Emission reduction strategies for the transport sector in Spain

A report produced under the framework of the EUKI Project

On behalf of:

Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety

European Climate Initiative EUKI

EUtrm EU TRANSPORTATION ROADMAP MODEL Powered by T&E

TRANSPORT & ENVIRONMENT

The European Climate Initiative (EUKI) is a project financing instrument by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMUB)

Transport & Environment
Published: July 2018
In house analysis by Transport & Environment
Coordination and transport modelling: Thomas Earl
Expert group: Carlos Calvo Ambel, Cristina Mestre, Lucien Mathieu, Heather Brooks, Samuel Kenny, Yoann Le Petit, Florent Grelier, & James Nix

To cite this study
Transport & Environment (2018) Emission Reduction Strategies for the Transport Sector in Spain.

Report available at:
www.transportenvironment.org/publications/euki-spain

Further Information
Thomas Earl
Data Analyst
Transport & Environment
thomas.earl@transportenvironment.org
Tel: +32 (0)2 851 02 09

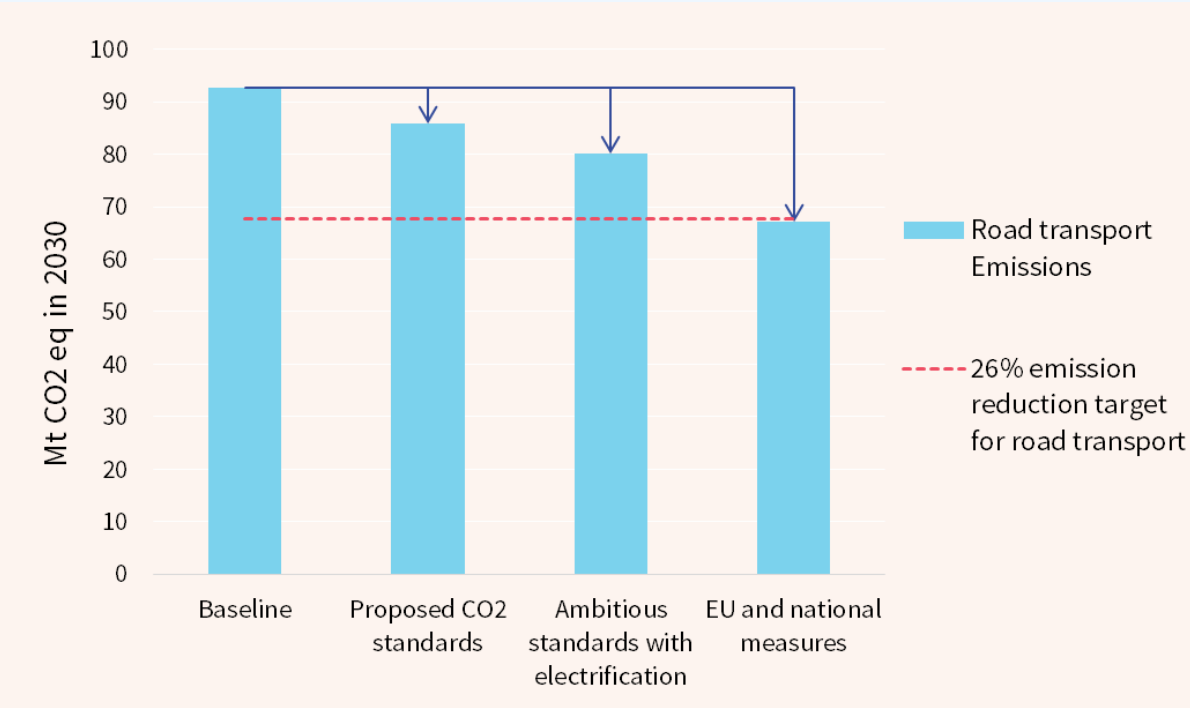
Square de Meeûs, 18, 2nd floor | B-1050 | Brussels | Belgium
www.transportenvironment.org | @transenv | fb: Transport & Environment

Acknowledgement
T&E acknowledges the generous funding of this project from the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety.

Executive Summary

Transport is the largest source of greenhouse gas emissions in Spain. Since 2012, transport emissions in Spain have been increasing; in the context of needing to be decarbonised by the mid-century under the Paris Agreement, this trend needs to be rapidly reversed. Spain is already experiencing amplified climate change and warming compared to Europe. If no action is taken, Spain risks not meeting their medium term European reduction targets. The objective of this report is to show how Spain 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 that enforces a 26% emissions reduction target in 2030 compared to 2005. Finally, policy recommendations are presented to enable Spain 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, Spain can meet and exceed its 2030 targets as long as ambitious vehicle standards, electrification, and national measures are implemented.



The scenarios in detail:

Baseline: If Spain takes no action and the proposed 2030 CO_2 standards for road vehicles are not implemented, Spain will fall short of its 2030 targets by 30.5 Mt of emissions. Under the CAR regulation, this may result in requiring the purchase of up to 210 million allowances. Assuming that the other sectors just meet their target, no flexibilities, and an allowance price of €100/tonne, this would be €21 billion, if loopholes in the regulation are not used.

Proposed Standards: If the European Commission's 2030 CO_2 standards for cars, vans, and trucks are implemented, Spain will fall short of its 2030 targets by 18.1 Mt of emissions; the proposed standards would close *the gap* between the target and the projected baseline emissions by only 27%.

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 a 50% 2030 CO_2 reduction targets for cars and 40% target for 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, this means sales of electric vehicles should reach 40% for cars, 40% for vans, and 30% for trucks, to help achieve the targets. Despite these significant gains, in this scenario Spain is set to miss its 2030 targets by 12.3 Mt of emissions; ambitious standards would close the gap by 51%.

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 more than half; only by combining national measures with ambitious standards and electrification will Spain be able to meet its 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 Spain to meet its targets.

EU Level:

Spain should adopt ambitious vehicle standards, and in particular insist on the 2025 targets. For cars, vans, and trucks this is a real 20% reduction by 2025.

A separate sales target for zero emission vehicles should be agreed for 2025 to drive the supply of electric vehicles in Europe. This can be done either via a dedicated ZEV mandate or by adding a malus to the currently proposed bonus system for cars.

National Level:

Fuel taxes and tax reform: Spain should align their diesel tax rate to that of petrol, harmonise the special tax on hydrocarbons (*impuesto de hidrocarburos*) across all regions, and end the diesel rebate offered to truckers.

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.

To shift car passengers to buses, trains, riding, and walking, Spain 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 putting 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 Spanish 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, a 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, Spain should implement tighter air pollution standards for ships calling at Spanish 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.

Table of Contents

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[iii][iv]. 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 Spain, 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].

Climate change is a global problem requiring global efforts to combat it, however there are specific threats and costs associated for Spain that have already been observed. For example, between 1995 and 2015, the death toll in Spain attributable to natural disasters was 1215 people[ix]. The average temperature of Spain has increased by 1°C over the last century compared to the EU average of 0.91°C; the region of Murcia saw a 2°C rise over the same period[x]. Rainfall intensity is decreasing, the Pyrenees have lost 90% of its glacial ice cover[xi], and wildfires (as well as the area burnt in Spain) have been increasing[xii]. The tendency to a hotter and drier Iberian Peninsula will exacerbate these events. As a peripheral country on the southern frontier of Europe, the number of climate change migrants that arrive in Spain 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 24th largest emitter in the world[xiii], and the 6th largest emitter in Europe[xiv], Spain 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 Spain 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)[xv], 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 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 Spanish 2030 emission reduction targets, but policy that will make the ultimate decarbonisation of transport an attainable reality by the mid-21st century.

1.3. Why does this report differ from other reports

As a large economy with a lot of potential to be a leading nation in terms of climate reduction, there have been other studies that have offered insight and analysis to decarbonise the economy and in particular, transport. Two notable independent examples are the Deloitte study[xvi] and Greenpeace study[xvii]. The Deloitte study looks at decarbonisation for Spain and outlines several policy driven trajectories to aim for decarbonisation by the mid-21st century in transport. One problem is that it sees a role for gas in heavy duty transport, a dead end[xviii]. The Greenpeace study mainly focused on the 6 largest cities in Spain and their surrounding regions and analysed all modes of urban transport. This thorough report based its projections on post-financial crisis recovery - in the baseline, emissions continue to decrease. The study was not able to quantify the recommendations to see their effect on reaching climate goals. Finally, Transport & Environment performed an analysis for Spain in its report 'Recipe for Spain' based on modelling work from Ricardo EEA[xix]. This report showed that with 2030 CO_2 standards for cars of about 42%, 2030 truck standards of 35%, and a broad range of national measures, Spain would fall short by about 12 Mt CO_2e. Since that report, T&E's modelling capacity has increased with the country specific details in the EURTM - this means that inputs can properly account for the specific Spanish case. This also allows for more tailored inputs such as electrification of light and heavy duty vehicles. Finally, the target and regulation is now written in to law, so there is less speculation about the actual targets required.

1.4. Transport & Environment and the EUKI project

The European Climate Initiative[xx] (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[xxi]. 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"[xxii], which has four overarching objectives, namely:

1. To provide accurate 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[xxiii] 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%[xxiv], for a number of reasons[xxv]. 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 kept is kept constant at 42%.

1.6. Baseline situation, modelling assumptions and projections

Projecting Spanish emissions in 2030 relies on the historically observed relationship between wealth and transport demand[xxvi]. 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 below. These assumptions are in line with the Commission's Reference Scenario[xxvii] although in 2050 the activity levels in the EUTRM are 5-10% higher. In 2015, the inputs are calibrated with the data from the Statistical Pocketbook: EU Transport in figures, 2017 (with 318 G p-km in passenger cars, and 178 G t-km of road freight, measured by territoriality[xxviii]).

Along with these assumptions, the oil price is kept constant. This assumption alone is the single 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, limiting demand and according to the report incentivises manufacturers of cars and trucks (OEMs, original equipment manufacturers) to produce more efficient vehicles, despite no historical evidence of this[xxix]. 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, if the EU and indeed the world do begin to take a trajectory of decarbonisation, the demand for oil will decrease, and from simple economic principles, price will not go up.

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

Metric	2015	2020	2030	2050
Population (millions)	46.4	45.7	44.5	45.6
GDP (2013 € billions)	1096	1209	1450	1857
Passenger car activity (G p-km)	314	347	415	539
Road Freight activity (G t-km)	166	185	231	312

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[xxx] and 6% for smaller trucks[xxxixxxii]. Other proposed legislation, such as the Commission's proposal on truck CO_2 standards and the 2030 standards for cars are still being debated in the European Parliament and Council. As they are still subject to change, these are not considered in the business-as-usual baseline. In terms of national law, despite the many options available, Spain has not implemented any law that will work to decarbonise transport. 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 Spain

This section will describe the last quarter of a century of emissions in Spain, the dominant and fast growing sectors, and the upcoming legislated targets and decarbonisation ambitions. From 1990, Spanish greenhouse gas (GHG) emissions from all sectors (including 'bunker', those emissions from international aviation and shipping) increased from around 300 Mt CO_2e to 477 Mt CO_2e, an increase of 59%, representing a year-on-year growth rate of 2.7% (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 359 Mt CO_2e, a 19% increase compared to 1990 representing a 3.1% year-on-year contraction. These figures belie a stagnation since 2013, and important aspect that will be discussed in further detail in this report. Crucially, from here on in, will Spanish emissions decline or will they increase again as the economy reinvigorates as per pre-financial crash? The largest emitting (and since 2013, the fastest growing) sector is transport with a 35% share in 2016, from which 24% is generated from domestic transport (i.e. road, rail, and domestic aviation and shipping). This represents a marked change from 1990 where the transport emission share (25%) was on par with industry (29%) and public electricity and heat (22%).

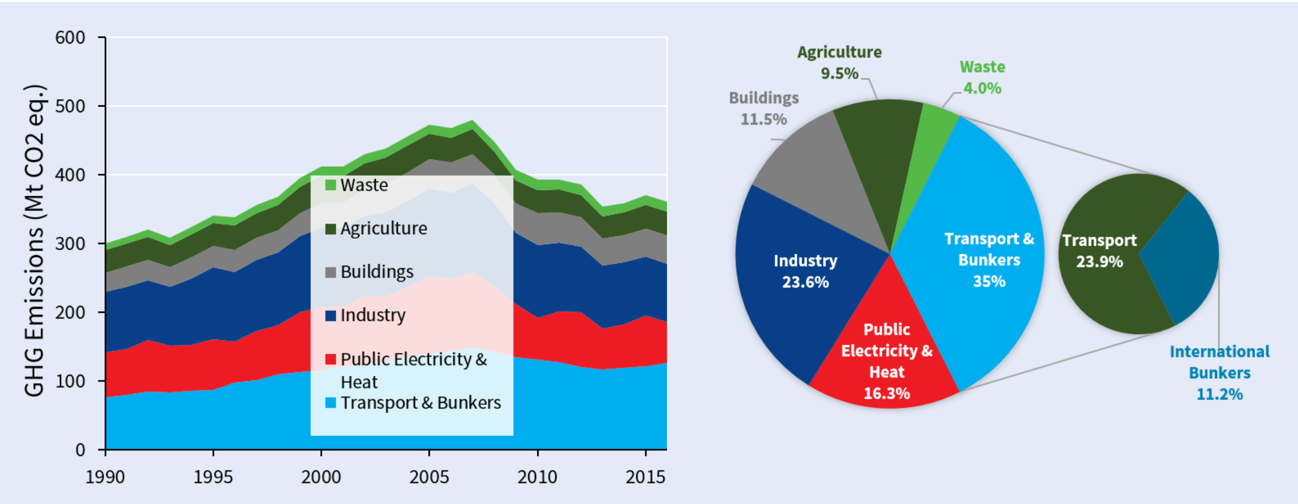


Figure 1: evolution and 2016 share of Spanish CO_2e emissions. Source: UNFCCC reporting[xxiii].

