POWER-TO-FUELS FOR CLIMATE CHANGE MITIGATION IN EU

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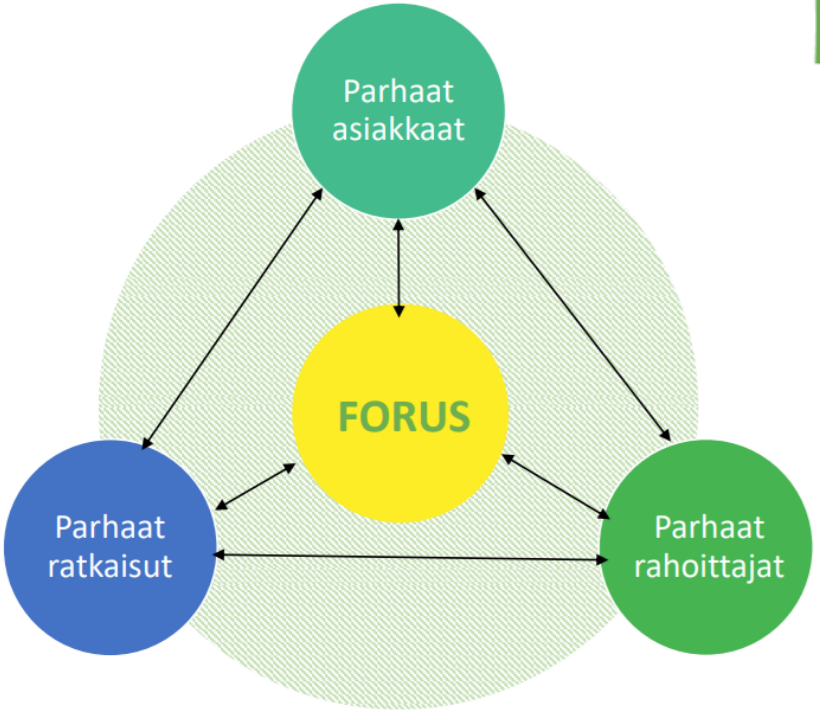

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Kauppalehti

Valoen osake ampaisi roimaan nousuun - nappasi merkittävän tilauksen

Antti Mustonen, Kauppalehti.fi, 2017-08-07, 17:54,

Aurinkosähköteknologiaan erikoistunut **Valoe** (entinen Cencorp) on allekirjoittanut ForUs Capitalin kanssa puitesopimuksen yhteensä noin 4 miljoonan euron arvoisten aurinkovoimaloiden toimittamisesta Suomeen.

Valoen osake oli 17,7 prosentin nousussa 1,73 eurossa tilausuutisen jälkeen Helsingin pörssissä maanantaina illansuussa.

"Valoen seuraavan sukupolven aurinkosähköjärjestelmien elinkaarikustannus tuotettua kilowattituntia kohti on merkittävästi pienempi tavanomaisiin paneeleihin verrattuna. On hienoa, että ForUs Capital on pitkään jatkuneen yhteistyön jälkeen vakuuttunut Valoen järjestelmien kilpailukyvystä. Uskomme yhteistyön Foruksen kanssa laajenevan jatkossa merkittävästi" toteaa Valoen toimitusjohtaja **Iikka Savisalo**.

ForUs Capital myy voimaloiden sähkön omille sopimuskumppaneilleen.

Ensimmäiset tilaukset, arvoltaan n. 450 000 eur, toimitetaan yhdeksään Hangon kaupungin omistamaan kohteeseen syksyn 2017 aikana.

Valoe ja aurinkosähkön ostaja tekevät jokaisen voimalan huollosta ja ylläpidosta palvelusopimuksen. Valoe vastaa aurinkovoimaloiden sähköntuotannosta ja antaa aurinkovoimaloilleen tuottotakuun.

Muiden toimitusten toteutumisen edellytyksenä on valtion investointituen saaminen ja rahoituksen lopullinen varmistuminen. Edellytysten täyttyessä voimalat toimitetaan viimeistään kesällä 2018.

