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Electric Vehicle Uptake: Modelling a Global Phenomenon

Bureau of Infrastructure, Transport and Regional Economics

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Foreword

This report describes and models the uptake of electric vehicles in 22 countries around the world.

Electric-powered vehicles began to come onto the scene around the world at the beginning of the 2010s. This means that there is generally only about seven to nine years data for each of the countries to work with. However, one advantage is the differences between countries, variations that allow better estimation of modelling coefficients.

Allowing for the difficulties, this report shows that electric vehicle sales, although varying in the different countries, are set to grow rapidly around the world in the coming decades

This project was undertaken by Dr David Gargett.

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August 2019

At a Glance

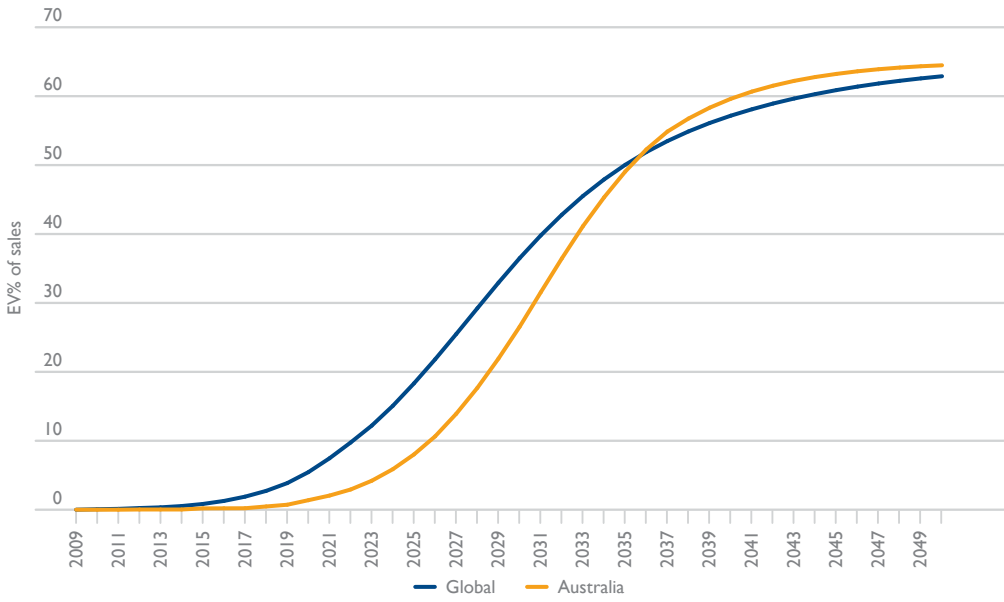
This Report describes modelling of electric vehicle (EV) uptake.

Estimates of the cost of electric vehicles out to 2030 are used in conjunction with purchase taxes and subsidies to allow a ratio of electric vehicle (EV) to fossil fuel vehicle (FFV) annual costs to be calculated for each country.

The ratio changes when different assumptions are used for future changes in electric vehicle subsidies, electric vehicle prices or oil prices, leading to changes in electric vehicle uptake.

In the base-case forecasts from the models (as shown in Figure A.1), the Australian EV share of new sales is predicted to reach 8 per cent by 2025 and 27 per cent by 2030. Globally, the EV share of new sales is predicted to reach 18 per cent by 2025 and 36 per cent by 2030.

Figure A.1 **Global and Australian predicted EV sales as a percentage of annual new passenger vehicle sales**



The models can provide estimates to policy makers of the effect on electric vehicle uptake rates of any detailed changes in subsidies, taxes or charges. Sensitivity testing suggests that the rate of uptake of EVs is influenced by future petrol prices and electric vehicle prices, but with the latter being far more influential.

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Executive Summary

Background

The spread of electric vehicles through the passenger vehicle (and truck) fleets in coming decades has the potential to substantially alter transport energy use and transport infrastructure, with implications that have to be considered by policy makers.

This report describes an approach for estimating likely electric passenger vehicle uptake for each of 22 counties around the world. The resulting models allow an understanding of the forces underlying electric vehicle uptake trends in each of the countries, thus providing estimates of the predicted speeds with which electric vehicle sales will replace sales of fossil fuel vehicles.

Models of electric vehicle uptake were derived for Australia, Austria, Belgium, Britain, Canada, China, Denmark, Finland, France, Germany, India, Ireland, Italy, Japan, Korea, the Netherlands, New Zealand, Norway, Spain, Sweden, Switzerland, and the United States (as well as for the 'Rest of Europe').

Modelling Electric Vehicle Uptake in Twenty-Two Countries

Data on new Electric Vehicle (EV) model characteristics by year from 2009 to 2021 is assembled. From that dataset, time series for kWh (kilowatt-hour) battery size, kilometre range and price are estimated.

Estimates and forecasts of battery price in US$/kWh are presented, showing that battery cost per kWh is set to more than halve by 2025 (from US$ 189 to $US72 per kWh), and to continue to decline thereafter. But battery size (and vehicle range) is set to more than double by 2025 (from 60 kWh to 154 kWh), before topping out. This means that the outlook is for a fairly constant battery price for EVs out to 2025, before the price starts to decline. As the aggregation of other elements of EV manufacturing costs is also set to remain constant out to 2025, total EV prices are also predicted to remain fairly constant out to 2025, before a decline begins.

Raw s-shaped (logistic) curves are estimated for the 22 countries in the study, allowing estimates of when EV sales reach 2 per cent of total vehicle sales for the 22 countries.

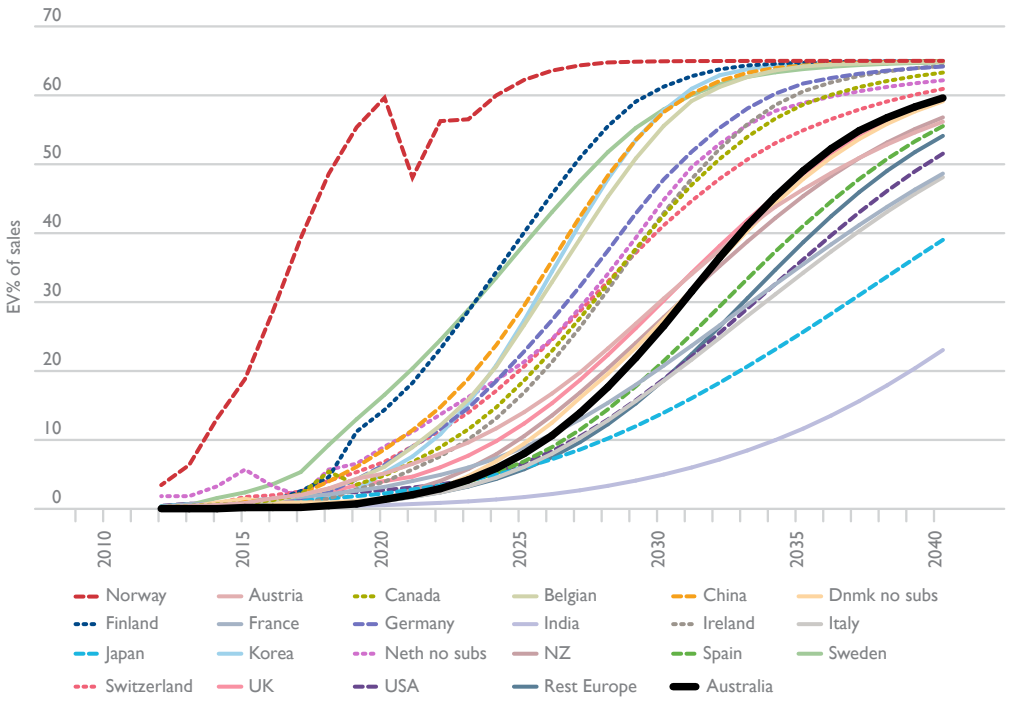
Calculating annual principal and interest costs of EV and Fossil Fuel Vehicles (FFV) purchases and adding in annual running costs (negative for EV subsidies and positive for FFV petrol costs) allows a ratio of EV to FFV annual costs to be calculated.

This cost ratio is then used in a model that predicts the date when EV sales reach 2 per cent of total vehicle sales for the 22 countries involved in the study. When the cost ratios change (for example with the addition or removal of EV subsidies), the model then allows a forecast of how the trend in EV uptake in the country involved will change (what the shift in the s-shaped uptake curve will be). For example, the model accurately predicts the reductions in uptake that occurred in Denmark and the Netherlands when subsidies were cut. Similar declines are forecast for Belgium and the United States where subsidy cuts are scheduled by 2020. Sweden has seen an uptick as subsidies have been increased.

The modelling produces cost-based raw forecasts of EV uptake in the 22 countries. However, the raw models are based on very early uptake rates, when sales are predominantly to richer people. A final adjustment is made to the cost-based raw model uptakes to stretch them out over time, simulating the slowing of uptake as sales move away from the rich. The result is termed a "predicted cost lagged " uptake rate. This is the final base-case estimate of how electric vehicle uptake is expected to play out.

On this basis, Australian EV share of new sales is predicted to reach 8 per cent by 2025 and 27 per cent by 2030. Globally, EV share of new sales is predicted to reach 18 per cent by 2025 and 36 per cent by 2030. Figure E1 shows the EV uptake rates for the 22 countries (with currently indicated subsidies).

Figure E1 Base-case (predicted cost lagged) EV per cent of sales for 22 countries



These predicted uptake rates are calculated using base-case forecasts for petrol and electric vehicle prices. The advantage of the cost-based models developed in this report lies in enabling scenarios for these prices to generate different uptake rates. Using fairly wide scenario assumptions, it is shown that the rate of uptake of EVs is influenced by both future petrol prices and electric vehicle prices, but with the latter being far more influential.

Policy Implications and Conclusion

An understanding of the speed of electric vehicle uptake in countries is important for policy makers in several ways.

As electric vehicles spread throughout the fleet, revenue from various taxes, especially those on fossil fuel such as excise taxes and carbon taxes, will decline. These taxes are currently used to fund a substantial part of the cost of road construction and maintenance, funding which will have to be replaced.

Also, existing tax exemptions from value-added taxes and other purchase taxes for electric vehicles will become increasingly expensive the faster they gain market share of new vehicle purchases. The same applies to subsidies for annual vehicle use.

The faster the increase in the electric vehicle fleet, the faster the growth in demand on the electricity supply, and the more urgent the needs for system reconfiguration.

On the other hand, the faster the spread of electric vehicles, the slower the increase in fossil fuel emissions from transport.

In all of these ways, the uptake estimates presented here, as a result of electric vehicle uptake modelling for the 22 countries, will be of interest to policy makers charged with maintaining and funding the transport and energy systems, and those charged with ensuring sustainable transport systems and reduced emissions.

CHAPTER 1
Modelling Electric Vehicle Prices

Summary

The cost of electric vehicles (EVs) relative to fossil fuel vehicles (FFVs) is important in modelling future EV uptake rates, as will be explained in Chapter 2. To model EV prices into the future, it is necessary to put together time series of past and future EV characteristics, and then use those to produce EV price forecasts. That is presented below.

Electric Vehicle Characteristics

The development of electric vehicles – defined as battery electric vehicles (BEVs) plus plug- in hybrid electric vehicles (PHEVs) – since 2009 has been rapid. Table 1.1 shows new models released over time (UBS 2017 and various sources). The orange-marked characteristics are those for vehicles costing more than $50,000 (US 2017$), which will be omitted from the analysis of the trend in EV characteristics as outliers.

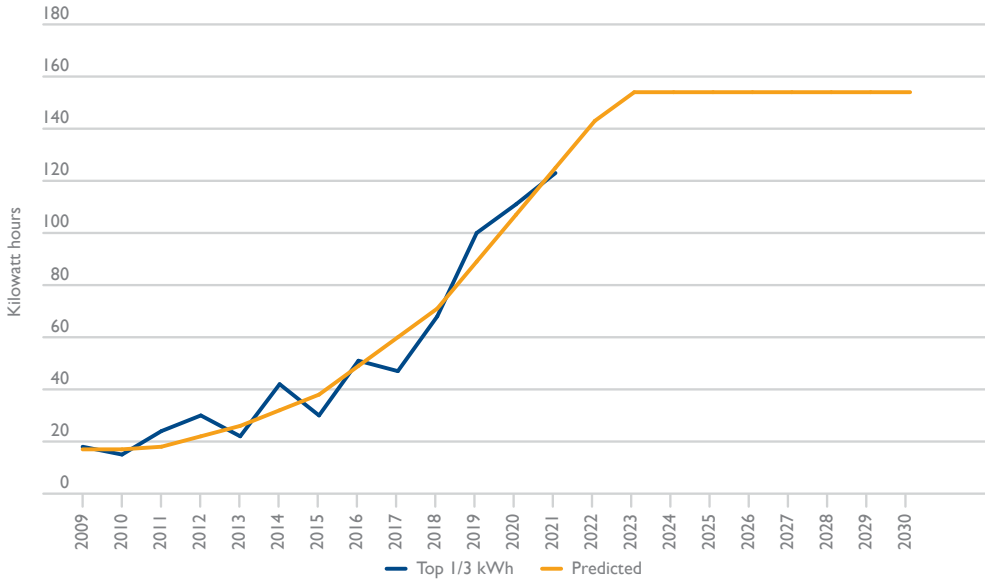
Table 1.1 Electric Vehicle Characteristics 2009–2021

	Make	Model	Range (kms)	Real 2017 US$ ('000)	kWh
2009	Daimler	Smart Edrive	110	30	18
2010	Mitsubishi	I MIEV	100	27	16
	Peugeot	Peugeot iOn	110	22	15
	Peugeot	Citroen C_Zero	110	22	15
2011	Renault	Twizy	80	9	6
	Renault	Kangoo ZE	110	24	22
	Renault	Fluence ZE	100	31	22
	Nissan	Leaf	120	31	24
2012	Tesla	S 70D	385	98	80
	Tesla	S 90D	460	115	90
	Ford	Focus	110	31	23
	Bollore	Bluecar	200	22	30
	Honda	Fit EV	135	38	20
2013	Renault	Zoe	170	25	22
	BMW	i3	135	41	19
	Volkswagen	e-Up!	120	31	19
	Fiat	500e	140	34	24
	GM	Chevy Spark	135	27	19
2014	Volkswagen	e-Golf	135	40	24
	BMW	i3	145	41	22
	Toyota	RAV4 EV	180	47	42
	Daimler	Mercedes B-Class ED	140	44	28
	Kia	Soul EV	160	32	27
	Nissan	e-NV200	170	27	24

	Make	Model	Range (kms)	Real 2017 US$ ('000)	kWh
2015	Tesla	Model X	420	91	75
	Volvo	C30 EV	145		24
	Nissan	Leaf 24	135	30	24
	Nissan	Leaf 30	250	35	30
2016	BMW	i3+	185	40	30
	Peugeot	Citroen e-Mehan	100	31	30
	Chevy	Bolt	385	38	60
	Chevy	Spark	131	27	19
	Daimler	Smart Fortwo	110	24	18
	Renault	Zoe	300	36	41
2017	Hyundai	Ioniq	200	30	28
	GM	Opel Ampera-E	380	37	60
	Volkswagen	Golf+	200	29	36
	Daimler	Smart Forfour	110	25	18
	Daimler	Smart Cabrio	110	28	18
	Honda	Clarity EV	130	30	26
	Ford	Focus+	160	27	30
2018	Tesla	Model 3	350	35	50
	Audi	Q6 e-tron	500	90	95
	Nissan	Leaf+	240	30	40
	Nissan	Micra EV	**240**	40	41
	Renault	Zoe+	360	35	64
	Audi	e-tron Quatro	500	45	95
	Volkswagen	up!	160	35	19
	Volkswagen	E-Golf	200	36	36
	Nissan	Leaf	380	38	60
	Hyundai	Kona	350	39	64
	Kia	Niro	385	30	65
	Mitsubishi	i-Miev	128	24	16
	Chevy	Bolt	385	37	60
	BMW	i3s	200	42	33
	NIO	ES8	355	68	70
	Jaguar	I-Pace	480	55	90
2019	Porche	Mission E	450	160	90
	Mercedes	EQ	400	55	70
	Volvo	XC40.2 Concept	500	38	100
	Aston Martin	Rapid E	350	255	**70**
	Ford	Focus	185	30	30
	Hyundai	Ioniq	200	30	28
	BMW	i5	600	55	130
	BYD	e6	300	65	61
	Lucid Motors	Air+	645	55	130
	Opel	Corsa EV	350	27	50
	Mini	Cooper E	300	32	**41**
	Toyota	BEV	**500**	**30**	
2020+(=2021)	Tesla	Model X	**500**	**99**	100
	Tesla	Model S 85D	**540**	**93**	100
	Tesla	Model S	400	70	75
	Audi	BEV	500		
	Volkswagen	ID Hatch	600	38	125
	Volkswagen	ID Crozz SUV	500	31	83
	Skoda	Kodiaq BEV	500		
	Skoda	Vision E	500		83
	BMW	I Vision Dynamics	600	55	
	BMW	i-Next	650		120
	Faraday	FF91	600	100	130
	Volkswagen	ID Buzz	600		111
	Ford	Mach 1	485	85	100
	Volkswagen	ID Vizzion	560		111
	Fisker	E-Motion	645		

Starting with trends in the battery capacity of electric vehicles, Figure 1.1 shows the trend in kilowatt hours (kWh) of battery storage in the top one third of EVs by range. The kWh forecast comes from a forecast for range that will be examined next.

Figure 1.1 Trend in kWh of top one-third of EVs



The relationship between kWh and range (in kilometres) is shown in Figure 1.2. It has been derived from the equation set out in Table 1.2.

Figure 1.2 The kWh-Range relationship

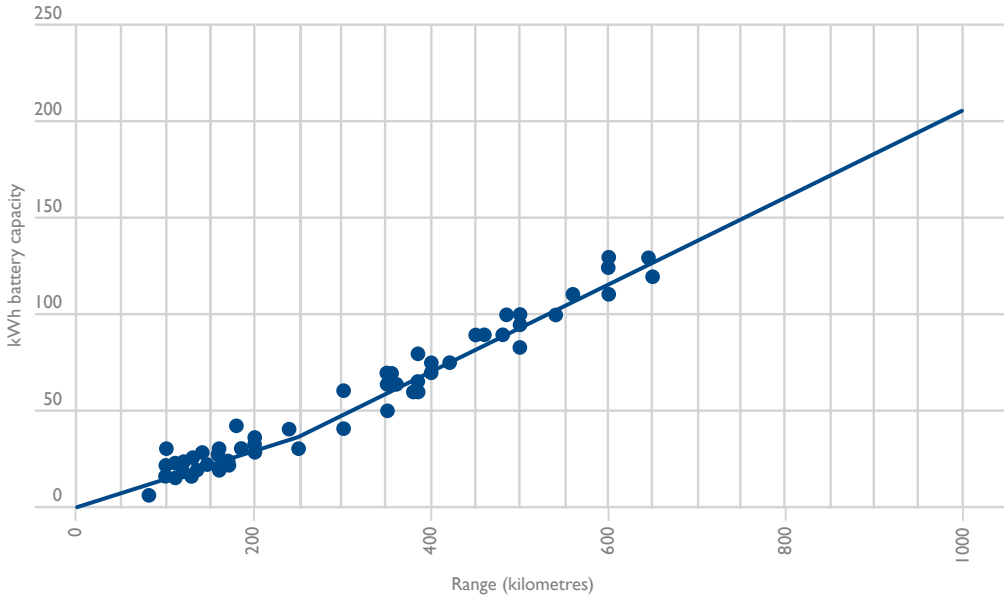


Table 1.2 The kWh-Range equation

Regression statistics	
Multiple R	0.995
R Square	0.990
Adjusted R Square	0.977
Standard Error	6.329
Observations	79

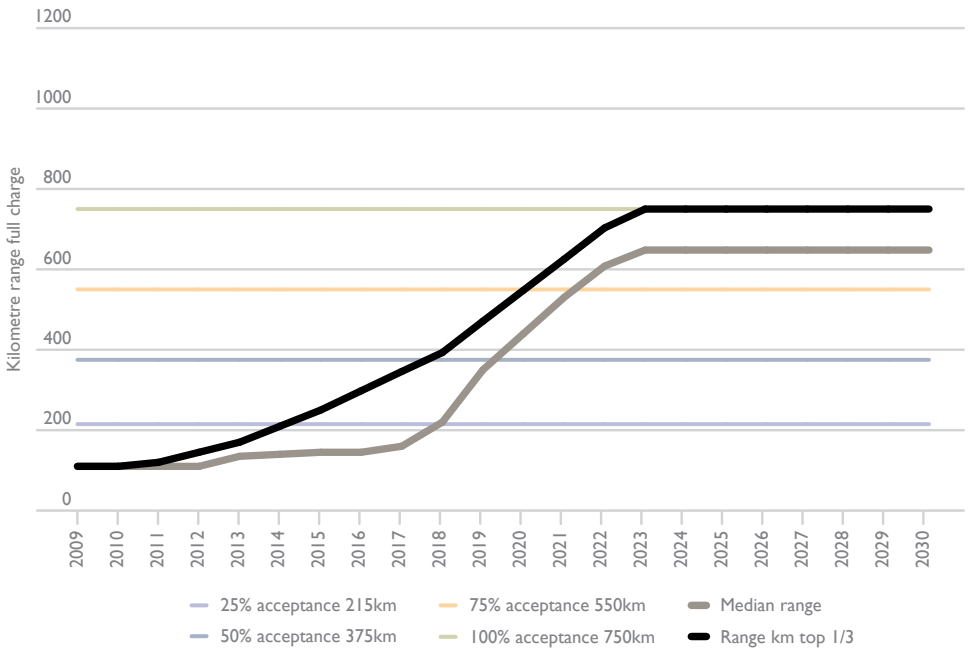
ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	297963	148982	3719	1.54441E-76
Residual	77	3085	40		
Total	79	301048			

	Coefficients	*Standard error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	0					
range	0.156	0.005	30.072	0.00000000	0.146	0.166
range>250	0.069	0.011	6.087	0.00000004	0.047	0.092

The trend over time in the range of the *top one-third* (by range) of EVs is shown in Figure 1.3, along with coloured horizontal lines representing the degree of 'range acceptance' based on a survey in major industrial countries (UBS 2017). The forecast range of the top one-third new vehicles past 2021 is assumed to top at 750 kilometres – the 100 per cent acceptance level from the study. Also shown in Figure 1.3 is the past and forecast range of the *median-range* EV. Its forecast range top-out is assumed to be a fraction of the top-third range – 650 kilometres. The median range has lagged behind the top third, but through to 2023 is set to share in rapid growth.

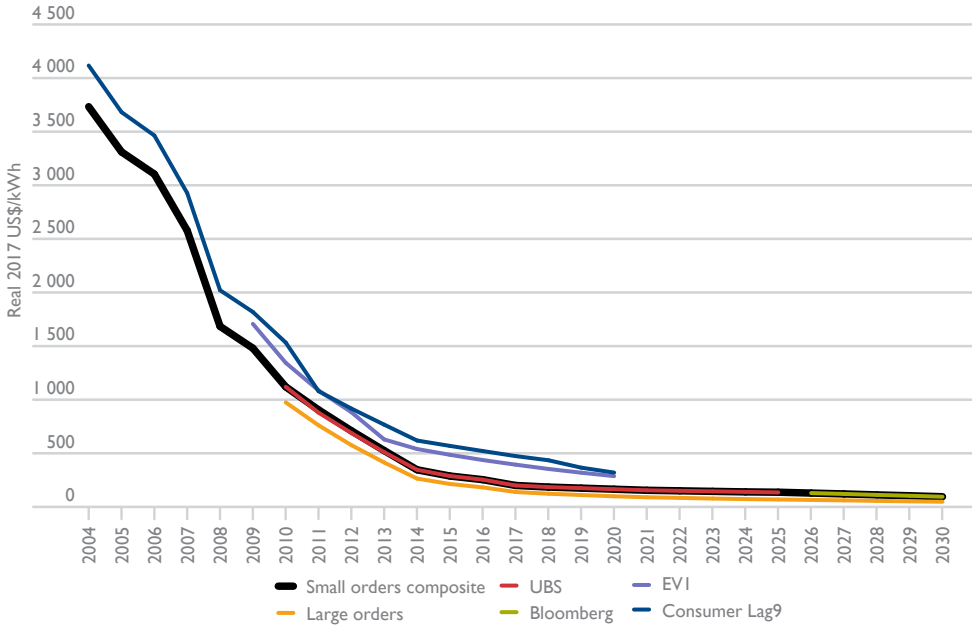
Figure 1.3 Past and forecast range of top one-third and median range vehicles



Battery Costs

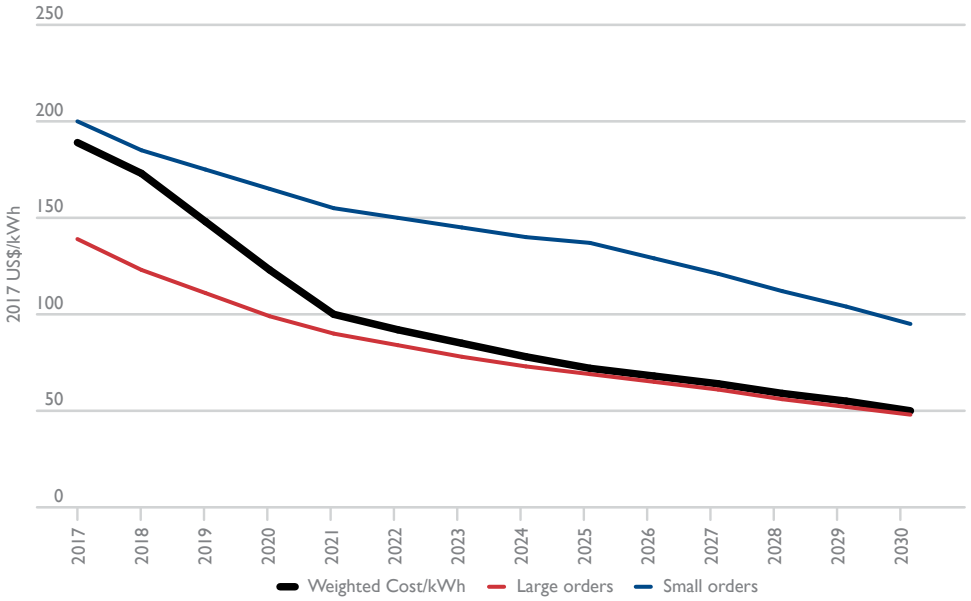
The per-kWh cost of batteries used in EVs has fallen dramatically over the years. Figure 1.4 shows several time series illustrating the fall. The black line is an estimated time series derived from 1) an estimate from the Australia Institute (2016) of the cost of consumer batteries lagged 9 years (2004 to 2020), 2) a UBS (2017) estimate and forecast (2010 to 2025) and 3) a Bloomberg New Energy Finance (2018) estimate (2026 to 2030). The series estimates the cost per kWh of batteries manufactured in relatively small quantities. Also shown is an estimate by Cairn Energy Research Advisors (2017) of the cost of batteries produced in mega-factories for large orders.

Figure 1.4 Battery prices over time



Because production is shifting to mega-factories, a composite battery price forecast is made assuming a shift to lower-cost mega-factories. The composite forecast falls below $100 per kWh by 2022, as shown in Figure 1.5.

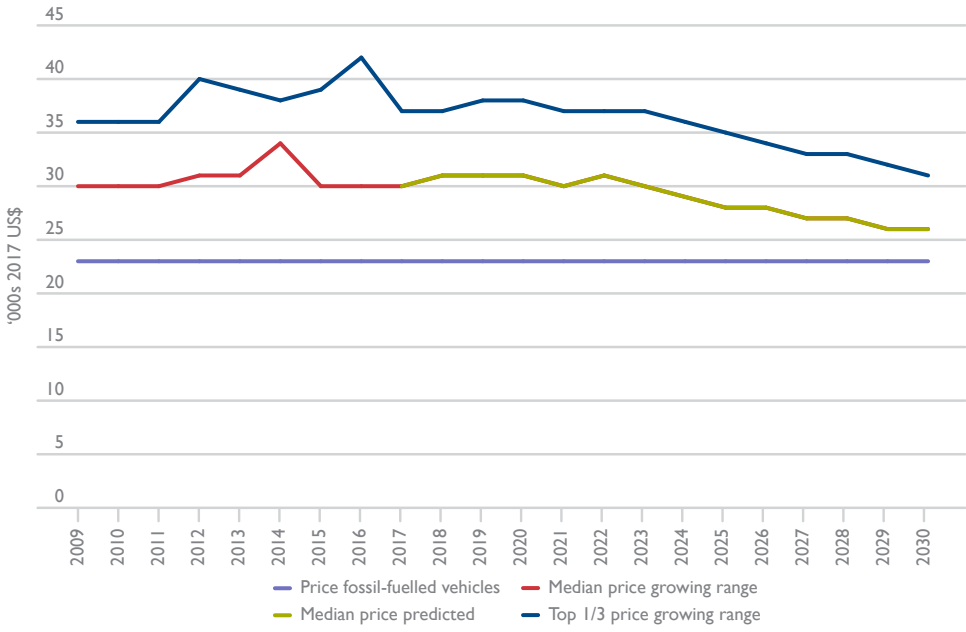
Figure 1.5 Small, large and weighted composite battery price forecasts



Electric Vehicle Prices

The trend in electric vehicle prices has been a composite of trends in: 1) the falling price per kWh of batteries – Figure 1.4, 2) growing kWhs and thus range – Figures 1.1 and 1.3, and 3) the growth in manufacturing efficiency and economies of scale. Figure 1.6 shows the trend in prices of the top third and medium range EVs. Forecasts for the top third are based on an analysis by UBS (2017). Median prices are assumed to follow those for the top third. FFV prices are assumed constant.

Figure 1.6 Prices of top third and medium range EVs versus FFVs



The analysis by UBS results in the forecast for the top third EV price presented in Table 1.3, where the UBS estimates are for the years 2017, 2025 and 2030, and the interpolations are in grey. The battery pack cost forecasts come from the previous battery price per kWh and kWh/range analyses.

There are three columns of interest. First, the battery pack cost remains essentially the same from 2017 to 2025, as a more than doubling of battery kWhs (and range) balances a more than halving of battery cost per kWh.

The indirect costs fall dramatically as manufacturing efficiencies improve with learning and larger scale production.

But this is balanced by the necessity of turning a negative profit into a positive profit.

The result is that EV costs only start downwards in earnest after 2023.

Table 1.3 Electric vehicle price forecasts

	Chevy bolt analysis							
	2017 US$ ('000)							
	Battery pack	Powertrain	Car body	Indirect mosts	Dealer margin	Profit	Top 1/3 price	Median price
2009	21.6	2.3	8.7	7.0	3.0	-6.2	36	30
2010	16.6	2.48	9.21	7.44	3.19	-6.2	36	30
2011	15.1	2.63	9.75	7.88	3.38	-6.2	36	30
2012	14.3	3.50	13.00	10.50	4.50	-6.2	40	31
2013	12.5	3.65	13.54	10.94	4.69	-6.2	39	31
2014	10.3	3.79	14.08	11.38	4.88	-6.2	38	32
2015	10.1	3.94	14.63	11.81	5.06	-6.2	39	30
2016	11.6	4.08	15.17	12.25	5.25	-6.2	42	30
2017	11.3	3.5	13.0	10.5	4.5	-6.2	37	30
2018	12.3	3.4	12.9	9.6	4.4	-5.2	37	31
2019	13.2	3.4	12.8	8.8	4.3	-4.3	38	31
2020	13.2	3.3	12.6	7.9	4.1	-3.3	38	31
2021	12.5	3.3	12.5	7.0	4.0	-2.4	37	30
2022	13.2	3.2	12.4	6.1	3.9	-1.4	37	31
2023	13.1	3.1	12.3	5.3	3.8	-0.4	37	30
2024	12.0	3.1	12.1	4.4	3.6	0.5	36	29
2025	11.1	3.0	12.0	3.5	3.5	1.5	35	28
2026	10.5	3.0	12.0	3.5	3.5	1.5	34	28
2027	9.8	3.0	12.0	3.5	3.5	1.5	33	27
2028	9.1	3.0	12.0	3.5	3.5	1.5	33	27
2029	8.4	3.0	12.0	3.5	3.5	1.5	32	26
2030	7.7	3.0	12.0	3.5	3.5	1.5	31	26

CHAPTER 2

Outline of Electric Vehicle Uptake Modelling

Summary

This chapter presents an outline of the modelling of electric vehicle uptake that will be used for twenty-two countries around the world in Chapter 3. The model is based on vehicle purchase and operating costs.

The prediction of the price of electric vehicles in the analysis in Chapter One feeds into a model predicting EV uptake based on vehicle purchase and operating costs. The modelling has several stages:

Stage 1: Raw logistic models are fit for EVs as a per cent of total passenger vehicle sales in 22 countries around the world (predicted raw uptake).

Stage 2: The year when uptake passes 2 per cent of sales is used as a dependent variable in a regression using the ratio of the total annual cost of ownership of EV to fossil fuel vehicles as an explanatory variable.

Stage 3: The resulting equation is used to vary the future raw uptake projections based on forecast EV/FFV cost ratios ('predicted cost' uptake).

Stage 4: Then corrections are made to the predicted cost uptake logistic models, where the rates of uptake are reduced to allow for the fact that most early adopters are those with higher incomes ('predicted cost lagged' – which are less steeply rising curves). These 'predicted cost lagged' curves are the final base-case uptake predictions.

Stage 5: Finally, the base-case predicted cost lagged curves can be tested for different cost scenarios – principally relating to vehicle prices and the price of petrol.

Stage 1: Fitting Raw Logistic Models

The raw logistic models have been fit on the assumption of a 65 per cent saturation level for EV sales as a percentage of total passenger vehicle sales.

Using that assumption, the logistic growth in EV percentage can be linearized and modelled as a function of time and, where necessary, dummy variables. Figure 2.1 shows the Korean linearization.

Reversing the linearization results in the fit to actual uptake shown in Figure 2.2. Then the uptake in future years is a function of time, and forecasts of the uptake curve can be made. The Korean and Australian raw forecasts are shown in Figure 2.3.

Figure 2.1 Linearized Logistic Korean EV uptake

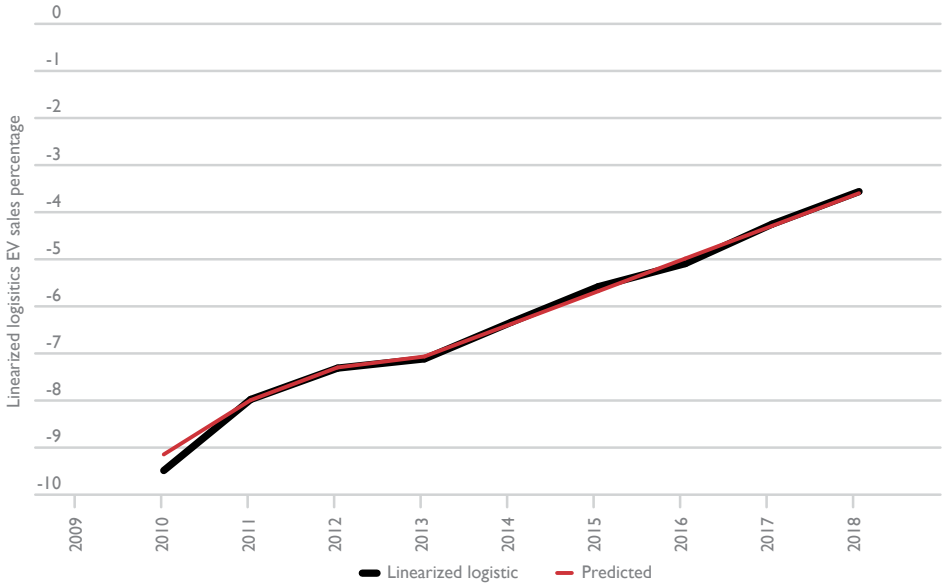


Figure 2.2 Korean raw logistic EV uptake

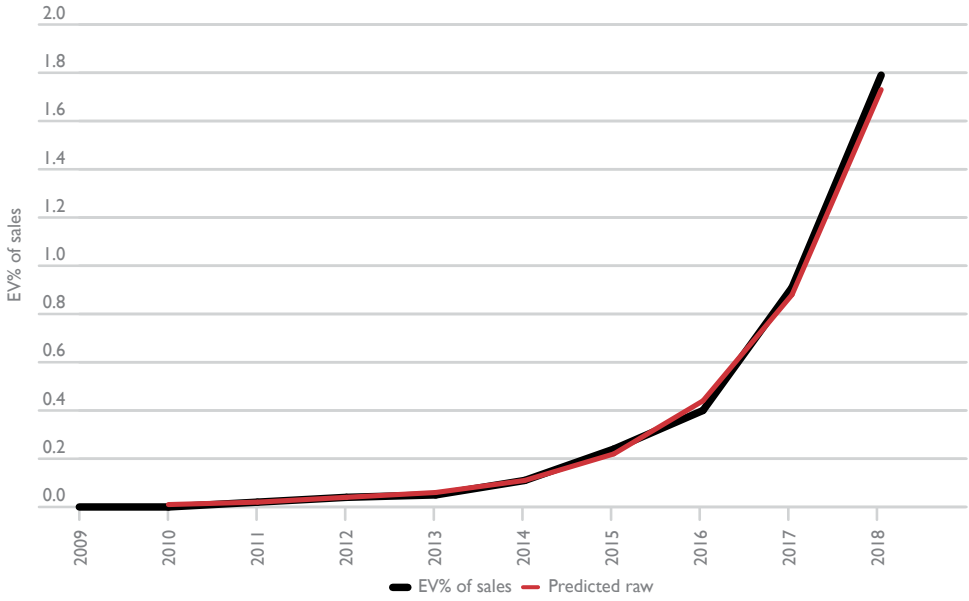
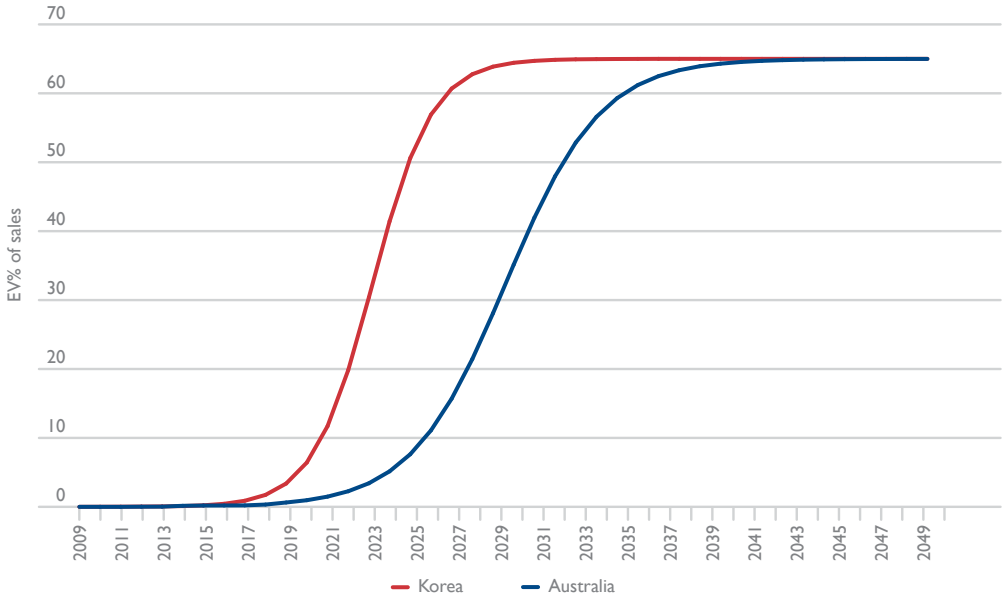


Figure 2.3 Predicated raw Korean and Australian EV uptakes



As can be seen, Australia starts later and then rises more slowly. These differences (in start time and steepness) are spread across the 22 countries, which group roughly into three categories based on the slope of the predicated raw uptake: steep, medium and flat. These groups are shown in Figures 2.4, 2.5 and 2.6.

Figure 2.4 Countries with steep raw uptake curves

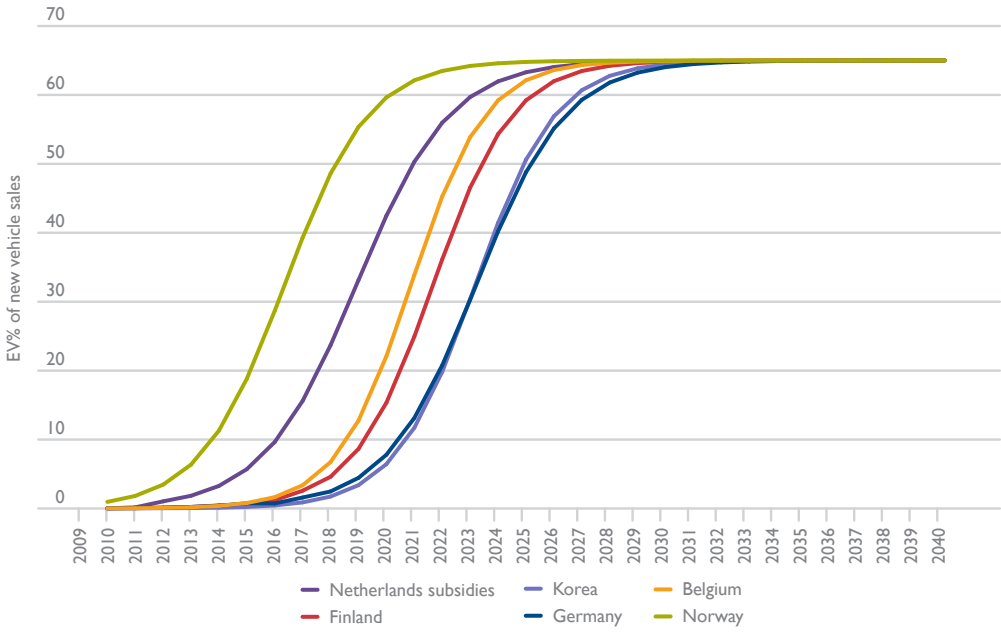


Figure 2.5 Countries with medium raw uptake curves

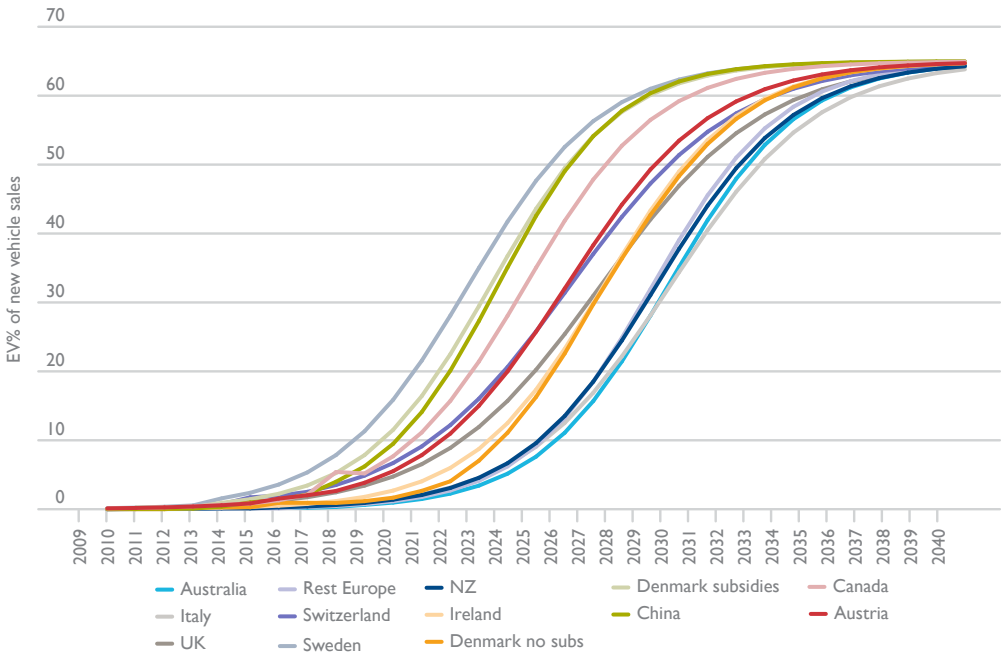
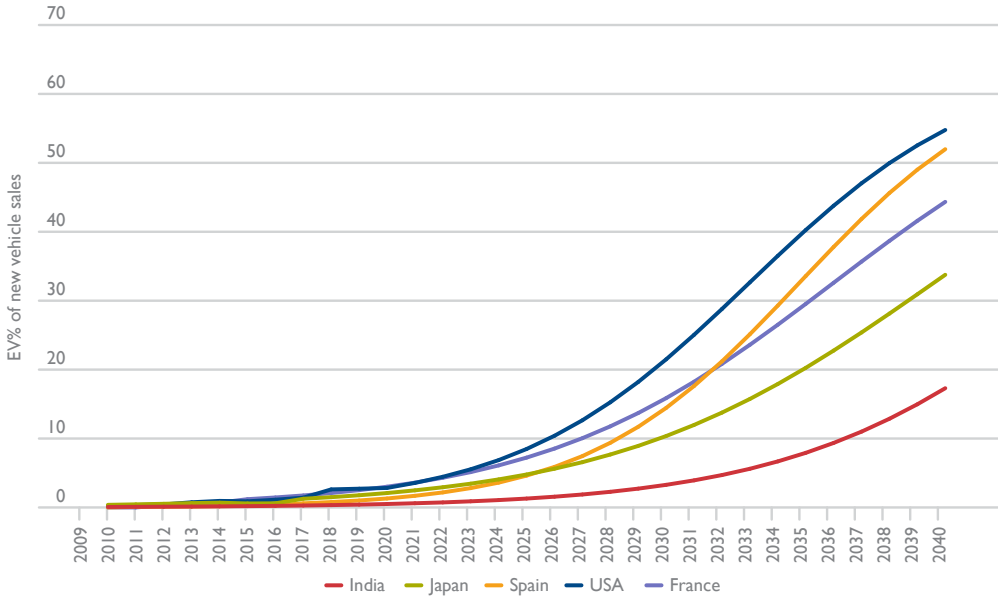


Figure 2.6 Countries with flat raw uptake curves



These curves represent the final output of stage 1 of the analysis.

Stage 2: Modelling the Two Percent Uptake Year

In Stage 2, the year that uptake reaches 2 per cent of new sales (actual or predicated raw) is recorded for each of the 22 countries. This becomes the dependent variable to be modelled in the analysis of EV uptake.

The major explanatory variable is the ratio of annual EV costs to FFV costs. Costs for both vehicle types are split into two components: *capital costs* and *running costs*.

Table 2.2 (on page 19 and 20) shows the calculation for Norway of the purchase price of Battery Electric Vehicles (BEVs), Plug-in Hybrid Electric Vehicles (PHEVs) and Fossil Fuel Vehicles (FFVs).

The 'base price' for both BEV and PHEV is the median EV price from Table 1.3 above. The base FFV price is assumed constant at 23 thousand 2017US$.

The rest of the columns are taxes charged and a cost of home charging installation for EVs. In Norway, up to 2017, BEVs were exempt from the purchase tax and the 25% Value Added Tax (VAT) charged on FFVs, and the owner tax was half that for FFVs. PHEVs have been exempt from VAT and purchase tax since 2013.

Both BEVs and PHEVs require an expenditure on Home charging installation, but the final BEV price and PHEV price are less than the final FFV price – the reverse of the situation for the initial base prices.

The annual *capital cost* for EVs and FFVs is then calculated as principal repayment (one fifth of the vehicle price) and interest (13 per cent of the vehicle price).

The *running costs* include the negative value of any EV subsidies (in Norway's case these include exemption from charges for parking, tollways and ferries) and the additional cost of petrol for FFVs. The cost of electricity for EVs is assumed to be balanced by their lower maintenance costs.

Combining annual capital costs and running costs gives the total annual costs for EVs (taken as the lowest of BEV and PHEV) and FFVs, and allows the EV/FFV cost ratio to be calculated, as shown in Table 2.1 below.

Table 2.1 Calculations of the ratio of EV/FFV total annual costs

	Evs	Evs	Evs	Evs	Evs	FFVs	FFVs	FFVs	FFVs	FFVs	EV/FFV
	EV price	Principal	Interest	Annual subs	Annual cost	FFV price	Principal	Interest	Fuel	Annual cost	Cost ratio
2012	193974	38795	25217	28230	35782	215488	43098	28013	13256	84367	0.42
2013	197800	39560	25714	28454	36820	217372	43474	28258	13489	85221	0.43
2014	227304	45461	29549	30309	44701	232985	46597	30288	13409	90294	0.50
2015	259622	51924	33751	38101	47575	298560	59712	38813	12725	111250	0.43
2016	270386	54077	35150	39573	49654	310952	62190	40424	12182	114797	0.43
2017	266430	53286	34636	38982	48940	305978	61196	39777	13067	114040	0.43
2018	263279	52656	34226	37825	49057	296240	59248	38511	16369	114128	0.43
2019	268019	53604	34842	37825	50621	296240	59248	38511	16206	113966	0.44
2020	266492	53298	34644	34825	53117	296240	59248	38511	16046	113805	0.47
2021	320547	64109	41671	31825	73956	296240	59248	38511	15887	113646	0.65
2022	324974	64995	42247	28825	78417	296240	59248	38511	15730	113489	0.69
2023	322120	64424	41876	25825	80475	296240	59248	38511	15574	113333	0.71
2024	311088	62218	40441	25825	76834	296240	59248	38511	15420	113179	0.68
2025	301616	60323	39210	25825	73708	296240	59248	38511	15267	113026	0.65
2026	296220	59244	38509	25825	71928	296240	59248	38511	15116	112875	0.64
2027	290824	58165	37807	25825	70147	296240	59248	38511	14966	112726	0.62
2028	284753	56951	37018	25825	68144	296240	59248	38511	14818	112577	0.61
2029	279357	55871	36316	25825	66363	296240	59248	38511	14672	112431	0.59
2030	273287	54657	35527	25825	64360	296240	59248	38511	14526	112285	0.57

Table 2.2 Norway vehicle cost calculations

BEV	2017 US$ ('000)	Kroner	%	Kroner	Kroner	Kroner	Kroner	Kroner	Kroner
	BEV base	BEV base	VAT%	VAT	Purchase tax	Owner tax	BEV price	Home charging	BEV price
2009	30	186088	0	0	0	3722	189810	12667	202476
2010	30	181391	0	0	0	3628	185019	11556	196575
2011	30	168249	0	0	0	3365	171614	11366	182980
2012	31	179481	0	0	0	3590	183071	10903	193974
2013	31	182820	0	0	0	3656	186476	11324	197800
2014	34	211037	0	0	0	4221	215258	12045	227304
2015	30	241880	0	0	0	4838	246718	12905	259622
2016	30	251919	0	0	0	5038	256958	13428	270386
2017	30	247889	0	0	0	4958	252847	13583	266430
2018	31	244737	0	0	0	4895	249632	13647	263279
2019	31	249384	0	0	0	4988	254372	13647	268019
2020	31	247887	0	0	0	4958	252845	13647	266492
2021	30	241654	25	60413	0	4833	306900	13647	320547
2022	31	245140	25	61285	0	4903	311327	13647	324974
2023	30	242892	25	60723	0	4858	308473	13647	322120
2024	29	234205	25	58551	0	4684	297441	13647	311088
2025	28	226747	25	56687	0	4535	287969	13647	301616
2026	28	222498	25	55625	0	4450	282573	13647	296220
2027	27	218249	25	54562	0	4365	277177	13647	290824
2028	27	213469	25	53367	0	4269	271106	13647	284753
2029	26	209221	25	52305	0	4184	265710	13647	279357
2030	26	204441	25	51110	0	4089	259640	13647	273287

PHEV	2017 US$ ('000)	Kroner	Kroner	Kroner	Kroner	Kroner	Kroner	Kroner	Kroner
	PHEV base	PHEV base	VAT%	VAT	purchase tax	Owner tax	PHEV price	Home charging	PHEV price
2009	30	186088	25	46522	43389	8678	284677	12667	297344
2010	30	181391	25	45348	41720	8344	276803	11556	288359
2011	30	168249	25	42062	38697	7739	256748	11366	268114
2012	31	179481	25	44870	40153	8031	272535	10903	283438
2013	31	182820	0	0	0	7313	190132	11324	201456
2014	34	211037	0	0	0	8441	219479	12045	231524
2015	30	241880	0	0	0	9675	251555	12905	264460
2016	30	251919	0	0	0	10077	261996	13428	275424
2017	30	247889	0	0	0	9916	257805	13583	271388
2018	31	244737	0	0	0	9789	254526	13647	268173
2019	31	249384	0	0	0	9975	259359	13647	273006
2020	31	247887	0	0	0	9915	257803	13647	271450
2021	30	241654	25	60413	0	9666	311733	13647	325380
2022	31	245140	25	61285	0	9806	316230	13647	329877
2023	30	242892	25	60723	0	9716	313331	13647	326978
2024	29	234205	25	58551	0	9368	302125	13647	315772
2025	28	226747	25	56687	0	9070	292504	13647	306151
2026	28	222498	25	55625	0	8900	287023	13647	300670
2027	27	218249	25	54562	0	8730	281542	13647	295189
2028	27	213469	25	53367	0	8539	275375	13647	289023
2029	26	209221	25	52305	0	8369	269894	13647	283542
2030	26	204441	25	51110	0	8178	263728	13647	277375

Table 2.2 Norway vehicle cost calculations (continued)

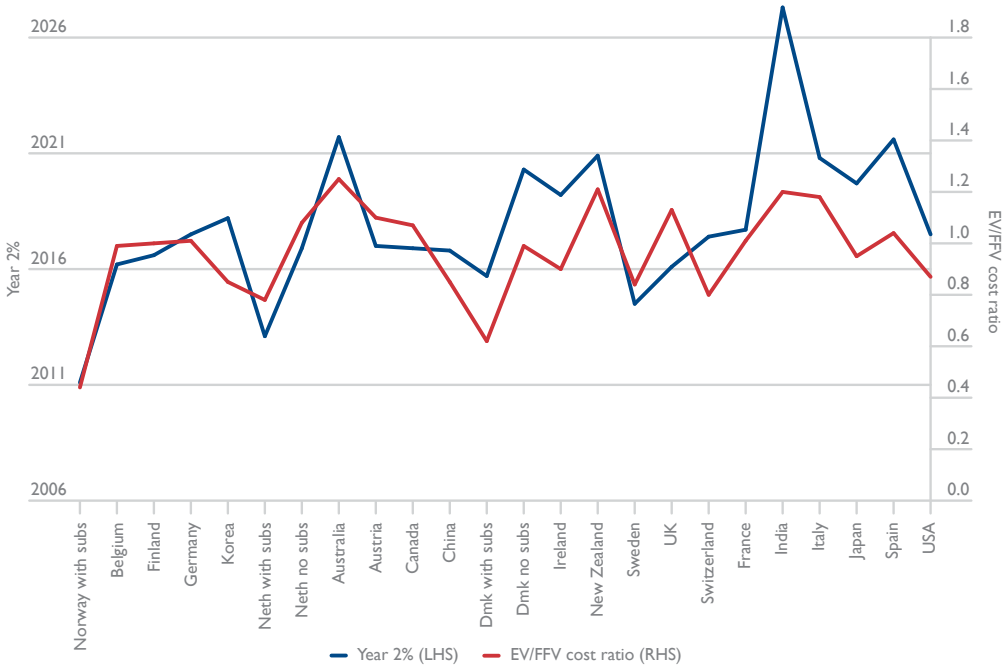
FFV	2017 US$ ('000)	Kroner	Kroner	Kroner	Kroner	Kroner	Kroner
	FFV base	FFV base	VAT%	VAT	Purchase tax	Owner tax	FFV price
2009	23	144632	25	36158	43389	8678	232857
2010	23	139066	25	34767	41720	8344	223897
2011	23	128991	25	32248	38697	7739	207675
2012	23	133844	25	33461	40153	8031	215488
2013	23	135013	25	33753	40504	8101	217372
2014	23	144711	25	36178	43413	8683	232985
2015	23	185441	25	46360	55632	11126	298560
2016	23	193138	25	48285	57941	11588	310952
2017	23	190049	25	47512	57015	11403	305978
2018	23	184000	25	46000	55200	11040	296240
2019	23	184000	25	46000	55200	11040	296240
2020	23	184000	25	46000	55200	11040	296240
2021	23	184000	25	46000	55200	11040	296240
2022	23	184000	25	46000	55200	11040	296240
2023	23	184000	25	46000	55200	11040	296240
2024	23	184000	25	46000	55200	11040	296240
2025	23	184000	25	46000	55200	11040	296240
2026	23	184000	25	46000	55200	11040	296240
2027	23	184000	25	46000	55200	11040	296240
2028	23	184000	25	46000	55200	11040	296240
2029	23	184000	25	46000	55200	11040	296240
2030	23	184000	25	46000	55200	11040	296240

From Table 2.1, it can be seen that the costs of running an EV in Norway have been less than half the costs of a FFV up to 2017. This will change in 2021 as VAT for EVs is reintroduced.

The final step in Stage 2 of the analysis involves making similar calculations of the EV/FFV ratio for the rest of the 22 countries, and then using these ratios to explain the different 2% raw uptake dates.

Figure 2.7 shows the two variables plotted against one another.

Figure 2.7 Two per cent EV uptake dates versus average (2012–2017) EV/FFV cost ratios



The agreement is rough, but several features should be noted.

First, the five countries with much later start dates on the end of the graph are all 'flat uptake curve' countries.

Secondly, for the two countries where subsidies have been wound back – the Netherlands and Denmark, the movement in the start date corresponds nicely to the movement in the EV/FFV cost ratio. So if the level of the predicted start date is raised or lowered by a dummy variable for any country in a regression, the resulting equation will probably accurately predict the future start date resulting from a change in the EV/FFV cost ratio.

This is the approach taken in the regression procedure, the result of which is shown in Table 2.3.

There are individual country dummies for Korea, Britain, the Netherlands, China, Denmark, Ireland, New Zealand, Switzerland, Spain, India, the United States, Austria, Italy, Japan and Australia.

One common dummy variable serves for both with and without subsidy cases for the Netherlands. The same applies for Denmark.

Table 2.3 Regression equation for 2 per cent EV uptake start date

Regression statistics	
Multiple R	0.995000939
R Square	0.990026868
Adjusted R Square	0.967231137
Standard Error	0.589344106
Observations	24

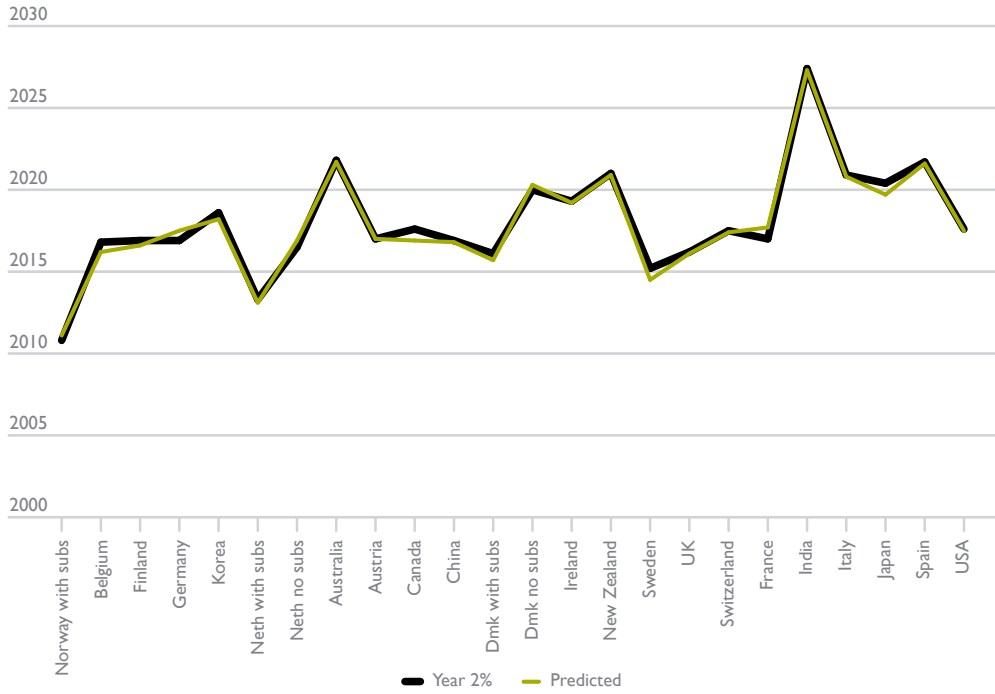
ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	16	241.3522406	15.08451504	43.43036341	1.90422E-05
Residual	7	2.431285326	0.347326475		
Total	23	243.7835259			

	Coefficients	*Standard error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	2006.095644	0.868744805	2309.188651	7.54323E-22	2004.041389	2008.149899
EV/FFV cost ratio	10.78390411	0.934400054	11.5409926	8.25717E-06	8.574399084	12.99340914
dumKorea	3.274700816	0.634836891	5.158334155	0.001311869	1.773550109	4.775851524
dumUK	2.727684552	0.637885336	4.276136159	0.003672808	1.219325416	4.236043688
dumNeth	-1.254426937	0.473194237	-2.650976787	0.032895021	-2.373353504	-0.135500369
dumChina	1.684064166	0.632548313	2.662348679	0.032356708	0.188325084	3.179803248
dumDenmark	3.265487224	0.481001605	6.788932079	0.000255768	2.128099164	4.402875283
dumIreland	3.558249093	0.630108161	5.647044925	0.000776865	2.068280055	5.048218132
dumNZ	1.900474769	0.689081067	2.757984308	0.028177724	0.271056967	3.52989257
dumSwitzerland	-2.104172988	0.662923267	-3.17408227	0.015618791	-3.671737422	-0.536608554
dumSpain	4.416813304	0.642214788	6.877470565	0.000236066	2.89821664	5.935409967
dumIndia	8.391890746	0.685773708	12.23711357	5.57527E-06	6.770293606	10.01348789
dumUSA	2.138688531	0.631185267	3.388368906	0.01162525	0.646172543	3.63120452
dumAustria	-0.866574869	0.654301029	-1.324428407	0.226963563	-2.41375095	0.680601212
dumItaly	2.051390587	0.67891673	3.02156435	0.01934354	0.446007623	3.656773551
dumJapan	4.094889343	0.630209359	6.497665081	0.000334868	2.60468101	5.585097677
dumAustralia	2.219450665	0.705530459	3.145790003	0.016247272	0.551136231	3.887765098

The resulting prediction of each country's 2% EV uptake start date is shown in Figure 2.8.

Figure 2.8 Actual and predicted 2 per cent EV uptake date



The equation given in Table 2.3 is the final outcome of Stage 2 of the analysis.

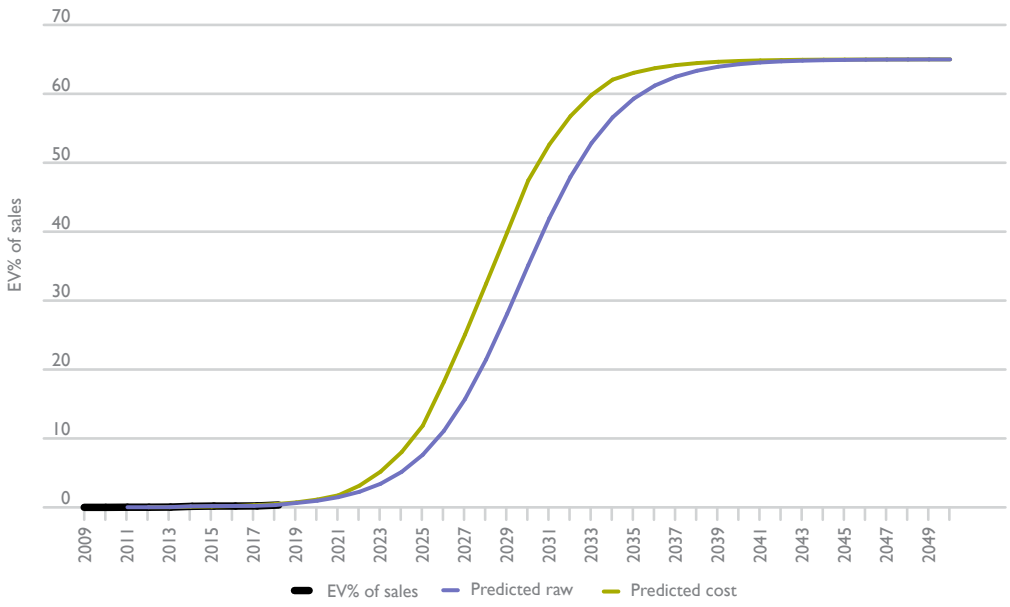
Stage 3: Using Predicted Costs to Shift the Curves

Stage 3 involves using the equation to vary the 'predicted raw' uptake based on forecast EV/FFV cost ratios (producing a 'predicted cost' uptake).

Figure 2.9 shows that the Australian predicted uptake adjusted for cost is faster than the predicted raw uptake.

This is due to the projection of a decline in the Australian EV/FFV cost ratio from about 1.23 in 2017 to 1.04 by 2030.

Figure 2.9 Australian 'predicted cost' EV uptake versus raw uptake



Stage 4: Early Adopters Adjustment – 'Predicted Cost Lagged' Base-Case

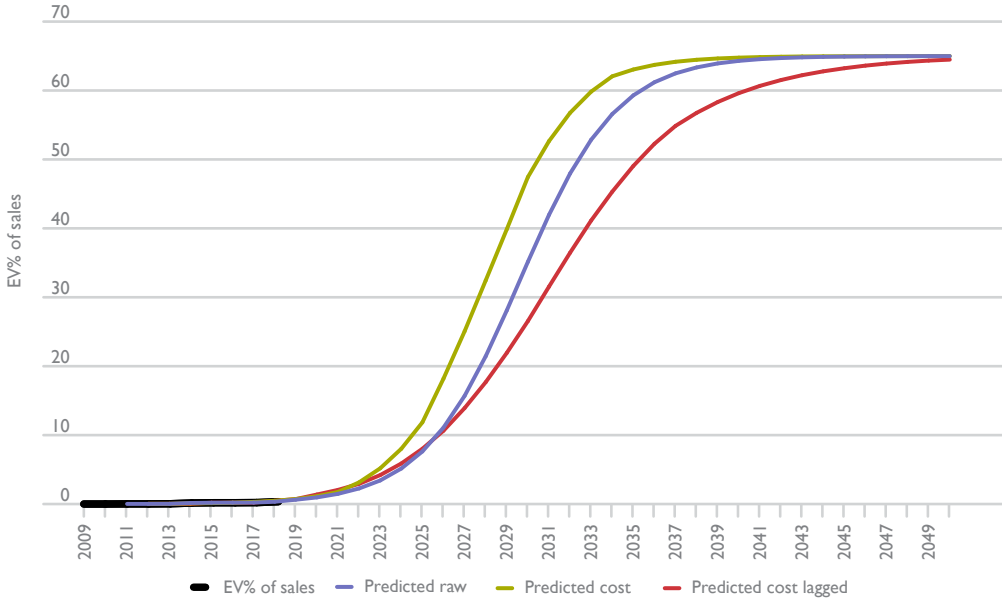
In stage 4 corrections are made to the predicted cost uptake curves.

Basically, the rates of uptake are reduced to allow for the fact that most early adopters are those with higher incomes. The adjustments are arbitrary, like the 65 per cent saturation assumption, and differ between countries. They are assigned annually from 2021 and the effect cumulated. The annual adjustment for each country is further modified by multiplying it by 0.0 to 1.0 if the EV/FFV cost ratio is between 0.6 and 0.9. Below 0.6 the multiplier is 0.0, above 0.9 the multiplier is 1.0. Thus for Norway, where currently the EV/FFV cost ratio is below 0.5, there would be no early-adopter lag factor each year, if all the subsidies were maintained.

The resulting 'predicted cost lagged' curves – which are less steeply rising curves – are the final base-case uptake EV uptake predictions.

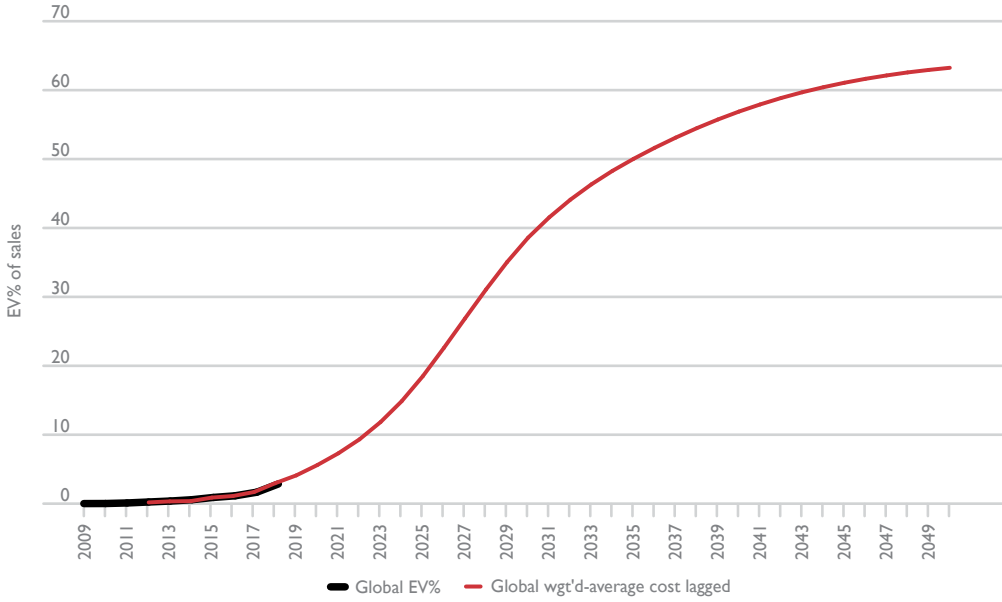
Figure 2.10 shows the effect of the early adopters adjustment assumed for Australia.

Figure 2.10 Australia 'Predicted Cost Lagged' (base-case) EV uptake curve and previous curves



When the same cost and early adopters adjustments are done for the rest of the 22 countries, the weighted (based on 2017 passenger vehicle sales) global EV share comes out as in Figure 2.11.

Figure 2.11 Global 'Predicted Cost Lagged' base-case EV uptake curve



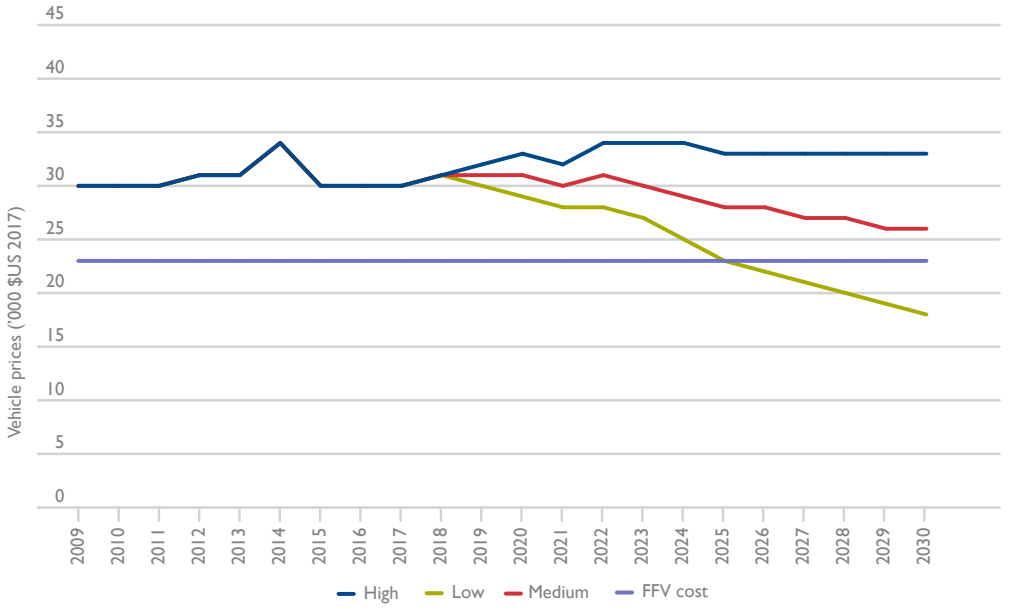
Stage 5: Scenario Testing

In stage 5, the modelling is used to predict the effect on EV uptake if different cost scenarios are assumed. Three scenarios are presented as examples: 1) if EV prices fall/rise when subsidies are changed, 2) if EV price trends change or 3) if petrol prices change.

It has already been seen that the model accurately predicted the falls in EV sales share (increases in the 2% year) that occurred when subsidies were cut in the Netherlands and Denmark (see Figures 2.7 and 2.8).

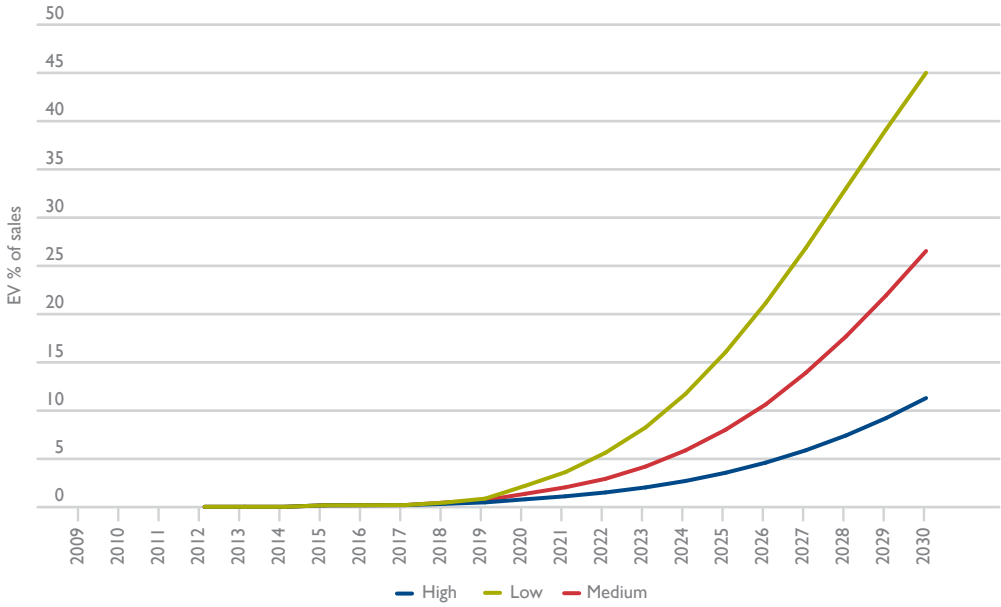
The second type of scenario testing has to do with the effect of assuming different trends in EV prices into the future. Figure 2.12 shows such vehicle price scenarios, with high prices in 2030 being 30 per cent up on medium prices, and low prices being 30 per cent down..

Figure 2.12 High, medium and low scenarios for global EV prices



Feeding these prices into the model gives the scenario EV uptake curves shown in Figure 2.13. It can be seen that EV prices have a large effect on EV uptake.

Figure 2.13 Australian EV uptake curves with high, medium and low EV price trend scenarios



The third type of scenario looks at the effect of different petrol price levels on EV uptake.

Figure 2.14 shows the three oil price scenarios adopted for this study, as derived in BITRE (2019).

Figure 2.14 Scenarios for world oil price

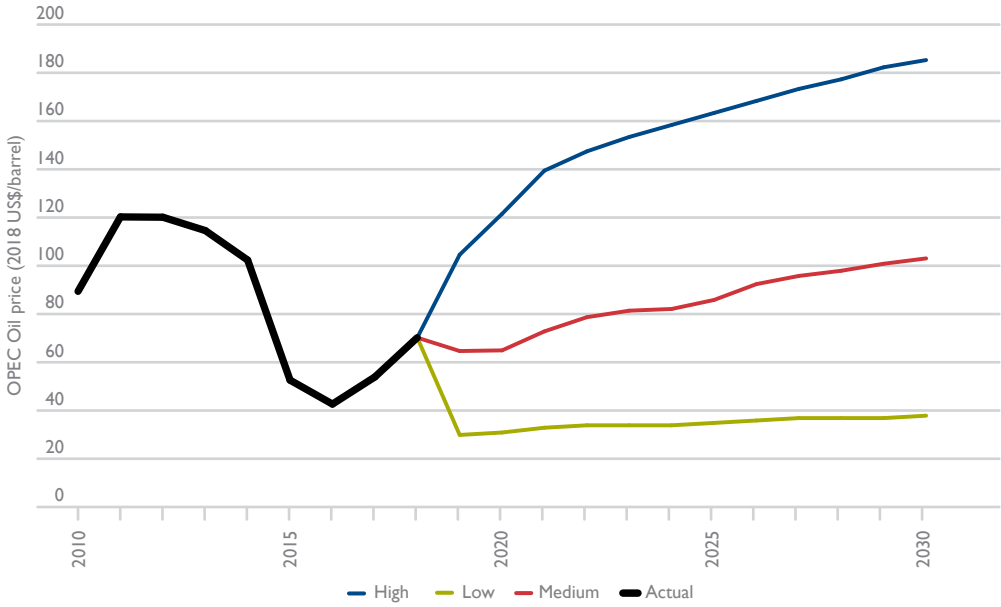
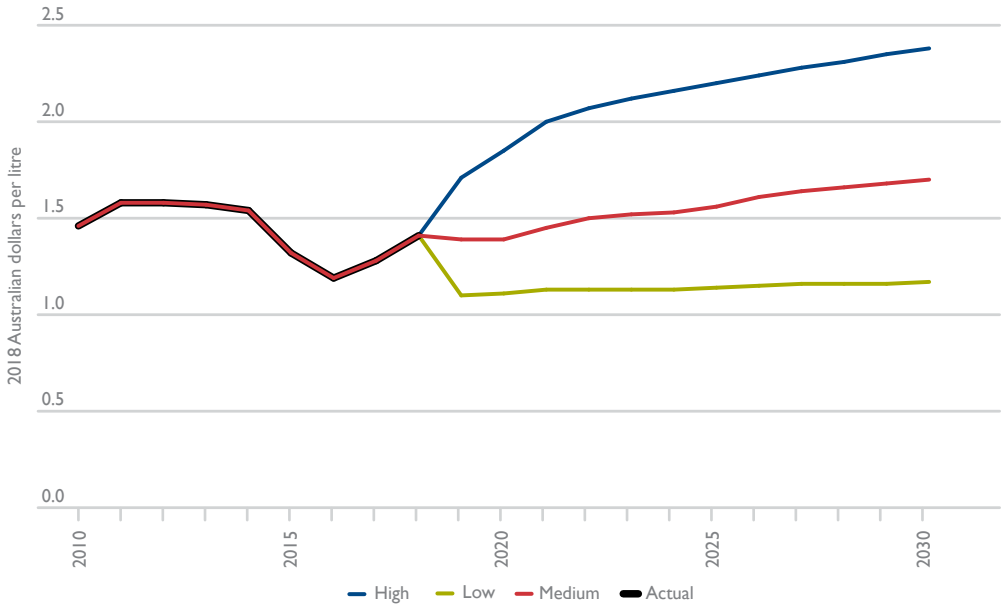


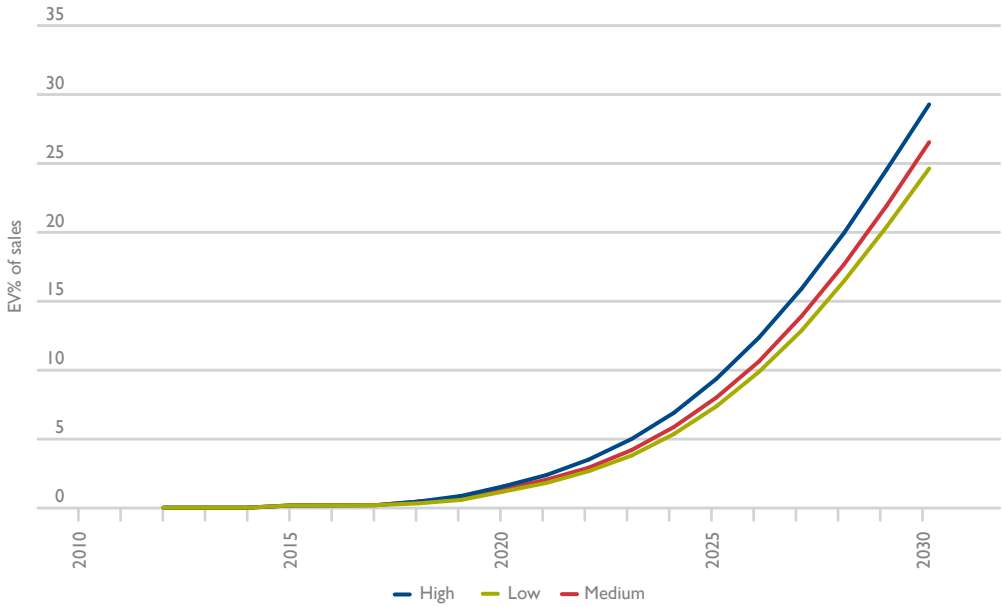
Figure 2.15 shows calculated scenarios for Australian petrol prices based on an oil to petrol price equation derived in BITRE (2019).

Figure 2.15 Australian petrol price scenarios



Feeding these prices into the model gives the scenario EV uptake curves shown in Figure 2.16. It can be seen that petrol prices do not have the same magnitude of effect on EV uptake as vehicle prices.

Figure 2.16 Australian EV uptake curves with high, medium and low petrol price scenarios



CHAPTER 3

Modelling Electric Vehicle Uptake in Twenty-Two Countries

Summary

This chapter presents modelling of electric vehicle uptake in twenty-two countries around the world. The procedure for each country is as outlined in Chapter 2.

The predictions of the price of electric vehicles in the analysis in Chapter One and the country models for petrol prices as a function of world oil prices both feed into a model predicting EV uptake based on vehicle purchase and operating costs. As outlined in Chapter 2, the modelling has several stages:

Stage 1: Raw logistic models are fit for EVs as a per cent of total passenger vehicle sales in 22 countries around the world (predicted raw uptake).

Stage 2: The year when uptake passes 2 per cent of sales is used as a dependent variable in a regression using the ratio of the total annual cost of ownership of EV to fossil fuel vehicles as an explanatory variable.

Stage 3: The resulting equation is used to vary the future raw uptake projection based on forecast EV/FFV cost ratios ('predicted cost' uptake).

Stage 4: Then corrections are made to the predicted cost uptake logistic models, where the rates of uptake are reduced to allow for the fact that most early adopters are those with higher incomes ('predicted cost lagged' – which are less steeply rising curves). These 'predicted cost lagged' curves are the final base-case uptake predictions.

Stage 5: Finally, the base-case predicted cost lagged curves can be tested for different cost scenarios – principally relating to vehicle prices and the price of petrol.

In the following chapter, the stages in this methodology will be described for each of the 22 countries in the study.

Estimates of EV sales for 2018 (based on the first six months of the year) have been used in the regressions in Stage 1. Although the estimates are very rough, it is important to add one more data point to what is a very small number of observations.

3.1 Australia

The linearized logistic uptake for Australia is shown in Figure 3.1, along with a predicted curve.

The regression shown in Table 3.1 has four variables – a time trend, a dummy for 2014 to 2015, a dummy for 2012 to 2013 and a dummy representing the withdrawal of EV models from the Australian market in 2017 to 2018. It is estimated over the period 2011 to 2018.

Figure 3.1 Australian linearized logistic EV sales percentage and prediction

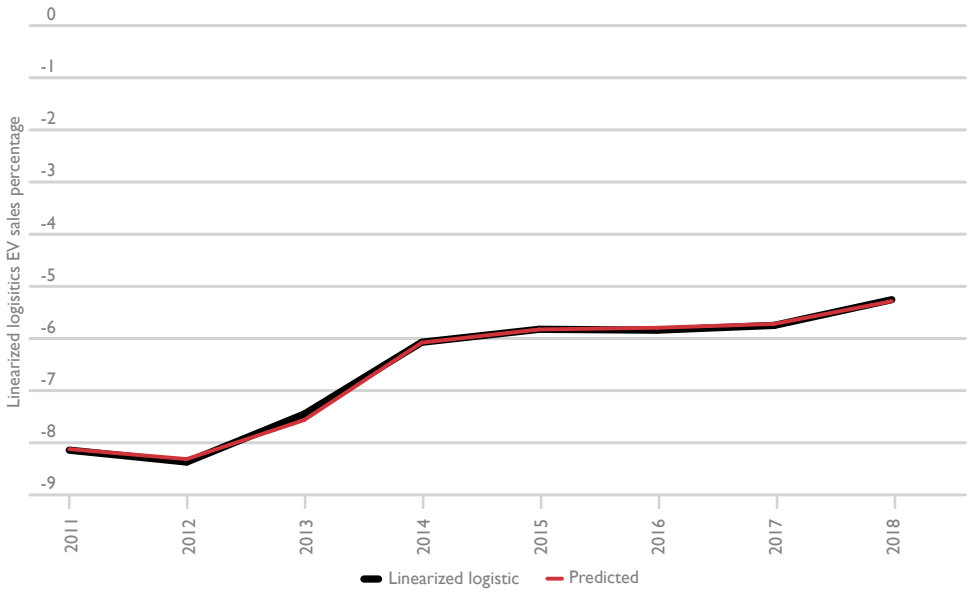


Table 3.1 Regression for Australian linearized logistic EV uptake

Regression statistics	
Multiple R	0.999009522
R Square	0.998020026
Adjusted R Square	0.99538006
Standard Error	0.08211825
Observations	8

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	10.19718532	2.549296329	378.0427782	0.000219995
Residual	3	0.020230221	0.006743407		
Total	7	10.21741554			

	Coefficients	*Standard error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-8.993352613	0.115252745	-78.03156984	4.63877E-06	-9.360138285	-8.626566941
time	0.436011647	0.023131469	18.84928485	0.000325989	0.362396989	0.509626305
dum1415	0.734171795	0.105493651	6.959393173	0.006086706	0.398443915	1.069899676
dum1213	-0.627427251	0.106463579	-5.893351076	0.009752251	-0.966241876	-0.288612625
model dum	-0.215094797	0.129612327	-1.659524228	0.195592717	-0.627579067	0.197389474

Figure 3.2 shows the fit of the de-linearized raw prediction, to the actual EV sales percentage of new passenger vehicle sales.

Figure 3.2 Australian EV sales as a percentage of passenger vehicle sales and raw prediction

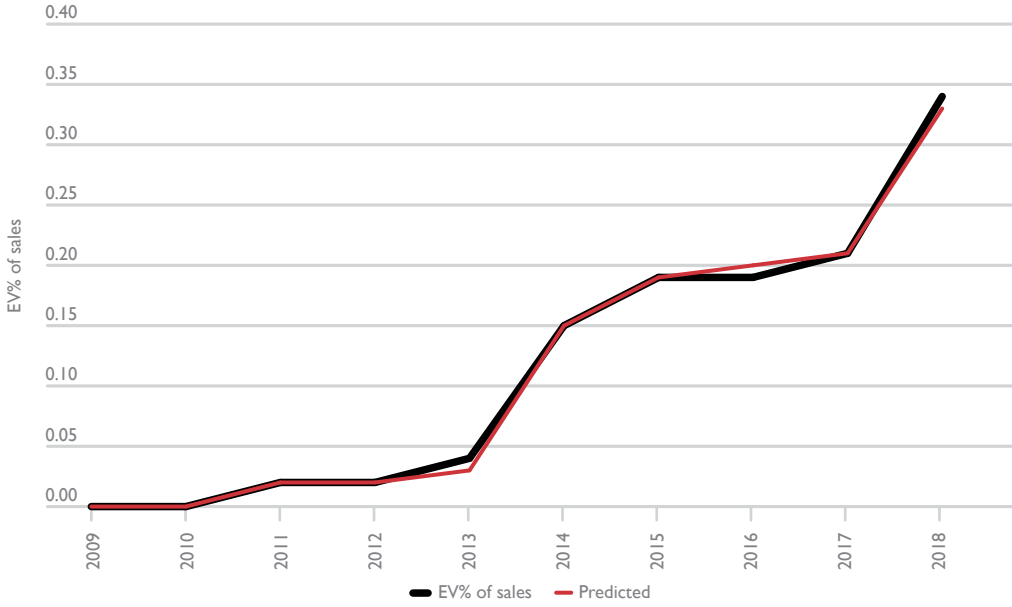
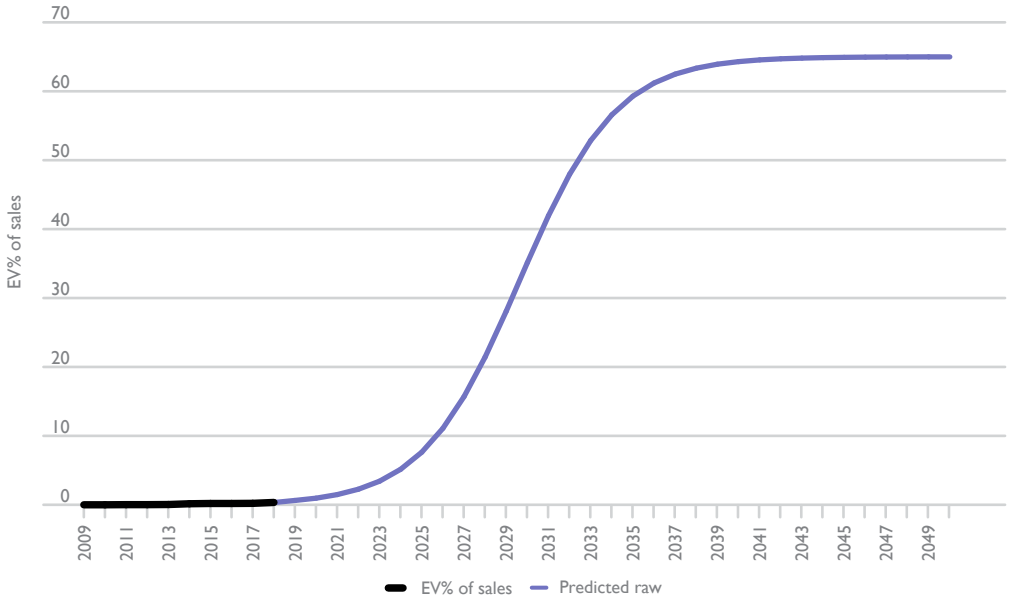


Figure 3.3 shows the extension of the forecast from this equation to 2050. This is the result of Stage 1 of the analysis.

Figure 3.3 Australian EV sales as a percentage of passenger vehicle sales and raw prediction to 2050



In Stage 2, the year that sales (or the raw prediction) pass the 2% mark is determined. For Australia, this is 2021.

Stage 3 involves assembling past and forecast EV and FFV costs to generate a time series of the ratio of EV to FFV annual costs. Table 3.2 shows the prices of BEVs, PHEVs and FFVs in Australia.

Table 3.2 Prices of BEVs, PHEVs and FFVs in Australia

BEV	2017 US$ ('000)	$A	$A	%	$A	$A	$A	$A	$A
	BEV base	BEV base	Stamp duty	GST%	GST	BEV price	Subsidies	Home charging	BEV price
2009	29.6	37943	1138	10	3794	42876	0	2200	45076
2010	30.0	32611	978	10	3261	36850	0	2200	39050
2011	30.0	28827	865	10	2883	32575	0	2200	34775
2012	30.8	29678	890	10	2968	33536	0	2200	35736
2013	31.1	32440	973	10	3244	36657	0	2200	38857
2014	33.5	37310	1119	10	3731	42160	0	2200	44360
2015	30.0	40188	1206	10	4019	45413	0	2200	47613
2016	30.0	40355	1211	10	4035	45601	0	2200	47801
2017	30.0	39004	1170	10	3900	44075	0	2200	46275
2018	30.6	41299	1239	10	4130	46668	0	2200	48868
2019	31.2	42084	1263	10	4208	47554	0	2200	49754
2020	31.0	41831	1255	10	4183	47269	0	2200	49469
2021	30.2	40779	1223	10	4078	46080	0	2200	48280
2022	30.6	41367	1241	10	4137	46745	0	2200	48945
2023	30.4	40988	1230	10	4099	46317	0	2200	48517
2024	29.3	39522	1186	10	3952	44660	0	2200	46860
2025	28.3	38264	1148	10	3826	43238	0	2200	45438
2026	27.8	37547	1126	10	3755	42428	0	2200	44628
2027	27.3	36830	1105	10	3683	41617	0	2200	43817
2028	26.7	36023	1081	10	3602	40706	0	2200	42906
2029	26.2	35306	1059	10	3531	39896	0	2200	42096
2030	25.6	34499	1035	10	3450	38984	0	2200	41184
PHEV	2017 US$ ('000)	$A	$A	$A	$A	$A	$A	$A	$A
	PHEV base	PHEV base	Stamp duty	GST%	GST	PHEV price	Subsidies	Home charging	PHEV price
2009	29.6	37943	1138	10	3794	42876	0	2200	45076
2010	30.0	32611	978	10	3261	36850	0	2200	39050
2011	30.0	28827	865	10	2883	32575	0	2200	34775
2012	30.8	29678	890	10	2968	33536	0	2200	35736
2013	31.1	32440	973	10	3244	36657	0	2200	38857
2014	33.5	37310	1119	10	3731	42160	0	2200	44360
2015	30.0	40188	1206	10	4019	45413	0	2200	47613
2016	30.0	40355	1211	10	4035	45601	0	2200	47801
2017	30.0	39004	1170	10	3900	44075	0	2200	46275
2018	30.6	41299	1239	10	4130	46668	0	2200	48868
2019	31.2	42084	1263	10	4208	47554	0	2200	49754
2020	31.0	41831	1255	10	4183	47269	0	2200	49469
2021	30.2	40779	1223	10	4078	46080	0	2200	48280
2022	30.6	41367	1241	10	4137	46745	0	2200	48945
2023	30.4	40988	1230	10	4099	46317	0	2200	48517
2024	29.3	39522	1186	10	3952	44660	0	2200	46860
2025	28.3	38264	1148	10	3826	43238	0	2200	45438
2026	27.8	37547	1126	10	3755	42428	0	2200	44628
2027	27.3	36830	1105	10	3683	41617	0	2200	43817
2028	26.7	36023	1081	10	3602	40706	0	2200	42906
2029	26.2	35306	1059	10	3531	39896	0	2200	42096
2030	25.6	34499	1035	10	3450	38984	0	2200	41184

Table 3.2 Prices of BEVs, PHEVs and FFVs in Australia (continued)

FFV	2017 US$ ('000)	$A	$A	$A	$A	$A
	FFV base	FFV base	Stamp duty	GST%	GST	FFV price
2009	23	29490	885	10	2949	33324
2010	23	25002	750	10	2500	28252
2011	23	22101	663	10	2210	24974
2012	23	22131	664	10	2213	25008
2013	23	23957	719	10	2396	27072
2014	23	25584	768	10	2558	28910
2015	23	30811	924	10	3081	34817
2016	23	30939	928	10	3094	34961
2017	23	29903	897	10	2990	33791
2018	23	31050	932	10	3105	35087
2019	23	31050	932	10	3105	35087
2020	23	31050	932	10	3105	35087
2021	23	31050	932	10	3105	35087
2022	23	31050	932	10	3105	35087
2023	23	31050	932	10	3105	35087
2024	23	31050	932	10	3105	35087
2025	23	31050	932	10	3105	35087
2026	23	31050	932	10	3105	35087
2027	23	31050	932	10	3105	35087
2028	23	31050	932	10	3105	35087
2029	23	31050	932	10	3105	35087
2030	23	31050	932	10	3105	35087

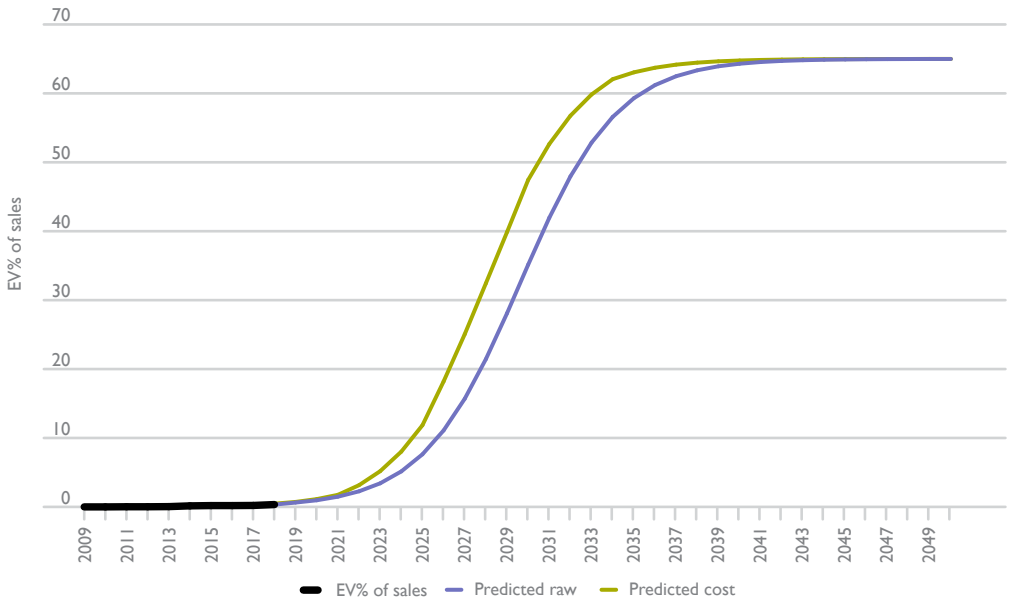
Table 3.3 shows past and forecast BEV and FFV costs used to generate a time series of the ratio of EV to FFV annual costs. Costs include principal (repay over 5 years), interest (13 per cent per year), annual EV subsidies, and petrol costs for FFV (with increasing fuel efficiency and a medium petrol price as set out in BITRE (2019)). It is assumed that the EVs cost of electricity is offset by their lower maintenance costs.

