



WP4 Task 4.3 Energy Assessment Studies

Date: June 7, 2014

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The project is co-funded by the European Union, Instrument for Pre-Accession Assistance

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1 INTRODUCTION

The town of Polverara is located to the south-east of the city of Padua, province capital, equidistant from the Padua – Piove di Sacco (SS 516) and Padua – Bovolenta – Anguillara Veneta (S.P. 3 Pratiarcati) roads. From the north clockwise, it borders with the towns of Ponte San Nicolò, Legnaro, Brugine, Bovolenta and Casalsèrugo. In addition to the town proper, the town of Polverara includes the Island of Abbà district.

The town covers 9,87 square kilometres with a total population of 3,162 as of 31/12/2012 (ISTAT source), with approximately 320.36 per/square kilometre average population density.

The territory is morphologically made up of a plain, extended from north to south, with altitude dropping from 4 m above sea level to 0 m above sea level, thus average 0.7 m/km gradient along the axis.

The territory is marked by roads: S.P. 35 “Volparo” that crosses the territory N-S and connects Polverara with the towns of Legnaro and Bovolenta and S.P. 30 “Bertipaglia” that runs E-W connecting the town with Brugine and Casalsèrugo. The town proper extends along these two roads, mainly to the N-S and W.

From the hydrographic standpoint, the town of Polverara belongs to the regional Brenta-Bacchiglione river basin, whose bed extends to the west and, then, south-south east partially marking the town’s western border¹.

The town of Polverara is found in the so-called “**urbanised-rural**” areas, thus from the territory/population ratio profile, it is found in an intermediate position between rural and urbanised area, with an average land surface density of 100 residents per 0.6 square kilometres, a value about three time higher than the one recorded in the urbanised area and three time lower than the rural area.

The residential settlement system is characterised by the historic evolution of small rural villages that, settled along the N-S and E-W connection roads, expanded along the historic roads occupying free space to form a construction curtain in the older concentrations. Furthermore, the Roncasette channel to the west designed town development in a strip that extends from north to south for the entire width of the town to the left of the waterway².

The population’s past traditional occupation was farming. Numerous crafts, retail, small-industry businesses have emerged in recent decades changing both the economy and land geography³.

¹ PAT abstract town of Polverara – Technical report.

² Ibidem.

³ PAT abstract town of Polverara – Technical report.

1.1 POPULATION AND DEMOGRAPHIC DYNAMICS

Demographic dynamics are a helpful indicator in territorial development assessment. The persistent low fertility rates, the gradual extension of average life expectancy and the increasingly higher number of individuals over age 65 are at the base of the demographic aging European populations are recently experiencing. In many cases, only immigration compensates for the negative aging effects, sustaining population growth⁴.

The resident population of Polverara as of January 1, 2013 is 3,162 residents⁵. Population growth in the period from 2005 – 2012 was 23.7% with a substantially linear trend to allow for a 3,730 population estimate in the next 7 years. In 2012, the ratio between males and females was 0.977, value that oscillates over the years around the 1 equality value.

The natural balance (difference between number of births and deaths recorded) is positive and in constant growth, just as the total balance. On the other hand, the migratory balance has been decreasing since 2006. Demographic mobility demonstrates a positive balance between registrations and cancellations from other towns. Values that demonstrate a certain attractiveness of the territory from the demographic standpoint, as well as the positive balance of foreign registrations.

The total migratory rate is higher than the provincial one and increased until 2006 to then diminish until 2010, year in which it matched the provincial base value. Overall, thus, the total growth rate in Polverara was higher than the provincial one in the last ten years⁶.

Age range distribution values demonstrate that from 2002 to 2005 approximately 15% of the population was under age 14 while about 70% were aged between 15 and 64. Residents 65 years old and over represent another 15% of the population. This distribution is thoroughly demonstrated in the diagram that indicates the so-called “age pyramid” that illustrates an upside down form with a very narrow base, due to the drop in birth rates in the population over the last years.

A increase in births in Polverara is notice in recent years with a consequent increase in the young population, a birth rate in line with the provincial ones, even if higher values were posted from 2005 to 2012, it is a natural birth rate higher than the provincial one in the last 10 years.

This led to an old age ration (ratio between 65 year olds and over and population between 0 and 14 years of age) and a senior citizen dependence rate (ratio between 65 year olds and over and the active population [15-64]) lower than the provincial one in the last ten years: the first is slightly reducing and the second is stationary. While, in the same period, the structural dependence ration (ratio between the non active population [0-14 and 65 and over] and the active population [15-64] is much lower than the provincial one and with an almost stationary oscillation, slightly increasing since 2008.

⁴ Ibidem.

⁵ Source: Demolstat

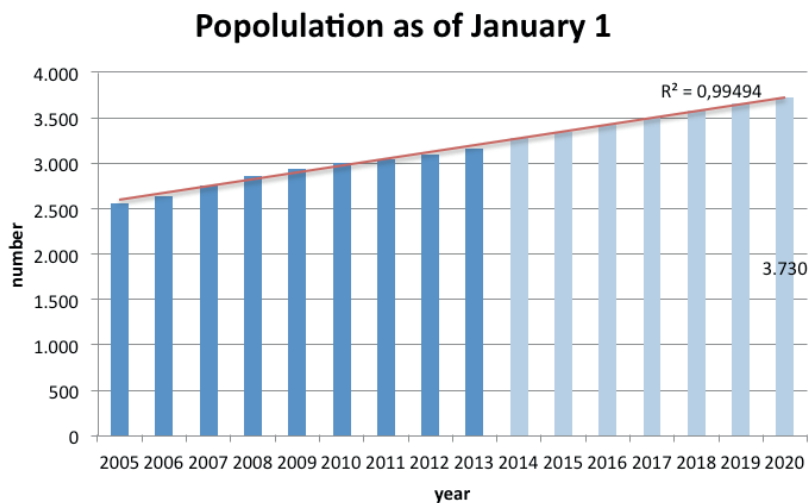
⁶ Comparing town and provincial data, the higher variability of town data time series compared to provincial data should be considered mainly due to the reduced population of Polverara.

