EU Transport GHG: Routes to 2050?

Summary findings on options

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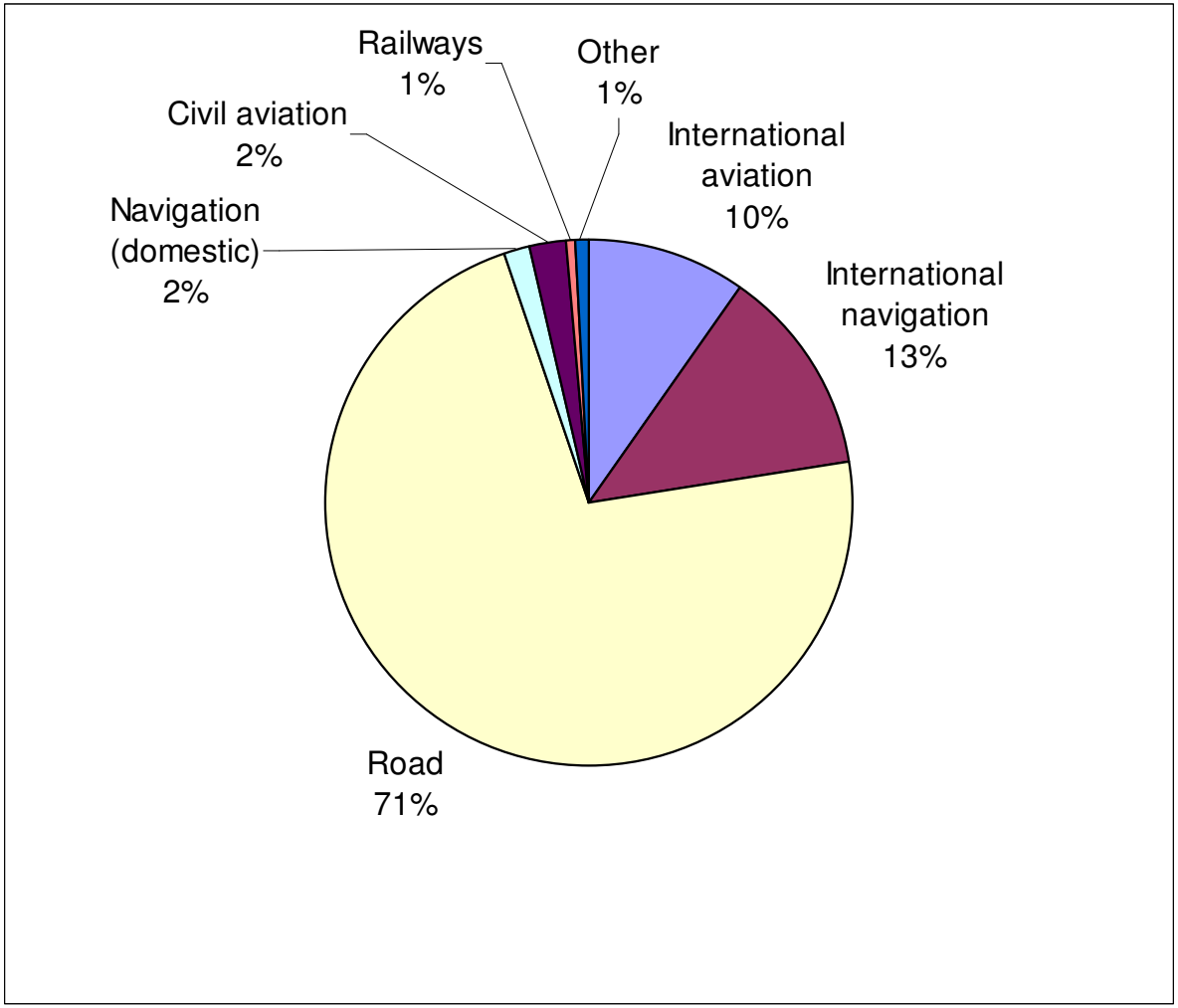
Second large stakeholder meeting
10 November 2009, European Commission

