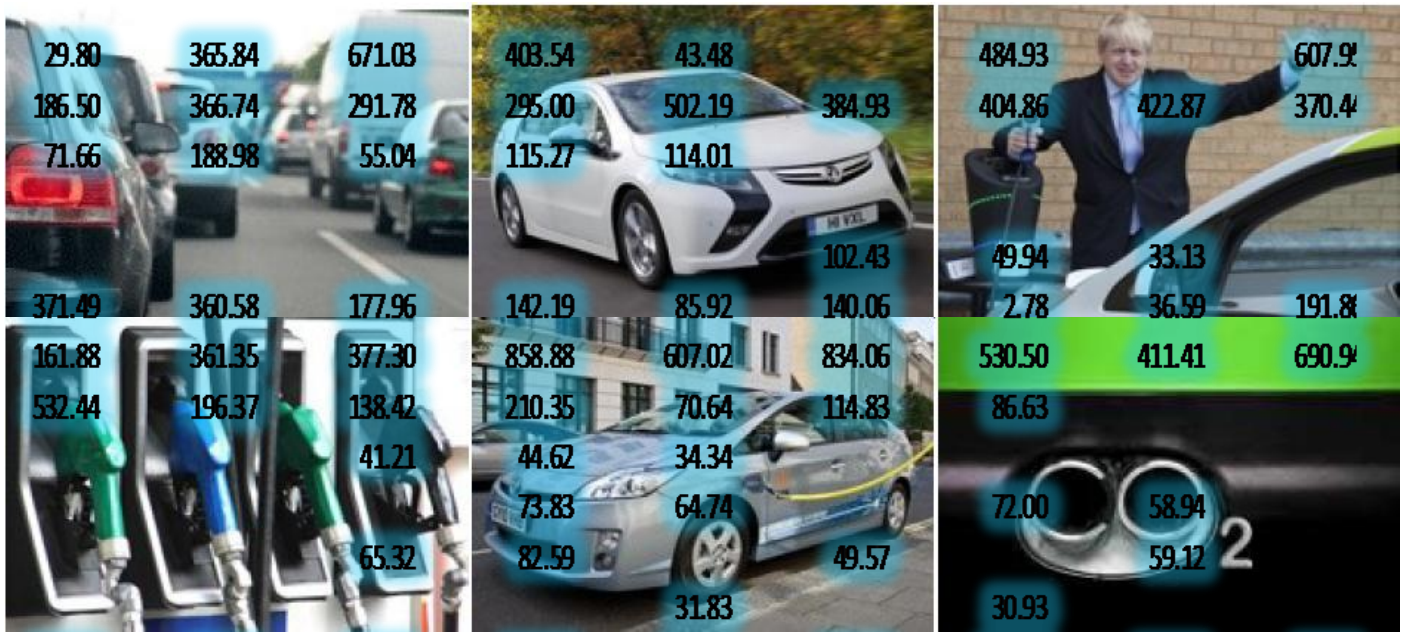
Green vehicle scoring in Europe: scope and methodologies



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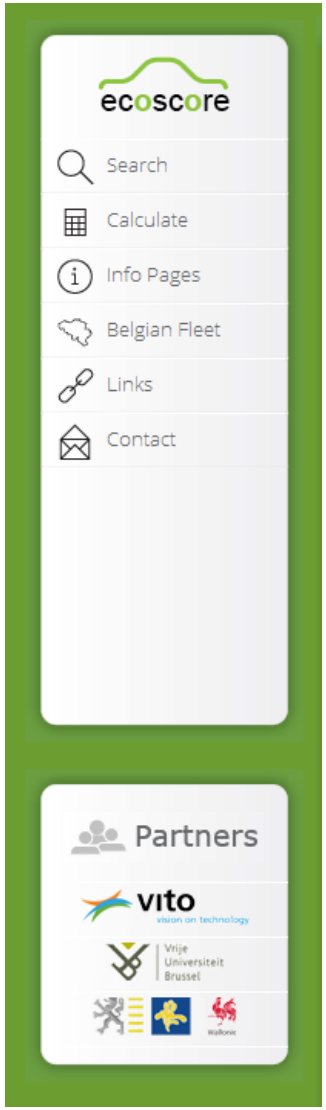
EU vehicle scoring/ratings systems

"The most important contribution of [LCA] methods is getting decision-makers to focus on the important attributes and to avoid looking and only one aspect of the fuel cycle or propulsion system" [1]

- Ecoscore (Belgium, LCA, 2003?-13)
  Belgian system developed by Vrije Uni. Brussels, VITO & CESSE – well supported live database
- Cleaner Drive (EU, LCA, 2001-2004)
  Car life cycle ratings – EU project 2001-2004 led by Energy Saving Trust, UK – discontinued
- Green Car Rating (UK, LCA, 2006-13)
  Developed by Next Green Car, UK based on EU Cleaner Drive – well supported live database
- CAIR Environmental Rating system (UK, TA data+, 1998-2006?)
  Centre for Automotive Industry Research (CAIR) at University of Cardiff, UK – discontinued
- ETA Car Buyer's Guide (UK, TA data, ??-2012)
  Environmental Transport Association – based on Type Approval data – Occasional updates
- VCD Environmental Car List (Germany, TA data, 2002-13)
  Basic points system based on Type Approval data generated annual Top Ten list – Annual
- EcoTest (EU, Real world tailpipe, 2003-13)
  Jointly developed by the FIA foundation and ADAC – 150+ cars tested annually real world cycle

