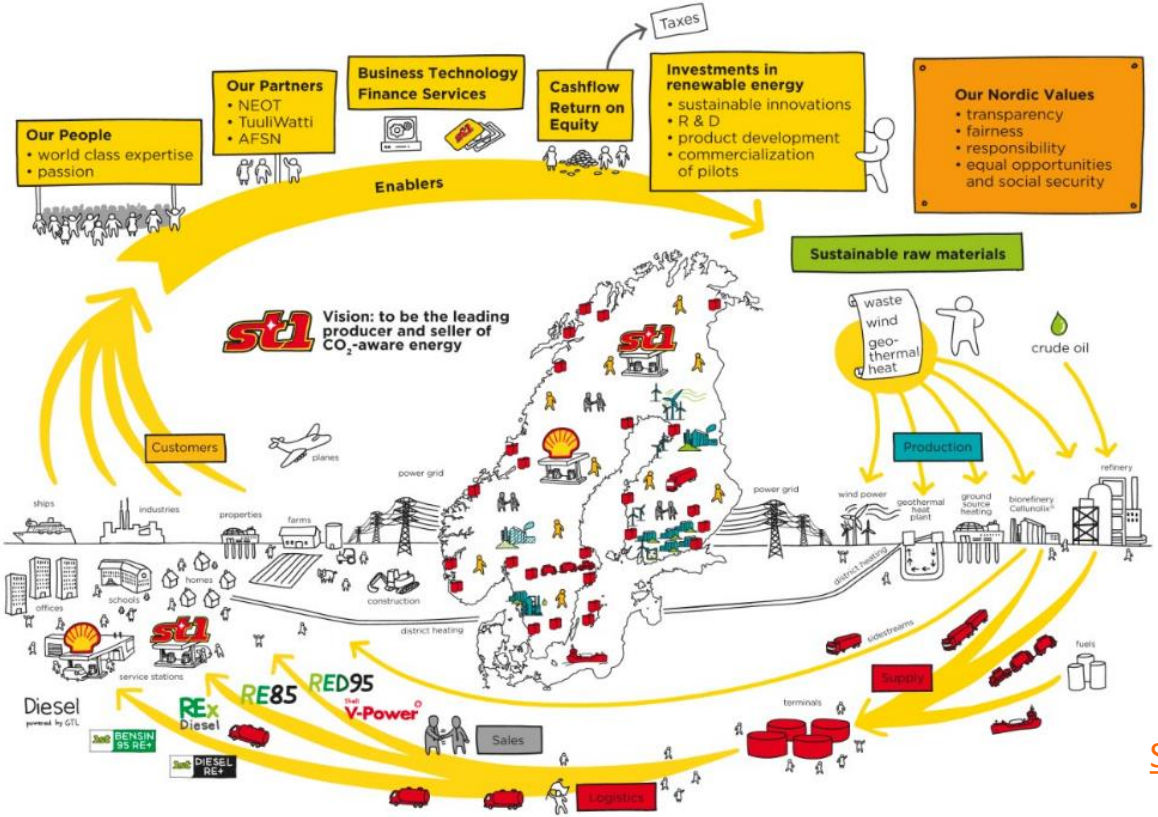
Energy & Climate

After work – pääomamarkkinayhdistykset

Helsinki, May 9th, 2019

St1, Mika Aho
Director, Public Affairs

VALUE CHAIN



St1 value chain video

St1 vision: ”To be the leading producer and seller of CO_2-aware energy”

Personnel

774

Investments MEUR

132

Renewable energy investments MEUR

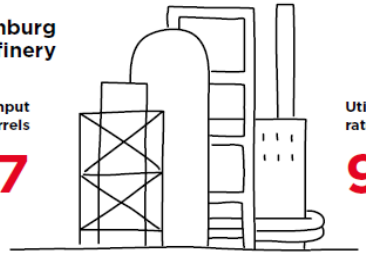
(incl. TuuliWatti)

42

Gothenburg refinery

Throughput million barrels

28.7



Utilization rate

90.4%

Excise & property taxes

MEUR

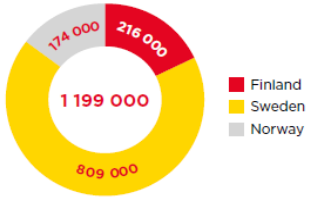
2177

Income taxes

MEUR

15.3

CO_2 -reduction from use of biofuels, tons



CO_2-reduction equalled more than

467 000

passenger cars [*]

[*] a car with an annual mileage of 17 000 km and emissions of 151 g CO/km

Biorefineries

100%

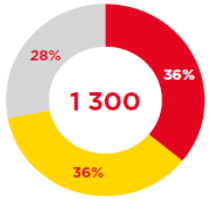
of the feedstock of our advanced ethanol production is waste and residues

Wind power production

GWh

628

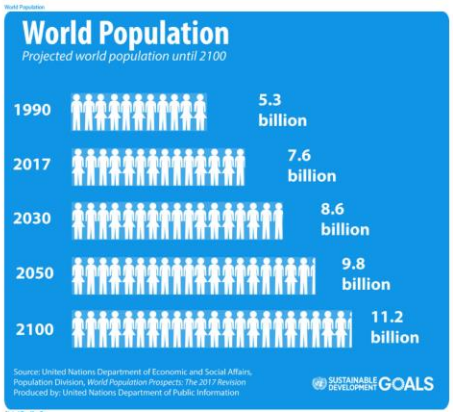
Retail station network



Finland Sweden Norway

Global Energy Challenge

The Global Energy Challenge



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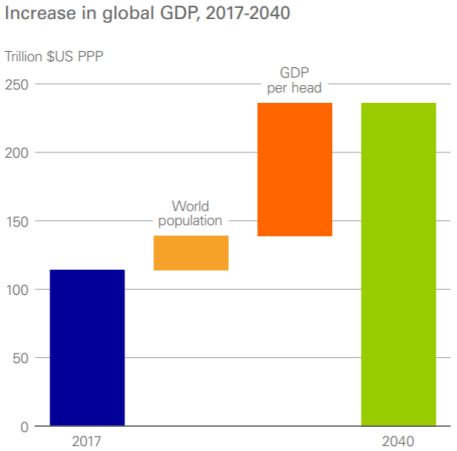

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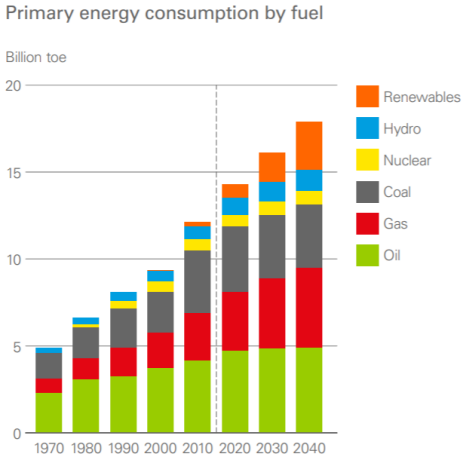

