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ACTION D3. RESIDENTIAL WOOD CONSUMPTION ESTIMATION IN THE PO VALLEY

REPORT ON THE SURVEY TO ESTIMATE WOODY BIOMASSES CONSUMPTION IN HOUSEHOLDS

01/02/2020

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Index

Action D.3 Residential wood consumption estimation in the Po Valley

1. Subject of the survey

The survey was carried out as part of the PREPAIR project, Action D.3 *Residential wood combustion estimation in the Po Valley*, with the aim of updating the estimates of woody biomasses consumed in the Po Valley as an energy source for households heating in 2018.

Previously, in the period from 2009 to 2013, some regions and autonomous provinces belonging to this territory had independently carried out similar surveys with the final objective of estimating the emissions of air pollutants related to the combustion of woody biomasses in households and therefore improve the regional / provincial atmospheric emission inventories. In all these regions and provinces, the related total annual emission estimates of PM10, PM2.5 and benzo(a)pyrene had highlighted the contribution of wood combustion for households heating as the main emission source.
In 2013, also the Italian National Institute of Statistics (ISTAT) carried out the survey "*Energy consumption in households*" which quantified the annual consumption of wood and pellet and the distribution of traditional and innovative combustion devices in Italy at regional level.

In order to update the Po Basin emission inventory (Action D.2[1]), in the spring of 2019 a survey with a mixed approach technique of CATI (Computer Assisted Telephone Interviewing) and CAWI (Computer Assisted Web Interviewing) was administered to a sample of about 20,000 residents in the Po Valley area. It aimed at estimating the woody biomasses consumption and the distribution of appliances burning wood and pellet in dwellings.
In order to give more strength to the estimates resulting from the survey, in November 2019 a further sample of 3,000 families was sampled through the CATI technique.
The survey concerned also other issues related to woody biomasses in households, such as: information on the sources of supply, frequency of use, methods of ignition and storage, maintenance issues, consumers inclination to replace older wood-burning appliances with cleaner and more efficient home heating systems (through financial incentives).

In the second phase of the Action D.3, a comprehensive energy balance will combine energy demand of households in the Po Valley, based on the Population and Housing census data (ISTAT), and the consumption of fuels such as natural gas, gasoil officially registered by authorities and providers with woody biomasses, estimated through this survey.

This report will also relate to the results of Action C.8[2], aimed at quantifying the supply flows of woody biomasses in the Po Valley.

After the consolidation of consumption estimates, pollutant emissions will be updated through the use of Emission Factors by type of heating appliance.

[1] *Periodic update of emission data*
[2] *Analysis of the logistics of consumption and supply of woody biomass*

2. Survey's operating method

The survey was carried out in two phases by two different market research companies: **Field Community s.c.a.r.l.** which was awarded the first of the two negotiated procedures[3] launched by ARPA Veneto and **Demetra opinioni.net s.r.l.**, winner of the second segment of the survey.
The questionnaire administered to the sample had the primary objective to collect data to estimate wood and pellet consumption to heat households and to cook food and the distribution of wood combustion devices in the Po Valley. It was made up of 7 sections, as reported in Annex 1.

The survey unit was the family, intended as a group of people living together and bound by emotional bonds, marriage, kinship, affinity, adoption and protection.
The Po Valley territory involved in the survey, included the Regions Valle d'Aosta, Piedmont, Lombardy, Veneto, Friuli-Venezia Giulia, Emilia-Romagna and the Autonomous Provinces of Trento and Bolzano.
Municipalities of the Po Basin have been stratified by demographics and altitude, crossing the following variables:

- central municipalities of the four metropolitan areas Turin, Milan, Venice, Bologna (according to 2011 ISTAT classification);
- with more than 50'000 inhabitants;
- altitude zone n. 5 (plain) with less than 10'000 inhabitants;
- altitude zone n. 5 (plain) with 10,000 to 50'000 inhabitants;
- altitude zone n. 1 (mountain) with less than 10'000 inhabitants;
- altitude zone n. 1 (mountain) with 10'000 to 50'000 inhabitants.
- altitude zone n. 3 and 4 (coastal and inland hills) with less than 10'000 inhabitants;
- altitude zone n. 3 and 4 (coastal and inland hills) with 10'000 to 50'000 inhabitants.

The number of families residing in all the municipalities of the Po valley regions is provided by the ISTAT census survey; these data are updated to 2011.
In order to use a more recent universe, a statistical projection was carried out to 2018, using the Geodemo data (ISTAT) of the aforementioned year (Table 1).

A probabilistic one-stage sampling design was followed. The reference population has been stratified with respect to the regions and the municipal typology listed above; in each layer the sample has been extracted proportionally to its total population. Smaller units have been oversampled to guarantee statistically significant results and an acceptable error for each layer of the sample.

The first group of questionnaires has been administered through a mixed CATI-CAWI survey technique to a sample of 20'000 families. CATI users were selected casually from public phone directories, while CAWI users from a provider's certified quality panel (to overcome privacy issues connected with e-mail addresses), with a threshold of 50% of CATIs.
This first phase of the investigation lasted about 6 weeks, from mid-March to the end of April 2019. In this first part the complete questionnaire, consisting of 7 sections, was administered to the sample.

[3] Art. 36, comma 2 lett. B), of the D.Lgs. n. 50/2016.

	central municip metrop area (TO, MI, VE, BO)	municip > 50.000 inh	plain municip < 10.000 inh	plain municip > 10.000 and < 50.000 inh	mountain municip < 10.000 inh	mountain municip > 10.000 and < 50.000 inh	hill municip < 10.000 inh	hill municip > 10.000 and < 50.000 inh	**TOTAL**
Valle d'Aosta	-	-	-	-	42.882	15.913	-	-	**58.795**
Piedmont	394.699	159.607	216.978	324.942	172.430	45.120	352.911	180.566	**1.847.255**
Lombardy	635.797	543.551	883.378	1.107.454	362.545	96.161	451.871	206.822	**4.287.579**
Veneto	124.113	340.754	440.677	616.822	109.066	41.290	157.880	165.844	**1.996.447**
Friuli-Venezia Giulia	-	170.806	147.273	90.926	26.320	4.624	63.872	37.178	**540.999**
Emilia-Romagna	197.822	663.030	228.625	416.132	81.284	12.055	164.113	198.934	**1.961.995**
Aut. prov. Bolzano	-	47.731	-	-	110.520	50.708	-	-	**208.960**
Aut. prov. Trento	-	51.787	-	-	137.112	40.300	-	-	**229.199**
TOTAL	**1.352.431**	**1.977.267**	**1.916.932**	**2.556.277**	**1.042.159**	**306.171**	**1.190.648**	**789.343**	**11.131.229**

Table 1: Number of families residing in the Po Valley, stratified by type of municipality, projection 2018 (*Format Research*)

Given the relevance of the results of the sample survey in defining the contribution of the domestic wood heating sector to PM10 and PM2.5 emissions, to strengthen the quantitative results of the survey and therefore increase the robustness of the estimates, a survey integration using only the CATI technique was carried out, focusing on survey units with higher number of inhabitants.

This **second part of the survey** has expanded the sample to 3'000 more families. The interviews were carried out by integrating two different frames to minimize the coverage error. The two frames used are the public telephone directory for landline telephone numbers and a list of randomly generated numbers (RDDs) for mobile phone numbers. It was decided to integrate the two frames as they represent different populations.

In this second part of the sample survey, only the first 4 sections of the questionnaire were administered, in order to integrate and consolidate data relating to woody biomasses consumption and the distribution of the types of appliance. Data collection lasted 4 weeks, in November 2019.

3. Main results

Consumption of woody biomasses in the Po Valley has been estimated using the percentage of biomass users, the number of burning appliances in each sample layer and the average annual amount of biomasses declared by interviewed.

Tables 2 and 3 report the statistics related to the % of users of woody biomasses. In addition to total biomass users, stratified by region and type of municipality, it shows the percentage of users of firewood, pellets, wood chips and briquettes. The percentage of biomass users is slightly lower than the sum of all the types of biomass considered, since there are some cases of mixed use. Use of wood chips and briquettes is in general very marginal and concentrated especially in the mountain areas, in particular with regard to the autonomous province of Bolzano.

