WP3 – Transport and Mobility Analysis

D.3.5. Transport Scenarios Results Report Nottingham

October 2015

314164 (ENER/FP7/314164)

Project acronym:

InSMART

Project full title:

Integrative Smart City Planning

Coordination and support action (Coordinating Action)

FP7-ENERGY-SMARTICITIES-2012

Start date of project: 2013-12-01

Duration: 3 years

Deliverable D3.5.

Transport Scenarios Results Report Nottingham

Work Package 3. Transport and Mobility Analysis

October 2015

Project co-funded by the European Commission within the Seventh Framework Programme		
Dissemination Level		
PU	Public	PU
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

Version	**Submitted by**	**Review Level***	**Date Submitted**	**Reviewed**
V01	SYSTRA	WPL	May 2015	May 2015
V02	SYSTRA	WPL	October 2015	October 2015

Editors		
	Name (organization)	**e-mail**
Leading participant	Matt Pollard (SYSTRA)	mpollard@systra.com
Contributing participants		
WP leader (WPL)	IRONS Duncan	dirons@systra.com

Executive Summary	
This report presents the results of the alternative scenarios of the transport model that has been developed in the framework of the INSMART project for the city of Nottingham.	
Keywords	Transport scenarios

InSmart – Integrative Smart City Planning

Reference number 102400




SCENARIOS REPORT - NOTTINGHAM

INSMART – INTEGRATIVE SMART CITY PLANNING

SCENARIOS REPORT - NOTTINGHAM

IDENTIFICATION TABLE	
Client/Project owner	European Commission
Project	InSmart – Integrative Smart City Planning
Study	Scenarios Report - Nottingham
Type of document	Report
Date	24/07/2015
File name	InSmart_ScenarioRunsReport_Nottingham_v1_20157620.docx
Reference number	102400
Number of pages	42

APPROVAL

Version	Name		Position	Date	Modifications
1	Author	Matt Pollard Greg Webster	Senior Consultant Consultant		
	Checked by	Duncan Irons	Project Director		
	Approved by			DD/MM/YY	
2	Author			DD/MM/YY	
	Checked by			DD/MM/YY	
	Approved by			DD/MM/YY	

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

IMAGE ATTRIBUTION

Top Left
Image: https://commons.wikimedia.org/wiki/File:Nottingham_railway_station.jpg
Attribution: David Ingham

Top Right
Image: https://commons.wikimedia.org/wiki/File:Ruddington_bus_at_Fletcher_Gate_-_geograph.org.uk_-_2478047.jpg
Attribution: John Sutton

Bottom Left:
Image: https://commons.wikimedia.org/wiki/File:RiverTrentNottingham.jpg
Attribution: Insignia3

Bottom Right
Image: https://commons.wikimedia.org/wiki/File:Nottingham_Castle_-_Nottingham_-_England_-_2004-11-04.jpg?uselang=en-gb
Attribution: Million_Moments

1. INTRODUCTION

1.1 Project Overview

1.1.1 InSmart is a three year, European funded project which involves four European Cities working in partnership towards a sustainable energy future. The primary objective of the project is to develop sustainable energy action plans for each partner city.

1.1.2 The four cities are;

- Cesena, Italy;
- Evora, Portugal;
- Nottingham, UK; and
- Trikala, Greece.

1.1.3 A mix of sustainable energy measures to improve the energy efficiency of each city will be identified through the use of a variety of tools and approaches. This will cover a wide range of sectors from the residential and transport sectors, to street lighting and waste collection.

1.1.4 SYSTRA's role within the project is to identify, test and report on a series of land use and transport based strategies aimed at reducing the transport-related energy usage and carbon generation of each city.

1.1.5 The initial task of calculating the current energy usage and carbon emissions generated by each city is recorded in the Base Model Reports for each city. The impact of the forecast strategies has then be obtained by comparing with the Do Nothing scenario which is the Base case forecast into the future with no schemes implemented.

1.2 Report Structure

1.2.1 This report is split into three sections

- Test Comparisons – Covering all scenarios;
- Future Year Base and Do Nothing Scenarios; and
- Individual Scenario Tests – Details of the specified future year scenarios

2. TEST COMPARISONS

2.1 Introduction

2.1.1 This report covers the city of Nottingham in the English county of Nottinghamshire, with the following scenarios being run.

- **Future Base**: change in vehicle fleet splits over time only;
- **Do Nothing:** change in population
- **Electric Buses;** Converting the entire city bus fleet to electric vehicles;
- **Parking Charges;** Parking charges in the city centre doubled;
- **NET Phase 2;** Extending the tram network to include the two new lines from the City Centre to Clifton and Beeston;
- **Southern Corridor**; Bus priority measures;
- **LSTF (Local Sustainable Transport Fund);** – Behavioural Change, Travel Plans and Homeworking; and
- **Nottingham – Derby Train Improvement;** Journey time reduced by 10 minutes.

2.1.2 A more detailed description of each scenario, along with information on model inputs and assumptions is given in later chapters. The purpose of this chapter is to provide a summary of all the tests run for easy comparison.

2.1.3 Figure 1 shows the total energy usage for all scenarios that have been run for Nottingham, compared to the Base Year, Future Base and Do Nothing scenarios.

2.1.4 It can be seen that the largest change in energy usage is between the Future Base and the Base. This represents the vehicle type splits changing over time, as people buy newer and more efficient vehicles. By 2030 this accounts for a 14% reduction in energy usage.

2.1.5 The Do Nothing scenario includes changes in population. Regional figures were used for Nottingham and forecasts predict a 2% increase in population by 2020 and a 9% increase by 2030. This leads to the 14% reduction seen in the Future Base being reduced to less than 3% in the Do Nothing, by 2030.

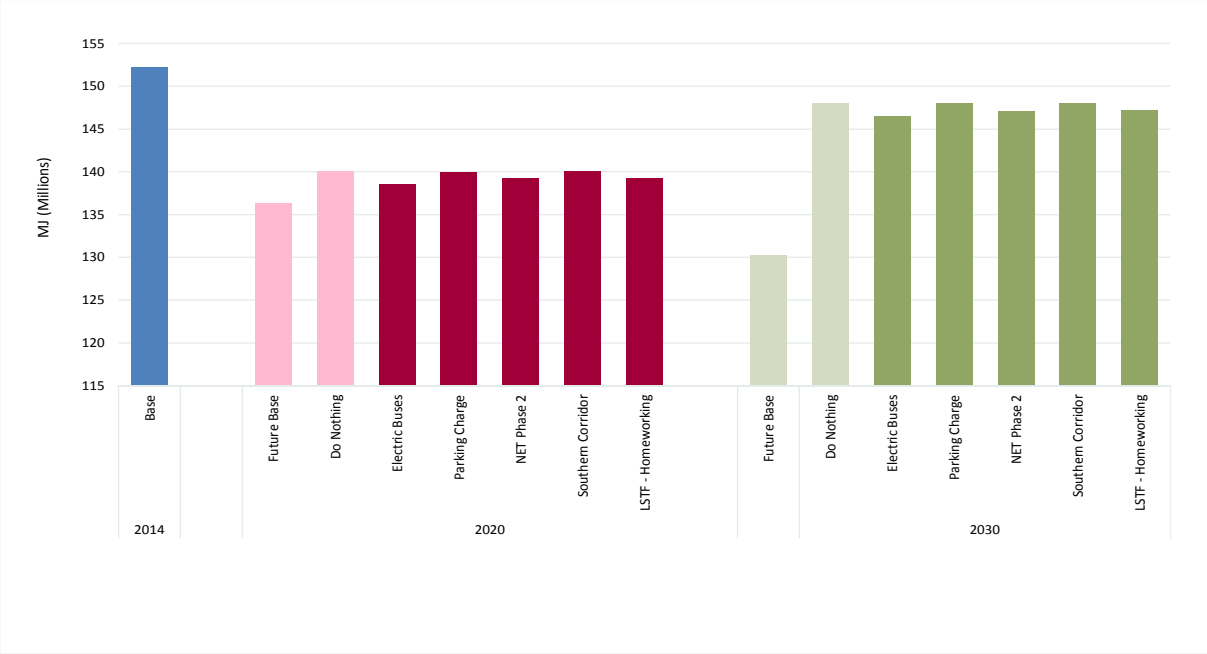


Figure 1. Total energy usage by scenario

2.1.6 Figure 2 shows the difference between each scenario and the Do Nothing scenario. It can be seen that all scenarios, except two lead to a reduction in the city-wide energy usage. However, the largest reduction is just over 1% from the Electric Buses scenario.

2.1.7 The Southern Corridor bus priority scenario shows a very small reduction in energy usage, but the speed increases from the package are not significant enough to lead to a large change in mode share. The reduction in journey time on the train between Nottingham and Derby has almost no impact as the majority of public transport demand to the external zone uses the bus. This is due to inconsistencies between bus and rail fares to the external zone.

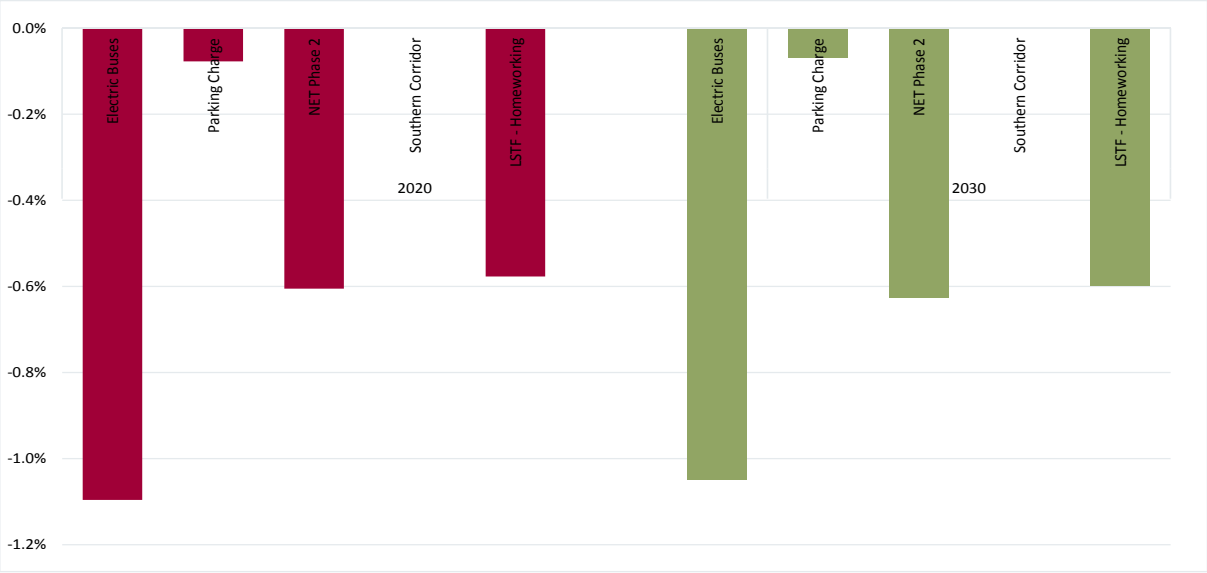


Figure 2. Change from Do Nothing scenario for each test

2.1.8 Table 1 shows a breakdown of the total energy usage by scenario.

Table 1. **Energy usage by scenario**

SCENARIO	ENERGY (MJ)			CHANGE FROM BASE YEAR	
	2014	2020	2030	2020	2030
Base Year	152,225,519				
Future Base		136,299,259	130,249,917	90%	86%
Do Nothing		140,097,931	148,099,117	92%	97%
Electric Buses		138,562,650	146,546,889	91%	96%
Parking Charge		139,988,865	147,996,276	92%	97%
NET Phase 2		139,249,639	147,172,451	91%	97%
Southern Corridor		140,095,061	148,095,524	92%	97%
LSTF		139,289,256	147,214,736	92%	97%
Notts-Derby JT Reduction		140,097,931	148,099,117	92%	97%

2.1.9 Table 2 and **Error! Reference source not found.** show the change in energy usage by vehicle type for the different scenarios for 2020 and 2030. The changes are shown as percentage changes from the Do Nothing scenarios.

2.1.10 Overall, the changes are small, with the largest being the reduction in energy use by replacing all the buses with electric ones. However, as buses represent only 1% of the total vehicles in the city the overall effect is small.

Table 2. **Energy Usage by Vehicle Type (2020)**

Vehicle Type	DoNothing	Electric Buses	Parking Charge	NET Phase 2	Southern Corridor	LSTF - Homeworking
Energy (MJ)						
Total	140,097,931	-1%	0%	-1%	0%	-1%
Cars	108,636,454	0%	0%	-1%	0%	-1%
Bikes	4,779,344	0%	0%	-1%	0%	-1%
Goods	24,692,822	0%	0%	0%	0%	0%
Buses	1,637,768	-94%	0%	0%	0%	0%
Trams	-	0%	0%	0%	0%	0%
Trains	351,543	0%	0%	0%	0%	0%
Vehicles						
Total	827,396	0%	0%	0%	0%	0%
Cars	726,612	0%	0%	0%	0%	0%
Bikes	45,002	0%	0%	0%	0%	0%
Goods	46,976	0%	0%	0%	0%	0%
Buses	8,398	0%	0%	0%	0%	0%
Trams	408	0%	0%	33%	0%	0%
Trains	495	0%	0%	0%	0%	0%
Energy / Vehicle (MJ)						
Total	169	-1%	0%	-1%	0%	-1%
Cars	150	0%	0%	-1%	0%	-1%
Bikes	106	0%	0%	-1%	0%	-1%
Goods	526	0%	0%	0%	0%	0%
Buses	195	-94%	0%	0%	0%	0%
Trams		0%	0%	0%	0%	0%
Trains	710	0%	0%	0%	0%	0%

Table 3. **Energy Usage by Vehicle Type (2020)**

Vehicle Type	DoNothing	Electric Buses	Parking Charge	NET Phase 2	Southern Corridor	LSTF - Homeworking
Energy (MJ)						
Total	148,099,117	-1%	0%	-1%	0%	-1%
Cars	109,037,069	0%	0%	-1%	0%	-1%
Bikes	5,070,980	0%	0%	-1%	0%	-1%
Goods	31,984,810	0%	0%	0%	0%	0%
Buses	1,654,716	-94%	0%	0%	0%	0%
Trams	-	0%	0%	0%	0%	0%
Trains	351,543	0%	0%	0%	0%	0%
Vehicles						
Total	891,676	0%	0%	0%	0%	0%
Cars	773,587	0%	0%	0%	0%	0%
Bikes	48,157	0%	0%	0%	0%	0%
Goods	61,126	0%	0%	0%	0%	0%
Buses	8,398	0%	0%	0%	0%	0%
Trams	408	0%	0%	33%	0%	0%
Trains	495	0%	0%	0%	0%	0%
Energy / Vehicle (MJ)						
Total	166	-1%	0%	-1%	0%	-1%
Cars	141	0%	0%	-1%	0%	-1%
Bikes	105	0%	0%	-1%	0%	-1%
Goods	523	0%	0%	0%	0%	0%
Buses	197	-94%	0%	0%	0%	0%
Trams	-	0%	0%	0%	0%	0%
Trains	710	0%	0%	0%	0%	0%

2.1.11 Table 4 and Table 5 show the change in energy usage by zone for all of the different scenarios for 2020 and 2030.

2.1.12 For all scenarios the changes are where we would expect them to be

- Electric Buses – public transport energy use is attributed to the zone that the route starts. In Nottingham most bus routes start from the centre of the city in

zone 1 and this zone shows the largest decrease. The reductions in the other zones reflect the distribution of routes throughout the city.

- Parking Charges – there are small decreases throughout the city as people redistribute away from the city centre, and to shorter trips, to avoid the increased parking charge.
- NET Phase 2 – this test shows reductions in energy use from the zones along the new route alignments and are driven by the switch from highway to the new tram service.
- LSTF – Zones 1 to 9 are impacted by this scenario and the changes in energy reflect this.
- The other two scenarios show very little to no change as discussed above.

Table 4. **Energy usage by zone for 2020 scenarios**

Zone	DoNothing	Electric Buses	Parking Charge	NET Phase 2	Southern Corridor	LSTF - Homeworking
Total	140,097,931	-1.1%	-0.1%	-0.6%	0.0%	-0.6%
1 - City Centre	10,135,338	-7.2%	-0.7%	-0.4%	0.0%	-2.9%
2 - Clifton	3,520,356	-1.7%	-0.1%	-2.8%	0.0%	-2.2%
3 - The Meadows	1,385,111	0.0%	0.0%	-0.3%	0.0%	-1.4%
4 - Colwick Park	971,358	-0.8%	0.0%	-0.2%	0.0%	-2.3%
5 - St Ann's	1,919,738	-0.6%	-0.1%	-0.1%	0.0%	-2.0%
6 - Bestwood	1,773,002	-2.0%	-0.1%	-0.1%	0.0%	-2.6%
7 - Bulwell	2,532,077	-1.9%	-0.1%	-1.9%	0.0%	-1.1%
8 - Wollaton Park	2,253,792	-0.9%	0.0%	-3.4%	0.0%	-1.0%
9 - Aspley	2,028,756	-0.6%	0.0%	-0.1%	0.0%	0.0%
10 - West Bridgford & South	28,335,768	-0.3%	0.3%	0.0%	0.0%	0.0%
11 - Hucknall & North	10,994,994	-0.1%	-0.4%	-0.7%	0.0%	0.0%
12 - Beeston & Kimberley	14,314,460	-0.3%	-0.1%	-1.6%	0.0%	0.0%
13 - Ilkeston & Long Eaton	9,470,668	-0.6%	-0.3%	-0.2%	0.0%	0.0%
14 - Arnold & East	16,697,955	-1.0%	-0.1%	0.0%	0.0%	0.0%
15 - External	33,764,557	-0.8%	0.0%	-0.7%	0.0%	-0.8%

Table 5. **Energy usage by zone for 2030 scenarios**

Zone	DoNothing	Electric Buses	Parking Charge	NET Phase 2	Southern Corridor	LSTF - Homeworking
Total	148,099,117	-1%	0%	-1%	0%	-1%
1 - City Centre	12,420,625	-6%	0%	0%	0%	-3%
2 - Clifton	3,801,773	-2%	0%	-3%	0%	-2%
3 - The Meadows	1,572,437	0%	0%	0%	0%	-1%
4 - Colwick Park	1,057,404	-1%	0%	0%	0%	-2%
5 - St Ann's	2,083,218	-1%	0%	0%	0%	-2%
6 - Bestwood	1,864,238	-2%	0%	0%	0%	-3%
7 - Bulwell	2,704,026	-2%	0%	-2%	0%	-1%
8 - Wollaton Park	2,419,700	-1%	0%	-4%	0%	-1%
9 - Aspley	2,134,920	-1%	0%	0%	0%	0%
10 - West Bridgford & South	28,413,827	0%	0%	0%	0%	0%
11 - Hucknall & North	10,858,347	0%	-1%	-1%	0%	0%
12 - Beeston & Kimberley	14,899,238	0%	0%	-2%	0%	0%
13 - Ilkeston & Long Eaton	9,849,392	-1%	0%	0%	0%	0%
14 - Arnold & East	17,898,521	-1%	0%	0%	0%	0%
15 - External	36,121,453	-1%	0%	-1%	0%	-1%

2.1.13 For each of the 2020 scenarios Table 6 shows the change in demand and mode share, Table 7 shows the change in average occupancy on buses, trams and trains and Table 8 shows the change in vehicle kilometres and average distance. Table 9 to Table 11 show the same information for 2030.

2.1.14 The scenarios cause different changes to private vehicle and public transport use, for example the NET Phase 2 scenario changes public transport occupancy considerably, with demand transferring from both car and the other public transport modes.

2.1.15 None of the scenarios seem to have a large impact on overall vehicle distance and average trip lengths.

Table 6. **Demand by Vehicle Class (2020)**

Zone	DoNothing	Electric Buses	Parking Charge	NET Phase 2	Southern Corridor	LSTF - Homeworking
Demand By Mode						
Highway	3,397,176	3,397,176	3,396,266	3,367,670	3,397,064	3,363,675
Public Transport	454,990	454,990	455,784	480,764	455,087	460,843
Mode Share						
Highway	88.2%	88.2%	88.2%	87.5%	88.2%	88.0%
Public Transport	11.8%	11.8%	11.8%	12.5%	11.8%	12.0%
Change in Highway Demand		-	- 910	- 29,505	- 112	- 33,501
Change in PT		-	795	25,775	98	5,853

Table 7. **Average Public Transport Occupancy (2020)**

Zone	DoNothing	Electric Buses	Parking Charge	NET Phase 2	Southern Corridor	LSTF - Homeworking
Total	54.2	54.2	54.3	58.3	54.2	54.9
Buses	48.0	48.0	48.1	39.3	48.1	48.7
Trams	117.7	117.7	117.8	348.6	117.3	119.2
Trains	107.2	107.2	107.9	60.9	106.8	107.2
%Change in Occupancy						
Total		0.0%	0.2%	7.5%	0.0%	1.4%
Buses		0.0%	0.2%	-18.1%	0.1%	1.5%
Trams		0.0%	0.1%	196.2%	-0.3%	1.3%
Trains		0.0%	0.7%	-43.2%	-0.4%	0.0%

Table 8. **Vehicle Kms & Average Distance (2020)**

Distance	DoNothing	Electric Buses	Parking Charge	NET Phase 2	Southern Corridor	LSTF - Homeworking
Vehicle KM						
Total	46,915,485	0.0%	-0.1%	-0.7%	0.0%	-0.8%
Cars	40,133,610	0.0%	-0.1%	-0.8%	0.0%	-0.9%
Bikes	2,469,902	0.0%	-0.1%	-0.8%	0.0%	-0.9%
Goods	4,311,973	0.0%	0.0%	0.0%	0.0%	0.0%
Average Distance KM						
Total	17.92	0.0%	-0.1%	0.1%	0.0%	0.1%
Cars	17.71	0.0%	-0.1%	0.1%	0.0%	0.1%
Bikes	17.60	0.0%	-0.1%	0.1%	0.0%	0.1%
Goods	20.40	0.0%	0.0%	0.0%	0.0%	0.0%

Table 9. **Demand by Vehicle Class (2030)**

Zone	DoNothing	Electric Buses	Parking Charge	NET Phase 2	Southern Corridor	LSTF - Homeworking
Demand By Mode						
Highway	3,648,952	3,648,952	3,646,281	3,614,601	3,648,806	3,610,549
Public Transport	517,241	517,241	519,574	547,249	517,369	523,950
Mode Share						
Highway	88%	88%	88%	87%	88%	87%
Public Transport	12%	12%	12%	13%	12%	13%
Change in Highway Demand		-	- 2,671	- 34,351	- 146	- 38,403
Change in PT		-	2,333	30,008	128	6,710

Table 10. **Average Public Transport Occupancy (2030)**

Zone	DoNothing	Electric Buses	Parking Charge	NET Phase 2	Southern Corridor	LSTF - Homeworking
Total	61.5	61.5	61.8	66.4	61.5	62.3
Buses	53.8	53.8	54.1	43.8	53.9	54.7
Trams	144.4	144.4	144.9	409.5	143.9	146.3
Trains	122.8	122.8	123.9	73.1	122.7	122.8
%Change in Occupancy						
Total		0.0%	0.5%	8.0%	0.0%	1.4%
Buses		0.0%	0.5%	-18.6%	0.1%	1.5%
Trams		0.0%	0.3%	183.5%	-0.4%	1.3%
Trains		0.0%	0.9%	-40.5%	-0.1%	0.0%

Table 11. **Vehicle Kms & Average Distance (2030)**

Distance	DoNothing	Electric Buses	Parking Charge	NET Phase 2	Southern Corridor	LSTF - Homeworking
Vehicle KM						
Total	50,678,528	0.0%	-0.2%	-0.8%	0.0%	-0.8%
Cars	42,461,424	0.0%	-0.2%	-0.9%	0.0%	-1.0%
Bikes	2,627,082	0.0%	-0.2%	-0.9%	0.0%	-1.0%
Goods	5,590,022	0.0%	0.0%	0.0%	0.0%	0.0%
Average Distance KM						
Total	17.80	0.0%	-0.1%	0.1%	0.0%	0.1%
Cars	17.53	0.0%	-0.2%	0.1%	0.0%	0.1%
Bikes	17.42	0.0%	-0.2%	0.1%	0.0%	0.1%
Goods	20.32	0.0%	0.0%	0.0%	0.0%	0.0%

2.1.16 The outputs from these tests can be summarised as follows;

- There is a large reduction from the 2014 Base Year to the Future Base tests as the efficiency of the vehicle fleet improves
- The decrease in energy usage to the Future Base is however reversed in the Do Nothing scenario by the impact of the increasing population;
- The changes at a city wide level resulting from the Scenario Tests vary between scenarios showing the different impacts of each test, with the NET Phase 2 and Behavioural Change tests showing the largest impacts.

2.1.17 More detail can be found in the chapters on each individual scenario.

3. FUTURE BASE AND DO NOTHING SCENARIOS

3.1 Introduction

3.1.1 To establish the scale of changes taking place in the model whilst progressing from the 2014 base year to the 2020 and 2030 future years, two scenarios were run.

- **Future Base Scenario**
  - Same population data as the 2014 Base Year run.
  - Vehicle Fleet splits from 2020 and 2030 – this captures the change in fleet over time as people purchase more fuel efficient cars.
- **Do Nothing Scenario**
  - Includes both changes to vehicle fleet and population changes. This shows the change in energy usage associated with doing "Nothing" – i.e. implementing no schemes/policy measures.

3.2 Future year changes

3.2.1 The population in Nottingham is projected to increase from around 1.07M in 2014 to 1.09M in 2020 and 1.16M in 2030. This will result in an increase in the demand for transport and consequently increase the energy requirements of the transport network, particularly in 2030.

3.2.2 Figure 3 shows the total energy usage for each scenario for the two future years from the 2014 Base year starting point. The effect of the population in 2030 can clearly be seen.

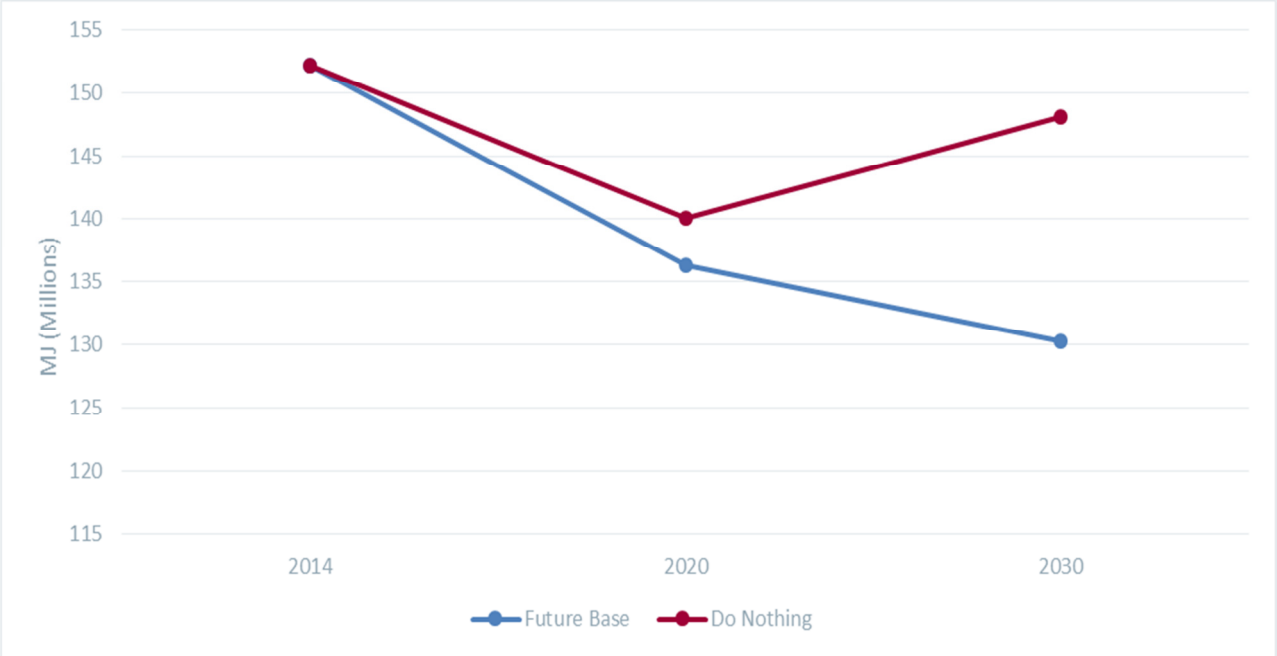


Figure 3. Change in energy usage over time for the Future Base and Do Nothing scenarios

3.2.3 Figure 4 shows the change in energy for each of the impacts – change in fleet splits, change in population and the combined change.

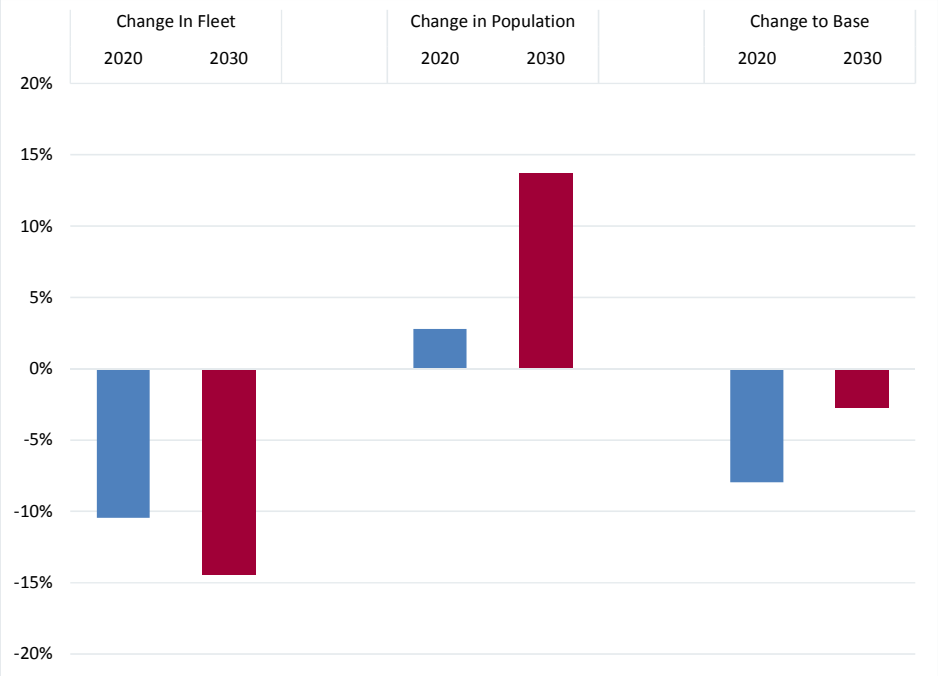


Figure 4. Change in Energy Usage for Future Base and Do Nothing

3.2.4 Table 12 shows the total changes in population, demand and energy for the Future Base and Do Nothing Scenarios.

Table 12. **Energy usage by person and trip compared between scenarios**

SCENARIO	POPULATION	DEMAND	ENERGY (MJ)	ENERGY PER PERSON (MJ)	ENERGY PER TRIP (MJ)
Base 2014	**1,068,955**	**4,087,072**	**152,225,519**	**142.4**	**37.2**
YEAR - 2020					
Future Base	**1,068,955**	**4,089,001**	**136,299,259**	**127.5**	**33.3**
Diff to Base			-15,926,260	-14.9	-3.9
%Diff to Base			-10.5%	-10.5%	-10.5%
Do Nothing	**1,089,100**	**4,183,089**	**140,097,931**	**128.6**	**33.5**
Diff to Base	20,145	94,088	3,798,672	1.1	0.2
%Diff to Base	1.9%	2.3%	2.8%	0.9%	0.5%
Diff to Future Base			-12,127,588	-13.8	-3.8
%Diff to Future Base			-8.0%	-9.7%	-10.1%
YEAR - 2030					
Future Base	**1,068,955**	**4,090,023**	**130,249,917**	**121.8**	**31.8**
Diff to Base			-21,975,602	-20.6	-5.4
%Diff to Base			-14.4%	-14.4%	-14.5%
Do Nothing	**1,165,461**	**4,587,369**	**148,099,117**	**127.1**	**32.3**
Diff to Base	96,506	497,346	17,849,200	5.2	0.4
%Diff to Base	9.0%	12.2%	13.7%	4.3%	1.4%
Diff to Future Base			-4,126,402	-15.3	-5.0
%Diff to Future Base			-2.7%	-10.8%	-13.3%

3.2.5 Figure 5 shows the change in energy usage by zone between the Do Nothing and the 2014 Base. The variation between zones reflects the different population growth factors applied.

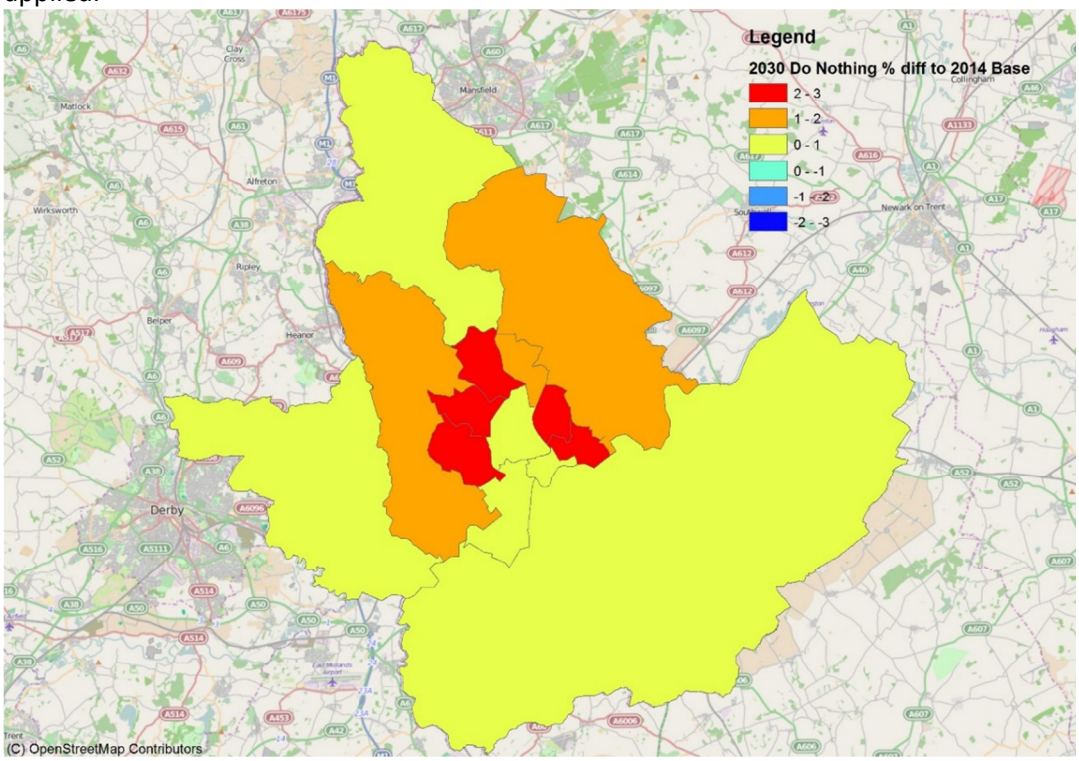


Figure 5. Do Nothing change in energy usage from 2014 Base

3.2.6 Table 13 and Table 14 display the energy usage data for all three scenarios broken down by vehicle type, isolating the effects of the fleet change and population change.

3.2.7 It can be seen that the largest reduction in energy usage comes from increased efficiency from cars. The increased efficiency for other vehicle types is much less, particularly for goods vehicles and buses which only decrease by less than 1%.

Table 13. **Fleet and Population change effect 2020**

Vehicle Type	Base Year (2014)	Future Base (2020)	DoNothing (2020)	Effect of Fleet Change		Effect of Population Change		Combined Effect	
Energy (MJ)									
Total	152,225,519	136,299,259	140,097,931	-15,926,260	-10%	3,798,672	3%	-12,127,588	-8%
Cars	123,142,621	107,449,365	108,636,454	-15,693,256	-13%	1,187,089	1%	-14,506,167	-12%
Bikes	4,779,278	4,719,251	4,779,344	-60,028	-1%	60,093	1%	66	0%
Goods	22,311,805	22,141,332	24,692,822	-170,473	-1%	2,551,489	12%	2,381,016	11%
Buses	1,640,271	1,637,768	1,637,768	-2,503	0%	-	0%	-2,503	0%
Trams	-	-	-	-	0%	-	0%	-	0%
Trains	351,543	351,543	351,543	-	0%	-	0%	-	0%
Vehicles									
Total	810,075	810,067	827,396	-8	0%	17,329	2%	17,321	2%
Cars	714,481	714,473	726,612	-8	0%	12,139	2%	12,131	2%
Bikes	44,169	44,169	45,002	0	0%	832	2%	832	2%
Goods	42,618	42,618	46,976	-	0%	4,358	10%	4,358	10%
Buses	8,398	8,398	8,398	-	0%	-	0%	-	0%
Trams	408	408	408	-	0%	-	0%	-	0%
Trains	495	495	495	-	0%	-	0%	-	0%
Energy / Vehicle (MJ)									
Total	188	168	169	-20	-10%	1	1%	-19	-10%
Cars	172	150	150	-22	-13%	-1	-1%	-23	-13%
Bikes	108	107	106	-1	-1%	-1	-1%	-2	-2%
Goods	524	520	526	-4	-1%	6	1%	2	0%
Buses	195	195	195	-0	0%	-	0%	-0	0%
Trams	-	-	-	-	0%	-	0%	-	0%
Trains	710	710	710	-	0%	-	0%	-	0%

Table 14. **Fleet and Population change effect 2030**

Vehicle Type	Base Year (2014)	Future Base (2030)	DoNothing (2030)	Effect of Fleet Change		Effect of Population Change		Combined Effect	
Energy (MJ)									
Total	152,225,519	130,249,917	148,099,117	-21,975,602	-14%	17,849,200	14%	-4,126,402	-3%
Cars	123,142,621	101,445,583	109,037,069	-21,697,038	-18%	7,591,485	7%	-14,105,553	-11%
Bikes	4,779,278	4,697,693	5,070,980	-81,586	-2%	373,287	8%	291,702	6%
Goods	22,311,805	22,118,188	31,984,810	-193,617	-1%	9,866,622	45%	9,673,005	43%
Buses	1,640,271	1,636,911	1,654,716	-3,360	0%	17,805	1%	14,445	1%
Trams	-	-	-						
Trains	351,543	351,543	351,543	-	0%	-	0%	-	0%
Vehicles									
Total	810,075	810,056	891,676	-18	0%	81,620	10%	81,601	10%
Cars	714,481	714,463	773,587	-18	0%	59,124	8%	59,106	8%
Bikes	44,169	44,169	48,157	-0	0%	3,988	9%	3,988	9%
Goods	42,618	42,618	61,126	-	0%	18,508	43%	18,508	43%
Trams	8,398	8,398	8,398	-	0%	-	0%	-	0%
Buses	408	408	408	-	0%	-	0%	-	0%
Trains	495	495	495	-	0%	-	0%	-	0%
Energy / Vehicle (MJ)									
Total	188	161	166	-27	-14%	5	3%	-22	-12%
Cars	172	142	141	-30	-18%	-1	-1%	-31	-18%
Bikes	108	106	105	-2	-2%	-1	-1%	-3	-3%
Goods	524	519	523	-5	-1%	4	1%	-0	0%
Buses	195	195	197	-0	0%	2	1%	2	1%
Trams	-	-	-	-	0%	-	0%	-	0%
Trains	710	710	710	-	0%	-	0%	-	0%

4. INDIVIDUAL SCENARIO TESTS: ELECTRIC BUSES

4.1 Introduction

4.1.1 This test looks at the change of the entire city bus fleet from the current diesel engine buses to being fully electric. Nottingham City Council has already started replacing buses on selected routes with electric buses so this represents the "extreme" conclusion of this process.

4.1.2 To implement the scheme the following change was made to the model inputs.

- The vehicle type for each bus route was changed from Diesel Bus to Electric Bus.

4.2 Demand Outputs

4.2.1 Table 15 to Table 17 provide an overview of changes in transport demand, average occupancy and vehicle kilometres within the modelled area for the Do Nothing and the Scenario, in both of the forecast years.

4.2.2 The scenario does not change highway or public transport demand as there have been no changes to the journey times or distances. It is possible that in reality there is a small increase in bus usage from people attracted to a low-carbon option. Also, the new electric buses are likely to be of a higher standard than some of the other, older diesel buses, which may also encourage an increase in patronage. However, there effects are not modelled here.

Table 15. **Demand & Mode Shares**

Mode	2020		2030	
	Do Nothing	Electric Buses	Do Nothing	Electric Buses
Demand By Mode				
Highway	3,397,176	3,397,176	3,648,952	3,648,952
Public Transport	454,990	454,990	517,241	517,241
Mode Share				
Highway	88.2%	88.2%	87.6%	87.6%
Public Transport	11.8%	11.8%	12.4%	12.4%
Change in Highway Demand		-		-
Change in PT		-		-

Table 16. **Average Public Transport Occupancy**

Mode	2020		2030	
	Do Nothing	Electric Buses	Do Nothing	Electric Buses
Occupancy				
Total	54.2	54.2	61.5	61.5
Buses	48.0	48.0	53.8	53.8
Trams	117.7	117.7	144.4	144.4
Trains	107.2	107.2	122.8	122.8
%Change in Occupancy				
Total		0.0%		0.0%
Buses		0.0%		0.0%
Trams		0.0%		0.0%
Trains		0.0%		0.0%

Table 17. **Vehicle Kms & Average Distance**

Distance	2020		2030	
	Do Nothing	Electric Buses	Do Nothing	Electric Buses
Vehicle KM				
Total	46,915,485	0.0%	50,678,528	0.0%
Cars	40,133,610	0.0%	42,461,424	0.0%
Bikes	2,469,902	0.0%	2,627,082	0.0%
Goods	4,311,973	0.0%	5,590,022	0.0%
Average Distance KM				
Total	17.92	0.0%	17.80	0.0%
Cars	17.71	0.0%	17.53	0.0%
Bikes	17.60	0.0%	17.42	0.0%
Goods	20.40	0.0%	20.32	0.0%

4.3 Energy Outputs

4.3.1 Table 18 and Table 19 provide an overview of the energy usage by vehicle type and zone for the 2020 and 2030 Do Nothing and the scenario, respectively.

4.3.2 The reduction in energy usage is attributed entirely to the introduction of the electric buses. No other mode experiences a change in energy usage as the introduction of the buses has no impact on demand, distances or journey times at all.

Table 18. **Energy Usage (MJ/day) by Vehicle Type**

Vehicle Type	2020		2030	
	DoNothing	Electric Buses	DoNothing	Electric Buses
Energy (MJ)				
Total	140,097,931	-1.1%	148,099,117	-1.0%
Cars	108,636,454	0.0%	109,037,069	0.0%
Bikes	4,779,344	0.0%	5,070,980	0.0%
Goods	24,692,822	0.0%	31,984,810	0.0%
Buses	1,637,768	-93.7%	1,654,716	-93.8%
Trams	-	0.0%	-	0.0%
Trains	351,543	0.0%	351,543	0.0%
Vehicles				
Total	827,396	0.0%	891,676	0.0%
Cars	726,612	0.0%	773,587	0.0%
Bikes	45,002	0.0%	48,157	0.0%
Goods	46,976	0.0%	61,126	0.0%
Buses	8,398	0.0%	8,398	0.0%
Trams	408	0.0%	408	0.0%
Trains	495	0.0%	495	0.0%
Energy / Vehicle (MJ)				
Total	169	-1.2%	166	-1.1%
Cars	150	0.0%	141	0.0%
Bikes	106	0.0%	105	0.0%
Goods	526	0.0%	523	0.0%
Buses	195	-93.7%	197	-93.8%
Trams	-	0.0%	-	0.0%
Trains	710	0.0%	710	0.0%

4.3.3 As energy usage for buses in the model is assigned to the zone in which the bus route starts, the distribution of energy reductions throughout the city reflects the extremities of the bus routes. The largest decrease in the city centre is due to the large number of bus routes that begin in the centre of the city. The return routes start in a variety of zones around the city and this is reflected in the changes in the other zones.

Table 19. **Energy Usage (MJ/day) by Zone**

Zone	2020		2030	
	DoNothing	Electric Buses	DoNothing	Electric Buses
Total	140,097,931	-1.1%	148,099,117	-1.0%
1 - City Centre	10,135,338	-7.2%	12,420,625	-5.9%
2 - Clifton	3,520,356	-1.7%	3,801,773	-1.6%
3 - The Meadows	1,385,111	0.0%	1,572,437	0.0%
4 - Colwick Park	971,358	-0.8%	1,057,404	-0.7%
5 - St Ann's	1,919,738	-0.6%	2,083,218	-0.6%
6 - Bestwood	1,773,002	-2.0%	1,864,238	-2.0%
7 - Bulwell	2,532,077	-1.9%	2,704,026	-1.8%
8 - Wollaton Park	2,253,792	-0.9%	2,419,700	-0.8%
9 - Aspley	2,028,756	-0.6%	2,134,920	-0.5%
10 - West Bridgford & South	28,335,768	-0.3%	28,413,827	-0.3%
11 - Hucknall & North	10,994,994	-0.1%	10,858,347	-0.1%
12 - Beeston & Kimberley	14,314,460	-0.3%	14,899,238	-0.3%
13 - Ilkeston & Long Eaton	9,470,668	-0.6%	9,849,392	-0.5%
14 - Arnold & East	16,697,955	-1.0%	17,898,521	-0.9%
15 - External	33,764,557	-0.8%	36,121,453	-0.7%

4.3.4 Figure 6 shows the distribution of the energy reductions for the city compared to the Do Nothing scenario for 2030.

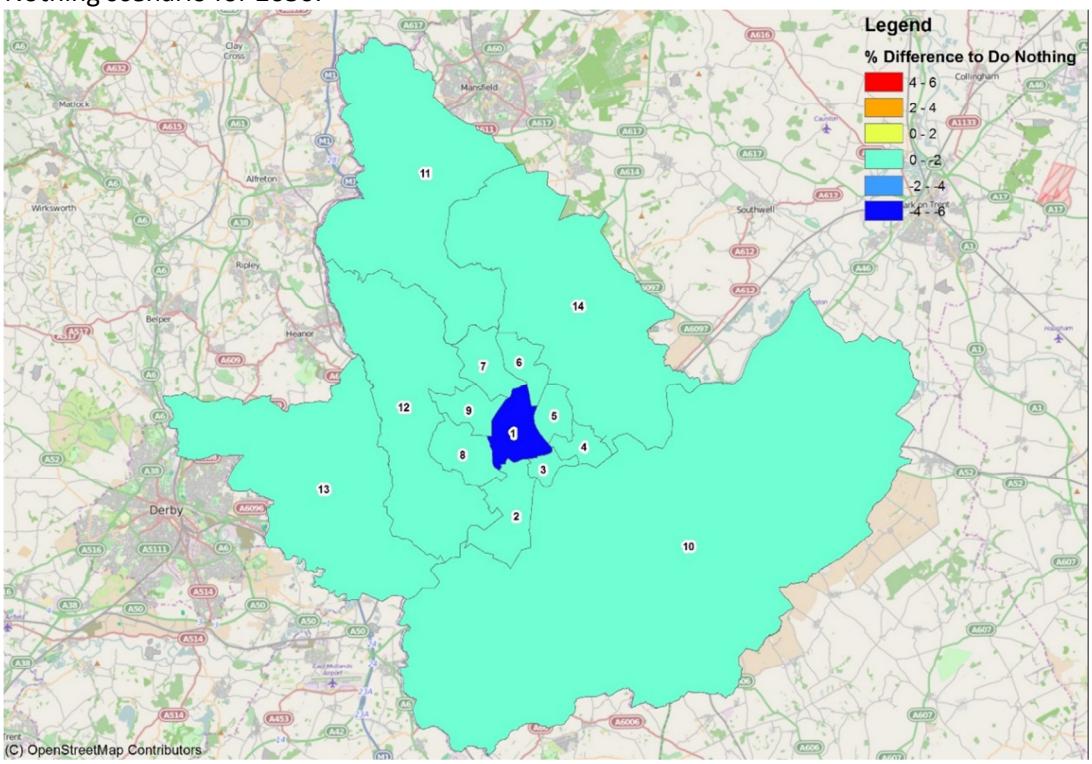


Figure 6. Energy usage by zone change 2030

4.4 Summary

4.4.1 The introduction of electric buses has no impact on demand for highway or public transport as they do not alter the attractiveness of bus trips in the model. They do however generate energy savings compared to standard diesel buses which can be seen clearly in the city centre zone where a large number of bus routes begin their routes.

5. INDIVIDUAL SCENARIO TESTS: PARKING CHARGES

5.1 Introduction

5.1.1 This test investigates the impact of doubling average parking charges in city centre zones 1 and 3. **Error! Reference source not found.** illustrates the new parking charges. Parking charges continue to only apply to private car trips with a destination zone of either 1 or 3.

5.2 Demand Outputs

5.2.1 Table 20 to Table 22 provide an overview of changes in transport demand, average occupancy and vehicle kilometres within the modelled area for the Do Nothing and the Scenario, in both of the forecast years.

5.2.2 The scenario creates a small switch from private vehicle to public transport as people switch mode to avoid paying the parking charge. These small changes are not enough to affect the overall mode share or average occupancies of public transport.

Table 20. **Demand & Mode Shares**

Mode	2020		2030	
	Do Nothing	Parking Charge	Do Nothing	Parking Charge
Demand By Mode				
Highway	3,397,176	3,396,266	3,648,952	3,646,281
Public Transport	454,990	455,784	517,241	519,574
Mode Share				
Highway	88.2%	88.2%	87.6%	87.5%
Public Transport	11.8%	11.8%	12.4%	12.5%
Change in Highway Demand		- 910		- 2,671
Change in PT		795		2,333

Table 21. **Average Public Transport Occupancy**

Mode	2020		2030	
	Do Nothing	Parking Charge	Do Nothing	Parking Charge
Occupancy				
Total	54.2	54.3	61.5	61.8
Buses	48.0	48.1	53.8	54.1
Trams	117.7	117.8	144.4	144.9
Trains	107.2	107.9	122.8	123.9
%Change in Occupancy				
Total		0.2%		0.5%
Buses		0.2%		0.5%
Trams		0.1%		0.3%
Trains		0.7%		0.9%

Table 22. **Vehicle Kms & Average Distance**

Distance	2020		2030	
	Do Nothing	Parking Charge	Do Nothing	Parking Charge
Vehicle KM				
Total	46,915,485	-0.1%	50,678,528	-0.2%
Cars	40,133,610	-0.1%	42,461,424	-0.2%
Bikes	2,469,902	-0.1%	2,627,082	-0.2%
Goods	4,311,973	0.0%	5,590,022	0.0%
Average Distance KM				
Total	17.92	-0.1%	17.80	-0.1%
Cars	17.71	-0.1%	17.53	-0.2%
Bikes	17.60	-0.1%	17.42	-0.2%
Goods	20.40	0.0%	20.32	0.0%

5.2.3 Table 22 provides an overview of the vehicle kilometres and the average distances travelled within the city. The small change in private vehicle demand causes a small decrease in vehicle kilometres. There is also a reduction in the average trip length for this group due to a redistribution of demand away from the city centre.

5.2.4 Table 23 shows the demand change for private vehicles compared to the Do Nothing scenario.

Table 23. **Change in Private Vehicle Demand (2030)**

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
All Purposes	City Centre	Clifton	The Meadows	Colwick Park	St Ann's	Bestwood	Bulwell	Wollaton Park	Aspley	West Bridgford & South	Hucknall & North	Beeston & Kimberley	Ilkeston & Long Eaton	Arnold & East	External	Total
1 City Centre	352	23	-624	12	46	19	23	36	33	4	3	20	5	15	-5	-39
2 Clifton	-1573	1273	-316	72	81	17	27	139	66	22	8	41	18	34	-14	-106
3 The Meadows	-176	14	106	22	14	2	1	2	1	1	0	1	0	1	-2	-13
4 Colwick Park	-343	30	-87	266	60	7	6	6	4	4	1	5	1	7	-5	-37
5 St Ann's	-830	31	-112	55	583	108	24	16	16	6	2	13	3	38	-7	-52
6 Bestwood	-487	4	-50	4	56	241	96	13	17	2	2	21	3	40	-6	-44
7 Bulwell	-881	12	-69	6	26	181	441	35	61	3	7	70	6	40	-10	-72
8 Wollaton Park	-1238	114	-88	13	34	47	71	695	142	6	8	55	26	32	-13	-97
9 Aspley	-1075	46	-67	8	30	60	114	122	568	4	7	73	14	30	-11	-78
10 West Bridgford & South	-23631	3634	-4471	1585	2540	1166	1276	1230	923	8059	869	2301	1134	2781	-96	-702
11 Hucknall & North	-4967	103	-423	31	75	127	184	110	118	51	3260	562	104	564	-16	-116
12 Beeston & Kimberley	-10569	391	-737	112	329	814	1413	579	848	115	499	4829	368	713	-47	-343
13 Ilkeston & Long Eaton	-5707	279	-531	58	123	179	209	431	273	93	139	574	3498	228	-24	-178
14 Arnold & East	-11938	431	-1137	203	1089	1794	1090	460	493	188	657	930	196	5133	-65	-474
15 External	-9957	1008	-1359	386	803	752	786	612	562	1351	863	1499	849	1525	0	-321
Total	-73021	7394	-9964	2833	5886	5514	5763	4486	4124	9908	6326	10993	6226	11182	-321	-2671

5.2.5 The decrease in trips to the city centre zone is most apparent from zones on the edge of the city. A proportion of these trips become intra-zonal instead of travelling to the city centre due to the cost increase from parking charges.

5.2.6 Figure 7 demonstrates the change in destination zone for the city with less trips heading to the zones with increased parking charges.

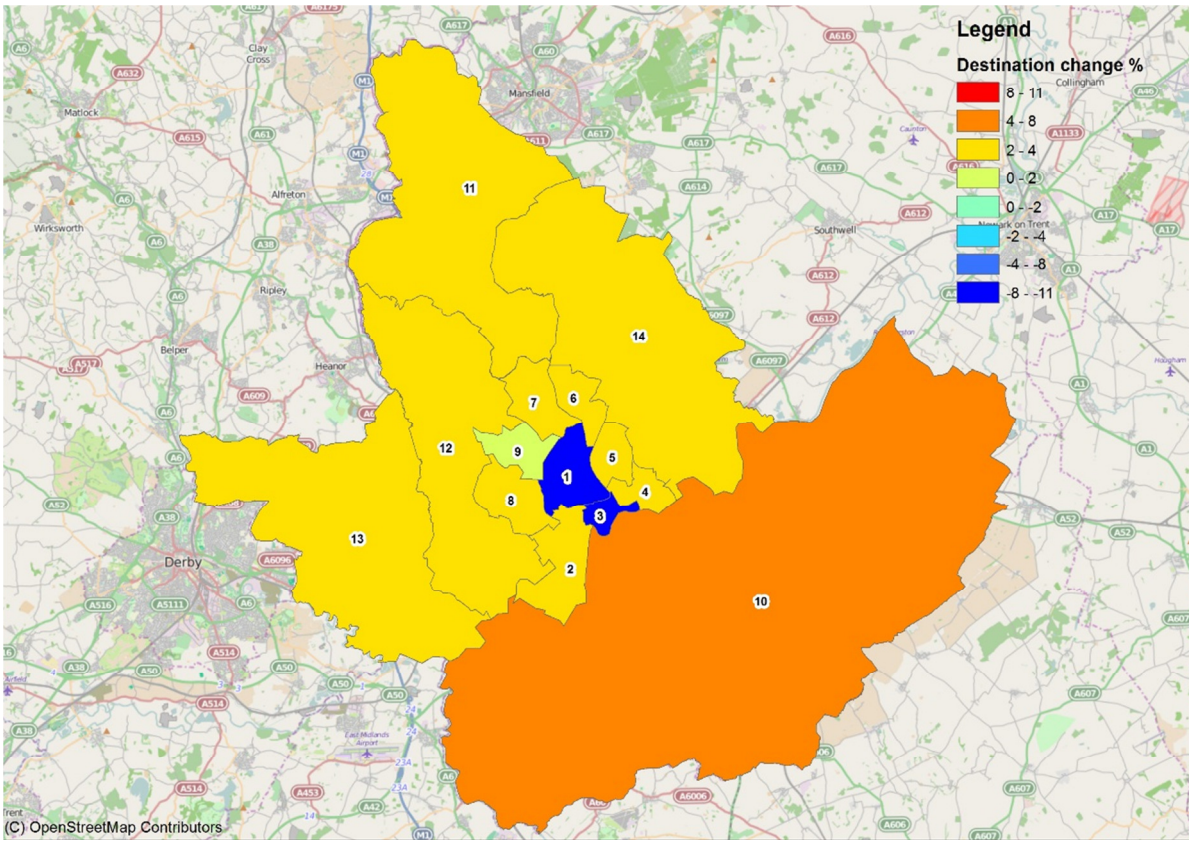


Figure 7. Changes in Trip Destination 2030

5.3 Energy Outputs

5.3.1 Table 24 and Table 25 provide an overview of the energy usage by vehicle type and by zone for the 2020 and 2030 Do Nothing and the Scenario.

5.3.2 Overall the energy usage in 2020 is around 110,000 MJ lower than in the Do Nothing scenario and 102,000 MJ lower in 2030.

5.3.3 The reduction in energy use by vehicle type shows that the reduction in private car use means that goods traffic experiences less congestion and therefore uses less energy.

5.3.4 The energy usage by zone shows that the change switch away from the city centre as the destination of trips originating on the outskirts of the city lead to reductions as vehicles travel less distance.

Table 24. **Energy Usage (MJ/day) by Vehicle Type**

Vehicle Type	2020		2030	
	DoNothing	Parking Charge	DoNothing	Parking Charge
Energy (MJ)				
Total	140,097,931	-0.1%	148,099,117	-0.1%
Cars	108,636,454	-0.1%	109,037,069	-0.1%
Bikes	4,779,344	-0.1%	5,070,980	0.0%
Goods	24,692,822	-0.1%	31,984,810	-0.1%
Buses	1,637,768	0.0%	1,654,716	0.0%
Trams	-	0.0%	-	0.0%
Trains	351,543	0.0%	351,543	0.0%
Vehicles				
Total	827,396	0.0%	891,676	0.0%
Cars	726,612	0.0%	773,587	0.0%
Bikes	45,002	0.0%	48,157	0.0%
Goods	46,976	0.0%	61,126	0.0%
Buses	8,398	0.0%	8,398	0.0%
Trams	408	0.0%	408	0.0%
Trains	495	0.0%	495	0.0%
Energy / Vehicle (MJ)				
Total	169	-0.1%	166	-0.1%
Cars	150	-0.1%	141	-0.1%
Bikes	106	-0.1%	105	0.0%
Goods	526	-0.1%	523	-0.1%
Buses	195	0.0%	197	0.0%
Trams	-	0.0%	-	0.0%
Trains	710	0.0%	710	0.0%

Table 25. **Energy Usage (MJ/day) by Zone**

Zone	2020		2030	
	DoNothing	Parking Charge	DoNothing	Parking Charge
Total	140,097,931	-0.1%	148,099,117	-0.1%
1 - City Centre	10,135,338	-0.7%	12,420,625	-0.1%
2 - Clifton	3,520,356	-0.1%	3,801,773	-0.2%
3 - The Meadows	1,385,111	0.0%	1,572,437	-0.1%
4 - Colwick Park	971,358	0.0%	1,057,404	-0.2%
5 - St Ann's	1,919,738	-0.1%	2,083,218	-0.1%
6 - Bestwood	1,773,002	-0.1%	1,864,238	-0.1%
7 - Bulwell	2,532,077	-0.1%	2,704,026	-0.2%
8 - Wollaton Park	2,253,792	0.0%	2,419,700	-0.1%
9 - Aspley	2,028,756	0.0%	2,134,920	-0.1%
10 - West Bridgford & South	28,335,768	0.3%	28,413,827	0.3%
11 - Hucknall & North	10,994,994	-0.4%	10,858,347	-0.5%
12 - Beeston & Kimberley	14,314,460	-0.1%	14,899,238	-0.1%
13 - Ilkeston & Long Eaton	9,470,668	-0.3%	9,849,392	-0.4%
14 - Arnold & East	16,697,955	-0.1%	17,898,521	-0.2%
15 - External	33,764,557	0.0%	36,121,453	0.0%

5.3.5 Figure 8 shows the change in energy by origin zone. The overall change in energy usage in all zones is very small.

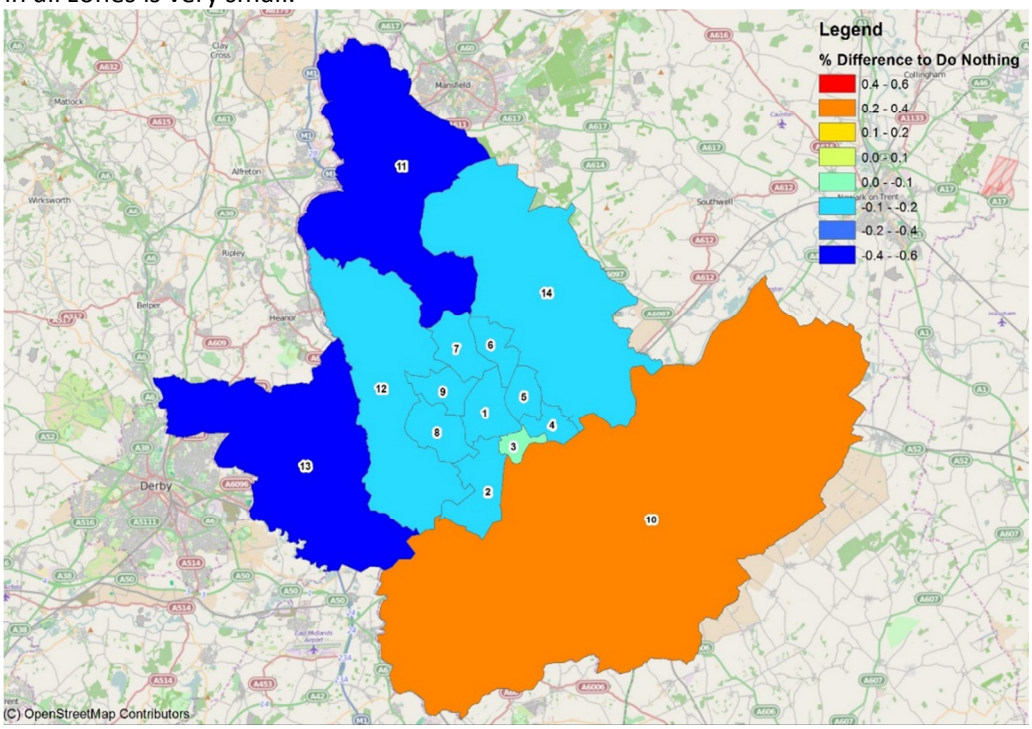


Figure 8. Change In Energy Usage (2030)

5.3.6 Table 26 shows the change in vehicle kilometres resulting from the redistribution that drive the change in energy usage.

