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Transport Forecasts 2018

Results from Transport Scotland's Land-use and Transport Models

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Summary forecast

Transport Forecasts 2018 reports the transport forecasts generated by the Transport Model for Scotland (TMfS) and the Transport and Economic Land-use Model of Scotland (TELMoS).

The purpose of producing these forecasts is to provide a baseline of transport demand. This baseline then provides:

- a means to identify future needs for transport and land-use policies
- a point from which future transport and land-use policies can be assessed

The forecasts are not self-fulfilling; i.e. the exogenous assumptions and agreed interventions from which this baseline was developed will change. Thus, the baseline will change over time in response to changes in traveller behaviour, along with improvements in data and evidence. The assumptions in this baseline are summarised in chapter three. As these assumptions change over time in response to global, national, local and technological changes, the forecasts will be updated on a regular basis.

The principal purpose of the modelling suite used to create these forecasts is to test proposed transport interventions. The latest version of the models may incorporate further updates; thus, if you are using any aspect of this report for the appraisal of transport interventions, it is recommended that you contact the LATIS team.

Transport is a derived demand. It is a product of the numbers of people living and visiting Scotland and the travel they make to do activities in Scotland. This includes working, shopping, education, school, etc.

The population of Scotland is growing. The National Records of Scotland predict a population increase of about 6.5% in the next 20 years. We’re living in smaller households though, so the number of households grows by 12% and because we’re living longer, the proportion of the population which has retired grows so the number of people employed only grows by 4.2%.

All these people make trips and Table 1 summarises the primary road traffic forecasts. Starting in 2014, the following changes are forecast for 2037:

- an increase of 25% in person trips by car and a 44% increase in Goods Vehicle trips
- a 37% increase in vehicle miles
- vehicle travel times increase with the average travel time per mile rising from 1 minute 29 seconds to 1 minute 40 seconds

- the average delay in the PM peak, as a proxy measure for congestion, increases from just under half a minute per mile to nearly one minute per mile

Table 1: Summary of road traffic forecasts

Year	Car Trips (millions p.a.)	Goods Vehicle Trips (million p.a.)	Traffic (billion veh miles p.a.)	Journey Time (min/mile)	PM peak Delay (secs/ mile)
2014	1,830	388	20.4	1.49	29.3
2017	1,890	400	20.2	1.49	29.9
2022	1,990	434	23.8	1.51	33.8
2027	2,100	471	25.4	1.55	40.0
2032	2,190	514	26.9	1.61	47.8
2037	2,280	558	28.0	1.67	57.1

Source: TMfS14 – 2014 and 2017 numbers in table are modelled. Numbers may not add up due to rounding.

Table 2 summarises the primary public transport forecasts for a selection of years from 2014 to 2037.

- a slow decline in urban bus passenger miles of 7%
- a 5% decrease in inter-urban bus passenger miles
- a 42% increase in rail passenger miles

Table 2: Summary of public transport forecasts

Year	Urban Bus	Inter-Urban Bus	Rail
	Million Passenger Miles p.a.		
2014	236	1,320	2,400
2017	238	1,280	2,580
2022	233	1,280	2,840
2027	227	1,280	3,030
2032	223	1,250	3,220
2037	220	1,250	3,400

Source: TMfS14 – 2014 and 2017 numbers in table are modelled. Numbers may not add up due to rounding.

Table 3 summarises the primary land-use forecasts of land allocations and take-up for residential, and office and industry through to 2037.

- new allocations of land for residential development tail off beyond 2027, such that nearly all the allocation is taken up by 2037

- whilst allocations for office and Industry use follow a similar trend to residential, overall, the proportion of these allocations developed remains similar over the period

Table 3: Summary of land-use forecasts

Land-use Allocated / % Developed				
	Office and Industry		Residential	
Year	Allocation (million m^2)	Developed (%)	Allocation (million m^2)	Developed (%)
2017	5.8	0%	8.8	59%
2022	14.1	7%	24.8	65%
2027	16.8	9%	34.9	79%
2032	17.6	10%	40.4	89%
2037	17.4	10%	44.1	94%

Source: TMfS14 – 2014 and 2017 numbers in table are modelled. Numbers may not add up due to rounding.

There is uncertainty associated with the input assumptions to the primary forecast. Chapter four provides outputs from tests that have been undertaken to understand the sensitivity of the model to some of the more influential assumptions; population, economic growth, fuel prices and car ownership.

1 Introduction

Transport demand

Transport demand is the measure of both our travel behaviour and that of the goods we use. In general, we do not travel for the sake of it, but as a means to an end. In this regard, travel is a 'derived demand'.

Transport demand can be measured in a number of ways, such as the number of trips we make, the miles we travel or freight-tonnes moved. This demand is not fixed but responds to changes in population, economy, infrastructure, policy, etc.

Why does transport demand matter?

Transport demand is an indicator of economic growth. Whilst the provision of transport infrastructure does not generate, by itself, economic growth; a lack of transport infrastructure can hamper economic growth and impose economic welfare costs through travel delays.

Transport demand can also, dependent on the mode of travel used, generate a number of other negative effects such as climate change emissions, air quality problems and accidents.

Demand for transport[1]

In 2015, Scottish residents made 51% of journeys as a car driver. Thirteen per cent of journeys were made as a car passenger. Bus travel accounted for 10% and rail travel for 2%. Just over a fifth of journeys were by walking (22%) and cycling accounted for 1% of all journeys.

Most journeys tended to be over short distances, with 23% of all journeys being under 1 km long and a further 25% between 1 and 3 km. The mean journey distance in 2015 was 8.9 km.

Transport demand forecasting

Forecasting is making predictions about how much and how the way we travel will change in the future. At a personal level, one way of thinking about these changes is to break them down into five questions:

- Where am I starting from and going to? Where we start a journey from will change over time. The most obvious change is when we move home, but other changes can occur too. For example, if a new supermarket opens on our route to and from work, we may choose to go there on route. That also changes our destination as we now shop in a different location.

[1] Scottish Transport Statistics No 36: 2016 Edition

- How often will I travel? Will we make the journey more or less frequently or at all? New technologies provide new opportunities such as working from home, video-conferencing. New developments can also change our travel frequency: For example, if your nearest cinema is 20 miles away you may only visit once a month, but if a new cinema opens 5 minutes walk from your home, you may visit weekly.

- How will I get there? Do I walk, cycle, catch the bus, take the train, or drive the car? This choice is affected by where you are, where you're going and what's available. Do I have and can I ride a bicycle; is there secure cycle parking at my destination?

- What route shall I take? What options are there and what restrictions apply to my chosen mode of travel? I can't walk or cycle along the motorway; I can't take the car over the footbridge across the river into town. Is my choice of route affected by congestion or having to turn right at those difficult cross-roads?

- When do I set off? This final choice is influenced by my decisions on where I'm going, how I'm going to get there and the route I've picked. Do I need to get ready to be at my destination at a particular time (e.g. to get to work) or do I set off when I'm ready (e.g. when I've finished work)? How would this change if my employer introduces flexi-time working?

In the short-term some of these choices are not available; we don't move home or job on a whim. Over the longer-term (10+ years) though, a significant proportion of the population will have made such changes. For example, in the 2011 Census, 11.3% of the population reported they were living in a different location compared to 12 months previous[2].

Moving on from the personal choices we make about travel, there are a number of other factors which influence overall transport demand.

- Population. When there are more people, there is more travel.

- Economy. People in work, out of work, retired, in education, etc. each have different travel behaviours. The economy also affects the quantity of freight moved within, to and from the country. It also impacts on car ownership, which in turn is a significant influence on the personal travel choices described earlier.

- Fuel cost. This is a combination of the price of fuel and the efficiency with which that fuel is used.

[2] Census 2011: UKMIG008 Migration (people)

- Land-use and transport interventions. Planning authorities make changes to what land can be used for, e.g. housing, retail, business, etc. Transport authorities change the infrastructure on which we travel providing new roads, railways, etc.

These travel choices are wholly or partly represented in the Transport Scotland's Land-use And Transport Models, which are discussed in more detail later in the chapter.

Using and interpreting forecasts

The purpose of creating these transport forecasts is to provide a baseline against which future transport and land-use policies can be assessed. There are many influences on transport demand and one of the objectives of this report is to provide insight into the assumptions, relationships and limitations in the models.

Transport forecasts have limitations. A forecast is a calculation showing what happens if:

- External assumptions occur. For example, how population and the economy change.

- Relationships hold true. For example, car ownership and income, age and licence holding.

- Model assumptions remain valid. All models are simplified representations of reality.

There is uncertainty in all of these elements which cannot be eliminated. In addition, ours is a diverse country varying from dense urban settlements to sparse rural communities; the model must trade detail with practicality in providing timely forecasts.

