International Transport Forum

Decarbonising Transport in Europe

The Way Forward

This paper summarises the findings of the project "Decarbonising Transport in Europe". Initiated, funded and supported by the European Commission, the DTEU project developed a suite of advanced models of transport activity in Europe that provide detailed quantitative evidence on the actual impact of CO_2 mitigation measures. These allows European decision makers to identify and assess realistic pathways towards decarbonising transport to 2050 and to help the European Union to achieve its CO_2 reduction ambitions for the transport sector.

Modelling Europe's path to zero-carbon transport

The European Union is embarking on an ambitious path to become climate-neutral by 2050.

The European Green Deal announced by the European Commission in 2019 entails a wide range of policy initiatives with the stated aim of making the European Union (EU) climate neutral by 2050 and reducing greenhouse gas emissions by at least 55% by 2030 compared to 1990.[1] The European Green Deal is underpinned by an action plan, a proposed European Climate Law that would turn the political commitment into a legal obligation, and a Just Transition Mechanism to assist those most affected by the move towards a green economy.

Transport (including international shipping and aviation) emitted 32% of the EU's greenhouse gas in 2019, up from 24% in 2000.[2] The EU's 2020 Sustainable and Smart Mobility Strategy and accompanying action plan define how the transport sector will contribute to meeting the Green Deal's objectives. The plan provides 82 initiatives, 10 milestones, and 10 "flagship" areas of action that will support reducing GHG emissions from the EU's transport sector by 90% to 2050.

The ITF modelled how different policy actions would impact future transport CO_2 emissions.

Two scenarios developed by the ITF as part of the EU-funded "Decarbonising Transport in Europe" project allow an assessment of how specific policies for each transport sub-sector will contribute towards reducing the carbon dependency of Europe's transport sector.

The scenarios cover passenger as well as freight transport and look at urban and non-urban transport activity. Rather than determining what measures would be necessary to meet established emission targets (backcasting), they assess how measures already in place or with the potential to be implemented impact transport CO_2 emissions over the three decades to 2050.

The Current Ambition (CA) scenario, includes a bundle of policies already in place or expected to be implemented in the foreseeable future. The second, labelled High Ambition (HA) scenario, applies the same measures as the CA but more aggressively. In addition, it assumes further decarbonisation measures that experts deem both technically and politically feasible to be introduced between now and 2050.

The simulations support decision-making for ambitious and realistic decarbonisation pathways.

The broad range of policy measures analysed in the scenarios enables a comprehensive assessment of policy impacts across all transport sub-sectors. They can be classified into six main interventions (pp. 2-3). Two key considerations informed the scenario development. First, the scenarios should reflect ambitious yet realistic policies in terms of expected CO_2 reductions. Second, the scenarios should provide applicable conclusions for decisions in support of the objectives of European Green Deal and the EU's Sustainable and Smart Mobility Strategy. To ensure both, the ITF brought together

[1] The EU 2011 "Roadmap to a Single European Transport Area" also informed this project, launched 2018 before the European Green Deal.

[2] European Environmental Agency, https://www.eea.europa.eu/data-and-maps/data/data-viewers/greenhouse-gases-viewer

stakeholders from industry, academia, local, national and international authorities and non-governmental organisations in two workshops to provide input and feedback which fed the definition of the two scenarios.[3]

Trends outside of transport significantly affect mobility demand and emissions

A wide range of exogenous factors are included in the two scenarios modelled. For example, e-commerce, teleworking and 3D-printing on an industrial scale can influence transport activity in different ways. Social awareness of the environmental impacts of transport may lead to changes in peoples' travel behaviour in the future. Increased low-carbon electricity generation and the spread of alternative fuels will cut demand for the transport of fossil fuels.

These trends were examined in detail during scenario development and ways to capture them accurately were discussed in depth with stakeholders.

In general, exogenous trends that can contribute to transport decarbonisation are assumed to develop more pronouncedly in the High Ambition scenario.

