

Introduction to Aerospace Engineering

Lecture slides



Prof.dr. Wubbo J. Ockels

Youth, innovation, sustainable development











The Shrinking Earth:

$t=0$



An aerial photograph of a vast, arid landscape. The terrain is dark and heavily textured with numerous small, irregular pits and ridges, characteristic of a salt flat or a dry lake bed. A bright, highly reflective area on the right side of the image suggests a wet or highly saline surface. The overall scene conveys a sense of extreme dryness and desolation.

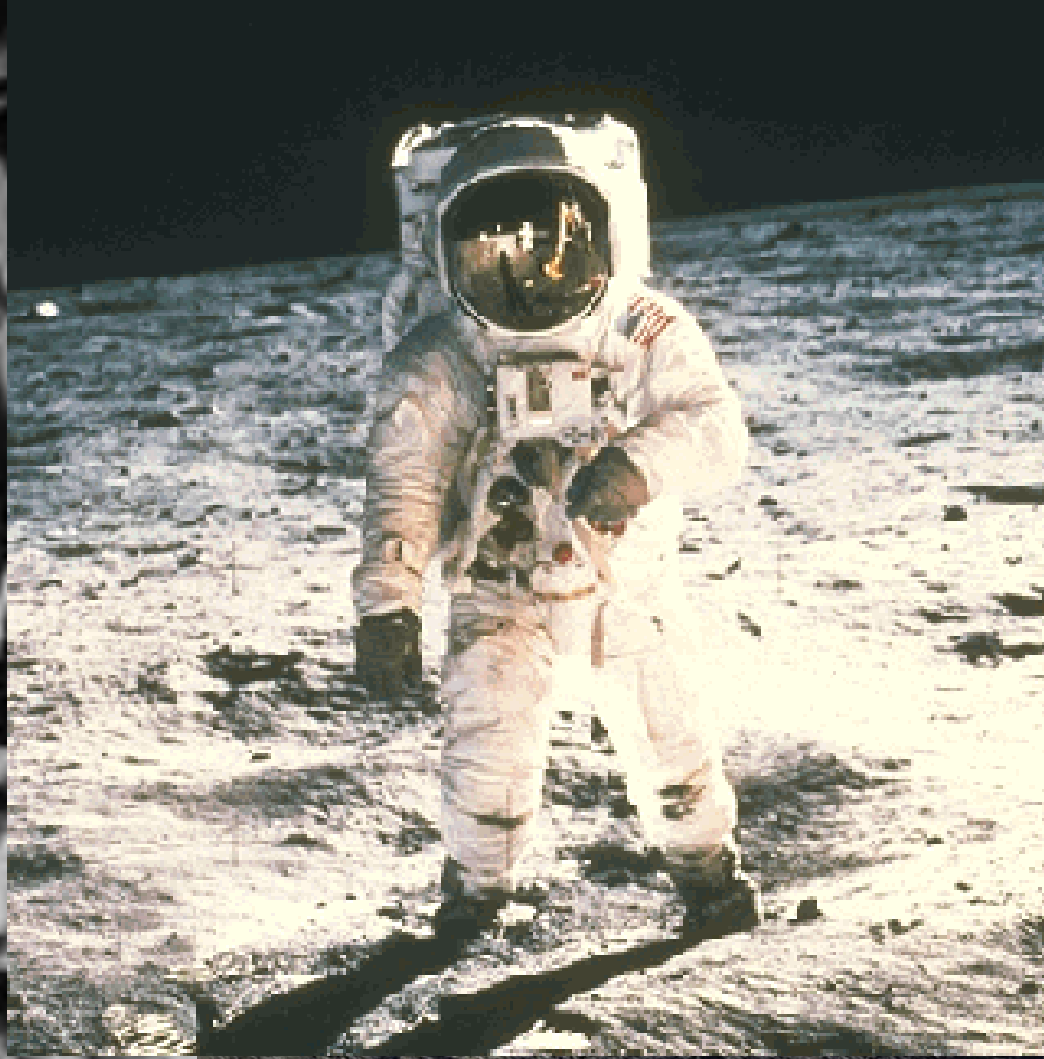
The Shrinking Earth:

t=45 min





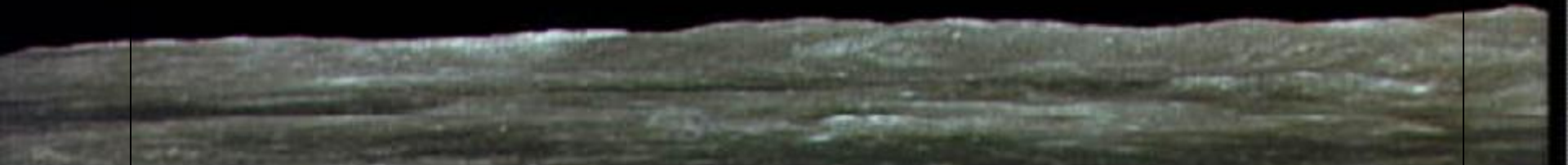
**Not Space is unique
It is the Earth!**



Our Earth?



Our spaceship !



