Industry view on worldwide biorefinery development

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Johan van Doesum
Innovation Director
DSM Bio-based Products & Services

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HEALTH · NUTRITION · MATERIALS

DSM – Innovation driven change

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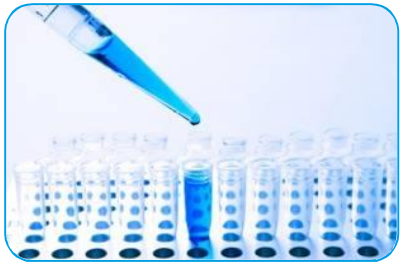
DSM: a century + of biotech innovations

CLASSICAL BIOTECH (19th century)

- Yeast
- Ethanol
- Yeast extracts
- Vitamins
- Penicillin
- Enzymes
- Citric acid

MODERN BIOTECH (20th century)



- Food & Feed enzymes
- Metabolic engineering
- Biocatalysis
- Cell culture

BIOECONOMY (21st century)

- Advanced Cellulosic Yeast & Enzymes
- Platform chemicals:
  - Succinic acid

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Our integrated strategy & targets

Driving Sustainable Markets

- Nutrition
- Climate & energy
- Circular and bio-based economy

Sustainable Growth Areas

Sustainability as Business Growth Driver

Eco+

People+

Brighter Living Solutions

- Profitable solutions better for people and planet
- 65% of DSM products by 2020

Securing Sustainable Operations

GHG efficiency
Renewable energy

Health & Safety
Engagement
Diversity

Sustainable Operations

• GHG efficiency improvements	40-45% by 2025 (1)
• % of purchased electricity from renewables	50% by 2025
• Employee engagement favorable score	75% by 2020
• Safety: Frequency recordable index	25% by 2020
• Leading in reporting benchmarks	Gold class DJSI

(1) Relative improvement as compared to baseline 2008

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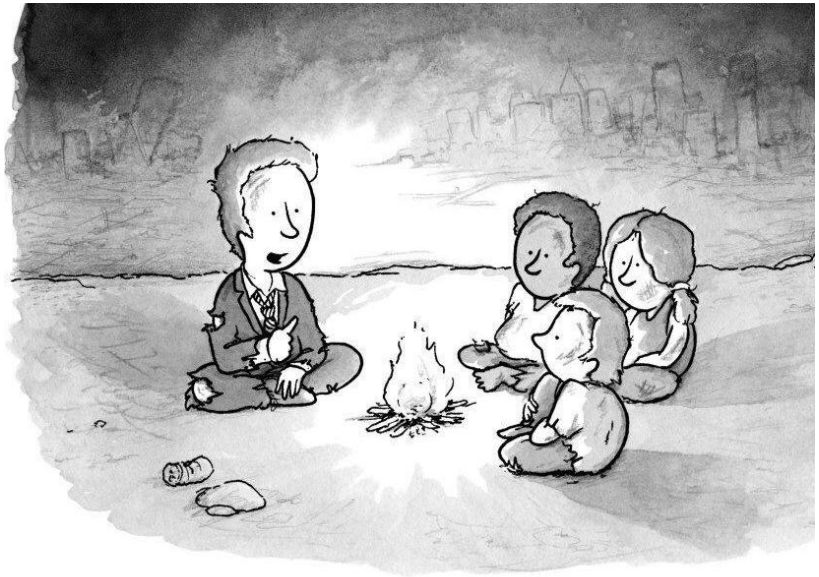
Why are we involved in the climate agenda?

RESPONSIBILITY
to act →



"Yes, the planet got destroyed, but for a beautiful moment in time we created a lot of value for shareholders."

OPPORTUNITY
for growth →

IEA: climate deal unlocks $13.5 trillion of investments in energy efficiency and low carbon technologies by 2030 – $8.3 trillion of which in the transport, buildings and industry sectors.

