004, Indian cement industry used 140 million tonnes (MT) limestone, 16 MT kiln fuel, 12 MT fly ash, 5 MT slag, 5.5 MT gypsum and 6 MT other additives to produce 120 MT cement
- In totality, 180 MT of loose and dry material and 120 MT fine cement – altogether 300 MT - was transported, handled and stored
- Even if just 0.1% of material was lost as fugitive dust – a gross underestimation – then **0.3 million tonnes** of fugitive dust was generated by the Indian cement industry during its life cycle – from raw material sourcing to product transportation

Issue in perspective

- The fugitive dust emissions from cement plants on an average are 10 times higher than those from the stacks
- Despite this no guideline or regulatory standard – other than one on ambient air quality –for fugitive dust in India
- Regulations exist in most developed countries
- Economically too, the loss of such a tiny fraction of material is immaterial for the industry
- Material handling and storage is very poor in most cement plants – leading to high fugitive dust

Estimating fugitive dust

- Regulators in the developed world have established emissions factors for fugitive dust
- Let us consider PM_{10} (particulates less than 10 microns in size) emissions from open limestone storage
- One hectare of open limestone storage, with continuous dust suppression with water (hardly used in India), can generate 0.3 kg of PM_{10} per hour.
- This translates into 1.3 tonnes PM_{10} emissions per year from just 1 hectare open limestone storage site.
- This is equivalent to the annual PM_{10} emissions by 250 LCVs.

Limestone storage

Most of the limestone is stored in the open…

At any point of time, in 36 plants assessed, 3.5 MT limestone is stored in open

Limestone storage

- Only 3 out of 36 plants, have provided covered yards
- Another 8 plants have partially-covered storage

Limestone storage

- Unloading of limestone at the crusher is a potential source of dust
- More than half of the plants have completely open crusher hopper, while half have partially covered unloading, but they don’t work

Limestone storage

- **Uncovered transfer point, open conveyor belts - all potential sources of fugitive dust**

Managing fly ash

- The potential fugitive emissions from fly ash are very high
- Yet, in 40% plants assessed, fly ash is transported in open trucks and jumbo bags
- In 15 of the 36 plants, fly ash is handled manually
- In 8 of the 36 plants, fly ash is stored in the open

Managing fly ash

- **Open storage and manual handling**

Managing fly ash

- **Good practice is to transport fly ash in the bulker, handle it pneumatically and store it in silos**

