Emission reduction strategies for the transport sector in Italy

A report produced under the framework of the EUKI Project

Supported by:

Federal Ministry
for the Environment, Nature Conservation
and Nuclear Safety

based on a decision of the German Bundestag

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the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMUB)

Transport & Environment
Published: January 2019
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To cite this study

Transport & Environment (2019) Emission Reduction Strategies for the Transport Sector in Italy.

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Acknowledgement

T&E acknowledges the generous funding of this project from the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety. T&E also acknowledges Kyoto Club, Cittadini per l'Aria, Fondazione Sviluppo Sostenibile, Legambiente, and WWF Italy for the input provided and useful discussion on national policies.

Legal notice

The project Emission Reduction Strategies for the Transport Sector in Italy is financed by the European Climate Initiative (EUKI). EUKI is a project financing instrument by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU). Its implementation is supported by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ).

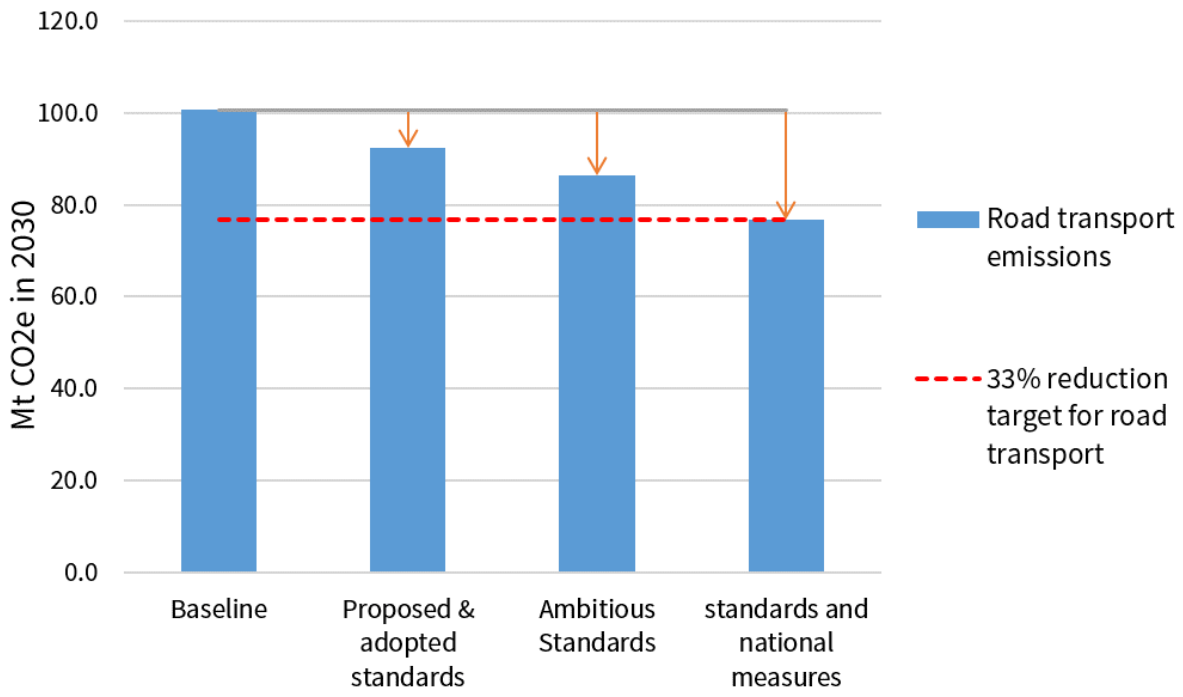
It is the overarching goal of the EUKI to foster climate cooperation within the European Union in order to mitigate greenhouse gas emissions. It does so through strengthening cross-border dialogue and cooperation as well as exchange of knowledge and experience.

The information and views set out in this report are those of the author(s) and do not necessarily reflect the official opinion of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

Executive Summary

Transport is the largest source of greenhouse gas emissions in Italy. In contrast to the industry and public electricity and heating sectors, transport emissions are still just above 1990 levels, but emissions from international shipping and aviation have doubled in the same time. In the context of needing to be decarbonised by the mid-century under the Paris Agreement, this trend needs to be rapidly reversed. Italy is already experiencing amplified climate change and warming compared to Europe. The objective of this report is to show how Italy can decrease their transport emissions from a broad range of European and national measures. In particular, the report focuses on reductions in road transport emissions that fall under the jurisdiction of the European Climate Action Regulation, which enforces a 33% emissions reduction target in 2030 compared to 2005. Finally, policy recommendations are presented to enable Italy to meet the most ambitious targets.

The effect of mitigating measures such as vehicle efficiency standards, modal shift, and demand reduction, among many others, are calculated using Transport & Environment's in-house transport model, the EUTRM. The main results of the scenarios investigated are shown below. Crucially, Italy can meet its 2030 targets as long as ambitious vehicle standards, electrification, and national measures are implemented.



The scenarios in detail:

Baseline: If Italy takes no action and the 2030 CO_2 standards for road vehicles are not implemented, Italy will fall short of its 2030 targets by 23.8 Mt of emissions. Under the CAR regulation, this may result in requiring the purchase of up to 133 million allowances. Assuming that the other sectors just meet their target, no flexibilities, and an allowance price of €100/tonne, this would be €13 billion, if loopholes in the regulation are not used.

Adopted and Proposed Standards: With the new EU CO_2 standard for cars & vans recently adopted and if the European Commission's 2030 CO_2 standards for trucks under discussions are implemented Italy will fall short of its 2030 targets by 15.6 Mt of emissions; the proposed trucks standards and the car recently adopted standards would close *the gap* between the target and the projected baseline emissions by only 34%.

Ambitious Standards with Electrification: The European Commission's 2030 CO_2 standards for cars, vans, and trucks are strengthened to their technical and economically viable potential. This means 40% 2030 CO_2 reduction targets for cars and vans; for trucks this would be 43%. Within these standards, the electrification of road transport is encouraged to ensure the eventual full decarbonisation of the sector. In 2030, sales of electric vehicles reach 40% for cars, 40% for vans, and 30% for trucks. In parallel, all new sales of city buses in Italy will be electric. Even with this ramp up of electrification, Italy will still not meet its 2030 targets by 9.6 Mt CO_2e; ambitious standards and electrification could deliver 60% of the effort required to close the gap.

National measures: There is a wide range of national measures that can help reduce demand and enable shifting to cleaner modes. Measures include shifting car passengers to trains, buses, walking, and cycling; improving road freight logistics and shifting road freight to rail; and getting more people into each car and bus. Taken in isolation, ambitious national measures could close the gap by 51%; combining national measures with ambitious standards and electrification could see Italy just meeting its CAR target.

Policy Recommendations:

This report cites independent research to set the ambitious levels based on technical and economic feasibility. To realise the full potential of these measures only requires political will. Below is a summary of the key policy recommendations for Italy to meet its targets.

EU Level:

- Italy should adopt ambitious CO_2 standards, and in particular monitor that the recently agreed EU 2025 targets are consistently met by the industry without test manipulation. For cars, vans, and trucks this is a real 15% reduction by 2025.
- A separately agreed incentive to achieve 15% sales of zero and low emission vehicles by 2025 should be carefully monitored to ensure carmakers roll-out plug-in cars effectively and focus on zero emission and regularly charged low emission models.

National Level:

- Road charging: harmonise rates at which vehicles are charged across the whole network, ensure all tolls are inclusive of separate infrastructure and (air and noise) pollution costs so that more polluting vehicles pay more, extend the toll charge for HDVs to secondary roads so that the damage they cause is accounted for wherever they drive. This will additionally prevent HDVs from using secondary roads to avoid the toll, and so relieve congestion on those roads.
- Fuel taxes and tax reform: Italy should align petrol and diesel taxes in a fiscally neutral way. Moreover the excise duty of natural gas used in transport is currently 230 to 300 times less than liquid fuels, on an energy content basis. Italy should therefore tax gas used in transport at a rate equivalent to petrol and diesel. Finally, there should be an end to the diesel rebate offered to truckers.
- To shift car passengers to buses, trains, riding, and walking, Italy should invest in high quality, affordable public transport and walking and cycling infrastructure, share relevant data with other transport providers and internet mobility platforms to enable Mobility as a Service (MaaS), introduce measures to encourage bike sharing, and reduce the number of car parking spots and increase parking fees.

- To encourage more passengers in cars, introduce city road pricing and/or congestion zones, facilitate the use of short and long distance car and ride sharing, and adapt fiscal incentives to deter private car use by ending tax benefits for company cars.
- To shift freight from trucks to (electric) trains, the Italian regulator must ensure that the railway infrastructure manager is treating all trains equally regarding track access, explore the idea of obliging the state-owned company to rent unused electric locomotives to new entrants that do not have the access to capital to buy such rolling stock, improve the flexibility and speed of freight services by investing in rail infrastructure that's not as complex or time-consuming as large cranes, and increase competition in the rail freight market.

Outside the CAR:

- For aviation, maintaining the ticket tax on flights, reforming the EU ETS as a means of introducing more effective carbon pricing, and ending the sector's kerosene tax exemption should be policy priorities
- For shipping, Italy should implement tighter air pollution standards for ships calling at Italian ports, consider mandates for zero emission shipping on specific domestic/short-sea shipping routes, make on-shore power supply available, and ensure the transparency and cargo data collection in the EU MRV (when revised) in order to break market barriers to the uptake energy efficiency technologies in shipping.

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1. Introduction and context

1.1. Climate change

Prior to the 1950s, CO_2 concentration levels in the earth's atmosphere hadn't surpassed 280 ppm in the last 400 000 years[i]. On 2 May 2013, the global concentration of CO_2 in the atmosphere reached 400 ppm for the first time over the course of one day[ii]. 400 ppm is significant because it is the central point of the uncertainty zone of the planet for the so-called safe operating space for humanity. According to the same paper, the upper-bound concentration for humanity to thrive is 350 ppm, a level surpassed in the mid-1980s[iiiiv]. As of June 2018, the seasonally adjusted average concentration stands at approximately 407 ppm[v], and rising. The increase in CO_2 is the most important of anthropogenic emissions that increases the amount of heat retained in the Earth's atmosphere and results in climate change[vi]. Climate change pertains to increases in the frequency and severity of natural disasters and droughts, to ocean acidification, temperature change, and sea-level rise, to name a few.

On 12 December 2015, 196 nations around the world adopted unanimously the Paris Agreement that aims to mitigate global greenhouse gas emissions. Specifically, the signatories agreed to take measures to hold the increase in temperature 'to well below 2°C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change'[vii]. This would mean limiting the CO_2 concentration to between 450 ppm and 480 ppm. The European Union, and by implication Italy, is signatory to this Agreement. For the EU, the Agreement translates to a full decarbonisation of the economy (i.e. no net CO_2 equivalent emissions) by early 2030 to limit warming by 1.5°C, or by 2050 to limit warming by 2°C, compared to pre-industrialisation levels[viii]. A special IPCC report on limiting global warming to 1.5 shows the benefits of keeping warming to that level[ix].

Climate change is a global problem requiring global efforts to combat it, however there are specific threats and costs associated for Italy that have already been observed. Between 1994 and 2012, Italy suffered numerous natural disasters - including landslides, floods and earthquakes - estimated to have cost at least €3.5 billion in damage each year[x]. The average temperature of Italy has increased by 1°C over the last century compared to the EU average of 0.91°C[xi]. While there has been no significant change in rainfall, the area covered by Alpine glaciers has decreased by over 50% since 1850, and if temperatures rise by 3°, this figure is expected to rise to 80% by the end of the century; the expected increase by 3-5 weeks in the number of heat wave days in 2031-2060 compared to 1961-1990 in Northern Italy will exacerbate these events[xii]. According to Eurostat, Italy has incurred one of the highest cumulative per capita losses due to climate in Europe over the period 1980 to 2015[xiii]. Further, as a peripheral country on the southern frontier of Europe, the number of climate change migrants that arrive in Italy will likely increase.

Climate change is a global problem caused by human activities that has and will have increasing environmental, social, and economic costs. As the 18th largest emitter in the world[xiv], and the 4th largest emitter in Europe accounting for 12% of the EU bloc's emissions[xv], Italy must play an important and leading role in reducing greenhouse gas emissions to avoid catastrophic climate change. *This report will detail a roadmap that will enable Italy to meet its climate obligations for the sector responsible for most of its emissions: transport.*

1.2. Scope of this report

The main legal framework that this report is based on is the Climate Action Regulation (CAR)[xvi], formally the Effort Sharing Regulation (ESR). As will be described in greater detail, the GHG emissions that fall within this regulation and the focal point of this report is land transport, i.e. passenger transport in cars, trains, and buses and freight transport in trucks and trains. Motorcycles are not considered in this report as they are a small percentage of the overall national road transport emissions and they have a clear and proven decarbonisation pathway through battery electric powertrains. The report will look at measures that can

be taken to decarbonise these sectors and in particular will use T&E's in-house transport model to show how much reduction is possible from each measure in reaching the 2030 target.

In this sense, the report will show the impact of what is accepted as technically possible in terms of some measures like the fuel efficiency improvement of vehicles, but also what is required to shift or reduce demand of transport. The emissions from shipping and aviation will also be discussed, but their emissions will not be modelled, among other reasons because they are not included under the CAR. Finally, for all of these modes of transport, this report offers pragmatic, technically feasible, and economically viable policy recommendations to pave the pathway for not only the achievement of the Italian 2030 emission reduction targets, but policy that will make the ultimate decarbonisation of transport an attainable reality by the mid-21st century.

1.3. How this report differ from others

As the eighth largest economy in the world[xvii] with a lot of potential to be a leading nation in terms of climate reduction, a number of studies have offered insight and analysis into how to decarbonise the economy and in particular, transport. Three notable examples are the Sustainable Development Foundation (SusDef) report 'CO_2 Reduction in the Transport Sector'[xviii], the EU Joint Research Centre (JRC) study 'Quantifying the Effects of Sustainable Urban Mobility Plans'[xix], and the Sustainable Development Solutions Network (SDSN) and Institute for Sustainable Development and International Relations (IDDRI) report 'Pathways to Deep Decarbonisation in Italy'[xx]. These reports are briefly described below, and comparison with their results will be made where applicable.

The SusDef study comprehensively looks at decarbonisation strategies in the transport sector and calculates the CO_2 reduction potential of several avoid, shift, and improve policy measures for 2020 and 2030 (compared to 2010). The report suggests that an optimistic EV uptake scenario, in which EVs make-up 50% of the new vehicles market in 2030, would result in 4.7 Mt CO_2 reduction. Undertaken during the economic and financial crisis, assumptions and policy measures presented in the report have since been updated allowing for a more accurate analysis of Italy's trajectory to the 2030 climate targets.

The study by the JRC, focuses on Sustainable Mobility Action Plans and takes into consideration a number of measures aimed at reducing emissions in transport. The research quantifies the global impact of each measure for the entire EU in terms of CO_2 emissions reduction, from a baseline year 2010 to 2030. While the study estimates for Italy a possible combined CO_2 reduction ranging from 2.25 and 2.82 million tonnes (7.2%-9%) between 2010 and 2030, it does not go into detail on the impact for the country, instead taking a wider European view.

Finally, the SDSN-IDDRI study focuses on possibilities for long term decarbonisation of the energy system. Scenario analysis, based on models of Italy's energy and economic systems, leads to the assessment of possible impacts on key energy and macroeconomic dimensions to help to identify strategies for decarbonisation. The report only briefly covers transport policies, however, and moreover, places large emphasis on the availability of Carbon Capture and Storage (CCS), a technology with an uncertain role in climate mitigation, at best.

This T&E report, therefore, will provide analysis of updated and most recent policy measures for the achievement of Italy's 2030 climate target, and long-term decarbonisation of the transport sector.

1.4. Transport & Environment and the EUKI project

The European Climate Initiative[xxi] (EUKI, from German Die Europäische Klimaschutzinitiative) is a project financing instrument by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMUB). The overarching goal of EUKI is to foster climate cooperation within the European Union in order to mitigate greenhouse gas emissions. It does so through strengthening cross-border dialogue and cooperation as well as exchange of knowledge and experience[xxii]. Under the EUKI initiative, T&E is

undertaking a project called "Delivering the EU-2030 and Long Term Climate Objectives in Central, Eastern and Southern Europe, with a Specific Focus on Transport"[xxiii], which has four overarching objectives, namely:

1. To provide as accurate as possible information on the potential of transport decarbonisation measures to meet climate targets in the targeted countries.
2. To foster NGO led development of national climate and energy plans
3. To enhance or create communication and exchanges between national organisations for target countries
4. To Identify additional savings through EU funding and measures - transformational projects in the transport sector

Transport & Environment coordinates this project which involves research and dissemination at national level in close collaboration with some of our national partners in Southern and Eastern EU Member States, specifically Romania, Spain, Italy, Hungary and Poland. Transport & Environment has more than 28 years expertise on transport decarbonisation policies and, thanks to that, T&E is uniquely placed to gather evidence, critically analyse, and recommend clear policy pathways to achieving decarbonisation of the transport sector[xxiv] from an impartial perspective.

