“A global overview on heavy duty hybrid vehicles”

Carlo Mol, VITO (Belgium)
Outline

» Short introduction VITO

» IEA-IA-HEV : Annex XII - Heavy-duty Hybrid Vehicles

» EIT–KIC-InnoEnergy

» Conclusions
Mission: As independent and customer-oriented research organization, VITO (± 600 employees) provides innovative technological solutions as well as scientifically based advice and support in order to stimulate sustainable development and reinforce the economic and social fabric of Flanders.

Active in Sustainable Technologies in the field of:
- Energy
  - Smart grids & integration of (PH)EV’s
  - Batteries & Ultracapacitors
- Environment
- Materials
- Remote sensing

More information: www.vito.be
More information: bluways.com
IEA–IA–Hybrid & Electric Vehicles

» International Energy Agency (IEA) : www.iea.org

» Implementing Agreement (IA) : Hybrid & Electric Vehicles (HEV)
  » Information source on hybrid & electric vehicles
  » More information : www.ieahev.org (newsletter, ...)

» Some running IA-HEV Annexes (task groups) 1994 - today :
  » Annex I: Information Exchange
  » Annex X: Electrochemical Systems
  » Annex XI: Electric Cycles
  » Annex XII: Heavy-Duty Hybrid Vehicles
  » Annex XIII: Fuel Cells Vehicles
  » Annex XIV: Market deployment of Evs & HEVs : “Lessons Learned”
  » Annex XV: Plug-in Hybrid Electric Vehicles, …
IEA–IA–HEV : Annex XII : Heavy-Duty Hybrid Vehicles

» Objective
   » Report the current status of the heavy-duty hybrid vehicles “playing field”. Besides a general description of the current heavy-duty hybrid vehicle situation, the status report will also focus on emerging hybrid vehicle technologies and market trends.

» Activities
   » Collect and organize information on heavy-duty hybrid vehicles technologies and market potential
   » Share and disseminate knowledge in participating countries

» Period : from 01/01/2007 until 30/11/2010

» 6 Participating countries : Belgium (VITO), Canada (NRCan), Finland (Aalto University), Switzerland (HESS), The Netherlands (Agency NL), United States (NREL)

» Website Annex XII: http://ieahev.vito.be
» Operating Agent : VITO (BE), contact : carlo.mol@vito.be
IEA–IA–HEV : Annex XII : Heavy-Duty Hybrid Vehicles

» Structure of Annex XII
  » Subtask I: Heavy-Duty Hybrid Vehicle Technologies
    » Technology oriented subtask
    » Study on components, systems and configurations
  » Subtask II: Heavy-Duty Hybrid Vehicle Market Situation, Trends and Potential
    » Market oriented subtask
    » Study on market potential in different applications: costs vs benefits
  » Subtask III: General Information Gathering and Dissemination
    » Support subtask I and II, write end report
    » Full end report only available for participating countries
    » Dissemination to broader public: website, papers, presentations, …

HEV (hybrid) (electric & hydraulic)
PHEV (plug-in hybrid)
EV (all electric)
Classification

» Important to setup a classification on heavy-duty vehicles because they all have it’s own specific requirements, driving cycle and other boundary conditions -> big impact on potential of electrification for vehicles suitable for the application
## Classification

<table>
<thead>
<tr>
<th>Main categories</th>
<th>Sub categories</th>
</tr>
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<tbody>
<tr>
<td>Bus</td>
<td>• city</td>
</tr>
<tr>
<td></td>
<td>• regional</td>
</tr>
<tr>
<td></td>
<td>• long distance</td>
</tr>
<tr>
<td>Truck</td>
<td>• city distribution/delivery truck</td>
</tr>
<tr>
<td></td>
<td>• regional distribution</td>
</tr>
<tr>
<td></td>
<td>• inter- and national transport</td>
</tr>
<tr>
<td>Mobile workmachines</td>
<td>• Construction, mining, and earth moving: loaders, excavators, dumpers, bulldozers, etc.</td>
</tr>
<tr>
<td></td>
<td>• Agriculture and forestry: tractors and their accessories, harvesters, forwarders, etc.</td>
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<tr>
<td></td>
<td>• Transportation of goods and material handling: forklifts, straddle carriers, RTGs, terminal tractors, etc.</td>
</tr>
<tr>
<td></td>
<td>• Municipal or janitorial machines: gardening, cleaning, etc.</td>
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</tbody>
</table>
Driving forces for electrification

- Economical: fuel cost reduction, ...
- Ecological: reduce global and local impact (urban traffic) on the environment
- Technical: performance, comfort, ...
- Legislation: emission standards, ...
- Government: oil independency, strategic energy plans (EU Renewable Energy Directive), ...
Benefits & Barriers for electrification of heavy-duty vehicles

- **Benefits:**
  - Increase energy efficiency
  - Reduce fuel consumption and emissions, ...