2.1. European climate law for GHG emissions

In this section the environmental laws applied by the European Union that Spain 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 the reduction target.

2.1.1. 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.

Spain has a rather unique aviation sector. Although other cleaner modes of transport can compete with domestic aviation on the Iberian Peninsula (such as rail, both high speed and conventional, and coaches), the Spanish regions in the Mediterranean Sea (Mallorca, Ibiza, Menorca), on the African continent (Ceuta and Melilla) and the Atlantic Ocean (the Canary Islands, denoted an outermost region under EU law) are more difficult. Notably, all flights to and from outermost regions (but not *within* the same region) are exempted from the ETS. In the case of Spain, flights from the mainland to the Canary Islands make up 55-60% of flight-km, which is a rough proxy for emissions[1]. Thus a majority of Spanish domestic aviation emissions are currently not covered by the ETS.

2.1.2. 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, which also happens to be the Spanish target. The targets were established based on GDP of the countries[xxxiv][xxxv]. 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[xxxvi]. As shown in Figure 2, Spain already achieved its 2020 targets and, in particular, is well on track to meet its ETS targets. The cumulative performance from 2013 to 2016 is 79.2 Mt CO_2. On the other hand, economic recovery has seen an increase in ESD emissions since 2012, which at the current trajectory will compromise the 2020 target. As Spain will have plenty of allowances banked, they will not foreseeably have to buy any allowances to make their target, however this will make meeting the reductions over 2021 to 2030 much harder, as seen in the following section.

2.1.3. 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[xxxvii]. 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. The regulation includes flexibilities such as using ETS allowances and access to credits from the land use sector[xxxviii]. Spain can reduce its target by 1.2% from this flexibility alone[xxxix]. 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[xl]. 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 will be either the reported average emissions in May 2019, or the average of 2016, 2017, and 2018 emissions in 2020, whichever results in a lower allocation. If the Spanish ESD emissions continue to increase, it will be the former of these options, and this could put Spain 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 Spain, as urgent measures will be required to avoid having to buy emission allowances from overachieving countries.

[1] T&E analysis of commercial airline transponder data for 2016.

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, Spain is likely to gain access to this flexibility mechanism, however the amount of extra credits for Spain is uncertain for the moment.

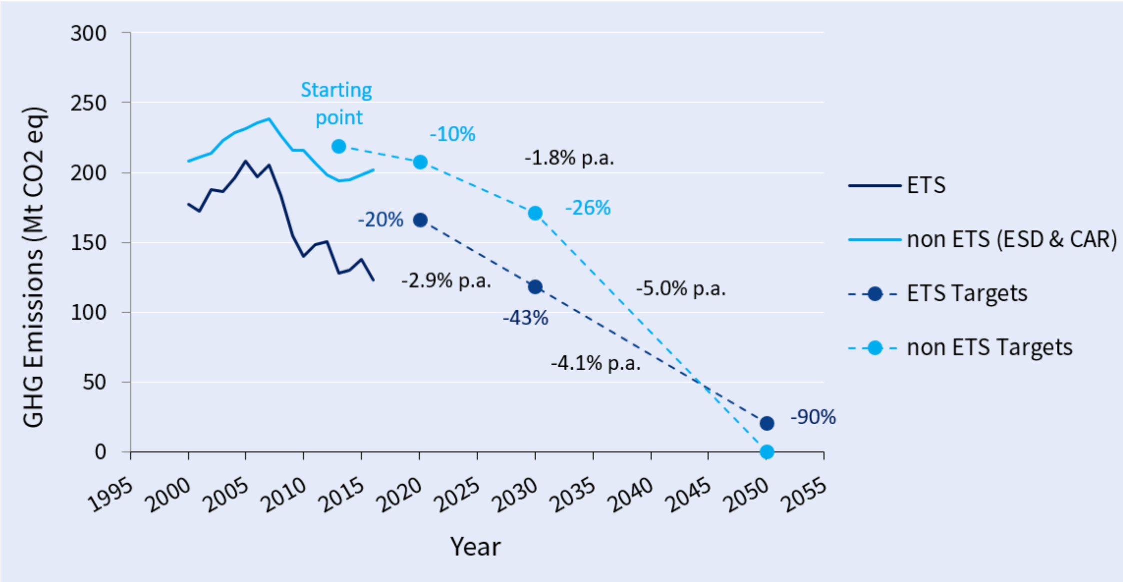


Figure 2: Evolution of Spanish ETS and ESD emissions. Source: UNFCCC reporting and EEA contributions of sector allocations.

2.1.4. Renewable Energy Directive (RED)

The Renewable Energy Directive (RED)[xli] established a policy for the production and promotion of energy from renewable sources in the EU[xlii]. 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[xliii], 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; to date, Spain has not indicated an intention to exceed this target. In 2016, Spain's overall renewable energy share in transport was 5.3%[xliv]; the contribution from food based biofuels was 1159 ktoe, or 4.1% of energy, so a little over half of the 7% cap. Advanced biofuels made up 0.5 ktoe, or 0.05% of liquid biofuels. Renewable electricity in rail was 84.5 ktoe while in road it was 8.9 ktoe. Applying the corresponding multipliers makes the total renewable energy share (RES). If that trends from 2013 to 2016 were to continue, food-based biofuels would reach a share of about 5.3%, thus a 2030 limit of 6.3% will apply to the Spanish fuel mix. In this report the biofuel share is assumed to stay constant from 2016 levels for two main reasons: Spanish biofuel is largely made up of palm oil[xlv], which will have to be phased out requiring a significant change of feedstock; there is no indication from the Spanish government as to whether there is a policy to actively increase this share. This report will not be exploring the best ways for Spain to reach its 2030 REDII target. However, for each scenario investigated to decarbonise Spanish transport, the compliance with the REDII will be analysed.

2.2. Global law for aviation and shipping

2.2.1. Maritime and IMO

Spain may have no inland waterway shipping activity, but it does have significant tonnage in domestic and international shipping. Spain has the fourth largest intake of inbound freight in the EU at 255 Mt and is the highest in terms of outbound tonnage at 192 Mt. The ports of Algeciras and Valencia both more than doubled their freight movements since 2000. In terms of emissions, 2016 domestic and international emissions totalled 26.4 Mt CO_2e, outstripping emissions from heavy duty trucks and buses (24.1 Mt CO_2e) and from international and domestic aviation (18.5 Mt CO_2e). These official reported figures are based on fuel consumption reported by ports, and as such they are likely to be an underestimate. Spanish domestic ships often bunker (or fill up their tanks) at the tax haven Gibraltar[xlvi][xlvii]. Unlike domestic shipping, which is covered by the EU submission[xlviii] 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. Spanish domestic emission have already fallen to 2 Mt CO_2e compared to 2005 emissions of 4.9 Mt CO_2e, however 2 Mt represents a doubling in emissions since 2014. International shipping on the other hand has not changed significantly from 2005. In the context of relatively stable maritime emissions, meeting the 2030 and 2050 reductions will require transformational policy and investment.

2.2.2. 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[xlix] has found that only 2% of offset projects actually delivered emission reductions"

In 2016, the number of passengers in Spain whose journey would have been covered by CORSIA was approximately 10.2 million, compared to 150 million domestic and intra-EU passengers. Although these passengers represent only a fraction of the passenger numbers (6.4%), in terms of emissions they are responsible for one third all aviation emissions[2]. Spain is a popular tourist destination, and there has been some backlash recently from cities about the impact on tourism for locals. Many of these passengers come from the UK (36 Million passengers in 2015) and Germany 25.2 million passengers in 2015). While these passengers pay the air passenger duty (APD) of £13 from the UK and the *Luftverkehrabgabe* of €7.46 from Germany, raising substantial revenues for those countries, flights from Spain have no such tax and thus Spain

[2] T&E analysis based on ETS and UNFCCC reported emissions, Eurostat and WTO passenger numbers, Plane Finder transponder data

loses considerable revenues. A ticket tax will have the benefit of raising revenues which can be used to mitigate some of tourism's negative impacts and may put downward pressure on demand that has increasingly become a contentious issue in Spain. At the same rate as the German ticket tax, Spain could have earnt €886 million on intra-EU flights, and €232 million on domestic flights (assuming no change in passenger demand).

2.3. History of climate mitigation in Spain

2.3.1. National law and transport measures

Measures have been implemented in Spain to reduce emissions in the non-ETS sectors. Looking at the transport measures, Spain has invested in or implemented several measures, namely:

- Emission reduction projects "Proyectos clima"[l]. This is a mechanism set out by the Spanish government for which entities can apply for public funding to carry out projects that will deliver emission reductions in the non-ETS sectors. To be awarded, the projects must be additional - i.e. reduce emissions beyond what measures that are currently in place would deliver - and their benefits must be measurable and verifiable. This program has been running since 2012 and has boosted projects such as the switch to electric vehicles fleet for municipal use; support for decarbonising transport sector for instance by replacing ICE buses for hybrid/electric buses; establishment of car-sharing schemes; etc., although most projects under the scheme didn't focus on transport.
- Promotion of modal shift both for freight and passengers transport (i.e. Framework legislation for development of infrastructure; tax breaks for citizens using public transport over private cars, etc.)
- Measures to transition from fossil fuels to other less carbon intensive energy sources. This includes renewable electricity, hydrogen and biofuels/biomethane. It is worth mentioning that Spain uses a big amount of palm oil based biodiesel, which according to the latest information available, its LCA emissions are worse than fossil diesel due to indirect emissions. [li]
- Improvement of efficiency in vehicles fleet. Spain has put in place incentives (e.g. tax breaks) for renewing the fleet - for passenger cars and also for LDVs and HDVs[lii]. This includes funding for eco-driving training.
- In 2012, VAT in Spain increased from 18% to 21%. This as an effect on the fuel prices paid at the pump, and long term trends indicate that the elasticity of fuel price on passenger transport demand is 10% (i.e. for a 10% increase in price, there will be a 1% reduction in activity). Trucks do not pay VAT on fuel because as businesses, they are VAT exempt.

In early April 2018, an expert group commissioned by the government, political parties and other stakeholders, published a report to advise the government on new law to combat climate change. The report, entitled Commission of Experts on Energy Transition - Analysis and proposals for decarbonisation (*Comisión de Expertos de Transición Energética - Análisis y propuestas para la descarbonización*)[liii] provides policy recommendations for Spain to decarbonise its economy. The all-encompassing report does have some positive suggestions and outlook for transport: increased investment in R&D for electric vehicles (Spain is the second largest manufacturer of road vehicles in the EU with 2.97 million units in 2017 after Germany, with 6.2 million units[liv]); the importance of renewable energy and smart grids; the important role of electric trucks in the future, and; taxation on domestic flights and dirty ships. However, the authors note that their predictions about the number of electric cars in the fleet (2.4 million cars, or 10% of the fleet) falls well short of projections in other countries.

The former Ministries of Environment and Energy have been elaborating the draft of the ES Law on Climate Change and Energy Transition (the Climate Change Law: *Ley de Cambio Climático y Transición Energética*) since March 2017. They launched a participatory process involving various ministries. In parallel, the elaboration of the National Energy and Climate Plan (*Plan Nacional Integral de Energía y Clima* 2020/2030) by the Spanish Government is also underway[lv]. The draft needs to be submitted to European Commission by December 2018, and to date no draft has been presented yet. This report aims to help shape the discussion on these two files.

As of June 2018, a new Spanish government was formed following the vote of no confidence on the former Prime Minister Rajoy. At the time of writing, there have been no new major policy announcements except to abolish tolls.[lvi] The latest Spanish position related to climate was to become part of the group of 'first-runner' countries that have called for more ambition in the target for Renewable Energy for the EU in 2030.

2.3.2. Road charging

Congestion in Spain is a particular challenge as an estimated 90% of passenger transport and 93% of goods transport is road-based[lvii]. The average driver in Spain loses 27 hours a year because of congestion[lviii]. Tolling vehicles for the use of roads ensures that the person that causes the damage - to infrastructure and through pollution - pays for it. Tolls can bring a number of additional benefits through the generation of revenue for the State budget, improvement of transport efficiency to reduce congestion, and the increased uptake of cleaner vehicles thus reducing pollution. Spain has for several years been undergoing a transformation of its system of public procurement to address the challenges that public-private partnerships have caused in the development of the country's road infrastructure[lix].

