Fuel Economy in Montenegro

Regional Implementation of the Global Fuel Economy Initiative (GFEI)

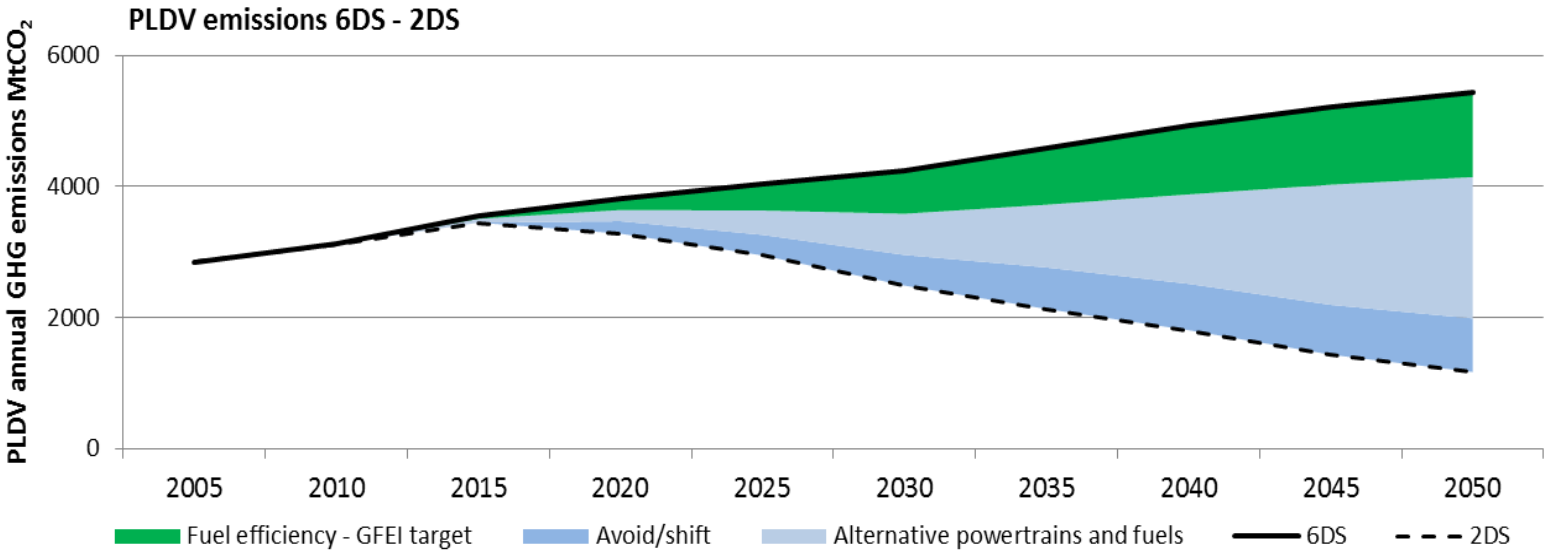
Podgorica, Nov 20 2015

alex_koerner@gmx.de

Content

- Introduction
- Fuel economy policies & instruments
- Fuel economy baseline data and methodology
- Fuel Economy Policy Instruments tool - FEPIT

Car fuel economy is a “low-hanging fruit” for GHG mitigation



- Transport accounts for 23% of energy related carbon emissions
- Improving fuel economy by 50% until 2050 can save up to 33 Gt CO_2 and up to USD 8 trillion globally

Typical national objectives related to fuel economy policies

- Reduce oil dependence (diversify fuels)
- Improve balance of payments
- Reduce pollutant emissions
- Reduce greenhouse gases
- Promote domestic economies/jobs

Fuel economy context

- **Fuel economy improvement can be achieved through**
  - Technical changes to vehicles
  - Changing the types of vehicles bought
  - Improving vehicle maintenance
  - Changing the way vehicles are driven (ecodriving)
  - Reducing traffic congestion
- **Fuel economy improvement to vehicles should be part of a broader strategy:**
  - Traffic management
  - City and regional planning
  - Promotion of public transit

Fuel economy policies and instruments

FE policies & instruments

1. **Regulatory – Fuel economy/CO_2 emission standard**
2. **Monetary – Fiscal instruments**
   - Vehicle registration/circulation tax
   - Feebate scheme
   - Fuel tax
   - Road pricing
3. **"Soft measures" – Consumer information**
   - Labelling schemes

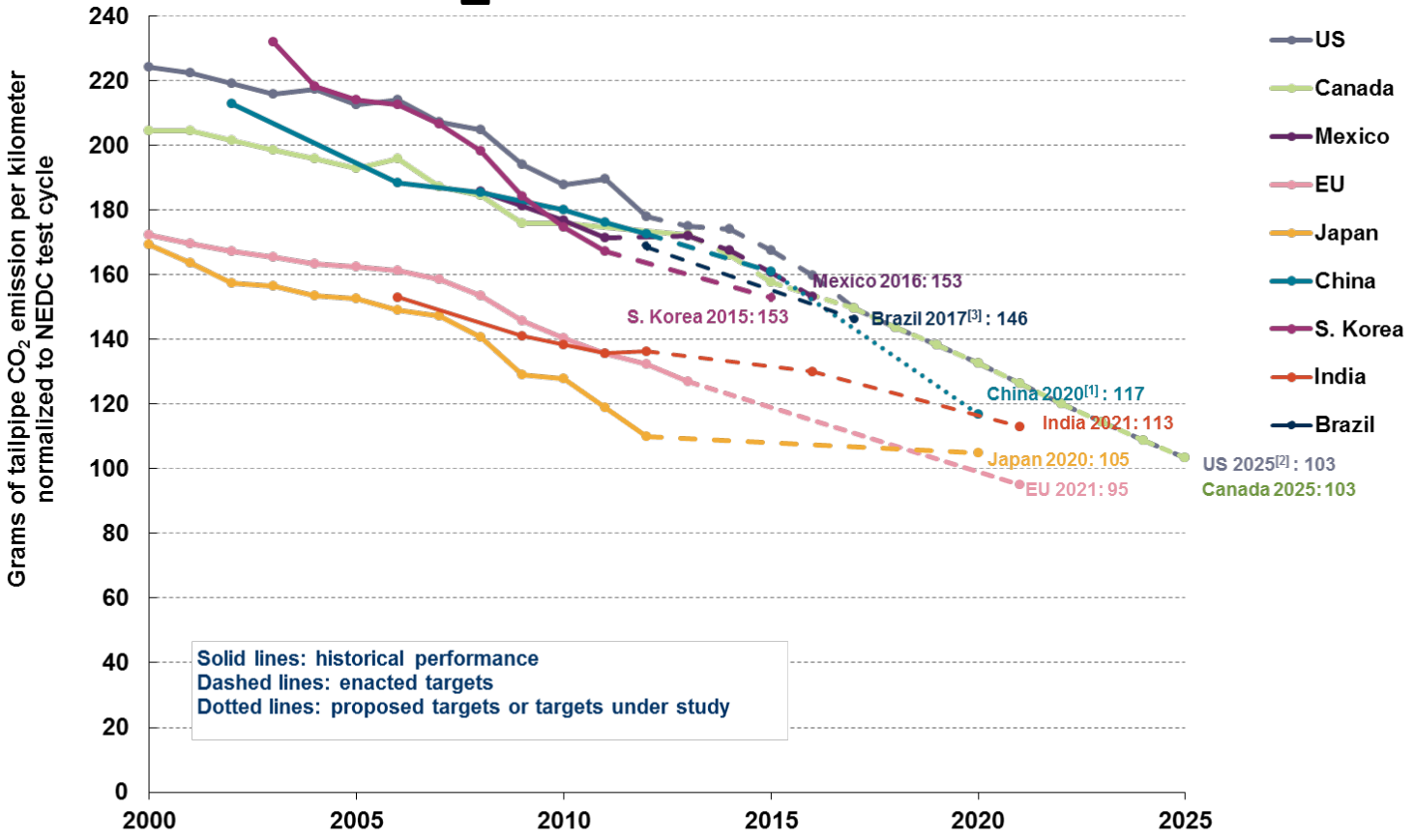
ICCT: Design Elements For Effective Incentives

- Base fiscal charges directly on vehicle fuel consumption levels, instead of vehicle physical attribute, avoid fixed charges
- Apply the incentive widely across fleet, instead of limiting to a portion of the fleet
- Provide continuous incentive on every fuel consumption or fuel consumption level
- Targeted incentive programs should also be linked to fuel consumption

FE/ CO_2 emission standards

- **Regulation of corporate average fuel economy/CO2 emission *of new cars* - based on sales weighted average (EU) or harmonic mean (US)**
- **Inclusion of super-credits for alternative fuel vehicles – e.g. multiplier on BEVs sales**
- **Efficient measure for countries with:**
  - Own car manufacturing
  - Big LDV markets

FE/ CO_2 emission standards



[1] China's target reflects gasoline vehicles only. The target may be higher after new energy vehicles are considered.
[2] US fuel economy stadards set by NHTSA reflecting tailpipe GHG emission (i.e. exclude low-GWP refrigerant credits).
[3] Gasoline in Brazil contains 22% of ethanol (E22), all data in the chart have been converted to gasoline (E00) equivalent
[4] Supporting data can be found at: http://www.theicct.org/info-tools/global-passenger-vehicle-standards.

