Options for Reducing Emissions from Freight

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Before thinking about how to reduce emissions ...... consider how we can prevent GROWTH in emissions!
- Tonne-km growth in EU27 is exceeding economic growth
- Freight grew 46% in 11 years – doubling every 25 yrs
Freight Transport – a big polluter

Trucks will grow from second largest polluter in the transport sector in 2000 (EU-30) to the largest in 2030
Growth in Freight - Choices

- More trucks
- More roads
- Bigger trucks
- More/bigger trains
- Grow local!
Reducing Carbon Footprint of Freight

Decouple freight growth from carbon emissions growth

- What are our options?
- Will the future be,
  1. Rail or
  2. Road?
Mainline power is changing from fossil fuels to nuclear, wind and maybe wave. Trains can use mains electricity. Hence, rail could provide a Carbon-neutral solution but.....
Rail vs Road

Gtkm (freight transport activity)

EU 25. The TERM report (EEA, 2009)
EU freight by Mode

- Rail is small and a diminishing % - seems unlikely to be the solution
- Inland water & air not significant
- Most European freight is by road or short sea shipping
Only 4% growth in European rail in ten years – rail is not currently providing the solution in the EU
  – competition between national authorities inhibiting efficiency
  – some growth in rail freight where it is deregulated
  – batch process – not efficient
• Ireland is an island – our distances are relatively short …. makes it harder to compete with road

• Ireland has not implemented the separation of functions: track from rolling stock
Rail freight in Ireland

- Ireland is an island – our distances are relatively short …. makes it harder to compete with road

- Ireland has not implemented the separation of functions: track from rolling stock

13th March, 2012: “Today's Cabinet meeting agreed not to seek a further derogation from EU rules on rail market access, at the suggestion of Transport Minister Leo Varadkar”.
Rail freight in Ireland

- Ireland is an island – our distances are relatively short …. makes it harder to compete with road
- Ireland has not implemented the separation of functions: track from rolling stock
- Irish Rail is the only company in Ireland offering a rail freight service (the market is small)
- Irish Rail appear to have prioritised passenger transport over freight
- Irish railways are not yet electrified!
Rail freight in Ireland

- Transferring between road/rail is expensive logistically
- Most freight will start and end its journey in a truck
Rail freight in Ireland

- Rail could be made more attractive to transport operators if incentivised financially or through the tax system.

- However, the fact remains that in a small country, significant modal shift from road freight to rail freight is not likely.

- Other ways of reducing emissions from road freight must be sought.
2. Road Freight Solutions

- If future freight is to be carried by road, how will we decouple growth from carbon emission?

- ERTRAC is the European Road Transport Research Advisory Council

- ERTRAC’s subcommittee on Long Distance Freight prepared a research roadmap for green, safe and efficient freight corridors
## ERTRAC on Long Distance Freight – Research Roadmap:

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<thead>
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<th>Indicator</th>
<th>Guiding objective for 2030</th>
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ERTRAC on Long Distance Freight – Research Roadmap:

- Vehicle technologies
- Driver environment
- Logistics & intermodality
- Infrastructure
- ICT in corridors

- Standardised, modular dimensions;
- Longer & heavier vehicles
- Optimised; aerodynamic design
- Reduced rolling resistance & friction;
- Will use new fuels/electric.
ERTRAC on Long Distance Freight – Research Roadmap:

- Vehicle technologies
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- Eco-driving (10-12% fuel saving);
- Advanced HMI supporting the driver;
- Smart loading (intelligent goods);
- Automated cargo handling.
- Anti-idling
- Air con./heating
# Best practice in reducing GHG in road freight (from Frey and Kuo, 2007)

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<td>Anti-idling</td>
<td>Off-board truck stop electrification</td>
</tr>
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<td>Truck-board stop electrification</td>
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<td>Auxiliary Power Units</td>
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<tr>
<td></td>
<td>Direct Fired heaters</td>
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<tr>
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<td>Direct Fired heaters with thermal storage units</td>
</tr>
<tr>
<td>Air conditioning system improvement</td>
<td>Enhanced air-conditioning system (1) for direction emissions, (2) for indirect emissions</td>
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<td></td>
<td>Alternative Refrigerants</td>
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<tr>
<td>Aerodynamic drag reduction</td>
<td>Vehicle profile improvement for (1) Tractor, (2) Truck side and underside (3) for van</td>
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<tr>
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<td>Pneumatic Aerodynamic drag reduction</td>
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<td>Planar boat tail plates on a tractor-trailer</td>
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<td>Vehicle load profile improvement</td>
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<td>Tyre rolling resistance improvement</td>
<td>Automatic tyre inflation system</td>
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<tr>
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<td>Wide-base tyres</td>
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<td>Low-rolling resistance tyres</td>
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<td>Pneumatic blowing to reducing rolling resistance</td>
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# Best practice in reducing GHG in road freight (from Frey and Kuo, 2007)

