

Composite bus version with five driveline possibility

*e*vopro Bus Kft, IPR covered and patented solutions



Content:



□ Why composite sandwich material built the structure?

- Weight and Curb weight relation, achieve the best passenger transportation capacity.
- Weight and powering requirements, and his outgrows, like energy consumption.
- Modularity and tooling cost. (welding v bonding)
- evopro1 material properties according the ECE autobus directive requirements
 - Emission;- noise and electromagnetic fields or exhausts gases
 - Absorption; water and humidity or ozone
- Cost

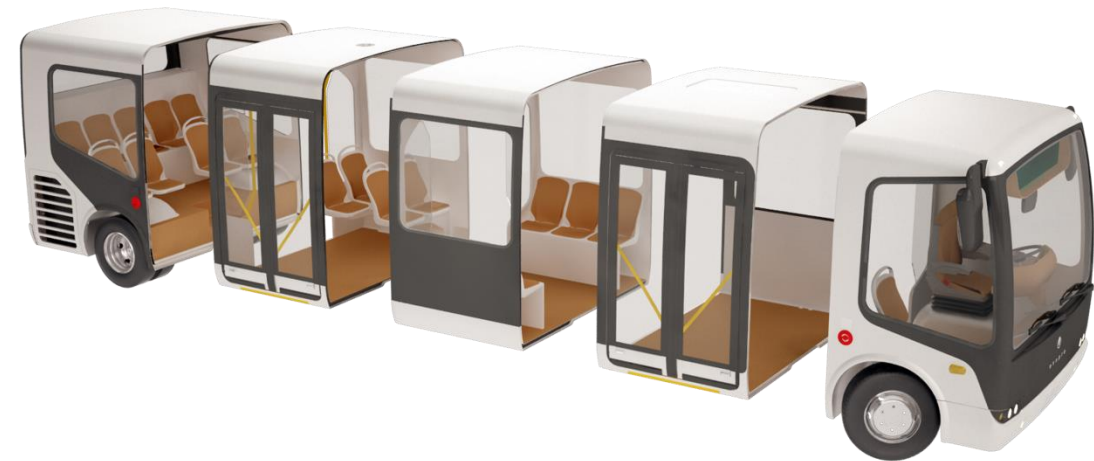
□ Five drivetrain possibilities?

- Diesel
- CNG
- Full battery powering
- Serial hybrid drive train
- Trolleybus possibility

□ Environmental protection.

- Recycling / rebuilding
- Infrastructure protection

□ The business ways possibilities



Why composite sandwich material built the structure?



- ❑ material strength comparable to carbon steel but its mass just 25%
- ❑ Young modulus can compensate with inertia increasing
- ❑ Reinforcement with quadraxial oriented rows in layer easy manufacturing access.
- ❑ Reduce the bus building access. No floor, no outer and inner sheeting no extra insulation
- ❑ Due to the composite material's corrosion resistance its lifetime is longer (20-25 years)
- ❑ One tooling system to different vehicles, but same spare parts
- ❑ The gross vehicle weight is less, so the axle loads are smaller, therefore the road stress decreases .
- ❑ Smaller weight, less energy consumption, smaller main component = smaller operational costs in traffic
- ❑ Investment cost is 15-25% lower, compared to a conventional bus building system



Calculations, then verifying measurements are executed on the basis of EEC and ECE Directives in their state of validity at (2001/85;97/27;) 2011.06.01 . The traditional 12m bus with 100 passenger capacity and GVW18 tons weight ,yet 13 tons 10,5m long vehicle 98 passenger



The manufacturing and assembly time can reduce with 223 hours, because the composite sandwich structure gives a better solution with painting materials. Water resistant and anti-vandal.

Weight and powering requirements, and his outgrows, like energy consumption.



The international requirements is a 5.9kW/tons according EEC or ECE regulation!

