GUIDELINE FOR A VEHICLE PURCHASE POLICY AIMING AT A SAFE AND SUSTAINABLE VEHICLE FLEET

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ABSTRACT

Vehicle safety and emissions are addressed in the UN Sustainable development goals 3.6, road traffic safety, and 13, reduced climate impact. In Sweden, a large proportion of new passenger vehicles (62%, 236 546 vehicles) were purchased by legal entities in 2017. Those vehicles are driven for 18 years in average. Therefore, well-reasoned company car policies in terms of safety and emissions are imperative to meet the global goals.

The objective was to show how a company car policy that includes requirements regarding safety and CO_2 emissions can be a tool to reach global safety and environmental goals. The paper describes the development of a vehicle purchase policy that was introduced by Folksam Insurance Group in 1998. The criteria of the policy have been revised on a yearly basis to meet developments of vehicle safety and environmental technology, as well as environmental goals.

The vehicle data consists of new passenger vehicles available on the Swedish market. Data regarding crash tests, safety equipment and CO_2 emissions are listed for every vehicle model and version. The safety requirements cover crashworthiness, performance in whiplash tests, and availability of selected safety systems. The environmental criteria are adapted to meet global goals regarding CO_2 emissions. The goal is zero carbon emissions from new vehicles in 2030. A general goal is that approximately 15 % of the new vehicles on the Swedish market should fulfill the requirements in the policy.

It is shown in this study that safety and environmental criteria have changed rapidly during the last two decades. Furthermore, it is shown that safety and emission policies are important tools to guide fleet procurement managers as well as private consumers. A comparison of vehicles for sale and with those that are actually sold shows a higher rate of safety assist system in sold models compared to models for sale. The CO_2 emission requirement has been halved during the two decades the policy has been active, indicating that the vehicle fleet has made large progress in reducing their CO_2 emissions as the proportion of vehicles fulfilling the requirements has been approximately 15% during the two decades.

It is important to guide vehicle fleet buyers of vehicles for private use to choose the safest and most environmentally friendly vehicles since those vehicles will be used for many years. Company car policies are important tools in this process. A vehicle purchase policy will indirectly influence car manufactures to offer vehicles that fulfil the requirements in the policy.

An important recommendation is that a vehicle purchase policy should be revised annually to follow rapid changes in available safety technology and emission standards in order to substantially influence the vehicle fleet. A vehicle purchase policy is an important tool to guide vehicle consumers towards the safest and most sustainable vehicles. It is recommended that a vehicle purchase policy should consist of requirements regarding crashworthiness, fitment of important safety systems, CO_2 emissions. Preferably, it should be complemented with a vehicle list for tangible and feasible advice to consumers.

BACKGROUND

In Sweden 4 845 609 passenger vehicles were registered in 2017 and 379 315 new vehicles were purchased [1], of which 236 546 (62%) were purchased by legal entities. Private cars are large contributors to CO_2 emissions [2, 3]. Crashworthiness and crash avoiding techniques for personal vehicles are crucial interventions to reduce accidents with serious or fatal outcome [4-6].

New vehicles have environmental and safety performances that will influence the number of road casualties and the environment for many years ahead, in average18 years in Sweden [7]. Although vehicle safety is generally a high priority for private buyers and fleet managers in Sweden compared to e.g. Spain [8], vehicle safety is not the most prioritized factor. On the other hand, consumers who focus on safety may need some guidance among all safety systems that may appear in new vehicles. A well founded vehicle safety policy may guide consumers

to choose the safest vehicle, even if safety is prioritized by the consumer. Investigations show that there is a need to continuously improve understanding of what safety means to consumers and policy makers [9].

Consumer test programs such as Euro NCAP are important in the way that they put focus on the best practice in vehicle safety. However, the fitment of specific safety equipment varies between countries. A policy with detailed safety criteria is therefore important in order to guide vehicle buyers to a specific model version with desirable safety equipment.

Governmental incentives provide one way for long-term guidance towards vehicles with less CO_2 emissions [10]. However, a buyer needs to find the specific vehicles that are affected by the incentives. A vehicle policy with continuously updated emission criteria also helps to guide towards long-term emission targets and to point out the specific vehicle models with high occupant safety and low emissions.