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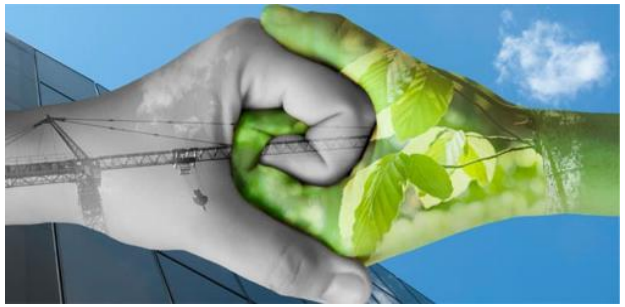
Our approach

REDUCE our own footprint

realize 40-45% GHG efficiency improvement 2008-2025 (via energy efficiency, 50% renewable purchased electricity, internal carbon price)

ENABLE low carbon economy

identify (and seize!) business & innovation opportunities arising from countries' climate action plans ("NDCs")



ADVOCATE climate action

creating markets in which our low-carbon products can *thrive*, with a focus on renewable energy and carbon pricing

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DSM’s Vison of the Future

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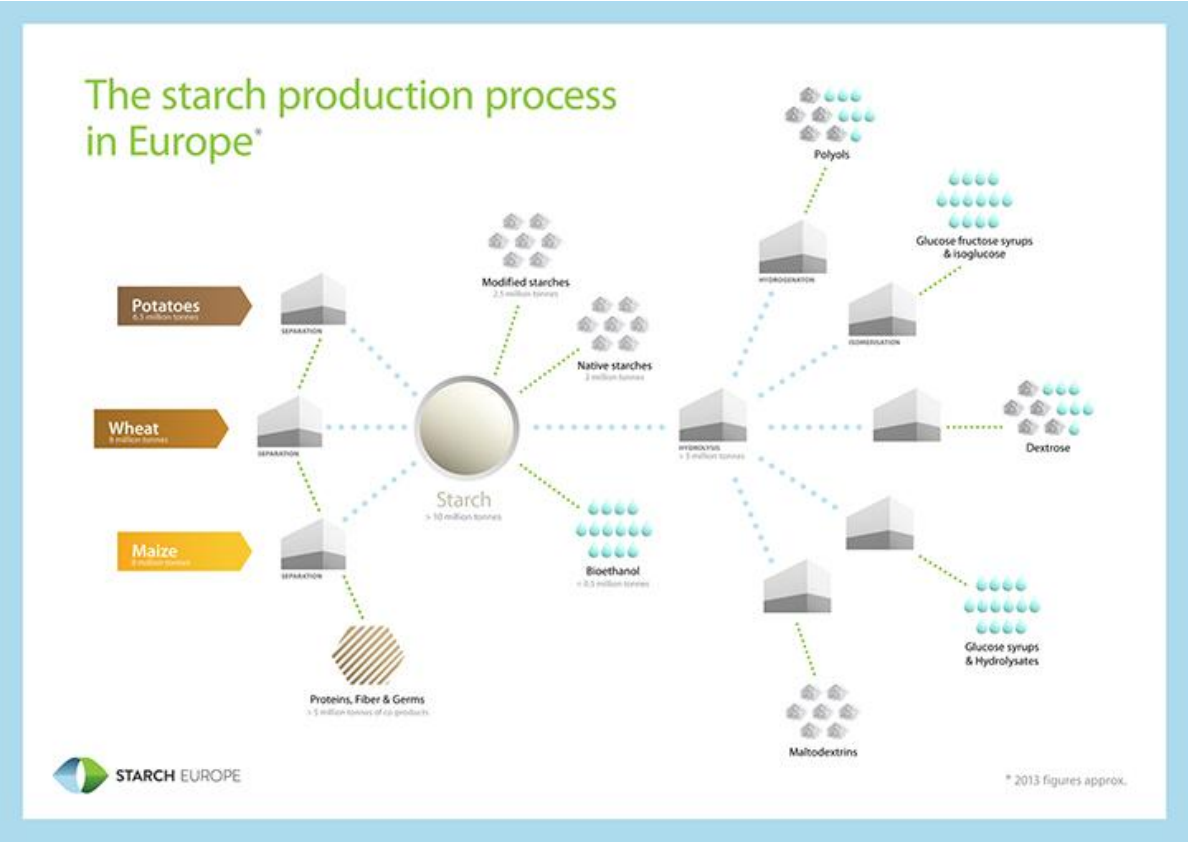
Bio refineries