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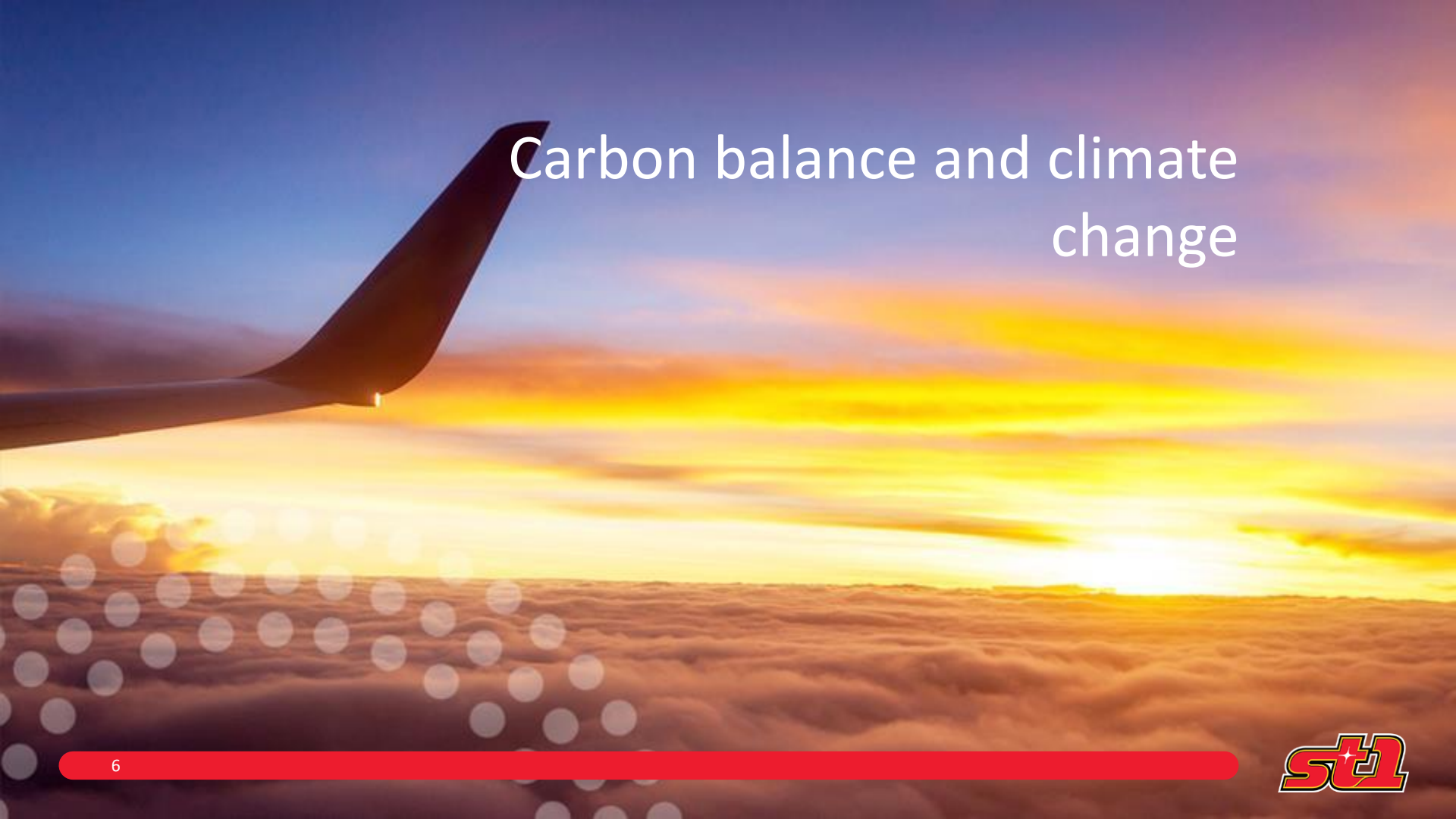
1) UN News World Population Prospects: The 2017 Revision
2,3) BP Energy Outlook – 2019 edition https://www.bp.com/en/global/corporate/energy-economics/energy-outlook.html

Carbon balance and climate change



Balancing Global Carbon Cycle

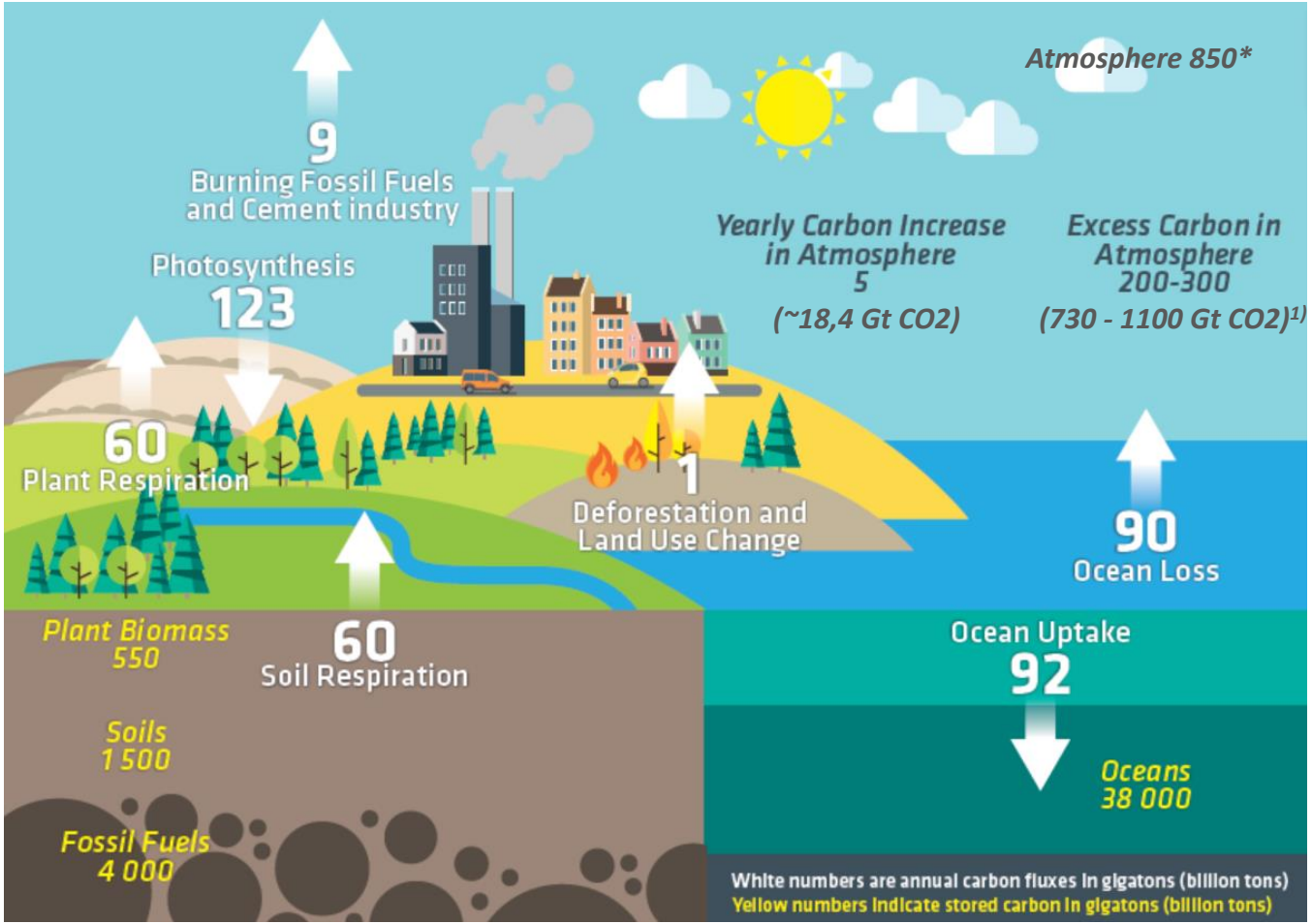
White numbers are annual carbon fluxes in gigatons.

Yellow numbers indicate stored carbon in gigatons.

1 Gt = 1 billion tons
BtC = Billion tons of carbon

Note!

- *Probably the biggest source of confusion and errors in climate discussions concerns "carbon" versus "carbon dioxide*
- *One ton of carbon equals 3.67 tons of CO_2*
- *The central climate number is the atmospheric concentration of carbon dioxide (~ 400 parts per million, ppm)*