Source: ICCT

- **About 80% of the global LDV market are already regulated**

CO_2 emission standard in the EU

- **2009: Introduction of mandatory CO_2 standard**
- **2015 target: 135 gCO_2/km**

  → 2014 average new vehicle fleet emission:

  123 gCO_2/km
- **2020 target: 95 gCO_2/km – with phase-in time effective by 2021**
- **Currently discussion of post 2021 targets**
  - 2030: overall reduction of GHG by 40% (compared to 1990)
  - 2050: transport emission reduction of 60%
- **WLTP – new driving cycle for vehicle testing, effective from 2017 onwards**

Fiscal measures

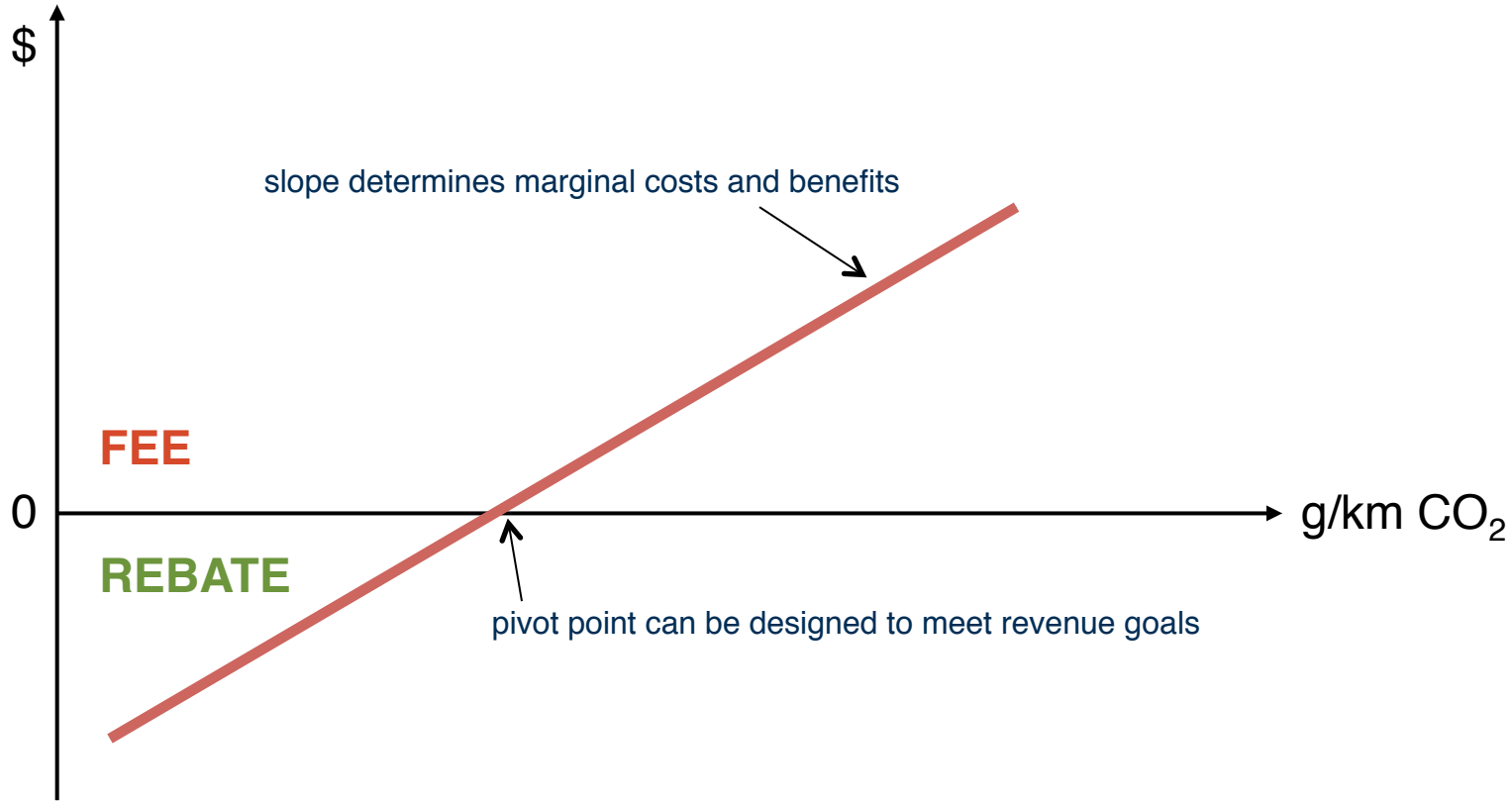
Fiscal policy type	Characteristics
Fuel tax	Set by fuel type; paid upon refueling
Vehicle circulation tax	Typically paid at annual registration; can be CO2-adjusted
Road pricing	Paid by km of driving or when passing a cordon line
Vehicle purchase tax/feebates	Paid at time of purchase; can be differentiated by fuel economy or CO2

What is a Feebate?

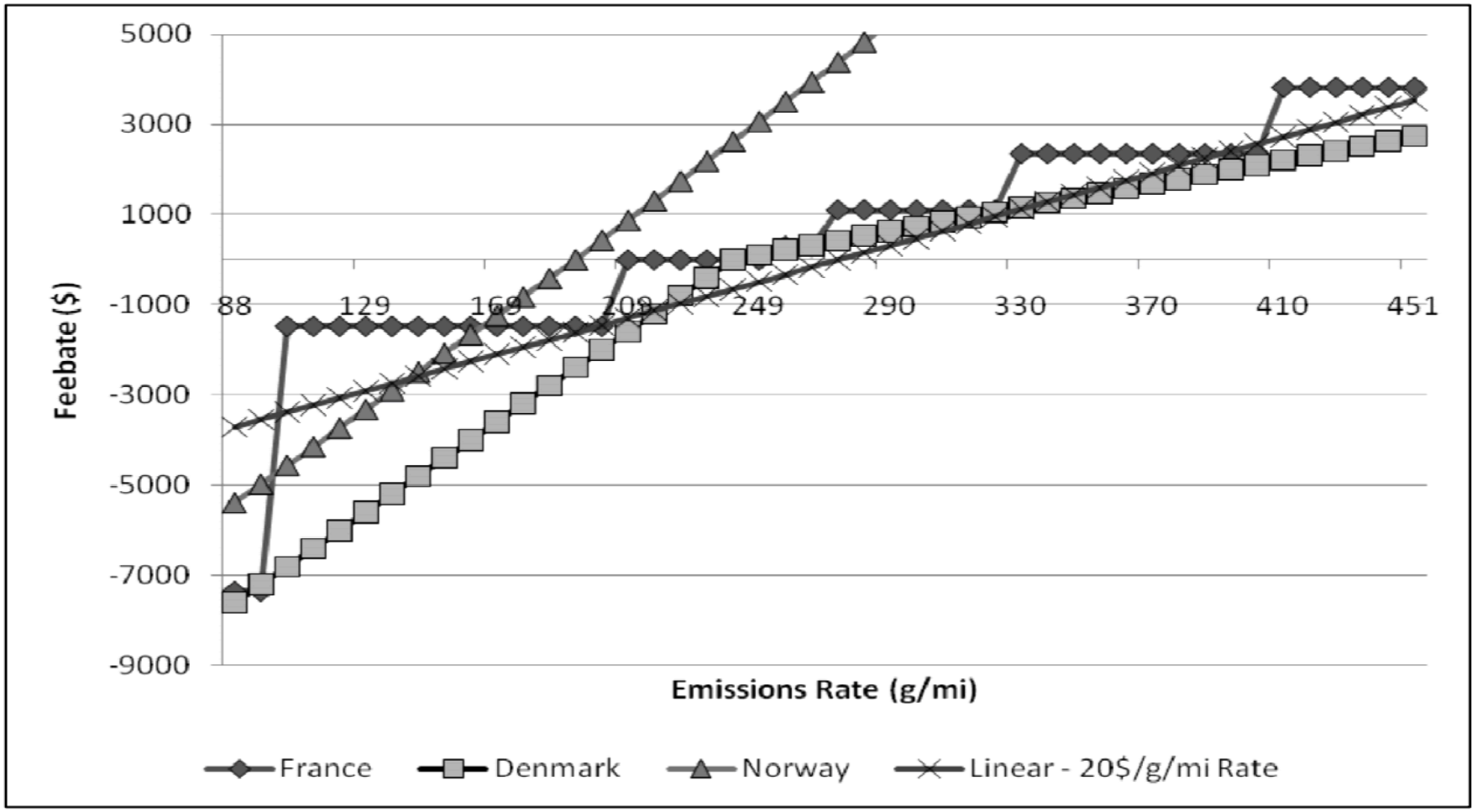
Feebate = Fee + Rebate

- Market-based policy that shifts consumer purchases (and potentially manufacturer production) to lower emission vehicles by placing a fee on higher-emitting vehicles and providing a rebate to lower-emitting vehicles
- Based on fuel economy or CO_2 differential between vehicles
- Could also take into account vehicle attributes like size or weight

How to design a feebate system?