www.eutransportghg2050.eu

Partners

AEA CE Delft TNO ISIS milieu

GHG breakdown by transport mode

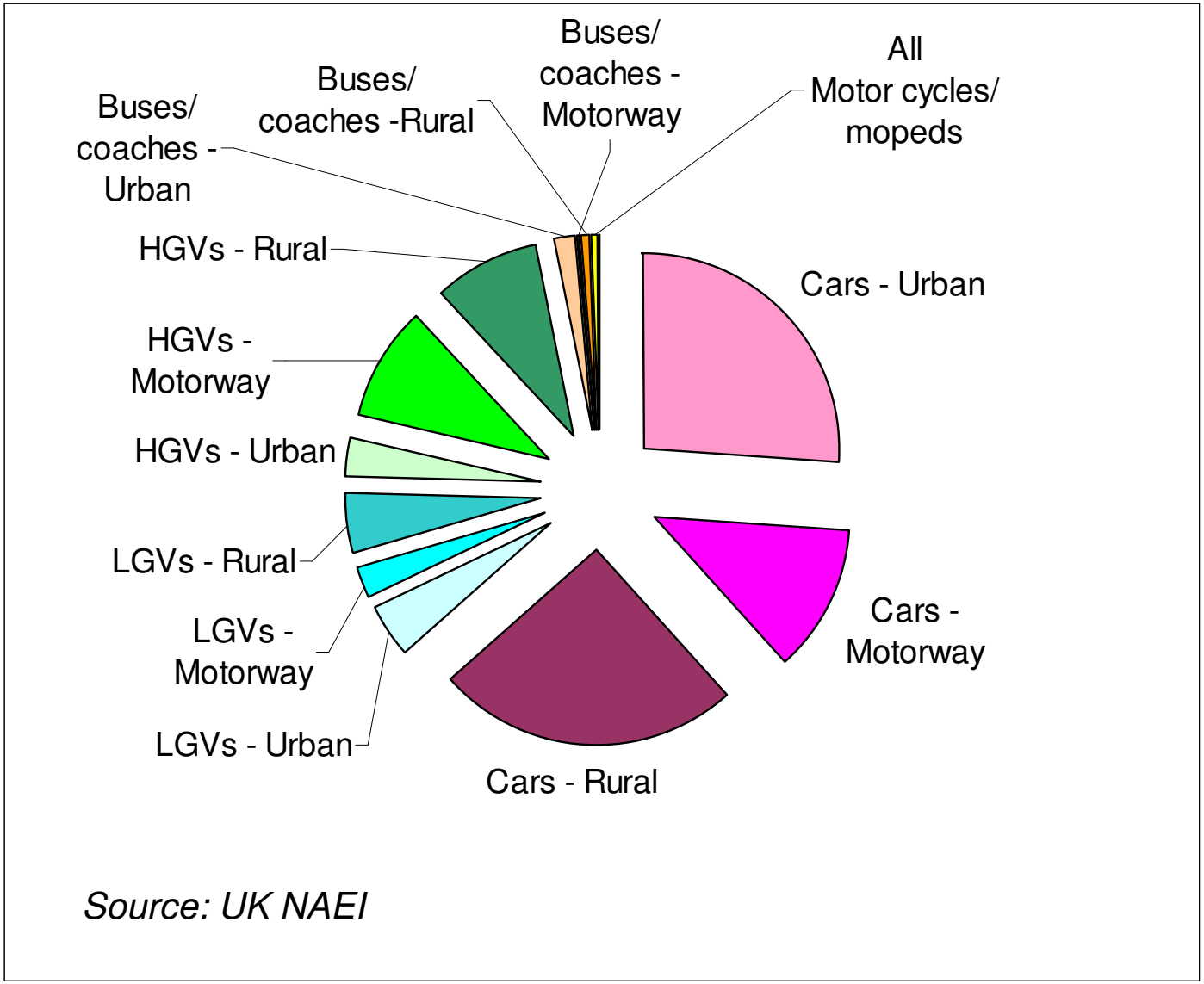


Source:

Based on figures in EEA (2008) Climate for a transport change – TERM 2007

Note: The figures include international bunker fuels for aviation and navigation (domestic and international)

Road transport carbon emissions by area (UK, 2007, petrol and diesel)



Source: UK NAEI

Options covered include…

Recall the **definition** used in the project:

- **Options** deliver GHG emission reductions in transport

Technical options include:

- Improving the **GHG efficiency of vehicles** (fuel efficiency)
- Lowering the **carbon intensity of the fuels** (alternative fuels)

Non-technical options include:

- **Driving the vehicle** more efficiently (operational options)
- **Increasing the utilisation** of the vehicle (per journey)
- Using **most suitable, least carbon intensive mode** for each (part of the) journey (co-modality)
- **Demand management**

