COST MINEA WG1 Workshop – Odense, Denmark

"Towards a knowledge base for material reserves and resources in buildings & infrastructures"

How much cement could we do without? Lessons from cement material flows in the UK

William Shanks, Cyrille Dunant, Michał Drewniok, Richard Lupton, André Serrenho, Julian Allwood
Resources, Conservation and Recycling, Volume 141, February 2019
DOI: 10.1016/j.resconrec.2018.11.002

Rick Lupton
rcl33@cam.ac.uk

30 October 2018

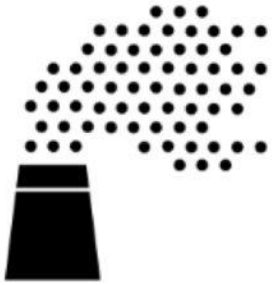
UNIVERSITY OF BATH

UNIVERSITY OF CAMBRIDGE

THE USE | LESS GROUP

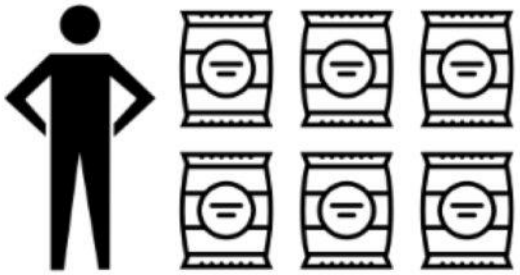
Cement is an important material

2nd-biggest industrial CO_2 emissions source (after steel)



5-8%
Global CO_2 emissions[1]

UK cement production in 2015:

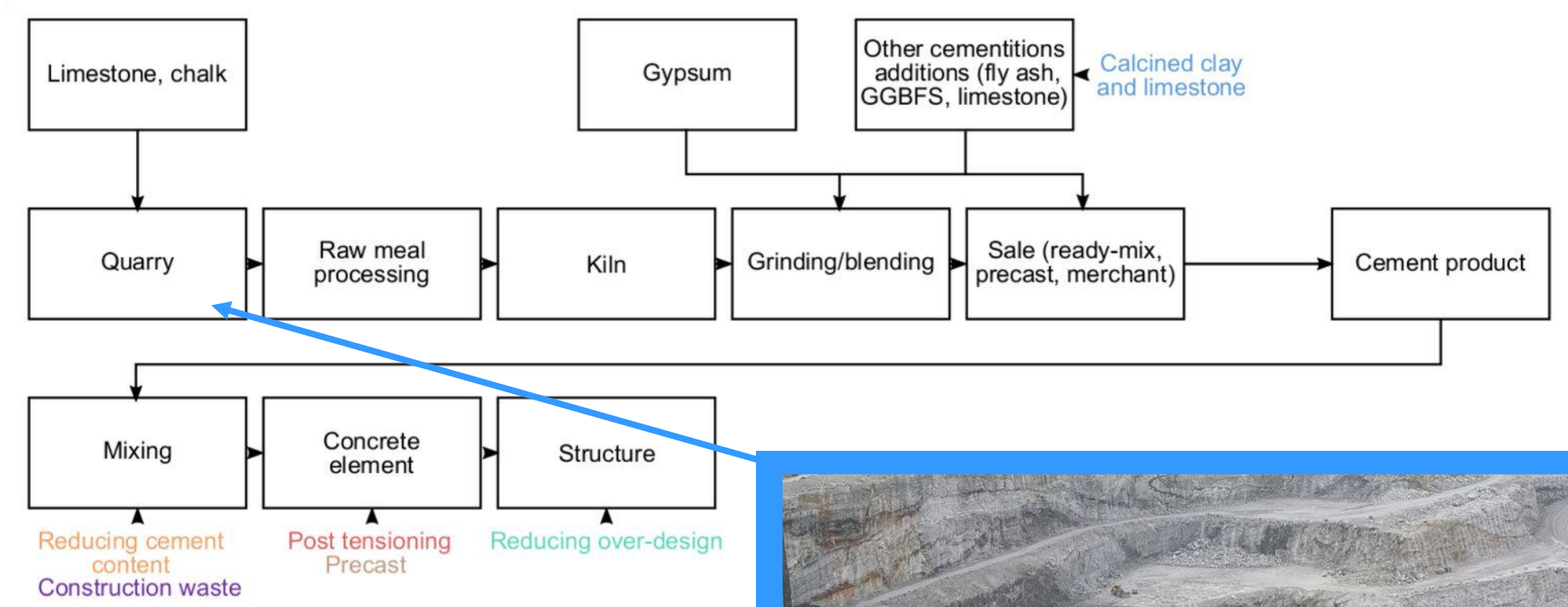


150
kg/person

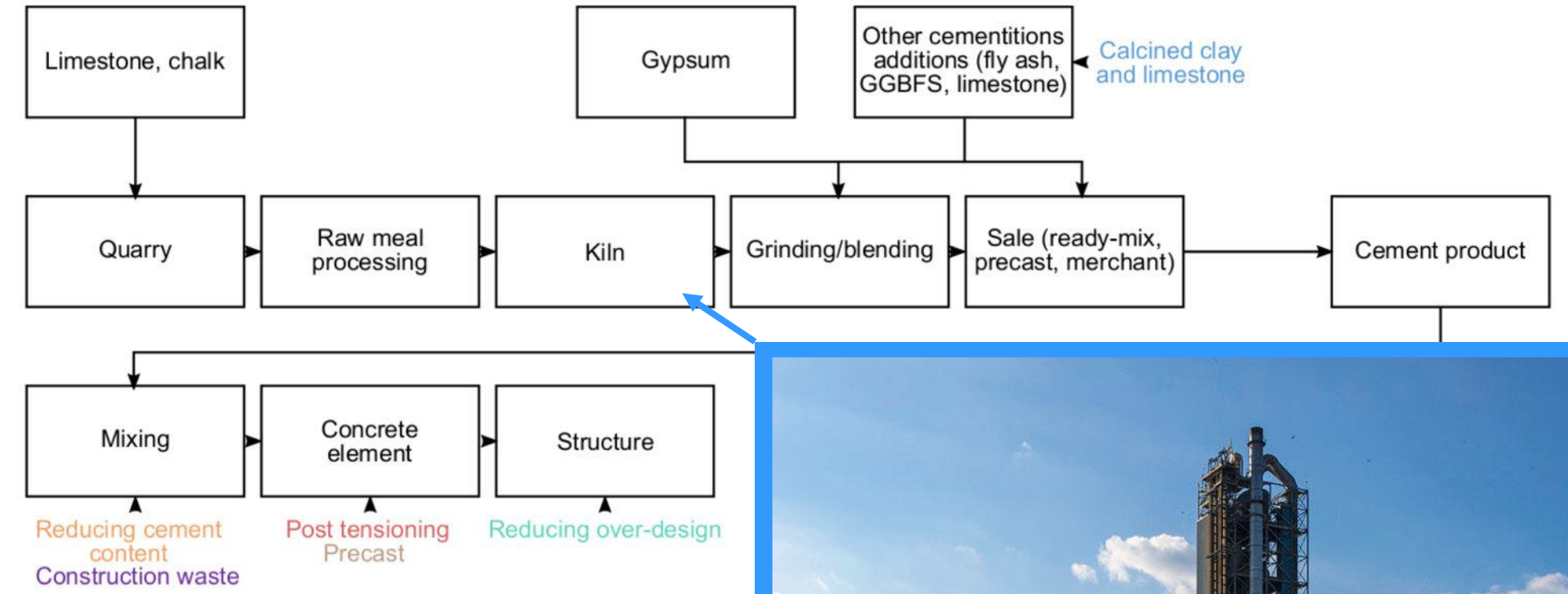
10
million
tonnes

We need to use less of it – but which material efficiency measures have the most potential and might be easiest to implement?