1.1.1 RESIDENT POPULATION

Table 1 Resident population as of 1 January, from 2005 to 2013 and forecast for 2002 (Source: Demoistat⁷)

population as of 1 January			projected population as of 1 January	
Year	Total	% yearly annual	Year	Total
2005	2.555		2014	3.302
2006	2.636	3,17%	2015	3.382
2007	2.754	4,48%	2016	3.461
2008	2.866	4,07%	2017	3.541
2009	2.945	2,76%	2018	3.621
2010	3.002	1,94%	2019	3.701
2011	3.048	1,53%	2020	3.780
2012	3.100	1,71%		
2013	3.162	2,00%		




Figure 1 Linear projection to 2020 (our processing). The 2013 population was taken from that at 31 December 2012.



1.1.2 THE FAMILY

In recent years, an increase in the number of families was recorded in Polverara with a growth of 33% from 2005 to 2012. The increase in the number of families, associated with an increase in population has, however, led to a decrease in the number of family members from 2.79 in 2005 to 2.51 in 2012.

Number of families, average number of members and annual increase

	2005	2007	2009	2012
 No. families	945	1.081	1.143	1.259
 Average no, members	2,79	2,65	2,63	2,51
 Annual increase	-	7,24%	2,24%	4,22%

⁷<http://demo.istat.it/pop2013/index.html>.

BUILDING ASSETS AND GROUND USE

1.2 BUILDING ASSETS

The town territory is still characterised by vast homogenous agricultural areas, other more or less extended zones with various levels of anthropisation, a vast area next to the Roncajette channel and an almost homogeneous diffusion of buildings along the main connection roads, with concentrations in historic districts⁸.

There are 1,235 homes in Polverara covering a total 180,391 square metre surface area (average 146 square metres per home). 2001 population census data was used to characterise the town of Polverara's building and housing since 2010 data is not yet available.

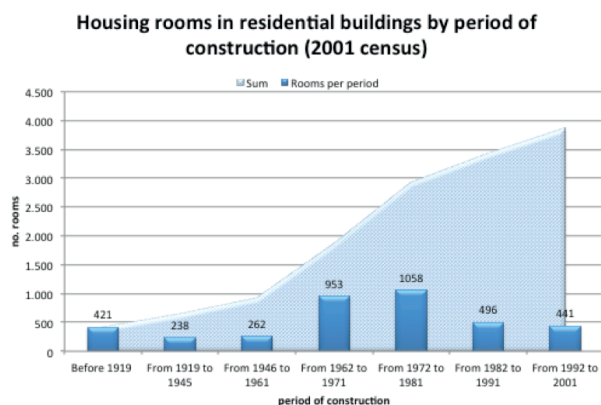
The "picture" of the building assets taken in 2001 by the ISTAT census on housing reveals the following: a strong increase in buildings in Polverara between 1962 and 1981, period of high construction expansion throughout Italy.

Number residential building by period of constructions. Polverara ISTAT 2011.			Number housing rooms in residential building by period of constructions. Polverara ISTAT 2011.			Number residential home by period of constructions Polverara ISTAT 2011.		
before 1919		62	before 1919		421	before 1919		84
from 1919 to 1945		42	from 1919 to 1945		238	from 1919 to 1945		52
from 1946 to 1951		42	from 1946 to 1951		262	from 1946 to 1951		57
from 1962 to 1971		147	from 1962 to 1971		953	from 1962 to 1971		203
from 1972 to 1981		144	from 1972 to 1981		1058	from 1972 to 1981		219
from 1982 to 1991		77	from 1982 to 1991		496	from 1982 to 1991		113
from 1992 to 2001		66	from 1992 to 2001		441	from 1992 to 2001		94

⁸ Town of Polverara PAT abstract

BUILDING ASSETS AND GROUND USE

Figure 5. No of rooms per home by construction period, Polverara ISTAT 2001

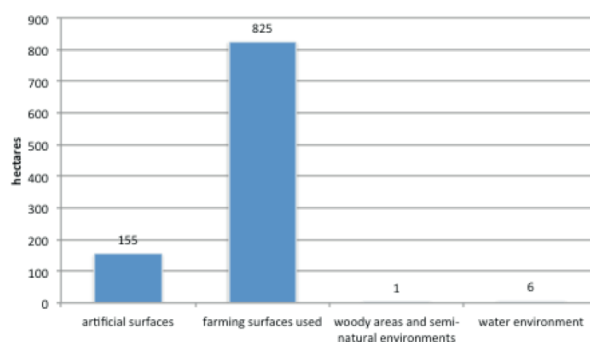


1.3 GROUND USE

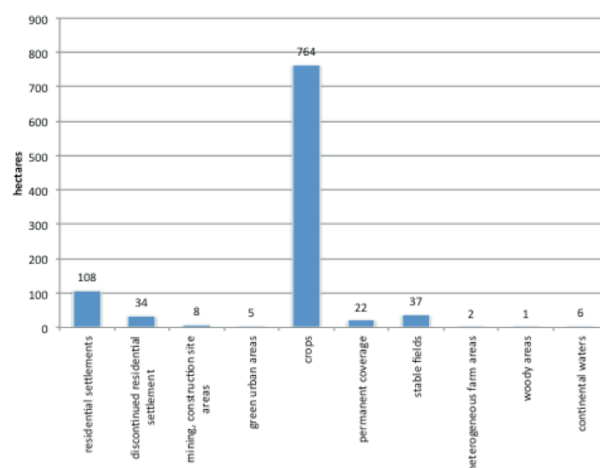
An overall picture of the territorial fabric of Polverara is given by the ground use classes in the regional coverage map. Ground coverage in the town of Polverara shows a majority of farm surface areas (83.6% of the total surface area), where crops (77,4%) prevail, and artificial surfaces (15.7%), characterised by residential settlements (10,9%).

Table 3. Ground coverage, description with detail level 1
(Source: Veneto Region Ground Coverage).

