

**Innovation
Management
(choosing options)
both from Industrial
and Academic
Perspective**

14 October 2020



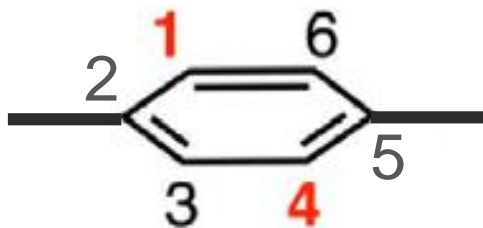
UNIVERSITY OF AMSTERDAM

Gert-Jan Gruter



CYCLOPHANES:

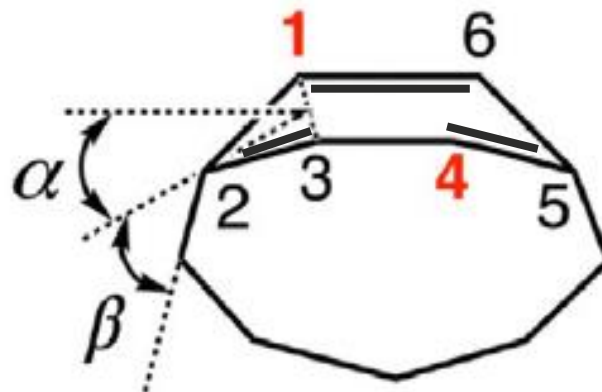
Master research project at VU Amsterdam



benzene

$$\alpha = 0^\circ$$

$$\beta = 0^\circ$$



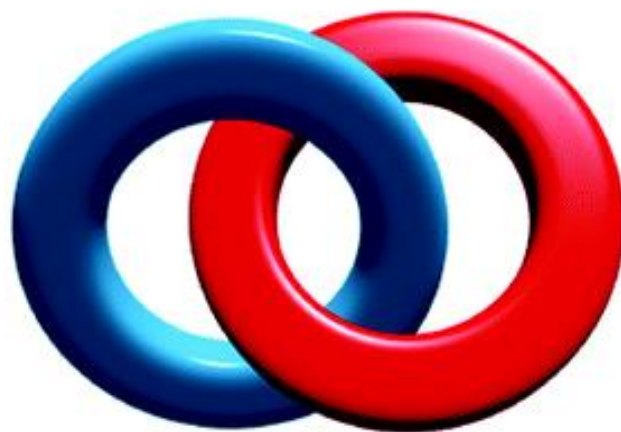
[5]paracyclophane

$$\alpha = \gamma = 23.1^\circ$$

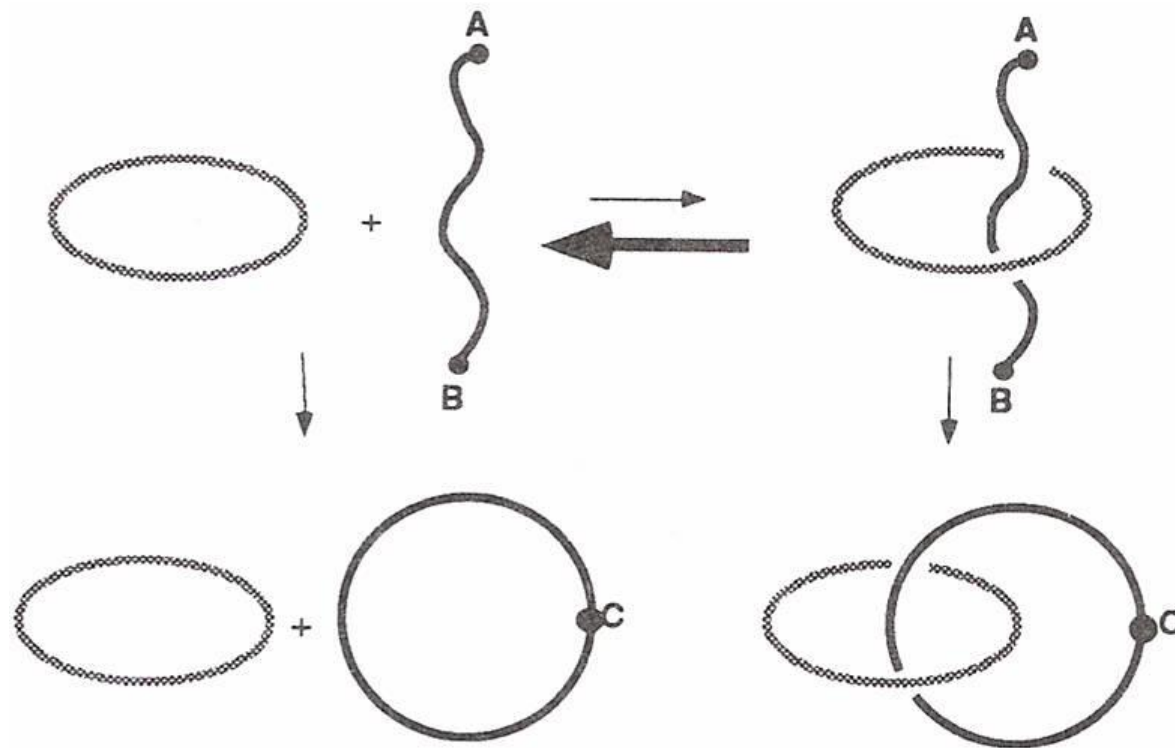
$$\beta = 29.8^\circ$$

Formation of catenanes

|Catenane



Formation of catenanes statistical threading



Statistical threading: not very efficient

bereid uit de beste ingrediënten

6 BORDEN

HONIG

Deense Rundvleessoep

KOOG A/D ZAAK

HONIG

VARIATIE TIP
RUNDVLEESSOEP MET STERRETJES EN RODE WIJN

2 plakjes bladerdeeg, ontdooid
1 pakje Honig Deense Rundvleessoep
1 kleine prei in dunne ringen
100 g gaar rundvlees in stukjes
1/2 dl rode wijn

- ◆ Verwarm de oven voor op 200 °C, gasoven stand 4 ◆ Steek of snijd uit het bladerdeeg figuurtjes (bijvoorbeeld sterretjes) en leg deze op een ingevette bakplaat ◆ Bak de figuurtjes in 10 minuten gaar en bruin ◆ Bereid de soep volgens de algemene bereidingswijze
- ◆ Voeg na 5 minuten kooktijd de prei en het vlees toe ◆ Breng de soep op smaak met de rode wijn en eventueel met zout en peper
- ◆ Garneer met de bladerdeegfiguurtjes ◆ Smakelijk eten.

ALGEMENE BEREIDINGSWIJZE

Zo maakt u 6 borden (1 1/2 liter) lekkere Deense Rundvleessoep:

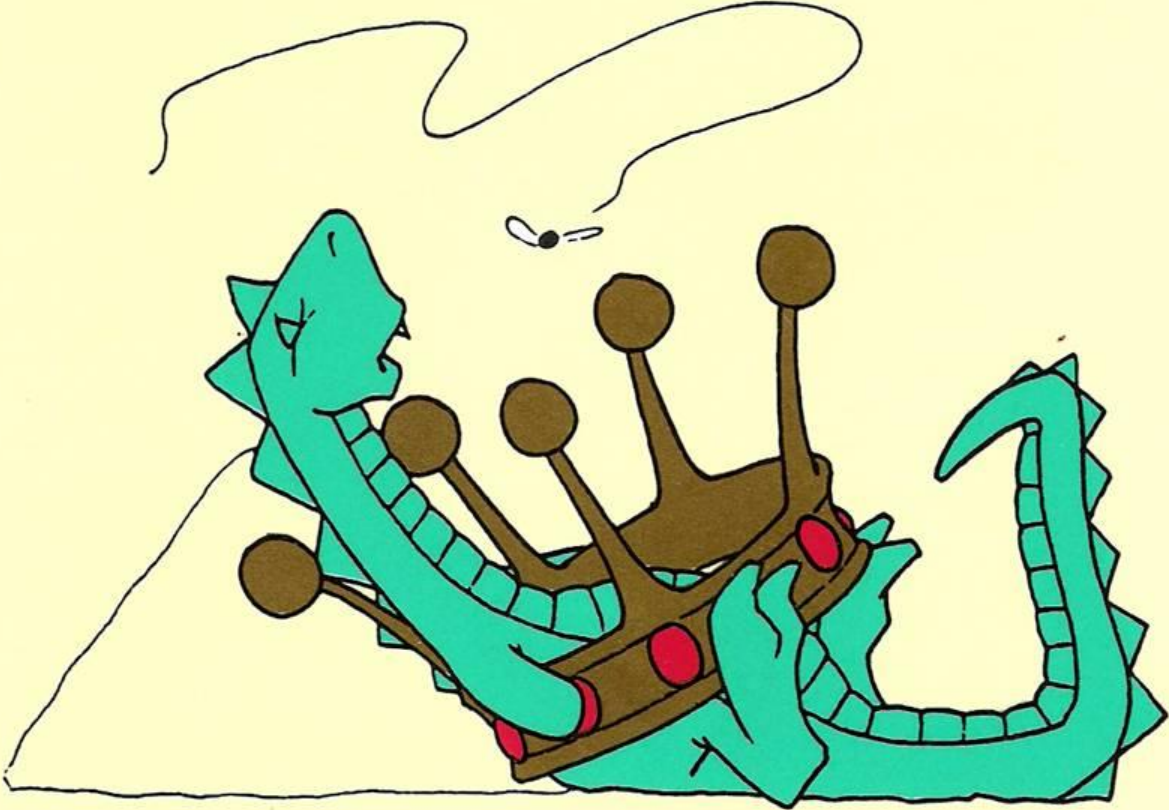
- 1 Breng 1 1/2 liter water aan de kook en voeg, al roerende met een garde, de inhoud van het zakje toe.
- 2 Wacht tot de soep kookt en doe het deksel op de pan (niet helemaal afsluiten).
- 3 Laat, onder af en toe roeren, de soep 10 minuten zachtjes koken.