Table 3.3 EV/FFV cost ratio calculations for Australia

	Evs	Evs	Evs	Evs	Evs	FFVs	FFVs	FFVs	FFVs	FFVs	EV/FFV
	EV price	Principal	Interest	Annual subs	Annual cost	FFV price	Principal	Interest	Fuel	Annual cost	Cost ratio
2012	35736	7147	4646	0	11793	25008	5002	3251	1643	9895	1.19
2013	38857	7771	5051	0	12823	27072	5414	3519	1616	10550	1.22
2014	44360	8872	5767	0	14639	28910	5782	3758	1549	11089	1.32
2015	47613	9523	6190	0	15712	34817	6963	4526	1306	12796	1.23
2016	47801	9560	6214	0	15774	34961	6992	4545	1132	12669	1.25
2017	46275	9255	6016	0	15271	33791	6758	4393	1228	12378	1.23
2018	48868	9774	6353	0	16127	35087	7017	4561	1339	12918	1.25
2019	49754	9951	6468	0	16419	35087	7017	4561	1303	12881	1.27
2020	49469	9894	6431	0	16325	35087	7017	4561	1292	12870	1.27
2021	48280	9656	6276	0	15933	35087	7017	4561	1339	12917	1.23
2022	48945	9789	6363	0	16152	35087	7017	4561	1369	12948	1.25
2023	48517	9703	6307	0	16010	35087	7017	4561	1376	12954	1.24
2024	46860	9372	6092	0	15464	35087	7017	4561	1367	12946	1.19
2025	45438	9088	5907	0	14994	35087	7017	4561	1381	12960	1.16
2026	44628	8926	5802	0	14727	35087	7017	4561	1415	12993	1.13
2027	43817	8763	5696	0	14460	35087	7017	4561	1425	13003	1.11
2028	42906	8581	5578	0	14159	35087	7017	4561	1426	13004	1.09
2029	42096	8419	5472	0	13892	35087	7017	4561	1432	13010	1.07
2030	41184	8237	5354	0	13591	35087	7017	4561	1433	13012	1.04

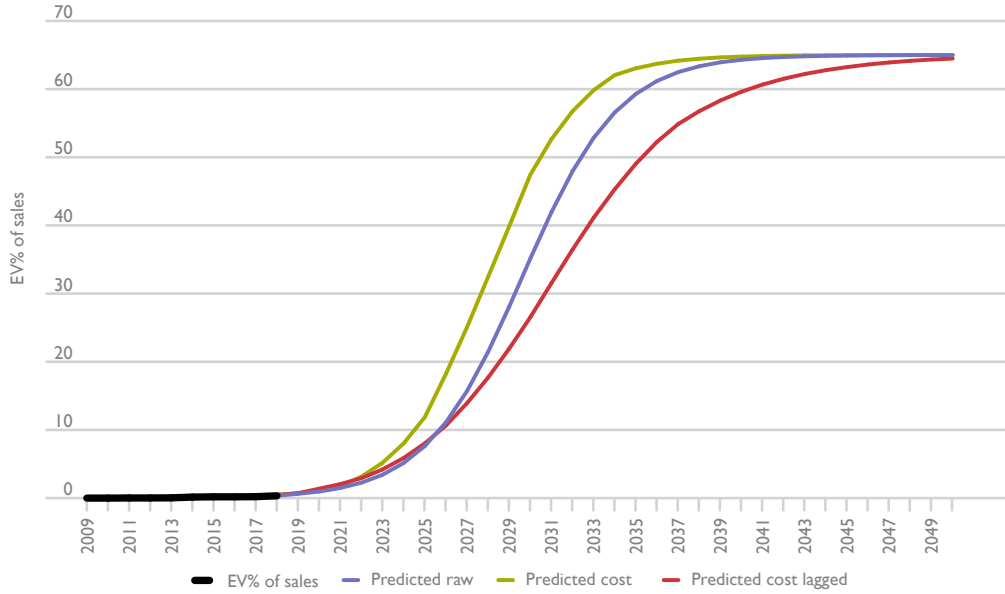
The resulting EV/FFV cost ratio time series is shown in the last column. This time series is then fed though the 2% year formula, which shifts the predicted raw uptake curve in line with shifts predicted for the cost ratio. Figure 3.4 shows that the predicted decline in the cost ratio from 2020 onwards results in a shift in the *predicted raw* curve to the left in the graph – the *predicted cost* curve. This is the result from Stage 3 of the Australian analysis.

Figure 3.4 Australian predicted raw and predicted cost EV per cent of sales curves



In stage 4 corrections are made to the predicted cost uptake curves. Basically, the rates of uptake are reduced to allow for the fact that most early adopters are those with higher incomes. The resulting Australian *predicted cost lagged* curve – which is a less steeply rising curve – is shown in Figure 3.5. This is the final base-case EV uptake prediction for Australia.

Figure 3.5 Australian predicted cost lagged EV uptake curve

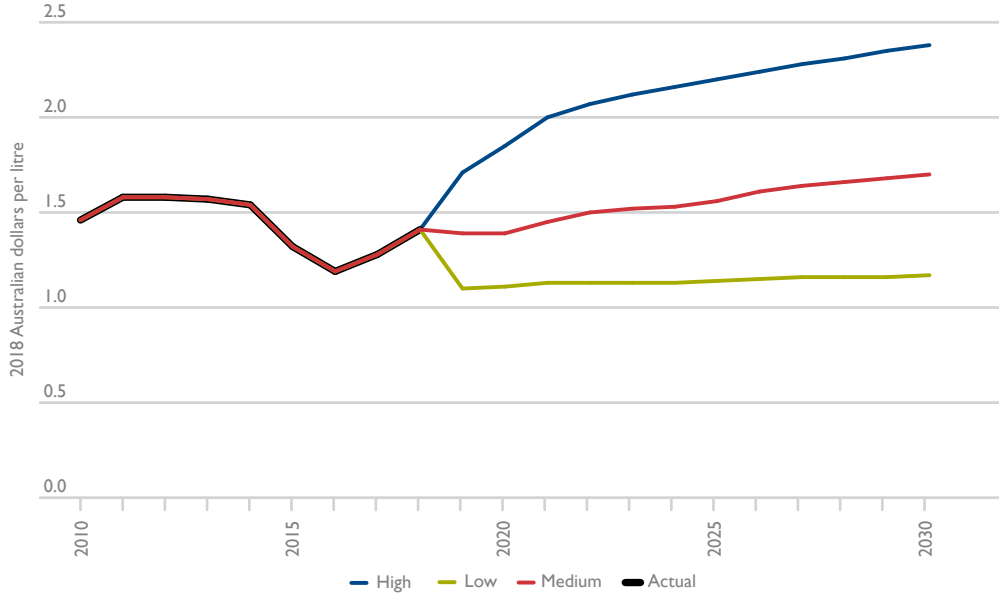


The resulting Australian uptake forecast has EVs as 8 per cent of sales in 2025 and 27 per cent in 2030.

Stage 5 of the analysis looks at high, medium and low scenarios for oil prices and for EV prices.

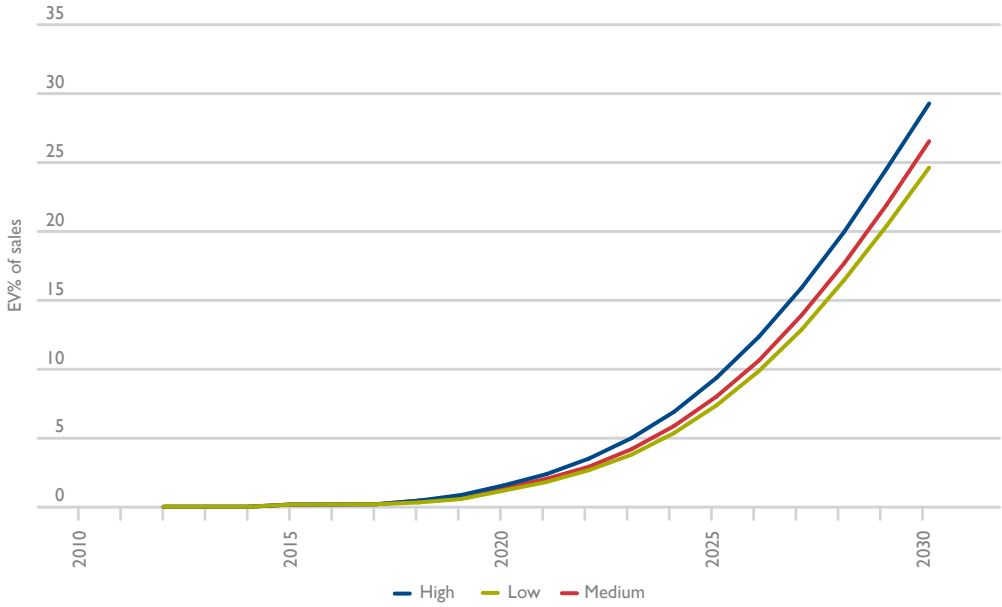
The oil price scenarios were given in Chapter 2. Corresponding Australian petrol prices have been derived from the oil to Australian petrol price equation in BITRE (2019). The resulting petrol price scenarios are shown in Figure 3.6.

Figure 3.6 Australian petrol price scenarios



When these scenario petrol prices are used in the calculation of the EV/FFV cost ratios, the following predicted cost lagged curves are generated.

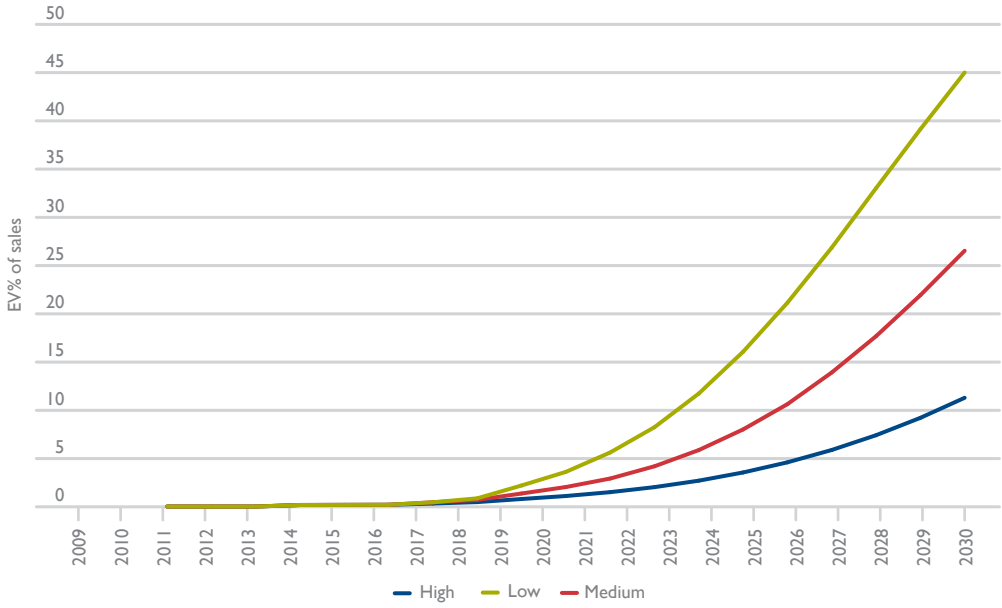
Figure 3.7 Scenarios for Australian EV uptake with high, medium and low oil prices



It can be seen that the oil price scenarios make very little difference to forecast uptake.

The second scenario test is when the prices of EVs are increased or decreased. The vehicle price scenarios were also covered in Chapter 2 (30 per cent up from the medium scenario, and 30 per cent down). When these scenario vehicle prices are used in the calculation of the EV/FFV cost ratios, the following predicted cost lagged curves are generated.

Figure 3.8 Scenarios for Australian EV uptake with high, medium and low EV prices



It can be seen that changes in vehicle prices have a large effect on projected uptake.

3.2 Austria

The linearized logistic uptake for Austria is shown in Figure 3.9, along with a predicted curve.

The regression shown in Table 3.4 has two variables – a time trend, and a dummy for 2016 to 2017. It is estimated over the period 2011 to 2018.

Figure 3.9 Austrian linearized logistic EV sales percentage and prediction

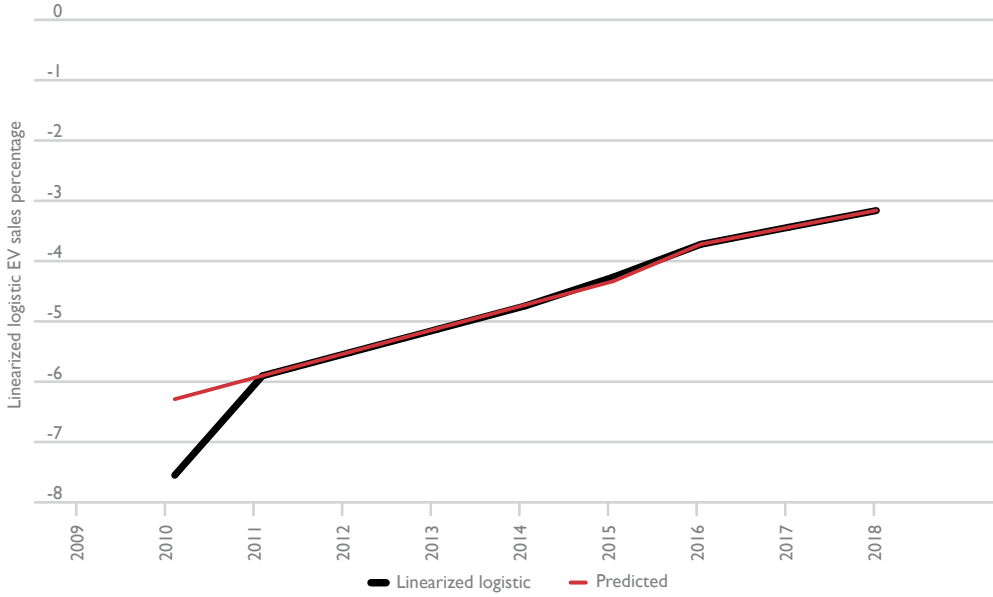


Table 3.4 Regression for Austrian linearized logistic EV uptake

Regression statistics	
Multiple R	0.999567317
R Square	0.999134822
Adjusted R Square	0.99878875 1
Standard Error	0.034713308
Observations	8

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	6.957939121	3.478969561	2887.078767	2.20173E-08
Residual	5	0.006025069	0.001205014		
Total	7	6.96396419			

	Coefficients	*Standard error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-6.681127695	0.032619777	-204.818312	5.2644E-11	-6.764979501	-6.597275888
time	0.391260537	0.00593641	65.90860719	1.52238E-08	0.376000508	0.406520565
dum1617	0.223124291	0.039087933	5.708265367	0.002304763	0.122645562	0.323603021

Figure 3.10 shows the fit of the de-linearized raw prediction to the actual EV sales percentage of new passenger vehicle sales.

Figure 3.10 Austrian EV sales as a percentage of passenger vehicle sales and raw prediction

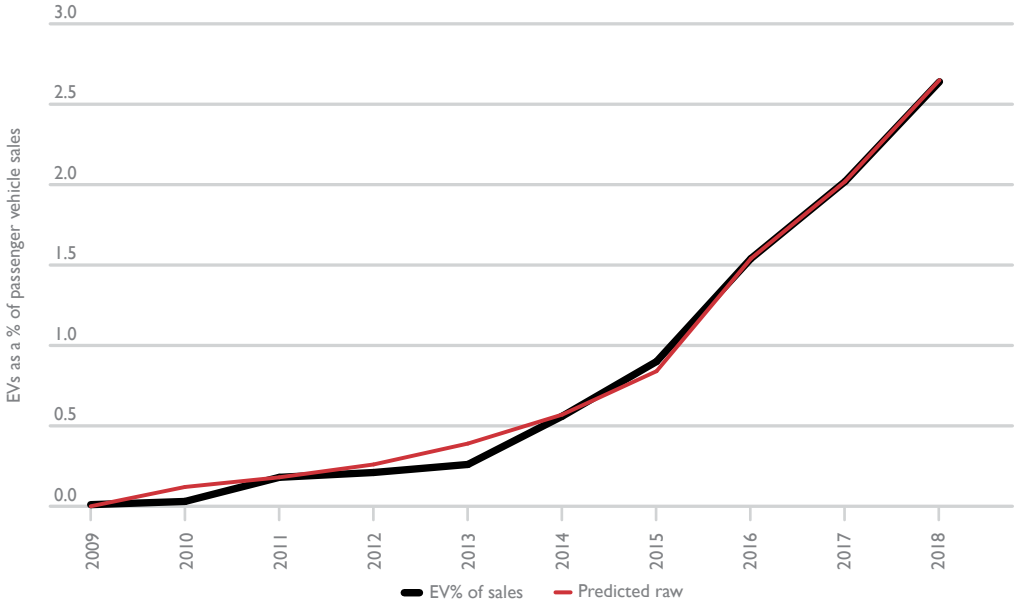
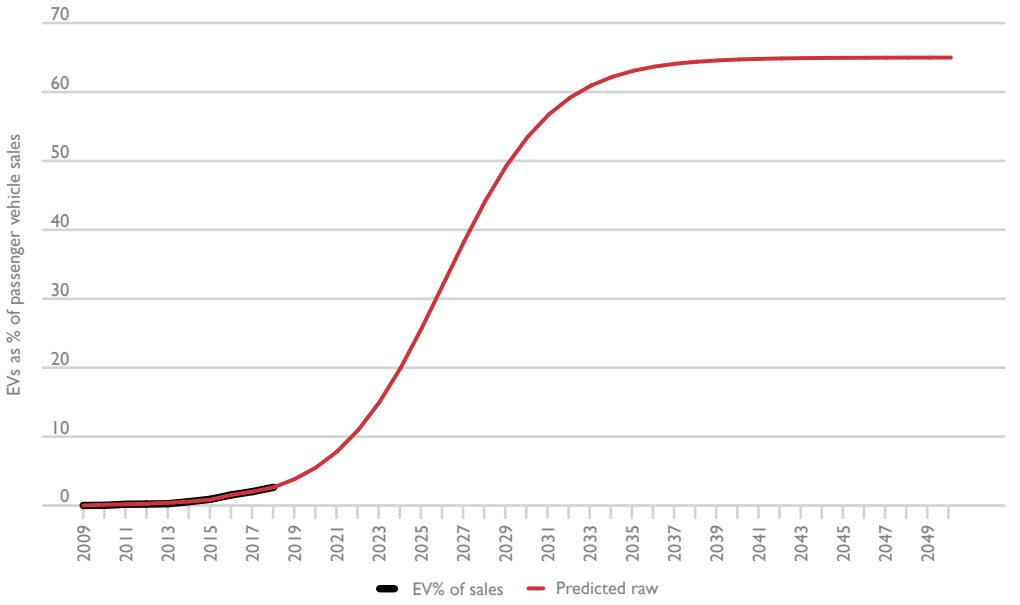


Figure 3.11 shows the extension of the forecast from this equation to 2050. This is the result of Stage 1 of the analysis.

Figure 3.11 Austrian EV sales as a percentage of passenger vehicle sales and raw prediction to 2050



In Stage 2, the year that sales (or the raw prediction) pass the 2% mark is determined. For Austria, this is 2017.

Stage 3 involves assembling past and forecast EV and FFV costs to generate a time series of the ratio of EV to FFV annual costs. Table 3.5 shows the prices of BEVs, PHEVs and FFVs in Austria.

Table 3.5 Prices of BEVs, PHEVs and FFVs in Austria

PHEV	2017 US$ ('000)	Euros	Euros				Euros		
	PHEV base	BEV base	Purchase tax	VAT%	VAT	PHEV price	Purch subs	Home charging	PHEV price
2009	30	21302	0	20	4260	25562	0	1450	27012
2010	30	22760	0	20	4552	27312	0	1450	28762
2011	30	21463	0	20	4293	25756	0	1450	27206
2012	31	23869	0	20	4774	28643	0	1450	30093
2013	31	23410	0	20	4682	28092	0	1450	29542
2014	34	25404	0	20	5081	30485	0	1450	31935
2015	30	27178	0	20	5436	32613	0	1450	34063
2016	30	27202	0	20	5440	32643	0	1450	34093
2017	30	26462	0	20	5292	31754	-4000	1450	29204
2018	31	26003	0	20	5201	31204	-3918	1450	28735
2019	31	26497	0	20	5299	31796	-3839	1450	29408
2020	31	26338	0	20	5268	31606	-3760	1450	29295
2021	30	25676	0	20	5135	30811	-3684	1450	28577
2022	31	26046	0	20	5209	31255	-3609	1450	29097
2023	30	25807	0	20	5161	30969	-3535	1450	28884
2024	29	24884	0	20	4977	29861	-3463	1450	27848
2025	28	24092	0	20	4818	28910	-3393	1450	26968
2026	28	23640	0	20	4728	28369	-3323	1450	26495
2027	27	23189	0	20	4638	27827	-3256	1450	26021
2028	27	22681	0	20	4536	27217	-3189	1450	25478
2029	26	22230	0	20	4446	26676	-3124	1450	25001
2030	26	21722	0	20	4344	26066	-3061	1450	24455

PHEV	2017 US$ ('000)	Euros	Euros				Euros		
	PHEV base	BEV base	Purchase tax	VAT%	VAT	PHEV price	Purch subs	Home charging	PHEV price
2009	30	21302	0	20	4260	25562	0	1450	27012
2010	30	22760	0	20	4552	27312	0	1450	28762
2011	30	21463	0	20	4293	25756	0	1450	27206
2012	31	23869	0	20	4774	28643	0	1450	30093
2013	31	23410	0	20	4682	28092	0	1450	29542
2014	34	25404	0	20	5081	30485	0	1450	31935
2015	30	27178	0	20	5436	32613	0	1450	34063
2016	30	27202	0	20	5440	32643	0	1450	34093
2017	30	26462	0	20	5292	31754	-1500	1450	31704
2018	31	26003	0	20	5201	31204	-1469	1450	31185
2019	31	26497	0	20	5299	31796	-1439	1450	31807
2020	31	26338	0	20	5268	31606	-1410	1450	31645
2021	30	25676	0	20	5135	30811	-1381	1450	30879
2022	31	26046	0	20	5209	31255	-1353	1450	31352
2023	30	25807	0	20	5161	30969	-1326	1450	31093
2024	29	24884	0	20	4977	29861	-1299	1450	30012
2025	28	24092	0	20	4818	28910	-1272	1450	29088
2026	28	23640	0	20	4728	28369	-1246	1450	28572
2027	27	23189	0	20	4638	27827	-1221	1450	28056
2028	27	22681	0	20	4536	27217	-1196	1450	27471
2029	26	22230	0	20	4446	26676	-1172	1450	26954
2030	26	21722	0	20	4344	26066	-1148	1450	26368

Table 3.5 Prices of BEVs, PHEVs and FFVs in Austria (continued)

FFV	2017 US$ ('000)	Euros	Euros			
	FFV base	BEV base	purchase tax	VAT%	VAT	FFV price
2009	23	16556	942	20	3311	20810
2010	23	17449	993	20	3490	21932
2011	23	16455	936	20	3291	20683
2012	23	17800	1013	20	3560	22373
2013	23	17288	968	20	3458	21714
2014	23	17420	952	20	3484	21855
2015	23	20836	1112	20	4167	26116
2016	23	20855	1090	20	4171	26116
2017	23	20288	1038	20	4058	25383
2018	23	19550	978	20	3910	24438
2019	23	19550	957	20	3910	24417
2020	23	19550	936	20	3910	24396
2021	23	19550	915	20	3910	24375
2022	23	19550	894	20	3910	24354
2023	23	19550	874	20	3910	24334
2024	23	19550	854	20	3910	24314
2025	23	19550	834	20	3910	24294
2026	23	19550	814	20	3910	24274
2027	23	19550	794	20	3910	24254
2028	23	19550	775	20	3910	24235
2029	23	19550	755	20	3910	24215
2030	23	19550	736	20	3910	24196

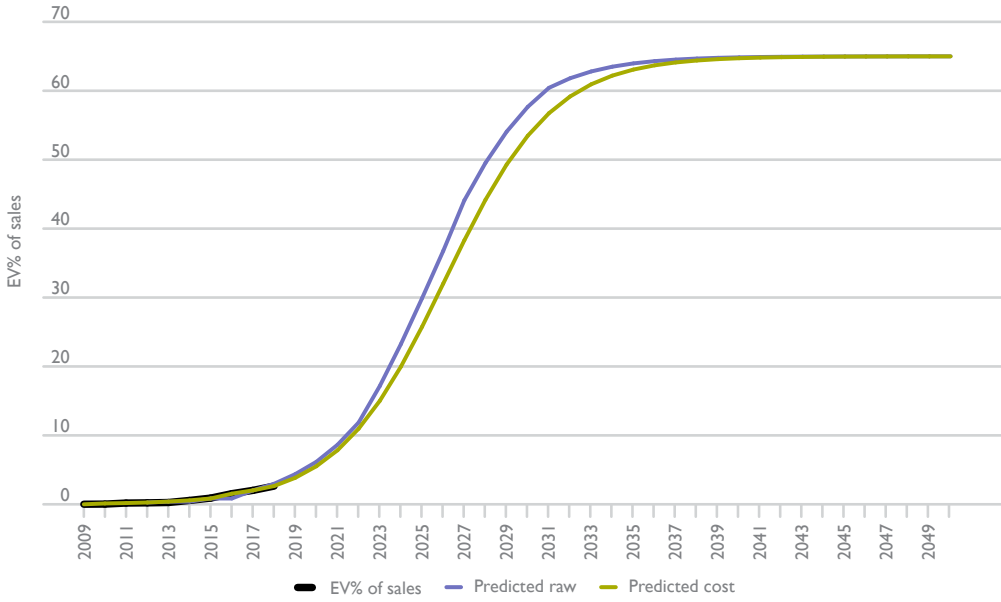
Table 3.6 shows past and forecast BEV and FFV costs used to generate a time series of the ratio of EV to FFV annual costs. Costs include principal (repay over 5 years), interest (13 per cent per year), annual EV subsidies, and petrol costs for FFV (with increasing fuel efficiency and a medium petrol price).

Table 3.6 EV/FFV cost ratio calculations for Austria

	Evs	Evs	Evs	Evs	Evs	FFVs	FFVs	FFVs	FFVs	FFVs	EV/ FFV
	EV price	Principal	Interest	Annual subs	Annual cost	FFV price	Principal	Interest	Fuel	Annual cost	Cost ratio
2012	30093	6019	3912	774	9157	22373	4475	2908	1282	8665	1.06
2013	29542	5908	3840	752	8997	21714	4343	2823	1201	8366	1.08
2014	31935	6387	4152	757	9781	21855	4371	2841	1134	8346	1.17
2015	34063	6813	4428	906	10335	26116	5223	3395	1004	9623	1.07
2016	34093	6819	4432	0	11251	26116	5223	3395	911	9529	1.18
2017	29204	5841	3797	0	9637	25383	5077	3300	936	9312	1.03
2018	28735	5747	3736	0	9483	24438	4888	3177	976	9041	1.05
2019	29408	5882	3823	0	9705	24417	4883	3174	957	9014	1.08
2020	29295	5859	3808	0	9667	24396	4879	3171	948	8999	1.07
2021	28577	5715	3715	0	9430	24375	4875	3169	973	9017	1.05
2022	29097	5819	3783	0	9602	24354	4871	3166	989	9026	1.06
2023	28884	5777	3755	0	9532	24334	4867	3163	991	9021	1.06
2024	27848	5570	3620	0	9190	24314	4863	3161	984	9007	1.02
2025	26968	5394	3506	0	8899	24294	4859	3158	990	9007	0.99
2026	26495	5299	3444	0	8743	24274	4855	3156	1007	9017	0.97
2027	26021	5204	3383	0	8587	24254	4851	3153	1011	9015	0.95
2028	25478	5096	3312	0	8408	24235	4847	3150	1010	9007	0.93
2029	25001	5000	3250	0	8250	24215	4843	3148	1011	9002	0.92
2030	24455	4891	3179	0	8070	24196	4839	3146	1010	8995	0.90

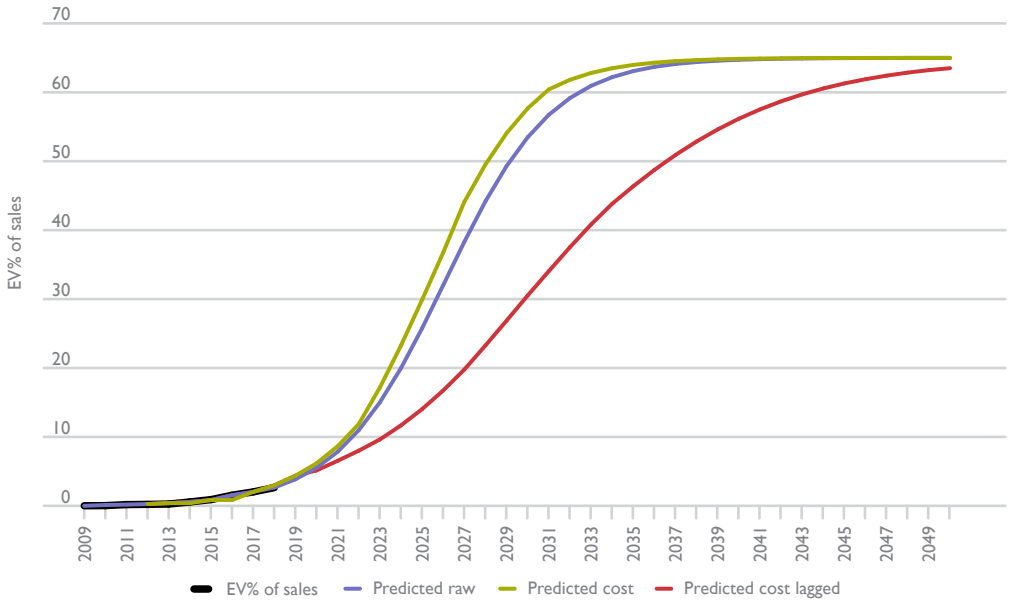
The resulting EV/FFV cost ratio time series is shown in the last column. This time series is then fed though the 2% year formula, which shifts the predicted raw uptake curve in line with shifts predicted for the cost ratio. Figure 3.12 shows that the predicted decline in the cost ratio from 2017 onwards results in a shift in the *predicted raw* curve to the left in the graph – the *predicted cost* curve. This is the result from Stage 3 of the Austrian analysis.

Figure 3.12 Austrian predicted raw and predicted cost EV per cent of sales curves



In Stage 4 corrections are made to the predicted cost uptake curves. Basically, the rates of uptake are reduced to allow for the fact that most early adopters are those with higher incomes. The resulting Austrian *predicted cost lagged* curve – which is a less steeply rising curve – is shown in Figure 3.13. This is the final base-case EV uptake prediction for Austria.

Figure 3.13 Austrian predicted cost lagged EV uptake curve

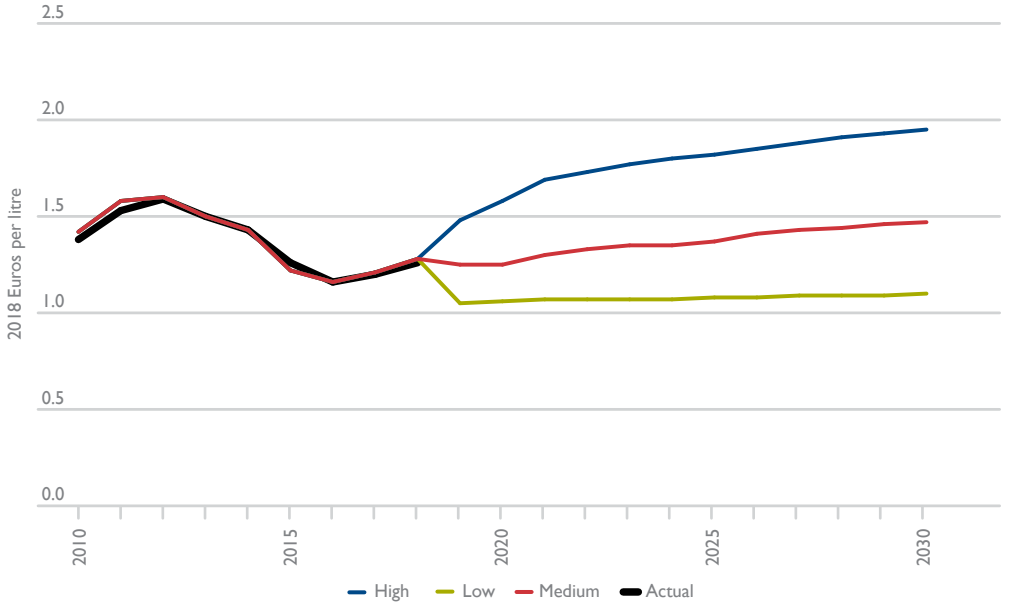


The resulting Austrian uptake forecast has EVs as 14 per cent of sales in 2025 and 31 per cent in 2030.

Stage 5 of the analysis looks at high, medium and low scenarios for oil prices and for EV prices.

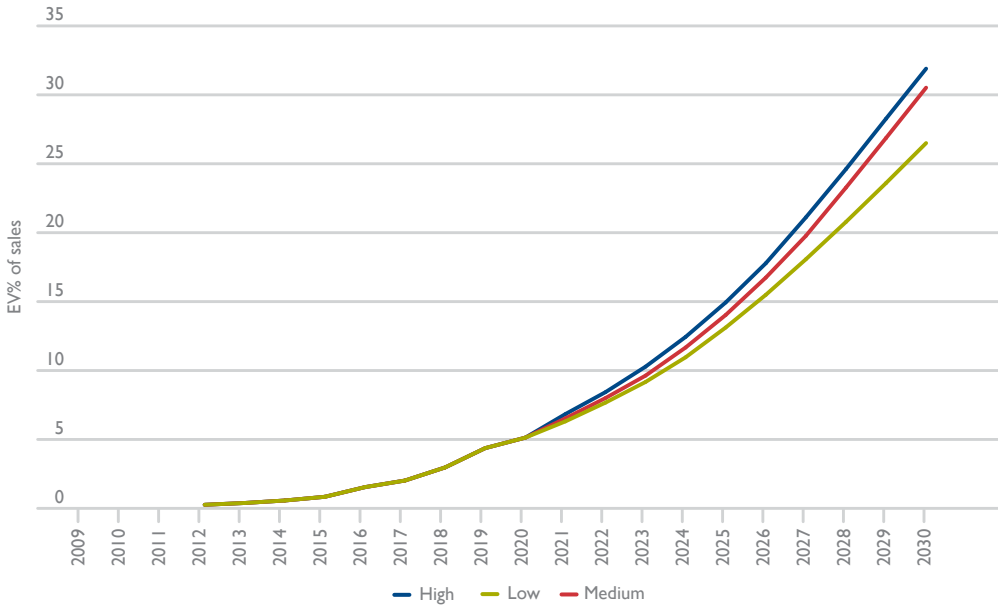
The oil price scenarios were given in Chapter 2. Corresponding Austrian petrol prices have been derived from the oil to Austrian petrol price equation in BITRE (2019). The resulting petrol price scenarios are shown in Figure 3.14.

Figure 3.14 Austrian petrol price scenarios



When these scenario petrol prices are used in the calculation of the EV/FFV cost ratios, the following predicted cost lagged curves are generated.

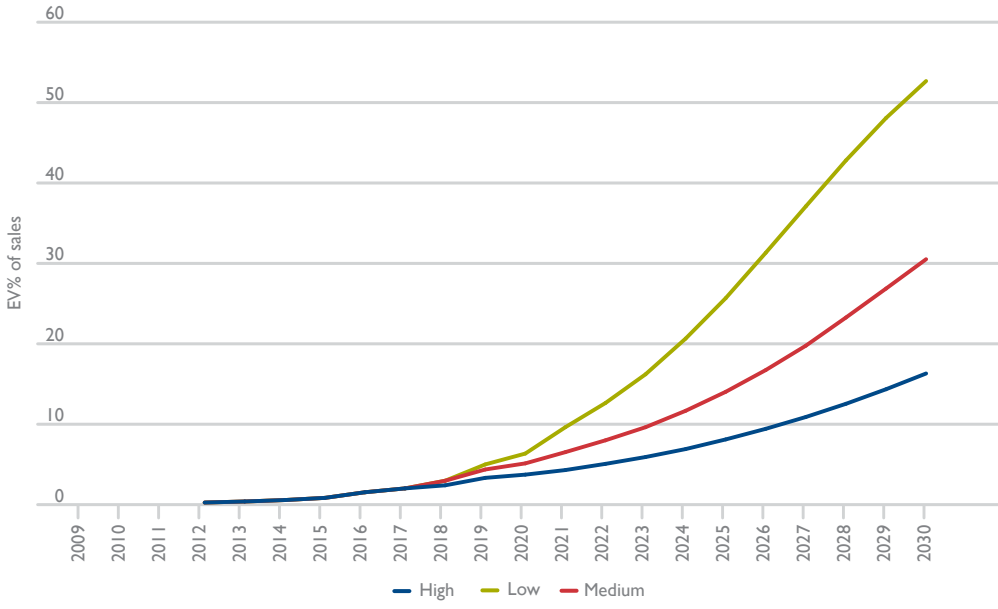
Figure 3.15 Scenarios for Austrian EV uptake with high, medium and low oil prices



It can be seen that the oil price scenarios do not make a huge difference to forecast uptake.

The second scenario test is when the prices of EVs are increased or decreased. The vehicle price scenarios were also covered in Chapter 2 (30 per cent up on the medium, 30 per cent down). When these scenario vehicle prices are used in the calculation of the EV/FFV cost ratios, the following predicted cost lagged curves are generated.

Figure 3.16 Scenarios for Austrian EV uptake with high, medium and low EV prices



It can be seen that changes in vehicle prices have a large effect on projected uptake.

3.3 Belgium

The linearized logistic uptake for Belgium is shown in Figure 3.17, along with a predicted curve.

The regression shown in Table 3.7 has only one variable – a time trend. It is estimated over the period 2013 to 2016, before the subsidy cuts began in earnest.

Figure 3.17 Belgian linearized logistic EV sales percentage and prediction

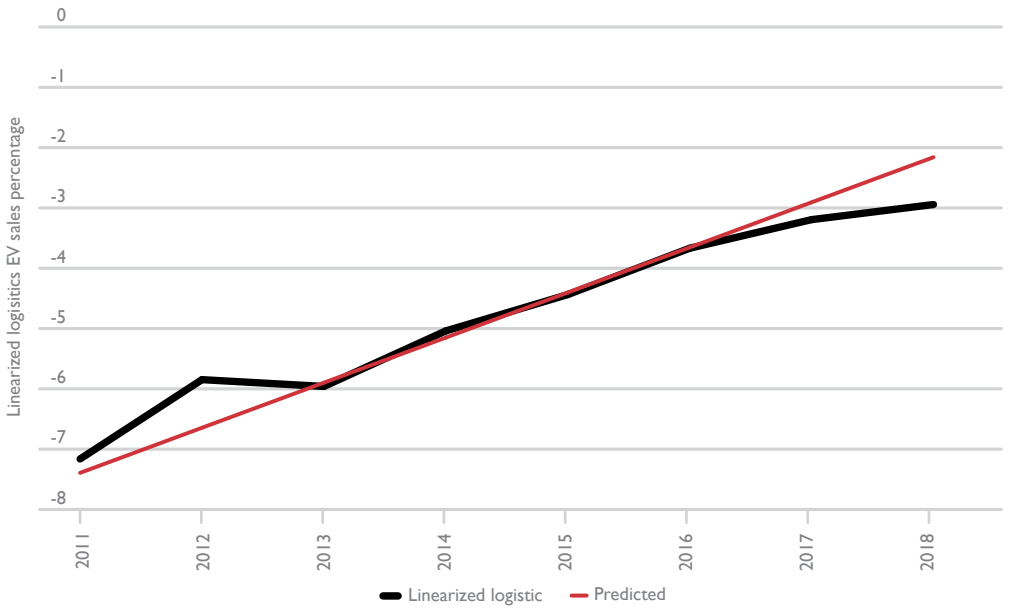


Table 3.7 Regression for Belgian linearized logistic EV uptake

Regression statistics	
Multiple R	0.996870634
R Square	0.993751061
Adjusted R Square	0.990626591
Standard Error	0.093744535
Observations	4

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	2.795073381	2.795073381	318.0543153	0.003129366
Residual	2	0.017576076	0.008788038		
Total	3	2.812649457			

	Coefficients	*Standard error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-8.888299495	0.235296916	-37.77482354	0.000700066	-9.900700414	-7.875898575
time	0.74767284	0.041923831	17.83407736	0.003129366	0.567289156	0.928056525

Figure 3.18 shows the fit of the de-linearized *raw prediction* to the actual EV sales percentage of new passenger vehicle sales. The drop-off of EV5 sales in 2017 and 2018 was due to cuts in EV purchase subsidies.

Figure 3.18 Belgian EV sales as a percentage of passenger vehicle sales and raw prediction

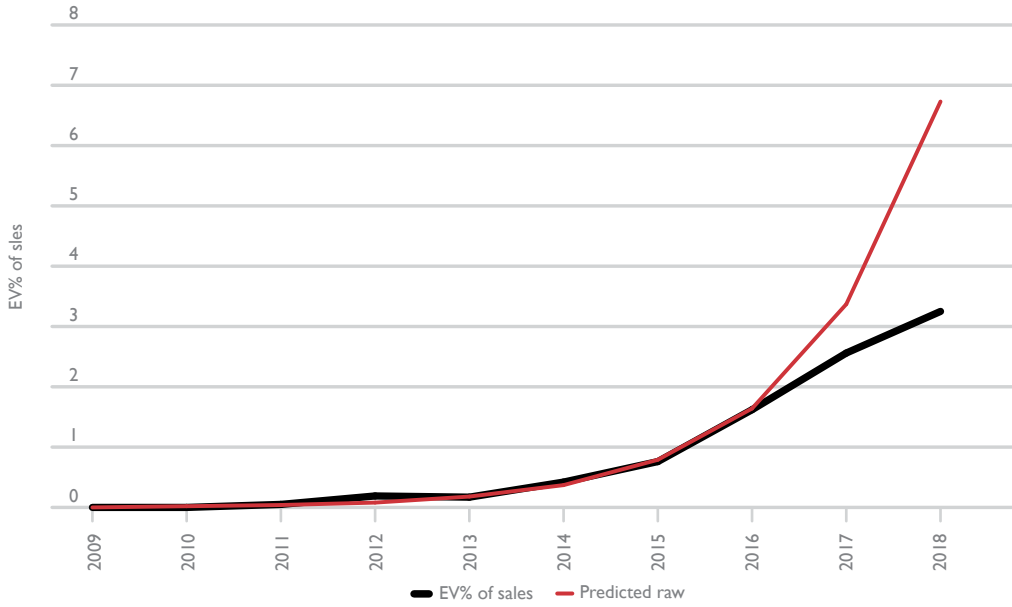
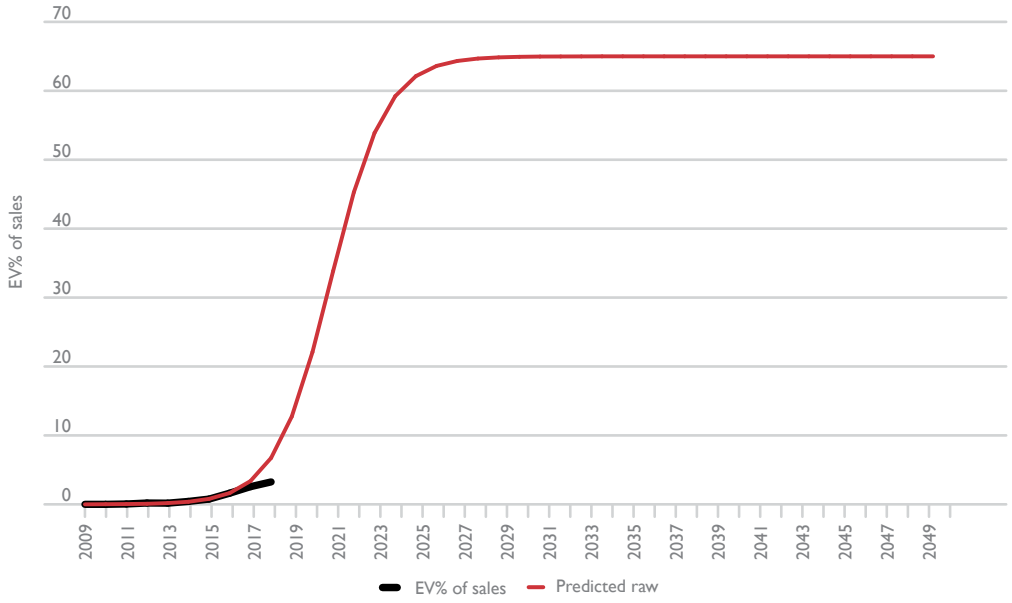


Figure 3.19 shows the extension of the forecast from this equation to 2050. This is the result of Stage 1 of the analysis.

Figure 3.19 Belgian EV sales as a percentage of passenger vehicle sales and raw prediction to 2050



In Stage 2, the year that sales (or the raw prediction) pass the 2% mark is determined. For Belgium, this is 2016.

Stage 3 involves assembling past and forecast EV and FFV costs to generate a time series of the ratio of EV to FFV annual costs. Table 3.8 shows the prices of BEVs, PHEVs and FFVs in Belgium.

Table 3.8 Prices of BEVs, PHEVs and FFVs in Belgium

BEV	2017 US$ ('000)	Euros	Euros from EU	%	Euros	Euros			Euros
	BEV base	BEV base	Purchase tax	VAT%	VAT	BEV price	Purchase subsidy	Home charging	BEV cost
2009	30	21302	0	21	4473	25775	-10337	1450	16889
2010	30	22760	0	21	4780	27540	-10115	1450	18875
2011	30	21463	0	21	4507	25971	-9771	1450	17649
2012	31	23869	0	21	5012	28881	-9503	1450	20828
2013	31	23410	0	21	4916	28326	-5218	1450	24558
2014	34	25404	0	21	5335	30739	-5199	1450	26990
2015	30	27178	0	21	5707	32885	-5170	1450	29165
2016	30	27202	0	21	5713	32915	-4063	1450	30302
2017	30	26462	0	21	5557	32019	-3000	1450	30469
2018	31	26003	0	21	5461	31464	-1969	1450	30945
2019	31	26497	0	21	5564	32061	-969	1450	32542
2020	31	26338	0	21	5531	31869	0	1450	33319
2021	30	25676	0	21	5392	31068	0	1450	32518
2022	31	26046	0	21	5470	31516	0	1450	32966
2023	30	25807	0	21	5420	31227	0	1450	32677
2024	29	24884	0	21	5226	30110	0	1450	31560
2025	28	24092	0	21	5059	29151	0	1450	30601
2026	28	23640	0	21	4964	28605	0	1450	30055
2027	27	23189	0	21	4870	28059	0	1450	29509
2028	27	22681	0	21	4763	27444	0	1450	28894
2029	26	22230	0	21	4668	26898	0	1450	28348
2030	26	21722	0	21	4562	26283	0	1450	27733

PHEV	2017 US$ ('000)	Euros	Euros from EU	%	Euros	Euros			Euros
	PHEV base	PHEV base	Purchase tax	VAT%	VAT	PHEV price	Purchase subsidy	Home charging	PHEV cost
2009	30	21302	0	21	4473	25775	0	1450	27225
2010	30	22760	0	21	4780	27540	0	1450	28990
2011	30	21463	0	21	4507	25971	0	1450	27421
2012	31	23869	0	21	5012	28881	0	1450	30331
2013	31	23410	0	21	4916	28326	0	1450	29776
2014	34	25404	0	21	5335	30739	0	1450	32189
2015	30	27178	0	21	5707	32885	0	1450	34335
2016	30	27202	0	21	5713	32915	0	1450	34365
2017	30	26462	0	21	5557	32019	0	1450	33469
2018	31	26003	0	21	5461	31464	0	1450	32914
2019	31	26497	0	21	5564	32061	0	1450	33511
2020	31	26338	0	21	5531	31869	0	1450	33319
2021	30	25676	0	21	5392	31068	0	1450	32518
2022	31	26046	0	21	5470	31516	0	1450	32966
2023	30	25807	0	21	5420	31227	0	1450	32677
2024	29	24884	0	21	5226	30110	0	1450	31560
2025	28	24092	0	21	5059	29151	0	1450	30601
2026	28	23640	0	21	4964	28605	0	1450	30055
2027	27	23189	0	21	4870	28059	0	1450	29509
2028	27	22681	0	21	4763	27444	0	1450	28894
2029	26	22230	0	21	4668	26898	0	1450	28348
2030	26	21722	0	21	4562	26283	0	1450	27733

Table 3.8 Prices of BEVs, PHEVs and FFVs in Belgium (continued)

FFV	2017 US$ ('000)	Euros	Euros from EU	%	Euros	Euros
	FFV base	FFV base	Purchase tax	VAT%	VAT	FFV price
2009	23	16556	0	21	3477	20033
2010	23	17449	0	21	3664	21114
2011	23	16455	0	21	3456	19911
2012	23	17800	0	21	3738	21538
2013	23	17288	0	21	3631	20919
2014	23	17420	0	21	3658	21078
2015	23	20836	0	21	4376	25212
2016	23	20855	0	21	4380	25235
2017	23	20288	0	21	4260	24548
2018	23	19550	0	21	4106	23656
2019	23	19550	0	21	4106	23656
2020	23	19550	0	21	4106	23656
2021	23	19550	0	21	4106	23656
2022	23	19550	0	21	4106	23656
2023	23	19550	0	21	4106	23656
2024	23	19550	0	21	4106	23656
2025	23	19550	0	21	4106	23656
2026	23	19550	0	21	4106	23656
2027	23	19550	0	21	4106	23656
2028	23	19550	0	21	4106	23656
2029	23	19550	0	21	4106	23656
2030	23	19550	0	21	4106	23656

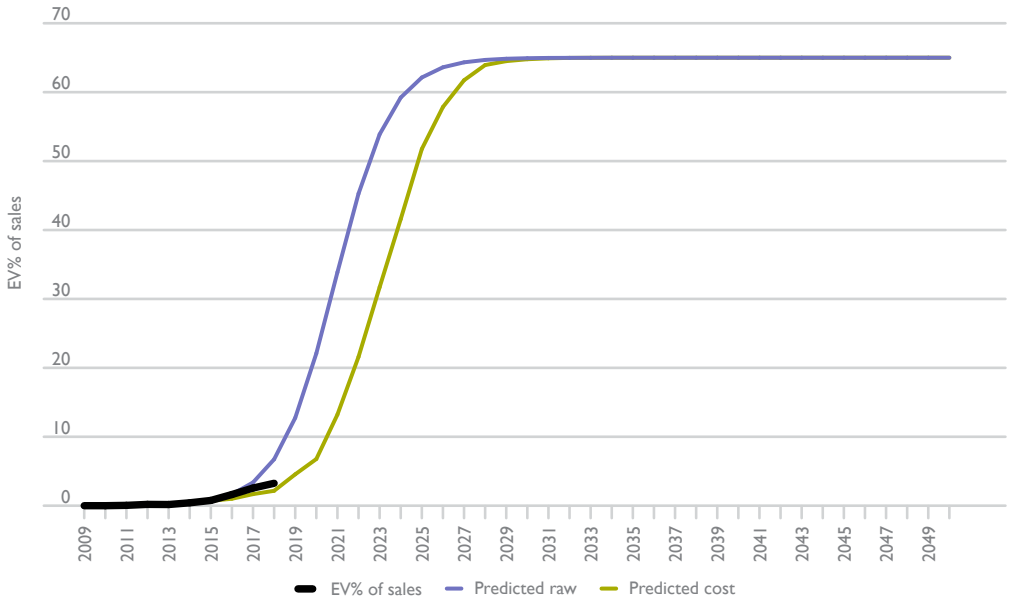
Table 3.9 shows past and forecast BEV and FFV costs used to generate a time series of the ratio of EV to FFV annual costs. Costs include principal (repay over 5 years), interest (13 per cent per year), annual EV subsidies, and petrol costs for FFV (with increasing fuel efficiency and a medium petrol price).

Table 3.9 EV/FFV cost ratio calculations for Belgium

	Evs	Evs	Evs	Evs	Evs	FFVs	FFVs	FFVs	FFVs	FFVs	EV/ FFV
	EV price	Principal	Interest	Annual subs	Annual cost	FFV price	Principal	Interest	Fuel	Annual cost	Cost ratio
2012	20828	4166	2708	0	6873	21538	4308	2800	1529	8637	0.80
2013	24558	4912	3193	0	8104	20919	4184	2719	1442	8345	0.97
2014	26990	5398	3509	0	8907	21078	4216	2740	1376	8332	1.07
2015	29165	5833	3791	0	9624	25212	5042	3278	1205	9525	1.01
2016	30302	6060	3939	0	10000	25235	5047	3281	1084	9412	1.06
2017	30469	6094	3961	0	10055	24548	4910	3191	1130	9231	1.09
2018	30945	6189	4023	0	10212	23656	4731	3075	1183	8989	1.14
2019	32542	6508	4230	0	10739	23656	4731	3075	1149	8955	1.20
2020	33319	6664	4331	0	10995	23656	4731	3075	1139	8945	1.23
2021	32518	6504	4227	0	10731	23656	4731	3075	1169	8975	1.20
2022	32966	6593	4286	0	10879	23656	4731	3075	1188	8994	1.21
2023	32677	6535	4248	0	10783	23656	4731	3075	1190	8997	1.20
2024	31560	6312	4103	0	10415	23656	4731	3075	1182	8989	1.16
2025	30601	6120	3978	0	10098	23656	4731	3075	1189	8996	1.12
2026	30055	6011	3907	0	9918	23656	4731	3075	1211	9017	1.10
2027	29509	5902	3836	0	9738	23656	4731	3075	1215	9022	1.08
2028	28894	5779	3756	0	9535	23656	4731	3075	1214	9020	1.06
2029	28348	5670	3685	0	9355	23656	4731	3075	1216	9022	1.04
2030	27733	5547	3605	0	9152	23656	4731	3075	1215	9021	1.01

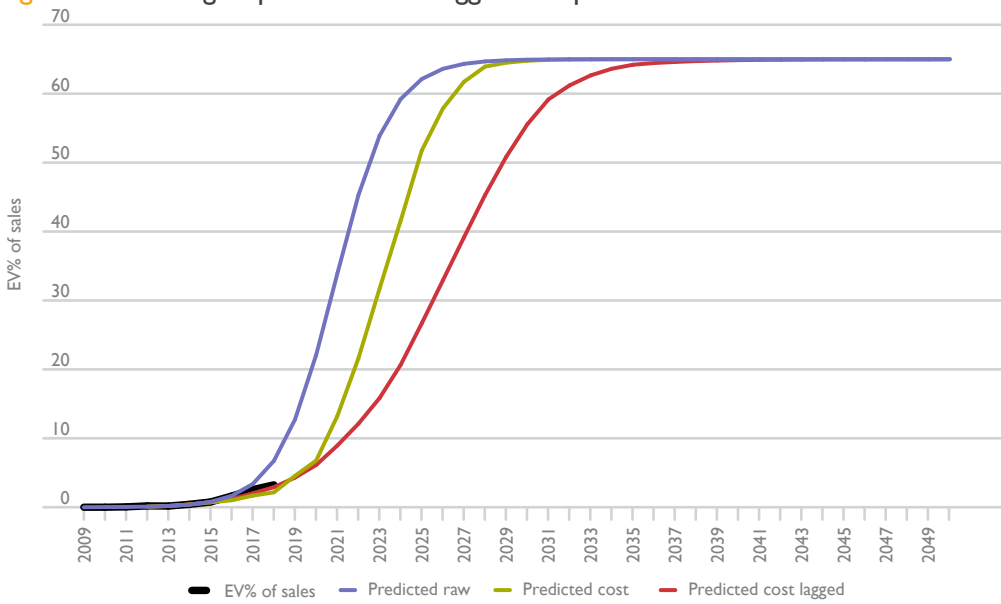
The resulting EV/FFV cost ratio time series is shown in the last column. This time series is then fed though the 2% year formula, which shifts the predicted raw uptake curve in line with shifts predicted for the cost ratio. Figure 3.20 shows that the removal of subsidies from 2017 onwards results in a shift in the *predicted raw* curve to the right in the graph, giving the *predicted cost* curve. This is the result from Stage 3 of the Belgian analysis.

Figure 3.20 Belgian predicted raw and predicted cost EV per cent of sales curves



In Stage 4 corrections are made to the predicted cost uptake curves. Basically, the rates of uptake are reduced to allow for the fact that most early adopters are those with higher incomes. The resulting Belgian *predicted cost lagged* curve – which is a less steeply rising curve – is shown in Figure 3.21. This is the final base-case EV uptake prediction for Belgium.

Figure 3.21 Belgian predicted cost lagged EV uptake curve

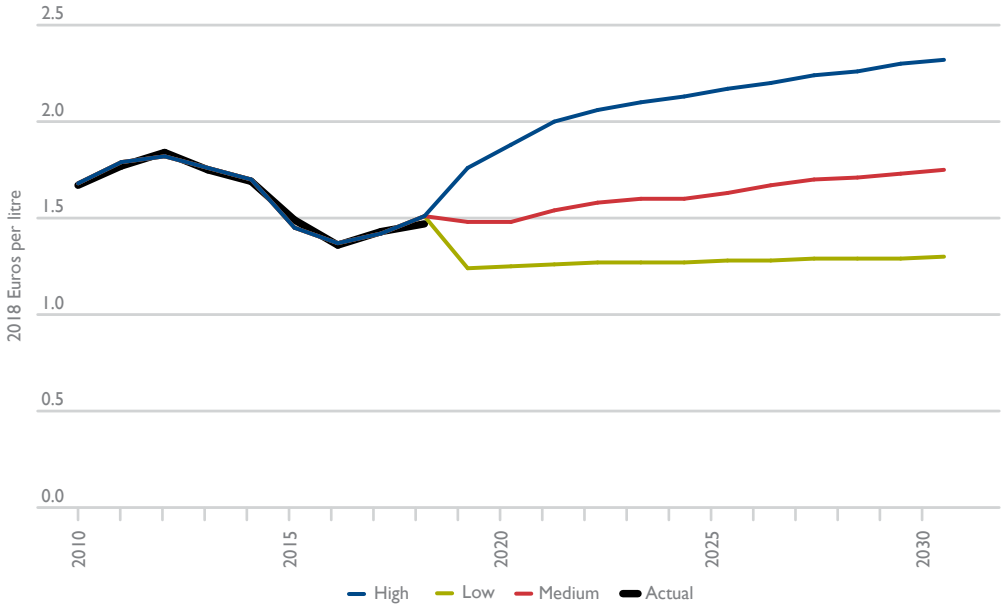


The resulting Belgian uptake forecast has EVs as 27 per cent of sales in 2025 and 56 per cent in 2030.

Stage 5 of the analysis looks at high, medium and low scenarios for oil prices and for EV prices.

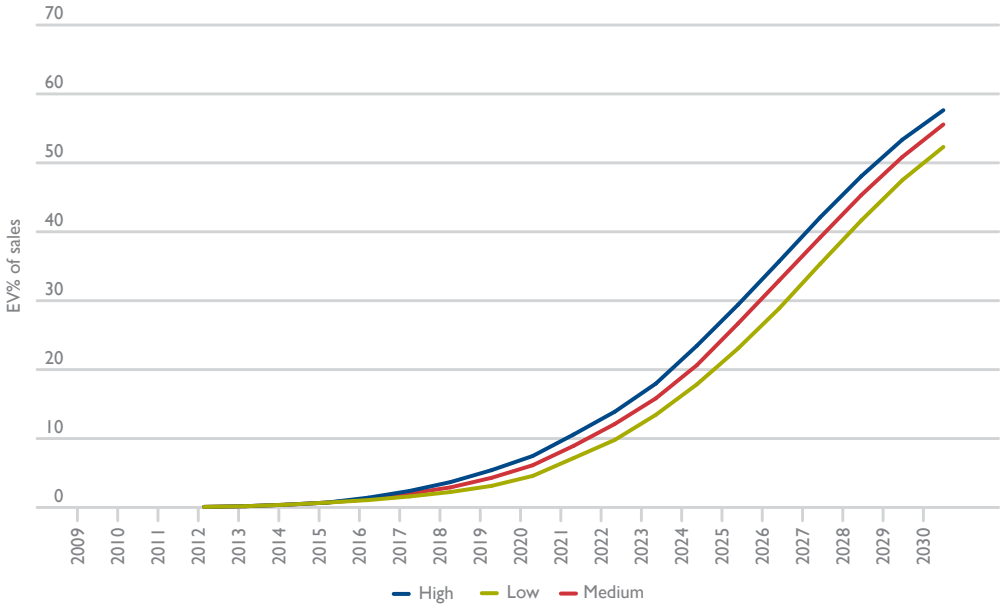
The oil price scenarios were given in Chapter 2. Corresponding Belgian petrol prices have been derived from the oil to Belgian petrol price equation in BITRE (2019). The resulting petrol price scenarios are shown in Figure 3.22.

Figure 3.22 Belgian petrol price scenarios



When these scenario petrol prices are used in the calculation of the EV/FFV cost ratios, the following predicted cost lagged curves are generated.

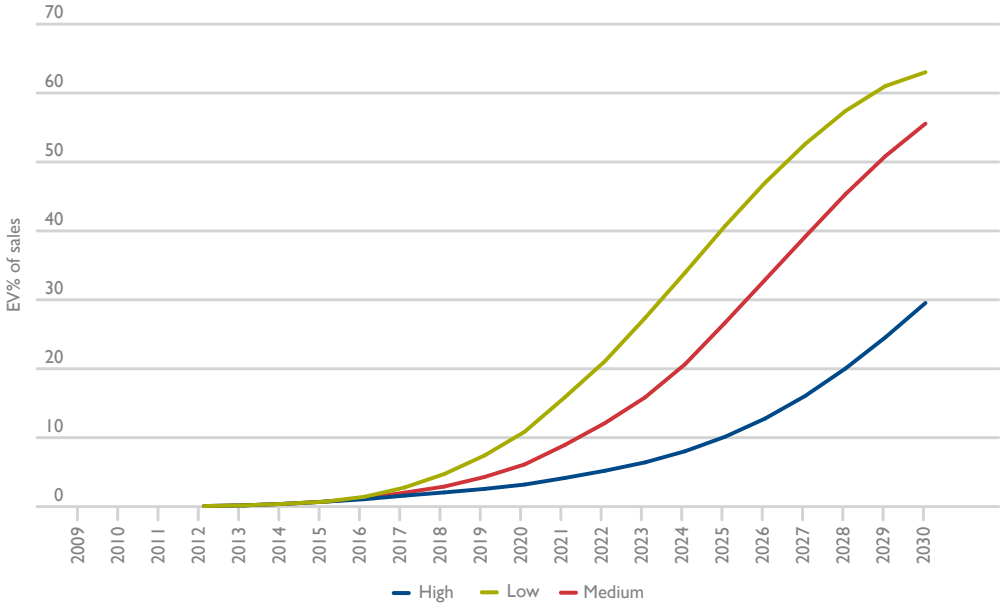
Figure 3.23 Scenarios for Belgian EV uptake with high, medium and low oil prices



It can be seen that the oil price scenarios do not make a huge difference to forecast uptake.

The second scenario test is when the prices of EVs are increased or decreased. The vehicle price scenarios were also covered in Chapter 2 (30 per cent up on the medium, 30 per cent down). When these scenario vehicle prices are used in the calculation of the EV/FFV cost ratios, the following predicted cost lagged curves are generated.

Figure 3.24 Scenarios for Belgian EV uptake with high, medium and low EV prices



It can be seen that changes in vehicle prices have a large effect on projected uptake.

3.4 Britain

The linearized logistic uptake for Britain is shown in Figure 3.25, along with a predicted curve.

The regression shown in Table 3.10 has three variables – a time trend, a dummy for 2011 to 2013 and a dummy for 2015. It is estimated over the period 2011 to 2018.

Figure 3.25 British linearized logistic EV sales percentage and prediction

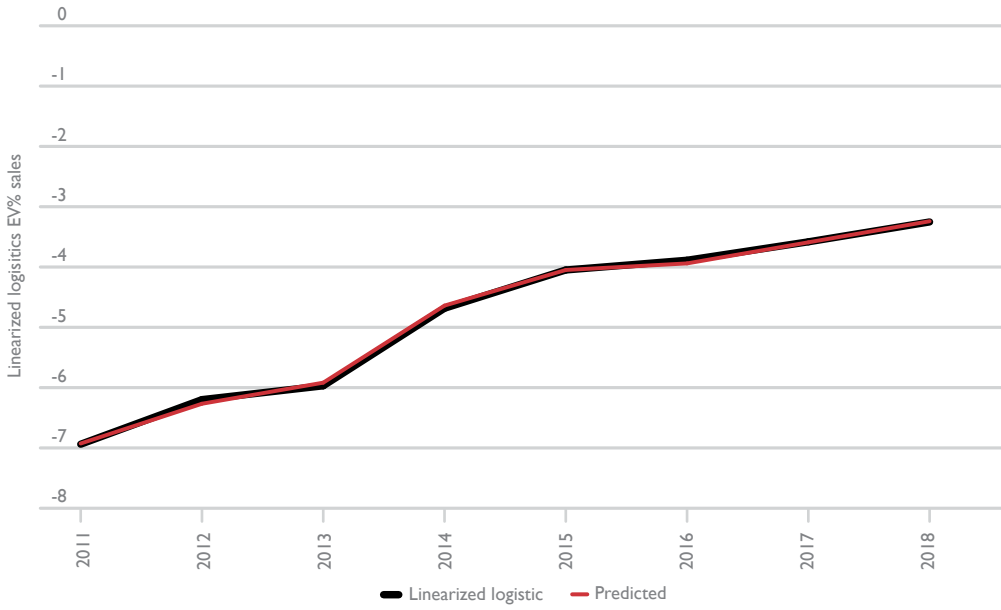


Table 3.10 Regression for British linearized logistic EV uptake

Regression statistics	
Multiple R	0.999508755
R Square	0.999017751
Adjusted R Square	0.998281064
Standard Error	0.056835401
Observations	8

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	13.14163279	4.380544263	1356.09533	1.80843E-06
Residual	4	0.012921051	0.003230263		
Total	7	13.15455384			

	Coefficients	*Standard error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-6.387517431	0.138354681	-46.16770021	1.31656E-06	-6.771651608	-6.003383254
time	0.349631559	0.018654513	18.74246557	4.77141E-05	0.297838329	0.401424789
dum15	0.240681264	0.067670952	3.556640758	0.023657183	0.052796582	0.428565947
dum1113	-1.237991916	0.10854149	-11.40570226	0.000337077	-1.539351405	-0.936632428

Figure 3.26 shows the fit of the de-linearized *raw prediction* to the actual EV sales percentage of new passenger vehicle sales.

Figure 3.26 British EV sales as a percentage of passenger vehicle sales and raw prediction

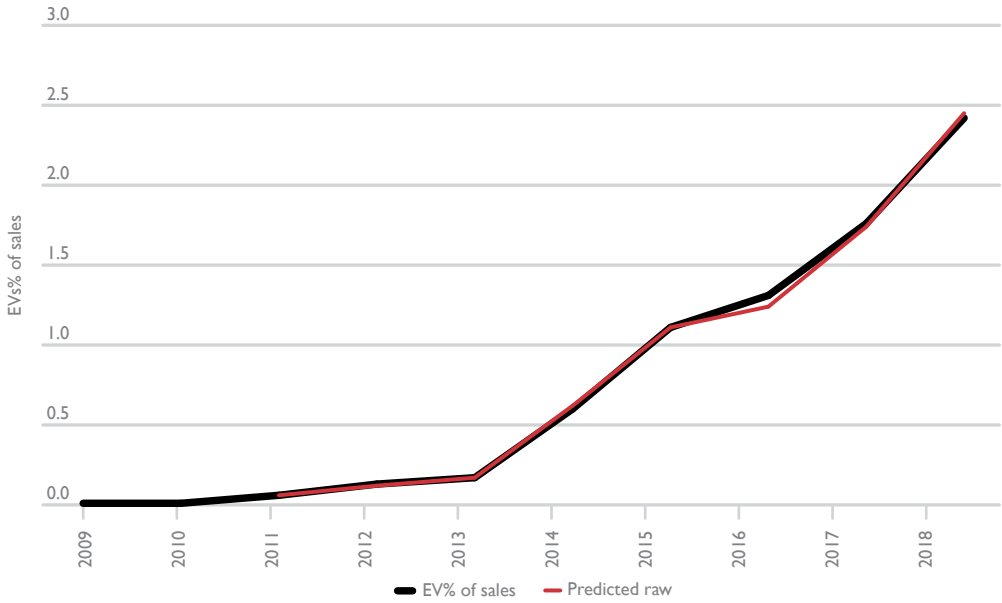
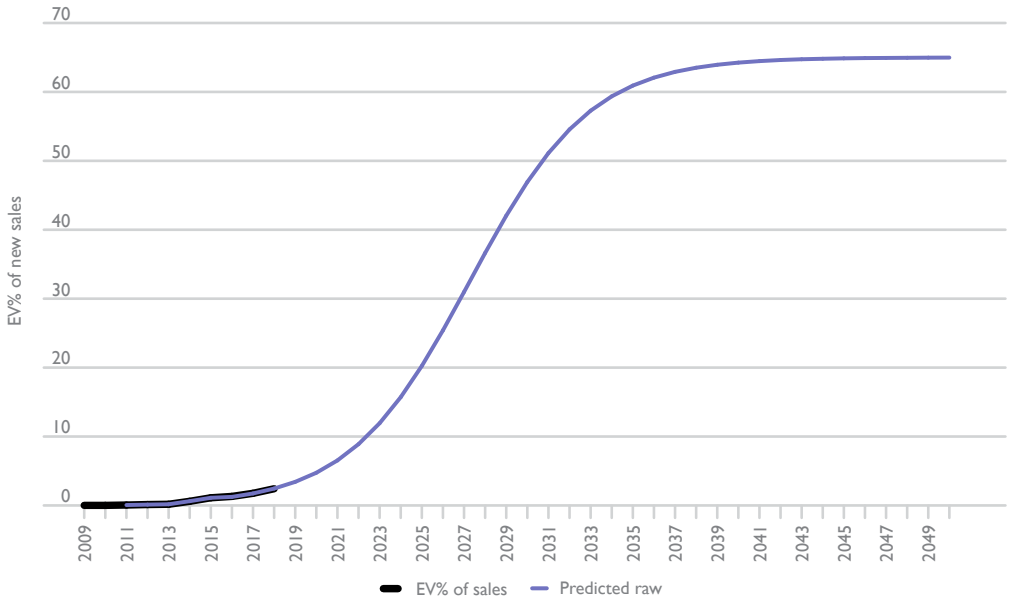


Figure 3.27 shows the extension of the forecast from this equation to 2050. This is the result of Stage 1 of the analysis.

Figure 3.27 British EV sales as a percentage of passenger vehicle sales and raw prediction to 2050



In Stage 2, the year that sales (or the raw prediction) pass the 2% mark is determined. For Britain, this is 2017.

Stage 3 involves assembling past and forecast EV and FFV costs to generate a time series of the ratio of EV to FFV annual costs. Table 3.11 shows the prices of BEVs, PHEVs and FFVs in Britain.

Table 3.11 Prices of BEVs, PHEVs and FFVs in Britain

BEV	2017 US$ ('000)	Pounds	%	Pounds	Pounds	Pounds	Pounds	Pounds
	BEV base	BEV base	VAT%	VAT	Plug-in grant	BEV price	Home charging	BEV price
2009	30	18996	15	2849	0	21845	1200	23045
2010	30	19447	17.5	3403	0	22850	1200	24050
2011	30	18690	20	3738	-5163	17266	1200	18466
2012	31	19372	20	3874	-5204	18043	1200	19243
2013	31	19927	20	3985	-5220	18693	1200	19893
2014	34	20386	20	4077	-5163	19300	1200	20500
2015	30	19663	20	3933	-5074	18522	1200	19722
2016	30	22394	20	4479	-5128	21745	1200	22945
2017	30	23132	20	4626	-5000	22758	1200	23958
2018	31	24474	20	4895	-4388	24981	1200	26181
2019	31	24938	20	4988	-4278	25648	1200	26848
2020	31	24789	20	4958	-4171	25575	1200	26775
2021	30	24165	20	4833	-4067	24931	1200	26131
2022	31	24514	20	4903	-3966	25451	1200	26651
2023	30	24289	20	4858	-3867	25280	1200	26480
2024	29	23421	20	4684	-3770	24334	1200	25534
2025	28	22675	20	4535	-3676	23534	1200	24734
2026	28	22250	20	4450	-3584	23115	1200	24315
2027	27	21825	20	4365	-3495	22695	1200	23895
2028	27	21347	20	4269	-3408	22209	1200	23409
2029	26	20922	20	4184	-3323	21784	1200	22984
2030	26	20444	20	4089	-3240	21293	1200	22493

PHEV	2017 US$ ('000)	Pounds	%	Pounds	Pounds	Pounds	Pounds	Pounds
	PHEV base	PHEV base	VAT%	VAT	Plug-in grant	PHEV price	Home charging	PHEV price
2009	30	18996	15	2849	0	21845	1200	23045
2010	30	19447	17.5	3403	0	22850	1200	24050
2011	30	18690	20	3738	-2762	19666	1200	20866
2012	31	19372	20	3874	-2686	20560	1200	21760
2013	31	19927	20	3985	-2619	21293	1200	22493
2014	34	20386	20	4077	-2582	21882	1200	23082
2015	30	19663	20	3933	-2580	21015	1200	22215
2016	30	22394	20	4479	-2564	24309	1200	25509
2017	30	23132	20	4626	-2500	25258	1200	26458
2018	31	24474	20	4895	-2438	26931	1200	28131
2019	31	24938	20	4988	-2377	27549	1200	28749
2020	31	24789	20	4958	-2317	27429	1200	28629
2021	30	24165	20	4833	-2260	26739	1200	27939
2022	31	24514	20	4903	-2203	27214	1200	28414
2023	30	24289	20	4858	-2148	26999	1200	28199
2024	29	23421	20	4684	-2095	26010	1200	27210
2025	28	22675	20	4535	-2042	25167	1200	26367
2026	28	22250	20	4450	-1991	24708	1200	25908
2027	27	21825	20	4365	-1942	24248	1200	25448
2028	27	21347	20	4269	-1893	23723	1200	24923
2029	26	20922	20	4184	-1846	23261	1200	24461
2030	26	20444	20	4089	-1800	22733	1200	23933

Table 3.11 Prices of BEVs, PHEVs and FFVs in Britain (continued)

FFV	2017 US$ ('000)	Pounds	%	Pounds	Pounds
	FFV base	FFV base	VAT%	VAT	FFV price
2009	23	14764	15	2215	16979
2010	23	14909	17.5	2609	17519
2011	23	14329	20	2866	17195
2012	23	14446	20	2889	17336
2013	23	14716	20	2943	17660
2014	23	13979	20	2796	16775
2015	23	15075	20	3015	18090
2016	23	17169	20	3434	20603
2017	23	17734	20	3547	21281
2018	23	18400	20	3680	22080
2019	23	18400	20	3680	22080
2020	23	18400	20	3680	22080
2021	23	18400	20	3680	22080
2022	23	18400	20	3680	22080
2023	23	18400	20	3680	22080
2024	23	18400	20	3680	22080
2025	23	18400	20	3680	22080
2026	23	18400	20	3680	22080
2027	23	18400	20	3680	22080
2028	23	18400	20	3680	22080
2029	23	18400	20	3680	22080
2030	23	18400	20	3680	22080

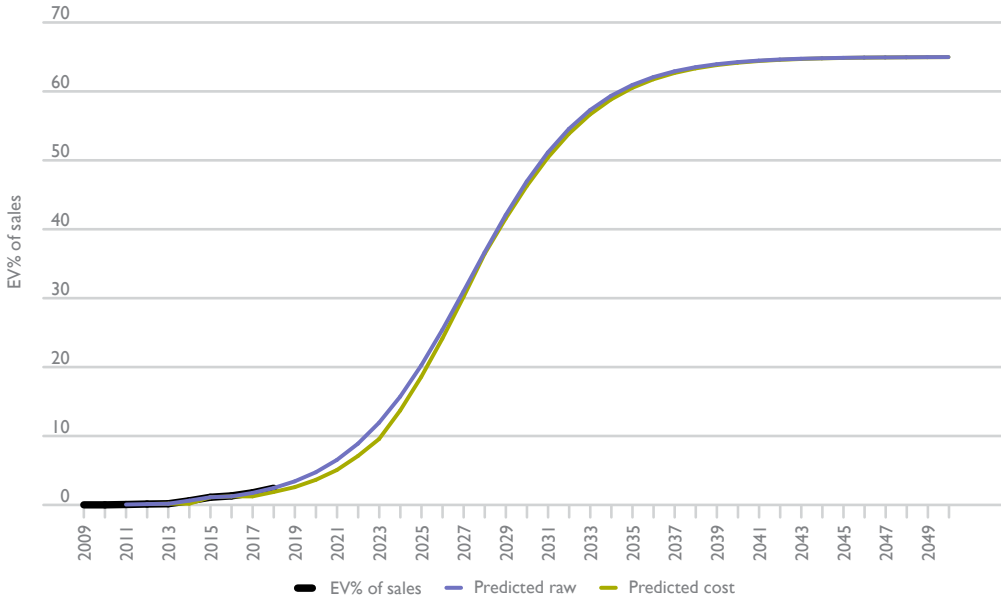
Table 3.12 shows past and forecast BEV and FFV costs used to generate a time series of the ratio of EV to FFV annual costs. Costs include principal (repay over 5 years), interest (13 per cent per year), annual EV subsidies, and petrol costs for FFV (with increasing fuel efficiency and a medium petrol price).

Table 3.12 EV/FFV cost ratio calculations for Britain

	Evs	Evs	Evs	Evs	Evs	FFVs	FFVs	FFVs	FFVs	FFVs	EV/ FFV
	EV price	Principal	Interest	Annual subs	Annual cost	FFV price	Principal	Interest	Fuel	Annual cost	Cost ratio
2012	19243	3849	2502	1000	5350	17336	3467	2254	1111	6832	0.78
2013	19893	3979	2586	1200	5365	17660	3532	2296	1058	6886	0.78
2014	20500	4100	2665	1350	5415	16775	3355	2181	968	6504	0.83
2015	19722	3944	2564	1350	5158	18090	3618	2352	827	6797	0.76
2016	22945	4589	2983	1350	6222	20603	4121	2678	804	7603	0.82
2017	23958	4792	3115	1350	6556	21281	4256	2767	831	7854	0.83
2018	26181	5236	3403	1350	7290	22080	4416	2870	861	8147	0.89
2019	26848	5370	3490	1350	7510	22080	4416	2870	840	8127	0.92
2020	26775	5355	3481	1350	7486	22080	4416	2870	833	8119	0.92
2021	26131	5226	3397	1355	7268	22080	4416	2870	853	8139	0.89
2022	26651	5330	3465	1355	7440	22080	4416	2870	865	8151	0.91
2023	26480	5296	3442	1355	7384	22080	4416	2870	866	8152	0.91
2024	25534	5107	3319	1355	7071	22080	4416	2870	860	8146	0.87
2025	24734	4947	3215	1355	6807	22080	4416	2870	864	8150	0.84
2026	24315	4863	3161	1355	6669	22080	4416	2870	878	8164	0.82
2027	23895	4779	3106	1355	6530	22080	4416	2870	880	8167	0.80
2028	23409	4682	3043	1355	6370	22080	4416	2870	879	8165	0.78
2029	22984	4597	2988	1355	6230	22080	4416	2870	879	8166	0.76
2030	22493	4499	2924	1355	6068	22080	4416	2870	878	8164	0.74

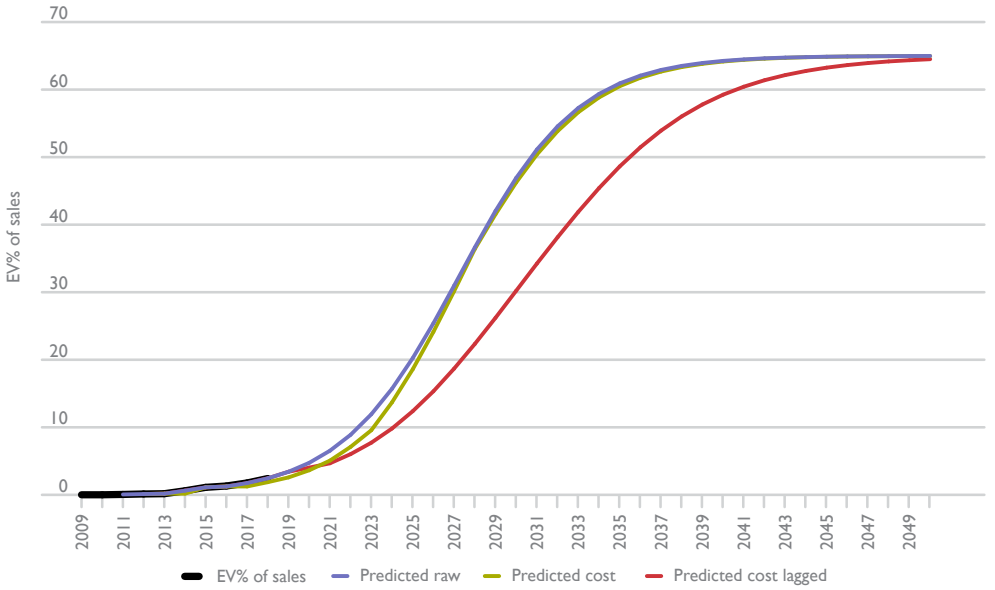
The resulting EV/FFV cost ratio time series is shown in the last column. This time series is then fed though the 2% year formula, which shifts the *predicted raw* uptake curve in line with shifts predicted for the cost ratio. Figure 3.28 shows that as the EV/FFV cost ratio rises and then falls, the result is a shift in the *predicted raw* curve to the right and then back to the left, giving the *predicted cost* curve. This is the result from Stage 3 of the British analysis.

Figure 3.28 British predicted raw and predicted cost EV per cent of sales curves



In Stage 4 corrections are made to the predicted cost uptake curves. Basically, the rates of uptake are reduced to allow for the fact that most early adopters are those with higher incomes. The resulting British *predicted cost lagged* curve – which is a less steeply rising curve – is shown in Figure 3.29. This is the final base-case EV uptake prediction for Britain.

Figure 3.29 British predicted cost lagged EV uptake curve

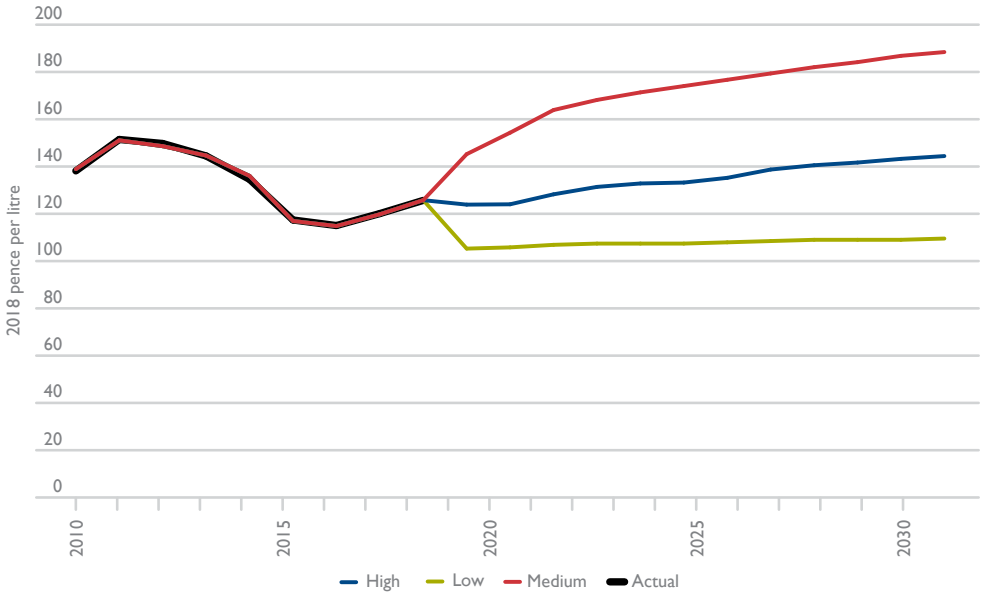


The resulting British uptake forecast has EVs as 12 per cent of sales in 2025 and 30 per cent in 2030.

Stage 5 of the analysis looks at high, medium and low scenarios for oil prices and for EV prices.

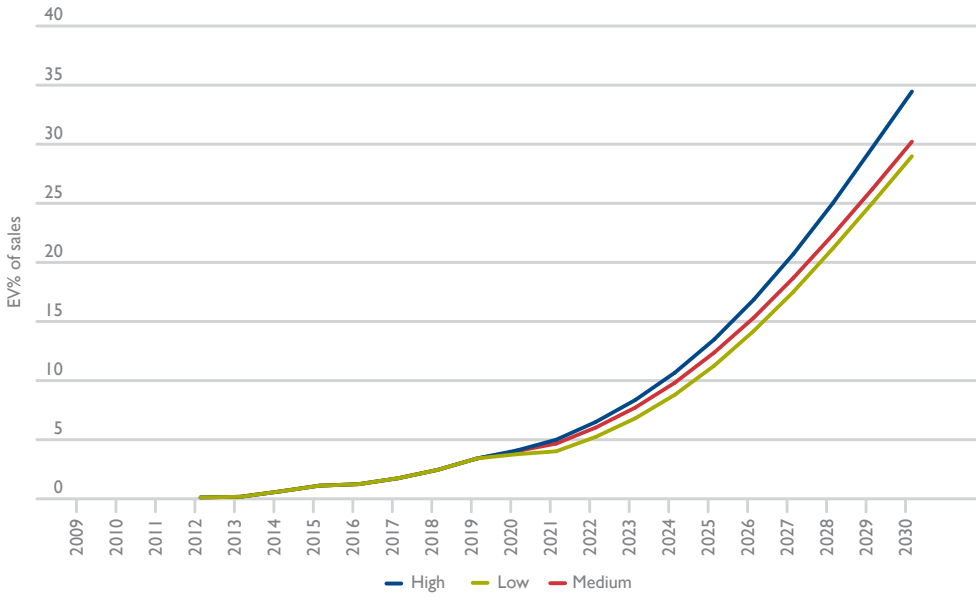
The oil price scenarios were given in Chapter 2. Corresponding British petrol prices have been derived from the oil to British petrol price equation in BITRE (2019). The resulting petrol price scenarios are shown in Figure 3.30.

Figure 3.30 British petrol price scenarios



When these scenario petrol prices are used in the calculation of the EV/FFV cost ratios, the following predicted cost lagged curves are generated.

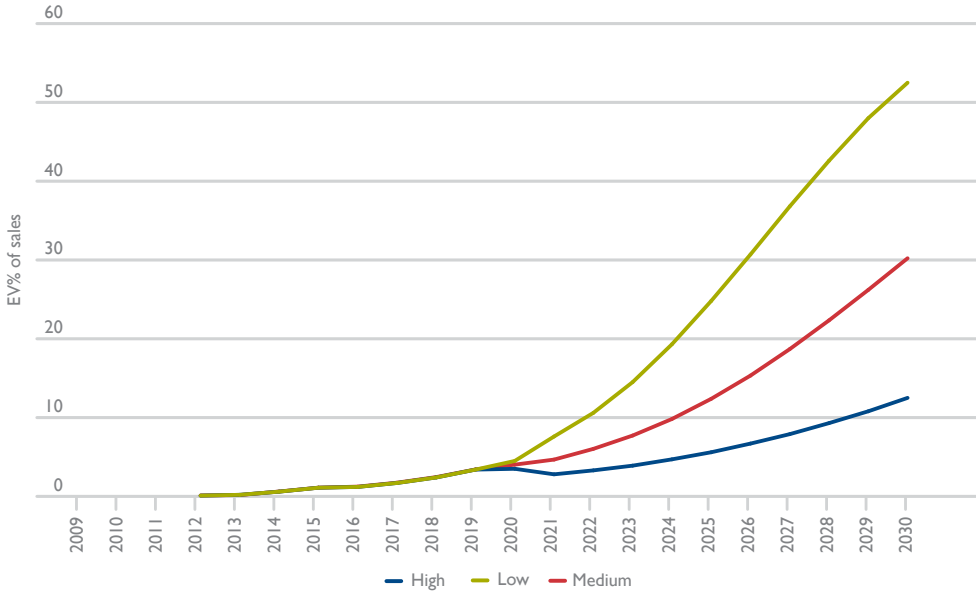
Figure 3.31 Scenarios for British EV uptake with high, medium and low oil prices



It can be seen that high oil prices do not make much difference to forecast uptake and low prices make almost no difference.

The second scenario test is when the prices of EVs are increased or decreased. The vehicle price scenarios were also covered in Chapter 2 (30 per cent up on the medium, 30 per cent down). When these scenario vehicle prices are used in the calculation of the EV/FFV cost ratios, the following predicted cost lagged curves are generated.

Figure 3.32 Scenarios for British EV uptake with high, medium and low EV prices



It can be seen that changes in vehicle prices have a large effect on projected uptake.

3.5 Canada

The linearized logistic uptake for Canada is shown in Figure 3.33, along with a predicted curve.

The regression shown in Table 3.13 has three variables – a time trend, a dummy for 2015 to 2017 and a dummy for 2018 representing shipment of Tesla models and the announced ending of Ontario purchase subsidies. It is estimated over the period 2012 to 2018.

Figure 3.33 Canadian linearized logistic EV sales percentage and prediction

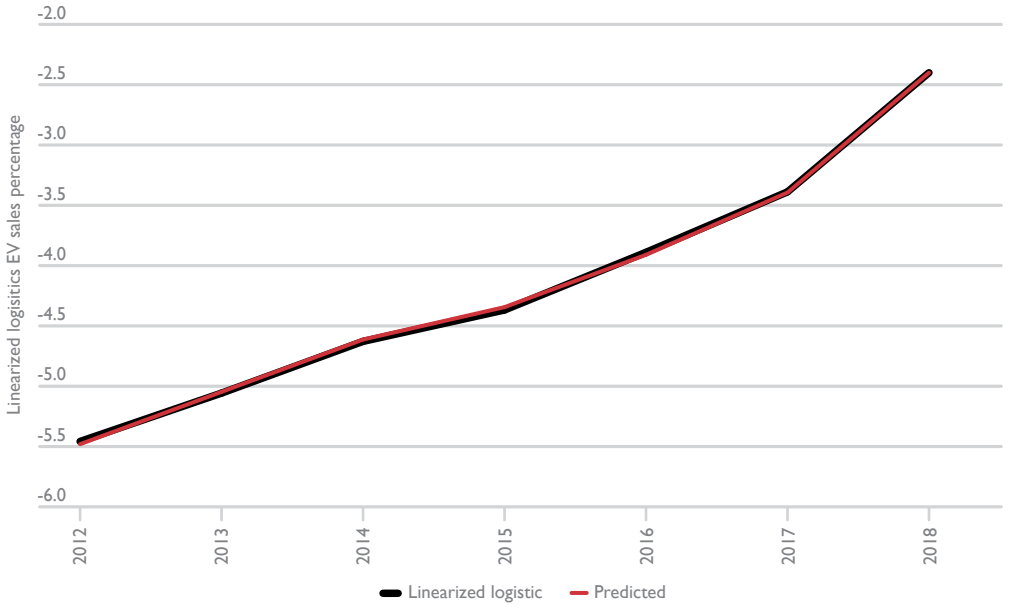


Table 3.13 Regression for Canadian linearized logistic EV uptake

Regression statistics	
Multiple R	0.999854881
R Square	0.999709783
Adjusted R Square	0.999419566
Standard Error	0.025103513
Observations	7

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	6.512405034	2.170801678	3444.697869	8.39258E-06
Residual	3	0.001890559	0.000630186		
Total	6	6.514295593			

	Coefficients	*Standard error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-6.781622935	0.03969214	-170.8555648	4.42109E-07	-6.907941039	-6.655304832
time	0.433734365	0.008482359	51.13369608	1.64722E-05	0.406739713	0.460729017
dum1517	-0.16501411	0.032280652	-5.111858087	0.014485019	-0.267745551	-0.06228267
TeslaOntario	0.477460779	0.048599984	9.82429919	0.002241816	0.322793941	0.632127617

Figure 3.34 shows the fit of the de-linearized *raw prediction* to the actual EV sales percentage of new passenger vehicle sales.