Osasto: Etusivun uutiset

Introduction

- Power-to-fuels (PtF) may have an important role in climate change mitigation
- Calculation rules regarding the consequences of PtF on GHG emissions are still immature
- There is a risk that a powerfull option for climate change mitigation and energy related challenges is hindered in EU due to immature calculation rules

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CCS ≠ CCU

- The benefit from avoided direct emissions when CO_2 is not released to air but permanently stored
- The benefit is partly decreased due to direct and indirect impacts of energy penalty of capture process
- Transportation of CO_2 causes some emissions

- The benefit from replaced fossil substitutes
- The benefit is partly decreased due to direct and indirect impacts of energy penalty of capture process ***and especially production of energy carriers, e.g. hydrogen***
- Transportation of products may increase or decrease emissions, depending on where products and replaced products are made

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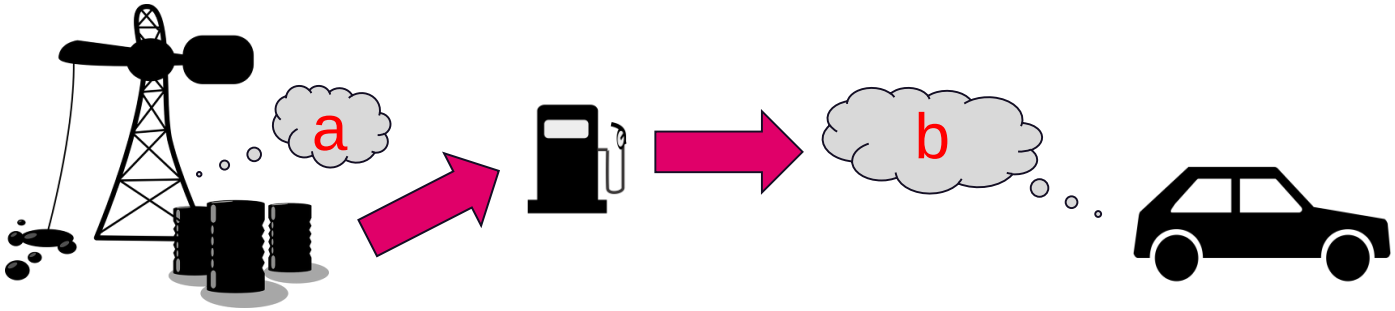
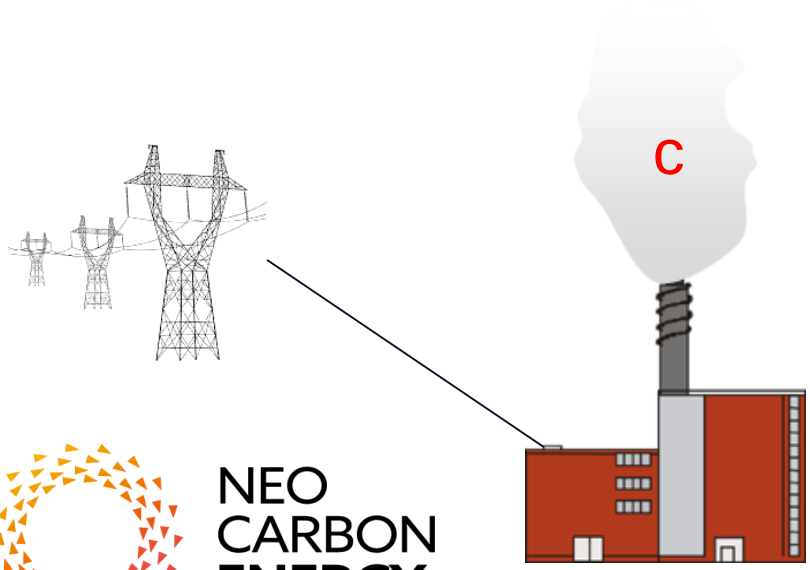
CLIMATE IMPACT OF CCU

