The Case for BECCS in the Hard-to-Abate Lime Industry

OPPORTUNITIES AND CHALLENGES OF BECCS IN THE LIME INDUSTRY

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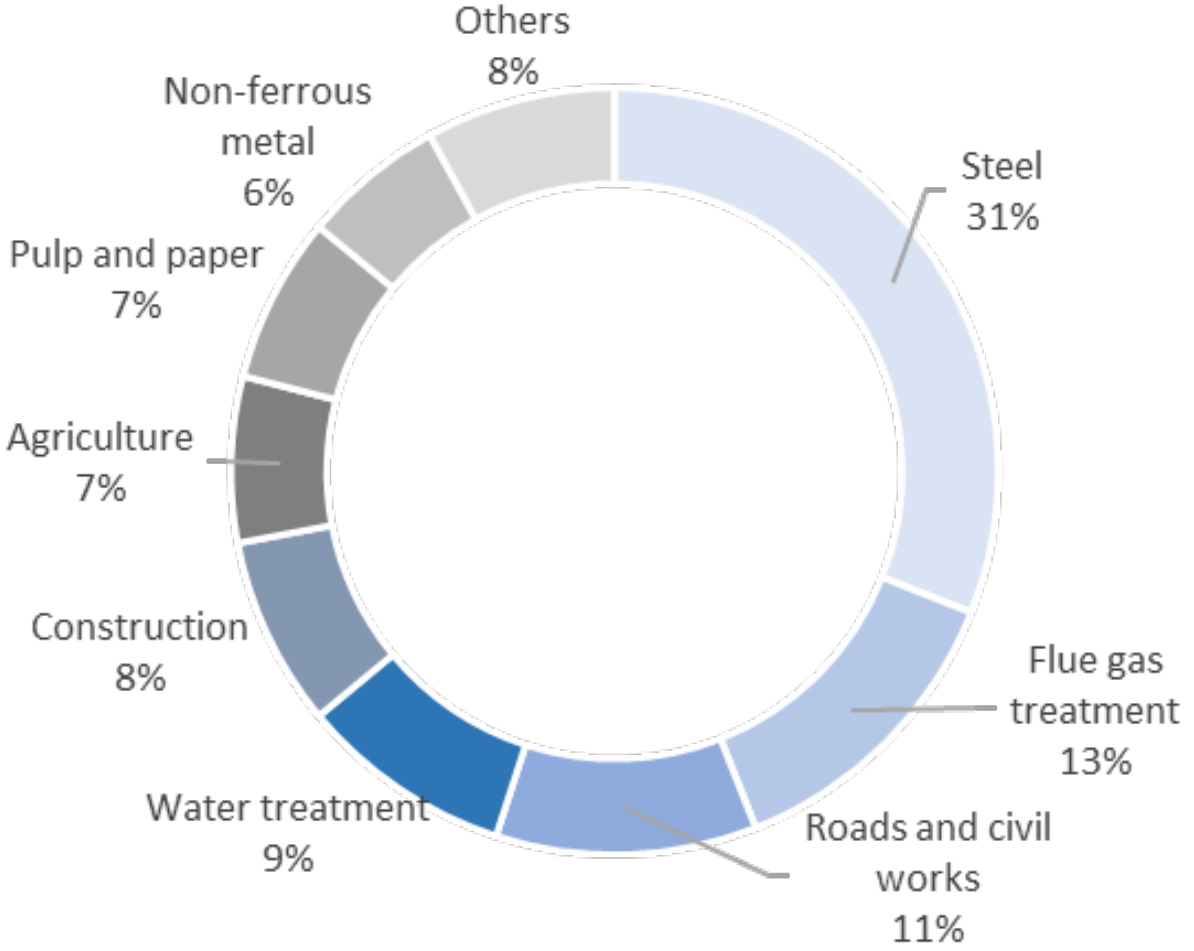
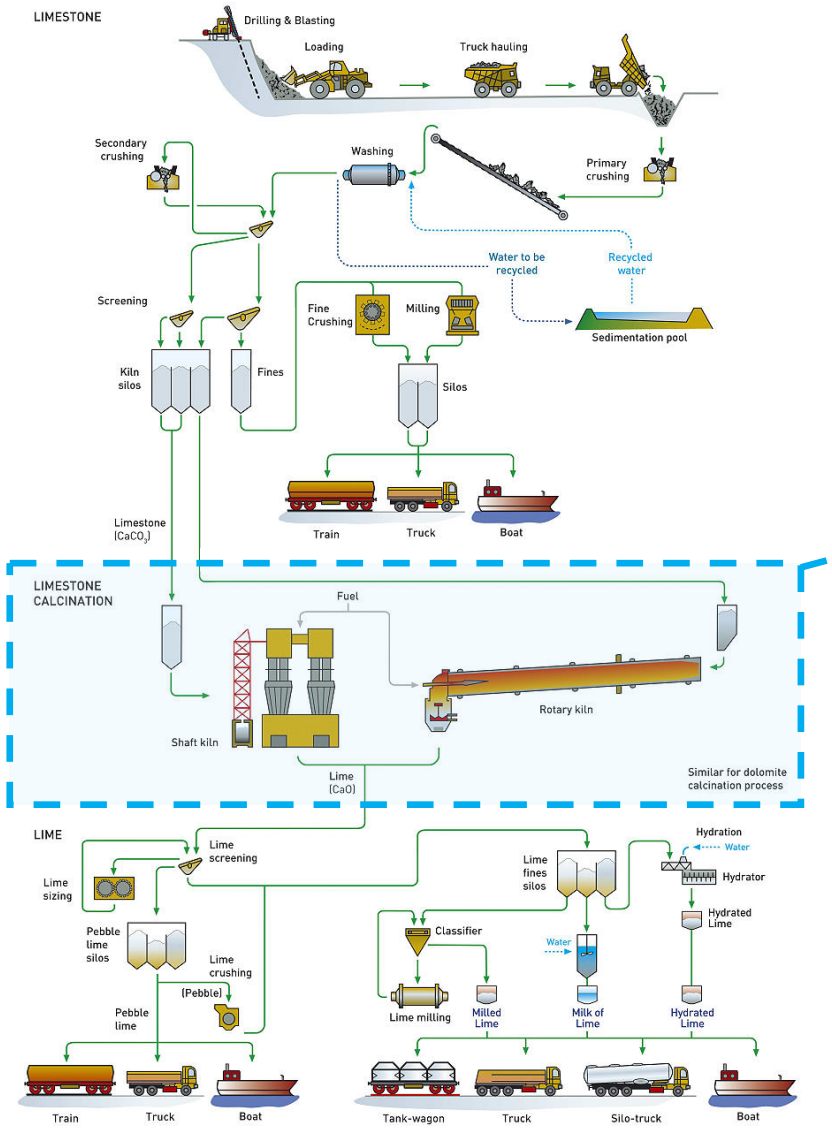
Lhoist