In 2017, the State announced its Extraordinary Plan for Investment in Roads (PIC) to finance €5 billion of infrastructure work on more than 2 000 km of roads between 2018-2019[lx]. However, it has been suggested that user charges (tolls) will not be applied to these roads[lxi]. Additional plans to abolish toll charging on three roads when concessions end over the next few years, announced by the new Minister of Development José Luis Ábalos, suggest a shift in the Spanish road sector away from tolling. It is unclear as yet how the maintenance of these roads will be paid (estimated by the minister to be between €50 000 to €68 000 per kilometre per year) but public pressure has been mounting as information has surfaced regarding the extraordinary profits of some private operators and the burden left to the State in the case of the failed Madrid network[lxii]. Further, lorries that use secondary roads to avoid the toll charges have recently been blamed for a number of deaths on these smaller roads. It is argued that removing the toll charge will prompt these lorries to return to the motorways[lxiii].

This all comes at a time when the State is regaining control of certain tolled roads after years of private sector management. The State has an opportunity now to review toll charges and generate revenue for the public budget. Without such charges, however, it will lose a vital mechanism of transport control and the ability to encourage more efficient transport behaviour, of particular importance in Spain. At the end of 2016, traffic on tolled roads increased by 5.55% compared to 2015 (with HDV traffic increasing by 3.85%)[lxiv], suggesting that congestion continues to be a challenge. Smart tolling can help reduce this.

2.3.3. Environmental performance of transport

In this last piece of historical analysis, a closer look at how Spain has decarbonised its economy, if at all. Historically speaking, economic growth (that may be measured by gross domestic product) leads to an increase of transport activity. Figure 3 shows exactly this trend: a GDP that increased from 1995, both passenger transport (measured in passenger kilometres, p-km) and road freight activity (measured in tonne kilometres, t-km) increased. After the financial crisis, both activity and emissions dipped with the contraction of the economy. Interestingly, the dip in emissions appears to predict the crisis.

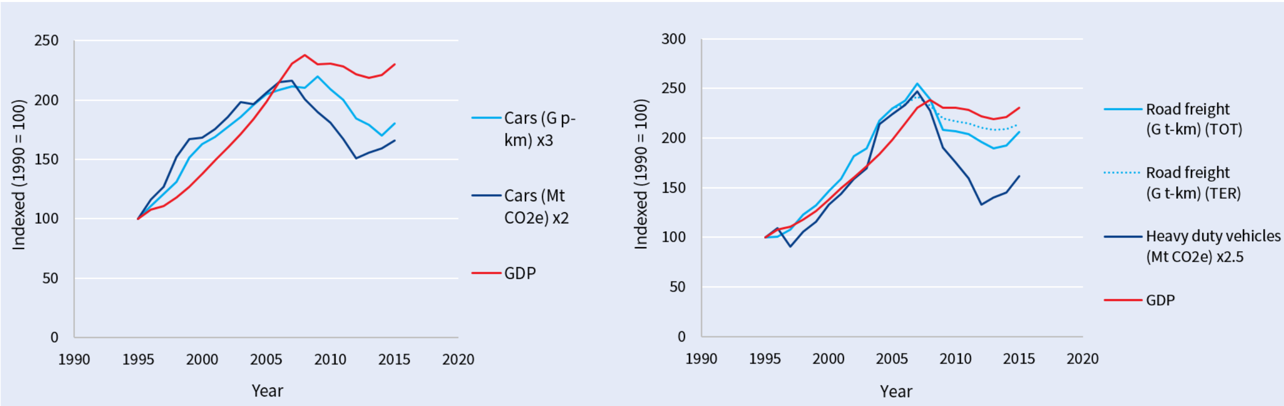


Figure 3: Evolution of Spanish GDP, transport activity and emissions. Note that the car passenger activity has been scaled with a factor of 3, car emissions with a factor of 2, and heavy duty vehicles emissions with a factor of 2.5 to aid visual comparison.

In order to see if a decoupling of emissions and activity has actually occurred in the last 20 years, the environmental transport performance is shown in Figure 4. While in the EU28 as a whole the passenger km of activity per emission has been steadily increasing (i.e., more passenger movements per unit of fuel burnt), the Spanish car fleet not only underperforms but has stagnated, achieving 6.5 pkm/kg CO_2e compared to 9 pkm/kg CO_2e in the EU in 2015. For road freight, however, Spanish environmental performance has improved more than the EU average, achieving close to 9 tkm/kg CO_2e in 2015 compared to 8 tkm/kg/CO_2e in the EU.

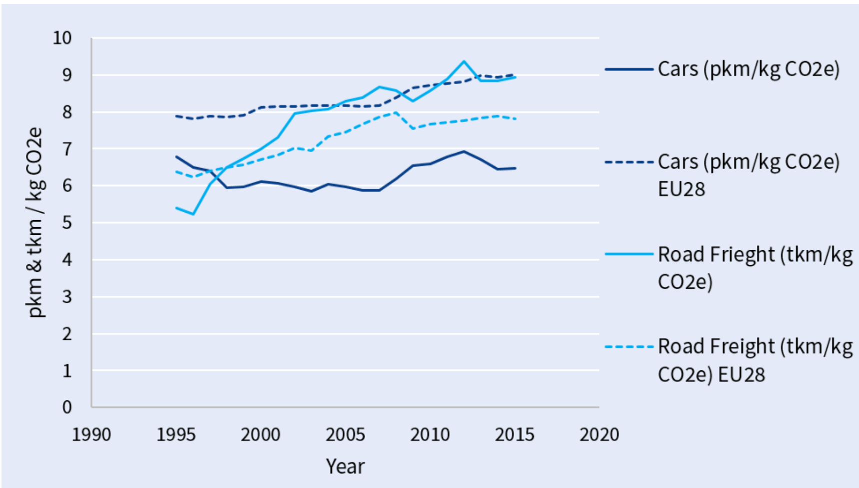


Figure 4: Comparison of the evolution of Spanish environmental transport performance against EU 28 average.

2.4. Where will Spanish transport be if no action is taken?

In terms of emissions, road transport in Spain[3] is on a trajectory to exceed its 26% ESR reduction by 24.9 Mt (Figure 5) in a business-as-usual scenario. Here lies another import assumption of this report: the equal distribution of reduction effort across sectors in the ESR. 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 ESR, 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 ESR target, and beyond where possible.

[3] Not including emissions from motorcycles

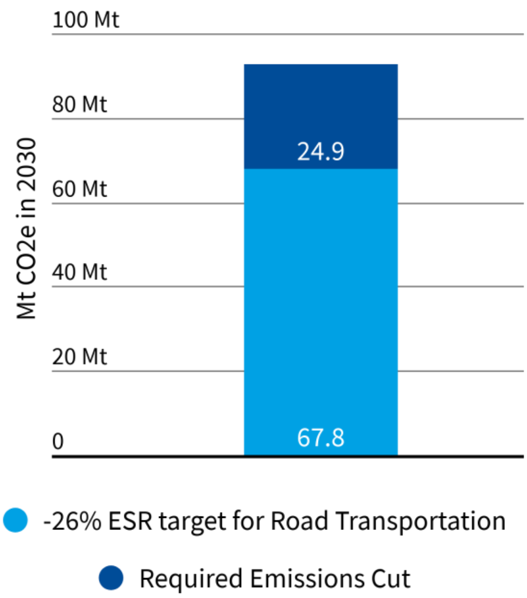


Figure 5: Baseline projection of road transport emissions in Spain will reach almost 93 Mt CO_2e, compared to the ESR reduction target of 67.8 Mt CO_2e. Spain must reduce its projected 2030 road transport emissions by 24.9 Mt CO_2e.

Given the above assumptions of the contribution that should be made by the transport sector, Spain will exceed its target by 37% when looking at transport only. If the cost of CO_2 allowances were to be €100/tonne, this would translate to €3 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 Spain would be liable to pay for would amount to 210 million (without the use of flexibilities or safety reserve). At the assumed price of €100/tonne, this equates to a sum or €21 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 Spain were not to take any action on GHG emission mitigation, consequences to the environment aside, this could result in a significant financial burden for Spain and would require a reduction in emissions of 4.5 Mt CO_2e per year in transport to decarbonise the sector by 2050.

3. How the EU can help

It was shown that road transport was the biggest sector of ESR 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[4]. 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 how much they can help Spain reduce their emissions. Secondly, more ambitious targets based on technical and economic analysis will be explored to see what EU CO_2 vehicle standards *should be*. Note: In this report, the emissions from motorbikes are not considered for measures to reduce emissions or in the calculation of targets and trajectories.

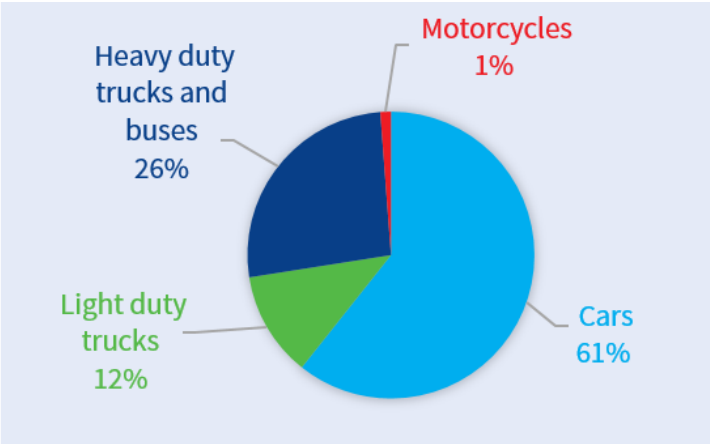


Figure 6: Road transport split by mode in Spain 2016[lxv].

3.1. Proposed EU measures for transport

In November 2017, the European Commission released a proposal for car and van CO_2 standards for 2025 and 2030. The proposed reductions for cars are 15% in 2025 and 30% in 2030 compared to 2021 Although there was no zero emission vehicle (ZEV) mandate in the proposal, a bonus system is included 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 (15% sales in 2025 and 30% in 2030). For example, if 16% of sales were zero and low emission vehicles (ZLEVs), the CO_2 standards could be reduced by 1%, making the target easier to reach[lxvi]. The bonus is capped at 5% reduction. There is however no malus or penalty if a manufacturer sells less ZLEVs than the benchmark. The proposed van standards are also 15% reduction in 2025 and 30% reduction by 2030 (with baseline year of 2020) with the ZLEV bonus system. 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).

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[lxvii]). Under the proposal which, like for cars and vans, is currently being debated, 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 draft, no ZEV mandate is proposed but rather a somewhat weak system of super credits, a point which will be discussed further on in the report.

[4] The UNFCCC category *1.A.3.b.ii. light duty trucks* are mostly vans, i.e. light duty vehicles used to carry up to 8 passengers or with a maximum permissible mass of 3.5 tonne, including load.

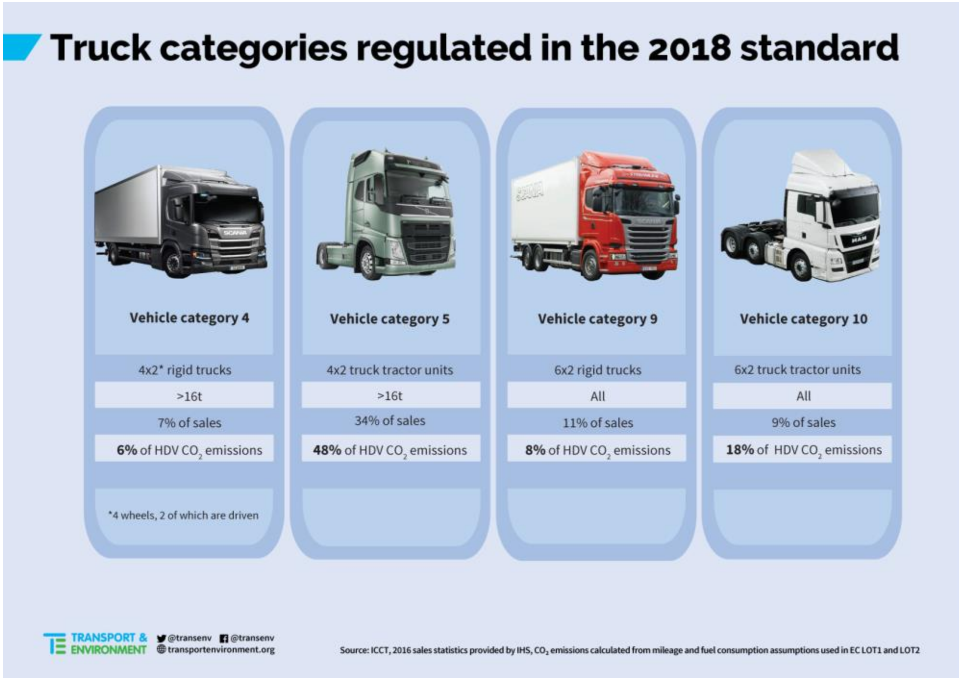


Figure 7**: Regulated trucks in the Commission's truck CO_2** standards proposal

If vehicle makers meet the Commission's proposals, but don't exceed them, it will deliver 27% of the required cuts for all of road transport, or 6.8 Mt of the required 24.9 Mt CO_2e (see Figure 8). The reduction in emissions does not equal the reduction in new vehicle efficiency owing to the time taken for fleet renewal. From the fleet of approximately 28.5 million, there were 1.2 million new vehicle registrations in 2017[lxviii], or a 4.2% renewal rate. The Spanish vehicle fleet is on average older than in the EU average, which means that older, more polluting vehicles tend to remain in the fleet longer than for other Western European countries. Therefore, in the situation that only the proposed CO_2 standards for road vehicles were to be implemented, Spain would have to come up with a range of national measures to be able to cut the remaining 24 Mt of emissions. Clearly, more has to be done and can be done, at the EU level before having to revert to national measures.