1.5. Introduction to EUTRM

Transport & environment has used its in-house model, the European transportation roadmap model (EUTRM) to analyse the effect of different policies on GHG emissions. The EUTRM is a demand driven bottom-up model that can compute GHG emissions in five year intervals, but has recently been modified to compute at yearly intervals for the years between 2016 and 2030. Passenger transport and freight demand are based on purchasing power parity (PPP) adjusted GDP, which is determined by historical and projected gross domestic product (GDP), population, and fuel price for each country. All transport demand within a Member State is met with effectively unlimited transport capacity for freight but with natural limits on motorisation rates for passenger cars through new or second hand sales.

The EUTRM is initialised and calibrated with historical data. For the example of trucks, the vehicle stock and number of new vehicles (both in number and in weight category), mileage, fuel consumption, transport activity, and load factor are considered. The bottom-up structure allows for vehicle based policy changes. Continuing the example of trucks, these can include policy driven modal shift (moving freight from road to rail), engine technology uptake (hybrid, electric, hydrogen), fuel efficiency (efficiency standards or market development), and logistical improvements (increase in load factors, the amount carried by each truck). Therefore, the strength of the EUTRM is in its ability to combine multiple policy decisions and show their effect on the business as usual case, and to quantify the relative importance of policies on GHGs.

Note on modelling fuel efficiency improvements: Cars and vans are type-approved by a laboratory test, known as the New European driving cycle (NEDC), to give a standardised method for determining fuel efficiency. Developed in 1997, a vehicles is placed on a chassis-dyno and the technician follows acceleration and braking patterns from approximated driving profiles based on urban/city driving, country road, and highway driving. The gap between what is measured in the lab during type approval and on the road was about 10% in 2000, however in 2017 it had grown to what appears to be a fleet average ceiling of 42%[xxv], for a number of reasons[xxvi]. The introduction of the new test cycle (the WLTP, the worldwide harmonised light vehicles test procedure), should partially help this, as the driving profiles are much more representative than in the NEDC. Aligning NEDC fuel consumption results with those measured with WLTP will vary between manufacturers and cars, and will not be known until 2019 and 2020 as the new WLTP regulation comes into force. This is one of the reasons the Commission opted for percentage reductions rather than g CO_2/km figure; the efficiency improvements should be as much as possible real world improvements. When

modelling car fuel efficiency in this report, reductions are based on NEDC fuel consumption and the gap is kept constant at 42%.

1.6. Baseline situation, modelling assumptions and projections

Projecting Italian emissions in 2030 relies on the historically observed relationship between wealth and transport demand[xxvii]. As will be shown, holding this assumption and without explicit measures to reduce the fuel efficiency of vehicles, an increase in the economy will lead to an increase in transport activity and thus an increase in emissions. The key socio economic assumptions that are exogenous and static inputs to the EUTRM are detailed in Table 1. These assumptions are in line with the Commission's Reference Scenario[xxviii] although in 2050 the activity levels in the EUTRM are 5-10% lower. In 2015, the inputs are calibrated with the data from the *Statistical Pocketbook: EU Transport in Figures, 2017* (with 679 G p-km in passenger cars, and 134 G t-km of road freight, measured by territoriality[xxix]). Note that the freight activity for vans is not included in these data, nor are they reflected in Table 1.

Along with these assumptions, the oil price is kept constant. This assumption alone appears to be the most import difference between the projections of the Commission's 2016 Reference Scenario and the EUTRM in 2050: an increase in oil price makes transport more expensive; according to the report, this incentivises manufacturers of cars and trucks (OEMs, original equipment manufacturers) to produce more efficient vehicles, despite no historical evidence of this[xxx]. The oil price is kept constant in the EUTRM for two main reasons: firstly, to negate an otherwise uncontrollable and external influence on transport demand, and secondly, because if the EU and indeed the world do begin to take a trajectory of decarbonisation, the demand for oil will decrease. From simple economic principles and with all else being equal, price will not tend to go up, although changes in oil price are far more complex than that[xxxi].

Table 1: Main socio-economic assumptions in the EUTRM.

Metric	2015	2020	2030	2050
Population (millions)	61.1	62.0	64.2	67.0
GDP (2013 € billions)	1589	1701	1913	2596
Passenger car activity (G p-km)	679	711	779	828
Road Freight activity (G t-km)	126	134	150	226

In the baseline, only fully legislated policies are included. The only law directly pertaining to the efficiency are the 2021 car and 2020 vans standards; these standards are included in the model. The monitoring and reporting regulation (MRV), a measure that will allow hauliers to compare like trucks against each other and choose the most fuel efficient for their operations, is assumed to increase large truck (>16t) fuel efficiency by 10% between 2010 to 2030[xxxii] and 6% for smaller trucks[xxxiiixxxiv]. Other legislation, such as the Commission's proposal on truck CO_2 standards and the newly adopted 2030 standards for cars and vans (in December 2018) are not considered in the business-as-usual baseline to show their importance for emission reductions in the sector. In terms of national law, Italy has a more ambitious renewable energy shares target for transport for 2030 (the *Strategia Energetica Nazionale*, or SEN[xxxv]), with a target of 21%. This will be dealt with separately in the report. These options and their implementation will be explored in the following sections. In short, the baseline presents a business-as-usual scenario; there will be no transformational and disruptive changes to the transport system, but a steady increase in demand and thus emissions will be observed by all modes.

1.7. Who should read this report

National level NGOs

NGOs that represent civil society with a focus on climate change and decarbonisation of the economy, ideally with experience on national and EU climate regulations. This report should be considered as a handbook on how to navigate the often complex legislation concerning climate, decarbonisation and sustainable transport with an aim contributing actively and positively to decision-making processes on these matters.

Decision and policy-makers at national, regional and local level.
Lawmakers at all levels have the responsibility to design and implement policies that must deliver greenhouse gas emission reductions in order to achieve the nation's and the EU's climate commitments. This report should for them be seen as technical and policy input, which offers accurate, positive, plausible options for the decarbonisation of the transport sector.

Private sector and individuals
European companies are world leaders in clean technology, to remain so requires ambitious regulatory framework that will not only keep European companies there, but will push for innovation and novel solutions.

Individuals, ultimately, hold the most power. Voting either at the ballot box or with your wallet gives signals to lawmakers and private companies that a sustainable, decarbonised future is what we need and what we want in order to secure our future. In a world full of information, this report aims to gives honest, accurate accounts and recommendations for an ambitious but feasible roadmap for 2030 and to the mid-century.

2. Environmental and political climate in Italy

2.1. The contraction of emissions in Italy

This section will describe the last quarter of a century of emissions in Italy, the dominant and fast growing sectors, and the upcoming legislated targets and decarbonisation ambitions. From 1990, Italian greenhouse gas (GHG) emissions from all sectors (including 'bunkers', those emissions from international aviation and shipping) increased from 514.3 Mt CO_2e to 586.9 Mt CO_2e in 2005, an increase of 14% (Figure 1). The global financial crisis of 2007 and 2008 led to a sharp contraction in emissions; as the economy contracted, demand for goods, transport, and electricity and heating reduced along with their associated emissions. In 2016, total emissions totalled 437.8 Mt CO_2e, a 15% decrease compared to 1990 representing a 2.3% year-on-year contraction from the 2005 peak. These figures belie a slight growth since 2014, and important aspect that will be discussed in further detail in this report. Crucially, from here on in, will Italian emissions decline or will they continue to increase as the economy reinvigorates as per pre-financial crash? The largest emitting sector is transport with a 28% share in 2016, from which 24% is generated from domestic transport (i.e. road, rail, and domestic aviation and shipping). This is a very different situation compared to 1990, where the transport emission share (22%) was on par with public electricity and heat (21%), but industry emissions dominated (32%).

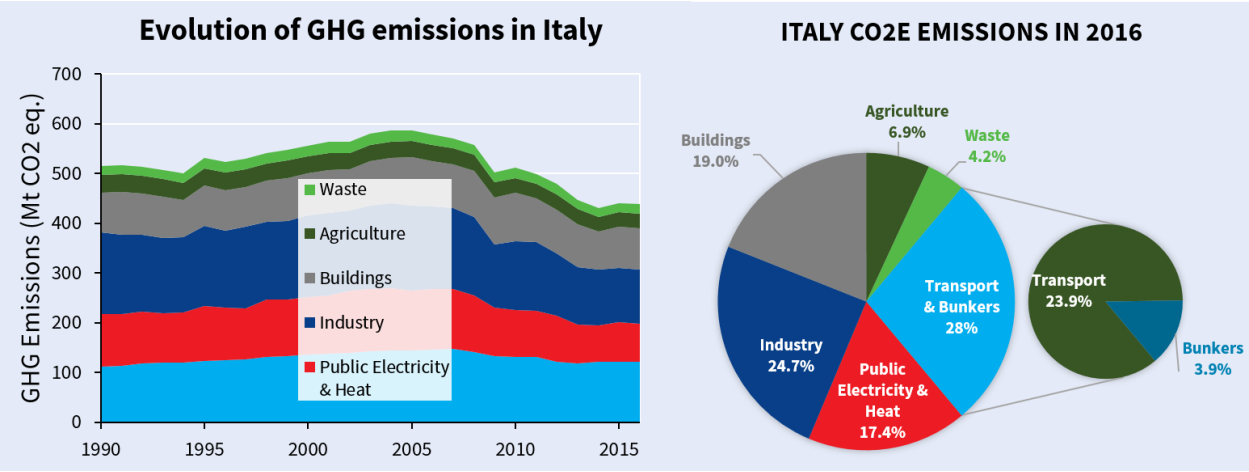

Figure 1: evolution and 2016 share of Italian CO_2e emissions. Source: UNFCCC reporting[xxxvi].

2.2. European climate law for GHG emissions

In this section the environmental laws applied by the European Union that Italy must abide to are introduced and discussed. In general, the laws set Member States or specific installations targets, with fines or severe expenses incurred for not meeting such reduction targets.

2.2.1. Emission trading scheme (ETS)

The European Union emissions trading system (EU ETS) is a scheme to reduce CO_2 emissions by trading and selling emissions permits on a free market where the availability of permits (and hence allowable emissions) reduces over time. The system operates in 31 countries (all 28 EU countries plus Iceland, Liechtenstein and Norway) and limits emissions from more than 11,000 heavy energy-using installations (such as power stations and metal factories) and, since 2012, airlines, although only for flights within Europe. The most relevant sector to this report are those emissions emitted by aviation.

Italy has one of the largest domestic aviation markets in EU, in 2016 there were 30.0 million domestic passengers, second only to Spain, and the fourth largest intra-EU passenger numbers. In terms of emissions, domestic emissions were fourth largest in Europe in 2016 with 2.2 Mt CO_2 equivalent. Other cleaner modes of transport can compete with domestic aviation on the Appennine Peninsula (such as rail, both high speed and conventional, and coaches), however this is not the case with the Italian islands Sicily

and Sardinia in the Mediterranean Sea. Flights from Rome to Sicily (airports at Catania and Palermo) in 2015 were among the busiest routes in Europe, with almost 3.5 million passengers combined. As these flights are covered by the EU ETS, an increasing carbon price should eventually be reached to put downward pressure on demand.

2.2.2. Effort Sharing Decision (ESD)

The Effort Sharing Decision, one of the key instruments of the EU to mitigate climate change, was established in 2009 and sets emission reduction targets for each Member State for the sectors not covered under the EU Emissions trading system. The law is in force for the period 2013-2020. The collective reduction target for the EU as a whole is 10% by 2020 compared to 2005; for Italy, the target is 13%. The targets were established based on GDP of the countries[xxxvii,xxxviii]. This means some richer countries have reduction targets of 20% while other countries had to limit their emissions growth to 20%. Member States must ensure that their emissions are less than the trajectory made from the average of their 2008, 2009 and 2010 emissions in 2013, then tracing a straight line to the 2020 target[xxxix]. As shown in Figure 2, Italy has already achieved its 2020 targets and, in particular, is well on track to meet its ETS targets. In terms of the ESD, the cumulative overachievement from 2013 to 2016 is 127.8 Mt CO_2. On the other hand, economic recovery has seen a plateauing of ESD emissions since 2013. If this trend continues, or if emissions begin to increase from here, this will make meeting the reductions over 2021 to 2030 much harder, as seen in the following section.

2.2.3. Climate Action Regulation (CAR)

The EU has just finalised the process on the piece of legislation that continues the ESD and sets the emission reduction targets for member states for the period 2021-2030[xl]. This time however the emission reduction targets are tighter - the overall reduction target for the EU in 2030 for the non-ETS sectors is 30% by 2030 compared to 2005 levels; for Italy, the target is 33%. The regulation includes flexibilities such as using ETS allowances and access to credits from the land use sector[xli]. Italy can reduce its target by 0.3% from this flexibility alone[xlii]. While flexibilities make it easier for Member States to achieve their targets, they are worse for the climate because it will be by credits, not real emission reductions, to meet the targets.

The banking and borrowing mechanism of the CAR is based on comparing reported emissions for a given year compared to a straight line drawn to the 2030 target. If emissions are below the line, the country is overachieving its emission reduction objectives and can bank (or sell) a part of the difference. Similarly, if reported emissions are above the line, a country can borrow (or buy) a limited part of the future allowances to comply with the yearly target.

A complexity of the CAR is the so-called starting point for calculating where to start drawing this straight line - the trajectory to the 2030 target from which the annual balance will be calculated. This seemingly irrelevant technical detail will determine how many emission allowances a country will be able to bank from the first year, 2021. In April 2018, the decision on how to compute the starting point for emission allocation was formalised[xliii]. The starting point baseline (i.e. the amount of emissions) is computed as the average of greenhouse gas emissions during 2016, 2017 and 2018. The starting point also has a time dimension. This will be in May 2019, or in 2020, whichever results in a lower allocation[xliv]. If the Italian ESD emissions continue to increase, it will be the former of these options, and this could put Italy in the position of needing to borrow emissions from 2021. Taking the starting point resulting in the lowest allocation is positive for the climate but difficult for Italy, as urgent measures will be required to avoid having to buy emission allowances from overachieving countries.

Finally, the CAR includes an extra flexibility instrument called Safety Reserve, which is essentially a pool of credits worth 105 Mt CO_2e. To access it, Member States have to meet a series of requirements, namely: have a 2013 GDP per capita below the EU average; not exceed their emission allocations in the period 2013-2020 (i.e. overachieve their targets); and exhaust the other available flexibilities. If these conditions are met, the country can access an amount of the credits in the safety reserve, not exceeding 20% of its overall

overachievement in the period 2013-2020. Based on these conditions, Italy could gain access to this flexibility mechanism, however the amount of extra credits for Italy is uncertain for the moment.

