Carbon footprint business as usual and scenario projections (WP5 Task 5.2.8)

Work realized under the project CLAiR-CITY - Citizen Led Air pollution Reduction in Cities

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1 FINALITY OF THE REPORT

This document reports about the WP5 Task 5.2.4 Carbon Footprint module activities related to BAU and scenario definition.

The module integrates in the overall model the Carbon Footprint evaluation. Another report[1] describes methodology and results to integrate in the overall model the specific module to compute the carbon footprint of the cities and in particular:

- Reviews existing carbon footprinting methodologies
- Establishes best methodology and relevant emission factors.
- Applies footprinting methodologies to six pilot cities based on activity data from previous tasks.

In this report methodology and results are reported for:

- ***BAU*** "business as usual": future situation without any policy interventions beyond what is decided upon at this point with 5-time horizons: 2020, 2025, 2030, 2035 and 2050;
- ***Scenario***: added policy interventions to the BAU, same time horizon as results from Stakeholder Dialogue Workshop;
- ***Unified Policy Scenario***: final scenario as a results of Policy Workshop.

The current edition contains the results for Bristol and Amsterdam BAU and scenarios case studies, future editions/ revision will include the results for the others city/regions included in the project.

2 FUTURE CARBON FOOTPRINT PROJECTIONS

2.1 Future Carbon footprint modelling tool set

Carbon footprint for future year (k) related to a specific activity (i), in a single territorial unit (e. g. LSOA, Buurt, …) (u), is estimated starting from the base year (0) carbon footprint and using specific projections factors (drivers) of activity level (a_{ikn}), due to activity measures n, specific drivers for emission factors (f_{ikm}) due to emissions control measures m, specific projections factors (drivers) of activity level related to a selected territorial unit (a^d_{ikun}) due to activity measures n and specific drivers for emission factor (f^d_{ikum}) due to emissions control measures m in the territorial unit u:

$$C^d_{iku} = C^d_{iu0}\ \Pi_m\Pi_n\ a_{ikn} f_{ikm}\ a^d_{ikun} f^d_{ikum}$$

[1] Techne Consulting, Carbon footprint methodologies & estimation for the pilot cities (WP5 Task 5.2.8), ECH.MA.15 FR2

2.2 Data input for projection model

At European level the reference scenario for Carbon footprint reductions is the EU 2050 low-carbon economy strategy (LCES)[2]. EU low-carbon economy roadmap[3] suggests that:

- By 2050, the EU should cut greenhouse gas emissions to 80% below 1990 levels
- Milestones to achieve this are 40% emissions cuts by 2030 and 60% by 2040.

In Table 1 Greenhouses Gases reductions by sector compared to 1990 are reported[4].

Table 1 – Greenhouses Gases reductions by sector compared to 1990

	2005	2030	2050
Power (CO_2)	-7%	-54 to -68%	-93 to -99%
Industry (CO_2)	-20%	-34 to -40%	-83 to -87%
Transport (incl. CO2 aviation, excl. maritime)	+30%	+20 to -9%	-54 to -67%
Residential and services (CO_2)	-12%	-37 to -53%	-88 to-91%
Agriculture (non-CO_2)	-20%	-36 to -37%	-42 to -49%
Other non-CO_2 emissions	-30%	-72 to -73%	-70 to -78%
Total	**-7%**	**-40 to -44%**	**-79 to -82%**

Emissions projections at city level for ClairCity will take into consideration national emissions measures and supplementary city level emissions measures.

We introduce the following definitions:

- ***Baseline***: the current situation (i.e. 2015 data), based on emission inventories and available data;
- ***BAU*** "business as usual": future situation without any policy interventions beyond what is decided upon at this point with 3-time horizons: 2025, 2035 and 2050; this future projection include:
  - the national measures defined in the 'with measures' (adopted measures) projection in the frame of energy/GHG strategies;
  - all the other measures *already adopted* at city level by local planning actions;
- ***Scenario***: added policy interventions to the BAU, same time horizon; this future projection includes:
  - the national measures defined in the 'with additional measures' (planned measures) projection in the frame of NECD;
  - all the other planned measures to be defined at city level by local planning actions.

3 BRISTOL

[2] EU 2050 low-carbon economy
[3] Total greenhouse gas emission trends and projections, 24 Nov 2017
[4] European Commission, A Roadmap for moving to a competitive low carbon economy in 2050, COM(2011) 112 final

3.1 Business As Usual projections

Business as Usual (BAU) scenario takes into consideration national and city level measures already defined/decided.

As a general input to the projection model, results from IRCI and Traffic models have been assumed for fuel consumptions.

For electricity emission factors an additional driver was introduced to take into consideration the evolution of carbon footprint from electricity generation. The driver is defined using official UK projection data up to 2035[5]. For 2050 we assume near-zero emissions for electricity according to the UK Committee on Climate Change that has recently fixed as a policy requirement that the power sector should be close to zero-carbon by 2030[6]. In the same document are also hypotheses of near-zero emissions for residential and domestic transport. However, some more cautious consideration has been recently reported[7], so in the projections the near-zero emissions hypothesis has been inserted only for the power sector.

In Table 2 Carbon Footprint by sector is reported for Bristol BAU expressed as CO_2, CO_2 equivalent and CO_2 equivalent on Life Cycle. In Table 3 CO_2 equivalent on Life Cycle reductions on 2015 are reported.

Table 2 – Bristol BAU Carbon Footprint by Sector (Gg)

Year	2015	2020	2025	2030	2035	2050
Carbon dioxide (CO_2)						
Residential	767,4	556,6	519,6	537,9	533,2	479,8
Services	364,8	199,8	146,6	141,9	115,5	65,8
Transport	339,6	336,6	331,1	308,2	276,3	135,3
Industry	409,4	232,2	173,2	151,9	130,3	97,7
Total	***1881,2***	***1325,1***	***1170,5***	***1139,9***	***1055,3***	***778,7***
Carbon dioxide equivalent (CO_{2eq})						
Industry	771,5	559,9	522,8	541,0	536,1	482,6
Services	365,9	200,3	146,9	142,2	115,7	65,8
Transport	340,5	337,5	332,0	309,0	277,1	135,7
Residential	410,5	232,7	173,6	152,2	130,5	97,8
Total	***1888,3***	***1330,4***	***1175,3***	***1144,5***	***1059,4***	***781,9***
Carbon dioxide equivalent on life cycle (CO_{2eq})						
Residential	901,1	659,7	618,5	640,9	637,2	576,6
Services	420,3	231,0	170,1	165,0	134,9	78,0
Transport	407,4	403,5	396,7	370,6	334,3	168,2
Industry	472,2	269,3	201,5	176,8	152,2	115,0
Total	***2201,1***	***1563,6***	***1386,8***	***1353,4***	***1258,7***	***937,9***

Table 3 – Bristol BAU Carbon Footprint by Sector: index (2015=100)

[5] UK Department for Business, Energy & Industrial Strategy, Projections of greenhouse gas emissions and energy demand from 2016 to 2035, Updated energy and emissions projections: 2016, March 2017
[6] Committee on Climate Change, UK climate action following the Paris Agreement, October 2016
[7] Committee on Climate Change, Reducing UK emissions, 2018 Progress Report to Parliament, June 2018

Year	2015	2020	2025	2030	2035	2050
Carbon dioxide equivalent on life cycle (CO_{2eq})						
Residential	100	73	68	70	69	63
Services	100	55	40	39	32	18
Transport	100	99	97	91	81	40
Industry	100	57	42	37	32	24
Total	***100***	***70***	***62***	***61***	***56***	***41***

Carbon Footprint, expressed as CO_2 equivalent on Life Cycle, is reported in Figure 1 by sector and in Figure 2 by fuel. The graphs highlight the largely dominant contribution of the residential and service sectors as described above, from the point of view of energy carriers, natural gas and electricity.

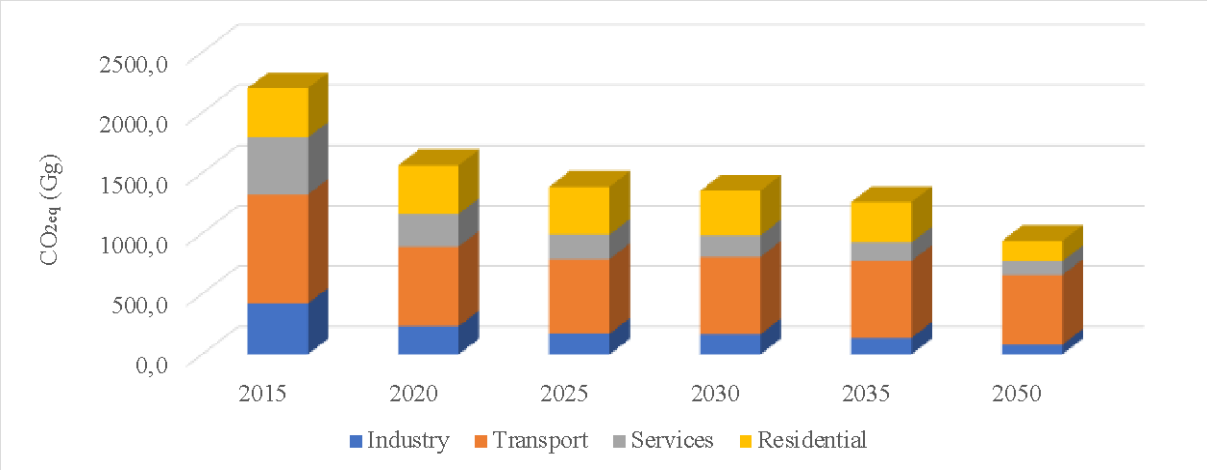

Figure 1 – Bristol BAU Carbon Footprint by sector (Gg CO_2 equivalent on Life Cycle)

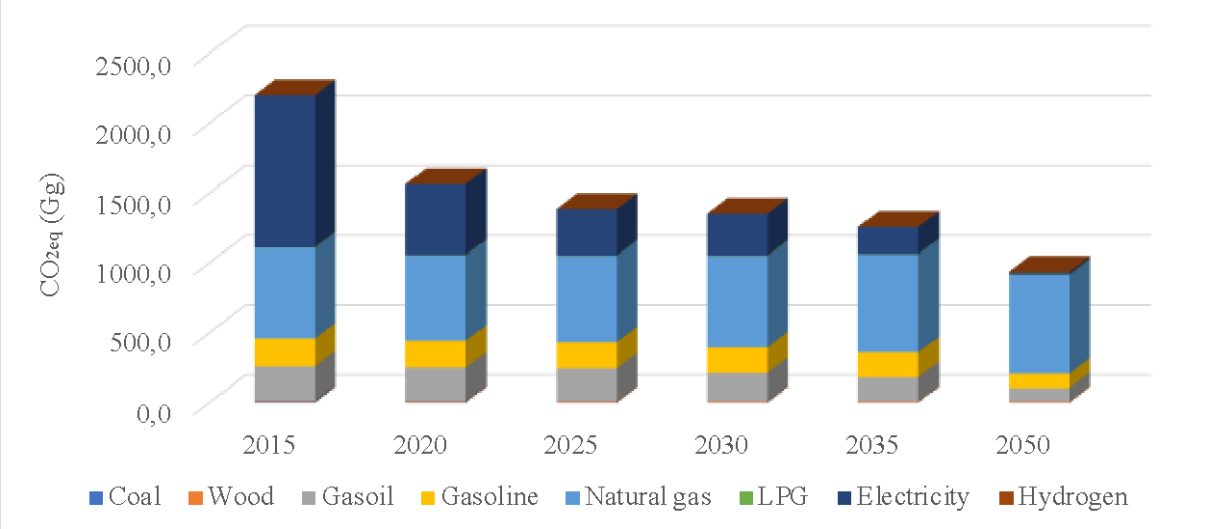

Figure 2 – Bristol BAU Carbon Footprint by fuel (Gg CO_2 equivalent on Life Cycle)

3.2 Scenario projections

Scenario projections take into consideration city level additional measures from Stakeholder dialog workshop (SWD). Also, in this case as a general input to the projection model, results from IRCI and Traffic models have been assumed for fuel consumptions.

3.2.1 Scenario 1

In Table 4 Carbon Footprint by sector is reported for Bristol Scenario 1 expressed as CO_2, CO_2 equivalent and CO_2 equivalent on Life Cycle. In Table 5 CO_2 equivalent on Life Cycle reductions on 2015 are reported.

For the Scenario 1, Carbon Footprint, expressed as CO_2 equivalent on Life Cycle, is reported in Figure 3 by sector and in Figure 4 by fuel.

Table 4 – Bristol Scenario 1 Carbon Footprint by Sector (Gg)

Year	2015	2020	2025	2030	2035	2050
Carbon dioxide (CO_2)						
Residential	767,4	553,1	513,7	532,6	529,8	479,4
Services	364,8	196,9	142,0	137,8	112,8	65,4
Transport	339,6	333,8	323,3	299,9	266,7	124,2
Industry	409,4	229,7	169,4	148,9	128,5	97,5
Total	***1881,2***	***1313,6***	***1148,4***	***1119,2***	***1037,9***	***766,4***
Carbon dioxide equivalent (CO_{2eq})						
Residential	771,5	556,5	516,8	535,7	532,8	482,1
Services	365,9	197,4	142,3	138,1	113,0	65,4
Transport	340,5	334,7	324,2	300,7	267,4	124,6
Industry	410,5	230,2	169,8	149,2	128,7	97,6
Total	***1888,3***	***1318,8***	***1153,0***	***1123,7***	***1042,0***	***769,6***
Carbon dioxide equivalent on life cycle (CO_{2eq})						
Residential	901,1	659,7	618,5	640,9	637,2	576,6
Services	420,3	231,0	170,1	165,0	134,9	78,0
Transport	407,4	361,7	311,6	290,9	262,0	128,8
Industry	472,2	269,3	201,5	176,8	152,2	115,0
Total	***2.201,1***	***1.521,8***	***1.301,6***	***1.273,7***	***1.186,4***	***898,5***

Table 5 – Bristol Scenario 1 Carbon Footprint by Sector: index (2015=100)

Year	2015	2020	2025	2030	2035	2050
Carbon dioxide equivalent on life cycle (CO_{2eq})						
Residential	100	73	68	70	70	64
Services	100	54	39	38	31	18
Transport	100	98	95	89	79	38
Industry	100	56	42	37	32	24
Total	***100***	***70***	***62***	***60***	***56***	***42***

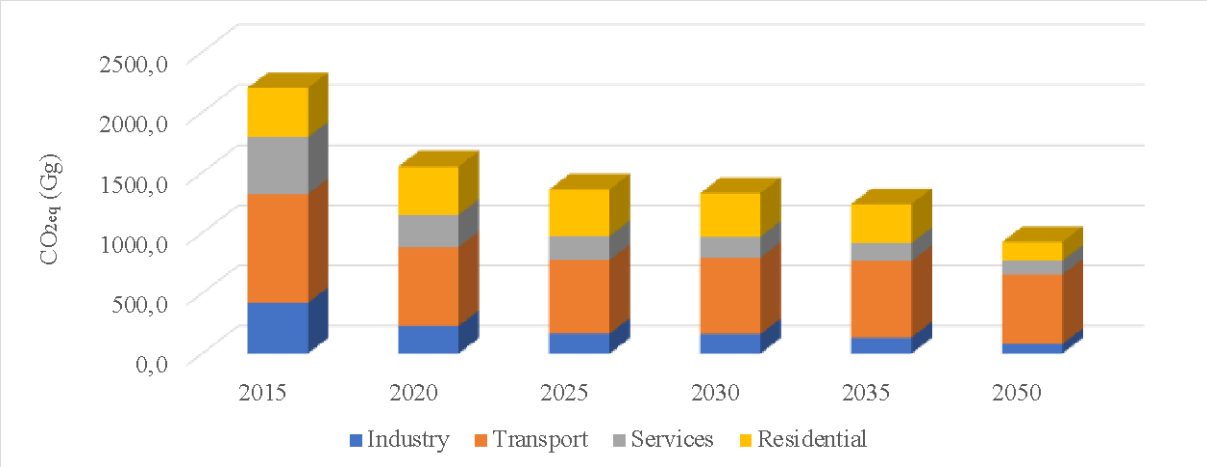

Figure 3 – Bristol Scenario 1 Carbon Footprint by sector (Gg CO_2 equivalent on Life Cycle)

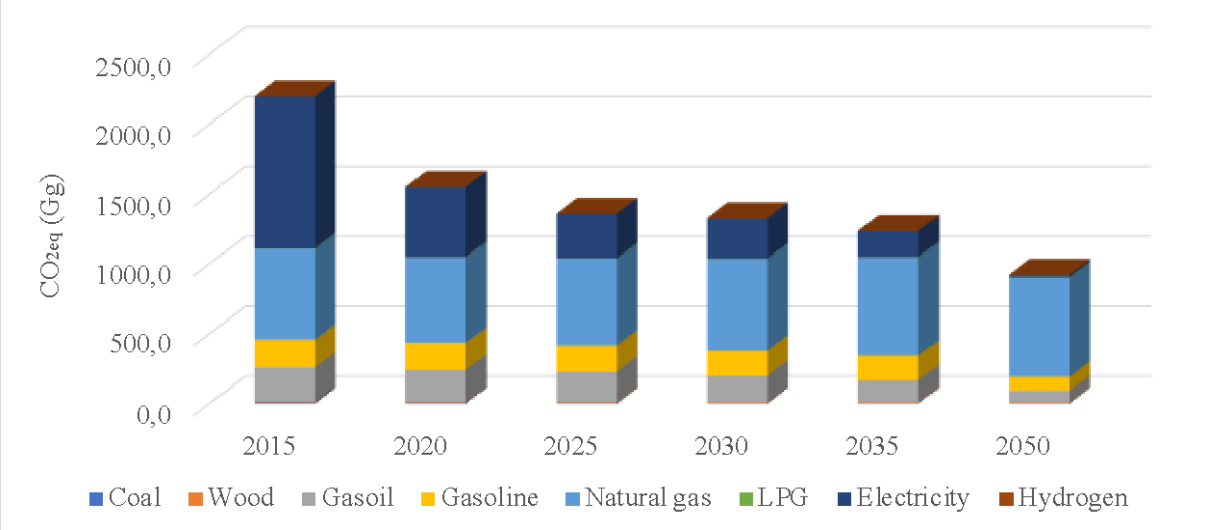

Figure 4 – Bristol Scenario 1 Carbon Footprint by fuel (Gg CO_2 equivalent on Life Cycle)

3.2.2 Scenario 2

In Table 6 Carbon Footprint by sector is reported for Bristol Scenario 2 expressed as CO_2, CO_2 equivalent and CO_2 equivalent on Life Cycle. In Table 7 CO_2 equivalent on Life Cycle reductions on 2015 are reported.

Table 6 – Bristol Scenario 2 Carbon Footprint by Sector (Gg)

Year	2015	2020	2025	2030	2035	2050
Carbon dioxide (CO_2)						
Residential	767,4	556,6	519,6	537,9	533,2	479,8
Services	364,8	199,8	146,6	141,9	115,5	65,8
Transport	339,6	301,7	260,0	242,0	216,8	103,5
Industry	409,4	232,2	173,2	151,9	130,3	97,7
Total	***1881,2***	***1290,3***	***1099,5***	***1073,8***	***995,8***	***746,8***
Carbon dioxide equivalent (CO_{2eq})						
Residential	771,5	559,9	522,8	541,0	536,1	482,6
Services	365,9	200,3	146,9	142,2	115,7	65,8
Transport	340,5	302,6	260,7	242,7	217,4	103,7
Industry	410,5	232,7	173,6	152,2	130,5	97,8
Total	***1.888,3***	***1.295,5***	***1.104,0***	***1.078,1***	***999,7***	***749,9***
Carbon dioxide equivalent on life cycle (CO_{2eq})						
Residential	901,1	659,7	618,5	640,9	637,2	576,6
Services	420,3	231,0	170,1	165,0	134,9	78,0
Transport	407,4	361,7	161,0	290,9	262,0	128,8
Industry	471,9	269,3	201,5	176,8	152,2	115,0
Total	***2200,7***	***1521,8***	***1151,0***	***1273,7***	***1186,4***	***898,5***

Table 7 – Bristol Scenario 2 Carbon Footprint by Sector: index (2015=100)

Year	2015	2020	2025	2030	2035	2050
Carbon dioxide equivalent on life cycle (CO_{2eq})						
Residential	100	73	69	71	71	64
Services	100	55	40	39	32	19
Transport	100	89	76	71	64	32
Industry	100	57	43	37	32	24
Total	***100***	***69***	***59***	***58***	***54***	***41***

For the Scenario 2, Carbon Footprint, expressed as CO_2 equivalent on Life Cycle, is reported in Figure 5 by sector and in Figure 6 by fuel.

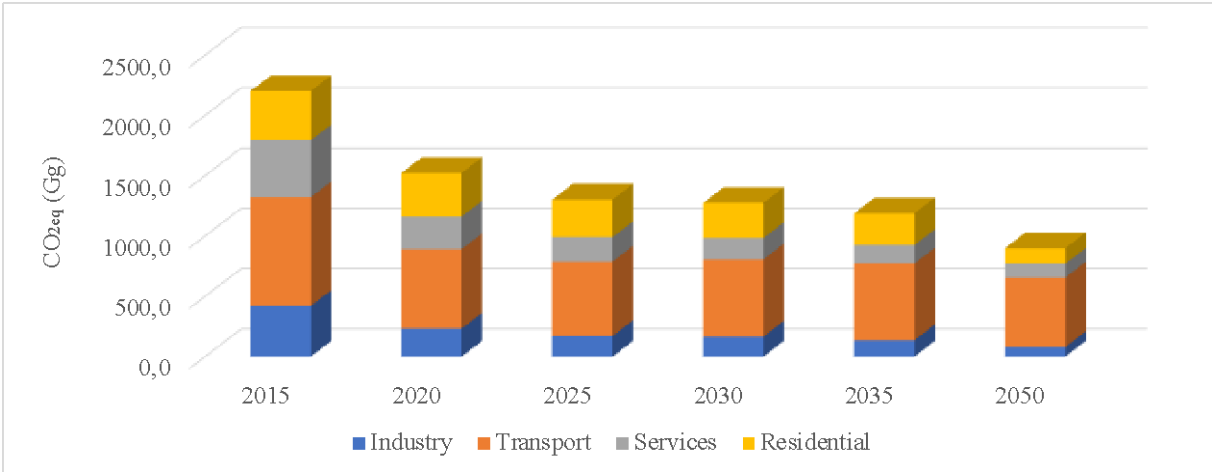

Figure 5 – Bristol Scenario 2 Carbon Footprint by sector (Gg CO_2 equivalent on Life Cycle)

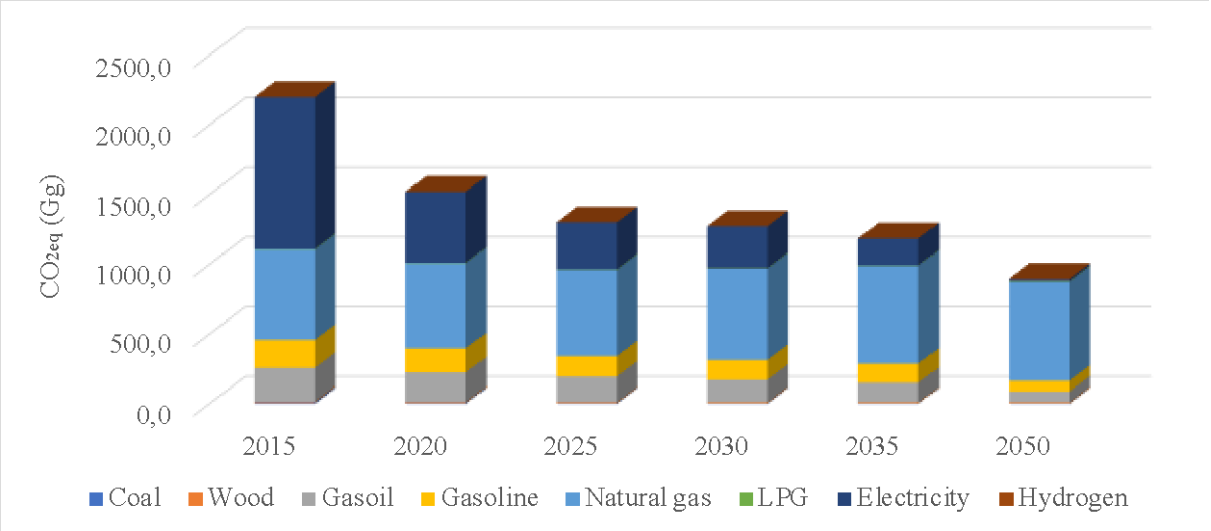

Figure 6 – Bristol Scenario 2 Carbon Footprint by fuel (Gg CO_2 equivalent on Life Cycle)

3.2.3 Scenario 3

In Table 8 Carbon Footprint by sector is reported for Bristol Scenario 3 expressed as CO_2, CO_2 equivalent and CO_2 equivalent on Life Cycle. In Table 9 CO_2 equivalent on Life Cycle reductions on 2015 are reported.

Finally, for the Scenario 3, in Figure 7 Carbon Footprint, expressed as CO_2 equivalent on Life Cycle, is reported by fuel and in Figure 8 by sector.

Table 8 – Bristol Scenario 3 Carbon Footprint by Sector (Gg)

Year	2015	2020	2025	2030	2035	2050
Carbon dioxide (CO_2)						
Residential	767,4	481,5	365,7	347,1	302,0	200,9
Services	364,8	187,0	122,8	113,9	85,0	31,3
Transport	339,6	262,6	167,8	132,7	94,8	38,2
Industry	409,4	229,7	169,4	148,9	128,5	97,5
Total	***1881,2***	***1160,8***	***825,7***	***742,5***	***610,3***	***367,9***
Carbon dioxide equivalent (CO_{2eq})						
Residential	771,5	484,4	367,8	349,1	303,7	202,2
Services	365,9	187,5	123,1	114,1	85,2	31,3
Transport	340,5	263,3	168,2	133,0	95,1	38,3
Industry	410,5	230,2	169,8	149,2	128,7	97,6
Total	***1888,3***	***1165,4***	***828,9***	***745,4***	***612,6***	***369,3***
Carbon dioxide equivalent on life cycle (CO_{2eq})						
Residential	901,1	569,7	433,6	411,8	359,7	241,6
Services	420,3	216,0	142,0	131,8	98,7	37,1
Transport	407,4	315,4	202,9	161,3	116,6	50,0
Industry	472,2	266,5	197,1	173,4	150,2	114,7
Total	***2201,1***	***1367,5***	***975,6***	***878,3***	***725,2***	***443,3***

Table 9 – Bristol Scenario 3 Carbon Footprint by Sector: index (2015=100)

Year	2015	2020	2025	2030	2035	2050
Carbon dioxide equivalent on life cycle (CO_{2eq})						
Residential	100	63	48	46	40	27
Services	100	51	34	31	23	9
Transport	100	77	50	40	29	12
Industry	100	56	42	37	32	24
Total	***100***	***62***	***44***	***40***	***33***	***20***

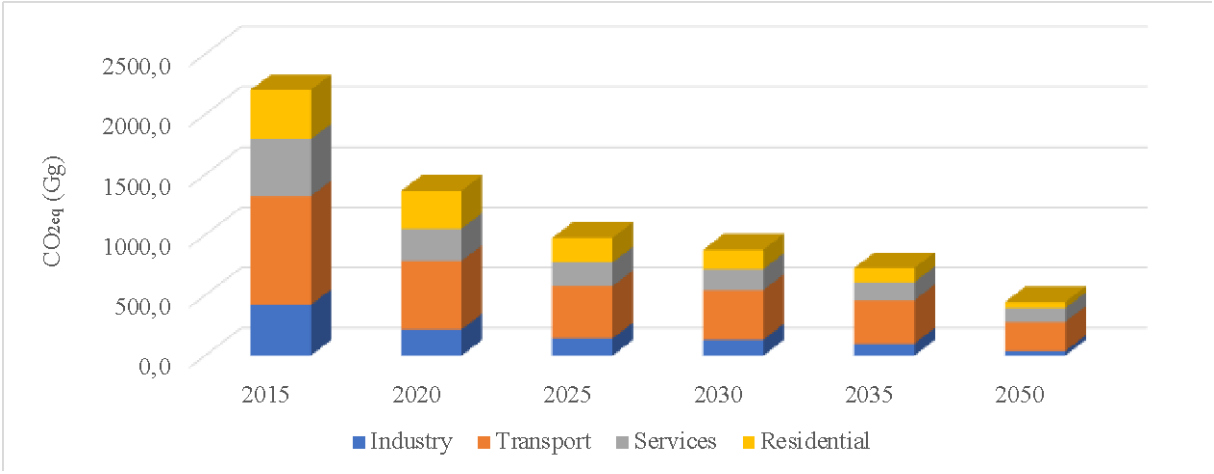

Figure 7 – Bristol Scenario 3 Carbon Footprint by sector (Gg CO_2 equivalent on Life Cycle)

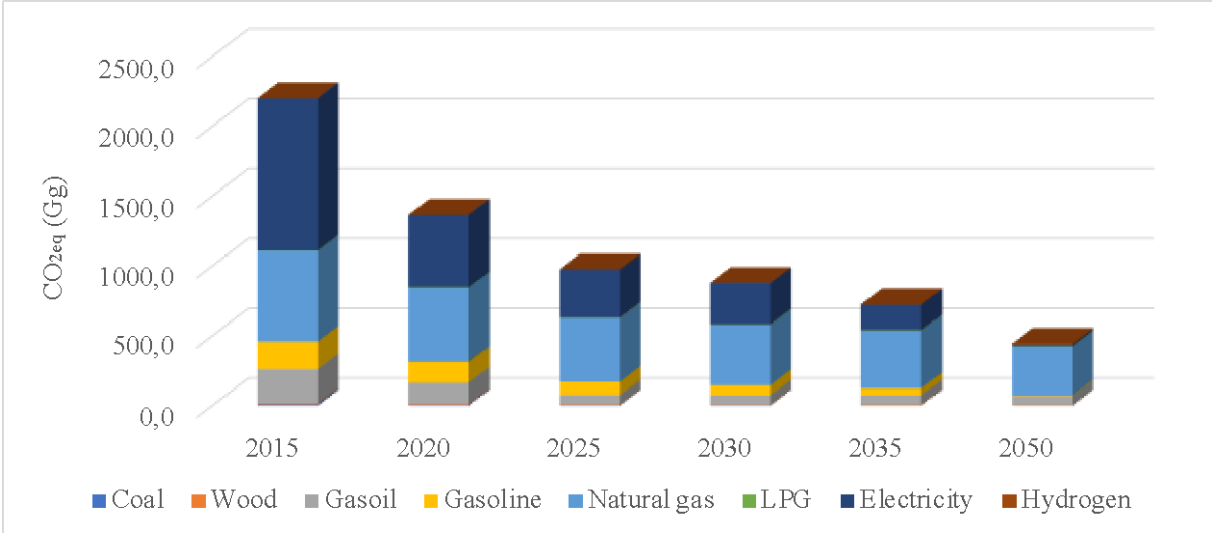

Figure 8 – Bristol Scenario 3 Carbon Footprint by fuel (Gg CO_2 equivalent on Life Cycle)

3.2.4 BAU and Scenarios comparison

Total Carbon Footprint in the different scenarios is compared in Figure 9 expressed as CO_2 equivalent on Life Cycle.

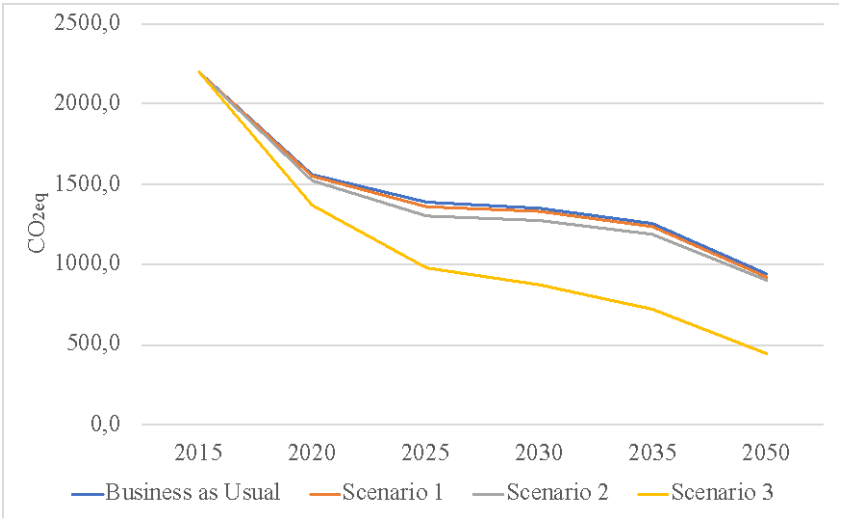

Figure 9 – Bristol Carbon Footprint (Mg CO_2 equivalent on Life Cycle) by scenario

3.3 Final Unified Policy Scenario projections

The final Unified Policy Scenario includes the measures of Scenario 3 and a supplemental measure *Bristol Carbon Neutral* where we assume the results of the Bristol City Council strategy[8] for carbon neutrality on 2050.