Whilst this is the first publication of Scotland-specific transport forecasts, UK forecasts have been generated in a variety of forms for many years. Those forecasts have and continue to influence both national and local government policy along with personal behaviours and choices. As such, the forecasts are not expected to be 'self-fulfilling' in that, the process of creating these forecasts will bring about reactions which change the assumptions about the future on which the forecasts were first based.

It is intended to update these forecasts on a regular basis.

It is strongly recommended that interpretation of these forecasts for decision or policy making purposes is discussed with Transport Scotland's Strategic Transport Planning team[3].

Land use and transport modelling

Transport Scotland's national Land-use and Transport modelling capability comprises two main elements; the Transport and Economic Land-use Model of Scotland (TELMoS) and the Transport Model for Scotland (TMfS).

These models also feed data into a number of second tier transport models. More information on the whole suite of models can be found in Land-use And Transport Integration in Scotland (LATIS) service section of the Transport Scotland website.

Transport and Economic Land-use Model of Scotland (TELMoS)

The land-use model provides a view of future land-use and a representation of the interaction between the pattern of land-use and transport demand over time. The model has three major inputs:

- Census data and demographic forecasts
- Employment and macroeconomic forecasts
- Forecasts of land available for development based upon planning policy inputs supplied by local authorities

The land-use model, like the transport model, is incremental. It considers changes to the pattern of land-use which result from forecast changes to baseline population and employment, given the availability of land for development

The model has three main sub-models which inform one another:

- the economic model
- the urban model
- the migration model

The economic model forecasts the growth or decline for different sectors of economy at regional level. Its main concern is the distribution of economic activity. Two distinct processes are represented within this model - trade and investment. The primary outputs of the economic model are changes in employment by sector and sub-region.

[3] Contact the Strategic Transport Planning team

The urban model deals with the location of households and jobs within each area. The urban model estimates the rent values resulting from the competition for different kinds of property in each zone.

The migration model forecasts the pattern of migration of households between different sub-regions.

Transport Model for Scotland (TMfS)

The Transport Model for Scotland is a strategic transport model, which provides a broad representation of transport supply and estimates of transport demand. The version used for these forecasts is TMfS12 which has a base year of 2012. The model:

- Covers the whole mainland population
- Details the choices made by people on how, where, why and when they travel
- Covers the main land-based motorised modes of car, bus and rail for personal travel
- Links with an interactive land-use model (TELMoS), which provides a land-use transport interaction
- Is designed for broad option identification, ranking and scheme/policy appraisal
- Is a demand model which does not model the detailed operation of junctions or congestion
- Has a wide range of model outputs
- The development of the models is underpinned by an extensive bank of transport data

Land-use and transport interaction

Figure 1.1 illustrates the relationship between TELMoS and TMfS and the sub-model relationships within each of the two main models.

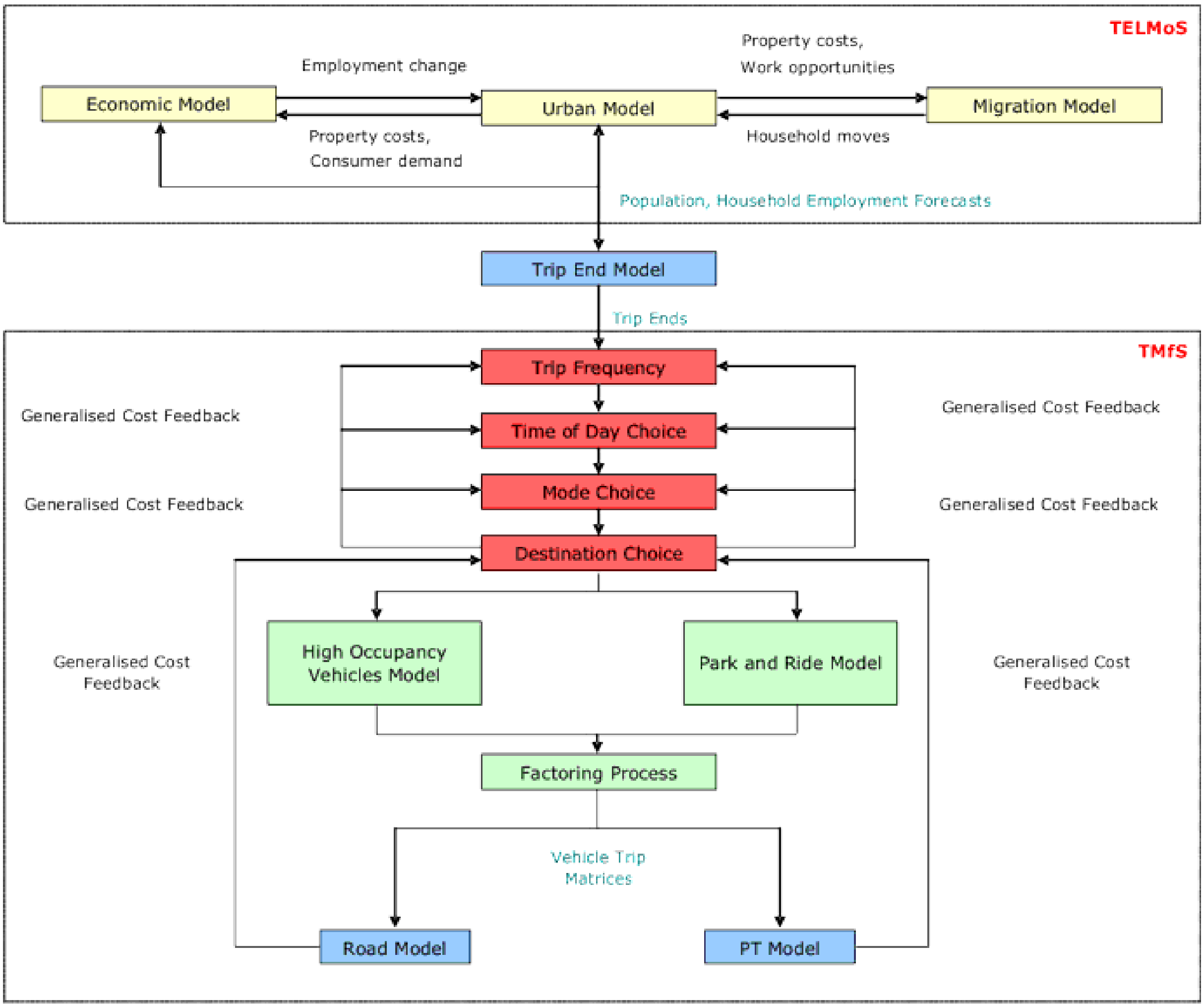

Figure 1.1: TELMoS and TMfS interaction

2 Transport and land-use forecasts

Overview

This chapter presents the primary TMfS forecasts of distance travelled, public transport patronage, travel time, and congestion and TELMoS forecasts of land-use.

The summary national results for the period 2014 to 2037, are a 37% increase in vehicle miles, and a 9% growth in public transport trips. The growth in road traffic, on a network which is already congested in part, leads to an even greater increase in congestion and travel time.

Forecast inputs and assumptions

The forecast inputs and assumptions are drawn from a range of sources as published at the commencement of this task. These are summarised in Table 2.1.

Table 2.1: Forecast inputs

Inputs	Source
Population and Households – 2012 mid-year projections	NRS
Modelling Guidance – November 2014	STAG and webTAG
Rail Fares 2015 onwards (Peak Fare change) - RPI p.a. 2015-2021 (Inter Peak Fare change) - RPI -1% p.a. 2022 onwards (Inter Peak Fare change) - RPI p.a.	Transport Scotland
Bus, Ferry and Subway – RPI p.a.	Transport Scotland
Car Parking Charges – RPI p.a.	Transport Scotland
Economic Scenario – Experian June 2015	Experian
Transport Interventions – see Appendix A	Transport Scotland

These inputs will change over time in response to global, national, local and technological developments.

Sitting alongside the inputs are a number of behavioural assumptions about individuals, society and those providing transport services. These include:

- Rates of trip making based on personal circumstances (e.g. household type, employment status, car ownership, area lived in, etc.) remain constant

- Rail services are subject to crowding but bus services are not
- There are no constraints on parking supply

Table 2.2 summarises the economic and demographic changes assumed in the model for a selection of years from 2014 to 2037.

Table 2.2: Assumed economic and demographic changes

Year	GVA (£billion[1])	Employment (million Jobs)	Population (millions)	Households (millions)
2014	121	2.54	5.35	2.41
2017	127	2.59	5.41	2.50
2022	141	2.61	5.52	2.59
2027	155	2.64	5.62	2.67
2032	171	2.67	5.70	2.74
2037	187	2.70	5.76	2.80

Source: TELMoS14 – 2014 and 2017 numbers in table are modelled. Numbers may not add up due to rounding.
[1] 2014 Values and Prices

Traffic forecasts

Table 2.3 summarises the primary road traffic forecasts. Starting in 2014, the following changes are forecast for 2037.

