Energy today and tomorrow

Anticipated changes in energy intensive industries

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- Impact on energy intensive industries
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Overall world situation

- Social development has not changed substantially during the last 40 years (1974÷2014);
- Population has doubled, from 3,5 billion to 7 billion;
- Reserves of resources are diminishing;
- With growing population also the energy needed for living is rising .
- „Added new value“ distribution is uneven and is approaching the critical level of concentration (number of very rich people is diminishing and number of poor people is growing abnormally, differences becoming larger and larger);
- Production of food is close to critical, with regard to available fertile land and water;
- The world footprint has reached 1,7 Earth of natural capacity;
- All data shows we are approaching to critical point where the society can expect a collapse of present way of life (consumer society as a base of capitalism, prevailing economic system);
- Call to action of Ban Kimun, UN secretary general at the beginning of November 2014 to politicians together with the 5. Asessment Report of IPCC just confirm the previous statements.

Population growth and energy use on the planet Earth

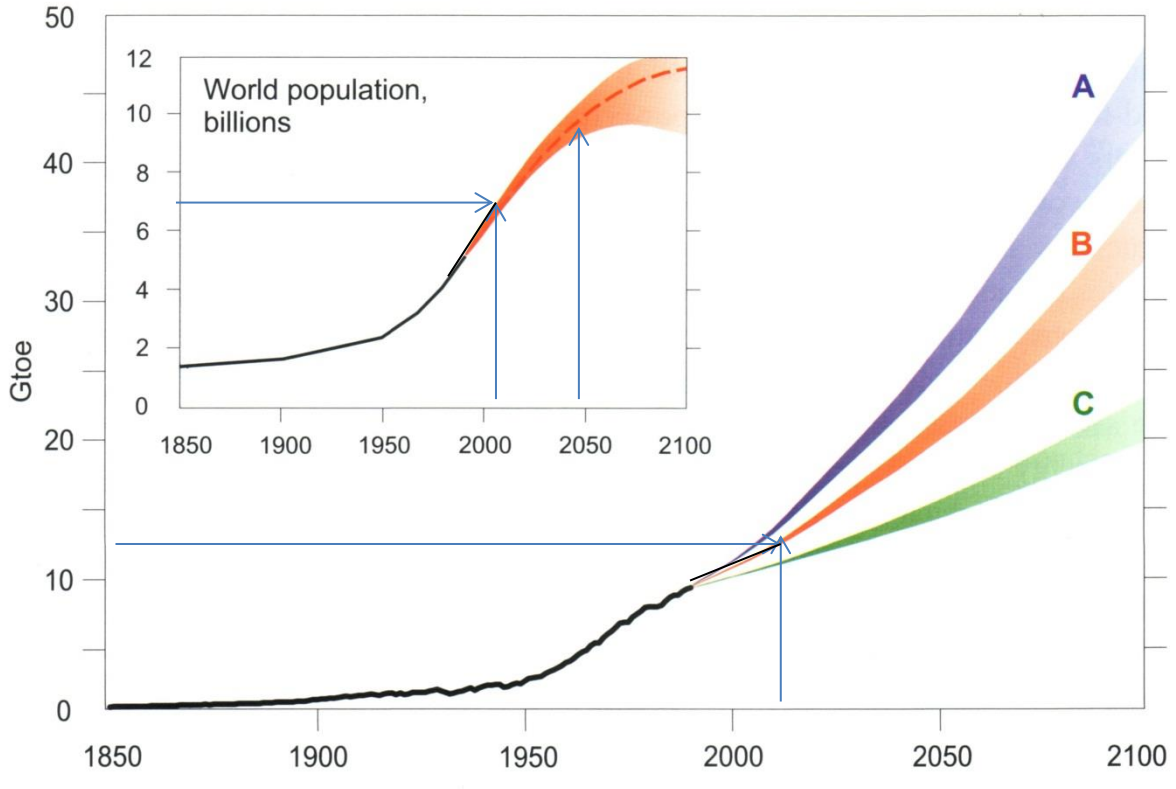


Figure 5.2: Global primary energy use, historical development from 1850 to 1990 and in the three cases to 2100, in Gtoe. The insert shows global population growth, 1850 to 1990 and projections to 2100, in billion people. Source: Bos *et al.*, 1992.

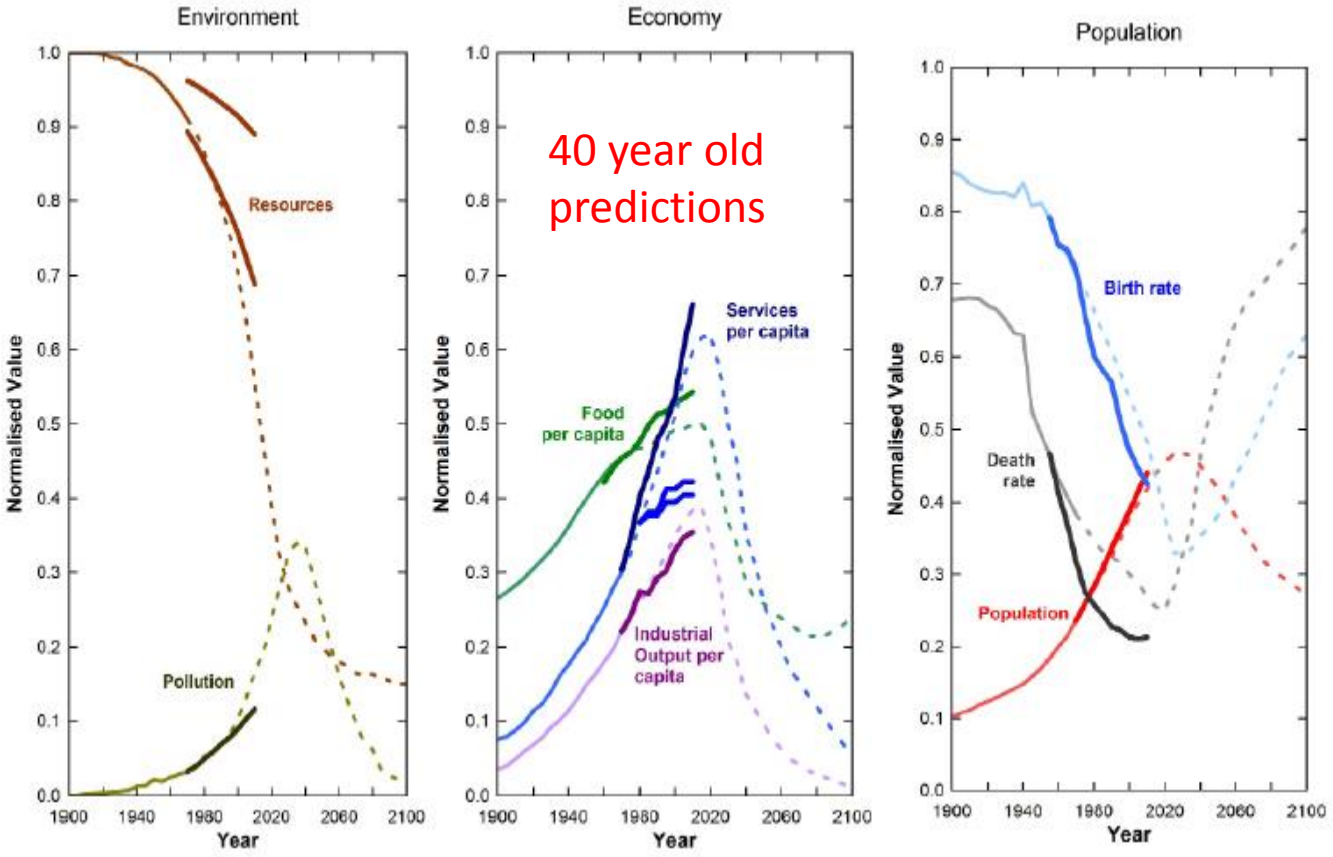
Population in 2014: ~7 bilions
Energy use in 2014: 550 EJ or ~13 Gtoe
Source :IEA-USA, 2014

What is important: predictions from year 1992 are very well in accordance with real development

20 years old!!

Environmental and economic situation on world

The proof of previous claims is the latest analysis carried out by MSSI, which compares the forecasts stated in the famous book “The Limits to Growth” (Club of Rome in 1972) and the actual data of the past 40 years based on the BAU (Business as Usual) model.