3.3.1 Unified Policy Scenario results

In Table 10 Carbon Footprint by sector is reported for Bristol Unified Policy Scenario expressed as CO_2, CO_2 equivalent and CO_2 equivalent on Life Cycle. In Table 11 CO_2 equivalent on Life Cycle reductions on 2015 are reported.

Table 10 – Bristol Unified Policy Scenario Carbon Footprint by Sector (Gg)

Year	2015	2020	2025	2030	2035	2050
Carbon dioxide (CO_2)						
Residential	767,4	453,8	321,1	241,8	138,3	4,7
Services	364,8	184,9	120,3	101,8	63,8	3,8
Transport	339,6	329,7	310,2	209,4	97,8	35,4
Industry	409,4	232,2	173,2	151,9	130,3	97,7
Total	***1881,2***	***1200,6***	***924,9***	***704,9***	***430,2***	***141,6***
Carbon dioxide equivalent (CO_{2eq})						
Residential	771,5	456,6	323,3	243,8	140,1	5,9
Services	365,9	185,4	120,6	102,1	64,0	3,8
Transport	340,5	330,6	311,1	210,0	98,1	35,5
Industry	410,5	232,7	173,6	152,2	130,5	97,8
Total	***1888,3***	***1205,4***	***928,6***	***708,0***	***432,6***	***143,1***
Carbon dioxide equivalent on life cycle (CO_{2eq})						

[8] Element Energy Limited, An evidence based strategy for delivering zero carbon heat in Bristol. A report for Bristol City Council, October 2018

Year	2015	2020	2025	2030	2035	2050
Residential	901,1	536,6	380,4	286,5	165,1	8,4
Services	420,3	213,4	138,8	117,2	73,4	4,4
Transport	407,4	395,6	372,8	252,9	120,6	47,1
Industry	472,2	269,3	201,5	176,8	152,2	115,0
Total	***2201,1***	***1414,9***	***1093,5***	***833,4***	***511,3***	***174,9***

Table 11 – Bristol Unified Policy Scenario Carbon Footprint by Sector: index (2015=100)

Year	2015	2020	2025	2030	2035	2050
Carbon dioxide equivalent on life cycle (CO_{2eq})						
Residential	100	60	42	32	18	1
Services	100	51	33	28	17	1
Transport	100	97	91	62	30	12
Industry	100	57	43	37	32	24
Total	***100***	***64***	***50***	***38***	***23***	***8***

For the Unified Policy Scenario, Carbon Footprint, expressed as CO_2 equivalent on Life Cycle, is reported in Figure 10 by sector and in Figure 11 by fuel.

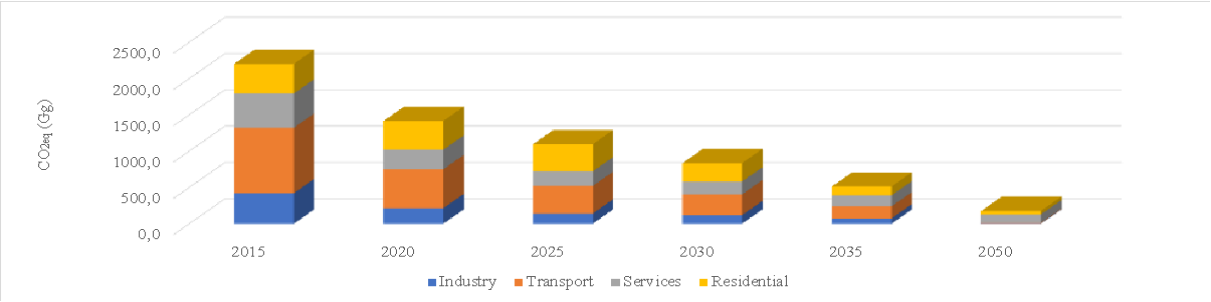

Figure 10 – Bristol Unified Policy Scenario Carbon Footprint by sector (Gg CO_2 equivalent on Life Cycle)

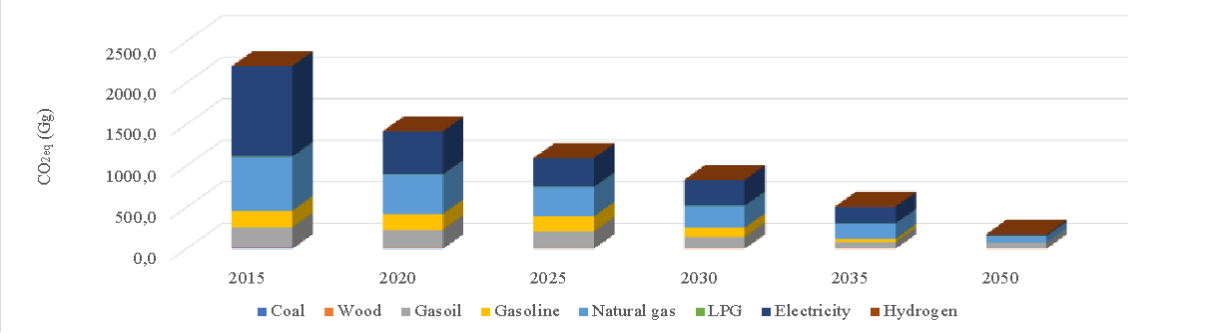

Figure 11 – Bristol Unified Policy Scenario Carbon Footprint by fuel (Gg CO_2 equivalent on Life Cycle)

3.3.2 BAU and Unified Policy Scenario comparison

Total Carbon Footprint in the business as usual (BAU) and unified policy scenario (UPS) is compared in Figure 12 expressed as CO_2 equivalent on Life Cycle. In Figure 13 results are reported by sector and in Figure 14 by sector and fuel. Finally, in Figure 15 Bristol Carbon Footprint on life cycle generated by citizens' activities is reported in BAU and UPS scenario.

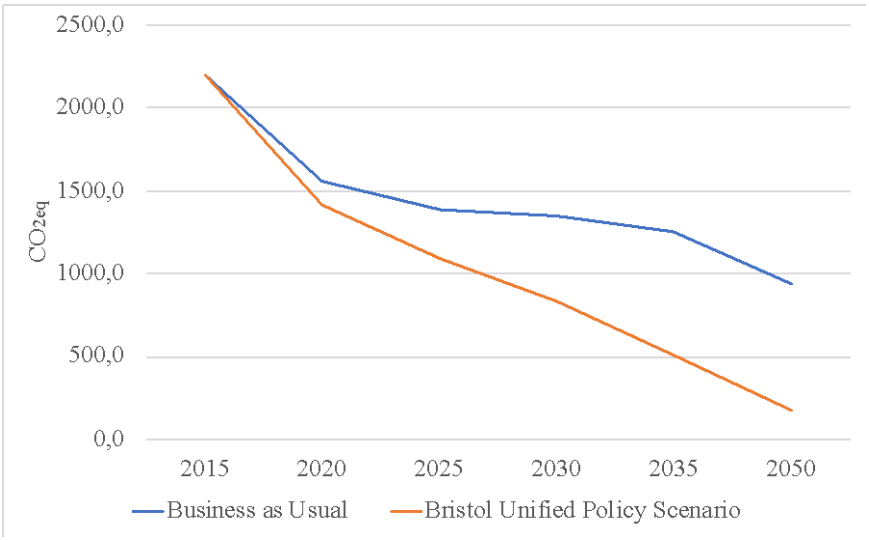

Figure 12 – Bristol Carbon Footprint BAU and UPS comparison (Mg CO_2 equivalent on Life Cycle)

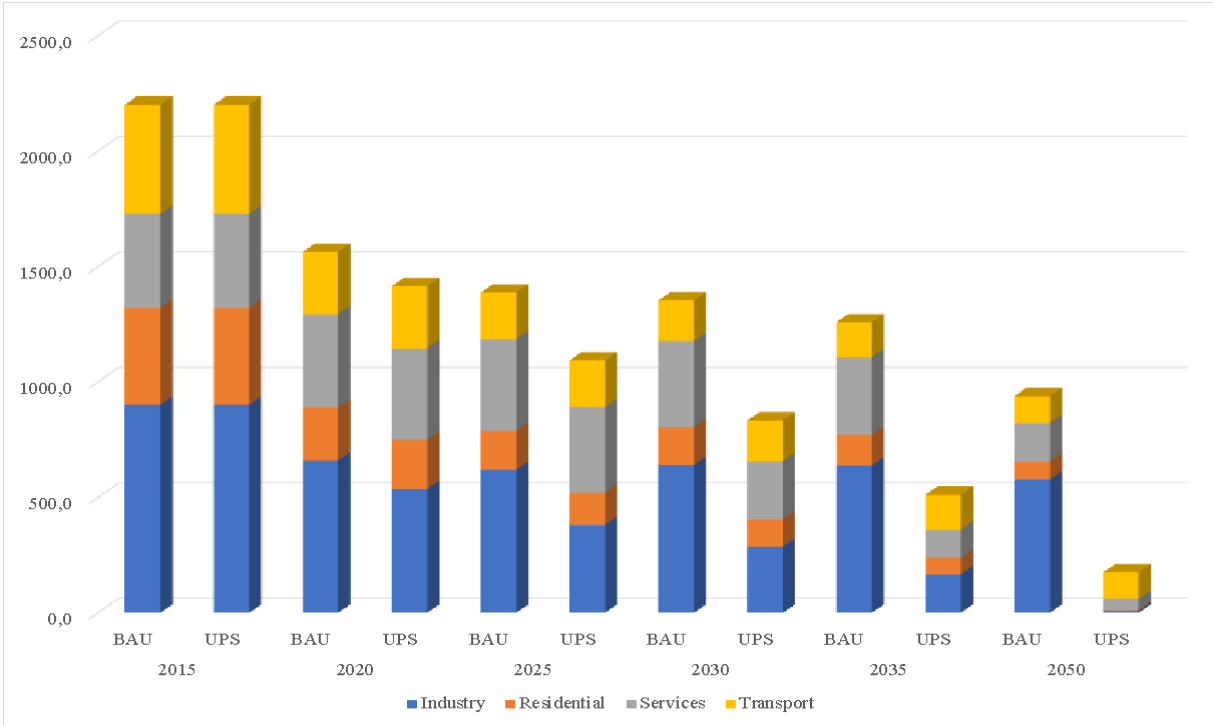

Figure 13 – Bristol Carbon Footprint BAU and UPS comparison by sector (Mg CO_2 equivalent on Life Cycle)

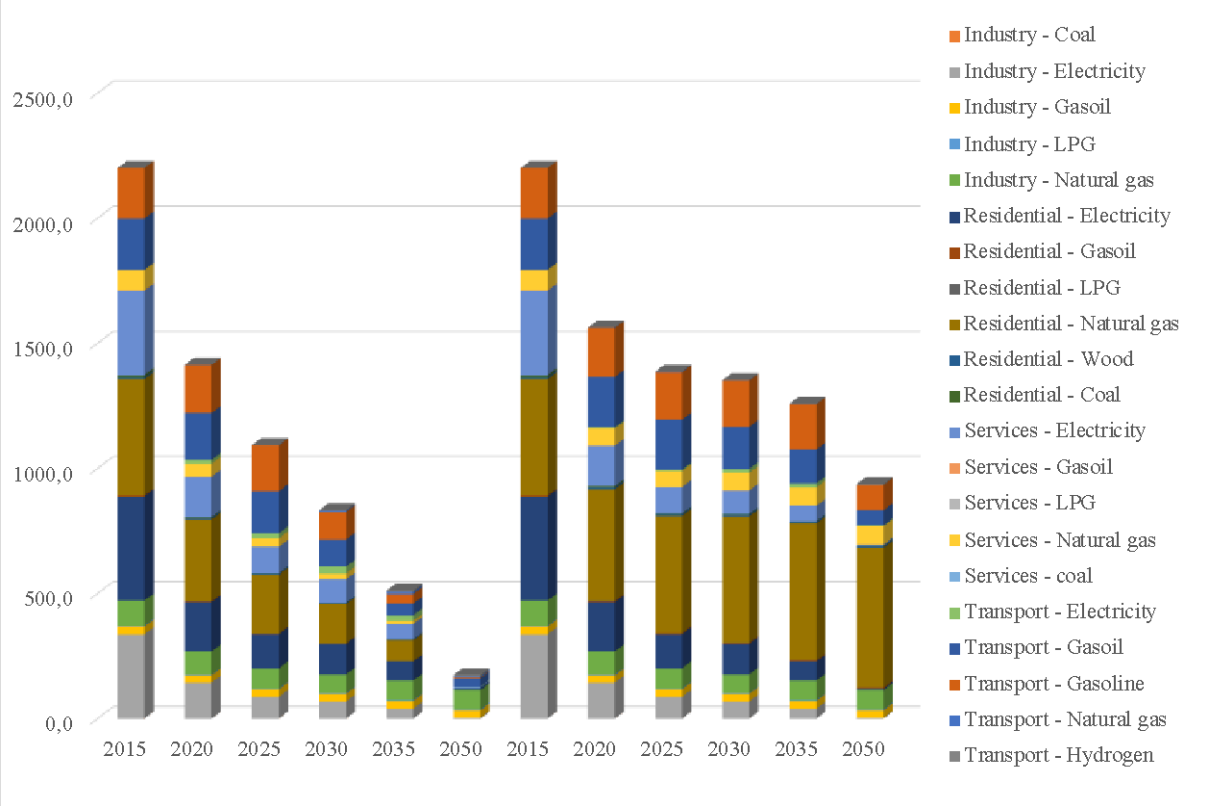

Figure 14 – Bristol Carbon Footprint BAU and UPS comparison by sector and fuel (Mg CO_2 equivalent on Life Cycle)

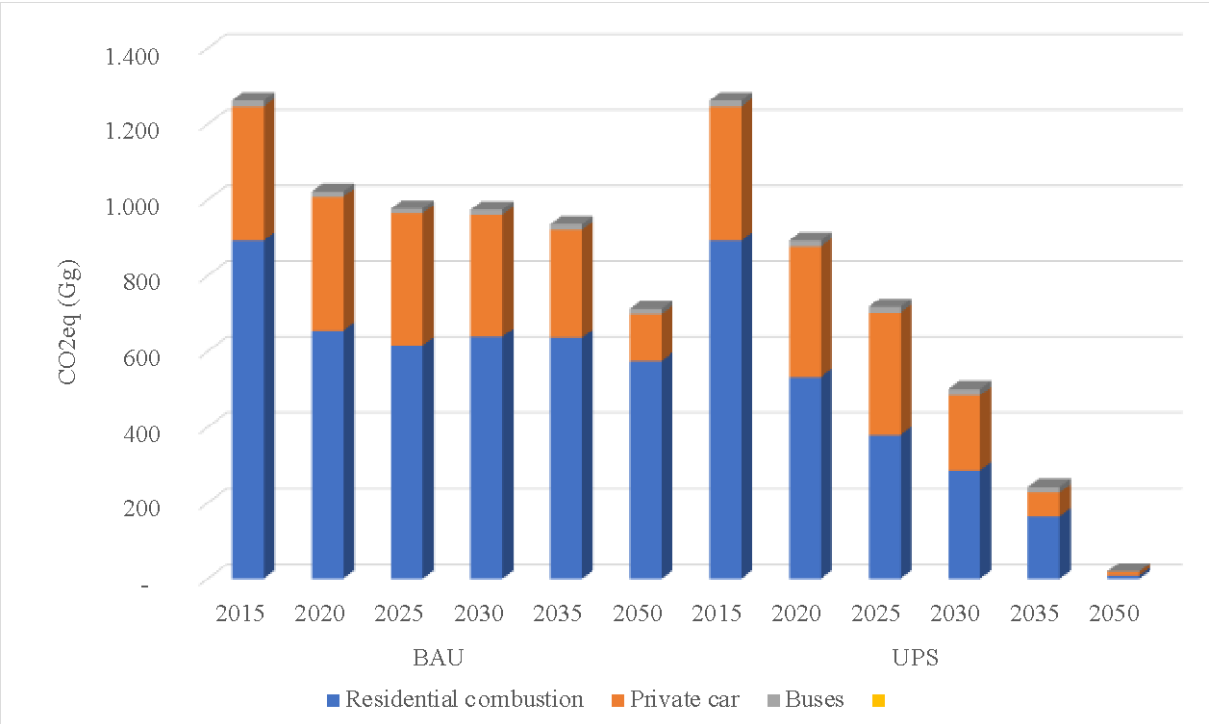

Figure 15 – Bristol Carbon Footprint generated by citizens' activities in BAU and UPS scenario (Mg CO_2 equivalent on Life Cycle)

4 AMSTERDAM

4.1 Business As Usual projections

Business as Usual (BAU) scenario takes into consideration national and city level measures already defined/decided. As a general input to the projection model, results from IRCI and Traffic models have been assumed for fuel consumptions.

For electricity emission factors an additional driver was introduced to take into consideration the evolution of carbon footprint from electricity generation. The driver is defined using official Netherland projection data up to 2030[9,10]. For 2050 we assume zero emissions for electricity according to Dutch Ministerie van Economische Zaken[11] that has fixed as a policy requirement that the power sector should be zero-carbon by 2050. In the same document are also hypotheses of near-zero emissions for all the energy system. Also, in this case, as for UK, some more cautious consideration has been adopted for the other sectors, so in the projections the near-zero emissions hypothesis has been inserted only for the power sector and not for industry sector where we maintain the more conservative 2030 projection in Seventh UNFCC Netherland National Communication, also considering that PBL not issued a National Energy Survey (NEV) after 2018. The management of the PBL has decided this in connection with the ongoing discussions about the Climate Agreement[12]. For the commercial and domestic sectors, we take the same assumptions as in the IRCI projections. Following the UNFCCC National communication[13], CO_2 emissions from the industry are expected to remain stable in the coming decade and no other information is available after 2030.

In Table 12 Carbon Footprint by sector is reported for Amsterdam BAU expressed as CO_2, CO_2 equivalent and CO_2 equivalent on Life Cycle. In Table 13 CO_2 equivalent on Life Cycle reductions on 2015 are reported.

[9] PBL, Nationale Energieverkenning 2017
[10] Netherland Ministry of Economic Affairs and Climate Policy, Seventh Netherlands National Communication under the United Nations Framework Convention on Climate Change
[11] Ministerie van Economische Zaken, Energieagenda: naar een CO_2-arme energievoorziening, 2016
[12] PBL, Vanwege werk aan Klimaatakkoord geen Nationale Energieverkenning in 2018
[13] Netherland Ministry of Economic Affairs and Climate Policy, Seventh Netherlands National Communication under the United Nations Framework Convention on Climate Change

Table 12 – Amsterdam BAU Carbon Footprint by Sector (Gg)

Year	2015	2020	2025	2030	2035	2050
Carbon dioxide (CO_2)						
Residential	1.275,9	1.035,9	941,6	802,8	713,1	695,8
Services	1.984,8	1.468,7	1.452,6	892,0	562,2	453,2
Transport	832,3	823,7	814,2	750,7	681,0	407,3
Industry	1.042,3	842,5	842,5	675,9	537,1	487,2
Total	***5.135,3***	***4.170,7***	***4.050,9***	***3.121,5***	***2.493,4***	***2.043,5***
Carbon dioxide equivalent (CO_{2eq})						
Residential	1.276,7	1.036,5	942,2	803,2	713,3	695,9
Services	1.987,2	1.470,2	1.454,2	892,9	562,5	453,3
Transport	834,7	826,0	816,5	752,9	682,9	408,5
Industry	1.043,8	843,6	843,6	676,8	537,8	487,7
Total	***5.142,4***	***4.176,4***	***4.056,5***	***3.125,7***	***2.496,4***	***2.045,4***
Carbon dioxide equivalent on life cycle (CO_{2eq})						
Residential	1.491,8	1.215,7	1.103,5	946,2	845,9	827,6
Services	2.281,0	1.695,4	1.676,3	1.033,4	660,7	538,1
Transport	1.017,5	1.007,0	995,6	919,4	836,0	500,0
Industry	1.196,4	970,1	970,1	781,5	624,3	567,7
Total	***5.986,7***	***4.888,3***	***4.745,5***	***3.680,5***	***2.967,0***	***2.433,4***

Table 13 – Amsterdam BAU Carbon Footprint by Sector: index (2015=100)

Year	2015	2020	2025	2030	2035	2050
Carbon dioxide equivalent on life cycle (CO_{2eq})						
Residential	100	81	74	63	57	55
Services	100	74	73	45	29	24
Transport	100	99	98	90	82	49
Industry	100	81	81	65	52	47
Total	100	82	79	61	50	41

Carbon Footprint, expressed as CO_2 equivalent on Life Cycle, is reported in Figure 16 by sector and in Figure 17 by fuel. The graphs highlight the largely dominant contribution of the residential and service sectors as described above, from the point of view of energy carriers, natural gas and electricity.

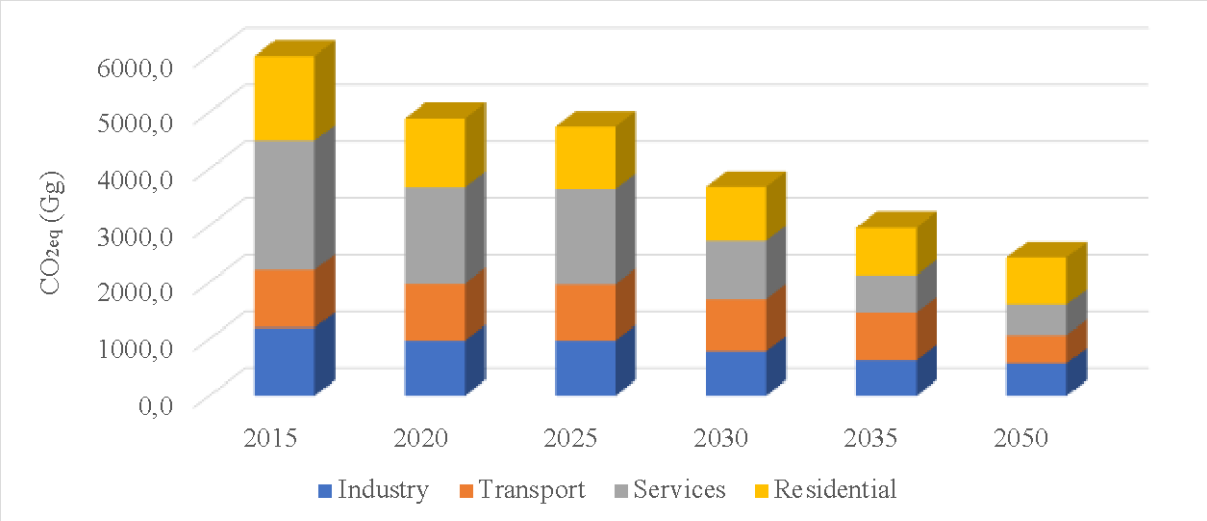

Figure 16 – Amsterdam BAU Carbon Footprint by sector (Gg CO_2 equivalent on Life Cycle)

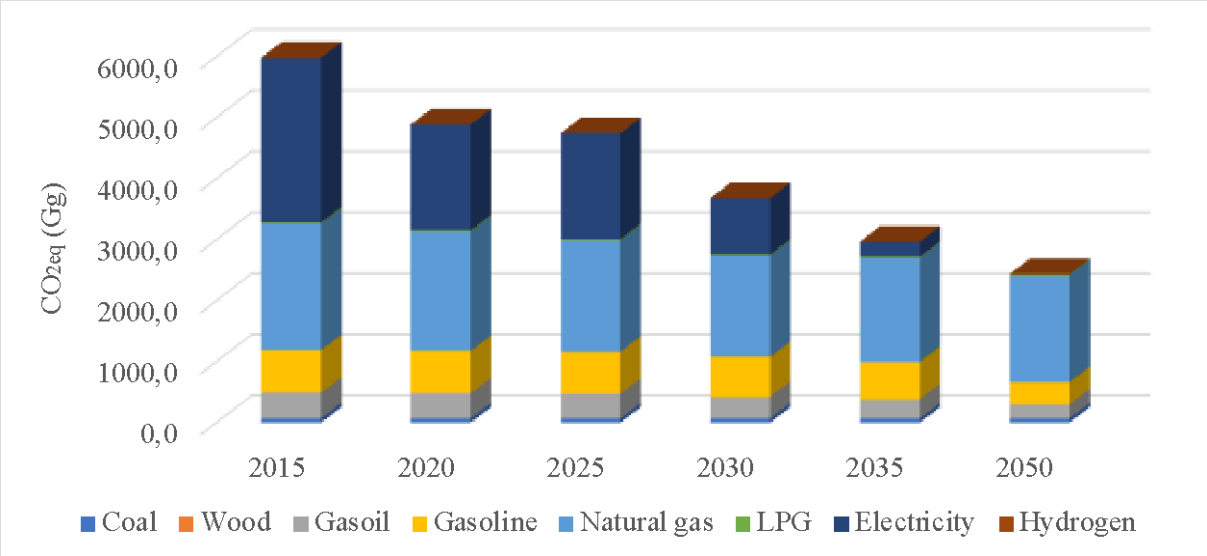

Figure 17 – Amsterdam BAU Carbon Footprint by fuel (Gg CO_2 equivalent on Life Cycle)

4.2 Scenario projections

Scenario projections take into consideration city level additional measures from Stakeholder dialog workshop (SWD). Also, in this case as a general input to the projection model, results from IRCI and Traffic models have been assumed for fuel consumptions.

4.2.1 Scenario *low*

In Table 14 Carbon Footprint by sector is reported for Amsterdam Scenario *low* expressed as CO_2, CO_2 equivalent and CO_2 equivalent on Life Cycle. In Table 15 CO_2 equivalent on Life Cycle reductions on 2015 are reported.

Table 14 – Amsterdam Scenario *low* Carbon Footprint by Sector (Gg)

Year	2015	2020	2025	2030	2035	2050
Carbon dioxide (CO_2)						
Residential	1.275,9	1.035,9	903,0	715,1	585,4	445,3
Services	1.984,8	1.468,7	1.418,9	834,9	479,0	290,0
Transport	832,3	818,9	804,6	733,6	658,2	385,2
Industry	1.042,3	842,5	842,5	675,9	537,1	487,2
Total	***5.135,3***	***4.166,0***	***3.969,0***	***2.959,5***	***2.259,7***	***1.607,7***
Carbon dioxide equivalent (CO_{2eq})						
Residential	1.276,7	1.036,5	903,5	715,4	585,4	445,3
Services	1.987,2	1.470,2	1.420,5	835,8	479,2	290,1
Transport	834,7	821,3	806,8	735,6	660,1	386,3
Industry	1.043,8	843,6	843,6	676,8	537,8	487,7
Total	***5.142,4***	***4.171,7***	***3.974,5***	***2.963,6***	***2.262,5***	***1.609,4***
Carbon dioxide equivalent on life cycle (CO_{2eq})						
Residential	1.491,8	1.215,7	1.057,4	841,7	693,8	529,5
Services	2.281,0	1.695,4	1.636,4	965,6	561,9	344,4
Transport	1.017,5	1.020,8	1.013,5	927,7	835,2	502,5
Industry	1.196,4	970,1	970,1	781,5	624,3	567,7
Total	***5.986,7***	***4.902,0***	***4.677,4***	***3.516,5***	***2.715,2***	***1.944,2***

Table 15 – Amsterdam Scenario *low* Carbon Footprint by Sector: index (2015=100)

Year	2015	2020	2025	2030	2035	2050
Carbon dioxide equivalent on life cycle (CO_{2eq})						
Residential	100	81	71	56	47	35
Services	100	74	72	42	25	15
Transport	100	100	100	91	82	49
Industry	100	81	81	65	52	47
Total	***100***	***82***	***78***	***59***	***45***	***32***

For the Scenario *low*, Carbon Footprint, expressed as CO_2 equivalent on Life Cycle, is reported in Figure 18 by sector and in Figure 19 by fuel.

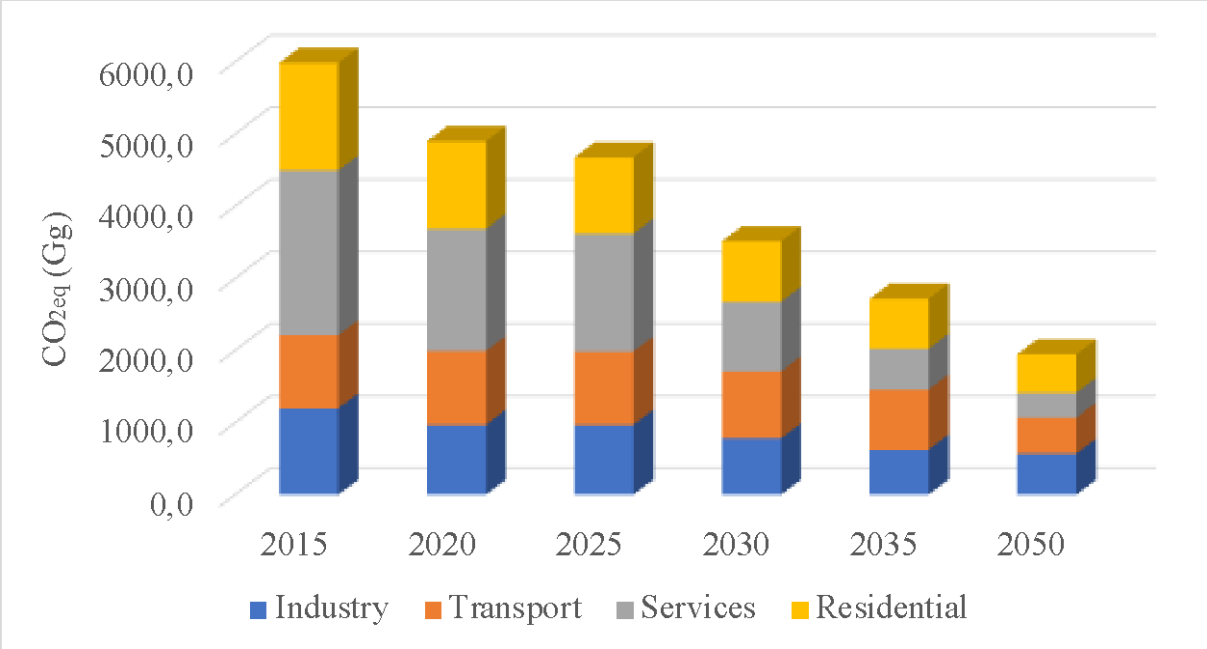

Figure 18 – Amsterdam Scenario *low* Carbon Footprint by sector (Gg CO_2 equivalent on Life Cycle)

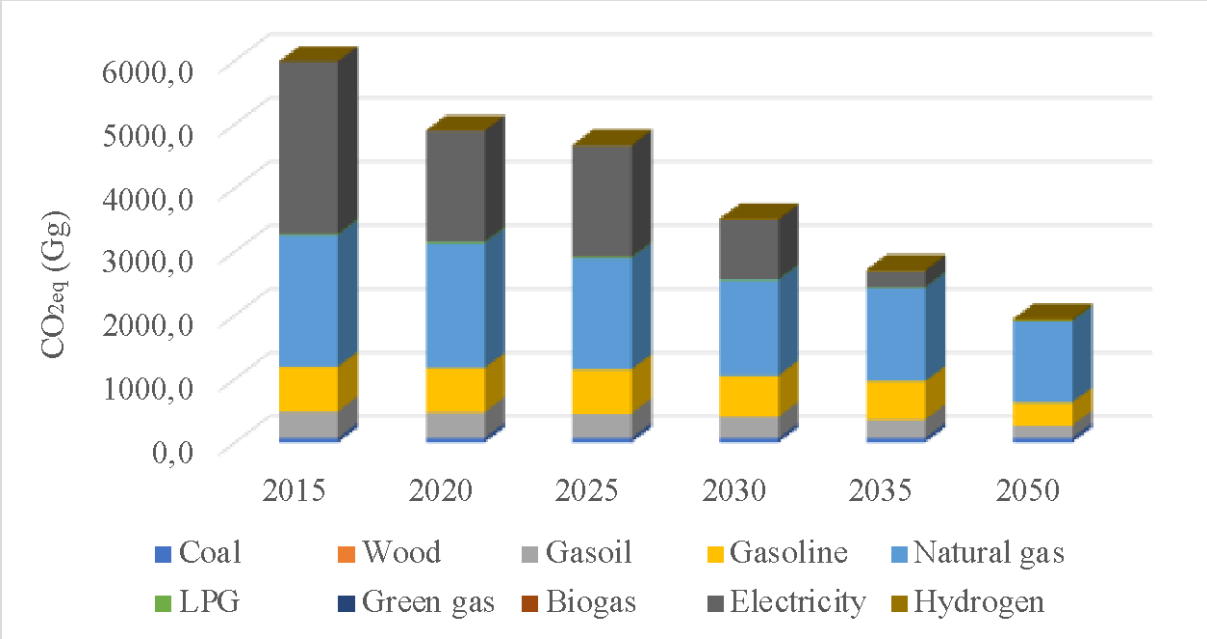

Figure 19 – Amsterdam Scenario *low* Carbon Footprint by fuel (Gg CO_2 equivalent on Life Cycle)

4.2.2 Scenario *high*

In Table 16 Carbon Footprint by sector is reported for Amsterdam Scenario *high* expressed as CO_2, CO_2 equivalent and CO_2 equivalent on Life Cycle. In Table 17 CO_2 equivalent on Life Cycle reductions on 2015 are reported.