Het lege pak kan bij het oud papier.

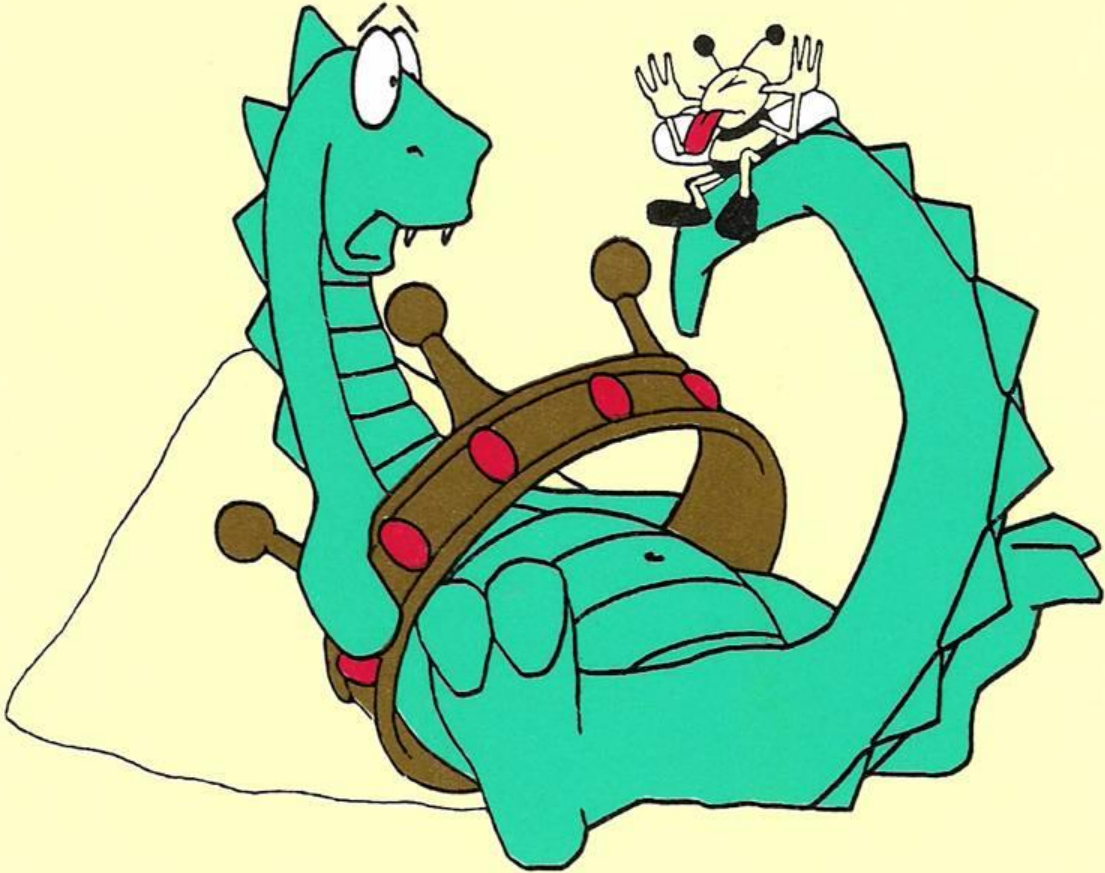
ui
peterselie
tomaat
wortel
knolselderij

→ Use self assembly and promote ring closure

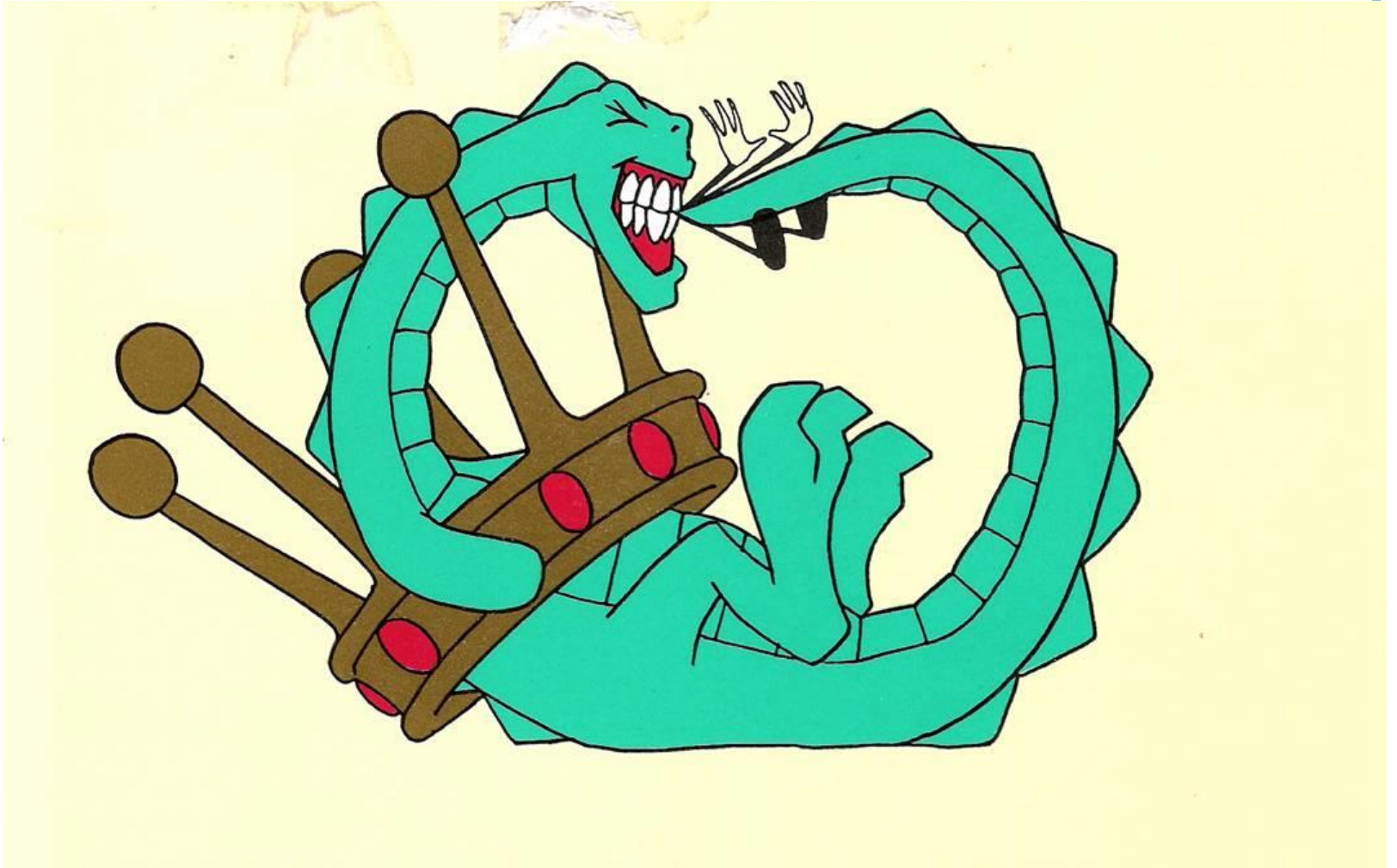
Use self-assembly



And promote.....



