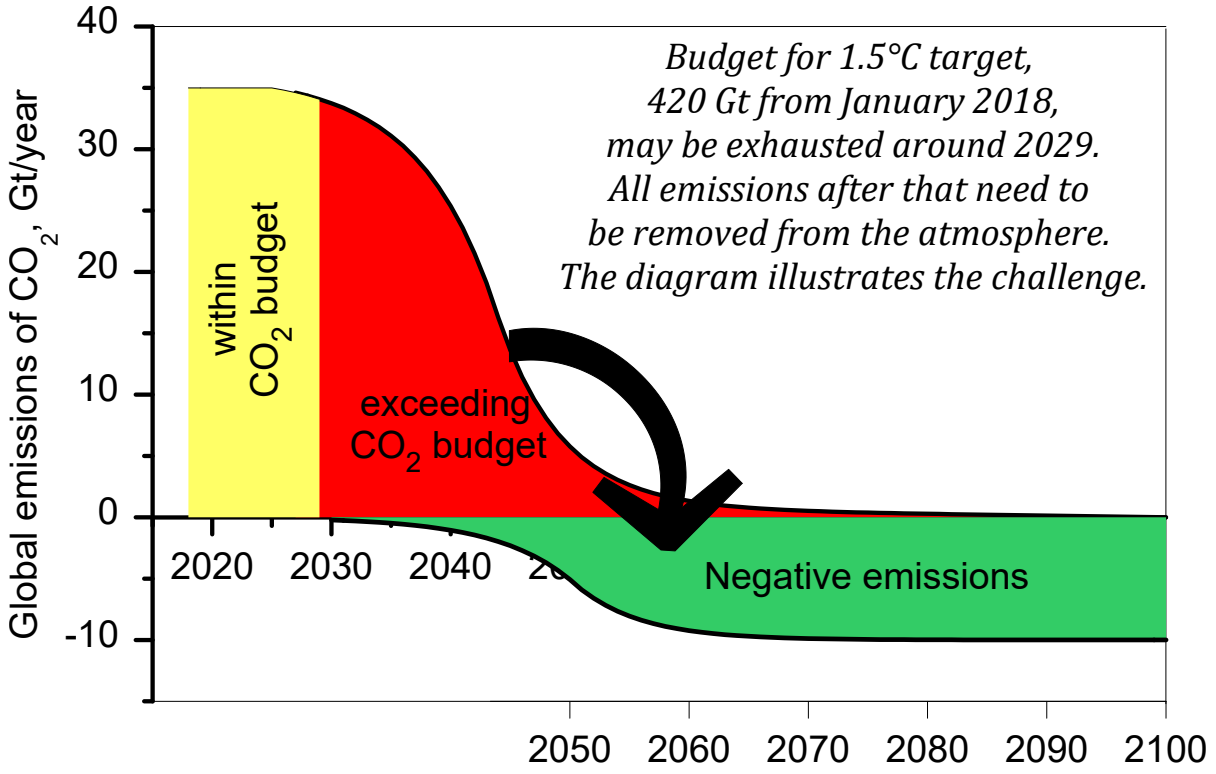
Long-term sustainable financing of negative emissions with a deposit system.

How to redeem the climate debt

and safely meet the 1.5-degree budget.

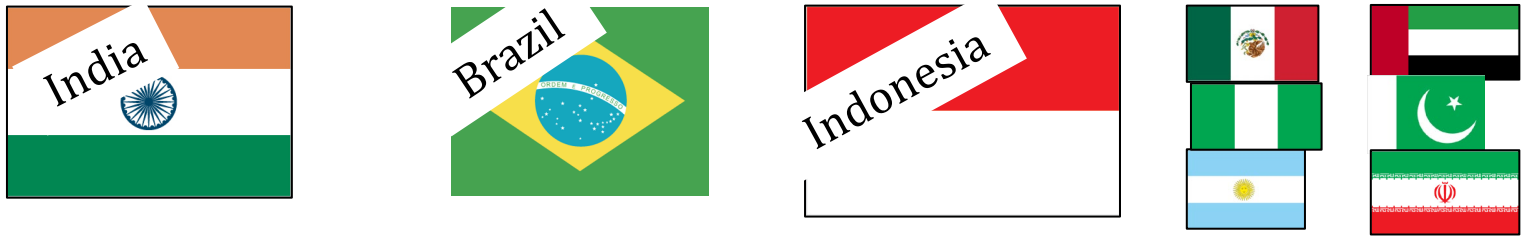
Anders Lyngfelt
and
Mathias Fridahl

- Global carbon budget for +1.5°C likely spent around 2029
- To meet max 1.5°C, ***all CO_2 emissions after 2029 must be removed from the atmosphere.***
- Leaves our children with a **climate debt**, to remove perhaps 800 Gt CO_2, or 100 t/capita (>10.000 €/capita) globally.
- **No realistic mechanism for financing** of future negative emissions in place.