Lime – an essential product for a wide range of applications

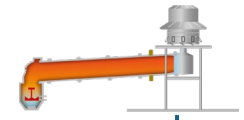


Lime production process

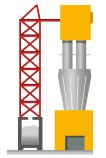
From Limestone To Lime



Kiln Type



Rotary kiln



Shaft kiln

Chemical Reaction

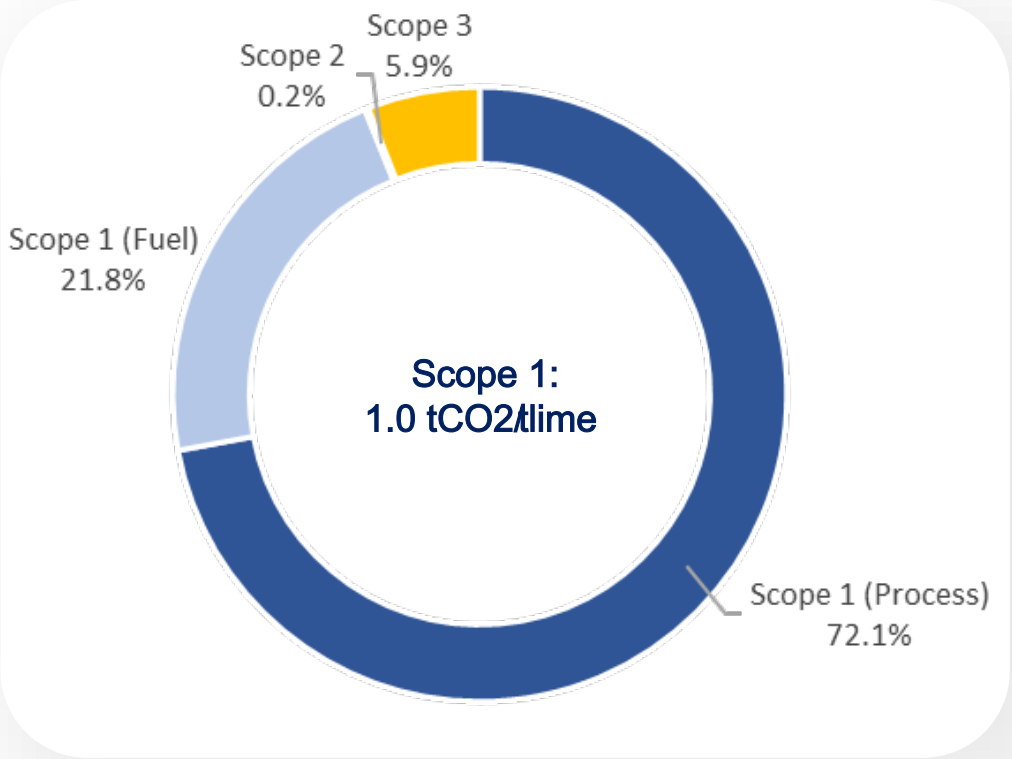
$CaCO_3$ + Energy ⇌ CaO + CO_2

100 g — 3200 kJ/kg CaO — *56 g* — *44 g*

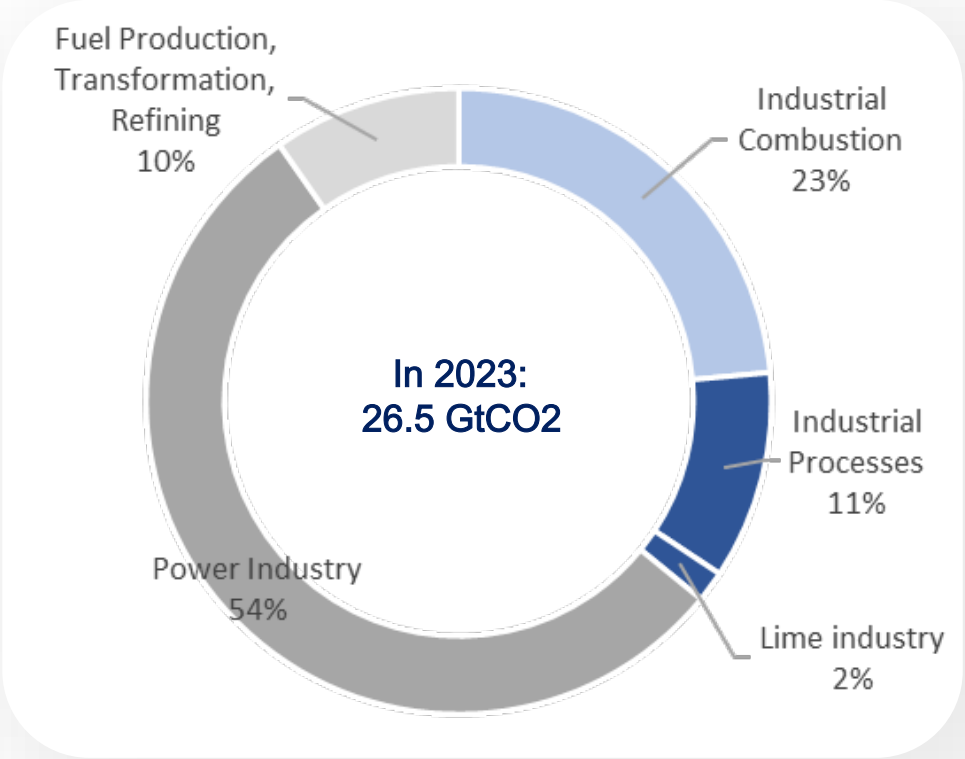
Source : Boynton

The carbon intensity challenge of lime

Carbon intensity of lime



