9th International Workshop on Sustainable Road Freights

(Virtual)

(December 12-14, 2022)

Workshop Synopsis[1]

[1] *This synopsis note was prepared by Niranjana Anand Unnithan and Shubham, Research Associates, Centre for Transportation and Logistics, Indian Institute of Management Ahmedabad*

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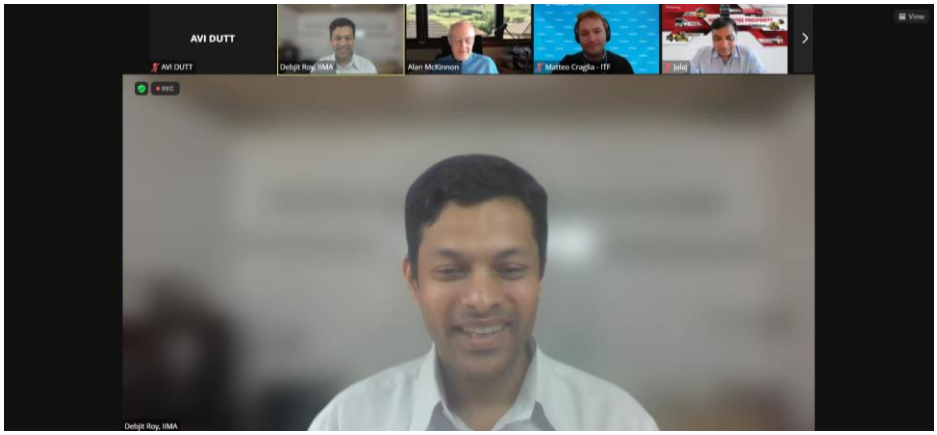
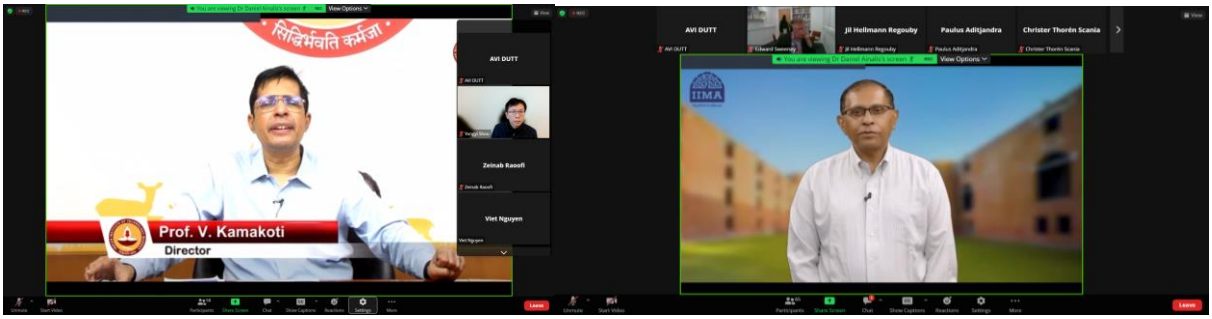
Synopsis of Sessions held on the First Day

Plenary Session 1: Changing Context for the Road to `Net Zero`

The first Plenary Session on 'Changing Context for the Road to Net Zero' of the 9th International SRF Workshop was chaired by Dr. Debjit Roy, Co-Chairperson, Centre for Transportation and Logistics, IIMA.



The welcome message was delivered by Dr. Kamakoti Veezhinathan, Director, Indian Institute of Technology, Madras and Dr. Arindam Banerjee, Dean (Faculty), Indian Institute of Management Ahmedabad.



Dr. Kamakoti outlined the need to decarbonise road freight transport since the road freight industry consumes vast amounts of fossil fuels and generates significant traffic. Hence, it will play a major role in achieving sustainable development goals and nationally determined contributions. He also highlighted the work done by IIT Madras in developing a hybrid engine that could work on multiple fuels. Weight, payload and distance are significant factors in the road freight industry, with the expectations of quality of service and short time making it more complex. This may imply that electric vehicles would not be able to address these challenges in the short run and hence alternatives like multiple-fuel engines would be needed. Inviting researchers to collaborate on projects on logistics sustainability at IIT Madras, Dr. Kamakoti expressed the hope that the workshop would prove to be a big step towards bringing sustainability to the road freight industry.

Dr. Banerjee highlighted the growing effort to develop sustainable solutions in the logistics industry in India. Noting that road transport emissions are estimated to grow in India, he highlighted various governmental efforts like the NHAI Fastag solution, the leap from BS IV to BS VI standards, the ethanol blending programme, and the focus on multimodal transport and supply chain solutions in the direction of mitigating the GHG emissions of the Indian logistics industry. Dr. Banerjee also underscored the work of the Centre for Transportation and Logistics on sustainable modes of transport, fleet electrification, route optimisation, and industry collaborations. He concluded his welcome note by emphasising the need to prepare a robust roadmap for net zero in the road freight industry.

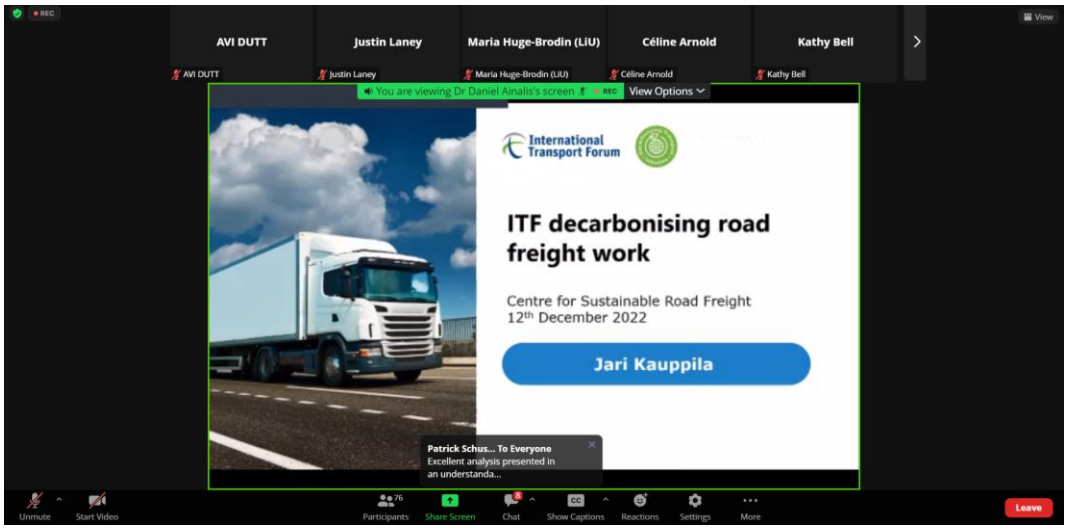
Keynote 1

Prof. Alan McKinnon from Kühne Logistics University delivered the first keynote speech. The talk mainly centered around the net zero theme of the SRF workshop. 8307 companies and 53 countries and regions had committed to achieving non-zero carbon emissions by 2050. He started with the definition of net zero road freight and highlighted that sequestration is often overlooked in net zero emissions. He briefly touched upon the two essential distinctions for net zero emissions : (i) Between carbon source and sink and (ii) Between stocks and flows. Prof. McKinnon stressed the importance of mitigating carbon emissions, ensuring less dependence on sequestration. He also discussed the decarbonisation techniques to bring emissions down, the five levers of which are given below:

1. Reducing the total demand for road freight through freight-reducing trends like circularity, localisation of production digitalisation, 3D printing, etc.
2. Modal shift to lower carbon freight – EU Sustainable and Smart Mobility Strategy.
3. Optimising the utilisation of road freight capacity.
4. Increasing energy efficiency in trucking: 15% improvement in efficiency by 2025 and 30% by 2030.
5. A long-term effort to reduce the carbon content in road freight energy use.

He stated that even the highly ambitious policy scenarios would fall short of meeting the 2030 and 2050 carbon dioxide reduction targets in the transport sector. The solution is to incentivise road freight carriers to intensify decarbonisation efforts.

Keynote 2



Dr. Jari Kauppila from the International Transport Forum gave a keynote speech on the work of ITF in decarbonising road freight. He began with a quick introduction to the ITF and the work carried out by ITF. He also shared insights from The ITF Transport Outlook 2021 whose theme was 'Reshaping mobility in the wake of Covid-19'. The outlook report highlighted the growing global demand for freight transport between 2015 and 2021, which is expected to grow going forward, across all regions though at different rates. Under today's policies, transport emissions are expected to rise by 16% in 2050 compared to 2015 levels. A deeper analysis reveals that emissions from the freight sector would rise by 22%, thus being the primary driver of the increase in transport emissions. Dr. Kauppila drew attention to the rising uncertainties from the Covid-19 pandemic and the war in Ukraine diverting resources meant for the transition to cleaner technology and modes. He also explained the ITF Driving implementation Actions Project and the findings from the project.

He touched upon the following points -

1. The dip in transport emissions due to the pandemic in 2020 saw a sharp rebound and the emissions are on a growth trajectory.
2. Policies and behavioural shifts are going to guide transport demand and chosen modes and consequently emissions.
3. Country and company-wise uptake of ITF Driving Implementations Actions Project.
4. Impact of electrification in reducing emissions with highest savings observed in battery-powered vehicles.
5. Financing is a key challenge in decarbonising road transport in developing economies.
6. Barriers faced by small fleet operators in implementing decarbonising actions.

7. Potential of zero-emission vehicles to outcompete diesel even without any policy support by 2040 in European markets.
8. Acceleration of zero-emission technology adoption requires different policy instruments at different stages of deployment with a specific focus on expansion and optimisation of charging infrastructure.

Keynote 3

Key points:

Mr. Jalaj Gupta from the Mahindra Group addressed the gathering and gave insights into Mahindra's core commitments to sustainability. He started by quoting the company's core philosophy - Philosophy of Rise - which means that as a business, we can rise only when we enable the rise of others.

He also highlighted the importance of the 'Total Cost of Ownership with a long-term perspective'. According to Mr. Gupta, the three megatrends that will change the world are the following.

- Climate change: The issue of climate change has gone from being a side conversation to a full-fledged concern
- Technological advancement has leapfrogged, catching many companies unawares
- Valuations of most companies are focused on ESG and other environmental commitments.

Mahindra, in line with its adherence to its core philosophy, has made ten commitments: Renewable energy, Project Hariyali, Nanhi Kali, Carbon Neutral, Water Positive, Women Empowerment, Energy

Productivity, Water Positive, Carbon Pricing Emphasis, and Gold Standard in Governance.

Mr. Gupta opined that organisations should commit to sustainability goals as part of their vision and goals, like Mahindra's Rise 2.0. He further emphasised the Act 3 levers Mahindra uses to leverage its sustainability commitments. These are products and services, sustainable operations, and infrastructure. However, independent monitoring and evaluation are necessary in the broader context.

Some of the industry challenges regarding sustainability initiatives are the following:

1. **Regulations and Compliances:** The automobile industry is highly regulated. The various rules that mandate changes in terms of safety, mileage, etc., ensure that products are being constantly upgraded. Compliance with government regulations is the priority.
2. **Stakeholder concerns:** All the stakeholders should have a clear understanding of the cost associated with technologies that are adopted towards sustainable net zero freight.
3. **After-sales:** New after-sales models should emerge to sustain the organisational commitment to make freight more sustainable

Breakout Session 1: Impacts of Climate Change on Freight Transport

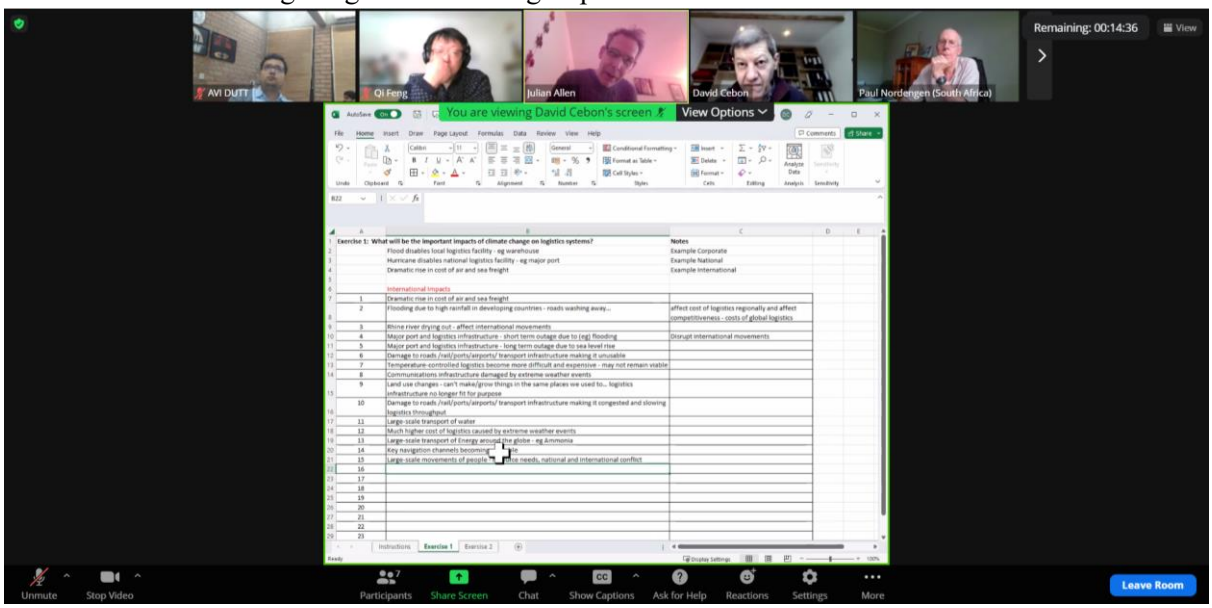
The first Breakout Session on the impacts of climate change on freight transport, logistics and supply chain systems was chaired by Dr. David Cebon.

With chances of the world limiting global warming to 1.5°C appearing bleak, the rate of climate emergencies and disruptions would likely accelerate going forward. The impact of climate change calls

for the logistics industry to invest and innovate accordingly to ensure the robustness of supply chains. The road freight industry also needs to plan for mitigating carbon emissions and adapt to the evolving business environment to remain relevant. A sustainable road freight industry is crucial to make the entire logistics industry resilient.

The participants were divided into six breakout groups with each group deliberating on the likely impact of climate change on worldwide logistics systems. These were discussed at three levels, namely, corporate, national, and international levels with two groups discussing one level each. A two-dimensional – four quadrant risk matrix was created to measure the intensity (high and low) of the impact of climate change on the logistics sector with severity and probability being the two dimensions. The exercise involved:

1. Creating a list of the likely impact of climate change at the assigned level of the group, and
2. Categorising each impact into one of the four quadrants of the risk matrix
3. Presenting insights from each group's discussions in the main Zoom room.