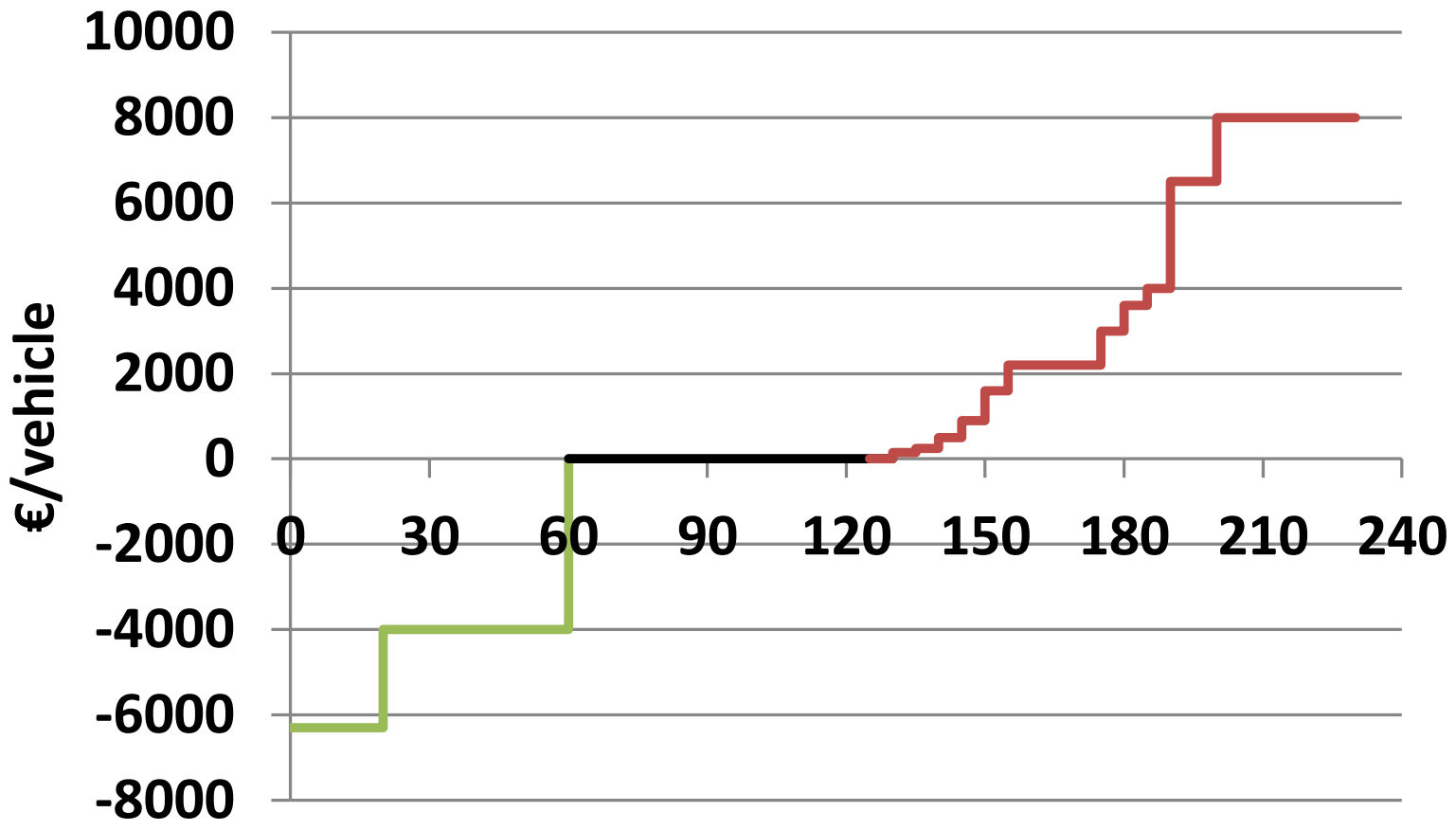


Feebates around Europe – many systems



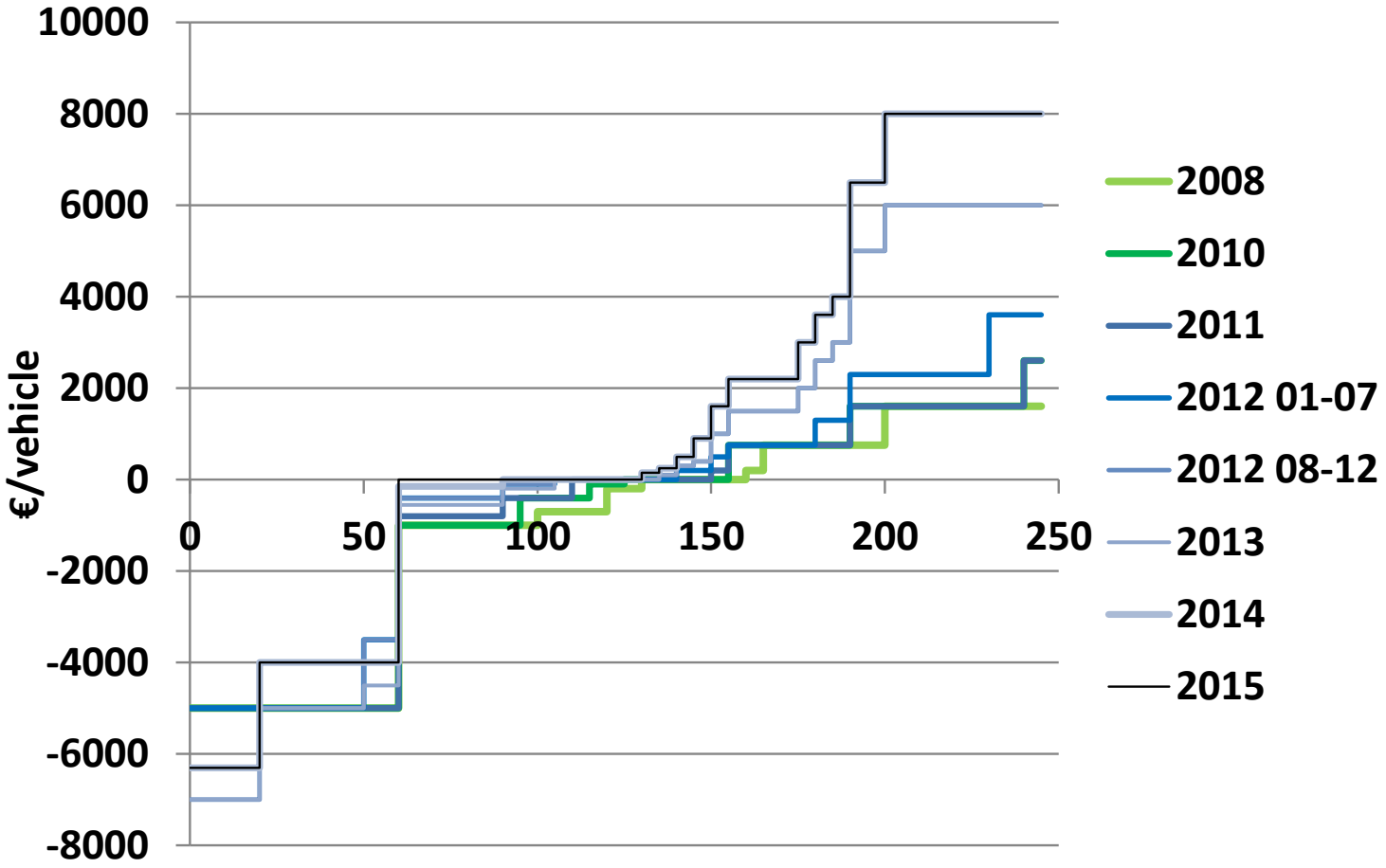
Source: Bunch and Greene

French feebate schedule 2015



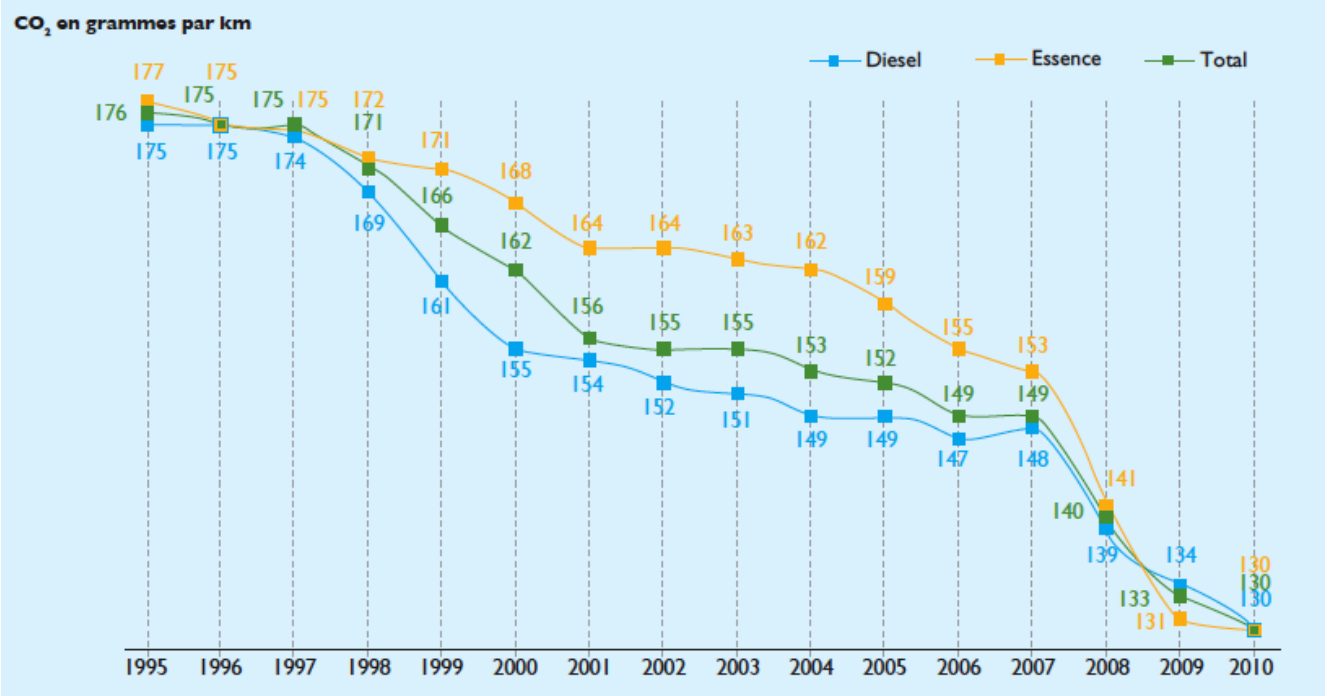
- The only vehicles receiving rebates have 60 g/km or below