....promote ring closure



1994

**THE ORGANOMETALLIC CHEMISTRY OF
1,3-XYLENE CROWN ETHERS**

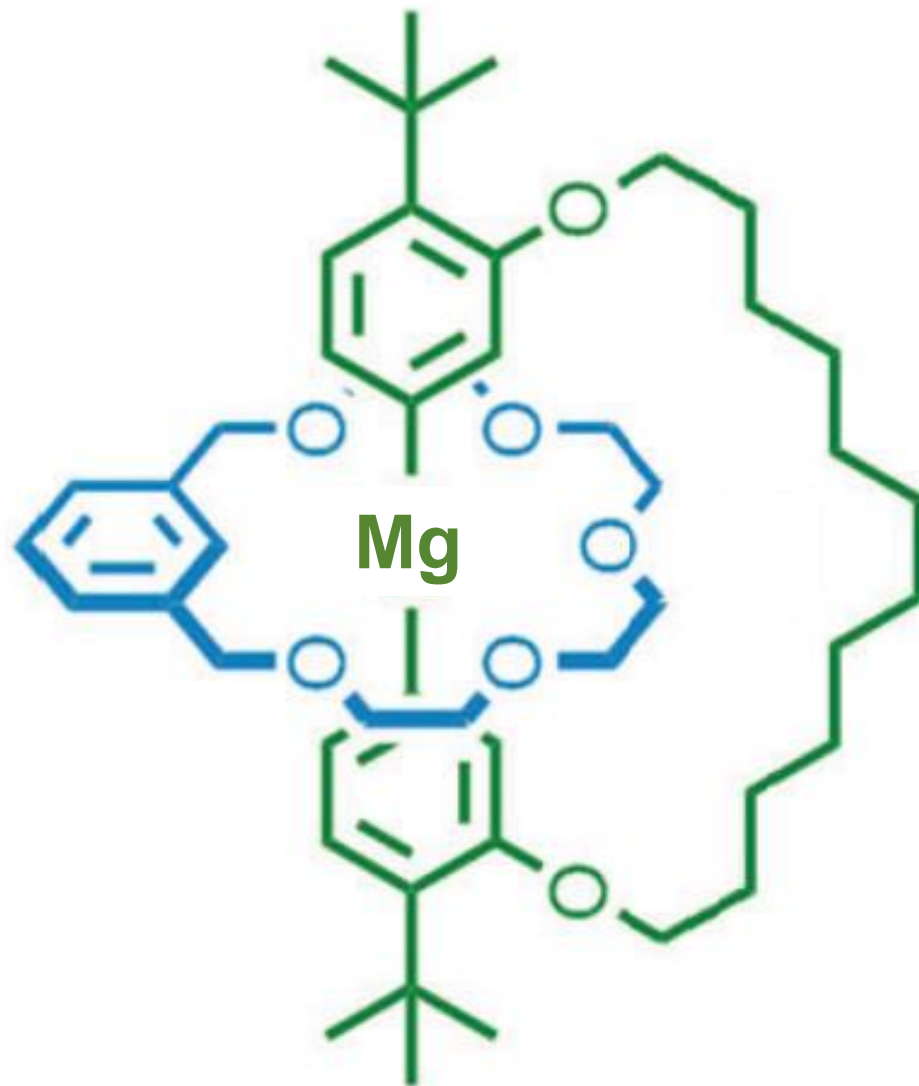
SYNTHESIS, REACTIVITY AND SPECTROSCOPY



G. J. M. GRUTER

The first organometallic catenane

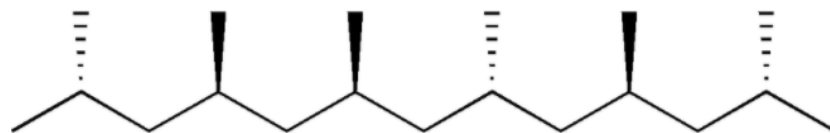
PhD 1990-1994 VU Amsterdam



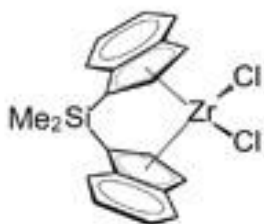
Metallocene catalysts for polyolefins (DSM Research 1994-2000)



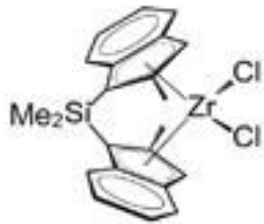
isotactic
Polypropylene (*i*-PP)



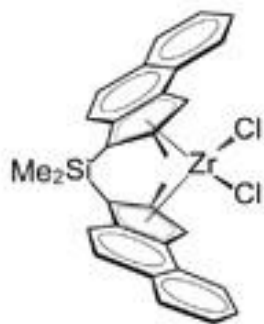
atactic
Polypropylene (*a*-PP)



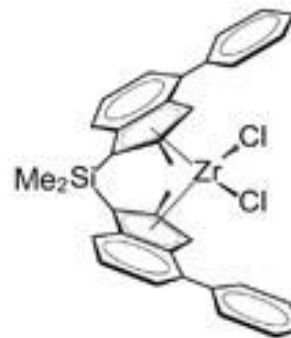
1-a



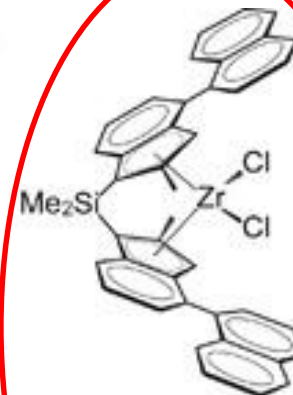
1-b



1-c



1-d



1-e

[mmmm]	0.817
Tm (°C)	137
Mw ($\times 10^4$)	3.6

[mmmm]	0.885
Tm (°C)	145
Mw ($\times 10^4$)	19.7

[mmmm]	0.887
Tm (°C)	146
Mw ($\times 10^4$)	33.0

[mmmm]	0.952
Tm (°C)	157
Mw ($\times 10^4$)	72.9

[mmmm]	0.991
Tm (°C)	161
Mw ($\times 10^4$)	92.0

Very active catalysts: up to 1000 kg PP/gram catalyst

INNOVATION (WIKIPEDIA)

- An innovation is something original and more effective and, as a consequence, new, that "breaks into" the market or society.
- Innovation is related to, but not the same as, invention: innovation is more apt to involve the practical implementation of an invention (i.e. new / improved ability) to make a meaningful impact in a market or society.
- Not all innovations require a new invention.



ALWAYS START with



WHY













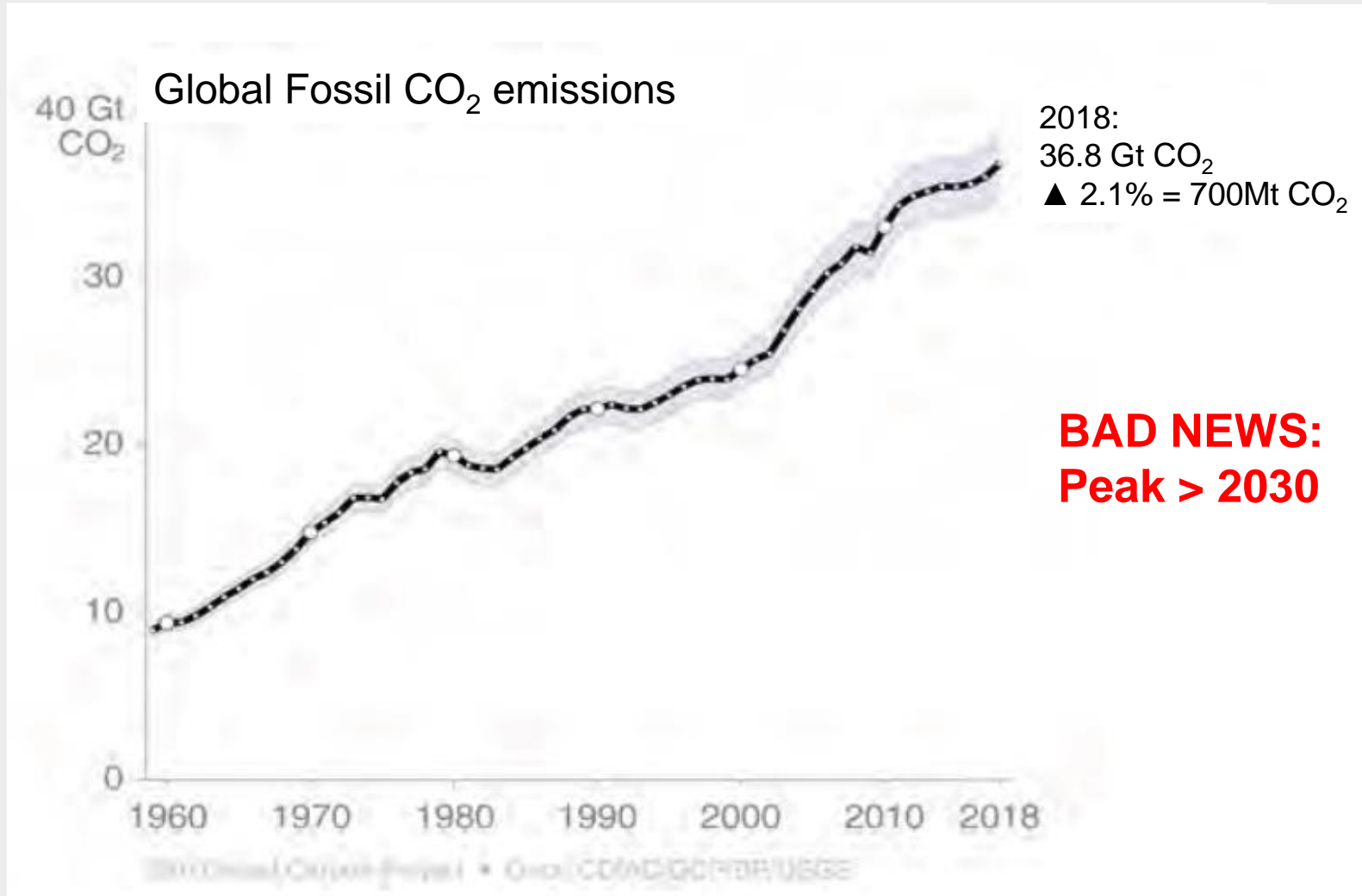
Sustainable chemistry opportunities

- **Human footprint ? Global warming or worse ? Peak-oil? Peak-elements? Plastic Soup !**
- **Can we develop new polymers that meet (compete on) cost and performance ?**
- **Can we design polymers with much improved end-of-life when ending up in nature ?**
 - Recyclable & or (bio)degradable (or both) ?
 - First or second generation feedstock ? Is there a competition with food ? In 2050 ?
 - Drop-in or new ?
 - Unmet needs ?
 - **Barrier ? Stability ? High Tg ? Degradability ?**
- **Can we design closed cycles ?**
- **Does the total picture fit (2050: # people, land-use, food, energy/chemicals/materials)?**
- **We must create “market pull”. Why is there hardly any “sense of urgency” with consumer? How can we change this ?**