Vehicle purchase policies used by large fleet purchasers such as companies and local authorities are important to guide towards safe and low emission vehicles [11, 12]. There is however a risk that those policies will quickly become inadequate due to rapid changes both regarding vehicle safety and emission standards. This paper illustrates the speed at which new safety systems are introduced and how difficult it is to predict. The speed of vehicle industry capability to reduce CO_2 has also been difficult to predict. Many CO_2 emission policies in Sweden has until recently used a definition of an environmentally friendly vehicle based on a state definition from 2013. This definition classified vehicles with CO_2 emissions below 120g/km as environmentally friendly. From 2018 this definition does no longer exist and there is a confusion within companies and local authorities how to define future CO_2 emission policies.

The paper aimed to show the development of the Folksam company car policy since the introduction 20 years ago and to describe the outcome of the 2019 year policy.

THE FOLKSAM VEHICLE PURCHASE POLICY

In 1997 the Folksam Group took a decision to adapt a company car policy consisting of vehicle safety and environmental requirements for vehicle transports within the company. The policy should contain tough requirements both regarding vehicle safety and CO_2 emissions. The policy criteria should be continuously improved with an annual revision regarding long-term goals but also to mirror continuous improvements in safety and emissions of the vehicle models for sale. The policy should also be supplemented with a vehicle list.

This decision also led to a guideline for rental cars used in the claims handling process at Folksam. In 2001 the policy was complemented with a vehicle list of models fulfilling the policy requirements.

Vehicles must fulfill criteria with respect to vehicle crashworthiness, fitment of safety assist systems and CO_2 emissions. An overall goal with the policy requirements was to select approximately 15% of the models for sale (in at least one version). The CO_2 emission requirement should at least be adapted to the European environmental goals [13].

The requirements in the Folksam company car policy have continuously been adapted to the developments in vehicle safety and CO_2 emissions since the introduction of the policy in 1998. In the beginning of 1998 the safety criteria consisted of crashworthiness requirements, limitations of curb weight, fitment of airbag, seat belt pretension, three point belt and head rest. The crashworthiness requirements were based on the Euro NCAP ratings and on the Folksam car model safety ratings (“How safe is your car?”) based on real-world crash data [14]. The use of Euro NCAP as a predictor of performance in real-world crashes has been verified in several studies, see for example [15-17].

The environmental criteria was initially covering fuel consumption based on vehicle size (the vehicle size was defined by a classification of exterior measures [9]) and diesel fuel was initially not approved due to high levels of NO_x and PM.

DEVELOPMENTS OF THE POLICY SINCE 1998

Two different databases have been used during the years containing data from new vehicles during the period 1998-2019. Between 1998-2013 data were used from a Swedish vehicle database “Bilfakta-Bisnode” and since 2014 the vehicle data has been provided by Jato Dynamics Ltd [18]. The vehicle data cover the current status of all new vehicle models for sale in Sweden. Every six months the vehicle list is updated with new models.

Developments of safety requirements

In 1998 the requirements regarding crash safety was that the vehicle should have least a three stars in the Euro NCAP rating or shown to be at least 20% better than average in the Folksam car model safety ratings. The requirements have been continuously harder during the years, see Table 1. In recent years top results in either Euro NCAP or Folksam ratings are required. In the late 1990s whiplash research [19, 20] led to additional criteria regarding whiplash protection. The whiplash protection has been shown by Folksam, IIWPG or Euro NCAP results. During the period 2005-2016, when IIWPG whiplash rating were used, 22(16 %) of 134 tested vehicle models in 2005 were "good" compared to 79 (75%) in 2016. Table 1 shows how the various safety criteria have been gradually changed in the policy since 1998.