Business as usual (reference)





Power plant or industrial site emitting CO_2

Total emissions from the system (E):

$E = a + b + c$

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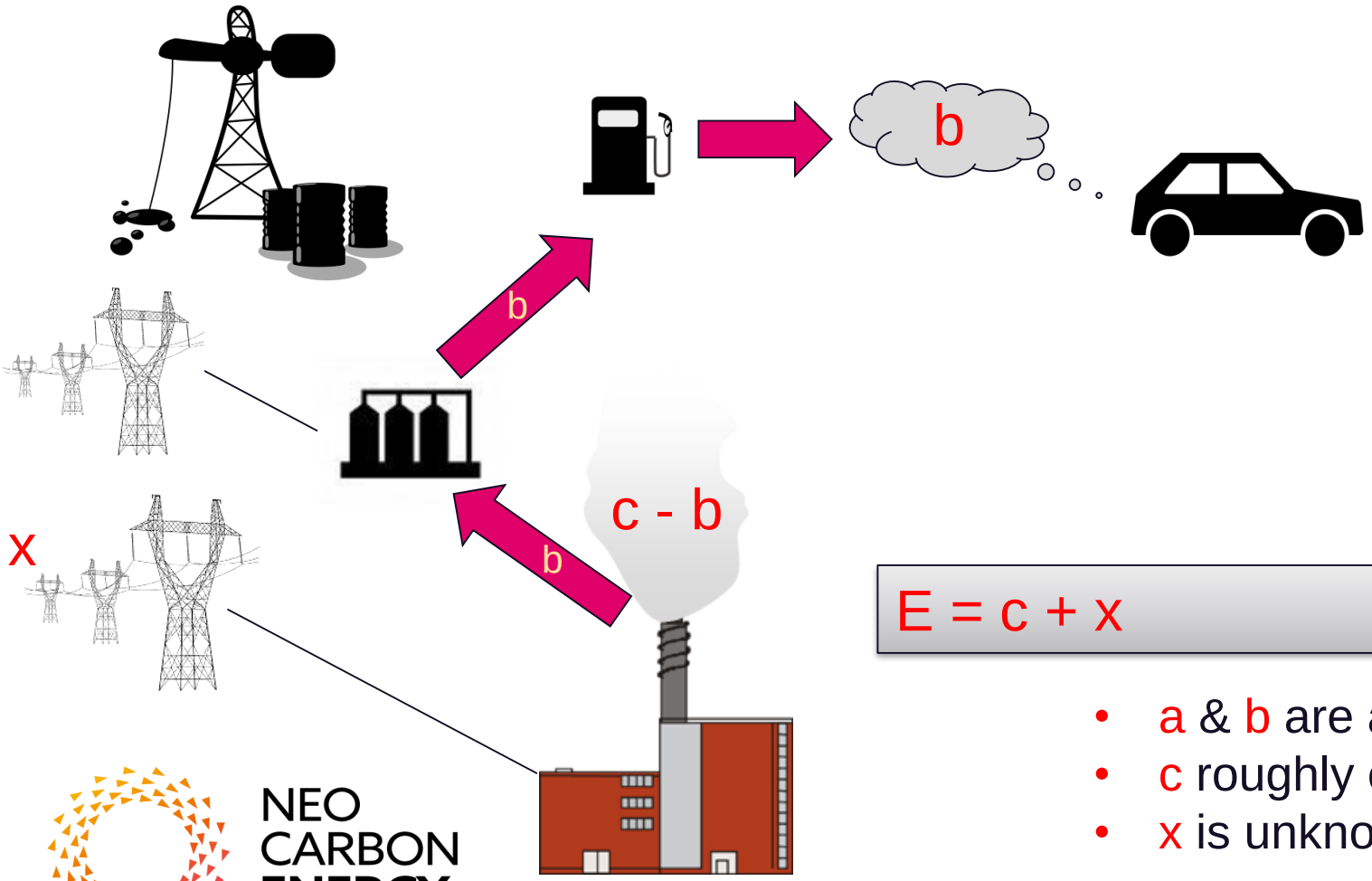
Power-to-fuels (PtF)



