"Electric cars compared to ultra-light electric vehicles and global warming"

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"Electric cars compared to ultra-light electric vehicles and global warming"

Although some effort has been done, if the full global warming effect is considered, also the parasitic methane emissions should be taken in account and not only CO2 for electric vehicles. Not just -20% (2020), but big changes are needed to counter the global warming problem. Drastic solutions are ultralight electric vehicles instead of the actual heavy ones. If the technology is well developed, it can reduce CO2 emissions by a factor 5 compared to usual electric vehicles (2050 target).

It has also effect on the indirect CH4 emissions in electricity, but also at tire dust, which might be even the biggest source of particulate matter PM10-PM2.5. A vehicle concept F2E for two electric is proposed, towards a very good compromise between energy, comfort, cost, global warming and pollution.
Leaks of methane?

CH4 LEAKS estimate in 2017….?
https://www.iea.org/Textbase/npsum/weo2017SUM.pdf

.... estimated 76 million tonnes of methane emitted worldwide each year in oil and gas operations...

CH4 GLOBAL PRODUCTION 2017

3680.4 Billion m³ ; 0.678 kg/m^3 = 2495 million ton

So, in 2017 the estimate was 76/2495= **3.05% leak** compared to natural gas production

- Does contain the CH4 leaks of oil production as well, does not contain end user leaks.
- Probably methane leaks are seriously underestimated: news 2018

Methane emissions from Pennsylvania’s oil and gas sites may be **522,400 tons a year** rather than the 112,100 tons oil and gas companies report to the Department of Environmental Protection, according to a new analysis released Thursday by the Environmental Defense Fund.

Methane emissions from Alberta oil/gas production under-reported by as much as 15 times – study Mar 28, 2018

-- A good *estimate today* could be 5% leak with 1.5% tolerance, so 3.5 … 6.5% --

Good news: big oil companies promise to reduce their part (3.4%) divided by two
Probably remaining 3%+-1% inaccuracy after 10 years

|| MethaneSAT will be able to detect and verify sources, launch 2021... ||

--- We take 3% leak in account after 2020, by expected near future improvements ---
Figure CH4 GWP and AGWP
(Fig 8.28 of reference IPCC WG1AR5)
Summarizes what people should know about global warming
\[ \text{GWP}_{\text{CH}_4} = \text{impulse effect of methane, a sudden release} = \text{120 times CO2} \]
\[ \text{AGWP}_{\text{CH}_4} = \text{absolute “step response” on a continuous release} = \text{26 times CO2 at 100 year horizon.} \]
\text{Is 84 times at 20 year horizon = melting of major artic ice surface.}
Tesla?
19.9 kWh/100 km ≈ 0.2 kWh/km

Additional kWh will be covered mainly by GTCC gas turbine combined cycle (even worse if partly coal...) Nuclear power plants are likely to close, not all are charging during day or when sun or wind is available. Average people will also not tolerate more wind turbines when “forced” to drive electric cars...

400 g CO2/kWh for GTCC
Without methane
0.2*0.4 = 80 g CO2/km
With methane leaks in account
0.2*0.4*(1+0.03*26) = 142 g CO2e/km

Tires? Rubber = PAH poly-aromatic-hydrocarbons
7 kg rubber wear for 20 000 miles = 32000 km; = 0.219 g dust/km: air, land, water, worse than diesel 0.005 g even with “gate”?
+ Battery?
Moves energy and pollution from end user to chemistry and mineral exploitation, adds about 33% on energy needs in 160 000 km.
-> 189 g CO2eb/km in total?
**GWP by cars with electricity from natural gas.**

Today, “good” electric Car?
About 15 kWh/100 km at wall plug.

**Additional kWh will be covered mainly by GTCC** gas turbine combined cycle (not better if partly coal…)
Nuclear power plants are likely to close, not all charging during day or when wind is available.

*Average people will also not tolerate more wind turbines as they are forced to drive electric cars…*

400 gCO2/kWh for GTCC
Without methane
0.15*0.4= 60 g CO2/km
With methane leaks
0.15*0.4*(1+0.03*26)=106.8 gCO2e/km
<20% better than diesel or gasoline?