Technical options: Papers and Technical Focus Groups

Paper 1: Technical options for road modes

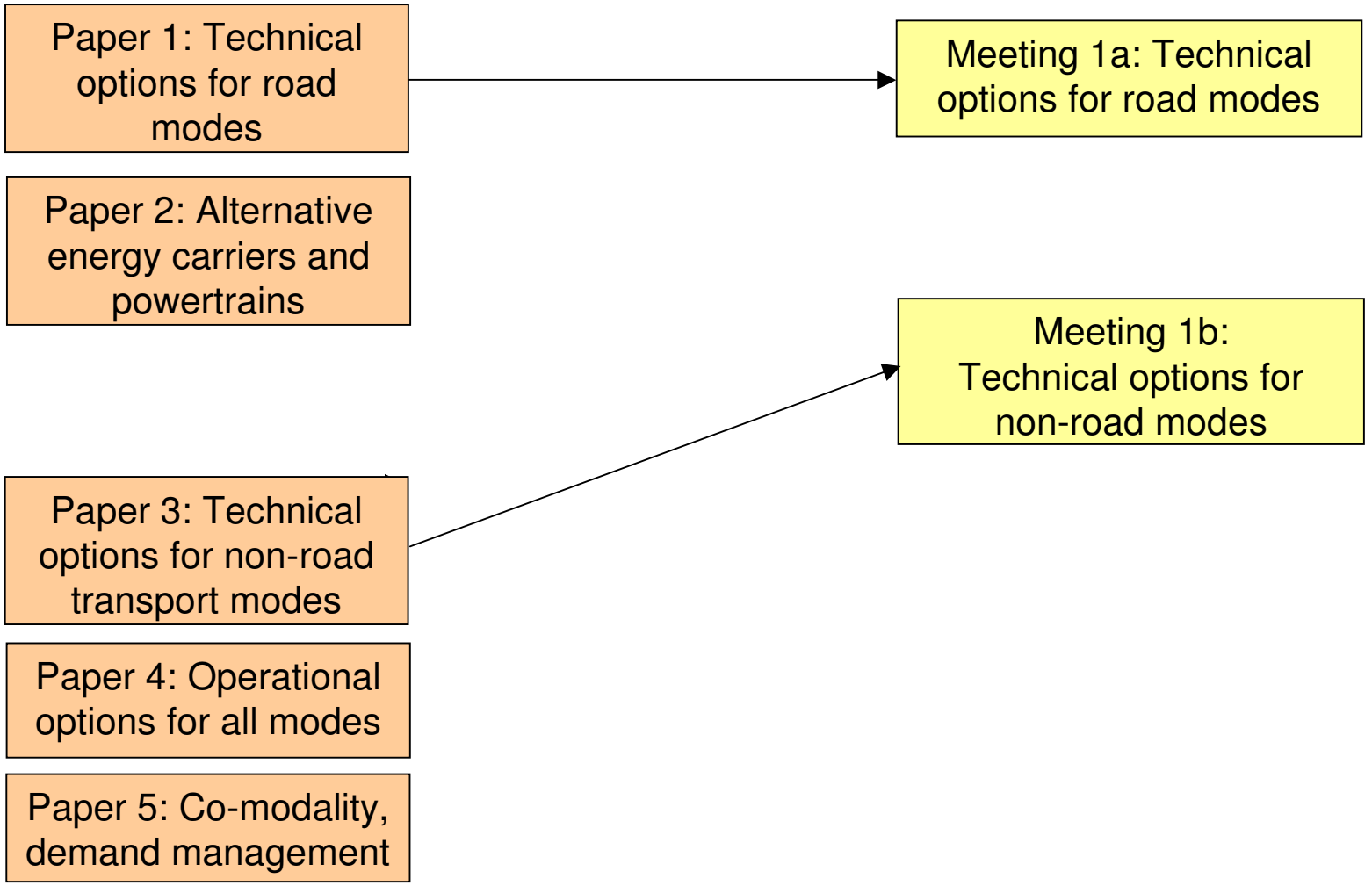
Paper 2: Alternative energy carriers and powertrains