1 – MacLean and Lave 2002 TA – Type Approval

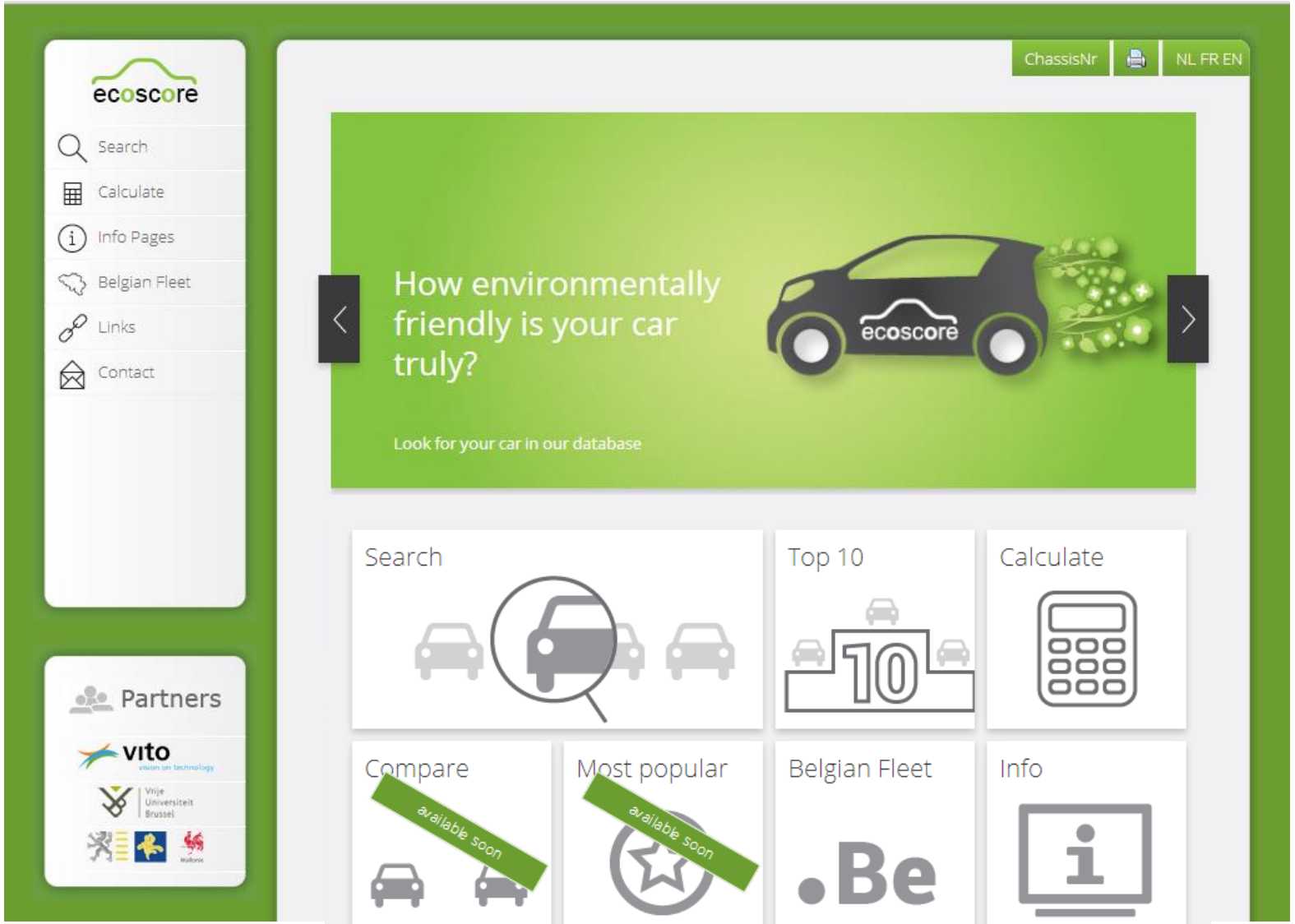
Ecoscore overview (Belgium)



- **ecoscore.be**[1] is a free to use consumer website developed by Vrije University Brussels, Flemish Institute of Technological Research (VITO) & Centre of Economical and Social Studies of the Environment (CESSE) Universite Libre de Bruxelles.
- Includes **LCA methodology related to fuel cycle** and expresses car's life cycle environment impact as a score out of 100: **100 greenest** to **0 most polluting**
- Ecoscore methodology includes 3x GHG emissions, 6x AQ regulated pollutants and noise – assesses impacts on climate change, air quality (human health and ecosystem).
- Website is free to use and allows users to search for specific models, provides 'Top 10' lists by vehicle class and a calculator to score any emissions dataset.

1 – http://www.ecoscore.be

Ecoscore website (Belgium)



1 – http://www.ecoscore.be

Ecoscore methodology (Belgium)

- Includes CO2+noise and all regulated emissions as measured by NEDC
- Other GHG and AQ emissions considered to compare all fuel types
- Methodology covers fuel life cycle (vehicle manufacture not included)

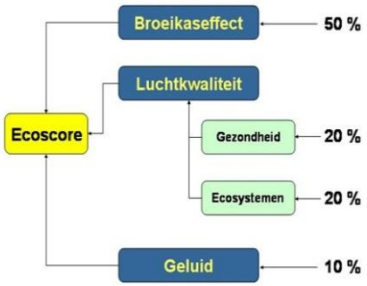
Weighting is set by methodology at:

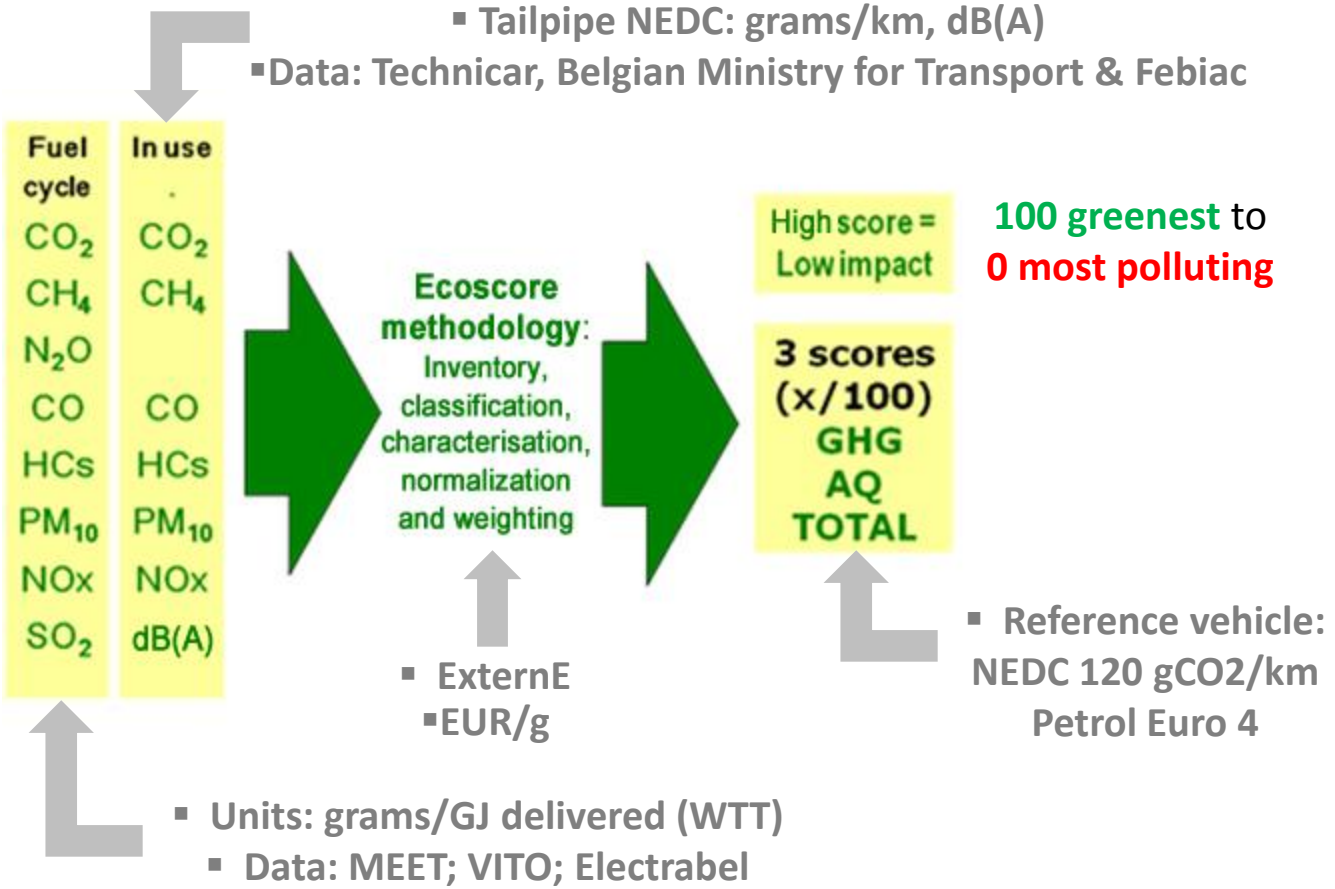
GHG: 50%

AQ (health): 20%

AQ (ecosystem): 20%

Noise: 10%





1 – CLEVER Project reports 2007, 2011

2 – http://www.ecoscore.be/en/ecoscore-information

Ecoscore calculations[1] (Belgium)

- **Ecoscore = 100*exp[-0.00357*(A*CO2 + B*HC + C*NOx + D*CO + E*PM + F*BV + G*dB(A) + H)]**
- **Ecoscore GHG = 100*exp[-0.00357*2*(A*CO2 + f1*BV + h1)]**
- **Ecoscore AQ = 100*exp[-0.00357*2.5*(B*HC + C*NOx + D*CO + E*PM + f2*BV)]**

BV = fuel economy in lit/100km, m3/100km or kWh/100km
Coefficients A, B, C, D, E, F, f1, f2, G and the constants H, h1, h2 correspond to fuel type and Euro standard

Example: Toyota Prius 1.8 VVT-i T3 HEV MY2013 89gCO2/km[2]

GHG calculation	CO_2	BV	constant	TOTAL
CO2 (g/km) & FC (l/100km)	89	3.9	-	-
Coefficients	0.36	1.12	0.71	-
Exponent	**32.04**	**4.368**	**0.71**	**37.118**
GHG ecoscore				**76.7**

AQ calculation	CO	HC	NO_x	PM	BV	TOTAL
Emm (g/km) & FC (l/100km)	0.258	0.058	0.006	-	3.9	-
Coefficients	0.011	23.17	101.88	1407.75	5.89	
Exponent	**0.0028**	**1.3439**	**0.6113**	**0.0000**	**22.971**	**24.929**
AQ ecoscore						**80.0**

AQ calculation	CO2	CO	HC	NO_x	PM	BV	dB(A)	constant	TOTAL
Emm (g/km) & FC (l/100km)	89	0.258	0.058	0.006	-	3.9	69.0		-
Coefficients	0.36	0.011	23.17	101.88	1407.75	7.01	**0.333**	**-12.63**	
Exponent	**32.04**	**0.0028**	**1.3439**	**0.6113**	**0.0000**	**27.339**	**22.977**	**-12.63**	**71.684**
AQ ecoscore									**77.4**

GHG ecoscore = 76.7 (1 dec pl.)

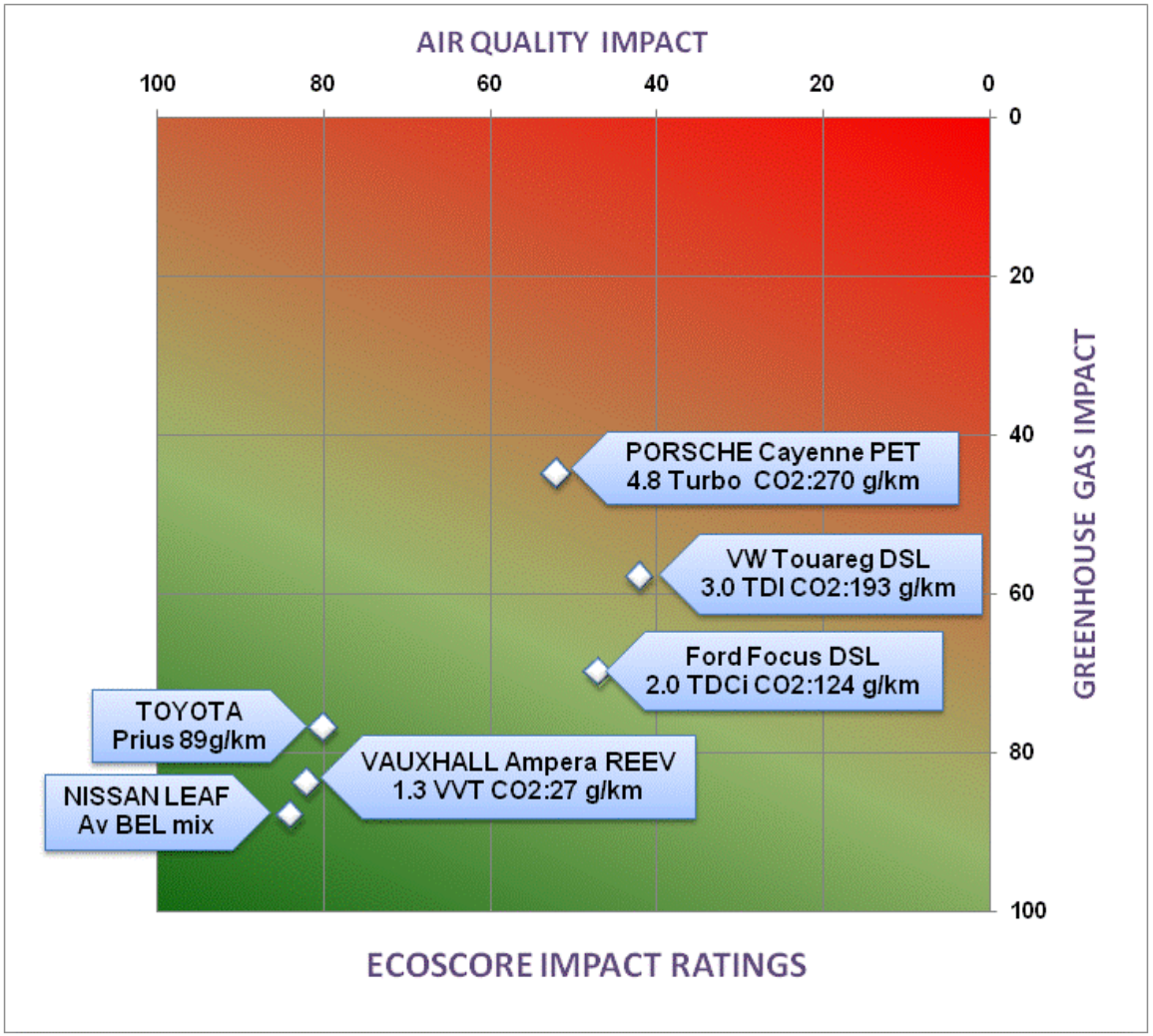
AQ ecoscore = 80.0 (1 dec pl.)