We must accept a (50 year) transition period

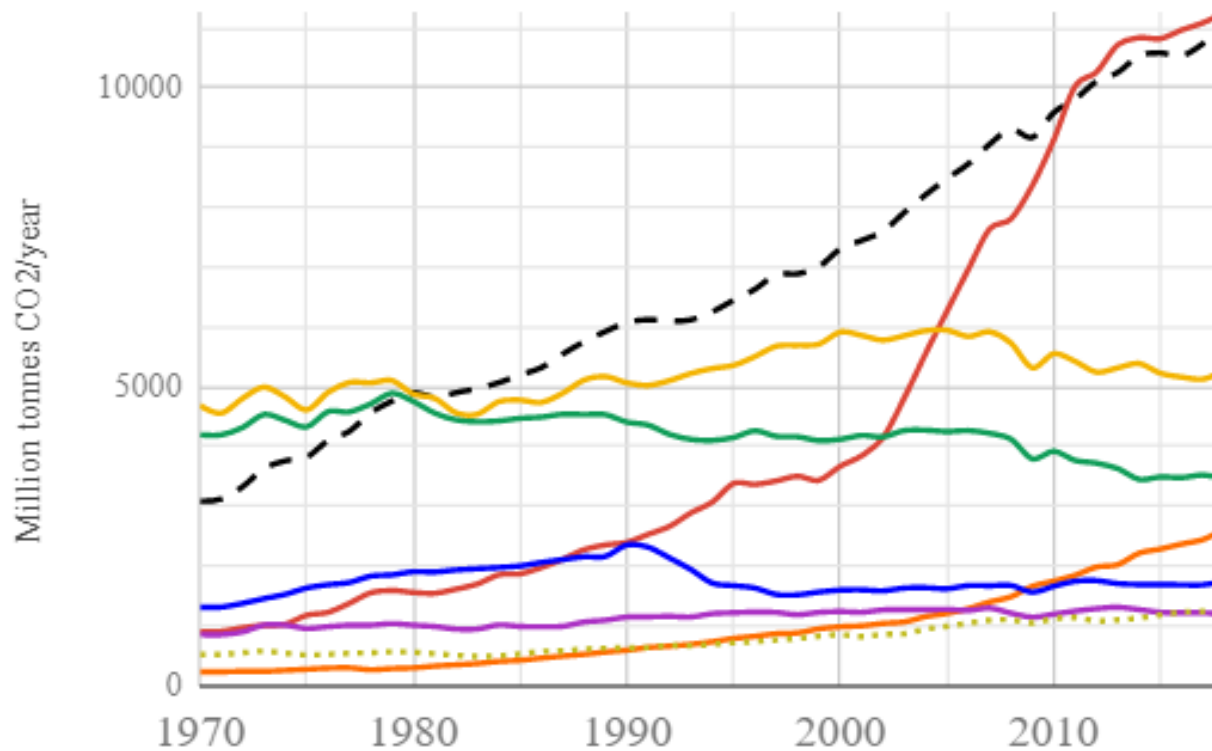
Can we make this quantitative ?

2018 emission numbers (publ. Dec '19)



- Other countries
- China
- United States
- EU28
- India
- Russia
- Japan
- International shipping and aviation

World fossil carbon dioxide emission 1970-2018





Ursula Von der Leyen announcing the new emissions target at the European Parliament on 16 September.
Photo: AFP/Getty

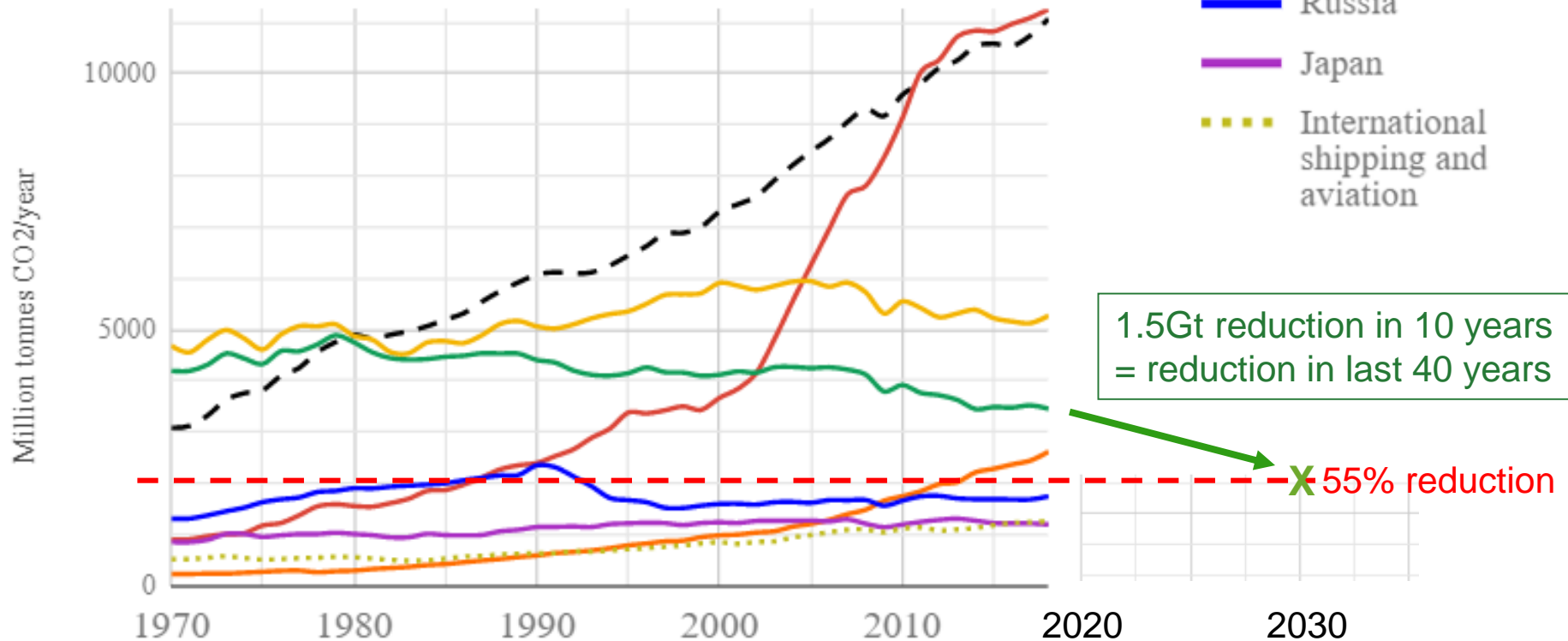


60%?

**EU's plan for ~~55%~~ emissions cut by 2030
may have significant impact on oil
demand**

- Other countries
- China
- United States
- EU28
- India
- Russia
- Japan
- International shipping and aviation

