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Renewable Energy and Case study Texel

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Kennemer College, Beverwijk
26 November 2015

Content

- ECN
- Our energy use
- Energy challenges and role of sustainable energy
- Case study Texel

Messages you should remember!

- There is no doubt about climate change and the role of CO_2 , we must drastically reduce the use of fossil fuels
- The most sustainable energy is non-used energy!
- We need to change the energy system completely, and we must be quick
- A lot of the technology for solving the problem is already available
- But … a sustainable energy system will be very visible and present

ECN

Locations

ECN Petten
(head office)

ECN Wieringerwerf

ECN Amsterdam

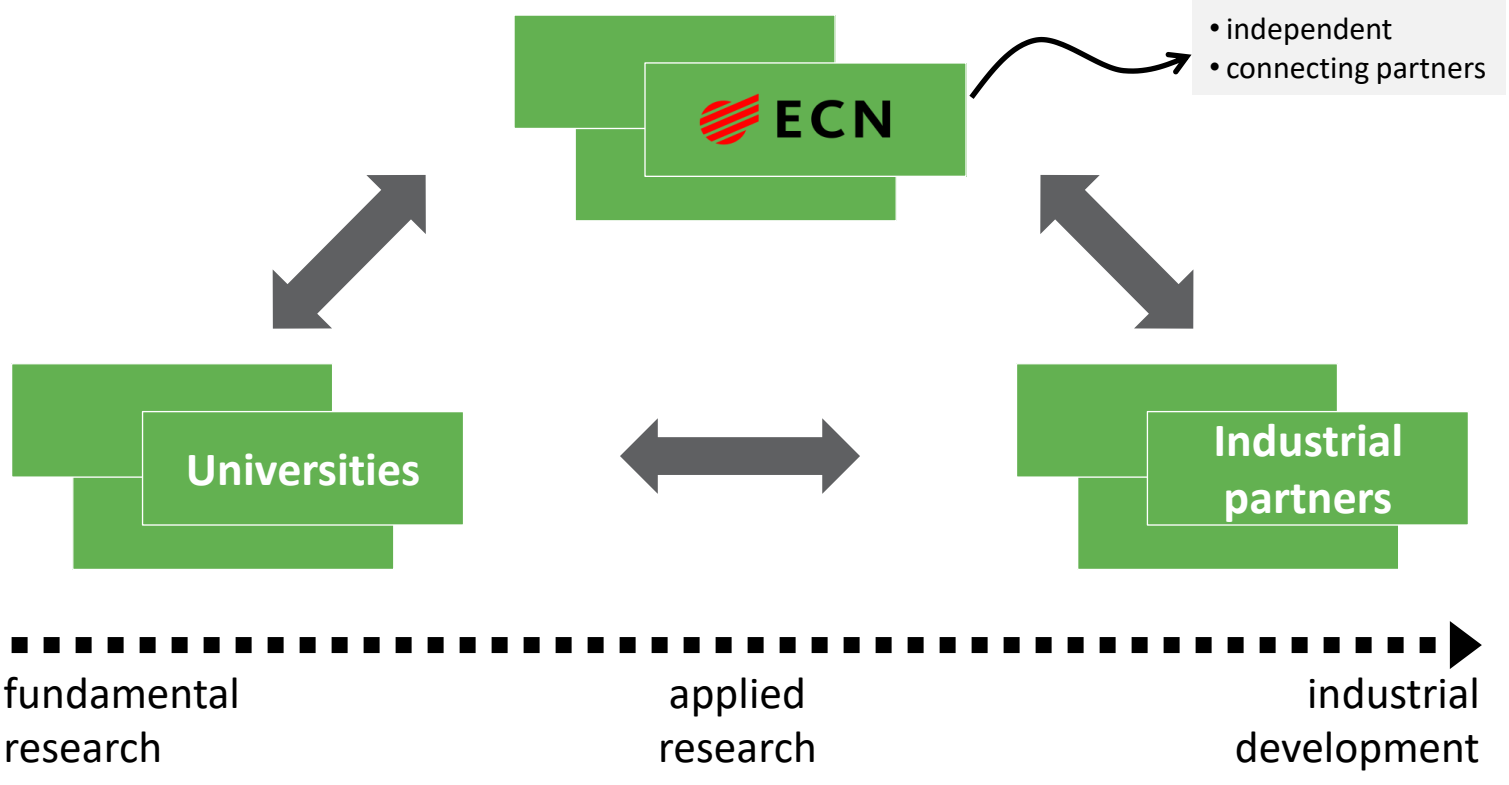
ECN Eindhoven

What we do

- Strategic & Technological studies
  Creating insights in energy technology and policy
- Problem solving
  Using our knowledge, technology, and facilities to solve our clients' issues
- Technology development
  Developing technology into prototypes and industrial application

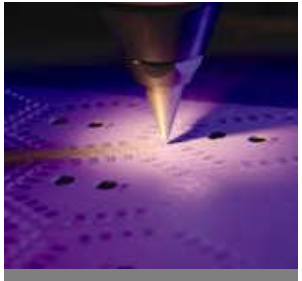
- Consultancy and services
- Research focussing on:
  - New technologies
  - Improve efficiency
  - Reduce cost

Position


ECN
• independent
• connecting partners
Universities
Industrial partners
fundamental research
applied research
industrial development

R&D fields

Policy Studies



Energy Engineering

Environment

Energy Efficiency

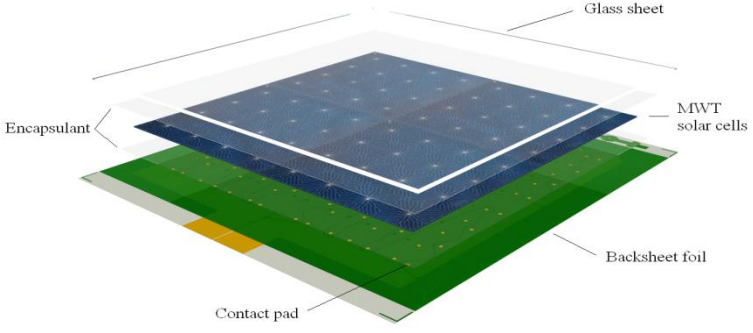
Process & Energy Industry

Solar Energy

Wind Energy

Biomass

Solar



Production technology solar panels

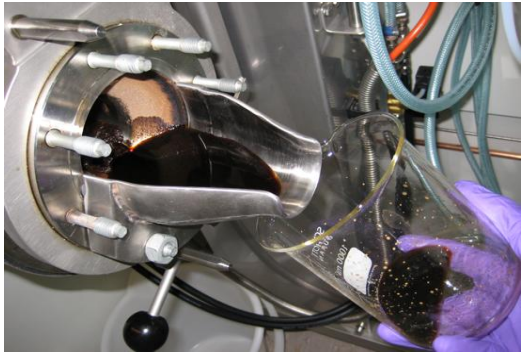
Improvement efficiecy of solar cells

Thin film: plastic solar cells

Biomass

VGasification (MILENA)

Tar removal (OLGA)



Biorefining (Organosolv)

Torrefactie

Wind

ECN Wind Testpark Wieringen

Design: Aerodynamics rotor and wind farm

Measurments and control

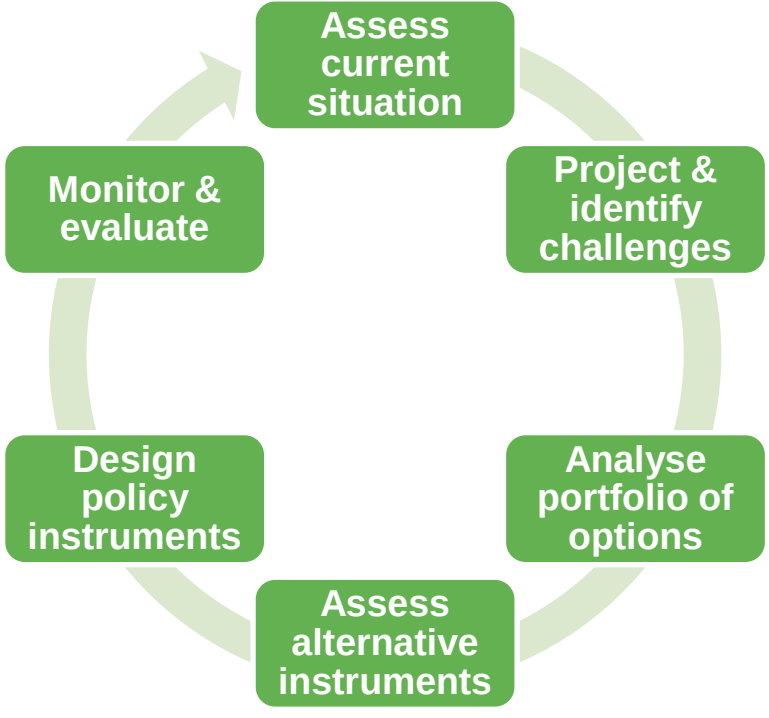
Material and blade test centrum (WMC)