Ground coverage - Level 1



Ground coverage - Level 2

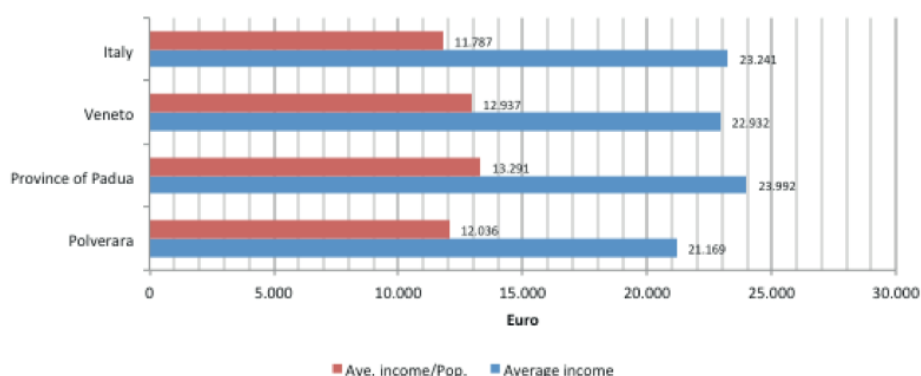


STRUCTURE, ECONOMIC DYNAMICS AND ECONOMIC ACTIVITIES

1.4 STRUCTURE AND ECONOMIC DYNAMICS

The annual income variation in Polverara is slowly aligning with the province of Padua growth rate, as indicated with reference to the year 2010.

Year	Declarants	Population	%pop	Amount	Ave/Dec.	Ave/Pop.
2005	1.425	2.636	54,10%	25.055.577	17.583	9.505
2006	1.574	2.754	57,20%	29.934.217	19.018	10.869
2007	1.648	2.866	57,50%	33.158.196	20.120	11.570
2008	1.694	2.945	57,50%	35.388.562	20.891	12.016
2009	1.729	3.002	57,60%	35.874.423	20.749	11.950
2010	1.733	3.048	56,90%	36.686.237	21.169	12.036



1.4.1 ECONOMIC ACTIVITIES

The most widespread activities fall under the construction, wholesale and retail businesses, manufacturing and professional, scientific and technical activities. Observing the number of workers, the highest number of workers are found in manufacturing, followed by those in “wholesale and retail”, construction.

Table 4 Local businesses/human resources in Polverara, ISTAT, 9th Industry and Service census.

Territory	Polverara					
Unit type	Local business unit					
Legal status	total					
Worker class	total					
Data type	Number of active units			Number of workers		
Year	2001	2011	Δ	2001	2011	Δ
A: agriculture, forestry and fishing	6	4	-2	10	8	-2
C: manufacturing	44	36	-8	155	184	29
F: buildings	47	61	14	76	104	28
G: automobile and motorcycle repair wholesale and retail	48	57	9	84	150	66
H: transport and warehousing	7	7	0	12	10	2
I: hospitality and catering services	3	4	1	5	12	7
J: information and communication services	3	2	-1	6	2	-4
K: financial and insurance activities	3	3	0	10	8	-2
L: real estate	4	5	1	4	6	2
M: professional, scientific and technical activities	9	21	12	10	22	12
N: rental, travel agencies, business support services	5	14	9	24	19	-5
P: education	..	1		..	1	
Q: healthcare and social services	4	9	5	5	9	4
R: artistic, sports, entertainment and recreational activities	1	2	1	2	2	0
S: other service activities	5	11	6	7	23	16
Total	189	237		410	560	

TRAFFIC AND MOBILITY

1.5 TRAFFIC AND MOBILITY



The town territory is centrally characterised by roads S.P. 30 "Bertipaglia" and S.P. 35 "Volparo". From the settlement standpoint, the entire town territory is thus divided into two parts: the area surrounding the main connection roads with high population density in the south-south east part of the territory; a mainly agricultural area with buildings spread in the north and west zones.

Surveys reveal inbound traffic equal to 9,289 9 vehicles and outbound traffic of 3,258 vehicles (see Saccisica P.A.T.I.).

The infrastructure system is characterised by a series of town roads, almost all branching off the main network.

The overall extension of existent bicycle paths in the province, updated to the year 2006, is 433 km; the bicycle path extension in the town of Polverara in the year 2006 was about 2 kilometres.

As for bicycle-pedestrian paths, the town has bicycle paths along the main arteries and especially in residential areas.

There is a bus network that crosses the territory from north to south along S.P. 35 and east to west along S.P. 30. Furthermore, the northern part of the town will be concerned by the Regional Metropolitan Railway System segment (SMR) with a train station. Local public transportation is guaranteed by BUSITALIA SITA Nord S.r.l. with three daily routes to Padua and three to Agna, on weekdays, with a single stop at the Polverara Sports Field.

The train stations closest to Polverara are in Padua (about 20 km), Montegrotto/Terme Euganee (about 16 km) not directly connected by bus lines, Piove di Sacco (about 10 8 km away), on the Adria-Venezia S. Lucia line.

In the town of Polverara, 2,584 motor vehicles were registered in 2012 of which 1,967 automobiles (76% of motor vehicles) and 369 motorcycles (18% of motor vehicles). There are thus 622.1 residents per 1000 automobiles, value over the provincial average. From 2005 to 2012 the number of vehicles increased by 28% while automobiles increased by 26% and motorcycles by 53%.

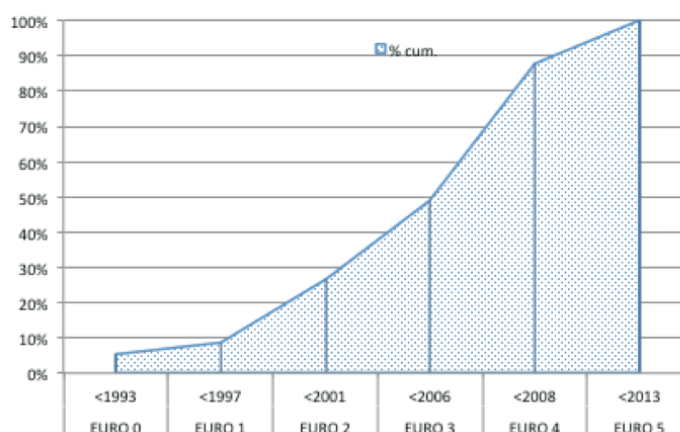
50% of the automobiles currently circulating are under EURO 4.