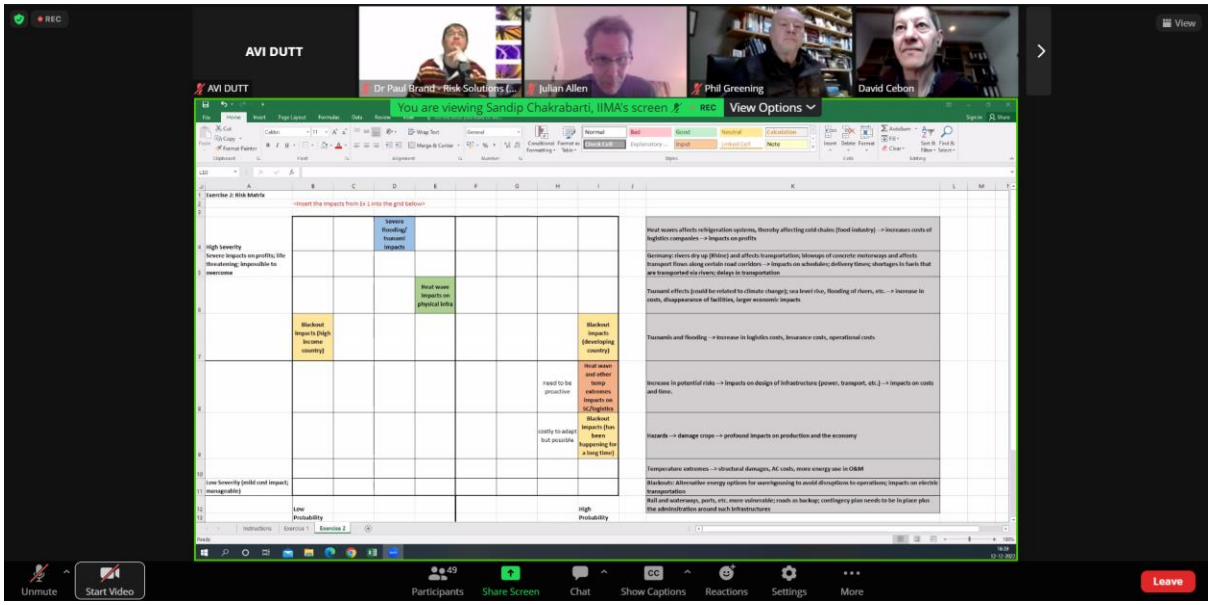


Here is a level-wise summary of the likely impact of climate change on logistics systems –

1. *Corporate level*: Multiple factors with high severity and high probability may affect corporations. The impact of climate change has started pushing up the cost of insurance and as climate emergencies become more frequent, the cost is expected to increase in the long term. The migration of people due to climate change mounts a challenge to existing systems and methods while creating opportunities for the creation of new demand, but at a significant cost. Blackouts are expected to increase in developing countries, thereby, significantly impacting electric transportation systems and warehousing operations. Also, temperature extremes may cause structural damage to equipment and cold chains which may increase the costs of operations and management.

2. *National Level*: At the national level, climate change may impact the logistics industry on multiple fronts, like agriculture, infrastructure, storage solutions, energy supply, and the labour force, among others. The rise in freak events and extreme temperatures may significantly damage power and transportation infrastructure like power grids, transmission lines, highways and bridges, and inland and marine navigation routes. Also, there may be a general shift to temperature-controlled supply chains, especially in agricultural items, thereby pushing up the demand for energy and fuel consumption. Finally, worker mobility may get affected and worker productivity might fall because of the fatigue caused by harsh working conditions.

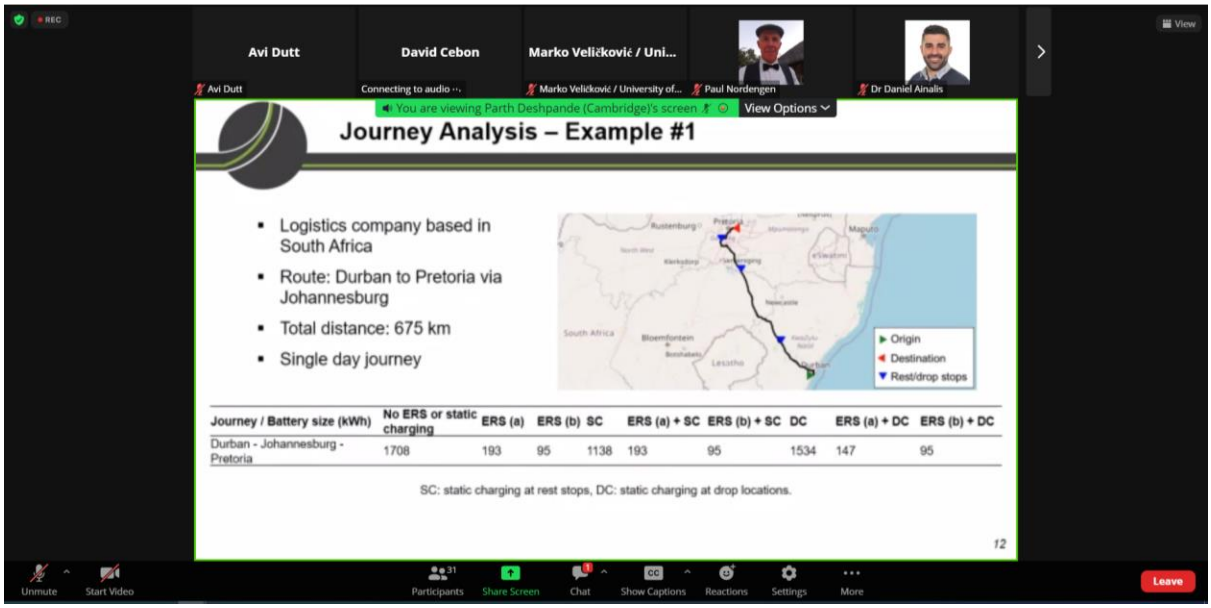
3. *International level*: Climatic changes play a major role in disrupting the supply chain and logistics at the global level, aviation and maritime being the industries most affected. Climate incidents affecting air space availability and political conflicts leading to longer air freight routes are the major challenges being faced on the aviation front. High tides and flooding impact access to the ports, and inclement weather disrupts port operations affecting shipping lines and routes.



Parallel Tracks 1: Role of E-highways in Sustainable Road Freight Systems

The session chair of Role of E- highways in Sustainable Road Freight Systems was Dr. Phil Greening.

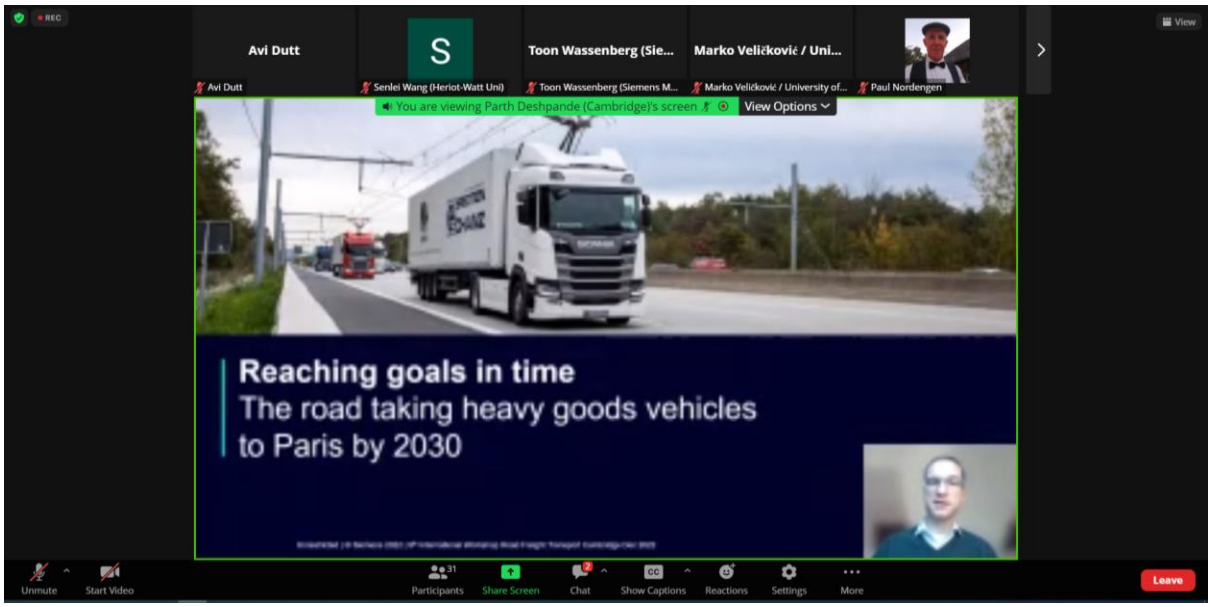
Presentation 1 - Accelerating road freight electrification in various countries using electric road systems: P. Deshpande, C. de Saxe, D. Ainalis, J. Miles, and D. Cebon



Key points:

- The study examines the energy consumption, emissions, and economic viability of adopting ERS in several nations to reduce greenhouse gas emissions from road freight.
- They have developed a formulation that aids in locating the country's network of roads that are appropriate for implementing ERS with a financially appealing cost breakeven.
- The formulation is applied to England, India, and South Africa to filter roads in the respective countries. The findings offer information to enable the implementation of ERS in both established and developing nations as well as nations with a variety of geographies and freight types. It also helps in identifying the most appropriate network topographies for an ERS network in these nations as well as how sensitive they are to the economic characteristics.
- The analysis can serve as the basis for the government's promotion of effective decarbonisation methods.
- There is scope to extend the study by analysing the data for more diverse journeys in different nations and evaluating static chargers and range extenders.

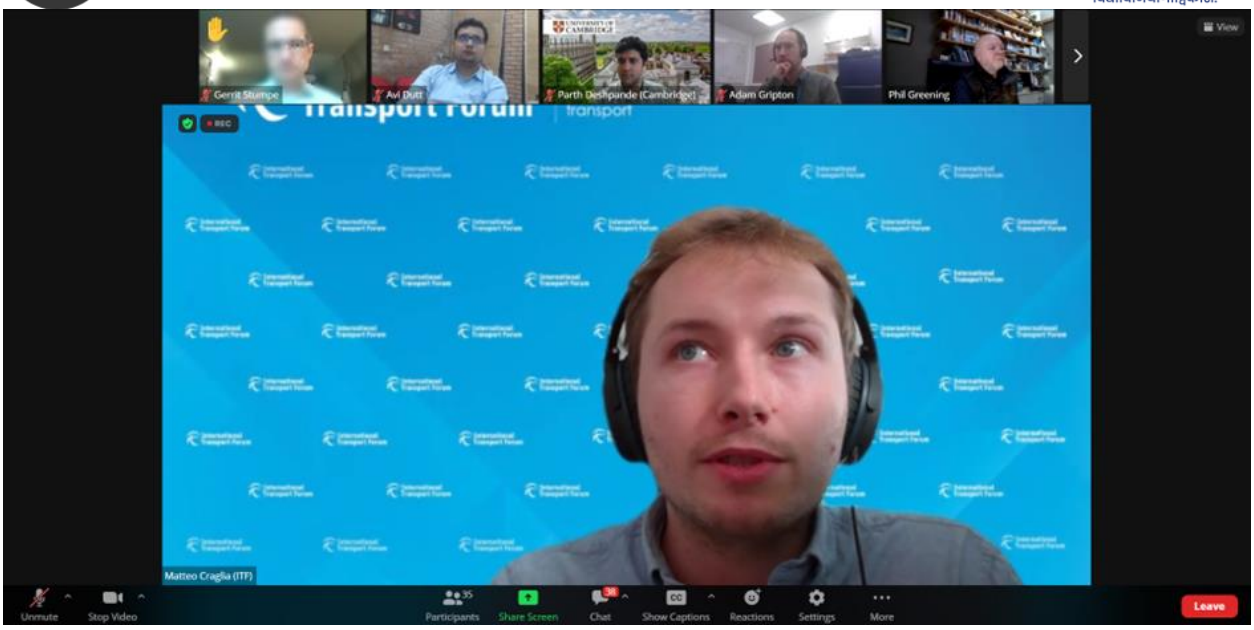
Presentation 2 - The road taking heavy goods vehicles to Paris by 2030: P. Akerman, M. Staub, G. Stumpe



Key points:

- The study talks about addressing climate change by implementing an overhead contact line and electric road system across Europe and the UK.
- It specifically mentions the current state of these systems and how they can be further optimised to make them commercially operational.
- This is established using three parameters - Maturity, Scalability, and Robustness.
- OCL-ERS developments require a coordinated effort from neighbouring countries to achieve economic profit and a quick transition of this technology to market.

Presentation 3 - Improving the conditioning of Electric Road System (ERS) feasibility studies through use of a preferential routing engine: A. Gripton



Key points:

- The open-source GraphHopper routing engine was modified in this study to incorporate an additional parameter that specifies how much a route query should take the location of ERS routes into account when determining its routing.
- This research demonstrates how the preferential routing engine's outcomes will improve the feasibility of more extensive evaluations of HGV battery capacity.
- The following points can be inferred from the study:
    - It is possible to calculate alternate routes with explicit ERS configuration information.
    - A schema that outlines how to balance trip time and estimated battery life to make thoughtful logistics considerations
    - Real-world interpretation of calibration parameter in the simple case of 'all vs none'.

Presentation 4 - Decarbonising Europe's Trucks: How to Minimise Cost Uncertainty: M. Craglia

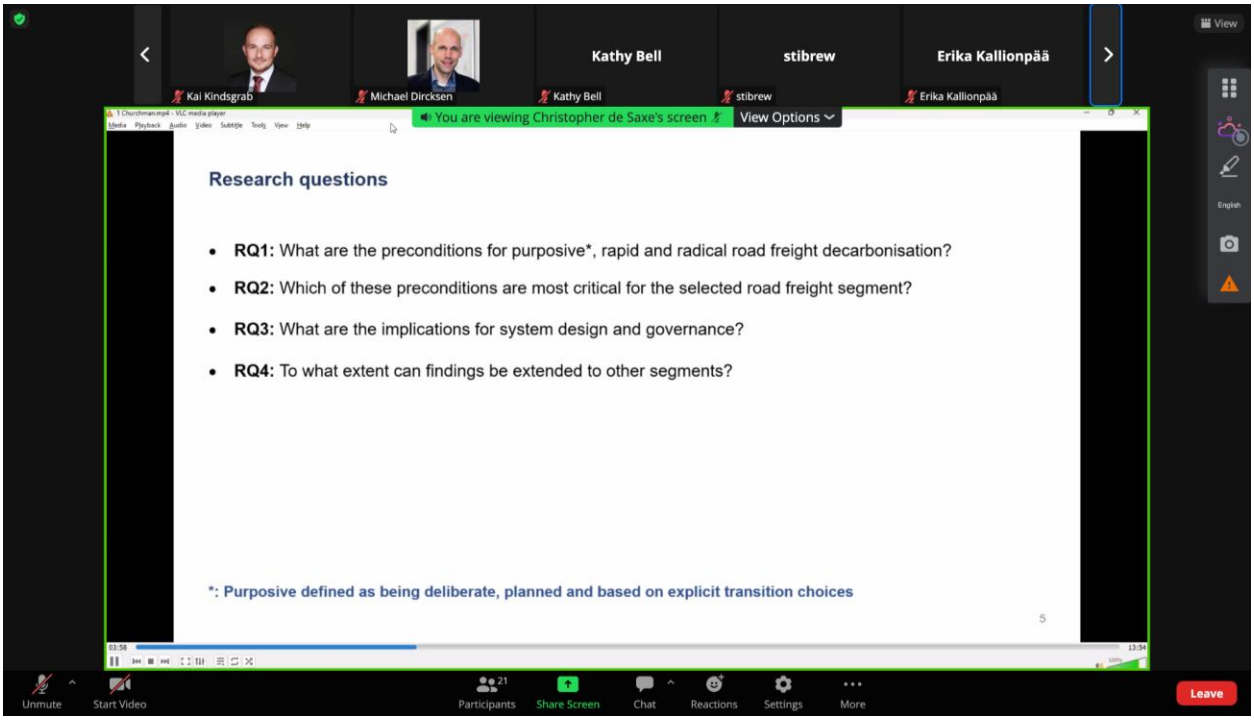
Key points:

- To decarbonise heavy-duty trucks, this research examines the viability of zero-emission powertrain technology. It compares the total cost of ownership (TCO) of three prominent technologies, including hydrogen fuel cell vehicles, electric road system vehicles, and battery electric vehicles (BEVs) (FCEVs).
- In this analysis, a novel contribution is made by employing 1000 distinct scenarios for each powertrain technology and nine different vehicle size segments in Europe to examine a broad variety of potential futures.
- Major findings of the study:
    - Most use cases between 2030 and 2040 will see zero-emission vehicles cost-competitive with traditional diesel trucks.
    - The most affordable solutions to replace conventional diesel trucks in Europe are probably BEVs and ERSVs.
    - For widespread market acceptance, FCEVs fall short of competing with other vehicle technologies.