TOTAL ecoscore = 77.4 (1 dec pl.)

1 – http://www.ecoscore.be/en/ecoscore-information 2 – VCA (UK) NEDC data

Ecoscore results (Belgium)

2012-13 models shown using reverse 2-D plot of AQ-GHG ecoscores – Belgium context



GHG/AQ /dB weighting 50:40:10

Weighting is set by methodology

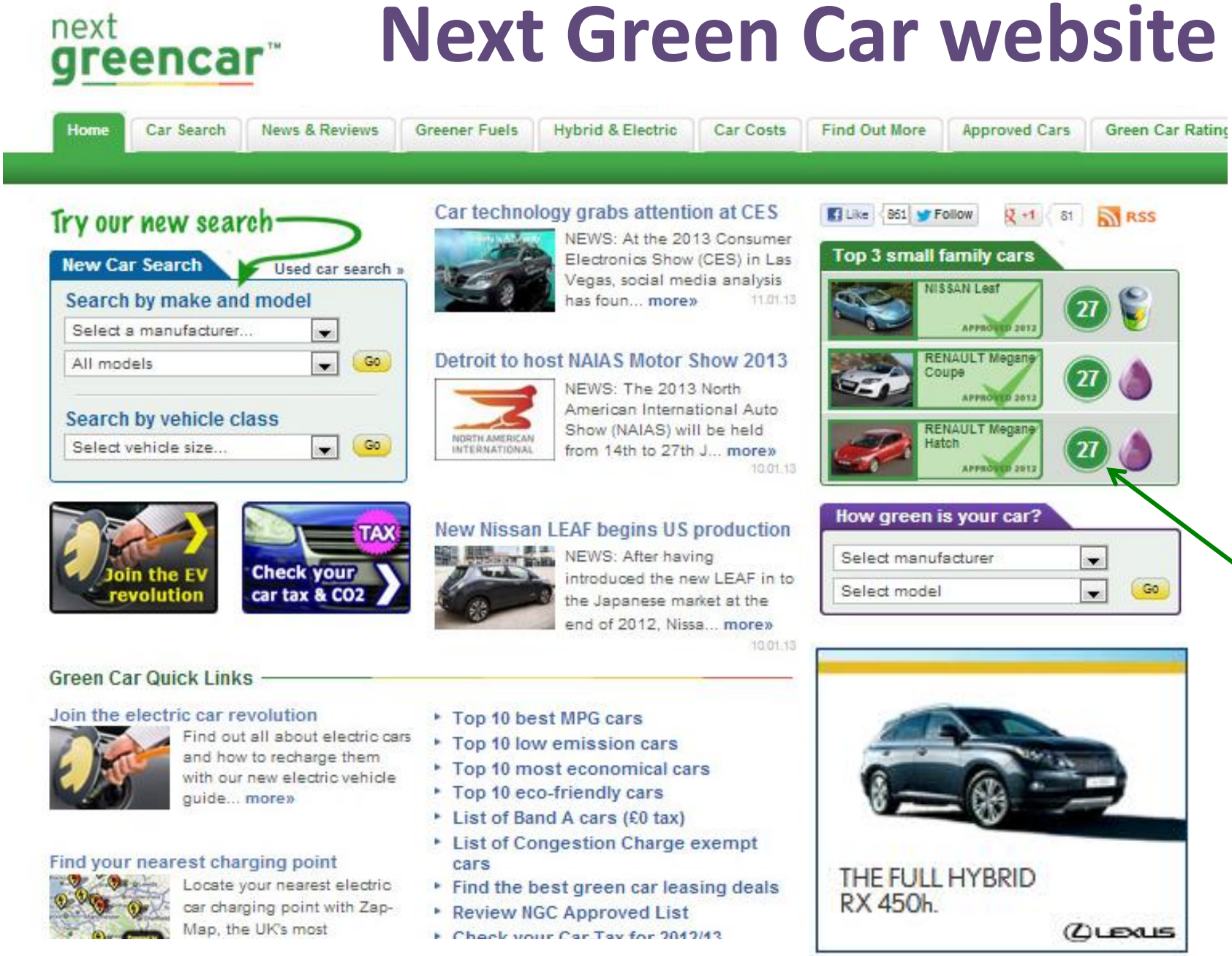
Next Green Car Overview (UK)

- **Nextgreencar.com**[1] is a free to use UK consumer website designed to help car buyers find, compare and buy greener cars – Est. 2006
- NGC is UK's No.1 green car website with 230k+ visitors and 900k+ page impressions per month[2]
- Includes **Green Car Rating** which expresses car's life cycle environment impact as a score out of 100: **0 greenest** to **100 most polluting**
- NGC is a commercial website with over 30k vehicle records in a database updated weekly - petrol, diesel, hybrid, LPG, CNG, BEV, PHEV, REEV, FCV
- Plus news, reviews and data for low emission cars; Approved Cars; Annual awards which recognise the best new green cars by class