Per 1000 residents
town



2005	592,6
2007	613,7
2009	615,9
2012	622,1

Age of the vehicle fleet in 2012 according to EURO classes



⁹ Polverara PAT technical report.

¹⁰ Ibidem

CLIMATE PROFILE

1.6 CLIMATE PROFILE

Polverara climate classification

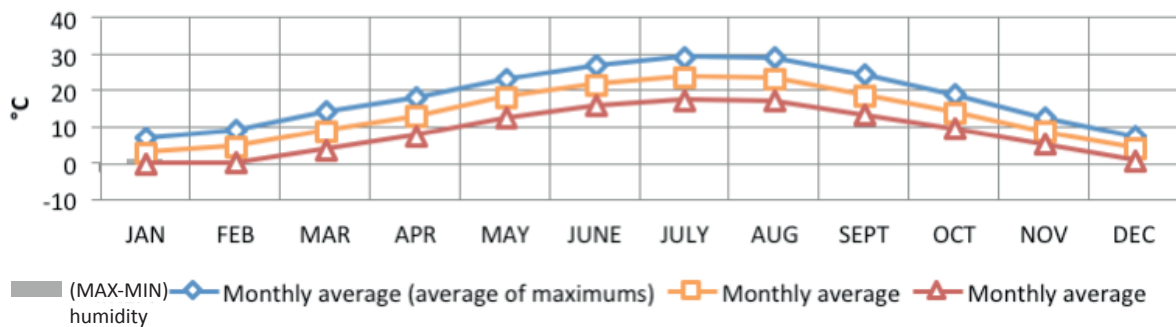
The town of Poverara is characterised by a temperate humid climate due, in addition to its geographic latitude ($45^{\circ} 18'$), to the relevant vicinity of the sea and lagoon waters, plain orientation and particular wind exposure.

The climate is classified by average yearly temperatures between 10 and 14.4°C , average temperature in the coldest month between -1.0 and 3.9°C , average temperature over 20°C for 1 – 3 months a year and annual temperature range (difference between average coldest and hottest month temperatures) over 19°C .¹¹

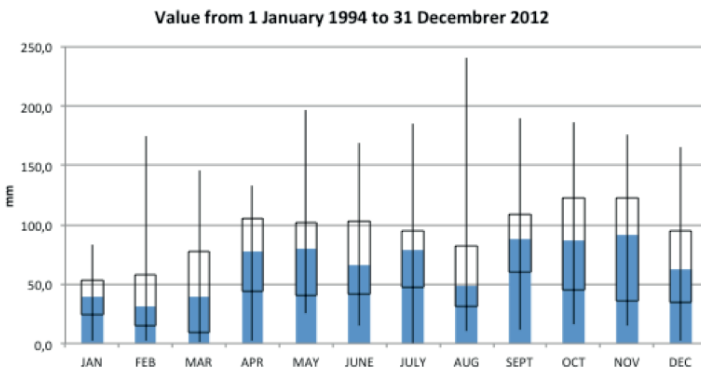
Weather data

The main weather variables were taken from data validated by the ARPAV weather stations between 1194 and 2202, published in the “ARPAV Teolo weather station report” and disclosed by the agency as “open data”. Specifically, data was used from the town of Legnaro weather station.

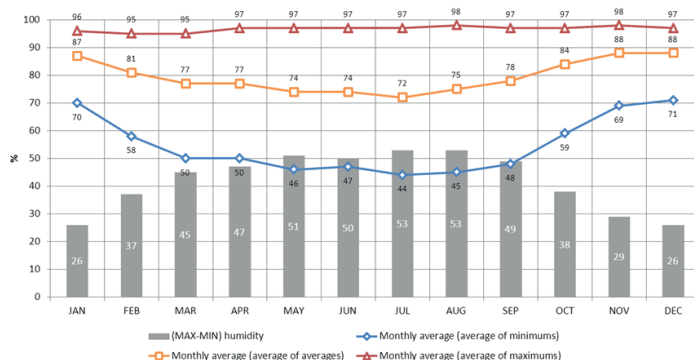
1.6.1.1 Average yearly temperatures



1.6.1.2 Rain



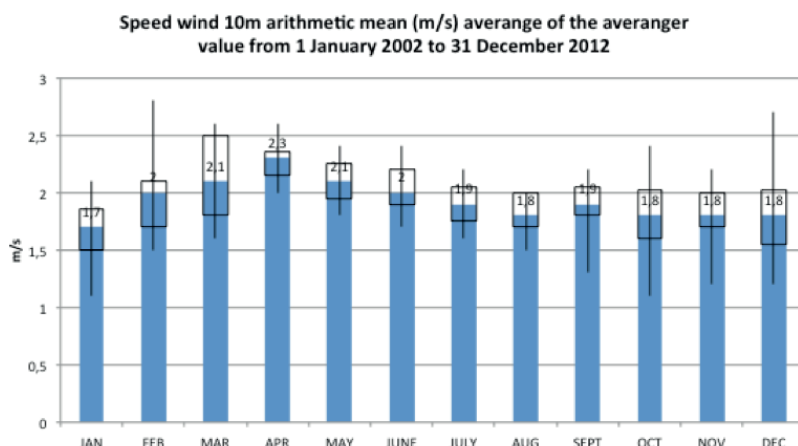
1.6.1.2 Relative humidity



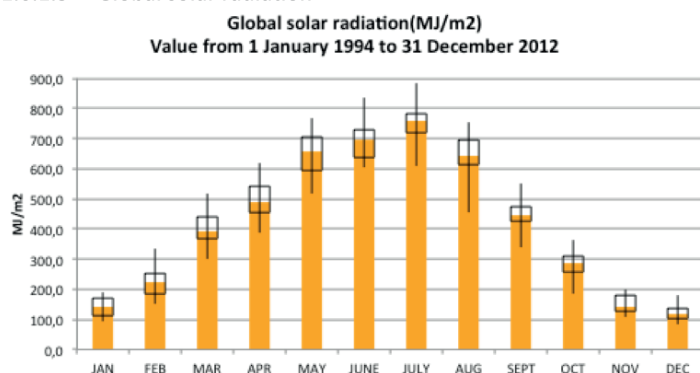
¹¹AA.VV. Veneto climate frame work, in Veneto agro-climate Atlante, 2011.