- **Barriers:**
  - Added cost for electrification versus benefits
  - Very diverse market with small production volumes compared to passenger car market
  - Procurement procedures, ...

- Matching the right vehicle with the right application (driving cycle, ...) = major challenge

- Choise of the right powertrain has a very big impact, but there are other parameters to take into account for higher energy efficiency
Other parameters for optimizing heavy-duty vehicles

- Hybrid and Electric powertrains (fuel savings reported in a broad range from -5% up to -50% depending on application)
- But also technology improvements besides powertrains are crucial for fuel savings:
  - Eco-driving (-8%)
  - Low-friction tires (-3%)
  - Lightweight materials
  - Aerodynamics
    - Platform for Aerodynamic Road Transport (www.part20.eu)
Trends and insight – Hybrid & Electric Buses

Hybrid & Electric Buses on the market: City buses

- Number of hybrid city buses growing worldwide
- Ex. : New York City Transit bus fleet
  - 12 month period study showed 34% to 40% higher fuel economy over the baseline diesel units operating under similar driving conditions

Also hybrid versions in articulated city buses

Figure 7. Orion VII bus with BAE Systems HybriDrive hybrid propulsion system
Hybrid & Electric Buses on the market: Trolleybuses

- All electric drive (local zero emission & noise)
- Brake energy recuperation in overhead lines (15 to 35%)
- Dual-mode possible
- Up to 220 passengers (high throughput)
- Visual aspect & investment cost
- Examples in countries like Switzerland, Germany, Italy, the Netherlands, …
Heavy-duty vehicles market is very diverse with very specific applications/drive cycles and this in relative small production numbers.

Matching the right vehicle with the right application = challenge.

Market of heavy-duty hybrid vehicles is still more or less in prototype/demonstration phase, except for some applications (e.g. city buses).

Technical results (lab- and real life fieldtests) show substantial benefits on e.g. fuel consumption, but not yet enough market data available on the added cost vs benefits (ROI).

Electrification of heavy-duty vehicles has a lot of potential, but …
**Conclusions IEA-IA-HEV Annex XII**

- Further research needed for next generation of heavy-duty hybrid vehicles to get to mass market:
  - European Green Car Initiative (EGCI) & American Recovery and Reinvestment Act (ARRA)
  - EU FP7 - Hybrid Commercial Vehicle (HCV), USA - 21st Century Truck Program, …

- Information dissemination is crucial:
  - IEA-IA-HEV : Annex XII - Heavy-duty Hybrid Vehicles (International)
    - [www.ieahev.org](http://www.ieahev.org) & [http://ieahev.vito.be](http://ieahev.vito.be)
  - Hybrid User Forum (Europe)
    - a forum which brings together (potential) users of hybrid buses, hybrid trucks and hybrid delivery vehicles with vehicle manufacturers.
TOPIC OF TODAY = NEW HORIZONS FOR URBAN TRAFFIC

USER CENTRAL APPROACH

CITIES
EIT – KIC - InnoEnergy

» EIT = European Institute of Innovation and Technology (http://eit.europa.eu/)

» KIC = Knowledge and Innovation Communities
  » Climate change mitigation and adaptation: Climate-KIC
  » Sustainable energy: KIC InnoEnergy (http://www.innoenergy-initiative.com/)
  » Future information and communication society: EIT ICT Labs

» EIT – KIC : aim is closing the knowledge triangle “education-research-innovation” and make sure that research results gets valorized quicker in Europe
CC BeNeLux focus is “smart cities” which integrates energy efficient buildings, smart grids and electric transport in a city environment.
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Full Partners:

Education  
TU/e Technische Universiteit Eindhoven University of Technology

Research  
TNO

Industry  
eandis

Katholieke Universiteit Leuven

vito vision on technology
CC BeNeLux focus is “smart cities” which integrates energy efficient buildings, smart grids and electric transport in a city environment.

EVCity

“Business & services models to support the roll-out of electric vehicles in cities”
CC BeNeLux focus is “smart cities” which integrates energy efficient buildings, smart grids and electric transport in a city environment.

- Transport concepts: urban planning, multi-modal transport (walk, bike, public transport, shared car, private car), ...
- Electric vehicles & components: improvement of energy-efficiency of components & systems inside the vehicles, ...
- Infrastructure for electric vehicles: standardisation of plugs, communication protocols grid-vehicle, roaming and billing concepts, control algorithms for optimal coordinated charging with minimal impact on grid and maximum use of renewable sources, ...
- Renewable energy sources, Intelligent houses, energy efficiency electricity/gas/heat/cold, ...
- Political framework: supportive actions on legislation, incentives, ... to stimulate the investments in renewable energy and infrastructure for electrified transport
Conclusion

» New horizons for Urban Traffic ? YES !

» From vehicle side : IEA-IA-HEV : Annex XII - Heavy-duty Hybrid Vehicles
» From customer side : EIT–KIC–InnoEnergy : Smart Cities
» Think “holistic” !
Thank you for your attention!

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