The mean percentage of biomass users in the Po Basin is 22%, with values ranging from a minimum of 14% in the Lombardy region to a maximum of 45% in the autonomous province of Trento.

	wood logs	pellets	wood chips	briquettes	Biomass users	Frequent biomass users
Valle d'Aosta	31,8%	9,3%	0,4%	0,0%	**38,9%**	**37,2%**
Piedmont	20,7%	7,3%	0,2%	0,1%	**26,2%**	**24,4%**
Lombardy	10,8%	4,0%	0,2%	0,0%	**14,4%**	**12,7%**
Veneto	23,9%	6,9%	0,3%	0,3%	**29,7%**	**28,6%**
Friuli-Venezia Giulia	29,1%	5,2%	0,1%	0,1%	**33,2%**	**31,2%**
Emilia-Romagna	15,8%	3,3%	0,1%	0,0%	**18,5%**	**16,7%**
Aut. prov. Bolzano	30,8%	7,2%	2,1%	1,5%	**37,7%**	**36,9%**
Aut. prov. Trento	40,6%	5,0%	0,8%	0,2%	**44,6%**	**42,5%**
TOTAL	**17,7%**	**5,1%**	**0,2%**	**0,1%**	21,9%	20,3%

Table 2: biomass users and frequent biomass users by region and autonomous province

	wood logs	pellets	wood chips	briquettes	Biomass users	Frequent biomass users
central municip metrop area (TO, MI, VE, BO)	3,8%	1,2%	0,0%	0,0%	**4,7%**	**3,5%**
municip > 50.000 inh	10,0%	2,3%	0,4%	0,1%	**12,1%**	**10,5%**
plain municip < 10.000 inh	20,3%	9,3%	0,1%	0,1%	**28,0%**	**26,2%**
plain municip > 10.000 and < 50.000 inh	12,5%	3,5%	0,1%	0,1%	**15,6%**	**14,4%**
mountain municip < 10.000 inh	43,6%	8,8%	0,4%	0,4%	**50,3%**	**48,3%**
mountain municip > 10.000 and < 50.000 inh	20,8%	4,2%	0,7%	0,6%	**24,9%**	**23,1%**
hill municip < 10.000 inh	30,7%	7,9%	0,5%	0,0%	**37,3%**	**35,2%**
hill municip > 10.000 and < 50.000 inh	16,0%	5,5%	0,2%	0,0%	**20,0%**	**18,1%**

Table 3: biomass users and frequent biomass users by type of municipality

Frequent users (using biomass-burning devices more than 4 times/year) are generally higher than 90% of total biomass users; overall average value of frequent users is 20% in the whole territory under investigation.

Tables 4 and 5 show the estimated number of wood burning devices in the different sample layers. Taking into account the most common types of appliances, the presence of approximately 480'000 pellet stoves, 470'000 open fireplaces and 460'000 closed fireplaces can be estimated in the Po Basin, as well as 990'000 traditional wood-burning stoves. The survey detects also about 150'000 biomass boilers, of which one third is fed with pellet.

Figures 1 and 2 show the breakdown in terms of percentages of appliances divided by region / autonomous province and by municipal typology respectively. In all the sample layers, the most widespread types of devices are those that use air as a heat transfer fluid. Open fireplaces, which represent the lowest energy efficiency typology, are still very common in the regions Lombardy and Emilia-Romagna.

On average of woody biomass users, each home has about **1.2 devices burning woody biomasses**.

Only a relatively small number of biomass appliances are installed in second houses, as reported in the last column of Table 4.

N. of appliances	Valle d'Aosta	Piedmont	Lombardy	Veneto	Friuli-Venezia Giulia	Emilia-Romagna	autonomous province of Bolzano	autonomous province of Trento	TOTAL	% of appliances in second houses
pellet stove	3.928	108.128	154.901	111.079	24.774	58.128	10.706	9.991	**481.635**	5,3%
closed or insert pellet fireplace	607	9.735	13.657	12.196	2.335	1.503	1.863	914	**42.810**	3,9%
pellet cooker	-	960	2.040	2.037	619	-	-	-	**5.656**	2,3%
pellet heating stove or cooker (connected to radiators)	723	9.130	3.164	6.918	1.365	7.215	-	-	**28.515**	0,6%
pellet boiler	944	19.817	12.412	12.385	1.392	5.254	2.484	766	**55.454**	1,4%
open wood fireplace	1.434	64.744	156.220	96.198	22.582	119.742	3.685	4.480	**469.085**	9,9%
wood stove	10.575	228.548	162.851	254.609	90.779	132.637	50.897	59.303	**990.199**	6,0%
closed or insert wood fireplace	3.788	90.635	158.183	83.894	33.038	81.622	2.948	4.629	**458.737**	4,6%
wood-burning cooker	387	13.145	4.629	51.410	27.508	7.817	9.737	20.983	**135.616**	2,1%
tiled stove	841	5.077	18.588	34.905	7.464	4.838	9.112	15.087	**95.912**	4,0%
wood-burning heating stove or cooker (connected to radiators)	1.060	19.600	6.513	26.192	6.974	19.137	1.863	7.691	**89.030**	1,3%
wood-fired boiler	2.121	40.503	18.925	10.271	4.396	7.525	11.173	4.864	**99.778**	1,9%
woodchips boiler	219	-	-	-	-	-	621	766	**1.606**	0,0%

Table 4: number of biomass burning appliances estimated by region and autonomous province in the Po Valley

N. of appliances	central municip metrop area (TO, MI, VE, BO)	municip > 50.000 inh	plain municip < 10.000 inh	plain municip > 10.000 and < 50.000 inh	mountain municip < 10.000 inh	mountain municip > 10.000 and < 50.000 inh	hill municip < 10.000 inh	hill municip > 10.000 and < 50.000 inh	TOTAL
pellet stove	13.946	40.186	154.621	71.319	75.399	10.228	79.475	36.461	**481.635**
closed or insert pellet fireplace	1.660	1.819	19.955	2.978	9.429	1.472	2.689	2.808	**42.810**
pellet cooker	-	-	3.239	1.640	172	397	-	208	**5.656**
pellet heating stove or cooker (connected to radiators)	383	5.310	5.692	3.981	2.924	730	6.662	2.833	**28.515**
pellet boiler	1.660	2.233	15.363	9.763	10.646	405	11.219	4.165	**55.454**
open wood fireplace	26.067	83.667	95.359	92.729	56.050	7.779	66.898	40.536	**469.085**
wood stove	11.919	72.694	176.605	141.274	272.487	36.678	213.641	64.901	**990.199**
closed or insert wood fireplace	13.723	56.826	104.742	85.300	74.227	12.308	88.746	22.865	**458.737**
wood-burning cooker	383	12.457	23.696	19.711	48.178	5.445	20.684	5.062	**135.616**
tiled stove	-	9.041	19.414	7.475	37.079	6.838	11.063	5.002	**95.912**
wood-burning heating stove or cooker (connected to radiators)	1.532	7.394	18.607	6.791	25.912	1.794	22.112	4.888	**89.030**
wood-fired boiler	4.708	9.294	8.572	5.648	42.549	4.299	22.368	2.340	**99.778**
woodchips boiler	-	-	-	-	1.555	51	-	-	**1.606**

Table 5: number of biomass burning appliances estimated by type of municipality in the Po Valley