Paper 3: Technical options for non-road transport modes

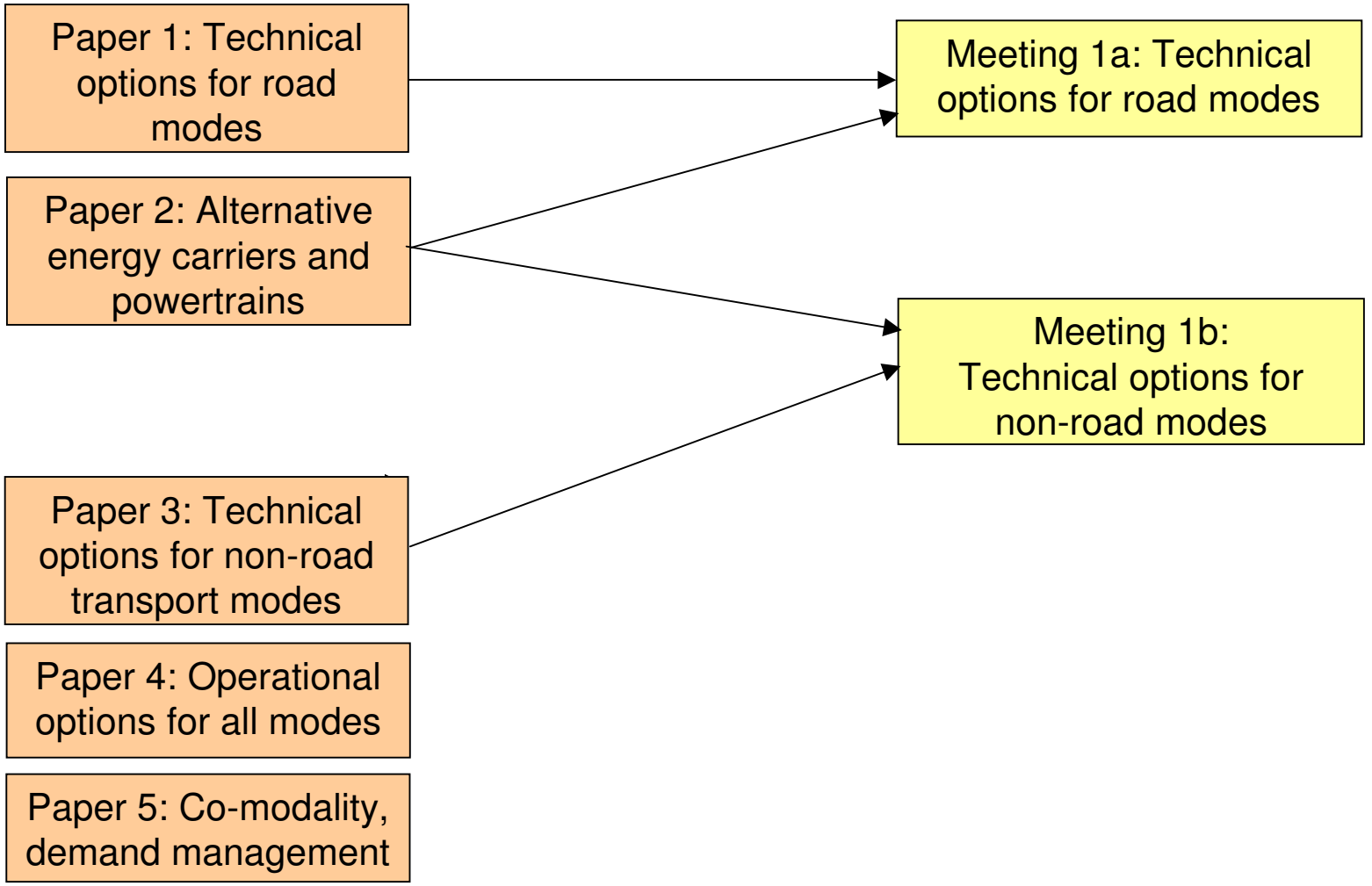
Paper 4: Operational options for all modes

