



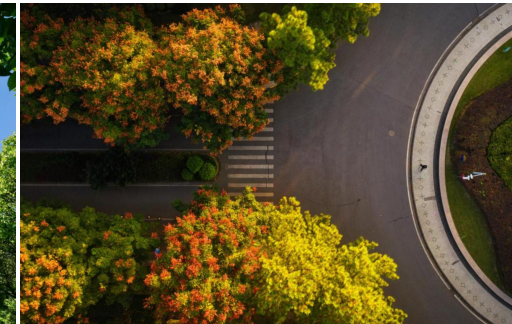
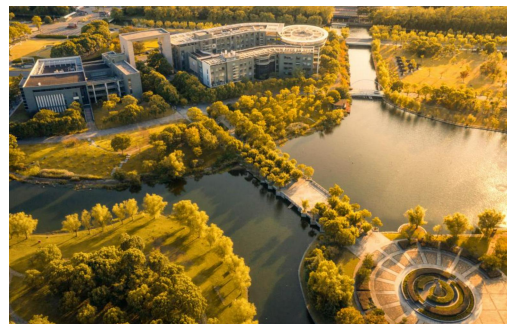
水泥行业减碳

- CO₂哪里来?

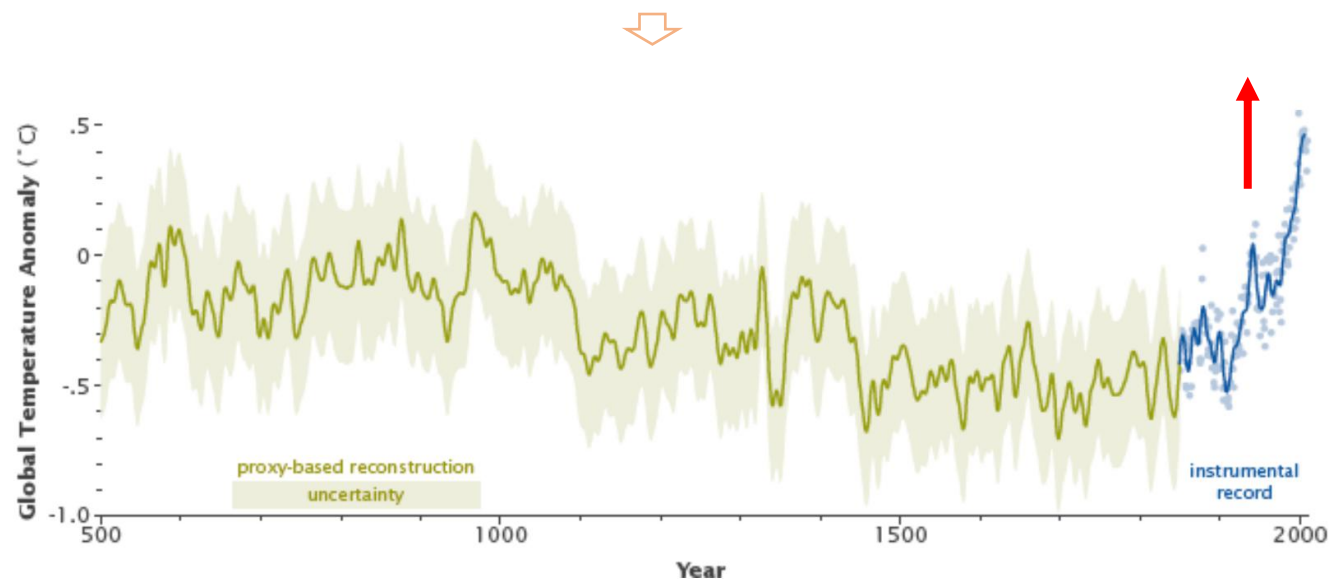
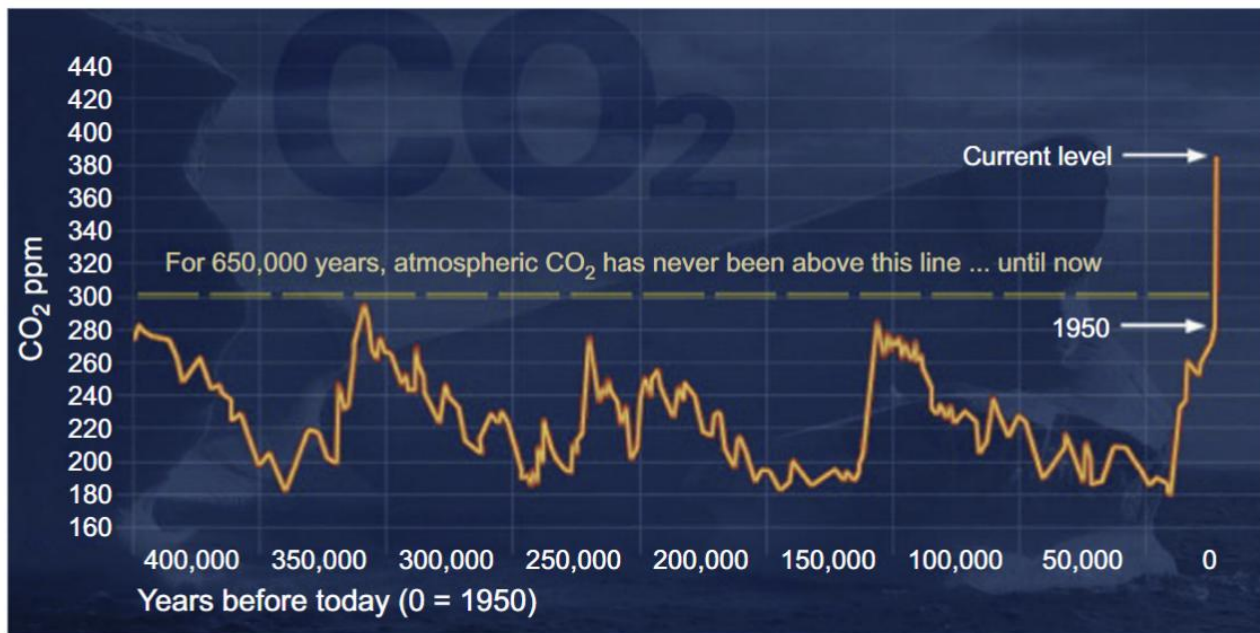
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极端天气



(网络图片)