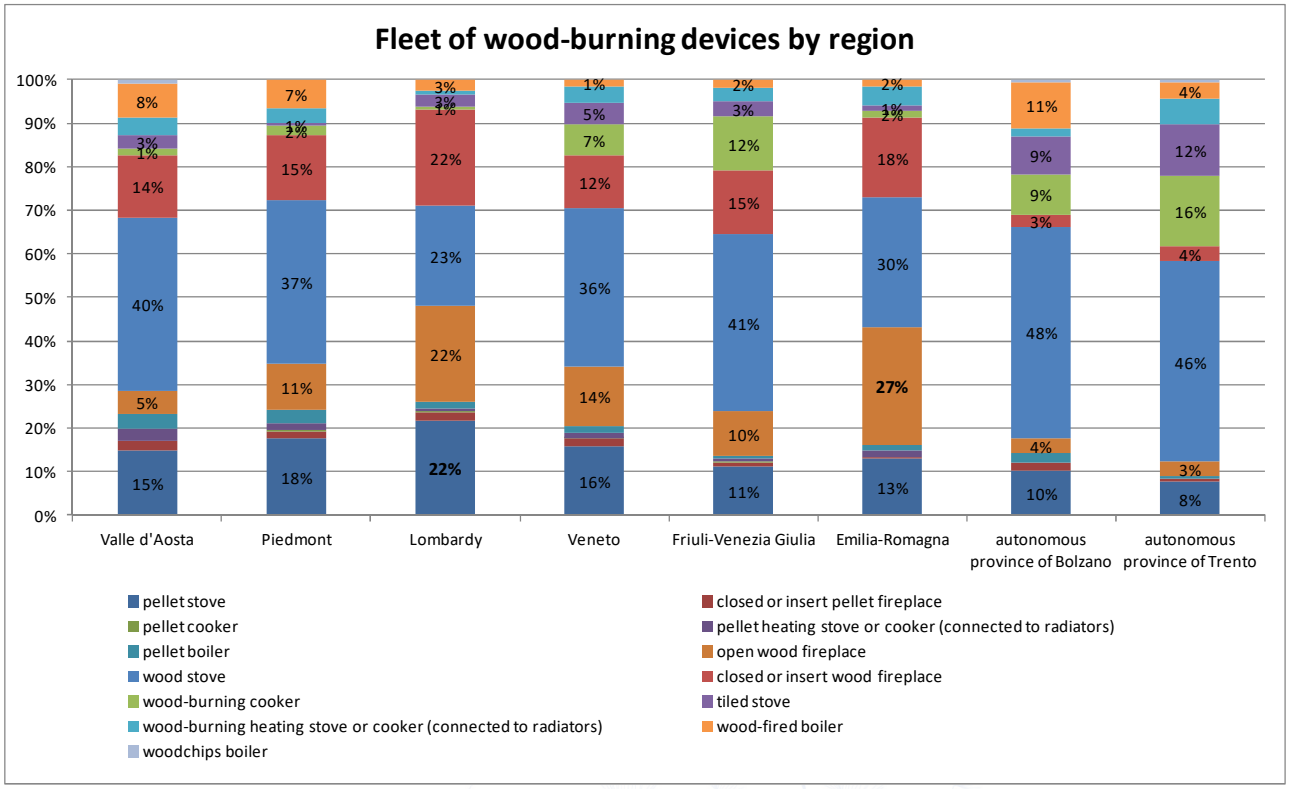


Figure 1: fleet of wood-burning devices by region/autonomous province

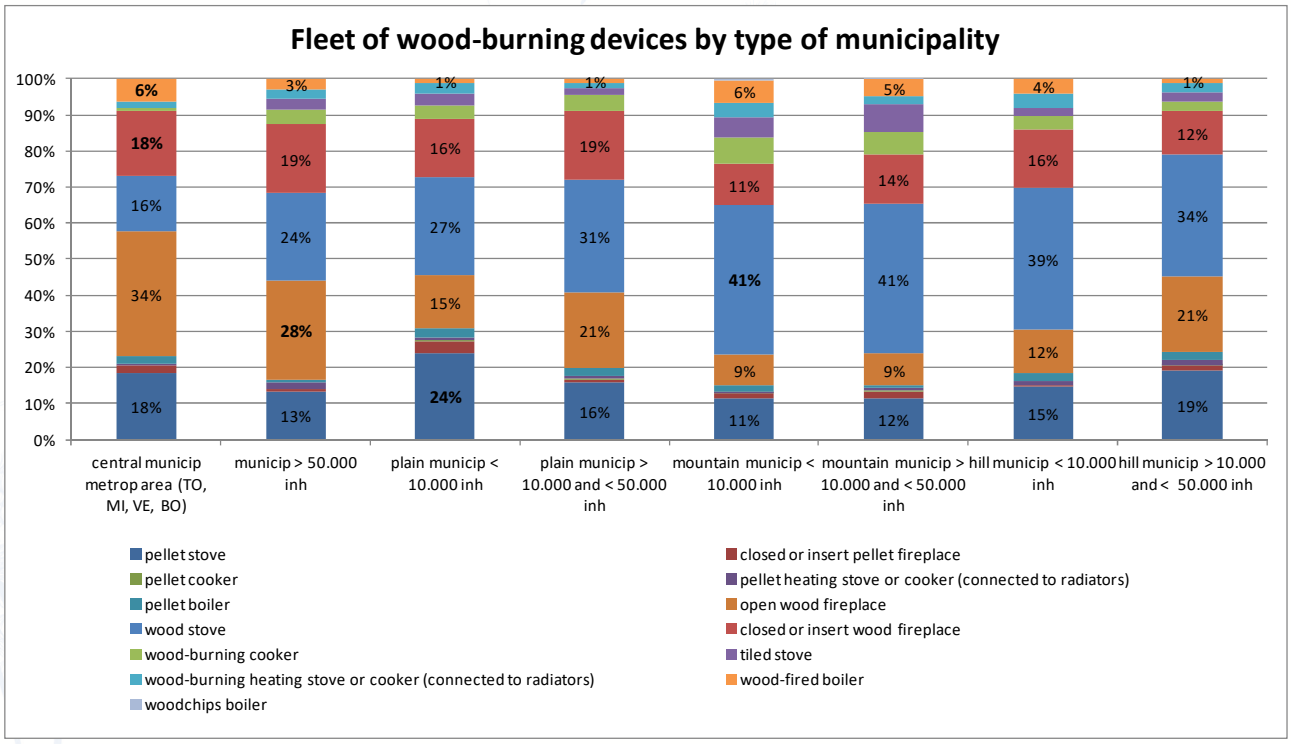


Figure 2: fleet of wood-burning devices by type of municipality

Moreover 16,000 centralized biomass burning plants should be added, located almost entirely in the mountain area of the Po Basin. For these plants it was not feasible to collect the consumption data by means of the interviews, so they are not included in the totals presented below.

The following tables show the average consumption derived from the answers provided by users. The average values obtained are the result of subsequent approximations: when the respondent could not quantify the annual consumption, this value was derived from the expenditure (considering the average prices per quintal shown in Table 6), or from the average value range suggested by the interviewer (see questionnaire in Annex 1). The comparison with the estimate obtained starting from the declared expenditure was also used to identify and eliminate out-of-range quantifications[4]. Through these quality control measures it was possible to reconstruct more than 70-80% of consumption data.

For devices installed in second houses, the 28% of pellet and the 40% of firewood average consumption reported in Table 6 was considered.

	average price (€/quintal)
FIREWOOD	14
PELLET	29
WOOD CHIPS	6
BRIQUETTES	17

Table 6: average price/quintal taken into account in the present study

	CATI surveys 2018		ISTAT survey 2013	
	pellet	**firewood**	pellet	firewood
Valle d'Aosta	11.624	66.246	13.368	74.241
Piedmont	249.833	1.227.531	138.203	1.759.641
Lombardy	282.245	1.134.936	250.018	1.461.341
Veneto	227.385	1.288.429	192.823	1.589.578
Friuli-Venezia Giulia	47.510	464.119	53.134	565.285
Emilia-Romagna	117.243	799.122	85.589	828.609
autonomous province of Bolzano	27.213	299.118	36.185	312.741
autonomous province of Trento	19.027	360.812	16.906	350.235
TOTAL	**982.081**	**5.640.312**	**786.226**	**6.941.671**

Table 7: estimate of annual consumption of woody biomasses in households by region/autonomous province of the Po Valley in **tonnes/year**

[4] An estimate of consumption per square meter was also made to verify that the annual values were compatible with biomass heated surfaces.

