The Green Hydrogen Economy now!

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Summary

After clarifying the misunderstandings of the term "hydrogen economy", the properties of a genuine green hydrogen economy are presented. It will be pointed out that the hydrogen economy is a heat guided energy economy, due to the permanent surplus of electrical power, which as a matter of principle, has no losses. The cheapest primary energy for the production of green hydrogen energy is biomass. If Europe abstains form agricultural exports at dumping prices, there will be enough biomass available to replace all atomic and fossil energies. Even today, bio-hydrogen from regional industrial process plants would be cheaper than natural gas. It is therefore possible to initiate the green hydrogen economy without fuel cells. This new energy economy will have regional beginnings, but will then spread around the world. Existing gas pipes are suitable for the distribution of energy. Setting up a completely new infrastructure with hydrogen factories and the enlargement of the pipeline network requires significantly less investment than the maintenance of the status quo and can be completed within a few years.

Introduction

A green hydrogen economy is not some future dream, but ready for utilization here and now. All the necessary technologies are available, and are sufficiently developed to make a start. Therefore we are able to calculate investments and energy prices for a hydrogen world. Regional hydrogen production from renewable sources would be a powerful answer to the energy question. Firstly, the question must be clarified: "why doesn't anyone do it?"

Public opinion about the hydrogen economy

In our increasingly global world, the political power has moved more and more to big business. That is why the energy question is geared towards today's interests of the energy industry. Iraq shows that propaganda ranges from manipulating "common opinion" to instigating wars. European institutions and organisations are also not free from this permeation. In debates about hydrogen and energy the following is claimed:

- There is no real alternative to the dominance of oil
- Hydrogen will always be more expensive than power
- It is better to use primary energy sources directly than to transform them into hydrogen with losses
- Hydrogen infrastructure requires immense investment
- Installation of a hydrogen economy requires half a century or more
- ...

Why should we believe that?

We believe that, because we believe the expert opinion of the energy companies. Thus the leading energy companies are officially called upon by governments to help in the decision making process. The German high court recently was obliged to criticise this practice.
It would be advisable for the political power to be returned to parliament.

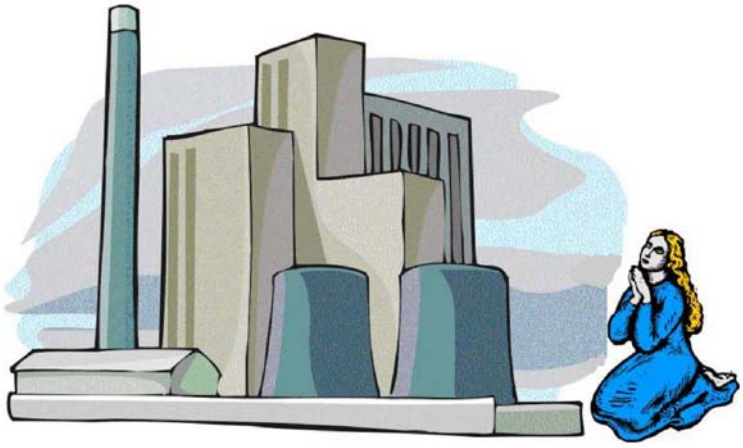


Fig. 1 We worship the power of energy

The current energy industry will of course fulfil all our requests – if its profit increases. It would never recommend a cost effective alternative such as the green hydrogen economy. Because by doing so, it would quickly lose its basis for doing business. Nearly all infrastructure investments would be stranded investments and all trade with power, natural gas, oil, coal and uranium energy would not be possible, because all are too expensive or do not fit the new infrastructure. That should make us think.

There is however another reason why the green hydrogen economy does not take off. It is the failure of our elite - whether they have been "bought", or whether they have aligned themselves to "common opinion", or just because they say what their financiers want to hear. The elite should really know better than most that the "common opinion" has more to do with power than truth.