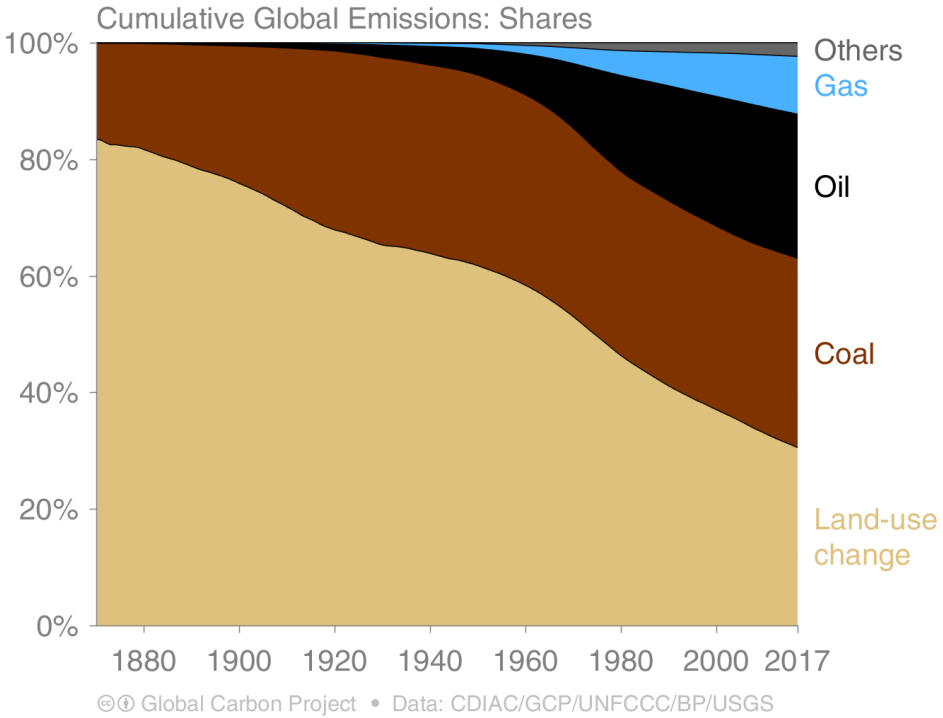


Sources: Earth System Science Data - Global Carbon Budget 2017; Pan et al. 2011; Clais et al. 2013 *calculated from the sources
1) Since ppm measuring has started in 1959, the increase of carbon in atmosphere is 185 BtC

Image St1 Oy

Historical cumulative emissions by source

Land-use change represents about 31% of cumulative emissions over 1870–2017, coal 32%, oil 25%, gas 10%, and others 2%



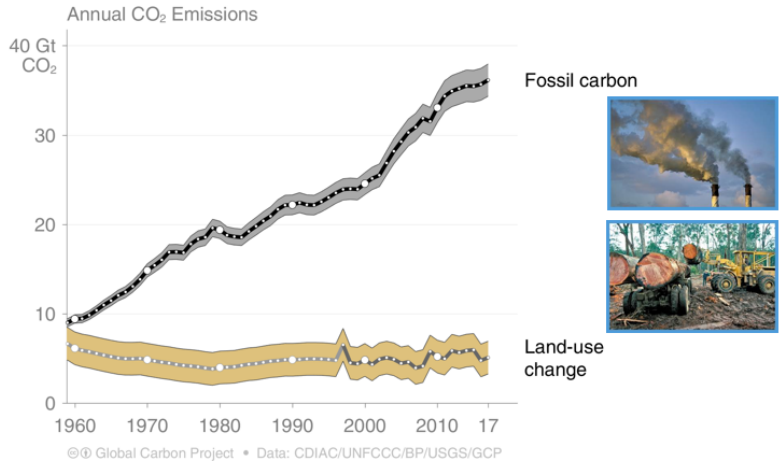
Others: Emissions from cement production and gas flaring

Source: CDIAC; Houghton and Nassikas 2017; Hansis et al 2015; Le Quéré et al 2018; Global Carbon Budget 2018

Fossil CO_2 emissions reach all time high in 2018

Total global emissions

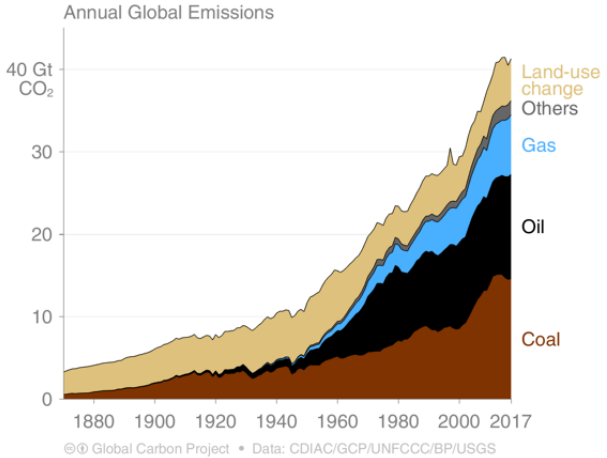
Total global emissions: 41.2 ± 2.8 $GtCO_2$ in 2017, 53% over 1990
Percentage land-use change: 43% in 1960, 13% averaged 2008–2017



Land-use change estimates from two bookkeeping models, using fire-based variability from 1997
Source: CDIAC; Houghton and Nassikas 2017; Hansis et al 2015; van der Werf et al. 2017; Le Quéré et al 2018; Global Carbon Budget 2018

Total global emissions by source

Land-use change was the dominant source of annual CO_2 emissions until around 1950.
Fossil CO_2 emissions now dominate global changes.

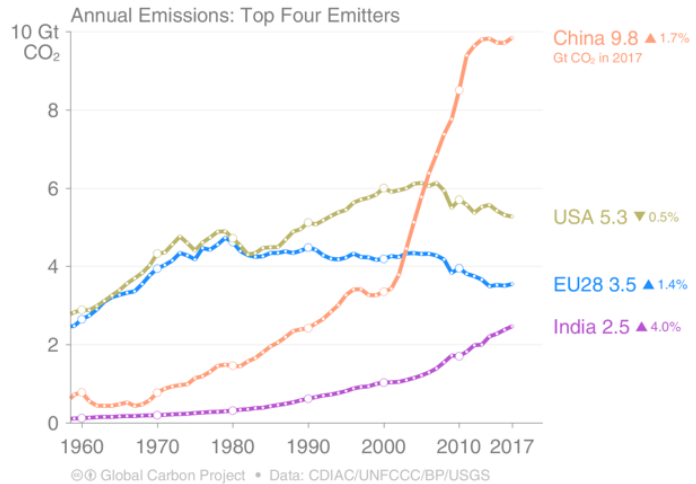


Others: Emissions from cement production and gas flaring
Source: CDIAC; Houghton and Nassikas 2017; Hansis et al 2015; Le Quéré et al 2018; Global Carbon Budget 2018

Significant CO_2 emission growth potential

Top emitters: Fossil CO_2 emissions

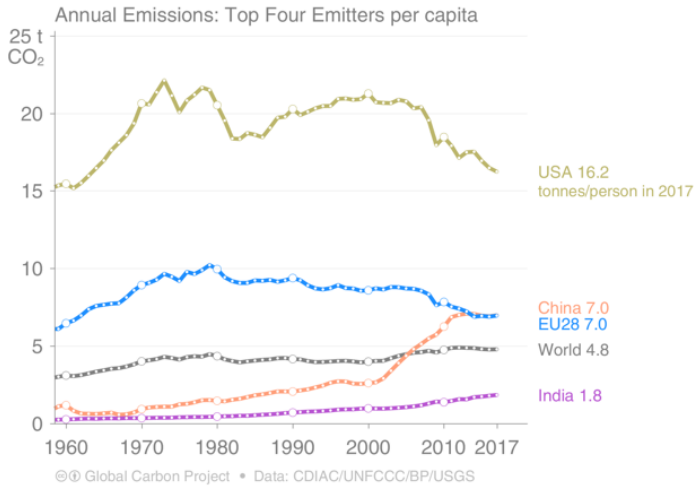
The top four emitters in 2017 covered 58% of global emissions
China (27%), United States (15%), EU28 (10%), India (7%)



Bunker fuels, used for international transport, are 3.2% of global emissions.
Statistical differences between the global estimates and sum of national totals are 0.7% of global emissions.
Source: CDIAC; Le Quéré et al 2018; Global Carbon Budget 2018

Top emitters: Fossil CO_2 Emissions per capita

Countries have a broad range of per capita emissions reflecting their national circumstances



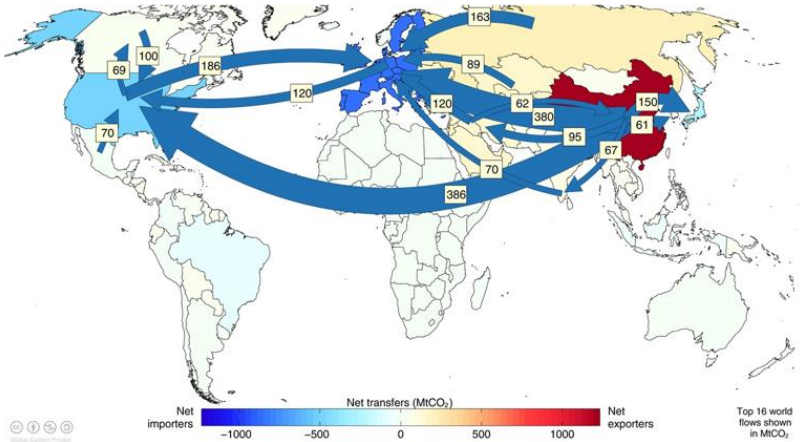
Source: CDIAC; Le Quéré et al 2018; Global Carbon Budget 2018