Table 1.
Safety criteria 1998-2019

	Crashworthiness						Seat belt			Whiplash						Safety assist				
Policy Year	How Safe is your Car	NCAP Star	NCAP Adult pt.	NCAP Pedestr pt.	Curb weight kg	Airbag driver	Pret front	3-p belt	Seat belt reminder	Head rest	Active head rest	Folksam test	IIWPG rating	NCAP rating	IIHS Dynamic rating	ESC	AEB City	AEB Urban	AEB pedestrian	LDW
1998	≥20%	≥3			1000-1600	Std	Std	Std		Std										
1999	≥20%	≥3			1000-1600	Std	Std	Std		Std										
2000	≥20%	≥3			1000-1600	Std	Std	Std		Std	Std									
2001	≥20%	≥3			1000-	Std	Std	Std		Std	Std									
2002	≥20%	≥3			1000-	Std	Std	Std		Std	Std									
2003	≥20%	≥4				Std	Std	Std		Std	Std									
2004	≥20%	≥4				Std	Std	Std		Std	Std									
2005	≥20%	≥4				Std	Std	Std		Std	Std	≤7,4p	A/G							
2006	≥20%	5				Std	Std	Std	≥1p	Std	Std	≤7,4p	A/G			Std				
2007	≥20%	5			-1900	Std	Std	Std	≥1p	Std	Std	Yellow/Green	A/G			Std				
2008	≥20%	5			-1900	Std	Std	Std	≥1p	Std	Std	Yellow/Green	A/G			Std				
2009	≥20%	5			-1900				≥1p		Std	Yellow/Green	A/G			Std				
2010	≥20%	5			-1900				≥1p		Std	Green	G	≥3p		Std				
2011	≥30%		≥88%	≥40%	-1900				≥2p			Green	G	≥3p		Std				
2012	≥30%		≥88%	≥40%	-1900				≥2p			Green	G	≥3p		Std				
2013	≥40%		≥88%	≥40%	-1900				≥2p				G	≥3p		Std				
2014	≥40%		≥88%	≥40%	-1900				≥2p				G	≥3p		Std				
2015	≥40%		≥88%	≥40%	-1900				≥2p				G	≥3p		Std				
2016	≥40%	5							≥2p				G	≥3p		Std	Std/opt			
2017	≥40%	5							≥2p				-	≥3p		Std	Std/opt			
2018	≥40%	5							≥2p				-	≥3p		Std	Std	Std		
2019	≥40%	5							≥2p				-	≥3p/G	G	Std	Std	Std	Std/opt	Std/opt

The crashworthiness of the vast majority of new vehicles has during the years been verified by Euro NCAP results. Rating results from real-world crash data has only been available for a smaller number of vehicles. Figure 1 shows the distribution of Euro NCAP stars for all new vehicles in Sweden 2019. 157 (58%) of 270 new vehicles available of model year 2019, have a five-star rating. 66 (24%) were either not tested or tested prior to 2012. In 2001, when the vehicle policy was complemented with a vehicle list, Euro NCAP data from 89 new vehicle were evaluated of which only one model received five stars and 42 (47%) received four stars. In 2001 the requirements for superminis and small family cars was that they should have at least four stars and for large family cars and executive cars that they should have at least three stars in Euro NCAP.

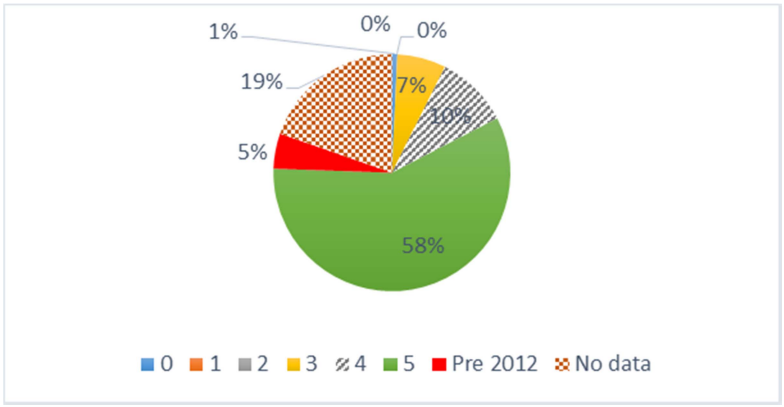

Figure 1. Euro NCAP star 1997-2019

Safety systems

Requirements regarding fitment of new effective safety technologies have been introduced continuously, see Table 1. In 2006 fitment of Electronic Stability Control (ESC) was introduced as a requirement (Table 1) and 82(32%) vehicle models have had ESC as standard on all versions and reached 80% in 2009 and 100% in 2017.

