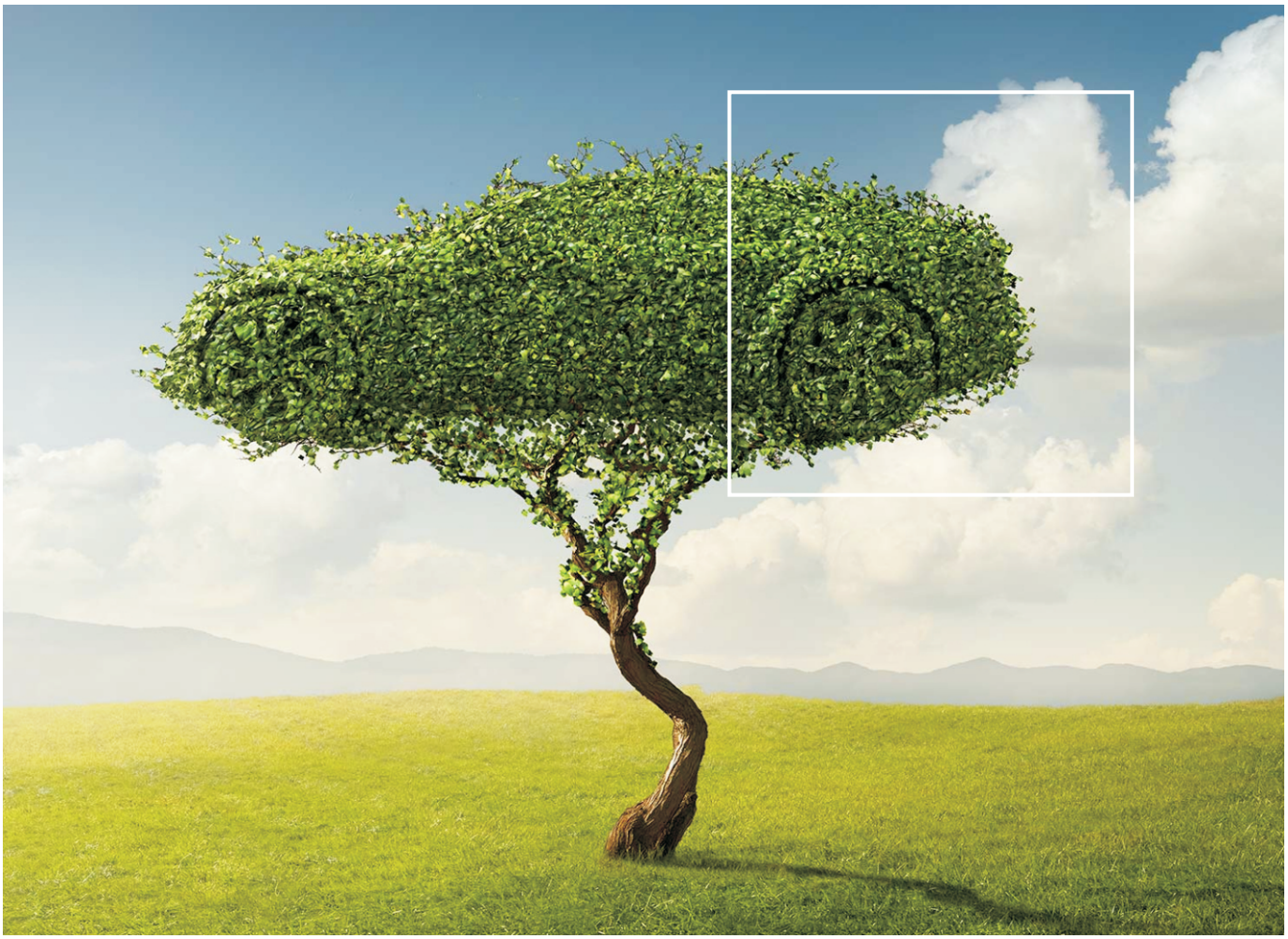
Arthur D Little

Automotive

The Automotive CO_2 Emissions Challenge

2020 Regulatory Scenario for Passenger Cars



Content

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Abstract

Oil dependency and *climate change* are topics highly debated by governments and communities, and as a consequence, original equipment manufacturers (OEMs) must define investments, control manufacturing costs and review their car portfolios constantly to cope with worldwide future challenges.

To predict the future development of automotive CO_2 regulations up to 2020, Arthur D. Little (ADL) defined key trends and regulation stability in different countries.

On the basis of ADL analysis, countries that are regulated up to 2020 will not change their policies; the only exception will be China and India, where a concurrence of factors such as a booming population, increasing wealth per capita and growing demand for road transportation fuel will contribute to the introduction of stricter standards.

As far as unregulated countries are concerned, oil-independent countries such as Russia and the Middle East will rely on their abundance of resources and not adopt any CO_2 regulation.

In terms of future political balance in the field of automotive CO_2 regulations, two countries will be identified as leaders/trendsetters: the first is the United States' policy reference for Canada and Mexico; the second is the European Union, which will provide a regulatory example for Switzerland.

Furthermore, between the European Union and China, there will be strong commonalities in automotive CO_2 regulations, with the Chinese government having already requested the European Commission's point of view on its Phase III regulation and expressed the desire to promote a common high-level regulatory scheme for easier trading for Chinese and European automotive companies.

Lastly, Japan, South Korea and Australia will be independently regulated countries.