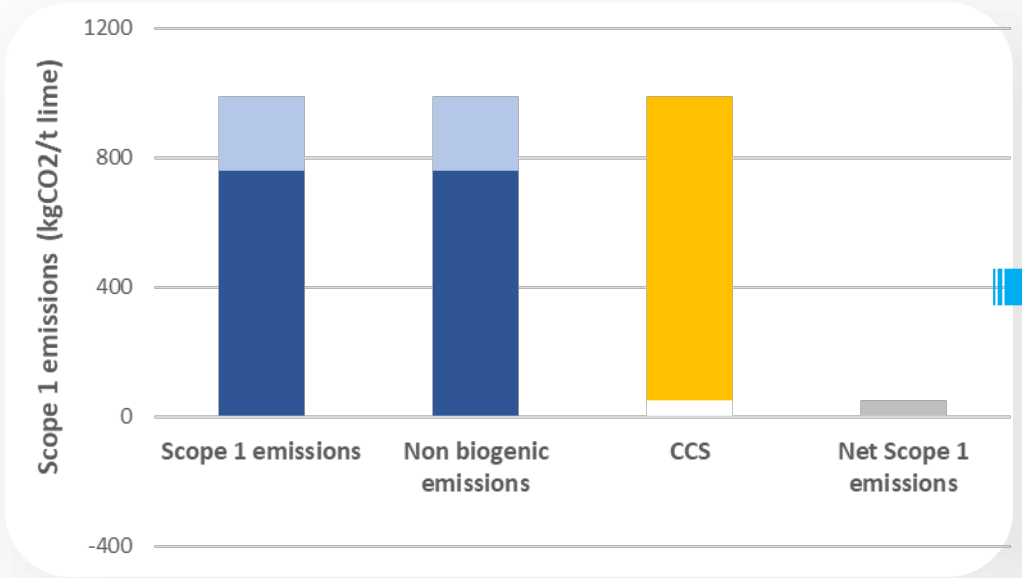
Worldwide direct industrial emissions



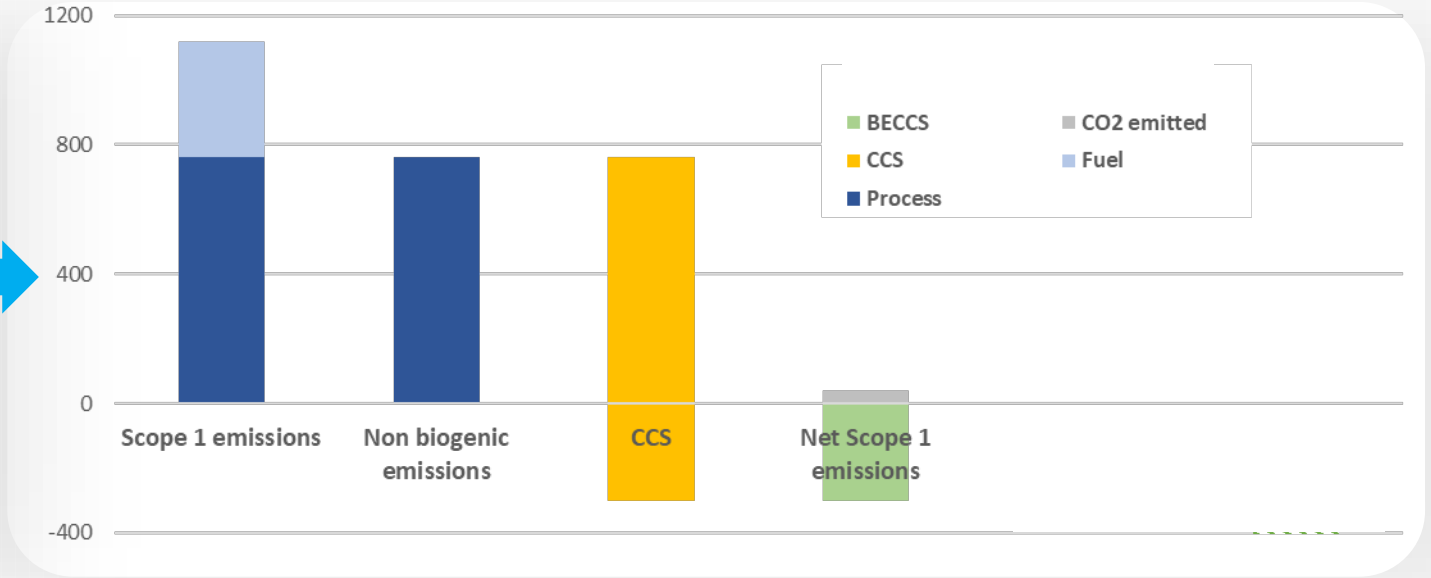
Source: IEA EDGAR CO2, a component of the EDGAR (Emissions Database for Global Atmospheric Research) Community GHG database version

Lime – a strong potential for negative carbon intensity

From the baseline: Natural Gas + CCS

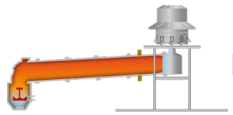


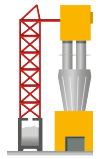
… to negative Scope 1 carbon intensity with BECCS