Parallel Tracks 1: Decarbonisation and Carbon Footprinting of Road Freight Transport Systems

The session chair of Decarbonisation and Carbon Footprinting of Road Freight Transport Systems was Dr. Maja Piecyk.

Presentation 1 - Transitions literature learnings for purposive United Kingdom (UK) road freight decarbonisation: P. Churchman and T. Dekker, J. Anable



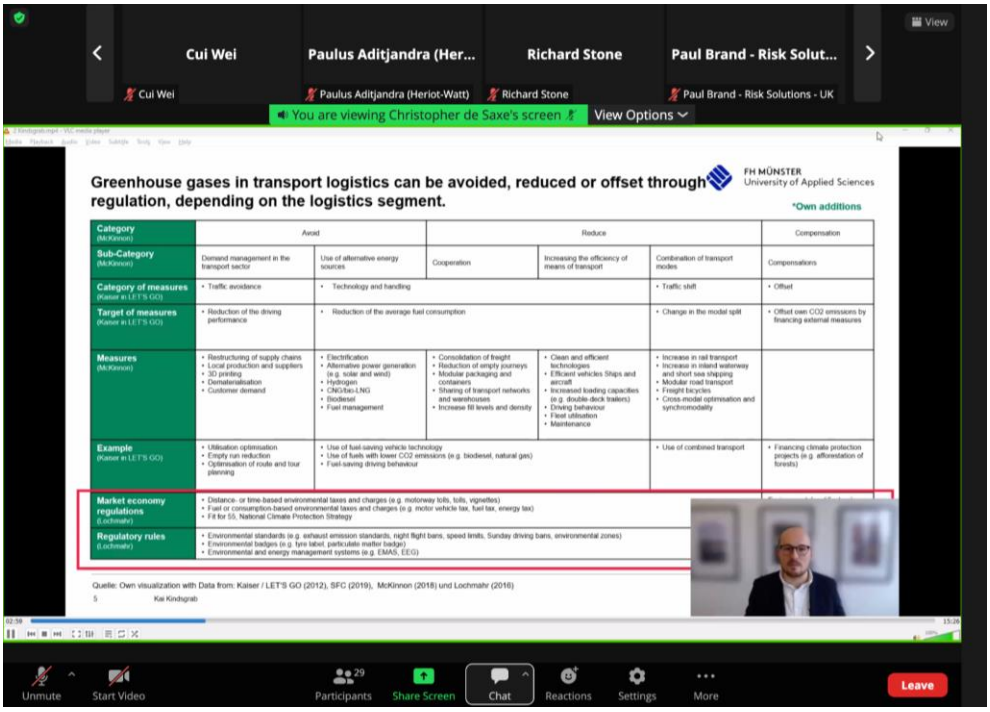
Key points:

- The predominance of techno-economic research and the need for socio-technical and political research in road freight decarbonisation-related research were highlighted. Most experts and shippers also identify political and socio-technical factors as key barriers to the decarbonisation of the road freight sector.
- The study aimed to determine the preconditions for purposive, rapid, and radical road freight decarbonisation and find the most critical preconditions for the selected road freight segment through insights from transitions literature.
- The implications of preconditions for systems design and governance, and the extent of applicability of these findings to other segments were also examined.
- The methodology involved the application of filters based on keywords and qualitative aspects in four phases to narrow down 18 papers out of the 2150 papers returned from Scopus using key

search terms on transitions literature. Two more papers were added through the same process by analysing the papers referred to in the 18 mentioned earlier.

- 24 socio-technical and political transition attributes were identified under five headings namely, actors, policy, politics, design, and arena through open, axial, and selective coding of the 20 selected papers.
- The findings emphasised the need to co-design road freight decarbonisation outcomes and pathways by actors in the arena where key design choices need to be coordinated across multiple sectors.
- Key pre-conditions for successful transitions were identified. Rapid decarbonisation requires the availability of feasible techno-economic options. Design choices that require coordinated action across multiple actors need to be understood carefully. Finally, a feasible political and socio-technical codesign framework is needed to shape design choices.

Presentation 2 - Sustainable logistic decisions – A simulation model of how avoidance costs of CO2e emissions influence transport cost calculations: K. Kindsgrab and M. Dircksen, I. H. Zadek



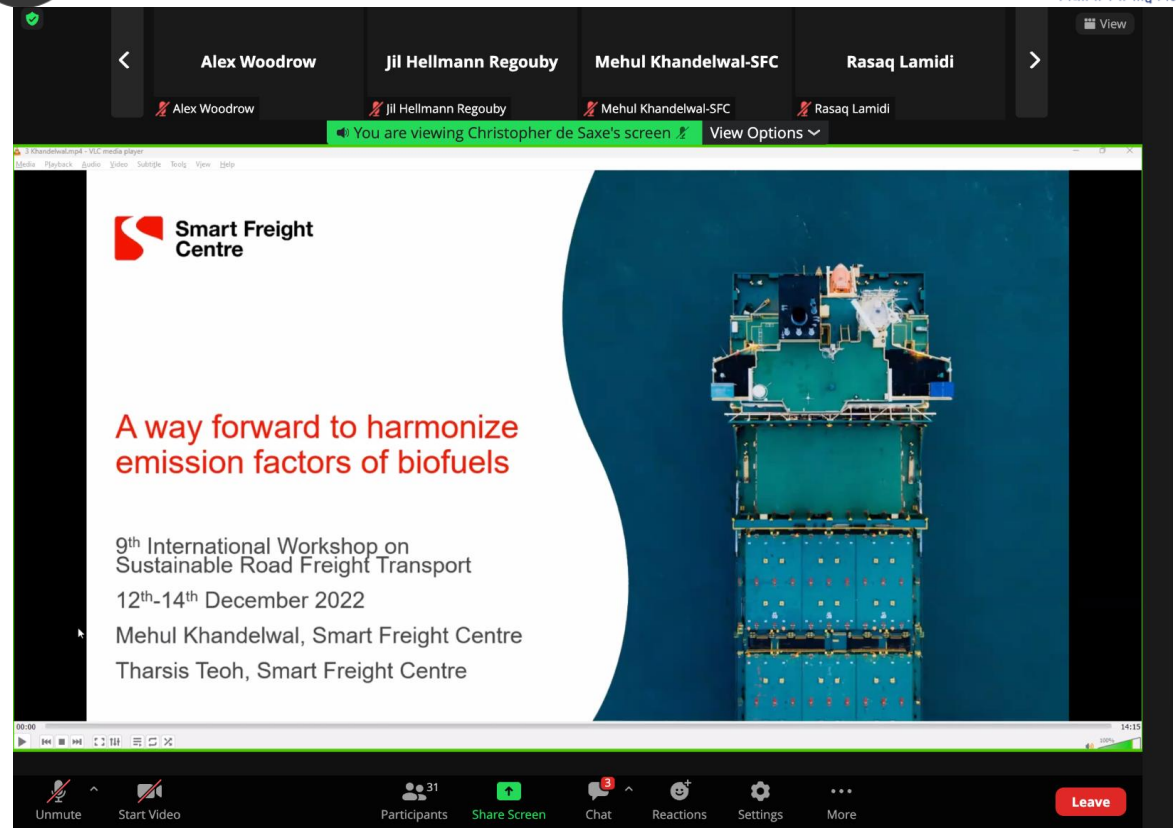
Key points:

- Increasing freak weather events like heat waves and forest fires in Germany have put the focus on sustainability in all sectors, including the road freight transport sector in Germany where the

emissions remained constant with respect to the transport volume, despite the introduction of many technological solutions and legal requirements.

- Freight forwarders and Logistics Service Providers tend to internalise costs associated with pricing for CO2 emissions making cost-bearing transport price and fleet management more dynamic and multi-dimensional.
- The study seeks to understand the impact of the internalisation of CO2e emissions-related legal regulations on the calculation of transport costs in Germany.
- The methodology involved the development of a simulation model for individual cost components while calculating transport prices through the Nyhuis model-building approach. The model used modified costs of BGL due to the change in weights caused by national CO2 pricing regulations.
- An MVP model that examined four main cost drivers and two main emissions drivers was developed. Cost drivers were fuel costs, driver's wages, kilometer-related road tolls and statutory social expenses while emissions drivers were Euro V and Euro VI.
- Four different scenarios caused by different national CO2 pricing models were analysed to understand the tipping points of investment in sustainability solutions from a financial perspective.
- There exists scope for future work to be done by incorporating other environmental measures in the model, and validating and discussing the effect on transport prices with carriers.

Presentation 3 - A way forward to harmonize emission factors of biofuels: M. Khandelwal and T. Teoh



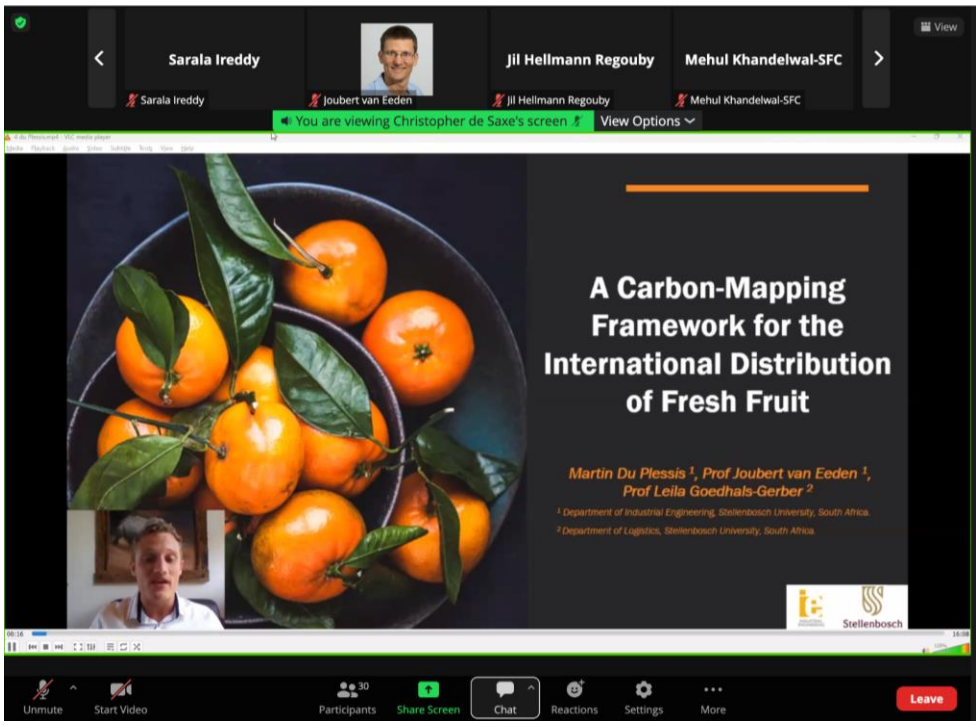
Key points:

- Multiple methodologies for accounting for carbon emissions exist in the biofuel production sector, which makes it difficult to understand the extent to which biofuel can help mitigate carbon emissions in the short and long run.

- The study aimed to compare different emissions accounting approaches namely, GREET, JEC, and RED currently in use by different entities and provide recommendations for harmonisation of US and European emissions factor calculation approaches across multiple dimensions.
- Reporting carbon emissions is a four-step process. The first step involves the collection of emissions data for Scope 1, 2 and 3. While data for Scope 1 and 2 can be collected from their fleet and assets, data for Scope 3 can be collected from suppliers. The second step involves calculating emissions intensity by dividing total CO2e by the activity factor. After that, verification and validation of the calculated figures are done and finally, the emissions are reported.
- A detailed comparison of the scope and methodological approach was carried out for the three aforementioned emissions accounting approaches. A qualitative analysis of emission categories and a quantitative analysis of emission numbers were also carried out.

- The analysis revealed remarkable differences in the emissions accounting between the US and European factors in biodiesel emission factors and bio LNG emission factors based on the WTT, TTW, and WTW stages.
- Such inconsistencies lead to inaccuracy in accounting and reporting for multimodal operators and lead to confusion in the market while picking the relevant emission factors for calculation.
- Thus, there is a clear need to develop consensus on a universal GHG accounting principle and incorporate indirect land use changes in the emission factor calculation through reliable estimation.

Presentation 4 - A Carbon Mapping Framework for the International Distribution of Fresh Fruit: M. Du Plessis, J. Van Eeden, L. L. Goedhals-Gerber



Key points:

- There exists no mechanism to calculate GHG emissions from the global distribution of fruit. Because of the difference in the seasonality of fruit production, and in the northern and southern hemispheres, significant emissions are generated from the transportation of fruit.
- Fresh fruit also requires cold storage through transportation and in warehousing and distribution, making their distribution more emissions-intense.
- The study aims to devise a framework to quantify emissions generated from the distribution of fresh fruit from South Africa to the northern hemisphere. It was devised by studying the available

literature, recording observations, preparing distribution chain diagrams, conducting semi-structured interviews, and collaborative partnerships with the industry.

- The framework involves the following six steps -
    - Identification of all emissions-generating activity
    - Collection of emissions data
    - Selection of emission intensity factors
    - Activity-wise calculation of emissions
    - Calculating activity-wise carbon footprint (emissions/net weight of fruit)
    - Determination of overall carbon footprint and total emissions.

- The framework helps in determining total emissions (kg CO2e) and the carbon footprint (kg CO2e/kg fruit) emanating from the shipment of fruit. It includes the estimation of emissions from the gates of the fruit farm to the destination port, also factoring in the empty round trips made.
- There exists scope for further research on generalising the framework to include emissions-mapping of other items and other trade routes.

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Synopsis of Sessions held on the Second Day

Plenary Session 2: Brace for impact. How to operate in the increasingly volatile environment?

The second Plenary Session on 'How to operate in increasingly volatile environment?' at the 9th International SRF Workshop was chaired by Dr. Shrikanthan Sridharan, Assistant Professor, Indian Institute of Technology Madras.

Keynote 4

The first keynote speech of the day was delivered by Prof. Gyöngyi Kovács, Professor in Humanitarian Logistics at Hanken School of Economics. The theme was on greening humanitarian logistics that aim to save lives and sustain livelihoods while extending it to the natural environment. She discussed the pertinent challenges relating to transport infrastructure during disasters and conflicts and also the environmental issues around it. She also emphasised the role of climatic changes in disasters and the importance of adopting meteorological forecasting in preparing for impending disasters.

