GHGT, Melbourne, 22.10.2018

Retrofitability of CO_2 capture technologies to cement plants

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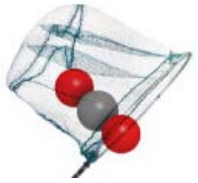
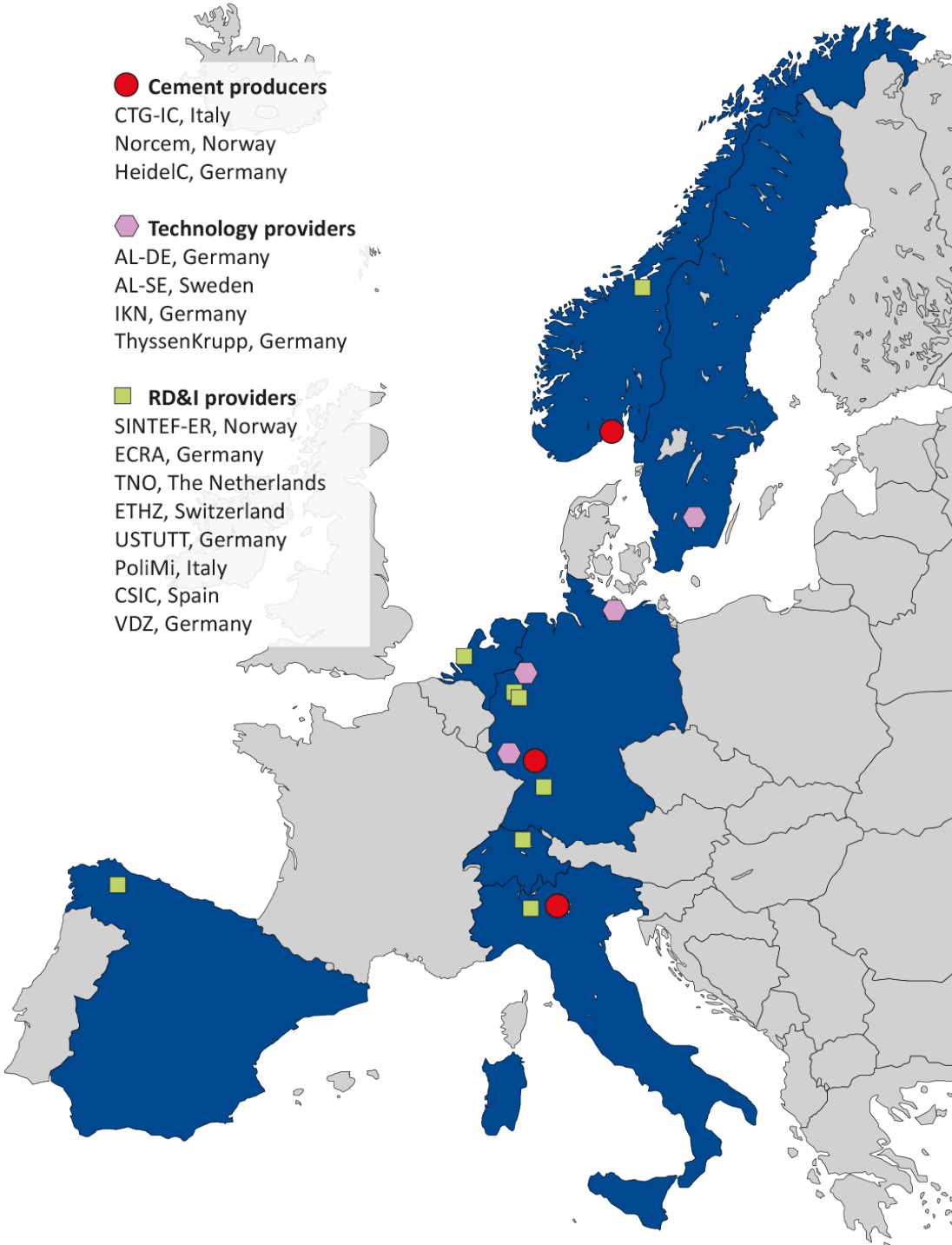
Introduction