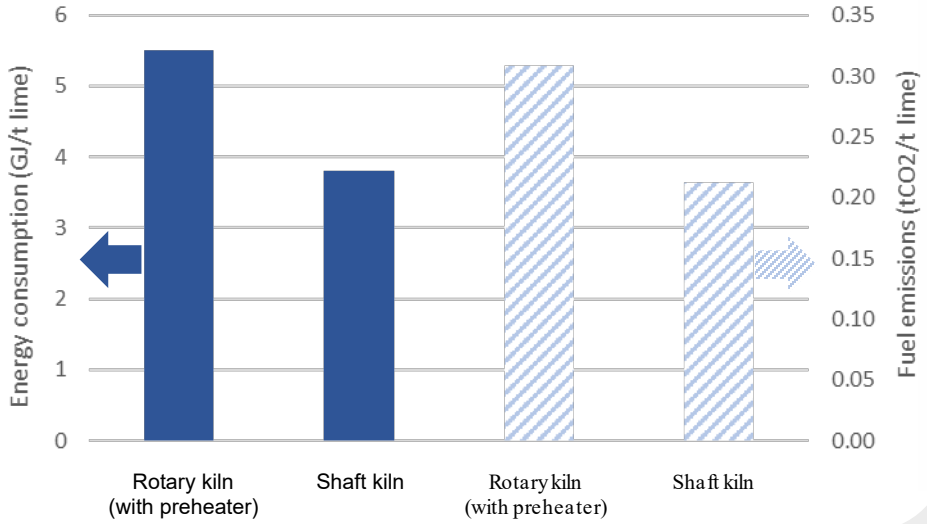
… and negative Scope 2 + 3 carbo
intensity withrecarbonation

Technical challenges with biomass



Rotary kiln → 1 → Shaft kiln  Natural Gas → 2 → Biomass 

1 The switch to more efficient kilns is the first step for GHG reduction



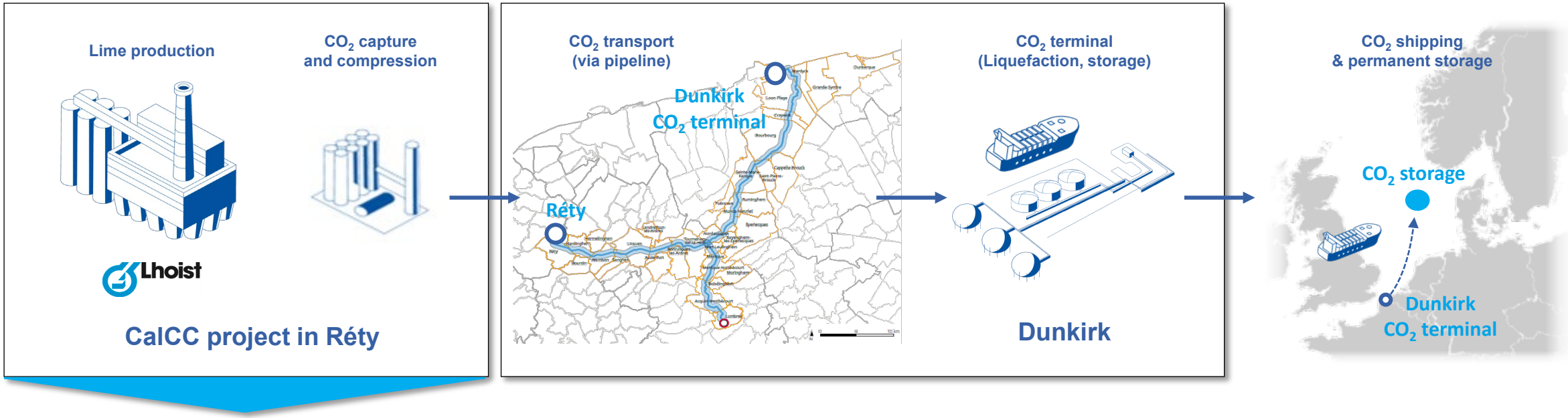
2 The switch to biomass, mainly in solid state, resolves the issue of fuel-related CO2 emissions, but presents various challenges

- Various impurities can affect the quality and effectiveness of the lime / dolime
- Additional impurities need to be managed in the flue gas (e.g. higher NOx levels)
- Biomass is more expensive than NG or Coal
- Extra equipment (handling, storage, etc.), and in some cases adaptations of the kilns are required
- Biomass has a higher carbon intensity than NG, leading to additional costs on the entire CO2 chain