CLIMATE PROFILE AND DEGREES DAY

1.6.1.4 Wind gauge

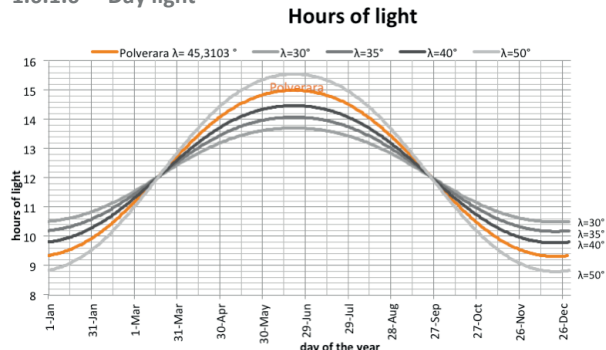


1.6.1.5 Global solar radiation



The data reveals average maximum 1.439 kWh/m2/year radiation, equal to about 3.9 kWh/m2/day, maintaining more favourable exposure: to the south with a 30° inclination.

1.6.1.6 Day light



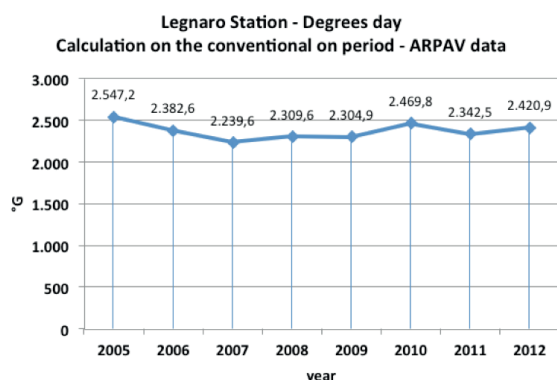
For this latitude, about 4,463 total theoretic light hours a year are calculated, with a maximum of 15h during the summer solstice (June 21) and 9h 18min during the winter solstice (December 21).

1.6.2 Degrees day

For a certain location, the degrees day parameters (Presidential Decree 412/1993) is the sum, extended to all days in the traditional heating year, of the sole positive daily differences between indoor room temperature (conventionally set at 20°) and the average outdoor daily temperature.

The town is in climate zone E (towns with a number of degrees – day over 2,100 and not over 3,000) with degrees day identified by the same decree 2,383, standard value.

CLIMATE FACTOR AND TEMPERATURE CORRECTIONS



Thermal energy consumption monitoring compared to the plan goal can take into account the temperature corrections that can be calculated using the "degrees day" factor (GG).

To compare the two consumption values net of the climate factor, degrees-day are used to standardise (temperature correction) consumption compared to a standard climate reference condition.

The applied correction formula is as follows:

$$CL_{cal,ct} = \frac{2383 * CL_{eff}}{GG}$$

where: $CL_{cal,ct}$ is corrected consumption; CL_{eff} is actual consumption; GG real degrees day calculated in a calendar year.

2 BEI, BASELINE EMISSION INVENTORY – METHODS AND KEY CONCEPTS

The *Baseline Emission Inventory* (BEI) is the tool that quantifies CO₂ emissions due to energy consumption in the town territory during the reference year. Drafting the BEI has the following objectives:

- Demonstrate the starting situation by identifying the main anthropic CO₂ emission sources for which reduction measures are identified;
- Allow for emission monitoring in years following the reference one, to demonstrate progress on SEAP goals, thus measure the efficiency of adopted measures.

BEI development is the next step following the initial framework or survey phase and is one of the *baseline survey* products. The BEI only concerns those sectors in which the authority has and will have, by strategic choice, real control, through long and medium term provisions implemented by the plan actions.

2.1 KEY CONCEPTS

Two notions drive the construction of the BEI: 1) the knowledge that CO₂ emissions from anthropic activities is mainly due to the combustion of organic compounds – mainly fossil fuels, for energy conversion; 2) that the focus of the Covenant of Mayors is on the demand side, meaning on final energy consumption.

Three key concepts on drafting the BEI:

- *Year of reference*, which for this SEAP is **2007**⁷. Year against which emission reduction results due to plan actions will be compared in 2020.
- *activity data*, that quantify human activities in the territory (expressed in energy consumption, i.e.: heat, electricity MWh, from renewable and non sources).
- *emission factors*, coefficients that quantify CO₂ emissions by activity unit (i.e.: t CO₂/MWh).

The BEI does not include “carbon capturing and storage (CSC)” (i.e.: changes in carbon stock in urban territory woods) and nuclear energy, since out of the Covenant of Mayors' application field.

2.2 DATA CALCULATION AND COLLECTION METHODS

The method approach chosen to calculate BEI CO₂ emissions is the “**standard**” one, that uses “standard emission factors” in calculations, in line with the *Intergovernmental Panel for Climate Change (IPCC)*, the United Nations' intergovernmental group of climate change experts.

CO₂ emissions are thus estimated by multiplying the emission factor by the corresponding activity data (normally expressed in energy units). The “standard” emission factors, adopted hereto for calculations, are based on the carbon content of each fuel, as applied in national greenhouse effect gas inventories drafted under the UN framework convention on climate changes (UNFCCC) and Kyoto Protocol.

⁷ 1990 is the year of reference for the Kyoto Protocol (1997) and the year from which the EU calculates the commitment to reduce CO₂ emissions by 20% by 2020. The efforts of each member state is, however, set according to their greenhouse effect gas emissions in 2005 (Decision no. 406/2009/EC).

According to this specific approach:

- the most important greenhouse effect gas is CO₂
- other greenhouse effect gas emissions such as CH₄ (methane) and N₂O (nitrous oxide) need not be calculated
- CO₂ emissions due to the use of *sustainable* biomass and biofuels and emissions due to “green electricity” are considered zero.

For sectors: Residential, Tertiary and private transport, estimates were made with indirect methods.