Table 26. **Change in Total Vehicle Km 2030**

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
All Purposes	City Centre	Clifton	The Meadows	Colwick Park	St Ann's	Bestwood	Bulwell	Wollaton Park	Aspley	West Bridgford & South	Hucknall & North	Beeston & Kimberley	Ilkeston & Long Eaton	Arnold & East	External	Total
1 City Centre	- 99	109	- 1,409	71	99	83	102	110	84	- 100	- 6	7	- 40	24	- 222	- 1,189
2 Clifton	- 7,212	2,045	- 1,144	376	506	188	261	667	393	185	89	289	178	307	- 461	- 3,334
3 The Meadows	- 287	- 17	- 645	5	16	12	41	35	13	- 56	8	69	20	48	- 411	- 1,148
4 Colwick Park	- 1,194	145	- 195	243	198	55	34	66	42	12	16	88	35	77	- 588	- 965
5 St Ann's	- 2,240	208	- 293	195	732	341	124	125	99	30	41	155	58	176	- 641	- 889
6 Bestwood	- 1,877	64	- 280	36	176	259	205	76	79	33	- 25	109	27	118	- 235	- 1,234
7 Bulwell	- 3,009	132	- 372	58	134	387	- 136	178	212	64	80	263	52	184	- 378	- 2,152
8 Wollaton Park	- 2,988	541	- 356	104	213	269	339	830	421	98	98	333	178	230	- 481	- 171
9 Aspley	- 2,495	288	- 312	65	167	280	395	382	642	65	76	343	112	195	- 401	- 197
10 West Bridgford & South	- 229,488	36,252	- 35,762	13,538	24,237	14,535	18,214	15,183	11,285	28,477	24,290	42,512	23,114	41,143	2,523	30,053
11 Hucknall & North	- 66,061	2,074	- 7,398	653	1,339	1,816	2,212	1,758	1,566	1,465	5,153	5,973	2,012	5,624	- 611	- 42,425
12 Beeston & Kimberley	- 60,736	4,434	- 6,516	1,225	2,846	4,546	6,263	4,060	4,058	2,222	5,188	9,718	3,938	6,777	- 1,715	- 13,692
13 Ilkeston & Long Eaton	- 58,118	3,736	- 7,107	903	1,722	2,201	2,604	3,509	2,408	2,026	2,676	6,270	3,834	3,821	- 883	- 30,398
14 Arnold & East	- 71,491	5,011	- 8,776	1,849	5,795	5,466	5,692	3,892	3,513	3,098	6,660	8,909	3,231	7,674	- 2,427	- 21,904
15 External	- 356,298	37,452	- 52,946	14,553	29,059	27,297	28,132	22,859	20,277	51,482	31,228	53,552	31,056	54,176		- 8,120
Total	- 863,592	92,474	- 123,510	33,874	67,239	57,735	64,482	53,730	45,091	89,101	75,572	128,590	67,806	120,573	- 6,930	- 97,765

5.4 Summary

5.4.1 The increase in parking charges in the city centre creates some energy savings as the overall distance travelled by private vehicles is reduced. This happens as trips are redistributed to alternative zones which are, in most cases, closer to the origin zone of the trips or transfer to other modes.

6. INDIVIDUAL SCENARIO TESTS: NET PHASE 2

6.1 Introduction

6.1.1 This test looked at the opening of NET Phase 2, extending the Nottingham tram system with two new lines from the city centre to Beeston and Clifton. There is also an increase in frequency along the existing line from the city centre to Hucknall

6.1.2 Figure 9 shows the location of the new tram lines in relation to the existing tram line and model zones.

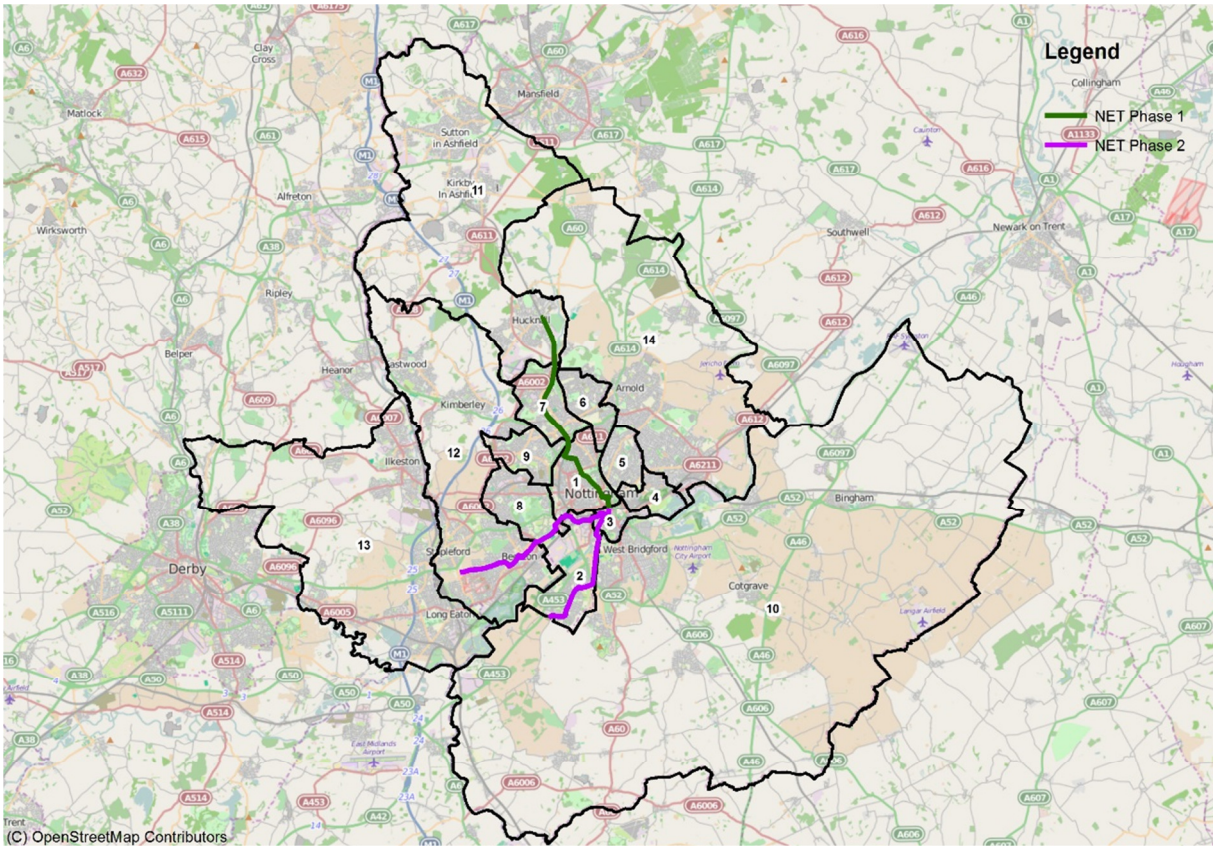


Figure 9. NET Phase 2 location

6.1.3 To include the scheme in the model the public transport services were updated to include the new lines and the frequency increases.

6.1.4 There is potential for over-estimating the impact of this test due to the size of the modelled zones. The tram route to Beeston terminates in zone 12, which covers a much larger area than the catchment of the new tram route. The addition of this line will lead to demand that is actually from the northern end of the zone being included in demand available to switch.

6.2 Demand Outputs

6.2.1 Table 27 to Table 29 provide an overview of changes in transport demand, average occupancy and vehicle kilometres within the modelled area for the Do Nothing and the Scenario, in both of the forecast years.

6.2.2 The scenario creates a large switch from highway to public transport, increasing PT mode share by 6%. There is also a significant switch from train and bus travel to the expanded tram system. The increase in tram occupancy seems very high, as does the reduction in rail demand which is not in direct competition with the new tram routes.

Table 27. **Demand & Mode Shares**

Mode	2020		2030	
	Do Nothing	NET Phase 2	Do Nothing	NET Phase 2
Demand By Mode				
Highway	3,397,176	3,367,670	3,648,952	3,614,601
Public Transport	454,990	480,764	517,241	547,249
Mode Share				
Highway	88.2%	87.5%	87.6%	86.9%
Public Transport	11.8%	12.5%	12.4%	13.1%
Change in Highway Demand		- 29,505		- 34,351
Change in PT		25,775		30,008

Table 28. **Average Public Transport Occupancy**

Mode	2020		2030	
	Do Nothing	NET Phase 2	Do Nothing	NET Phase 2
Occupancy				
Total	54.2	58.3	61.5	66.4
Buses	48.0	39.3	53.8	43.8
Trams	117.7	348.6	144.4	409.5
Trains	107.2	60.9	122.8	73.1
%Change in Occupancy				
Total		7.5%		8.0%
Buses		-18.1%		-18.6%
Trams		196.2%		183.5%
Trains		-43.2%		-40.5%

Table 29. **Vehicle Kms & Average Distance**

Distance	2020		2030	
	Do Nothing	NET Phase 2	Do Nothing	NET Phase 2
Vehicle KM				
Total	46,915,485	-0.7%	50,678,528	-0.8%
Cars	40,133,610	-0.8%	42,461,424	-0.9%
Bikes	2,469,902	-0.8%	2,627,082	-0.9%
Goods	4,311,973	0.0%	5,590,022	0.0%
Average Distance KM				
Total	17.92	0.1%	17.80	0.1%
Cars	17.71	0.1%	17.53	0.1%
Bikes	17.60	0.1%	17.42	0.1%
Goods	20.40	0.0%	20.32	0.0%

6.2.3 Table 29 provides an overview of the vehicle kilometres and the average distances travelled within the city. There is a small decrease in overall vehicle kilometres travelled and a small increase in the average distance travelled. This shows that mainly short to medium distance trips, previously undertaken by private vehicle, are now done using public transport.

6.2.4 Figure 10 shows the change in public transport trips by origin zone for the test. It shows that the zones to the west of the city see a large increase in public transport usage due to the location of the new line sections.

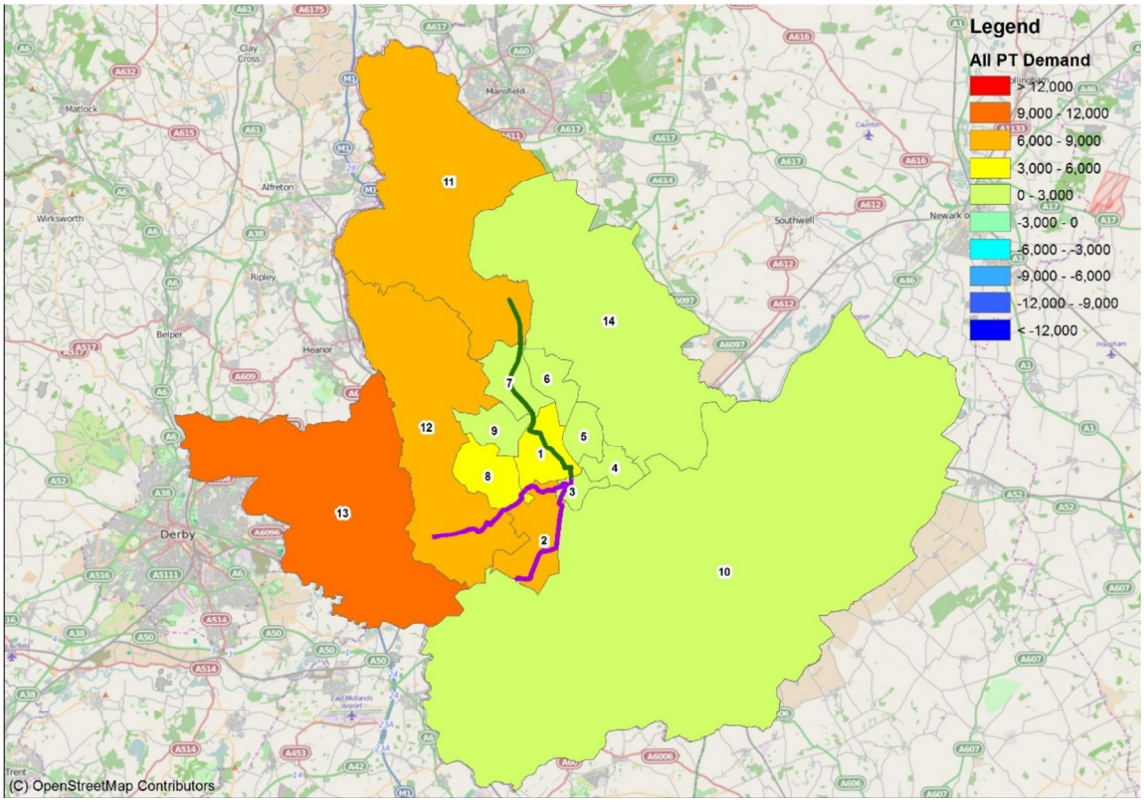


Figure 10. Changes in Public Transport Trip Origins (2030)

6.3 Energy Outputs

6.3.1 Table 30 and Table 31 provide an overview of the energy usage by vehicle type and by zone for the 2020 and 2030 Do Nothing and the Scenario.

6.3.2 The energy savings resulting from NET Phase 2 come from the reduction in private vehicle trips. As trams are treated as consuming no energy there is no corresponding increase in energy usage resulting from the running of the new trams.

Table 30. **Energy Usage (MJ/day) by Vehicle Type**

Vehicle Type	2020		2030	
	DoNothing	NET Phase 2	DoNothing	NET Phase 2
Energy (MJ)				
Total	140,097,931	-0.6%	148,099,117	-0.6%
Cars	108,636,454	-0.7%	109,037,069	-0.8%
Bikes	4,779,344	-0.7%	5,070,980	-0.8%
Goods	24,692,822	0.0%	31,984,810	0.0%
Buses	1,637,768	0.0%	1,654,716	0.0%
Trams	-	0.0%	-	0.0%
Trains	351,543	0.0%	351,543	0.0%
Vehicles				
Total	827,396	0.0%	891,676	0.0%
Cars	726,612	0.0%	773,587	0.0%
Bikes	45,002	0.0%	48,157	0.0%
Goods	46,976	0.0%	61,126	0.0%
Buses	8,398	0.0%	8,398	0.0%
Trams	408	33.3%	408	33.3%
Trains	495	0.0%	495	0.0%
Energy / Vehicle (MJ)				
Total	169	-0.7%	166	-0.7%
Cars	150	-0.7%	141	-0.8%
Bikes	106	-0.7%	105	-0.8%
Goods	526	0.0%	523	0.0%
Buses	195	0.0%	197	0.0%
Trams	-	0.0%	-	0.0%
Trains	710	0.0%	710	0.0%

Table 31. **Energy usage (MJ/day) by Zone**

Zone	2020		2030	
	DoNothing	NET Phase 2	DoNothing	NET Phase 2
Total	140,097,931	-0.6%	148,099,117	-0.6%
1 - City Centre	10,135,338	-0.4%	12,420,625	-0.5%
2 - Clifton	3,520,356	-2.8%	3,801,773	-2.8%
3 - The Meadows	1,385,111	-0.3%	1,572,437	-0.2%
4 - Colwick Park	971,358	-0.2%	1,057,404	-0.2%
5 - St Ann's	1,919,738	-0.1%	2,083,218	-0.1%
6 - Bestwood	1,773,002	-0.1%	1,864,238	-0.1%
7 - Bulwell	2,532,077	-1.9%	2,704,026	-1.9%
8 - Wollaton Park	2,253,792	-3.4%	2,419,700	-3.7%
9 - Aspley	2,028,756	-0.1%	2,134,920	-0.1%
10 - West Bridgford & South	28,335,768	0.0%	28,413,827	0.0%
11 - Hucknall & North	10,994,994	-0.7%	10,858,347	-0.7%
12 - Beeston & Kimberley	14,314,460	-1.6%	14,899,238	-1.6%
13 - Ilkeston & Long Eaton	9,470,668	-0.2%	9,849,392	-0.3%
14 - Arnold & East	16,697,955	0.0%	17,898,521	-0.1%
15 - External	33,764,557	-0.7%	36,121,453	-0.7%

6.3.3 No zone sees an increase in energy usage as a result of the scheme and the largest decreases in energy usage come from the zones in the city that the tram network serves. This is demonstrated in Figure 11.

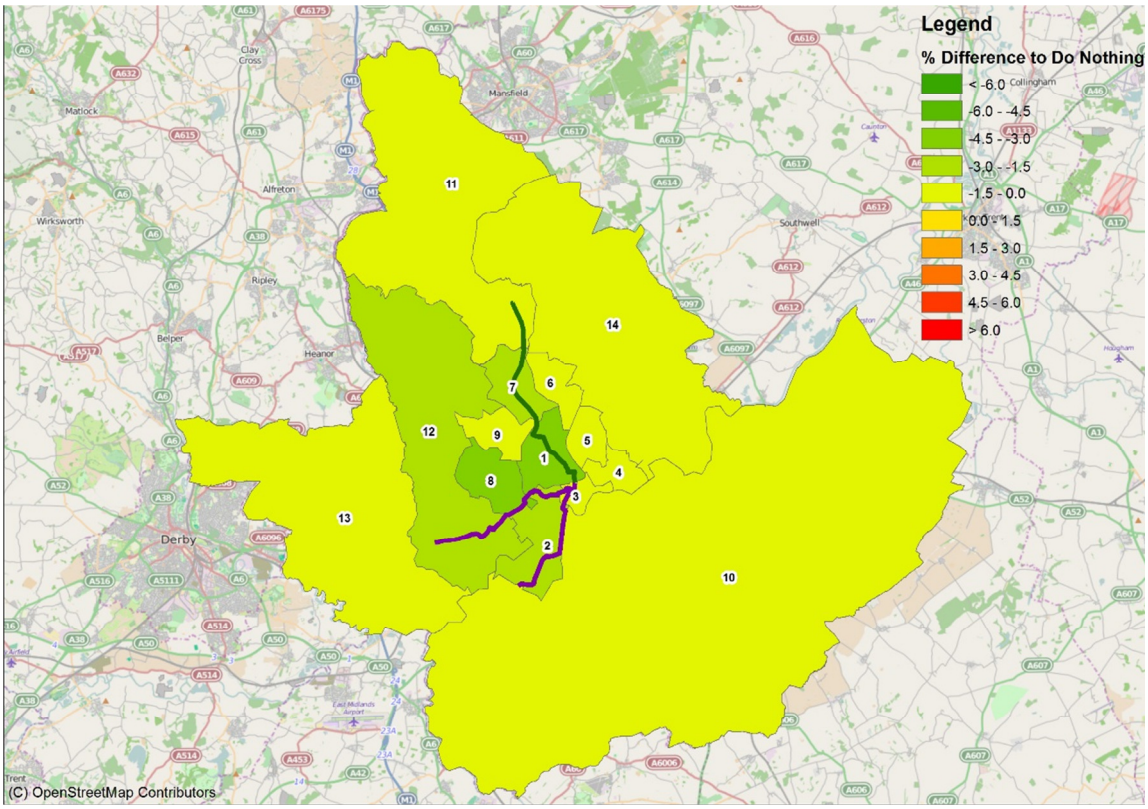


Figure 11. Change in Energy Usage (2030)

6.3.4 The overall energy usage in 2020 is around 850,000 MJ lower than the Do Nothing scenario in 2020 and 925,000 MJ lower in 2030.

6.4 Summary

6.4.1 The introduction of NET Phase 2 has the effect of moving private vehicle users onto public transport and also changing the mode of existing public transport users to the tram. This results in a decrease in energy usage as public transport uses less energy per person than private vehicle usage.

6.4.2 The decrease in energy consumption is however overstated as there is no recorded increase in energy usage from the tram system in them model.

7. INDIVIDUAL SCENARIO TESTS: SOUTHERN CORRIDOR

7.1 Introduction

7.1.1 This test looks at a range of bus priority improvements to a corridor to the south of the city. This includes new bus-only lanes and increased priority to buses at important junctions, with the aim of both reducing journey times and increasing reliability.

7.1.2 To include the scheme in the model the sections of bus trips along the route of the corridor that go through area type 2 were sped up by 10%. The location of the corridor as modelled is detailed in Figure 12.

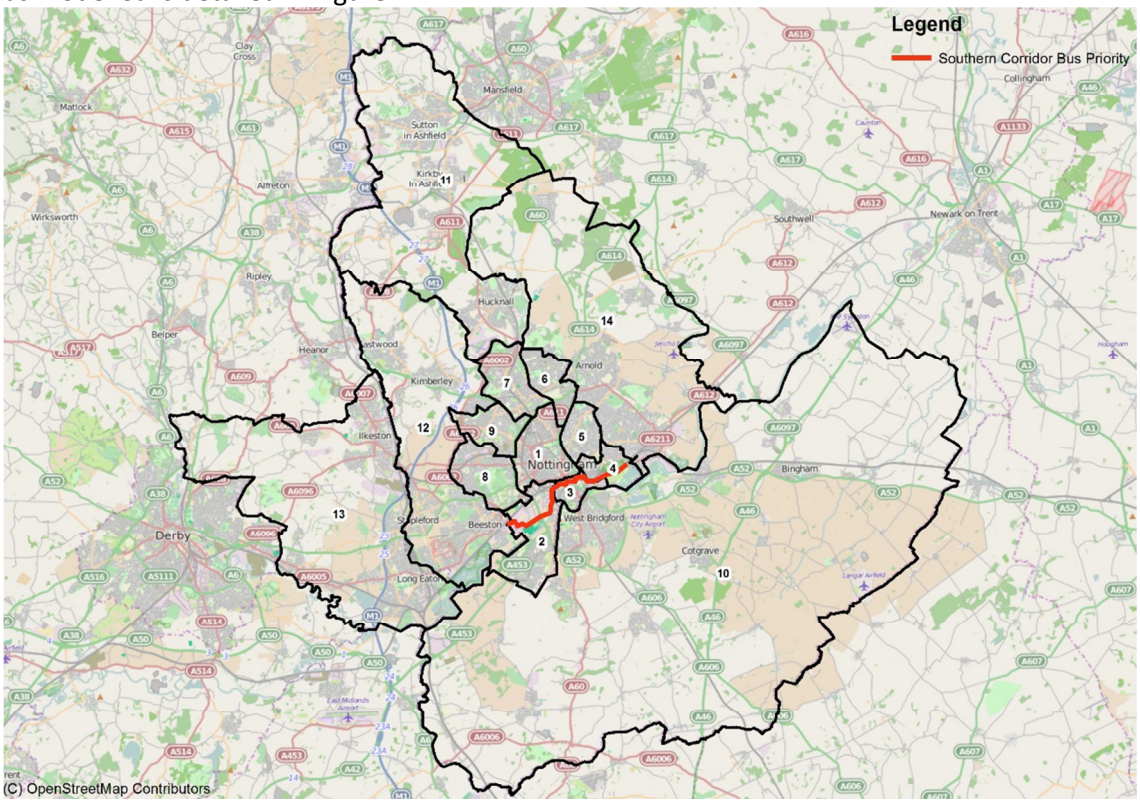


Figure 12. Scheme Details - Southern Corridor

7.2 Demand Outputs

7.2.1 Table 32 to Table 34 provide an overview of changes in transport demand, average occupancy and vehicle kilometres within the modelled area for the Do Nothing and the Scenario, in both of the forecast years.

7.2.2 The scenario sees a small mode shift from private vehicle to public transport.

Table 32. **Demand & Mode Shares**

Mode	2020		2030	
	Do Nothing	Southern Corridor	Do Nothing	Southern Corridor
Demand By Mode				
Highway	3,397,176	3,397,064	3,648,952	3,648,806
Public Transport	454,990	455,087	517,241	517,369
Mode Share				
Highway	88.2%	88.2%	87.6%	87.6%
Public Transport	11.8%	11.8%	12.4%	12.4%
Change in Highway Demand		- 112		- 146
Change in PT		98		128

Table 33. **Average Public Transport Occupancy**

Mode	2020		2030	
	Do Nothing	Southern Corridor	Do Nothing	Southern Corridor
Occupancy				
Total	54.2	54.2	61.5	61.5
Buses	48.0	48.1	53.8	53.9
Trams	117.7	117.3	144.4	143.9
Trains	107.2	106.8	122.8	122.7
%Change in Occupancy				
Total		0.0%		0.0%
Buses		0.1%		0.1%
Trams		-0.3%		-0.4%
Trains		-0.4%		-0.1%

Table 34. **Vehicle Kms & Average Distance**

Distance	2020		2030	
	Do Nothing	Southern Corridor	Do Nothing	Southern Corridor
Vehicle KM				
Total	46,915,485	0.0%	50,678,528	0.0%
Cars	40,133,610	0.0%	42,461,424	0.0%
Bikes	2,469,902	0.0%	2,627,082	0.0%
Goods	4,311,973	0.0%	5,590,022	0.0%
Average Distance KM				
Total	17.92	0.0%	17.80	0.0%
Cars	17.71	0.0%	17.53	0.0%
Bikes	17.60	0.0%	17.42	0.0%
Goods	20.40	0.0%	20.32	0.0%

7.2.3 Table 34 provides an overview of the vehicle kilometres and the average distances travelled within the city. Overall there is no detectable change in total vehicle distance travelled or average distance.

7.2.4 Table 35 shows the change in public transport demand form the Do Nothing test for 2030. Movements that have seen a reduced bus journey time are highlighted with a white box.

Table 35. **Change in Public Transport Demand (2030)**

	All Purposes	City Centre	Clifton	The Meadows	Colwick Park	St Ann's	Bestwood	Bulwell	Wollaton Park	Aspley	West Bridgford & South	Hucknall & North	Beeston & Kimberley	Ilkeston & Long Eaton	Arnold & East	External	Total
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
1	City Centre	-150	158	-43	81	-12	-4	-6	-7	-8	0	-1	38	-1	16	5	65
2	Clifton	-44	-54	118	2	-1	-1	6	-2	-1	0	3	8	2	3	3	41
3	The Meadows	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
4	Colwick Park	-8	5	-1	-3	0	0	0	0	0	0	0	2	0	9	0	4
5	St Ann's	-4	5	-1	2	-2	0	0	0	0	0	0	2	0	0	0	2
6	Bestwood	-2	0	-1	3	0	-2	0	0	0	0	0	4	0	0	0	1
7	Bulwell	-1	-1	0	5	0	0	-1	0	0	0	0	0	0	0	0	1
8	Wollaton Park	-1	-1	-1	4	0	0	0	0	0	0	0	0	0	0	0	1
9	Aspley	-1	-1	-1	4	0	0	0	0	0	0	0	0	0	0	0	0
10	West Bridgford & South	-1	0	0	5	0	0	0	0	0	0	0	0	0	-3	0	1
11	Hucknall & North	-1	0	0	4	0	0	0	0	0	0	0	0	0	-1	0	1
12	Beeston & Kimberley	-1	0	0	5	0	0	0	0	0	0	0	-1	0	0	0	1
13	Ilkeston & Long Eaton	-1	0	0	3	0	0	0	0	0	0	0	0	-1	0	0	1
14	Arnold & East	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	External	-16	8	5	9	-1	-1	0	-1	-1	0	0	4	0	2	0	8
	Total	-232	120	76	125	-18	-8	-2	-11	-11	-1	1	55	0	25	8	128

7.2.5 Of the movements that experience a public transport journey time saving not all result in an increase in public transport usage as the saving is not enough to make demand switch away from private vehicles. There is also a redistribution of existing public transport trips as certain movements become more attractive relative to others.

7.3 Energy Outputs

7.3.1 Table 36 and Table 37 provide an overview of the energy usage by vehicle type and by zone for the 2020 and 2030 Do Nothing test and the Scenario respectively.

7.3.2 Both tables show that the scenario has no real impact on total energy usage as very little demand is switched from private vehicle to public transport. The speed changes relate to only a small section of routes along the corridor and fail to reduce journey time sufficiently to see any increase in demand.

7.3.3 The overall energy usage is reduced by around 2,800 MJ in 2020 compared to the Do Nothing scenario and by 3,600 MJ in 2030. This is a very small impact.

Table 36. **Energy Usage (MJ/day) by Vehicle Type**

Vehicle Type	2020		2030	
	DoNothing	Southern Corridor	DoNothing	Southern Corridor
Energy (MJ)				
Total	140,097,931	0.0%	148,099,117	0.0%
Cars	108,636,454	0.0%	109,037,069	0.0%
Bikes	4,779,344	0.0%	5,070,980	0.0%
Goods	24,692,822	0.0%	31,984,810	0.0%
Buses	1,637,768	0.0%	1,654,716	0.0%
Trams	-	0.0%	-	0.0%
Trains	351,543	0.0%	351,543	0.0%
Vehicles				
Total	827,396	0.0%	891,676	0.0%
Cars	726,612	0.0%	773,587	0.0%
Bikes	45,002	0.0%	48,157	0.0%
Goods	46,976	0.0%	61,126	0.0%
Buses	8,398	0.0%	8,398	0.0%
Trams	408	0.0%	408	0.0%
Trains	495	0.0%	495	0.0%
Energy / Vehicle (MJ)				
Total	169	-0.1%	166	-0.1%
Cars	150	0.0%	141	0.0%
Bikes	106	0.0%	105	0.0%
Goods	526	0.0%	523	0.0%
Buses	195	0.0%	197	0.0%
Trams	-	0.0%	-	0.0%
Trains	710	0.0%	710	0.0%

Table 37. **Energy Usage (MJ/day) by Zone**

Zone	2020		2030	
	DoNothing	Southern Corridor	DoNothing	Southern Corridor
Total	140,097,931	0.0%	148,099,117	0.0%
1 - City Centre	10,135,338	0.0%	12,420,625	0.0%
2 - Clifton	3,520,356	0.0%	3,801,773	0.0%
3 - The Meadows	1,385,111	0.0%	1,572,437	0.0%
4 - Colwick Park	971,358	0.0%	1,057,404	0.0%
5 - St Ann's	1,919,738	0.0%	2,083,218	0.0%
6 - Bestwood	1,773,002	0.0%	1,864,238	0.0%
7 - Bulwell	2,532,077	0.0%	2,704,026	0.0%
8 - Wollaton Park	2,253,792	0.0%	2,419,700	0.0%
9 - Aspley	2,028,756	0.0%	2,134,920	0.0%
10 - West Bridgford & South	28,335,768	0.0%	28,413,827	0.0%
11 - Hucknall & North	10,994,994	0.0%	10,858,347	0.0%
12 - Beeston & Kimberley	14,314,460	0.0%	14,899,238	0.0%
13 - Ilkeston & Long Eaton	9,470,668	0.0%	9,849,392	0.0%
14 - Arnold & East	16,697,955	0.0%	17,898,521	0.0%
15 - External	33,764,557	0.0%	36,121,453	0.0%

7.3.4 Figure 13 shows the zonal changes graphically. The changes are very small, but in the right locations.

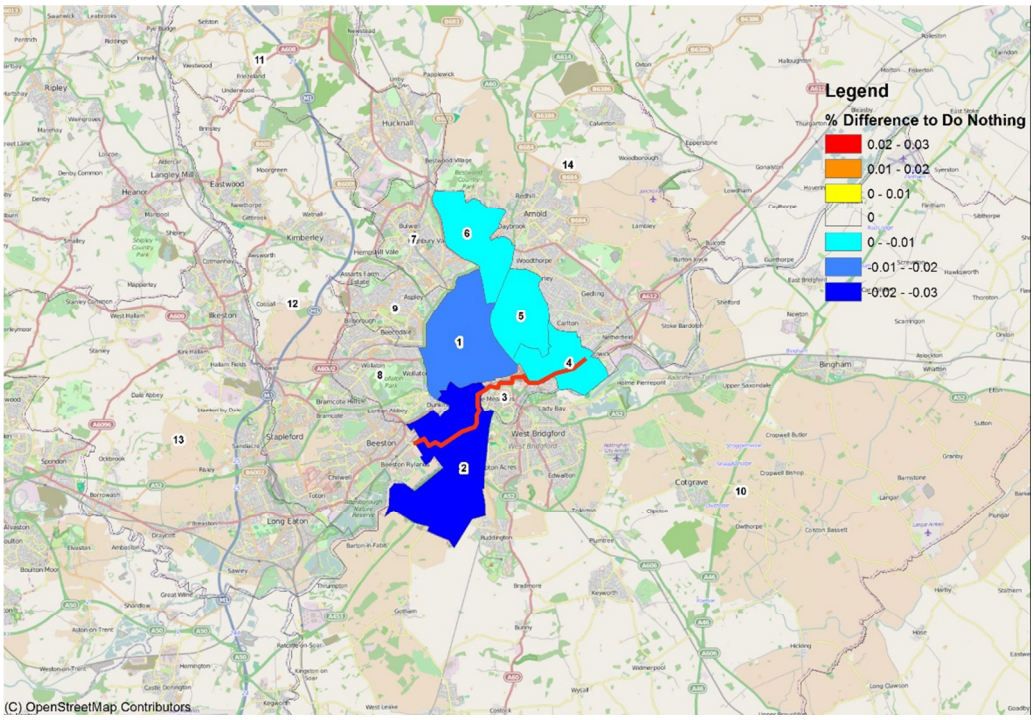


Figure 13. Change in Energy Usage (2030)

7.4 Summary

7.4.1 The reduction in bus journey times created by the Southern Corridor scheme is not substantial enough to effect a large mode shift to public transport away from private car. This results in a limited overall reduction in energy usage for the city.

8. INDIVIDUAL SCENARIO TESTS: LSTF - HOME WORKING

8.1 Introduction

8.1.1 This test investigated strategies to promote the use of non-motorised modes, walking and cycling, as well as encouraging people to utilise opportunities to work from home or car share to work.

8.1.2 To implement the scheme a 12% demand reduction was applied to private vehicles traveling between all zones in the central part of the city. A small portion of this demand is assumed to use public transport and the rest is treated as using active modes or not travelling (working from home). This is based on previous modelling work undertaken for this scheme.

8.2 Demand Outputs

8.2.1 Table 38 to Table 40 provide an overview of changes in transport demand, average occupancy and vehicle kilometres within the modelled area for the Do Nothing and the Scenario, in both of the forecast years.

8.2.2 The scenario reduces highway demand substantially whist public transport use see a small increase in use, increasing its mode share slightly. The additional public transport trips are made using buses and trams, increasing their average occupancies.

Table 38. **Demand & Mode Shares**

Mode	2020		2030	
	Do Nothing	LSTF - Homeworking	Do Nothing	LSTF - Homeworking
Demand By Mode				
Highway	3,397,176	3,363,675	3,648,952	3,610,549
Public Transport	454,990	460,843	517,241	523,950
Mode Share				
Highway	88.2%	88.0%	87.6%	87.3%
Public Transport	11.8%	12.0%	12.4%	12.7%
Change in Highway Demand		- 33,501		- 38,403
Change in PT		5,853		6,710

Table 39. **Average Public Transport Occupancy**

Mode	2020		2030	
	Do Nothing	LSTF - Homeworking	Do Nothing	LSTF - Homeworking
Occupancy				
Total	54.2	54.9	61.5	62.3
Buses	48.0	48.7	53.8	54.7
Trams	117.7	119.2	144.4	146.3
Trains	107.2	107.2	122.8	122.8
%Change in Occupancy				
Total		1.4%		1.4%
Buses		1.5%		1.5%
Trams		1.3%		1.3%
Trains		0.0%		0.0%

Table 40. **Vehicle Kms & Average Distance**

Distance	2020		2030	
	Do Nothing	LSTF - Homeworking	Do Nothing	LSTF - Homeworking
Vehicle KM				
Total	46,915,485	-0.8%	50,678,528	-0.8%
Cars	40,133,610	-0.9%	42,461,424	-1.0%
Bikes	2,469,902	-0.9%	2,627,082	-1.0%
Goods	4,311,973	0.0%	5,590,022	0.0%
Average Distance KM				
Total	17.92	0.1%	17.80	0.1%
Cars	17.71	0.1%	17.53	0.1%
Bikes	17.60	0.1%	17.42	0.1%
Goods	20.40	0.0%	20.32	0.0%

8.2.3 Table 40 provides an overview of the vehicle kilometres and the average distances travelled within the city. The decrease in private vehicle trips leads to a decrease in total vehicle kilometres for cars and bikes. Average trip length is slightly longer for these modes as more shorter trips are removed than longer trips.

8.3 Energy Outputs

8.3.1 Table 41 and Table 42 provide an overview of the energy usage by vehicle type and by zone for the 2020 and 2030 Do Nothing and the Scenario.

8.3.2 As the scheme involves removing private vehicle demand, there is a corresponding decrease in energy usage from cars and bikes. Zonal energy usage has also decreased in the targeted zones (1 to 9).

Table 41. **Energy Usage (MJ/day) by Vehicle type**

Vehicle Type	2020		2030	
	DoNothing	LSTF - Homeworking	DoNothing	LSTF - Homeworking
Energy (MJ)				
Total	140,097,931	-0.6%	148,099,117	-0.6%
Cars	108,636,454	-0.7%	109,037,069	-0.8%
Bikes	4,779,344	-0.7%	5,070,980	-0.8%
Goods	24,692,822	0.0%	31,984,810	0.0%
Buses	1,637,768	0.0%	1,654,716	0.0%
Trams	-	0.0%	-	0.0%
Trains	351,543	0.0%	351,543	0.0%
Vehicles				
Total	827,396	0.0%	891,676	0.0%
Cars	726,612	0.0%	773,587	0.0%
Bikes	45,002	0.0%	48,157	0.0%
Goods	46,976	0.0%	61,126	0.0%
Buses	8,398	0.0%	8,398	0.0%
Trams	408	0.0%	408	0.0%
Trains	495	0.0%	495	0.0%
Energy / Vehicle (MJ)				
Total	169	-0.6%	166	-0.7%
Cars	150	-0.7%	141	-0.8%
Bikes	106	-0.7%	105	-0.8%
Goods	526	0.0%	523	0.0%
Buses	195	0.0%	197	0.0%
Trams	-	0.0%	-	0.0%
Trains	710	0.0%	710	0.0%

Table 42. **Energy Usage (MJ/day) by Zone**

Zone	2020		2030	
	DoNothing	LSTF - Homeworking	DoNothing	LSTF - Homeworking
Total	140,097,931	-0.6%	148,099,117	-0.6%
1 - City Centre	10,135,338	-2.9%	12,420,625	-2.9%
2 - Clifton	3,520,356	-2.2%	3,801,773	-2.0%
3 - The Meadows	1,385,111	-1.4%	1,572,437	-1.2%
4 - Colwick Park	971,358	-2.3%	1,057,404	-1.8%
5 - St Ann's	1,919,738	-2.0%	2,083,218	-1.7%
6 - Bestwood	1,773,002	-2.6%	1,864,238	-2.5%
7 - Bulwell	2,532,077	-1.1%	2,704,026	-1.1%
8 - Wollaton Park	2,253,792	-1.0%	2,419,700	-0.9%
9 - Aspley	2,028,756	0.0%	2,134,920	0.0%
10 - West Bridgford & South	28,335,768	0.0%	28,413,827	0.0%
11 - Hucknall & North	10,994,994	0.0%	10,858,347	0.0%
12 - Beeston & Kimberley	14,314,460	0.0%	14,899,238	0.0%
13 - Ilkeston & Long Eaton	9,470,668	0.0%	9,849,392	0.0%
14 - Arnold & East	16,697,955	0.0%	17,898,521	0.0%
15 - External	33,764,557	-0.8%	36,121,453	-0.8%

8.3.3 Figure 14 shows the changes in energy use on a zonal basis.

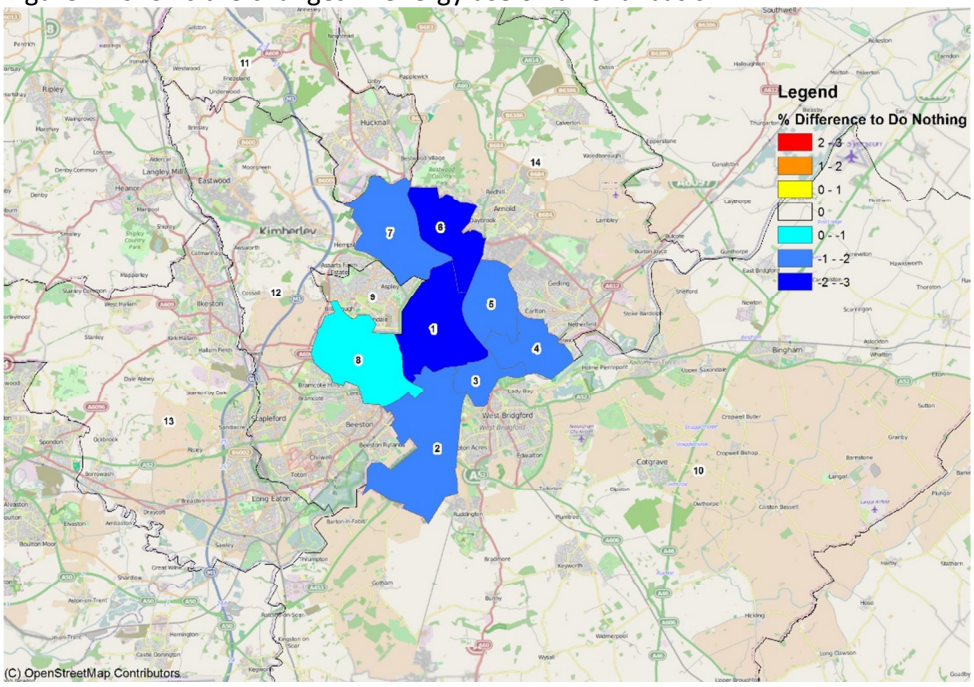


Figure 14. Change in Energy Usage (2030)

8.4 Summary

8.4.1 The scheme is assumed to reduce private vehicle trips by 12% in the core of the city centre. This results in a large decrease in energy usage between these zones. The reduction in energy usage is entirely dependent on the assumed impact of the scheme on private vehicle demand. As the scheme is predicted to have a large impact on reducing private car demand, it results in a large reduction in energy usage.

WP3 – Transport and Mobility Analysis

D.3.6. Transport Scenarios Results Report Trikala

October 2015

314164 (ENER/FP7/314164)

Project acronym:

InSMART

Project full title:

Integrative Smart City Planning

Coordination and support action (Coordinating Action)

FP7-ENERGY-SMARTICITIES-2012

Start date of project: 2013-12-01

Duration: 3 years

Deliverable D3.6.

Transport Scenarios Results Report Trikala

Work Package 3. Transport and Mobility Analysis

October 2015

Project co-funded by the European Commission within the Seventh Framework Programme		
Dissemination Level		
PU	Public	PU
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

Version	**Submitted by**	**Review Level***	**Date Submitted**	**Reviewed**
V01	CRES	WPL	May 2015	May 2015
V02	CRES	WPL	October 2015	October 2015

Editors		
	Name (organization)	**e-mail**
Leading participant	Matt Pollard (SYSTRA)	mpollard@systra.com
Contributing participants		
WP leader (WPL)	IRONS Duncan	dirons@systra.com

Executive Summary	
This report presents the results of the alternative scenarios of the transport model that has been developed in the framework of the INSMART project for the city of Trikala.	
Keywords	Transport scenarios




SCENARIOS REPORT - TRIKALA

INSMART – INTEGRATIVE SMART CITY PLANNING

SCENARIOS REPORT - TRIKALA

IDENTIFICATION TABLE	
Client/Project owner	European Commission
Project	InSmart – Integrative Smart City Planning
Study	Scenarios Report - Trikala
Type of document	Report
Date	
File name	InSmart_ScenarioRunsReport_Trikala_v1_20150722.docx
Reference number	102400
Number of pages	36

APPROVAL

Version	Name		Position	Date	Modifications
1	Author	James Whitehead Matthew Pollard	Analyst Project Manager		
	Checked by	Matt Pollard	Project Manager		
	Approved by	Duncan Irons	Project Director		
2	Author			DD/MM/YY	
	Checked by			DD/MM/YY	
	Approved by			DD/MM/YY	

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

IMAGE ATTRIBUTION

Top Left
Image: https://commons.wikimedia.org/wiki/File:Koursoum_Mosque,_Trikala.jpg
Attribution: Egmontaz

Top Right
Image: https://commons.wikimedia.org/wiki/File:Trikala_bus_terminal.JPG
Attribution: Horiuchi73

Bottom Left:
Image: https://commons.wikimedia.org/wiki/File:Lithaiosrivertrikala.jpg
Attribution: Tilemachos Efthimiadis

Bottom Right
Image: https://commons.wikimedia.org/wiki/File:Fort_of_Trikala.jpg
Attribution: Τόμμυ

1. INTRODUCTION

1.1 Project Overview

1.1.1 InSmart is a three year, European funded project which involves four European Cities working partnership towards a sustainable energy future. The primary objective of the project is to develop sustainable energy action plans for each partner city.

1.1.2 The four cities are:

- Cesena, Italy;
- Evora, Portugal;
- Nottingham, UK; and
- Trikala, Greece.

1.1.3 A mix of sustainable energy measures to improve the energy efficiency of each city will be identified through the use of a variety of tools and approaches and covering a wide range of sectors from the residential and transport sectors to street lighting and waste collection.

1.1.4 SYSTRA's role within the project is to identify, test and report on a series of land use and transport based strategies aimed at reducing the transport-related energy usage and carbon generation of each city.

1.1.5 The initial task of calculating the current energy usage and carbon emissions generated by each city is recorded in the Base Model Reports for each city. The impact of the forecast strategies has then been obtained by comparing them with the Do Nothing Scenario, which represents technological/efficiency and population changes from the Base Year with no schemes implemented in 2020 and 2030.

1.2 Report Structure

1.2.1 The report is split into three sections:

- Model Run Comparisons – a comparison of various outputs from modelled scenarios;
- Future Year Base and Do Nothing Scenarios – looking at changes between the base year and forecast years; and
- Individual Scenario Tests – a more detailed analysis of each of the specified future year scenarios.

2. TEST COMPARISONS

2.1 Introduction

2.1.1 This report covers the city of Trikala in the northwest Greek region of Thessaly. The following Do Something scenarios being run for the forecast years of 2020 and 2030:

- **Future Base**: change in vehicle fleet splits over time only;
- **Do Nothing:** change in population;
- **New Ring Road**: construction of a new 1.28km section of highway to the east of Trikala, connecting the national roads of 'Trikala – Phili' and 'Trikala – Ioannina'.
- **New Cycle Lane:** implementation of a new 2km cycle lane alongside Kalampaka Road, to the north of the city.

2.1.2 A more detailed description of each scenario, along with information on model inputs and assumptions is given in later chapters. The purpose of this chapter is to provide a summary of all the tests run for easy comparison.

2.1.3 Figure 1 shows the total energy usage for all scenarios that have been run for Trikala, compared to the Base year, Future Base and Do Nothing scenarios.

2.1.4 It can be seen that the largest change in energy usage is between the Future Base and the Base. This represents the vehicle types changing over time, as people buy newer and more efficient vehicles. By 2030 this accounts for a 16% reduction in energy usage.

2.1.5 The Do Nothing scenario includes changes in population. National figures were used for Trikala and forecasts predict a 1% drop in population by 2030, which results in a minimal change in energy use between the Future Base and Do Nothing scenarios.

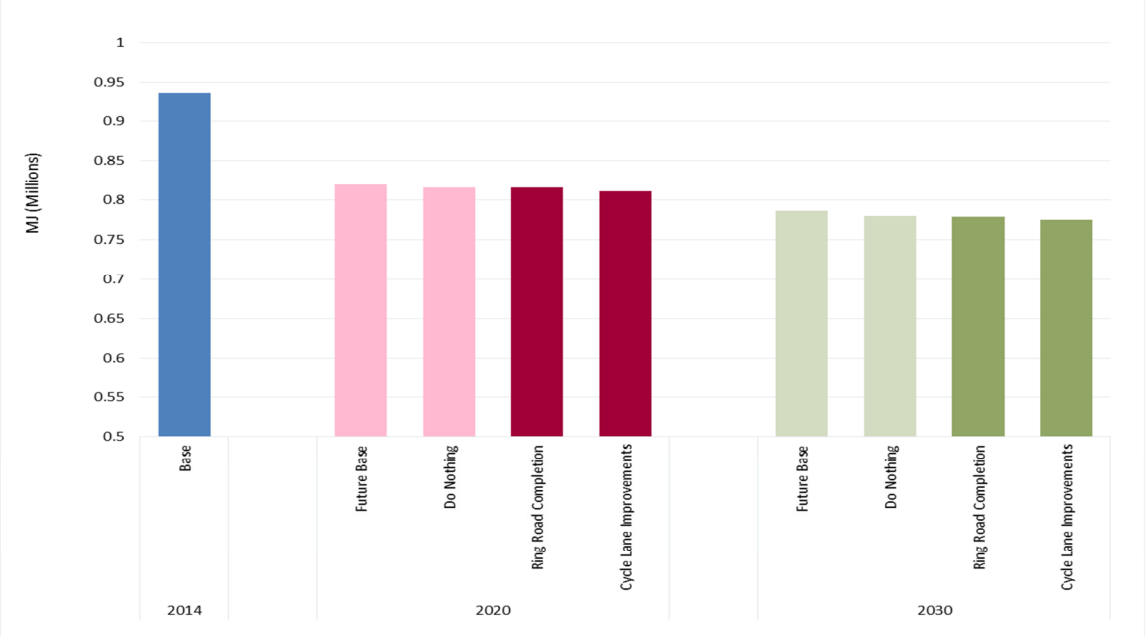


Figure 1. Total Energy Usage by Scenario

2.1.6 Figure 2 shows the difference between each Do Something scenario and the Do Nothing scenario. It can be seen that of the two scenarios run both reduce the energy consumption of the city, but only by a very small amount – both less than 1%, with the cycle lane improvements providing the greatest impact as this measure encourages people to transfer from car to cycling.

2.1.7 At a more detailed level, looking at the zones close to the areas affected there are larger changes and these are shown in the more detailed scenario chapters that follow.

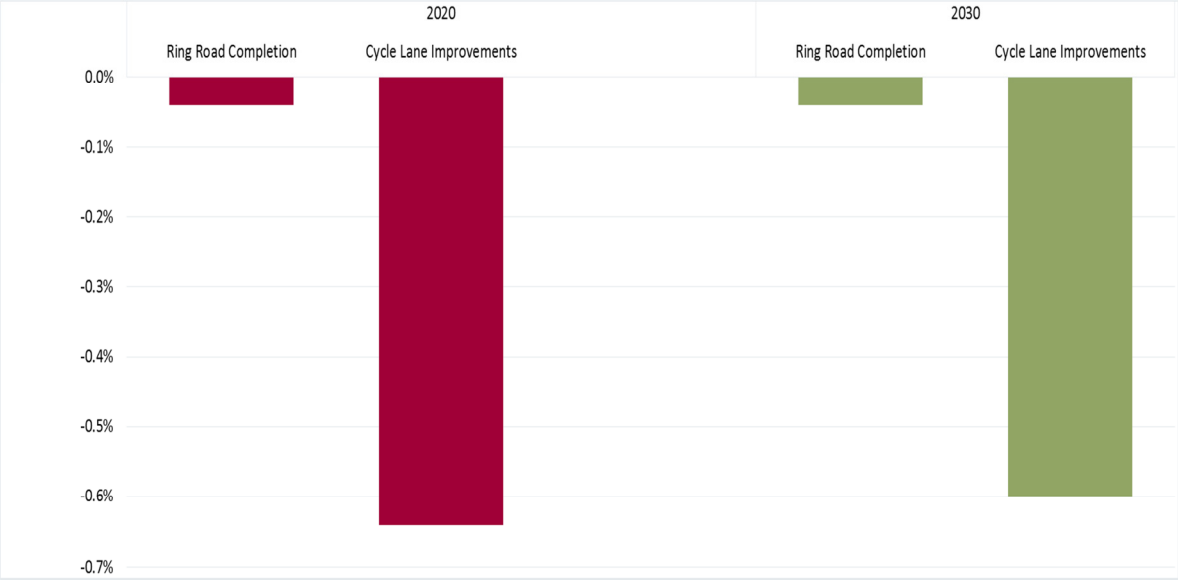


Figure 2. Change from Do Nothing Scenario per Test

2.1.8 Table 1 shows a breakdown of the total energy usage by scenario and the percentage change compared to the Base Year test.

Table 1. Energy Usage by Scenario

SCENARIO	ENERGY (MJ)			CHANGE FROM BASE YEAR	
	2014	2020	2030	2020	2030
Base Year	934,855	-	-	-	-
Future Base	-	818,495	785,902	88%	84%
Do Nothing	-	815,245	779,008	87%	83%
Ring Road Completion	-	814,917	778,692	87%	83%
Cycle Lane Improvements	-	810,015	774,338	87%	83%

2.1.9 Table 2 and Table 3 show the change in energy usage by vehicle type for the different scenarios for 2020 and 2030. The changes are shown as percentage changes from the Do Nothing scenarios.

2.1.10 Although the changes are small over the whole model the overall impact by vehicle type is in the expected areas of the city in the catchment areas of the scheme. One of the stated aims of the new ring road was to remove goods traffic from the centre of the city reducing energy usage and there is an almost 2% reduction.

2.1.11 The cycling improvements are modelled as a reduction in car, moped and motorcycle demand, which represents the shift to cycling. The predicted reduction in energy usage is consistent with this response to the measure.

Table 2. Energy Usage (MJ/day) by Vehicle Type (2020)

Vehicle Type	Do Nothing	Ring Road Completion	Cycle Lane Improvements
Energy (MJ)			
Total	815,245	0.0%	-0.6%
Cars	518,695	0.0%	-0.7%
Bikes	218,142	0.0%	-0.7%
Goods	11,866	-1.9%	0.0%
Buses	61,831	0.0%	0.0%
Trains	4,711	0.0%	0.0%
Vehicles			
Total	48,837	0.0%	0.0%
Cars	30,921	0.0%	-0.1%
Bikes	17,182	0.0%	0.0%
Goods	245	0.0%	0.0%
Buses	478	0.0%	0.0%
Trains	12	0.0%	0.0%
Energy / Vehicle (MJ)			
Total	17	0.0%	-0.6%
Cars	17	0.0%	-0.7%
Bikes	13	0.0%	-0.7%
Goods	48	-1.9%	0.0%
Buses	129	0.0%	0.0%
Trains	393	0.0%	0.0%

Table 3. Energy Usage (MJ/day) by Vehicle Type (2030)

Vehicle Type	Do Nothing	Ring Road Completion	Cycle Lane Improvements
Energy (MJ)			
Total	779,008	0.0%	-0.6%
Cars	484,789	0.0%	-0.7%
Bikes	215,903	0.0%	-0.7%
Goods	11,860	-1.9%	0.1%
Buses	61,746	0.0%	0.0%
Trains	4,711	0.0%	0.0%
Vehicles			
Total	48,593	0.0%	0.0%
Cars	30,762	0.0%	-0.1%
Bikes	17,096	0.0%	0.0%
Goods	245	0.0%	0.0%
Buses	478	0.0%	0.0%
Trains	12	0.0%	0.0%
Energy / Vehicle (MJ)			
Total	16	0.0%	-0.6%
Cars	16	0.0%	-0.6%
Bikes	13	0.0%	-0.7%
Goods	48	-1.9%	0.1%
Buses	129	0.0%	0.0%
Trains	393	0.0%	0.0%

2.1.12 Table 4 and Table 5 show the change in energy usage by zone for all of the scenarios for 2020 and 2030.

2.1.13 For both years the Ring Road Completion scenario shows very little change. The largest percentage change are in zones 13 and 14 which are both small and show only small absolute changes. These increases come about due to an increase in the distance travelled from these zones with the inclusion of the new road, and a corresponding increase in vehicle kilometres.

2.1.14 The 2% reduction in energy usage from Goods vehicles seen in Table 3 is small in the overall context of the city centre in terms of the total energy change as goods vehicles representing only 1% of the total number of vehicles.

2.1.15 The changes in energy usage for the Cycle Lane Improvements test are in line with expectations – the largest changes are at zones 4 and 7 which are the residential end of the cycle lane. The other zone affected are also along the cycle route corridor.

Table 4. Energy Usage (MJ/day) by Zone (2020)

Zone	Do Nothing	Ring Road Completion	Cycle Lane Improvements
Total	815,245	0.0%	-0.6%
1 - City Centre	39,116	0.0%	-0.1%
2 - Alexandra	13,244	0.0%	-0.4%
17 - Kentro	13,191	0.0%	0.0%
20 - Siggrou	6,371	0.0%	0.0%
9 - Alonia Baras	26,383	0.0%	0.0%
10 - Spartis	3,001	0.0%	0.0%
15 - Archimidi	8,163	0.0%	0.0%
16 - Dim Ntai	11,489	0.0%	-1.2%
18 - Varousi	29,245	0.0%	-0.8%
3 - Pirgos	56,430	0.0%	0.0%
4 - Amygdalies	130,693	0.0%	-3.1%
5 - Papamanou	5,117	-0.6%	0.0%
6 - Pirgetos	53,963	0.0%	0.0%
7 - Nekrotafio Trikalon	25,384	0.0%	-2.8%
8 - Keramaria	122,612	0.0%	0.0%
11 - General Hospital	22,662	0.0%	0.0%
12 - Agia Moni Gardikaki Ampelakia	92,120	0.0%	0.0%
13 - Patmou	5,054	0.7%	0.0%
14 - Flamouliou	4,336	2.6%	0.0%
19 - Ethniko Stadium	60,350	-0.9%	0.0%
21 - External	86,321	0.0%	0.0%

Table 5. Energy Usage (MJ/day) by Zone for (2030)

Zone	Do Nothing	Ring Road Completion	Cycle Lane Improvements
Total	779,008	0.0%	-0.6%
1 - City Centre	38,683	0.0%	0.0%
2 - Alexandra	12,732	0.0%	-0.2%
17 - Kentro	12,537	0.0%	0.2%
20 - Siggrou	6,053	0.0%	0.2%
9 - Alonia Baras	24,939	0.0%	0.1%
10 - Spartis	2,855	0.0%	0.0%
15 - Archimidi	7,761	0.0%	0.1%
16 - Dim Ntai	10,918	0.0%	-1.1%
18 - Varousi	27,705	0.0%	-0.7%
3 - Pirgos	53,692	0.0%	0.1%
4 - Amygdalies	124,514	0.0%	-3.2%
5 - Papamanou	4,897	-0.6%	0.1%
6 - Pirgetos	51,551	0.0%	0.0%
7 - Nekrotafio Trikalon	24,209	0.0%	-2.7%
8 - Keramaria	116,439	0.0%	0.1%
11 - General Hospital	21,601	0.0%	0.0%
12 - Agia Moni Gardikaki Ampelakia	87,799	0.0%	0.1%
13 - Patmou	4,819	0.6%	0.0%
14 - Flamouliou	4,141	2.6%	0.0%
19 - Ethniko Stadium	57,538	-0.9%	0.0%
21 - External	83,624	0.0%	0.0%

2.1.16 For each of the 2020 scenarios Table 6 shows the change in demand and mode share, Table 7 shows the change in average occupancy on public transport and Table 8 shows the change in vehicle kilometres and average distance. Table 9 to Table 11 show the same information for 2030.

2.1.17 Overall, the changes are very small which is to be expected given the magnitude of the proposed measures that have been identified.

Table 6. Demand by Vehicle Class (2020)

Mode	Do Nothing	Ring Road Completion	Cycle Lane Improvements
Demand By Mode			
Highway	163,570	163,582	162,354
Public Transport	10,559	10,547	10,478
Mode Share			
Highway	94%	94%	94%
Public Transport	6%	6%	6%
Change in Highway Demand		12	- 1,216
Change in Public Transport Demand		- 12	- 81

Table 7. Average Public Transport Occupancy (2020)

Sub Mode	Do Nothing	Ring Road Completion	Cycle Lane Improvements
Average Occupancy			
Total	25.1	25.0	24.9
Buses	25.7	25.6	25.5
Trains	1.3	1.3	1.3
%Change in Occupancy			
Total		99.9%	99.3%
Buses		99.9%	99.3%
Trains		100.0%	100.0%

Table 8. Vehicle Kms & Average Distance (2020)

Vehicle Type	Do Nothing	Ring Road Completion	Cycle Lane Improvements
Vehicle Km			
Total	383,746	99.5%	98.9%
Cars	239,532	99.5%	98.8%
Bikes	133,747	99.5%	98.9%
Goods	2,208	97.2%	100.0%
Buses	8,001	100.0%	100.0%
Trains	258	100.0%	100.0%
Average Distance (Km)			
Total	9.22	99.9%	100.0%
Cars	2.92	100.0%	100.1%
Bikes	2.93	100.0%	100.1%
Goods	2.00	97.2%	100.0%
Buses	16.74	100.0%	100.0%
Trains	21.50	100.0%	100.0%

Table 9. Demand & Mode Shares (2030)

Mode	Do Nothing	Ring Road Completion	Cycle Lane Improvements
Demand By Mode			
Highway	162,214	162,227	160,976
Public Transport	11,036	11,023	10,951
Mode Share			
Highway	94%	94%	94%
Public Transport	6%	6%	6%
Change in Highway Demand		13	- 1,238
Change in Public Transport Demand		- 13	- 85

Table 10. Average Public Transport Occupancy (2030)

Sub Mode	Do Nothing	Ring Road Completion	Cycle Lane Improvements
Average Occupancy			
Total	26.2	26.2	26.0
Buses	26.8	26.8	26.6
Trains	1.3	1.3	1.3
%Change in Occupancy			
Total		99.9%	99.3%
Buses		99.9%	99.3%
Trains		100.0%	100.0%

Table 11. Vehicle Kms & Average Distance (2030)

Vehicle Type	Do Nothing	Ring Road Completion	Cycle Lane Improvements
Vehicle Km			
Total	382,060	98.7%	98.0%
Cars	238,454	98.7%	97.9%
Bikes	133,138	98.7%	98.0%
Goods	2,208	97.4%	100.2%
Buses	8,001	100.0%	100.0%
Trains	258	100.0%	100.0%
Average Distance (Km)			
Total	9.22	99.9%	100.0%
Cars	2.92	99.9%	100.0%
Bikes	2.93	99.9%	100.0%
Goods	2.00	97.4%	100.2%
Buses	16.74	100.0%	100.0%
Trains	21.50	100.0%	100.0%

2.1.18 Table 8 and Table 11 suggest that the average distance travelled by the city's bus services is relatively high, at 16.46km. The reason for such a high value is that all but four of the city's bus services incorporate external areas of the model within their routes; thereby adding 21.5km to the distance they travel (the average external PT distance travelled) within the internal modelled area. If all the services where to be modelled only within the city boundary, the average distance for buses would be closer to the 4-6km of the bus services that do not travel to the external zone.

2.1.19 The outputs from the tests can be summarised as follows;

- The largest change is from the Base Year to the Future Base and is due to the change in vehicle splits and a shift to more efficient vehicles;
- The population is forecast to remain roughly the same (1% reduction by 2030) so the change from the Future Base to the Do Nothing is minimal;
- On a city-wide level both Scenario Tests have very little impact. At a more detailed local level the impact is increased, but it is still small.

3. FUTURE BASE AND DO NOTHING SCENARIOS

3.1 Introduction

3.1.1 To establish the scale of changes taking place in the model whilst progressing from the base year to the future years, two scenarios were run.

- **Future Base Scenario**
  - Same population data as the 2014 Base Year run.
  - Vehicle Fleet splits from 2020 and 2030 – this captures the change in fleet over time as people purchase more fuel efficient cars.
- **Do Nothing Scenario**
  - Includes both changes to vehicle fleet and population changes. This shows the change in energy usage associated with doing "Nothing" – i.e. implementing no schemes/policy measures.

3.2 Future Year Changes and Outcomes

3.2.1 The population in Trikala is projected to fall from around 62,150 in 2014 to 61,900 in 2020 and 61,600 in 2030. This is based on National growth rates as no local data was available.

3.2.2 The forecast vehicle fleet splits are based on UK data as no other comparable local data was available. This introduces a limitation to the model as these splits may not be the same for Trikala. However, in the final assessment of scenarios these splits will be determined by the TIMES model.

3.2.3 Figure 3 shows the total energy usage for each scenario for the two future years, compared to the 2014 Base year. As a result of the small expected decrease in Trikala's population, there is very limited difference between the Future Base and Do Nothing scenarios for the forecast years of 2020 and 2030.

