

# Biofuels – a challenging opportunity for Norway

Jens Ulltveit-Moe | August 22nd 2018

# Agenda

- ▶ **Fundamental energy balance**

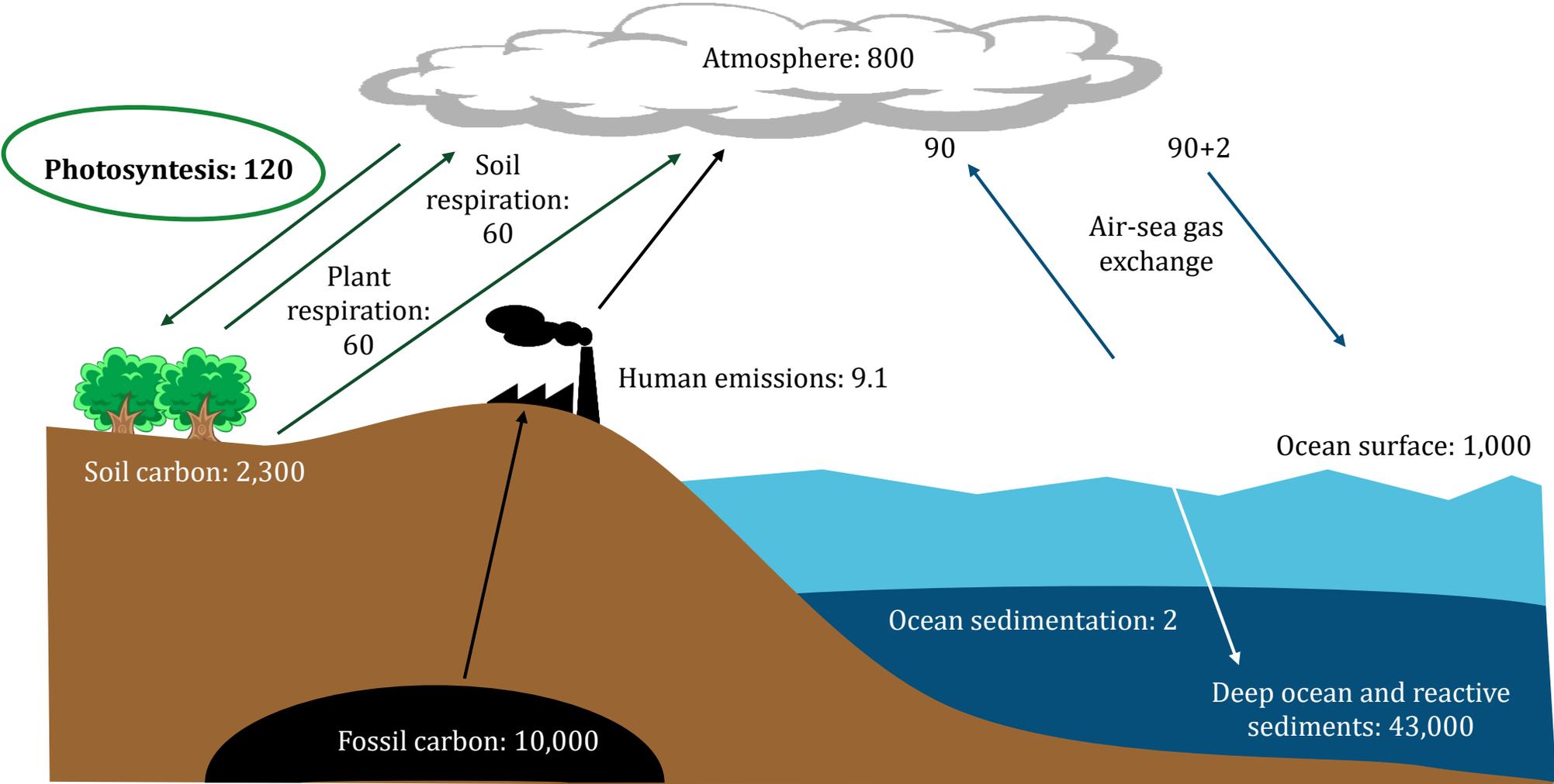