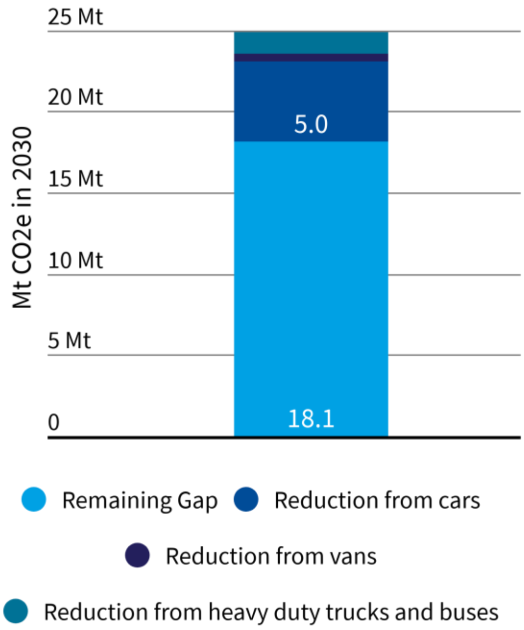


Figure 8: Reduction in Road transport emissions from Commission proposals on car, van, and truck fuel efficiency standards for 2030

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

3.2.1. Ambitious CO_2 standards and electrification

CO_2 emissions of new cars can feasibly be reduced by over 50% by 2030 as shown by International Council on Clean Transportation (ICCT)[lxix]. 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[lxx] 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. As regards ZEV vans, there is a clear lack of models and choice on EU market[lxxi], which the bespoke ZEV sales target for new vans in 2025 and 2030 is indispensable to address.

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)[lxxii]. 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[lxxiii] 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 technology improvements leading to efficiency gains employed in trucks could be utilised in coaches. Therefore, we assume that the efficiency gains proposed by the Commission for trucks could feasibly be applied to coaches (i.e. a 15% by 2025; at least 30% in 2030, compared to 2019).

To help meet these ambitious standards and encourage the uptake of electric vehicles, Europe should employ a zero emissions vehicle (ZEV) sales target (also known as a benchmark or mandate). 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[lxxiv] and buses[lxxv] 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[lxxvi]. 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[lxxvii]. 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. BEV car sales target should be at least 40% in 2030. If in the simple scenario there are only BEVs and ICEs sold, a

[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.

40% ZEVs target would mean that the ICEs would only need to improve by 17% compared to 2021, but in reality the target could also include any number of PHEVs and hydrogen fuel cell vehicles.

The sales targets for cars are in-line with those identified by the Deloitte study[lxxviii]. A clear ZEV sales target (or mandate) would create volume certainty and ensure OEMs invest and offer sufficient supply of appropriate ZEV models in the future. Additionally, the target of at least 20% sales in 2025 and over 40% in 2030 is in line with carmakers' own projections[lxxix] 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. Alongside a ZEV mandate for cars to stimulate supply, the best practices of other European countries as detailed by the ICCT[lxxx] to help ZEV uptake and adoption should be considered by each Member State. 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.

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 an independent market monitoring and analysis orders for electric buses 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 Spanish manufacturer Irizar has been providing electric buses to cities like Madrid[lxxxi] and Barcelona[lxxxii], all of which were produced in the Basque Country. Other major European electric bus manufacturers include Solaris (Poland) and VDL (Netherlands). In Spain, the electric bus fleet was around 60 battery electric and 40 plug-in hybrid buses, running in at least 6 cities[lxxxiii]. 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[lxxxiv]. 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[lxxxv] while the proposal for the Revision of the Clean Vehicle Directive suggests that Spanish cities will have to procure 50% "clean buses" by 2025 and 75% by 2030[lxxxvi]. 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[lxxxviilxxxviii]. Therefore, based on the above we assume 50% of new city buses purchased in Spain will be zero emission from 2025 and 100% from 2030[6].

Small electric vans are already economically viable as shown by example of the success of the Street Scooter and independent studies[lxxxix]. As small vans make up approximately 40% of total van sales, the main limitation is the number of models available. A BEV sales target for vans (no PHEVs, owing to their expense and the price sensitivity of business operators) should reach be set to at least of 40% by 2030.

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[xc] or within the next decade[xcixcii]. In Spain, 31% of vehicle km and 29% of tkm are journeys less than 300 km, and almost half of road freight movements are less 500 km[xciii]. 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[xciv]. 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[xcv]. 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

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

to electrify heavy duty road transport[xcvi]. 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[xcvii]. 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.

As is the case for cars, a ZEV mandate spurs investment in new technology and will lead to a diverse option of trucks with electric drivetrains. A significant portion of these journeys could 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[xcviii] 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. Most importantly, this sales target prepares for further decarbonisation to 2050. The results of ambitious CO_2 standards for cars, vans, and trucks, which can be met with the help of ZEV sales targets, are shown in Figure 9. As can be seen, these measures close the gap by 51% (leaving 12.3 Mt CO_2e still to cut), a significant improvement compared to the Commission's proposal.

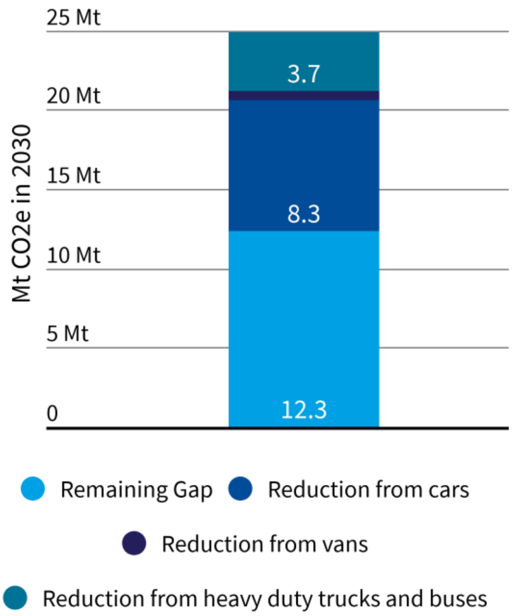


Figure 9: Combination of ambitious 2025 and 2030 standards, and ZEV mandates and promotion

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 the following section. To summarise, Spain should push through ambitious European vehicles standards, because they can halve the effort required by national measures.

[7] Directive 2011/76/EU

4. The national measures needed in Spain to achieve the 2030 GHG reduction targets

4.1. What has been proposed or considered in Spain

In this section, the various mechanisms available to Spain 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

Figure 10 shows that, in real terms, the excise duty applied to fuel in Spain has been decreasing since 1996[8] from a sales weighted average of about €0.50/l to €0.40/l in 2016. This compares to the EU average in 2016 at €0.55/l. As is the case in the EU, there is a significant difference between the taxation of petrol and diesel. In 2016, the Spanish state earned €12 billion from fuel duty; had the diesel duty been the same as the petrol duty, revenues would have been €14.5 billion, or 20% more, all else being equal. Similarly, if Spanish taxes were not only equalised but also €0.15/l higher to be in line with the current EU average, revenues would be €19 billion, a 60% more than they were.

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 would be around 14% for petrol and 30% for diesel. Part of this increase could fall under a harmonisation of the special tax on hydrocarbons (*impuesto de hidrocarburos*) across all regions to the maximum allowed to €0.048/l. Further, there is a sales weighted average reduction offered to truckers of €0.0271/litre in Spain[xcix]. These increases are largely in-line with recommendations from the expert group[c] report contributing to the future Spanish Climate Change and Energy Transition Law. Their proposal for decarbonisation they proposed a diesel price increase of 28% and petrol by 2%.

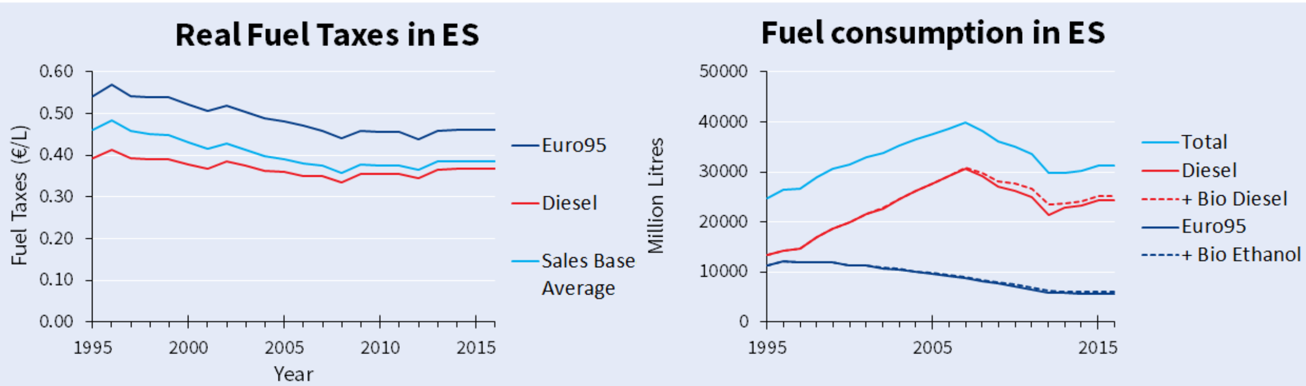


Figure 10: Evolution of fuel taxes and fuel consumption in Spain.

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 -0.3 for car use[ci], the decrease in ICE vehicle

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

[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 -0.1 results in a change in demand of 30% x -0.3 = -9%, that is a 9% reduction.

activity based on the implementation of all above measures would decrease by around 9% - 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. 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 into the 2025 standards currently under discussion as described under EU measures will help Spain has 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. Spain has shown little ambition on electro-mobility in their national plan for the deployment of alternative fuels infrastructure (under the Directive 2014/94/EU) to date[cii]. The absence of targets for publicly accessible recharging points for 2020 is a risk to the large scale market deployment of electric vehicles. Long term targets and financial support is needed to provide certainty for market actors. Currently about 17 000 electric vehicles are on the road in Spain[ciii] while the 2020 target ranges between 38 000 and 150 000. Spain has about 5 000 public charging points, and investment and deployment should not taper off in order to facilitate EV deployment. Spain clearly needs more ambition if the country doesn't want to lag behind the other Western European countries and wishes to reach their 2.6 million EV target by 2030. To stimulate adoption of alternative fuels, Spanish government has successfully deployed the MOVEA plan (officially called the 2017 Movalt Plan) which grants €5 500 for the purchase of an electric vehicle. In total, €20 million will be allocated for the purchase of alternative fuelled vehicles and €15 million for recharging and refuelling infrastructure as of end 2017[civ]. The CIRVE Project[cv] (Iberian Infrastructure Corridors for fast Re-charging of Electric Vehicles) started in 2017 with the cooperation of eight companies. This project is supported by the Ministry of Public Works and Transport and Ministry of Economy and is financed by the Connecting Europe Facility. Its objective is the implementation of 25 new fast recharge points in Spain and the adaptation of another 15 existing recharge points. The CIRVE project will be developed until the end of 2020 and its 40 recharging points will be part of the Trans-European Transport Network (TEN-T). 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 Spanish National Policy Framework (presented by the previous administration) focuses on liquefied petroleum gas (LPG) and natural gas as desirable alternative fuels, for which substantial infrastructure is already in place and strong vehicle and infrastructure growth is anticipated. 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 discussed previously, Spain plans to remove tolls which concessions are about to end at a time when the State is finally regaining control of some of its roads. The State has an opportunity now to take control of the toll charges and generate revenue for the public budget. Removing toll charging from these roads altogether means that the damage caused by vehicles will no longer be accounted for. Crucially, the State will lose a vital mechanism of transport control and ability to encourage more efficient transport behaviour with smart tolling. Rather than abolishing tolls altogether, the State should reassess how tolls could be charged, and consider extending the toll for HDVs to local roads. Transport and logistics companies pass on 85%[cvi] of tolling costs to clients, which means that the economic burden of tolling on truck companies is very low. For those clients who pick up the bill, transport is between 2-5%[cvii] of production costs. So tolling does not place an unbearable burden on trucking companies or businesses. In fact, tolling HDVs on all roads would reduce congestion on secondary roads as HDVs return to motorways (because they reduce journey times) and ensure that the damage they cause in terms of infrastructure and pollution is captured no matter where they travel.

Road charging is highly 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. Spain is one of fifteen EU countries that currently have distance-based road charging[cviii] in 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[cix].

Tolling can play complimentary 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.