Basic question for everybody:

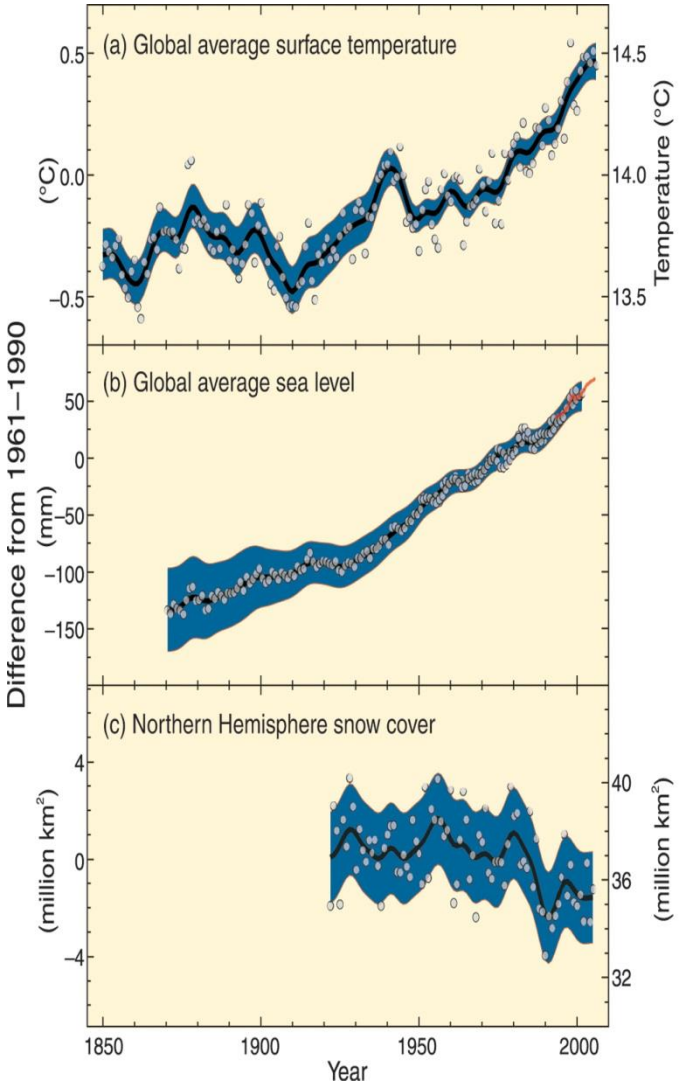
Do we go to the collapse?

Can the financial centres and politicians change the direction of the development in the sustainable society?

Answer in present social relationship is practically impossible.

Vir:Turner, G. (2014) »Is Global Collapse Imminent?«, MSSI Research Paper No.4, Melbourne Sustainable Society Institute, The University Melbourne

5. Asessment report of IPCC - findings



Global average temperature on the planet Earth is growing 0,85 °C from 1850 ÷2010.

Global average sea level is slowly growing up to 19 cm.

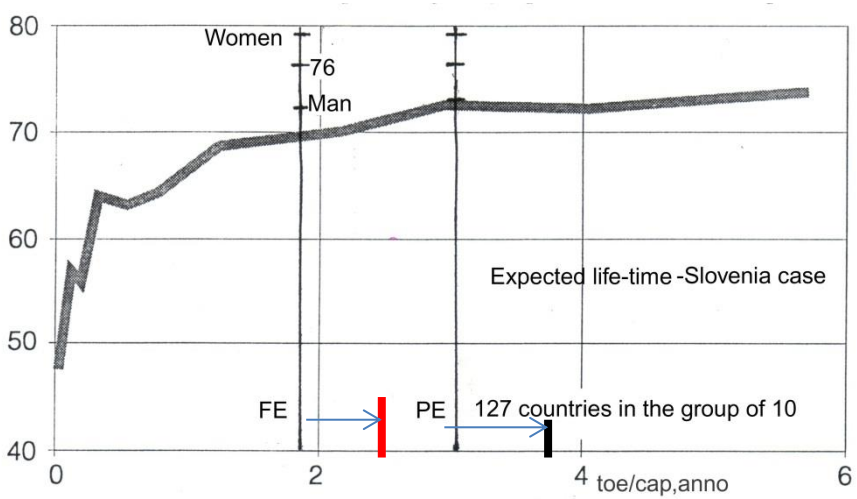
Northern Hemisphere snow cover is diminishing.

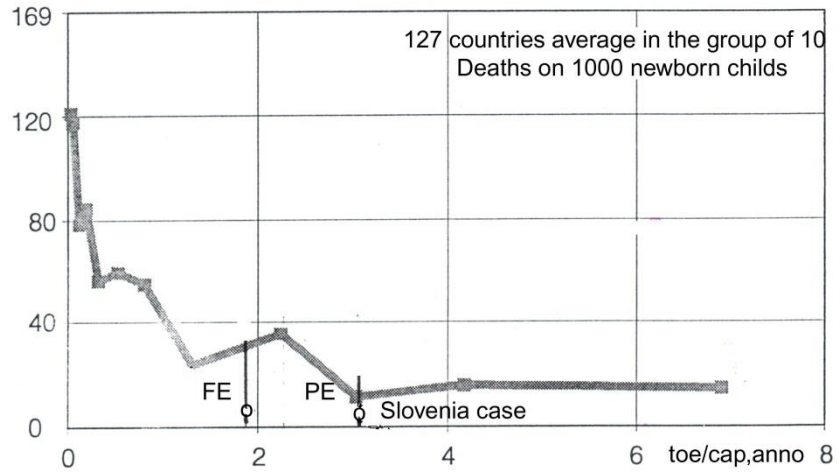
Are these signals powerful enough for changes?

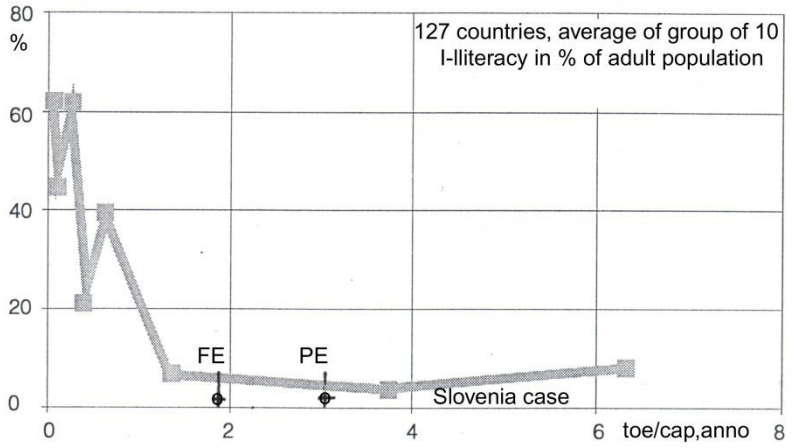
Answer to this question lies first of all in financial centres in the world. Without changes in money flow there will not be any societal or economic changes, except in revolutions.

Source: IPCC 5. Asessment, 2014

How much energy do we need for high quality of life ?







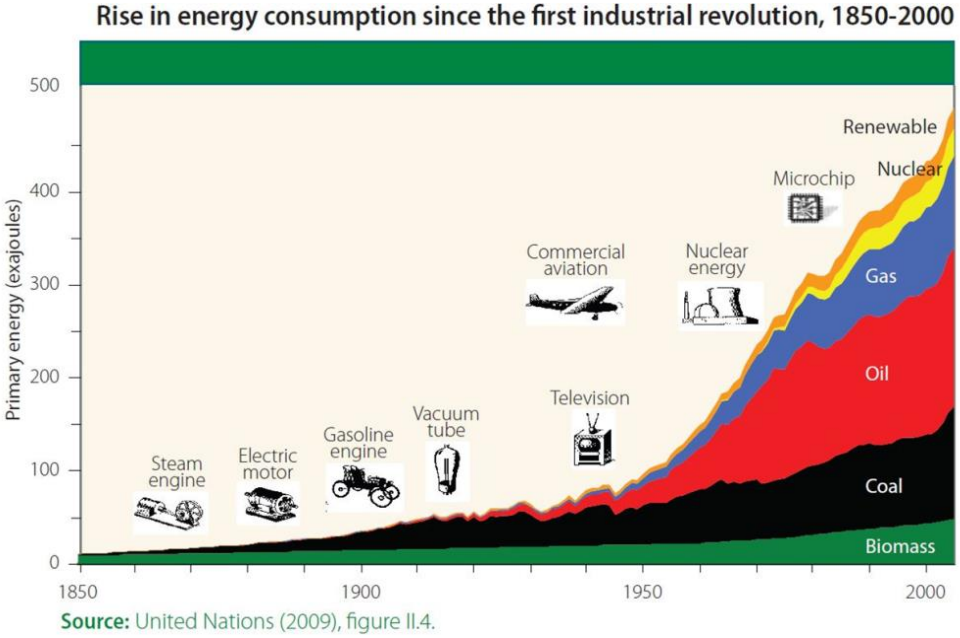
Basic conclusion: minimum energy supply for a normal prosperity and human well being taken from history is **2 - 3,0 toe/y (ton of oil equivalent per year) of PE.**

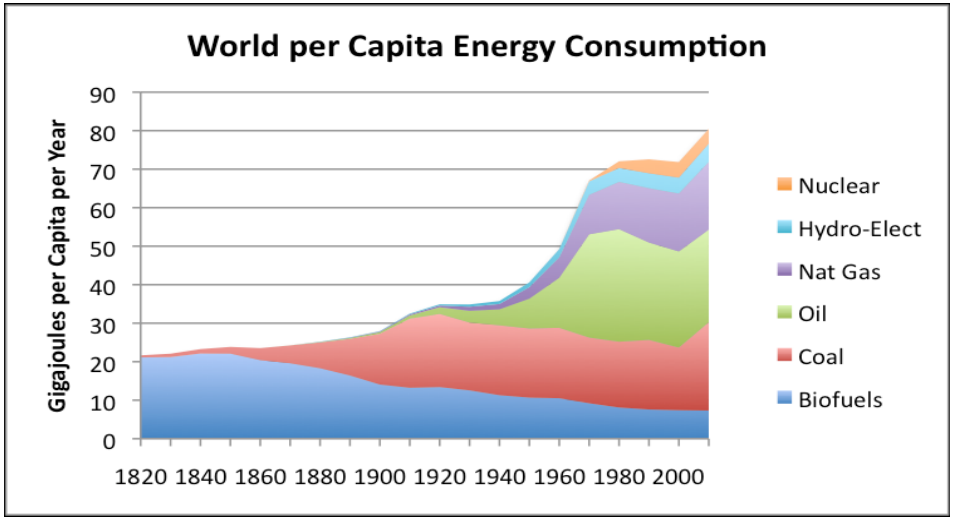
For seven billion population in 2014 on the world 14 to 21 Gtoe/y of primary energy will be enough.