Managing kiln fuel

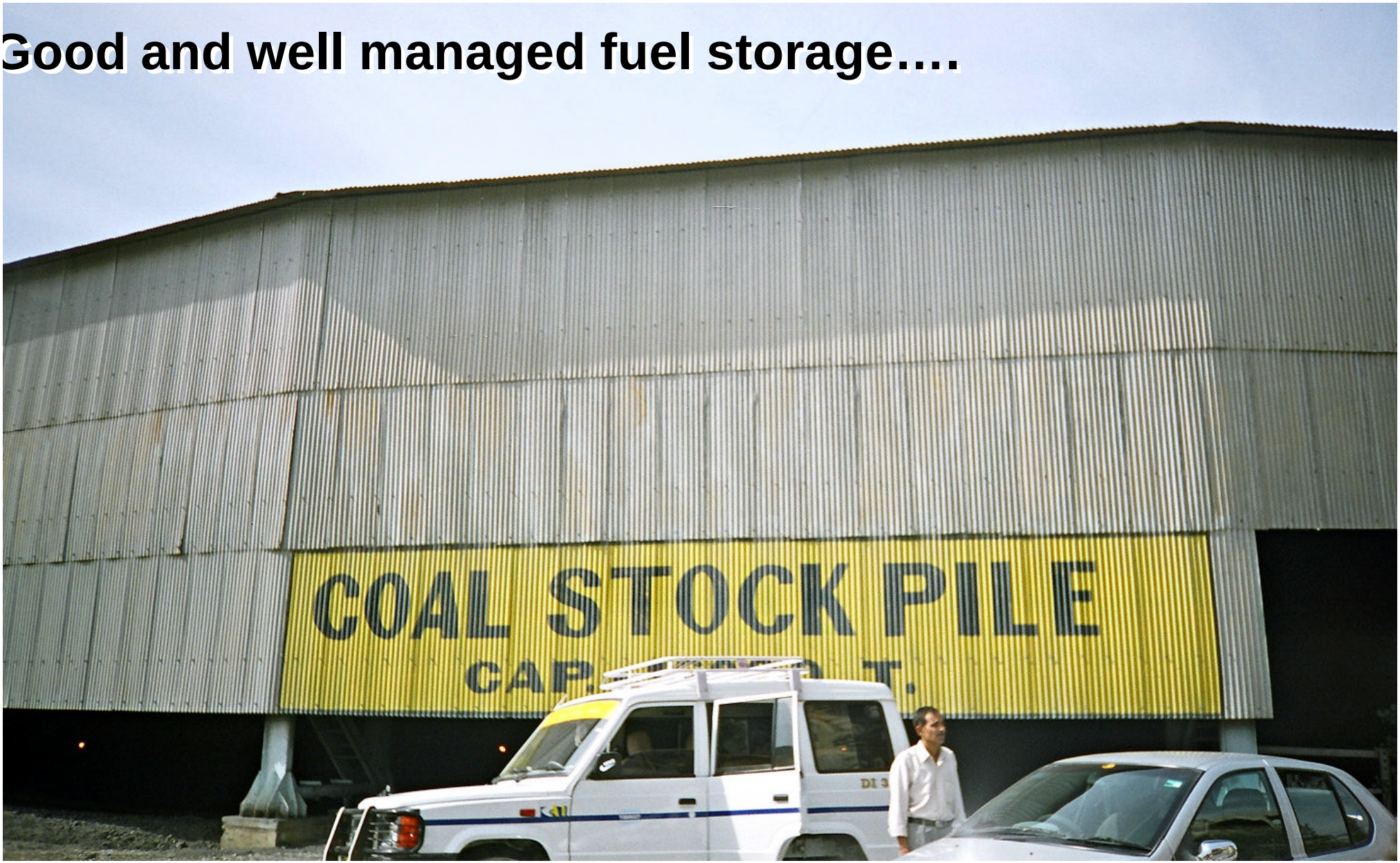
- As many as 27 plants out of 36, store some part of coal in the open – 16 of them store their entire inventory in open
- In 17 of the 36 plants, coal is handled manually
- Four of the six plants using petcoke store it in the open – only two have completely closed storage yards

Managing kiln fuel

- Open and poorly managed fuel storage….

Managing kiln fuel

Good and well managed fuel storage….



Managing additives — Gypsum

Gypsum handling extremely poor, mostly stored in open and manually handled

Managing clinker

- Plants have increased their capacity, but have not increased infrastructure to store clinker
- Result: most plants store some part of their inventory in open – which can range from 10,000 tonnes to 0.7 MT
- GRP estimates that, approx. 35% of total clinker produced is stored in the open at the plants before being used for cement making or sold.
- In only 8 plants out of 36, clinker is completely stored in silos

Managing clinker

Many plants stored clinker in the open and in many cases it is poorly stored even in a clinker stockpile….

Cement packaging

- Packaging and loading section, high dust zone…
- Issues of concern in this area are:
  - High fugitive dust
  - Poor lightning
  - Poor ventilation
  - Open conveyors for bag transportation
  - Very dusty loading operation
  - More number of contract workers

Cement packaging

Packaging and loading section, another high dust zone…

- 55 per cent units have poor or below average ventilation while 6 per cent units had poor or below average lighting