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. The Spanish intercity railway system has undergone a seismic shift since 1995 with huge investment in high speed rail, resulting in the longest high speed rail network in Europe, second only to China in the world. 63% of the entire Spanish railway network is electrified[cx], which is higher than the EU average. Of all rail activity in Spain (both freight and passenger), 83.6% of total train-km are electric (or 81.1% in terms of gross tkm)[cxi]. 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 Wi-Fi and clean toilets. Long distance coach journeys have also seen a rapid expansion in Europe with competition and market liberalisation[cxii]. Companies like Flixbus have expanded rapidly offering regular services that are reliable, easy to book, and cheap[cxiii]. 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

[10] For pre-Euro 6 vehicles.

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 MARES program[cxiv] in Madrid is working on such issues, including the availability of city bikes. Several city based bike sharing programs are in use in different cities around Spain, such as BiciMad in Madrid, Sevici in Seville, and Bicing in Barcelona.

Alongside cycling and walking, the public transport itself must also be reliable and affordable. In Spain, there have been several good examples where this has occurred. For example, in 2015, the Region of Madrid introduced a €20/month card for 7-25 year olds so they can use public transport, where the typical normal monthly card is €54.60. In 2017, Castilla la Mancha introduced a similar scheme with a 50% discount for trips inside the region for young people (14-29 years old). Although ticket prices are generally cheap compared to other western European countries, Spanish cities do not rank well when considering the ratio with expendable income to ticket prices[cxv][cxvi].

In 2015, the Spain-wide modal split of passenger transport in terms of passenger km (not by trips made) was 79.9% by car, 11.7% by bus and coach, 6.6% by rail, and 1.8% by tram and metro. Considering car transport was 317.6 billion pkm, shifting 5% of this activity to rail would imply a 60% increase in capacity. From 2000 to 2015, rail activity grew by 30%; the implication here is that a 5% shift is feasible but very optimistic; keeping with historic trends would see a shift closer to 2%. Spain will need to see continued and increased investment and policy choices to make it happen. For buses and coaches, from 2000 to 2015, activity decreased slightly by 3.9 billion pkm, or -8%. A 5% shift of car passengers to bus will implies a 34% increase in bus activity on 2015 levels, or 24% on 2000 levels. This shift will be helped by cleaner, more reliable electric buses and in conjunction with congestion zones in cities.

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, Zity). Evidence[cxvii] 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[cxviii][cxix]. 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.[cxx] 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[cxxi]. Survey by the Pew research centre[cxxii] and work by the Union Internationale des Transports Publics (UITP)[cxxiii] 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.[cxxiv]

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[cxxv] 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[cxxvi]. However, the JRC[cxxvii] and others[cxxviii] 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 kilometer by up to 12% (in line with findings from Ricardo[cxxix]), but in a more realistic scenario, it would more likely be 3%[cxxx]. Imposing lower speed limits comes under the jurisdiction of the Autonomous Communities, and there has been precedent in the EU (in France[cxxxi] and Belgium[cxxxii]) and in Spain. In 2017, the city of Madrid established a protocol to limit the speed of vehicles on the M-40, M-45 and ring road when high levels of pollution occur (NO2)[cxxxiii][cxxxiv]. Reducing speed limits in cities improve pedestrian and cyclist safety with less severe injuries and smaller probability of fatalities[cxxxv]. However, the CO_2 savings will generally not be as significant.

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

From Ricardo 2016[cxxxvi] and the European Commission[cxxxvii] state that widespread and rapid deployment of C-ITS can deliver reduce the fleet emissions from 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[cxxxviii]. 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. As a comparison, in Spain in 2016, 59.4% of all rail freight traffic was electric (56.9% of gross tkm).[cxxxix]. In 2015, railways transported 18% of freight in Europe in terms of tkm. Spain is well below the EU average, at 5.6% and 11.1 billion tkm. This is despite the concerted efforts of the Strategic Plan to promote the Railway Transport of Goods in Spain (2010) that had an objective for the modal share of rail in transport of goods between 8-10% by 2020.

Although in the EU as a whole, 50% of rail freight is international, in Spain, international undertakings represent only 19% of tkm. Clearly, the priorities of the TEN-T network to enable smoother international freight, particularly to and via France to other large EU Member States is vital for rail freights viability. In addition, Spanish railways have the potential to increase their capacity by three-fold, based on the availability of slots. However, attaining this potential is not at all simple, as described in greater detail by the Rail Freight platform coordinated by T&E[cxl].

International rail freight has a significant physical barrier in Spain: rail gauge widths, that is, the distance between the two rails. Spain has three separate railway gauges: international standard gauge (1435 mm) which is 2540 km of the network; Iberian gauge (*ancho ibérico,* 1668 mm) which is 11 461 km of the network and the and the metre gauge (1000 mm) making up 1207 km of the network[cxli]. Without dedicated standard gauge tracks, international rail freight will have to undergo a locomotive and wagon switch, causing significant delay.

Rail is highly dependent on the type of goods being transported in the country. As shown in Figure 11, Spanish rail transports bulk commodities such as coal and iron. In the context of a decarbonising energy, the amount of coal transported will continue its decline to zero. On the one hand, this may open up more slots for other rail freight. On the flip side, a lot of this transport is on dedicated lines that go directly to the power stations, and thus will likely be unused. Secondly, 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). For rail freight to and from Madrid, this distance essentially covers most of the country. Furthermore, road transport is comparatively trouble-free when crossing borders.

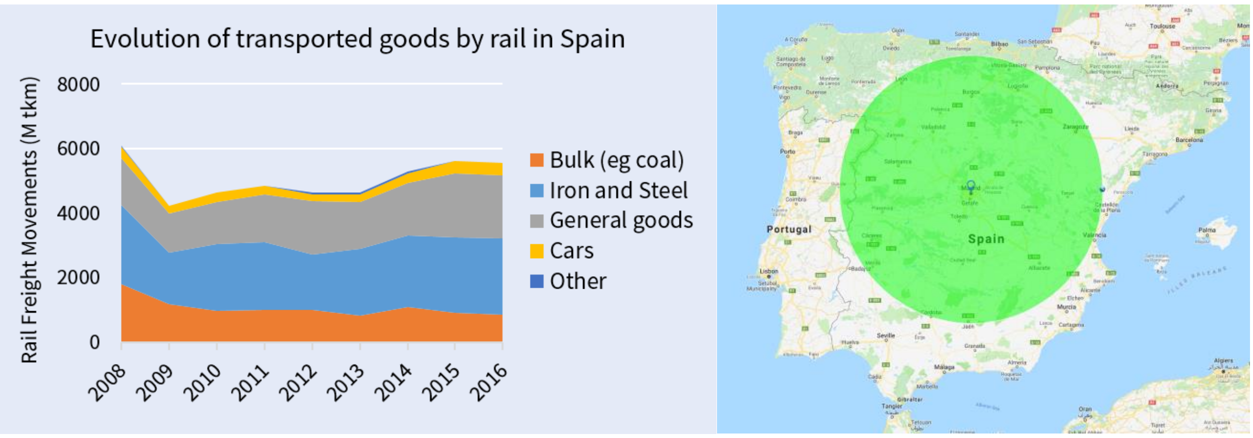


Figure 11: Evolution of freight carried by rail by type of goods carried and Madrid with a 300 km radius area centred on Madrid, overlaid.

Freight modal shift to rail is also considered in the expert group report[cxlii] and Deloitte study[cxliii] that identify barriers such as bottlenecks in the network, lack of electrification, tracks that bypass main urban areas, inadequate access to sea ports, and the management of logistics terminals. In 2017, the Ministry of Interior presented the Plan to promote rail freight transport 2017-2023[cxliv]. Among other measures, it includes: the acquisition of new locomotives by Renfe Mercancías; the search for a strategic partner for the public company that adds value to the business; aid worth €25 million per year for five years to encourage the use of the freight rail, and; the development of railway highways, which implementation process has already begun. This ambitious plan aims to achieve the goal of 30% share in 2030 and 50% in 2050.

Finally, the Asociación Valenciana de Empresarios (AVE) conducted a review of the Spanish railway network and other studies and concluded that a modal share of 13% could be achieved by 2030 following appropriate strategic investments - this represents more than a two-fold increase on current levels. Considering the barriers as outlined above, and the potential as outlined in several studies, we assume that 5% or heavy duty truck freight (i.e. trucks greater than 16t) could be shifted, resulting in a rail share of approximately 11% by 2030. This is within a context of increasing freight demand, meaning that the total freight volumes transported by rail would considerably increase. This is less ambitious than the Deloitte study[cxlv], that suggested a 15%-20% share of freight being on electric rail; as discussed, this is not a realistically achievable aim, albeit a desirable one.

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 Spain

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. These policies can have complex interactions and not necessarily result in accumulative benefits. In this section, the inputs to the model are detailed along with a brief justification.

Table 2: Summary of inputs of Spanish National level policies

Policy Lever	**Reduction by 2030 (* 2025)**	**Measure**	**Main policy interactions and justification**
1	5.00%	SHARE OF LDV ACTIVITY SHIFTED TO BUS	Fuel tax normalisation, new electric buses being able to offer cheaper services, congestion zones blocking cars, coach market expansion. 5% of car passengers represent a third of current bus passengers, so this shift implies bus and coach passenger growth of 3% p.a. between 2020-30
2	10.00%	BUS LOAD FACTOR INCREASE (PASSENGERS/VEHICLE)	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	2.00%	SHARE OF LDV ACTIVITY SHIFTED TO RAIL	This represents a 47% increase of current tram, metro and train ridership. 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. This is a more conservative shift than described above.
4	2.00%	MODE SHIFT FROM LDV TO WALK/BIKE	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, particularly buses.
5	5.00%	LDV LOAD FACTOR INCREASE (PASSENGERS/VEHICLE)	Car sharing, 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)
6	5.00%	LDV ACTIVITY - REDUCTION FROM BASE CASE	Combination of fuel tax harmonisation with the EU, 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	5.00%*	FREIGHT TRUCK LOGISTICS IMPROVEMENTS	Fuel taxes normalisation and ending rebate to truckers, road charging, and digitalisation.

8	5.00%	SHARE OF HHDV ACTIVITY SHIFTED TO RAIL	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 Portugal with the TEN-T.
9	6.25%*	FREIGHT TRUCK PAYLOAD INCREASE (METRIC TONS/VEHICLE)	Eurovignette and distance based charging, digitalisation. See T&E report Roadmap to climate-friendly land freight and buses in Europe[cxlvi] for more
10	5.00%	REDUCTION IN IN-USE FUEL CONSUMPTION OF ON-ROAD VEHICLES	C-ITS, eco-driving, congestion relief through time based charging, reduced and heavily enforced speed limits.

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 14.3 Mt CO_2e reduction compared to the baseline. This illustrates that Spain, and the rest of Europe, do benefit a great deal from EU measures such as CO_2 standards and electrification.

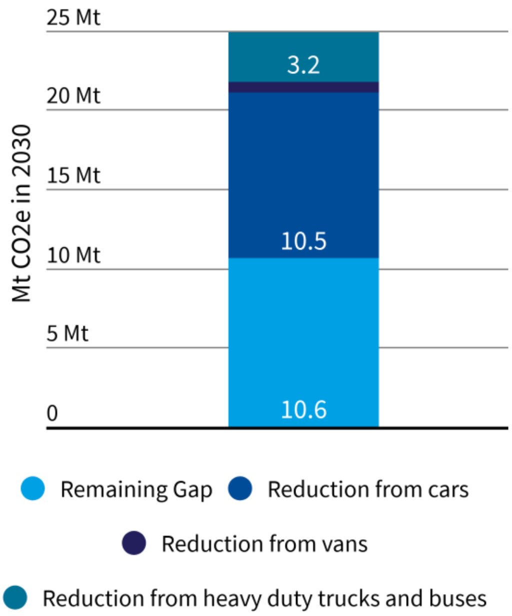


Figure 12: What national measures can deliver on their own in Spain, without EU standards and EV sales targets.

Figure 13 shows the combination of ambitious standards with 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 1.6 Mt CO_2e per year (or 2.6% per annum) compared to the 2020 is required. This is in sharp contrast to the emissions recorded between 2012 and 2016 that have seen an average increase of 1.4 Mt CO_2e.

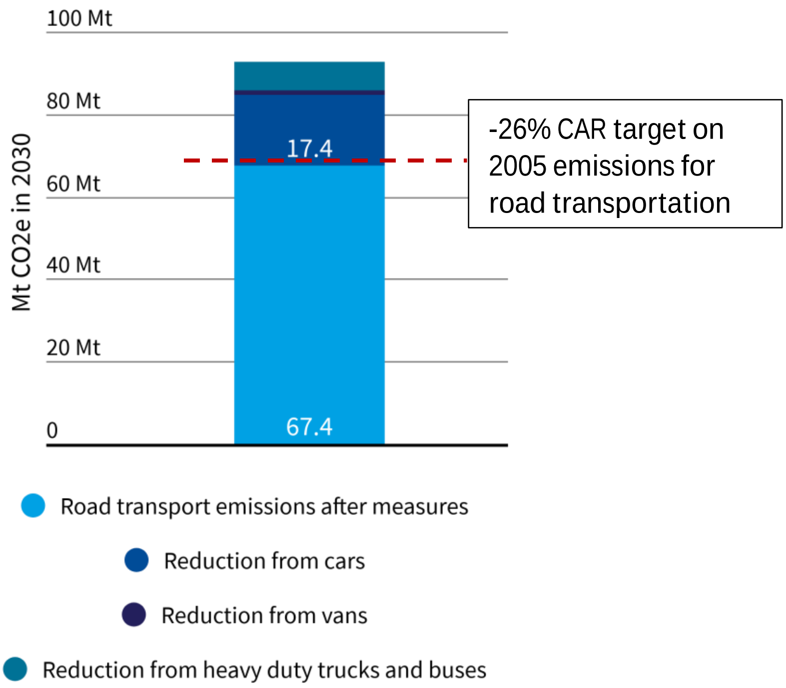


Figure 13: Combination of European and Spanish measures to achieve 2030 targets.