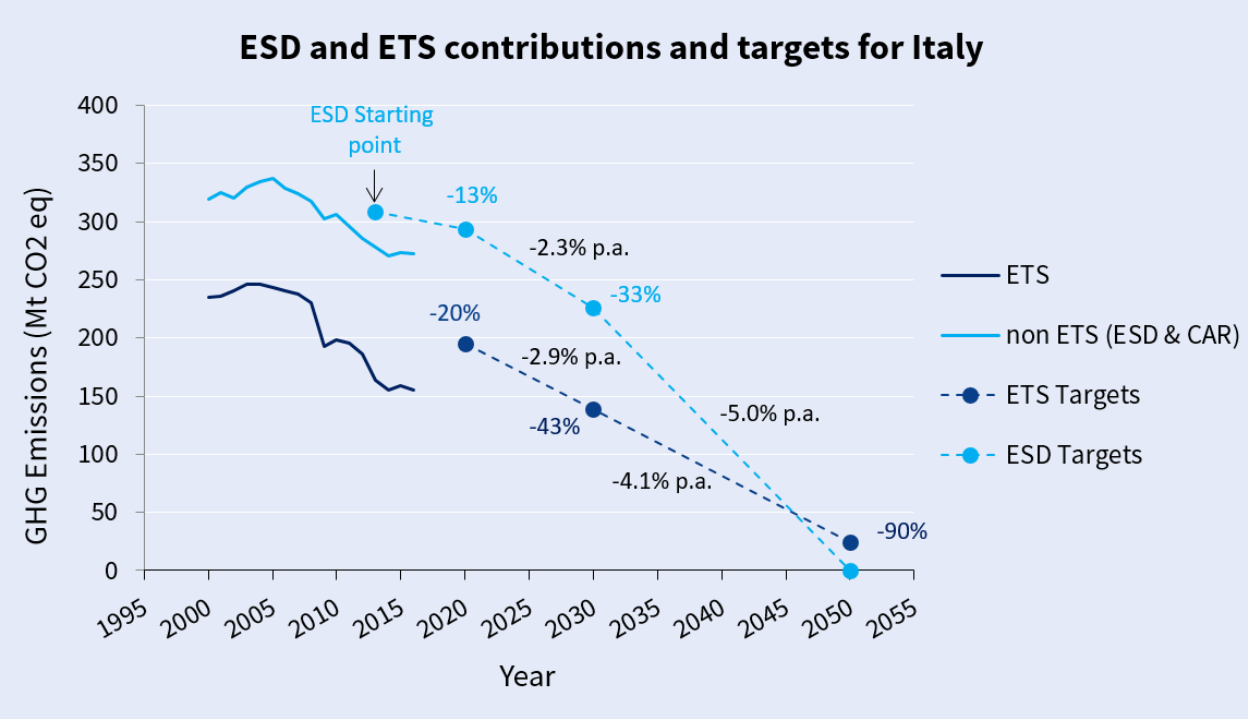

Figure 2: Evolution of Italian ETS and ESD emissions. Source: UNFCCC reporting and EEA contributions of sector allocations.

2.2.4. Renewable Energy Directive (RED)

The Renewable Energy Directive (RED)[xlv] established a policy for the production and promotion of energy from renewable sources in the EU[xlvi]. The relevance for transport is that all EU countries must ensure that at least 10% of the energy used in transport (via biofuels or electrification) come from renewable sources by 2020. Although the RED is not specifically a climate law, its goal of increasing the share of renewable energy will see benefits for the climate. The REDII, which formally ended negotiations in June 2018, is the revision of the RED and will apply from 2021 to 2030. The REDII sets a binding target for advanced fuels, which include advanced biofuels, renewable electricity, hydrogen, etc., in an attempt to promote the use of sustainable and cleaner forms of transport. In addition, the EU is slowly moving away from food-based biofuels that are unsustainable and have negative impacts on climate and environment[xlvii], by eliminating a binding target for food-based biofuels and setting a limit on their use.

The use of advanced fuels will be promoted thanks to the binding target of 7% established on the REDII. Furthermore, the use of advanced biofuels and electricity will be multiplied by 2 and 4 times respectively, to make it more attractive for Member States and boost the support. Importantly, in terms of CO_2 emission accounting, renewable fuels are zero rated.

It is up to each Member State to decide the policies to pursue to reach (or exceed) this target; as part of its national energy strategy (SEN), Italy has indicated an intention to exceed this target, with an ambition of 21% in 2030. In 2016, Italy's overall renewable energy share was 7.24%[xlviii]; the contribution from food based biofuels was 264 ktoe, or 0.8% of energy, far from the 7% cap and a significant reduction from the 1338 ktoe it consumed in 2011. Advanced biofuels made up 774 ktoe, or 2.4% of liquid biofuels. Renewable electricity in rail was 156.5 ktoe while in road it was 2.0 ktoe. Applying the corresponding multipliers makes the total renewable energy share (RES). If the trends from 2013 to 2016 were to continue, food-based biofuels would be phased out. In this report the biofuel share is assumed to stay constant from 2016 levels. This report will not be exploring the best ways for Italy to reach its 2030 REDII target or SEN target.

2.3. Global law for aviation and shipping

2.3.1. Maritime and IMO

Italy may have an extensive inland waterways system - with 1,562 km regularly used for transport - but little to no freight shipping activity is carried out on this network. Having said that, Italy's ports are very active with the third largest intake of inbound freight in the EU at 287 Mt and the fourth highest in terms of outbound tonnage at 163 Mt. Five of the top 40 ranking ports for tonnes of freight loaded and unloaded in 2015 were Italian, namely Trieste, Genova, Livorno, Gioia Tauro, and Ravenna. In terms of emissions, 2016 domestic and international emissions totalled 10.69 Mt CO_2e, compared to 21.52 Mt CO_2e from heavy trucks and buses, and 12.5 Mt CO_2e from domestic and international aviation. These official reported figures are based on fuel consumption reported by ports, and as such they are likely to be an underestimate.

Unlike domestic shipping, which is covered by the EU submission[xlix] of nationally determined contributions (NDCs) and the CAR, the GHG emissions from international maritime activity is not covered by any European measure. In May 2018, the International Maritime Organisation (IMO) agreed an initial decision to reduce ship emissions by 50% in 2050 compared to 2005. Italian domestic emissions have seen a downward trend since the 1990s falling from over 6 Mt CO_2e to 3.9 Mt CO_2e in 2016. On the other hand, international shipping, which peaked at 8.44 Mt CO_2e in 2008 and declined following the economic crisis, has seen a sharp increase over the last few years from 4.45 Mt CO_2e in 2014 to 6.82 Mt CO_2e in 2016. With a trend of rising maritime emissions, the Italian government will need to take measures to ensure they can meet their 2030 and 2050 reduction targets.

2.3.2. Aviation and CORSIA

Domestic and intra-EU flights are covered by the EU-ETS, a system which continues to under-price carbon and whose declining cap remains out of sync with the reductions required by the Paris Agreement. Flights to and from third countries (outside the EU) are not covered by any climate measure. Rather, parties to the International Civil Aviation Organisation (ICAO), the UN aviation agency, agreed to adopt a global market-based mechanism (CORSIA; carbon offset and reduction scheme for international aviation) to offset aviation emissions above 2020 levels. CORSIA won't reduce emissions from the aviation sector - the objective is to purchase emission reductions from other sectors. However even that limited objective won't be achieved, as the system is likely to be flooded with worthless offset credits and airlines will be permitted to burn biofuels with few sustainability criteria in place. Offsetting has been proven to be a discredited mitigation measure. The European Commission's own research[l] has found that only 2% of offset projects actually delivered emission reductions.

In 2016, the number of passengers in Italy (arrivals and departures) whose journey would have been covered by CORSIA was approximately 24.8 million, compared to 109.4 million domestic and intra-EU passengers[li]. Although these passengers represent only a small share of the passenger numbers (18.5%), in terms of emissions they are responsible for half all aviation emissions[1]. Italy is a popular tourist destination, and there has been some backlash recently from cities about the impact on tourism for locals[lii]. Most of the passenger numbers are flights to and from European countries (79.4 million passengers in 2016). From within the EU, the most passengers fly to and from the UK (14.1 million) and Germany (12.4 million). The Italian City Council tax imposes a levy on departing passengers from Italian airports. The amount is set to €6.50 for all city airports except Rome, where it is €7.5[liii]. With about 25% of passenger numbers going through Rome, this implies tax collection of €555 million. Finally, Italy imposes a luxury tax on private aircraft passengers, banded by distance[liv]. These measures are commendable in a climate where industry push negative analysis of jobs and tourism income, or threaten to reduce services owing to aviation taxes.

[1] T&E analysis based on ETS and UNFCCC reported emissions, Eurostat and WTO passenger numbers, Plane Finder transponder data. Does not include extra-EU international passengers in transit.

2.4. History of climate mitigation in Italy

2.4.1. National law and transport measures

Over the past few years there have been several policy developments regarding climate, energy and mobility to reduce emissions in the non-ETS sectors[2]. Looking at the transport measures, Italy has invested in or implemented the following:

- Alternative fuels infrastructure Directive, "AFI Directive": approved on 16 December 2016 and published on 13 January 2017, the directive mandates Member States to publish their National Policy Framework detailing the plans for the development of the national infrastructure to supply alternative fuels (electricity, LPG, CNG, hydrogen and biofuels). According to the directive, by the end of 2020, there should be an adequate number of public electric vehicle charging stations, in accordance with the forecasted number of electric vehicles circulating. For Italy, the PNIRE (last update 2016), "Piano nazionale infrastrutturale per la ricarica dei veicoli alimentati ad energia elettrica" ("National plan for the infrastructure to recharge electric vehicles"), sets a forecast between 45 000 and 130 000 electric vehicles circulating in Italy by end 2020. This results in a target of 4 500 to 13 000 "slow" recharge stations (under 22 kW), plus 2 000 to 6 000 "fast" recharge stations (above 22 kW). Even if the regulation is dated 2016, the plan has not been implemented yet as it was pending the agreement with regional authorities found in July 2018. It will be hopefully put in place in the following months.

  In addition to to the PNIRE, the AFI Directive requires new residential and non-residential buildings of a certain size to include electric vehicle charging points. The Italian National Plan has a very conservative approach for electro-mobility with low estimates for the number of future EVs on the road. In addition it puts a lot of emphasis on gas, Italy being among the top 3 most ambitious Member State for gas along with Czech Republic and Hungary[lv]. The national plan targets 1,350 CNG refuelling stations although the country already has a dense network of public refuelling points, especially in the northern regions[lvi]. The technological neutral approach of the AFI Directive in and of itself is not a policy that will necessarily accelerate the adoption of zero emission vehicles. On the contrary, in Italy, is likely to increase the natural gas infrastructure for transport, which would offer no climate benefit at all[lvii].

- Sustainable and safe mobility, "Connettere l'Italia" (Connecting Italy): This sets out a strategy for investments in transport infrastructure. Crucially, it updates the SNIT (Sistema Nazionale Integrato dei Trasporti, National Integrated Transport System), a core transport infrastructure document created in 2001. The SNIT classifies infrastructure in a 1st tier (national relevance) and a 2nd tier (local/regional relevance) system. The updates consider bikeway networks as a national priority along with road, rail, ports and inter-ports for the first time. All funding regarding transport infrastructure will be linked to mandatory SUMPs (Sustainable Urban Mobility Plans) developed by cities, the selection of which will be based (at least partly) on environmental considerations. Although innovative and a key framework from which to fund clean infrastructure, Connecting Italy allows infrastructure projects such as new roads and highways, which will have the likely effect of increasing traffic and thus in the short term, road transport emissions.

- National Energy Strategy, "Strategia Energetica Nazionale"[lviii]: The main goals of the Italian National Energy Strategy are to increase the country's competitiveness, reach the 2030 EU energy and climate goals, and improve the security of energy supply. It includes a target for 21% of final transport energy demand to be provided by renewable sources by 2030. This will be achieved with electric cars, biomethane and biofuels. Additionally, urban modal shift will be increased (where walking and biking account for at least 10% and public transport 40%), there will be an increase in

[2] At the time of writing, a new government has just been formed for which policy development is an ongoing process. As such, it is possible there will be a change in direction in regards the climate policies over the next few months.

the length of the tram/metro line by 20% per inhabitant, access to all ports and airports related to the EU CORE network will be possible within 2 hours, freight modal share will be increased by 30%, and the population served by the HSR will be increased by 30%.

- Bio-Methane Decree: While promoting the use of bio-methane, the Decree aims to increase the overall share of renewables in the transport sector to reach 10% in 2020, with sub-targets for advanced biofuels of 0.9% in 2020 and 1.5% in 2021[lix]. The decree also sets up a system of guarantees of origin for the producers of bio-methane, similar to those used for renewable electricity.

- Development of a Sustainable Mobility Roadmap[lx]: The roadmap mostly sets out the current situation in Italy in regards to transport, but does additionally include some policy options and comparisons to other countries. Possible policies relate to incentives for purchase of cleaner vehicles, traffic management and development of collective mobility, communication and awareness campaigns, making the PUMS (plans for sustainable mobility at urban level) mandatory at national level.

- Sustainable Urban Mobility Plan (SUMP): receiving EU Commissions recommendations contained in the Action Plan on Urban Mobility[lxi] the Decree aims at promoting an homogenous and coordinated application of SUMPs guidelines in Italy. A Sustainable Urban Mobility Plan has as its central goal improving accessibility of urban areas and providing high-quality and sustainable mobility and transport to, through and within the urban area. It regards the needs of the 'functioning city' and its hinterland rather than a municipal administrative region. SUMPs are prepared with a ten year time frame and updated every five years. SUMPs are a necessary requisites to access state funding for mass transport and also to European project funding.

- Art. 1031 Budget Act (145/2018)[lxii]: Introduction of a temporary grant (from March 2019 to December 2021) to those who buy a vehicle with CO2 emissions of less than 70 g/km and an official price of less than €50 000. The contribution is differentiated by classes of emissions (0-20 g/km and 21-70 g/km), it increases if a vehicle from Euro 1 to Euro 4 is contextually scrapped and ranges from €1 500 to €6 000. On the other hand, the law imposes the payment of a tax for the purchase of vehicles of category M1 (passenger transport with maximum 8 seats and 5 tons mass) if the CO_2 emissions are higher than 160 g/km. The tax varies from €1 100 to €2 500 based on emissions.

- Polluter pays principle: the governing contract between Five Stars and League parties[lxiii] mentioned the 'polluter pays' principle should be a concept to be applied in transport policies. Concretely, it states that Italy should progressively abandon diesel and petrol vehicles in order to reduce pollution and contribute to fulfil Paris agreement's objectives as well as the need to adopt financial instruments to promote electric and hybrid vehicles with contextual scrapping of older more polluting vehicles.

2.4.2. Road charging

Italy has one of the oldest vehicle fleets in Western Europe with EURO 0 - EURO 3 accounting for around 45% of the total fleet[lxiv]. Aside from some limited exceptions, road charging in Italy is generally not linked to the environmental performance of vehicles, nor to congestion times or zones[lxv]. Generally, toll charges are differentiated for vehicles depending on the number of axles and, for 2-axle vehicles, the height[lxvi]. Smart tolling can play an important role in reducing emissions and encouraging the uptake of cleaner vehicles. Tolling vehicles aims to ensure that the person who causes damage - whether to infrastructure or the environment - pays for it.

Contracts signed with private companies before 10 June 2008 are excluded from regulation by the Eurovignette Directive "for as long as those arrangements remain in force and provided that they are not

substantially amended" (Art. 7e)[lxvii]. So while the current Directive differentiates tariffs for trucks dependent on EURO emission class (Art. 7g)[lxviii], contracts signed before this date are not required to do the same. For example, Autostrade per l'Italia (ASPI), overseeing a network of more than 3,400 km across Europe and managing roughly 60% of the Italian network[lxix], as well as the other major concessionaires in Italy do not differentiate tolls according to EURO class. This leaves the majority of Italian tolled roads working without environmental considerations.

Italy's Elements for a Sustainable Mobility Roadmap contains suggestions for a transition towards sustainable transport. Several of the suggestions relate to reducing polluting vehicles and incentivising the purchase of cleaner vehicles[lxx]. Smart tolling can help achieve this by incentivising the purchase of cleaner vehicles through pricing. The introduction of tolls in Germany have been shown not only to decrease heavy truck empty headings[lxxi], encouraging efficient transport behaviour, but in addition has increased the purchase of cleaner trucks, which benefit from a lower toll rate than dirtier models[lxxii].

Indeed, toll differentiation ensures that those who pollute pay. A study performed for T&E showed that in the EU, trucks are responsible for €143 billion in infrastructure and external costs but only cover 30% of such costs[lxxiii]. Without toll differentiation, the cost for the external damage caused by vehicles falls to the State, meaning it will be paid by all, and not just by those that pollute. Furthermore, although a pricing signal based on EURO class is a just way of ensuring externalities are covered, most proceeds will be directed to ASPI or to the private concessionary company and not to government coffers. In the current system, the raised money from tolls would likely be directed to motorway network infrastructure rather than to climate mitigation actions.