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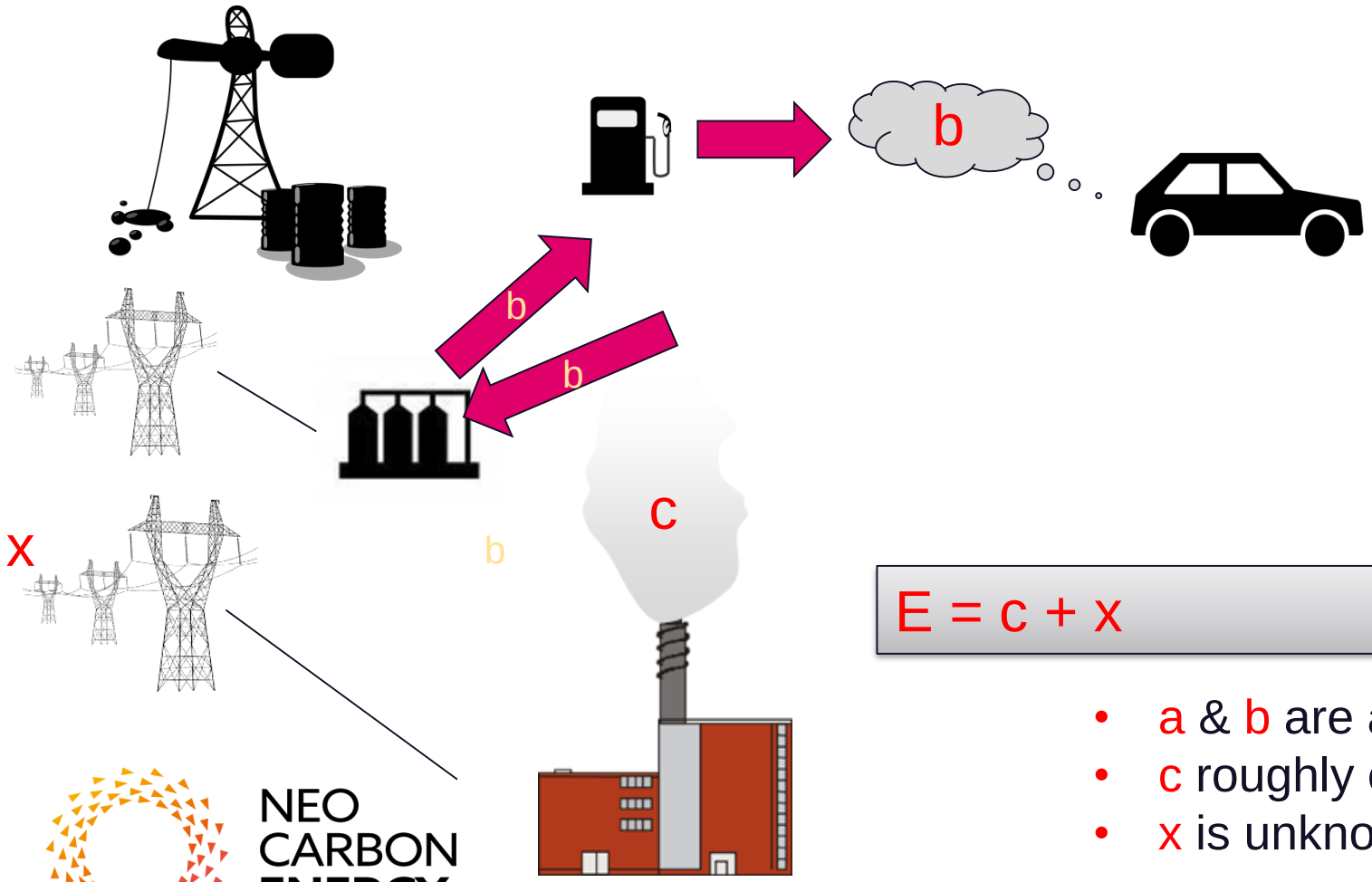
Power plant or industrial site emitting CO_2