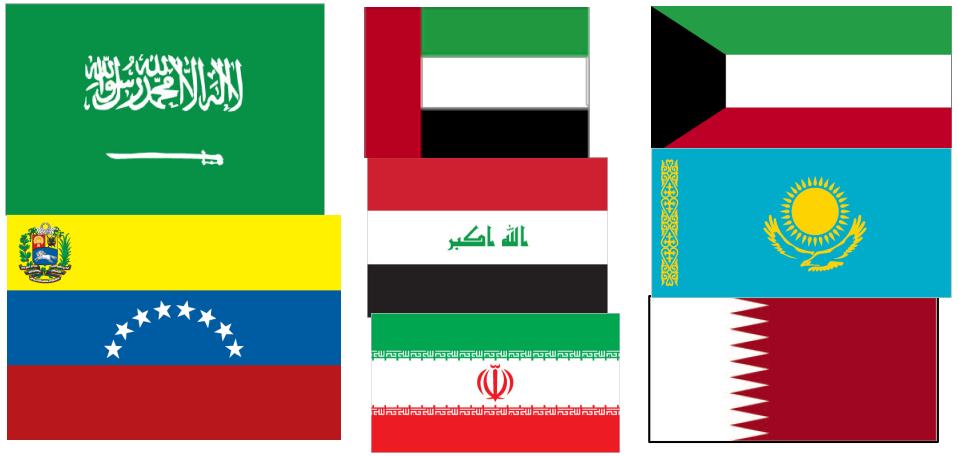


How can the climate dept be shared between countries?

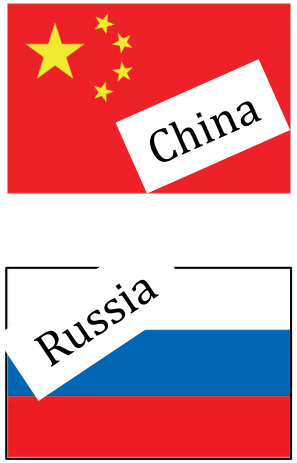
We created the climate crisis with our historic emissions. But all must share this burden.



Our historical emissions are small and we cannot afford it!



We only exported a lot of oil.



Our emissions have only been big a few decades. It's not up to us!

We're cold and don't care!

Which Ministry of Finance will give priority to negative emissions?

MINISTRY OF FINANCE UNITED KINGDOM

Federal Ministry of Finance

THE DEPARTMENT OF THE TREASURY 1789

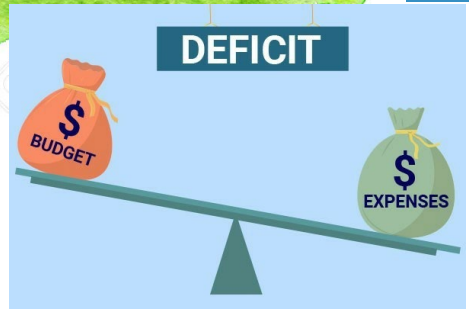
MOF 财政部

財務省 Ministry of Finance Japan

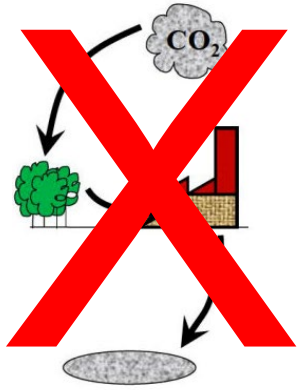
MINISTÈRE DE L'ÉCONOMIE, DES FINANCES ET DE LA RELANCE
Liberté Égalité Fraternité

MEF Ministero dell'Economia e delle Finanze

Priorities:



Negative emissions



Will we leave our children and grandchildren with a problem that is **insoluble**?