Rety CalCC: the most advanced large-scale CCS project in lime worldwide

Funded by the European Union

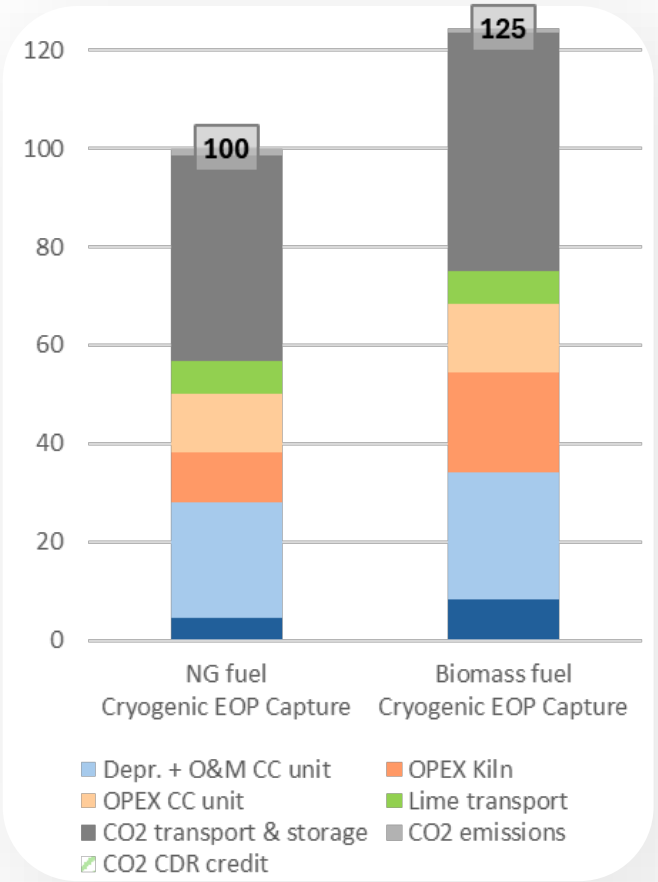
« D'Artagnan » scope



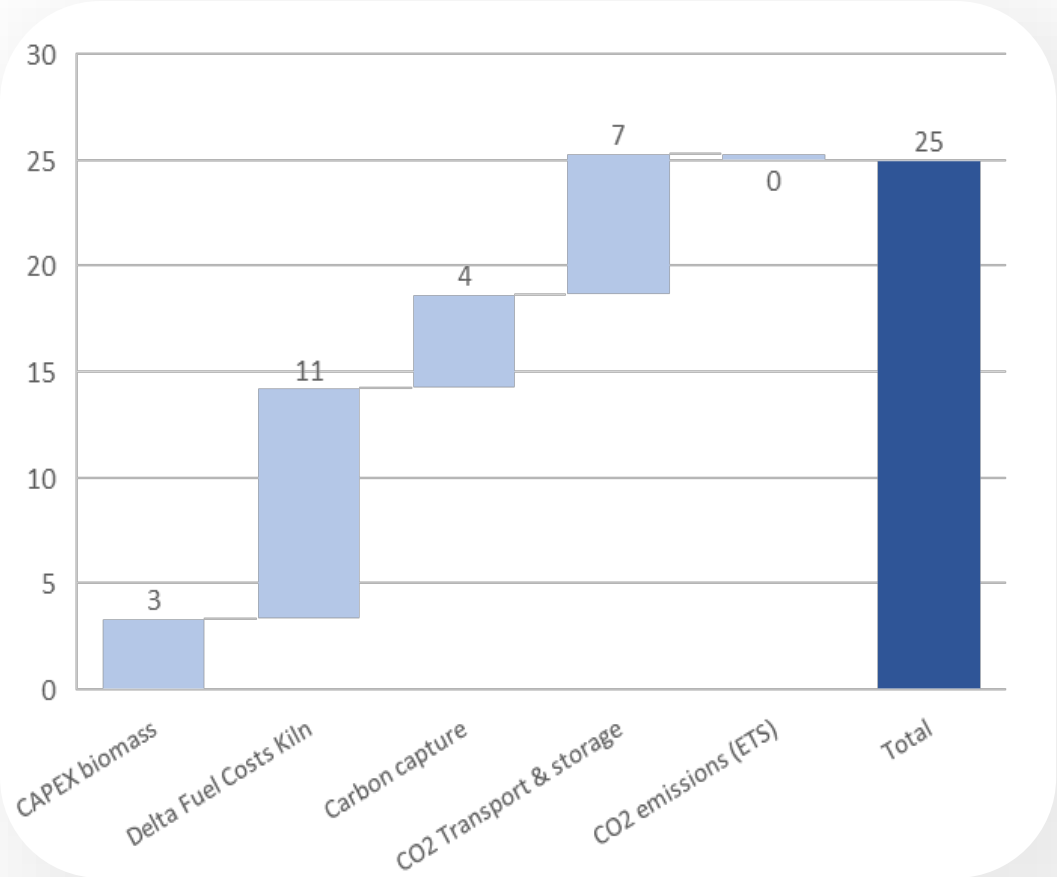
- **Context** The Réty CCS project aims at fully decarbonizing the largest lime plant in France
- **Target** avoiding approx. 600 kTons of CO_2 emissions per year
- **Challenge** as the most advanced large-scale CCS project in lime worldwide, Rety CalCC has to contend with the challenges of the developing CO2 infrastructure, and the complexities of the business models

Δ in Green Lime production costs: BECCS vs NG+CCS

Green Lime Production cost (€/t lime)
(normalized, NG+CCS = 100)



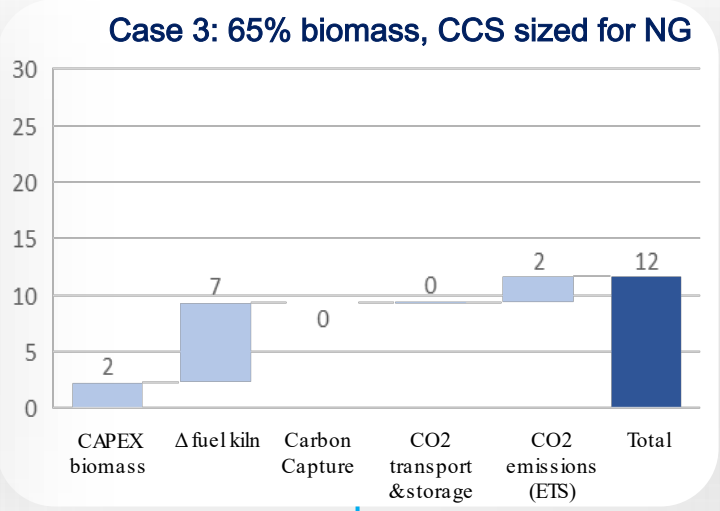
Breakdown of Δ Production Cost between
NG+CCS and BECCS (% baseline cost)