1. The Current Situation in Automotive CO_2 Regulations

In the past few years, governments have focused on automotive CO_2 regulations because of the influence of road transport on CO_2 emissions (16.4% of global CO_2 emissions) and oil consumption (38% of global oil demand).[1] These estimates are likely to increase even more under the pressure of the increasing global population and expanding vehicle fleet (+28% in 2020 compared with 2013).[2]

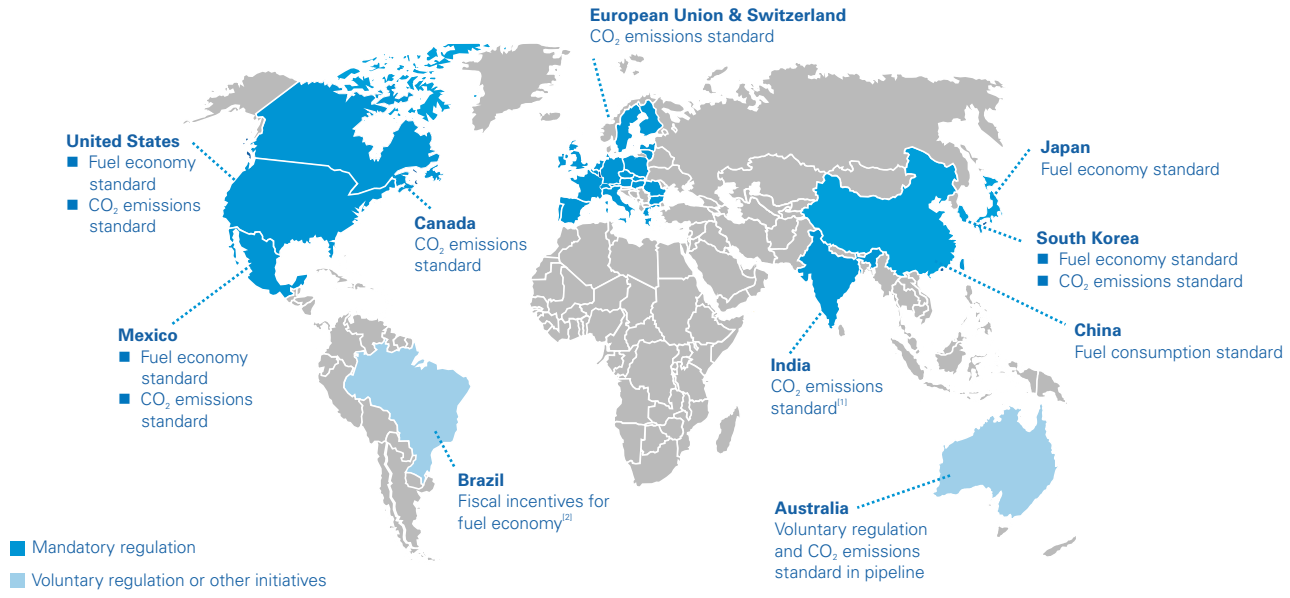
Despite the growing importance of automotive CO_2 regulations, a uniform global approach to tackling the issue has not been developed. Countries have adopted different regulatory policies and implementation procedures, resulting in a high degree of complexity in the global landscape. The most widespread approaches are the CO_2 emissions standard and the fuel economy standard.[3]

The former standard measures the level of CO_2 emissions produced when operating the vehicle (fuel combustion); the latter standard measures the amount of fuel used to cover a given distance. These two "direct" approaches, which are focused on the performance of newly produced passenger cars, are interconnected and together contribute to reducing both CO_2 emissions and oil consumption.

Other approaches are based on fiscal incentives or traffic-control measures (on local level), and can be considered "indirect" strategies to achieve goals because their primary influence is on costumers' purchasing behavior shifting purchasing habits towards "cleaner" and "efficient" vehicles.

Therefore, governments are free to decide the most appropriate policy mix (direct or indirect approaches) to adopt in order to achieve CO_2-emission-level and oil-consumption objectives. Nevertheless, it is important to underline that direct regulations (the object of this report) are more effective in reaching the above-mentioned goals.

Figure 1: Automotive CO_2 Regulation Map



Source: Arthur D. Little analysis

[1] India's CO_2 Emission Standard has been defined in 2013 and will be apply from 2016
[2] Brazil's fiscal incentives are provided for OEMs

1 *World Energy Outlook 2013*, International Energy Agency.
2 IHS Automotive data, 2020 fleet forecast.
3 It is important not to confuse automotive CO_2 regulations with automotive vehicle-emission standards, which are used to address conventional tailpipe pollutants and usually governed by separate regulations at national level; vehicle-emissions standards govern vehicle pollutant emissions such as NOx, CO, NC, and PM. CO_2 emissions and pollutants are cogenerated from fossil-fuel combustion; this cogeneration link suggests potential synergies between carbon mitigation and pollutant-abatement policies.

1.1 Automotive CO_2 Regulation Adoption

In 2013, over 70% of the global market for passenger cars was subject to automotive CO_2 regulations[4] (Figure 1). The majority of countries adopting mandatory regulations are economically advanced, such as the United States, Canada, Japan, South Korea, and members of the European Union. However, in the past 10 years, emerging economies have also faced CO_2 regulation policies: China implemented its first regulation in 2005, Mexico adopted one in 2013 and India finalized its first passenger vehicle fuel economy standards on January 30, 2014, to be effective from April 2016.

In Australia, the government adopted a voluntary CO_2 emissions standard in 2005 and is now discussing a mandatory regulation. Another example as such is Brazil, which approved a program called "Inovar-Auto" in October 2012 to encourage innovation in vehicle technology through fiscal incentives for OEMs to respect specific requirements (e.g. vehicle-efficiency target, investment in R&D/technology, participation in the vehicle labeling scheme).