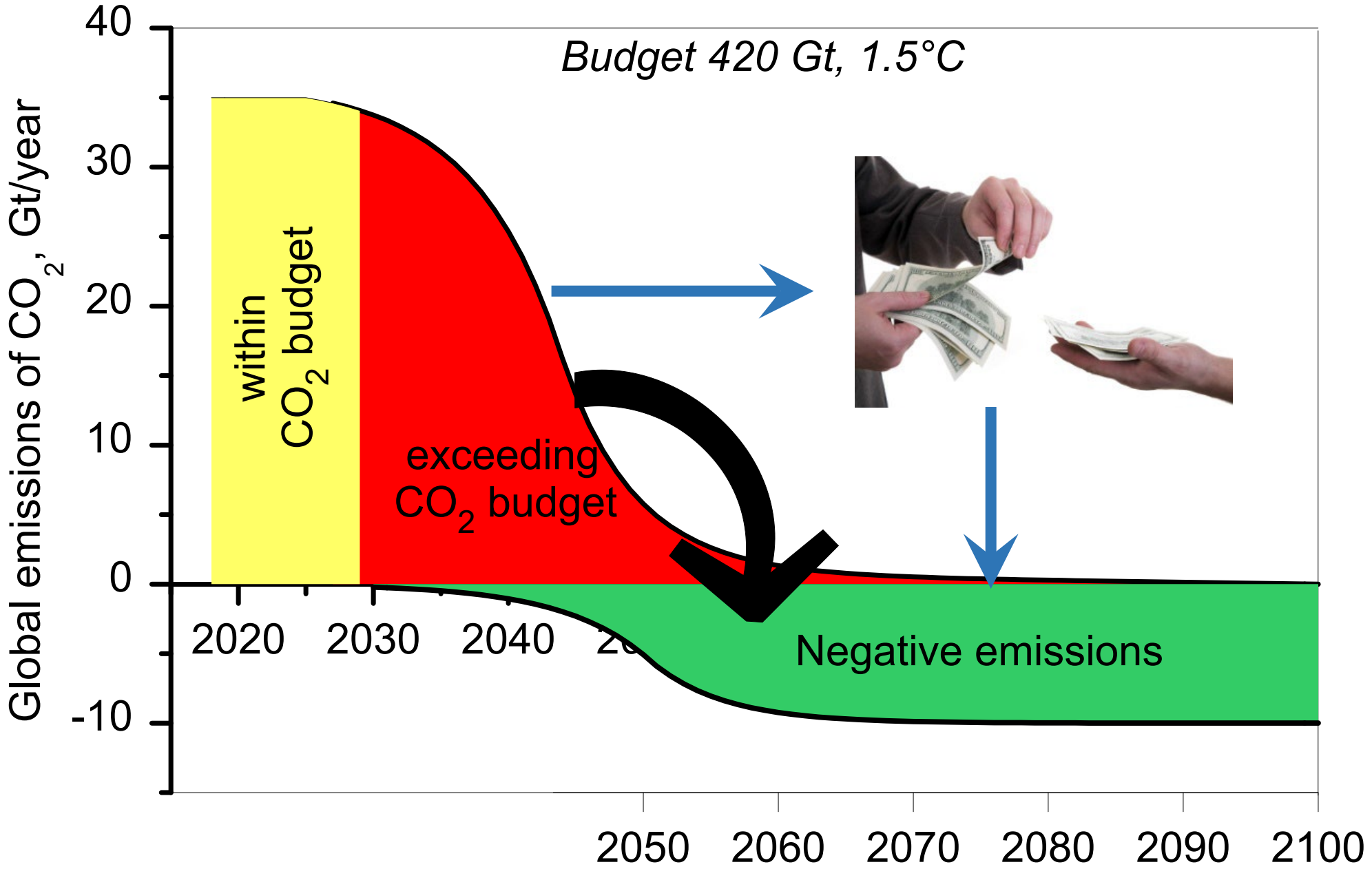
A possible solution is a **CO_2 recovery liability**