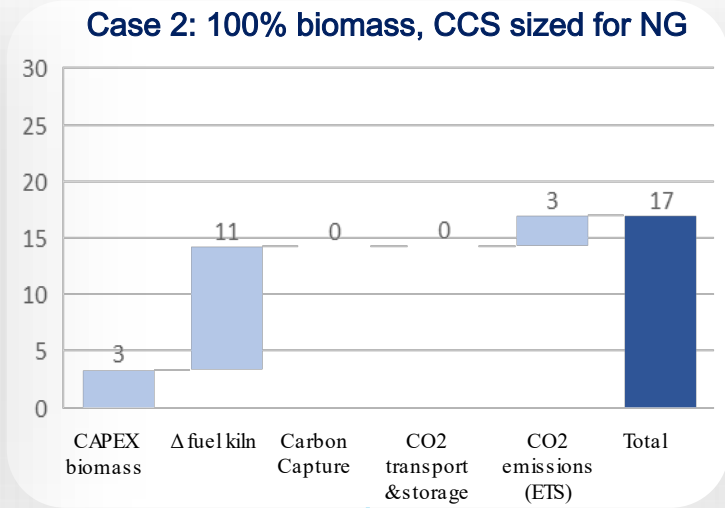


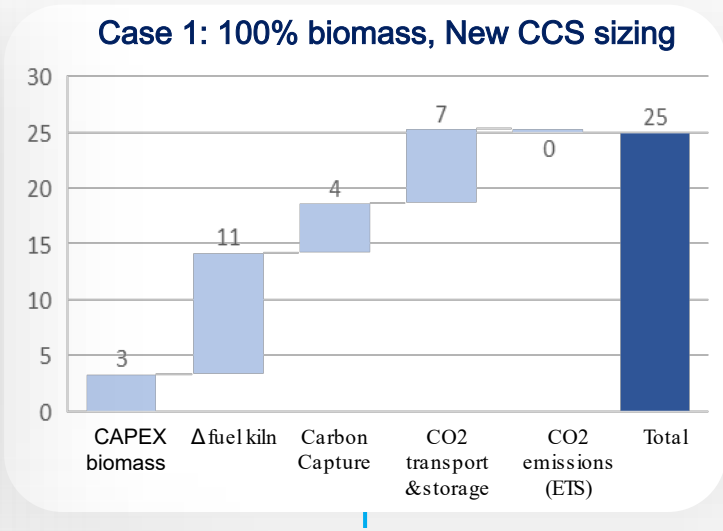
Breakeven BECCS vs NG+CCS: finding the optimum

ΔLime Production Cost

(relative to baseline of NG+CCS)