给人类生存环境造成破坏
给生命安全带来了威胁 ☹️



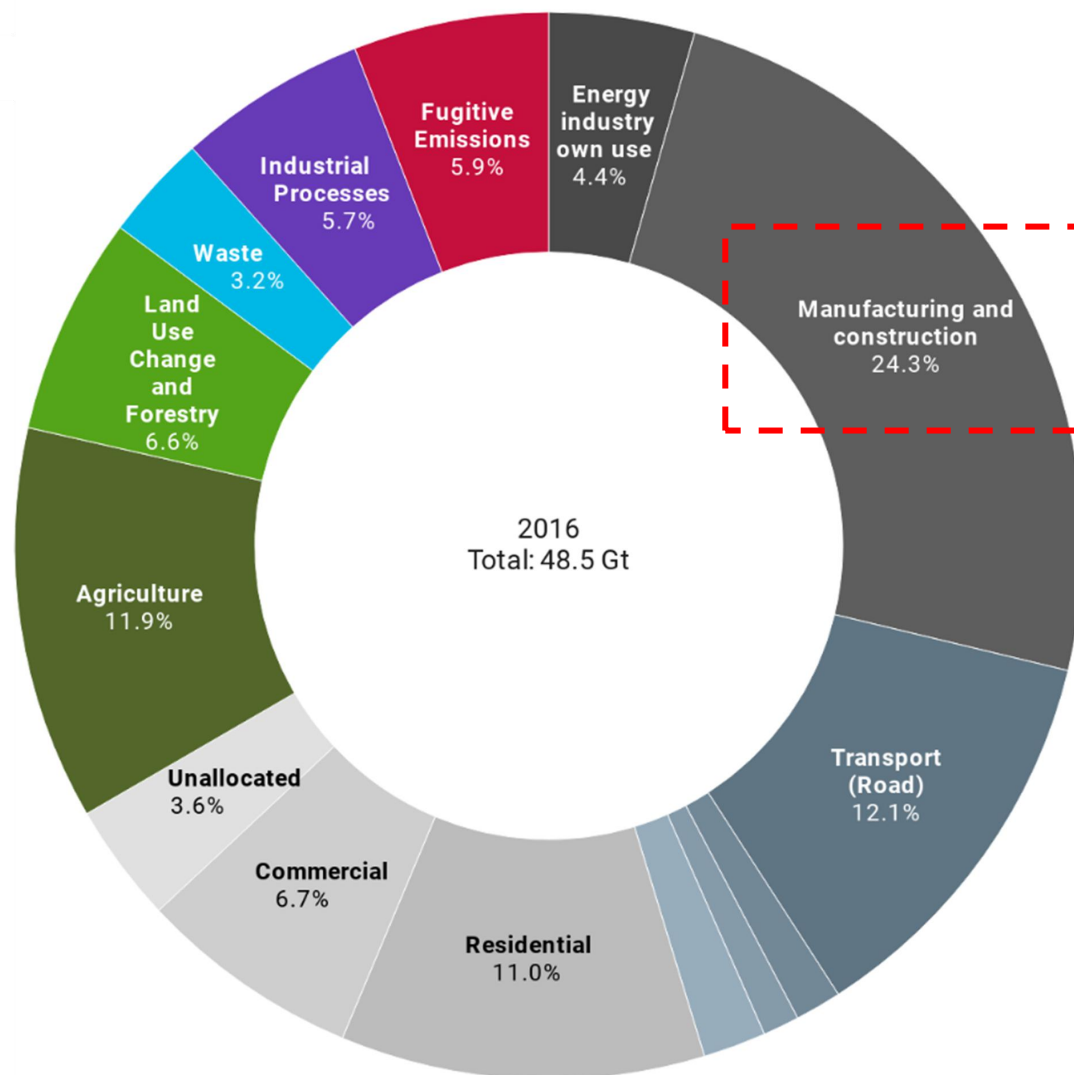
《巴黎协定》（The Paris Agreement），是由全世界178个缔约方共同签署的气候变化协定，是对2020年后全球应对气候变化的行动作出的统一安排。《巴黎协定》的长期目标是将全球平均气温较前工业化时期上升幅度控制在2摄氏度以内，并努力将温度上升幅度限制在1.5摄氏度以内^[1]。

(<https://baike.baidu.com/item/%E5%B7%B4%E9%BB%8E%E5%8D%8F%E5%AE%9A/19138374>)



2020年9月22日，习近平总书记在第75届联合国大会一般性辩论上的讲话宣布：“中国将提高国家自主贡献力度，采取更加有力的政策和措施，二氧化碳排放力争于2030年前达到峰值，努力争取2060年前实现碳中和。”

(<http://www.mofcom.gov.cn/article/i/jyj/1/202012/20201203020929.shtml>)



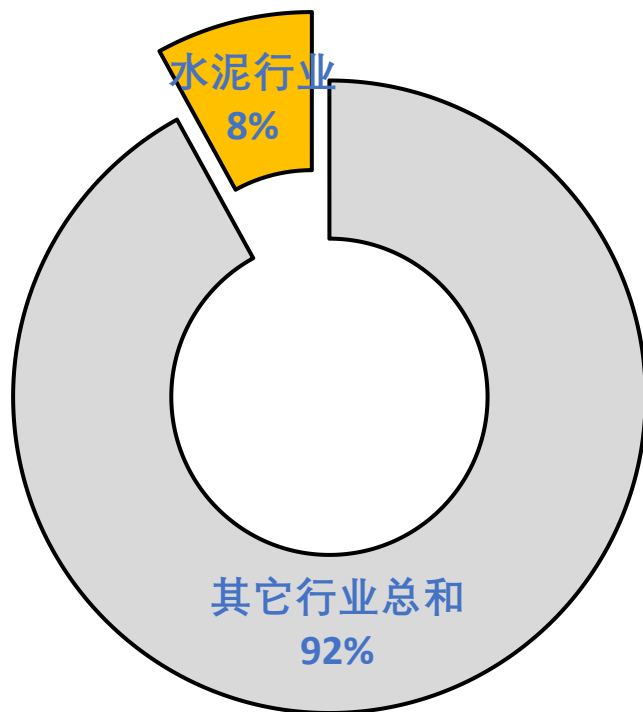
土木工程: 水泥混凝土材料生产与应用

制造和建造 24.3%

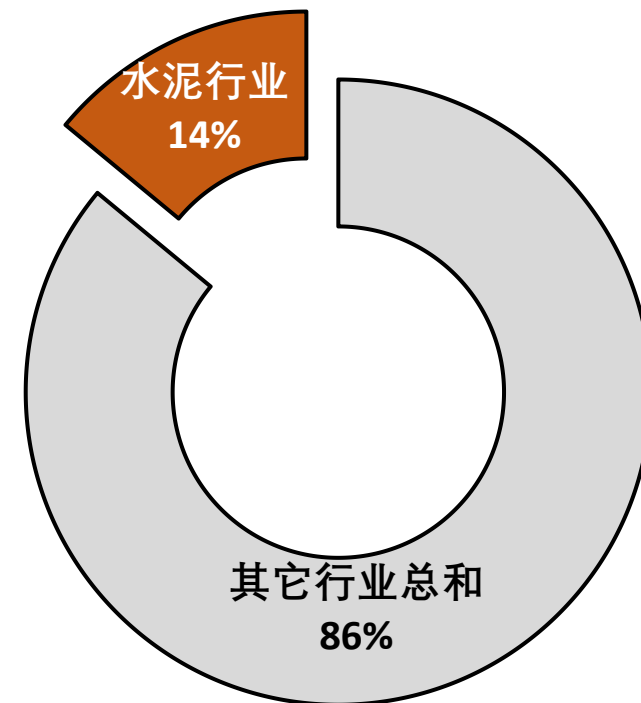
Global GHG Emissions by Sector

2016 global emissions of greenhouse gases
(fuel combustion emissions attributed to energy consumers)