In 2016 fitment of Autonomous Emergency Braking (AEB) was introduced as a requirement (see Table 1). In 2016, AEB City (all versions with 100% fitment) was available in 24% of vehicle models (see Table 2). In comparison 59% of sold models have had AEB City 2016 (see Table 2). It is shown in Table 2 that 76% of vehicle models in 2016 have had AEB city as standard, option or not available, depending on the model version. A higher rate of safety assist systems in sold models compared to models for sale can be seen in Table 2-4. The implementation of AEB interurban, and AEB with detection of vulnerable road users (VRU) is not as fast as for the AEB city. For AEB interurban, 26% of all models with standard fitment was reached in 2017 (see Table 3). Standard fitment of AEB with VRU detection reached 22% in 2017 (see Table 4). In 2018 the proportion of vehicle models with standard fitment of AEB Interurban was 42% and for AEB VRU it was 37%, which was lower than for AEB city (59%). The number of sold vehicle models with standard fitment of AEB of all types, has increased more rapidly than the fitment rate in the models for sale. The rate of sold vehicle models 2017 with standard fitted AEB with VRU detection was 45% lower than for AEB city.

In 2019 also AEB with detection of VRU was introduced as a requirement (see Table 1). This is a result of real-world results indicating a good safety performance [21] [22] together with the rapid implementation of this system since 2014 (see Table 4).

Standard fitment of Lane departure warning (LDW) is not as common as AEB city/interurban, neither for vehicle models for sale or for sold vehicles. In 2018 29% of vehicle models had LDW as standard fitment (see Table 5). LDW was introduced as a requirement in 2019 (see Table 1) as a consequence of studies indicating good safety performance [6, 23].

Table 2.
City AEB – fitment/sold models

		2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
100% Std	Fitment	5,0%	5,0%	8,0%	15,9%	23,6%	38,0%	58,7%
	Sold	18,0%	26,0%	30,0%	50,8%	58,6%	69,0%	No data
Std/Opt/Not available	Fitment	6,0%	5,0%	5,0%	10,5%	11,1%	14,8%	4,2%
	Sold	5,0%	2,0%	7,0%	3,6%	19,8%	12,0%	No data
100% Option	Fitment	12,0%	15,0%	21,0%	13,2%	13,2%	11,8%	12,5%
	Sold	20,0%	25,0%	23,0%	15,2%	9,6%	9,0%	No data
100% Not available t	Fitment	77,0%	75,0%	66,0%	60,3%	52,0%	35,4%	24,7%
	Sold	57,0%	47,0%	40,0%	30,4%	12,0%	10,0%	No data

Table 3.
Interurban AEB – fitment/sold models

		2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
100% Std	Fitment	0,0%	0,0%	3,0%	8,5%	11,6%	25,5%	42,4%
	Sold	0,0%	0,0%	7,0%	17,8%	24,4%	59,0%	No data
Std/Opt/ Not available	Fitment	5,0%	5,0%	7,0%	8,8%	13,3%	10,3%	2,8%
	Sold	10,0%	9,0%	15,0%	12,3%	23,2%	9,0%	No data
100% Option	Fitment	5,0%	8,0%	12,0%	12,2%	12,3%	10,7%	12,5%
	Sold	10,0%	13,0%	25,0%	20,7%	19,1%	12,0%	No data
100% Not available	Fitment	90,0%	85,0%	78,0%	70,5%	62,8%	53,5%	42,4%
	Sold	80,0%	78,0%	53,0%	47,9%	33,4%	20,0%	No data

