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RESEARCH ARTICLE

Gas propulsion or e-mobility is the solution on the way of clean and carbon free road transportation?

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Abstract
Most of the political revelations are speaking of the e-mobility as the cleanest and final solution on the way of vehicles technology improvements. On the other hand, too little attention is paid for the gas propulsion, however it's technology is proved, the environmental benefits can be as much as at the e-mobility, but requires far less investment.

Keywords
gas propulsion · e-mobility · carbon

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1 The introductory main question: is it needed to have an energetic alternative in transport, and if so, to what extent?

To make a foundation of the question in the subtitle, here are some warming-up sub-questions:

- In the light of transport costs, how big item is the energy bill?
- To what extent do industry and agriculture show sensibility towards the change of transport costs?
- Within European transport sector, how big is the share what comes from the oil?
- In what ratio is the EU transport sector in need of import energy?
- How much will influence the demand and supply balance of the refinery capacities from the middle of the decade, as the northern SECA zone coming into effect? And if further SECA zones followed by it shortly? How Europe wide the refinery investment requirements looks like to cover the gasoil demand?
- What kind of fuel price change and volatility vision can we foresee for the next decade and decades?
- How many years will it take that we still find the price of oil-based fuels affordable and exploitable, and when will it already cause significant damages?
- What kinds of industries are also using the oil as a basically important raw material? How price sensitive are they?
- How is the balance of oil extraction and demand developing looks like for the next?
- What attitude do we have to environmental and climate protection issues?
- Can we afford the change?
- Who shall pay for the change?

2 An alternative is needed, but what kind?

- Based on economic, environmental and climate protection aspects, the right answer is: any kind of locally available energy source which is able to apply may be good, in case it is at least not more harmful than oil!

- Books can be filled with the long list of alternatives, and it is a comprehensive task to analyse and evaluate them, but a scientific approach is absolutely needed, as marketing humbugs and political slogans very rarely meet reality.
- To justify this sentence let stay here two examples:

  ❶ Bioethanol is getting to be something that is judged harmful due to land-use change and food supply problems. Despite the fact is, in Hungary one million hectares are uncultivated and above it, on the cultivated area of 4.5 million hectares, cereals and corn are produced, in a significant ratio for export. The procurement price of which (in case the crop does not remain in storage) greatly fall behind that level, as if it were utilized at home as an energy source.

  ❷ Often said: the electric propulsion is emission-free, and it is the cleanest alternative. However transport, as a human action, must not be viewed only there, where the movement is just occurring. Transport is a two-player energy conversion process, out of which one is energy, and the other one is the instrument that transforms it, namely the vehicle. None of these is just simply to be there. They are to be produced, and they are to be made available, and just than can be the transport done after all.

3 An objective analysis must consider the whole process

Paradoxically, it is just the evaluation of renewable energy sources during which the so called lifecycle assessment has become more and more necessary. The fact is, that even with the use of primary and secondary fossil energy, it comes significant environmental impact surplus, than it is shown by the well-known exhaust emission, which now is mandatory to be published.

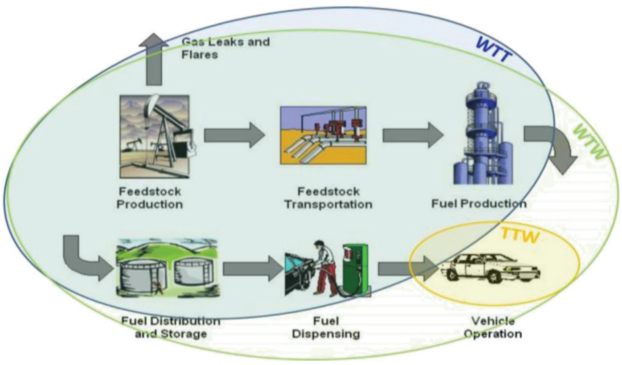


Fig. 1. WTT + TTW = WTW. To make a consideration is not enough to evaluate the technology of the vehicle alone, but have to take a look to the complete energy-chain.

4 Emission of the energy conversion process lasting from the tank to the end of the exhaust pipe – it is just one part of the story

Based on TTW (Tank-to-Wheel) emission, hydrogen propulsion – and of course, electric propulsion with no exhaust – are the most promising ways of transport, as they are clean and emission-free. Inherently from the molecular structure among the hydrocarbons, according to the climate protection aspects, the methane is the most favourable; it results about 25% CO_2 savings, compared to petrol and gasoline use.

However, in terms of global warming, with regard to the CO_2 concentration of atmosphere (and other gases, like halogens with their global warming potential), the really normative factors are the value getting of „new carbon" to the atmosphere or controversy the avoidance of it, as well as the fixation of atmospheric carbon.

Naturally, it is impossible to put aside the problem with a wave of the hand that the pollutant emissions of our present vehicles have a considerable health-damaging potential; it is enough to go out to the streets of Budapest for a proof. By the drastic aggravation of emission limits it can only be ensured that vehicles, thanks to the significant technology development, are more favourable in their new condition, than before. However, besides technology results, maintenance and a replacement period should be much shorter than it is actually now days.