- ▶ Biofuels in Scandinavia

- ▶ Our Brazilian experience

- ▶ The Norwegian road ahead

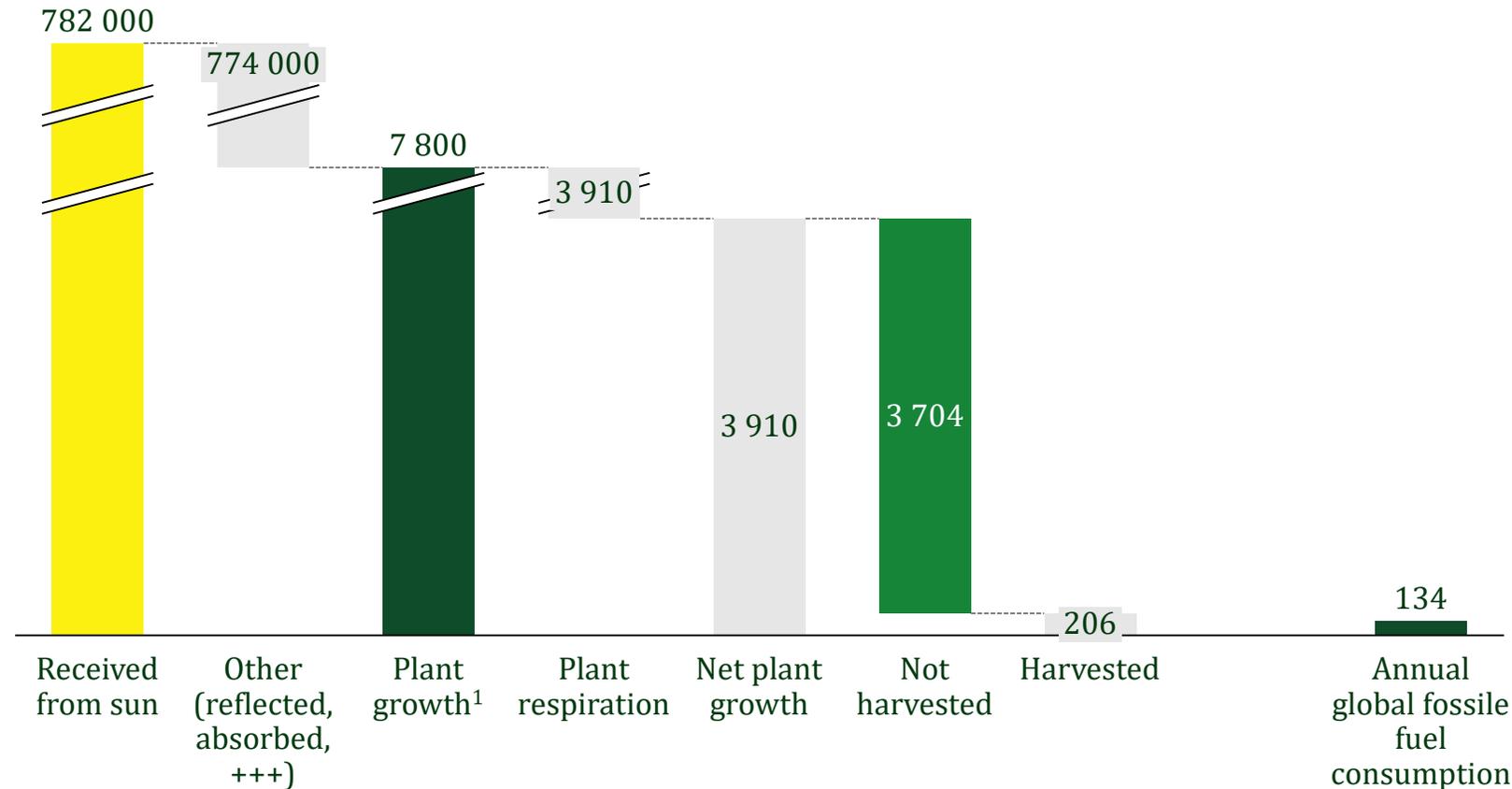
# Plants capture each year carbon equal to 13 years of human emissions