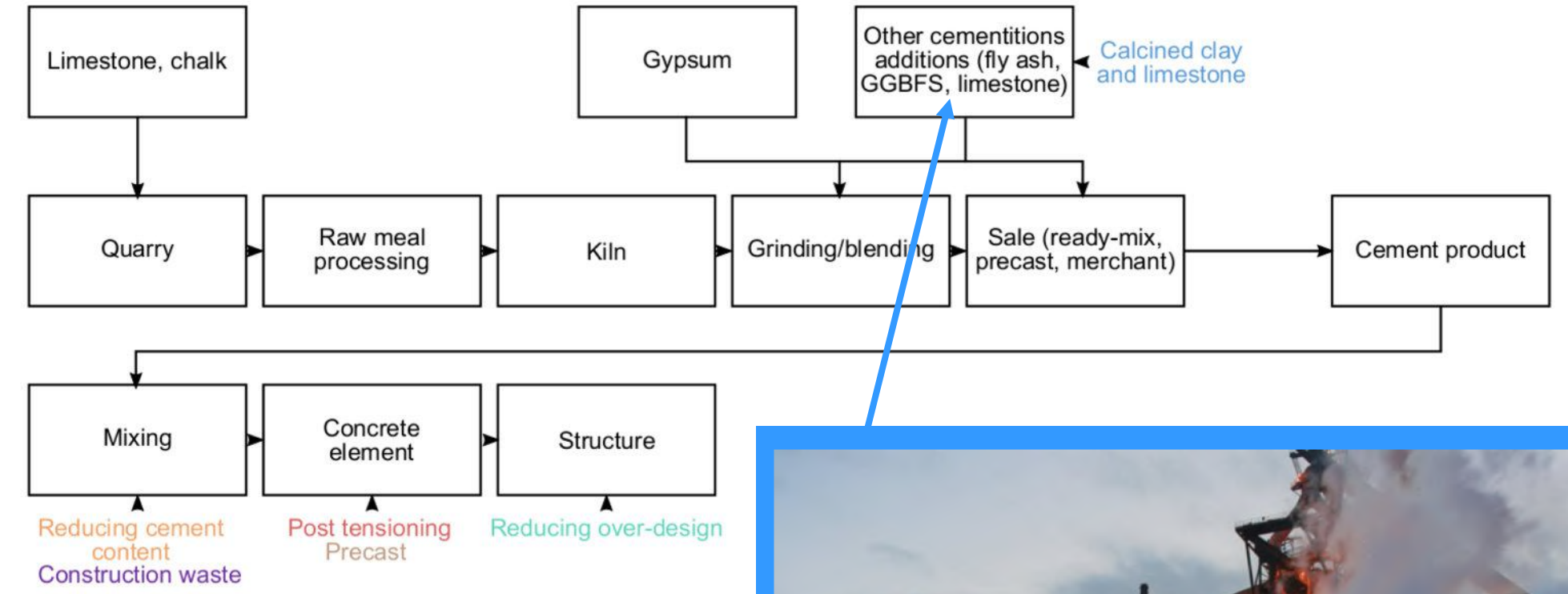
Cement and concrete production



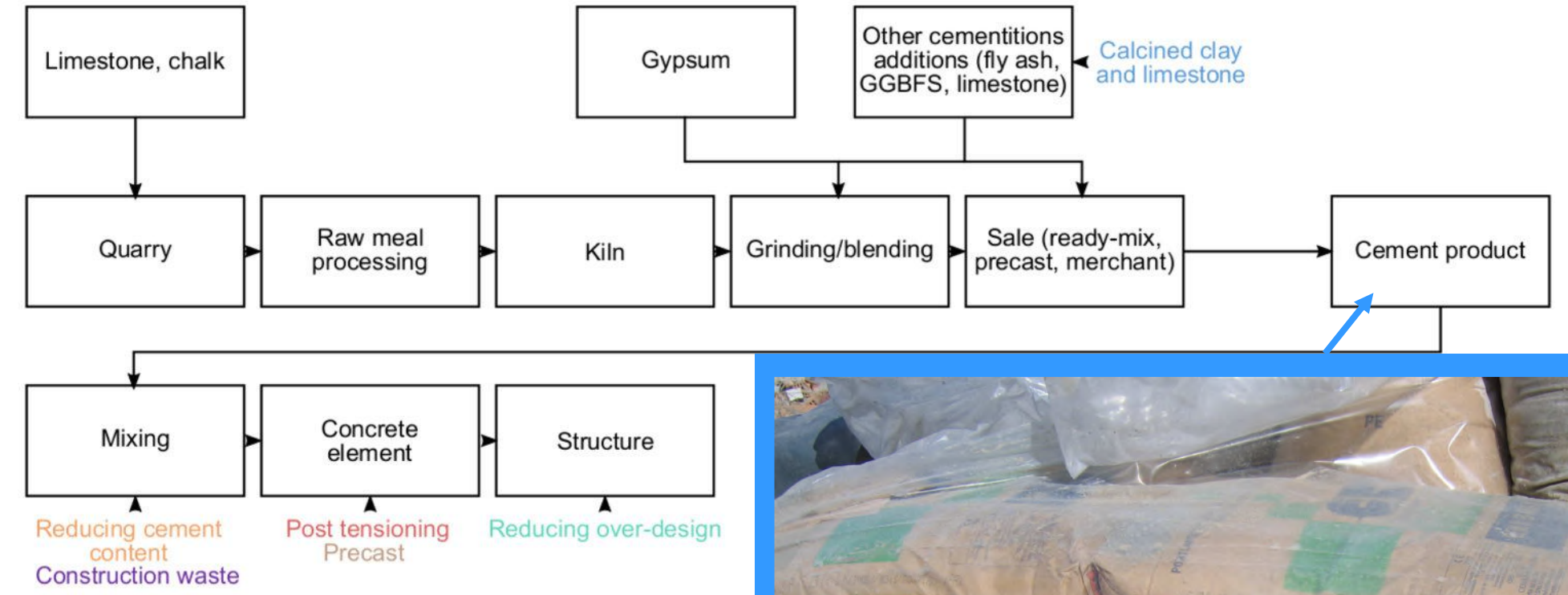
Cement and concrete production



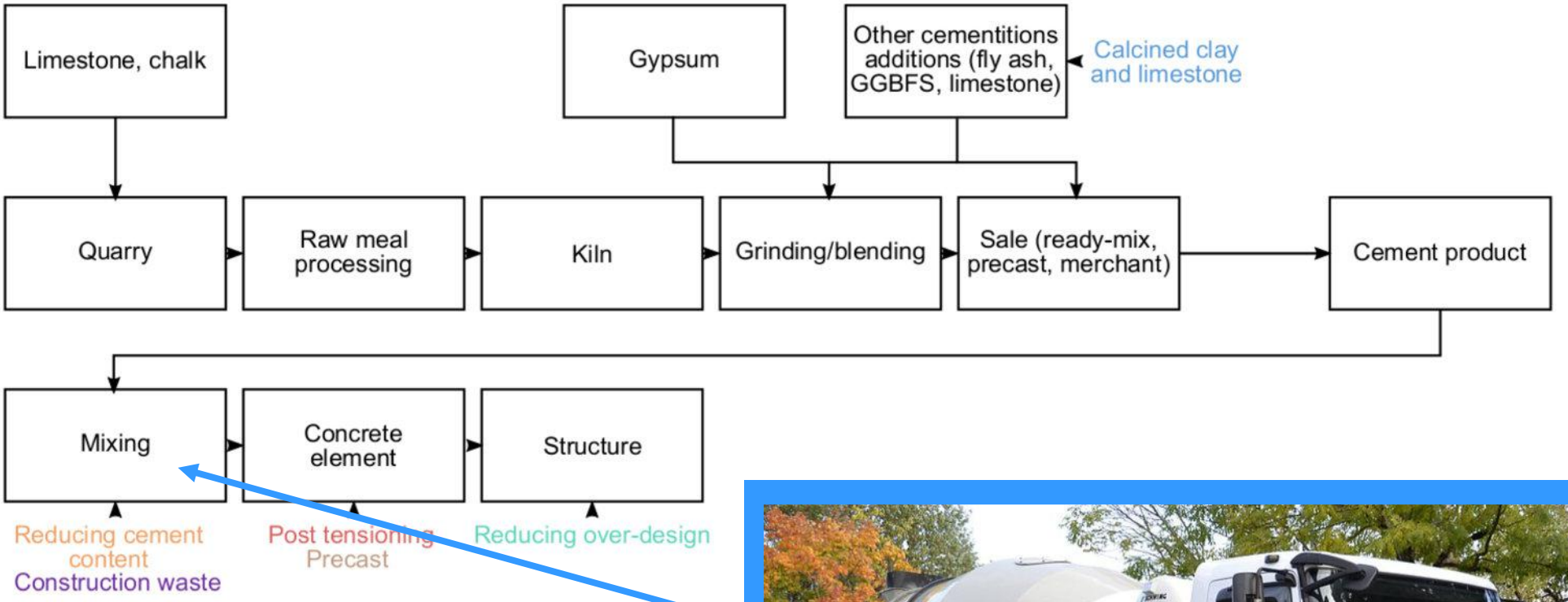
Cement and concrete production



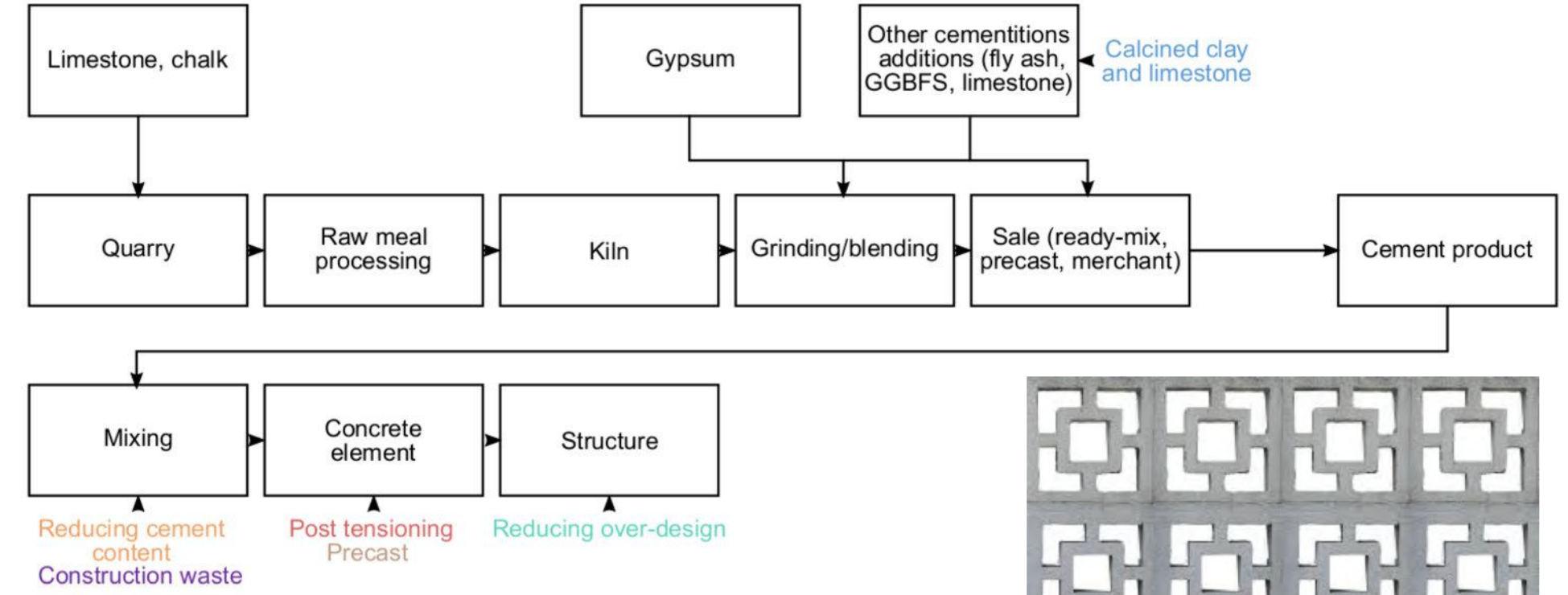
Cement and concrete production