making emitters responsible for removing their emissions from the atmosphere

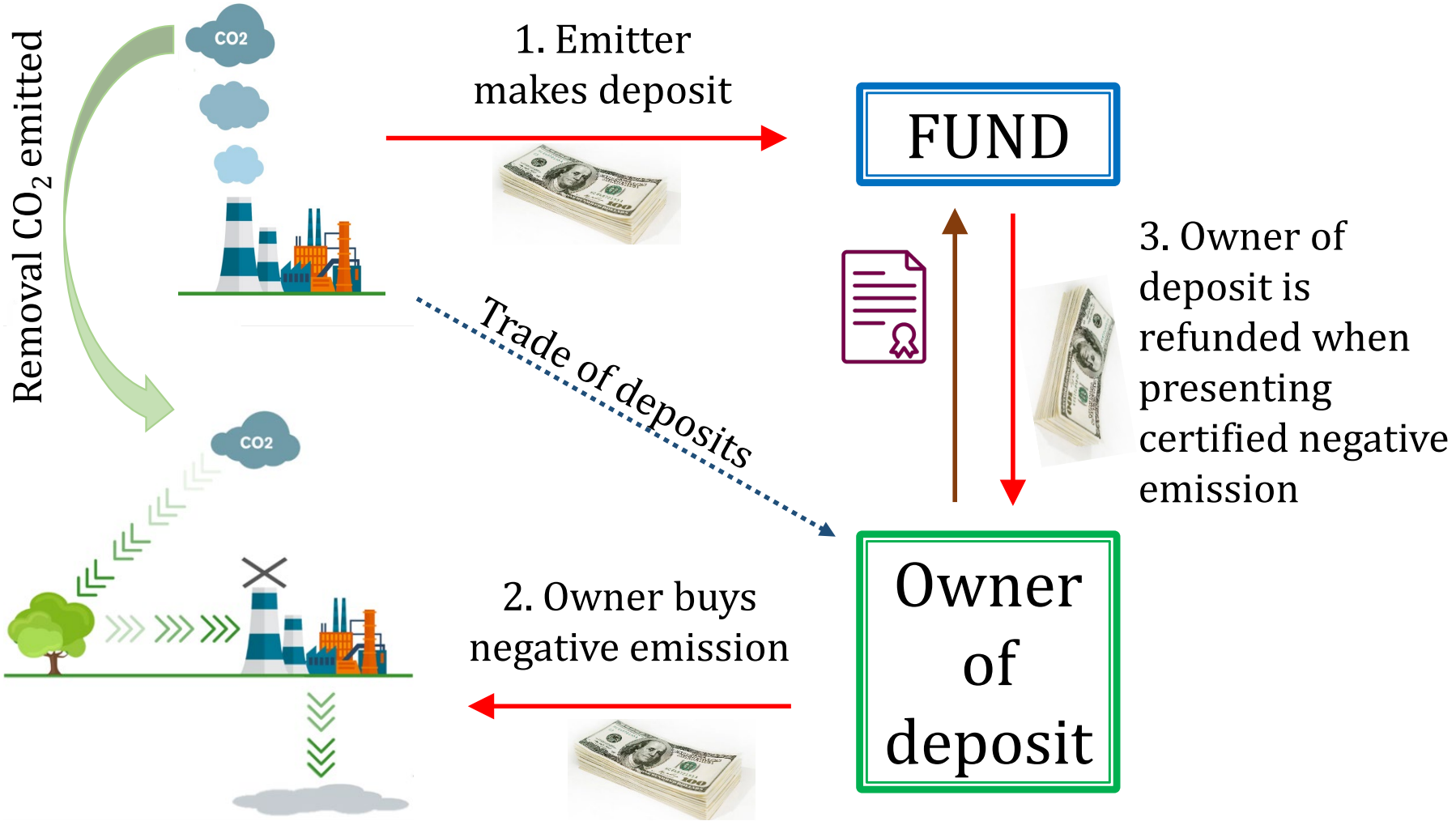
It would be simple, reasonable, comprehensible, fair, rational, sustainable,

which should facilitate acceptance.

It would also give a good incentive for not emitting CO_2


Budget 420 Gt, 1.5°C
Global emissions of CO_2, Gt/year
40
30
20
10
0
-10
within CO_2 budget
exceeding CO_2 budget
Negative emissions
2020
2030
2040
2050
2060
2070
2080
2090
2100

A CO_2 Emitter Liability can be operationalized by **Atmospheric CO_2 Removal Deposits (ACORDs)**



Lyngfelt, Anders, and Fridahl, Mathias, CO_2 Emitter Liability using Atmospheric CO_2 Removal Deposits (ACORDs) for Financing of Future Negative Emissions, *2nd International Conference on Negative CO_2 Emissions*, June 14-17, 2022, Göteborg, Sweden

Owner of deposits is motivated to make long-term contracts with operators of negative emission plants.

Long-term contracts will secure investments in Negative Emission Technologies.