Figure 3.34 Canadian EV sales as a percentage of passenger vehicle sales and raw prediction

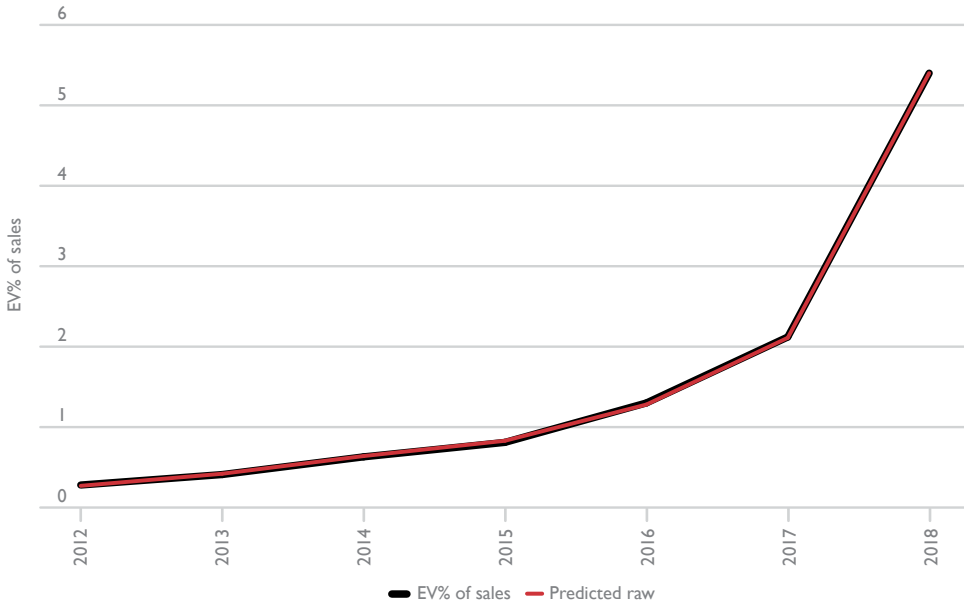
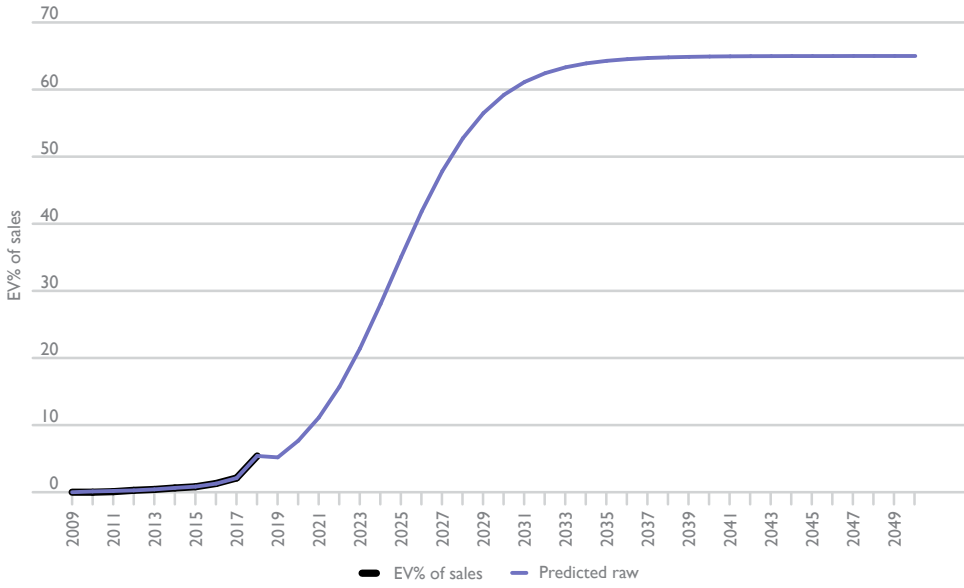


Figure 3.35 shows the extension of the forecast from this equation to 2050 (with the 2018 dummy put back to zero). This is the result of Stage 1 of the analysis.

Figure 3.35 Canadian EV sales as a percentage of passenger vehicle sales and raw prediction to 2050



In Stage 2, the year that sales (or the raw prediction) pass the 2% mark is determined. For Canada, this is 2017.

Stage 3 involves assembling past and forecast EV and FFV costs to generate a time series of the ratio of EV to FFV annual costs. Table 3.14 shows the prices of BEVs, PHEVs and FFVs in Canada.

Table 3.14 Prices of BEVs, PHEVs and FFVs in Canada

BEV	2017 US$ ('000)	Cdn$	Cdn$	%	Cdn$	Cdn$	Cdn$	Cdn$	Cdn$
	BEV base	BEV base	Purchase tax	VAT%	VAT	BEV price	Purchase subsidy	Home charging	BEV price
2009	30	33827	0	13	4398	38225	-191	2200	40234
2010	30	30905	0	13	4018	34923	-1969	2033	34986
2011	30	29634	0	13	3852	33487	-2096	2033	33424
2012	31	30800	0	13	4004	34804	-4578	1850	32076
2013	31	32198	0	13	4186	36384	-4536	1850	33698
2014	34	37119	0	13	4826	41945	-4451	1850	39344
2015	30	38628	0	13	5022	43649	-4401	1850	41098
2016	30	39681	0	13	5159	44840	-4821	1683	41702
2017	30	38859	0	13	5052	43911	-5028	1683	40566
2018	31	39770	0	13	5170	44940	-4081	1683	42542
2019	31	40525	0	13	5268	45793	-2558	1975	45210
2020	31	40282	0	13	5237	45518	-2505	1975	44988
2021	30	39269	0	13	5105	44374	-2454	1975	43895
2022	31	39835	0	13	5179	45014	-2403	1975	44585
2023	30	39470	0	13	5131	44601	-2354	1975	44222
2024	29	38058	0	13	4948	43006	-2306	1975	42675
2025	28	36846	0	13	4790	41636	-2258	1975	41353
2026	28	36156	0	13	4700	40856	-2212	1975	40619
2027	27	35466	0	13	4611	40076	-2166	1975	39885
2028	27	34689	0	13	4510	39198	-2122	1975	39052
2029	26	33998	0	13	4420	38418	-2078	1975	38315
2030	26	33222	0	13	4319	37540	-2035	1975	37480

PHEV	2017 US$ ('000)	Cdn$	Cdn$	%	Cdn$	Cdn$	Cdn$	Cdn$	Cdn$
	PHEV base	PHEV base	Purchase tax	VAT%	VAT	PHEV price	Purchase subsidy	Home charging	PHEV price
2009	30	33827	0	13	4398	38225	-191	2200	40234
2010	30	30905	0	13	4018	34923	-1313	2033	35643
2011	30	29634	0	13	3852	33487	-1458	2033	34062
2012	31	30800	0	13	4004	34804	-2244	1850	34410
2013	31	32198	0	13	4186	36384	-2223	1850	36010
2014	34	37119	0	13	4826	41945	-2182	1850	41613
2015	30	38628	0	13	5022	43649	-2157	1850	43342
2016	30	39681	0	13	5159	44840	-2297	1683	44226
2017	30	38859	0	13	5052	43911	-2250	1683	43344
2018	31	39770	0	13	5170	44940	-1796	1683	44828
2019	31	40525	0	13	5268	45793	-1039	1975	46729
2020	31	40282	0	13	5237	45518	-1018	1975	46475
2021	30	39269	0	13	5105	44374	-997	1975	45352
2022	31	39835	0	13	5179	45014	-976	1975	46012
2023	30	39470	0	13	5131	44601	-956	1975	45620
2024	29	38058	0	13	4948	43006	-937	1975	44044
2025	28	36846	0	13	4790	41636	-917	1975	42694
2026	28	36156	0	13	4700	40856	-899	1975	41933
2027	27	35466	0	13	4611	40076	-880	1975	41171
2028	27	34689	0	13	4510	39198	-862	1975	40311
2029	26	33998	0	13	4420	38418	-844	1975	39549
2030	26	33222	0	13	4319	37540	-827	1975	38689

Table 3.14 Prices of BEVs, PHEVs and FFVs in Canada (continued)

FFV	2017 US$ ('000)	Cdn$	Cdn$	%	Cdn$	Cdn$
	FFV base	FFV base	purchase tax	VAT%	VAT	FFV price
2009	23	26291	0	13	3418	29709
2010	23	23694	0	13	3080	26774
2011	23	22720	0	13	2954	25673
2012	23	22968	0	13	2986	25954
2013	23	23778	0	13	3091	26870
2014	23	25453	0	13	3309	28762
2015	23	29615	0	13	3850	33465
2016	23	30422	0	13	3955	34377
2017	23	29792	0	13	3873	33665
2018	23	29900	0	13	3887	33787
2019	23	29900	0	13	3887	33787
2020	23	29900	0	13	3887	33787
2021	23	29900	0	13	3887	33787
2022	23	29900	0	13	3887	33787
2023	23	29900	0	13	3887	33787
2024	23	29900	0	13	3887	33787
2025	23	29900	0	13	3887	33787
2026	23	29900	0	13	3887	33787
2027	23	29900	0	13	3887	33787
2028	23	29900	0	13	3887	33787
2029	23	29900	0	13	3887	33787
2030	23	29900	0	13	3887	33787

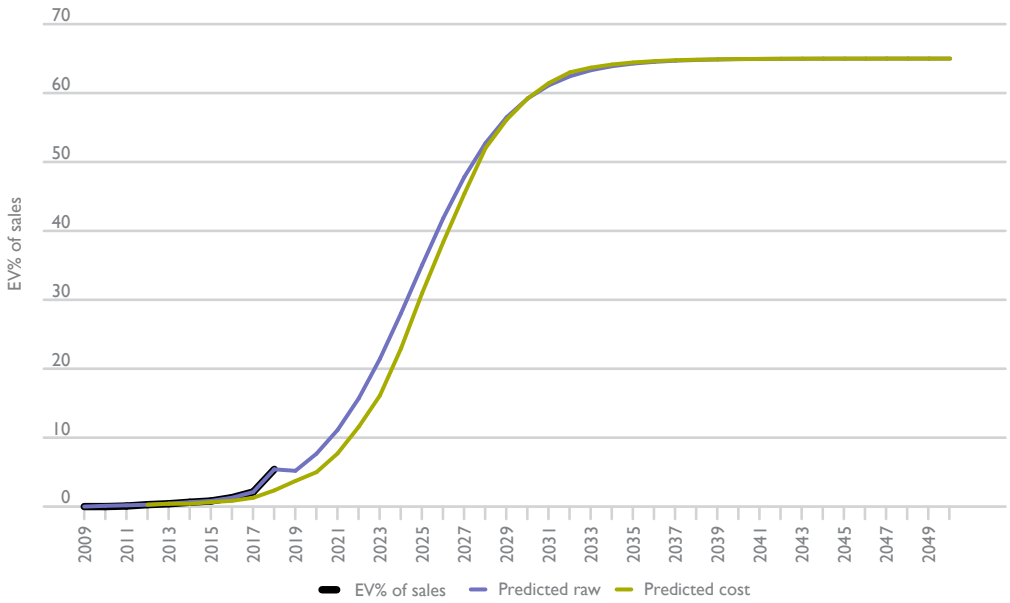
Table 3.15 shows past and forecast BEV and FFV costs used to generate a time series of the ratio of EV to FFV annual costs. Costs include principal (repay over 5 years), interest (13 per cent per year), annual EV subsidies, and petrol costs for FFV (with increasing fuel efficiency and a medium petrol price).

Table 3.15 EV/FFV cost ratio calculations for Canada

	Evs	Evs	Evs	Evs	Evs	FFVs	FFVs	FFVs	FFVs	FFVs	EV/ FFV
	EV price	principal	interest	annual subs	Annual cost	FFV price	Principal	Interest	Fuel	Annual cost	Cost ratio
2012	32076	6415	4170	0	10585	25954	5191	3374	1902	10467	1.01
2013	33698	6740	4381	0	11120	26870	5374	3493	1875	10742	1.04
2014	39344	7869	5115	0	12984	28762	5752	3739	1827	11318	1.15
2015	41098	8220	5343	0	13562	33465	6693	4350	1489	12532	1.08
2016	41702	8340	5421	0	13762	34377	6875	4469	1377	12721	1.08
2017	40566	8113	5274	0	13387	33665	6733	4376	1481	12590	1.06
2018	42542	8508	5530	0	14039	33787	6757	4392	1649	12798	1.10
2019	45210	9042	5877	0	14919	33787	6757	4392	1545	12695	1.18
2020	44988	8998	5848	0	14846	33787	6757	4392	1533	12682	1.17
2021	43895	8779	5706	0	14485	33787	6757	4392	1586	12735	1.14
2022	44585	8917	5796	0	14713	33787	6757	4392	1620	12770	1.15
2023	44222	8844	5749	0	14593	33787	6757	4392	1627	12777	1.14
2024	42675	8535	5548	0	14083	33787	6757	4392	1617	12767	1.10
2025	41353	8271	5376	0	13647	33787	6757	4392	1632	12782	1.07
2026	40619	8124	5281	0	13404	33787	6757	4392	1671	12820	1.05
2027	39885	7977	5185	0	13162	33787	6757	4392	1682	12831	1.03
2028	39052	7810	5077	0	12887	33787	6757	4392	1682	12832	1.00
2029	38315	7663	4981	0	12644	33787	6757	4392	1689	12839	0.98
2030	37480	7496	4872	0	12368	33787	6757	4392	1690	12840	0.96

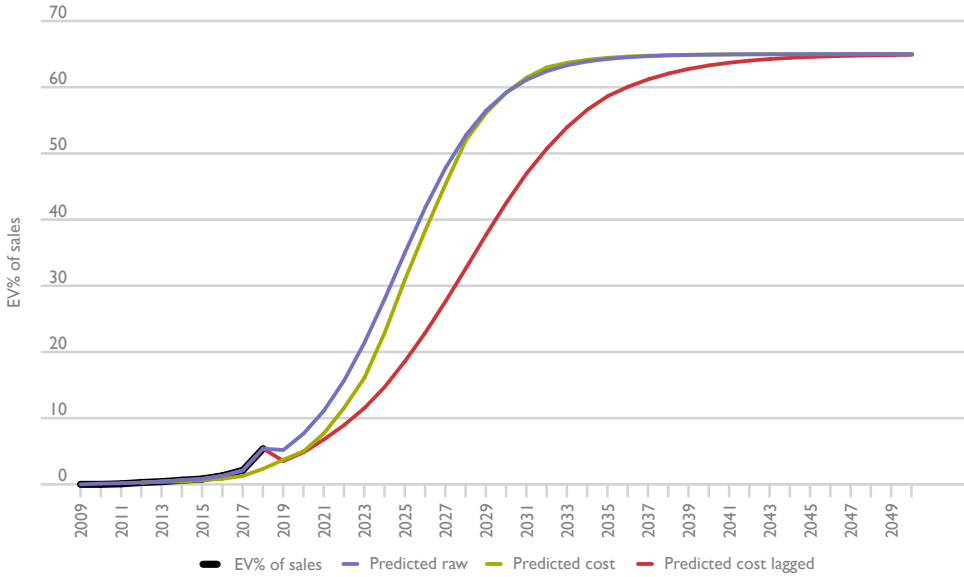
The resulting EV/FFV cost ratio time series is shown in the last column. This time series is then fed though the 2% year formula, which shifts the predicted raw uptake curve in line with shifts predicted for the cost ratio. Figure 3.36 shows that as the EV/FFV cost ratio rises with the ending of purchase subsidies in Ontario, the result is a shift in the *predicted raw* curve to the right in the graph, giving the *predicted cost* curve. This is the result from Stage 3 of the Canadian analysis.

Figure 3.36 Canadian predicted raw and predicted cost EV per cent of sales curves



In Stage 4 corrections are made to the predicted cost uptake curves. Basically, the rates of uptake are reduced to allow for the fact that most early adopters are those with higher incomes. The resulting Canadian *predicted cost* lagged curve – which is a less steeply rising curve – is shown in Figure 3.37. This is the final base-case EV uptake prediction for Canada.

Figure 3.37 Canadian predicted cost lagged EV uptake curve

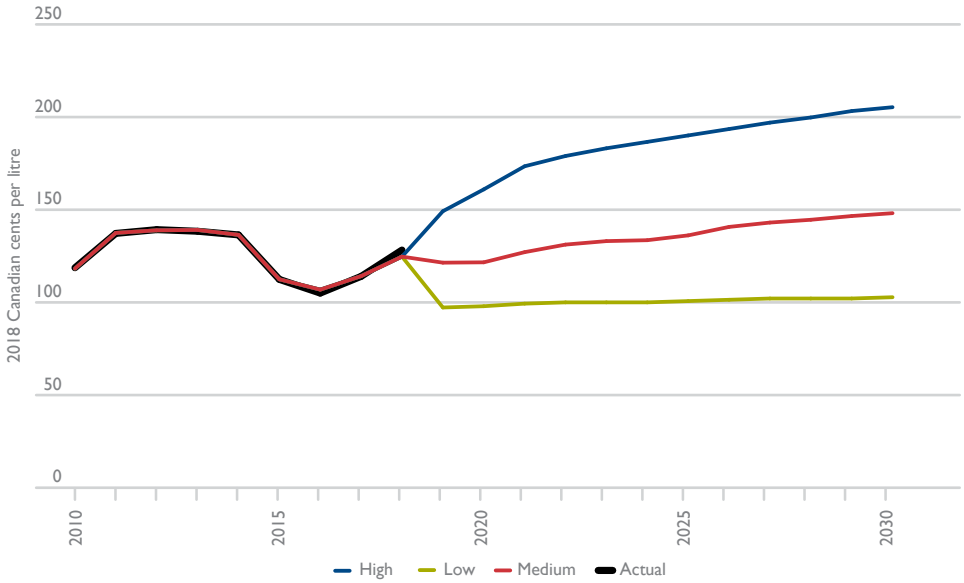


The resulting Canadian uptake forecast has EVs as 19 per cent of sales in 2025 and 43 per cent in 2030.

Stage 5 of the analysis looks at high, medium and low scenarios for oil prices and for EV prices.

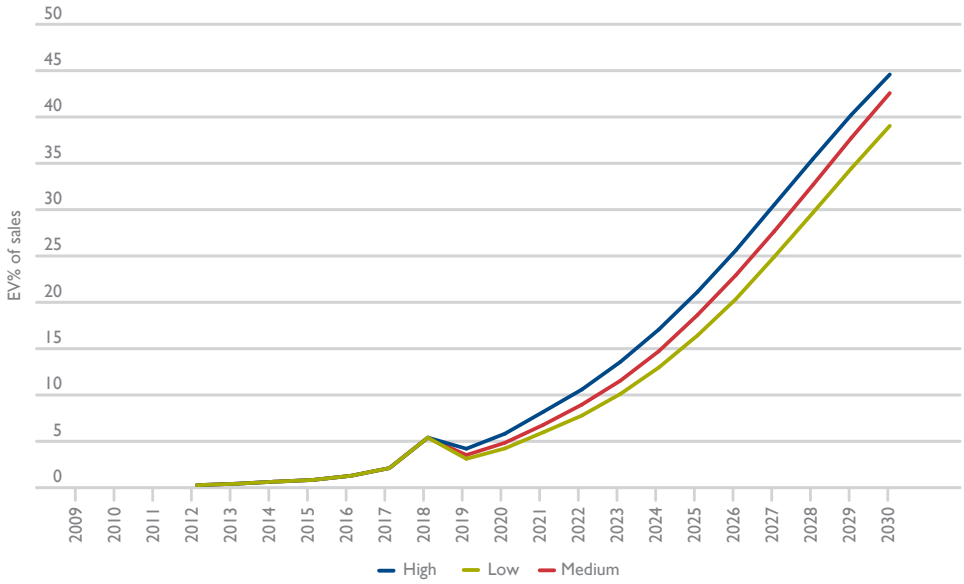
The oil price scenarios were given in Chapter 2. Corresponding Canadian petrol prices have been derived from the oil to Canadian petrol price equation in BITRE (2019). The resulting petrol price scenarios are shown in Figure 3.38.

Figure 3.38 Canadian petrol price scenarios



When these scenario petrol prices are used in the calculation of the EV/FFV cost ratios, the following predicted cost lagged curves are generated.

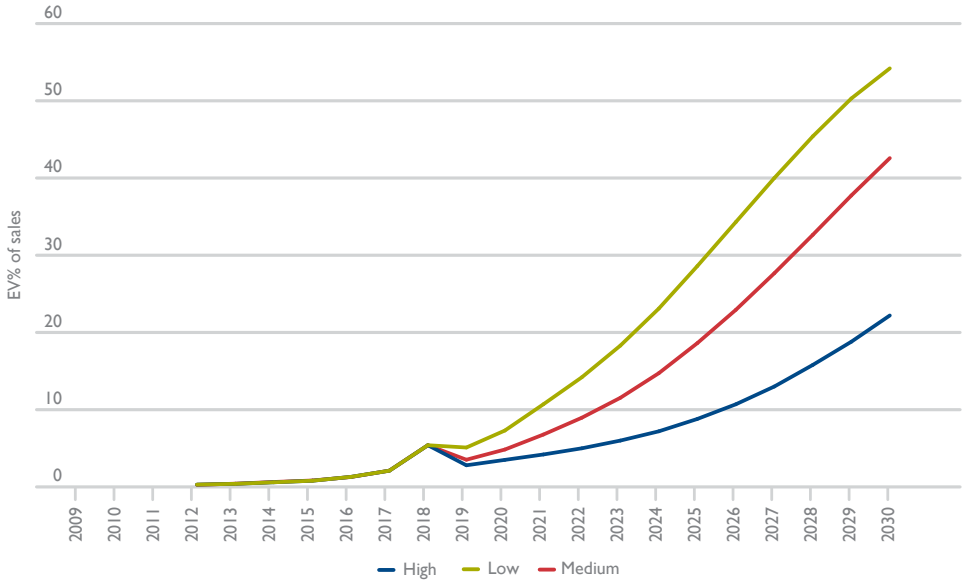
Figure 3.39 Scenarios for Canadian EV uptake with high, medium and low oil prices



It can be seen that low oil prices do not make a huge difference to forecast uptake and high prices make very little difference.

The second scenario test is when the prices of EVs are increased or decreased. The vehicle price scenarios were also covered in Chapter 2 (30 per cent up on the medium, 30 per cent down). When these scenario vehicle prices are used in the calculation of the EV/FFV cost ratios, the following predicted cost lagged curves are generated.

Figure 3.40 Scenarios for Canadian EV uptake with high, medium and low EV prices



It can be seen that changes in vehicle prices have a large effect on projected uptake.

3.6 China

The linearized logistic uptake for China is shown in Figure 3.41, along with a predicted curve.

The regression shown in Table 3.16 has three variables – a time trend, a dummy for 2011 to 2014 and a dummy for 2016 to 2017. It is estimated over the period 2011 to 2018.

Figure 3.41 Chinese linearized logistic EV sales percentage and prediction

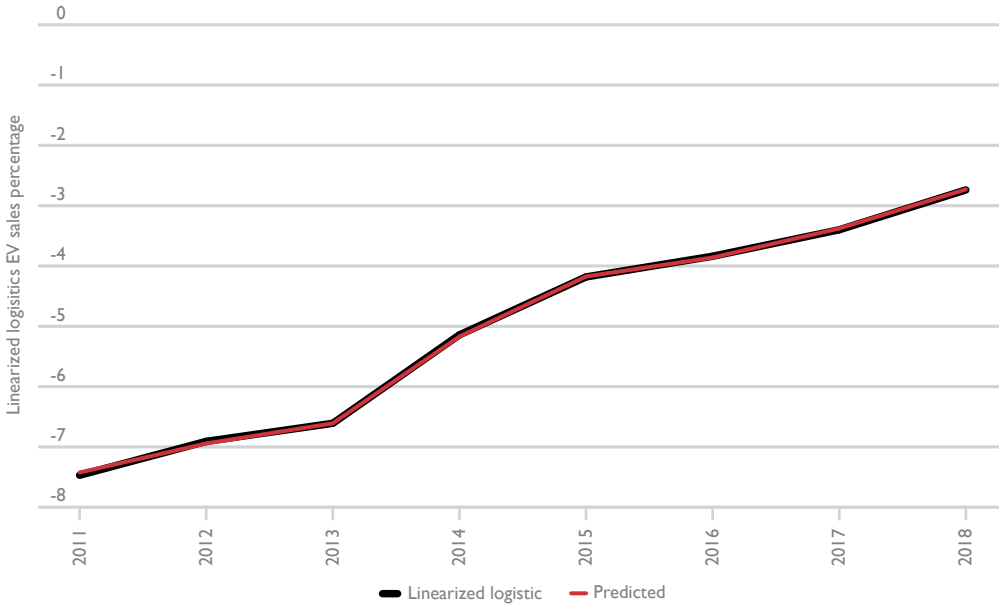


Table 3.16 Regression for Chinese linearized logistic EV uptake

Regression statistics	
Multiple R	0.999882208
R Square	0.999764429
Adjusted R Square	0.999587751
Standard Error	0.036021534
Observations	8

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	22.02724658	7.342415526	5658.67243	1.04043E-07
Residual	4	0.005190204	0.001297551		
Total	7	22.03243678			

	Coefficients	*Standard error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-7.062433732	0.09184959	-76.89129309	1.71456E-07	-7.317449076	-6.807418387
time	0.481456382	0.01228305	39.19681107	2.53085E-06	0.447353169	0.515559596
Dum1114	-1.471960629	0.065893933	-22.33833327	2.37776E-05	-1.654911516	-1.289009743
dum1617	-0.167430704	0.034703465	-4.824610561	0.008494487	-0.263782969	-0.071078438

Figure 3.42 shows the fit of the de-linearized *raw prediction* to the actual EV sales percentage of new passenger vehicle sales.

Figure 3.42 Chinese EV sales as a percentage of passenger vehicle sales and raw prediction

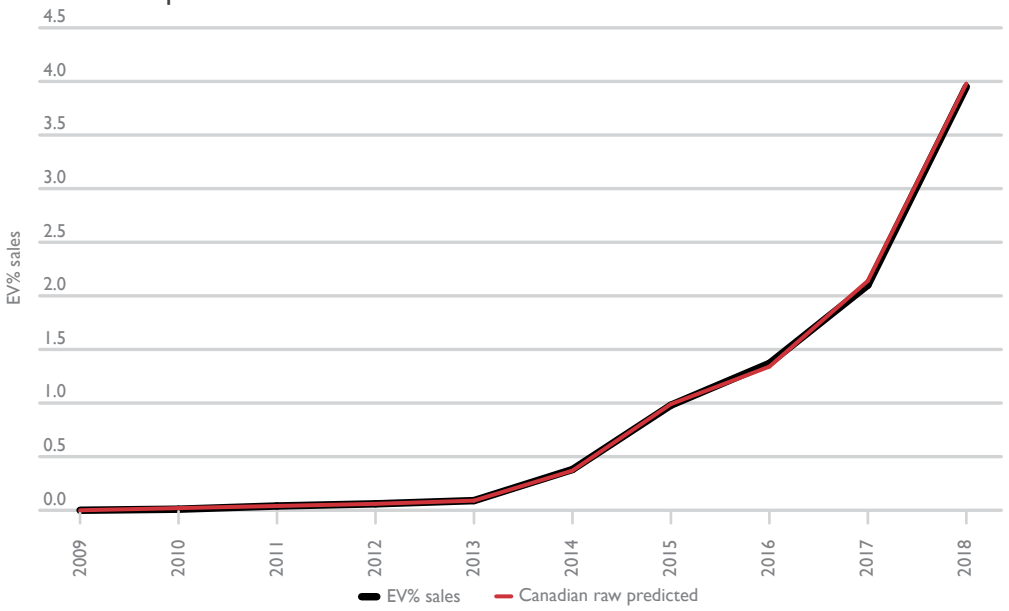
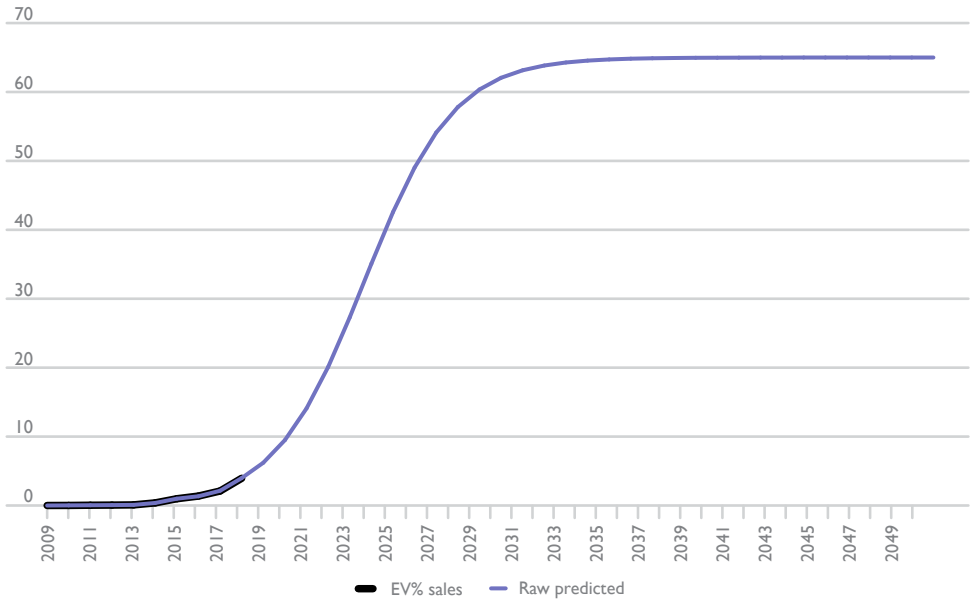


Figure 3.43 shows the extension of the forecast from this equation to 2050. This is the result of Stage 1 of the analysis.

Figure 3.43 Chinese EV sales as a percentage of passenger vehicle sales and raw prediction to 2050



In Stage 2, the year that sales (or the raw prediction) pass the 2% mark is determined. For China, this is 2017.

Stage 3 involves assembling past and forecast EV and FFV costs to generate a time series of the ratio of EV to FFV annual costs. Table 3.17 shows the prices of BEVs, PHEVs and FFVs in China.

Table 3.17 Prices of BEVs, PHEVs and FFVs in China

BEV	2017 US$ ('000)	RMB	RMB	%	RMB	RMB	RMB	RMB	RMB	RMB
	BEV base	BEV base	Purchase tax	VAT%	VAT	BEV price	Purch subs	3yr subsidies	Home charging	BEV price
2009	30	202147	20215	17	34365	256727	-70257	-1330	13760	198900
2010	30	203085	20309	17	34524	257918	-68497	-1330	12938	201029
2011	30	193764	19376	17	32940	246080	-63368	-1330	13090	194473
2012	31	194693	19469	17	33098	247260	-60709	-1330	11827	197048
2013	31	192881	19288	17	32790	244958	-83530	-1330	11947	172046
2014	34	206040	20604	17	35027	261671	-81505	-1330	11760	190596
2015	30	186852	18685	17	31765	237302	-82462	-1330	9969	163479
2016	30	199269	19927	17	33876	253072	-86832	-1330	10622	175531
2017	30	202554	20255	17	34434	257244	-86423	-1330	11099	180590
2018	31	208026	20803	16	33284	262113	-87040	-1330	11600	185343
2019	31	211976	21198	16	33916	267090	-87040	-1330	11600	190320
2020	31	210704	21070	16	33713	265487	-87040	-1330	11600	188717
2021	30	205406	20541	16	32865	258811	-87040	-1330	11600	182041
2022	31	208369	20837	16	33339	262545	-87040	-1330	11600	185775
2023	30	206459	20646	16	33033	260138	-87040	-1330	11600	183368
2024	29	199074	19907	16	31852	250834	-87040	-1330	11600	174064
2025	28	192735	19273	16	30838	242846	-87040	-1330	11600	166076
2026	28	189123	18912	16	30260	238296	-87040	-1330	11600	161526
2027	27	185512	18551	16	29682	233745	-87040	-1330	11600	156975
2028	27	181449	18145	16	29032	228626	-87040	-1330	11600	151856
2029	26	177837	17784	16	28454	224075	-87040	-1330	11600	147305
2030	26	173774	17377	16	27804	218956	-87040	-1330	11600	142186

PHEV	2017 US$ ('000)	RMB	RMB	%	RMB	RMB	RMB	RMB	RMB	RMB
	PHEV base	BEV base	purchase tax	VAT%	VAT	PHEV price	Purch subs	3yr subsidies	Home charging	PHEV price
2009	30	202147	20215	17	34365	256727	-58547	-1330	13760	210609
2010	30	203085	20309	17	34524	257918	-57081	-1330	12938	212445
2011	30	193764	19376	17	32940	246080	-52807	-1330	13090	205034
2012	31	194693	19469	17	33098	247260	-50591	-1330	11827	207166
2013	31	192881	19288	17	32790	244958	-48943	-1330	11947	206632
2014	34	206040	20604	17	35027	261671	-47757	-1330	11760	224345
2015	30	186852	18685	17	31765	237302	-48318	-1330	9969	197623
2016	30	199269	19927	17	33876	253072	-50878	-1330	10622	211485
2017	30	202554	20255	17	34434	257244	-50639	-1330	11099	216374
2018	31	208026	20803	16	33284	262113	-51000	-1330	11600	221383
2019	31	211976	21198	16	33916	267090	-51000	-1330	11600	226360
2020	31	210704	21070	16	33713	265487	-51000	-1330	11600	224757
2021	30	205406	20541	16	32865	258811	-51000	-1330	11600	218081
2022	31	208369	20837	16	33339	262545	-51000	-1330	11600	221815
2023	30	206459	20646	16	33033	260138	-51000	-1330	11600	219408
2024	29	199074	19907	16	31852	250834	-51000	-1330	11600	210104
2025	28	192735	19273	16	30838	242846	-51000	-1330	11600	202116
2026	28	189123	18912	16	30260	238296	-51000	-1330	11600	197566
2027	27	185512	18551	16	29682	233745	-51000	-1330	11600	193015
2028	27	181449	18145	16	29032	228626	-51000	-1330	11600	187896
2029	26	177837	17784	16	28454	224075	-51000	-1330	11600	183345
2030	26	173774	17377	16	27804	218956	-51000	-1330	11600	178226

Table 3.17 Prices of BEVs, PHEVs and FFVs in China (continued)

FFV	2017 US$ ('000)	RMB	RMB	%	RMB	RMB
	FFV base	BEV base	purchase tax	VAT%	VAT	FFV price
2009	23	157113	15711	17	26709	199534
2010	23	155699	15570	17	26469	197737
2011	23	148552	14855	17	25254	188662
2012	23	145188	14519	17	24682	184388
2013	23	142444	14244	17	24215	180903
2014	23	141284	14128	17	24018	179431
2015	23	143253	14325	17	24353	181932
2016	23	152773	15277	17	25971	194022
2017	23	155291	15529	17	26400	197220
2018	23	156400	15640	16	25024	197064
2019	23	156400	15640	16	25024	197064
2020	23	156400	15640	16	25024	197064
2021	23	156400	15640	16	25024	197064
2022	23	156400	15640	16	25024	197064
2023	23	156400	15640	16	25024	197064
2024	23	156400	15640	16	25024	197064
2025	23	156400	15640	16	25024	197064
2026	23	156400	15640	16	25024	197064
2027	23	156400	15640	16	25024	197064
2028	23	156400	15640	16	25024	197064
2029	23	156400	15640	16	25024	197064
2030	23	156400	15640	16	25024	197064

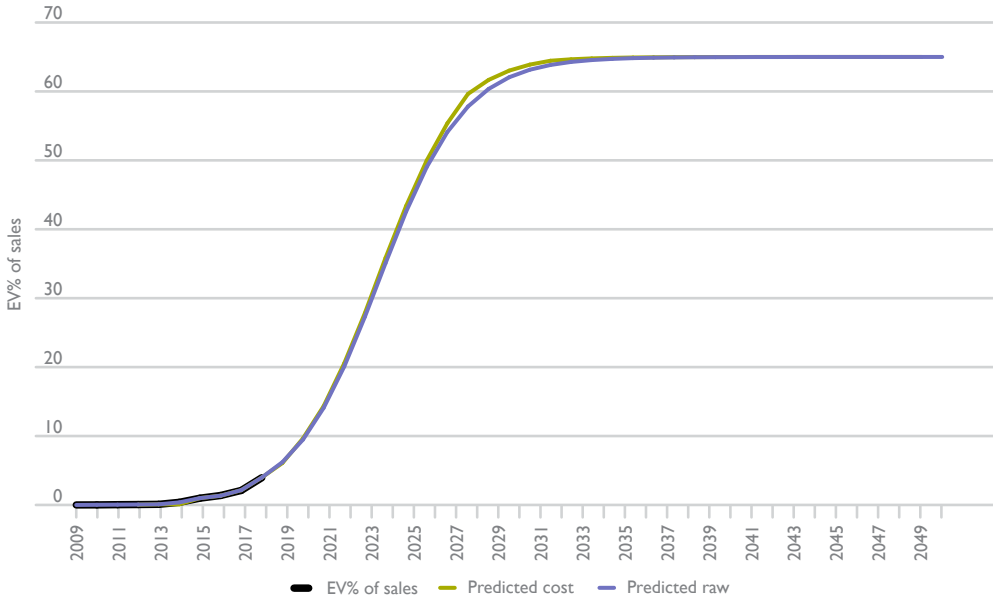
Table 3.18 shows past and forecast BEV and FFV costs used to generate a time series of the ratio of EV to FFV annual costs. Costs include principal (repay over 5 years), interest (13 per cent per year), annual EV subsidies, and petrol costs for FFV (with increasing fuel efficiency and a medium petrol price).

Table 3.18 EV/FFV cost ratio calculations for China

	Evs	Evs	Evs	Evs	Evs	FFVs	FFVs	FFVs	FFVs	FFVs	EV/FFV
	EV price	Principal	Interest	Annual subs	Annual cost	FFV price	Principal	Interest	Fuel	Annual cost	Cost ratio
2012	197048	39410	25616	0	65026	184388	36878	23970	11911	72759	0.89
2013	172046	34409	22366	0	56775	180903	36181	23517	10817	70516	0.81
2014	190596	38119	24778	0	62897	179431	35886	23326	9678	68891	0.91
2015	163479	32696	21252	0	53948	181932	36386	23651	6381	66418	0.81
2016	175531	35106	22819	0	57925	194022	38804	25223	5965	69992	0.83
2017	180590	36118	23477	0	59595	197220	39444	25639	5594	70677	0.84
2018	185343	37069	24095	0	61163	197064	39413	25618	6308	71339	0.86
2019	190320	38064	24742	0	62806	197064	39413	25618	6003	71034	0.88
2020	188717	37743	24533	0	62277	197064	39413	25618	5910	70941	0.88
2021	182041	36408	23665	0	60074	197064	39413	25618	6243	71274	0.84
2022	185775	37155	24151	0	61306	197064	39413	25618	6451	71482	0.86
2023	183368	36674	23838	0	60511	197064	39413	25618	6478	71510	0.85
2024	174064	34813	22628	0	57441	197064	39413	25618	6397	71428	0.80
2025	166076	33215	21590	0	54805	197064	39413	25618	6473	71504	0.77
2026	161526	32305	20998	0	53303	197064	39413	25618	6688	71719	0.74
2027	156975	31395	20407	0	51802	197064	39413	25618	6732	71763	0.72
2028	151856	30371	19741	0	50112	197064	39413	25618	6712	71743	0.70
2029	147305	29461	19150	0	48611	197064	39413	25618	6725	71757	0.68
2030	142186	28437	18484	0	46921	197064	39413	25618	6704	71735	0.65

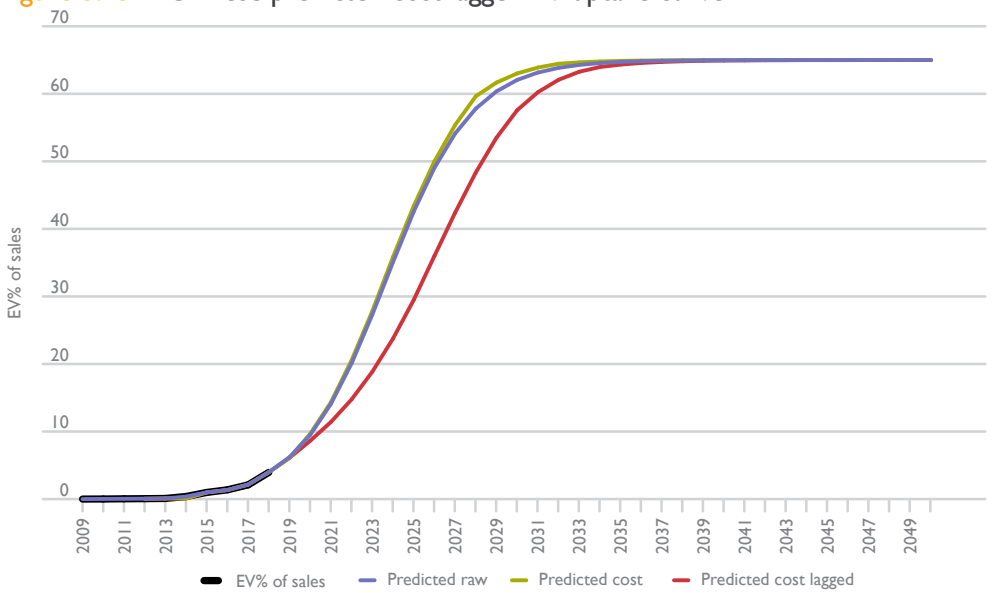
The resulting EV/FFV cost ratio time series is shown in the last column. This time series is then fed though the 2% year formula, which shifts the predicted raw uptake curve in line with shifts predicted for the cost ratio. Figure 3.44 shows that as the EV/FFV cost ratio falls, the result is a shift in the *predicted raw* curve to the left in the graph, giving the *predicted cost* curve. This is the result from Stage 3 of the Chinese analysis.

Figure 3.44 Chinese predicted raw and predicted cost EV per cent of sales curves



In Stage 4 corrections are made to the predicted cost uptake curves. Basically, the rates of uptake are reduced to allow for the fact that most early adopters are those with higher incomes. The resulting Chinese *predicted cost lagged* curve – which is a less steeply rising curve – is shown in Figure 3.45. This is the final base-case EV uptake prediction for China.

Figure 3.45 Chinese predicted cost lagged EV uptake curve

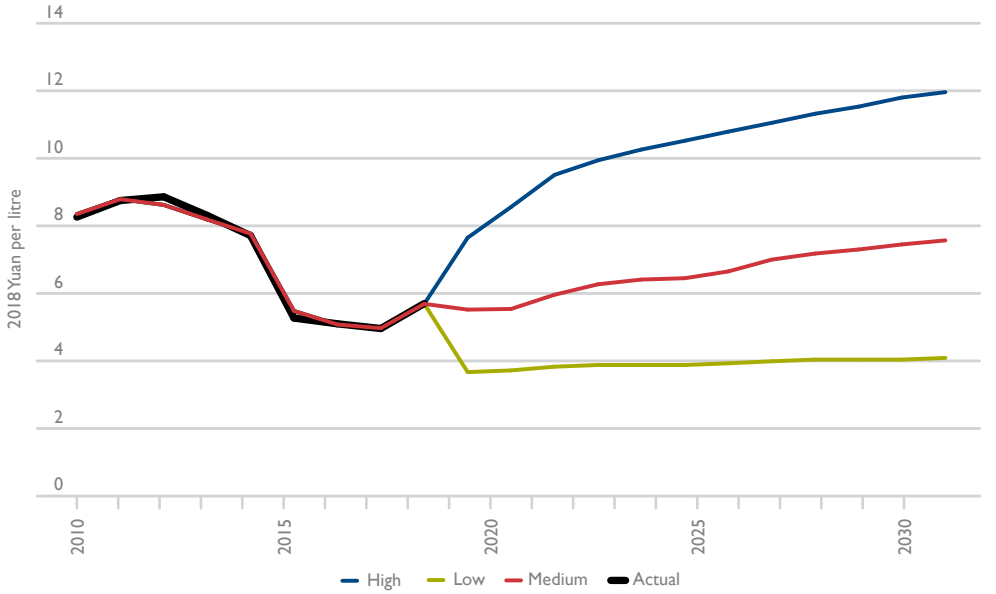


The resulting Chinese uptake forecast has EVs as 29 per cent of sales in 2025 and 58 per cent in 2030.

Stage 5 of the analysis looks at high, medium and low scenarios for oil prices and for EV prices.

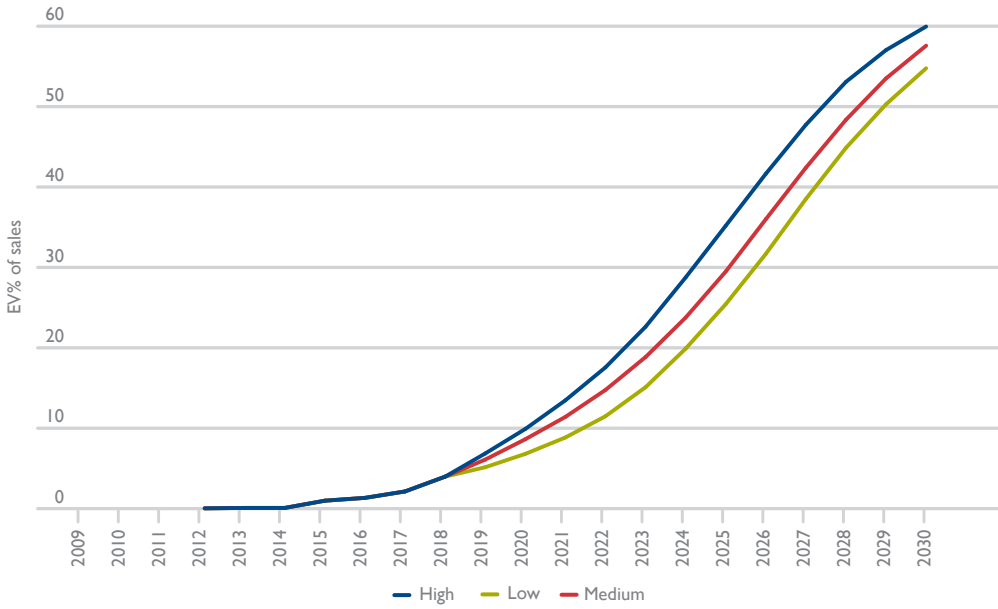
The oil price scenarios were given in Chapter 2. Corresponding Chinese petrol prices have been derived from the oil to Chinese petrol price equation in BITRE (2019). The resulting petrol price scenarios are shown in Figure 3.46.

Figure 3.46 Chinese petrol price scenarios



When these scenario petrol prices are used in the calculation of the EV/FFV cost ratios, the following predicted cost lagged curves are generated.

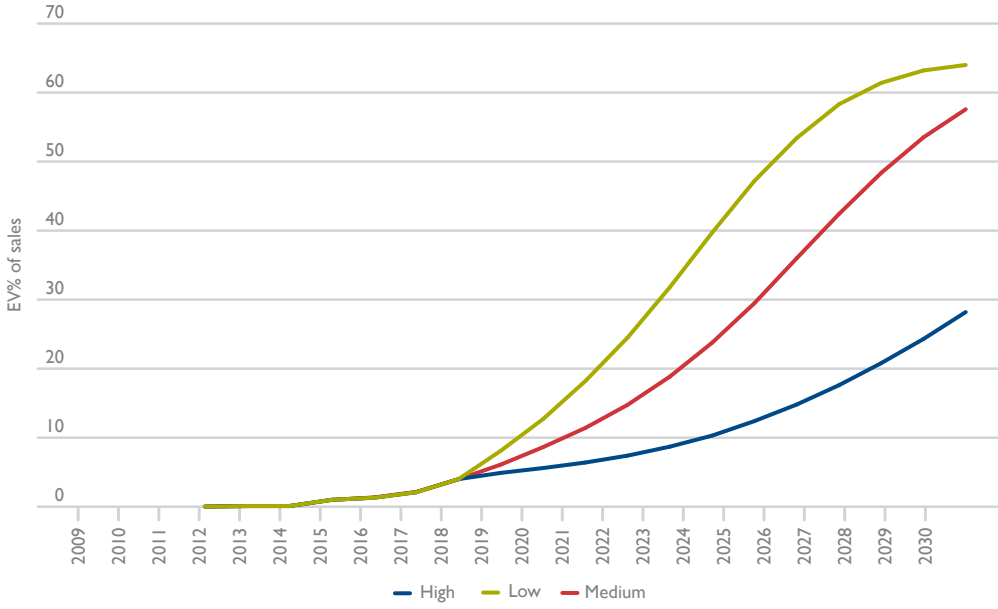
Figure 3.47 Scenarios for Chinese EV uptake with high, medium and low oil prices



It can be seen that oil price scenarios do not make a huge difference to forecast uptake.

The second scenario test is when the prices of EVs are increased or decreased. The vehicle price scenarios were also covered in Chapter 2 (30 per cent up on the medium, 30 per cent down). When these scenario vehicle prices are used in the calculation of the EV/FFV cost ratios, the following predicted cost lagged curves are generated.

Figure 3.48 Scenarios for Chinese EV uptake with high, medium and low EV prices



It can be seen that changes in vehicle prices have a large effect on projected uptake.

3.7 Denmark

The linearized logistic uptake for Denmark is shown in Figure 3.49, along with a predicted curve. EV sales that occurred in sharp peaks before the reduction of subsidies have been removed from the data.

The regression shown in Table 3.19 has two variables – a time trend and a dummy for 2012 to 2013. It is estimated over the period 2011 to 2015.

Figure 3.49 Danish linearized logistic EV sales percentage and prediction

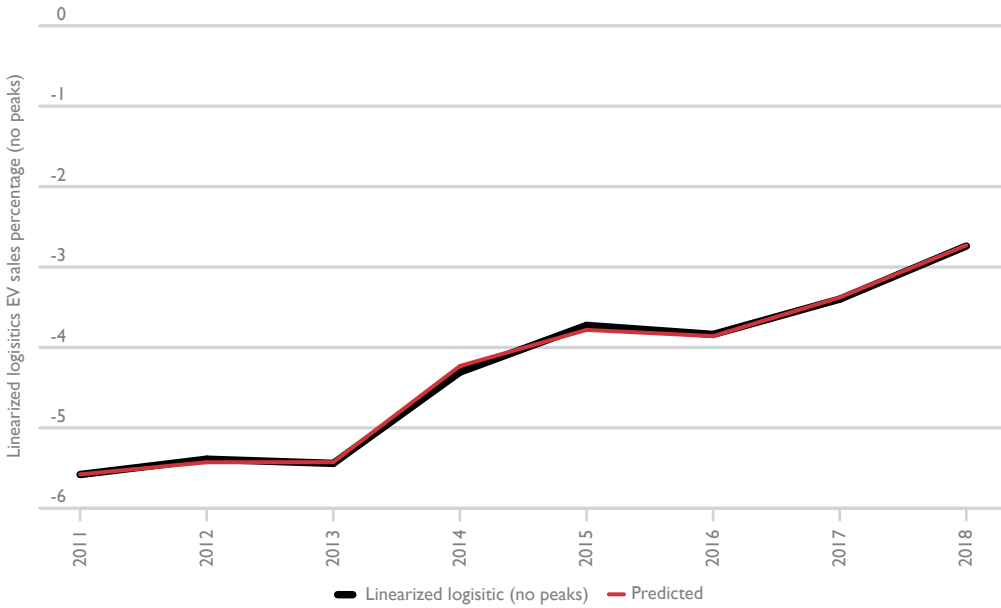


Table 3.19 Regression for Danish linearized logistic EV uptake

Regression statistics	
Multiple R	0.998052298
R Square	0.99610839
Adjusted R Square	0.992216781
Standard Error	0.072827631
Observations	5

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	2.715186701	1.35759335	255.963087	0.00389161
Residual	2	0.010607728	0.005303864		
Total	4	2.725794428			

	Coefficients	*Standard error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-6.477579413	0.104462518	-62.00864717	0.000259972	-6.927045351	-6.028113476
time	0.449306215	0.023273831	19.30521109	0.002672436	0.349167004	0.549445426
dum1213	0.746581582	0.083982203	8.88975948	0.01241855	0.385235329	1.107927836

Figure 3.50 shows the fit of the de-linearized *raw prediction* to the actual EV sales percentage of new passenger vehicle sales. The effect the removal of subsidies from 2016 on is apparent.

Figure 3.50 Danish EV sales as a percentage of passenger vehicle sales and raw prediction

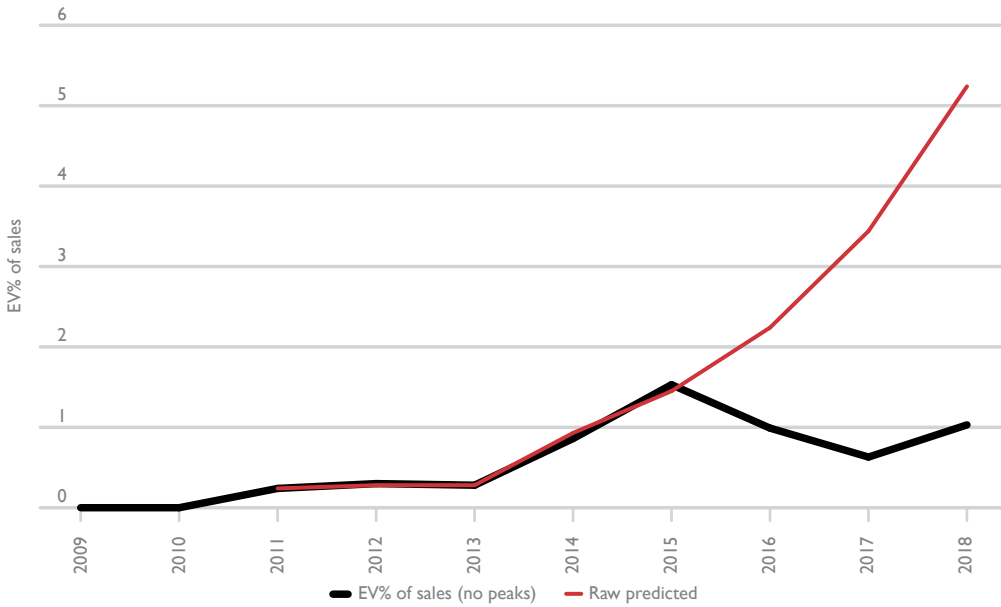
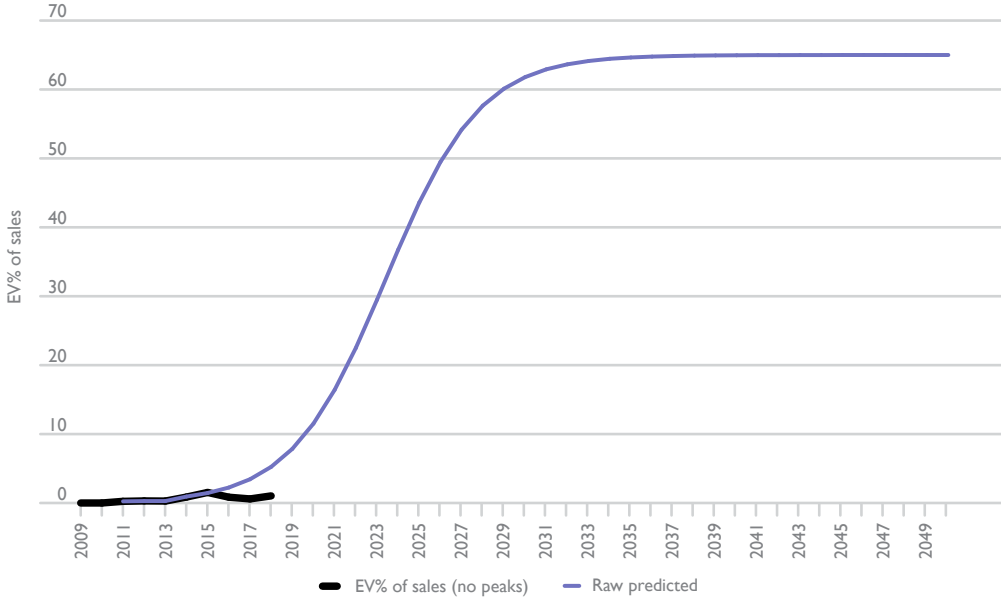


Figure 3.51 shows the extension of the forecast from this equation to 2050. This is the result of Stage 1 of the analysis.

Figure 3.51 Danish EV sales as a percentage of passenger vehicle sales and raw prediction to 2050



In Stage 2, the year that sales (or the raw prediction) pass the 2% mark is determined. For Denmark (with subsidies), this is 2016.

Stage 3 involves assembling past and forecast EV and FFV costs to generate a time series of the ratio of EV to FFV annual costs. Table 3.20 shows the prices of BEVs, PHEVs and FFVs in Denmark.

Table 3.20 Prices of BEVs, PHEVs and FFVs in Denmark

BEV	2017 US$ ('000)	Krone	Krone	%	Krone	Krone		Krone
	BEV base	BEV base	BPMrego tax	VAT%	VAT	BEV price	Home charging	BEV price
2009	30	158642	0	25	39660	198302	5799	204101
2010	30	168722	0	25	42181	210903	5749	216652
2011	30	160865	0	25	40216	201082	5868	206949
2012	31	178800	0	25	44700	223501	5862	229362
2013	31	174942	0	25	43736	218678	5836	224514
2014	34	188473	0	25	47118	235591	5758	241348
2015	30	201806	0	25	50452	252258	5767	258024
2016	30	201981	70792	25	50495	323269	5766	329035
2017	30	197859	118608	25	49465	365932	5842	371774
2018	31	198849	168964	25	49712	417525	6088	423613
2019	31	202624	170100	25	50656	423381	6088	429469
2020	31	201408	170100	25	50352	421860	6088	427949
2021	30	196344	170100	25	49086	415530	6088	421618
2022	31	199176	170100	25	49794	419070	6088	425158
2023	30	197350	170100	25	49338	416788	6088	422876
2024	29	190292	170100	25	47573	407965	6088	414053
2025	28	184232	170100	25	46058	400390	6088	406478
2026	28	180780	170100	25	45195	396075	6088	402163
2027	27	177328	170100	25	44332	391759	6088	397848
2028	27	173444	170100	25	43361	386905	6088	392993
2029	26	169992	170100	25	42498	382590	6088	388678
2030	26	166108	170100	25	41527	377735	6088	383823

PHEV	2017 US$ ('000)	Krone	Krone	%	Krone	Krone		Krone
	PHEV base	PHEV base	BPMrego tax	VAT%	VAT	PHEV price	Home charging	PHEV price
2009	30	158642	0	25	39660	198302	5799	204101
2010	30	168722	0	25	42181	210903	5749	216652
2011	30	160865	0	25	40216	201082	5868	206949
2012	31	178800	0	25	44700	223501	5862	229362
2013	31	174942	0	25	43736	218678	5836	224514
2014	34	188473	0	25	47118	235591	5758	241348
2015	30	201806	0	25	50452	252258	5767	258024
2016	30	201981	70792	25	50495	323269	5766	329035
2017	30	197859	118608	25	49465	365932	5842	371774
2018	31	198849	168964	25	49712	417525	6088	423613
2019	31	202624	170100	25	50656	423381	6088	429469
2020	31	201408	170100	25	50352	421860	6088	427949
2021	30	196344	170100	25	49086	415530	6088	421618
2022	31	199176	170100	25	49794	419070	6088	425158
2023	30	197350	170100	25	49338	416788	6088	422876
2024	29	190292	170100	25	47573	407965	6088	414053
2025	28	184232	170100	25	46058	400390	6088	406478
2026	28	180780	170100	25	45195	396075	6088	402163
2027	27	177328	170100	25	44332	391759	6088	397848
2028	27	173444	170100	25	43361	386905	6088	392993
2029	26	169992	170100	25	42498	382590	6088	388678
2030	26	166108	170100	25	41527	377735	6088	383823

Table 3.20 Prices of BEVs, PHEVs and FFVs in Denmark (continued)

FFV	2017 US$ ('000)	krone	krone	%	krone	krone
	FFV base	FFV base	BPMrego tax	VAT%	VAT	FFV price
2009	23	123300	137940	25	30825	292065
2010	23	129354	148837	25	32338	310529
2011	23	123330	137994	25	30833	292157
2012	23	133336	156005	25	33334	322675
2013	23	129196	148553	25	32299	310048
2014	23	129238	148629	25	32310	310176
2015	23	154718	194492	25	38679	387890
2016	23	154852	177593	25	38713	371158
2017	23	151692	173169	25	37923	362784
2018	23	149500	170100	25	37375	356975
2019	23	149500	170100	25	37375	356975
2020	23	149500	170100	25	37375	356975
2021	23	149500	170100	25	37375	356975
2022	23	149500	170100	25	37375	356975
2023	23	149500	170100	25	37375	356975
2024	23	149500	170100	25	37375	356975
2025	23	149500	170100	25	37375	356975
2026	23	149500	170100	25	37375	356975
2027	23	149500	170100	25	37375	356975
2028	23	149500	170100	25	37375	356975
2029	23	149500	170100	25	37375	356975
2030	23	149500	170100	25	37375	356975

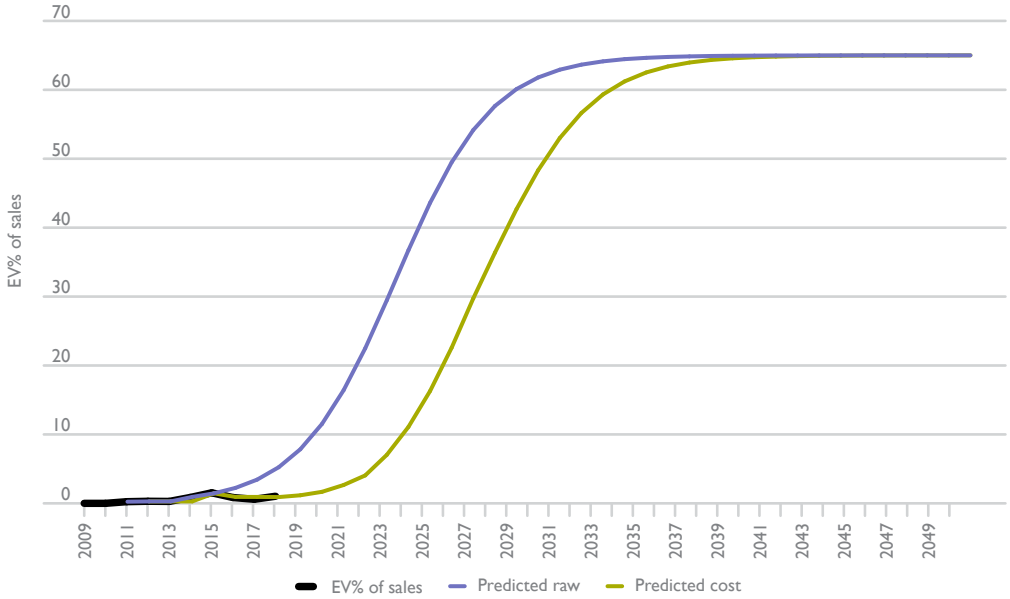
Table 3.21 shows past and forecast BEV and FFV costs used to generate a time series of the ratio of EV to FFV annual costs. Costs include principal (repay over 5 years), interest (13 per cent per year), annual EV subsidies, and petrol costs for FFV (with increasing fuel efficiency and a medium petrol price).

Table 3.21 EV/FFV cost ratio calculations for Denmark

	Evs	Evs	Evs	Evs	Evs	FFVs	FFVs	FFVs	FFVs	FFVs	EV/ FFV
	EV price	Principal	Interest	Annual subs	Annual cost	FFV price	Principal	Interest	Fuel	Annual cost	Cost ratio
2012	229362	45872	29817	2250	73440	322675	64535	41948	13582	120065	0.61
2013	224514	44903	29187	2250	71839	310048	62010	40306	13149	115465	0.62
2014	241348	48270	31375	2250	77395	310176	62035	40323	12599	114957	0.67
2015	258024	51605	33543	2250	82898	387890	77578	50426	11329	139333	0.59
2016	329035	65807	42775	2250	106332	371158	74232	48251	10528	133010	0.80
2017	371774	74355	48331	2250	120435	362784	72557	47162	10925	130643	0.92
2018	423613	84723	55070	2250	137542	356975	71395	46407	11449	129251	1.06
2019	429469	85894	55831	2250	139475	356975	71395	46407	11075	128877	1.08
2020	427949	85590	55633	2250	138973	356975	71395	46407	10977	128779	1.08
2021	421618	84324	54810	2250	136884	356975	71395	46407	11224	129026	1.06
2022	425158	85032	55271	2250	138052	356975	71395	46407	11375	129176	1.07
2023	422876	84575	54974	2250	137299	356975	71395	46407	11381	129183	1.06
2024	414053	82811	53827	2250	134387	356975	71395	46407	11300	129102	1.04
2025	406478	81296	52842	2250	131888	356975	71395	46407	11350	129152	1.02
2026	402163	80433	52281	2250	130464	356975	71395	46407	11519	129321	1.01
2027	397848	79570	51720	2250	129040	356975	71395	46407	11549	129350	1.00
2028	392993	78599	51089	2250	127438	356975	71395	46407	11524	129326	0.99
2029	388678	77736	50528	2250	126014	356975	71395	46407	11531	129333	0.97
2030	383823	76765	49897	2250	124412	356975	71395	46407	11508	129310	0.96

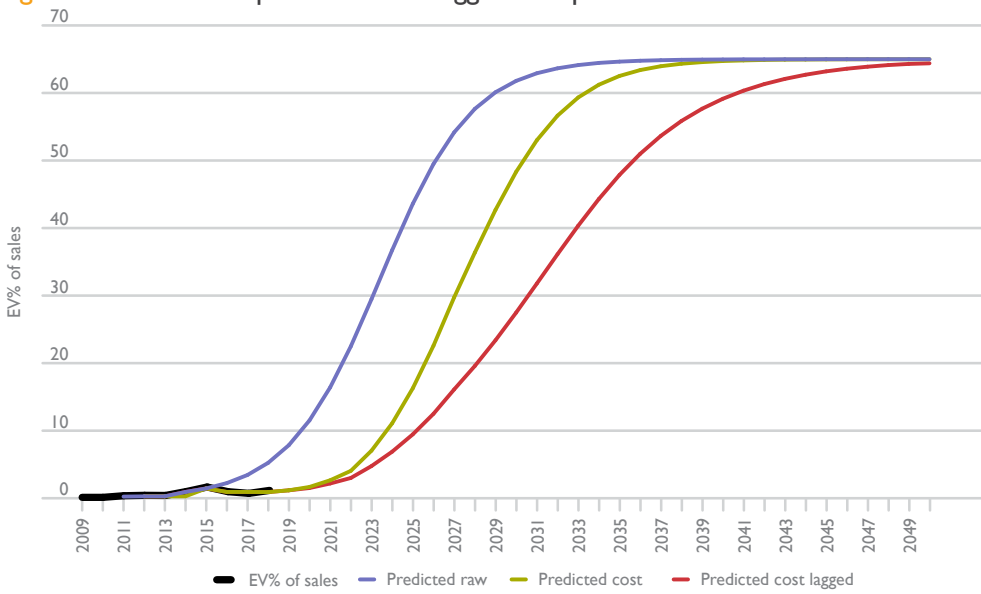
The resulting EV/FFV cost ratio time series is shown in the last column. This time series is then fed though the 2% year formula, which shifts the predicted raw uptake curve in line with shifts predicted for the cost ratio. Figure 3.52 shows that as the EV/FFV cost ratio rose with the end of subsidies, the result was a shift in the *predicted raw* curve to the right in the graph, giving the *predicted cost* curve. This is the result from Stage 3 of the Danish analysis.

Figure 3.52 Danish predicted raw and predicted cost EV per cent of sales curves



In Stage 4 corrections are made to the predicted cost uptake curves. Basically, the rates of uptake are reduced to allow for the fact that most early adopters are those with higher incomes. The resulting Danish *predicted cost lagged* curve – which is a less steeply rising curve – is shown in Figure 3.53. This is the final base-case EV uptake prediction for Denmark.

Figure 3.53 Danish predicted cost lagged EV uptake curve

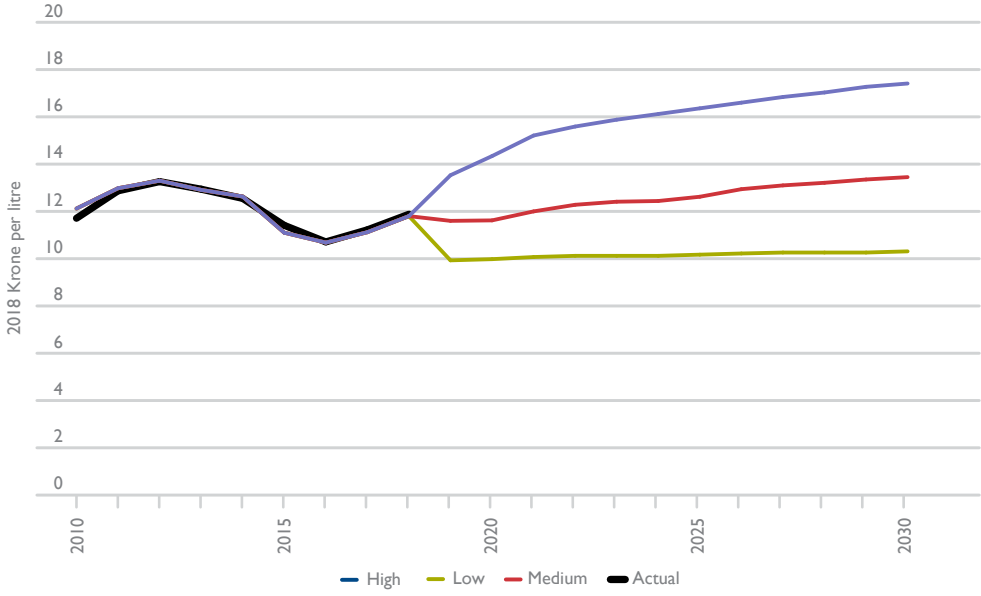


The resulting Danish uptake forecast has EVs as 9 per cent of sales in 2025 and 27 per cent in 2030.

Stage 5 of the analysis looks at high, medium and low scenarios for oil prices and for EV prices.

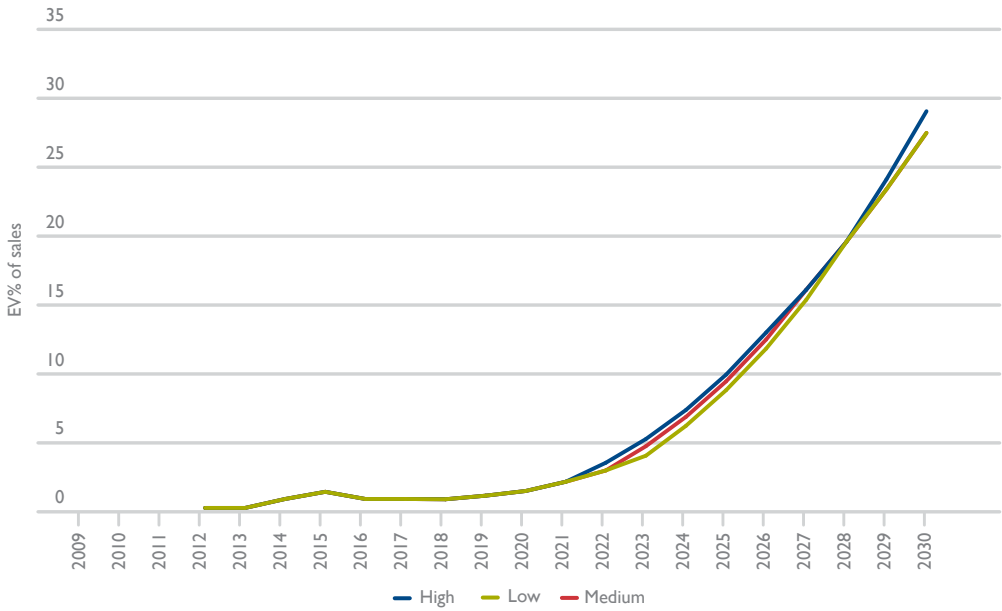
The oil price scenarios were given in Chapter 2. Corresponding Danish petrol prices have been derived from the oil to Danish petrol price equation in BITRE (2019). The resulting petrol price scenarios are shown in Figure 3.54.

Figure 3.54 Danish petrol price scenarios



When these scenario petrol prices are used in the calculation of the EV/FFV cost ratios, the following predicted cost lagged curves are generated.

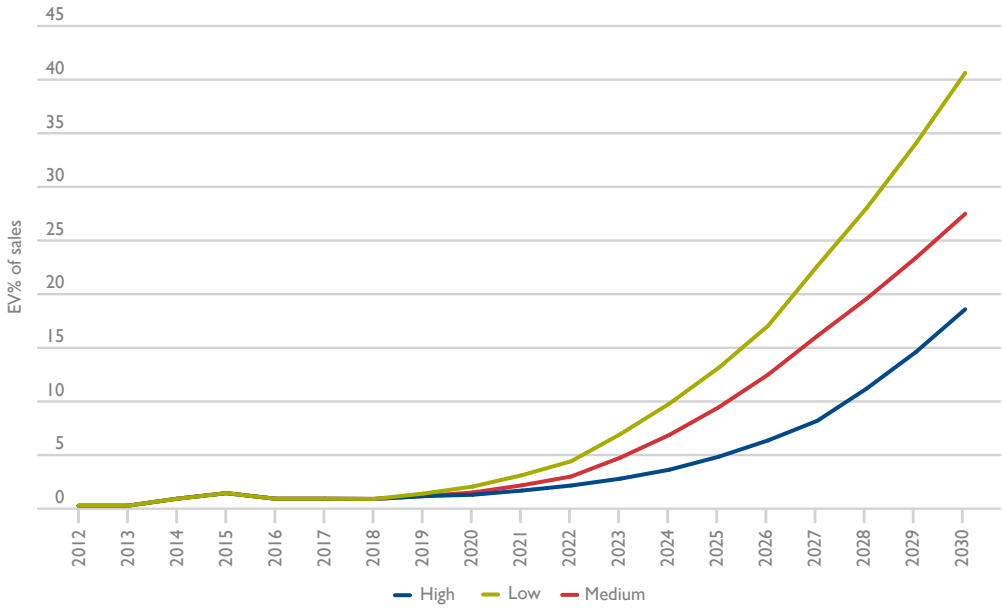
Figure 3.55 Scenarios for Danish EV uptake with high, medium and low oil prices



It can be seen that oil price scenarios do not make a huge difference to forecast uptake.

The second scenario test is when the prices of EVs are increased or decreased. The vehicle price scenarios were also covered in Chapter 2 (30 per cent up on the medium, 30 per cent down). When these scenario vehicle prices are used in the calculation of the EV/FFV cost ratios, the following predicted cost lagged curves are generated.

Figure 3.56 Scenarios for Danish EV uptake with high, medium and low EV prices



It can be seen that changes in vehicle prices have a large effect on projected uptake.

3.8 Finland

The linearized logistic uptake for Finland is shown in Figure 3.57, along with a predicted curve.

The regression shown in Table 3.22 has three variables – a time trend, a dummy for 2013 to 2014, and a dummy for 2017. It is estimated over the period 2013 to 2018.

Figure 3.57 Finnish linearized logistic EV sales percentage and prediction

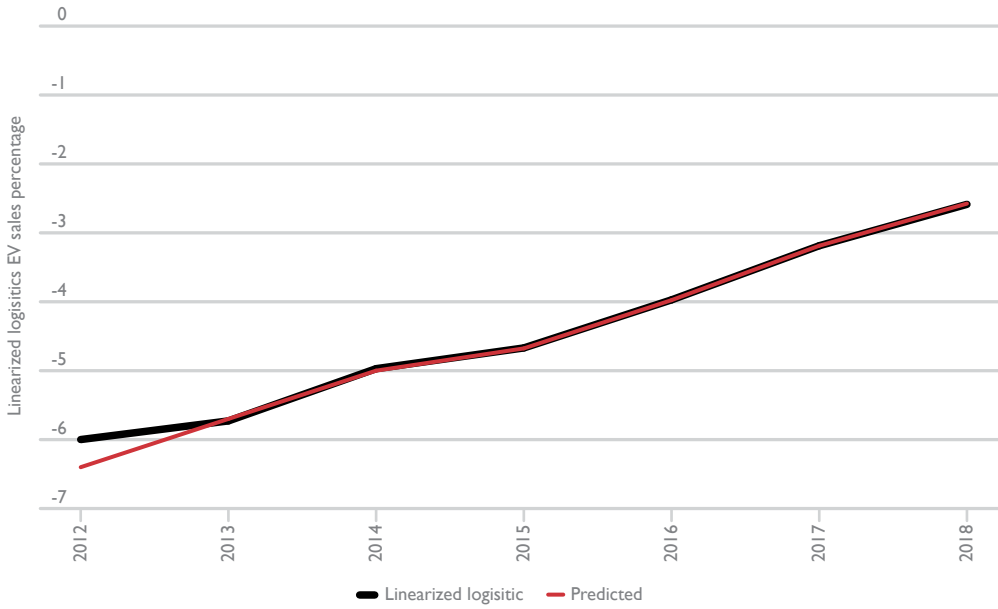


Table 3.22 Regression for Finnish linearized logistic EV uptake

Regression statistics	
Multiple R	0.999864864
R Square	0.999729745
Adjusted R Square	0.999324364
Standard Error	0.030382064
Observations	6

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	6.829268489	2.27642283	2466.143793	0.000405354
Residual	2	0.00184614	0.00092307		
Total	5	6.831114629			

	Coefficients	*Standard error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-8.878960227	0.099576885	-89.16688032	0.000125751	-9.307404985	-8.450515469
time	0.700360509	0.013366326	52.39738375	0.000364035	0.64284985	0.757871168
dum1314	0.377606808	0.046940994	8.04428659	0.015104202	0.175636012	0.579577604
dum17	0.088906203	0.036196182	2.456231546	0.13338054	-0.066833397	0.244645803

Figure 3.58 shows the fit of the de-linearized *raw prediction* to the actual EV sales percentage of new passenger vehicle sales.

Figure 3.58 Finnish EV sales as a percentage of passenger vehicle sales and raw prediction

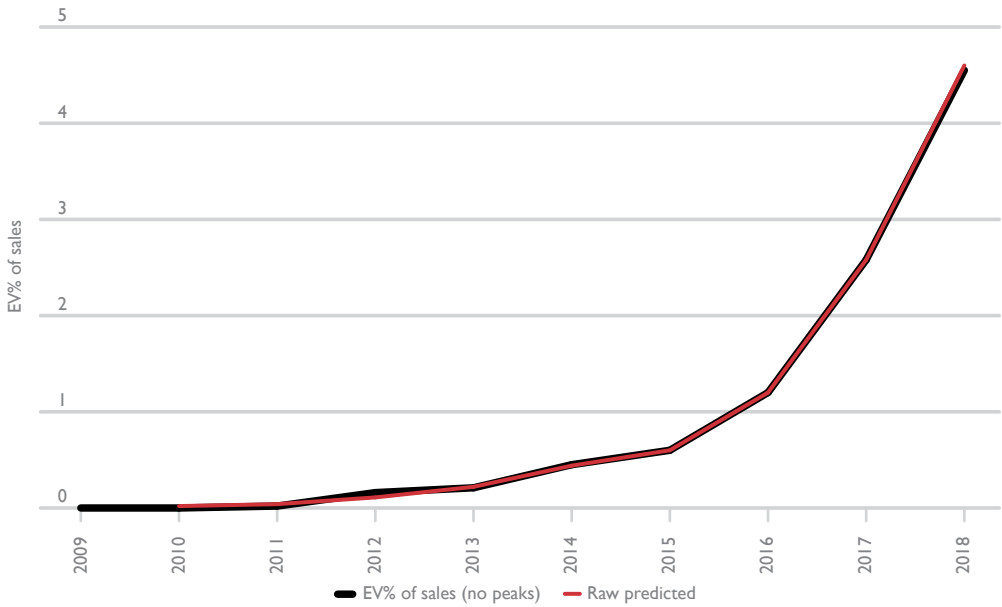
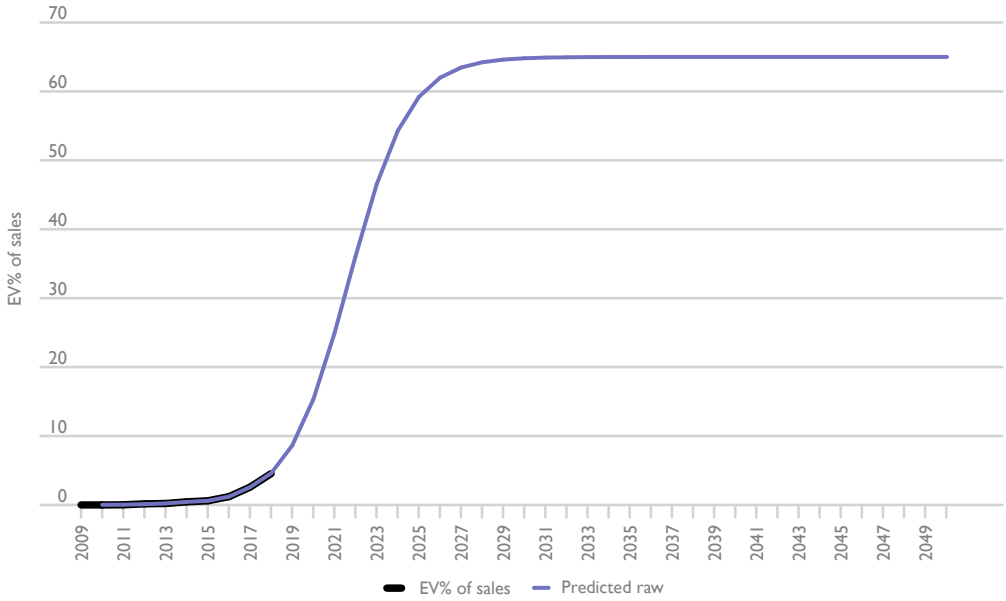


Figure 3.59 shows the extension of the forecast from this equation to 2050. This is the result of Stage 1 of the analysis.

Figure 3.59 Finnish EV sales as a percentage of passenger vehicle sales and raw prediction to 2050



In Stage 2, the year that sales (or the raw prediction) pass the 2% mark is determined. For Finland, this is 2017.

Stage 3 involves assembling past and forecast EV and FFV costs to generate a time series of the ratio of EV to FFV annual costs. Table 3.23 shows the prices of BEVs, PHEVs and FFVs in Finland.

Table 3.23 Prices of BEVs, PHEVs and FFVs in Finland

BEV	2017 US$ (000')	Euros	Euros	%	Euros	Euros			Euros
	BEV base	BEV base	Purchase tax	VAT%	VAT	BEV price	Purchase subsidy	Home charging	BEV cost
2009	30	21302	174	22	4686	26162	0	1450	27612
2010	30	22760	183	22	5007	27951	0	1450	29401
2011	30	21463	173	23	4937	26573	0	1450	28023
2012	31	23869	240	23	5490	29599	0	1450	31049
2013	31	23410	233	24	5618	29262	0	1450	30712
2014	34	25404	235	24	6097	31736	0	1450	33186
2015	30	27178	281	24	6523	33982	0	1450	35432
2016	30	27202	232	24	6529	33963	0	1450	35413
2017	30	26462	182	24	6351	32995	0	1450	34445
2018	31	26003	132	24	6241	32376	-1985	1450	31841
2019	31	26497	132	24	6359	32988	-1970	1450	32468
2020	31	26338	132	24	6321	32791	-1956	1450	32285
2021	30	25676	132	24	6162	31970	-1941	1450	31479
2022	31	26046	132	24	6251	32429	-1927	1450	31952
2023	30	25807	132	24	6194	32133	-1912	1450	31671
2024	29	24884	132	24	5972	30988	-1898	1450	30540
2025	28	24092	132	24	5782	30006	-1884	1450	29572
2026	28	23640	132	24	5674	29446	-1870	1450	29026
2027	27	23189	132	24	5565	28886	-1856	1450	28480
2028	27	22681	132	24	5443	28257	-1842	1450	27864
2029	26	22230	132	24	5335	27697	-1828	1450	27318
2030	26	21722	132	24	5213	27067	-1815	1450	26702

PHEV	2017 US$ (000')	Euros	Euros	%	Euros	Euros			Euros
	PHEV base	PHEV base	Purchase tax	VAT%	VAT	PHEV price	Purchase subsidy	Home charging	PHEV cost
2009	30	21302	174	22	4686	26162	0	1450	27612
2010	30	22760	183	22	5007	27951	0	1450	29401
2011	30	21463	173	23	4937	26573	0	1450	28023
2012	31	23869	240	23	5490	29599	0	1450	31049
2013	31	23410	233	24	5618	29262	0	1450	30712
2014	34	25404	235	24	6097	31736	0	1450	33186
2015	30	27178	281	24	6523	33982	0	1450	35432
2016	30	27202	232	24	6529	33963	0	1450	35413
2017	30	26462	182	24	6351	32995	0	1450	34445
2018	31	26003	132	24	6241	32376	-1985	1450	31841
2019	31	26497	132	24	6359	32988	-1970	1450	32468
2020	31	26338	132	24	6321	32791	-1956	1450	32285
2021	30	25676	132	24	6162	31970	-1941	1450	31479
2022	31	26046	132	24	6251	32429	-1927	1450	31952
2023	30	25807	132	24	6194	32133	-1912	1450	31671
2024	29	24884	132	24	5972	30988	-1898	1450	30540
2025	28	24092	132	24	5782	30006	-1884	1450	29572
2026	28	23640	132	24	5674	29446	-1870	1450	29026
2027	27	23189	132	24	5565	28886	-1856	1450	28480
2028	27	22681	132	24	5443	28257	-1842	1450	27864
2029	26	22230	132	24	5335	27697	-1828	1450	27318
2030	26	21722	132	24	5213	27067	-1815	1450	26702

Table 3.23 Prices of BEVs, PHEVs and FFVs in Finland (continued)

FFV	2017 US$ (000')	Euros	Euros	%	Euros	Euros
	FFV base	FFV base	purchase tax	VAT%	VAT	FFV price
2009	23	16556	3477	22	3642	23676
2010	23	17449	3664	22	3839	24953
2011	23	16455	3456	23	3785	23695
2012	23	17800	4806	23	4094	26700
2013	23	17288	4668	24	4149	26105
2014	23	17420	4703	24	4181	26304
2015	23	20836	5626	24	5001	31463
2016	23	20855	5631	24	5005	31491
2017	23	20288	5478	24	4869	30634
2018	23	19550	5279	24	4692	29521
2019	23	19550	5279	24	4692	29521
2020	23	19550	5279	24	4692	29521
2021	23	19550	5279	24	4692	29521
2022	23	19550	5279	24	4692	29521
2023	23	19550	5279	24	4692	29521
2024	23	19550	5279	24	4692	29521
2025	23	19550	5279	24	4692	29521
2026	23	19550	5279	24	4692	29521
2027	23	19550	5279	24	4692	29521
2028	23	19550	5279	24	4692	29521
2029	23	19550	5279	24	4692	29521
2030	23	19550	5279	24	4692	29521

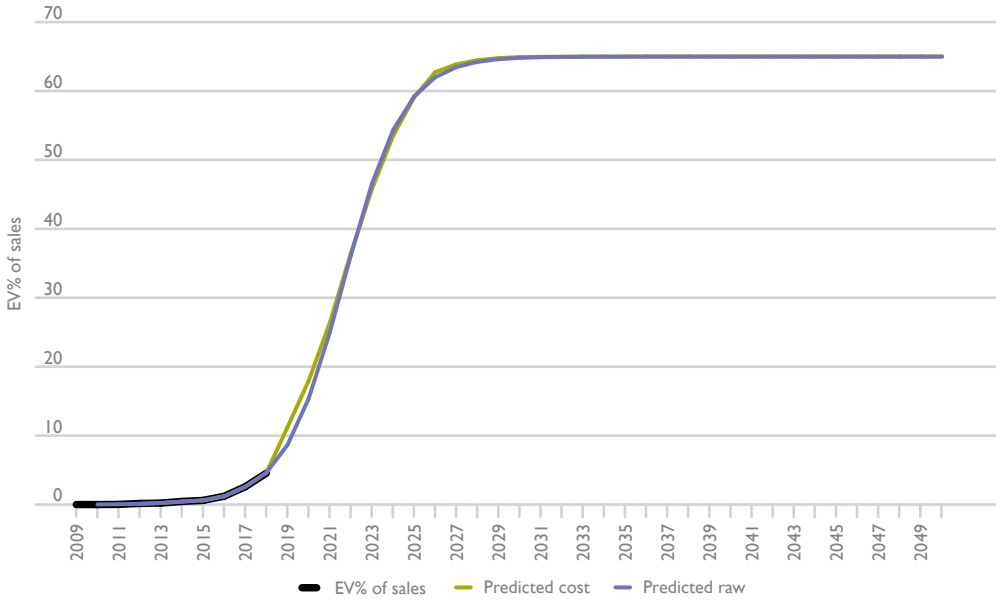
Table 3.24 shows past and forecast BEV and FFV costs used to generate a time series of the ratio of EV to FFV annual costs. Costs include principal (repay over 5 years), interest (13 per cent per year), annual EV subsidies, and petrol costs for FFV (with increasing fuel efficiency and a medium petrol price).

Table 3.24 EV/FFV cost ratio calculations for Finland

	Evs	Evs	Evs	Evs	Evs	FFVs	FFVs	FFVs	FFVs	FFVs	EV/ FFV
	EV price	Principal	Interest	Annual subs	Annual cost	FFV price	Principal	Interest	Fuel	Annual cost	Cost ratio
2012	31049	6210	4036	0	10246	26700	5340	3471	1707	10518	0.97
2013	30712	6142	3993	0	10135	26105	5221	3394	1665	10279	0.99
2014	33186	6637	4314	0	10951	26304	5261	3420	1615	10296	1.06
2015	35432	7086	4606	0	11692	31463	6293	4090	1462	11845	0.99
2016	35413	7083	4604	0	11686	31491	6298	4094	1357	11749	0.99
2017	34445	6889	4478	0	11367	30634	6127	3982	1414	11524	0.99
2018	31841	6368	4139	0	10508	29521	5904	3838	1465	11207	0.94
2019	32468	6494	4221	0	10714	29521	5904	3838	1431	11173	0.96
2020	32285	6457	4197	0	10654	29521	5904	3838	1418	11160	0.95
2021	31479	6296	4092	0	10388	29521	5904	3838	1448	11189	0.93
2022	31952	6390	4154	0	10544	29521	5904	3838	1465	11207	0.94
2023	31671	6334	4117	0	10451	29521	5904	3838	1465	11207	0.93
2024	30540	6108	3970	0	10078	29521	5904	3838	1454	11196	0.90
2025	29572	5914	3844	0	9759	29521	5904	3838	1460	11202	0.87
2026	29026	5805	3773	0	9579	29521	5904	3838	1480	11221	0.85
2027	28480	5696	3702	0	9399	29521	5904	3838	1482	11224	0.84
2028	27864	5573	3622	0	9195	29521	5904	3838	1479	11220	0.82
2029	27318	5464	3551	0	9015	29521	5904	3838	1479	11221	0.80
2030	26702	5340	3471	0	8812	29521	5904	3838	1475	11217	0.79

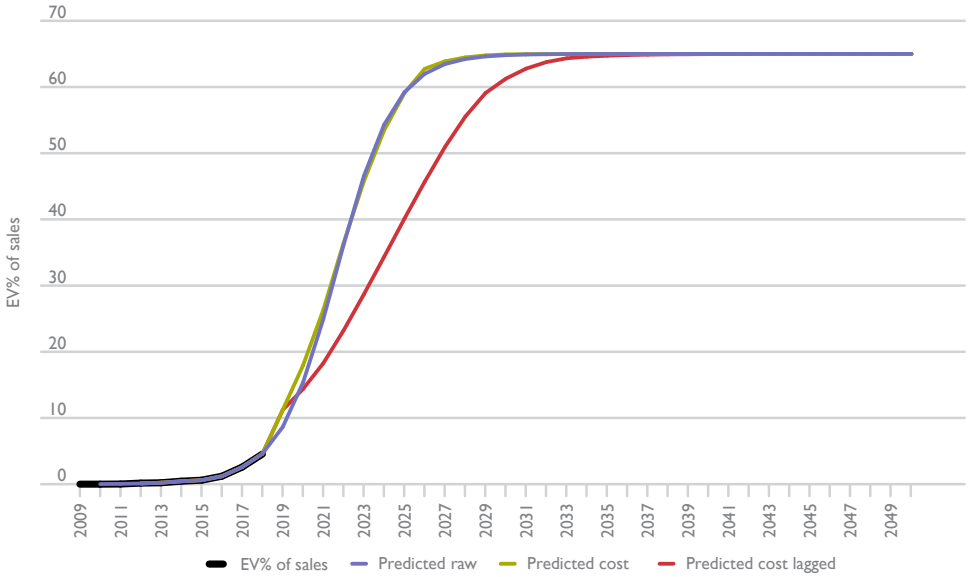
The resulting EV/FFV cost ratio time series is shown in the last column. This time series is then fed though the 2% year formula, which shifts the predicted raw uptake curve in line with shifts predicted for the cost ratio. Figure 3.60 shows that as the EV/FFV cost ratio falls with the introduction of subsidies in 2019, the result is a shift in the *predicted raw* curve slightly to the left in the graph, giving the *predicted cost* curve. This is the result from Stage 3 of the Finnish analysis.

Figure 3.60 Finnish predicted raw and predicted cost EV per cent of sales curves



In Stage 4 corrections are made to the predicted cost uptake curves. Basically, the rates of uptake are reduced to allow for the fact that most early adopters are those with higher incomes. The resulting Finnish *predicted cost lagged* curve – which is a less steeply rising curve – is shown in Figure 3.61. This is the final base-case EV uptake prediction for Finland.

Figure 3.61 Finnish predicted cost lagged EV uptake curve

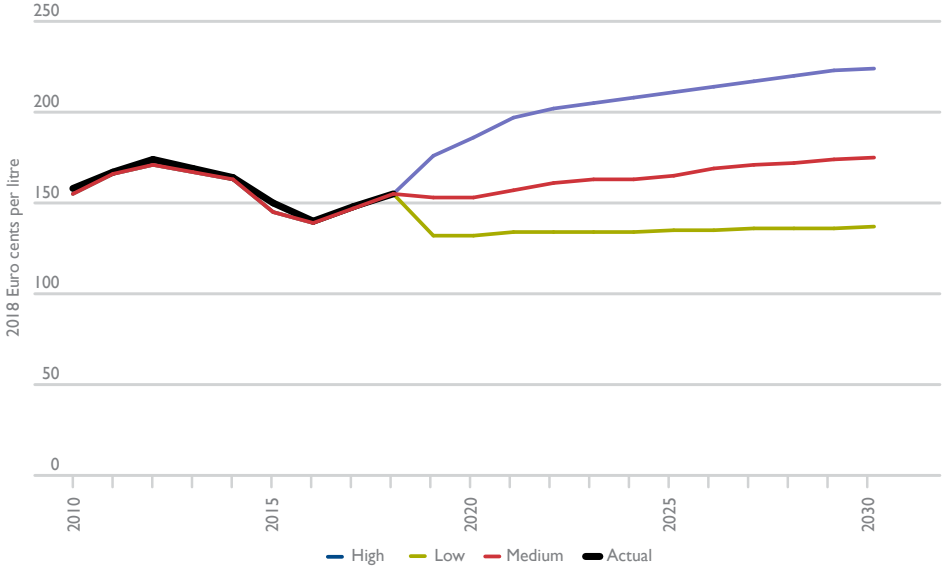


The resulting Finnish uptake forecast has EVs as 40 per cent of sales in 2025 and 61 per cent in 2030.

Stage 5 of the analysis looks at high, medium and low scenarios for oil prices and for EV prices.