	CATI surveys 2018	
	pellet	**firewood**
central municip metrop area (TO, MI, VE, BO)	11.336	102.460
municip > 50.000 inh	69.470	424.602
plain municip < 10.000 inh	292.047	984.479
plain municip > 10.000 and < 50.000 inh	162.540	642.893
mountain municip < 10.000 inh	176.468	1.799.032
mountain municip > 10.000 and < 50.000 inh	16.513	195.255
hill municip < 10.000 inh	200.412	1.217.959
hill municip > 10.000 and < 50.000 inh	53.295	273.632
Totale complessivo	**982.081**	**5.640.312**

Table 8: estimate of annual consumption of woody biomasses in households by type of municipality of the Po Valley in **tonnes/year**

Total consumption estimated by the integrated CATI surveys is consistent with the results of ISTAT 2013 but with substantial variations: it exceeds ISTAT's[5] by 25% for pellet and it is lower than 20% for firewood.

Moreover, Table 9 shows the comparison of average consumptions per household: the present survey is on average lower than ISTAT's for firewood and slightly higher for pellet (with the exceptions of the province of Bolzano and the Veneto region). Differences arise from a series of factors, ranging from the different estimation methods (in the present case the average consumption per device was estimated before the consumption per household), to the changes occurred in the fleet of devices, and in part to the variation in the number of families.

The comparison of the total amount of woody biomasses consumed should also take into account that the winter season 2018/19 was warmer than the 2013's one.

In spite of these differences, integrated CATI surveys show a shift of use towards pellet, especially for the four most populated regions of the Po Valley.

These estimates will be revised within the activity of the households energy balance in the Po Basin, as second part of the action D3; energy demand of houses will be estimated, together with a more precise evaluation of the degree-days in the winters 2013 (reference year of ISTAT's survey) and 2018 (present CATI surveys).

Tables do not include estimates of wood chips and briquettes, as they are affected by a high degree of uncertainty arising from the small number of appliances and consumption declared by the sample. These two types of woody biomasses are used both in pellet and wood-burning appliances; even in the case of the wood chip boiler, the number of answers quantifying the specific consumption for this type of biomass is very limited.

[5] ISTAT data included in Tables 8 and 10 are from: https://www.istat.it/it/files//2014/12/StatReport_Consumi_energetici.pdf, Table 5 pag. 13

	average pellet consumption		average firewood consumption	
	CATIs 2018	ISTAT 2013	CATIs 2018	ISTAT 2013
Valle d'Aosta	1,9	1,6	3,0	3,6
Piedmont	1,6	1,5	2,5	4,1
Lombardy	1,5	1,3	2,1	2,6
Veneto	1,5	1,7	2,2	2,9
Friuli-Venezia Giulia	1,5	1,4	2,2	3,2
Emilia-Romagna	1,5	1,4	2,2	2,5
autonomous province of Bolzano	1,6	2,4	3,1	3,2
autonomous province of Trento	1,6	1,3	2,8	3,2

Table 9: pellet and firewood average consumption per household (tonnes/year)

It is possible to estimate the total consumption for such biomasses, at Po Basin level, by multiplying the users by an average annual consumption of 17 quintals of wood chips and 20 quintals of briquettes, obtaining 35’000 tons/year of wood chips and 25’000 tons/year of briquettes.

The average age of the wood burning devices is a useful indicator to estimate their performance in terms of air emissions.

Table 10 and Figure 3 clearly show that, based on answers given to CATIs, pellet appliances are typically more recent, while the proportion of wood-burning appliances older than 15 years is still very significant, with a low environmental performance (1 star class).

average age	<2 years	2-5 years	5-10 years	10-15 years	15-20 years	20-25 years	>25 years	age (in years)
pellet stove	13%	35%	32%	15%	3%	1%	2%	6,8
closed or insert pellet fireplace	12%	20%	26%	26%	6%	2%	9%	10,2
pellet cooker	0%	41%	42%	17%	0%	0%	0%	6,7
pellet heating stove or cooker (connected to radiators)	18%	41%	32%	6%	1%	1%	1%	5,6
pellet boiler	19%	45%	22%	9%	1%	1%	2%	5,7
open wood fireplace	1%	4%	9%	11%	13%	9%	52%	22,3
wood stove	5%	16%	21%	18%	13%	7%	19%	14,2
closed or insert wood fireplace	4%	9%	21%	21%	18%	11%	15%	14,9
wood-burning cooker	3%	6%	14%	17%	14%	9%	35%	18,6
tiled stove	2%	12%	30%	18%	13%	7%	18%	14,2
wood-burning heating stove or cooker (connected to	4%	22%	23%	14%	10%	7%	20%	13,6
wood-fired boiler	3%	19%	23%	23%	11%	9%	13%	13,2
woodchips boiler	0%	0%	38%	0%	0%	24%	39%	19,8

Table 10: average age of devices (from CATI)

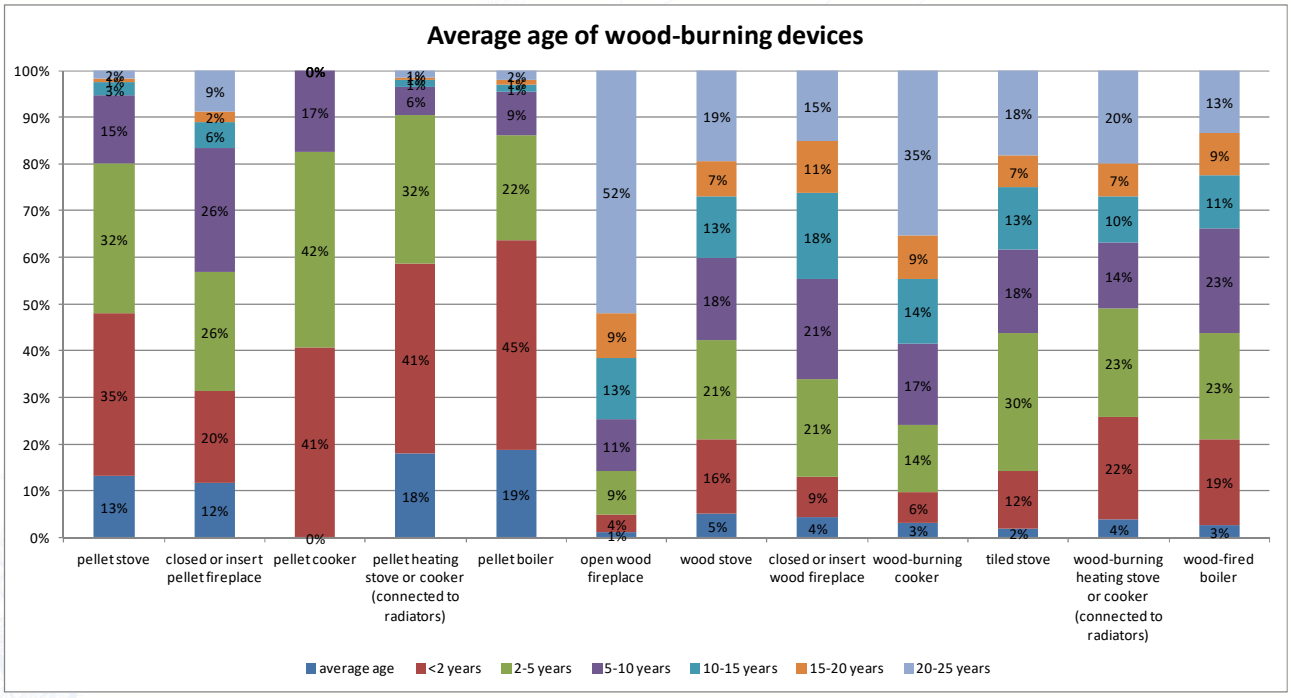


Figure 3: average age of devices (from CATI)

4. Additional information

In addition to the questions relating to average consumption and the types of appliance used for the combustion of wood biomass in households, the questionnaire provide an overview of the phenomenon of domestic wood-burning in the Po Valley.