end oil

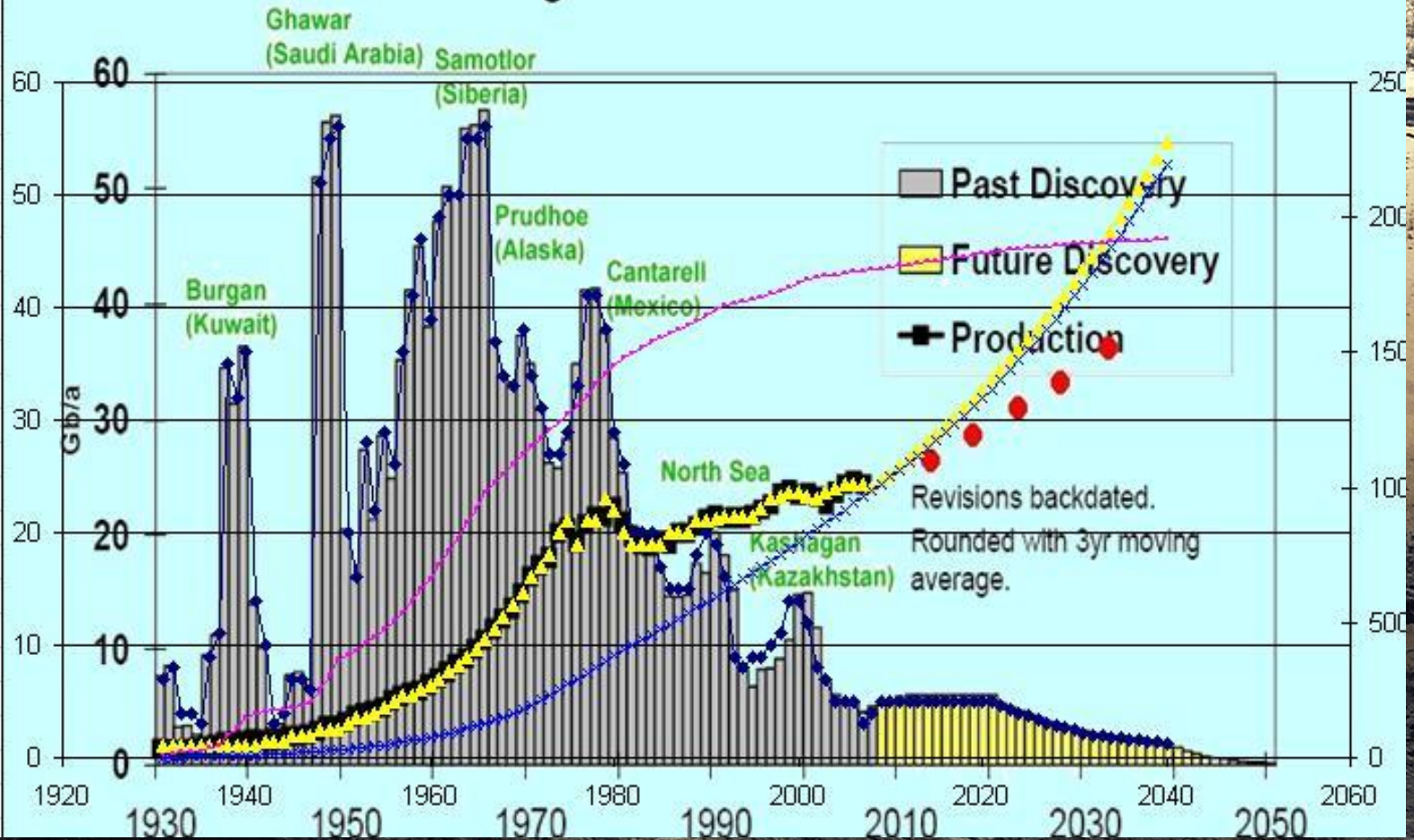
2035

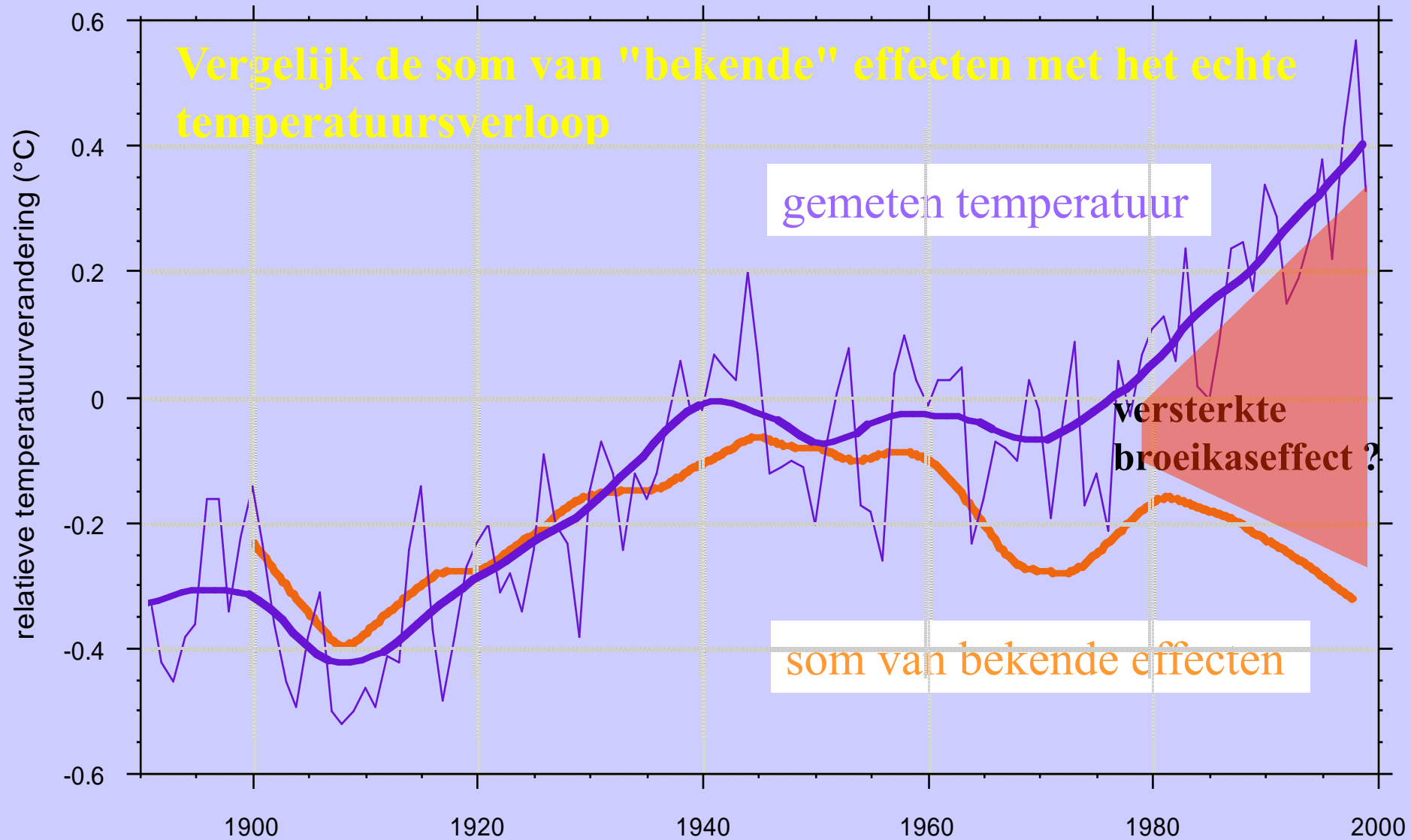
Crisis

2020

2025

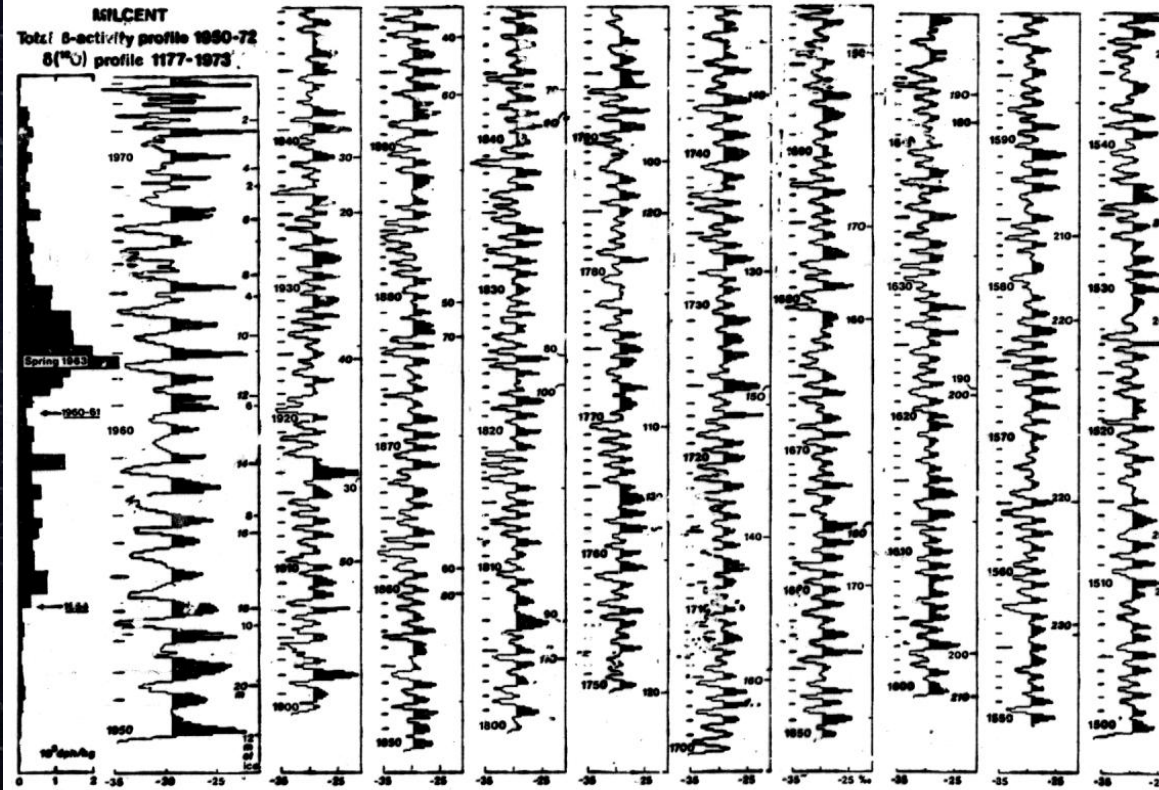
THE GROWING GAP Regular Conventional Oil





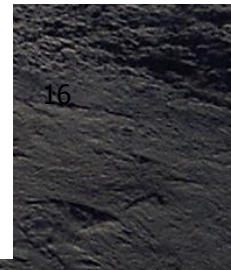
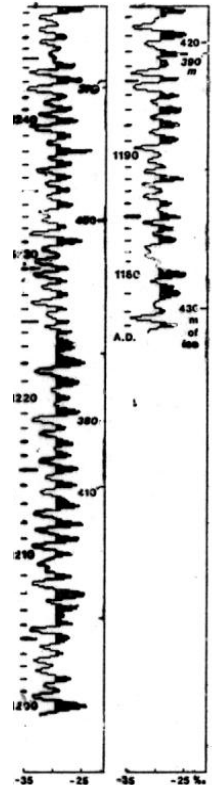
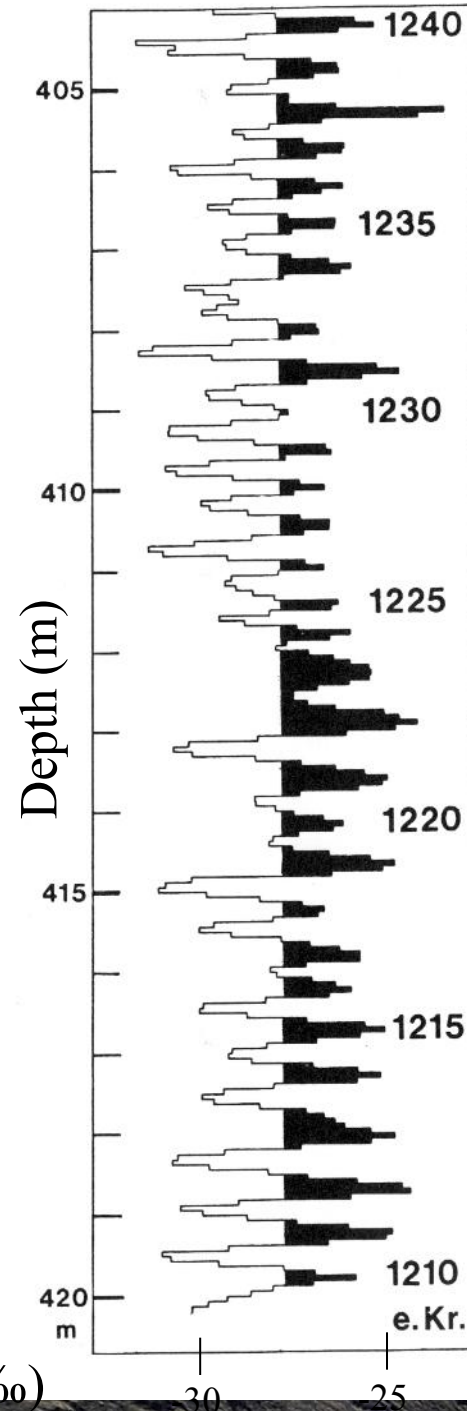


GISP Ice core, Central Greenland



Medieval warm period
(colonisation of Greenland)

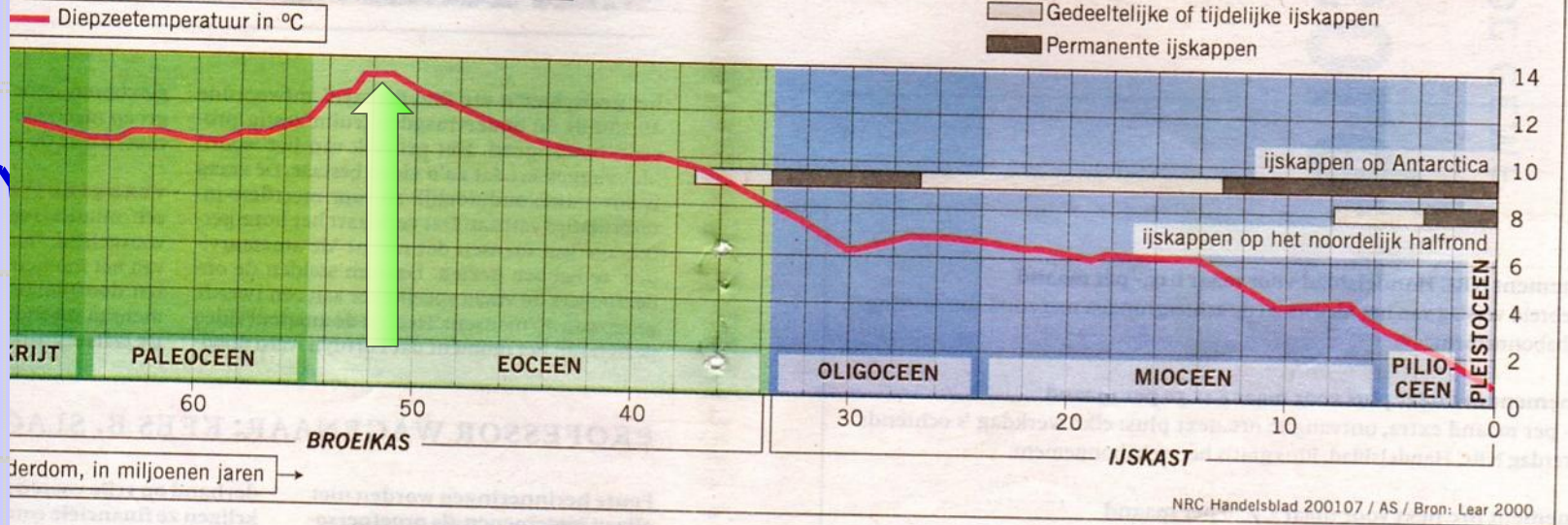
$\delta^{18}O$ (‰)



metingen aan luchtbelletjes uit ijs
honderduizenden jaren terug

CO₂ (ppm)

WARMTE EN KOU IN DE LAATSTE 70 MILJOEN JAAR



ijstijd ijstijd ijstijd ijstijd

wereldwijd, in miljoenen jaren →

NRC Handelsblad 200107 / AS / Bron: Lear 2000



Nature has no mercy

After the industrial revolution,
Bulldozing through nature

Play with nature in win-win manner

An aerial photograph of a coastline. A river flows from the top right towards the center, forming a delta. The river meets a sandy beach that curves along the coast. The ocean is visible on the right side, with waves breaking onto the shore. The overall scene is a natural landscape with a mix of water, sand, and vegetation.

Changes to the environment...

Scientific question:

will doubling CO₂ cause a problem?

Responsible question:

Is there any evidence on the basis of which we expect that doubling of Co₂ does not cause a catastrophe?



save the date 22th september 2009
Internationale Filmpremière

THE AGE OF STOPPED



?

6
0
20

A sunset over the ocean with a person's silhouette on the left. The sun is low on the horizon, creating a bright orange and yellow glow. The text is overlaid on the image in a light green color.

The energy solution is nuclear energie

$$E=mc^2$$

Highly reliable 4 Billion years to go

Very constant <0.008%

Safe distance 140 Million km

No political influence

No terrorist attack

At no cost

For everyone

A sunset over the ocean with a person's silhouette on the left. The sun is low on the horizon, creating a bright orange and yellow glow. The sky is filled with soft, wispy clouds. The water is calm, reflecting the colors of the sky. The overall mood is peaceful and contemplative.

