

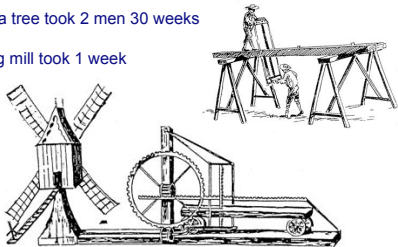
Cornelis Corneliszoon van Uitgeest

inventor (1593) enabling Holland's Golden Age (1600-1750)

Sawing a tree took 2 men 30 weeks

A sawing mill took 1 week

Tekening bij het afdrukken van een door uitvinder van de draaibank uitgeest vervaardigde draaibank. Aan de Staat van Holland van Cornelis Corneliszoon van Uitgeest vervaardigd op 15 Januari 1593



Still today we know hardly anything on Cornelis van Uitgeest

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From Golden Age to Stagnation & Crisis of 1850

- 1500 Rotterdam 500 people and Erasmus
- 1580-1670 Upswing of the Dutch Golden Age
- 1670-1750 Height of Golden Age
- 1750-1850 Stagnation
- 1777 Nederlandse Maatschappij voor Nijverheid en Handel (Economische tak van Hollandsche Maat. Wetenschap.)
- 1793-1810 Franse overheersing
- 1813-1848 Willem I (1815-1830 België, canals, railway 1839)
- 1760-1860 Rotterdam became isolated harbor
 - West via Hellevoetsluis & Kanaal door Voorne
 - East via Hollands Diep, Dordrecht, Oude Maas Vlaardingen, Nieuwe Maas to Rotterdam
- 1858 Idea of Caland to re-establish (concentrated) river flow
- 1863-1872 Nieuwe Waterweg through dunes at Hook of Holland

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From the Crisis of 1850 to 1900

- 1858 Idea of Caland
 - 1863-1872 Nieuwe Waterweg through dunes at Hook of Holland
 - 450 m at end of Scheur to 900m at HvH
- Criticism: you need locks as North Sea Canal in A'dam
1872-1881 not 7 m, but 3 m deep, too wide
1881-1895 8 m, and big success

- 1860 Suez Canal and larger (steam) boats which needed open access
 - Area of mass mobility started
 - Old "stapelhandel" changed into "transito" handel
 - Transito needed faster turnover
 - thanks to Caland Rotterdam became succesfull-winner
 - tonnage went from 0,3 Mt in 1850, via 6 in 1900 and 400 today
 - Amsterdam got stuck in "stapelhandel" & limited by lock size
 - Vlissingen got stuck in difficult (rail/road) connections to Germany

• When Caland retired he got a nice letter, that's all

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Rotterdam, yesterday and today

- 1500 Rotterdam 500 people and Erasmus
- 1600 The Dutch Golden Age (Windmills 2 man in weeks 30 to 1)
- 1850 Isolated harbor – with Caland's idea and steam Nieuwe Waterweg
- 1900 Transito area - start of mass-transportation
 - 6000 ton grain transito took 126 men 882 workdays
 - Grain elevators took 14 men 56 workdays (16 to 1)
- 1950 Time period of "easy oil" and expansion Europoort
- 2000 Largest container harbor in a globalizing world
 - But 5 out of 6 harbor labor jobs disappeared (6 to 1)

• Today: facing less growth in Europe, growth explosion in BRICKS, scarcity in rare materials, fossil energy and climate risks

• But also a very efficient and competitive complex of very large systems serving the energy supply and materials of hundreds of millions of customers; it's a 50 x 5 km area for 100-250 M customers



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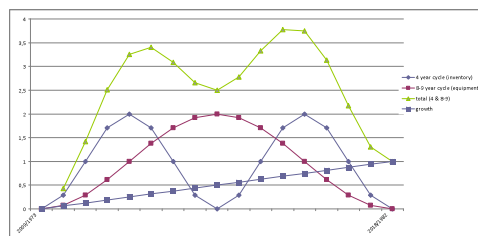
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- **The Rotterdam Rijnmond Ambition 2020-2030-2050**
 - Don't get choked-up in shifting container for China, like grain elevators, that is pasted history
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Economische groei en golven van 4-5 en 8-10 jaar (4-5 jaar voorraden en 8-10 jaar investeringen in machines)