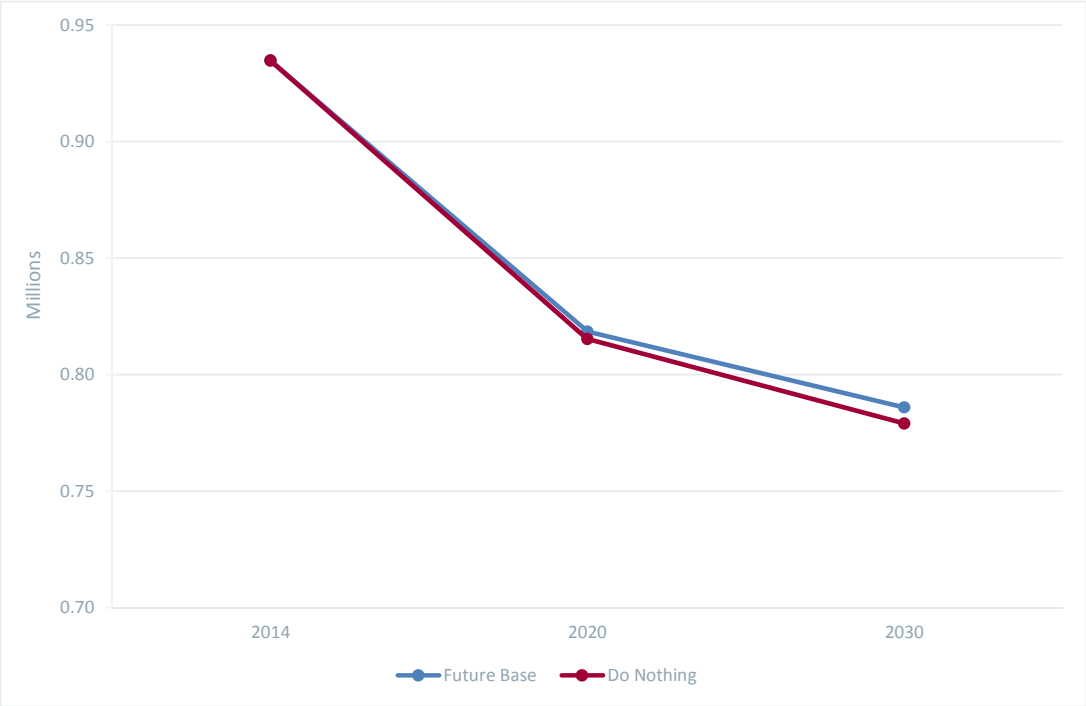


Figure 3. Energy Usage for Future Base and Do Nothing Scenarios

3.2.4 Figure 4 shows the change in energy the change in fleet splits, change in population and the combined change. The change in population has very little impact.

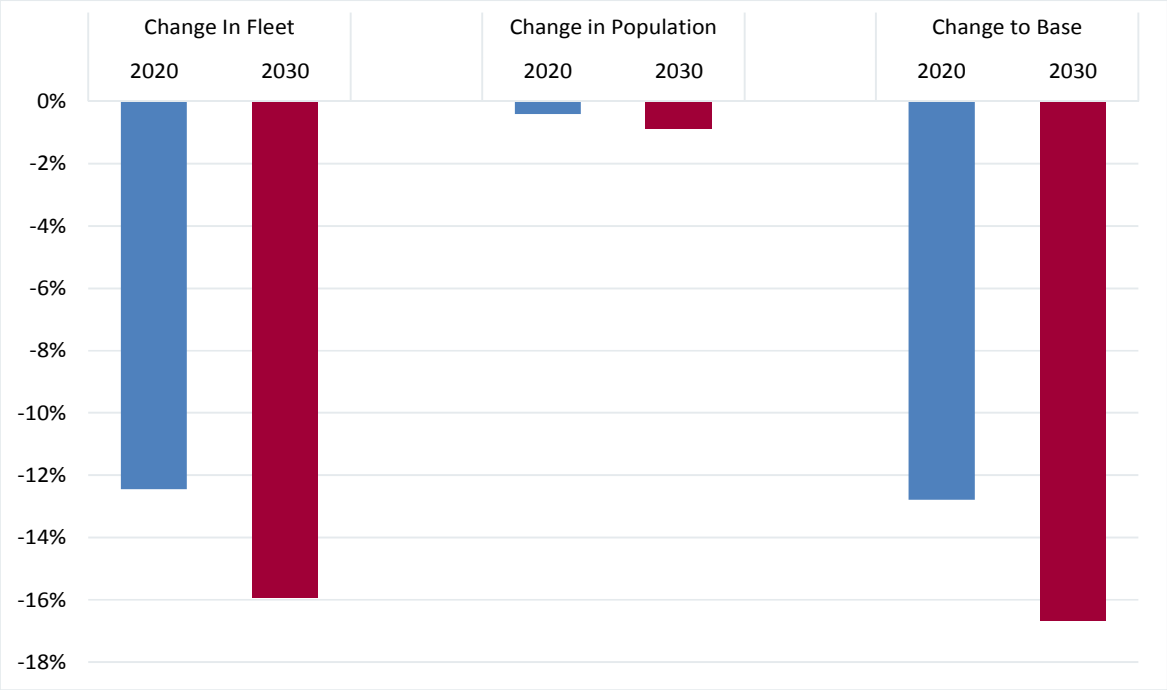


Figure 4. Change in Energy split by component

3.2.5 Table 12 shows the total changes in population, demand, energy usage for the Future Base and Do Nothing.

Table 12. Energy usage by person and trip compared between scenarios

SCENARIO	POPULATION	DEMAND	ENERGY (MJ)	ENERGY PER PERSON (MJ)	ENERGY PER TRIP (MJ)
Base 2014	**62,154**	**178,091**	**934,855**	**15.0**	**5.2**
YEAR - 2020					
Future Base	**62,154**	**178,010**	**818,495**	**13.2**	**4.6**
Diff to Base			-116,360	-1.9	-0.7
%Diff to Base			-12.4%	-12.4%	-12.4%
Do Nothing	**61,905**	**177,237**	**815,245**	**13.2**	**4.6**
Diff to Base	-249	-853	-119,611	-1.9	0.0
%Diff to Base	-0.4%	-0.5%	-12.8%	-12.4%	0.0%
Diff to Future Base			-3,250	0.0	0.0
%Diff to Future Base			-0.4%	0.0%	0.0%
YEAR - 2030					
Future Base	**62,154**	**178,099**	**785,902**	**12.6**	**4.4**
Diff to Base			-148,954	-2.4	-0.8
%Diff to Base			-15.9%	-15.9%	-15.9%
Do Nothing	**61,595**	**176,433**	**779,008**	**12.6**	**4.4**
Diff to Base	-559	-1,657	-155,847	-2.4	-0.8
%Diff to Base	-0.9%	-0.9%	-16.7%	-15.9%	-15.9%
Diff to Future Base			-6,894	0.0	0.0
%Diff to Future Base			-0.9%	0.0%	0.1%

3.2.6 As can be seen in both Figure 4 and Table 12 the big impact is the change in fleet, leading to a 13% reduction in energy usage in 2020 and a 17% reduction in 2030.

3.2.7 Figure 5 shows the change in energy usage by zone between the Base Year test and the Do Nothing. This indicates that there is predicted to be a reduction in transport energy use in all areas of the city, which reflects the changes in the vehicle fleet mix to more energy efficient vehicles.

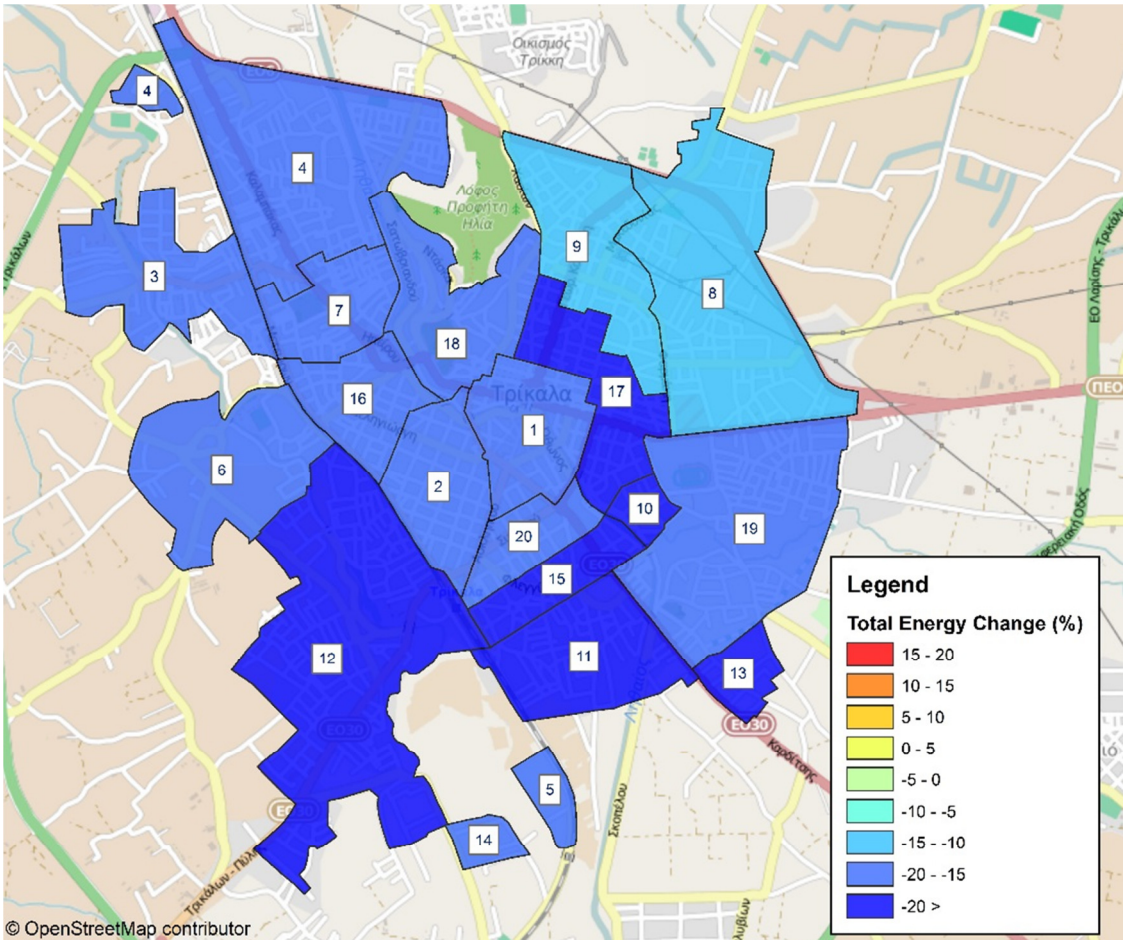


Figure 5. Difference Between Base Year and 2030 Do Nothing (%)

3.2.8 Table 13 and Table 14 display the energy usage data for the Base Year, Future Base and Do Nothing scenarios by vehicle type, isolating the effects of the fleet change and population change.

3.2.9 It can be seen that the largest reduction in energy usage comes from increased efficiency from cars. The increased efficiency for other vehicle types is much less, particularly for goods vehicles and buses which only decrease by less than 1%.

Table 13. 2020 Energy Usage per Scenario

Vehicle Type	Base Year (2014)	Future Base (2020)	Do Nothing (2020)	Effect of Fleet Change		Effect of Population Change		Combined Effect	
Energy (MJ)									
Total	934,855	818,495	815,245	- 116,360	-12%	- 3,250	-0.4%	- 119,611	-13%
Cars	625,389	520,984	518,695	- 104,405	-17%	- 2,289	-0.4%	- 106,694	-17%
Bikes	230,646	219,104	218,142	- 11,542	-5%	- 962	-0.4%	- 12,504	-5%
Goods	11,960	11,866	11,866	- 94	-1%	-	0.0%	- 94	-1%
Buses	62,150	61,831	61,831	- 319	-1%	-	0.0%	- 319	-1%
Trains	4,711	4,711	4,711	-	0%	-	0.0%	-	0%
Vehicles									
Total	49,022	49,031	48,837	9	0%	- 194	-0.4%	- 184	0%
Cars	31,036	31,046	30,921	9	0%	- 124	-0.4%	- 115	0%
Bikes	17,251	17,251	17,182	0	0%	- 69	-0.4%	- 69	0%
Goods	245	245	245	-	0%	-	0.0%	-	0%
Buses	478	478	478	-	0%	-	0.0%	-	0%
Trains	12	12	12	-	0%	-	0.0%	-	0%
Energy / Vehicle (MJ)									
Total	19	17	17	- 2	-12%	- 0	0.0%	- 2	-12%
Cars	20	17	17	- 3	-17%	- 0	0.0%	- 3	-17%
Bikes	13	13	13	- 1	-5%	- 0	0.0%	- 1	-5%
Goods	49	48	48	- 0	-1%	-	0.0%	- 0	-1%
Buses	130	129	129	- 1	-1%	-	0.0%	- 1	-1%
Trains	393	393	393	-	0%	-	0.0%	-	0%

Table 14. 2030 Energy Usage per Scenario

Vehicle Type	Base Year (2014)	Future Base (2030)	Do Nothing (2030)	Effect of Fleet Change		Effect of Population Change		Combined Effect	
Energy (MJ)									
Total	934,855	785,902	779,008	- 148,954	-16%	- 6,894	-1%	- 155,847	-17%
Cars	625,389	489,721	484,789	- 135,668	-22%	- 4,932	-1%	- 140,600	-22%
Bikes	230,646	217,842	215,903	- 12,804	-6%	- 1,939	-1%	- 14,744	-6%
Goods	11,960	11,852	11,860	- 108	-1%	7	0%	- 100	-1%
Buses	62,150	61,776	61,746	- 374	-1%	- 29	0%	- 403	-1%
Trains	4,711	4,711	4,711	-	0%	-	0%	-	0%
Vehicles									
Total	49,022	49,027	48,593	6	0%	- 435	-1%	- 429	-1%
Cars	31,036	31,042	30,762	6	0%	- 279	-1%	- 274	-1%
Bikes	17,251	17,251	17,096	-	0%	- 155	-1%	- 155	-1%
Goods	245	245	245	-	0%	-	0%	-	0%
Buses	478	478	478	-	0%	-	0%	-	0%
Trains	12	12	12	-	0%	-	0%	-	0%
Energy / Vehicle (MJ)									
Total	19	16	16	- 3	-16%	0	0%	- 3	-16%
Cars	20	16	16	- 4	-22%	- 0	0%	- 4	-22%
Bikes	13	13	13	- 1	-6%	0	0%	- 1	-6%
Goods	49	48	48	- 0	-1%	0	0%	- 0	-1%
Buses	130	129	129	- 1	-1%	- 0	0%	- 1	-1%
Trains	393	393	393	-	0%	-	0%	-	0%

4. INDIVIDUAL SCENARIO TESTS: NEW RING ROAD

4.1 Introduction

4.1.1 This scenario looks at the implementation of a new 1.28Km section of ring road that is expected to connect the national roads of 'Trikala-Pili' and 'Trikala-Ioannina'. The anticipated impact of this scheme is that vehicles will re-route away from the centre of Trikala and along the new road, with a significant number of the heavy vehicles adopting this approach.

4.1.2 This project is planned to be completed within 2015, and is most likely due to affect the journeys between the city's eastern zones of 5, 8, 11, 12, 13, 14, and 19.

4.1.3 Information on the location of the new infrastructure was received from Trikala Municipality. The anticipated effects that would be generated by the scheme were established following a review of the affected zone-zone journeys. Figure 6 shows the new road link and the zonal movements that are effected.

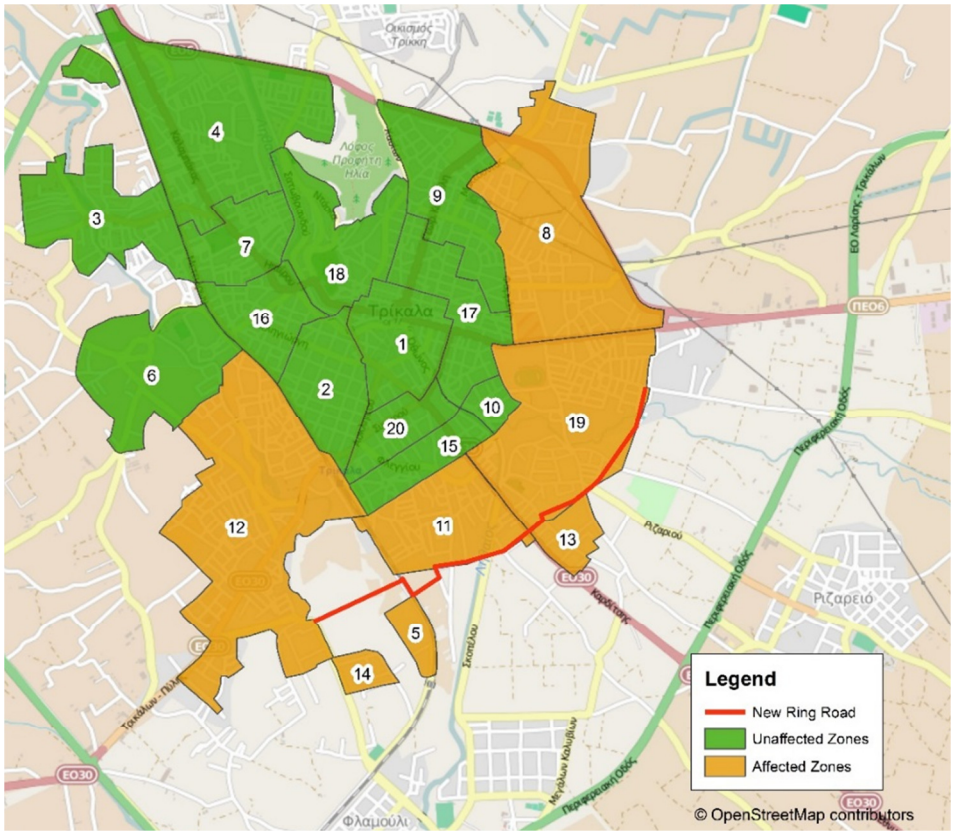


Figure 6. Scheme Details – New Ring Road

4.1.4 To implement the scheme the following changes were made to the model inputs:

- The affected zone-zone journeys were re-routed, through an ArcGIS process, to utilise the new ring road section.

- The changing of the route for each zone-zone journey subsequently altered the journey distance and the zones passed through. Both of these altered data sets were then used to change the model inputs.

4.1.5 Figure 7 and Figure 8 illustrate the changes made in zonal movements following the introduction of the proposed new ring road.

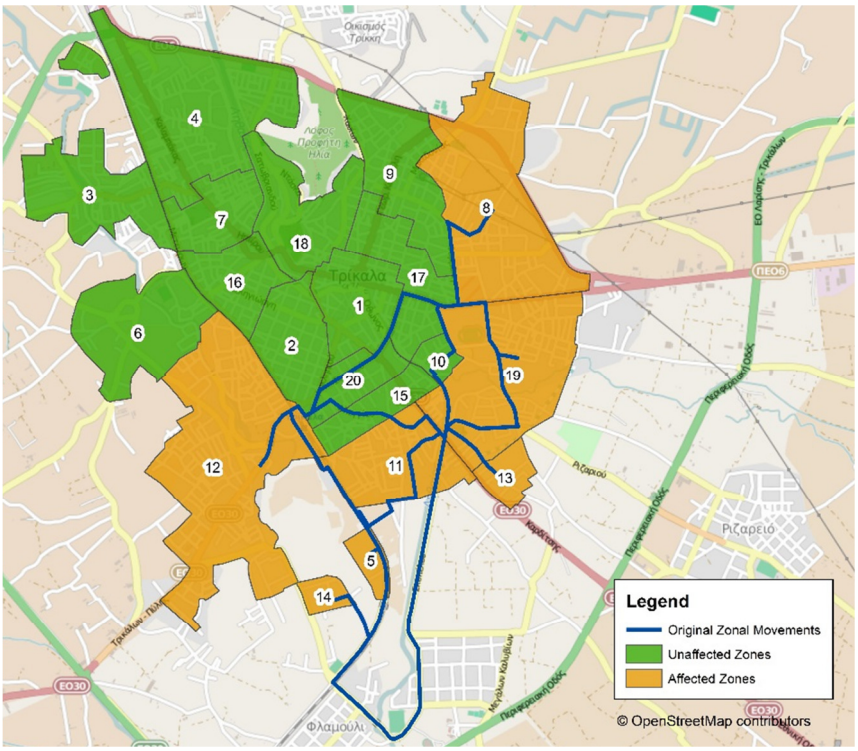


Figure 7. Zonal Movements – Do Nothing

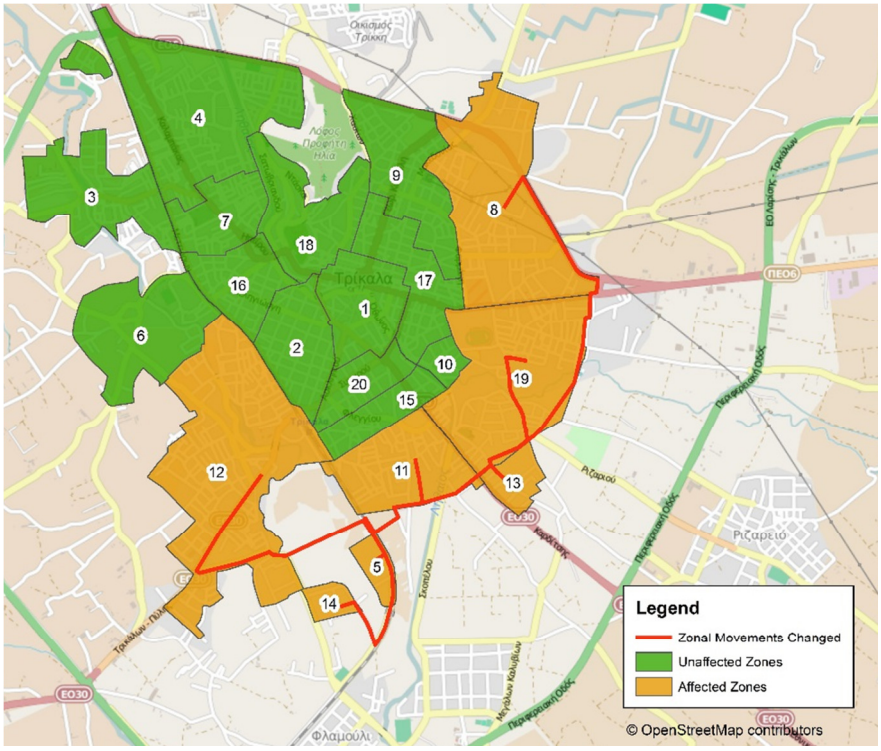


Figure 8. Zonal Movements – New Ring Road

4.1.6 The aggregate approach adopted for the transport modelling has resulted in a number of assumptions being made which have simplified the assessment of this scheme. These include:

- It has been assumed that there are no changes to speeds in the model. It is likely that the new road will be quicker than the previous route via the city centre which is likely to be more congested.
- Energy usage is reported only at the Origin or Destination of the trip, which for this scenario show very little change.

4.2 Demand Outputs

4.2.1 Table 15 to Table 17 provides an overview of changes in transport demand, average occupancy and vehicle kilometres within the modelled area for the Do Nothing and the Scenario, in both of the forecast years.

4.2.2 The scenario leads to very little mode shift from highway to public transport. This leads to very little change in the average occupancies of the bus and rail services.

Table 15. Demand & Mode Shares

Mode	2020		2030	
	Do Nothing	Ring Road Completion	Do Nothing	Ring Road Completion
Demand By Mode				
Highway	163,570	163,582	162,214	162,227
Public Transport	10,559	10,547	11,036	11,023
Mode Share				
Highway	94%	94%	94%	94%
Public Transport	6%	6%	6%	6%
Change in Highway Demand		12		13
Change in Public Transport Demand		- 12		- 13

Table 16. Average Public Transport Occupancy

Sub Mode	2020		2030	
	Do Nothing	Ring Road Completion	Do Nothing	Ring Road Completion
Average Occupancy				
Total	25.1	25.0	26.2	26.2
Buses	25.7	25.6	26.8	26.8
Trains	1.3	1.3	1.3	1.3
%Change in Occupancy				
Total		99.9%		99.9%
Buses		99.9%		99.9%
Trains		100.0%		100.0%

Table 17. Vehicle Kms & Average Distance

Vehicle Type	2020		2030	
	Do Nothing	Ring Road Completion	Do Nothing	Ring Road Completion
Vehicle Km				
Total	383,746	99.5%	382,060	98.7%
Cars	239,532	99.5%	238,454	98.7%
Bikes	133,747	99.5%	133,138	98.7%
Goods	2,208	97.2%	2,208	97.4%
Buses	8,001	100.0%	8,001	100.0%
Trains	258	100.0%	258	100.0%
Average Distance (Km)				
Total	9.22	99.9%	9.22	99.9%
Cars	2.92	100.0%	2.92	99.9%
Bikes	2.93	100.0%	2.93	99.9%
Goods	2.00	97.2%	2.00	97.4%
Buses	16.74	100.0%	16.74	100.0%
Trains	21.50	100.0%	21.50	100.0%

4.2.3 Table 17 provides further evidence of the effect the introduction of the new section of highway has on reducing journey distances. In both forecast years, the distances travelled by all cars, bikes and goods vehicles decreased, with goods vehicles showing the largest reduction. A total journey time value decrease of 0.3% across all journeys further supports the effect of the new ring road.

4.2.4 Table 18 shows the demand change for private car compared to the Do Nothing scenario for 2030. There is a general redistribution of trips between the affected zones – for example trips from zone 13 are redistributed to zones 12 and 19 as the distances between these zones is now reduced.

Table 18. Demand Change Table Between Do Nothing and Scenario (2030)

	1	2	17	20	9	10	15	16	18	3	4	5	6	7	8	11	12	13	14	19	21	
Private Vehicles	City Centre	Alexandra	Kentro	Siggrou	Alonia Baras	Spartis	Archimidi	Dim Ntai	Varousi	Pirgos	Amygdalies	Papamanou	Pirgetos	Nekrotafio Trikalon	Keramaria	General Hospital	Agia Moni Gardikaki Ampelakia	Patmou	Flamouliou	Ethniko Stadium	External	Total
1 City Centre	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2 Alexandra	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
17 Kentro	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
20 Siggrou	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
9 Alonia Baras	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
10 Spartis	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
15 Archimidi	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
16 Dim Ntai	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
18 Varousi	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
3 Pirgos	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
4 Amygdalies	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
5 Papamanou	-2%	-2%	-2%	-1%	0%	-2%	0%	-2%	-2%	0%	-4%	0%	0%	-4%	0%	-1%	-12%	41%	0%	219%	0%	0%
6 Pirgetos	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
7 Nekrotafio Trikalon	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
8 Keramaria	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	-2%	0%	0%	0%	0%
11 General Hospital	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
12 Agia Moni Gardikaki Ampelakia	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	35%	0%	0%	0%	0%
13 Patmou	-2%	-2%	-2%	-1%	-1%	-2%	0%	-2%	-2%	0%	-4%	0%	0%	-4%	0%	-2%	50%	-15%	0%	47%	0%	0%
14 Flamouliou	1%	3%	1%	1%	1%	1%	0%	1%	1%	0%	8%	0%	0%	8%	0%	5%	13%	-26%	0%	-34%	0%	0%
19 Ethniko Stadium	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	-1%	0%	0%	-1%	0%	0%	-1%	50%	0%	1%	0%	0%
21 External	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	6%	0%	0%	0%	0%
Total	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	6%	0%	0%	0%	0%

4.3 Energy Outputs

4.3.1 Table 19 and Table 20 provide an overview of the energy usage by vehicle type and by zone for the 2020 and 2030 Do Nothing and the Ring Road Completion Scenario.

4.3.2 Overall the scenario has almost no impact on the total energy usage across the city. The largest percentage impact is from goods vehicles, though as they represent less than 1% of the total vehicles in the city this reduction is dwarfed by the car and bike energy usage.

Table 19. Energy Usage (MJ/day) by Vehicle Type

Vehicle Type	2020		2030	
	Do Nothing	Ring Road Completion	Do Nothing	Ring Road Completion
Energy (MJ)				
Total	815,245	0.0%	779,008	0.0%
Cars	518,695	0.0%	484,789	0.0%
Bikes	218,142	0.0%	215,903	0.0%
Goods	11,866	-1.9%	11,860	-1.9%
Buses	61,831	0.0%	61,746	0.0%
Trains	4,711	0.0%	4,711	0.0%
Vehicles				
Total	48,837	0.0%	48,593	0.0%
Cars	30,921	0.0%	30,762	0.0%
Bikes	17,182	0.0%	17,096	0.0%
Goods	245	0.0%	245	0.0%
Buses	478	0.0%	478	0.0%
Trains	12	0.0%	12	0.0%
Energy / Vehicle (MJ)				
Total	17	0.0%	16	0.0%
Cars	17	0.0%	16	0.0%
Bikes	13	0.0%	13	0.0%
Goods	48	-1.9%	48	-1.9%
Buses	129	0.0%	129	0.0%
Trains	393	0.0%	393	0.0%

4.3.3 The two zones to benefit the most are zones 5 and 14 which are both adjacent to the new road.

4.3.4 Energy usage from zones 13 and 14 actually increase with the building of the new road. This is due to an overall increase in the distance from these zones to others. With no adjustments to the speeds this leads to longer journey times. In reality, the new ring road would be quicker and over a better quality than the roads through the city centre. Including speed increases might help mitigate these increases in distances. Both these zones are small though, so their overall effect on the total energy usage is small.

Table 20. Energy Usage (MJ/day) by Zone

Zone	2020		2030	
	Do Nothing	Ring Road Completion	Do Nothing	Ring Road Completion
Total	815,245	0.0%	779,008	0.0%
1 - City Centre	39,116	0.0%	38,683	0.0%
2 - Alexandra	13,244	0.0%	12,732	0.0%
17 - Kentro	13,191	0.0%	12,537	0.0%
20 - Siggrou	6,371	0.0%	6,053	0.0%
9 - Alonia Baras	26,383	0.0%	24,939	0.0%
10 - Spartis	3,001	0.0%	2,855	0.0%
15 - Archimidi	8,163	0.0%	7,761	0.0%
16 - Dim Ntai	11,489	0.0%	10,918	0.0%
18 - Varousi	29,245	0.0%	27,705	0.0%
3 - Pirgos	56,430	0.0%	53,692	0.0%
4 - Amygdalies	130,693	0.0%	124,514	0.0%
5 - Papamanou	5,117	-0.6%	4,897	-0.6%
6 - Pirgetos	53,963	0.0%	51,551	0.0%
7 - Nekrotafio Trikalon	25,384	0.0%	24,209	0.0%
8 - Keramaria	122,612	0.0%	116,439	0.0%
11 - General Hospital	22,662	0.0%	21,601	0.0%
12 - Agia Moni Gardikaki Ampelakia	92,120	0.0%	87,799	0.0%
13 - Patmou	5,054	0.7%	4,819	0.6%
14 - Flamouliou	4,336	2.6%	4,141	2.6%
19 - Ethniko Stadium	60,350	-0.9%	57,538	-0.9%
21 - External	86,321	0.0%	83,624	0.0%

4.3.5 The reduction in demand is reflected in the energy consumption for the city with reductions experienced across areas of the city along the new road alignment. Figure 9 shows the change in energy usage by zone compared to the 2030 Do Nothing scenario.

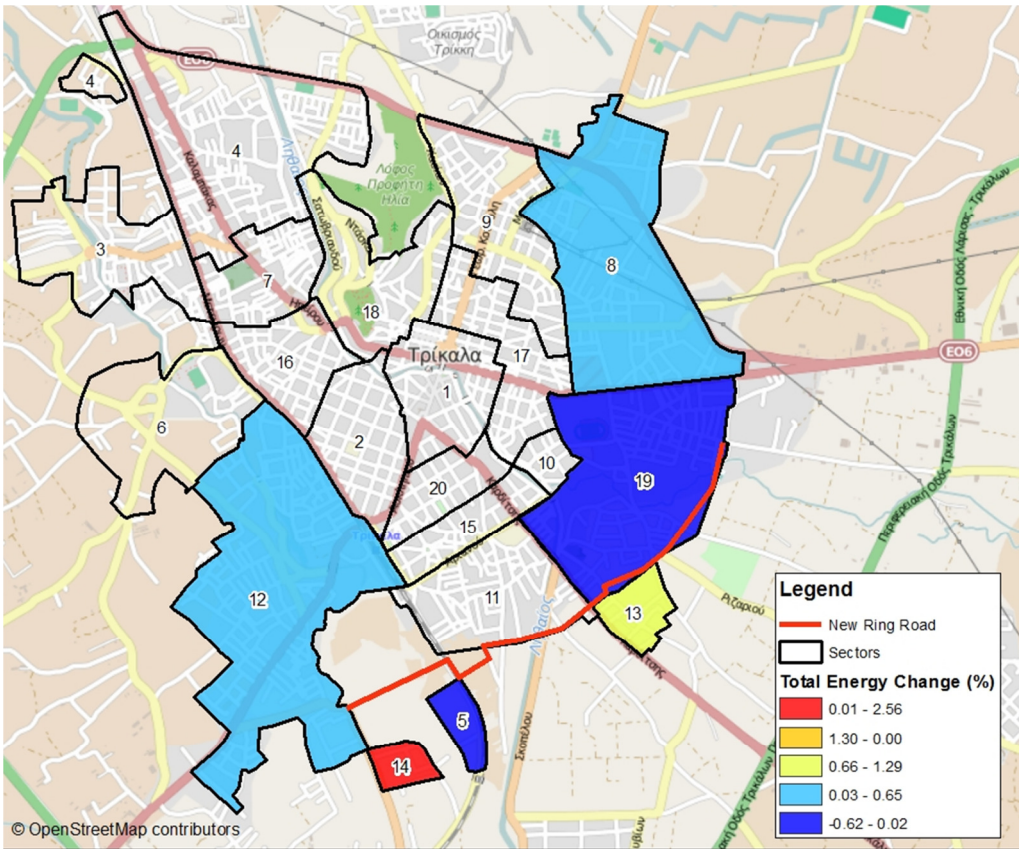


Figure 9. Energy Change Between Do Nothing and New Road Scenario (2030)

4.3.6 Although there are some changes in both demand and energy usage between certain zone-zone pairings, these are not significant enough to impact upon the overall demand, which remains unchanged.

4.4 Summary

4.4.1 The introduction of this scheme within Trikala reduces the total energy usage by around 300MJ in both forecast years, though this represents less than 1% of the total energy usage. At a more detailed level, the pattern is more mixed with some zones showing an increase in energy usage due to increased distance travelled.

5. INDIVIDUAL SCENARIO TESTS: NEW CYCLE LANE

5.1 Introduction

5.1.1 This test looks at the extension of the city's cycling infrastructure by 4km. The new cycle lane is situated along a 2Km stretch of Kalampaka Road, with two 1.0m wide cycle-only lanes running in both directions, adjacent to the highway.

5.1.2 The anticipated impact of the cycling infrastructure improvements is a 15% shift away from car use and a 10% shift away from public transport use, for journeys, in both directions, between zones 4 and 7, and zones 1, 2, 16 and 18.

5.1.3 The location of the new infrastructure and the anticipated mode shift that would be generated by it were received from Trikala Municipality.

5.1.4 Figure 10 shows the details of the scheme and the affected zones.

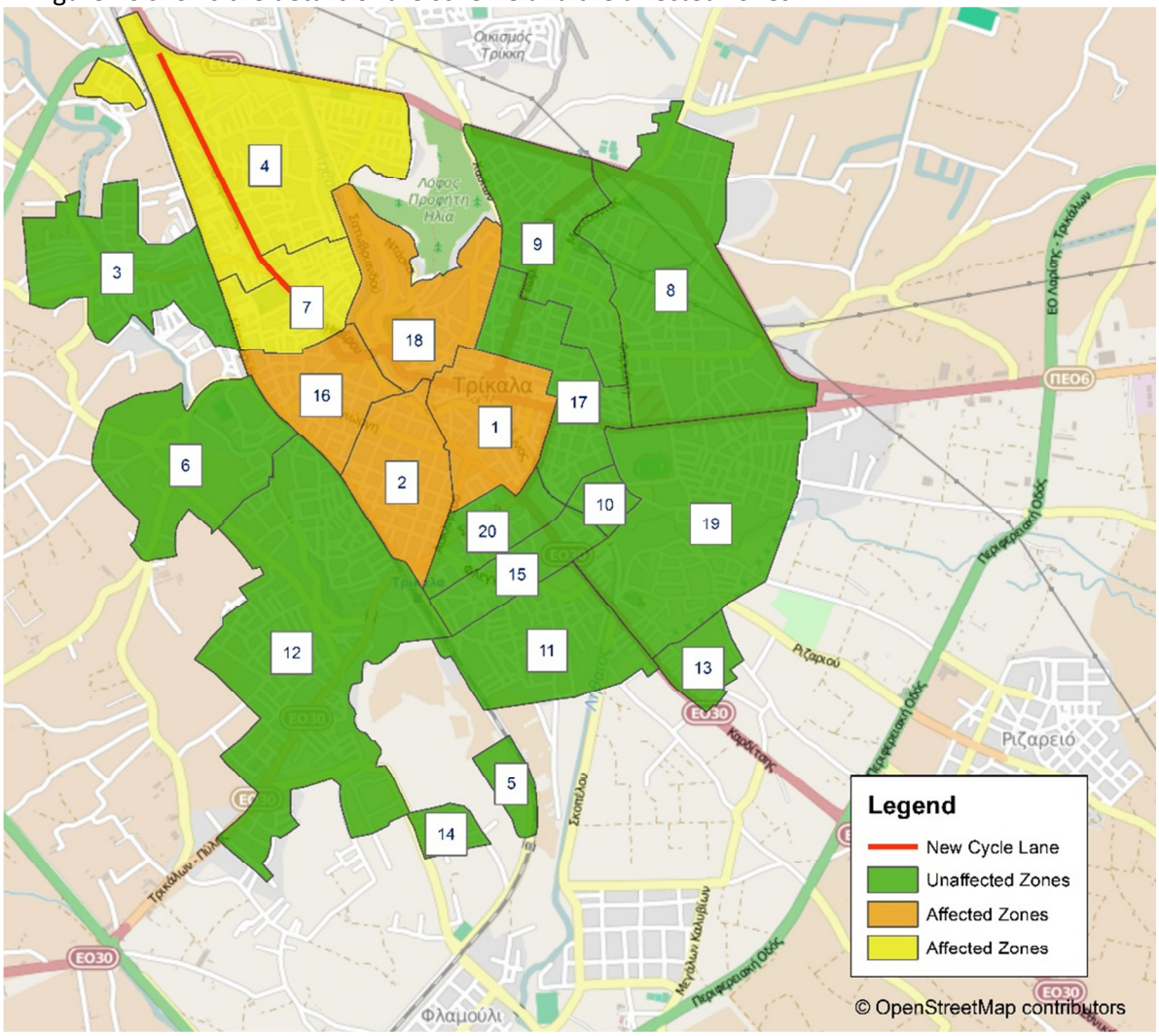


Figure 10. Scheme Details – New Cycle Infrastructure

5.1.5 To implement the scheme the following changes were made to the model inputs:

- The demand for car, between the relevant zones, was decreased by 15%
- The demand for public transport, between the relevant zones, was decreased by 10%.

5.1.6 The limitations of this method of modelling the scheme are that it is entirely dependent on the assumptions of the mode shift to cycling figures that have been provided by Trikala.

5.2 Demand Outputs

5.2.1 Table 21 to Table 23 provides an overview of changes in transport demand, average occupancy and vehicle kilometres within the modelled area for the Do Nothing and the Scenario, in both of the forecast years.

5.2.2 The scenario leads to very small reduction in both highway and public transport demand, though less than 1% of the total in both cases. This leads to almost no change in the mode share, and also only a small drop in the average bus occupancy.

Table 21. Demand & Mode Shares

Mode	2020		2030	
	Do Nothing	Cycle Lane Improvements	Do Nothing	Cycle Lane Improvements
Demand By Mode				
Highway	163,570	162,354	162,214	160,976
Public Transport	10,559	10,478	11,036	10,951
Mode Share				
Highway	94%	94%	94%	94%
Public Transport	6%	6%	6%	6%
Change in Highway Demand		- 1,216		- 1,238
Change in Public Transport Demand		- 81		- 85

Table 22. Average Public Transport Occupancy

Sub Mode	2020		2030	
	Do Nothing	Cycle Lane Improvements	Do Nothing	Cycle Lane Improvements
Average Occupancy				
Total	25.1	24.9	26.2	26.0
Buses	25.7	25.5	26.8	26.6
Trains	1.3	1.3	1.3	1.3
%Change in Occupancy				
Total		99.3%		99.3%
Buses		99.3%		99.3%
Trains		100.0%		100.0%

Table 23. Vehicles Kms & Average Distance

Vehicle Type	2020		2030	
	Do Nothing	Cycle Lane Improvements	Do Nothing	Cycle Lane Improvements
Vehicle Km				
Total	383,746	98.9%	382,060	98.0%
Cars	239,532	98.8%	238,454	97.9%
Bikes	133,747	98.9%	133,138	98.0%
Goods	2,208	100.0%	2,208	100.2%
Buses	8,001	100.0%	8,001	100.0%
Trains	258	100.0%	258	100.0%
Average Distance (Km)				
Total	9.22	100.0%	9.22	100.0%
Cars	2.92	100.1%	2.92	100.0%
Bikes	2.93	100.1%	2.93	100.0%
Goods	2.00	100.0%	2.00	100.2%
Buses	16.74	100.0%	16.74	100.0%
Trains	21.50	100.0%	21.50	100.0%

5.2.3 Table 23 provides an overview of the vehicle kilometres and the average distances travelled within the city. There is a reduction in total vehicle kilometres travelled due to the reduction in highway (cars & bikes) demand. The reduction in public transport demand has no effect on vehicle kilometres, and therefore also energy usage, as the number of buses is unchanged.

5.2.4 Table 24 shows the change in vehicles kilometres between the Do Nothing and the Scenario. It can be seen that the reduction is between the movements affected, as expected.

Table 24. Change in Vehicle Kilometres (2030)

	%Change in Veh Kms	1 City Centre	2 Alexandra	17 Kentro	20 Siggrou	9 Alonia Baras	10 Spartis	15 Archimidi	16 Dim Ntai	18 Varousi	3 Pirgos	4 Amygdalies	5 Papamanou	6 Pirgetos	7 Nekrotafio Trikalon	8 Keramaria	11 General Hospital	12 Agia Moni Gardikaki Ampelakia	13 Patmou	14 Flamouliou	19 Ethniko Stadium	21 External	Total
1	City Centre	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	-13%	0%	0%	-14%	0%	0%	0%	0%	0%	0%	0%	0%
2	Alexandra	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	-14%	0%	0%	-14%	0%	0%	0%	0%	0%	0%	0%	0%
17	Kentro	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
20	Siggrou	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
9	Alonia Baras	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
10	Spartis	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
15	Archimidi	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
16	Dim Ntai	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	-13%	0%	0%	-14%	0%	0%	0%	0%	0%	0%	0%	-1%
18	Varousi	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	-15%	0%	0%	-15%	0%	0%	0%	0%	0%	0%	0%	-1%
3	Pirgos	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
4	Amygdalies	-15%	-15%	0%	0%	0%	0%	0%	-15%	-15%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	-3%
5	Papamanou	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
6	Pirgetos	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
7	Nekrotafio Trikalon	-15%	-15%	0%	0%	0%	0%	0%	-15%	-15%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	-3%
8	Keramaria	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
11	General Hospital	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
12	Agia Moni Gardikaki Ampelakia	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
13	Patmou	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
14	Flamouliou	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
19	Ethniko Stadium	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
21	External	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	Total	-3%	-4%	0%	0%	0%	0%	0%	-2%	-2%	0%	-1%	0%	0%	-1%	0%	0%	0%	0%	0%	0%	0%	-1%

5.3 Energy Outputs

5.3.1 Table 25 and Table 26 provide an overview of the energy usage by vehicle type and by zone for the 2020 and 2030 Do Nothing and the Scenario, respectively.

5.3.2 Overall the scenario leads to a slight reduction in total energy usage. This reduction comes entirely from cars, mopeds and motorbikes as the number of buses hasn't reduced, even though the PT demand has.

Table 25. Energy Usage (MJ/day) by Vehicle Type

Vehicle Type	2020		2030	
	Do Nothing	Cycle Lane Improvements	Do Nothing	Cycle Lane Improvements
Energy (MJ)				
Total	815,245	-0.6%	779,008	-0.6%
Cars	518,695	-0.7%	484,789	-0.7%
Bikes	218,142	-0.7%	215,903	-0.7%
Goods	11,866	0.0%	11,860	0.1%
Buses	61,831	0.0%	61,746	0.0%
Trains	4,711	0.0%	4,711	0.0%
Vehicles				
Total	48,837	0.0%	48,593	0.0%
Cars	30,921	-0.1%	30,762	-0.1%
Bikes	17,182	0.0%	17,096	0.0%
Goods	245	0.0%	245	0.0%
Buses	478	0.0%	478	0.0%
Trains	12	0.0%	12	0.0%
Energy / Vehicle (MJ)				
Total	17	-0.6%	16	-0.6%
Cars	17	-0.7%	16	-0.6%
Bikes	13	-0.7%	13	-0.7%
Goods	48	0.0%	48	0.1%
Buses	129	0.0%	129	0.0%
Trains	393	0.0%	393	0.0%

5.3.3 Whilst the over change is small it can be seen that there is a 3% reduction in energy usage in zones 4 and 7, which are the two zones that benefit most from the scheme. In addition there are also changes along the entire corridor of the new cycle route.

Table 26. Energy Usage (MJ/day) by Zone

Zone	2020		2030	
	Do Nothing	Cycle Lane Improvements	Do Nothing	Cycle Lane Improvements
Total	815,245	-0.6%	779,008	-0.6%
1 - City Centre	39,116	-0.1%	38,683	0.0%
2 - Alexandra	13,244	-0.4%	12,732	-0.2%
17 - Kentro	13,191	0.0%	12,537	0.2%
20 - Siggrou	6,371	0.0%	6,053	0.2%
9 - Alonia Baras	26,383	0.0%	24,939	0.1%
10 - Spartis	3,001	0.0%	2,855	0.0%
15 - Archimidi	8,163	0.0%	7,761	0.1%
16 - Dim Ntai	11,489	-1.2%	10,918	-1.1%
18 - Varousi	29,245	-0.8%	27,705	-0.7%
3 - Pirgos	56,430	0.0%	53,692	0.1%
4 - Amygdalies	130,693	-3.1%	124,514	-3.2%
5 - Papamanou	5,117	0.0%	4,897	0.1%
6 - Pirgetos	53,963	0.0%	51,551	0.0%
7 - Nekrotafio Trikalon	25,384	-2.8%	24,209	-2.7%
8 - Keramaria	122,612	0.0%	116,439	0.1%
11 - General Hospital	22,662	0.0%	21,601	0.0%
12 - Agia Moni Gardikaki Ampelakia	92,120	0.0%	87,799	0.1%
13 - Patmou	5,054	0.0%	4,819	0.0%
14 - Flamouliou	4,336	0.0%	4,141	0.0%
19 - Ethniko Stadium	60,350	0.0%	57,538	0.0%
21 - External	86,321	0.0%	83,624	0.0%

5.3.4 The change in demand is reflected in the emissions for the city with reductions experienced predominantly in the vicinity of the new infrastructure. Figure 11 shows the change in energy usage by zone compared to the 2030 Do Nothing scenario.

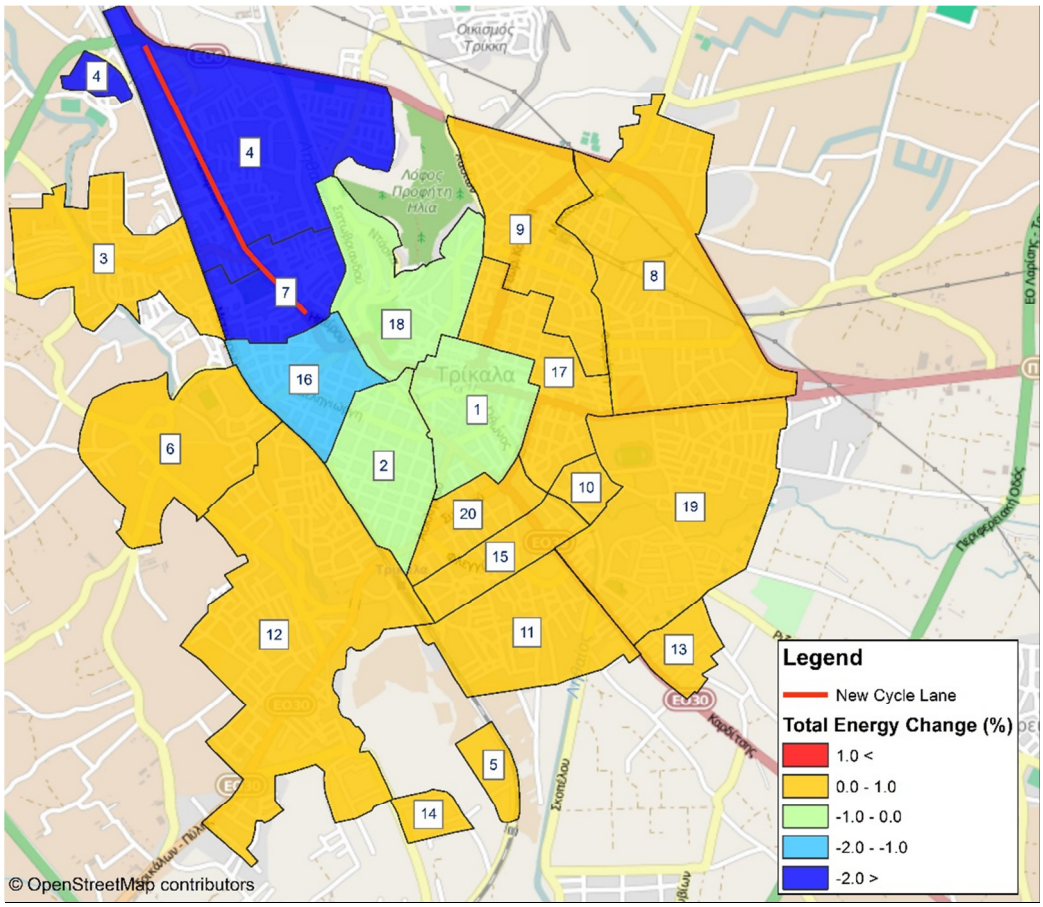


Figure 11. Energy Change Between Do Nothing and New Cycle Lane Scenario (2030)

5.3.5 This reflects the demand changes, illustrating how the reduction in energy is most noticeable in the zones where the demand drops the most; along the route of the new cycle lane.

5.3.6 The reductions in demand result in 1,299 fewer daily journeystravelling in 2020 and 1,326 fewer in 2030 than in the respective Do Nothing scenarios. This in turn results in a reduction in Carbon Dioxide emissions of around 385kg in 2020 and 344kg in 2030 across all vehicle types.

5.4 Summary

The introduction of this scheme within Trikala reduces the total energy usage by around 5,000MJ in both forecast years (a drop of -0.6%), as well as producing a reduction of most of the vehicle emissions in 2030. Though the overall impact of the scheme is small there are larger, more significant improvements around the location of the route.

WP3 – Transport and Mobility Analysis

D.3.7. Transport Scenarios Results Report Évora

October 2015

314164 (ENER/FP7/314164)

Project acronym:

InSMART

Project full title:

Integrative Smart City Planning

Coordination and support action (Coordinating Action)

FP7-ENERGY-SMARTICITIES-2012

Start date of project: 2013-12-01

Duration: 3 years

Deliverable D3.7.

Transport Scenarios Results Report Évora

Work Package 3. Transport and Mobility Analysis

October 2015

Project co-funded by the European Commission within the Seventh Framework Programme		
Dissemination Level		
PU	Public	PU
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

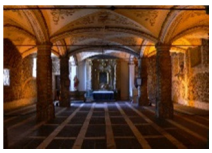
Version	**Submitted by**	**Review Level***	**Date Submitted**	**Reviewed**
V01	SYSTRA	WPL	May 2015	May 2015
V02	SYSTRA	WPL	October 2015	October 2015

Editors		
	Name (organization)	**e-mail**
Leading participant	Matt Pollard (SYSTRA)	mpollard@systra.com
Contributing participants		
WP leader (WPL)	IRONS Duncan	dirons@systra.com

Executive Summary	
This report presents the results of the alternative scenarios of the transport model that has been developed in the framework of the INSMART project for the city of Évora.	
Keywords	Transport scenarios

InSmart – Integrative Smart City Planning

Reference number 102400

SCENARIOS REPORT - ÉVORA

INSMART – INTEGRATIVE SMART CITY PLANNING

SCENARIOS REPORT - ÉVORA

IDENTIFICATION TABLE	
Client/Project owner	European Commission
Project	InSmart – Integrative Smart City Planning
Study	Scenarios Report - Évora
Type of document	Report
Date	
File name	InSmart_ScenarioRunsReport_Evora_v2_20150722.docx
Reference number	102400
Number of pages	59

APPROVAL

Version	Name		Position	Date	Modifications
1	Author	Greg Webster Matt Pollard	Consultant Senior Consultant		
	Checked by	Duncan Irons	Project Director		
	Approved by			DD/MM/YY	
2	Author			DD/MM/YY	
	Checked by			DD/MM/YY	
	Approved by			DD/MM/YY	

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

IMAGE ATTRIBUTION

Top Left
Image: http://commons.wikimedia.org/wiki/File:%C3%89vora_-_Pra%C3%A7a_do_Giraldo.jpg
Attribution: Digitalsignal

Top Right
Image: http://commons.wikimedia.org/wiki/File:Capela_dos_ossos.jpg
Attribution: Nuno Sequeira André

Bottom Left:
Image: http://commons.wikimedia.org/wiki/File:Roman_temple,_Evora,_Alentejo,_Portugal,_28_September_2005.jpg
Attribution: Rei-artur

Bottom Right
Image: http://commons.wikimedia.org/wiki/File:Evora_view.jpg
Attribution: Digitalsignal

1. INTRODUCTION

1.1 Project Overview

1.1.1 InSmart is a three year, European funded project which involves four European Cities working in partnership towards a sustainable energy future. The primary objective of the project is to develop sustainable energy action plans for each partner city.

1.1.2 The four cities are;

- Cesena, Italy;
- Évora, Portugal;
- Nottingham, UK; and
- Trikala, Greece.

1.1.3 A mix of sustainable energy measures to improve the energy efficiency of each city will be identified through the use of a variety of tools and approaches and covering a wide range of sectors from the residential and transport sectors to street lighting and waste collection.

1.1.4 SYSTRA's role within the project is to identify, test and report on a series of land use and transport based strategies aimed at reducing the transport-related energy usage and carbon generation of each city.

1.1.5 The initial task of calculating the current energy usage and carbon emissions generated by each city is recorded in the Base Model Reports for each city. The impact of the forecast strategies has then be obtained by comparing with the Do Nothing scenario which is the Base case forecast into the future with no schemes implemented in 2020 and 2030.

1.2 Report Structure

1.2.1 The report is split into three sections:

- Model Run Comparisons – a comparison of various outputs from modelled scenarios;
- Future Year Base and Do Nothing Scenarios – looking at changes between the base year and forecast years; and
- Individual Scenario Tests – a more detailed analysis of each of the specified future year scenarios.

2. TEST COMPARISONS

2.1 Introduction

2.1.1 This report covers the city of Évora in the Portuguese region of Alentejo. The following Do Something scenarios being run for the forecast years of 2020 and 2030:

- **Future Base**: change in vehicle fleet splits over time only;
- **Do Nothing:** change in population;
- **Cycling Improvements:** new cycle route added;
- **Increased Parking Charges:** parking charges in the city centre doubled;
- **Traffic Restrictions in the City Centre:** all vehicles, except public transport and goods vehicles, banned from using the city centre zone;
- **Speed Changes (30kph zones);** speeds of all vehicles restricted to 30km/h in certain zones;
- **New Roads;** additional roads across the city; and
- **Developments Changes;** opening of two new retail developments in the city.

2.1.2 A more detailed description of each scenario, along with information on model inputs and assumptions is given in later chapters. The purpose of this chapter is to provide a summary of all the tests run for easy comparison.

2.1.3 Figure 1 shows the total energy usage for all scenarios that have been run for Évora, compared to the Base Year, Future Base and Do Nothing scenarios.

2.1.4 It can be seen that the largest change in energy usage is between the Future Base and the Base. This represents the vehicle types changing over time, as people buy newer and more efficient vehicles. By 2030 this accounts for a 15% reduction in energy usage.

2.1.5 The Do Nothing scenario includes changes in population. Regional figures were used for Évora and forecasts predict a 5% drop in population by 2020 and 10% reduction by 2030. This leads to a further large drop in energy usage between the Future Base and the Do Nothing

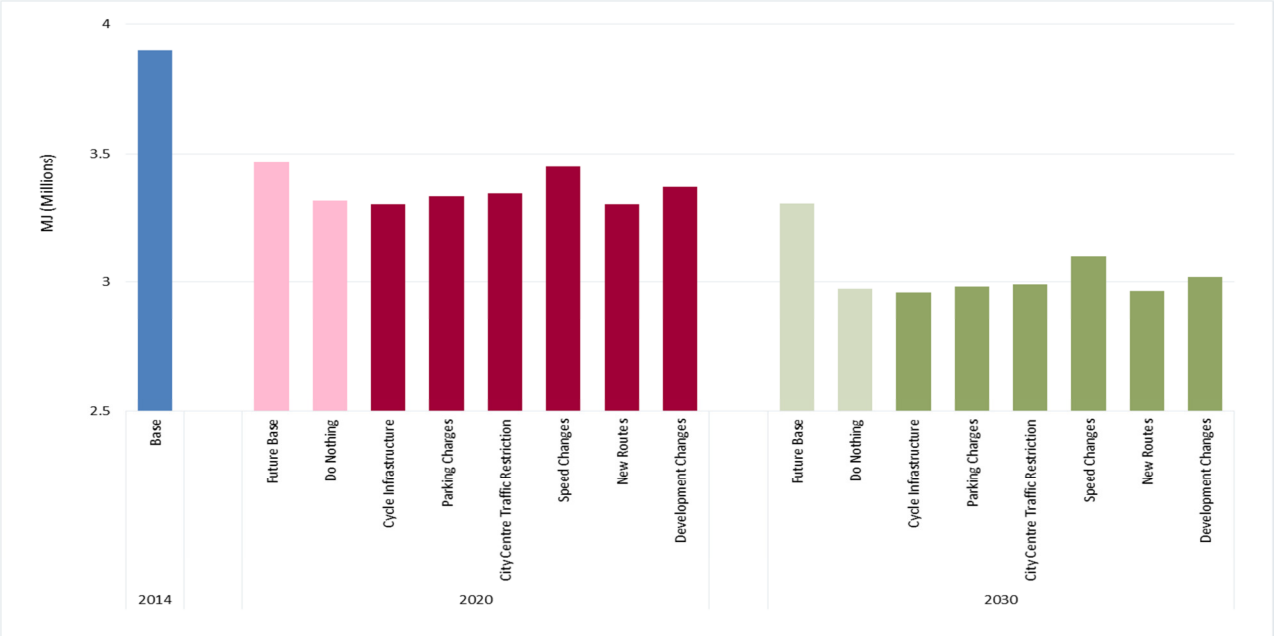


Figure 1. Total energy usage by scenario

2.1.6 Figure 2 shows the difference between each scenario and the Do Nothing scenario. It can be seen that most of the scenarios increase total energy consumption slightly, with only two scenarios leading to a reduction. The Parking Charges and City Centre Traffic Restrictions scenarios both see increases in distances due to re-distribution of trips, whilst the new Development scenario leads to additional goods vehicle traffic.

2.1.7 At a more detailed level, looking at the zones close to the areas affected there are larger changes and these are shown in the more detailed scenario chapters that follow.

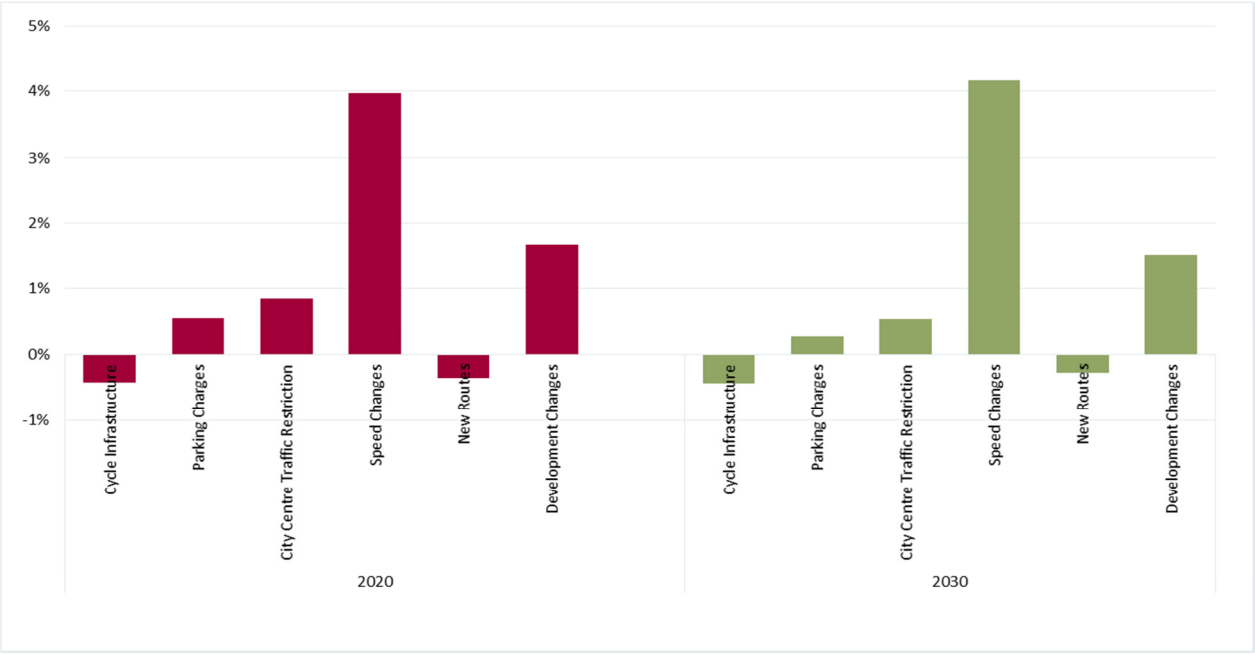


Figure 2. Change from Do Nothing scenario for each test

2.1.8 Table 1 shows a breakdown of the total energy usage by scenario and the percentage change compared to the Base Year test.

Table 1. Energy usage by scenario

SCENARIO	ENERGY (MJ)			CHANGE FROM BASE YEAR	
	2014	2020	2030	2020	2030
Base Year	3,900,627				
Future Base		3,467,075	3,306,457	89%	85%
Do Nothing		3,316,116	2,973,905	85%	76%
Cycle Infrastructure		3,302,069	2,961,177	85%	76%
Parking Charges		3,334,834	2,981,914	85%	76%
Traffic Restrictions		3,344,191	2,990,186	86%	77%
Speed Changes		3,447,647	3,098,141	88%	79%
New Roads		3,304,291	2,965,750	85%	76%
Development Changes		3,371,461	3,018,483	86%	77%

2.1.9 Table 2 and Table 3 show the change in energy usage by vehicle type for the different scenarios for 2020 and 2030. The changes are shown as percentage changes from the Do Nothing scenarios.

2.1.10 Although the changes for some scenarios are quite small on a city-wide level there is larger variation by vehicle type. For example, the new retail developments add 11% more goods vehicles to the city, though this only results in a 2% increase in energy overall as they only make up around 4% of the total number of vehicles.

Table 2. Energy usage (MJ/day) by vehicle type (2020)

Vehicle Type	DoNothing	Cycle Improvements	Parking Charges	Traffic Restrictions	Speed Changes	New Roads	Development Changes
Energy (MJ)							
Total	3,316,116	0%	1%	1%	4%	0%	2%
Cars	2,844,631	0%	1%	1%	5%	0%	0%
Bikes	96,716	0%	2%	0%	5%	0%	1%
Goods	267,599	0%	0%	0%	-1%	-1%	16%
Buses	58,625	0%	0%	1%	0%	-1%	0%
Trains	48,544	0%	0%	0%	0%	0%	0%
Vehicles							
Total	44,062	0%	0%	0%	0%	0%	0%
Cars	36,690	0%	0%	0%	0%	0%	0%
Bikes	5,407	0%	0%	0%	0%	0%	0%
Goods	1,481	0%	0%	0%	0%	0%	11%
Buses	417	0%	0%	0%	0%	0%	0%
Trains	68	0%	0%	0%	0%	0%	0%
Energy / Vehicle (MJ)							
Total	75	0%	1%	1%	4%	0%	1%
Cars	78	0%	1%	1%	5%	0%	0%
Bikes	18	0%	2%	0%	5%	0%	1%
Goods	181	0%	0%	0%	-1%	-1%	4%
Buses	141	0%	0%	1%	0%	-1%	0%
Trains	714	0%	0%	0%	0%	0%	0%

Table 3. Energy usage (MJ/day) by vehicle type (2030)

Vehicle Type	DoNothing	Cycle Improvements	Parking Charges	Traffic Restrictions	Speed Changes	New Roads	Development Changes
Energy (MJ)							
Total	2,973,905	0%	0%	1%	4%	0%	1%
Cars	2,511,979	0%	0%	1%	5%	0%	0%
Bikes	90,589	0%	2%	0%	5%	0%	0%
Goods	265,395	0%	0%	1%	0%	0%	16%
Buses	57,397	0%	0%	2%	1%	0%	0%
Trains	48,544	0%	0%	0%	0%	0%	0%
Vehicles							
Total	41,277	0%	0%	0%	0%	0%	0%
Cars	34,262	0%	0%	0%	0%	0%	0%
Bikes	5,049	0%	0%	0%	0%	0%	0%
Goods	1,481	0%	0%	0%	0%	0%	11%
Buses	417	0%	0%	0%	0%	0%	0%
Trains	68	0%	0%	0%	0%	0%	0%
Energy / Vehicle (MJ)							
Total	72	0%	0%	1%	4%	0%	1%
Cars	73	0%	0%	1%	5%	0%	0%
Bikes	18	0%	2%	0%	5%	0%	0%
Goods	179	0%	0%	1%	0%	0%	4%
Buses	138	0%	0%	2%	1%	0%	0%
Trains	714	0%	0%	0%	0%	0%	0%

2.1.11 Table 4 and Table 5 show the change in energy usage by zone for all of the different scenarios for 2020 and 2030.

2.1.12 For all scenarios the changes are where we would expect them to be.

- Cycle Improvements – the zones showing the largest reductions are closest to the cycle schemes and therefore have access to these routes;
- Speed Changes – increases from all zones, but with the largest changes seen in the affected zones. Most movements will have to pass through the affected zones therefore the impacts of the lowering of speeds and the resultant increases in energy usage affect all areas..