World fossil carbon dioxide emission 1970-2018



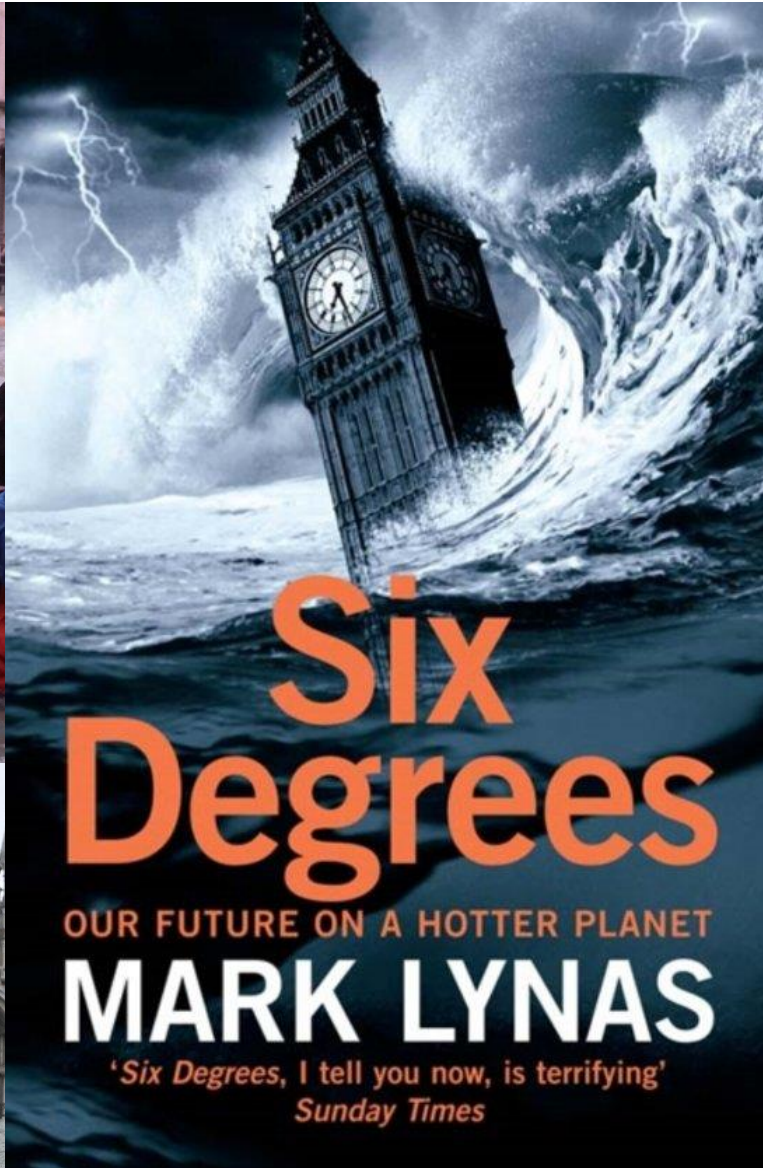


Venice, Italy, November 12 2019



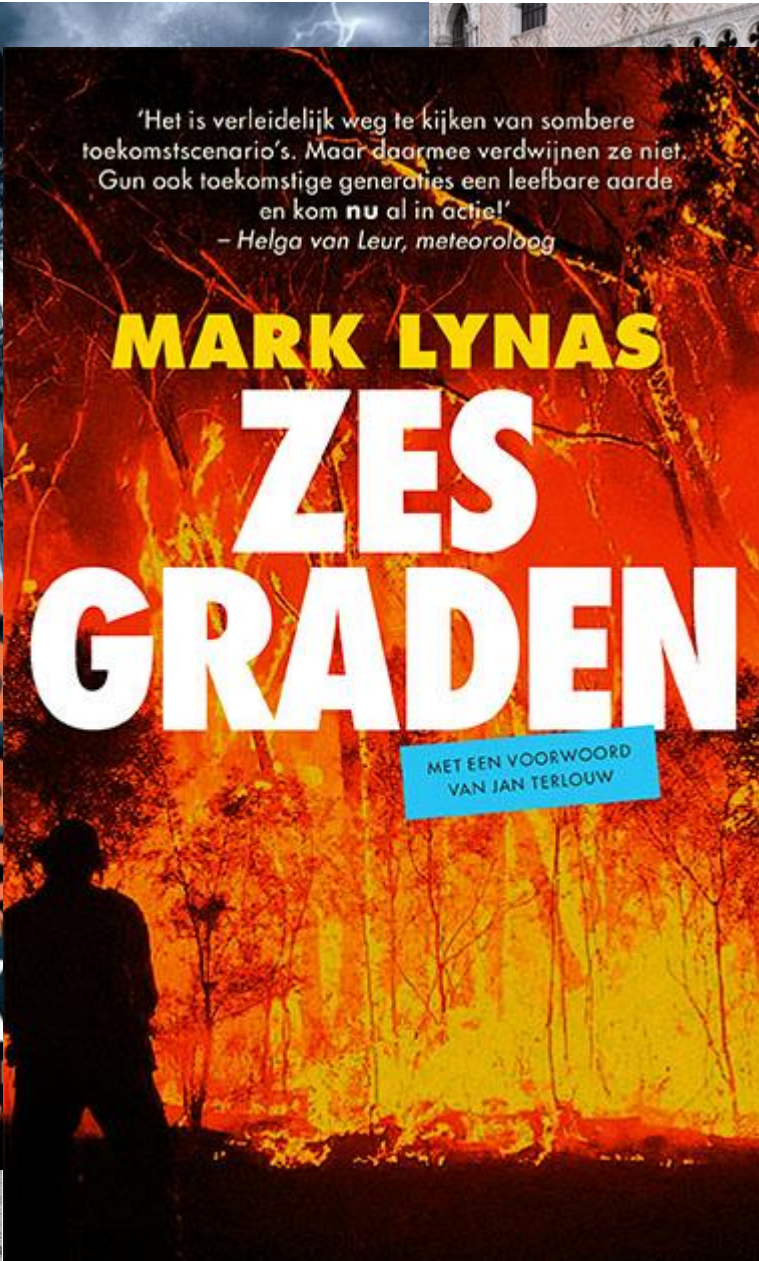


Venice, Italy, November 12 2019





Venice, Italy, November 12 2019



'Het is verleidelijk weg te kijken van sombere toekomstscenario's. Maar daarmee verdwijnen ze niet. Gun ook toekomstige generaties een leefbare aarde en kom nu al in actie!'
- Helga van Leur, meteoroloog

MARK LYNAS

ZES GRADEN

MET EEN VOORWOORD VAN JAN TERLOUW

OUR FUTURE OF

MARK

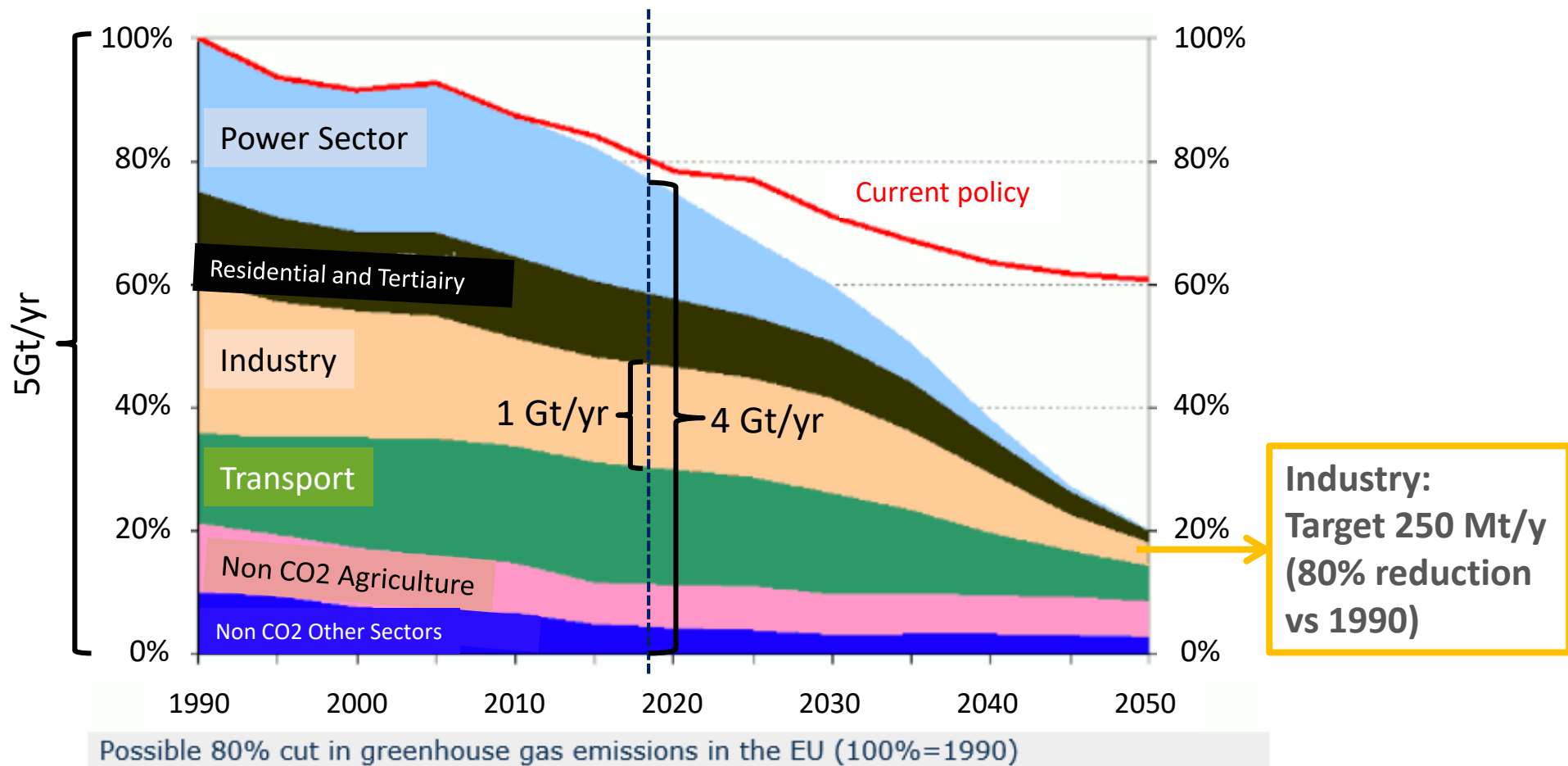
'Six Degrees, I tell Sun

Emissions cuts by sector



All sectors need to contribute to the low-carbon transition according to their technological and economic potential.

Action in all **main sectors** responsible for Europe's emissions – power generation, industry, transport, buildings, construction and agriculture – will be needed, but differences exist between sectors on the amount of reductions that can be expected.



Plastic Worlds



avantium



8 - 10 Mt plastic ends up in the oceans every year !

Ratio of plastics to fish in the ocean (by weight)



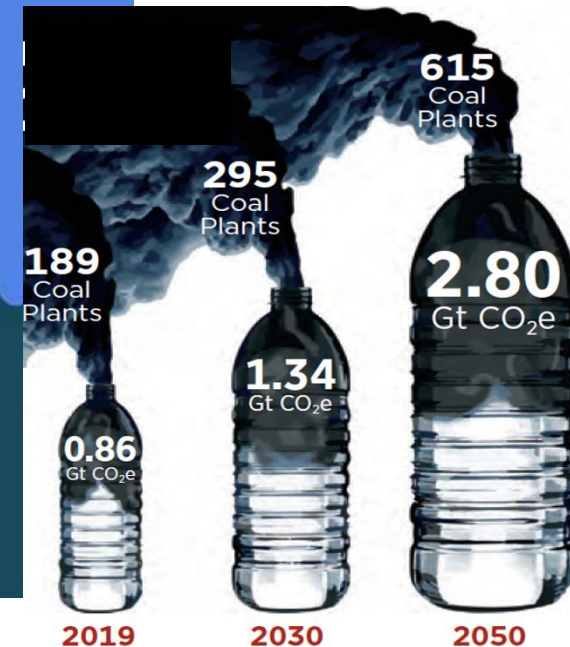
Plastics' share of global oil consumption