1.2 Automotive CO_2 Regulation Features

When comparing automotive CO_2 regulations across countries and regions (Figure 2), we observed different approaches and derogations being pursued to improve vehicle efficiency. The main differentiating parameters were the following:

1. **Standard type:** As already stated, automotive CO_2 regulations can be based on fuel economy, CO_2 emissions or both. In addition, governments can limit other greenhouse gases (GHGs) produced by fuel combustion, such as N_2O, CH_4 (less than 2% of total tailpipe emissions). Nonetheless, compliance with these GHG targets does not represent a challenge for OEMs, which are already easily meeting the parameters with current technologies.
2. **Time frame:** The number of years covered by automotive CO_2 regulations is variable. Most governments have regulated up to 2020, covering the next six years. Exceptions to this are the United States and Canada, which have set a target for 2025 (albeit scheduling a target

Figure 2: Automotive CO_2 Regulations Features (excerpt)

Country or Region	Target Year	Standard Type	Unadjusted Fleet Target[1]	Calculation Method	Test Cycle	Penalties
European Union	2015	CO_2	130 gCO_2/km	Weight-based corporate avg.	NEDC	Economical fines
	2021		95 gCO_2/km			
Japan	2015	Fuel economy	16.8 km/L	Weight-based corporate avg.	JC08	Economical fines
	2020		20.3 km/L			Public proclamation
Canada	2016	CO_2 + other GHGs	217 gCO_2/mi	FP-based corporate avg.	US combined	Economical fines
	2025 (proposed)		N/A			Sales restriction
India	(from 2016)	CO_2	(130 g/km)	Weight-based corporate avg.	NED for low-powered vehicle	Not Available
	2021		113 g/km			
China	2015	Fuel consumption	6.9 L/100km	Weight-class based corporate avg.	NEDC	Economical fines
	2020 (proposed)		5 L/100km			Public proclamation
United States	2016	Fuel economy/ CO_2 + other GHGs	36.2 mpg or 225 gCO_2/mi	FP-based corporate avg.	US combined	Economical fines
	2025		56.2 mpg or 143 gCO_2/mi			Sales restriction
South Korea	2015	Fuel economy/ CO_2 + other GHGs	17 km/L or 140 gCO_2/km	Weight-based corporate avg.	US combined	Public proclamation
Mexico	2016	Fuel economy/ CO_2 + other GHGs	39.3 mpg or 140 g/km	FP-based corporate avg.	US combined	Economical fines

Source: Arthur D. Little analysis on government's documentation

[1] Unadjusted fleet target is set considering national test cycle

4 Arthur D. Little analysis on IHS Automotive data.

review in 2018), and South Korea and Mexico, which are about to terminate their mandates (2015 and 2016, respectively). Taking these differences into account, it is important for OEMs to work in long, regulated time frames since there is more room to plan and optimize investment decisions and phasing in of technologies.

3. **Calculation method of OEM's target:** Governments define fuel economy and/or CO_2 emissions targets based on either vehicle footprint or weight. The former measure is employed in North America, with the United States being the first to have used vehicle footprint as a reference feature, followed by Canada and Mexico. The rest of the world follows vehicle weight (e.g. the European Union, China, India, Japan, and South Korea). Therefore, OEMs must respect CO_2 emission and/or fuel economy targets set by governments for the vehicle fleet sold in the year (in the specific market).[5]
4. **Test cycle:**[6] in order to define fuel economy and/or CO_2 emissions per vehicle model, governments adopt test cycles diverging on several aspects and modalities (e.g. average and max speed, max acceleration, length, external temperature). International initiatives have brought governments and OEMs together to work on new harmonized test procedures to be adopted around the world, but this process will probably take years to complete.
5. **Penalties:** Governments verify annually the compliance with targets for each OEM operating in the national market. In cases of non-compliance with automotive CO_2 regulations, governments establish sets of penalties ranging from economic fines to sales restriction to public statements.[7]
6. **Program flexibilities:** Governments allow for different degrees of flexibility in their automotive CO_2 regulations: subjects and selection criteria to help with these change country by country (Figure 3). The reason for program flexibility is to guarantee a fair regulatory "playing field" for all stakeholders (e.g. big vs. small OEMs, green-technology innovators vs. engine-technology followers) and address OEMs' investment toward cleaner vehicles. The regulatory complexity introduced by program flexibilities could represent either a threat or an opportunity for OEMs, depending on the ability of OEMs to leverage their knowledge of national automotive CO_2 regulations to take advantage of the regulatory framework.

Figure 3: Program Flexibilities for Main Car Markets (excerpt)

	USA	EU	China
Derogation for middle-volume manufacturer	✓	✓	
Derogation for small-volume manufacturer	✓	✓	
Pooling[1]	✓	✓	✓
Advantages for flexible-fuel[2] & alternative-fuel vehicles[3]	✓	✓	✓
Advantages for advanced technology vehicles[4]	✓	✓	✓
Eco-innovators[5]	✓	✓	
Banking and trading CO_2 emissions credits	✓		

[1] Manufacturers may form a pool for the purposes of meeting their obligations (Fuel economy and CO_2 emissions targets).
[2] Flexible-fuel vehicles (FFVs) can run both on an alternative fuel and conventional fuel.
[3] Dedicated alternative-fuel vehicles are vehicles that run exclusively on an alternative fuel.
[4] Electric vehicles (EVs) and fuel-cell vehicles (FCVs), and the electric portion of plug-in hybrid electric vehicles (PHEVs).
[5] Innovative technologies not captured on the current test cycle.