The scenarios capture Covid-19 disruptions and socio-economic mega-trends

Both the Current Ambition and the High Ambition scenarios assume that governments will take steps to mitigate the disruptive impacts of Covid-19 on the transport sector and the economy in general. They assume that changes in mobility behaviour caused by the pandemic will have mostly faded by 2030. However, some phenomena such as increased teleworking, e-commerce or cycling and reduced air travel may be here to stay. Both scenarios also capture demographic trends, economic growth and expected trade patterns based on data and forecasts provided by the OECD, the United Nations and the World Bank.[4]

Figure 1 - Six types of decarbonisation interventions captured in the simulations

[3] Summaries of the two workshops are available here and here.

[4] The project's modelling reports for urban passenger transport, non-urban passenger transport, urban freight and non-urban freight transport provide further details. A third scenario in which governments harness Covid-19 recovery to reinforce positive trends kick-started by the pandemic in the long run is presented in the ITF Transport Outlook 2021.

Figure 2 - Specific decarbonisation actions and trends for each type of intervention

What the simulations tell us

Europe is not on track to achieve the objectives of the European Green Deal.

The transport decarbonisation policies currently in place or in the pipeline in the EU (the Current Ambition scenario) will not suffice remotely to reduce Europe's transport emissions sufficiently to meet the target of 90% less transport CO_2 in 2050 compared to 1990. With policies based on current ambitions, the EU will never reach this target.

Even under the more aggressive policies assumed under the High Ambition scenario, the European Commission's stated aim to limit transport CO_2 emissions to around 60 million tonnes by 2050 will not happen. That said, such increased ambition would suffice to cut transport CO_2 emissions by around 60%, down to c. 250 million tonnes. This cut would at least surpass the Commission's previous decarbonisation goal, set in 2011. Figure 3 shows the model's projections for CO_2 emissions by transport sub-sector; Table 1 presents the transport activity underlying those emissions.[5]

Almost all CO_2 emissions from urban mobility can be eliminated by 2050 with ambitious policies.

Carbon-free city travel hinges on the availability and acceptance of shared mobility options. These range from mass public transport via shared on-demand minibus services to micro-mobility options such as shared bicycles and e-bikes. Functioning, integrated shared mobility can limit the excessive use of private vehicles and render urban transport systems truly sustainable. Motorised shared modes will need to use electric vehicles.

Non-urban passenger and freight transport can cut their CO_2 emissions by more than 70% compared to 2015 with ambitious policies in place.

Improved rail infrastructure should divert some freight and passenger demand from highly carbon-intensive road transport to rail. A shift away from imported fossil fuels towards locally produced, alternative sources of energy will also reduce emissions from freight transport indirectly via less transport activity related to petroleum imports into Europe.

Road freight transport will sharply improve its environmental performance through more efficient vehicles and operations, among other measures. However, long-distance trucking and air travel in particular will remain difficult to decarbonise even further to the required levels, despite regulatory, technological and operational advancements and an expected slowdown in demand growth.

Non-urban transport will contribute 93% of transport CO_2 by 2050 under ambitious policies.

This is a significant increase from the 2015 level, when non-urban transport had a share of 68% (Figure 4). The rise is a result of the different degrees to which the urban and non-urban transport sectors achieve decarbonisation by 2050. It underlines the challenge to reduce the carbon footprint of transport activity taking place outside of cities where the tools for demand management available to urban transport planners exist only to a much lesser extent or not at all.

Only stronger political leadership and accelerated technological development will achieve the pathway of the High Ambition scenario.

The Covid-19 health crisis has not only disrupted transport activity, it has also changed how citizens view the role of governments. Political decision makers can seize the opportunity to channel Covid-19 recovery towards measures that will bolster trends which reduce transport carbon emissions such as teleworking, the use of active transport modes and a shift from long-distance to local leisure travel. Recovery funds should also boost investments in low-carbon infrastructure and technologies. With more ambitious action in these areas, the EU could realise even greater emission cuts and achieve the objectives of the European Green Deal.

[5] Detailed scenario outputs are available in the Overview of ITF policy scenarios - Description, assumptions and results.