5 From the source of energy carrier to the tank

- From the input data of MOL (Hungarian Oil & Gas Company Plc), for conventional fuels, an excess of 17-18% can be calculated, but only for domestic activities, that is without exploitation and international delivery costs. According to the data of the European CONCAWE project Well-to-Tank Report (2008), average CO_2 input values are the following:

  for petrol 12.5 g/MJ, energy input 14%;

  for gasoline 14.2 g/MJ, energy input 16%,

  (equivalent to 16.8 and 19.4 % greenhouse gas input resp.),

  LPG 8 g/MJ, energy input 12%.
- In case of natural gas as fuel, by the WTT Report analysis:

  ❶ EU mix from gas pipe compressed to CNG 8.7 g/MJ, energy input 12%;

  ❷ Russian import gas compressed to CNG 22.3 g/MJ, energy input 30%;

  ❸ Liquid natural gas to CNG 20.8 g/MJ, energy input 26%;

  ❹ Liquid natural gas as LNG 19.3 g/MJ, energy input 23%;

It is to be noted that, as regards WTT Report basic data, liquefaction input and LNG-to-CNG input considerably exceed the possibilities provided by today's technology and documented by market players.

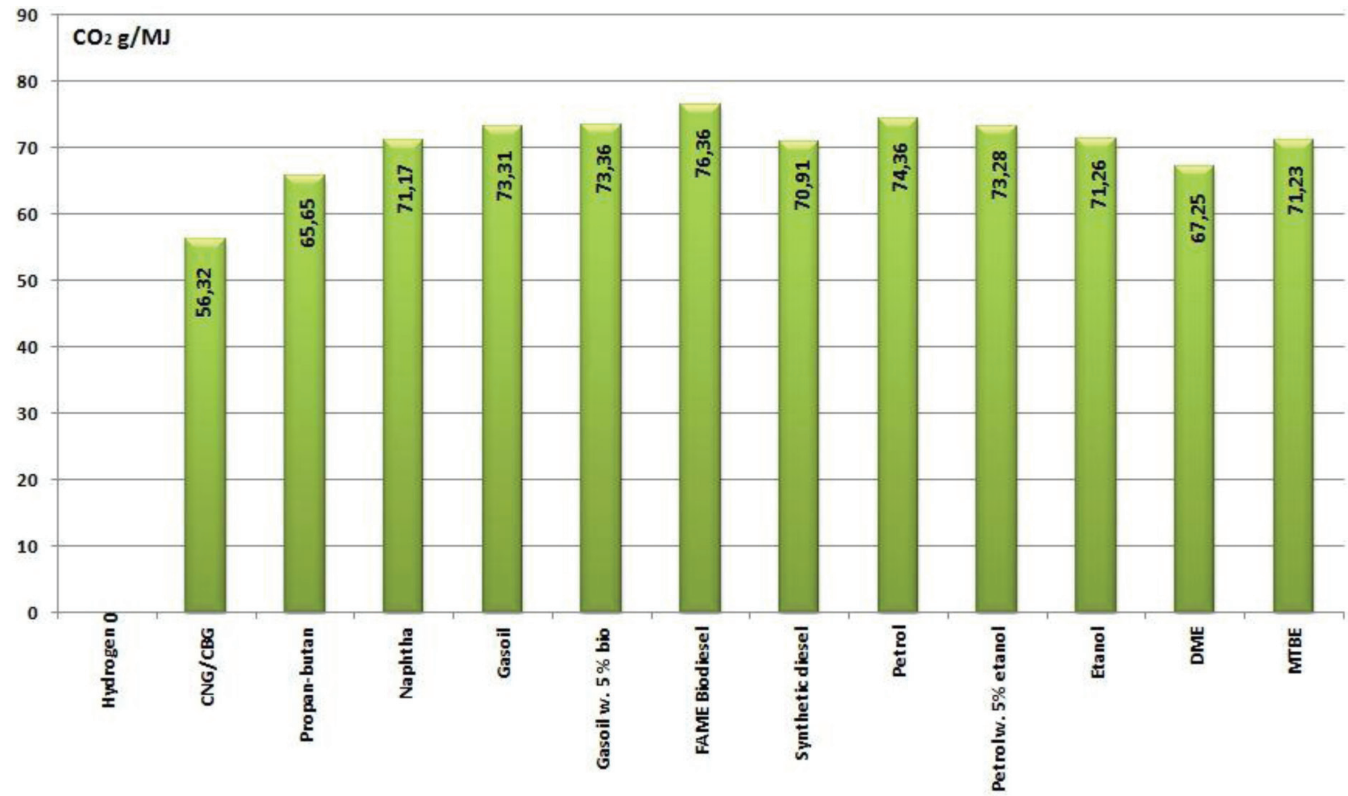


Fig. 2. The tailpipe greenhouse gas emission is depends of the molecule mixture in the burned energy carrier. *Figures from CONCAWE WTT report.*

6 What do renewable bring in the WTT calculation?

In the table, multipliers of greenhouse gas emission decrease specified in the Appendix of Directive No.