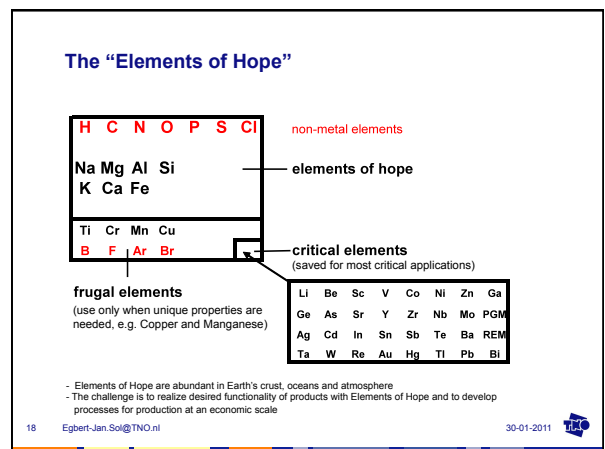
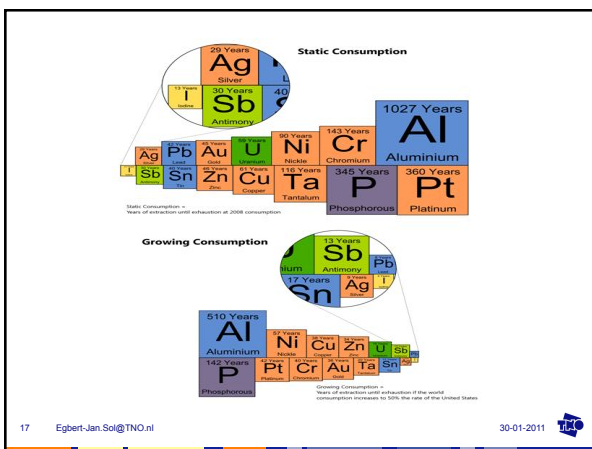
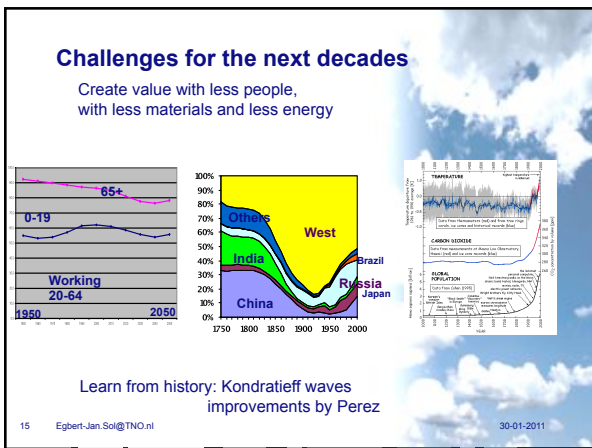
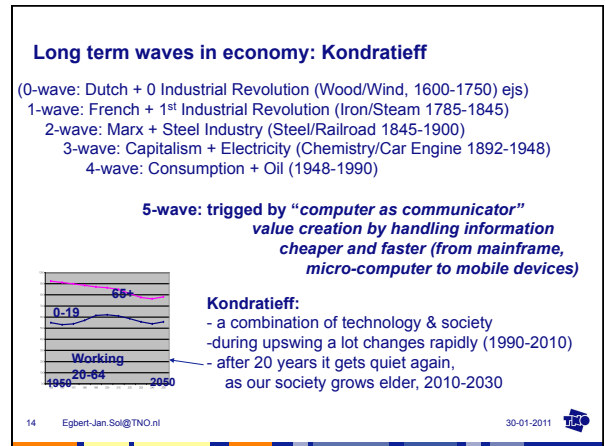
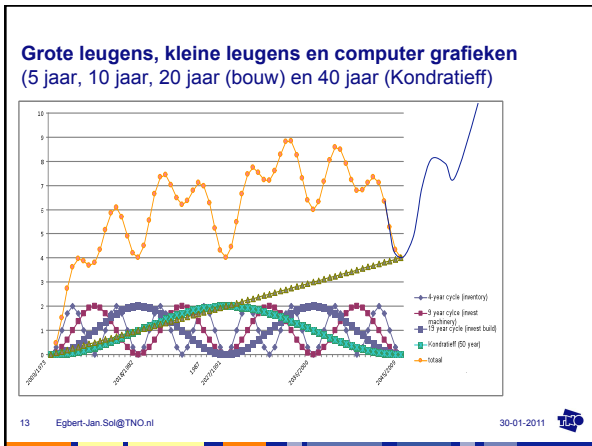