The sun gives us light, heat and wind
Plenty of energy for everyone
Netherlands 100 times
Earth 8000 times

Optimism
Is a responsibility


CRADLE TO CRADLE **DESIGN PARADIGM**

- **WASTE EQUALS FOOD**
- **USE CURRENT SOLAR INCOME**
- **CELEBRATE DIVERSITY**



CRADLE TO CRADLE METABOLISMS



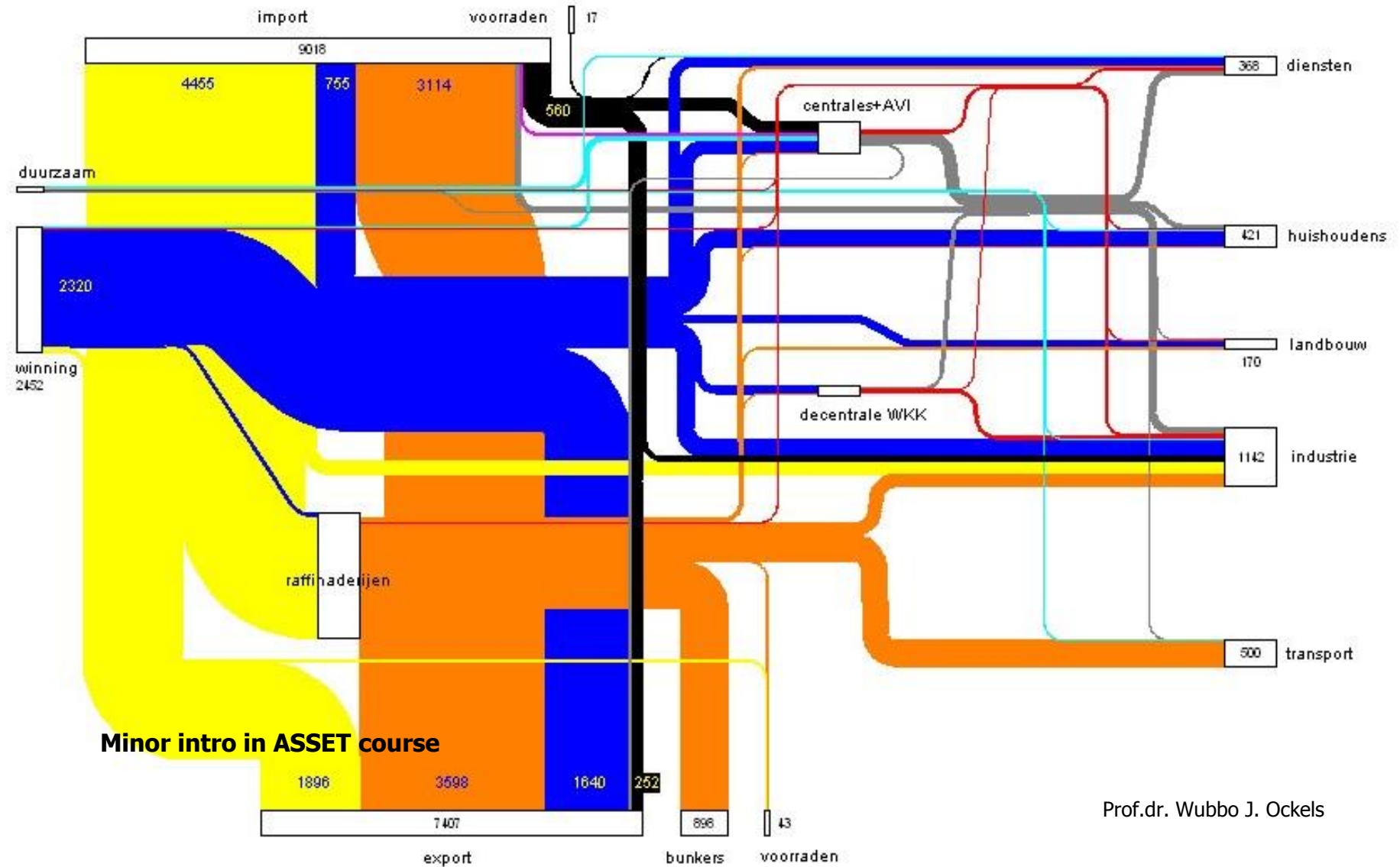
 Country/Region	Cumulative MW - end 2006	Est. average full load hours	Est. average capacity factor	Est. electricity production in 2005 TWh ¹⁾
Germany	20,652	1,831	20.9%	37.81
Spain	11,614	2,100	24.0%	24.39
USA	11,635	2,300	26.3%	26.76
India	6,228	1,800	20.5%	11.21
Denmark	3,101	2,250	25.7%	6.98
Italy	2,118	2,000	22.8%	4.24
United Kingdom	1,967	2,628	30.0%	5.17
P.R. China	2,588	2,100	24.0%	5.44
The Netherlands	1,557	2,100	24.0%	3.27
Japan	1,457	2,100	24.0%	3.06
Austria	966	1,794	20.5%	1.73
France	1,585	2,100	24.0%	3.33
Australia	796	2,500	28.5%	1.99
Greece	862	2,500	28.5%	2.16
Canada	1,459	2,278	26.0%	3.32
Sweden	571	2,100	24.0%	1.20
Rest of World	5,150	2,000	22.8%	10.30
Total	74,306	(avg. 2,050)	(avg. 23.4%)	152.35

©ckels

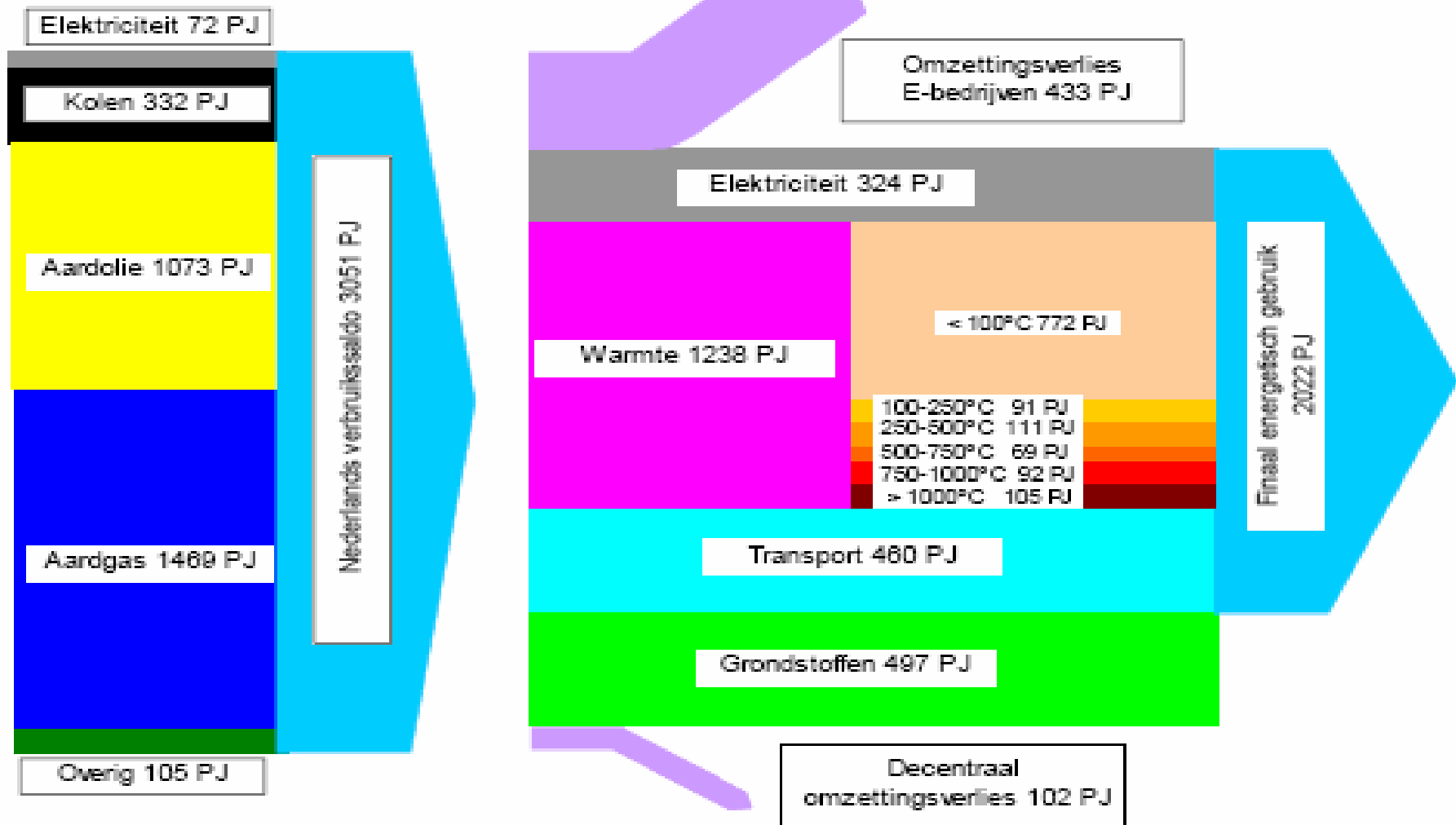
25

25

Energiestromen in Nederland



Prof.dr. Wubbo J. Ockels



PV annual pro	0.288 PJ/km2	Nederlai	33783 km2
		8%	2760 km2
1.60E+07 people		96.0	GW
6 kW		3027	PJ/year

2003 ECN overzicht				
primaire energie vraag				
	fossiel	electr	gen loss	sum
industrie	993	124	249	1366
transport	477	6	12	495
huishoudens	347	84	169	600
diensten en ov	240	80	161	481
landbouw	200	40	80	320
	2257	334	672	3263

transfer gas to electric		
new electr	fossiel	total electric
200	644	324
159	0	165
52	0	136
50	0	130
	200	40
461	844	795

surface needed:	2761 km2	8.17%
fossile fuel redurction	2419	74.13%
surface Ockels	1644.31 km2	4.87%

30 km 6m high solar PV

=> 50000 kWh/day

18000 cars/day

=> 36000 L fuel/day

1 L fuel => 1.4 kWh on wheels

350 PJ = 64 panels 70 m²

11000 kWh/y

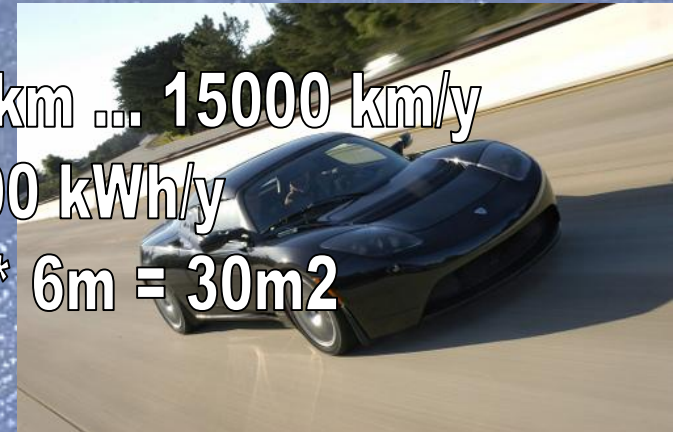
140 kWh/m² y

4 areas 20km*20km

20 kWh/100 km ... 15000 km/y

3000 kWh/y

PV 5m * 6m = 30m²





Positive to environment:
More energy then used
More clean air out then in
More clean water out then in
More biodiversity then before



10 Euro/Wp

1980

Learning rate = 20%

2005

2006

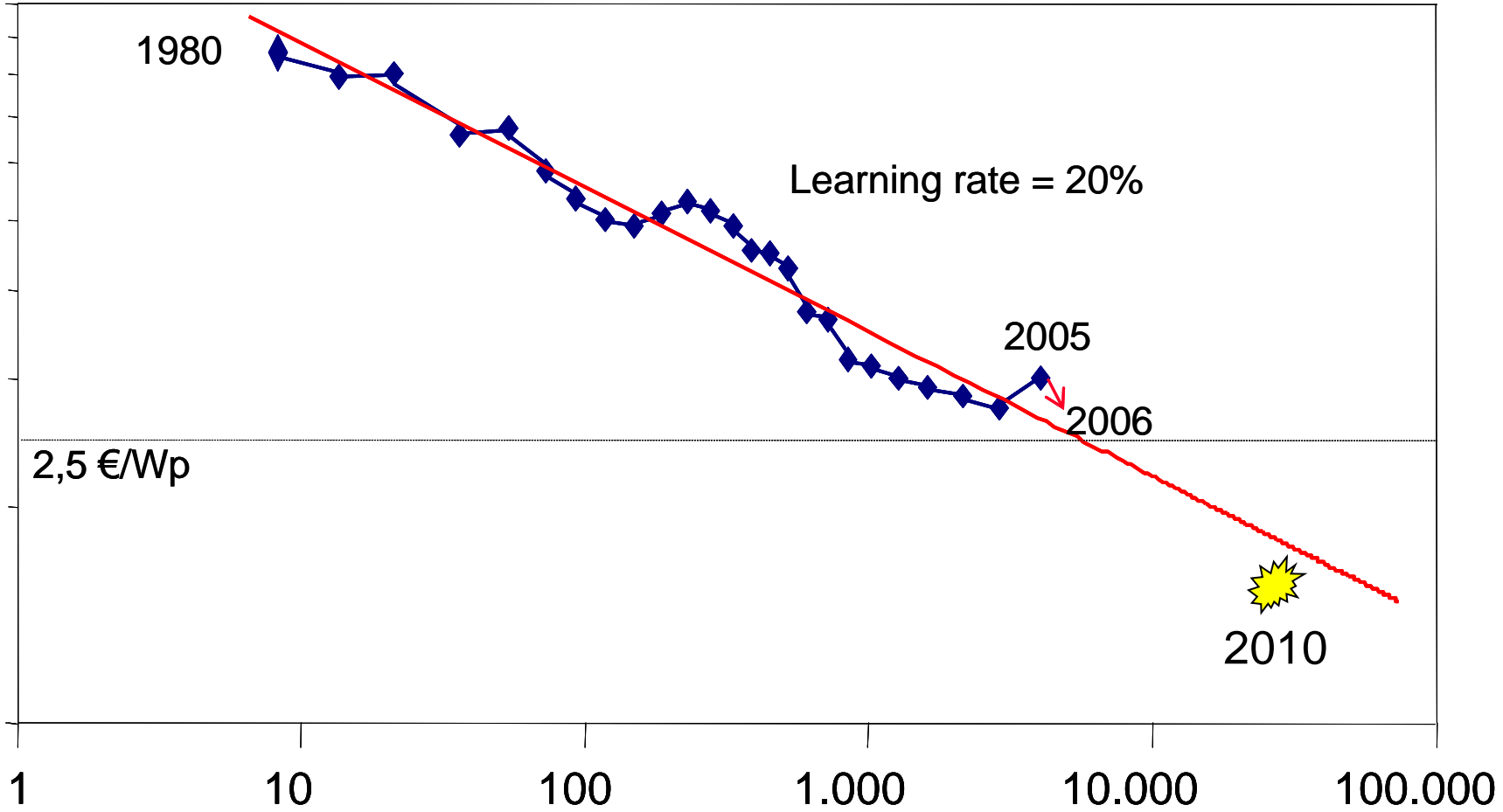
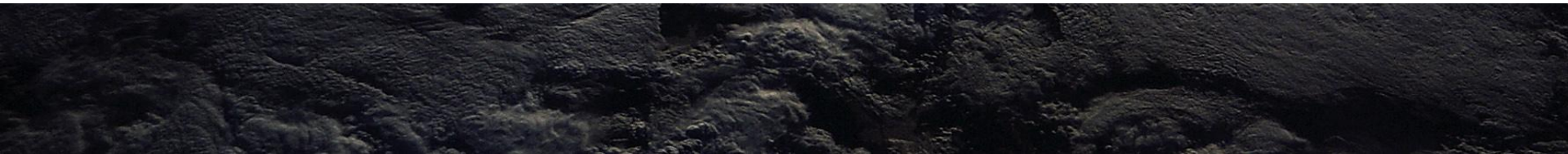
2,5 €/Wp