Emissions are de-facto traded – but not priced

GLOBAL CARBON PROJECT

Major flows from production to consumption

Flows from location of generation of emissions to location of consumption of goods and services

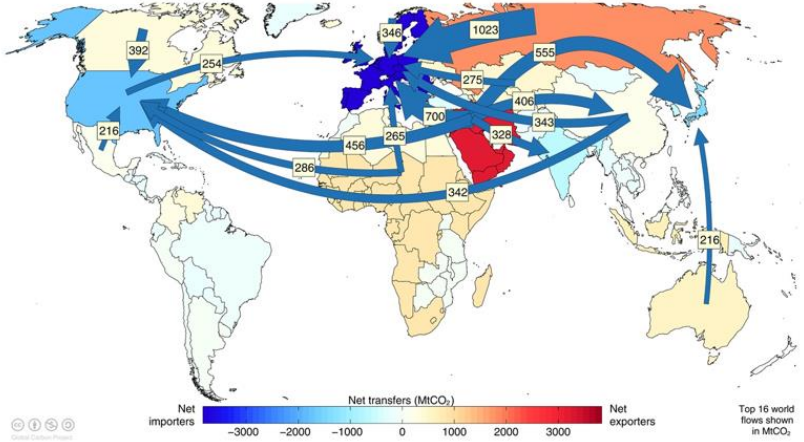


Values for 2011. EU is treated as one region. Units: $MtCO_2$
Source: Peters et al 2012

GLOBAL CARBON PROJECT

Major flows from extraction to consumption

Flows from location of fossil fuel extraction to location of consumption of goods and services



Values for 2011. EU is treated as one region. Units: $MtCO_2$
Source: Andrew et al 2013

Global energy system and the need for carbon market

Annual Growth

Advanced Biofuels 2030 (IRENA)

1G Biofuels 2030 (IRENA)

Electric Vehicles 2040

(IEA WEO 2017 Sustainable Development Scenario)

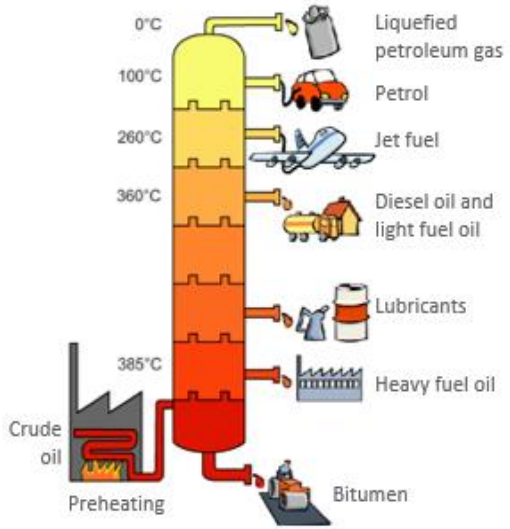
Oil Demand 2030

Biofuels 2018

“The distillation curve challenge”

Crude oil refining produces always the same product slate: light distillates, middle distillates, heavy distillates and residuum (eg. if you produce Jet fuel, the process produces the other products as well)

Crude oil product slate

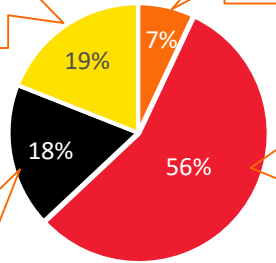


How oil is used mb/d

Total other 19%

Power generation	6%
Buildings	8%
Agriculture and fishing	3%
Other	2%

Refinery losses and own use 7%



Total transportation 56%

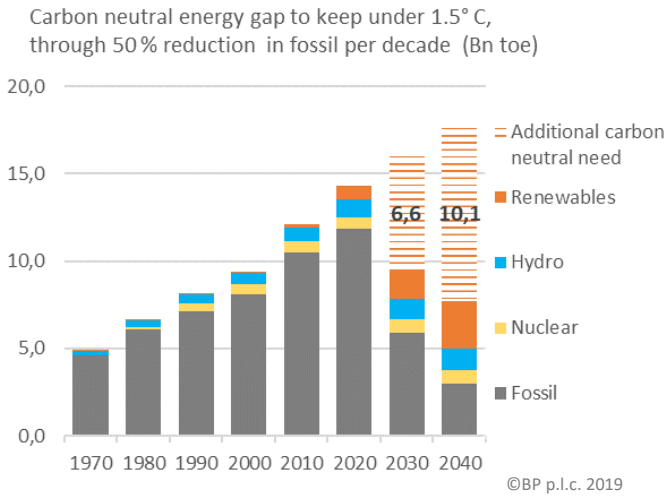
Road transport	43%
- personal light-duty vehicles	26%
- freight	18%
Aviation	6 %
Marine bunker	5%
Other	1%

Total industry 18%

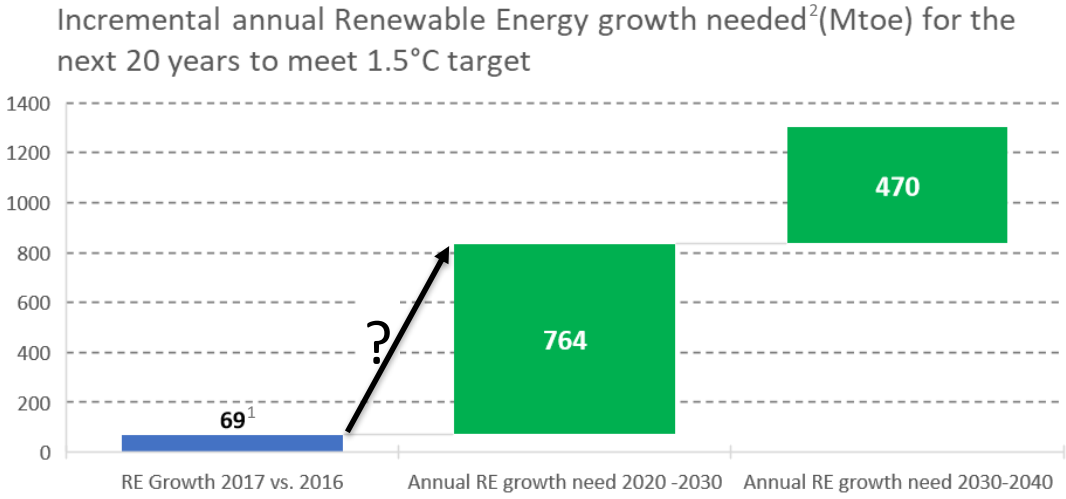
Petrochemical feedstock	12%
Steam and process heat	6%
Other industry	1%

Source: Morgan Stanley Research, Petroleum & Biofuels Association Finland, Economic Information Office

Growth in Renewable Energy needs to be >10 times higher than today



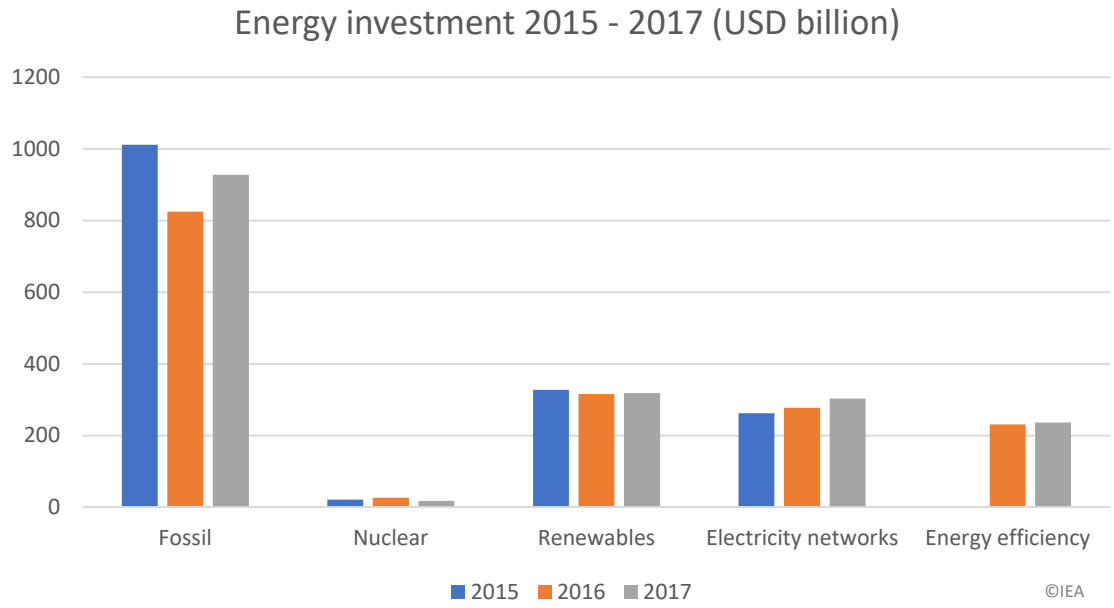
To stay within the Carbon Budget of 580 Gt the use fossil energy needs to halved every decade