With present use of ~12,5 Gtoe/y PE we can cover most of the needs, if distribution will be uniform.

20% of world population is using 79% of PE, 80% of population has to be satisfied with the 21%.

Primary energy (total primary energy supply - TPES) growth on the world





TPES supply in 2014: ~550 EJ/y, (12.500 Mtoe), or: 80 GJ/cap,y
22,2 MWh/cap, y
1,9 toe/cap,y

Anticipated growth to 2030: 17÷30%
2050. 56÷60%

GHG emissions in 2013: 33,5* Gt CO_{2ekv}

GHG concentration in the air: ~400 ppm

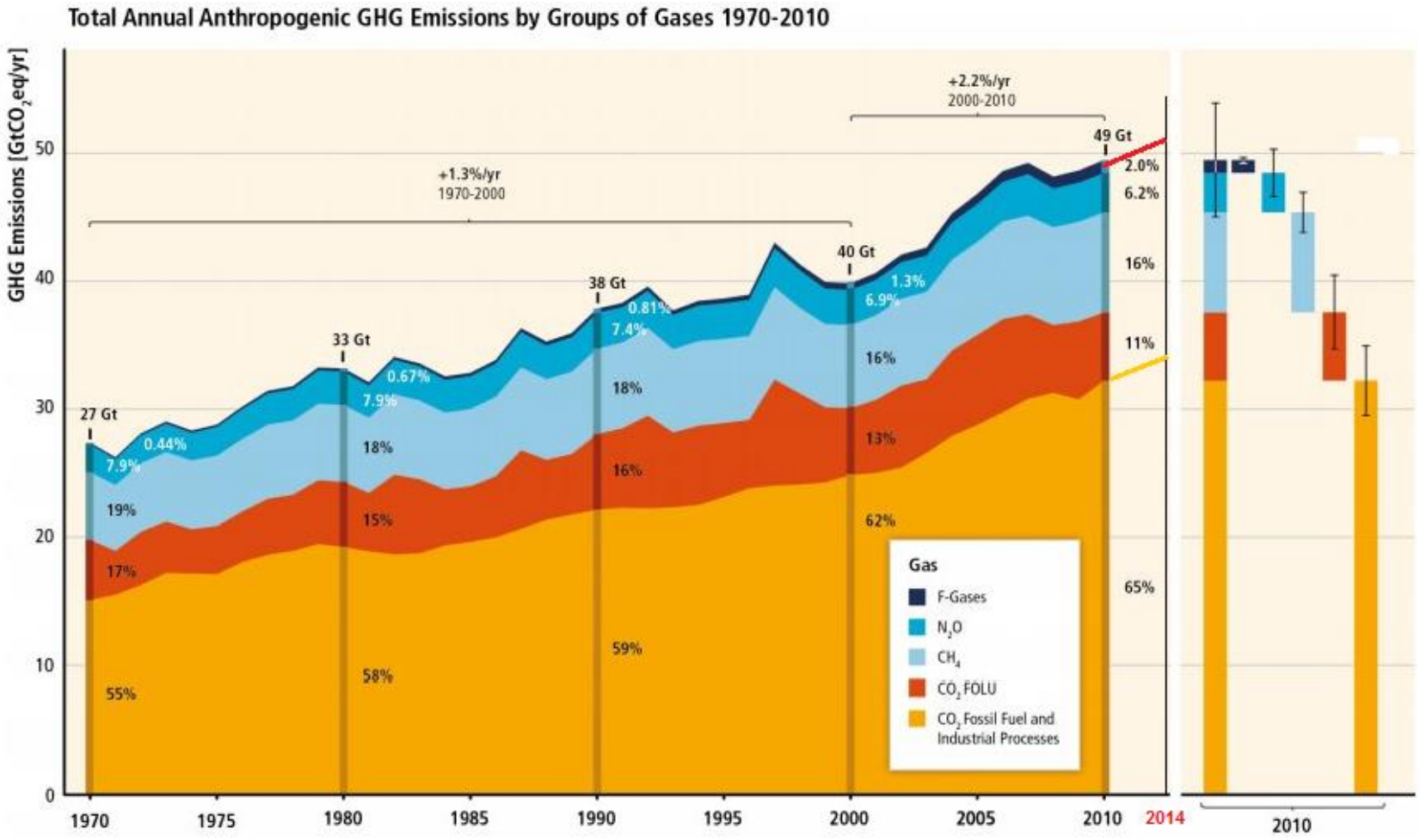
Expected temperature rice: < 2K

*From fossil fuels, EUR 26098 EN

Fossil fuels share of GHG emissions is ~ 65%, with inclusion of natural methane from biomass decay 81%.

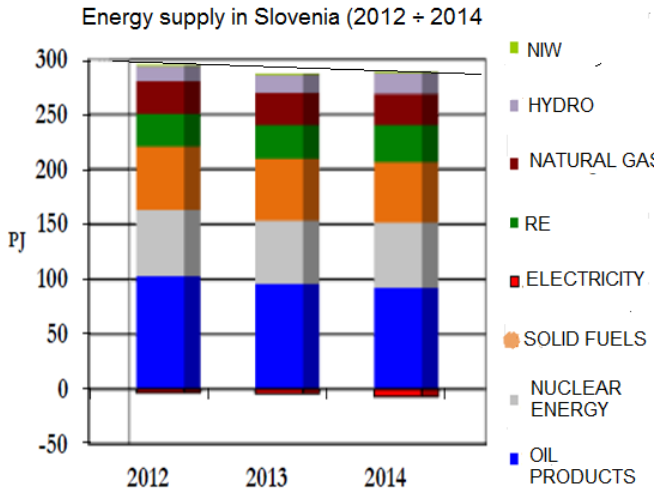
85% GHG emissions reduction according to proposal in EU signify almost 100% elimination of fossil fuels use, presenting today 80,6% of total energy supply.

Total emissions of GHG per year on the world, between 1970 ÷ 2010 with projection up to 2014