- H2020 project CEMCAP

- Motivation:
  - 7-9% of global anthropogenic CO_2 emissions from the cement industry – CCS only viable option
  - Cement plants lifetime: ca 30-50 year

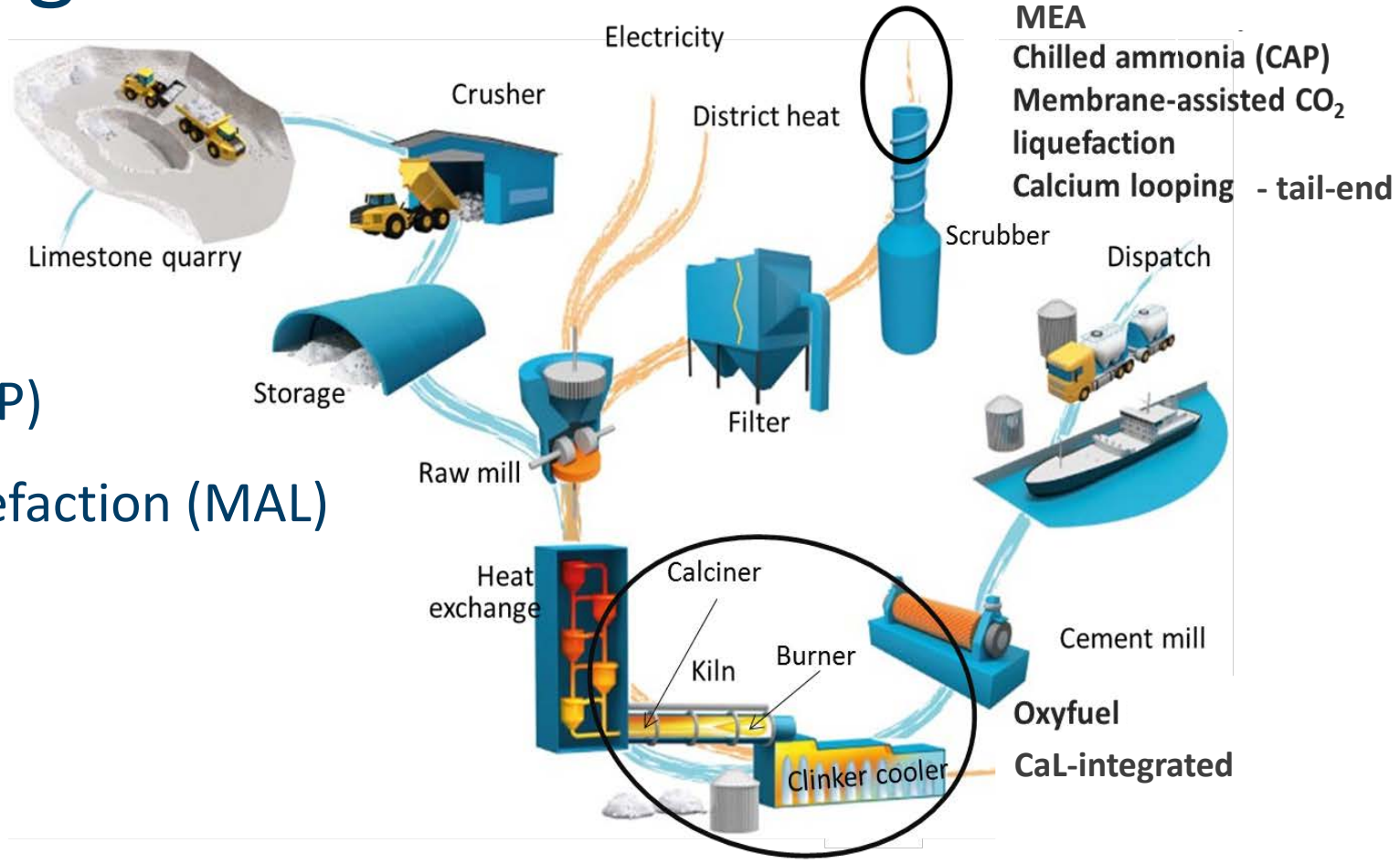
    → Retrofitability important

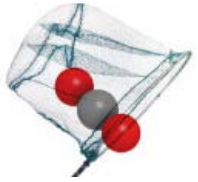




CEMCAP technologies

- MEA (reference)
- Oxyfuel process
- Chilled ammonia process (CAP)
- Membrane-assisted CO_2 liquefaction (MAL)
- Calcium looping (CaL)
  - Tail-end
  - Integrated entrained flow





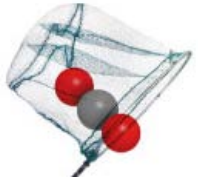
Approach

What would a plant owner have to consider?

- Impact on cement production
- Equipment and footprint
- Utilities and services
- New chemicals/subsystems
- Available experience

Color coding:

✔	retrofitability o.k
!	*some* attention needed for plant retrofit
!!	special attention needed for plant retrofit
?	needs further assessment for plant retrofit
X	retrofit not possible



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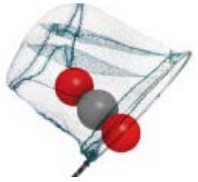
Impact on cement production

	Criteria	MEA/ amine	Oxyfuel	CAP	MAL	CaL (tail-end)	CaL (integrated)
1	Impact on cement production	✔	!!	✔	✔	✔	!
2	Equipment and footprint						
3	Utilities and services						
4	Introduction of new chemicals/subsystems						
5	Available experiences						

- Post combustion – no impact
- Oxyfuel – impact on clinker cooler, kiln, calciner, preheater…
- CaL integrated – impact on calciner and preheater