ACORDs creates a market that promotes technology development and reduces costs

Likely cost of negative emissions ≈ 0.1-0.2 €/kg CO_2

Carbon dioxide intensity in global economy: 0.25 kg CO_2/€

Thus: a CO_2 tax/cost of 0.15 €/kg corresponds to ***3.75% of global economy***

The cost to avoid CO_2 emission is normally lower than 0.15 €/kg.

Thus: Cost well below 4% of GDP.

Overcompensation:

Emitter must buy deposits in excess of the actual emissions, e.g removal of 1.5 tonne of CO2 for every tonne emitted.

Why:

- To reach tougher climate goals
- Failure to introduce ACORDs in time
- Rich countries must take a greater share of negative emissions
- Overcompensation gives higher price, which also promotes lowering of fossil emissions
- To compensate for less safe carbon removal options, e.g. nature-based.

Carbon intensity in EU is around 0.17 kg CO_2/€,

so a cost of 0.15 €/kg corresponds to 2.5% of EU economy.

Proposal for Sweden* Emitter Recovery Liability for non-ETS-emissions.

- 23 Mt/year, >halving Swedish domestic CO_2 emissions
- mainly transportation fuels

Cost: 23 billion kr/year assuming 1000 kr/tonne

0.5% of GDP

2300 kr/Swede,year

2.3 kr/L petrol

*Lyngfelt, A., and Fridahl, M., *Så kan vi halvera Sveriges koldioxidutsläpp nu*, DN Debatt, Dagens Nyheter, 16 april 2020.

Existing CO_2 capture technologies have
large costs/energy penalties of **gas separation**

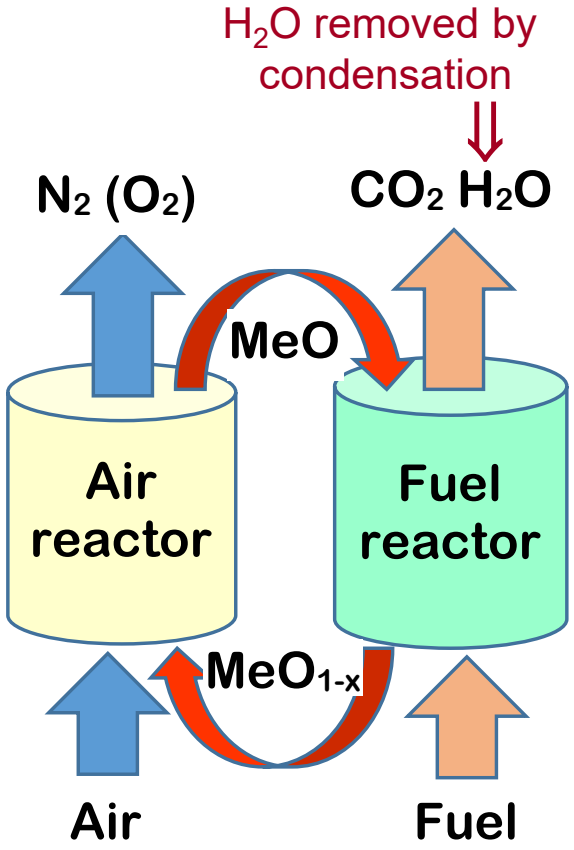
But, gas separation is *not needed* with
Chemical-Looping Combustion (CLC) !

- Oxygen is transferred from air to fuel by metal oxide particles

- Inherent CO_2 capture:
  - fuel and combustion air *never mixed*
  - *no active gas separation needed*

Estimated cost: 200 kr/tonne CO_2

But does it work in practice ??



Yes, it works!!