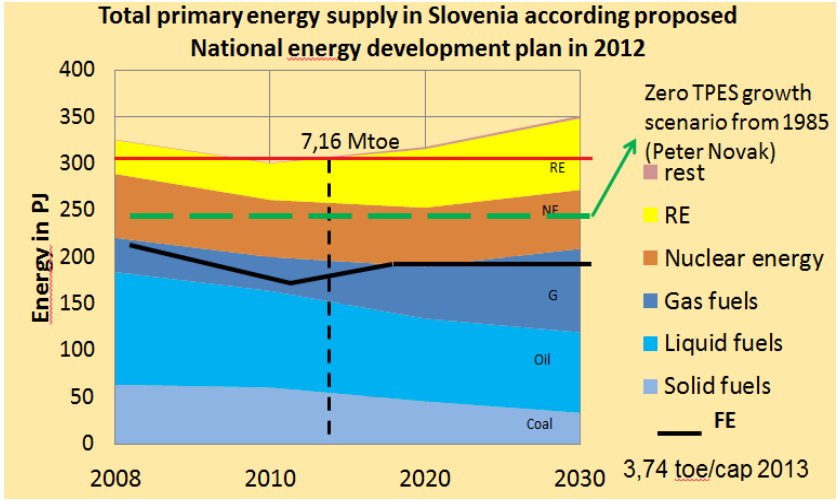


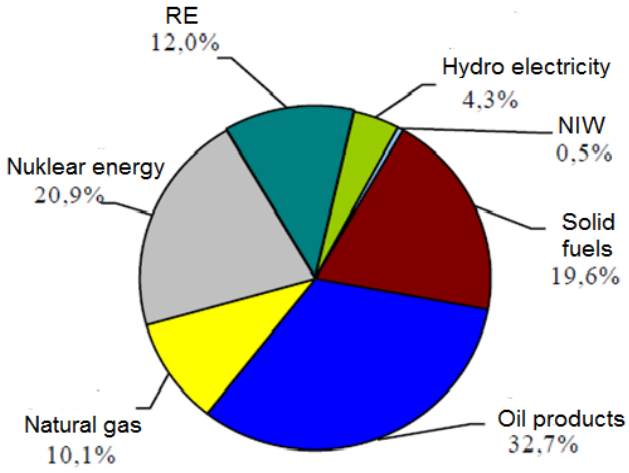
http://static.businessinsider.com/ 2013

Energy in Slovenija



Source: Ministry of infrastructure; STAT-SI (2012,2913); Energy supplier

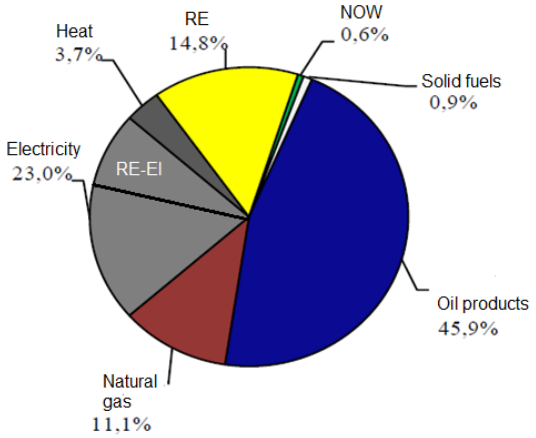




Source: Ministry for infrastructure; Energy supplier

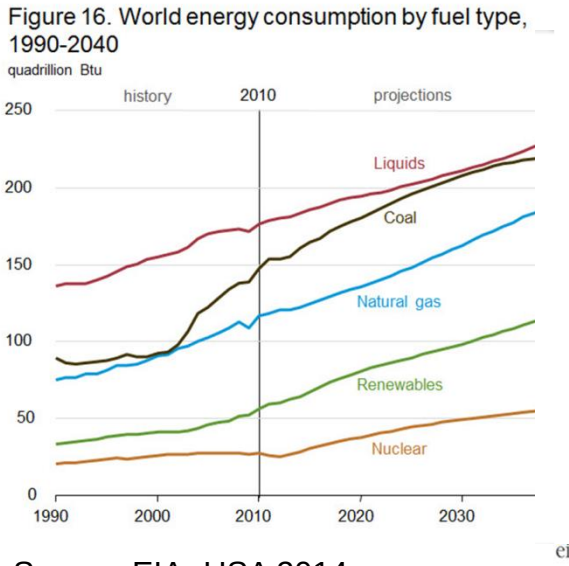
EBS 2015 - plan:
TPES: 282,2 PJ
RE ~21,7% (with HE)
Import dependency: 45,1%
Costs for imported energy 2013:
~ 2,9 bill. €/y

EBS 2015
Final energy: 199,3 PJ
Energy efficiency:
FE/TPESS = 0,71

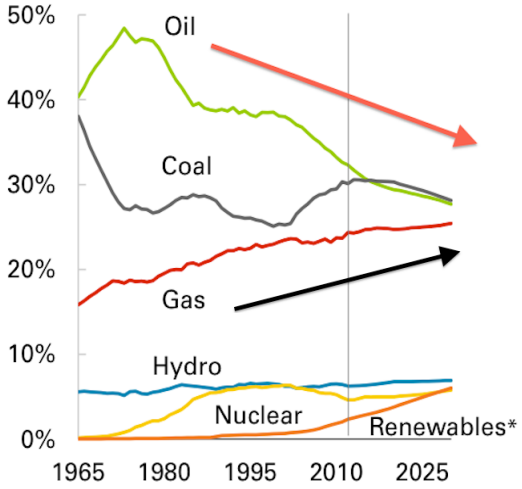


Source: Ministry for infrastructure, Energy supplier

Future energy supply anticipation from different analisys

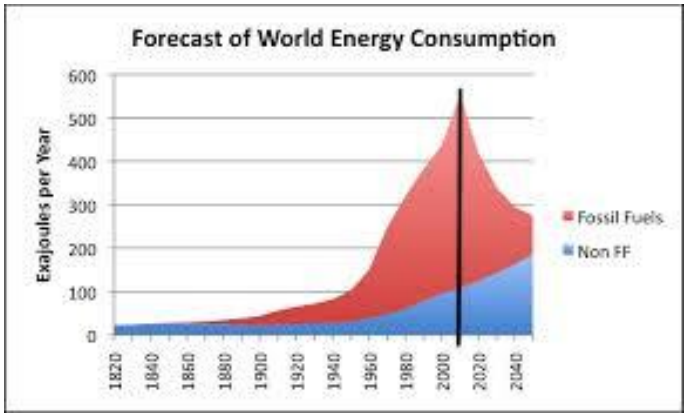


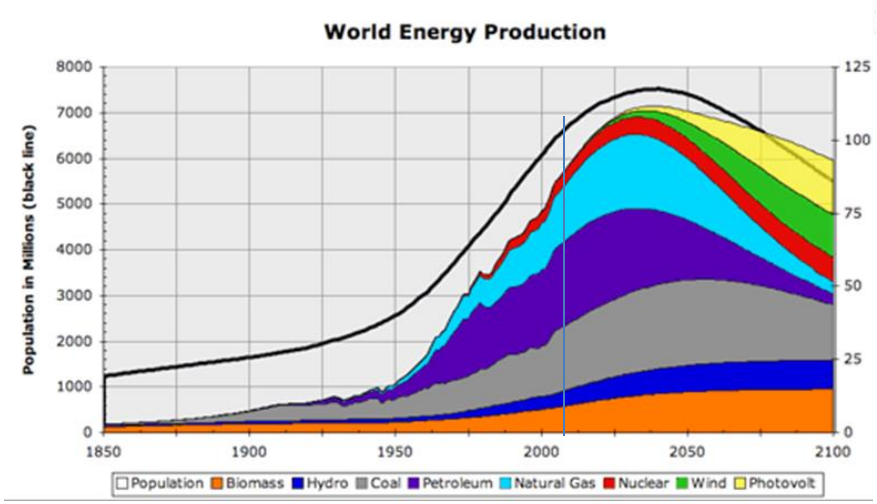
Source: EIA- USA 2014

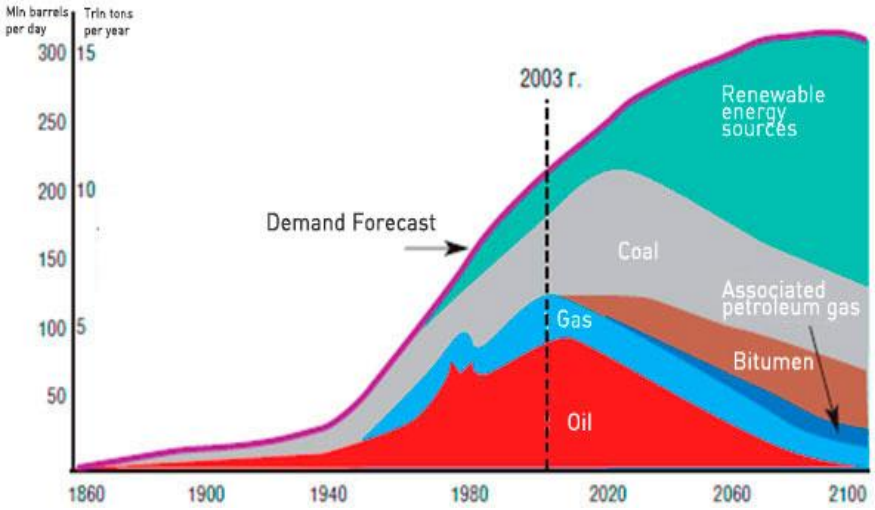


BP EO 2012

Source: www.tqe.quker.org

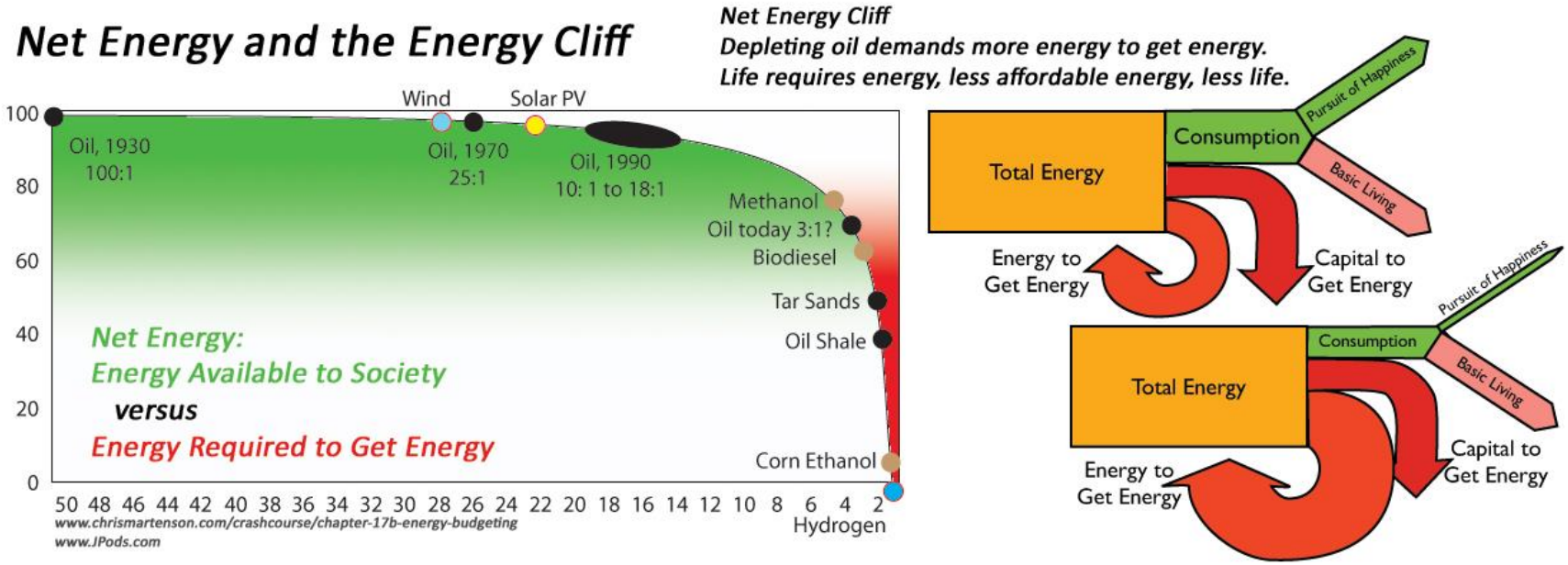






www.resilience.org

Net energy and energy cliff



„Net Energy Cliff“ represents the end of the process „Business as Usual“. Ordinate represents the share of energy available to population, abscise represents the remaining share of the natural resources. Source: (http://www.jayhanson.us/america.htm#sthash.DmIFoews.dpuf).