Cement packaging

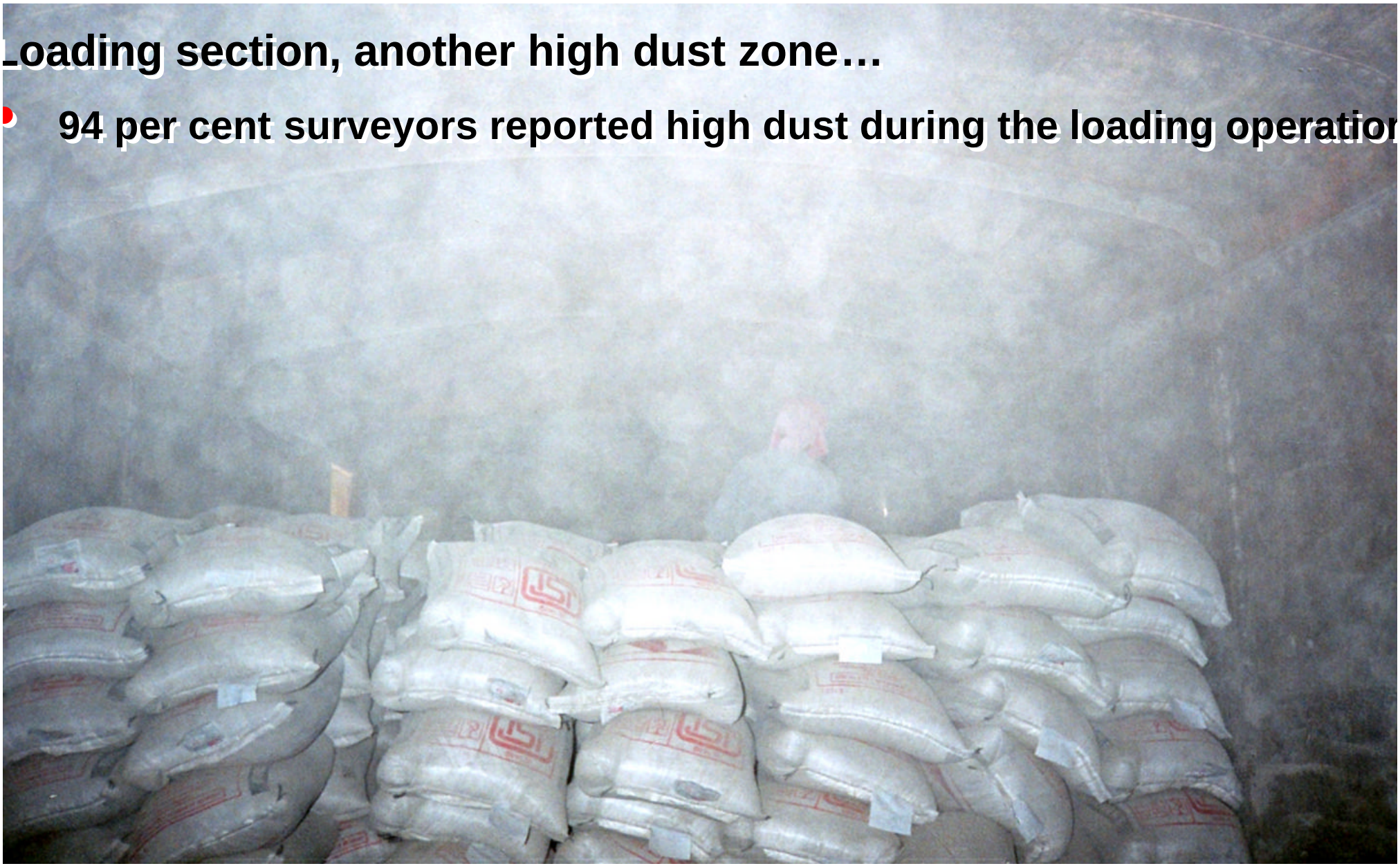
Packaging and loading section, another high dust zone…

- **77 per cent of surveyors reported high fugitive dust or poor ambience in the packaging section**