- Development Changes – increase in energy from the two zones with the new developments in. The extra retail floorspace generates additional goods traffic which drives this increase.
- The other scenarios only show small changes and largely result in re-distribution of the destination end of the trip.

Table 4. Energy usage by zone for 2020 scenarios

Zone	DoNothing	Cycle Improvements	Parking Charges	Traffic Restrictions	Speed Changes	New Roads	Development Changes
Total	3,316,116	0%	1%	1%	4%	0%	2%
21 - Catedral de Evora	24,609	0%	-1%	0%	1%	-1%	0%
18 - Jardim Publico de Evora	56,317	0%	0%	1%	4%	0%	0%
19 - Aquaduct	102,163	0%	1%	1%	5%	0%	1%
20 - Universidade de Evora	43,167	0%	1%	1%	7%	0%	1%
6 - Bairro de Almeirim	52,284	0%	1%	1%	4%	0%	0%
7 - Evora Retail Park	85,895	0%	0%	0%	-1%	-1%	13%
8 - Aerodromo	25,953	0%	1%	1%	5%	-1%	0%
9 - Monte das Flores	31,658	0%	1%	1%	8%	-1%	1%
10 - Horta das Figueiras	50,283	-1%	1%	1%	3%	0%	0%
11 - Bairro Nossa sra do Carmo	51,864	-1%	0%	1%	2%	0%	1%
12 - Bairro De Santa Maria	208,953	0%	1%	1%	9%	0%	1%
13 - Bairro dos Tres Bicos	92,463	-2%	1%	2%	8%	0%	1%
14 - Ceniterio de Evora	32,962	-1%	0%	1%	4%	0%	1%
15 - Nossa Sra da Saude	233,174	0%	2%	2%	8%	0%	1%
16 - Bairro Frei Aleixo	127,807	-1%	1%	1%	6%	-2%	18%
1 - Valverde	368,859	0%	0%	1%	3%	0%	1%
2 - Sao Mancos	394,328	0%	1%	1%	3%	-1%	0%
3 - Nossa Sra de Machede	226,457	0%	1%	1%	4%	0%	0%
4 - Azaruja	179,701	0%	0%	1%	6%	-1%	0%
5 - Canaviais	127,178	0%	0%	1%	3%	0%	0%
17 - Bacelo	181,005	-3%	1%	1%	4%	-1%	0%
22 - External	619,035	-1%	0%	0%	1%	0%	1%

Table 5. Energy usage by zone for 2030 scenarios

Zone	DoNothing	Cycle Improvements	Parking Charges	Traffic Restrictions	Speed Changes	New Roads	Development Changes
Total	2,973,905	0%	0%	1%	4%	0%	1%
21 - Catedral de Evora	23,236	0%	-1%	1%	2%	0%	0%
18 - Jardim Publico de Evora	49,789	0%	0%	1%	4%	0%	0%
19 - Aquaduct	90,281	0%	1%	1%	5%	0%	0%
20 - Universidade de Evora	38,281	0%	0%	1%	7%	0%	0%
6 - Bairro de Almeirim	48,342	0%	0%	1%	5%	0%	0%
7 - Evora Retail Park	84,722	0%	0%	1%	0%	0%	13%
8 - Aerodromo	24,261	0%	0%	1%	5%	0%	0%
9 - Monte das Flores	28,228	0%	0%	1%	8%	0%	0%
10 - Horta das Figueiras	47,267	-1%	0%	0%	3%	0%	0%
11 - Bairro Nossa sra do Carmo	48,965	-1%	0%	1%	2%	0%	1%
12 - Bairro De Santa Maria	186,902	0%	0%	1%	9%	0%	0%
13 - Bairro dos Tres Bicos	81,971	-2%	0%	1%	9%	0%	0%
14 - Ceniterio de Evora	30,422	-1%	0%	1%	4%	0%	0%
15 - Nossa Sra da Saude	206,739	0%	1%	1%	8%	0%	0%
16 - Bairro Frei Aleixo	117,221	-1%	0%	1%	7%	-2%	18%
1 - Valverde	326,382	0%	0%	0%	3%	0%	0%
2 - Sao Mancos	348,827	0%	0%	0%	3%	-1%	0%
3 - Nossa Sra de Machede	200,318	0%	1%	1%	4%	0%	0%
4 - Azaruja	159,242	0%	0%	1%	6%	-1%	0%
5 - Canaviais	113,264	0%	0%	1%	4%	0%	0%
17 - Bacelo	160,315	-3%	1%	1%	4%	-1%	0%
22 - External	558,929	-1%	0%	0%	1%	0%	2%

2.1.13 For each of the 2020 scenarios Table 6 shows the change in demand and mode share, Table 7 shows the change in average occupancy on buses and trains and Table 8 shows the change in vehicle kilometres and average distance. Table 9 to Table 11 show the same information for 2030.

2.1.14 Overall the changes are small but do show variation between the different scenarios. For example, the speed change scenario produces a 20% increase in public transport demand, albeit from a very small base.

Table 6. Demand by Vehicle Class (2020)

Mode	DoNothing	Cycle Improvements	Parking Charges	Traffic Restrictions	Speed Changes	New Roads	Development Changes
Demand By Mode							
Highway	149,611	148,674	149,569	149,596	149,255	149,608	149,595
Public Transport	1,797	1,797	1,839	1,802	2,154	1,800	1,814
Mode Share							
Highway	99%	99%	99%	99%	99%	99%	99%
Public Transport	1%	1%	1%	1%	1%	1%	1%
Change in Highway Demand		- 938	- 42	- 16	- 357	- 3	- 17
Change in PT		-	42	5	357	3	17

Table 7. Average Public Transport Occupancy (2020)

Mode	DoNothing	Cycle Improvements	Parking Charges	Traffic Restrictions	Speed Changes	New Roads	Development Changes
Occupancy							
Total	6.8	6.8	7.0	6.8	8.1	6.8	6.9
Buses	4.9	4.9	5.1	5.0	5.9	5.0	5.0
Trains	1.9	1.9	1.9	1.9	2.2	1.9	1.9
%Change in Occupancy							
Total		100.0%	102.4%	100.2%	119.9%	100.2%	101.0%
Buses		100.0%	102.4%	100.3%	120.0%	100.2%	101.1%
Trains		100.0%	102.4%	100.0%	119.8%	100.0%	100.8%

Table 8. Vehicle Kms & Average Distance (2020)

Distance	DoNothing	Cycle Improvements	Parking Charges	Traffic Restrictions	Speed Changes	New Roads	Development Changes
Vehicle KM							
Total	1,388,394	-0.5%	0.2%	0.0%	-0.3%	-0.4%	0.5%
Cars	1,279,741	-0.5%	0.2%	0.0%	-0.3%	-0.4%	0.0%
Bikes	57,680	-0.4%	1.7%	0.5%	0.9%	-0.3%	0.3%
Goods	50,973	0.0%	0.0%	0.0%	0.1%	-0.2%	14.0%
Average Distance KM							
Total	11.27	0.1%	0.2%	0.0%	0.0%	-0.4%	0.0%
Cars	12.60	0.1%	0.2%	0.0%	-0.1%	-0.4%	0.0%
Bikes	3.85	0.3%	1.7%	0.5%	1.2%	-0.3%	0.3%
Goods	7.65	0.0%	0.0%	0.0%	0.1%	-0.2%	2.6%

Table 9. Demand by Vehicle Class (2030)

Mode	DoNothing	Cycle Improvements	Parking Charges	Traffic Restrictions	Speed Changes	New Roads	Development Changes
Demand By Mode							
Highway	139,729	138,823	139,699	139,714	139,414	139,733	139,726
Public Transport	1,664	1,664	1,693	1,669	1,978	1,660	1,667
Mode Share							
Highway	99%	99%	99%	99%	99%	99%	99%
Public Transport	1%	1%	1%	1%	1%	1%	1%
Change in Highway Demand		- 906	- 29	- 15	- 314	4	- 3
Change in PT		-	29	5	314	- 4	3

Table 10. Average Public Transport Occupancy (2030)

Mode	DoNothing	Cycle Improvements	Parking Charges	Traffic Restrictions	Speed Changes	New Roads	Development Changes
Occupancy							
Total	6.3	6.3	6.4	6.3	7.5	6.3	6.3
Buses	4.6	4.6	4.7	4.6	5.4	4.6	4.6
Trains	1.7	1.7	1.8	1.7	2.0	1.7	1.7
%Change in Occupancy							
Total		100.0%	101.9%	100.3%	118.9%	99.7%	100.4%
Buses		100.0%	101.6%	100.1%	118.9%	99.6%	100.2%
Trains		100.0%	102.6%	100.9%	119.0%	100.0%	100.9%

Table 11. Vehicle Kms & Average Distance (2030)

Distance	DoNothing	Cycle Improvements	Parking Charges	Traffic Restrictions	Speed Changes	New Roads	Development Changes
Vehicle KM							
Total	1,299,328	-0.5%	0.3%	0.0%	-0.3%	-0.4%	0.6%
Cars	1,194,334	-0.5%	0.2%	0.0%	-0.3%	-0.4%	0.1%
Bikes	53,974	-0.4%	1.8%	0.5%	0.8%	-0.3%	0.4%
Goods	51,020	0.0%	0.0%	0.0%	0.0%	-0.3%	14.1%
Average Distance KM							
Total	11.25	0.1%	0.3%	0.0%	-0.1%	-0.4%	0.0%
Cars	12.59	0.1%	0.2%	0.0%	-0.1%	-0.4%	0.1%
Bikes	3.86	0.3%	1.9%	0.5%	1.0%	-0.3%	0.4%
Goods	7.65	0.0%	0.0%	0.0%	0.0%	-0.3%	2.6%

2.1.15 The outputs from the tests can be summarised as follows;

- There is a large reduction from the Base Year to the Future Base tests as the efficiency of the vehicle fleet improves;
- The decrease in energy usage to the Future Base is then followed by another sizable decrease to the Do Nothing scenarios where the impact of the declining population is also considered;
- The changes at a city wide level resulting from the Scenario Tests are small but vary between scenarios

2.1.16 More detail can be found in the chapters on each individual scenario.

3. FUTURE BASE AND DO NOTHING SCENARIOS

3.1 Introduction

3.1.1 To establish the scale of changes taking place in the model whilst progressing from the base year to the future years, two scenarios were run.

- **Future Base Scenario**
  - Same population data as the 2014 Base Year run.
  - Vehicle Fleet splits from 2020 and 2030 – this captures the change in fleet over time as people purchase more fuel efficient cars.
- **Do Nothing Scenario**
  - Includes both changes to vehicle fleet and population changes. This shows the change in energy usage associated with doing "Nothing" – i.e. implementing no schemes/policy measures.

3.2 Future year changes

3.2.1 The population in Évora is projected to fall from around 56,600 in 2014 to 54,000 in 2020 (-5%) and 50,500 in 2030 (-11%), based on regional growth forecasts. This will result in a fairly large decrease in the demand for transport and consequently reduce the energy requirements of the transport network.

3.2.2 It should be noted that the forecast vehicle fleet splits are based on UK data as no other comparable local data was available covering all years. This introduces a limitation to the model as these splits may not be the same for Évora. However, in the final assessment of scenarios these splits will be determined by the TIMES model.

3.2.3 Figure 3 shows the total energy usage for each scenario for the two future years, compared to the 2014 Base year starting position. The effect of the drop in population can clearly be seen.

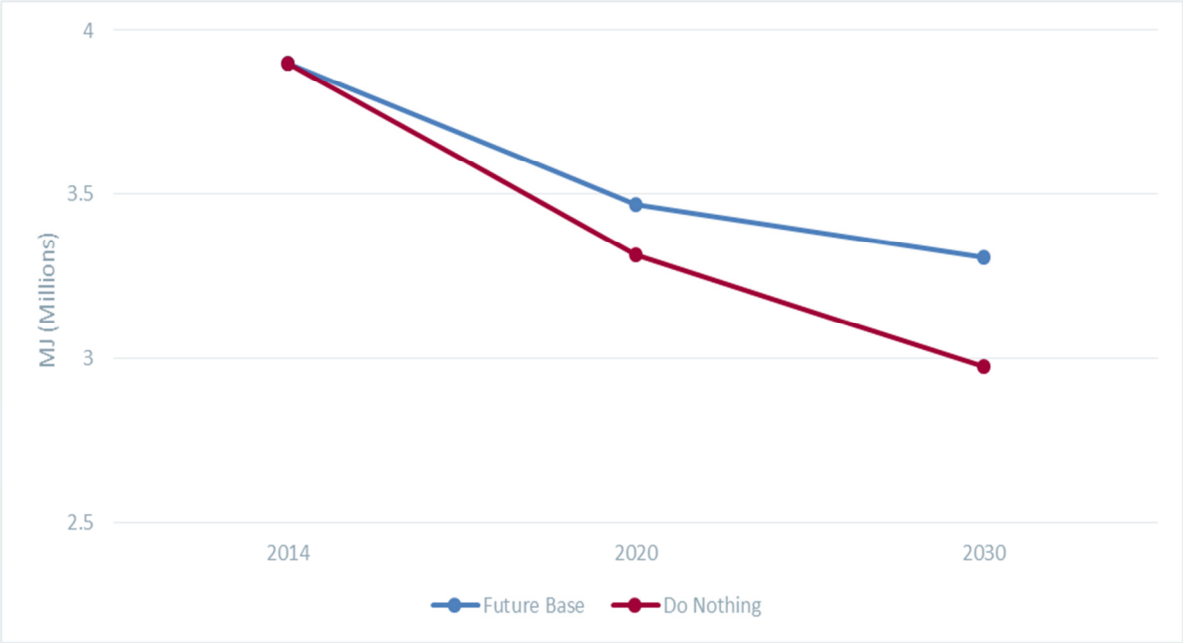


Figure 3. Change in energy usage over time for Future Base and Do Nothing scenarios

3.2.4 Figure 4 shows the change in energy for each of the impacts – change in fleet splits, change in population and the combined change.

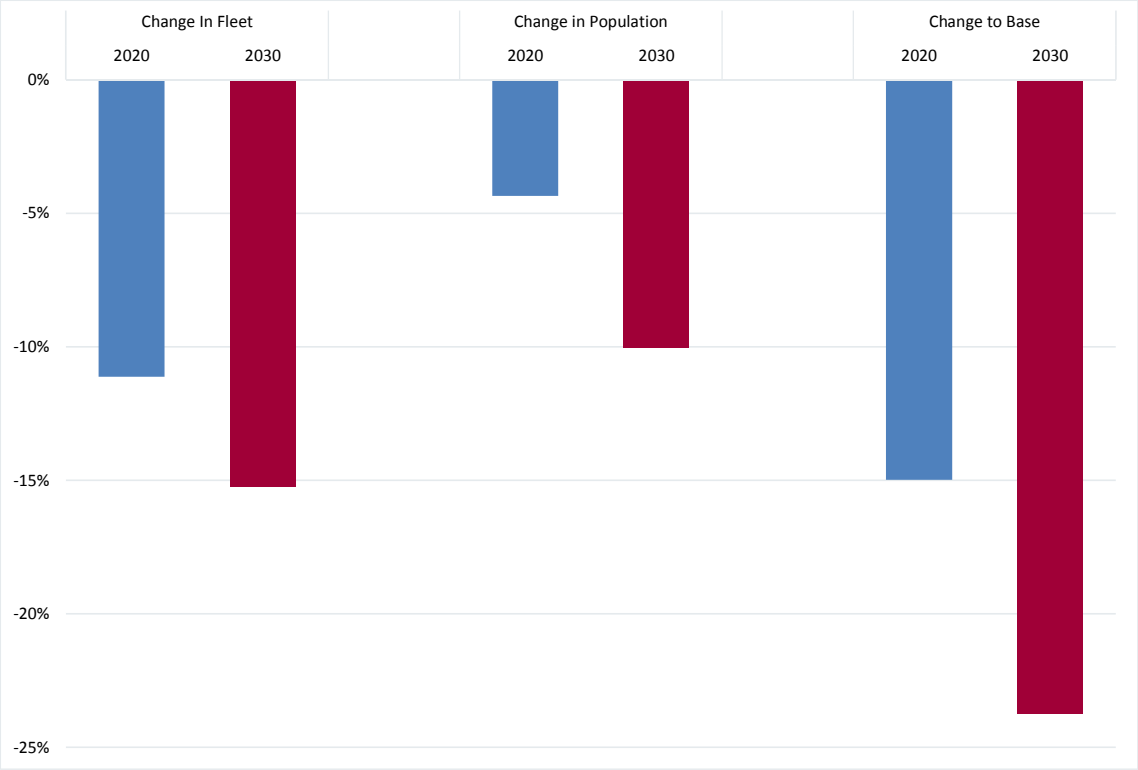


Figure 4. Change in Energy Split by Component

3.2.5 Table 12 provides the total changes in population, demand and energy usage for the Future Base and Do Nothing.

Table 12. Energy usage by person and trip compared between scenarios

SCENARIO	POPULATION	DEMAND	ENERGY (MJ)	ENERGY PER PERSON (MJ)	ENERGY PER TRIP (MJ)
Base 2014	**56,565**	**166,833**	**3,900,627**	**68.9**	**23.4**
YEAR - 2020					
Future Base	**56,595**	**166,831**	**3,467,075**	**61.3**	**20.8**
Diff to Base			-433,552	-7.7	-2.6
%Diff to Base			-11.1%	-11.1%	-11.1%
Do Nothing	**54,046**	**159,685**	**3,316,116**	**61.4**	**20.8**
Diff to Base	-2,549	-7,146	-150,959	0.1	0.0
%Diff to Base	-4.5%	-4.3%	-4.4%	0.2%	-0.1%
Diff to Future Base			-584,511	-7.6	-2.6
%Diff to Future Base			-15.2%	-11%	-11.2%
YEAR - 2030					
Future Base	**56,595**	**166,827**	**3,306,459**	**58.4**	**19.8**
Diff to Base			-594,170	-10.5	-3.6
%Diff to Base			-15.2%	-15.2%	-15.2%
Do Nothing	**50,471**	**149,645**	**2,973,905**	**58.9**	**19.9**
Diff to Base	-6,124	-17,182	-322,551	0.5	0.1
%Diff to Base	-10.8%	-10.3%	-10.1%	0.9%	0.3%
Diff to Future Base			-926,722	-10.0	-3.5
%Diff to Future Base			-23.8%	-14.5%	-15.0%

3.2.6 Figure 5 shows the change in energy usage by zone between the Do Nothing and the 2014 Base. This indicates that there is predicted to be a small reduction in transport energy use in all areas of the city which reflects the overall reduction due mainly to changes in the vehicle fleet mix to more energy efficient vehicles

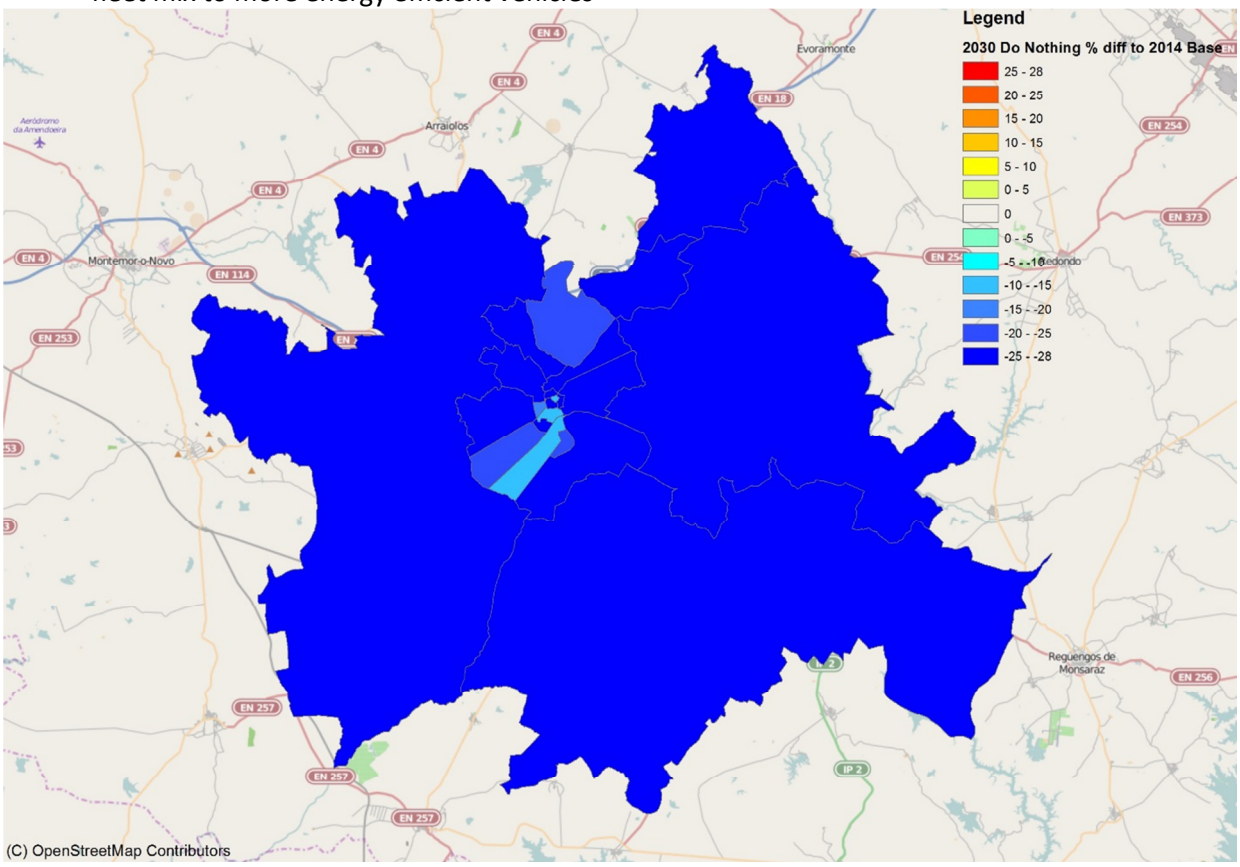


Figure 5. Difference Between Base Year and 2030 Do Nothing (%)

3.2.7 Table 13 and Table 14 display the energy usage data for the Base Year, Future Base and Do Nothing scenarios by vehicles type, isolating the effects of the fleet change and population change.

3.2.8 It can be seen that the largest reduction in energy usage comes from increased efficiency from cars. The increased efficiency for other vehicle types is much less, particularly for goods vehicles and buses which decrease by less than 1%.

Table 13. Fleet and population change effect (2020)

Vehicle Type	Base Year (2014)	Future Base (2020)	DoNothing (2020)	Effect of Fleet Change		Effect of Population Change		Combined Effect	
Energy (MJ)									
Total	3,900,627	3,467,075	3,316,116	- 433,552	-11%	- 150,959	-4%	- 584,511	-15%
Cars	3,421,265	2,990,447	2,844,631	- 430,818	-13%	- 145,816	-5%	- 576,634	-17%
Bikes	102,025	101,383	96,716	- 641	-1%	- 4,667	-5%	- 5,308	-5%
Goods	269,579	267,658	267,599	- 1,921	-1%	- 59	0%	- 1,980	-1%
Buses	59,214	59,043	58,625	- 171	0%	- 418	-1%	- 588	-1%
Trains	48,544	48,544	48,544	-	0%	-	0%	-	0%
Vehicles									
Total	46,048	46,048	44,062	- 1	0%	- 1,986	-4%	- 1,986	-4%
Cars	38,421	38,421	36,690	- 1	0%	- 1,731	-5%	- 1,731	-5%
Bikes	5,662	5,662	5,407	0	0%	- 255	-5%	- 255	-5%
Goods	1,481	1,481	1,481	-	0%	-	0%	-	0%
Buses	417	417	417	-	0%	-	0%	-	0%
Trains	68	68	68	-	0%	-	0%	-	0%
Energy / Vehicle (MJ)									
Total	85	75	75	- 9	-11%	- 0	0%	- 9	-11%
Cars	89	78	78	- 11	-13%	- 0	0%	- 12	-13%
Bikes	18	18	18	- 0	-1%	- 0	0%	- 0	-1%
Goods	182	181	181	- 1	-1%	- 0	0%	- 1	-1%
Buses	142	142	141	- 0	0%	- 1	-1%	- 1	-1%
Trains	714	714	714	-	0%	-	0%	-	0%

Table 14. Fleet and Population change effect (2030)

Vehicle Type	Base Year (2014)	Future Base (2030)	DoNothing (2030)	Effect of Fleet Change		Effect of Population Change		Combined Effect	
Energy (MJ)									
Total	3,900,627	3,306,457	2,973,905	- 594,170	-15%	- 332,551	-10%	- 926,722	-24%
Cars	3,421,265	2,829,871	2,511,979	- 591,395	-17%	- 317,891	-11%	- 909,286	-27%
Bikes	102,025	101,561	90,589	- 464	0%	- 10,972	-11%	- 11,436	-11%
Goods	269,579	267,386	265,395	- 2,193	-1%	- 1,991	-1%	- 4,184	-2%
Buses	59,214	59,095	57,397	- 119	0%	- 1,697	-3%	- 1,816	-3%
Trains	48,544	48,544	48,544	-	0%	-	0%	-	0%
Vehicles									
Total	46,048	46,047	41,277	- 2	0%	- 4,770	-10%	- 4,772	-10%
Cars	38,421	38,420	34,262	- 2	0%	- 4,158	-11%	- 4,159	-11%
Bikes	5,662	5,662	5,049	-	0%	- 613	-11%	- 613	-11%
Goods	1,481	1,481	1,481	-	0%	-	0%	-	0%
Buses	417	417	417	0	0%	- 0	0%	-	0%
Trains	68	68	68	-	0%	-	0%	-	0%
Energy / Vehicle (MJ)									
Total	85	72	72	- 13	-15%	0	0%	- 13	-15%
Cars	89	74	73	- 15	-17%	- 0	0%	- 16	-18%
Bikes	18	18	18	- 0	0%	0	0%	- 0	0%
Goods	182	181	179	- 1	-1%	- 1	-1%	- 3	-2%
Buses	142	142	138	- 0	0%	- 4	-3%	- 4	-3%
Trains	714	714	714	-	0%	-	0%	-	0%

4. INDIVIDUAL SCENARIO TESTS: CYCLING IMPROVEMENTS

4.1 Introduction

4.1.1 This test looks at the extension of the city's cycling infrastructure by 7km. The anticipated impact of the cycling infrastructure improvements is

- a 10% reduction in car use between zone 17 and the city centre zones 18 to 21; and
- a 5% reduction in car use between all remaining zonal movements the new cycle route passes through.

4.1.2 Figure 6 shows the location of the cycle improvements. The existing cycling infrastructure is displayed in purple whilst the new cycle lane that is the focus of the scenario test is displayed in blue.

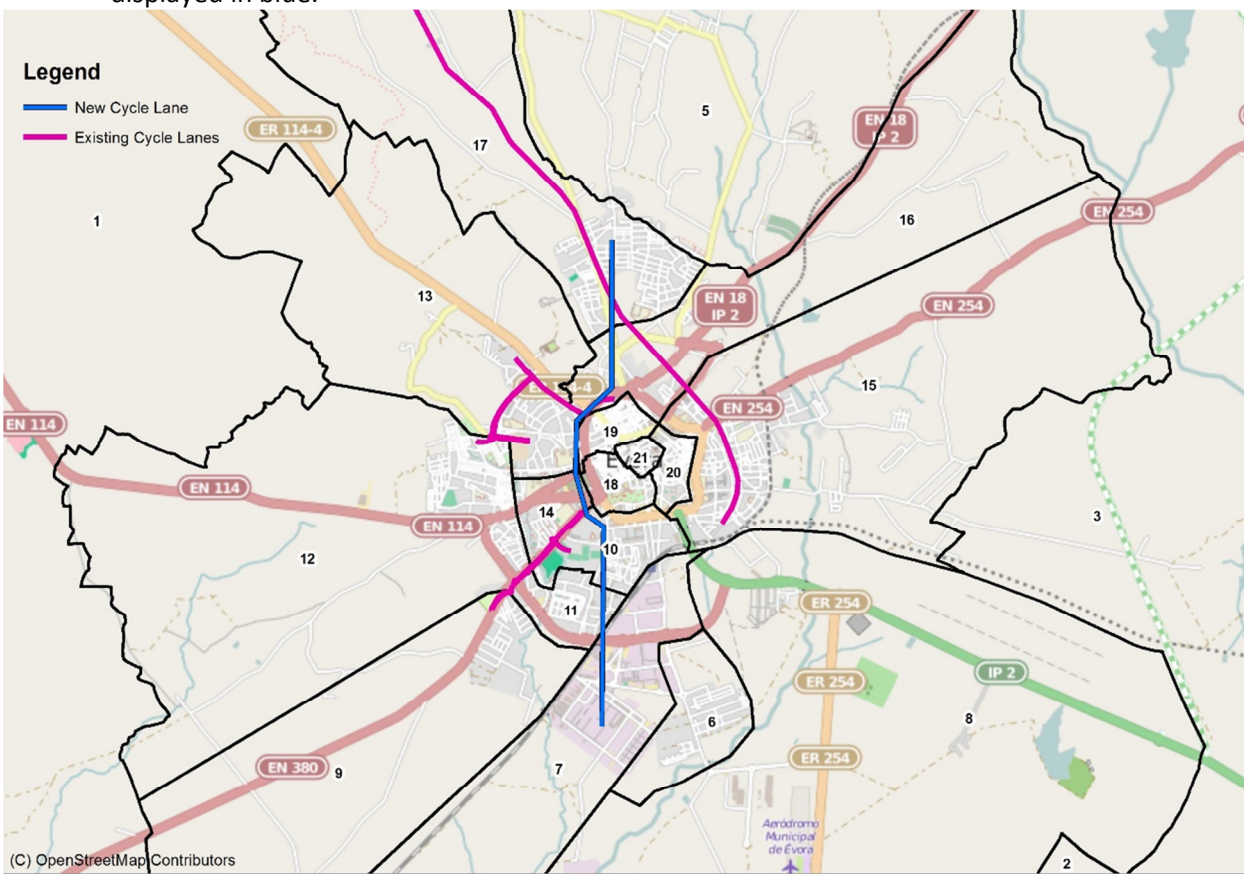


Figure 6. Scheme Details - Cycling Improvements

4.1.3 To implement the scheme the following changes were made to the model inputs:

- Car demand was manually reduced in the demand tables by the specified percentages for the specified zones, in order to simulate the introduction of the new infrastructure.

4.1.4 The limitations of this method of modelling the scheme are that it is completely dependent on the assumptions of demand change provided by Évora Municipality.

4.2 Demand Outputs

4.2.1 Table 15 to Table 17 provide an overview of changes in transport demand, average occupancy and vehicle kilometres within the modelled area for the Do Nothing and the Scenario, in both of the forecast years.

4.2.2 The scenario removes highway demand but does not create mode shift to public transport (as for both modes the costs remain unchanged). This leads to no change in the average occupancies of the bus and rail services.

Table 15. Demand & Mode Shares

Mode	2020		2030	
	DoNothing	Cycle Improvements	DoNothing	Cycle Improvements
Demand By Mode				
Highway	149,611	148,674	139,729	138,823
Public Transport	1,797	1,797	1,664	1,664
Mode Share				
Highway	99%	99%	99%	99%
Public Transport	1%	1%	1%	1%
Change in Highway Demand		- 938		- 906
Change in PT		-		-

Table 16. Average Public Transport Occupancy

Mode	2020		2030	
	DoNothing	Cycle Improvements	DoNothing	Cycle Improvements
Occupancy				
Total	6.8	6.8	6.3	6.3
Buses	4.9	4.9	4.6	4.6
Trains	1.9	1.9	1.7	1.7
%Change in Occupancy				
Total		100.0%		100.0%
Buses		100.0%		100.0%
Trains		100.0%		100.0%

Table 17. Vehicle Kms & Average Distance

Distance	2020		2030	
	DoNothing	Cycle Improvements	DoNothing	Cycle Improvements
Vehicle KM				
Total	1,388,394	-0.5%	1,299,328	-0.5%
Cars	1,279,741	-0.5%	1,194,334	-0.5%
Bikes	57,680	-0.4%	53,974	-0.4%
Goods	50,973	0.0%	51,020	0.0%
Average Distance KM				
Total	11.27	0.1%	11.25	0.1%
Cars	12.60	0.1%	12.59	0.1%
Bikes	3.85	0.3%	3.86	0.3%
Goods	7.65	0.0%	7.65	0.0%

4.2.3 Table 17 shows that the reduction in highway demand leads to a reduction in vehicle kilometres.

4.3 Energy Outputs

4.3.1 Table 18 and Table 19 provide an overview of the energy usage by vehicle type and zone for the 2020 and 2030 Do Nothing and the scenario, respectively.

4.3.2 The reduction in energy usage reflects the reduction in demand. Only highway demand has shifted to cycling and so they are the only vehicle classes to show a reduction.

Table 18. Energy Usage (MJ/day) by Vehicle Type

Vehicle Type	2020 DoNothing	2020 Cycle Improvements	2030 DoNothing	2030 Cycle Improvements
Energy (MJ)				
Total	3,316,116	-0.4%	2,973,905	-0.4%
Cars	2,844,631	-0.5%	2,511,979	-0.5%
Bikes	96,716	-0.4%	90,589	-0.4%
Goods	267,599	0.0%	265,395	0.0%
Buses	58,625	0.0%	57,397	0.0%
Trains	48,544	0.0%	48,544	0.0%
Vehicles				
Total	44,062	0.0%	41,277	0.0%
Cars	36,690	0.0%	34,262	0.0%
Bikes	5,407	0.0%	5,049	0.0%
Goods	1,481	0.0%	1,481	0.0%
Buses	417	0.0%	417	0.0%
Trains	68	0.0%	68	0.0%
Energy / Vehicle (MJ)				
Total	75	-0.4%	72	-0.4%
Cars	78	-0.5%	73	-0.5%
Bikes	18	-0.4%	18	-0.4%
Goods	181	0.0%	179	0.0%
Buses	141	0.0%	138	0.0%
Trains	714	0.0%	714	0.0%

4.3.3 As the information shown is based on the home-based origin of the trip the zones most affected by the scenario are those where there is a large proportion of residential use. Therefore, the city centre zones show only a small change as they are primarily destinations for trips.

Table 19. Energy Usage (MJ/day) by Zone

Zone	2020		2030	
	DoNothing	Cycle Improvements	DoNothing	Cycle Improvements
Total	3,316,116	-0.4%	2,973,905	-0.4%
21 - Catedral de Evora	24,609	0.0%	23,236	0.0%
18 - Jardim Publico de Evora	56,317	-0.1%	49,789	-0.1%
19 - Aquaduct	102,163	-0.3%	90,281	-0.3%
20 - Universidade de Evora	43,167	-0.1%	38,281	-0.1%
6 - Bairro de Almeirim	52,284	0.0%	48,342	0.0%
7 - Evora Retail Park	85,895	0.0%	84,722	0.0%
8 - Aerodromo	25,953	0.0%	24,261	0.0%
9 - Monte das Flores	31,658	0.0%	28,228	0.0%
10 - Horta das Figueiras	50,283	-1.4%	47,267	-1.3%
11 - Bairro Nossa sra do Carmo	51,864	-0.6%	48,965	-0.6%
12 - Bairro De Santa Maria	208,953	0.0%	186,902	0.0%
13 - Bairro dos Tres Bicos	92,463	-2.4%	81,971	-2.5%
14 - Ceniterio de Evora	32,962	-1.2%	30,422	-1.2%
15 - Nossa Sra da Saude	233,174	0.0%	206,739	0.0%
16 - Bairro Frei Aleixo	127,807	-1.4%	117,221	-1.3%
1 - Valverde	368,859	0.0%	326,382	0.0%
2 - Sao Mancos	394,328	0.0%	348,827	0.0%
3 - Nossa Sra de Machede	226,457	0.0%	200,318	0.0%
4 - Azaruja	179,701	0.0%	159,242	0.0%
5 - Canaviais	127,178	0.0%	113,264	0.0%
17 - Bacelo	181,005	-2.7%	160,315	-2.7%
22 - External	619,035	-0.5%	558,929	-0.5%

4.3.4 The reduction in demand is reflected in the energy usage for the city with reductions experienced in the vicinity of the new infrastructure. Figure 7 shows the change in energy usage by zone compared to the Do Nothing scenario.

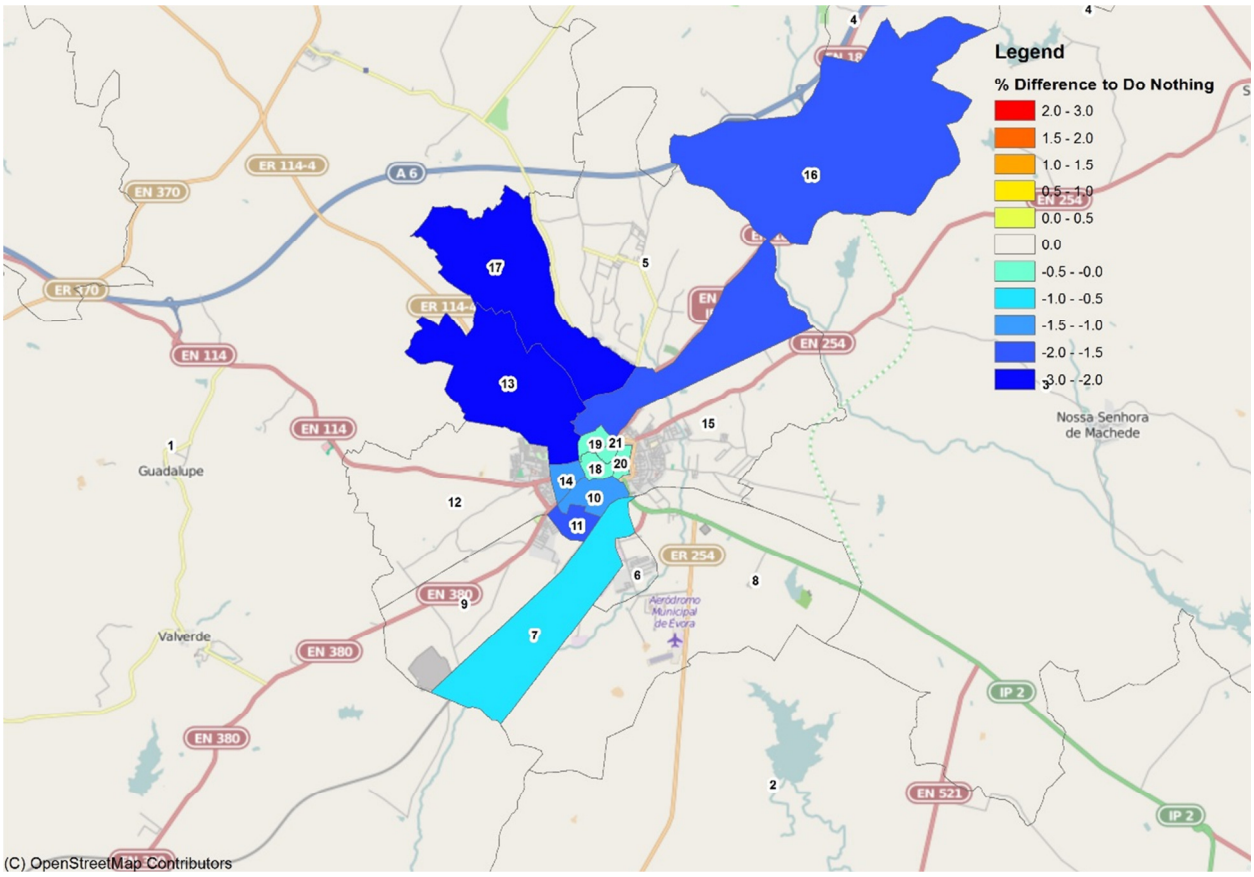


Figure 7. Energy usage by zone change 2030

4.3.5 Figure 7 change from the Do Nothing is roughly the same for both 2020 and 2030 but the differences are slightly smaller in 2030 as the improved efficiency of the vehicle fleet reduces the energy saving by a small amount.

4.3.6 The reductions in demand result in 938 fewer trips in 2020 and 906 fewer in 2030 than the respective Do Nothing scenarios. This in turn results in a small reduction in Carbon Dioxide emissions of around 950kg in total across all vehicle types.

4.3.7 According to the model, the cycle infrastructure improvements would reduce emissions of all types of pollution by 0.4%

4.4 Summary

4.4.1 The scheme reduces total energy usage and emissions. The reduction in demand is only small and therefore any benefits from decongestion are small, meaning there is little if any re-distribution or mode shift.

5. INDIVIDUAL SCENARIO TESTS: PARKING CHARGES

5.1 Introduction

5.1.1 This test looks at the doubling of parking charges in city centre zones 18 to 21. These charges apply to cars only and over all trip purposes. Residents of these zones are not impacted by the parking charges as they are assumed to have their own parking arrangements. The charges are therefore only applied to trips with a destination zone within the city centre.

5.1.2 Table 20 contains the details of the parking costs used in the model for this test. Charges in bold have been doubled from the Do Nothing scenario charges.

Table 20. New parking costs.

Zone	Parking Charge	
	Work	Other
10	€ 4.80	€ 1.20
14	€ 4.80	€ 1.20
18	**€ 9.60**	**€ 2.40**
19	**€ 9.60**	**€ 2.40**
20	**€ 9.60**	**€ 2.40**
21	**€ 9.60**	**€ 2.40**

5.2 Demand Outputs

5.2.1 Table 21 to Table 23 provide an overview of changes in transport demand, average occupancy and vehicle kilometres within the modelled area for the Do Nothing and the Scenario, in both of the forecast years.

5.2.2 The scenario leads to a small amount of mode shift from private vehicle to public transport leading to a slight rise in public transport vehicle occupancy.

Table 21. Demand & Mode Shares

Mode	2020		2030	
	DoNothing	Parking Charges	DoNothing	Parking Charges
Demand By Mode				
Highway	149,611	149,569	139,729	139,699
Public Transport	1,797	1,839	1,664	1,693
Mode Share				
Highway	99%	99%	99%	99%
Public Transport	1%	1%	1%	1%
Change in Highway Demand		- 42		- 29
Change in PT		42		29

Table 22. Average Public Transport Occupancy

Mode	2020 DoNothing	2020 Parking Charges	2030 DoNothing	2030 Parking Charges
Occupancy				
Total	6.8	7.0	6.3	6.4
Buses	4.9	5.1	4.6	4.7
Trains	1.9	1.9	1.7	1.8
%Change in Occupancy				
Total		102.4%		101.9%
Buses		102.4%		101.6%
Trains		102.4%		102.6%

Table 23. Vehicle Kms & Average Distance

Distance	2020 DoNothing	2020 Parking Charges	2030 DoNothing	2030 Parking Charges
Vehicle KM				
Total	1,388,394	0.2%	1,299,328	0.3%
Cars	1,279,741	0.2%	1,194,334	0.2%
Bikes	57,680	1.7%	53,974	1.8%
Goods	50,973	0.0%	51,020	0.0%
Average Distance KM				
Total	11.27	0.2%	11.25	0.3%
Cars	12.60	0.2%	12.59	0.2%
Bikes	3.85	1.7%	3.86	1.9%
Goods	7.65	0.0%	7.65	0.0%

5.2.3 Table 23 provides an overview of the vehicle kilometres and the average distances travelled within the city. Despite the small shift away from private vehicles the overall distance and the average distance increase for all modes except goods demand. This is due to a redistribution of demand away from the city centre to avoid the parking charges, resulting in longer trips.

5.2.4 Table 24 shows the demand change for private vehicles and public transport compared to the Do Nothing scenario.

Table 24. Change In Private Vehicles Demand (2030)

	21	18	19	20	6	7	8	9	10	11	12	13	14	15	16	1	2	3	4	5	17	22	
All Purposes	Catedral de Evora	Jardim Publico de Evora	Aquaduct	Universidade de Evora	Bairro de Almeirim	Evora Retail Park	Aerodromo	Monte das Flores	Horta das Figueiras	Bairro Nossa sra do Carmo	Bairro De Santa Maria	Bairro dos Tres Bicos	Ceniterio de Evora	Nossa Sra da Saude	Bairro Frei Aleixo	Valverde	Sao Mancos	Nossa Sra de Machede	Azaruja	Canaviais	Bacelo	External	Total
21 Catedral de Evora	16%	-66%	-76%	-59%	0%	0%	-2%	0%	-7%	0%	-4%	-1%	0%	-3%	7%	0%	0%	0%	-7%	-6%	2%	0%	0%
18 Jardim Publico de Evora	-73%	2%	-70%	-53%	0%	0%	0%	0%	2%	0%	1%	1%	0%	1%	1%	0%	0%	0%	2%	2%	1%	0%	0%
19 Aquaduct	0%	-37%	0%	-27%	0%	0%	0%	0%	0%	0%	0%	1%	2%	1%	7%	0%	0%	0%	0%	0%	1%	0%	0%
20 Universidade de Evora	0%	-41%	-45%	1%	0%	0%	0%	0%	1%	0%	0%	1%	1%	1%	0%	0%	0%	0%	0%	0%	1%	0%	0%
6 Bairro de Almeirim	-60%	-52%	-56%	-48%	0%	0%	4%	0%	7%	0%	5%	3%	2%	5%	5%	0%	0%	0%	7%	7%	2%	0%	0%
7 Evora Retail Park	-56%	-51%	-53%	-48%	0%	0%	3%	0%	6%	0%	6%	3%	2%	5%	4%	0%	0%	0%	6%	6%	2%	0%	0%
8 Aerodromo	-50%	-47%	-48%	-45%	0%	0%	5%	0%	8%	0%	7%	3%	2%	6%	3%	0%	0%	0%	8%	8%	2%	0%	0%
9 Monte das Flores	-59%	-57%	-58%	-47%	0%	0%	3%	0%	6%	0%	5%	3%	2%	5%	5%	0%	0%	0%	6%	6%	2%	0%	0%
10 Horta das Figueiras	-67%	-37%	-48%	-26%	0%	0%	0%	0%	0%	0%	0%	2%	2%	2%	14%	0%	0%	0%	0%	0%	2%	0%	0%
11 Bairro Nossa sra do Carmo	-66%	-64%	-65%	-55%	0%	0%	3%	0%	6%	0%	6%	4%	2%	6%	7%	0%	0%	0%	7%	7%	2%	0%	0%
12 Bairro De Santa Maria	-61%	-50%	-59%	-39%	0%	0%	1%	0%	4%	0%	4%	2%	2%	3%	3%	0%	0%	0%	4%	4%	2%	0%	0%
13 Bairro dos Tres Bicos	-65%	-56%	-65%	-50%	0%	0%	1%	0%	6%	0%	6%	4%	1%	5%	3%	0%	0%	0%	6%	6%	1%	0%	0%
14 Ceniterio de Evora	-70%	-66%	-70%	-52%	0%	0%	3%	0%	6%	0%	5%	4%	1%	4%	9%	0%	0%	0%	6%	6%	1%	0%	0%
15 Nossa Sra da Saude	-63%	-52%	-60%	-60%	0%	0%	5%	0%	11%	0%	9%	5%	1%	9%	5%	0%	0%	0%	11%	11%	1%	0%	0%
16 Bairro Frei Aleixo	-50%	-40%	-47%	-40%	0%	0%	3%	0%	9%	0%	8%	3%	1%	5%	5%	0%	0%	0%	9%	9%	1%	0%	0%
1 Valverde	0%	-15%	-21%	-10%	0%	0%	0%	0%	1%	0%	0%	1%	1%	1%	1%	0%	0%	0%	0%	0%	1%	0%	0%
2 Sao Mancos	-27%	-26%	-27%	-25%	0%	0%	3%	0%	7%	0%	6%	3%	1%	5%	2%	0%	0%	0%	7%	7%	1%	0%	0%
3 Nossa Sra de Machede	-38%	-34%	-37%	-37%	0%	0%	4%	0%	9%	0%	8%	4%	1%	8%	3%	0%	0%	0%	9%	9%	1%	0%	0%
4 Azaruja	0%	-17%	-22%	-14%	0%	0%	0%	0%	1%	0%	0%	1%	1%	1%	0%	0%	0%	0%	0%	0%	1%	0%	0%
5 Canaviais	-59%	-51%	-57%	-50%	0%	0%	1%	0%	7%	0%	5%	3%	1%	5%	2%	0%	0%	0%	8%	8%	1%	0%	0%
17 Bacelo	-66%	-54%	-66%	-51%	0%	0%	2%	0%	8%	0%	7%	4%	1%	7%	5%	0%	0%	0%	9%	9%	1%	0%	0%
22 External	-39%	-23%	-49%	-44%	0%	0%	2%	0%	7%	0%	6%	3%	1%	6%	4%	0%	0%	0%	9%	8%	1%	0%	0%
Total	-39%	-23%	-49%	-44%	0%	0%	2%	0%	7%	0%	6%	3%	1%	6%	4%	0%	0%	0%	9%	8%	1%	0%	0%

Table 25. Change In Public Transport Demand (2030)

	21	18	19	20	6	7	8	9	10	11	12	13	14	15	16	1	2	3	4	5	17	22	
All Purposes	Catedral de Evora	Jardim Publico de Evora	Aquaduct	Universidade de Evora	Bairro de Almeirim	Evora Retail Park	Aerodromo	Monte das Flores	Horta das Figueiras	Bairro Nossa sra do Carmo	Bairro De Santa Maria	Bairro dos Tres Bicos	Ceniterio de Evora	Nossa Sra da Saude	Bairro Frei Aleixo	Valverde	Sao Mancos	Nossa Sra de Machede	Azaruja	Canaviais	Bacelo	External	Total
21 Catedral de Evora	-4%	-3%	-3%	-2%	0%	-1%	0%	0%	-4%	-1%	-2%	-1%	0%	-1%	1%	0%	0%	0%	0%	-4%	0%	-2%	-2%
18 Jardim Publico de Evora	1%	1%	1%	2%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%	1%	1%
19 Aquaduct	0%	8%	0%	17%	0%	0%	0%	0%	0%	0%	0%	1%	1%	1%	1%	0%	0%	0%	0%	0%	1%	1%	1%
20 Universidade de Evora	0%	1%	1%	1%	0%	0%	0%	0%	1%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%	0%
6 Bairro de Almeirim	4%	4%	3%	7%	0%	0%	0%	0%	3%	0%	2%	1%	1%	2%	2%	0%	0%	0%	0%	4%	1%	1%	1%
7 Evora Retail Park	3%	4%	3%	6%	0%	0%	0%	0%	3%	0%	3%	1%	1%	2%	2%	0%	0%	0%	0%	3%	1%	2%	2%
8 Aerodromo	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
9 Monte das Flores	3%	4%	3%	5%	0%	0%	0%	0%	3%	0%	2%	1%	1%	2%	2%	0%	0%	0%	0%	3%	1%	2%	2%
10 Horta das Figueiras	1%	5%	0%	7%	0%	0%	0%	0%	0%	0%	0%	1%	1%	1%	5%	0%	0%	0%	0%	0%	1%	1%	1%
11 Bairro Nossa sra do Carmo	4%	4%	3%	5%	0%	0%	0%	0%	3%	0%	3%	2%	1%	2%	3%	0%	0%	0%	0%	4%	1%	2%	2%
12 Bairro De Santa Maria	2%	3%	2%	4%	0%	0%	0%	0%	2%	0%	2%	1%	1%	2%	1%	0%	0%	0%	0%	2%	1%	1%	1%
13 Bairro dos Tres Bicos	4%	4%	3%	5%	0%	0%	0%	0%	3%	0%	2%	2%	1%	3%	1%	0%	0%	0%	0%	3%	1%	2%	2%
14 Ceniterio de Evora	3%	4%	3%	4%	0%	0%	0%	0%	3%	0%	1%	1%	0%	1%	2%	0%	0%	0%	0%	3%	1%	2%	2%
15 Nossa Sra da Saude	6%	6%	5%	7%	0%	0%	0%	0%	6%	0%	4%	2%	1%	4%	2%	0%	0%	0%	0%	6%	1%	3%	3%
16 Bairro Frei Aleixo	5%	4%	4%	5%	0%	0%	0%	0%	5%	0%	4%	1%	1%	2%	2%	0%	0%	0%	0%	5%	1%	3%	3%
1 Valverde	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2 Sao Mancos	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
3 Nossa Sra de Machede	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
4 Azaruja	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
5 Canaviais	4%	4%	4%	5%	0%	0%	0%	0%	4%	0%	2%	1%	0%	2%	1%	0%	0%	0%	0%	4%	1%	2%	2%
17 Bacelo	5%	5%	4%	6%	0%	0%	0%	0%	4%	0%	3%	1%	1%	2%	2%	0%	0%	0%	0%	4%	1%	2%	2%
22 External	3%	4%	3%	6%	0%	0%	0%	0%	3%	0%	3%	1%	1%	2%	1%	0%	0%	0%	0%	4%	1%	0%	2%
Total	3%	4%	3%	6%	0%	0%	0%	0%	3%	0%	3%	1%	1%	2%	1%	0%	0%	0%	0%	4%	1%	2%	2%

5.2.5 The decrease in trips to the city centre zones is apparent in the private vehicle matrix due to the increased cost of parking. There is also a fairly large increase in trips with the central zone (zone 21) as a result of reduced congestion as there is a 6kph increase in speed. There is also a redistribution of trips to other zones away from the city centre to avoid the parking charges as expected.

5.2.6 There is a small switch to public transport use to access the city centre zones. Noticeably the city centre residents use less public transport as there is less congestion preventing them from driving.

5.3 Energy Outputs

5.3.1 Table 26 and Table 27 provide an overview of the energy usage by vehicle type and by zone for the 2020 and 2030 Do Nothing and the Scenario, respectively.

5.3.2 The overall energy usage in 2020 is around 18,700 MJ higher than the Do Nothing scenario. This drops to an increase of around 8,000 MJ in 2030.

5.3.3 Motorbikes and mopeds show the largest increase in energy use, followed by cars. This reflects the changes in vehicles kilometres shown in Table 23. Buses show a slight reduction in energy usage due to a speed increase with in the city centre caused by reduced congestion.

5.3.4 The zonal energy usage shows small increases in most zones, with the city centre zone being the exception. This reduction is a combination of the reduction in bus energy usage and a drop in the highway trip length from zone 21.

Table 26. Energy Usage (MJ/day) by Vehicle Type

Vehicle Type	2020		2030	
	DoNothing	Parking Charges	DoNothing	Parking Charges
Energy (MJ)				
Total	3,316,116	0.6%	2,973,905	0.3%
Cars	2,844,631	0.6%	2,511,979	0.3%
Bikes	96,716	2.1%	90,589	1.9%
Goods	267,599	0.0%	265,395	0.0%
Buses	58,625	-0.3%	57,397	-0.2%
Trains	48,544	0.0%	48,544	0.0%
Vehicles				
Total	44,062	0.0%	41,277	0.0%
Cars	36,690	0.0%	34,262	0.0%
Bikes	5,407	0.0%	5,049	0.0%
Goods	1,481	0.0%	1,481	0.0%
Buses	417	0.0%	417	0.0%
Trains	68	0.0%	68	0.0%
Energy / Vehicle (MJ)				
Total	75	0.6%	72	0.3%
Cars	78	0.6%	73	0.3%
Bikes	18	2.1%	18	1.9%
Goods	181	0.0%	179	0.0%
Buses	141	-0.3%	138	-0.2%
Trains	714	0.0%	714	0.0%

Table 27. Energy Usage (MJ/day) by Zone

Zone	2020		2030	
	DoNothing	Parking Charges	DoNothing	Parking Charges
Total	3,316,116	0.6%	2,973,905	0.3%
21 - Catedral de Evora	24,609	-0.6%	23,236	-0.6%
18 - Jardim Publico de Evora	56,317	0.3%	49,789	0.0%
19 - Aquaduct	102,163	1.0%	90,281	0.6%
20 - Universidade de Evora	43,167	0.5%	38,281	0.0%
6 - Bairro de Almeirim	52,284	0.5%	48,342	0.2%
7 - Evora Retail Park	85,895	0.0%	84,722	0.0%
8 - Aerodromo	25,953	0.5%	24,261	0.2%
9 - Monte das Flores	31,658	0.8%	28,228	0.3%
10 - Horta das Figueiras	50,283	0.7%	47,267	0.4%
11 - Bairro Nossa sra do Carmo	51,864	0.5%	48,965	0.3%
12 - Bairro De Santa Maria	208,953	0.7%	186,902	0.1%
13 - Bairro dos Tres Bicos	92,463	0.9%	81,971	0.3%
14 - Ceniterio de Evora	32,962	0.5%	30,422	0.2%
15 - Nossa Sra da Saude	233,174	1.7%	206,739	1.2%
16 - Bairro Frei Aleixo	127,807	0.8%	117,221	0.3%
1 - Valverde	368,859	0.3%	326,382	0.0%
2 - Sao Mancos	394,328	0.5%	348,827	0.3%
3 - Nossa Sra de Machede	226,457	1.0%	200,318	0.6%
4 - Azaruja	179,701	0.4%	159,242	0.0%
5 - Canaviais	127,178	0.4%	113,264	0.2%
17 - Bacelo	181,005	1.0%	160,315	0.7%
22 - External	619,035	0.1%	558,929	0.0%

5.3.5 The increase in energy usage can be explained by the change in car destinations resulting in longer journeys to zones further away as demonstrated in Table 28, showing change in vehicle kilometres. This increase is bigger than the energy reduction resulting from the small switch to public transport.

Table 28. Change in total vehicle km 2030

	21	18	19	20	6	7	8	9	10	11	12	13	14	15	16	1	2	3	4	5	17	22	
All Purposes	Catedral de Evora	Jardim Publico de Evora	Aquaduct	Universidade de Evora	Bairro de Almeirim	Evora Retail Park	Aerodromo	Monte das Flores	Horta das Figueiras	Bairro Nossa sra do Carmo	Bairro De Santa Maria	Bairro dos Tres Bicos	Ceniterio de Evora	Nossa Sra da Saude	Bairro Frei Aleixo	Valverde	Sao Mancos	Nossa Sra de Machede	Azaruja	Canaviais	Bacelo	External	Total
21 Catedral de Evora	18	-7	-2	-11	0	-1	-1	0	-4	1	-12	0	0	-2	10	0	0	0	-1	-3	0	-263	-277
18 Jardim Publico de Evora	-9	15	-9	-52	0	0	1	0	3	0	17	2	0	3	13	0	0	0	1	2	1	-563	-575
19 Aquaduct	0	-26	0	-71	0	0	0	0	0	0	0	5	3	7	307	0	0	0	0	0	8	-245	-12
20 Universidade de Evora	0	-5	-1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	-266	-268
6 Bairro de Almeirim	-19	-54	-22	-72	0	0	12	0	25	0	68	4	2	18	49	0	0	0	5	9	3	-95	-69
7 Evora Retail Park	-2	-4	-2	-6	0	0	1	0	2	0	5	0	0	1	3	0	0	0	0	1	0	-6	-5
8 Aerodromo	-11	-28	-12	-37	0	0	3	0	22	0	35	2	1	9	13	0	0	0	4	6	1	0	7
9 Monte das Flores	-16	-37	-18	-58	0	0	7	0	17	0	53	3	1	12	35	0	0	0	4	9	2	-16	-3
10 Horta das Figueiras	-1	-14	-4	-26	0	0	0	0	1	0	1	4	2	4	121	0	0	0	0	0	5	-2	91
11 Bairro Nossa sra do Carmo	-14	-30	-16	-50	0	0	7	0	7	0	70	4	1	16	38	0	0	0	4	8	2	17	63
12 Bairro De Santa Maria	-56	-161	-66	-243	0	0	14	0	51	0	85	10	4	33	200	0	0	0	13	23	10	-436	-520
13 Bairro dos Tres Bicos	-29	-79	-29	-120	0	0	12	0	46	0	120	5	1	28	72	0	0	0	13	27	3	-59	11
14 Ceniterio de Evora	-10	-20	-10	-39	0	0	4	0	11	0	53	2	0	9	27	0	0	0	3	8	0	-10	28
15 Nossa Sra da Saude	-115	-334	-151	-208	0	1	114	0	328	1	765	34	4	154	227	0	0	0	99	193	6	890	2009
16 Bairro Frei Aleixo	-80	-209	-95	-293	1	0	34	0	181	1	262	19	8	71	58	0	0	0	70	79	9	150	265
1 Valverde	0	-64	-22	-82	1	4	1	0	1	4	5	14	14	15	119	0	0	0	0	0	12	0	23
2 Sao Mancos	-386	-953	-414	-1281	1	2	214	0	1202	2	1137	53	17	293	215	0	0	0	182	188	14	0	485
3 Nossa Sra de Machede	-314	-619	-324	-997	0	1	140	0	818	1	948	43	8	260	159	0	0	0	322	184	8	0	640
4 Azaruja	0	-37	-11	-49	0	1	0	0	1	1	2	8	7	8	43	0	0	0	0	0	7	0	-18
5 Canaviais	-77	-170	-88	-258	0	2	22	0	109	2	215	13	3	60	69	0	0	0	28	95	4	-39	-13
17 Bacelo	-116	-294	-130	-430	1	1	43	0	196	1	505	30	4	134	244	0	0	0	43	223	6	368	829
22 External	-565	-1374	-804	-1540	-641	-852	234	0	1100	-948	2639	117	-127	895	508	0	0	0	109	692	-30	0	-587
Total	-1802	-4506	-2229	-5921	-637	-840	862	0	4116	-934	6972	375	-47	2027	2529	0	0	0	898	1742	72	-572	2106

5.3.6 Figure 8 shows the change in energy usage by zone for 2030 compared to the Do Nothing scenario.

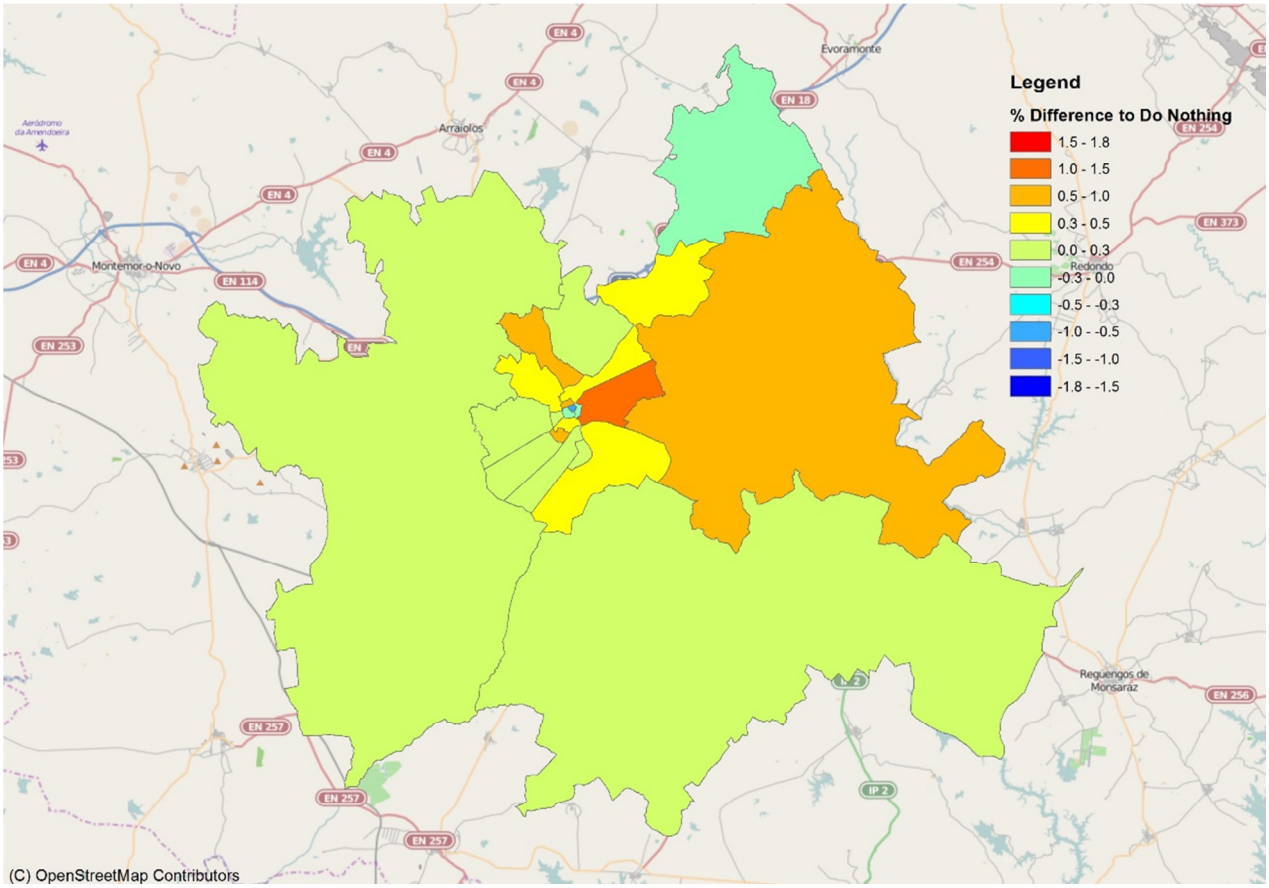


Figure 8. Energy usage by zone change 2030

5.3.7 The reduction in congestion in the city centre results in a net decrease in energy usage despite residents switching from public transport to private vehicle use. This is due to a reduction in the average distance travelled by the residents of zone 21 as more travel within the zone.