**Tires? Rubber = PAH**
PAH poly-aromatic-hydrocarbons = toxic
https://en.wikipedia.org/wiki/Polycyclic_aromatic_hydrocarbon
5 kg rubber for 50 000 km
= 0.1 g dust/km **(similar to actual cars)**
-> air, water, land
843 Billion car km in Belgium
= 84300 tons of rubber particulates

**Euro 6 tailpipe “limit” is 0.005 g/km**

**+Battery?**
33% energy for manufacturing of battery in 160 000 km
-> 142 gCO2eb/km in total
### F2E For Two Electric Concept at UGENT EELAB

<table>
<thead>
<tr>
<th>Feature</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type</strong></td>
<td>F2E</td>
</tr>
<tr>
<td><strong>Persons</strong></td>
<td>Two</td>
</tr>
<tr>
<td><strong>Curb weight (+/-20%)</strong></td>
<td>150 kg</td>
</tr>
<tr>
<td><strong>Total weight for the performance</strong></td>
<td>350 kg</td>
</tr>
<tr>
<td><strong>Driven front wheels</strong></td>
<td>2</td>
</tr>
<tr>
<td><strong>Rear wheels (under discussion)</strong></td>
<td>2</td>
</tr>
<tr>
<td><strong>Drag coefficient</strong></td>
<td>0.35</td>
</tr>
<tr>
<td><strong>Frontal area</strong></td>
<td>0.9 m²</td>
</tr>
<tr>
<td><strong>Rolling resistance</strong></td>
<td>0.008</td>
</tr>
<tr>
<td><strong>Auxiliaries (light, dashboard, fan)</strong></td>
<td>35W</td>
</tr>
<tr>
<td><strong>Battery &lt;30 and &lt;40 kg based on LiFePO4, 96V</strong></td>
<td>4.5 kWh</td>
</tr>
<tr>
<td><strong>Acceleration 0-50km/h</strong></td>
<td>8 s</td>
</tr>
<tr>
<td><strong>Maximum speed</strong></td>
<td>90 km/h</td>
</tr>
<tr>
<td><strong>Gradeability</strong></td>
<td>20%</td>
</tr>
<tr>
<td><strong>Average efficiency from battery to wheel</strong> (The peak efficiency is much higher)</td>
<td>&gt;80%</td>
</tr>
<tr>
<td><strong>Maximum efficiency from battery to wheel</strong></td>
<td>&gt;90%</td>
</tr>
</tbody>
</table>

*Fig: Losses at the wheel level for F2E, two persons, at 350kg total weight (two persons in it)*

- **Country= constant speed,**
- **City = stopping 300 times/100km, 50% recovery**
- **Hill= 1000m in 100km**

In the example next slide we take **3 kWh/100 km**
Ultralight electric vehicle F2E

**kWh covered by GTCC** gas turbine combined cycle (not better if partly coal…)

400 gCO2/kWh for GTCC
Without methane
0.03*0.4 = 12 g CO2/km
With methane leaks
0.03*0.4*(1+0.03*26) = 21.4 gCO2e/km

It is only beaten by pedelecs and velomobiles, that do not give the same speed nor the same safety.
Two person: so a wider use for people and luggage or shopping.

**Tires?** Rubber
Emission proportional to weight
0.100*250/1500 = 0.016 g/km
An incredible reduction of tire particulates

**Battery?**
With battery manufacturing: **28 gCO2eb/km**

**Electricity partly produced by the PV panel of the roof.**
F2E “For Two Electric”
Prototype under construction EELAB June 2017
Ugent Technologiepark 913 B9000 Gent

See it riding:
https://www.youtube.com/watch?v=VXKnS0q

It is an improvement on this keynote in Skikda 2012
https://www.researchgate.net/project/Ultralight-and-efficient-electric-vehicles
and
https://www.researchgate.net/publication/281584740_How_to_reduce_the_energy_needs_of_electrical_and_conventional_vehicles

Who wants to invest in further development and production?

It is not only mechanics but a lot of auxiliary power electronic circuits are needed to function well, management of battery, PV panels, chargers, drives, lights, wiper, dashboard, suspension; quite different from what is common available but gives added value.
Conclusion and suggestions

- Global warming should change drastically.
- For commuting purpose, a factor 5 is possible compared to the actual electric cars.
- F2E “for two electric”
- Ultra-light electric vehicles could solve at least the short-medium distance commuting;
- Who invests?

Business plan, international connections, engineering to make it more cost effective, design to make it attractive, marketing…
A warm Thank You