2.3 EMISSION FACTORS

Following is a summary table of conversion factors used:

VECTOR	EMISSION FACTORS
Electricity	0,483 t CO ₂ /MWh _{el}
Natural gas	0,202 t CO ₂ /MWh _{comb}
Petrol	0.249 t CO ₂ /MWh _{comb}
Diesel fuel	0.267 t CO ₂ /MWh _{comb}
LPG	0,231 t CO ₂ /MWh _{comb}

For energy from biomass, the guidelines set that “even if a biofuel/biomass provides a **neutral balance** in CO₂ terms, its use may not be considered sustainable if its production causes the **high emission of other greenhouse effect gases** –such as N₂O due to the use of fertilizers or CO₂ due to changes in ground use – or have an impact on biodiversity”.

2.3.1 Summary of the criteria adopted to draft the BEI

Some criteria for the draft and calculation of BEI defined in the European guidelines are optional and left to the administrator’s discretion.

To singularly identify the choices made, the criteria adopted are summarised in the following points:

- The method approach chosen for BEI CO₂ emission calculations is the “**standard**” one that uses “**standard emission factors**” (IPCC). Emission factors are FIXED.
- The calculation of CO₂ emission reduction in 2020 will be **pro-capita** based.
- The correction of thermal consumption based on real degree days will **not be applied**.
- To calculate electricity production from renewable sources: an estimated produced energy self-consumption factor equal to 55% is considered; this way, consumption by a home equipped with a photovoltaic plant will lower consumption based on self-consumed energy. The remaining part of energy, produced and *introduced in the grid*, is considered as “**green production**” (evaluated as a reduction of consumed energy).

2.4 REFERENCE SECTORS

The activity sectors considered in the BEI are those listed in the following table. Those spheres not pertinent to SEAP policy were not considered such as: industries involved in EU ETS, air and sea/river transport, emission sources not associated with energy consumption (fugitive emissions, process emissions, agriculture, ground use); and those spheres not included **by choice** in this SEAP; other road and rail transport; off-road transport; solid waste processing; consumption due to the energy production sector.

BUILDINGS, EQUIPMENT/PLANTS AND INDUSTRY	Town buildings, equipment/plants	YES – direct calculation
	Tertiary sector buildings, equipment/plants (non town private and public)	YES – real and estimated data (*)
	Residential buildings (private)	YES – estimated data
	Public lighting (town)	YES – direct calculation
	Industries not involved in EU ETS (if in SEAP)	YES – estimated data
TRANSPORT	Urban ground transport: Town fleet (and services)	YES – direct calculation
	Urban ground transport: Public transport (urban and extra-urban lines in the territory)	YES – estimated data
	Urban ground transport: Private and retail transport	YES – estimated data
	Other transport (not under the local authority's control and if in SEAP)	NO
	Urban rail transport	NO
	Other rail transport (if in SEAP)	NO
	Off-road transport	NO
OTHER EMISSION SOURCES not associated with energy consumption	Solid waste processing (if in SEAP)	NO
	Energy consumption for electricity production (if in SEAP) ⁸	NO
	Fuel consumption for heating/cooling production.	
	Only if heating/cooling is provided as a product to end users in the territory. ⁹	YES
ENERGY PRODUCTION		

(*) real data refers to provincial public lighting.

⁸Only for <20 MW fuel plant that are not part of EU ETS.

⁹Plants and units that provide heating/cooling as a base product to end users in the territory (for example, district heating or co-generation plant) [Guidelines].

Please note that the data collected for BEI allow CO₂ emissions due to energy consumed in the administrative territory, both directly, via fuel combustion in the town, and indirectly, using electricity and or heating/cooling in the town area, to be calculated.

2.4.1 TOWN AND NON TOWN PUBLIC DIVISIONS

For plants managed by the administration, data was collected directly from consumption invoices. Real meter values were always considered and estimates taken from the provider only in the cases where other procedures could not be implemented. For plants managed by outsourced providers, annual consumption values for each user or supply point (SP) were directly provided by the service provider.

2.4.2 PRIVATE DIVISION

The private division includes thermal energy consumption for heating, electricity consumption and private and retail transport consumption. While the non town public division includes local public transport, tertiary building consumption (if applicable) and public lighting (non town).

Table 1. Metadata on consumption values for BEI.

Category	Sub-category	Source	Notes
Residential buildings	Residential construction	Enel Distribuzione, Acegas, Verde Energia, INEMAR	Consumption data, estimates
Tertiary buildings, equipment/plants (non town)	Provincial road public lighting	Enel Distribuzione, Enel Rete Gas, Acegas, INEMAR	Consumption data, estimates
Private and retail transport	Private and retail transport	ACI, Padua chamber of commerce	Estimates from calculation model
Public transport	Local public transport	SITA - Bus Italia	Estimates from calculation model
Industries		Enel Distribuzione, Enel Rete Gas, Acegas, INEMAR	Consumption data, estimates

The INEMAR database is not an accurate emission calculation but an estimate of emission contributions from the group of anthropic and natural activities found in a certain territory during a certain period of time. The exact calculation of pollutant emissions would not be feasible given the complexity and quantity of existent sources.

Thus, the BEI will be updated as soon as real data on methane gas consumption is available for the Residential, Tertiary and Industrial sectors.

3 ENERGY CONSUMPTION

3.1 BUILDINGS, PLANTS AND INDUSTRY

3.1.1 TOWN ASSETS

For BEI purposes, public town assets are made up of buildings, public and service lighting systems, motor vehicles, owned by the town.

15 buildings owned by the town of Polverara were included in BEI: 9 of which from 2007. The total estimated heated surface area is about 8,446 square metres while the total volume is about 39,576 cubic metres.

PLANTS

8 town buildings are serviced by district heating. Four buildings have photovoltaic systems with a total peak power of 48.69 kWp (about 56 MWh energy produced in 2012); no building is equipped with solar heating systems.

Town building energy consumption using the TRL plant was about 370 MWh in 2012.