Energy efficiency in the industry

CO_2 capture

Membrane development and testing

Policy studies



Independent

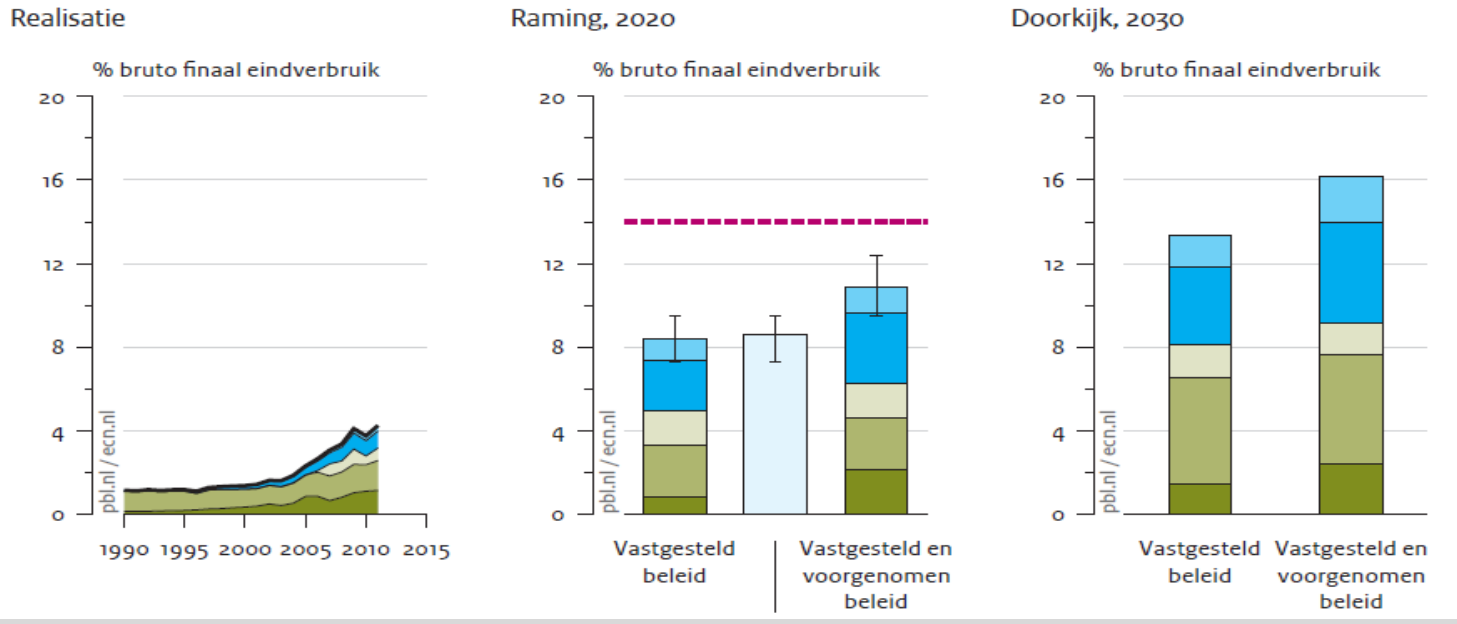
Covering all sectors

- Energy production
- Industry & agriculture
- Built environment
- Transport
- Market & infrastructure

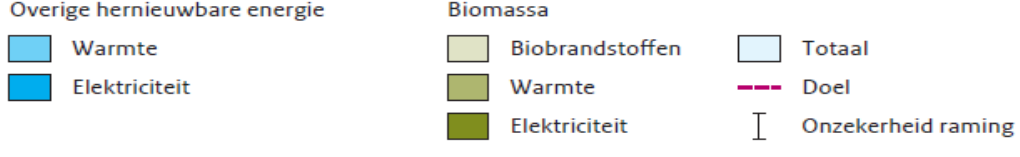
Multidisciplinary

- Energy use & emissions
- Economics & finance
- Social
- Political
- Innovation

Policy studies: advice governments and business



Share of renewable energy is increasong, but will not meet target of 14%



Our energy use

Energy use for energy services

- Energy use for:
  - Space heating and cooling
  - Hot tap water
  - Cooling/conservation (refrigerator, freezer)
  - Food processing (cooking, baking , …)
  - Cleaning (cloths, dishes, vacuum cleaner, …)
  - Lighting
  - Information, communication and entertainment (audio, video, computer, phone, …)
  - Services from all kinds of electrical appliances
  - Mobility
  - …

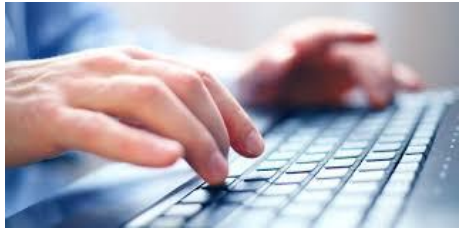
We love energy !



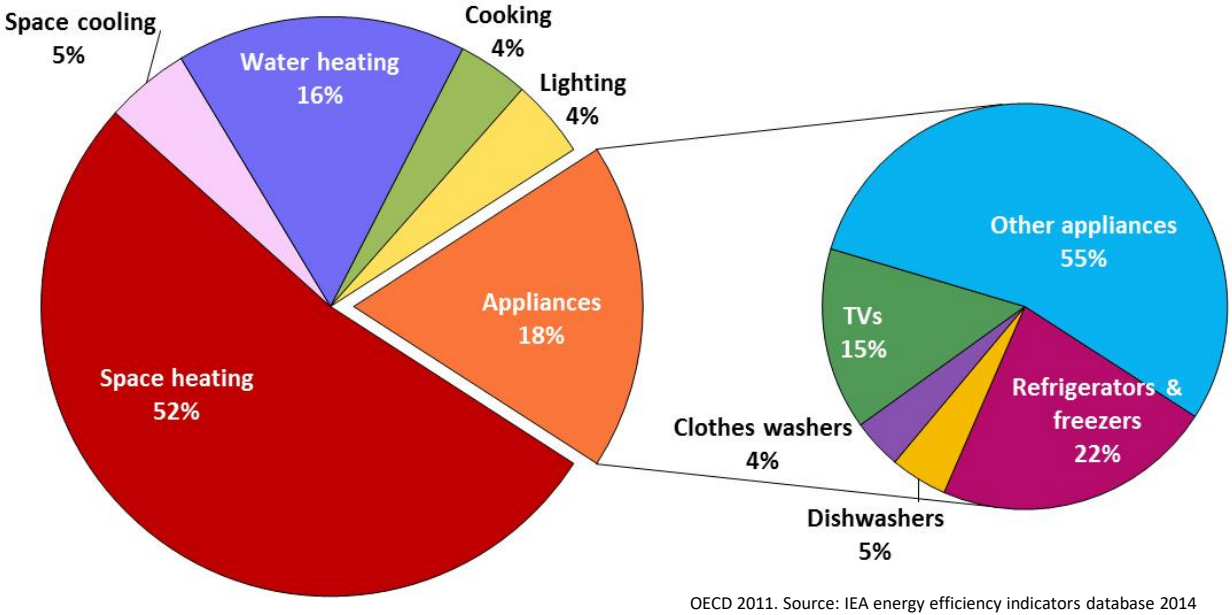









Breakdown of energy consumption in the residential sector (households)



OECD 2011. Source: IEA energy efficiency indicators database 2014

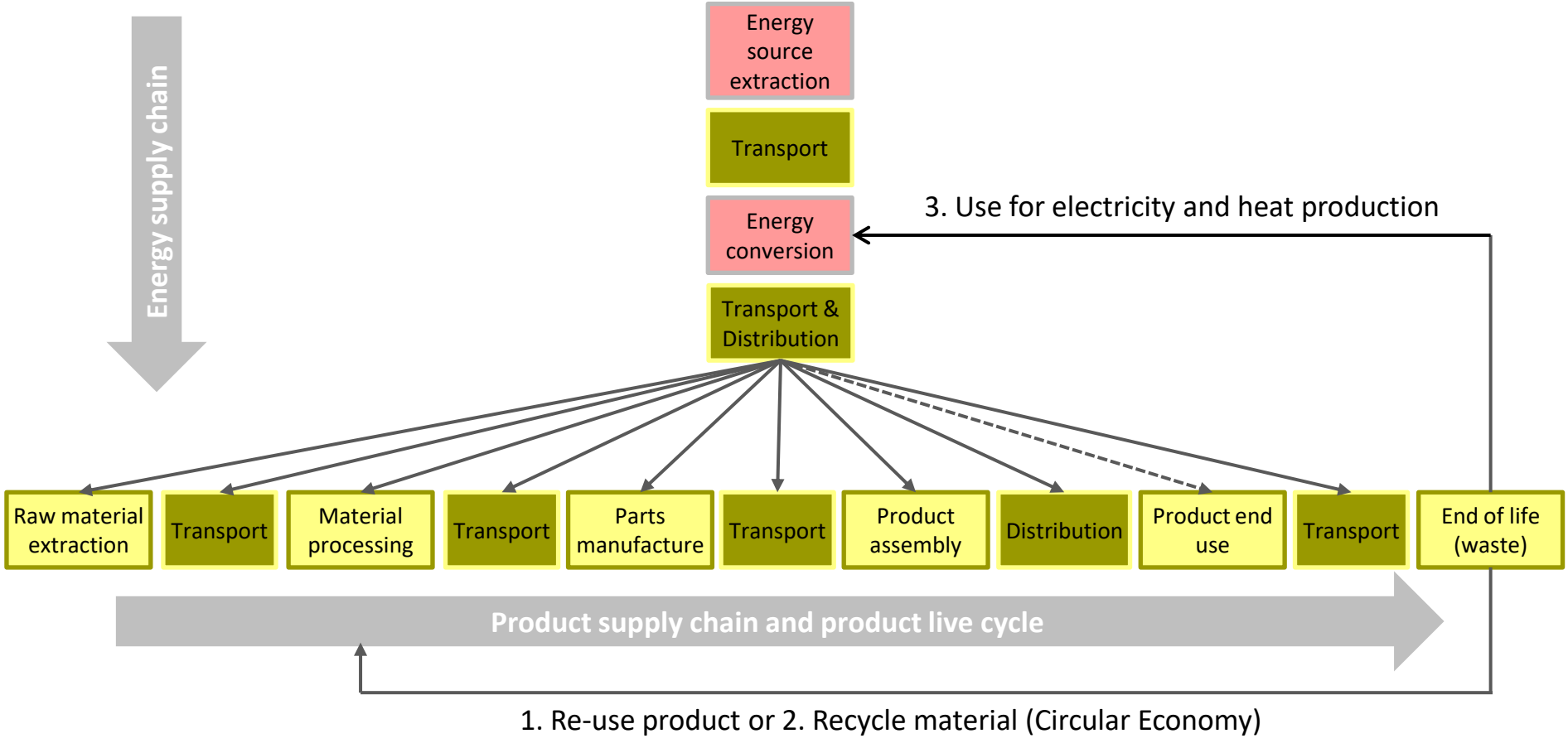
- Energy consumption average Dutch household:
  - 3.300 kWh electricity
  - 1.600 Nm^3 natural gas (ca. 14.100 kWh in energy content!)