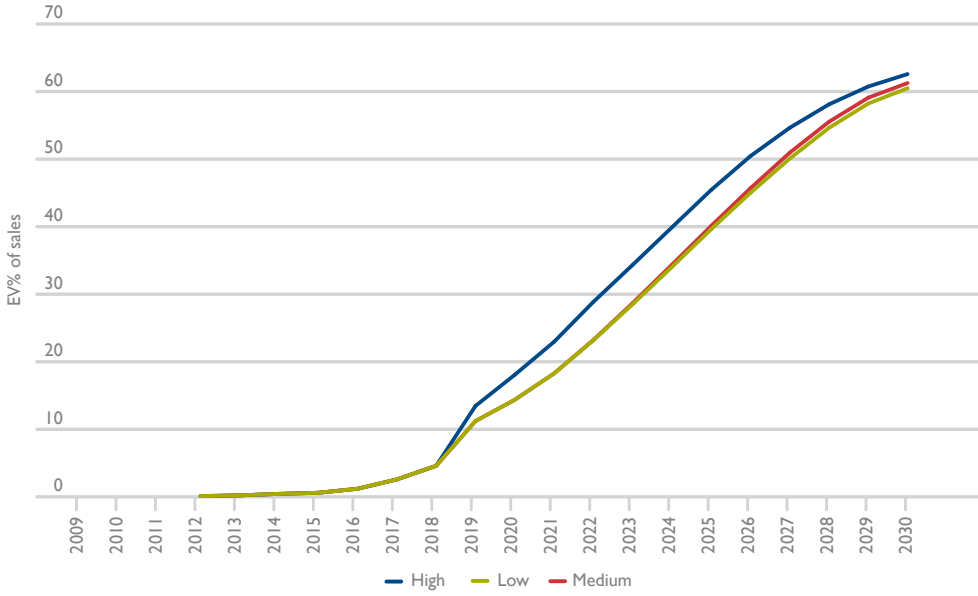
The oil price scenarios were given in Chapter 2. Corresponding Finnish petrol prices have been derived from the oil to Finnish petrol price equation in BITRE (2019). The resulting petrol price scenarios are shown in Figure 3.62.

Figure 3.62 Finnish petrol price scenarios



When these scenario petrol prices are used in the calculation of the EV/FFV cost ratios, the following predicted cost lagged curves are generated.

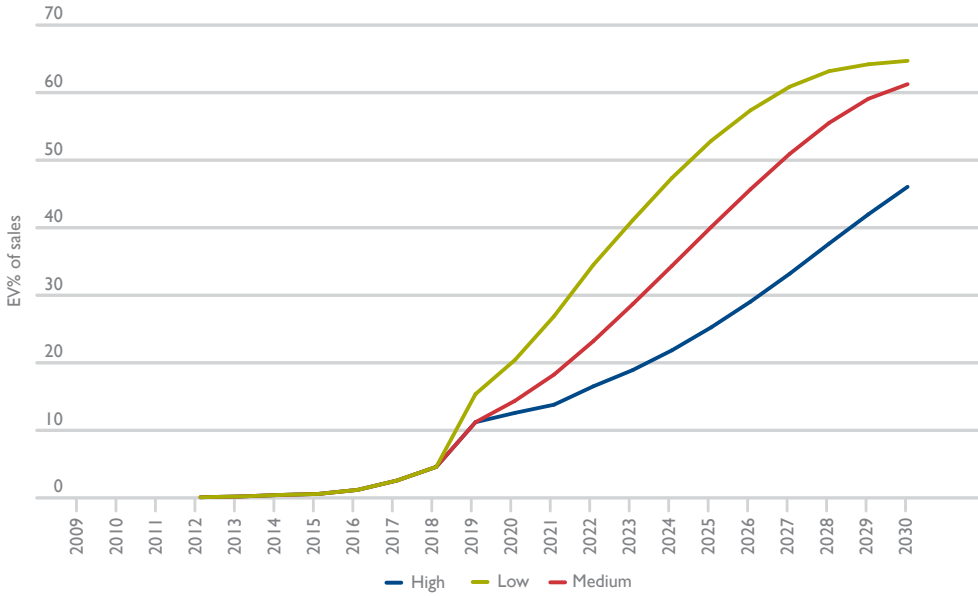
Figure 3.63 Scenarios for Finnish EV uptake with high, medium and low oil prices



It can be seen that oil price scenarios very little difference to forecast uptake.

The second scenario test is when the prices of EVs are increased or decreased. The vehicle price scenarios were also covered in Chapter 2 (30 per cent up on the medium, 30 per cent down). When these scenario vehicle prices are used in the calculation of the EV/FFV cost ratios, the following predicted cost lagged curves are generated.

Figure 3.64 Scenarios for Finnish EV uptake with high, medium and low EV prices



It can be seen that changes in vehicle prices have a large effect on projected uptake.

3.9 France

The linearized logistic uptake for France is shown in Figure 3.65, along with a predicted curve.

The regression shown in Table 3.25 has two variables – a time trend and a dummy for 2012 to 2014. It is estimated over the period 2012 to 2018.

Figure 3.65 French linearized logistic EV sales percentage and prediction

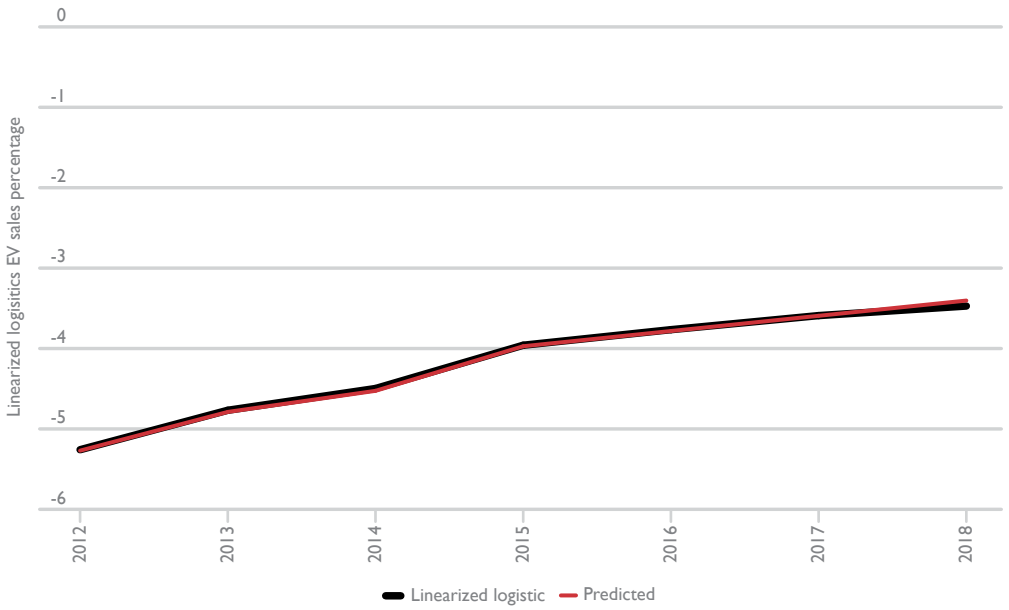


Table 3.25 Regression for French linearized logistic EV uptake

Regression statistics	
Multiple R	0.999164747
R Square	0.998330191
Adjusted R Square	0.997495286
Standard Error	0.033870851
Observations	7

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	2.743592331	1.371796166	1195.741698	2.78826E-06
Residual	4	0.004588938	0.001147235		
Total	6	2.74818127			

	Coefficients	*Standard error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-5.108515464	0.101822713	-50.17068707	9.44499E-07	-5.391220637	-4.825810291
time	0.189430109	0.013611307	13.91711135	0.00015458	0.151639062	0.227221157
dum1214	-0.729822031	0.074743116	-9.764404687	0.000616305	-0.937342189	-0.522301873

Figure 3.66 shows the fit of the de-linearized *raw prediction* to the actual EV sales percentage of new passenger vehicle sales.

Figure 3.66 French EV sales as a percentage of passenger vehicle sales and raw prediction

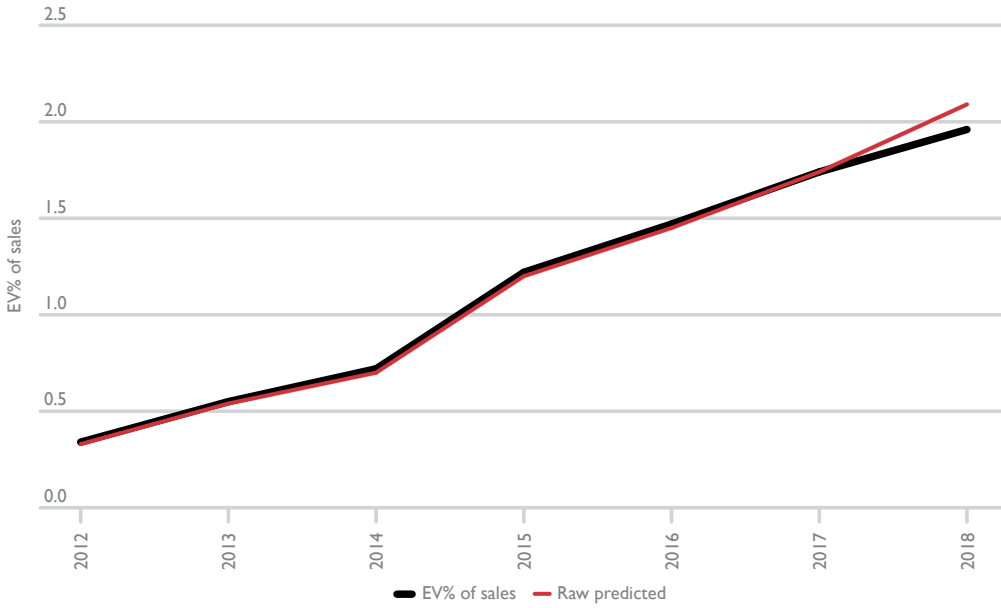
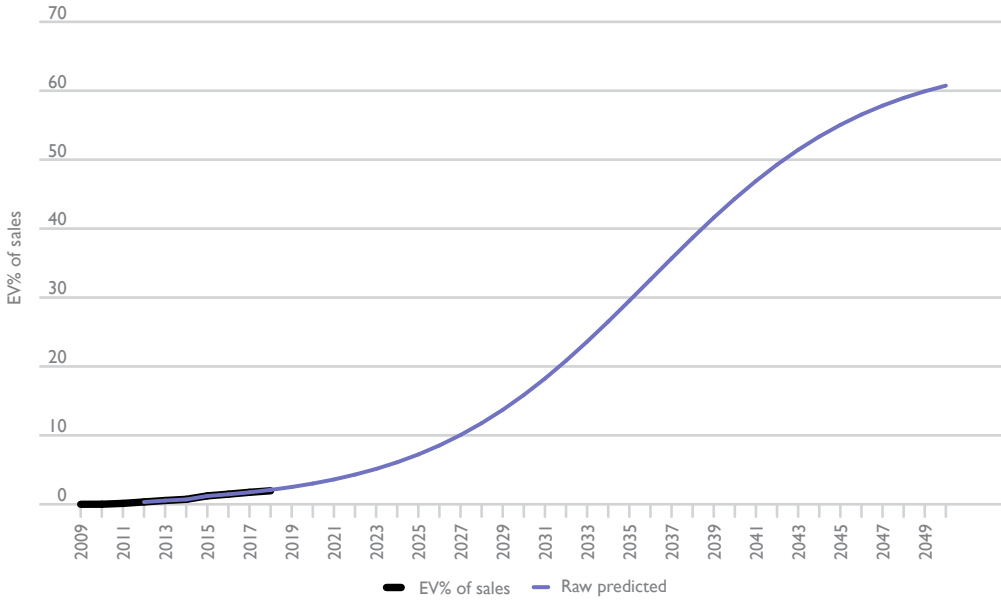


Figure 3.67 shows the extension of the forecast from this equation to 2050. This is the result of Stage 1 of the analysis. France is one of the 'flat' uptake curve countries.

Figure 3.67 French EV sales as a percentage of passenger vehicle sales and raw prediction to 2050



In Stage 2, the year that sales (or the raw prediction) pass the 2% mark is determined. For France, this is 2018.

Stage 3 involves assembling past and forecast EV and FFV costs to generate a time series of the ratio of EV to FFV annual costs. Table 3.26 shows the prices of BEVs, PHEVs and FFVs in France.

Table 3.26 Prices of BEVs, PHEVs and FFVs in France

BEV	2017 US$ (000')	Euros		Euros	Euros	Euros	Euros
	BEV base	BEV base	VAT%	BEV price	Subsidies	Home charging	BEV price
2009	30	21302	19.8	25516	-5425	1450	21540
2010	30	22760	22.0	27773	-5343	1450	23880
2011	30	21463	24.6	26733	-5233	1450	22950
2012	31	23869	25.7	29996	-5132	1450	26314
2013	31	23410	25.2	29307	-7124	1450	23633
2014	34	25404	24.9	31721	-6379	1450	26792
2015	30	27178	22.6	33322	-6377	1450	28395
2016	30	27202	21.7	33102	-6365	1450	28187
2017	30	26462	22.9	32528	-6000	1450	27978
2018	31	26003	23.0	31984	-5939	1450	27495
2019	31	26497	23.0	32591	-5878	1450	28163
2020	31	26338	23.0	32396	-5818	1450	28027
2021	30	25676	23.0	31581	-5759	1450	27272
2022	31	26046	23.0	32037	-5700	1450	27786
2023	30	25807	23.0	31743	-5642	1450	27551
2024	29	24884	23.0	30608	-5585	1450	26473
2025	28	24092	23.0	29633	-5528	1450	25555
2026	28	23640	23.0	29078	-5471	1450	25056
2027	27	23189	23.0	28522	-5416	1450	24557
2028	27	22681	23.0	27898	-5360	1450	23987
2029	26	22230	23.0	27343	-5306	1450	23487
2030	26	21722	23.0	26718	-5252	1450	22916
PHEV	2017 US$ (000')	Euros		Euros	Euros	Euros	Euros
	PHEV base	PHEV base	VAT%	PHEV price	Subsidies	Home charging	PHEV price
2009	30	21302	19.8	25516	-3255	1450	23711
2010	30	22760	22.0	27773	-3206	1450	26017
2011	30	21463	24.6	26733	-3140	1450	25043
2012	31	23869	25.7	29996	-3079	1450	28367
2013	31	23410	25.2	29307	-3053	1450	27704
2014	34	25404	24.9	31721	-3038	1450	30133
2015	30	27178	22.6	33322	-3036	1450	31735
2016	30	27202	21.7	33102	-1010	1450	33541
2017	30	26462	22.9	32528	-1000	1450	32978
2018	31	26003	23.0	31984	-990	1450	32444
2019	31	26497	23.0	32591	-980	1450	33062
2020	31	26338	23.0	32396	-970	1450	32876
2021	30	25676	23.0	31581	-960	1450	32071
2022	31	26046	23.0	32037	-950	1450	32537
2023	30	25807	23.0	31743	-940	1450	32253
2024	29	24884	23.0	30608	-931	1450	31127
2025	28	24092	23.0	29633	-921	1450	30162
2026	28	23640	23.0	29078	-912	1450	29616
2027	27	23189	23.0	28522	-903	1450	29070
2028	27	22681	23.0	27898	-893	1450	28454
2029	26	22230	23.0	27343	-884	1450	27908
2030	26	21722	23.0	26718	-875	1450	27293

Table 3.26 Prices of BEVs, PHEVs and FFVs in France (continued)

FFV	2017 US$ (000')	Euros		Euros
	FFV base	FFV base	VAT%	FFV price
2009	23	16556	19.8	19831
2010	23	17449	22.0	21293
2011	23	16455	24.6	20495
2012	23	17800	25.7	22369
2013	23	17288	25.2	21644
2014	23	17420	24.9	21751
2015	23	20836	22.6	25547
2016	23	20855	21.7	25378
2017	23	20288	22.9	24938
2018	23	19550	23.0	24047
2019	23	19550	23.0	24047
2020	23	19550	23.0	24047
2021	23	19550	23.0	24047
2022	23	19550	23.0	24047
2023	23	19550	23.0	24047
2024	23	19550	23.0	24047
2025	23	19550	23.0	24047
2026	23	19550	23.0	24047
2027	23	19550	23.0	24047
2028	23	19550	23.0	24047
2029	23	19550	23.0	24047
2030	23	19550	23.0	24047

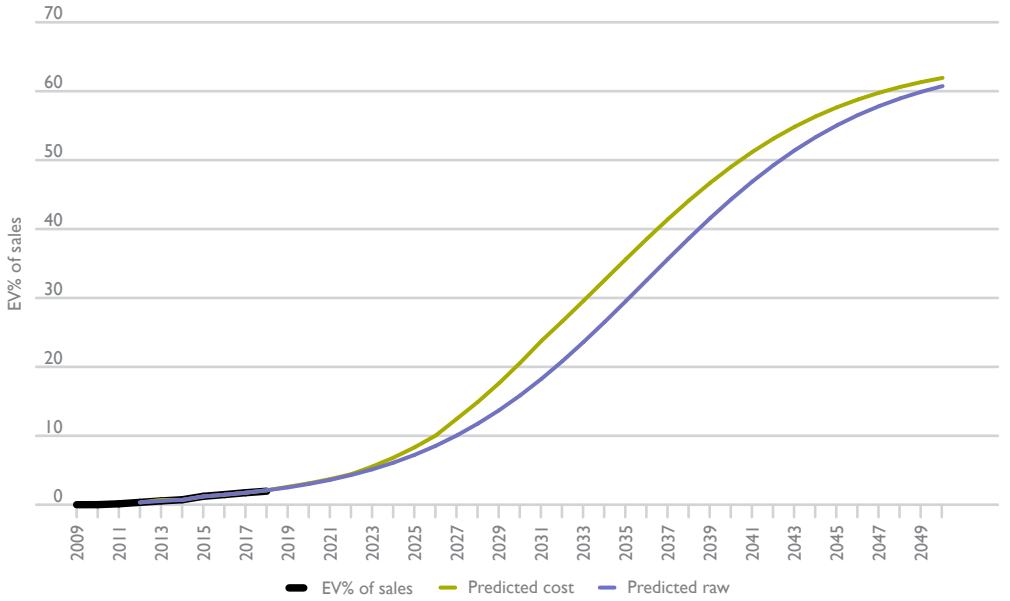
Table 3.27 shows past and forecast BEV and FFV costs used to generate a time series of the ratio of EV to FFV annual costs. Costs include principal (repay over 5 years), interest (13 per cent per year), annual EV subsidies, and petrol costs for FFV (with increasing fuel efficiency and a medium petrol price).

Table 3.27 EV/FFV cost ratio calculations for France

	Evs	Evs	Evs	Evs	Evs	FFVs	FFVs	FFVs	FFVs	FFVs	EV/ FFV
	EV price	Principal	Interest	Annual subs	Annual cost	FFV price	Principal	Interest	Fuel	Annual cost	Cost ratio
2012	26314	5263	3421	50	8634	22369	4474	2908	1047	8429	1.02
2013	23633	4727	3072	50	7749	21644	4329	2814	1014	8156	0.95
2014	26792	5358	3483	50	8791	21751	4350	2828	971	8149	1.08
2015	28395	5679	3691	50	9320	25547	5109	3321	889	9320	1.00
2016	28187	5637	3664	50	9252	25378	5076	3299	843	9218	1.00
2017	27978	5596	3637	50	9183	24938	4988	3242	874	9103	1.01
2018	27495	5499	3574	50	9023	24047	4809	3126	929	8865	1.02
2019	28163	5633	3661	50	9244	24047	4809	3126	886	8822	1.05
2020	28027	5605	3644	50	9199	24047	4809	3126	878	8814	1.04
2021	27272	5454	3545	50	8950	24047	4809	3126	898	8833	1.01
2022	27786	5557	3612	50	9119	24047	4809	3126	910	8845	1.03
2023	27551	5510	3582	50	9042	24047	4809	3126	911	8846	1.02
2024	26473	5295	3441	50	8686	24047	4809	3126	904	8839	0.98
2025	25555	5111	3322	50	8383	24047	4809	3126	908	8843	0.95
2026	25056	5011	3257	50	8219	24047	4809	3126	921	8857	0.93
2027	24557	4911	3192	50	8054	24047	4809	3126	924	8859	0.91
2028	23987	4797	3118	50	7866	24047	4809	3126	922	8857	0.89
2029	23487	4697	3053	50	7701	24047	4809	3126	922	8858	0.87
2030	22916	4583	2979	50	7512	24047	4809	3126	920	8856	0.85

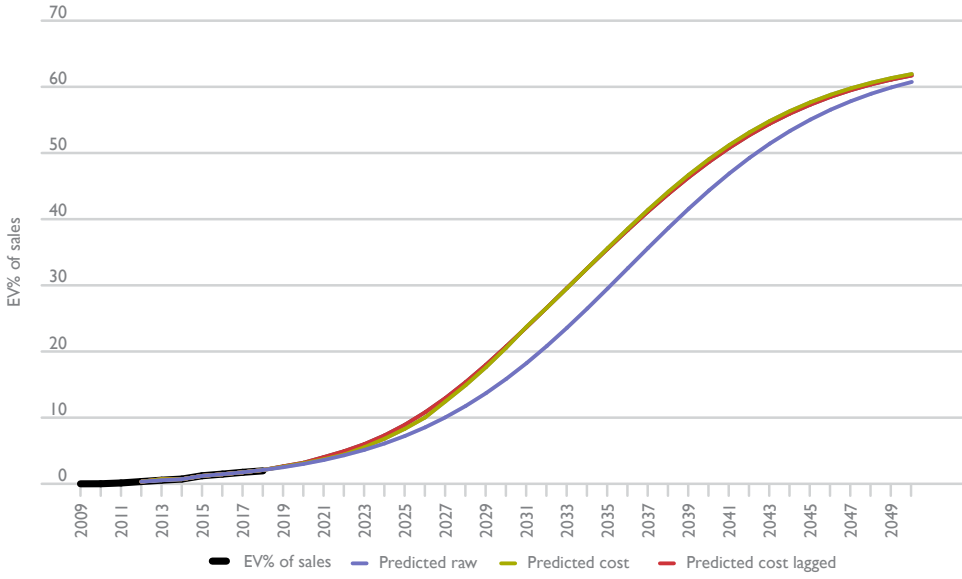
The resulting EV/FFV cost ratio time series is shown in the last column. This time series is then fed though the 2% year formula, which shifts the predicted raw uptake curve in line with shifts predicted for the cost ratio. Figure 3.68 shows that as the EV/FFV cost ratio decreases, the result is a shift in the *predicted raw* curve to the left in the graph, giving the *predicted cost* curve. This is the result from Stage 3 of the French analysis.

Figure 3.68 French predicted raw and predicted cost EV per cent of sales curves



In Stage 4 corrections are usually made to the predicted cost uptake curves. But the French uptake is already flatter than most countries. The resulting French *predicted cost* lagged curve is assumed equal to the predicted cost curve, as shown in Figure 3.69. This is the final base-case EV uptake prediction for France.

Figure 3.69 French predicted cost lagged EV uptake curve

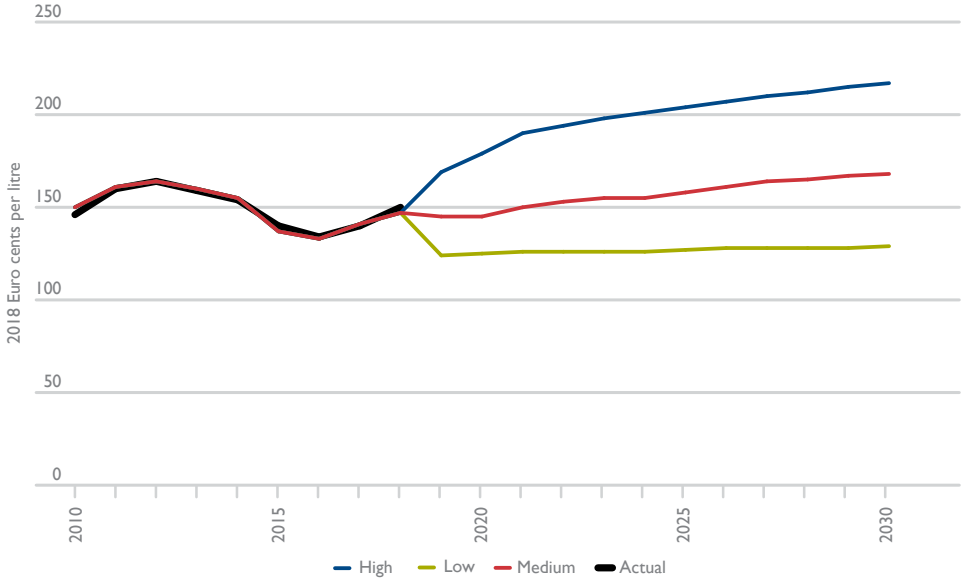


The resulting French uptake forecast has EVs as 9 per cent of sales in 2025 and 21 per cent in 2030.

Stage 5 of the analysis looks at high, medium and low scenarios for oil prices and for EV prices.

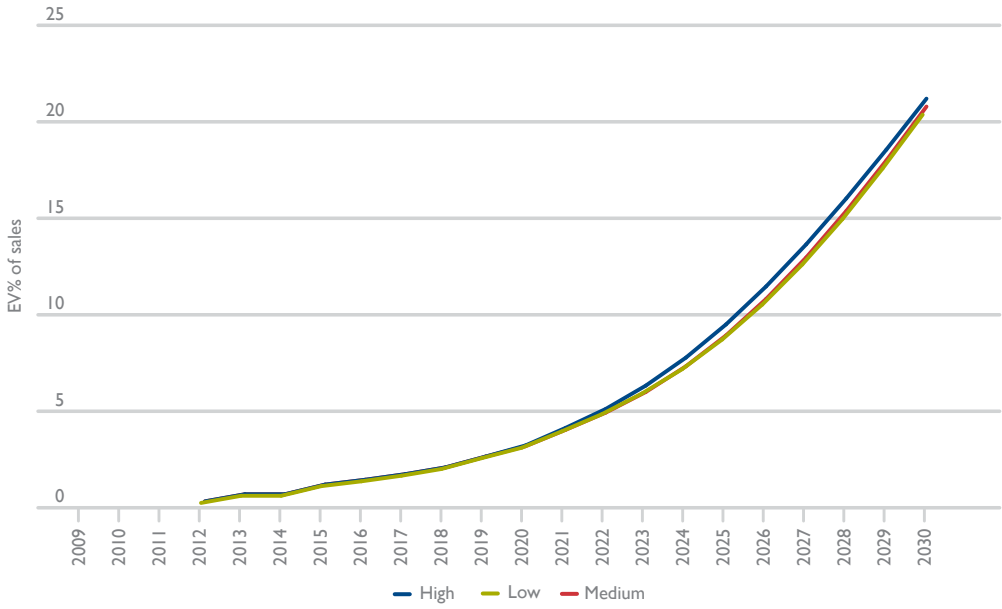
The oil price scenarios were given in Chapter 2. Corresponding French petrol prices have been derived from the oil to French petrol price equation in BITRE (2019). The resulting petrol price scenarios are shown in Figure 3.70.

Figure 3.70 French petrol price scenarios



When these scenario petrol prices are used in the calculation of the EV/FFV cost ratios, the following predicted cost lagged curves are generated.

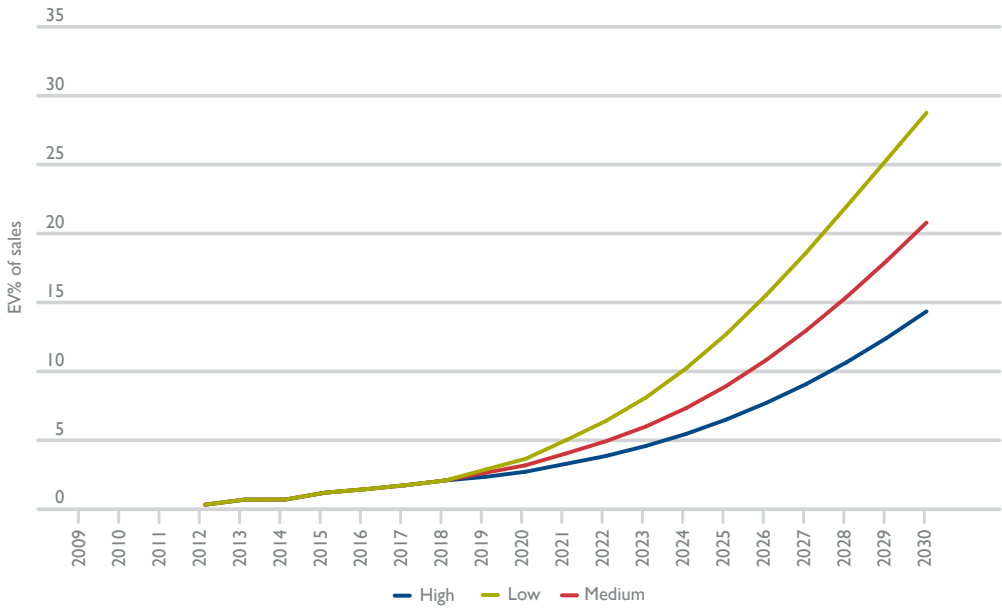
Figure 3.71 Scenarios for French EV uptake with high, medium and low oil prices



It can be seen that oil price scenarios make next to no difference to forecast uptake.

The second scenario test is when the prices of EVs are increased or decreased. The vehicle price scenarios were also covered in Chapter 2 (30 per cent up on the medium, 30 per cent down). When these scenario vehicle prices are used in the calculation of the EV/FFV cost ratios, the following predicted cost lagged curves are generated.

Figure 3.72 Scenarios for French EV uptake with high, medium and low EV prices



It can be seen that changes in vehicle prices have a large effect on projected uptake

3.10 Germany

The linearized logistic uptake for Germany is shown in Figure 3.73, along with a predicted curve.

The regression shown in Table 3.28 has three variables – a time trend, a dummy for 2012 to 2015, and a dummy for 2017. It is estimated over the period 2012 to 2018.

Figure 3.73 German linearized logistic EV sales percentage and prediction

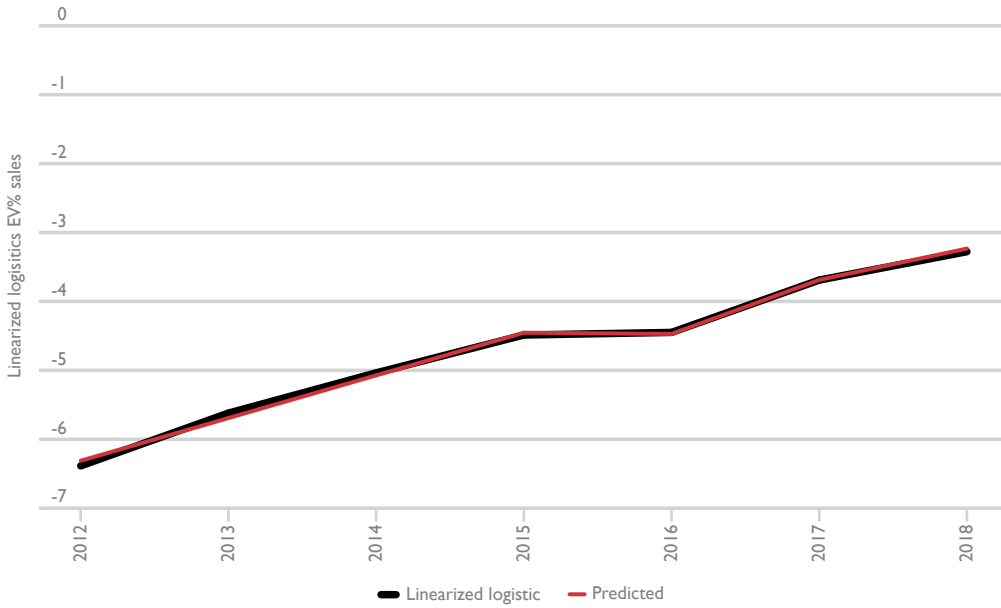


Table 3.28 Regression for German linearized logistic EV uptake

Regression statistics	
Multiple R	0.998990307
R Square	0.997981634
Adjusted R Square	0.995963267
Standard Error	0.068742632
Observations	7

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	7.00964642	2.336548807	494.4501805	0.000153846
Residual	3	0.014176649	0.00472555		
Total	6	7.023823068			

	Coefficients	*Standard error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-8.806327208	0.213466154	-41.25397423	3.13441E-05	-9.485671781	-8.126982636
time	0.619270968	0.025982273	23.83436478	0.000161851	0.53658378	0.701958156
dum1215	0.637185047	0.108691645	5.862318537	0.009897872	0.291279722	0.983090372
dum17	0.164467367	0.084192186	1.953475417	0.145777874	-0.103469746	0.432404479

Figure 3.74 shows the fit of the de-linearized *raw prediction* to the actual EV sales percentage of new passenger vehicle sales.

Figure 3.74 German EV sales as a percentage of passenger vehicle sales and raw prediction

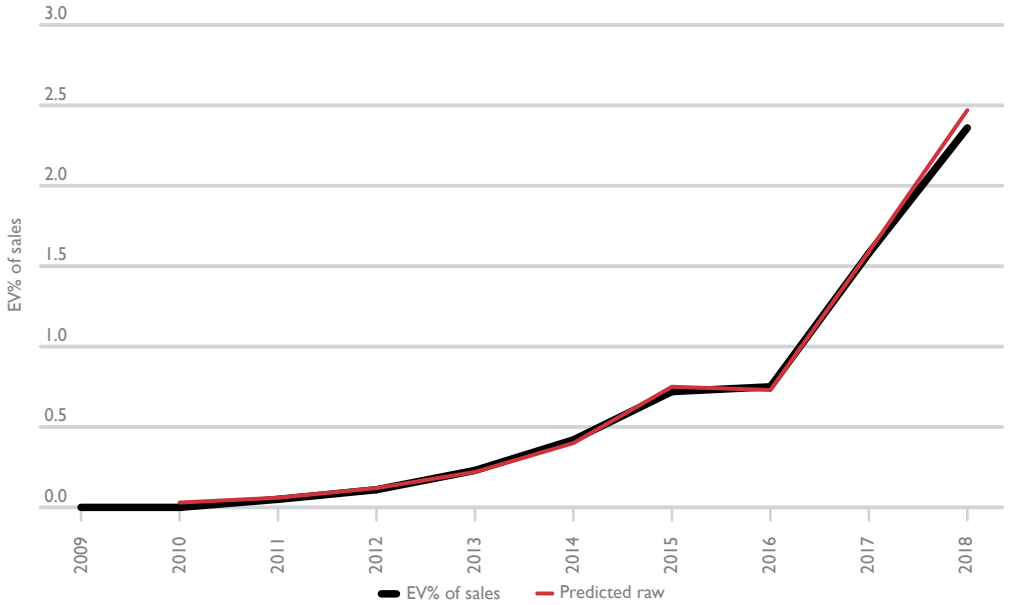
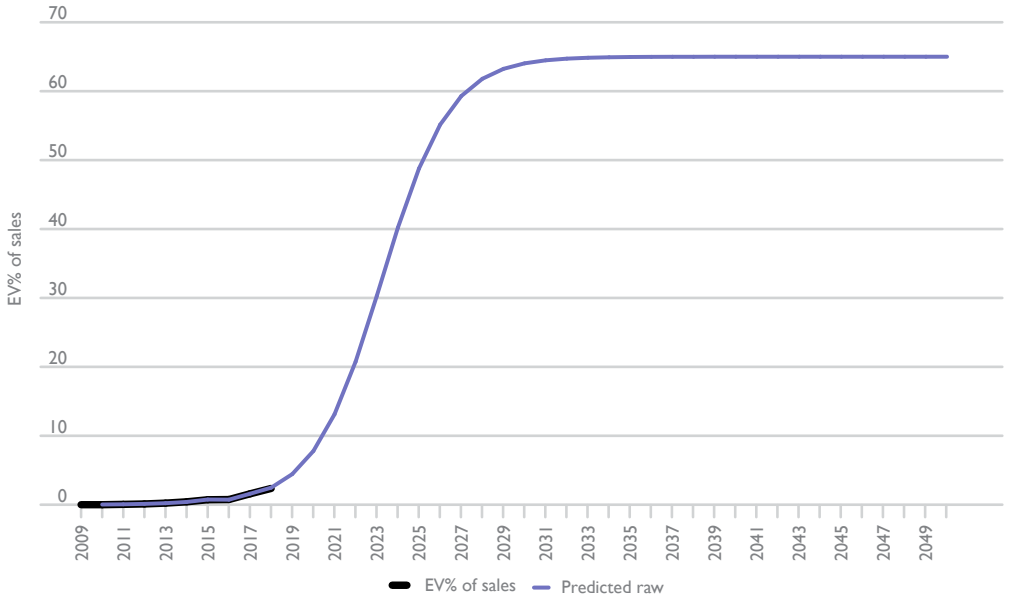


Figure 3.75 shows the extension of the forecast from this equation to 2050. This is the result of Stage 1 of the analysis.

Figure 3.75 German EV sales as a percentage of passenger vehicle sales and raw prediction to 2050



In Stage 2, the year that sales (or the raw prediction) pass the 2% mark is determined. For Germany, this is 2017.

Stage 3 involves assembling past and forecast EV and FFV costs to generate a time series of the ratio of EV to FFV annual costs. Table 3.29 shows the prices of BEVs, PHEVs and FFVs in Germany.

Table 3.29 Prices of BEVs, PHEVs and FFVs in Germany

BEV	2017 US$ ('000)	Euros	From EU	= half sales		Euros			
	BEV base	BEV base	Import duty	Corp. subsidy	VAT%	VAT	BEV price	Home charging	BEV price
2009	30	21302	0	0	20.1	4292	25594	1450	27044
2010	30	22760	0	0	22.2	5055	27815	1450	29265
2011	30	21463	0	0	24.4	5233	26696	1450	28146
2012	31	23869	0	0	26.4	6293	30162	1450	31612
2013	31	23410	0	-5170	25.6	5984	24224	1450	25674
2014	34	25404	0	-5124	24.6	6259	26540	1450	27990
2015	30	27178	0	-4600	22.3	6062	28640	1450	30090
2016	30	27202	0	-4578	20.8	5670	28294	1450	29744
2017	30	26462	0	-4500	21.9	5805	27767	1450	29217
2018	31	26003	0	-4423	22.0	5721	27301	1450	28751
2019	31	26497	0	-4347	22.0	5829	27979	1450	29429
2020	31	26338	0	-4273	22.0	5794	27859	1450	29309
2021	30	25676	0	-4200	22.0	5649	27124	1450	28574
2022	31	26046	0	-4128	22.0	5730	27648	1450	29098
2023	30	25807	0	-4058	22.0	5678	27427	1450	28877
2024	29	24884	0	-3988	22.0	5475	26371	1450	27821
2025	28	24092	0	-3920	22.0	5300	25472	1450	26922
2026	28	23640	0	-3853	22.0	5201	24988	1450	26438
2027	27	23189	0	-3787	22.0	5102	24504	1450	25954
2028	27	22681	0	-3722	22.0	4990	23949	1450	25399
2029	26	22230	0	-3659	22.0	4891	23462	1450	24912
2030	26	21722	0	-3596	22.0	4779	22905	1450	24355

PHEV	2017 US$ ('000)	Euros	from EU	=half sales					
	PHEV base	PHEV base	Import duty	Corp. subsidy	VAT%	VAT	PHEV price	Home charging	PHEV price
2009	30	21302	0	0	20.1	4292	25594	1450	27044
2010	30	22760	0	0	22.2	5055	27815	1450	29265
2011	30	21463	0	0	24.4	5233	26696	1450	28146
2012	31	23869	0	0	26.4	6293	30162	1450	31612
2013	31	23410	0	-2585	25.6	5984	26809	1450	28259
2014	34	25404	0	-2562	24.6	6259	29102	1450	30552
2015	30	27178	0	-2300	22.3	6062	30940	1450	32390
2016	30	27202	0	-2289	20.8	5670	30583	1450	32033
2017	30	26462	0	-2250	21.9	5805	30017	1450	31467
2018	31	26003	0	-2212	22.0	5721	29512	1450	30962
2019	31	26497	0	-2174	22.0	5829	30153	1450	31603
2020	31	26338	0	-2137	22.0	5794	29996	1450	31446
2021	30	25676	0	-2100	22.0	5649	29224	1450	30674
2022	31	26046	0	-2064	22.0	5730	29712	1450	31162
2023	30	25807	0	-2029	22.0	5678	29456	1450	30906
2024	29	24884	0	-1994	22.0	5475	28365	1450	29815
2025	28	24092	0	-1960	22.0	5300	27432	1450	28882
2026	28	23640	0	-1926	22.0	5201	26915	1450	28365
2027	27	23189	0	-1893	22.0	5102	26397	1450	27847
2028	27	22681	0	-1861	22.0	4990	25810	1450	27260
2029	26	22230	0	-1829	22.0	4891	25291	1450	26741
2030	26	21722	0	-1798	22.0	4779	24703	1450	26153

Table 3.29 Prices of BEVs, PHEVs and FFVs in Germany (continued)

FFV	2017 US$ ('000)	Euros	From EU			
	FFV base	FFV base	Import duty	VAT%	VAT	FFV price
2009	23	16556	0	20.1	3336	19893
2010	23	17449	0	22.2	3876	21325
2011	23	16455	0	24.4	4012	20467
2012	23	17800	0	26.4	4693	22493
2013	23	17288	0	25.6	4420	21708
2014	23	17420	0	24.6	4292	21712
2015	23	20836	0	22.3	4648	25484
2016	23	20855	0	20.8	4347	25202
2017	23	20288	0	21.9	4450	24738
2018	23	19550	0	22.0	4301	23851
2019	23	19550	0	22.0	4301	23851
2020	23	19550	0	22.0	4301	23851
2021	23	19550	0	22.0	4301	23851
2022	23	19550	0	22.0	4301	23851
2023	23	19550	0	22.0	4301	23851
2024	23	19550	0	22.0	4301	23851
2025	23	19550	0	22.0	4301	23851
2026	23	19550	0	22.0	4301	23851
2027	23	19550	0	22.0	4301	23851
2028	23	19550	0	22.0	4301	23851
2029	23	19550	0	22.0	4301	23851
2030	23	19550	0	22.0	4301	23851

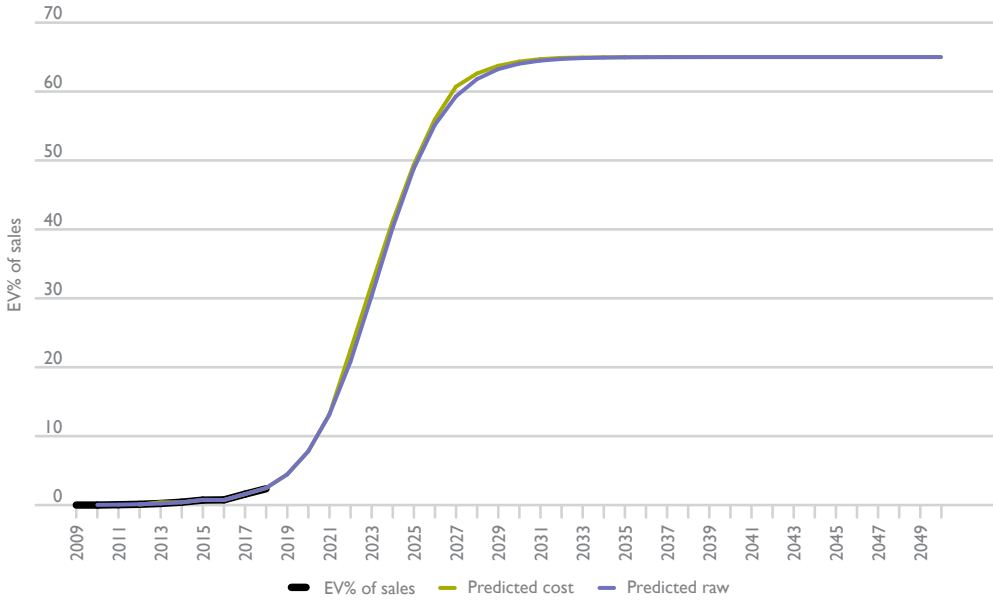
Table 3.30 shows past and forecast BEV and FFV costs used to generate a time series of the ratio of EV to FFV annual costs. Costs include principal (repay over 5 years), interest (13 per cent per year), annual EV subsidies, and petrol costs for FFV (with increasing fuel efficiency and a medium petrol price).

Table 3.30 EV/FFV cost ratio calculations for Germany

	Evs	Evs	Evs	Evs	Evs	FFVs	FFVs	FFVs	FFVs	FFVs	EV/ FFV
	EV price	Principal	Interest	Annual subs	Annual cost	FFV price	Principal	Interest	Fuel	Annual cost	Cost ratio
2012	31612	6322	4110	500	9932	22493	4499	2924	1410	8832	1.12
2013	25674	5135	3338	500	7973	21708	4342	2822	1345	8509	0.94
2014	27990	5598	3639	530	8707	21712	4342	2823	1278	8443	1.03
2015	30090	6018	3912	530	9400	25484	5097	3313	1142	9552	0.98
2016	29744	5949	3867	530	9285	25202	5040	3276	1051	9368	0.99
2017	29217	5843	3798	530	9112	24738	4948	3216	1077	9240	0.99
2018	28751	5750	3738	530	8958	23851	4770	3101	1097	8968	1.00
2019	29429	5886	3826	530	9182	23851	4770	3101	1095	8966	1.02
2020	29309	5862	3810	530	9142	23851	4770	3101	1085	8956	1.02
2021	28574	5715	3715	530	8900	23851	4770	3101	1109	8979	0.99
2022	29098	5820	3783	530	9072	23851	4770	3101	1123	8994	1.01
2023	28877	5775	3754	530	9000	23851	4770	3101	1123	8994	1.00
2024	27821	5564	3617	530	8651	23851	4770	3101	1115	8986	0.96
2025	26922	5384	3500	530	8354	23851	4770	3101	1120	8990	0.93
2026	26438	5288	3437	530	8195	23851	4770	3101	1136	9006	0.91
2027	25954	5191	3374	530	8035	23851	4770	3101	1138	9009	0.89
2028	25399	5080	3302	530	7852	23851	4770	3101	1135	9006	0.87
2029	24912	4982	3239	530	7691	23851	4770	3101	1136	9007	0.85
2030	24355	4871	3166	530	7507	23851	4770	3101	1133	9004	0.83

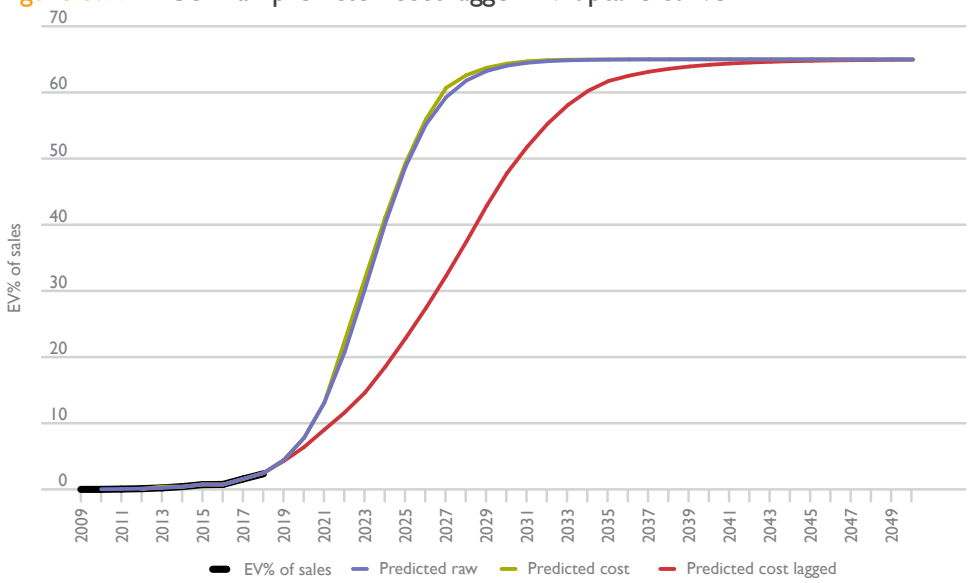
The resulting EV/FFV cost ratio time series is shown in the last column. This time series is then fed though the 2% year formula, which shifts the predicted raw uptake curve in line with shifts predicted for the cost ratio. Figure 3.76 shows the *predicted cost* curve is not much different from the *predicated raw* curve. This is the result from Stage 3 of the German analysis.

Figure 3.76 German predicted raw and predicted cost EV per cent of sales curves



In Stage 4 corrections are usually made to the predicted cost uptake curves. Basically, the rates of uptake are reduced to allow for the fact that most early adopters are those with higher incomes. The resulting German *predicted cost* lagged curve – which is a less steeply rising curve – is shown in Figure 3.77. This is the final base-case EV uptake prediction for Germany.

Figure 3.77 German predicted cost lagged EV uptake curve

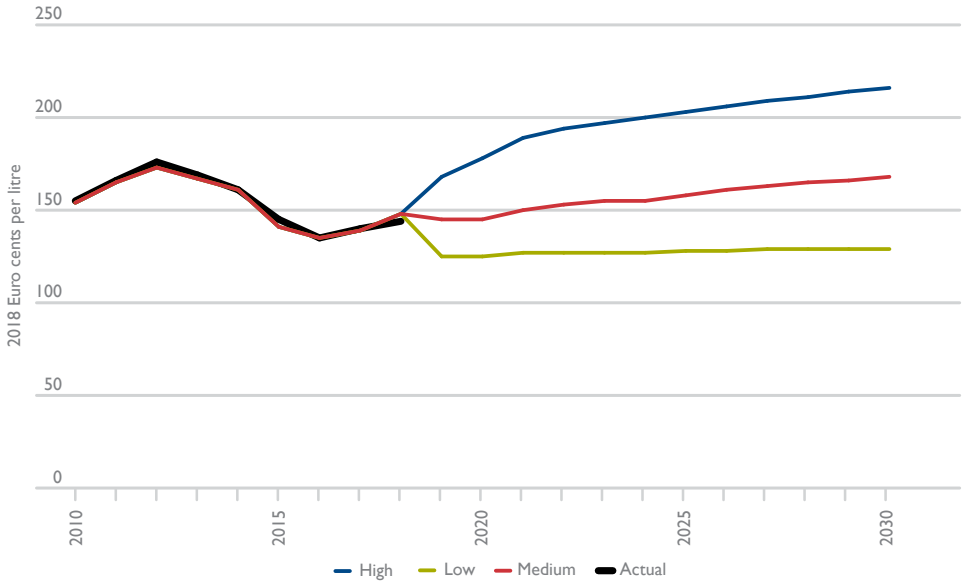


The resulting German uptake forecast has EVs as 23 per cent of sales in 2025 and 48 per cent in 2030.

Stage 5 of the analysis looks at high, medium and low scenarios for oil prices and for EV prices.

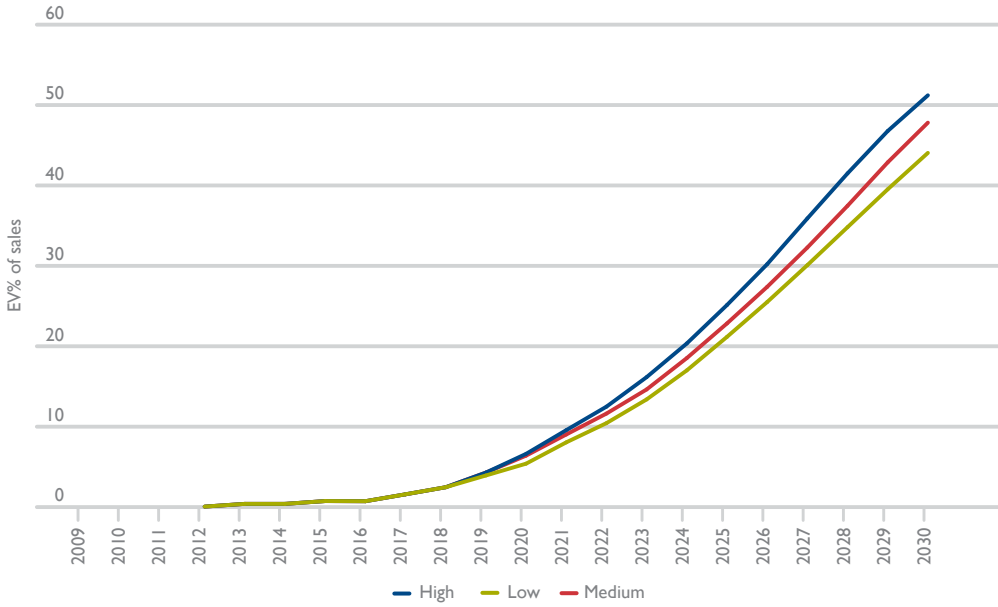
The oil price scenarios were given in Chapter 2. Corresponding German petrol prices have been derived from the oil to German petrol price equation in BITRE (2019). The resulting petrol price scenarios are shown in Figure 3.78.

Figure 3.78 German petrol price scenarios



When these scenario petrol prices are used in the calculation of the EV/FFV cost ratios, the following predicted cost lagged curves are generated.

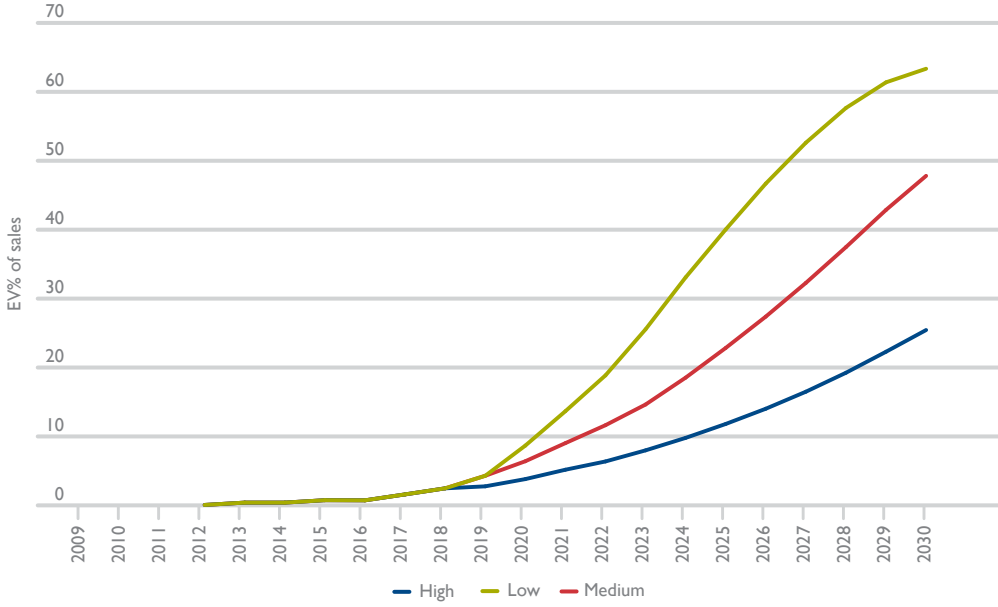
Figure 3.79 Scenarios for German EV uptake with high, medium and low oil prices



It can be seen that oil price scenarios make little difference to forecast uptake.

The second scenario test is when the prices of EVs are increased or decreased. The vehicle price scenarios were also covered in Chapter 2 (30 per cent up on the medium, 30 per cent down). When these scenario vehicle prices are used in the calculation of the EV/FFV cost ratios, the following predicted cost lagged curves are generated.

Figure 3.80 Scenarios for German EV uptake with high, medium and low EV prices



It can be seen that changes in vehicle prices have a large effect on projected uptake

3.11 India

The linearized logistic uptake for India is shown in Figure 3.81, along with a predicted curve.

The regression shown in Table 3.31 has only one variable – a time trend. It is estimated over the period 2012 to 2017.

Figure 3.81 Indian linearized logistic EV sales percentage and prediction

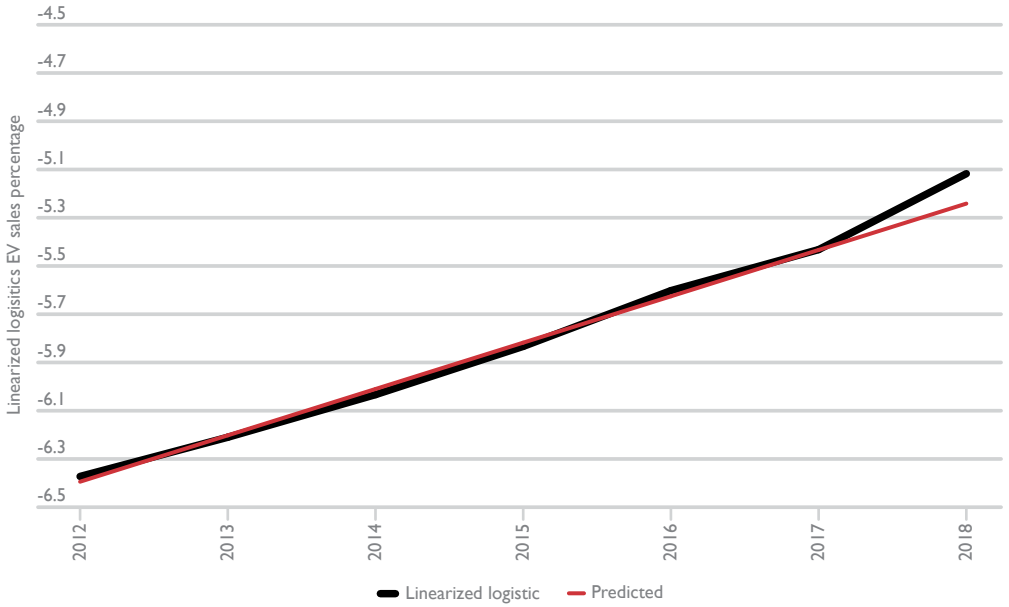


Table 3.31 Regression for Indian linearized logistic EV uptake

Regression statistics	
Multiple R	0.998545908
R Square	0.997093931
Adjusted R Square	0.996367414
Standard Error	0.021696922
Observations	6

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.64608015	0.64608015	1372.429789	3.17004E-06
Residual	4	0.001883026	0.000470756		
Total	5	0.647963176			

	Coefficients	*Standard error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-6.970714637	0.029869642	-233.3712135	2.0226E-09	-7.053646059	-6.887783215
time	0.192142826	0.005186556	37.04631951	3.17004E-06	0.177742637	0.206543016

Figure 3.82 shows the fit of the de-linearized *raw prediction* to the actual EV sales percentage of new passenger vehicle sales.

Figure 3.82 Indian EV sales as a percentage of passenger vehicle sales and raw prediction

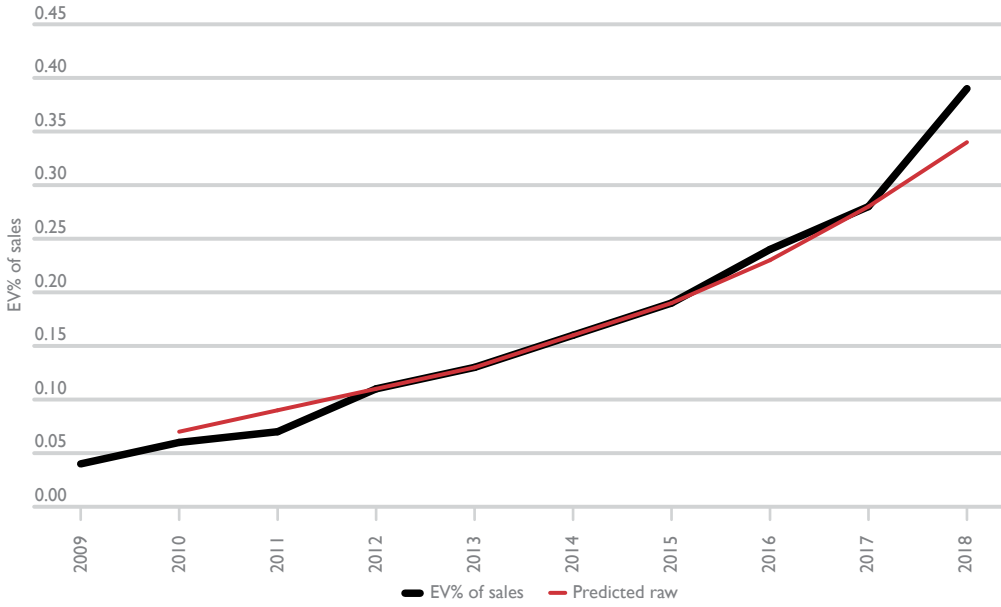
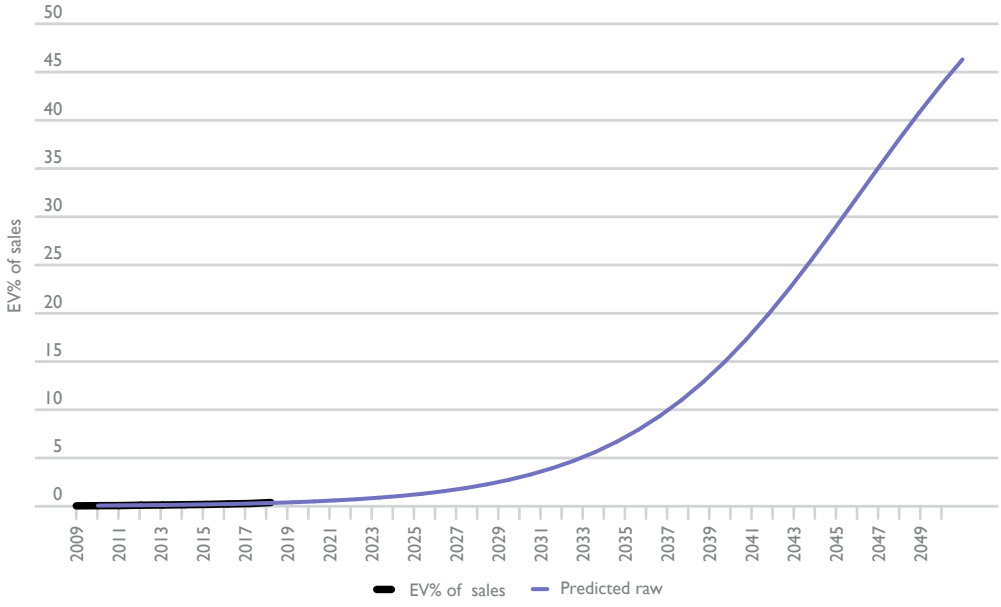


Figure 3.83 shows the extension of the forecast from this equation to 2050. This is the result of Stage 1 of the analysis.

Figure 3.83 Indian EV sales as a percentage of passenger vehicle sales and raw prediction to 2050



In Stage 2, the year that sales (or the raw prediction) pass the 2% mark is determined. For India, this is 2027.

Stage 3 involves assembling past and forecast EV and FFV costs to generate a time series of the ratio of EV to FFV annual costs. Table 3.32 shows the prices of BEVs, PHEVs and FFVs in India.

Table 3.32 Prices of BEVs, PHEVs and FFVs in India

BEV	2017 US$ ('000)	Rupees	Rupees	%	Rupees	Rupees	Rupees	Rupees	Rupees
	BEV base	BEV base	Purchase tax	VAT%	VAT	BEV price	Purchase subsidy	Home charging	BEV price
2009	30	1430280		16.7	238857	1669137	0	97357	1766494
2010	30	1369521		16.7	228710	1598231	-273904	87249	1411576
2011	30	1397346		16.7	233357	1630703	-279469	94401	1445635
2012	31	1646195		16.7	274915	1921109	-329239	100004	1691874
2013	31	1822384		20	364477	2186861	0	112878	2299738
2014	34	2045889		20	409178	2455067	-169248	116774	2402593
2015	30	1923219		25	480805	2404024	-161332	102608	2345300
2016	30	2014716		27	543973	2558689	-153735	107393	2512347
2017	30	1951977		27	527034	2479011	-150000	106960	2435970
2018	31	1988487		27	536891	2525378	-146356	110882	2489905
2019	31	2026245		27	547086	2573331	-142800	110882	2541413
2020	31	2014084		27	543803	2557886	-139331	110882	2529438
2021	30	1963436		27	530128	2493564	-135946	110882	2468501
2022	31	1991760		27	537775	2529535	-132643	110882	2507774
2023	30	1973501		27	532845	2506346	-129420	110882	2487808
2024	29	1902917		27	513787	2416704	-126276	110882	2401310
2025	28	1842319		27	497426	2339746	-123208	110882	2327420
2026	28	1807798		27	488105	2295903	-120215	110882	2286571
2027	27	1773276		27	478784	2252060	-117294	110882	2245648
2028	27	1734439		27	468298	2202737	-114444	110882	2199175
2029	26	1699917		27	458978	2158894	-111664	110882	2158113
2030	26	1661080		27	448492	2109571	-108951	110882	2111502

PHEV	2017 US$ ('000)	Rupees	Rupees	%	Rupees	Rupees	Rupees	Rupees	Rupees
	PHEV base	PHEV base	purchase tax	VAT%	VAT	PHEV price	Purchase subsidy	Home charging	PHEV price
2009	30	1430280		16.7	238857	1669137	0	97357	1766494
2010	30	1369521		16.7	228710	1598231	-273904	87249	1411576
2011	30	1397346		16.7	233357	1630703	-279469	94401	1445635
2012	31	1646195		16.7	274915	1921109	-329239	100004	1691874
2013	31	1822384		20	364477	2186861	0	112878	2299738
2014	34	2045889		20	409178	2455067	-169248	116774	2402593
2015	30	1923219		25	480805	2404024	-161332	102608	2345300
2016	30	2014716		27	543973	2558689	-153735	107393	2512347
2017	30	1951977		27	527034	2479011	-150000	106960	2435970
2018	31	1988487		27	536891	2525378	-146356	110882	2489905
2019	31	2026245		27	547086	2573331	-142800	110882	2541413
2020	31	2014084		27	543803	2557886	-139331	110882	2529438
2021	30	1963436		27	530128	2493564	-135946	110882	2468501
2022	31	1991760		27	537775	2529535	-132643	110882	2507774
2023	30	1973501		27	532845	2506346	-129420	110882	2487808
2024	29	1902917		27	513787	2416704	-126276	110882	2401310
2025	28	1842319		27	497426	2339746	-123208	110882	2327420
2026	28	1807798		27	488105	2295903	-120215	110882	2286571
2027	27	1773276		27	478784	2252060	-117294	110882	2245648
2028	27	1734439		27	468298	2202737	-114444	110882	2199175
2029	26	1699917		27	458978	2158894	-111664	110882	2158113
2030	26	1661080		27	448492	2109571	-108951	110882	2111502

Table 3.32 Prices of BEVs, PHEVs and FFVs in India (continued)

FFV	2017 US$ ('000)	Rupees	Rupees	%	Rupees	Rupees
	FFV base	FFV base	Purchase tax	VAT%	VAT	FFV price
2009	23	1111645		16.7	185645	1297290
2010	23	1049966		16.7	175344	1225310
2011	23	1071299		16.7	178907	1250205
2012	23	1227609		16.7	205011	1432620
2013	23	1345843		20	269169	1615011
2014	23	1402892		20	280578	1683470
2015	23	1474468		25	368617	1843085
2016	23	1544616		27	417046	1961662
2017	23	1496516		27	404059	1900575
2018	23	1495000		27	403650	1898650
2019	23	1495000		27	403650	1898650
2020	23	1495000		27	403650	1898650
2021	23	1495000		27	403650	1898650
2022	23	1495000		27	403650	1898650
2023	23	1495000		27	403650	1898650
2024	23	1495000		27	403650	1898650
2025	23	1495000		27	403650	1898650
2026	23	1495000		27	403650	1898650
2027	23	1495000		27	403650	1898650
2028	23	1495000		27	403650	1898650
2029	23	1495000		27	403650	1898650
2030	23	1495000		27	403650	1898650

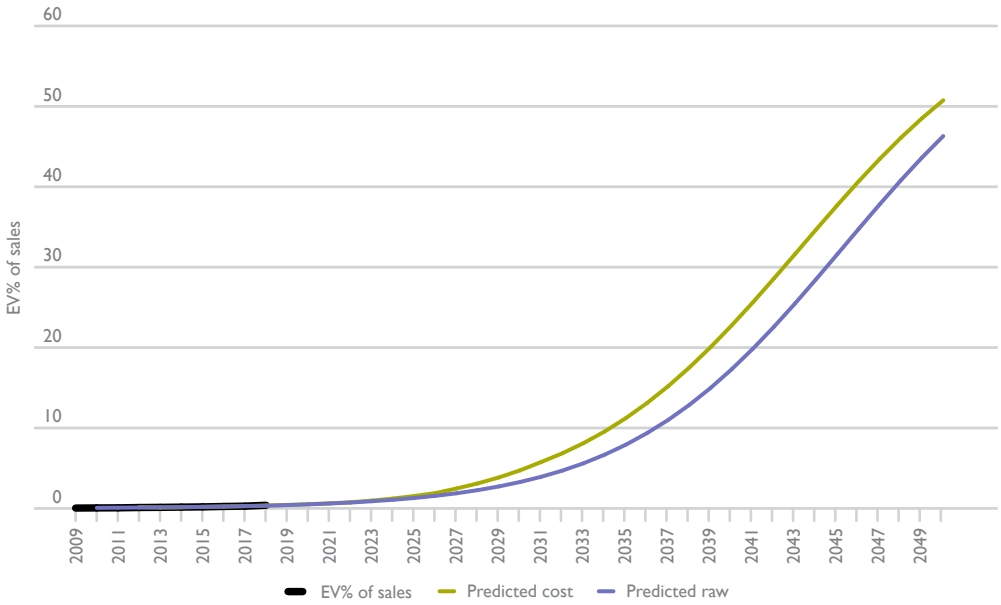
Table 3.33 shows past and forecast BEV and FFV costs used to generate a time series of the ratio of EV to FFV annual costs. Costs include principal (repay over 5 years), interest (13 per cent per year), annual EV subsidies, and petrol costs for FFV (with increasing fuel efficiency and a medium petrol price).

Table 3.33 EV/FFV cost ratio calculations for India

	Evs	Evs	Evs	Evs	Evs	FFVs	FFVs	FFVs	FFVs	FFVs	EV/ FFV
	EV price	Principal	Interest	Annual subs	Annual cost	FFV price	Principal	Interest	Fuel	Annual cost	Cost ratio
2012	1691874	338375	219944	0	558318	1432620	286524	186241	60631	533396	1.05
2013	2299738	459948	298966	0	758914	1615011	323002	209951	55765	588719	1.29
2014	2402593	480519	312337	0	792856	1683470	336694	218851	52209	607754	1.30
2015	2345300	469060	304889	0	773949	1843085	368617	239601	43611	651829	1.19
2016	2512347	502469	326605	0	829074	1961662	392332	255016	43445	690794	1.20
2017	2435970	487194	316676	0	803870	1900575	380115	247075	45627	672817	1.19
2018	2489905	497981	323688	0	821668	1898650	379730	246825	49035	675589	1.22
2019	2541413	508283	330384	0	838666	1898650	379730	246825	47775	674329	1.24
2020	2529438	505888	328827	0	834715	1898650	379730	246825	47394	673949	1.24
2021	2468501	493700	320905	0	814605	1898650	379730	246825	49632	676186	1.20
2022	2507774	501555	326011	0	827565	1898650	379730	246825	51136	677691	1.22
2023	2487808	497562	323415	0	820977	1898650	379730	246825	51539	678093	1.21
2024	2401310	480262	312170	0	792432	1898650	379730	246825	51267	677821	1.17
2025	2327420	465484	302565	0	768049	1898650	379730	246825	51992	678547	1.13
2026	2286571	457314	297254	0	754568	1898650	379730	246825	53623	680177	1.11
2027	2245648	449130	291934	0	741064	1898650	379730	246825	54187	680741	1.09
2028	2199175	439835	285893	0	725728	1898650	379730	246825	54336	680891	1.07
2029	2158113	431623	280555	0	712177	1898650	379730	246825	54719	681274	1.05
2030	2111502	422300	274495	0	696796	1898650	379730	246825	54875	681429	1.02

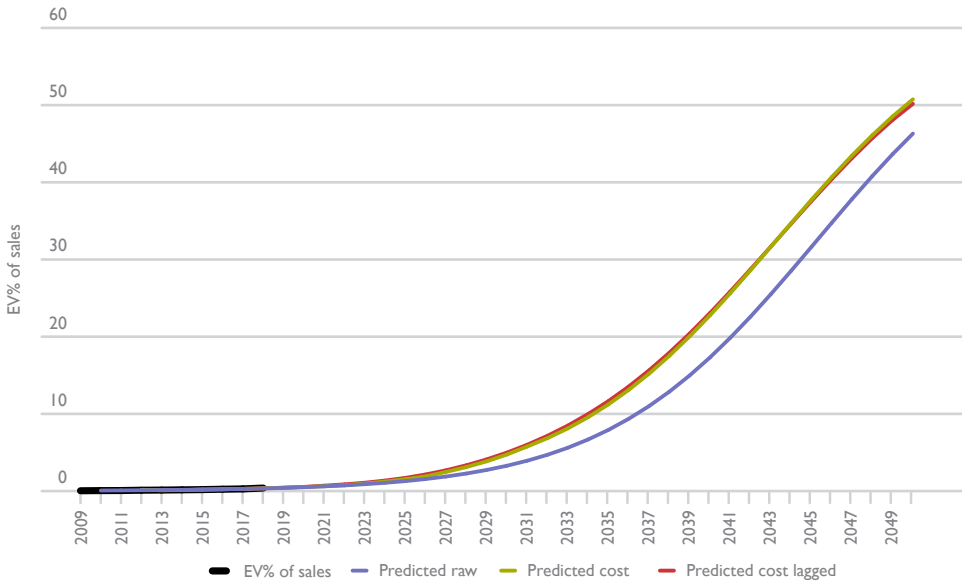
The resulting EV/FFV cost ratio time series is shown in the last column. This time series is then fed though the 2% year formula, which shifts the predicted raw uptake curve in line with shifts predicted for the cost ratio. Figure 3.84 shows the *predicted cost* curve is shifted to the left from the *predicated raw* curve. This is the result from Stage 3 of the Indian analysis.

Figure 3.84 Indian predicted raw and predicted cost EV per cent of sales curves



In Stage 4 corrections are usually made to the predicted cost uptake curves to allow for the fact that most early adopters are those with higher incomes. But the Indian curve is one of the flat curves and so no adjustment is made. The resulting Indian *predicted cost lagged* curve is shown in Figure 3.85. This is the final base-case EV uptake prediction for India.

Figure 3.85 Indian predicted cost lagged EV uptake curve

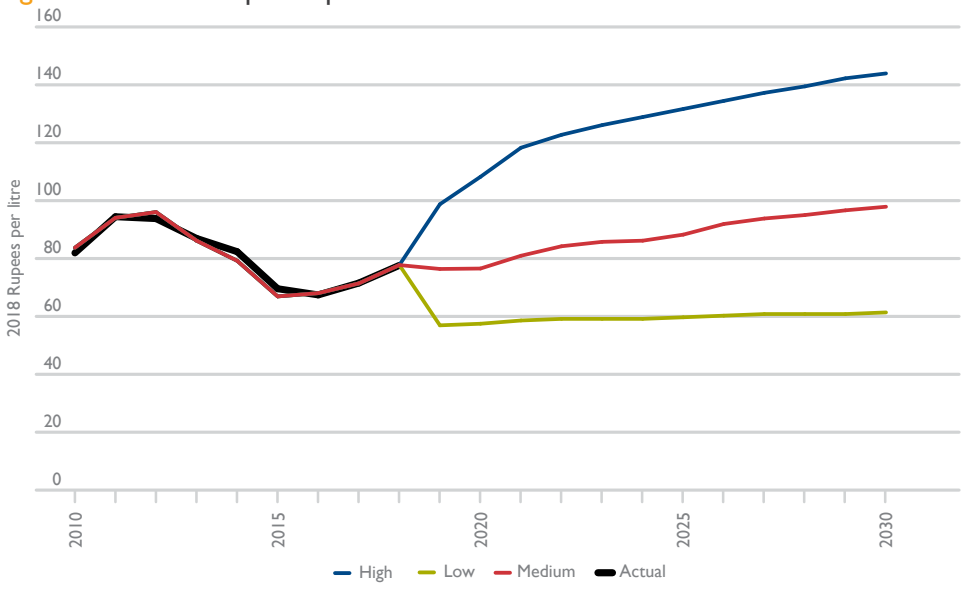


The resulting Indian uptake forecast has EVs as 1.7 per cent of sales in 2025 and 5 per cent in 2030.

Stage 5 of the analysis looks at high, medium and low scenarios for oil prices and for EV prices.

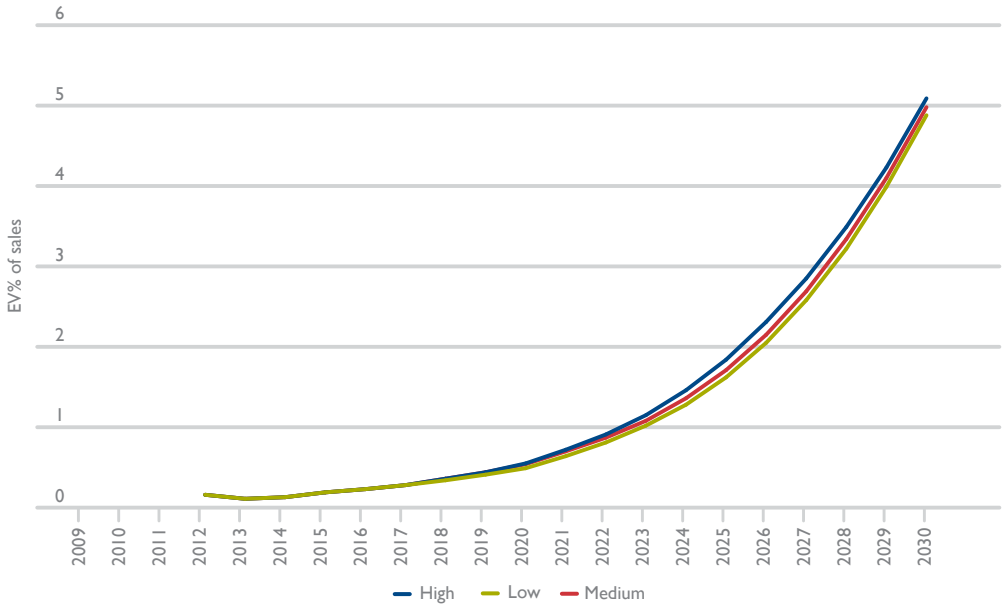
The oil price scenarios were given in Chapter 2. Corresponding Indian petrol prices have been derived from the oil to Indian petrol price equation in BITRE (2019). The resulting petrol price scenarios are shown in Figure 3.86.

Figure 3.86 Indian petrol price scenarios



When these scenario petrol prices are used in the calculation of the EV/FFV cost ratios, the following predicted cost lagged curves are generated.

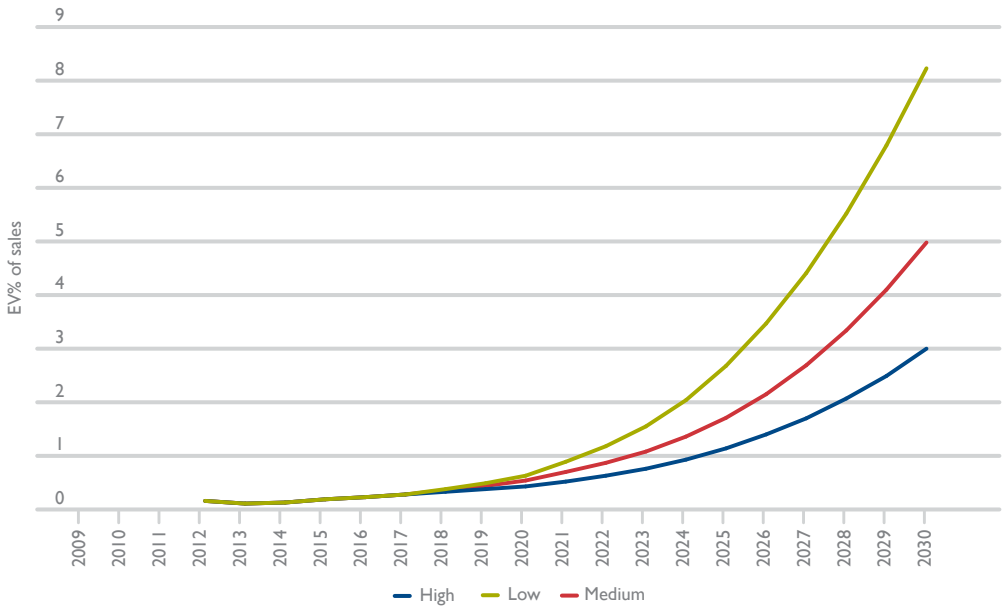
Figure 3.87 Scenarios for Indian EV uptake with high, medium and low oil prices



It can be seen that oil price scenarios make next to no difference to forecast uptake.

The second scenario test is when the prices of EVs are increased or decreased. The vehicle price scenarios were also covered in Chapter 2 (30 per cent up on the medium, 30 per cent down). When these scenario vehicle prices are used in the calculation of the EV/FFV cost ratios, the following predicted cost lagged curves are generated.

Figure 3.88 Scenarios for Indian EV uptake with high, medium and low EV prices



It can be seen that changes in vehicle prices have a large effect on projected uptake

3.12 Ireland

The linearized logistic uptake for Ireland is shown in Figure 3.89, along with a predicted curve.

The regression shown in Table 3.34 has only one variable – a time trend. It is estimated over the period 2012 to 2018.

Figure 3.89 Irish linearized logistic EV sales percentage and prediction

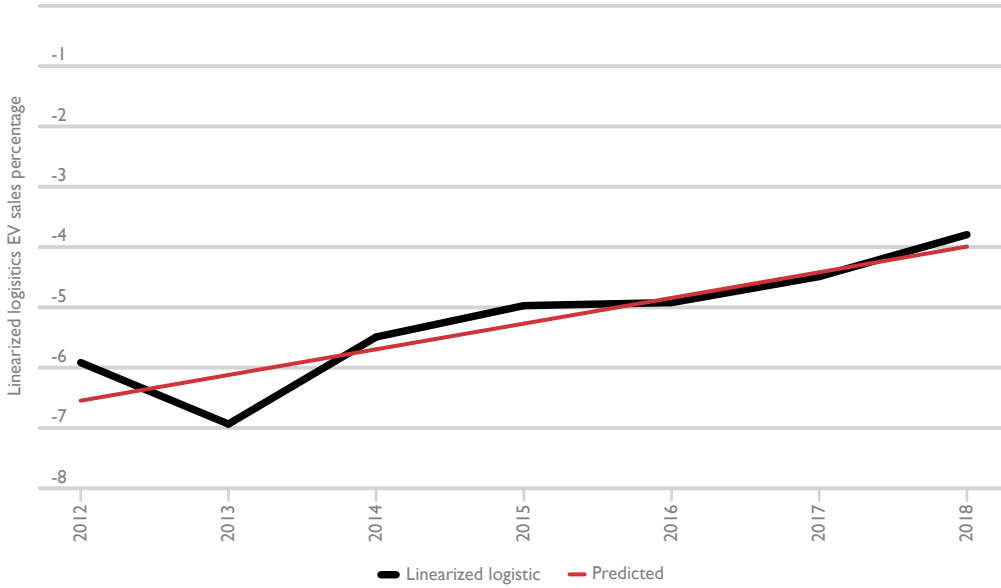


Table 3.34 Regression for Irish linearized logistic EV uptake

Regression statistics	
Multiple R	0.897108492
R Square	0.804803647
Adjusted R Square	0.765764377
Standard Error	0.496374044
Observations	7

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	5.07932929	5.07932929	20.61523271	0.006166437
Residual	5	1.231935958	0.246387192		
Total	6	6.311265248			

	Coefficients	*Standard error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-7.825204656	0.505160107	-15.49054357	2.03597E-05	-9.123760052	-6.52664926
time	0.425916209	0.093805877	4.54040006	0.006166437	0.184780526	0.667051893

Figure 3.90 shows the fit of the de-linearized *raw prediction* to the actual EV sales percentage of new passenger vehicle sales.

Figure 3.90 Irish EV sales as a percentage of passenger vehicle sales and raw prediction

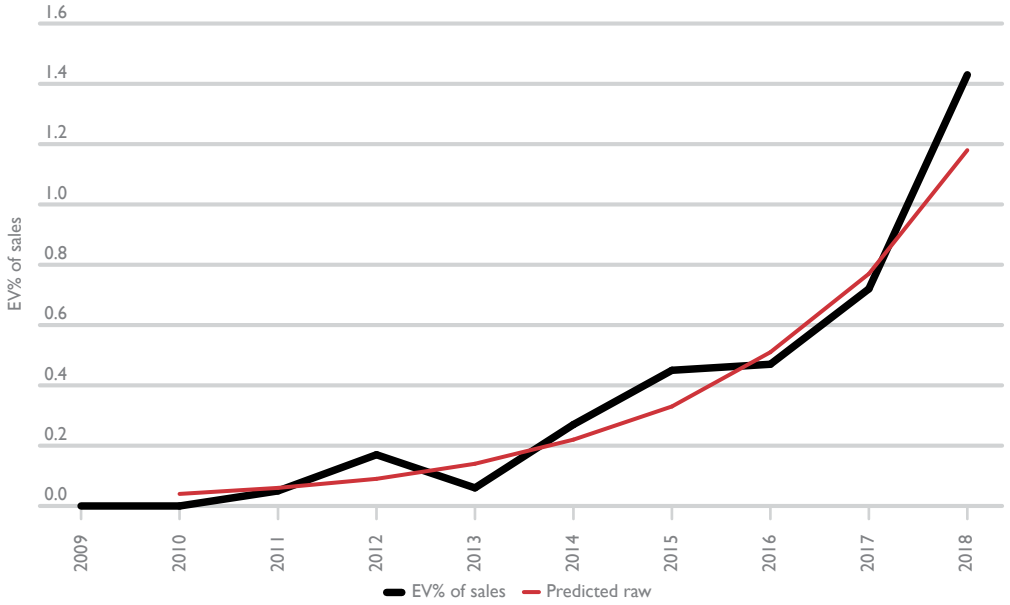
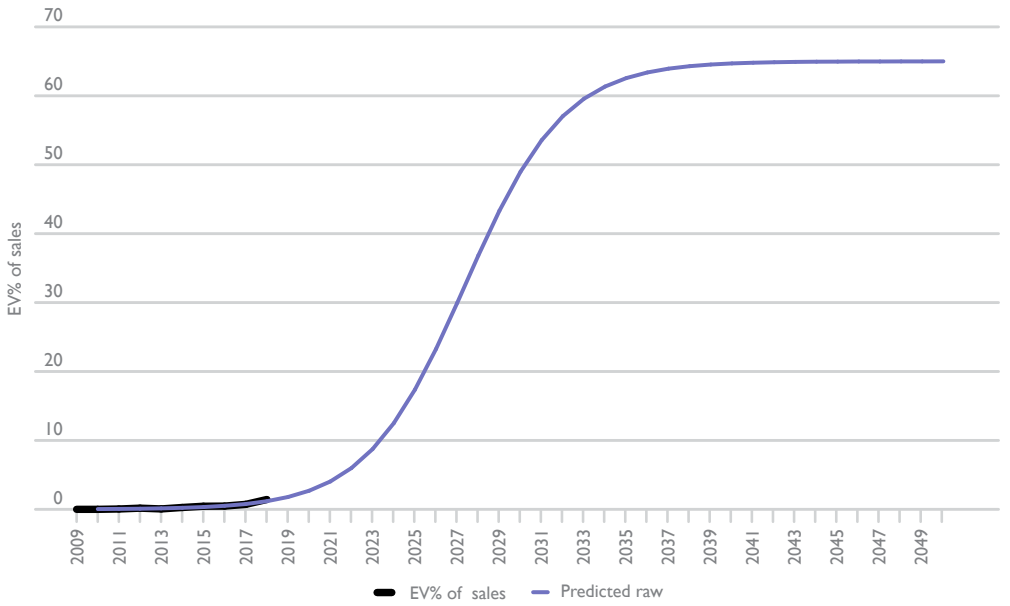


Figure 3.91 shows the extension of the forecast from this equation to 2050. This is the result of Stage 1 of the analysis.

Figure 3.91 Irish EV sales as a percentage of passenger vehicle sales and raw prediction to 2050



In Stage 2, the year that sales (or the raw prediction) pass the 2% mark is determined. For Ireland, this is 2019.

Stage 3 involves assembling past and forecast EV and FFV costs to generate a time series of the ratio of EV to FFV annual costs. Table 3.35 shows the prices of BEVs, PHEVs and FFVs in Ireland.

Table 3.35 Prices of BEVs, PHEVs and FFVs in Ireland

BEV	2017 US$ ('000)	Euros	Euros	%	Euros	Euros				Euros
	BEV base	BEV base	Veh rego tax	VAT%	VAT	BEV price	Co. tax write-off	Purchase subsidy	Home charging	BEV price
2009	30	21302	121	21	4457	25880		0	1450	27330
2010	30	22760	435	21	4763	27958		0	1450	29408
2011	30	21463	243	21	4491	26198		0	835	27033
2012	31	23869	930	23	5490	30289		-5037	846	26097
2013	31	23410	840	23	5384	29635		-5012	849	25471
2014	34	25404	1349	23	5843	32596		-5002	850	28443
2015	30	27178	1777	23	6251	35206		-5017	848	31037
2016	30	27202	1784	23	6257	35243		-5017	848	31074
2017	30	26462	1616	23	6086	34164		-5000	850	30014
2018	31	26003	1518	23	5981	33502	-2094	-4983	852	27277
2019	31	26497	1658	23	6094	34249	-2141	-4966	854	27997
2020	31	26338	1635	23	6058	34031	-2127	-4949	856	27811
2021	30	25676	1486	23	5905	33067	-2067	-4933	858	26926
2022	31	26046	1596	23	5991	33632	-2102	-4916	860	27475
2023	30	25807	1553	23	5936	33296	-2081	-4899	862	27178
2024	29	24884	1338	23	5723	31946	-1997	-4883	864	25931
2025	28	24092	1157	23	5541	30790	-1924	-4866	866	24866
2026	28	23640	1061	23	5437	30138	-1884	-4850	868	24273
2027	27	23189	964	23	5333	29487	-1843	-4833	870	23681
2028	27	22681	854	23	5217	28751	-1797	-4817	872	23010
2029	26	22230	757	23	5113	28099	-1756	-4800	874	22417
2030	26	21722	646	23	4996	27364	-1710	-4784	876	21746

PHEV	2017 US$ ('000)	Euros	Euros	%	Euros	Euros				Euros
	PHEV base	PHEV base	Veh rego tax	VAT%	VAT	PHEV price	Co. tax write-off	Purchase subsidy	Home charging	PHEV price
2009	30	21302	5326	21	4457	31085		0	1450	32535
2010	30	22760	5690	21	4763	33213		0	1450	34663
2011	30	21463	2561	21	4491	28516		0	835	29351
2012	31	23869	2519	23	5490	31877		0	846	32723
2013	31	23410	2506	23	5384	31300		0	849	32149
2014	34	25404	2501	23	5843	33748		0	850	34598
2015	30	27178	2509	23	6251	35937		-5017	848	31768
2016	30	27202	2509	23	6257	35967		-5017	848	31798
2017	30	26462	2500	23	6086	35048		-5000	850	30898
2018	31	26003	2492	23	5981	34476	-2155	-4983	852	28190
2019	31	26497	2483	23	6094	35074	-2192	-4966	854	28770
2020	31	26338	2475	23	6058	34870	-2179	-4949	856	28598
2021	30	25676	2466	23	5905	34047	-2128	-4933	858	27845
2022	31	26046	2458	23	5991	34495	-2156	-4916	860	28283
2023	30	25807	2450	23	5936	34193	-2137	-4899	862	28018
2024	29	24884	2441	23	5723	33049	-2066	-4883	864	26965
2025	28	24092	2433	23	5541	32066	-2004	-4866	866	26062
2026	28	23640	2425	23	5437	31503	-1969	-4850	868	25552
2027	27	23189	2417	23	5333	30939	-1934	-4833	870	25042
2028	27	22681	2408	23	5217	30306	-1894	-4817	872	24467
2029	26	22230	2400	23	5113	29743	-1859	-4800	874	23957
2030	26	21722	2392	23	4996	29110	-1819	-4784	876	23382

Table 3.35 Prices of BEVs, PHEVs and FFVs in Ireland (continued)

FFV	2017 US$ ('000)	Euros	Euros	%	Euros	Euros
	FFV base	FFV base	veh rego tax	VAT%	VAT	FFV price
2009	23	16556	4139	21	3464	24160
2010	23	17449	4362	21	3651	25463
2011	23	16455	4114	21	3443	24012
2012	23	17800	4450	23	4094	26344
2013	23	17288	4322	23	3976	25587
2014	23	17420	4355	23	4007	25781
2015	23	20836	5209	23	4792	30838
2016	23	20855	5214	23	4797	30866
2017	23	20288	5072	23	4666	30026
2018	23	19550	4888	23	4497	28934
2019	23	19550	4888	23	4497	28934
2020	23	19550	4888	23	4497	28934
2021	23	19550	4888	23	4497	28934
2022	23	19550	4888	23	4497	28934
2023	23	19550	4888	23	4497	28934
2024	23	19550	4888	23	4497	28934
2025	23	19550	4888	23	4497	28934
2026	23	19550	4888	23	4497	28934
2027	23	19550	4888	23	4497	28934
2028	23	19550	4888	23	4497	28934
2029	23	19550	4888	23	4497	28934
2030	23	19550	4888	23	4497	28934

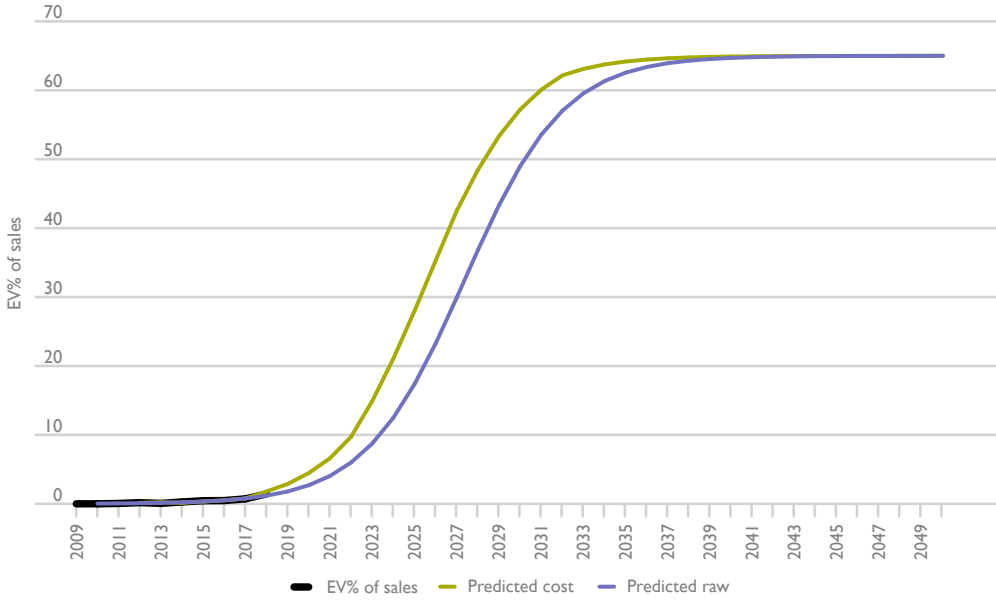
Table 3.36 shows past and forecast BEV and FFV costs used to generate a time series of the ratio of EV to FFV annual costs. Costs include principal (repay over 5 years), interest (13 per cent per year), annual EV subsidies, and petrol costs for FFV (with increasing fuel efficiency and a medium petrol price).