$$E = c + x$$

- a & b are avoided
- c roughly equal
- x is unknown

Power-to-fuels (PtF) with DAC



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Power plant or industrial site emitting CO_2

$$E = c + x$$

- a & b are avoided
- c roughly equal
- x is unknown

X = consequences of increased electricity consumption

- The most important and uncertain factor contributing on total climate impact of PtF
- Proposed EU regulation (proposal for RED, Brussels, 23.2.2017) rules to use average share of electricity from RES

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RED proposal

Proposal for a DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL
on the promotion of the use of energy from renewable sources (recast)
Article 25, Mainstreaming renewable energy in the transport sector

(a) When electricity is used for the production of renewable liquid and gaseous transport fuels of non-biological origin, either directly or for the production of intermediate products, either the average share of electricity from renewable energy sources in the Union or the share of electricity from renewable energy sources in the country of production, as measured two years before the year in question, may be used to determine the share of renewable energy. In both cases, an equivalent amount of guarantees of origin issued in accordance with Article 19 shall be cancelled.

However, electricity obtained from direct connection to an installation generating renewable electricity (i) that comes into operation after or at the same time as the installation producing the renewable liquid and gaseous transport fuel of non-biological origin and (ii) is not connected to the grid, can be fully counted as renewable electricity for the production of that renewable liquid and gaseous transport fuel of non-biological origin.

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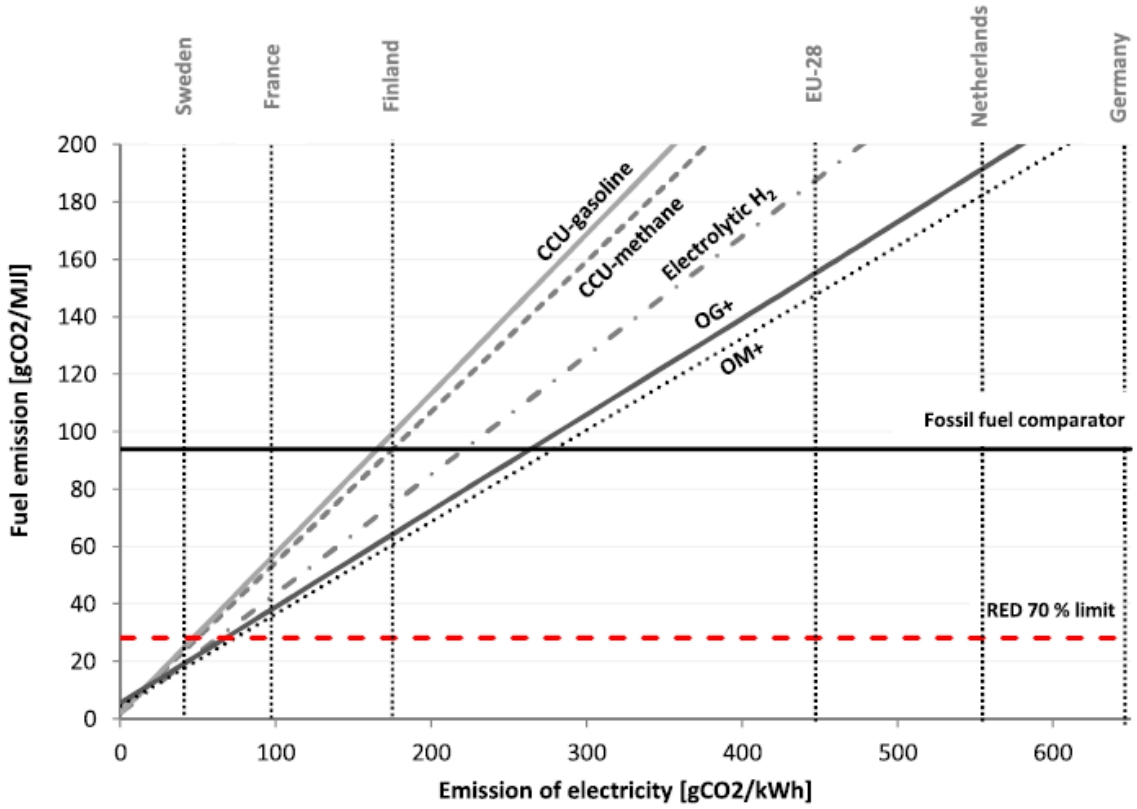
Problem of average values