“GREEN” ELECTRICITY PURCHASES

Since 2006, the town has been purchasing electricity from renewable energy sources¹⁰. Until 2008, the amount of energy from renewable sources accounted for 30% of the total, since 2009 on, this value rose to 100%. In the 2007 BEI, the CO₂ emission values for electricity for the entire public town division was thus reduced by 30% and set to zero in 2010 and 2012.

3.1.1.1 TOWN AND SERVICE PUBLIC LIGHTING

Public town lighting is one of the most important sectors in energy consumption and administration cost management.

Table 2 Town public lighting consumption.

TOWN PUBLIC LIGHTING	Year		
	2007(*)	2010(*)	2012
Number of light points	321	319	341
Consumption (kWh)	94.239	128.066	121.207

(*) for some meters (3 in all), consumption data was not collected for the years 2007 and 2010.

¹⁰ Global Power Spa supplier in the years considered: Period 2007 – 2012.

3.1.1.2 TOWN FLEET TRANSPORT

Town fleet vehicles, including vehicles servicing schools (outsourced), totalled 3 in 2007 and 5 in 2010 and 2012. In 2012, 3 were fuel powered, 1 methane and 1 LPG. Table 3. Fuel consumption table for town fleet vehicles.

	kWh		
Fuel type	2007	2010	2012
diesel fuel	12.390	22.721	26.889
Methane/petrol	5.149	5.620	5.460
LPG/petrol	0	4.239	4.369
TOTAL	17.539	32.580	36.718

3.1.2 NON TOWN PUBLIC DIVISION

The non town public division included in BEI is made up of provincial public lighting sectors (paid by the town) and local public transport (road lines). There are no non town public buildings in Polverara.

Electricity consumption data for the years 2007, 2010 and 2012 for provincial public lighting are provided in the following table.

Table 4. Provincial public lighting consumption.

PROVINCIAL PUBLIC LIGHTING	Year		
	2007	2010 (*)	2012 (*)
Number of light points	118	118	110
Consumption (kWh)	78.057	126.640	83.345

(*) In 2012, the two street meters were merged with other meters.

3.1.3 INDUSTRY AND SERVICES

Electricity consumption in the tertiary and industrial sectors were provided by Enel Distribuzione, that grouped data by goods category. For the tertiary sector, BEI town and non town public divisions electricity shares were subtracted from the value provided by Enel, calculated directly from invoices since Enel included them in this sector. For the industrial sector, data was taken from Enel, knowing that there are no industries in the EU-ETS (*Emissions Trading System*) system in Polverara which would otherwise be excluded.

3.2 GROUND TRANSPORT

3.2.1 PUBLIC TRANSPORTATION

The kilometres travelled by SITA BUS Italia line vehicles within town lines were considered to estimate public transport consumption. From this value, and based on average consumption per kilometre, the litres of fuel consumed (diesel) and annual CO₂ emissions were calculated.

3.2.2 PRIVATE AND RETAIL TRANSPORT

Data on the amount of fuel sold on the provincial level in 2011 was considered to determine private transport sector consumption. These values were spread over the provincial vehicle pool based on category: motor vehicles, light industrial vehicles and heavy industrial vehicles; additional distinctions by fuel type (ACI data). Based on meters, the three categories were attributed different unit consumption coefficients, the same for the various types of fuel (respectively: 0,2; 0,3; 0,6; COPERT data). To refer, lastly, this data on the town scale, the *abundance rates* compared to the provincial vehicle pool were considered for categories:

“motor vehicles” and “industrial vehicles” (grouping “heavy” and “light” sub-categories) in Polverara; divided by fuel

type,¹¹.

Of these, petrol, diesel and LPG values sold in the ordinary network for the years 2007, 2010 and 2011 are considered (in lack of data for 2012, 2011 consumption was considered).

Table 5 Petrol, diesel, LPG sales in the ordinary network in the province of Padua.

ORDINARY NETWORK SALES (TONNES)	2007	2010	2011
PETROL	166.630	124.766	112.163
DIESEL	239.082	219.587	210.980
LPG	14.607	25.659	34.878
TOTAL	420.319	370.012	358.021

Table 6. Abundance rates in the town compared to the province for the two considered vehicle categories.

ABUNDANCE RATE (%)	2007	2010	2012
MOTOR VEHICLES	0,322%	0,335%	0,345%
INDUSTRIAL VEHICLES	0,275%	0,298%	0,304%

3.3 RAILWAY TRANSPORT

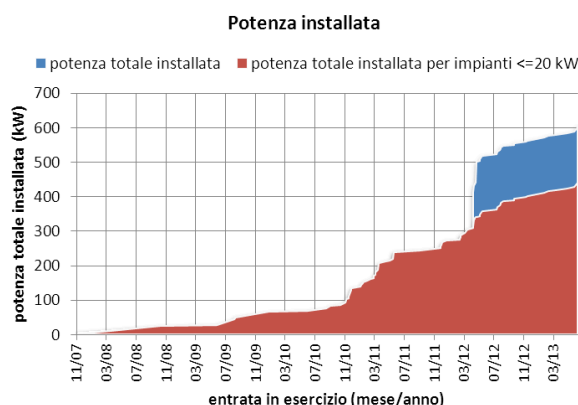
There is no train station in the town of Polverara. The train station most convenient to Polverara is in Padua (about 20 km away). The Montegrotto/Terme Euganee station is not far off (about 16 km away) but it is not directly connected to Polverara by bus. The "littorina" train, a local train that runs on the Adria- Venezia Santa Lucia line, can be taken from the Piove di Sacco station (about 8 km away).

4 LOCAL HEAT AND ELECTRICITY PRODUCTION

When calculating BEI local electricity production, all plants that meet the following criteria can be included: 1) the plant must not be included in the EU ETS system; 2) the plant must have input thermal energy less than or equal to 20 MW fuel – for fossil fuels and biomass combustion plants – or less than or equal to 20 MWe rated power – for other renewable energy plants (i.e.: wind or solar). Furthermore, photovoltaic systems are mainly considered in the BEI for electricity production.

¹¹ This data is periodically published by the Ministry for Economic development.

4.1 PHOTOVOLTAIC



Data on photovoltaic system (FV) installed in Polverara were taken from the GSE "Atlasole" regarding photovoltaic systems that receive the Energy Bill incentive (CE) or applied for it.