Table 3.36 EV/FFV cost ratio calculations for Ireland

	Evs	Evs	Evs	Evs	Evs	FFVs	FFVs	FFVs	FFVs	FFVs	EV/ FFV
	EV price	principal	interest	annual subs	Annual cost	FFV price	principal	interest	fuel	Annual cost	cost ratio
2012	26097	5219	3393	0	8612	26344	5269	3425	1378	10072	0.86
2013	25471	5094	3311	0	8405	25587	5117	3326	1337	9781	0.86
2014	28443	5689	3698	0	9386	25781	5156	3352	1270	9778	0.96
2015	31037	6207	4035	0	10242	30838	6168	4009	1128	11304	0.91
2016	31074	6215	4040	0	10254	30866	6173	4013	1046	11232	0.91
2017	30014	6003	3902	0	9905	30026	6005	3903	1098	11006	0.90
2018	27277	5455	3546	0	9001	28934	5787	3761	1129	10677	0.84
2019	27997	5599	3640	0	9239	28934	5787	3761	1109	10658	0.87
2020	27811	5562	3615	0	9178	28934	5787	3761	1100	10648	0.86
2021	26926	5385	3500	0	8886	28934	5787	3761	1124	10672	0.83
2022	27475	5495	3572	0	9067	28934	5787	3761	1139	10687	0.85
2023	27178	5436	3533	0	8969	28934	5787	3761	1140	10688	0.84
2024	25931	5186	3371	0	8557	28934	5787	3761	1132	10680	0.80
2025	24866	4973	3233	0	8206	28934	5787	3761	1136	10685	0.77
2026	24273	4855	3156	0	8010	28934	5787	3761	1153	10701	0.75
2027	23681	4736	3078	0	7815	28934	5787	3761	1156	10704	0.73
2028	23010	4602	2991	0	7593	28934	5787	3761	1154	10702	0.71
2029	22417	4483	2914	0	7398	28934	5787	3761	1154	10702	0.69
2030	21746	4349	2827	0	7176	28934	5787	3761	1152	10700	0.67

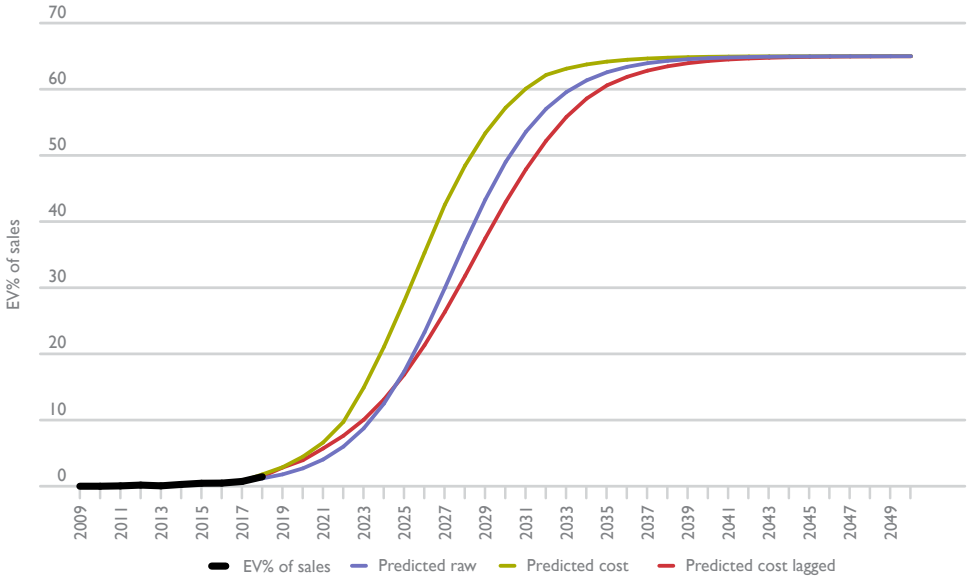
The resulting EV/FFV cost ratio time series is shown in the last column. This time series is then fed though the 2% year formula, which shifts the predicted raw uptake curve in line with shifts predicted for the cost ratio. Figure 3.92 shows the *predicted cost* curve is shifted to the left from the *predicated raw* curve. This is the result from Stage 3 of the Irish analysis.

Figure 3.92 Irish predicted raw and predicted cost EV per cent of sales curves



In Stage 4 corrections are usually made to the predicted cost uptake curves to allow for the fact that most early adopters are those with higher incomes. The resulting Irish predicted *cost lagged* curve – which is a less steeply rising curve – is shown in Figure 3.93. This is the final base-case EV uptake prediction for India.

Figure 3.93 Irish predicted cost lagged EV uptake curve

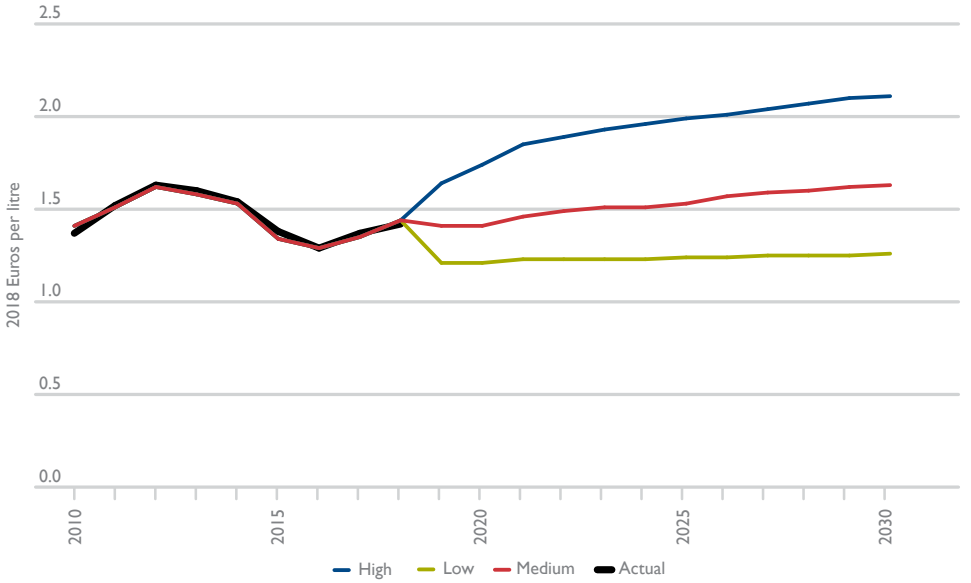


The resulting Irish uptake forecast has EVs as 17 per cent of sales in 2025 and 43 per cent in 2030.

Stage 5 of the analysis looks at high, medium and low scenarios for oil prices and for EV prices.

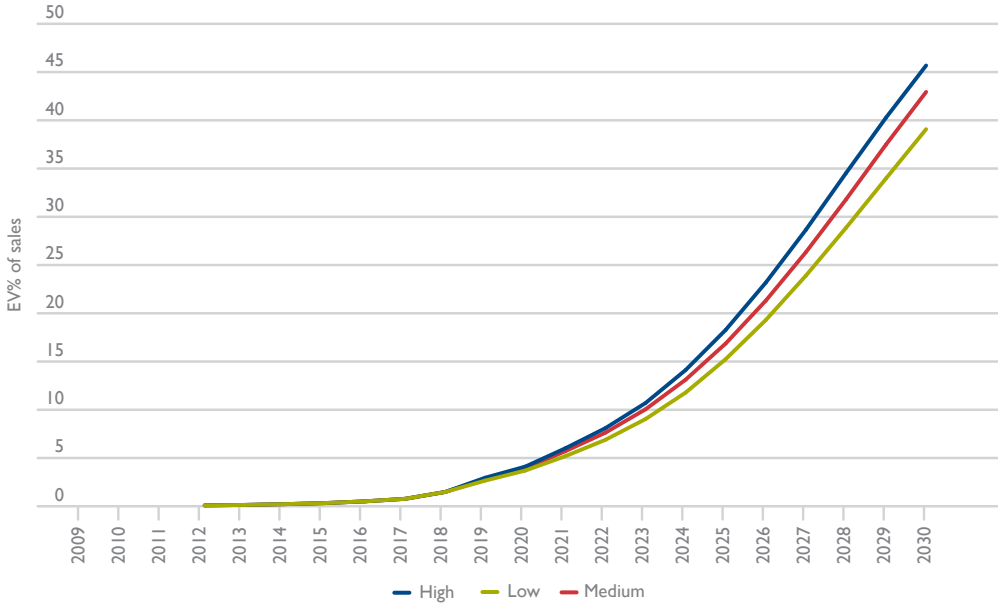
The oil price scenarios were given in Chapter 2. Corresponding Irish petrol prices have been derived from the oil to Irish petrol price equation in BITRE (2019). The resulting petrol price scenarios are shown in Figure 3.94.

Figure 3.94 Irish petrol price scenarios



When these scenario petrol prices are used in the calculation of the EV/FFV cost ratios, the following predicted cost lagged curves are generated.

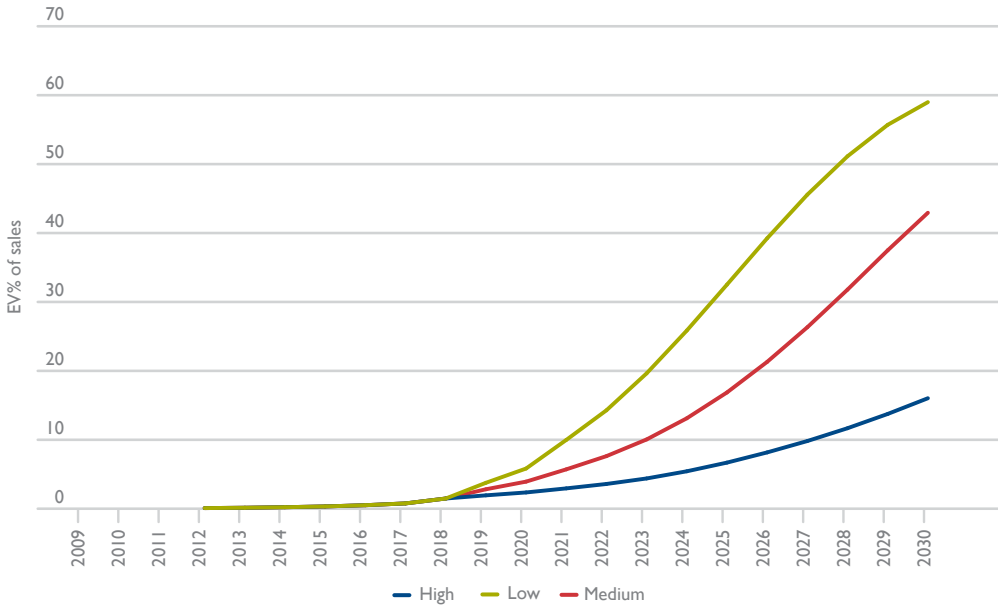
Figure 3.95 Scenarios for Irish EV uptake with high, medium and low oil prices



It can be seen that oil price scenarios make very little difference to forecast uptake.

The second scenario test is when the prices of EVs are increased or decreased. The vehicle price scenarios were also covered in Chapter 2 (30 per cent up on the medium, 30 per cent down). When these scenario vehicle prices are used in the calculation of the EV/FFV cost ratios, the following predicted cost lagged curves are generated.

Figure 3.96 Scenarios for Irish EV uptake with high, medium and low EV prices



It can be seen that changes in vehicle prices have a large effect on projected uptake

3.13 Italy

The linearized logistic uptake for Italy is shown in Figure 3.97, along with a predicted curve.

The regression shown in Table 3.37 has three variables – a time trend, a dummy for 2016 to 2017 and a dummy for 2013 to 2014. It is estimated over the period 2012 to 2018.

Figure 3.97 Italian linearized logistic EV sales percentage and prediction

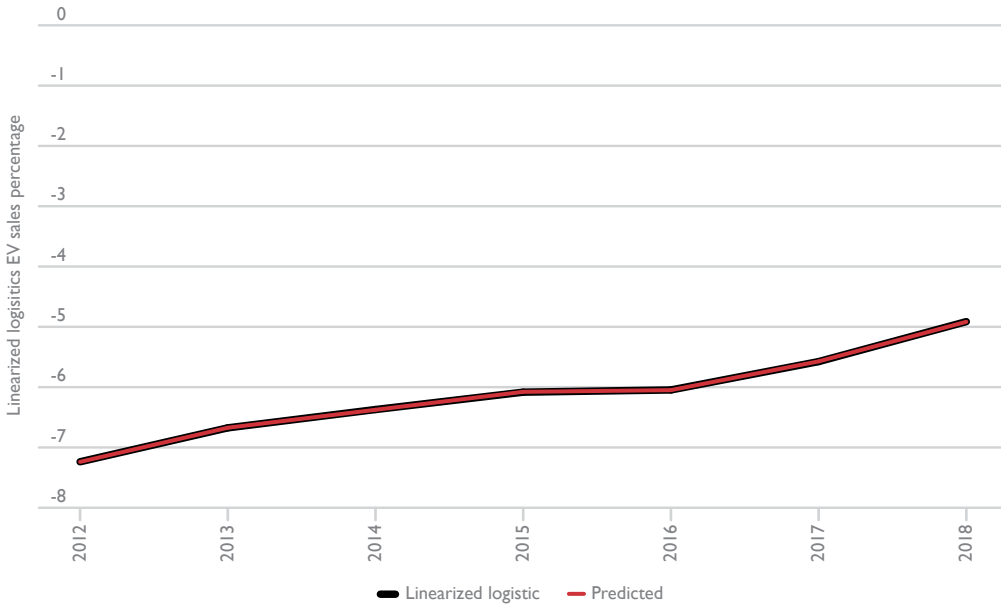


Table 3.37 Regression for Italian linearized logistic EV uptake

Regression statistics	
Multiple R	0.999987397
R Square	0.999974795
Adjusted R Square	0.999949589
Standard Error	0.005327113
Observations	7

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	3.377546627	1.125848876	39673.11529	2.14825E-07
Residual	3	8.51344E-05	2.83781E-05		
Total	6	3.377631761			

	Coefficients	*Standard error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-8.400351434	0.007979693	-1052.716055	1.89032E-09	-8.42574638	-8.374956488
time	0.387088346	0.001222521	316.63131	6.94694E-08	0.38319774	0.390978953
dum1617	-0.358794592	0.005714145	-62.7905958	8.90001E-06	-0.376979553	-0.340609631
dum1314	0.178832034	0.00646098	27.67877658	0.000103513	0.15827031	0.199393757

Figure 3.98 shows the fit of the de-linearized *raw prediction* to the actual EV sales percentage of new passenger vehicle sales.

Figure 3.98 Italian EV sales as a percentage of passenger vehicle sales and raw prediction

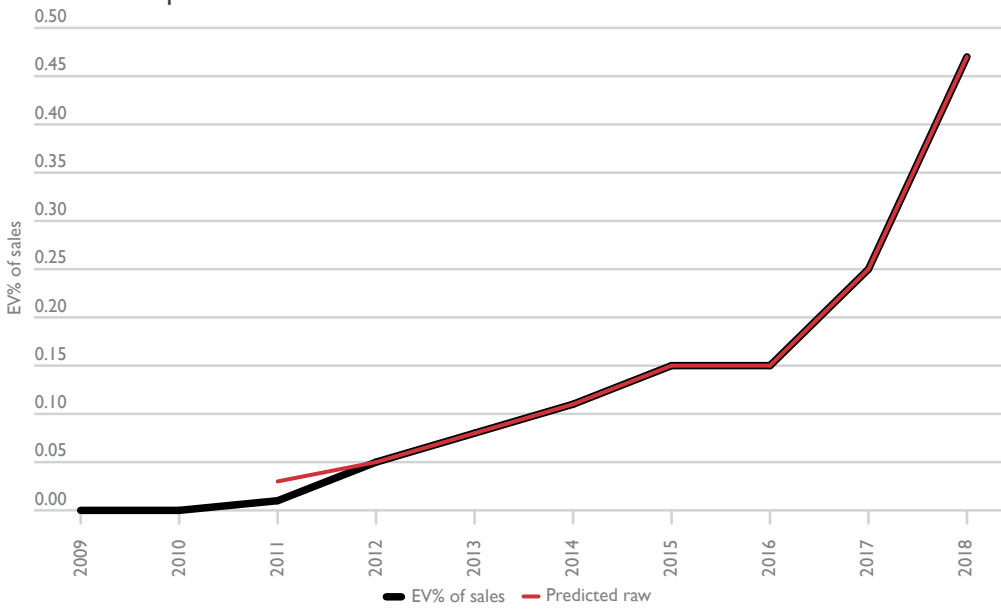
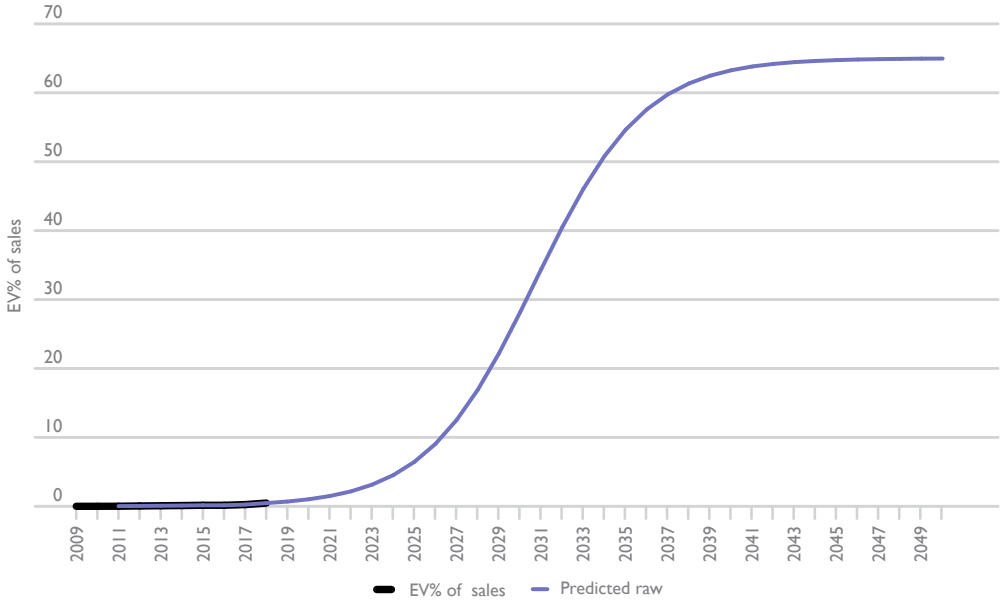


Figure 3.99 shows the extension of the forecast from this equation to 2050. This is the result of Stage 1 of the analysis.

Figure 3.99 Italian EV sales as a percentage of passenger vehicle sales and raw prediction to 2050



In Stage 2, the year that sales (or the raw prediction) pass the 2% mark is determined. For Italy, this is 2021.

Stage 3 involves assembling past and forecast EV and FFV costs to generate a time series of the ratio of EV to FFV annual costs. Table 3.38 shows the prices of BEVs, PHEVs and FFVs in Italy.

Table 3.38 Prices of BEVs, PHEVs and FFVs in Italy

BEV	2017 US$ ('000)	Euros	%	Euros	Euros	Euros	Euros	Euros
	BEV base	BEV base	VAT%	VAT	BEV price	Purchase subsidy	Home charging	BEV price
2009	30	21302	20	4260	25562	0	1450	27012
2010	30	22760	20	4552	27312	0	1450	28762
2011	30	21463	20	4293	25756	0	1450	27206
2012	31	23869	21	5012	28881	0	1450	30331
2013	31	23410	21	4916	28326	0	1450	29776
2014	34	25404	22	5589	30993	-3000	1450	29443
2015	30	27178	22	5979	33157	0	1450	34607
2016	30	27202	22	5985	33187	0	1450	34637
2017	30	26462	22	5822	32284	0	1450	33734
2018	31	26003	22	5721	31724	0	1450	33174
2019	31	26497	22	5829	32326	0	1450	33776
2020	31	26338	22	5794	32132	0	1450	33582
2021	30	25676	22	5649	31324	0	1450	32774
2022	31	26046	22	5730	31776	0	1450	33226
2023	30	25807	22	5678	31485	0	1450	32935
2024	29	24884	22	5475	30359	0	1450	31809
2025	28	24092	22	5300	29392	0	1450	30842
2026	28	23640	22	5201	28841	0	1450	30291
2027	27	23189	22	5102	28291	0	1450	29741
2028	27	22681	22	4990	27671	0	1450	29121
2029	26	22230	22	4891	27120	0	1450	28570
2030	26	21722	22	4779	26501	0	1450	27951

PHEV	2017 US$ ('000)	Euros	%	Euros	Euros	Euros	Euros	Euros
	PHEV base	PHEV base	VAT%	VAT	PHEV price	Purchase subsidy	Home charging	PHEV price
2009	30	21302	20	4260	25562	0	1450	27012
2010	30	22760	20	4552	27312	0	1450	28762
2011	30	21463	20	4293	25756	0	1450	27206
2012	31	23869	21	5012	28881	0	1450	30331
2013	31	23410	21	4916	28326	0	1450	29776
2014	34	25404	22	5589	30993	-3000	1450	29443
2015	30	27178	22	5979	33157	0	1450	34607
2016	30	27202	22	5985	33187	0	1450	34637
2017	30	26462	22	5822	32284	0	1450	33734
2018	31	26003	22	5721	31724	0	1450	33174
2019	31	26497	22	5829	32326	0	1450	33776
2020	31	26338	22	5794	32132	0	1450	33582
2021	30	25676	22	5649	31324	0	1450	32774
2022	31	26046	22	5730	31776	0	1450	33226
2023	30	25807	22	5678	31485	0	1450	32935
2024	29	24884	22	5475	30359	0	1450	31809
2025	28	24092	22	5300	29392	0	1450	30842
2026	28	23640	22	5201	28841	0	1450	30291
2027	27	23189	22	5102	28291	0	1450	29741
2028	27	22681	22	4990	27671	0	1450	29121
2029	26	22230	22	4891	27120	0	1450	28570
2030	26	21722	22	4779	26501	0	1450	27951

Table 3.38 Prices of BEVs, PHEVs and FFVs in Italy (continued)

FFV	2017 US$ (000')	Euros	%	Euros	Euros
	FFV base	FFV base	VAT%	VAT	FFV price
2009	23	16556	20	3311	19868
2010	23	17449	20	3490	20939
2011	23	16455	20	3291	19746
2012	23	17800	21	3738	21538
2013	23	17288	21	3631	20919
2014	23	17420	22	3832	21252
2015	23	20836	22	4584	25420
2016	23	20855	22	4588	25443
2017	23	20288	22	4463	24751
2018	23	19550	22	4301	23851
2019	23	19550	22	4301	23851
2020	23	19550	22	4301	23851
2021	23	19550	22	4301	23851
2022	23	19550	22	4301	23851
2023	23	19550	22	4301	23851
2024	23	19550	22	4301	23851
2025	23	19550	22	4301	23851
2026	23	19550	22	4301	23851
2027	23	19550	22	4301	23851
2028	23	19550	22	4301	23851
2029	23	19550	22	4301	23851
2030	23	19550	22	4301	23851

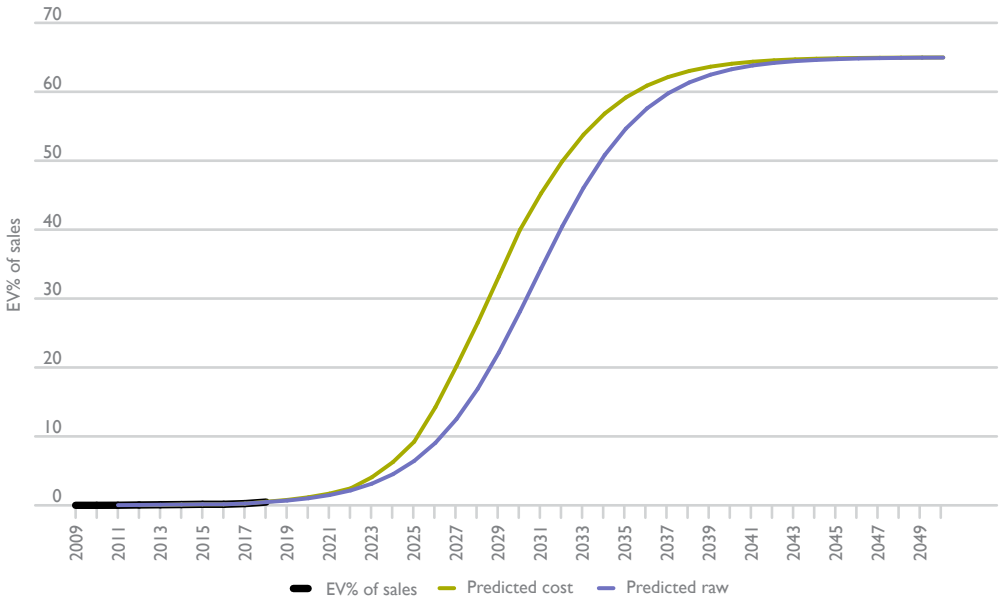
Table 3.39 shows past and forecast BEV and FFV costs used to generate a time series of the ratio of EV to FFV annual costs. Costs include principal (repay over 5 years), interest (13 per cent per year), annual EV subsidies, and petrol costs for FFV (with increasing fuel efficiency and a medium petrol price).

Table 3.39 EV/FFV cost ratio calculations for Italy

	Evs	Evs	Evs	Evs	Evs	FFVs	FFVs	FFVs	FFVs	FFVs	EV/FFV
	EV price	Principal	Interest	Annual subs	Annual cost	FFV price	Principal	Interest	Fuel	Annual cost	Cost ratio
2012	30331	6066	3943	0	10009	21538	4308	2800	944	8052	1.24
2013	29776	5955	3871	0	9826	20919	4184	2719	920	7823	1.26
2014	29443	5889	3828	810	8906	21252	4250	2763	904	7917	1.12
2015	34607	6921	4499	810	10610	25420	5084	3305	773	9162	1.16
2016	34637	6927	4503	810	10620	25443	5089	3308	749	9146	1.16
2017	33734	6747	4385	810	10322	24751	4950	3218	776	8944	1.15
2018	33174	6635	4313	810	10137	23851	4770	3101	796	8667	1.17
2019	33776	6755	4391	810	10336	23851	4770	3101	786	8657	1.19
2020	33582	6716	4366	810	10272	23851	4770	3101	779	8650	1.19
2021	32774	6555	4261	810	10006	23851	4770	3101	796	8667	1.15
2022	33226	6645	4319	810	10155	23851	4770	3101	806	8677	1.17
2023	32935	6587	4282	810	10059	23851	4770	3101	806	8677	1.16
2024	31809	6362	4135	810	9687	23851	4770	3101	801	8671	1.12
2025	30842	6168	4009	810	9368	23851	4770	3101	804	8675	1.08
2026	30291	6058	3938	810	9186	23851	4770	3101	816	8686	1.06
2027	29741	5948	3866	810	9004	23851	4770	3101	818	8688	1.04
2028	29121	5824	3786	810	8800	23851	4770	3101	816	8687	1.01
2029	28570	5714	3714	810	8618	23851	4770	3101	816	8687	0.99
2030	27951	5590	3634	810	8414	23851	4770	3101	814	8685	0.97

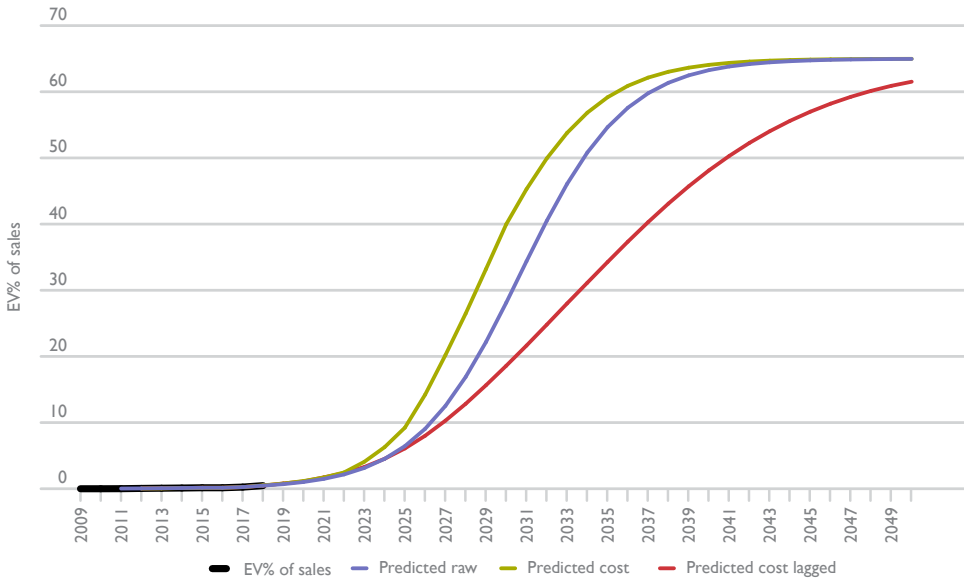
The resulting EV/FFV cost ratio time series is shown in the last column. This time series is then fed though the 2% year formula, which shifts the predicted raw uptake curve in line with shifts predicted for the cost ratio. Figure 3.100 shows the *predicted cost* curve is shifted to the left from the *predicated raw* curve. This is the result from Stage 3 of the Italian analysis.

Figure 3.100 Italian predicted raw and predicted cost EV per cent of sales curves



In Stage 4 corrections are usually made to the predicted cost uptake curves to allow for the fact that most early adopters are those with higher incomes. The resulting Italian predicted *cost lagged* curve – which is a less steeply rising curve – is shown in Figure 3.101. This is the final base-case EV uptake prediction for Italy.

Figure 3.101 Italian predicted cost lagged EV uptake curve

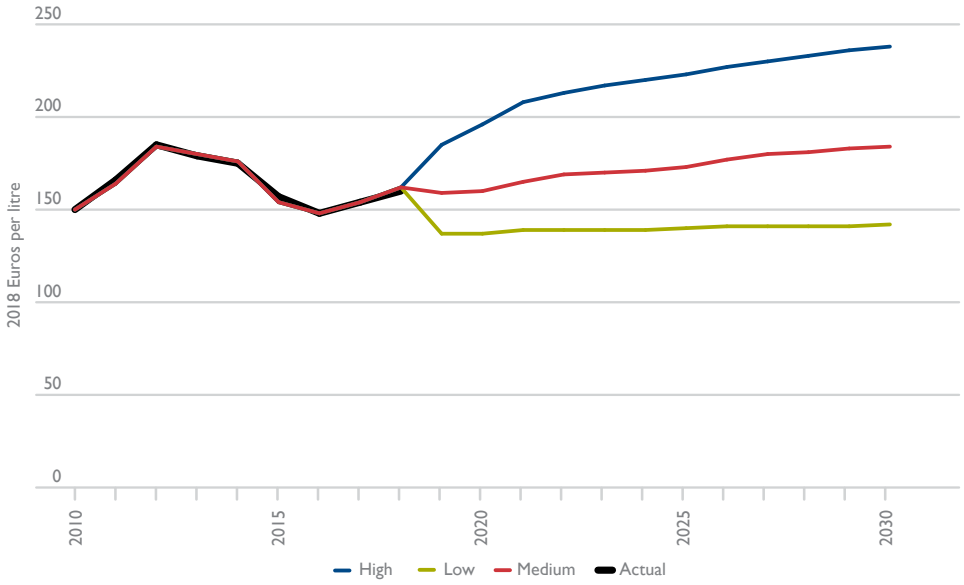


The resulting Italian uptake forecast has EVs as 6 per cent of sales in 2025 and 19 per cent in 2030.

Stage 5 of the analysis looks at high, medium and low scenarios for oil prices and for EV prices.

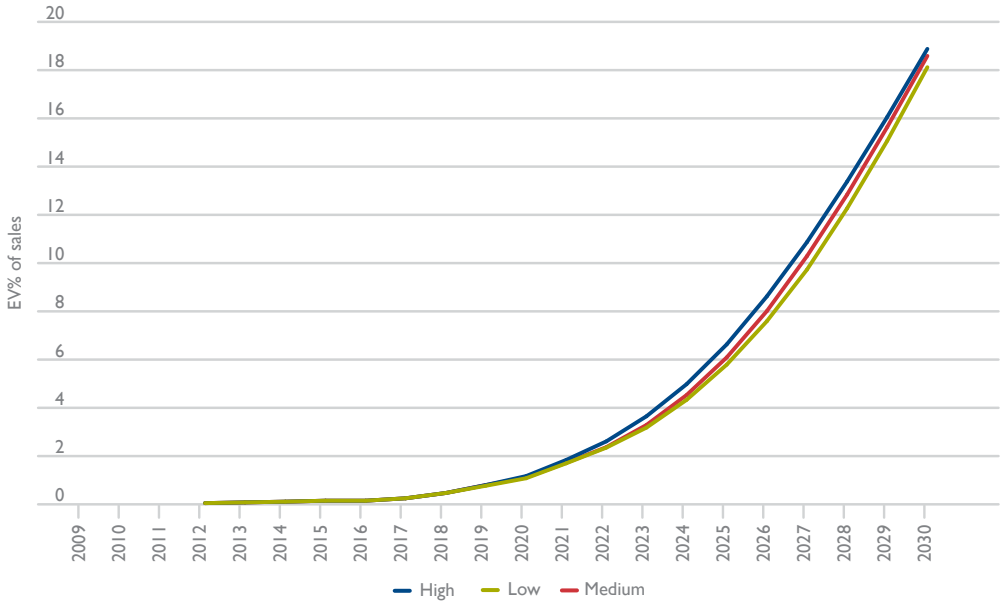
The oil price scenarios were given in Chapter 2. Corresponding Italian petrol prices have been derived from the oil to Italian petrol price equation in BITRE (2019). The resulting petrol price scenarios are shown in Figure 3.102.

Figure 3.102 Italian petrol price scenarios



When these scenario petrol prices are used in the calculation of the EV/FFV cost ratios, the following predicted cost lagged curves are generated.

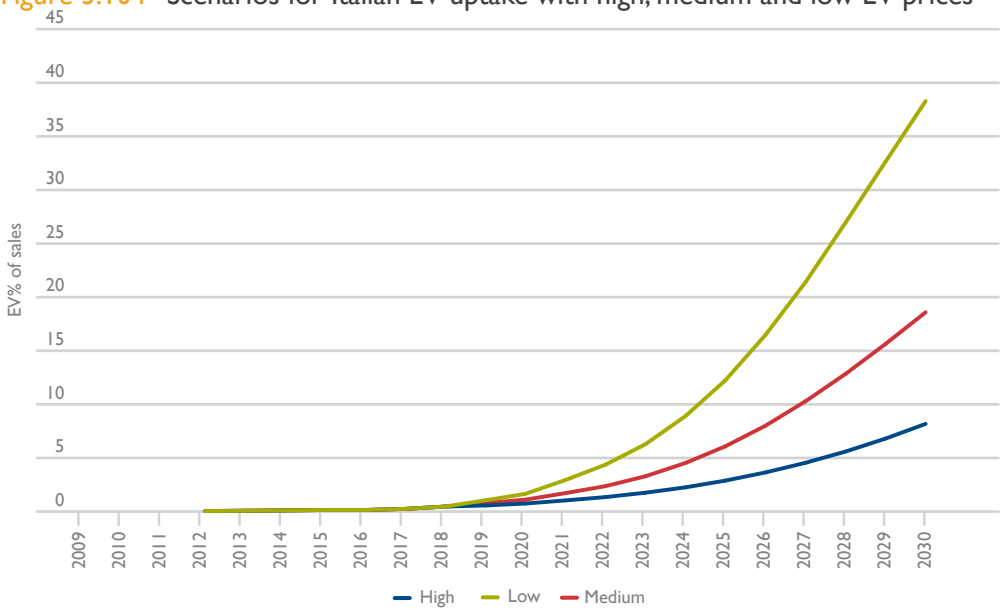
Figure 3.103 Scenarios for Italian EV uptake with high, medium and low oil prices



It can be seen that oil price scenarios make next to no difference to forecast uptake.

The second scenario test is when the prices of EVs are increased or decreased. The vehicle price scenarios were also covered in Chapter 2 (30 per cent up on the medium, 30 per cent down). When these scenario vehicle prices are used in the calculation of the EV/FFV cost ratios, the following predicted cost lagged curves are generated.

Figure 3.104 Scenarios for Italian EV uptake with high, medium and low EV prices



It can be seen that changes in vehicle prices have a large effect on projected uptake

3.14 Japan

The linearized logistic uptake for Japan is shown in Figure 3.105, along with a predicted curve.

The regression shown in Table 3.40 has two variables – a time trend and a dummy for 2014 to 2016. It is estimated over the period 2012 to 2018.

Figure 3.105 Japanese linearized logistic EV sales percentage and prediction

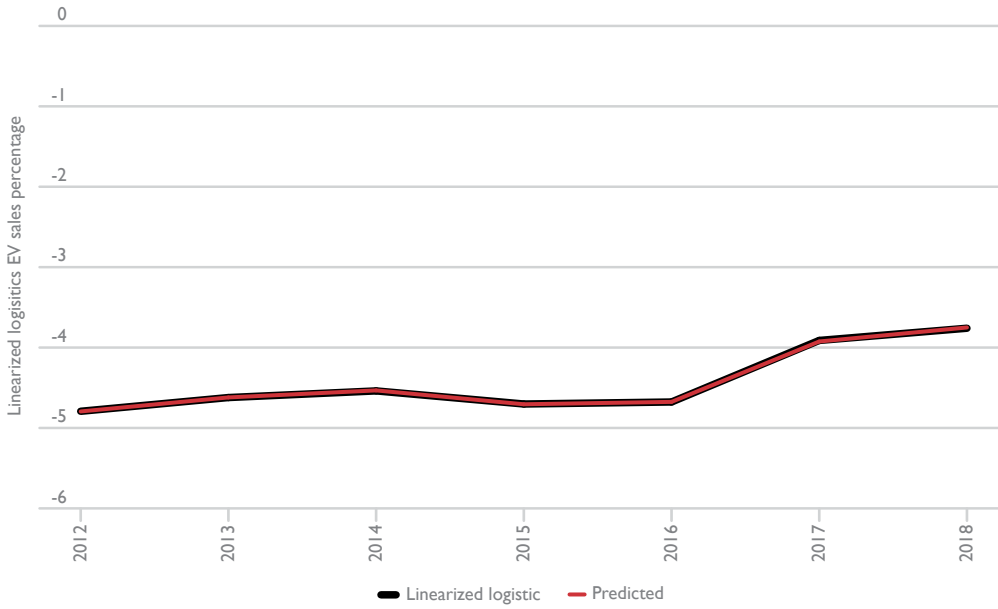


Table 3.40 Regression for Japanese linearized logistic EV uptake

Regression statistics	
Multiple R	0.999848383
R Square	0.99969679
Adjusted R Square	0.999545185
Standard Error	0.00885037
Observations	7

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	1.033016303	0.516508152	6594.082313	9.19365E-08
Residual	4	0.000313316	7.8329E-05		
Total	6	1.033329619			

	Coefficients	*Standard error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-5.316375578	0.010606462	-501.2392779	9.50516E-11	-5.345823839	-5.286927318
time	0.173989034	0.001693116	102.762607	5.37696E-08	0.16928819	0.178689878
dum1416	-0.577069034	0.008664009	-66.60531291	3.04413E-07	-0.601124179	-0.553013888

Figure 3.106 shows the fit of the de-linearized *raw prediction* to the actual EV sales percentage of new passenger vehicle sales.

Figure 3.106 Japanese EV sales as a percentage of passenger vehicle sales and raw prediction

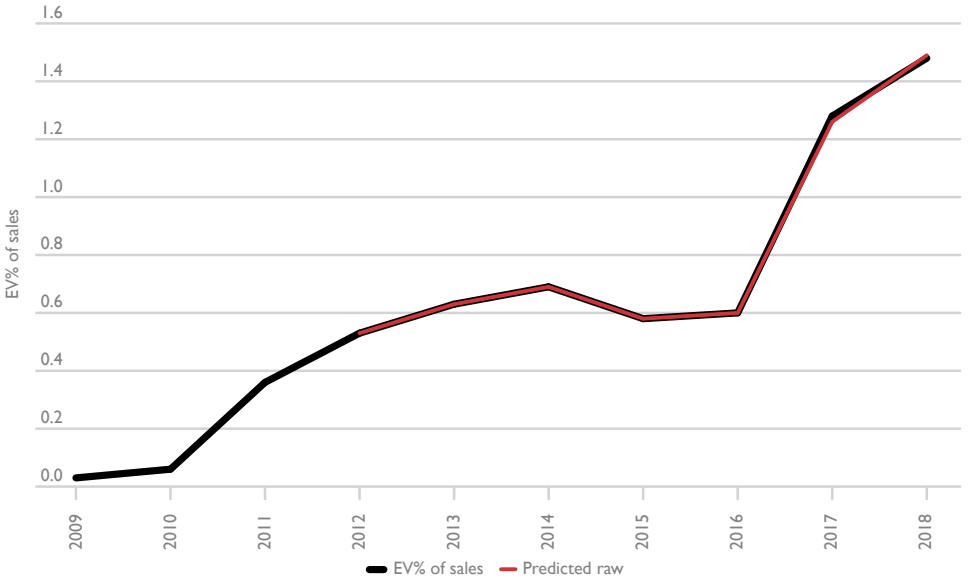
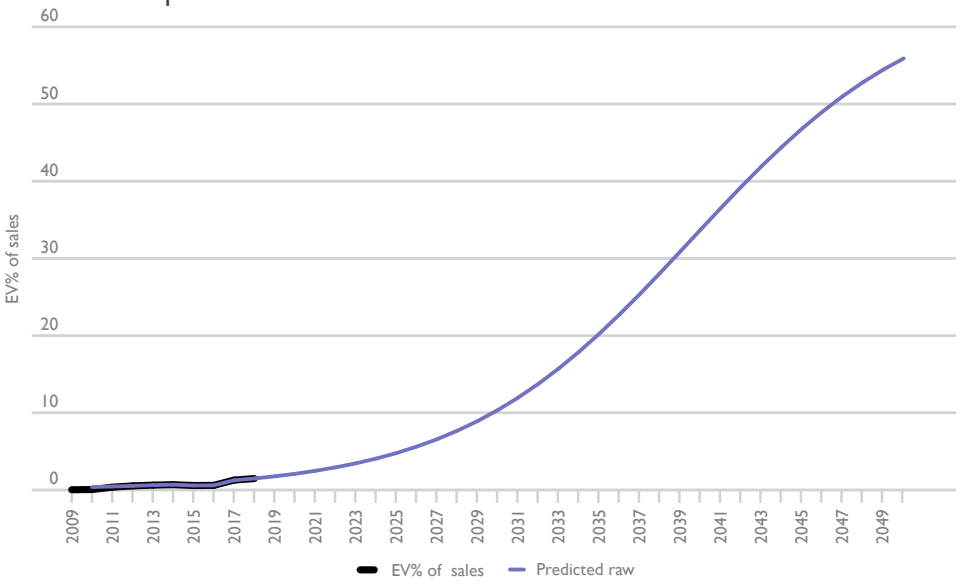


Figure 3.107 shows the extension of the forecast from this equation to 2050. This is the result of Stage 1 of the analysis.

Figure 3.107 Japanese EV sales as a percentage of passenger vehicle sales and raw prediction to 2050



In Stage 2, the year that sales (or the raw prediction) pass the 2% mark is determined. For Japan, this is 2020.

Stage 3 involves assembling past and forecast EV and FFV costs to generate a time series of the ratio of EV to FFV annual costs. Table 3.41 shows the prices of BEVs, PHEVs and FFVs in Japan.

Table 3.41 Prices of BEVs, PHEVs and FFVs in Japan

BEV	2017 US$ (000')	Yen	%	Yen	Yen		Yen	Yen	Yen
	BEV base	BEV base	VAT%	VAT	BEV price	EcoCar CleanEnergy	Purchase subsidy	Home charging	BEV price
2009	30	2768980	5	138449	2907429	-225734	-100000	188481	2770176
2010	30	2612774	5	130639	2743413	-209521	-100000	166454	2600347
2011	30	2388065	5	119403	2507469	-213110	-100000	161331	2355690
2012	31	2465493	5	123275	2588767	-185836	-100000	149775	2452706
2013	31	3042322	5	152116	3194438	-428450	-760580	188440	2193848
2014	34	3559194	5	177960	3737154	-141270	-889799	203149	2909235
2015	30	3628145	8	290252	3918397	-148132	-907036	193570	3056799
2016	30	3268426	8	261474	3529900	-145682	-817106	174220	2741332
2017	30	3359618	8	268769	3628387	-160000	-839904	184092	2812575
2018	31	3365131	8	269210	3634342	-218971	-841283	187647	2761735
2019	31	3429029	8	274322	3703352	-217946	-857257	187647	2815795
2020	31	3408449	8	272676	3681125	-216927	-852112	187647	2799733
2021	30	3322738	8	265819	3588557	-215912	-830684	187647	2729607
2022	31	3370670	8	269654	3640324	-214902	-842668	187647	2770401
2023	30	3339770	8	267182	3606952	-213897	-834943	187647	2745759
2024	29	3220320	8	257626	3477946	-212896	-805080	187647	2647617
2025	28	3117771	8	249422	3367193	-211900	-779443	187647	2563497
2026	28	3059350	8	244748	3304098	-210909	-764837	187647	2515998
2027	27	3000928	8	240074	3241002	-209922	-750232	187647	2468495
2028	27	2935204	8	234816	3170020	-208940	-733801	187647	2414926
2029	26	2876782	8	230143	3106925	-207963	-719196	187647	2367413
2030	26	2811058	8	224885	3035943	-206990	-702764	187647	2313835

PHEV	2017 US$ (000')	Yen	%	Yen	Yen		Yen	Yen	Yen
	PHEV base	PHEV base	VAT%	VAT	PHEV price	EcoCar CleanEnergy	Purchase subsidy	Home charging	PHEV price
2009	30	2768980	5	138449	2907429	-195636	-100000	188481	2800273
2010	30	2612774	5	130639	2743413	-181584	-100000	166454	2628283
2011	30	2388065	5	119403	2507469	-173152	-100000	161331	2395648
2012	31	2465493	5	123275	2588767	-172562	-100000	149775	2465980
2013	31	3042322	5	152116	3194438	-412581	-760580	188440	2209716
2014	34	3559194	5	177960	3737154	-141270	-889799	203149	2909235
2015	30	3628145	8	290252	3918397	-148132	-907036	193570	3056799
2016	30	3268426	8	261474	3529900	-145682	-817106	174220	2741332
2017	30	3359618	8	268769	3628387	-160000	-839904	184092	2812575
2018	31	3365131	8	269210	3634342	-218971	-841283	187647	2761735
2019	31	3429029	8	274322	3703352	-217946	-857257	187647	2815795
2020	31	3408449	8	272676	3681125	-216927	-852112	187647	2799733
2021	30	3322738	8	265819	3588557	-215912	-830684	187647	2729607
2022	31	3370670	8	269654	3640324	-214902	-842668	187647	2770401
2023	30	3339770	8	267182	3606952	-213897	-834943	187647	2745759
2024	29	3220320	8	257626	3477946	-212896	-805080	187647	2647617
2025	28	3117771	8	249422	3367193	-211900	-779443	187647	2563497
2026	28	3059350	8	244748	3304098	-210909	-764837	187647	2515998
2027	27	3000928	8	240074	3241002	-209922	-750232	187647	2468495
2028	27	2935204	8	234816	3170020	-208940	-733801	187647	2414926
2029	26	2876782	8	230143	3106925	-207963	-719196	187647	2367413
2030	26	2811058	8	224885	3035943	-206990	-702764	187647	2313835

Table 3.41 Prices of BEVs, PHEVs and FFVs in Japan (continued)

FFV	2017 US$ (000')	Yen	%	Yen	Yen
	FFV base	FFV base	VAT%	VAT	FFV price
2009	23	2152112	5	107606	2259718
2010	23	2003127	5	100156	2103283
2011	23	1830850	5	91543	1922393
2012	23	1838580	5	91929	1930509
2013	23	2246775	5	112339	2359114
2014	23	2440584	5	122029	2562613
2015	23	2781578	8	222526	3004104
2016	23	2505793	8	200463	2706257
2017	23	2575707	8	206057	2781764
2018	23	2530000	8	202400	2732400
2019	23	2530000	8	202400	2732400
2020	23	2530000	8	202400	2732400
2021	23	2530000	8	202400	2732400
2022	23	2530000	8	202400	2732400
2023	23	2530000	8	202400	2732400
2024	23	2530000	8	202400	2732400
2025	23	2530000	8	202400	2732400
2026	23	2530000	8	202400	2732400
2027	23	2530000	8	202400	2732400
2028	23	2530000	8	202400	2732400
2029	23	2530000	8	202400	2732400
2030	23	2530000	8	202400	2732400

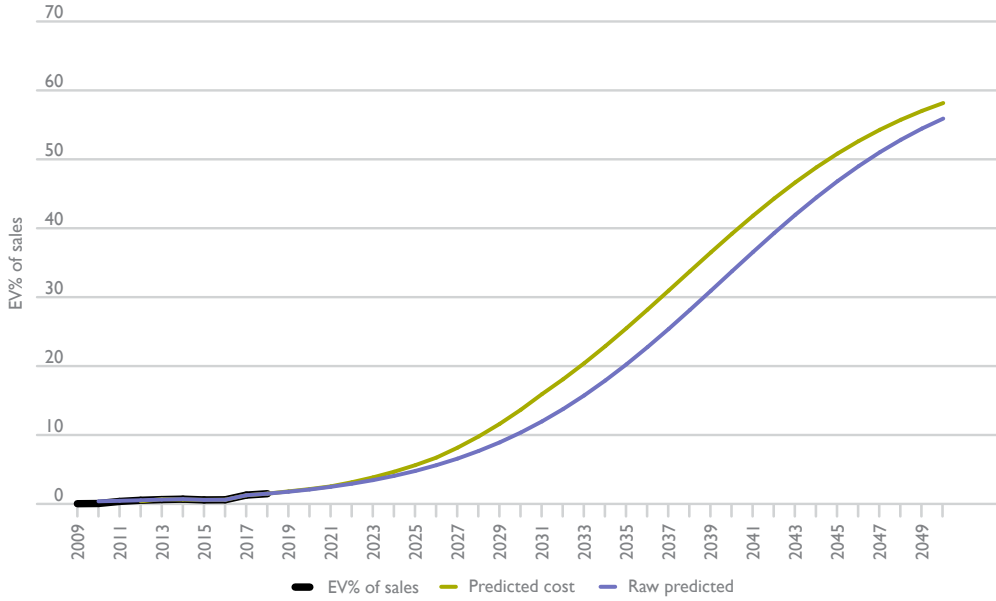
Table 3.42 shows past and forecast BEV and FFV costs used to generate a time series of the ratio of EV to FFV annual costs. Costs include principal (repay over 5 years), interest (13 per cent per year), annual EV subsidies, and petrol costs for FFV (with increasing fuel efficiency and a medium petrol price).

Table 3.42 EV/FFV cost ratio calculations for Japan

	Evs	Evs	Evs	Evs	Evs	FFVs	FFVs	FFVs	FFVs	FFVs	EV/ FFV
	EV price	Principal	Interest	Annual subs	Annual cost	FFV price	Principal	Interest	Fuel	Annual cost	Cost ratio
2012	2452706	490541	318852	26548	782845	1930509	386102	250966	74801	711869	1.10
2013	2193848	438770	285200	15869	708101	2359114	471823	306685	78368	856876	0.83
2014	2909235	581847	378201	17659	942389	2562613	512523	333140	78825	924487	1.02
2015	3056799	611360	397384	18517	990227	3004104	600821	390534	65268	1056623	0.94
2016	2741332	548266	356373	18538	886102	2706257	541251	351813	57324	950389	0.93
2017	2812575	562515	365635	18451	909698	2781764	556353	361629	61909	979891	0.93
2018	2761735	552347	359026	18451	892921	2732400	546480	355212	68080	969772	0.92
2019	2815795	563159	366053	18451	910761	2732400	546480	355212	64413	966105	0.94
2020	2799733	559947	363965	18451	905460	2732400	546480	355212	63875	965567	0.94
2021	2729607	545921	354849	18451	882319	2732400	546480	355212	66135	967827	0.91
2022	2770401	554080	360152	18451	895781	2732400	546480	355212	67614	969306	0.92
2023	2745759	549152	356949	18451	887649	2732400	546480	355212	67916	969608	0.92
2024	2647617	529523	344190	18451	855262	2732400	546480	355212	67498	969190	0.88
2025	2563497	512699	333255	18451	827503	2732400	546480	355212	68147	969839	0.85
2026	2515998	503200	327080	18451	811828	2732400	546480	355212	69766	971458	0.84
2027	2468495	493699	320904	18451	796152	2732400	546480	355212	70245	971937	0.82
2028	2414926	482985	313940	18451	778474	2732400	546480	355212	70283	971975	0.80
2029	2367413	473483	307764	18451	762795	2732400	546480	355212	70572	972264	0.78
2030	2313835	462767	300799	18451	745114	2732400	546480	355212	70618	972310	0.77

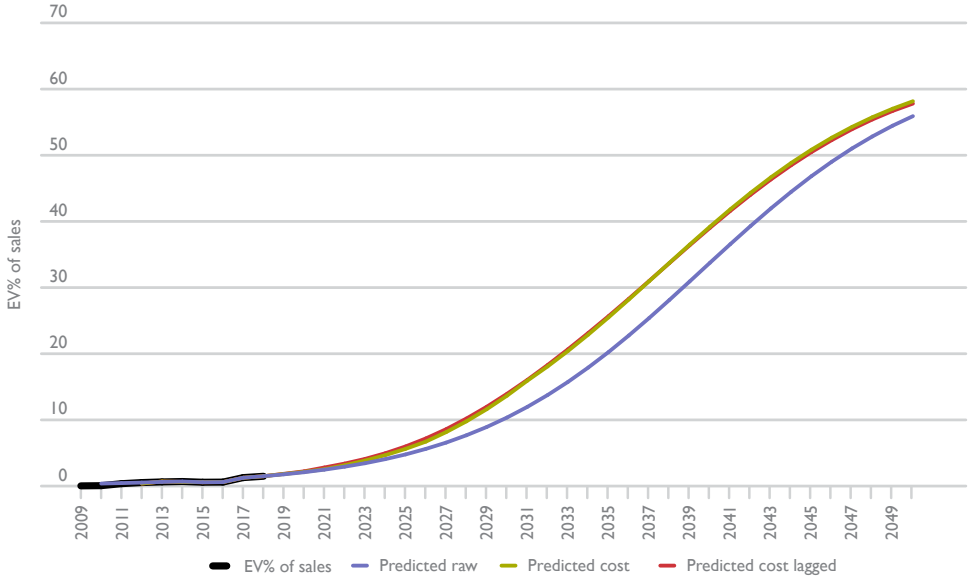
The resulting EV/FFV cost ratio time series is shown in the last column. This time series is then fed though the 2% year formula, which shifts the predicted raw uptake curve in line with shifts predicted for the cost ratio. Figure 3.108 shows the *predicted cost* curve is shifted to the left from the *predicated raw* curve. This is the result from Stage 3 of the Japanese analysis.

Figure 3.108 Japanese predicted raw and predicted cost EV per cent of sales curves



In Stage 4 corrections are usually made to the predicted cost uptake. But Japan is one of the 'flat' curves so no adjustment is made The resulting Japanese predicted cost lagged curve is shown in Figure 3.109. This is the final base-case EV uptake prediction for Japan.

Figure 3.109 Japanese predicted cost lagged EV uptake curve

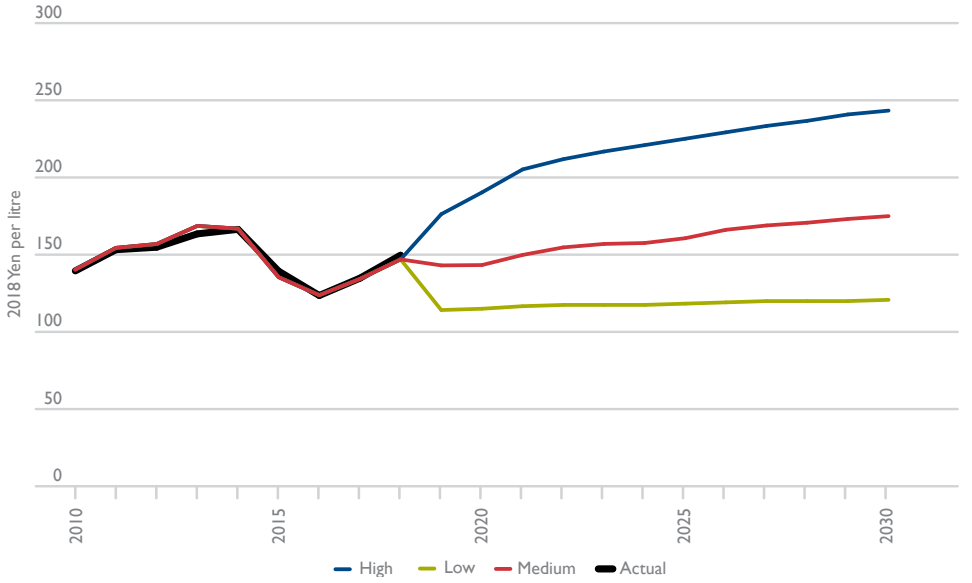


The resulting Japanese uptake forecast has EVs as 6 per cent of sales in 2025 and 14 per cent in 2030.

Stage 5 of the analysis looks at high, medium and low scenarios for oil prices and for EV prices.

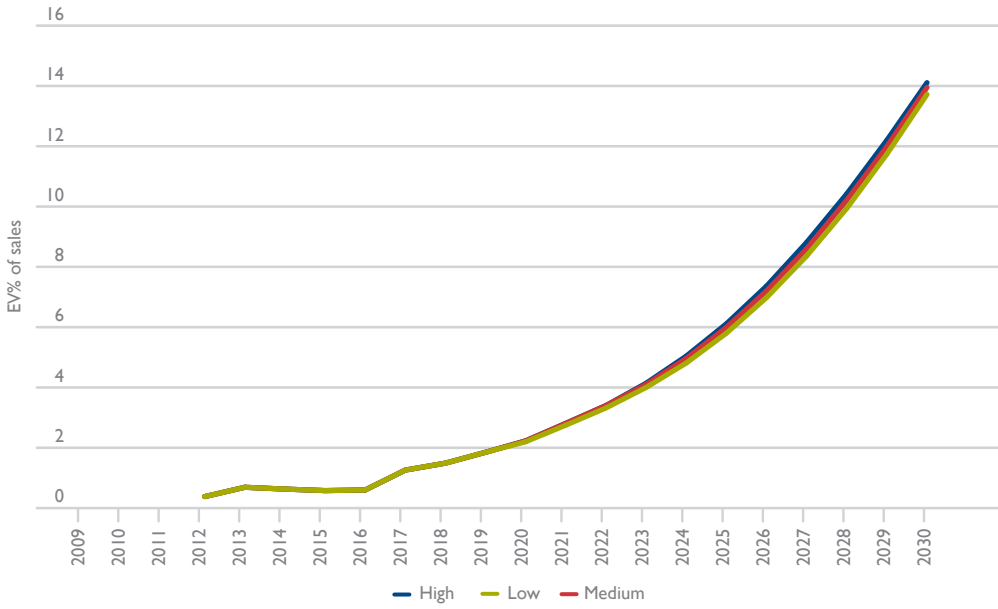
The oil price scenarios were given in Chapter 2. Corresponding Japanese petrol prices have been derived from the oil to Japanese petrol price equation in BITRE (2019). The resulting petrol price scenarios are shown in Figure 3.110.

Figure 3.110 Japanese petrol price scenarios



When these scenario petrol prices are used in the calculation of the EV/FFV cost ratios, the following predicted cost lagged curves are generated.

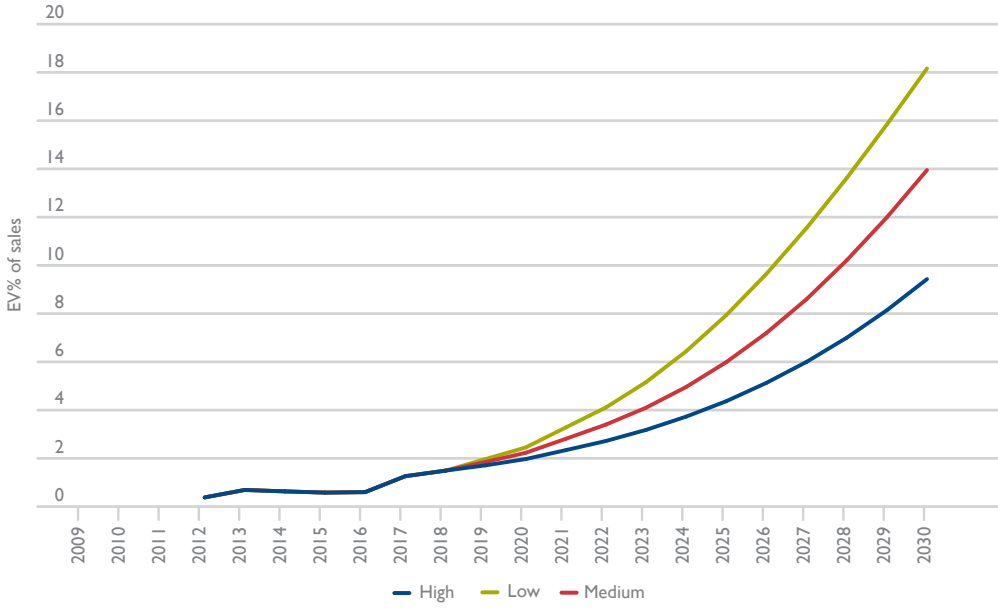
Figure 3.111 Scenarios for Japanese EV uptake with high, medium and low oil prices



It can be seen that oil price scenarios make next to no difference to forecast uptake.

The second scenario test is when the prices of EVs are increased or decreased. The vehicle price scenarios were also covered in Chapter 2 (30 per cent up on the medium, 30 per cent down). When these scenario vehicle prices are used in the calculation of the EV/FFV cost ratios, the following predicted cost lagged curves are generated.

Figure 3.112 Scenarios for Japanese EV uptake with high, medium and low EV prices



It can be seen that changes in vehicle prices have a large effect on projected uptake.

3.14 Korea

The linearized logistic uptake for Korea is shown in Figure 3.113, along with a predicted curve.

The regression shown in Table 3.43 has two variables – a time trend and a dummy for 2012. It is estimated over the period 2012 to 2018.

Figure 3.113 Korean linearized logistic EV sales percentage and prediction

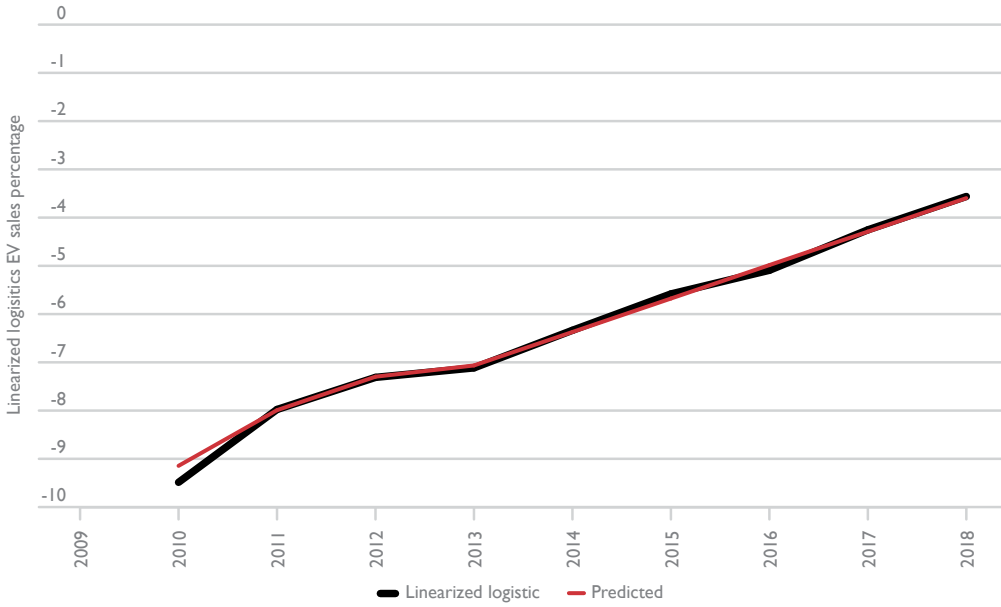


Table 3.43 Regression for Korean linearized logistic EV uptake

Regression statistics	
Multiple R	0.998788122
R Square	0.997577713
Adjusted R Square	0.99636657
Standard Error	0.080128522
Observations	7

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	10.57682755	5.288413777	823.6660558	5.86747E-06
Residual	4	0.02568232	0.00642058		
Total	6	10.60250987			

	Coefficients	*Standard error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-9.839083747	0.152635294	-64.46139342	3.46941E-07	-10.26286726	-9.415300231
time	0.693550658	0.024728199	28.04695435	9.61472E-06	0.624894172	0.762207143
dum12	0.460618387	0.109476402	4.207467346	0.013613839	0.156663166	0.764573607

Figure 3.114 shows the fit of the de-linearized *raw prediction* to the actual EV sales percentage of new passenger vehicle sales.

Figure 3.114 Korean EV sales as a percentage of passenger vehicle sales and raw prediction

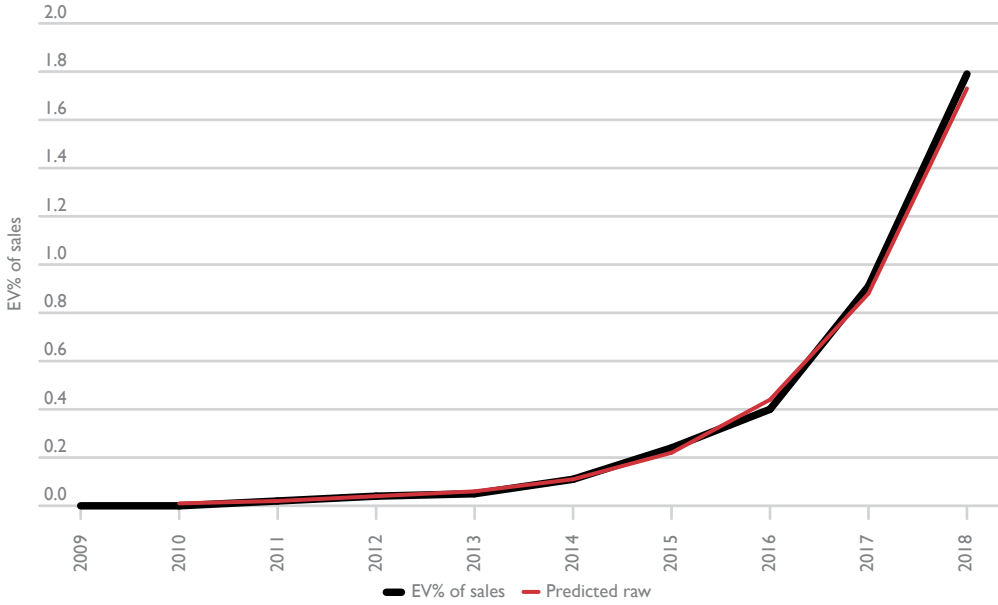
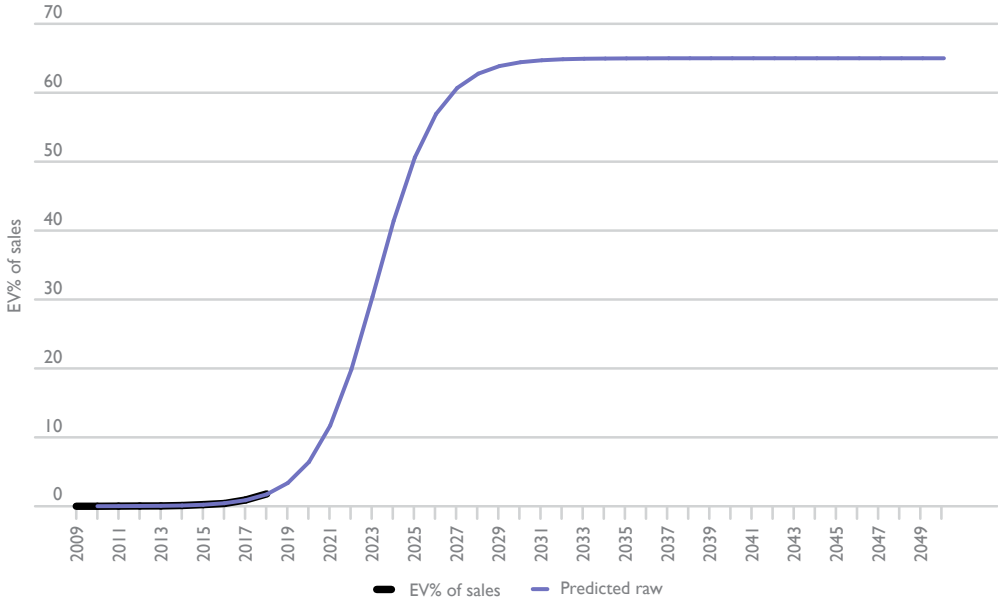


Figure 3.115 shows the extension of the forecast from this equation to 2050. This is the result of Stage 1 of the analysis.

Figure 3.115 Korean EV sales as a percentage of passenger vehicle sales and raw prediction to 2050



In Stage 2, the year that sales (or the raw prediction) pass the 2% mark is determined. For Korea, this is about 2018.

Stage 3 involves assembling past and forecast EV and FFV costs to generate a time series of the ratio of EV to FFV annual costs. Table 3.44 shows the prices of BEVs, PHEVs and FFVs in Korea.

Table 3.44 Prices of BEVs, PHEVs and FFVs in Korea

BEV	2017 US$ (000')	m Won	m Won	m Won		m Won	m Won	m Won	m Won	m Won	m Won
	BEV base	BEV base	Con-sumption	Education	VAT%	VAT	Acquis-ition	Subsidy	BEV price	Home charging	BEV price
2009	30	38	0.0	10.7	10.0	3.8	1.1	0.0	53	2	55
2010	30	35	0.0	9.8	10.0	3.5	1.0	0.0	49	1	50
2011	30	33	0.0	9.3	10.0	3.3	1.0	-12.0	35	2	36
2012	31	35	0.0	9.8	10.0	3.5	1.0	-12.0	37	1	38
2013	31	34	0.0	9.6	10.0	3.4	1.0	-12.0	36	1	38
2014	34	35	0.0	10.0	10.0	3.5	1.0	-12.0	38	1	39
2015	30	34	0.0	9.6	10.0	3.4	1.0	-12.0	36	1	37
2016	30	35	0.0	9.8	10.0	3.5	1.0	-14.0	35	1	36
2017	30	34	0.0	9.5	10.0	3.4	1.0	-14.0	34	1	35
2018	31	34	0.0	9.7	10.0	3.4	1.0	-14.0	35	1	36
2019	31	35	0.0	9.9	10.0	3.5	1.0	-11.0	39	1	40
2020	31	35	0.0	9.9	10.0	3.5	1.0	-11.0	38	1	39
2021	30	34	0.0	9.6	10.0	3.4	1.0	-11.0	37	1	38
2022	31	34	0.0	9.7	10.0	3.4	1.0	-11.0	38	1	39
2023	30	34	0.0	9.6	10.0	3.4	1.0	-11.0	37	1	38
2024	29	33	0.0	9.3	10.0	3.3	1.0	-11.0	35	1	37
2025	28	32	0.0	9.0	10.0	3.2	0.9	-11.0	34	1	35
2026	28	31	0.0	8.8	10.0	3.1	0.9	-11.0	33	1	34
2027	27	31	0.0	8.6	10.0	3.1	0.9	-11.0	32	1	33
2028	27	30	0.0	8.4	10.0	3.0	0.9	-11.0	31	1	32
2029	26	29	0.0	8.2	10.0	2.9	0.9	-11.0	30	1	32
2030	26	29	0.0	8.0	10.0	2.9	0.8	-11.0	29	1	31

PHEV	2017 US$ (000')	m Won	m Won	m Won		m Won	m Won	m Won	m Won	m Won	m Won
	PHEV base	PHEV base	Con-sumption	Education	VAT%	VAT	Acquis-ition	Subsidy	PHEV price	Home charging	PHEV price
2009	30	38	0.0	10.7	10.0	3.8	1.1	0.0	53	2	55
2010	30	35	0.0	9.8	10.0	3.5	1.0	0.0	49	1	50
2011	30	33	0.0	9.3	10.0	3.3	1.0	-12.0	35	2	36
2012	31	35	0.0	9.8	10.0	3.5	1.0	-12.0	37	1	38
2013	31	34	0.0	9.6	10.0	3.4	1.0	-12.0	36	1	38
2014	34	35	0.0	10.0	10.0	3.5	1.0	-12.0	38	1	39
2015	30	34	0.0	9.6	10.0	3.4	1.0	-12.0	36	1	37
2016	30	35	0.0	9.8	10.0	3.5	1.0	-14.0	35	1	36
2017	30	34	0.0	9.5	10.0	3.4	1.0	-14.0	34	1	35
2018	31	34	0.0	9.7	10.0	3.4	1.0	-14.0	35	1	36
2019	31	35	0.0	9.9	10.0	3.5	1.0	-11.0	39	1	40
2020	31	35	0.0	9.9	10.0	3.5	1.0	-11.0	38	1	39
2021	30	34	0.0	9.6	10.0	3.4	1.0	-11.0	37	1	38
2022	31	34	0.0	9.7	10.0	3.4	1.0	-11.0	38	1	39
2023	30	34	0.0	9.6	10.0	3.4	1.0	-11.0	37	1	38
2024	29	33	0.0	9.3	10.0	3.3	1.0	-11.0	35	1	37
2025	28	32	0.0	9.0	10.0	3.2	0.9	-11.0	34	1	35
2026	28	31	0.0	8.8	10.0	3.1	0.9	-11.0	33	1	34
2027	27	31	0.0	8.6	10.0	3.1	0.9	-11.0	32	1	33
2028	27	30	0.0	8.4	10.0	3.0	0.9	-11.0	31	1	32
2029	26	29	0.0	8.2	10.0	2.9	0.9	-11.0	30	1	32
2030	26	29	0.0	8.0	10.0	2.9	0.8	-11.0	29	1	31

Table 3.44 Prices of BEVs, PHEVs and FFVs in Korea (continued)

FFV	2017 US$ (000')	m Won	m Won	m Won		m Won	m Won	m Won
	FFV base	FFV base	Con-sumption	Education	VAT%	VAT	Acquis-ition	FFV price
2009	23	29	1.5	8.8	10.0	3.1	2.2	45
2010	23	27	1.3	8.0	10.0	2.8	2.0	41
2011	23	25	1.3	7.6	10.0	2.7	1.9	39
2012	23	26	1.3	7.7	10.0	2.7	1.9	39
2013	23	25	1.3	7.6	10.0	2.6	1.9	38
2014	23	24	1.2	7.3	10.0	2.5	1.8	37
2015	23	26	1.3	7.8	10.0	2.7	1.9	40
2016	23	27	1.3	8.0	10.0	2.8	2.0	41
2017	23	26	1.3	7.8	10.0	2.7	1.9	40
2018	23	26	1.3	7.8	10.0	2.7	1.9	40
2019	23	26	1.3	7.8	10.0	2.7	1.9	40
2020	23	26	1.3	7.8	10.0	2.7	1.9	40
2021	23	26	1.3	7.8	10.0	2.7	1.9	40
2022	23	26	1.3	7.8	10.0	2.7	1.9	40
2023	23	26	1.3	7.8	10.0	2.7	1.9	40
2024	23	26	1.3	7.8	10.0	2.7	1.9	40
2025	23	26	1.3	7.8	10.0	2.7	1.9	40
2026	23	26	1.3	7.8	10.0	2.7	1.9	40
2027	23	26	1.3	7.8	10.0	2.7	1.9	40
2028	23	26	1.3	7.8	10.0	2.7	1.9	40
2029	23	26	1.3	7.8	10.0	2.7	1.9	40
2030	23	26	1.3	7.8	10.0	2.7	1.9	40

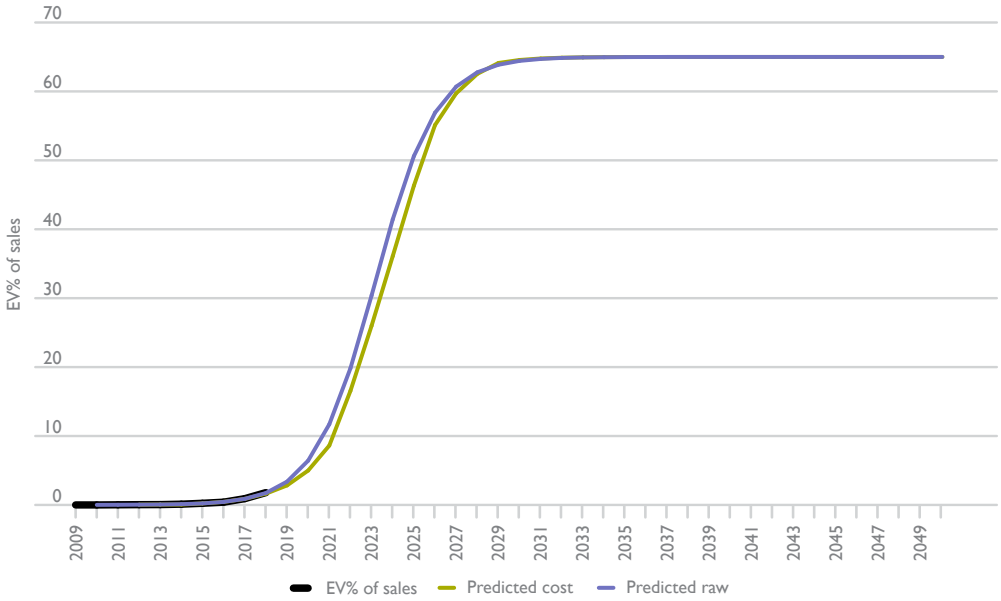
Table 3.45 shows past and forecast BEV and FFV costs used to generate a time series of the ratio of EV to FFV annual costs. Costs include principal (repay over 5 years), interest (13 per cent per year), annual EV subsidies, and petrol costs for FFV (with increasing fuel efficiency and a medium petrol price).

Table 3.45 EV/FFV cost ratio calculations for Korea

	Evs	Evs	Evs	Evs	Evs	FFVs	FFVs	FFVs	FFVs	FFVs	EV/ FFV
	EV price	Principal	Interest	Annual subs	Annual cost	FFV price	Principal	Interest	fuel	Annual cost	Cost ratio
2012	38.1	7.6	5.0	0.0	12.6	39.4	7.9	5.1	1.8	14.8	0.85
2013	37.5	7.5	4.9	0.0	12.4	38.5	7.7	5.0	1.6	14.4	0.86
2014	39.2	7.8	5.1	0.0	12.9	37.0	7.4	4.8	1.5	13.7	0.94
2015	37.0	7.4	4.8	0.0	12.2	39.8	8.0	5.2	1.3	14.5	0.85
2016	36.2	7.2	4.7	0.0	11.9	40.8	8.2	5.3	1.2	14.6	0.82
2017	34.7	6.9	4.5	0.0	11.4	39.5	7.9	5.1	1.2	14.3	0.80
2018	35.8	7.2	4.6	0.0	11.8	39.5	7.9	5.1	1.3	14.3	0.82
2019	39.7	7.9	5.2	0.0	13.1	39.5	7.9	5.1	1.3	14.3	0.92
2020	39.4	7.9	5.1	0.0	13.0	39.5	7.9	5.1	1.2	14.3	0.91
2021	38.1	7.6	5.0	0.0	12.6	39.5	7.9	5.1	1.3	14.3	0.88
2022	38.8	7.8	5.0	0.0	12.8	39.5	7.9	5.1	1.3	14.4	0.89
2023	38.4	7.7	5.0	0.0	12.7	39.5	7.9	5.1	1.3	14.4	0.88
2024	36.6	7.3	4.8	0.0	12.1	39.5	7.9	5.1	1.3	14.3	0.84
2025	35.1	7.0	4.6	0.0	11.6	39.5	7.9	5.1	1.3	14.4	0.81
2026	34.3	6.9	4.5	0.0	11.3	39.5	7.9	5.1	1.3	14.4	0.79
2027	33.4	6.7	4.3	0.0	11.0	39.5	7.9	5.1	1.3	14.4	0.77
2028	32.5	6.5	4.2	0.0	10.7	39.5	7.9	5.1	1.3	14.4	0.74
2029	31.6	6.3	4.1	0.0	10.4	39.5	7.9	5.1	1.3	14.4	0.73
2030	30.7	6.1	4.0	0.0	10.1	39.5	7.9	5.1	1.3	14.4	0.70

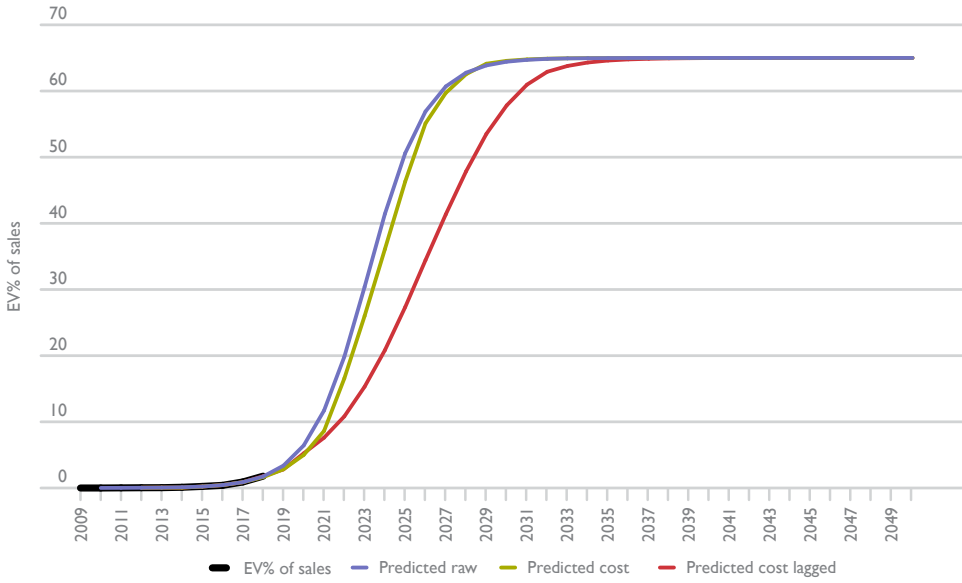
The resulting EV/FFV cost ratio time series is shown in the last column. This time series is then fed though the 2% year formula, which shifts the predicted raw uptake curve in line with shifts predicted for the cost ratio. Figure 3.116 shows the *predicted cost* curve is shifted slightly to the right from the *predicated raw* curve, as subsidies are reduced. This is the result from Stage 3 of the Korean analysis.

Figure 3.116 Korean predicted raw and predicted cost EV per cent of sales curves



In Stage 4 corrections are usually made to the predicted cost uptake curves to allow for the fact that most early adopters are those with higher incomes. The resulting Korean *predicted cost* lagged curve – which is a less steeply rising curve – is shown in Figure 3.117. This is the final base-case EV uptake prediction for Korea.

Figure 3.117 Korean predicted cost lagged EV uptake curve

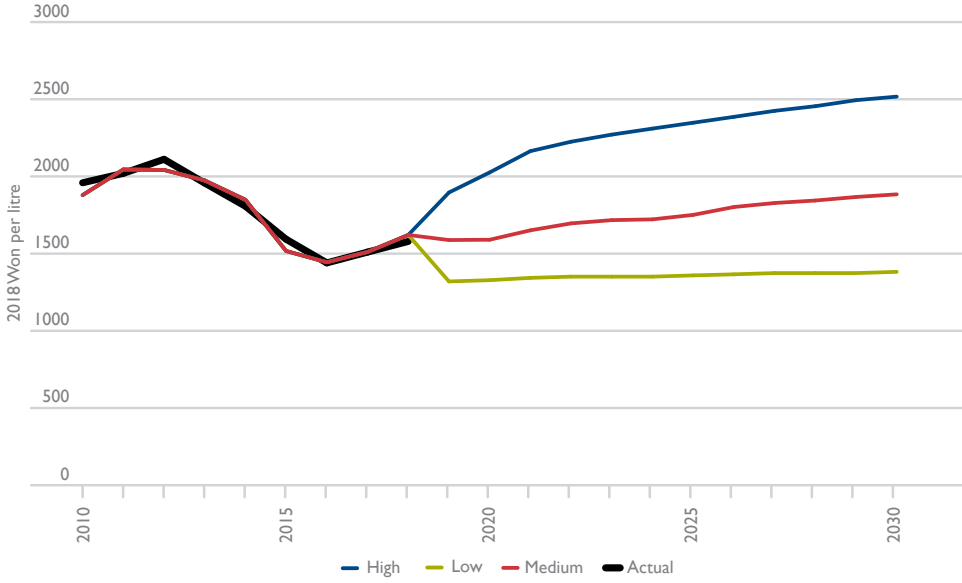


The resulting Korean uptake forecast has EVs as 27 per cent of sales in 2025 and 58 per cent in 2030.

Stage 5 of the analysis looks at high, medium and low scenarios for oil prices and for EV prices.

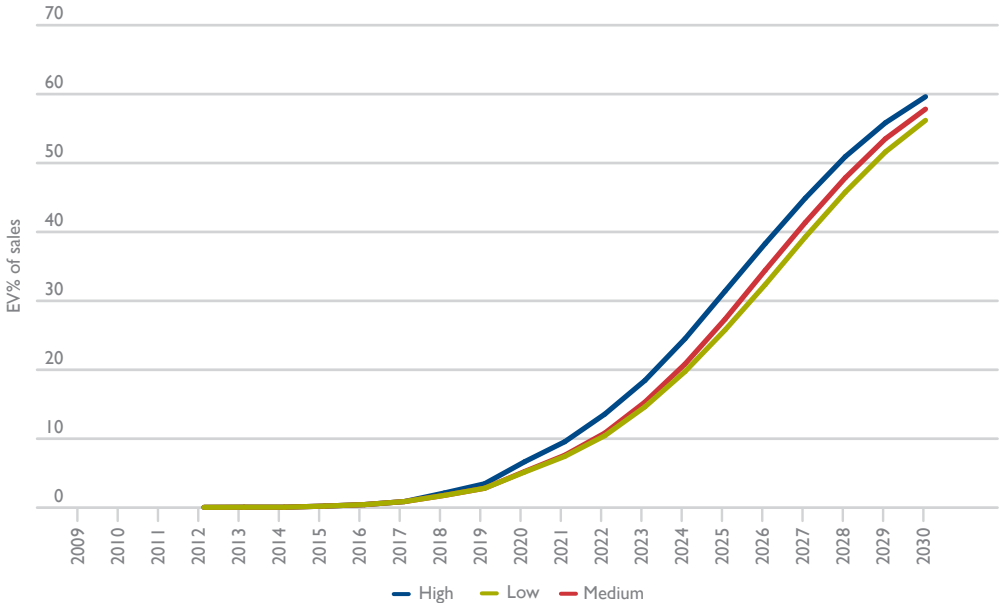
The oil price scenarios were given in Chapter 2. Corresponding Korean petrol prices have been derived from the oil to Korean petrol price equation in BITRE (2019). The resulting petrol price scenarios are shown in Figure 3.118.

Figure 3.118 Korean petrol price scenarios



When these scenario petrol prices are used in the calculation of the EV/FFV cost ratios, the following predicted cost lagged curves are generated.

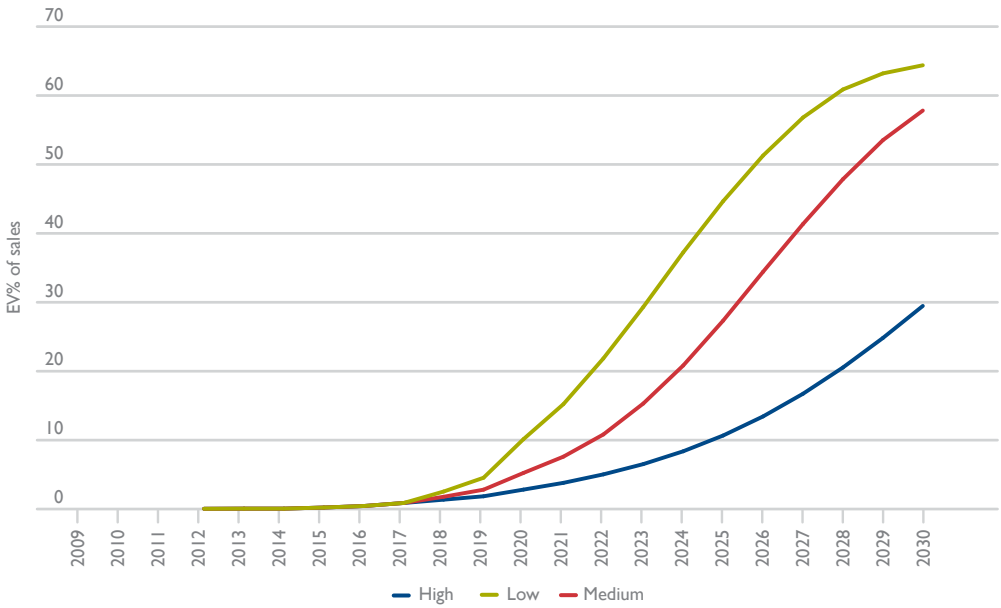
Figure 3.119 Scenarios for Korean EV uptake with high, medium and low oil prices



It can be seen that oil price scenarios make very little difference to forecast uptake.

The second scenario test is when the prices of EVs are increased or decreased. The vehicle price scenarios were also covered in Chapter 2 (30 per cent up on the medium, 30 per cent down). When these scenario vehicle prices are used in the calculation of the EV/FFV cost ratios, the following predicted cost lagged curves are generated.

Figure 3.120 Scenarios for Korean EV uptake with high, medium and low EV prices



It can be seen that changes in vehicle prices have a large effect on projected uptake

3.16 The Netherlands

The linearized logistic uptake for the Netherlands is shown in Figure 3.121, along with a predicted curve.

The regression shown in Table 3.46 has two variables – a time trend and a dummy for 2010 to 2011. It is estimated over the period 2010 to 2015, the period before the major cuts in subsidies in 2016. Peaks in EV sales in 2013, 2015 and 2016, in anticipation of reductions in various subsidies, have been eliminated.

Figure 3.121 Dutch linearized logistic EV sales percentage and prediction

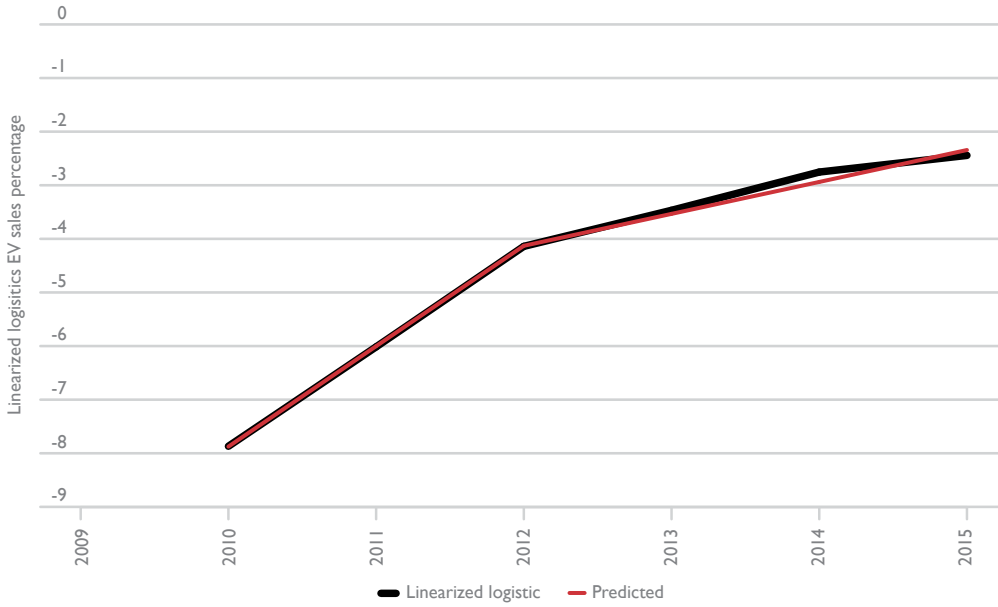


Table 3.46 Regression for Dutch linearized logistic EV uptake

Regression statistics	
Multiple R	0.998879016
R Square	0.997759288
Adjusted R Square	0.99626548
Standard Error	0.127771151
Observations	6

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	21.80853888	10.90426944	667.9300116	0.000106067
Residual	3	0.048976401	0.016325467		
Total	5	21.85751529			

	Coefficients	*Standard error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-5.916352259	0.250733661	-23.59616265	0.000166781	-6.714298673	-5.118405844
time	0.595573022	0.054839064	10.86037914	0.001670462	0.421050647	0.770095397
dum1011	-1.277389815	0.122623874	-10.41713799	0.001888002	-1.66763371	-0.887145921

Figure 3.122 shows the fit of the de-linearized raw prediction to the actual EV sales percentage of new passenger vehicle sales. The effect of the cut in subsidies is clear.

Figure 3.122 Dutch EV sales as a percentage of passenger vehicle sales and raw prediction

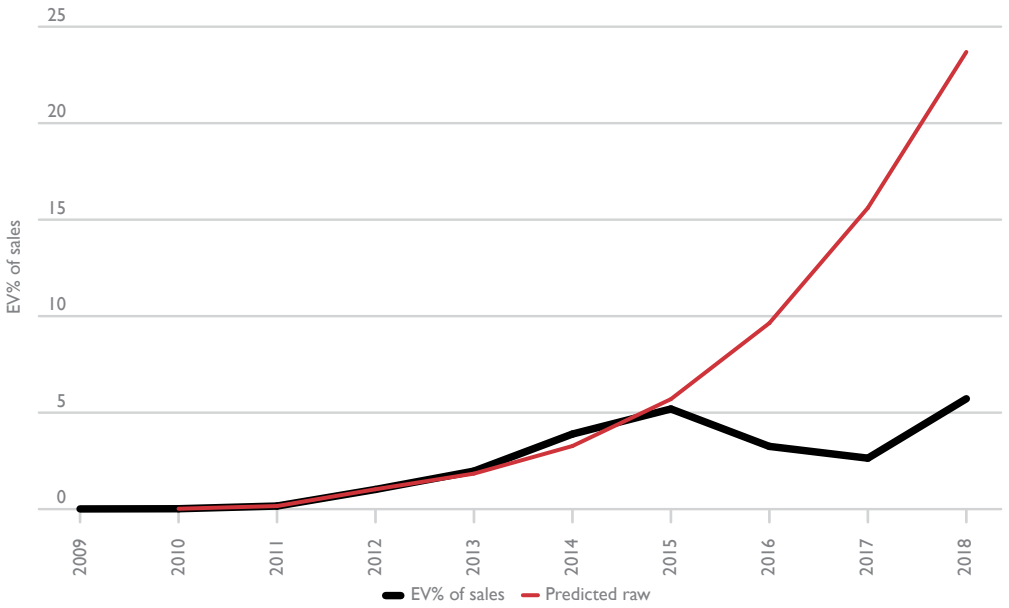
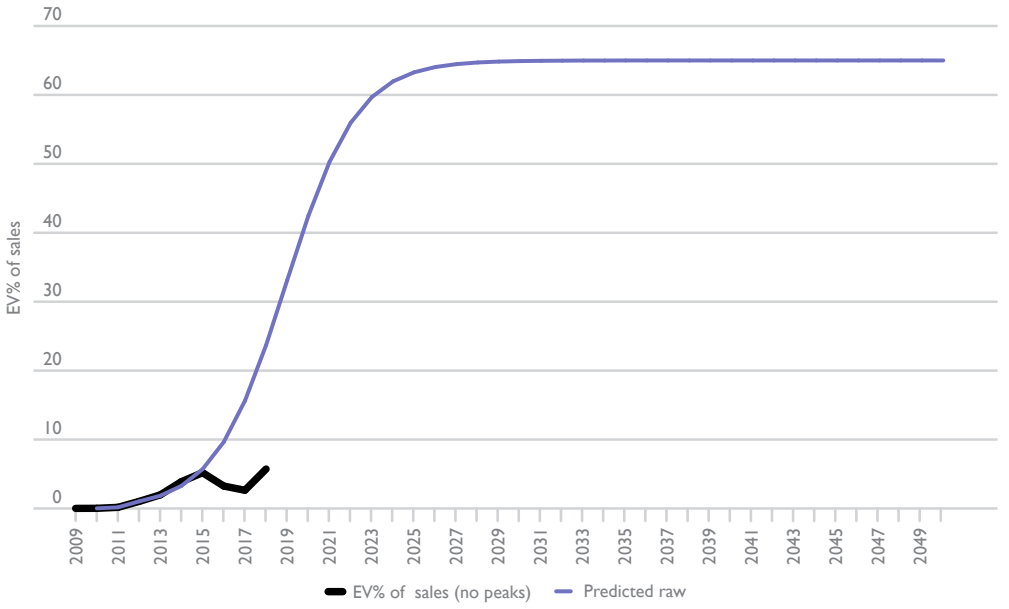


Figure 3.123 shows the extension of the forecast from this equation to 2050. This is the result of Stage 1 of the analysis.