2010

1

1 10 100 1.000 10.000 100.000

cumulative shipments MWp



A sunset over the ocean with a person's silhouette on the left. The sun is low on the horizon, creating a bright orange glow. The sky is filled with soft, horizontal clouds. The water is calm with gentle ripples. The person's silhouette is dark against the bright sky.

2011 0.003

2012 0.006

2013 0.012

2014 0.024

2015 0.05

2016 0.10

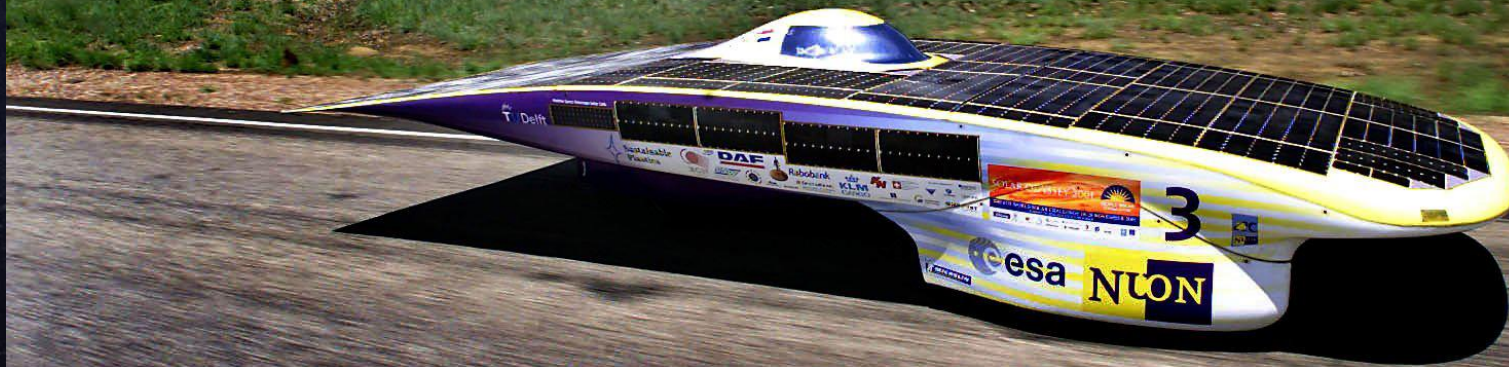
2017 0.20

2018 0.40

2019 0.80

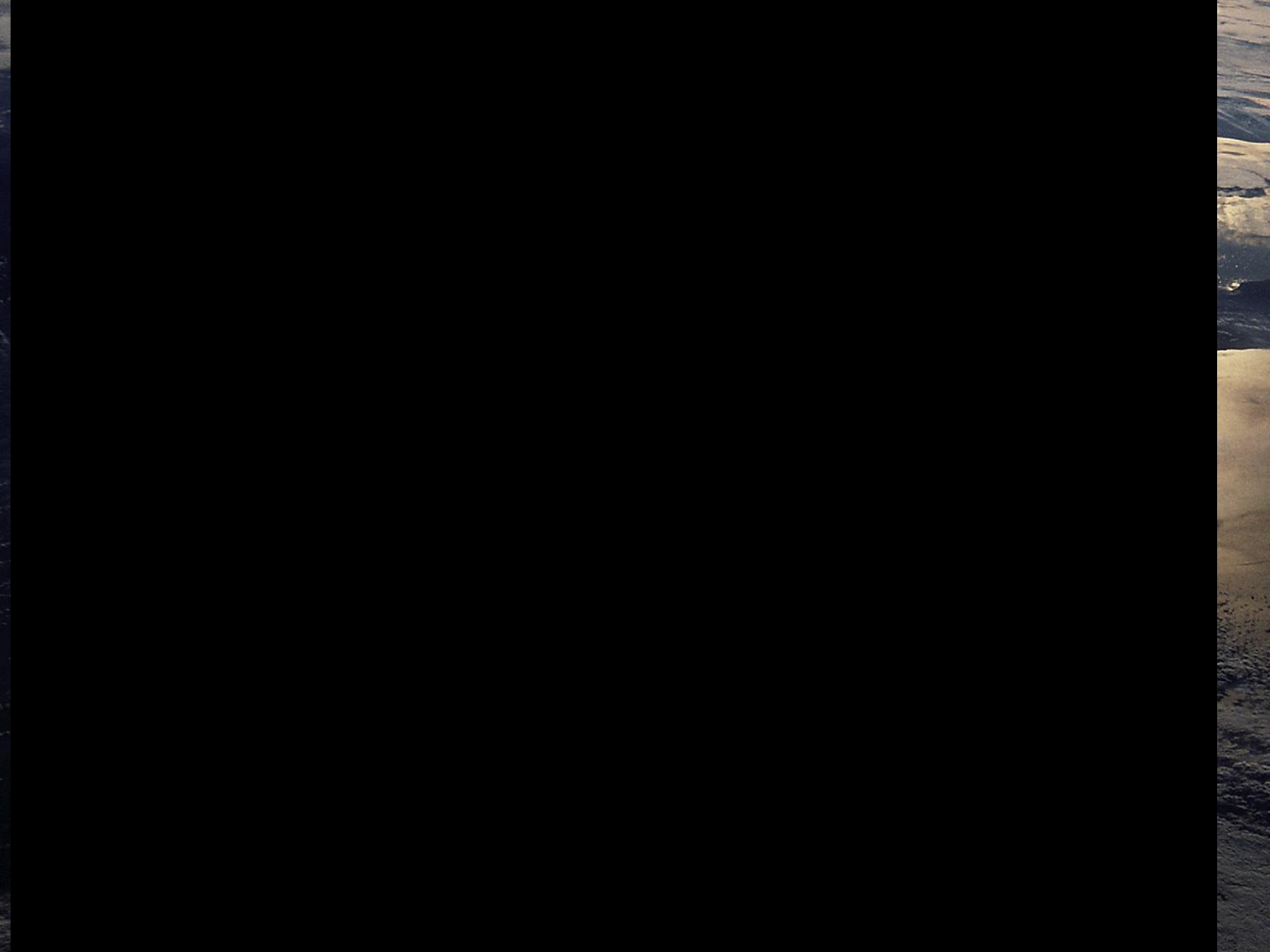
2020 > 1

World Solar Challenge 2001: 93 km/h



World Solar Challenge 2003 : 97 km/h





World Solar Challenge 2005: 103 km/h



World Solar Challenge 2007: 92 km/h

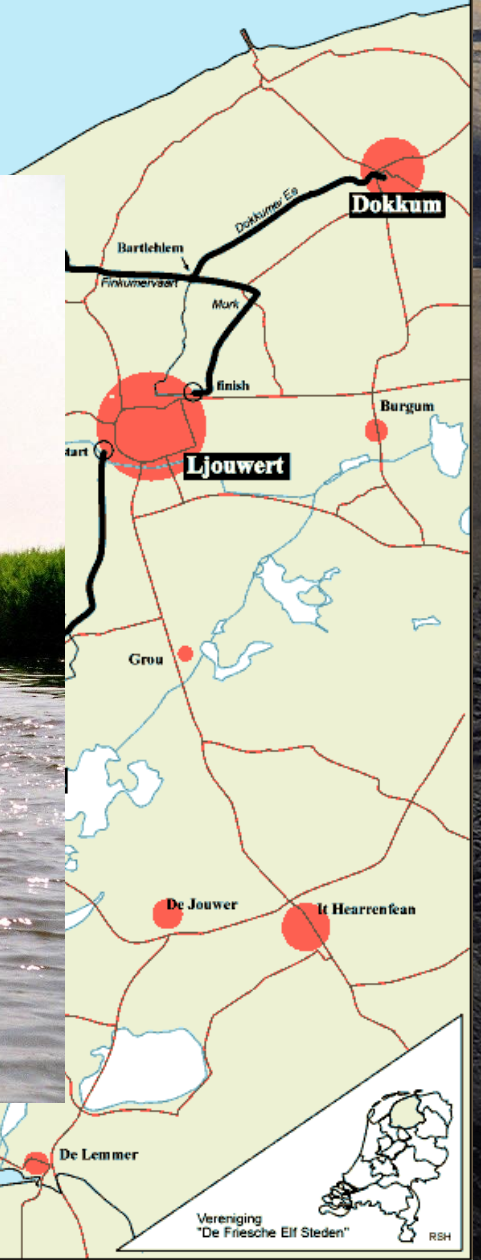








Elfsteden-route





26

Delft



actory



The S
building

Rabobank

Czeers
SOLARBOATS

SH

delta Lloyd

delta Lloyd

C 05



FLAPP BENEUX
victrol energy

www.puulboote.nl

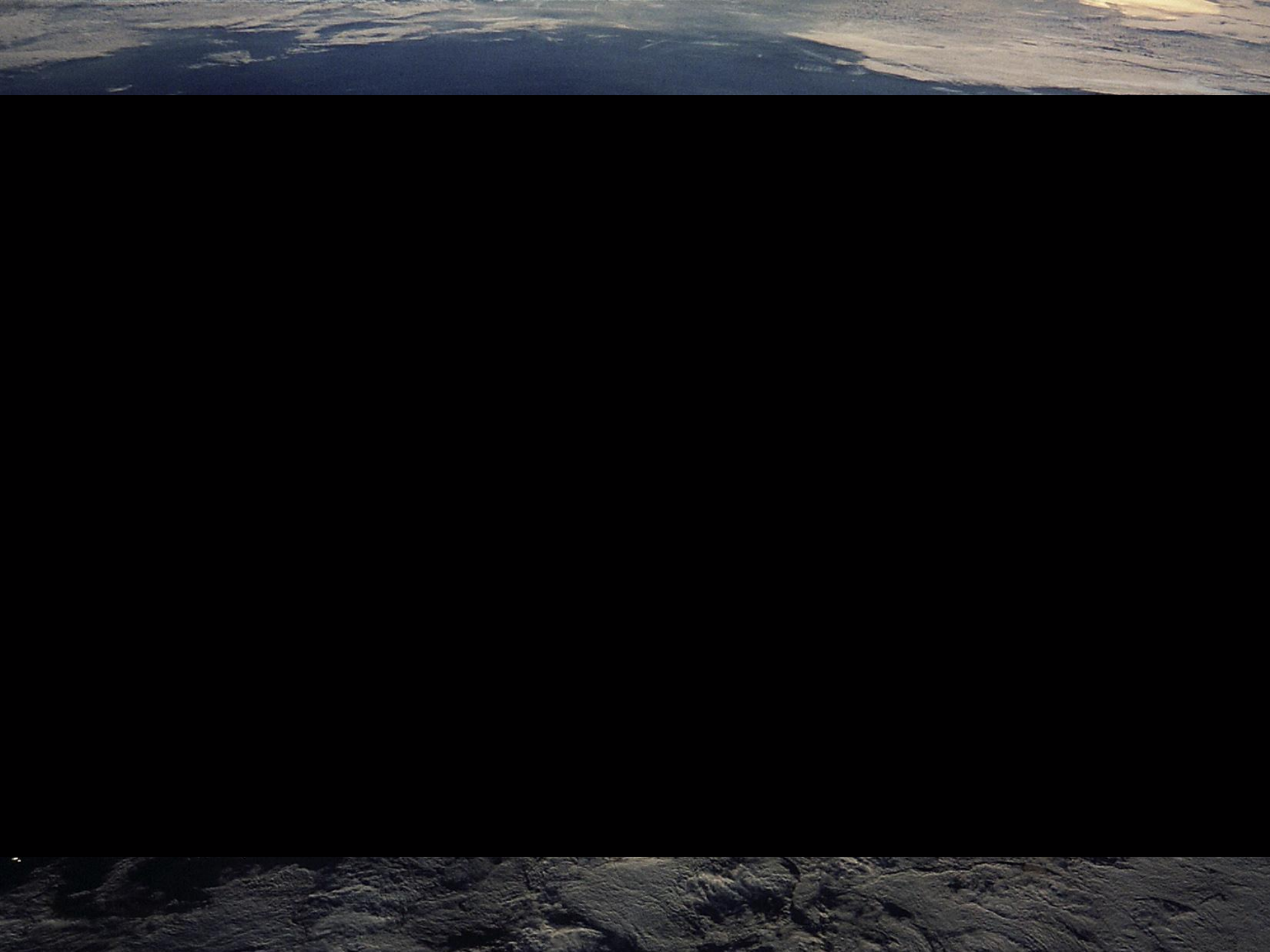
www.puulboote.nl

PRIVATE Energy
Solarboat Team

PRIVATE Energy

T 83

SWETTE SWITTER



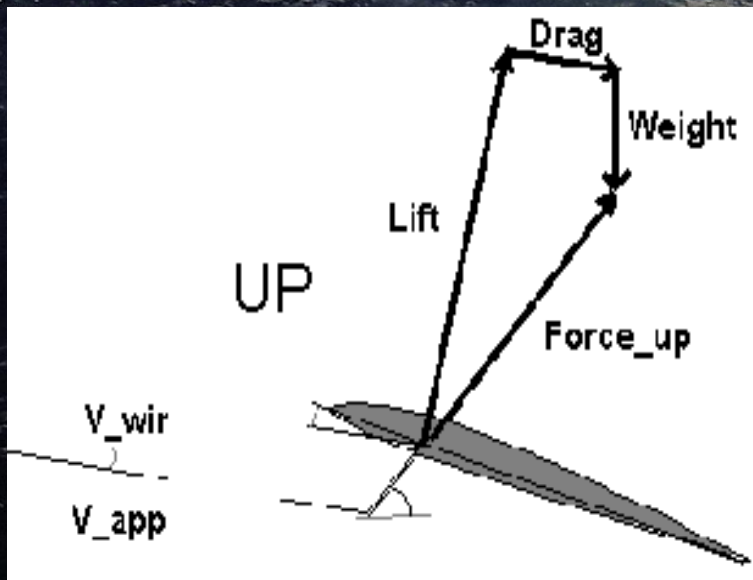
Kite power



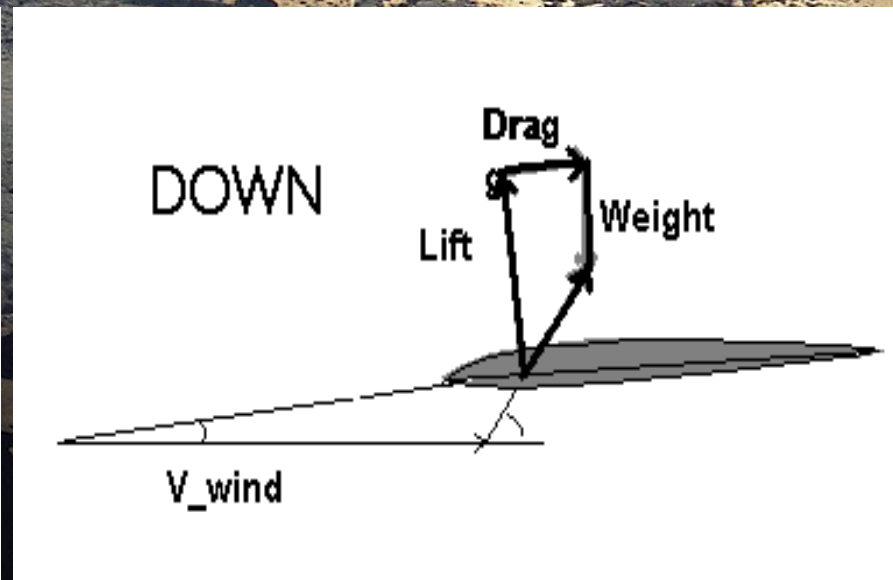
Laddermill concept

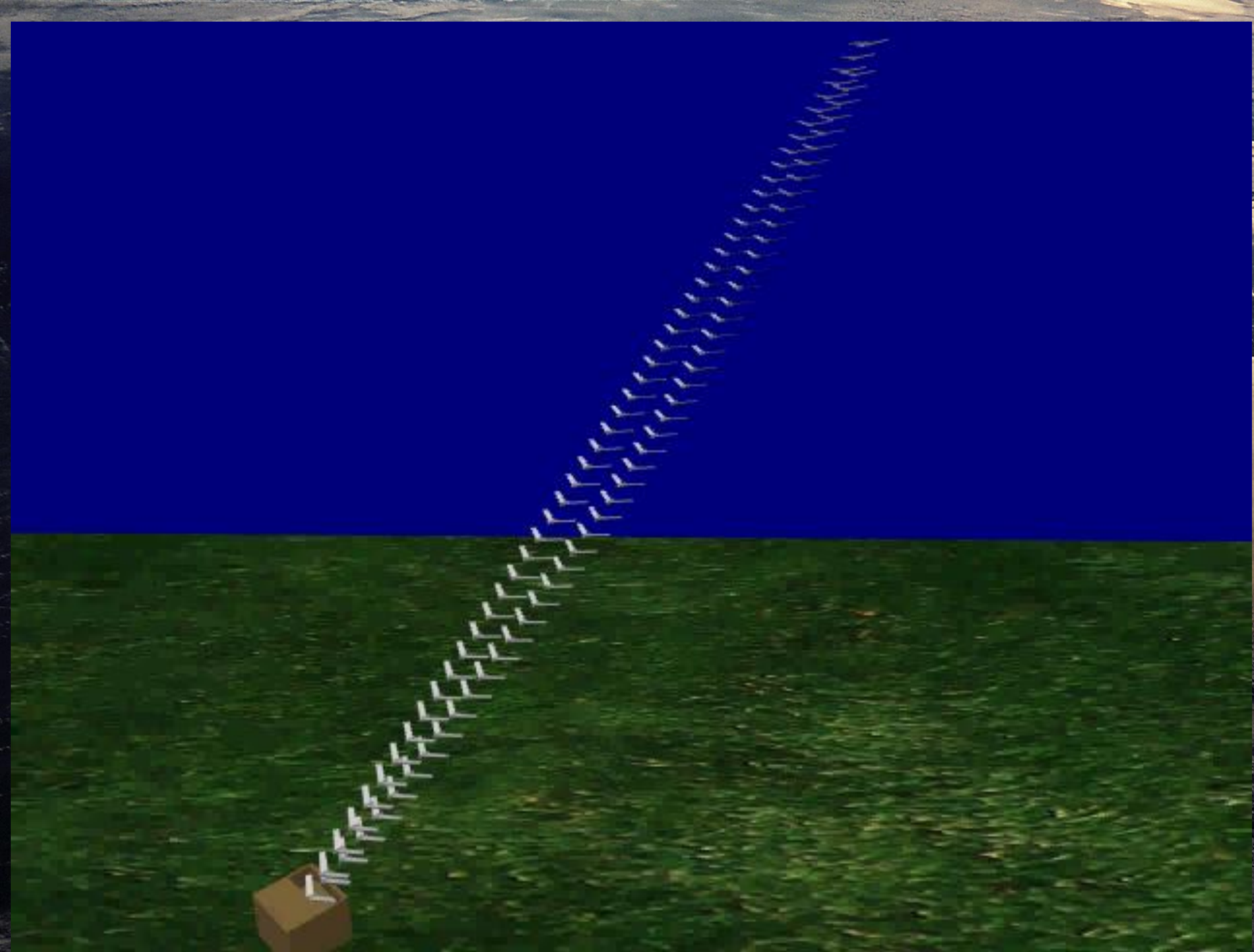
Combine airplane knowledge with kites

As kite going up



As airplane going down