Gigatons carbon



# The sun dwarfs everything else

PWh

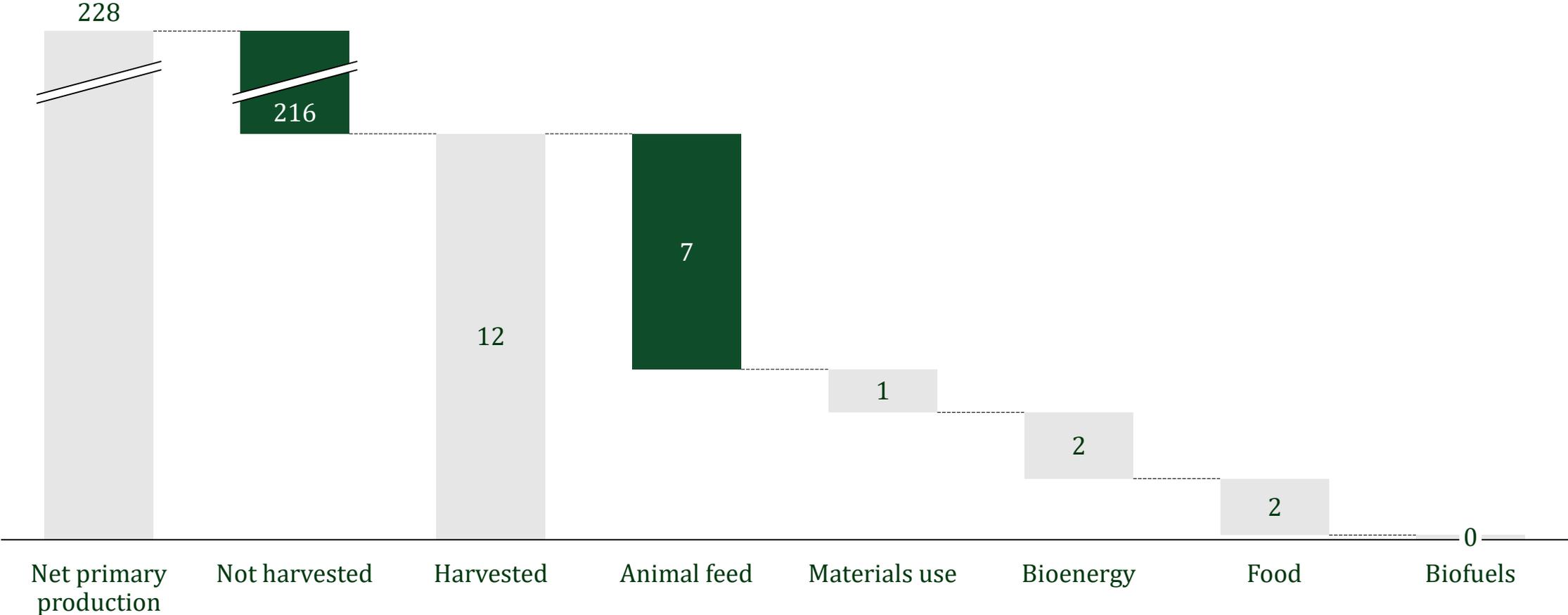


- Less than 1% of solar radiation converted to biomass
- Less than 10% of net plant growth is harvested annually
- Energy content of harvested and consumed plants is ~1.5x global annual fossil fuel consumption
- Sustainable harvesting (i.e., what is harvested and what is not, and where) is critical
- All studies point towards a need to increase the global harvest (to mitigate climate change)

1: Assumes 1% photosynthetic efficiency (Pisciotta et al., PLOS One (2010))

SOURCE: BP Statistical Review of World Energy 2018

# The Earth represents a huge energy potential



SOURCE: BP Statistical Review of World Energy 2018; Pietrowski et al., Open Agriculture (2016); Wikipedia; Gough et al., Nature Education Knowledge (2011); Liao and Zhuang, Earth Interactions (2015)

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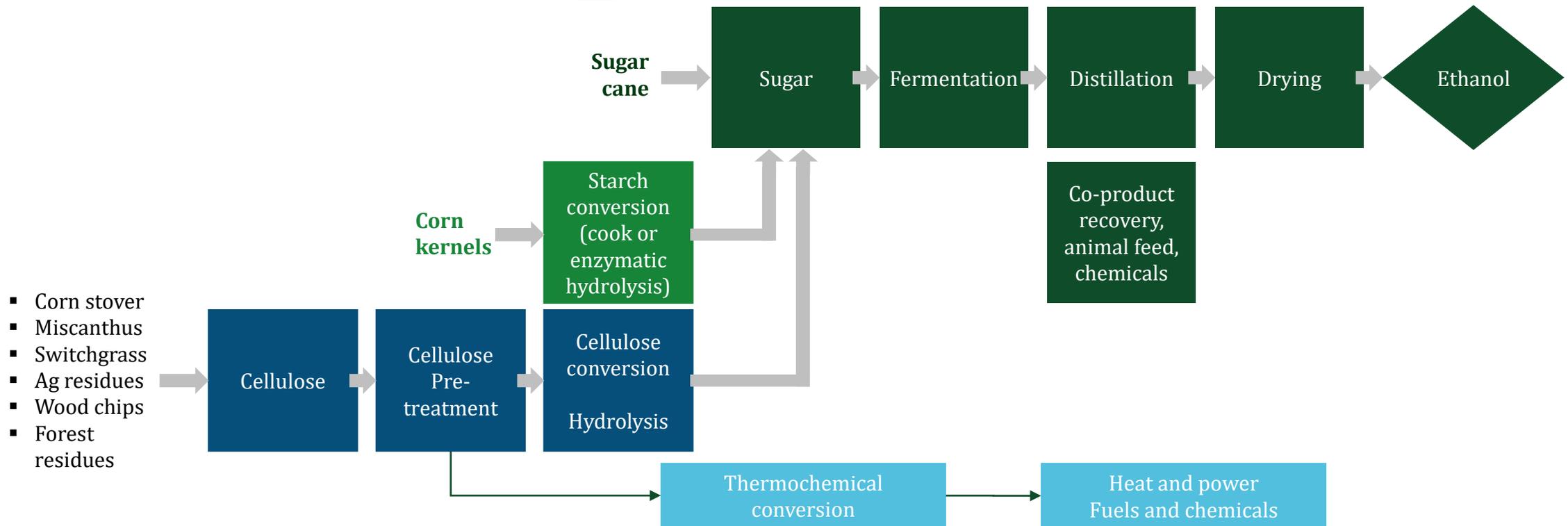
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# Wood based biofuels require additional refining steps