Table 16 – Amsterdam Scenario *high* Carbon Footprint by Sector (Gg)

Year	2015	2020	2025	2030	2035	2050
Carbon dioxide (CO_2)						
Residential	1.275,9	854,2	520,9	153,8	40,7	0,0
Services	1.984,8	1.326,1	1.085,4	469,3	124,2	0,0
Transport	832,3	771,0	702,0	500,7	288,5	119,9
Industry	1.042,3	842,5	842,5	675,9	537,1	487,2
Total	***5.135,3***	***3.793,8***	***3.150,7***	***1.799,7***	***990,6***	***607,1***
Carbon dioxide equivalent (CO_{2eq})						
Residential	1.276,7	854,8	521,4	154,0	40,8	0,0
Services	1.987,2	1.327,7	1.086,9	470,1	124,4	0,0
Transport	834,7	773,2	704,0	502,1	289,3	120,3
Industry	1.043,8	843,6	843,6	676,8	537,8	487,7
Total	***5.142,4***	***3.799,3***	***3.155,9***	***1.803,0***	***992,3***	***608,0***
Carbon dioxide equivalent on life cycle (CO_{2eq})						
Residential	1.491,8	1.021,7	647,2	240,5	99,3	40,8
Services	2.281,0	1.550,0	1.288,0	603,0	198,0	43,9
Transport	1.017,5	988,7	941,0	683,0	412,9	189,9
Industry	1.196,4	970,1	970,1	781,5	624,3	567,7
Total	***5.986,7***	***4.530,4***	***3.846,3***	***2.308,0***	***1.334,5***	***842,3***

Table 17 – Amsterdam Scenario *high* Carbon Footprint by Sector: index (2015=100)

Year	2015	2020	2025	2030	2035	2050
Carbon dioxide equivalent on life cycle (CO_{2eq})						
Residential	100	68	43	16	7	3
Services	100	68	56	26	9	2
Transport	100	97	92	67	41	19
Industry	100	81	81	65	52	47
Total	100	76	64	39	22	14

For the Scenario *high*, Carbon Footprint, expressed as CO_2 equivalent on Life Cycle, is reported in Figure 20 by sector and in Figure 21 by fuel.

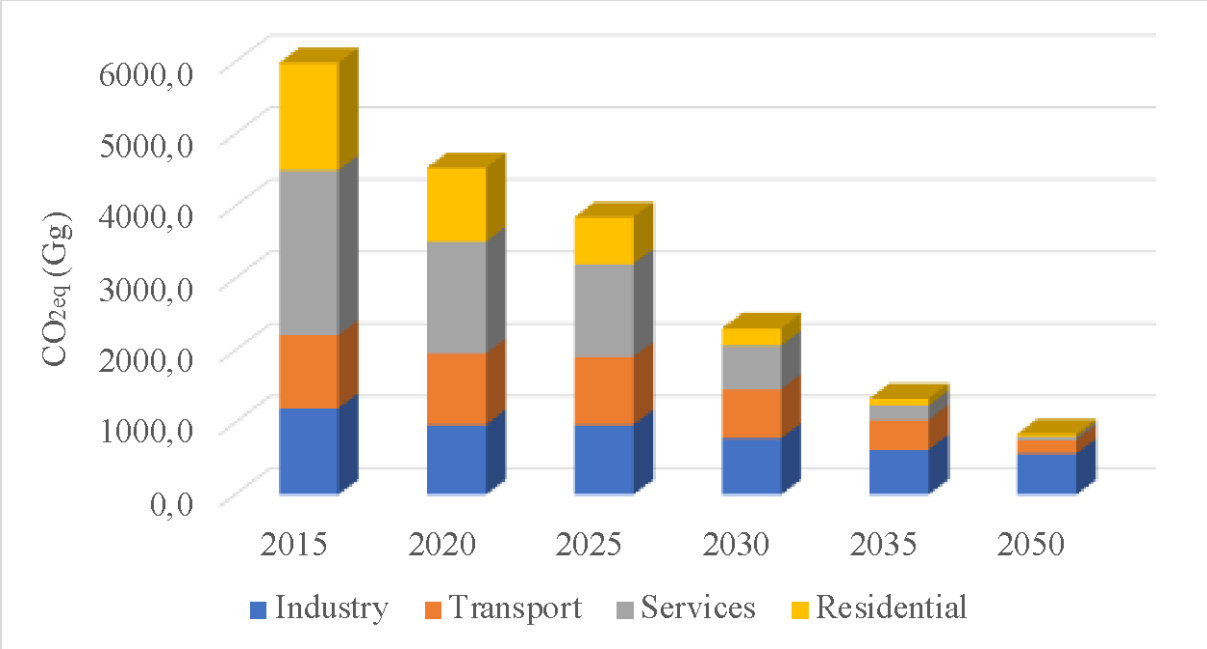

Figure 20 – Amsterdam Scenario *high* Carbon Footprint by sector (Gg CO_2 equivalent on Life Cycle)

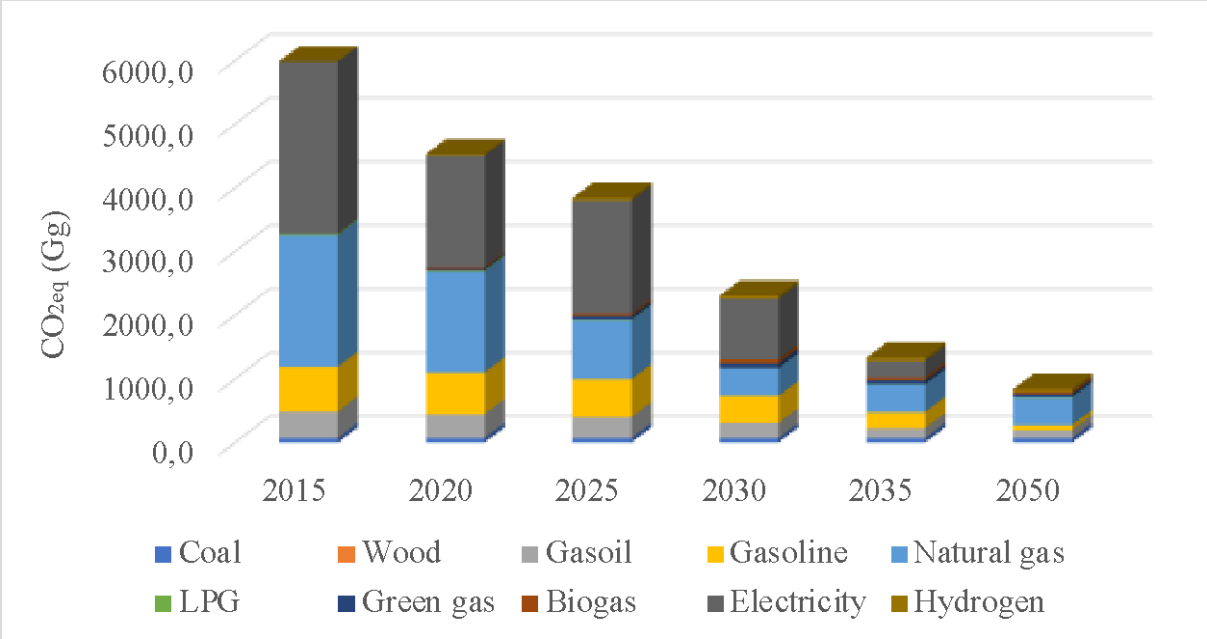

Figure 21 – Amsterdam Scenario *high* Carbon Footprint by fuel (Gg CO_2 equivalent on Life Cycle)

4.2.3 BAU and Scenarios comparison

Total Carbon Footprint in the different scenarios is compared in Figure 22 expressed as CO_2 equivalent on Life Cycle.

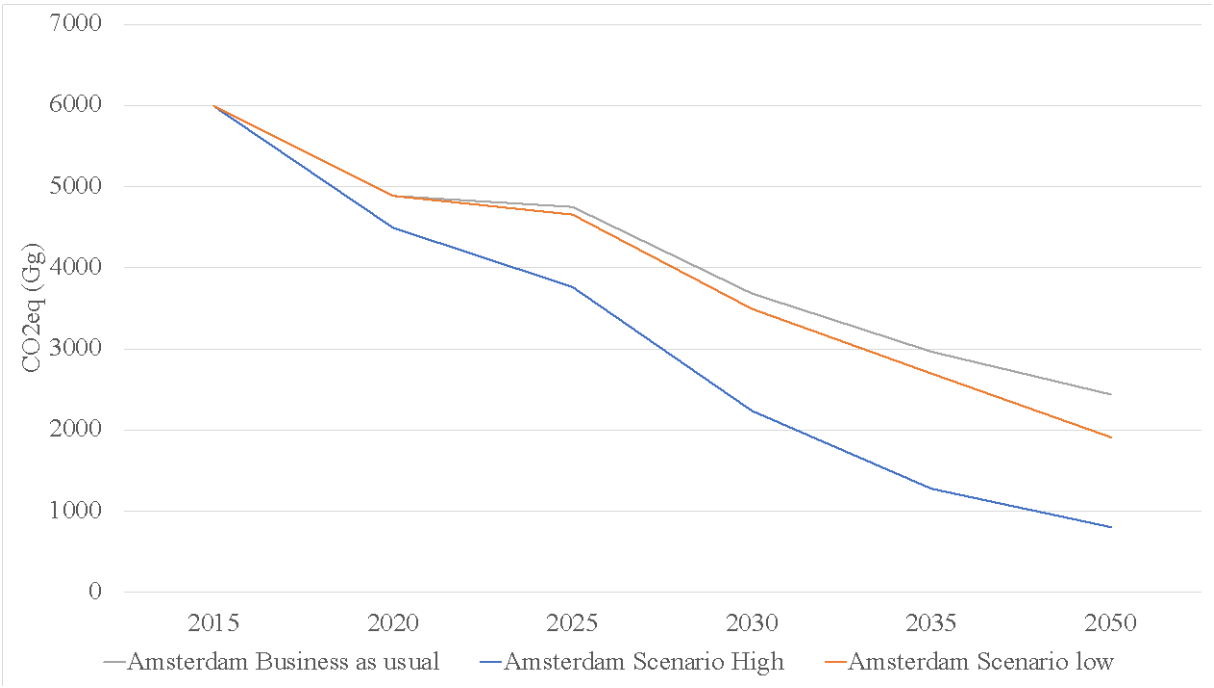

Figure 22 – Amsterdam Carbon Footprint (Mg CO_2 equivalent on Life cycle) by scenario

4.3 Final Unified Policy Scenario projections

Also, for the final Unified Policy Scenario as a general input to the projection model, results from IRCI and Traffic models have been assumed for fuel consumptions.

4.3.1 Unified Policy Scenario results

In Table 18 Carbon Footprint by sector is reported for Amsterdam Scenario 1 expressed as CO_2, CO_2 equivalent and CO_2 equivalent on Life Cycle. In Table 19 CO_2 equivalent on Life Cycle reductions on 2015 are reported.

Table 18 – Amsterdam Unified Policy Scenario Carbon Footprint by Sector (Gg)

Year	2015	2020	2025	2030	2035	2050
Carbon dioxide (CO_2)						
Residential	1.275,9	950,3	701,9	387,0	183,8	0,0
Services	1.984,8	1.401,5	1.243,3	621,2	217,4	0,0
Transport	832,3	783,3	726,6	524,2	303,2	125,0
Industry	1.042,3	842,5	842,5	675,9	537,1	487,2
Total	***5.135,3***	***3.977,6***	***3.514,2***	***2.208,3***	***1.241,7***	***612,1***
Carbon dioxide equivalent (CO_{2eq})						
Residential	1.276,7	950,9	702,3	387,3	183,9	0,0
Services	1.987,2	1.403,1	1.244,9	622,0	217,7	0,0
Transport	834,7	785,5	728,6	525,6	304,1	125,3
Industry	1.043,8	843,6	843,6	676,8	537,8	487,7
Total	***5.142,4***	***3.983,1***	***3.519,5***	***2.211,7***	***1.243,4***	***613,0***
Carbon dioxide equivalent on life cycle (CO_{2eq})						

Year	2015	2020	2025	2030	2035	2050
Residential	1.491,8	1.119,7	829,8	469,0	239,6	40,8
Services	2.281,0	1.622,0	1.440,4	730,7	276,5	43,9
Transport	1.017,5	978,1	919,8	672,4	401,2	184,4
Industry	1.196,4	970,1	970,1	781,5	624,3	567,7
Total	***5.986,7***	***4.689,9***	***4.160,2***	***2.653,6***	***1.541,6***	***836,8***

Table 19 – Amsterdam Unified Policy Scenario Carbon Footprint by Sector: index (2015=100)

Year	2015	2020	2025	2030	2035	2050
Carbon dioxide equivalent on life cycle (CO_{2eq})						
Residential	100	75	56	31	16	3
Services	100	71	63	32	12	2
Transport	100	96	90	66	39	18
Industry	100	81	81	65	52	47
Total	***100***	***78***	***69***	***44***	***26***	***14***

For the Unified Policy Scenario, Carbon Footprint, expressed as CO_2 equivalent on Life Cycle, is reported in Figure 23 by sector and in Figure 24 by fuel.

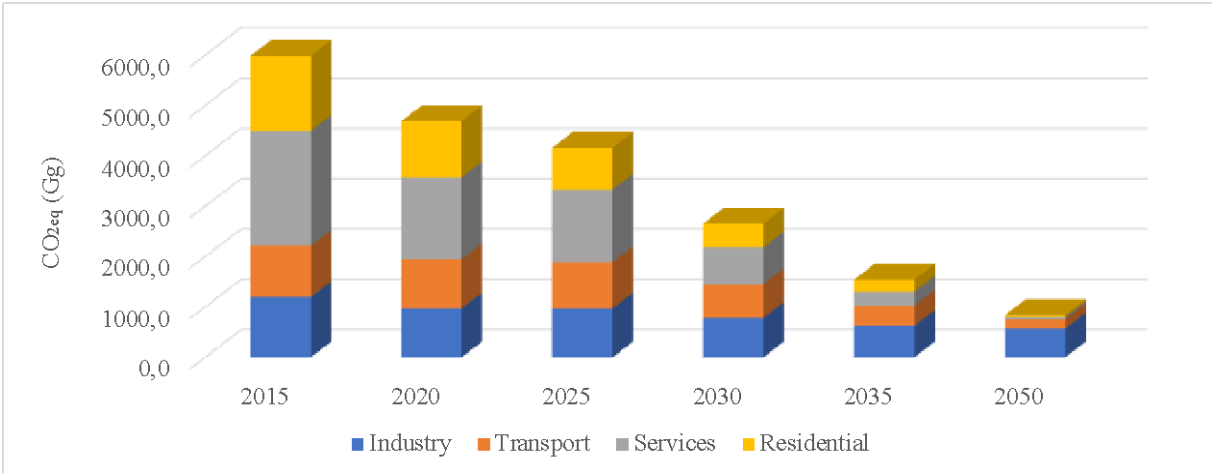

Figure 23 – Amsterdam Unified Policy Scenario Carbon Footprint by sector (Gg CO_2 equivalent on Life Cycle)

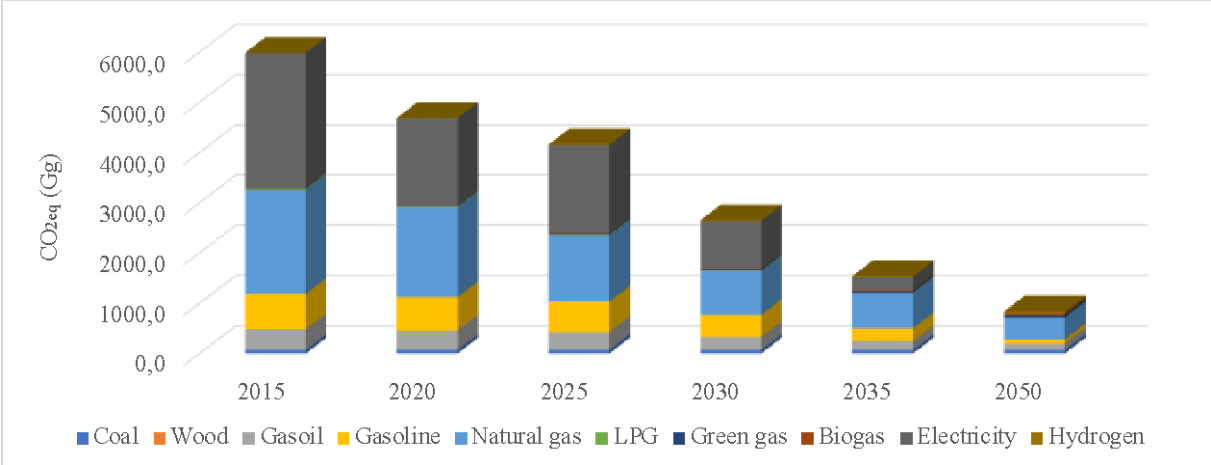

Figure 24 – Amsterdam Unified Policy Scenario Carbon Footprint by fuel (Gg CO_2 equivalent on Life Cycle)

4.3.2 BAU and Unified Policy Scenario comparison

Total Carbon Footprint in the business as usual (BAU) and unified policy scenario (UPS) is compared in Figure 25 expressed as CO_2 equivalent on Life Cycle. In Figure 26 results are reported by sector and in Figure 27 by sector and fuel. Finally, in Figure 28 Amsterdam Carbon Footprint on life cycle generated by citizens' activities is reported in BAU and UPS scenario.

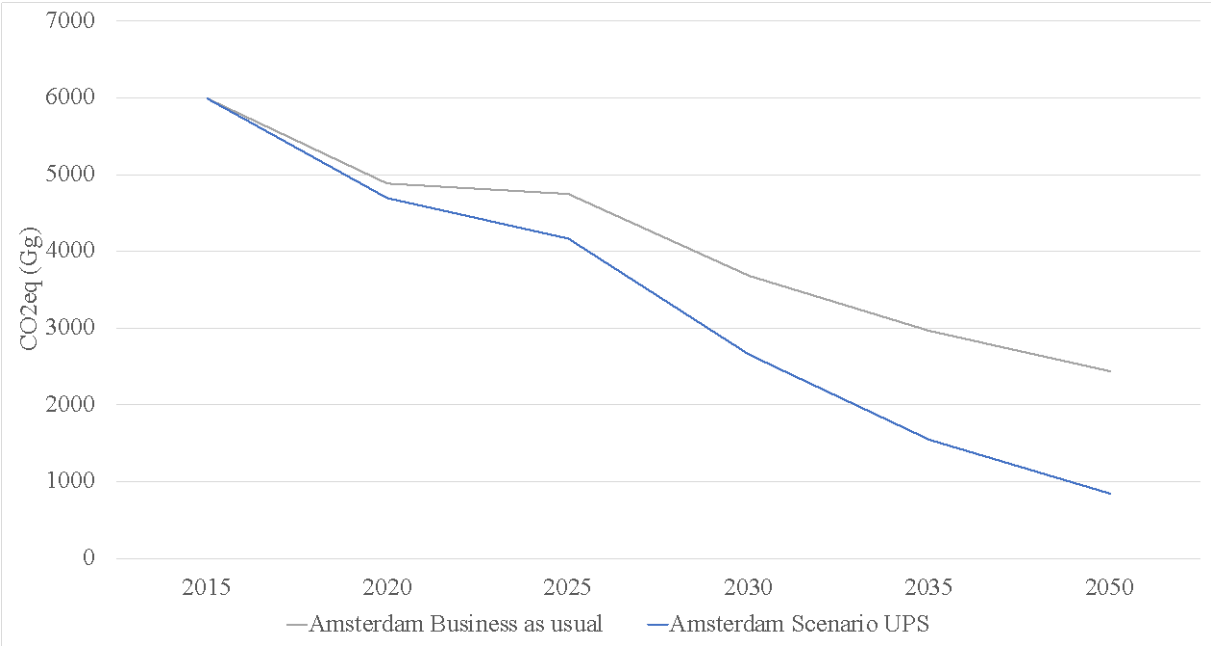

Figure 25 – Amsterdam Carbon Footprint (Mg CO_2 equivalent on Life cycle) by scenario

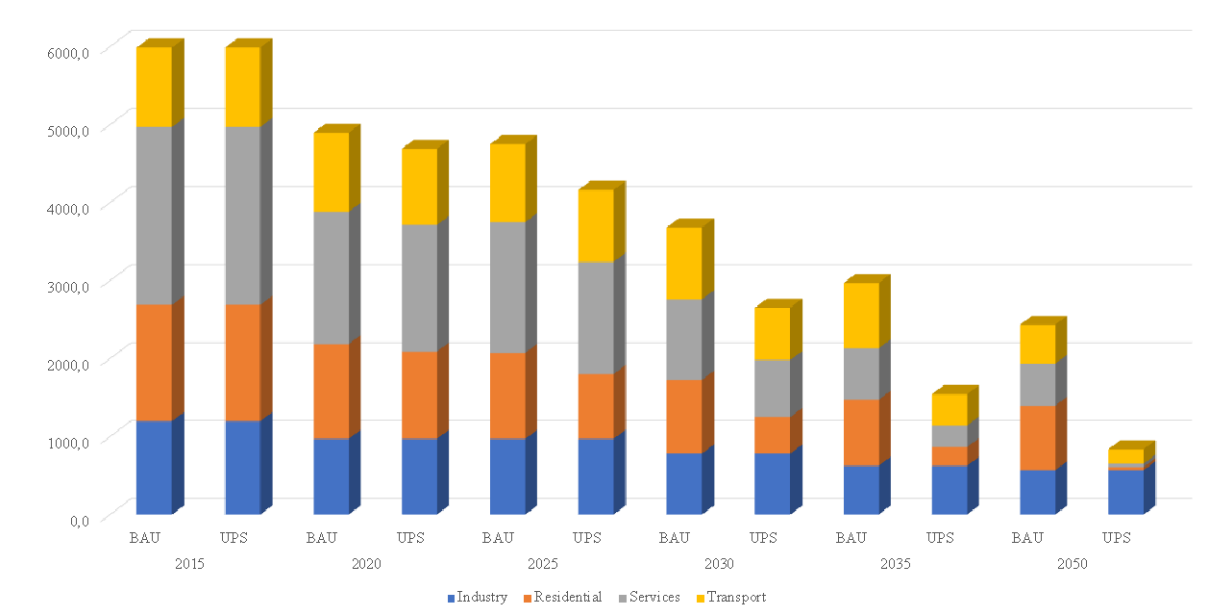

Figure 26 – Amsterdam Carbon Footprint BAU and UPS comparison by sector (Mg CO_2 equivalent on life cycle)

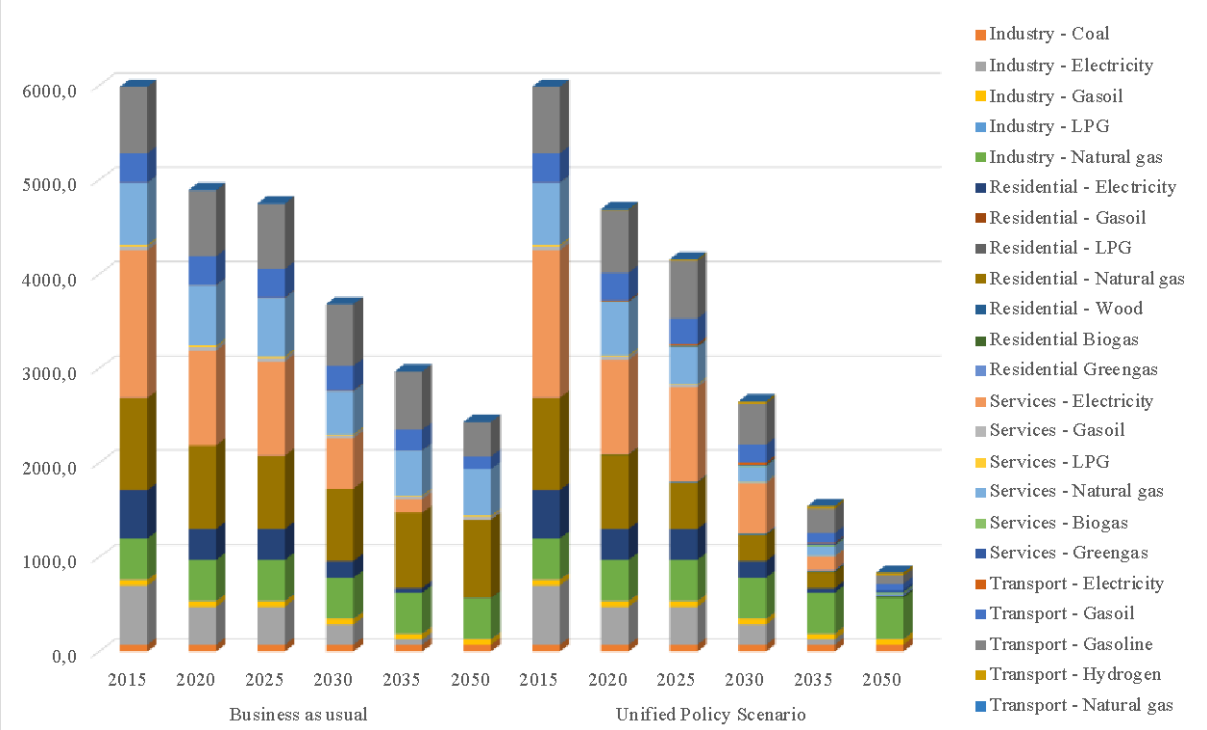

Figure 27 – Amsterdam Carbon Footprint BAU and UPS comparison by sector and fuel (Mg CO_2 equivalent on life cycle)

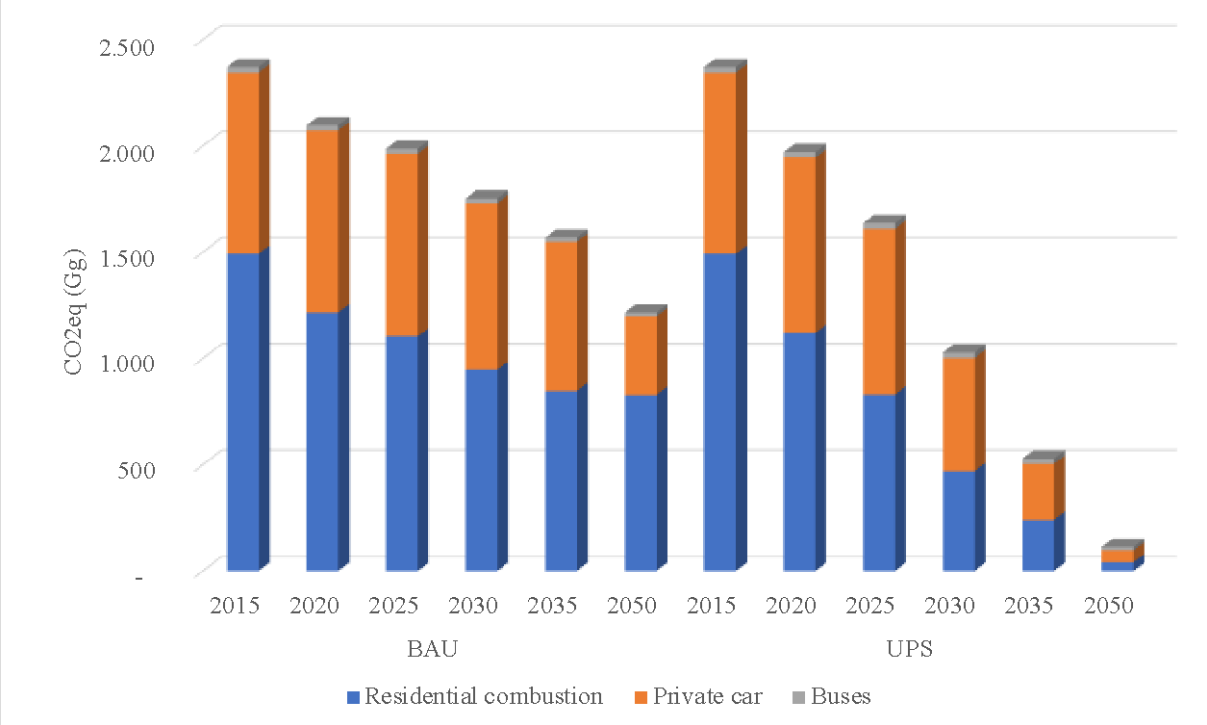

Figure 28 – Amsterdam Carbon Footprint generated by citizens' activities in BAU and UPS scenario (Mg CO_2 equivalent on life cycle)

5 SOSNOWIEC

5.1 Business As Usual projections

Business as Usual (BAU) scenario takes into consideration national and city level measures already defined/decided. As a general input to the projection model, results from IRCI and Traffic models have been assumed for fuel consumptions.

For electricity emission factors an additional driver was introduced to take into consideration the evolution of carbon footprint from electricity generation. The driver is defined using official Poland projection data up to 2040[14]. For 2050 we assume no variation from 2040 as no goal is officially fixed by Poland . The evolution of carbon footprint in industrial sector has been evaluated using data from UNFCCC National communication[15] in Manufacturing industries and construction up to 2040 assuming the values constat for 2050 as no other information is available.

[14] The Republic of Polland, Seventh National Communication and Third Biennial Report Under the United Nations Framework Convention on Climate Change
[15] Netherland Ministry of Economic Affairs and Climate Policy, Seventh Netherlands National Communication under the United Nations Framework Convention on Climate Change

In Table 20 Carbon Footprint by sector is reported for Sosnowiec BAU expressed as CO_2, CO_2 equivalent and CO_2 equivalent on Life Cycle. In Table 21 CO_2 equivalent on Life Cycle reductions on 2015 are reported.

Table 20 – Sosnowiec BAU Carbon Footprint by Sector (Gg)

Year	2015	2020	2025	2030	2035	2050
Carbon dioxide (CO_2)						
Residential	540,3	487,5	477,9	485,6	491,6	497,1
Services & Industry	828,4	861,8	901,5	971,0	1.016,0	1.037,5
Transport	96,5	97,0	96,9	93,2	88,8	62,4
Total	***1.465,3***	***1.446,3***	***1.476,3***	***1.549,8***	***1.596,5***	***1.597,0***
Carbon dioxide equivalent (CO_{2eq})						
Residential	543,2	490,2	480,4	488,0	494,1	499,5
Services & Industry	831,6	865,2	904,9	974,7	1.019,9	1.041,5
Transport	96,8	97,2	97,2	93,5	89,1	62,5
Total	***1.471,6***	***1.452,5***	***1.482,5***	***1.556,3***	***1.603,0***	***1.603,6***
Carbon dioxide equivalent on life cycle (CO_{2eq})						
Residential	577,5	522,6	512,9	521,4	528,7	534,8
Services & Industry	896,4	932,7	975,8	1.050,7	1.099,4	1.122,6
Transport	114,2	114,7	114,7	110,2	105,0	73,4
Total	***1.588,1***	***1.570,0***	***1.603,3***	***1.682,3***	***1.733,1***	***1.730,9***

Table 21 – Sosnowiec BAU Carbon Footprint by Sector: index (2015=100)

Year	2015	2020	2025	2030	2035	2050
Carbon dioxide equivalent on life cycle (CO_{2eq})						
Residential	100	90	89	90	92	93
Services	100	104	109	117	123	125
Transport	100	100	100	97	92	64
Total	***100***	***99***	***101***	***106***	***109***	***109***

Carbon Footprint, expressed as CO_2 equivalent on Life Cycle, is reported in Figure 29 by sector and in Figure 30 by fuel. The graphs highlight the largely dominant contribution of the residential and service sectors as described above, from the point of view of energy carriers, natural gas and electricity.