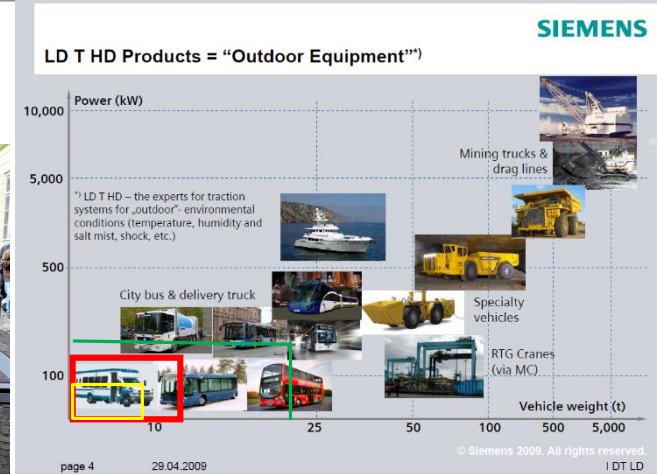
- ❑ The over dimensioned powering is useless, only increase the GCW and reduce the payload
- ❑ In the M3/I and M3/II vehicle class the torque much more important as a power

❑ **evopro Busz recommendation powering:**

- ❑ The ICE category :
 - ❑ Diesel : Cummins ISB4,5 E6 -210 (151kW / 742Nm)
 - ❑ CNG: Cummins –Westport BGe5,9-230 (172kw /678Nm)
- ❑ The hybrid category: Cummins ISF2,8 S6 (120kW /360Nm)
- ❑ The BEV category: Siemens AG. 1DB2016-1NB06 (160kW/1019Nm optionally: USH EDU200 (200kW/2215Nm) or Yasa750-EP (200kW/790Nm) x2 or x4

❑ **The energy consumption: Measured by TÜV according S.O.R.T.2**

- ❑ Clear diesel 22-27 l/100km
- ❑ Clear Battery driven 60-90kWh/100km
- ❑ Serial hybrid with ISF 2,8 11L/100km +60kWh/100km
- ❑ Clear CNG ISB 5,9 E6 17,8-22kg/100km



Modularity and tooling cost. (welding v bonding)

NEWEST AUTOMOTIVE TECHNOLOGY

Smallest dimensions more accuracy!



ADJUSTED BONDING AND HARDENING TIME TECHNOLOGICALLY



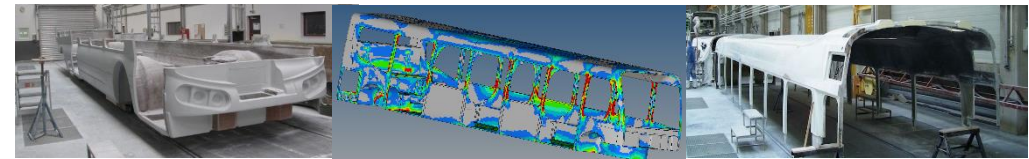
MINIMIZED STEEL BRACKET ONLY BONDED +SCREWED



WITH COMPLETE TOOLING CAN CREATE FIVE VEHICLE CATEGORY

OLD, SHIP TECHNOLOGY

Large dimension less accuracy!



CRITICAL TECHNOLOGICAL TIME, AT BONDING AND RTL



LARGE BRACKET TO INSTALLATION, INSERTION



WITH COMPLETE TOOLING ONLY ONE CATEGORY OF VEHICLE

evopro1 material properties according the ECE autobus directive requirements

THE ENERGY SOURCING ARE ZERO EMISSIONS OR ICE HAVE EURO 6-OBD 4 CERTIFICATIONS

Diesel:

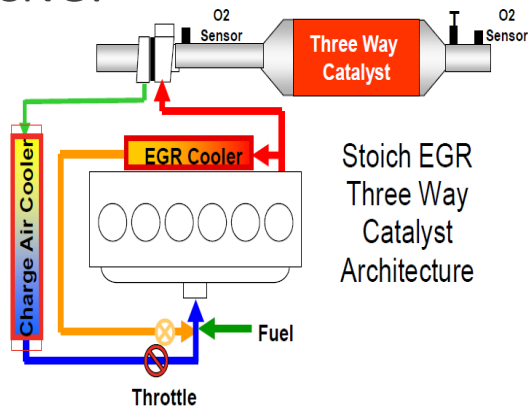


IT SELF'S THE COMPOSITE MATERIAL:

❑ Non flammable according ECE R118.02!