## Cellulose process

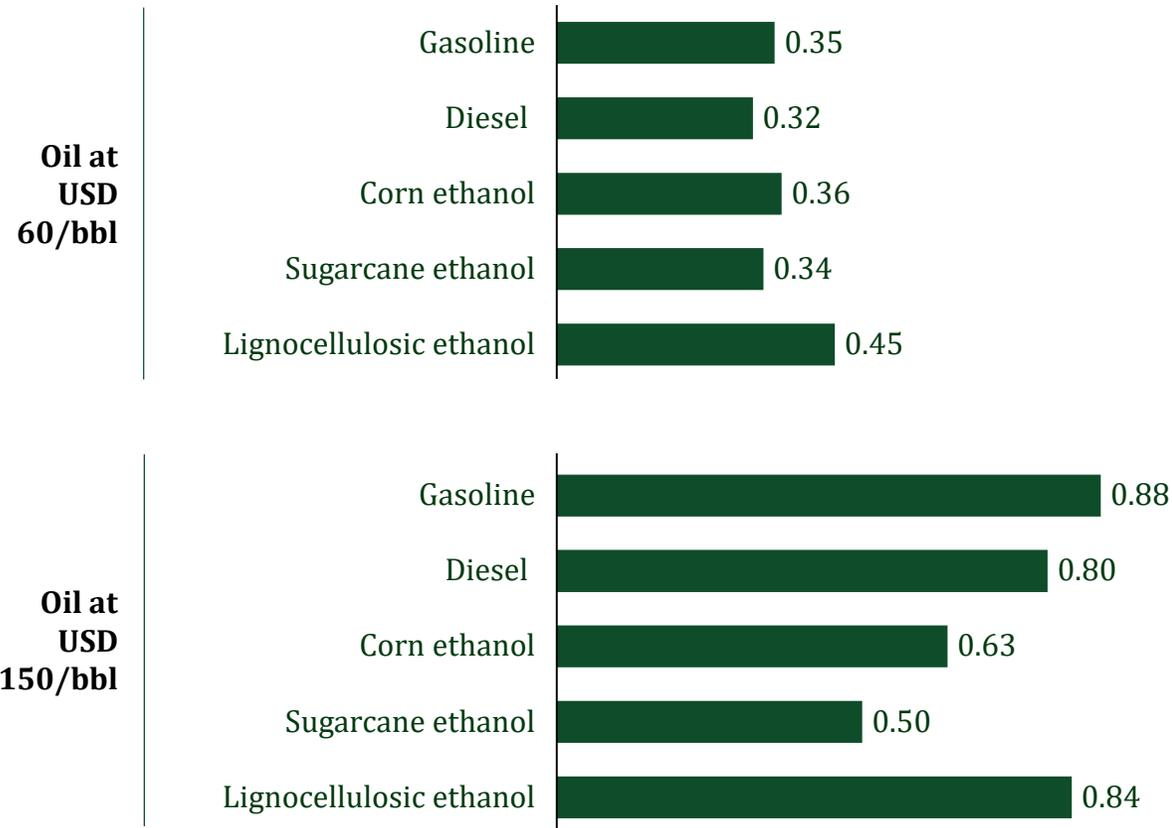
## Corn process

## Sugar cane process



# Wood based-biofuels currently uncompetitive

Driving costs, NOK/km



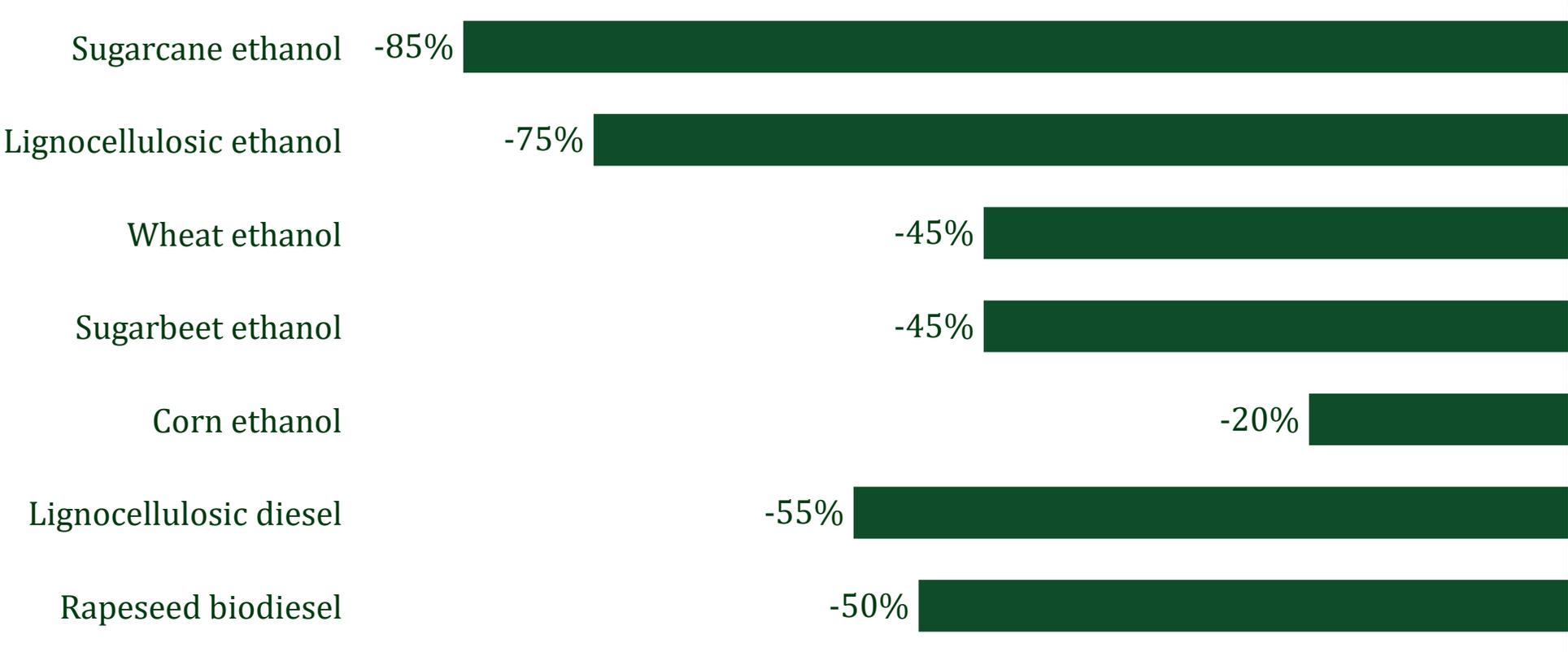
- Production costs for all fuels depend on crude oil prices, as harvesting and transportation require diesel
- Sugarcane wins on cost
  - Among the most photoefficient plant on earth (8% of sunlight converted to biomaterial, vs less than 1% for most plants)<sup>1</sup>
  - Sugar can be directly processed into ethanol, whereas plants containing starch or cellulose need processing before the distillation into ethanol can take place
- Lignocellulosic ethanol, however, has the advantage that the raw material can be waste material (e.g., bagasse, corn stover, wood chips, branches and tops) or grasses (e.g., miscanthus, ...) that can be grown on marginal land