Looking more carefully, one discovers that the term "hydrogen economy" has been given a wrong meaning. It does *not* have to do with a "hydrogen economy", but modern "electric power management", as in the end electricity is delivered to the end user, not hydrogen.

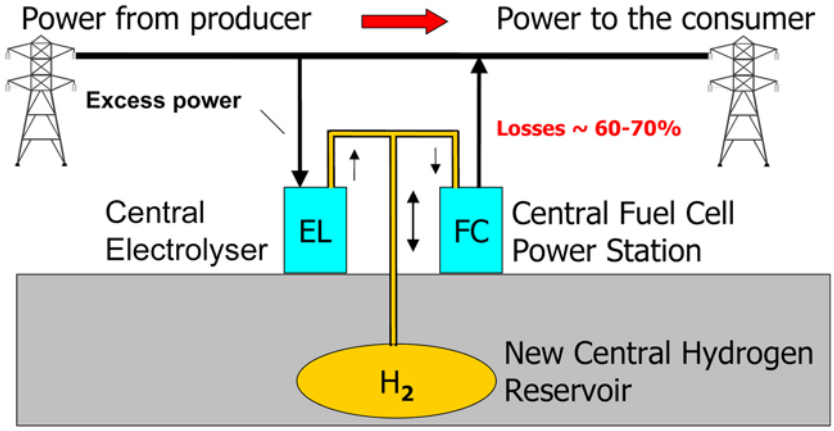


Fig. 2 Modern power management - not a hydrogen economy

This modern power management is afflicted by massive losses and requires immense investments – even just to provide hydrogen for filling stations. The energy industry need have no true fear of this type of fake "hydrogen economy": it is expensive and inefficient. Producing electricity from electricity via hydrogen would cost at least four times as much as solar electricity (which is not exactly cheap).

If we give terms wrong meanings, it is not only our language, but also our thinking which fails, as without clear language we cannot think clearly. In the Bible, the tower of Babel could not be completed because someone had confused the language of the builders. Could it be that someone has confused our language – so that we cannot find our way out of the oil and climate trap?

A hydrogen economy is completely different from what we were told

In a real hydrogen economy, dealings and operations are done on every level with hydrogen. It is recognisable by hydrogen being delivered to the end user. Not until reaching the end user is it finally transformed into electricity and heat. In this way, the entire energy for power, heat and vehicle fuel can be delivered via pipes. Existing natural gas pipes are suitable for transportation, as it once was a hydrogen pipe network: town gas is principally made up of hydrogen.

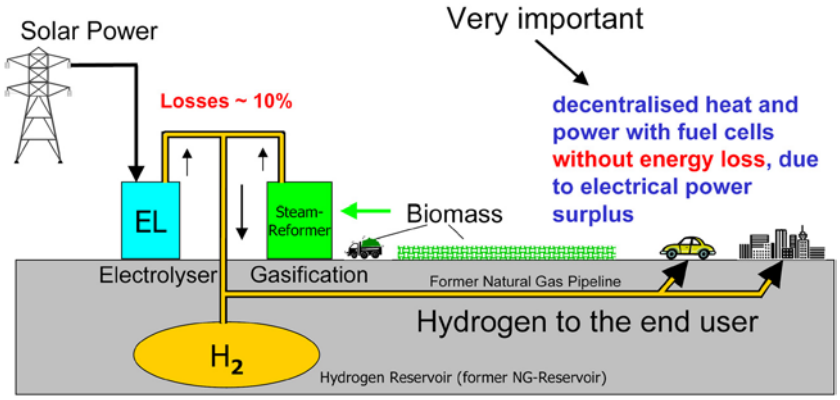


Fig. 3 Genuine hydrogen economy

When converting hydrogen at the end user, around half the energy produced is electrical, and around half is heat. That is three times more than is commonly needed. This surplus of electricity can however be transformed without losses into heat. The other way around would obviously not work. An energy economy which has a surplus of electricity is called a heat-guided energy economy, which has in principle no energy losses, because electricity has the same value as heat.