Total chemical-looping operation at Chalmers: 4 200 h in four pilots

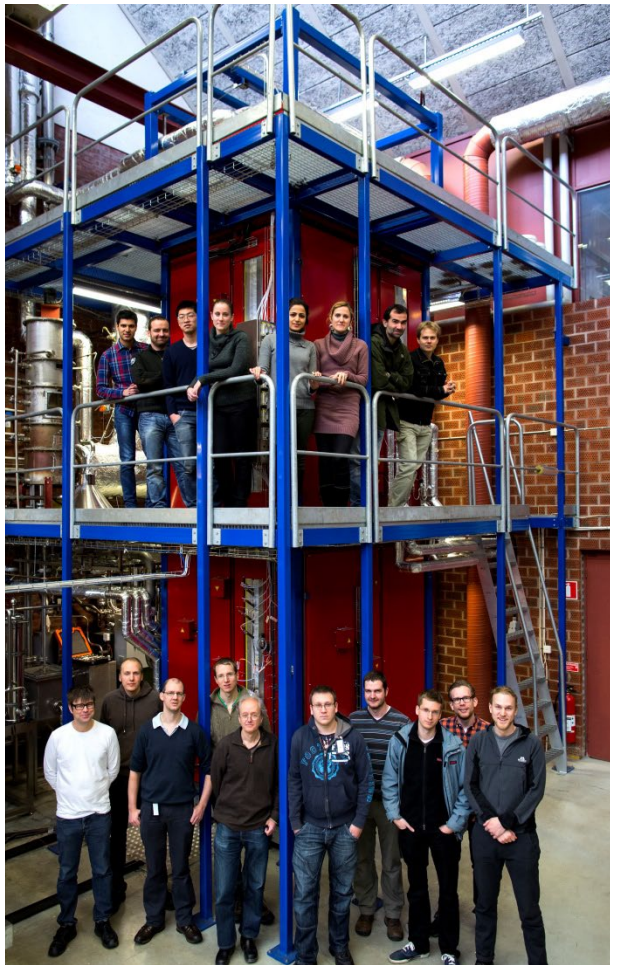
Worldwide: 12 000 h in 50 pilots

Sweden is world-leading

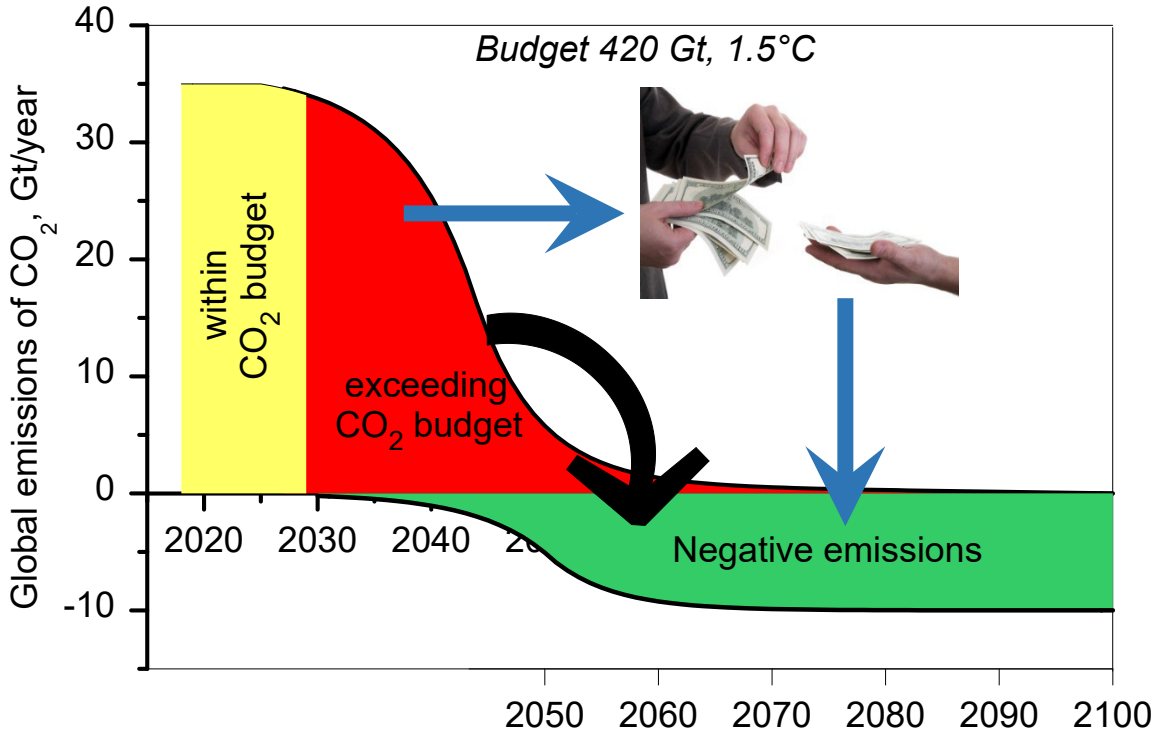
10 kW gas, 2003

300 W gas, 2004

10 kW solid fuel, 2006



100 kW solid fuel, 2011



Thank you !

Chemical-looping combustion

Estimated cost: 200 kr/tonne