2.4.3. Environmental performance of transport

In this last piece of historical analysis, a closer look at indicators to see how Italy has decarbonised its economy. Historically, economic growth (that may be measured by gross domestic product) leads to an increase in transport activity, and that activity leads to more emissions. In Figure 3, GDP, which increased from 1995, and both passenger transport (measured in passenger kilometres, pkm) and road freight activity (measured in tonne kilometres, tkm) are plotted. For passenger cars, the correlation between the three metrics is clear (noting that the emissions and activity have been scaled with a factor of 4 to aid visual comparison). With the financial crisis of 2007, which affected Italy particularly strongly, activity and emissions reduced, as did GDP. Activity and emissions are on a trajectory to reach pre-crisis levels, without any decoupling which would indicate a more efficient transport sector. As for the emissions of road freight, emissions and activity are closely correlated, but not with GDP. This may normally indicate modal shift to rail, however that is not the case, as the Italian railways have maintained a relatively constant tonnage over the last 15 years. Therefore, this reduction in tkm of road freight may be a result of a changing economy, where the haulage of goods around the country is decreasing with a shift away from industrial outputs. Evidence of this is confirmed from Eurostat data[3], where looking at the largest quantities of goods carried, the transport of *metal ores and other mining and quarrying products* decreased by 263 Mt or 65%; *other non metallic mineral products* by 161 Mt or 60%; and *Other Goods n.e.c* by 87 Mt or 55%, from 2008 to 2017. It should be noted that for the purposes of modelling, these changes to the economy are assumed to be complete, and an increase in GDP will result in an increase in activity.

[3] Eurostat table road_go_ta_tg, accessed July 2018

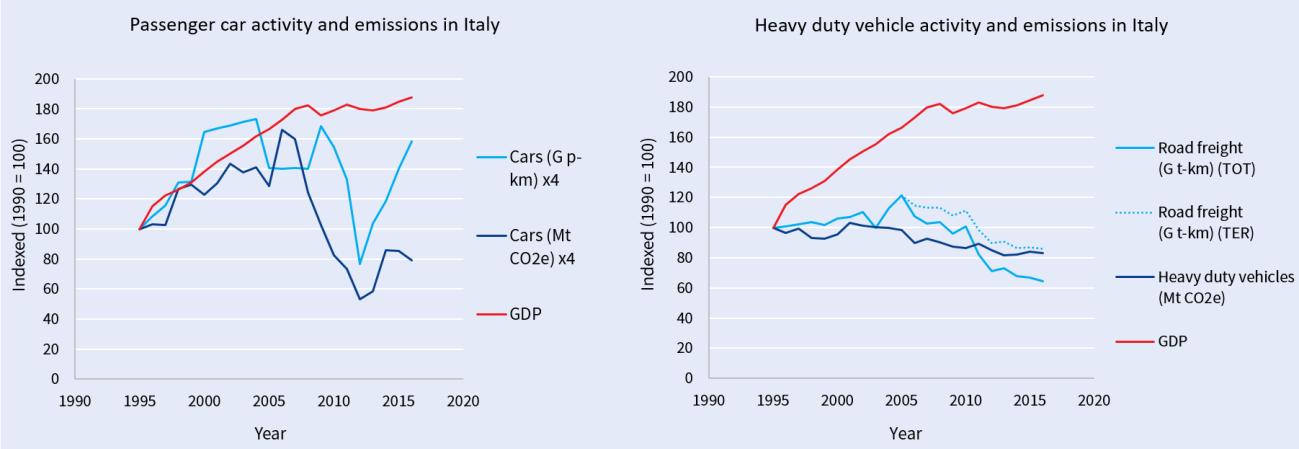

Figure 3: Evolution of Italian GDP, transport activity and emissions. Note that the car passenger activity and emissions have been scaled with a factor of 4 to aid visual comparison.

In order to see if a decoupling of emissions and activity has actually occurred in the last 20 years, a closer analysis of the environmental transport performance is shown in Figure 4. For the EU28, the activity per emission has been steadily increasing (i.e., more passenger movements per unit of fuel burnt); this observation is also true of the Italian car fleet albeit at a more efficient 10.8 pkm/kg CO_2e compared to 9 pkm/kg CO_2e in the EU in 2015. For road freight, however, the environmental performance has declined sharply in the last 5 years with close 6.1 tkm/kg CO_2e in 2015 compared to 8 tkm/kg CO_2e in the EU. This implies that there is a strong potential for logistical improvements in Italy to be more in line with the EU average.

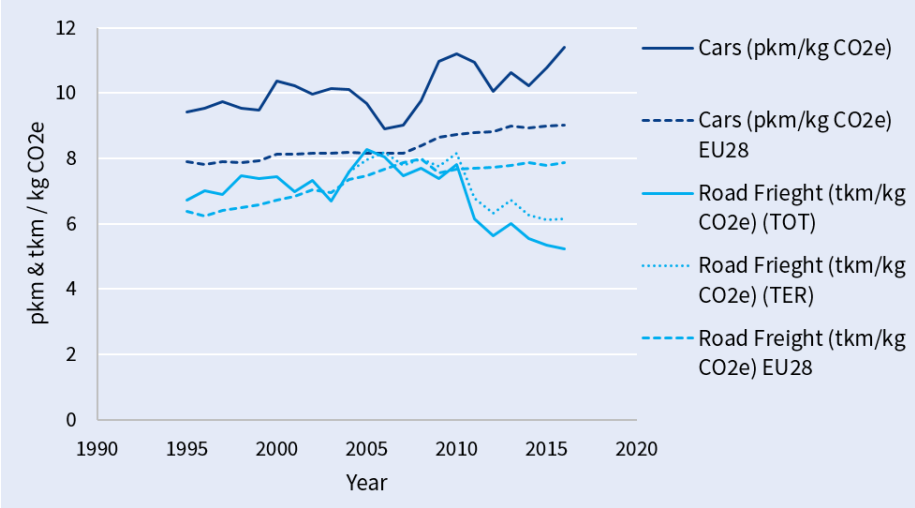

Figure 4: Comparison of the evolution of Italian environmental transport performance against EU 28 average.

2.5. Where will Italian transport be if no action is taken?

In terms of emissions, road transport in Italy[4] is on a trajectory to exceed its 33% CAR reduction by 23.8 Mt (Figure 5) in the business-as-usual scenario as defined in this report (i.e. without considering the effect of post-2020 vehicle standards). Here lies another import assumption of this report: the equal distribution of reduction effort across sectors in the CAR. In publications released by the European Commission, it is stated that transport in the EU should only reduce its emissions by between 18% and 20%. As the biggest sector in the CAR, and a sector where clear technological pathways exist for decarbonisation, it is surprising that the industry and building sectors need to reduce their emissions more than transport. The authors of this report would argue that transport should achieve *at least* the CAR target, and beyond where possible.

[4] Not including emissions from motorcycles

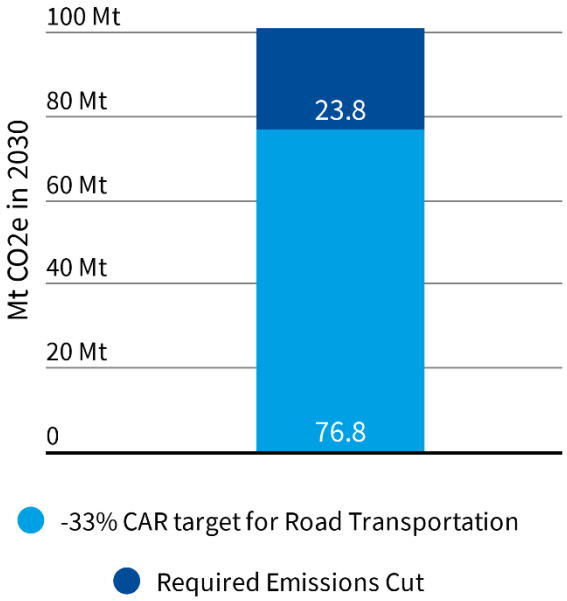

Figure 5: Baseline projection of road transport emissions in Italy will reach 100.7 Mt CO_2e, compared to the CAR reduction target of 76.8 Mt CO_2e. Italy must reduce its projected 2030 road transport emissions by 23.8 Mt CO_2e.

Given the above assumptions of the contribution that should be made by the transport sector, Italy will exceed its target by 31% when looking at transport only. If the cost of CO_2 allowances were to be €100/tonne, this would translate to €2.4 billion in 2030 alone. However, the actual loss will be far greater, because of the aforementioned yearly targets. With the starting point assumed to be at May 2019, the cumulative allowances (tonnes of CO_2) that Italy would be liable to pay for would amount to 133 million (without the use of flexibilities or safety reserve). At the assumed price of €100/tonne, this equates to a sum or €13.3 billion in the period 2020-2030, an amount only from the transport sector, unless other CAR sectors would decrease their emissions considerably. If the EU and Italy were not to take any action on GHG emission mitigation, consequences to the environment aside, this could result in a significant financial burden for Italy and would require a reduction in emissions of 5.0 Mt CO_2e per year in transport to decarbonise the sector by 2050.

3. Quantifying the impact of proposed and adopted EU post-2020 measures

It was shown that road transport was the biggest sector of CAR emissions. Figure 6 further breaks road transport down into its constituent parts. As can be seen, the largest share of emissions in 2016 was from passenger cars, followed by those from heavy duty trucks and buses[lxxiv]. In this section, the specific EU mechanisms to ratchet up climate ambition in transport will be explored. Firstly, a look at the current proposals (under negotiation) and to the newly adopted post-2020 light duty vehicles standards is assessed. Secondly, more ambitious targets based on technical and economic analysis will be explored to see what more ambitious EU CO_2 vehicle standards *could deliver*. In particular the 2030 light duty vehicles standard for 2030 will be reviewed in 2023, an opportunity to increase their ambition Note: In this report, the emissions from motorbikes are not considered for measures to reduce emissions or in the calculation of targets and trajectories.

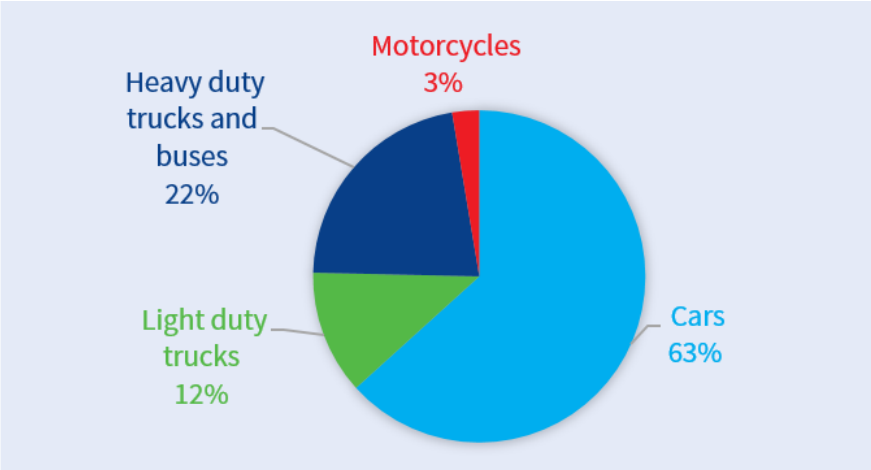

Figure 6: Road transport split by mode in Italy 2016[lxxv].

3.1. Proposed and newly adopted EU measures for transport

In December 2018, the European Parliament, Commission and Council agreed to cut carbon emissions from new cars and vans by 15% in 2025 and by 37.5% from cars and 31% from vans in 2030, compared to 2021 levels. Unlike the 2020 and 2021 targets that were given in gCO_2/km, the percentage reduction allows for the change to the new driving test cycle (WLTP) from the existing one (NEDC). A bonus system is included in the new law whereby car manufacturers are able to reduce their fleet-wide CO_2 targets if they sell more zero and low emission vehicles than the sales benchmark proposed. The bonus is capped at 5% reduction. There is however no malus or penalty if a manufacturer sells less ZLEVs than the benchmark. It was also agreed that the Commission will develop a system using information from fuel consumption meters to ensure emission reductions are delivered on the road but this will not come into force until 2030. A review clause provides for a possible revision of the 2030 targets in 2023.

As concerns HVDs, in May 2018, the Commission proposed truck fuel efficiency standards. The truck standards do not include CO_2 improvements from modifications to the trailer (for example from better aerodynamics), only the tractor. Furthermore, the truck standards apply to only a select subgroup of trucks ('regulated categories', 4, 5, 9, 10) which cover approximately 80% of truck emissions in terms of CO_2 emissions per year and historical sales (Figure 7[lxxvi]). Under the proposal these regulated truck sales must reduce their emissions by 15% in 2025 and at least 30% in 2030 (the latter to be revised by 2022), compared to 2019. Similar to the cars and vans original Commission's proposal, no ZEV mandate is proposed but rather a somewhat weak system of supercredits, a point which will be discussed further on in the report.

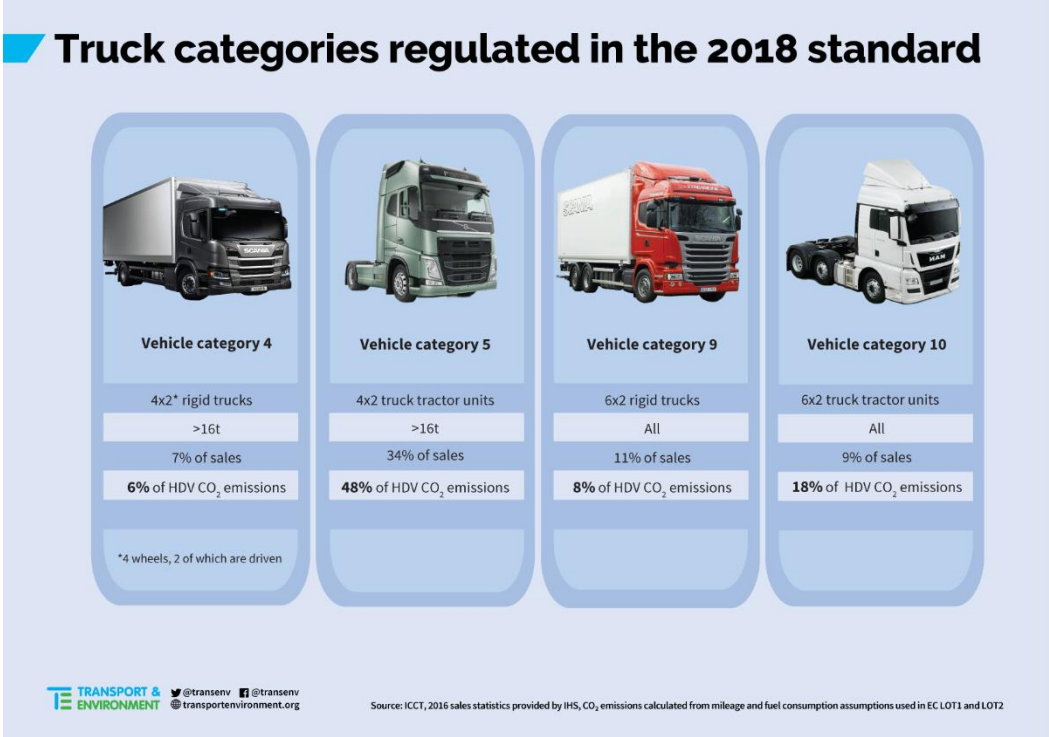

Figure 7: Regulated trucks in the Commission's truck CO_2 standards proposal

If vehicle makers meet the Commission's proposals for trucks and the adopted laws for light duty vehicles in the real world, but don't exceed them, it will deliver 34% of the required cuts for all of road transport, or 8.2 Mt of the required 23.8 Mt CO_2e (see Figure 8). The real world achievement of these targets is a crucial component of these reductions. If, as evidence suggests, car makers are inflating their WLTP values so as to generate savings in the lab rather than on the road, or abuse the double counting sales incentives in countries with a market share of ZLEV sales below 60% of the EU average, the savings would be much less[lxxvii]. On the other hand if the 2025 target are correctly met by carmakers, there are chances that the EU EVs market will be grow substantially in early 2020', creating the condition for a more ambitious 2030 target to be more easily achievable. This would open up possibilities to uplift the 2030 target in 2023 revision, and allow Europe to be more in line with the reduction needed to be delivered under the Paris agreement.

This target uplift together with more ambitious outcome of the negotiation on-going for trucks standards can deliver a greater contribution at national level and reduce the national effort to close the gap, as will be shown in the next section.