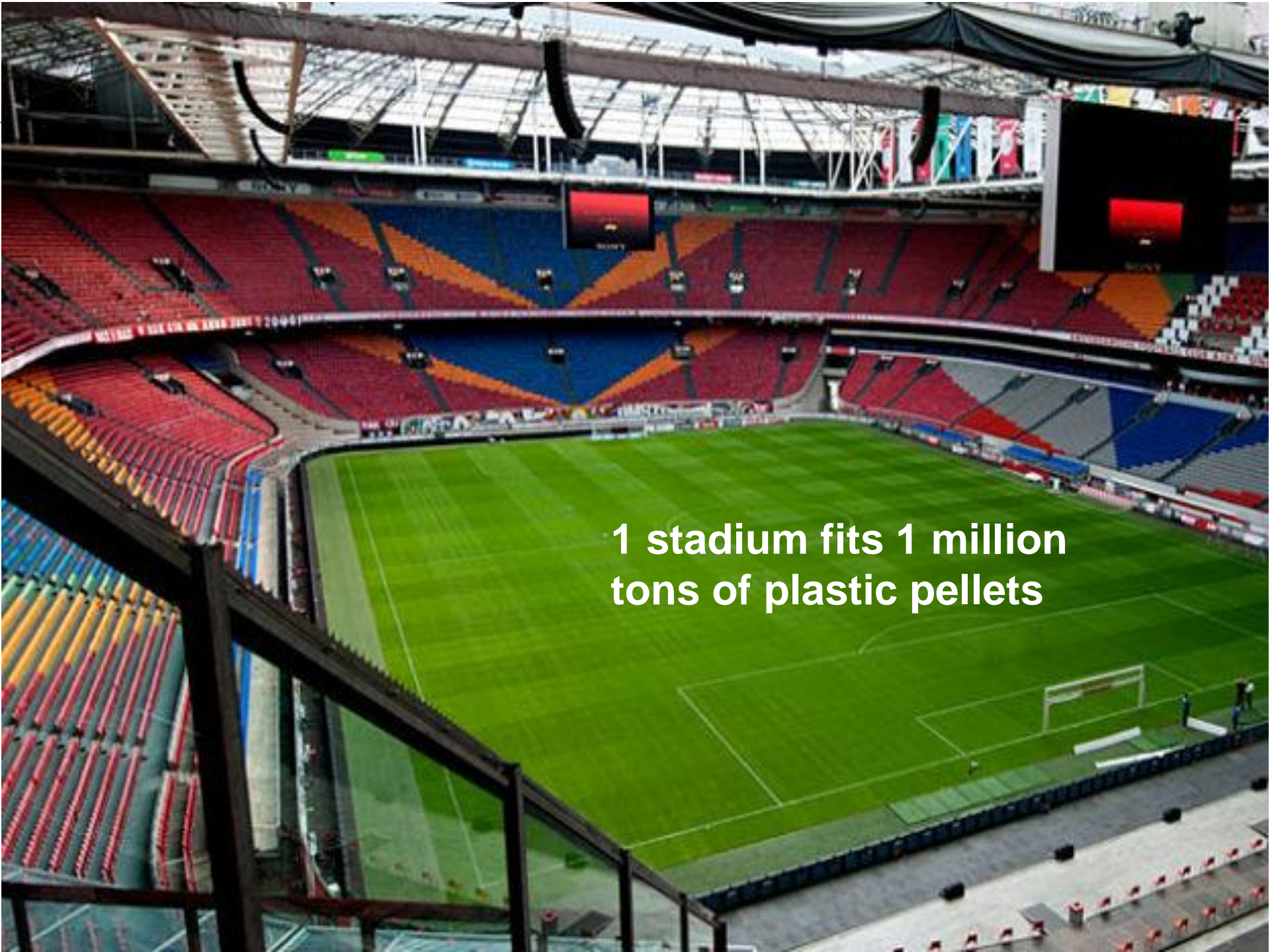


6%



20%





**1 stadium fits 1 million
tons of plastic pellets**



(Flickr/Gage Skidmore)

Politics & Society

President Obama Says The Denial of Science And Facts Could Mean The End of Democracy

“People just make stuff up.”



STAFF, SCIENCE AF
18 JUL 2018

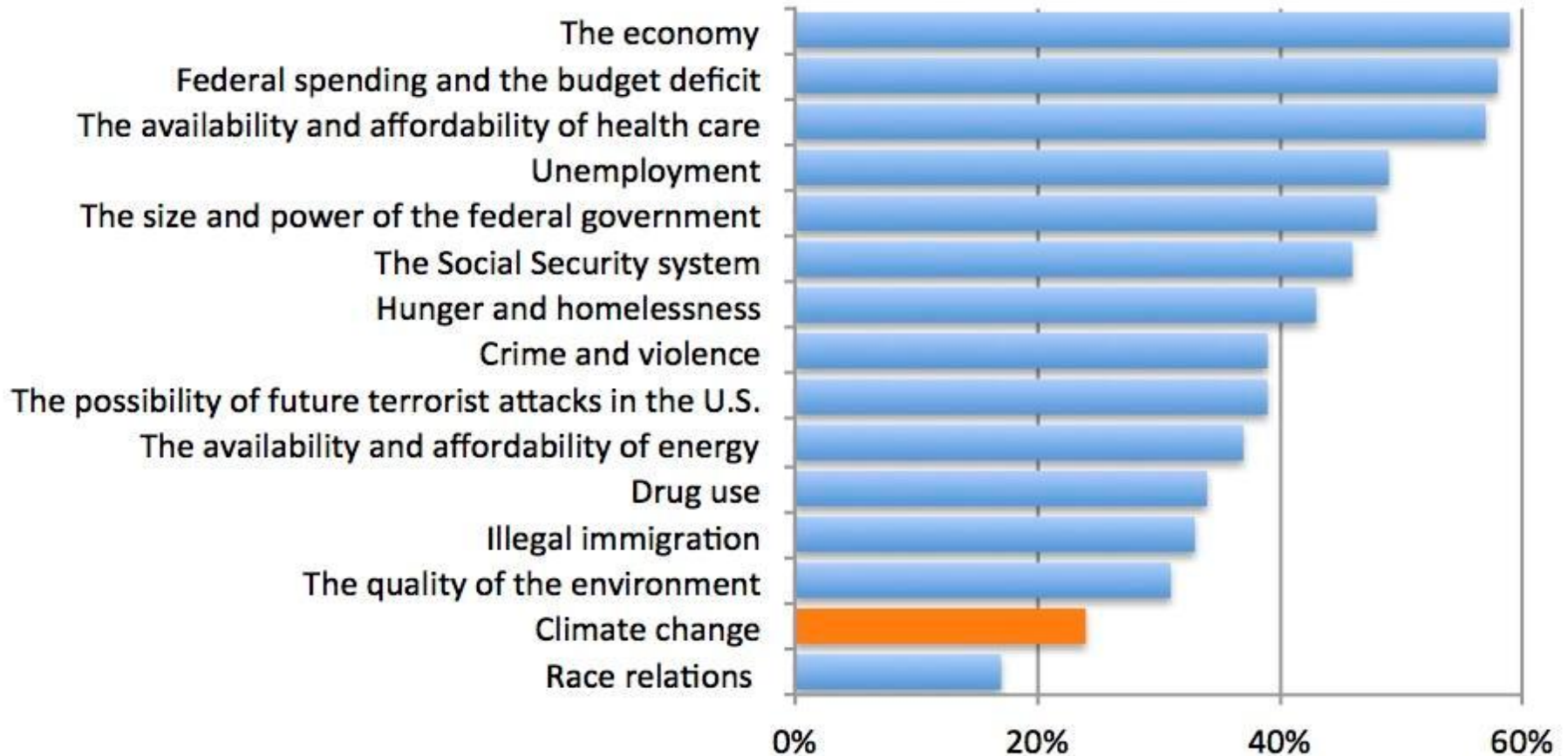
When it comes to protecting science and objective reality, former President Barack Obama has no idea where to start



Sen. Inhofe (Okla.) has, once and for all, disproven climate change. While "eggheads" at "science laboratories" were busy worrying about long-term upward temperature shift, Inhofe happened to notice that it was *weirdly* cold outside. So cold, in fact, **that water falling from the sky had *frozen solid***.

So he brought some of this frozen water onto the Senate floor to show everyone, but mostly to show the *eggheads*.

Problems US Worry Great Deal About, 2014



facebook.com/bjornlomborg



Fortunately one thing has been changing
in the past few years.....



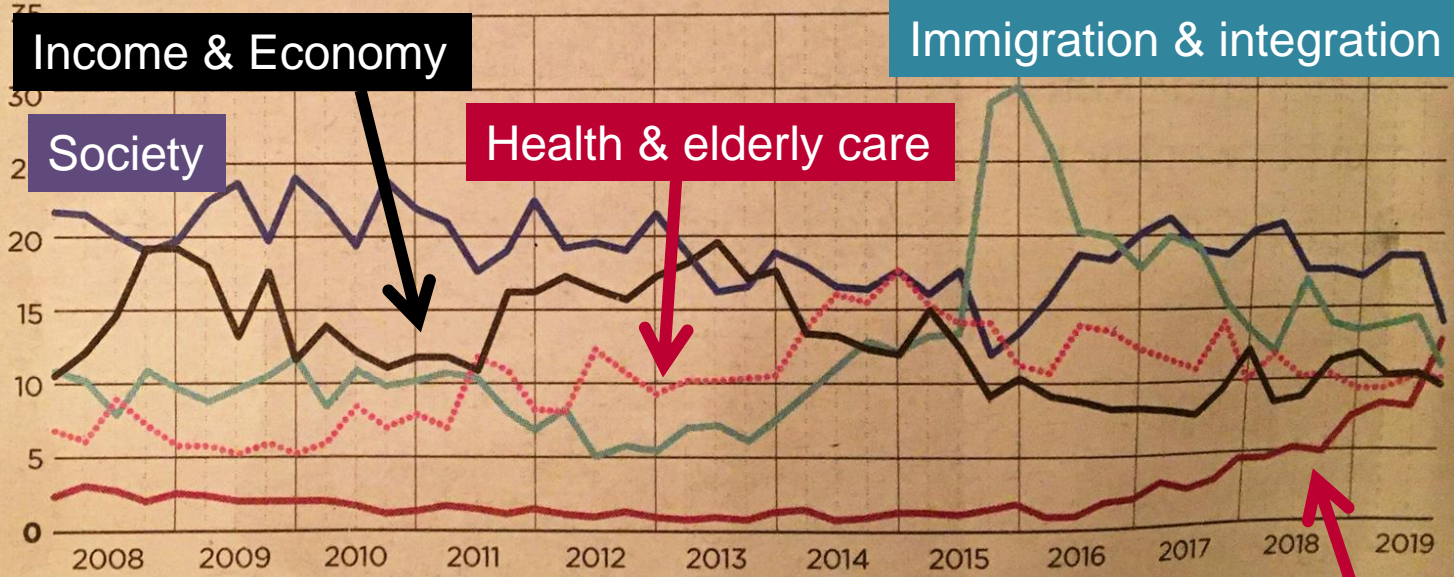
YOU!