Cement packaging

Loading section, another high dust zone…

- 94 per cent surveyors reported high dust during the loading operation

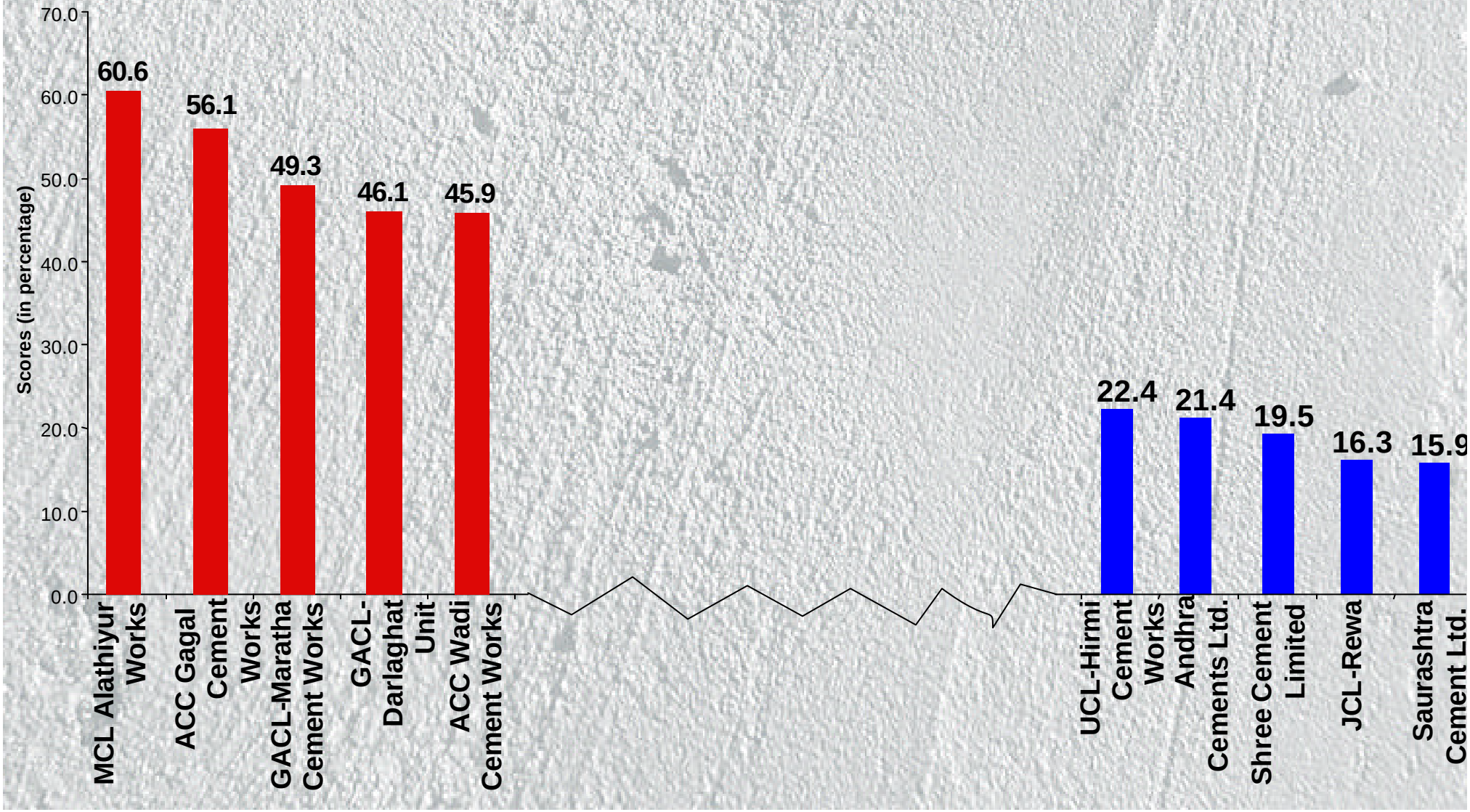


Challenges

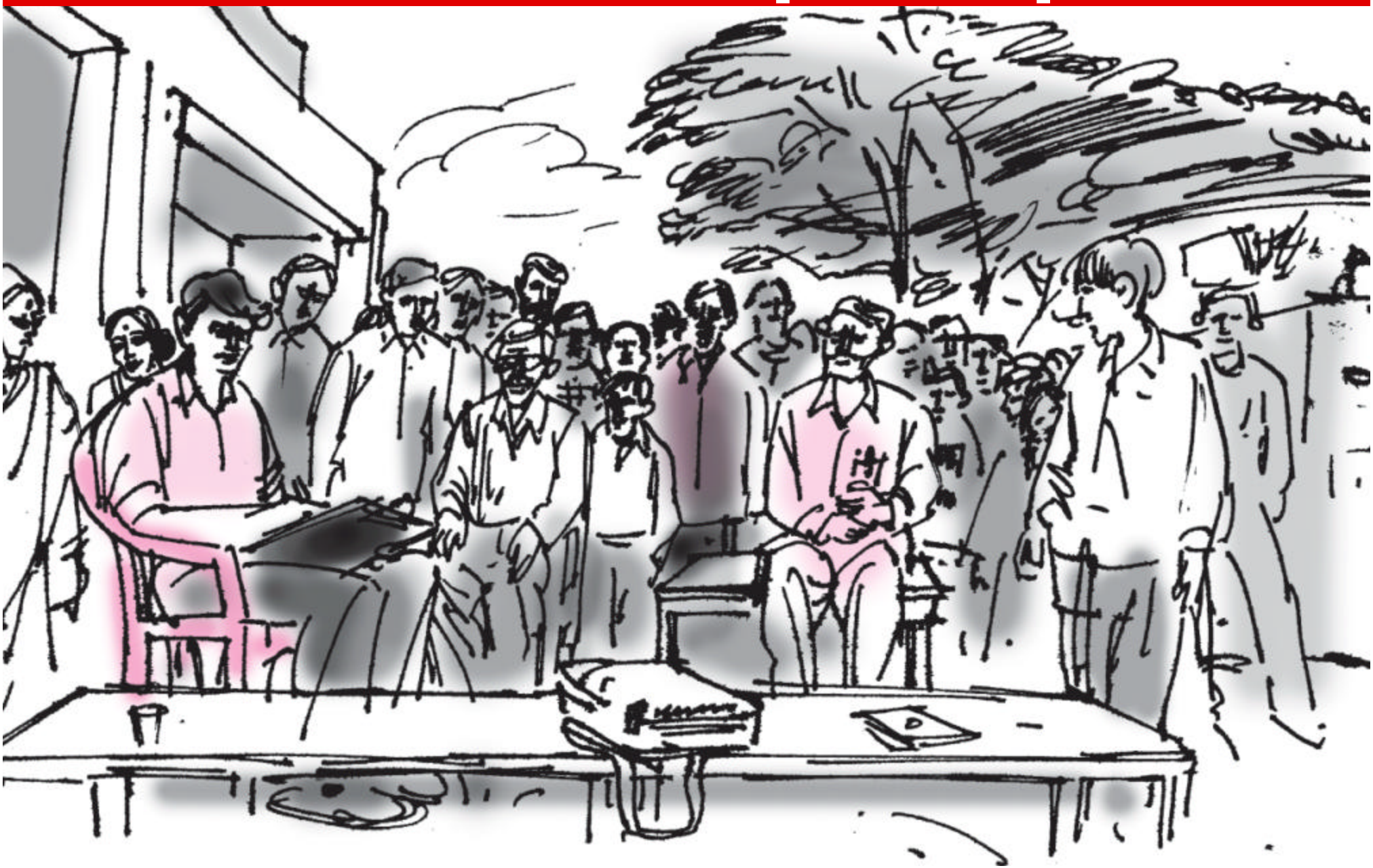
- Transportation, handling and storage of materials is the biggest challenge for the Indian cement industry
- Packaging and loading of cement is another challenge, which the industry cannot ignore due to the sheer occupational health problems