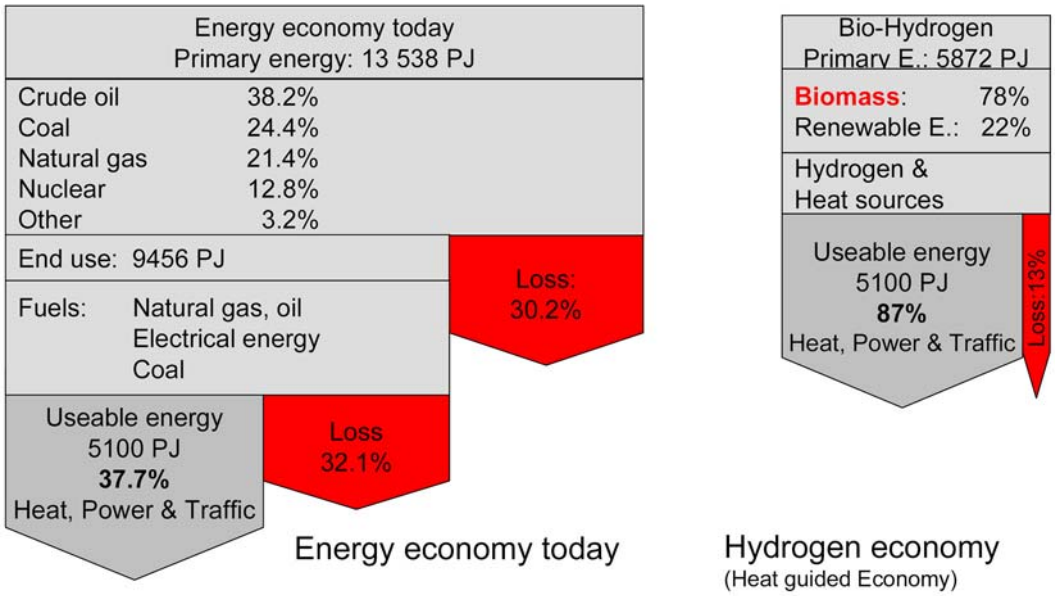
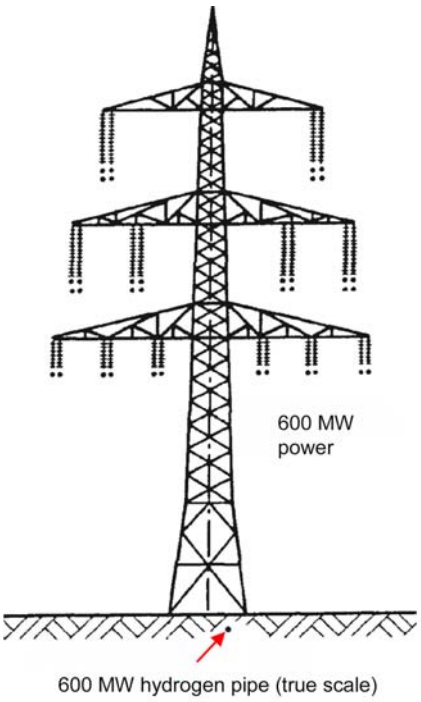


Fig. 4 Efficiency of the German energy economy

The German energy economy with hydrogen as secondary energy carrier can achieve 87% efficiency. Only around 80% of the primary energy need be provided in the form of electricity and /or biomass. The rest can be thermally extracted from the surroundings, from air or underground for example. The temperature level may be raised cost-efficiently using a hydrogen-powered heat pump. In Germany therefore, the equivalent of only one third of our current primary energy demand would be required in the form of electricity and /or biomass. This is important when considering the potential. Biomass is already cheaper today than fossil-based primary energy sources. Then if only one third of it is required and the infrastructure is much simpler, we have the first indication of our future energy bill.