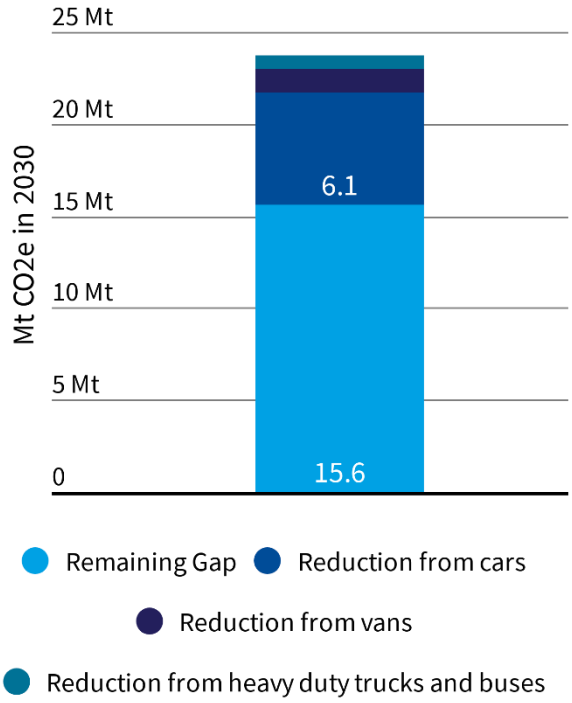

Figure 8: Reduction in road transport emissions from newly adopted light-duty vehicle standard and Commission proposals on truck fuel efficiency standards for 2030. Cars, vans, and trucks reduce emissions respectively by 6.1 Mt, 1.3 Mt, and 0.7 Mt CO_2e.

3.2. What ambitious and feasible EU measures in Italy can deliver

3.2.1. Ambitious CO_2 standards and electrification

As mentioned in the previous section the cars and vans standard are up for a review in 2023. CO_2 emissions of new cars can be feasibly reduced by over 50% by 2030 as shown by International Council on Clean Transportation (ICCT)[lxxviii], through a combination of fuel efficiency improvements and ZLEV sales. This is also more in line with the ambition levels necessary for transport to deliver the Paris Agreement goals. Van CO_2 standards were shown to be optimum in the Commission impact assessment[lxxix] at a 40% reduction, by comparing the required investment in technology from the OEMs and the fuel savings that would generate for consumers - typically businesses and tradespeople. This is significantly more ambitious than the agreed target of 31%.

The truck fuel efficiency proposal should eventually include the trailers and non-regulated trucks. Owing to the large variety of trucks and their operations, fuel efficiency will be calculated with the simulation tool VECTO (Vehicle Energy Consumption Calculation Tool)[lxxx]. This tool could be easily and feasibly modified to not only account for all categories of trucks, but their trailers as well. This will allow manufacturers to have a holistic approach to reducing the real world emissions of the truck. If this were the case, the ICCT shows that a 24% reduction (tractor unit only) is economically viable and technically feasible by 2025, increasing to a 45% reduction (with trailers included) in 2030[lxxxi] compared to a 2015 fleet average truck. Trailers are not included in the 2025 reduction target, so the Commission proposal of a 2025 reduction of 15% for regulated trucks is assumed to remain. The "at least" 30% target for 2030, on the other hand will be reviewed and finalised no later than 2022. After trailers are regulated in the early 2020s, T&E expects that total reductions from tractor and trailer (where applicable) should average 45% compared to a 2015 baseline (or approximately a 43% reduction compared to the 2019 baseline). There is currently very little information on applying vehicles standards to coaches[5]. However, it seems reasonable to expect that the

[5] We consider buses to fall under two broad categories: coaches, for intercity travel, and city buses; those that operate under a fixed timetable in metropolitan areas.

technology improvements leading to efficiency gains employed in trucks could be to some extent utilised in coaches, however this is not explicitly dealt with for this report.

There are also complementary measures to promote electrification of the fleet, for example by accelerating standardisation and deployment of EU charging infrastructure. The renewable electricity share in transport (RES-T) target is also one such mechanism, however with a multiplier of 4 recently agreed on in the revision of the Renewable Energy Directive, this will not necessarily lead to a large uptake. Finally, there are some modes, particularly vans[lxxxii] and buses[lxxxiii] where evidence suggests that electrified versions are already economically viable on a total cost basis; all that is missing is the supply from European OEMs[lxxxiv]. Importantly, an uptake in electrification should not allow OEMs to reduce ambition on internal combustion engines; selling an EV should not reduce the efficiency of the other vehicles.

For passenger cars, there remains a constrained supply and choice of plug-in vehicles (PHEVs and BEVs) in Europe; as carmakers in Europe are lacking a regulatory push to invest in sufficient capacity and increase sales[lxxxv]. But an increased offering is expected in 2019/20 as carmakers have to meet their 2021 CO_2 targets. The complexity of PHEV dual drivetrain systems will eventually be too expensive to compete with BEVs in the context of rapidly falling battery prices and no investment required for pollutant suppression. A national target of at least 20% sales in 2025 and over 40% in 2030 is in line with carmakers' own projections[lxxxvi] This would spur the investment in OEM factories and supply chain (e.g. battery cells) in Europe, as well as recharging networks, and enable power companies to anticipate the future electricity demand that will help investment of clean renewable energy. The best practices of other European countries to help the uptake of ZEVs are detailed by the ICCT[lxxxvii]. These include tax exemptions, priority parking and priority lanes, and zero emission zones in cities (discussed in the national measures section) that help promote ZEVs on the one hand and restrict ICE vehicles on the other. Italy has in place several frameworks to promote electric vehicles. Note that for modelling these effects, electric cars are included in the overall ambitious CO_2 target itself, which we take to be to 50%.

Electric buses are a well proven technology, the salient example being Shenzhen in China where 100% of the city bus fleet (16 400 buses) were replaced with electric. In Europe, electric urban buses are gaining traction, according to a market monitoring and analysis[lxxxviii], orders for electric buses more than doubled in 2017 compared to 2016 reaching around 10% of the total European city bus market.

New electric bus suppliers are emerging in Europe. The Italian manufacturer Rampini has been providing electric buses to cities like Vienna[lxxxix] and Foligno[xc], all of which were produced in the province of Perugia. Other major European electric bus manufacturers include Solaris (Poland) and VDL (Netherlands). In Italy, the electric bus fleet is composed of about 131 electric buses (including trolleybuses with batteries) and another 88 are ordered and not yet delivered as of end of 2017[xci]. These buses are running in cities like Cagliari, Milan, or Turin (20 BYD buses)[xcii]. According to an industry survey by UITP data, 41% of city buses procured in the EU by 2025 will be zero emission, rising to 62% by 2030[xciii]. Joachim Drees, CEO of MAN Trucks and Buses, has proven to be more ambitious and expects that European cities will only procure electric buses from 2025 onward[xciv] while the proposal for the Revision of the Clean Vehicle Directive suggests that Italian cities will have to procure 50% "clean buses" by 2025 and 75% by 2030[xcv]. However, based on the favourable total cost of ownership compared to diesel and gas buses and the desire for municipalities to improve air quality and reduce noise, it is unlikely that cities would procure expensive and polluting buses that rely on imported oil or gas after 2030[xcvixcvii]. More so true given the recent series of bus explosions due to short circuits; in Rome, 36% of buses are not in use because they are awaiting repairs[xcviii].Therefore, based on the above we assume 50% of new city buses purchased in Italy will be zero emission from 2025 and 100% from 2030[6].

[6] Urban v-kms from the model TREMOVE are used as a proxy for possible sales.

Small electric vans are already economically viable as shown by example of the success of the Street Scooter and independent studies[xcix]. As small vans make up approximately 40% of total van sales, the main limitation is the number of models available. We assume BEV sales of vans (no PHEVs, owing to their expense and the price sensitivity of business operators) reach sales of 50% by 2030. This is on top of fuel efficiency gains for larger vans of 40%.

Finally, there has been an increasing number of battery electric trucks (BETs) in most weight categories in China, the US, and in Europe. They have been shown to have a favourable total cost of ownership (TCO) in many operations today[c] or within the next decade[cicii]. In Italy, 52% of vehicle km and 53% of tkm are journeys less than 300 km, and 70% half of road freight movements are less 500 km[ciii]. These types of journeys could feasibly be covered by battery electric trucks with today's technology (in terms of battery energy density).

Another technology that is currently undergoing significant testing and offers a pathway to electrifying road freight is the e-highway[civ]. This is charge-on-the-move technology, where trucks connect to overhead wires with a pantograph on arterial routes. Hybrid versions or on-board battery storage can be used off the e-highway grid[cv]. This technology would require an EU wide coordinated and standardised roll-out to reap maximum benefit. According to the German Ministry of Environment, e-highways are the cheapest option to electrify heavy duty road transport[cvi]. Indirect forms of electrical power are more inefficient. Hydrogen and power-to-liquid technology require from 3 to 5 times more electrical energy than for direct use of electricity[cvii]. Additionally, these e-fuels are much further from maturity and much more expensive, and this may hinder any significant market share before the late 2020s, too late to be deployed to achieve the 2030 climate goals.

A ZEV mandate spurs investment in new technology and will lead to a diverse option of trucks with electric drivetrains. We assume that a significant portion of these journeys will be electrified in BETs, with 20% of new truck sales <16t and 10% truck sales >16t being battery electric trucks by 2030. This is close to the TNO analysis[cviii] under which 33% of new truck sales (in categories 4, 5, 9 and 10) must be zero emission in 2030 to meet the EU climate targets. The results of more ambitious standards with ZEV mandates as described in this section are shown in Figure 9.

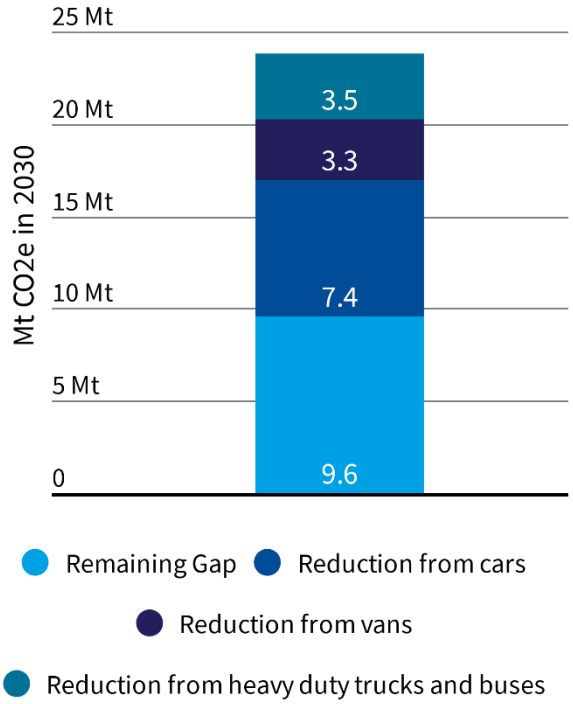

Figure 9: Combination of ambitious 2025 and 2030 standards, and ZEV mandates and promotion

An uplift of 2030 light-duty vehicle standards under the 2023 revision and more ambitious 2025 and 2030 target for trucks can increase the EU contribution to the national CAR target by a further 6Mt of CO_2. In this case the national gap to be closed will be equal to 9.6 Mt CO_2 instead of 15.6 Mt CO_2.

3.2.2. Other EU measures

Other measures that fall under the jurisdiction of the EU include *Eurovignette*[7] (road charging for trucks) and the ongoing construction of the TEN-T network with harmonisation in the EU with respect to signalling (ETRMS) and rail gauge. These measures will indeed help with incentivising and facilitating modal shift, demand reduction, and logistic efficiency, however it will largely be up to each Member State to implement and lever these frameworks to maximise the benefits. These, among many more options, are described in the following section.

[7] Directive 2011/76/EU

4. National measures Italy needs to achieve the 2030 GHG reduction targets

4.1. What has been proposed or considered in Italy

In this section, the various mechanisms available to Italy will be discussed. Although some measures have quantifiable impacts, the effect of the full combination of measures that may partially overlap is difficult and arguably futile. Thus, each measure is discussed and analysed and a thorough assessment given as to how the measures may reduce GHG emissions. All inputs into the model are summarised towards the end of the section.

4.1.1. Fuel taxes and tax reform

In Italy, 287 000 of the 1.6 million (18%) new cars sold in 2015 were company cars[cix]. Company cars are taxed differently to private cars. Legislation in Italy provides a series of tax deductions for vehicles owned by a company, for example, an individual using a company car for both personal and professional reasons is considered to be using a 'fringe benefit', which is partly taxable. A study by the European Commission found that a favourable tax system for company cars not only encourages car ownership, but affects car model and driving habits, and as such worsens environmental pollution caused by the transport sector[cx]. Indeed, company car legislation doesn't include environmental consideration as no differentiation is given for EURO class; moreover, diesel, petrol and electric-powered vehicles are taxed equally[cxi,cxii].

There is potential, therefore, for changes to be introduced. Re-designing the company car tax legislation to introduce higher tax deductions for electric cars could encourage the uptake of cleaner vehicles by companies. This could be very effective as companies are usually quicker than individuals to look at the bottom line and typically change vehicles more often; a study by ASSILEA (Italian Association of Leasing Companies) suggests that more than 60% of company cars are less than 4 years old[cxiii].

Fuel taxes for transport are quite high in Italy with the second highest excise duty for petrol (behind only the Netherlands) and the second highest for diesel (behind the UK): petrol is charged at €0.728/l, diesel at €0.617/l, while LPG is taxed at €0.15/l and natural gas €0.00331 per m^3 [cxiv] . In terms of energy content, and assuming that the density of natural gas under standard atmospheric conditions is 0.8 kg/m3 with an energy density of around 55 MJ/kg, the natural gas taxation is €0.075/GJ, less than the mandatory EU minimum of €2.6/GJ[cxv]. Comparing the equivalent taxation per energy unit of petrol (€22.6/GJ) and diesel (€17.2/GJ), gas enjoys a tax rate of between 230 and 300 times lower. This appears to be legally possible based on Article 15.1(i) of the Energy Taxation Directive (2003/96/EC[cxvi]) that allows Member States to apply full or partial exemptions to natural gas used as a propellant. Figure 10 shows that, in real terms, the excise duty applied to fuel in Italy had been decreasing since 1996[8] from a sales weighted average of about €0.87/l to €0.52/l in 2011. From 2012, taxes jumped by €0.13/l (part of austerity measures following the financial crisis[cxvii]), and have remained stable since then at €0.65/l. This compares to the EU average in 2017 of €0.53/l. As is the case in the EU, there is a significant difference between the taxation of petrol and diesel, for Italy the difference is €0.11 or 18%. In 2017, the Italian state earned €23.4 billion from fuel duty; had the diesel duty been the same as the petrol duty, revenues would have been €26.4 billion, or 12.8% more, all else being equal.

As the price of fuel paid at the pump is not just excise duty, but the price of fuel itself (including refining, distribution, and profit) and VAT, the relative increase paid at the pump by harmonising the diesel price to that of petrol would be around 12.5%. Further, there is a sales weighted average reduction offered to truckers of €0.214/l in Italy[cxviii].

[8] T&E analysis on the Fuel bulletin database and Eurostat data.

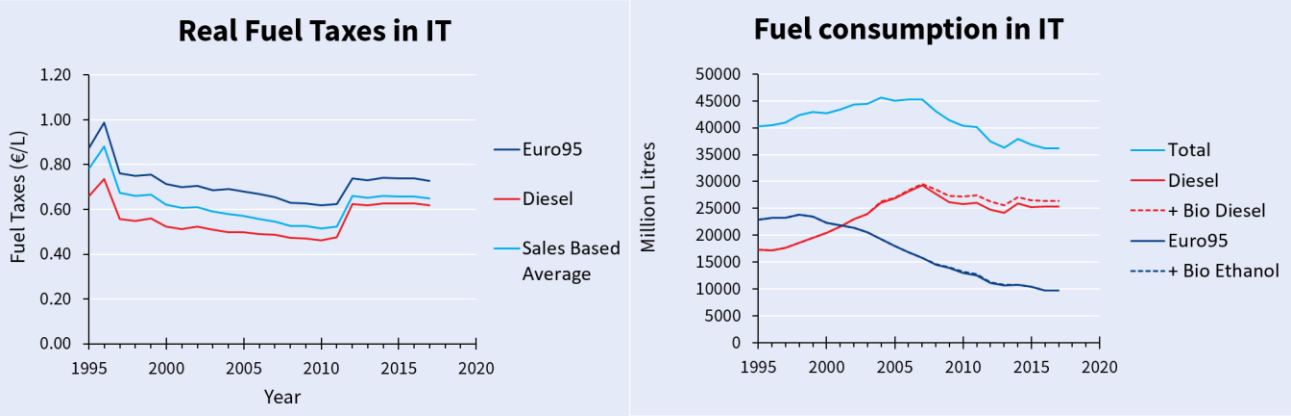

Figure 10: Evolution of fuel taxes and fuel consumption in Italy.