[\(http://earthcharts.org/emissions-sources/\)](http://earthcharts.org/emissions-sources/)



- 全球: 水泥行业 CO₂ ~ 8- 9%



- 我国: 水泥行业 CO₂ ~ 14%






水泥减碳

[网页](#)
[图片](#)
[视频](#)
[学术](#)
[词典](#)
[地图](#)
[更多](#)

约 512,000 个结果 时间不限

M “中国加速迈向碳中和” 水泥篇：水泥行业碳减排路径 – ...
<https://www.mckinsey.com.cn/中国加速迈向碳中和...>
 网页 2022-11-23 · 中国水泥行业碳减排路径 综合考量碳减排成本、技术可行性、资源... 他们认为需求下降、能效提升、替代燃料、碳捕捉技术的加速推动是中国水泥行业碳减排... 手。据此，我们绘制了中国水泥行业从2020年到2030和2050年的碳减排路径...

**水泥行业
减碳主力军**

- 进一步探索
-  水泥行业碳排放现状分析与减排关键路径探讨 - 知乎 [zhuankan.zhihu.com](#)
 -  水泥行业碳排放现状与减排关键路径 - 知乎 [zhuankan.zhihu.com](#)
 -  水泥行业碳排放现状分析与减排关键路径探讨混凝土 ... [163.com](#)
 -  水泥行业碳排放现状分析与减排关键路径探讨-北极星 ... [huanbao.bjx.com.cn](#)
 -  水泥行业碳排放现状分析与减排关键路径探讨 - 湖南 ... [gxt.hunan.gov.cn](#)
- 根据热度为您推荐·反馈

水泥碳排怎么产生？

水泥行业如何实现减污降碳协同增效？ - 生态中国网
https://www.eco.gov.cn/news_info/57962.html
 网页 2022-8-22 · 我国水泥行业 60% 以上的二氧化碳排放来自工艺过程，随着熟料产量的增加，二氧化碳排放量也持续增加，水泥行业碳减排将进入平台期。在需求方面，房地产业与水...

水泥行业，为何成为我国减碳主战场？_腾讯新闻
<https://new.qq.com/omn/20220316/20220316A08SAB00.html>
 网页 2022-3-16 · 水泥是一个从生产到售卖每个环节都极其传统的行业，减碳转型尤为艰难。全球每年生产35亿吨普通硅酸盐水泥，每生产1吨水泥，排放561-622千克二氧化碳，水泥工...

Decarbonization of Cement Industry for Sustainability
<https://carbonfinance.in/decarbonization-of-cement-industry-for-sustainability>
 网页 2021-11-14 · sauravkumar. Nov 14, 2021 - 10:18. 0 50. Decarbonization of Cement Industry for Sustainability. (#sustainability research notes by www.carbonfinance.in) Global ...

Decarbonising the cement industry | World Cement
<https://www.worldcement.com/special-reports/01112021/decarbonising-the-cement-industry>
 网页 2021-11-1 · Decarbonising the cement industry. Cement manufacture accounts for roughly 8% of total manmade CO 2 emissions. Today, cement and concrete producers are ...

Deep decarbonisation of industry: The cement sector
https://www.metis.ec.europa.eu/deep-decarbonisation-industry-cement-sector_en
 网页 2020-1-1 · Description. This factsheet looks into the possible technological pathways to decarbonise the cement sector by comparing deep decarbonisation scenarios from ...

Toward Net Zero: Decarbonization Roadmap for China's ...
<https://www.transition.org/publications/decarbonization-roadmap-for-chinas...>
 September 2022. China is the world's largest producer and consumer of cement. The country accounts for 50 percent of the country's total carbon emissions, making it the most carbon-intensive industry after power and steel. Therefore, decarbonization of this industry is critical to achieving the country's carbon neutrality.

Decarbonising the cement industry - International Cement ...
<https://www.cemnet.com/News/story/169473/decarbonising-the-cement-industry.html>
 网页 2020-9-4 · Decarbonising the cement industry. 04 September 2020. This week over 40 leading cement and concrete companies, gathered under the umbrella of the Global Cement and Concrete Association (GCCA), unveiled the industry's '2050 Climate Ambition' and commitment to achieving carbon neutrality: "GCCA members commit to continue to drive ...

Decarbonization of Cement Industry in Mexico — Global ...
<https://www.globalefficiencyintel.com/decarbonization-of-cement-industry-in-mexico>
 网页 Cement production is one of the most energy-intensive and highest carbon dioxide (CO2) emitting manufacturing processes. In fact, the cement industry alone accounts for around 7% of total anthropogenic CO2 emissions in the world. Mexico is the 11th largest cement producing country in the world producing 51 million tonne (Mt) of cement in 2021.

胶凝材料

石膏

水泥

化学激发剂胶凝材料

其他胶凝材料

硅酸盐系水泥

铝酸盐系水泥

硫铝酸盐系水泥

铁铝酸盐系水泥

硅酸盐水泥

普通硅酸盐水泥

矿渣硅酸盐水泥

火山灰硅酸盐水泥

粉煤灰硅酸盐水泥

复合硅酸盐水泥



~0.8 t CO₂ / t clinker !!!