Biomass is also the cheapest source of primary energy. Electricity would have to cost less than 1.5 ct/kWh to be competitive. That is not possible with either "green" electricity or nuclear energy – not even with written-off assets. Fuel for internal combustion engines would have to cost less than 10 ct/litre in order to compete with fuel cell vehicles which run on hydrogen.

Fig. 5 Energy distribution

It is worth considering that energy distribution via the grid is ten times more expensive than via hydrogen gas pipes. This high distribution cost is another reason why we shouldn't use the national grid. The national grid will not be required in a hydrogen economy. Electricity cables will have at most local relevance – for example within buildings or factories.

Hydrogen economy as a cost-effective alternative

All types of energy are basically suitable for the production of hydrogen. Energy generated in the form of electricity is converted into hydrogen by electrolysis. Stored solar energy such as biomass can be transformed directly into hydrogen using a chemical process. This process has been known for the last 200 years as "Steam-Reforming". Investments and production costs for hydrogen can therefore be quoted with sufficient accuracy.

Regional Steam Reformer 500 MW Hydrogen

	LHV	HHV	
Payment to the farmer	0.015 €/kWh		← 73 €/tonne of dry matter (a very good price for the farmer, no subsidies needed)
Loss	0.005 €/kWh		
Investment + Labour	0.005 €/kWh		← This figure is an approximation
Σ= manufacturing cost	**0.025** €/kWh	**0.021 €/kWh**	
Industry rate	0.028 €/kWh	0.024 €/kWh	
Household rate*	0.032 €/kWh	0.027 €/kWh*	← Your price for heat and power

All figures before tax

Table 1 Manufacturing cost and customer prices of hydrogen

This table shows the manufacturing cost of a 500 MW industrial Steam-Reforming plant. Benefits of scale for bigger plants are not significant.

A private household can therefore produce its own electricity for around 3 ct/kWh. Grid electricity costs 6-7 times more –the distribution alone costs roughly 8 ct/kWh. For heating the price difference is not as large. For example, in 2006, natural gas cost around 6 ct/kWh in Germany (before tax) and hydrogen around 3 ct/kWh. *One could therefore begin a hydrogen economy entirely without fuel cells*. Only the burner nozzles on heating equipment would have to be replaced.

It is however important that the introduction of hydrogen not be planned as an extension to the old structures, but as an *alternative* to the existing energy industry.

Although the installation of a different type of energy economy like the hydrogen economy requires significant investment, maintaining the status quo for 15 years for example is much more costly.

Business as usual	10^9 €	**Green Hydrogen Economy**	10^9 €
Repair and building of power plants and national grid	200	Hydrogen factories	25
Lifting the share of renewable energies to 20% to the year 2020 (Essener Declaration)	200	Enlargement of natural gas net	10
Reconstruction of buildings to save energy	1,000	No saving of energy required	
Σ	**1,400**	Σ	**35**

Table 2 Comparison of future energy Investments in Germany in the next 15 years

Please consider that fuel cell cars and fuel cell heaters will be less expensive than traditional products if production volume is greater than 10^6 units.

The construction of the gas pipe network should not be exaggerated as every fuel cell vehicle is also a tanker as well as a mobile power socket, but spends most of its time parked. The pipe network will therefore be smaller than our current power grid.

In Germany, we would realistically have to spend roughly 35,000 million euros over 15 years, to build a completely new energy world. This is actually quite feasible within a few years. Were we to carry on as before, we would have to invest 40 times more and still it would not be sustainable. Anyone still believing the energy industry – that it would take about half a century – is diluded.

Realistically speaking, our window to solve the energy and climate question is a maximum of 20 years. After that, everybody will be at war with everybody.

Biomass Potential

So, if biomass is the most cost-effective source for hydrogen, then we need to ask whether Europe is capable of producing enough biomass for a full supply. In the face of the wily management of surplus agricultural produce in the European bureaucracy, it is not easy to explain this in just a few sentences. At this point, a scientific examination is more helpful.