Volkskrant 4 January 2020

What do we care about most?

Nationaal probleembesef: de vijf belangrijkste thema's waar Nederlanders (18+) zich druk over maken, in %

— Samenleven — Milieu en klimaat — Immigratie en integratie
 Gezondheids- en ouderenzorg — Inkomen en economie



De nieuwste cijfers

Hoe denken Nederlandse burgers over de staat van het land? Het SCP publiceerde daarover deze week de nieuwste cijfers. Wij vroegen ons af: waar maken Nederlanders zich druk om en waar moet de regering meer geld aan uitgeven?

WAAR MOET MEER GELD NAARTOE?

Netto aandeel* van de Nederlandse bevolking (18+) dat meer uitgaven wil aan politiek doel (2019 - 4de kwartaal)

Environment and climate



Understanding and changing
**Consumer perceptions and
behavior towards polymers**

Journal of Environmental Psychology 69 (2020) 101433

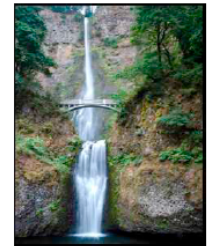


ELSEVIER

Contents lists available at [ScienceDirect](https://www.sciencedirect.com)

Journal of Environmental Psychology

journal homepage: www.elsevier.com/locate/jep



Applying an attitude network approach to consumer behaviour towards plastic

Maria V. Zwicker^{a,*}, Hannah U. Nohlen^a, Jonas Dalege^a, Gert-Jan M. Gruter^b,
Frenk van Harreveld^{a,c}

^a Department of Social Psychology, University of Amsterdam, Nieuwe Achtergracht 129-B, 1018 WT, Amsterdam, the Netherlands

^b Industrial Sustainable Chemistry, University of Amsterdam, Science Park 904, 1098 XH, Amsterdam, the Netherlands

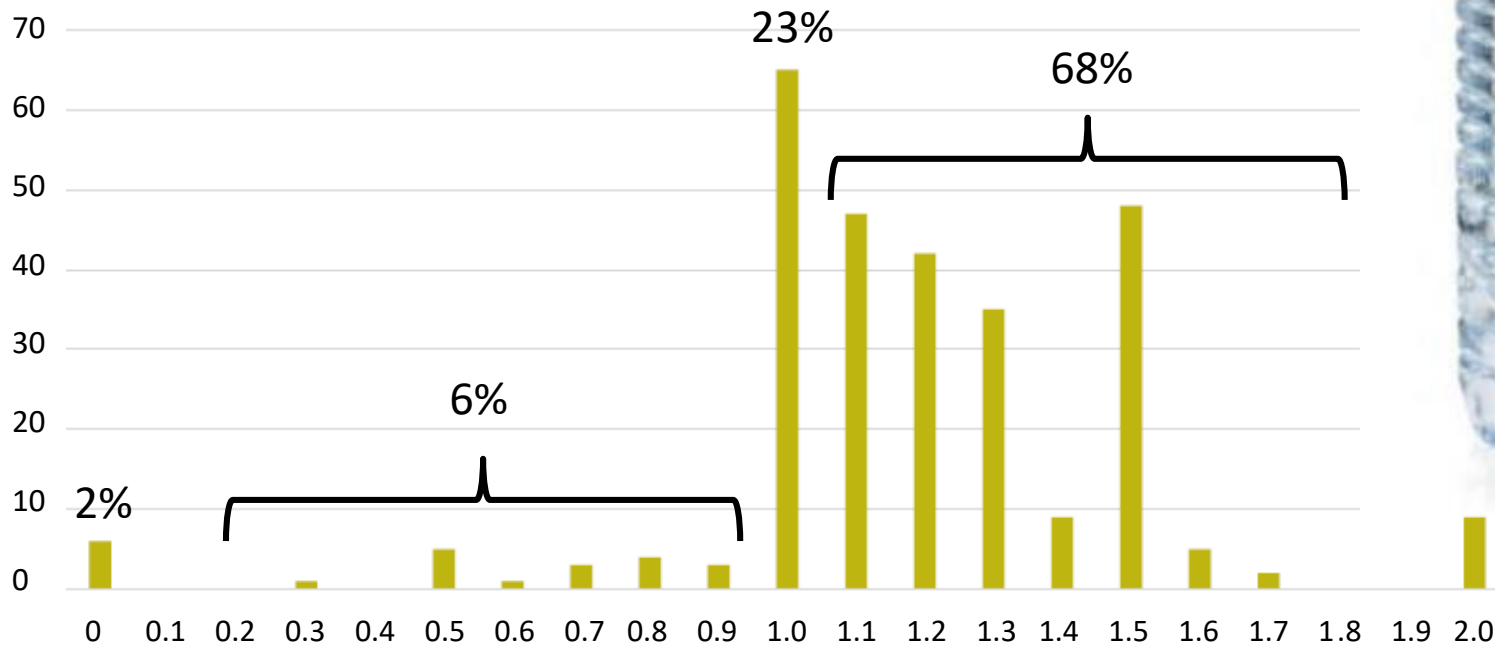
^c National Institute for Public Health and the Environment (RIVM), Antonie van Leeuwenhoeklaan 9, 3720 MA, Bilthoven, the Netherlands



Willingness to pay for bio-based

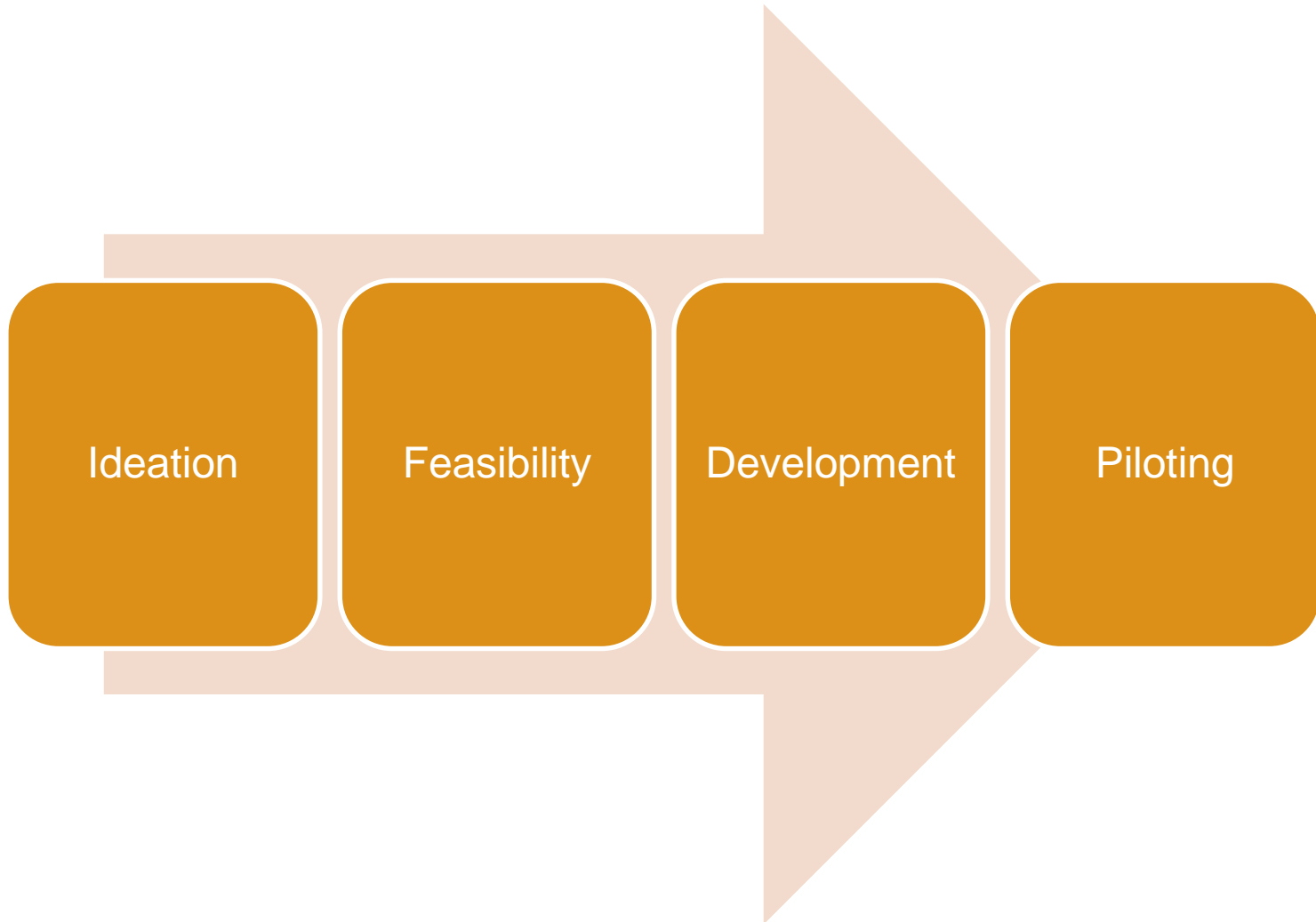
N = 280

PET bottle: €1.00

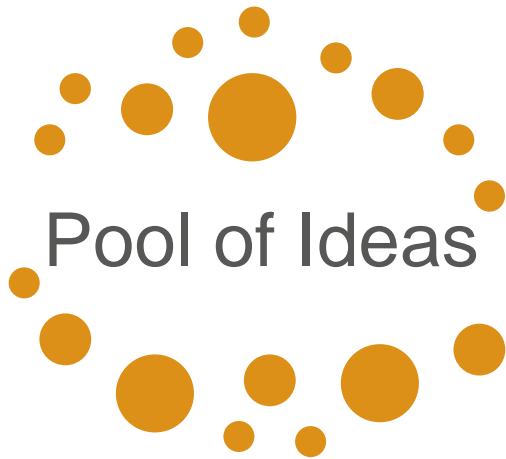


How we select technologies for evaluation

RNC Portfolio Management – Process



RNC Portfolio Management



- Bio based
- CO₂
- Recycling

- Prioritized based on
- Market Feasibility
 - Technical Feasibility
 - Strategic Fit
- } 8 factors