CNG:



❑ Electrically worked as a isolator until 5000Vdc

❑ Ozone proofed

❑ Water and corrosion resistant life time

❑ Good energy absorber at side impact

❑ Non human dangerous



Cost comparison if the traditional bus is 100%

COMPOSITE SYSTEM



TRADITIONAL BUS SYSTEM

Row material:

- ❑ The glass fiber , and resin prices go down , because the chemical sector funded new possibilities (compared in painted structure)8%
- ❑ Assortment of row material is lower21%

- ❑ The compound steel price increasing, the austenitic stainless steel have extremely high price.
- ❑ Assortment of row material is high

Technology:

- ❑ The energy consumption at manufacturing.....12%
- ❑ The assortment of technology: homogeny and simplified.....17 %
- ❑ Technologically required manufacturing time: some technological steps missing, like sheeting or flooring, covering11%

- ❑ The welding, foting, pressing technology absorbed to much energy.
- ❑ To much heavy industries actions
- ❑ The part translation needed time, and different location exists e.g. the heavy technology

Tooling:

- ❑ Smaller tooling, more accuracy valid to full bus family.....27%
- ❑ The tooling valid only 400 pcs / annually+15%

- ❑ Large size of tools , all time repairing and adjusting , valid to one bus type
- ❑ Usually enough 1000pcs/annually but continuously repairing required

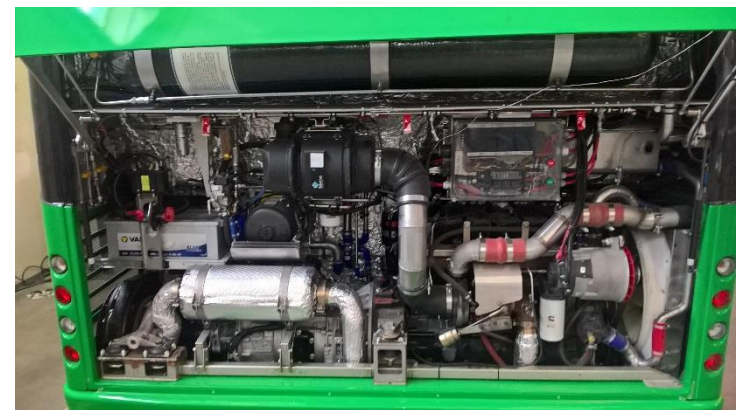
Critical items: The electrical systems and battery technology is new

The environment protection, the filtration system, like SCR or EGR are very expensive and complicate solution

Five drivetrain possibilities advantages



- ❑ Can build to identical vehicle structure, only the holders and brackets under changing.
- ❑ Can upgrade the drivetrain to required environmental protection level.
- ❑ Can rebuild the system with different drivetrain with specified kits system (eg. Diesel to EV)
Lifetime of structure is a 20-25 years!
- ❑ At fleet user large advantages the identical spare parts usable, and the storage cost is lower.
- ❑ The local content applicable



Working busses with environmental solution



Why we recommended the MODULO solutions to operators ?



Recommendations:

Before take any steps in e-mobility please check and analyze the traffic situation on every routes!

Please make a carefully decision from charging strategy !

Please check yours company capability to electrical drive systems, failure detestation, repeating , and education system.

Please check yours information systems which belonging to traffic organization

❑ The municipality or final service provider can minimize the investment:

- ❑ The solution can optimize to routs properties. (stations)
- ❑ The infrastructure protection in high level.
- ❑ The flexible vehicle operations timely , locally, costly.



❑ The „one working day charging” concept.

- ❑ The maximum distances pro day is 250-300km, the average speed 18-22km/h means that 165kwh energy is a acceptable amount at battery.
- ❑ Charging in safe location (service or garage) no risk, and minimize, and concentrate the infrastructure modification
- ❑ Personalized vehicles , less defekt means less cost.

❑ Must be understood the professionalism changing, less mechanic more electricians. Forced the supplier supports.