共同点: 熟料 + 石膏

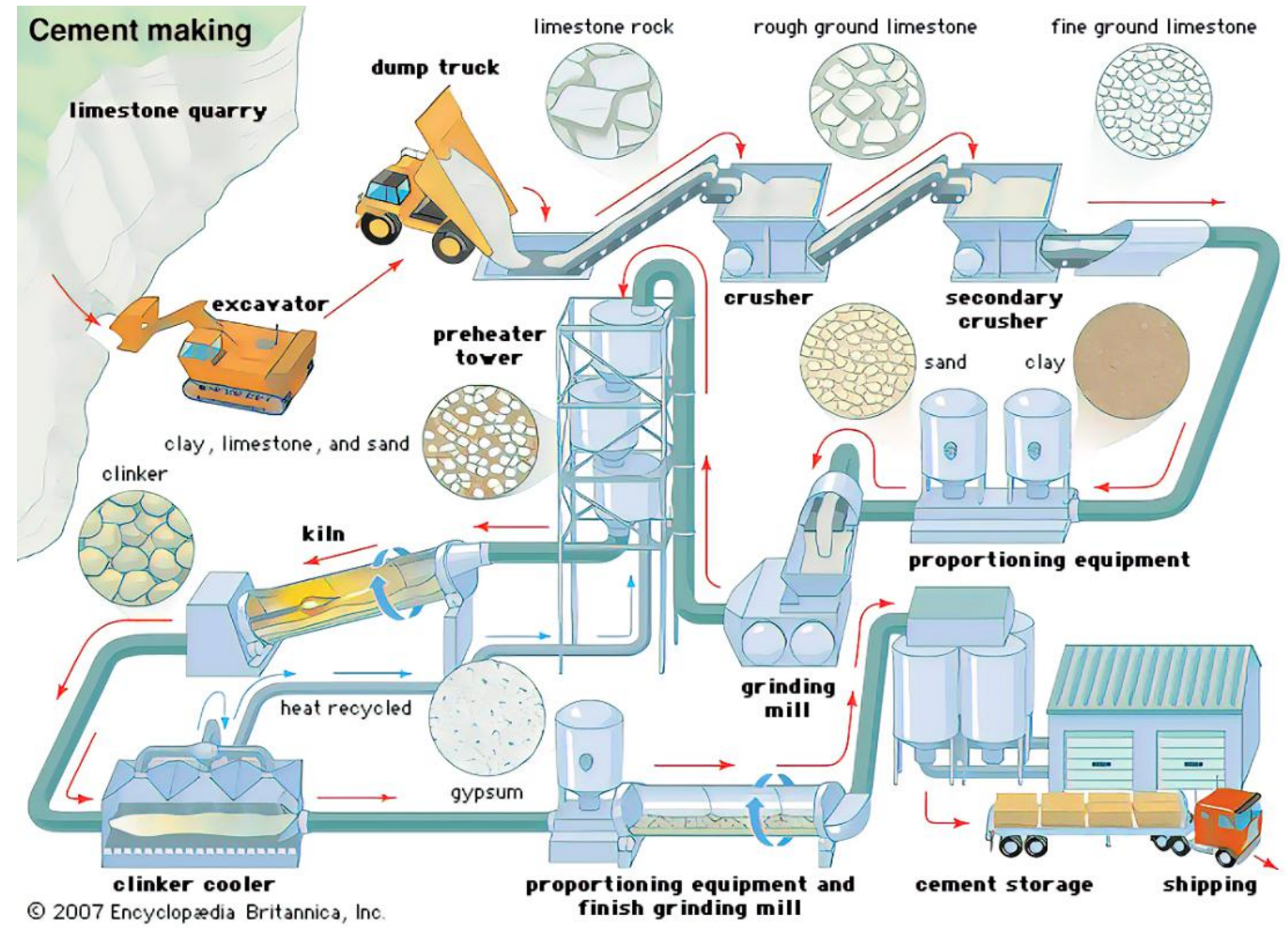
不同点: 混合材料: 类型 & 比例

水泥熟料
(Clinker)



品种	代号	熟料 + 石膏	组分(wt.%)				替代组分
			主要组分			替代组分	
			粒化高炉矿渣	石灰石	粉煤灰		火山灰质混合材
硅酸盐水泥	P.I	100	-	-	-	-	-
	P.II	95 - 100	0 - 5	0 - 5	-	-	-
普通硅酸盐水泥	P.O	80 - 95	5 - 20	-	-	-	0 - 5
矿渣硅酸盐水泥	P.S.A	50 - 80	20 - 50	-	-	-	-
	P.S.A	30 - 50	50 - 70	-	-	-	0 - 8
粉煤灰硅酸盐水泥	P.F	60 - 80	-	-	20 - 40	-	-
火山灰质硅酸盐水泥	P.P	60 - 80	-	-	-	20 - 40	-

硅酸盐系水泥生产原料与工艺



(<https://civildigital.com/cement-manufacturing-process-simplified-flow-chart/>)

原材料

石灰质原料

石灰石 石灰石凝灰岩

CaO

粘土质原料

粘土质岩 铁矿石 硅藻土

SiO₂, Al₂O₃,
及少量 Fe₂O₃

校正原料

铁矿粉 砂岩 煤渣

Fe₂O₃
SiO₂, Al₂O₃,

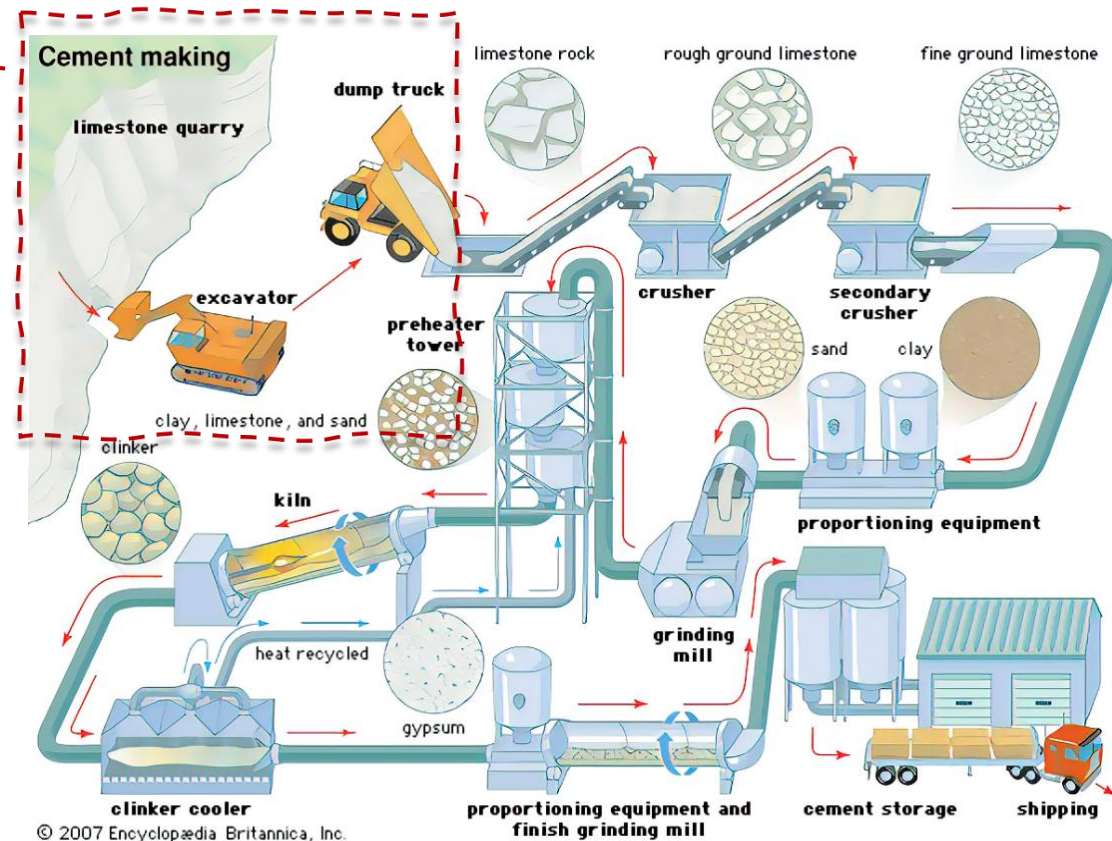
矿化剂

铜矿渣 重晶石

BaSO₄



44%



(<https://civildigital.com/cement-manufacturing-process-simplified-flow-chart/>)

