


Assessment of alternative approaches to regulating CO_2 emissions from light duty road vehicles for the period after 2020

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Presentations of results of two linked studies

- **First presentation:**
  - wide assessment of options and issues
- **Second presentation:**
  - detailed assessment of how different metrics might influence technology choices and cost effectiveness of meeting targets

All figures used and targets assumed are for illustrative purposes only


Scope

- Focus of the work was on assessing pros and cons of:
  - different metrics for regulation
  - alternative policy options

- Table the issues
- Assess options
- Not the intention to provide solutions or propose preferred options

- Purpose is to explore the impacts of different regulatory mechanisms, not the desirability or achievability of specific target levels

Introduction


Aspects covered in the assessment

- Development of assessment criteria
- Impact of various metrics on WTW emissions
  - WTW CO_2 increase with increasing ZEV shares
  - Flexibility with respect to the technology mix for meeting a target
  - Impacts of different metrics on emissions and energy consumption at the fleet level
- Pros and cons of different metrics and options
- Other relevant issues for post 2020 regulation
  - Combining different options and inclusion of additional modalities
  - Interaction between CO_2 regulation and the FQD and EU-ETS
  - Choice of utility parameter
  - Border between van and car legislation


Current CO_2 regulation for cars and vans based on TA tailpipe CO_2 emissions

Regulation (EC) 443/2009 and Regulation (EU) 510/2011

- Tailpipe CO_2 emissions = Tank-to-wheel (TTW) CO_2
  - Upstream emissions ignored
- New energy carriers:
  - electricity & hydrogen count as zero emission (ZEV)
  - overestimation of contribution to WTW GHG reduction
  - provides incentive to use BEVs, PHEV/EREVs and FCEVs as means to reach target
  - no incentive to make ZEVs more efficient
  - ignores composition of fuel: biofuels count as 100% fossil
  - underestimates contribution to WTW GHG reduction especially for dedicated biofuel vehicles
- Consequently not technology neutral

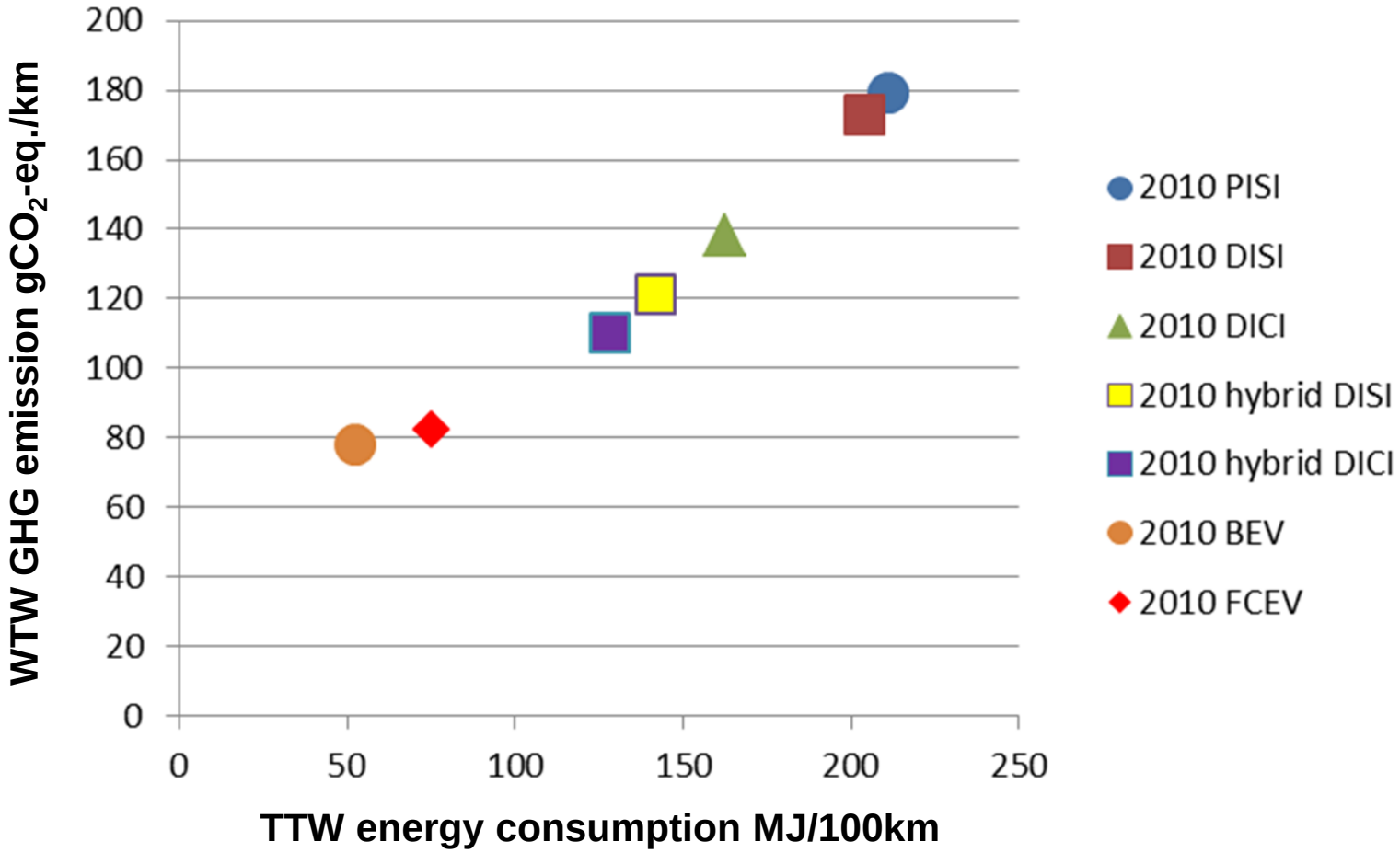
Possible problems with current definition