Production of energy carriers obeys the principles of thermodynamics. The energy source becomes useless if energy for production equals energy stored in carrier.
When the energy source‘s locations will be exhausted in such a manner, they become economically unattractive, regardless of available quantities.

New estimations of energy reserves and resources in the light of climate change

Scarcity adjusted values for energy resource depletion (ERD)

Fuel	Annual production	Reserves	Resources	Sum of reserves and resources	Years of production left as of 2005	Scarcity ratio (oil set at 1)	Adjusted ERD impact value
	EJ/yr	EJ	EJ	EJ	Years		€$_{2012}$ /kg oil equivalent
Oil	168.1	10930	18200	29130	173	1.00	0.15
Gas	99.4	49650	89100	138750	1 396	0.12	0.02
Coal	123.8	19150	363000	382150	3 087	0.06	0.01
Uranium	24.7	2400	7400	9800	397	0.44	0.07

Source: Subsidies and costs of EU energy; © Ecofys 2014 by order of: European Commission; DESNL14583, October 2014

The latest estimates of world reserves and resources show, that we are far away from energy cliff. Problem is not in scarcity and prices of fossil fuels, but in expected negative impact on environment.

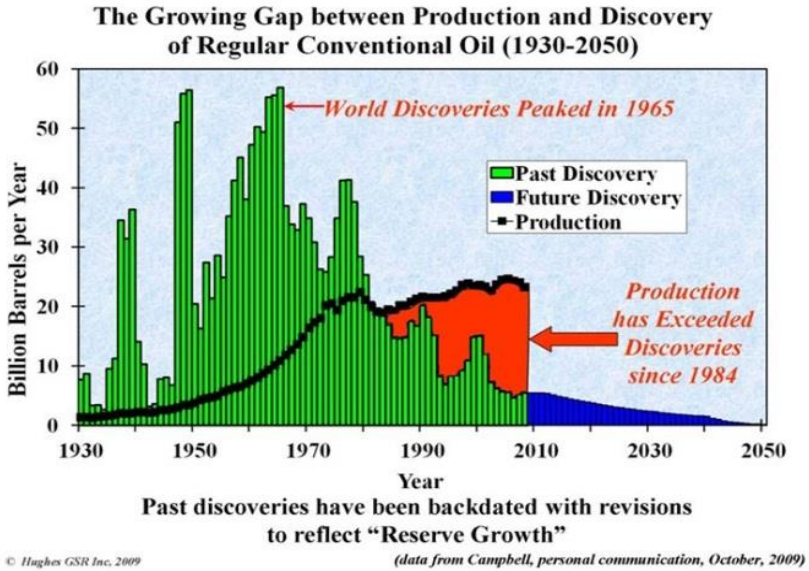
Investment in RE in 2013 in the world exceeds 249 billion $. Share of RE in the world TPES increased to 19% and more as 22% of world electricity is made from RE.

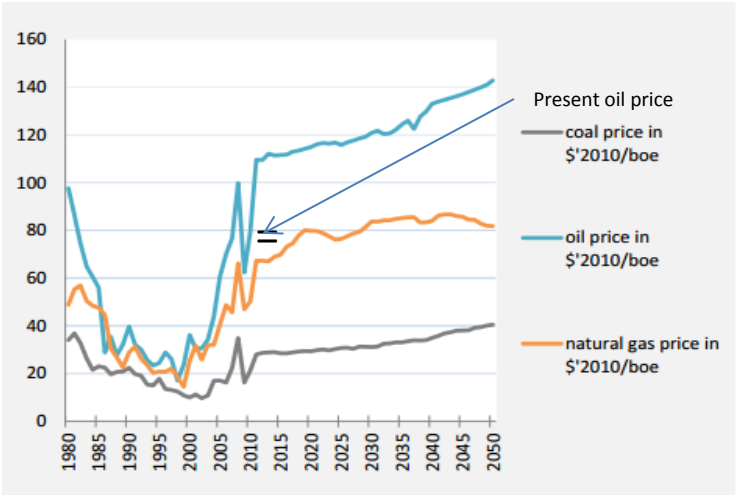
This is an important signal, that world energy supply is slowly reversing to sustainability, using more RE.

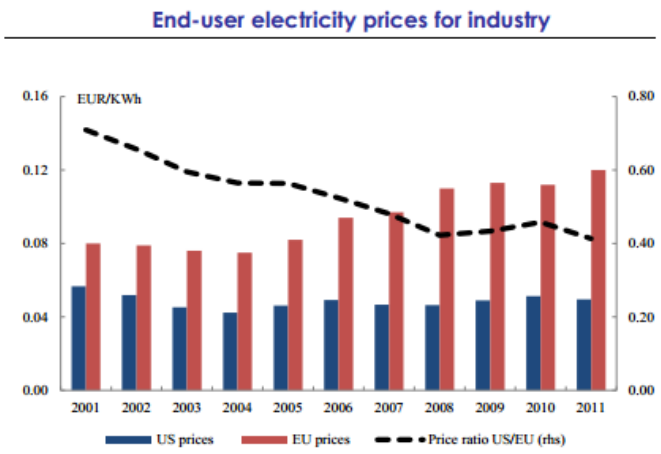
Expected energy price changes

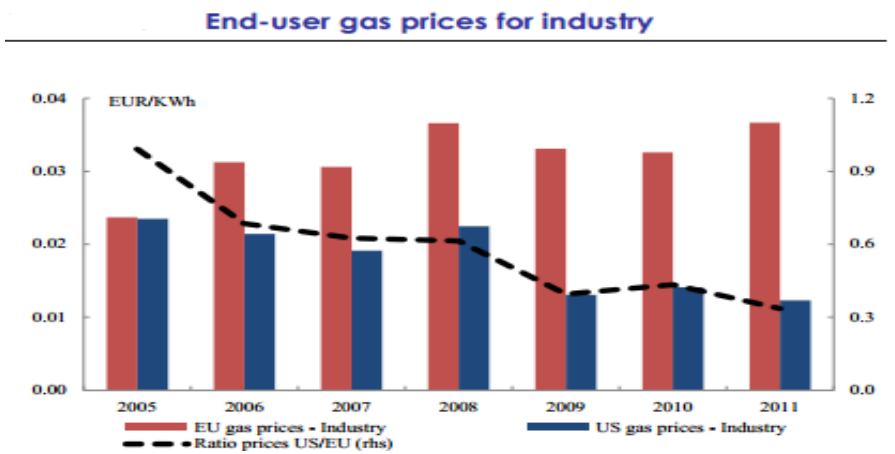
1. Present final energy prices are not connected with their production and processing costs. Different subsidies and taxes have totally deformed the market.
2. Energy prices don't include the environmental damages (external costs);
3. Known fossil fuel reserves prevent larger price changes because of scarcity or production/processing costs;
4. Coal will be in this century the cheapest fossil fuel, following gas, oil and RE;
5. Market prices of fuels will depend on political decisions (climate change, compulsory introduction of RE, new infrastructure for them,…);
6. World market energy prices will start to grow after depletion of cheap find spots (net energy cliff) or other reasons (war);
7. Political and societal instabilities in the world can in very short time change the fuel prices, especially for imported ones;
8. Larger energy independence is a goal for Slovenia and EU;
9. Capital, technology or human work cannot create the energy, they can create the favorable conditions for energy recovery or transformation from different energy sources (fossil fuels as in the past accumulated solar energy or RE as daily solar energy);
10. It is important to know, that we are loosing the quality of energy in each step of economic processes, therefore it is important to assure not only the quantity, but also the energy efficiency.