Figure 3.123 Dutch EV sales as a percentage of passenger vehicle sales and raw prediction to 2050



In Stage 2, the year that sales (or the raw prediction) pass the 2% mark is determined. For The Netherlands, this is 2013.

Stage 3 involves assembling past and forecast EV and FFV costs to generate a time series of the ratio of EV to FFV annual costs. Table 3.47 shows the prices of BEVs, PHEVs and FFVs in the Netherlands.

Table 3.47 Prices of BEVs, PHEVs and FFVs in the Netherlands

BEV	2017 US$ (000')	Euros	Euros	%	Euros	Euros
	BEV base	BEV base	BPMrego tax	VAT%	VAT	BEV price
2009	30	21302	0	19	4047	25349
2010	30	22760	0	19	4324	27085
2011	30	21463	0	19	4078	25541
2012	31	23869	0	19	4535	28404
2013	31	23410	0	21	4916	28326
2014	34	25404	1016	21	5335	31755
2015	30	27178	1087	21	5707	33972
2016	30	27202	1088	21	5713	34003
2017	30	26462	1058	21	5557	33078
2018	31	26003	1040	21	5461	32504
2019	31	26497	1060	21	5564	33121
2020	31	26338	1054	21	5531	32923
2021	30	25676	1027	21	5392	32095
2022	31	26046	1042	21	5470	32558
2023	30	25807	1032	21	5420	32259
2024	29	24884	995	21	5226	31105
2025	28	24092	964	21	5059	30115
2026	28	23640	946	21	4964	29551
2027	27	23189	928	21	4870	28986
2028	27	22681	907	21	4763	28351
2029	26	22230	889	21	4668	27787
2030	26	21722	869	21	4562	27152
PHEV	2017 US$ (000')	Euros	Euros	%	Euros	Euros
	PHEV base	PHEV base	BPMrego tax	VAT%	VAT	PHEV price
2009	30	21302	450	19	4047	25799
2010	30	22760	450	19	4324	27535
2011	30	21463	450	19	4078	25991
2012	31	23869	450	19	4535	28854
2013	31	23410	450	21	4916	28776
2014	34	25404	1016	21	5335	31755
2015	30	27178	1902	21	5707	34788
2016	30	27202	4080	21	5713	36995
2017	30	26462	3969	21	5557	35988
2018	31	26003	3900	21	5461	35364
2019	31	26497	3975	21	5564	36036
2020	31	26338	3951	21	5531	35820
2021	30	25676	3851	21	5392	34919
2022	31	26046	3907	21	5470	35423
2023	30	25807	3871	21	5420	35098
2024	29	24884	3733	21	5226	33843
2025	28	24092	3614	21	5059	32765
2026	28	23640	3546	21	4964	32151
2027	27	23189	3478	21	4870	31537
2028	27	22681	3402	21	4763	30846
2029	26	22230	3334	21	4668	30232
2030	26	21722	3258	21	4562	29542

Table 3.47 Prices of BEVs, PHEVs and FFVs in the Netherlands (continued)

FFV	2017 US$ (000')	Euros	Euros	%	Euros	Euros
	FFV base	FFV base	BPMrego tax	VAT%	VAT	FFV price
2009	23	16556	2483	19	3146	22186
2010	23	17449	2617	19	3315	23382
2011	23	16455	2468	19	3126	22050
2012	23	17800	2670	19	3382	23852
2013	23	17288	2593	21	3631	23512
2014	23	17420	2613	21	3658	23691
2015	23	20836	3125	21	4376	28337
2016	23	20855	3128	21	4380	28363
2017	23	20288	3043	21	4260	27591
2018	23	19550	2933	21	4106	26588
2019	23	19550	2933	21	4106	26588
2020	23	19550	2933	21	4106	26588
2021	23	19550	2933	21	4106	26588
2022	23	19550	2933	21	4106	26588
2023	23	19550	2933	21	4106	26588
2024	23	19550	2933	21	4106	26588
2025	23	19550	2933	21	4106	26588
2026	23	19550	2933	21	4106	26588
2027	23	19550	2933	21	4106	26588
2028	23	19550	2933	21	4106	26588
2029	23	19550	2933	21	4106	26588
2030	23	19550	2933	21	4106	26588

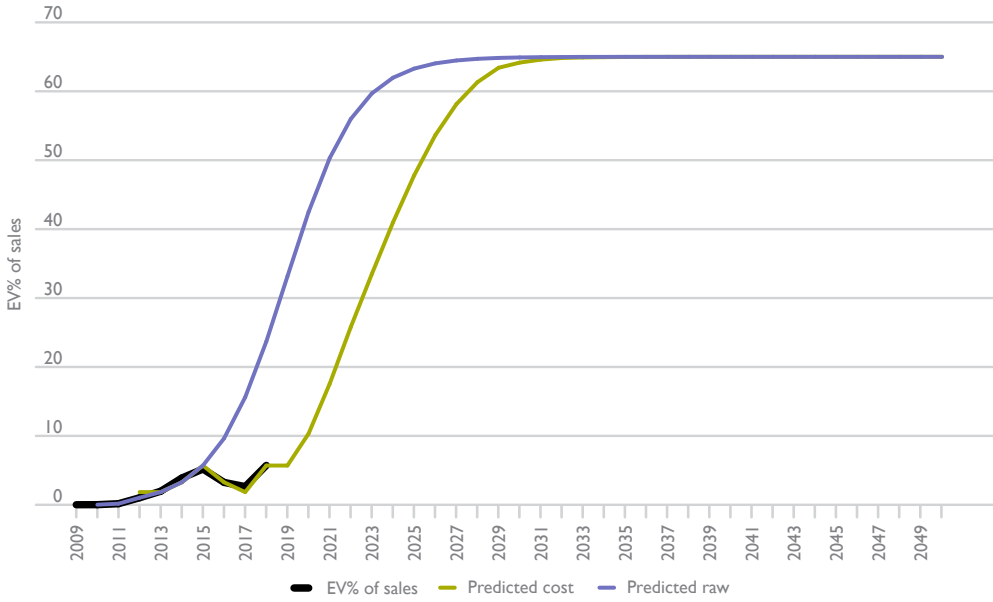
Table 3.48 shows past and forecast BEV and FFV costs used to generate a time series of the ratio of EV to FFV annual costs. Costs include principal (repay over 5 years), interest (13 per cent per year), annual EV subsidies, and petrol costs for FFV (with increasing fuel efficiency and a medium petrol price).

Table 3.48 EV/FFV cost ratio calculations for the Netherlands

	PHEVs	PHEVs	PHEVs	PHEVs	PHEVs	FFVs	FFVs	FFVs	FFVs	FFVs	EV/FFV
	EV price	Principal	Interest	Annual subs	Annual cost	FFV price	Principal	Interest	Fuel	Annual cost	Cost ratio
2012	28854	5771	3751	2709	6813	23852	4770	3101	1374	9245	0.74
2013	28776	5755	3741	2631	6865	23512	4702	3057	1311	9070	0.76
2014	31755	6351	4128	2651	7828	23691	4738	3080	1259	9077	0.86
2015	34788	6958	4522	3171	8309	28337	5667	3684	1133	10485	0.79
2016	36995	7399	4809	550	11658	28363	5673	3687	1055	10415	1.12
2017	35988	7198	4678	0	11876	27591	5518	3587	1083	10188	1.17
2018	35364	7073	4597	0	11670	26588	5318	3456	1107	9881	1.18
2019	36036	7207	4685	0	11892	26588	5318	3456	1095	9869	1.20
2020	35820	7164	4657	0	11821	26588	5318	3456	1085	9859	1.20
2021	34919	6984	4539	0	11523	26588	5318	3456	1106	9880	1.17
2022	35423	7085	4605	0	11689	26588	5318	3456	1118	9892	1.18
2023	35098	7020	4563	0	11582	26588	5318	3456	1118	9892	1.17
2024	33843	6769	4400	0	11168	26588	5318	3456	1109	9884	1.13
2025	32765	6553	4259	0	10812	26588	5318	3456	1113	9887	1.09
2026	32151	6430	4180	0	10610	26588	5318	3456	1127	9901	1.07
2027	31537	6307	4100	0	10407	26588	5318	3456	1128	9902	1.05
2028	30846	6169	4010	0	10179	26588	5318	3456	1125	9899	1.03
2029	30232	6046	3930	0	9977	26588	5318	3456	1125	9899	1.01
2030	29542	5908	3840	0	9749	26588	5318	3456	1122	9896	0.99

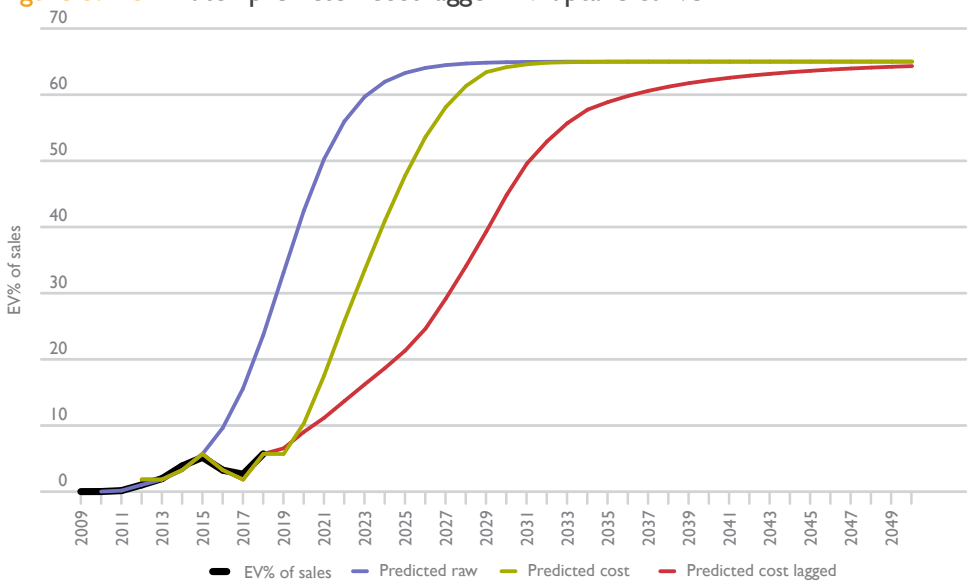
The resulting EV/FFV cost ratio time series is shown in the last column. This time series is then fed though the 2% year formula, which shifts the predicted raw uptake curve in line with shifts predicted for the cost ratio. Figure 3.124 shows the *predicted cost* curve is shifted to the right from the *predicated raw* curve following the cuts to EV subsidies. This is the result from Stage 3 of the Dutch analysis.

Figure 3.124 Dutch predicted raw and predicted cost EV per cent of sales curves



In Stage 4 corrections are usually made to the predicted cost uptake curves to allow for the fact that most early adopters are those with higher incomes. The resulting Dutch *predicted cost lagged* curve – which is a less steeply rising curve – is shown in Figure 3.125. This is the final base-case EV uptake prediction for the Netherlands.

Figure 3.125 Dutch predicted cost lagged EV uptake curve

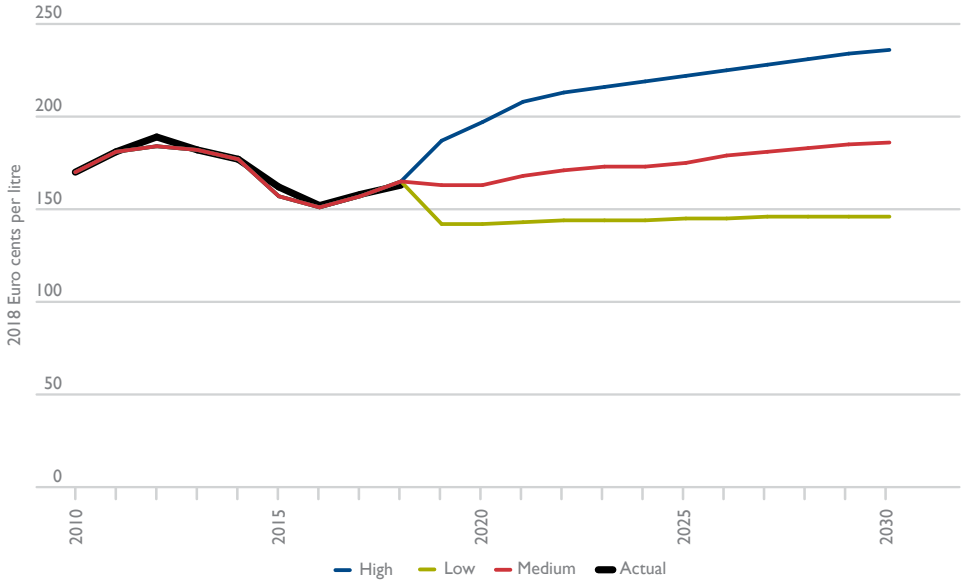


The resulting Dutch uptake forecast has EVs as 21 per cent of sales in 2025 and 45 per cent in 2030.

Stage 5 of the analysis looks at high, medium and low scenarios for oil prices and for EV prices.

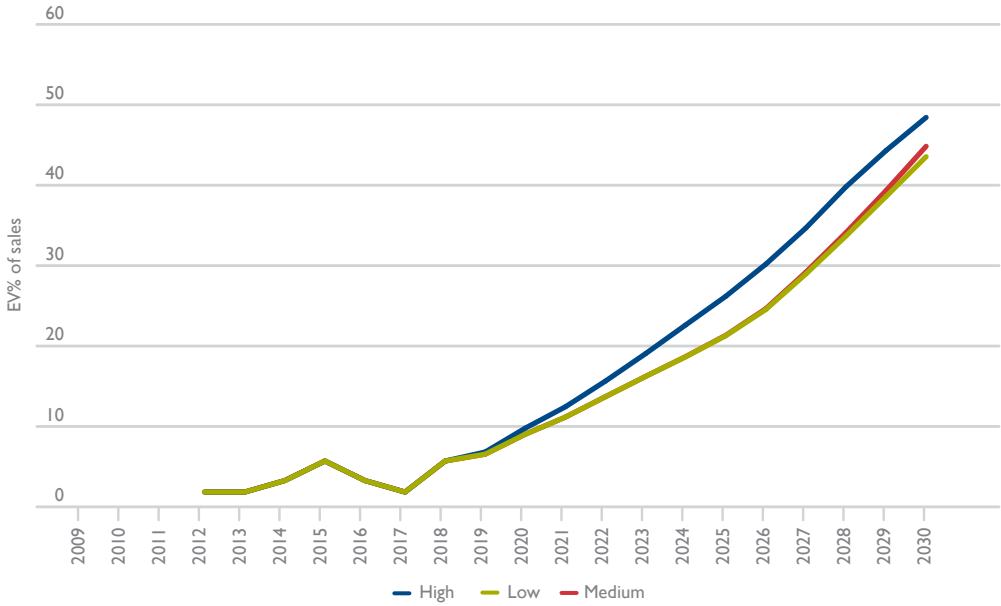
The oil price scenarios were given in Chapter 2. Corresponding Dutch petrol prices have been derived from the oil to Dutch petrol price equation in BITRE (2019). The resulting petrol price scenarios are shown in Figure 3.126.

Figure 3.126 Dutch petrol price scenarios



When these scenario petrol prices are used in the calculation of the EV/FFV cost ratios, the following predicted cost lagged curves are generated.

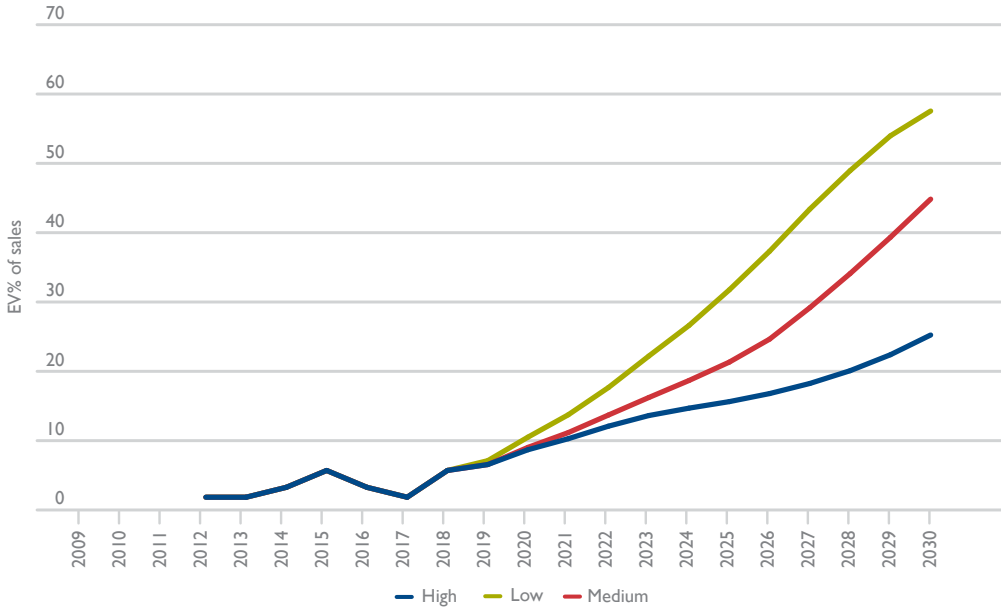
Figure 3.127 Scenarios for Dutch EV uptake with high, medium and low oil prices



It can be seen that oil price scenarios make very little difference to forecast uptake.

The second scenario test is when the prices of EVs are increased or decreased. The vehicle price scenarios were also covered in Chapter 2 (30 per cent up on the medium, 30 per cent down). When these scenario vehicle prices are used in the calculation of the EV/FFV cost ratios, the following predicted cost lagged curves are generated.

Figure 3.128 Scenarios for Dutch EV uptake with high, medium and low EV prices



It can be seen that changes in vehicle prices have a large effect on projected uptake.

3.17 New Zealand

The linearized logistic uptake for New Zealand is shown in Figure 3.129, along with a predicted curve.

The regression shown in Table 3.49 has two variables – a time trend and a dummy for 2015. It is estimated over the period 2014 to 2018.

Figure 3.129 Kiwi linearized logistic EV sales percentage and prediction

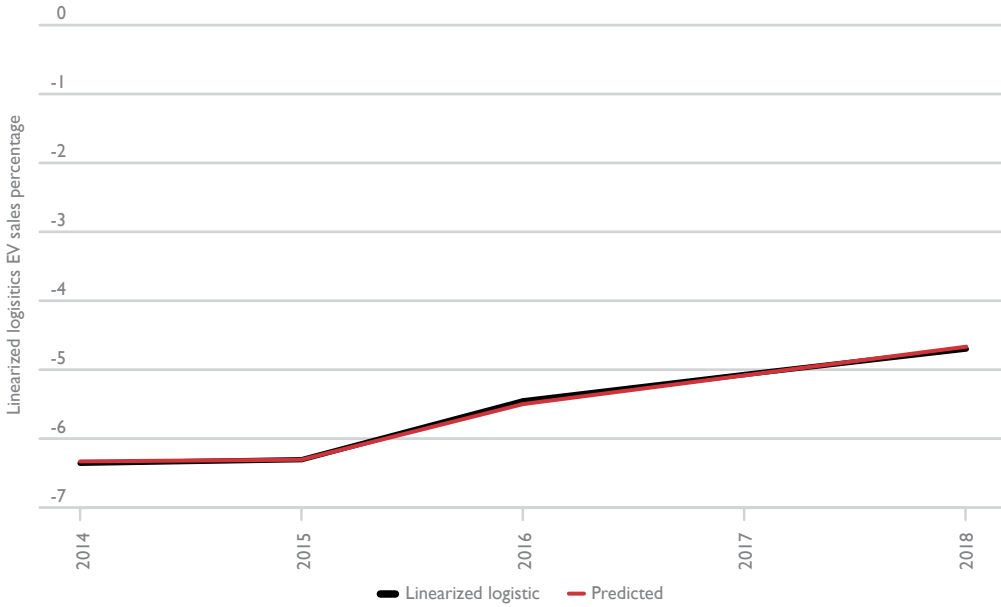


Table 3.49 Regression for Kiwi linearized logistic EV uptake

Regression statistics	
Multiple R	0.998994507
R Square	0.997990025
Adjusted R Square	0.99598005
Standard Error	0.046847033
Observations	5

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	2.17936367	1.089681835	496.5186	0.002009975
Residual	2	0.004389289	0.002194645		
Total	4	2.183752959			

	Coefficients	*Standard error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-8.412000603	0.117184489	-71.78424968	0.000194006	-8.916204763	-7.907796442
time	0.416178783	0.015837188	26.27857841	0.001444954	0.348036863	0.484320702
dum15	-0.390697658	0.055992915	-6.97762673	0.019927368	-0.631615725	-0.149779591

Figure 3.130 shows the fit of the de-linearized *raw prediction* to the actual EV sales percentage of new passenger vehicle sales.

Figure 3.130 Kiwi EV sales as a percentage of passenger vehicle sales and raw prediction

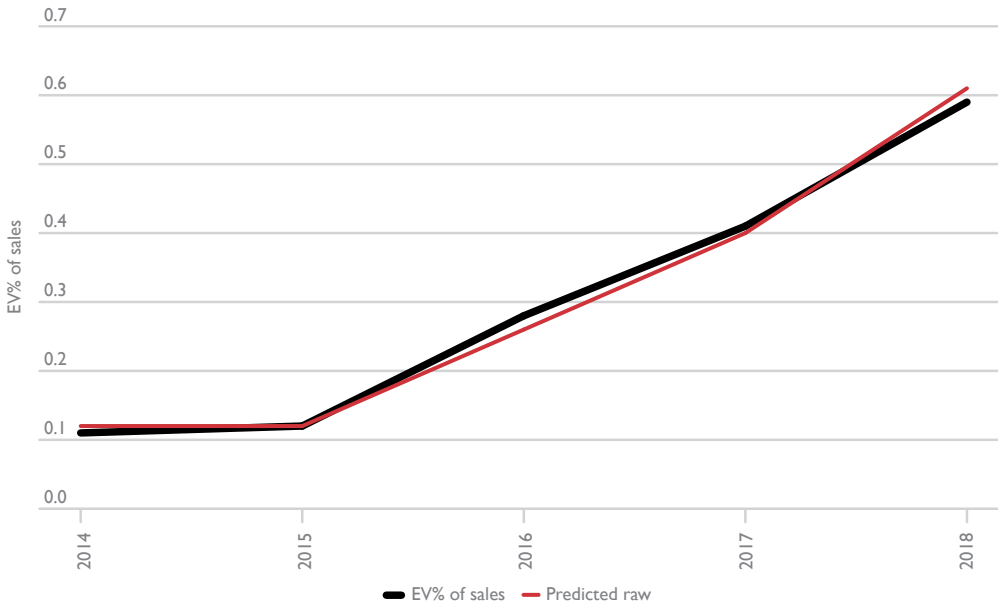
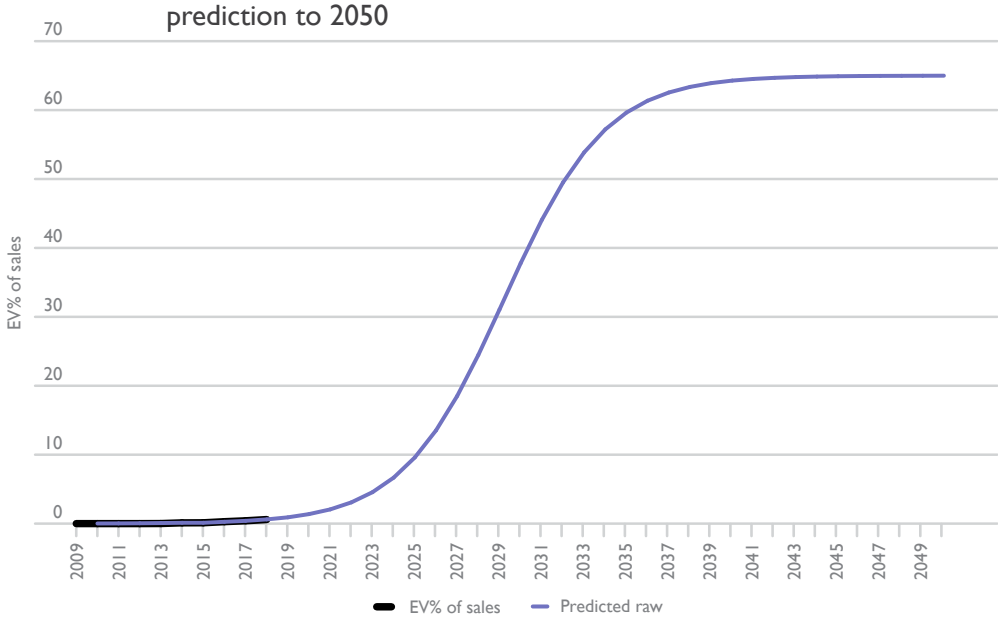


Figure 3.131 shows the extension of the forecast from this equation to 2050. This is the result of Stage 1 of the analysis.

Figure 3.131 Kiwi EV sales as a percentage of passenger vehicle sales and raw prediction to 2050



In Stage 2, the year that sales (or the raw prediction) pass the 2% mark is determined. For New Zealand, this is 2020.

Stage 3 involves assembling past and forecast EV and FFV costs to generate a time series of the ratio of EV to FFV annual costs. Table 3.50 shows the prices of BEVs, PHEVs and FFVs in New Zealand.

Table 3.50 Prices of BEVs, PHEVs and FFVs in New Zealand

BEV	2017 US$ (000')	NZ$			NZ$	NZ$	NZ$
	BEV base	BEV base	VAT%	VAT	BEV price	Home charging	BEV price
2009	30	47348	19.8	9366	56714	3223	59937
2010	30	41668	22.0	9178	50846	2655	53501
2011	30	37647	24.6	9243	46890	2543	49433
2012	31	37872	25.7	9722	47594	2301	49894
2013	31	38069	25.2	9590	47659	2358	50017
2014	34	40584	24.9	10091	50675	2316	52991
2015	30	43242	22.6	9775	53017	2307	55324
2016	30	43071	21.7	9340	52411	2296	54707
2017	30	42158	22.9	9664	51822	2310	54132
2018	31	42829	23.0	9851	52680	2388	55068
2019	31	43642	23.0	10038	53680	2388	56068
2020	31	43380	23.0	9977	53358	2388	55746
2021	30	42289	23.0	9727	52016	2388	54404
2022	31	42899	23.0	9867	52766	2388	55155
2023	30	42506	23.0	9776	52283	2388	54671
2024	29	40986	23.0	9427	50413	2388	52801
2025	28	39681	23.0	9127	48807	2388	51196
2026	28	38937	23.0	8956	47893	2388	50281
2027	27	38194	23.0	8785	46978	2388	49366
2028	27	37357	23.0	8592	45949	2388	48338
2029	26	36614	23.0	8421	45035	2388	47423
2030	26	35777	23.0	8229	44006	2388	46394
PHEV	2017 US$ (000')	NZ$			NZ$	NZ$	NZ$
	PHEV base	PHEV base	VAT%	VAT	PHEV price	Home charging	PHEV price
2009	30	47348	19.8	9366	56714	3223	59937
2010	30	41668	22.0	9178	50846	2655	53501
2011	30	37647	24.6	9243	46890	2543	49433
2012	31	37872	25.7	9722	47594	2301	49894
2013	31	38069	25.2	9590	47659	2358	50017
2014	34	40584	24.9	10091	50675	2316	52991
2015	30	43242	22.6	9775	53017	2307	55324
2016	30	43071	21.7	9340	52411	2296	54707
2017	30	42158	22.9	9664	51822	2310	54132
2018	31	42829	23.0	9851	52680	2388	55068
2019	31	43642	23.0	10038	53680	2388	56068
2020	31	43380	23.0	9977	53358	2388	55746
2021	30	42289	23.0	9727	52016	2388	54404
2022	31	42899	23.0	9867	52766	2388	55155
2023	30	42506	23.0	9776	52283	2388	54671
2024	29	40986	23.0	9427	50413	2388	52801
2025	28	39681	23.0	9127	48807	2388	51196
2026	28	38937	23.0	8956	47893	2388	50281
2027	27	38194	23.0	8785	46978	2388	49366
2028	27	37357	23.0	8592	45949	2388	48338
2029	26	36614	23.0	8421	45035	2388	47423
2030	26	35777	23.0	8229	44006	2388	46394

Table 3.50 Prices of BEVs, PHEVs and FFVs in New Zealand (continued)

FFV	2017 US$ (000')	NZ$			NZ$
	FFV base	FFV base	VAT%	VAT	FFV price
2009	23	36800	19.8	7279	44079
2010	23	31946	22.0	7036	38982
2011	23	28863	24.6	7086	35949
2012	23	28242	25.7	7250	35492
2013	23	28114	25.2	7082	35196
2014	23	27829	24.9	6920	34748
2015	23	33152	22.6	7494	40646
2016	23	33021	21.7	7161	40182
2017	23	32321	22.9	7409	39730
2018	23	32200	23.0	7406	39606
2019	23	32200	23.0	7406	39606
2020	23	32200	23.0	7406	39606
2021	23	32200	23.0	7406	39606
2022	23	32200	23.0	7406	39606
2023	23	32200	23.0	7406	39606
2024	23	32200	23.0	7406	39606
2025	23	32200	23.0	7406	39606
2026	23	32200	23.0	7406	39606
2027	23	32200	23.0	7406	39606
2028	23	32200	23.0	7406	39606
2029	23	32200	23.0	7406	39606
2030	23	32200	23.0	7406	39606

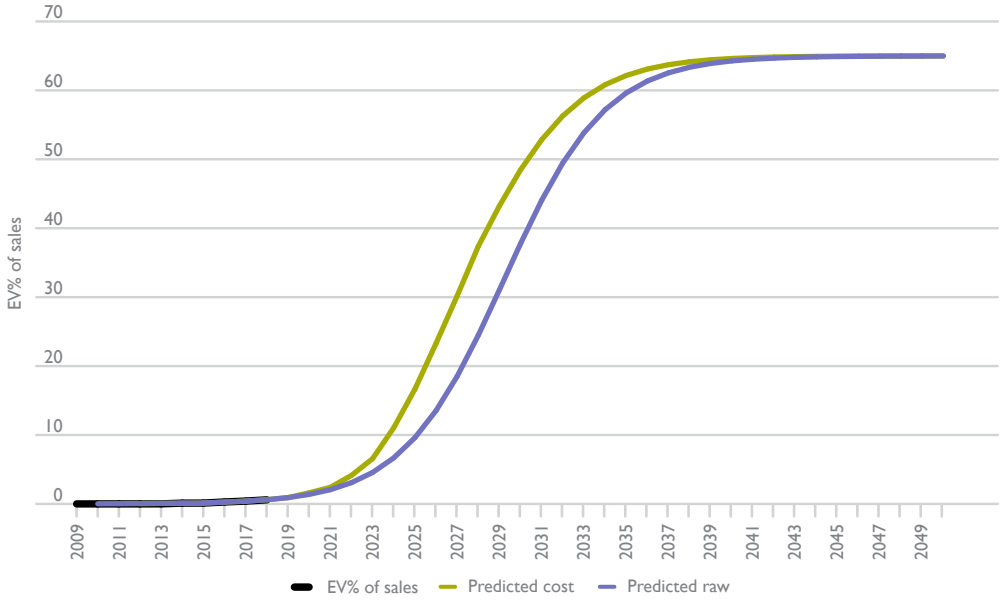
Table 3.51 shows past and forecast BEV and FFV costs used to generate a time series of the ratio of EV to FFV annual costs. Costs include principal (repay over 5 years), interest (13 per cent per year), annual EV subsidies, and petrol costs for FFV (with increasing fuel efficiency and a medium petrol price).

Table 3.51 EV/FFV cost ratio calculations for New Zealand

	Evs	Evs	Evs	Evs	Evs	FFVs	FFVs	FFVs	FFVs	FFVs	EV/ FFV
	EV price	Principal	Interest	Annual subs	Annual cost	FFV price	Principal	Interest	Fuel	Annual cost	Cost ratio
2012	49894	9979	6486	0	16465	35492	7098	4614	2217	13929	1.18
2013	50017	10003	6502	0	16506	35196	7039	4576	2186	13800	1.20
2014	52991	10598	6889	0	17487	34748	6950	4517	2145	13612	1.28
2015	55324	11065	7192	0	18257	40646	8129	5284	1922	15336	1.19
2016	54707	10941	7112	0	18053	40182	8036	5224	1806	15067	1.20
2017	54132	10826	7037	0	17863	39730	7946	5165	1890	15001	1.19
2018	55068	11014	7159	511	17661	39606	7921	5149	2053	15123	1.17
2019	56068	11214	7289	511	17991	39606	7921	5149	1999	15069	1.19
2020	55746	11149	7247	511	17885	39606	7921	5149	1982	15052	1.19
2021	54404	10881	7073	511	17442	39606	7921	5149	2047	15117	1.15
2022	55155	11031	7170	511	17690	39606	7921	5149	2089	15159	1.17
2023	54671	10934	7107	511	17530	39606	7921	5149	2096	15166	1.16
2024	52801	10560	6864	511	16913	39606	7921	5149	2083	15153	1.12
2025	51196	10239	6655	511	16384	39606	7921	5149	2101	15171	1.08
2026	50281	10056	6537	511	16082	39606	7921	5149	2146	15216	1.06
2027	49366	9873	6418	511	15780	39606	7921	5149	2159	15229	1.04
2028	48338	9668	6284	511	15440	39606	7921	5149	2159	15229	1.01
2029	47423	9485	6165	511	15139	39606	7921	5149	2166	15236	0.99
2030	46394	9279	6031	511	14799	39606	7921	5149	2167	15237	0.97

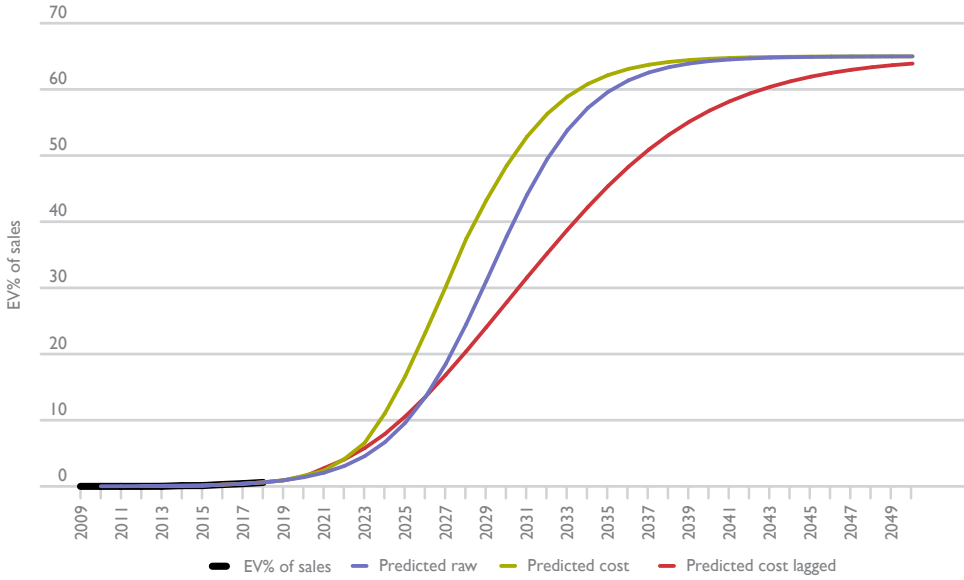
The resulting EV/FFV cost ratio time series is shown in the last column. This time series is then fed though the 2% year formula, which shifts the predicted raw uptake curve in line with shifts predicted for the cost ratio. Figure 3.132 shows the *predicted cost* curve is shifted to the left from the *predicated raw* curve. This is the result from Stage 3 of the Kiwi analysis.

Figure 3.132 Kiwi predicted raw and predicted cost EV per cent of sales curves



In Stage 4 corrections are usually made to the predicted cost uptake curves to allow for the fact that most early adopters are those with higher incomes. The resulting Kiwi *predicted cost lagged* curve – which is a less steeply rising curve – is shown in Figure 3.133. This is the final base-case EV uptake prediction for New Zealand.

Figure 3.133 Kiwi predicted cost lagged EV uptake curve

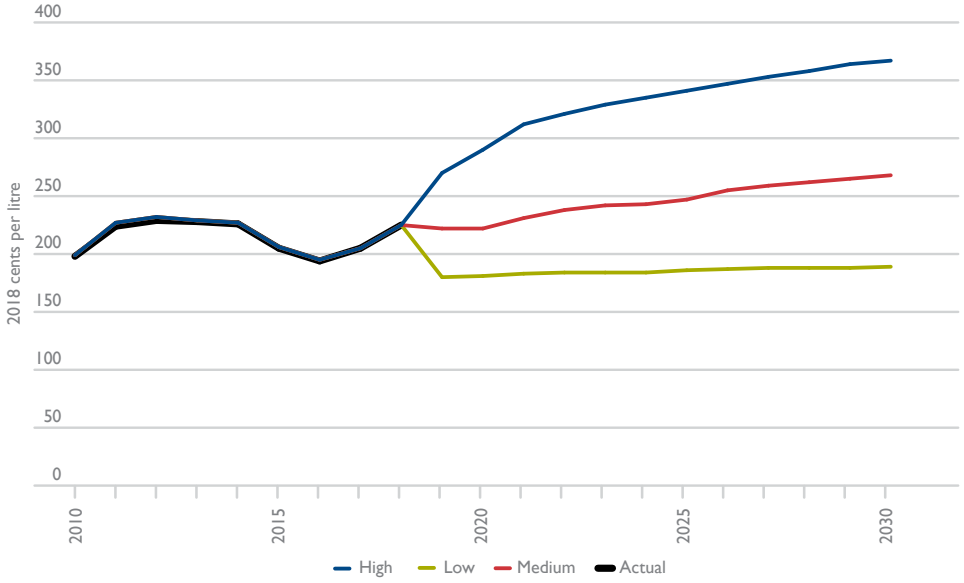


The resulting Kiwi uptake forecast has EVs as 11 per cent of sales in 2025 and 28 per cent in 2030.

Stage 5 of the analysis looks at high, medium and low scenarios for oil prices and for EV prices.

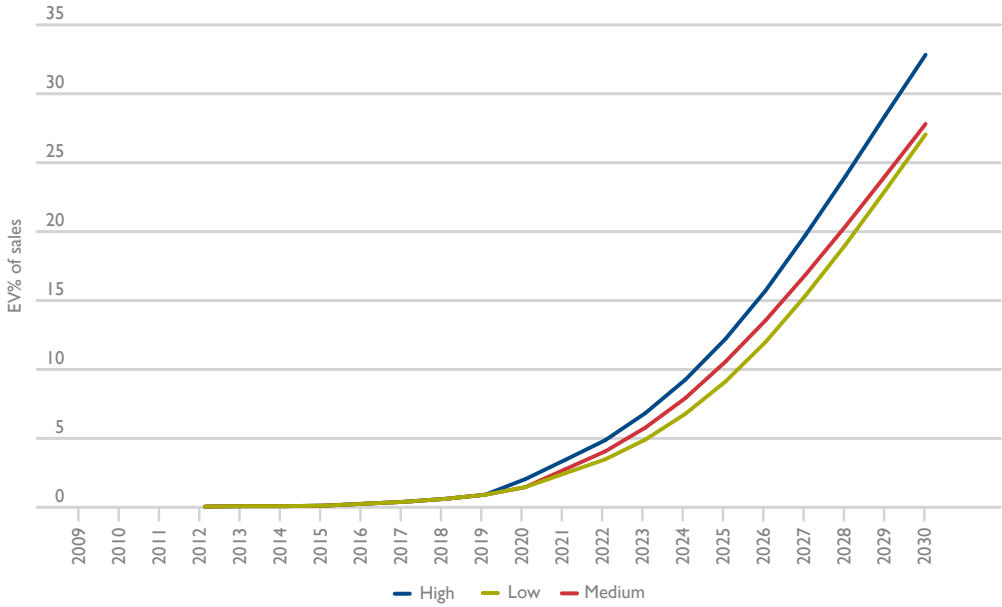
The oil price scenarios were given in Chapter 2. Corresponding Kiwi petrol prices have been derived from the oil to Kiwi petrol price equation in BITRE (2019). The resulting petrol price scenarios are shown in Figure 3.134.

Figure 3.134 Kiwi petrol price scenarios



When these scenario petrol prices are used in the calculation of the EV/FFV cost ratios, the following predicted cost lagged curves are generated.

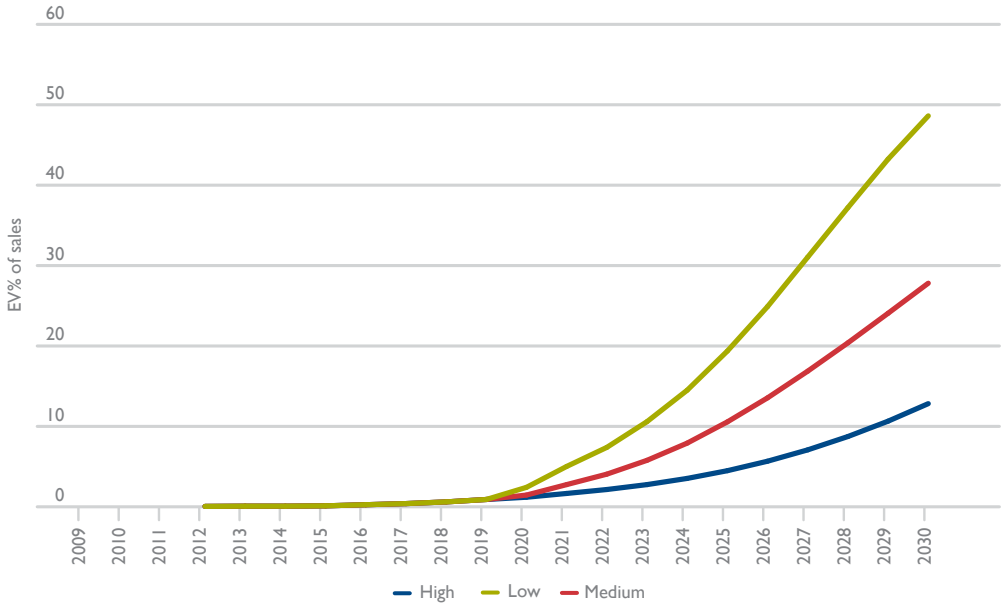
Figure 3.135 Scenarios for Kiwi EV uptake with high, medium and low oil prices



It can be seen that oil price scenarios make only a small difference to forecast uptake.

The second scenario test is when the prices of EVs are increased or decreased. The vehicle price scenarios were also covered in Chapter 2 (30 per cent up on the medium, 30 per cent down). When these scenario vehicle prices are used in the calculation of the EV/FFV cost ratios, the following predicted cost lagged curves are generated.

Figure 3.136 Scenarios for Kiwi EV uptake with high, medium and low EV prices



It can be seen that changes in vehicle prices have a large effect on projected uptake

3.18 Norway

The linearized logistic uptake for Norway is shown in Figure 3.137, along with a predicted curve.

The regression shown in Table 3.52 has two variables – a time trend and a dummy for 2014 to 2015. It is estimated over the period 2012 to 2018.

Figure 3.137 Norwegian linearized logistic EV sales percentage and prediction

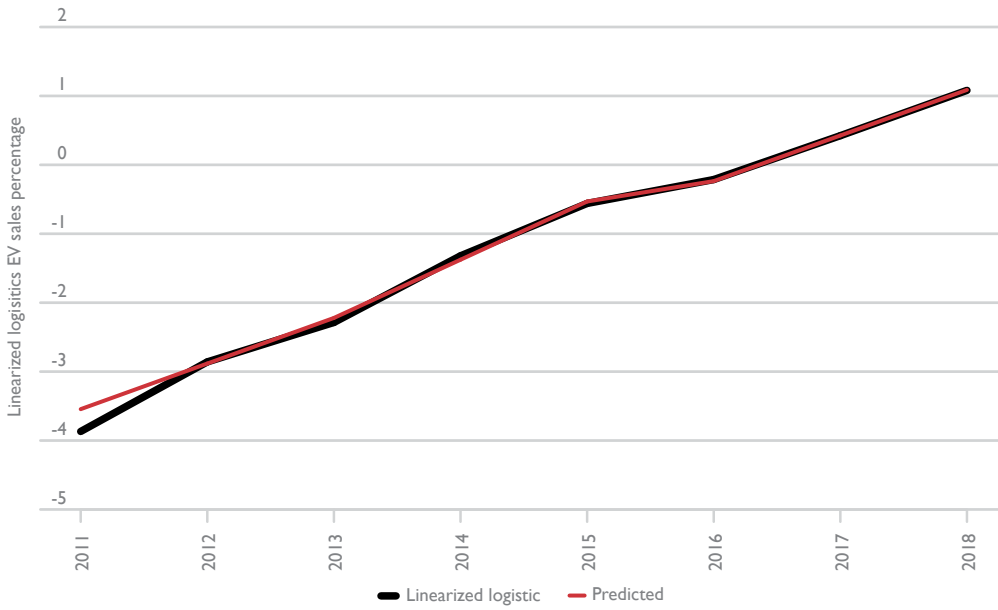


Table 3.52 Regression for Norwegian linearized logistic EV uptake

Regression statistics	
Multiple R	0.999611132
R Square	0.999222415
Adjusted R Square	0.998833622
Standard Error	0.048604745
Observations	7

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	12.14315041	6.071575204	2570.064593	6.04639E-07
Residual	4	0.009449685	0.00236242 1		
Total	6	12.15260009			

	Coefficients	*Standard error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
intercept	-4.868186238	0.060334826	-80.68617302	1.4142E-07	-5.035702572	-4.700669905
time	0.661733529	0.009229915	71.69443199	2.26802E-07	0.636107176	0.687359882
dum1415	0.366099691	0.050683788	7.223210856	0.001948407	0.225378934	0.506820447

Figure 3.138 shows the fit of the de-linearized *raw prediction* to the actual EV sales percentage of new passenger vehicle sales.

Figure 3.138 Norwegian EV sales as a percentage of passenger vehicle sales and raw prediction

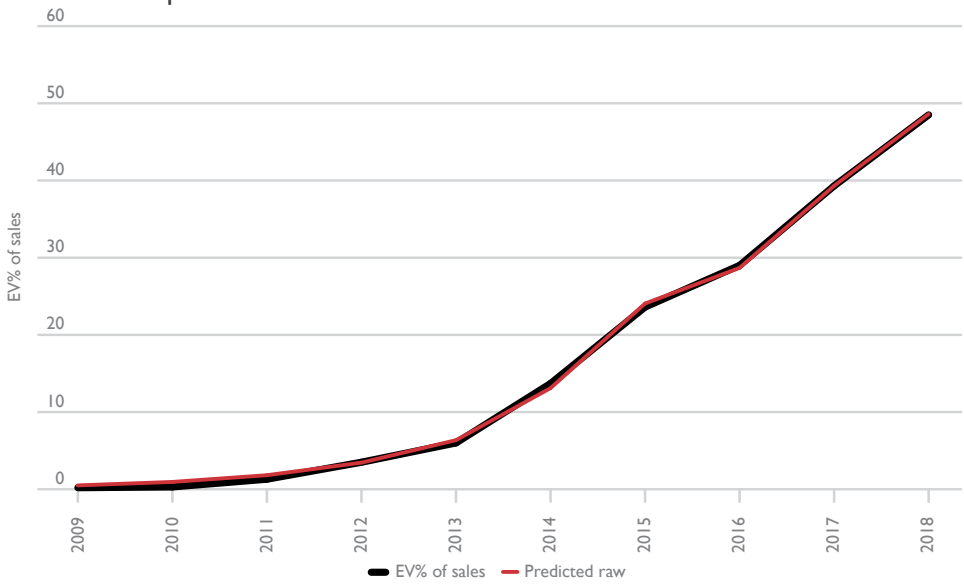
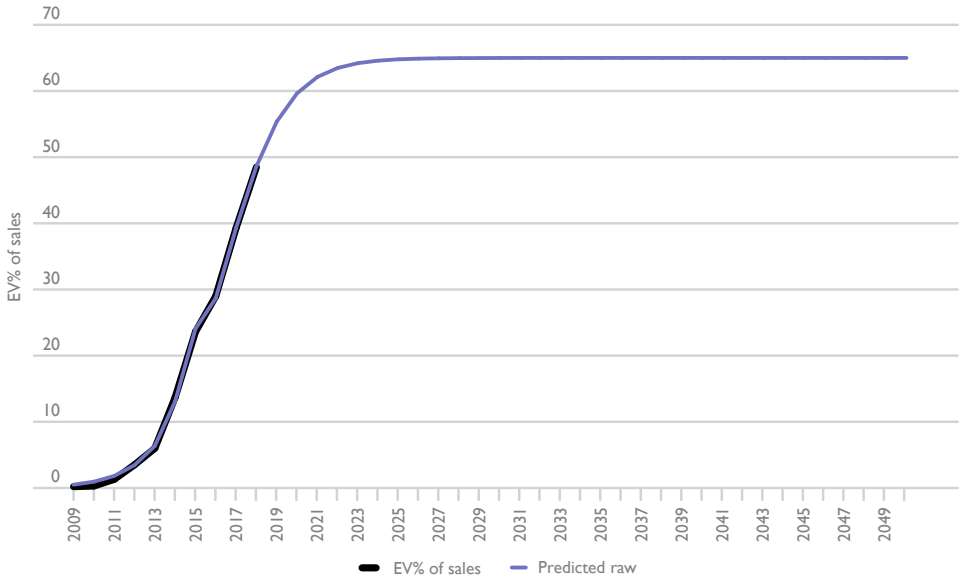


Figure 3.139 shows the extension of the forecast from this equation to 2050. This is the result of Stage 1 of the analysis.

Figure 3.139 Norwegian EV sales as a percentage of passenger vehicle sales and raw prediction to 2050



In Stage 2, the year that sales (or the raw prediction) pass the 2% mark is determined. For Norway, this is 2011.

Stage 3 involves assembling past and forecast EV and FFV costs to generate a time series of the ratio of EV to FFV annual costs. Table 3.53 shows the prices of BEVs, PHEVs and FFVs in Norway.

Table 3.53 Prices of BEVs, PHEVs and FFVs in Norway

BEV	2017 US$ (000')	Kroner	%	Kroner	Kroner	Kroner	Kroner	Kroner	Kroner
	BEV base	BEV base	VAT%	VAT	purchase tax	Owner tax	BEV price	Home charging	BEV price
2009	30	186088	0	0	0	3722	189810	12667	202476
2010	30	181391	0	0	0	3628	185019	11556	196575
2011	30	168249	0	0	0	3365	171614	11366	182980
2012	31	179481	0	0	0	3590	183071	10903	193974
2013	31	182820	0	0	0	3656	186476	11324	197800
2014	34	211037	0	0	0	4221	215258	12045	227304
2015	30	241880	0	0	0	4838	246718	12905	259622
2016	30	251919	0	0	0	5038	256958	13428	270386
2017	30	247889	0	0	0	4958	252847	13583	266430
2018	31	244737	0	0	0	4895	249632	13647	263279
2019	31	249384	0	0	0	4988	254372	13647	268019
2020	31	247887	0	0	0	4958	252845	13647	266492
2021	30	241654	25	60413	0	4833	306900	13647	320547
2022	31	245140	25	61285	0	4903	311327	13647	324974
2023	30	242892	25	60723	0	4858	308473	13647	322120
2024	29	234205	25	58551	0	4684	297441	13647	311088
2025	28	226747	25	56687	0	4535	287969	13647	301616
2026	28	222498	25	55625	0	4450	282573	13647	296220
2027	27	218249	25	54562	0	4365	277177	13647	290824
2028	27	213469	25	53367	0	4269	271106	13647	284753
2029	26	209221	25	52305	0	4184	265710	13647	279357
2030	26	204441	25	51110	0	4089	259640	13647	273287

PHEV	2017 US$ (000')	Kroner	Kroner	Kroner	Kroner	Kroner	Kroner	Kroner	Kroner
	PHEV base	PHEV base	VAT%	VAT	purchase tax	Owner tax	PHEV price	Home charging	PHEV price
2009	30	186088	25	46522	43389	8678	284677	12667	297344
2010	30	181391	25	45348	41720	8344	276803	11556	288359
2011	30	168249	25	42062	38697	7739	256748	11366	268114
2012	31	179481	25	44870	40153	8031	272535	10903	283438
2013	31	182820	0	0	0	7313	190132	11324	201456
2014	34	211037	0	0	0	8441	219479	12045	231524
2015	30	241880	0	0	0	9675	251555	12905	264460
2016	30	251919	0	0	0	10077	261996	13428	275424
2017	30	247889	0	0	0	9916	257805	13583	271388
2018	31	244737	0	0	0	9789	254526	13647	268173
2019	31	249384	0	0	0	9975	259359	13647	273006
2020	31	247887	0	0	0	9915	257803	13647	271450
2021	30	241654	25	60413	0	9666	311733	13647	325380
2022	31	245140	25	61285	0	9806	316230	13647	329877
2023	30	242892	25	60723	0	9716	313331	13647	326978
2024	29	234205	25	58551	0	9368	302125	13647	315772
2025	28	226747	25	56687	0	9070	292504	13647	306151
2026	28	222498	25	55625	0	8900	287023	13647	300670
2027	27	218249	25	54562	0	8730	281542	13647	295189
2028	27	213469	25	53367	0	8539	275375	13647	289023
2029	26	209221	25	52305	0	8369	269894	13647	283542
2030	26	204441	25	51110	0	8178	263728	13647	277375

Table 3.53 Prices of BEVs, PHEVs and FFVs in Norway (continued)

FFV	2017 US$ (000')	Kroner	Kroner	Kroner	Kroner	Kroner	Kroner
	FFV base	FFV base	VAT%	VAT	purchase tax	Owner tax	FFV price
2009	23	144632	25	36158	43389	8678	232857
2010	23	139066	25	34767	41720	8344	223897
2011	23	128991	25	32248	38697	7739	207675
2012	23	133844	25	33461	40153	8031	215488
2013	23	135013	25	33753	40504	8101	217372
2014	23	144711	25	36178	43413	8683	232985
2015	23	185441	25	46360	55632	11126	298560
2016	23	193138	25	48285	57941	11588	310952
2017	23	190049	25	47512	57015	11403	305978
2018	23	184000	25	46000	55200	11040	296240
2019	23	184000	25	46000	55200	11040	296240
2020	23	184000	25	46000	55200	11040	296240
2021	23	184000	25	46000	55200	11040	296240
2022	23	184000	25	46000	55200	11040	296240
2023	23	184000	25	46000	55200	11040	296240
2024	23	184000	25	46000	55200	11040	296240
2025	23	184000	25	46000	55200	11040	296240
2026	23	184000	25	46000	55200	11040	296240
2027	23	184000	25	46000	55200	11040	296240
2028	23	184000	25	46000	55200	11040	296240
2029	23	184000	25	46000	55200	11040	296240
2030	23	184000	25	46000	55200	11040	296240

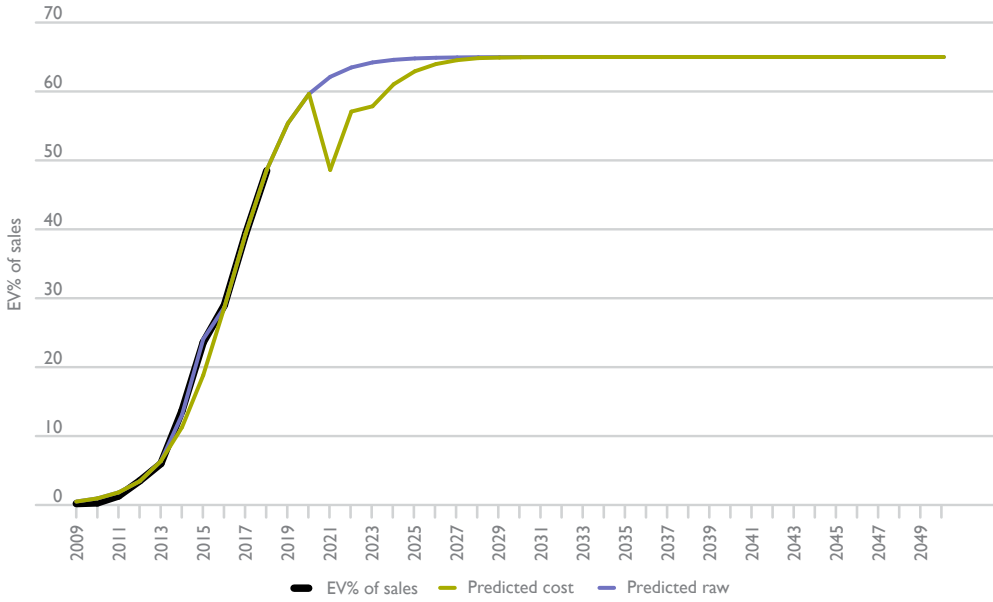
Table 3.54 shows past and forecast BEV and FFV costs used to generate a time series of the ratio of EV to FFV annual costs. Costs include principal (repay over 5 years), interest (13 per cent per year), annual EV subsidies, and petrol costs for FFV (with increasing fuel efficiency and a medium petrol price).

Table 3.54 EV/FFV cost ratio calculations for Norway

	Evs	Evs	Evs	Evs	Evs	FFVs	FFVs	FFVs	FFVs	FFVs	EV/FFV
	EV price	Principal	Interest	Annual subs	Annual cost	FFV price	Principal	Interest	Fuel	Annual cost	Cost ratio
2012	193974	38795	25217	28230	35782	215488	43098	28013	13256	84367	0.42
2013	197800	39560	25714	28454	36820	217372	43474	28258	13489	85221	0.43
2014	227304	45461	29549	30309	44701	232985	46597	30288	13409	90294	0.50
2015	259622	51924	33751	38101	47575	298560	59712	38813	12725	111250	0.43
2016	270386	54077	35150	39573	49654	310952	62190	40424	12182	114797	0.43
2017	266430	53286	34636	38982	48940	305978	61196	39777	13067	114040	0.43
2018	263279	52656	34226	37825	49057	296240	59248	38511	16369	114128	0.43
2019	268019	53604	34842	37825	50621	296240	59248	38511	16206	113966	0.44
2020	266492	53298	34644	34825	53117	296240	59248	38511	16046	113805	0.47
2021	320547	64109	41671	31825	73956	296240	59248	38511	15887	113646	0.65
2022	324974	64995	42247	28825	78417	296240	59248	38511	15730	113489	0.69
2023	322120	64424	41876	25825	80475	296240	59248	38511	15574	113333	0.71
2024	311088	62218	40441	25825	76834	296240	59248	38511	15420	113179	0.68
2025	301616	60323	39210	25825	73708	296240	59248	38511	15267	113026	0.65
2026	296220	59244	38509	25825	71928	296240	59248	38511	15116	112875	0.64
2027	290824	58165	37807	25825	70147	296240	59248	38511	14966	112726	0.62
2028	284753	56951	37018	25825	68144	296240	59248	38511	14818	112577	0.61
2029	279357	55871	36316	25825	66363	296240	59248	38511	14672	112431	0.59
2030	273287	54657	35527	25825	64360	296240	59248	38511	14526	112285	0.57

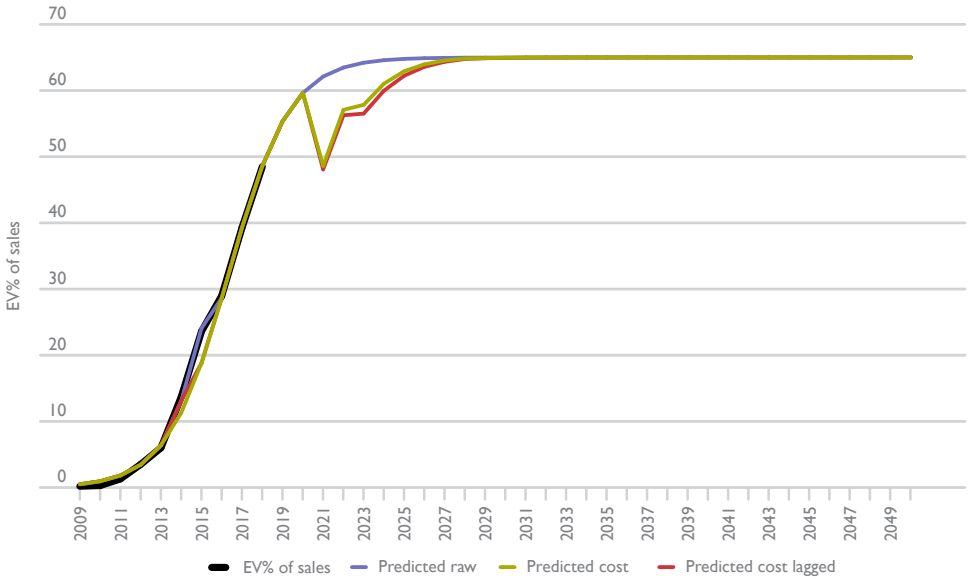
The resulting EV/FFV cost ratio time series is shown in the last column. This time series is then fed though the 2% year formula, which shifts the predicted raw uptake curve in line with shifts predicted for the cost ratio. Figure 3.140 shows the *predicted cost* curve dips down from the *predicated raw* curve as the scheduled reinstatement of VAT for EVs kicks in. This is the result from Stage 3 of the Norwegian analysis.

Figure 3.140 Norwegian predicted raw and predicted cost EV per cent of sales curves



In Stage 4 corrections are usually made to the predicted cost uptake curves to allow for the fact that most early adopters are those with higher incomes. . The resulting Norwegian *predicted cost lagged* curve – which is at a lower EV per cent of sales – is shown in Figure 3.141. The scheduled re-instating of VAT in 2021 means that the cost ratio rises to 0.7 in the 2020s, setting off a minor and brief rise above the base-level cost ratio of 0.6. The result is the small adoption lag effect shown below. This is the final base-case EV uptake prediction for Norway.

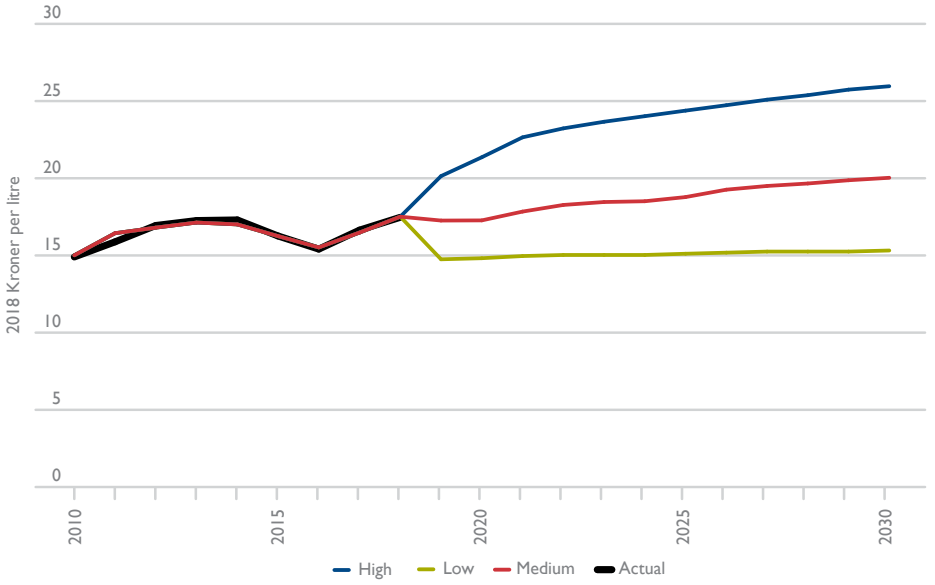
Figure 3.141 Norwegian predicted cost lagged EV uptake curve



The resulting Norwegian uptake forecast has EVs as 62 per cent of sales in 2025 and 65 per cent in 2030.

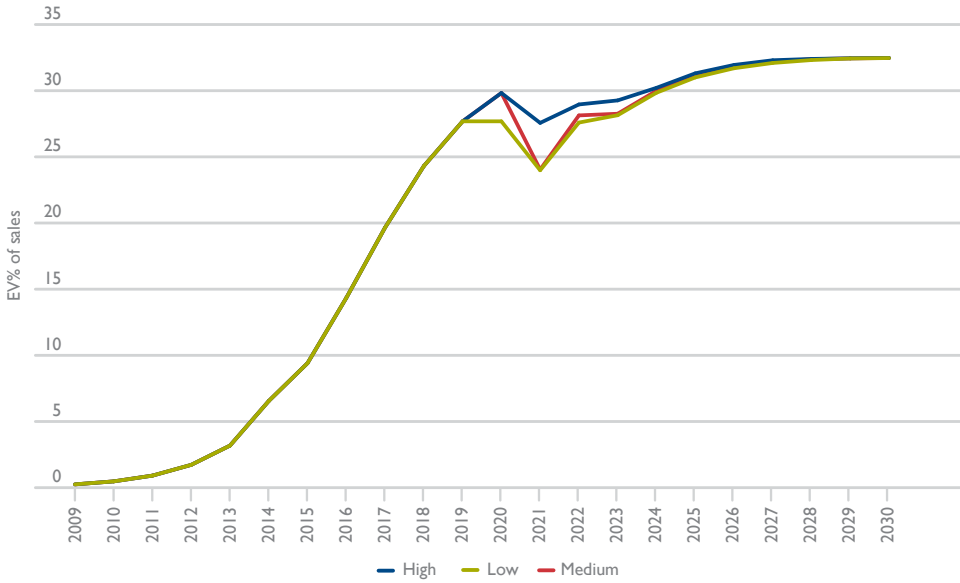
Stage 5 of the analysis looks at high, medium and low scenarios for oil prices and for EV prices. The oil price scenarios were given in Chapter 2. Corresponding Norwegian petrol prices have been derived from the oil to Norwegian petrol price equation in BITRE (2019). The resulting petrol price scenarios are shown in Figure 3.142.

Figure 3.142 Norwegian petrol price scenarios



When these scenario petrol prices are used in the calculation of the EV/FFV cost ratios, the following predicted cost lagged curves are generated.

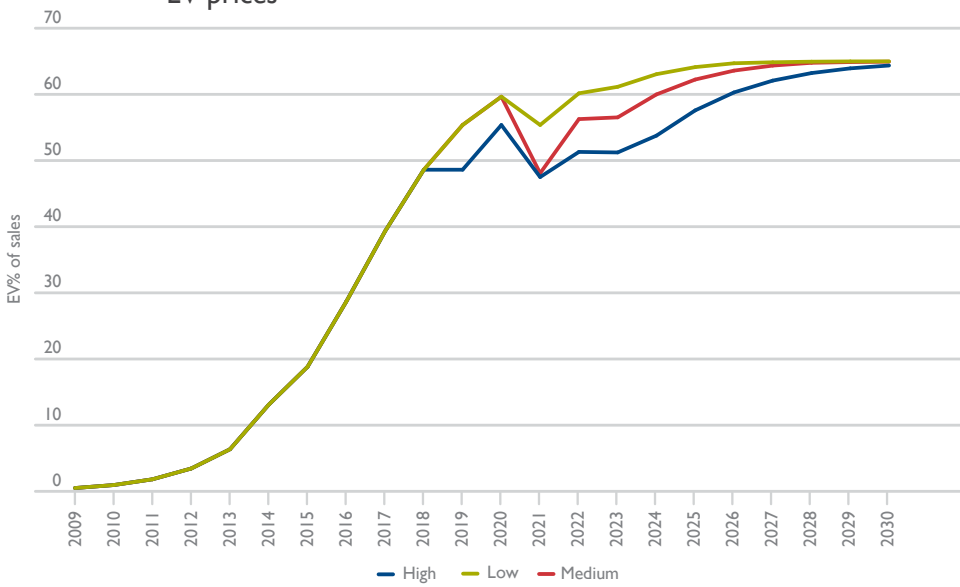
Figure 3.143 Scenarios for Norwegian EV uptake with high, medium and low oil prices



It can be seen that only the high oil price scenario makes a difference to forecast uptake.

The second scenario test is when the prices of EVs are increased or decreased. The vehicle price scenarios were also covered in Chapter 2 (30 per cent up on the medium, 30 per cent down). When these scenario vehicle prices are used in the calculation of the EV/FFV cost ratios, the following predicted cost lagged curves are generated.

Figure 3.144 Scenarios for Norwegian EV uptake with high, medium and low EV prices



It can be seen that even changes in vehicle prices have only moderate effects on projected uptake, as long as most EV purchase and operating subsidies remain, and the 65 per cent saturation level is appropriate for Norway.

3.19 Spain

The linearized logistic uptake for Spain is shown in Figure 3.145, along with a predicted curve.

The regression shown in Table 3.55 has two variables – a time trend and a dummy for 2013 to 2016. It is estimated over the period 2013 to 2018

Figure 3.145 Spanish linearized logistic EV sales percentage and prediction

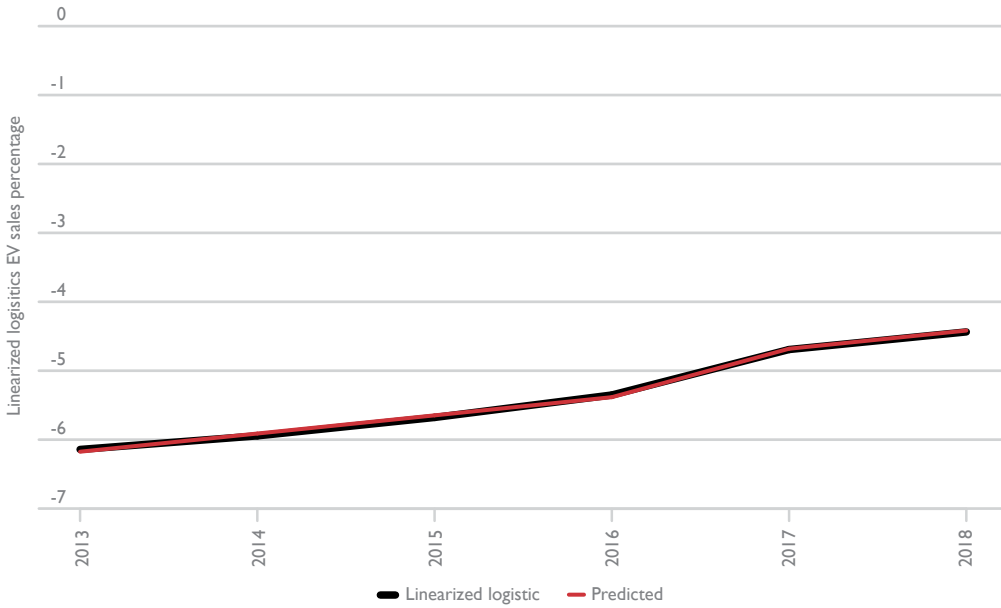


Table 3.55 Regression for Spanish linearized logistic EV uptake

Regression statistics	
Multiple R	0.998413093
R Square	0.996828705
Adjusted R Square	0.99365741
Standard Error	0.045701169
Observations	5

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	1.313011504	0.656505752	314.3286106	0.003171295
Residual	2	0.004177194	0.002088597		
Total	4	1.317188698			

	Coefficients	*Standard error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-6.790464159	0.169772309	-39.99747787	0.000624493	-7.520935447	-6.059992872
time	0.263695819	0.020438184	12.90211579	0.005953689	0.17575741	0.351634228
dum1316	-0.43924468	0.072259893	-6.078678782	0.026012033	-0.750153907	-0.128335453

Figure 3.146 shows the fit of the de-linearized *raw prediction* to the actual EV sales percentage of new passenger vehicle sales.

Figure 3.146 Spanish EV sales as a percentage of passenger vehicle sales and raw prediction

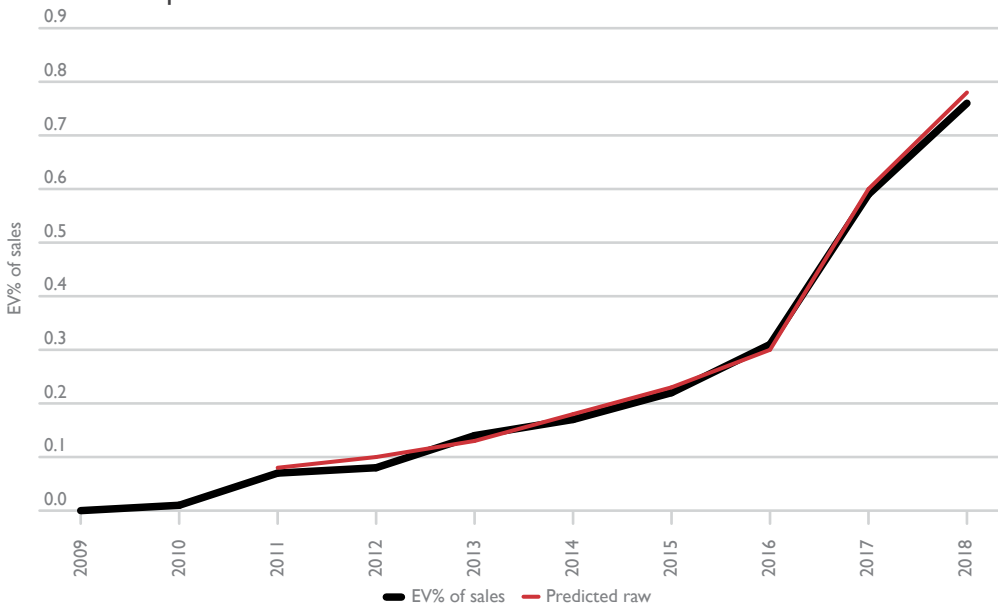
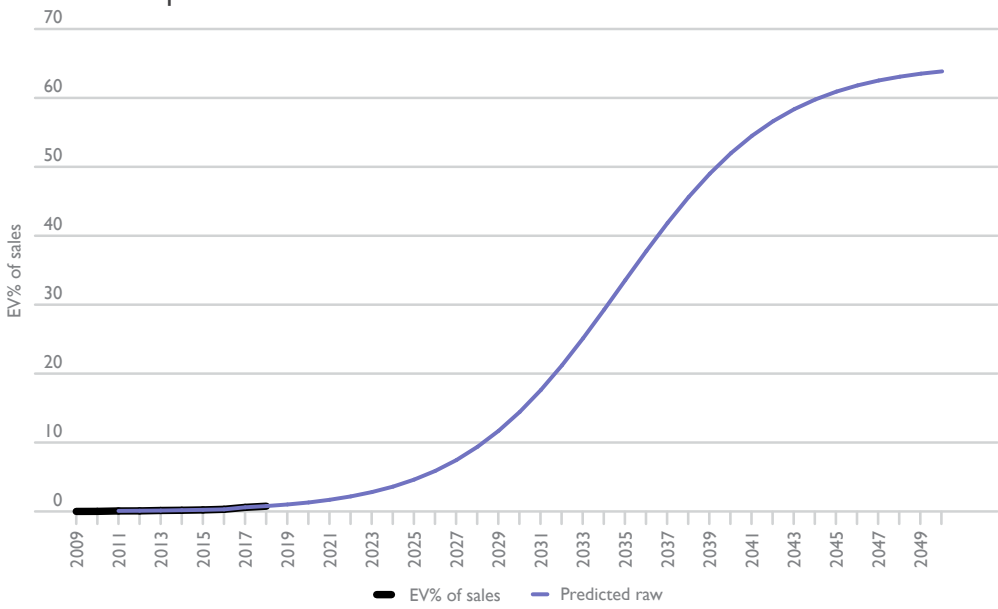


Figure 3.147 shows the extension of the forecast from this equation to 2050. This is the result of Stage 1 of the analysis.

Figure 3.147 Spanish EV sales as a percentage of passenger vehicle sales and raw prediction to 2050



In Stage 2, the year that sales (or the raw prediction) pass the 2% mark is determined. For Spain, this is 2021.

Stage 3 involves assembling past and forecast EV and FFV costs to generate a time series of the ratio of EV to FFV annual costs. Table 3.56 shows the prices of BEVs, PHEVs and FFVs in Spain.

Table 3.56 Prices of BEVs, PHEVs and FFVs in Spain

BEV	2017 US$ (000')	Euros	Euros	%	Euros	Euros			Euros
	BEV base	BEV base	purchase tax	VAT%	VAT	BEV price	Purchase subsidy	Home charging	BEV price
2009	30	21302	1012	16	3408	25722	-5704	1450	27172
2010	30	22760	1081	16	3642	27483	-5987	1450	22946
2011	30	21463	1020	18	3863	26346	-5471	1450	22325
2012	31	23869	1134	18	4296	29299	-5939	1450	24810
2013	31	23410	1112	21	4916	29438	-5744	1450	25144
2014	34	25404	1207	21	5335	31946	-5897	1450	27498
2015	30	27178	1291	21	5707	34176	-5927	1450	29699
2016	30	27202	1292	21	5713	34207	-6118	1450	29539
2017	30	26462	1257	21	5557	33276	-6000	1450	28726
2018	31	26003	0	21	5461	31464	-5394	1450	27520
2019	31	26497	0	21	5564	32061	-5291	1450	28221
2020	31	26338	0	21	5531	31869	-5189	1450	28130
2021	30	25676	0	21	5392	31068	-5089	1450	27428
2022	31	26046	0	21	5470	31516	-4991	1450	27974
2023	30	25807	0	21	5420	31227	-4895	1450	27782
2024	29	24884	0	21	5226	30110	-4801	1450	26759
2025	28	24092	0	21	5059	29151	-4709	1450	25892
2026	28	23640	0	21	4964	28605	-4618	1450	25436
2027	27	23189	0	21	4870	28059	-4530	1450	24979
2028	27	22681	0	21	4763	27444	-4443	1450	24452
2029	26	22230	0	21	4668	26898	-4357	1450	23991
2030	26	21722	0	21	4562	26283	-4219	1450	23514

PHEV	2017 US$ (000')	Euros	Euros	%	Euros	Euros			Euros
	PHEV base	PHEV base	purchase tax	VAT%	VAT	PHEV price	Purchase subsidy	Home charging	PHEV price
2009	30	21302	1012	16	3408	25722	-2142	1450	25172
2010	30	22760	1081	16	3642	27483	-2104	1450	26828
2011	30	21463	1020	18	3863	26346	-2039	1450	25757
2012	31	23869	1134	18	4296	29299	-1991	1450	28759
2013	31	23410	1112	21	4916	29438	-1963	1450	28925
2014	34	25404	1207	21	5335	31946	-1966	1450	31430
2015	30	27178	1291	21	5707	34176	-1976	1450	33650
2016	30	27202	1292	21	5713	34207	-2039	1450	33618
2017	30	26462	1257	21	5557	33276	-2000	1450	32726
2018	31	26003	0	21	5461	31464	-1962	1450	30952
2019	31	26497	0	21	5564	32061	-1924	1450	31588
2020	31	26338	0	21	5531	31869	-1887	1450	31432
2021	30	25676	0	21	5392	31068	-1851	1450	30667
2022	31	26046	0	21	5470	31516	-1815	1450	31151
2023	30	25807	0	21	5420	31227	-1780	1450	30897
2024	29	24884	0	21	5226	30110	-1746	1450	29814
2025	28	24092	0	21	5059	29151	-1712	1450	28889
2026	28	23640	0	21	4964	28605	-1679	1450	28375
2027	27	23189	0	21	4870	28059	-1647	1450	27862
2028	27	22681	0	21	4763	27444	-1615	1450	27279
2029	26	22230	0	21	4668	26898	-1584	1450	26763
2030	26	21722	0	21	4562	26283	-1554	1450	26179

Table 3.56 Prices of BEVs, PHEVs and FFVs in Spain (continued)

FFV	2017 US$ (000')	Euros	Euros	%	Euros	Euros
	FFV base	FFV base	purchase tax	VAT%	VAT	FFV price
2009	23	16556	786	16	2649	19992
2010	23	17449	829	16	2792	21070
2011	23	16455	782	18	2962	20199
2012	23	17800	845	18	3204	21849
2013	23	17288	821	21	3631	21740
2014	23	17420	827	21	3658	21906
2015	23	20836	990	21	4376	26202
2016	23	20855	991	21	4380	26225
2017	23	20288	964	21	4260	25512
2018	23	19550	929	21	4106	24584
2019	23	19550	929	21	4106	24584
2020	23	19550	929	21	4106	24584
2021	23	19550	929	21	4106	24584
2022	23	19550	929	21	4106	24584
2023	23	19550	929	21	4106	24584
2024	23	19550	929	21	4106	24584
2025	23	19550	929	21	4106	24584
2026	23	19550	929	21	4106	24584
2027	23	19550	929	21	4106	24584
2028	23	19550	929	21	4106	24584
2029	23	19550	929	21	4106	24584
2030	23	19550	929	21	4106	24584

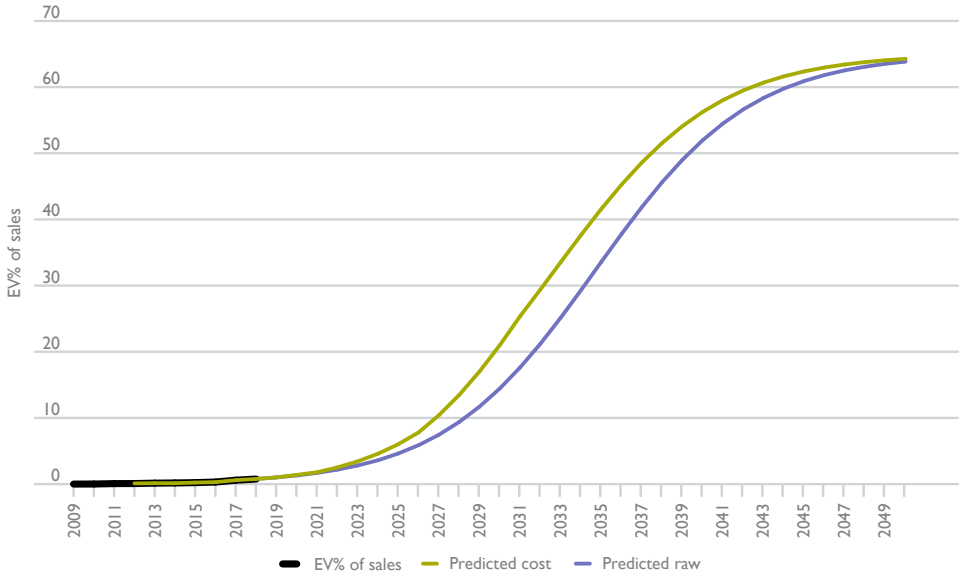
Table 3.57 shows past and forecast BEV and FFV costs used to generate a time series of the ratio of EV to FFV annual costs. Costs include principal (repay over 5 years), interest (13 per cent per year), annual EV subsidies, and petrol costs for FFV (with increasing fuel efficiency and a medium petrol price).

Table 3.57 EV/FFV cost ratio calculations for Spain

	Evs	Evs	Evs	Evs	Evs	FFVs	FFVs	FFVs	FFVs	FFVs	EV/FFV
	EV price	Principal	Interest	Annual subs	Annual cost	FFV price	Principal	Interest	Fuel	Annual cost	Cost ratio
2012	24810	4962	3225	0	8187	21849	4370	2840	847	8058	1.02
2013	25144	5029	3269	0	8298	21740	4348	2826	888	8062	1.03
2014	27498	5500	3575	0	9074	21906	4381	2848	907	8136	1.12
2015	29699	5940	3861	0	9801	26202	5240	3406	835	9481	1.03
2016	29539	5908	3840	0	9748	26225	5245	3409	794	9448	1.03
2017	28726	5745	3734	0	9480	25512	5102	3317	816	9235	1.03
2018	27520	5504	3578	0	9082	24584	4917	3196	843	8955	1.01
2019	28221	5644	3669	0	9313	24584	4917	3196	829	8942	1.04
2020	28130	5626	3657	0	9283	24584	4917	3196	822	8935	1.04
2021	27428	5486	3566	0	9051	24584	4917	3196	842	8955	1.01
2022	27974	5595	3637	0	9232	24584	4917	3196	854	8967	1.03
2023	27782	5556	3612	0	9168	24584	4917	3196	855	8968	1.02
2024	26759	5352	3479	0	8830	24584	4917	3196	849	8962	0.99
2025	25892	5178	3366	0	8544	24584	4917	3196	853	8966	0.95
2026	25436	5087	3307	0	8394	24584	4917	3196	867	8980	0.93
2027	24979	4996	3247	0	8243	24584	4917	3196	870	8982	0.92
2028	24452	4890	3179	0	8069	24584	4917	3196	868	8981	0.90
2029	23991	4798	3119	0	7917	24584	4917	3196	869	8982	0.88
2030	23514	4703	3057	0	7760	24584	4917	3196	868	8980	0.86

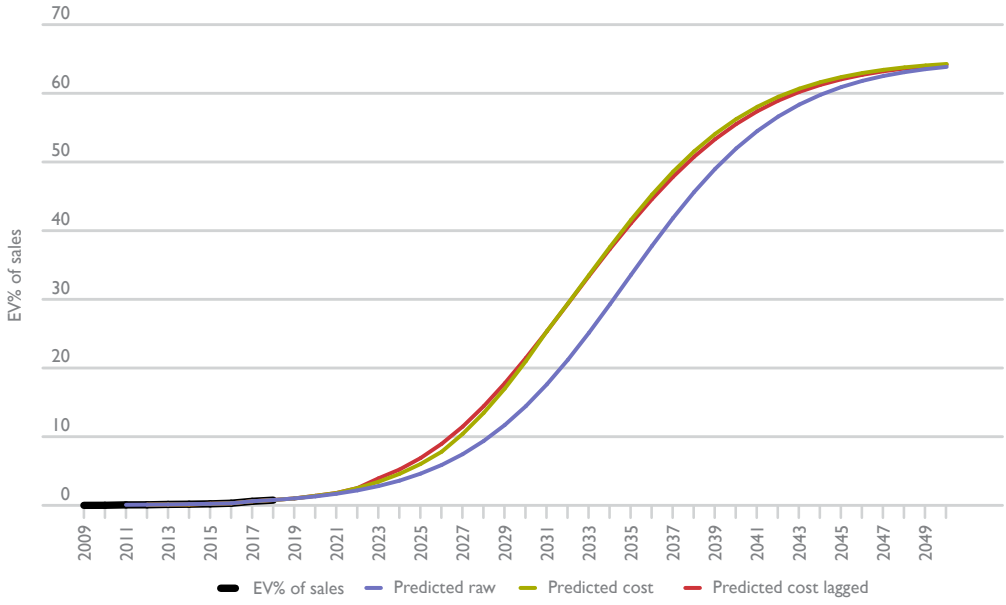
The resulting EV/FFV cost ratio time series is shown in the last column. This time series is then fed though the 2% year formula, which shifts the predicted raw uptake curve in line with shifts predicted for the cost ratio. Figure 3.148 shows the *predicted cost* curve is shifted left from the *predicated raw* curve. This is the result from Stage 3 of the Spanish analysis.

Figure 3.148 Spanish predicted raw and predicted cost EV per cent of sales curves



In Stage 4 corrections are usually made to the predicted cost uptake curves to allow for the fact that most early adopters are those with higher incomes. But Spain is one of the 'flat' uptake countries, so the Spanish *predicted cost lagged* curve is assumed the same as the *predicted cost* curve, as shown in Figure 3.149. This is the final base-case EV uptake prediction for Spain.

Figure 3.149 Spanish predicted cost lagged EV uptake curve

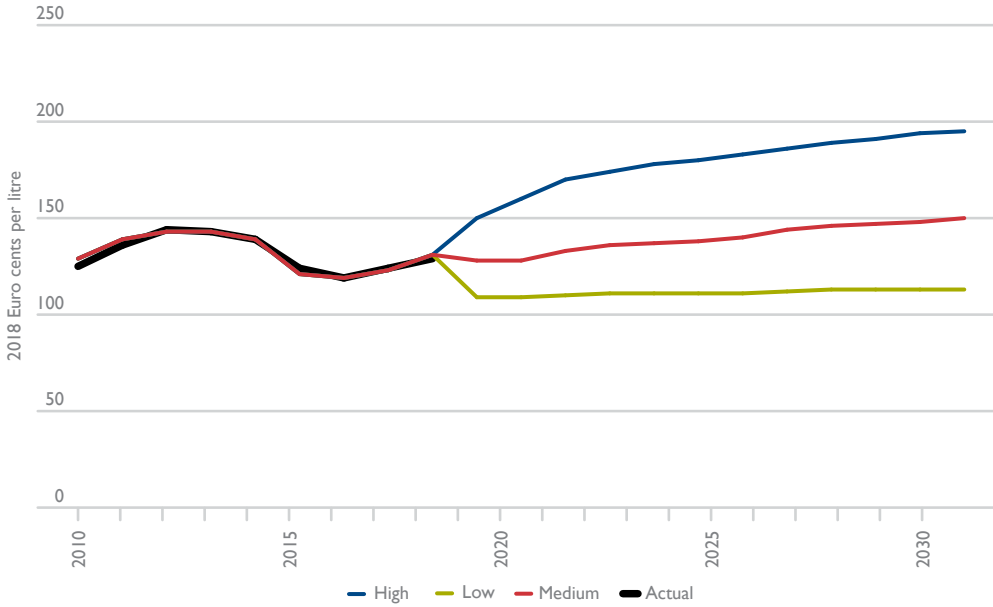


The resulting Spanish uptake forecast has EVs as 7 per cent of sales in 2025 and 21 per cent in 2030.

Stage 5 of the analysis looks at high, medium and low scenarios for oil prices and for EV prices.

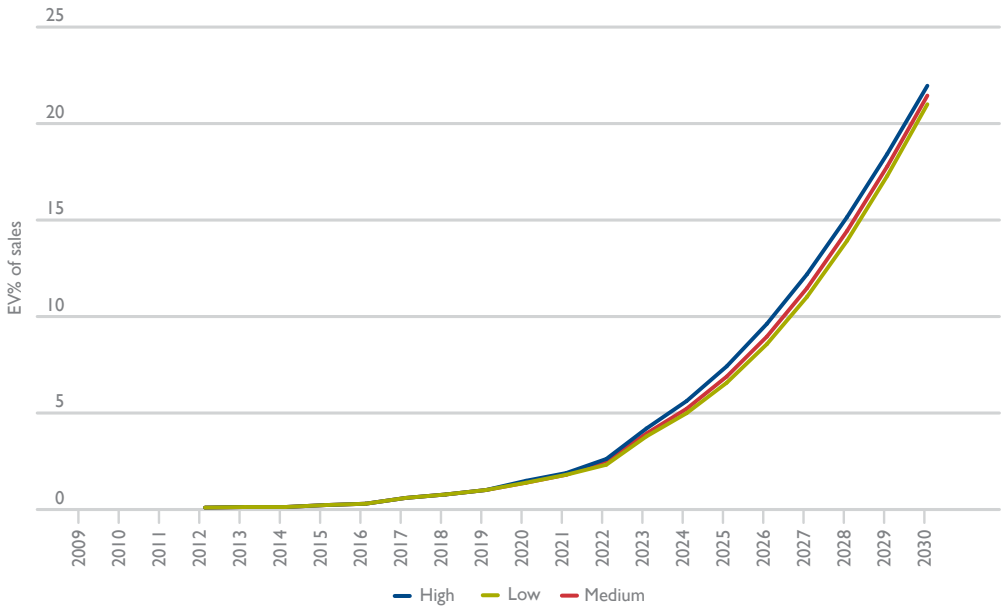
The oil price scenarios were given in Chapter 2. Corresponding Spanish petrol prices have been derived from the oil to Spanish petrol price equation in BITRE (2019). The resulting petrol price scenarios are shown in Figure 3.150.

Figure 3.150 Spanish petrol price scenarios



When these scenario petrol prices are used in the calculation of the EV/FFV cost ratios, the following predicted cost lagged curves are generated.

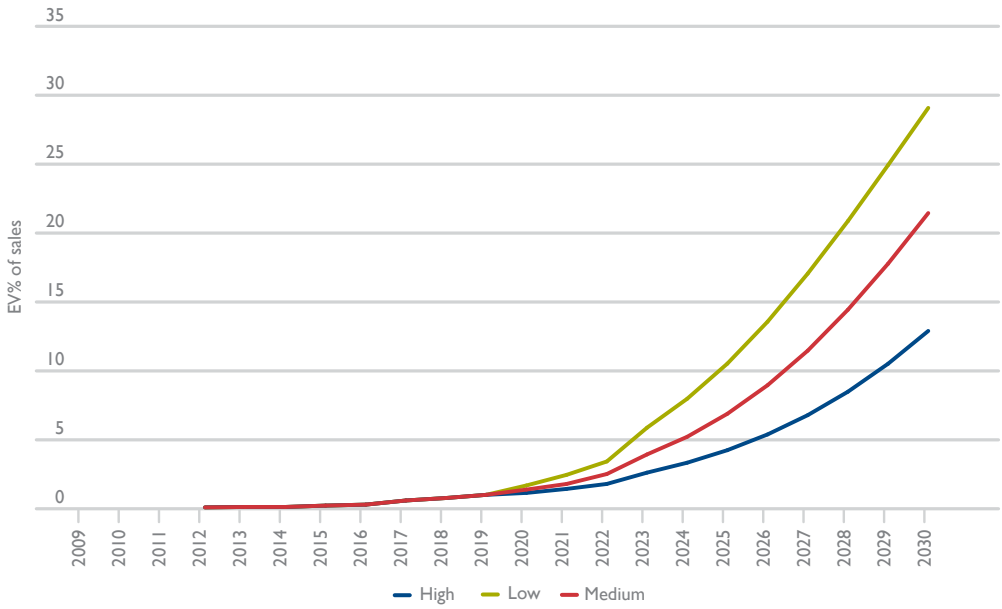
Figure 3.151 Scenarios for Spanish EV uptake with high, medium and low oil prices



It can be seen that oil price scenarios make very little difference to forecast uptake.

The second scenario test is when the prices of EVs are increased or decreased. The vehicle price scenarios were also covered in Chapter 2 (30 per cent up on the medium, 30 per cent down). When these scenario vehicle prices are used in the calculation of the EV/FFV cost ratios, the following predicted cost lagged curves are generated.

Figure 3.152 Scenarios for Spanish EV uptake with high, medium and low EV prices



It can be seen that changes in vehicle prices have a substantial effect on projected uptake.

3.20 Sweden

The linearized logistic uptake for Sweden is shown in Figure 3.153, along with a predicted curve.

The regression shown in Table 3.58 has two variables – a time trend and a dummy for 2012 to 2013. It is estimated over the period 2012 to 2017.