- An increase of 25% in person trips by car and a 44% increase in Goods Vehicle trips
- A 37% increase in vehicle miles
- Vehicle travel times increase with the average travel time per mile rising from 1 minute 29 seconds to 1 minute 40 seconds
- The average delay in the PM peak, as a proxy measure for congestion, increases from just under half a minute per mile to nearly one minute per mile

Table 2.3: Summary of road traffic forecasts

Year	Car Trips (millions p.a.)	Goods Vehicle Trips (million p.a.)	Traffic (billion veh miles p.a.)	Journey Time (min/mile)	PM peak Delay (secs/ mile)
2014	1,830	388	20.4	1.49	29.3
2017	1,890	400	20.2	1.49	29.9
2022	1,990	434	23.8	1.51	33.8
2027	2,100	471	25.4	1.55	40.0
2032	2,190	514	26.9	1.61	47.8
2037	2,280	558	28.0	1.67	57.1

Source: TMfS14 – 2014 and 2017 numbers in table are modelled. Numbers may not add up due to rounding.

It should be noted that modelled figures may differ from other reported values due to differences in definition, etc. The change in values over time is of more relevance (i.e. the relative difference) than the values themselves.

Public transport forecasts

Table 2.4 summarises the public transport forecasts for a selection of years from 2014 to 2037.

- A slow decline in urban bus passenger miles of 7%
- A 5% decrease in inter-urban bus passenger miles
- A 42% increase in rail passenger miles

Table 2.4: Summary of public transport forecasts

Year	Urban Bus	Inter-Urban Bus	Rail
Million Passenger Miles p.a.			
2014	236	1,320	2,400
2017	238	1,280	2,580
2022	233	1,280	2,840
2027	227	1,280	3,030
2032	223	1,250	3,220
2037	220	1,250	3,400

Source: TMfS14 – 2014 and 2017 numbers in table are modelled. Numbers may not add up due to rounding.

It should be noted that modelled figures may differ from other reported values due to differences in definition, etc. The change in values over time is of more relevance (i.e. the relative difference) than the values themselves.

The decline in bus passenger mileage results primarily from increasing car ownership. Rail demand continues to grow despite this as it is not affected by road congestion particularly for travel into the cities.

Land-use forecasts

Transport is a derived demand. It is a product of the numbers of people living and visiting Scotland and the travel they make to do activities in Scotland. This includes working, shopping, education, school, etc.

Hence, where people live and where the places they will go are important drivers of travel demand.

Table 2.5 summarises some of the forecasts of land-use by type and the proportions vacant and undeveloped for a selection of years from 2017 to 2037.

- Virtually all land allocated for housing is used. The small proportion of undeveloped housing land declines by 2037 as there is relatively little information on new housing allocations beyond 2027.

- At a Scotland level, there is a similar dearth of information on where land may be allocated in later years for commercial use, but given there is still a significant allocation vacant and undeveloped in these years, this still provides developers with options on where to develop.

Table 2.5: Summary of land-use forecasts

Land-use (billion m²)			
	2017	**2027**	**2037**
Residential	247	273	282
% Vacant	0.3%	0.6%	0.4%
% Undeveloped	1.5%	2.7%	0.9%
Office	16.6	23.7	24.6
% Vacant	2.0%	1.5%	1.6%
% Undeveloped	27%	47%	48%
Industry	18.3	22.1	21.8
% Vacant	4.8%	6.6%	9.6%
% Undeveloped	7.3%	18%	18%

Source: TELMoS14. 2017 numbers in table are modelled.

Alternative growth scenarios

Two alternative growth scenarios have been undertaken by varying some of the assumptions made about the future. More details on the creation of scenarios can be found in Appendix C which summarises an earlier project which investigated 7 alternatives.

Assumptions on future population, economic growth and fuel prices were combined to create 'High' and 'Low' alternative growth scenarios. The 'High' and 'Low' refer to the impact on road traffic demand. Table 2.6 summarises the assumptions made.

Table 2.6: Scenario assumptions

Change from 2014 to 2037			
Scenario	**Low**	**Primary**	**High**
Population	+3.8%	+7.6%	+12.3%
Economy	+38%	+54%	+73%
Fuel Price	+56%	+25%	-2%

Figure 2.1 compares the traffic growth for the three scenarios.

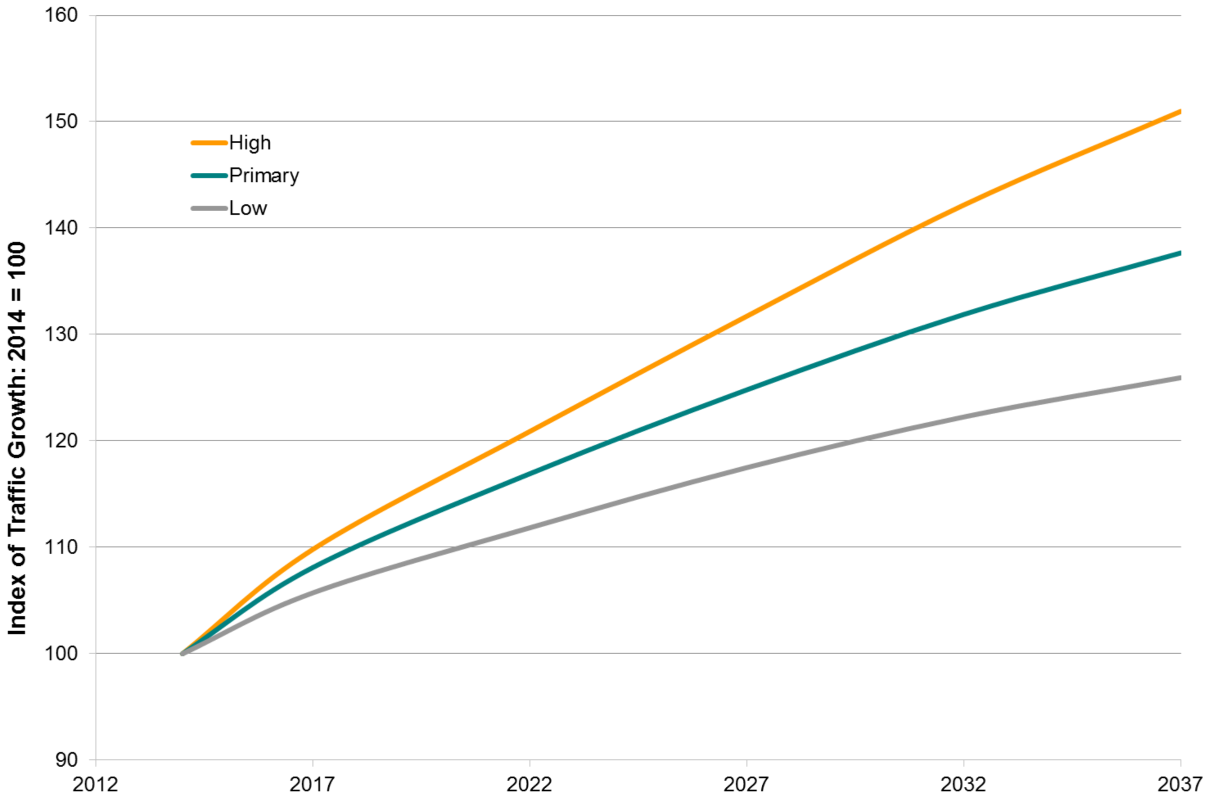

Figure 2.1: Alternative scenarios: index of growth in vehicle miles

Against a primary scenario forecast of a 37% increase in vehicle miles by 2037, the ‘high’ scenario is 51% and the ‘low’ scenario is 26%.

The strong growth in the first three years will be strongly influenced by the major road based schemes opening in 2017 including the M8 M73 M74 Improvements Scheme and the Aberdeen Western Peripheral Route (AWPR).

3 Forecasts by area

Traffic forecasts by area

This section presents results split into aggregations of Planning Authority areas:

- Each of the four Strategic Development Plan Areas (SDPA)
- Ayrshires
- Dumfries & Galloway
- Stirling, Clackmannanshire and Falkirk
- Highland, Moray, Argyll and Bute, and Islands

Table 3.1 presents the road traffic growth for these areas over the period 2014 to 2037 in five-year increments.

The areas with above average growth are: Aberdeen City and Shire; Glasgow & Clyde Valley SDPA; Stirling, Clackmannanshire & Falkirk.