Sugar beet ethanol	61%
Wheat ethanol without indication of fuel used for processing	32%
Wheat ethanol (fuel used for processing is lignite, in cogeneration power plant)	32%
Wheat ethanol (fuel used for processing is natural gas, in conventional boiler)	45%
Wheat ethanol (fuel used for processing is natural gas, in cogeneration power plant)	53%
Wheat ethanol (fuel used for processing is straw, in cogeneration power plant)	69%
Corn ethanol produced in the EC (fuel used for processing is natural gas, in cogeneration power plant)	56%
Sugar cane ethanol	71%
Rapeseed biodiesel	45%
Sunflower biodiesel	58%
Soybean biodiesl	40%
Palm oil biodiesel (non-defined process)	36%
Palm oil biodiesel (during the process methane fixation is made in the oil-presser)	62%
Biodiesel made from waste vegetable or animal oil	88%
Hydrogen treated plant oil from rape	51%
Hydrogen treated plant oil from sunflower	65%

Hydrogen treated plant oil from palm oil (non-defined process)	40%
Hydrogen treated plant oil from palm oil (during the process methane fixation is made in the oil-presser)	68%
Clean plant oil from rape	58%
Biogas from organic houshold waste as compressed natural gas	80%
Biogas from wet manure as compressed natural gas	84%
Biogas from dry manure as compressed natural gas	86%
Wheat straw ethanol	87%
Ethanol from wood waste	80%
Ethanol from cultivated wood	76%
Wood waste based Fischer-Tropsch diesel	95%
Cultivated wood based Fischer-Tropsch diesel	93%
Wood waste dymethil ether (DME)	95%
Cultivated wood dymethil ether (DME)	92%
Wood waste methanol	94%
Cultivated wood methanol	91%
Methyl tert-butyl ether (MTBE), the part made from renewable energy sources	as methanol
Ethyl tert-butyl ether (ETBE), the part made from renewable energy sources	as ethanol
Tert-amyl ethyl ether (TAEE), the part made from renewable energy sources	as ethanol
Hydrogen treated plant oil from sunflower	65%

Fig. 3. It is how to count the avoided carbon emission into the air, through the replacement of conventional fuels by renewables. *Figures from the Appendix of Directive No. 2009/28 EC of the European Union.*

2009/28 EC of the European Union are included, which serve as guidelines in comparison with the level measured for the relevant fossil fuel emission of each alternative, after taking lifecycle calculation into consideration. When using the table, it is possible to prove a divergent result, just as the occasionally divergent measure of carbon fixation deriving from land-use change must also be taken into account.

In this sense, also the saving result of landfill gas utilization for biomethane purposes greatly depends on the starting conditions. The neutralization-free landfill gas emission of the dump will provide another result than the one when we take a collected and torched status as a starting point.

In addition to the data in the table, biomethane deriving from agriculturally cultivated base material must also be listed, which, according to the CONCAWE WTT Report analysis, including the cultivation process, results the following CO_2 savings:

CBG from wheat
-55%, energy input 120%

As for this value, it is also to be noted that cultivated plants, according to their species, can produce very different crop yields, and also the gas yield of biogas factories can be greatly influenced by the recipe applied, and the composition of the organic materials added.

A great part of the world is committed to the future participation of „clean hydrogen" in transport. While promising-looking developments of internal combustion engines are – at least temporarily – broken off, due to technological problems, the onboard electricity generation, notably the fuel cell technological development is an ongoing course. Today, the main motivation of development in the industry is not to reach applicability, but to reduce production cost by two orders of magnitude. For expansion, however, a dense network of fuelling infrastructure sized for small effective range would be needed – but neither the State of California, after serious investments, can call it as sufficient with its network, what is not reaching 40 units. Based on a joint Shell-GM analysis, for a sufficient level of hydrogen fuel station infrastructure for United States, would require an investment of about USD 15 billion. All this is without saying a word on the source of hydrogen. Though, this item is the most critical of all in hydrogen-based transport.

Without making a particular and detailed analysis here, for the evaluation of H_2 fuel, let us take (from the CONCAWE study) as an example the CO_2 input of the currently cheapest and most frequent production version, namely that of the natural gas reformation and compression:

Hydrogen from natural gas
227.1 g/MJ, energy input 272%.

It clearly shows that hydrogen, along this line, does not provide a sustainable alternative. This statement can be, of course, varied with the favourable results provided by the much more expensive production technologies; however the market-based realization of all these more expensive processes seems to be unimaginable.

7 How great advantages are carried by electric propulsion?

- For politicians, electric propulsion gives the vision of emission-free transport, on the basis that the fully electric driven vehicle does not have an exhaust pipe.
- However, it has a battery package with some Li-ion technology and a large mass (150-500 kg for personal cars), the manufacturing of which is not only extremely expensive in itself, but its environmental load by lifecycle exceeds that of the production of a whole vehicle. Also, rare metals used for electric motor production press the point of long term produce ability, and, in the part the world outside China, the issue of competitiveness.