- Increasing the share of ZEVs leads to increased WTW CO_2 emissions
  - For every ZEV sold 130 / 95 ICEVs are allowed to emit 1 g/km more, so TTW emissions are not reduced
  - But WTT emissions of ZEVs are not zero, so net effect is an increase in WTW emissions
  - This is further enhanced by super-credits

    In relation to 130 g/km target for vehicles (cars) emitting below 50g/km:
    - 1 vehicle counted as 3.5 vehicles in 2012 and 2013,
    - 1 vehicle counted as 2.5 vehicles in 2014
    - 1 vehicle counted as 1.5 vehicles in 2015
    - the scheme expires as of 2016

- Regulation may promote solutions that are not the most cost effective from a societal perspective
  - BEVs and FCEVs count as zero but have different WTW impacts
  - BEVs, PHEVs, FCEVs and biofuels may have different cost effectiveness for reducing WTW GHG emissions

Simulated fuel cycle performance of different 2010 fuel-vehicle technology combinations



Source: data from JEC - Joint Research Centre-EUCAR-CONCAWE collaboration, WTW study, version 4, 2013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Requirements for post-2020 regulation

- Post-2020 regulation needs to:
  - cater for the future
  - reduce uncertainty or risks for manufacturers
  - provide incentives to the market to improve conventional technology AND develop and implement technologies needed to meet longer term targets
  - provide the right incentives to OEMs to develop and market CO_2 reduction options that are most cost-effective from a societal point of view
  - ensure that GHG emission reductions are in line with those foreseen