Prof. Kovács talked about prevention and mitigation in humanitarian logistics through a build-back strategy preferably in a different location. It can also be with different materials or as a preparation for a different disaster. She cited the example of building back communities in Australia. However, this is not always a possibility and could lead to migrational issues and conflicts. She concluded that some of the techniques that can be adopted by green humanitarian logistics are -

1. Reducing needs
2. Waste management and reverse logistics
3. Systemic changes such as cash programming and localisation strategies

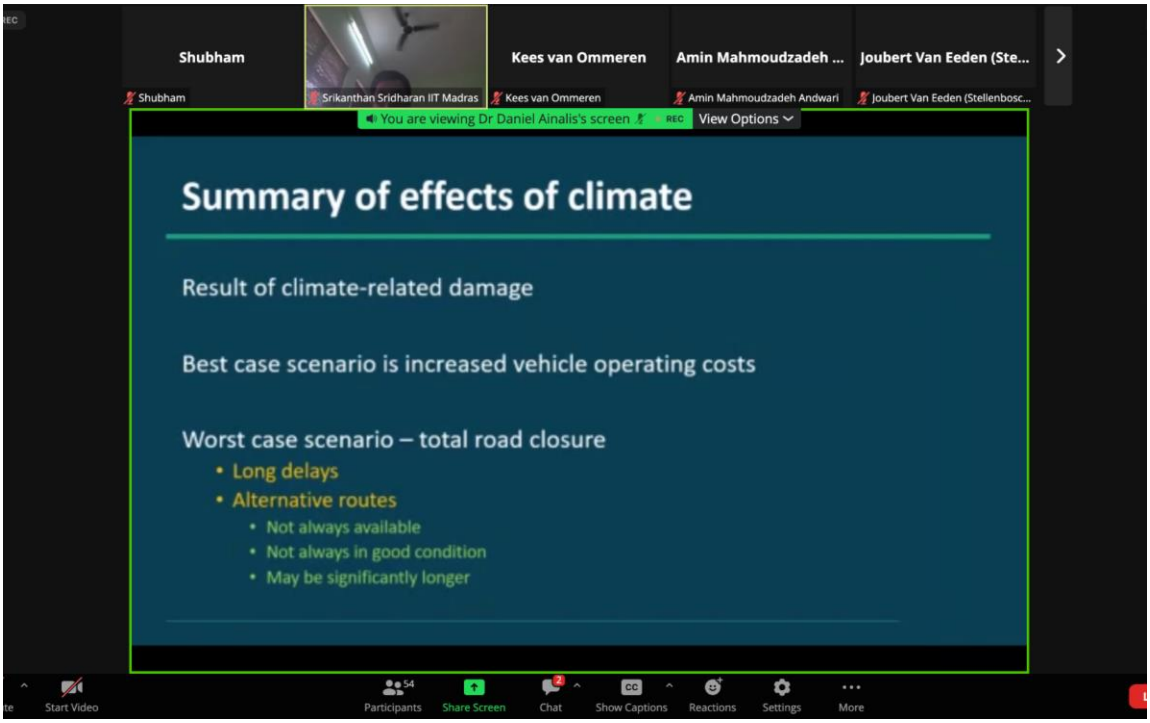
Keynote 5

The second keynote speech of the day was delivered by Mr. Phillip Paige-Green, Director, Paige-Green Consulting and Professor, Tshwane University of Technology. The theme of his keynote speech was 'Transport infrastructure adaptation for a changing climate' where he discussed the importance of the condition of the road network in reducing the impact of disruptive events of climate emergencies in the road freight industry. He highlighted how extreme events render roads temporarily impassable and cause excessive war. Further, he talked about the damage caused by extreme events to the road surface which leads to an increase in vehicle operating costs and slows down vehicle movement. It is worth noting that roads and bridges may entirely collapse which leads to the temporary closure of the route and a longer time to make that route functional. He also discussed how the impact of extreme events is higher on unpaved roads compared to paved roads, and the role that can be played by investing in their maintenance and upkeep to ensure their workability even in extreme weather events. He underscored the possibility of the impact of climate change affecting the road infrastructure of developing countries more severely since they face problems with adequate funding to maintain and repair their roads, are more vulnerable to extreme climate events, and face the problem of overloaded vehicles that negatively impact their road conditions.

He also touched upon the following points:

- Inundation of roads is better than a total washaway since it may take years to rebuild and reconstruct.
- Poor construction and quality of materials make roads significantly more vulnerable to damage due to climate events.

- Road authorities would be the primary driver of bringing change in the condition of roads in any country and making them more resilient.
- Freight operators should ensure their vehicles are not overloaded or indulge in overspeeding since these actions make the road rougher and indirectly increase vehicle operating costs.
- Developing countries may expect more in terms of adaptation from the freight transport sector since they face paucity of funds in developing new routes and maintaining their condition.
- Freight transporters can act as a lobby or pressure group to convince the government to spend more on the quality of the road network.



Keynote 6

In his keynote address, Mr. Mirko Woitzik, Director of Intelligence Solutions at Everstream Analytics, spoke about building resilience in the face of growing supply chain turmoil. He mainly discussed three crucial areas - supply chain turmoil in 2022, the preparedness of companies, and the pace of decarbonisation challenges. He started with the importance of resilience in the supply chain, stating that all companies are significantly affected by it. According to a report by Gardner, 97% of supply chains have had at least one disruption in the past two years, and the associated cost is exceptionally high. Furthermore, 2022 faced some of the biggest challenges disrupting the supply chain, such as the pandemic, war in Ukraine, tensions between China and Taiwan, energy crisis, labour unrest, and natural calamities such as heat waves and floods. As a result, material, supplier, and shipping disruptions have heavily impacted the global supply chain. However, companies can prepare for the next crisis by developing risk monitoring capabilities, taking informed actions, and practising strategic risk management.

While discussing the companies' preparedness, Mr. Woitzik identified that the weakest link in the supply chain is poor visibility beyond Tier 1. Although nearly 51.1% of the disruptions occur in Tier 2 and below, only 2% of organisations have visibility below this tier. Against this backdrop, companies should improve visibility into their multi-tier supply chains by asking the right questions, identifying the supplier's supplier and the products they supply, the number of facilities and locations, etc. For this, graph technology can be adopted to map supplier networks worldwide to understand sub-tier dependencies and the flow of goods. Once a multitude of visibility is achieved, companies can start to monitor suppliers, and get a head start on disruptions that would eventually impact their operations.

Finally, Mr. Woitzik highlighted that ongoing supply chain disruptions have negatively impacted the decarbonisation movement.

Breakout Session 2: How to Mitigate the Impact of Climate Change on Freight Transport, Logistics, and Supply Chain Systems

The second Breakout Session on 'How to Mitigate the Impacts of Climate Change on Freight Transport, Logistics and Supply Chain Systems' was chaired by Dr. David Cebon.

Carrying forward the points from the breakout session from the previous day, the breakout session on Day 2 involved deliberating on the steps and action plans that can be taken to mitigate the harmful impacts of climate change on global logistics and supply chain systems. The participants were divided into four breakout rooms with each group discussing the likely impact on the assigned level (corporate/ national/ international) under the two broad umbrellas of -

1. Needs: This involved trying to understand the work that needs to be done. It could be in the form of research needed, policy regulation or even implementation.
2. Call for action: This involved a discussion on what could be the next step, and on the role of different stakeholders in taking short and long-term action measures in mitigating the harmful impact of climate change.

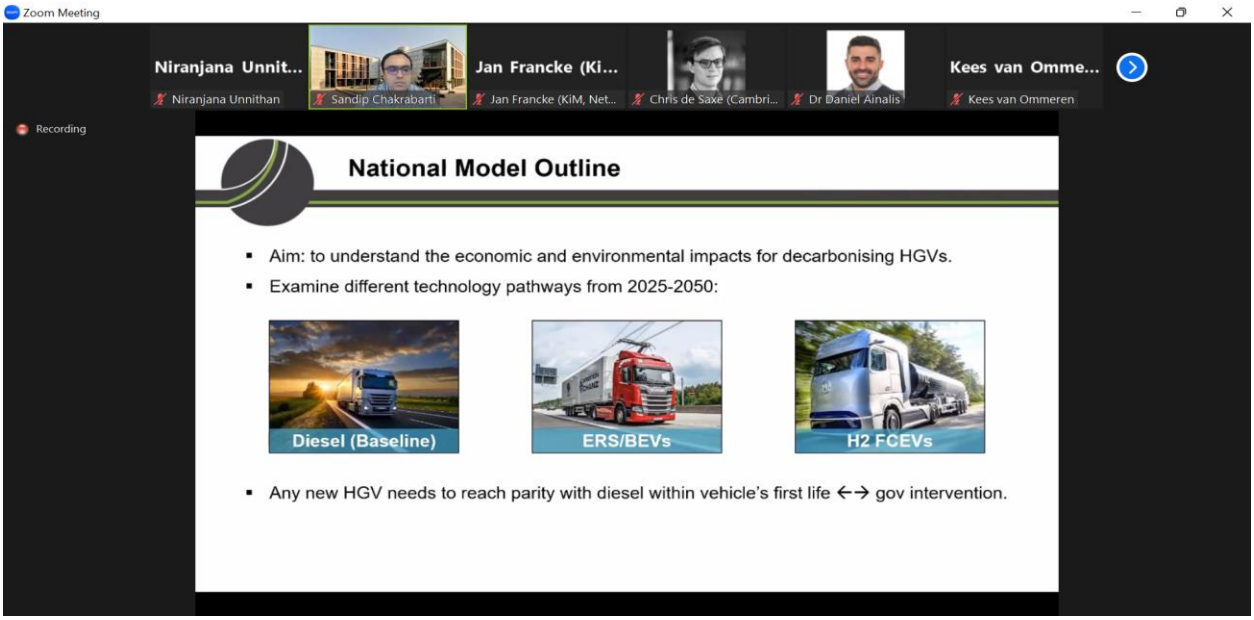
Here is a summary of the discussions:

S.No.	International Level	National Level	Corporate Level
1.	International efforts are needed to resolve global conflicts.	Communication outages due to climate disasters and geopolitical reasons can be averted by deploying alternative communication technologies like Starlink, as is being used in Ukraine.	Research is needed on the tradeoff between resilience and cost efficiency to arrive at a good suboptimal solution that takes both aspects into consideration.
2.	Alternative backup sources should be identified by governments in case of global geopolitical tensions.	Immediate efforts could be made to shift data to cloud-based servers in order to make data and communication systems resilient to external threats.	As some routes become challenging to operate on, corporations need to create vulnerability maps for corporate assets.
3.	A database on logistics hubs and alternate short-term plans can be created to tackle the impact of short-term outages in international logistics infrastructure.	Electricity disruptions during weather events in remote areas can be contained through solar-based AC and DC microgrids.	Modal shift from roads to railways and airways can be tackled via decarbonisation of the road freight system.
4.	The plan should be formulated by intragovernmental agencies and logistics service providers.	Solar grids should be installed by the government and subsidies can help enhance the uptake of solar power at a micro level.	An increase in logistics costs can be passed on to customers.
5.	Energy-efficient cold storage systems and coordination with global organisations like the United Nations are needed to ensure food security amidst changes in weather patterns.	Climate emergencies causing damage to critical national assets need a SCADA monitoring system and constant upgrades to make the system resilient overall.	Rising insurance costs, especially for small firms can be averted through fiscal incentives from the government and strategic plans at the firm level.
6.	In the near term, efforts to make agricultural practices water efficient can be made along with regular updates in storage infrastructure to avert food security crises.	Resilient products need to be made using eco-friendly materials to withstand extreme temperatures.	Regulatory support in terms of flexibility and incentives is needed to cope with disruptions caused due to climate events.

Parallel Tracks 2: Role of E-highways in Sustainable Road Freight Systems

The session chair of "Role of E-highways in Sustainable Road Freight Systems" was Dr. Sandip Chakrabarti.

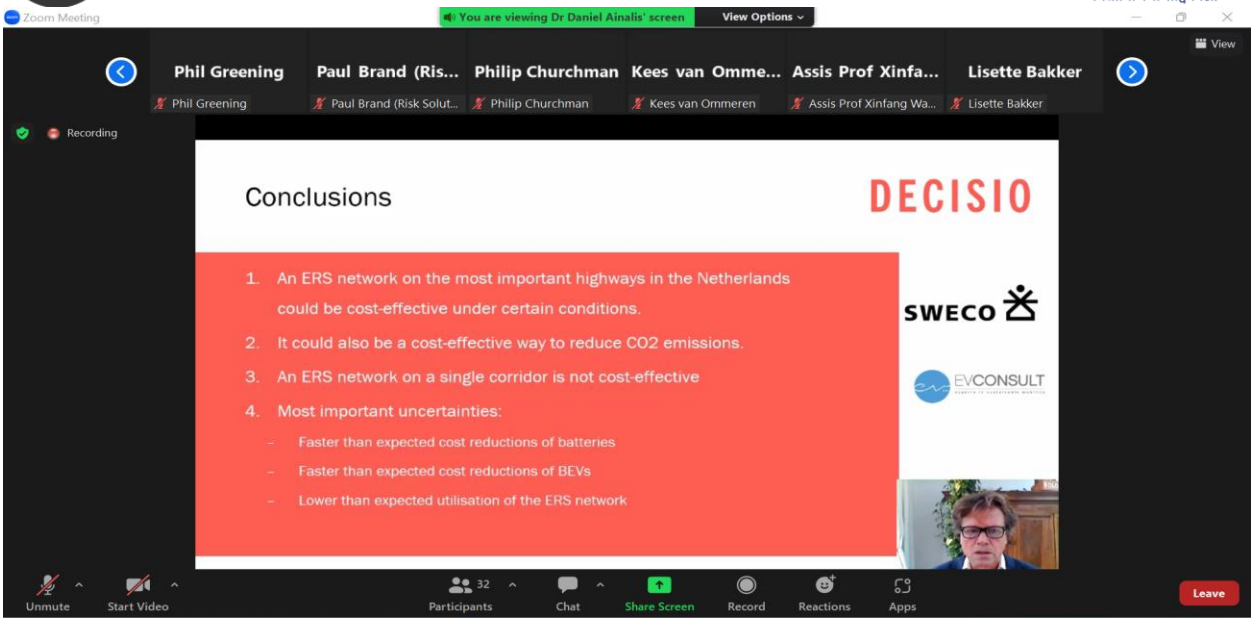
Presentation 1 - A National Framework to Assess Electric Road Systems: a UK Case Study: D. Ainalis and C. de Saxe, J. Miles, A. Gripton, P. Greening, C. Thorne, and D. Cebon



Key ideas:

- In 2019, the UK government made revisions to the Climatic Change Act to ensure net zero emissions of Greenhouse Gases (GHG) by 2050. Diesel-powered Heavy Goods Vehicles (HGVs) are responsible for transporting 90% of the goods in the UK and are the primary sources of Greenhouse gases and harmful emissions. It is also challenging to decarbonise these vehicles due to their high power and range requirements. This creates a need for alternative sources of power for such vehicles. Electric Road Systems (ERS) at a national level are one of the solutions to enable net zero HGVs.
- The project aims to conduct a feasibility study for zero-emission heavy vehicle goods in the United Kingdom. It also develops a robust framework to assess the electrification of long-haul road freights. It examined technology pathways from 2025 to 2050 and studied the economic and environmental impact of decarbonising HGVs.
    - Different possible solutions for GHG reduction, such as Internal Combustion Engines with biofuels or synthetic fuels, full battery electric HGVs, electric HGVs using ERS as a source of external energy supply, and HGVs using hydrogen as a source of on-board energy supply are evaluated.
    - A nationwide picture of logistics and HGV movements is created with the help of various data sources.
    - It is crucial to have a thorough understanding of the operational profile of the vehicles at a national level. Therefore, ERS coverage at different levels, from no coverage to an extensive network that covers 15,000 lane-km, is considered.
    - Environmental, Financial, and Societal benefits to all the stakeholders are assessed with the help of models.
- There is scope to improve the study by applying the model to a range of sensitivities and refining the cost and input with the availability of new data.