Paper 5: Co-modality, demand management

Technical options: Papers and Technical Focus Groups



Technical options: Papers and Technical Focus Groups



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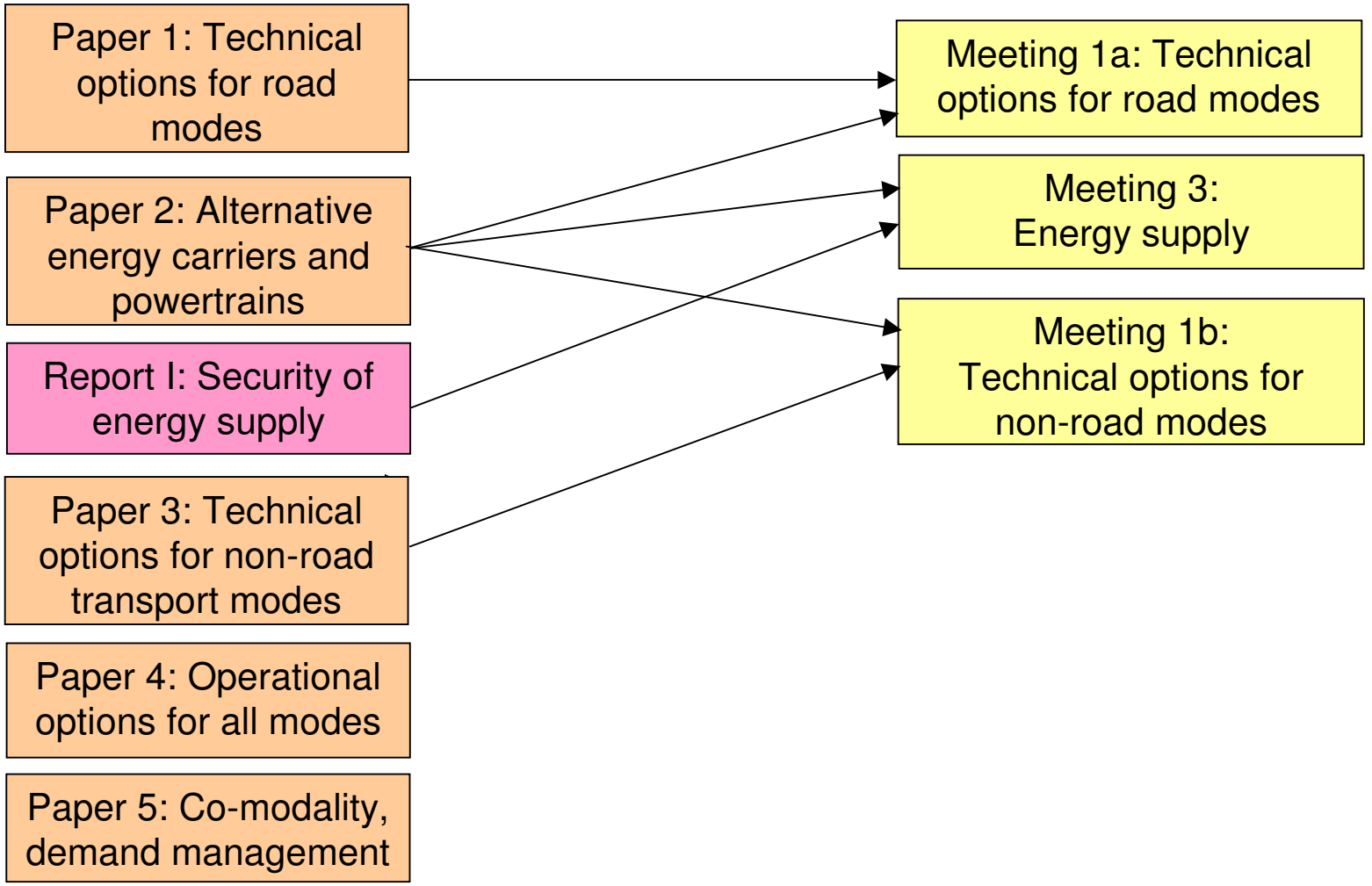

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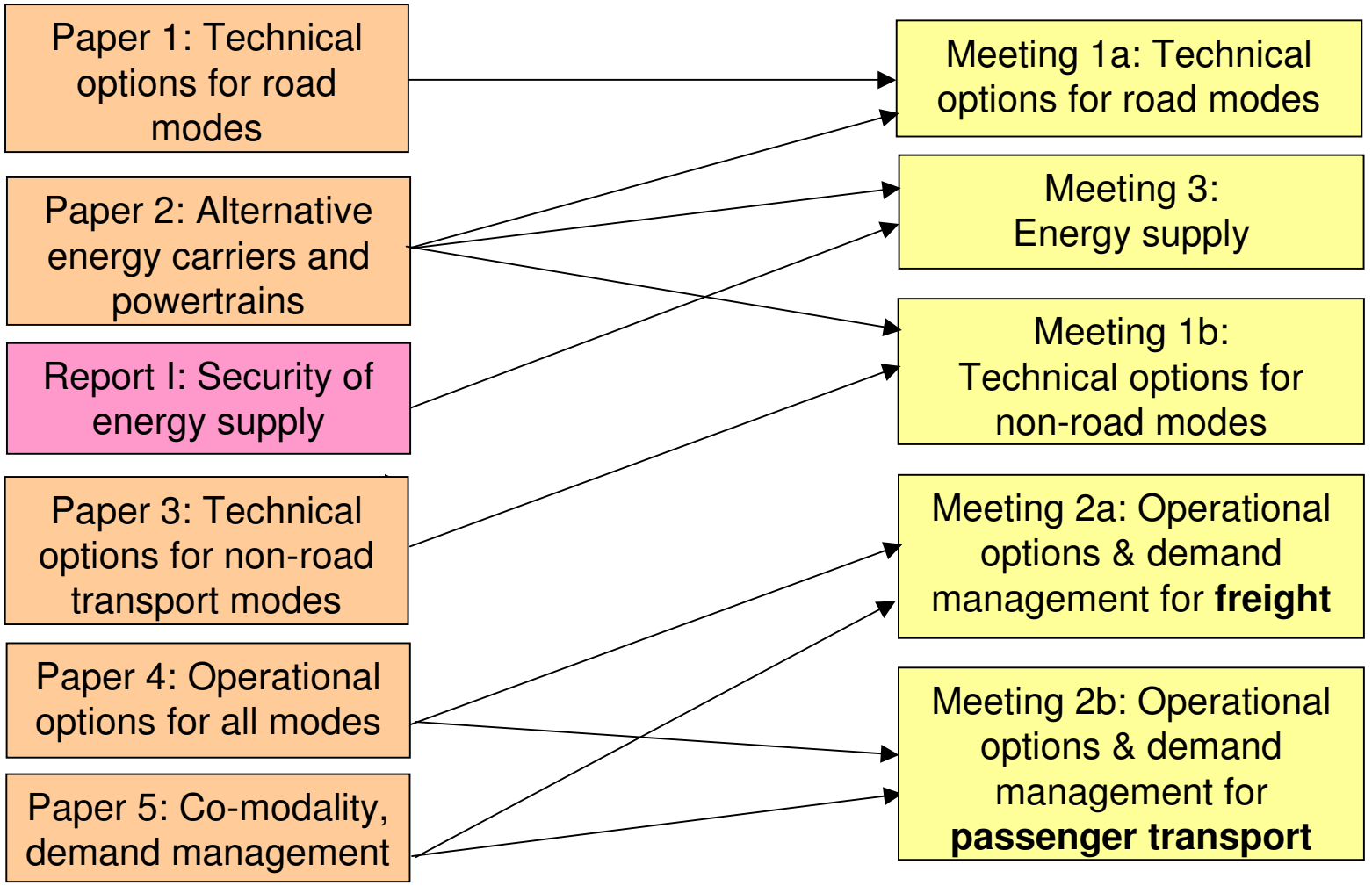