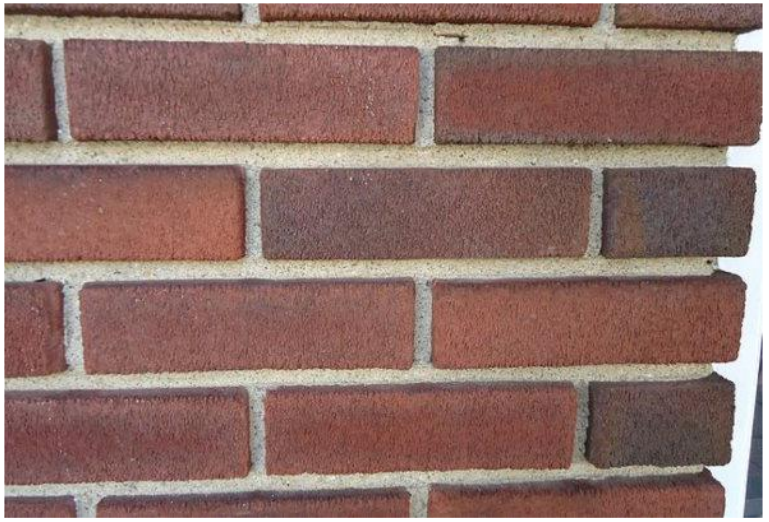


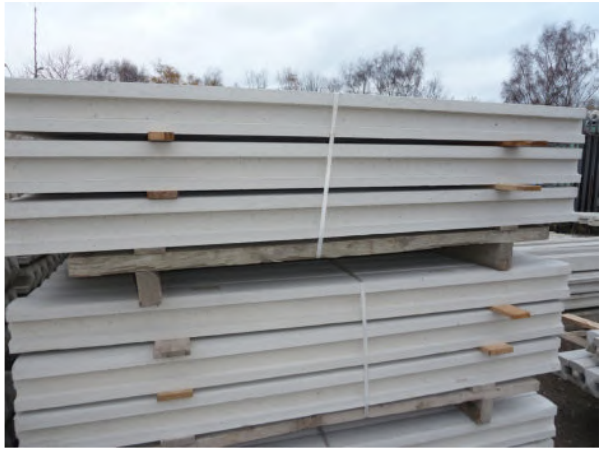
Cement and concrete production



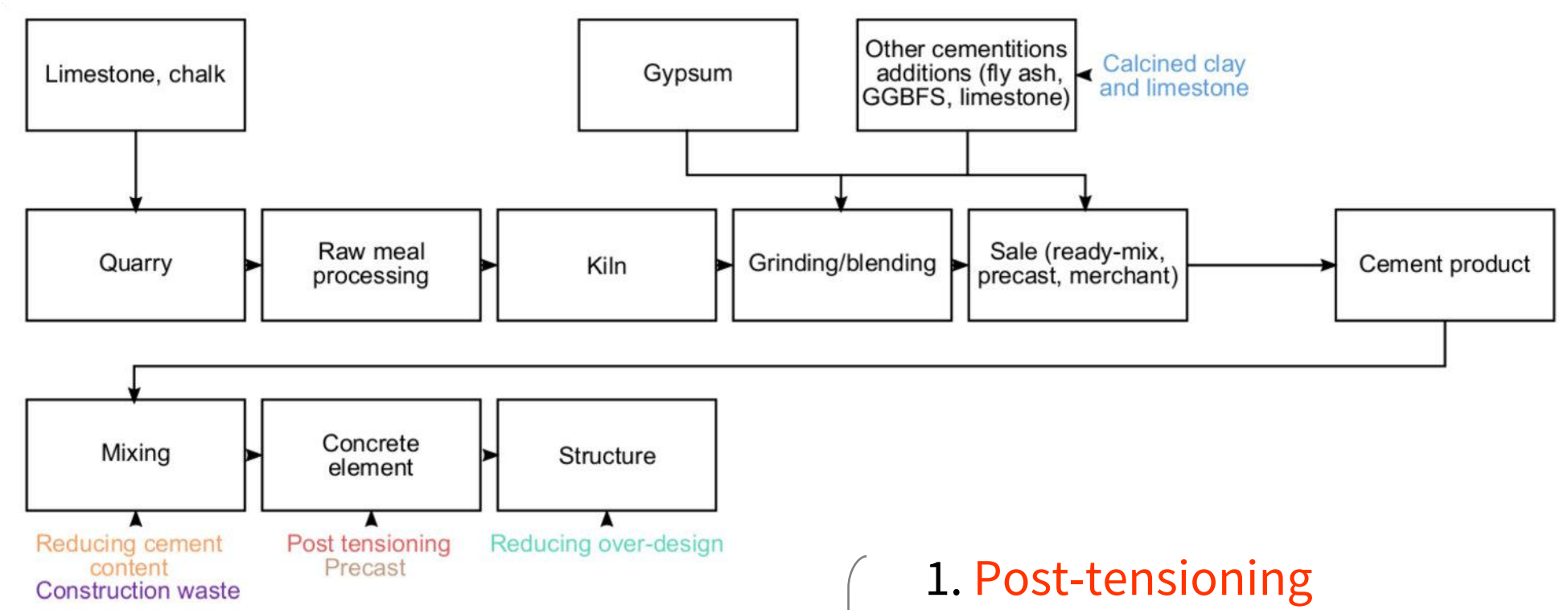
Cement and concrete production







Material efficiency measures

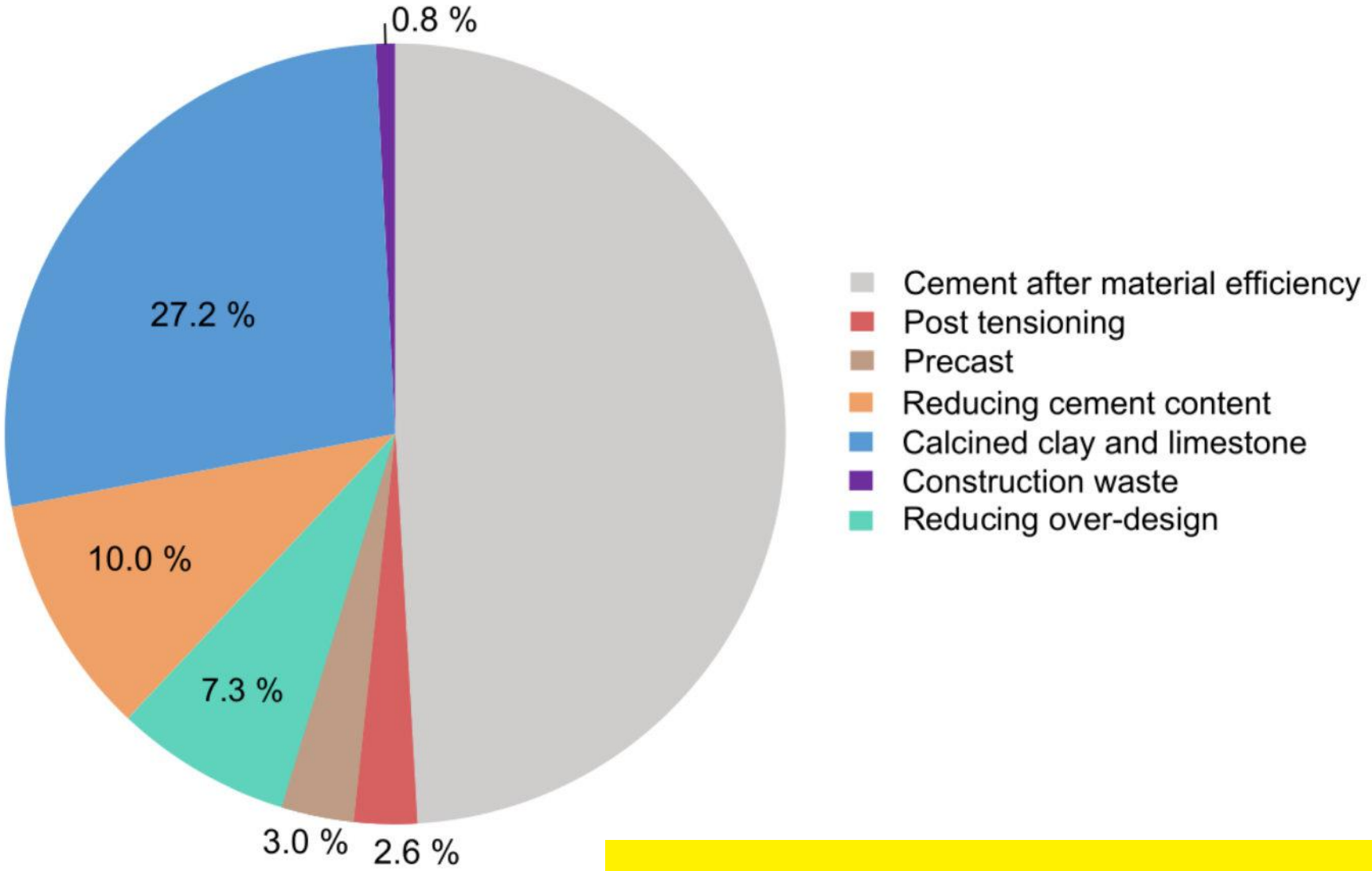


Order reflects state-of-readiness of each measure

1. Post-tensioning
2. Pre-cast systems
3. Reducing cement content
4. Calcinated clay + limestone
5. Construction waste
6. Reducing over-design

Methods and results validated through interviews with structural designers from Ramboll UK, Expedition Engineering, Price & Myers

How much cement could we do without?