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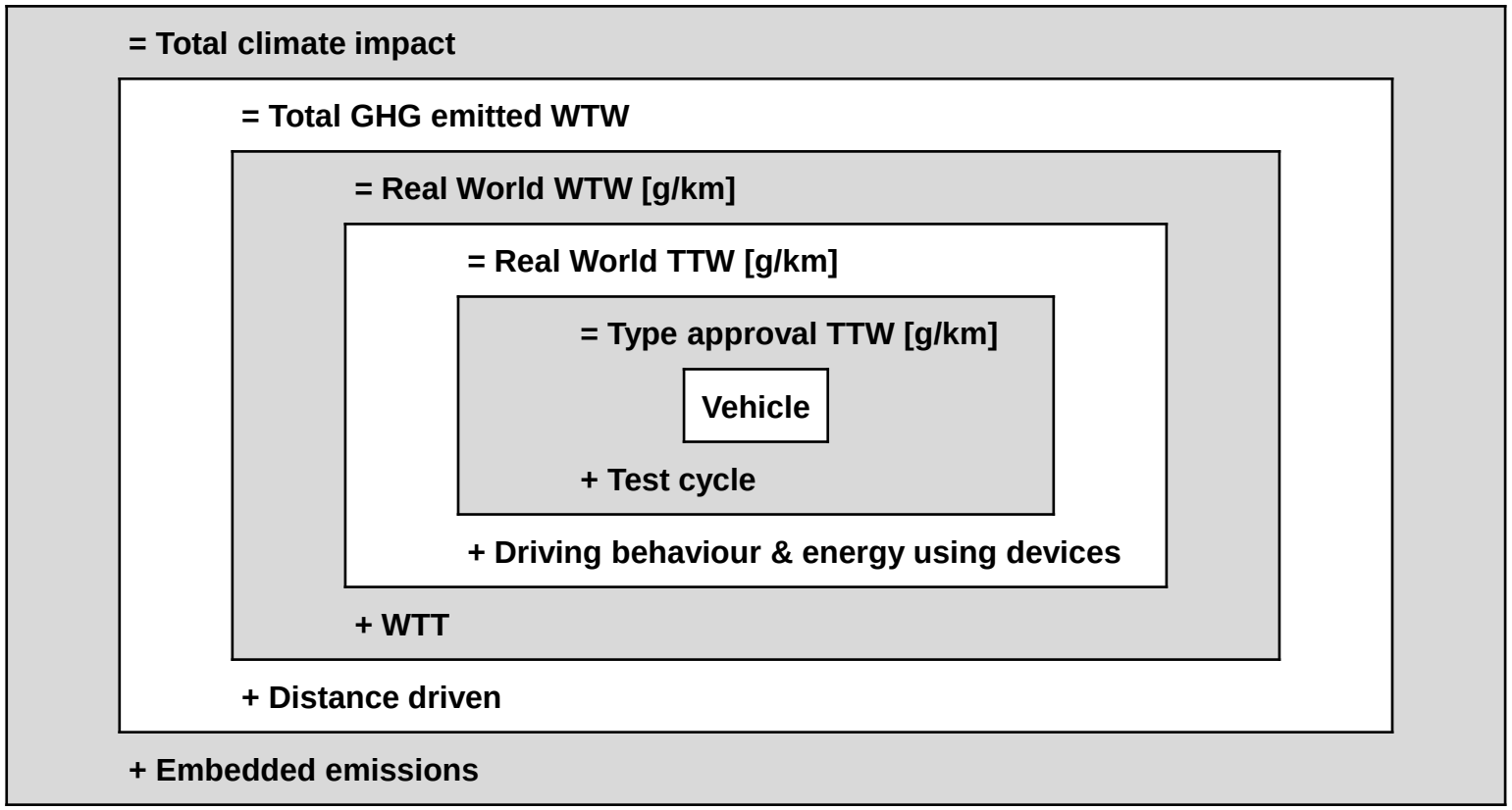
Inventory of options

Schematic overview of various levels on which CO_2 emission targets can be defined




Main options for post-2020 metric and regulatory approaches

Alternative Metrics *with current system*

Vehicle CO_2 emissions

1. tailpipe (TTW) CO_2 emissions as in existing Regulation
2. tailpipe CO_2 emissions for ICEVs with exclusion of ZEVs
3. TTW CO_2 emissions with notional GHG intensity for ZEVs
4. WTW CO_2 emissions

Vehicle energy use

5. TTW energy used per vehicle-km
6. WTW energy used per vehicle-km


Main options for post-2020 metric and regulatory approaches

Other instruments

7. inclusion of road fuel use in the EU ETS

8. vehicle manufacturer based trading scheme based on lifetime vehicle GHG emissions
9. cap and trade system for vehicle manufacturers, of total CO_2 emissions of vehicles sold

Additional options that can be combined with other elements of the legislation:

9. inclusion of embedded emissions in the WTW approaches listed above
10. combining different options with size-dependent mileage weighting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Criteria for assessment of options