French feebate schedule over time



- The fees have risen and the rebates declined

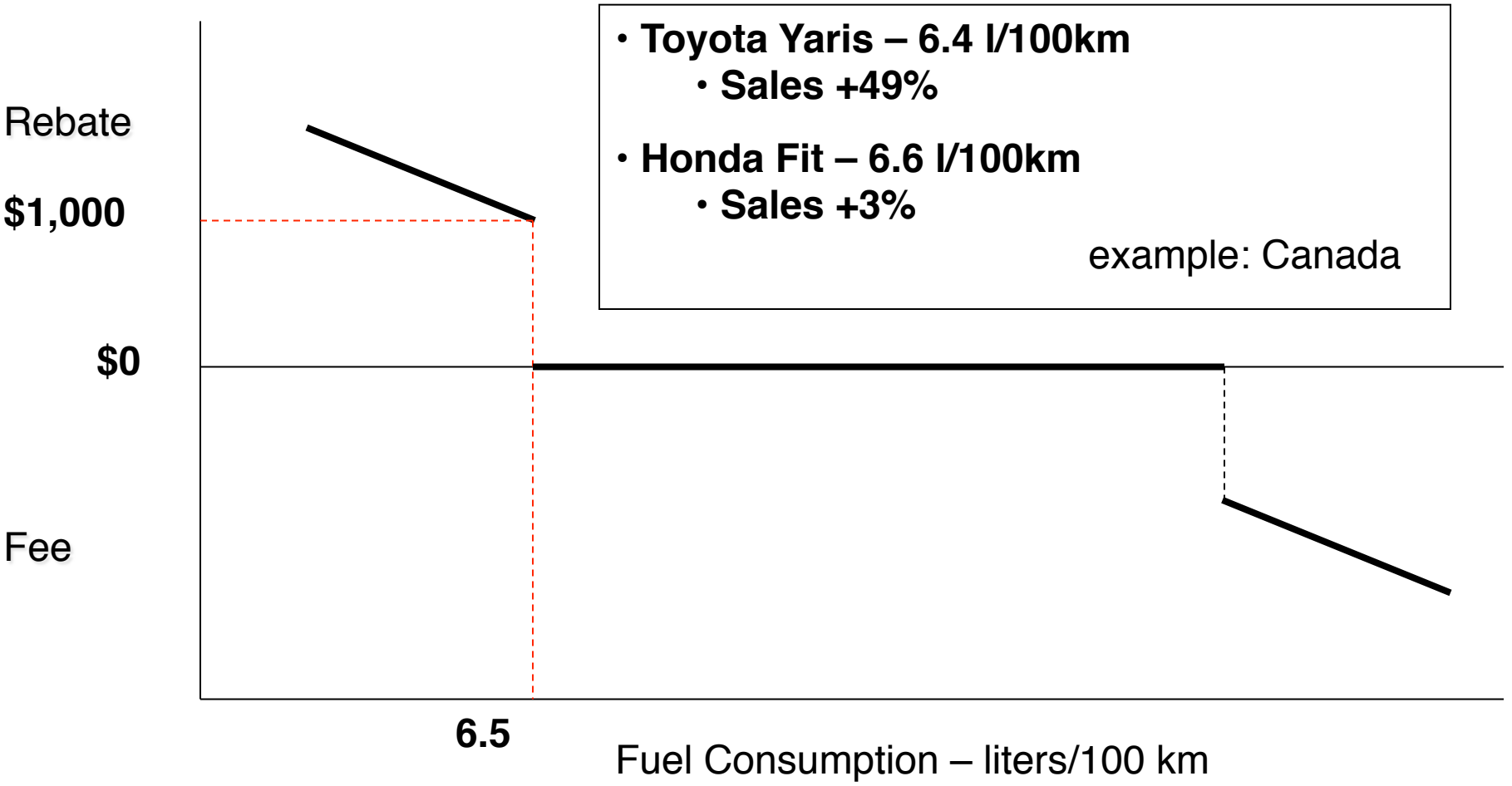
French feebate system led to significant drop in CO_2 emissions



Source: Les véhicules particuliers en France (Ademe), March 2011

- **2001–2007 avg. reduction new vehicle CO2 = 1 g/km per year**
- **2008: emissions drop 9 g/km and 2009 by 7 g/km, Ministry of Transport attributes to introduction of bonus/malus system**
- **Cost 2008: 225 Million EUR – not cost neutral! → Changed 2010/2011**

Important to have a continuous slope, no steps



Standards v. Feebates

Standards	Feebates
"Guarantee" a minimum level of fuel economy	Do not guarantee level
No incentive to go beyond minimum	On-going incentive
Must be regularly updated to maintain pressure	Must be regularly updated to meet revenue targets
No cap on costs	Provide a cap on cost
Could ban some vehicles	Wouldn't ban any vehicles
No clear price signals	Clear price signals to consumers and producers

Source: Bunch and Greene

Fuel economy baseline data and methodology

GFEI target – Maximising the benefits of improved fuel economy

- Reduce new passenger light-duty vehicle fuel consumption (Lge/100km) by 50% until 2030 globally

- Reduce passenger light-duty vehicle stock fuel consumption (Lge/100km) by 50% until 2050 globally

Technical steps to introduce FE policies

- Baseline – What is the average fuel economy of new passenger vehicles sold today in your country?
- Target – Where will fuel economy need to be in the future?
- Identification of policies – Which measures are appropriate to reach the target?
- Quantification of policy measures – regulatory, monetary and soft measures

FE baseline – newly registered vehicles are of interest

- **FE policy instruments such as standards, feebates, registration taxes or import taxes target newly registered vehicles only**
- **New registrations are relatively easy to influence**
- **Baseline setting for vehicle stock in use more complicated**
  - Much more older cars – difficulty to find FE data
- **Vehicle stock only targeted by fuel and vehicle circulation tax**

FE baseline setting: How to get from the vehicle registration database to average new vehicle FE?

Country	Year	Vehicle Type	Model	Engine ccm	Engine kW	Fuel type	Transmission type	Emission standard	Vehicles registered	Final FE data, lge/100km
xxx	2013	Pass.	VW Polo	1199	55	Diesel	Manual	EURO5	614	4.1
xxx	2013	Pass.	VW Polo	1199	55	Diesel	Manual	EURO5	512	3.7
xxx	2013	Pass.	Renault Clio	1461	55	Diesel	Manual	EURO5	1474	3.9
xxx	2013	Pass.	Renault Clio	1461	55	Diesel	Manual	EURO5	1448	4.1
xxx	2013	Pass.	Renault Clio	1461	55	Diesel	Manual	EURO5	1140	4.3
xxx	2013	Pass.	Suzuki Grand Vitara	1870	95	Diesel	Manual	EURO5	217	7.5
xxx	2013	Pass.	Jaguar XF	2179	147	Diesel	Automatic	EURO5	20	5.8
xxx	2013	Pass.	Audi A7	2967	180	Diesel	Automatic	EURO5	37	6.5
xxx	2013	Pass.	Audi A7	2967	180	Diesel	Automatic	EURO6	29	6.4
xxx	2013	Pass.	BMW 535	2993	230	Diesel	Automatic	EURO6	2	6.0
xxx	2013	Pass.	BMW 535	2993	230	Diesel	Automatic	EURO5	1	6.2
xxx	2013	Pass.	Jeep Grand Cherokee	2987	184	Diesel	Automatic	EURO5	97	8.1
xxx	2013	Pass.	BMW X6	2993	180	Diesel	Automatic	EURO5	61	8.0
xxx	2013	Pass.	Citroen C5	1560	84	Diesel	Manual	EURO5	286	5.2
xxx	2013	Pass.	Citroen C5	1560	84	Diesel	Automatic	EURO5	247	4.8

Sales weighted average FE

SUM =SUMPRODUCT(J2:J16,K2:K16)/SUM(J2:J16)

SUMPRODUCT(**array1**, [array2], [array3], [array4], ...)