8 Success depends not only on technology, but on the base material as well

- In case in the decade 2020-30 the hybrid and fully electric vehicles, according to many analyst expectations, reach or perhaps exceed a 20% market share, then the demand for copper, neodymium ($_{60}Nd$) and lithium will grow 200-fold of the present level! There are also doubts regarding the future financial coverage and price of dysprosium ($_{66}Dy$) – used as further base material component of magnets (of which, 95% of the present 1,100 tons world exploitation can be found in China) – and praseodymium ($_{59}Pr$).

9 How much is the true of zero emission?

- Calculated from EUROSTAT data (in 2006) CO_2 intensity of Hungarian electricity is 0.2459 kg/kWh,
- which value is slightly favourable than the EU-27 0.2563 kg/kWh average.

10 It seems to be a good result, but is it true?

- A - statistically - realistic emission can be checked and calculated by the data queues to be found in 151 page long, latest MEH Statistical Yearbook (all further table data queues derive from here and relate to the latest accessible year 2010; cases different from it, are indicated)

11 How much output belongs to the „non-neglect able sized" emissions?

It is to be added to all these data queues, that the MEH report does not include the CO2 input of the explorations and deliveries to power plants of the all together 403.8 PJ primary energies. The value of this input, according to the applied CONCAWE study, is 22% for gas (kWh/kWh energy quantity). However, regarding to a number of used energy carriers, a weighting is

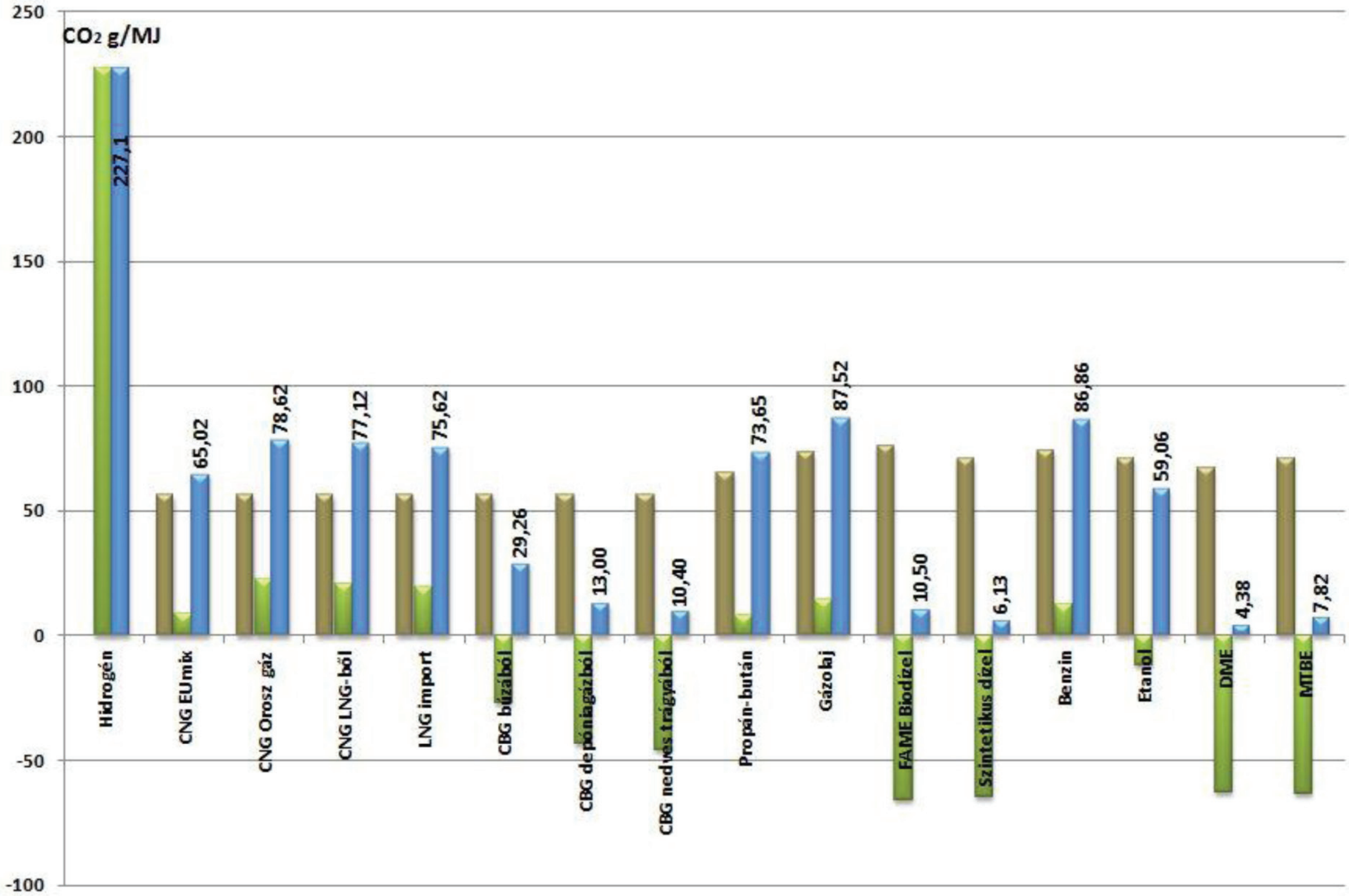


Fig. 4. The diagram is comparing the different fuel alternatives through the TTW (brown) WTT (green) and WTW (blue) emission. *Figures based on CONCAWE WTW report.*