Figure 3.153 Swedish linearized logistic EV sales percentage and prediction

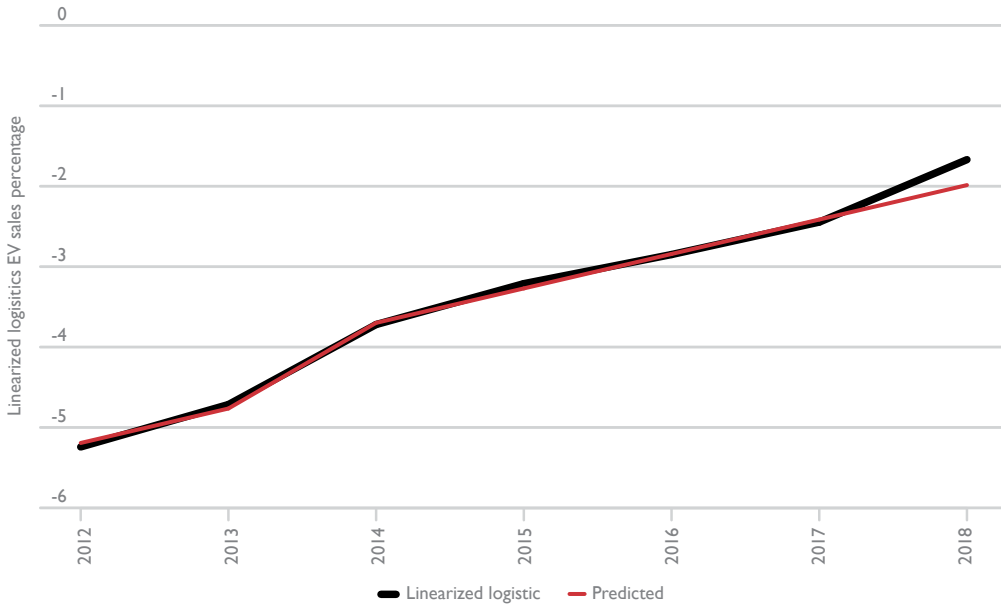


Table 3.58 Regression for Swedish linearized logistic EV uptake

Regression statistics	
Multiple R	0.999165054
R Square	0.998330804
Adjusted R Square	0.997218007
Standard Error	0.057509661
Observations	6

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	5.934308478	2.967154239	897.1364742	6.81963E-05
Residual	3	0.009922083	0.003307361		
Total	5	5.944230561			

	Coefficients	*Standard error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-5.84061299	0.161967239	-36.06045901	4.69003E-05	-6.356065032	-5.325160948
time	0.428303572	0.024522202	17.46595097	0.000409065	0.350262982	0.506344162
dum1213	-0.637073953	0.088840116	-7.171016695	0.005586384	-0.919802851	-0.354345055

Figure 3.154 shows the fit of the de-linearized *raw prediction* to the actual EV sales percentage of new passenger vehicle sales.

Figure 3.154 Swedish EV sales as a percentage of passenger vehicle sales and raw prediction

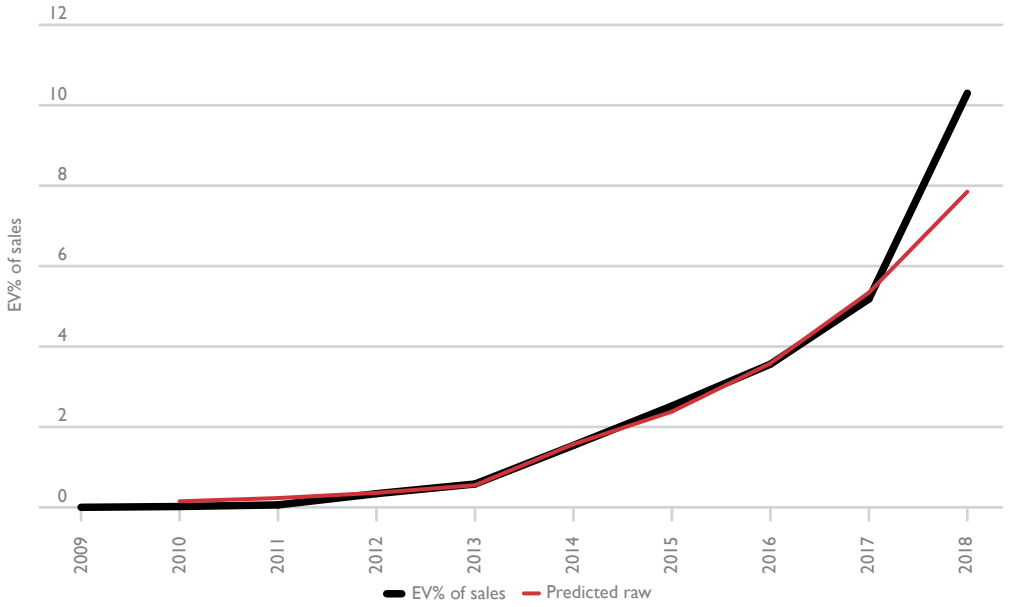
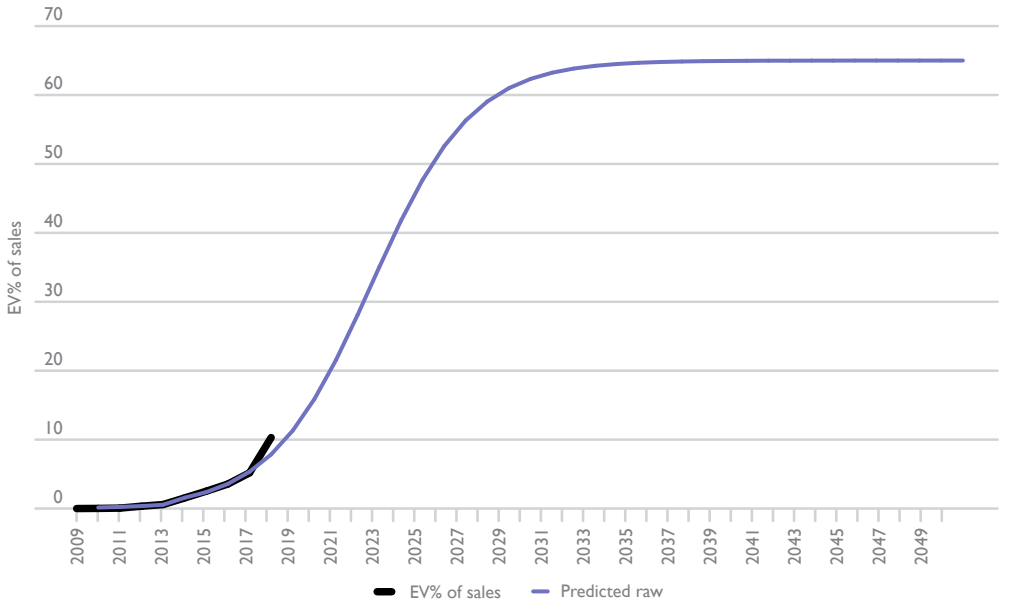


Figure 3.155 shows the extension of the forecast from this equation to 2050. This is the result of Stage 1 of the analysis.

Figure 3.155 Swedish EV sales as a percentage of passenger vehicle sales and raw prediction to 2050



In Stage 2, the year that sales (or the raw prediction) pass the 2% mark is determined. For Sweden, this is 2014.

Stage 3 involves assembling past and forecast EV and FFV costs to generate a time series of the ratio of EV to FFV annual costs. Table 3.59 shows the prices of BEVs, PHEVs and FFVs in Sweden with forecasts assuming continuation of EV subsidies.

Table 3.59 Prices of BEVs, PHEVs and FFVs in Sweden

BEV	2017 US$ (000')	Krona	Krona	%	Krona	Krona	Krona	krona
	BEV base	BEV base	Purchase tax	VAT%	VAT	BEV price	Purchase subsidy	BEV price
2009	30	226496		25	56624	283120	0	283120
2010	30	215889		25	53972	269861	0	269861
2011	30	194940		25	48735	243675	0	243675
2012	31	208823		25	52206	261029	-41006	220023
2013	31	202861		25	50715	253576	-41024	212553
2014	34	229882		25	57471	287353	-41098	246255
2015	30	253083		25	63271	316353	-41117	275236
2016	30	256875		25	64219	321094	-40716	280378
2017	30	256199		25	64050	320248	-40000	280248
2018	31	260033		25	65008	325041	-58945	266096
2019	31	264970		25	66243	331213	-57908	273305
2020	31	263380		25	65845	329225	-56890	272335
2021	30	256757		25	64189	320946	-55890	265057
2022	31	260461		25	65115	325576	-54907	270669
2023	30	258073		25	64518	322591	-53941	268650
2024	29	248843		25	62211	311054	-52993	258061
2025	28	240919		25	60230	301148	-52061	249088
2026	28	236404		25	59101	295505	-51145	244360
2027	27	231890		25	57972	289862	-50246	239617
2028	27	226811		25	56703	283514	-49362	234152
2029	26	222297		25	55574	277871	-48494	229377
2030	26	217218		25	54305	271523	-47641	223881
PHEV	2017 US$ (000')	Krona	Krona	%	Krona	Krona	Krona	krona
	PHEV base	PHEV base	Purchase tax	VAT%	VAT	PHEV price	Purchase subsidy	PHEV price
2009	30	226496		25	56624	283120	0	283120
2010	30	215889		25	53972	269861	0	269861
2011	30	194940		25	48735	243675	0	243675
2012	31	208823		25	52206	261029	-41006	220023
2013	31	202861		25	50715	253576	-41024	212553
2014	34	229882		25	57471	287353	-41098	246255
2015	30	253083		25	63271	316353	-41117	275236
2016	30	256875		25	64219	321094	-20358	300736
2017	30	256199		25	64050	320248	-20000	300248
2018	31	260033		25	65008	325041	-19648	305393
2019	31	264970		25	66243	331213	-19303	311910
2020	31	263380		25	65845	329225	-18963	310262
2021	30	256757		25	64189	320946	-18630	302316
2022	31	260461		25	65115	325576	-18302	307274
2023	30	258073		25	64518	322591	-17980	304611
2024	29	248843		25	62211	311054	-17664	293389
2025	28	240919		25	60230	301148	-17354	283795
2026	28	236404		25	59101	295505	-17048	278457
2027	27	231890		25	57972	289862	-16749	273114
2028	27	226811		25	56703	283514	-16454	267060
2029	26	222297		25	55574	277871	-16165	261706
2030	26	217218		25	54305	271523	-15880	255642

Table 3.59 Prices of BEVs, PHEVs and FFVs in Sweden (continued)

FFV	2017 US$ (000')	Krona	Krona	%	Krona	Krona
	FFV base	FFV base	Purchase tax	VAT%	VAT	FFV price
2009	23	176038		25	44009	220047
2010	23	165515		25	41379	206893
2011	23	149454		25	37363	186817
2012	23	155725		25	38931	194656
2013	23	149814		25	37454	187268
2014	23	157633		25	39408	197041
2015	23	194030		25	48507	242537
2016	23	196938		25	49234	246172
2017	23	196419		25	49105	245524
2018	23	195500		25	48875	244375
2019	23	195500		25	48875	244375
2020	23	195500		25	48875	244375
2021	23	195500		25	48875	244375
2022	23	195500		25	48875	244375
2023	23	195500		25	48875	244375
2024	23	195500		25	48875	244375
2025	23	195500		25	48875	244375
2026	23	195500		25	48875	244375
2027	23	195500		25	48875	244375
2028	23	195500		25	48875	244375
2029	23	195500		25	48875	244375
2030	23	195500		25	48875	244375

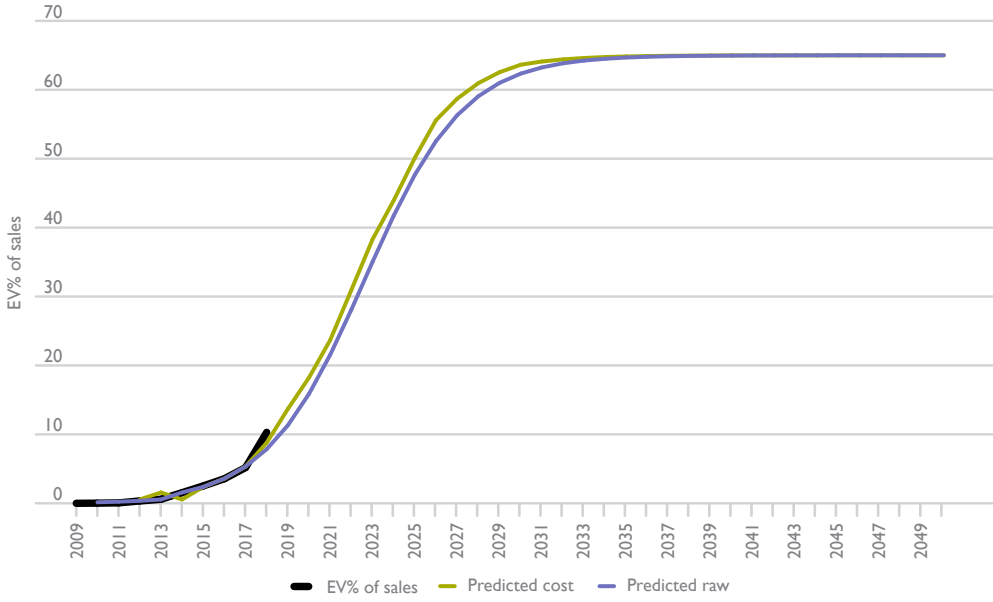
Table 3.60 shows past and forecast BEV and FFV costs used to generate a time series of the ratio of EV to FFV annual costs. Costs include principal (repay over 5 years), interest (13 per cent per year), annual EV subsidies, and petrol costs for FFV (with increasing fuel efficiency and a medium petrol price).

Table 3.60 EV/FFV cost ratio calculations for Sweden

	Evs	Evs	Evs	Evs	Evs	FFVs	FFVs	FFVs	FFVs	FFVs	FFVs	EV/ FFV
	EV price	Principal	Interest	Annual subs	Annual cost	FFV price	Principal	Interest	CO2 cost	Fuel	Annual cost	Cost ratio
2012	220023	44005	28603	11036	61572	194656	38931	25305	0	13420	77656	0.79
2013	212553	42511	27632	10690	59452	187268	37454	24345	0	12880	74678	0.80
2014	246255	49251	32013	11174	70090	197041	39408	25615	0	12541	77565	0.90
2015	275236	55047	35781	13342	77486	242537	48507	31530	0	11446	91483	0.85
2016	280378	56076	36449	13383	79141	246172	49234	32002	0	11178	92415	0.86
2017	280248	56050	36432	13118	79364	245524	49105	31918	0	11664	92687	0.86
2018	266096	53219	34593	12835	74976	244375	48875	31769	1230	12654	94528	0.79
2019	273305	54661	35530	12610	77581	244375	48875	31769	1230	12099	93972	0.83
2020	272335	54467	35404	12388	77483	244375	48875	31769	1230	11992	93866	0.83
2021	265057	53011	34457	12170	75299	244375	48875	31769	1230	12257	94130	0.80
2022	270669	54134	35187	11956	77365	244375	48875	31769	1230	12418	94292	0.82
2023	268650	53730	34925	11746	76909	244375	48875	31769	1230	12424	94298	0.82
2024	258061	51612	33548	11539	73621	244375	48875	31769	1230	12334	94208	0.78
2025	249088	49818	32381	11336	70863	244375	48875	31769	1230	12387	94261	0.75
2026	244360	48872	31767	11137	69502	244375	48875	31769	1230	12568	94442	0.74
2027	239617	47923	31150	10941	68132	244375	48875	31769	1230	12599	94473	0.72
2028	234152	46830	30440	10749	66521	244375	48875	31769	1230	12571	94445	0.70
2029	229377	45875	29819	10560	65135	244375	48875	31769	1230	12577	94451	0.69
2030	223881	44776	29105	10374	63507	244375	48875	31769	1230	12552	94425	0.67

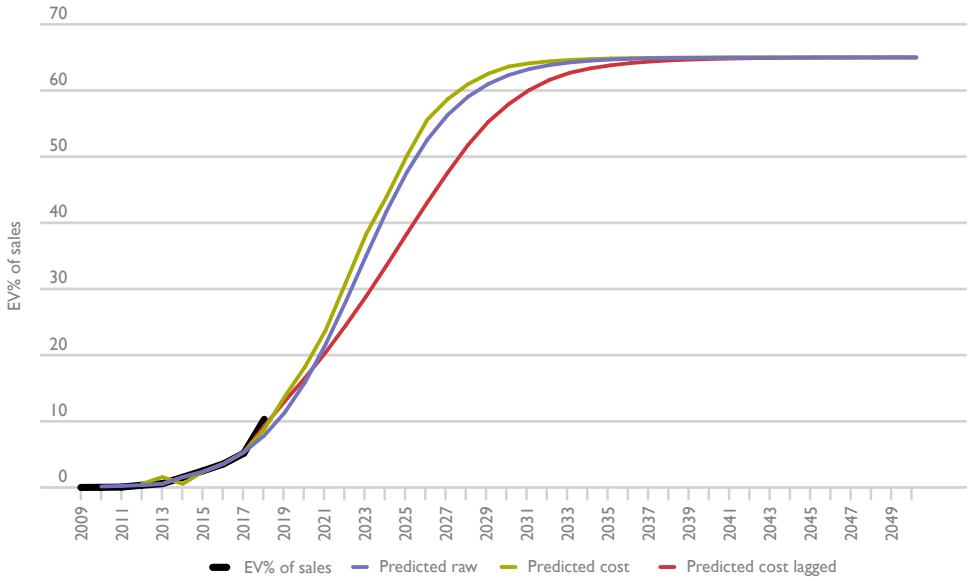
The resulting EV/FFV cost ratio time series is shown in the last column. This time series is then fed though the 2% year formula, which shifts the predicted raw uptake curve in line with shifts predicted for the cost ratio. Figure 3.156 shows the *predicted cost* curve is shifted left from the *predicated raw* curve, as EV subsidies increase in 2018. This is the result from Stage 3 of the Swedish analysis.

Figure 3.156 Swedish predicted raw and predicted cost EV per cent of sales curves



In Stage 4 corrections are usually made to the predicted cost uptake curves to allow for the fact that most early adopters are those with higher incomes. The resulting Swedish *predicted cost lagged* curve – which is a less steeply rising curve – is shown in Figure 3.157

Figure 3.157 Swedish predicted cost lagged EV uptake curve

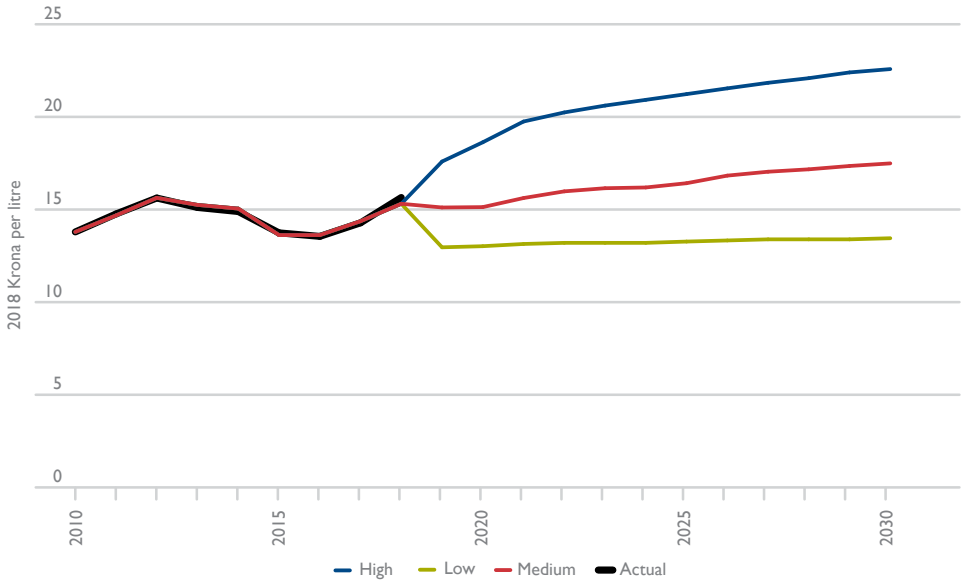


The resulting Swedish uptake forecast has EVs as 37 per cent of sales in 2025 and 58 per cent in 2030.

Stage 5 of the analysis looks at high, medium and low scenarios for oil prices and for EV prices.

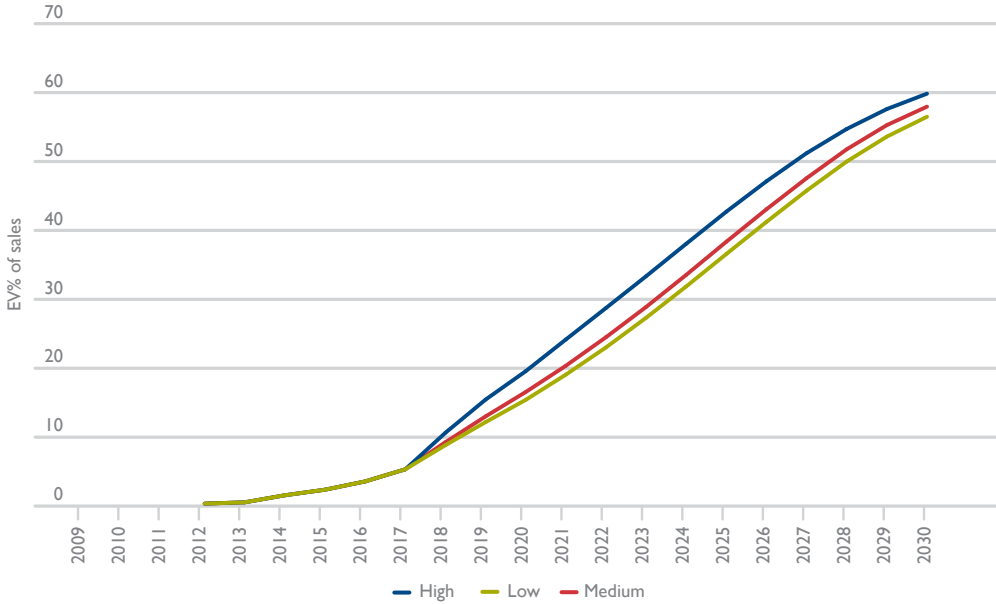
The oil price scenarios were given in Chapter 2. Corresponding Swedish petrol prices have been derived from the oil to Swedish petrol price equation in BITRE (2019). The resulting petrol price scenarios are shown in Figure 3.158.

Figure 3.158 Swedish petrol price scenarios



When these scenario petrol prices are used in the calculation of the EV/FFV cost ratios, the following predicted cost lagged curves are generated.

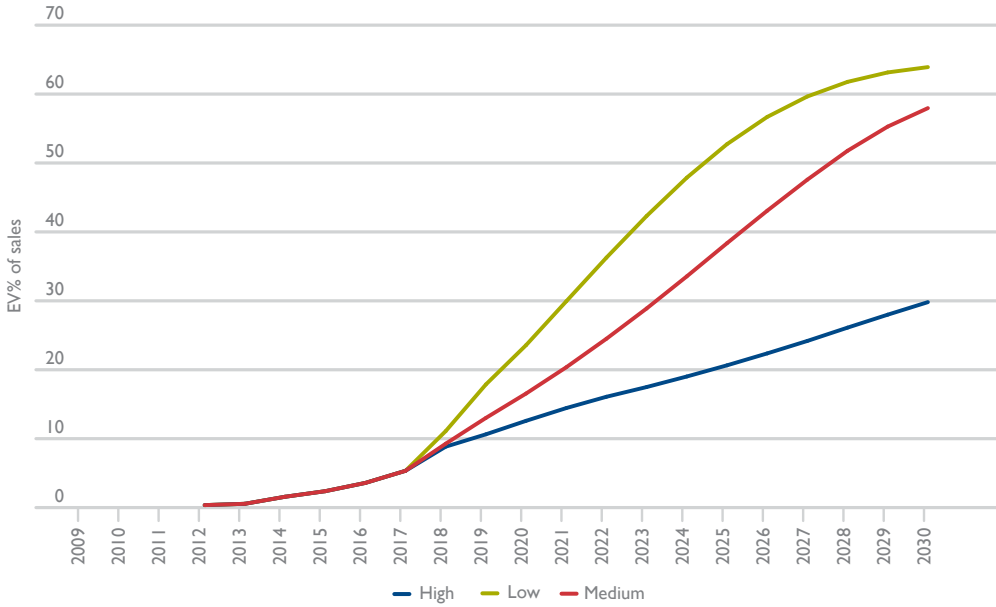
Figure 3.159 Scenarios for Swedish EV uptake with high, medium and low oil prices



It can be seen that only the high oil price scenario makes a difference to forecast uptake.

The second scenario test is when the prices of EVs are increased or decreased. The vehicle price scenarios were also covered in Chapter 2 (30 per cent up on the medium, 30 per cent down). When these scenario vehicle prices are used in the calculation of the EV/FFV cost ratios, the following predicted cost lagged curves are generated.

Figure 3.160 Scenarios for Swedish EV uptake with high, medium and low EV prices



It can be seen that changes in vehicle prices have a substantial effect on projected uptake.

3.21 Switzerland

The linearized logistic uptake for Switzerland is shown in Figure 3.161, along with a predicted curve.

The regression shown in Table 3.61 has three variables – a time trend to 2015, a dummy for 2015 to 2016, and a second time trend from 2016 on. It is estimated over the period 2011 to 2018.

Figure 3.161 Swiss linearized logistic EV sales percentage and prediction

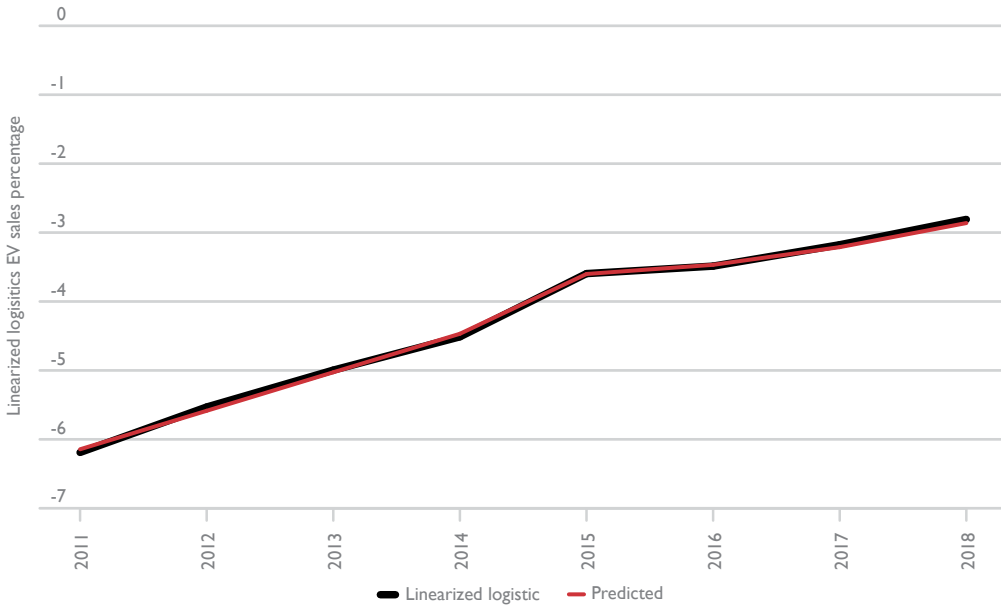


Table 3.61 Regression for Swiss linearized logistic EV uptake

Regression statistics	
Multiple R	0.999517574
R Square	0.99903538
Adjusted R Square	0.998311915
Standard Error	0.049242906
Observations	8

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	10.04551007	3.348503358	1380.903689	1.74411E-06
Residual	4	0.009699455	0.002424864		
Total	7	10.05520953			

	Coefficients	*Standard error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-7.261647942	0.076390362	-95.05973967	7.34251E-08	-7.473741589	-7.049554295
time1	0.558639825	0.020146988	27.728206	1.00625E-05	0.50270282	0.614576831
dum1516	0.308877784	0.075214084	4.106648237	0.014772536	0.10005001	0.517705558
time2	0.349236107	0.025594398	13.64502118	0.000167056	0.278174665	0.420297549

Figure 3.162 shows the fit of the de-linearized *raw prediction* to the actual EV sales percentage of new passenger vehicle sales.

Figure 3.162 Swiss EV sales as a percentage of passenger vehicle sales and raw prediction

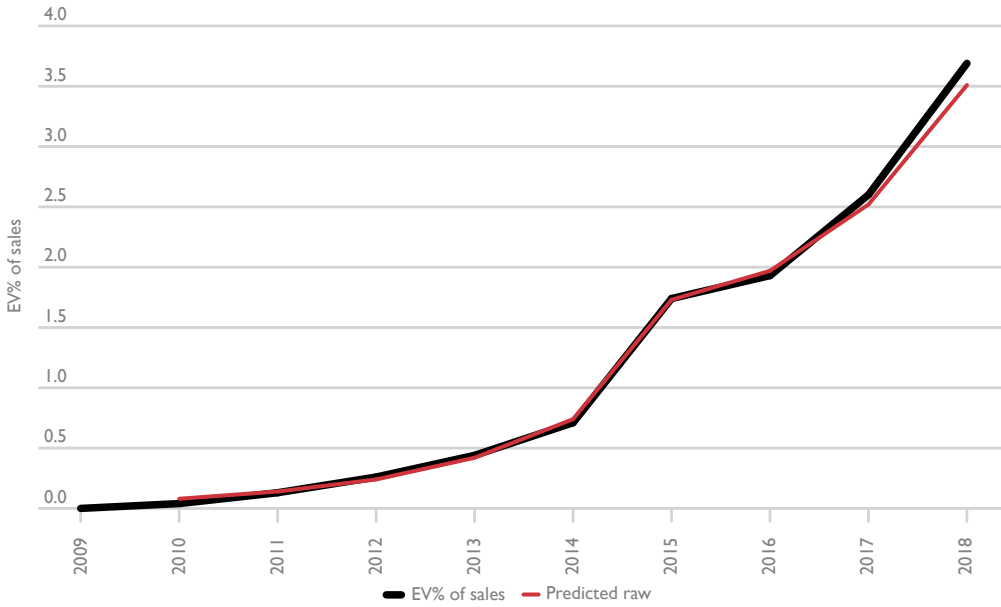
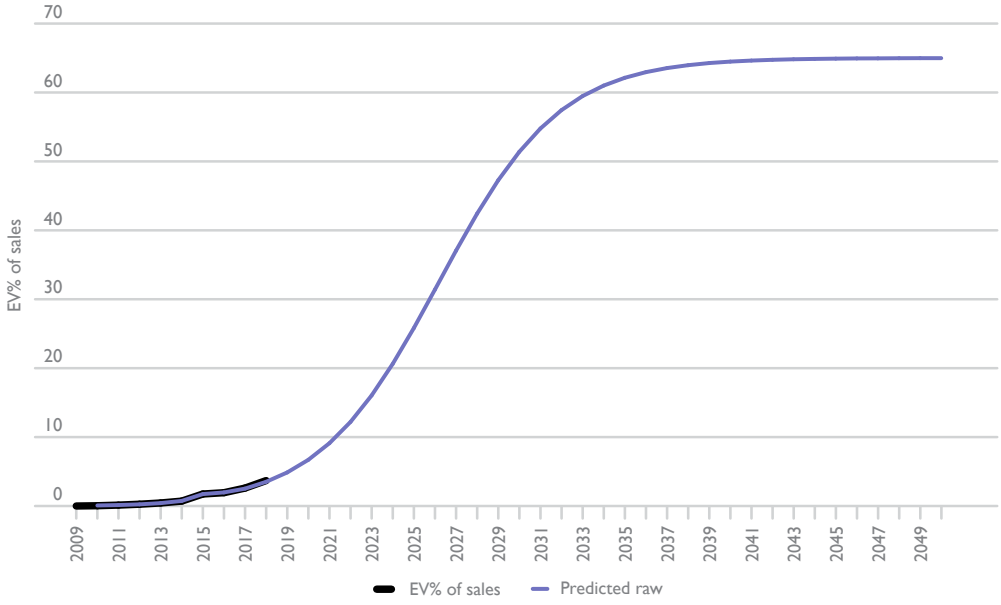


Figure 3.163 shows the extension of the forecast from this equation to 2050. This is the result of Stage 1 of the analysis.

Figure 3.163 Swiss EV sales as a percentage of passenger vehicle sales and raw prediction to 2050



In Stage 2, the year that sales (or the raw prediction) pass the 2% mark is determined. For Switzerland, this is 2016.

Stage 3 involves assembling past and forecast EV and FFV costs to generate a time series of the ratio of EV to FFV annual costs. Table 3.62 shows the prices of BEVs, PHEVs and FFVs in Switzerland with forecasts assuming continuation of EV subsidies.

Table 3.62 Prices of BEVs, PHEVs and FFVs in Switzerland

BEV	2017 US$ (000')	Francs	Francs	%	Francs	Francs		Francs
	BEV base	BEV base	initial rego tax	VAT%	VAT	BEV price	Home charging	BEV price
2009	30	32201	1288	10.6	3428	36916	1450	38366
2010	30	31143	1246	11.6	3601	35989	1450	37439
2011	30	26442	1058	12.7	3369	30868	1450	32318
2012	31	28745	1150	13.0	3747	33642	1450	35092
2013	31	28791	0	13.0	3732	32523	1450	33973
2014	34	30817	0	12.6	3881	34698	1450	36148
2015	30	28889	0	10.7	3103	31992	1450	33442
2016	30	29651	0	10.4	3075	32726	1450	34176
2017	30	29485	0	11.1	3276	32762	1450	34212
2018	31	29980	0	11.1	3331	33311	1450	34761
2019	31	30550	0	11.1	3394	33944	1450	35394
2020	31	30366	0	11.1	3374	33740	1450	35190
2021	30	29603	0	11.1	3289	32892	1450	34342
2022	31	30030	0	11.1	3337	33366	1450	34816
2023	30	29754	0	11.1	3306	33060	1450	34510
2024	29	28690	0	11.1	3188	31878	1450	33328
2025	28	27777	0	11.1	3086	30863	1450	32313
2026	28	27256	0	11.1	3028	30284	1450	31734
2027	27	26736	0	11.1	2971	29706	1450	31156
2028	27	26150	0	11.1	2906	29056	1450	30506
2029	26	25630	0	11.1	2848	28477	1450	29927
2030	26	25044	0	11.1	2783	27827	1450	29277
PHEV	2017 US$ (000')	Francs	Francs	%	Francs	Francs		Francs
	PHEV base	PHEV base	Initial rego tax	VAT%	VAT	PHEV price	Home charging	PHEV price
2009	30	32201	1288	10.6	3428	36916	1450	38366
2010	30	31143	1246	11.6	3601	35989	1450	37439
2011	30	26442	1058	12.7	3369	30868	1450	32318
2012	31	28745	1150	13.0	3747	33642	1450	35092
2013	31	28791	0	13.0	3732	32523	1450	33973
2014	34	30817	0	12.6	3881	34698	1450	36148
2015	30	28889	0	10.7	3103	31992	1450	33442
2016	30	29651	0	10.4	3075	32726	1450	34176
2017	30	29485	0	11.1	3276	32762	1450	34212
2018	31	29980	0	11.1	3331	33311	1450	34761
2019	31	30550	0	11.1	3394	33944	1450	35394
2020	31	30366	0	11.1	3374	33740	1450	35190
2021	30	29603	0	11.1	3289	32892	1450	34342
2022	31	30030	0	11.1	3337	33366	1450	34816
2023	30	29754	0	11.1	3306	33060	1450	34510
2024	29	28690	0	11.1	3188	31878	1450	33328
2025	28	27777	0	11.1	3086	30863	1450	32313
2026	28	27256	0	11.1	3028	30284	1450	31734
2027	27	26736	0	11.1	2971	29706	1450	31156
2028	27	26150	0	11.1	2906	29056	1450	30506
2029	26	25630	0	11.1	2848	28477	1450	29927
2030	26	25044	0	11.1	2783	27827	1450	29277

Table 3.62 Prices of BEVs, PHEVs and FFVs in Switzerland (continued)

FFV	2017 US$ (000')	Francs	Francs	%	Francs	Francs
	FFV base	FFV base	initial rego tax	VAT%	VAT	FFV price
2009	23	25027	1001	10.6	2664	28692
2010	23	23876	955	11.6	2761	27592
2011	23	20272	811	12.7	2583	23666
2012	23	21435	857	13.0	2795	25087
2013	23	21262	850	13.0	2756	24869
2014	23	21132	845	12.6	2661	24638
2015	23	22149	886	10.7	2379	25413
2016	23	22733	909	10.4	2357	25999
2017	23	22606	904	11.1	2512	26021
2018	23	22540	902	11.1	2504	25946
2019	23	22540	902	11.1	2504	25946
2020	23	22540	902	11.1	2504	25946
2021	23	22540	902	11.1	2504	25946
2022	23	22540	902	11.1	2504	25946
2023	23	22540	902	11.1	2504	25946
2024	23	22540	902	11.1	2504	25946
2025	23	22540	902	11.1	2504	25946
2026	23	22540	902	11.1	2504	25946
2027	23	22540	902	11.1	2504	25946
2028	23	22540	902	11.1	2504	25946
2029	23	22540	902	11.1	2504	25946
2030	23	22540	902	11.1	2504	25946

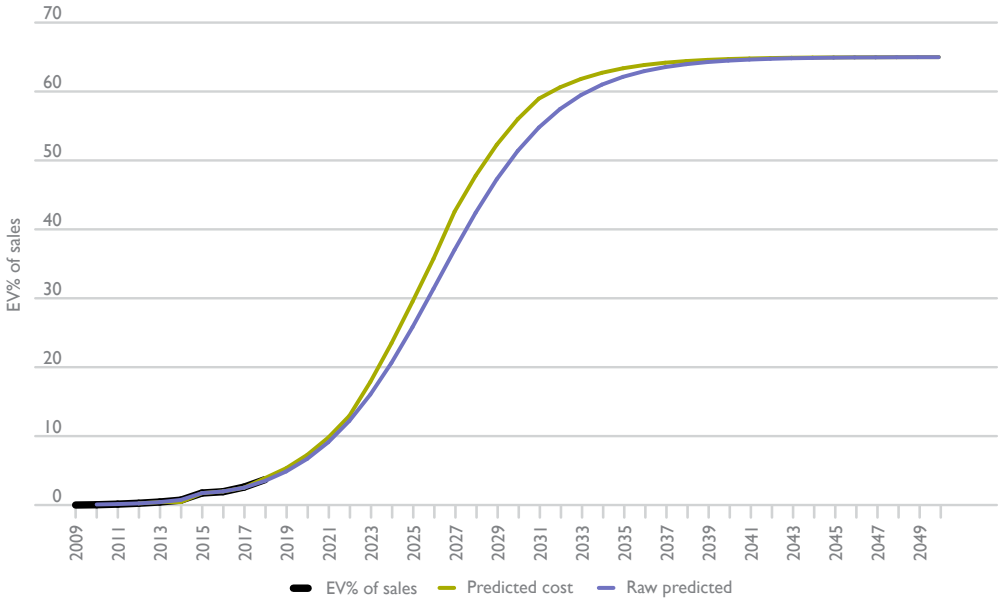
Table 3.63 shows past and forecast BEV and FFV costs used to generate a time series of the ratio of EV to FFV annual costs. Costs include principal (repay over 5 years), interest (13 per cent per year), annual EV subsidies, and petrol costs for FFV (with increasing fuel efficiency and a medium petrol price).

Table 3.63 EV/FFV cost ratio calculations for Switzerland

	Evs	Evs	Evs	Evs	Evs	FFVs	FFVs	FFVs	FFVs	FFVs	EV/ FFV
	EV price	Principal	Interest	Annual subs	Annual cost	FFV price	Principal	Interest	Fuel	Annual cost	Cost ratio
2012	35092	7018	4562	665	10915	25087	5017	3261	1275	9554	1.14
2013	33973	6795	4416	665	10546	24869	4974	3233	1260	9467	1.11
2014	36148	7230	4699	665	11264	24638	4928	3203	1210	9341	1.21
2015	33442	6688	4348	665	10371	25413	5083	3304	1033	9419	1.10
2016	34176	6835	4443	665	10613	25999	5200	3380	992	9571	1.11
2017	34212	6842	4448	665	10625	26021	5204	3383	1046	9633	1.10
2018	34761	6952	4519	665	10806	25946	5189	3373	1108	9671	1.12
2019	35394	7079	4601	665	11015	25946	5189	3373	1052	9614	1.15
2020	35190	7038	4575	665	10948	25946	5189	3373	1043	9605	1.14
2021	34342	6868	4464	665	10668	25946	5189	3373	1064	9626	1.11
2022	34816	6963	4526	665	10824	25946	5189	3373	1077	9639	1.12
2023	34510	6902	4486	665	10723	25946	5189	3373	1077	9639	1.11
2024	33328	6666	4333	665	10333	25946	5189	3373	1069	9631	1.07
2025	32313	6463	4201	665	9998	25946	5189	3373	1073	9635	1.04
2026	31734	6347	4125	665	9807	25946	5189	3373	1087	9649	1.02
2027	31156	6231	4050	665	9617	25946	5189	3373	1089	9651	1.00
2028	30506	6101	3966	665	9402	25946	5189	3373	1086	9649	0.97
2029	29927	5985	3891	665	9211	25946	5189	3373	1086	9649	0.95
2030	29277	5855	3806	665	8996	25946	5189	3373	1084	9646	0.93

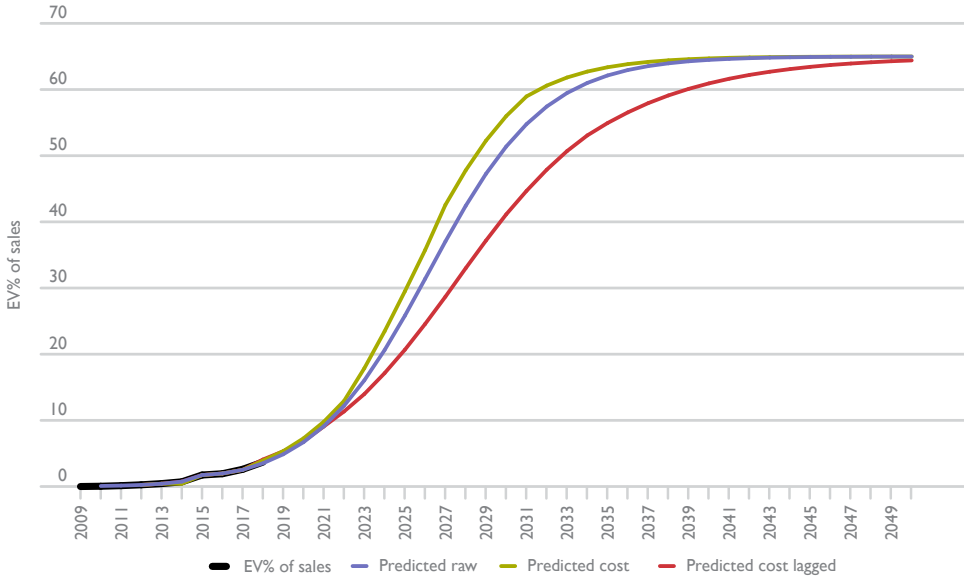
The resulting EV/FFV cost ratio time series is shown in the last column. This time series is then fed though the 2% year formula, which shifts the predicted raw uptake curve in line with shifts predicted for the cost ratio. Figure 3.164 shows the *predicted cost* curve is shifted left from the *predicated raw* curve. This is the result from Stage 3 of the Swiss analysis.

Figure 3.164 Swiss predicted raw and predicted cost EV per cent of sales curves



In Stage 4 corrections are usually made to the predicted cost uptake curves to allow for the fact that most early adopters are those with higher incomes. The resulting Swiss *predicted cost lagged* curve – which is a less steeply rising curve – is shown in Figure 3.165.

Figure 3.165 Swiss predicted cost lagged EV uptake curve

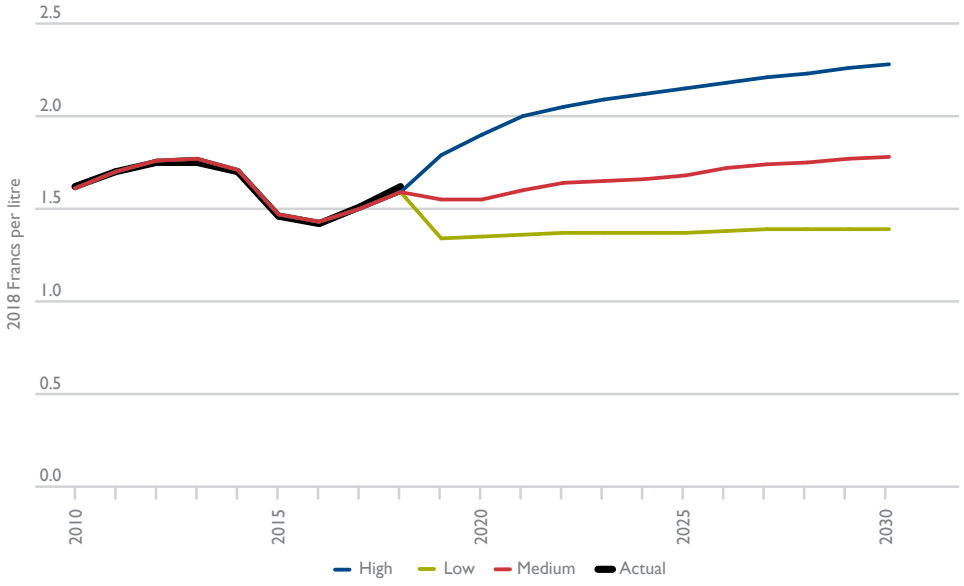


The resulting Swiss uptake forecast has EVs as 21 per cent of sales in 2025 and 41 per cent in 2030.

Stage 5 of the analysis looks at high, medium and low scenarios for oil prices and for EV prices.

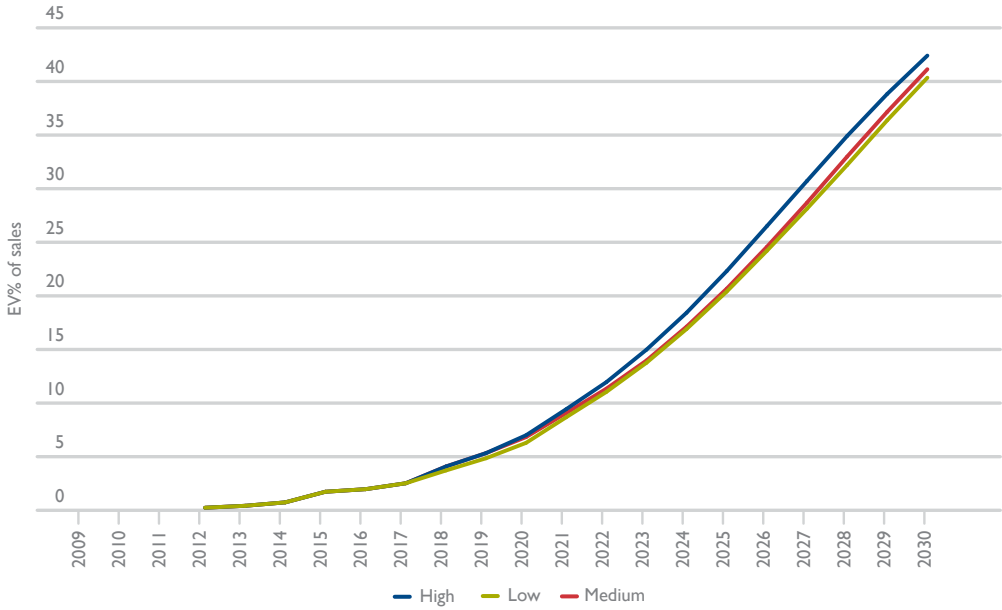
The oil price scenarios were given in Chapter 2. Corresponding Swiss petrol prices have been derived from the oil to Swiss petrol price equation in BITRE (2019). The resulting petrol price scenarios are shown in Figure 3.166.

Figure 3.166 Swiss petrol price scenarios



When these scenario petrol prices are used in the calculation of the EV/FFV cost ratios, the following predicted cost lagged curves are generated.

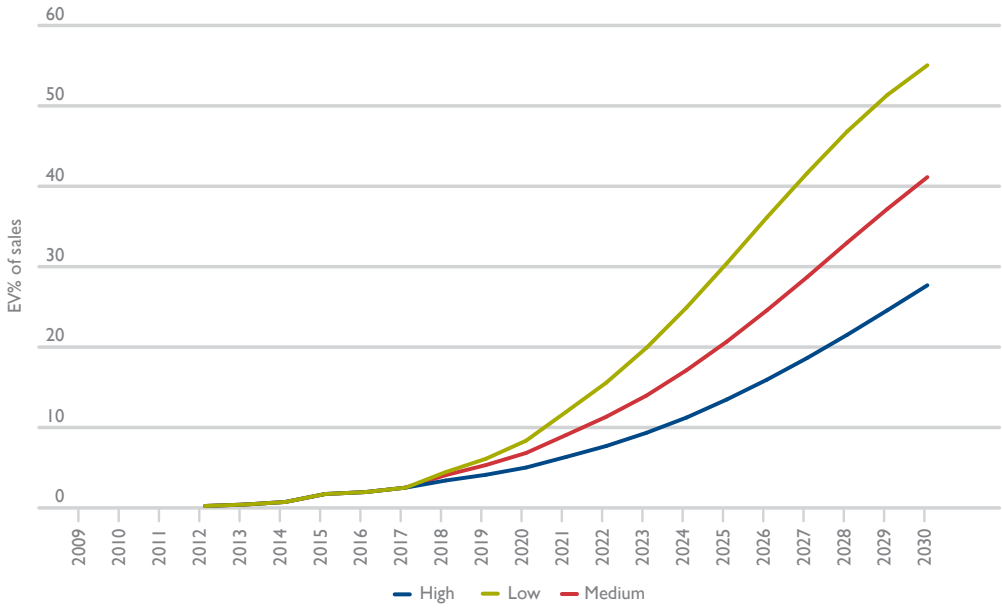
Figure 3.167 Scenarios for Swiss EV uptake with high, medium and low oil prices



It can be seen that oil price scenarios makes little difference to forecast uptake.

The second scenario test is when the prices of EVs are increased or decreased. The vehicle price scenarios were also covered in Chapter 2 (30 per cent up on the medium, 30 per cent down). When these scenario vehicle prices are used in the calculation of the EV/FFV cost ratios, the following predicted cost lagged curves are generated.

Figure 3.168 Scenarios for Swiss EV uptake with high, medium and low EV prices



It can be seen that changes in vehicle prices have a substantial effect on projected uptake.

3.22 The United States

The linearized logistic uptake for the United States is shown in Figure 3.169, along with a predicted curve.

The regression shown in Table 3.64 has three variables – a time trend, a dummy for 2013 to 2014, and a dummy for a lift in EV sales before the federal subsidy runs out in 2018 and 2019. It is estimated over the period 2012 to 2018.

Figure 3.169 American linearized logistic EV sales percentage and prediction

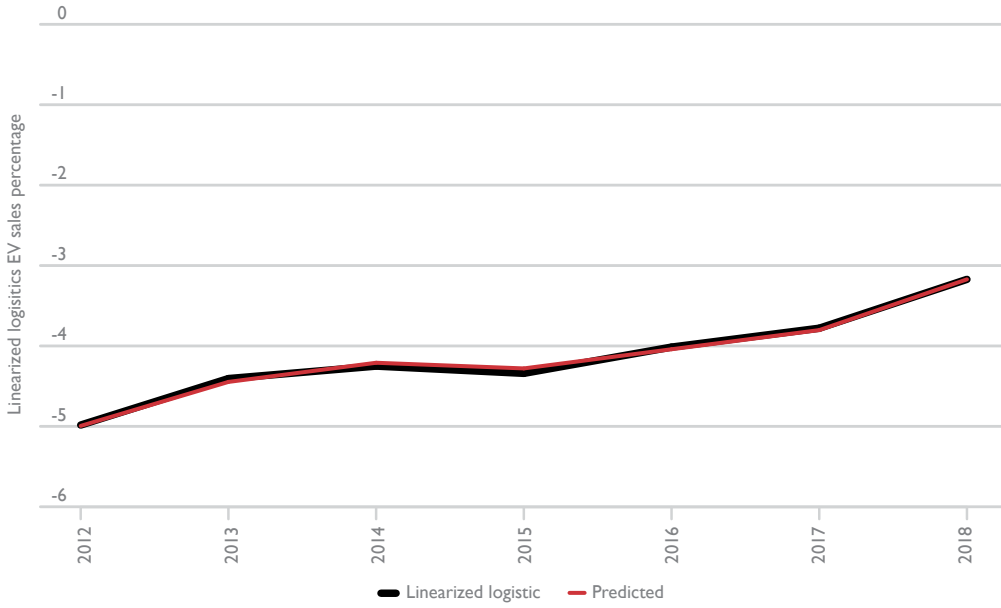


Table 3.64 Regression for American linearized logistic EV uptake

Regression statistics	
Multiple R	0.997741883
R Square	0.995488866
Adjusted R Square	0.990977732
Standard Error	0.053699125
Observations	7

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	1.909001843	0.636333948	220.6737495	0.000513675
Residual	3	0.008650788	0.002883596		
Total	6	1.917652631			

	Coefficients	*Standard error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-5.70907477	0.088770332	-64.31286917	8.28322E-06	-5.991581586	-5.426567954
time	0.238278312	0.014102081	16.89667718	0.000451458	0.193399196	0.283157428
dum1314	0.308709388	0.051089643	6.04250436	0.009090224	0.146119344	0.471299432
fed dum	0.392765439	0.073445989	5.347677196	0.012789023	0.159027524	0.626503355

Figure 3.170 shows the fit of the de-linearized *raw prediction* to the actual EV sales percentage of new passenger vehicle sales.

Figure 3.170 American EV sales as a percentage of passenger vehicle sales and raw prediction

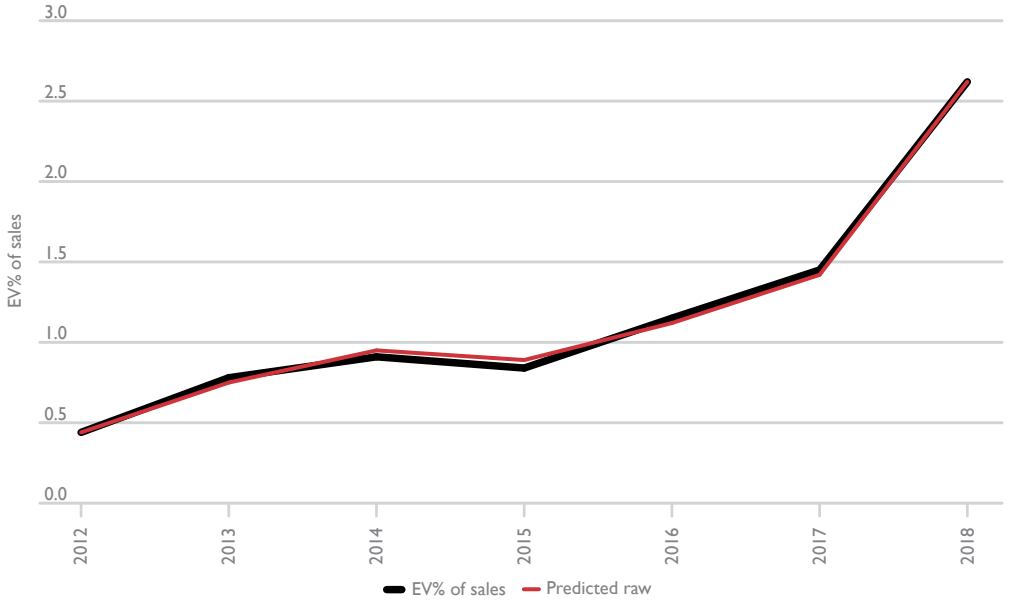
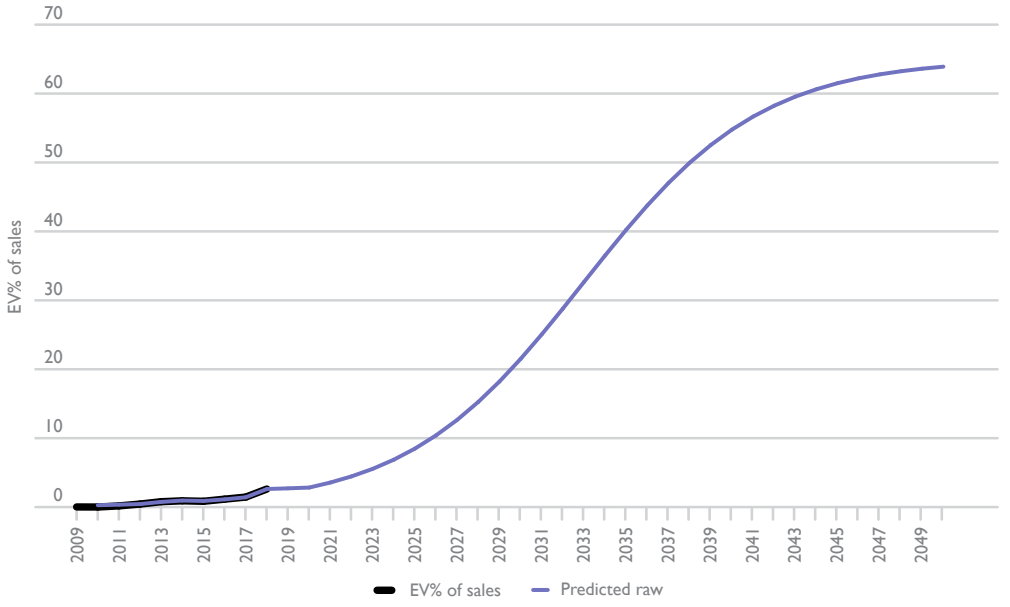


Figure 3.171 shows the extension of the forecast from this equation to 2050. This is the result of Stage 1 of the analysis.

Figure 3.171 American EV sales as a percentage of passenger vehicle sales and raw prediction to 2050



In Stage 2, the year that sales (or the raw prediction) pass the 2% mark is determined. For The United States, this is mid-2017.

Stage 3 involves assembling past and forecast EV and FFV costs to generate a time series of the ratio of EV to FFV annual costs. Table 3.65 shows the prices of BEVs, PHEVs and FFVs in The United States with forecasts assuming continuation of EV subsidies.

Table 3.65 Prices of BEVs, PHEVs and FFVs in the United States

BEV	2017 US$ (000')	US$	%	US$	US$	US$	US$	US$	US$
	BEV base	BEV base	Sales Tax%	Sales Tax	BEV price	Federal subsidy	State subsidies	Home charging	BEV price
2009	30	29593	6	1776	31368	-8571	-1714	853	21936
2010	30	30000	6	1800	31800	-8432	-1686	853	22534
2011	30	30000	6	1800	31800	-8176	-1635	853	22842
2012	31	30842	6	1851	32693	-8014	-1603	853	23929
2013	31	31144	6	1869	33013	-7903	-1581	853	24382
2014	34	33542	6	2013	35554	-7774	-1555	853	27078
2015	30	30000	6	1800	31800	-7758	-1552	853	23344
2016	30	30000	6	1800	31800	-7660	-1532	853	23461
2017	30	30000	6	1800	31800	-7500	-1500	853	23653
2018	31	30592	6	1836	32428	-7500	-1461	853	24320
2019	31	31173	6	1870	33043	-5000	-1423	853	27473
2020	31	30986	6	1859	32845	-2500	-1386	853	29812
2021	30	30207	6	1812	32019	0	-1350	853	31522
2022	31	30642	6	1839	32481	0	-1315	853	32019
2023	30	30362	6	1822	32183	0	-1281	853	31756
2024	29	29276	6	1757	31032	0	-1247	853	30638
2025	28	28343	6	1701	30044	0	-1215	853	29682
2026	28	27812	6	1669	29481	0	-1183	853	29151
2027	27	27281	6	1637	28918	0	-1153	853	28618
2028	27	26684	6	1601	28285	0	-1123	853	28015
2029	26	26153	6	1569	27722	0	-1093	853	27481
2030	26	25555	6	1533	27088	0	-1065	853	26876

PHEV	2017 US$ (000')	US$	%	US$	US$	US$	US$	US$	US$
	PHEV base	PHEV base	Sales Tax%	Sales Tax	PHEV price	Federal subsidy	State subsidies	Home charging	PHEV price
2009	30	29593	6	1776	31368	-2857	-857	853	28507
2010	30	30000	6	1800	31800	-2811	-843	853	28999
2011	30	30000	6	1800	31800	-2725	-818	853	29110
2012	31	30842	6	1851	32693	-2671	-801	853	30073
2013	31	31144	6	1869	33013	-2634	-790	853	30441
2014	34	33542	6	2013	35554	-2591	-777	853	33038
2015	30	30000	6	1800	31800	-2586	-776	853	29291
2016	30	30000	6	1800	31800	-2553	-766	853	29334
2017	30	30000	6	1800	31800	-2500	-750	853	29403
2018	31	30592	6	1836	32428	-2500	-730	853	30050
2019	31	31173	6	1870	33043	-1667	-711	853	31518
2020	31	30986	6	1859	32845	-833	-693	853	32172
2021	30	30207	6	1812	32019	0	-675	853	32197
2022	31	30642	6	1839	32481	0	-657	853	32677
2023	30	30362	6	1822	32183	0	-640	853	32396
2024	29	29276	6	1757	31032	0	-624	853	31261
2025	28	28343	6	1701	30044	0	-607	853	30289
2026	28	27812	6	1669	29481	0	-592	853	29742
2027	27	27281	6	1637	28918	0	-576	853	29195
2028	27	26684	6	1601	28285	0	-561	853	28576
2029	26	26153	6	1569	27722	0	-547	853	28028
2030	26	25555	6	1533	27088	0	-532	853	27409

Table 3.65 Prices of BEVs, PHEVs and FFVs in the United States (continued)

FFV	2017 US$ (000')	US$	%	US$	US$
	FFV base	FFV base	Sales Tax%	Sales Tax	FFV price
2009	23	23000	6	1380	24380
2010	23	23000	6	1380	24380
2011	23	23000	6	1380	24380
2012	23	23000	6	1380	24380
2013	23	23000	6	1380	24380
2014	23	23000	6	1380	24380
2015	23	23000	6	1380	24380
2016	23	23000	6	1380	24380
2017	23	23000	6	1380	24380
2018	23	23000	6	1380	24380
2019	23	23000	6	1380	24380
2020	23	23000	6	1380	24380
2021	23	23000	6	1380	24380
2022	23	23000	6	1380	24380
2023	23	23000	6	1380	24380
2024	23	23000	6	1380	24380
2025	23	23000	6	1380	24380
2026	23	23000	6	1380	24380
2027	23	23000	6	1380	24380
2028	23	23000	6	1380	24380
2029	23	23000	6	1380	24380
2030	23	23000	6	1380	24380

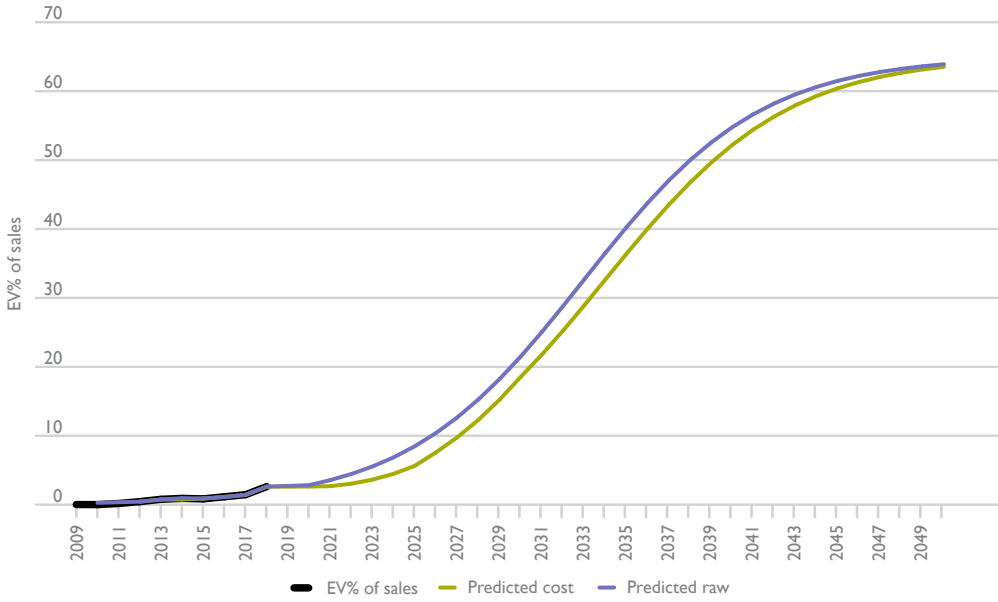
Table 3.66 shows past and forecast BEV and FFV costs used to generate a time series of the ratio of EV to FFV annual costs. Costs include principal (repay over 5 years), interest (13 per cent per year), annual EV subsidies, and petrol costs for FFV (with increasing fuel efficiency and a medium petrol price).

Table 3.66 EV/FFV cost ratio calculations for the United States

	Evs	Evs	Evs	Evs	Evs	FFVs	FFVs	FFVs	FFVs	FFVs	EV/ FFV
	EV price	Principal	Interest	Annual subs	Annual cost	FFV price	principal	Interest	Fuel	Annual cost	Cost ratio
2012	23929	4786	3111	0	7896	24380	4876	3169	1560	9605	0.82
2013	24382	4876	3170	0	8046	24380	4876	3169	1476	9521	0.85
2014	27078	5416	3520	0	8936	24380	4876	3169	1376	9421	0.95
2015	23344	4669	3035	0	7703	24380	4876	3169	978	9023	0.85
2016	23461	4692	3050	0	7742	24380	4876	3169	860	8906	0.87
2017	23653	4731	3075	0	7805	24380	4876	3169	925	8971	0.87
2018	24320	4864	3162	0	8025	24380	4876	3169	1006	9051	0.89
2019	27473	5495	3572	0	9066	24380	4876	3169	974	9019	1.01
2020	29812	5962	3876	0	9838	24380	4876	3169	988	9033	1.09
2021	31522	6304	4098	0	10402	24380	4876	3169	1073	9118	1.14
2022	32019	6404	4162	0	10566	24380	4876	3169	1133	9178	1.15
2023	31756	6351	4128	0	10479	24380	4876	3169	1166	9211	1.14
2024	30638	6128	3983	0	10110	24380	4876	3169	1169	9214	1.10
2025	29682	5936	3859	0	9795	24380	4876	3169	1205	9251	1.06
2026	29151	5830	3790	0	9620	24380	4876	3169	1273	9318	1.03
2027	28618	5724	3720	0	9444	24380	4876	3169	1306	9351	1.01
2028	28015	5603	3642	0	9245	24380	4876	3169	1330	9375	0.99
2029	27481	5496	3573	0	9069	24380	4876	3169	1362	9407	0.96
2030	26876	5375	3494	0	8869	24380	4876	3169	1372	9418	0.94

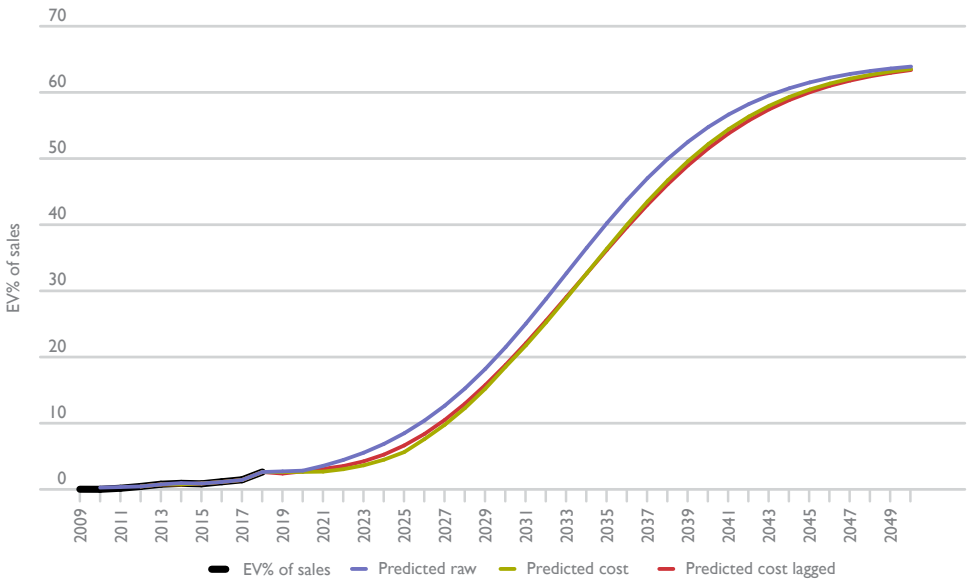
The resulting EV/FFV cost ratio time series is shown in the last column. This time series is then fed though the 2% year formula, which shifts the predicted raw uptake curve in line with shifts predicted for the cost ratio. Figure 3.172 shows the *predicted cost* curve is shifted right from the *predicated raw* curve, as EV subsidies decrease from 2019. This is the result from Stage 3 of the American analysis.

Figure 3.172 American predicted raw and predicted cost EV per cent of sales curves



In Stage 4 corrections are usually made to the predicted cost uptake curves to allow for the fact that most early adopters are those with higher incomes. But the United States is one of the 'flat' uptake countries, so the American *predicted cost lagged* curve is assumed the same as the *predicted cost* curve, as shown in Figure 3.173.

Figure 3.173 American predicted cost lagged EV uptake curve

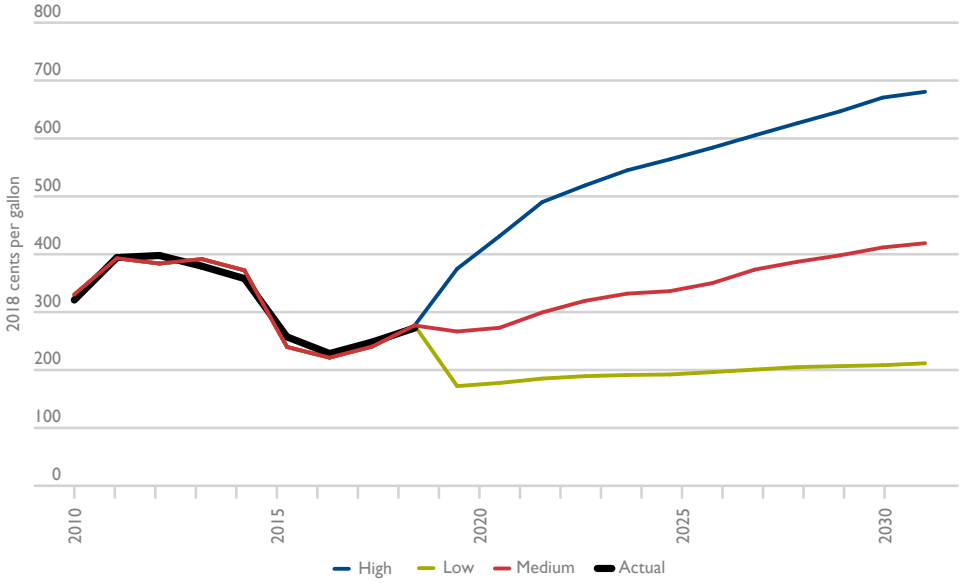


The resulting American uptake forecast has EVs as 7 per cent of sales in 2025 and 19 per cent in 2030.

Stage 5 of the analysis looks at high, medium and low scenarios for oil prices and for EV prices.

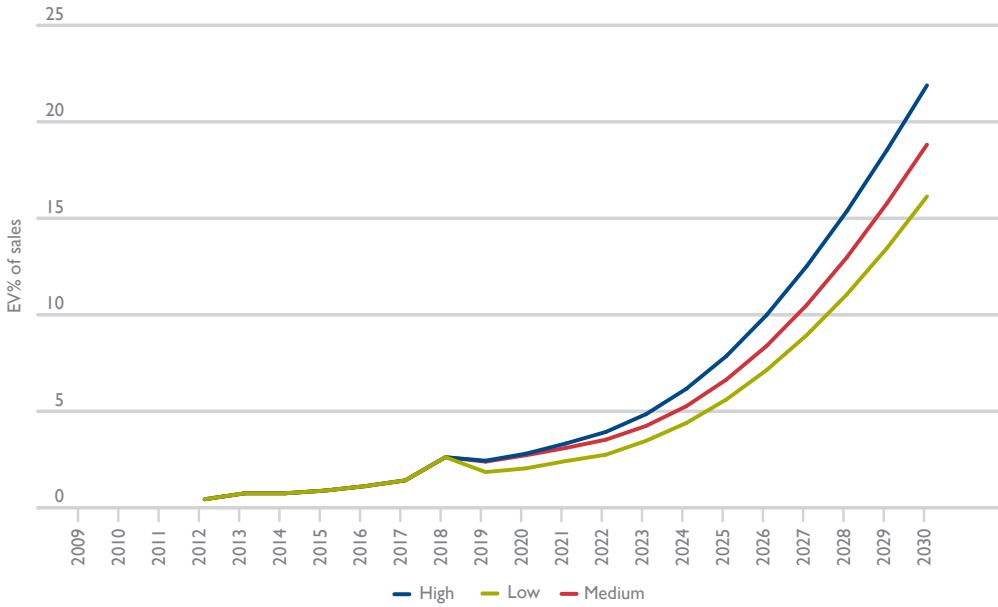
The oil price scenarios were given in Chapter 2. Corresponding American petrol prices have been derived from the oil to American petrol price equation in BITRE (2019). The resulting petrol price scenarios are shown in Figure 3.174.

Figure 3.174 American petrol price scenarios



When these scenario petrol prices are used in the calculation of the EV/FFV cost ratios, the following predicted cost lagged curves are generated.

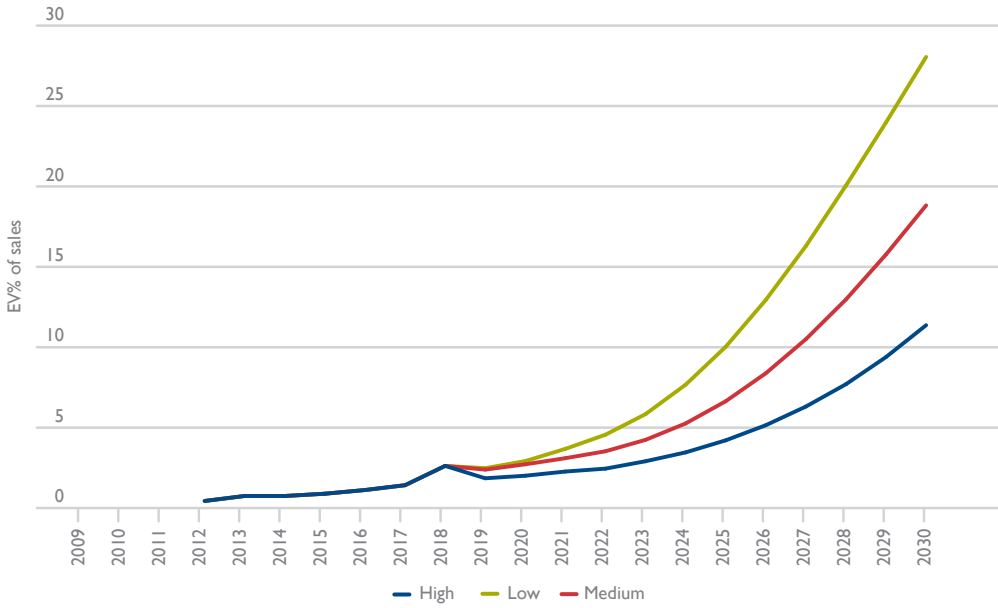
Figure 3.175 Scenarios for American EV uptake with high, medium and low oil prices



It can be seen that the high and low oil price scenarios make an appreciable difference to forecast uptake.

The second scenario test is when the prices of EVs are increased or decreased. The vehicle price scenarios were also covered in Chapter 2 (30 per cent up on the medium, 30 per cent down). When these scenario vehicle prices are used in the calculation of the EV/FFV cost ratios, the following predicted cost lagged curves are generated.

Figure 3.176 Scenarios for American EV uptake with high, medium and low EV prices



It can be seen that changes in vehicle prices have a substantial effect on projected uptake.

3.23 The Rest of Europe

The linearized logistic uptake for the Rest of Europe is shown in Figure 3.177, along with a predicted curve.

The regression shown in Table 3.67 has two variables – a time trend, and a dummy for 2013 and 2016. It is estimated over the period 2012 to 2017.

Figure 3.177 Rest of Europe linearized logistic EV sales percentage and prediction

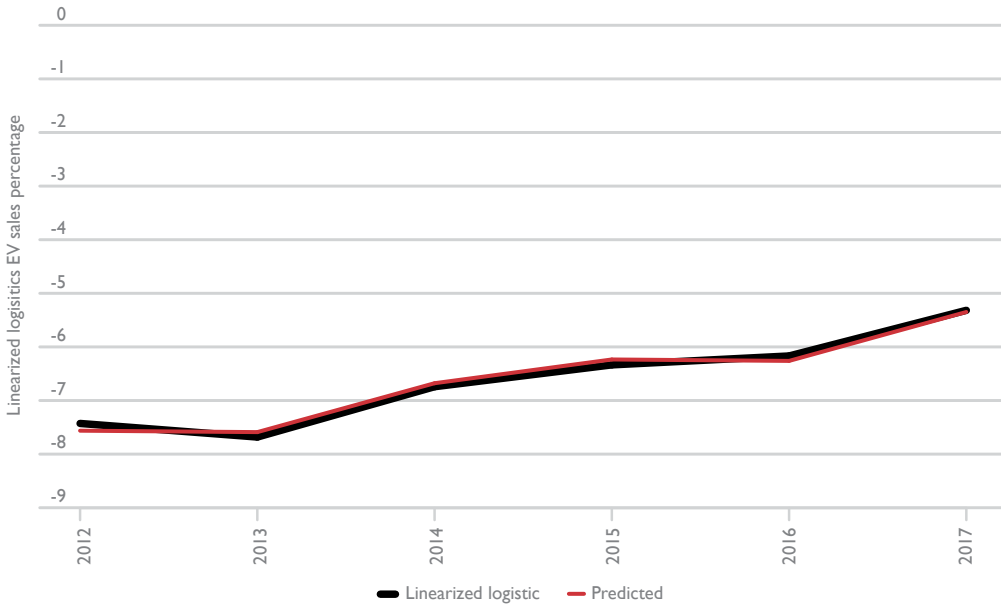


Table 3.67 Regression for Rest of Europe linearized logistic EV uptake

Regression statistics	
Multiple R	0.993287707
R Square	0.986620469
Adjusted R Square	0.977700782
Standard Error	0.12976842
Observations	6

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	3.725362401	1.8626812	110.6115546	0.001547609
Residual	3	0.050519529	0.016839843		
Total	5	3.775881929			

	Coefficients	*Standard error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-8.891266428	0.182534468	-48.71006845	1.90527E-05	-9.472172572	-8.310360285
time	0.442818643	0.031020586	14.27499299	0.000744943	0.344097295	0.541539992
dum13,16	-0.469427518	0.112382749	-4.177042512	0.024991965	-0.827079581	-0.111775455

Figure 3.178 shows the fit of the de-linearized *raw prediction* to the actual EV sales percentage of new passenger vehicle sales.

Figure 3.178 Rest of Europe EV sales as a percentage of passenger vehicle sales and raw prediction

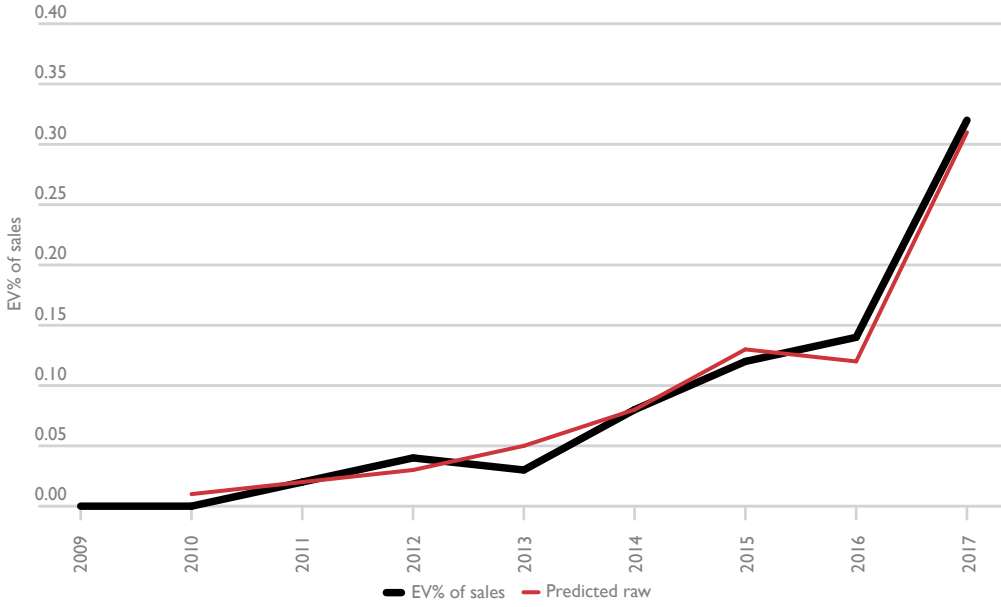
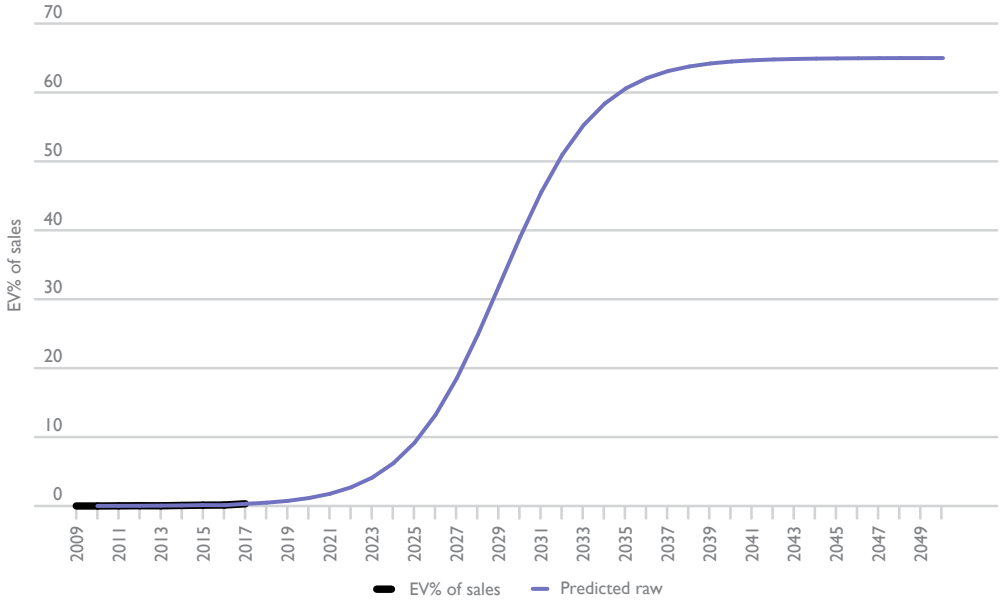


Figure 3.179 shows the extension of the forecast from this equation to 2050. This is the result of Stage 1 of the analysis.

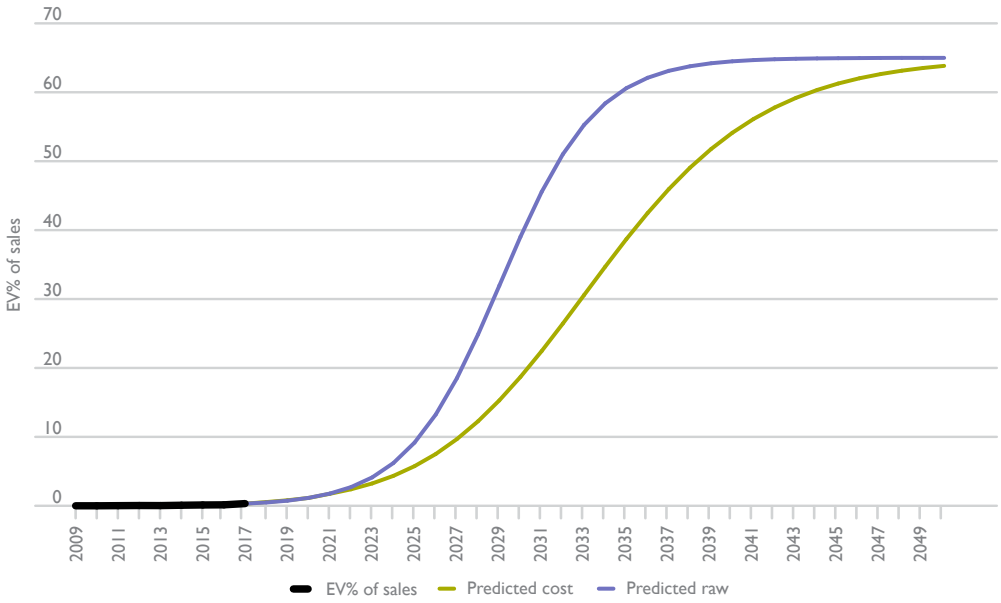
Figure 3.179 Rest of Europe EV sales as a percentage of passenger vehicle sales and raw prediction to 2050



In Stage 2, the year that sales (or the raw prediction) pass the 2% mark is determined. For The Rest of Europe, this is mid-2021.

Stage 3 usually involves assembling past and forecast EV and FFV costs to generate a time series of the ratio of EV to FFV annual costs. However this has not been done for the Rest of Europe. Instead, the predicated raw curve has been lagged to give the equivalent to a Stage 4 *predicted cost lagged* curve for the Rest of Europe. This is shown in Figure 3.180.

Figure 3.180 Rest of Europe predicted cost lagged EV uptake curve



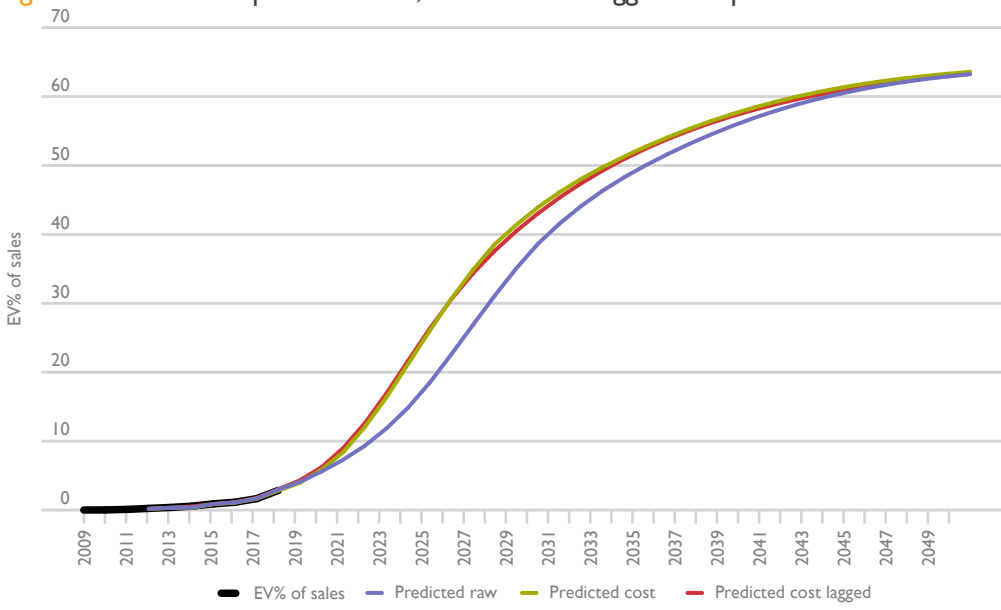
The resulting Rest of Europe uptake forecast has EVs as 6 per cent of sales in 2025 and 19 per cent in 2030.

Stage 5 of the analysis usually looks at high, medium and low scenarios for oil prices and for EV prices. But as cost analysis was not done for the Rest of Europe, scenarios are not able to be presented.

3.24 Global EV Uptake

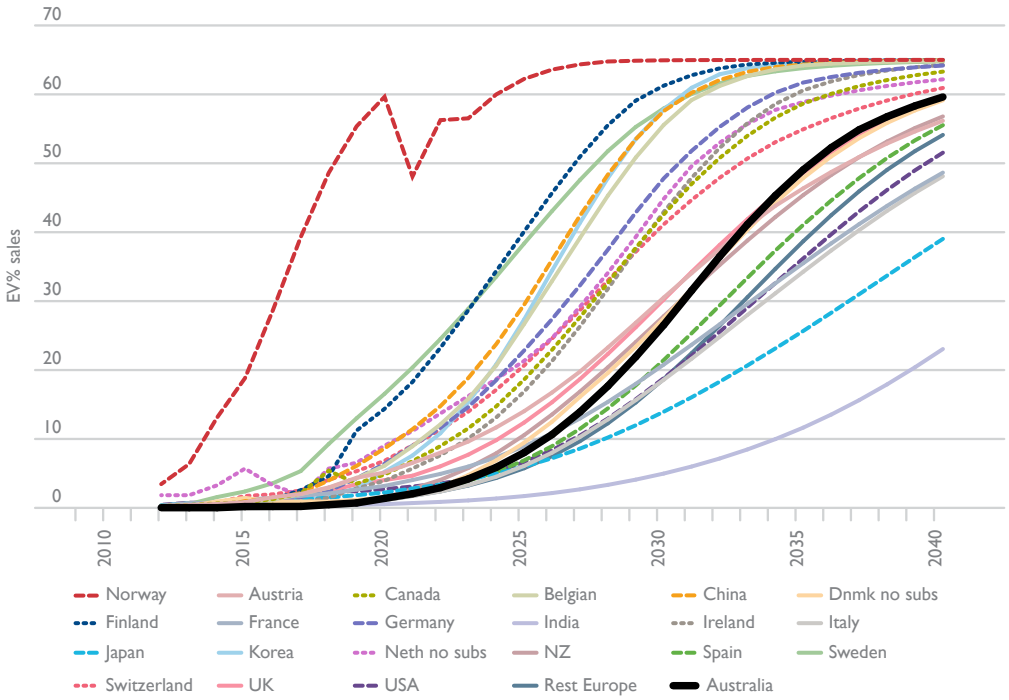
The weighted averages (weighted by total passenger vehicle sales) for the three uptake rates in the 22 country aggregation are shown in Figure 3.181. This is the equivalent to Stages 1 to 4 of the country analyses. The resulting Global *predicted cost lagged* uptake forecast has EVs as 18 per cent of sales in 2025 and 36 per cent in 2030.

Figure 3.181 Global predicted raw, cost and cost lagged EV uptake curves



Individual country *predicted cost lagged* uptake forecasts are shown in Figure 3.182. The European countries are represented in dashed lines. Norway is in a class of it's own. The first group of European countries (read off at the 50% line) includes Finland, Sweden and Belgium, with China and Korea in the middle of the group. The second European group includes Germany, the Netherlands, Ireland and Switzerland, with Canada in the middle of the group. The third European group includes the UK, Denmark, Austria, Spain, the Rest of Europe, France and Italy, with Australia and New Zealand towards the front of the group and the USA towards the back. Bringing up last are Japan and India.

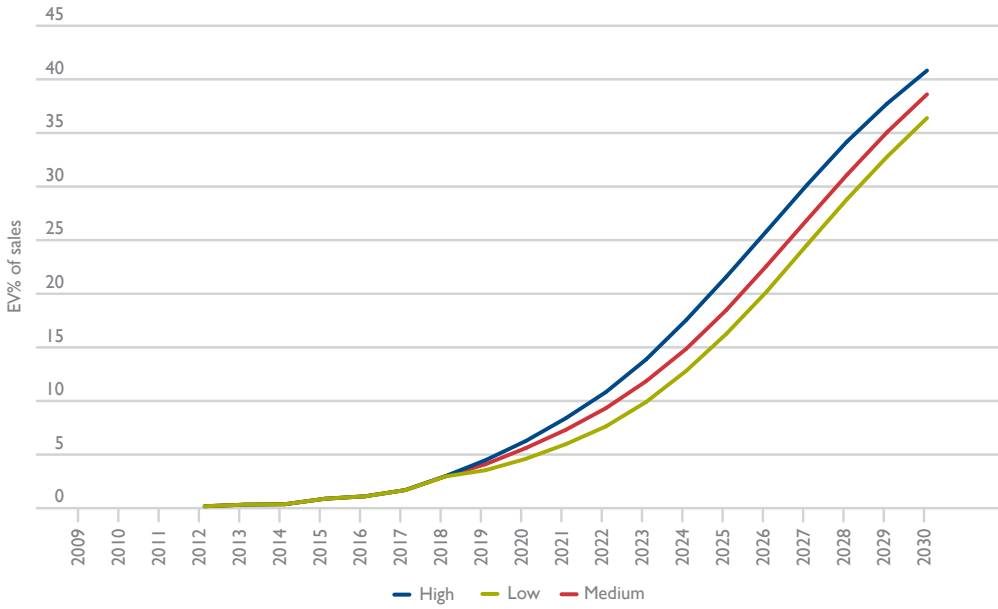
Figure 3.182 Individual country predicted cost lagged uptake forecasts



Stage 5 of the analysis looks at high, medium and low global uptake scenarios for oil prices and for EV prices.

The oil price scenarios were given in Chapter 2. Feeding them into the country petrol price formulas and deriving the country uptake scenarios for high, medium and low oil prices shown in this chapter, the following global weighted average scenario curves are generated.

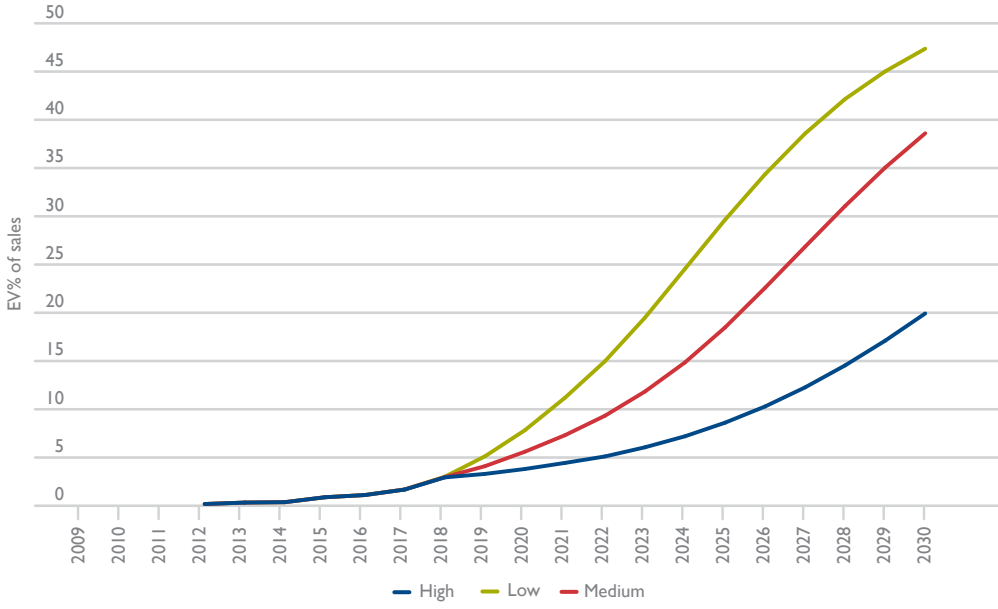
Figure 3.183 Scenarios for Global EV uptake with high, medium and low oil prices



It can be seen that the oil price scenarios don't make an appreciable difference to forecast uptakes.

The second scenario test is when the prices of EVs are increased or decreased. The vehicle price scenarios were also covered in Chapter 2 (30 per cent up on the medium, 30 per cent down). When these scenario vehicle prices are used in the calculation of the EV/FFV cost ratios, the following predicted cost lagged curves are generated, using weighted averages of the 22 countries.