Table 4.
AEB VRU detection – fitment/sold models

		2012	2013	2014	2015	2016	2017	2018
100% Std	Fitment	0,0%	0,0%	2,0%	5,0%	12,0%	22,1%	36,8%
	Sold	0,0%	0,0%	4,0%	12,0%	20,0%	38,0%	No data
Std/Opt/ Not available	Fitment	0,0%	0,0%	1,0%	3,0%	5,0%	1,5%	1,7%
	Sold	0,0%	0,0%	4,0%	6,0%	10,0%	17,0%	No data
100% Option	Fitment	3,0%	3,0%	5,0%	6,0%	7,0%	8,1%	10,4%
	Sold	6,0%	6,0%	10,0%	12,0%	14,0%	11,0%	No data
100% Not available	Fitment	97,0%	97,3%	92,0%	86,0%	76,0%	68,3%	51,0%
	Sold	94,0%	94,0%	82,0%	70,0%	56,0%	34,0%	No data

Table 5.
LDW fitment models

Fitment	2016	2017	2018
100%Std	7,1%	20,7%	28,8%
Std/Option/ Not available	29,2%	25,4%	25,7%
100% Option	18,6%	17,3%	17,7%
100% Not available	45,2%	36,6%	27,8%
Sum	100,0%	100,0%	100,0%

Emission criteria

The CO_2 emission requirements in 1998-2012 were divided for various vehicle size groups. From 2013-2019 this criterion was changed to emission level by curb weight. To be able to present the emission figures from 1998-2019 with respect to vehicle size in this paper, the average curb weight was calculated for each vehicle size and model year and associated emission figures are presented (see Table 5-8).

During 1998-2002 vehicles with diesel engines were not allowed in the policy. In 2003-2012 diesel engines needed to have a 20% lower fuel consumption than petrol to fulfill the emission criteria. Since 2013 the CO_2 emission criteria were equal for diesel and petrol.

The CO_2 emission requirements have been tightened during 1998-2019. Table 5 presents the CO_2 limits for petrol vehicles in the vehicle policy, showing a reduction in emission level of 47-50% between 1998 and 2019.

Table 5.
CO_2 emission limit petrol 1998-2019

Policy year	CO_2 g/km Super mini	CO_2 g/km Small family car	CO_2 g/km Large family car	CO_2 g/km Executive car
1998	186	186	205	231
1999	182	182	201	227
2000	151	177	196	222
2001	149	175	194	219
2002	146	172	191	215
2003	144	168	186	210
2004	139	163	182	205
2005	139	163	182	205
2006	139	158	179	201
2007	137	156	175	196
2008	132	153	170	191
2009	130	151	168	189
2010	127	149	165	184
2011	125	146	158	177
2012	123	142	151	170
2013	112	120	126	139
2014	105	105	113	126
2015	105	105	109	120

2016	105	105	110	120
2017	104	104	109	118
2018	99	99	108	116
2019	99	99	108	115
Change (%)	-46,9	-46,9	-47,6	-50,1

Table 7 shows the reduction of CO_2 emission limit during 16 years. For smaller family cars a 36% reduction can be seen and for large vehicles a 39% reduction.

Table 7.
CO_2 emission limit diesel 2003-2019

Policy year	CO_2 g/km Super mini	CO_2 g/km Small family car	CO_2 g/km Large family car	CO_2 g/km Executive car
2003	131	152	168	189
2004	125	147	165	187
2005	125	147	165	187
2006	125	144	163	181
2007	123	144	160	179
2008	120	141	157	173
2009	120	139	155	171
2010	120	136	152	168
2011	123	133	149	163
2012	123	133	147	157
2013	112	120	126	139
2014	96	105	113	126
2015	88	101	109	120
2016	90	102	110	120
2017	88	101	109	118
2018	89	99	108	116
2019	90	98	108	115
Change (%) 2003-2019	31,3	35,5	35,7	39,1

THE FOLKSAM VEHICLE PURCHASE POLICY 2019

Safety criteria

The vehicle crash worthiness was verified either from the Folksam car model safety ratings [24] or from vehicle safety ratings from Euro NCAP results. The car must be at least 40% better than average in the Folksam ratings or receiving a five star rating in Euro NCAP. Since the Euro NCAP test protocol continuously undergoes changes, older test results than 2012 was not accepted in the 2019 years requirements of the policy.