Criteria for comparing / assessing options

- **Net GHG emission impact of the metric**
  - Control over the net contribution of the legislation to reaching overall goals with respect to reduction of GHG emissions and energy consumption, including.:
    - real world vs type approval (RW/TA)
    - knock-on consequences
  - Sensitivity of:
    - WTW GHG emissions of newly sold vehicles
    - WTW GHG emissions of entire fleet
    - fleet wide direct GHG emissions, according to the IPCC definition (emissions attributable to EU or Member States)

    with respect to variations in mix of technologies and energy carriers

Criteria for comparing / assessing options

- **Impact of the metric on technology development and implementation**
  - Degree to which the approach:
    - may favour specific technologies and thus depart from the accepted **technological neutrality** desired in EU legislation
    - stimulates manufacturers to invest in technologies that may effectively contribute to the transition towards a long term sustainable transport system
  - Alignment of technology mix that leads to lowest costs for manufacturers or users with the technology mix that leads to lowest GHG abatement costs from a societal perspective
  - Promoting improvements in energy efficiency in all powertrain technologies, including Low Emission Vehicles (LEVs)


Criteria for comparing / assessing options

Technology neutrality (1)

- Important guiding principle in the definition of the CO_2 legislation
  - Simple definition: policy defined without specifying technologies with which manufacturers should meet the target
  - Allowing OEMs to choose optimal technologies is believed to lead to highest cost-effectiveness

- Even without explicitly prescribing the use of a certain technology, a policy can implicitly favour or disfavour certain technologies on grounds that are not necessarily consistent with the overall goals
  - E.g. LEVs counting as zero emission under TTW CO_2 target while WTW emissions are non-zero

Criteria for comparing / assessing options

Technology neutrality (2)

- Ideally, for technological neutrality policy should incentivise different technologies proportional to the contribution that each has to meeting the specified overall objective
  - Explored in the other study by comparing alignment of optimal LEV shares from different cost perspectives and for lowest WTW emissions => see next presentation

- Three alternative definitions of technology neutrality are also considered. These are that OEMs should have the possibility to
  1. meet target with technology of their choice, irrespective of costs
  2. meet the target with multiple technologies at comparable additional manufacturer cost
  3. meet the target with multiple technologies with achievable shares of alternatives


Criteria for comparing / assessing options

- **Economic impacts of the metric**
  - Cost effectiveness from a manufacturer, user and societal perspective
  - Resilience, or sensitivity of the costs to variations in compliance strategies
  - Wider economic impacts would include:
    - impacts on the competitiveness of the European car industry;
    - impacts on competitiveness of businesses using vehicles;
    - impacts on employment and economic growth in the EU;
    - effects on mobility volumes and modal choice and indirect impacts of that on other parts of the economy.

Criteria for comparing / assessing options

- **Impact of the metric on energy dependence**
  - Total primary energy consumption
  - Primary energy consumption from different sources
  - Degree to which energy efficiency is promoted

- **Compatibility with other policy instruments**
  - Suitability of the values based on a given metric for application in labelling or in vehicle taxation differentiated by CO_2 emissions or energy consumption
  - Interaction with the RED and FQD

- **Potential effects on air pollution, noise, and safety, etc.**


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Criteria for comparing / assessing options