	A	B	C	D	E	F	G	H	I	J	K
1	Country	Year	Vehicle Type	Model	Engine ccm	Engine kW	Fuel type	Transmission type	Emission standard	Vehicles registered	Final FE data, lge/100km
2	xxx	2013	Pass.	VW Polo	1199	55	Diesel	Manual	EURO5	614	4.1
3	xxx	2013	Pass.	VW Polo	1199	55	Diesel	Manual	EURO5	512	3.7
4	xxx	2013	Pass.	Renault Clio	1461	55	Diesel	Manual	EURO5	1474	3.9
5	xxx	2013	Pass.	Renault Clio	1461	55	Diesel	Manual	EURO5	1448	4.1
6	xxx	2013	Pass.	Renault Clio	1461	55	Diesel	Manual	EURO5	1140	4.3
7	xxx	2013	Pass.	Suzuki Grand Vitara	1870	95	Diesel	Manual	EURO5	217	7.5
8	xxx	2013	Pass.	Jaguar XF	2967	147	Diesel	Automatic	EURO5	20	5.8
9	xxx	2013	Pass.	Audi A7	2967	180	Diesel	Automatic	EURO5	37	6.5
10	xxx	2013	Pass.	Audi A7	2967	180	Diesel	Automatic	EURO6	29	6.4
11	xxx	2013	Pass.	Audi A5	2967	230	Diesel	Automatic	EURO6	2	6.0
12	xxx	2013	Pass.	BMW 335	2993	225	Diesel	Automatic	EURO5	1	6.2
13	xxx	2013	Pass.	Jeep Grand Cherokee	2987	184	Diesel	Automatic	EURO5	97	8.1
14	xxx	2013	Pass.	BMW X6	2993	180	Diesel	Automatic	EURO5	61	8.0
15	xxx	2013	Pass.	Citroen C5	1560	84	Diesel	Manual	EURO5	286	5.2
16	xxx	2013	Pass.	Citroen C5	1560	84	Diesel	Automatic	EURO5	247	4.8
17											
18	Total average									6185	4.4
19											
20	<4									1986	3.8
21	4 to 5									3449	4.2
22	5 to 6									306	5.2
23	6 to 7									69	6.4
24	>7									375	7.7

$$FE = \sum_{i}^{n} Sales_i \times FE_i \; / \sum_{i}^{n} Sales_i$$

Baseline – minimum data requirement

Number of sales in at least one past year by:

- Vehicle make and model (e.g. Toyota Corolla)
- Year of first registration
- Model production year (important for used imports)
- Engine displacement (liters or cubic centimeters)
- Engine power (kW or HP)
- Fuel type (e.g. gasoline, diesel, LPG, CNG, electricity)
- Rated fuel economy (Lge/100km, alternatively CO_2 emission, gCO_2/km) and test cycle basis (NEDC, FTP, JC08)

Baseline data – “nice to have”

Number of sales in at least one past year by:

- Transmission type (automatic, number of gears)
- Vehicle footprint (wheelbase x track width)
- Vehicle weight (mass in running order)
- Axle configuration (4x2, 4x4)
- Vehicle price

Baseline setting challenges

- **Level of detail available**
  - Accuracy depends on level of detail of registration database – ideally: Manufacturer, model, engine displacement, engine power, fuel, transmission
- **Used imports vs. new sales**
- **Availability of alternative sources to fill gaps, example: FE data by model**
  - FE data – EEA, EPA, Chinese government website…

Filling the fuel economy data

Country	Year	Vehicle Type	Model	Engine ccm	Engine kW	Fuel type	Transmission type	Emission standard	Vehicles registered	Final FE data, lge/100km
xxx	2013	Pass.	VW Polo	1199	55	Diesel	Manual	EURO5	614	4.1
xxx	2013	Pass.	VW Polo	1199	55	Diesel	Manual	EURO5	512	3.7
xxx	2013	Pass.	Renault Clio	1461	55	Diesel	Manual	EURO5	1474	3.9
xxx	2013	Pass.	Renault Clio	1461	55	Diesel	Manual	EURO5	1448	4.1
xxx	2013	Pass.	Renault Clio	1461	55	Diesel	Manual	EURO5	1140	4.3
xxx	2013	Pass.	Suzuki Grand Vitara	1870	95	Diesel	Manual	EURO5	217	7.5
xxx	2013	Pass.	Jaguar XF	2179	147	Diesel	Automatic	EURO5	20	5.8
xxx	2013	Pass.	Audi A7	2967	180	Diesel	Automatic	EURO5	37	6.5
xxx	2013	Pass.	Audi A7	2967	180	Diesel	Automatic	EURO6	29	6.4
xxx	2013	Pass.	BMW 535	2993	230	Diesel	Automatic	EURO6	2	6.0
xxx	2013	Pass.	BMW 535	2993	230	Diesel	Automatic	EURO5	1	6.2
xxx	2013	Pass.	Jeep Grand Cherokee	2987	184	Diesel	Automatic	EURO5	97	8.1
xxx	2013	Pass.	BMW X6	2993	180	Diesel	Automatic	EURO5	61	8.0
xxx	2013	Pass.	Citroen C5	1560	84	Diesel	Manual	EURO5	286	5.2
xxx	2013	Pass.	Citroen C5	1560	84	Diesel	Automatic	EURO5	247	4.8

- **Targeted FE coverage: 85% of the newly registered cars**
- **Identification of the best selling 20 to 50 models (based on above criteria)**
- **Match with FE data sources**

Freely available FE data by model

Country	Source
Australia	Green Vehicle Guide Factsheets
	http://www.greenvehicleguide.gov.au
Brazil	Programa Brasiliero de Etiquetagem
	http://pbeveicular.petrobras.com.br/TabelaConsumo.aspx
Chile	Comparador de Autos
	http://www.consumovehicular.cl/?q=comparador
China	轻型汽车燃料消耗量通告 通告日期
	http://chinaafc.miit.gov.cn/n2257/n2280/index.html
European Union (EEA)	Monitoring of CO2 emissions from passenger cars – Regulation 443/2009
	http://www.eea.europa.eu/data-and-maps/data/co2-cars-emission-8#tab-european-data
France	Consommation conventionnelles de carburant et émissions de gaz carbonique
	http://www2.ademe.fr/servlet/getDoc?cid=96&m=3&id=52820&p1=00&p2=12&ref=17597
Japan	自動車燃費一覧
	http://www.mlit.go.jp/jidosha/jidosha_fr10_000019.html
Mexico	Indicadores de Eficiencia Energética y Emisiones Vehiculares
	http://www.ecovehiculos.gob.mx/
Singapore	One Motoring Fuel Cost Calculator
	https://vrl.lta.gov.sg/lta/vrl/action/pubfunc?ID=FuelCostCalculator
South Korea	소비자 체감에 부합하는 새로운 연비표시 방법 확정
	http://bpms.kemco.or.kr/transport_2012/main/main.aspx
South Africa	COMPARATIVE PASSENGER CAR FUEL ECONOMY AND CO2 EMISSIONS DATA
	http://www.naamsa.co.za/ecelabels/
Switzerland	Automobil Revue catalogue
	http://katalog.automobilrevue.ch/
UK	Car Fuel Data Booklet
	http://carfueldata.direct.gov.uk/
	To download the data
	http://carfueldata.dft.gov.uk/downloads/
US	DoE / EPA Fuel Economy ratings
	http://www.fueleconomy.gov/
	To download the data
	http://www.fueleconomy.gov/feg/download.shtml

Source:

Draft guideline for fuel economy baseline-setting

FE data – fuel conversion

L/100km to Lge/100km	Diesel	FE*1.08
Retrofit adjustment	CNG	FE*1.12
	LPG	FE*1.15

- **The first conversion factor accounts for the different energy densities of gasoline and diesel to convert L/100km to LGE/100km**
- **The retrofit adjustment accounts for the efficiency losses of cars when retrofitted to LPG or CNG.**

FE data – Driving cycle conversion

Gasoline	Unit: gCO2 per km	NEDC to CAFE	CAFE	=	0.8658	*	NEDC	+	14.076
		CAFE to NEDC	NEDC	=	1.1325	*	CAFE	-	13.739
		JC08 to CAFE	CAFE	=	0.7212	*	JC08	+	36.736
		CAFE to JC08	JC08	=	1.2749	*	CAFE	-	38.423
		JC08 to NEDC	NEDC	=	0.8457	*	JC08	+	24.840
		NEDC to JC08	JC08	=	1.1430	*	NEDC	-	24.907
Diesel	Unit: gCO2 per km	NEDC to CAFE	CAFE	=	0.7683	*	NEDC	+	23.928
		CAFE to NEDC	NEDC	=	1.2209	*	CAFE	-	21.218
		JC08 to CAFE	CAFE	=	0.6050	*	JC08	+	44.338
		CAFE to JC08	JC08	=	1.3691	*	CAFE	-	38.393
		JC08 to NEDC	NEDC	=	0.8230	*	JC08	+	21.950
		NEDC to JC08	JC08	=	1.1720	*	NEDC	-	21.122

Introduction to FEPIT

Purpose of FEPIT

- Simple tool to estimate the impact of selected policy measures on the average fuel economy of newly registered cars in a given year in the future
- Support for decision makers to implement policy schemes to achieve region specific fuel economy targets in the light of the GFEI target
- Light application running in MS EXCEL with limited data requirements and with a simple and user-friendly interface
- Does not replace in-depth policy study: magnitude of the impact of the policy measures rather than exact forecast