1973/2009

1982/2018

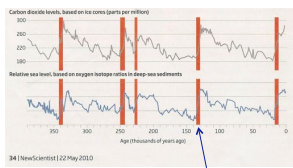
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Save the Planet (is really: save us)

- Mankind:
 - Lucy 4 My
 - more signs 1 M
 - Homo Heidelberg (300.000 y)
- Last 2 ice age (100.000 y) periods 6 m delta in less then 100 years of a period from max ice to no ice of 5000 years
- Last century: rise in order of decimeter, this century in order of meter?
- Today CO2 380 ppm and rising rapidly (max fossil 440 ppm)
- Back to Miocene (20My ago): 6 °C warmer & 40 m sea rise in ?????y (New Scientist, 22 may 2010, p36 (and the good news is: no ice ages any more))



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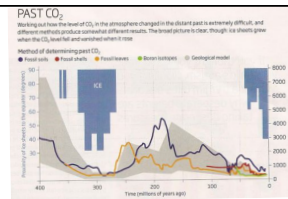
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Earth Climate: Moderate or Monster

- Earth 4.5 Billion years old
- Sun heat increases by 40% over 10 Billion years, we are half way
- First Billion years, more CO2, creating a warm blanket when sun was still cold
- Ice ages 2.2B ago, then 1B year warm period, then the super ice age
- 300M y again huge period of ice ages with low CO2 (New Scientist, 26 jun 2010)
- Last 2M years ups & downs, last 1M years 4 period around CO2 220-280
- Sea level can be -120 m below and 75 m above today's level
- Antarctica and Greenland 15% of world area (Wikipedia) and 1500 m land ice, if melted 65 m sea level rise



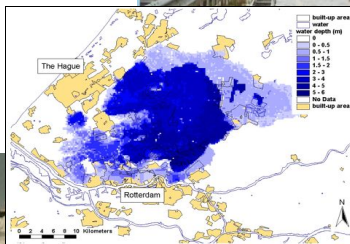
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This is our problem: Water from 4 sides – sea, river, rain, soil



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What will happen by 2015-2020

- BRICKs economy will grow rapidly, increase in demand for energy and materials, not for 1B, but for 5B consumers
- Energy prices and minerals grow more the rapidly, because of minimal price elasticity: with huge demand, price explosion
- Then every country want to lower it dependency on fossil fuels, but installing sustainable solutions is too expensive,
- Need for more sustainable energy, even 10-20% in NL creates a huge demand for indium for 1000+ km2 solar cells or neodymium for high power magnets for 10.000+ direct drive windmills
- And then models for land-ice melting in Antarctica gets accurate and CO2 reduction is desperately pursued to avoid wakening a climate monster.
- This is a perfect storm scenario

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Other scenarios

- Black Swan
 - Gran Traditionne
 - Closed continents
 - Perfect Storm
 - WO III
- Surprising invention and we live happy after More of the same, but with some tensions Europe is lacking resources (depleted), cost welfare Tensions all over, drop in welfare, some win, many loose Everybody loses
- Fixed
 - BRICKs will (at least initially) continue to grow fast
 - Fossil fuels and minerals will get more expensive
 - Scenario invariance – postpone/delay hitting the wall
 - Lower consumption patterns (less usage, smaller products)
 - Secondary mining (recycle) and cradle to cradle designs
 - Substitution and Elements of hope
 - Early start and rapid deployment of transition to sustainable energy
 - Technology will play a key role, so we better take the lead, develop innovative solutions and accelerate the introduction of those greener solutions
 - By 2040 clean energy become more and more abundant available, recycling works as planned
 - There is enough for everyone's need, but there is not enough for everybody's greed