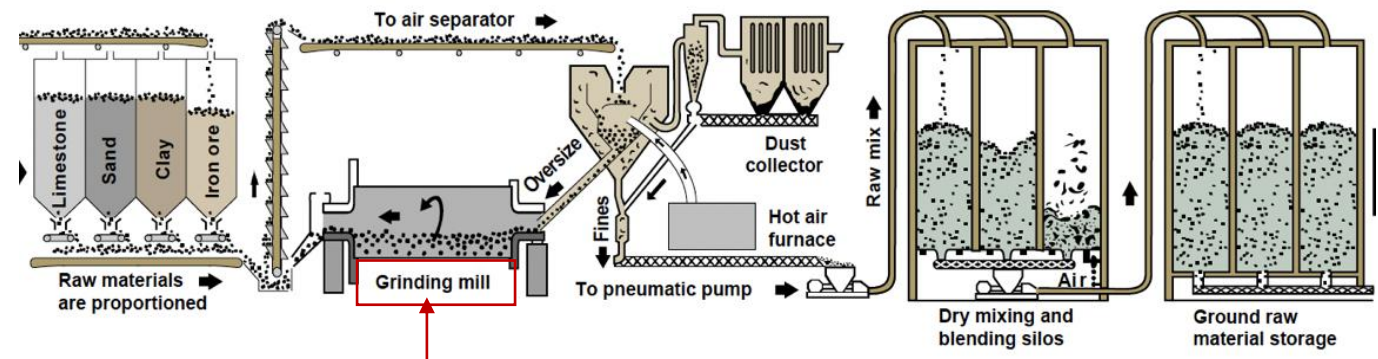
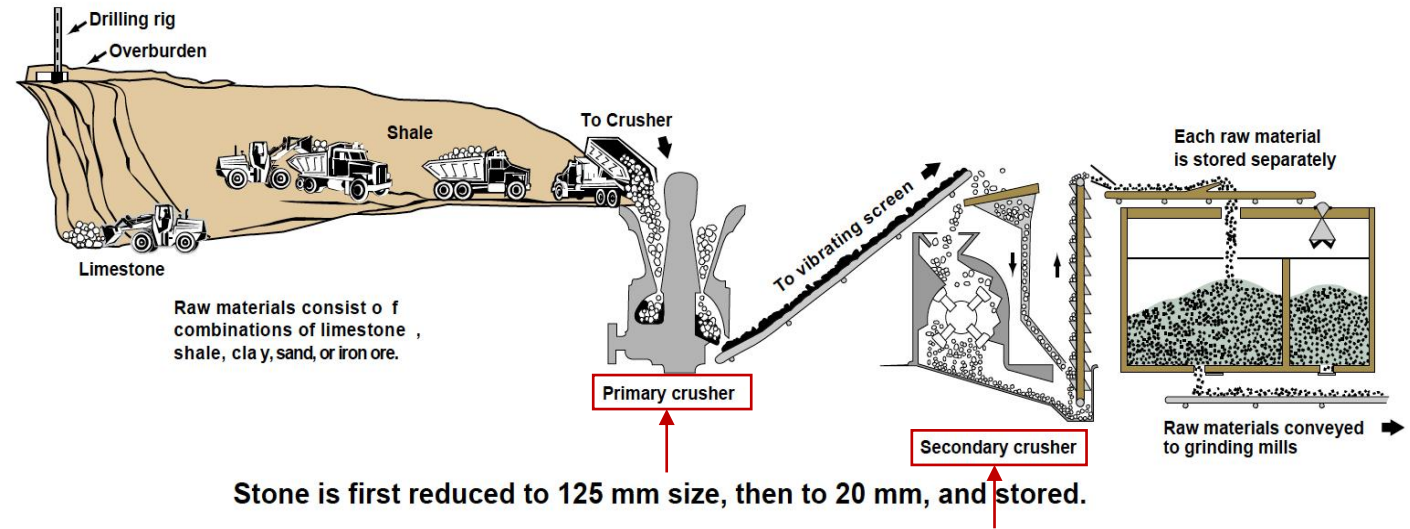
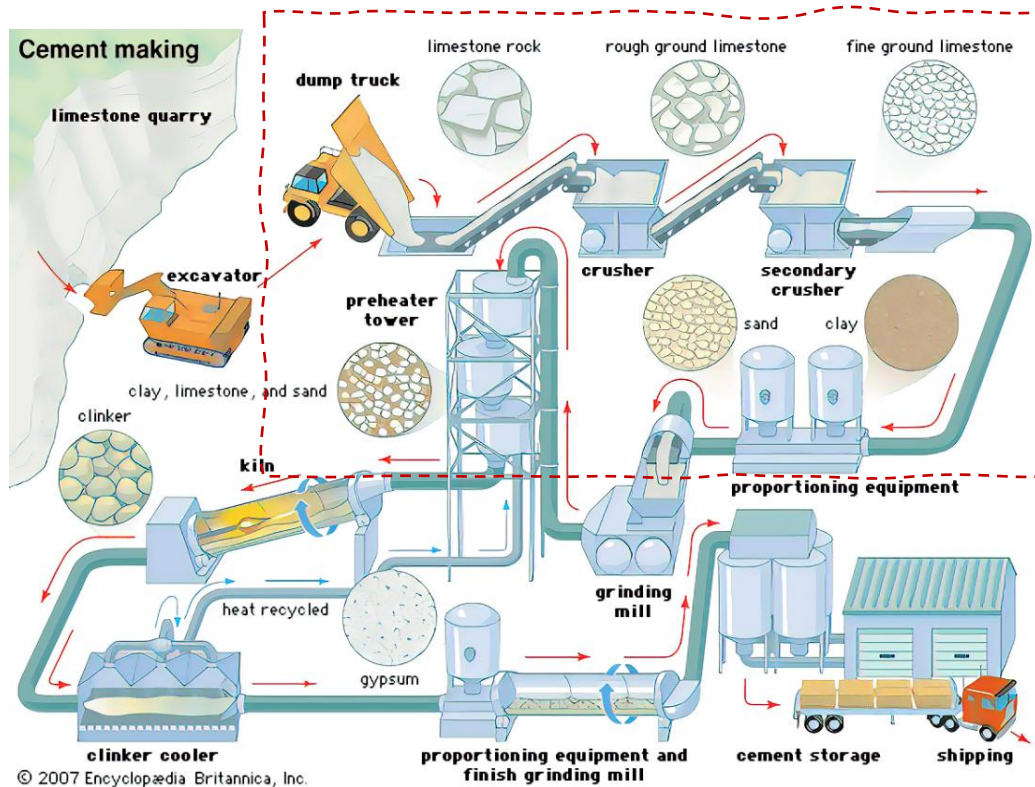
原料挖掘、运输、破碎、研磨