The **annual** growth of RE in primary energy consumption would have to be ~760 Mtoe between 2020 and 2030. In 2017 it was only 69 Mtoe.

1) *IEA WEO 2018*
2) *Calculation: The growing energy need and halving the use of fossil energy use every decade would be covered by incremental renewable energy*

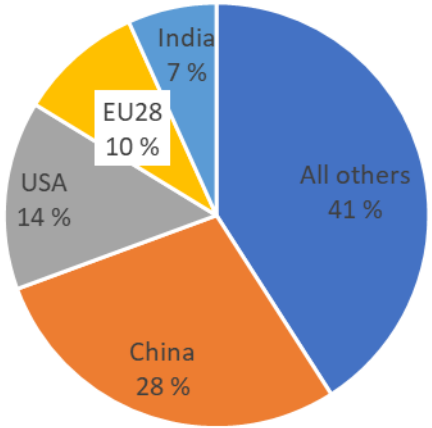
Global Energy investments (USD billion)



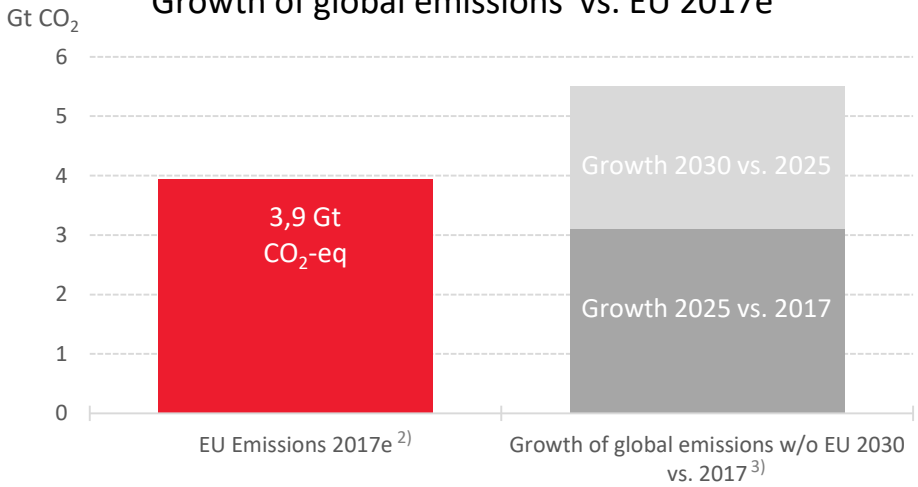
IEA World Energy Investment 2018 https://webstore.iea.org/download/direct/1242?fileName=WEI2018.pdf
IEA World Energy Investment 2017 https://webstore.iea.org/download/direct/225?fileName=WEI2017.pdf
IEA World Energy Investment 2016 https://webstore.iea.org/download/direct/235?fileName=WEI2016.pdf

”Showing example” inside the EU is just not enough

Global CO_2 emissions Projections 2017[1)]



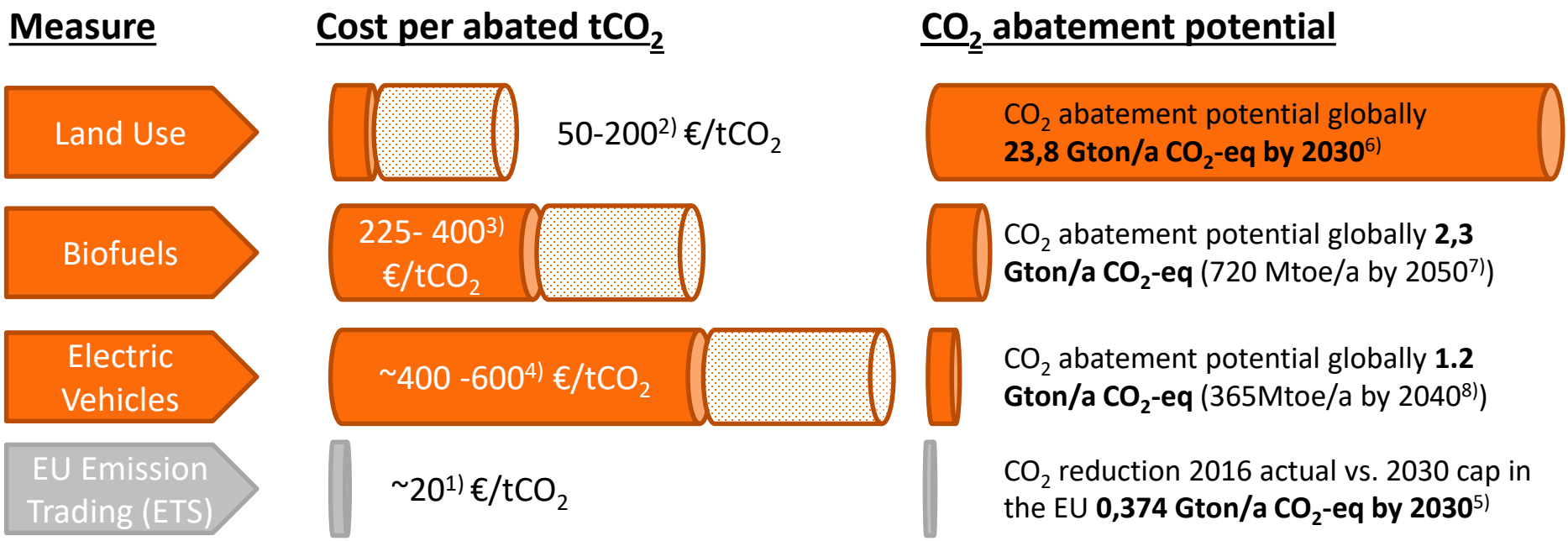
Growth of global emissions vs. EU 2017e



Allowing CO_2 abatement actions outside the EU is needed

1) Global Carbon Project, Global Carbon Budget 2017: http://www.globalcarbonproject.org/carbonbudget/17/files/GCP_CarbonBudget_2017.pdf
2) European Environment Agency: https://www.eea.europa.eu/data-and-maps/indicators/greenhouse-gas-emission-trends-6/assessment-1
3) IEA, World Energy Outlook 2018, Current Policies Scenario