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Improvements on Kondratieff waves

- Kondratieff (1930) – basic mechanism
 - Predictions in Stalin period resulted in death in Goulag
- Perez (2000)
 - Improvements in interactions in technology and financial mechanisms within a Kondratieff cycle of 40-50 years
 - (2010 financial crisis, next one is technological crisis)
 - (2000 was Internet bubble, 2020 ?? Energy scarcity??)
- Current Kondratieff wave – end of 5th – depression/stagnation – then 6th
 - 5th digitalization (computers, mobile telephony, Internet, mobile data)
 - Global economy, open innovation, but also looming scarcity issues, elderly population, climate risks
 - (relatively) Less growth for many years to come (debt restructuring, high(-er) prices for energy and raw material, wealth shifts)



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6th Kondratieff 2020-2050 Sustainability

- Nr 5 from 1990-2020 society adapts fast to new tech
- New tech takes/took 25-30 years from idea to 1% use and another 30 years from 1% to massive use
 - Internet 1960-1985, now 2010 everywhere
 - Co-operative driving 1990-2015 (1%), 2040 standard
- The 6th is about sustainability – (you can't predict the future: Jules Verne)
 - if company, region adapts to sustainable before 2020 and full sustainability by 2050, they continue to grow, else they dissolve in history (too expensive, etc)
 - Renewable energy, green/biobased energy/raw materials, nano-technologies (small products)
- Rotterdam, is not sea containers, but Chemie+Energy=Chem/nergy
- The Caland of 2050 is working now on that technology



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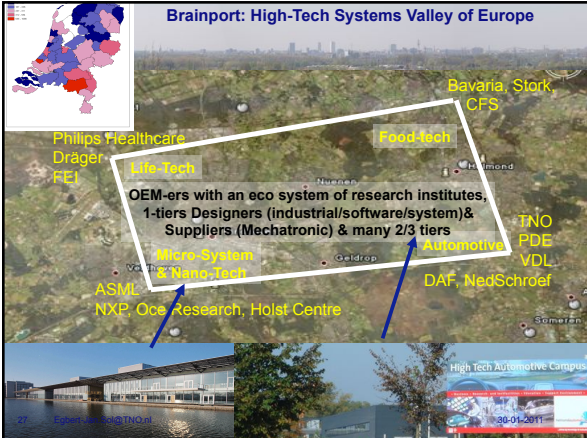
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Brainport: High-Tech Systems Valley of Europe



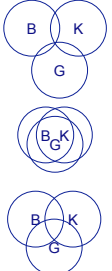
Philips Healthcare Dräger FEI
 Food-tech
 Auto-tech
 Micro-System & Nano-Tech
 ASML, NXP, Océ Research, Holst Centre
 TNO, PDE, VDL
 DAF, NedSchroef
 OEM-ers with an eco system of research institutes, 1-tiers Designers (industrial/software/system) & Suppliers (Mechatronic) & many 2/3 tiers

High Tech Automotive Campus

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The Triple Helix model

from open innovation to open governance



- Sub-optimal – too less, no help
- State monopoly – too rigid, over-regulated
- Balanced Triple Helix e.g. accelerating co-operation to acquire public/EU funds

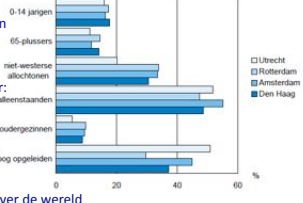
The challenge is the tricky balance, not too much or too less with three parties (with two it will not work!!)