We could reduce CO_2 emissions by ~50%

Available data lacks resolution…

Great Britain
2003 - 2014
United Kingdom
2015 -

Annual Cement Channel of Sale 2003 - 2015

mpa essential materials sustainable solutions

mpa cement

(Figures in Thousand tonnes)	Ready Mix	Merchant	Products	Other	TOTAL
2003	5442	2423	3213	578	11656
2004	5613	2399	3118	546	11676
2005	5610	2204	2918	574	11307
2006	5949	2158	2764	453	11324
2007	6404	2198	2837	459	11898
2008	5402	1992	2206	541	10141
2009	3991	1580	1594	447	7612
2010	4189	1572	1777	287	7825
2011	4535	1614	1936	313	8398
2012	4250	1496	1782	260	7787
2013	4680	1519	1761	360	8321
2014	4717	1611	2182	468	8978
2015	5273	1701	2360	829	10163

Available data lacks resolution…

Great Britain

2003 - 2014

Ur

20

Association Européenne du Ciment
The European Cement Association
CEMBUREAU

ix. Cement consumption by end uses of cement

Cement consumption, by end uses of cement (general) (%)

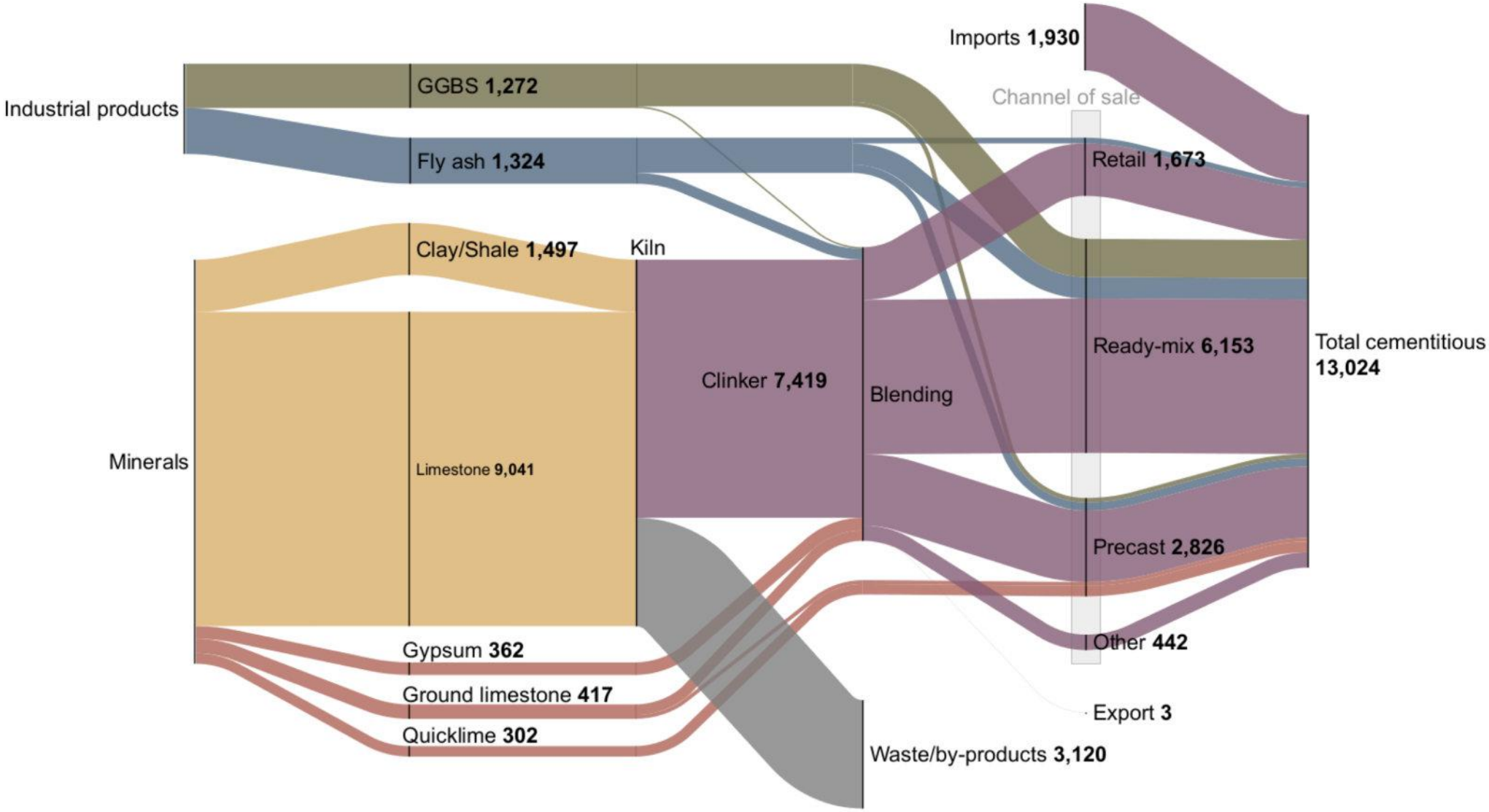
			2000		
	Housing	Non Residential	Civil Engineering	Repair & Maintenance	Housi
Austria	30	27	34	9	21
Belgium	27	25	11	37	21
Bulgaria	na	na	na	na	na
Croatia	na	na	na	na	na
Czech Republic	11	42	27	20	14
Denmark	0	54	26	20	31
Estonia	4	25	18	53	13
Finland	26	37	28	9	30
France	27	22	38	14	30

Outline

1. Assessment of cement-saving potential of Material Efficiency measures
2. Detailed analysis of how cement is used in the UK
3. Conclusions