Power plant annual emission	Total emissions
(CO_2 (20-80 \$/t)	12,958,520 t
SO_2 (1,000-13,000 €/t)	8,705 t
NO_x (700-9,600 €/t)	12,891 t
CO	3,822 t

Fig. 5. Annual emission of the Hungarian Power plants, over 50 MW capacity, and in bracket the external cost of these emissions. *Quantity figures coming from MEH Statistical Yearbook, external cost of CO2 IPCC WGIII Report, and cost of harmful emission INFRAS Handbook on external cost estimation on the transport sector, CO mostly not evaluated separately.*

Power plant electricity production	37,370,818	MWh
Of which the over 50 MW plants	30,969,936	MWh
Of which small power plants	6,400,882	MWh
Of which renewable	3,402,450	MWh
Import-export balance	5,195,163	MWh

Fig. 6. Base figures of the electrical energy production in Hungary. *Figures are from MEH.*

For the measure of specific emissions, must be taken into consideration the system losses too

Power plant electricity production, over 50 MW plants	30 969 936	MWh
Power plant electricity sales, over 50 MW plants	28 556 856	MWh
Power plant self-consumption, 50 MW plants (calculated)	2 413 080	MWh
Ratio of power plant net production to total production, 50 MW plants	92.21	%

The following data serve the simplified calculation of network losses of electricity coming out from power plants:

Total quantity of electricity fed into distribution network	40 512 458	MWh
Electric energy transfer network losses	373 793	MWh
Distribution network losses	3 426 864	MWh
Degree of efficiency of distribution and transfer network losses	90.62	MWh
Renewable energy correction for further consideration	109.10	%

Fig. 7. Calculation of the lost and intern used energy in the Hungarian electricity production chain. *Figures are from MEH, calculation from the author.*

necessary in a proportion that reflects their share and place of origin as they arrive into the power plants. Ignoring further wide-ranging examination of this issue, for the calculation of the emissions of the vehicle finally presented, a factor of 1.2 hypothetically average is used.

12 Efficiency examination of electric propulsion

Arguing in favour of the electric propulsion, beyond zero emissions, we can appreciate excellent electromotor efficiency values. Here we favour a partial truth again. Modern e-motor, through construction type and design perfection, can operate even with 97% peak efficiency; for the full operating range, typically a value between 85 and 97% is realized, which is of course an excellent result. For the whole of transport needs, it can be taken as an average of 90%. However, the process going on in the vehicle does not end here, as a serious role falls to the transformers, to the converter and inverter units, which, in the form of heat, lose some quantities of input energy, and naturally the charge uptake and discharge energy of batteries cannot be completely identical either – on top of all this, high-voltage wiring and junctions also use up energy. In addition, all these consumption points will become more „hungry" by time. All in all, an efficiency of 85% can be set up, which includes cooling-heating energy requirement of drive system elements needed for maintaining operating temperature window.

In reality, heat energy requirement of the cabin – due to passenger comfort requirements – contributes a large extent to the energy consumption of electric vehicles. Electric heater and climate compressor, which, under real circumstances, are becoming electric consumers both in winter and summer, do not need extreme weather conditions to reduce the effective range even by 40% during a standard consumption period. (This is verified by a number of European and American measurements and self experience as well.)

With internal combustion engines – disregarding the luxury of supplementary heating – the cabin is heated by the heat loss, which we otherwise deduct as thermal loss from the engine efficiency, so here heating typically does not require any excess energy. In case of conventional drive chain, during consumption metering, the cycle must be run in the switched-off position of the climate compressor, so the energy requirement of it is not taken into account at the electric propulsion either.

For heating, by calculating 5 months and an average of 20% energy needs, a range reduction of 8.33% is to be considered to simulate real circumstances.

13 Alternative energetic potential - or how much space is there to replace oil?

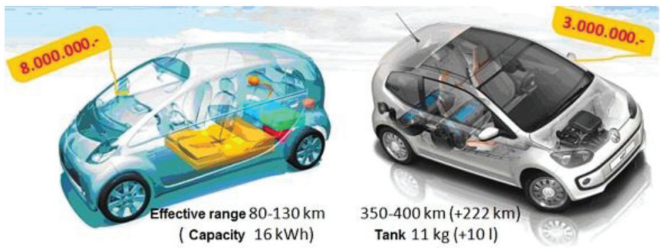
- Energy consumption of the domestic surface transport in Hungary (without air traffic) culminated in 2008 on a level of 205.85 PJ (of which 194.5 PJ oil-based), and then, along the economic recession, it decreased by more than 10% (total WTW emissions were 17.35 million tons of CO_2). Based on future perspectives, mobility needs will grow again with the development of a permanent economic upwards. In parallel on the other side, vehicle efficiency will continuously increase, and thanks to all these, future energy consumption is to be expected in a range between 200-215 PJ. Therefore in a time horizon of one decade or over, in order to replace 100% of oil we must input 200 PJ of alternative energy to transport.