1: Average sugar cane yields for Peru in 2014 was 126 tons/hectare (=12,6 kg/m<sup>2</sup>), while most other crops are around 10 tons/ha (corn and potatoes are both: ~50 t/ha)

Note: Assumes successful technology development (for some fuels this may not occur until ~2030). Assumes gains from co-products where applicable

# Sugar cane best on CO<sub>2</sub> abatement

CO<sub>2</sub>-abatement effect relative to gasoline



# Swedish forest industry invests aggressively

Investeringarna i nordisk massaindustri ökar efterfrågan på massaved med 10 miljoner kubikmeter, ett guldläge för svenska skogsägare.

## Skogsindustrin blomstrar – ökad efterfrågan

Skogsbruket i Sverige fortsätter gå bra och skogsägarna är optimistiska för framtiden.

En "perfekt storm" i skogen – nu ökar kampen om virket

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## Höjda priser ger starkare skogsägare

Mellanskog genomför nu en prishöjning på barr- och granmassaved och höjer samtidigt grundpriset på timmer.

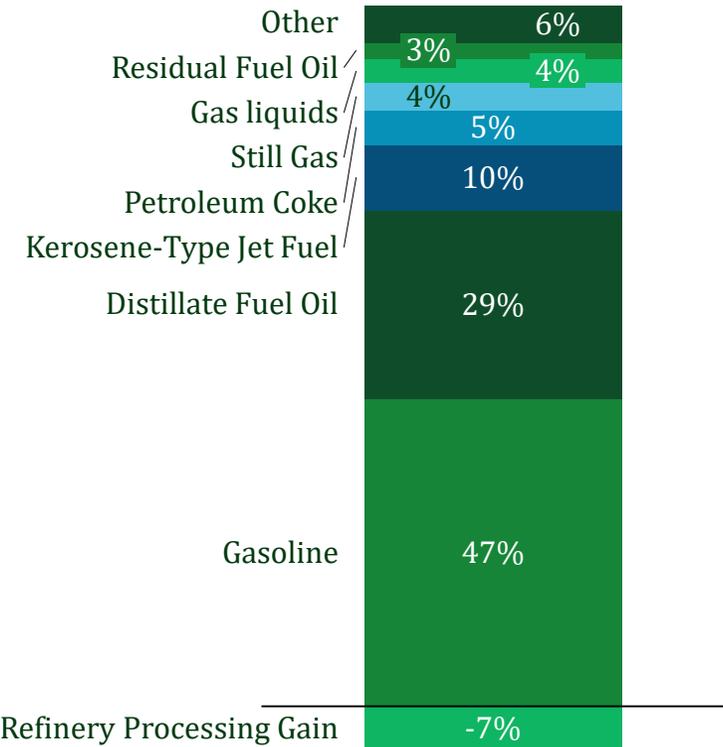
## Skogsbolaget når rekordförsäljning – varnar för träbrist

– 2017 toppar fyra mycket tunga investeringsår på raken för svensk skogsindustri, säger Katrin Heinsoo, marknadsanalytiker på Skogsindustrierna.