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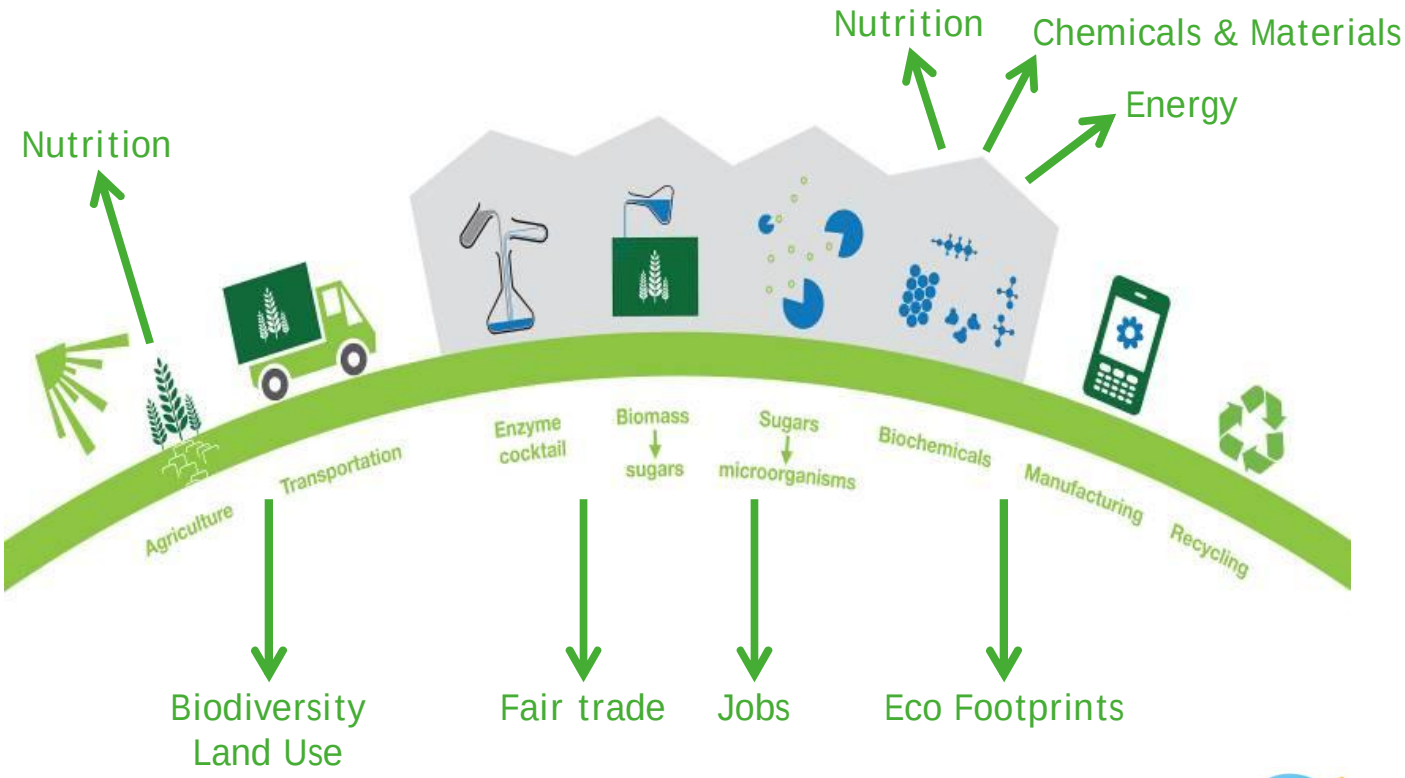
Integrated biorefineries: 'Crops are the future oil'



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Integrated biorefineries

- Gen 1 corn ethanol developments (sparked a lot)
  - Ethanol
  - CO2
  - Fractionation of corn
    - Oil
    - Fibers
  - Oligomers
- Next?
  - High value compounds made by yeast next to or instead of ethanol

- Gen 2 (lignocellulosic biomass)
  - Sugars
    - Ethanol, plus other high value compounds
  - Lignin (+ derivatives thereof)
  - Oligomers of glucose, xylose
  - Other sugars

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Integrated biorefineries: need for partnerships

- Knowledge and experience needed in broad areas (throughout value chain)
  - Raw materials
  - Local infrastructure
  - Conversion technologies
  - End products (chemicals, fuels, food/feed) application and markets
- Large capital investments
- Time horizon to multiple commercially operational units (i.e. stamina)
- Organizational and cultural aspects!