An aerial photograph of a vast, textured landscape, likely a salt flat or desert. The terrain is dark and highly textured, with a prominent bright, reflective area on the right side, possibly a pool of water or a salt deposit. The text "Kite Steering Pod" is overlaid in the center.

Kite Steering Pod

Prof.dr.Wubbo Ockels







Minor intro in ASSET course

Prof.dr. Wubbo J. Ockels







Duurzaam ... 't hoeft niet minder maar 't moet anders







Ir. Joris Melkert
Assistant professor

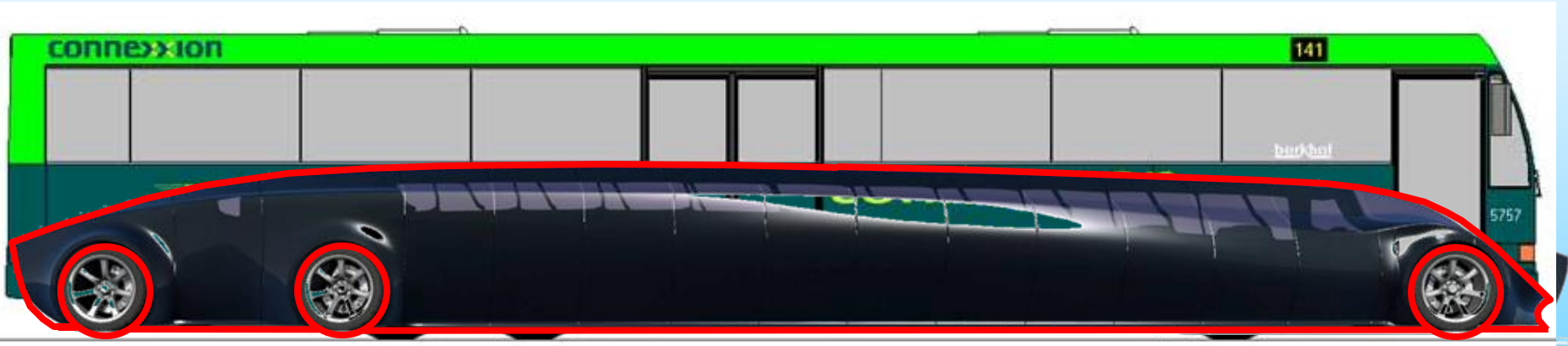


Dr. Antonia Terzi
Assistant professor



Prof. dr. Wubbo Ockels

SUPERBUS



25 persons in separate compartments of 2, 3 or 5 persons,
Every compartment has its own door
Internet, TV, etc....

Superbus combines highspeed train service with individual car

Your personal service

*flexible routing on demand
reaches individual destination
privacy in your compartment
individual doors
full multi media service*



Affordable thru intelligence:

***cost
environment
space***

*low cost high speed infrastructure
lean chauffeurs organisation
no emission electric transport
bundling with existing hiways
state-of-the-art safety*



Sensors

Superbus has 750 sensors on board. These sensors are used to detect if all the passengers have fastened their seatbelts and if there is anybody standing in range of the doors while they are opening and closing. Furthermore, Superbus has an obstacle detection system which works through a radar signal that detects objects from a few hundred meters away.