Results presented by…

- **Technical options**, including alternative fuels, by:
  - Rail
  - Maritime shipping
  - Inland waterway vessels
  - Aviation
  - Light duty road vehicles
  - Heavy duty road vehicles
- **Non-technical options** by:
  - Operational options
  - Improved logistics and vehicle utilisation
  - Co-modality/inter-modality
  - Demand management

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Rail – technical options

- **Regenerative braking** - potential savings (< 15% on AC networks)
  - Rail vehicles need to be fitted with appropriate technology
- Other measures provide potential modest savings (<5%), e.g.
  - **New trains:** Mass reduction, changes to air conditioning/aerodynamics
  - Measures often characterised by **moderate to long pay back**
  - **Limited potential** for retrofitting
- **Hybridisation** of existing diesel trains ongoing

- Potential for some additional **electrification of lines**
  - 50% of lines already electrified; others generally less well used
  - Potential to achieve GHG savings (20% to 40%) on well used lines
  - But, capital intensive measure

- Little role for alternative fuels/energy carriers:
  - Some **fuel cell** powered rail vehicles being tested
  - **Biofuels** blended; potential benefits from **2nd generation biofuels**

Rail – 2050 vision for technical options?

- New trains all designed/manufactured using **best available technologies, such as regenerative braking, mass reduction, improved aerodynamics** (e.g. required by regulation)
- **Developed network** to cope with potential increased demand for rail travel
- All main lines in the network **electrified**
- **Fuel cell powered vehicles** for selected applications, e.g. shunting
- **Personal Rapid Transit Systems** (source: Advanced Transport Systems Ltd, www.atsltd.co.uk)

Maritime shipping – technical options

- Short term (pre 2020, so **retrofitting**) – **Significant scope** for GHG reductions with pay backs of < 15 years, by:
  - **Hull:** Modern coatings (< 5%); coatings based on nano-technology
  - **Propellers**: Recovery of energy (5-10%); upgrades (5-10%); optimisation
  - **Engine**: Upgrades (1-2%)
  - **Auxiliary:** Efficient lighting and controlling speed of pumps/fans

- Long-term (post 2020; **new ships**) – Potential significant savings from:
  - **Hull:** Design
  - **Engine:** Energy recovery (< 10%)
  - **Larger ships**

- Alternative fuels/energy carriers:
  - **Limited** proven, short-term potential, other than perhaps LNG
  - Potential use of **biofuels**
  - Medium to long-term: **Sails or towing kites** (10 to 35%)

Inland waterways – technical options

- Short term (pre 2020, so **retrofitting**) – **Some potential** for GHG reductions with short/moderate pay backs, by:
  - **Engine**: More efficient diesel engines (15% to 20%)
  - **Propellers**: Improved systems (20% to 30%)

- Long-term (post 2020, **new vessels**) – Potential significant savings from:
  - **Hull design,** including light weight hulls (up to 20%)
  - **Diesel electric propulsion:** 10%
  - **Larger vessels**

- Alternative fuels/energy carriers:
  - **Limited** proven, short-term potential, other than perhaps LNG
  - Potential use of **biofuels**

Aviation – technical options

- Short term (pre 2020, i.e. **existing aircraft**) – **Some potential** for GHG reductions:
  - **Riblets (2%)**
  - **Winglets (4% to 6%)**

- Long-term (post 2020; **new aircraft**) – Potentially significant savings from:
  - **New aircraft designs** (open rotors (25% to 30%); blended wing)
  - Advanced **aircraft materials** (< 20%)
  - **Electric** aircraft systems (2% to 5%)

- Alternative fuels/energy carriers:
  - **Limited** potential, other than **biofuels**, which could be important

2050 vision for water/air technical options?