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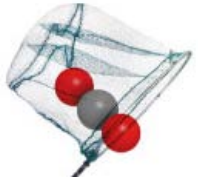
Equipment and footprint

	Criteria	MEA/ amine	Oxyfuel	CAP	MAL	CaL (tail-end)	CaL (integrated)
1	Impact on cement production	✔	!!	✔	✔	✔	!
2	Equipment and footprint	!	!!	!	!	!	!!
3	Utilities and services						
4	Introduction of new chemicals/subsystems						
5	Available experiences						

- *Some* attention needed for all technologies
- Post combustion – can be installed away from kiln
- Oxyfuel and CaL integrated – space required close to kiln



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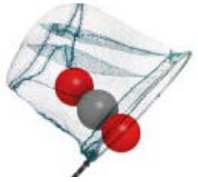
Utilities and services

	Criteria	MEA/ amine	Oxyfuel	CAP	MAL	CaL (tail-end)	CaL (integrated)
1	Impact on cement production	✔	!!	✔	✔	✔	!
2	Equipment and footprint	!	!!	!	!	!	!!
3	Utilities and services	!	!	!	!	!	!
4	Introduction of new chemicals/subsystems						
5	Available experiences						

- Amine and CAP: Steam and power
- Oxyfuel and MAL: Power demand
- CaL: Coal demand, integrated power generation (import/export)



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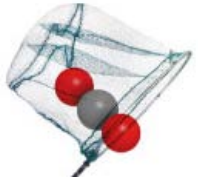
New chemicals/subsystems

	Criteria	MEA/ amine	Oxyfuel	CAP	MAL	CaL (tail-end)	CaL (integrated)
1	Impact on cement production	✔	!!	✔	✔	✔	!
2	Equipment and footprint	!	!!	!	!	!	!!
3	Utilities and services	!	!	!	!	!	!
4	Introduction of new chemicals/subsystems	!	!	!	✔	!	!
5	Available experiences						