Direct and indirect energy use

- Direct energy use (final energy consumption)
  - Electricity
  - Natural gas (mainly methane)
  - Butane, propane (cylinder/canister)
  - Fuel oil
  - Wood(pellets)
  - Transport fuels: gasoline; diesel, LPG, kerosine, etc.

- Indirect energy use
  - Food
  - Products; everything we buy, use and consume!

Energy and product supply chain



Enery use in the world; 2012

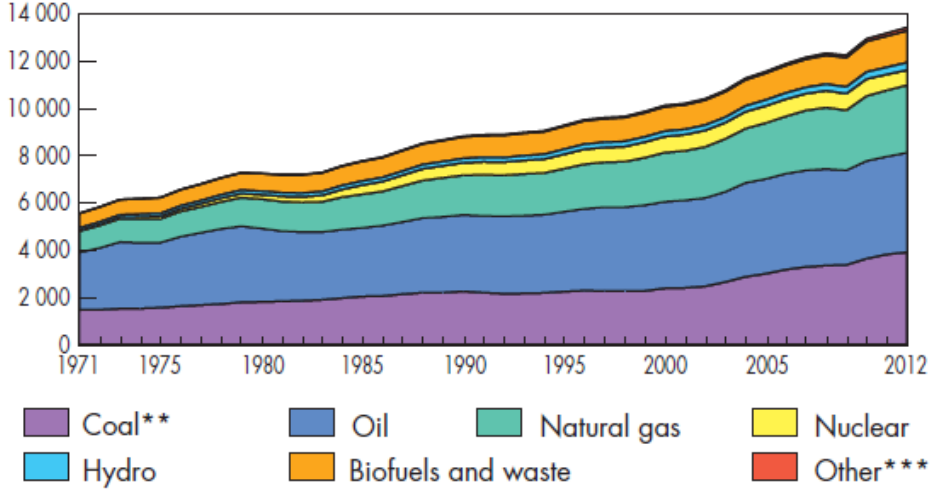
	France	Italy	Lithuania	Netherlands	EU28
Total Primary Energy Supply [PJ]	10.598	6.670	310	3.300	69.032
Population [mln]	62,8	60,9	3,0	16,8	505
Energy use [GJ/capita]	169	109	104	197	137

	Africa	China	India	USA	World
Total Primary Energy Supply [PJ]	30.786	122.178	33.101	89.906	561.582
Population [mln]	1.083	1.358	1.237	314	7.037
Energy use [GJ/capita]	28	90	27	286	80

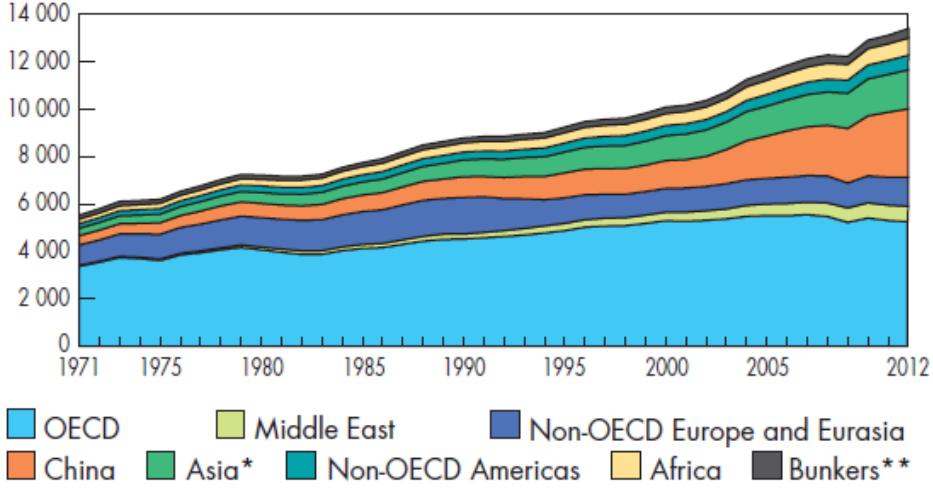
Source: IEA Key Worrld Energy Statistics 2014

Development world energy use

World Total Primary Energy Supply (TPES) by fuel [Mtoe]



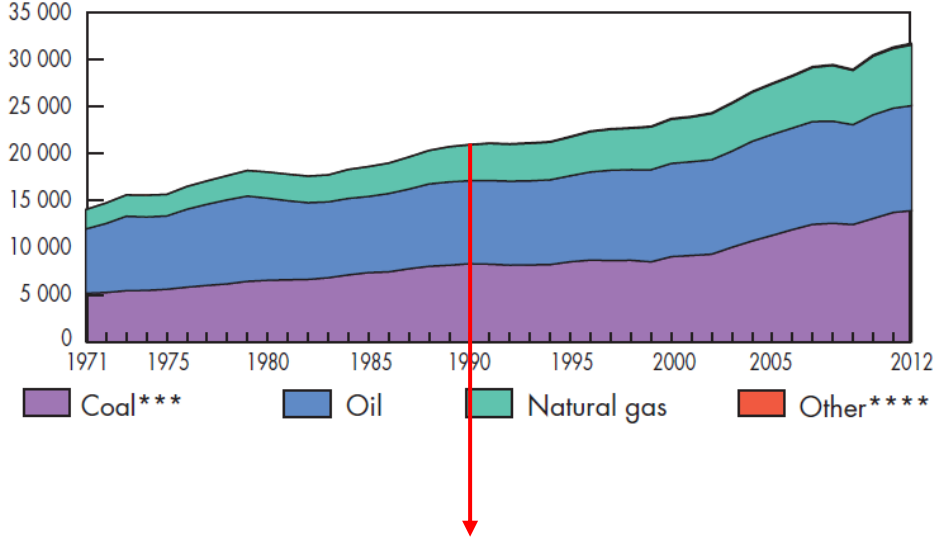
World Total Primary Energy Supply (TPES) by region [Mtoe]



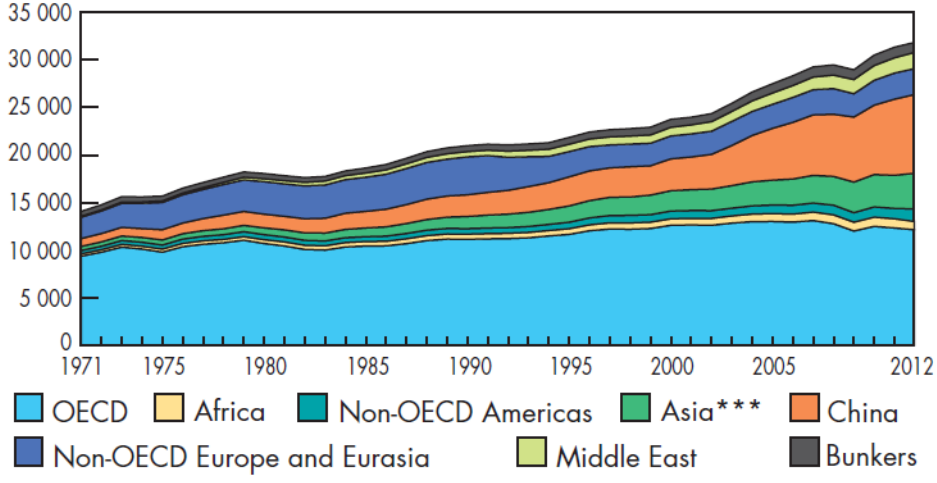
Source: IEA Key Worrld Energy Statistics 2014

Development world energy use and challenge for "tomorrow"

World CO_2 emissions by fuel [Mt of CO_2]



World CO_2 emissions by region [Mt of CO_2]