1 - http://www.nextgreencar.com

2 – Google Analytics March 2013

Next Green Car website



1 - http://www.nextgreencar.com

Next Green Car website

next greencar™

Home | Car Search | News & Reviews | Greener Fuels | Hybrid & Electric | Car Costs | Find Out More | Approved Cars | Green Car Rating

Your results | Car Price | Car Tax | BIK Rate | Performance

Order by Green Car Rating

	Green Car Rating	MPG (Comb)	CO2 (g/km)	OTR Price	Fuel Type
NISSAN Leaf Electric Car 90kW Auto 5dr / Electric (av UK mix) APPROVED 2013	27	169 MPG equiv	0	£23,490 (inc grant)	
RENAULT Megane Coupe 1.5 dCi 110 Expression+ Stop and Start Manual 6-speed 2dr APPROVED 2013	27	81	90	£19,645	
RENAULT Megane Hatch 1.5 dCi 110 Expression+ Stop and Start Manual 6-speed 5dr APPROVED 2013	27	81	90	£19,145	
FORD Focus 1.6 TDCi Edge Econetic 105PS DPF 88g Manual 6-speed 5dr APPROVED 2013	28 (est)	85 (est)	88	£18,645	
VOLVO V40 1.6 D2 115HP ES Start/Stop Manual 6-speed 5dr APPROVED 2013	29 (est)	85 (est)	88	£20,345	
RENAULT Fluence Electric Car Expression+ 70kW Auto 4dr / Electric (av UK mix) APPROVED 2013	29	149 MPG equiv	0	£17,495 (inc grant) +£76 /mth	
DACIA Logan 1.5 dCi Ambiance 90hp Manual 5-speed 5dr APPROVED 2013	29 (est)	75 (est)	99	£9,395	
SKODA Octavia Hatch 1.6 TDI CR S 105PS Manual 6-speed 5dr APPROVED 2013	29	74	99	£18,040	

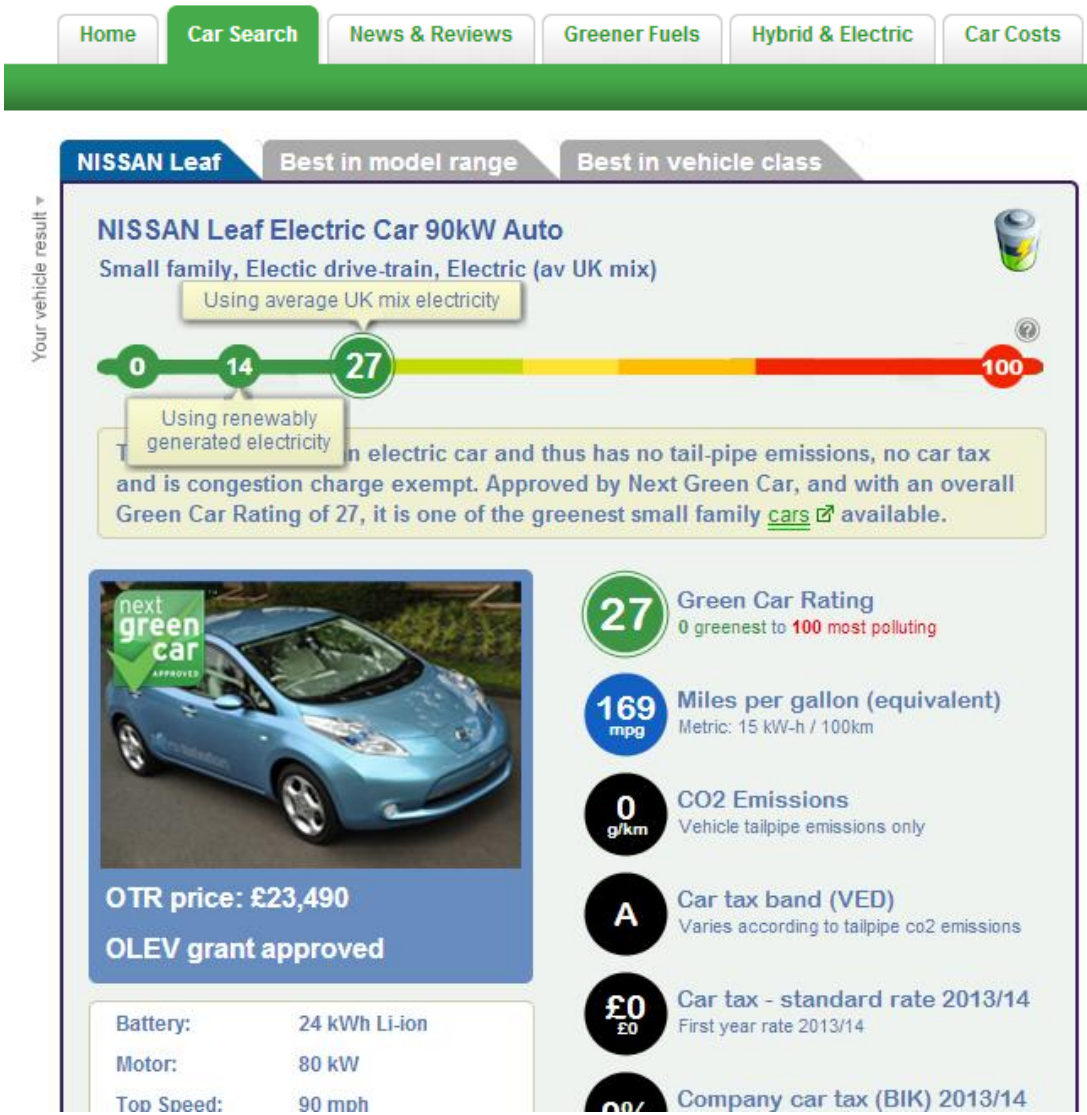
C-segment search

Model list shows key consumer info:

- Green Car Rating
- Fuel economy (MPG)
- Tailpipe CO2 (g/km)
- Pricing (capital)
- Fuel type (EVs treated in similar way to ICEs)