It should be noted that sections 5 to 7 of the questionnaire were administered only to the sample of 20,000 families interested by the first phase of the survey.

With regards to information about houses, biomass users reside in dwellings that, more frequently (18% more) than the average of the interviewed or in any case above the average, are located outside the urban centres, in single or multi-family detached houses.
Regarding the age of buildings, it is interesting to analyze the differences between pellet users and wood users (including wood chips and briquettes, which are however present in a clear minority), compared to the total sample interviewed.
It is evident that pellets are more frequently used in recently built houses and therefore having greater energy efficiency, contrary to firewood that it is often used in houses dating back even more than one century (see Figure 4).

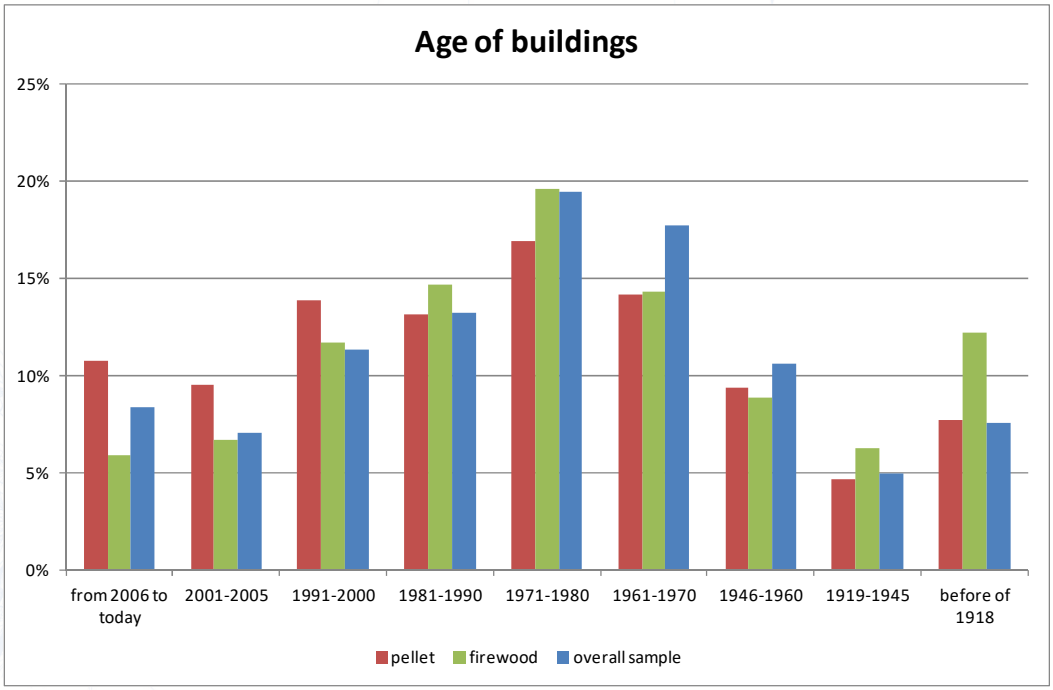


Figure 4: Age of buildings overall sample and biomass users (pellet and firewood)

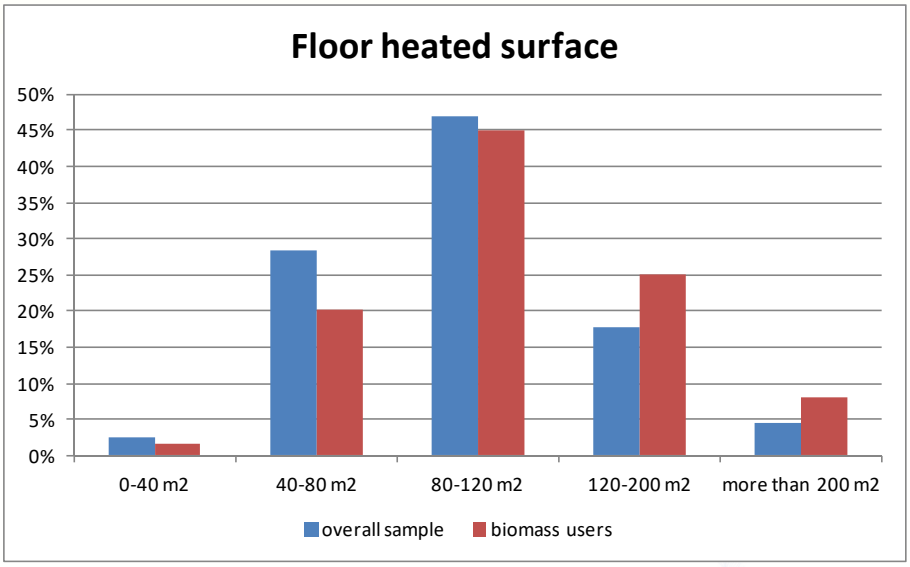


Figure 5: Heated floor space (overall sample and biomass users)

Approximating the average value for each size range and assuming 200 m^2 for larger houses, the size of dwellings of biomass users is approximately 12% higher than the average of the overall sample.

Only a relatively small number of families heat the house exclusively with biomass, about 6.2% of the sample. Considering only woody biomasses users, in the majority of cases households have one or more systems that heat one or more rooms, which are typically associated with an autonomous system or a centralized system, generally fed with natural gas.

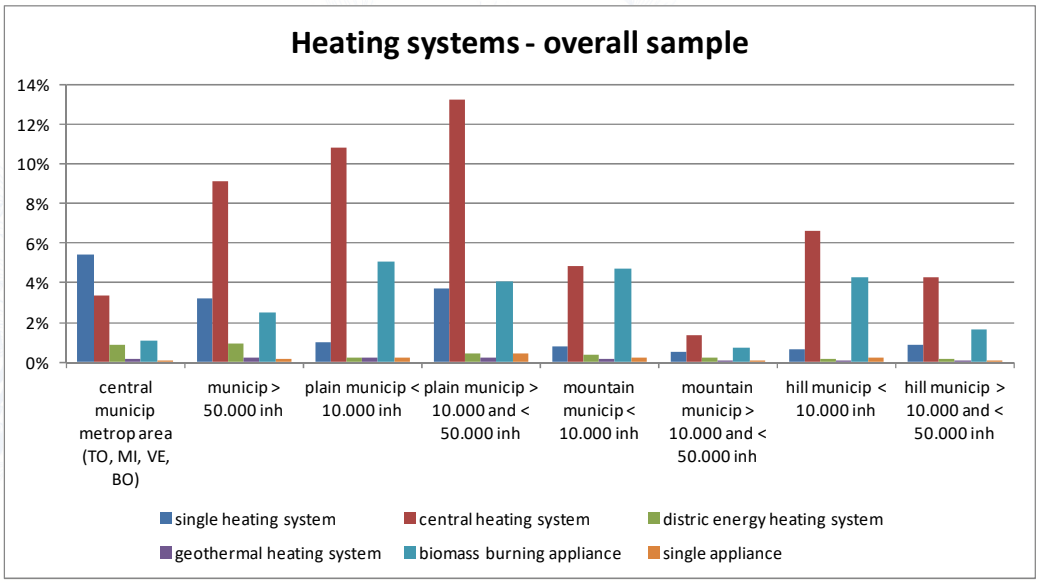
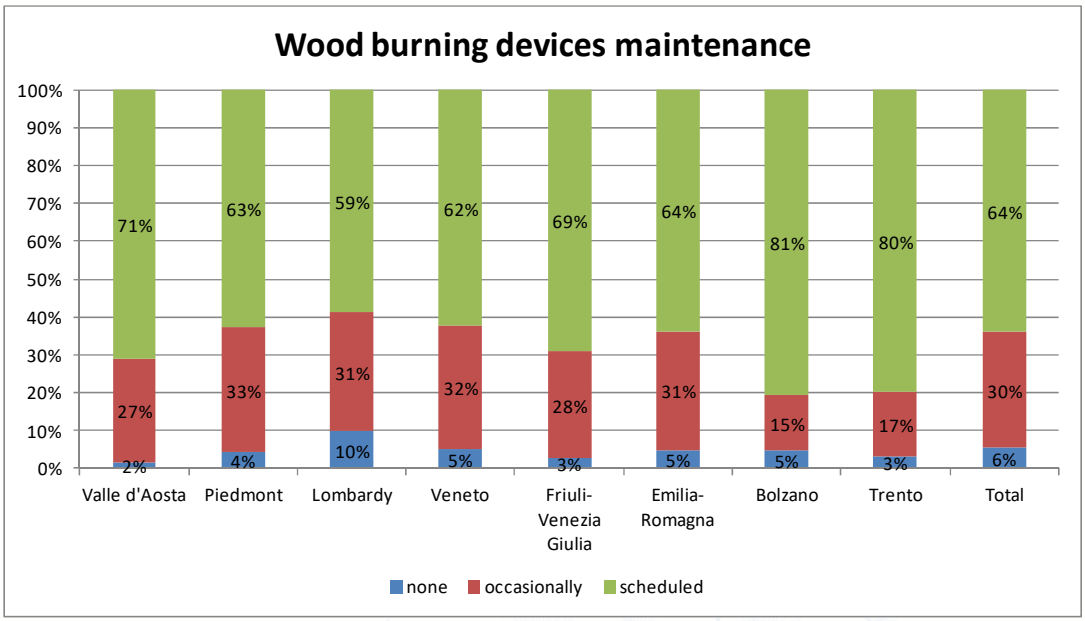