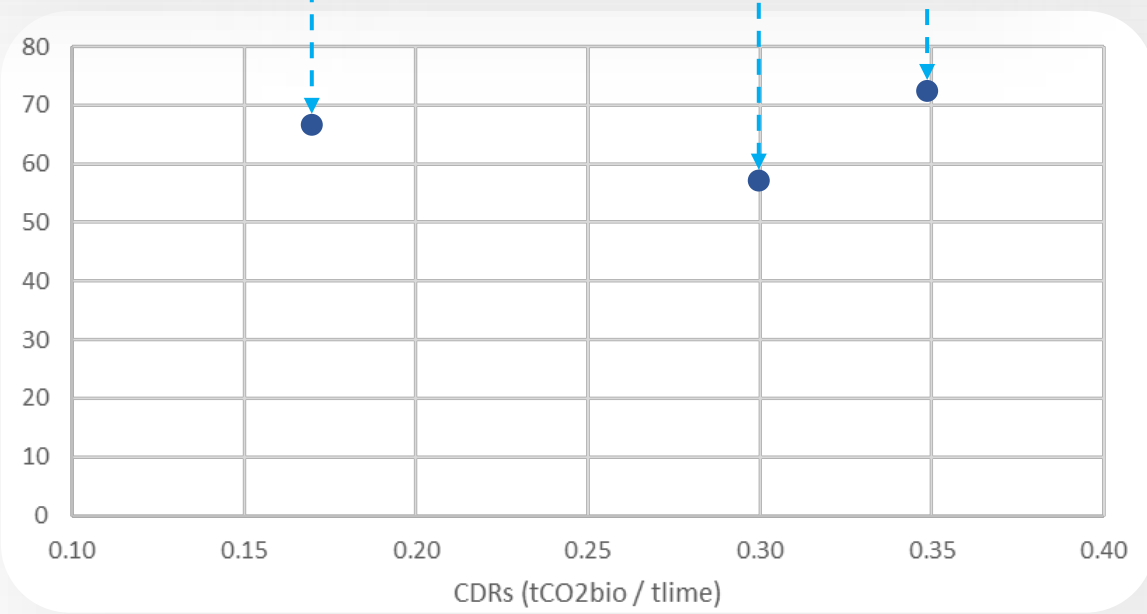




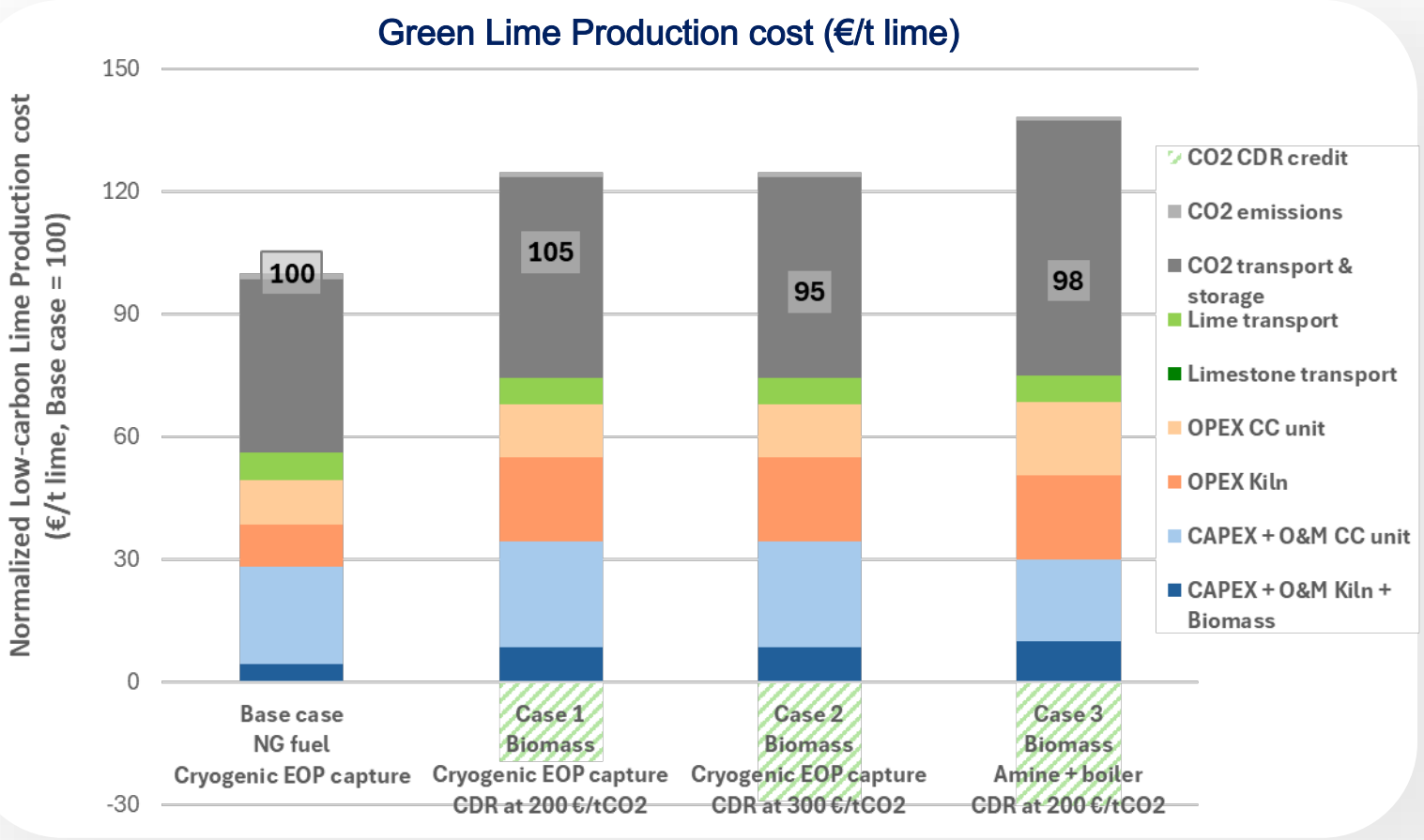


BreakevenCDR Price

(relative to baseline of NG+CCS)



BECCS in lime: the overall economics



CDR values required on this project for BECCS to be viable largely exceed pricing on the EU ETS

Lower pricing viable with extra CDRs generated by amine + boiler

Such a setup consumes 89% more biomass than the one with cryogenic capture

How much biomass is needed for a 600ktpa lime plant to be continuously supplied?

- We consider the biomass and land use to cover 100% of the needs of a RetroCalCC plant

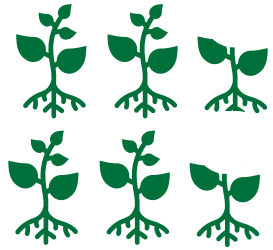
Scenario 1 : Dedicated energy crop (miscanthus 15.6t/ha)

Considering 3 years for yield maturity

(Cryogenics)

(26,000 ha)

(Amine)



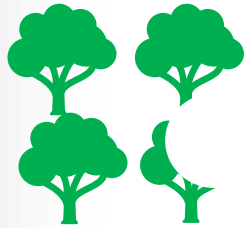
(50,000 ha)

= 10,000 ha

Scenario2 : Dedicated tree farm (eucalyptus,40t/ha)

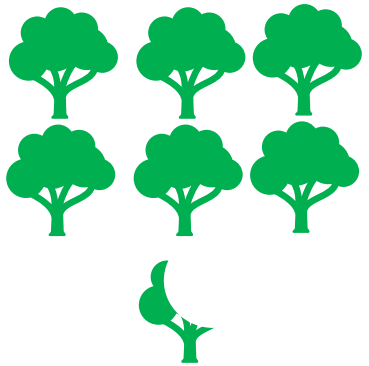
Considering 10 years for yield maturity

(Cryogenics)



(34,000 ha)

(Amine)



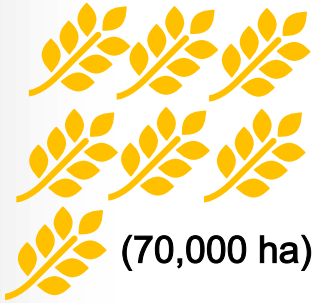
(63,000 ha)

= 10,000 ha

Scenario 3 : Waste from agric. (wheat straw2t/ha)

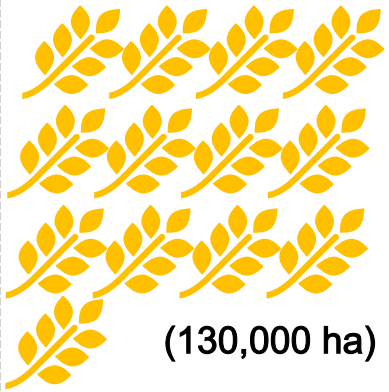
Considering 1 year for yield maturity

(Cryogenics)



(70,000 ha)

(Amine)