Fuel taxation is not only a means to earn money for the state, it helps internalise the externalities of transport (societal costs of infrastructure, congestion, health problems related to pollution, injuries and loss of life due to accidents) and more significantly, it influences the long term behaviour and choices of passengers and freight operators. With a long term elasticity[9] of -0.36 for petrol and -0.73 for diesel (taking -0.55 on average)[cxix] for car use, the decrease in diesel car activity (which represent 43% of the fleet[cxx]) based on the implementation of harmonising diesel to petrol taxes would amount to a decrease of around 3% - demand in EVs would remain unchanged. However, it may have other effects such as increasing carpooling or modal shift to bus or train. In terms of the change in freight movements, this could lead to a preference of more efficient vehicles (which would only be available with the European standards) and an improvement in logistics efficiency. According to Ricardo, the EU average elasticity for trucks and vans is also -0.3. With a simplifying assumption that trucks are all diesel powered, and they all receive the generous fuel abatement, if the price of fuel was to be equivalent to petrol, the demand reduction could be in the order of 11%. It is important to note that this assumes no improvement in fuel efficiency, which reduces the fuel component of the operating costs. These types of measures would reduce the transport activity of road modes, and with appropriate policy can enable cleaner modes such as rail to increase their share of transport.

4.1.2. Facilitate and encourage electromobility

The vehicles carmakers place on the market across EU countries, or supply, in EU is governed by the car and van CO_2 standards. Including the ZEV sales target as described above (under the EU measures) will help Italy have a bigger offer of ZEV models as well as make them more affordable due to economies of scale. But this cannot and should not occur in a policy vacuum in the Member States. Italy has shown a very conservative approach on electromobility in their National Policy Framework under the Alternative Fuels Infrastructure Directive (see targets above, Section 2.4.1). However the new government has shown good ambition on electro-mobility and targets one million EVs on the road in 2022[cxxi]. While Italy is a laggard for electro-mobility today and severely brings down the European EV sales share (4,800 EVs were sold in 2017, which is a 0.2% market share, only 7 Member States did worse), achieving one million EVs in 2022 would make Italy a clear leader in electro-mobility. Consumer incentives play a critical role in reducing electric vehicle costs in the near term while they remain higher than conventional vehicles. The *Ecobonus* recently adopted by the government that provides fiscal incentives from €1500 to €6000 for the purchase of PHEVS and BEVs go in the right direction. Nevertheless in order to reach the target of 5 million BEVs and PHEVS in 2030, (National Energy Strategy[cxxii]), much tougher policies are needed.

[9] Elasticity is the measure of how one variable (here, car use) changes with another variable (here, fuel price). In the most general case, as a something becomes more expensive, demand for it reduces. For the case described here, increasing the fuel price by 30% with the elasticity of -0.3 results in a change in demand of 30% x -0.3 = -9%, that is a 9% reduction.

Italy currently suffers from a technological gap: it is the 4th largest economy of the EU and the 4th largest automotive market but is the 17th market for EV share. Currently about 13 500 electric vehicles (of which, 5000 are battery electric) are on the road which can access today about 2 580 normal power chargers and 540 publicly accessible high power chargers. Italy clearly needs more ambition if the country doesn't want to lag behind the other Western European countries and wishes to reach their one million EV target by 2022. Italy is making good progress on planned fast and ultra-fast charging infrastructure. Enel (a major European utility company) and it's subsidy Enel X (dedicated to charging infrastructure) are coordinating the deployment of the ultra-fast charging network E-Via Flex-E which plans the installation of 8 ultra-fast charging sites (and 6 more in France and Spain) and will enable drivers to charge up to more than 250 km in 10 minutes while connecting them to neighbouring countries. These types of projects are the types of investment that are required and the roll out should be accelerated as EV uptake increases.

Unfortunately, the Italian National Policy Framework (presented by the previous administration) focuses on natural gas as desirable alternative fuels, for which substantial infrastructure is already in place and strong vehicle and infrastructure growth is anticipated. Italy is today the European leader for CNG fuelled vehicles and is the only Member State with Hungary and the Czech Republic to have high ambition for gas vehicles. This poses many risks to the cross-border continuity of Europe's roads and jeopardises the transition towards a low-carbon economy and away from dependence on foreign fossil fuel imports.

4.1.3. Road charging and low emission zones

As previously discussed, Italy's tolling system generally doesn't differentiate tariffs for cleaner vehicles. With the second highest motorisation rate in Europe at 625 passenger cars per 1000 inhabitants (compared to the EU average of 505 per 1000 inhabitant) and one of the oldest vehicle fleets[cxxiii], smart toll charging can have a great impact on air quality. As such, the State should reassess how tolls could be charged, and consider extending the toll for HDVs to local roads to apply the polluter pays principle. In this framework the procedure recently initiated by the present government to revoke the ASPI concession (even though the extension of the concession up to 2042 has already received green light from Brussels) offers a unique opportunity to redesign the toll system in order to ensure that the polluter pays principle is applied and that the income from tolls are directed to the State's coffers to cover negative externalities and fund sustainable mobility measures. The State, therefore, should redesign its tolling policy to ensure that tolls differentiate according to a vehicle's environmental class. This would bring tolling in line with the Government's action plans on sustainable transport by ensuring the polluter pays principle is applied.

The economic burden of extending the toll for truck companies would be very low as transport and logistics companies have been shown to pass on around 85%[cxxiv] of tolling costs to clients. For those clients who pick up the bill, transport is between 2-5%[cxxv] of production costs. So tolling does not place an unbearable burden on trucking companies or businesses. In fact, tolling HDVs on all roads would ensure that the damage they cause in terms of infrastructure and pollution is captured no matter where they travel, and, in addition, would reduce congestion on secondary roads as toll-avoiding HDVs return to motorways (which tend to reduce journey times).

Road charging is perhaps even more important for curbing the emissions of trucking. Directive 2011/76/EU, commonly known as the Eurovignette Directive, is the European legislation that establishes how EU Member States can toll trucks for their use of infrastructure. There is no EU obligation on Member States to introduce a road toll for trucks but, if they choose to do so, then the toll has to be in accordance with this Directive. Italy is one of fifteen EU countries that currently have distance-based road charging[cxxvi] on some of its roads. The external costs of trucking can be significant in terms of pollution[10], and for infrastructure wear and tear, noise, and congestion[cxxvii]. Reinvesting toll revenues into the maintenance of existing infrastructure is imperative, particularly in regards to critical infrastructure such as bridges, which has reportedly declined over the last decade and has resulted in 10 bridge collapses in the last 5 years in

[10] For pre-Euro 6 vehicles.

Italy[cxxviii]. This typified by the collapse of the Polcevera viaduct in Genoa, on 14 August 2018, resulting the tragic loss of 43 lives.

Tolling can play complementary role in the uptake of cleaner, more fuel efficient vehicles and ZEVs. Firstly, applying CO_2 differentiation of road charges based on tailpipe emissions would complement and gradually replace differentiation based on air pollution. For cars Euro class differentiation should play a role but it must be based on Real Driving Emission test results and not on the discredited laboratory tests. A 75% toll discount for all zero emission trucks across Europe would provide a financial incentive to encourage the purchase of zero emission trucks, which would help create a bigger market for zero emission vehicles. But those contracts signed with concessionaires before 10 June 2008 are exempt for regulation by the Eurovignette Directive. In Italy, this applies to all tolled roads under management by ASPI (estimated to account for 60% of Italy's network)[cxxix]. Ensuring that the Directive applies to all tolled roads in Europe is vital to European cohesion and reducing logistic complexities for trucking companies.

Finally, tolls can be used to reduce congestion and to create zero emission zones. Cars spend a lot of time in cities, but a disproportionate amount of that time is spent parked. A duration based charging system, whereby users pay per hour of city access, can reduce the amount of cars in city centres without limiting mobility. Such a system encourages collective mobility (i.e. train, bus, or carpooling) and allows for more space to become available for better cycling/walking infrastructure or parks. This charge could be further differentiated to promote the use of cleaner vehicles so that those vehicles that do continue to enter cities are more likely to emit less. For congestion, a higher price can be charged for trucks driving in the busiest periods of the day. This can help reduce traffic during peak hours as trucks adapt to plan deliveries off-peak.

4.1.4. Shifting car passengers to buses, trains, riding, and walking

Shifting passengers from cars to buses and trains can be divided into two broad categories, intercity and metropolitan. Italy was amongst the first countries in Europe to begin construction of high speed rail, beginning with 224 km of network in 1985 which has been expanded to 981 km today. High speed rail in Italy saw the introduction one of the first genuine competitors, from Italo, which was recently acquired for €2 billion and is touted as being one of the only money making high speed rail providers in the EU[cxxx]. Evidence suggests that the high speed line between Rome and Milan and then the introduction of Italo to compete on the route lead to reduction of 1 million air passengers[cxxxi], however we have not seen data that shows the new demand created and the number of reduction in car trips between the two cities.

71% of the Italian railway network is electrified[cxxxii], which is higher than the EU average. The existence of rail in itself does not induce passengers to use it, however. Train schedules must be reliable, pricing fair and competitive with other modes, punctual services, and finally, modern and well-maintained rolling stock that can offer services such as wifi and clean toilets. Long distance coach journeys have also seen a rapid expansion in Europe with competition and market liberalisation[cxxxiii]. Companies like Flixbus have expanded rapidly offering regular services that are reliable, easy to book, and cheap[cxxxiv]. Coaches do not only compete with car transport; they can offer cheaper services than rail owing to their comparatively low costs such as infrastructure and vehicle costs compared to rail. Coaches should therefore not be granted discounts to road charging or exemptions to any future vehicles standards to ensure that they both do not too heavily undercut rail but also pay their fair share of infrastructure and societal costs (CO_2, pollutant, and noise emissions).

In cities, in order to shift car passengers to public transport, an essential component is appropriate infrastructure for walking and cycling. While a journey by car is typically characterised by door to door transport, a public transport journey is often part of a multimodal trip, and may involve walking or cycling to a bus stop, a bus trip to the metro station, a metro trip, and then a walk to reach the final destination from the metro station. Although walking in itself will not be able to offer the same transport capacity as cars, it is an integral element of facilitating the journey. Cycling enables short distance trips to be completely replaced, especially with the generalization of electric bikes, making cycling a transport solution

for more people. The most successful cities and countries (such as the Netherlands and Copenhagen) have high cycling rates owing to extensive infrastructure that is separate from the road and gives cyclists priority over cars. The National Integrated Transport System, as part of the Connect Italy framework, moves in this direction categorising for the first time a national bikeway network as a national priority (placing its importance on the same level as road, rail and ports)[cxxxv]. Several city based bike sharing programs are already in use in different cities around Italy, such as Mille e una bici in Florence, [TO]BIKE in Turin, and BikeMi in Milan.

Alongside cycling and walking, the public transport itself must also be reliable and affordable. In Europe, monthly subscription costs an average of €64, compared to €38 for a monthly subscription in Turin[cxxxvi]. When GDP is taken into account (€21 400 per person for Turin), Italy's price remains comparable to the European average (with a GDP of €40 700 per person). However, Italian public transport is one of the least developed in Western Europe; the total length of metro lines in all Italian cities is less than in the city of Madrid alone (235 km compared to 291 km in Madrid)[cxxxvii]. This fact is reflected in the low share of public transport in comparison to private car use.

In 2015, the Italy-wide modal split of passenger transport in terms of passenger km (not by trips made) was 80.7% by car, 12.2% by bus and coach, 6.2% by rail, and 0.8% by tram and metro. Considering car transport was 679.4 billion pkm, shifting 5% of this activity to rail would imply a 65% increase in capacity. From 2000 to 2015, rail activity grew by 5%; the implication here is that a 5% shift may be feasible but very optimistic; keeping with historic trends would see a shift of around half a percent on today's car passenger numbers. On top of this, Italy will need to see continued and increased investment and policy choices to make it happen. Moreover, around 85% of trips are for distances shorter than 20km[cxxxviii], which suggests there is potential for encouraging more people out of their cars and to take public transport, cycle and walk. In terms of trams and metros, which can contribute to these shorter urban trips, Italy is under performing. Compared to a country with a good light rail network like Austria, which has 14% of the population of Italy, Italians travelled 500 million km less by these modes. Therefore there is a lot of potential to invest and improve these shares.

4.1.5. Putting more passengers in each car and sharing resources

The transport system is on the verge of a paradigm shift from the tradition of private car ownership to models around sharing and mobility as a service (MaaS). This has largely been through a revolution in digitalisation and application based services (Blablacar, Uber), and business models that facilitate infrastructure sharing (Car2go, DriveNow, IoGuido). Evidence[cxxxix] shows that these developments can lead to a significant reduction of single occupancy private car use and an increase of public transport use, leading to a strong reduction in congestion, local air pollution, and CO_2 emissions[cxlcxli]. The French environment and energy management agency (ADEME) found that each shared car replaces in average 5 to 6 private vehicles, while freeing up at least 2 parking places.[cxlii] These benefits will occur when more vehicles are shared and private car ownership is reduced; when these shared vehicles are electric, the benefits are even greater.

Modelling by the International Transport Forum found that in Lisbon ridesharing services could make public transport more efficient and thus end congestion, reduce traffic emissions by one third, and decrease required parking space[cxliii]. Survey by the Pew Research Center[cxliv] and work by the Union Internationale des Transports Publics (UITP)[cxlv] indicate that car and ride sharing complement public transport, but do not replace it. As citizens abandon their cars and opt for shared resources, more active forms of transport (walking and cycling) become attractive as streets are cleared of congestion and cars, liberating space for appropriate footpaths and cycling paths. The technology behind these applications can enable more passengers per car, as pooling services are enabled. This can be reinforced with favourable conditions for cars with multiple (more than 2) occupants on key city roads. While the development of shared mobility seems unstoppable, whether the transition from ownership models to sharing will lead to short term increase in congestion because of induced demand will largely vary from city to city.[cxlvi]

4.1.6. Eco-driving, speed limit reduction, communicating intelligent transport systems (C-ITS), and connected vehicles

Eco-driving is a program for drivers that can reduce CO_2 emissions from cars, vans, trucks and buses by training drivers to reduce speeds, anticipate traffic situations to maintain more constant speeds, and reduce the severity of accelerations or braking. One source with authors from the industry[cxlvii] has shown that the benefits of eco-driving is highly dependent on how many eco-drivers there are and the level of congestion. It showed that in congested roads, eco-driving has a maximum benefit of 4% if all drivers adopted and use eco-driving practices, while in free flowing traffic, the benefit ranges from a 4% benefit, if 25% of drivers employ eco-driving, up to 15% in the ambitious scenario of all drivers employ eco-driving. Other studies from car manufacturers showed that eco-driving could bring a potential saving[cxlviii]. However, the JRC[cxlix] and others[cl] found that the impacts of eco-driving tends to decrease over time. This implies that the benefits would require extensive and repetitive training programs of all drivers to see appreciable benefit. Although this may be feasible for professional drivers where the burden may fall on transport companies, such a broad program for all drivers is unlikely.

Reducing speed can have a significant impact on CO_2 emissions, particularly at highway speeds, as aerodynamic drag increases proportionally to the square of a vehicle's speed. With full compliance of speed limits, the EEA reports that modern cars could reduce their CO_2 emissions per kilometre by up to 12% (in line with findings from Ricardo[cli]), but in a more realistic scenario, it would more likely be 3%[clii]. Imposing lower speed limits comes under the jurisdiction of the Autonomous Communities, and there has been precedent in the EU (in France[cliii] and Belgium[cliv]). In Italy, a national urban speed limit of 50 km/h is in place, while rural areas are only limited to 90 km/h, and motorways to 130 km/h (enforcement is ranked relatively high, however)[clv]. In Italy, the introduction of so-called 'Safety Tutors', which measure average distance travelled over a stretch of motorway, have reportedly reduced average speed by 15% and peak speed by 25%[clvi] (though there is no independent analysis to verify this). Reducing speed limits in cities will improve pedestrian and cyclist safety with less severe injuries and smaller probability of fatalities[clvii] (CO_2 savings will generally not be particularly high, however). Italian authorities reported a relatively high 3 385 road traffic fatalities in 2013 (the WHO puts that figure at 3 721), with 16% of those deaths being pedestrians and another 7% cyclists[clviii]. The WHO suggests that reducing average speed by 5% can result in a cut in the number of fatal crashes by 30%, and moreover, states that when combining motorised traffic with pedestrians and cyclists, the speed limit should be under 30 km/h[clix].