Carbon sinks are both imperative and cost effective

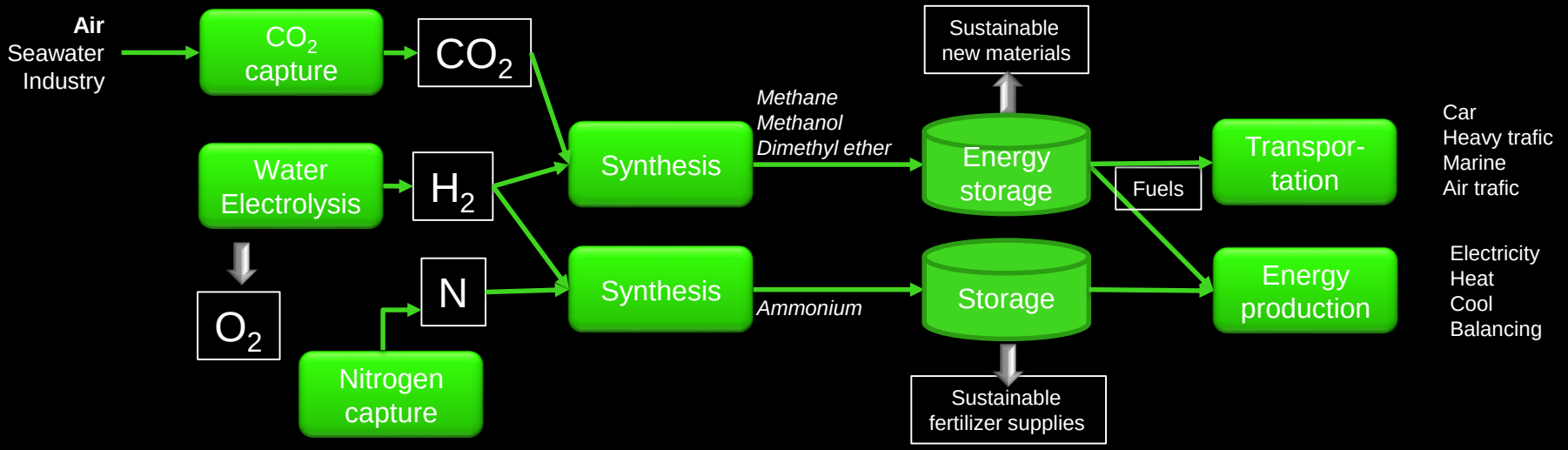


1) eex: https://www.eex.com/en/market-data/environmental-markets/spot-market/european-emission-allowances#!/2018/11/29
2) St1 own analysis for Carbon Farming project. Several sources.
3) Current market price for HVO in the Nordic market, Actual offer for 225 €/tCO2 and by market intelligence estimated price span for 2030
4) Integrated Fuels and Vehicles Roadmap 2030+ (Roland Berger, April 27, 2016): The societal cost for long-range BEVs across different personnel vehicle segments
5) European Environment Agency: https://www.eea.europa.eu/data-and-maps/indicators/greenhouse-gas-emission-trends-6/assessment-1
6) Natural climate solutions, PNAS: http://www.pnas.org/content/114/44/11645
7) Global Energy Transformation: A Roadmap to 2050, IRENA: file:///C:/Users/MIAHO/Downloads/IRENA_Report_GET_2018.pdf
8) Electric Vehicle Outlook 2018, BloombergNEF: https://about.bnef.com/electric-vehicle-outlook/#toc-download

Renewable energy developments by controlled exploitation of CO_2 cycles

Strategic modelling of global transition of technologies, by country on an hourly level

Electricity - Solar & Wind, Batteries, Storage



System Efficiency and Grid Management

Carbon Market is needed to achieve Carbon neutral EU by 2050

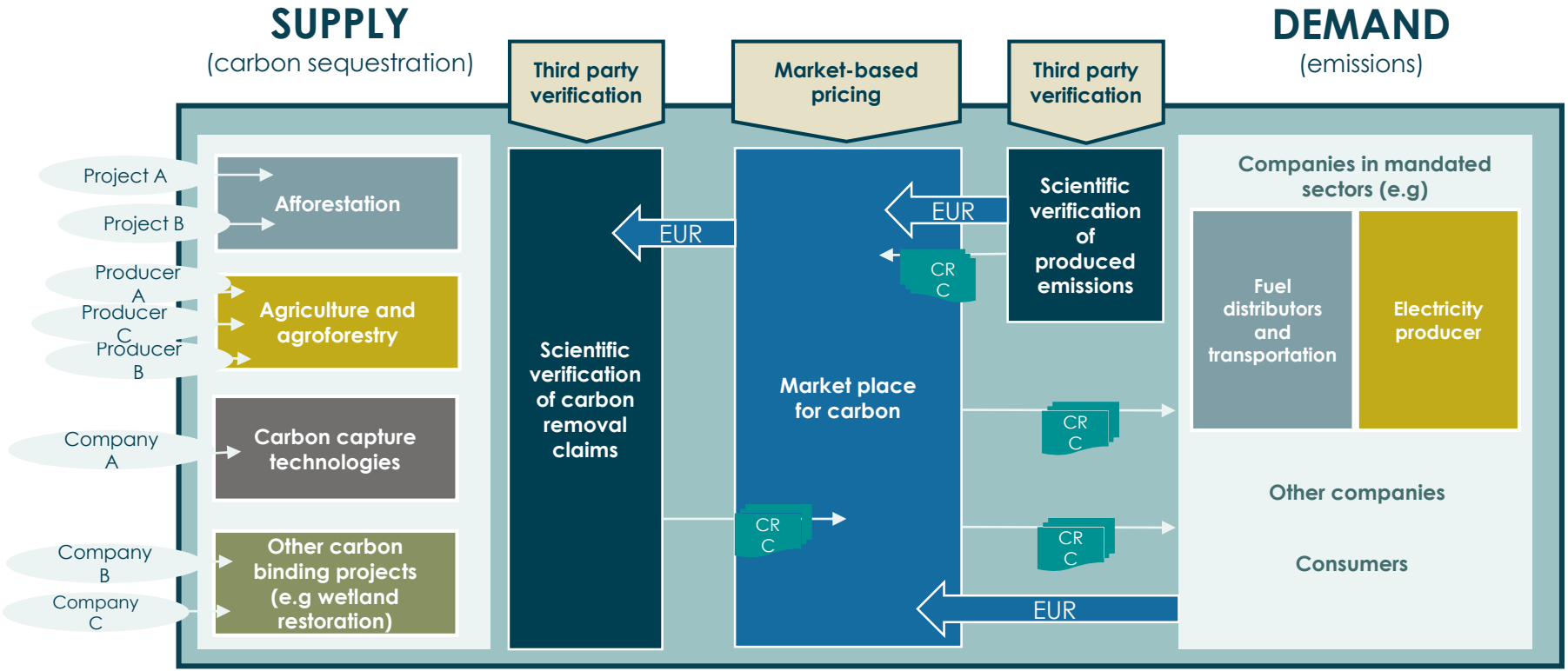
Set CO_2 emission reduction obligations to companies

Carbon Market: Create a market place for emitted and sequestrated CO_2

Allow CO_2 reduction activities across the sectors and in the 3rd countries (incl. carbon sinks)

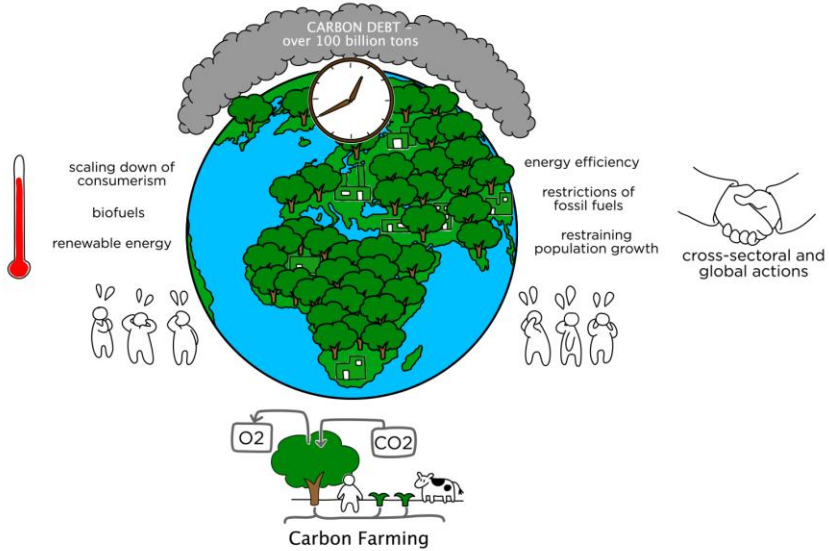
Inside the EU a minimum CO_2 reduction level to be set, with the emphasis on globally scalable measures and technologies

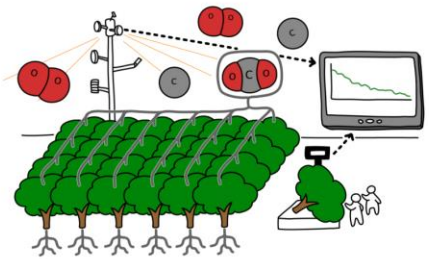
Market place for carbon removed from the atmosphere