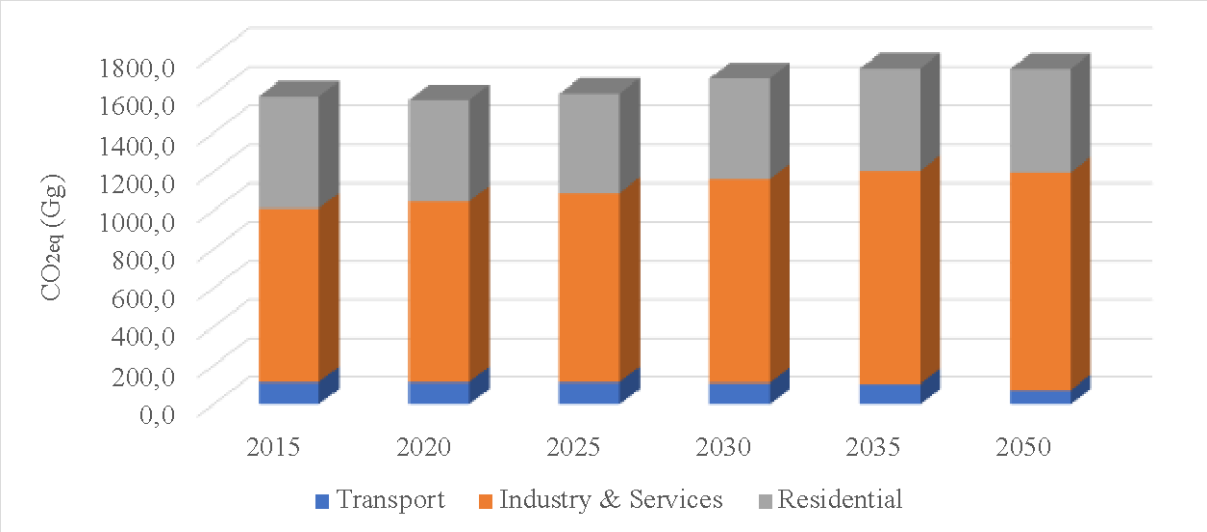

Figure 29 – Sosnowiec BAU Carbon Footprint by sector (Gg CO_2 equivalent on Life Cycle)

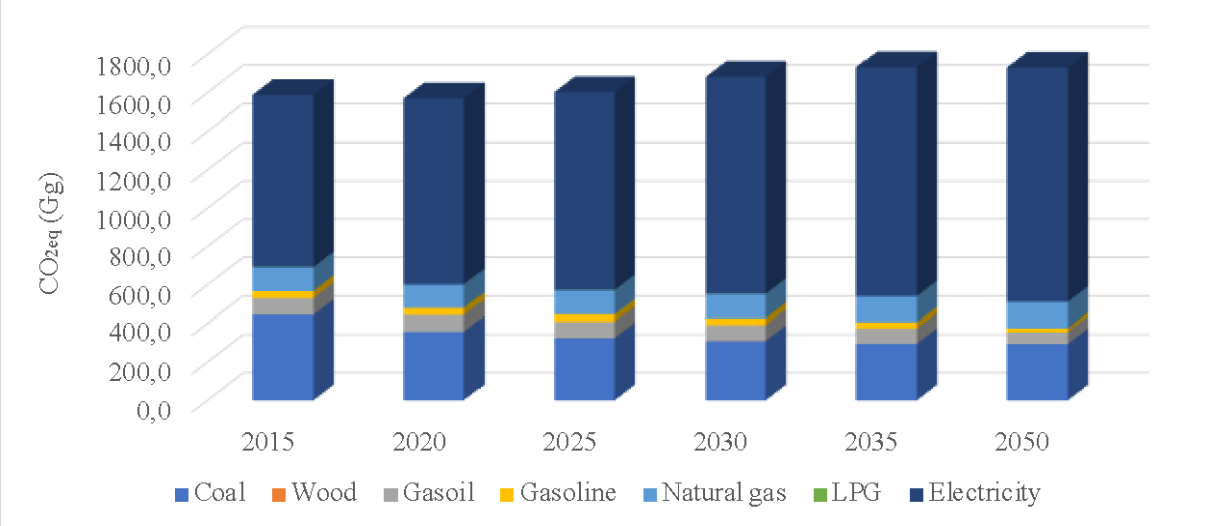

Figure 30 – Sosnowiec BAU Carbon Footprint by fuel (Gg CO_2 equivalent on Life Cycle)

5.2 Scenario projections

Scenario projections take into consideration city level additional measures from Stakeholder dialog workshop (SWD). Also, in this case as a general input to the projection model, results from IRCI and Traffic models have been assumed for fuel consumptions.

5.2.1 Scenario *low*

In Table 22 Carbon Footprint by sector is reported for Sosnowiec Scenario *low* expressed as CO_2, CO_2 equivalent and CO_2 equivalent on Life Cycle. In Table 23 CO_2 equivalent on Life Cycle reductions on 2015 are reported.

Table 22 – Sosnowiec Scenario *low* Carbon Footprint by Sector (Gg)

Year	2015	2020	2025	2030	2035	2050
Carbon dioxide (CO_2)						
Residential	540,3	487,5	468,2	476,7	483,4	489,3
Services & Industry	828,4	861,8	900,7	970,3	1.015,4	1.036,9
Transport	96,5	95,1	93,3	87,0	80,3	57,5
Total	***1.465,3***	***1.444,4***	***1.462,1***	***1.534,1***	***1.579,1***	***1.583,8***
Carbon dioxide equivalent (CO_{2eq})						
Residential	543,2	490,2	470,6	479,1	485,8	491,7
Services & Industry	831,6	865,2	904,2	974,0	1.019,2	1.040,9
Transport	96,8	95,3	93,5	87,2	80,6	57,6
Total	***1.471,6***	***1.450,6***	***1.468,3***	***1.540,4***	***1.585,6***	***1.590,3***
Carbon dioxide equivalent on life cycle (CO_{2eq})						
Residential	577,5	522,6	502,7	512,1	520,1	526,7
Services & Industry	896,4	932,7	975,0	1.049,9	1.098,7	1.122,0
Transport	114,2	112,5	110,2	102,8	94,8	67,5
Total	***1.588,1***	***1.567,7***	***1.587,9***	***1.664,8***	***1.713,6***	***1.716,2***

Table 23 – Sosnowiec Scenario *low* Carbon Footprint by Sector: index (2015=100)

Year	2015	2020	2025	2030	2035	2050
Carbon dioxide equivalent on life cycle (CO_{2eq})						
Residential	100	90	87	89	90	91
Services	100	104	109	117	123	125
Transport	100	98	97	90	83	59
Total	***100***	***99***	***100***	***105***	***108***	***108***

For the Scenario *low*, Carbon Footprint, expressed as CO_2 equivalent on Life Cycle, is reported in Figure 30 by sector and in Figure 31 by fuel.

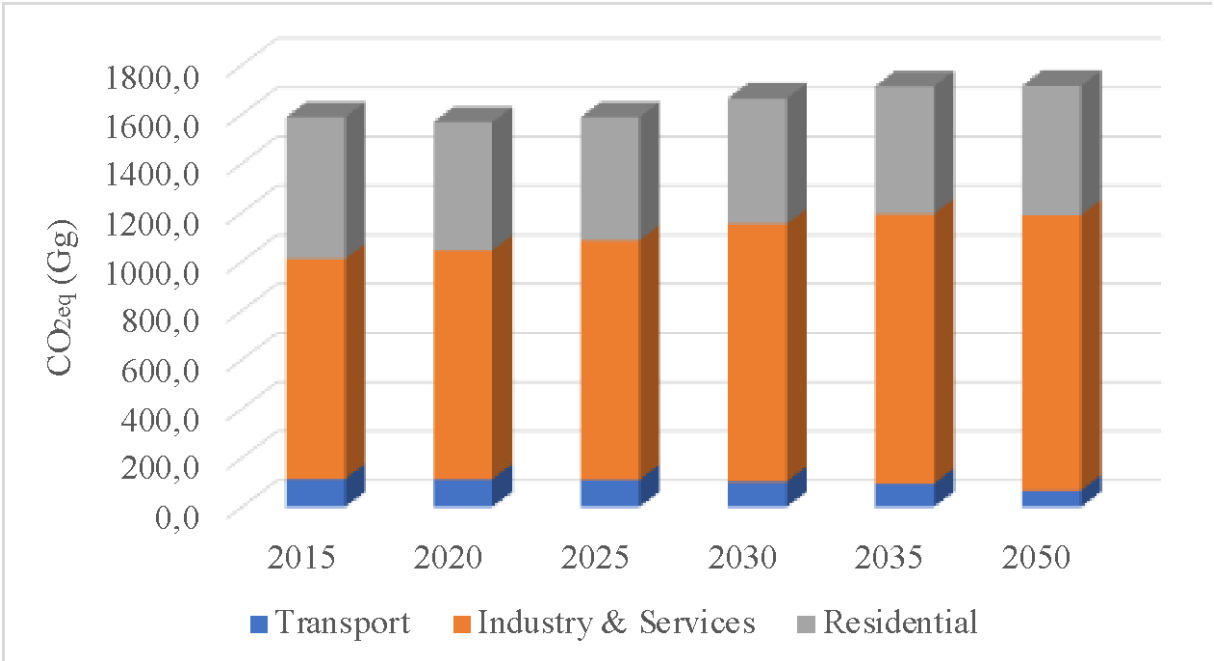

Figure 31 – Sosnowiec Scenario *low* Carbon Footprint by sector (Gg CO_2 equivalent on Life

Cycle)

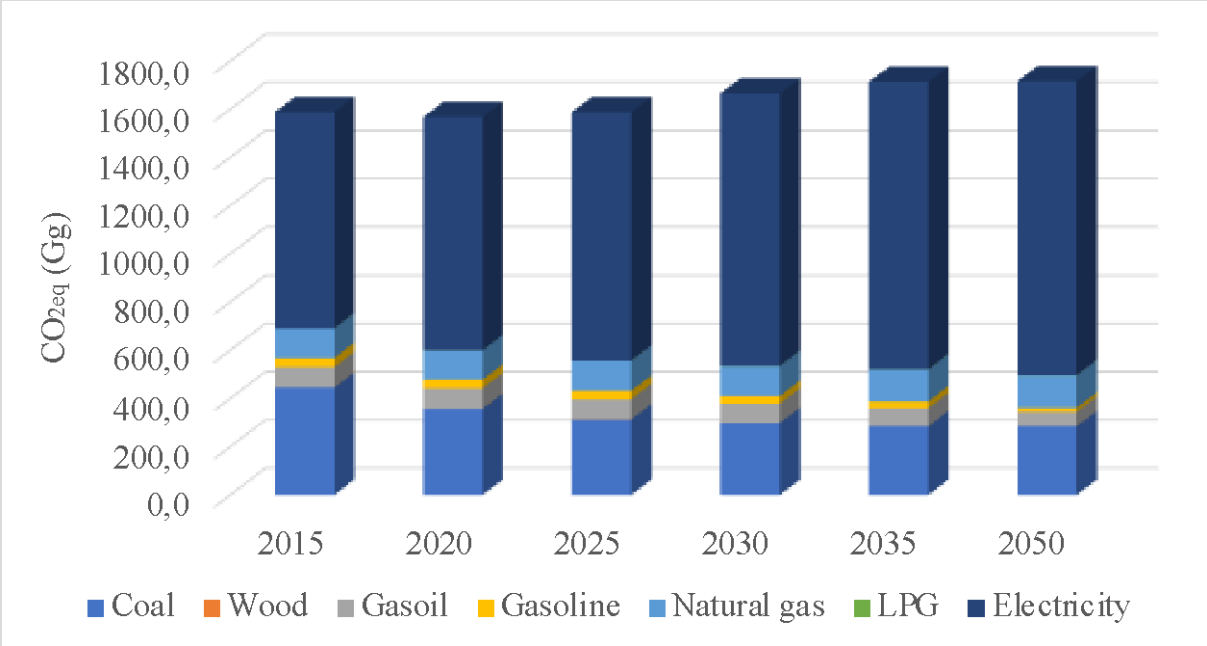

Figure 32 – Sosnowiec Scenario *low* Carbon Footprint by fuel (Gg CO_2 equivalent on Life Cycle)

5.2.2 Scenario *high*

In Table 24 Carbon Footprint by sector is reported for Sosnowiec Scenario *high* expressed as CO_2, CO_2 equivalent and CO_2 equivalent on Life Cycle. In Table 25 CO_2 equivalent on Life Cycle reductions on 2015 are reported.

Table 24 – Sosnowiec Scenario *high* Carbon Footprint by Sector (Gg)

Year	2015	2020	2025	2030	2035	2050
Carbon dioxide (CO_2)						
Residential	540,3	381,3	380,5	396,9	409,2	419,6
Services & Industry	828,4	853,5	893,8	964,0	1.009,5	1.031,4
Transport	96,5	80,0	63,3	60,4	57,3	44,7
Total	***1.465,3***	***1.314,8***	***1.337,6***	***1.421,3***	***1.476,0***	***1.495,8***
Carbon dioxide equivalent (CO_{2eq})						
Residential	543,2	383,3	382,4	398,8	411,1	421,6
Services & Industry	831,6	856,7	897,2	967,7	1.013,4	1.035,4
Transport	96,8	80,2	63,5	60,5	57,5	44,8
Total	***1.471,6***	***1.320,3***	***1.343,1***	***1.427,1***	***1.481,9***	***1.501,8***
Carbon dioxide equivalent on life cycle (CO_{2eq})						
Residential	577,5	411,2	410,7	428,4	442,3	453,6
Services & Industry	896,4	923,9	967,8	1.043,4	1.092,6	1.116,2
Transport	114,2	94,2	74,2	70,6	67,1	52,1
Total	***1.588,1***	***1.429,4***	***1.452,6***	***1.542,4***	***1.601,9***	***1.621,9***

Table 25 – Sosnowiec Scenario *high* Carbon Footprint by Sector: index (2015=100)

Year	2015	2020	2025	2030	2035	2050
Carbon dioxide equivalent on life cycle (CO_{2eq})						
Residential	100	71	71	74	77	79
Services & Industry	100	103	108	116	122	125
Transport	100	82	65	62	59	46
Total	***100***	***90***	***91***	***97***	***101***	***102***

For the Scenario *high*, Carbon Footprint, expressed as CO_2 equivalent on Life Cycle, is reported in Figure 34 by sector and in Figure 35 by fuel.

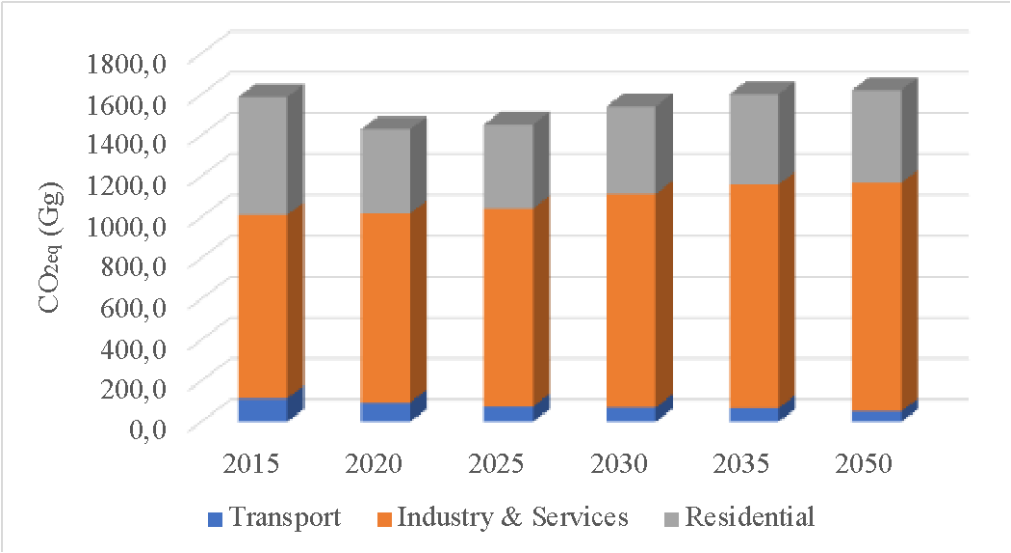

Figure 33 – Sosnowiec Scenario *high* Carbon Footprint by sector (Gg CO_2 equivalent on Life Cycle)

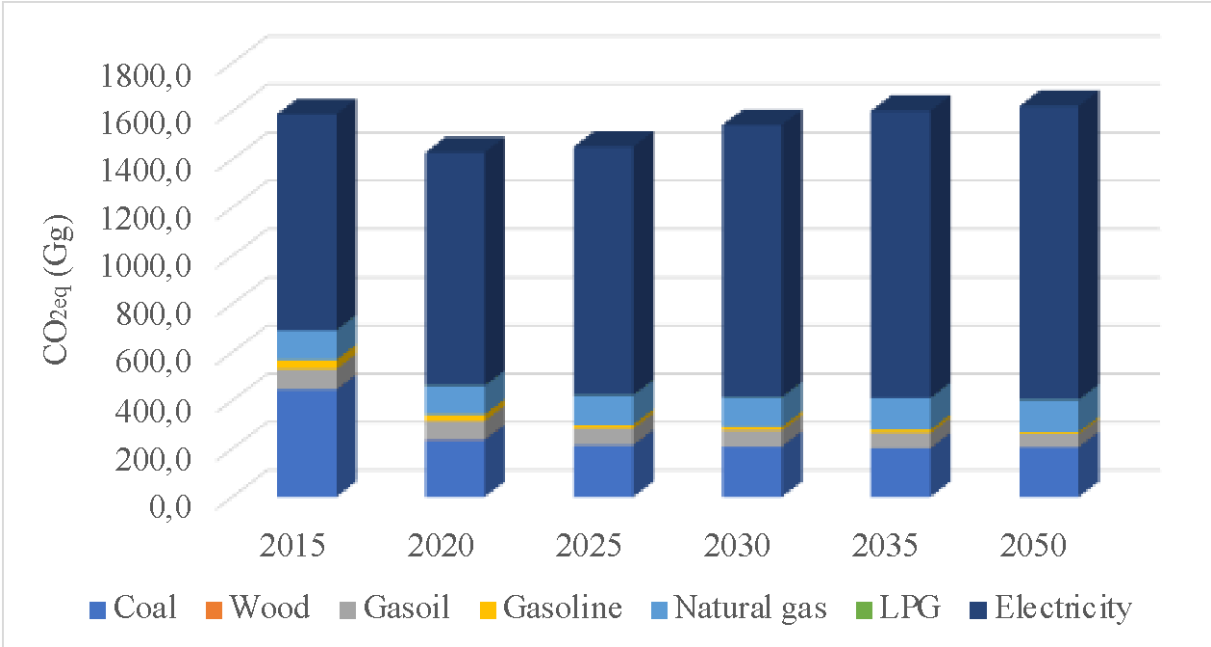

Figure 34 – Sosnowiec Scenario *high* Carbon Footprint by fuel (Gg CO_2 equivalent on Life

Cycle)

5.2.3 BAU and Scenarios comparison

Total Carbon Footprint in the different scenarios is compared in Figure 35 expressed as CO_2 equivalent on Life Cycle.

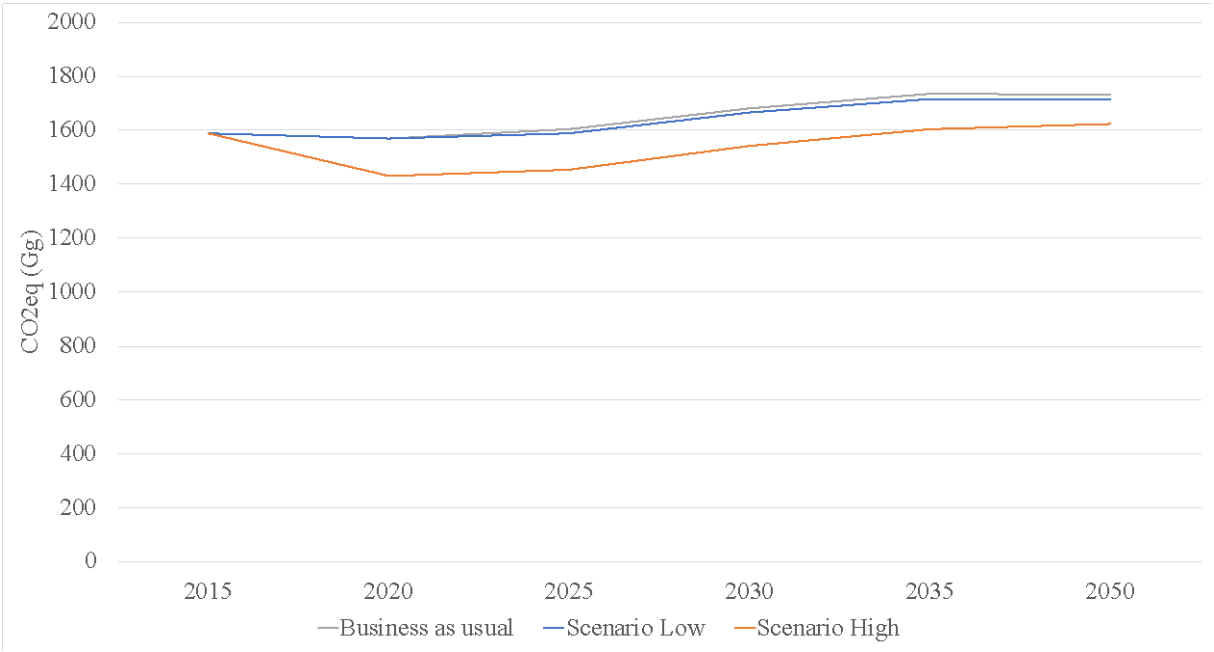

Figure 35 – Sosnowiec Carbon Footprint (Mg CO_2 equivalent on Life cycle) by scenario

5.3 Final Unified Policy Scenario projections

Also, for the final Unified Policy Scenario as a general input to the projection model, results from IRCI and Traffic models have been assumed for fuel consumptions.

5.3.1 Unified Policy Scenario results

In Table 26 Carbon Footprint by sector is reported for Sosnowiec Scenario 1 expressed as CO_2, CO_2 equivalent and CO_2 equivalent on Life Cycle. In Table 27 CO_2 equivalent on Life Cycle reductions on 2015 are reported.

Table 26 – Sosnowiec Unified Policy Scenario Carbon Footprint by Sector (Gg)

Year	2015	2020	2025	2030	2035	2050
	Carbon dioxide (CO_2)					
Residential	540,3	487,5	468,2	476,7	483,4	489,3
Services & Industry	828,4	861,8	900,7	970,3	1.015,4	1.036,9
Transport	96,5	89,0	81,0	72,6	63,8	45,9
Total	***1.465,3***	***1.438,3***	***1.449,9***	***1.519,7***	***1.562,6***	***1.572,1***
	Carbon dioxide equivalent (CO_{2eq})					

Residential	543,2	490,2	470,6	479,1	485,8	491,7
Services & Industry	831,6	865,2	904,2	974,0	1.019,2	1.040,9
Transport	96,8	89,2	81,2	72,8	64,0	46,0
Total	***1.471,6***	***1.444,5***	***1.456,0***	***1.526,0***	***1.569,0***	***1.578,6***
Carbon dioxide equivalent on life cycle (CO_{2eq})						
Residential	577,5	522,6	502,7	512,1	520,1	526,7
Services & Industry	896,4	932,7	975,0	1.049,9	1.098,7	1.122,0
Transport	114,2	105,1	95,5	85,5	74,9	53,5
Total	***1.588,1***	***1.560,4***	***1.573,2***	***1.647,5***	***1.693,7***	***1.702,2***

Table 27 – Sosnowiec Unified Policy Scenario Carbon Footprint by Sector: index (2015=100)

Year	2015	2020	2025	2030	2035	2050
Carbon dioxide equivalent on life cycle (CO_{2eq})						
Residential	100	90	87	89	90	91
Services & Industry	100	104	109	117	123	125
Transport	100	92	84	75	66	47
Industry	100	98	99	104	107	107
Total	***100***	***90***	***87***	***89***	***90***	***91***

For the Unified Policy Scenario, Carbon Footprint, expressed as CO_2 equivalent on Life Cycle, is reported in Figure 36 by sector and in Figure 37 by fuel.

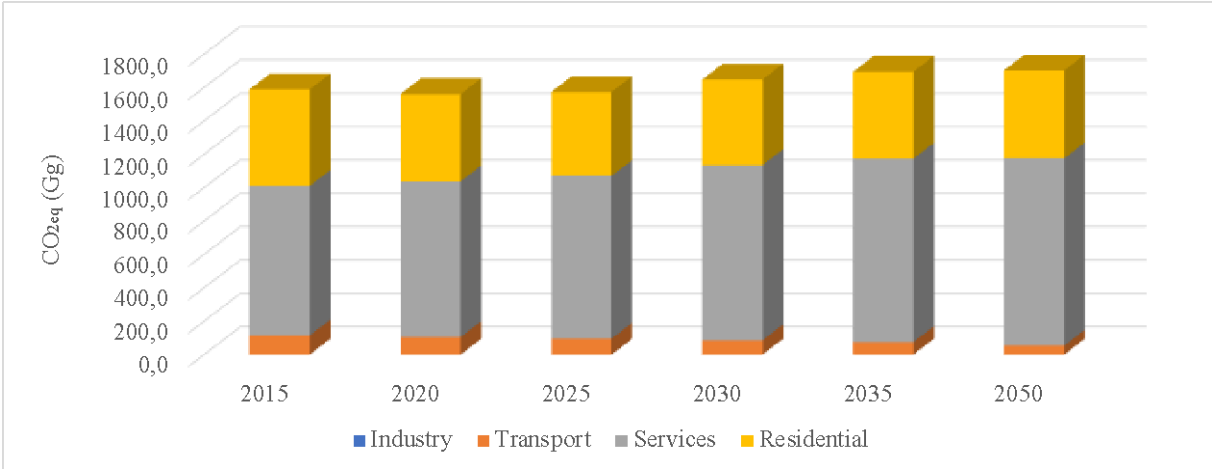

Figure 36 – Sosnowiec Unified Policy Scenario Carbon Footprint by sector (Gg CO_2 equivalent on Life Cycle)

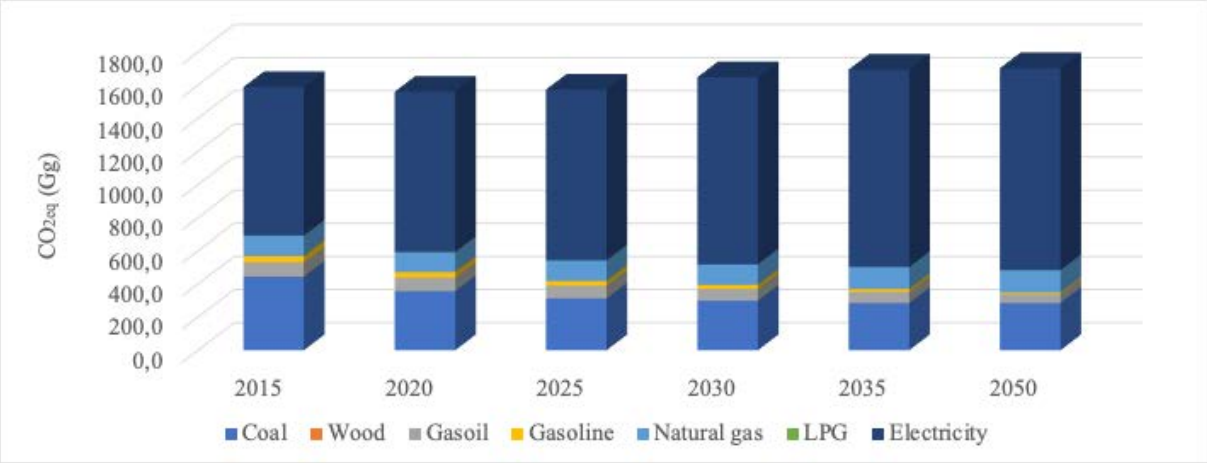

Figure 37 – Sosnowiec Unified Policy Scenario Carbon Footprint by fuel (Gg CO_2 equivalent on Life Cycle)

5.3.2 BAU and Unified Policy Scenario comparison

Total Carbon Footprint in the business as usual (BAU) and unified policy scenario (UPS) is compared in Figure 25 expressed as CO_2 equivalent on Life Cycle. Finally, in Figure 38 Sosnowiec Carbon Footprint on life cycle generated by citizens' activities is reported in BAU and UPS scenario.

In Finally, in Figure 41 Carbon Footprint on life cycle generated by citizens' activities is reported in BAU and UPS scenario.

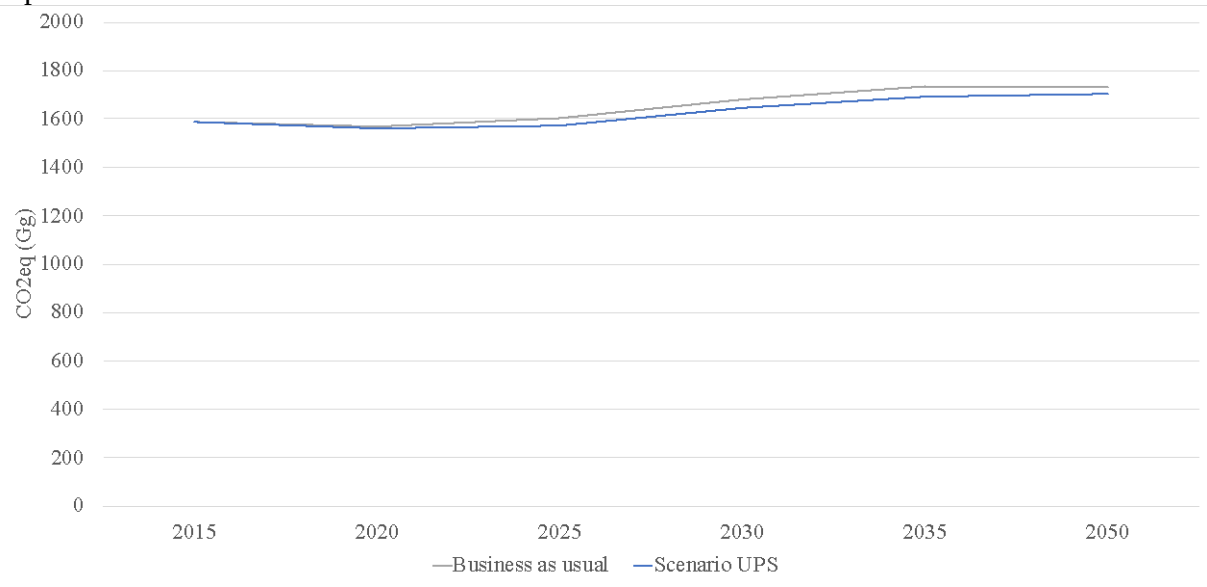

Figure 38 – Sosnowiec Carbon Footprint (Mg CO_2 equivalent on Life cycle) by scenario

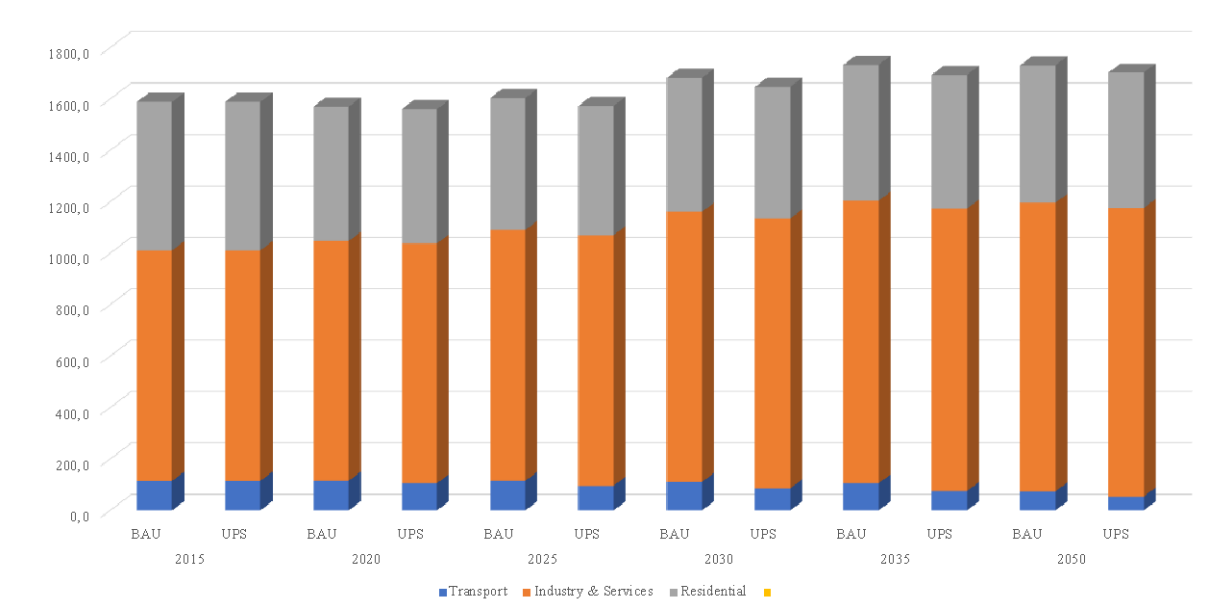

Figure 39 results are reported by sector and in Figure 40 by sector and fuel. Finally, in Figure 41 Carbon Footprint on life cycle generated by citizens' activities is reported in BAU and UPS scenario.