Source: Arthur D. Little analysis on government's documentation

5 OEMs' target defined on average vehicle fleet footprint or weight considering the vehicles sold in the year. China is the only country that also envisions a target per each car model sold in the same year.
6 Test cycle simulates a range of driving conditions (highway vs. urban driving) in order to assess CO_2 emissions and fuel economy for passenger cars.
7 For Asian countries such as Japan, South Korea and China, a public proclamation ("name and shame") on OEMs that exceeded target limits is considered the most severe form of punishment.

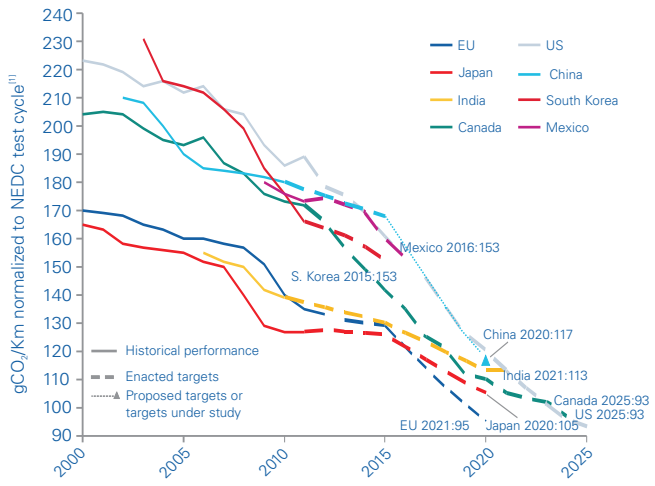
1.3 Comparison of Automotive CO_2 Regulations Target

Japan and Europe are the best performers in historical-fleet-average CO_2 emissions for passenger cars, and have set even more ambitious targets for 2020-2021 (105 and 95 gCO_2/km, respectively); a similar level of CO_2 emissions is set for the United States and Canada, but for 2025 (93 gCO_2/km) (Figure 4). Currently, both these countries are characterized by poor CO_2 emissions performance, as is China, but the reasons are different. In fact, the United States and Canada are typified by a high-average-engine-size fleet, China by an old one.

However, all three countries are planning higher CO_2 reduction rates (annual reduction equal to 4.9% for the US, 4.8% for China and 4.2% for Canada).

This means that in these markets OEMs' car portfolios will change soon in order to offer products appealing to fuel economy, safety, quality and convenience.

Figure 4: Mandatory CO_2 Regulations for Passenger Cars



[1] Conversion of fuel economy standard by NEDC test cycle

Source: International Council on Clean Transportation (ICCT) report, February 2014

1.4 Implications for the Automotive Sector

In this extremely fragmented regulatory framework, OEMs are directing their efforts toward cost-effective technologies to be applied to mass-production models (e.g. alternative fuels or hybrid electric engines).

These choices stem from OEMs' desires to:

- Respect automotive CO_2 regulation established for the short and mid-terms.
- Enhance the performance of large-engine vehicles, on which OEMs usually have better margins, but whose sales are likely to become tricky with future CO_2 scenario.
- Develop "green" core competencies to avoid leadership monopolies based on knowledge expertise.
- Retain a positive brand perception in the climate change debate.

A boost for OEMs' technology innovation and implementation could originate from government actions, such as in influencing the venture-capital sector to invest in automotive technologies and providing public money for R&D consortia and subsidies for customers who purchase fuel-efficient vehicles.

The Chinese government stands out as an interesting example of a state trying to improve the performance and competitiveness of its national OEMs against American and European OEMs by enthusiastically backing local, new-energy vehicle manufacturers.[8]

These incentives come in the form of both direct subsidies to OEMs to produce pure NEVs, and strategic partnerships to support their diffusion.[9]

8 New-energy vehicles: electric vehicles, plug-in hybrid electric vehicles and fuel-cell vehicles.

9 As the pledge of SGCC, China's largest power grid-state company, to build a total of 2,351 electric vehicle-charging facilities and battery-swap stations and 220,000 charging poles to meet the growing needs of the electric-vehicle industry.

2. The Main Drivers that have Influenced Current Automotive CO_2 Regulations

By carefully examining the historical evolution of automotive CO_2 regulations, it is possible to identify the main drivers influencing policy. Specifically, two links have been studied: the link relating automotive CO_2 regulations to oil prices and national oil dependency, and the link connecting automotive CO_2 regulations to climate change commitment.