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<th>Hybrid trucks</th>
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<td>Diesel engine improvement</td>
<td>Engine friction reduction through low-viscosity engine lubricants</td>
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<td>Increase peak cylinder pressures</td>
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<td>Improved fuel injectors</td>
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<td>Turbocharged, direct injection to improved thermal management</td>
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<td>Thermoelectric technology to recover waste heat</td>
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<tr>
<td>Accessory load reduction</td>
<td>Electric auxiliaries</td>
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<td>Fuel cell-operated auxiliaries</td>
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<tr>
<td>Driver operation improvement</td>
<td>Truck driver training programme</td>
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<tr>
<td>Alternative Fuel</td>
<td>Biodiesel fuel</td>
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**SOURCE:** Best practice guidebook for GHG Reductions in Freight Transportation, Final report for the US Dept of Transportation.
ERTRAC on Long Distance Freight – Research Roadmap:

- Vehicle technologies
- Driver environment
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- Infrastructure
- ICT in corridors

- Optimised use of all transport modes;
- Green hubs and corridors;
- Connections between corridors and cities.
- Changing buyer behaviour (pass on carbon cost of goods)
ERTRAC on Long Distance Freight – Research Roadmap:

- Vehicle technologies
- Driver environment
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Roads will be:
- Adaptable;
The Adaptable Road

- Porous, low noise surfacing, light reflecting for night time driving.
- Adaptable to freight transport communications, location and monitoring requirements.
- Flexible, durable surface, self repairing/self-cleaning and instant crack repair.
- In-built sensors for traffic monitoring/control and condition monitoring.
- In-built lane control/vehicle guidance.
- In-built power system for electric vehicles.
- Removable/self-cleaning drainage reservoirs feeding carbon capture planting.
- Adaptable/removable communication/power channels for lane control, traffic monitoring, driver information and condition monitoring.
- Low carbon sub-base and pavement.
- Pre-fabricated inter-locking, sub-base with integrated drainage, services and communications channels.
- Energy harvesting grid and storage/use of solar energy to power lighting, signs and sensors.
- In-built system for replacing and adding lanes/infrastructure, e.g. barriers, signs and sensors.
ERTRAC on Long Distance Freight – Research Roadmap:

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Rocks will be:
- Adaptable;
- Automated
ERTRAC on Long Distance Freight – Research Roadmap:

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Roads will be:
- Adaptable;
- Automated and
- Resilient.
The Resilient Road

- Pavement to building heat exchange for resilience to extreme weather.
- Planting and soil stabilisation for storm water protection.
- Integrated road de-icing system.
- Drainage system and reservoirs for storm control and water management.
- In-vehicle weather, incident warning and information system.
- Geothermal and solar energy harvesting for resilience to extreme weather.
- Demand and condition responsive traffic control for extreme weather conditions.
- Real time local weather forecast information system.
And smoother to reduce energy costs
ERTRAC on Long Distance Freight – Research Roadmap:

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V2V, V2I and I2V communications:
- Vehicle tells infrastructure that road needs repair
- Car tells next car that road is frosty
- Vehicle convoyming technologies
Vehicle Technologies - Fuels

a) Biodiesel
b) Fuel cell
c) Electric
Biodiesel has many advantages:

- It can be produced domestically, reducing dependency on importing of fuel and providing farmers with an alternative income generator.

- Ireland is particularly well-suited to the production of biomass for energy.
(a) Biodiesel

- Biodiesels MAY result in lower carbon emissions, decreased hydrocarbons and lower particulate emissions at the exhaust pipe.
- Plants producing biodiesel absorb carbon dioxide – which can be offset against carbon that is produced when biodiesel fuels are made.
(a) Biodiesel

BUT:

- Does biodiesel really result in lower carbon emissions? As many researchers have pointed out, we can only answer this definitively following a life stage analysis of the production of biodiesel, including its transportation and refining.