1 - www.nextgreencar.com/new-car-search/

Next Green Car website



Nissan LEAF 2012

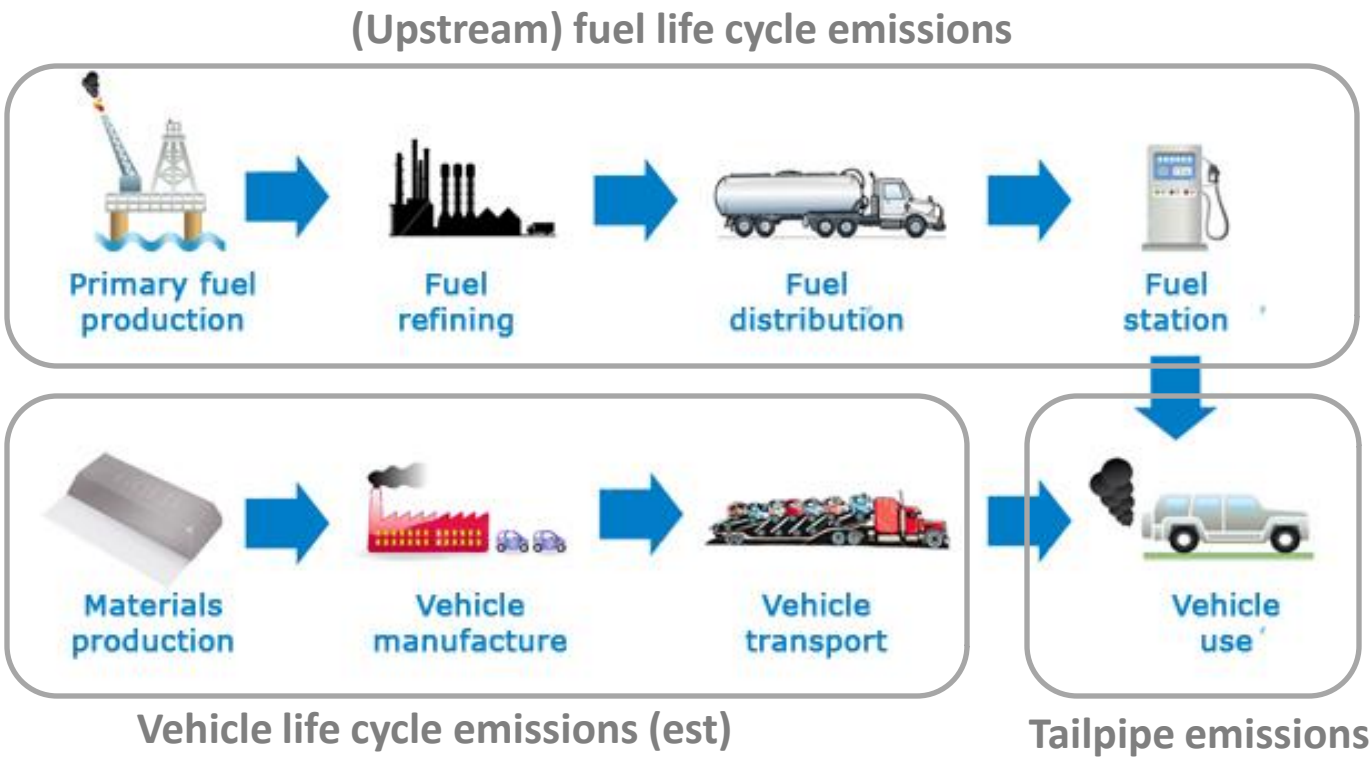
Model info shows key consumer info:

- **Green Car Rating (for different energy sources where available)**
- **Fuel economy (MPGe used for EVs)**
- **Tailpipe CO2 (g/km) linked to tax**
- **Options to compare within model range and vehicle class**

1 - www.nextgreencar.com/view-car/45426/NISSAN-Leaf-Electric-Car-90kW-Auto-Electric-(av-UK-mix)

Green Car Rating methodology (UK)

- GCR methodology based on Cleaner Drive Environmental Rating Tool 2004
- Extended to include vehicle production emissions (estimated)
- For ICEs, this adds 10-15% on life cycle CO2 – more for cars with electric drive-trains