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 if possible: Decarbonising from this point on will require a reduction of 5% p.a., or 3.4 Mt CO_2e cut per year. . 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.

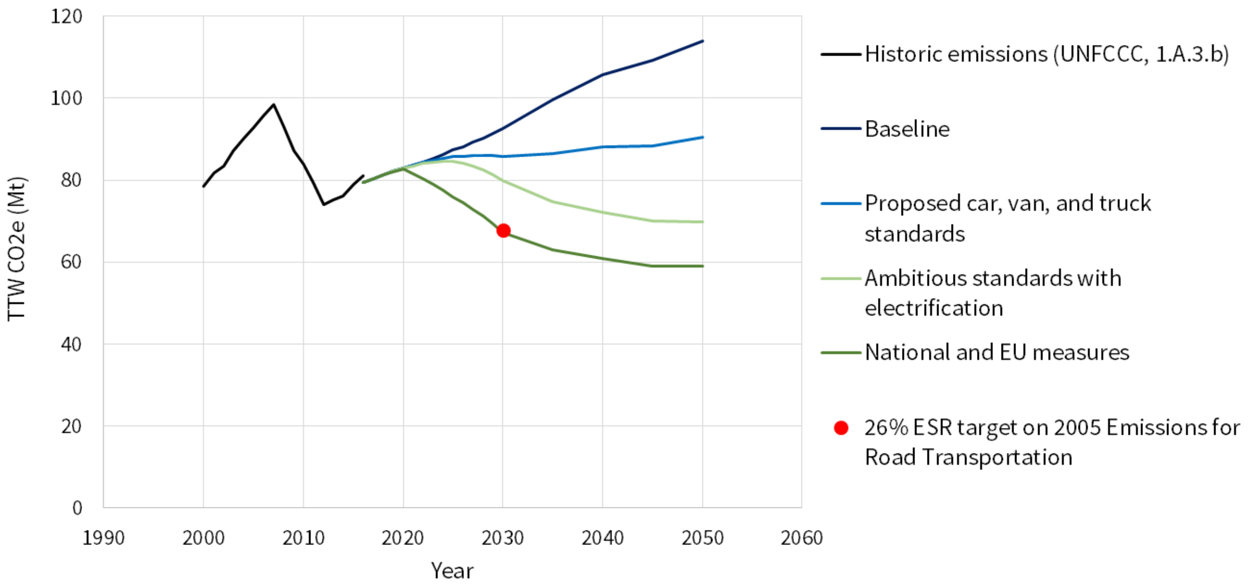


Figure 14: Long term trajectories of tank-to-wheel CO_2 emissions in Spain, compared to the 26% reduction target on 2005 levels.

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, Spain 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, money is flowing out of the EU economy to these regions[cxlvii].

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 Spain as the second largest vehicles producer in the EU, which could see its economy thrive with the right investments. Electric cars do not have emit pollutants, a huge benefit for air quality, health, reduction in noise pollution and liveable cities.

6. Policy recommendations

This report has shown the potential of a wide range of European and Spanish 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, Spain 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 Spain can take to make it happen.

6.1. Vehicle standards

Cars and Vans

- Agree without a delay a binding and ambitious 2025 CO_2 standard for new cars and vans of at least 20% in 2025. 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 Spain 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, a not-to-exceed limit should be set for all manufacturers in 2021. This limit should be verified using either a newly developed Real-world Driving Emissions test for CO_2 or the Fuel Consumption meters.

Trucks

- 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 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, Spain 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 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

Spain 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 Spain, locally produced batteries could help the large car manufacturing industry there.

Cars and Vans

- As part of the EU CO_2 standards for cars and vans, the separate sales target for zero emission vehicles should be agreed for 2025 to drive the supply of electric cars in Europe. This can be done either via a dedicated ZEV mandate or by adding a malus to the currently proposed bonus system. This will spur innovation into electric powertrains and the supply chain in Europe, driving better offer and more affordable choice of clean cars. While plug-in hybrid cars should be included they should be rewarded less than zero emission vehicles such as battery cars, in line with their CO_2 emissions.
- Spain 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 recharging infrastructure 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.

- Sustainable and reliable support schemes and financial incentives to boost demand for plug-in cars should be put in place. Notably, the bonus-malus tax system which in a revenue neutral way helps the purchase of zero emission cars should be seriously considered.

Trucks and buses

- Spain 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
- Spain 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. Spain 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, Spain 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

- Spain should align their diesel tax rate to that of petrol, and should consider increasing excise duty to be more in line with the EU average.
- Spain should work with its autonomous regions to harmonise the special tax on hydrocarbons (*impuesto de hidrocarburos*) across all regions to the maximum allowed to €0.048/l.
- The rebate offered to truckers of €0.0271/litre in Spain 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.
- 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.
- 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.
- 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

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

- 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 but to be effective, most or all drivers need to employ eco-driving, especially on the long term that would require regular trainings or better, mandatory use of eco-driving modes on cars that would moderate how the car is driven to maximise efficiency. Car manufacturers have been pushing the European Commission to qualify eco-driving as an eco-innovation. However, it does not qualify as an eco-innovation as there is no guarantee that the driver will use or respect it, creating here an important loophole. A mandatory system would however qualify. A simpler approach to encourage eco-driving is simply to rigorously enforce speed limits that achieves similar benefits.

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 Spain want 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 Spanish 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[cxlviii][cxlix] 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 Spain, 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 Spanish transport sector. Spain can push for the following measures to ensure that these emissions are properly regulated and kept at bay.

Aviation:
- A ticket tax on flights could yield significant revenues (€1.1 billion based on 2015 passenger numbers) and help curb demand, helping to combat excessive tourism
- 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
- 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 Spanish ports, both for SO_x and NO_x 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[cl] 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 Spanish shipping very painful because of insignificant GHG benefits at the expense of huge infrastructure and ship retrofitting costs[cli].

7. References

[i] Graphic: The relentless rise of carbon dioxide. *NASA*.
https://climate.nasa.gov/climate_resources/24/graphic-the-relentless-rise-of-carbon-dioxide/
[ii] For first time, Earth's single-day CO_2 tops 400 ppm (2013, 9 May) *NASA*.
https://climate.nasa.gov/news/916/for-first-time-earths-single-day-co2-tops-400-ppm/
[iii] Why is 400 an important number? *Climate Stewards*.
https://www.climatestewards.org/resources/atmospheric-co2/
[iv] Steffen, W., Richardson, K., Rockström, J., Cornell, S. E., Fetzer, I., Bennett, E. M. Biggs, R., Carpenter, S. R., de Vries, W., de Wit, C. A., Folke, C., Gerten, D., Heinke, J., Mace, G. M., Persson, L. M., Ramanathan, V., Reyers, B., Sörlin, S. (2015) Planetary boundaries: Guiding human development on a changing planet. *Science.* Vol. 347, Issue 6223, DOI: 10.1126/science.1259855.
http://science.sciencemag.org/content/347/6223/1259855
[v] NOAA Earth System Research Laboratory. Recent Global CO_2. Accessed June 2018.
https://www.esrl.noaa.gov/gmd/ccgg/trends/global.html
[vi] Le Quéré, C. (2013) Past, current and projected changes of global GHG emissions and concentrations. *IPCC AR5 Working Group 1*. Chapter 6 [presentation]
https://unfccc.int/sites/default/files/6_lequere13sed2.pdf
[vii] Paris Agreement, Article 2(a). Available :
https://unfccc.int/sites/default/files/spanish_paris_agreement.pdf
[viii] Graichen, J. (2016) Targets for the non-ETS sectors in 2040 and 2050. Report prepared for Transport & Environment by Öko-Institut e.V.
https://www.transportenvironment.org/sites/te/files/publications/2050%20ESR%20targets%20v5.pdf
[ix] Planelles, M. (2017, 9 June) Spain: time to get serious about addressing climate change. *El Pais*.
https://elpais.com/elpais/2017/06/07/inenglish/1496829932_378726.html
[x] Climate change in Spain. *ClimateChangePost*. Accessed June 2018:
https://www.climatechangepost.com/spain/climate-change/
[xi] Climate change in Spain. *ClimateChangePost*. Accessed June 2018:
https://www.climatechangepost.com/spain/climate-change/
[xii] Forest Fires Spain. *ClimateChangePost*. Accessed June 2018:
https://www.climatechangepost.com/spain/forest-fires/
[xiii] CO_2 time series 1990-2015 per region/country. *European Commission*. Accessed: June 2018.
http://edgar.jrc.ec.europa.eu/overview.php?v=CO2ts1990-2015&sort=des9
[xiv] National Inventory Submissions 2018*. United Nations Climate Change*.
https://unfccc.int/process/transparency-and-reporting/reporting-and-review-under-the-convention/greenhouse-gas-inventories/submissions-of-annual-greenhouse-gas-inventories-for-2018
[xv] European Parliament position P8_TC1-COD(2016)0231.
http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//TEXT+TA+P8-TA-2018-0097+0+DOC+XML+V0//EN&language=EN#BKMD-8
[xvi] Deloitte (2017) A decarbonised transport model for Spain in 2050. Recommendations for the transition
https://perspectivas.deloitte.com/decarbonised-transport-model
[xvii] González de Tejada, M. Porto, M. Mateos, M., Sanz, A. (2016) El transporte en las ciudades: Un motor sin freno del cambio climático. GreenPeace.
https://archivo-es.greenpeace.org/espana/Global/espana/2016/report/cambio-climatico/movilidadtambienporelclimal_GEA.pdf
[xviii] Transport & Environment (2016) Gas in road transport: (still) a dead-end
https://www.transportenvironment.org/publications/gas-road-transport-still-dead-end
[xix] Hill, N. (2016) SULTAN modelling to explore the wider potential impacts of transport GHG reduction policies in 2030. *Report for the European Climate Foundation*. Ref. DG-1509-55582.
https://europeanclimate.org/wp-content/uploads/2016/02/ECF-Transport-GHG-reduction-for-2030_Final_Issue21.pdf
[xx] http://www.euki.de/
[xxi] https://www.transportenvironment.org/what-we-do/effort-sharing-regulation/implementation-euki-project

[xxii] EUKI: Delivering the EU-2030 and Long Term Climate Objectives in Central, Eastern and Southern Europe, with a Specific Focus on Transport
http://www.euki.de/delivering-the-eu-2030-and-long-term-climate-objectives-in-central-eastern-and-southern-europe-with-a-specific-focus-on-transport/?lang=en
[xxiii] https://www.transportenvironment.org/about-us
[xxiv] ICCT (2017) Real-world vehicle fuel consumption gap in Europe at all-time high
https://www.theicct.org/news/EU-real-world-vehicle-fuel-consumption-gap-all-time-high
[xxv] Transport & Environment (2016) Mind the Gap.
https://www.transportenvironment.org/publications/mind-gap-2016-report
[xxvi] EEA (2017) Freight transport demand.
https://www.eea.europa.eu/data-and-maps/indicators/freight-transport-demand-version-2/assessment-7
and EEA (2017) Passenger transport demand.
https://www.eea.europa.eu/data-and-maps/indicators/passenger-transport-demand-version-2/assessment-9
[xxvii] EU Reference Scenario 2016: Energy, transport and GHG emissions Trends to 2050
https://ec.europa.eu/energy/sites/ener/files/documents/ref2016_report_final-web.pdf
[xxviii] Statistical pocketbook 2017. EU Transport in figures.
https://ec.europa.eu/transport/facts-fundings/statistics/pocketbook-2017_en
[xxix] Transport & Environment (2016) 20 years of truck CO_2 progress – revisited.
https://www.transportenvironment.org/newsroom/blog/20-years-truck-co2-progress-revisited
[xxx] Hill, N., Finnegan, S., Norris, J. Brannigan, C., Wynn, D., Baker, H., Skinner, I. (2011) Reduction and Testing of Greenhouse Gas (GHG) Emissions from Heavy Duty Vehicles – Lot 1: Strategy (p.192)
https://ec.europa.eu/clima/sites/clima/files/transport/vehicles/docs/ec_hdv_ghg_strategy_en.pdf
[xxxi] Umwelt Bundesamt (2015) Zukünftige Maßnahmen zur Kraftstoffeinsparung und Treibhausgasminderung bei schweren Nutzfahrzeugen
https://www.umweltbundesamt.de/sites/default/files/medien/378/publikationen/texte_32_2015_kraftstoffeinsparung_bei_nutzfahrzeugen.pdf
[xxxii] Transport & Environment (2017) Roadmap to climate-friendly land freight and buses in Europe
https://www.transportenvironment.org/publications/roadmap-climate-friendly-land-freight-and-buses-europe
[xxxiii] National Inventory Submissions 2018. *United Nations Climate Change.*
https://unfccc.int/process/transparency-and-reporting/reporting-and-review-under-the-convention/greenhouse-gas-inventories-annex-i-parties/national-inventory-submissions-2018
[xxxiv] European Parliament Position P8_TC1-COD(2016)0231
http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//TEXT+TA+P8-TA-2018-0097+0+DOC+XML+V0//EN&language=EN#BKMD-8
[xxxv] Effort sharing: Member States' emission targets. *European Commission*.
https://ec.europa.eu/clima/policies/effort_en#tab-0-3
[xxxvi] Annual emission allocations 2013-2020 and flexibilities. *European Commission*.
https://ec.europa.eu/clima/policies/effort/framework_en
[xxxvii] European Parliament Position P8_TC1-COD(2016)0231
http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//TEXT+TA+P8-TA-2018-0097+0+DOC+XML+V0//EN&language=EN#BKMD-8
[xxxviii] Effort sharing 2021-2030: targets and flexibilities
https://ec.europa.eu/clima/policies/effort/proposal_en
[xxxix] Effort sharing 2021-2030: targets and flexibilities
https://ec.europa.eu/clima/policies/effort/proposal_en
[xl] European Parliament position P8_TC1-COD(2016)0231, Article 18. Accessed:
http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//TEXT+TA+P8-TA-2018-0097+0+DOC+XML+V0//EN&language=EN#BKMD-8
[xli] Directive 2009/28/EC of the European Parliament and of the Council
http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32009L0028
[xlii] Renewable energy directive. European Commission
https://ec.europa.eu/energy/en/topics/renewable-energy/renewable-energy-directive
[xliii] Valin, H., Peters, D., van den Berg, M., Frank, S., Havlik, P., Forsel, N., Hamelinck, C. (2015) The land use change impact of biofuels consumed in the EU Quantification of area and greenhouse gas impacts.
https://ec.europa.eu/energy/sites/ener/files/documents/Final%20Report_GLOBIOM_publication.pdf
and Transport & Environment (2016) Globiom: the basis for biofuel policy post-2020