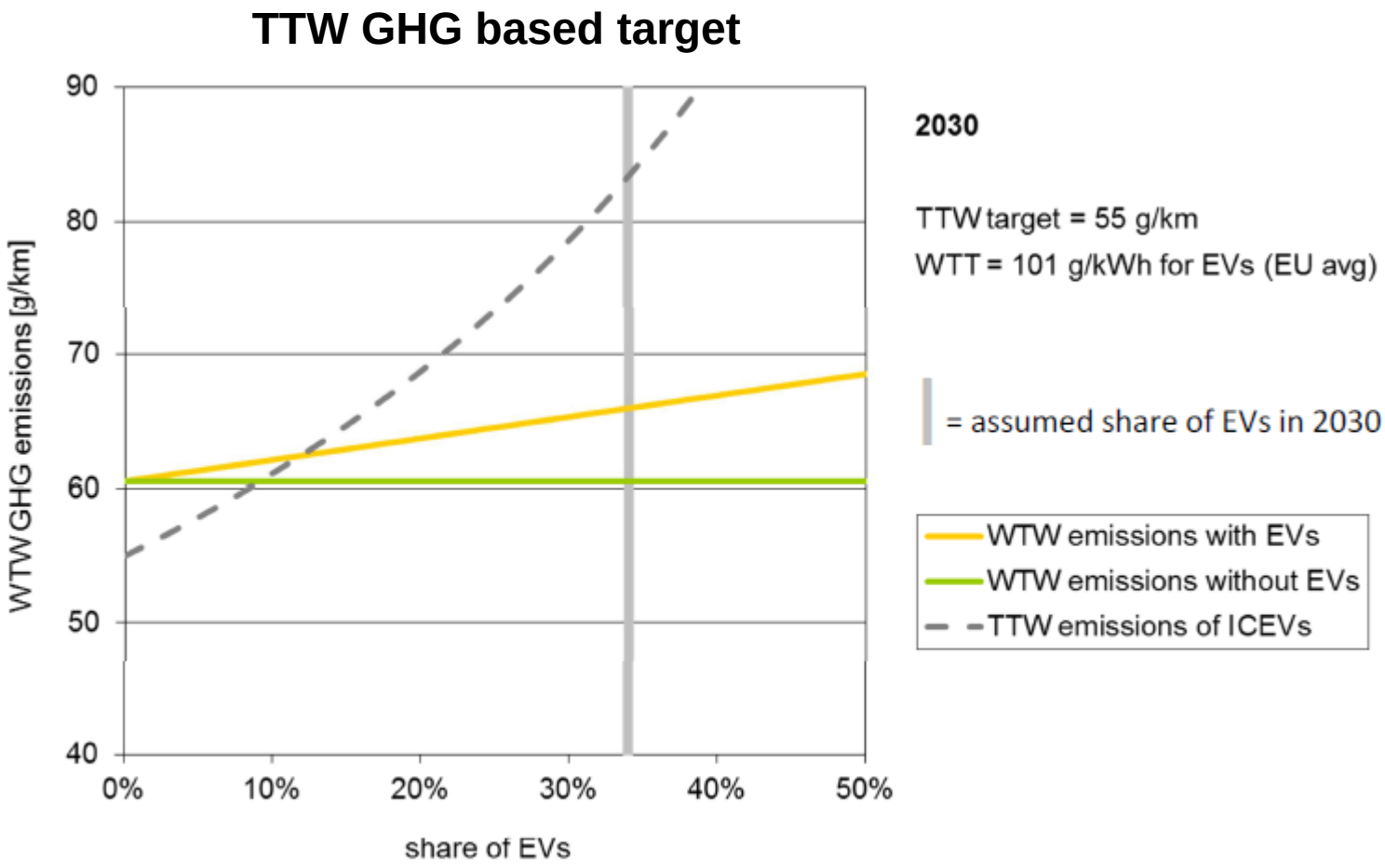
- **Ease of implementation**
  - Administrative burden
  - “Measurability”
- **Acceptability**
  - Acceptance by stakeholders, including industry and Member States
  - Representativeness of the values based on a given metric for the impacts in specific countries
  - Transparency, intelligibility, simplicity

Assessment of options

Studying the “internal logic” of different metrics

Impact of various metrics on WTW emissions of new vehicles in the target year and interaction of technologies

WTW CO_2 increase with increasing ZEV shares



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Impact of various metrics on WTW emissions of new vehicles in the target year and interaction of technologies

WTW CO_2 increase with increasing ZEV shares

- TTW CO_2: WTW increase is most pronounced in the medium term, with the ZEV share becoming significant while WTT emissions of their energy carriers are still relatively high
- WTW CO_2: safeguards against WTW increase
- TTW MJ/km: can be considered to solve the problem
  - WTW emissions decrease rather than increase with an increasing share of ZEVs if WTT emissions of these ZEVs are sufficiently low
- WTW MJ/km: shows similar behaviour as TTW MJ/km
  - Sensitivity of WTW CO_2 emissions to variations in the share of ZEVs and their WTT emissions depends on relation between WTT GHG emissions and WTT energy consumption
    - This relation is not straightforward (e.g. renewables vs. CCS)