Table 3.1: Regional road traffic forecasts

	Road Traffic (billion vehicle miles p.a.)			
Sub-National Area	**2014**	**2017**	**2027**	**2037**
SESplan	4.33	4.62	5.35	5.98
Aberdeen City and Shire	2.01	2.28	2.72	3.04
TAYplan	2.46	2.68	3.12	3.40
Glasgow & Clyde Valley SDPA	5.72	6.03	7.09	7.94
Ayrshires	1.33	1.40	1.55	1.66
Dumfries & Galloway	1.04	1.14	1.26	1.32
Stirling, Clackmannanshire & Falkirk	1.28	1.34	1.54	1.72
Highland, Argyll, Moray & Islands	2.20	2.52	2.81	3.00
Scotland	**20.4**	**22.0**	**25.4**	**28.0**

Source: TMfS14 – 2014 numbers in table are modelled. Numbers may not add up due to rounding.

These growth demand forecasts feed through into the road congestion forecasts in Table 3.2. Delay has been reported for the PM peak as this is where the highest level of delay is seen. The reduction in delay for Aberdeen City and Shire between 2014 and 2017 can be predominantly be attributed to the impact of the Aberdeen Western Peripheral Route (AWPR).

Table 3.2: Regional road congestion forecasts

PM Peak Road Delay (seconds/mile)				
Sub-National Area	**2014**	**2017**	**2027**	**2037**
SESplan	57.0	62.5	68.6	81.4
Aberdeen City and Shire	30.2	21.5	25.8	31.4
TAYplan	8.2	9.6	11.9	14.5
Glasgow & Clyde Valley SDPA	35.4	36.0	42.5	49.9
Ayrshires	12.6	13.3	13.8	15.7
Dumfries & Galloway	3.4	4.2	3.6	4.1
Stirling, Clackmannanshire & Falkirk	17.0	17.0	16.1	18.6
Highland, Argyll, Moray & Islands	6.2	7.9	8.7	9.8
Scotland	29.3	29.9	33.8	40.0

Source: TMfS14 – 2014 numbers in table are modelled. Numbers may not add up due to rounding.

The highest levels of congestion occur in the SESplan area and this area also sees the highest growth in congestion over the period 2014 to 2037.

Public transport forecasts by area

Bus passenger mileage forecasts are shown in Table 3.4.

Table 3.4: Regional bus passenger mileage forecasts

	Bus Passenger (million passenger miles p.a.)			
Sub-National Area	**2014**	**2017**	**2027**	**2037**
SESplan	451	427	445	449
Aberdeen City and Shire	158	156	159	166
TAYplan	180	171	163	159
Glasgow & Clyde Valley SDPA	467	464	442	414
Ayrshires	63	60	56	53
Dumfries & Galloway	54	57	57	56
Stirling, Clackmannanshire & Falkirk	58	57	53	52
Highland, Argyll, Moray & Islands	126	128	129	128
Scotland	1,560	1,520	1,500	1,480

Source: TMfS14 – 2014 numbers in table are modelled. Numbers may not add up due to rounding.

Generally a mixed picture but set against a continued long-term decline.

Rail passenger mileage forecasts are shown in Table 3.5.

Table 3.5: Regional rail passenger mileage forecasts

Sub-National Area	Rail Passenger (million passenger miles p.a.)			
	2014	2017	2027	2037
SESplan	602	663	783	899
Aberdeen City and Shire	92	102	126	141
TAYplan	251	272	313	342
Glasgow & Clyde Valley SDPA	829	882	1,040	1,181
Ayrshires	150	152	162	172
Dumfries & Galloway	172	175	198	213
Stirling, Clackmannanshire & Falkirk	146	160	214	251
Highland, Argyll, Moray & Islands	161	175	195	206
Scotland	2,400	2,580	3,030	3,410

Source: TMfS14 – 2014 numbers in table are modelled. Numbers may not add up due to rounding.

All areas show strong growth in rail passenger demand over the 23 year period of the forecasts.

Land-use forecasts by area

Regional forecasts of residential land with proportions of that which is either vacant or undeveloped are shown in Table 3.6.

Table 3.6: Regional residential land-use forecasts

Residential Land (million m^2) (% Vacant / Undeveloped)						
Sub-National Area	2017		2027		2037	
SESplan	54,700	1.5%	61,600	2.2%	63,100	0.4%
Aberdeen City and Shire	24,000	1.6%	27,700	1.1%	29,200	0.1%
TAYplan	24,700	2.1%	26,800	3.9%	27,500	2.0%
Glasgow & Clyde Valley SDPA	75,200	1.0%	81,500	2.5%	85,000	1.3%
Ayrshires	18,000	2.2%	19,600	5.1%	20,000	2.2%
Dumfries & Galloway	8,300	3.2%	9,100	7.5%	9,400	3.6%
Stirling, Clackmannanshire & Falkirk	13,800	2.4%	15,200	4.9%	15,800	1.3%
Highland, Argyll, Moray & Islands	28,100	3.2%	31,200	5.9%	32,200	2.4%

Source: TELMoS14. Numbers may not add up due to rounding.

Between 2017 and 2027 most areas show a growth in residential land supply which is greater than demand as demonstrated by an increase in the proportion of that which vacant or undeveloped. The exception is Aberdeen City and Shire which despite an increase in residential land supply still sees a drop in the proportion of that which is vacant or undeveloped.

There are few allocations of residential land beyond 2027, so the growth in residential land supply in the following ten years through to 2037 are much smaller than between 2017 and 2027. Nonetheless, the population is still forecast to grow over that period and thus the proportion of land remaining vacant or undeveloped drops in all areas.

Regional forecasts of office land with proportions of that which is either vacant or undeveloped are shown in Table 3.7.

Table 3.7: Regional office land-use forecasts

Office Land (million m^2) (% Vacant / Undeveloped)						
Sub-National Area	2017		2027		2037	
SESplan	6,100	40%	9,500	60%	10,100	57%
Aberdeen City and Shire	1,600	20%	2,200	36%	2,200	33%
TAYplan	1,100	16%	1,300	38%	1,300	47%
Glasgow & Clyde Valley SDPA	4,600	17%	5,600	28%	5,800	30%
Ayrshires	600	11%	700	29%	700	37%
Dumfries & Galloway	400	58%	1,200	75%	1,200	73%
Stirling, Clackmannanshire & Falkirk	1,100	47%	1,700	71%	1,800	72%
Highland, Argyll, Moray & Islands	1,100	21%	1,500	48%	1,600	55%

Source: TELMoS14. Numbers may not add up due to rounding.

The area of land available for office development increases in all areas from 2017 to 2027 and similar to residential land, much smaller or no growth in the following ten years through to 2037.

Between 2017 and 2027, there is a 3% overall increase in the total demand for office land across Scotland; this is repeated in the next ten years. However, the increase in supply between 2017 and 2027 is much greater than this in all areas, resulting in an increase in vacant or undeveloped office land everywhere.

Beyond 2027, strong demand for office land continues in SESplan but is much weaker elsewhere.

Regional forecasts of industry land with proportions of that which is either vacant or undeveloped are shown in Table 3.8.

Table 3.8: Regional industry land-use forecasts

Industry Land-use Allocated (million m^2) (% Vacant / Undeveloped)						
Sub-National Area	2017		2027		2037	
SESplan	4,100	19%	4,600	26%	4,500	28%
Aberdeen City and Shire	1,700	8%	2,900	32%	2,900	31%
TAYplan	1,500	7%	1,500	12%	1,400	19%
Glasgow & Clyde Valley SDPA	5,700	5%	6,000	9%	6,000	13%
Ayrshires	1,200	7%	1,200	14%	1,100	19%
Dumfries & Galloway	800	21%	1,100	38%	1,100	35%
Stirling, Clackmannanshire & Falkirk	1,500	26%	2,400	48%	2,400	50%
Highland, Argyll, Moray & Islands	1,900	13%	2,500	34%	2,600	43%

Source: TELMoS14. Numbers may not add up due to rounding.

The area of land available for industrial development either increases or remains constant in all areas from 2017 to 2027 and similar to office and residential land, much smaller or no growth and in some areas even a decline in the following ten years through to 2037.

Between 2017 and 2027, there is a 7% overall increase in the total demand for industrial land across Scotland; however, this is slightly revered in the next ten years with a 2% decline in demand. Similar to office, the increase in supply between 2017 and 2027 is much greater than demand in all areas, resulting in an increase in vacant or undeveloped industrial land everywhere.

Beyond 2027, there is a small increase in demand for industrial land in Aberdeen City and Shire but with either no change or a decline in demand elsewhere.

Scenario forecasts by area

Figure 3.1 shows the forecasts of the percentage of traffic growth in 2037 compared to 2014 by area.