5.3.8 The difference in energy usage to the Do Nothing is slightly smaller in 2030 as the improved efficiency of the vehicle fleet and smaller population reduces the energy usage and demand for travel.

5.3.9 The increased length of private vehicle journeys results in slightly higher levels of emissions associated with private car use. The total emissions of Carbon Dioxide increase by around 1,400kg in 2020 and 600kg in 2030 compared to the Do Nothing scenarios.

5.3.10 Emissions from buses decrease slightly as they benefit from less congested traffic conditions in the city centre. Bus speeds in the city centre zone increase by 20%.

5.4 Summary

5.4.1 The scheme reduces total energy usage and emissions in the city centre zone. However this is the exception as the parking charges cause more people to change destination changing mode, traveling further and therefore using more energy and producing more emissions.

5.4.2 The impact of the scheme is relatively small with regards to overall change in energy usage, but the change is an increase rather than a decrease.

6. INDIVIDUAL SCENARIO TESTS: TRAFFIC RESTRICTIONS

6.1 Introduction

6.1.1 This test investigated the banning of all vehicles from the city centre zone 21. The exceptions to the ban were goods vehicles, public transport vehicles and residents of the zone.

6.1.2 Figure 9 shows the extent of the traffic restriction.

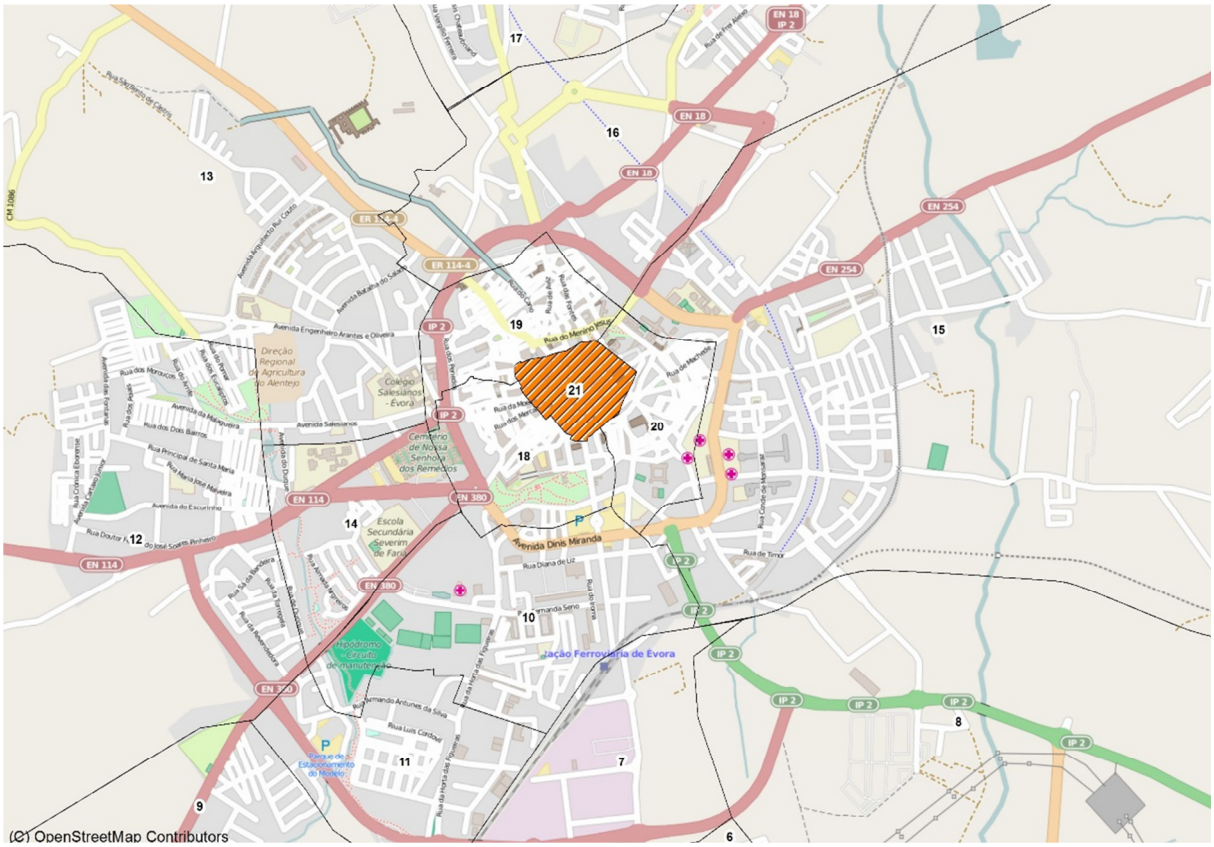


Figure 9. Scheme details – Traffic Restrictions

6.1.3 To implement the scheme the following changes were made to the model inputs:

- The appropriate vehicle types were banned from the restricted zone (21) forcing them to travel to alternative destinations.

6.1.4 The main limitation of this approach is that car demand is forced to redistribute away from the central zone, when in reality most of the demand would be likely to drive to a nearby zone, park and walk to their final destination.

6.2 Demand Outputs

6.2.1 Table 29 to Table 31 provide an overview of changes in transport demand, average occupancy and vehicle kilometres within the modelled area for the Do Nothing and the Scenario, in both of the forecast years.

6.2.2 The scenario reduces highway demand very slightly, with some trips switching to public transport. However these changes are not enough to change the mode share of public transport being less than 1%.

Table 29. Demand & Mode Shares

Mode	2020		2030	
	Do Nothing	Traffic Restrictions	Do Nothing	Traffic Restrictions
Demand By Mode				
Highway	149,611	149,596	139,729	139,714
Public Transport	1,797	1,802	1,664	1,669
Mode Share				
Highway	99%	99%	99%	99%
Public Transport	1%	1%	1%	1%
Change in Highway Demand		- 16		- 15
Change in PT		5		5

Table 30. Average Public Transport Occupancy

Mode	2020		2030	
	Do Nothing	Traffic Restrictions	Do Nothing	Traffic Restrictions
Occupancy				
Total	6.8	6.8	6.3	6.3
Buses	4.9	5.0	4.6	4.6
Trains	1.9	1.9	1.7	1.7
%Change in Occupancy				
Total		100.2%		100.3%
Buses		100.3%		100.1%
Trains		100.0%		100.9%

Table 31. Vehicle Kms & Average Distance

Distance	2020		2030	
	Do Nothing	Traffic Restrictions	Do Nothing	Traffic Restrictions
Vehicle KM				
Total	1,388,394	0.0%	1,299,328	0.0%
Cars	1,279,741	0.0%	1,194,334	0.0%
Bikes	57,680	0.5%	53,974	0.5%
Goods	50,973	0.0%	51,020	0.0%
Average Distance KM				
Total	11.27	0.0%	11.25	0.0%
Cars	12.60	0.0%	12.59	0.0%
Bikes	3.85	0.5%	3.86	0.5%
Goods	7.65	0.0%	7.65	0.0%

6.2.3 Table 31 provides an overview of the vehicle kilometres and the average distances travelled within the city. There is no overall change to total distance travelled or average trip lengths as a result of the scheme. This results from a balancing of longer trips to zones beyond the city centre with shorter trips now not travelling as far as the centre.

6.2.4 Table 32 shows the demand change between this scenario and the Do Nothing scenario. There are three affects present

- No demand to the city centre zone, with a fairly even redistribution of the demand between other zones;
- An increase in demand within the city centre zone from residents, with a corresponding reduction in demand to other zones; and
- Very little mode shift (less than 1%).

Table 32. Private vehicle demand change 2030

	21	18	19	20	6	7	8	9	10	11	12	13	14	15	16	1	2	3	4	5	17	22	
All Purposes	Catedral de Evora	Jardim Publico de Evora	Aquaduct	Universidade de Evora	Bairro de Almeirim	Evora Retail Park	Aerodromo	Monte das Flores	Horta das Figueiras	Bairro Nossa sra do Carmo	Bairro De Santa Maria	Bairro dos Tres Bicos	Ceniterio de Evora	Nossa Sra da Saude	Bairro Frei Aleixo	Valverde	Sao Mancos	Nossa Sra de Machede	Azaruja	Canaviais	Bacelo	External	Total
21 Catedral de Evora	12%	-8%	-9%	-6%	0%	0%	-4%	0%	-10%	0%	-7%	-3%	-1%	-5%	-1%	0%	0%	0%	-11%	-9%	0%	0%	0%
18 Jardim Publico de Evora	-100%	1%	1%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	0%	0%	0%
19 Aquaduct	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
20 Universidade de Evora	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
6 Bairro de Almeirim	-100%	1%	1%	1%	0%	0%	1%	0%	1%	0%	1%	0%	0%	1%	0%	0%	0%	0%	1%	1%	0%	0%	0%
7 Evora Retail Park	-100%	1%	1%	1%	0%	0%	1%	0%	1%	0%	1%	0%	0%	1%	0%	0%	0%	0%	1%	1%	0%	0%	0%
8 Aerodromo	-100%	1%	2%	1%	0%	0%	1%	0%	2%	0%	1%	0%	0%	1%	0%	0%	0%	0%	2%	2%	0%	0%	0%
9 Monte das Flores	-100%	1%	1%	1%	0%	0%	0%	0%	1%	0%	1%	0%	0%	1%	0%	0%	0%	0%	1%	1%	0%	0%	0%
10 Horta das Figueiras	-100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
11 Bairro Nossa sra do Carmo	-100%	1%	1%	1%	0%	0%	0%	0%	1%	0%	1%	0%	0%	1%	0%	0%	0%	0%	1%	1%	0%	0%	0%
12 Bairro De Santa Maria	-100%	1%	1%	0%	0%	0%	0%	0%	1%	0%	1%	0%	0%	0%	0%	0%	0%	0%	1%	1%	0%	0%	0%
13 Bairro dos Tres Bicos	-100%	1%	1%	1%	0%	0%	0%	0%	1%	0%	1%	1%	0%	1%	0%	0%	0%	0%	1%	1%	0%	0%	0%
14 Ceniterio de Evora	-100%	1%	1%	1%	0%	0%	1%	0%	1%	0%	1%	1%	0%	1%	0%	0%	0%	0%	1%	1%	0%	0%	0%
15 Nossa Sra da Saude	-100%	2%	2%	2%	0%	0%	1%	0%	2%	0%	2%	1%	0%	2%	0%	0%	0%	0%	2%	2%	0%	0%	0%
16 Bairro Frei Aleixo	-100%	2%	2%	2%	0%	0%	1%	0%	2%	0%	2%	0%	0%	1%	0%	0%	0%	0%	2%	2%	0%	0%	0%
1 Valverde	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2 Sao Mancos	-100%	2%	3%	2%	0%	0%	1%	0%	3%	0%	2%	1%	0%	2%	0%	0%	0%	0%	3%	3%	0%	0%	0%
3 Nossa Sra de Machede	-100%	3%	3%	3%	0%	0%	1%	0%	3%	0%	3%	1%	0%	2%	1%	0%	0%	0%	3%	3%	0%	0%	0%
4 Azaruja	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
5 Canaviais	-100%	1%	2%	1%	0%	0%	0%	0%	2%	0%	1%	1%	0%	1%	0%	0%	0%	0%	2%	2%	0%	0%	0%
17 Bacelo	-100%	1%	2%	1%	0%	0%	0%	0%	2%	0%	2%	1%	0%	1%	0%	0%	0%	0%	2%	2%	0%	0%	0%
22 External	-100%	1%	2%	1%	0%	0%	1%	0%	2%	0%	1%	0%	0%	1%	0%	0%	0%	0%	2%	2%	0%	0%	0%
Total	-76%	1%	2%	1%	0%	0%	1%	0%	2%	0%	1%	0%	0%	1%	0%	0%	0%	0%	2%	2%	0%	0%	0%

6.2.5 Figure 10 shows the change in demand by destination for 2030, showing it switching away from the city centre.

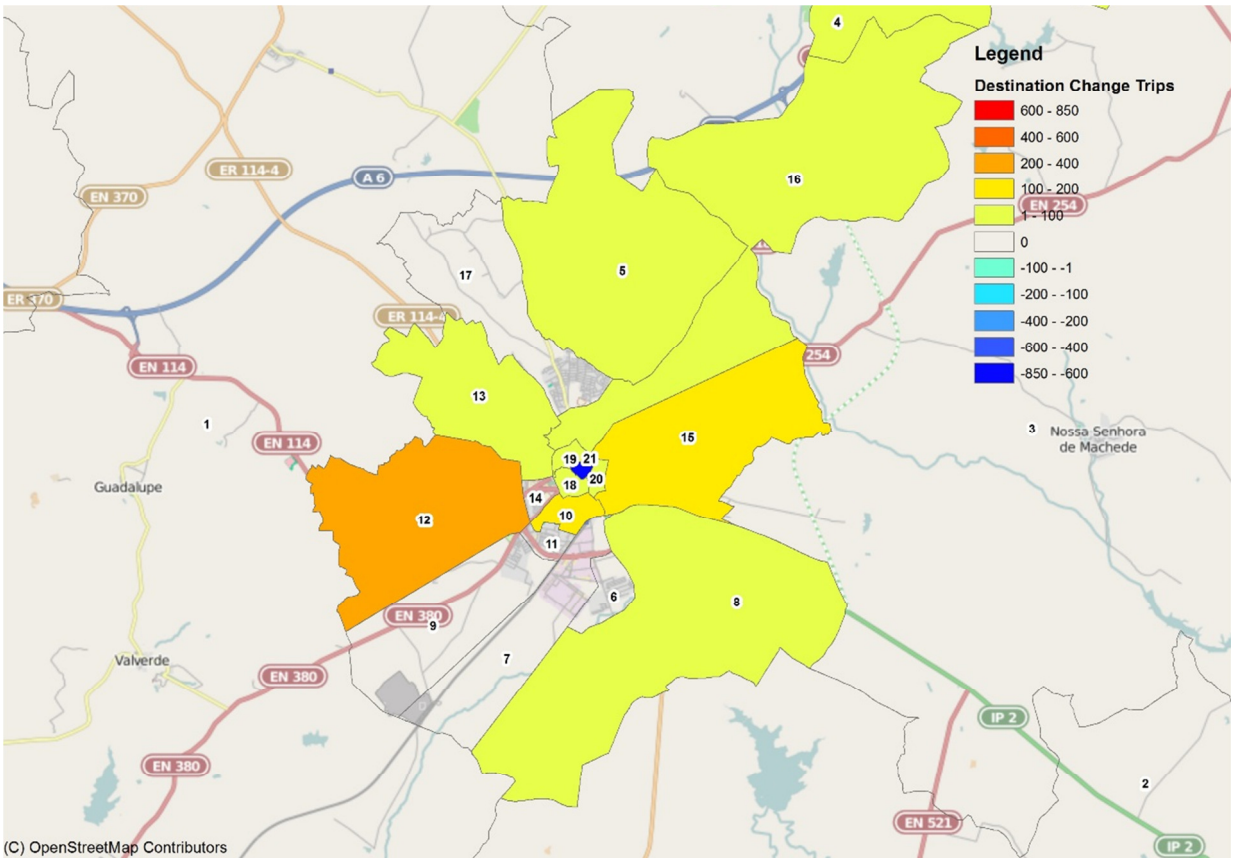


Figure 10. Changes in trip destination 2030

6.2.6 Very few people make the switch to public transport as a result of the scheme. It is possible that the increase in cost of changing destination away from the city centre to a similar alternative zone, is less than the cost of using public transport to continue to access the city centre.

6.3 Energy Outputs

6.3.1 Table 33 and Table 34 provide an overview of the energy usage by vehicle type and by zone for the 2020 and 2030 Do Nothing and the Scenario, respectively.

6.3.2 All vehicle types and zones see increases in energy usage on an trip-origin basis, though some are more affected than others. Change in energy usage by destination zone may show a more varied picture, with a large drop to the city centre zone.

Table 33. Energy Usage (MJ/day) by Vehicle Type

Vehicle Type	2020		2030	
	DoNothing	Traffic Restrictions	DoNothing	Traffic Restrictions
Energy (MJ)				
Total	3,316,116	0.8%	2,973,905	0.5%
Cars	2,844,631	1.0%	2,511,979	0.5%
Bikes	96,716	0.5%	90,589	0.3%
Goods	267,599	0.1%	265,395	0.9%
Buses	58,625	0.5%	57,397	1.9%
Trains	48,544	0.0%	48,544	0.0%
Vehicles				
Total	44,062	0.0%	41,277	0.0%
Cars	36,690	0.0%	34,262	0.0%
Bikes	5,407	0.0%	5,049	0.0%
Goods	1,481	0.0%	1,481	0.0%
Buses	417	0.0%	417	0.0%
Trains	68	0.0%	68	0.0%
Energy / Vehicle (MJ)				
Total	75	0.8%	72	0.5%
Cars	78	0.9%	73	0.5%
Bikes	18	0.5%	18	0.3%
Goods	181	0.1%	179	0.9%
Buses	141	0.5%	138	1.9%
Trains	714	0.0%	714	0.0%

Table 34. Energy Usage (MJ/day) by Zone

Zone	2020		2030	
	DoNothing	Traffic Restrictions	DoNothing	Traffic Restrictions
Total	3,316,116	0.8%	2,973,905	0.5%
21 - Catedral de Evora	24,609	0.0%	23,236	0.9%
18 - Jardim Publico de Evora	56,317	1.2%	49,789	0.8%
19 - Aquaduct	102,163	1.3%	90,281	0.8%
20 - Universidade de Evora	43,167	1.3%	38,281	0.8%
6 - Bairro de Almeirim	52,284	0.9%	48,342	0.9%
7 - Evora Retail Park	85,895	0.1%	84,722	1.1%
8 - Aerodromo	25,953	0.9%	24,261	1.1%
9 - Monte das Flores	31,658	1.4%	28,228	0.8%
10 - Horta das Figueiras	50,283	0.6%	47,267	0.3%
11 - Bairro Nossa sra do Carmo	51,864	0.6%	48,965	0.7%
12 - Bairro De Santa Maria	208,953	1.4%	186,902	0.8%
13 - Bairro dos Tres Bicos	92,463	1.5%	81,971	0.9%
14 - Ceniterio de Evora	32,962	0.9%	30,422	1.1%
15 - Nossa Sra da Saude	233,174	1.7%	206,739	1.0%
16 - Bairro Frei Aleixo	127,807	1.3%	117,221	1.1%
1 - Valverde	368,859	0.7%	326,382	0.3%
2 - Sao Mancos	394,328	0.8%	348,827	0.4%
3 - Nossa Sra de Machede	226,457	1.0%	200,318	0.6%
4 - Azaruja	179,701	1.1%	159,242	0.5%
5 - Canaviais	127,178	1.0%	113,264	0.6%
17 - Bacelo	181,005	1.1%	160,315	0.7%
22 - External	619,035	0.1%	558,929	0.0%

6.3.3 The overall energy usage in 2020 is around 28,000 MJ higher than the Do Nothing scenario. This drops to an increase of around 16,300 MJ in 2030. Overall demand has not really changed and private vehicle users instead access alternative zones to the city centre. In doing so they do not travel further overall, however they may be travelling on different road types with different speeds, thus using more energy.

6.3.4 Figure 11 shows the change in energy usage by zone 2030 compared to the Do Nothing scenario.

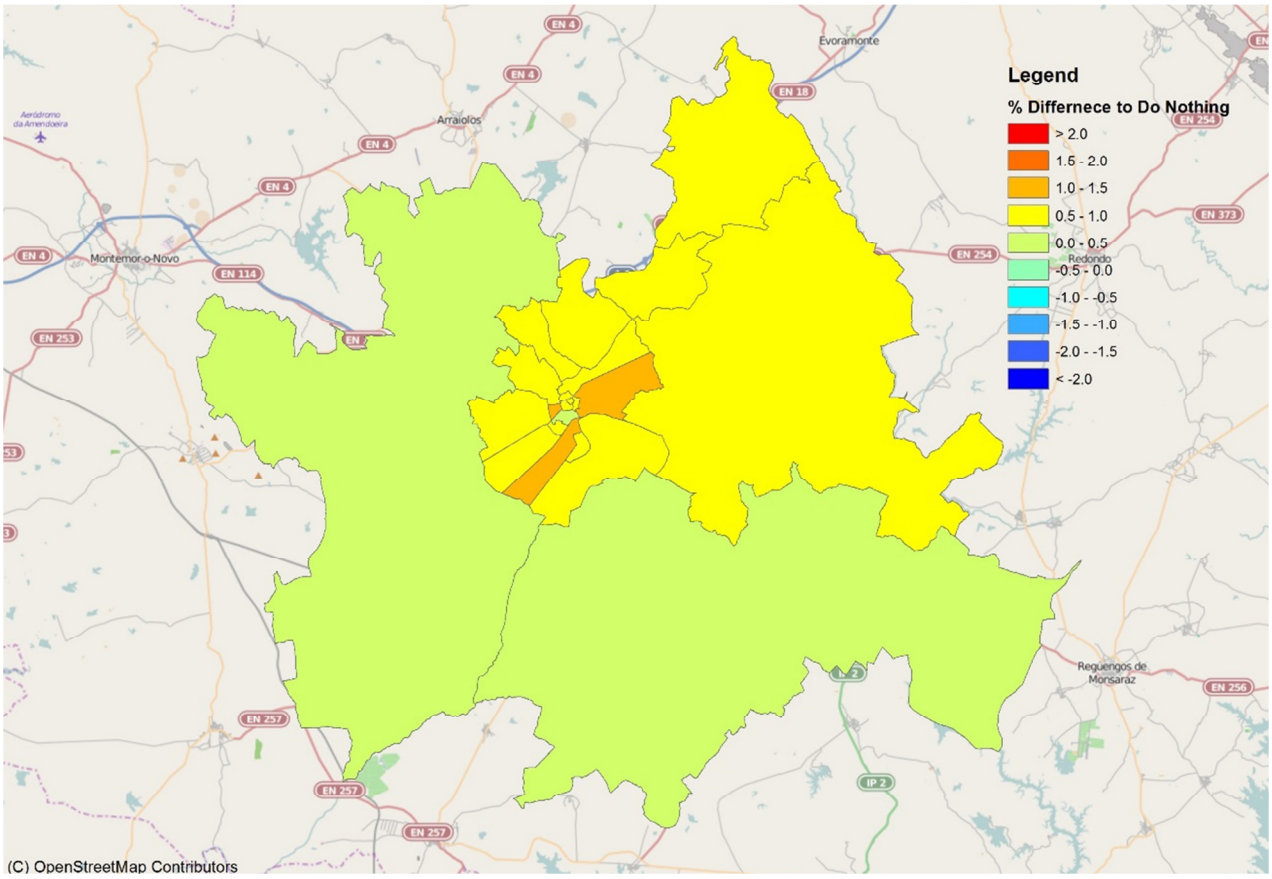


Figure 11. Change in Energy Usage (2030)

6.3.5 The changes compared to the Do Nothing scenarios are slightly different between 2020 and 2030. However all of these changes are small.

6.3.6 All zones with the exception of the city centre in 2020 see an increase in energy usage as most zones have trips to the city centre and the energy is grouped by origin zone.

6.3.7 Carbon Dioxide emissions increased by around 2,100kg in 2020 and around 1,200kg in 2030 compared to the respective Do Nothing scenarios.

6.4 Summary

6.4.1 The scheme creates an overall increase in energy usage due to the redistribution of private vehicle traffic. People choose to remain in their private vehicles and travel to different destinations resulting in almost no switching to public transport.

7. INDIVIDUAL SCENARIO TESTS: SPEED CHANGES

7.1 Introduction

7.1.1 This test looks at the introduction of 30km/h zones in some areas of the city, around the main historic centre. Figure 12 shows the zones in which the new speeds were applied.

7.1.2 To implement the scheme the following changes were made to the model inputs:

- Speeds for the zones shown were reduced to 30kph from 40kph.
- Speeds for goods vehicles and buses were already 30kph and these remained the unchanged.

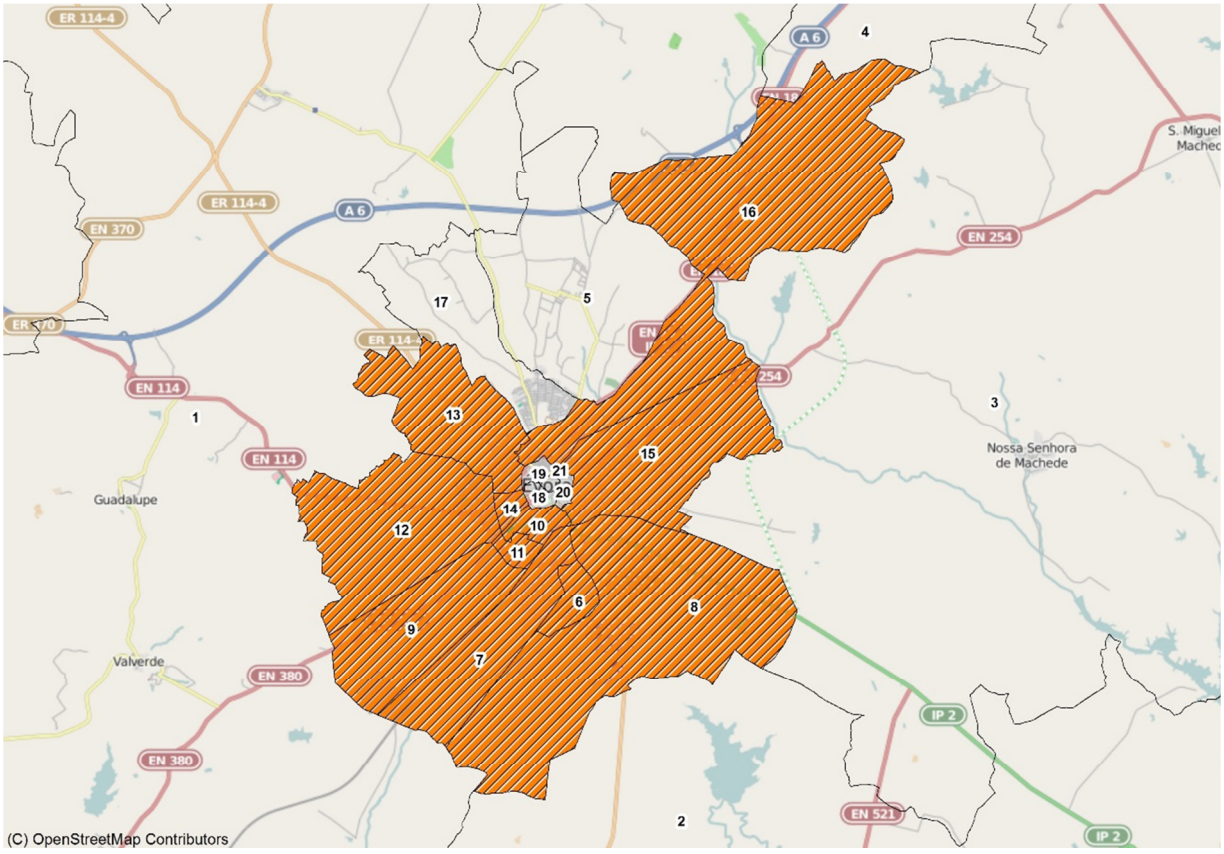


Figure 12. Scheme Details - Location of 30km/h zones

7.1.3 This method of representing the 30km/h zones possibly over estimates their effect as in reality the planned restriction zones would be smaller than the zones of the model. Zones 6 to 16 were treated as 30km/h zones.

7.2 Demand Outputs

7.2.1 Table 35 to Table 37 provide an overview of changes in transport demand, average occupancy and vehicle kilometres within the modelled area for the Do Nothing and the Scenario, in both of the forecast years.

7.2.2 The scenario causes a shift from highway to public transport . This switch is not enough to make an impact on the overall mode share of public transport but it is the largest increase in public transport usage seen in any of the scenario tests – a 20% increase in public transport demand, albeit from a small base. Consequently bus and train average occupancies increase.

Table 35. Demand & Mode Shares

Mode	2020		2030	
	Do Nothing	Speed Changes	Do Nothing	Speed Changes
Demand By Mode				
Highway	149,611	149,255	139,729	139,414
Public Transport	1,797	2,154	1,664	1,978
Mode Share				
Highway	99%	99%	99%	99%
Public Transport	1%	1%	1%	1%
Change in Highway Demand		- 357		- 314
Change in PT		357		314

Table 36. Average Public Transport Occupancy

Mode	2020		2030	
	Do Nothing	Speed Changes	Do Nothing	Speed Changes
Occupancy				
Total	6.8	8.1	6.3	7.5
Buses	4.9	5.9	4.6	5.4
Trains	1.9	2.2	1.7	2.0
%Change in Occupancy				
Total		119.9%		118.9%
Buses		120.0%		118.9%
Trains		119.8%		119.0%

Table 37. Vehicle Kms & Average Distance

Distance	2020		2030	
	Do Nothing	Speed Changes	Do Nothing	Speed Changes
Vehicle KM				
Total	1,388,394	-0.3%	1,299,328	-0.3%
Cars	1,279,741	-0.3%	1,194,334	-0.3%
Bikes	57,680	0.9%	53,974	0.8%
Goods	50,973	0.1%	51,020	0.0%
Average Distance KM				
Total	11.27	0.0%	11.25	-0.1%
Cars	12.60	-0.1%	12.59	-0.1%
Bikes	3.85	1.2%	3.86	1.0%
Goods	7.65	0.1%	7.65	0.0%

7.2.3 Table 37 provides an overview of the vehicle kilometres and the average distances travelled within the city. There is an overall reduction in vehicle kilometres due to a combination of the mode shift to public transport and the effects of re-routing.

7.2.4 Table 38 and Table 39 show the change in demand from the Do Nothing scenario for 2030.

Table 38. Change in Private Vehicle Demand (2030)

All Purposes	21 Catedral de Evora	18 Jardim Publico de Evora	19 Aquaduct	20 Universidade de Evora	6 Bairro de Almeirim	7 Evora Retail Park	8 Aerodromo	9 Monte das Flores	10 Horta das Figueiras	11 Bairro Nossa sra do Carmo	12 Bairro De Santa Maria	13 Bairro dos Tres Bicos	14 Ceniterio de Evora	15 Nossa Sra da Saude	16 Bairro Frei Aleixo	1 Valverde	2 Sao Mancos	3 Nossa Sra de Machede	4 Azaruja	5 Canaviais	17 Bacelo	22 External	Total
21 Catedral de Evora	12%	27%	30%	20%	-2%	-10%	-13%	0%	16%	6%	-15%	-10%	17%	-16%	-9%	0%	0%	0%	-12%	-1%	7%	0%	0%
18 Jardim Publico de Evora	13%	14%	15%	4%	-1%	-3%	-7%	0%	-1%	2%	-26%	-9%	8%	-15%	-2%	0%	0%	0%	-22%	-8%	2%	0%	0%
19 Aquaduct	0%	14%	17%	11%	-1%	-2%	-2%	0%	10%	4%	-3%	-8%	13%	-8%	-6%	0%	0%	0%	0%	0%	6%	0%	0%
20 Universidade de Evora	0%	10%	20%	6%	0%	-1%	-2%	0%	14%	2%	0%	-5%	13%	-4%	-2%	0%	0%	0%	0%	0%	7%	0%	0%
6 Bairro de Almeirim	27%	22%	30%	23%	0%	0%	-8%	0%	26%	0%	-11%	-3%	11%	-11%	-2%	0%	0%	0%	7%	3%	2%	0%	0%
7 Evora Retail Park	20%	18%	24%	19%	0%	0%	-7%	0%	23%	0%	-12%	-4%	9%	-11%	-2%	0%	0%	0%	5%	0%	1%	0%	0%
8 Aerodromo	19%	17%	22%	18%	0%	0%	-7%	0%	15%	0%	-9%	-3%	8%	-9%	-1%	0%	0%	0%	8%	2%	1%	0%	0%
9 Monte das Flores	35%	26%	33%	19%	-1%	-1%	-5%	0%	26%	-1%	-11%	-8%	12%	-10%	0%	0%	0%	0%	5%	13%	3%	0%	0%
10 Horta das Figueiras	72%	16%	35%	11%	0%	0%	0%	0%	-1%	-1%	-1%	-2%	14%	-8%	-5%	0%	0%	0%	31%	39%	5%	0%	0%
11 Bairro Nossa sra do Carmo	40%	33%	39%	25%	0%	0%	-10%	0%	37%	0%	-18%	-4%	13%	-17%	-3%	0%	0%	0%	5%	10%	4%	0%	0%
12 Bairro De Santa Maria	38%	26%	35%	20%	0%	0%	-1%	0%	27%	0%	-7%	-7%	11%	-3%	0%	0%	0%	0%	16%	14%	0%	0%	0%
13 Bairro dos Tres Bicos	41%	37%	39%	26%	0%	0%	-1%	0%	32%	1%	-10%	-9%	13%	-7%	-3%	0%	0%	0%	12%	12%	1%	0%	0%
14 Ceniterio de Evora	57%	50%	56%	35%	-1%	-2%	-6%	0%	38%	1%	-13%	-10%	-4%	1%	-3%	0%	0%	0%	14%	24%	12%	0%	0%
15 Nossa Sra da Saude	28%	27%	26%	27%	0%	-1%	-8%	0%	17%	-1%	-10%	-8%	15%	-15%	-3%	0%	0%	0%	5%	2%	2%	0%	0%
16 Bairro Frei Aleixo	15%	16%	15%	12%	0%	0%	-5%	0%	8%	0%	-8%	-5%	8%	-8%	-5%	0%	0%	0%	12%	6%	-1%	0%	0%
1 Valverde	0%	3%	4%	3%	0%	-1%	-3%	0%	2%	1%	2%	-1%	3%	-2%	-2%	0%	0%	0%	0%	0%	0%	0%	0%
2 Sao Mancos	5%	5%	6%	6%	1%	0%	0%	0%	2%	1%	-4%	-1%	2%	0%	-3%	0%	0%	0%	-8%	1%	0%	0%	0%
3 Nossa Sra de Machede	8%	7%	7%	8%	0%	-1%	-7%	0%	2%	1%	-8%	-3%	3%	-3%	0%	0%	0%	0%	30%	-2%	1%	0%	0%
4 Azaruja	0%	4%	5%	2%	-1%	-1%	-2%	0%	3%	1%	0%	-2%	4%	-2%	2%	0%	0%	0%	0%	0%	0%	0%	0%
5 Canaviais	8%	10%	10%	7%	-1%	-3%	-7%	0%	2%	3%	-13%	-10%	6%	-14%	-1%	0%	0%	0%	-9%	24%	10%	0%	0%
17 Bacelo	22%	17%	22%	15%	0%	-2%	-7%	0%	9%	3%	-16%	-12%	4%	-13%	-6%	0%	0%	0%	-11%	32%	11%	0%	0%
22 External	20%	17%	21%	17%	0%	-1%	-5%	0%	12%	1%	-10%	-7%	8%	-10%	-2%	0%	0%	0%	12%	19%	5%	0%	0%
Total	20%	17%	21%	17%	0%	-1%	-5%	0%	12%	1%	-10%	-7%	8%	-10%	-2%	0%	0%	0%	12%	19%	5%	0%	0%

Table 39. Change in Public Transport Demand (2030)

All Purposes	21 Catedral de Evora	18 Jardim Publico de Evora	19 Aquaduct	20 Universidade de Evora	6 Bairro de Almeirim	7 Evora Retail Park	8 Aerodromo	9 Monte das Flores	10 Horta das Figueiras	11 Bairro Nossa sra do Carmo	12 Bairro De Santa Maria	13 Bairro dos Tres Bicos	14 Ceniterio de Evora	15 Nossa Sra da Saude	16 Bairro Frei Aleixo	1 Valverde	2 Sao Mancos	3 Nossa Sra de Machede	4 Azaruja	5 Canaviais	17 Bacelo	22 External	Total
21 Catedral de Evora	16%	13%	15%	14%	9%	13%	0%	0%	15%	13%	15%	10%	12%	13%	11%	0%	0%	0%	0%	16%	9%	13%	13%
18 Jardim Publico de Evora	5%	8%	8%	4%	11%	11%	0%	0%	7%	11%	10%	6%	10%	8%	10%	0%	0%	0%	0%	7%	6%	9%	9%
19 Aquaduct	0%	7%	9%	6%	8%	9%	0%	0%	8%	9%	10%	8%	9%	9%	9%	0%	0%	0%	0%	0%	8%	9%	9%
20 Universidade de Evora	0%	6%	12%	4%	11%	11%	0%	0%	12%	12%	11%	10%	12%	12%	9%	0%	0%	0%	0%	0%	10%	11%	11%
6 Bairro de Almeirim	33%	31%	32%	27%	14%	18%	0%	0%	34%	19%	29%	18%	17%	22%	16%	0%	0%	0%	0%	34%	15%	22%	22%
7 Evora Retail Park	33%	32%	32%	29%	14%	16%	0%	0%	34%	17%	30%	19%	16%	25%	16%	0%	0%	0%	0%	34%	15%	23%	23%
8 Aerodromo	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
9 Monte das Flores	34%	33%	33%	32%	14%	20%	0%	0%	35%	20%	30%	20%	19%	25%	16%	0%	0%	0%	0%	35%	15%	26%	26%
10 Horta das Figueiras	43%	24%	32%	31%	14%	20%	0%	0%	43%	21%	28%	14%	15%	18%	14%	0%	0%	0%	0%	44%	13%	27%	27%
11 Bairro Nossa sra do Carmo	29%	27%	28%	27%	14%	17%	0%	0%	30%	18%	27%	17%	14%	21%	16%	0%	0%	0%	0%	29%	13%	23%	23%
12 Bairro De Santa Maria	39%	35%	37%	33%	14%	16%	0%	0%	39%	17%	32%	20%	17%	28%	16%	0%	0%	0%	0%	39%	16%	24%	24%
13 Bairro dos Tres Bicos	36%	33%	35%	33%	13%	14%	0%	0%	36%	15%	30%	24%	17%	29%	14%	0%	0%	0%	0%	36%	16%	23%	23%
14 Ceniterio de Evora	32%	27%	31%	31%	13%	21%	0%	0%	34%	22%	28%	21%	22%	23%	17%	0%	0%	0%	0%	34%	17%	28%	28%
15 Nossa Sra da Saude	31%	30%	30%	30%	14%	18%	0%	0%	32%	20%	26%	19%	18%	27%	15%	0%	0%	0%	0%	32%	16%	25%	25%
16 Bairro Frei Aleixo	34%	28%	32%	29%	13%	17%	0%	0%	34%	18%	31%	19%	17%	23%	17%	0%	0%	0%	0%	34%	16%	24%	24%
1 Valverde	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2 Sao Mancos	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
3 Nossa Sra de Machede	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
4 Azaruja	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
5 Canaviais	12%	10%	12%	11%	8%	11%	0%	0%	12%	11%	12%	7%	8%	9%	9%	0%	0%	0%	0%	12%	5%	11%	11%
17 Bacelo	15%	13%	15%	13%	9%	10%	0%	0%	15%	10%	15%	8%	6%	9%	10%	0%	0%	0%	0%	16%	6%	12%	12%
22 External	26%	23%	26%	23%	12%	14%	0%	0%	28%	15%	24%	15%	13%	22%	12%	0%	0%	0%	0%	26%	11%	0%	19%
Total	26%	23%	26%	23%	12%	14%	0%	0%	28%	15%	24%	15%	13%	22%	12%	0%	0%	0%	0%	26%	11%	19%	19%

7.2.5 There is a switch from private vehicle to public transport for several zone to zone movements, most noticeably for trips originating in the 30km/h zone. There is also an increase in car trips to the city centre zones from the 30km/h zones.

7.2.6 Private vehicle trips seem to change destination in favour of the city centre away from the affected zones.

7.2.7 Figure 13 shows the changes in destination zone for 2030.

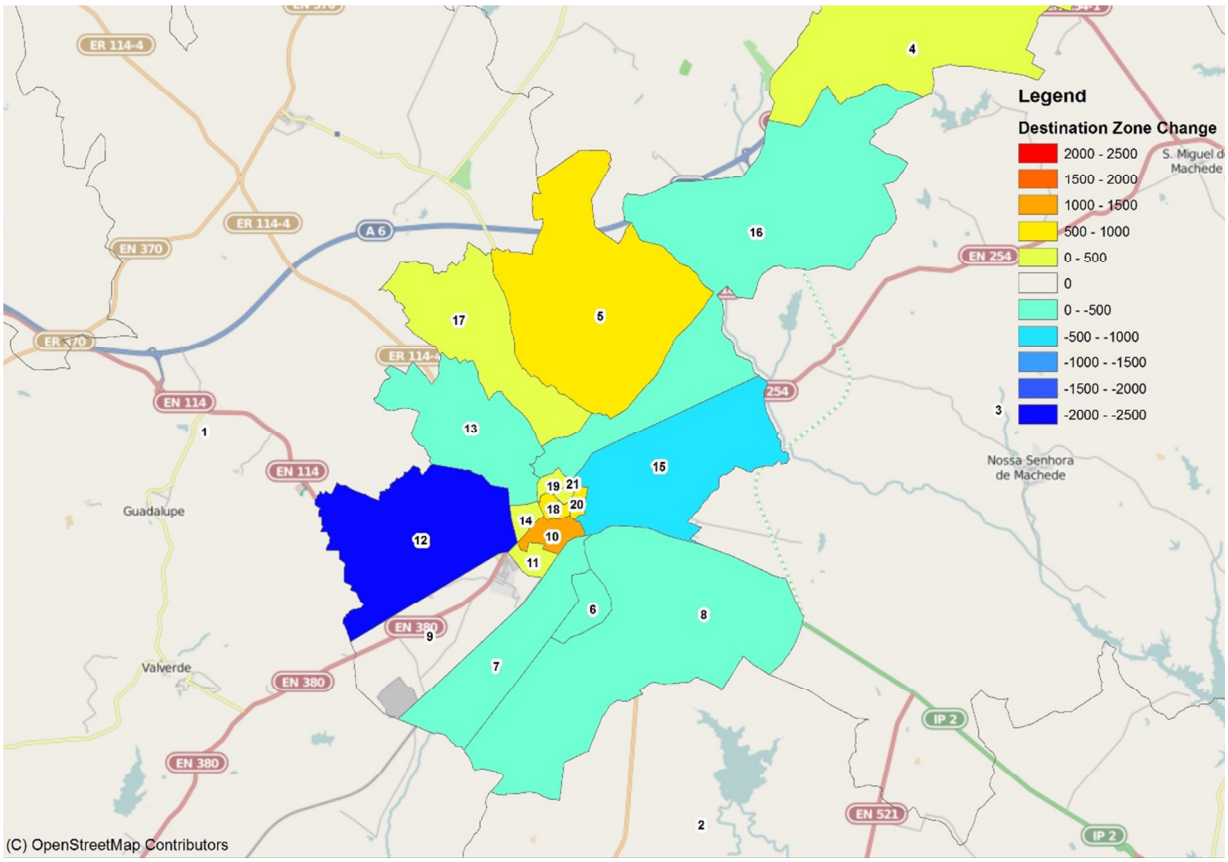


Figure 13. Change in Trip Destination (2030)

7.2.8 There are fewer trips to the affected zones on either side of the city centre where the30km/h areas are located. The same city wide patterns are observed in the 2020 model year also.

7.3 Energy Outputs

7.3.1 Table 40 and Table 41 provide an overview of the energy usage by vehicle type and by zone for the 2020 and 2030 Do Nothing test and the Scenario respectively.

7.3.2 Overall the scenario leads to a fairly large increase in the energy usage and the largest seen for any scenario run for Évora. This is the result of the vehicles now travelling at a less efficient speed.

7.3.3 Figure 14 shows the fuel consumption by speed. The effect of reducing the speeds from 40kph to 30kph increases the fuel consumption by 14%.

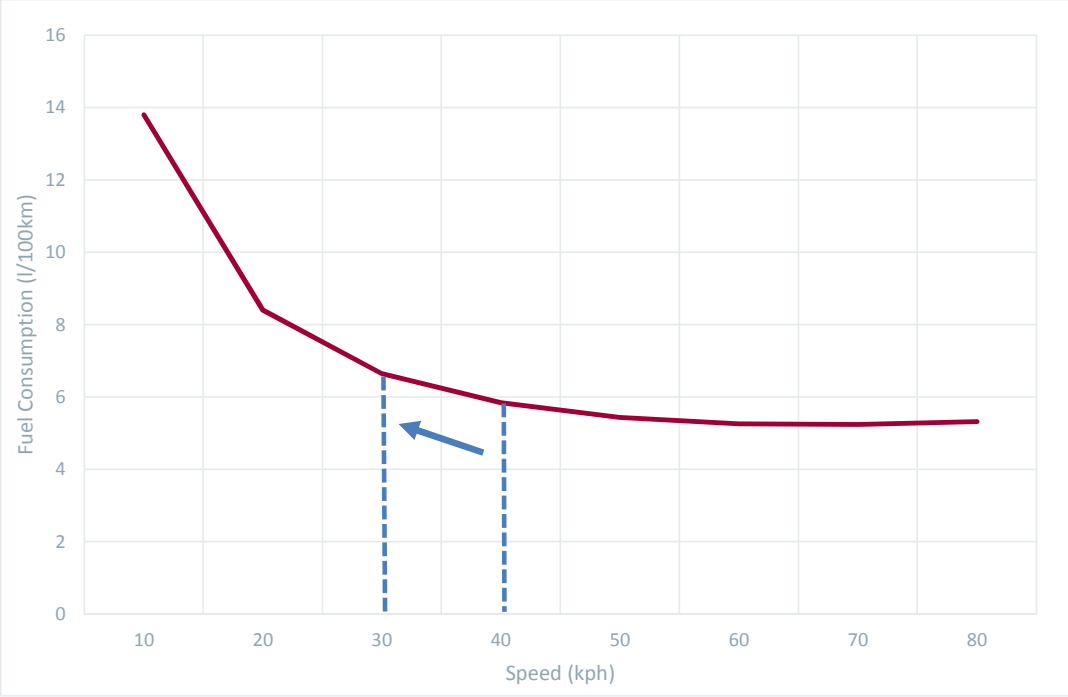


Figure 14. Effect of Speed Changes on Fuel Consumption

Table 40. Energy Usage (MJ/day) by Vehicle Type

Vehicle Type	2020		2030	
	DoNothing	Speed Changes	DoNothing	Speed Changes
Energy (MJ)				
Total	3,316,116	4.0%	2,973,905	4.2%
Cars	2,844,631	4.5%	2,511,979	4.7%
Bikes	96,716	5.3%	90,589	5.1%
Goods	267,599	-0.7%	265,395	0.0%
Buses	58,625	-0.4%	57,397	0.9%
Trains	48,544	0.0%	48,544	0.0%
Vehicles				
Total	44,062	0.0%	41,277	0.0%
Cars	36,690	0.0%	34,262	0.0%
Bikes	5,407	0.0%	5,049	0.0%
Goods	1,481	0.0%	1,481	0.0%
Buses	417	0.0%	417	0.0%
Trains	68	0.0%	68	0.0%
Energy / Vehicle (MJ)				
Total	75	4.0%	72	4.2%
Cars	78	4.5%	73	4.7%
Bikes	18	5.3%	18	5.1%
Goods	181	-0.7%	179	0.0%
Buses	141	-0.4%	138	0.9%
Trains	714	0.0%	714	0.0%

Table 41. Energy Usage (MJ/day) by Zone

Zone	2020		2030	
	DoNothing	Speed Changes	DoNothing	Speed Changes
Total	3,316,116	4.0%	2,973,905	4.2%
21 - Catedral de Evora	24,609	1.0%	23,236	1.7%
18 - Jardim Publico de Evora	56,317	3.7%	49,789	3.6%
19 - Aquaduct	102,163	5.4%	90,281	5.3%
20 - Universidade de Evora	43,167	6.6%	38,281	6.7%
6 - Bairro de Almeirim	52,284	4.3%	48,342	4.7%
7 - Evora Retail Park	85,895	-0.7%	84,722	0.2%
8 - Aerodromo	25,953	4.9%	24,261	5.4%
9 - Monte das Flores	31,658	7.6%	28,228	8.1%
10 - Horta das Figueiras	50,283	3.3%	47,267	3.2%
11 - Bairro Nossa sra do Carmo	51,864	1.7%	48,965	1.9%
12 - Bairro De Santa Maria	208,953	8.6%	186,902	9.0%
13 - Bairro dos Tres Bicos	92,463	8.5%	81,971	8.8%
14 - Ceniterio de Evora	32,962	3.8%	30,422	4.3%
15 - Nossa Sra da Saude	233,174	7.9%	206,739	8.3%
16 - Bairro Frei Aleixo	127,807	6.4%	117,221	6.9%
1 - Valverde	368,859	3.3%	326,382	3.5%
2 - Sao Mancos	394,328	2.9%	348,827	3.0%
3 - Nossa Sra de Machede	226,457	4.2%	200,318	4.3%
4 - Azaruja	179,701	5.7%	159,242	6.0%
5 - Canaviais	127,178	3.3%	113,264	3.6%
17 - Bacelo	181,005	4.0%	160,315	4.2%
22 - External	619,035	0.8%	558,929	0.8%

7.3.4 The overall energy usage in 2020 is around 131,500 MJ higher than the Do Nothing and around 124,200 MJ in 2030. This is due to the slower, less efficient speeds in the 30km/h zones.

7.3.5 The affect lower speeds can be seen in Table 42 which shows the increases in the generalised cost of zone to zone movements due to the change in speeds. Almost all movements are effected, with the exception of the rural and the central zones.

Table 42. Change in Generalised cost 2030

	21	18	19	20	6	7	8	9	10	11	12	13	14	15	16	1	2	3	4	5	17	22	
Private Vehicles, Purpose 8	Catedral de Evora	Jardim Publico de Evora	Aquaduct	Universidade de Evora	Bairro de Almeirim	Evora Retail Park	Aerodromo	Monte das Flores	Horta das Figueiras	Bairro Nossa Sra do Carmo	Bairro De Santa Maria	Bairro dos Tres Bicos	Ceniterio de Evora	Nossa Sra da Saude	Bairro Frei Aleixo	Valverde	Sao Mancos	Nossa Sra de Machede	Azaruja	Canaviais	Bacelo	External	Total
21 Catedral de Evora	7%	0%	0%	2%	26%	27%	28%	18%	5%	13%	22%	20%	3%	23%	27%	11%	11%	13%	18%	12%	8%	4%	12%
18 Jardim Publico de Evora	0%	0%	0%	3%	26%	27%	28%	24%	6%	19%	25%	16%	3%	17%	23%	12%	10%	13%	17%	9%	8%	4%	11%
19 Aquaduct	0%	0%	0%	2%	21%	22%	24%	19%	5%	13%	23%	21%	3%	22%	26%	11%	10%	14%	18%	11%	8%	4%	11%
20 Universidade de Evora	2%	3%	2%	0%	24%	25%	27%	25%	7%	21%	23%	22%	6%	22%	27%	12%	10%	13%	18%	14%	11%	5%	12%
6 Bairro de Almeirim	14%	13%	12%	12%	33%	33%	33%	33%	14%	33%	33%	28%	15%	33%	31%	16%	12%	19%	22%	24%	23%	6%	17%
7 Evora Retail Park	16%	16%	15%	15%	33%	33%	33%	33%	15%	33%	33%	29%	17%	33%	31%	17%	13%	20%	23%	25%	24%	6%	19%
8 Aerodromo	19%	19%	17%	18%	33%	33%	33%	33%	20%	33%	33%	30%	20%	33%	32%	20%	13%	21%	24%	26%	26%	9%	21%
9 Monte das Flores	11%	13%	12%	15%	33%	33%	33%	33%	15%	33%	33%	33%	15%	33%	28%	14%	14%	18%	23%	20%	22%	6%	18%
10 Horta das Figueiras	7%	7%	6%	8%	33%	33%	33%	33%	33%	33%	33%	25%	10%	33%	31%	14%	12%	16%	19%	16%	18%	5%	15%
11 Bairro Nossa sra do Carmo	6%	7%	6%	9%	33%	33%	33%	33%	7%	33%	33%	25%	10%	33%	31%	14%	12%	16%	19%	17%	18%	5%	15%
12 Bairro De Santa Maria	13%	14%	13%	14%	33%	33%	33%	33%	17%	33%	33%	33%	15%	30%	30%	14%	15%	20%	21%	22%	25%	5%	18%
13 Bairro dos Tres Bicos	10%	10%	11%	12%	28%	28%	29%	33%	13%	26%	33%	33%	14%	31%	31%	15%	13%	18%	21%	21%	25%	6%	17%
14 Ceniterio de Evora	4%	4%	4%	7%	30%	30%	31%	33%	10%	28%	33%	33%	33%	25%	28%	13%	11%	15%	19%	15%	17%	4%	14%
15 Nossa Sra da Saude	12%	11%	12%	11%	33%	33%	33%	33%	16%	33%	30%	31%	14%	33%	32%	15%	13%	18%	21%	22%	24%	7%	18%
16 Bairro Frei Aleixo	18%	17%	18%	19%	31%	31%	32%	28%	21%	31%	30%	31%	19%	32%	33%	18%	17%	18%	20%	22%	27%	6%	21%
1 Valverde	7%	7%	7%	7%	12%	12%	16%	10%	8%	10%	9%	11%	7%	11%	14%	0%	11%	11%	5%	9%	9%	0%	9%
2 Sao Mancos	7%	7%	7%	6%	9%	10%	9%	11%	9%	9%	11%	10%	8%	9%	13%	11%	0%	0%	13%	9%	9%	0%	8%
3 Nossa Sra de Machede	8%	8%	8%	7%	16%	16%	18%	14%	10%	13%	15%	14%	9%	13%	13%	12%	0%	0%	0%	12%	11%	0%	9%
4 Azaruja	12%	12%	12%	13%	20%	21%	21%	21%	14%	17%	19%	18%	13%	19%	16%	5%	14%	0%	0%	13%	16%	0%	13%
5 Canaviais	6%	5%	5%	6%	21%	22%	23%	16%	8%	15%	18%	17%	7%	18%	17%	11%	10%	14%	13%	0%	0%	0%	10%
17 Bacelo	3%	4%	3%	4%	21%	22%	23%	19%	8%	15%	21%	20%	6%	19%	24%	12%	10%	13%	17%	0%	0%	5%	11%
22 External	4%	4%	4%	4%	6%	6%	8%	5%	4%	5%	4%	5%	4%	6%	5%	0%	0%	0%	0%	0%	5%	0%	4%
Total	9%	8%	8%	9%	19%	19%	21%	18%	11%	16%	19%	17%	10%	18%	21%	11%	10%	12%	15%	13%	14%	4%	12%

7.3.6 Figure 15 shows the change in energy usage by zone for 2030.

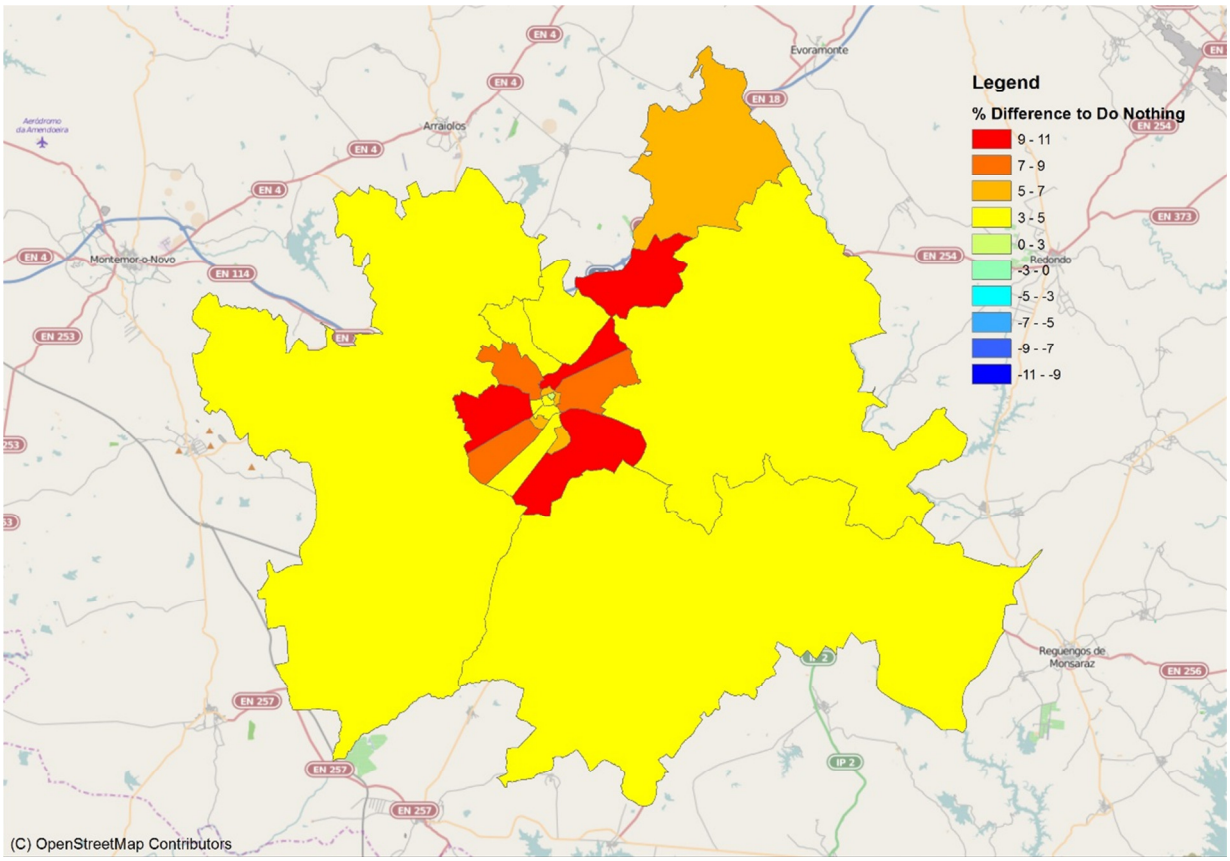


Figure 15. Change in Energy Usage (2030)

7.3.7 The highest percentage increases in energy usage correlate with the location of the 30km/h zones. There is also higher energy usage for almost all other zones. This reflects the fact that trips into and out of the city centre now have to go through the belt of 30km/h zones, increasing journey times and therefore energy usage for the origin zone.

7.3.8 Carbon Dioxide emissions increased by around 9,800kg in 2020 and around 9,200kg in 2030 compared to the Do Nothing scenarios.

7.4 Summary

7.4.1 The introduction of the 30km/h zones causes an increase in overall energy consumption. There is little change to the overall distance travelled and average trip rates. There is a switch to public transport from private vehicle and a change in destination away from the new 30 km/h zones. The increase in energy consumption is caused by cars traveling at a less efficient speed, within the new 30 km/h zones.

8. INDIVIDUAL SCENARIO TESTS: NEW ROADS

8.1 Introduction

8.1.1 This test investigates the impact of a collection of new roads in the city. Figure 16 shows the location of the new roads.

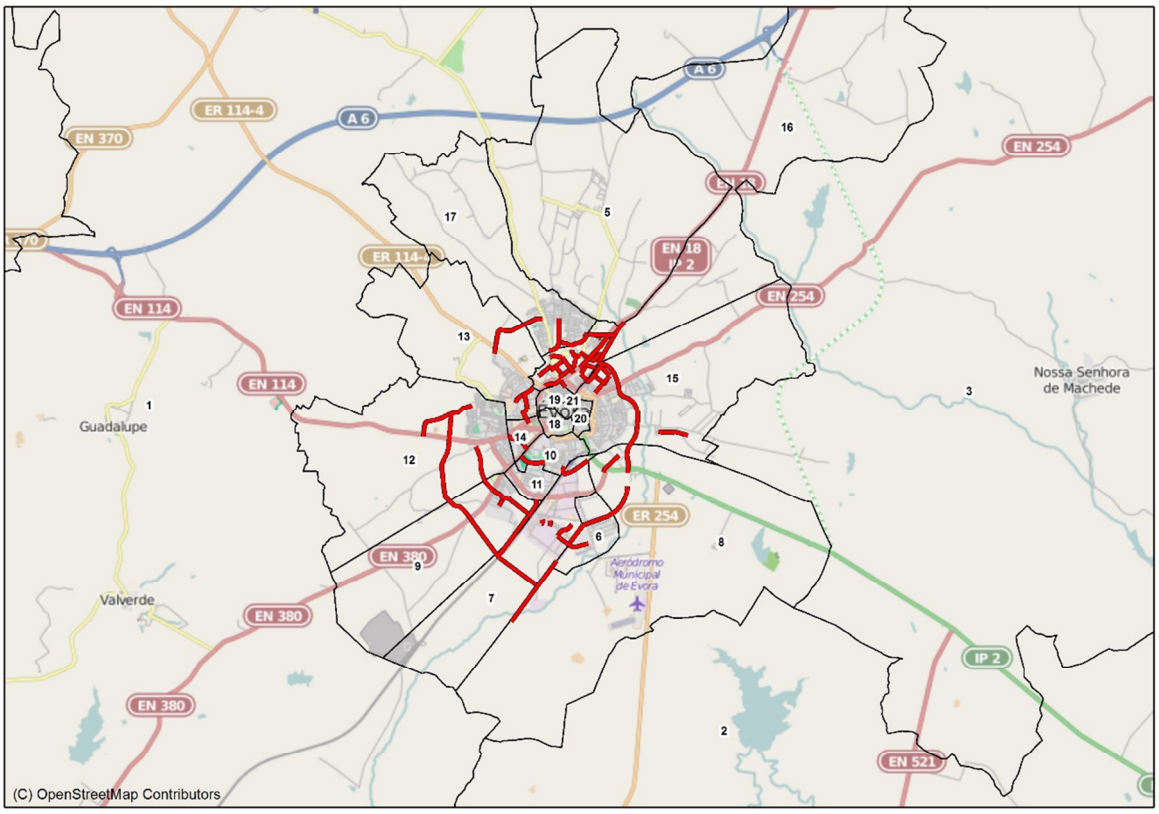


Figure 16. New Roads in the city of Évora

8.1.2 The new roads allow several zone to zone movements to be undertaken using new routes. The model uses an average distance between zones and applies this to all trips making that origin to destination movement. These average distances were recalculated using the new road network.