Source: IEA Key Worrld Energy Statistics 2014

Goal world: reducing CO_2 emissions by 50% in 2050 relative to 1990

EU target: reducing CO_2 emissions by at least 80% in 2050 relative to 1990

Energy challenges and role of sustainable energy

Energy challenges

- Reducing greenhouse gas emissions
  - -20% in 2020
  - -80% - 95% in 2050
  - All sectors: power, industry, transport, …
- Reducing air pollution
  - NO_X; CO; SO_2; VOC; $PM_{10\,/\,2.5}$
- Securing future energy supply
  - Reduce dependence on imports
  - Anticipate resource depletion
- Affordable, practically feasible, time schedule

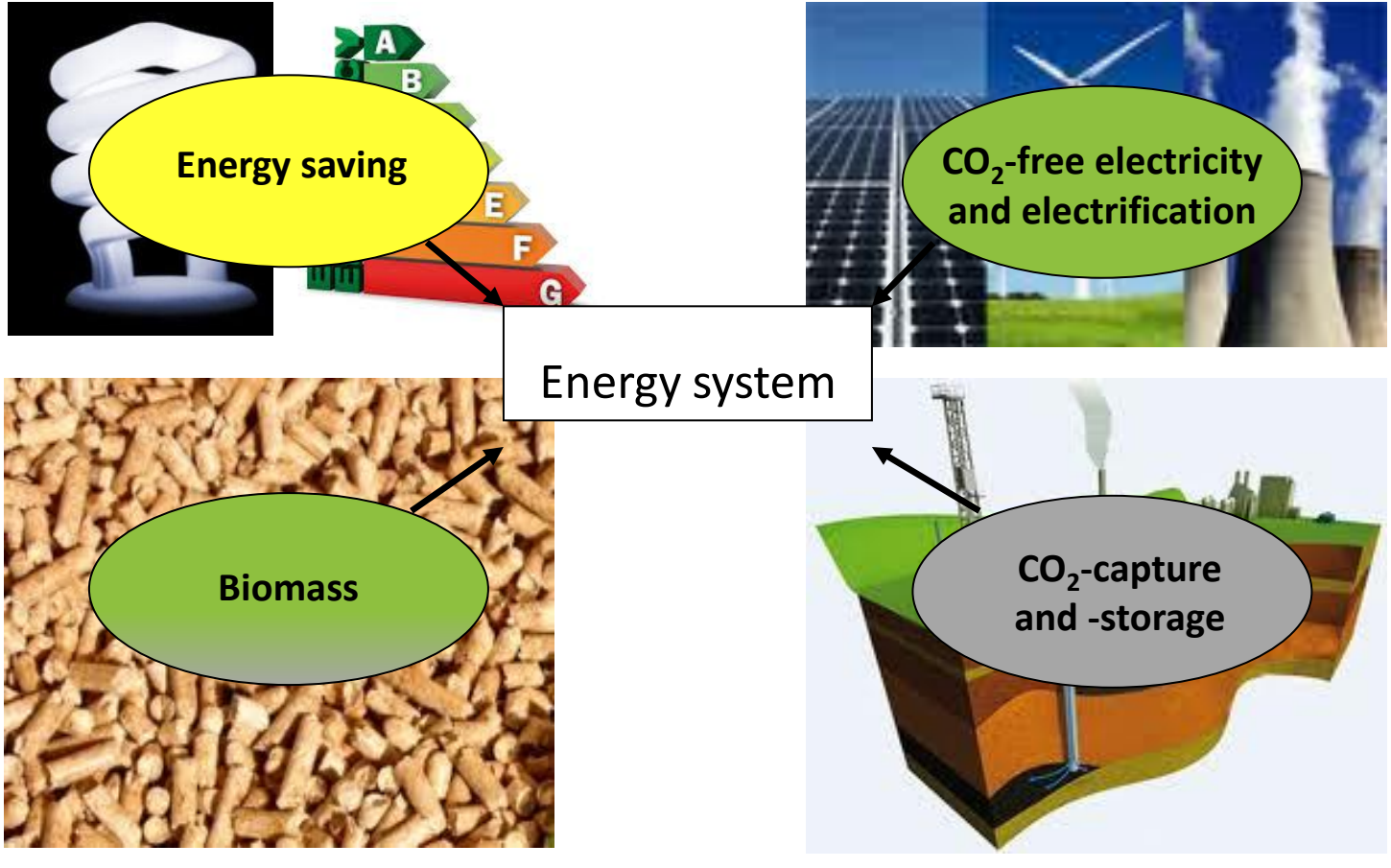
Dutch response
to the European
Low Carbon Roadmap

http://www.ecn.nl/docs/library/report/2011/o11076.pdf

Strategy for energy sustainability: Trias Energetica Concept

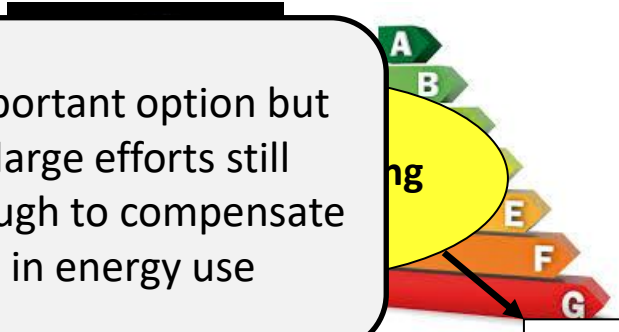
0. Quantify/analyse starting point to determine focus and target

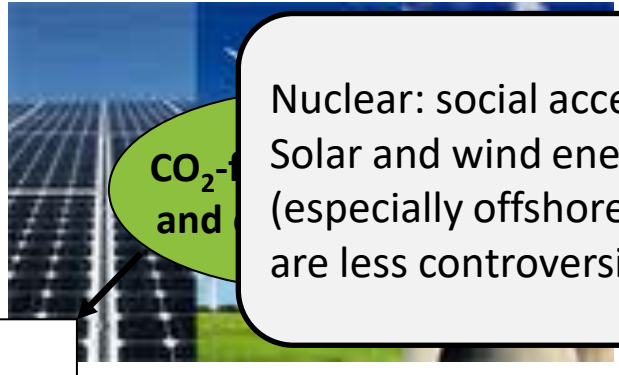
Conclusion: for now, use all options to cope with the many challenges



All option have pros, cons, limitations and uncertainties

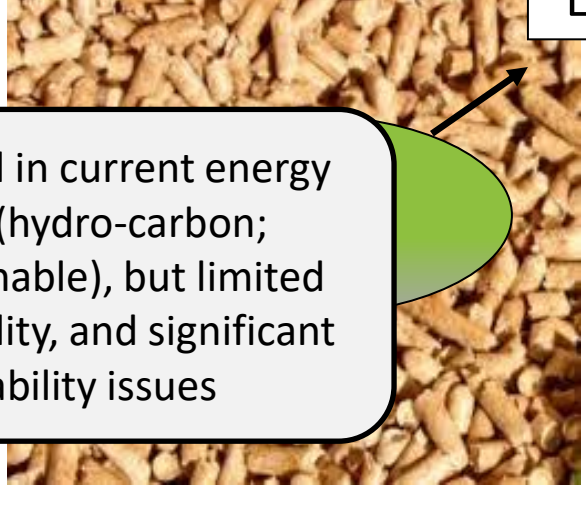
Very important option but despite large efforts still not enough to compensate increase in energy use



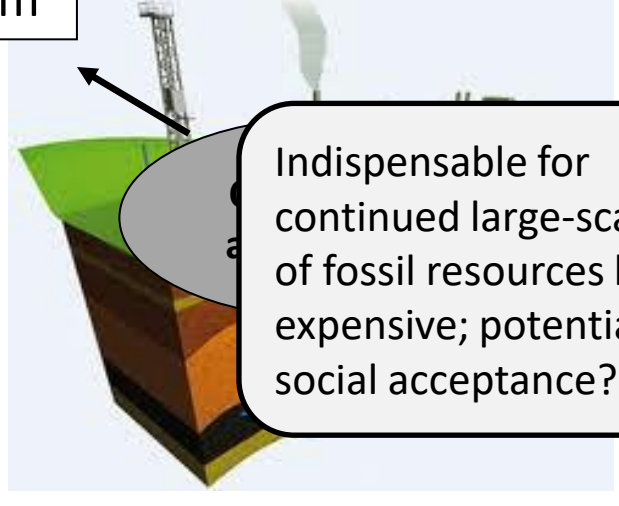


Nuclear: social acceptance? Solar and wind energy (especially offshore wind) are less controversial!

Energy system



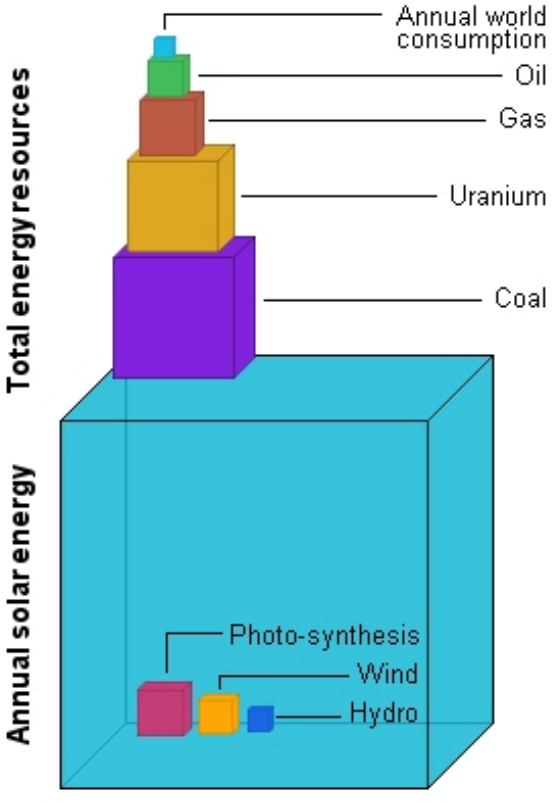
Fits well in current energy system (hydro-carbon; dispatchable), but limited availability, and significant sustainability issues



Indispensable for continued large-scale use of fossil resources but: expensive; potential?; social acceptance?