In addition to pricing pressure, technology can play a role in making transport more efficient. The flow of real time information regarding cargo space and arrival time is underutilised in road haulage. Internet applications are being developed and increasingly used, enabling road haulage companies to be more aware of goods available to be transported near their trucks. These tools can help to eradicate dead mileage and reduce empty legs. Increasing the cost of road transport will increase the uptake of such technologies as road is currently too cheap for this technology to be adopted at the extent necessary to have an impact on logistic efficiency

Both Ricardo 2016[clx] and the European Commission[clxi] state that widespread and rapid deployment of C-ITS can reduce the fleet emissions of cars by 1.0%, buses by 1.7%, vans by 0.8%, and 0.7% for trucks. The maximum potential for each mode does not exceed 4.5% (for buses) in 2050, which gives an indication of improvements to new vehicles.

4.1.7. Shifting freight from trucks to trains

Modal shift has long been lauded and promoted as a key driver to decarbonize freight transport. The railway network in Europe is largely electric and far more energy efficient than today's truck transport[clxii]. In 2011, 86% of train-km for freight were performed on electric traction in the EU. However, only 60% of freight railway total energy consumption is performed by electric traction. In 2015, railways transported 18.2% of freight in Europe in terms of tkm, excluding from pipelines. With the same metric, Italy is below the EU

average, at 13.4% and 20.8 billion tkm. This is despite market liberalisation of the railway sector in 2001 and the influx of competing companies.

In the EU as a whole, 50% of rail freight is international undertakings and this is also the case in Italy although there are no transit undertakings[clxiii]. Clearly, the priorities of the TEN-T network to enable smoother international freight, particularly to and via France and to Germany (via Austria or Switzerland), or to other large EU Member States is vital for rail freight viability. In Italy, the vast majority of railways have the international standard gauge width of 1435 mm. This means that generally speaking, there is no physical barrier and no need for changing trains when crossing borders for international freight. However, attaining this potential is not at all simple, as described in greater detail by the Rail Freight platform coordinated by T&E[clxiv]. In addition, and as noted by the SDSN-IDDRI study, Italy's orographic features is a physical barrier and would also make new rail corridors more difficult, and thus costly, to build.

Rail is highly dependent on the type of goods being transported in the country. For example, rail is particularly suited to the transport of non-perishable goods that may not necessarily have a time constraint, such as coal, however in a decarbonising economy, transport of fossil fuels will decrease. As shown in Figure 11 bulk goods to take up a significant (32%) share of bulk goods, however of these only 2% are fossil fuels. This would indicate that Italian rail freight will not have a problem of reducing market share within the context of a decarbonising economy reducing bulk goods. A distance of 300 km and below is where road transport is typically superior to rail in terms of flexibility and operational costs (i.e. infrastructure charges, loading costs, fuel taxes, driver costs, and capital costs for purchase of equipment). Rail freight between major centres such as Milan and Rome exceed this distance and thus are favourable to rail freight. New rail connections through the Alps such as the Gotthard Base Tunnel, opened in 2016, will improve access to large markets such as Germany and BENELUX.

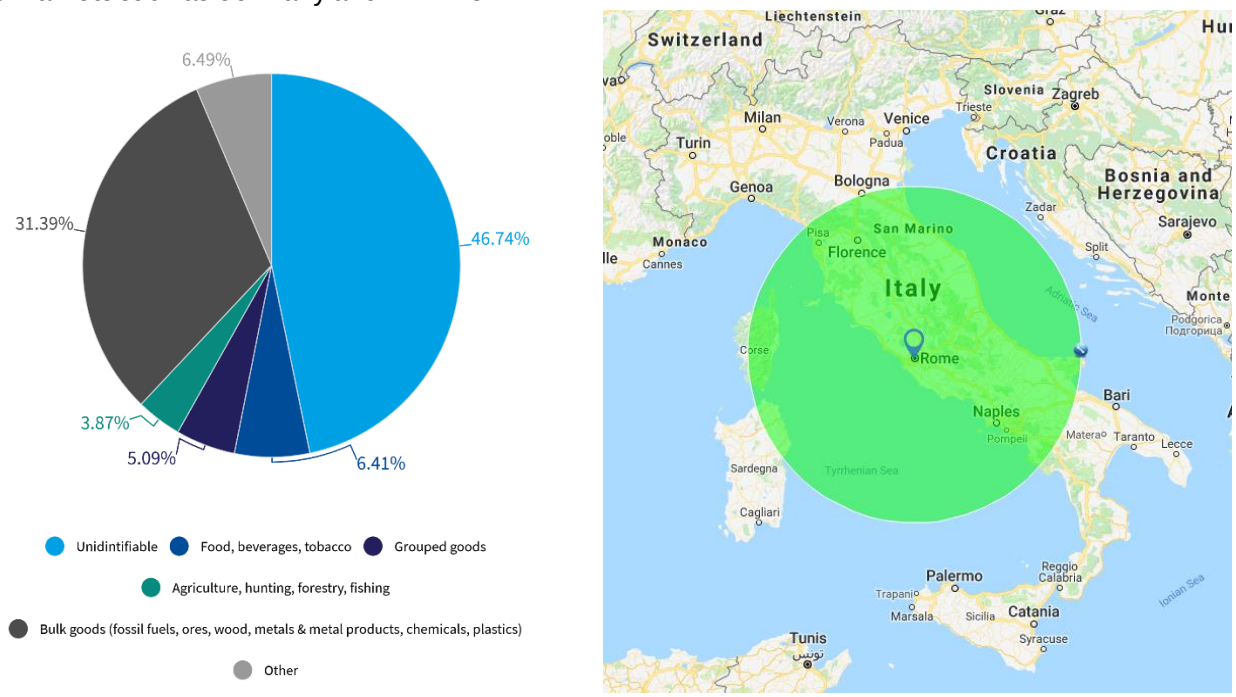

Figure 11: Freight carried by rail by type of goods carried and Italy in 2016 with a 300 km radius area centred on Rome[clxv], overlaid.

Market liberalisation of the rail freight sector in 2001 has led to an increase in the number of companies operating in the rail service sector. In 2014, around 30 companies were granted the right to provide freight services on the national infrastructure (21 of these provided cargo services while seven were specialised in both passenger and freight service)[clxvi]. Thanks to new private rail freight companies entering the market the share of good transported by rail has been increasing[clxvii] . The system has large margin for improvement and opportunity to boost competition further as Ferrovie dello Stato Italiane (FSI) Group actually retains a huge rolling stock fleet estimated to be 150 times bigger than that of its main competitors. A study by the

Centre on Regulation in Europe suggests that this difference between new entrants to the sector and the dominant FSI Group (in terms of development opportunities and the associated additional costs) is the biggest barrier to entry for new companies. In addition to this, the study highlights a number of barriers to improved freight operations including a lack of sea-rail interfaces, ineffective management of freight services (including market timing and reliability), and a highly competitive road-transport sector[clxviii].

Regional Law n. 15/2009 'Measures for rail transport of goods', issued by Emilia Romagna, aimed to provide Railway Undertakings (RUs) and logistics operators with monetary contributions[11] if they offered additional rail services (new links and/or new services on existing links) compared to the previous year, which have both O/D within the region[clxix].

Further, two national schemes to encourage a shift from road to rail and sea were announced by the European Commission in 2016. The first measure, the Rail Freight Transport Scheme[clxx], grants subsidies to rail transport operators in a bid to encourage a shift from road to rail. With a budget of €255 million, the level of support beneficiaries can receive under the scheme is based on a reduction of the infrastructure charges and external costs borne by rail transport operators when compared to road transport. The second scheme set up by the Ministry for Infrastructure and Transport under the Stability Law provides incentives for freight travel by sea. The Marebonus[clxxi] targets shipping companies with three-year projects to implement new Ro-Ro and Ro-Pax maritime services and improve existing shipping routes, with the aim of reducing congestion on the road network. The scheme has a budget of €138 million with the first incentive period between December 13, 2017 and December 12, 2018.

Considering the analysis above, we assume that 10% or heavy duty truck freight (i.e. trucks greater than 16t) could be shifted, resulting in a rail share of approximately 22% by 2030, almost doubling 2015 rail freight activity to 39 Gtkm. This is line with a decarbonisation study by Transport & Environment[clxxii] adapting data from the German Federal Environment Agency (UBA)[clxxiii]. This is within a context of increasing freight demand, meaning that the total freight volumes transported by rail would considerably increase from.

Whatever potential growth that is possible for rail is unlikely to materialise without improvements in rail capability and greater customer service by rail freight operators. This shift in business model (i.e. a more customer-oriented and international vision) will come from a better environment for competition whereby more train operators can compete fairly with the state-owned operators. This also is somewhat reliant on road charging, as the cost of road has to increase significantly so that the external costs of road transport (such as air pollution, GHG emissions and infrastructure costs) are internalised.

4.2. What national measures can deliver in Italy

The previous sections described and quantified where possible the potential impacts of policy on transport demand, modal shift to cleaner transport, and policies to increase the efficiency of the transport system. In Table 2, the inputs to the EUTRM[12] are detailed along with a brief justification and the policy levers required. These policies can have complex interactions and do not necessarily result in accumulative benefits. Therefore, these inputs are based on careful consideration of each measure so as not to overstate the potential of any given measure or combination of measures. On the other hand, these measures could be seen as targets that Italy would need to achieve in order to meet its climate targets while designing policy. For example, to ensure car passengers are shifted to walking and cycling by the amount stated below, impact assessments should investigate how to achieve this, and what type of policy and investment is required to get there. All percentage changes shown in Table 2 are compared to the respective year in the *baseline scenario*. Note that rebound effects of more efficient vehicles and lower fuel costs for electric

[11] The maximum amount is 1 €cent per tonne-km. In case service lasts more than a year, the amount varies on a decreasing scale, as follows: (a) for the 1st year is 1 €cent per tonne-km; (b) for the 2nd year is 0.9 €cents per tonne km; (c) for the 3rd year is 0.8 €cent cents per tonne-km

[12] See Section 1.5

vehicles (where reduced costs induce more demand), are not considered in this study, as the combination of other measures are assumed to be designed to negate this effect.

Table 2: Summary of inputs of Italian National level policies

Policy Lever	Measure	Change by 2030 (*2025)	Main policy interactions and justification
1	SHARE OF CAR PASSENGER ACTIVITY SHIFTED TO BUS	2.00%	Petrol and diesel fuel tax harmonisation, new electric buses being able to offer cheaper services, low emission zones in cities, a ban on the future sales of diesel/petrol cars, coach market expansion. 2% of car passengers represent just under 15% of current bus passengers.
2	BUS LOAD FACTOR INCREASE (PASSENGERS/VEHICLE)	10.00%	As more passengers are lured onto buses (policy lever 1), buses will tend to be filled, increasing efficiency. This will be supported by service improvements (that will follow from increased ridership), pricing, and multimodal ticketing.
3	SHARE OF CAR PASSENGER ACTIVITY SHIFTED TO RAIL	2.00%	If half of this shift is in urban centres, this represents: a doubling of current tram, metro and train ridership; a 15% increase on long distance journeys. This will be facilitated from fuel tax normalisation, TEN-T network implementation, intermodality, train pricing and improved punctuality, competition offering new and more attractive services.
4	MODE SHIFT FROM CAR PASSENGER TO WALK/BIKE	2.50%	As part of a city infrastructure investment (foot and bike paths), congestion charges that reduce traffic in order to reclaim space, more people willing to take public transport.
5	CAR LOAD FACTOR INCREASE (PASSENGERS/VEHICLE)	5.00%	Priority access to carpooling cars. High congestion charge for single occupancy vehicles, higher vehicle registration tax, low emission zones, higher fuel prices and taxes, car ownership not a status symbol anymore (social justification), car sharing.
6	CAR PASSENGER ACTIVITY - REDUCTION FROM BASE CASE	1.00%	Petrol and diesel tax harmonisation, low emission zones, congestion zones, toll roads and distance based charging. Some of the reduction in demand has been through modal shift (policy levers 1,3,4)
7	FREIGHT TRUCK LOGISTICS IMPROVEMENTS	5.00%*	Fuel taxes harmonisation and ending the rebate to truckers, road charging, digitalisation.
8	SHARE OF HHDV ACTIVITY SHIFTED TO RAIL*	10.00%	Combination of diverse measures required to enable rail freight to be more competitive. Trucks should be charged for their pollution and infrastructure damage through fuel taxes and road charging. Improved connections with France and Germany with the TEN-T.
9	FREIGHT TRUCK PAYLOAD INCREASE (METRIC TONNES/VEHICLE)	6.25%*	Eurovignette and distance based charging, digitalisation.

10	REDUCTION IN IN-USE FUEL CONSUMPTION OF ON-ROAD VEHICLES	5.00%	Congestion relief through time based charging, reduced and heavily enforced speed limits, C-ITS, eco-driving.

Figure 12 shows the result of applying only these national measures, without the EU measures on CO_2 standards and electrification. As standalone measures, they amount to about 12.0 Mt CO_2e reduction compared to the baseline. This illustrates that Italy, and the rest of Europe, do benefit a great deal from EU measures such as CO_2 standards and electrification.

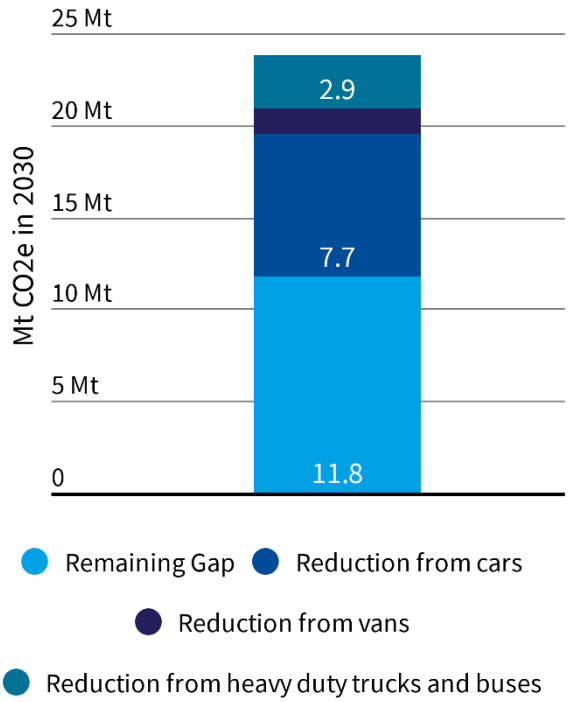

Figure 12: What national measures can deliver on their own in Italy, without EU standards and EV sales targets.

Figure 13 shows the combination of ambitious standards, ZEV sales target, and national measures. The measures together can completely close the gap, and surpass it. Although the measures described to reach this goal are ambitious, no measure goes beyond what independent research says is technically and economically feasible. Between 2020 and 2030, an average reduction in emissions of 2.1 Mt CO_2e per year (or 2.1% per annum) compared to the 2020 is required. This will be equivalent to the emissions reduction recorded between 2007 and 2016, although that reduction could also be attributed to the contraction of the economy from the financial crisis.

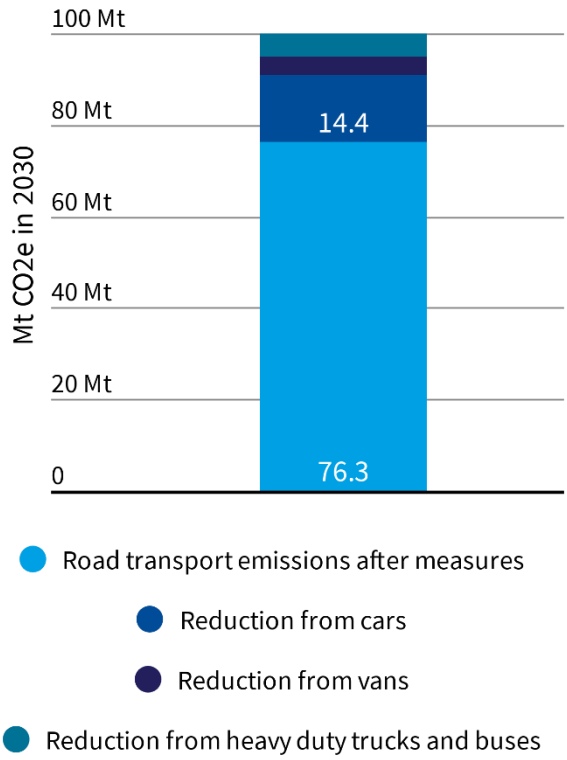

Figure 13: Combination of European and Italian measures to achieve 2030 targets.