- With average values for emissions of electricity production, it is extremely difficult to reach the required RED limit
- Impact of increased electricity use on CO_2 emissions is much more complicated than annual average
- The risk is that effective technology for climate change mitigation is prevented by too simplified regulation in EU



Source: Koponen & Hannula
Applied Energy 200 (2017) 106–118

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Typical ways to estimate the emissions of increased electricity consumption

- ***Annual average values*** of national systems often used, but not well justified
  - Grids and markets are international
  - ”Average production” is not reacting on consumption changes
  - PtF processes can enable higher shares of intermittent renewables

- More sophisticated analyses have based on ***marginal electricity production***
  - Typically more C-intensive than average
    - In some regions (e.g. France and Nordic countries) multifold in comparison to average values

- Also **several other** approaches are used (e.g. producer based, product based…)

- **None of these approaches typically take the rebound effects into account**

Taking into account the EU ETS

- Since 2005 EU ETS has been the most important rebound effect influencing on CO_2 emissions in EU
  - Seldom taken into account in the academic studies

- In EU, electricity production belongs under the cap of EU ETS

→ increased electricity consumption does not increase the amount of available emission allowances

→ **impact of PtF on CO_2 emissions in EU is near to zero!**

- Global emissions may increase due to potential carbon leakages, for example electricity imports from the regions not covered by EU ETS

» From climate change perspective, **focus should be on preventing these leakages**, not preventing mitigation options in EU

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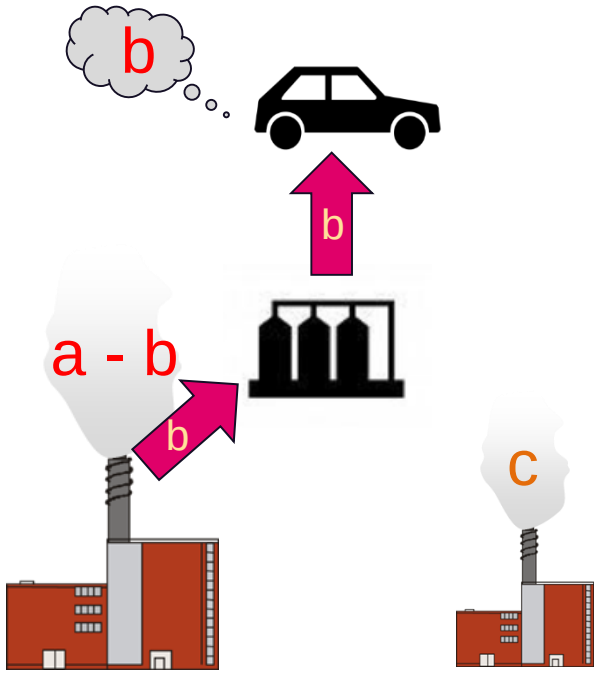
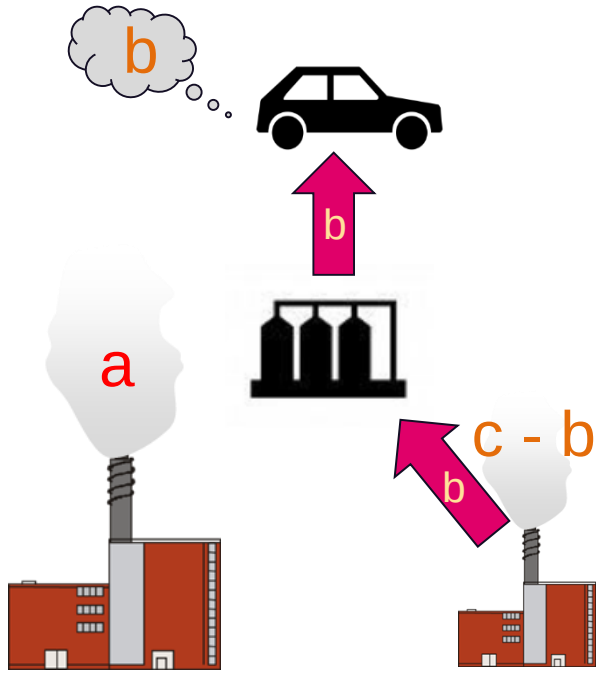
No difference between fossil and biogenic CO_2