Expected energy price changes



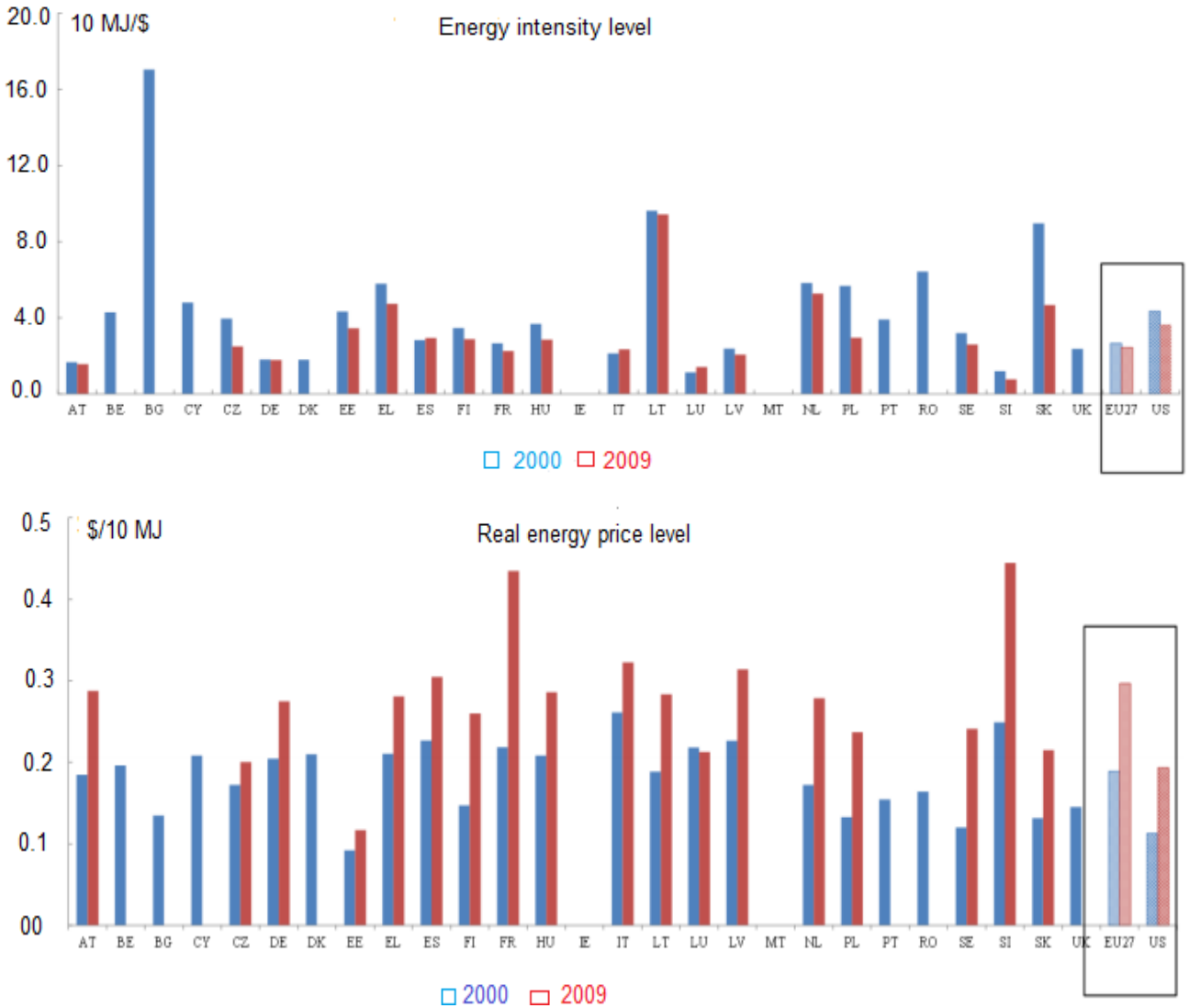






Source: Subsidies and costs of EU energy; © Ecofys 2014 by order of: European Commission; DESNL14583, October 2014

Energy intensity and real prices comparisons between EU 28 countries and USA



Source: Subsidies and costs of EU energy; © Ecofys 2014 by order of: European Commission; DESNL14583, October 2014

World oil and gas reserves and real extraction and processing costs

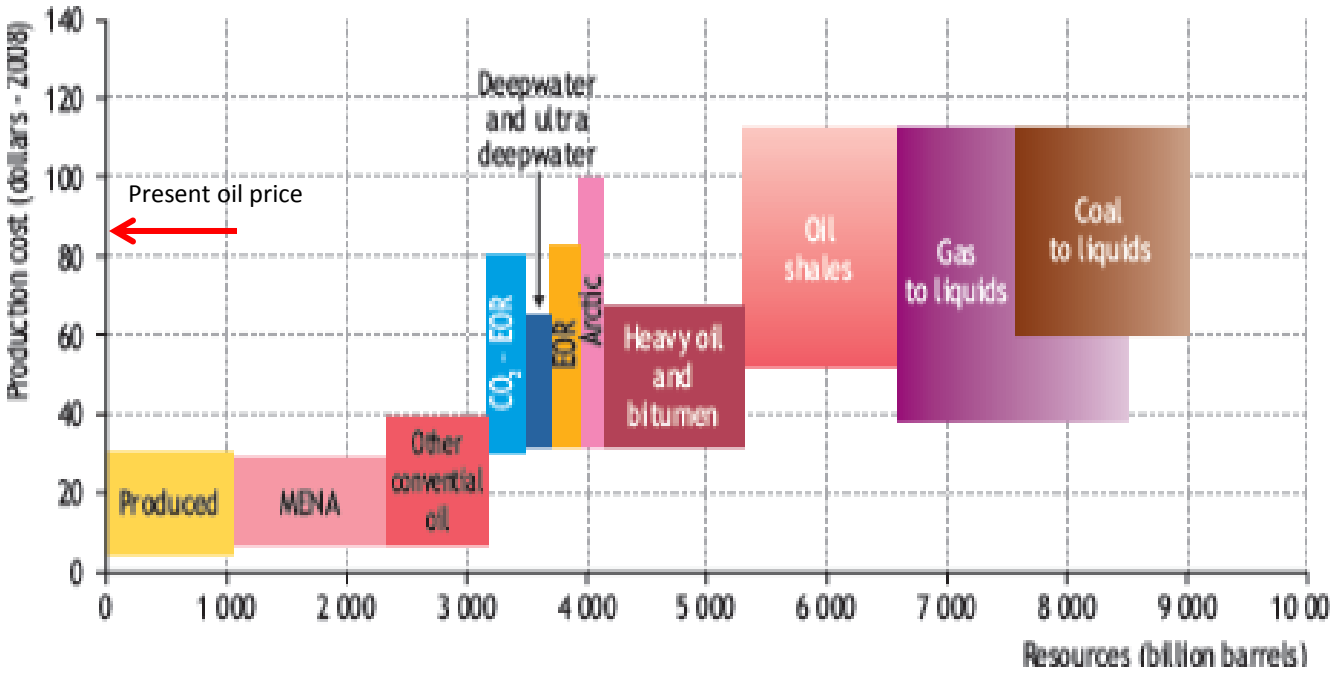
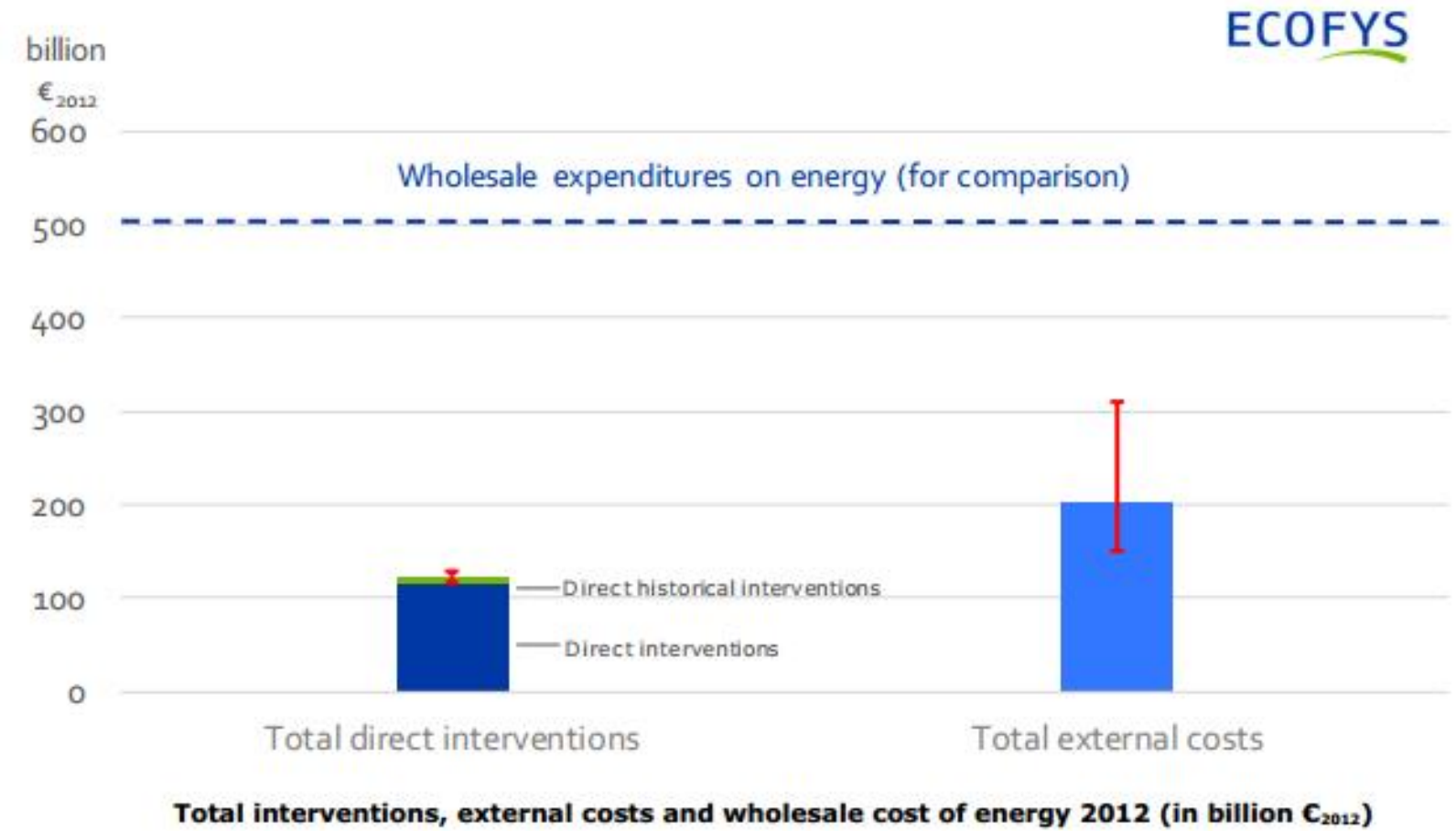


Figure 3: Cost-supply curve for oil of different sources (Source: IEA, WEO 2008, Figure 9.10)

Present research and extraction costs for oil and gas are so low, that even at higher taxation including external environmental costs, the big oil and gas corporations will still have a large part of profit.