2.1 Linkage between CO_2 Regulations, Oil Price and Oil Dependency

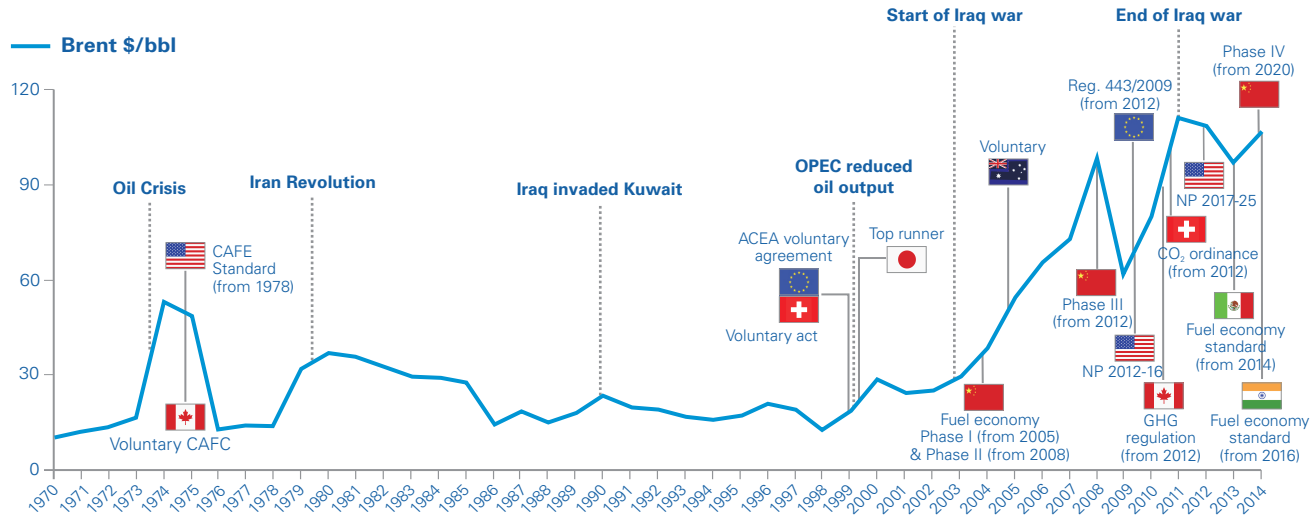
Oil price plays a fundamental role in defining the scope of automotive CO_2 regulations, in that whenever oil prices increase, regulations are introduced or made more stringent (Figure 5). This phenomenon has its roots in the desire for "energy independence", which leads countries to use automotive CO_2 regulations as a tool to decrease reliance on oil. This applies specifically to heavy oil importers that attempt to guarantee national economic stability and limit the impact of exogenous factors such as oil price and availability. The United States, historically an oil importer, introduced its vehicle fuel-efficiency regulations in 1975, just after the oil shortage caused by the oil crisis of 1973.[10] Likewise, an oil production cut undertaken by OPEC countries in 1998-1999 gave rise to automotive CO_2 regulations in Japan (mandatory) and the European Union (voluntary) – countries that are characterized by poor oil resources.

In recent times, the increasing price of oil following the Iraq War (2003-2011) remarkably changed the global CO_2 regulation framework.

On the one hand, industrialized states, traditionally relying on oil imports, adopted mandatory stringent targets (e.g. European Union member states and Japan); on the other hand, developing countries introduced some mandatory CO_2 regulations (e.g. China, India and Mexico) as a consequence of their inability to fully meet the increasing internal oil demand with their own resources.

To sum up, oil price and oil dependency affect automotive CO_2 regulations. The more a country relies on oil, the more it will suffer from an increase in oil prices and the more likely it will be to adopt new or introduce more stringent CO_2 regulations to improve national energy stability.

Figure 5: Automotive CO_2 Regulation's History[1]



Source: Global Data (Oil price); Arthur D. Little analysis

[1] In the figure is considered the adoption year of the regulation

10 The Oil Crisis started in October 1973, when the members of the Organization of Arab Petroleum Exporting Countries proclaimed an oil embargo.

2.2 Linkage between CO_2 Regulations and Climate Change Policies

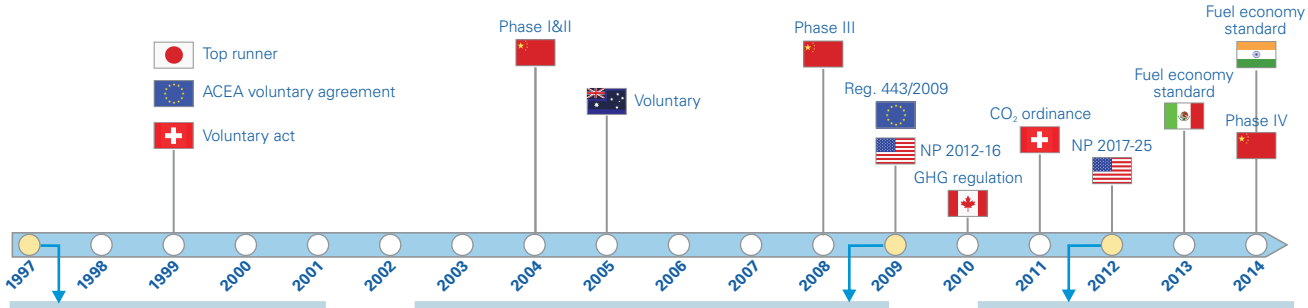
Climate change commitments on various levels are another influence on automotive CO_2 regulations. Despite the difficulty in clearly quantifying this relation, a linkage pattern is discernible when inspecting the historical evolution in automotive CO_2 worldwide. In particular, we notice that key events on the international agenda have generally resulted in the introduction of standards or the revision of previously implemented ones (target reductions) in the automotive sector as well.

Shortly after the Kyoto agreement of 1997, by which a group of industrialized countries agreed to legally binding emission limitations or reduction targets in two commitment periods (2008-2012 and 2013-2020),[11] the European Union and Switzerland introduced a voluntary regulation in the automotive sector, while Japan approved its mandatory regulation.

Another pivotal international discussion took place in Copenhagen in 2009 (COP 15) and constituted an occasion to fortify developed countries' commitments and encourage numerous developing countries to adopt voluntary national targets.[12] The effect of this conference is visible in the wealth of CO_2 regulations that followed in the years 2009-2012 in both developed and developing countries (Figure 6).