Cooling

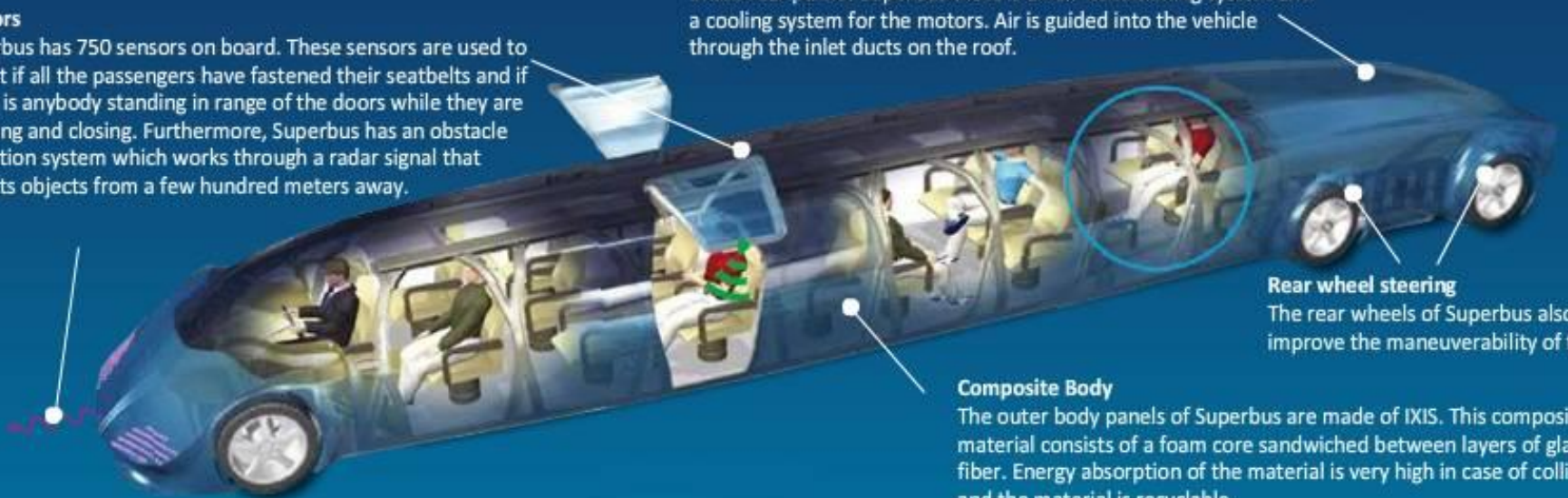
In the rear part of Superbus there is an air-conditioning system and a cooling system for the motors. Air is guided into the vehicle through the inlet ducts on the roof.

Rear wheel steering

The rear wheels of Superbus also steer to improve the maneuverability of the vehicle.

Composite Body

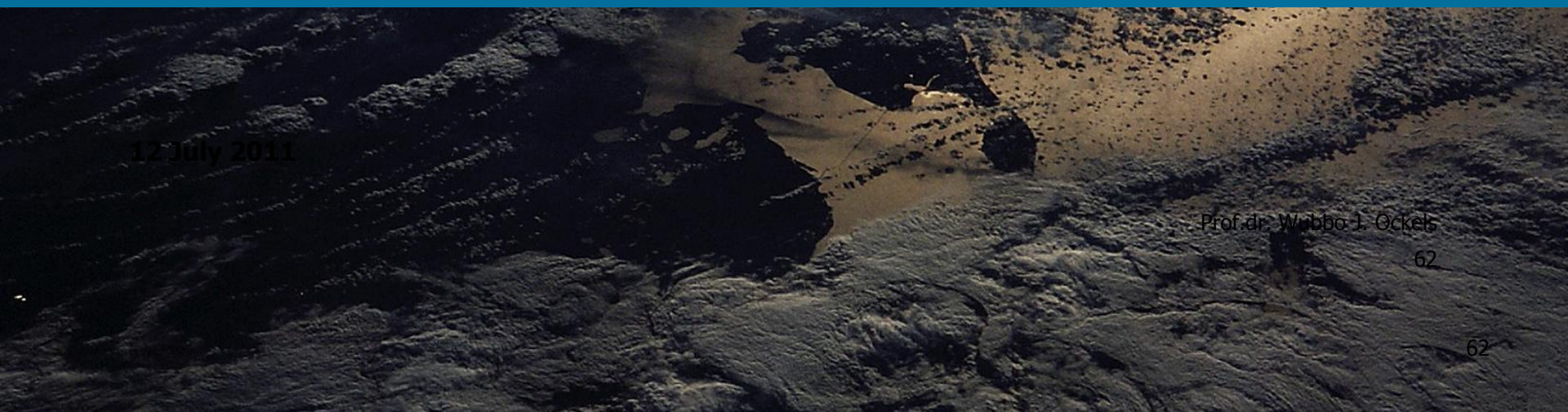
The outer body panels of Superbus are made of IXIS. This composite material consists of a foam core sandwiched between layers of glass fiber. Energy absorption of the material is very high in case of collision, and the material is recyclable.



12 July 2011

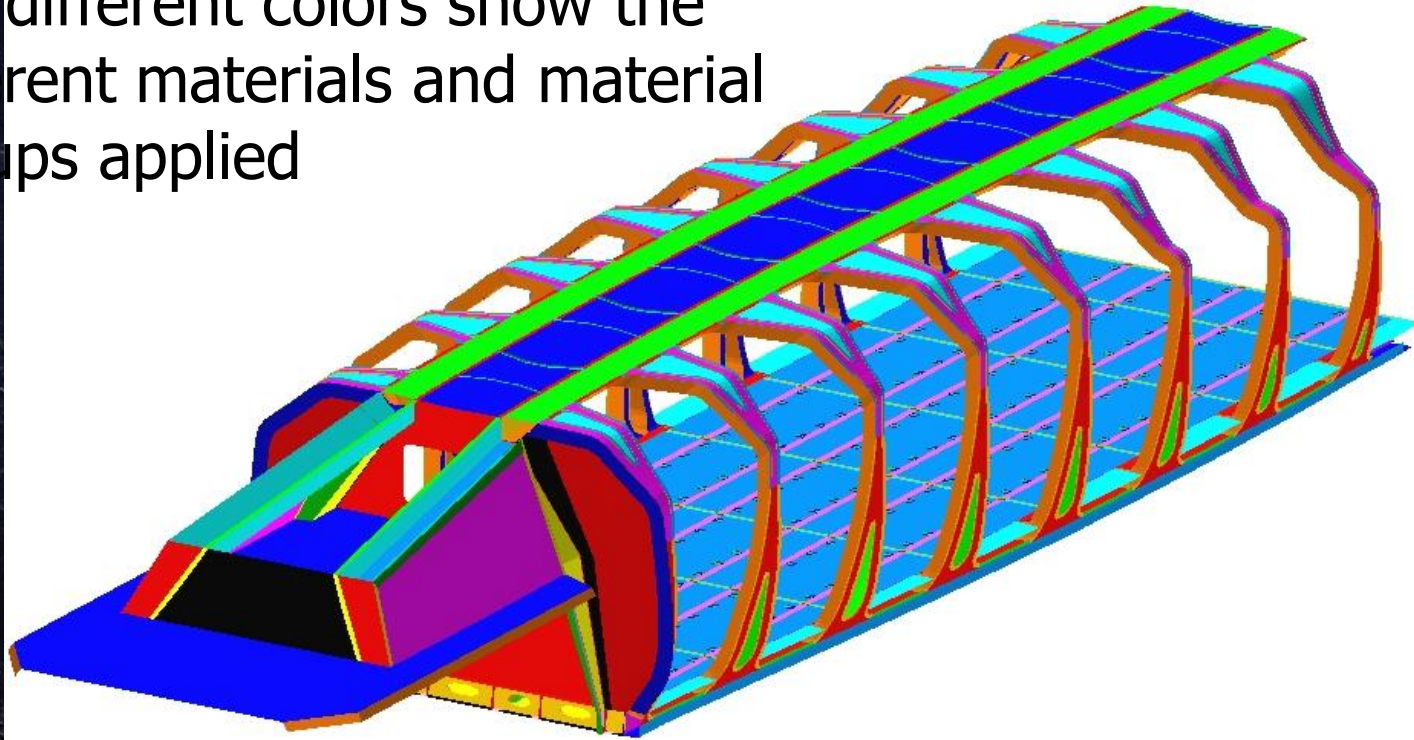
Prof. dr. Wubbo J. Ockels

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Finite Element Model

The different colors show the different materials and material lay ups applied





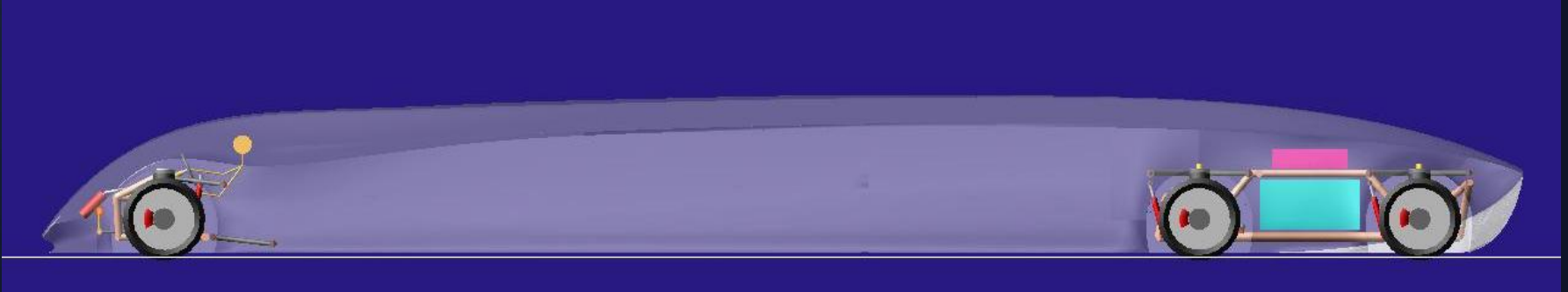
Minor intro in ASSET course

Powertrain system

Energy storage in battery-pack

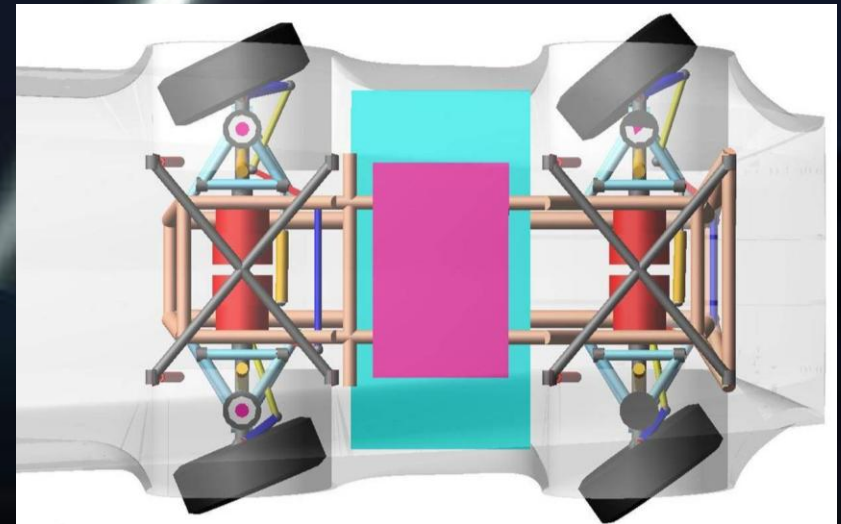
Reference target distance 210 km between battery charges