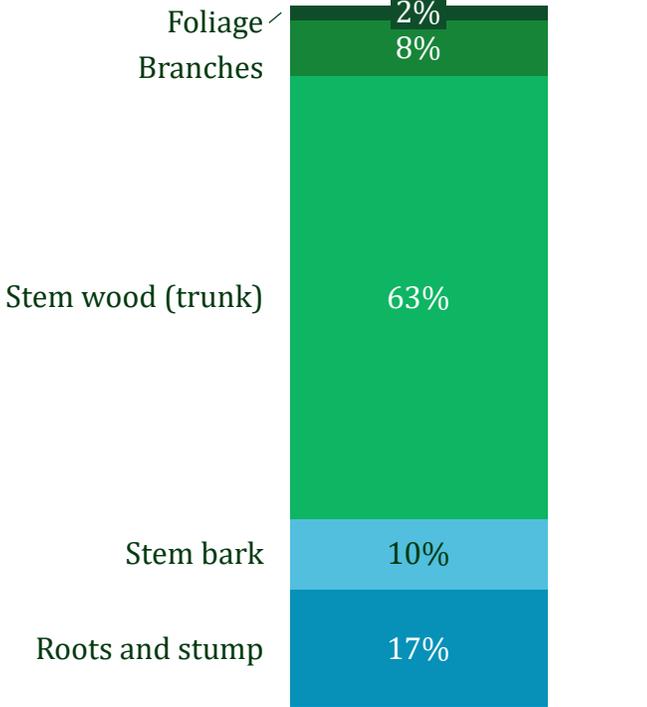
- The Swedish forest industry is large and profitable. Exports in 2017 were SEK 132 billion
- Gross harvest 2017 was 93 million m<sup>3</sup>sk (compared to 11 million million m<sup>3</sup>sk in Norway)
- Industry profits are high, and demand for wood is strong. Swedish demand has also led to increasing prices in Norway (pulp wood +25% y-o-y, timber +7%)
- Known capacity additions in Sweden (~6-8 mill m<sup>3</sup>sk) and Finland will increase Nordic demand for wood by about 10 million m<sup>3</sup>sk

# Most of the tree must be used to be profitable

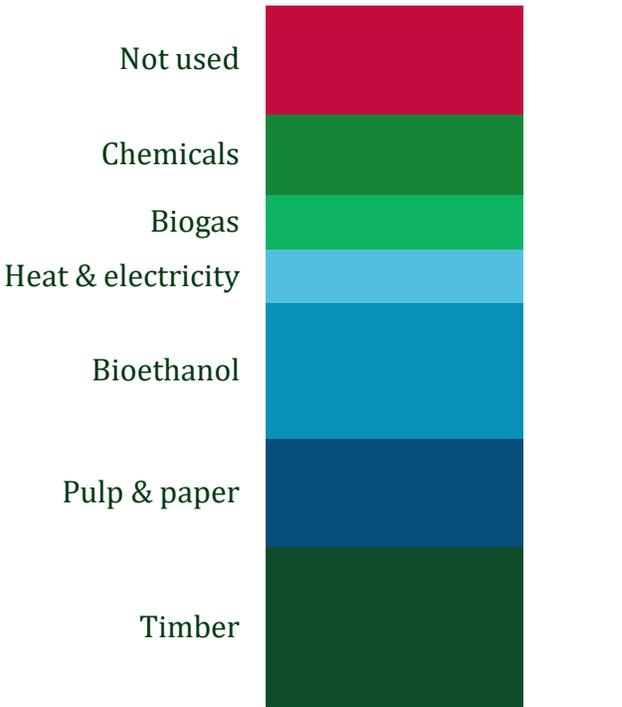
Composition of crude oil (after refining)



Composition of a tree



Uses of a tree (illustrative)



1: Prices are for Gasoline RBOB (Gulf Coast) and WTI, and are wholesale spot prices per Aug 6<sup>th</sup>

2: Swedish annual district heating volumes are about 50 TWh, of which 4 TWh was excess heat from industry. The same numbers for Norway were 6.1 TWh and 0.2 TWh, respectively