Lastly, during COP 18 in Doha (2012), the Kyoto Protocol was amended and updated with new targets for the second commitment period. However, the amendment to Kyoto is not legally binding yet, and has been able to attract only 15% of global emissions producers.[13] Due to its limited coverage and timing of implementation, COP 18's aftermath was not marked by substantial changes in automotive CO_2 regulations.

Figure 6: International Agreements on Climate Change vs. Automotive CO_2 Regulation History[1]



Kyoto Protocol
- EU sets 8% reduction target
- Switzerland sets 8% reduction target
- Japan sets 6% reduction target
- Canada sets 6% reduction target
- India takes no binding obligations
- China takes no binding obligations
- USA does not ratify the Protocol
- Brazil takes no binding obligations
- Mexico takes no binding obligations

COP 15 Copenhagen
- EU pledges a 20% reduction target
- Switzerland pledges a 20% reduction target
- Japan pledges a 25% reduction target
- Canada pledges a 17% reduction target
- India pledges a 25% reduction in emissions per unit of GDP
- China pledges a 45% reduction in national carbon intensity
- USA pledges a 17% reduction target
- Brazil pledges a 38.9% reduction in GHG emissions in 2020 compared to WEO projection for the same year
- Mexico pledges a decrease of 30% GHG emissions in 2020 compared to WEO projections for the same year

COP 18 Doha
- EU sets a 20% target for 2020
- Switzerland sets a16% reduction target
- Japan exits the Protocol
- Canada exits the Protocol
- India takes no binding obligations
- China takes no binding obligations
- USA takes no binding obligations
- Brazil takes no binding obligations
- Mexico takes no binding obligations

[1] In the figure is considered the adoption year of the regulation

Source: International Transport Forum 2010; Kyoto Protocol 1997; Doha Amendment to the Kyoto Protocol 2012

11 The parties with binding targets in the "first commitment period" were Australia, Bulgaria, Canada, Croatia, the Czech Republic, Estonia, the European Union, Hungary, Iceland, Japan, Latvia, Liechtenstein, Lithuania, Monaco, New Zealand, Norway, Poland, Romania, Russia Federation, Slovakia, Sweden, Switzerland and Ukraine. The parties with binding targets in the "second commitment period" were Australia, the European Union, Belarus, Iceland, Kazakhstan, Liechtenstein, Monaco, Norway, Switzerland, Ukraine.

12 Public pledges of governments during international climate change conferences: the Chinese government pledged a 40-45% reduction in national carbon intensity from 2005 levels by 2020; India pledged to cut CO_2 emissions per unit of GDP by 20-25% from 2005 levels by 2020; and Brazil pledged a decrease of 36.1% GHG emissions in 2020 compared to the BAU projection for the same year.

13 The US, Canada, Japan, Russia, Belarus, Ukraine and New Zealand and all developing countries did not commit to the target defined during COP 18.

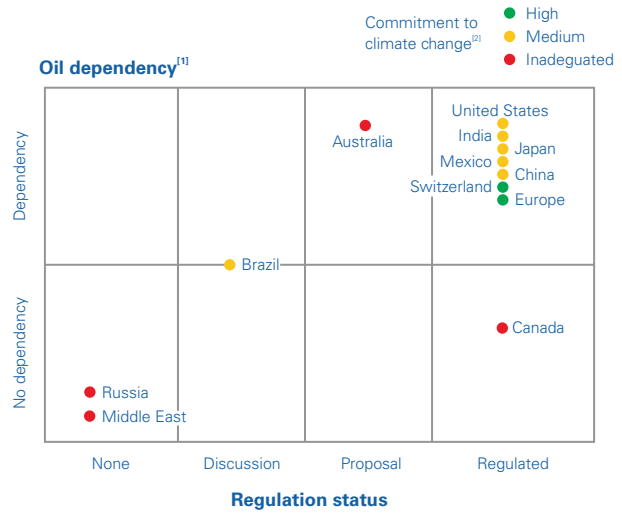
2.3 Behavior Matrix on Automotive CO_2 Regulations

Assessing the impact of oil dependency and climate change commitment on the regulation status, countries can be classified into two main behavior clusters (Figure 7).

The first cluster includes countries heavily dependent on oil imports, for the most part with medium-high commitments towards climate change (India, Switzerland, Japan, China and European Union countries); this group adopts mandatory CO_2 regulations.

The second group encircles countries abundant with oil resources and not highly devoted to climate change, such as Russia and the Middle East. Given their wealth of oil, these countries have no interest in enacting specific automotive CO_2 regulations.

Figure 7: Behavior Matrix on CO_2 Regulation



[1] Oil import/oil consumption
[2] Climate Action Tracker Index

Source: Arthur D. Little analysis, Global Data

Even if this cluster grouping is highly explanatory, certain countries present endemic characteristics and follow unique behaviors. For example, Australia is more dependent on oil imports because its national oil production has declined over 30% since 2000, while domestic consumption and demand for exports from Asia have increased.[14]

Thus, Australia has only recently begun to explore the possibility of introducing a mandatory CO_2 regulation.

Similarly, Brazil is just now developing its policy framework because the economic growth pressure of road transportation fuels demand that the sugarcane ethanol industry is not able to supply anymore.

Lastly, Canada presents itself as an outlier in the global scenario, being a highly regulated country with generous reserves; this choice is explained by the historic alignment of Canadian policies with American transportation regulations.