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Issues voor Rotterdam

- Economische groei beperkt door de ruimte in de haven:
 - Fysieke ruimte
 - Transportcapaciteit
 - Milieuruimte
- Weinig werk voor hoog opgeleiden
- Kapitaalintensieve industrie:
 - Trage dynamiek
 - Remmende voorsprong
- Versnipperde kennisinfrastructuur:
 - Twee hogescholen
 - Drie ROC's
 - TUD en TNO niet betrokken
- Grote uitdagingen:
 - CO2 beperking
 - Verandering grondstofmix
 - Wijzigende handelstromen over de wereld

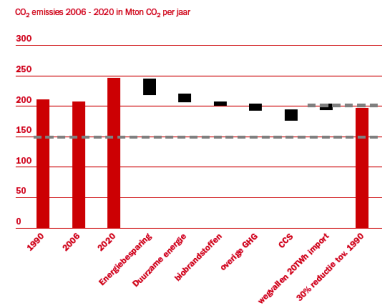


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Electrical Power production – Challenges: CO₂

Figuur 5: CO₂-emissies en reductiedoel in 2020 bij ongewijzigd beleid en inzet van maatregelen voor CO₂-reductie

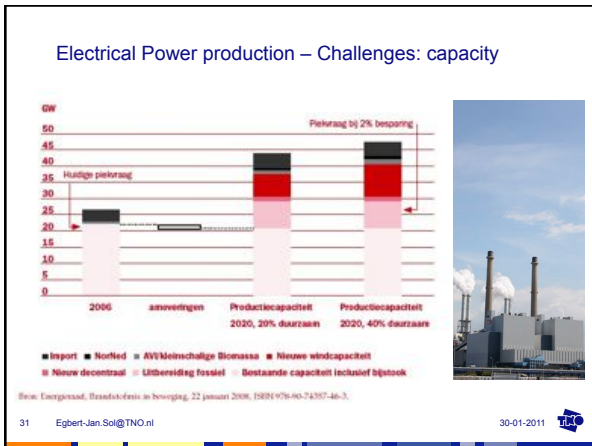
CO₂ emissies 2006 - 2020 in Mton CO₂ per jaar



1990 2000 2020
 Energiebesparing
 Duurzame energie
 Industrieel toelaten
 overige 6005
 2025
 weghalen 30TWh import
 30% reductie t.o.v. 1990



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Energy Big-Bang (few sec.) Photons
Free Electrons

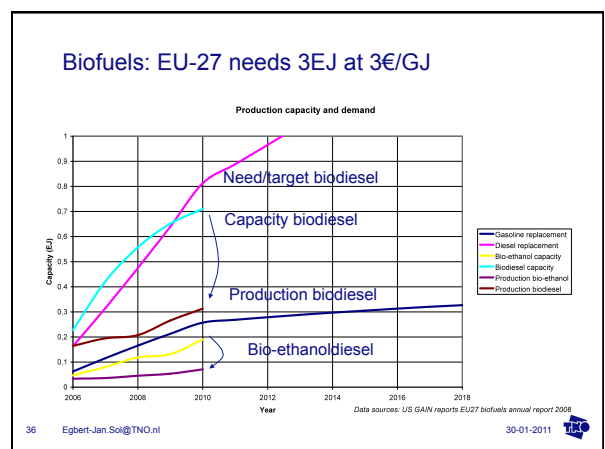
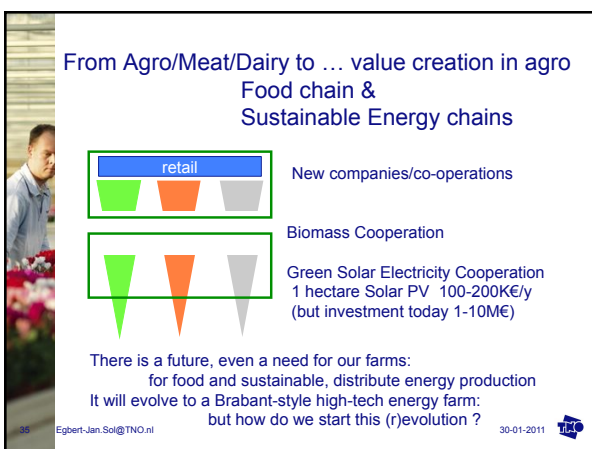
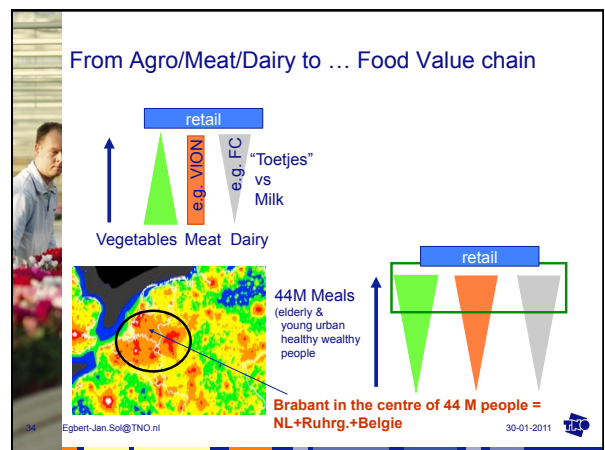
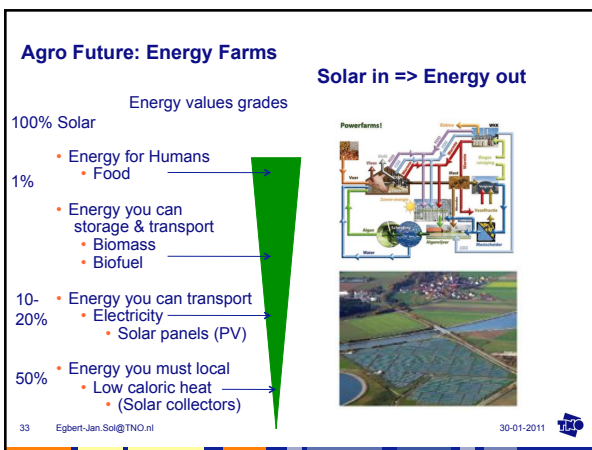
Chem/nergy Sun (100 Million °C) Hydrogen (H₂)
Earth with our T and pressure Hydrocarbons
methane (CH₄), Ethane (C₂H₆), Propane (C₃H₈), ... Petrol (C₈...C₁₀), Diesel (~C₁₂)