Data updated to January 14, 2014 on the GSE "Atlasole" portal indicate: 83 plants and 604.9 kW incentivised peak (against a mean provincial value of 1,653 kW_p).

If only plants with power not over 20 kW peak are considered (value within which plants can be considered "residential use"): 81 plants installed and total 444.6 kW_p power.

4.2 LOCAL HEATING/COOLING PRODUCTION

The Town of Polverara district heating plant has been operating since 2010 supplying heat for heating and hot water. The plant exclusively produces thermal energy, is powered by a agro-forestry origin wood biomass boiler, it has 700 kW/t rated power and uses chip wood as fuel. The plant operates six months a year, from September to May, and is assisted by a methane backup/recovery boiler located in the "Giovanni XXIII" elementary school and whose consumption is covered by the district heating concessionary company. The two boilers can only work in parallel and thus in shifts. In 2010 the plant, through the TRL network, serviced 5 public users and 57 private users while in 2012 it serviced 5 public users and 67 private users. Private user consumption in 2012 totalled 388.64 MWh (average of 8,801 kWh/user) while public users totalled 369.60 MWh, for a total of 758 MWh, equivalent to avoided CO₂ emissions from methane gas for 153 t CO₂/year.

Furthermore, please note that private sector consumption for 2010 included in BEI was estimated from 2012 consumption based on average unit consumption, due to a lack of data.

Table 7. District heating plant features and users serviced in 2012.

Average yearly consumption (t)	fuel	Installed power (kW /t)	Notes	2010 users	2012 users
500 (chip wood)		700	Operations from September to May	57 private users and 5 public.	67 private users and 5 public.

4.3 BIOMASS COGENERATION PLANTS

A private biogas plant is located in a rural area peripheral to the town with average power (999 kWe + 570 kWt); the owner and manager is Polverara Biogas Srl.

The plant is intended to produce electricity; the heat obtained in electricity production processes is only partially recovered: it is used to heat the processes in the digester and to heat offices servicing the plant).

5 CO₂ EMISSION BALANCE SHEET

The following table summarises CO₂ energy consumption and emission values divided between the public and private sectors. The pro-capita calculation takes into account 2,754 residents in 2007 and 3,100 in 2012¹⁴.

POLVERARA SEAP - BEI

POLVERARA SEAP - BEI												
			2007	2007	POP 2007	2010	2010	POP 2010	2012	2012	POP 2012	
					2.754			3.002			3.100	
			2007	2007	2010	2010	2012	2012	2012	2012	2012	
			MWh	t CO2	tCO2 /pop	MWh	t CO2	tCO2 /pop	MWh	t CO2	tCO2 /pop	
DIVISION	SECTOR	VECTOR	MWh	t CO2	tCO2 /pop	MWh	t CO2	tCO2 /pop	MWh	t CO2	tCO2 /pop	
TOWN TERRITORY	TOWN ASSET DIVISION	BUILDINGS	486	98	0,036	136	28	0,009	238	48	0,016	
		BUILDINGS	6	1	0,001	7	2	0,001	3	1	0,000	
		BUILDINGS	0	0	0,000	0	0	0,000	0	0	0,000	
		BUILDINGS	0	0	0,000	417	0	0,000	370	0	0,000	
		BUILDINGS	106	36	0,013	138	0	0,000	133	0	0,000	
		PUBLIC LIGHTING	94	32	0,012	128	0	0,000	121	0	0,000	
		TOWN FLEET (AND SERVICES)	18	4	0,002	33	8	0,003	37	9	0,003	
		TOTAL PUBLIC TOWN DIVISION		172	0,062		37	0,012		58	0,019	
		PUBLIC TRANSPORTATION	diesel fuel	84	22	0,008	84	22	0,007	84	22	0,007
		PROVINCIAL ROAD PUBLIC LIGHTING	electricity	78	42	0,015	127	0	0,000	83	0	0,000
		TOTAL PUBLIC DIVISION (NON TOWN)		64	0,023		22	0,007		22	0,007	
	PRIVATE DIVISION	RESIDENTIAL CONSTRUCTION	electricity	2.946	1.423	0,517	3.224	1.557	0,519	3.258	1.574	0,508
			natural gas	18.904	3.819	1,387	20.380	4.117	1,371	19.808	4.001	1,291
			LPG	2.521	572	0,208	2.780	631	0,210	2.725	619	0,200
			diesel fuel	1.562	417	0,151	1.722	460	0,153	1.688	451	0,145
			biomass (chip wood)	0	0	0,000	331	0	0,000	389	0	0,000
			Total heating	22.987	4.808	1,746	25.213	5.208	1,735	24.609	5.070	1,636
		TOTAL RESIDENTIAL CONSTRUCTION		6.231	2,262		6.765	2,253		6.644	2,143	
		TERTIARY	electricity	1.211	585	0,212	1.002	484	0,161	1.405	679	0,219
			natural gas	2.999	606	0,220	3.307	668	0,223	3.241	655	0,211
		TOTAL TERTIARY		1.190	0,432		1.152	0,384		1.333	0,430	
		INDUSTRY	electricity	1.120	541	0,196	1.350	652	0,217	1.027	496	0,160
			natural gas	619	125	0,045	619	125	0,042	619	125	0,040
		TOTAL INDUSTRY		666	0,242		777	0,259		621	0,200	
		PRIVATE AND RETAIL TRANSPORT	LPG	613	139	0,050	1.123	255	0,085	1.572	357	0,115
			diesel fuel	8.604	2.297	0,834	8.388	2.240	0,746	8.286	2.212	0,714
			petrol	6.589	1.641	0,596	5.135	1.279	0,426	4.752	1.183	0,382
TOTAL PRIVATE AND RETAIL TRANSPORT			4.077	1,480		3.774	1,257		3.752	1,210		
TOTAL PRIVATE DIVISION				12.164	4,417		12.468	4,153		12.351	3,984	
TOTAL				12.399	4,502		12.527	4,173		12.431	4,010	

¹⁴ The considered population value is the one on January 1.