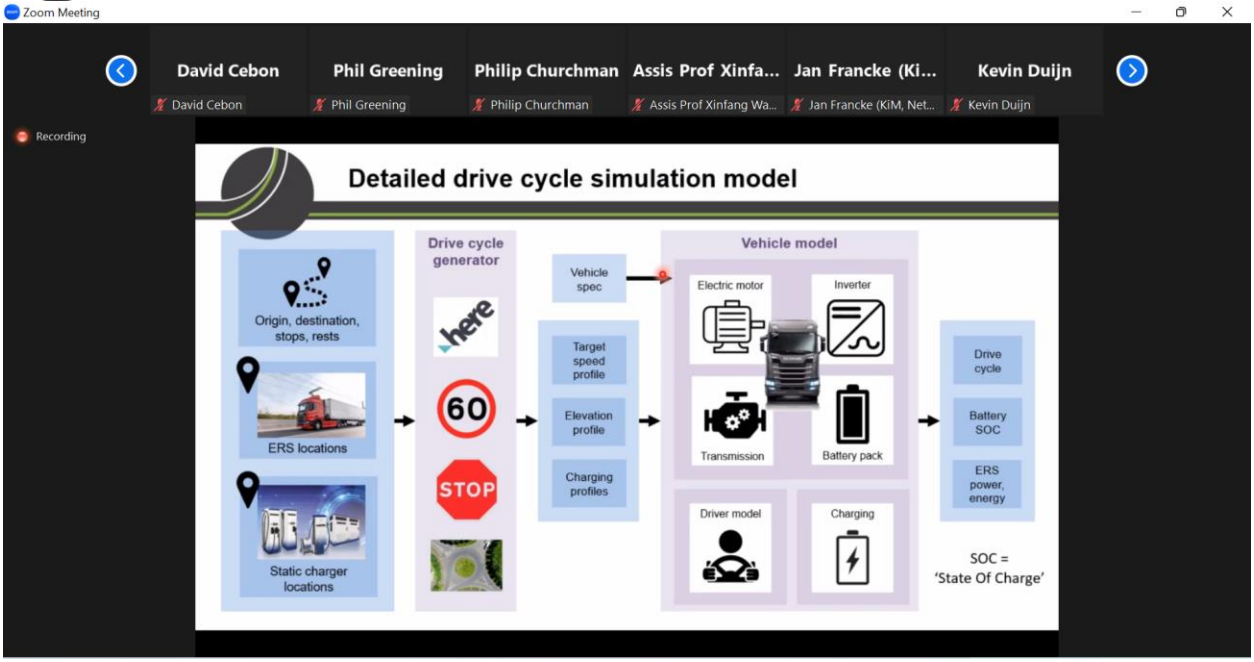
Presentation 2 - ERS can be a cost-effective way of achieving Zero Emission Road Transport: K. van Ommeren, M. Aldenkamp, J. Quee



Key ideas:

- The study aims to evaluate the profitability of installing ERS networks on the main highways of the Netherlands subject to conditions. It also shows the cost-effectiveness of ERS in reducing carbon emissions.
- The cost recovery rates indicate that the ERS network is a feasible option for transport operators to invest in compared to battery electric vehicles, diesel, or hydrogen trucks.
- However, ERS requires an initial investment that can only be recovered from long-term usage.
- The study concludes that the ERS network is a cost-effective and environmentally friendly approach to achieving net zero under certain conditions. However, the ERS network on a single corridor is not adequate. Unanticipated cost reductions of batteries and battery electric vehicles and underutilisation of ERS networks are some of the uncertainties involved.

Presentation 3 - Vehicle battery requirements for a UK electric Road Freight System : C. de Saxe, D. Ainalis, J. Miles, P. Greening, A. Gripton, C. Thorne, D. Cebon



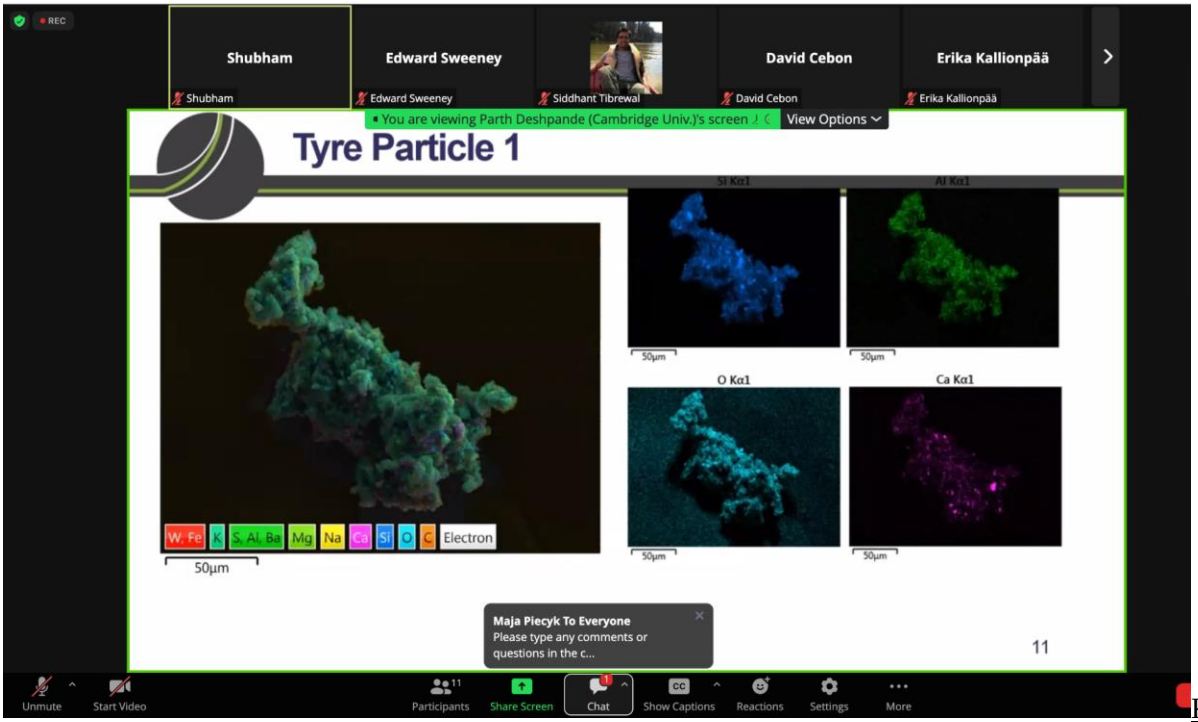
Key ideas:

- ERS systems have been identified as an economically feasible and viable solution for decarbonising Heavy Goods Vehicles in the United Kingdom.
- ERS helps reduce battery capacities, which in turn reduces the vehicle cost, weight of the vehicle, and emissions from the vehicle.
- The study aims to mimic logistics trips across various ERS and static charging conditions in the UK and analyse the effect on battery sizes.
- The authors analysed eight real 44t HGV journeys against 12 ERS and static charging stations. The reduction in battery sizes by ERS for these journeys is as follows:
    - 41% for ERS light, 62% for ERS medium, and 75% for ERS heavy
- The future scope of the study involves large-scale simulations using a simplified model and analysing the economic implications at a national scale.

Parallel Tracks 2: Vehicle Technologies and Tyre Management for Sustainable Road Freight Systems

The session chair of 'Vehicle Technologies and Tyre Management for Sustainable Road Freight Systems' was Dr. Maja Piecyk.

Presentation 1 - Developing equipment and methodology for brake and tyre wear generation, collection and analysis: M. Haugen, D. O' Loughlin, C. Liu, D. Ainalis, D. Cebon, and A. Boies



Key

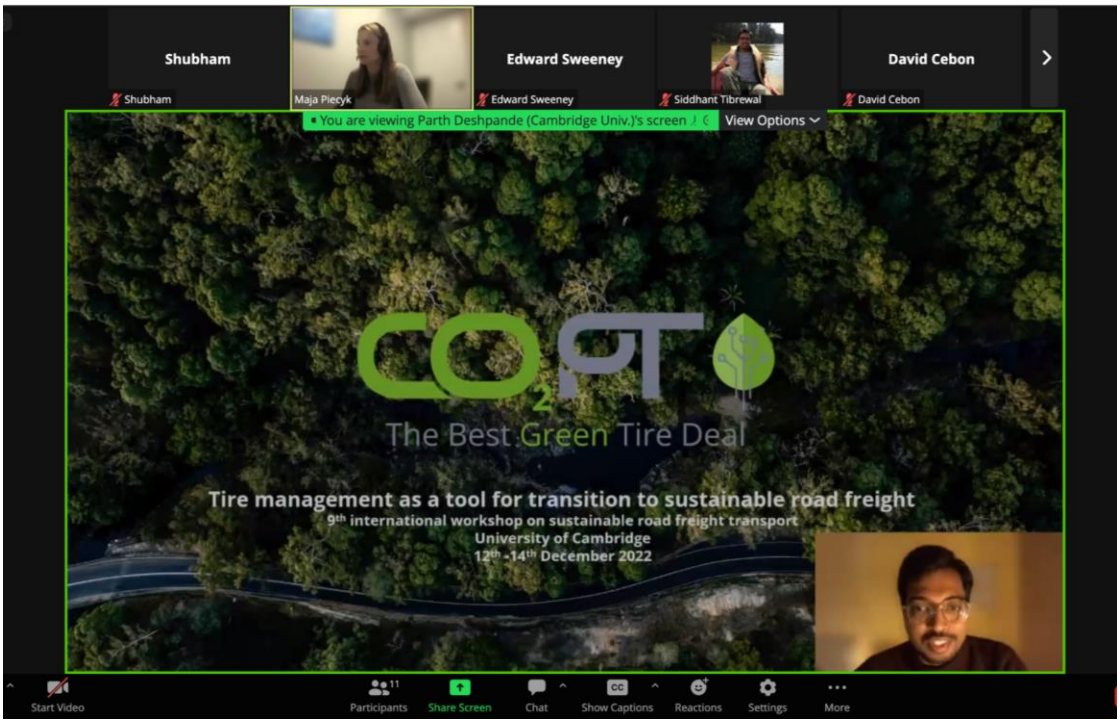
Key points:

1. Brake and tyre wear particles (BTWPs) contribute to road emissions in their own way. It is important to look into their emissions since they represent significant emissions from non-combustion vehicles.
2. The project involves three components which it is investigating, namely, BTWP emission generation, real-time (online) analysis, and offline particle and toxicology analysis.
3. A tyre rig has been developed to test certain metrics related to tyre wear like rotational speed, frictional force, slip rate, and temperature. Particle generation from different surfaces can also be tested in the rig thereby providing a comprehensive view of tyre particle generation surface-wise. A brake rig is also in the pipeline to test particle generation from brake wear.
4. An Electrical Low-Pressure Impactor instrument (ELPI+) is used to monitor air quality and can measure particles of size 0.006µm to 10 µm. It is used to determine key particle metrics for

BTWP. ELPI+ can help determine particle number, lung deposited surface area, particle mass, and overall particle size distributions.

5. Through ELPI+, the concentration of wear particles based on controlled inputs can be characterised to attribute particle emissions to specific driving styles.
6. Detailed chemical analyses of tyre particles help in understanding the impact of different brake temperatures on tyre chemistry. The impact on human lungs and health can be determined by analysing the elemental composition of particle emissions from tyres and brakes and examining the toxicology of the particles.
7. Opportunities exist for collaboration in the project in all three components.

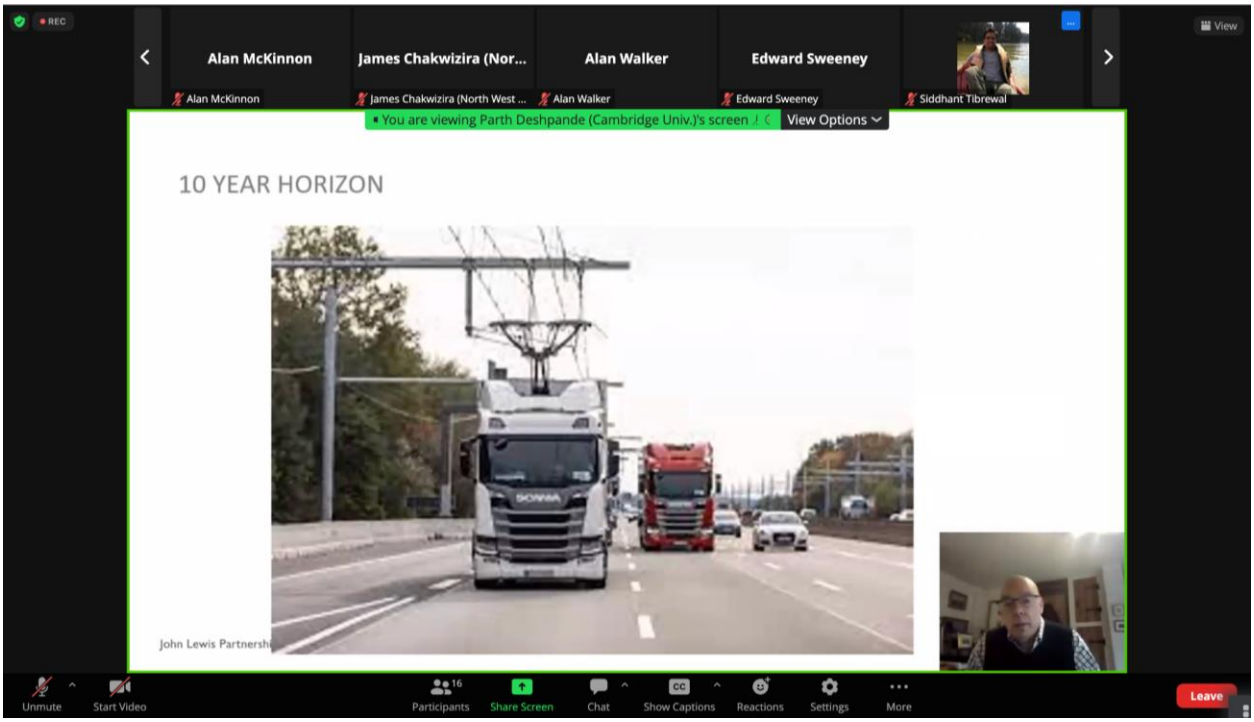
Presentation 2 - Tyre Management as a tool for transition to sustainable road freight: S. Tibrewal



Key points:

1. Though tyres contribute directly to 5% of the total cost of ownership of a vehicle, their impact is spread to 40% of TCO (30% fuel and 5% maintenance costs).
2. The right tyre and right air pressure in tyres can significantly impact fuel consumption and carbon emissions.
3. The project involves the application of telematics to solve the problem of sub optimal tyre configuration in the road freight industry.
4. The digital platform monitors multiple metrics to incorporate data-driven decision-making in tyre fitments per truck per axle.
5. Deployment of the technology has an estimated impact of a 10% reduction in carbon emissions through savings in fuel to the tune of 3500-4000 litres of diesel/heavy-vehicle/year.
6. The findings also indicated TCO savings of EUR 500 per regional truck per year and EUR 1500 per long haul truck per year.