8.1.3 The average route is also split into sectors for each zone that it passes through. The route sectors are then given the characteristics of the zone they are within.

8.2 Demand Outputs

8.2.1 Table 43 to Table 45 provide an overview of changes in transport demand, average occupancy and vehicle kilometres within the modelled area for the Do Nothing and the Scenario, in both of the forecast years.

8.2.2 The scenario has little to no impact on overall demand with a very small mode shift to public transport.

Table 43. Demand & Mode Shares

Mode	2020		2030	
	Do Nothing	New Roads	Do Nothing	New Roads
Demand By Mode				
Highway	149,611	149,608	139,729	139,733
Public Transport	1,797	1,800	1,664	1,660
Mode Share				
Highway	99%	99%	99%	99%
Public Transport	1%	1%	1%	1%
Change in Highway Demand		- 3		4
Change in PT		3		- 4

Table 44. Average Public Transport Occupancy

Mode	2020		2030	
	Do Nothing	New Roads	Do Nothing	New Roads
Occupancy				
Total	6.8	6.8	6.3	6.3
Buses	4.9	5.0	4.6	4.6
Trains	1.9	1.9	1.7	1.7
%Change in Occupancy				
Total		100.2%		99.7%
Buses		100.2%		99.6%
Trains		100.0%		100.0%

Table 45. Vehicle Kms & Average Distance

Distance	2020		2030	
	Do Nothing	New Roads	Do Nothing	New Roads
Vehicle KM				
Total	1,388,394	-0.4%	1,299,328	-0.4%
Cars	1,279,741	-0.4%	1,194,334	-0.4%
Bikes	57,680	-0.3%	53,974	-0.3%
Goods	50,973	-0.2%	51,020	-0.3%
Average Distance KM				
Total	11.27	-0.4%	11.25	-0.4%
Cars	12.60	-0.4%	12.59	-0.4%
Bikes	3.85	-0.3%	3.86	-0.3%
Goods	7.65	-0.2%	7.65	-0.3%

8.2.3 Table 45 provides an overview of the vehicle kilometres and the average distances travelled within the city. The total distance and average trip length are both reduced as a result of the new roads providing more direct routes between areas of the city.

8.2.4 Table 46 and Table 47 show the demand changes compared to the Do Nothing scenario. For the private car demand the movements that have changed as a result of the new roads are highlighted with boxes.

Table 46. Private Vehicle demand change 2030

All Purposes	21 Catedral de Evora	18 Jardim Publico de Evora	19 Aquaduct	20 Universidade de Evora	6 Bairro de Almeirim	7 Evora Retail Park	8 Aerodromo	9 Monte das Flores	10 Horta das Figueiras	11 Bairro Nossa sra do Carmo	12 Bairro De Santa Maria	13 Bairro dos Tres Bicos	14 Ceniterio de Evora	15 Nossa Sra da Saude	16 Bairro Frei Aleixo	1 Valverde	2 Sao Mancos	3 Nossa Sra de Machede	4 Azaruja	5 Canaviais	17 Bacelo	22 External	Total
21 Catedral de Evora	0%	-1%	0%	-1%	-1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	6%	0%	0%	0%	6%	0%	0%	0%	0%
18 Jardim Publico de Evora	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
19 Aquaduct	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
20 Universidade de Evora	0%	0%	0%	-1%	-1%	0%	-1%	0%	0%	0%	0%	0%	0%	0%	3%	0%	0%	0%	0%	0%	0%	0%	0%
6 Bairro de Almeirim	0%	-1%	0%	-1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	5%	0%	0%	0%	9%	0%	0%	0%	0%
7 Evora Retail Park	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%
8 Aerodromo	-3%	-2%	-2%	-3%	-1%	-1%	-2%	0%	-2%	-1%	2%	-1%	0%	-2%	7%	0%	0%	0%	11%	17%	0%	0%	0%
9 Monte das Flores	-1%	-1%	-1%	-1%	-1%	-1%	13%	0%	-1%	0%	-1%	0%	0%	-1%	5%	0%	0%	0%	-1%	-1%	0%	0%	0%
10 Horta das Figueiras	0%	-1%	0%	-2%	0%	0%	0%	0%	0%	0%	-2%	0%	0%	0%	3%	0%	0%	0%	0%	0%	0%	0%	0%
11 Bairro Nossa sra do Carmo	0%	0%	0%	-1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	3%	0%	0%	0%	0%	0%	0%	0%	0%
12 Bairro De Santa Maria	0%	0%	0%	0%	0%	0%	2%	0%	-1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
13 Bairro dos Tres Bicos	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	-1%	-2%	0%	0%	0%	0%	0%	0%	0%	7%	0%	0%
14 Ceniterio de Evora	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
15 Nossa Sra da Saude	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	4%	0%	0%	0%	3%	0%	0%	0%	0%
16 Bairro Frei Aleixo	3%	-3%	-3%	3%	2%	-1%	11%	0%	3%	1%	-3%	-3%	-3%	4%	-1%	0%	0%	0%	-3%	-3%	6%	0%	0%
1 Valverde	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2 Sao Mancos	-3%	-2%	-2%	-2%	0%	-1%	-1%	0%	4%	0%	-2%	-1%	0%	-2%	3%	0%	0%	0%	6%	3%	0%	0%	0%
3 Nossa Sra de Machede	-1%	-1%	-1%	-1%	1%	-1%	8%	0%	-1%	0%	-1%	-1%	-1%	-1%	-1%	0%	0%	0%	-1%	17%	3%	0%	0%
4 Azaruja	0%	-2%	-2%	1%	2%	-1%	3%	0%	-2%	-1%	-1%	-2%	-2%	0%	-1%	0%	0%	0%	0%	0%	7%	0%	0%
5 Canaviais	0%	0%	0%	0%	0%	0%	9%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
17 Bacelo	-1%	-2%	-1%	-3%	-1%	-1%	-1%	0%	-1%	-1%	-1%	12%	-2%	-1%	8%	0%	0%	0%	21%	-1%	-2%	0%	0%
22 External	0%	-1%	-1%	-1%	0%	0%	1%	0%	0%	0%	0%	1%	-1%	0%	1%	0%	0%	0%	2%	0%	0%	0%	0%
Total	0%	-1%	-1%	-1%	0%	0%	1%	0%	0%	0%	0%	1%	-1%	0%	1%	0%	0%	0%	2%	0%	0%	0%	0%

Table 47. Public Transport demand change 2030

All Purposes	21 Catedral de Evora	18 Jardim Publico de Evora	19 Aquaduct	20 Universidade de Evora	6 Bairro de Almeirim	7 Evora Retail Park	8 Aerodromo	9 Monte das Flores	10 Horta das Figueiras	11 Bairro Nossa sra do Carmo	12 Bairro De Santa Maria	13 Bairro dos Tres Bicos	14 Ceniterio de Evora	15 Nossa Sra da Saude	16 Bairro Frei Aleixo	1 Valverde	2 Sao Mancos	3 Nossa Sra de Machede	4 Azaruja	5 Canaviais	17 Bacelo	22 External	Total
21 Catedral de Evora	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
18 Jardim Publico de Evora	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
19 Aquaduct	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
20 Universidade de Evora	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
6 Bairro de Almeirim	0%	0%	0%	-1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
7 Evora Retail Park	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
8 Aerodromo	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
9 Monte das Flores	0%	0%	0%	-1%	-1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	-1%	0%	0%	0%	0%	0%	0%	0%	0%
10 Horta das Figueiras	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
11 Bairro Nossa sra do Carmo	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
12 Bairro De Santa Maria	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
13 Bairro dos Tres Bicos	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	-1%	-1%	0%	0%	0%	0%	0%	0%	0%	-1%	0%	0%
14 Ceniterio de Evora	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
15 Nossa Sra da Saude	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
16 Bairro Frei Aleixo	-2%	-2%	-2%	-1%	-1%	-2%	0%	0%	-2%	-2%	-2%	-2%	-2%	-2%	-1%	0%	0%	0%	0%	-2%	-2%	-2%	-2%
1 Valverde	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2 Sao Mancos	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
3 Nossa Sra de Machede	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
4 Azaruja	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
5 Canaviais	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
17 Bacelo	-1%	-1%	-1%	-1%	-1%	-1%	0%	0%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	0%	0%	0%	0%	-1%	-1%	-1%	-1%
22 External	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Total	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

8.2.5 There has been no real change in overall demand or switching between modes as a result of the scheme. However the movements that have been shortened have become slightly more attractive, drawing in trips from other areas of the city, redistributing existing demand.

8.3 Energy Outputs

8.3.1 The overall energy usage is reduced by around 11,800 MJ in 2020 compared to the Do Nothing scenario and by around 8,100 MJ in 2030. As this reduction can't be attributed to mode shift or reduced private vehicle demand, it would appear that the new average routes are more efficient. The average journey length for many movements has been reduced by the construction of the new road infrastructure.

8.3.2 Many of the new roads relocate traffic from the edge of the city into areas with average higher speeds. This means that the journeys are more fuel efficient as they travel further per unit of fuel used.

8.3.3 Table 48 and Table 49 provide an overview of the energy usage by vehicle type and by zone for the 2020 and 2030 Do Nothing and the Scenario, respectively.

Table 48. Energy Usage (MJ/day) by Vehicle Type

Vehicle Type	2020		2030	
	DoNothing	New Roads	DoNothing	New Roads
Energy (MJ)				
Total	3,316,116	-0.4%	2,973,905	-0.3%
Cars	2,844,631	-0.3%	2,511,979	-0.3%
Bikes	96,716	-0.1%	90,589	-0.1%
Goods	267,599	-1.0%	265,395	-0.3%
Buses	58,625	-1.2%	57,397	0.0%
Trains	48,544	0.0%	48,544	0.0%
Vehicles				
Total	44,062	0.0%	41,277	0.0%
Cars	36,690	0.0%	34,262	0.0%
Bikes	5,407	0.0%	5,049	0.0%
Goods	1,481	0.0%	1,481	0.0%
Buses	417	0.0%	417	0.0%
Trains	68	0.0%	68	0.0%
Energy / Vehicle (MJ)				
Total	75	-0.4%	72	-0.3%
Cars	78	-0.3%	73	-0.3%
Bikes	18	-0.1%	18	-0.1%
Goods	181	-1.0%	179	-0.3%
Buses	141	-1.2%	138	0.0%
Trains	714	0.0%	714	0.0%

Table 49. Energy Usage (MJ/day) by Zone

Zone	2020		2030	
	DoNothing	New Roads	DoNothing	New Roads
Total	3,316,116	-0.4%	2,973,905	-0.3%
21 - Catedral de Evora	24,609	-0.8%	23,236	0.0%
18 - Jardim Publico de Evora	56,317	0.0%	49,789	0.0%
19 - Aquaduct	102,163	0.0%	90,281	0.0%
20 - Universidade de Evora	43,167	-0.5%	38,281	-0.5%
6 - Bairro de Almeirim	52,284	-0.5%	48,342	-0.1%
7 - Evora Retail Park	85,895	-0.9%	84,722	0.0%
8 - Aerodromo	25,953	-1.0%	24,261	-0.4%
9 - Monte das Flores	31,658	-0.5%	28,228	-0.4%
10 - Horta das Figueiras	50,283	-0.1%	47,267	-0.1%
11 - Bairro Nossa sra do Carmo	51,864	-0.3%	48,965	0.0%
12 - Bairro De Santa Maria	208,953	-0.1%	186,902	0.0%
13 - Bairro dos Tres Bicos	92,463	-0.1%	81,971	-0.1%
14 - Ceniterio de Evora	32,962	-0.5%	30,422	0.0%
15 - Nossa Sra da Saude	233,174	-0.3%	206,739	-0.2%
16 - Bairro Frei Aleixo	127,807	-2.1%	117,221	-1.8%
1 - Valverde	368,859	0.0%	326,382	0.0%
2 - Sao Mancos	394,328	-0.6%	348,827	-0.6%
3 - Nossa Sra de Machede	226,457	-0.3%	200,318	-0.3%
4 - Azaruja	179,701	-0.8%	159,242	-0.8%
5 - Canaviais	127,178	-0.3%	113,264	-0.2%
17 - Bacelo	181,005	-0.6%	160,315	-0.5%
22 - External	619,035	0.0%	558,929	0.0%

8.3.4 The largest percentage drop is for buses benefiting from reduced congestion in the central zones as the demand is moved to the edge of the city. Overall, almost all zones show a reduction in energy usage.

8.3.5 Figure 17 shows the energy change by origin zone for 2030.

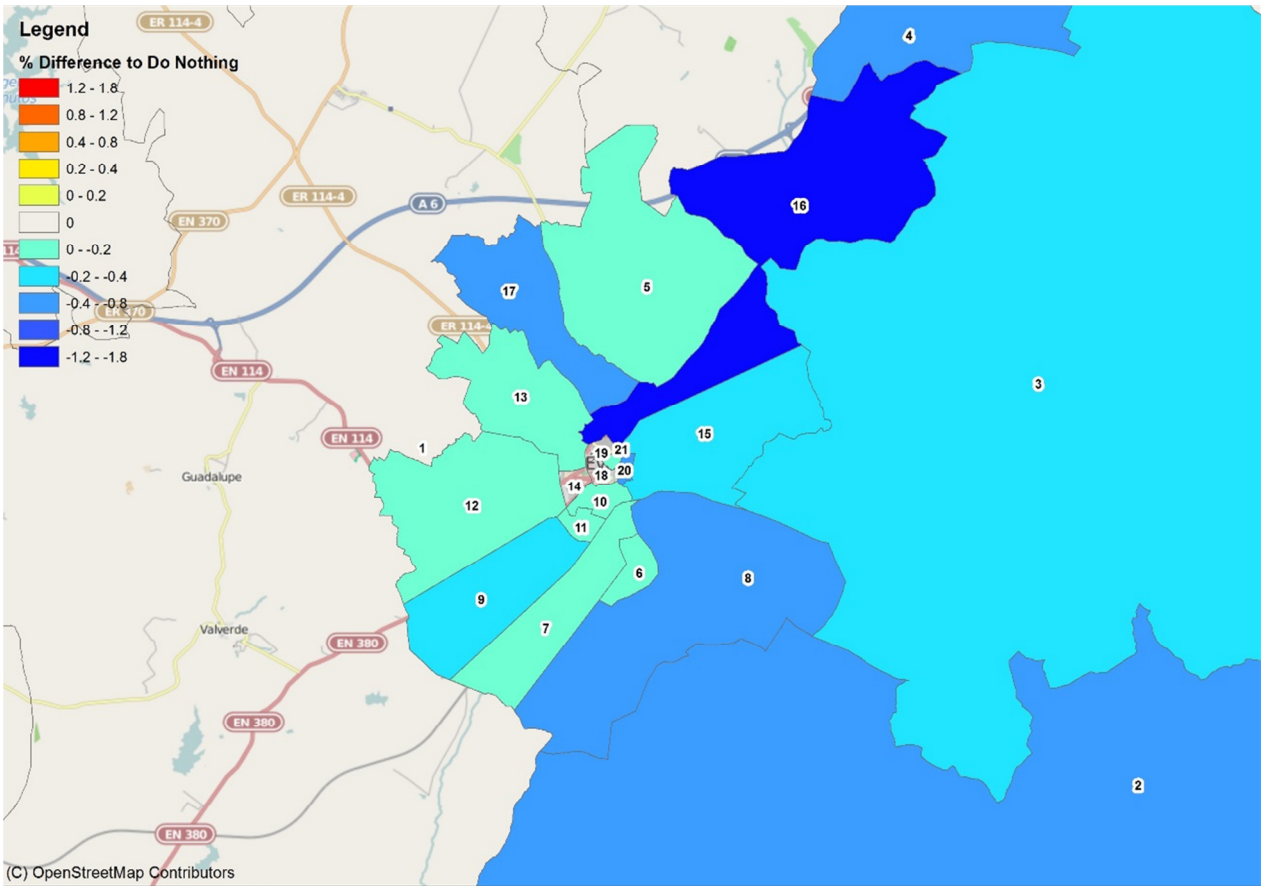


Figure 17. Energy usage by zone change 2030

8.3.6 There appears to be a small reduction in energy usage throughout the city with zones close to the new roads benefiting from slightly larger decreases in energy use.

8.3.7 Carbon Dioxide emissions reduce by around 900kg compared to the Do Nothing scenario in 2020 and by around 600kg in 2030 due to the new infrastructure. The distances travelled are shorter and at faster speeds, creating less pollution.

8.4 Summary

8.4.1 The new roads create faster, shorter routes between many model zones. This reduces average trip length and total distance travelled slightly. This combined with the more efficient speeds on the new road links acts to reduce energy consumption. As a side effect the buses are also speeded up due to reduced congestion in the central zones. Demand is redistributed slightly but does not grow overall as a result of the new infrastructure.

9. INDIVIDUAL SCENARIO TESTS: DEVELOPMENT CHANGES

9.1 Introduction

9.1.1 This test looks at the consequences of the creation of two new shopping centre developments in the city. They are located in zones 7 and 16, both with a floor space of 20,000m^2.

9.1.2 The locations of current supermarkets, the new developments and the model zone numbers are shown in Figure 18.

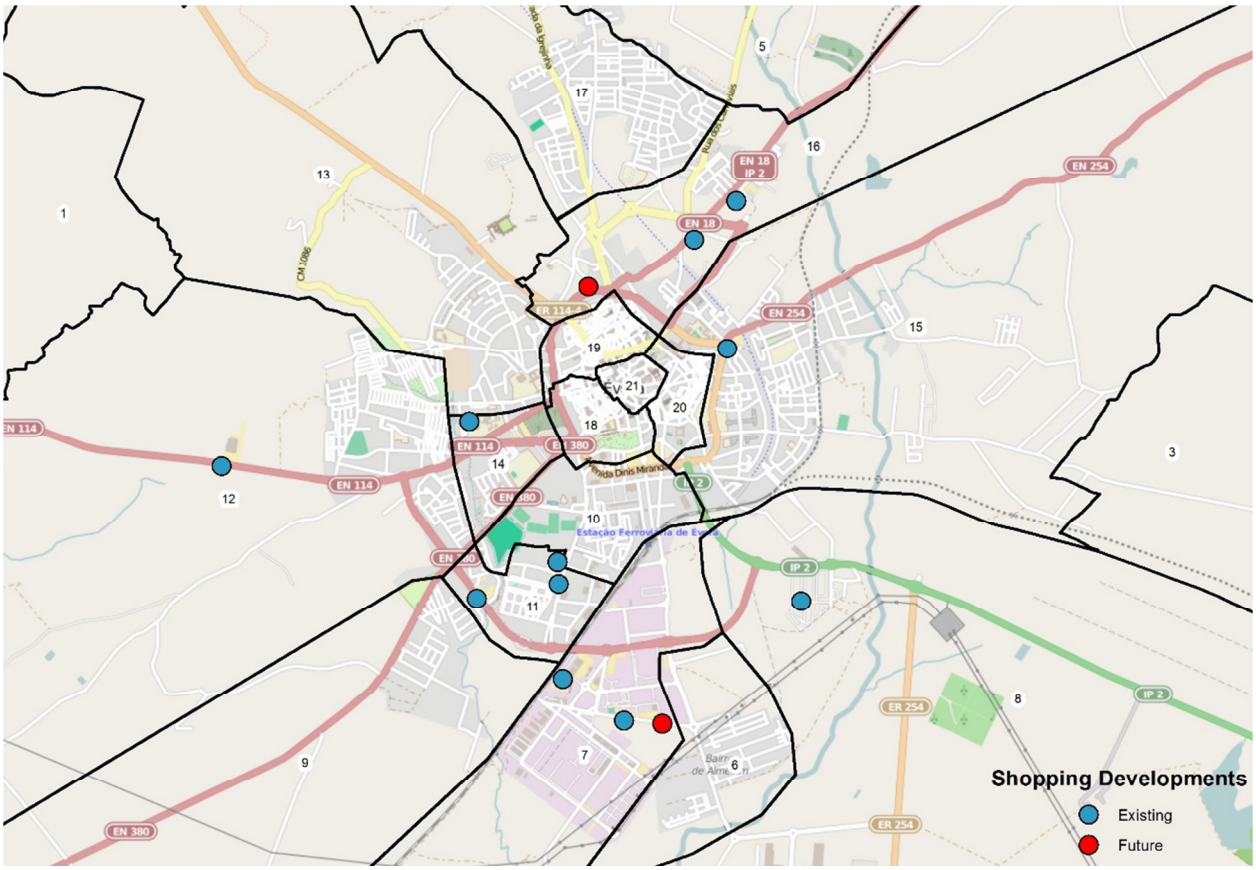


Figure 18. Location of existing and new developments

9.1.3 The new developments were inserted into the model by altering the land use table.

9.1.4 Although the exact location of the developments is known, the increase in floor space is applied at the zonal level. Zone 16 is an elongated zone with the new store at the edge closest to the city centre. However the effect of the new store will apply equally to all trips to this zone, possibly creating more trips from zones to the North East of the city centre than would occur in reality.

9.2 Demand Outputs

9.2.1 Table 50 to Table 52 provide an overview of changes in transport demand, average occupancy and vehicle kilometres within the modelled area for the Do Nothing and the Scenario, in both of the forecast years.

9.2.2 The scenario results in no change in overall demand and a slight switch from private vehicle to public transport. These changes are minimal and therefor do not change the overall mode split between highway and public transport.

Table 50. Demand & Mode Shares

Mode	2020		2030	
	Do Nothing	Development Changes	Do Nothing	Development Changes
Demand By Mode				
Highway	149,611	149,595	139,729	139,726
Public Transport	1,797	1,814	1,664	1,667
Mode Share				
Highway	99%	99%	99%	99%
Public Transport	1%	1%	1%	1%
Change in Highway Demand		- 17		- 3
Change in PT		17		3

Table 51. Average Public Transport Occupancy

Mode	2020		2030	
	Do Nothing	Development Changes	Do Nothing	Development Changes
Occupancy				
Total	6.8	6.9	6.3	6.3
Buses	4.9	5.0	4.6	4.6
Trains	1.9	1.9	1.7	1.7
%Change in Occupancy				
Total		101.0%		100.4%
Buses		101.1%		100.2%
Trains		100.8%		100.9%

Table 52. Vehicle Kms & Average Distance

Distance	2020		2030	
	Do Nothing	Development Changes	Do Nothing	Development Changes
Vehicle KM				
Total	1,388,394	0.5%	1,299,328	0.6%
Cars	1,279,741	0.0%	1,194,334	0.1%
Bikes	57,680	0.3%	53,974	0.4%
Goods	50,973	14.0%	51,020	14.1%
Average Distance KM				
Total	11.27	0.0%	11.25	0.0%
Cars	12.60	0.0%	12.59	0.1%
Bikes	3.85	0.3%	3.86	0.4%
Goods	7.65	2.6%	7.65	2.6%

9.2.3 Table 52 provides an overview of the vehicle kilometres and the average distances travelled within the city. There is a significant increase in the total distance covered by goods vehicles and the average trip length for this segment of demand goes up accordingly. This is not surprising given the 11% increase in the number of goods vehicles.

9.2.4 Table 53 shows the change in private vehicle demand in 2030 compared to the Do Nothing scenario. It shows a strong decrease in trips to zone 11 which has 3 supermarkets in it. There is also an increase in trips to zone 16 which contains one of the new stores. There is a very small increase in demand to zone 7 which contains the other new store.

Table 53. Private Vehicle demand change 2030

	21	18	19	20	6	7	8	9	10	11	12	13	14	15	16	1	2	3	4	5	17	22	
All Purposes	Catedral de Evora	Jardim Publico de Evora	Aquaduct	Universidade de Evora	Bairro de Almeirim	Evora Retail Park	Aerodromo	Monte das Flores	Horta das Figueiras	Bairro Nossa sra do Carmo	Bairro De Santa Maria	Bairro dos Tres Bicos	Ceniterio de Evora	Nossa Sra da Saude	Bairro Frei Aleixo	Valverde	Sao Mancos	Nossa Sra de Machede	Azaruja	Canaviais	Bacelo	External	Total
21 Catedral de Evora	0%	0%	0%	0%	0%	6%	0%	0%	0%	-7%	0%	0%	0%	0%	28%	0%	0%	0%	0%	0%	0%	0%	0%
18 Jardim Publico de Evora	0%	0%	0%	0%	0%	1%	0%	0%	0%	-1%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%
19 Aquaduct	0%	0%	0%	0%	0%	1%	0%	0%	0%	-1%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%
20 Universidade de Evora	0%	0%	0%	0%	0%	1%	0%	0%	0%	-1%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%
6 Bairro de Almeirim	0%	0%	0%	0%	0%	2%	0%	0%	0%	-4%	0%	0%	0%	0%	3%	0%	0%	0%	0%	0%	0%	0%	0%
7 Evora Retail Park	0%	0%	0%	0%	0%	1%	0%	0%	0%	-2%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%
8 Aerodromo	0%	0%	0%	0%	0%	1%	0%	0%	0%	-3%	0%	0%	0%	0%	2%	0%	0%	0%	0%	0%	0%	0%	0%
9 Monte das Flores	0%	0%	0%	0%	0%	4%	0%	0%	0%	-5%	0%	0%	0%	0%	7%	0%	0%	0%	0%	0%	0%	0%	0%
10 Horta das Figueiras	0%	0%	0%	0%	0%	3%	0%	0%	0%	-2%	0%	0%	0%	0%	2%	0%	0%	0%	0%	0%	0%	0%	0%
11 Bairro Nossa sra do Carmo	0%	0%	0%	0%	0%	1%	0%	0%	0%	-1%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%
12 Bairro De Santa Maria	0%	0%	0%	0%	0%	1%	0%	0%	0%	-2%	0%	0%	0%	0%	2%	0%	0%	0%	0%	0%	0%	0%	0%
13 Bairro dos Tres Bicos	0%	0%	0%	0%	0%	1%	0%	0%	0%	-3%	0%	0%	0%	0%	3%	0%	0%	0%	0%	0%	0%	0%	0%
14 Ceniterio de Evora	0%	0%	0%	0%	0%	8%	0%	0%	0%	-5%	0%	0%	0%	0%	18%	0%	0%	0%	0%	0%	0%	0%	0%
15 Nossa Sra da Saude	0%	0%	0%	0%	0%	2%	0%	0%	0%	-5%	0%	0%	0%	0%	6%	0%	0%	0%	0%	0%	0%	0%	0%
16 Bairro Frei Aleixo	0%	0%	0%	0%	0%	-1%	0%	0%	0%	-7%	0%	0%	0%	0%	5%	0%	0%	0%	0%	0%	0%	0%	0%
1 Valverde	0%	0%	0%	0%	0%	2%	0%	0%	0%	-6%	0%	0%	0%	0%	11%	0%	0%	0%	0%	0%	0%	0%	0%
2 Sao Mancos	0%	0%	0%	0%	0%	1%	0%	0%	0%	-4%	0%	0%	0%	0%	4%	0%	0%	0%	0%	0%	0%	0%	0%
3 Nossa Sra de Machede	0%	0%	0%	0%	0%	0%	0%	0%	0%	-6%	0%	0%	0%	0%	5%	0%	0%	0%	0%	0%	0%	0%	0%
4 Azaruja	0%	0%	0%	0%	0%	0%	0%	0%	0%	-3%	0%	0%	0%	0%	3%	0%	0%	0%	0%	0%	0%	0%	0%
5 Canaviais	0%	0%	0%	0%	0%	0%	0%	0%	0%	-9%	0%	0%	0%	0%	13%	0%	0%	0%	0%	0%	0%	0%	0%
17 Bacelo	0%	0%	0%	0%	0%	1%	0%	0%	0%	-3%	0%	0%	0%	0%	4%	0%	0%	0%	0%	0%	0%	0%	0%
22 External	0%	0%	0%	0%	0%	1%	0%	0%	0%	-4%	0%	0%	0%	0%	5%	0%	0%	0%	0%	0%	0%	0%	0%
Total	0%	0%	0%	0%	0%	1%	0%	0%	0%	-4%	0%	0%	0%	0%	5%	0%	0%	0%	0%	0%	0%	0%	0%

9.2.5 Table 54 shows the change in public transport demand in 2030 compared to the Do Nothing scenario. It shows a similar pattern to the private vehicle demand.

Table 54. Public Transport demand change 2030

	21	18	19	20	6	7	8	9	10	11	12	13	14	15	16	1	2	3	4	5	17	22	
All Purposes	Catedral de Evora	Jardim Publico de Evora	Aquaduct	Universidade de Evora	Bairro de Almeirim	Evora Retail Park	Aerodromo	Monte das Flores	Horta das Figueiras	Bairro Nossa sra do Carmo	Bairro De Santa Maria	Bairro dos Tres Bicos	Ceniterio de Evora	Nossa Sra da Saude	Bairro Frei Aleixo	Valverde	Sao Mancos	Nossa Sra de Machede	Azaruja	Canaviais	Bacelo	External	Total
21 Catedral de Evora	0%	0%	0%	0%	0%	3%	0%	0%	0%	-12%	0%	0%	0%	0%	53%	0%	0%	0%	0%	0%	0%	1%	1%
18 Jardim Publico de Evora	0%	0%	0%	0%	0%	2%	0%	0%	0%	-2%	0%	0%	0%	0%	4%	0%	0%	0%	0%	0%	0%	0%	0%
19 Aquaduct	0%	0%	0%	0%	0%	1%	0%	0%	0%	-2%	0%	0%	0%	0%	3%	0%	0%	0%	0%	0%	0%	0%	0%
20 Universidade de Evora	0%	0%	0%	0%	0%	0%	0%	0%	0%	-2%	0%	0%	0%	0%	2%	0%	0%	0%	0%	0%	0%	0%	0%
6 Bairro de Almeirim	0%	0%	0%	0%	0%	2%	0%	0%	0%	-4%	0%	0%	0%	0%	9%	0%	0%	0%	0%	0%	0%	0%	0%
7 Evora Retail Park	0%	0%	0%	0%	0%	1%	0%	0%	0%	-2%	0%	0%	0%	0%	4%	0%	0%	0%	0%	0%	0%	0%	0%
8 Aerodromo	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
9 Monte das Flores	0%	0%	0%	0%	0%	4%	0%	0%	0%	-4%	0%	0%	0%	0%	14%	0%	0%	0%	0%	0%	0%	0%	0%
10 Horta das Figueiras	0%	0%	0%	0%	0%	4%	0%	0%	0%	-4%	0%	0%	0%	0%	14%	0%	0%	0%	0%	0%	0%	1%	1%
11 Bairro Nossa sra do Carmo	0%	0%	0%	0%	0%	2%	0%	0%	0%	-2%	0%	0%	0%	0%	5%	0%	0%	0%	0%	0%	0%	0%	0%
12 Bairro De Santa Maria	0%	0%	0%	0%	0%	1%	0%	0%	0%	-2%	0%	0%	0%	0%	4%	0%	0%	0%	0%	0%	0%	0%	0%
13 Bairro dos Tres Bicos	0%	0%	0%	0%	0%	1%	0%	0%	0%	-2%	0%	0%	0%	0%	4%	0%	0%	0%	0%	0%	0%	0%	0%
14 Ceniterio de Evora	0%	0%	0%	0%	0%	5%	0%	0%	0%	-10%	0%	0%	0%	0%	50%	0%	0%	0%	0%	0%	0%	2%	2%
15 Nossa Sra da Saude	0%	0%	0%	0%	0%	1%	0%	0%	0%	-6%	0%	0%	0%	0%	10%	0%	0%	0%	0%	0%	0%	0%	0%
16 Bairro Frei Aleixo	0%	0%	0%	0%	0%	-1%	0%	0%	0%	-6%	0%	0%	0%	0%	4%	0%	0%	0%	0%	0%	0%	0%	0%
1 Valverde	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2 Sao Mancos	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
3 Nossa Sra de Machede	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
4 Azaruja	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
5 Canaviais	0%	0%	0%	0%	0%	0%	0%	0%	0%	-7%	0%	0%	0%	0%	11%	0%	0%	0%	0%	0%	0%	0%	0%
17 Bacelo	0%	0%	0%	0%	0%	1%	0%	0%	0%	-3%	0%	0%	0%	0%	4%	0%	0%	0%	0%	0%	0%	0%	0%
22 External	0%	0%	0%	0%	0%	1%	0%	0%	0%	-4%	0%	0%	0%	0%	6%	0%	0%	0%	0%	0%	0%	0%	0%
Total	0%	0%	0%	0%	0%	1%	0%	0%	0%	-4%	0%	0%	0%	0%	6%	0%	0%	0%	0%	0%	0%	0%	0%

9.2.6 Table 55 shows the change in goods demand in 2030 compared to the Do Nothing scenario. It shows an increase in goods trips to and from the new developments and other existing retail land use, creating an overall growth in demand.

Table 55. Goods demand change 2030

		21	18	19	20	6	7	8	9	10	11	12	13	14	15	16	1	2	3	4	5	17	22	
All Purposes		Catedral de Evora	Jardim Publico de Evora	Aquaduct	Universidade de Evora	Bairro de Almeirim	Evora Retail Park	Aerodromo	Monte das Flores	Horta das Figueiras	Bairro Nossa sra do Carmo	Bairro De Santa Maria	Bairro dos Tres Bicos	Ceniterio de Evora	Nossa Sra da Saude	Bairro Frei Aleixo	Valverde	Sao Mancos	Nossa Sra de Machede	Azaruja	Canavais	Bacelo	External	Total
21	Catedral de Evora	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
18	Jardim Publico de Evora	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
19	Aquaduct	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
20	Universidade de Evora	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
6	Bairro de Almeirim	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
7	Evora Retail Park	0%	0%	0%	0%	0%	22%	0%	0%	0%	1%	0%	0%	0%	0%	111%	0%	0%	0%	0%	0%	0%	14%	14%
8	Aerodromo	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
9	Monte das Flores	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
10	Horta das Figueiras	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
11	Bairro Nossa sra do Carmo	0%	0%	0%	0%	0%	5%	0%	0%	0%	-2%	0%	0%	0%	0%	43%	0%	0%	0%	0%	0%	0%	0%	0%
12	Bairro De Santa Maria	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
13	Bairro dos Tres Bicos	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
14	Ceniterio de Evora	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
15	Nossa Sra da Saude	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
16	Bairro Frei Aleixo	0%	0%	0%	0%	0%	97%	0%	0%	0%	26%	0%	0%	0%	0%	132%	0%	0%	0%	0%	0%	0%	64%	64%
1	Valverde	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	Sao Mancos	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
3	Nossa Sra de Machede	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
4	Azaruja	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
5	Canaviais	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
17	Bacelo	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
22	External	0%	0%	0%	0%	0%	21%	0%	0%	0%	1%	0%	0%	0%	0%	102%	0%	0%	0%	0%	0%	0%	0%	12%
	Total	0%	0%	0%	0%	0%	21%	0%	0%	0%	1%	0%	0%	0%	0%	102%	0%	0%	0%	0%	0%	0%	12%	12%

9.2.7 The change in demand is a reflection of the change in floorspace of the zones of the model. Table 56 shows the total floorspace for all retail land use types combined and how the new developments change their share of the total floorspace. The amount of retail floorspace in zone 16 almost doubles the total floorspace in that zone. However, zone 7 already has a large amount of retail floorspace so the percentage increase here is much smaller, and hence its effect on attracting new demand.

Table 56. Change in Floorspace (square metres)

Zone	Floorspace		% of Total Floorspace	
	Do Nothing	Test	Do Nothing	Test
1	-	-	-	-
2	-	-	-	-
3	-	-	-	-
4	-	-	-	-
5	-	-	-	-
6	-	-	-	-
7	218,686	238,720	35%	36%
8	16,902	16,902	3%	3%
9	-	-	-	-
10	-	-	-	-
11	292,131	292,131	47%	44%
12	46,780	46,780	8%	7%
13	-	-	-	-
14	10,275	10,275	2%	2%
15	11,162	11,162	2%	2%
16	20,884	40,918	3%	6%
17	-	-	-	-
18	-	-	-	-
19	296	296	0%	0%
20	679	679	0%	0%
21	-	-	-	-
Total	**617,795**	**657,863**	**100%**	**100%**

9.3 Energy Outputs

9.3.1 The total energy usage increases by around 55,300 MJ in 2020 compared to the Do Nothing scenario and by around 44,500 MJ in 2030. This is an increase of 1.7% in 2020 and 0.6% in 2030.

9.3.2 A large proportion of this increase in energy usage is associated with the increase in goods demand. Goods demand makes up 76% of the increase in energy usage in 2020 and 94% of the increase in 2030, with the remainder mainly from private vehicle trips. The overall effect on the total city-wide energy is less though as goods vehicles only make up less than 5% of the total number of vehicles.

Table 57. Energy Usage (MJ/day) by Vehicle Type

Vehicle Type	2020		2030	
	DoNothing	Development Changes	DoNothing	Development Changes
Energy (MJ)				
Total	3,316,116	1.7%	2,973,905	1.5%
Cars	2,844,631	0.4%	2,511,979	0.1%
Bikes	96,716	0.6%	90,589	0.4%
Goods	267,599	15.8%	265,395	15.8%
Buses	58,625	0.0%	57,397	0.0%
Trains	48,544	0.0%	48,544	0.0%
Vehicles				
Total	44,062	0.4%	41,277	0.4%
Cars	36,690	0.0%	34,262	0.0%
Bikes	5,407	0.0%	5,049	0.0%
Goods	1,481	11.2%	1,481	11.2%
Buses	417	0.0%	417	0.0%
Trains	68	0.0%	68	0.0%
Energy / Vehicle (MJ)				
Total	75	1.3%	72	1.1%
Cars	78	0.4%	73	0.1%
Bikes	18	0.6%	18	0.4%
Goods	181	4.2%	179	4.2%
Buses	141	0.0%	138	0.0%
Trains	714	0.0%	714	0.0%

Table 58. Energy Usage (MJ/day) by Zone

Zone	2020		2030	
	DoNothing	Development Changes	DoNothing	Development Changes
Total	3,316,116	1.7%	2,973,905	1.5%
21 - Catedral de Evora	24,609	0.4%	23,236	0.3%
18 - Jardim Publico de Evora	56,317	0.4%	49,789	0.1%
19 - Aquaduct	102,163	0.5%	90,281	0.1%
20 - Universidade de Evora	43,167	0.6%	38,281	0.1%
6 - Bairro de Almeirim	52,284	0.4%	48,342	0.1%
7 - Evora Retail Park	85,895	13.3%	84,722	13.4%
8 - Aerodromo	25,953	0.4%	24,261	0.0%
9 - Monte das Flores	31,658	0.9%	28,228	0.4%
10 - Horta das Figueiras	50,283	0.4%	47,267	0.1%
11 - Bairro Nossa sra do Carmo	51,864	0.7%	48,965	0.6%
12 - Bairro De Santa Maria	208,953	0.7%	186,902	0.1%
13 - Bairro dos Tres Bicos	92,463	0.8%	81,971	0.2%
14 - Ceniterio de Evora	32,962	0.7%	30,422	0.4%
15 - Nossa Sra da Saude	233,174	0.8%	206,739	0.2%
16 - Bairro Frei Aleixo	127,807	17.6%	117,221	18.4%
1 - Valverde	368,859	0.6%	326,382	0.4%
2 - Sao Mancos	394,328	0.3%	348,827	0.1%
3 - Nossa Sra de Machede	226,457	0.3%	200,318	-0.1%
4 - Azaruja	179,701	0.3%	159,242	-0.1%
5 - Canaviais	127,178	0.2%	113,264	-0.1%
17 - Bacelo	181,005	0.4%	160,315	0.1%
22 - External	619,035	1.5%	558,929	1.6%

9.4 Summary

9.4.1 The new supermarket in zone 16 redistributes both private vehicle and public transport demand as well as generating goods demand. The new development in zone 7 does the same but not to the same extent, due to the total quantity of floorspace in the zone.

9.4.2 Zone 11 sees a fall in demand. This zone has similar land use to the zones containing the new developments. The new developments offer people a choice of where to shop, meaning that people shift to the most convenient location for them from their only previous destination choice.

9.4.3 The higher energy usage due mainly to the increase in goods traffic supplying the new stores. This increase is not counterbalanced by a significant decrease to other existing stores as they will still need deliveries. Carbon Dioxide and other emissions associated with goods vehicle increase also.

WP3 – Transport and Mobility Analysis

D.3.8. Transport Scenarios Results Report Cesena

October 2015

314164 (ENER/FP7/314164)

Project acronym:

InSMART

Project full title:

Integrative Smart City Planning

Coordination and support action (Coordinating Action)

FP7-ENERGY-SMARTICITIES-2012

Start date of project: 2013-12-01

Duration: 3 years

Deliverable D3.8

Transport Scenarios Results Report Cesena

Work Package 3. Transport and Mobility Analysis

October 2015

Project co-funded by the European Commission within the Seventh Framework Programme		
Dissemination Level		
PU	Public	PU
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

Version	**Submitted by**	**Review Level***	**Date Submitted**	**Reviewed**
V01	SYSTRA	WPL	May 2015	May 2015
V02	SYSTRA	WPL	October 2015	October 2015

Editors		
	Name (organization)	**e-mail**
Leading participant	Matt Pollard (SYSTRA)	mpollard@systra.com
Contributing participants		
WP leader (WPL)	IRONS Duncan	dirons@systra.com

Executive Summary	
This report presents the results of the alternative scenarios of the transport model that has been developed in the framework of the INSMART project for the city of Cesena.	
Keywords	Transport scenarios

InSmart – Integrative Smart City Planning

Reference number 102400




SCENARIOS REPORT - CESENA

INSMART – INTEGRATIVE SMART CITY PLANNING

SCENARIOS REPORT - CESENA

IDENTIFICATION TABLE	
Client/Project owner	European Commission
Project	InSmart – Integrative Smart City Planning
Study	Scenarios Report - Cesena
Type of document	Report
Date	
File name	InSmart_ScenarioRunsReport_Cesena_v1_20150722.docx
Reference number	102400
Number of pages	65

APPROVAL					
Version	**Name**		**Position**	**Date**	**Modifications**
1	Author	James Whitehead Matt Pollard	Analyst Senior Consultant		
	Checked by	Duncan Irons	Project Director		
	Approved by			DD/MM/YY	
2	Author			DD/MM/YY	
	Checked by			DD/MM/YY	
	Approved by			DD/MM/YY	

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

IMAGE ATTRIBUTION

Top Left
Image: http://commons.wikimedia.org/wiki/File:Fontana_del_Masini.jpg
Attribution: Uomodis08

Top Right
Image: http://commons.wikimedia.org/wiki/File:Biblioteca_Malatestiana2.jpg
Attribution: Uomodis08

Bottom Left:
Image: http://commons.wikimedia.org/wiki/File:La_rocca_malatestiana_di_Cesena_di_notte.jpg
Attribution: Uomodis08

Bottom Right
Image: http://commons.wikimedia.org/wiki/File:Barriera_Cavour_2.jpg
Attribution: Uomodis08

1. INTRODUCTION

1.1 Project Overview

1.1.1 InSmart is a three year, European funded project which involves four European Cities working partnership towards a sustainable energy future. The primary objective of the project is to develop sustainable energy action plans for each partner city.

1.1.2 The four cities are:

- Cesena, Italy;
- Evora, Portugal;
- Nottingham, UK; and
- Trikala, Greece.

1.1.3 A mix of sustainable energy measures to improve the energy efficiency of each city will be identified through the use of a variety of tools and approaches and covering a wide range of sectors from the residential and transport sectors to street lighting and waste collection.

1.1.4 SYSTRA's role within the project is to identify, test and report on a series of land use and transport based strategies aimed at reducing the transport-related energy usage and carbon generation of each city.

1.1.5 The initial task of calculating the current energy usage and carbon emissions generated by each city is recorded in the Base Model Reports for each city. The impact of the forecast strategies has then been obtained by comparing them with the Do Nothing Scenario, which represents technological/efficiency and population changes from the Base Year with no schemes implemented.

1.2 Report Structure

1.2.1 The report is split into three sections:

- **Model Run Comparisons:** a comparison of various outputs from modelled scenarios;
- **Future Year Base and Do Nothing Scenarios:** looking at changes between the base year and forecast years; and
- **Individual Scenario Tests:** a more detailed analysis of each of the specified future year scenarios.

2. TEST COMPARISONS

2.1 Introduction

2.1.1 This report covers the city of Cesena in the Italian region of Emilia-Romagna. The following scenarios were run for the forecast years 2020 and 2030:

- **Future Base**: change in vehicle fleet splits over time only;
- **Do Nothing:** change in population;
- **Bretella-Gronda Road:** construction of a new 3.4km highway to the north of the city, which is expected to reduce journey times between the A14 and Cesena, and reduce demand through Villa Chiaviche.
- **Bretella-Gronda Road with speed changes:** as above, with an increase in vehicle speeds along the Bretella-Gronda Road.
- **Slower speeds along Cervese Road:** implement speed reductions along the Villa Chiaviche region of Cervese Road.
- **Development – Comparto A:** include the proposed Comparto A residential developments, within Zone 3**.**
- **Development – Comparto B:** include the proposed Comparto B mixed developments, within Zone 14. A small section of this development is due to be complete by 2020, with full completion expected by 2030.
- **Development – Comparto C**: include the proposed Comparto C residential developments, within Zone 15.
- **Development – Comparto A + B + C:** include all three of the proposed Comparto developments in the model.

2.1.2 A more detailed description of each scenario, along with information on model inputs and assumptions is given in later chapters. The purpose of this chapter is to provide a summary of all the tests run for easy comparison. However, it should be noted that the development tests are run on the assumption that any extra housing is on top of that already required through the change in population present in the Do Nothing.

2.1.3 Figure 1 shows the total energy usage for all scenarios that have been run for Cesena, compared to the Base year, Future Base and Do Nothing scenarios.

2.1.4 It can be seen that the largest change in energy usage is between the Future Base and the Base. This represents the vehicle types changing over time, as people buy newer and more efficient vehicles. By 2030 this accounts for a 10% reduction in energy usage.

2.1.5 The Do Nothing scenario includes changes in population. Population growth figures were provided on a zonal level and overall predict an 11% increase in population by 2030. This increase in population reduces the impact of the vehicle fleet efficiency improvements, reducing the reduction from 10% to 3.5% by 2030.

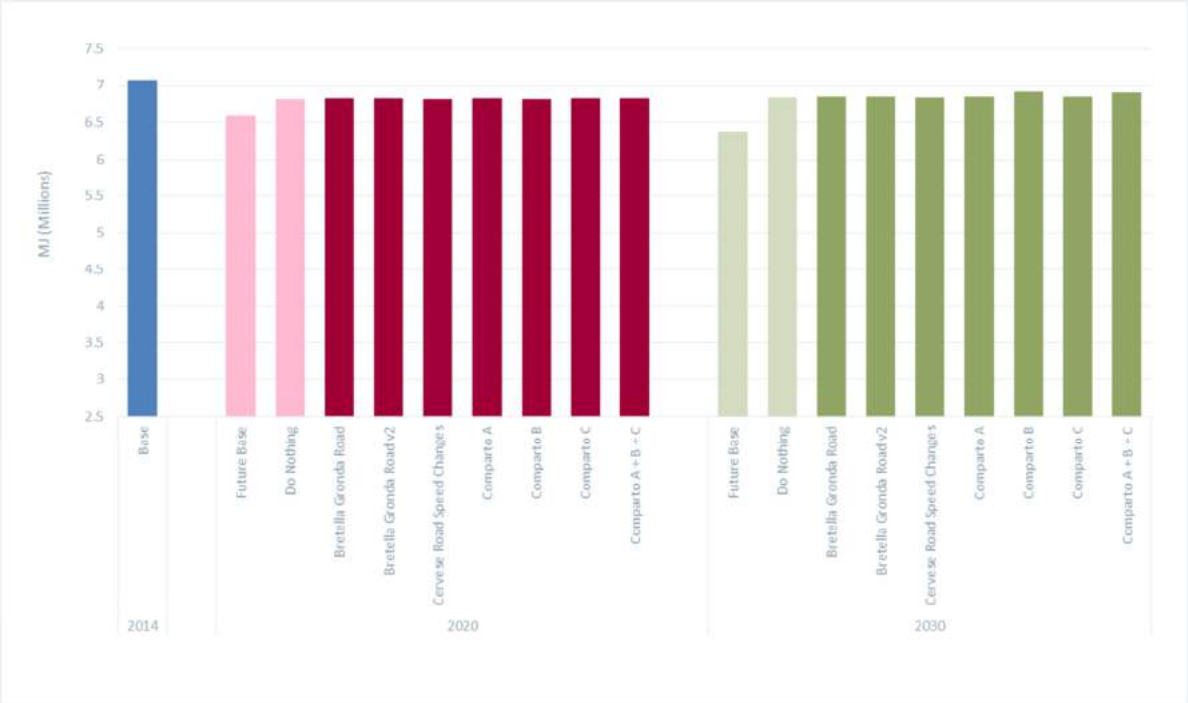


Figure 1. Total Energy Usage by Scenario

2.1.6 Figure 2 shows the difference between each scenario and the Do Nothing scenario. It can be seen that all of the scenarios run increase the energy consumption of the city, most noticeably the developments introduced in the Comparto B scenario, which generates a large number of extra trips due to the new residential development.

2.1.7 At a more detailed level, looking at the zones close to the areas affected there are larger changes and these are shown in the more detailed scenario chapters that follow.

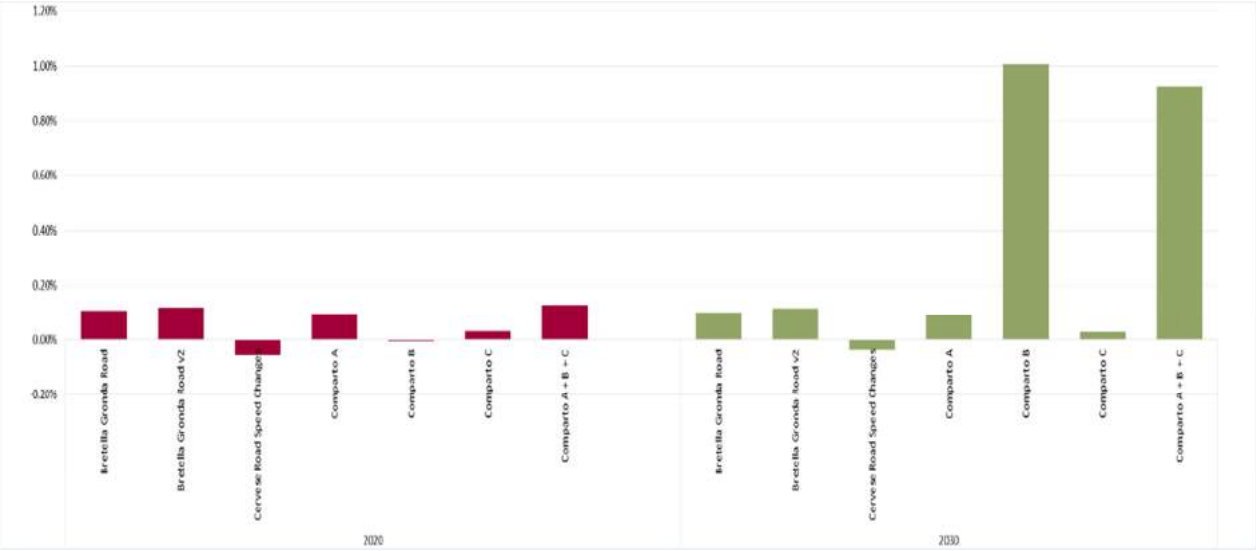


Figure 2. Change from Do Nothing Scenario

2.1.8 Table 1 shows a breakdown of the total energy usage by scenario and the percentage change compared to the Base Year test.

Table 1. Energy Usage by Scenario

SCENARIO	ENERGY (MJ)			CHANGE FROM BASE YEAR	
	2014	2020	2030	2020	2030
Base	7,076,076	-	-	-	-
Future Base	-	6,585,081	6,367,563	93%	90%
Do Nothing	-	6,812,852	6,835,405	96%	97%
Bretella Gronda Road	-	6,820,215	6,842,477	96%	97%
Bretella Gronda Road – Speed Changes	-	6,821,044	6,843,396	96%	97%
Cervese Road Speed Changes	-	6,809,166	6,833,036	96%	97%
Comparto A	-	6,819,534	6,841,771	96%	97%
Comparto B	-	6,812,611	6,904,289	96%	98%
Comparto C	-	6,815,128	6,904,289	96%	97%
Comparto A + B + C	-	6,821,568	6,898,562	96%	97%

2.1.9 Table 2 and Table 3 show the change in energy usage by vehicle type for all of the different scenarios for 2020 and 2030. The changes are shown as percentage changes from the appropriate Do Nothing year.

2.1.10 The new developments are modelled as an increase in land use for residential and non-residential developments, where applicable. As such, it is expected that an increase in vehicles/vehicle-km would occur and the increase in energy usage is consistent with that expectation.

Table 2. Energy Usage by Vehicle Type for 2020 Scenarios

Vehicle Type	Do Nothing	Bretella Gronda Road	Bretella Gronda Road v2	Cervese Road Speed Changes	Comparto A	Comparto B	Comparto C	Comparto A + B +C
Energy (MJ)								
Total	6,812,852	0.1%	0.1%	-0.1%	0.1%	0.0%	0.0%	0.1%
Cars	3,789,788	0.1%	0.2%	-0.1%	0.1%	0.0%	0.0%	0.2%
Bikes	862,862	0.1%	0.1%	0.0%	0.1%	0.0%	0.1%	0.2%
Goods	1,869,896	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
Buses	173,850	0.0%	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%
Trains	116,457	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Vehicles								
Total	87,796	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Cars	59,217	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Bikes	19,742	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Goods	7,853	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Buses	916	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Trains	68	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Energy / Vehicle (MJ)								
Total	78	0.1%	0.1%	-0.1%	0.1%	0.0%	0.0%	0.1%
Cars	64	0.2%	0.2%	-0.1%	0.1%	0.0%	0.1%	0.2%
Bikes	44	0.1%	0.1%	0.0%	0.1%	0.0%	0.1%	0.2%
Goods	238	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
Buses	190	0.0%	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%
Trains	1,713	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Table 3. Energy Usage by Vehicle Type for 2030 Scenarios

Vehicle Type	Do Nothing	Bretella Gronda Road	Bretella Gronda Road v2	Cervese Road Speed Changes	Comparto A	Comparto B	Comparto C	Comparto A + B +C
Energy (MJ)								
Total	6,835,405	0.1%	0.1%	0.0%	0.1%	1.0%	0.0%	0.9%
Cars	3,773,865	0.1%	0.1%	0.0%	0.1%	1.4%	0.0%	1.2%
Bikes	896,666	0.1%	0.1%	0.0%	0.1%	1.3%	0.0%	1.2%
Goods	1,874,636	0.1%	0.1%	0.0%	0.0%	0.3%	0.0%	0.3%
Buses	173,782	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Trains	116,457	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Vehicles								
Total	92,407	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%
Cars	62,650	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Bikes	20,921	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Goods	7,853	0.0%	0.0%	0.0%	0.0%	0.4%	0.0%	0.4%
Buses	916	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Trains	68	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Energy / Vehicle (MJ)								
Total	74	0.1%	0.1%	0.0%	0.1%	0.9%	0.0%	0.9%
Cars	60	0.1%	0.1%	0.0%	0.1%	1.3%	0.0%	1.2%
Bikes	43	0.1%	0.1%	0.0%	0.1%	1.3%	0.0%	1.2%
Goods	239	0.1%	0.1%	0.0%	0.0%	-0.1%	0.0%	-0.1%
Buses	190	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Trains	1,713	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

2.1.11 Table 4 and Table 5 show the change in energy usage by zone for all of the different scenarios for 2020 and 2030.

2.1.12 For both years the Bretella-Gronda Road scenario shows very little change. The largest percentage change are in zones 4 and 10 which are both small and show only small absolute changes. These increases come about due to an increase in the distance travelled from these zones with the inclusion of the new road, and a corresponding increase in vehicle kilometres.

2.1.13 Residents of zone 4 incur the greatest impact from the Cervese Road scenario as there is a noticeable decrease in energy usage from this zone. As the section of the road which is experiencing the speed reductions is within zone 4, the results in Table 4 are consistent with what might be expected.

2.1.14 The changes in energy usage for the development scenarios are in line with expectations with the largest changes are at zones 14 in the Comparto B scenario, where there is a large development proposed. The other two developments are much smaller, residential-only developments and so show a much smaller impact.

Table 4. Energy Usage by Zone for 2020 Scenarios

Zone	Do Nothing	Bretella Gronda Road	Bretella Gronda Road v2	Cervese Road Speed Changes	Comparto A	Comparto B	Comparto C	Comparto A + B +C
Total	6,812,852	0.1%	0.1%	-0.1%	0.1%	0.0%	0.0%	0.1%
1 - Centro Urban 2	449,396	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3 - Fiorenzuola	432,705	0.0%	0.0%	-0.2%	1.0%	0.0%	0.0%	1.0%
14 - Cervese Sud 2	333,288	0.3%	0.2%	0.2%	0.0%	0.0%	0.0%	0.0%
15 - Oltre Savio 2	358,517	0.0%	0.0%	-0.1%	0.0%	0.0%	0.4%	0.4%
2 - Cesuola	193,068	0.1%	0.1%	-0.1%	0.0%	0.0%	0.0%	0.0%
4 - Cervese Sud 1	154,522	0.5%	0.7%	-2.6%	0.0%	0.0%	0.0%	0.0%
5 - Oltre Savio1	219,270	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
11 - Ravennate	288,180	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
12 - Dismano	552,762	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
13 - Centro Urban 1	52,899	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
6 - Valle Savio	376,093	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
7 - Borello	189,165	-0.1%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
8 - Rubicone	431,554	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
9 - Al Mare	319,519	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
10 - Cervese Nord	396,191	1.4%	1.5%	0.4%	0.0%	0.0%	0.0%	0.0%
16 - External	2,065,723	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.2%

Table 5. Energy Usage by Zone for 2030 Scenarios

Zone	Do Nothing	Bretella Gronda Road	Bretella Gronda Road v2	Cervese Road Speed Changes	Comparto A	Comparto B	Comparto C	Comparto A + B +C
Total	6,835,405	0.1%	0.1%	0.0%	0.1%	1.0%	0.0%	0.9%
1 - Centro Urban 2	457,728	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3 - Fiorenzuola	429,867	0.0%	0.0%	0.0%	1.0%	0.0%	0.0%	-0.2%
14 - Cervese Sud 2	338,039	0.3%	0.3%	0.3%	0.0%	13.3%	0.0%	13.2%
15 - Oltre Savio 2	365,401	0.0%	0.0%	0.0%	0.0%	0.0%	0.4%	0.2%
2 - Cesuola	172,622	0.0%	0.0%	-0.1%	0.0%	0.1%	0.0%	-1.3%
4 - Cervese Sud 1	156,430	0.4%	0.7%	-2.8%	0.0%	-0.2%	0.0%	-0.2%
5 - Oltre Savio1	225,097	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%
11 - Ravennate	294,687	0.0%	0.0%	0.0%	0.0%	-0.2%	0.0%	-0.1%
12 - Dismano	560,849	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
13 - Centro Urban 1	53,507	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	-0.3%
6 - Valle Savio	349,015	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
7 - Borello	198,278	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%
8 - Rubicone	436,121	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
9 - Al Mare	319,734	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%
10 - Cervese Nord	404,102	1.4%	1.5%	0.5%	0.0%	-0.1%	0.0%	-0.1%
16 - External	2,073,927	0.0%	0.0%	0.0%	0.1%	1.2%	0.0%	1.1%

2.1.15 For each of the 2020 scenarios Table 6 shows the change in demand and mode share. Table 7 shows the change in average occupancy on buses and trains and Table 8 shows the change in vehicle kilometres and average distance. Table 9 to Table 11 show the same information for 2030.

2.1.16 Overall, the changes are very small which is to be expected given the magnitude of the changes we have seen so far.

Zone	Do Nothing	Bretella Gronda Road	Bretella Gronda Road v2	Cervese Road Speed Changes	Comparto A	Comparto B	Comparto C	Comparto A + B +C
Demand By Mode								
Highway	254,104	253,915	253,955	254,060	254,522	254,107	254,258	254,680
Public Transport	28,078	28,267	28,226	28,121	28,109	28,074	28,096	28,125
Mode Share								
Highway	90.05%	89.98%	90.00%	90%	90%	90%	90%	90%
Public Transport	9.95%	10.02%	10.00%	10%	10%	10%	10%	10%
Change in Highway Demand		- 189	- 148	- 43	419	3	154	576
Change in Public Transport Demand		189	148	43	32	- 3	19	47

Table 6. Demand by Vehicle Class (2020)

Table 7. Average Public Transport Occupancy (2020)

Zone	Do Nothing	Bretella Gronda Road	Bretella Gronda Road v2	Cervese Road Speed Changes	Comparto A	Comparto B	Comparto C	Comparto A + B +C
Total	31.8	32.0	31.9	31.8	31.8	31.8	31.8	31.8
Buses	34.0	34.2	34.2	34.0	34.0	34.0	34.0	34.0
Trains	1.8	1.9	1.9	1.8	1.8	1.8	1.8	1.8
%Change in Occupancy								
Total		100.7%	100.6%	100.2%	100.1%	100.0%	100.1%	100.2%
Buses		100.7%	100.5%	100.2%	100.1%	100.0%	100.1%	100.2%
Trains		105.8%	105.0%	99.2%	100.0%	100.0%	100.0%	100.0%

Table 8. Vehicle Kms & Average Distance (2020)

Vehicle Type	Do Nothing	Bretella Gronda Road	Bretella Gronda Road v2	Cervese Road Speed Changes	Comparto A	Comparto B	Comparto C	Comparto A + B +C
Vehicle Km								
Total	2,700,344	100.1%	100.1%	100.0%	100.1%	100.0%	100.0%	100.2%
Cars	1,713,374	100.1%	100.1%	100.0%	100.1%	100.0%	100.0%	100.2%
Bikes	567,501	100.1%	100.1%	100.0%	100.1%	100.0%	100.1%	100.2%
Goods	390,964	100.1%	100.1%	99.9%	100.0%	100.0%	100.0%	100.0%
Buses	22,127	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Trains	6,378	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Average Distance (Km)								
Total	30.42	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Cars	11.58	100.2%	100.2%	100.0%	100.0%	100.0%	100.0%	100.0%
Bikes	11.50	100.2%	100.2%	100.0%	100.0%	100.0%	100.0%	100.0%
Goods	11.07	100.1%	100.1%	99.9%	100.0%	100.0%	100.0%	100.0%
Buses	24.16	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Trains	93.80	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 9. Demand & Mode Shares (2030)

Zone	Do Nothing	Bretella Gronda Road	Bretella Gronda Road v2	Cervese Road Speed Changes	Comparto A	Comparto B	Comparto C	Comparto A + B +C
Demand By Mode								
Highway	264,917	264,803	264,851	264,779	265,331	269,178	265,069	268,943
Public Transport	33,263	33,376	33,329	33,401	33,299	34,075	33,284	34,501
Mode Share								
Highway	89%	89%	89%	89%	89%	89%	89%	89%
Public Transport	11%	11%	11%	11%	11%	11%	11%	11%
Change in Highway Demand		- 114	- 66	- 139	414	4,261	152	4,025
Change in Public Transport Demand		114	66	139	36	813	22	1,239

Zone	Do Nothing	Bretella Gronda Road	Bretella Gronda Road v2	Cervese Road Speed Changes	Comparto A	Comparto B	Comparto C	Comparto A + B +C
Total	37.6	37.7	37.7	37.8	37.6	38.6	37.6	39.0
Buses	40.0	40.1	40.1	40.2	40.0	41.0	40.0	41.5
Trains	5.3	5.4	5.3	5.4	5.3	5.6	5.3	5.6
%Change in Occupancy								
Total		100.4%	100.2%	100.4%	100.1%	102.6%	100.1%	103.7%
Buses		100.4%	100.2%	100.4%	100.1%	102.6%	100.1%	103.7%
Trains		100.6%	100.3%	100.8%	100.0%	105.2%	100.0%	105.5%

Table 10. Average Public Transport Occupancy (2030)

Table 11. Vehicle Kms & Average Distance (2030)

Vehicle Type	Do Nothing	Bretella Gronda Road	Bretella Gronda Road v2	Cervese Road Speed Changes	Comparto A	Comparto B	Comparto C	Comparto A + B +C
Vehicle Km								
Total	2,787,357	103.4%	103.4%	103.2%	103.3%	104.5%	103.3%	104.4%
Cars	1,778,469	104.0%	104.0%	103.8%	103.9%	105.3%	103.8%	105.1%
Bikes	590,118	104.2%	104.2%	103.9%	104.1%	105.4%	104.0%	105.3%
Goods	390,265	99.9%	99.9%	99.8%	99.8%	100.1%	99.8%	100.1%
Buses	22,127	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Trains	6,378	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Average Distance (Km)								
Total	30.41	100.0%	100.0%	99.9%	99.9%	99.9%	99.9%	99.9%
Cars	11.55	99.9%	99.9%	99.7%	99.7%	99.5%	99.7%	99.5%
Bikes	11.47	100.0%	100.0%	99.7%	99.7%	99.5%	99.7%	99.5%
Goods	11.05	99.9%	99.9%	99.8%	99.8%	99.8%	99.8%	99.8%
Buses	24.16	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Trains	93.80	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

2.1.17 The outputs from the tests can be summarised as follows;

- The largest change is from the Base Year to the Future Base and is due to the change in vehicle splits and a shift to more efficient vehicles;
- The population is forecast to increase (an additional 11% by 2030) so the increase in energy usage from the Future Base to the Do Nothing is significant, negating most of the effects of the efficiency savings from changes in vehicle splits;
- On a city-wide level all Scenario Tests have relatively little impact, except for the Comparto B development. At a more detailed local level the impact is increased.