Figure 6: Distribution by municipal type of heating and hot water production systems (overall sample)

Biomass users were asked for some information about the maintenance of their wood burning devices and the cleaning of the chimney flue. It should be noted that best practice involves scheduled maintenance together with a periodic cleaning of the flue carried out by specialized technical personnel (chimney sweeps). These activities, in addition to increasing the efficiency of biomass plants and consequently decreasing consumption and related emissions into the atmosphere, also reduce the risk of fires in the flues and roofs of houses.

Figures 7 a) and b) show the maintenance frequency of wood and pellet systems respectively. Overall, in the Po Valley, the frequency of maintenance of the appliances is generally high, even if those powered by pellets are checked more frequently.



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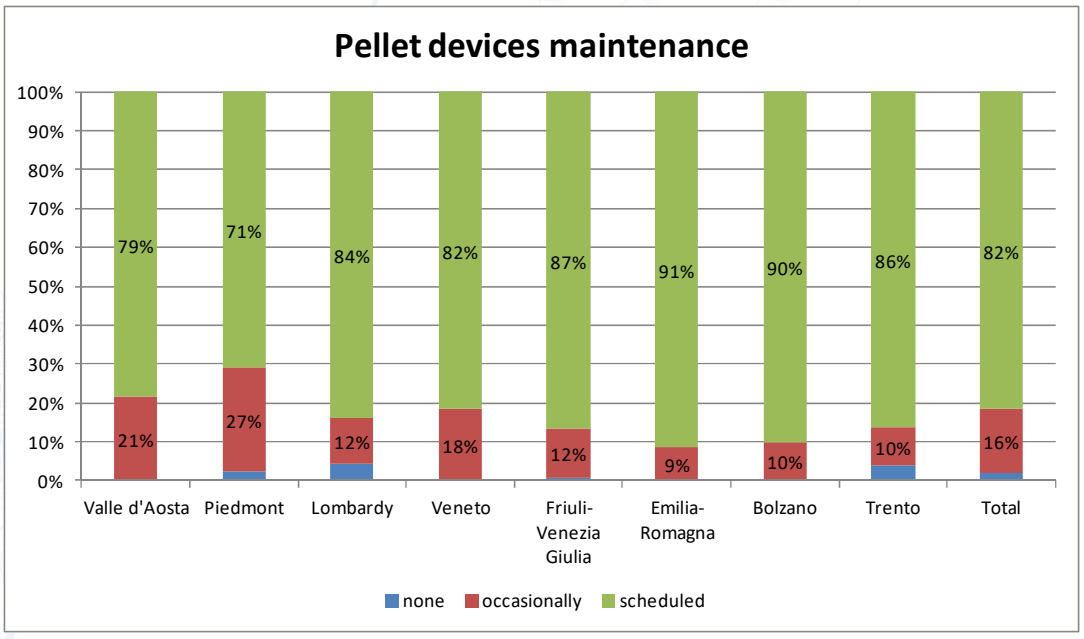
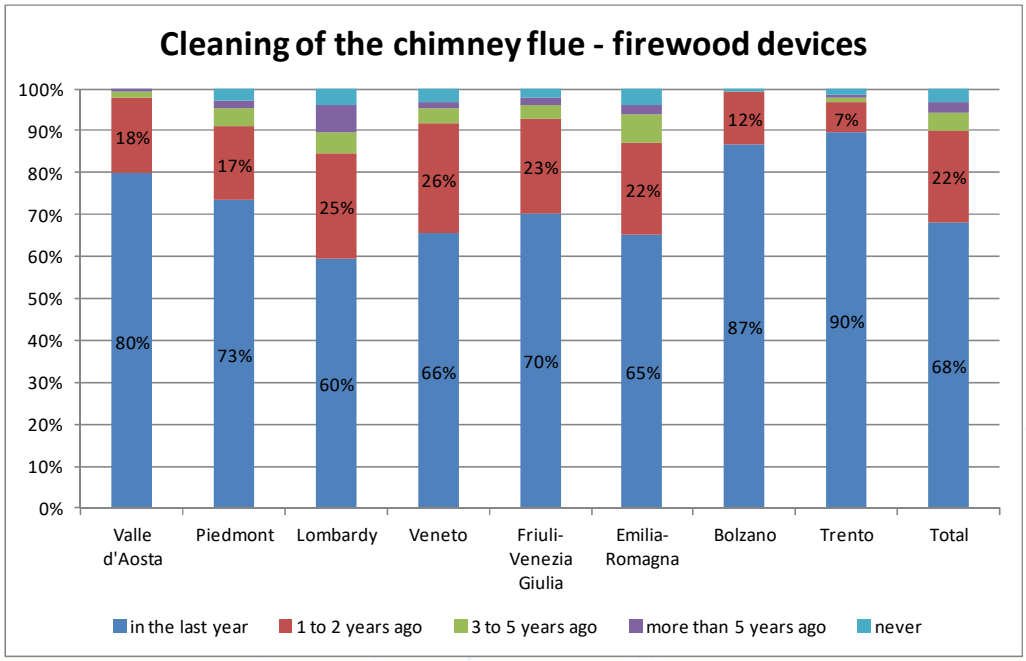


b)

Figura 7: Firewood (a) and pellet (b) devices frequency of maintenance.

Only 2% of pellet appliances and 6% of wood-burning appliances undergo any maintenance, while 16% of pellet and 30% of wood systems are checked occasionally, in case of need. Scheduled and frequent maintenance is carried out in 82% of pellets and in 64% of wood appliances.

As for the frequency of cleaning of the chimney flue, analyzing separately the results of firewood and pellet (Figures 8 a and b), it appears that in the last year interventions were carried out in 79% in the case of pellet plants and in 68% of firewood-burning ones, while in the last two years for 15% of pellet and 22% of the firewood. This operation is never performed in only 4% of the cases for pellet and 3% for wood.