Figure 3 – Total emissions by transport sector and scenario in Europe

Million tonnes of CO_2

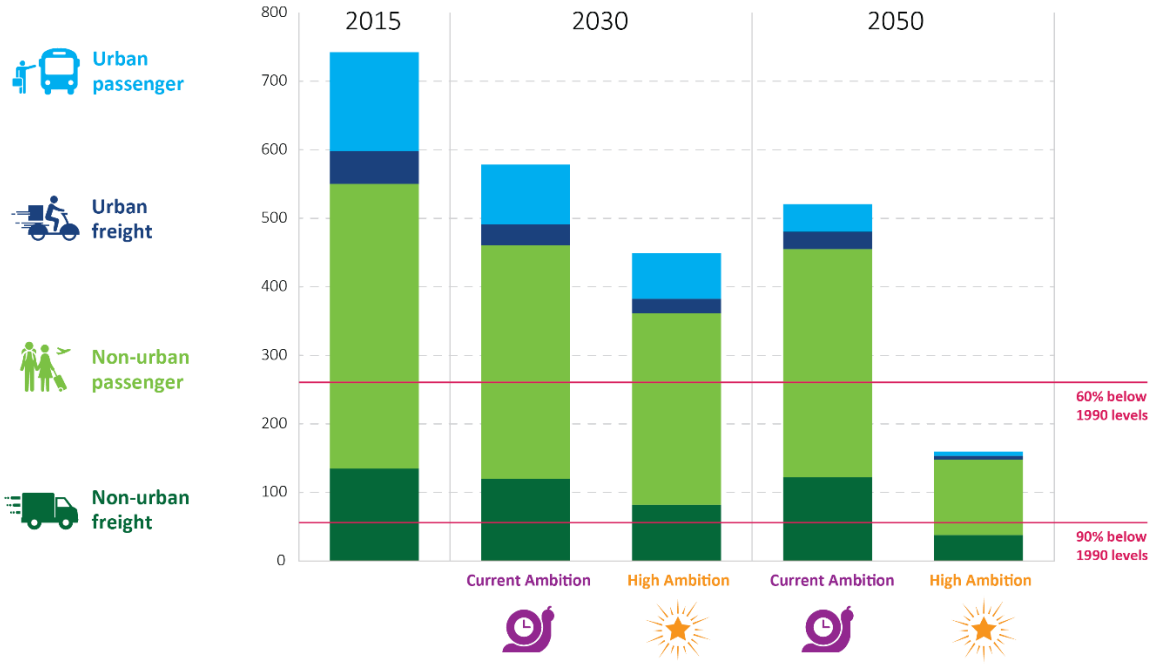

Figure 4 – Share of emissions by transport sector and scenario to 2050

Percent of CO_2 emissions from transport

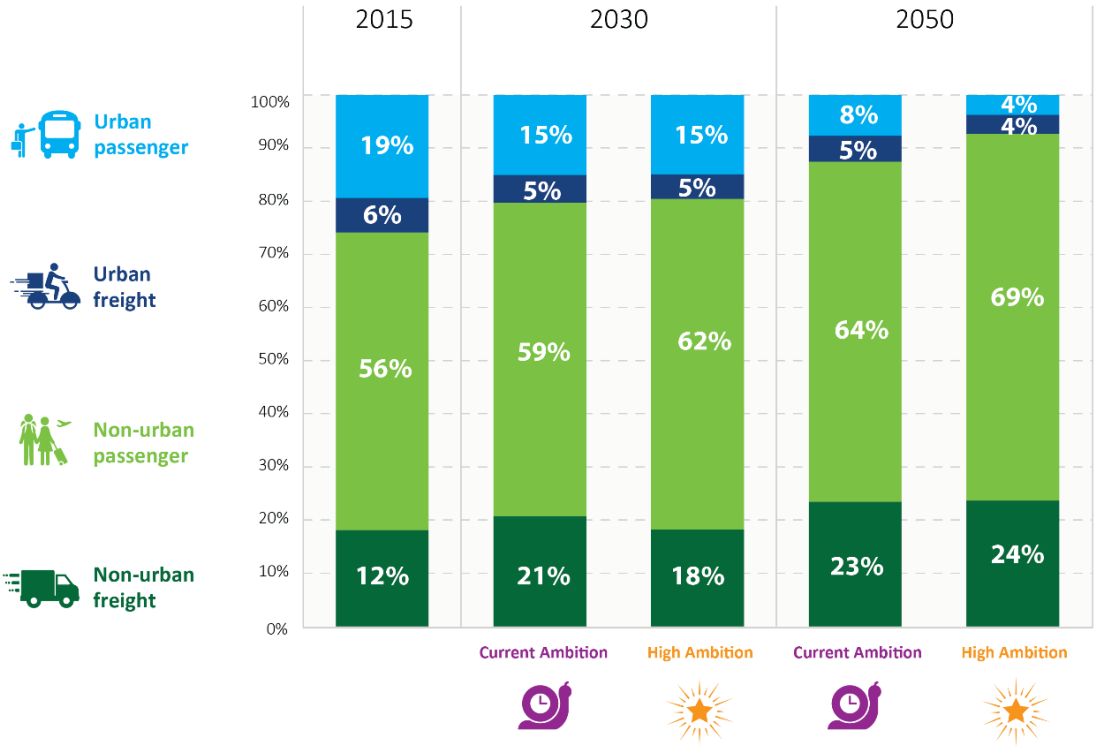

Table 1 - Total activity by transport sector and scenario

Billion passenger-kilometres and tonne-kilometres

Sector	2015	2030		2050	
		Current Ambition	High Ambition	Current Ambition	High Ambition
Non-urban freight	3 640	4 689	4 467	7 380	6 755
Non-urban passenger	6 167	6 575	6 229	7 912	7 263
Urban passenger	1 808	1 934	2 170	1 899	1 988
Urban freight	191	211	196	298	238

Europe's citizens and its economy will benefit from the necessary interventions, despite the initial costs of reducing transport emissions.

Low-carbon technologies will eventually reduce the marginal cost of travel for several transport modes, leading to greater consumer surplus across sectors. The transport costs for exports will decrease more in Europe than in any other region, increasing the region's competitiveness in the global market. High ambition policies generally favour movement over shorter distances and by efficient modes. Therefore, they may boost industrial activity within Europe as well as inter-European tourism demand due to an abundance of destinations accessible by rail.

Meanwhile, decreasing consumption of fossil fuels, which are primarily imported from other regions, will improve Europe's trade balance. The increased uptake of active modes will reduce air and noise pollution, improve public health and can lead to freeing up (urban) space, which can then serve to increase the liveability of our (urban) environments.

Decarbonisation creates more equitable transport systems and living spaces.