5. Long term impacts of climate change mitigation policies in transport

Figure 14 shows the projections of the different scenarios discussed in this paper, until 2030. In all scenarios, the policies and consumer behaviour are again frozen in time, as was the case when defining the baseline for the modelling projections. This perspective shows the benefit in exceeding the 2030 target with the view of zero emissions in 2050; overachieving the 2030 target will put Italy on the right trajectory for transport decarbonisation by mid-century.. What is sure is that beyond 2030, *even more effort* will be required to reach full decarbonisation by the mid-century, necessary to abide by the Paris Agreement. Full electrification of the vehicle fleet will be necessary, and the electricity grid in the meantime will need to phase out fossil fuel generation.

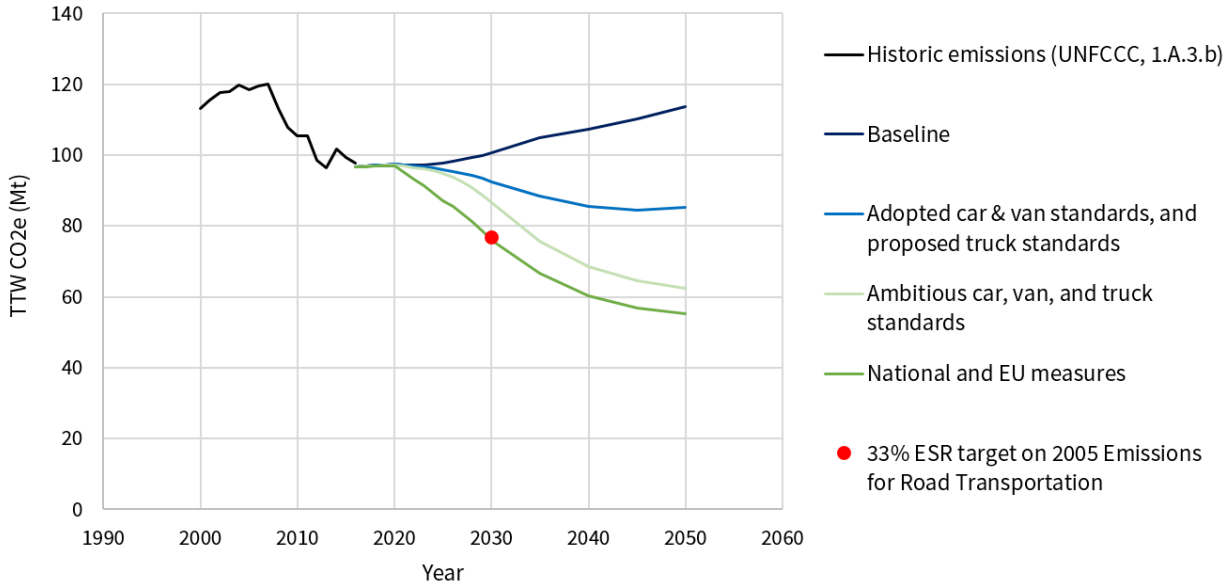

Figure 14: Long term trajectories of tank-to-wheel CO_2e emissions in Italy, compared to the 33% reduction target on 2005 levels.

5.1. Co-benefits

Reducing GHG emissions from transport is first and foremost a positive for the environment. As discussed in the opening paragraphs of these reports, Italy is a significant emitter in the EU and the world, and is already experiencing climate change that is amplified compared to what is being observed in the rest of Europe. Environment aside, there are other compelling arguments to reduce fossil fuel use. Most of the EU's oil is imported, thus the energy security of the continent is dependent on unstable regions in the world and, on top of this, and money is flowing out of the EU economy to these regions[clxxiv].

Dependence on foreign oil will be reduced. The electric revolution can bring a lot of jobs in the EU - more jobs if we take the lead. This is particularly important in Italy as the sixth largest vehicles producer in the EU[clxxv], which could see its economy thrive with the right investments. Finally, electric cars do not emit pollutants, a huge benefit for air quality, health, reduction in noise pollution and liveable cities. Air pollution in particular has been prevalent recently, following from the so-called Dieselgate scandal, where vehicles have been found to emit significantly higher emissions of nitrous oxides than the legal limits[clxxvi].

6. Policy recommendations

This report has shown the potential of a wide range of European and Italian specific measures that can be met on technical and economically viable metrics based on independent research. The main barrier to their uptake would be a political one. With strong political ambition, Italy can invest in future technologies that are beneficial for the society and the environment. In this section, we outline the key and concrete actions that Italy can take to make it happen.

6.1. Vehicle standards

Cars and Vans

- Closely monitor the implementation of the recently agreed 2025 CO_2 vehicle standards to ensure the industry rolls out plug-in cars effectively and does not manipulate the regulation. This is the key policy that will reduce CO_2 emissions from cars and vans in the coming decade, as well as driving investments into zero emission vehicles and more fuel efficient petrol and diesel cars. The 2025 target is indispensable to help Italy achieve its Climate Action Regulation goals in 2030.
- To ensure CO_2 reductions are achieved on the road and the current gap between laboratory results and the real-world decreases, Italy should closely monitor the real-world emissions of new cars via fuel consumption meters as foreseen by the new car CO_2 regulation. .Following the 2023 review, the compliance with the CO_2 standards should be measured on the road using fuel consumption meters for enforcement.
- Support a more ambitious 2030 target in the review of the cars and vans CO_2 standards regulation that will occur in 2023.

Trucks

- Support a yearly sales benchmark target for zero emission trucks of 5% as of 2025. This benchmark should be introduced now and not be postponed for the review in 2022. Such a benchmark is an essential incentive to make a shift away from fossil fuels and clean up air in cities.
- Agree without a delay a binding and ambitious 2025 CO_2 standard for regulated trucks of at least 20% effective reductions in 2025. Similarly for light duty vehicles, this is together with the sales benchmark is the key policy that will reduce CO_2 emissions from trucks in the coming decade, as well as driving investments into zero emission vehicles.
- In the 2022 review, Italy should push for trailers to be included in the regulation, along with ambitious standards for all truck categories. The efficiency improvement targets should be set as close as possible to the technical and economically feasible potential, which is 43% reduction for the tractor and trailer. For tractor trucks this means the 2030 target should be set at at least 30% effective reductions.
- Monitor and report carbon emissions and fuel consumption of buses and trucks. Transparent fuel consumption information enable public authorities and truck hauliers to make more informed choices based on total-cost of ownership and actual fuel consumption

6.2. ZEV mandate and promotion

Italy should closely monitor how carmakers roll-out zero and low emission vehicles in its market following the adoption of the EU car CO_2 standards. In particular, Italy should incentivise carmakers to roll-out zero emission vehicles, while ensuring that low emission vehicles are regularly charged so that their use is in electric mode.

Italy should support the Commission in the creation of a joint undertaking for the research and development of battery technologies. Such a joint venture could be half funded by the EU budget and half funded by industry stakeholders. The EU could then use such a body to improve the European market for battery technologies while also researching how to reduce the environmental impact of the supply chain, as well as the best means to integrate electromobility into smart electricity grids. For Italy, locally produced batteries could help the large car manufacturing industry there.

Cars and Vans

- Italy just approved a bonus-malus tax system that is designed to encourage the purchase of zero emission cars in a revenue neutral way[clxxvii], which represents a good step forward. However, the neutral band of the scheme covers an emission range from 70 gCO_2/km to 160 gCO_2/km, where in particular the upper limit is high compared to the 2021 car CO2 target of 95 gCO_2/km, which is not a disincentive to the purchase of high emission vehicles. In addition, the purchase taxes applying to vehicles greater than 160 gCO_2/km are low (161-175 gCO_2/km incurs a tax of €1 100; 176-200 gCO_2/km incurs €1 600; 201-250 gCO_2/km incurs €2 000, and >251g gCO_2/km incurs €2 500) and may not be able to cover the full cost of the bonus, particularly as the average fleet becomes more fuel efficient. The scheme must be improved by reducing the upper limit, and increasing the tax amounts for high emitting vehicles. Additionally, the neutral band should move in line with the CO_2 reductions enforced by the post 2020 car CO_2 targets.
- Italy should without delay finalise its National Policy Framework on the infrastructure for alternatively fuelled vehicles such as plug-in cars. An ambitious target for the number of publicly accessible fast recharging infrastructure and simplified procedures to install residential charging would speed up the sales and uptake of plug-in cars while providing market certainty to electro-mobility players. This requires a joint approach to all levels of government to ensure infrastructure is rolled out rapidly and in the right locations, in a demand-driven way with innovative business models promoted.
- Italy should adopt the best practices of ZEV incentives[clxxviii]. Some measures include, reduced VAT and registration taxes on vehicle purchase, reduced parking fees, or dedicated parking,

Trucks and buses

- Italy should push for Europe to introduce a well-designed benchmark system with a bonus and a malus or a mandate for zero emission trucks of 5-10% by 2025 and 25-35% by 2030 and for buses of at least 50% by 2025 and 100% by 2030
- Italy should consider reducing rates for electricity for transport in the short term to help enable the uptake of battery electric trucks and buses.
- Within the Weights & Dimensions Directive (96/53/EC), an additional one tonne of legally permissible weight for trucks up to 26 tonnes that are powered by "alternative fuels", including electric powertrains. This allowance does not apply to tractor trailer trucks, however. Italy should push to change this law so that all trucks can benefit from additional tonnage to account for the alternative technology. As the batteries can range from 1t to 4t, Italy may consider pushing for a small increase in gross vehicle weight (GVW) to accommodate these technologies so there is no or reduced penalty on the payload. The Commission is also expected to progress the implementation of rounder, more aerodynamic truck cabs during 2018. This will be a benefit to both battery electric trucks and to the new best in class ICEs.
- Cities across Europe have significant potential to push investment to electric trucks and to shift their urban buses fleet to zero emission. This bottom-up pressure will further incentivise vehicle makers to invest in zero emission trucks and buses, as a coalition of cities can constitute the majority of the population on the continent.
- Require 100% of newly publicly procured buses and trucks to be zero emission from 2030. This should be reflected in the review of the Clean Vehicles Directive.

6.3. Fuel taxes and tax reform

- A reform to the Company Car Taxation should introduce higher tax deductions for companies that employ zero emissions cars, and differentiate taxes according to EURO class.
- Italy should align their transport fuel taxes so that they are equivalent in terms of energy content. As discussed in Section 4.1.1, gas is currently taxed at less than the ETD minimum levels and is 230 to 300 times less than liquid fuels. This would ensure that a shift away from liquid fuels to gas would not significantly reduce the State's excise duty revenues and would also more fairly represent the

climate impact. This could be achieved through raising the diesel excise to that of petrol, or otherwise in a fiscally neutral manner, i.e. setting the excise duty of both petrol and diesel to the consumption weighted average. Gas should then be set to this equivalent level, approximately €0.86 per m^3.

- The rebate offered to truckers of €0.214/l in Italy should be scrapped.

6.4. Road charging

- Reassess toll charging for those concessions that are ending soon to ensure tariffs are set at a fair rate. Ideally, the rates at which vehicles are charged should be consistent across the whole network.
- Ensure all tolls are inclusive of separate infrastructure and (air and noise) pollution costs. Toll rates should be differentiated so that more polluting vehicles pay more than cleaner vehicles on the road, for example by EURO class.
- Extend the toll charge for HDVs to expressways so that the damage they cause is accounted for wherever they drive. This will additionally prevent HDVs from using expressways to avoid the toll, and so relieve congestion on those roads.
- Tolls have additional benefits for road transport as they improve logistic efficiency and can be used to encourage the uptake of cleaner vehicles provided rates are differentiated according to the environmental performance of a vehicle
- Any reformulation of road charging must allocate a portion of the additional revenues to the State National Fund to ensure investments in alternative infrastructure projects, such as railways and bike paths, cover negative externalities and fund decarbonisation measures.

6.5. Shifting car passengers to buses, trains, riding, and walking – shared mobility.

- Invest in high quality, affordable public transport. Share relevant data with other transport providers and internet mobility platforms to enable Mobility as a Service (MaaS) and offer a real alternative to private car ownership.
- Improve the city infrastructure to encourage walking and cycling. This should lead to public space reallocation with less road space for cars, and more bike lanes.
- Introduce measures to encourage bike sharing, including appropriate locations for shared bikes, larger bike lanes, adequate street signs.
- Reduced the number of car parking slots and increase parking fees to incentivise the use of public transport.

6.6. Putting more passengers in cars

- Introduce city road pricing and/or congestion zones as a policy to reduce private car use.
- Facilitate the use of short and long distance car and ride sharing, as the occupancy of these vehicles is above average.
- Adapt fiscal incentives to deter private car use: end tax benefits for company cars, equalise taxation between petrol and diesel

6.7. Eco-driving, speed limits and communicating intelligent transport systems (C-ITS)

- As shown in this report, eco-driving has a potential to reduce CO_2 emissions from vehicles. To be effective, most or all drivers need to employ eco-driving, especially on the long term that would require regular training or better, mandatory use of eco-driving modes on cars that would moderate how the car is driven to maximise efficiency. The only way to realise the potential reductions is through a mandatory system.
- A simpler approach to encourage eco-driving is simply to rigorously enforce speed limits that achieves similar benefits. Reducing speed limits, particularly on highways, has also been shown to reduce CO_2 emissions.

- Use C-ITS for better traffic management.
- Implement unified, compatible timetables and tariffs for all public transport within Italy.
- Introduce on-road remote control of emissions.

6.8. Shifting freight from trucks to trains

Shifting freight to trains, and ideally electrified trains, requires a holistic and concerted approach for policy and investment. If Italy wants to shift more freight from road to rail then there are a number of measures that can help to achieve that.

- Apply a moderate toll to reduce the distance that rail becomes cost-competitive with road. Trains pay per kilometre of track access, and rail is more costly than road due to the increased requirements regarding labour and infrastructure, as well as the prices that rail companies set for their service.
- The Italian regulator must ensure that the railway infrastructure manager is treating all trains equally regarding track access. This means equal treatment for new entrants and foreign trains. An independent and unbiased infrastructure manager is essential to a well-functioning railway market.
- Explore the idea of obliging the state-owned company to rent unused electric locomotives to new entrants that do not have the access to capital to buy such rolling stock and, therefore, use cheaper and more polluting diesel locomotives
- Improve the flexibility and speed of freight services by investing in rail infrastructure that's not as complex or time-consuming as large cranes. For example, a company in Switzerland has developed a system[clxxix,clxxx] whereby special trucks can quickly load containers and trailers from trucks to trains and vice-versa. The infrastructure is not expensive but there's a lot of potential to improve the ease at which trains are loaded.
- Increase competition in the rail freight market. Although the rail market is already open to competition in Italy, this has had so far an insignificant impact on modal shift. A common issue across Europe is that new entrants compete for pre-existing rail freight volumes rather than trying to get the business of freight that's being moved by road. This is indicative of how rail is often reserved for captured markets and rarely tries to adapt services to compete with road freight.

6.9. Aviation and Maritime

Although these modes were not explicitly modelled and fall out of the framework of the CAR, aviation and maritime activity and their associated emissions are significant in the Italian transport sector. Italy can push for the following measures to ensure that these emissions are properly regulated and kept at bay.

Aviation:

- Retain and reform the EU ETS as a means of introducing more effective carbon pricing and put the sector on a long-term path to decarbonisation.
- Maintain the City Tax for departing flights and consider introducing banded rates (like in the UK and Germany) that reflect the increased climate damage from longer flights.
- End the sector's kerosene tax exemption, starting with domestic aviation, and using Article 14 of the Energy Taxation Directive to begin ending the exemption for international flights on a regional basis.

Shipping:

- Implement tighter air pollution standards for ships calling at Italian ports, both for SOx and NOx emissions;
- Electrify Ro-Ro ships (passenger and cargo) involved in short-sea shipping;
- Making on-shore power supply available, especially for RoRo and cruise ship terminals;
- Consider mandates[clxxxi] for zero emission shipping on specific domestic/short-sea shipping routes which can switch to batteries/hydrogen fuel cells in the immediate future;

- Ensure the transparency and cargo data collection in the EU MRV (when revised) in order to break market barriers to the uptake energy efficiency technologies in shipping;
- LNG as maritime fuel will make the decarbonisation of Italian shipping very painful because of insignificant GHG benefits at the expense of huge infrastructure and ship retrofitting costs[clxxxii].

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