- MEA: amine
- Oxyfuel: ASU, possibly ORC
- CAP: ammonia, refrigeration
- MAL: refrigeration
- CaL: ASU, steam cycle



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Available experiences (I)

	Criteria	MEA/ amine	Oxyfuel	CAP	MAL	CaL (tail-end)	CaL (integrated)
1	Impact on cement production	✔	!!	✔	✔	✔	!
2	Equipment and footprint	!	!!	!	!	!	!!
3	Utilities and services	!	!	!	!	!	!
4	Introduction of new chemicals/subsystems	!	!	!	✔	!	!
5	Available experiences	✔	?	!			

Amine:
Boundary dam
Norcem Brevik
370 ton CO_2 / 2700 h

Oxyfuel:
CEMCAP – unit pilots

CAP:
Mountaineer
50 MW_{th}
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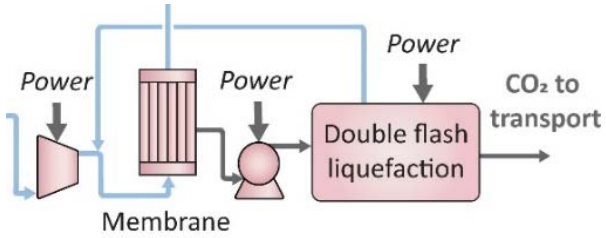
Available experiences (II)

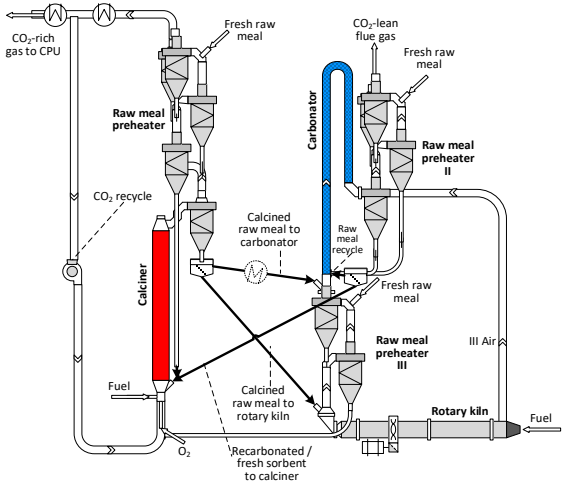
	Criteria	MEA/ amine	Oxyfuel	CAP	MAL	CaL (tail-end)	CaL (integrated)
1	Impact on cement production	✔	!!	✔	✔	✔	!
2	Equipment and footprint	!	!!	!	!	!	!!
3	Utilities and services	!	!	!	!	!	!
4	Introduction of new chemicals/subsystems	!	!	!	✔	!	!
5	Available experiences	✔	?	!	?	!	?

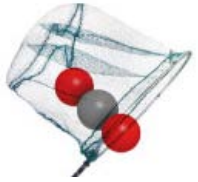
MAL:
CEMCAP liquefaction pilot
Norcem membrane testing