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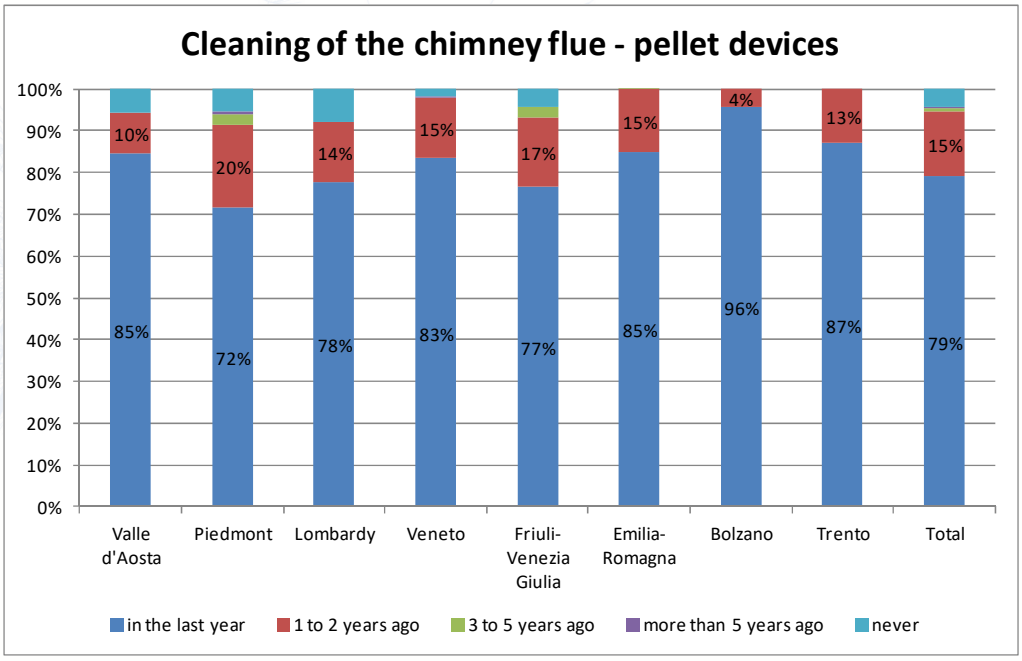


b)

Figura 8: Frequency of clearing of the chimney flue for firewood (a) and pellet (b)

Another group of questions was focused on some best practices regarding the ignition methods and the use of wood-burning devices.

Firewood should be ignited in the fireplace from the upper part of the pile of logs to reduce air emissions; unfortunately 85% of users declare to light it from below (see Figure 9).

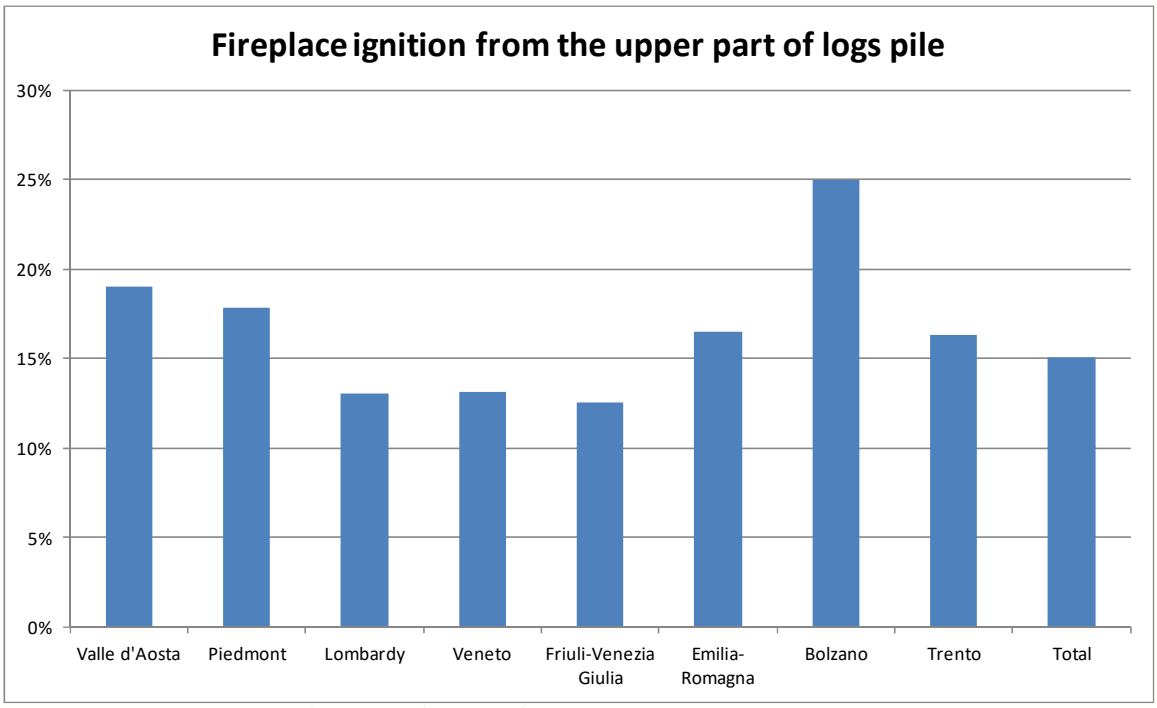


Figure 9: Ignition mode of the firewood appliances

The most "virtuous" ignition materials are the dry sticks followed by the firelighters and the correct running device's method is the closure of the door of the device's chamber during the combustion. For both issues, almost all the users adopt the best behaviour, employing dry sticks and firelighters, and closing the device's door.

About half of firewood used for domestic heating is self-produced or collected from rows, hedges or woods of rural origin, while the forest is the main source of supply in mountain areas (see Figures from 10 to 13).

A very significant portion of the self-produced and recovered wood is of rural origin (on average in the sample in 67% of cases), as can also be seen from the graph in Figure 12 and the subsequent one in Figure 13 in which the answers are stratified by type of municipality .

27% have a forest origin and a remaining 6% add up to the other categories (waste and recycled material, other and unknown origin).