RNC Portfolio Management

In Q4 2017, 70 ideas listed; 34 pre-selected ideas looked at; 12 ideas prioritized



- Bio based
- CO₂
- Recycling

Prioritized based on

- Market Feasibility
- Technical Feasibility
- Strategic Fit

} 8 factors

Winning Ideas' Discussion and Scoring

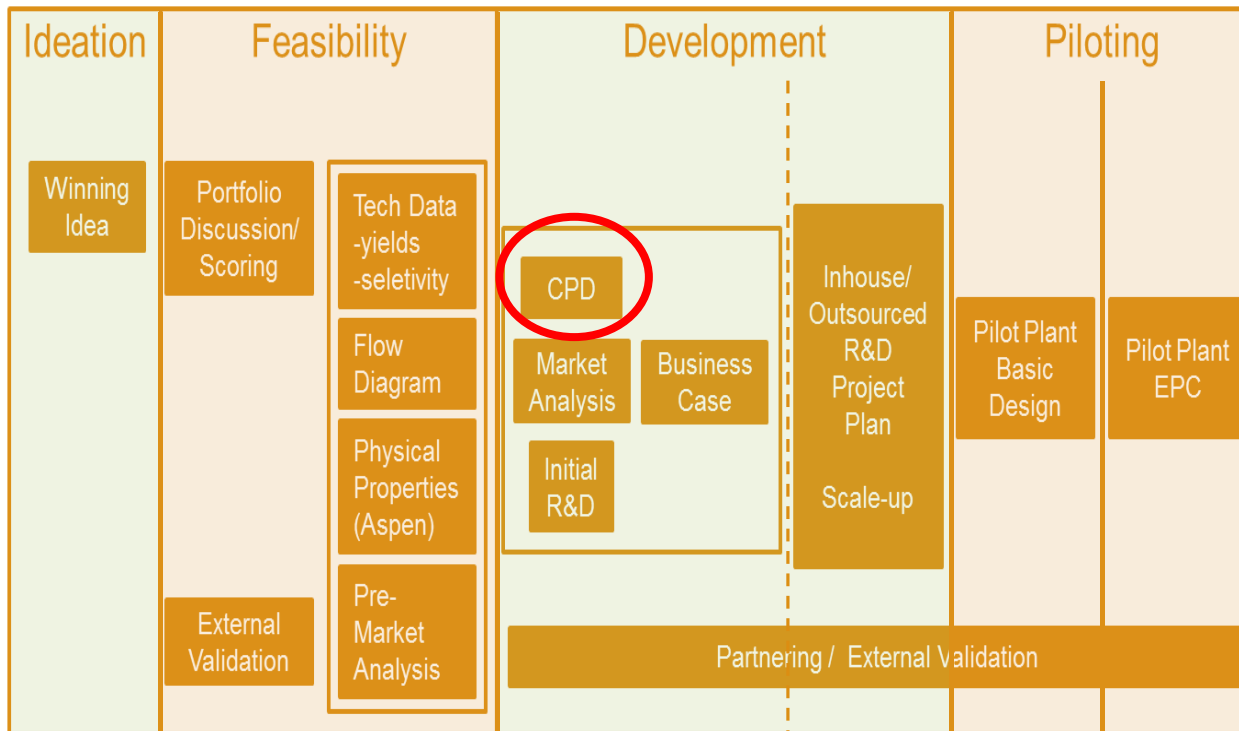
- Scoring, after valuable discussion, on scale of 1 – 10 using a model for advanced technology projects
- Scored on following factors
 - Probability of technical success
 - Probability of commercial success
 - Reward
 - Business strategy fit
 - Strategic leverage
- Scored with group of cross-functional personnel
 - IP
 - Finance/Grants
 - Business
 - Operations
 - Technical

19 factors



RNC Portfolio Management

Confidential



PoP experiments

Preliminary process concept

Proof of (Business) Concept

Approval for CPD

Preliminary Business Case

Budget and Operational Plan

Scale Up

Update CPD(s) and Business Case

Strategic Hypothesis
 Process status and technical risks
 Pilot Plant EPC scope, schedule and cost
 Intellectual Property status
 Monetization Strategy
 Deployment Scenarios
 Partner Engagement Status
 Budget & financing

Stage Gate

1

2

3

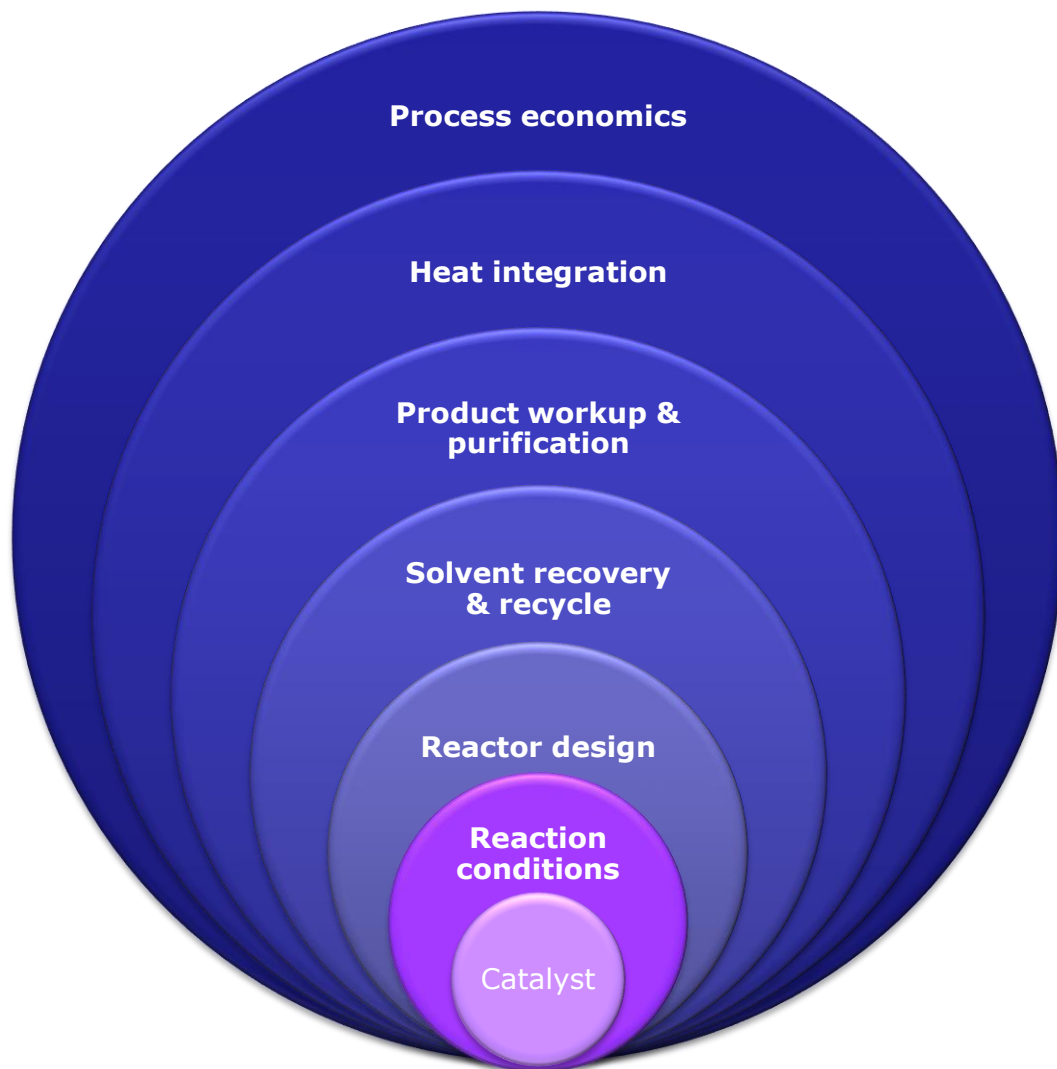
4



Techno-economics @ Avantium



- Starts with a good catalyst lead
- But there is a lot more to a good process than a good catalyst!
- We want a much better understanding of the factors that will influence the cost of our process and products
- So we use conceptual process design to help set our R&D goals



Start of development Phase CPD. What is it ?



- Aim
 - To find the cheapest way to convert raw materials into products
- Requires
 - Expert chemical engineers
 - A systematic methodology
 - Specialised software tools
- Process screening
 - Fail early: Some processes will never be economic
- Typically results in:
 - 20 to 50% savings in cost
 - Up to 50% reduction in time
- Physical property modelling (Aspen Properties)
- Reaction scheme definition
- Reactor evaluation (READPERT knowledge based system)
- Process concept brainstorming
- Process simulation & flowsheeting (Aspen Plus)
- Process costing (heuristic costing models)