Partnerships to include:

- Industry
- Local and national authorities
- Knowledge institutes

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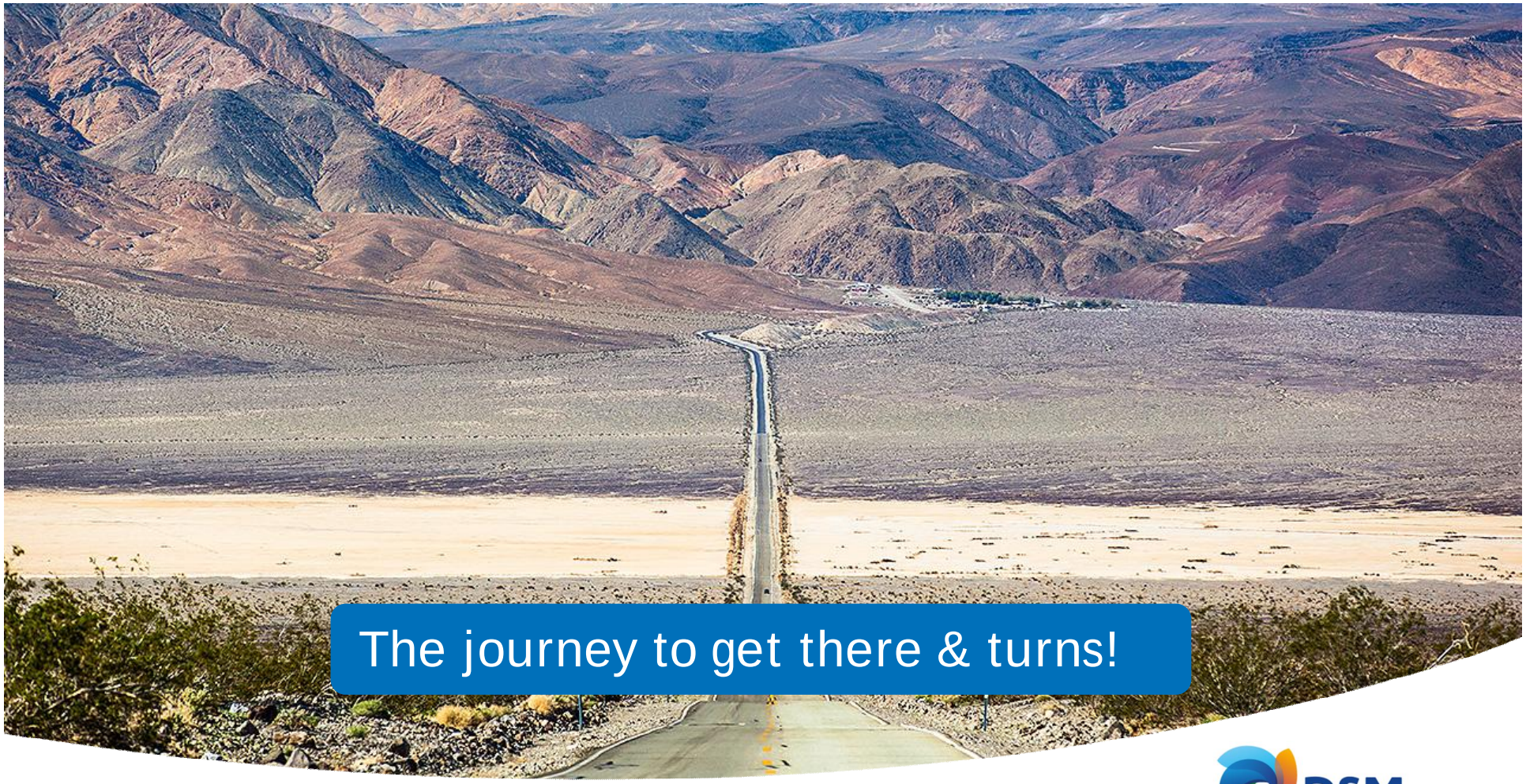

The journey to get there & turns!

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Steady Progress at Project Liberty:

1) Design yield targets achieved (71g/t)
2) Recent decision to build On-site Enzyme Factory

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Marathon – Current Focus on Market Development

New realities require new ways of thinking

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Role of government

- Stimulating
  - Subsidies
  - Grants
  - Removing regulatory hurdles

  Generally this is local, with many different requirements. No transparency for companies for investment, time-consuming investigations and reporting, uncertainty on duration of stimulus etc.

- Carbon tax

Current systems are ‘broken’ due to too high free rights, leading to low prices.

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Carbon Pricing Leadership Coalition

What is it?

- A voluntary initiative to catalyze action towards the successful implementation of carbon pricing (via tax / emissions trading scheme).
- Brings together over 200 stakeholders: leaders from government, business and civil society.