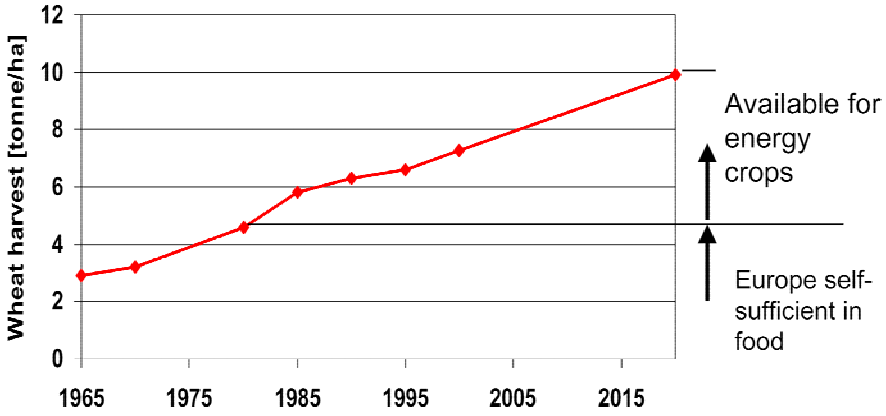


Fig. 6 Crop yield improvement in food: e.g. wheat

It was in 1979 that the EU attained a level of 100% self-sufficiency in food. Since then, food production has been increasing. The area of arable land no longer required could be used to grow energy crops. Figure 6 shows the increase in wheat yields by way of example. The picture for other products is similar. In addition to this, modern highly sophisticated meat production requires less and less feed. Figure 6 refers to the old EU members. The new members have much more farmland to grow energy crops.

As yields increase, more and more arable land will become available to grow energy crops, which will also increase in yield. The available energy potential will in the long term far exceed current energy consumption. The European Union expects that energy consumption remains constant or decreases slightly.

If the installation of the hydrogen economy can be more or less complete by 2020, more than half of the arable land would be available for energy plants. If the surplus arable land is distributed fairly across all member states, and food production is reduced to 100% self-sufficiency, the following picture results.