- Maritime transport (2050 ship - 50-55% reduction cfd 2008 ship??):
  - All new ships designed/manufactured using **best available technology,** e.g. redesigned and coated hulls, energy recovered from engines and propellers, all systems optimised
  - **Wide use of LNG**; some use of **wind** (sails, kites) and **biofuels**; **solar** for auxiliary applications

- Inland waterways:
  - All new vessels designed/manufactured using **best available technology,** e.g. lighter, better designed hulls, optimised systems
  - **LNG** powered barges? Use of **biofuels**

- Aviation (2050 plane - 50% reduction compared to 2009 plane??):
  - All new planes designed/manufactured using **best available technology,** e.g. new designs, advanced materials, electric systems
  - Powered by **biofuels and conventional kerosene**?

- "Best available technologies" could be, e.g., required by regulation

Light duty road vehicles – technical options

- Short term (up to 2020): **Reduction potential** through engine & transmission improvements, mild to extreme engine down-sizing, start-stop & hybridisation, heat recovery and range of vehicle-related measures (aerodynamics, rolling resistance, weight, efficient components)
- Further, longer-term **reductions limited** (without perceived welfare losses) to around 80gCO_2/km seem feasible **for ICE vehicles** (new vehicle fleet average), through further optimisation of pre-2020 measures and application of light-weight materials

- Further reductions to come from shift to low carbon energy carriers, e.g.:
  - **CNG and LNG –** Particularly in the medium-term
  - **Biofuels** – Lower blends in the short-term; better fuels in longer-term? Biogas for urban vans?
  - **Electricity** – Plug-in hybrids and pure electric vehicles
  - **Fuel cells**

Heavy duty road vehicles – technical options

- HGVs:
  - Already designed with **fuel efficiency** in mind
  - **Improvements in new vehicles still possible** (20% by 2020?)
  - Potential to **optimise specification** for purpose
- Options:
  - In medium-term, potential for **hybrid traction** in urban areas
  - Improvements in **aerodynamic profile** of truck-trailer (10-20%?)
  - **Weight reduction** (e.g. trailers) by using of advanced materials
  - **Longer vehicles** could deliver GHG reduction (possible rebound effects)
  - **Biofuels** are also a possibility
- For new buses:
  - **Hybrid traction** well-suited to stop-start drive cycle
  - Weight reduction
  - Potential for **hydrogen fuel cells** in urban conditions
  - NG a mid-term option? Biofuels and biogas?
- Electric trolley buses and trucks?

2050 vision for road transport technical options?

- **Diverse range of vehicles** to meet different needs (e.g. urban, inter-urban travel)
- All vehicles designed and manufactured using **best available technologies**, e.g. hybridisation, down-sizing, heat recovery
- Vehicles will generally be **lighter and more aerodynamic**
- Majority (if not all) vehicles will have an **electric drive train**

- **Light duty vehicles**
  - Significant numbers of **electric vehicles**
  - Use of **biofuels in decline** after having peaked (as use prioritised for other transport applications)
  - Fuel cells used in **specialised applications**, e.g. fleets

- **Heavy duty vehicles**
  - **Hydrogen fuel cells** for urban buses
  - Use of **biofuels in long-distance heavy-duty vehicles**

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Operational options

- **Optimisation of speeds and routes:**
  - Potential GHG reductions **from speed reduction** in many modes
  - Eco-driving has 10% reduction potential (short-term) for **road transport**
  - **Inland shipping**: Speed optimisation and routing
  - **Maritime shipping**: Voyage optimisation (weather routing); fleet management; speed reduction (5-50% in total)
  - **Rail**: Energy efficient driving and optimising routes, movements, signalling
  - **Aviation**: Optimise air traffic management (6%-12% reduction by 2050)
  - Evidence generally **limited for non-road modes**
- **Improve maintenance and optimisation of existing vehicles:**
  - **Optimised tyre inflation** for road transport
  - **Water vessels:** Improved maintenance of hulls, engines, propellers (3-5%)
- **Cold-ironing** – Using land-based "low carbon intensity" electrical power while at berth (ships and inland waterway vessels)/in the airport (planes)

Improved logistics and vehicle utilisation

- **For commercial operations, maximising utilisation is part of core business**
- **Improving utilisation of freight transport:**
  - Improving load factor
  - “Bundling” of products
  - Improving the route planning
  - Reduce mistakes in the deliveries and ‘no-answers’
  - Reduce the delivery frequency
- **Improving utilisation of passenger transport, e.g.**:
  - Car sharing and car clubs
  - Park and ride facilities at railway stations/outside of city centres
  - Revenue management by airlines
- **Reduction potential highly dependent on specific circumstances, e.g. products being transported**