Specific emissions of domestic electricity production, based on the previously mentioned facts

	Total emissions	Specific emissions for net energy production, corrected by the renewables	Specific emissions for net energy production, corrected by the renewables and losses of the network
CO_2	12,958,520 t	0.41591 kg/kWh	0.45897 kg/kWh
SO_2	8,705 t	0.27939 g/kWh	0.30832 g/kWh
NO_x	12,891 t	0.41375 g/kWh	0.45658 g/kWh
CO	3,822 t	0.12267 g/kWh	0.13537 g/kWh

Fig. 8. Calculated specific emission values of the Hungarian electricity production and supply network.
Figures based on the MEH data, divided by the author.

Translated into vehicle, the WTW emission can be compared



	Citroën C-Zero	VW Up! CNG
Avg.cons.	12.5 kWh/100 km	130.79 MJ/100 km
CO_2	80.99* (~=85.36) g/km	85.04962 g/km
SO_2	0.97755* g/kWh	0 g/kWh
NO_x	1.44763* g/kWh	0.0048 g/kWh
CO	0.42920* g/kWh	<<1 g/kWh

**To cover the heating needs detailed later, an additional 9.09 % emission must be calculated, so the the 85.36 g/km is the real CO2 emission, so far values of the pollutants also to be corrected.*

Fig. 9. CThe price labels on the picture above are showing the approx. purchase price in Hungarian Forint, with all the taxes. *The consumption figures based producer data, as average consumption per 100 km, measured follow the NEDC-cycle. Emission values for the e-mobil based on the previous calculation, for NGV simply general and producer data.*

Power plant electricity production	134,535 TJ
Power plant heat generation	46,030 TJ
Power plant energy carrier use	403,836 TJ
Power plant conversion efficiency	44.71 %
Proportion of power plant output to generated electricity	92.21 %
Degree of efficiency of distribution and transformer network losses	90.62 %
Degrees of efficiency total	37.36 %
Total charge/discharge efficiency of energy storage system	85.00 %
Average efficiency of electric engine	90.00 %
Final efficiency	**28.58 %**
Final efficiency for driving in consideration of heating needs	26.38 %

Fig. 10. Efficiency calculation for the e-mobil, where to note, this is an actual TTW efficiency, while the primer energy carrier exploration and its transport is not evaluated, just an evaluation of the energy cycle from the quantity of primer energy to the wheel. Finally it is considered a basic energy consumption of cabin heating. *Figures are from MEH data and calculation of author.*

- In 2011, our imports of Russian natural gas fell back to 59% of the total gas consumption, from the 70.7% in 2008. In this year, however, the 12.383 cubic metres quantity, in the proportion of imports from Russia, is higher, than the 62.9% experienced at the peak consumption in 2005, when 14.325 cubic metres were used. Altogether, the gas import from Russia is decreased about 2.2 cubic metres, which is equal to 75 PJ energy quantity. This capacity is available, with a good accessibility, without any network investment and supply disturbances. Its disadvantage is the relatively high price, thanks to the long term delivery contract.
- An alternative or supplement of the present Russian gas supply capacity is another Russian pipe, the South Stream pipeline project, from which an additional 6 billion cubic metres gas could arrive to us for the end of the decade and that is 200 PJ. Its disadvantage is the high price that is mostly or fully indexed to oil, therefore, it means a strategically wrong decision to increase the dependency for the future.
- An alternative of the Russian pipeline is another pipe project, the European Nabucco-West, with an intended capacity of 10 billion cubic meters, of which we may have a share of 1 billion cubic meters, that is approximately 35 PJ could be obtained. It has the advantage of a lower price, but also the disadvantage that on sixth of Nabucco-West investment budget would be charged to Hungary.
- Similarly, about 1 billion cubic metres of gas could be received by building up the pipeline between the planned LNG terminal in the Krk Island (Croatia) and the Hungarian border, which seems to be feasible by 2018, so a 35 PJ energy quantity is expectable from here as well. Its advantage is the opportunity of the lowest gas purchase price, disadvantage is the project cost.