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Impact of various metrics on WTW emissions of new vehicles in the target year and interaction of technologies

Flexibility with respect to the technology mix for meeting a target

- Hidden complexity attached to all metrics when applied to a single target for the average performance of the entire new vehicle sales
  - becomes apparent especially in the longer term
  - indicates limits to setting targets regardless of the metric
- Single target offers inherent flexibility for internal averaging and the choice of technologies for meeting the target
- Setting targets that are beyond what is technically feasible with ICEVs requires assumptions about feasible market shares of ZEVs
- Deviations from expected share of ZEVs need to be compensated by:
  - changing efficiency of ICEVs => no potential and limited impacts
  - adjustment of the energy efficiency of ZEVs => limited potential


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sensitivity
o = not sensitive
\+ = weak
+++ = moderate
+++++ = strong
(-) = sign reversed
red = case not realistic

Metric	TTW GHG	TTW GHG with notional GHG intensity		WTW GHG		TTW energy		WTW energy	
		ICEVs only	ICEVs + ZEVs	ICEVs only	ICEVs + ZEVs	ICEVs only	ICEVs + ZEVs	ICEVs only	ICEVs + ZEVs
Sensitivity of WTW emissions to WTT electricity GHG intensity									
2020	+	+	+	o	o	+	+	+/o	+/o
2030	+++++	+++++	+++++	o	o	+++++	+++++	+++++	+++++
2050	+	+	+	o	o	+	+	+	+
Sensitivity of WTW emissions to ZEV share									
2020	+++++	+++/o	+++/o	o	o	+++++ (-)	+++++ (-)	++++++ (-)	+++++ (-)
2030	+++++	+++/o	+++/o	o	o	+++++ (-)	+++++ (-)	+++++ (-)	+++++ (-)
2050	+	+/o	+/o	o	o	+++++ (-)	+++++ (-)	+++++ (-)	+++++ (-)
Sensitivity of ICE TTW emissions to ZEV share									
2020	+++	++	++	+	+	+++	+++	+/o	+/o
2030	+++	++	++	++	++	+++	+++	++ (-)	+
2050	+++++	+++++	+++++	+++++	+++++	+++++ (-)	+++++	+++++ (-)	+++++

Summary of pros & cons for the different options


List of options

Alternative Metrics

1. tailpipe (TTW) CO_2 emissions as in existing Regulation
2. tailpipe CO_2 emissions for ICEVs with exclusion of ZEVs
3. TTW CO_2 emissions with notional GHG intensity for ZEVs
4. WTW CO_2 emissions
5. TTW energy used per vehicle-km
6. WTW energy used per vehicle-km

Other instruments

7. inclusion of road fuel use in the EU ETS
8. vehicle manufacturer based trading scheme based on lifetime vehicle GHG emissions

Additional options

9. cap and trade system for vehicle manufacturers, of total CO_2 emissions of vehicles sold
10. include embedded emissions in the WTW approaches listed above
11. combining different options with size-dependent mileage weighting


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Pros & cons of different options

1. TTW CO_2 as in existing Regulation

- **Pros:**
  - Focus on CO_2 implies that the goal of contributing to CO_2 reductions is more likely to be achieved.
  - Tight targets promote a more rapid transition to alternative energy carriers with low TTW emissions (electricity and hydrogen).
  - Similar approach currently used in the US, Japan and other regions worldwide.
    - But US approach foresees move to WTW for electricity
  - This regulatory approach has been generally accepted by vehicle manufacturers and automotive industry for the current situation.


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Pros & cons of different options

1. TTW CO_2 as in existing Regulation

- **Cons:**
  - Vehicles with zero TTW emissions are overstimulated if overall goal is to reduce WTW emissions.
  - Upstream emissions continue to be ignored.
  - Increasing the share of vehicles with zero TTW emissions such as EVs and FCEVs to meet the TTW target leads to increase in WTW emissions compared to the situation where the target is met without zero TTW emission vehicles or with a lower share of ZEVs.
  - Overstimulates electric and hydrogen vehicles in comparison with other, possibly more cost-effective CO_2 reduction options.
  - Provides no incentive for efficiency improvement for zero TTW emission vehicles
  - Does not provide intrinsic credits for biofuel vehicles.