To reach top score in Euro NCAP, specific safety equipment needs to be available on the test vehicle. Since the availability varies for different markets, it was a need to have additional requirements for important safety systems. The safety systems required in the policy are shown in Table 1.

Table 1. Required safety systems in Folksam vehicle policy

Safety system	Availability
AEB (Autonomous Emergency Braking)	Standard
AEB VRU (AEB with detection of vulnerable road user)	Standard or option
LDW (Lane Departure Warning)	Standard or option
ESC (Electronic Stability Control)	Standard

The level of whiplash protection was also included in the safety requirements verified through whiplash rear impact score in Euro NCAP. The whiplash score for the front seats had to be “Green”. As an alternative, the dynamic rating in “Head restraint & seats” published by IIHS was used [25]. The dynamic rating score had to be “Good”.

Emission criteria

The current emission criteria for 2019, was adapted to reach the European targets of CO_2 emission [13]. However, the long-term goal is to reach net zero emission of new vehicles by 2030 [26].

The 2019 year revision of the policy consists of two levels of CO_2-emissions. Until 2019 the assessed CO_2 emissions have been based on the driving cycle NEDC (New European Driving Cycle). Since September 1st 2017, a new driving cycle, WLTP (Worldwide Harmonized Light Vehicle Test Procedure) was introduced and became mandatory for vehicles launched September 1st 2018 and onwards. During 2019 two CO_2 emissions figures will appear for new vehicles, NEDC values or NEDC corr values. NEDC corr was used as a transition to WLTP and was calculated from the WLTP value. From 2020 only WLTP will be used.

The emission criteria are illustrated in Figure 3. The CO_2 emission value are related to the vehicle curb weight. NEDC emission limits start at 99 g/km and ends at 110 g/km. NEDC corr emission limits is higher to correspond to the differences between NEDC and NEDC corr values. The limit starts at 108 g/km and ends at 121g/km.