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# Umoe Bioenergy

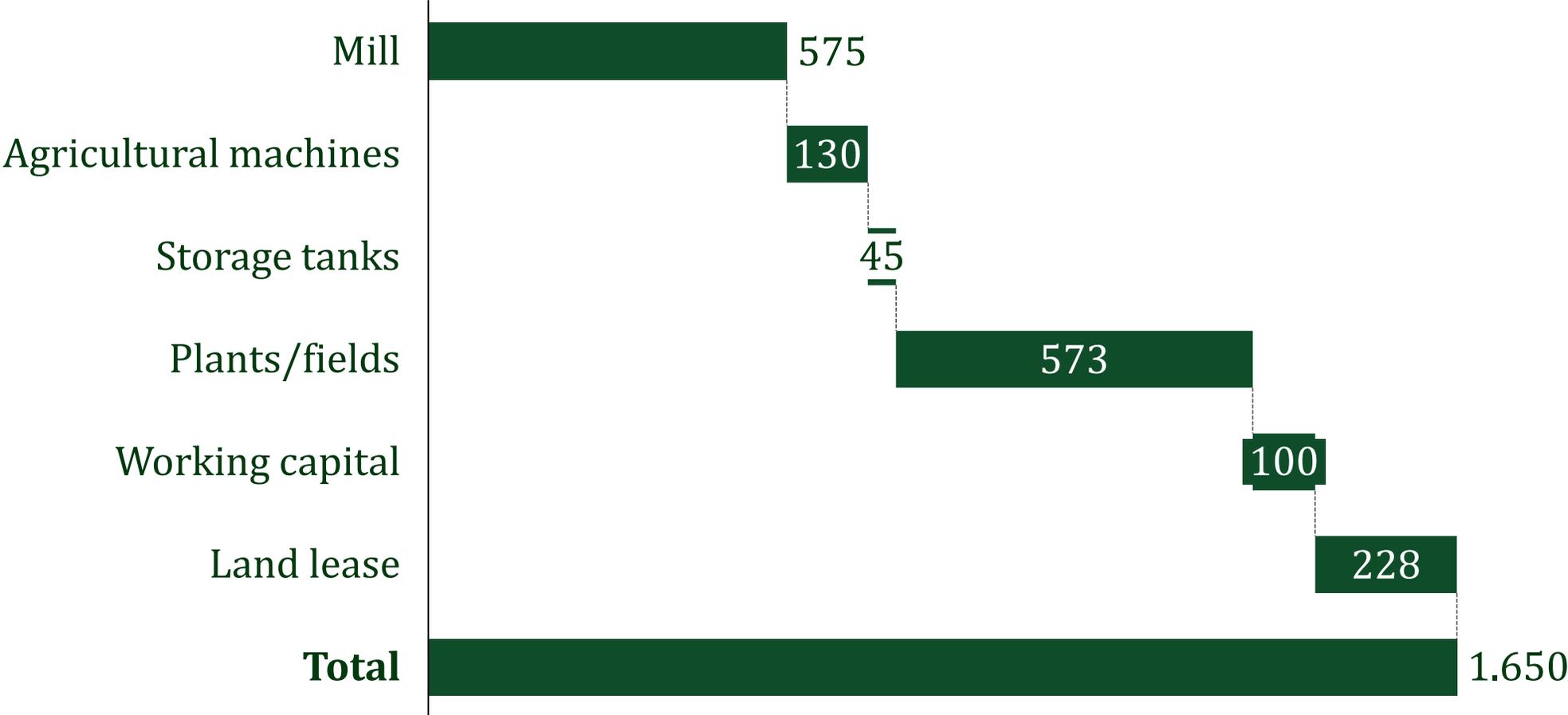
**Umoe Bioenergy produces sustainable bioethanol from sugar cane – a fuel costing less than competing fossil fuels while also reducing CO<sub>2</sub> emissions from cars and electricity generation**



- Located in Sao Paulo, Brazil
- Part of Umoe since 2007
- 1,600 employees
- 40,000 hectares of leased arable land
- Mill capacity of 2.6 million tons

# Ethanol production is capital intensive

Invested capital (per 2017), NOK millions



# The CO<sub>2</sub> abatement from Umoe's mill in Brazil corresponds to 11% of emissions from Norwegian gasoline cars

## 2016, Norway

- 3.2 million tons CO<sub>2</sub> from gasoline powered vehicles
- 

## Umoe Bioenergy

- 200 million litres of ethanol, corresponding to 134 million litres of gasoline
- 

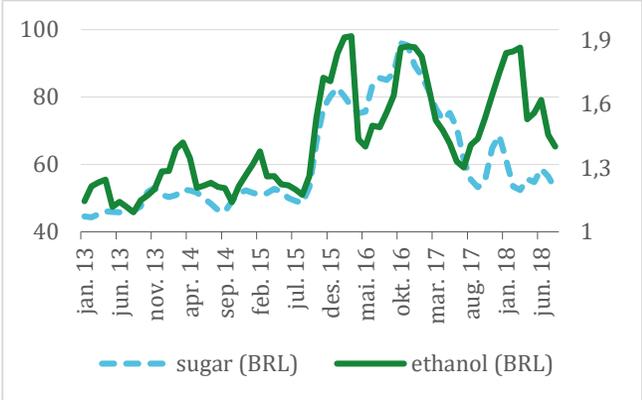
## Effect in Norway from importing 200 million litres of ethanol

- 0.34 million tons CO<sub>2</sub> abatement (11 % of current gasoline-based emissions)

# Profitability depends politics and world markets

## 1. Sugar price

- Strong link between sugar and ethanol 2013-16, weaker since
- Many Brazilian mills equipped for both sugar and ethanol, depending on prices

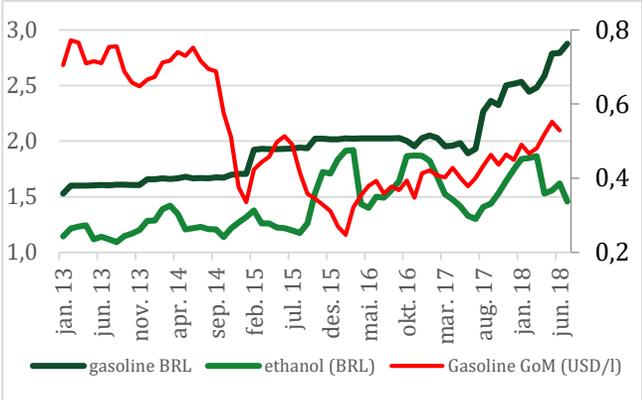


## 3. Politics

- Brazilian domestic politics has been, and is, unpredictable and unstable
- For years, Brazil forced Petrobras to sell gasoline at the pump with a loss to keep inflation at bay
- Nevertheless, broad support for sugarcane industry (through high blending rates, flex fuel policy, substantial financing programs)

## 2. Oil price

- Relatively weak link to global oil price; stronger link to Brazilian domestic gasoline price