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Pros & cons of different options

2. TTW CO_2 for ICEVs with exclusion of ZEVs

- **Pros:**
  - Targets for conventional vehicles are not compromised by introducing other technologies. This option avoids the leverage by zero-emission vehicles on the overall average WTW emissions.
  - Focus on CO_2 implies that the goal of contributing to CO_2 reductions is more likely to be achieved.

- **Cons:**
  - It is not a fundamental long term solution.
  - Does not promote the transition to low-carbon or renewable energy carriers.
  - Provides no incentive for efficiency improvement for zero TTW emission vehicles
  - Does not provide intrinsic credits for biofuel vehicles.

Pros & cons of different options

3. TTW CO_2 with notional GHG intensity for ZEVs

- **Pros:**
  - Focus on CO_2 implies that the goal of contributing to CO_2 reductions is more likely to be achieved.
  - Under the condition that WTT and/or WTW/TTW factors are chosen correctly this method avoids the problem that an increased share of zero TTW-emission vehicles leads to increased WTW emissions.
  - Notional WTT and/or WTW/TTW factors do not need to be very exact (i.e. true WTT factors) and do not require a complex monitoring system.

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Pros & cons of different options

3. TTW CO_2 with notional GHG intensity for ZEVs

- **Cons:**
  - Requires definition of, and agreement on, notional WTT and/or WTW/TTW factors.
  - OEMs might argue that they are not responsible for these WTT emissions.
  - Too frequent updates of WTT factors would make planning more difficult for OEMs.


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Pros & cons of different options

4. WTW CO_2

- **Pros:**
  - Focus on GHG emissions.
  - Focus on the most important parameter with respect to world-wide climate impacts.
  - Technology neutral.

- **Cons:**
  - Determining actual WTT and/or WTW emission factors requires complex monitoring system.
  - OEMs might argue that they are not responsible for these WTT emissions.
  - Using actual WTW or WTT emission factors, or very frequent updates of these factors, would make planning more difficult for OEMs.


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Pros & cons of different options

WTW approach and manufacturer responsibility

- Manufacturers can affect WTW GHG emissions from cars in 2 ways:
  - making cars more efficient
  - making cars run on alternative energy carriers

- Using a WTW based metric does NOT make manufacturers responsible for upstream emissions or energy consumption
- But it does make them responsible for taking knowledge of upstream emission into account in decisions w.r.t. the technology portfolio they choose to develop and market
- It is conceptually no different from the current approach which gives OEMs the signal that upstream emissions are zero

Pros & cons of different options

5. TTW energy use

- **Pros:**
  - Reduces the overstimulation of electric and fuel cell vehicles and other vehicles with zero TTW emissions.
  - Reduces the leverage of zero TTW emission vehicles on WTW emissions.

  - If goal of TTW energy-based regulation would be to improve TTW energy efficiency, this option can be considered technology neutral.
    - But…=>

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Pros & cons of different options

5. TTW energy use

- **Cons:**
  - If TTW energy-based regulation is implemented with the aim to reduce WTW CO_2 emissions, this option is not technology neutral.
    - Energy efficiencies of ICEVs and various ZEVs do not necessarily reflect their respective contribution to reducing WTW CO_2 emissions.
  - Does not fundamentally solve issue of TTW CO_2-based regulation:
    - For high WTT emission values still WTW CO_2 leakage with increasing share of ZEVs.
  - Focus on energy efficiency could reduce effectiveness of achieving reduction goal with respect to WTW GHG emissions.


Pros & cons of different options

6. WTW energy use

- **Pros:**
  - Promotes overall resource efficiency (in relation to energy use).
  - Improves impact relative to TTW energy with respect to reducing the leverage of zero-emission vehicles.
  - Promotes energy efficiency in vehicles running on alternative energy carriers.