Rating - material handling

Sector average – 33%



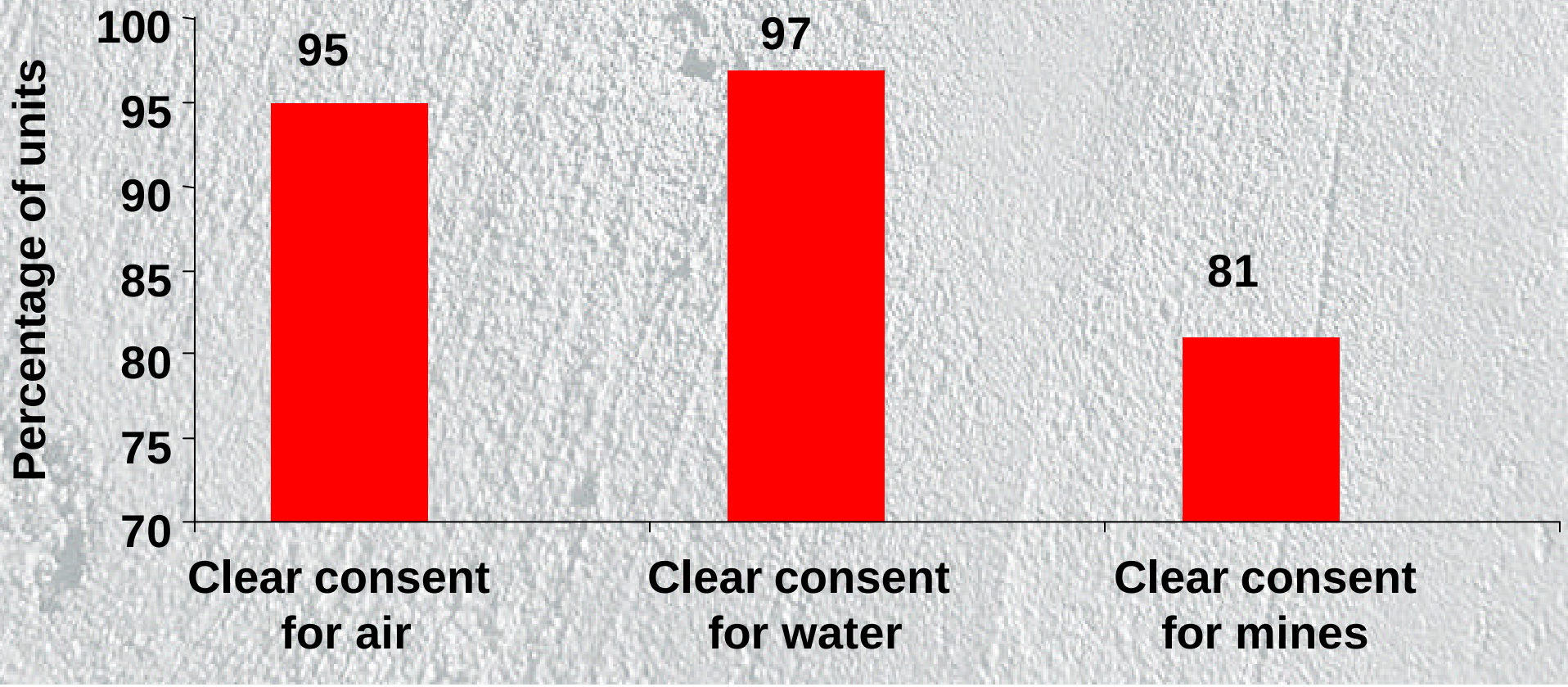
Stakeholders' perception