CO₂



同濟大學
TONGJI UNIVERSITY

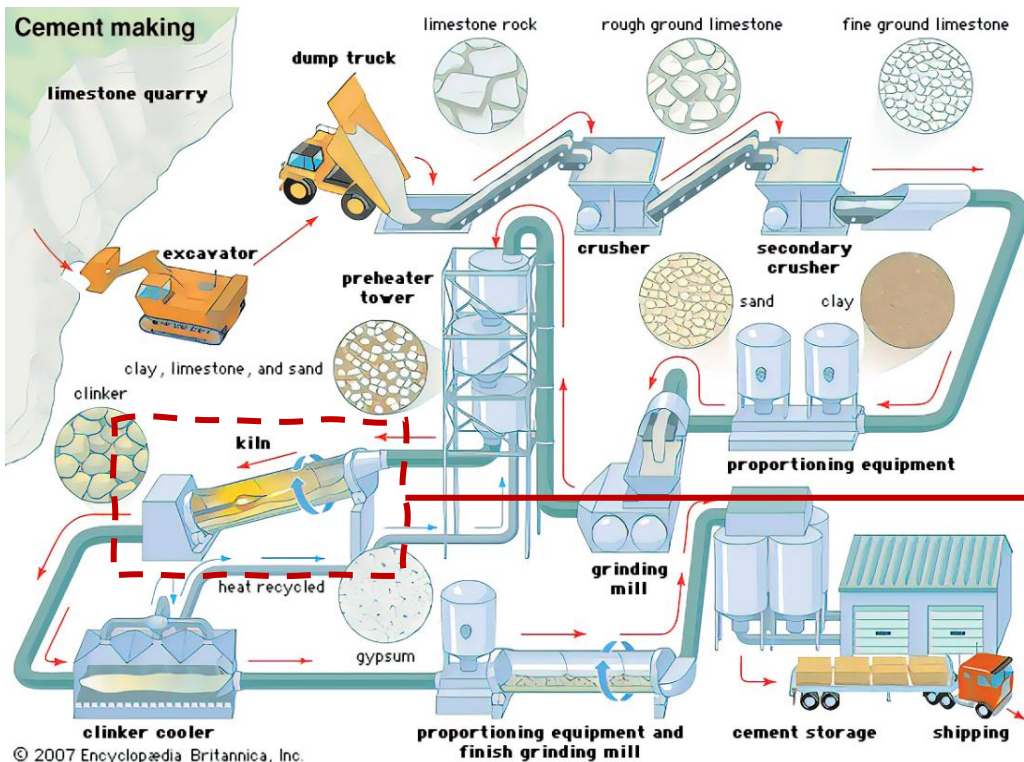
土木工程學院
COLLEGE OF CIVIL ENGINEERING



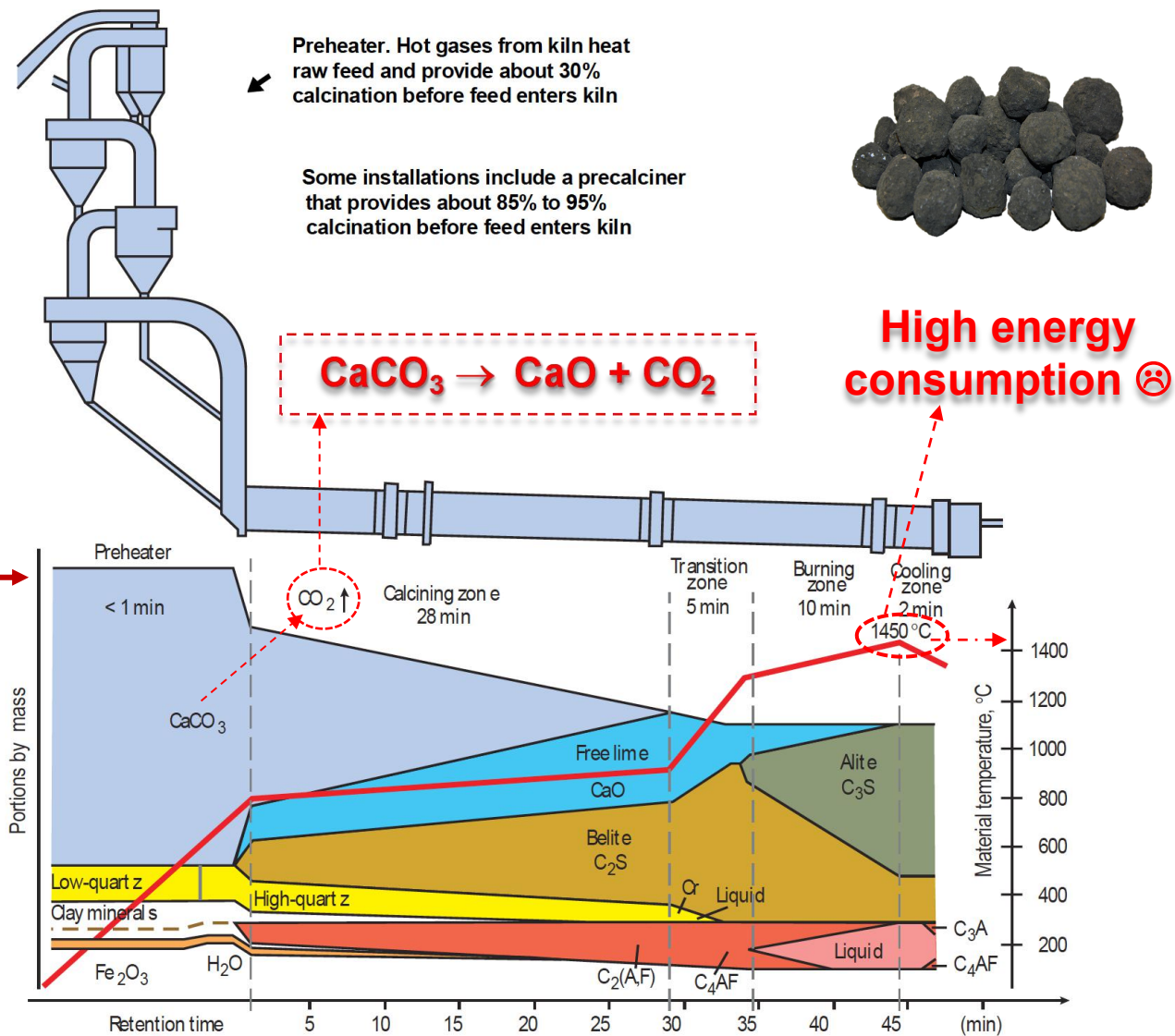
Raw materials are ground to powder and blended.