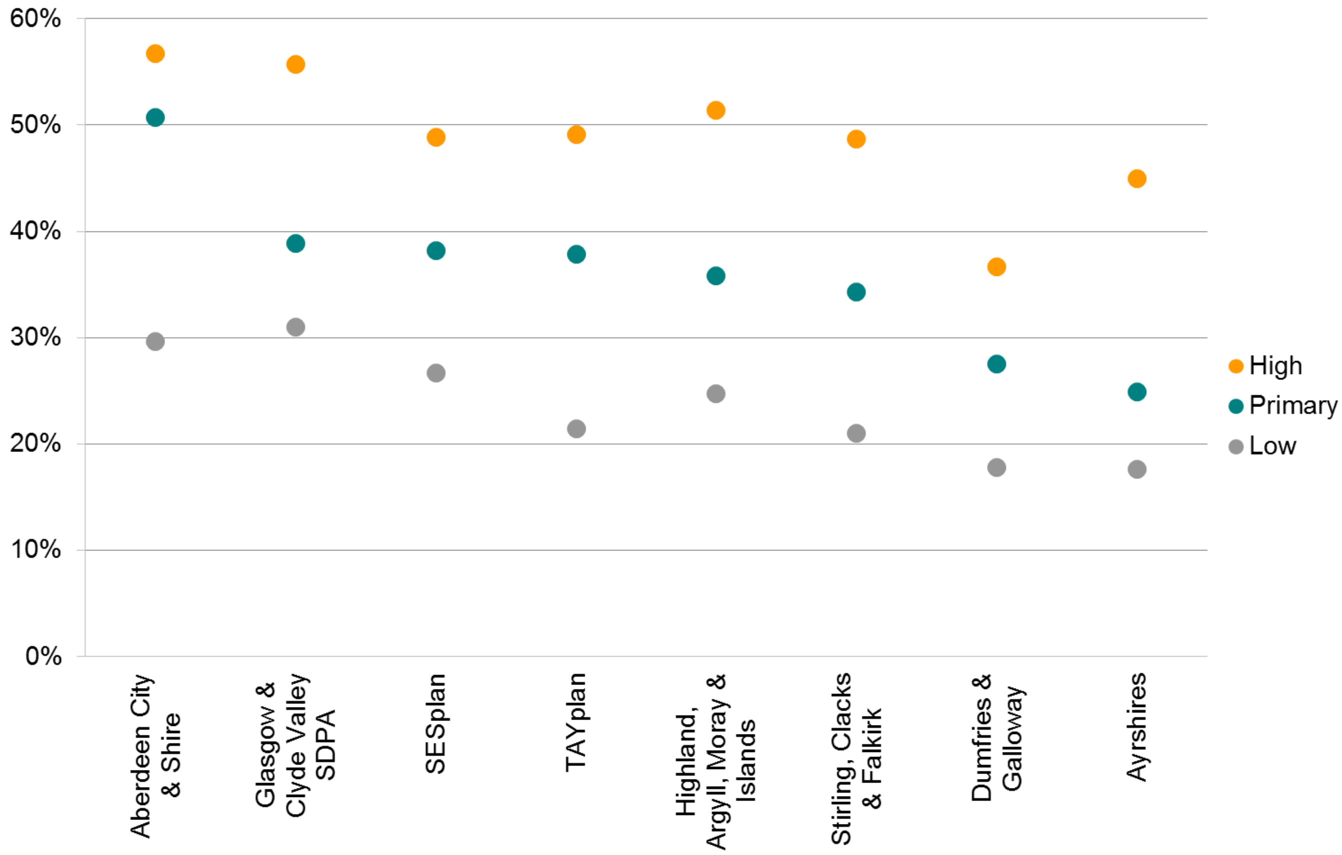

Figure 3.1: Regional growth rates by scenario 2014 to 2037

4 Next steps

Transport Forecasts 2018 sets out the baseline of what transport in Scotland will look like based on current travel behaviours and committed transport schemes. Sections 2.3 to 2.5 set out the 'primary forecast'.

Moving forward though, the NTS Review states: "The review of the NTS will set out an updated vision for what kind of transport system we want for the whole of Scotland over the next 20 years or so and how we plan to get there." The plan to get us to the "updated vision" will, in turn, depend on first knowing where we are heading without a plan (i.e. the Baseline).

As transport is a 'derived demand', the baseline is influenced by both interventions implemented by the transport sector and many external factors over which we have no control.

At the 2017 Modelling and Appraisal User Group attendees were invited to suggest factors which they believed will influence future transport demand over the next 20 years. Excluding duplicates, 168 factors were suggested.

Section 2.6 and Appendix C explored a number of alternative baseline scenarios based around variation to four drivers of transport demand. Individually exploring the impact of 168 factors is impractical, never mind when combinations of factors are considered.

In response to this problem, Transport Scotland are developing a scenario planning process.

Scenario planning

Scenario planning creates a range of futures. Some of these are illustrated in Figure 4.1.

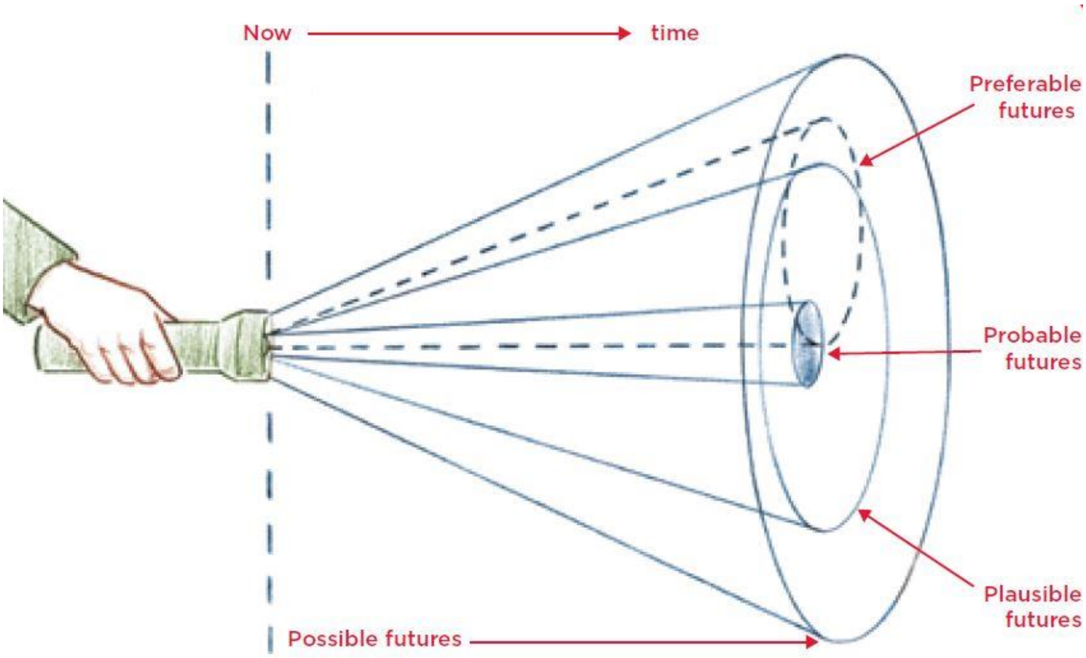

Figure 4.1: The futures cone

The primary forecast is the middle of the torch beam and represents what is considered to be the most *probable future* based on what we currently know.

Sitting around the *probable future* are the *plausible futures*. These encompass the range of futures which are based on current knowledge, systems and bounds of variation.

Finally, there are *possible futures*. These include futures which involve concepts which do not (yet) exist (e.g. teleportation) or are beyond the realms of expectation (e.g. population of Scotland doubles in 20 years).

It is envisaged that the scenario planning process will create, in addition to the *probable future* (primary forecast) about a dozen *plausible futures* using coherent combinations of those factors which will affect future transport demand.

Appendix A: Transport infrastructure assumptions

Table A1 describes the transport infrastructure assumed to be in place for each forecast year. Note that this is not the year of opening, it is the year in which the intervention appears in the models which are run in five year increments. These infrastructure assumptions are also consistent across all the sensitivity tests.

Table A1: Future year transport infrastructure assumptions (2014-2027)

Mode	Scheme / Intervention	Year
Road	Queensferry Crossing (Forth Replacement Crossing)	2017
Road	M8 Baillieston to Newhouse and Improvements at Raith Interchange.	2017
Road	Aberdeen Western Peripheral Route / Balmedie to Tipperty	2017
Road	A96 Inveramsay Bridge	2017
Road	A68 Pathhead to Tynehead Junction	2017
Road	A702 Candymill Bend and Edmonstone Brae	2017
Road	A95 Lackghie	2017
Road	A75 Dunragit Bypass	2017
Road	A75 Hardgrove to Kinmount	2017
Road	A82 Crianlarich Bypass	2017
Road	A82 Pulpit Rock	2017
Road	Glasgow East End Regeneration Route Phase 3	2017
Road	Portstown Link Road	2017
Road	Third Don Crossing	2017
Road	Soutra South to Oxton	2017
Road	Dundee Waterfront	2017
Road	Dyce Drive Link Road	2017
Road	Inverness West Link	2022
Road	Cross Tay Link Road	2022
Road	M8 J29a Bishopton Junction	2022
Road	M8 Winchburgh Junction	2027
Rail	Aberdeen – Inverness rail improvements package, including Dalcross Station & P&R site (STPR Intervention 19)	2017
Rail	Perth – Inverness rail improvements package (STPR Intervention 17)	2017
Rail	Edinburgh – Glasgow Improvements Programme (EGIP) (STPR Intervention 15)	2017
Rail	Carstairs rail line service improvements	2017
Rail	Glasgow – Paisley additional four services per hour, representing original GARL services that only extend to Paisley from Glasgow Central	2017

Appendix B: Land-use and transport models

Introduction to the models

Transport Scotland's national land-use and transport modelling capability comprises two main elements; the Transport and Economic Land-use Model of Scotland (TELMoS) and the Transport Model for Scotland (TMfS).