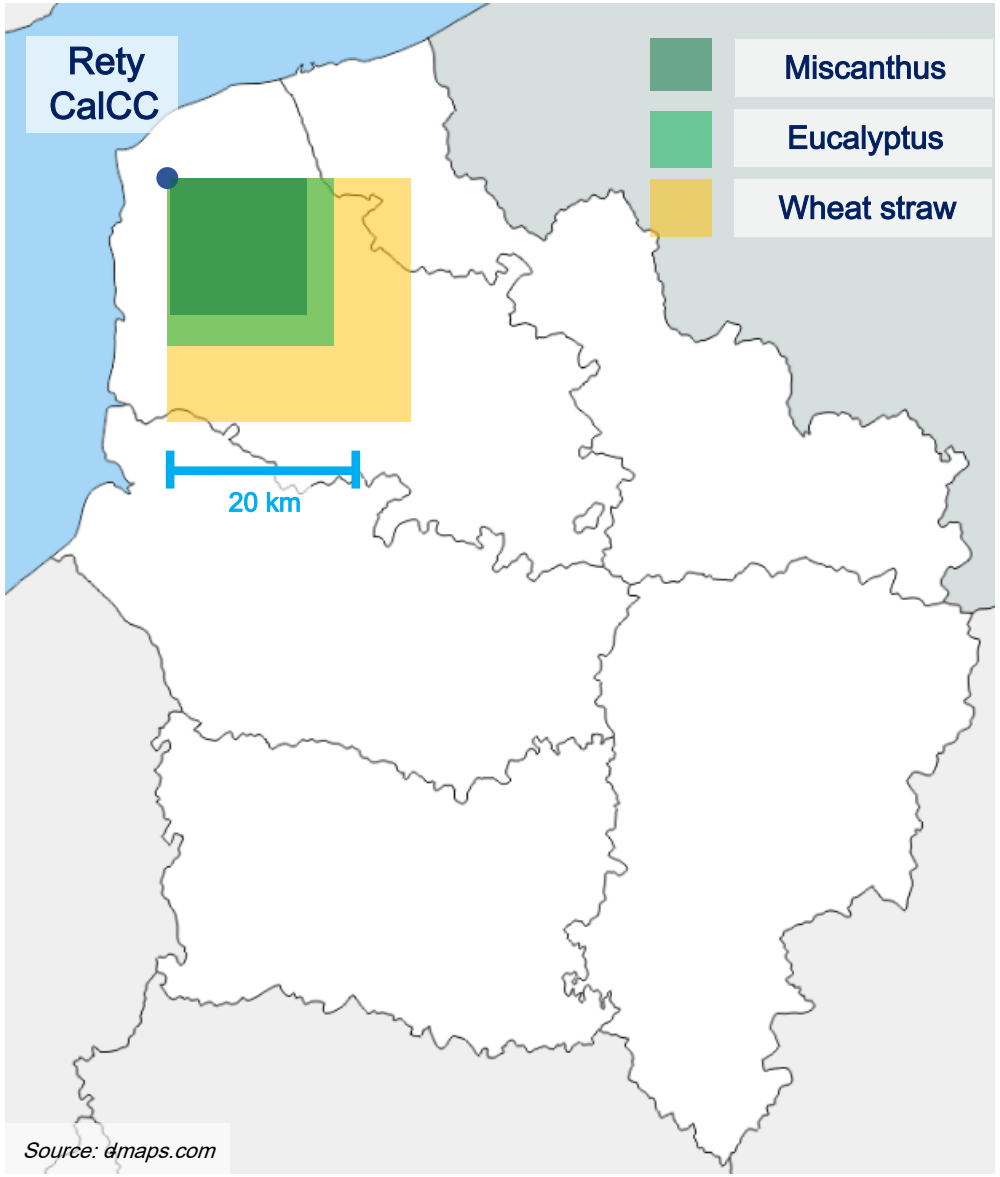
(130,000 ha)

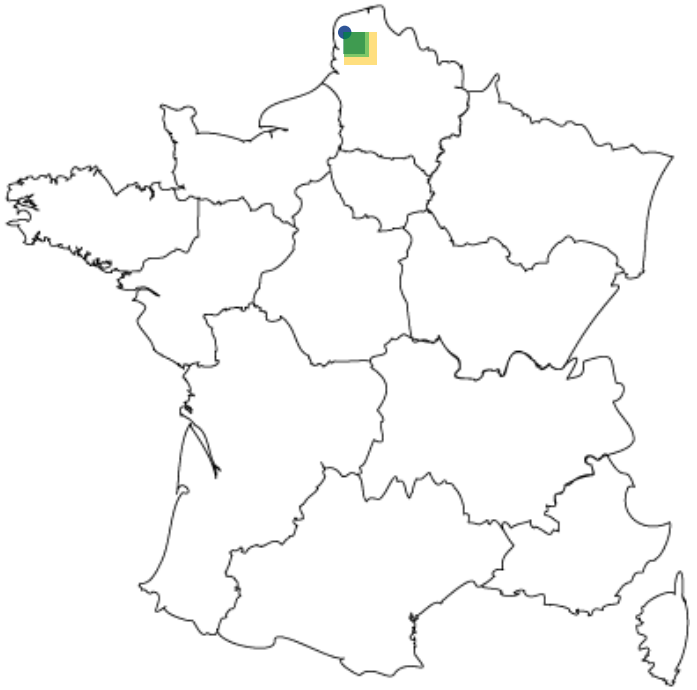
= 10,000 ha

***10,000 ha = 100 km²**

****Average LHV of considered biomass: 18 GJ/t biomass; 8400 GJpd need → 470 tpd biomass → ~140 ktpa biomass (80% time operating)**

The biomass sourcing challenge





- The lime industry accounts for ~1.6% of direct industrial emissions in France
- With 105Mtpyof unused residual biomass in France, shifting the entire lime production to biofuel would require ~0.7% of this residual biomass
- The biomass needs are nevertheless significant, and very difficult to obtain
- Various types of biomass might be needed to supply the needs of a plant

Conclusions

There are various advantages of BECCS in the lime industry:

- Lime is an essential product for key human activities
- The hard-to-abate process CO_2 from the stone results in a high CO_2 concentration, generating higher efficiency in the BECCS process
- The negative emissions from BECCS complement the role of lime as a partial carbon sink in its downstream applications

Various conditions are needed to make this setup viable:

- Access to sustainable and sufficient quantities of biomass
- Regulatory or economic support for CCS projects: CO_2 infrastructure, CO_2 pricing, leading markets, etc.
- A value of CDRs that reflects the benefits of carbon removals, and the associated costs

Back-up slides