- Some researchers are sceptical of the ability of biodiesel to reduce carbon emissions.
(a) Biodiesel

- Its performance is dependent on the blend used – higher blends (>20%) achieve better results in terms of lower carbon emissions.

- Biodiesel MAY result in higher NOx emissions, especially at higher blends.
(a) Biodiesel

Conclusion:

- We need Irish studies to explore more fully how biodiesel production and biodiesel use might impact upon carbon emissions in Ireland.
Fuel cell electric vehicles, as with biodiesel, have significant advantages:

- The only by-product is water so there are no GHG emissions, no noise and no particulates.
- Hydrogen is also the most plentiful element in the universe so we are not going to run out.
Fuel cells can be used to power auxiliary power units (to run heating, air conditioning etc when the truck is stopped), reducing idling of vehicles, and hence reducing GHG emissions.
(b) Fuel Cell

BUT:

- Expensive to produce. More expensive than producing diesel? But perhaps not in the future?

- Expensive to transport as hydrogen is bulky.

- If vehicles were to be allowed to refuel with pure hydrogen, infrastructure would need to be developed to enable this.
Mainline power is changing from fossil fuels to renewables
Power for transport is a particular challenge
Future cars will be electric but what about trucks?
(c) Electric Trucks

- Trucks require too much energy to run on batteries
- Hybrid electric/diesel truck with mains electricity is technically feasible
- Already made by Siemens
- In use in quarries
- Currently use diesel & use electricity for ‘boost’ on steep climbs
(c) Electric Trucks

- So future could be trucks using biodiesel on side roads
- And tapping into mains electricity when they get to the highway
- Big infrastructural cost to put in overhead wires but road infrastructure is only about 9% of total freight transport cost – the only issue is recovering the initial investment
ERTRAC on Long Distance Freight – Research Roadmap:

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But most of this is not Ireland-specific – more efficient vehicles, etc, will arrive on Ireland’s roads. How is it relevant to us?
Ireland-specific Research Challenges

- Vehicle technologies
- Driver environment
- Logistics & intermodality
- Infrastructure
- ICT in corridors

- Standardised, modular dimensions;
- Longer & heavier vehicles
- Optimised; aerodynamic design
- Reduced rolling resistance & friction;
- Will use new fuels.
Bigger Trucks & Road Trains

• Road Trains are cheaper to operate (one driver for more freight)
• Much more freight in much less road space
• Much less energy usage per tonne carried
• It may be difficult to gain acceptance in Europe
Long-Combination Vehicles (LCV’s)

- Could be a compromise acceptable in Europe
- 25.5 m trucks are already allowed in Sweden & Finland
- Dutch ‘test’ programme has been extended
- Plans for trials in Germany
- Going to be tested in Norway
## Claimed Benefits of Long-Combination Vehicles (LCV’s)

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2 LCV’s carry freight of 3 semi-trailers

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2 LCV’s carry freight of 3 semi-trailers

We are ‘land-locked’!

Long Combination Vehicles
• Bigger trucks, road trains and convoys, all represent potential problems for Ireland’s bridges
  – they were not designed for such heavy concentrations of loading
  – many bridges (especially in minor roads) are old and not designed for modern traffic
  – there may be problems of dynamics from regular patterns of loading

• The ‘bridge issue’ is being used as an argument to prevent the introduction of larger trucks

• Need research on accurate assessment of the traffic loading on bridges
  – and the implications of new concepts
Conclusions – We Have a Problem

- Overall, in the EU, freight is tracking GDP – doubling every 25 years
- Our freight transport carbon footprint is more likely to grow than reduce
- Rail takes a small & reducing % in EU
  - And even less in Ireland
Vehicle technologies will help
  - Improved fuel efficiencies
Eco-driving will help
Roads can be smoother with reduced carbon footprint
Fuels:
  - Biodiesel – yes
  - Fuel cell – maybe
  - Electric – good idea but .....
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Longer & heavier vehicles are the ‘low hanging fruit’ of freight transport

- Much improved fuel efficiency
- Inexpensive to implement
- Reduced transportation costs