These models also feed data into a number of second tier transport models. More information on the whole suite of models can be found in Land-use And Transport Integration in Scotland (LATIS) section of the Transport Scotland website[4].

Transport and Economic Land-use Model of Scotland (TELMoS)

The land-use model provides a view of future land-use and a representation of the interaction between the pattern of land-use and transport demand over time. The model has three major inputs:

- Census data and demographic forecasts
- Employment and macroeconomic forecasts
- Forecasts of land available for development based upon planning policy inputs supplied by local authorities

The land-use model, like the transport model, is incremental. It considers changes to the pattern of land-use which result from forecast changes to baseline population and employment, given the availability of land for development.

The model has three main sub-models which inform one another:

- the economic model
- the urban model
- the migration model

The economic model forecasts the growth or decline for different sectors of economy at regional level. Its main concern is the distribution of economic activity. Two distinct processes are represented within this model – trade and investment. The primary outputs of the economic model are changes in employment by sector and sub-region.

[4] Land-use And Transport Integration in Scotland

The urban model deals with the location of households and jobs within each area. The urban model estimates the rent values resulting from the competition for different kinds of property in each zone.

The migration model forecasts the pattern of migration of households between different sub-regions.

Transport Model for Scotland (TMfS)

The Transport Model for Scotland is a strategic transport model, which provides a broad representation of transport supply and estimates of transport demand. The version used for these forecasts is TMfS14 which has a base year of 2014. The model:

- Covers the whole mainland population
- Details the choices made by people on how, where, why and when they travel.
- Covers the main land-based motorised modes of car, bus and rail for personal travel
- Links with an interactive land-use model (TELMoS), which provides a land-use transport interaction
- Is designed for broad option identification, ranking and scheme/policy appraisal
- Is a demand model which does not model the detailed operation of junctions or congestion
- Has a wide range of model outputs
- The development of the models is underpinned by an extensive bank of transport data.

Appendix C: Model sensitivity analysis

Development of alternative forecasts

There are many factors which can affect future transport demand. These can be broadly grouped as:

- Planned interventions [e.g. new infrastructure, policies, land allocations]
- External demand drivers [economy, fuel price, population]
- Paradigm shifts [future behaviour is different to current behaviour]

Planned interventions are generally taken account of as part of the development of a standard forecast where these are already input into the model.

At the 2012 Transport Scotland Modelling and Appraisal User Group a workshop was held to discuss what the attendees considered to be the most important factors in determining future transport demand. Fifteen different factors were proposed and ranked by the attendees for their significance and predictability. The two most significant factors were economy and fuel price and these were also ranked as the least predictable. Population was only ranked as the sixth most significant factor, but given the relatively straightforward relationship between population and travel demand and the availability of alternative population forecasts this was chosen along with economy and fuel price for the testing of alternatives forecasts. These are all examples of ‘external demand drivers’.

As the development of the alternative forecasts progressed a car ownership variation was also added to the list [this had been ranked twelfth at the user group] which is an example of a ‘paradigm shift driver’.

It is recognised that there are many other factors which affect traffic demand beyond these. Results from a Modelling and Appraisal User Group workshop are presented in Appendix D. As we continue to develop the models these may be taken into consideration in future alternative forecasts.

Details of changes to all the outputs in this report are available in the associated spreadsheet. This section focusses on a limited subset of indicators of vehicle miles and public transport trips.

The three parameters population, economy and fuel price have been tested incrementally with higher and lower variants to the primary forecast; that is adding each new parameter onto the previous alternative rather than testing each parameter individually. The fourth parameter, car ownership, was tested in isolation.

Population

The National Records of Scotland (NRS) produce biennial projections of Scotland's population[5]. Their principal projection for Scotland's population is used in the primary forecast of travel demand in the model. Over the period 2012 to 2037, there is a forecast increase in Scotland's population of about 10% (+ 548,000 people).

NRS also produce a number of variant population projections considering factors such as fertility, life expectancy and migration. For this study, the low and high migration variants were chosen as these would have a more immediate impact on travel demand compared to the fertility and life expectancy variants.

The high and low migration sensitivity tests have an increase in population over the period 2012 to 2037 of 14.5% (+766,000) and 4.4% (+232,000) respectively.

Population and economy

For the purposes of this testing, the high and low variants for economic growth were assumed to be concurrent with high and low variants of migration. Hence, high migration is more likely to happen in a stronger economy and low migration in a weaker economy.

The economy assumptions (see Table 3.1) were growth at 0.5% per annum more or less than the primary forecast. Thus the average GVA growth for the higher sensitivity test was 1.94% p.a. and for the lower sensitivity test was 0.94% p.a.

Population, economy and fuel price

Similar to the economy, for the purposes of this testing the low fuel price sensitivity was linked to higher economic growth and the high fuel price sensitivity to lower economic growth.

The low fuel price variant assumes that the resource and duty component costs of fuel remain constant in real terms and the VAT falls to 17.5%.

The high fuel price variant was derived by taking extrapolating a line of best fit applied to the resource and duty cost of fuel over the period 1979 to 2014 with an increase in VAT to 22.5%.

Note that the selection of VAT levels is purely to create what is considered to be a plausible variation in fuel costs and does not constitute any intention to change the rate of VAT on fuel by Transport Scotland or the Scottish Government.

[5] National Records of Scotland – Population Projections

Car ownership

The car ownership is a scenario run independent of the sensitivity tests and applied solely to the primary forecast.

The scenario applied constraints so that the total number of cars owned by households within the four local authority areas of Aberdeen, Dundee, Edinburgh and Glasgow remained constant over the forecast period.

Note that this scenario does not constitute any intention to curb car ownership in cities by Transport Scotland or the Scottish Government. It was undertaken in response to observations that car ownership could have reached or be close to reaching its peak in major conurbations even though there is little evidence of this happening yet in Scotland[6].

Results

As for the main forecasts, the effects of the sensitivity tests and the scenario test are reported against the same key parameters. More detailed tables are available in the associated spreadsheet with this report.

Summary

Table C.1 provides a summary of the same forecasts as used in chapter three showing the overall change between 2012 and 2037 for the primary forecast, six sensitivity tests and one alternative scenario.

[6] Census 2001 Table UV62 and Census 2011 Table KS404SC

Table C.1: Summary selected forecasts – change between 2012 and 2037

Change 2012 to 2037 Sensitivity Test / Scenario	Trips		Traffic (veh miles)
	Cars	GV	
Primary	+16%	+39%	+37%
Low Population	+12%	+39%	+34%
High Population	+18%	+39%	+39%
Low Population and Economy	+7%	+23%	+29%
High Population and Economy	+22%	+57%	+45%
Low Population, Economy and High Fuel	+7%	+23%	+24%
High Population, Economy and Low Fuel	+23%	+57%	+47%
Car Ownership	+9%	+39%	+35%

Change 2012 to 2037 Sensitivity Test / Scenario	Journey Time	PM peak Delay
Primary	+10%	+88%
Low Population	+10%	+83%
High Population	+11%	+91%
Low Population and Economy	+6%	+54%
High Population and Economy	+15%	+122%
Low Population, Economy and High Fuel	+7%	+56%
High Population, Economy and Low Fuel	+15%	+121%
Car Ownership	+7%	+67%

Change 2012 to 2037 Sensitivity Test / Scenario	Urban Bus	Inter-urban Bus	Rail
Primary	-7%	+5%	+42%
Low Population	-9%	+2%	+39%
High Population	-10%	+1%	+39%
Low Population and Economy	-3%	+9%	+40%
High Population and Economy	-9%	+3%	+46%
Low Population, Economy and High Fuel	-3%	+7%	+37%
High Population, Economy and Low Fuel	-18%	-5%	+26%
Car Ownership	+4%	+9%	+46%

Car and Goods Vehicle trip making

Figure C.4 indexes the growth in car-based trips over the range of sensitivity and scenario tests investigated.