https://www.transportenvironment.org/publications/globiom-basis-biofuel-policy-post-2020
[xliv] Eurostat. SHARES (Renewables)
http://ec.europa.eu/eurostat/web/energy/data/shares
[xlv] Transport & Environment (2016) Cars and trucks burn almost half of palm oil used in Europe
https://www.transportenvironment.org/publications/eu-biodiesel-market-briefing
[xlvi]European Union Committee (2017) Brexit: Gibraltar. 13th Report of Session 2016-17 HL Paper. Chpt. 2 Sect. 21.
https://publications.parliament.uk/pa/ld201617/ldselect/ldeucom/116/11605.htm#_idTextAnchor015
[xlvii] Govan ; F. (2013, 14 August) Spain threatens to clamp down on Gibraltar's ship refuelling industry. *The Telegraph*
https://www.telegraph.co.uk/news/worldnews/europe/gibraltar/10242845/Spain-threatens-to-clamp-down-on-Gibraltars-ship-refuelling-industry.html
[xlviii] European Union Communication (2015, 6 March) Intended Nationally Determined Contribution of the EU and its Member States.
www4.unfccc.int/Submissions/INDC/Published%20Documents/Latvia/1/LV-03-06-EU%20INDC.pdf
[xlix] Cames, M., Harthan, R. O., Füssler; J., Lazarus, M., Lee, C. M., Erickson, P., Spalding-Fecher, R. (2016) How additional is the Clean Development Mechanism? Oko-Institut e.V. CLIMA.B.3/SERI2013/0026r
https://ec.europa.eu/clima/sites/clima/files/ets/docs/clean_dev_mechanism_en.pdf
[l] Proyectos Clima, Gobierno de España.
http://www.mapama.gob.es/es/cambio-climatico/temas/proyectos-clima/
[li] Transport & Environment (2016) Globiom: the basis for biofuel policy post-2020
https://www.transportenvironment.org/publications/globiom-basis-biofuel-policy-post-2020
[lii] Proyectos Clima, Gobierno de España.
http://www.mapama.gob.es/es/cambio-climatico/temas/mitigacion-politicas-y-medidas/transporte.aspx
[liii] Comisión de Expertos sobre Escenarios de Transición Energética. Análisis y propuestas para la descarbonización (2018)
http://www6.mityc.es/aplicaciones/transicionenergetica/informe_cexpertos_20180402_veditado.pdf
[liv] The Automobile Industry Pocket Guide 2017-2018 - page 22.
http://www.acea.be/publications/article/acea-pocket-guide
[lv] *La Vanguardia* (2018) El PSPV acusa a Rajoy de retrasar la publicación del Plan de Energía y Clima.
http://www.lavanguardia.com/local/valencia/20180201/44450158014/el-pspv-acusa-a-rajoy-de-retrasar-la-publicacion-del-plan-de-energia-y-clima.html
[lvi] Muños, R. (2018, 18 June) Fomento quitará los peajes de las autopistas cuando acabe su concesión. *El País.*
https://elpais.com/economia/2018/06/17/actualidad/1529266170_481968.html
[lvii] *La* Moncloa (2017, 14 July) Mariano Rajoy announces 5-billion euro investment in highways through public-private collaboration.
http://www.lamoncloa.gob.es/lang/en/presidente/news/Paginas/2017/20170714_highways.aspx
[lviii] Hours spent in road congestion annually. *European Commission.* Accessed June 2018.
https://ec.europa.eu/transport/facts-fundings/scoreboard/compare/energy-union-innovation/road-congestion_en
[lix] Public procurement – Study on administrative capacity in the EU. Spain Country Profile. *European Commission.*
http://ec.europa.eu/regional_policy/sources/policy/how/improving-investment/public-procurement/study/country_profile/es.pdf
[lx] Gobierno de España, Ministerio de Fomento.
http://www.fomento.es/MFOMBPrensa/Noticias/El-Gobierno-presenta-un-Plan-Extraordinario-de-en-/4f1f4869-26cc-4245-8858-2fc9052b751e
[lxi] EP (2018, 13 July) Rajoy presents tomorrow a plan of 5,000 million to relaunch the public work. *Expansión.*
http://www.expansion.com/economia/2017/07/12/59666e1aca47418f018b4623.html
[lxii] García de Blas (2018, 18 June) La voluntad del Gobierno es no parar ninguna de las inversiones ya previstas. *El País.*
https://elpais.com/economia/2018/06/17/actualidad/1529250568_734252.html
[lxiii] Carretero, N. (2018, 24 June) Cuando el peaje es una cuestión de vida o muerte. *El País.*
https://politica.elpais.com/politica/2018/06/22/actualidad/1529692258_337599.html
[lxiv] 2018 Member's National Reports. Spain. Accessed June 2018. Available:
http://www.asecap.com/member-s-national-reports.html
[lxv] UNFCCC reporting by Member States
https://unfccc.int/process/transparency-and-reporting/reporting-and-review-under-the-convention/greenhouse-gas-inventories-annex-i-parties/national-inventory-submissions-2018

[lxvi] ICCT (2018) The European Commission regulatory proposal for post-2020 CO_2 targets for cars and vans: A summary and evaluation
https://www.theicct.org/sites/default/files/publications/ICCT_EU-CO2-proposal_briefing_20180109.pdf
[lxvii] Sources for Figure: ICCT (2016). sales statistics provided by IHS Markit, CO_2 emissions calculated from mileage and fuel consumption assumptions used in: Reduction and Testing of Greenhouse Gas Emissions from Heavy Duty Vehicles (*LOT1, LOT2*)
LOT1: Nikolas Hill et al. (2011) Reduction and Testing of Greenhouse Gas Emissions from Heavy Duty Vehicles – Lot 1: Strategy. *Ricardo-AEA Ltd*
LOT2: TU Graz (2012) IVT, Reduction and Testing of Greenhouse Gas Emissions from Heavy Duty Vehicles - LOT 2 Development and Testing of a Certification Procedure for CO_2 Emissions and Fuel Consumption of HDV
[lxviii] The Automobile Industry Pocket Guide 2017-2018 - pages 22 and 41.
http://www.acea.be/publications/article/acea-pocket-guide
[lxix] ICCT (2017) 2020-2030 CO_2 standards for new cars and light-commercial vehicles in the European Union
https://www.theicct.org/sites/default/files/publications/ICCT_Post-2020-CO2-stds-EU_briefing_20171026_rev20171129.pdf
[lxx] European Commission (2017)
https://ec.europa.eu/clima/sites/clima/files/transport/vehicles/docs/swd_2017_650_p1_en.pdf
[lxxi] van Bokhorst, M., van Wijngaarden, L., Otten, M., Hoen, A. (2018) Van use in Europe and their environmental impact. *CE Delft.* Available:
https://www.transportenvironment.org/publications/co2-emissions-vans-time-put-them-back-track
[lxxii] Fontaras, G. (2016) Report on VECTO Technology Simulation Capabilities and Future Outlook. JRC Technical Reports.
https://ec.europa.eu/jrc/en/publication/report-vecto-technology-simulation-capabilities-and-future-outlook
[lxxiii] Delgado, O., Rodriguez, F., Muncrief, R. (2017) Fuel Efficiency Technology in European Heavy-Duty Vehicles: Baseline and Potential for the 2020–2030 Time Frame
www.theicct.org/sites/default/files/publications/EU-HDV-Tech-Potential_ICCT-white-paper_14072017_vF.pdf
[lxxiv] van Bokhorst, M., van Wijngaarden, L., Otten, M., Hoen, A. (2018) Van use in Europe and their environmental impact. *CE Delft.* Available:
https://www.transportenvironment.org/publications/co2-emissions-vans-time-put-them-back-track
[lxxv] Bloomberg New Energy Finance (2018) Electric Buses in Cities Driving Towards Cleaner Air and Lower CO_2
https://data.bloomberglp.com/bnef/sites/14/2018/05/Electric-Buses-in-Cities-Report-BNEF-C40-Citi.pdf
[lxxvi] Transport & Environment (2018) Small electric vans cost the same as dirty diesel ones today but are in short supply
https://www.transportenvironment.org/press/small-electric-vans-cost-same-dirty-diesel-ones-today-are-short-supply
[lxxvii] Transport & Environment (2018) European carmakers invest seven times more in EV production in China than at home
https://www.transportenvironment.org/press/european-carmakers-invest-seven-times-more-ev-production-china-home
[lxxviii] A decarbonised transport model for Spain in 2050. Recommendations for the transition. 2017. Deloitte. Available:
https://perspectivas.deloitte.com/decarbonised-transport-model
[lxxix] Transport & Environment (2018) EU playing catch-up: China leading the race for electric car investments
https://www.transportenvironment.org/publications/eu-playing-catch-china-leading-race-electric-car-investments
[lxxx] Lutsey, N., Grant, M., Wappelhorst, S., Zhou, H. (2018) POWER PLAY: HOW GOVERNMENTS ARE SPURRING THE ELECTRIC VEHICLE INDUSTRY. *The ICCT*
https://www.theicct.org/sites/default/files/publications/EV_Government_WhitePaper_20180514.pdf
[lxxxi] Martínez, G. G. (2018) 15 nuevos autobuses eléctricos circulan ya por Madrid. *Movilidad Electrica*
https://movilidadelectrica.com/15-nuevos-autobuses-electricos-circulan-ya-madrid/
[lxxxii] Martínez, G. G. (2017) Barcelona contará con cuatro autobuses eléctricos articulados de Irizar
https://movilidadelectrica.com/barcelona-contara-cuatro-autobuses-electricos-articulados-irizar/
[lxxxiii] ZeEUS eBus Report #2 An updated overview of electric buses in Europe (2017)
http://zeeus.eu/uploads/publications/documents/zeeus-ebus-report-2.pdf
[lxxxiv] ZeEUS eBus Report #2 An updated overview of electric buses in Europe (2017)
http://zeeus.eu/uploads/publications/documents/zeeus-ebus-report-2.pdf
[lxxxv] White, P. (2018, 21 May) “We are on the brink of radical change” – Joachim Drees, MAN Truck & Bus. *Fleet Transport.*
https://fleet.ie/we-are-on-the-brink-of-radical-change-joachim-drees-man-truck-bus/