CCU with fossil CO_2



CCU with biogenic CO_2



Total CO_2 emission to atmosphere is equal: a + c (where c is biogenic)

Where biogenic CCU makes a difference?

- Value in marketing
- Decreased risk when investing for CO_2 capture plant
- If operation of CO_2 source is changed
  - New income from CO_2 → increased operation hours/fuel usage
  - Energy penalty from capture → increased/decreased operation/fuel usage
  - Note: Rebound from allowances in EU ETS!
- When profitability of investment for a new CO_2 source which is not included in EU ETS is changed (significantly) due to CCU

To mitigate climate change, use of fossil fuels needs to be dramatically decreased. This is driven by several policies and regulations but does not impact on the benefit of CCU. There is a benefit when CO_2 is reused, even if it would originate from fossil fuels.

Why fuel choice is not impacted by CCU (in the case of large CO_2 sources)

- Scale:
  - CO_2 emissions from power plants often over Mt/a, realistic CCU processes are an order of magnitude smaller

  → Utilised CO_2 is a sidestream or waste stream from the main process, CCU has no impact or a minor impact on the main process or fuel choice

- Balance and regulation:
  - CO_2 from large point sources is regulated under the EU ETS and CO_2 emissions are accounted for original CO_2 source, even if CO_2 would be utilised. The benefit of biogenic CO_2 is gained in EU ETS as bioenergy is considered C-neutral.
  - To avoid double counting of emissions, the products utilising CO_2 are therefore C-neutral, independently whether the CO_2 is biogenic or fossil.

CCU in EU ETS

- This allocation does not mean that there is no economic incentive for CCU
- The incentive is that CO_2 is not counted as emission from products i.e. the products can be C-neutral (if e.g. electricity is)

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Article 49

Transferred CO_2

1. The operator shall subtract from the emissions of the installation any amount of CO_2 originating from fossil carbon in activities covered by Annex I to Directive 2003/87/EC, which is not emitted from the installation, but transferred out of the installation to any of the following:

(a) a capture installation for the purpose of transport and long-term geological storage in a storage site permitted under Directive 2009/31/EC;

(b) a transport network with the purpose of long-term geological storage in a storage site permitted under Directive 2009/31/EC;

(c) a storage site permitted under Directive 2009/31/EC for the purpose of long-term geological storage.