Goal is for carbon prices to:

- expand: coverage of global GHG emissions 50% in 2020s
  - currently, this is just 13%
- deepen: increase price levels to ensure they are meaningful
  - currently, most prices are below $10/CO_2$
- connect: more “linkage” between carbon pricing systems across world
  - currently, i.e. California and Quebec schemes are linked

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90 countries mention carbon pricing in their national climate plans, several even consider it *conditional*

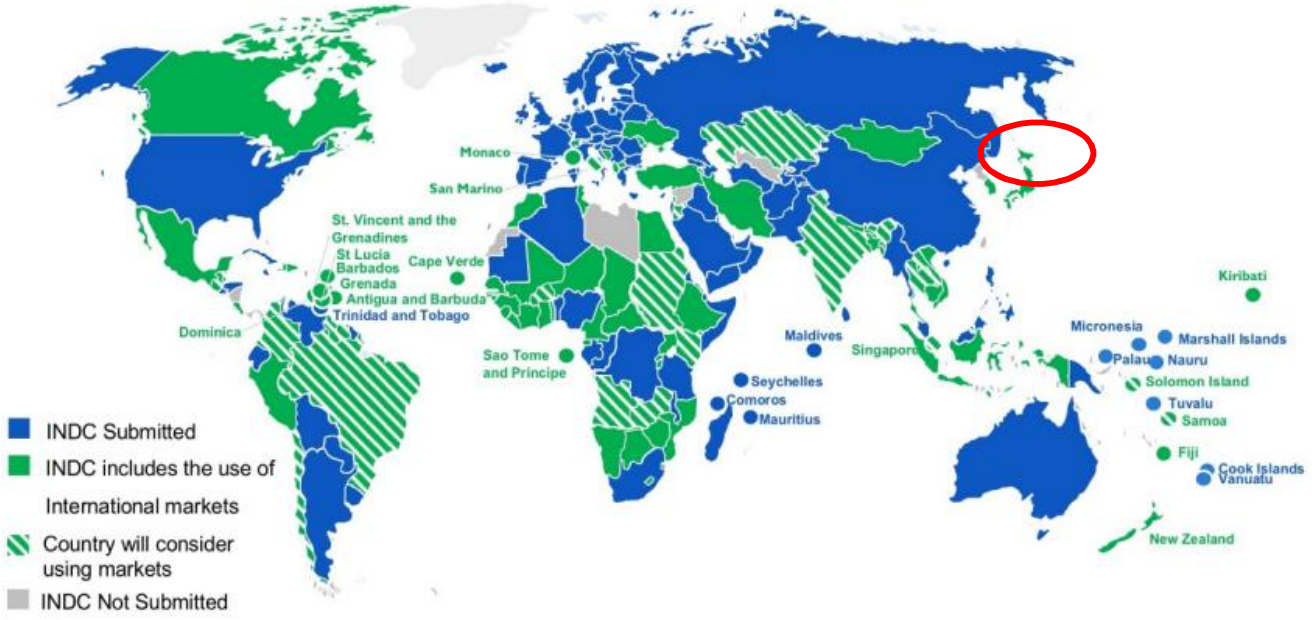

Figure 1: Carbon Markets and INDCs. Map provided by IETA's INDC Tracker.

Link to source
http://www.ieta.org/resources/Resources/Reports/Carbon_Pricing_The_Paris_Agreements_Key_Ingredient.pdf

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DSM involvement in carbon pricing

Examples:

- Internal carbon price of €50/CO_{2e} (when reviewing large investment decisions)
- Initiated an online learning community with webinars on internal carbon pricing (editions: DSM, Microsoft, Yale, Mahindra)
- To stimulate discussion on "meaningful carbon price levels":
- "*Carbon Pricing Corridors Initiative*"
- High level discussion among CEOs at the WEF in Davos 2017

CEO Feike Sijbesma is co-chair of the Carbon Pricing Leadership Coalition's High Level Assembly

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€50 internal carbon price

Helps us to:

- ü spot energy/cost saving opportunities at an early stage
- ü redirect and/or scale up investments towards low-carbon technologies and low(er) carbon energy sources
- ü understand future costs/risks and build confidence to all stakeholders (incl. investors) that we are preparing DSM for a future in which carbon will increasingly have a price
- ü raise environmental awareness

How:

- €50 per ton CO_{2e} (investment proposals must submit two business cases: one with, and one without the internal carbon price)
- Official corporate policy; required when reviewing large investment decisions, requiring significant capital expenditure

Has enabled decision-making on:

- Energy savings projects, renewable energy projects, and generally to improve our "integrated reporting & decision-making"

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Conclusions

- A long term vision is key to create transformative innovation
- Right Partners essential for success
- Put your money where your mouth is
- Sustainability also requires business success and thus profitable growth
- Consistent government behavior to shape the business environment

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