Data requirement – FE baseline & additional info

- **New registrations by fuel economy segment for at least one past year**
- **Average fuel economy by fuel economy segment of all newly registered cars for at least one past year**
- **Additional Information on:**
  - Vehicle taxation (registration and circulation tax/feebate)
  - Fuel price and fuel taxation
  - Fuel composition of newly registered cars (gasoline/diesel)

Policy measures in FEPIT

- Fuel economy regulation/standard
- CO_2-Based Vehicle registration tax/feebate scheme
- CO_2-Based Vehicle circulation tax/feebate scheme
- Fuel taxation

Eco-labelling not explicitly considered: it is assumed to be a pre-requisite for the application for all other policies

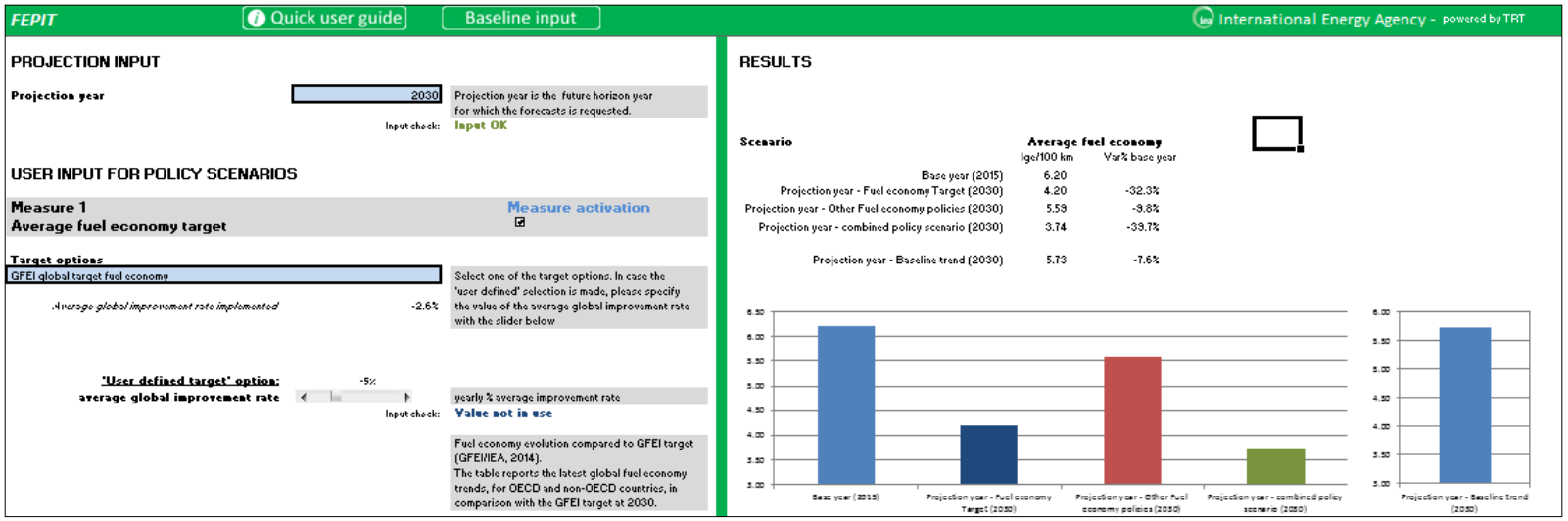
Use of FEPIT

1.) Baseline input

- Filling the baseline input fields

2.) Projection input and results worksheet:

- Setting the assumptions for the policy scenarios
- Reading the results of the calculations



FEPIT input – New car registrations

Baseline input worksheet

- **New cars registrations**

NEW CARS REGISTRATIONS

New registrations classes

Fuel consumption thresholds

	(lge/100km)
ICE <	4.0
ICE 4-	5.0
ICE 5-	6.0
ICE 6-	7.0
ICE >	7.0

Input check: Input OK

These values define the segments used by the tool to represent the registration mix of conventional Internal Combustion Engine cars.
CO2 based vehicle taxation policies are described in the tool by applying taxes differentiated according to these segments.
See the user guide for more details on the choice of the thresholds

New registrations composition

Composition for Base year (2015)

Battery electric	0.0%
Hybrid Plug-in electric	0.0%
Hybrid electric	0.3%
ICE <4 lge/100km	0.5%
ICE 4-5 lge/100km	9.0%
ICE 5-6 lge/100km	44.4%
ICE 6-7 lge/100km	28.8%
ICE >7 lge/100km	17.1%

Input check: Input OK

The composition of new registrations is defined in terms of share of cars registered in each segment (according to the classes defined above).
Hybrid (electric and plug-in) and battery electric cars are kept separeted.
The sum of the shares has to be 100%.

FEPIT input – FE by segment

Baseline input worksheet – fuel economy

NEW CARS FUEL ECONOMY

Average fuel consumption

Fuel consumption by segment for Base year (2015)	(lge/100km)	
Battery electric	1.50	The average fuel consumption has to be defined according to the new registrations classes defined above. It is expressed in terms of lge/100 km (litre-gasoline-equivalent per 100 kilometre).
Hybrid Plug-in electric	3.00	
Hybrid electric	4.50	
ICE <4 lge/100km	3.86	
ICE 4-5 lge/100km	4.71	
ICE 5-6 lge/100km	5.54	
ICE 6-7 lge/100km	6.47	
ICE >7 lge/100km	8.35	
	Input check:	Input OK

Past year		This is a past year for which data on fuel consumption by car segment is available.
	Input check:	Past year not in use

Fuel consumption by segment for Past year ()	(lge/100km)	
Battery electric		Data related to past year is used to estimate the endogenous changing fuel consumption of new registrations according to past trend. If past year data is not available cells should be empty
Hybrid Plug-in electric		
Hybrid electric		
ICE <4 lge/100km		
ICE 4-5 lge/100km		
ICE 5-6 lge/100km		
ICE 6-7 lge/100km		
ICE >7 lge/100km		
	Input check:	Input OK

FEPIT input – Vehicle taxation

Baseline input worksheet

- **Vehicle taxation in the base year**
  - Level of registration tax for each car segment, net of any value added tax
  - level of circulation tax for each car segment

VEHICLE TAXATION

Average REGISTRATION tax in the base year

Tax level by segment for Base year (2015)	($)
Battery electric	0.00
Hybrid Plug-in electric	0.00
Hybrid electric	0.00
ICE <4 lge/100km	150.00
ICE 4-5 lge/100km	500.00
ICE 5-6 lge/100km	1000.00
ICE 6-7 lge/100km	2000.00
ICE >7 lge/100km	3000.00
Input check:	Input OK

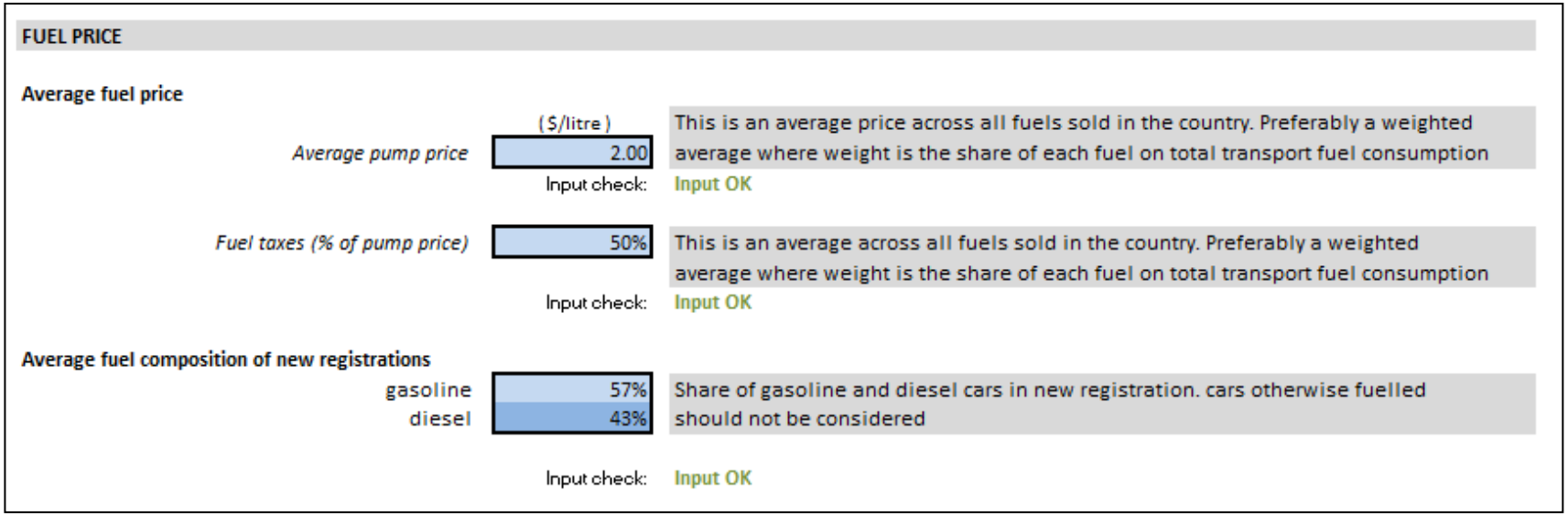
The REGISTRATION tax is a tax paid only once when the vehicle is purchased and registered. It does NOT include any VAT or similar tax applied to the purchase price