CaL tail-end:
La Pereda 1.7 MW
CEMCAP

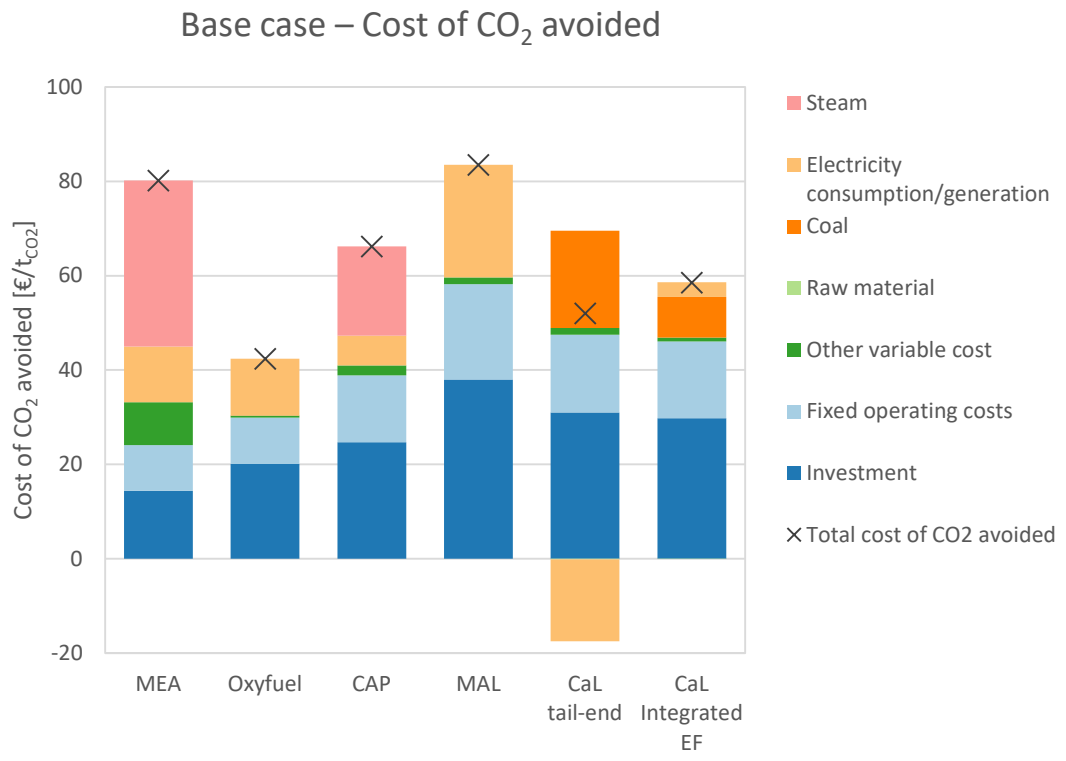
CaL integrated:
CEMCAP
Laboratory scale

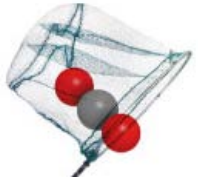




Retrofitability versus cost

	Criteria	MEA/ amine	Oxyfuel	CAP	MAL	CaL (tail-end)	CaL (integrated)
1	Impact on cement production	✔	!!	✔	✔	✔	!
2	Equipment and footprint	!	!!	!	!	!	!!
3	Utilities and services	!	!	!	!	!	!
4	Introduction of new chemicals/subsystems	!	!	!	✔	!	!
5	Available experiences	✔	?	!	?	!	?





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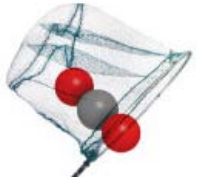
Conclusions

	Criteria	MEA/ amine	Oxyfuel	CAP	MAL	CaL (tail-end)	CaL (integrated)
1	Impact on cement production	✔	!!	✔	✔	✔	!
2	Equipment and footprint	!	!!	!	!	!	!!
3	Utilities and services	!	!	!	!	!	!
4	Introduction of new chemicals/subsystems	!	!	!	✔	!	!
5	Available experiences	✔	?	!	?	!	?

- Most aspects require *some* attention
- *No* aspects assessed as *retrofit not possible* for any technologies
- Post-combustion technologies easier retrofit

Full report:
D4.5 Retrofitability study for CO_2 capture technologies in cement plants
To be shared in: https://zenodo.org/communities/cemcap/



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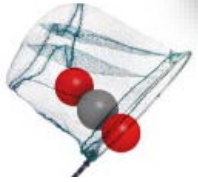

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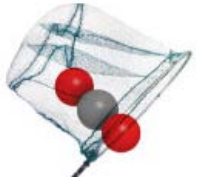

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