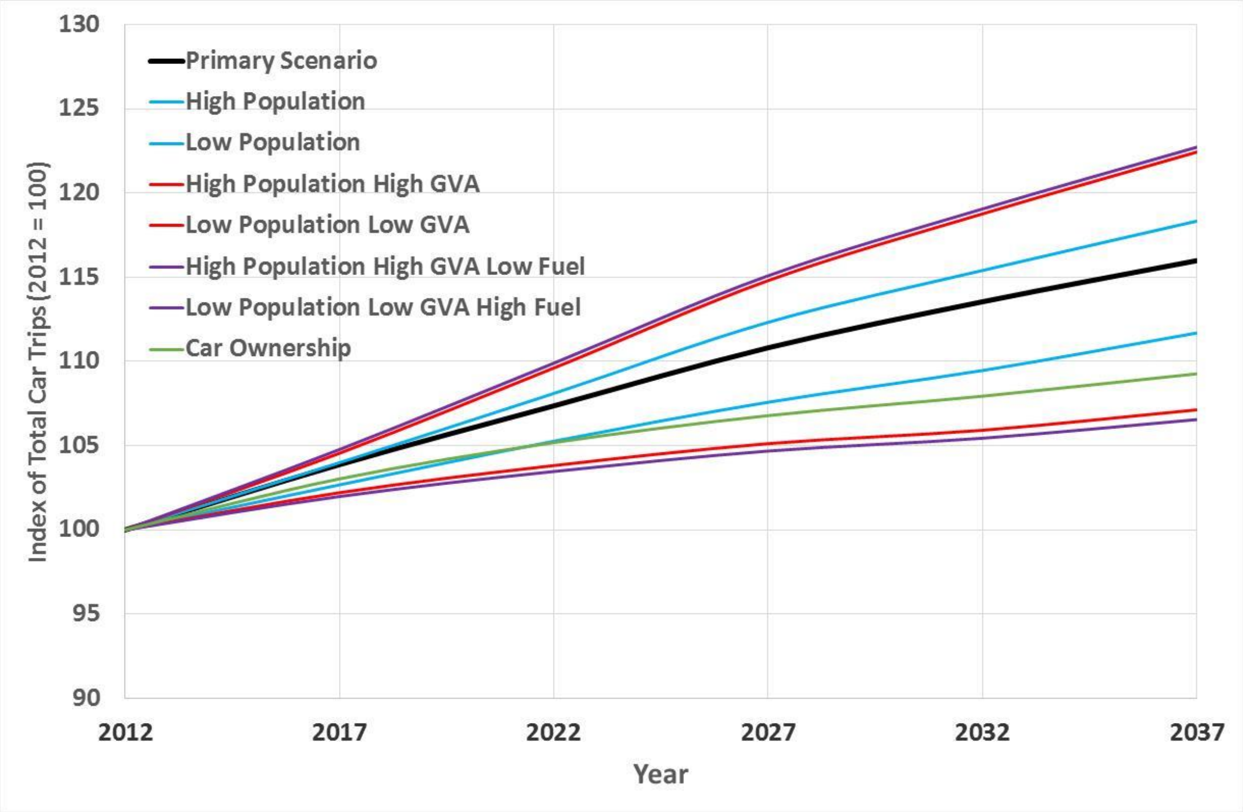

Figure C.4: Indexed growth in car-based trips

An obvious component of the change in car-based trips comes from the change in the number of people in Scotland. The primary forecast has a 10% increase in population and a 16% increase in car-based trips. The larger increase in car-based trips comes from an assumption that, over time, the proportion of households with access to a car (or multiple cars) also continues to rise so less car sharing and fewer PT travel trips. The reduction in trip making for the low population variant (+12%) is in line with 4% fewer people compared to the primary forecast. However, the increase in trip making for the high population variant (+18%) is lower than might be expected from a test with 4% more people compared to the primary scenario. This is because population growth is dominated by urban areas where increases in congestion favour shorter more PT trips. The car ownership scenario, where no increase in the number of cars in the four major cities is imposed, shows a growth in car-based trip making very similar to that of the general population growth.

Both economic variations are in line with expectations on creating stronger or weaker car ownership responses.

The fuel price variations have very little effect on car-based trip making as these have no impact on car ownership choice.

TMfS and TELMoS are primarily focussed on person travel. The change in the growth of goods traffic is treated relatively simplistically and is directly linked in the model to the economy. Population and fuel prices have no impact on goods vehicle miles but stronger or weaker economic growth is assumed to result in more or less goods respectively being moved around the country.

<u>Road travel distance and travel time</u>

Figures C.5 and C.6 index the growth in total road travel distance and road travel time respectively for Scotland over the range of sensitivity and scenario tests investigated.