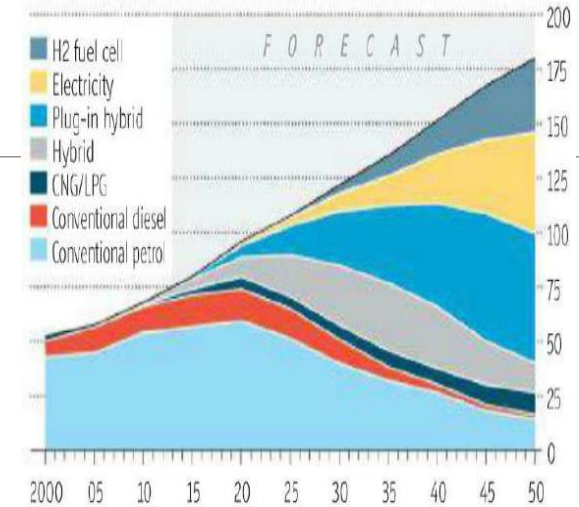
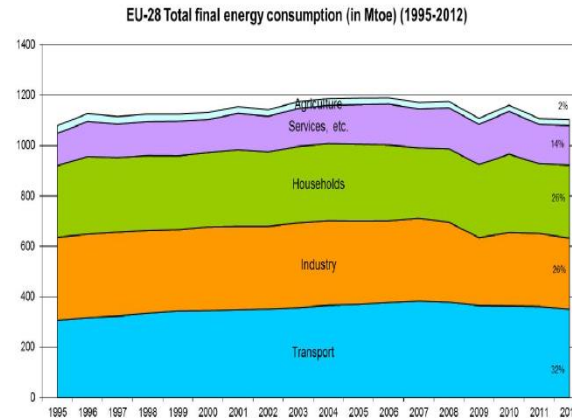


❑ Must be strongly select the information's which belonging to safety, to technical operation, to traffic organization systems.

Environmental protection.

GHG:

Emitted GHG is a 25% oncoming from vehicles



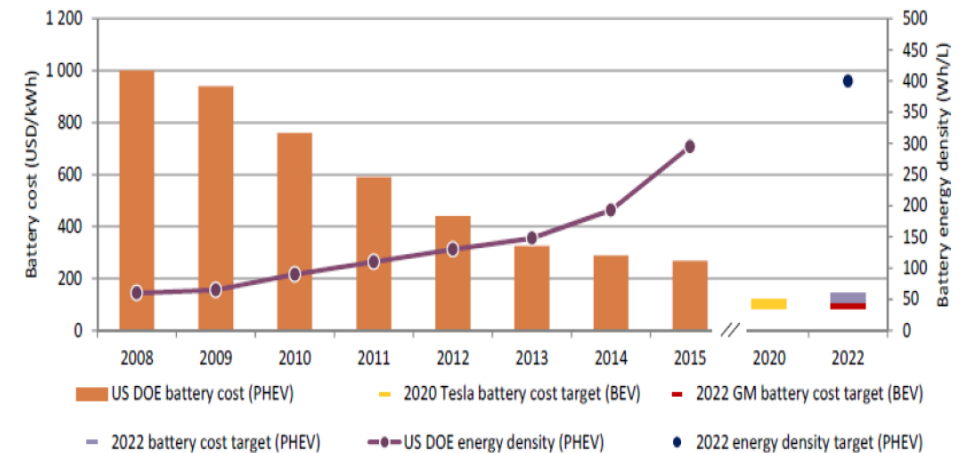
Energy footprint:

Recycling: street and airfield covering

- Highway and building funds.
- Some panel manufacturing to architect

Sources : USDEO Observation EV and Hybrid cars

Evolution of battery energy density and cost



The business ways possibilities



BUSINESS STEPS

- Signed the derivate specification
- Create the contract, legal and financial conditions. Define the final target.
 - Prototyping and prototype acceptance CBU process
 - According the main group system create the SKD solution to delivery system.
 - According the agreed content create the CKD delivery content
 - Localization possibility
 - Licensing (as a separated contract)

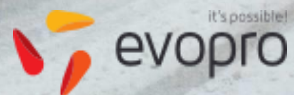
ACTION

- Studied the technical offer, clear the option items and any other costumer requirements
- Participate on prototype building, understood the functional building system – according main group arrangement
- Acquire the SKD principle and specification
- Acquire the CKD
- Collect and summarize the local content and supplier. Must be have permit to design modification from IPR owner
- Take a decision technical or technological license required.

Thanks for your attention !

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