Expenditures on energy in EU, subsidies and external costs

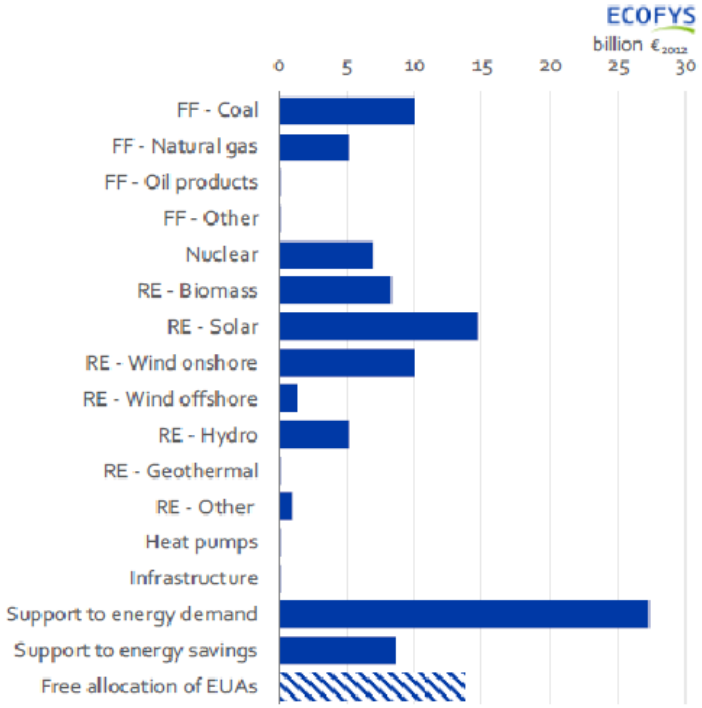


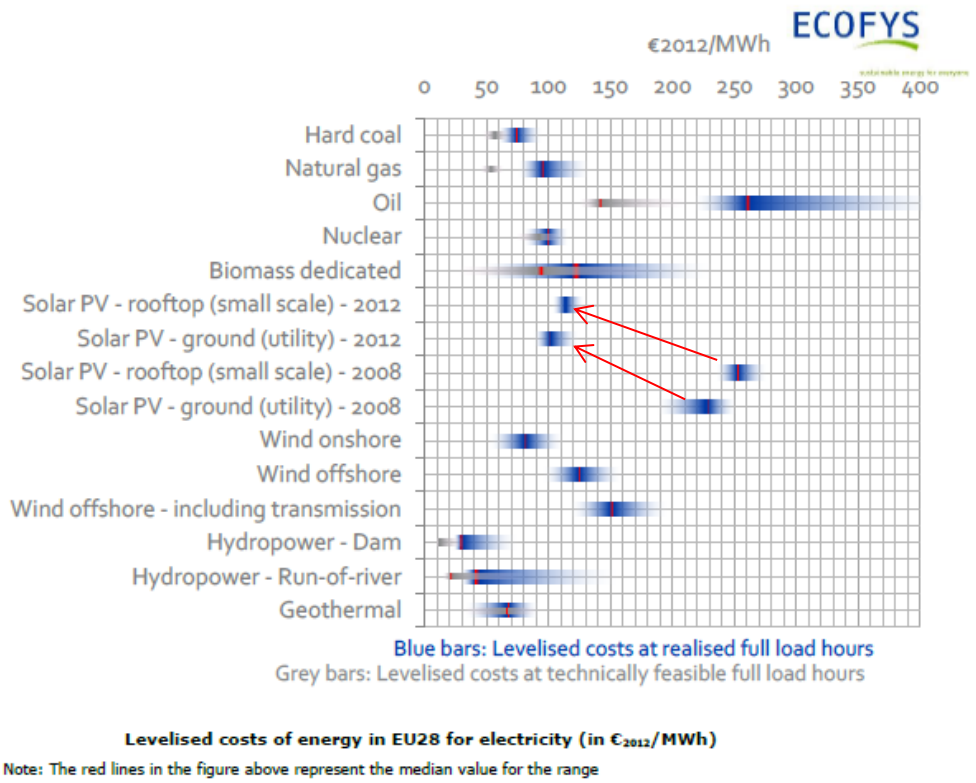
Total interventions, external costs and wholesale cost of energy 2012 (in billion $€_{2012}$)

The direct historic support is shown as a range on top of the total interventions. Total interventions include the EU ETS free allocations.

Source: Subsidies and costs of EU energy; © Ecofys 2014 by order of: European Commission; DESNL14583, October 2014

Latest data on energy subsidies in EU 28 countries and levelized price of electricity for different technologies





Levelised costs of energy in EU28 for electricity (in €2012/MWh)

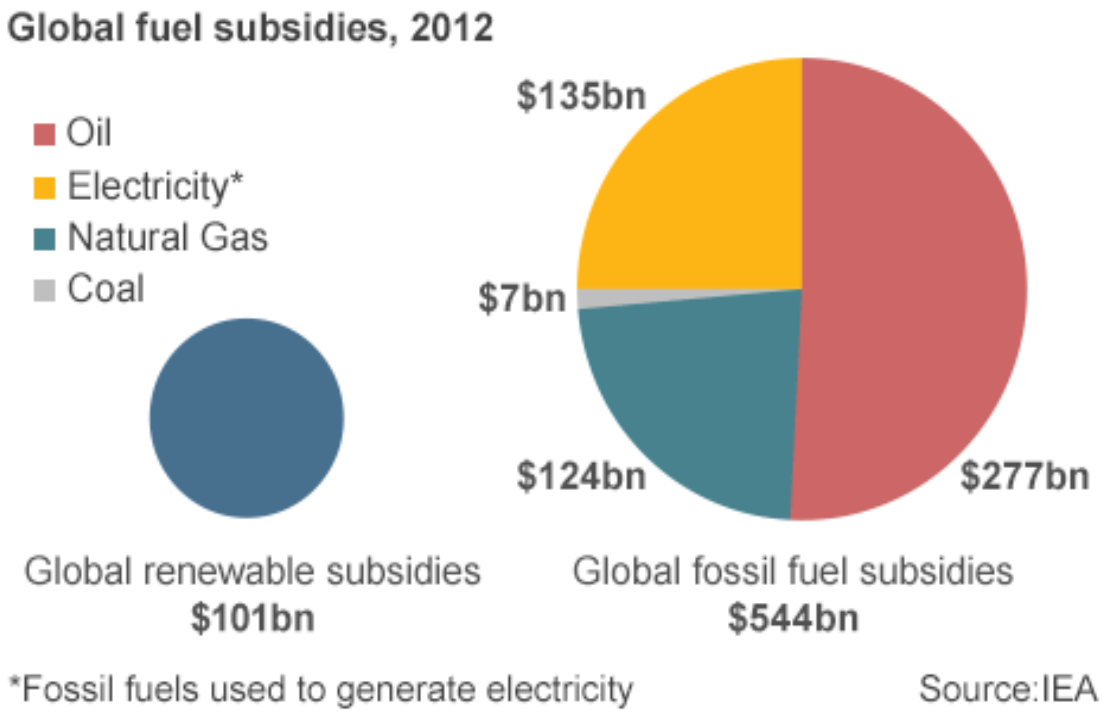
Note: The red lines in the figure above represent the median value for the range

All subsidies in 28 EU countries for fuels and RE in billions €, including the EU interventions in 2013. Historical subsidies are not included.

Red lines shows the extreme large change in PV electricity costs in last 4 years. The costs has been falling for more than 2,5 time.

Source: Subsidies and costs of EU energy; © Ecofys 2014 by order of: European Commission; DESNL14583, October 2014

Fuel subsidies in the world



Source: (http://www.bbc.com/news/business-27142377)

Government subsidies for renewable energy cause great consternation to those who believe in the sanctity of free markets.

" If they can't stand on their own feet, then why support them?" the argument goes. But in actual fact, most energy sources are subsidised, and none more so than fossil fuels.