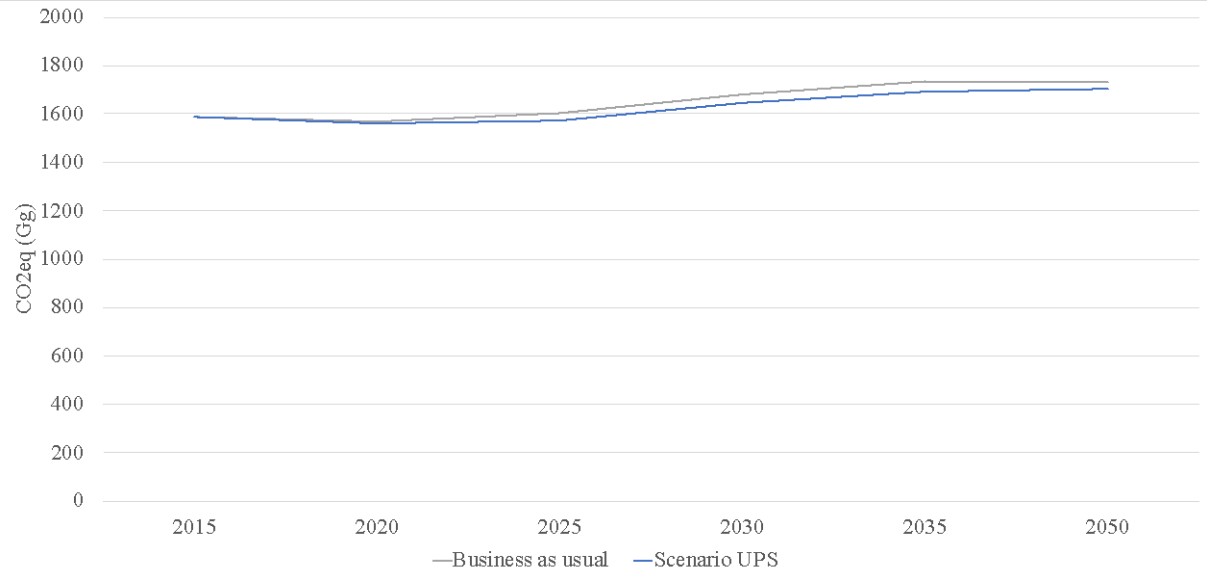

Figure 38 – Sosnowiec Carbon Footprint (Mg CO_2 equivalent on Life cycle) by scenario

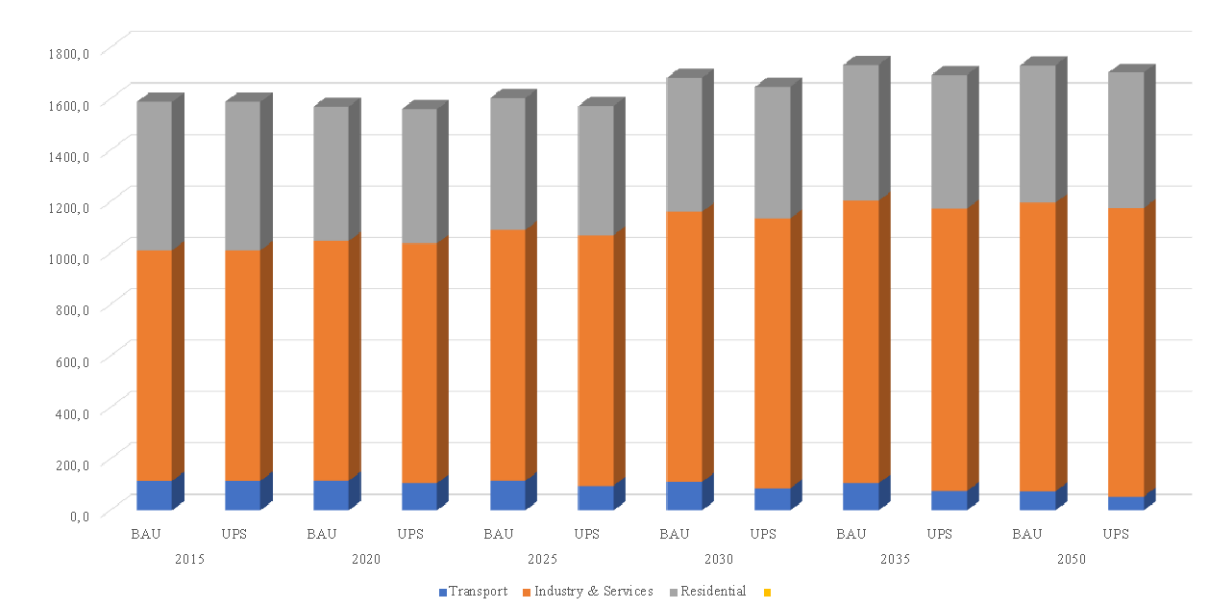

Figure 39 – Sosnowiec Carbon Footprint on life cycle BAU and UPS comparison by sector (Mg CO_2 equivalent)

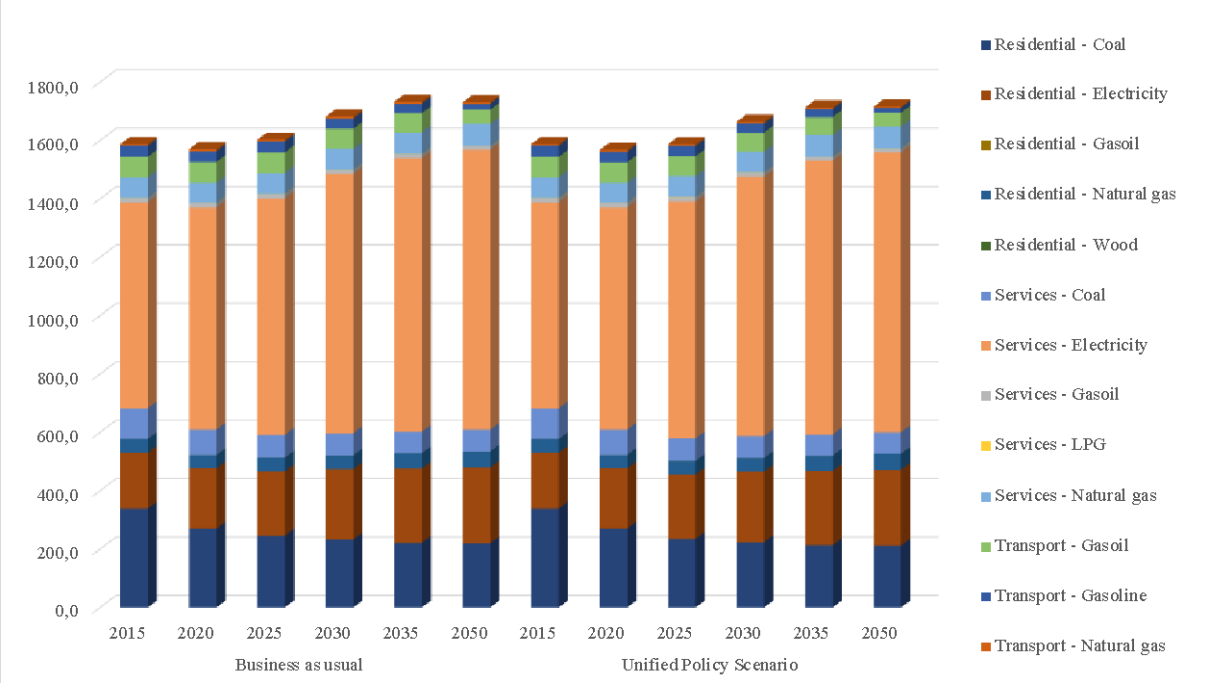

Figure 40 – Sosnowiec Carbon Footprint on life cycle BAU and UPS comparison by sector and fuel (Mg CO_2 equivalent)

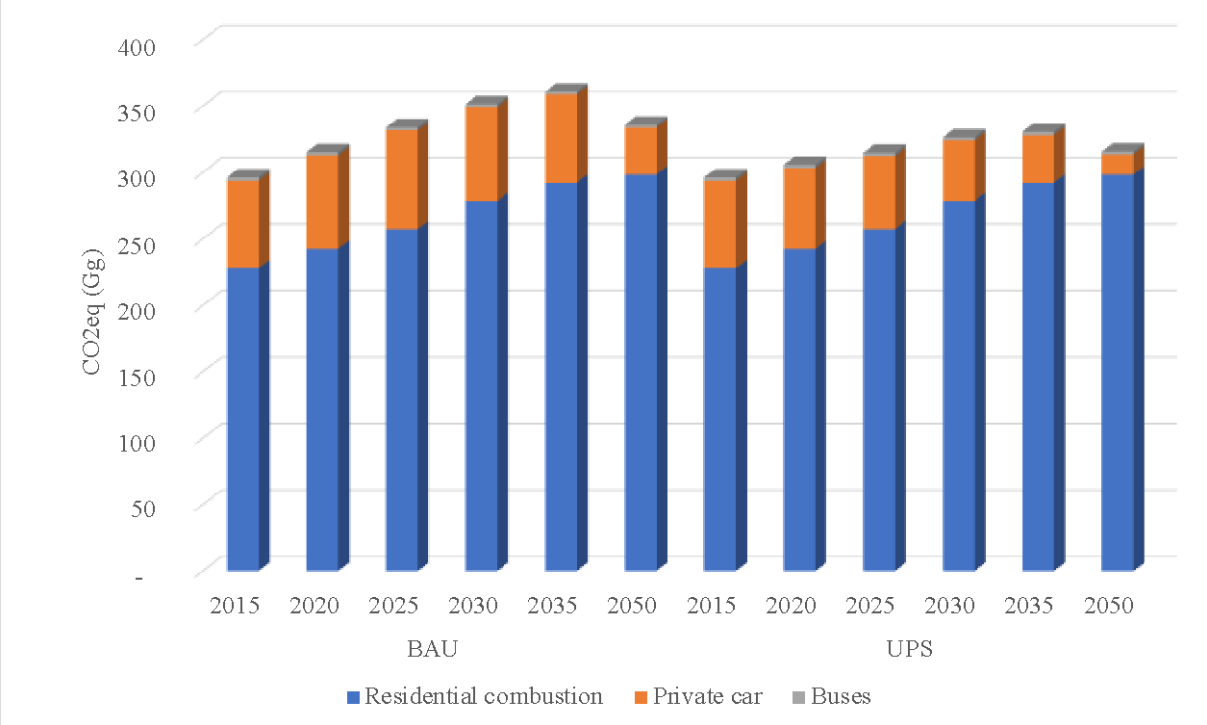

Figure 41 – Sosnowiec Carbon Footprint on life cycle generated by citizens' activities in BAU and UPS scenario (Mg CO_2 equivalent)

6 LJUBLJIANA

6.1 Business As Usual projections

Business as Usual (BAU) scenario takes into consideration national and city level measures already defined/decided. As a general input to the projection model, results from IRCI and Traffic models have been assumed for fuel consumptions.

For electricity emission factors an additional driver was introduced to take into consideration the evolution of carbon footprint from electricity generation reported in the 7th national communication to UNFCCC[16] using scenario with additional measures (WAM). By 2050, despite the declaration of intent to move towards carbon neutrality, in the absence of precise data, the 2035 objective was kept constant. For industry in absence of energy consumptions projection subdivided by fuel the distribution between fuels has been kept constant.

In Table 28 Carbon Footprint by sector is reported for Ljubljiana BAU expressed as CO_2, CO_2 equivalent and CO_2 equivalent on Life Cycle. In Table 29 CO_2 equivalent on Life Cycle reductions on 2015 are reported.

[16] Republic of Slovenia, Ministry of the Environment and Spatial Planning 7th National Communication & 3rd Biennial Report from Slovenia under the United Nations Framework Convention on Climate Change, March 2018

Table 28 – Ljubljiana BAU Carbon Footprint by Sector (Gg)

Year	2015	2020	2025	2030	2035	2050
Carbon dioxide (CO_2)						
Residential	337,6	341,0	295,2	245,9	214,8	214,8
Services	341,3	325,9	291,0	258,8	234,0	234,0
Transport	275,1	280,8	280,3	268,0	255,6	211,8
Industry	337,1	367,4	368,6	363,3	362,3	362,3
Total	***1.291,0***	***1.315,1***	***1.235,0***	***1.136,0***	***1.066,6***	***1.022,8***
Carbon dioxide equivalent (CO_{2eq})						
Industry	339,6	342,8	296,8	247,3	216,0	216,0
Services	342,8	327,5	292,3	259,9	235,0	235,0
Transport	275,8	281,6	281,0	268,7	256,2	212,4
Residential	338,3	368,8	369,9	364,6	363,5	363,5
Total	***1.296,6***	***1.320,6***	***1.240,1***	***1.140,5***	***1.070,7***	***1.026,8***
Carbon dioxide equivalent on life cycle (CO_{2eq})						
Residential	380,0	384,5	333,5	278,2	243,5	243,5
Services	369,6	351,6	314,8	280,8	254,5	254,5
Transport	329,5	336,4	335,7	320,1	304,4	249,9
Industry	371,5	405,0	407,6	403,4	403,6	403,6
Total	***1.450,6***	***1.477,5***	***1.391,6***	***1.282,5***	***1.206,0***	***1.151,5***

Table 29 – Ljubljiana BAU Carbon Footprint by Sector: index (2015=100)

Year	2015	2020	2025	2030	2035	2050
Carbon dioxide equivalent on life cycle (CO_{2eq})						
Residential	100	101	88	73	64	64
Services	100	95	85	76	69	69
Transport	100	102	102	97	92	76
Industry	100	109	110	109	109	109
Total	***100***	***102***	***96***	***88***	***83***	***79***

Carbon Footprint, expressed as CO_2 equivalent on Life Cycle, is reported in Figure 42 by sector and in Figure 43 by fuel. The graphs highlight the largely dominant contribution of the residential and service sectors as described above, from the point of view of energy carriers, natural gas and electricity.

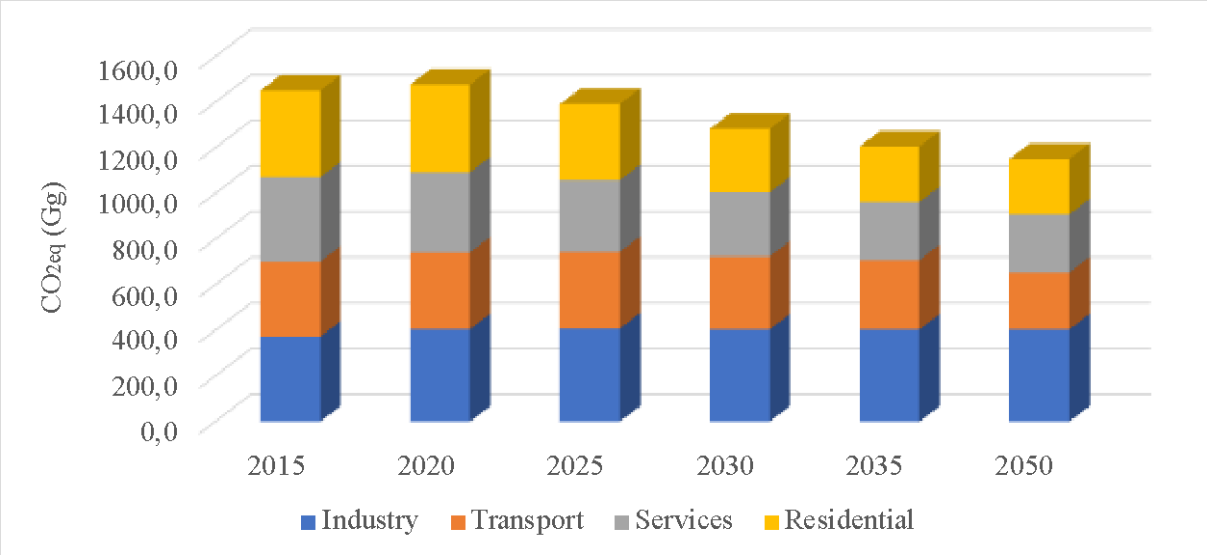

Figure 42 – Ljubljiana BAU Carbon Footprint by sector (Gg CO_2 equivalent on Life Cycle)

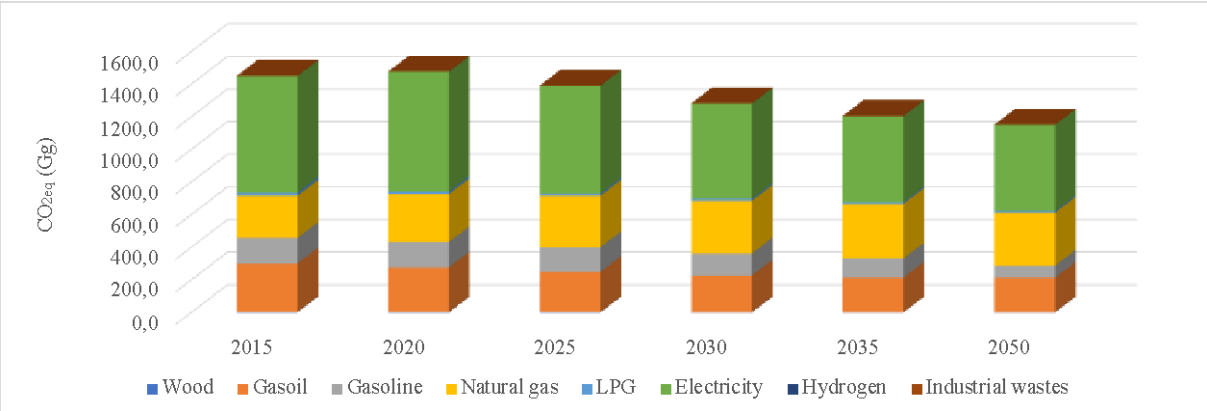

Figure 43 – Ljubljiana BAU Carbon Footprint by fuel (Gg CO_2 equivalent on Life Cycle)

6.2 Scenario projections

Scenario projections take into consideration city level additional measures from Stakeholder dialog workshop (SWD). Also, in this case as a general input to the projection model, results from IRCI and Traffic models have been assumed for fuel consumptions.

6.2.1 Scenario *low*

In Table 30 Carbon Footprint by sector is reported for Ljubljiana Scenario *low* expressed as CO_2, CO_2 equivalent and CO_2 equivalent on Life Cycle. In Table 31 CO_2 equivalent on Life Cycle reductions on 2015 are reported.

Table 30 – Ljubljiana Scenario *low* Carbon Footprint by Sector (Gg)

Year	2015	2020	2025	2030	2035	2050
Carbon dioxide (CO_2)						

Residential	337,6	341,0	295,2	245,9	214,8	214,8
Services	341,3	320,3	286,1	252,5	228,4	228,4
Transport	275,1	270,7	261,3	237,5	211,2	118,3
Industry	337,1	367,4	368,6	363,3	362,3	362,3
Total	***1.291,0***	***1.299,4***	***1.211,2***	***1.099,2***	***1.016,6***	***923,7***
Carbon dioxide equivalent (CO_{2eq})						
Residential	339,6	342,8	296,8	247,3	216,0	216,0
Services	342,8	321,8	287,4	253,6	229,4	229,4
Transport	275,8	271,5	262,0	238,1	211,7	118,6
Industry	338,3	368,8	369,9	364,6	363,5	363,5
Total	***1.296,6***	***1.304,9***	***1.216,1***	***1.103,6***	***1.020,6***	***927,4***
Carbon dioxide equivalent on life cycle (CO_{2eq})						
Residential	380,0	384,5	333,5	278,2	243,5	243,5
Services	369,6	345,7	309,6	274,1	248,6	248,6
Transport	329,5	324,4	313,2	284,4	252,6	141,8
Industry	371,5	405,0	407,6	403,4	403,6	403,6
Total	***1.450,6***	***1.459,5***	***1.363,9***	***1.240,1***	***1.148,3***	***1.037,5***

Table 31 – Ljubljiana Scenario *low* Carbon Footprint by Sector: index (2015=100)

Year	2015	2020	2025	2030	2035	2050
Carbon dioxide equivalent on life cycle (CO_{2eq})						
Residential	100	101	88	73	64	64
Services	100	94	84	74	67	67
Transport	100	98	95	86	77	43
Industry	100	109	110	109	109	109
Total	***100***	***101***	***94***	***85***	***79***	***72***

For the Scenario *low*, Carbon Footprint, expressed as CO_2 equivalent on Life Cycle, is reported in Figure 44 by sector and in Figure 45 by fuel.

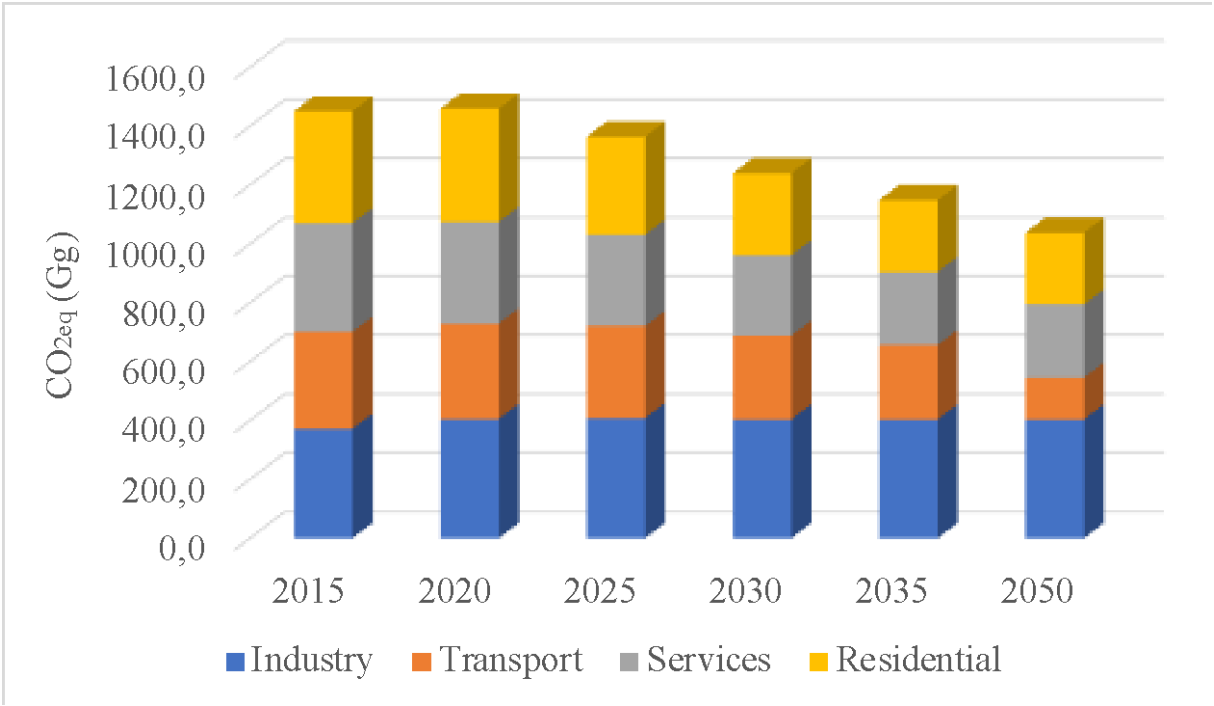

Figure 44 – Ljubljiana Scenario *low* Carbon Footprint by sector (Gg CO_2 equivalent on Life Cycle)

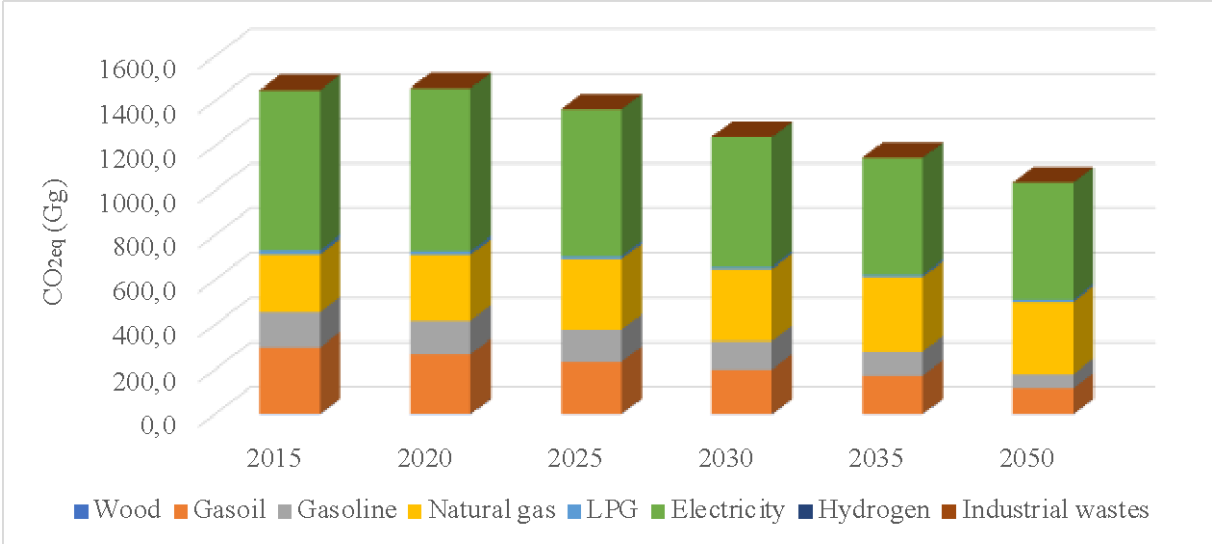

Figure 45 – Ljubljiana Scenario *low* Carbon Footprint by fuel (Gg CO_2 equivalent on Life Cycle)

6.2.2 Scenario *high*

In Table 32 Carbon Footprint by sector is reported for Ljubljiana Scenario *high* expressed as CO_2, CO_2 equivalent and CO_2 equivalent on Life Cycle. In Table 33 CO_2 equivalent on Life Cycle reductions on 2015 are reported.

Table 32 – Ljubljiana Scenario *high* Carbon Footprint by Sector (Gg)

Year	2015	2020	2025	2030	2035	2050
Carbon dioxide (CO_2)						
Residential	337,6	341,0	295,2	245,9	214,8	214,8
Services	341,3	320,3	286,1	252,5	228,4	228,4
Transport	275,1	265,1	247,5	220,8	193,9	114,8
Industry	337,1	367,4	368,6	363,3	362,3	362,3
Total	***1.291,0***	***1.293,7***	***1.197,4***	***1.082,5***	***999,4***	***920,2***
Carbon dioxide equivalent (CO_{2eq})						
Residential	339,6	342,8	296,8	247,3	216,0	216,0
Services	342,8	321,8	287,4	253,6	229,4	229,4
Transport	275,8	265,8	248,2	221,4	194,4	115,1
Industry	338,3	368,8	369,9	364,6	363,5	363,5
Total	***1.296,6***	***1.299,2***	***1.202,3***	***1.086,8***	***1.003,3***	***924,0***
Carbon dioxide equivalent on life cycle (CO_{2eq})						
Residential	380,0	384,5	333,5	278,2	243,5	243,5
Services	369,6	345,7	309,6	274,1	248,6	248,6
Transport	329,5	317,6	296,7	264,2	231,8	137,5
Industry	371,5	405,0	407,6	403,4	403,6	403,6
Total	***1.450,6***	***1.452,7***	***1.347,3***	***1.219,9***	***1.127,4***	***1.033,2***

Table 33 – Ljubljiana Scenario *high* Carbon Footprint by Sector: index (2015=100)

Year	2015	2020	2025	2030	2035	2050
Carbon dioxide equivalent on life cycle (CO_{2eq})						
Residential	100	101	88	73	64	64
Services	100	94	84	74	67	67
Transport	100	96	90	80	70	42
Industry	100	109	110	109	109	109
Total	***100***	***100***	***93***	***84***	***78***	***71***

For the Scenario *high*, Carbon Footprint, expressed as CO_2 equivalent on Life Cycle, is reported in Figure 46 by sector and in Figure 47 by fuel.

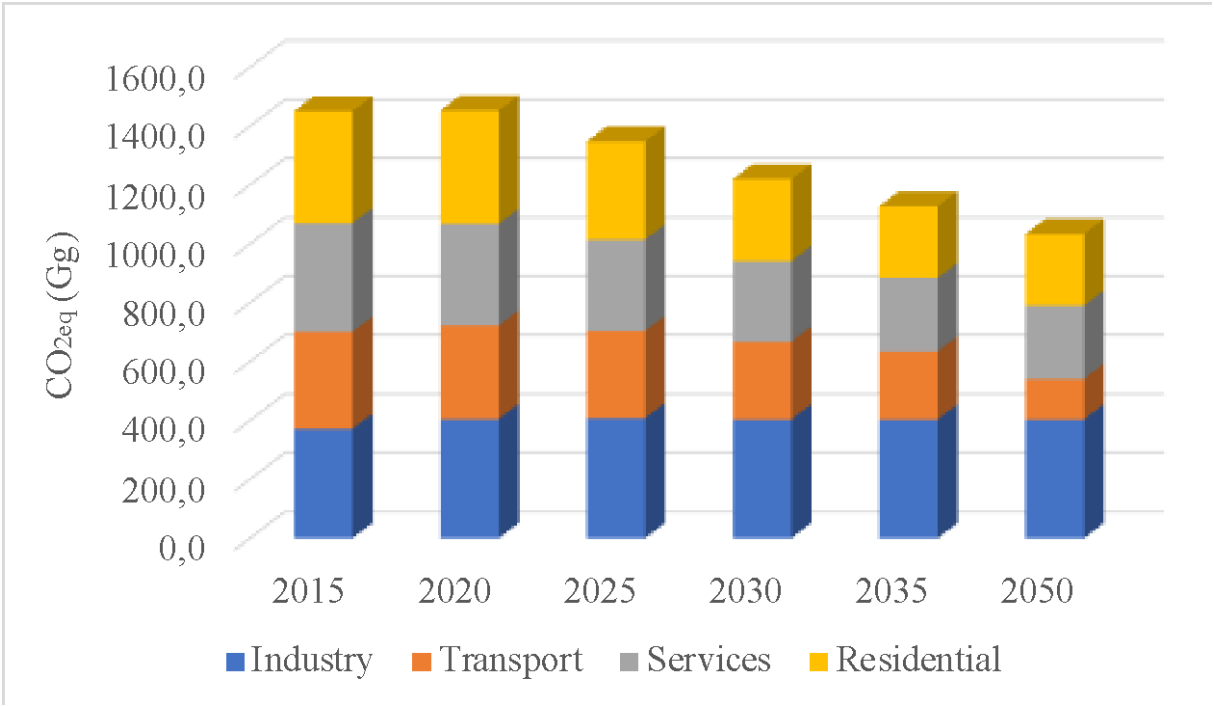

Figure 46 – Ljubljiana Scenario *high* Carbon Footprint by sector (Gg CO_2 equivalent on Life Cycle)

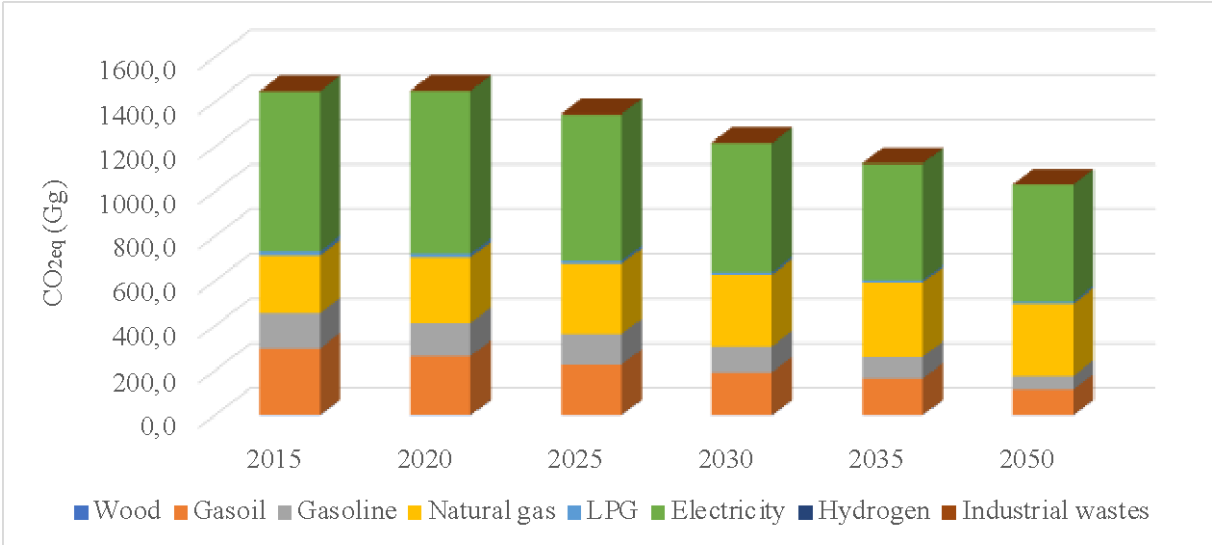

Figure 47 – Ljubljiana Scenario *high* Carbon Footprint by fuel (Gg CO_2 equivalent on Life Cycle)

6.2.3 BAU and Scenarios comparison

Total Carbon Footprint in the different scenarios is compared in Figure 48 expressed as CO_2 equivalent on Life Cycle.