Energy-efficiency: power per passenger below 0.3 MJ/km



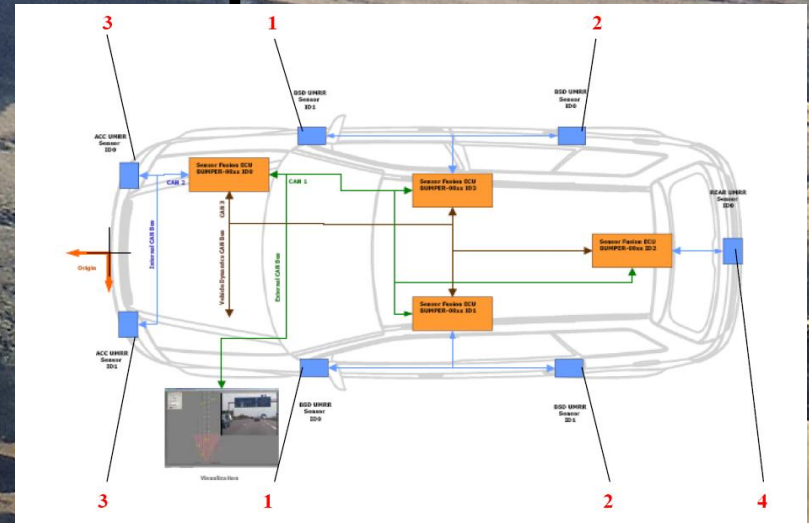
Powered by 4 electric motors


Management system of battery
And motors integrated with
Control system



Navigation

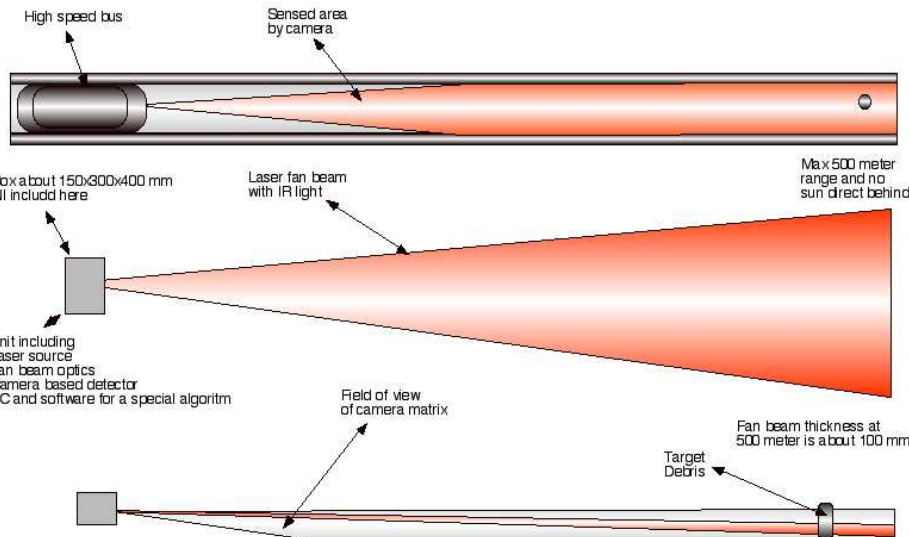
GPS receiver and RADARS
for vehicle positioning



 **LASER
OPTRONIX**
www.laseroptronix.se

Obstacle detection system

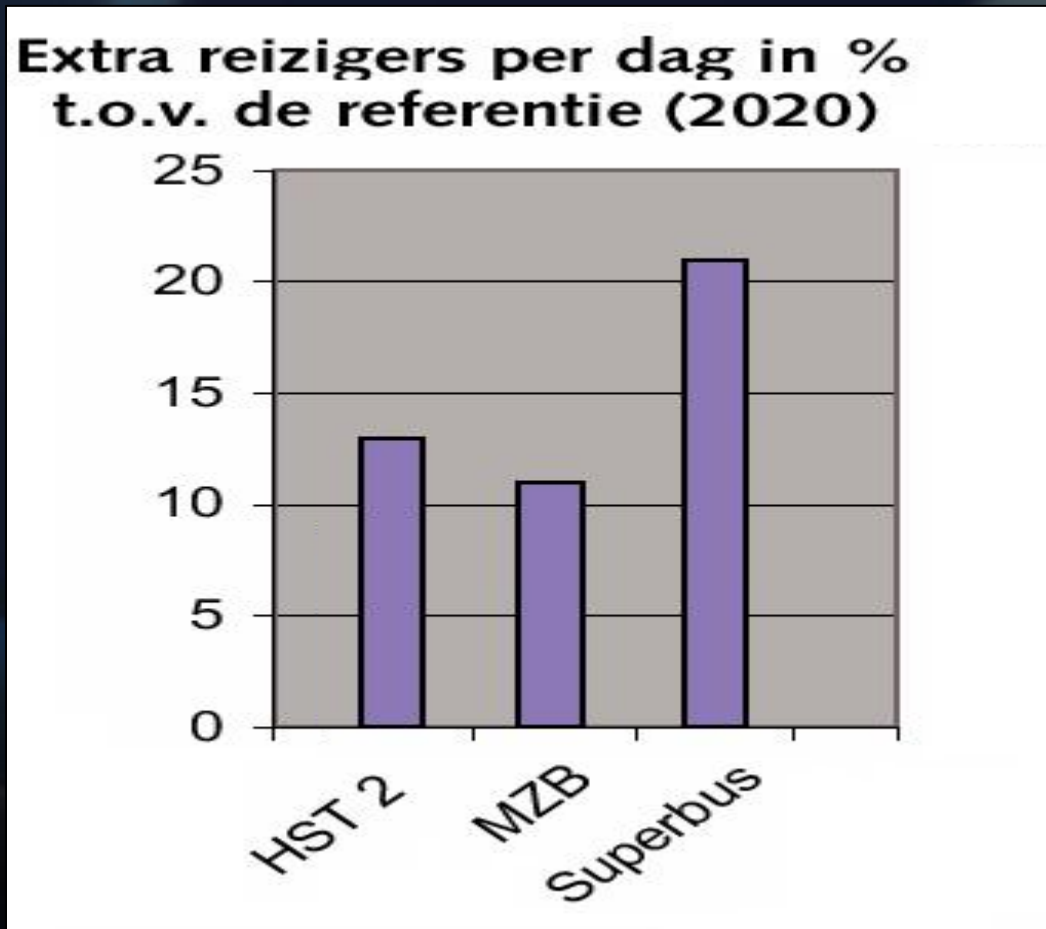
Laseroptronix AB
Enthusslingan 23
167 40 Täby
Sweden