Our capability today in technology: PhotoVoltaic Solar cell at 20%
Capture photon, lives short, but transform it fast into a free electron
Electron in conductor to transport its energy, but you can not store it

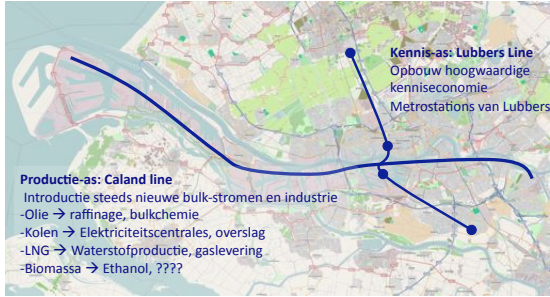
Nature's capability: Photosynthesis to store energy in Hydrocarbon chains
Capture photon, make out of H₂O a H⁺ (proton) and e⁻ (and O₂), then use energy to break CO₂ into C and O₂ and add the free C + 2H⁺ to extend a C_nH_{2n+2}

Our Challenge: copy nature's photosynthesis with technology
PV Solar (+) with H₂O and CO₂, splitting and H⁺/C hydrocarbon extension
or PV Solar with CH₄ extending a hydrocarbon (or as in Fischer-Tropsch H₂+CO)

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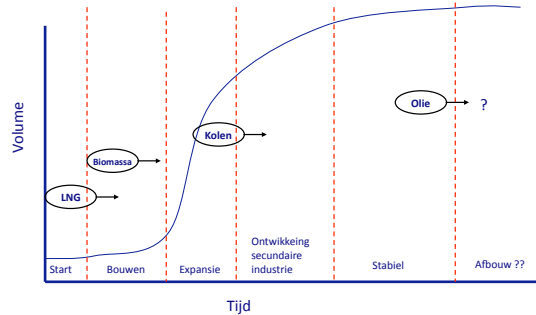
Contouren van de visie