Presentation 3 - The Practicalities of Decarbonising a Fleet: J. Laney

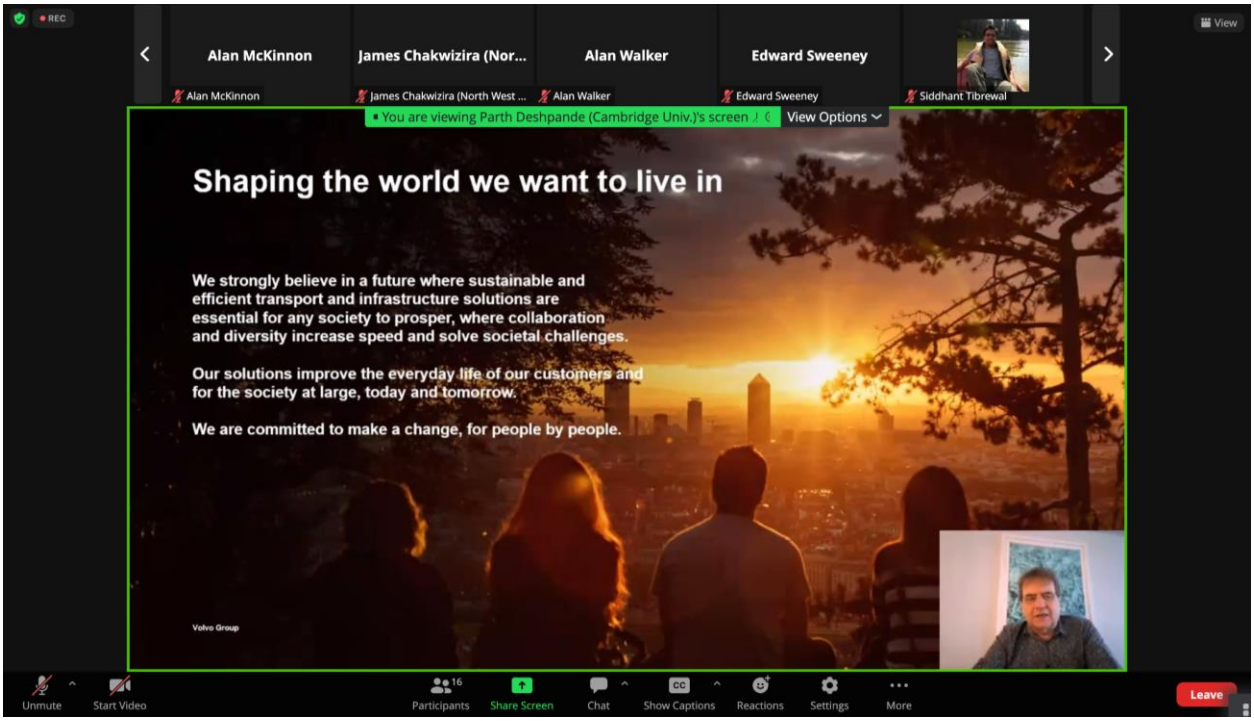


Key points:

1. Transition from diesel fuel vehicles to zero emissions vehicles requires the fulfilment of two key conditions -
    a. Positive business case compared to diesel vehicles
    b. Resilience and structural robustness
2. Key ways to reduce emissions include using alternative fuels like biomethane, biodiesel and electricity, reducing fuel burn per vehicle through the use of telematics, drag reduction and covering fewer miles through optimising routes, scheduling, backhaul and fronthaul, and collaboration.
3. Net zero by 2035 would be achieved by powering cars, vans, and small trucks with renewable energy, heavy-duty trucks with biomethane, and HVO biodiesel for the remaining niches.
4. Driver attrition rates are becoming a huge challenge for road freight operators. Electric vehicles offer significant scope in improving working conditions and enhancing safety for truck drivers thereby improving driver retention rates.
5. Risks in decarbonising:

a. Vehicle risks: non-credible startups and greenwashing
b. Sustainable fuels: greenwashing, lack of sufficient quantities, and secondary effects
c. Safety: voltage issues, battery fires and high-pressure gas.

Presentation 4 - Shaping the world we want to live in



Key points:

1. The Volvo roadmap for net zero emissions involves a mix of liquified methane, battery electric vehicles, and fuel cell electric vehicles with a majority share being of the last two. They intend to reduce their emissions by 50% by 2035.
2. European Emissions Standard 6 has greatly improved the emissions efficiency of vehicles.
3. The three key considerations for adopting electric trucks into operations-
    a. Payload and axle configurations
    b. Range
    c. Charging infrastructure
4. While refuelling a truck may require 10-20 minutes for each case scenario (diesel, LNG, hydrogen, and lithium-ion batteries), the challenge lies in the lack of a network of stations for refuelling LNG or dedicated hydrogen or battery charging stations for HGV.

5. Increasing the weight of EV trucks may not be ideal for European markets due to the restrictions on the weight loads a truck may carry.

9th International Workshop on Sustainable Road Freights

(Virtual)

(December 12-14, 2022)

Synopsis of Sessions held on the Third Day

Plenary Session 3: We need to act now: How do we implement the no-regrets solutions?

The third Plenary Session on 'We need to act now: How do we implement the no regrets solutions?' of the 9th International SRF Workshop was chaired by Dr. Shrikanthan Sridharan, Assistant Professor, Indian Institute of Technology Madras.

Keynote 7

Mr. S. A. Sundaresan, Vice President at Ashok Leyland, talked about the challenges faced by the OEMs on the path to net zero freight in the keynote address. He also added that the previous edition of the SRF event had benefited the company in formulating a strategy for sustainable road freight. He started by pointing out the internal debate surrounding sustainability, such as the cause of climate change, accountability, and ownership. Some of the key points covered in the discussion were:

1. Climate change is real, and OEMs play an important role in mitigation.
2. There are a wide variety of alternative technologies available to power vehicles, such as electricity, LNG, CNG, biofuels, hydrogen, etc. There are strong advocates of and documents supporting each technology and even stronger opposition. Hence, it is difficult to come to a conclusion.

3. When it comes to the commercial vehicle market, India is an ardent follower of European regulations, typically with a lag of a few years. However, there is no clear direction this time from the European side.
4. Webinars help in the dissemination of knowledge and ideas around new technologies.
5. Mr. S. A. Sundaresan introduced the Observe Orient Decide Act loop they follow in the company. He suggests interacting with multiple entities such as Universities, research labs, governmental organizations, customers, etc.
6. This is the decade for transition and the uncertainties have to be anticipated.

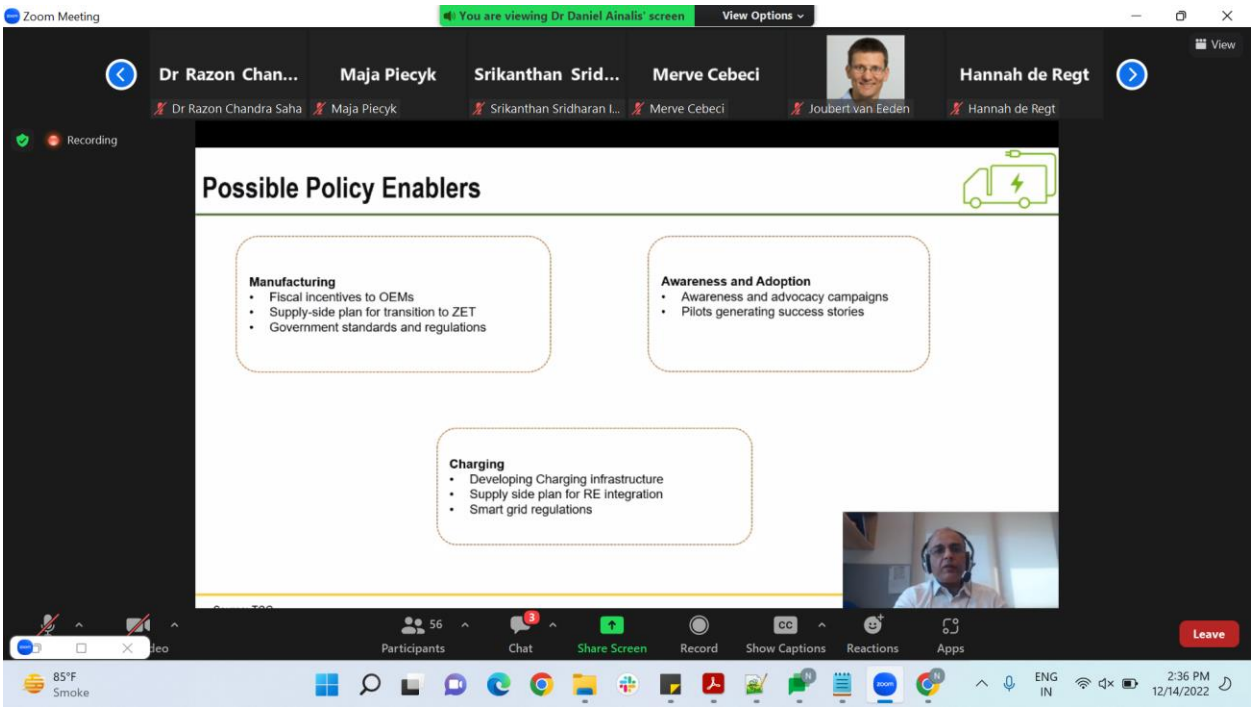
Keynote 8

The second keynote of the day and the eighth of the workshop was delivered by Mr. Grant Cooper, Head of Future Markets at National Grid, UK. Mr. Cooper discussed the emerging relationship between the national grid and the road freight industry in the UK. The road freight industry has not been a conventional customer of national grids, and with the rising calls for decarbonisation of the road freight industry through electrification of the fleet, it is important to understand the impact of such demand from the transport sector on the national grids of countries. He estimated the electricity demand of the UK to double by 2050, 20% of which would likely be fuelled by the decarbonisation of the transport sector. He

explained the role of the national grid, which is neither production nor sale but rather the transmission of power from one source to another. His keynote address broadly covered the following points:

1. The UK's national grid would need to expand by two times while the clean energy generation would be required to quadruple by 2050 to meet the target of net zero.
2. Most of the electricity in the UK is generated by renewable means.
3. The UK's initiative of GBP 950 mn Rapid Charge Fund aims to expand the charging network to all roads and road vehicles.
4. GBP 200 mn initiative called zero emission road freight demonstrator (ZERFD) programme to support trials of battery, hydrogen, and catenary heavy goods vehicles.
5. How the national grid would enable decarbonisation of the transport sector.
6. Need to be technology agnostic to promote rapid decarbonisation of the sector.
7. The economic and social costs of not transitioning to net zero.
8. Prospects of collaboration of power grids with industry and government in accelerating the transition to net zero.

Keynote 9



The third keynote session of the day and the last of the workshop was delivered by Mr. Anshu Bhardwaj, Chief Executive Officer, Shakti Sustainable Energy Foundation. He explained the various initiatives and the ongoing research by the Shakti foundation towards decarbonisation of the logistics sector. He pointed to the rapid growth of the freight sector which is inconsistent with India's net-zero targets. He underscored the need to conduct a detailed techno-economic analysis in the Indian context for the introduction of transition technologies. Pointing out possible alternative options like biofuels, CNG, LNG, hydrogen fuel cell vehicles, and battery electric vehicles, Mr. Bharadwaj emphasised the need to settle on one technology and work towards scaling that option to make the goal of net zero achievable at the earliest. The main highlights of his keynote address are -

1. Qualitative comparative analysis of biofuels, CNG/LNG, hydrogen fuel cell vehicles and battery electric vehicles.
2. The analysis revealed that hydrogen fuel cell and battery-powered vehicles are the only long-term solutions.
3. The following policy efforts are needed to enable the sectoral transition to net zero:
    1. Manufacturing
        a. Fiscal incentives to OEMs
        b. Supply-side plan for transition to zero-emission
        c. Government standards and regulations
    2. Awareness and adoption

a. Awareness and advocacy campaigns
b. Pilots generating success stories

3. Charging
   a. Developing charging infrastructure
   b. Supply-side plan for RE integration
   c. Smart grid regulation

Poster Session

The poster session was chaired by Prof. Yongyi Shou.

S. No.	Title of the paper	Author/s	Summary
1.	Making resilient transition towards net-zero freight transport process easier through socio - economic, regulatory and political factors : Case study of Mehsana city in India	Ankit R. Patel Dhaval R. Vyas and Rajesh S. Patel	• Understands user's perception of ways to achieve transition to net zero. • Survey of 108 people from the city of Mehsana was conducted to assess their perception towards sustainability in transport systems. • The findings suggest positive feedback related to EVs in the city. • Recommends customer's preferences to be kept in mind while manufacturing and selling EVs. This stands true even in the case of freight and commercial cargo vehicles.
2.	Financing an accelerated shift to zero emission vehicles by deploying High-Capacity Transport with Intelligent Access by 2024	Ben Kraaijenhagen Sten Wandel	• Explores synergies by bundling High Capacity Transport, Intelligent Access and Zero emission vehicle reforms. • Researchers analysed the three state-of-the-art reforms and answered various research questions. The state of the art was obtained through literature review, conference presentations, and participation in projects and workshops. • The four building blocks to accelerate the shift to non-zero emissions by 2024 are the deployment of High Capacity Transport, Intelligent Access to Infrastructure, Electrification of Heavy-Duty Vehicles, and Uniform road fees to invest in zero-emission HDV and energy infrastructure.
3.	Concerns about	Gabriela Rubio	• The use of biofuels in the road

	sustainability in using biofuels for transport	Domingo Tharsis Teoh	freight sector must be carefully considered if it is to lessen its influence on climate change without having a negative impact on other environmental and socio-economic factors. ● The study seeks to understand the sustainability impacts of biofuels by analysing the principles defined in the existing sustainability framework. It also aims to determine how legislation can direct people to use sustainable biofuels. ● Major findings: ○ In addition to negating the carbon benefits of biofuels, the replacement of high carbon-holding soils, such as forests and peatlands, may result in ecosystem or biodiversity losses. ○ Legislative and certification frameworks disregard short-lived climate forces. ○ The price and availability of food and, consequently, food security, especially in rural and disadvantaged areas, may be impacted by the use of crops or the displacement of food farmland for biofuel feedstock. In addition, if more land is made available for food crops, it could result in indirect land use change emissions. ○ Although the production of livestock can have a positive impact on the economic well-being of the country, it may reduce social equity among marginal groups. ● Recommendations: ○ As long as the potential

			effects other than greenhouse gas emissions are properly taken into account and proved to have restricted access across the value chain, biofuels may be a sustainable decarbonisation solution. ○ When purchasing biofuels that adhere to an appropriate, reputable certification process, especially in cases where local regulation is insufficient, consumers can be guaranteed this. ○ It would be advantageous and supportive for multimodal transport operators if legal frameworks were to become even more uniform in their definitions of sustainability issues.
4.	A carbon abatement tool for the Sustainable Freight Buyers Alliance	Hannah de Regt	● Displayed the creation of a tool to provide information on solutions for reducing emissions from road freight transportation. ● The tool generates an abatement curve to demonstrate to the user how actions' potential to reduce emissions and costs relate to one another. ● Additional research is required to evaluate the implementation costs and anticipated savings possibilities in a specific scenario.
5.	The adoption of battery electric vehicles:challenges from the perspective of hauliers and forwarders.	Jorge Gutierrez Maria Huge Brodin and Uni Sallnäs	● The objective is to identify and categorise the perceived hurdles in the adoption of Battery Electric Vehicles from the perspective of truck drivers. ● An explorative study using semi-structured interviews with

			respondents from hauliers and forwarders was carried out. ● The implementation of BEVs in heavy road freight transportation poses multidimensional and interconnected obstacles for both CVM and hauliers, which if not addressed properly at the early stage of implementation can become formidable obstacles.
6.	Perspectives on Strategy and Value of Freight Transport for Modal Shift: A Case Study on Dhaka Chittagong Highway	Dr. Razon Chandra Saha	● The case study examined the problems and obstacles in the modal shift of freight from road to rail and inland waterways in reducing the excessive pressure on the Dhaka-Chittagong highway. ● A quantitative data analysis method is used to determine the volume of cargo and containers imported and exported through the primary seaport Chittagong Port and transported along the Dhaka - Chittagong Highway ● The results show high usage of the Dhaka Chittagong highway due to lack of modal shift options which also creates a hurdle in the movement of passenger traffic on the highway.
7.	Eco-Driving – Improving Driver Behaviour and Externalities to the Environment	Subhadeep Nayak	● The Indian economy is benefiting from the expanding road freight industry, but it confronts challenges due to rising energy consumption and pollutant emissions. ● The study was carried out in Bhubaneswar in 2021 to evaluate the current driving and road freight patterns. ● To obtain a driving licence, the Government of India mandates that applicants complete an approved training programme in eco-driving, although most drivers are found to be inexperienced and incompetent,