LIDAR and InfraRed for
obstacle detection

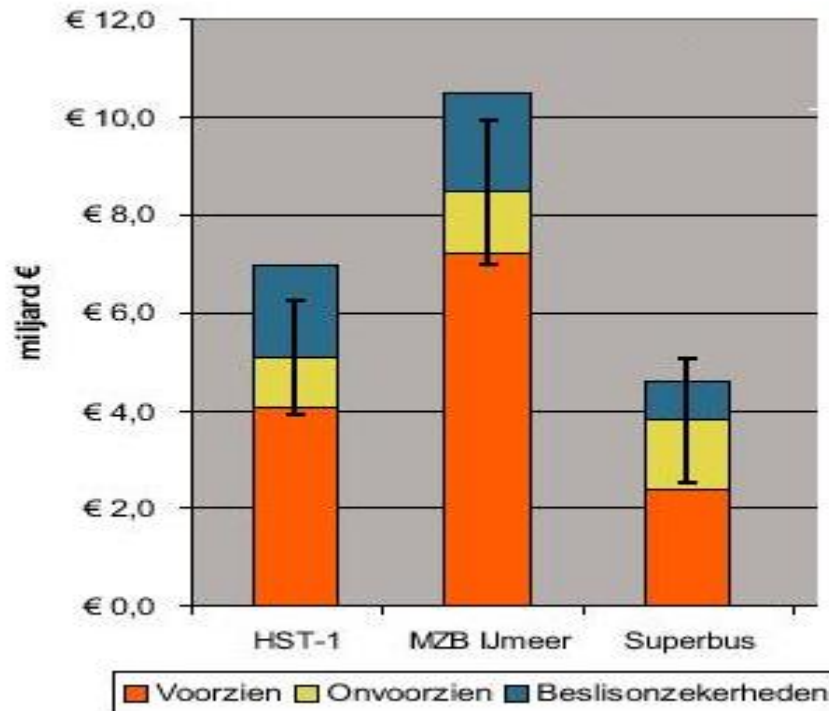
Prof. dr. Wibbo J. Ockels

Superbus compared to HST and MZB attraction of passengers 200km line

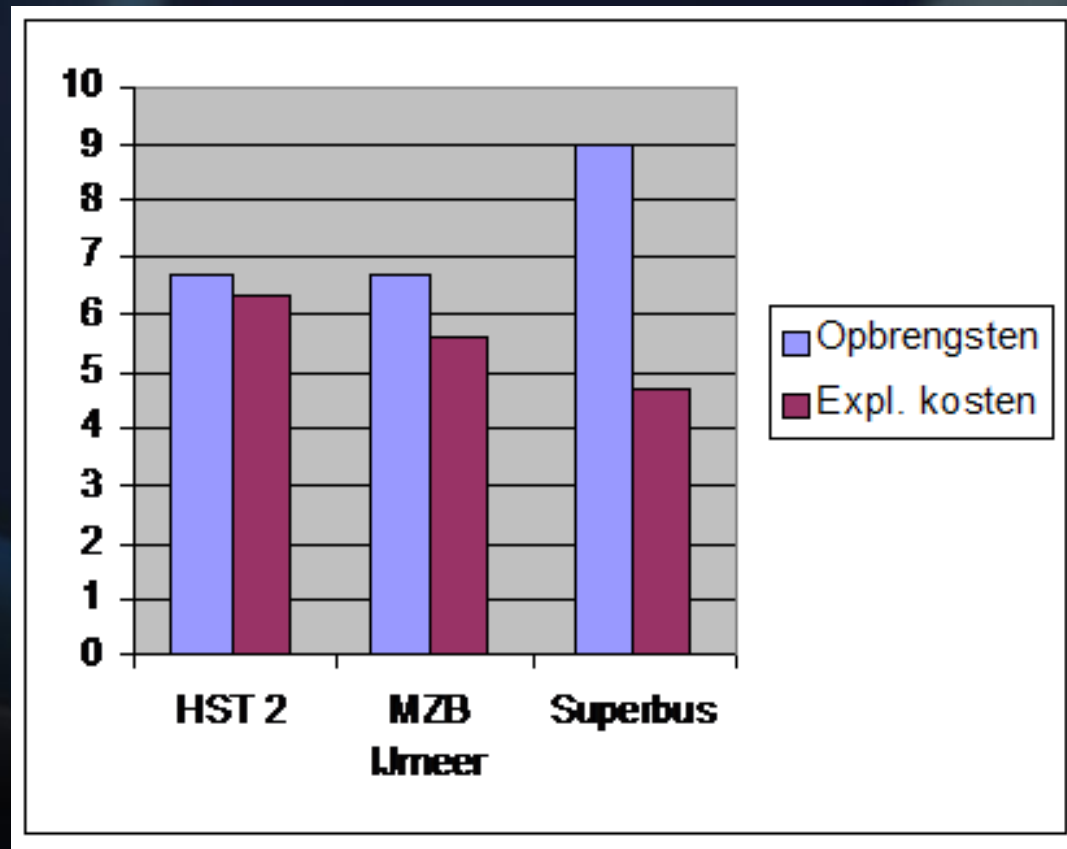


Superbus compared to HST and MZB cost of infra structure 200 km line

Figuur 7.4 Aanlegkosten inclusief risico's en beslisonzekerheden



Superbus compared to HST and MZB Business case 200 km line





Combine with parcel courier



WWW.SUPERBUSPROJEKT.DU

→
American Trucks
Busse / Busses
Teile und Zubehör
Parts

16

KRONE

A 24
A 18
Engineering



SPROJECT.COM



SS SU

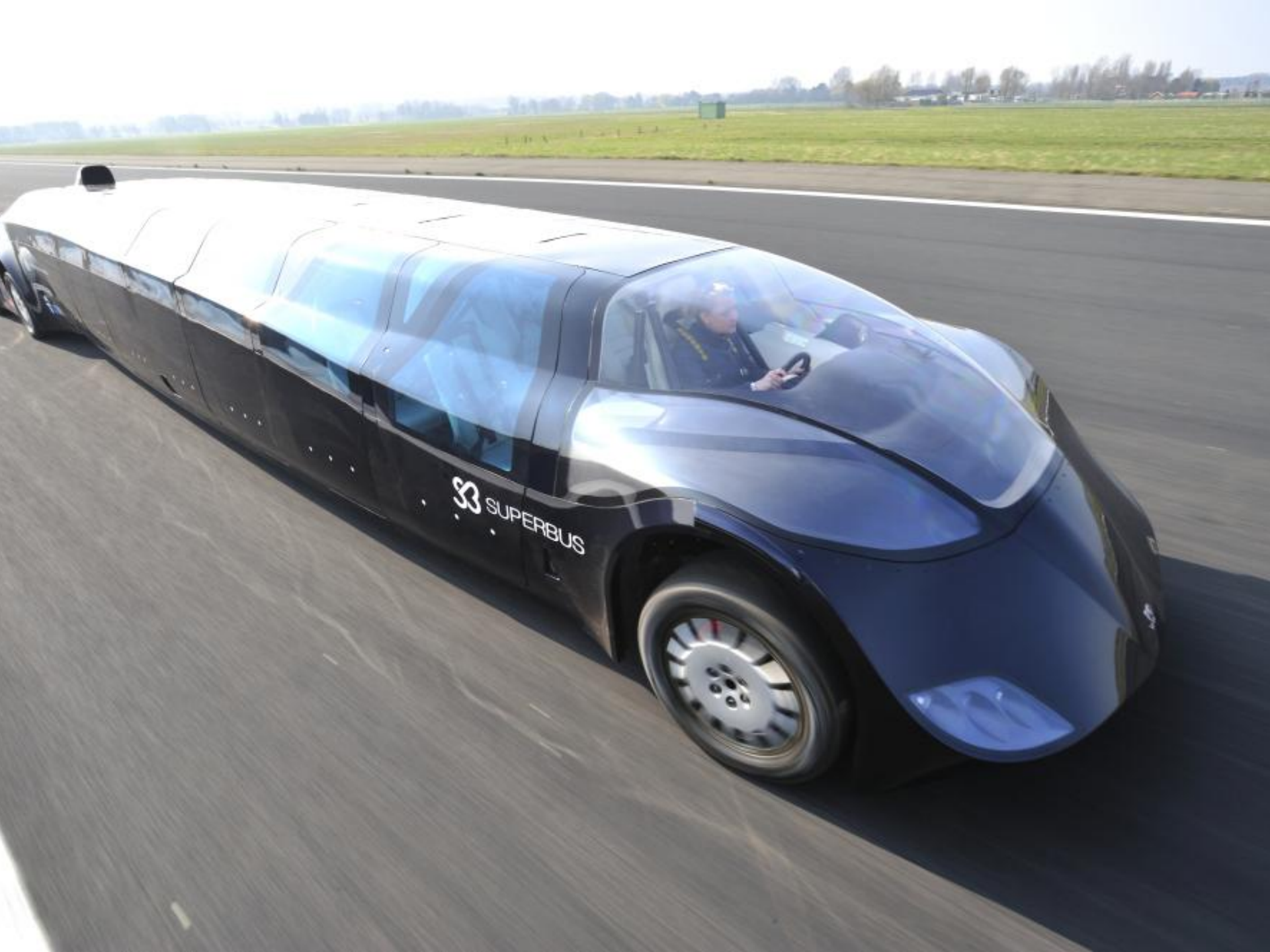




SUPERBUS



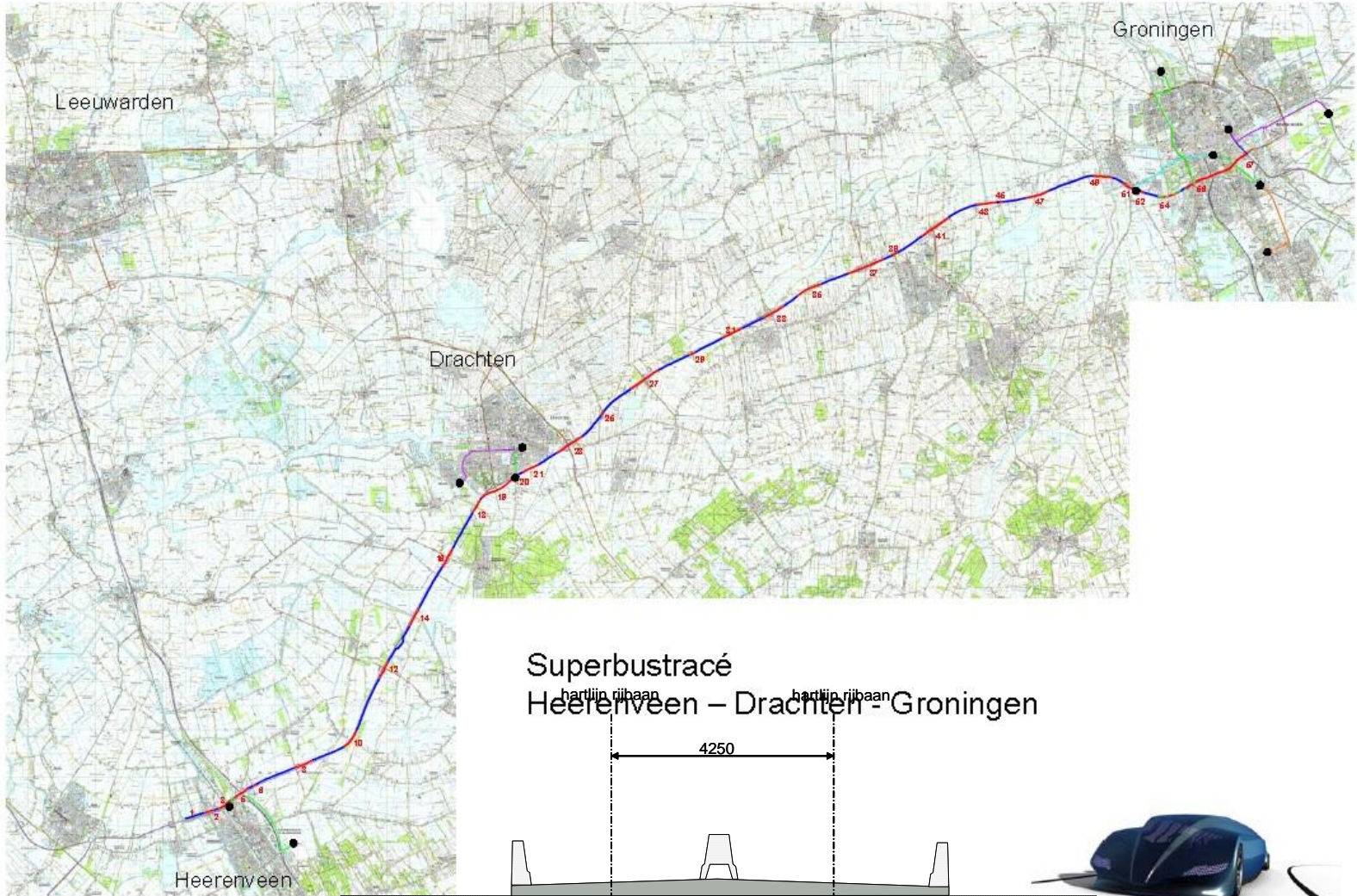


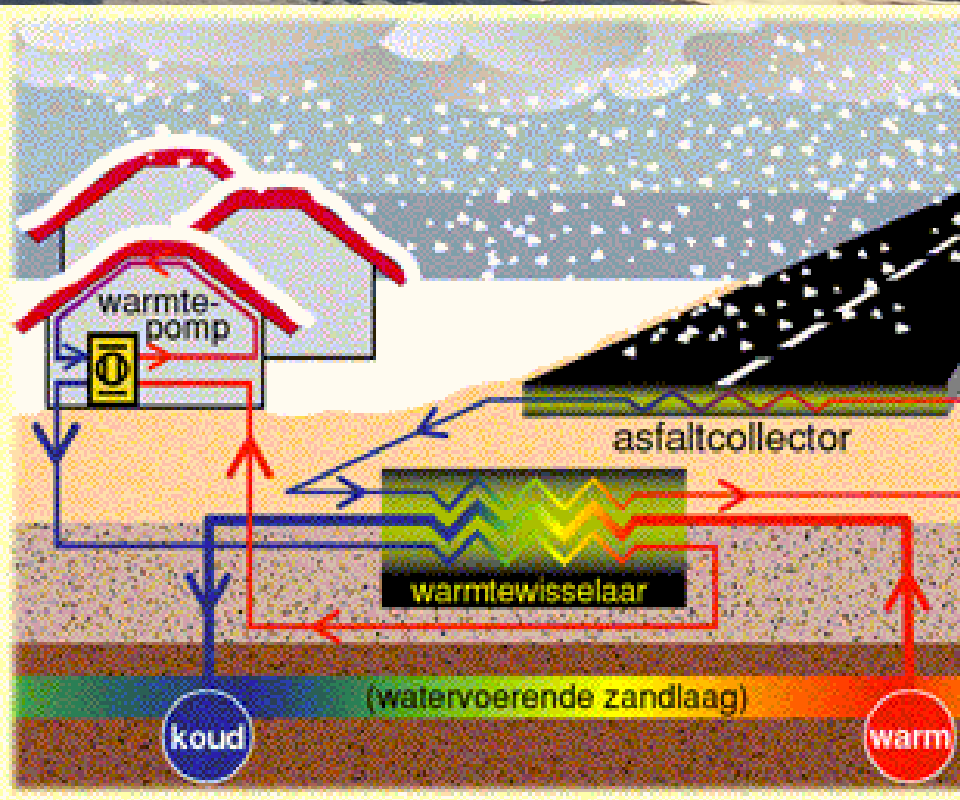
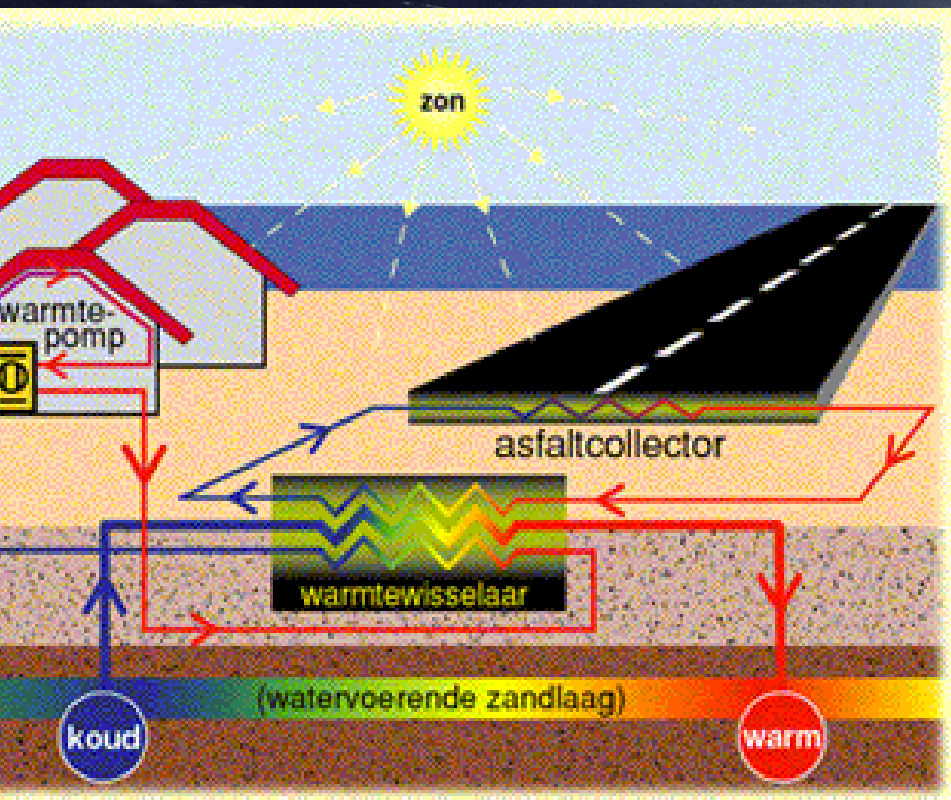


33 SUPERBUS











TAL

compact bedrijfsdeuren
www.rolflex.com

DEWALT

Pioneer

connexion
TU Delft

SUZUKI SUPERBUS

SUZUKI RIZLA



Innovation is disruptive

Transition to sustainability=

More sustainable activities and less non-sustainable

The power is with the non-sustainable

Risk of innovation is less than

Risk of NOT acting and go as usual

But responsibility is hard to assign

61 A 201



Climate Reality Project



SAMEN POSITIEF

We will survive
Is built-in in DNA



HAPPY ENERGY = HAPPY PLANET = HAPPY FUTURE



+



+



=