<https://civildigital.com/cement-manufacturing-process-simplified-flow-chart/>

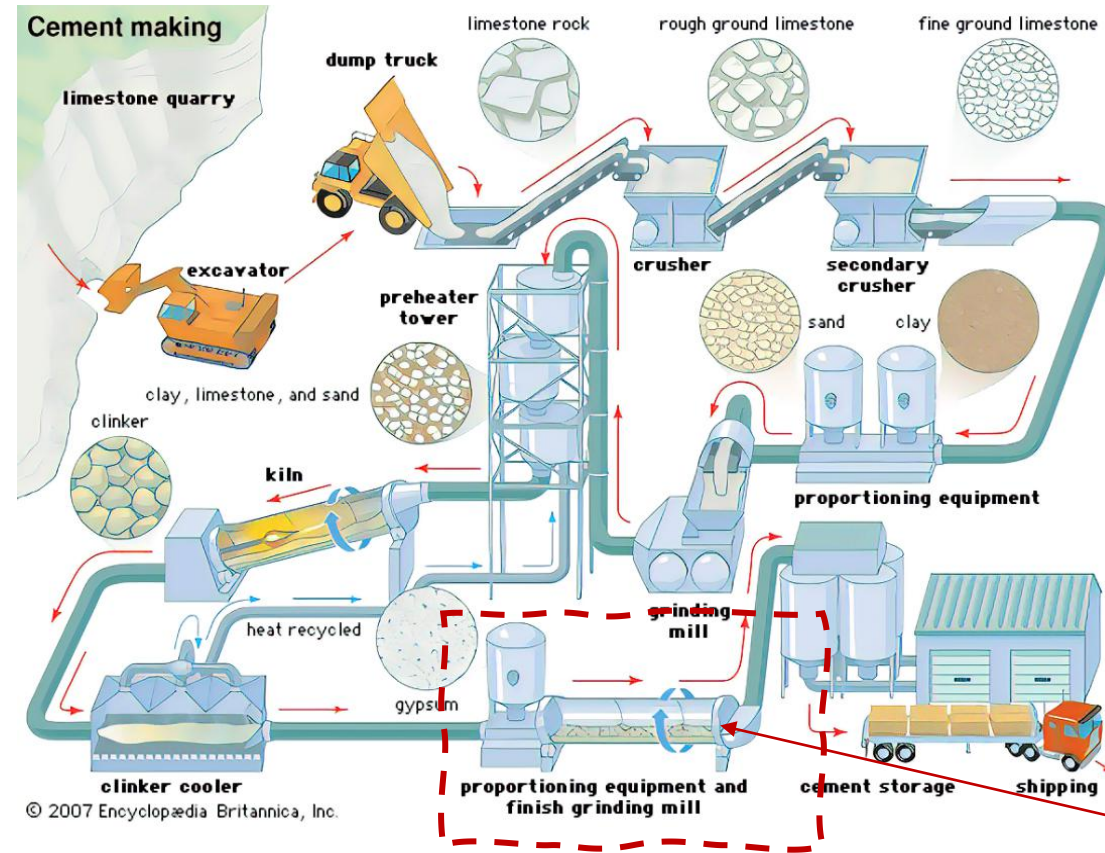
(摘自: << 土木工程材料>>, 莫立武 主编)



<https://civildigital.com/cement-manufacturing-process-simplified-flow-chart/>



Transformation of rawmix to clinker products during cement manufacturing.