The tax/rebate level has to be defined according to the registration classes defined above.
Taxes should be coded as positive values, rebates should be coded as negative values.
The values of the registration tax should be provided in US Dollars
If registration tax does not exist in the base year all values should be set to zero

FEPIT input – Fuel price

Baseline input worksheet

- **Fuel price in the base year**
  - Average fuel price at the pump (pump price), in $/liter
  - Average share of fuel taxes on pump price
  - Split of newly registered cars between gasoline and diesel



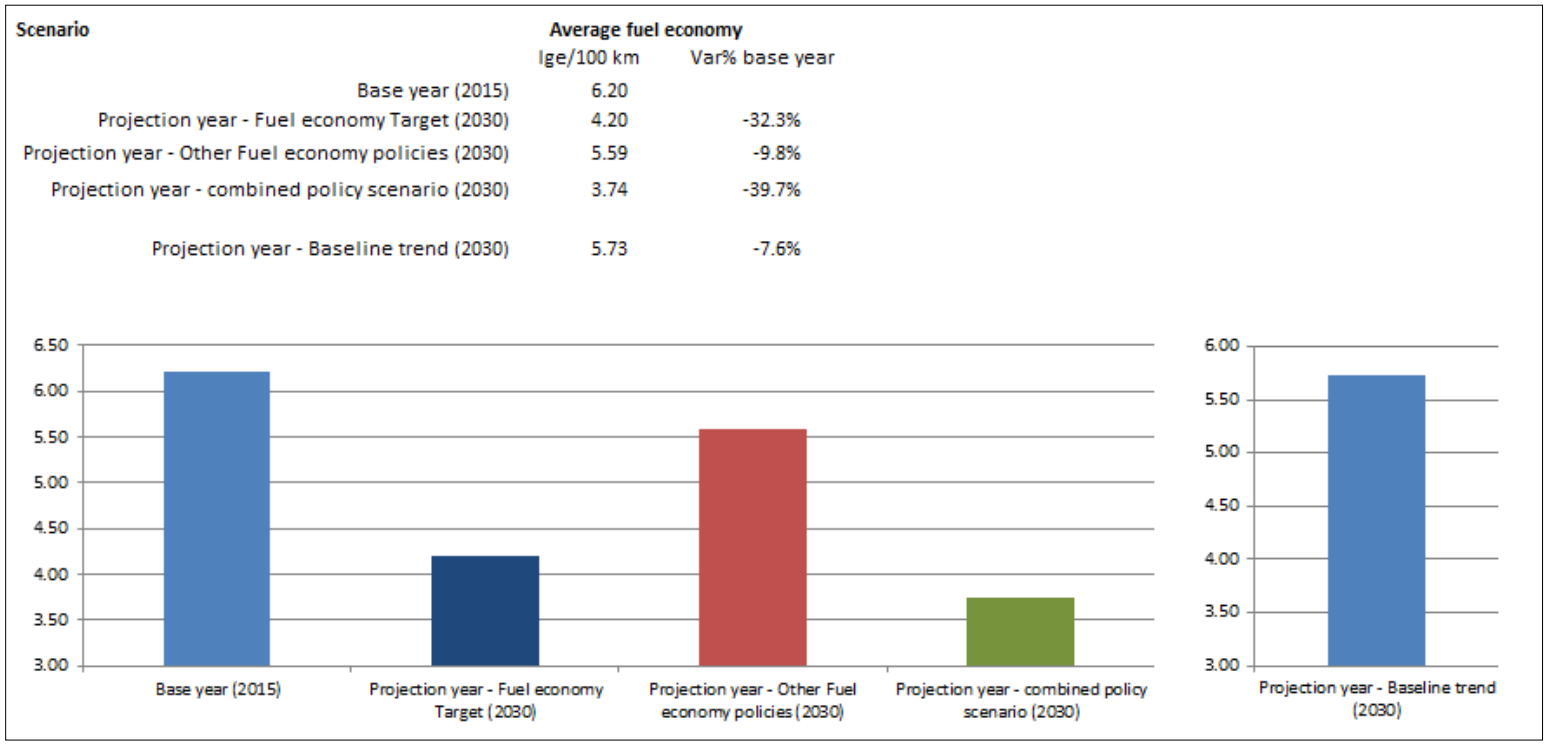
FUEL PRICE			
Average fuel price			
		($/litre)	
Average pump price		2.00	This is an average price across all fuels sold in the country. Preferably a weighted average where weight is the share of each fuel on total transport fuel consumption
	Input check:		Input OK
Fuel taxes (% of pump price)		50%	This is an average across all fuels sold in the country. Preferably a weighted average where weight is the share of each fuel on total transport fuel consumption
	Input check:		Input OK
Average fuel composition of new registrations			
gasoline		57%	Share of gasoline and diesel cars in new registration. cars otherwise fuelled should not be considered
diesel		43%	
	Input check:		Input OK

FEPIT results

Projection input and results worksheet

Reading results: average fuel economy

Scenario	Average fuel economy	
	lge/100 km	Var% base year
Base year (2015)	6.20	
Projection year - Fuel economy Target (2030)	4.20	-32.3%
Projection year - Other Fuel economy policies (2030)	5.59	-9.8%
Projection year - combined policy scenario (2030)	3.74	-39.7%
Projection year - Baseline trend (2030)	5.73	-7.6%



FEPIT download

- The tool is available for download at the following link: http://www.iea.org/gfei/FEPIT2015.xlsb
- It is accompanied by a user guide and a methodology report.
- FEPIT - User guide: http://www.iea.org/gfei/FEPITUserGuide.pdf
- FEPIT – Methodology report: http://www.iea.org/gfei/FEPITMethodologyReport.pdf

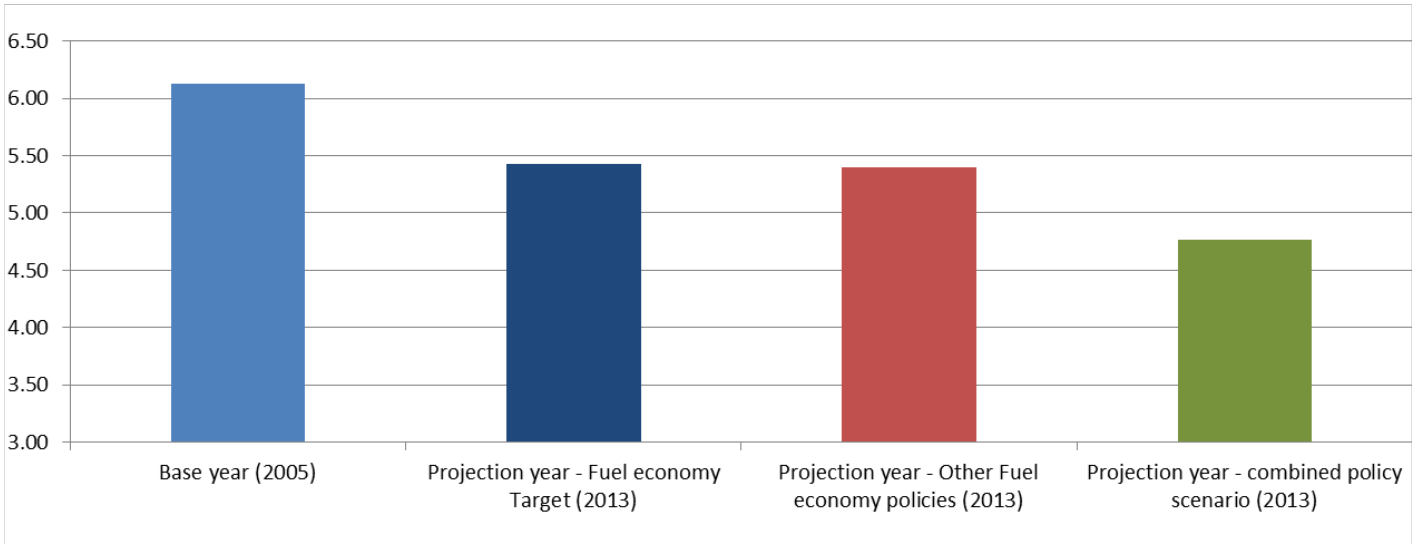
Thank you very much!