… but in the longer run

- Finite fossil and nuclear sources
- Renewable energy sources, also:
  - Geothermal
  - Waves
  - Tidal

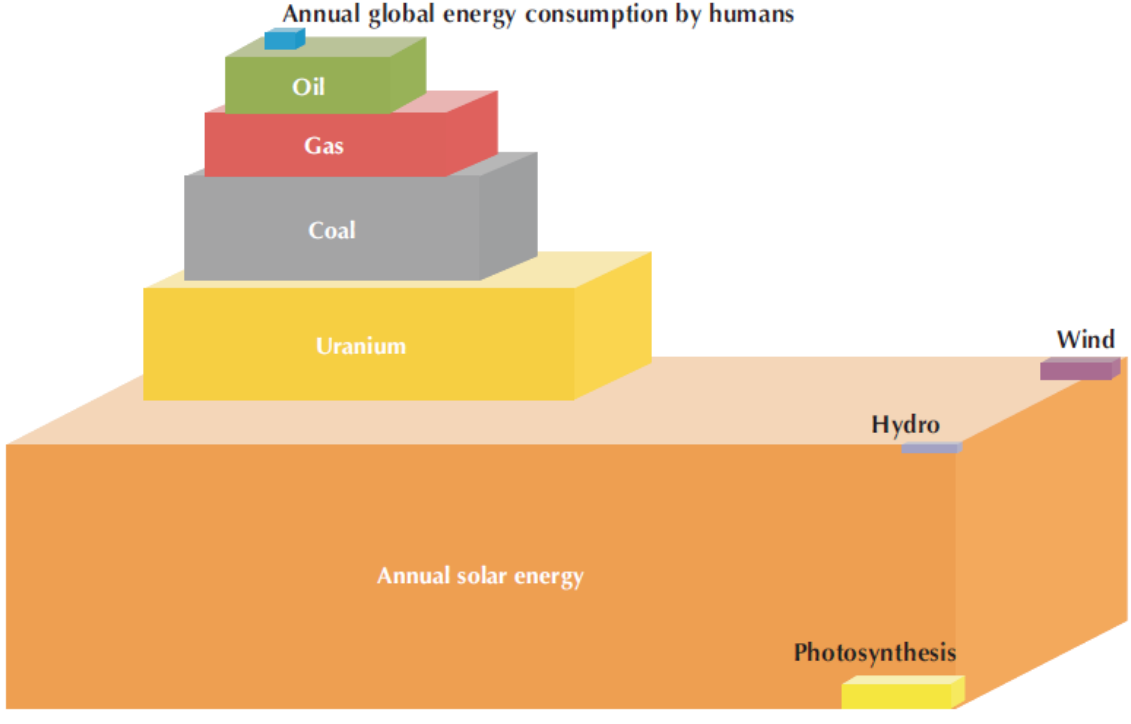


Solar will become the backbone of the system

… but in the longer run

- Finite fossil and nuclear sources

- Renewable energy sources, also:
  - Geothermal
  - Waves
  - Tidal



Source: National Petroleum Council, 2007, after Craig, Cunningham and Saigo (republished from IEA, 2008b).

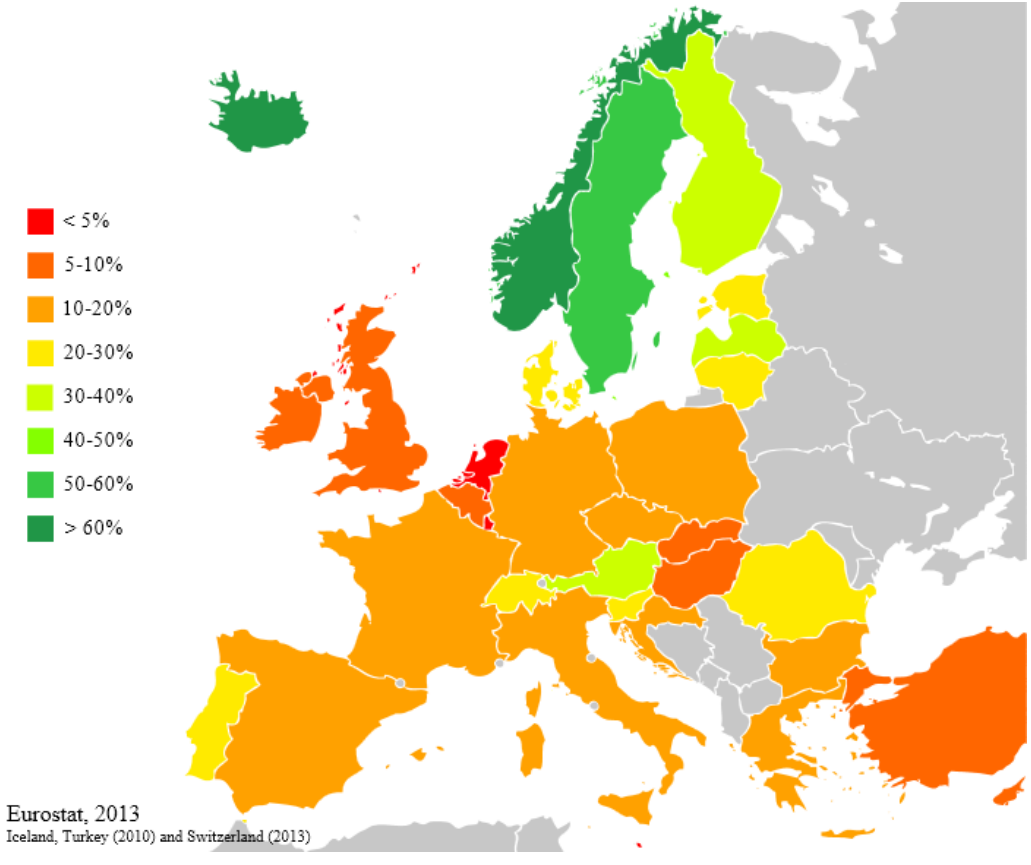
What are our targets?

- About what do we all agree?
  - Worldwide agreement: the average temperature rise on earth may not exceed 2 °C (CO_2 must stay below 450 ppm)
- European agreements for 2020:
  - 20% energy saving
  - 20% CO_2 emission reduction
  - 20% of final energy use is from renewables (about 34% of electricty). Targets per country; FR 23%; IT 17%; LT 23%; NL 14%
- New European agreements for 2030:
  - 27% energy saving compared to business-as-usual
  - 40% CO_2 emission reduction compared to 1990 level
  - 27% share renewable energy in final energy consumption

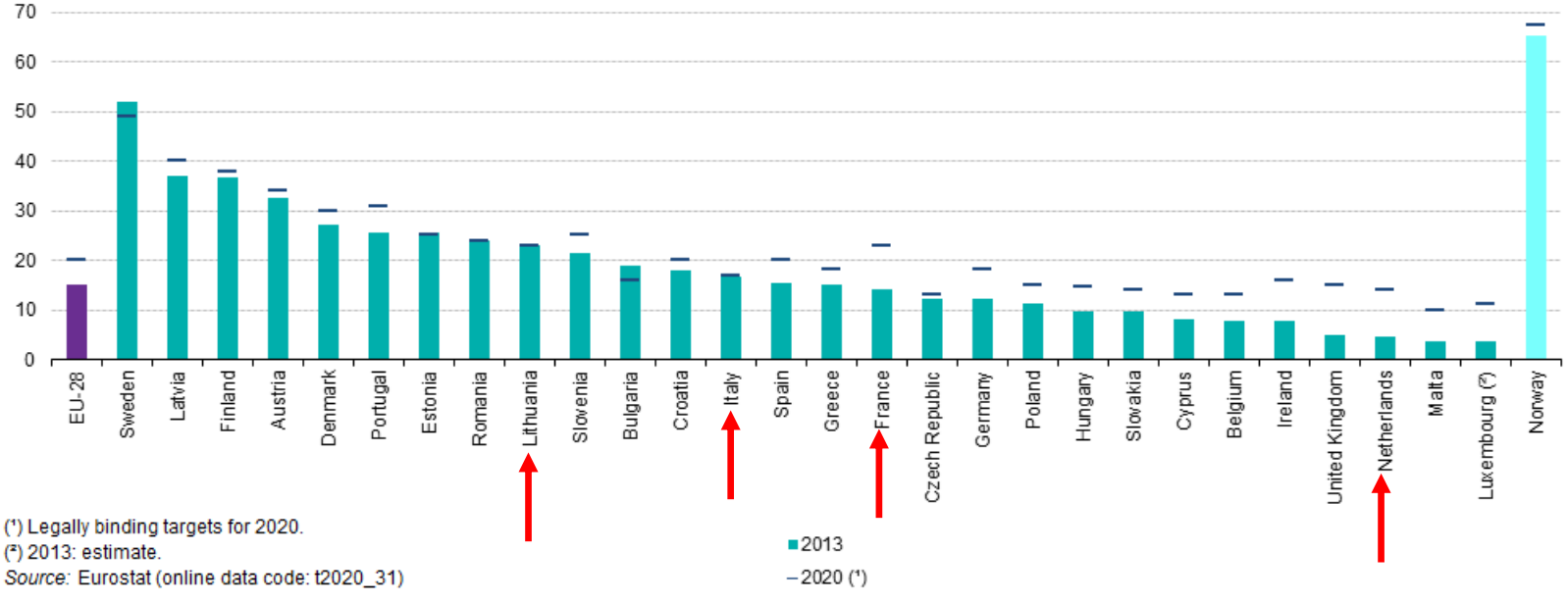
Targets on EU-level! So who will do what share?