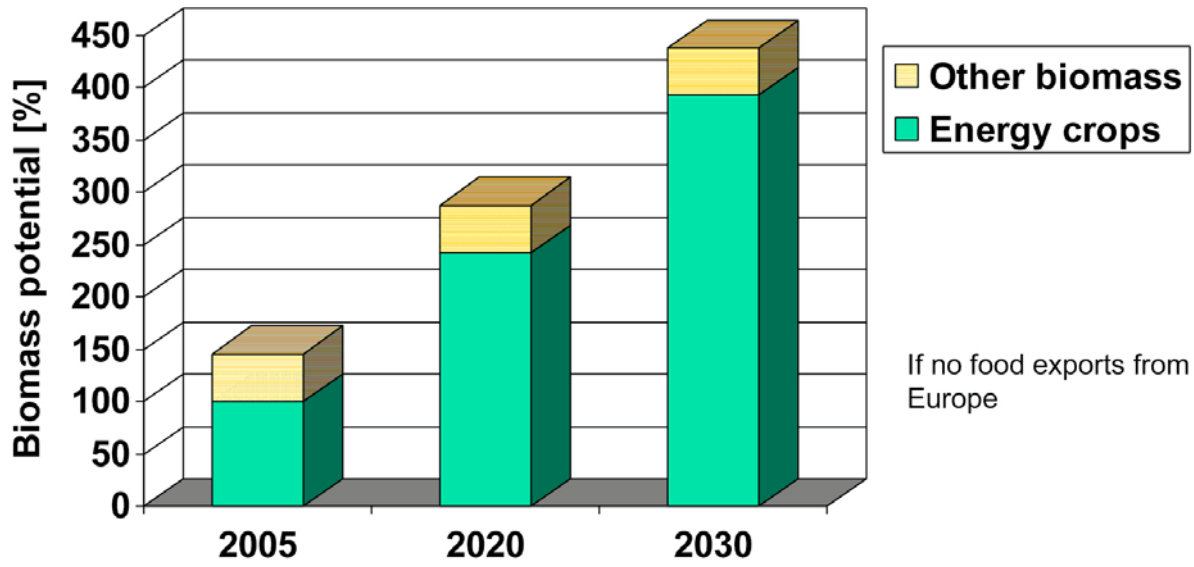


Fig. 7 EU Biomasse Potential

We can confidently say today, that we will have enough biomass in 2020 to replace all nuclear and fossil-based energy sources.

It is very important to note that estimations of potential are dependent on available technology. As shown in Fig. 4, we have a potential of 100% if we replace a third of our primary energy with biomass. Furthermore, in the production of hydrogen, a variety of types of green biomass and silage can be used which would otherwise not be efficiently usable – at least not when compared to power plants or heating stations. Two harvests per year are also possible in Europe.

By producing energy rather than just food, agricultural profits will increase such that it will no longer be necessary to subsidise farming. The knock-on effects are immense. Consider this: An energy price for biomass of 73 Euro/tonne (this is equivalent to an oil price of 24 Euro/barrel or 31 US $/bbl) will give the farmer a higher income than the production of subsidised wheat. This will influence food production such that there will be no place for food export at give-away prices. Even if the oil price were to fall to zero, this would still be too costly for industrialised nations, because of the social cost of that energy.

Are we ready to start?

As we have seen, the hydrogen economy presents neither financial nor technological problems. The only problem is the energy companies and their influence on politics.

Common renewable energy requires government subsidies. However, the introduction of hydrogen as an alternative to natural gas requires no national government sponsorship. It is sufficient if we put a regional gas provider in the position to freely decide to provide pure hydrogen. For this the EU rules and regulations may have to be amended – which the energy industry may try to jeopardise. If this first regional provider is successful, the hydrogen economy will spread worldwide. If our regional provider is sufficiently wise to sell his shares in power plants and the national grid before they become worthless, he will not even need new money for his business venture.

Our regional provider need not even exploit the full benefits of scale. Were he to build a factory with a power output of only 50 MW instead of 500 MW, then the hydrogen cost would only rise by around one cent per kWh. This is still significantly cheaper than the price of oil or natural gas.

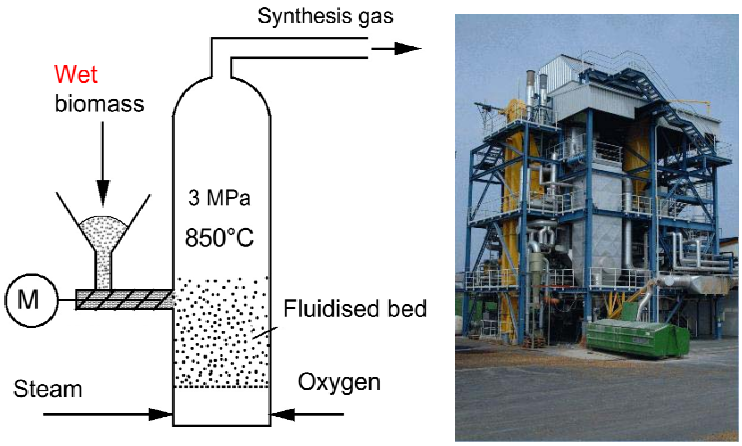


Fig. 8 Simplified scheme and a view of future 200 MW Steam-Reformer

This figure showed the Güssing Steam-Reformer of 8 MW, which is pressure-less. If pressured by 25 bar (2.5 MPa), it will have 200 MW output of hydrogen at the identical dimension. Now you can visualise your investment into a new world of peace and prosperity.