[lxxxvi] European Commission (2017) ANNEX to the Proposal for a Directive of the European Parliament and of the Council amending Directive 2009/33/EC on the promotion of clean and energy-efficient road transport vehicles https://eur-lex.europa.eu/resource.html?uri=cellar:ef8ec14a-c55d-11e7-9b01-01aa75ed71a1.0001.02/DOC_2&format=PDF
[lxxxvii] Bloomberg New Energy Finance (2018) Electric Buses in Cities Driving Towards Cleaner Air and Lower CO_2 https://data.bloomberglp.com/bnef/sites/14/2018/05/Electric-Buses-in-Cities-Report-BNEF-C40-Citi.pdf
[lxxxviii] http://zeeus.eu/
[lxxxix] https://www.transportenvironment.org/publications/co2-emissions-vans-time-put-them-back-track
[xc] Earl, T., Mathieu, L., Cornelis, S., Kenny, S., Calvo Ambel, C., Nix, J. (2018) Analysis of long hauls battery electric trucks in the EU. *8th Commercial Vehicles Workshop, Graz, Austria. 17-18 May.*
[xci] TNO (2018) Assessments with respect to the EU HDV CO_2 legislation: work in support of the Dutch position on EU regulation on the CO_2 emissions of heavy-duty vehicles https://repository.tudelft.nl/view/tno/uuid:cdc11c45-1636-431a-8016-5f582769c1c3/
[xcii] Moultak, M., Lutsey, L., Hall, D. (2017) Transitioning to zero-emission heavy-duty freight vehicles. *The ICCT* https://www.theicct.org/publications/transitioning-zero-emission-heavy-duty-freight-vehicles
[xciii] Eurostat. Road freight transport statistics. Accessed: June 2018 http://ec.europa.eu/eurostat/statistics-explained/index.php/Road_freight_transport_statistics
[xciv] eHighway – Electrification of road freight transport. Siemens. https://www.siemens.com/global/en/home/products/mobility/road-solutions/electromobility/ehighway.html
[xcv] Transport & Environment (2017) Roadmap to climate-friendly land freight and buses in Europe https://www.transportenvironment.org/publications/roadmap-climate-friendly-land-freight-and-buses-europe
[xcvi] Kasten, P., Mottschall, M., Köppel,W., Degünther, C., Schmied, M., Wüthrich, P. (2016) Erarbeitung einer fachlichen Strategie zur Energieversorgung des Verkehrs bis zum Jahr 2050 https://www.umweltbundesamt.de/sites/default/files/medien/377/publikationen/2016-11-10_endbericht_energieversorgung_des_verkehrs_2050_final.pdf
[xcvii] Transport & Environment (2017) Roadmap to climate-friendly land freight and buses in Europe https://www.transportenvironment.org/publications/roadmap-climate-friendly-land-freight-and-buses-europe
[xcviii] TNO (2016) Dutch CO_2 emission factors for road vehicles. [Support for preparation of impact assessment for CO_2 emissions standards] https://publications.tno.nl/publication/34620445/oCrCGA/TNO-2016-R10449.pdf
[xcix] Transport & Environment: Europe's tax deals for diesel (2015), Page 19. Available: https://www.transportenvironment.org/publications/europes-tax-deals-diesel
[c] Comisión de Expertos sobre Escenarios de Transición Energética. Análisis y propuestas para la descarbonización (2018) http://www6.mityc.es/aplicaciones/transicionenergetica/informe_cexpertos_20180402_veditado.pdf
[ci] Bakhat, M., Labeaga, J. M., Labandeira, X., López, X. 2013. Economic Crisis and Elasticities of Car Fuels: Evidence for Spain (WP FA15/2013). Table 3.
[cii] Platform for electromobility (2018) How EU Member States roll-out electric-mobility: Electric Charging Infrastructure in 2020 and beyond https://www.transportenvironment.org/sites/te/files/publications/Emobility%20Platform%20AFID%20analysis.pdf
[ciii] http://www.eafo.eu/europe
[civ] http://www.idae.es/ca/node/12933
[cv] http://cirveproject.com/
[cvi] Transport & Logistiek Vlaanderen (2017) 1 jaar kilometerheffing: transporteurs rekenen meer door dan verwacht, klanten wachten nog te lang met betalen http://www.transportenlogistiekvlaanderen.be/nl/publicaties/persberichten/1-jaar-kilometerheffing-transporteurs-rekenen-meer-door-dan-verwacht-kl
[cvii] Fraunhofer (2016) Economic impact of introducing road charging for Heavy Goods Vehicles www.transportenvironment.org/sites/te/files/publications/2017_04_road_tolls_report_EN_exec_summary.pdf
[cviii] Transport & Environment (2017) The Economic Impacts of Road Tolls https://www.transportenvironment.org/publications/benefits-road-tolls
[cix] Transport & Environment (2017) Are Trucks taking their Toll II https://www.transportenvironment.org/publications/are-trucks-taking-their-toll-ii
[cx] European Commission. Electrified railway lines. Accessed June 2018. https://ec.europa.eu/transport/facts-fundings/scoreboard/compare/energy-union-innovation/share-electrified-railway_en

[cxi] Castañares Hernández, G. of Renfe Operadora. Personal communication. June 2018
[cxii] Regulation (EC) No 1073/2009 of the European Parliament and of the Council of 21 October 2009 on common rules for access to the international market for coach and bus services, and amending Regulation (EC) No 561/2006 https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32009R1073
[cxiii] DW (2018) Flixbus: Europe's hottest bus operator turns 5
https://p.dw.com/p/2saMj
[cxiv] https://maresmadrid.es/
[cxv] 20 Minutos (2016) El abono de transportes en Europa es 10 euros más caro de media que en Madrid y Barcelona https://www.20minutos.es/noticia/2866621/0/cuanto-cuesta-la-movilidad-en-europa/
[cxvi] García, J. M. (2015) El precio de un viaje de metro, bus, taxi y tren en 71 ciudades del mundo. *La Vanguardia.* http://www.lavanguardia.com/vangdata/20151001/54437767027/precio-metro-bus-taxi-tren-principales-ciudades-mundo.html
[cxvii] ITF (2017) A New Paradigm for Urban Mobility How Fleets of Shared Vehicles Can End the Car Dependency of Cities https://www.itf-oecd.org/sites/default/files/docs/cop-pdf-03.pdf
[cxviii] Finger, Bert, Kupfer, Montero, Wolek, (2017) Research for TRAN Committee – Infrastructure funding challenges in the sharing economy, European Parliament, Policy Department for Structural and Cohesion Policies, Brussels
http://www.europarl.europa.eu/RegData/etudes/STUD/2017/601970/IPOL_STU(2017)601970_EN.pdf
[cxix] Rao, S. (2016) London's new late night alternative: The Night Tube + Uber
https://medium.com/uber-under-the-hood/londons-new-late-night-alternative-the-night-tube-uber-8f38e56de983
[cxx] 6t-bureau de recherche. 2016. Enquête Nationale sur l'Autopartage – Edition 2016 – Etat des lieux technique et méthodologique. ADEME. 53 pages.
http://www.ademe.fr/sites/default/files/assets/documents/enquete-nationale-autopartage-ena1bis-2017-etats-lieux.pdf
[cxxi] ITF (2017) Transition to Shared Mobility. How large cities can deliver inclusive transport services.
https://www.itf-oecd.org/sites/default/files/docs/transition-shared-mobility.pdf
[cxxii] Pew Research Center (2016) On-demand: Ride-hailing apps
http://www.pewinternet.org/2016/05/19/on-demand-ride-hailing-apps/
[cxxiii] UITP (2016) PUBLIC TRANSPORT: AT THE HEART OF THE NEW MOBILITY WORLD
http://www.uitp.org/publication/integrated-mobility-solution

[cxxiv] UC Davis (2017) Disruptive Transportation: The Adoption, Utilization, and Impacts of Ride-Hailing in the United States
http://www.trb.org/Main/Blurbs/176762.aspx
[cxxv] Morello, E. Toffolo, S., Magra, G. (2016) Impact analysis of eco-driving behaviour using suitable simulation platform (ICT-EMISSIONS project). Transportation Research Procedia 14 (2016) 3119–3128
[cxxvi] Lopez-Ruiz, H. G., Christidis, P., Demirel, H., Kompil, M. (2013) Quantifying the Effects of Sustainable Urban Mobility Plans. *Joint Research Centre.* doi:10.2791/21875
http://www.eltis.org/sites/default/files/trainingmaterials/quantifying_the_effects_of_sustainable_urban_mobility_plans.pdf
[cxxvii] Nemry, F., Leduc, G., Mongelli, I., Uihlein, A. (2008) Environmental Improvement of Passenger Cars (IMPRO-car).
http://ftp.jrc.es/EURdoc/JRC40598.pdf
[cxxviii] Catarina C. Rolima,*, Patricia C. Baptistaa ; Gonçalo O. Duartea , Tiago L. Farias (2014) Impacts of on-board devices and training on Light Duty Vehicle Driving Behavior. Procedia - Social and Behavioral Sciences 111 (2014) 711 – 720
https://www.sciencedirect.com/science/article/pii/S1877042814001062
[cxxix] Hill, N. (2016) SULTAN modelling to explore the wider potential impacts of transport GHG reduction policies in 2030. *Report for the European Climate Foundation*. Ref. DG-1509-55582.
https://europeanclimate.org/wp-content/uploads/2016/02/ECF-Transport-GHG-reduction-for-2030_Final_Issue21.pdf
[cxxx] European Environmental Agency (2011) Do lower speed limits on motorways reduce fuel consumption and pollutant emissions?
https://www.eea.europa.eu/themes/transport/speed-limits
[cxxxi] http://www.securite-routiere.gouv.fr/connaitre-les-regles/reglementation-et-sanctions/baisse-de-la-vitesse-maximale-autorisee-de-90-a-80-km-h
[cxxxii] https://www.vlaanderen.be/nl/mobiliteit-en-openbare-werken/wegen/70-kmuur-buiten-de-bebouwde-kom-vlaanderen

[cxxxiii] Barroso, J. (2017) Cifuentes limitará la velocidad por alta polución en radiales, M-40 y M-45. *El País.* https://elpais.com/ccaa/2017/10/31/madrid/1509470362_626767.html
[cxxxiv] Sánchez, E. (2017) El Gobierno aprueba el protocolo para episodios de alta contaminación de la región. *El País.* https://elpais.com/ccaa/2017/11/21/madrid/1511268777_112622.html
[cxxxv] L.T. Aarts, J.J.F. Commandeur, R. Welsh, S. Niesen, M. Lerner, P. Thomas, N. Bos, R. J. Davidse (2016) Study on Serious Road Traffic Injuries in the EU. MOVE/C4/SER/2015- 162/SI2.714669 https://ec.europa.eu/transport/road_safety/sites/roadsafety/files/injuries_study_2016.pdf
[cxxxvi] Hill, N. (2016) SULTAN modelling to explore the wider potential impacts of transport GHG reduction policies in 2030. *Report for the European Climate Foundation*. Ref. DG-1509-55582. https://europeanclimate.org/wp-content/uploads/2016/02/ECF-Transport-GHG-reduction-for-2030_Final_Issue21.pdf
[cxxxvii] C-ITS Platform (2016) Final Report. https://ec.europa.eu/transport/sites/transport/files/themes/its/doc/c-its-platform-final-report-january-2016.pdf
[cxxxviii] European Environmental Agency (2017) Energy efficiency and specific CO_2 emissions https://www.eea.europa.eu/data-and-maps/indicators/energy-efficiency-and-specific-co2-emissions/energy-efficiency-and-specific-co2-9
[cxxxix] Castañares Hernández, G. of Renfe Operadora. Personal communication. June 2018
[cxl] http://lowcarbonfreight.eu/
[cxli] Observatorio del Ferrocarril en España - Informe 2016. (December 2017)
[cxlii] Comisión de Expertos sobre Escenarios de Transición Energética. Análisis y propuestas para la descarbonización (2018) http://www6.mityc.es/aplicaciones/transicionenergetica/informe_cexpertos_20180402_veditado.pdf
[cxliii] A decarbonised transport model for Spain in 2050. Recommendations for the transition. 2017. Deloitte. Available: https://perspectivas.deloitte.com/decarbonised-transport-model
[cxliv] https://www.fomento.gob.es/MFOMBPrensa/Noticias/El-ministro-de-Fomento-presenta-un-plan-para-el-de/f3eaac03-07c4-4fe7-b9bf-d3217ddacad5
[cxlv] A decarbonised transport model for Spain in 2050. Recommendations for the transition. 2017. Deloitte. https://perspectivas.deloitte.com/decarbonised-transport-model
[cxlvi] Transport & Environment (2017) Roadmap to climate-friendly land freight and buses in Europe www.transportenvironment.org/publications/roadmap-climate-friendly-land-freight-and-buses-europe
[cxlvii] Transport & Environment (2016) 80% of EU oil imports now supplied by non-European companies – study https://www.transportenvironment.org/press/80-eu-oil-imports-now-supplied-non-european-companies-%E2%80%93-study
[cxlviii] van den Bold (2018) LOADING CONTAINERS IN A FEW MINUTES AND REDUCING CO_2 EMISSIONS AS A RESULT: THE POTENTIAL OF A NEW TECHNIQUE http://lowcarbonfreight.eu/blogs/loading-containers-minutes-reducing-co2-emissions-result-potential-new-technique/
[cxlix] http://www.innovatrain.ch/
[cl] Ship & bunker (2018) Norway Mandates World's First Zero-Emission ECA for No Later Than 2026. https://shipandbunker.com/news/emea/186487-norway-mandates-worlds-first-zero-emission-eca-for-no-later-than-2026
[cli] Transport & Environment (2018) Natural gas is a $22bn distraction for EU shipping that won't decarbonise the sector – study https://www.transportenvironment.org/press/natural-gas-22bn-distraction-eu-shipping-won%E2%80%99t-decarbonise-sector-%E2%80%93-study