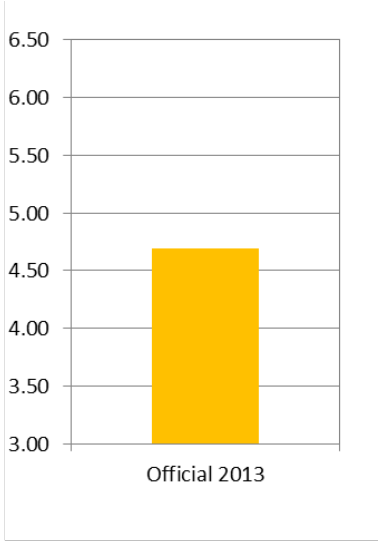
Backup

FEPIT validation

France: back casting exercise 2005 to 2013

- GFEI data for 2005 as baseline
- Projection year: 2013
- Comparison of results: 2% deviation projection vs. 2013 data



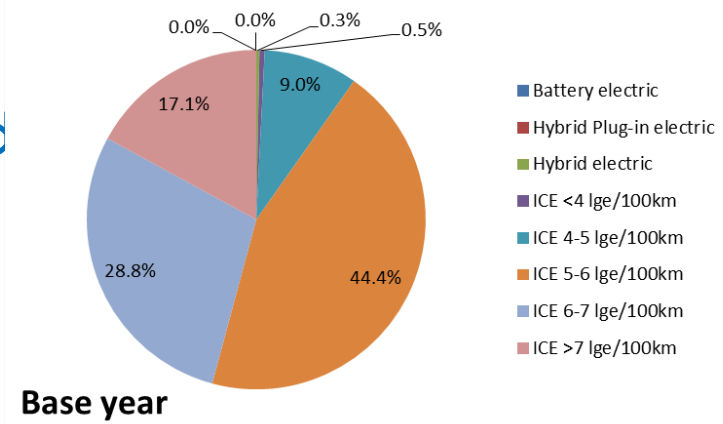


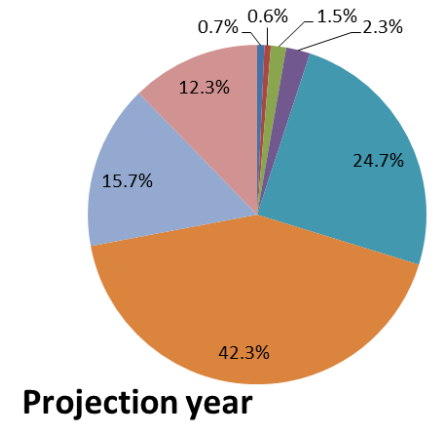
FEPIT – Methodology

Methodological approach

Theoretical approach

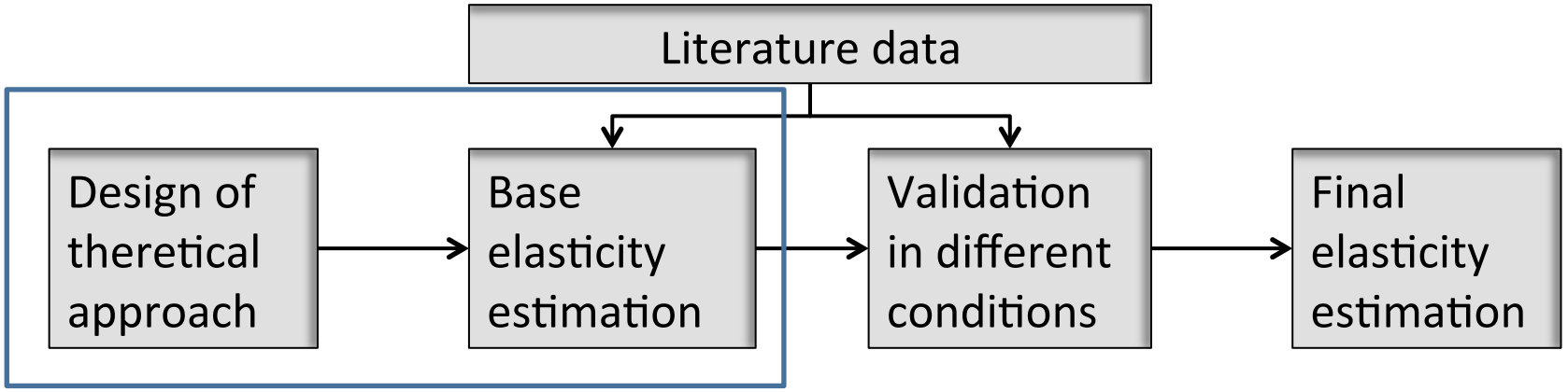
- New vehicles registrations segmented into fuel consumption classes
- Each segment represented by the related average fuel consumption
- Policies affect both
  - the new registration composition, and
  - the average fuel consumption by segment
- Context factors and interaction between policies affect the size of final impacts





Methodological approach

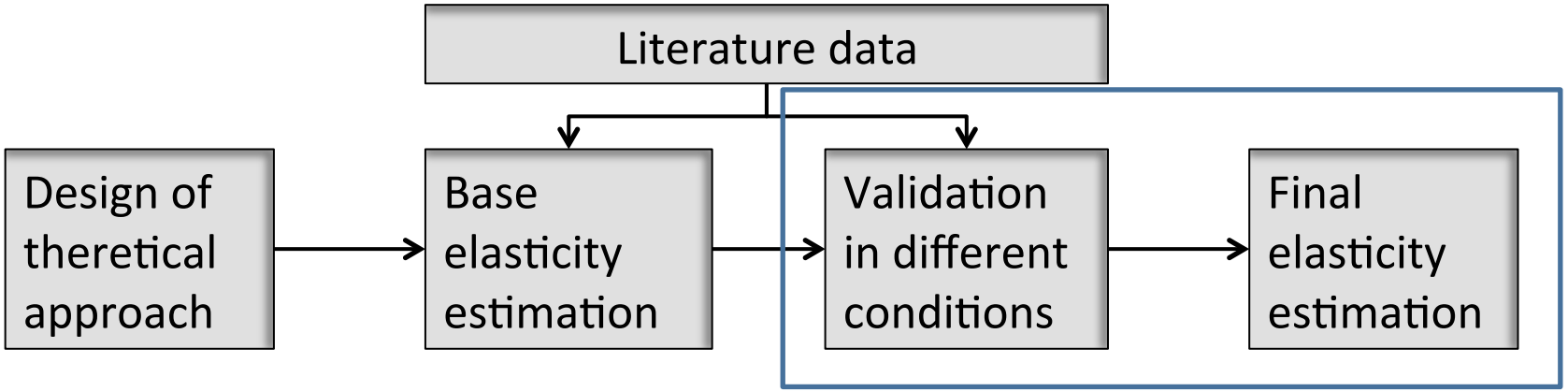
- **Elasticity parameters estimated on the basis of literature data to provide realistic responses in different conditions**



Methodological approach

Validation in different conditions:

- Simulating various case studies
- Revision of the elasticity parameters



Methodological approach

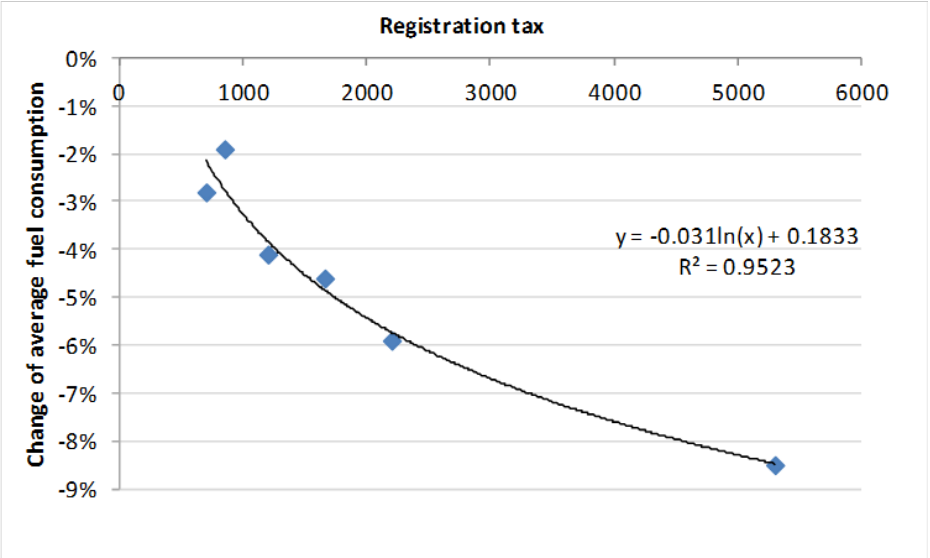
Theoretical approach

- Impact on new registrations composition by segment
  - Direct change of the natural logarithm in car registrations in a given segment in response to a 1000 Euro tax/rebate (registration share of segment s change by x%) *[D'Haultfœuille et al. (2012), Klier and Linn (2012)]*
  - Compensation of direct change by changes in the other segments (for instance, if the most energy intensive class loses 2% of share, this 2% is gained by less energy intensive segments, proportionally to the relative shares they had in the base year)

Methodological approach

Theoretical approach

- **Impact on the average fuel consumption by segment**
  - **Due to changes of the distribution of the registrations within the segments and the deployment of technical improvements *[COWI (2002), Bunch, Greene et al. (2011)]***



  - **Function estimated on COWI (2002) data, generated by registration tax under a fleet neutrality assumption**

Methodological approach

Theoretical approach

- Base elasticities drawn from studies based on the experience of vehicle taxation in Europe.
- The effect of vehicle taxation may potentially be quite different in other contexts
- Taking into account context factors influencing the base elasticities: effect of the baseline fuel price
  - Comparing the effect of feebate scheme related to registration tax in US *[Bunch, Greene et al. (2011)]* and France *[Klier and Linn (2012)]*
  - reduction of the elasticity parameters to simulate lower responsiveness in US with respect to the EU reference case (assumed to be related to baseline fuel price differences)

Methodological approach

Theoretical approach

- **Interaction between measures:**
  - **Circulation and registration taxes: the effect is larger when combined *[COWI (2002)]***
  - **Fuel consumption target and other policies: responsiveness to other measures is reduced assuming that, as vehicle efficiency gradually improves, the incentive to choose a more fuel efficient car also gradually declines**
- **Electric vehicles segments**
  - **Comparing the effect of incentives *[Mock, P. and Yang, Z. (2014)]***
  - **Smoothing the elasticities**
  - **Estimating shares at projection year based also on an exogenous increasing trend from 2012 onward**