2.4 Other Additional Drivers

"Secondary" drivers that have to be monitored due to their potential impact on CO_2 regulations are traffic-control measures adopted by megacities and fiscal incentive programs.

2.4.1 The Role of the Megacities

Change in the regulatory landscape could also take place at city level. Actually, the 29 megacities account for 11% of global CO_2 emissions and represent the largest market for new cars.[15, 16] Megacities usually limit air pollution[17] and GHG emissions through traffic-control measures adopted at short notice, while regulatory initiatives at national level take years to be implemented (Figure 8).

CO_2 emissions and air pollutants are cogenerated from fossil fuel combustion of the operating vehicle, and traffic measures can act at local level as pollution abatement and carbon mitigation policies.

14 US Energy Information Administration.
15 Megacity: metropolitan area with a total population in excess of 10 million people.
16 US Energy Information Administration, CO_2 emissions per megacities.
17 According to the United Nations, the scale and impact of urban air pollution (UAP) is responsible for 1 million premature and 1 million pre-native deaths annually, with an overall cost of 2% (in developed countries) to 5% (in developing countries) of GDP.

Even if not directly linked to national regulation, megacities' traffic measures contribute to the achievement of air-quality, climate change and oil-saving goals and provide a hint of the national awareness towards those topics.

For these reasons, large cities could be considered a pacemaker for short-term changes in the national regulation policies.

2.4.2 Fiscal Incentives

Fiscal incentives are another useful instrument to reduce CO_2 emissions and fuel consumption, especially when paired with national CO_2 regulation.

These kinds of incentives can come in the form of registration fees, tax for ownership and fuel taxes, and could push the client to purchase cleaner vehicles (e.g. hybrid or "downsize" vehicles).

It is therefore appropriate to keep these measures in mind when analyzing the strategies governments can adopt to reach the goals.

Figure 8: Current Traffic Measures in Selected Megacities

London

Key traffic measures:

- **Congestion Charge Zone:** Fee charged on most motor vehicles operating in Central London (Exemption is linked to CO_2 emissions for cars that emit >100g/km).
- **Low-Emission Zone:** The zone covers most of Greater London. Truck, bus, coach or other specialist heavy diesel vehicles in the Low-Emission Zone (LEZ) need to meet certain emissions standards **(cars and motorcycles are not affected).**

Beijing

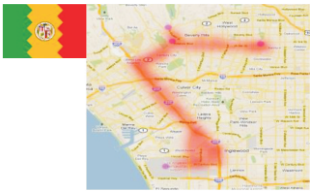
Key traffic measures:

- **Odd-even license plate system:** Allows cars to drive on alternate days, based on the license plate number (fine 100 yen).
- **Traffic restriction for non-residents of Beijing.**
- **Increasing parking fees.**
- **Control of license plates** (monthly plate lottery).
- In 2011 announced the introduction of **Congestion Charge - not implemented yet.**

Los Angeles

Key traffic measures:

- **High Occupancy Vehicle lanes (HOV):** Restricted traffic lanes for exclusive use of vehicles with a driver and one or more passengers.
- **High Occupancy Toll (HOT):** Congestion pricing that gives motorists in single-occupant vehicles access to HOV.
- **ATSAC:** (Automated Traffic Surveillance and Control).
- **Plans to improve public transport** (LA's 30/10).



Source: Arthur D. Little Lab, Future of Urban Mobility

3. Future Scenario in CO_2 Regulation

To predict the future development of automotive CO_2 regulations up to 2020, a wide set of drivers have been taken into consideration in order to define key trends and regulation stability in different countries.

The performed quantitative analyses have also been integrated with interviews with experts and opinion leaders to better understand future regulation framework of the key countries, as well as with discussions of pipeline and rumors.

In our prediction scenario, oil price is the main driver, subject to a high degree of uncertainty in the mid-term because it is affected by geopolitical events and national export strategies.

Other drivers (e.g. climate change commitment, oil consumption and dependency, GDP, car fleet) can be considered foreseeable.

For these reasons, the key parameter to define CO_2 regulation outlook reliability in the mid-term is oil price: if countries follow through with energy policies and measures that have been adopted as of the end of 2013 and remain consistent with their announced commitments, oil price is expected to reach 113 $/barrel in 2020.[18]