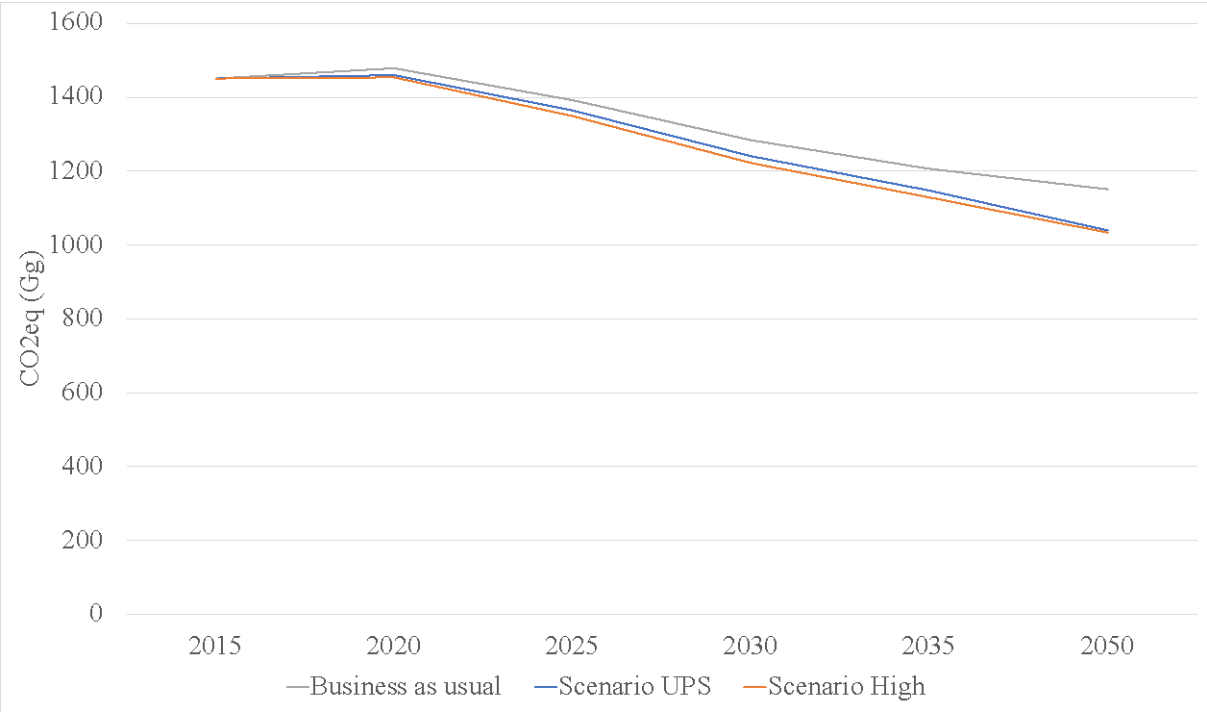

Figure 48 – Ljubljiana Carbon Footprint (Mg CO_2 equivalent on Life cycle) by scenario

6.3 Final Unified Policy Scenario projections

Also, for the final Unified Policy Scenario as a general input to the projection model, results from IRCI and Traffic models have been assumed for fuel consumptions.

6.3.1 Unified Policy Scenario results

In Table 34 Carbon Footprint by sector is reported for Ljubljiana Scenario 1 expressed as CO_2, CO_2 equivalent and CO_2 equivalent on Life Cycle. In Table 35 CO_2 equivalent on Life Cycle reductions on 2015 are reported.

Table 34 – Ljubljiana Unified Policy Scenario Carbon Footprint by Sector (Gg)

Year	2015	2020	2025	2030	2035	2050
Carbon dioxide (CO_2)						
Residential	337,6	341,0	295,2	245,9	214,8	214,8
Services	341,3	325,9	291,0	258,8	234,0	234,0
Transport	275,1	273,3	264,0	235,0	204,6	115,3
Industry	337,1	367,4	368,6	363,3	362,3	362,3
Total	***1.291,0***	***1.307,6***	***1.218,8***	***1.103,0***	***1.015,6***	***926,3***
Carbon dioxide equivalent (CO_{2eq})						
Residential	339,6	342,8	296,8	247,3	216,0	216,0
Services	342,8	327,5	292,3	259,9	235,0	235,0
Transport	275,8	274,1	264,7	235,6	205,1	115,6
Industry	338,3	368,8	369,9	364,6	363,5	363,5
Total	***1.296,6***	***1.313,1***	***1.223,7***	***1.107,4***	***1.019,6***	***930,1***

Year	2015	2020	2025	2030	2035	2050
Carbon dioxide equivalent on life cycle (CO_{2eq})						
Residential	380,0	384,5	333,5	278,2	243,5	243,5
Services	369,6	351,6	314,8	280,8	254,5	254,5
Transport	329,5	327,5	316,5	281,4	244,6	138,3
Industry	371,5	405,0	407,6	403,4	403,6	403,6
Total	***1.450,6***	***1.468,6***	***1.372,4***	***1.243,8***	***1.146,2***	***1.039,9***

Table 35 – Ljubljiana Unified Policy Scenario Carbon Footprint by Sector: index (2015=100)

Year	2015	2020	2025	2030	2035	2050
Carbon dioxide equivalent on life cycle (CO_{2eq})						
Residential	100	101	88	73	64	64
Services	100	95	85	76	69	69
Transport	100	99	96	85	74	42
Industry	100	109	110	109	109	109
Total	***100***	***101***	***95***	***86***	***79***	***72***

For the Unified Policy Scenario, Carbon Footprint, expressed as CO_2 equivalent on Life Cycle, is reported in Figure 49 by sector and in Figure 50 by fuel.

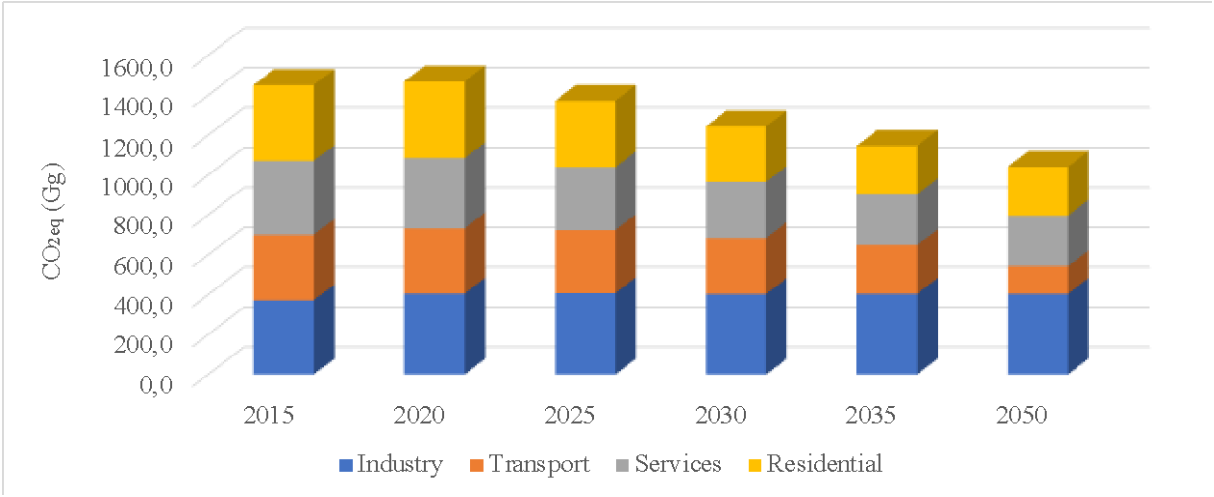

Figure 49 – Ljubljiana Unified Policy Scenario Carbon Footprint by sector (Gg CO_2 equivalent on Life Cycle)

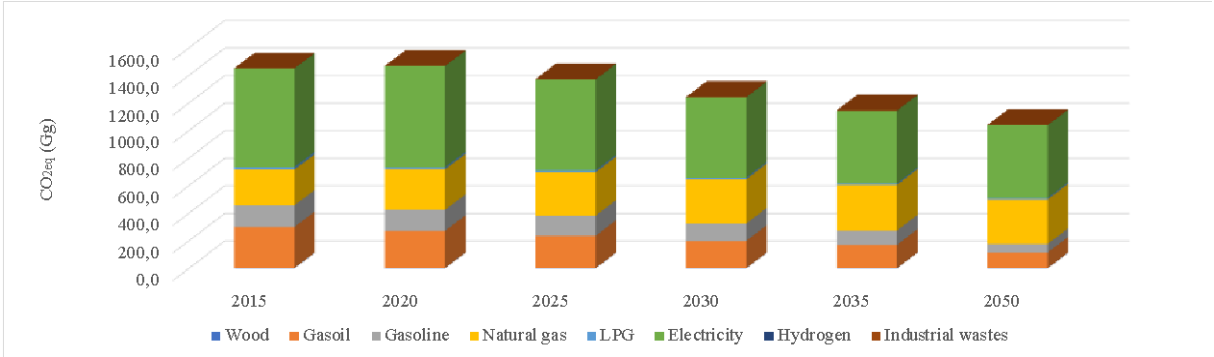

Figure 50 – Ljubljiana Unified Policy Scenario Carbon Footprint by fuel (Gg CO_2 equivalent on Life Cycle)

6.3.2 BAU and Unified Policy Scenario comparison

Total Carbon Footprint in the business as usual (BAU) and unified policy scenario (UPS) is compared in Figure 51 expressed as CO_2 equivalent on Life Cycle.

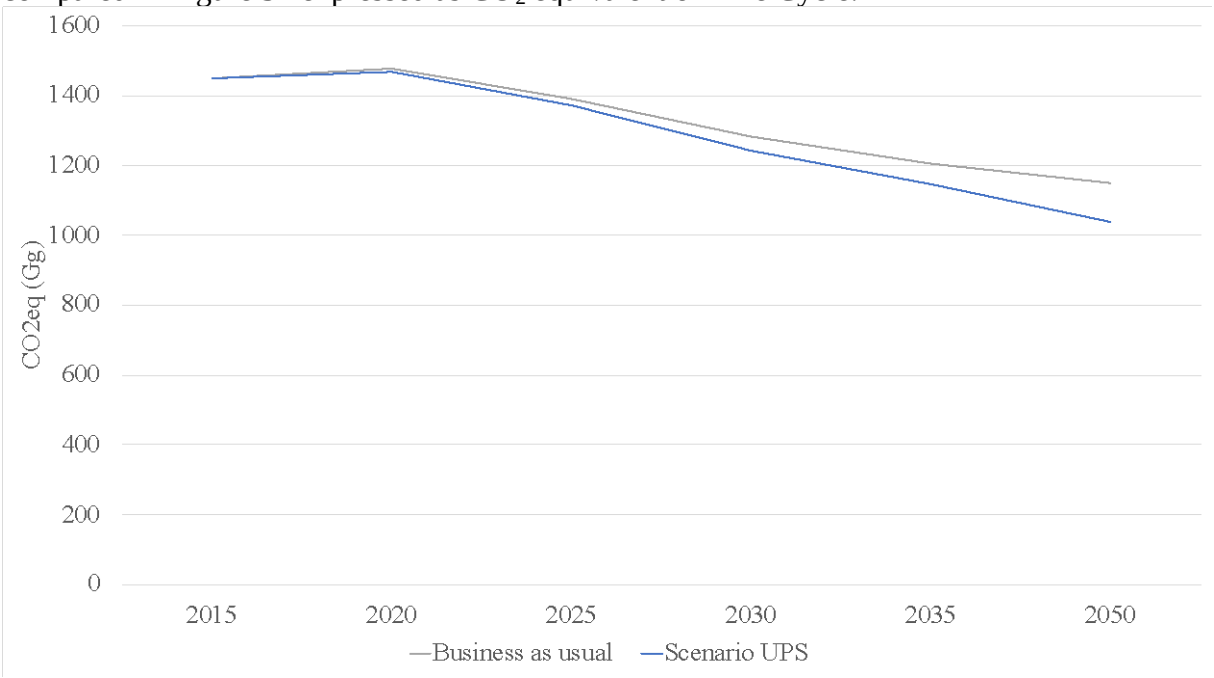

Figure 51 – Ljubljiana Carbon Footprint (Mg CO_2 equivalent on Life cycle) by scenario

In Figure 52 results are reported by sector and in Figure 53 by sector and fuel. Finally, in Figure 54 Carbon Footprint on life cycle generated by citizens' activities is reported in BAU and UPS scenario.

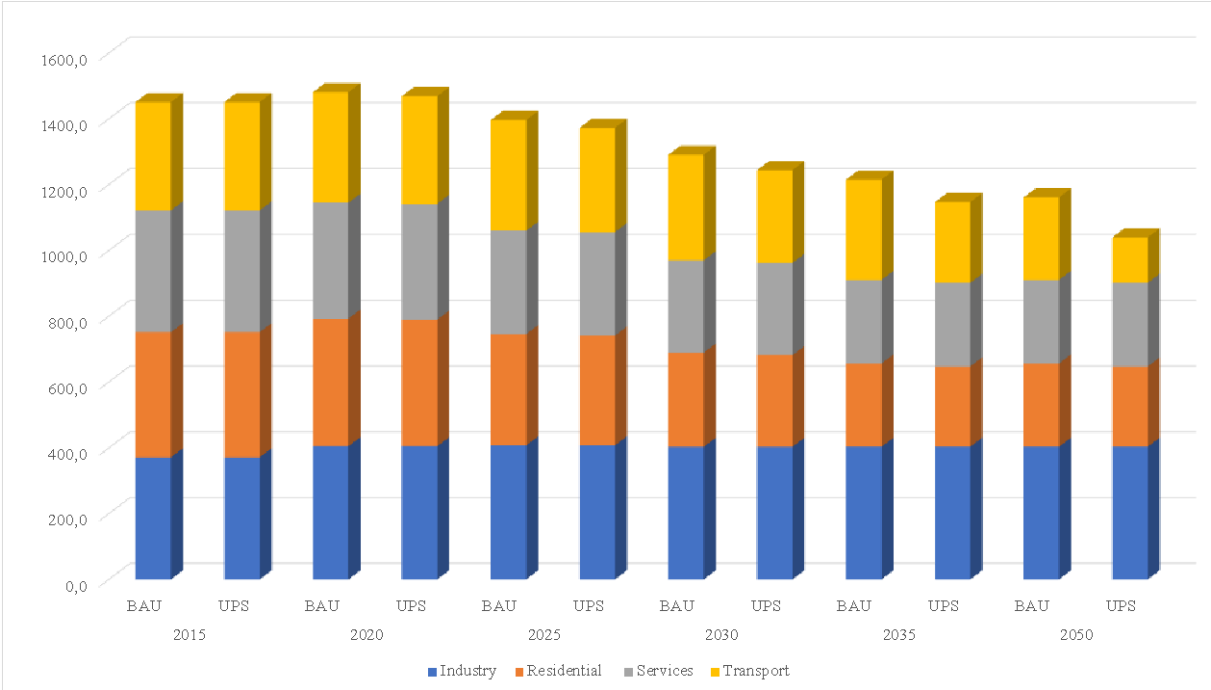

Figure 52 – Ljubljiana Carbon Footprint on life cycle BAU and UPS comparison by sector (Mg CO_2 equivalent)

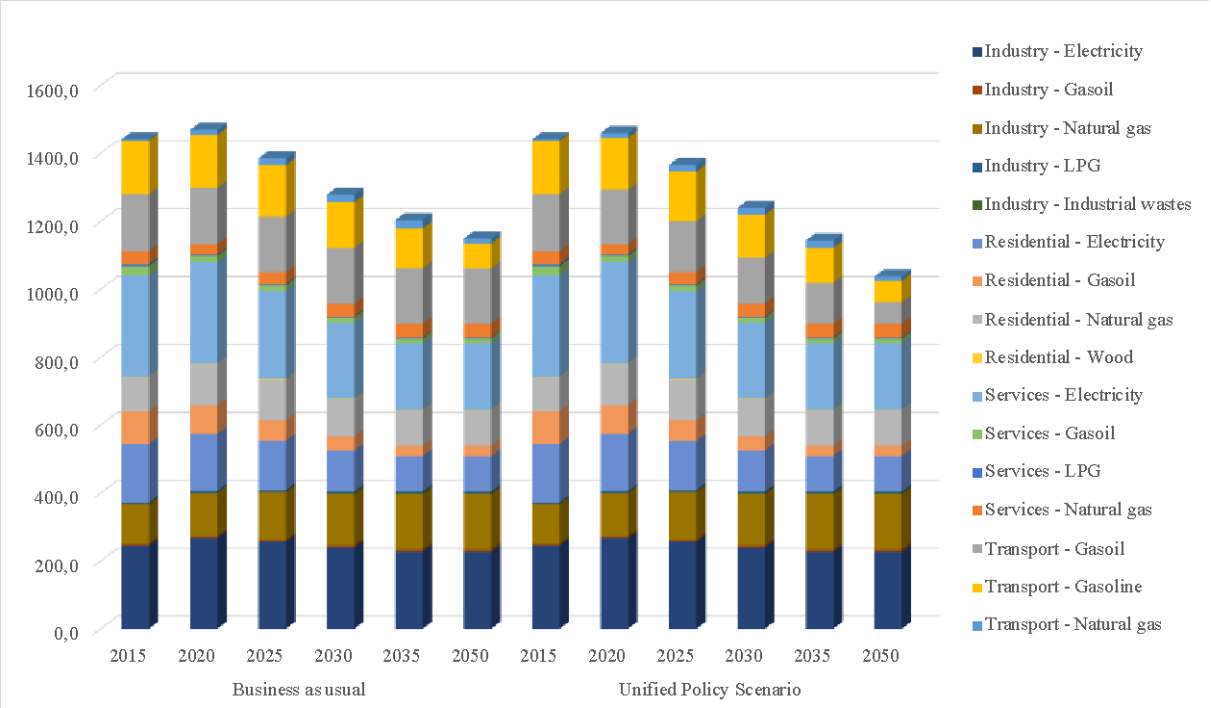

Figure 53 – Ljubljiana Carbon Footprint on life cycle BAU and UPS comparison by sector and fuel (Mg CO_2 equivalent)

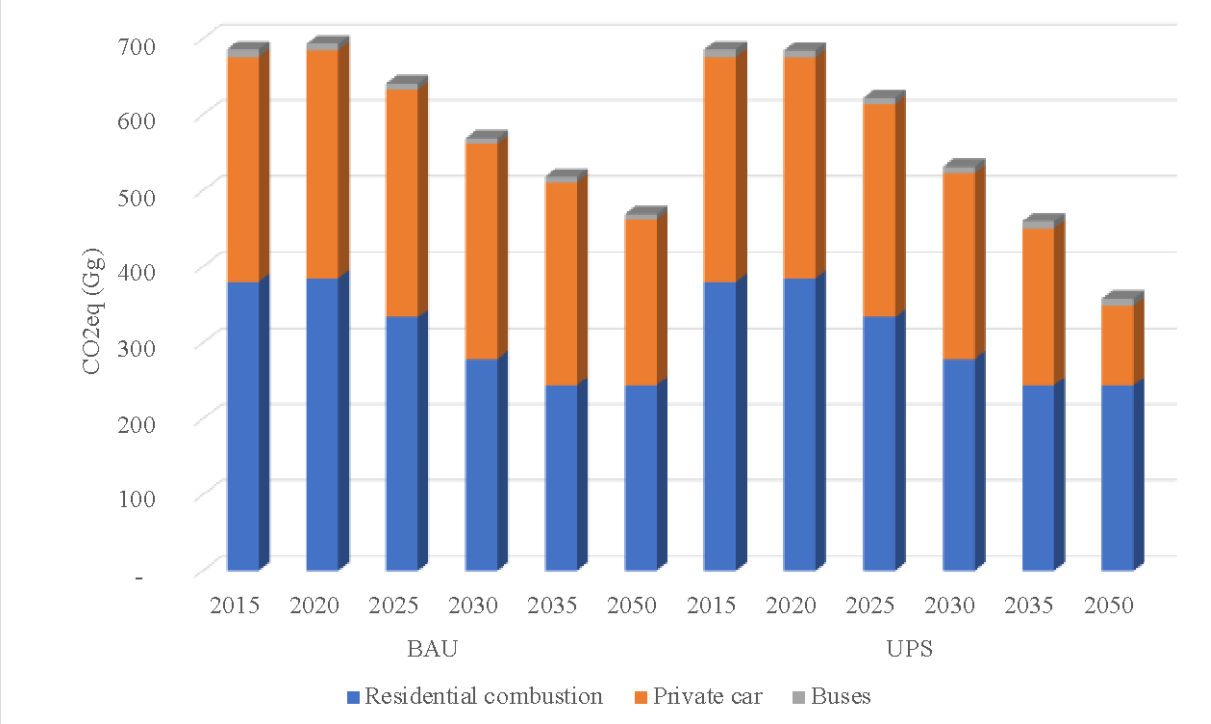

Figure 54 – Ljubljiana Carbon Footprint on life cycle generated by citizens' activities in BAU and UPS scenario (Mg CO_2 equivalent)

7 REGIONE LIGURIA (GENOA AREA)

7.1 Business As Usual projections

Business as Usual (BAU) scenario takes into consideration national and city level measures already defined/decided. As a general input to the projection model, results from IRCI and Traffic models have been assumed for fuel consumptions[17] up to 2030. In a conservative way, taking into consideration the uncertainty of national projections behind 2030 and the outlines of policy workshop no further reductions are foreseen for 2050.

For electricity emission factors an additional driver was introduced to take into consideration the evolution of carbon footprint from electricity generation. The driver is defined using official Italy projection data up to 2050[18].

In Table 36 Carbon Footprint by sector is reported for Genoa BAU expressed as CO_2, CO_2 equivalent and CO_2 equivalent on Life Cycle. In Table 37 CO_2 equivalent on Life Cycle reductions on 2015 are reported.

Table 36 – Genoa BAU Carbon Footprint by Sector (Gg)

Year	2015	2020	2025	2030	2035	2050
Carbon dioxide (CO_2)						
Residential	691,7	626,0	521,6	413,3	392,1	326,3
Services	306,4	267,1	228,7	181,1	149,8	48,2
Transport	231,3	212,6	194,5	186,9	179,6	140,1
Industry	291,5	265,3	221,0	173,1	153,1	93,2
Total	***1.520,8***	***1.371,1***	***1.165,8***	***954,4***	***874,6***	***607,8***
Carbon dioxide equivalent (CO_{2eq})						
Industry	693,0	627,1	522,6	414,0	392,8	326,8
Services	307,3	267,9	229,4	181,6	150,2	48,3
Transport	231,9	213,2	195,0	187,4	180,1	140,5
Residential	292,0	265,8	221,4	173,4	153,4	93,3
Total	***1.524,2***	***1.374,1***	***1.168,3***	***956,5***	***876,4***	***608,8***
Carbon dioxide equivalent on life cycle (CO_{2eq})						
Residential	830,3	751,0	625,7	495,5	469,3	388,1
Services	377,6	329,2	281,8	223,1	184,4	58,8
Transport	276,9	254,6	233,0	222,7	212,8	165,3

[17] Ministero dello Sviluppo Economico Ministero dell'Ambiente e della Tutela del Territorio e del Mare Ministero delle Infrastrutture e dei Trasporti Proposta di Piano Nazionale Integrato per l'Energia ed il Clima, 31 Dicembre 2018

[18] Ministero dello sviluppo economico, Ministero dell'Ambiente e per la Tutela del Territorio e del Mare, Strategia Energetica Nazionale, 10 Novembre 2017

Industry	355,1	323,1	268,9	210,4	185,7	111,6
Total	***1.839,9***	***1.658,0***	***1.409,5***	***1.151,7***	***1.052,2***	***723,8***

Table 37 – Genoa BAU Carbon Footprint by Sector: index (2015=100)

Year	2015	2020	2025	2030	2035	2050
Carbon dioxide equivalent on life cycle (CO_{2eq})						
Residential	100	90	75	60	57	47
Services	100	87	75	59	49	16
Transport	100	92	84	80	77	60
Industry	100	91	76	59	52	31
Total	***100***	***90***	***77***	***63***	***57***	***39***

Carbon Footprint, expressed as CO_2 equivalent on Life Cycle, is reported in Figure 55 by sector and in Figure 56 by fuel. The graphs highlight the largely dominant contribution of the residential and service sectors as described above, from the point of view of energy carriers, natural gas and electricity.

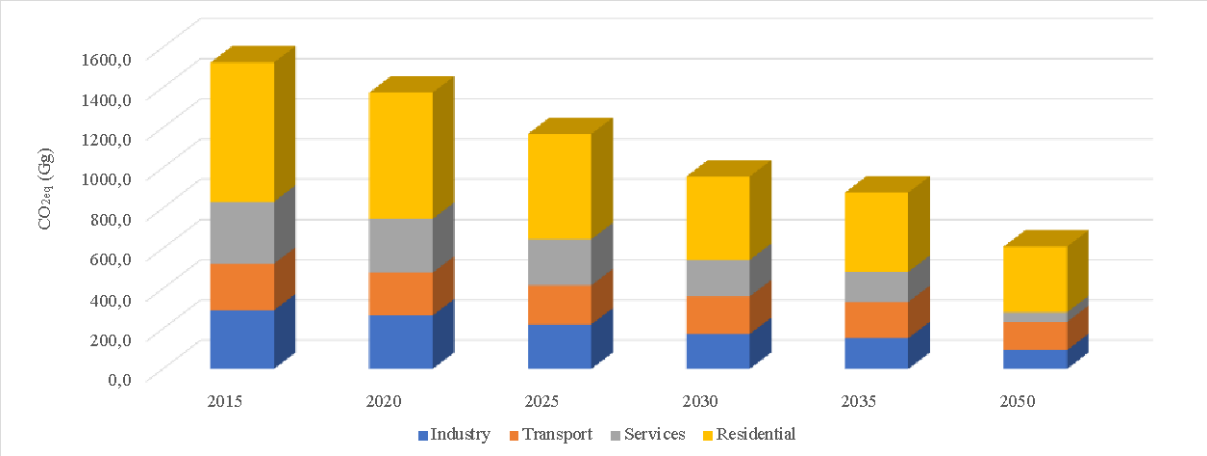

Figure 55 – Genoa BAU Carbon Footprint by sector (Gg CO_2 equivalent on Life Cycle)

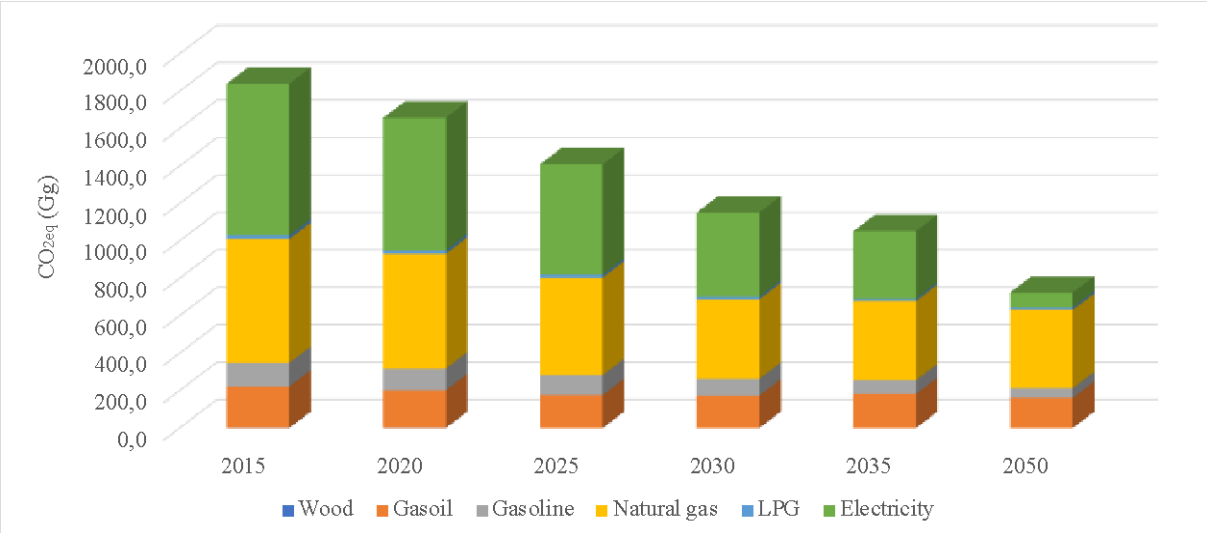

Figure 56 – Genoa BAU Carbon Footprint by fuel (Gg CO_2 equivalent on Life Cycle)

7.2 Scenario projections

Scenario projections take into consideration city level additional measures from Stakeholder dialog workshop (SWD). Also, in this case as a general input to the projection model, results from IRCI and Traffic models have been assumed for fuel consumptions.

7.2.1 Scenario

In Table 38 CO_2 equivalent on Life Cycle reductions on 2015 are reported. In Table 39 Carbon Footprint by sector is reported for Genoa Scenario *low* expressed as CO_2, CO_2 equivalent and CO_2 equivalent on Life Cycle.

Table 38 – Genoa Scenario Carbon Footprint by Sector (Gg)

Year	2015	2020	2025	2030	2035	2050
Carbon dioxide (CO_2)						
Residential	691,7	626,0	521,6	413,3	392,1	326,3
Services	306,4	267,1	228,7	181,1	149,8	48,2
Transport	231,3	215,7	198,8	180,9	163,1	78,9
Industry	291,5	265,3	221,0	173,1	153,1	93,2
Total	***1.520,8***	***1.374,1***	***1.170,1***	***948,4***	***858,1***	***546,7***
Carbon dioxide equivalent (CO_{2eq})						
Residential	693,0	627,1	522,6	414,0	392,8	326,8
Services	307,3	267,9	229,4	181,6	150,2	48,3
Transport	231,9	216,3	199,3	181,4	163,5	79,1
Industry	292,0	265,8	221,4	173,4	153,4	93,3
Total	***1.524,2***	***1.377,1***	***1.172,6***	***950,4***	***859,9***	***547,5***
Carbon dioxide equivalent on life cycle (CO_{2eq})						
Residential	830,3	751,0	625,7	495,5	469,3	388,1
Services	377,6	329,2	281,8	223,1	184,4	58,8
Transport	276,9	258,3	238,2	215,8	193,5	93,1
Industry	355,1	323,1	268,9	210,4	185,7	111,6
Total	***1.839,9***	***1.661,6***	***1.414,7***	***1.144,8***	***1.032,9***	***651,6***

Table 39 – Genoa Scenario Carbon Footprint by Sector: index (2015=100)

Year	2015	2020	2025	2030	2035	2050
Carbon dioxide equivalent on life cycle (CO_{2eq})						
Residential	100	90	75	60	57	47
Services	100	87	75	59	49	16
Transport	100	93	86	78	70	34
Industry	100	91	76	59	52	31
Total	***100***	***90***	***77***	***62***	***56***	***35***

For the Scenario, Carbon Footprint, expressed as CO_2 equivalent on Life Cycle, is reported in Figure 57 by sector and in Figure 58 by fuel.