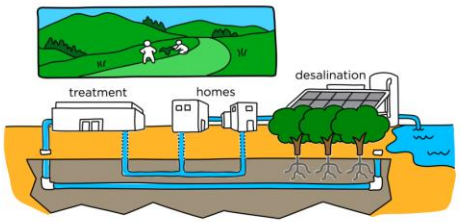


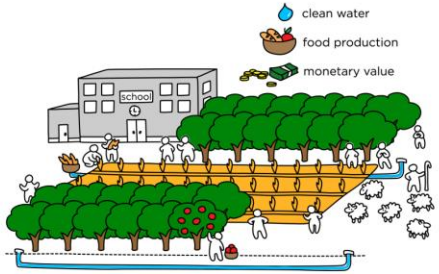
CRC (Carbon Removal Credit) traceability ensures the authenticity and traceability of carbon credits

Carbon Farming - Healing the lungs of our planet









NEOT

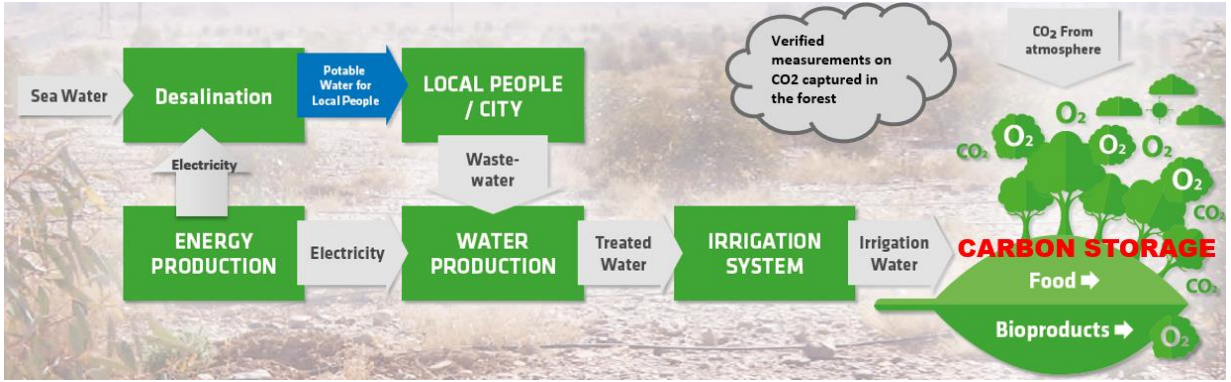
Carbon Farming – In a Nutshell

Description of the solution

Forestation as globally accepted and verified GHG reduction solution for companies to fulfil their obligations or voluntary actions.

Large tree plantations, with crop farming benefiting local people, renewable energy as the energy source, create carbon sinks for different companies and purposes.

Carbon Farming Concept



Benefits

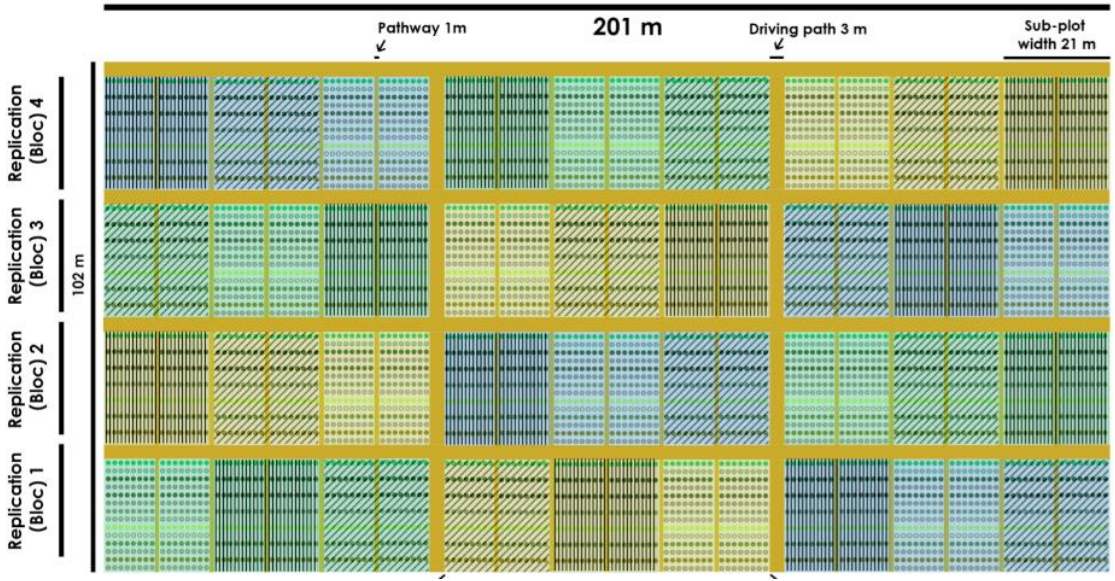
- Carbon Storage/Sinks → reduce CO_2 from atmosphere
- Improved local conditions (eg. Erosion and deforestation prevention)
- Work and income for local people
- Multi-party collaboration needed

Open questions

- Local and Global acceptance
- Carbon trade acceptance – measuring carbon sequestration
- Trading place
- Local people commitment
- Strong local ownerships
- Landownership issues

Small Scale Pilot Project in Morocco

TO IDENTIFY TREE SPECIES PLANTED TOGETHER WITH SOIL IMPROVEMENT AND IRRIGATION FOR OPTIMAL CO_2 SEQUESTRATION IN SEMI-ARID REGIONS



1. Paulownia elongata
2. Moringa
3. Carob
4. Pistachia atlantica
5. Acacia gummifera
6. Eucalyptus Camaldulensis
7. Pinus halepensis
8. *Prosopis juliflora*

e

NEOT

Let's make Sahara green again

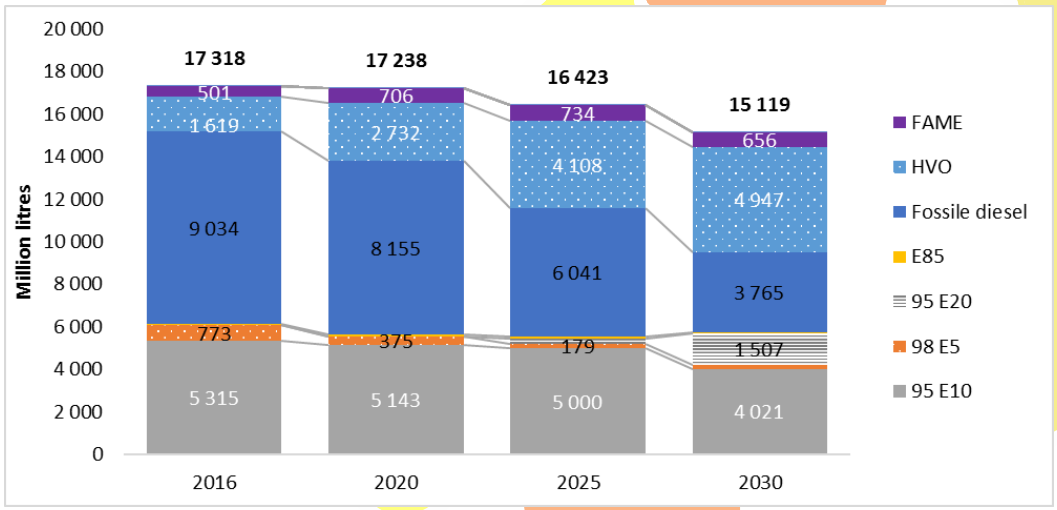
Image http://clubofmozambique.com/news/southern-africa-join-great-green-wall-august-30-2016/

St1 invests in Advanced Biofuels

Liquid fuels still needed in the Nordics in 2030

Due to blending walls for Gasoline (E10) and Diesel (B7) biofuels growth comes from HVO

Electric scenario (mill.litr)



THE NEED FOR HYDROTREATED RENEWABLE DIESEL ~5 mill. m^3 BY 2030

Sources: Final thesis of Westerlund, Kilpeläinen and Giacosa, Aalto University, 2017

Renewable Diesel (HVO) 200kt investment at St1 Refinery

St1 is probably to the most biomandated company in world

Own production of the HVO is strategic investment to meet the upwards price pressure of HVO