- Climate summit Paris 2015, Nov. 30 – Dec.11, 2015??????

Renewable energy use across the European union (and partners)

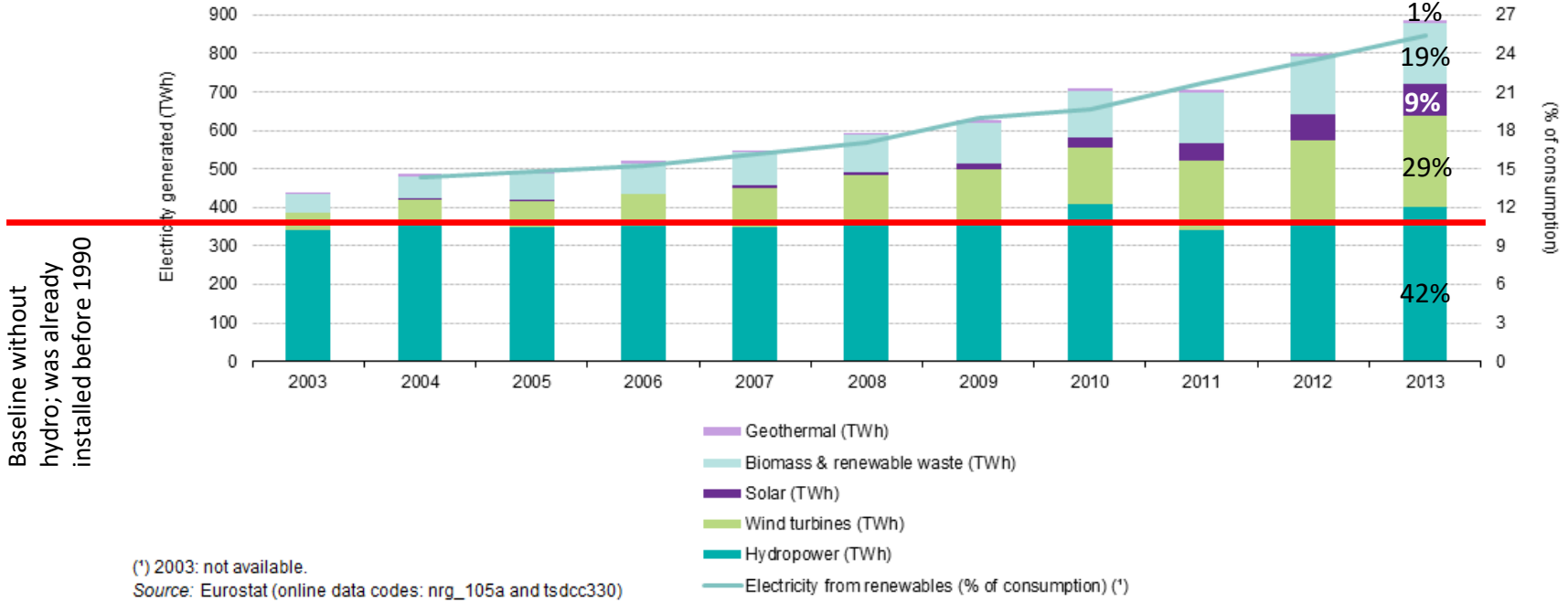


Share renewables in gross final energy use relative to target



(¹) Legally binding targets for 2020.
(²) 2013: estimate.
Source: Eurostat (online data code: t2020_31)

Electricity generated from renewable energy sources in EU28



(*) 2003: not available.
Source: Eurostat (online data codes: nrg_105a and tsdcc330)

Case study Texel (2007!)

For full report see e.g.:
http://www.globalislands.net/greenislands/docs/netherlands_3.pdf

Starting points

- Ambition Texel 2030: sustainable energy system in place in 2030, preferably self-sufficient
- Stringent policy framework (e.g. nature preservation areas, …)
- Strong desire to preserve island characteristics









Objective

- To develop realistic plans and perspectives for the way in which Texel could meet its sustainable energy ambition for 2030, …

  … fitting within developments in agriculture, while strengthening Texel's touristic attractiveness and maximizing opportunities for employment, …

  … providing a basis and direction for adjustment of the current restrictive policy framework.

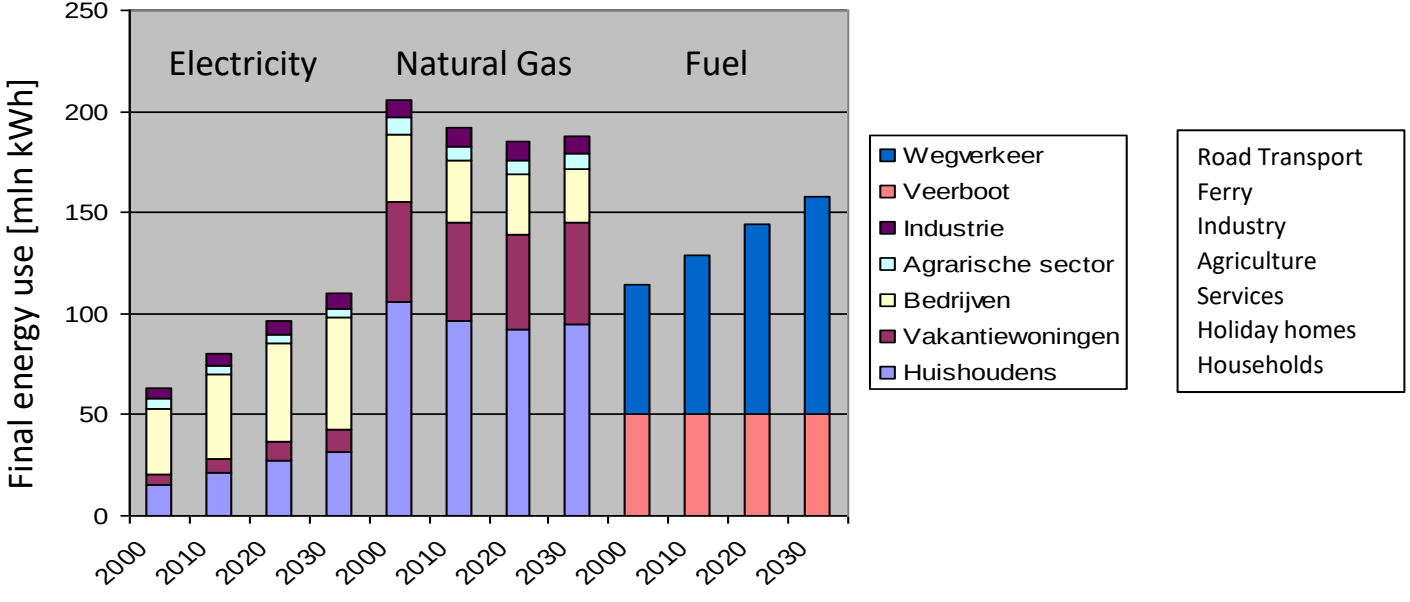
Approach energy analysis

1. Current energy use
2. Energy use in 2030 (business as usual scenario)
3. Ways to meet energy demand 2030
    a. Options for energy saving
    b. Local small-scale renewable energy options
    c. 3 Variants for large-scale renewable energy options
4. Evaluation impact
5. Conclusions

Three variant of a self-sufficient sustainable energy system

- Truly self-sufficient
  - Current energy carriers replaced by energy carriers from renewable energy sources of the island
- Pseudo self-sufficient
  - Compensation of the energy content of imported energy carriers with renewable energy from the island
- Partly self-sufficient
  - Renewable energy from the island supplemented with renewable energy from elsewhere

Energy use Texel 2000 – 2030: starting point for actions



- Energy use excluding fishery fleet

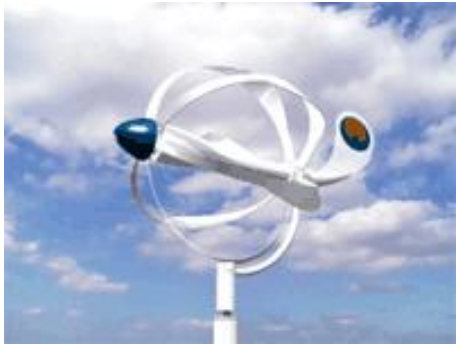
Energy saving and local small-scale renewable energy options