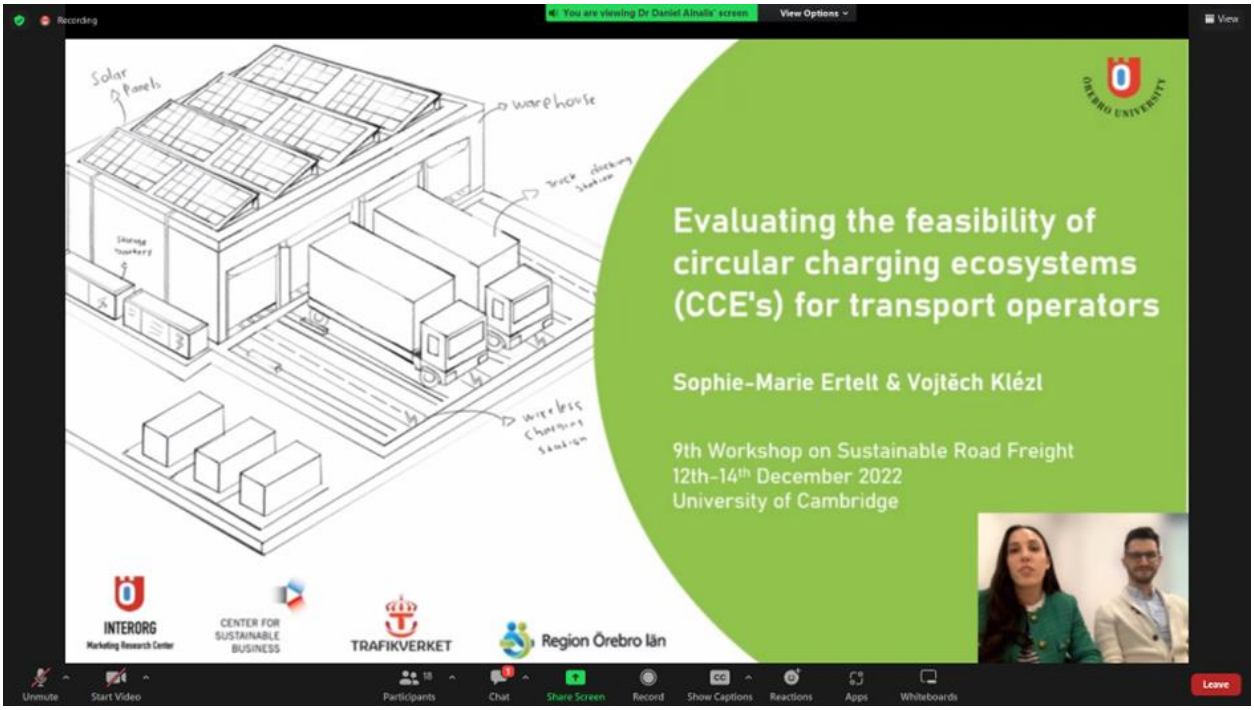
			frequently using inefficient techniques for daily commuting. ● The study used statistical inference processes to identify the hindrance to adopting green practices. ● Challenges faced: ○ A majority of drivers simply possess a rudimentary level of education, and only a small percentage are aware of safe driving practices like maintaining tyre pressure and limiting speed. ○ Less fuel efficiency as no periodical maintenance is followed by the owner or the operator. ○ Lack of awareness of GPS technology. ● These issues can be resolved by encouraging operators and owners to utilise technology, enhancing coordination amongst the key actors, and improving driver behaviour through efficient training techniques.
8.	Does local context matter? The case of sustainable urban logistics governance	Subina Shrestha	● Urban logistics must be transformed in order to achieve the aims of urban sustainability, and this topic has received a lot of attention in recent years in both policy and research. ● Due to vertical processes (multilevel governance perspectives) and horizontal processes, there is an increasing emphasis on urban logistics, particularly at the city level (network and policy mobility perspectives). ● The research aims to investigate the influence of vertical and horizontal processes in shaping sustainable urban logistics planning.

			• The transfer of sustainability goals in urban logistics from being established at the EU level to being embraced as well as modified at the local level is examined through the lens of localisation. • Four Norwegian cities—Bergen, Oslo, Stavanger, and Trondheim—were used as case studies for a thematic analysis of papers on transportation at the three levels of governance: the EU, the national level of Norway, and the local level. Environment, Technology, Regulation, Governance, and Finance were identified as the 5 themes that refer to the aspects of sustainable transitions in urban logistics. • Urban logistics must collaborate across both horizontal and vertical governance processes as well as at the local level (inter-departmental and multi-stakeholder) in order to achieve the zero-emission aim. • The goals and agenda for cities to advance sustainable urban logistics have already been determined in part by these processes. However, both vertical and horizontal coordination is necessary for the level and rate at which these goals are achieved.

Parallel Tracks 3: Charging Solutions and Refuelling Infrastructure for Sustainable Road Freight Systems

The session chair of Charging Solutions and Refuelling Infrastructure for Sustainable Road Freight Systems was Dr. Chris de Saxe.

Presentation 1 - Evaluating the feasibility of Circular Charging Ecosystems (CCEs) for transport operators: S. M. Ertelt and V. Klézl

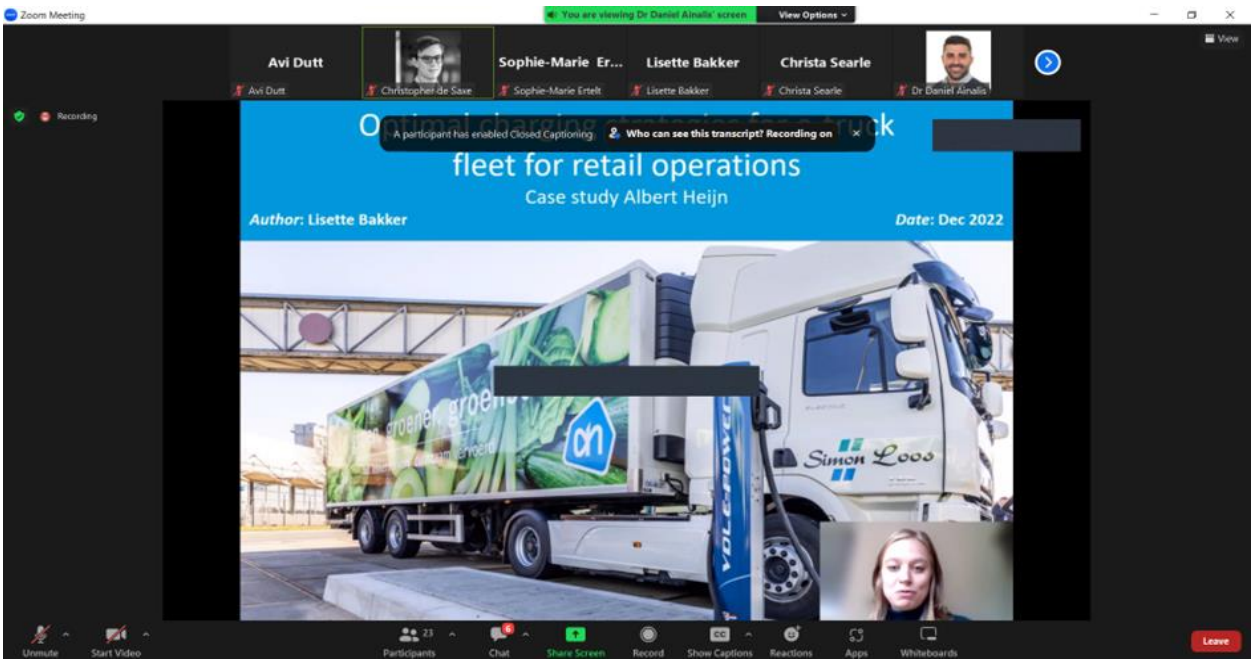


Key points:

- The ambitious target in Sweden is to cut fossil fuel emissions from heavy vehicles by 70% by 2030 and to net zero by 2045.
- It is commonly acknowledged that electrifying freight transportation is a practical way to reduce industry CO2 emissions, noise, and pollution.
- Large-scale electrification of the road freight transport sector is possible with the help of battery-powered systems, stationary charging networks, electric road systems on highways, and hydrogen fuel cell technology.
- However, switching to electricity as an alternative fuel source requires many changes to existing business practices.
- Increased operational complexities and fluctuating electricity prices due to the ongoing crisis add to the uncertainties of electrification.
- A solution to the uncertainties is to adopt Circular Charging Ecosystems (CCEs) that allow for wireless charging of electric trucks with self produced climate neutral electricity.
- The study aims to examine the development initiatives required to construct circular charging ecosystems at the depots of local logistic enterprises. It helps to identify business models, technology and system challenges associated with a cost efficient transition to electrification with the help of circular charging systems.

- The findings of the study analyse the business case and financing strategies for circular charging solutions for freight transporters, taking into account factors like the total cost of ownership, the possibility for new revenue streams, and the sharing of technology investments across various freight transporters.

Presentation 2 - Optimal charging strategies for e-truck fleet for retail operations: L Bakker



Key points:

- The Dutch government agreed to implement zero-emission zones in order to hasten the transition to the use of electrical transportation in metropolitan areas.
- Highly intensive and dynamic last-mile retail operations are heavily dependent on trucks that are powered by internal combustion engines burning fossil fuels.
- The main challenge of integration of retail operations with electrical transport is the operational cost associated with it.
- The study uses a mixed integer linear programme (MILP) to optimise the charging logistics of an electric truck fleet employed in a typical supermarket's daily retail operations. Sessions are scheduled during the night and around the break timings of the drivers. The experiments are conducted for short-term and long-term e-trucks.
- The results of the study indicate that a combination of charging strategies should be adopted for continuous transport operations with e-truck fleets.

- The study can be generalised to all retail companies that intend to integrate e-vehicles into their daily operations.
- In light of these findings, further inquiry into charging logistics for both continuous travel planning and lengthier individual journeys is warranted.

Presentation 3 - Dynamic Charging System for Heavy-Duty Trucks to Passenger Cars: T. Tajima

Key points:

- The total carbon dioxide emissions at a global level were 36.75 billion tonnes in 2016, out of which the transportation sector contributed 7.87 billion tonnes.
- Introducing vehicles that operate entirely by motor, such as electric vehicles (EVs) and fuel cell vehicles (FCVs), is one of the solutions to curb carbon emissions.
- However, electric vehicles come with their challenges. Driving range, quantity of batteries installed, charging, infrastructure installation, and deterioration of driving performance are some of the associated challenges.
- The research proposes a novel system of using dynamic charge system (DCS) that uses conductive charging from the side. The application of DCS to passenger cars and race cars has also been studied with specific attention to resolution of issues with cargo vehicles.

- Electric power supply, transmission efficiency, safety, convenience, infrastructure installation, maintainability, and cost are some of the key factors influencing DCS development.
- The researchers aim to achieve early practical application of the system with a focus on charging multiple vehicles at the same time, safety, and reliability for the overall development of society.

Presentation 4 - Multimodal Hydrogen Refuelling Infrastructure Design with Pipelines: C. Searle and P. Greening

Key points:

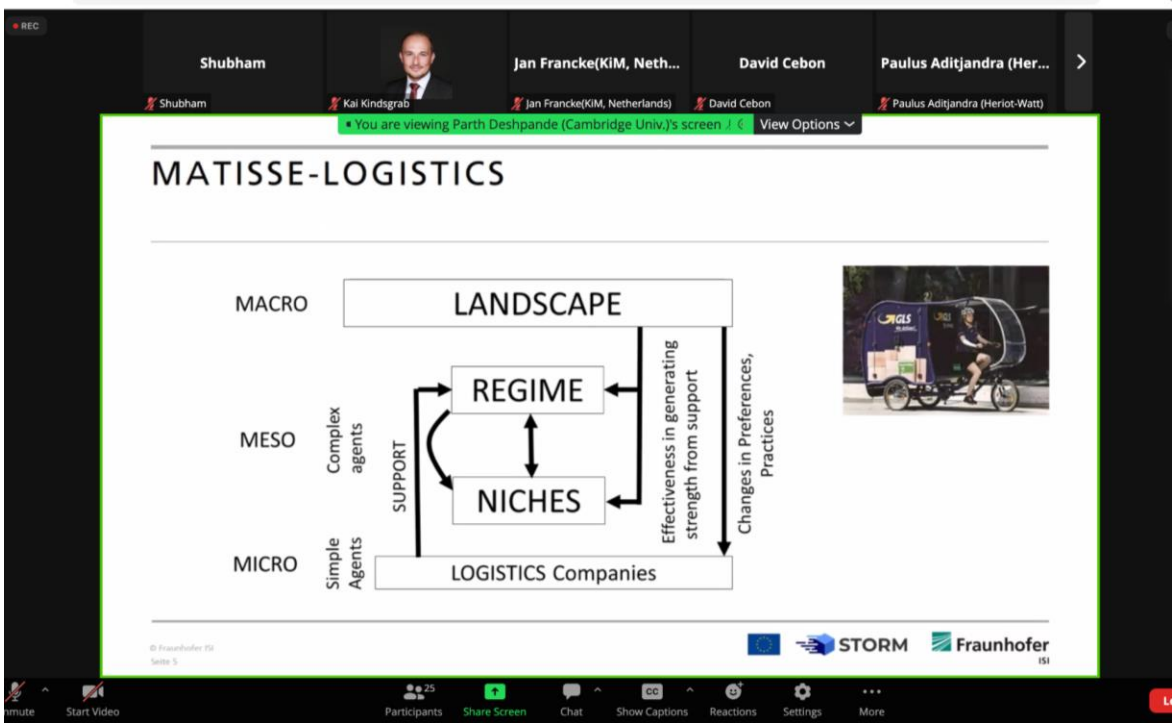
- Understanding the scope of developing a new refuelling infrastructure for alternative fuels, like hydrogen, is crucial.
- Estimating the minimum number of refuelling stations, determining the location and size of the stations, and configuring hydrogen production supply and delivery to these stations are some of the research questions to be addressed.
- In order to identify and suggest a hydrogen refuelling infrastructure for efficient deployment, the study seeks to create a framework called Analysis of a Strategic Hydrogen Refuelling Infrastructure (ATHENA). It includes a 3-phased approach involving demand data analysis, an optimisation model and analysis, and an agent-based model and analysis.
- The framework is expanded to take into account a comprehensive multimodal approach that permits pipeline delivery of hydrogen.
- A case study is also conducted on designing multimodal hydrogen refuelling infrastructure for heavy goods vehicles, refuse collection vehicles, and port handling equipment in Northern

England. In order to analyse the impact of the various hydrogen production supply and distribution alternatives, a series of scenarios are taken into consideration in this case study.