Source	Biogas yield (Mm3)	Methane content (%)	Biometh. yield (Mm3)	Energy yield (PJ)
Processing industry	100	60	60	2.28
Manure from agricultural animal husbandry	500	57	285	10.83
Artichoke cultivation for energy purposes (0.875 Mha.)	5,930	60	3,558	135.20
Communal waste (4.5 Mt*29% org. contents)	326	60	196	7.44
Total			4,088.75	155.75

Fig. 11. This is an example of the biomethane potential calculation in Hungary. *Figures from the LNG supply and consumer chain project, coordinated by the author.*

- The natural gas alternative is an opportunity available today and being able to cover oil replacement entirely; however, in the interest of climate protection, for the real start-up of decarbonisation process, the methane gas of renewable origin is a far more important alternative. Its initial disadvantage is that, besides many small-scale, but relatively low-cost technological biomass developments, a full economic chain must be established, together with a wide-ranging attitude development, more likely transformation. Its advantage is, that can be produced at competitive prices in the long run, creating a great number of rural jobs, increasing the value creation ability of arable land, meeting destruction obligations based on ecological aspects in the most useful way, replacing import energy. Our national biomethane potential, according to one of our realizable simulation, is as follows
- It is possible to reach even 75% of oil replacement without arising any food supply or animal feeding problems.
- Investment costs of biomethane-producing technology are, according to the simulation, in good approximation, 10 HUF/MJ, that is 1.550 billion HUF.
- Of course, for transport-oriented utilization, the extension of filling station network is also needed. For a widespread extension, considering area sizes of Hungary, about 200 filling points are necessary to be established; with an expenditure of 50 million HUF per one facility, the total comes to 10 billion HUF.
- The extra charge of vehicle stock that is 75% gas-operated is about 1,300 billion HUF.

14 What is our option at the e-mobility pathway?

- The power plant net electricity production (in 2010) totals 34,613 TWh = 124.6 PJ, and also considering network and distribution losses, this value shrinks to 112.9 PJ, which is only 56.4% of the energy quantity, what would need to replace petrol, gasoline and LPG. For the achievement of a significant electric car proportion, a power plant capacity extension is needed, and naturally actions such as distribution network extension, building up an electricity storage system and lately, but not lastly the establishment of ten thousands of filling points also required. If we aim to reach a vehicle proportion of 20% in the next decade (as many analyst are predicting), with regard to the internal energy efficiency of the electric vehicle, then 38% of the energy contents of replaceable conventional fuel should be made available, that is, from the power plant side, the building up of an electricity production capacity of 17 PJ (= 4.75 TWh) should be targeted.

15 How big investment is needed for 20 % e-mobility share?

- Making multiplications for nuclear power plants, theoretically an investment of 120 billion HUF is needed, for the power plant coverage of 20 % capacity.
- Ignoring (the massive) investment requirement of network development and capacity extension, but partly taking it into consideration for the establishment of filling points, an average of 150 billion HUF development amount must be counted on.
- Of course, a vehicle surcharge price is also to be calculated for realization, which means that – with the estimation of a 40% future decrease of the present (minimum) 5 million HUF surcharge price – for reaching a 20% ratio in vehicle park, 600,000 electric cars can be calculated, and, with a smaller increase of the number of pieces per thousand people, an additional 100,000 electric cars can be calculated. Making the multiplication, the result will be about 2,100 billion HUF.

Therefore, based on present knowledge, the conversion of 20% of the vehicle park into electric propulsion requires an investment of 2,370 billion HUF.

Power plant average investment costs

Specific investment costs for power plant	$/MWh
Solar collector	312
Offshore wind generator	243
Solar cell	211
Carbon power plant with CCS technology	136
Nuclear power plant	114
Biomass-fired power plant	112
Onshore wind generator	97
Carbon power plant	95
Gas power plant with CCS technology	89
Hydroelectric power plant	86
Combined cycle gas power plant	63

Fig. 12. Indicating the specific investment costs for a state-of-the-art designed power plant technologies, as design them today and opened for 2016, values in US$ per MWh capacity. *Median values of data compiled by the Institute of Energy Research published in 2011 in the Annual Energy Outlook by the US Energy Information Administration.*

Gas propulsion vs. e-mobility – till the end of the next decade

	Gas prop.	E-mob.	
Possible rate of oil replacement	100	20	%
Possible rate of renewable	<75	20-30	%
Specific costs of oil replacement with low-carbon energy carrier (for 1 % oil = 2 PJ oil replace)	38.13*	118.5**	bln HUF/1 %

**Biogas-CNG route 1% oil replacement costs*

***Nuclear – electricity route 1% oil replacement costs*

Fig. 13. Prospect and cost of the oil replacement is in the transportation sector. *Rate of replacement by e-mobility is based on a mean value in different studies, for 2030.*

16 Fiscal aspects

Sustainability issues are obviously important for policy representatives, but naturally the balance of budget and the assurance of tax revenues are centred. In Hungary, both of the compared alternative fuels are exempt from excise duty payment. As for gas, based on the European Union unified green energy taxation plan, a uniform, energy based tax should be imposed on fuels in the future, according to the current proposal submissions, until 2030 to support the building up of infrastructure, with a preference of 50% for gases. By this plan, the widespread extension of gas propulsion, on the excise duty line, from the 500-600 billion HUF revenues, will result – temporarily, in the period 2018-2030 – a tax revenue decrease of 2.5-3 billion HUF per year and per percentage of conventional fuel replaced. It is important, however, to consider the fact that gas propulsion will spread first of all in public transport, where the participation of the central budget is unavoidable, and the measure of the necessary support is much higher than this. With the spreading of gas propulsion, fuel costs of bus transport service companies can be reduced by even a total of 30 billion HUF, so the opportunity to reduce the support amount will exceed the expected decrease in excise duty revenues.