Key findings — PCB perception

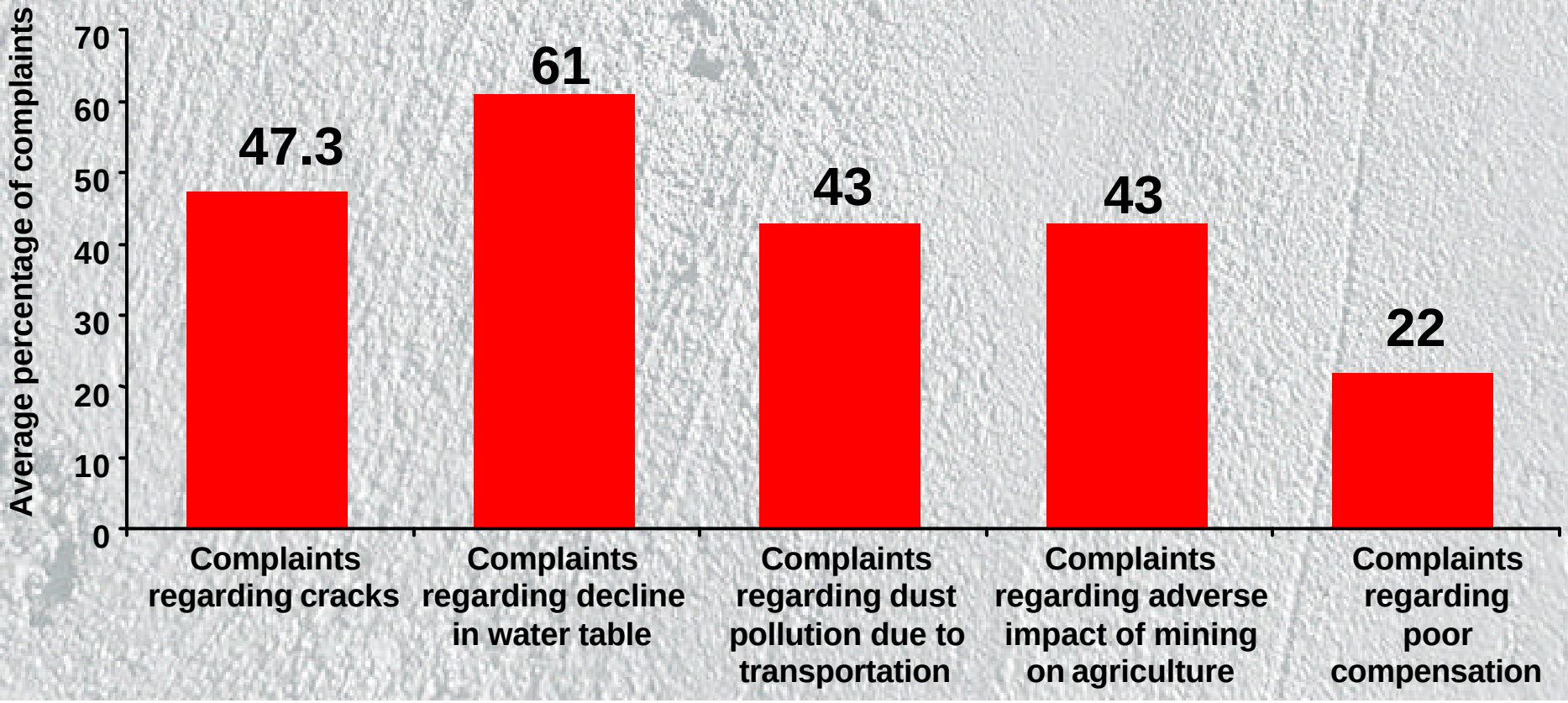
Regulators happy with cement industry….