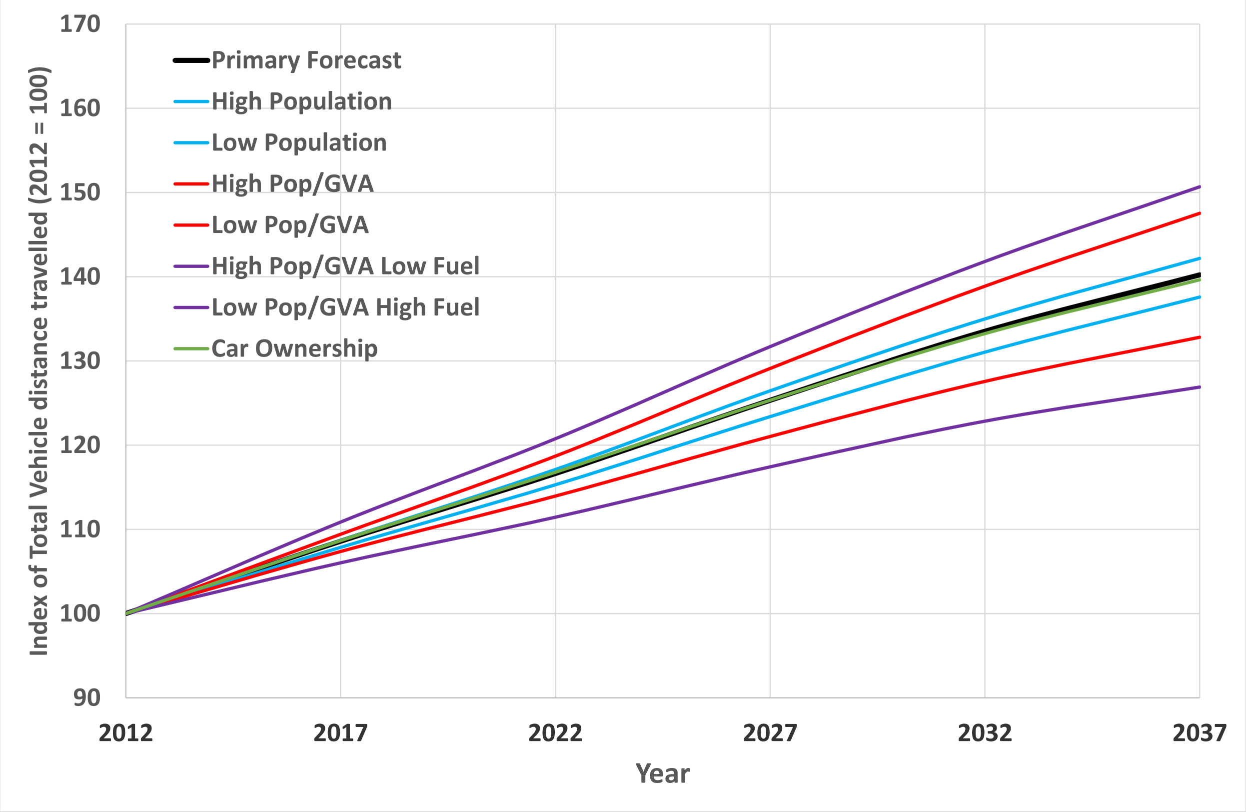

Figure C.5: Index of road travel distance growth

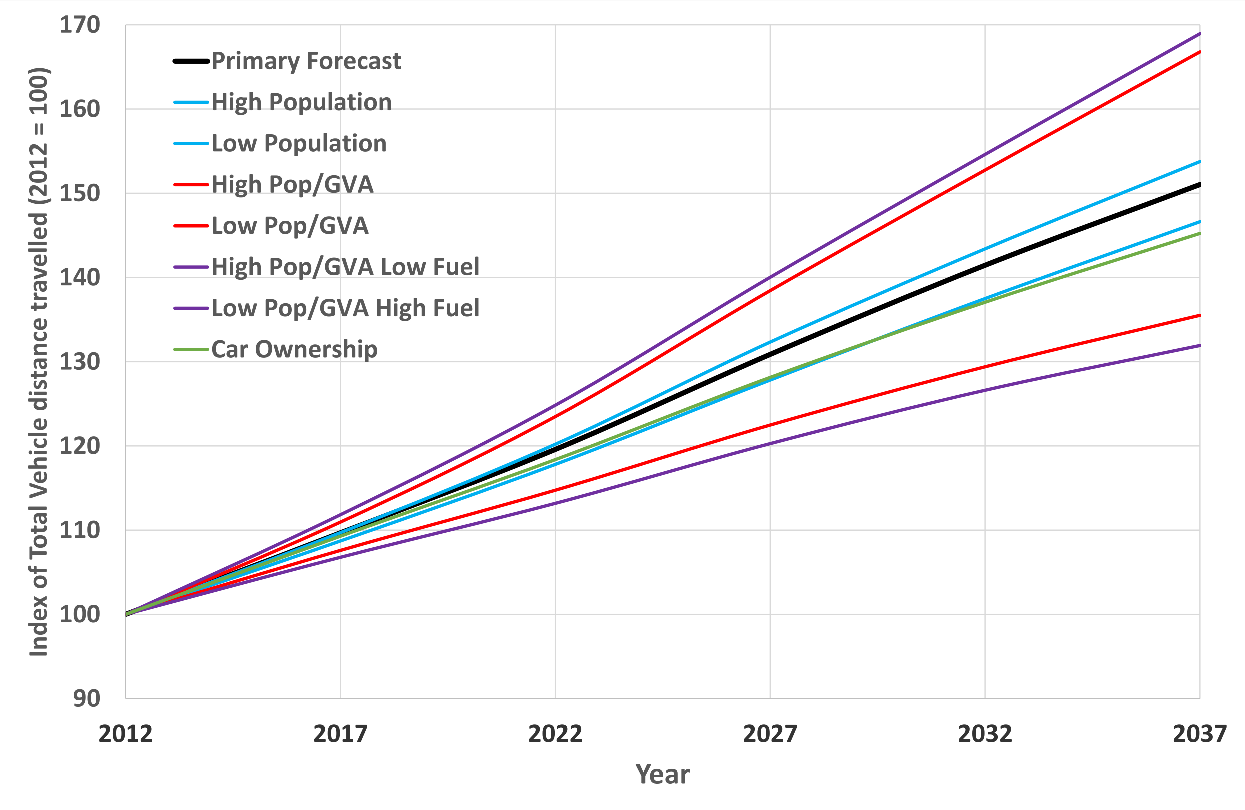

Figure C.6: Index of road travel time growth

Figures C.5 and C.6 illustrate how the different variations of population, economic growth and fuel prices complement each other. Higher population growth, more economic growth and lower fuel prices all lead to higher levels of road traffic and vice versa.

For each sensitivity test, the relative growth in travel time is greater than the relative growth in travel distance. This is because all the tests result in an increase in congestion.

However, the figures also illustrate some of the complexities of the relationship between vehicle miles and vehicle hours under different circumstances:

- The suppressed car ownership scenario shows very little difference in vehicle miles from the primary forecast (both +40% in 2037). However, the supressed car ownership shows lower growth in total vehicle hours compared to the primary forecast (+45% vs. +51%). This is because suppression of car ownership was only applied in the cities; whilst this resulted in only a very small reduction in vehicle miles, these trips are on the slowest and generally most congested roads thus it has a much greater impact travel time.

- The most sensitive response in growth in vehicle hours compared to vehicle miles was seen with the economic variants. This is because economic growth occurs where there is the greatest levels of existing economic activity which are the cities. These are where traffic speeds are lowest and congestion greatest.

- The least sensitive response in growth in vehicle hours compared to vehicle miles was seen with the fuel price variant. Whilst there is still a greater magnitude of growth in travel time than distance, a lower fuel price has a greater marginal effect in places with less congestion.

Considering the fuel price sensitivity results with that from the previous section on the number of car based trips illustrates that car drivers respond more to changes in fuel price by making shorter or longer trips rather than changing mode. This is as expected.

Appendix D: Modelling and appraisal user group - extract

Question 2

What order do you perceive the following to have in terms of significance of effect on future travel demand over the next 20 years (rank your four highest)?

Age profile of population
Car Ownership
Driving Licence Holding
Economy
Fares (Public Transport)
Freight Demand
Fuel Price (petrol, diesel and electricity)
Household size
Infrastructure (new roads / railways)
Land-use Planning Allocations and Policies
Parking Supply
Population
Technology (internet, laptops, etc.)
Vehicle Purchase Price and Maintenance
Weather
Other

Response

The responses received were averaged and ranked accordingly. The resulting average rank of perceived most significant effects on future travel demand is ordered as follows (1 being the most significant):

Rank	Ave.	Parameter
1	2.23	Economy
2	2.51	Fuel Price (petrol, diesel and electricity)
3	3.46	Technology (internet, laptops, etc.)
4	4.25	Population
5	4.34	Land-use Planning Allocations and Policies
6	4.38	Fares (Public Transport)
7	4.58	Age profile of population
8	4.63	Parking Supply
9	4.71	Car Ownership
10	4.72	Infrastructure (new roads / railways)
11	4.78	Driving Licence Holding
12	4.82	Vehicle Purchase Price and Maintenance
13	4.83	Freight Demand
=14	4.88	Household size
=14	4.88	Weather

Note: Some respondents continued to rank effects beyond their top four perceived most significant. For the purposes of this evaluation, those responses have been ignored beyond the top four.

Other answers

- Other: Wider culture and lifestyle change e.g. whether shared taxi use becomes trendy, use of personal travel services becomes normal
- Other: Employment
- Other: Media coverage - both social acceptability of car use & doomsday view of economy - people's individual behaviours change to match perceived economic necessity
- Other: Changing attitudes to personal/business spend and behaviour
- Other: Disposable income

Comments

- New energy sources for travel will be more important than all of this *(pointing to all fifteen parameters)*
- Interaction between many of these *(pointing to all fifteen parameters)*
- Economy - do I want to travel, fuel price - can I afford to travel, fares - cost of travel
- Fuel price and road pricing/fiscal structures
- Technology/work at home
- Population size/distribution
- Population: location shift west-east e.g.
- Population: change in distribution
- Freight demand/trade

Question 3

How do you perceive each of those chosen parameters in terms of predictability / stability (1 very predictable / stable to 5 very unpredictable / unstable)?

Age profile of population
Car Ownership
Driving Licence Holding
Economy
Fares (Public Transport)
Freight Demand
Fuel Price (petrol, diesel and electricity)
Household size
Land-use Planning Allocations and Policies
Infrastructure (new roads / railways)
Parking Supply
Population
Technology (internet, laptops, etc.)
Vehicle Purchase Price and Maintenance
Weather
Other

Response

The responses received were averaged and ranked accordingly. The resulting average rank of perceived predictability/stability of the fifteen identified parameters is ordered as follows (with 1 being the most predictable/stable):

Rank	Ave.	Parameter
15	4.03	*Economy*
14	3.83	*Fuel Price (petrol, diesel and electricity)*
13	3.82	*Weather*
12	3.50	*Technology (internet, laptops, etc.)*
11	3.01	*Fares (Public Transport)*
10	2.888	*Freight Demand*
9	2.887	*Land-use Planning Allocations and Policies*
8	2.62	*Vehicle Purchase Price and Maintenance*
7	2.62	*Parking Supply*
6	2.38	*Infrastructure (new roads / railways)*
5	2.37	*Driving Licence Holding*
4	2.31	*Car Ownership*
3	2.13	*Household size*
2	1.96	*Population*
1	1.66	*Age profile of population*

Note: Six respondents did not answer Question 3. Also, most respondents rated the perceived predictability/stability of all fifteen identified parameters rather than the four they had chosen earlier in Question 2. Therefore, in the above ranking, all responses have been taken into account.

Other answers

- Other: Migration

Comments

- Land-use planning allocations and policies - policies OK but actual build out?

The table below sets out the results from both Question 2 and 3 for comparison.

Significance *(see response to Question 2)* (1 is the most significant)	**Predictability/stability** (15 is the least predictable/stable)
1 Economy	**15** *Economy*
2 Fuel Price (petrol, diesel and electricity)	**14** *Fuel Price (petrol, diesel and electricity)*
3 Technology (internet, laptops, etc.)	**13** *Weather*
4 Population	**12** *Technology (internet, laptops, etc.)*
5 Land-use Planning Allocations and Policies	**11** *Fares (Public Transport)*
6 Fares (Public Transport)	**10** *Freight Demand*
7 Age profile of population	**9** *Land-use Planning Allocations and Policies*
8 Parking Supply	**8** *Vehicle Purchase Price and Maintenance*
9 Car Ownership	**7** *Parking Supply*
10 Infrastructure (new roads / railways)	**6** *Infrastructure (new roads / railways)*
11 Driving Licence Holding	**5** *Driving Licence Holding*
12 Vehicle Purchase Price and Maintenance	**4** *Car Ownership*
13 Freight Demand	**3** *Household size*
=14 Household size	**2** *Population*
=14 Weather	**1** *Age profile of population*

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