Contrary to the gas propulsion taxation system, the method of excise taxation of the electricity filled into cars is not at all elaborated; there is not any solution for it even on a conceptual level. Regarding its amount, the replaced conventional fuel causes a drop-out of 5-6 billion HUF per percentage; therefore, in view of the 20% proportion targeted for the next decade, it means 100-120 billion HUF for the state budget (on the current taxation level).

Specialists avoid pressing this point so much, while as network system developers are looking for car batteries as significant sized electricity buffer storage of the future. In the system, batteries are hanging on the wire, discharging in the peak period, and filling up in the off-peak period. Therefore, the connection will become bi-directional, and it keeps on making excise taxation functions baseless and impossible.

Of course, it is also feasible to introduce a taxation attached to vehicle purchase price and payable as one sum or a monthly lump-sum amount. However, it is to be stated that this solution would definitely act as an obstacle to the widespread extension, so neither energy strategy nor environmental health aspects make it reasonable to recommend it.

17 Conclusions

This parallel analysis gave a good example for understanding the value of the differences between primary and secondary energy carrier.

As it coming from the previous figures, e-mobility is not clean at all, but environmentally harmful! In medium term the place is there, but only in a moderate share is possible to phase out the oil by electricity. The cost however is remarkable, and the question is who shall pay for it. Also the tax income outage is to be hardly considered. The e-mobility will comes viable by the time, as first in long term, as the electric vehicles reaching their mass reduction by a factor 5 or more, and the consumption is decreasing in a horizon of one tens the today's level, and beside that, also the electricity should comes to be less polluting by magnitudes than today.

Compared to the e-mobility, the gas fuelling is a viable solution of today. The energy carrier is available for facing out the oil even by 100 percent. As target is, not only to reducing the CO2 emission by the factor of 20 percent but decreasing it down close to the zero, than the biogas solution seems to be the most ready alternative. Good examples is ahead of as, as Sweden consuming two third of its gas from renewable, or Germany, where not only the number of CNG stations are sufficient, but in a short term have been doubled the number of biomethane filling points. Potentially biomethane could serve in Hungary three-quarter of the total energy consumption, with wide range of co-effects, like the increased income possibility for rural, or the booming green industry.

But have to notice, that vehicle industry is now still taking care insufficiently for developing the gas powered vehicles. As far, the offered range size will not be comparable to the petrol and diesel vehicle lists, the gas powering will stay in a marginal level. Have to make intention, that only in medium and slow speed engine size to be found as real efficient engines (better than diesel engines, powered by oil). For the road vehicles no one yet made a breakthrough gas engine, just some modified engines got to be on the market.

Because of the reality of the shortage of wells, first of all in the money what is able to be spend, politicians have to realize the fact that the gas vehicles are the only way forward today and in their promotions have to take care for this!

Notations

SECA Zone :Emission Control Area, where the sulfur emission is forbidden (limit 0.1%, compared to 1.5 % as emission limit otherwise). The first ECA areas around the US and Canadian cost, and SECA area is for the European North Sea and Baltic Sea plus the English Channel will take into force as starting 2015. Further ECA, SECA areas will come into force.

TTW :Tank-to-Wheel, the commonly called as tailpipe emission

WTT :Well-to-Tank, from the origin of the energy to the vehicle energy storage

WTW : Well-to-Wheel, the complete energy circle from the production of the primer energy to the energy consumption of the vehicle

GHG :Greenhouse gas emission, the content of the emission which has influence to the global warming, expressed in CO_2 equivalent. The concentration of the CO_2 in the atmosphere (measured in ppm) a proven inflict of the undesired climate change

Biogas :a gas from renewable source with different composition, where a significant proportion is methane, what is the main contributor to the fossil natural gas. The source of the biogas can be the agriculture, the forestry, the livestock, the food industry, as well the urban environment, with its municipal solid waste, or the waste water treatment, where organic waste is to be recovered for biogas production

Biomethane :from residues and inert content cleaned biogas is the biomethane, where methane content is over 75% and the rest is CO_2, so the name is coming from. The compressed biomethane is equally usable for vehicle propulsion to the compressed natural gas, and it is able to mix it in any rate. The compressed biomethane (often CBG or bio-CNG) is clean and worthy biofuel, with extremely low emission level

E-mobility :transport via purely electrically driven vehicles. These vehicles can be charged to their accumulator from the electric grid, but also the fuel-cell vehicles are considered as e-mobile, where the fuel can be the hydrogen (as today's FC technology allowed for the vehicle propulsion). This paper in the analysis is ignoring the FCEV (Fuel-Cell Electric Vehicle) route

HUF :Hungarian Forint, 1 Euro is about 300 Forint

MJ :energy unit, 10^6 Joule

PJ :10^{12} Joule

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