Today fuel cells are expensive. At the end of 2007 Ballard will start to produce 2,900 fuel cell systems of 4-20 kW at 500 €/kW. At this price it is very nearly feasible to install a fuel cell heater in every home.

A Green Hydrogen Economy is more

A green hydrogen economy is more than a cost effective alternative for our energy economy. In the new economic order, farming and forestry re-enter the primary sector. This situation is also beneficial for the development of third world countries.

The farmers can give us all we need:

- 100% Food
- 100% Energy
- 100% Supply security
- 100% organic products of chemistry
- 100% Environmental and climatic protection
- Lots of peace and prosperity
- Political independence

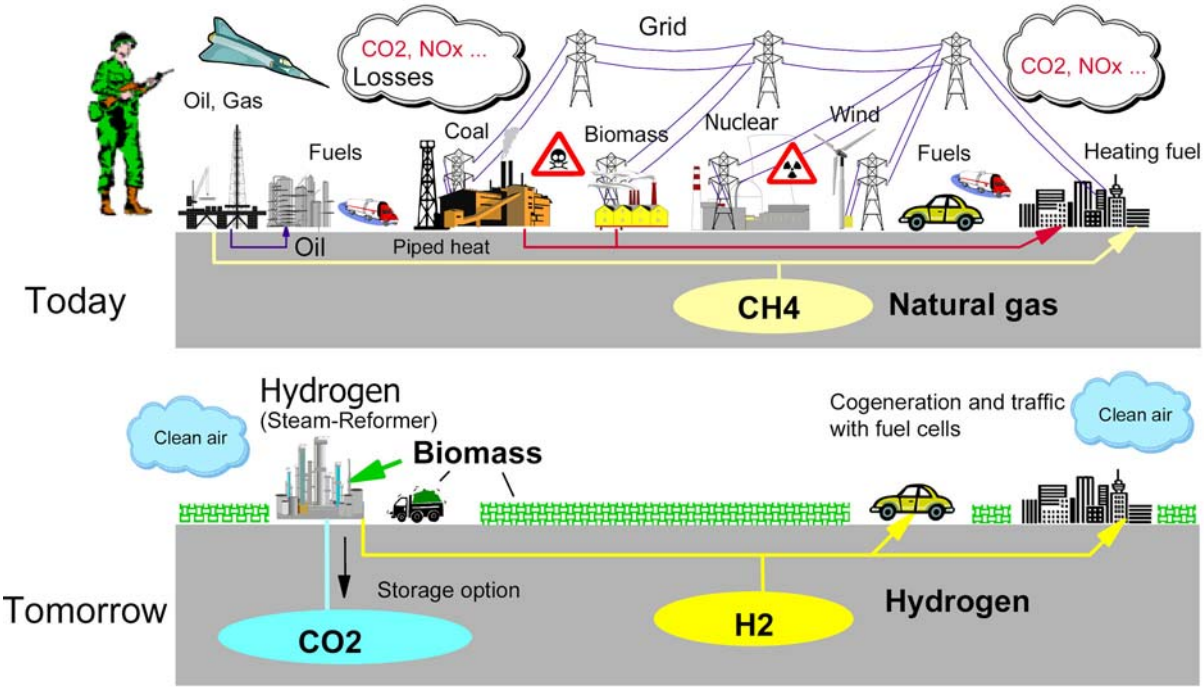


Fig. 9 A green hydrogen economy will change the world completely

With the installation of autonomous energy economy, world powers and rouge states will be thrust aside and the institutions of "Washington consensus" like the WTO will become paper tigers. It is necessary to recognise this political challenge, and to derive practical steps to maintain peace. It is the task of parliaments to retrieve the capacity to shape a people-oriented civil society with no fear or terror.

Literature

Karl-Heinz Tetzlaff; Bio-Wasserstoff – Eine Strategie zur Befreiung aus der selbstverschuldeten Abhängigkeit vom Öl; BoD Verlag, Norderstedt (2005): ISBN 3-8334-2616-0

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