- The introduction of the three Comparto developments result in an increase in the number of trips made across all modes. This is due to the extra residential housing following the completion of the developments.
- In general all the scenarios lead to an increase in the distance travelled across all of the tests, except in the Cervese Road Speed Changes test. The increase in the Bretella-Gronda tests is due to the longer length of the new road, compared to the alternate Cervese Road; the increase within the Comparto tests occur due to re-distribution of journeys to the new developments.

3. FUTURE BASE AND DO NOTHING SCENARIOS

3.1 Introduction

3.1.1 To establish the scale of changes taking place in the model whilst progressing from the base year to the future years, two scenarios were run:

- **Future Base Scenario**
  - Same population data as the 2014 Base Year run.
  - Vehicle Fleet splits from 2020 and 2030 – this captures the change in fleet over time as people purchase more fuel efficient cars.
- **Do Nothing Scenario**
  - Includes both changes to vehicle fleet and population changes. This shows the change in energy usage associated with doing "Nothing" – i.e. implementing no schemes/policy measures.

3.2 Future Year Changes and Outcomes

3.2.1 The population in Cesena is projected to rise from around 96,900 in 2014 to 101,700 in 2020 and 107,700 in 2030. This is expected to result in an increase in the demand for transport and consequently increase the energy requirements of the transport network.

3.2.2 The forecast vehicle fleet splits are based on UK data as no other comparable local data was available. This introduces a limitation to the model as these splits may not be the same for Cesena. However, in the final assessment of scenarios these splits will be determined by the TIMES model.

3.2.3 Figure 3 shows the total energy usage for each scenario for the two future years, compared to the 2014 Base year starting position. As a result of the expected increase in Cesena's population, there is a reasonable difference between the Future Base and Do Nothing scenarios for the forecast years of 2020 and 2030.

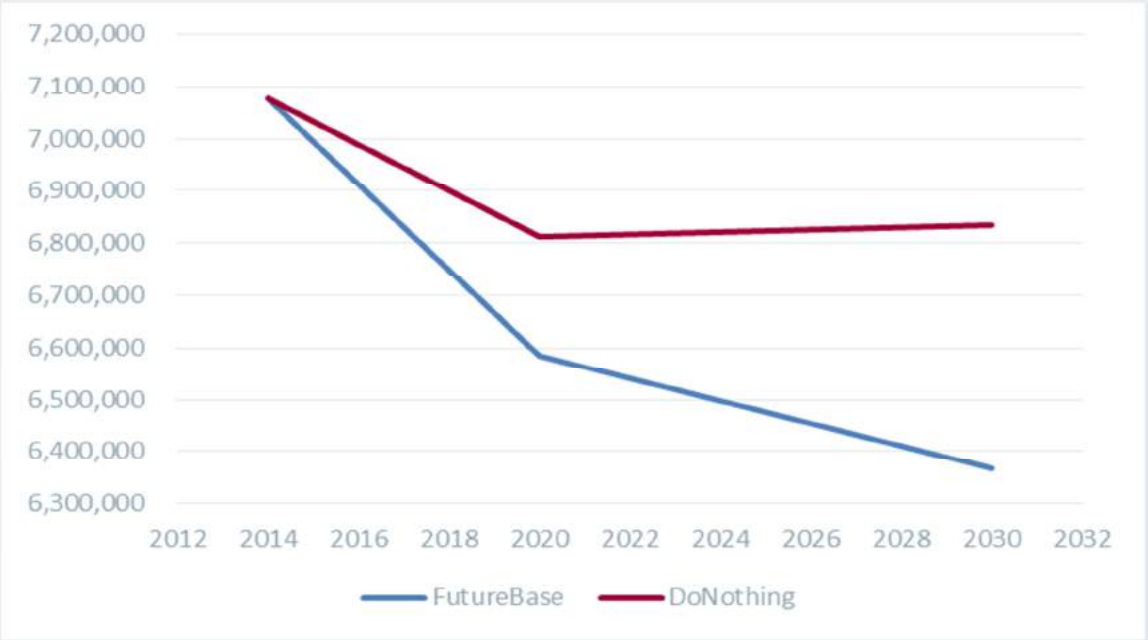


Figure 3. Energy Usage for Future Base and Do Nothing Scenarios

3.2.4 Figure 4 shows the change in energy for each of the impacts – change in fleet splits, change in population and the combined change.

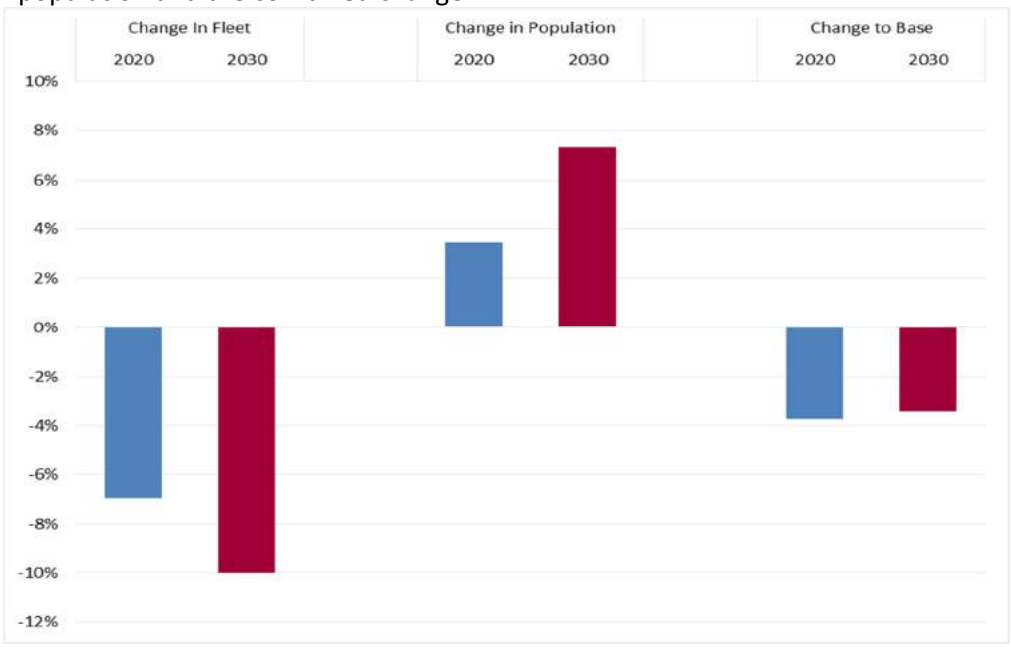


Figure 4. Change in Energy Split by Component

3.2.5 As can be seen in Figure 4, the biggest impact is the change in fleet, which leads to a 7% reduction in energy usage in 2020 and a 10% reduction in 2030. However, the increase in population reduces much of this impact, leading to an overall reduction of around 3.5%.

3.2.6 Table 12 shows the total changes in population, demand, energy usage for the Future Base and Do Nothing.

Table 12. Energy Usage by Person and Trip Compared Between Scenarios

SCENARIO	POPULATION	DEMAND	ENERGY (MJ)	ENERGY PER PERSON (MJ)	ENERGY PER TRIP (MJ)
Base 2014	**96,875**	**312,469**	**7,076,076**	**73.0**	**22.6**
YEAR - 2020					
Future Base	**96,875**	**312,756**	**6,585,081**	**68.0**	**21.1**
Diff to Base			-490,995	-5.1	-1.6
%Diff to Base			-6.9%	-6.9%	-7.0%
Do Nothing	**101,676**	**327,705**	**6,812,852**	**67.0**	**20.8**
Diff to Base	4,801	15,237	-263,224	-6.0	-1.9
%Diff to Base	5.0%	4.9%	-3.7%	-8.3%	-8.2%
Diff to Future Base			227,772	-1.0	-0.3
%Diff to Future Base			3.5%	-1.4%	-1.3%
YEAR - 2030					
Future Base	**96,875**	**313,111**	**6,367,563**	**65.7**	**20.3**
Diff to Base			-708,513	-7.3	-2.3
%Diff to Base			-10.0%	-10.0%	-10.2%
Do Nothing	**107,746**	**344,271**	**6,835,405**	**63.4**	**19.9**
Diff to Base	10,871	31,802	-240,671	-9.6	-2.8
%Diff to Base	11.2%	10.2%	-3.4%	-13.1%	-12.3%
Diff to Future Base			467,842	-2.3	-0.5
%Diff to Future Base			7.3%	-3.5%	-2.4%

3.2.7 Figure 5 shows the change in energy usage by zone between the Base Year and the Future Base. This highlights that the changes in vehicle efficiency are fairly consistent across zones. Differences are caused by the allocation of buses to zones and the location of goods vehicle attractors, for which both vehicle types show very little improvement in efficiency.

3.2.8 Figure 6 shows the change in energy usage by zone between the Base Year test and the Do Nothing. This shows the effects of both the efficiency changes and the population changes which were provided at a zonal level. The variation seen is due to the zonal variation present in the population growth figures.

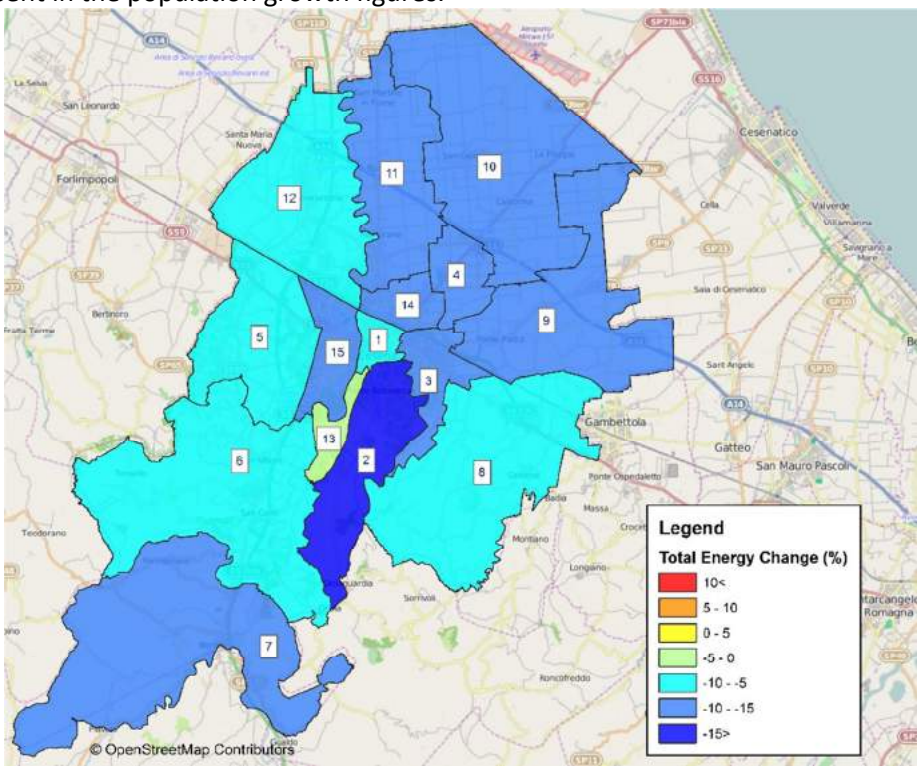


Figure 5. Difference Between 2014 Base and 2030 Future Base (%)

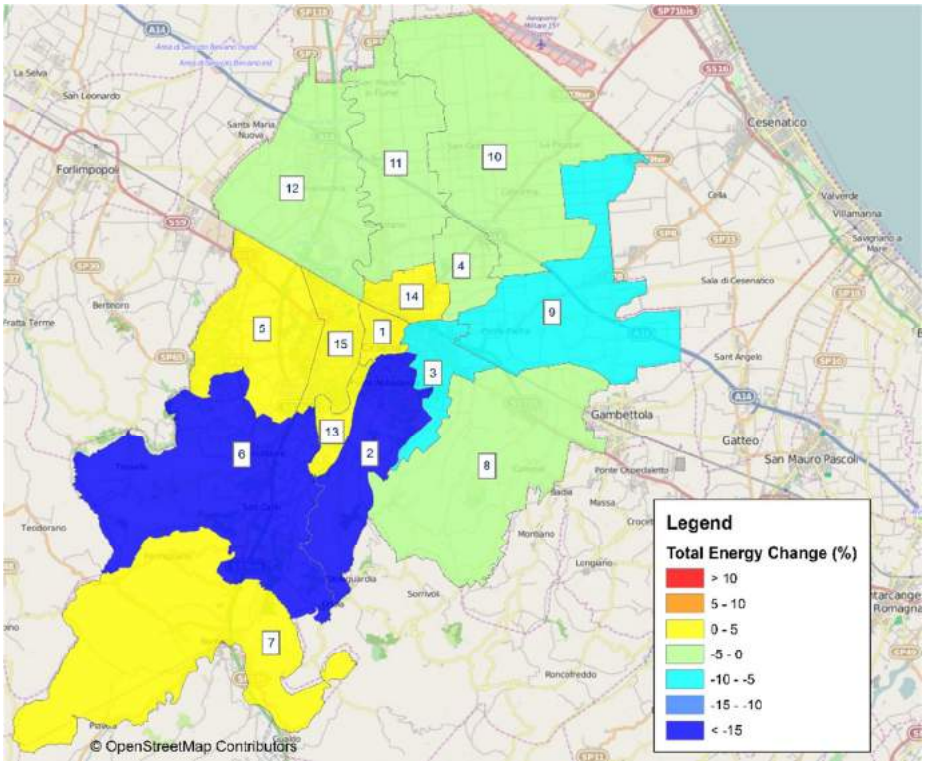


Figure 6. Difference Between 2014 Base and 2030 Do Nothing (%)

3.2.9 Table 14 display the energy usage data for the Base Year, Future Base and Do Nothing scenarios by vehicle type, isolating the effects of the fleet change and population change.

3.2.10 It can be seen that the largest reduction in energy usage comes from increased efficiency from cars. The increased efficiency for other vehicle types is much less, particularly for goods vehicles and buses which only decrease by less than 1%.

Table 13. 2020 Energy Usage per Scenario

Vehicle Type	Base Year (2014)	Future Base (2020)	DoNothing (2020)	Effect of Fleet Change		Effect of Population Change		Combined Effect	
Energy (MJ)									
Total	7,076,076	6,585,081	6,812,852	- 490,995	-7%	227,772	3%	- 263,224	-4%
Cars	4,064,280	3,604,400	3,789,788	- 459,881	-11%	185,388	5%	- 274,493	-7%
Bikes	836,511	820,700	862,862	- 15,810	-2%	42,162	5%	26,352	3%
Goods	1,884,301	1,869,896	1,869,896	- 14,405	-1%	-	0%	- 14,405	-1%
Buses	174,528	173,628	173,850	- 900	-1%	222	0%	- 678	0%
Trains	116,457	116,457	116,457	-	0%	-	0%	-	0%
Vehicles									
Total	84,140	84,087	87,796	- 53	0%	3,709	4%	3,656	4%
Cars	56,493	56,440	59,217	- 53	0%	2,777	5%	2,724	5%
Bikes	18,810	18,810	19,742	0	0%	932	5%	932	5%
Goods	7,853	7,853	7,853	-	0%	-	0%	-	0%
Buses	916	916	916	-	0%	-	0%	-	0%
Trains	68	68	68	-	0%	-	0%	-	0%
Energy / Vehicle (MJ)									
Total	84	78	78	- 6	-7%	- 1	-1%	- 7	-8%
Cars	72	64	64	- 8	-11%	0	0%	- 8	-11%
Bikes	44	44	44	- 1	-2%	0	0%	- 1	-2%
Goods	240	238	238	- 2	-1%	-	0%	- 2	-1%
Buses	191	190	190	- 1	-1%	0	0%	- 1	0%
Trains	1,713	1,713	1,713	-	0%	-	0%	-	0%

Table 14. 2030 Energy Usage per Scenario

Vehicle Type	Base Year (2014)	Future Base (2030)	DoNothing (2030)	Effect of Fleet Change		Effect of Population Change		Combined Effect	
Energy (MJ)									
Total	7,076,076	6,367,563	6,835,405	- 708,513	-10%	467,842	7%	- 240,671	-3%
Cars	4,064,280	3,401,132	3,773,865	- 663,148	-16%	372,733	11%	- 290,415	-7%
Bikes	836,511	808,736	896,666	- 27,775	-3%	87,931	11%	60,156	7%
Goods	1,884,301	1,867,818	1,874,636	- 16,483	-1%	6,818	0%	- 9,665	-1%
Buses	174,528	173,421	173,782	- 1,107	-1%	360	0%	- 746	0%
Trains	116,457	116,457	116,457	-	0%	-	0%	-	0%
Vehicles									
Total	84,140	84,020	92,407	- 120	0%	8,387	10%	8,267	10%
Cars	56,493	56,373	62,650	- 120	0%	6,276	11%	6,157	11%
Bikes	18,810	18,810	20,921	-	0%	2,111	11%	2,111	11%
Goods	7,853	7,853	7,853	-	0%	-	0%	-	0%
Buses	916	916	916	-	0%	-	0%	-	0%
Trains	68	68	68	-	0%	-	0%	-	0%
Energy / Vehicle (MJ)									
Total	84	76	74	- 8	-10%	- 2	-2%	- 10	-12%
Cars	72	60	60	- 12	-16%	- 0	0%	- 12	-16%
Bikes	44	43	43	- 1	-3%	- 0	0%	- 2	-4%
Goods	240	238	239	- 2	-1%	1	0%	- 1	-1%
Buses	191	189	190	- 1	-1%	0	0%	- 1	0%
Trains	1,713	1,713	1,713	-	0%	-	0%	-	0%

4. INDIVIDUAL SCENARIO TEST: BRETELLA-GRONDA ROAD

4.1 Introduction

4.1.1 This test looks at the implementation of a new 3.4Km highway that connects Cesena to the A14 north of the city, allowing traffic to by-pass the area of Villa Chiaviche. This highway consists of around 2.4Km of entirely new infrastructure, and 1Km of upgraded existing highway (previously the "circle of S. Egidio").

4.1.2 The projected result of the new infrastructure is that there should be a decrease in the number of vehicles, especially goods-based vehicles, that travel along the urban section of Cervese Road.

4.1.3 This project is planned to be completed in 2015, and is most likely to affect the journeys involving the city's northern and central zones of 2, 3, 4, 8, 10,11 and 14.

4.1.4 The location for the new infrastructure was received from Cesena Municipality. The anticipated effects that would be generated by the scheme were established following a review of the affected zone-zone journeys. Figure 7 shows the details of the scheme.

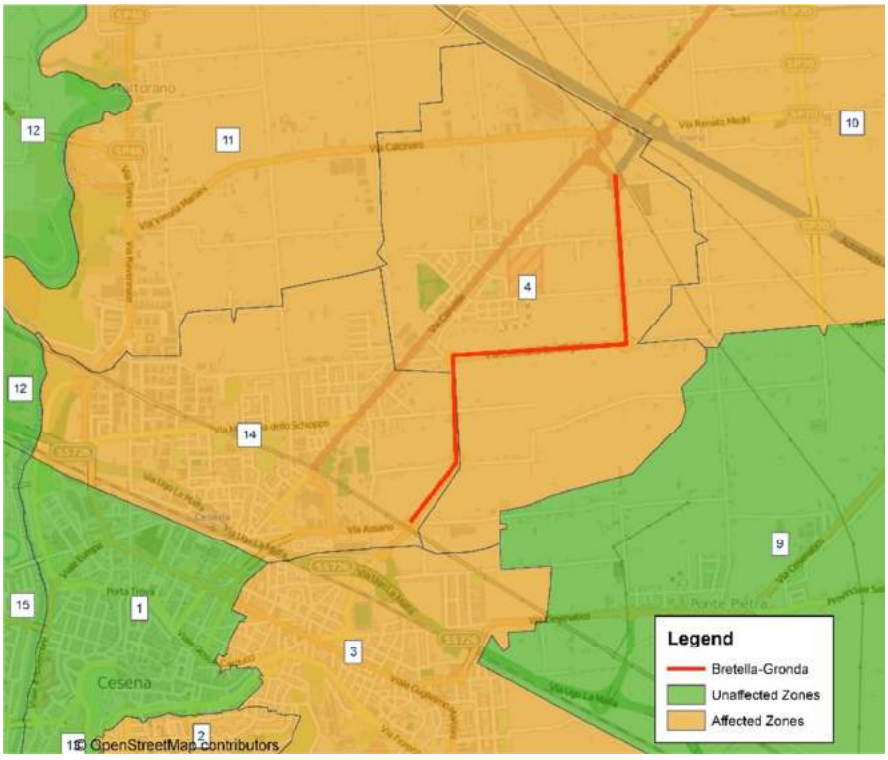


Figure 7. Scheme Details – Bretella Gronda Road

4.1.5 To implement the scheme the following changes were made to the model inputs:

- The affected zone-zone journeys were re-routed, through an ArcGIS process, to utilise the new road.
- The changing of the route for each zone-zone journey subsequently altered the journey distance and the zones passed through.

4.1.6 Figure 8 and Figure 9 illustrate the changes made in zonal movements following the introduction of the proposed Bretella-Gronda road.

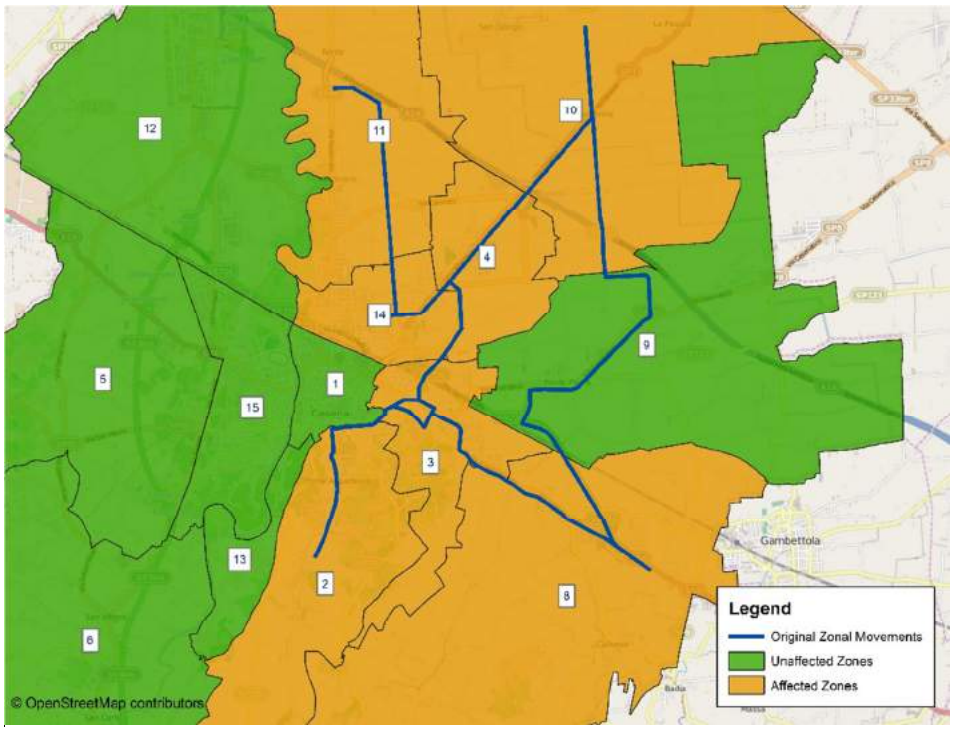


Figure 8. Original Zonal Movements

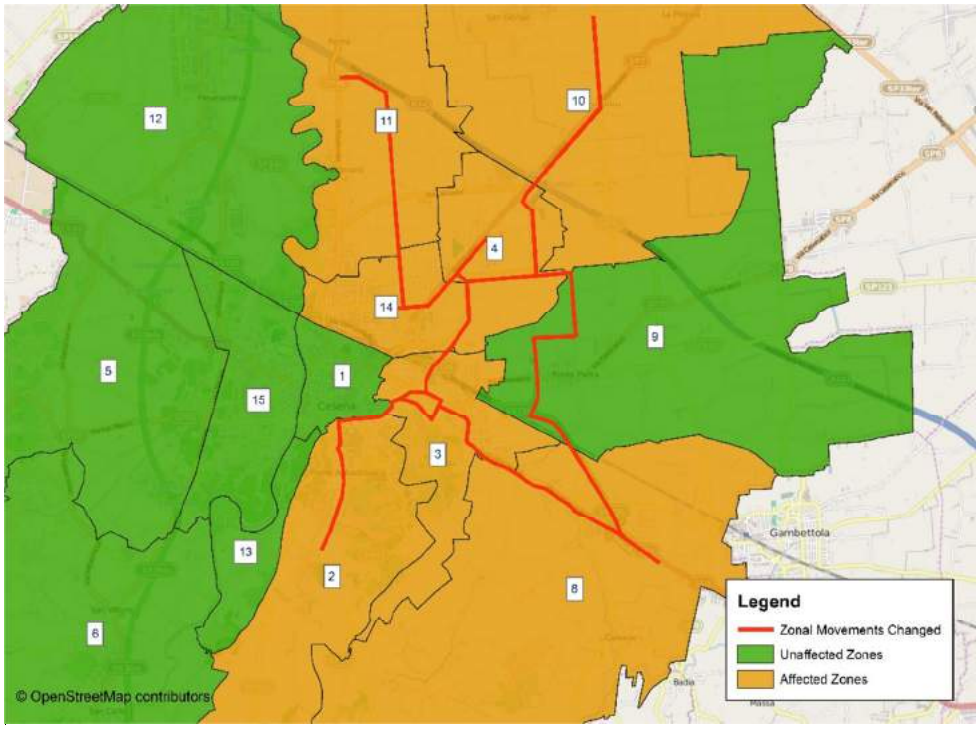


Figure 9. Zonal Movements Changed to Account for Bretella-Gronda Road

4.1.7 This scenario assumes that there are no changes to speeds in the model. In reality it is likely that the new road will be quicker than the previous route via Villa Chiaviche which passes through a more built-up residential area and is likely to be more congested. This is addressed in a subsequent scenario.

4.2 Demand Outputs

4.2.1 Table 15 to Table 17 provides an overview of changes in transport demand, average occupancy and vehicle kilometres within the modelled area for the Do Nothing and the Scenario, in both of the forecast years.

4.2.2 The scenario leads to a small mode shift from highway to public transport. This leads to a little change in the average occupancies of the bus services, with a larger shift to rail services.

Table 15. Demand and Mode Shares

Zone	2020		2030	
	Do Nothing	Bretella Gronda Road	Do Nothing	Bretella Gronda Road
Demand By Mode				
Highway	254,104	253,915	264,917	264,803
Public Transport	28,078	28,267	33,263	33,376
Mode Share				
Highway	90%	90%	89%	89%
Public Transport	10%	10%	11%	11%
Change in Highway Demand		- 189		- 114
Change in Public Transport Demand		189		114

Table 16. Average Public Transport Occupancy

Zone	2020		2030	
	Do Nothing	Bretella Gronda Road	Do Nothing	Bretella Gronda Road
Total	31.8	32.0	37.6	37.7
Buses	34.0	34.2	40.0	40.1
Trains	1.8	1.9	5.3	5.4
%Change in Occupancy				
Total		100.7%		100.4%
Buses		100.7%		100.4%
Trains		105.8%		100.6%

Table 17. Vehicle Kms and Average Distance

Vehicle Type	2020		2030	
	Do Nothing	Bretella Gronda Road	Do Nothing	Bretella Gronda Road
Vehicle Km				
Total	2,700,344	100.1%	2,787,357	100.2%
Cars	1,713,374	100.1%	1,778,469	100.2%
Bikes	567,501	100.1%	590,118	100.2%
Goods	390,964	100.1%	390,265	100.1%
Buses	22,127	100.0%	22,127	100.0%
Trains	6,378	100.0%	6,378	100.0%
Average Distance (Km)				
Total	30.42	100.0%	30.41	100.0%
Cars	11.58	100.2%	11.55	100.2%
Bikes	11.50	100.2%	11.47	100.2%
Goods	11.07	100.1%	11.05	100.1%
Buses	24.16	100.0%	24.16	100.0%
Trains	93.80	100.0%	93.80	100.0%

4.2.3 Table 17 provides further evidence of the effect the introduction of the new section of highway has on increasing journey distances. In both forecast years, the distances travelled by all vehicles increased.

4.2.4 Table 18 shows the demand change for private vehicles (including cars, mopeds and motorcycles) compared to the Do Nothing scenario for 2030. There is a redistribution of trips away from the affected movements due to the increase in distance, and hence journey times. The cells highlighted indicate the zone-zone journeys that have been directly re-routed to use the new road.

Table 18. Change In Demand

		1	3	14	15	2	4	5	11	12	13	6	7	8	9	10	16	
Private Vehicles		Centro Urban 2	Fiorenzuola	Cervese Sud 2	Oltre Savio 2	Cesuola	Cervese Sud 1	Oltre Savio1	Ravennate	Dismano	Centro Urban 1	Valle Savio	Borello	Rubicone	Al Mare	Cervese Nord	External	Total
1	Centro Urban 2	0.0%	0.0%	0.1%	0.0%	0.0%	-2.1%	0.1%	0.1%	0.2%	0.0%	0.1%	0.0%	0.1%	0.1%	0.1%	0.0%	0.0%
3	Fiorenzuola	0.0%	0.0%	0.3%	0.2%	0.0%	-2.1%	0.3%	0.3%	0.4%	0.0%	0.3%	0.0%	0.4%	0.3%	-10.7%	0.0%	0.0%
14	Cervese Sud 2	0.7%	0.7%	-1.4%	0.6%	0.6%	-2.6%	1.0%	1.4%	1.5%	2.9%	1.3%	0.7%	1.4%	0.9%	-20.2%	-0.1%	-0.1%
15	Oltre Savio 2	0.0%	0.0%	0.1%	0.0%	0.0%	-1.5%	0.0%	0.1%	0.1%	-1.0%	0.1%	0.1%	0.1%	0.0%	0.1%	0.0%	0.0%
2	Cesuola	0.0%	0.0%	0.1%	0.0%	0.0%	-1.1%	0.1%	0.1%	0.1%	0.0%	0.1%	0.0%	0.1%	0.1%	-8.0%	0.0%	0.0%
4	Cervese Sud 1	0.8%	-0.6%	-1.6%	0.5%	1.2%	-0.7%	2.0%	1.9%	1.8%	2.3%	1.7%	3.4%	0.5%	2.7%	2.2%	-0.3%	-0.3%
5	Oltre Savio1	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
11	Ravennate	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
12	Dismano	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
13	Centro Urban 1	0.1%	0.3%	0.2%	-0.5%	0.4%	-1.0%	0.3%	0.2%	0.2%	0.0%	0.2%	0.2%	0.2%	0.3%	0.2%	0.0%	0.0%
6	Valle Savio	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
7	Borello	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
8	Rubicone	0.0%	0.0%	0.0%	0.0%	0.0%	-1.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	2.3%	0.0%	0.0%
9	Al Mare	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
10	Cervese Nord	6.4%	-6.5%	-12.7%	6.4%	-3.9%	3.6%	4.9%	4.0%	2.5%	17.2%	3.2%	9.7%	5.2%	6.2%	5.5%	-0.2%	-0.2%
16	External	0.3%	-0.4%	-1.6%	0.3%	-0.3%	-0.4%	0.3%	1.1%	0.5%	0.4%	0.2%	0.0%	0.6%	1.1%	1.5%	0.0%	0.0%
	Total	0.3%	-0.4%	-1.6%	0.3%	-0.3%	-0.4%	0.3%	1.1%	0.5%	0.4%	0.2%	0.0%	0.6%	1.1%	1.5%	0.0%	0.0%

4.3 Energy Outputs

4.3.1 Table 19 and Table 20 provide an overview of the energy usage by vehicle type and by zone for the 2020 and 2030 Do Nothing and the Scenario, respectively.

4.3.2 Overall the scenario has a small impact on the total energy usage across the city. The largest percentage impact is seen from cars, bikes and goods vehicles, although the increase in energy usage is approximately 0.1%.

Table 19. Energy Usage (MJ/day) by Vehicle Type

Vehicle Type	2020		2030	
	Do Nothing	Bretella Gronda Road	Do Nothing	Bretella Gronda Road
Energy (MJ)				
Total	6,812,852	0.1%	6,835,405	0.1%
Cars	3,789,788	0.1%	3,773,865	0.1%
Bikes	862,862	0.1%	896,666	0.1%
Goods	1,869,896	0.1%	1,874,636	0.1%
Buses	173,850	0.0%	173,782	0.0%
Trains	116,457	0.0%	116,457	0.0%
Vehicles				
Total	87,796	0.0%	92,407	0.0%
Cars	59,217	0.0%	62,650	0.0%
Bikes	19,742	0.0%	20,921	0.0%
Goods	7,853	0.0%	7,853	0.0%
Buses	916	0.0%	916	0.0%
Trains	68	0.0%	68	0.0%
Energy / Vehicle (MJ)				
Total	78	0.1%	74	0.1%
Cars	64	0.2%	60	0.1%
Bikes	44	0.1%	43	0.1%
Goods	238	0.1%	239	0.1%
Buses	190	0.0%	190	0.0%
Trains	1,713	0.0%	1,713	0.0%

4.3.3 The two zones that benefit the most are zones 4 and 10, the former as it is closest to the new road, and the latter as the new road provides a less congested route to Cesena City Centre.

4.3.4 Energy usage from zones 4, 10 and 14 actually increase with the building of the new road. This is due to an overall increase in the distance from these zones to others. With no adjustments to the speeds this leads to longer journey times. In reality, the new road would be quicker and a better quality than the Cervese Road. Including speed increases might itigate these increases in distances.

Table 20. Energy Usage (MJ/day) by Zone

Zone	2020		2030	
	Do Nothing	Bretella Gronda Road	Do Nothing	Bretella Gronda Road
Total	6,812,852	0.1%	6,835,405	0.1%
1 - Centro Urban 2	449,396	0.0%	457,728	0.0%
3 - Fiorenzuola	432,705	0.0%	429,867	0.0%
14 - Cervese Sud 2	333,288	0.3%	338,039	0.3%
15 - Oltre Savio 2	358,517	0.0%	365,401	0.0%
2 - Cesuola	193,068	0.1%	172,622	0.0%
4 - Cervese Sud 1	154,522	0.5%	156,430	0.4%
5 - Oltre Savio1	219,270	0.1%	225,097	0.0%
11 - Ravennate	288,180	0.1%	294,687	0.0%
12 - Dismano	552,762	0.1%	560,849	0.0%
13 - Centro Urban 1	52,899	0.1%	53,507	0.0%
6 - Valle Savio	376,093	0.0%	349,015	0.0%
7 - Borello	189,165	-0.1%	198,278	0.0%
8 - Rubicone	431,554	0.0%	436,121	0.0%
9 - Al Mare	319,519	0.0%	319,734	0.0%
10 - Cervese Nord	396,191	1.4%	404,102	1.4%
16 - External	2,065,723	0.0%	2,073,927	0.0%

4.3.5 The increase in demand is reflected in the energy consumption for the city with increases experienced across the city along the new road alignment. Figure 10 shows the change in energy usage by zone compared to the 2030 Do Nothing scenario.

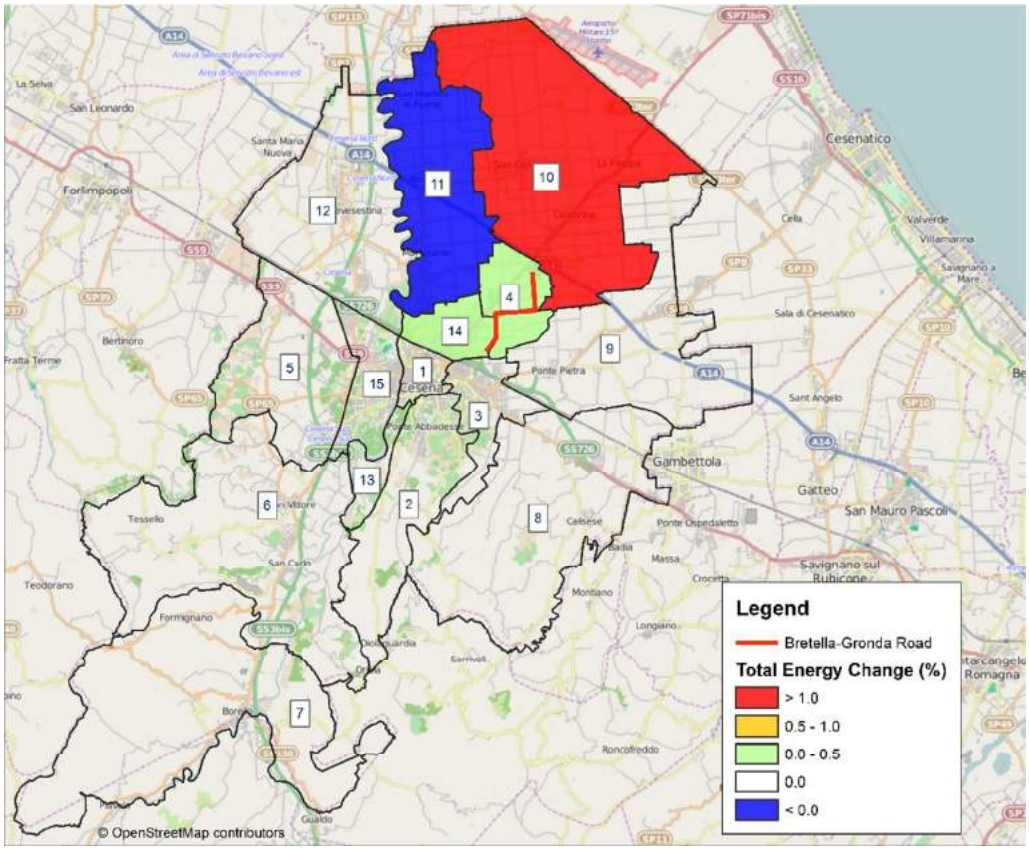


Figure 10. Change in Energy (2030)

4.4 Summary

4.4.1 The introduction of this scheme within Cesena increases the total energy usage by around 7,000MJ in both forecast years, though this represents less than 1% of the total energy usage. At a more detailed zonal level, the pattern is more mixed with some zones showing an increase in energy usage due to increased distance travelled, although these are still only small changes.

5. INDIVIDUAL SCENARIO TEST: BRETELLA-GRONDA ROAD WITH SPEED CHANGES

5.1 Introduction

5.1.1 This test looks at an extension to the previous Bretell-Gronda Road test with vehicle speeds increased along the new section of highway. Due to the nature of this test, the expected effects of the Bretella-Gronda Road are the same as those expressed in section 4.1, with the additional expectation that journey times decrease with the rise in vehicle speeds.

5.1.2 To implement the scheme the same changes were made to the model inputs as seen in section 4.1.5, as well as the following:

- The affected zone-zone journeys that were previously re-routed, were subject to a 20% increase in speeds for all vehicle types that may travel alongany section of the new road.
- A 20% increase was also applied to all public transport services that continue to use the 'by-passed' section of Cersvese Road. This speed increase is due to reduced congestion allowing the buses to travel quicker.

5.2 Demand Outputs

5.2.1 Table 21 to Table 23 provides an overview of changes in transport demand, average occupancy and vehicle kilometres within the modelled area for the Do Nothing and the Scenario, in both of the forecast years.

5.2.2 The scenario leads to a small mode shift from highway to public transport. It should be noted that the extent of this shift has decreased following the introduction of the speed changes, compared to the previous test as the extra distance of the new road is mitigated slightly by the increase in speeds.

Table 21. Demand and Mode Shares

Zone	2020		2030	
	Do Nothing	Bretella Gronda Road v2	Do Nothing	Bretella Gronda Road v2
Demand By Mode				
Highway	254,104	253,955	264,917	264,851
Public Transport	28,078	28,226	33,263	33,329
Mode Share				
Highway	90%	90%	89%	89%
Public Transport	10%	10%	11%	11%
Change in Highway Demand		- 148		- 66
Change in Public Transport Demand		148		66

Table 22. Average Public Transport Occupancy

Zone	2020		2030	
	Do Nothing	Bretella Gronda Road v2	Do Nothing	Bretella Gronda Road v2
Total	31.8	31.9	37.6	37.7
Buses	34.0	34.2	40.0	40.1
Trains	1.8	1.9	5.3	5.3
%Change in Occupancy		0		0
Total		100.6%		100.2%
Buses		100.5%		100.2%
Trains		105.0%		100.3%

Table 23. Vehicle Kms and Average Distance

Vehicle Type	2020		2030	
	Do Nothing	Bretella Gronda Road v2	Do Nothing	Bretella Gronda Road v2
Vehicle Km				
Total	2,700,344	100.1%	2,787,357	100.2%
Cars	1,713,374	100.1%	1,778,469	100.2%
Bikes	567,501	100.1%	590,118	100.2%
Goods	390,964	100.1%	390,265	100.1%
Buses	22,127	100.0%	22,127	100.0%
Trains	6,378	100.0%	6,378	100.0%
Average Distance (Km)				
Total	30.42	100.0%	30.41	100.0%
Cars	11.58	100.2%	11.55	100.2%
Bikes	11.50	100.2%	11.47	100.2%
Goods	11.07	100.1%	11.05	100.1%
Buses	24.16	100.0%	24.16	100.0%
Trains	93.80	100.0%	93.80	100.0%

5.2.3 Table 23 provides further evidence of the effect the introduction of the new section of highway has on increasing journey distances. In both forecast years, the distances travelled by all non-public transport vehicles increased.

5.2.4 The introduction of the speed changes has provided a total journey time decrease of 0.4%, compared with the effect of the new road without the speed changes.

5.2.5 Table 24 shows the demand change for private vehicles (including cars, mopeds and motorcycles) compared to the Do Nothing scenario for 2030. There is a general redistribution of trips between the affected zones. The cells highlighted indicate the zone-zone journeys that have been affected by the changes made in this test scenario.

5.2.6 In contrast to the test without the speed changes there are locations that show an increase in demand. This shows that the increase in the speed leads to a journey time improvement from the new road which is a more expected result. However, there are still a number of movements where journey times increase by using the new road, noticeably to/from zone 10.

Table 24. Demand Change Table

	Private Vehicles	Centro Urban 2	Fiorenzuola	Cervese Sud 2	Oltre Savio 2	Cesuola	Cervese Sud 1	Oltre Savio1	Ravennate	Dismano	Centro Urban 1	Valle Savio	Borello	Rubicone	Al Mare	Cervese Nord	External	Total
		1	3	14	15	2	4	5	11	12	13	6	7	8	9	10	16	
1	Centro Urban 2	0.0%	0.0%	0.1%	0.0%	0.0%	-2.1%	0.1%	0.1%	0.2%	0.0%	0.1%	0.0%	0.1%	0.1%	0.1%	0.0%	0.0%
3	Fiorenzuola	0.0%	0.0%	0.3%	0.2%	0.0%	-2.1%	0.3%	0.3%	0.4%	0.0%	0.3%	0.0%	0.4%	0.3%	-10.7%	0.0%	0.0%
14	Cervese Sud 2	0.7%	0.7%	-1.4%	0.6%	0.5%	-2.7%	0.9%	1.3%	1.4%	2.9%	1.2%	0.7%	1.3%	0.8%	-20.2%	-0.2%	-0.2%
15	Oltre Savio 2	0.0%	0.0%	0.1%	0.0%	0.0%	-1.5%	0.0%	0.1%	0.1%	-1.0%	0.1%	0.1%	0.1%	0.0%	0.1%	0.0%	0.0%
2	Cesuola	0.0%	0.0%	0.1%	0.0%	0.0%	-1.1%	0.1%	0.1%	0.1%	0.0%	0.1%	0.0%	0.1%	0.1%	-8.0%	0.0%	0.0%
4	Cervese Sud 1	-3.5%	6.1%	-4.0%	-5.7%	17.4%	-3.3%	-0.8%	0.4%	0.8%	-1.9%	0.5%	-4.3%	4.1%	-3.2%	-0.7%	0.0%	0.0%
5	Oltre Savio1	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
11	Ravennate	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
12	Dismano	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
13	Centro Urban 1	0.1%	0.3%	0.2%	-0.5%	0.4%	-1.0%	0.3%	0.2%	0.2%	0.0%	0.2%	0.2%	0.2%	0.3%	0.2%	0.0%	0.0%
6	Valle Savio	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
7	Borello	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
8	Rubicone	0.0%	0.0%	0.0%	0.0%	0.0%	-1.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	2.3%	0.0%	0.0%
9	Al Mare	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
10	Cervese Nord	1.2%	-0.4%	-7.6%	0.7%	9.2%	0.9%	1.0%	1.3%	0.6%	6.2%	0.8%	1.8%	7.7%	0.6%	1.1%	-0.1%	-0.1%
16	External	0.0%	0.3%	-1.3%	0.0%	1.1%	-1.4%	0.1%	0.4%	0.2%	0.0%	0.1%	0.0%	0.8%	0.1%	-0.9%	0.0%	0.0%
	Total	0.0%	0.3%	-1.3%	0.0%	1.1%	-1.4%	0.1%	0.4%	0.2%	0.0%	0.1%	0.0%	0.8%	0.1%	-0.9%	0.0%	0.0%

5.3 Energy Outputs

5.3.1 Table 25 and Table 26 provide an overview of the energy usage by vehicle type and by zone for the 2020 and 2030 Do Nothing and the Scenario, respectively.

5.3.2 Overall the scenario has a small impact on the total energy usage across the city. The largest percentage impact is seen from cars, bikes and goods vehicles, although the increase in energy usage is no greater than 0.2%.

Table 25. Energy Usage (MJ/day) by Vehicle Type

Vehicle Type	2020		2030	
	Do Nothing	Bretella Gronda Road v2	Do Nothing	Bretella Gronda Road v2
Energy (MJ)				
Total	6,812,852	0.1%	6,835,405	0.1%
Cars	3,789,788	0.2%	3,773,865	0.1%
Bikes	862,862	0.1%	896,666	0.1%
Goods	1,869,896	0.1%	1,874,636	0.1%
Buses	173,850	0.0%	173,782	0.0%
Trains	116,457	0.0%	116,457	0.0%
Vehicles				
Total	87,796	0.0%	92,407	0.0%
Cars	59,217	0.0%	62,650	0.0%
Bikes	19,742	0.0%	20,921	0.0%
Goods	7,853	0.0%	7,853	0.0%
Buses	916	0.0%	916	0.0%
Trains	68	0.0%	68	0.0%
Energy / Vehicle (MJ)				
Total	78	0.1%	74	0.1%
Cars	64	0.2%	60	0.1%
Bikes	44	0.1%	43	0.1%
Goods	238	0.1%	239	0.1%
Buses	190	0.0%	190	0.0%
Trains	1,713	0.0%	1,713	0.0%

5.3.3 The two zones that benefit the most are zones 4 and 10, the former as it is closest to the new road, and the latter as the new road provides a less congested route to Cesena City Centre and all southern zones.

5.3.4 With an adjustment to the speeds, this leads to quicker journey times than seen in the previous test. Following the implementation of the speed changes, the new vehicle speeds along the Bretella-Gronda Road are approximately 60km/h. At this speed there is little change in the fuel consumption compared to the original speed so the speeds increases are attributable to the increases in distance.

Table 26. Energy Usage (MJ/day) by Zone

Zone	2020		2030	
	Do Nothing	Bretella Gronda Road v2	Do Nothing	Bretella Gronda Road v2
Total	6,812,852	0.1%	6,835,405	0.1%
1 - Centro Urban 2	449,396	0.0%	457,728	0.0%
3 - Fiorenzuola	432,705	0.0%	429,867	0.0%
14 - Cervese Sud 2	333,288	0.2%	338,039	0.3%
15 - Oltre Savio 2	358,517	0.0%	365,401	0.0%
2 - Cesuola	193,068	0.1%	172,622	0.0%
4 - Cervese Sud 1	154,522	0.7%	156,430	0.7%
5 - Oltre Savio1	219,270	0.1%	225,097	0.0%
11 - Ravennate	288,180	0.1%	294,687	0.0%
12 - Dismano	552,762	0.1%	560,849	0.0%
13 - Centro Urban 1	52,899	0.1%	53,507	0.0%
6 - Valle Savio	376,093	0.0%	349,015	0.0%
7 - Borello	189,165	-0.1%	198,278	0.0%
8 - Rubicone	431,554	0.0%	436,121	0.0%
9 - Al Mare	319,519	0.0%	319,734	0.0%
10 - Cervese Nord	396,191	1.5%	404,102	1.5%
16 - External	2,065,723	0.0%	2,073,927	0.0%

5.3.5 The increase in demand is reflected in the energy consumption for the city with increases experienced across the city along the new road alignment. Figure 11 shows the change in energy usage by zone compared to the 2030 Do Nothing scenario.

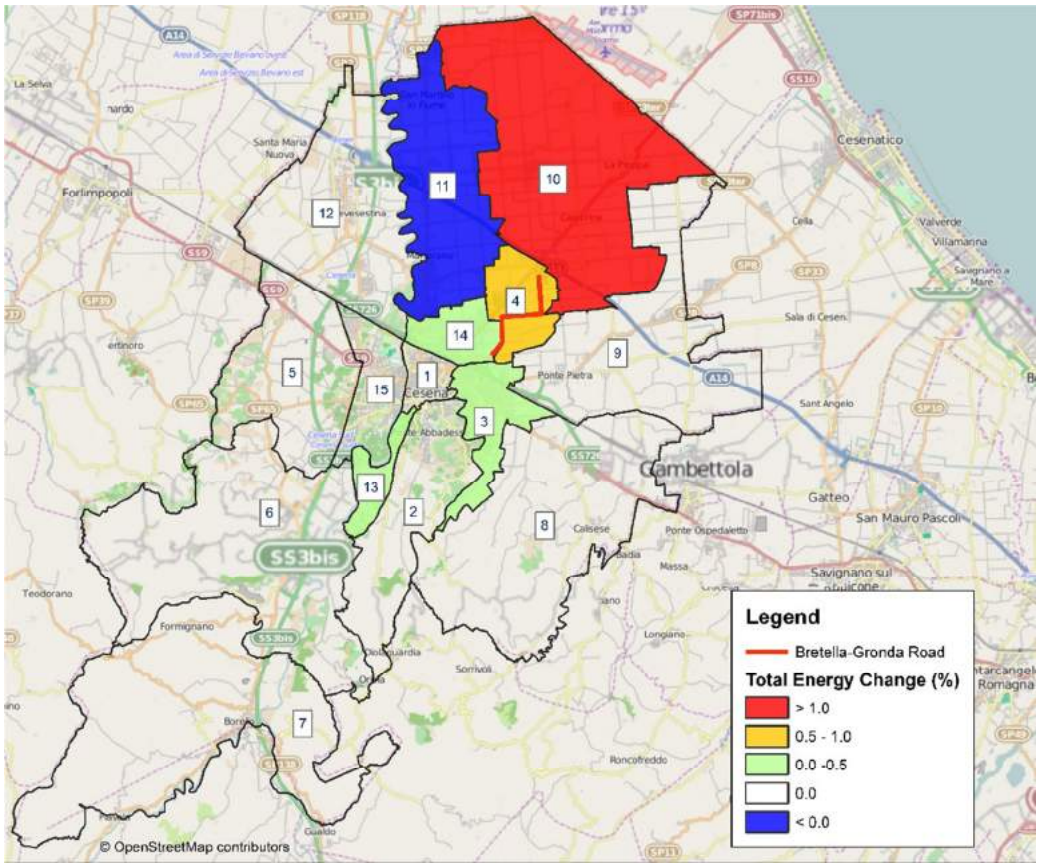


Figure 11. Change in Energy (2030)

5.4 Summary

5.4.1 The introduction of this scheme, and the associated speed changes, within Cesena increases the total energy usage by approximately 8,000MJ in both forecast years, though this represents less than 1% of the total energy usage. This is slightly more than in the scenario without speed changes. Without the speed changes the extra distance required to use the new road causes demand to redistribute to alternative, shorter trips. By increasing the speed on the road it becomes more attractive, but the resulting extra distance travelled drives an increase in energy usage.

6. INDIVIDUAL SCENARIO TEST: CERVESE ROAD SPEED REDUCTION

6.1 Introduction

6.1.1 This test looks at the implementation of traffic calming along the Villa Chiviche section of Cervese Road. The introduction of measures such as speed bumps and traffic signals will aim to increase safety within this populated area by reducing speeds.

6.1.2 The projected result of the new infrastructure is that there should be a decrease in the speed of vehicles, and an increase in journey times, for journeys along this section of Cervese Road.

6.1.3 This project is planned to be completed within 2015, and is most likely due to affect the journeys involving the city's northern and central zones of 2, 3, 4, 8, 10,11 and 14.

6.1.4 The location for the new infrastructure was received from Cesena Municipality. The anticipated effects that would be generated by the scheme were established following a review of the affected zone-zone journeys. Figure 12 shows the details of the scheme.

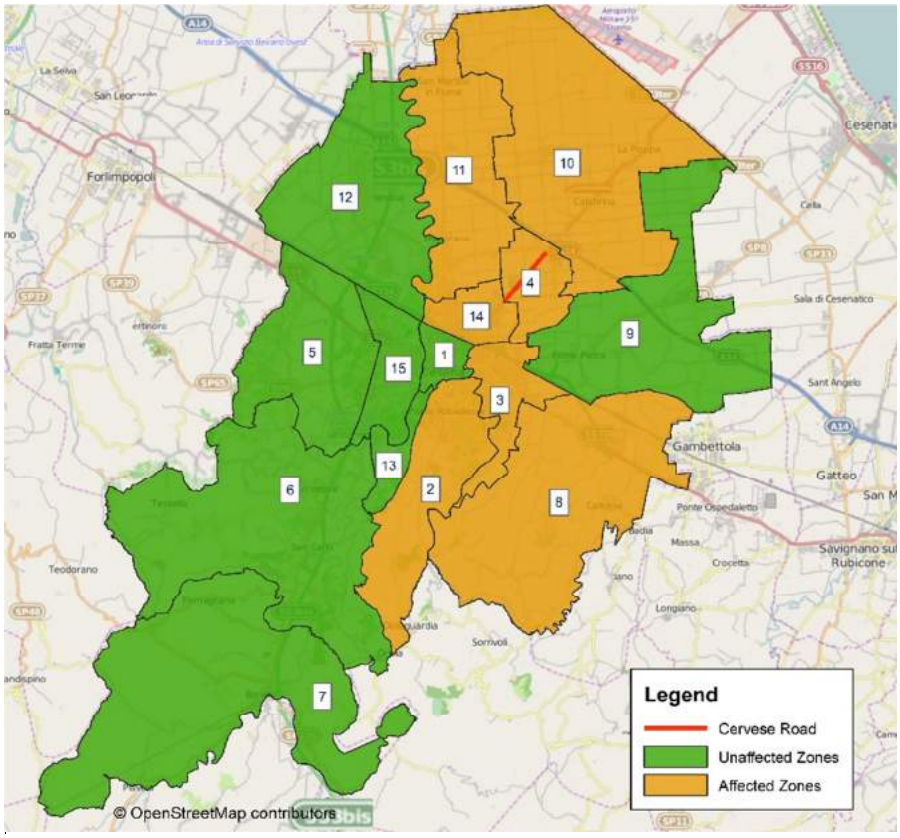


Figure 12. Scheme Details – Speed Reductions

6.1.5 To implement the scheme the following changes were made to the model inputs:

- The affected zone-zone journeys were established through an ArcGIS process.

- Having identified all of the affected zone-zone journeys, a speed reduction factor of 50% was applied to all vehicle types within the model inputs.

6.1.6 The aggregate approach adopted for the transport modelling has resulted in a number of assumptions being made which have simplified the assessment of this scheme. These include:

- As the implementation of the speed changes are introduced by Area Type, there is a possibility that the effect of the changes could be experienced on more than one occasion within sections of the zone-zone route other than along the Cervese Road, where these sections are also part of the same Area Type.
- No figure was provided for the anticipated speed reduction on the road. A speed reduction of 50% was assumed and may be considered too large to be realistic result of introduction such traffic calming measures. However, this represents an extreme case.

6.2 Demand Outputs

6.2.1 Table 27 to Table 29 provides an overview of changes in transport demand, average occupancy and vehicle kilometres within the modelled area for the Do Nothing and the Scenario, in both of the forecast years.

6.2.2 The scenario leads to a small mode shift from highway to public transport. This leads to a small positive change in the average occupancies of the bus services, with a negative shift to rail services in 2020, before rising in 2030.

Table 27. Demand and Mode Shares

Zone	2020		2030	
	Do Nothing	Cervese Road Speed Changes	Do Nothing	Cervese Road Speed Changes
Demand By Mode				
Highway	254,104	254,060	264,917	264,779
Public Transport	28,078	28,121	33,263	33,401
Mode Share				
Highway	90%	90%	89%	89%
Public Transport	10%	10%	11%	11%
Change in Highway Demand		- 43		- 139
Change in Public Transport Demand		43		139

Table 28. Average Public Transport Occupancy

Zone	2020		2030	
	Do Nothing	Cervese Road Speed Changes	Do Nothing	Cervese Road Speed Changes
Total	31.8	31.8	37.6	37.8
Buses	34.0	34.0	40.0	40.2
Trains	1.8	1.8	5.3	5.4
%Change in Occupancy				
Total		100.2%		100.4%
Buses		100.2%		100.4%
Trains		99.2%		100.8%

Table 29. Vehicle Kms and Average Distance

Vehicle Type	2020		2030	
	Do Nothing	Cervese Road Speed Changes	Do Nothing	Cervese Road Speed Changes
Vehicle Km				
Total	2,700,344	100.0%	2,787,357	100.0%
Cars	1,713,374	100.0%	1,778,469	100.0%
Bikes	567,501	100.0%	590,118	100.0%
Goods	390,964	99.9%	390,265	99.9%
Buses	22,127	100.0%	22,127	100.0%
Trains	6,378	100.0%	6,378	100.0%
Average Distance (Km)				
Total	30.42	100.0%	30.41	100.0%
Cars	11.58	100.0%	11.55	100.0%
Bikes	11.50	100.0%	11.47	100.0%
Goods	11.07	99.9%	11.05	99.9%
Buses	24.16	100.0%	24.16	100.0%
Trains	93.80	100.0%	93.80	100.0%

6.2.3 Table 29 provides further evidence of the effect the introduction of traffic calming measures on increasing journey distances. In both forecast years, the distances travelled by all vehicles either remained the same, or changed by less than 0.1%. The exception being goods vehicles which decreased by 0.1%.

6.2.4 Table 30 shows the demand change for private vehicles compared to the Do Nothing scenario for 2030. The cells highlighted indicate the zone-zone journeys that have been affected by the changes made in this test scenario. It can be seen that there is a redistribution of trips away from the affected areas to avoid the traffic calming. Despite this there is almost no change in the total vehicle kilometres travelled.

Table 30. Demand Change Table

		1	3	14	15	2	4	5	11	12	13	6	7	8	9	10	16	
Private Vehicles		Centro Urban 2	Fiorenzuola	Cervese Sud 2	Oltre Savio 2	Cesuola	Cervese Sud 1	Oltre Savio1	Ravennate	Dismano	Centro Urban 1	Valle Savio	Borello	Rubicone	Al Mare	Cervese Nord	External	Total
1	Centro Urban 2	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3	Fiorenzuola	0.0%	0.0%	0.1%	0.1%	0.0%	0.1%	0.1%	0.1%	0.2%	0.0%	0.2%	0.0%	0.2%	0.1%	-36.5%	0.0%	0.0%
14	Cervese Sud 2	0.1%	0.1%	0.6%	0.2%	0.0%	0.8%	0.5%	0.8%	1.1%	0.0%	0.9%	0.0%	1.0%	0.5%	0.8%	0.4%	0.4%
15	Oltre Savio 2	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2	Cesuola	0.0%	0.1%	0.1%	0.1%	0.0%	0.2%	0.1%	0.1%	0.2%	0.1%	0.2%	0.0%	0.2%	0.2%	-48.0%	0.0%	0.0%
4	Cervese Sud 1	16.1%	-21.1%	-16.5%	11.9%	-45.7%	27.0%	-61.3%	22.2%	15.0%	-20.6%	-57.4%	-59.3%	-9.3%	-1.3%	-10.3%	-2.6%	-2.6%
5	Oltre Savio1	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
11	Ravennate	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
12	Dismano	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
13	Centro Urban 1	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
6	Valle Savio	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
7	Borello	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
8	Rubicone	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
9	Al Mare	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
10	Cervese Nord	4.1%	3.8%	-26.4%	2.4%	1.8%	4.3%	3.9%	5.6%	3.8%	20.3%	4.2%	5.2%	4.0%	2.1%	4.5%	0.1%	0.1%
16	External	0.4%	-0.7%	-3.5%	0.3%	-0.7%	5.3%	-0.2%	2.0%	0.9%	0.5%	-0.1%	0.0%	0.2%	0.3%	-1.2%	0.0%	-0.1%
	Total	0.4%	-0.7%	-3.5%	0.3%	-0.7%	5.3%	-0.2%	2.0%	0.9%	0.5%	-0.1%	0.0%	0.2%	0.3%	-1.2%	-0.1%	-0.1%

6.3 Energy Outputs

6.3.1 Table 31 and Table 32 provide an overview of the energy usage by vehicle type and by zone for the 2020 and 2030 Do Nothing and the Scenario, respectively.

6.3.2 Overall the scenario has a small impact on the total energy usage across the city. The largest percentage impact is seen from cars and buses, although this decrease in energy usage is approximately 0.1%.

Table 31. Energy Usage (MJ/day) by Vehicle Type

Vehicle Type	2020		2030	
	Do Nothing	Cervese Road Speed Changes	Do Nothing	Cervese Road Speed Changes
Energy (MJ)				
Total	6,812,852	-0.1%	6,835,405	0.0%
Cars	3,789,788	-0.1%	3,773,865	0.0%
Bikes	862,862	0.0%	896,666	0.0%
Goods	1,869,896	0.0%	1,874,636	0.0%
Buses	173,850	-0.1%	173,782	0.0%
Trains	116,457	0.0%	116,457	0.0%
Vehicles				
Total	87,796	0.0%	92,407	0.0%
Cars	59,217	0.0%	62,650	0.0%
Bikes	19,742	0.0%	20,921	0.0%
Goods	7,853	0.0%	7,853	0.0%
Buses	916	0.0%	916	0.0%
Trains	68	0.0%	68	0.0%
Energy / Vehicle (MJ)				
Total	78	-0.1%	74	0.0%
Cars	64	-0.1%	60	0.0%
Bikes	44	0.0%	43	0.0%
Goods	238	0.0%	239	0.0%
Buses	190	-0.1%	190	0.0%
Trains	1,713	0.0%	1,713	0.0%

6.3.3 Zone 4 sees the largest reduction in energy usage with the speed changes leading to a shift to shorter journeys, where the extra journey time is felt less. This is countered by increases in energy usage in zones 10 and 14 where the shift is to longer, but quicker movements.