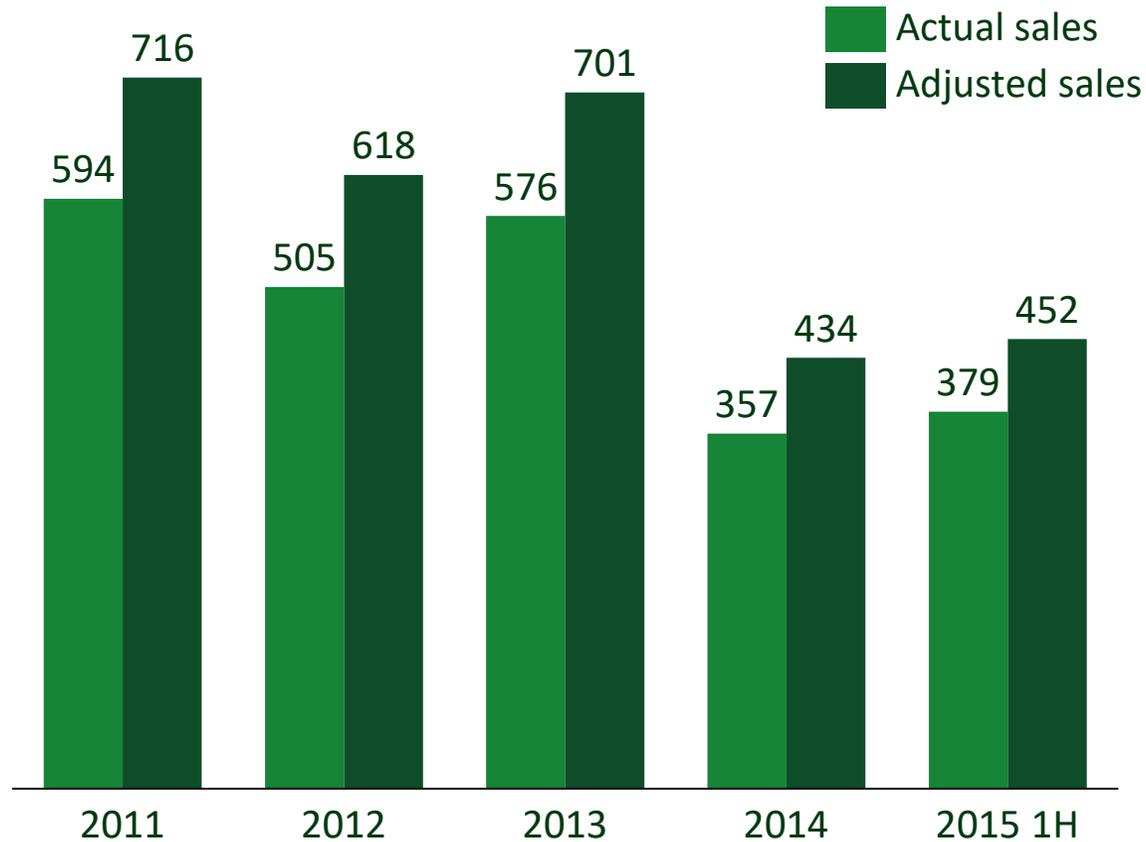
## 4. Land yield and mill performance

- Land yield depends on local soil and weather conditions *and* the sugar cane farmer’s agricultural performance (planting, weed control, pest control, harvesting operations etc.)
- UBE was some years ago a bottom performer (i.e., lowest yield per hectare), but is steadily improving and is now around median



# Umoe Bioenergy lost about 500 MNOK from market intervention by the government

NOK million



- Brazil set gasoline prices artificially low from 2011 to 2015, forcing a loss for both Petrobras and the ethanol industry
- The average gasoline price lag was 17% at the refinery (before distribution to final customers).
- A “true” price would have been NOK 0.50-0.75 higher per liter of ethanol.
- The chart assumes additional revenues of NOK 0,75/liter of ethanol

# RenovaBio rewards the sugar cane industry for CO<sub>2</sub> reductions

- Overall purpose:
  - reinvigorate the bioenergy industry
  - reduce GHG emissions as part of Brazil's commitments under the Paris agreement
- Fuel distributors
  - increase the amount of biofuels they sell every year
  - buy credits to offset their sale of fossil fuels
- The credits will be granted to ethanol producers, based on carbon footprint.,
  - Land yield
  - Consumption of fertilizers
  - Fuel consumption
  - Amount of straw collected
- Ethanol producers will probably make about R\$0,1 per liter from the credits. For Umoe, that would be about NOK 50 million.

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# A successful Norwegian venture into biofuels requires new technology, favorable prices, and efficient use of the tree

1

**2nd generation technology matures into cost-efficiency**

Norwegian plants are starch (C<sub>5</sub>) and/or cellulose-based, requiring additional refining vs sugar-based plants (C<sub>6</sub>)

2

**Profits are sufficient to compete with Swedish demand for raw materials**

Swedish p&p-industry is

- profitable and expanding
- could potentially pay more for Norwegian wood

3

**Profitability requires efficient capitalization of all parts of the tree**

Big residual value in

- grot and bark
- feedstock for the chemical industry
- speciality extractives.