- Energy saving: avoid, reduce, improve/promote efficiency
  - Impact saving options depends on point of departure
  - Behaviour part of energy saving requires continuous effort for a lasting effect
  - Potential: order of magnitude 10 -20%

- Local renewable energy options (“behind the meter”)
  - Potential estimated to be about 5% of final energy use

Solar collectors

PV-panels



Urban turbines

Central large-scale renewable energy options

- **Offshore wind:** no option within municipality borders
- **Tidal energy:** (pre-)prototype stage (floating construction!)
- **Wave energy:** no potential
- **Geothermal heat:** no favourable conditions (no concentrated demand; too low temperature for district heating system
- **“Blue Energy”:** production of electricity from a concentration difference of ion/anions in fresh water and sea water - no potential within municipality borders and still laboratory scale/experimental

Central large-scale renewable energy options

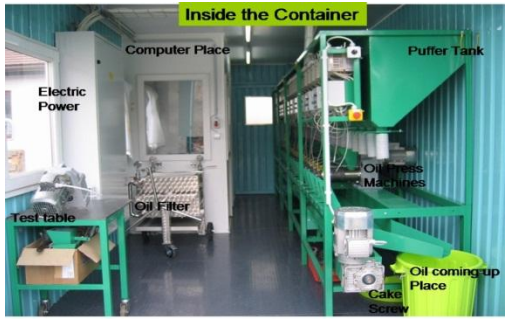
	Variant 1	Variant 2
level of self-sufficiency	Truly	Pseudo
Electricity	Onshore wind	Onshore wind (Photovoltaics)
Natural gas	Biogas from digestion (Bio-SNG)	
Gasoline	Bio-ethanol (FT-biofuel)	
Diesel	Biodiesel (FT-biofuel)	

Variant 1: bio-fuels (demand 2000 - 2030)

First generation biofuels

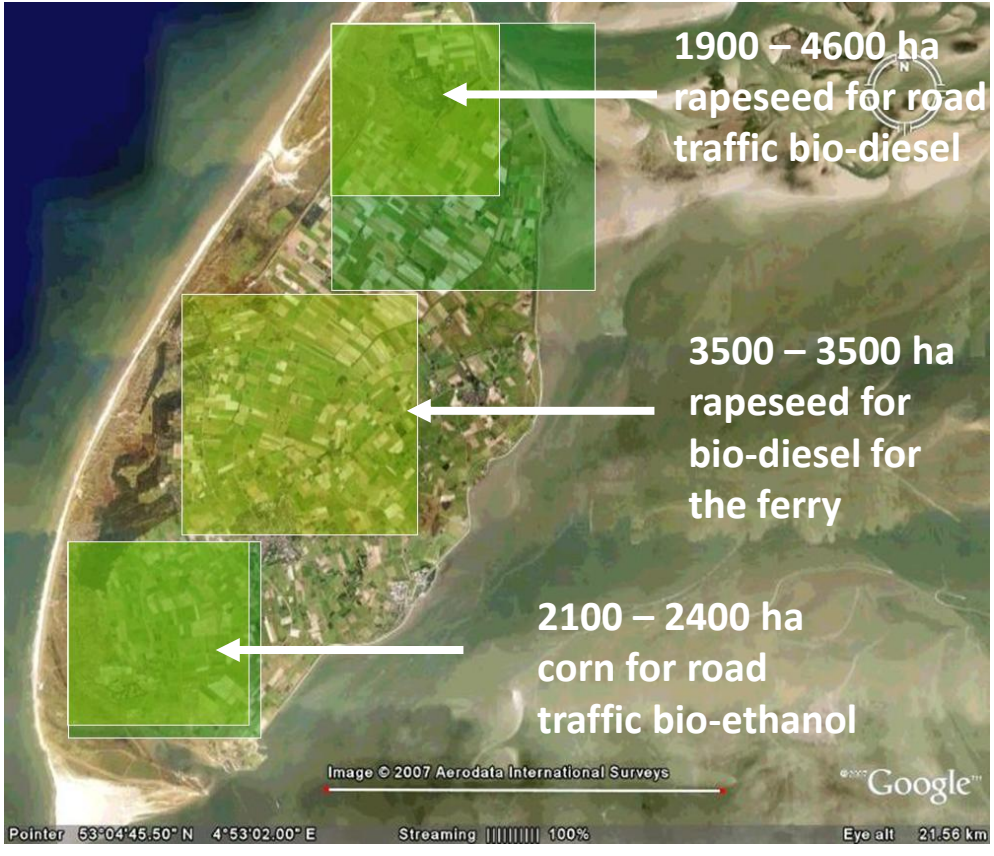
2nd generation

- Biodiesel from rapeseed:
  - 8.5 - 12.7 mln ltr/yr
  - 5400 - 8100 ha/yr
  - 9 MW_{th} plant
- Bio-ethanol from corn:
  - 6.2 - 7.0 mln ltr/yr
  - 2100 - 2400 ha/yr
  - 4 MW_{th} plant
- Fisher-Tropsch fuels from willow (after 2020):
  - 4600 - >6300 ha/yr



50 mln ltr/yr bio-ethanol plant, Norrköpping, Sweden (8x the size required for Texel)

Variant 1: bio-fuels (demand 2000 – 2030)



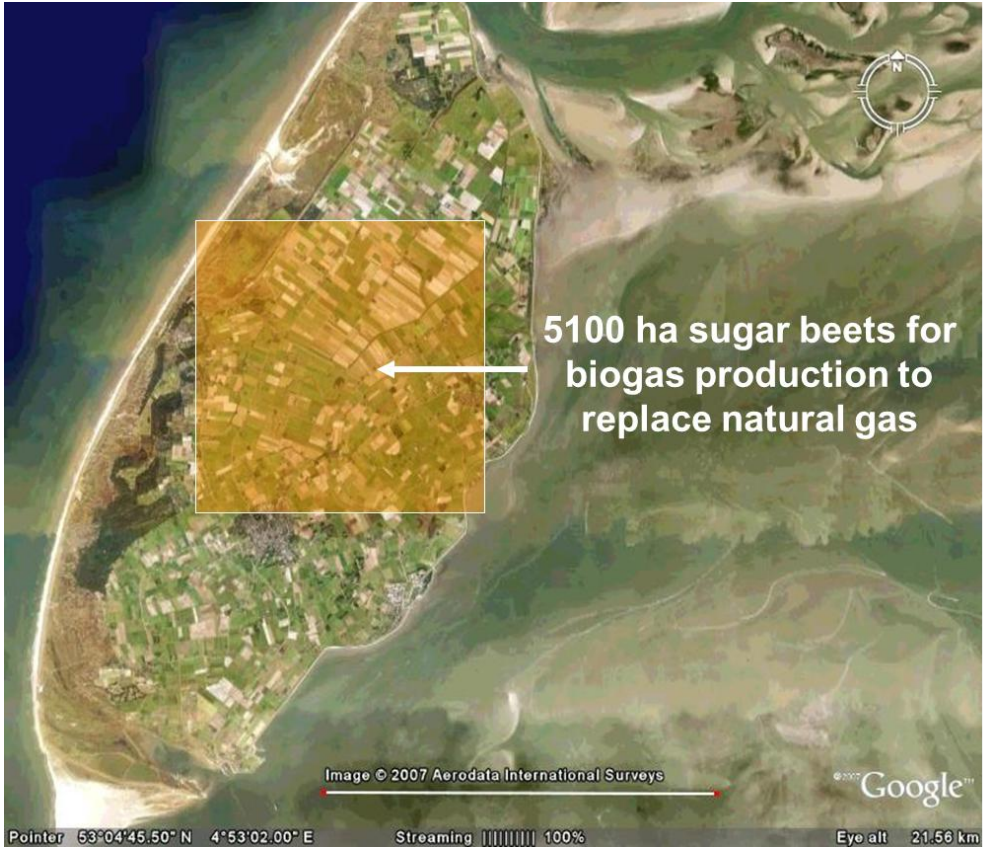
Variant 1: bio-”natural gas” (demand 2030)

- Biogas from sugar beet digestion:
  - 5100 ha/yr
  - 24 MW_{th} plant

- Bio-SNG from willow (after 2020):
  - 6100 ha/yr
  - Typical plant 40x Texel size

0.5 mln m^3 NG eqv./yr co-digester manure-corn (Makkinga); 45x required for Texel

Variant 1: bio-”natural-gas” (demand 2030)



Variant 1: electricity (demand 2000-2030)

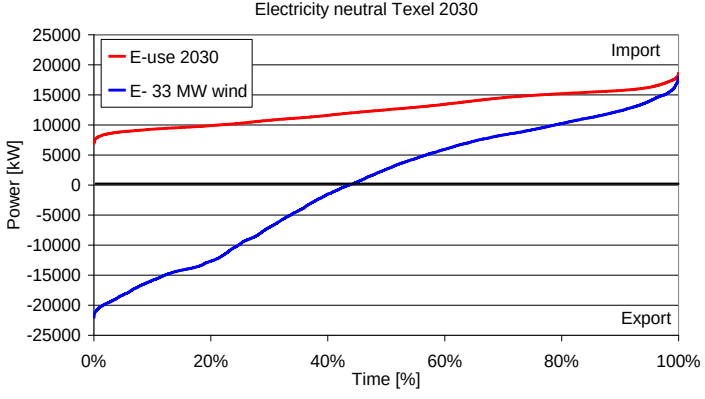
- Electricity from onshore wind:
  - 9 - 16 turbines of 3MW
  - 390 - 680 ha
  - Footprint in the order of 100 m^2; remaining area can still be used for conventional agriculture