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Pros & cons of different options

6. WTW energy use

- **Cons:**
  - Comparing primary energy use of fossil and renewable sources is an “apples & pears” comparison. Fossil sources are finite.
  - WTW energy consumption does not correlate with WTW GHG emissions.
  - Not technology neutral for achieving a CO_2 goal in case of overall sales average target, due to intrinsic differences in WTW energy efficiency of various propulsion systems and limited correlation between WTW CO_2 emissions and energy use.
  - Focus on energy efficiency could reduce effectiveness of achieving reduction goal with respect to WTW GHG emissions.


Pros & cons of different options

7. Inclusion of road fuel use in EU ETS

- **Pros:**
  - Theoretically economic instruments such as a cap & trade system promote the most cost effective reduction options.
  - Comparing cap & trade system to a CO_2 tax:
    - With cap and trade, the total CO_2 emission reduction is given but the price incentive is uncertain;
    - With a CO_2 tax, the price incentive is given but the total CO_2 emission reduction is uncertain.

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Pros & cons of different options

7. Inclusion of road fuel use in EU ETS

- **Cons (1):**
  - At current CO_2 prices under EU-ETS the impact on fuel prices is very small.

	g/litre	€/ton	€/litre
diesel	2609	50	0.13

  - Market barriers to achieving economically optimal levels of GHG reduction and fuel efficiency for LDVs inhibit the effective operation of a market instrument.
    - Proven by effectiveness of current CO_2 legislation in stimulating cost-effective reduction options even with significant levels of fuel taxes.

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Pros & cons of different options

7. Inclusion of road fuel use in EU ETS

- **Cons (2):**
  - A cap & trade system does not automatically stimulate timely action that is required to get longer term, transitional options (such as EVs) implemented
    - CO_2 price too low to compensate for initial high price of alternatives
    - No long term price guarantee, so investment risk
  - No significant CO_2 emission reduction in the transport sector is guaranteed (since it may be possible that the CO_2 cap is reached by implementing reduction measures in other economic sectors).

Pros & cons of different options

8. Manufacturer-based trading system based on lifetime GHG emissions
9. Cap & trade system for OEMs based on CO_2 emissions

- **Pros:**
  - Overall cap on total vehicle CO_2 introduces joint responsibility of OEMs and shared interest in reducing CO_2. This could encourage more collaboration.
  - Not only targets vehicle efficiency / CO_2 emissions but also total sales, and thus avoids market growth leading to increased emissions.
- **Cons:**
  - Makes the engineering target for vehicle efficiency very dependent on economic / market fluctuations (i.e. total sales of cars).

Pros & cons of different options

10. Inclusion of embedded emissions in WTW approaches

- **Pros:**
  - Provides incentive for manufacturers to take account of differences in embedded emissions for different technologies in planning product portfolio.

- **Cons:**
  - As with WTT emissions and lifetime mileage OEMs might argue that they do not have full control over embedded emissions. This is mainly true for components they buy from suppliers although this could be addressed in contracting (chain management).
  - Implementation would require a system for determining default embedded emission factors or OEM-specific values.


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Pros & cons of different options

11. Combining different options with size-dependent mileage weighting

- **Pros:**
  - Lifetime mileage-weighting could correct for fact that some technologies or size segments have higher mileage than others, so that 1 g/km reduction in one segment has more/less impact on total GHG emissions than 1 g/km reduction in other segment.
  - Could improve cost effectiveness for society and OEMs.

- **Cons:**
  - Lifetime mileage figures need to be established.
  - Manufacturers may argue they have no control over how far cars are driven.

Pros & cons of different options

Other considerations

- The regulated entities should understand and be able to control enough parameters to enable them to comply with their regulatory objective
- For the automotive industry predictability of specific targets for individual OEMs is extremely important.
  - Frequency of updates of relevant factors is crucial.
  - Predictability is improved if elements in legislation that OEMs cannot influence are the same for all manufacturers and determined well in advance to allow product portfolio planning by OEMs in response to periodic changes in these elements.
- The acceptability of additional factors also strongly depends on the methodology used to determine these factors.
  - Agreement on the monitoring mechanisms is important
    - Especially relevant for embedded emissions

Link:

Report available to download at:

http://ec.europa.eu/clima/policies/transport/vehicles/docs/alternatives_en.pdf