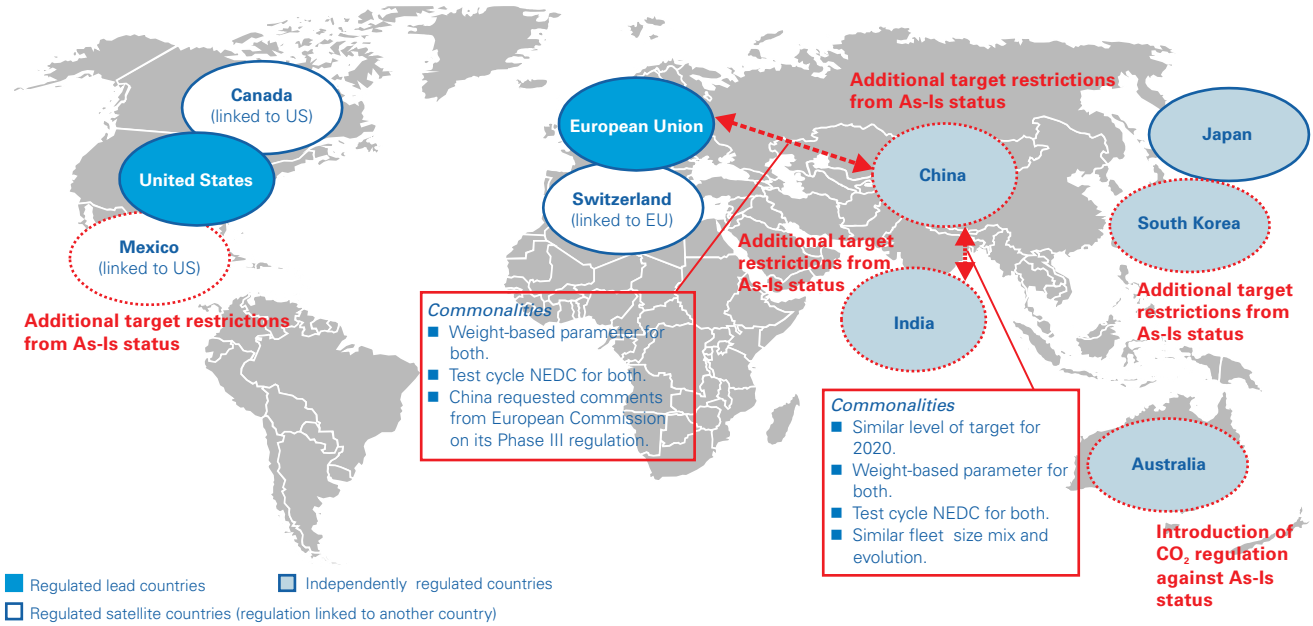
This steady increase is seen as the most probable future, as defined by the International Energy Agency, and is the basis for our predictions.[19]

3.1 2020 Automotive CO_2 Regulation Outlook (Figure 9)

On the basis of the assumptions stated above, countries that are regulated up to 2020 will not change their policies, given that they have prepared for a slight increase in oil price.

The only exceptions will be China and India, where a concurrence of factors such as a booming population, increasing wealth per capita and a growing demand for road

Figure 9: 2020 Automotive CO_2 Regulation Framework



Source: Arthur D. Little analysis

18 Brent Crude Oil spot price as of June 1st, 2014: 109.34 US dollars per barrel.
19 *World Energy Outlook 2013*, International Energy Agency.

transportation fuel will contribute to the introduction of stricter standards. Regarding the countries with "expiring" regulation, Mexico will introduce new fuel economy and CO_2 emissions regulations, keeping the scheme and targets aligned with US regulation in order to regulate the year from 2017; South Korea will set new fuel economy and CO_2 emissions regulations, reducing the 2020 target to the level of best performers Japan and the European Union (105 vs 95 gCO_2/km).[20]

As far as unregulated countries are concerned, oil-independent countries such as Russia and the Middle East will rely on their abundance of resources without adopting any CO_2 regulations.

Instead, Australia, which is currently unregulated, will resort to detailed and binding automotive CO_2 regulations in the hope of curbing its oil dependency.

Brazil will continue to focus on fiscal incentives to push technological innovation and reduce fuel consumption from the road transportation sector.

In terms of future political balance in the field of automotive CO_2 regulations, two countries will be identified as leaders/trendsetters.

The first is the United States' policy reference for Canada and Mexico; the second is the European Union, which will provide a regulatory example for Switzerland. Furthermore, between the European Union and China, there will be strong commonalities in automotive CO_2 regulations, with the Chinese government having already requested the European Commission's point of view on its Phase III regulation and expressed the desire to promote a common high level of regulatory scheme to make trading easier for Chinese and European automotive companies.[21]

In turn, China will keep alignment with India given their similarities in terms of regulation strategies (e.g. target level) and car-fleet evolution (increase in car number and average weight of the new car fleet).

Lastly, Japan, South Korea and Australia will be independently regulated countries.

20 gCO_2/km normalized to NEDC test cycle.

21 The European Union's comments are focused on: more clarity on target calculation methods; introduction of flexibility clauses for manufacturers (e.g. free pooling); clarity on the penalty system; derogation for small-volume manufacturers.

4. Take-aways for OEMs and Suppliers

With more stringent and converging CO_2 emission standards in both advanced and emerging markets, OEMs will have to think about their CO_2 strategies globally.

This means new vehicles will have to be launched in a more synchronized way, which should somehow accelerate the introduction of new technology solutions worldwide, and thus the effort of OEMs ahead.

Technology such as aerodynamic, lightweight-design, energy-recovery ICE technologies (e.g. turbo direct injection) and NEV technologies (e.g. BEV, PHEV) will be more critical than ever to making the necessary improvement steps in performance and meeting more stringent emission requirements.

Alliances with other OEMs will be needed to share simultaneous investments in either technologies or vehicle platforms, with benefits on overall CO_2 performance.

On the one hand, OEMs will have to decide upfront which technologies they want to focus their own resources on (e.g. PHEV or BEV).

Depending on their footprints and exposure to national regulations, suppliers also will have to position themselves and bet on the right upcoming winning technologies.

This supposes a closed monitoring of regulation and market developments, but also a high level of cooperation with their preferred OEM clients.

In the last years, Arthur D. Little has been a strategic business partner for OEMs and suppliers: the CO_2 regulatory management advice provided by Arthur D. Little to its clients has helped them face future challenging in order to:

- Collect and update CO_2 regulation worldwide.
- Define CO_2 strategic options.
- Engage client's stakeholders.

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Arthur D. Little

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Arthur D. Little has offices in the most important business cities around the world. We are proud to serve many of the Fortune 500 companies globally, in addition to other leading firms and public sector organizations.

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