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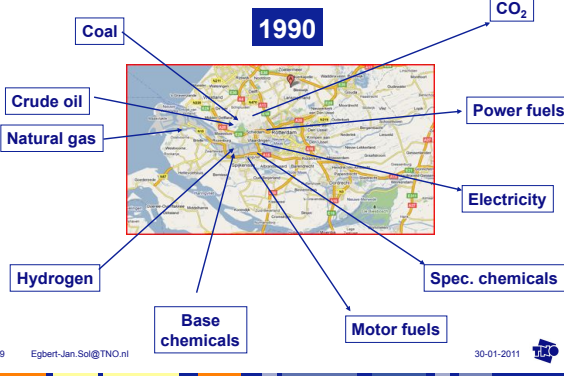
De ontwikkeling van een golf bulkgoederen



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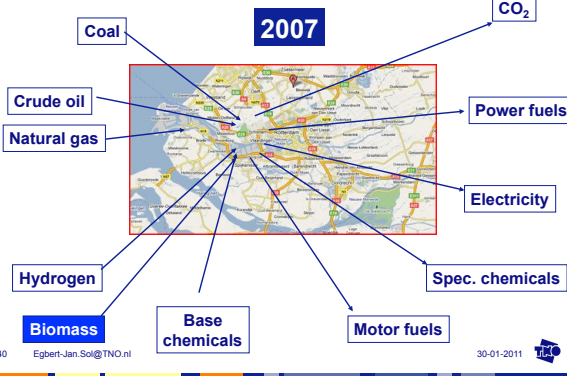
Evolving Rotterdam



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Evolving Rotterdam



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| Resources | Primary conversion | Intermediate | Secondary conversion | Application |
|---------------------------|-----------------------------|-------------------------|-----------------------------|-------------|
| Biomass (wood, straw etc) | Combustion | Producer gas Syn-gas | Fischer-Tropsch synthesis | Heat |
| Wet biomass | Gasification | Bio oil Bio crude | Extraction + Esterification | Electricity |
| Liquid waste streams | Pyrolysis | Biogas | Hydrocracking | Fuel |
| Sugar Starch | Hydro-thermal upgrading | Hydrogen Syn-gas | Methanisation | Chemicals |
| Oil crops | Digestion | Bioethanol | De-oxygenation | |
| | Super Critical Gasification | Fermentation broth | Hydrolysis + Fermentation | |
| | Hydrolysis + Fermentation | Biodiesel | | |
| | Extraction + Esterification | | | |

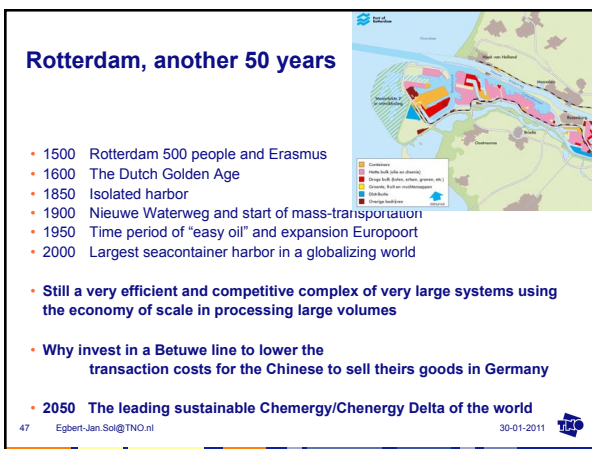
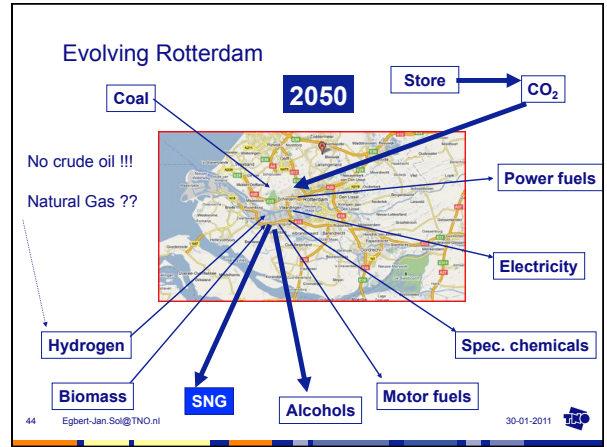
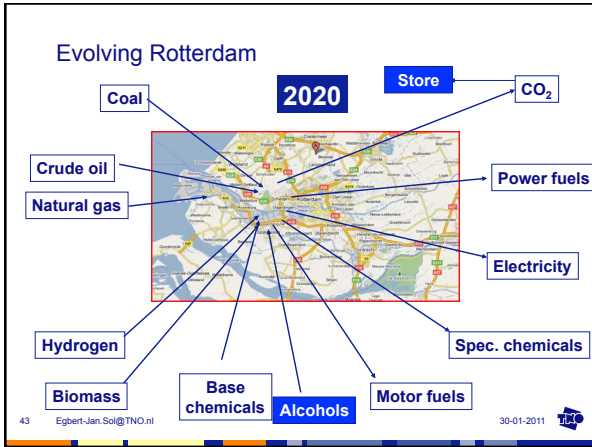
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| | Super Critical Gasification | Fermentation broth | Hydrolysis + Fermentation | |
| | Hydrolysis + Fermentation | Biodiesel | | |
| | Extraction + Esterification | | | |