Two stage investment

- New hydrogen production unit, start-up in summer 2019
- HVO production unit, planned decision in 2019 and the production start in 2021

Flexible feedstock base

St1 Advanced Ethanol Production in Circular Economy

Waste & process residues sources

Food Industry & Retail

Municipal & Commercial

Wood Industry

Recycling

Feedstock & Sourcing Partners

St1 Biorefinery Solutions

Etanolix®

Bionolix®

Cellunolix®

Technology & Development Partners

Products and co-products

Ethanol | **Biogas** | **Heat & Power**

Advanced Biofuels & Renewable Energy

Animal Feed | **Soil Improvers** | **Fertilizers**

Agriculture & Nutrient Recovery

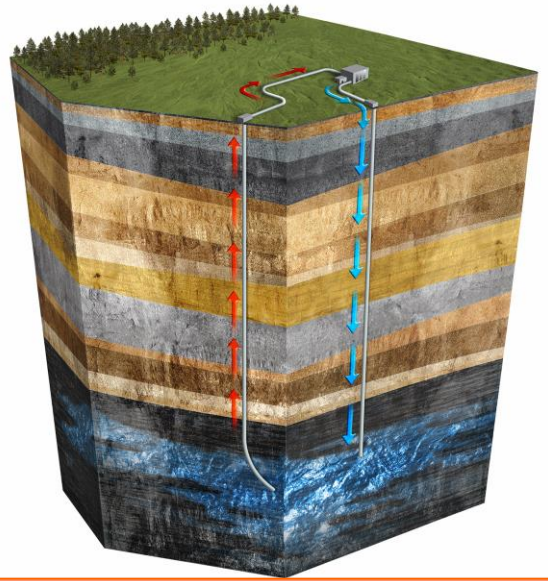
Future Products

Off take & Development Partners

St1 Deep Heat

St1 Deep Heat concept: Enhanced Geothermal Energy (EGS) for District Heating

- Sustain-able
- Reliable
- Small Footprint
- Cost Effective



Principal is simple. Depth and the Finnish bedrock make the project challenging .

Windpower

TuuliWatti Oy is a joint venture by St1 and S-Voima – the leading operator in industrial wind power in Finland

- 23% of Finland’s windpower production in 2017

Several new projects in development phase

TuuliWatti invests in strong know-how and the latest wind power technology

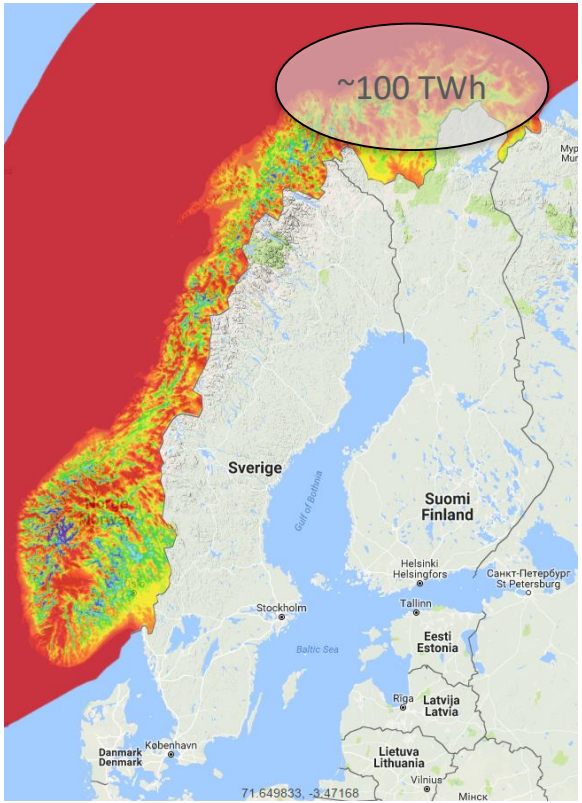
Projects are developed together with wind power positive communs

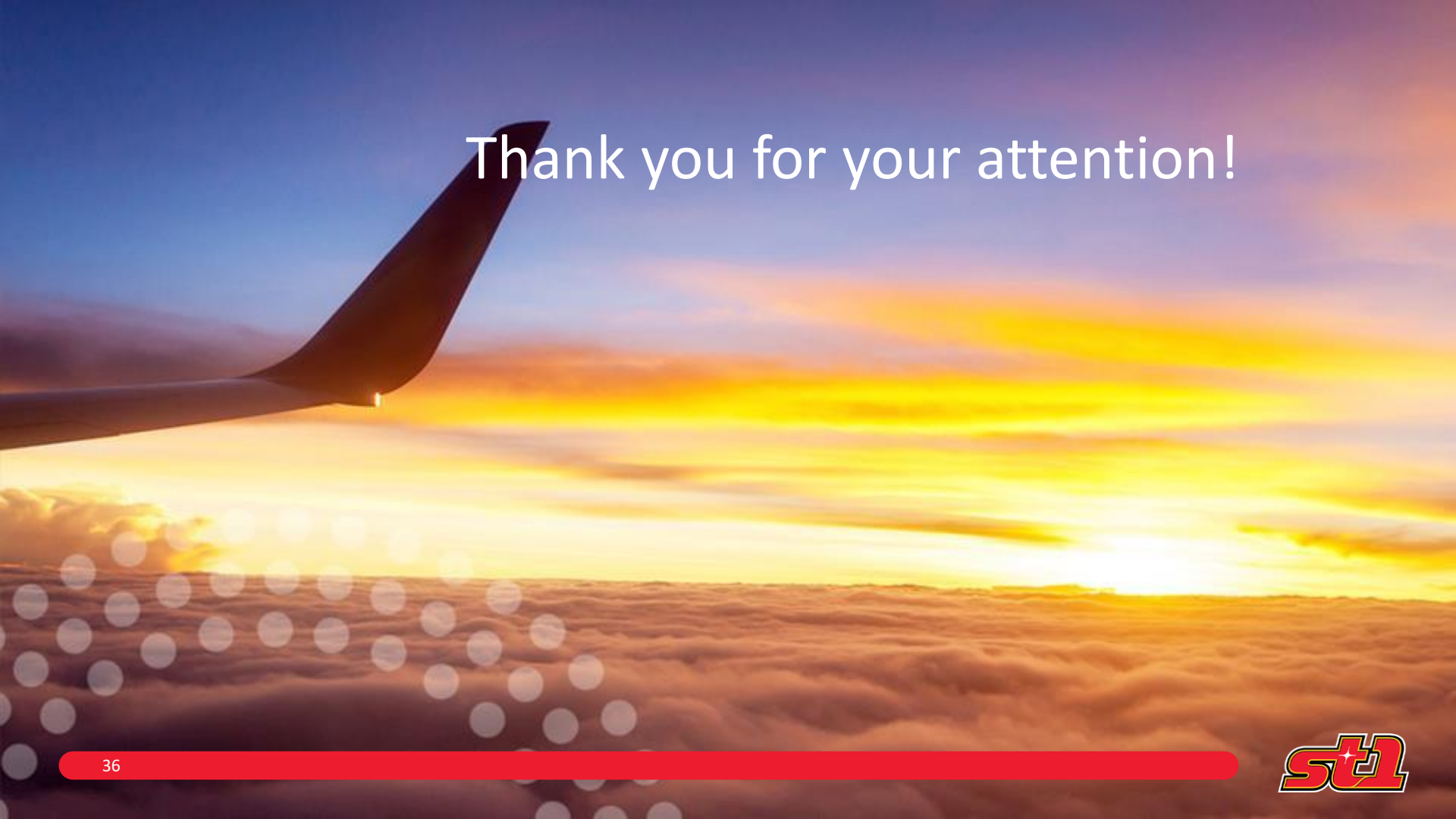
Arctic Energy Initiative

- power gateway to Europe

Arctic Wind

- The Arctic parts of the Nordic Region could secure clean power production for the whole Baltic Sea region
  - In addition to GHG emission reductions, new production would reduce dependence on imports
  - Would support the targets of the EU Energy Union
- Excellent wind conditions mean wind farms could be built without subsidies
- Balancing power available
- Wind power construction is currently impossible due to bottlenecks in transmission capacity
- A new transmission line could complement the list of Projects of Common Interest in the Nordics




Thank you for your attention!