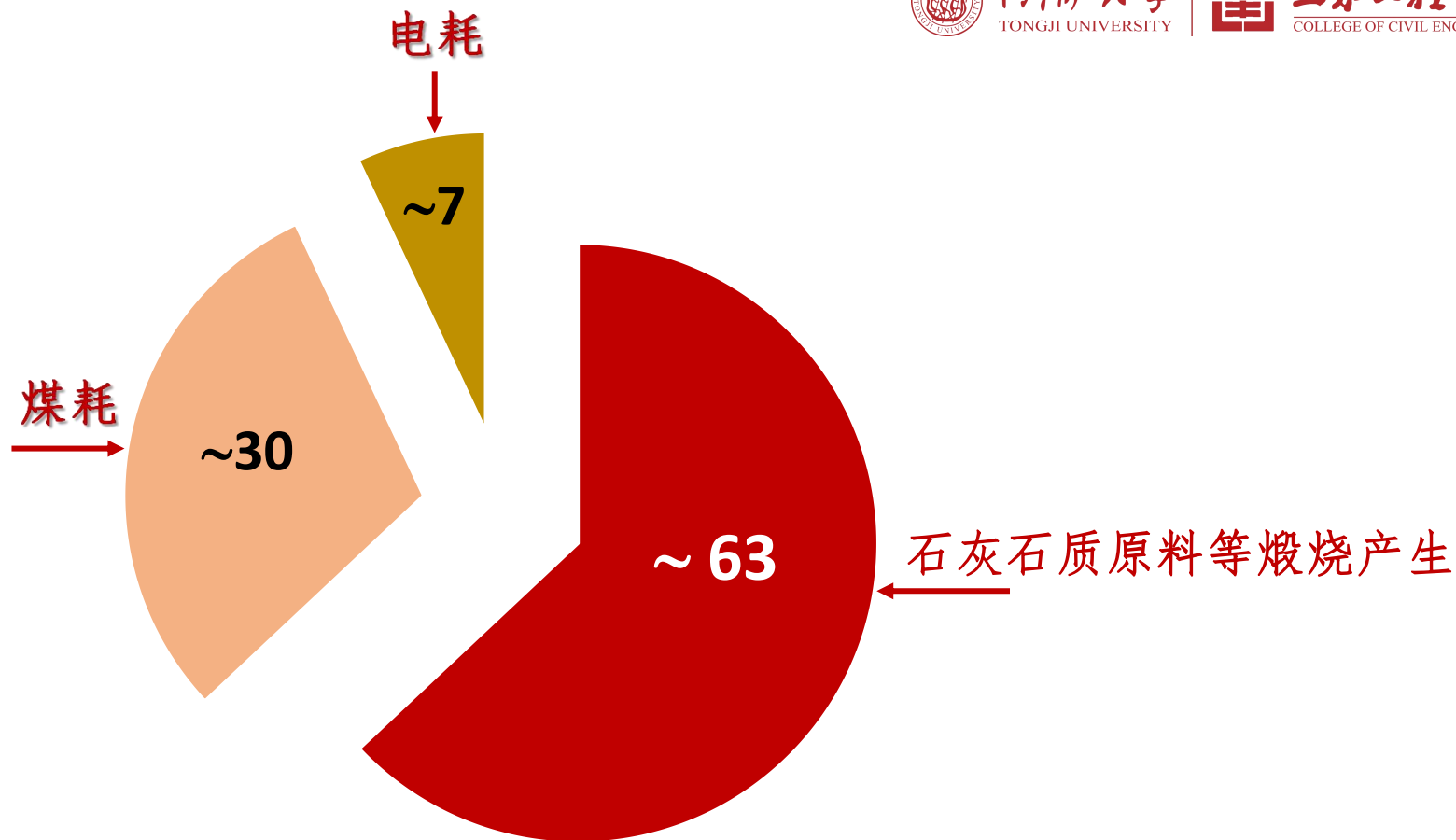
石膏
调节水泥凝结



(<https://civildigital.com/cement-manufacturing-process-simplified-flow-chart/>)



水泥熟料
(Clinker)

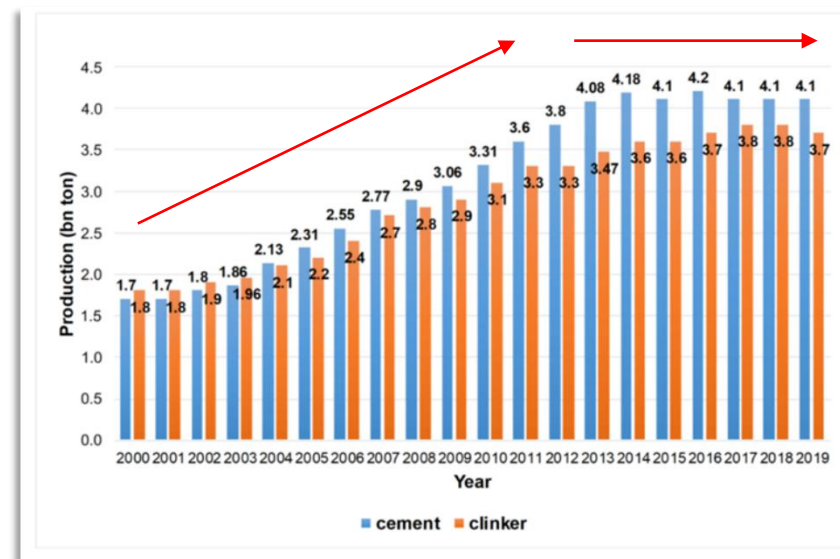


~ 0.8 - 1t CO₂ /1t clinker

世界水泥年产量

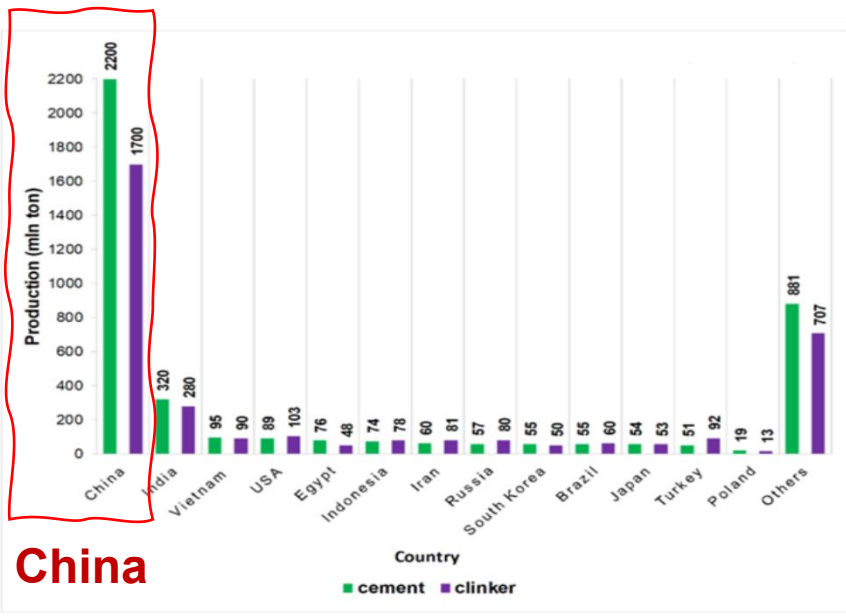
- ✓ 2000年: ~17亿吨
- ✓ 2016年~42亿吨, 2019年~41亿吨

增长速率: 1.56亿吨/年



- World production of cement and clinker in the world (from U.S. Geological Survey)

(<https://www.usgs.gov/centers/nmic/mineral-commodity-summaries>)



China

- World production of cement and clinker by country in 2019 (from U.S. Geological Survey)

(<https://www.usgs.gov/centers/nmic/mineral-commodity-summaries>)

2019年世界各国水泥产量

- ✓ 中国位居榜首: ~22亿吨, 占全球总量~52%
- ✓ 印度位列第二: ~3.2亿吨

高單位碳排

(~ 0.8 - 1t CO₂ /1t 熟料)

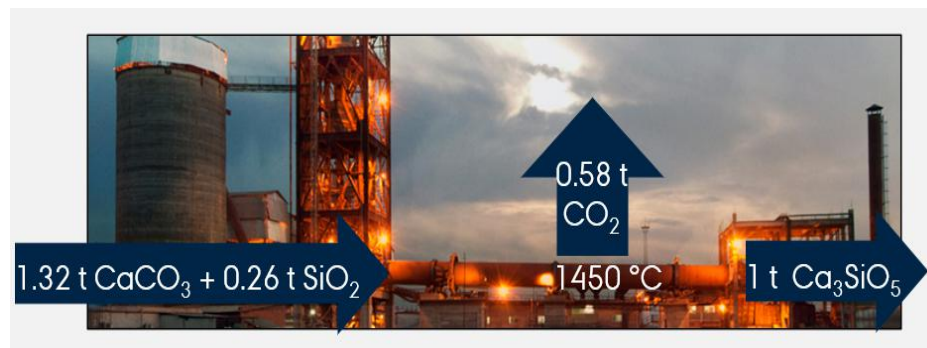
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高水泥產量

(全球 ~ 41 億t)

=

水泥行業
高CO₂排放量





Thanks ! 😊

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欢迎学术交流与讨论！！