- **Most cement plants have clear consent for operations including mining**



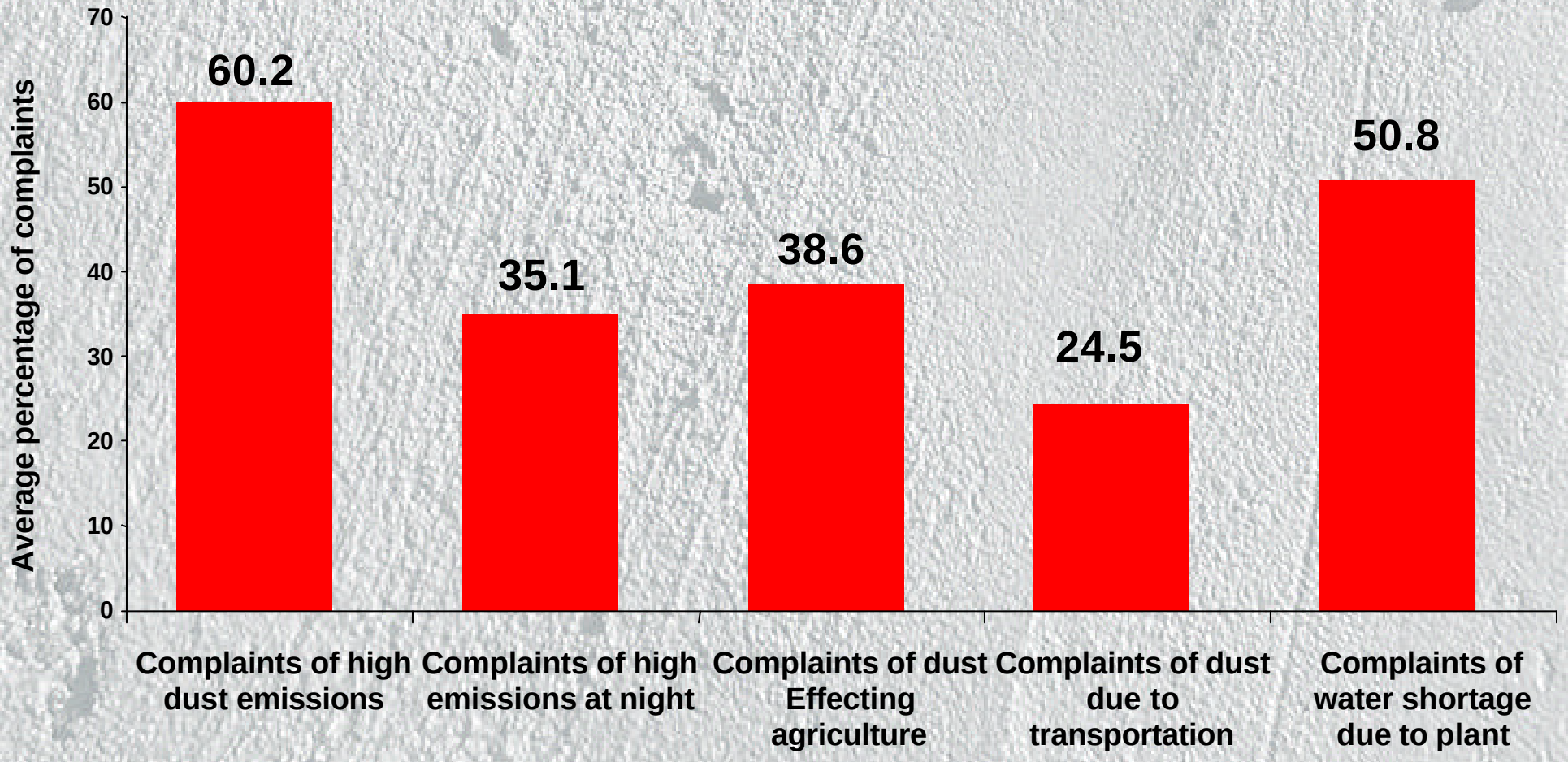
Local community - about mines

- **Most communities living near mines expressed their unhappiness over various issues**
- **Maximum complaints related to water scarcity and impact of blasting**



Local community - about plant

High dust emissions from plants



Rating

Sector average 40%