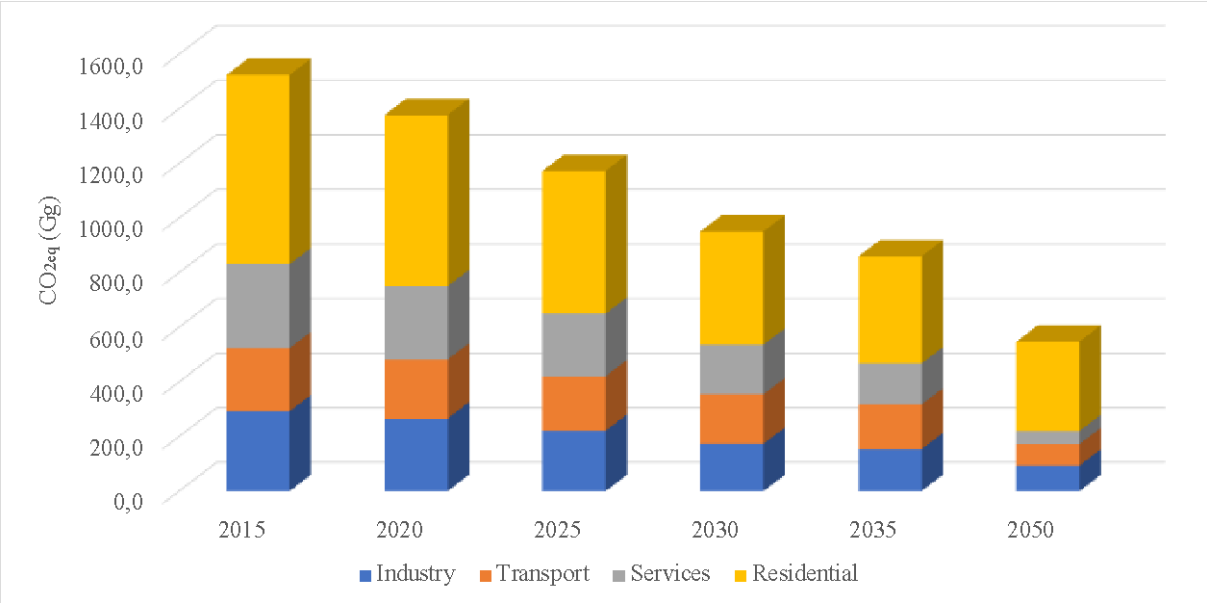

Figure 57 – Genoa Scenario Carbon Footprint by sector (Gg CO_2 equivalent on Life Cycle)

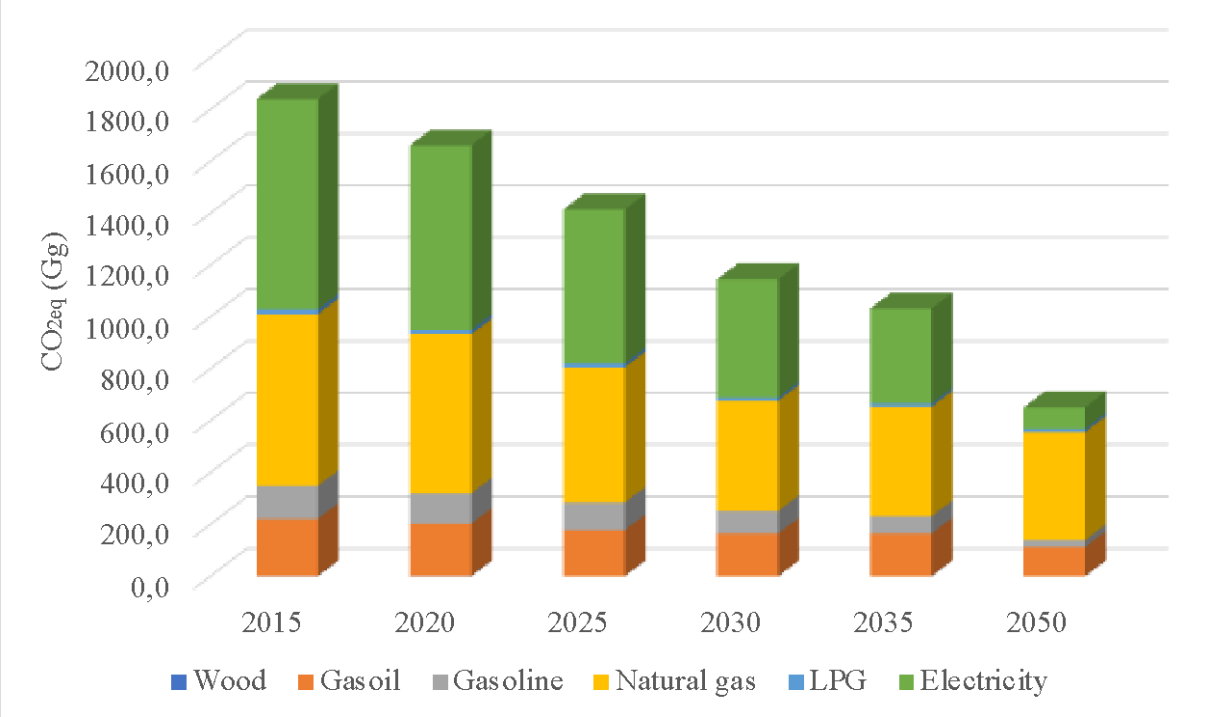

Figure 58 – Genoa Scenario Carbon Footprint by fuel (Gg CO_2 equivalent on Life Cycle)

7.2.2 BAU and Scenarios comparison

Total Carbon Footprint in the different scenarios is compared in Figure 59 expressed as CO_2 equivalent on Life Cycle.

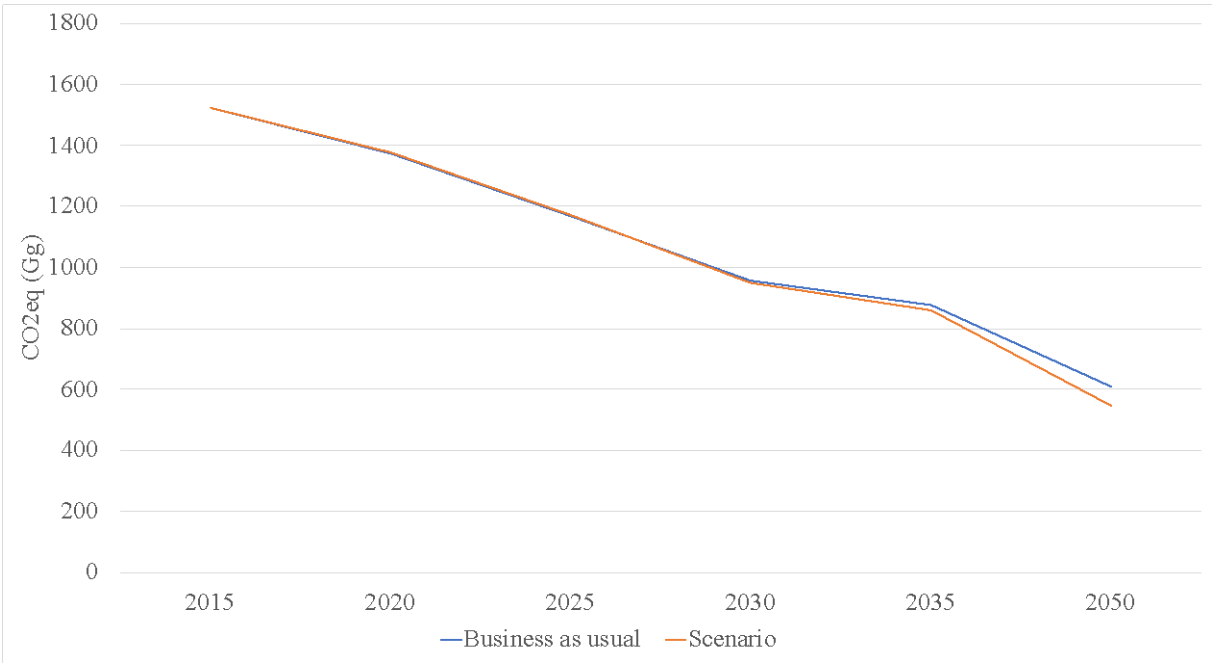

Figure 59 – Genoa Carbon Footprint (Mg CO_2 equivalent on Life cycle) by scenario

7.3 Final Unified Policy Scenario projections

Also, for the final Unified Policy Scenario as a general input to the projection model, results from IRCI and Traffic models have been assumed for fuel consumptions.

7.3.1 Unified Policy Scenario results

Unified Policy Scenario is the same as the Scenario from the Stakeholder dialog workshop.

For the this Scenario, Carbon Footprint, expressed as CO_2 equivalent on Life Cycle, is reported in Figure 60 by sector and in Figure 61 by fuel.

Figure 60 – Genoa Unified Policy Scenario Carbon Footprint by sector (Gg CO_2 equivalent on Life Cycle)

Figure 61 – Genoa Unified Policy Scenario Carbon Footprint by fuel (Gg CO_2 equivalent on Life Cycle)

7.3.2 BAU and Unified Policy Scenario comparison

Total Carbon Footprint in the business as usual (BAU) and unified policy scenario (UPS) is compared in Figure 62 expressed as CO_2 equivalent on Life Cycle. Finally, in Genoa Carbon Footprint on life cycle generated by citizens' activities is reported in BAU and UPS scenario.

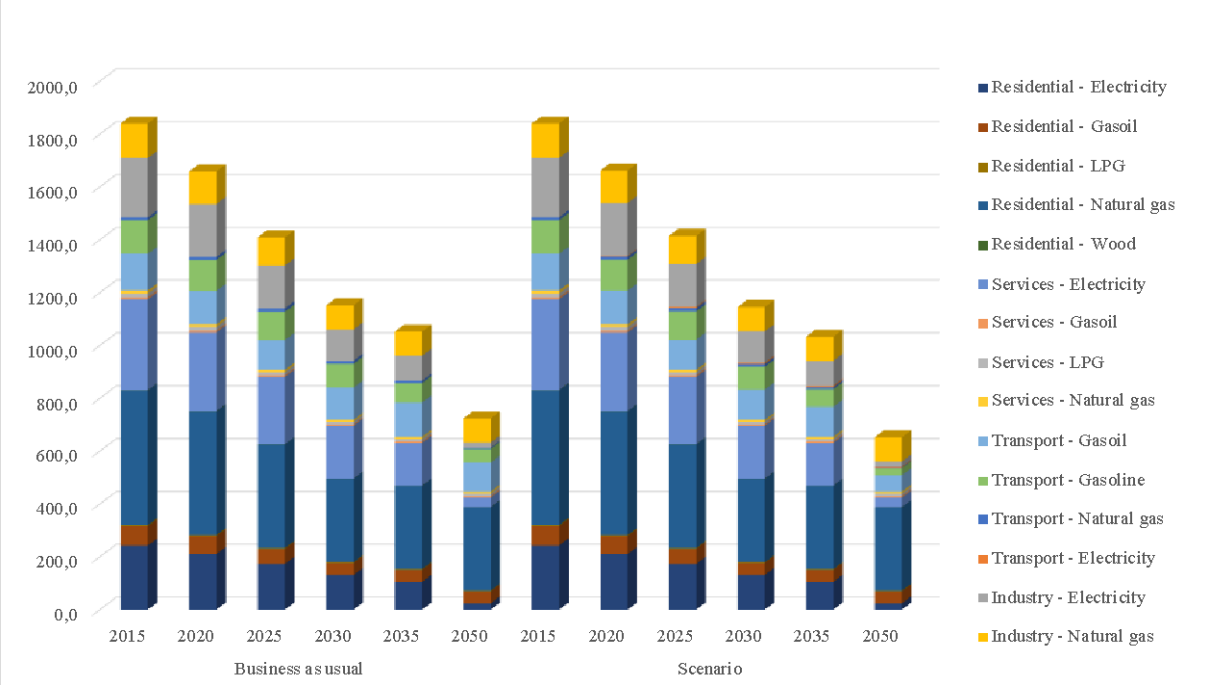

Figure 62 – Genoa Carbon Footprint (Mg CO_2 equivalent on Life cycle) by scenario

In

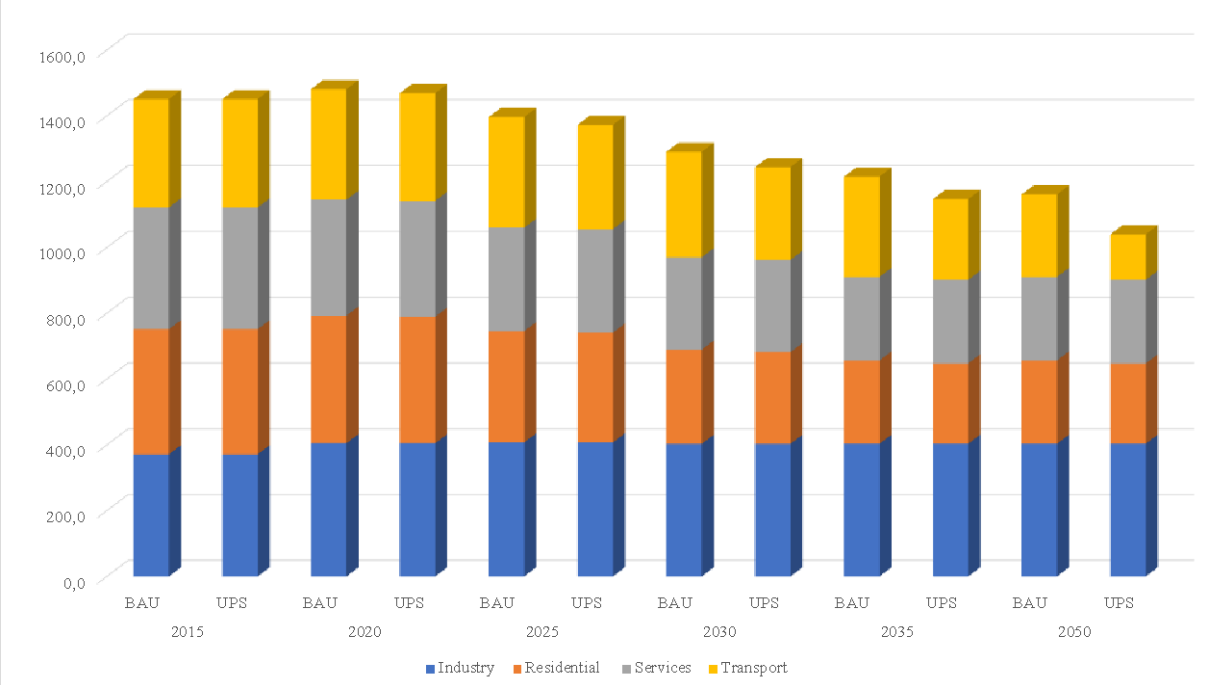

Figure 52 results are reported by sector and in Figure 53 by sector and fuel. Finally, in Figure 54 Carbon Footprint on life cycle generated by citizens' activities is reported in BAU and UPS scenario.

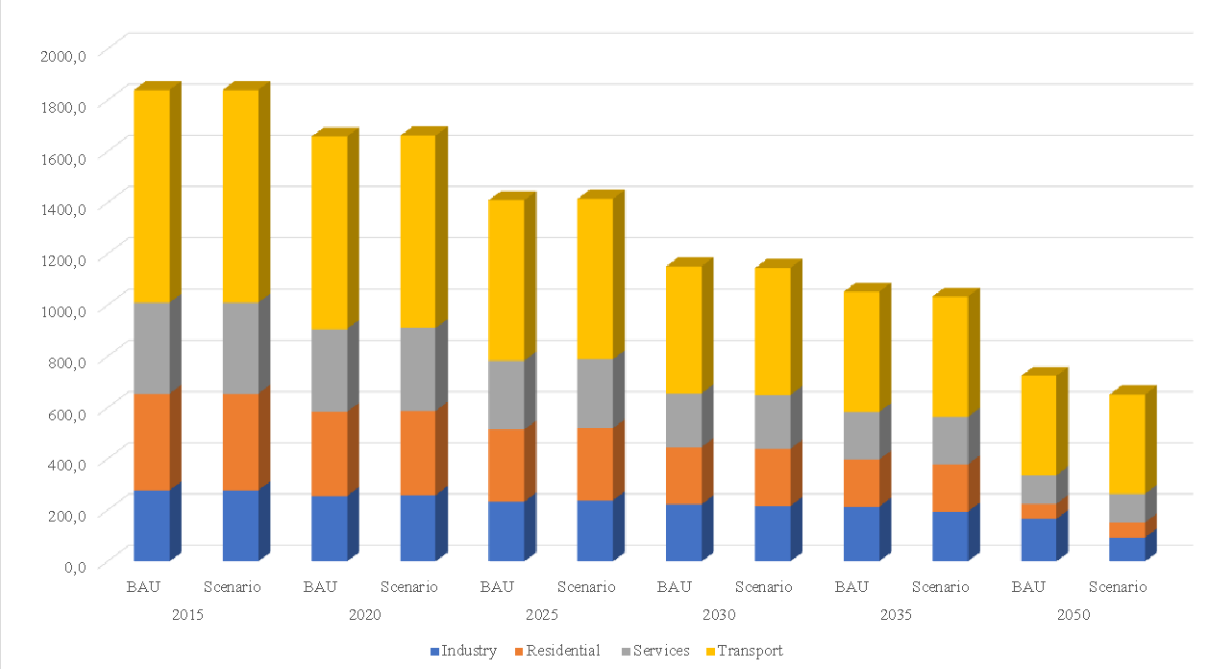

Figure 63 – Genoa Carbon Footprint on life cycle BAU and Scenario comparison by sector (Mg CO_2 equivalent)

Figure 64 – Genoa Carbon Footprint on life cycle BAU and UPS comparison by sector and fuel (Mg CO_2 equivalent)

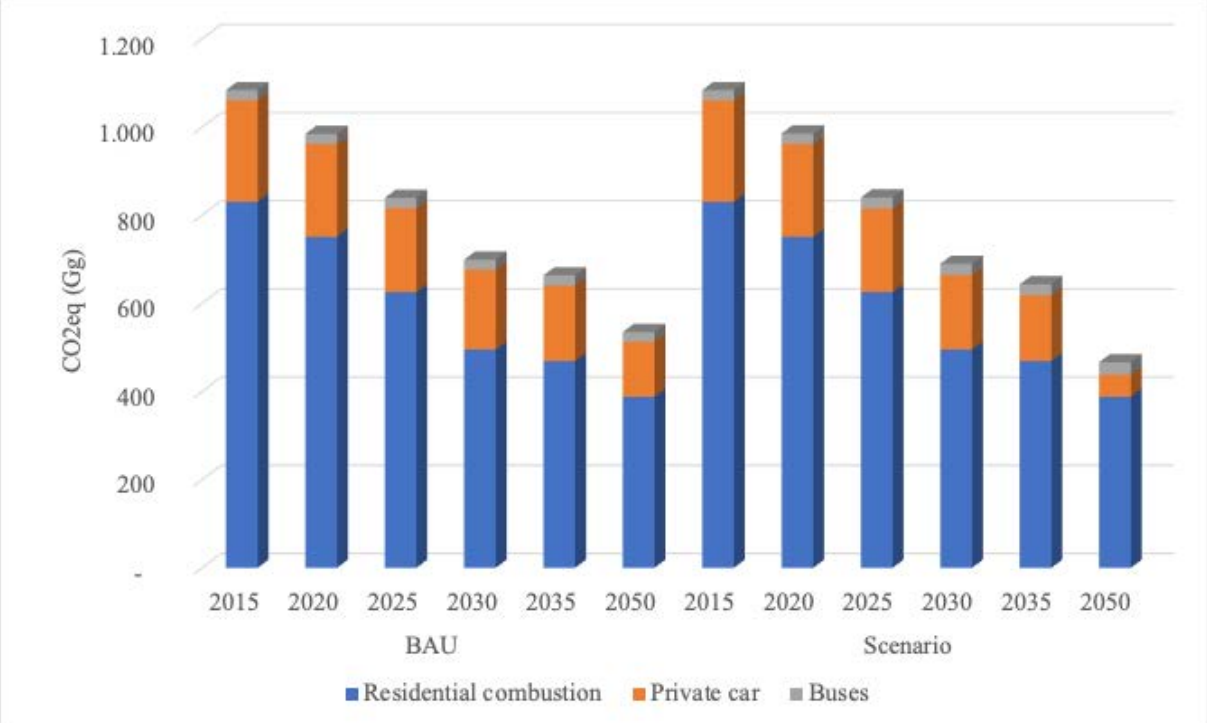

Figure 65 – Genoa Carbon Footprint on life cycle generated by citizens' activities in BAU and UPS scenario (Mg CO_2 equivalent)

8 AVEIRO

8.1 Business As Usual projections

Business as Usual (BAU) scenario takes into consideration national and city level measures already defined/decided. As a general input to the projection model, results from IRCI and Traffic models have been assumed for fuel consumptions.

For electricity emission factors an additional driver was introduced to take into consideration the evolution of carbon footprint from electricity generation. The driver is defined using the projections of greenhouse gas emissions and energy demand from the 7th national communication to UNFCCC[19] using scenario with additional measures (WAM) and the 2050 of July 2019[20]. The evolution of use of fuels in the industrial, residential and commercial sectors is derived from the information in the quoted documents using as a reference the global reductions of final use of different fuels.

In Table 40 Carbon Footprint by sector is reported for Aveiro BAU expressed as CO_2, CO_2 equivalent and CO_2 equivalent on Life Cycle. In Table 41 CO_2 equivalent on Life Cycle reductions on 2015 are reported.

Table 40 – Aveiro BAU Carbon Footprint by Sector (Gg)

Year	2015	2020	2025	2030	2035	2050
Carbon dioxide (CO_2)						
Residential	326,4	343,6	293,3	101,6	60,5	19,3
Services	251,8	266,6	228,2	63,1	35,1	13,1
Transport	1.447,2	1.395,1	1.333,2	1.234,8	1.134,3	772,9
Industry	842,2	917,3	847,1	483,8	350,4	139,8
Total	***2.867,7***	***2.922,6***	***2.701,8***	***1.883,3***	***1.580,3***	***945,1***
Carbon dioxide equivalent (CO_{2eq})						
Industry	334,4	351,3	301,5	109,3	67,1	21,8
Services	253,3	268,2	229,5	63,3	35,1	13,1
Transport	1.451,2	1.399,0	1.336,9	1.238,1	1.137,3	775,0
Residential	845,8	921,1	850,2	484,3	350,6	139,9
Total	***2.884,8***	***2.939,5***	***2.718,0***	***1.895,0***	***1.590,1***	***949,7***
Carbon dioxide equivalent on life cycle (CO_{2eq})						
Residential	401,5	420,8	363,2	140,0	88,8	29,1
Services	295,8	313,2	268,2	74,7	41,6	15,5
Transport	1.717,6	1.652,1	1.574,8	1.456,3	1.335,3	909,8
Industry	990,4	1.079,3	997,6	572,5	415,0	165,3

[19] Portuguese Environment Agency, 7th National Communication to the United Nations Framework Convention on Climate Change

[20] 2050, julho 2019

Total	***3.405,4***	***3.465,4***	***3.203,9***	***2.243,5***	***1.880,7***	***1.119,7***

Table 41 – Aveiro BAU Carbon Footprint by Sector: index (2015=100)

Year	2015	2020	2025	2030	2035	2050
Carbon dioxide equivalent on life cycle (CO_{2eq})						
Residential	100	105	90	35	22	7
Services	100	106	91	25	14	5
Transport	100	96	92	85	78	53
Industry	100	109	101	58	42	17
Total	***100***	***102***	***94***	***66***	***55***	***33***

Carbon Footprint, expressed as CO_2 equivalent on Life Cycle, is reported in Figure 66 by sector and in Figure 67 by fuel. The graphs highlight the largely dominant contribution of the residential and service sectors as described above, from the point of view of energy carriers, natural gas and electricity.

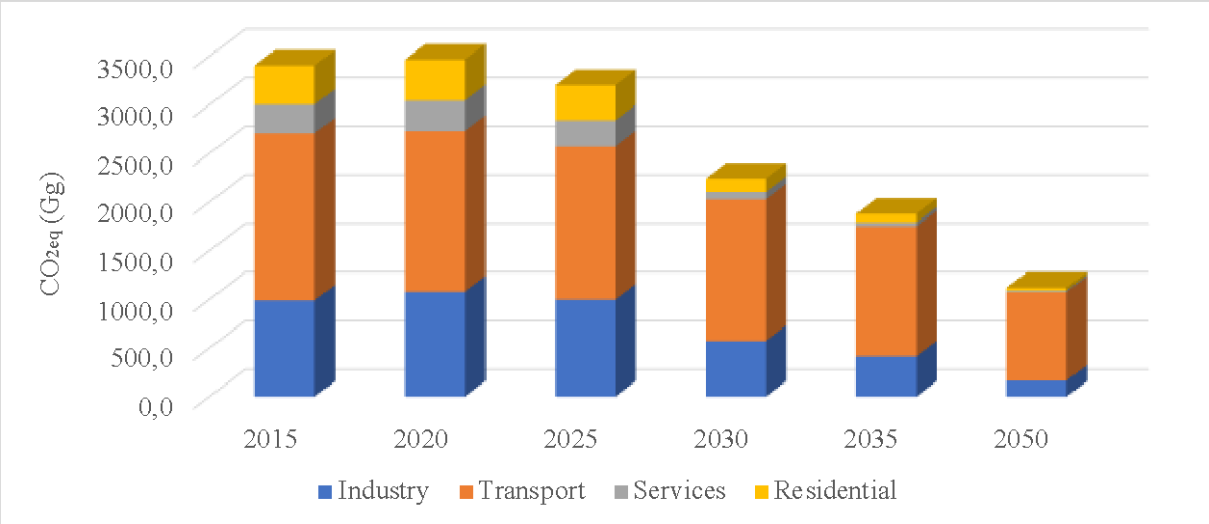

Figure 66 – Aveiro BAU Carbon Footprint by sector (Gg CO_2 equivalent on Life Cycle)

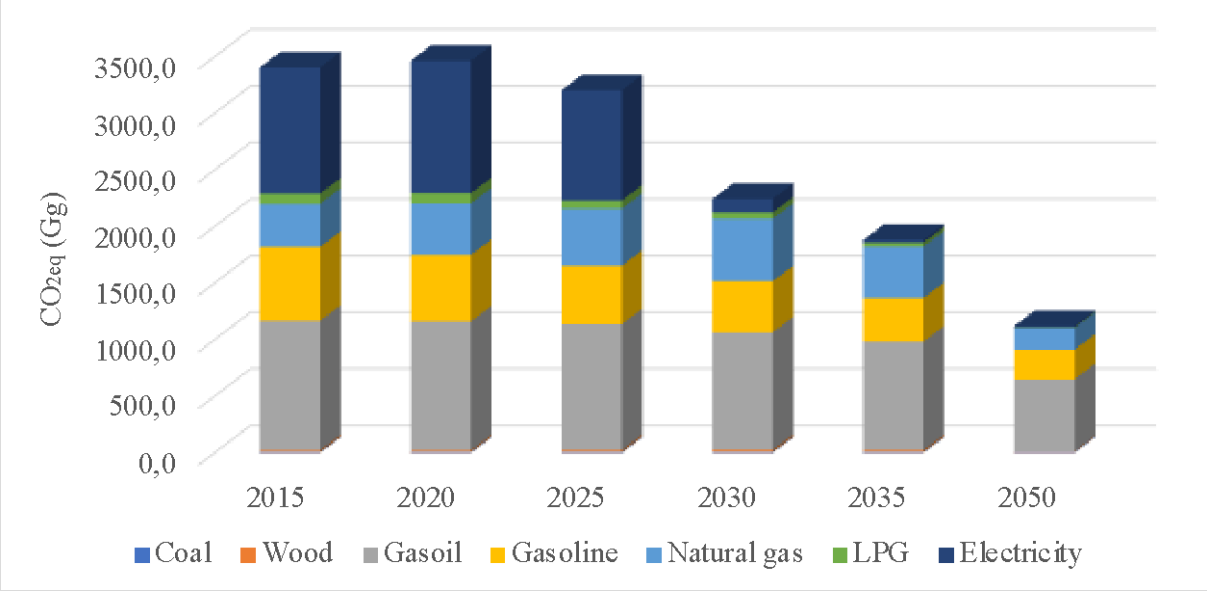

Figure 67 – Aveiro BAU Carbon Footprint by fuel (Gg CO_2 equivalent on Life Cycle)

8.2 Scenario projections

Scenario projections take into consideration city level additional measures from Stakeholder dialog workshop (SWD). Also, in this case as a general input to the projection model, results from IRCI and Traffic models have been assumed for fuel consumptions.

8.2.1 Scenario *low*

In Table 42 CO_2 equivalent on Life Cycle reductions on 2015 are reported. In Table 43 Carbon Footprint by sector is reported for Aveiro Scenario *low* expressed as CO_2, CO_2 equivalent and CO_2 equivalent on Life Cycle.

Table 42 – Aveiro Scenario *low* Carbon Footprint by Sector (Gg)

Year	2015	2020	2025	2030	2035	2050
Carbon dioxide (CO_2)						
Residential	326,4	343,6	293,3	101,6	60,5	19,3
Services	251,8	266,6	228,2	63,1	35,1	13,1
Transport	1.447,2	1.297,2	1.147,9	1.049,4	949,6	674,4
Industry	842,2	917,3	847,1	483,8	350,4	139,8
Total	***2.867,7***	***2.824,7***	***2.516,5***	***1.698,0***	***1.395,6***	***846,6***
Carbon dioxide equivalent (CO_{2eq})						
Residential	334,4	351,3	301,5	109,3	67,1	21,8
Services	253,3	268,2	229,5	63,3	35,1	13,1
Transport	1.451,2	1.300,8	1.151,0	1.052,3	952,2	676,2
Industry	845,8	921,1	850,2	484,3	350,6	139,9
Total	***2.884,8***	***2.841,3***	***2.532,2***	***1.709,1***	***1.404,9***	***851,0***
Carbon dioxide equivalent on life cycle (CO_{2eq})						
Residential	401,5	420,8	363,2	140,0	88,8	29,1

Services	295,8	313,2	268,2	74,7	41,6	15,5
Transport	1.717,6	1.535,2	1.353,5	1.236,7	1.118,4	790,9
Industry	990,4	1.079,3	997,6	572,5	415,0	165,3
Total	***3.405,4***	***3.348,4***	***2.982,6***	***2.023,9***	***1.663,7***	***1.000,8***

Table 43 – Aveiro Scenario *low* Carbon Footprint by Sector: index (2015=100)

Year	2015	2020	2025	2030	2035	2050
Carbon dioxide equivalent on life cycle (CO_{2eq})						
Residential	100	100	105	90	35	22
Services	100	100	106	91	25	14
Transport	100	100	89	79	72	65
Industry	100	100	109	101	58	42
Total	***100***	***100***	***98***	***88***	***59***	***49***

For the Scenario *low*, Carbon Footprint, expressed as CO_2 equivalent on Life Cycle, is reported in Figure 68 by sector and in Figure 69 by fuel.

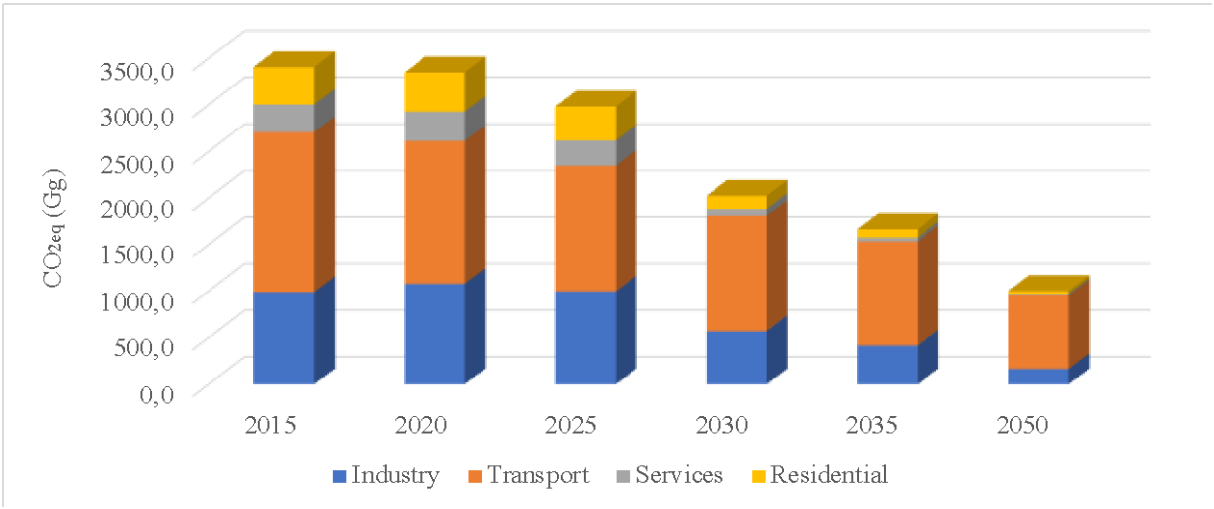

Figure 68 – Aveiro Scenario *low* Carbon Footprint by sector (Gg CO_2 equivalent on Life Cycle)

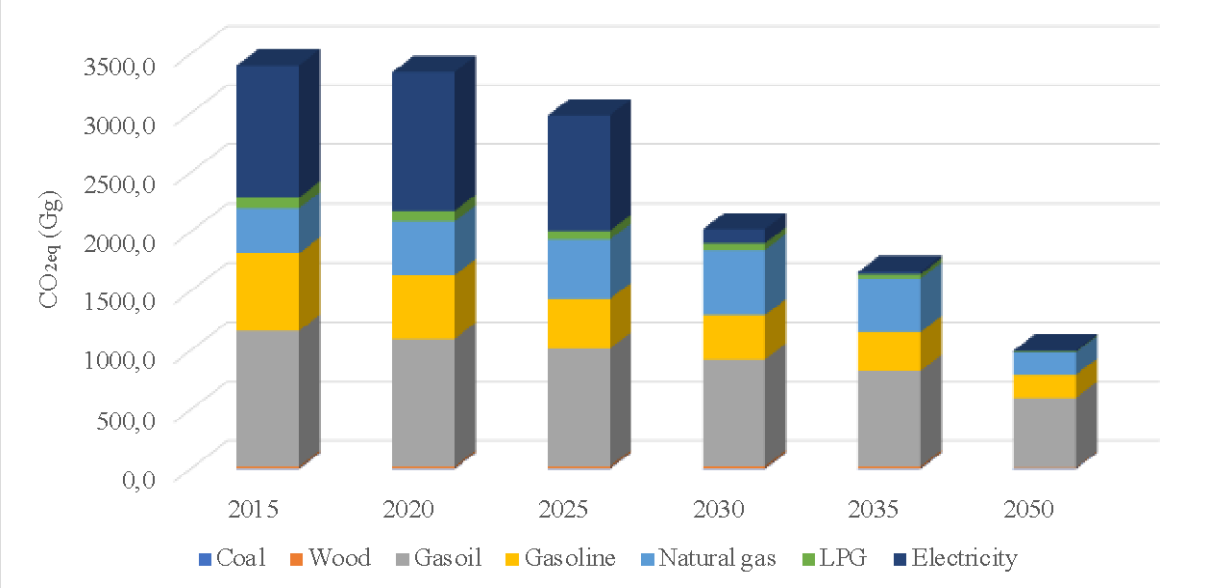

Figure 69 – Aveiro Scenario *low* Carbon Footprint by fuel (Gg CO_2 equivalent on Life Cycle)

8.2.2 Scenario *high*

In Table 44 Carbon Footprint by sector is reported for Aveiro Scenario *high* expressed as CO_2, CO_2 equivalent and CO_2 equivalent on Life Cycle. In Table 45 CO_2 equivalent on Life Cycle reductions on 2015 are reported.