Possible development directions

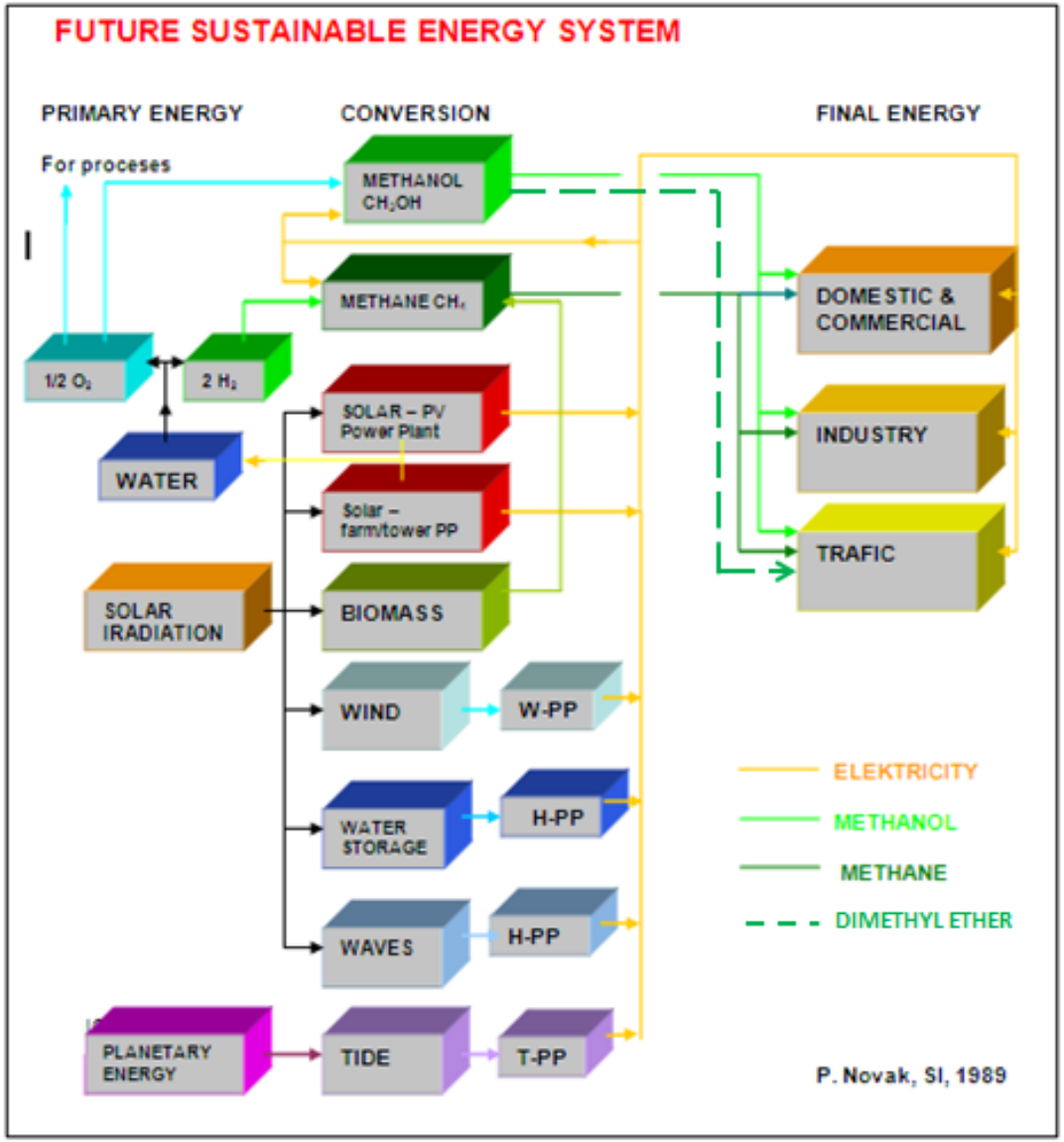
Energy supply and energetic systems are on the crossroad:

- Fossil fuels cause environmental problems
- Nuclear energy is in crisis because of the unsolved storage problem for HRW and accidents
- Renewable energy is expensive, but is sustainable

We need a transition to a new, sustainable energy system (SES), which will be durable and without GHG emissions. New system has to fulfill the following 6 criteria:

1. Energy source has to be unlimited and available everywhere on the planet Earth.
2. Energy carrier transformation should be without emissions of GHG.
3. Energy has to be available at all times in all needed energy forms (solid, liquid, gaseous, electricity)
4. New energy system should use existing infrastructure with minor adaptations;
5. In transition period both systems should work in parallel without disturbances.
6. Sustainable energy system has to be competitive with inclusion of all external costs in the price of fossil fuels.

SUSTAINABLE ENERGY SYSTEM CONSISTS ONLY FROM (PN,1989):



2 energy sources:

- solar irradiation and
- planetary energy

4 secondary energy carriers

5 conversion technologies

3 final energy carriers:

1. **Electricity**
2. **Methane** CH_4 (gaseous fuel)
3. **Methanol** $CH_3(OH)$ (liquid fuel)

The last two energy carriers use only 1 carbon to carry 4 hydrogen atoms.

4. ***Dimethyl ether CH_3OCH_3*** (liquid fuel)

Dimethyl ether can be a transition fuel for diesel engines)

For synthetic methane:

Hydrogen – water electrolyisis

*Carbon: **from waste biomass***

For methanol:

sinthetic methane

oxigen – w. electr.; wasted CO2

System with carbon recycling in nature

Fulfilling the required criteria for SES

Proposed system fulfills all 6 criteria and is applicable for all countries on the world. The main point of the system is enabling the circulation of the carbon and hydrogen through the combined natural and artificial processes and can become integral part of the circular economy.

SES enables:

- Continuous transition to the full use of RE, using the existing infrastructure (power lines, gas pipelines, oil pipelines) including modernization and adaptations.
- Use of new high tech transmission lines for electricity.
- Stepwise introduction of distributed electricity production with short term capital return.
- Creating of a number of new workplaces for the next 30 years.
- Solving the chemical storage of electricity.
- Transportation transition to a new system is easy, no need for new engines with minor adaptations
- Unlimited supply of energy locally, regionally or intercontinentaly for industry, commercial, households use and transportation.

Transition in energy intensive industries

Environmental point of view

Energy intensive industries (cement industry, metallurgy, paper and pulp industry, chemical synthesis, glass factories…) in the competitive markets today are under severe pressure from the following two factors:

- high emissions of GHG and
- energy costs.

Cement industry doesn't see any appropriate exit, except reduction of production and CCS (Carbon Capture and Sequestration). Similar is valid for the metallurgy, where the following five possibilities for reduction of GHG emissions are being analyzed:

- improving energy efficiency,
- fuel change,
- CCS technology breakthrough,
- intensive recycling and to
- **increase the added value.**

The same is valid also for pulp and paper industry.

Energy price changes and energy intensive industries

Societal point of view on the energy prices

- The prices of oil and gas in the world market are under the monopoly of small number of big corporations, it is impossible to talk about the real market legitimacy.
- Fuel and electricity prices are formally at market prices, but within the internal structure of the prices, there are many possibilities to adapt them to different users.
- The excise and sales taxes for filling the states' budgets caused deformation of free market; we don't have any market legitimacy and there will never exist one.
- This means that the approach towards the forming of the final structure of the fuel and electricity price should be made selectively and from the society's point of view holistically.
- Market and prices are deviated in such a manner that state intervention can be justified.
- Re-industrialization of member states in EU and new goals for solving the problems with CC should be reflected also in energy price policy for large energy users.
- The main question is how to co-ordinate the principles of liberal market economy **with principles of integrated sustainable economy.**
- Free flow of goods and services is only sustainable if all costs from birth to grave are included, especially in energy intensive industries.

Energy price changes and energy intensive industries

Energy – technological point of view

Pulp and paper industry is the fourth in the line of energy intensive industries.

- In the world, ~6% of primary energy is used for pulp and paper production with only 3% share of GHG emission, because of RE use.
- Based on the expert analysis in pulp and paper industry, achievable energy saving can reach up to 30%, especially if the recycling increases (p.e. by pulp recycling we need to add only 0,3 to 3,0 GJ/t of energy).
- Because the pulp and paper industry uses renewable raw material in production processes, we believe that this industry should be entirely based on RE – biomass (as a waste or recycled).
- Electricity supply should be based on cogeneration with biomass and electricity from other RE sources (water, wind, solar).
- If this is the case, the states schemes for energy efficiency and RE can be applied for heat and electricity generation, to correct the final price of energy.

Energy for the pulp and paper production (BAT)

Table 1: The best energy indicators in pulp and paper industry in the world (BAT)

Type	Steam GJ/t*	Electricity kWh/t*	Primary energy GJ/t*	Comments
Pulp factories	11,2	640	11	All have cogeneration
Paper factories	5,1 ÷7,5	535 ÷ 810	11,3 ÷ 16,3	Depends on paper quality
Integrated factories - pulp and paper	-1,3 ÷ 14	1000 ÷ 2200	22,7 ÷ 33,4	Depends on cogeneration portion

* per ton of air dry material

Source: Industrial Efficiency Technology Base

Goal: Slovenia‘s paper industry should achieve and overcome the BAT value in production to be able to convert the own production on the RE sources as soon as possible.

It is of interest to notice that american pulp and paper industry energy intensity with 950 ktoe/ bn,$ exceeds the European production (400 ktoe/bn$) two times. Twice lower prices of energy can be the reason for that waste of energy.

Conclusions -1

- In the next years, all energy intensive industries are going to face a demand for substantial changes, requiring additional investments in equipment to increase the quality (added value), energy efficiency, energy carrier change, and transition to the RE.
- Additionally, high level of recycling of material, water and chemicals is expected.
- Information technology will influence the amount of paper used, but paper will nevertheless stay an important product for everyday life, from books, documentation materials to packaging.
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- We are living in the period of big societal and economic changes.
- Approaching to the collapse point of human development, we have the possibility to direct the development into a new sustainable cycle or the global collapse.
- Available time to change is in the upcoming decades.

Conclusions -2

- We have to remember, that after the collapse of economically and socially well-organized Roman Imperium in 400 a. d. it took more than 1000 years of development to reach the renaissance.
- We needed additional 200 years to reach the industrial revolution, running on energy from coal, oil and gas, which displaced the accumulated solar energy in biomass – the energy of the old and middle ages.
- Negative impact of this development is expressed in climate change.
- We are approaching to the moment when we have to turn back to Sun and use its energy to preserve the achievements of all preceding civilizations.
- Sustainable energy system represented is one of many possibilities.
- All technologies for such a change are available.
- Capital is not a limitation; the limitation is in our brains, courage and recognition, that we can be better and more progressive than others, also in the paper industry.

Thanks for your attention.

Questions are welcome.