Parallel Tracks 3: Specific Challenges of Multimodal, Urban, Digitalised, and Cold Chain Logistics Systems

The session chair of Specific Challenges of Multimodal, Urban, Digitalised, and Cold Chain Logistics Systems was Dr. Lori Tavasszy.

Presentation 1 - Modelling Digitalised Logistics Systems: an Agent-Based Approach: J. Koehler and C. Brauer



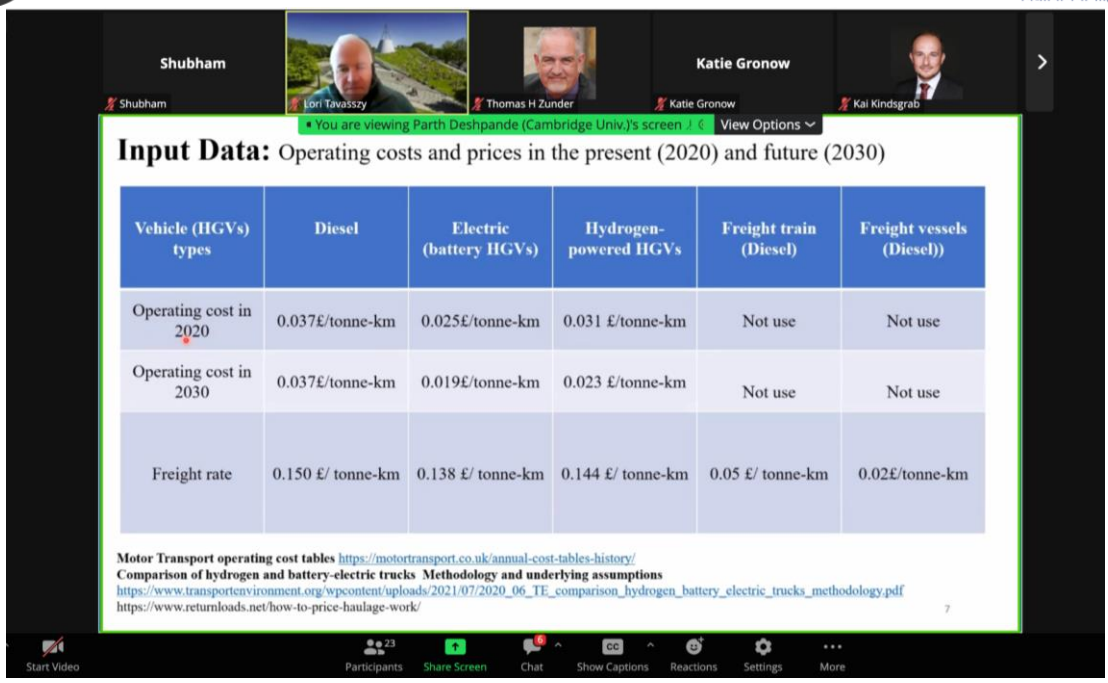
Key points:

- Gaps in information and insights exist in current freight transport modelling, which are:
    a. Estimates of changes in the logistics sector driving structural changes in it.
    b. Scenario simulations based on digitalised logistics structures and net zero in freight transport.

c. Simulation models on the effects of policy packages on freight transport.

- Research directions to address these issues include:
    a. Using blockchain technology to extend micro ABM and network methods to a bigger scale.
    b. Freight transport models that can dynamically and rapidly respond to address different policy scenarios.
- The study proposes the adoption of the transitions approach of (Koehler et al., 2022) which integrates a qualitative scenario approach with an implementation using an ABM for simulating transition scenarios.
- The four steps were:
    1. STEEPL factors,
    2. Development of future assumptions,
    3. Development of scenario drafts, and
    4. Scenario simulation and policy assessment.
- The main factors were identified using STEEPL (social, technological, environmental, economic, policy, and legal) which were then included in the MATISSE ABM model (Haxeltine et al., 2008) to represent the development and diffusion of structural change in logistics systems.
- Possible decision variables would consist of 3PL concentration level, international and national GHG emissions from transport supply chains, the capital cost in alternative vehicles, and the ratio of small operators among others.
- The model ultimately simplifies system change.

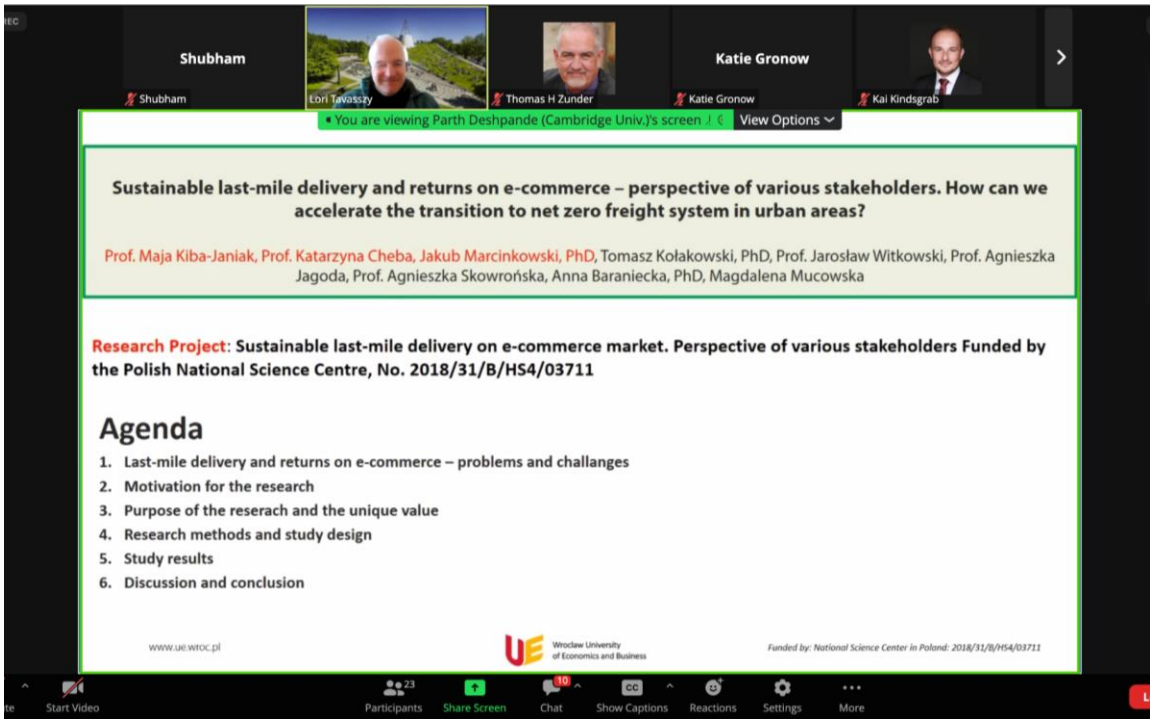
Presentation 2 - Multi-Modal Operations and Infrastructure Modelling to decarbonise UK freight transportation: an Agent Based Approach: S. Wang, P. Greening, D. Utomo



Key points:

- The study evaluated road freight-specific decarbonisation methods for the UK's inland multimodal freight system.
- The following two strategies were compared by adopting an agent-based modelling approach to evaluate their impact on modal splits and carbon emissions:
    1. Alternative energy sources to power road freight
    2. Carbon pricing mechanism
- The ABM model took into consideration the cargo transport between the ports of Grimsby and Immingham in the UK to 382 warehouses (warehouse agents) in the UK by road, rail, and inland waterways.
- Modal choice probabilities were assigned using the multinomial logit model of (de Jong et al., 2004; Department for Transport, 2020).
- The model so developed, can calculate the following:
    1. Modal percentage of freight transported
    2. Total carbon emissions (million tCO2e)
    3. Total cost for systems configuration of each type
- The findings from the model in alternative power source showed that battery electric vehicles are more carbon emissions and cost-effective than hydrogen fuel cell powered vehicles.
- The findings also show that the carbon pricing mechanism does not lead to a significant reduction in carbon emissions and thus should not be relied upon as a primary source of decarbonising the road sector. It can be used as a complementary measure to accelerate the transition of vehicles from fossil fuels to zero-carbon vehicles.

Presentation 3 - Sustainable last-mile delivery and returns on e-commerce – perspective of various stakeholders. How can we accelerate the transition to net zero freight system in urban areas?: M. Kiba-Janiak et al.

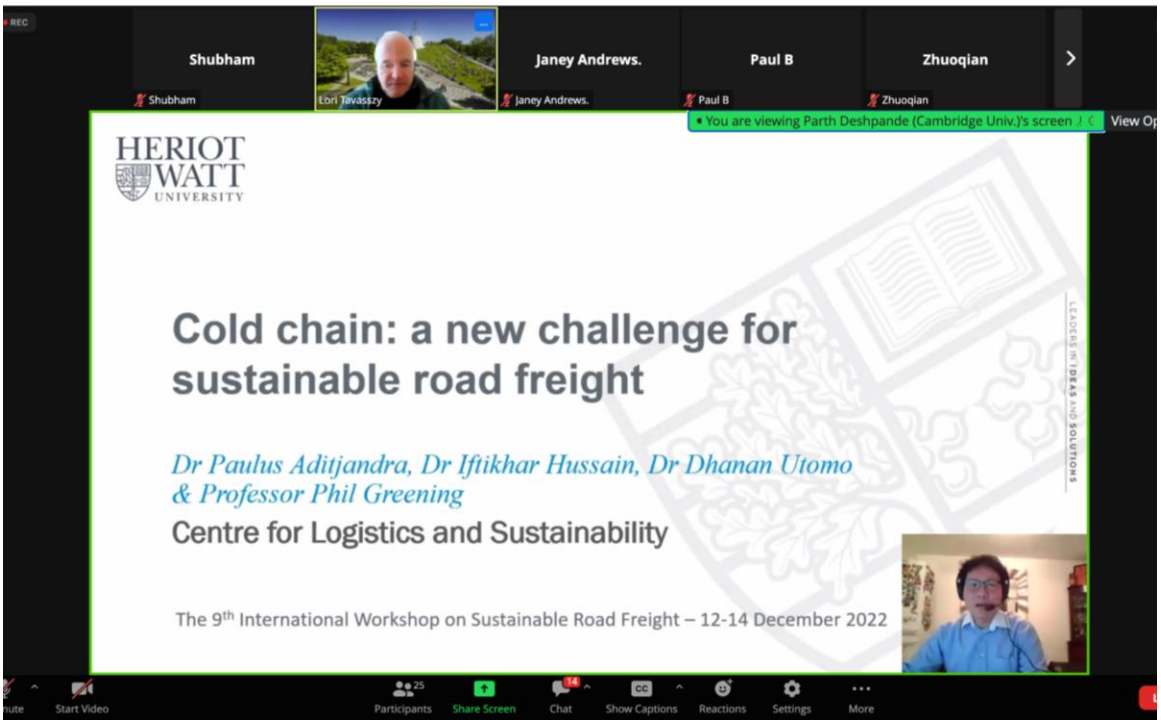


Key points:

- The rising demand for delivery of goods through e-commerce stands between governmental efforts to reduce carbon emissions from the transport sector. While on one hand, e-commerce is expanding, it is also leading to more vehicles on the road to facilitate the last-mile delivery of goods ordered online.
- There is also a tendency on the part of customers to look for free delivery options, further complicating investments in decarbonising last-mile logistics vehicles. Further, research showed that 40% of customers opt for e-commerce due to free-of-cost return of goods, putting additional strain on delivery managers.
- There is a dearth of literature on stakeholder perception related to e-commerce and sustainable logistics solutions. Likewise, there is very little research on the possible solutions to this problem.
- The study analysed the views of different stakeholders on sustainability in last-mile logistics, their willingness to adapt and pay, and the motivational factors for facilitating the transition.

- The methodology involved a survey of 1200 Polish e-commerce users and other stakeholders whose results were analysed using the conjoint method, cluster analysis, and factor analysis.
- The results showed that there exists scope for a compromise between sellers' expectation of delivery costs being paid by the customer and customers' expectation of free delivery.

Presentation 4 - Cold Chain: a new challenge for sustainable road freight?: P. Aditjandra, I. Hussain, D. Utomo, P. Greening



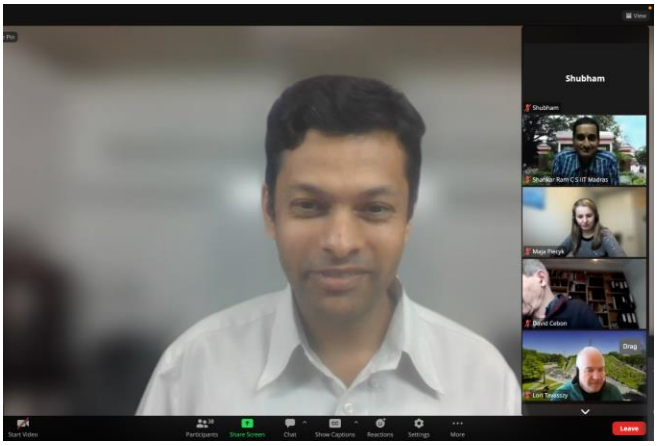
Key points:

- This review paper's goals are to provide background information for logistics and transportation studies and to support the creation of cold chain modelling and simulation.
- A semi-systematic review was done using tools like Google Scholar, Scopus, Web of Science, etc.
- It highlighted the importance of cold chain systems in overcoming challenges like food security and vaccine distribution, including allied problems like GHG and HFC emissions.
- Refrigeration is promoted by the government to improve the socio-economic well-being of households but at the same time, this has emerged as a critical consumer of electricity.
- There exists a gap in studying technological advancements in transport refrigeration from the logistics and transportation sector as the research has been mostly done from the perspective of thermal and energy engineering, and food and agriculture science.

- Cold chain systems can be categorised into four types:
    1. Pre-cooling
    2. Warehouse refrigeration
    3. Refrigerated transport
    4. Domestic/retail refrigeration.
- The UK is one of the few countries to predominantly use renewable energy in powering their supply chains. Also, the Cold Chain Federation of the UK has started consultations in the industry to transition to net zero in cold chain infrastructure.

Workshop wrapup

The closing remarks for the workshop were given by Dr. Debjit Roy, Co-Chair, Centre for Transportation and Logistics and Dr. Shankar Subramanian, Associate Professor, Indian Institute of Technology Madras.



Prof. Roy summarised the proceedings of the workshop, which covered the following broad topics -

1. The levers of road freight decarbonisation and sequestration potential in the road freight industry.
2. Key strengths, challenges, and opportunities in the electrification of the road transport fleet including risk management and cost estimation.
3. Impact of climate change on the logistics sector across corporate, national, and international levels and possible action plans in mitigating these impacts.
4. Policy and regulatory requirements to facilitate the transition to net zero.
5. Building resilience in supply chains to overcome global systemic, regulatory, and geopolitical challenges.
6. Novel frameworks and methodologies to assess emissions from road freight including non-exhaust sources like particle emissions.
7. Possible types of electronic road systems and their economic and technological viability.

8. Use of telematics, artificial intelligence, and other digital technologies in decarbonising the logistics sector.
9. Decarbonising through innovation in material and vehicle technologies like biofuels, tyre management, and engineering solutions.
10. Challenges and opportunities in cold chain infrastructure.

Prof. Subramanian and other members of the International Scientific Committee acknowledged the valuable contribution of all the members of the organising team and expressed the hope that they would be able to meet everyone again in the next edition of the workshop.