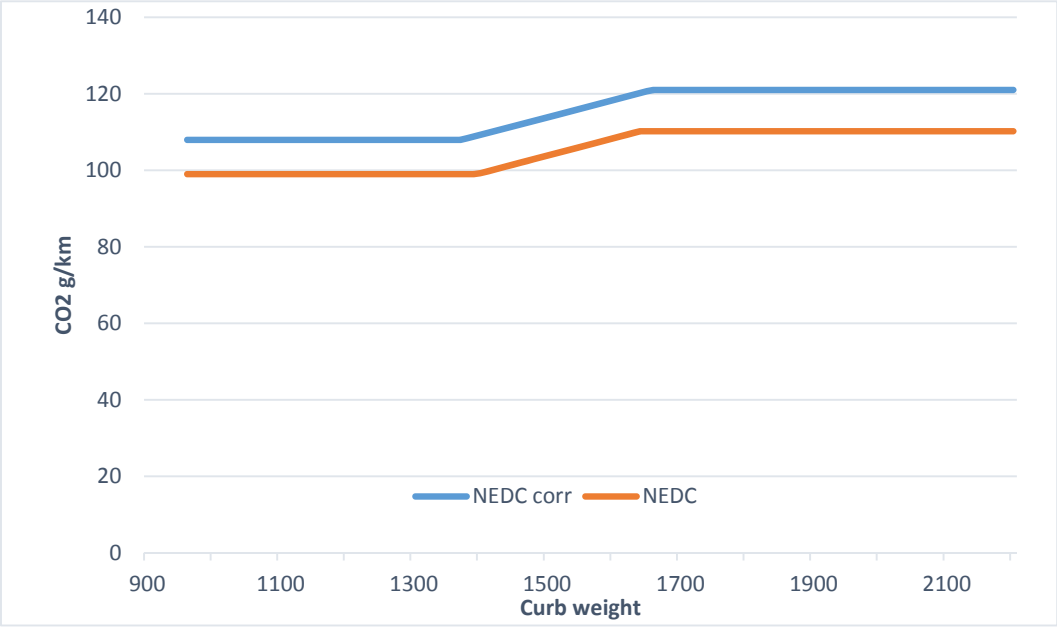

Figure 2. Emission criteria

The difference of emission values between NEDC and NEDC corr were evaluated from an analysis of 1253 vehicle model versions with model year 2017, identical to current versions (see Figure 3). The analysis shows that 75% of the observed versions had an increase of CO_2 from NEDC to NEDC corr of 0-20 g/km. The difference in emission between NEDC and NEDC corr was also shown to be larger for larger vehicles in general. This is the reason for the difference of 9-11 grams between NEDC and NEDC corr CO_2 limits (see Figure 2).

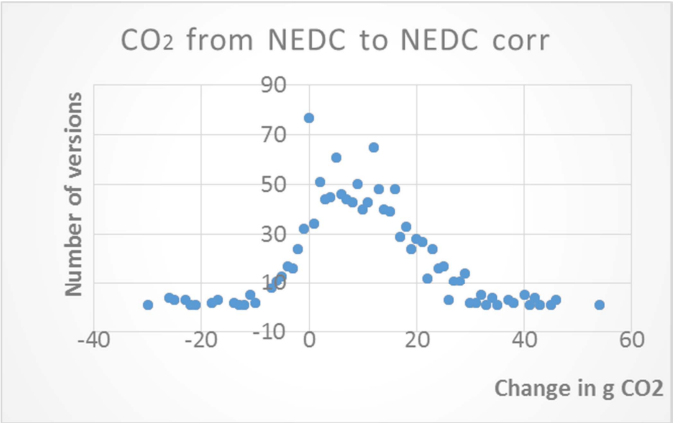

Figure 3. Number of model versions with changed CO_2 emission values from NEDC to NEDC corr

Out of 270 new vehicle models of model year 2019, 44 models (16%) fulfilled the requirements in the policy. In total 44 out of the 270 available models fulfilled the requirements of the 2019 revision of the policy (see Table 9). The listed models have at least one version that fulfills the policy requirements. In total 206 versions of these models fulfilled the requirements (see Table 10). Only a few superminis, large MPVs and Large SUVs can be seen in Table 9 and 10, showing that these size categories have lower specifications regarding safety and/or higher CO_2 emissions.

Table 9.
Number of models with at least one approved version vs. models without any approved version

Size	Models fulfilling the requirements	Models without any version approved	Total
Super mini	1	32	33
Small family car	8	52	60
Large family car	13	24	37
Executive car	8	26	34
Small MPV	5	8	13
Large MPV	0	12	12
Small SUV	8	35	43
Large SUV	1	37	38
Total	44	226	270

Table 10.
Number of model versions approved/failed

Size	Versions approved	Versions failed	Total
Super mini	10	207	217
Small family car	27	517	544
Large family car	90	584	674
Executive car	40	603	643
Small MPV	6	78	84
Large MPV	0	135	135
Small SUV	28	468	496
Large SUV	5	462	467
Total	206	3054	3260

The vast majority of the vehicle models fulfilling the criteria (23) are models with diesel engines. Only three models have pure petrol engines. Nine models have at least one electric hybrid version. Thirteen models have at least one plug-in hybrid version. Six pure electrical vehicle models are among the ones fulfilling the policy requirements. Two models with CNG (Compressed Natural Gas) and one model with fuel cell also fulfill the policy requirements 2019.

DISCUSSIONS

It is important to guide vehicle fleet buyers of personal vehicles to choose the most safe and environmentally friendly vehicles since those vehicles will be used for many years. It is also important that the requirements follow the developments in vehicle safety and that they are in line with the global emission targets.

One of the purposes with a vehicle purchase policy is to speed up the implementation rate of important safety technologies. One example of a fast implementation in Sweden is the introduction of ESC [27]. ESC only had 15% market penetration in the 2003, but after five years the fitment rate was above 90%. Since 2009 the increase has been slow, but in 2017 the fitment rate of ESC in Sweden was 100%. ESC has been included in the Folksam policy since 2006. However, in the 2020 revision of the policy it might be excluded.