Figure 3.184 Scenarios for Global EV uptake with high, medium and low EV prices



It can be seen that changes in vehicle prices have a substantial effect on projected uptake.

CHAPTER 4
Country-Specific Scenario Testing

The effect on each country's EV uptake rate of the EV price scenarios and petrol price scenarios was illustrated in Chapter 4. This chapter presents two additional scenarios in individual countries:

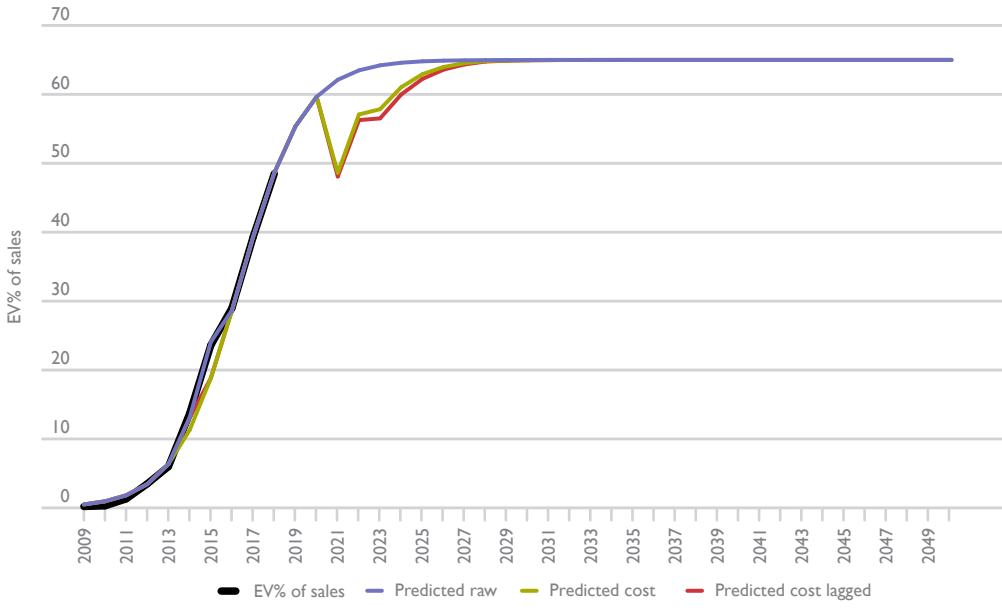
1. The total elimination of subsidies in Norway.
2. The possible mandating of EV-only vehicle purchases. The example used will be Britain.

The aim is to examine how the projections for each country will change if you change the assumptions, and in the process, illustrate how the projection calculations work.

4.1 Elimination of subsidies in Norway

Norway plans to start charging EV purchasers with VAT in 2021 – equivalent to 25 per cent of the retail price of vehicles. This will add 60,000 kroner to the price, or 12,000 principal and 8,000 interest to annual cost. This is what raises the projected EV/FFV cost ratio from .47 in 2020 to .65 in 2021, and causes the dip in EVs as a per cent of sales shown in Figure 4.1 (the base-case forecasts for Norway from Chapter 4).

Figure 4.1 Base-case Norwegian EV uptake forecasts



But there are many subsidies still in operation:

1. Exemption from Purchase subsidy – equivalent to 30 per cent of the retail purchase price – or 72,500 kroner in 2021. This equates to 14,500 principal and 9,500 interest per year.
2. Exemption from the motor vehicle tax – equivalent to 2,500 per year.
3. Exemption from parking fees – 18,000 per year
4. Exemption from tolls – 11,000 per year

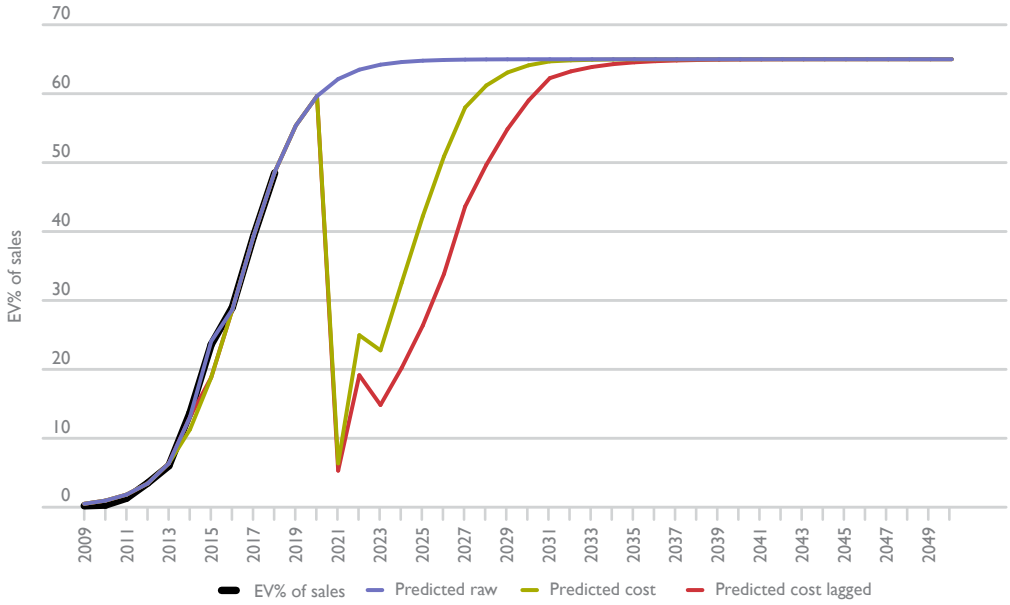
In total subsidies of 55,500 kroner per year.

In 2021, with the reintroduction of the VAT, EVs annual cost per year is set to be 74,000 kroner per year, versus a FFV cost of 113,000 – giving an EV/FFV cost ratio of 0.65. This is up from 0.47 the previous year (without VAT).

If the remaining subsidies listed above were also abolished in 2021, the annual cost of an EV would rise to 129,500 versus 113,000 for a FFV – giving an EV/FFV ratio of about 1.15.

Such a reversal in the cost ratio would be predicted to produce an equally large collapse in EV sales share, as shown below

Figure 4.2 Norwegian EV uptake forecasts with all subsidies removed



Because EV prices have now risen above FFV prices, the adoption lag factor would also kick in in a major way and further delay the recovery.

4.2 Targets for EV new vehicle sales

Many countries have set targets for EV uptake. Table 4.1 sets these out for 13 countries (Climate Works 2018).

Table 4.1 EV uptake targets by country

Country	Policy target	Date target set
Austria	No new FFVs sold after 2020	April 2016
Britain	No new FFVs sold after 2040	July 2017
China	No new FFVs sold after 2040	September 2017
Denmark	5,000 Evs on road by 2019	2008
France	No new FFVs sold after 2040	July 2017
Germany	No FFVs on road by 2030	October 2016
India	No new FFVs sold after 2030	April 2017
Ireland	No new FFVs sold after 2030	July 2017
Isreal	No new FFVs sold after 2030	February 2018
Netherlands	No new FFVs sold after 2030	October 2017
Scotland	No new FFVs sold after 2030	September 2017
Korea	Evs 30% of sales by 2020	June 2016
Taiwan	No new FFVs sold after 2040	Decenber 2017

Many of these goals are challenging, given the analyses of Chapter 3. For example, Britain has a goal of making 100 per cent of vehicle purchases in 2040 electric (zero internal combustion engines).

To simulate that, the current British EV per cent of sales logistic was linearized assuming a 100% saturation instead of a 65% saturation. Then a regression was repeated using the same variables – a time trend, a dummy for 2011 to 2013 and a dummy for 2015. It was estimated over the period 2011 to 2018. The regression results are shown in Table 4.2.

Table 4.2 Regression for British linearized logistic EV uptake, 100% per cent saturation

Regression statistics	
Multiple R	0.999522082
R Square	0.999044392
Adjusted R Square	0.998327687
Standard Error	0.05593736
Observations	8

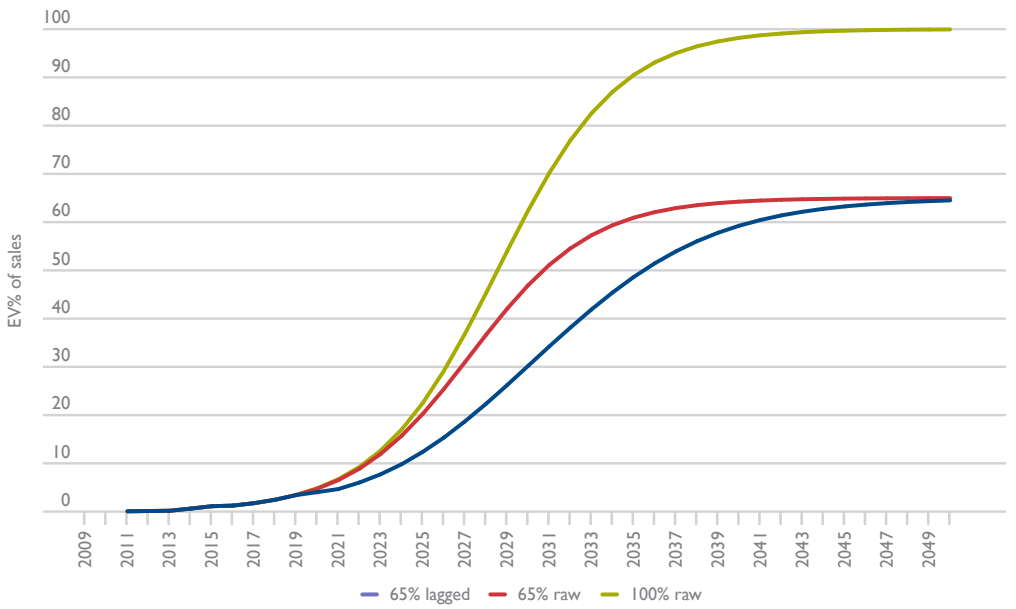
ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	13.0848602	4.361620067	1393.939426	1.71168E-06
Residual	4	0.012515953	0.003128988		
Total	7	13.09737615			

	Coefficients	*Standard error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-6.819323747	0.136168576	-50.08001071	9.51349E-07	-7.197388324	-6.441259171
time	0.348923468	0.018359758	19.00479707	4.51569E-05	0.297948609	0.399898327
dum15	0.239868116	0.066601701	3.601531365	0.022727139	0.054952149	0.424784083
dum1113	-1.235098158	0.106826455	-11.56172557	0.000319673	-1.531695946	-0.938500369

The regression is almost a perfect fit for either the 65% or 100% saturation assumptions. So the small amount of data available for most countries will not indicate which saturation level is appropriate. Figure 4.2 shows the 100% raw prediction, along with the 65% raw prediction and the 65% cost lagged prediction for British EV uptake.

Figure 4.3 British saturation at 65 per cent and 100 per cent share EV of sales curves



In the country analyses in Chapter 4, the 65% saturation level was chosen as an estimate of the fraction of the fleet for which EVs would provide satisfactory service. Equally, the adoption lag factors were chosen as an estimate of the amount of slow-down in adoption that would occur as less wealthy purchasers started to make up more of the market.

The British 100% saturation raw prediction comes very close to 100 per cent by 2040. But for Britain to reach its target along that path (without resorting to legally requiring all sales be EVs), the following would have to hold:

1. Electric vehicles would have to be modified to provide acceptable service for all road users (100% saturation), and
2. People currently choosing FFVs on a cost basis would have to have acceptable-service EVs priced at less than two-thirds comparable FFV prices (almost zero adoption lag).

CHAPTER 5
Conclusions

This report has described an overview of the different patterns of EV uptake in Australia and in 21 other countries around the world. In addition, it has modelled the determinants of EV uptake in all these locations, including:

1. The short-term (since 2010,2011 mostly) turned into a *predicted raw* forecast, based on an assumed 65 per cent saturation level.
2. This forecast modified by future changes/trends in the ratio of EV to FFV annual costs into a *predicted cost* forecast.
3. This forecast in turn modified by assumed adoption lag factors, chosen as an estimate of the amount of slow-down in adoption that would occur as less wealth purchasers started to make up more of the market. The resulting *predicted cost lagged* forecast uptakes were generally less steep.

The resulting Global *predicted cost lagged* uptake forecast has EVs as 20 per cent of sales in 2025 and 39 per cent in 2030.

The corresponding Australian *predicted cost lagged* forecast has EVs as 9 per cent of sales in 2025 and 27 per cent in 2030.

The model resulting from linking 2% year of uptake to EV/FFV cost ratios allows predictions of how these base-case uptake forecasts would change with changes in the trend in EV prices or changes in EV subsidies in the individual countries.

Scenario testing has shown little effect on EV uptake rates from oil price changes, but substantial effects from EV price changes.

Norway has the largest EV subsidies in the world, and the highest global EV take-up rate. Were these subsidies to be eliminated, Norwegian EV sales as a percentage of total passenger vehicle sales would plummet to levels seen in other countries around the world.

Targets of 100 per cent EV sales by 2040 (such as in Britain) are possible, but they rely on;

1. Electric vehicles being modified to provide acceptable service for all road users.
2. People currently choosing FFVs on a cost basis having acceptable-service EVs priced much lower than comparable FFVs.

APPENDIX A

EV Uptake Modelling Data

BEV new regios ('000s)

	Australia	Austria	Belgium	Canada	China	Denmark	Finland	France	Germany	India	Ireland	Italy	Japan	Korea	Netherlands	New Zealand	Norway	Spain	Sweden	Switzerland	UK	USA	Rest Europe	Total
2005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.010	0.020	0.099	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.220	1.120	0.000	1.469
2006	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.020	0.123	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.320	1.237	0.000	1.700
2007	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.020	0.135	0.000	0.000	0.000	0.000	0.000	0.000	0.010	0.000	0.000	0.000	0.450	1.353	0.000	1.968
2008	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.070	0.195	0.000	0.000	0.000	0.000	0.010	0.000	0.240	0.000	0.000	0.000	0.220	1.470	0.000	2.205
2009	0.000	0.040	0.000	0.000	0.480	0.031	0.000	0.100	0.020	0.250	0.000	0.000	0.986	0.000	0.030	0.000	0.150	0.000	0.000	0.030	0.180	1.330	0.000	3.627
2010	0.037	0.112	0.000	0.000	1.090	0.000	0.000	0.190	0.140	0.290	0.018	0.040	2.440	0.060	0.120	0.000	0.390	0.073	0.060	0.123	0.260	1.190	0.004	6.637
2011	0.148	0.631	0.288	0.220	4.750	0.415	0.029	2.630	1.400	0.410	0.046	0.117	12.610	0.270	0.860	0.000	1.840	0.568	0.183	0.398	1.210	9.750	0.430	39.203
2012	0.130	0.427	0.585	0.620	9.640	0.471	0.051	5.660	2.210	0.300	0.139	0.507	13.470	0.510	0.790	0.000	4.180	0.443	0.300	0.463	1.710	14.650	0.887	58.143
2013	0.207	0.654	0.494	1.640	14.610	0.497	0.050	8.780	5.310	0.410	0.047	0.836	14.760	0.600	2.250	0.010	8.200	0.921	0.444	1.127	2.680	47.690	0.684	112.901
2014	0.180	1.271	1.169	2.830	48.910	1.533	0.185	10.570	8.350	0.650	0.222	1.075	16.110	1.310	2.660	0.040	18.090	1.035	1.203	1.292	6.810	63.420	1.757	190.672
2015	0.559	1.677	1.358	4.380	147	4.524	0.242	17.270	12.080	0.825	0.460	1.451	10.470	2.920	2.540	0.068	27.790	1.422	2.978	3.065	10.100	71.040	2.325	326.264
2016	0.900	3.826	2.054	5.220	257	1.312	0.223	21.752	11.410	1.413	0.392	1.377	15.460	5.100	4.268	0.383	24.222	2.005	2.945	3.295	10.264	86.730	2.493	464.044
2017	1.283	5.433	2.709	9.838	468	0.698	0.502	24.910	25.056	2.000	0.622	1.967	21.840	11.810	9.897	0.687	33.025	3.920	4.217	4.773	13.597	104.487	5.817	757.088

PHEV new regios ('000s)

	Australia	Austria	Belgium	Canada	China	Denmark	Finland	France	Germany	India	Ireland	Italy	Japan	Korea	Netherlands	New Zealand	Norway	Spain	Sweden	Switzerland	UK	USA	Rest Europe	Total
2005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2006	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2007	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2008	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2009	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.440	0.000	0.000	0.004	0.000	0.000	0.000	0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.448
2010	0.003	0.000	0.000	0.000	0.340	0.000	0.000	0.000	0.000	0.880	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.020	0.000	0.000	1.243
2011	0.004	0.000	0.000	0.300	0.320	0.000	0.000	0.100	0.250	1.330	0.000	0.000	0.010	0.000	0.020	0.000	0.000	0.008	0.000	0.038	0.010	7.980	0.017	10.387
2012	0.003	0.267	0.326	1.400	0.260	0.033	0.128	0.600	1.160	2.760	0.000	0.145	10.970	0.000	4.330	0.000	0.330	0.109	0.657	0.394	0.980	38.590	0.144	63.586
2013	0.133	0.184	0.319	1.480	0.730	0.011	0.168	0.840	1.620	2.950	0.000	0.218	14.120	0.000	20.170	0.006	0.320	0.087	1.112	0.218	1.070	49.010	0.172	94.938
2014	1.142	0.434	0.852	2.240	24	0.100	0.291	2.070	4.390	3.350	0.035	0.446	16.180	0.000	12.430	0.214	1.670	0.417	3.472	0.837	7.930	55.360	0.549	138.669
2015	1.212	1.101	2.451	2.580	61	0.444	0.415	5.680	11.110	4.350	0.099	0.891	14.180	0.270	41.230	0.227	7.820	0.869	5.712	2.558	19.240	42.830	1.572	227.501
2016	0.847	1.237	6.671	6.360	79	0.572	1.207	7.429	13.751	5.350	0.298	1.452	9.390	0.160	18.628	0.331	20.686	1.511	10.296	2.829	24.899	72.890	2.789	288.583
2017	0.610	1.721	11.287	8.726	111	0.614	2.553	11.868	29.439	6.350	0.326	2.863	34.160	0.296	1.158	0.422	29.288	3.370	15.447	3.404	31.154	89.992	7.271	403.319

BEV and PHEV new regios ('000s)

	Australia	Austria	Belgium	Canada	China	Denmark	Finland	France	Germany	India	Ireland	Italy	Japan	Korea	Netherlands	New Zealand	Norway	Spain	Sweden	Switzerland	UK	USA	Rest Europe	Total
2005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.010	0.020	0.099	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.220	1.120	0.000	1.469
2006	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.020	0.123	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.320	1.237	0.000	1.700
2007	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.020	0.135	0.000	0.000	0.000	0.000	0.000	0.000	0.010	0.000	0.000	0.000	0.450	1.353	0.000	1.968
2008	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.070	0.195	0.000	0.000	0.000	0.000	0.010	0.000	0.240	0.000	0.000	0.000	0.220	1.470	0.000	2.205
2009	0.000	0.040	0.000	0.000	0.480	0.000	0.000	0.100	0.020	0.690	0.000	0.000	0.990	0.000	0.030	0.000	0.154	0.000	0.000	0.000	0.180	1.330	0.000	4.014
2010	0.040	0.112	0.000	0.000	1.430	0.000	0.000	0.190	0.140	1.170	0.000	0.040	2.440	0.060	0.120	0.000	0.390	0.073	0.060	0.123	0.280	1.190	0.004	7.862
2011	0.152	0.631	0.288	0.520	5.070	0.415	0.029	2.730	1.650	1.740	0.046	0.117	12.620	0.270	0.880	0.000	1.840	0.576	0.183	0.436	1.220	17.730	0.447	49.590
2012	0.133	0.694	0.911	2.020	9.900	0.504	0.179	6.260	3.370	3.060	0.139	0.652	24.440	0.510	5.120	0.000	4.510	0.552	0.957	0.857	2.690	53.240	1.031	121.729
2013	0.340	0.838	0.813	3.120	15.340	0.508	0.218	9.620	6.930	3.360	0.047	1.054	28.880	0.600	22.420	0.016	8.520	1.008	1.556	1.345	3.750	96.700	0.856	207.839
2014	1.322	1.705	2.021	5.070	73.170	1.633	0.476	12.640	12.740	4.000	0.257	1.521	32.290	1.310	15.090	0.254	19.760	1.452	4.675	2.129	14.740	118.780	2.306	329.341
2015	1.771	2.778	3.809	6.960	207	4.968	0.657	22.950	23.190	5.175	0.559	2.342	24.650	3.190	43.770	0.295	35.610	2.291	8.690	5.623	29.340	113.870	3.897	553.765
2016	1.747	5.063	8.725	11.580	336	1.884	1.430	29.181	25.161	6.763	0.690	2.829	24.850	5.260	22.896	0.714	44.908	3.516	13.241	6.124	35.163	159.620	5.282	752.627
2017	1.893	7.154	13.996	19.237	579	1.312	3.055	36.778	54.495	8.350	0.948	4.830	56.000	12.106	11.055	1.109	62.313	7.290	19.664	8.177	44.751	194.479	13.088	1161.080
2018	3.000	9.216	18.308	48.223	1100	2.283	5.625	42.955	81.494	12.000	1.805	9.050	64.000	23.750	25.891	1.581	73.353	10.100	36.775	11.160	57.461	350.000	23.446	2011.477

All new pass vehicle sales ('000s) no PUps

	Australia	Austria	Belgium	Canada	China	Denmark	Finland	France	Germany	India	Ireland	Italy	Japan	Korea	Netherlands	New Zealand	Norway	Spain	Sweden	Switzerland	UK	USA	Rest Europe	Total
2005	789	308	480			148	148	2068	3341	1062	172	2265			465	235	110	1649	274		2439	13145		
2006	769	309	526			157	145	2001	3466	1143	178	2354			484	205	109	1634	282		2344	12998		
2007	835	298	525			163	125	2065	3147	1380	186	2513			506	203	129	1615	306		2404	12660		
2008	791	294	536			151	139	2050	3088	1550	152	2174			500	170	111	1161	254		2131	10693		
2009	729	319	475	748	11399	112	90	2243	3790	1553	57	2165	3924	1225	387	130	99	953	212	297	1989	8652	2584	44132
2010	827	328	546	710	12547	153	111	2203	2878	1950	88	1967	4212	1218	483	157	128	982	289	297	2025	9522	2721	46343
2011	803	356	572	691	13695	170	126	2161	3174	2514	90	1744	3525	1211	556	150	138	808	305	328	1937	10541	2858	48454
2012	883	336	487	732	15249	171	111	1861	3082	2761	79	1396	4572	1176	503	161	128	700	280	334	2040	12038	2671	51750
2013	900	319	486	759	17523	181	103	1756	2952	2578	74	1287	4562	1137	417	187	142	723	270	308	2265	12333	2856	54119
2014	884	303	483	806	19367	189	106	1765	3037	2573	96	1371	4700	1140	388	226	144	855	304	302	2476	13003	3011	57530
2015	924	309	501	855	21203	207	109	1886	3206	2727	125	1584	4216	1309	452	249	151	1034	345	324	2634	13624	3388	61361
2016	927	330	540	889	24526	223	119	1984	3351	2830	147	1844	4146	1325	385	257	155	1147	372	317	2693	13843	3889	66238
2017	917	354	547	906	27571	222	119	2108	3441	2950	131	1970	4391	1329	418	273	159	1235	379	314	2544	13400	4125	69804
2018	890	349	563	892	27875	222	124	2193	3451	3100	126	1909	4326	1324	452	270	151	1329	357	302	2374	13381	4360	70321

	EV (BEV+PHEV) market share (% new sales)																							
	Australia	Austria	Belgium	Canada	China	Denmark	Finland	France	Germany	India	Ireland	Italy	Japan	Korea	Netherlands	New Zealand	Norway	Spain	Sweden	Switzerland	UK	USA	Rest Europe	Total
2005	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	
2006	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	
2007	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.02	0.01	0.00	
2008	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.22	0.00	0.00	0.00	0.01	0.01	0.00	
2009	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.03	0.00	0.01	0.00	0.16	0.00	0.00	0.00	0.01	0.02	0.00	0.01
2010	0.00	0.03	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.06	0.00	0.00	0.06	0.00	0.02	0.00	0.31	0.01	0.02	0.04	0.01	0.01	0.00	0.02
2011	0.02	0.18	0.05	0.08	0.04	0.24	0.02	0.13	0.05	0.07	0.05	0.01	0.36	0.02	0.16	0.00	1.33	0.07	0.06	0.13	0.06	0.17	0.02	0.10
2012	0.02	0.21	0.19	0.28	0.06	0.30	0.16	0.34	0.11	0.11	0.17	0.05	0.53	0.04	1.02	0.00	3.52	0.08	0.34	0.26	0.13	0.44	0.04	0.24
2013	0.04	0.26	0.17	0.41	0.09	0.28	0.21	0.55	0.23	0.13	0.06	0.08	0.63	0.05	5.38	0.01	5.99	0.14	0.58	0.44	0.17	0.78	0.03	0.38
2014	0.15	0.56	0.42	0.63	0.38	0.86	0.45	0.72	0.42	0.16	0.27	0.11	0.69	0.11	3.89	0.11	13.70	0.17	1.54	0.71	0.60	0.91	0.08	0.57
2015	0.19	0.90	0.76	0.81	0.98	2.40	0.60	1.22	0.72	0.19	0.45	0.15	0.58	0.24	9.68	0.12	23.63	0.22	2.52	1.74	1.11	0.84	0.12	0.90
2016	0.19	1.54	1.62	1.30	1.37	0.84	1.20	1.47	0.75	0.24	0.47	0.15	0.60	0.40	5.95	0.28	29.05	0.31	3.56	1.93	1.31	1.15	0.14	1.14
2017	0.21	2.02	2.56	2.12	2.10	0.59	2.58	1.74	1.58	0.28	0.72	0.25	1.28	0.91	2.64	0.41	39.28	0.59	5.18	2.60	1.76	1.45	0.32	1.66
2018	0.34	2.64	3.25	5.40	3.95	1.03	4.55	1.96	2.36	0.39	1.43	0.47	1.48	1.79	5.72	0.59	48.53	0.76	10.30	3.69	2.42	2.62	0.54	2.86

		year 2%	Predicted	Cost ratio	dumKorea	dumUK	dumNeth	dumChina	dumDenmark	dumIreland	dumNZ	dumSwitzerland	dumSpain	dumIndia	dumUSA	dumAustria	dumItaly	dumJapan	dumAustralia
	Norway	2011.1	2010.8	0.43	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Belgium	2016.2	2016.7	0.98	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Finland	2016.6	2016.8	0.99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Steep	Germany	2017.5	2016.8	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Korea	2018.2	2018.2	0.82	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Neth with subs	2013.1	2013.2	0.77	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	Neth no subs	2016.5	2016.5	1.08	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	Australia	2021.7	2021.7	1.24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	Austria	2017.0	2017.0	1.09	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
	Canada	2016.9	2017.5	1.06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	China	2016.8	2016.8	0.84	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Medium	Dmk with subs	2015.7	2016.0	0.62	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
	Dmk no subs	2020.3	2020.0	0.99	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
	Ireland	2019.2	2019.2	0.89	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
	New Zealand	2020.9	2020.9	1.20	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
	Sweden	2014.5	2015.1	0.83	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Switzerland	2016.1	2016.1	1.12	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
	UK	2017.4	2017.4	0.79	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	France	2017.7	2016.9	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	India	2027.3	2027.3	1.19	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
	Italy	2020.8	2020.8	1.17	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
	Japan	2019.7	2019.7	0.88	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Flat	Spain	2021.6	2021.6	1.03	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
	USA	2017.5	2017.5	0.86	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0

APPENDIX B

Scenario Data: EVs as a Percentage of Sales

B.1 Australia

Australian EV uptake scenarios			
	Petrol price		
	High	Medium	Low
2009			
2010			
2011			
2012	0.03	0.03	0.03
2013	0.03	0.03	0.03
2014	0.03	0.03	0.03
2015	0.19	0.19	0.19
2016	0.20	0.20	0.20
2017	0.21	0.21	0.21
2018	0.47	0.47	0.34
2019	0.88	0.72	0.59
2020	1.58	1.38	1.20
2021	2.39	2.05	1.82
2022	3.52	2.93	2.68
2023	5.00	4.20	3.80
2024	6.91	5.88	5.37
2025	9.38	8.02	7.38
2026	12.37	10.64	9.88
2027	15.91	13.92	12.87
2028	19.96	17.68	16.47
2029	24.55	21.93	20.41
2030	29.28	26.54	24.63
2031	34.04	31.54	28.92
2032	38.57	36.46	33.22
2033	42.82	41.14	37.41
2034	46.68	45.32	41.34
2035	50.00	49.06	44.80
2036	52.62	52.27	47.96
2037	54.87	54.87	50.77
2038	56.76	56.76	53.23
2039	58.33	58.33	55.33
2040	59.62	59.62	57.10
2041	60.67	60.67	58.58
2042	61.52	61.52	59.81
2043	62.22	62.22	60.81
2044	62.78	62.78	61.64
2045	63.23	63.23	62.31
2046	63.61	63.61	62.88
2047	63.91	63.91	63.33
2048	64.15	64.15	63.70
2049	64.34	64.34	63.99
2050	64.48	64.48	64.22

Australian EV uptake scenarios			
	EV vehicle price		
	High	Medium	Low
2009			
2010			
2011			
2012	0.03	0.03	0.03
2013	0.03	0.03	0.03
2014	0.03	0.03	0.03
2015	0.19	0.19	0.19
2016	0.20	0.20	0.20
2017	0.21	0.21	0.21
2018	0.34	0.47	0.47
2019	0.49	0.72	0.88
2020	0.81	1.38	2.21
2021	1.12	2.05	3.62
2022	1.52	2.93	5.63
2023	2.04	4.20	8.25
2024	2.71	5.88	11.74
2025	3.56	8.02	16.07
2026	4.61	10.64	21.15
2027	5.89	13.92	26.86
2028	7.42	17.68	33.02
2029	9.22	21.93	39.13
2030	11.30	26.54	45.01
2031	13.69	31.54	50.16
2032	16.38	36.46	54.46
2033	19.36	41.14	57.92
2034	22.60	45.32	60.45
2035	26.06	49.06	62.04
2036	29.65	52.27	63.08
2037	33.30	54.87	63.69
2038	36.93	56.76	64.11
2039	40.44	58.33	64.40
2040	43.76	59.62	64.59
2041	46.84	60.67	64.72
2042	49.64	61.52	64.81
2043	52.13	62.22	64.87
2044	54.32	62.78	64.91
2045	56.21	63.23	64.94
2046	57.90	63.61	64.96
2047	59.31	63.91	64.97
2048	60.48	64.15	64.98
2049	61.44	64.34	64.99
2050	62.23	64.48	64.99

B.2 Austria

Austrian EV uptake scenarios			
	Petrol price		
	High	Medium	Low
2009			
2010			
2011			
2012	0.26	0.26	0.26
2013	0.39	0.39	0.39
2014	0.57	0.57	0.57
2015	0.84	0.84	0.84
2016	1.54	1.54	1.54
2017	2.02	2.02	2.02
2018	2.97	2.97	2.97
2019	4.37	4.37	4.37
2020	5.13	5.13	5.13
2021	6.84	6.53	6.31
2022	8.43	8.00	7.67
2023	10.28	9.63	9.17
2024	12.44	11.67	10.96
2025	14.94	14.03	13.12
2026	17.78	16.74	15.49
2027	21.11	19.77	18.07
2028	24.61	23.27	20.78
2029	28.27	26.87	23.60
2030	31.90	30.52	26.50
2031	35.54	34.05	29.43
2032	39.10	37.52	32.28
2033	42.42	40.82	35.16
2034	45.30	43.83	38.03
2035	47.99	46.37	40.84
2036	50.44	48.74	43.54
2037	52.64	50.91	46.09
2038	54.58	52.87	48.47
2039	56.28	54.62	50.65
2040	57.75	56.17	52.63
2041	59.00	57.52	54.39
2042	60.05	58.69	55.95
2043	60.94	59.70	57.32
2044	61.67	60.56	58.51
2045	62.28	61.29	59.53
2046	62.79	61.90	60.41
2047	63.20	62.42	61.15
2048	63.54	62.86	61.79
2049	63.81	63.22	62.32
2050	64.02	63.50	62.76

Austrian EV uptake scenarios			
	EV vehicle price		
	High	Medium	Low
2009			
2010			
2011			
2012	0.26	0.26	0.26
2013	0.39	0.39	0.39
2014	0.57	0.57	0.57
2015	0.84	0.84	0.84
2016	1.54	1.54	1.54
2017	2.02	2.02	2.02
2018	2.40	2.97	2.97
2019	3.33	4.37	5.00
2020	3.73	5.13	6.35
2021	4.30	6.53	9.63
2022	5.07	8.00	12.64
2023	5.92	9.63	16.21
2024	6.91	11.67	20.65
2025	8.11	14.03	25.68
2026	9.43	16.74	31.33
2027	10.90	19.77	37.10
2028	12.54	23.27	42.81
2029	14.35	26.87	48.08
2030	16.31	30.52	52.68
2031	18.47	34.05	56.36
2032	20.82	37.52	59.17
2033	23.37	40.82	61.08
2034	26.07	43.83	62.41
2035	28.90	46.37	63.29
2036	31.80	48.74	63.82
2037	34.74	50.91	64.19
2038	37.66	52.87	64.44
2039	40.51	54.62	64.62
2040	43.25	56.17	64.74
2041	45.83	57.52	64.82
2042	48.24	58.69	64.88
2043	50.45	59.70	64.92
2044	52.44	60.56	64.94
2045	54.23	61.29	64.96
2046	55.81	61.90	64.97
2047	57.20	62.42	64.98
2048	58.40	62.86	64.99
2049	59.44	63.22	64.99
2050	60.33	63.50	64.99

B.3 Belgium

BelgianEV uptake scenarios			
	Petrol price		
	High	Medium	Low
2009			
2010			
2011			
2012	0.08	0.08	0.08
2013	0.18	0.18	0.18
2014	0.40	0.40	0.40
2015	0.71	0.71	0.71
2016	1.42	1.19	1.07
2017	2.39	2.02	1.59
2018	3.68	2.91	2.24
2019	5.41	4.30	3.13
2020	7.46	6.12	4.57
2021	10.59	8.94	7.17
2022	13.89	12.11	9.80
2023	17.97	15.83	13.44
2024	23.47	20.65	17.86
2025	29.41	26.68	23.06
2026	35.69	32.92	28.86
2027	42.09	39.17	35.33
2028	48.05	45.31	41.63
2029	53.36	50.85	47.48
2030	57.64	55.57	52.31
2031	60.27	59.18	56.35
2032	62.14	61.21	59.47
2033	63.32	62.66	61.59
2034	63.84	63.62	62.62
2035	64.20	64.20	63.34
2036	64.45	64.45	63.84
2037	64.61	64.61	64.19
2038	64.73	64.73	64.44
2039	64.81	64.81	64.61
2040	64.87	64.87	64.72
2041	64.91	64.91	64.80
2042	64.93	64.93	64.86
2043	64.95	64.95	64.90
2044	64.97	64.97	64.93
2045	64.98	64.98	64.95
2046	64.98	64.98	64.97
2047	64.99	64.99	64.98
2048	64.99	64.99	64.98
2049	64.99	64.99	64.99
2050	65.00	65.00	64.99

BelgianEV uptake scenarios			
	EV vehicle price		
	High	Medium	Low
2009			
2010			
2011			
2012	0.08	0.08	0.08
2013	0.18	0.18	0.18
2014	0.40	0.40	0.40
2015	0.71	0.71	0.71
2016	1.07	1.19	1.42
2017	1.59	2.02	2.76
2018	2.06	2.91	4.74
2019	2.57	4.30	7.42
2020	3.20	6.12	10.86
2021	4.15	8.94	15.85
2022	5.20	12.11	21.08
2023	6.41	15.83	27.34
2024	8.03	20.65	33.93
2025	10.13	26.68	40.71
2026	12.78	32.92	47.01
2027	16.06	39.17	52.62
2028	20.02	45.31	57.39
2029	24.56	50.85	61.02
2030	29.55	55.57	63.03
2031	34.77	59.18	64.21
2032	39.96	61.21	64.65
2033	44.86	62.66	64.87
2034	49.24	63.62	64.94
2035	52.98	64.20	64.97
2036	56.01	64.45	64.99
2037	58.39	64.61	64.99
2038	60.20	64.73	65.00
2039	61.54	64.81	65.00
2040	62.52	64.87	65.00
2041	63.23	64.91	65.00
2042	63.73	64.93	65.00
2043	64.10	64.95	65.00
2044	64.36	64.97	65.00
2045	64.55	64.98	65.00
2046	64.68	64.98	65.00
2047	64.77	64.99	65.00
2048	64.84	64.99	65.00
2049	64.89	64.99	65.00
2050	64.92	65.00	65.00

B.4 Britain

BritishEV uptake scenarios	Petrol price		
	High	Medium	Low
2009			
2010			
2011			
2012	0.12	0.12	0.12
2013	0.17	0.17	0.17
2014	0.62	0.62	0.62
2015	1.11	1.11	1.11
2016	1.24	1.24	1.24
2017	1.74	1.74	1.74
2018	2.45	2.45	2.45
2019	3.42	3.42	3.42
2020	4.09	4.03	3.77
2021	5.00	4.67	4.02
2022	6.50	6.03	5.24
2023	8.36	7.72	6.81
2024	10.67	9.82	8.80
2025	13.49	12.38	11.27
2026	16.86	15.33	14.21
2027	20.71	18.69	17.51
2028	25.02	22.34	21.18
2029	29.72	26.21	25.03
2030	34.46	30.22	28.98
2031	39.10	34.24	32.98
2032	43.46	38.14	36.89
2033	47.44	41.90	40.57
2034	50.90	45.41	44.05
2035	53.78	48.62	47.26
2036	56.03	51.46	50.14
2037	57.89	53.93	52.68
2038	59.41	56.04	54.88
2039	60.63	57.80	56.74
2040	61.60	59.25	58.31
2041	62.37	60.43	59.60
2042	62.97	61.39	60.66
2043	63.43	62.15	61.53
2044	63.79	62.76	62.23
2045	64.07	63.25	62.80
2046	64.29	63.63	63.26
2047	64.46	63.93	63.62
2048	64.58	64.17	63.91
2049	64.68	64.35	64.14
2050	64.76	64.50	64.32

BritishEV uptake scenarios	EV vehicle price		
	High	Medium	Low
2009			
2010			
2011			
2012	0.1	0.12	0.1
2013	0.2	0.17	0.2
2014	0.6	0.62	0.6
2015	1.1	1.11	1.1
2016	1.2	1.24	1.2
2017	1.7	1.74	1.7
2018	2.4	2.45	2.4
2019	3.4	3.42	3.4
2020	3.5	4.03	4.5
2021	2.8	4.67	7.6
2022	3.3	6.03	10.6
2023	3.9	7.72	14.5
2024	4.7	9.82	19.3
2025	5.6	12.38	24.8
2026	6.7	15.33	30.7
2027	7.9	18.69	36.8
2028	9.3	22.34	42.6
2029	10.8	26.21	48.0
2030	12.5	30.22	52.5
2031	14.3	34.24	56.0
2032	16.3	38.14	58.8
2033	18.3	41.90	60.7
2034	20.5	45.41	62.0
2035	22.8	48.62	62.9
2036	25.2	51.46	63.5
2037	27.5	53.93	64.0
2038	29.9	56.04	64.3
2039	32.3	57.80	64.5
2040	34.7	59.25	64.6
2041	37.1	60.43	64.7
2042	39.4	61.39	64.8
2043	41.6	62.15	64.9
2044	43.7	62.76	64.9
2045	45.7	63.25	64.9
2046	47.7	63.63	65.0
2047	49.5	63.93	65.0
2048	51.1	64.17	65.0
2049	52.7	64.35	65.0
2050	54.1	64.50	65.0

B.5 Canada

EV uptake scenarios	Petrol price		
	High	Medium	Low
2009			
2010			
2011			
2012	0.27	0.27	0.27
2013	0.42	0.42	0.42
2014	0.64	0.64	0.64
2015	0.83	0.83	0.83
2016	1.28	1.28	1.28
2017	2.11	2.11	2.11
2018	5.40	5.40	5.40
2019	4.20	3.52	3.11
2020	5.82	4.84	4.23
2021	8.19	6.78	5.98
2022	10.59	8.96	7.78
2023	13.57	11.54	10.11
2024	17.07	14.73	12.97
2025	21.11	18.62	16.41
2026	25.61	22.93	20.35
2027	30.54	27.67	24.92
2028	35.46	32.65	29.65
2029	40.24	37.74	34.45
2030	44.59	42.58	39.05
2031	48.55	47.01	43.40
2032	52.00	50.76	47.38
2033	54.83	53.99	50.81
2034	56.94	56.64	53.53
2035	58.67	58.67	55.86
2036	60.08	60.08	57.79
2037	61.20	61.20	59.37
2038	62.08	62.08	60.64
2039	62.77	62.77	61.64
2040	63.30	63.30	62.43
2041	63.71	63.71	63.04
2042	64.02	64.02	63.51
2043	64.26	64.26	63.87
2044	64.44	64.44	64.14
2045	64.58	64.58	64.35
2046	64.68	64.68	64.51
2047	64.76	64.76	64.63
2048	64.82	64.82	64.72
2049	64.86	64.86	64.79
2050	64.90	64.90	64.84

EV uptake scenarios	EV vehicle price		
	High	Medium	Low
2009			
2010			
2011			
2012	0.3	0.27	0.3
2013	0.4	0.42	0.4
2014	0.6	0.64	0.6
2015	0.8	0.83	0.8
2016	1.3	1.28	1.3
2017	2.1	2.11	2.1
2018	5.4	5.40	5.4
2019	2.8	3.52	5.1
2020	3.5	4.84	7.3
2021	4.2	6.78	10.7
2022	5.0	8.96	14.2
2023	6.0	11.54	18.3
2024	7.2	14.73	23.1
2025	8.8	18.62	28.6
2026	10.7	22.93	34.3
2027	13.0	27.67	40.0
2028	15.8	32.65	45.4
2029	18.8	37.74	50.3
2030	22.2	42.58	54.2
2031	25.9	47.01	57.4
2032	29.8	50.76	59.7
2033	33.9	53.99	61.4
2034	37.9	56.64	62.4
2035	41.8	58.67	63.1
2036	45.5	60.08	63.6
2037	48.9	61.20	63.9
2038	51.9	62.08	64.2
2039	54.5	62.77	64.4
2040	56.7	63.30	64.5
2041	58.5	63.71	64.6
2042	59.9	64.02	64.7
2043	61.1	64.26	64.8
2044	62.0	64.44	64.8
2045	62.7	64.58	64.9
2046	63.2	64.68	64.9
2047	63.7	64.76	64.9
2048	64.0	64.82	65.0
2049	64.2	64.86	65.0
2050	64.4	64.90	65.0

B.6 China

EV uptake scenarios			
	Petrol price		
	High	Medium	Low
2009			
2010			
2011			
2012	0.04	0.04	0.04
2013	0.09	0.09	0.09
2014	0.09	0.09	0.09
2015	0.99	0.99	0.99
2016	1.34	1.34	1.34
2017	2.14	2.14	2.14
2018	3.98	3.98	3.98
2019	6.86	6.10	5.15
2020	9.91	8.63	6.81
2021	13.47	11.41	8.85
2022	17.57	14.76	11.49
2023	22.62	18.85	15.10
2024	28.75	23.76	19.90
2025	35.18	29.48	25.43
2026	41.64	35.99	31.68
2027	47.74	42.40	38.51
2028	53.08	48.36	44.87
2029	57.03	53.51	50.29
2030	59.96	57.58	54.77
2031	61.97	60.24	58.12
2032	63.20	62.08	60.26
2033	63.85	63.27	61.79
2034	64.28	63.97	62.85
2035	64.54	64.33	63.57
2036	64.71	64.57	64.06
2037	64.82	64.72	64.38
2038	64.89	64.82	64.59
2039	64.93	64.89	64.73
2040	64.96	64.93	64.83
2041	64.97	64.95	64.89
2042	64.98	64.97	64.93
2043	64.99	64.98	64.95
2044	64.99	64.99	64.97
2045	65.00	64.99	64.98
2046	65.00	64.99	64.99
2047	65.00	65.00	64.99
2048	65.00	65.00	64.99
2049	65.00	65.00	65.00
2050	65.00	65.00	65.00

EV uptake scenarios			
	EV vehicle price		
	High	Medium	Low
2009			
2010			
2011			
2012	0.0	0.04	0.0
2013	0.1	0.09	0.1
2014	0.1	0.09	0.1
2015	1.0	0.99	1.0
2016	1.3	1.34	1.3
2017	2.1	2.14	2.1
2018	4.0	3.98	4.0
2019	4.9	6.10	8.1
2020	5.6	8.63	12.7
2021	6.4	11.41	18.2
2022	7.4	14.76	24.5
2023	8.7	18.85	31.8
2024	10.3	23.76	39.7
2025	12.4	29.48	47.2
2026	14.8	35.99	53.4
2027	17.6	42.40	58.3
2028	20.8	48.36	61.4
2029	24.3	53.51	63.2
2030	28.2	57.58	64.0
2031	32.3	60.24	64.5
2032	36.5	62.08	64.7
2033	40.6	63.27	64.8
2034	44.5	63.97	64.9
2035	48.0	64.33	64.9
2036	51.2	64.57	65.0
2037	54.0	64.72	65.0
2038	56.2	64.82	65.0
2039	58.1	64.89	65.0
2040	59.7	64.93	65.0
2041	60.9	64.95	65.0
2042	61.8	64.97	65.0
2043	62.6	64.98	65.0
2044	63.2	64.99	65.0
2045	63.6	64.99	65.0
2046	63.9	64.99	65.0
2047	64.2	65.00	65.0
2048	64.4	65.00	65.0
2049	64.5	65.00	65.0
2050	64.6	65.00	65.0

B.7 Denmark

EV uptake scenarios	Petrol price		
	High	Medium	Low
2012	0.28	0.28	0.28
2013	0.28	0.28	0.28
2014	0.93	0.93	0.93
2015	1.45	1.45	1.45
2016	0.93	0.93	0.93
2017	0.93	0.93	0.93
2018	0.91	0.91	0.91
2019	1.17	1.17	1.17
2020	1.51	1.51	1.51
2021	2.18	2.18	2.18
2022	3.56	3.00	3.00
2023	5.28	4.76	4.07
2024	7.39	6.89	6.24
2025	9.95	9.46	8.82
2026	13.01	12.50	11.84
2027	16.11	16.11	15.38
2028	19.58	19.58	19.58
2029	24.11	23.39	23.39
2030	29.06	27.49	27.49
2031	34.45	31.78	31.78
2032	40.29	36.12	36.12
2033	46.62	40.34	40.34
2034	49.98	44.30	44.30
2035	52.87	47.87	47.87
2036	55.28	50.99	50.99
2037	57.25	53.65	53.65
2038	58.85	55.86	55.86
2039	60.12	57.67	57.67
2040	61.13	59.14	59.14
2041	61.94	60.34	60.34
2042	62.59	61.31	61.31
2043	63.11	62.08	62.08
2044	63.52	62.70	62.70
2045	63.84	63.20	63.20
2046	64.09	63.59	63.59
2047	64.29	63.89	63.89
2048	64.42	64.13	64.13
2049	64.50	64.30	64.30
2050	64.51	64.39	64.39

EV uptake scenarios	EV vehicle price		
	High	Medium	Low
2012	0.28	0.28	0.28
2013	0.28	0.28	0.28
2014	0.93	0.93	0.93
2015	1.45	1.45	1.45
2016	0.93	0.93	0.93
2017	0.93	0.93	0.93
2018	0.91	0.91	0.91
2019	1.17	1.17	1.41
2020	1.30	1.51	2.06
2021	1.69	2.18	3.12
2022	2.16	3.00	4.42
2023	2.80	4.76	6.95
2024	3.64	6.89	9.81
2025	4.85	9.46	13.15
2026	6.37	12.50	17.06
2027	8.20	16.11	22.63
2028	11.20	19.58	28.03
2029	14.61	23.39	34.05
2030	18.59	27.49	40.63
2031	23.33	31.78	47.45
2032	29.19	36.12	51.39
2033	33.45	40.34	54.64
2034	37.69	44.30	57.23
2035	41.75	47.87	59.23
2036	45.50	50.99	60.74
2037	48.85	53.65	61.87
2038	51.76	55.86	62.71
2039	54.22	57.67	63.32
2040	56.27	59.14	63.77
2041	57.98	60.34	64.10
2042	59.39	61.31	64.35
2043	60.54	62.08	64.52
2044	61.47	62.70	64.65
2045	62.22	63.20	64.75
2046	62.81	63.59	64.82
2047	63.28	63.89	64.86
2048	63.65	64.13	64.89
2049	63.95	64.30	64.90
2050	64.14	64.39	64.90

B.8 Finland

EV uptake scenarios			
	Petrol price		
	High	Medium	Low
2009			
2010			
2011			
2012	0.11	0.11	0.11
2013	0.22	0.22	0.22
2014	0.44	0.44	0.44
2015	0.60	0.60	0.60
2016	1.20	1.20	1.20
2017	2.58	2.58	2.58
2018	4.60	4.60	4.60
2019	13.46	11.22	11.22
2020	18.07	14.37	14.37
2021	22.95	18.27	18.27
2022	28.86	23.22	23.17
2023	34.34	28.68	28.51
2024	39.90	34.36	34.03
2025	45.44	40.11	39.62
2026	50.45	45.69	45.01
2027	54.64	50.95	50.08
2028	58.11	55.53	54.63
2029	60.75	59.10	58.23
2030	62.59	61.26	60.49
2031	63.70	62.78	62.15
2032	64.20	63.77	63.30
2033	64.51	64.34	64.04
2034	64.70	64.58	64.47
2035	64.81	64.73	64.65
2036	64.89	64.83	64.77
2037	64.93	64.89	64.85
2038	64.96	64.93	64.90
2039	64.97	64.95	64.93
2040	64.98	64.97	64.95
2041	64.99	64.98	64.97
2042	64.99	64.99	64.98
2043	65.00	64.99	64.99
2044	65.00	64.99	64.99
2045	65.00	65.00	64.99
2046	65.00	65.00	65.00
2047	65.00	65.00	65.00
2048	65.00	65.00	65.00
2049	65.00	65.00	65.00
2050	65.00	65.00	65.00

EV uptake scenarios			
	EV vehicle price		
	High	Medium	Low
2009			
2010			
2011			
2012	0.11	0.11	0.11
2013	0.22	0.22	0.22
2014	0.44	0.44	0.44
2015	0.60	0.60	0.60
2016	1.20	1.20	1.20
2017	2.58	2.58	2.58
2018	4.60	4.60	4.60
2019	11.22	11.22	15.38
2020	12.59	14.37	20.41
2021	13.81	18.27	26.91
2022	16.53	23.22	34.51
2023	18.93	28.68	41.10
2024	21.86	34.36	47.38
2025	25.26	40.11	52.88
2026	29.06	45.69	57.39
2027	33.21	50.95	60.89
2028	37.65	55.53	63.19
2029	41.99	59.10	64.21
2030	46.07	61.26	64.72
2031	49.73	62.78	64.89
2032	52.87	63.77	64.96
2033	55.49	64.34	64.98
2034	57.61	64.58	64.99
2035	59.28	64.73	65.00
2036	60.59	64.83	65.00
2037	61.59	64.89	65.00
2038	62.36	64.93	65.00
2039	62.96	64.95	65.00
2040	63.41	64.97	65.00
2041	63.76	64.98	65.00
2042	64.03	64.99	65.00
2043	64.24	64.99	65.00
2044	64.41	64.99	65.00
2045	64.54	65.00	65.00
2046	64.64	65.00	65.00
2047	64.72	65.00	65.00
2048	64.78	65.00	65.00
2049	64.83	65.00	65.00
2050	64.87	65.00	65.00

B.9 France

EV uptake scenarios	Petrol price		
	High	Medium	Low
2009			
2010			
2011			
2012	0.33	0.33	0.33
2013	0.70	0.70	0.70
2014	0.70	0.70	0.70
2015	1.20	1.20	1.20
2016	1.45	1.45	1.45
2017	1.74	1.74	1.74
2018	2.09	2.09	2.09
2019	2.65	2.65	2.65
2020	3.23	3.19	3.19
2021	4.14	4.04	4.04
2022	5.12	4.93	4.93
2023	6.33	6.00	6.00
2024	7.78	7.33	7.26
2025	9.50	8.93	8.80
2026	11.47	10.82	10.61
2027	13.65	12.97	12.69
2028	16.03	15.38	15.04
2029	18.56	18.00	17.66
2030	21.20	20.79	20.45
2031	23.96	23.67	23.39
2032	26.80	26.62	26.42
2033	29.68	29.61	29.48
2034	32.59	32.59	32.53
2035	35.51	35.51	35.51
2036	38.38	38.38	38.38
2037	41.17	41.17	41.17
2038	43.82	43.82	43.82
2039	46.33	46.33	46.33
2040	48.65	48.65	48.65
2041	50.78	50.78	50.78
2042	52.71	52.71	52.71
2043	54.44	54.44	54.44
2044	55.97	55.97	55.97
2045	57.31	57.31	57.31
2046	58.49	58.49	58.49
2047	59.50	59.50	59.50
2048	60.37	60.37	60.37
2049	61.10	61.10	61.10
2050	61.71	61.71	61.71

EV uptake scenarios	EV vehicle price		
	High	Medium	Low
2009			
2010			
2011			
2012	0.33	0.33	0.33
2013	0.70	0.70	0.70
2014	0.70	0.70	0.70
2015	1.20	1.20	1.20
2016	1.45	1.45	1.45
2017	1.74	1.74	1.74
2018	2.09	2.09	2.09
2019	2.35	2.65	2.88
2020	2.72	3.19	3.66
2021	3.29	4.04	5.00
2022	3.86	4.93	6.40
2023	4.59	6.00	8.10
2024	5.46	7.33	10.21
2025	6.50	8.93	12.69
2026	7.71	10.82	15.53
2027	9.08	12.97	18.62
2028	10.65	15.38	21.95
2029	12.41	18.00	25.34
2030	14.35	20.79	28.76
2031	16.49	23.67	32.08
2032	18.83	26.62	35.28
2033	21.34	29.61	38.30
2034	24.01	32.59	41.17
2035	26.80	35.51	43.82
2036	29.68	38.38	46.33
2037	32.59	41.17	48.65
2038	35.51	43.82	50.78
2039	38.38	46.33	52.71
2040	41.17	48.65	54.44
2041	43.82	50.78	55.97
2042	46.33	52.71	57.31
2043	48.65	54.44	58.49
2044	50.78	55.97	59.50
2045	52.71	57.31	60.37
2046	54.44	58.49	61.10
2047	55.97	59.50	61.71
2048	57.31	60.37	62.20
2049	58.49	61.10	62.58
2050	59.50	61.71	62.86

B.10 Germany

EV uptake scenarios			
	Petrol price		
	High	Medium	Low
2009			
2010			
2011			
2012	0.06	0.06	0.06
2013	0.40	0.40	0.40
2014	0.40	0.40	0.40
2015	0.75	0.75	0.75
2016	0.73	0.73	0.73
2017	1.59	1.59	1.59
2018	2.47	2.47	2.47
2019	4.29	4.29	3.93
2020	6.62	6.40	5.40
2021	9.57	9.03	8.05
2022	12.49	11.63	10.44
2023	16.16	14.63	13.39
2024	20.35	18.53	17.00
2025	25.13	22.84	21.17
2026	30.21	27.39	25.50
2027	35.90	32.28	30.09
2028	41.50	37.47	34.81
2029	46.77	42.87	39.52
2030	51.21	47.81	44.05
2031	55.06	51.81	48.10
2032	58.17	55.27	51.18
2033	60.40	58.10	53.86
2034	61.66	60.25	56.09
2035	62.58	61.72	57.91
2036	63.25	62.52	59.37
2037	63.73	63.13	60.54
2038	64.08	63.58	61.46
2039	64.33	63.92	62.19
2040	64.51	64.18	62.77
2041	64.64	64.37	63.22
2042	64.74	64.52	63.58
2043	64.81	64.63	63.87
2044	64.86	64.72	64.10
2045	64.90	64.78	64.28
2046	64.92	64.84	64.43
2047	64.95	64.87	64.55
2048	64.96	64.90	64.64
2049	64.97	64.93	64.71
2050	64.98	64.94	64.77

EV uptake scenarios			
	EV vehicle price		
	High	Medium	Low
2009			
2010			
2011			
2012	0.06	0.06	0.06
2013	0.40	0.40	0.40
2014	0.40	0.40	0.40
2015	0.75	0.75	0.75
2016	0.73	0.73	0.73
2017	1.59	1.59	1.59
2018	2.47	2.47	2.47
2019	2.76	4.29	4.29
2020	3.81	6.40	8.67
2021	5.17	9.03	13.66
2022	6.37	11.63	18.86
2023	7.98	14.63	25.54
2024	9.79	18.53	33.08
2025	11.81	22.84	40.03
2026	14.02	27.39	46.69
2027	16.49	32.28	52.62
2028	19.24	37.47	57.66
2029	22.29	42.87	61.38
2030	25.44	47.81	63.35
2031	28.75	51.81	64.23
2032	32.13	55.27	64.68
2033	35.47	58.10	64.84
2034	38.69	60.25	64.93
2035	41.73	61.72	64.97
2036	44.53	62.52	64.98
2037	47.07	63.13	64.99
2038	49.34	63.58	64.99
2039	51.36	63.92	65.00
2040	53.14	64.18	65.00
2041	54.70	64.37	65.00
2042	56.08	64.52	65.00
2043	57.29	64.63	65.00
2044	58.36	64.72	65.00
2045	59.29	64.78	65.00
2046	60.11	64.84	65.00
2047	60.82	64.87	65.00
2048	61.43	64.90	65.00
2049	61.96	64.93	65.00
2050	62.41	64.94	65.00

B.11 India

EV uptake scenarios	Petrol price		
	High	Medium	Low
2009			
2010			
2011			
2012	0.16	0.16	0.16
2013	0.11	0.11	0.11
2014	0.13	0.13	0.13
2015	0.19	0.19	0.19
2016	0.23	0.23	0.23
2017	0.28	0.28	0.28
2018	0.36	0.36	0.34
2019	0.44	0.44	0.41
2020	0.55	0.54	0.49
2021	0.72	0.70	0.64
2022	0.91	0.87	0.81
2023	1.15	1.08	1.02
2024	1.46	1.36	1.28
2025	1.84	1.71	1.62
2026	2.31	2.15	2.05
2027	2.85	2.69	2.58
2028	3.49	3.34	3.22
2029	4.23	4.10	3.99
2030	5.09	4.98	4.88
2031	6.07	6.00	5.92
2032	7.20	7.16	7.10
2033	8.50	8.48	8.44
2034	9.98	9.98	9.96
2035	11.65	11.65	11.65
2036	13.54	13.54	13.54
2037	15.63	15.63	15.63
2038	17.92	17.92	17.92
2039	20.40	20.40	20.40
2040	23.05	23.05	23.05
2041	25.84	25.84	25.84
2042	28.73	28.73	28.73
2043	31.67	31.67	31.67
2044	34.63	34.63	34.63
2045	37.56	37.56	37.56
2046	40.41	40.41	40.41
2047	43.14	43.14	43.14
2048	45.72	45.72	45.72
2049	48.08	48.08	48.08
2050	50.17	50.17	50.17

EV uptake scenarios	EV vehicle price		
	High	Medium	Low
2009			
2010			
2011			
2012	0.16	0.16	0.16
2013	0.11	0.11	0.11
2014	0.13	0.13	0.13
2015	0.19	0.19	0.19
2016	0.23	0.23	0.23
2017	0.28	0.28	0.28
2018	0.33	0.36	0.38
2019	0.38	0.44	0.49
2020	0.43	0.54	0.63
2021	0.52	0.70	0.89
2022	0.63	0.87	1.18
2023	0.76	1.08	1.55
2024	0.93	1.36	2.04
2025	1.14	1.71	2.68
2026	1.40	2.15	3.47
2027	1.70	2.69	4.41
2028	2.07	3.34	5.52
2029	2.49	4.10	6.79
2030	3.00	4.98	8.23
2031	3.59	6.00	9.82
2032	4.29	7.16	11.58
2033	5.12	8.48	13.51
2034	6.08	9.98	15.63
2035	7.20	11.65	17.92
2036	8.50	13.54	20.40
2037	9.98	15.63	23.05
2038	11.65	17.92	25.84
2039	13.54	20.40	28.73
2040	15.63	23.05	31.67
2041	17.92	25.84	34.63
2042	20.40	28.73	37.56
2043	23.05	31.67	40.41
2044	25.84	34.63	43.14
2045	28.73	37.56	45.72
2046	31.67	40.41	48.08
2047	34.63	43.14	50.17
2048	37.56	45.72	51.96
2049	40.41	48.08	53.42
2050	43.14	50.17	54.53

B.12 Ireland

EV uptake scenarios			
	Petrol price		
	High	Medium	Low
2009			
2010			
2011			
2012	0.09	0.09	0.09
2013	0.14	0.14	0.14
2014	0.22	0.22	0.22
2015	0.33	0.33	0.33
2016	0.51	0.51	0.51
2017	0.77	0.77	0.77
2018	1.48	1.48	1.48
2019	2.96	2.82	2.66
2020	4.11	3.93	3.70
2021	6.01	5.71	5.19
2022	8.10	7.63	6.89
2023	10.70	10.05	9.04
2024	14.12	13.12	11.78
2025	18.28	16.87	15.25
2026	23.18	21.31	19.30
2027	28.65	26.33	23.90
2028	34.52	31.79	28.85
2029	40.28	37.49	33.98
2030	45.68	42.94	39.08
2031	50.38	47.89	43.91
2032	54.37	52.22	48.18
2033	57.54	55.82	51.94
2034	59.85	58.60	55.09
2035	61.37	60.59	57.64
2036	62.48	61.88	59.63
2037	63.26	62.81	61.13
2038	63.81	63.47	62.24
2039	64.19	63.94	63.05
2040	64.45	64.27	63.63
2041	64.62	64.50	64.04
2042	64.75	64.65	64.33
2043	64.83	64.76	64.54
2044	64.88	64.84	64.68
2045	64.92	64.89	64.78
2046	64.95	64.92	64.84
2047	64.96	64.95	64.89
2048	64.98	64.96	64.93
2049	64.98	64.98	64.95
2050	64.99	64.98	64.96

EV uptake scenarios			
	EV vehicle price		
	High	Medium	Low
2009			
2010			
2011			
2012	0.09	0.09	0.09
2013	0.14	0.14	0.14
2014	0.22	0.22	0.22
2015	0.33	0.33	0.33
2016	0.51	0.51	0.51
2017	0.77	0.77	0.77
2018	1.48	1.48	1.48
2019	1.94	2.82	3.76
2020	2.36	3.93	5.83
2021	2.95	5.71	9.98
2022	3.59	7.63	14.28
2023	4.39	10.05	19.64
2024	5.43	13.12	25.85
2025	6.69	16.87	32.52
2026	8.17	21.31	39.24
2027	9.82	26.33	45.57
2028	11.68	31.79	51.14
2029	13.75	37.49	55.70
2030	16.03	42.94	58.99
2031	18.54	47.89	61.24
2032	21.30	52.22	62.75
2033	24.30	55.82	63.69
2034	27.50	58.60	64.20
2035	30.84	60.59	64.51
2036	34.25	61.88	64.68
2037	37.64	62.81	64.79
2038	40.94	63.47	64.86
2039	44.09	63.94	64.91
2040	47.02	64.27	64.94
2041	49.70	64.50	64.96
2042	52.10	64.65	64.97
2043	54.22	64.76	64.98
2044	56.05	64.84	64.99
2045	57.62	64.89	64.99
2046	58.95	64.92	65.00
2047	60.07	64.95	65.00
2048	60.99	64.96	65.00
2049	61.76	64.98	65.00
2050	62.38	64.98	65.00

B.13 Italy

EV uptake scenarios	Petrol price		
	High	Medium	Low
2009			
2010			
2011			
2012	0.05	0.05	0.05
2013	0.08	0.08	0.08
2014	0.11	0.11	0.11
2015	0.15	0.15	0.15
2016	0.15	0.15	0.15
2017	0.25	0.25	0.25
2018	0.47	0.47	0.47
2019	0.80	0.80	0.77
2020	1.17	1.11	1.08
2021	1.84	1.72	1.70
2022	2.61	2.37	2.35
2023	3.65	3.29	3.18
2024	4.98	4.53	4.33
2025	6.63	6.09	5.79
2026	8.62	8.01	7.59
2027	10.87	10.29	9.73
2028	13.38	12.84	12.27
2029	16.06	15.64	15.07
2030	18.88	18.59	18.12
2031	21.85	21.64	21.28
2032	24.91	24.80	24.54
2033	28.00	28.00	27.86
2034	31.14	31.14	31.14
2035	34.27	34.27	34.27
2036	37.35	37.35	37.35
2037	40.30	40.30	40.30
2038	43.10	43.10	43.10
2039	45.71	45.71	45.71
2040	48.12	48.12	48.12
2041	50.30	50.30	50.30
2042	52.28	52.28	52.28
2043	54.04	54.04	54.04
2044	55.61	55.61	55.61
2045	56.99	56.99	56.99
2046	58.20	58.20	58.20
2047	59.24	59.24	59.24
2048	60.14	60.14	60.14
2049	60.90	60.90	60.90
2050	61.52	61.52	61.52

EV uptake scenarios	EV vehicle price		
	High	Medium	Low
2009			
2010			
2011			
2012	0.05	0.05	0.05
2013	0.08	0.08	0.08
2014	0.11	0.11	0.11
2015	0.15	0.15	0.15
2016	0.15	0.15	0.15
2017	0.25	0.25	0.25
2018	0.47	0.47	0.47
2019	0.57	0.80	1.05
2020	0.75	1.11	1.65
2021	1.04	1.72	2.94
2022	1.35	2.37	4.37
2023	1.76	3.29	6.28
2024	2.26	4.53	8.90
2025	2.89	6.09	12.25
2026	3.65	8.01	16.48
2027	4.55	10.29	21.39
2028	5.60	12.84	26.95
2029	6.81	15.64	32.64
2030	8.18	18.59	38.29
2031	9.73	21.64	43.57
2032	11.47	24.80	48.32
2033	13.40	28.00	52.27
2034	15.52	31.14	55.45
2035	17.83	34.27	57.82
2036	20.31	37.35	59.68
2037	22.93	40.30	61.10
2038	25.68	43.10	62.17
2039	28.51	45.71	62.95
2040	31.40	48.12	63.53
2041	34.30	50.30	63.95
2042	37.16	52.28	64.25
2043	39.97	54.04	64.46
2044	42.67	55.61	64.62
2045	45.23	56.99	64.73
2046	47.63	58.20	64.81
2047	49.85	59.24	64.86
2048	51.86	60.14	64.90
2049	53.68	60.90	64.93
2050	55.29	61.52	64.94

B.14 Japan

EV uptake scenarios			
	Petrol price		
	High	Medium	Low
2009			
2010			
2011			
2012	0.38	0.38	0.38
2013	0.69	0.69	0.69
2014	0.63	0.63	0.63
2015	0.58	0.58	0.58
2016	0.60	0.60	0.60
2017	1.26	1.26	1.26
2018	1.49	1.49	1.49
2019	1.85	1.85	1.85
2020	2.23	2.23	2.20
2021	2.81	2.81	2.75
2022	3.40	3.40	3.32
2023	4.14	4.10	4.00
2024	5.04	4.96	4.81
2025	6.11	5.99	5.80
2026	7.36	7.20	6.98
2027	8.81	8.60	8.36
2028	10.42	10.21	9.94
2029	12.20	11.99	11.74
2030	14.11	13.95	13.72
2031	16.18	16.05	15.87
2032	18.38	18.30	18.16
2033	20.71	20.67	20.57
2034	23.14	23.14	23.09
2035	25.68	25.68	25.68
2036	28.31	28.31	28.31
2037	31.00	31.00	31.00
2038	33.70	33.70	33.70
2039	36.39	36.39	36.39
2040	39.03	39.03	39.03
2041	41.59	41.59	41.59
2042	44.03	44.03	44.03
2043	46.34	46.34	46.34
2044	48.49	48.49	48.49
2045	50.48	50.48	50.48
2046	52.29	52.29	52.29
2047	53.94	53.94	53.94
2048	55.41	55.41	55.41
2049	56.70	56.70	56.70
2050	57.81	57.81	57.81

EV uptake scenarios			
	EV vehicle price		
	High	Medium	Low
2009			
2010			
2011			
2012	0.38	0.38	0.38
2013	0.69	0.69	0.69
2014	0.63	0.63	0.63
2015	0.58	0.58	0.58
2016	0.60	0.60	0.60
2017	1.26	1.26	1.26
2018	1.49	1.49	1.49
2019	1.71	1.85	1.97
2020	1.97	2.23	2.45
2021	2.34	2.81	3.28
2022	2.72	3.40	4.11
2023	3.18	4.10	5.16
2024	3.73	4.96	6.44
2025	4.37	5.99	7.94
2026	5.13	7.20	9.65
2027	6.00	8.60	11.55
2028	7.00	10.21	13.62
2029	8.14	11.99	15.84
2030	9.43	13.95	18.16
2031	10.89	16.05	20.57
2032	12.51	18.30	23.09
2033	14.31	20.67	25.68
2034	16.28	23.14	28.31
2035	18.42	25.68	31.00
2036	20.71	28.31	33.70
2037	23.14	31.00	36.39
2038	25.68	33.70	39.03
2039	28.31	36.39	41.59
2040	31.00	39.03	44.03
2041	33.70	41.59	46.34
2042	36.39	44.03	48.49
2043	39.03	46.34	50.48
2044	41.59	48.49	52.29
2045	44.03	50.48	53.94
2046	46.34	52.29	55.41
2047	48.49	53.94	56.70
2048	50.48	55.41	57.81
2049	52.29	56.70	58.73
2050	53.94	57.81	59.46

B.15 Korea

EV uptake scenarios	Petrol price		
	High	Medium	Low
2009			
2010			
2011			
2012	0.04	0.04	0.04
2013	0.06	0.06	0.06
2014	0.06	0.06	0.06
2015	0.22	0.22	0.22
2016	0.44	0.44	0.44
2017	0.88	0.88	0.88
2018	2.13	1.78	1.78
2019	3.46	2.81	2.81
2020	6.66	5.24	5.16
2021	9.56	7.60	7.43
2022	13.57	10.82	10.44
2023	18.45	15.31	14.62
2024	24.50	20.83	19.74
2025	31.41	27.34	25.78
2026	38.30	34.43	32.35
2027	44.90	41.36	39.25
2028	50.93	47.86	45.78
2029	55.84	53.52	51.61
2030	59.62	57.82	56.19
2031	62.12	60.96	59.72
2032	63.34	62.91	62.14
2033	64.06	63.79	63.56
2034	64.48	64.31	64.15
2035	64.71	64.61	64.51
2036	64.84	64.78	64.71
2037	64.91	64.87	64.83
2038	64.95	64.93	64.90
2039	64.97	64.96	64.94
2040	64.98	64.98	64.97
2041	64.99	64.99	64.98
2042	65.00	64.99	64.99
2043	65.00	65.00	64.99
2044	65.00	65.00	65.00
2045	65.00	65.00	65.00
2046	65.00	65.00	65.00
2047	65.00	65.00	65.00
2048	65.00	65.00	65.00
2049	65.00	65.00	65.00
2050	65.00	65.00	65.00

EV uptake scenarios	EV vehicle price		
	High	Medium	Low
2009			
2010			
2011			
2012	0.04	0.04	0.04
2013	0.06	0.06	0.06
2014	0.06	0.06	0.06
2015	0.22	0.22	0.22
2016	0.44	0.44	0.44
2017	0.88	0.88	0.88
2018	1.36	1.78	2.54
2019	1.85	2.81	4.54
2020	2.82	5.24	10.14
2021	3.80	7.60	15.22
2022	5.03	10.82	21.85
2023	6.52	15.31	29.32
2024	8.38	20.83	37.24
2025	10.67	27.34	44.67
2026	13.44	34.43	51.29
2027	16.73	41.36	56.81
2028	20.54	47.86	60.88
2029	24.82	53.52	63.21
2030	29.47	57.82	64.39
2031	34.30	60.96	64.77
2032	39.12	62.91	64.90
2033	43.70	63.79	64.96
2034	47.85	64.31	64.98
2035	51.45	64.61	64.99
2036	54.47	64.78	65.00
2037	56.90	64.87	65.00
2038	58.83	64.93	65.00
2039	60.32	64.96	65.00
2040	61.46	64.98	65.00
2041	62.32	64.99	65.00
2042	62.98	64.99	65.00
2043	63.48	65.00	65.00
2044	63.86	65.00	65.00
2045	64.14	65.00	65.00
2046	64.36	65.00	65.00
2047	64.52	65.00	65.00
2048	64.64	65.00	65.00
2049	64.73	65.00	65.00
2050	64.80	65.00	65.00

B.16 Netherlands

EV uptake scenarios			
	Petrol price		
	High	Medium	Low
2009			
2010			
2011			
2012	1.84	1.84	1.84
2013	1.84	1.84	1.84
2014	3.27	3.27	3.27
2015	5.70	5.70	5.70
2016	3.27	3.27	3.27
2017	1.84	1.84	1.84
2018	5.70	5.70	5.70
2019	6.82	6.55	6.55
2020	9.79	9.03	9.03
2021	12.44	11.16	11.16
2022	15.64	13.70	13.70
2023	19.05	16.22	16.22
2024	22.62	18.68	18.66
2025	26.18	21.33	21.28
2026	30.18	24.64	24.54
2027	34.68	29.18	28.96
2028	39.80	34.10	33.68
2029	44.31	39.33	38.59
2030	48.43	44.84	43.55
2031	51.97	49.59	48.35
2032	54.72	52.96	51.84
2033	56.37	55.71	54.79
2034	57.75	57.75	57.17
2035	58.89	58.89	58.89
2036	59.82	59.82	59.82
2037	60.59	60.59	60.59
2038	61.22	61.22	61.22
2039	61.75	61.75	61.75
2040	62.18	62.18	62.18
2041	62.56	62.56	62.56
2042	62.88	62.88	62.88
2043	63.15	63.15	63.15
2044	63.40	63.40	63.40
2045	63.61	63.61	63.61
2046	63.80	63.80	63.80
2047	63.96	63.96	63.96
2048	64.10	64.10	64.10
2049	64.22	64.22	64.22
2050	64.32	64.32	64.32

EV uptake scenarios			
	EV vehicle price		
	High	Medium	Low
2009			
2010			
2011			
2012	1.84	1.84	1.84
2013	1.84	1.84	1.84
2014	3.27	3.27	3.27
2015	5.70	5.70	5.70
2016	3.27	3.27	3.27
2017	1.84	1.84	1.84
2018	5.70	5.70	5.70
2019	6.55	6.55	7.11
2020	8.69	9.03	10.51
2021	10.28	11.16	13.73
2022	12.09	13.70	17.67
2023	13.62	16.22	22.20
2024	14.69	18.68	26.62
2025	15.63	21.33	31.75
2026	16.79	24.64	37.32
2027	18.25	29.18	43.40
2028	20.09	34.10	48.95
2029	22.39	39.33	53.97
2030	25.24	44.84	57.55
2031	28.29	49.59	60.31
2032	31.44	52.96	61.89
2033	34.58	55.71	62.97
2034	37.62	57.75	63.51
2035	40.48	58.89	63.88
2036	43.12	59.82	64.07
2037	45.51	60.59	64.21
2038	47.65	61.22	64.33
2039	49.55	61.75	64.43
2040	51.25	62.18	64.51
2041	52.77	62.56	64.58
2042	54.14	62.88	64.63
2043	55.39	63.15	64.68
2044	56.52	63.40	64.73
2045	57.53	63.61	64.76
2046	58.43	63.80	64.79
2047	59.24	63.96	64.82
2048	59.96	64.10	64.85
2049	60.59	64.22	64.87
2050	61.16	64.32	64.89

B.17 New Zealand

EV uptake scenarios	Petrol price		
	High	Medium	Low
2009			
2010			
2011			
2012	0.05	0.05	0.05
2013	0.08	0.08	0.08
2014	0.08	0.08	0.08
2015	0.12	0.12	0.12
2016	0.26	0.26	0.26
2017	0.40	0.40	0.40
2018	0.61	0.61	0.61
2019	0.91	0.91	0.91
2020	2.04	1.46	1.46
2021	3.44	2.76	2.47
2022	4.87	4.06	3.48
2023	6.83	5.78	4.91
2024	9.26	7.92	6.78
2025	12.21	10.56	9.12
2026	15.71	13.55	11.98
2027	19.75	16.87	15.36
2028	24.02	20.39	19.05
2029	28.46	24.07	23.01
2030	32.83	27.81	27.05
2031	37.00	31.57	31.07
2032	40.95	35.22	35.03
2033	44.53	38.80	38.80
2034	47.59	42.21	42.21
2035	50.33	45.40	45.40
2036	52.74	48.30	48.30
2037	54.82	50.89	50.89
2038	56.58	53.16	53.16
2039	58.07	55.12	55.12
2040	59.30	56.80	56.80
2041	60.33	58.21	58.21
2042	61.18	59.40	59.40
2043	61.88	60.40	60.40
2044	62.46	61.23	61.23
2045	62.93	61.93	61.93
2046	63.32	62.50	62.50
2047	63.64	62.97	62.97
2048	63.90	63.35	63.35
2049	64.10	63.66	63.66
2050	64.25	63.90	63.90

EV uptake scenarios	EV vehicle price		
	High	Medium	Low
2009			
2010			
2011			
2012	0.05	0.05	0.05
2013	0.08	0.08	0.08
2014	0.08	0.08	0.08
2015	0.12	0.12	0.12
2016	0.26	0.26	0.26
2017	0.40	0.40	0.40
2018	0.61	0.61	0.61
2019	0.91	0.91	0.91
2020	1.19	1.46	2.42
2021	1.66	2.76	5.02
2022	2.15	4.06	7.39
2023	2.76	5.78	10.59
2024	3.53	7.92	14.50
2025	4.49	10.56	19.37
2026	5.67	13.55	24.90
2027	7.08	16.87	31.05
2028	8.74	20.39	37.21
2029	10.65	24.07	43.24
2030	12.83	27.81	48.62
2031	15.28	31.57	53.25
2032	17.99	35.22	56.85
2033	20.93	38.80	59.55
2034	24.08	42.21	61.30
2035	27.39	45.40	62.50
2036	30.78	48.30	63.23
2037	34.19	50.89	63.76
2038	37.55	53.16	64.13
2039	40.79	55.12	64.39
2040	43.86	56.80	64.57
2041	46.71	58.21	64.70
2042	49.31	59.40	64.79
2043	51.65	60.40	64.85
2044	53.74	61.23	64.90
2045	55.56	61.93	64.93
2046	57.14	62.50	64.95
2047	58.50	62.97	64.96
2048	59.64	63.35	64.97
2049	60.60	63.66	64.98
2050	61.40	63.90	64.98

B.18 Norway

EV uptake scenarios			
	Petrol price		
	High	Medium	Low
2009	0.50	0.496	0.50
2010	0.95	0.954	0.95
2011	1.82	1.824	1.82
2012	3.45	3.445	3.45
2013	6.36	6.361	6.36
2014	13.10	13.102	13.10
2015	18.82	18.818	18.82
2016	28.68	28.682	28.68
2017	39.31	39.315	39.31
2018	48.61	48.613	48.61
2019	55.37	55.370	55.37
2020	59.65	59.647	55.37
2021	55.13	48.077	47.97
2022	57.92	56.264	55.18
2023	58.53	56.516	56.29
2024	60.43	59.986	59.69
2025	62.62	62.244	62.00
2026	63.89	63.590	63.39
2027	64.60	64.351	64.19
2028	64.80	64.768	64.63
2029	64.90	64.880	64.87
2030	64.95	64.938	64.93
2031	64.98	64.968	64.96
2032	64.99	64.983	64.98
2033	65.00	64.991	64.99
2034	65.00	64.996	65.00
2035	65.00	64.998	65.00
2036	65.00	64.999	65.00
2037	65.00	64.999	65.00
2038	65.00	65.000	65.00
2039	65.00	65.000	65.00
2040	65.00	65.000	65.00
2041	65.00	65.000	65.00
2042	65.00	65.000	65.00
2043	65.00	65.000	65.00
2044	65.00	65.000	65.00
2045	65.00	65.000	65.00
2046	65.00	65.000	65.00
2047	65.00	65.000	65.00
2048	65.00	65.000	65.00
2049	65.00	65.000	65.00
2050	65.00	65.000	65.00

EV uptake scenarios			
	EV vehicle price		
	High	Medium	Low
2009	0.50	0.50	0.50
2010	0.95	0.95	0.95
2011	1.82	1.82	1.82
2012	3.45	3.45	3.45
2013	6.36	6.36	6.36
2014	13.10	13.10	13.10
2015	18.82	18.82	18.82
2016	28.68	28.68	28.68
2017	39.31	39.31	39.31
2018	48.61	48.61	48.61
2019	48.61	55.37	55.37
2020	55.37	59.65	59.65
2021	47.50	48.08	55.37
2022	51.30	56.26	60.16
2023	51.22	56.52	61.14
2024	53.76	59.99	63.05
2025	57.58	62.24	64.12
2026	60.29	63.59	64.70
2027	62.08	64.35	64.85
2028	63.22	64.77	64.94
2029	63.93	64.88	64.98
2030	64.36	64.94	64.99
2031	64.62	64.97	65.00
2032	64.77	64.98	65.00
2033	64.87	64.99	65.00
2034	64.92	65.00	65.00
2035	64.95	65.00	65.00
2036	64.97	65.00	65.00
2037	64.98	65.00	65.00
2038	64.99	65.00	65.00
2039	64.99	65.00	65.00
2040	65.00	65.00	65.00
2041	65.00	65.00	65.00
2042	65.00	65.00	65.00
2043	65.00	65.00	65.00
2044	65.00	65.00	65.00
2045	65.00	65.00	65.00
2046	65.00	65.00	65.00
2047	65.00	65.00	65.00
2048	65.00	65.00	65.00
2049	65.00	65.00	65.00
2050	65.00	65.00	65.00

B.19 Spain

EV uptake scenarios	Petrol price		
	High	Medium	Low
2009			
2010			
2011			
2012	0.10	0.10	0.10
2013	0.13	0.13	0.13
2014	0.13	0.13	0.13
2015	0.23	0.23	0.23
2016	0.30	0.30	0.30
2017	0.60	0.60	0.60
2018	0.78	0.78	0.78
2019	1.01	1.01	1.01
2020	1.49	1.39	1.39
2021	1.89	1.80	1.80
2022	2.62	2.52	2.32
2023	4.20	3.94	3.79
2024	5.62	5.22	4.99
2025	7.42	6.89	6.57
2026	9.62	8.96	8.57
2027	12.19	11.47	11.02
2028	15.16	14.44	13.93
2029	18.43	17.78	17.29
2030	21.96	21.45	21.00
2031	25.71	25.34	24.98
2032	29.58	29.36	29.08
2033	33.47	33.39	33.21
2034	37.34	37.34	37.25
2035	41.08	41.08	41.08
2036	44.61	44.61	44.61
2037	47.85	47.85	47.85
2038	50.77	50.77	50.77
2039	53.33	53.33	53.33
2040	55.53	55.53	55.53
2041	57.39	57.39	57.39
2042	58.94	58.94	58.94
2043	60.21	60.21	60.21
2044	61.23	61.23	61.23
2045	62.05	62.05	62.05
2046	62.70	62.70	62.70
2047	63.21	63.21	63.21
2048	63.61	63.61	63.61
2049	63.93	63.93	63.93
2050	64.16	64.16	64.16

EV uptake scenarios	EV vehicle price		
	High	Medium	Low
2009			
2010			
2011			
2012	0.10	0.10	0.10
2013	0.13	0.13	0.13
2014	0.13	0.13	0.13
2015	0.23	0.23	0.23
2016	0.30	0.30	0.30
2017	0.60	0.60	0.60
2018	0.78	0.78	0.78
2019	1.01	1.01	1.01
2020	1.15	1.39	1.69
2021	1.44	1.80	2.46
2022	1.80	2.52	3.43
2023	2.62	3.94	5.88
2024	3.34	5.22	7.98
2025	4.25	6.89	10.53
2026	5.39	8.96	13.57
2027	6.79	11.47	17.06
2028	8.49	14.44	20.87
2029	10.52	17.78	24.93
2030	12.90	21.45	29.08
2031	15.64	25.34	33.21
2032	18.72	29.36	37.25
2033	22.12	33.39	41.08
2034	25.76	37.34	44.61
2035	29.58	41.08	47.85
2036	33.47	44.61	50.77
2037	37.34	47.85	53.33
2038	41.08	50.77	55.53
2039	44.61	53.33	57.39
2040	47.85	55.53	58.94
2041	50.77	57.39	60.21
2042	53.33	58.94	61.23
2043	55.53	60.21	62.05
2044	57.39	61.23	62.70
2045	58.94	62.05	63.21
2046	60.21	62.70	63.61
2047	61.23	63.21	63.93
2048	62.05	63.61	64.16
2049	62.70	63.93	64.34
2050	63.21	64.16	64.47

B.20 Sweden

EV uptake scenarios			
	Petrol price		
	High	Medium	Low
2009			
2010			
2011			
2012	0.36	0.36	0.36
2013	0.55	0.55	0.55
2014	1.57	1.57	1.57
2015	2.38	2.38	2.38
2016	3.58	3.58	3.58
2017	5.34	5.34	5.34
2018	10.64	9.27	8.84
2019	15.45	13.01	12.18
2020	19.57	16.55	15.41
2021	24.17	20.36	19.07
2022	28.74	24.50	23.02
2023	33.35	28.89	27.32
2024	38.06	33.55	31.87
2025	42.72	38.36	36.58
2026	47.13	43.07	41.24
2027	51.21	47.58	45.77
2028	54.72	51.77	50.00
2029	57.61	55.28	53.61
2030	59.84	57.96	56.49
2031	61.45	60.06	58.83
2032	62.49	61.61	60.64
2033	63.25	62.68	61.98
2034	63.78	63.34	62.89
2035	64.15	63.81	63.45
2036	64.41	64.15	63.87
2037	64.59	64.39	64.17
2038	64.72	64.57	64.39
2039	64.80	64.69	64.55
2040	64.86	64.78	64.67
2041	64.91	64.84	64.76
2042	64.93	64.89	64.82
2043	64.95	64.92	64.87
2044	64.97	64.94	64.90
2045	64.98	64.96	64.93
2046	64.98	64.97	64.95
2047	64.99	64.98	64.96
2048	64.99	64.98	64.97
2049	64.99	64.99	64.98
2050	65.00	64.99	64.98

EV uptake scenarios			
	EV vehicle price		
	High	Medium	Low
2009			
2010			
2011			
2012	0.36	0.36	0.36
2013	0.55	0.55	0.55
2014	1.57	1.57	1.57
2015	2.38	2.38	2.38
2016	3.58	3.58	3.58
2017	5.34	5.34	5.34
2018	8.84	9.27	11.10
2019	10.63	13.01	17.87
2020	12.59	16.55	23.57
2021	14.44	20.36	29.93
2022	16.08	24.50	36.27
2023	17.49	28.89	42.31
2024	19.02	33.55	47.87
2025	20.64	38.36	52.73
2026	22.37	43.07	56.68
2027	24.18	47.58	59.65
2028	26.11	51.77	61.77
2029	27.99	55.28	63.14
2030	29.81	57.96	63.91
2031	31.55	60.06	64.37
2032	33.18	61.61	64.62
2033	34.68	62.68	64.77
2034	36.05	63.34	64.86
2035	37.26	63.81	64.91
2036	38.32	64.15	64.94
2037	39.22	64.39	64.96
2038	39.99	64.57	64.97
2039	40.63	64.69	64.98
2040	41.19	64.78	64.99
2041	41.68	64.84	64.99
2042	42.12	64.89	65.00
2043	42.54	64.92	65.00
2044	42.95	64.94	65.00
2045	43.36	64.96	65.00
2046	43.77	64.97	65.00
2047	44.17	64.98	65.00
2048	44.57	64.98	65.00
2049	44.96	64.99	65.00
2050	45.35	64.99	65.00

B.21 Switzerland

EV uptake scenarios	Petrol price		
	High	Medium	Low
2009			
2010			
2011			
2012	0.24	0.24	0.24
2013	0.42	0.42	0.42
2014	0.74	0.74	0.74
2015	1.73	1.73	1.73
2016	1.97	1.97	1.97
2017	2.52	2.52	2.52
2018	4.08	4.08	3.71
2019	5.33	5.33	4.85
2020	7.00	6.83	6.29
2021	9.43	9.07	8.68
2022	11.95	11.34	11.04
2023	14.98	13.97	13.76
2024	18.43	17.13	16.91
2025	22.31	20.67	20.40
2026	26.50	24.57	24.20
2027	30.72	28.69	28.13
2028	34.91	32.99	32.20
2029	38.84	37.17	36.38
2030	42.41	41.14	40.35
2031	45.67	44.68	44.00
2032	48.54	47.89	47.33
2033	50.94	50.70	50.29
2034	53.07	53.07	52.84
2035	54.94	54.94	54.94
2036	56.55	56.55	56.55
2037	57.94	57.94	57.94
2038	59.11	59.11	59.11
2039	60.10	60.10	60.10
2040	60.93	60.93	60.93
2041	61.63	61.63	61.63
2042	62.21	62.21	62.21
2043	62.69	62.69	62.69
2044	63.09	63.09	63.09
2045	63.43	63.43	63.43
2046	63.71	63.71	63.71
2047	63.93	63.93	63.93
2048	64.12	64.12	64.12
2049	64.28	64.28	64.28
2050	64.40	64.40	64.40

EV uptake scenarios	EV vehicle price		
	High	Medium	Low
2009			
2010			
2011			
2012	0.24	0.24	0.24
2013	0.42	0.42	0.42
2014	0.74	0.74	0.74
2015	1.73	1.73	1.73
2016	1.97	1.97	1.97
2017	2.52	2.52	2.52
2018	3.41	4.08	4.46
2019	4.12	5.33	6.11
2020	5.02	6.83	8.36
2021	6.34	9.07	11.95
2022	7.70	11.34	15.58
2023	9.34	13.97	19.91
2024	11.24	17.13	24.93
2025	13.48	20.67	30.41
2026	15.94	24.57	36.12
2027	18.63	28.69	41.61
2028	21.52	32.99	46.81
2029	24.57	37.17	51.35
2030	27.69	41.14	55.05
2031	30.89	44.68	57.87
2032	34.11	47.89	60.01
2033	37.29	50.70	61.46
2034	40.38	53.07	62.49
2035	43.33	54.94	63.16
2036	46.08	56.55	63.66
2037	48.61	57.94	64.02
2038	50.91	59.11	64.29
2039	52.95	60.10	64.49
2040	54.76	60.93	64.63
2041	56.34	61.63	64.73
2042	57.70	62.21	64.81
2043	58.88	62.69	64.86
2044	59.88	63.09	64.90
2045	60.74	63.43	64.93
2046	61.46	63.71	64.95
2047	62.07	63.93	64.96
2048	62.57	64.12	64.97
2049	63.00	64.28	64.98
2050	63.35	64.40	64.98

B.22 United States

EV uptake scenarios			
	Petrol price		
	High	Medium	Low
2009			
2010			
2011			
2012	0.44	0.44	0.44
2013	0.75	0.75	0.75
2014	0.75	0.75	0.75
2015	0.89	0.89	0.89
2016	1.12	1.12	1.12
2017	1.42	1.42	1.42
2018	2.62	2.62	2.62
2019	2.44	2.39	1.85
2020	2.80	2.72	2.04
2021	3.33	3.10	2.42
2022	3.93	3.53	2.75
2023	4.85	4.24	3.47
2024	6.16	5.26	4.39
2025	7.86	6.64	5.61
2026	9.98	8.38	7.13
2027	12.51	10.50	8.94
2028	15.36	12.97	11.05
2029	18.53	15.77	13.45
2030	21.89	18.82	16.13
2031	25.40	22.09	19.07
2032	29.01	25.53	22.24
2033	32.64	29.08	25.58
2034	36.21	32.64	29.08
2035	39.69	36.21	32.64
2036	43.02	39.69	36.21
2037	46.13	43.02	39.69
2038	48.98	46.13	43.02
2039	51.54	48.98	46.13
2040	53.80	51.54	48.98
2041	55.76	53.80	51.54
2042	57.44	55.76	53.80
2043	58.85	57.44	55.76
2044	60.02	58.85	57.44
2045	61.00	60.02	58.85
2046	61.79	61.00	60.02
2047	62.44	61.79	61.00
2048	62.96	62.44	61.79
2049	63.38	62.96	62.44
2050	63.71	63.38	62.96

EV uptake scenarios			
	EV vehicle price		
	High	Medium	Low
2009			
2010			
2011			
2012	0.44	0.44	0.44
2013	0.75	0.75	0.75
2014	0.75	0.75	0.75
2015	0.89	0.89	0.89
2016	1.12	1.12	1.12
2017	1.42	1.42	1.42
2018	2.62	2.62	2.62
2019	1.85	2.39	2.48
2020	2.01	2.72	2.92
2021	2.27	3.10	3.68
2022	2.45	3.53	4.56
2023	2.91	4.24	5.84
2024	3.46	5.26	7.67
2025	4.21	6.64	10.03
2026	5.15	8.38	12.94
2027	6.31	10.50	16.29
2028	7.70	12.97	20.05
2029	9.39	15.77	23.98
2030	11.37	18.82	28.05
2031	13.65	22.09	32.06
2032	16.24	25.53	35.94
2033	19.11	29.08	39.60
2034	22.24	32.64	43.02
2035	25.58	36.21	46.13
2036	29.08	39.69	48.98
2037	32.64	43.02	51.54
2038	36.21	46.13	53.80
2039	39.69	48.98	55.76
2040	43.02	51.54	57.44
2041	46.13	53.80	58.85
2042	48.98	55.76	60.02
2043	51.54	57.44	61.00
2044	53.80	58.85	61.79
2045	55.76	60.02	62.44
2046	57.44	61.00	62.96
2047	58.85	61.79	63.38
2048	60.02	62.44	63.71
2049	61.00	62.96	63.98
2050	61.79	63.38	64.18

Abbreviations and terms

$	dollar
ACEA	European Automoblile Manufacturers Association
AEMO	Australian Energy Market Operator
APEC	Asia-Pacific Economic Cooperation
b	barrel
BEV	Battery Electric Vehicles
BITRE	Bureau of Infrastructure, Transport and Regional Economics
c	cents
CPI	Consumer Price Index
EAFO	European Alternative Fuels Observatory
EIA	Energy Information Agency
EV	Electric Vehicle (battery electric plus plug-in hybrid electric vehicles)
FFV	Fossil Fuel Vehicle
gal	gallon
GST	Goods and Services Tax
ICCT	International Council on Clean Transportation
IEA	International Energy Agency
IRF	International Road Federation
ITS UC Davis	Institute of Transport Studies, University of California, Davis
kWh	kilowatt hour
l	litre
OECD	Organisation for Economic Co-operation and Development
OPEC	Organisation of Petroleum Exporting Countries
PHEV	Plug-in Hybrid Electric Vehilces
regios	new vehicle registrations
SDRs	Special Drawing Rights
US	United States
VAT	Value Added Tax
WTI	West Texas Intermediate (oil)

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