Table 32. Energy Usage (MJ/day) by Zone

Zone	2020		2030	
	Do Nothing	Cervese Road Speed Changes	Do Nothing	Cervese Road Speed Changes
Total	6,812,852	-0.1%	6,835,405	0.0%
1 - Centro Urban 2	449,396	0.0%	457,728	0.0%
3 - Fiorenzuola	432,705	-0.2%	429,867	0.0%
14 - Cervese Sud 2	333,288	0.2%	338,039	0.3%
15 - Oltre Savio 2	358,517	-0.1%	365,401	0.0%
2 - Cesuola	193,068	-0.1%	172,622	-0.1%
4 - Cervese Sud 1	154,522	-2.6%	156,430	-2.8%
5 - Oltre Savio1	219,270	0.0%	225,097	0.0%
11 - Ravennate	288,180	0.0%	294,687	0.0%
12 - Dismano	552,762	0.0%	560,849	0.0%
13 - Centro Urban 1	52,899	0.0%	53,507	0.0%
6 - Valle Savio	376,093	0.0%	349,015	0.0%
7 - Borello	189,165	0.0%	198,278	0.0%
8 - Rubicone	431,554	0.0%	436,121	0.0%
9 - Al Mare	319,519	0.0%	319,734	0.0%
10 - Cervese Nord	396,191	0.4%	404,102	0.5%
16 - External	2,065,723	0.0%	2,073,927	0.0%

6.3.4 The increase in demand is reflected in the energy consumption for the city with increases experienced in the zones either side of Cervese Road, and a larger decrease in the zone where the traffic calming measures are to be introduced. Figure 13 shows the change in energy usage by zone compared to the 2030 Do Nothing scenario.

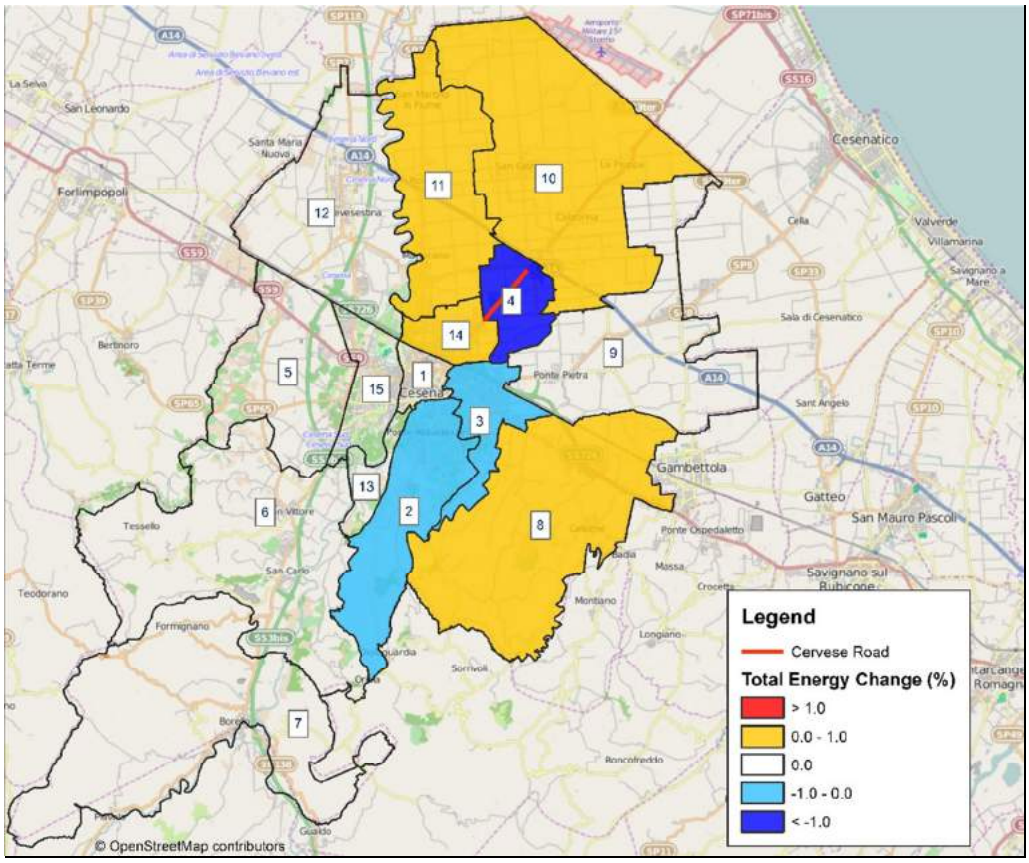


Figure 13. Change in Energy (2030)

6.4 Summary

6.4.1 The introduction of this scheme within Cesena reduces the total energy usage by approximately 3,500MJ in 2020 and 2,400MJ in 2030, though both values represent less than 1% of the total energy usage. At a more detailed zonal level, the pattern is more mixed with some zones showing an increase in energy usage due to increased distance travelled.

7. INDIVIDUAL SCENARIO TEST: DEVELOPMENT 1 – COMPARTO A

7.1 Introduction

7.1.1 This test looks at the effects of a new development, 'Comparto A', within land southeast of Cesena City Centre. The proposed development will see an extra 52 houses introduced into zone 3, with an increase in energy usage expected due to the additional journeys made from these houses.

7.1.2 This project is planned to be completed before the forecast year of 2020. The total area that is to be developed is to be approximately 65,000 sqm, of which 28,000 sqm will be residential and 37,000 sqm associated development (parking, pathways and public "green" space).

7.1.3 The location for the new infrastructure was received from Cesena Municipality. Figure 14 shows the details of the scheme.

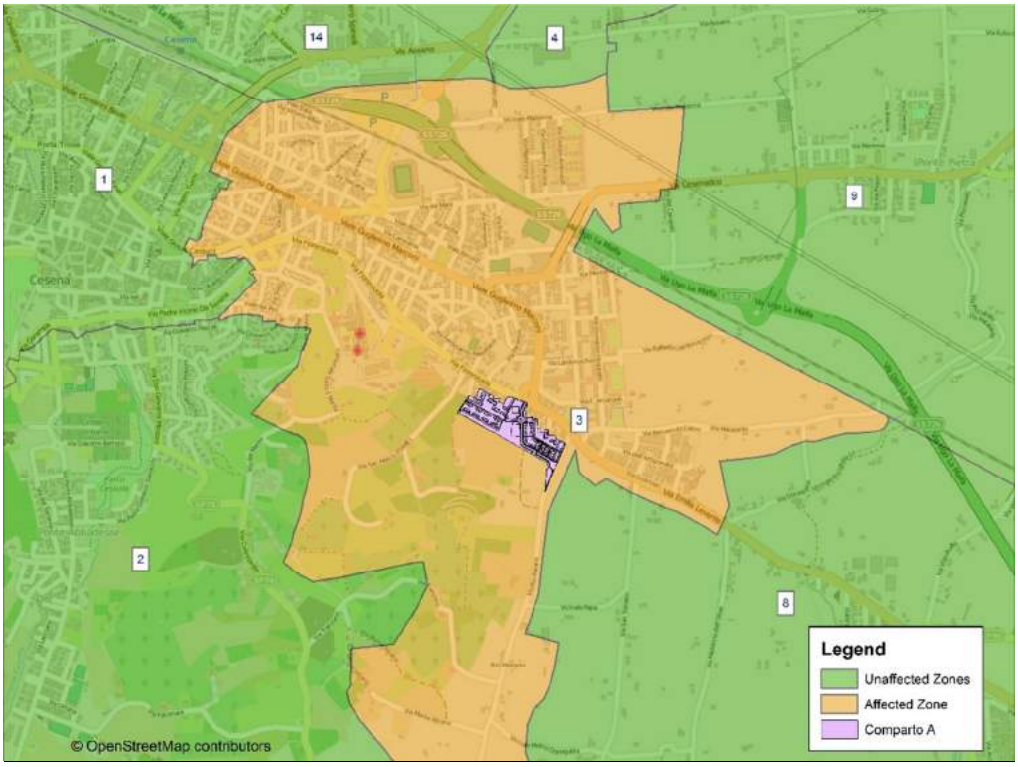


Figure 14. Scheme Details – Development A

7.1.4 To implement the scheme the following change was made to the model input:

- The additional 52 residential houses were added to the existing zone 3 houses within the Land Use input; increasing the number of houses to 2,744 in 2020 and 2,850 in 2030.

7.2 Demand Outputs

7.2.1 Table 33 to Table 35 provides an overview of changes in transport demand, average occupancy and vehicle kilometres within the modelled area for the Do Nothing and the Scenario, in both of the forecast years.

7.2.2 The scenario leads to a rise in both highway to public transport demand. This leads to a small positive increase in the average occupancies of the bus services, with a no effect on the rail services.

Table 33. Demand and Mode Shares

Zone	2020		2030	
	Do Nothing	Comparto A	Do Nothing	Comparto A
Demand By Mode				
Highway	254,104	254,522	264,917	265,331
Public Transport	28,078	28,109	33,263	33,299
Mode Share				
Highway	90%	90%	89%	89%
Public Transport	10%	10%	11%	11%
Change in Highway Demand		419		414
Change in Public Transport Demand		32		36

Table 34. Average Public Transport Occupancy

Zone	2020		2030	
	Do Nothing	Comparto A	Do Nothing	Comparto A
Total	31.8	31.8	37.6	37.6
Buses	34.0	34.0	40.0	40.0
Trains	1.8	1.8	5.3	5.3
%Change in Occupancy				
Total		100.1%		100.1%
Buses		100.1%		100.1%
Trains		100.0%		100.0%

Table 35. Vehicle Kms and Average Distance

Vehicle Type	2020		2030	
	Do Nothing	Comparto A	Do Nothing	Comparto A
Vehicle Km				
Total	2,700,344	100.1%	2,787,357	100.1%
Cars	1,713,374	100.1%	1,778,469	100.1%
Bikes	567,501	100.1%	590,118	100.1%
Goods	390,964	100.0%	390,265	100.0%
Buses	22,127	100.0%	22,127	100.0%
Trains	6,378	100.0%	6,378	100.0%
Average Distance (Km)				
Total	30.42	100.0%	30.41	100.0%
Cars	11.58	100.0%	11.55	100.0%
Bikes	11.50	100.0%	11.47	100.0%
Goods	11.07	100.0%	11.05	100.0%
Buses	24.16	100.0%	24.16	100.0%
Trains	93.80	100.0%	93.80	100.0%

7.2.3 Table 35 provides an indication as to the effect of the new development on journey distances. In both forecast years, the distances travelled by all cars and bikes increase by 0.1%.

7.3 Energy Outputs

7.3.1 Table 36 and Table 37 provide an overview of the energy usage by vehicle type and by zone for the 2020 and 2030 Do Nothing and the Scenario.

7.3.2 Overall the scenario has a small impact on the total energy usage across the city. The 52 new houses represent an increase of less than 2% of the existing stock in the zone and around 0.1% of the stock in the entire city.

7.3.3 The largest percentage impact is seen from cars and bikes, with an increase in energy usage of 0.1%. Energy usage from goods vehicles and public transport remain the same as there is no development that generates extra demand or extra service provisions.

Table 36. Energy Usage (MJ/day) by Vehicle Type

Vehicle Type	2020		2030	
	Do Nothing	Comparto A	Do Nothing	Comparto A
Energy (MJ)				
Total	6,812,852	0.1%	6,835,405	0.1%
Cars	3,789,788	0.1%	3,773,865	0.1%
Bikes	862,862	0.1%	896,666	0.1%
Goods	1,869,896	0.0%	1,874,636	0.0%
Buses	173,850	0.0%	173,782	0.0%
Trains	116,457	0.0%	116,457	0.0%
Vehicles				
Total	87,796	0.0%	92,407	0.0%
Cars	59,217	0.0%	62,650	0.0%
Bikes	19,742	0.0%	20,921	0.0%
Goods	7,853	0.0%	7,853	0.0%
Buses	916	0.0%	916	0.0%
Trains	68	0.0%	68	0.0%
Energy / Vehicle (MJ)				
Total	78	0.1%	74	0.1%
Cars	64	0.1%	60	0.1%
Bikes	44	0.1%	43	0.1%
Goods	238	0.0%	239	0.0%
Buses	190	0.0%	190	0.0%
Trains	1,713	0.0%	1,713	0.0%

7.3.4 As zone 3 is the only zone affected due to the location of the developments, it is subsequently the only zone which experiences a change in the number of trips that originate from it. As such, the resulting increase in journeys from zone 3 affect the energy usage, as seen in Table 37.

7.3.5 It is also worth noting that there is an increase in the energy usage within the External zone as a result of the development. This is due to the way the model produces external trips as a percentage of the internal trips. As a result, an increase in the number of internal trips, as, in this case, produced by zone 3, corresponds to a proportional increase in the external trips.

Table 37. Energy Usage (MJ/day) by Zone

Zone	2020		2030	
	Do Nothing	Comparto A	Do Nothing	Comparto A
Total	6,812,852	0.1%	6,835,405	0.1%
1 - Centro Urban 2	449,396	0.0%	457,728	0.0%
3 - Fiorenzuola	432,705	1.0%	429,867	1.0%
14 - Cervese Sud 2	333,288	0.0%	338,039	0.0%
15 - Oltre Savio 2	358,517	0.0%	365,401	0.0%
2 - Cesuola	193,068	0.0%	172,622	0.0%
4 - Cervese Sud 1	154,522	0.0%	156,430	0.0%
5 - Oltre Savio1	219,270	0.0%	225,097	0.0%
11 - Ravennate	288,180	0.0%	294,687	0.0%
12 - Dismano	552,762	0.0%	560,849	0.0%
13 - Centro Urban 1	52,899	0.0%	53,507	0.0%
6 - Valle Savio	376,093	0.0%	349,015	0.0%
7 - Borello	189,165	0.0%	198,278	0.0%
8 - Rubicone	431,554	0.0%	436,121	0.0%
9 - Al Mare	319,519	0.0%	319,734	0.0%
10 - Cervese Nord	396,191	0.0%	404,102	0.0%
16 - External	2,065,723	0.1%	2,073,927	0.1%

7.3.6 The increase in demand is reflected in the energy consumption for the city with increases in zone 3, and negligible changes in the city's other zones. Figure 15 shows the change in energy usage by zone compared to the 2030 Do Nothing scenario.

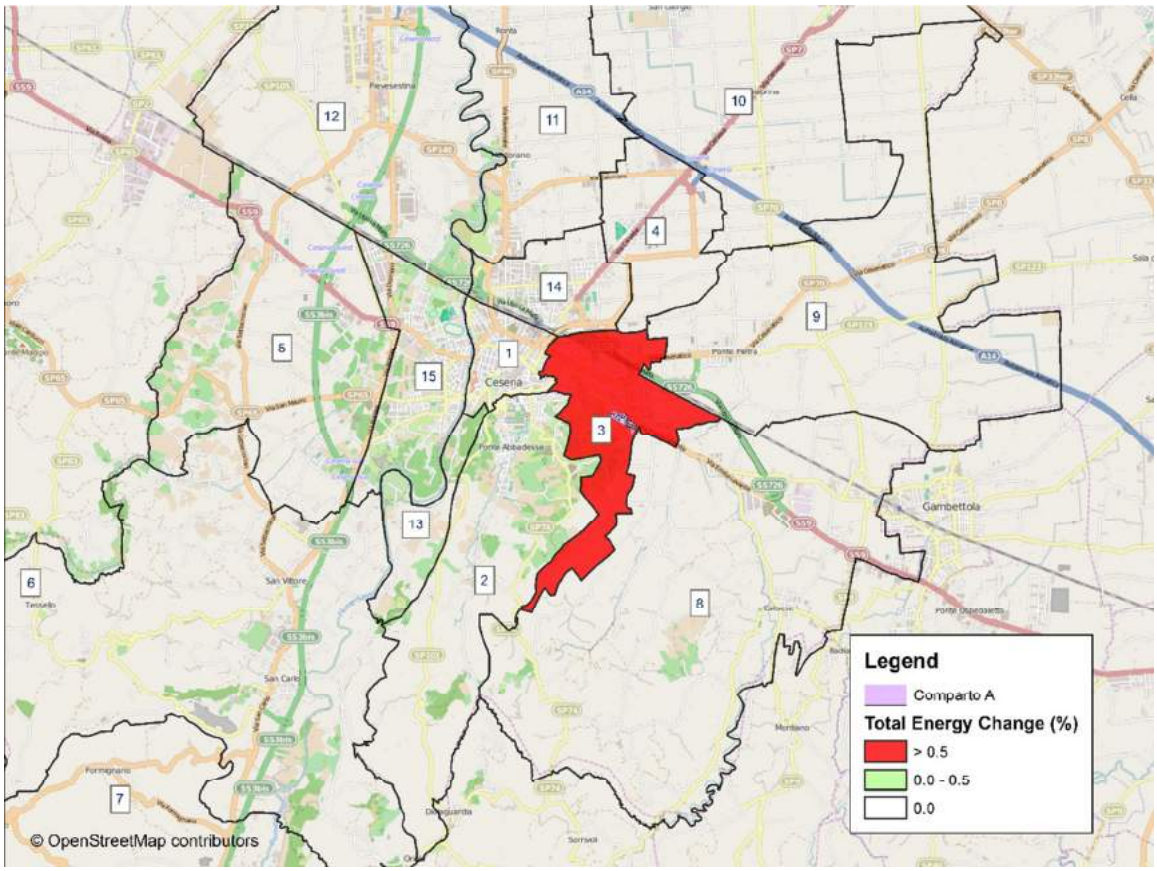


Figure 15. Change in Energy (2030)

7.4 Summary

7.4.1 The introduction of this scheme within Cesena increases the total energy usage by approximately 6,700MJ in 2020 and 6,400MJ in 2030, though both values represent less than 1% of the total energy usage.

8. INDIVIDUAL SCENARIO TEST: DEVELOPMENT 2 – COMPARTO B

8.1 Introduction

8.1.1 This test considers the effects of a new development, 'Comparto B', within land northwest of Cesena City Centre. The proposed development will see mixed residential and industrial buildings introduced into zone 14, with an increase in energy usage expected due to the additional journeys made both to and from this complex.

8.1.2 This project is planned to be completed in two stages, with a small section being finished before the forecast year of 2020, and the remaining developments constructed by 2030. The total area that is to be developed is to be approximately 212,000 sqm, of which 86,000 sqm will be mixed residential/industrial and 126,000 sqm associated development (parking, pathways and public "green" space).

8.1.3 The 86,000 sqm of land that is assigned for the mixed development will be completed as follows:

- Due to be completed by 2020:
  - 8,000 sqm for Office land use.
- Due to be completed by 2030:
  - 586 residential housing (52,000 sqm);
  - 5,000 sqm for Shopping Centre land use;
  - 9,000 sqm for Business Park land use; and
  - 12,000 sqm for Office land use.

8.1.4 The location for the new infrastructure was received from Cesena Municipality. Figure 16 shows the details of the scheme, which is concentrated just to the north of Cesena Rail Station.

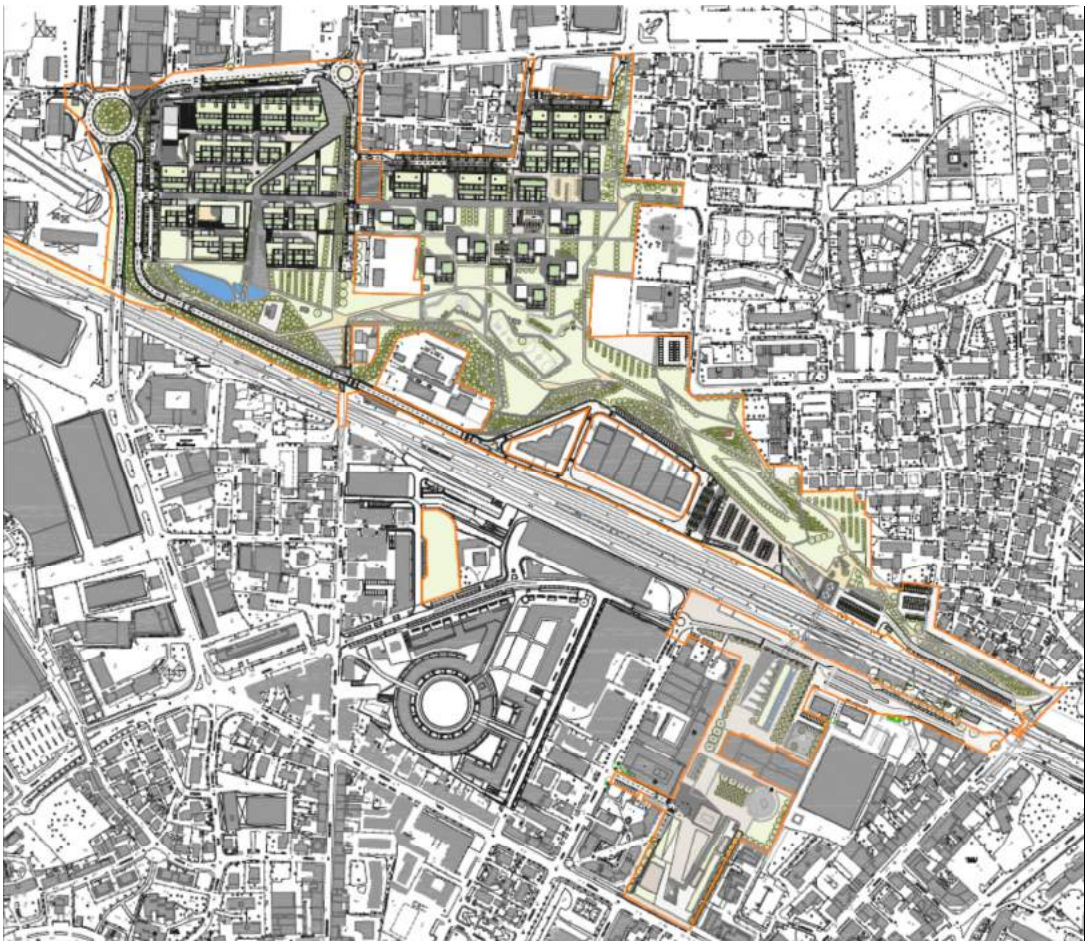


Figure 16. Scheme Details – Development B

8.1.5 To implement the scheme the following changes were made to the land use inputs for zone 14:

- The number of houses increased to 2,234 in 2030;
- Shopping Centre land used increased to 133,052 sqm in 2030;
- Office land use increased to 421,936 sqm in 2020, and 433,525 sqm in 2030; and
- Business Park land use increased to 9,325 sqm in 2030.

8.1.6 The aggregate approach adopted for the transport modelling has resulted in a number of assumptions being made which have simplified the assessment of this scheme. These include:

- A small section of the development is included on the southern side of the railway, in zone 1. Due to the lack of a detailed breakdown of the location of each type of development all of the new land use has been included within zone 14 only.

8.2 Demand Outputs

8.2.1 Table 38 to Table 40 provide an overview of changes in transport demand, average occupancy and vehicle kilometres within the modelled area for the Do Nothing and the Scenario, in both of the forecast years.

8.2.2 The scenario shows almost no change in demand in 2020 as the majority of the development is not completed. However, by 2030 there are a large number of extra trips due to the number of extra houses built. This leads to an increase in public transport average occupancies and total vehicle kilometres. However, there is a reduction in the average distance travelled by cars and bikes due to a redistribution to the new developments.

Table 38. Demand and Mode Shares

Zone	2020		2030	
	Do Nothing	Comparto B	Do Nothing	Comparto B
Demand By Mode				
Highway	254,104	254,107	264,917	269,178
Public Transport	28,078	28,074	33,263	34,075
Mode Share				
Highway	90%	90%	89%	89%
Public Transport	10%	10%	11%	11%
Change in Highway Demand		3		4,261
Change in Public Transport Demand		- 3		813

Table 39. Average Public Transport Occupancy

Zone	2020		2030	
	Do Nothing	Comparto B	Do Nothing	Comparto B
Total	31.8	31.8	37.6	38.6
Buses	34.0	34.0	40.0	41.0
Trains	1.8	1.8	5.3	5.6
%Change in Occupancy				
Total		100.0%		102.6%
Buses		100.0%		102.6%
Trains		100.0%		105.2%

Table 40. Vehicle Kms and Average Distance

Vehicle Type	2020		2030	
	Do Nothing	Comparto B	Do Nothing	Comparto B
Vehicle Km				
Total	2,700,344	100.0%	2,787,357	101.2%
Cars	1,713,374	100.0%	1,778,469	101.4%
Bikes	567,501	100.0%	590,118	101.4%
Goods	390,964	100.0%	390,265	100.3%
Buses	22,127	100.0%	22,127	100.0%
Trains	6,378	100.0%	6,378	100.0%
Average Distance (Km)				
Total	30.42	100.0%	30.41	100.0%
Cars	11.58	100.0%	11.55	99.8%
Bikes	11.50	100.0%	11.47	99.8%
Goods	11.07	100.0%	11.05	100.0%
Buses	24.16	100.0%	24.16	100.0%
Trains	93.80	100.0%	93.80	100.0%

8.2.3 Table 41 shows the demand change for private vehicles compared to the Do Nothing scenario for 2030. The cells highlighted indicate the zone-zone journeys that have been affected by the changes made in this test scenario. It can be seen that there is a significant increase in the number of trips originating from zone 14, as well as a redistribution of trips away from a number of other zones. The size and location of the new development might provide a more attractive alternative destination for some trips.

Table 41. Demand Change Table

	Private Vehicles	1 Centro Urban 2	3 Fiorenzuola	14 Cervese Sud 2	15 Oltre Savio 2	2 Cesuola	4 Cervese Sud 1	5 Oltre Savio1	11 Ravennate	12 Dismano	13 Centro Urban 1	6 Valle Savio	7 Borello	8 Rubicone	9 Al Mare	10 Cervese Nord	16 External	Total
1	Centro Urban 2	-0.1%	-0.1%	4.2%	-0.2%	0.0%	-1.4%	-0.8%	-1.2%	-1.8%	-0.7%	-1.5%	-0.1%	-1.6%	-0.8%	-1.4%	0.0%	0.0%
3	Fiorenzuola	-0.2%	-0.2%	4.8%	-0.7%	0.0%	-1.4%	-1.2%	-1.4%	-1.6%	-0.5%	-1.5%	-0.1%	-1.6%	-1.1%	-1.5%	0.0%	0.0%
14	Cervese Sud 2	19.1%	19.1%	22.7%	18.8%	19.5%	16.3%	17.4%	16.4%	15.2%	16.2%	16.0%	19.2%	15.7%	17.7%	16.1%	19.4%	19.4%
15	Oltre Savio 2	-0.1%	-0.3%	4.0%	-0.1%	0.0%	-0.6%	-0.4%	-0.5%	-0.6%	-0.9%	-0.6%	-0.3%	-0.6%	-0.4%	-0.6%	0.0%	0.0%
2	Cesuola	-0.2%	-0.3%	4.6%	-0.4%	0.0%	-0.8%	-0.7%	-0.8%	-0.8%	-0.7%	-0.8%	-0.2%	-0.8%	-0.6%	-0.8%	0.1%	0.1%
4	Cervese Sud 1	-0.2%	-0.2%	3.0%	-0.4%	0.0%	-1.6%	-1.3%	-1.7%	-2.2%	-2.2%	-1.8%	-0.2%	-1.9%	-0.7%	-1.6%	-0.1%	-0.1%
5	Oltre Savio1	-0.2%	-0.2%	3.8%	-0.1%	0.0%	-0.6%	-0.2%	-0.5%	-0.5%	-0.9%	-0.4%	-0.2%	-0.5%	-0.3%	-0.5%	0.0%	0.0%
11	Ravennate	-0.2%	-0.1%	2.3%	-0.1%	0.0%	-1.0%	-0.4%	-1.2%	-1.4%	-1.7%	-1.0%	-0.2%	-1.2%	-0.2%	-0.7%	-0.2%	-0.2%
12	Dismano	-0.2%	-0.3%	3.2%	-0.1%	0.0%	-0.5%	-0.3%	-0.5%	-0.3%	-1.4%	-0.4%	-0.3%	-0.5%	-0.2%	-0.5%	0.0%	0.0%
13	Centro Urban 1	-0.1%	-0.3%	4.4%	-0.5%	0.0%	-0.9%	-0.8%	-0.7%	-0.9%	-0.4%	-0.9%	-0.1%	-0.9%	-0.8%	-0.9%	0.0%	0.0%
6	Valle Savio	-0.1%	-0.1%	3.9%	-0.1%	0.0%	-0.5%	-0.2%	-0.5%	-0.4%	-0.5%	-0.2%	-0.1%	-0.4%	-0.2%	-0.4%	0.0%	0.0%
7	Borello	-0.1%	-0.1%	3.9%	-0.1%	0.0%	-0.5%	-0.2%	-0.5%	-0.4%	-0.5%	-0.2%	-0.1%	-0.4%	-0.2%	-0.4%	0.0%	0.0%
8	Rubicone	-0.1%	-0.1%	3.4%	-0.2%	0.0%	-0.8%	-0.5%	-0.6%	-0.7%	-0.7%	-0.7%	-0.1%	-0.4%	-0.2%	-0.6%	0.0%	0.0%
9	Al Mare	-0.2%	-0.1%	3.9%	-0.3%	0.0%	-0.9%	-0.6%	-0.9%	-1.0%	-0.9%	-0.9%	-0.1%	-0.8%	-0.2%	-0.7%	0.0%	0.0%
10	Cervese Nord	-0.3%	-0.2%	3.6%	-0.3%	0.0%	-1.0%	-0.7%	-1.0%	-1.1%	-1.5%	-1.0%	-0.2%	-1.0%	-0.3%	-0.8%	-0.1%	-0.1%
16	External	0.5%	1.6%	8.3%	0.8%	0.8%	1.6%	0.3%	0.4%	0.2%	-0.5%	-0.1%	-0.1%	-0.2%	0.2%	-0.2%	0.0%	1.6%
	Total	0.5%	1.6%	8.3%	0.8%	0.8%	1.6%	0.3%	0.4%	0.2%	-0.5%	-0.1%	-0.1%	-0.2%	0.2%	-0.2%	1.6%	1.6%

8.3 Energy Outputs

8.3.1 Table 42 and Table 43 provide an overview of the energy usage by vehicle type and by zone for the 2020 and 2030 Do Nothing and the Scenario.

8.3.2 Overall the scenario has almost no impact on the total energy usage across the city for 2020 with only redistribution to the new offices effecting the outputs. The results show a larger increase in 2030, when the entire development is complete.

8.3.3 The largest percentage impact is seen in 2030 from cars and bikes, with an increase in energy usage of 1.4% and 1.3% respectively. Energy usage from public transport services remain the same, even though there is an increase in demand, as there are no extra service provisions.

Table 42. Energy Usage (MJ/day) by Vehicle Type

Vehicle Type	2020		2030	
	Do Nothing	Comparto B	Do Nothing	Comparto B
Energy (MJ)				
Total	6,812,852	0.0%	6,835,405	1.0%
Cars	3,789,788	0.0%	3,773,865	1.4%
Bikes	862,862	0.0%	896,666	1.3%
Goods	1,869,896	0.0%	1,874,636	0.3%
Buses	173,850	0.0%	173,782	0.0%
Trains	116,457	0.0%	116,457	0.0%
Vehicles				
Total	87,796	0.0%	92,407	0.1%
Cars	59,217	0.0%	62,650	0.0%
Bikes	19,742	0.0%	20,921	0.0%
Goods	7,853	0.0%	7,853	0.4%
Buses	916	0.0%	916	0.0%
Trains	68	0.0%	68	0.0%
Energy / Vehicle (MJ)				
Total	78	0.0%	74	0.9%
Cars	64	0.0%	60	1.3%
Bikes	44	0.0%	43	1.3%
Goods	238	0.0%	239	-0.1%
Buses	190	0.0%	190	0.0%
Trains	1,713	0.0%	1,713	0.0%

8.3.4 Zone 14 is the main zone directly affected due to the location of the developments, it is subsequently the only zone which experiences a change in the number of trips that originate from it. The increase in journeys from zone 14 results in a large increase in the energy usage for that zone, as seen in Table 37. There are also a number of minor energy use reductions within other zones that occur following the redistribution of trips to the new development.

Table 43. Energy Usage (MJ/day) by Zone

Zone	2020		2030	
	Do Nothing	Comparto B	Do Nothing	Comparto B
Total	6,812,852	0.0%	6,835,405	1.0%
1 - Centro Urban 2	449,396	0.0%	457,728	0.0%
3 - Fiorenzuola	432,705	0.0%	429,867	0.0%
14 - Cervese Sud 2	333,288	0.0%	338,039	13.3%
15 - Oltre Savio 2	358,517	0.0%	365,401	0.0%
2 - Cesuola	193,068	0.0%	172,622	0.1%
4 - Cervese Sud 1	154,522	0.0%	156,430	-0.2%
5 - Oltre Savio1	219,270	0.0%	225,097	0.0%
11 - Ravennate	288,180	0.0%	294,687	-0.2%
12 - Dismano	552,762	0.0%	560,849	0.0%
13 - Centro Urban 1	52,899	0.0%	53,507	0.1%
6 - Valle Savio	376,093	0.0%	349,015	0.0%
7 - Borello	189,165	0.0%	198,278	0.1%
8 - Rubicone	431,554	0.0%	436,121	0.0%
9 - Al Mare	319,519	0.0%	319,734	0.0%
10 - Cervese Nord	396,191	0.0%	404,102	-0.1%
16 - External	2,065,723	0.0%	2,073,927	1.2%

8.3.5 The increase in demand is reflected in the energy consumption for the city with increases experienced in zone 14, small decreases in zones 4 and 14. Figure 15 shows the change in energy usage by zone compared to the 2030 Do Nothing scenario. It can be seen that areas to the North and East of the development show a small reduction in energy usage, whereas areas to the South and West see increases in energy usage, due to redistribution of trips changing distances travelled.

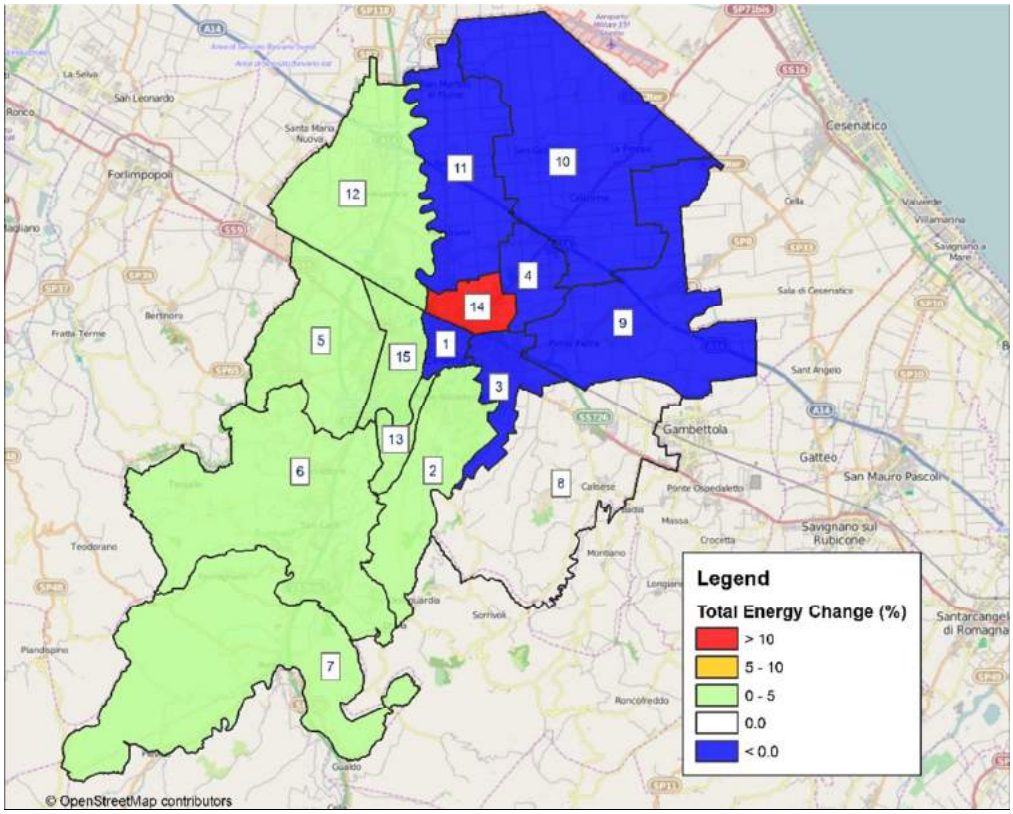


Figure 17. Change in Energy (2030)

8.4 Summary

8.4.1 The introduction of this scheme within Cesena increases the total energy usage by approximately 69,000MJ in 2030, which represents 1% of the total energy usage.

9. INDIVIDUAL SCENARIO TEST: DEVELOPMENT 3 – COMPARTO C

9.1 Introduction

9.1.1 This test looks at the effects of a new development, 'Comparto C', within land northwest of Cesena City Centre. The proposed development will see an extra 20 houses introduced into zone 15.

9.1.2 This project is planned to be completed before the forecast year of 2020. The total area that is to be developed is to be approximately 85,000 sqm, of which 12,000 sqm will be residential and 73,000 sqm associated development (parking, pathways and public "green" space).

9.1.3 The location for the new infrastructure was received from Cesena Municipality. Figure 18 shows the details of the scheme, which is located on the southern side of the railway line close to Via Ugo la Malfa.

Figure 18. Scheme Details – Development C

9.1.4 To implement the scheme the following change was made to the model input:

- The additional 20 residential houses were added to the existing houses in zone 15; increasing the number of houses to 2,293 in 2020 and 2,476 in 2030.

9.2 Demand Outputs

9.2.1 Table 44 to Table 46 provide an overview of changes in transport demand, average occupancy and vehicle kilometres within the modelled area for the Do Nothing and the Scenario, in both of the forecast years.

9.2.2 The scenario leads to a rise in both highway to public transport demand due to the extra trips from the new houses. However, the number of extra journeys is too small to affect the total modelled vehicle kilometres.

Table 44. Demand and Mode Shares

Zone	2020		2030	
	Do Nothing	Comparto C	Do Nothing	Comparto C
Demand By Mode				
Highway	254,104	254,258	264,917	265,069
Public Transport	28,078	28,096	33,263	33,284
Mode Share				
Highway	90%	90%	89%	89%
Public Transport	10%	10%	11%	11%
Change in Highway Demand		154		152
Change in Public Transport Demand		19		22

Table 45. Average Public Transport Occupancy

Zone	2020		2030	
	Do Nothing	Comparto C	Do Nothing	Comparto C
Total	31.8	31.8	37.6	37.6
Buses	34.0	34.0	40.0	40.0
Trains	1.8	1.8	5.3	5.3
%Change in Occupancy				
Total		100.1%		100.1%
Buses		100.1%		100.1%
Trains		100.0%		100.0%

Table 46. Vehicle Kms and Average Distance

Vehicle Type	2020		2030	
	Do Nothing	Comparto C	Do Nothing	Comparto C
Vehicle Km				
Total	2,700,344	100.0%	2,787,357	100.0%
Cars	1,713,374	100.0%	1,778,469	100.0%
Bikes	567,501	100.1%	590,118	100.0%
Goods	390,964	100.0%	390,265	100.0%
Buses	22,127	100.0%	22,127	100.0%
Trains	6,378	100.0%	6,378	100.0%
Average Distance (Km)				
Total	30.42	100.0%	30.41	100.0%
Cars	11.58	100.0%	11.55	100.0%
Bikes	11.50	100.0%	11.47	100.0%
Goods	11.07	100.0%	11.05	100.0%
Buses	24.16	100.0%	24.16	100.0%
Trains	93.80	100.0%	93.80	100.0%

9.3 Energy Outputs

9.3.1 Table 47 and Table 48 provide an overview of the energy usage by vehicle type and by zone for the 2020 and 2030 Do Nothing and the Scenario, respectively.

9.3.2 Overall the scenario has a small impact on the total energy usage across the city, with all changes being less than 0.1%. This is expected given that the addition of 20 houses represents an increase in stock of less than 0.1% across the city.

Table 47. Energy Usage (MJ/day) by Vehicle Type

Vehicle Type	2020		2030	
	Do Nothing	Comparto C	Do Nothing	Comparto C
Energy (MJ)				
Total	6,812,852	0.0%	6,835,405	0.0%
Cars	3,789,788	0.0%	3,773,865	0.0%
Bikes	862,862	0.1%	896,666	0.0%
Goods	1,869,896	0.0%	1,874,636	0.0%
Buses	173,850	0.0%	173,782	0.0%
Trains	116,457	0.0%	116,457	0.0%
Vehicles				
Total	87,796	0.0%	92,407	0.0%
Cars	59,217	0.0%	62,650	0.0%
Bikes	19,742	0.0%	20,921	0.0%
Goods	7,853	0.0%	7,853	0.0%
Buses	916	0.0%	916	0.0%
Trains	68	0.0%	68	0.0%
Energy / Vehicle (MJ)				
Total	78	0.0%	74	0.0%
Cars	64	0.1%	60	0.0%
Bikes	44	0.1%	43	0.0%
Goods	238	0.0%	239	0.0%
Buses	190	0.0%	190	0.0%
Trains	1,713	0.0%	1,713	0.0%

9.3.3 As zone 15 is the only zone affected due to the location of the developments, it is subsequently the only zone which experiences a change in the number of trips that originate from it. As such, the resulting increase in journeys from zone 15 affect the energy usage, as seen in Table 48.

9.3.4 It is also worth noting that there is an increase in the energy usage within the External zone as a result of the development. This is due to the way the model produces external trips as a percentage of the internal trips. As a result, an increase in the number of internal trips, as, in this case, produced by zone 15, corresponds to a proportional increase in the external trips.

Table 48. Energy Usage (MJ/day) by Zone

Zone	2020		2030	
	Do Nothing	Comparto C	Do Nothing	Comparto C
Total	6,812,852	0.0%	6,835,405	0.0%
1 - Centro Urban 2	449,396	0.0%	457,728	0.0%
3 - Fiorenzuola	432,705	0.0%	429,867	0.0%
14 - Cervese Sud 2	333,288	0.0%	338,039	0.0%
15 - Oltre Savio 2	358,517	0.4%	365,401	0.4%
2 - Cesuola	193,068	0.0%	172,622	0.0%
4 - Cervese Sud 1	154,522	0.0%	156,430	0.0%
5 - Oltre Savio1	219,270	0.0%	225,097	0.0%
11 - Ravennate	288,180	0.0%	294,687	0.0%
12 - Dismano	552,762	0.0%	560,849	0.0%
13 - Centro Urban 1	52,899	0.0%	53,507	0.0%
6 - Valle Savio	376,093	0.0%	349,015	0.0%
7 - Borello	189,165	0.0%	198,278	0.0%
8 - Rubicone	431,554	0.0%	436,121	0.0%
9 - Al Mare	319,519	0.0%	319,734	0.0%
10 - Cervese Nord	396,191	0.0%	404,102	0.0%
16 - External	2,065,723	0.0%	2,073,927	0.0%

9.3.5 The increase in demand is reflected in the energy consumption for the city with increases experienced in zone 15, and negligible changes in the city's other zones. Figure 19 shows the change in energy usage by zone compared to the 2030 Do Nothing scenario.

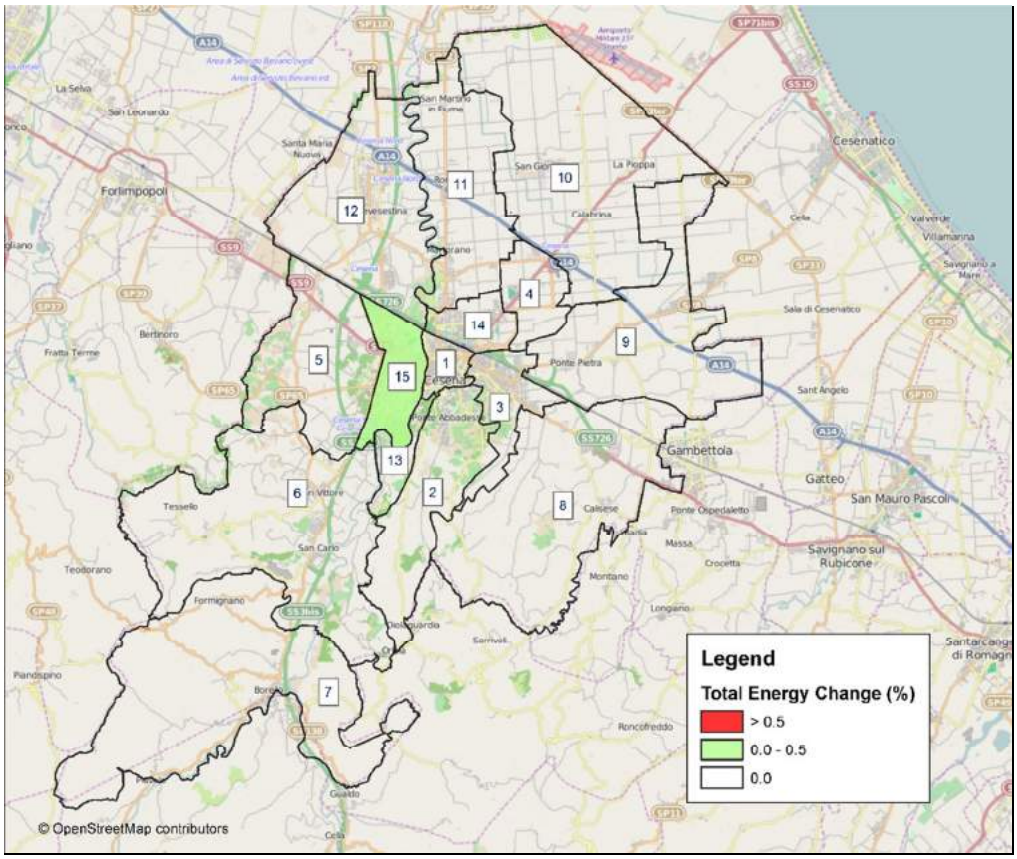


Figure 19. Change in Energy (2030)

9.4 Summary

9.4.1 The introduction of this scheme within Cesena increases the total energy usage by approximately 2,300MJ in 2020 and 2,150MJ in 2030, though both values represent less than 1% of the total energy usage.

10. INDIVIDUAL SCENARIO TEST: DEVELOPMENT 4 – COMPARTO A + B + C

10.1 Introduction

10.1.1 This test looks at the effects on Cesena if all three 'Comparto' developments are introduced. The details of each separate development are given within their individual test review, however below is an overview of the additions to the Land Use input for this test:

- Due to be completed by 2020:
  - 72 residential houses; and
  - 8,000 sqm for Office land use.
- Due to be completed by 2030:
  - 586 residential houses;
  - 5,000 sqm for Shopping Centre land use;
  - 9,000 sqm for Business Park land use; and
  - 12,000 sqm for Office land use.

10.1.2 The locations of the new developments were received from Cesena Municipality. Figure 20 shows the locations of each scheme in relation to Cesena (Comparto A: Red, Comparto B: Green, and Comparto C: Orange).

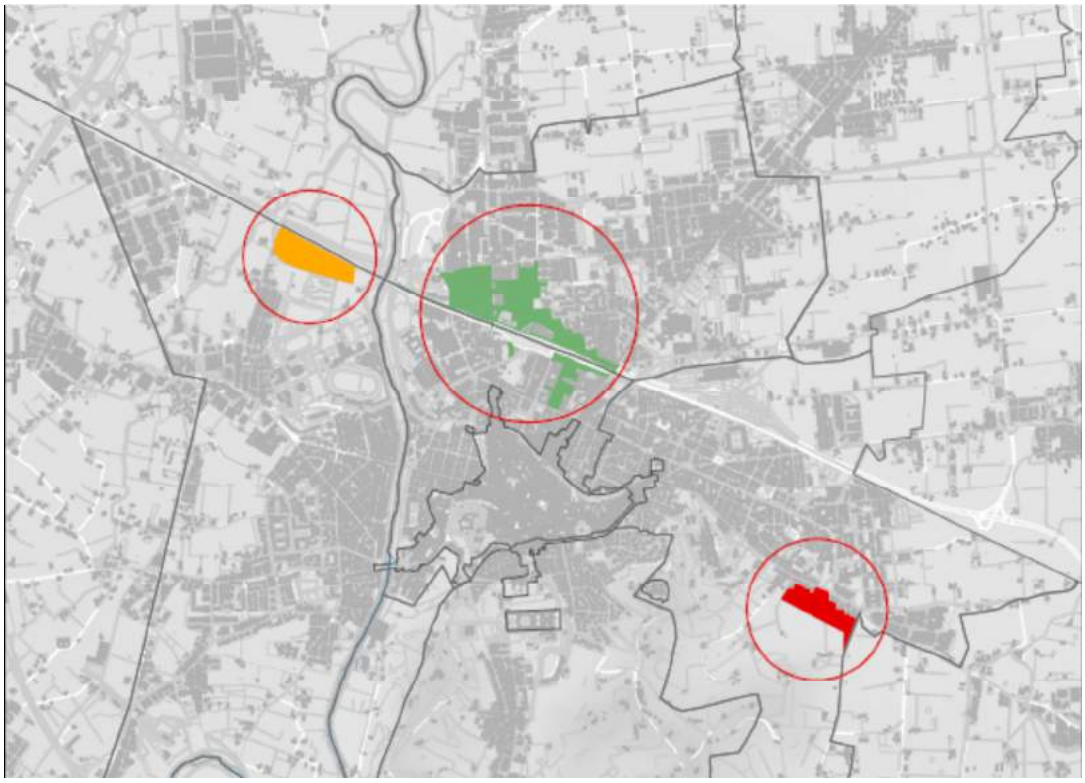


Figure 20. Scheme Details – Development A + B + C

10.1.3 For details on the changes made to the model see the section relating to the individual development tests. These are:

- Comparto A – section 7.1.4;
- Comparto B – section 8.1.5; and
- Comparto C – section 9.1.4.

10.1.4 The limitations in the modelling methodology for this test is are same as that described in section 8.1.6 for the 'Comparto B' test scenario.

10.2 Demand Outputs

10.2.1 Table 49 to Table 51 provide an overview of changes in transport demand, average occupancy and vehicle kilometres within the modelled area for the Do Nothing and the Scenario, in both of the forecast years.

10.2.2 The scenario leads to an increase in demand for car and public transport in 2020, before resulting in a more substantial rise in both highway to public transport demand in 2030. This leads to an increase in the average occupancies of all public transport services in 2020, with an even greater effect in 2030.

Table 49. Demand and Mode Shares

Zone	2020		2030	
	Do Nothing	Comparto A + B +C	Do Nothing	Comparto A + B +C
Demand By Mode				
Highway	254,104	254,680	264,917	268,943
Public Transport	28,078	28,125	33,263	34,501
Mode Share				
Highway	90%	90%	89%	89%
Public Transport	10%	10%	11%	11%
Change in Highway Demand		576		4,025
Change in Public Transport Demand		47		1,239

Table 50. Average Public Transport Occupancy

Zone	2020		2030	
	Do Nothing	Comparto A + B +C	Do Nothing	Comparto A + B +C
Total	31.8	31.8	37.6	39.0
Buses	34.0	34.0	40.0	41.5
Trains	1.8	1.8	5.3	5.6
%Change in Occupancy				
Total		100.2%		103.7%
Buses		100.2%		103.7%
Trains		100.0%		105.5%

Table 51. Vehicle Kms and Average Distance

Vehicle Type	2020		2030	
	Do Nothing	Comparto A + B +C	Do Nothing	Comparto A + B +C
Vehicle Km				
Total	2,700,344	100.2%	2,787,357	101.1%
Cars	1,713,374	100.2%	1,778,469	101.3%
Bikes	567,501	100.2%	590,118	101.3%
Goods	390,964	100.0%	390,265	100.3%
Buses	22,127	100.0%	22,127	100.0%
Trains	6,378	100.0%	6,378	100.0%
Average Distance (Km)				
Total	30.42	100.0%	30.41	100.0%
Cars	11.58	100.0%	11.55	99.7%
Bikes	11.50	100.0%	11.47	99.8%
Goods	11.07	100.0%	11.05	100.0%
Buses	24.16	100.0%	24.16	100.0%
Trains	93.80	100.0%	93.80	100.0%

10.2.3 Total vehicle kilometres increase slightly due to the increase in demand. However, the average distance travelled reduces slightly due to redistribution to the new Comparto B development.

10.2.4 Table 52 shows the demand change for private vehicles compared to the Do Nothing scenario for 2030. It can be seen that there is a significant increase in the number of trips originating from zone 14, as well as a redistribution of trips away from a number of other zones. The size and location of the Comparto B development drives many of the changes seen in the increase, decrease and redistribution of the demand.

Table 52. Demand Change Table

		1	3	14	15	2	4	5	11	12	13	6	7	8	9	10	16	
Private Vehicles		Centro Urban 2	Fiorenzuola	Cervese Sud 2	Oltre Savio 2	Cesuola	Cervese Sud 1	Oltre Savio1	Ravennate	Dismano	Centro Urban 1	Valle Savio	Borello	Rubicone	Al Mare	Cervese Nord	External	Total
1	Centro Urban 2	1.0%	-0.2%	1.0%	-0.5%	0.0%	-3.0%	-1.8%	-2.4%	-5.0%	-0.7%	-4.0%	-0.1%	-4.2%	-2.3%	-3.7%	-0.1%	-0.1%
3	Fiorenzuola	0.2%	-0.1%	2.3%	-0.7%	0.1%	-1.4%	-1.2%	-1.3%	-1.6%	-0.4%	-1.4%	0.0%	-1.5%	-1.1%	-1.5%	-0.2%	-0.2%
14	Cervese Sud 2	19.3%	19.2%	20.7%	18.9%	19.5%	17.8%	18.1%	17.5%	17.9%	16.2%	17.7%	19.2%	17.8%	18.7%	18.0%	19.3%	19.3%
15	Oltre Savio 2	0.4%	0.1%	3.1%	0.3%	0.4%	-0.5%	-0.3%	-0.3%	-1.1%	-0.5%	-0.8%	0.1%	-0.8%	-0.4%	-0.7%	0.3%	0.3%
2	Cesuola	0.2%	-0.4%	2.2%	-0.9%	0.0%	-2.2%	-1.9%	-2.0%	-4.1%	-0.7%	-3.6%	-0.2%	-3.7%	-2.8%	-3.2%	-1.1%	-1.1%
4	Cervese Sud 1	-0.1%	-0.2%	1.5%	-0.4%	0.0%	-1.0%	-1.1%	-1.3%	-1.2%	-2.2%	-1.3%	-0.2%	-1.2%	-0.4%	-0.9%	-0.2%	-0.2%
5	Oltre Savio1	-0.1%	-0.2%	2.9%	-0.1%	0.0%	-0.6%	-0.3%	-0.6%	-0.7%	-0.9%	-0.6%	-0.2%	-0.7%	-0.3%	-0.6%	-0.1%	-0.1%
11	Ravennate	-0.1%	-0.1%	1.7%	-0.1%	0.0%	-0.9%	-0.3%	-1.0%	-0.9%	-1.7%	-0.8%	-0.2%	-0.9%	-0.2%	-0.6%	-0.1%	-0.1%
12	Dismano	-0.2%	-0.3%	2.8%	-0.1%	0.0%	-0.5%	-0.3%	-0.5%	-0.3%	-1.4%	-0.4%	-0.3%	-0.5%	-0.2%	-0.5%	0.0%	0.0%
13	Centro Urban 1	0.1%	-0.4%	2.1%	-1.3%	0.0%	-2.2%	-2.2%	-1.8%	-4.1%	-0.4%	-4.1%	-0.1%	-3.4%	-3.1%	-3.2%	-1.2%	-1.2%
6	Valle Savio	0.0%	-0.1%	3.2%	-0.1%	0.0%	-0.6%	-0.2%	-0.5%	-0.5%	-0.5%	-0.3%	-0.1%	-0.5%	-0.2%	-0.4%	0.0%	0.0%
7	Borello	0.1%	-0.1%	3.2%	-0.1%	0.0%	-0.6%	-0.3%	-0.5%	-0.7%	-0.5%	-0.4%	-0.1%	-0.6%	-0.2%	-0.5%	-0.1%	-0.1%
8	Rubicone	0.0%	-0.1%	2.8%	-0.2%	0.0%	-0.7%	-0.5%	-0.6%	-0.6%	-0.7%	-0.6%	-0.1%	-0.3%	-0.1%	-0.5%	0.0%	0.0%
9	Al Mare	0.0%	-0.1%	2.6%	-0.3%	0.0%	-0.9%	-0.6%	-0.9%	-1.0%	-0.9%	-0.9%	-0.1%	-0.8%	-0.2%	-0.7%	-0.1%	-0.1%
10	Cervese Nord	0.0%	-0.2%	2.4%	-0.3%	0.0%	-0.8%	-0.6%	-0.8%	-0.7%	-1.5%	-0.8%	-0.2%	-0.7%	-0.2%	-0.5%	-0.1%	-0.1%
16	External	1.2%	1.6%	6.7%	0.9%	0.9%	1.9%	0.2%	0.4%	0.1%	-0.4%	-0.5%	-0.1%	-0.2%	0.2%	0.0%	0.0%	1.5%
	Total	1.2%	1.6%	6.7%	0.9%	0.9%	1.9%	0.2%	0.4%	0.1%	-0.4%	-0.5%	-0.1%	-0.2%	0.2%	0.0%	1.5%	1.5%

10.3 Energy Outputs

10.3.1 Table 53 and Table 54 provide an overview of the energy usage by vehicle type and by zone for the 2020 and 2030 Do Nothing and the Scenario, respectively.

10.3.2 Overall the scenario has little impact on the total energy usage across the city for 2020, but results in a more significant overall increase in 2030. The largest percentage impact is seen in 2030 from cars and bikes, with an increase in energy usage of 1.2%. Energy usage from public transport services remain the same as there is no extra service provisions.

Table 53. Energy Usage (MJ/day) by Vehicle Type

Vehicle Type	2020		2030	
	Do Nothing	Comparto A + B +C	Do Nothing	Comparto A + B +C
Energy (MJ)				
Total	6,812,852	0.1%	6,835,405	0.9%
Cars	3,789,788	0.2%	3,773,865	1.2%
Bikes	862,862	0.2%	896,666	1.2%
Goods	1,869,896	0.0%	1,874,636	0.3%
Buses	173,850	0.0%	173,782	0.0%
Trains	116,457	0.0%	116,457	0.0%
Vehicles				
Total	87,796	0.0%	92,407	0.0%
Cars	59,217	0.0%	62,650	0.0%
Bikes	19,742	0.0%	20,921	0.0%
Goods	7,853	0.0%	7,853	0.4%
Buses	916	0.0%	916	0.0%
Trains	68	0.0%	68	0.0%
Energy / Vehicle (MJ)				
Total	78	0.1%	74	0.9%
Cars	64	0.2%	60	1.2%
Bikes	44	0.2%	43	1.2%
Goods	238	0.0%	239	-0.1%
Buses	190	0.0%	190	0.0%
Trains	1,713	0.0%	1,713	0.0%

10.3.3 Zones 3, 14 and 15 are directly affected due to the location of the developments and they show an increase in demand. However, the redistributive effects of the development in zone 14 leads to a net reduction in the energy usage from zone 3 as demand from this zone can now make shorter journeys. Table 54 also shows there are a number of other zones that benefit from the redistribution allowing for shorter journeys.

10.3.4 It is also worth noting that there is an increase in the energy usage within the External zone as a result of the developments. This is due to the way the model produces external trips as a percentage of the internal trips. As a result, an increase in the number of internal trips corresponds to a proportional increase in the external trips.

Table 54. Energy Usage (MJ/day) by Zone

Zone	2020		2030	
	Do Nothing	Comparto A + B +C	Do Nothing	Comparto A + B +C
Total	6,812,852	0.1%	6,835,405	0.9%
1 - Centro Urban 2	449,396	0.0%	457,728	0.0%
3 - Fiorenzuola	432,705	1.0%	429,867	-0.2%
14 - Cervese Sud 2	333,288	0.0%	338,039	13.2%
15 - Oltre Savio 2	358,517	0.4%	365,401	0.2%
2 - Cesuola	193,068	0.0%	172,622	-1.3%
4 - Cervese Sud 1	154,522	0.0%	156,430	-0.2%
5 - Oltre Savio1	219,270	0.0%	225,097	-0.1%
11 - Ravennate	288,180	0.0%	294,687	-0.1%
12 - Dismano	552,762	0.0%	560,849	0.0%
13 - Centro Urban 1	52,899	0.0%	53,507	-0.3%
6 - Valle Savio	376,093	0.0%	349,015	0.0%
7 - Borello	189,165	0.0%	198,278	0.0%
8 - Rubicone	431,554	0.0%	436,121	0.0%
9 - Al Mare	319,519	0.0%	319,734	-0.1%
10 - Cervese Nord	396,191	0.0%	404,102	-0.1%
16 - External	2,065,723	0.2%	2,073,927	1.1%

10.3.5 The increase in demand is reflected in the energy consumption for the city with increases experienced in zones 14 and 15, small decreases in zone 2, and negligible changes in the city's other zones. Figure 21 shows the change in energy usage by zone compared to the 2030 Do Nothing scenario.

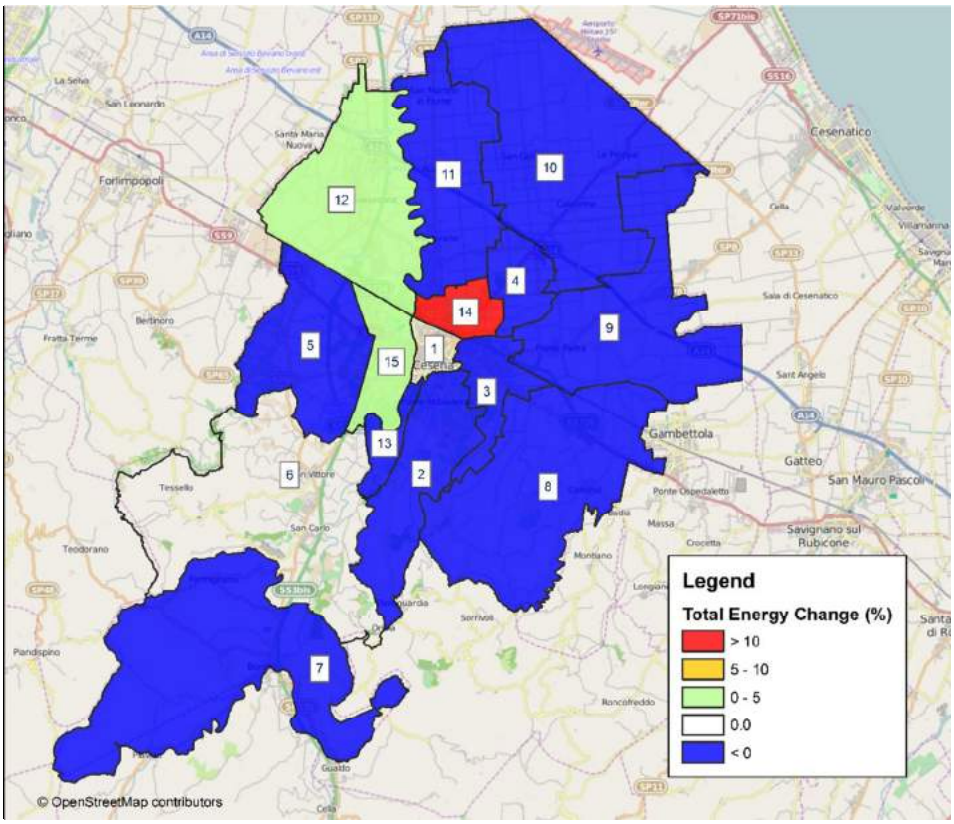


Figure 21. Change in Energy (2030)

10.4 Summary

10.4.1 The introduction of this scheme within Cesena increases the total energy usage by approximately 8,700MJ in 2020 and 63,200MJ in 2030, though the 2020 value represents less than 1% of the total energy usage, with 2030 representing 1.0%