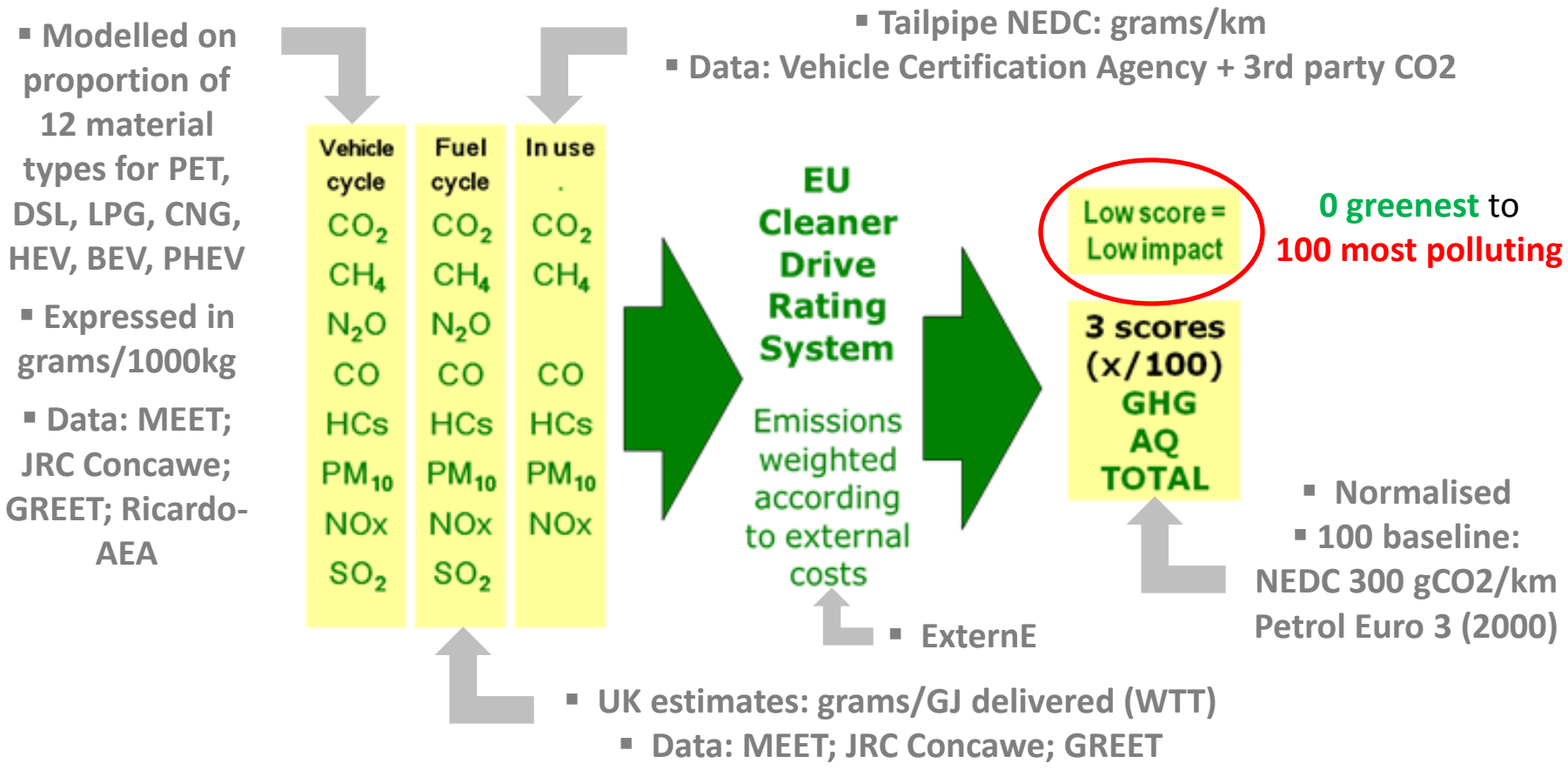


- Stages not included in LCA: End-of-life, waster management, recycling (beyond use of recycled materials as normal part of feedstock)

1 - www.nextgreencar.com/ratings.php

Green Car Rating methodology (UK)

- Includes CO2 and all regulated emissions as measured by NEDC
- Other GHG and AQ emissions considered to compare all fuel types (excl. dB(A))
- External costing method – GHG/AQ weighting determined by costs and ref. vehicle



1 - www.nextgreencar.com/ratings.php

Green Car Rating calculation (UK)

- **External cost $Q_{GHG/AQ}$ (EUR/km) = $\sum_i p_i.c_i$**

p_i = emission of pollutant *i* in grams/km
c_i = external cost of emission of pollutant *i* in EUR/grams

- **GHG Rating = 100 × Q_{GHG} (vehicle) / Q_{GHG}(maximum)**
- **AQ Rating = 100 × Q_{AQ} (vehicle) / Q_{AQ} (maximum)**
- **Green Car Rating = 100 × Q_{TOTAL} (vehicle) / Q_{TOTAL} (maximum)**

Example: Toyota Prius 1.8 VVT-i T3 HEV MY2013 89gCO2/km[2]

GHG external costs	CO_2	CH_4	N_2O	TOTAL
Tailpipe emissions (g/km)	89	0.012 (est)	0.005 (est)	-
Tailpipe ext costs (EUR/km)	0.00409	0.00001	0.00007	-
Indirect ext costs (EUR/km)	0.00221	0.00004	0.00000	-
GHG external costs	**0.00630**	**0.00005**	**0.00007**	**0.00642**
Max GHG ext cost				**0.01718**

AQ external costs	CO	HC	NO_x	PM	SO_2	TOTAL
Tailpipe emissions (g/km)	0.258	0.058	0.006	-	-	-
Tailpipe ext costs (EUR/km)	0.00000	0.00000	0.00000	0.00000	0.00000	-
Indirect ext costs (EUR/km)	0.00000	0.00069	0.00031	0.00012	0.00095	-
AQ external costs	**0.00000**	**0.00069**	**0.00031**	**0.00012**	**0.00095**	**0.00208**
Max AQ ext cost						**0.01165**

GHG Rating = 100 × 0.00642 / 0.01718 = 37.0 (1 dec pl.)

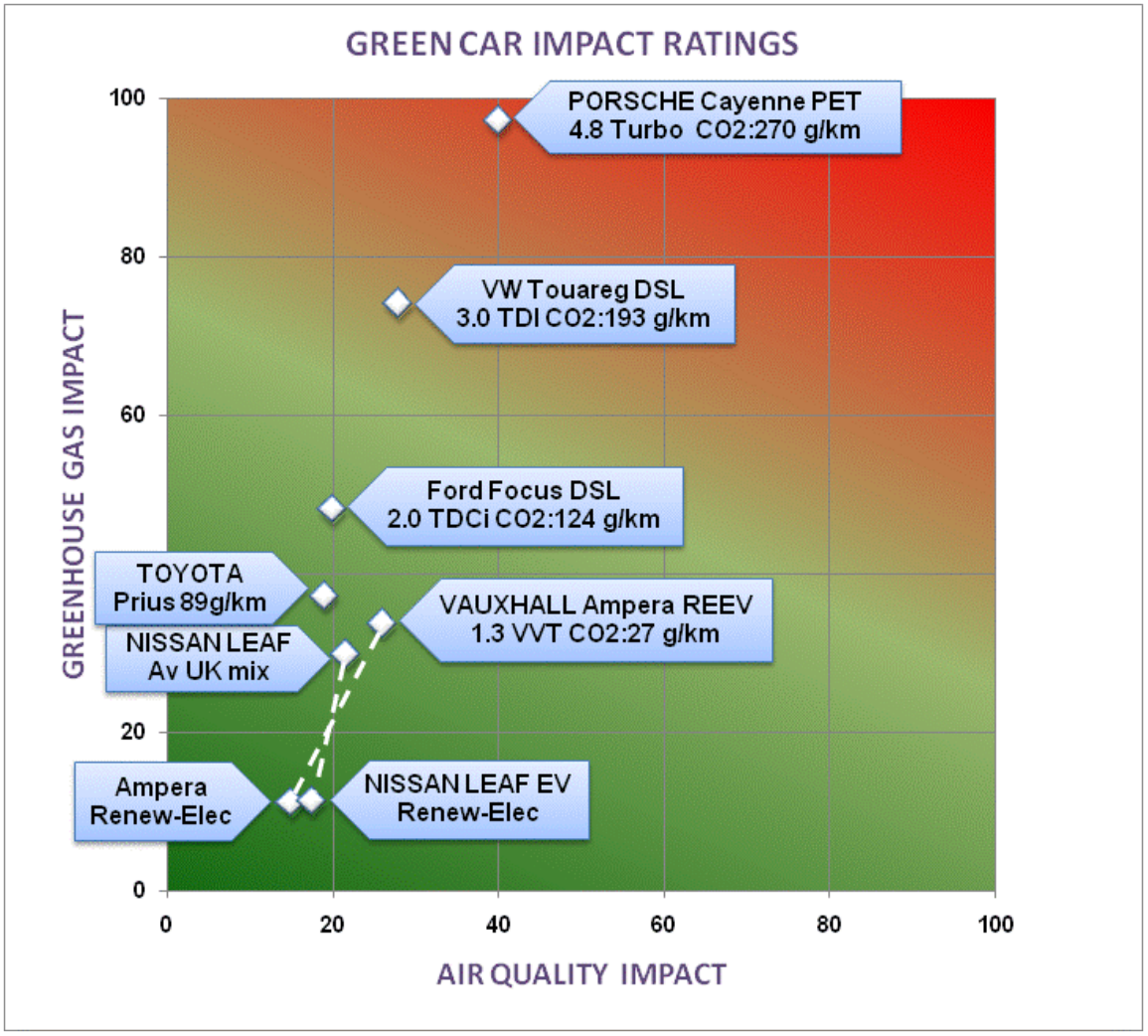
AQ Rating = 100 × 0.00208 / 0.01165 = 19.0 (1 dec pl.)