For any other transfer of CO_2 out of the installation, no subtraction of CO_2 from the installation's emissions shall be allowed.

http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32012R0601&from=EN

Cases are often more complicated

- Allocating emissions for by-products
  - Heat from PtF can be utilised as process heat or district heat
  - By-product oxygen from electrolysers
  - Also hydrogen can be a by-product!
    - Emissions could be allocated based on price, not energy
    - Or avoid allocation and compare the emissions of the system before and after CCU investment
- Small CO_2 sources
  - Capture may impact on operation and EU ETS cap is not limiting
- Refining process gases (also fossil)
  - For example steel mill can produce C-neutral transportation fuel from fossil sources

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Data requirements and principles for calculating the life cycle GHG intensity of novel transport fuels and invitation to submit data

Where the supply of an input is considered:

1) **rigid,** then the greenhouse gas intensity of that input shall be assessed by considering the impact of removing a quantity of that material or energy from its current use.
2) **elastic**, then its greenhouse gas intensity shall be assessed through attributional lifecycle assessment of its production process.

Blast furnace gas:

The greenhouse gas intensity will then be the one of the extra electricity requirement of the steel mill. This is a *difference calculation* that reflects the overall *change* in emissions resulting from an increase in production of the novel transport fuel. Blast furnace gas is an example of a ***rigid source*** *of energy* for converting to transport fuel.

Renewable electricity:

a) From grid: In this case renewable electricity is a rigid source so, one would calculate the GHG intensity of the electricity that replaces the renewable electricity diverted to fuel production.

b) **Supply of renewable electricity should be additional to what would be consumed otherwise**. For example, additional renewable electricity could come from a new wind farm not connected via the grid, or renewable electricity that would not otherwise be delivered to users because of grid instability.

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https://ec.europa.eu/clima/sites/clima/files/transport/fuel/docs/novel_transport_fuels_default_values_en.pdf

Conclusions

- CCU is a good option in climate change mitigation. The benefit comes from avoided emissions of replaced fossil fuels

- When CO_2 emission of large point source is accounted in EU ETS, the emission should not be double-counted for transportation fuels
  - The product is C-neutral, also when fossil CO_2 is used
  - RED proposal seems to be valid for utilised CO_2, but not for CO_2 caused by increased electricity consumption

- Consequenses of increased electricity consumption by PtF are complex. National average emissions are not well justified. There is a risk, that the proposed rules may prevent effective options for climate change mitigation in EU.
  - The cap of EU ETS should be taken into account

Discussion (1/2)

- Future of EU ETS:
  - If the cap of EU ETS is not finally limiting the emissions, but allowances are cancelled based on surplus and political decission, any activity may impact on the amount of allowances to be cancelled
  - In that case, it is impossible to estimate the real impact of any operation, technology, investment etc. on CO_2 emissions in EU.
    - Unfavourable conditions to invest in EU
    - Useless research on climate impacts
  - Targets of EU ETS should be clear in long-term, ambitious and untouchable after decided

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Discussion (2/2)

- Analogy with electric vehicles (EV):
  - The climate benefit of PtF and EV's comes from replacement of fossil fuels
    - If same fuel is replaced, the avoided emission is equal
  - In both cases, electricity production under EU ETS is increased
    - PtF is indirect electrification of transportation sector
    - From the climate chance perspective, the impacts are similar, but in the case of EV's overall efficiency is higher
  - Why greater emission reduction is required in the case of PtF?

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Policy recommendations

- Accounting rules of RED proposal regarding CO_2 from electricity use should be improved
  - Because electricity production belongs under the cap of EU ETS
    - PtF moves CO_2 emissions from transportation sector under the cap of EU ETS
    - Overall cost effectiveness of EU climate policy
  - Because increased electricity use leads to increased investments on renewables
    - Also unlocking potential of intermittent renewable electricity
  - Because electrolysers are not operated during the highest electricity prices, when electricity production is based on fossil fuels

- Focus on permanently decreasing the amount of allowances in EU ETS (ambitious cap) and monitoring and preventing carbon leakages, for example electricity imports from regions not covered by EU ETS
  - Real impact on emissions instead of releasing allowances by expensive overlapping regulations.

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NEO-CARBON ENERGY project is one of the Tekes strategic research openings and the project is carried out in cooperation with Technical Research Centre of Finland VTT Ltd, Lappeenranta University of Technology LUT and University of Turku, Finland Futures Research Centre FFRC.