Residents of large metropolitan areas currently emit more CO_2 emissions than those living in smaller urban areas; wealthier regions emit more than Europe's less well-off regions. Governments have struggled to garner broad support for ambitious climate action in part because the costs and benefits of decarbonisation policies can be unevenly distributed.Providing sustainable transport solutions will often

go hand in hand with enhancing the accessibility to opportunities in a fair and equitable way, however. Transport systems that pollute less, use less space and improve access to opportunities for all will be to the benefit of an entire community. They may also counterbalance the disparity of emission levels among different population groups and regions in Europe.

Climate action will make Europe's transport systems more resilient and enhance connectivity.

Climate action in transport will often mean providing sustainable transport alternatives to the ones already in place, i.e. from improving rail connections across the continent to providing sustainable micro-mobility options in urban areas. Such an increased transport offer will help the system to withstand shocks and disruption (caused by climate or other) that may affect the functioning of certain transport infrastructure or services.

Europe's decarbonisation agenda will also generate benefits outside of the region.

As a major centre for consumption and production of goods traded worldwide, Europe's policies can reduce carbon emissions from transport activity globally. Its large market for passenger travel, low-carbon regulation and innovations can spill over into other regions. As leaders across the globe persuade their constituents to support the decarbonisation agenda, Europe can also provide a leading example.