Green Car Rating = 100 × 0.00959 / 0.02883 = 30.0 (1 dec pl.)

1 – http://www.ecoscore.be/en/ecoscore-information 2 – VCA (UK) NEDC data

Green Car Rating results (UK)

2012-13 models shown using 2-D plot of AQ-GHG ratings coordinates – UK context

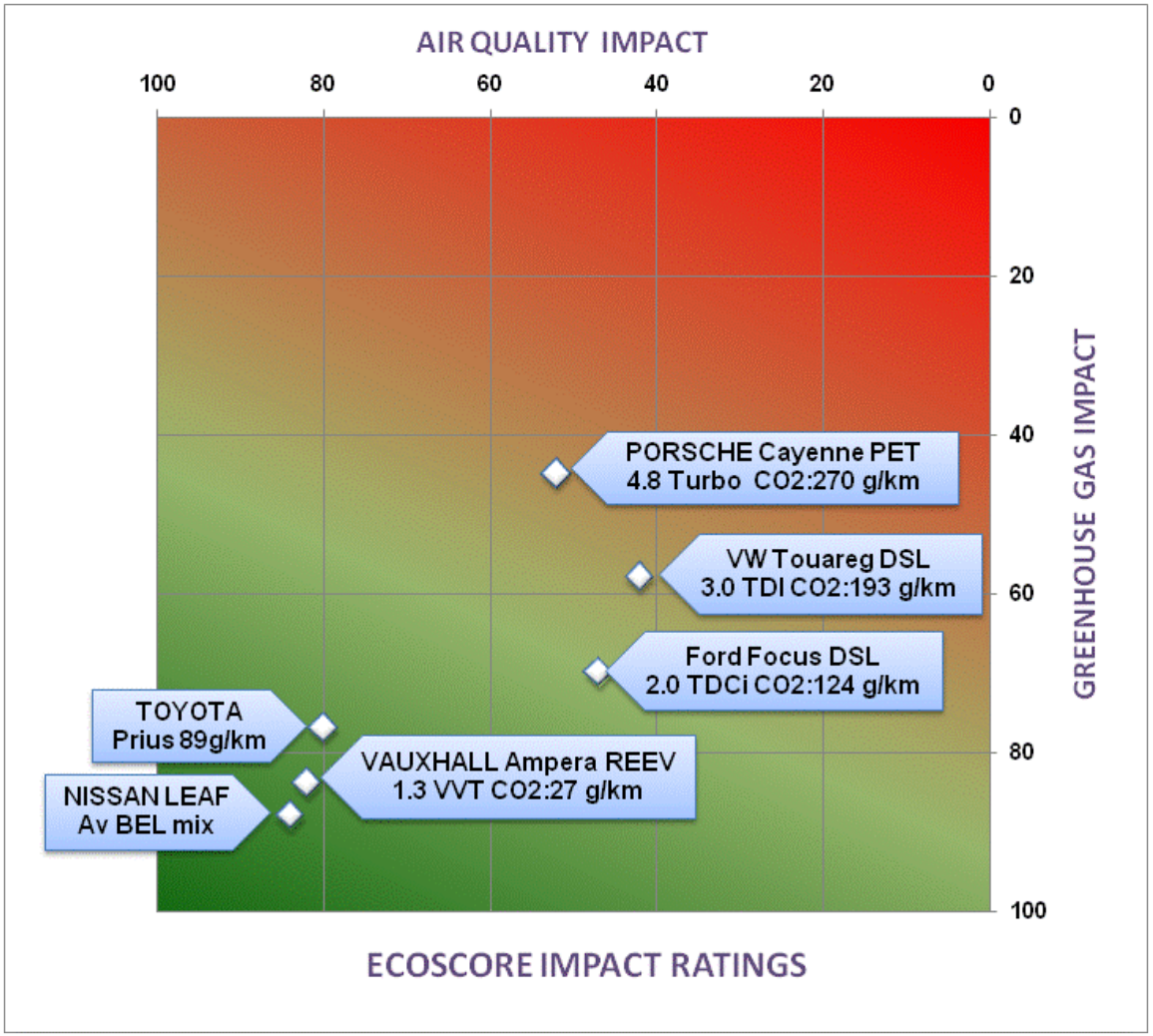


GHG/AQ weighting 60:40 approx.

Weighting arises purely out of relative value of external costs and emissions characteristics of baseline model

Ecoscore results (Belgium)

2012-13 models shown using reverse 2-D plot of AQ-GHG ecoscores – Belgium context



GHG/AQ /dB weighting 50:40:10

Weighting is set by methodology

EU vehicle scoring/ratings summary

High-quality and robust vehicle rating/score systems need to :

- **Include all measured air-based emissions (not just CO2)** – allows a realistic comparison between different vehicle and fuel types (PET vs DSL)
- **Include life cycle emissions (beyond tailpipe)** – enables a fair comparison of all conventional and alternative vehicle types – and means that ultra-low and zero-emission vehicles can be fairly compared – *this will become a major issue in future*
- **Include vehicle manufacturing cycle (as well as fuel cycle)** – while manufacturer of ICEs only contributes 10-15% of life cycle CO2, this is set to dramatically increase with introduction electric drive-trains (may be >50% embodied energy)
- **Incorporate an impact assessment (as well as an emissions inventory)** – not only does this account for the impacts and location of different emissions, considering impact enables: (a) comparison between emission types and (b) emission vectors to be aggregated
- **Be easy-to-search and easy-to-understand for non-experts** – common approach is to use a score out of 100 ranging from **the greenest vehicles** to **the most polluting**
- Be a trusted source of information (already known to be an issue re labelling) – common standards available include ISO 14040-14044 standards and PAS2050 accreditation (Next Green Car working towards PAS2050)

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