Table 44 – Aveiro Scenario *high* Carbon Footprint by Sector (Gg)

Year	2015	2020	2025	2030	2035	2050
Carbon dioxide (CO_2)						
Residential	326,4	343,6	293,3	101,6	60,5	19,3
Services	251,8	266,6	228,2	63,1	35,1	13,1
Transport	1.447,2	1.229,4	1.019,4	886,3	751,2	491,7
Industry	842,2	917,3	847,1	483,8	350,4	139,8
Total	***2.867,7***	***2.756,9***	***2.388,0***	***1.534,9***	***1.197,2***	***663,9***
Carbon dioxide equivalent (CO_{2eq})						
Residential	334,4	351,3	301,5	109,3	67,1	21,8
Services	253,3	268,2	229,5	63,3	35,1	13,1
Transport	1.451,2	1.232,8	1.022,2	888,7	753,2	493,1
Industry	845,8	921,1	850,2	484,3	350,6	139,9
Total	***2.884,8***	***2.773,3***	***2.403,4***	***1.545,6***	***1.205,9***	***667,8***
Carbon dioxide equivalent on life cycle (CO_{2eq})						
Residential	401,5	420,8	363,2	140,0	88,8	29,1
Services	295,8	313,2	268,2	74,7	41,6	15,5
Transport	1.717,6	1.463,6	1.219,2	1.068,9	916,3	593,9
Industry	990,4	1.079,3	997,6	572,5	415,0	165,3
Total	***3.405,4***	***3.276,9***	***2.848,3***	***1.856,1***	***1.461,6***	***803,8***

Table 45 – Aveiro Scenario *high* Carbon Footprint by Sector: index (2015=100)

Year	2015	2020	2025	2030	2035	2050

	Carbon dioxide equivalent on life cycle (CO_{2eq})					
Residential	100	105	90	35	22	7
Services	100	106	91	25	14	5
Transport	100	85	71	62	53	35
Industry	100	109	101	58	42	17
Total	***100***	***96***	***84***	***55***	***43***	***24***

For the Scenario *high*, Carbon Footprint, expressed as CO_2 equivalent on Life Cycle, is reported in Figure 70 by sector and in Figure 71 by fuel.

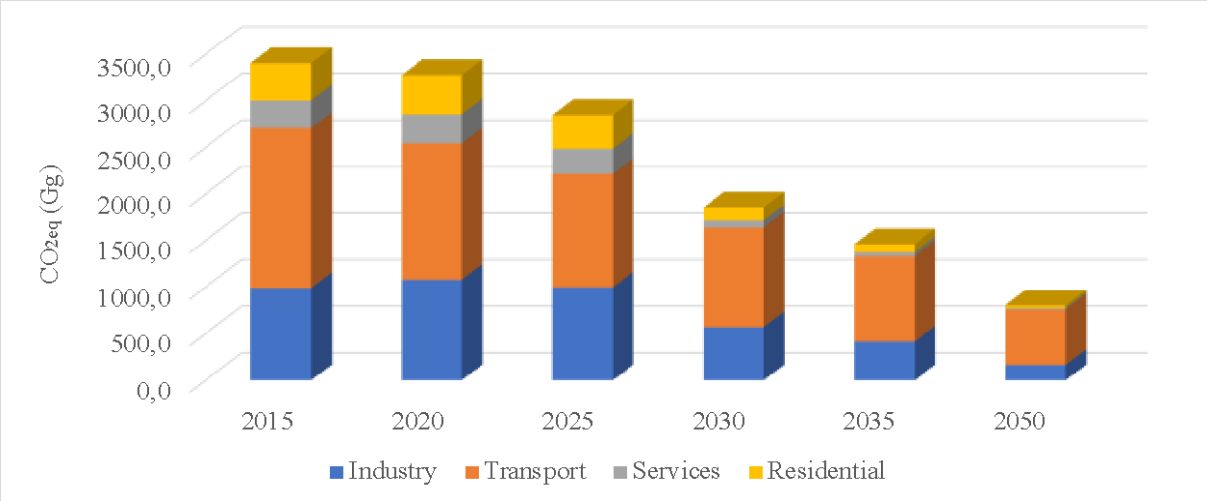

Figure 70 – Aveiro Scenario *high* Carbon Footprint by sector (Gg CO_2 equivalent on Life Cycle)

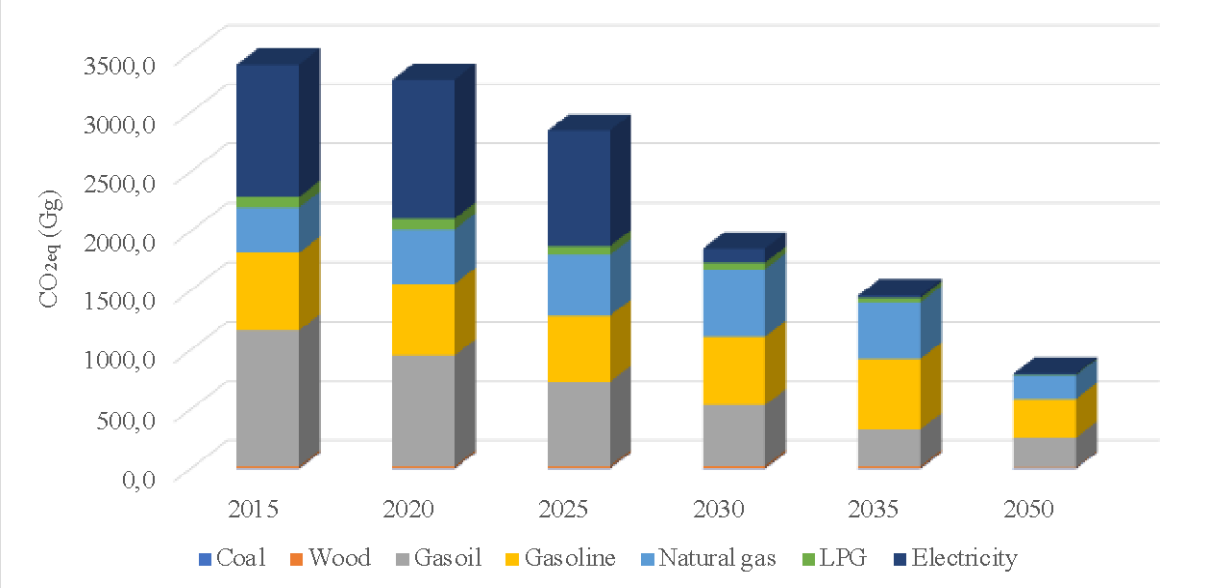

Figure 71 – Aveiro Scenario *high* Carbon Footprint by fuel (Gg CO_2 equivalent on Life Cycle)

8.2.3 BAU and Scenarios comparison

Total Carbon Footprint in the different scenarios is compared in Figure 72 expressed as CO_2 equivalent on Life Cycle.

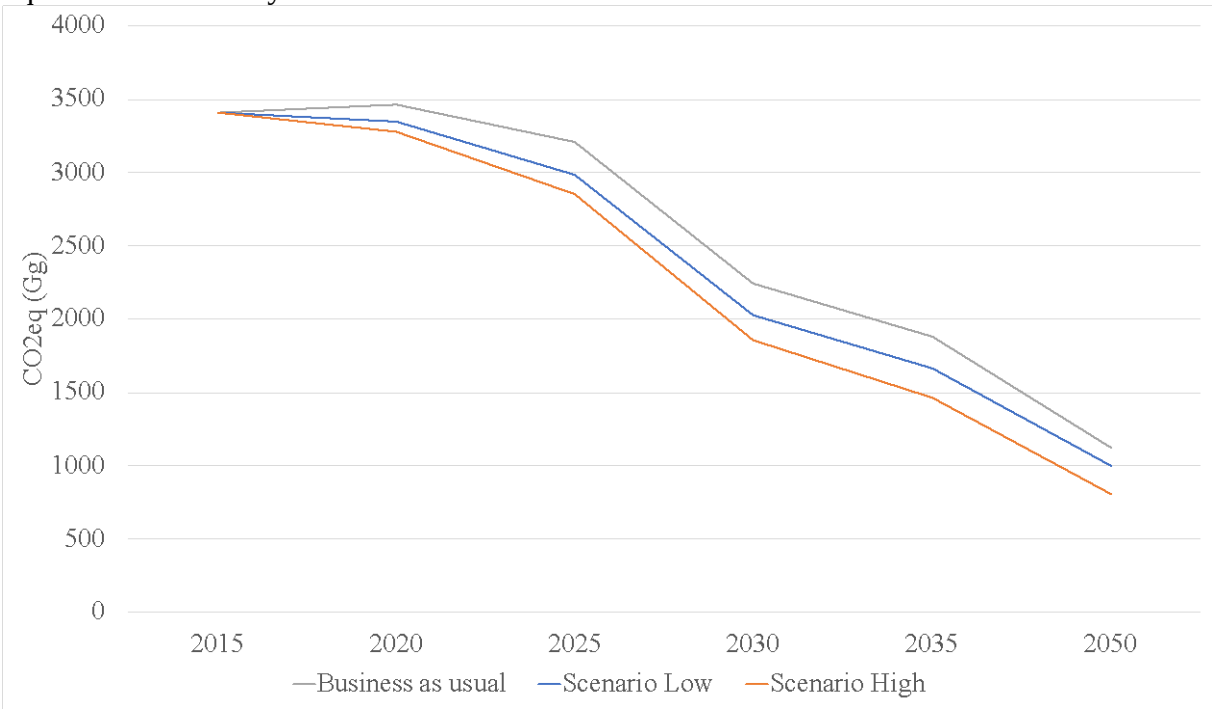

Figure 72 – Aveiro Carbon Footprint (Mg CO_2 equivalent on Life cycle) by scenario

8.3 Final Unified Policy Scenario projections

Also, for the final Unified Policy Scenario as a general input to the projection model, results from IRCI and Traffic models have been assumed for fuel consumptions.

8.3.1 Unified Policy Scenario results

In Table 46 Carbon Footprint by sector is reported for Aveiro Unified Policy Scenario expressed as CO_2, CO_2 equivalent and CO_2 equivalent on Life Cycle. In Table 47 CO_2 equivalent on Life Cycle reductions on 2015 are reported.

Table 46 – Aveiro Unified Policy Scenario Carbon Footprint by Sector (Gg)

Year	2015	2020	2025	2030	2035	2050
Carbon dioxide (CO_2)						
Residential	326,4	343,6	293,3	101,6	60,5	19,3
Services	251,8	266,6	228,2	63,1	35,1	13,1
Transport	1.447,2	1.296,8	1.157,6	1.057,8	972,3	619,3
Industry	842,2	917,3	847,1	483,8	350,4	139,8
Total	***2.867,7***	***2.824,3***	***2.526,2***	***1.706,4***	***1.418,3***	***791,5***
Carbon dioxide equivalent (CO_{2eq})						
Residential	334,4	351,3	301,5	109,3	67,1	21,8
Services	253,3	268,2	229,5	63,3	35,1	13,1
Transport	1.451,2	1.300,4	1.160,8	1.060,7	974,9	621,0

Year	2015	2020	2025	2030	2035	2050
Industry	845,8	921,1	850,2	484,3	350,6	139,9
Total	***2.884,8***	***2.840,9***	***2.542,0***	***1.717,6***	***1.427,7***	***795,7***
Carbon dioxide equivalent on life cycle (CO_{2eq})						
Residential	401,5	420,8	363,2	140,0	88,8	29,1
Services	295,8	313,2	268,2	74,7	41,6	15,5
Transport	1.717,6	1.532,9	1.361,6	1.242,6	1.140,7	725,3
Industry	990,4	1.079,3	997,6	572,5	415,0	165,3
Total	***3.405,4***	***3.346,2***	***2.990,7***	***2.029,8***	***1.686,0***	***935,2***

Table 47 – Aveiro Unified Policy Scenario Carbon Footprint by Sector: index (2015=100)

Year	2015	2020	2025	2030	2035	2050
Carbon dioxide equivalent on life cycle (CO_{2eq})						
Residential	100	105	90	35	22	7
Services	100	106	91	25	14	5
Transport	100	89	79	72	66	42
Industry	100	109	101	58	42	17
Total	***100***	***98***	***88***	***60***	***50***	***27***

For the Unified Policy Scenario, Carbon Footprint, expressed as CO_2 equivalent on Life Cycle, is reported in Figure 73 by sector and in Figure 74 by fuel.

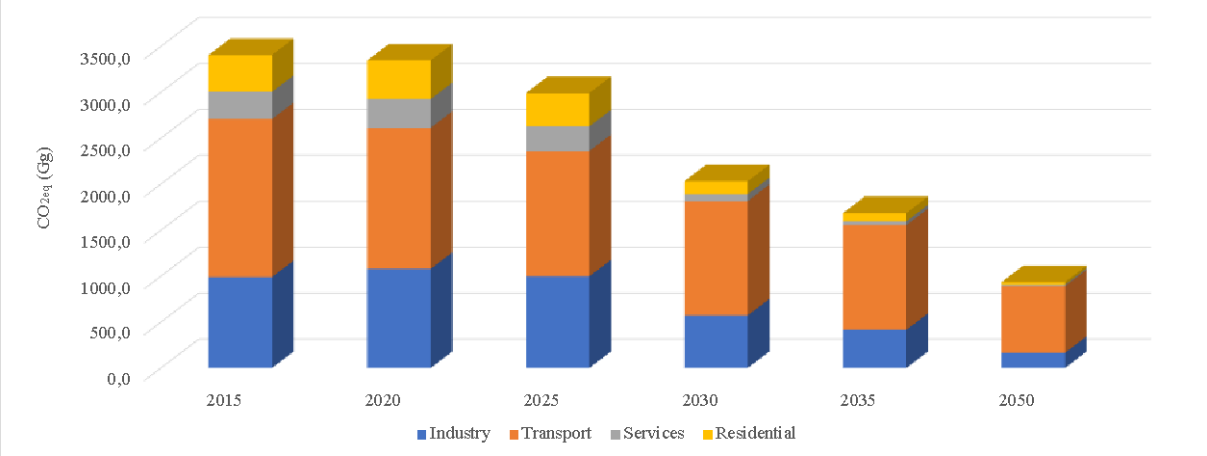

Figure 73 – Aveiro Unified Policy Scenario Carbon Footprint by sector (Gg CO_2 equivalent on Life Cycle)

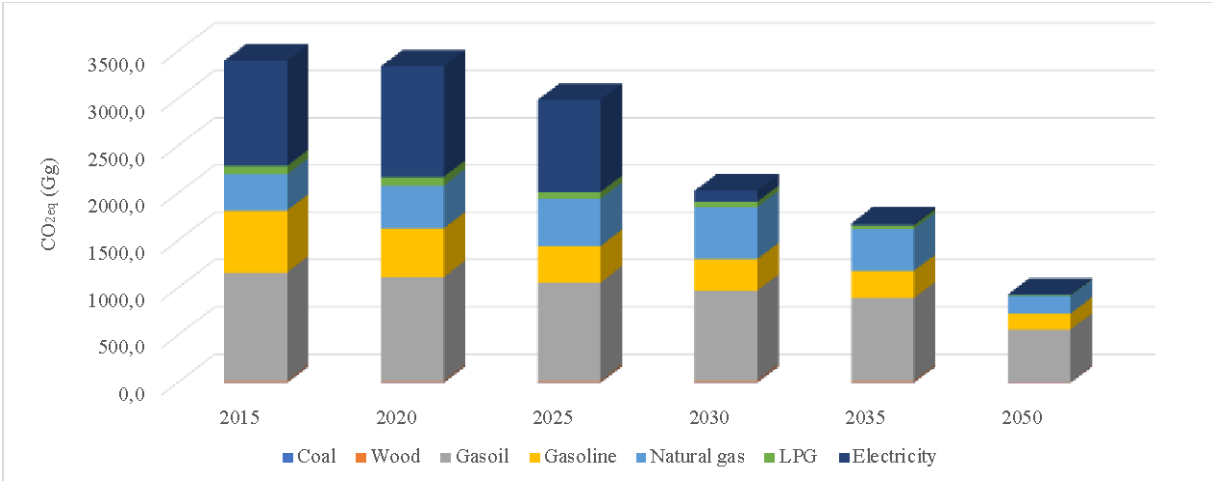

Figure 74 – Aveiro Unified Policy Scenario Carbon Footprint by fuel (Gg CO_2 equivalent on Life Cycle)

8.3.2 BAU and Unified Policy Scenario comparison

Total Carbon Footprint in the business as usual (BAU) and unified policy scenario (UPS) is compared in Figure 75 expressed as CO_2 equivalent on Life Cycle.

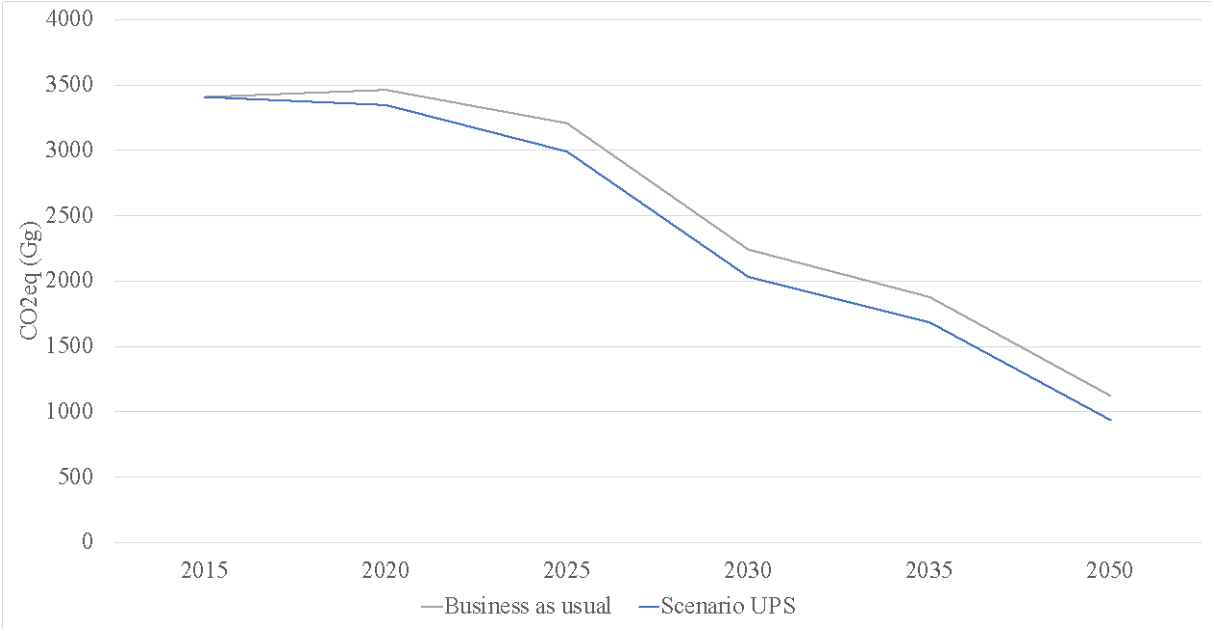

Figure 75 – Aveiro Carbon Footprint (Mg CO_2 equivalent on Life cycle) by scenario

In Figure 76 results are reported by sector and in Figure 77 by sector and fuel. Finally, in

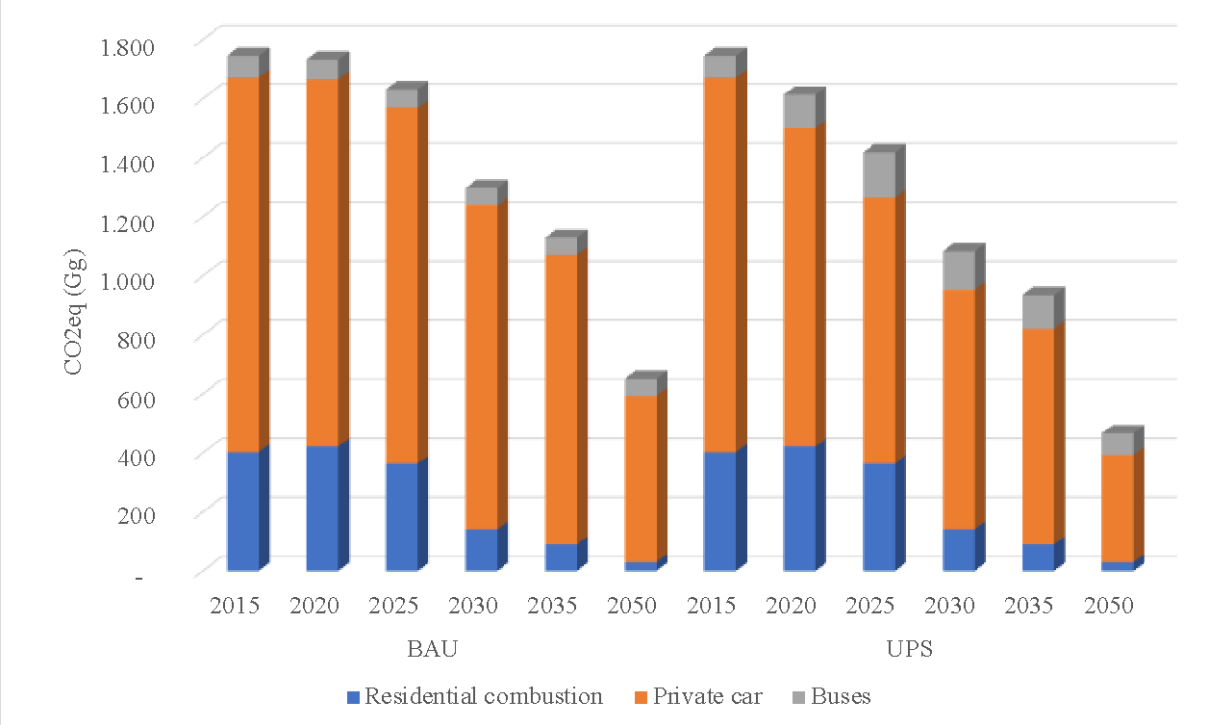

Figure 78 Carbon Footprint on life cycle generated by citizens' activities is reported in BAU and UPS scenario.

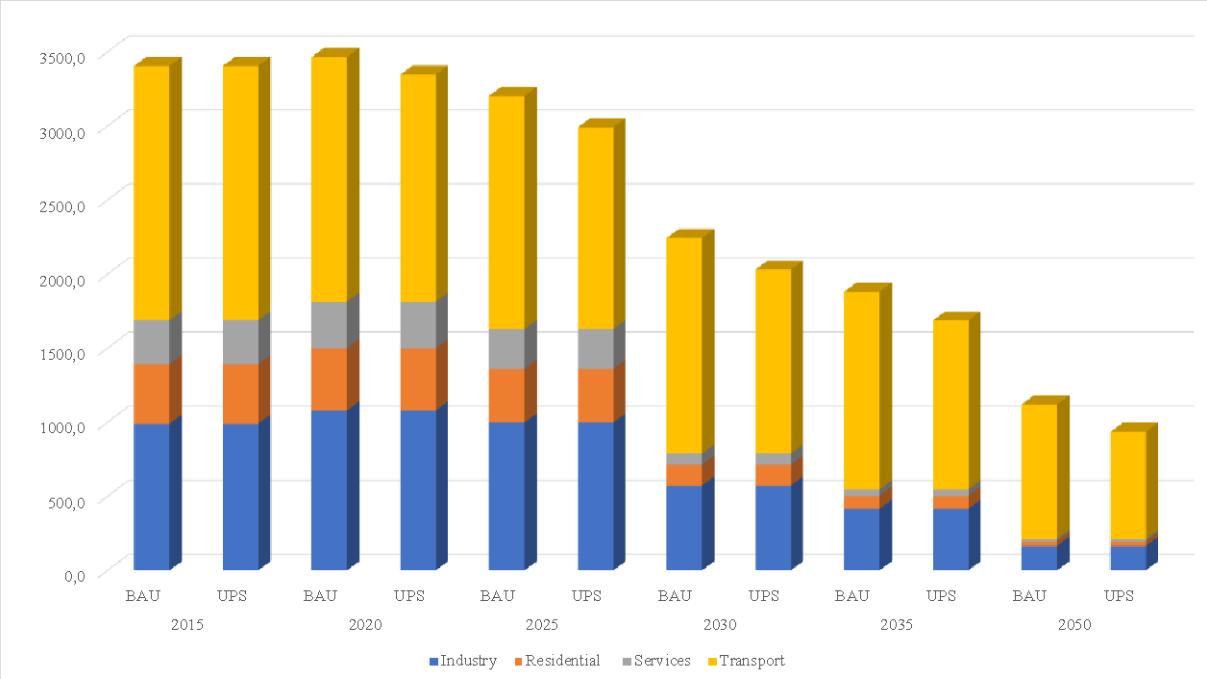

Figure 76 – Aveiro Carbon Footprint on life cycle BAU and UPS comparison by sector (Mg CO_2 equivalent)

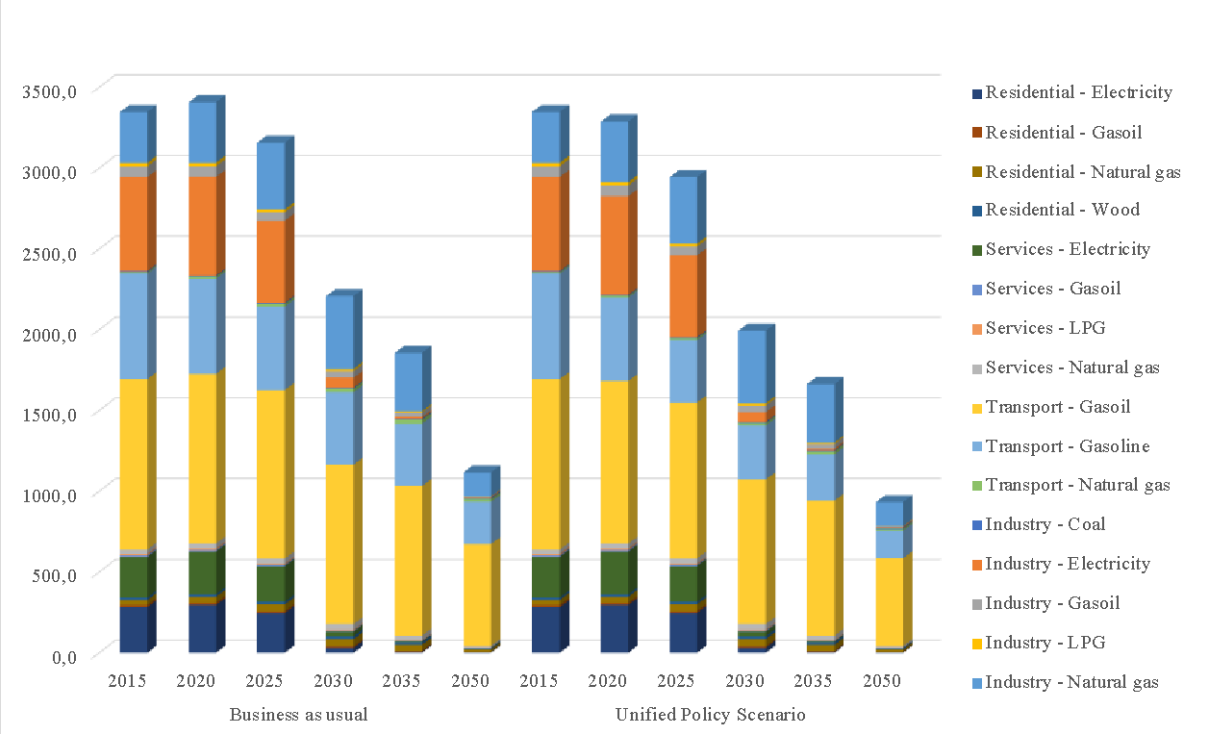

Figure 77 – Aveiro Carbon Footprint on life cycle BAU and UPS comparison by sector and fuel (Mg CO_2 equivalent)

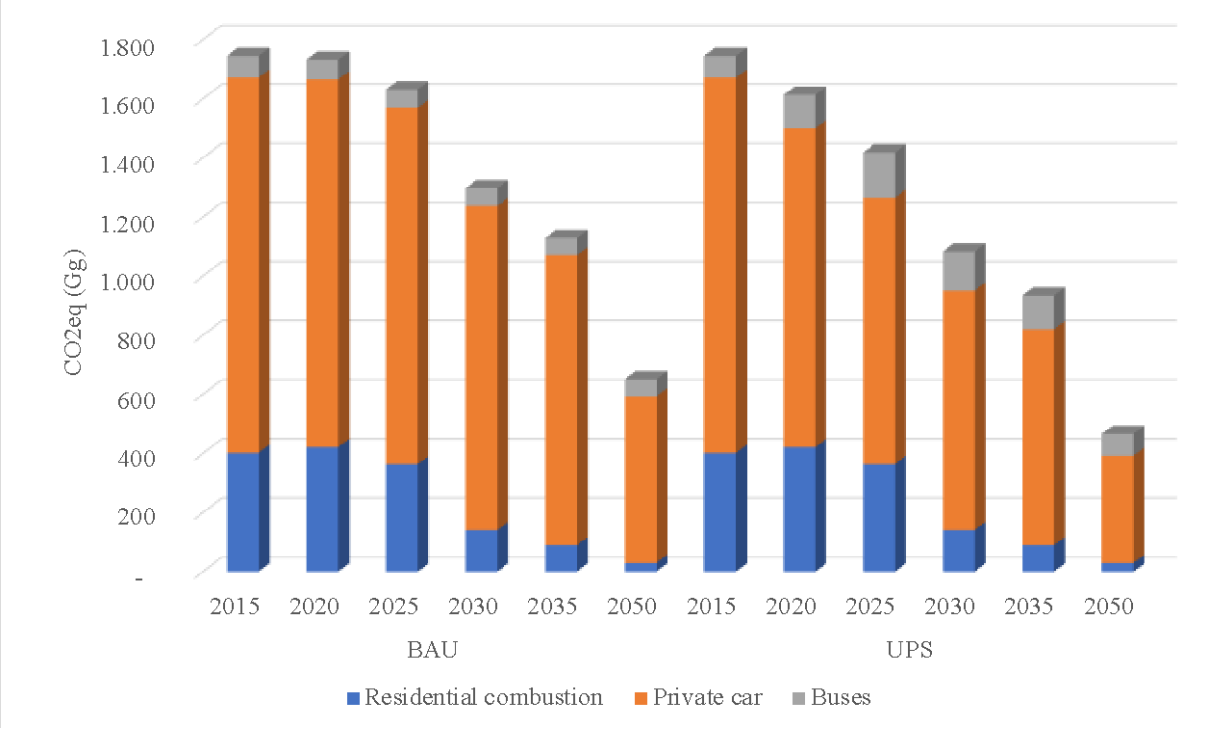

Figure 78 – Aveiro Carbon Footprint on life cycle generated by citizens' activities in BAU and UPS scenario (Mg CO_2 equivalent)