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Plan van Caland – anno 2010 voor 2050

- Sustainable Energy, Local power generation and Peak loads
 - Make from coal electrical energy when price is high
 - Make base-chemicals when price is low (wind/solar surplus)
- Peak load predictions and their storage
 - Hydro (static/kinetic energy, not in NL)
 - Synthetic Oil (Carbon hydrate) =>chemical energy)
- Large scale version: Future of Rotterdam Rijnmond & LNG/CO2
 - Bulk C-1 economy (CH4, C, CO2) to added value hydrocarbons
- Medium scale: Distributed Energy Farms
- Small scale: a Synthetic Oil shoe box at home for ethanol & Petrol (not to be published in Scandinavia)

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Super Systems: (Not discussed, but also needed) Large Installations of 1+ BEuro & 40 years lifetime

- Mix into refinery becomes more complicated
 - More sour oil, mixture of biomass
 - Old designers and skilled operators grow old (retirement)
 - Inter dependencies grow future
 - New technologies as process intensification
 - Larger mix in output request
 - Safety requirements become more complex (In overregulation fire department becomes over powerful)
 - Maintenance only possible with simultaneous shutdowns
- We need a new paradigm of super systems with a plant captain (gezagvoerder) with all the (digital) tools to control (monitor & plan) production, safety & maintenance in one hand
- This requires a generations of (digital) plant CAD-alike models

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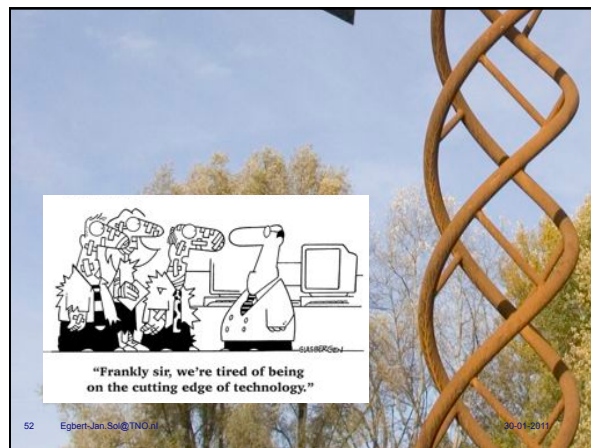


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 - Accelerate biobased economy with **High-Tech energy Farms**
 - Crank-up process technology & manage **Super-Systems**
 - Merge Delft into RR and create **Innovation axe**
 - Caland 2010 = Innovation plan
 - Business 2050 = Chenergy

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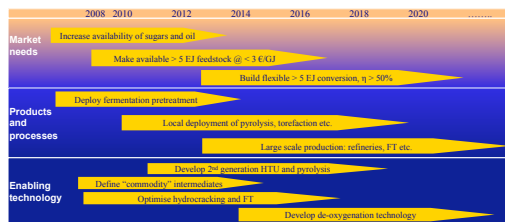
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A technology roadmap



EU 5.75% milestone

EU 10% milestone

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