Co-modality/inter-modality (1)

- Shifting transport volume/passengers from modes with **relatively high carbon intensities** to modes with **lower carbon intensities** can ***in principle*** contribute to GHG emissions reduction

- GHG reduction potential of such a shift depends on:
  - **Difference in carbon intensity** for the modes concerned; and
  - **Potential volumes/passenger** that can be shifted

- For freight transport:
  - Large differences in ***average*** **carbon intensity exist between modes**
  - Differences **in specific cases much smaller**
  - Potential volumes that can be shifted **are limited in many cases**
  - Hence, total GHG reduction potential from freight limited – e.g. estimates range road ->rail: **4-23%** (most estimates at lower end)

Co-modality/inter-modality (2)

- For passenger transport:
  - Large differences in carbon intensity exist **between** and **within** modes
  - Potential for shift highest in **urban areas**, as more alternatives and shorter distances
  - For longer journeys, potential for **increasing mix of modes** to improve GHG intensity of journey as a whole
  - Hence, total GHG reduction potential from passenger transport limited – e.g. estimates for road->rail: **2-14%**
- In order to achieve potential GHG reduction, high investment in infrastructure is often needed
- Important to note that there are additional benefits of co-modality

Demand management

- Technical and non-technical options have **indirect impacts** on demand through e.g. costs and travel time
- Impacts can be **complex**, e.g. technical option that increases vehicle price, but reduces operational costs (rebound effects)
- **Not possible** to identify GHG reduction potential without identifying modes that would travel less/journeys that would not be taken
- GHG reduction potential also **dependent on scale, scope and ambition** of policy instruments introduced to manage demand
- Risk of **adverse economic and social impacts** if demand is restricted (depending on journeys affected and substitutes available)

The role of Intelligent Transport Systems

- **Technology (ITS) can assist in delivering options**
- **Operationally at the vehicle level:**
  - E.g. smoother driving dynamics, platooning
  - In the long run, ITS that enables collision avoidance allows for much lighter/more compact vehicle design and thus lower energy use
- **Vehicle utilisation:**
  - Logistics – makes cooperation and bundling easier
  - Facilitates car pooling and car sharing arrangement
  - Route and speed optimisation
- **Fleet management**
- **Optimisation of networks:**
  - Road traffic management
  - Air traffic control for aviation
- **Replacing journeys:**
  - Shopping
  - Personal business (banking, etc)
  - Business (teleconferencing, etc)

2050 vision for transport operations and utilisation?

- **Optimisation of speeds and routes:**
  - All drivers/pilots fully aware of how to optimise speeds
  - Route optimisation supported by ITS
  - Network optimisation (road, rail, inland waterway) aided by ITS
  - Traffic management (air and sea) aided by ITS
- **All vehicles optimally maintained:**
  - Intelligent monitoring systems as standard
  - Engines, propellers, hulls/chassis optimally maintained
- **Freight and passenger vehicle utilisation optimised:** Supported by ITS
- **Potential for co-modality optimised:** Supported by ITS

- **New business models**: From selling vehicles to selling mobility

Barriers (1)

Technical options:

- (Perceived) Costs to consumer and to society more widely of many of the options
- Consumer preferences
- Life time of non-road vehicles

Alternative fuels/energy carriers:

- Infrastructure lacking for some alternative fuels (e.g. H_2 fuel cells)
- Technical lock-in (consumer familiarity, infrastructure, etc)
- Varying GHG reduction potential of some alternative fuels:
  - **Biofuels?** Depends on land use concerns and potential competition for land, e.g. with food and future biomass uses, and availability of water resources
  - **Electricity?** Depends on fuel mixed used, as well as technical and cost developments
  - **Hydrogen fuel cells?** Depends on how H_2 is produced

Barriers (2)

Operational options:

- Consumer preferences
- (Perceived) Cost to operators (e.g. from speed reduction)
- Ensuring application of options/enforcement

Various options:

- Number of stakeholders involved
- Lack of shared vision/competing business models
- Institutional barriers

Concluding remarks

- Options implemented to reduce GHG emissions must be **cost-effective** taking into account wider social, economic and environmental **costs and benefits**...
- … but costs of GHG mitigation, as well as fossil fuel energy price, likely to increase so **cost-effectiveness of various options will change**
- … also, **costs of technologies** are likely to come down over time
- Some options (e.g. new car design by using electric propulsion, ITS) may bring **added value to user**

- **Consumer preferences** can (and do) change

- Ultimate potential GHG reduction of options depends on the **scale, scope and level of ambition** of the policies implemented to stimulate their uptake

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Panel response

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