Other safety technologies that have been introduced and that have increased their implementation rate is various kinds of AEB and LDW. Many of these technologies have a more than 50% fitment rate of sold cars in 2019. In Table 2, 76% of the vehicle models have AEB City as standard, option or not depending on model version. The vehicle policy guides the consumer to find vehicle models fitted with those safety systems, but it also influence the vehicle manufacturers to make the important safety systems as standard fitment. This is important because fleet purchasers or private consumers often have difficulties to identify which of the safety features that are of importance for safety. An example is ABS, that has been shown to be less effective [28, 29] in contrast to for example AEB or lane departure system that have been shown to be effective[4, 6].

Table 2-4 show differences in fitment rates between vehicle models for sale and sold models. There are probably several reasons for this. In Sweden there is a lot of communications towards vehicle consumers that e.g. AEB is an important feature so customers are aware of its importance. Several car fleet purchasers also include safety requirements in their purchase policies. It is not surprising that sold vehicles have a higher safety standard compared to the models for sale.

During the last two decades limitations in curb weight have been included in the requirements. Studies of vehicle compatibility shows that there is a need to limit the large variation in curb weight [5, 30-32]. The upper limitation of 1900kg was previously included in the Folksam policy as a result of this knowledge[33]. There is however a development towards a larger spread in curb weight. Small vehicles becomes heavier but new smaller vehicle segments appear. It is still 11 new vehicle models of model year 2019 in the database, which has a curb weight below 1000kg. At the same time there are 45 vehicle models with curb weight over 2000kg in the database. 16 of those heavier vehicle models are supported by electrical motors. In conclusion there will be a need for a curb weight limitation in the policy criteria that does not exclude new environmentally friendly engine techniques.

The list of model presented in Table 9 shows that only a few models of the vehicle categories superminis, large MPVs and Large SUVs fulfill the requirements. The main reason for the superminis to fail is the absence of AEB with pedestrian detection. The large MPVs most commonly fail due to large emissions but also lack of AEB with pedestrian detection. MPVs are not usually fitted with alternative fuels such as batteries. The large SUVs fail most often due to large emissions.

The emission requirement contains only limits regarding CO_2. The emission of CO_2 is crucial for the climate change and historically diesel engines has had lower CO_2 emissions compared to petrol engines. However emission of NOx, especially from diesel engines, is also a health problem, especially in dense cities [34]. There is a need to control the NOx emission as well since investigation of real emissions is shown to be extensively higher than the emission level defined by Euro 6. In the transition period to alternative fuels, diesel and petrol will be used. The RDE (Real Driving Emission) which is included in the WLTP test cycle from 2017, measures NOx emitted by the vehicles while driven on the road [35]. This will probably control the NOx emission and will mean that requirements for NO_x emission does not need to be included in the policy.

There is an increasing interest of more fuel saving vehicles and vehicles that can be driven fossil free. Fuel economy is one of top three purchase criteria which makes PHEV vehicles and electrical cars of special interest for car buyers [36]. The number of plug-in hybrids for sale is increasing. However, there are relatively few plug-in hybrids in the policy list 2019. One reason is the change from the emission driving cycle NEDC to WLTP. A large number of plug-in hybrids has not been tested according to WLTP and will therefore need to wait until the WLTP test is done.

CONCLUSIONS

It is important to guide vehicle fleet buyers of vehicles for private use to choose the safest and most environmentally friendly vehicles since those vehicles will be used for many years. Company car policies are important tools in this process. A vehicle purchase policy will indirectly influence car manufactures to offer vehicles that fulfil the requirements in the policy.

An important recommendation is that a vehicle purchase policy should be revised annually to follow rapid changes in available safety technology and emission standards in order to substantially influence the vehicle fleet. A vehicle purchase policy is an important tool to guide vehicle consumers towards the safest and most sustainable vehicles. It is recommended that a vehicle purchase policy should consist of requirements regarding crashworthiness, fitment of important safety systems, CO_2 emissions. Preferably, it should be complemented with a vehicle list for tangible and feasible advice to consumers

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