Typical dimension:

- Rotor diameter 70 - 90 meter
- Hub height 60 - 110 meter

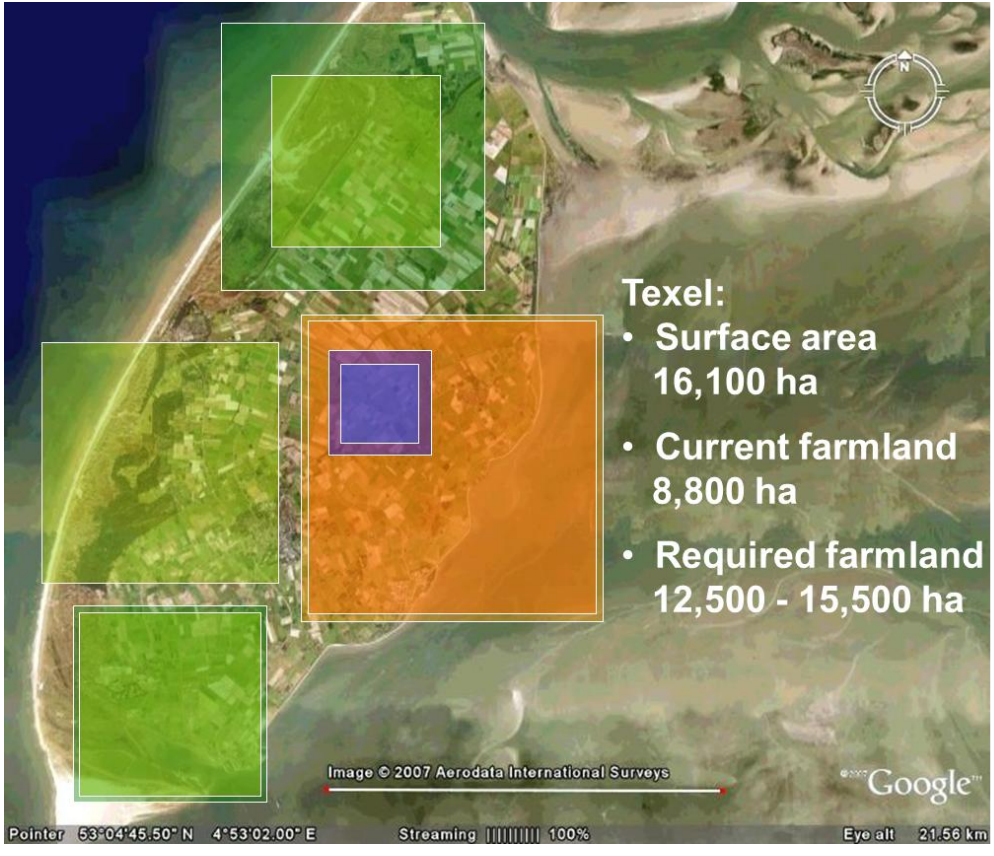
source: www.enercon.de

- Electricity from offshore wind:
  - 310 - 540 ha
  - 8 - 13 turbines of 3 MW



Variant 1: electricity (demand 2000 – 2030)

Variant 1: truly self-sufficient



Variant 2: pseudo self-sufficient onshore wind turbines

Variant 2: pseudo self-sufficient photovoltaics

Conclusions

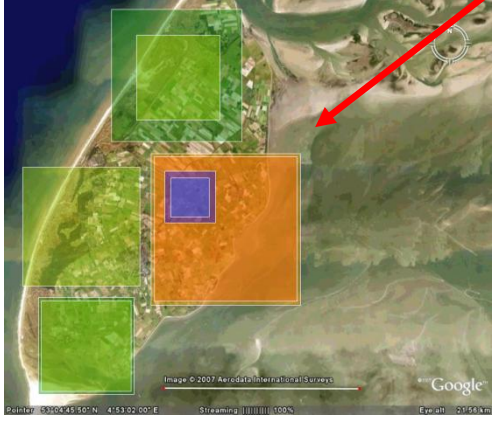
- Not enough Texel for a truly self-sufficient energy system based on renewable energy sources

- Pseudo self-sufficient would fit physically but still significant spatial impact:
  - Full compensation of local final energy use with locally produced electricity
  - Improvement of use own generation by electrification of demand (e.g. electric cars, electric buses, …)
  - Issues: public acceptance (social) and grid integration variable renewables (technical)

- Partly self-sufficient with external compensation seems most realistic:
  - Realistic level of self-sufficiency estimated to be about 1/3 (for Texel)
  - 2/3 of the energy has to be imported “green” or compensated by external projects

Wider implications Texel case

Specifc energy use		Texel	NL
Electricity	GJ/capita/yr	18	22
Natural gas	GJ/capita/yr	51	42
Motor fuels	GJ/capita/yr	31	27
Total final energy	**GJ/capita/yr**	**100**	**92**
Population density	people/km^2	85	403
Energy intensity	**toe/km^2/yr**		**1892**



From hydrocarbons

to electricity based
(and hydrogen!)

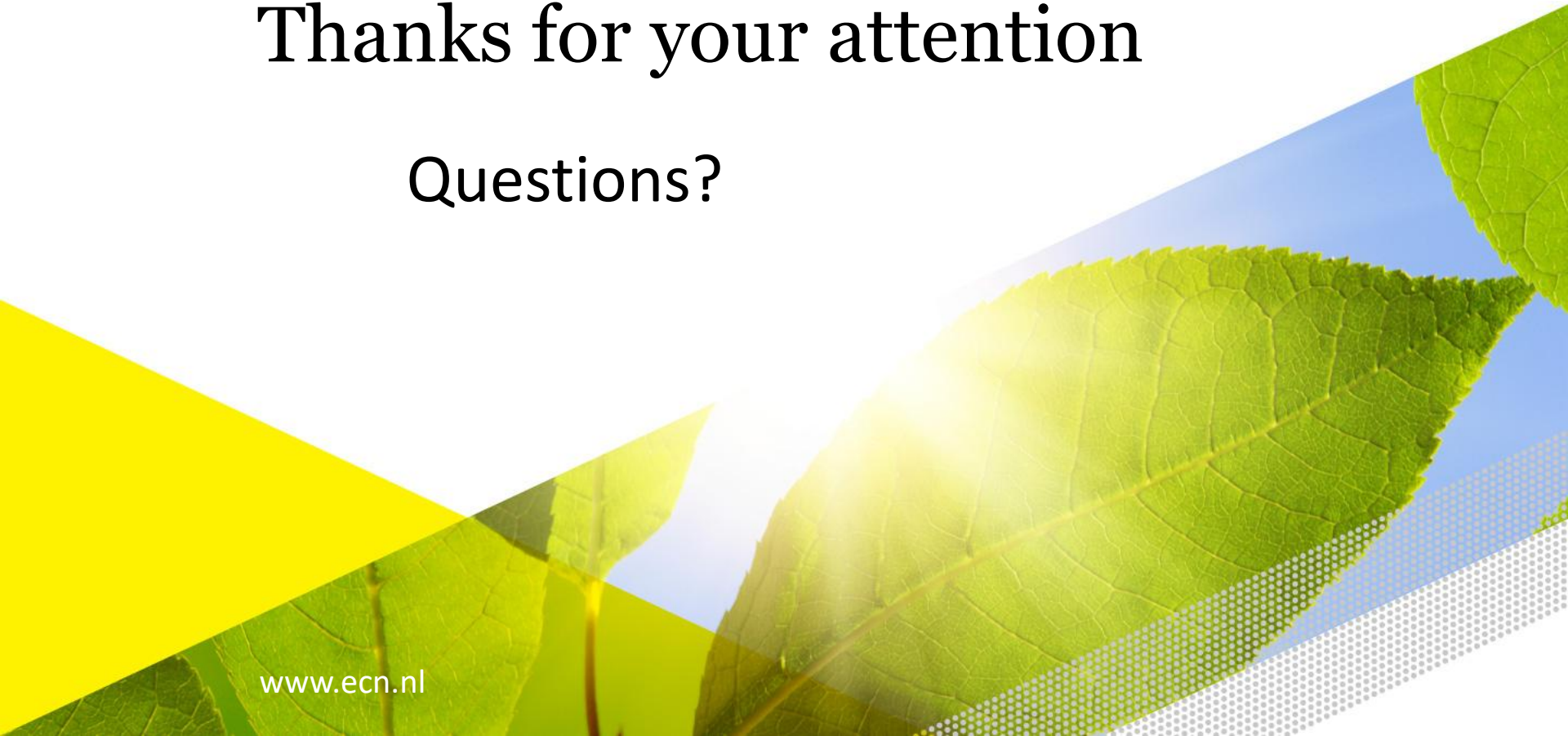
Messages you should remember!

- There is no doubt about climate change and the role of CO_2 , we must drastically reduce the use of fossil fuels
- The most sustainable energy is non-used energy!
- We need to change the energy system completely, and we must be quick
- A lot of the technology for solving the problem is already available
- But … a sustainable energy system will be very visible and present

ECN
Your energy. Our passion.

Thanks for your attention

Questions?



www.ecn.nl