Table 2 – Opportunities and challenges of transport decarbonisation by transport sub-sector

Sector	Opportunities	Challenges
Non-urban freight 	Europe´s share of global import/export transport activity and related emissions is significant. This can give global leverage to the policies adopted in Europe. Increased reliance on renewable energy sources for transport activity will ultimately increase efficiency and reduce costs for transport operators (especially where carbon taxes are in place). It will also reduce fossil fuel imports and enhance Europe's trade balance.	Road freight decarbonisation requires high ambition. Export-related emissions are particularly difficult to reduce due to the expected growth in related transport demand.
Non-urban passenger 	Surface modes can decarbonise by 2050; new travel options will create a more resilient transport system; and increased intra-regional travel activity can benefit Europe's tourism sector.	International aviation will be costly to decarbonise, resulting in a loss of consumer surplus for travel between Europe and farthest regions.
Urban passenger 	Urban passenger emissions can get close to zero using new vehicle technologies, the development of new mobility services and the growth in active modes, while greatly enhancing the liveability of cities, the resilience of their transport systems and the accessibility to opportunities for all.	Motorised vehicles must decarbonise quickly to allow for a zero-emission pathway on time. Shared and efficient mobility services must become reliable alternatives within this decade.
Urban freight 	Operator costs will likely increase with extra charges due to decarbonisation measures. These will ultimately lead to higher efficiency and cost reductions that can be passed on to the consumers.	Significant increase in e-commerce and related parcel deliveries increase the importance of this sub-sector for CO2 mitigation policies.

Ten recommendations for transport decarbonisation in Europe

1 Act now. Do not delay policy decisions.

New solutions and policies take time to implement. They take even more time to produce a sizeable effect. The world has reached a point at which there is no time left to lose if we want to stop global warming.

2 Set policy and build infrastructure so it adapts to changing conditions. Invest in multiple solutions and contingency plans.

Europe should prepare for inevitable uncertainties that exist. It should also avoid dependence on a narrow set of decarbonisation solutions. Some technologies may not reach market soon enough to make the required difference in time, for instance ultra-high-speed rail. Others may materialise differently than currently thought. Unforeseen disruptions could also alter the course of developments in the transport sector and beyond, just as Covid-19 caught the world off guard. Policies and infrastructure investments should therefore be designed in ways that allow adjustments when needed. Policies could have mechanisms for regular, and potentially frequent, updates. Infrastructure could be designed for easy capacity adjustments.

3 Create cross-sectoral governance structures with the power to address decarbonisation challenges.

The interlinkages between transport and other sectors hold great opportunities for decarbonisation. They also often present enormous barriers. The sensors used to combat human trafficking and fight illegal fishing could be used in smart logistics systems to make freight transport more efficient, for example. And cutting costs along the supply chain of sustainbale biofuels could dramatically increase their use in aviation. On the other hand, a shift to electric mobility would merely displace transport emissions if the electricity is not produced in sustainable ways. Integrated governance structures should therefore be created to align decarbonisation action across sectors. Addressing the interconnectedness of the energy and transport sectors is particularly important. It must be ensured that emissions are not shifted from transport to power generation and that the energy sector can provide transport with renewable energy affordably and at scale. Such innovative governance structures will enhance the mutual understanding of sectoral needs, help spread effective solutions to other sectors and generally foster innovation.

4 Use decarbonisation to make transport more resilient, sustainable, accessible and equitable

Transport decarbonisation relies not least on creating sustainable alternatives to traditional, fossil fuel-powered transport modes. Done the right way, new mobility options can also improve citizens' access to opportunities, for example by alleviating congestions and providing more and cheapter alternatives to private vehicle use, and better account for, and reduce, the many externalities of transport activity. Policy measures should be well assessed and designed for such potentials to materialise. This will result in enhanced transport-system resilience and sustainability, and ensure that the transition to low-carbon transport is fair and leaves no one behind – whether this concerns specific social groups, geographic areas, people with reduced mobility or genders.