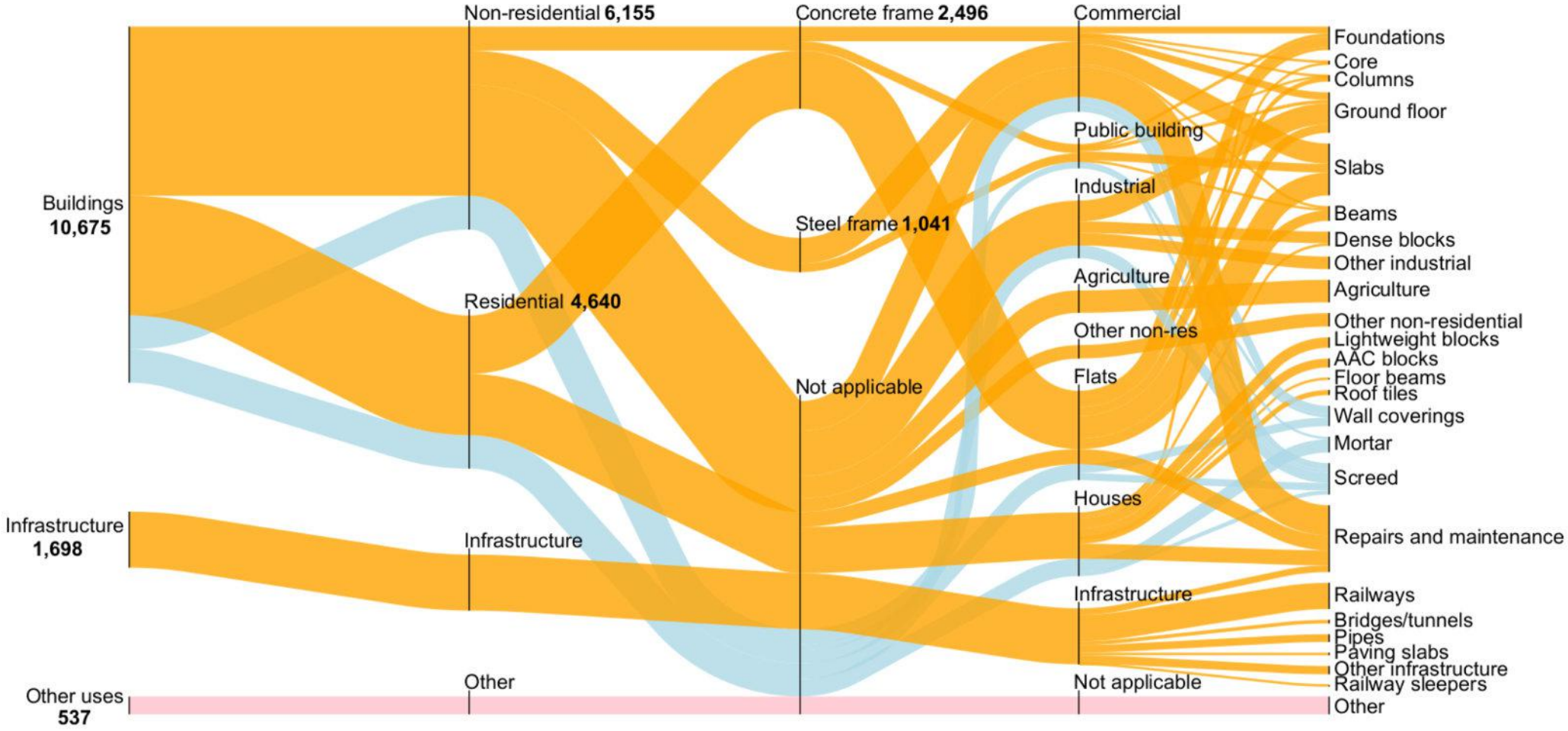
Production of cement in the UK

Mass of cement (UK, 2014)



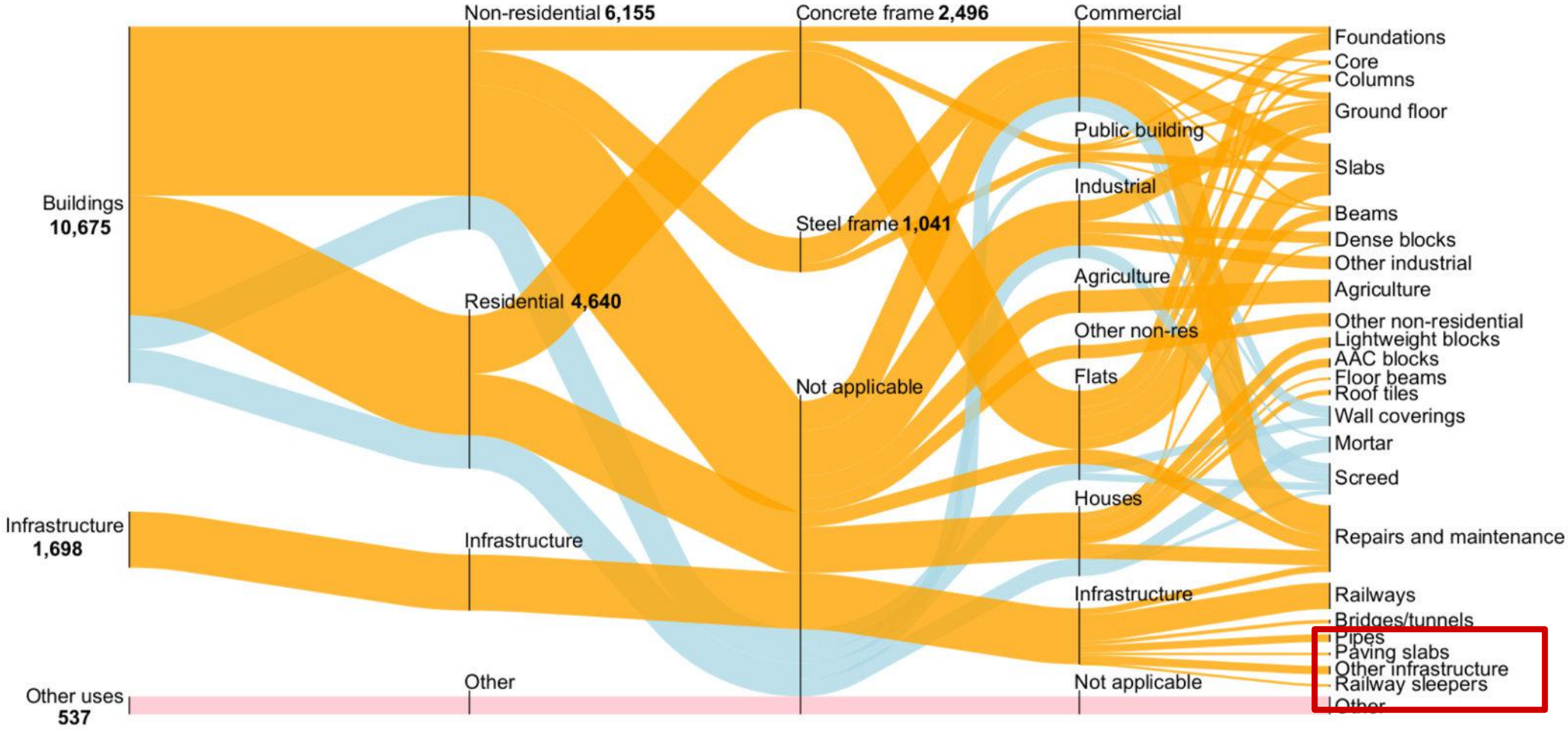
End-uses of cement in the UK

Mass of cement (UK, 2014)



End-uses of cement in the UK

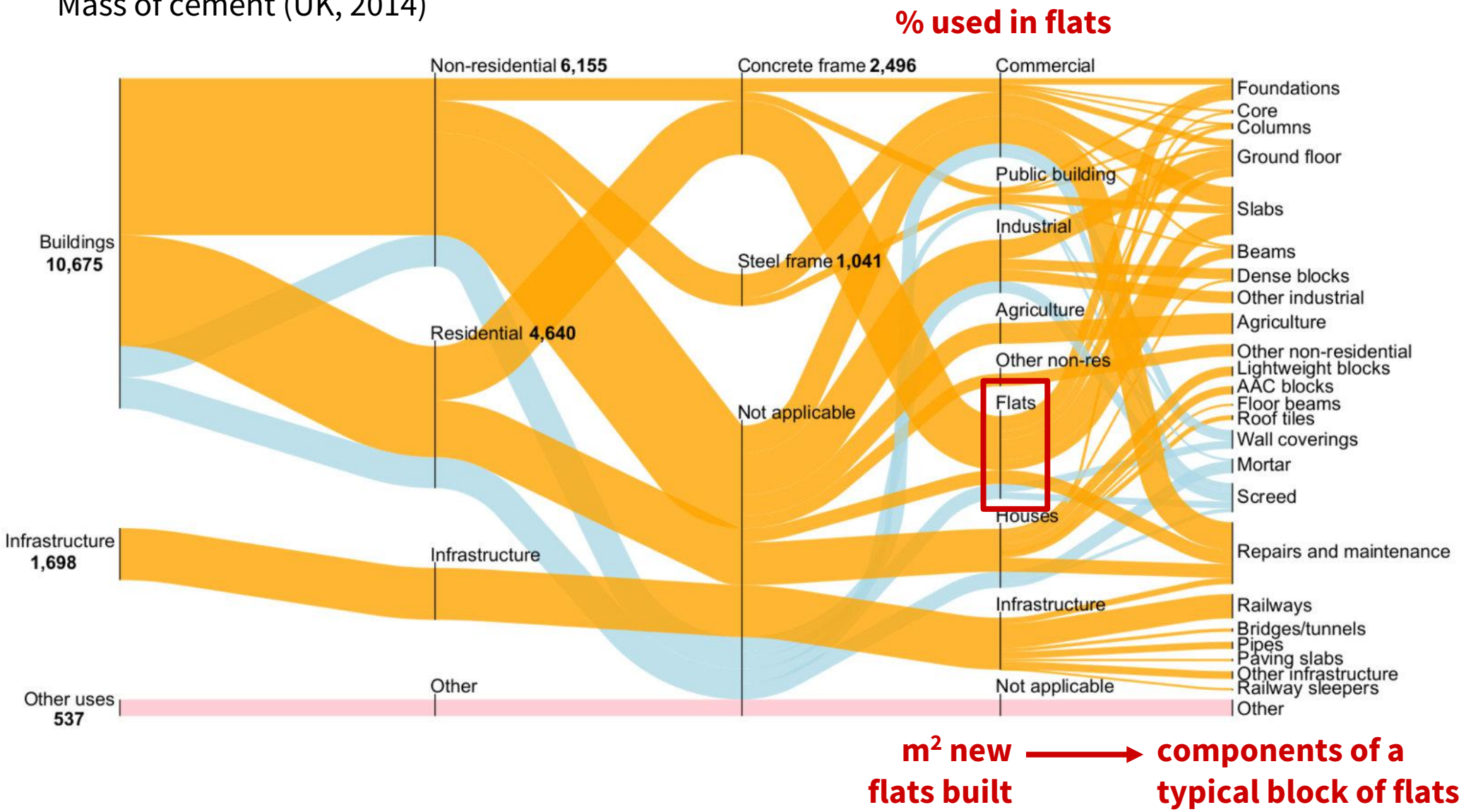
Mass of cement (UK, 2014)