5 Communicate the wider benefits of transport decarbonisation to ensure citizens' acceptance and involvement.

Transport choices are individual choices. The uptake of new solutions and hence a successful transition to sustainable mobility will depend on each of us accepting new ways of travelling and different price structures. A redesigned, carbon-free transport system will bring many benefits, from more liveable cities to improved access to opportunities. Clearly communicating these will accelerate the acceptance of new solutions and motivate people to re-assess their travel behaviour and the way goods are moved.

6 Increase support for innovative technologies and services and ensure new solutions are introduced where they have most impact.

New technologies and services often become available in limited areas, e.g. in urban cores where the high number of users and above-average incomes make them profitable for operators. However, the less affluent and less dense areas often have greater decarbonisation potentials, as citizens there lack alternatives to their own car. Therefore, governments should target support to ensure these areas also benefit from innovative transport technologies and services. Support for innovation can take various forms and should address transport

users, service operators, as well as solution developers and manufacturers.

7 Empower local authorities to take transport decarbonisation actions that correspond to local specificities.

Local policy makers must be able to shape climate action in their area of responsibility. Differences in culture, local practices, infrastructure, incomes, housing situation and mobility needs and many other factors create specific conditions that require corresponding approaches to encourage sustainable transport behaviour and operations. Top-down measures may not always be able to account for important differences and may lead to unintended results or opposition to climate action.

8 Invest in digital transport infrastructure and use the decarbonisation opportunities that digitalisation has to offer.

Digitalisation provides policy makers with a powerful lever for reducing transport emissions. Digital technology can make transfers easier for transport users, thereby facilitating multimodal travel and related payments, and lowering emissions per trip. In freight transport, it can help to optimise loads and reduce the number of empty runs. Digitalisation is also critically important for implementing effective congestion charging and access restrictions, for instance by differentiating between vehicle types and their emission levels and facilitating payments systems. Not least, digital tools help the acceptance of electric mobility, e.g. by optimising charging operations. Many decarbonisation opportunities thanks to digitalisation are likely to develop. Policy makers should stay abreast of such developments, support them and ensure their best use to make transport sustainable.

9 Design stimulus packages for economic recovery from the pandemic to accelerate the transition to low-carbon transport and energy generation

Increased public spending to support economic recovery after the pandemic should prioritise investments that support the transition to a low-carbon economy. Its backbones must be sustainable transport and a green energy generation. Stimulus packages should therefore focus on the rapid roll-out of alternative vehicle fuels and the massive scaling-up of renewable energy sources more generally. The latter is important to ensure not only that alternative energy is available to power transport activity, but also to ensure that new vehicle technologies are climate-neutral over their life cycle. Other investment priorities include the creation of digital transport infrastructure, the attractiveness of public transport and encouraging citizens to walk and cycle. Support for transport operators should be conditional on concrete sustainability commitments.

10 Help transport sector companies to accelerate the uptake of green solutions by reducing uncertainty through transparency and collaboration.

The transport industry's business decisions and investment plans are shaped not least by the visibility and predictability of government policy. Information on how economic policy will develop, what regulatory measures are in the pipeline or which support programmes are under consideration reduces uncertainty. Less uncertainty enables bolder decisions, for instance to embrace new technologies and business models that can achieve deep and timely emission cuts. The higher the degree of uncertainty, the more incremental changes towards sustainable transport will tend to be and the more time and opportunities for meeting climate goals will be lost.

Further reading

This overview is based on a number of deliverables developed in the course of the DTEU project. Outputs of the DTEU project also fed into other reports that provide relevant information for decarbonising transport in Europe.

DTEU project deliverables

Title	Description
Outputs and overview of the ITF Baseline and alternative policy scenarios (2020)	Insights into the scenarios, underlying assumptions and outputs, and implications for policy making.
Decarbonising Transport in Europe (DTEU): Policy implications and scenario feasibility (2020)	Summary of the final project event
Urban passenger transport model - Methodological note (2020) Non-urban passenger transport model – Methodological note (2020) Urban freight transport model - Methodological note (2020) Non-urban freight transport model – Methodological note (2020)	Insights into ITF transport models, underlying methods, assumptions and the data used
Setting Scenarios for Non-Urban Transport and Related CO_2 Measures (2020) Setting Scenarios for Urban Transport and Related CO_2 Measures (2020) Modelling Non-Urban Transport and Related CO_2 Mitigation Measures (2019) Modelling Urban Transport and Related CO_2 Mitigation Measures (2019)	Workshop summaries

Major ITF outputs that refer to DTEU project work

Title	Description
ITF Transport Outlook 2021 (2021)	ITF's biennial flagship publication providing global transport activity scenarios to 2050, related emissions impacts and resulting policy recommendations.
Transport Climate Action Directory (2020)	Online database of transport CO_2 reduction policy measures with the evidence-base needed to assess their effectiveness.

European Commission policy documents relevant for the DTEU project

Title	Description
Sustainable and Smart Mobility Strategy – putting European transport on track for the future (2020)	The EU's strategy for the digital and green transformation of its transport systems.
The European Green Deal (2019)	The EU's plan for a sustainable European economy.
Roadmap to a Single European Transport Area - towards a competitive and resource efficient transport system (2011)	The EU's roadmap of 40 initiatives to increase mobility, remove barriers and fuel growth and employment.

About this project

The approach

The "Decarbonising Transport in Europe" (DTEU) project was carried out by the International Transport Forum (ITF) in collaboration with the European Commission. Funding came from the European Commission's Horizon 2020 Framework Programme under grant agreement no. 831743. The DTEU project formed part of the ITF's Decarbonising Transport initiative, which helps governments and industry translate climate ambitions into actions.

The project built on two pillars: On the one hand, the ITF's suite of transport models contributed the capacity to simulate future transport demand and project their associated emissions. On the other hand, a systematic and inclusive policy dialogue with European governments, companies, sectoral organisations, multilateral development banks and research institutions provided a platform to discuss modelling methods and assumptions, and develop mitigation scenarios.

The first round of workshops in 2019 addressed urban and non-urban transport respectively. These focused on how to develop the ITF models so outputs would complement other studies and capture promising CO_2 mitigation measures. A second round of workshops in 2020 specified plausible decarbonisation scenarios based on the available policy instruments. The ITF then further explored these using its suite of transport models.

A final event in December 2020 discussed the modelling results of the decarbonisation scenarios and their implications for policy. The meeting also identified implementation strategies for decarbonising transport in Europe. More information on all events can be found on the DTEU project webpage.

The contributors

The DTEU project was managed by Elisabeth Windisch; its modeling work was overssen by Luis Martinez (both ITF). The project team further consisted of Francisco Furtado, Jonathan Leape, Dimitrios Papaioannou, Mallory Trouvé, Olga Petrik, John Pritchard, and Vatsalya Sohu (all ITF). Eimear Grant provided essential administrative support. Contributions came from Guineng Chen, Philippe Crist, Jagoda Egeland, Malithi Fernando, Orla McCarthy and Olaf Merk (all ITF). Jari Kauppila (ITF) directed the project.

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The next step

A follow-up project "Decarbonising Transport - Driving Implementation Actions" (DT Implement) was launched in early 2021 to drive climate action in the three transport sectors that are particulary hard to decarbonise: aviation, shipping and heavy-duty trucking.

Three country-led stakeholder fora, or "common interest groups", bring together experts from governments, industry, the research community and NGOs for peer-to-peer exchange and mutual learning.

Each of the three groups plans to meet four times within the project's two-year timeframe (2021/22). The aim is to identify concrete policy pathways to scale up solutions that help achieve significant CO_2 reductions in the three areas.

More information is available on the DT Implement webpage.

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International Transport Forum
2 rue André Pascal
F-75775 Paris Cedex 16
+33 (0)1 73 31 25 00
contact@itf-oecd.org
www.itf-oecd.org

OECD

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