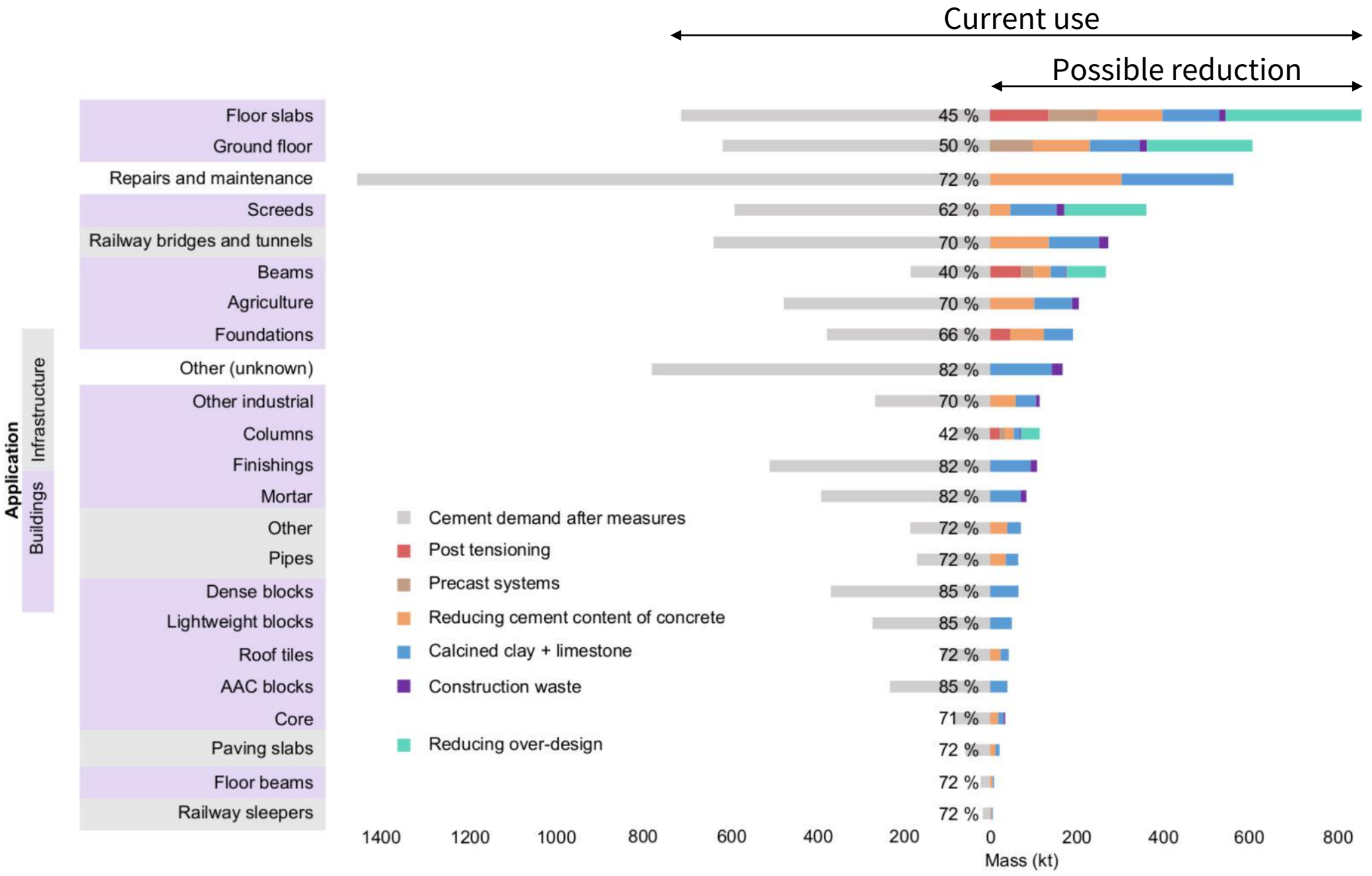
number of paving slabs and sleepers produced

End-uses of cement in the UK

Mass of cement (UK, 2014)



How much cement could we do without?



Conclusions

Cement demand from **floors**, **repairs and maintenance**, **concrete beams**, and applications within the **transport sector** should be targeted.

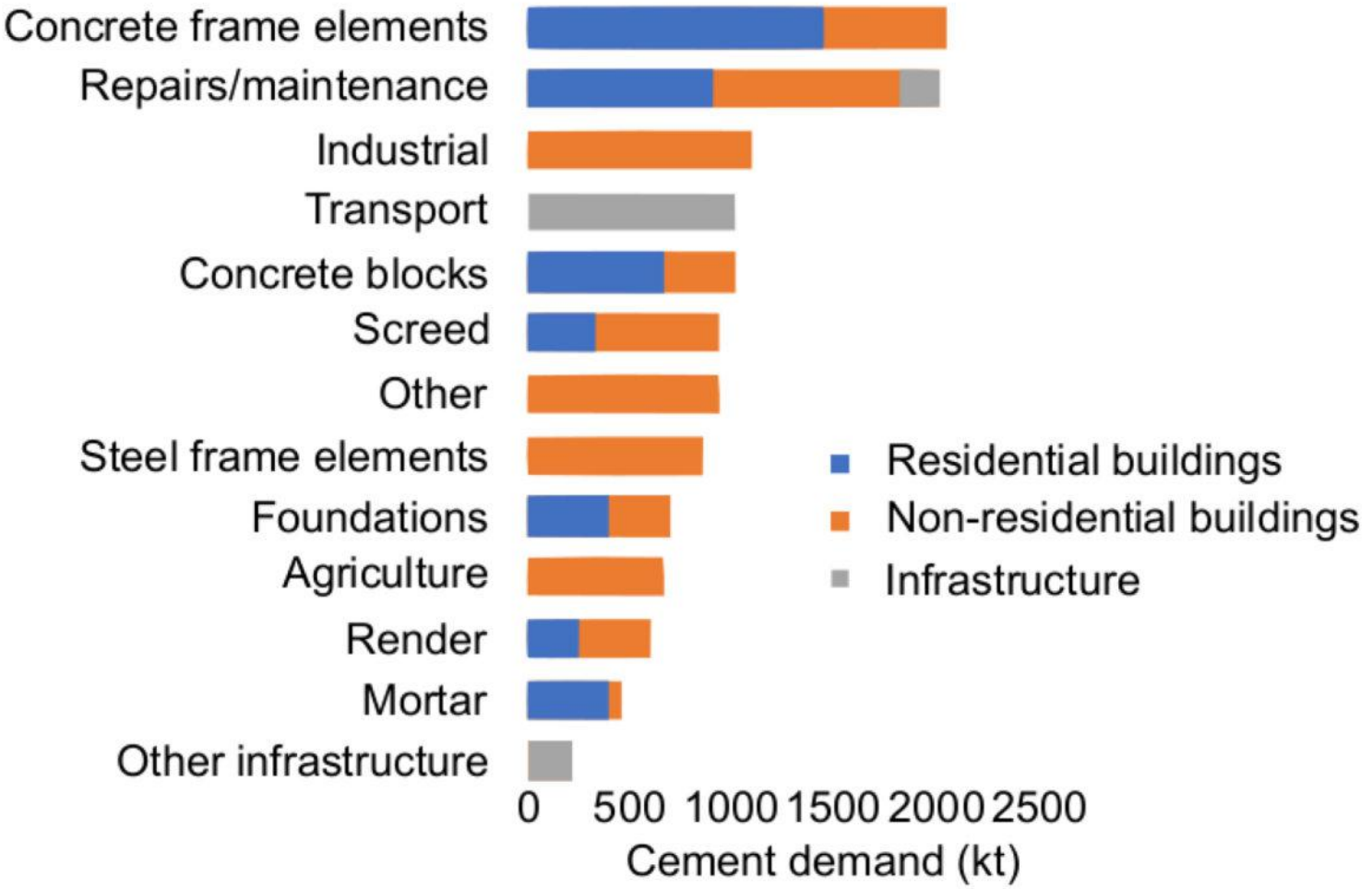
The substitution of cement with **calcined clay and limestone** has the biggest potential to reduce cement demand (27%) and carbon emissions in the UK. **Reducing the amount of cement in concrete** has the next highest potential (10%), followed by **post-tensioning floor slabs** (3%).

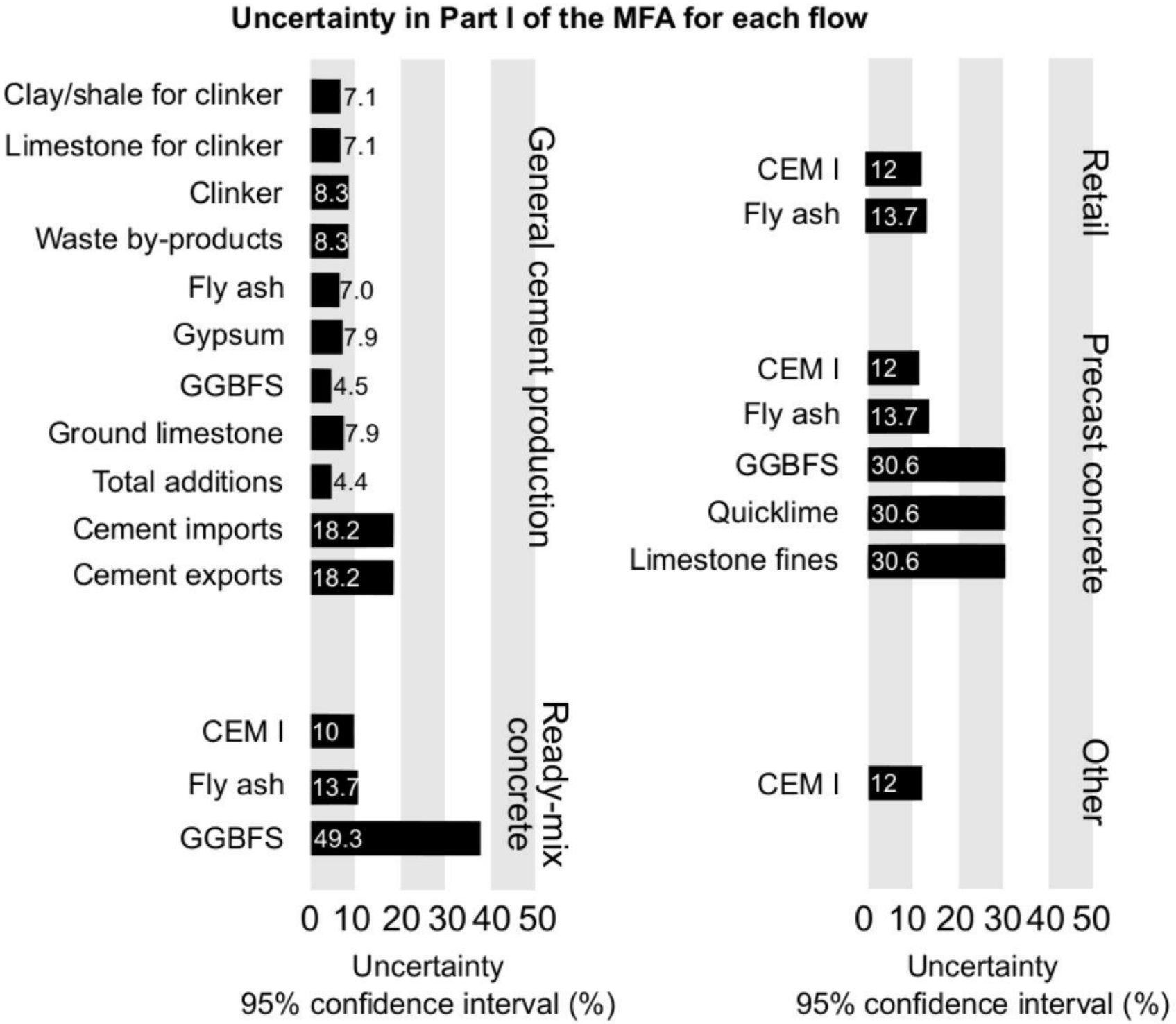
Savings from **changes in design** are difficult to quantify so haven't been included – but they could provide more opportunities.

Thank you!

End-uses of cement in the UK

Mass of cement (UK, 2014)




Uncertainty in Part I of the MFA for each flow
Clay/shale for clinker
7.1
Limestone for clinker
7.1
Clinker
8.3
Waste by-products
8.3
Fly ash
7.0
Gypsum
7.9
GGBFS
4.5
Ground limestone
7.9
Total additions
4.4
Cement imports
18.2
Cement exports
18.2
General cement production
CEM I
10
Fly ash
13.7
GGBFS
49.3
Ready-mix concrete
0 10 20 30 40 50
Uncertainty
95% confidence interval (%)
CEM I
12
Fly ash
13.7
Retail
CEM I
12
Fly ash
13.7
GGBFS
30.6
Quicklime
30.6
Limestone fines
30.6
Precast concrete
CEM I
12
Other
0 10 20 30 40 50
Uncertainty
95% confidence interval (%)