Figure 10: Distribution of firewood sources of supply

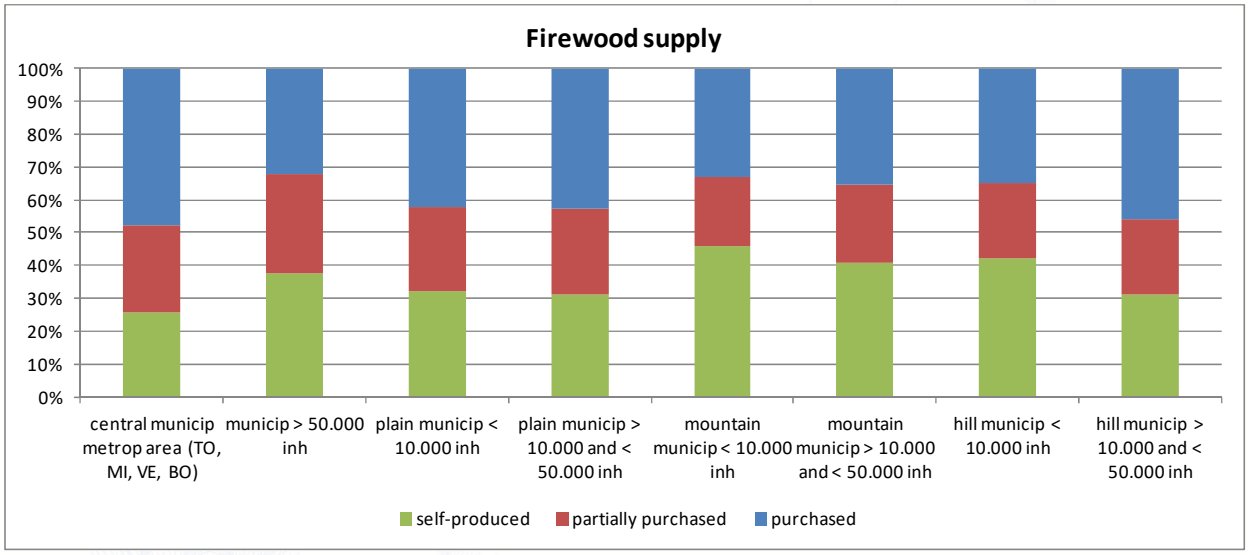


Figure 11: Distribution of firewood sources of supply by municipal typology

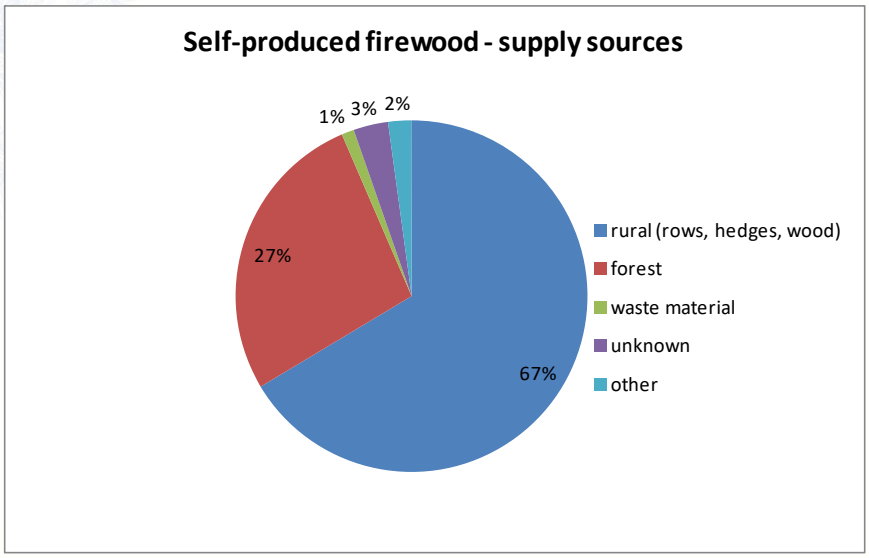


Figure 12: Supply sources of self-produced/collected firewood

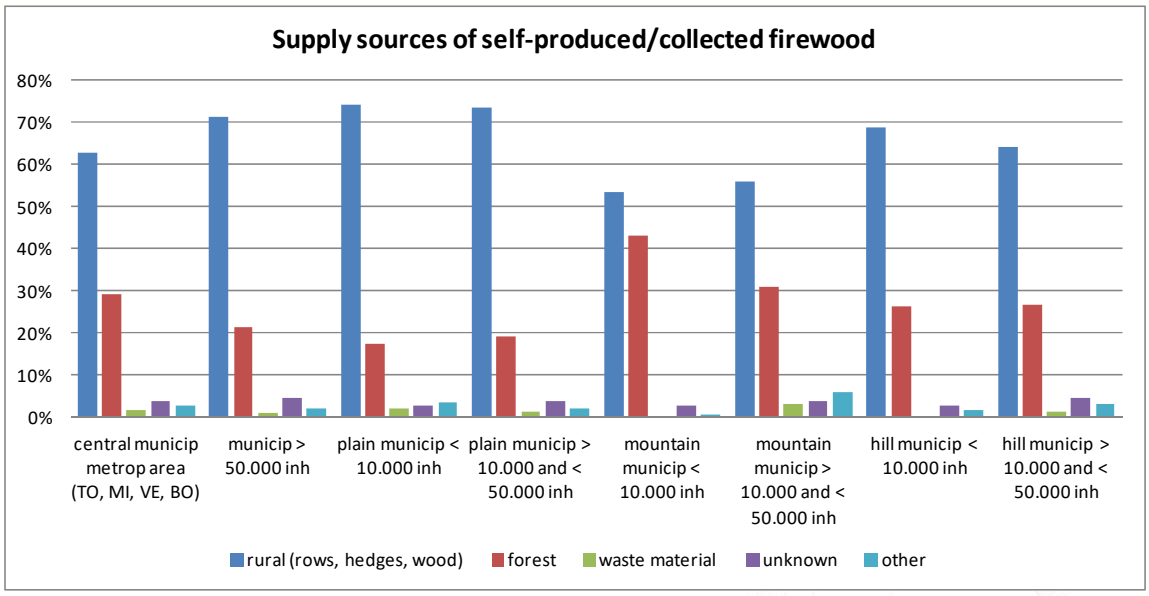


Figura 13: Supply sources of self-produced/collected firewood by municipal typology

As far as the users interviewed are aware, biomass purchased is mainly of local and regional origin (70%), 14% national and abroad and in 16% of cases it is not known.

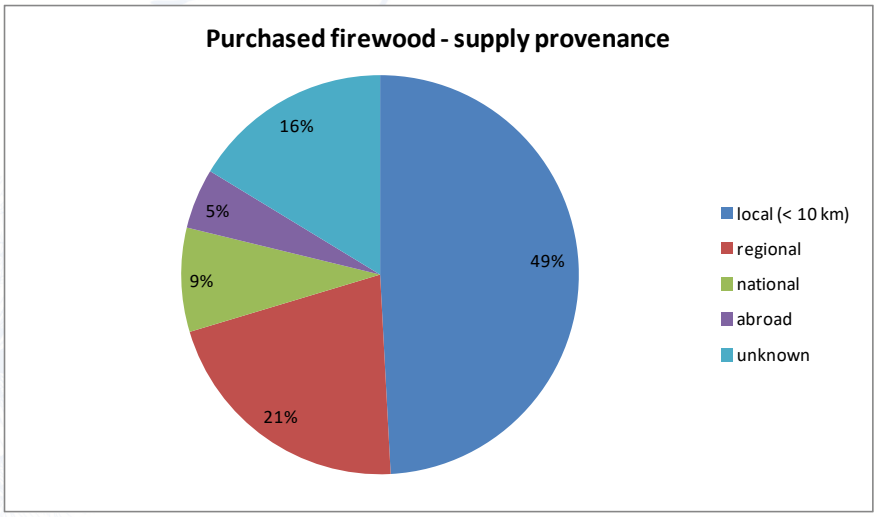


Figure 14: Supply sources of purchased firewood

Hardwood (beech, oak, hornbeam, ash, chestnut) is mostly used, as shown in Figure 15.

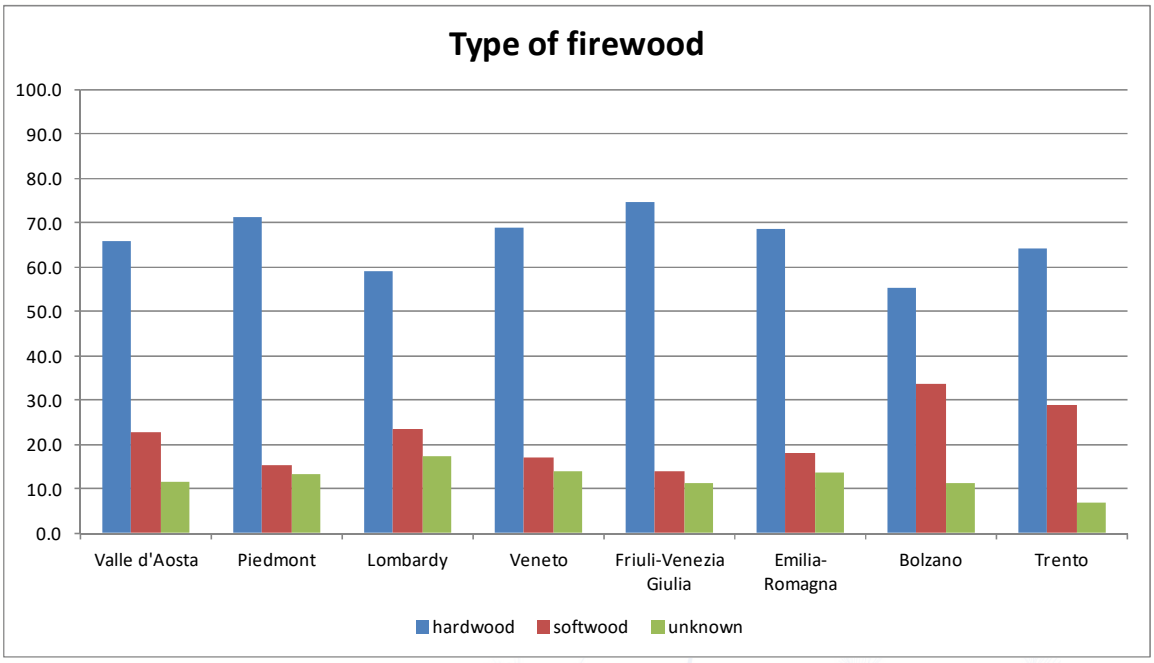
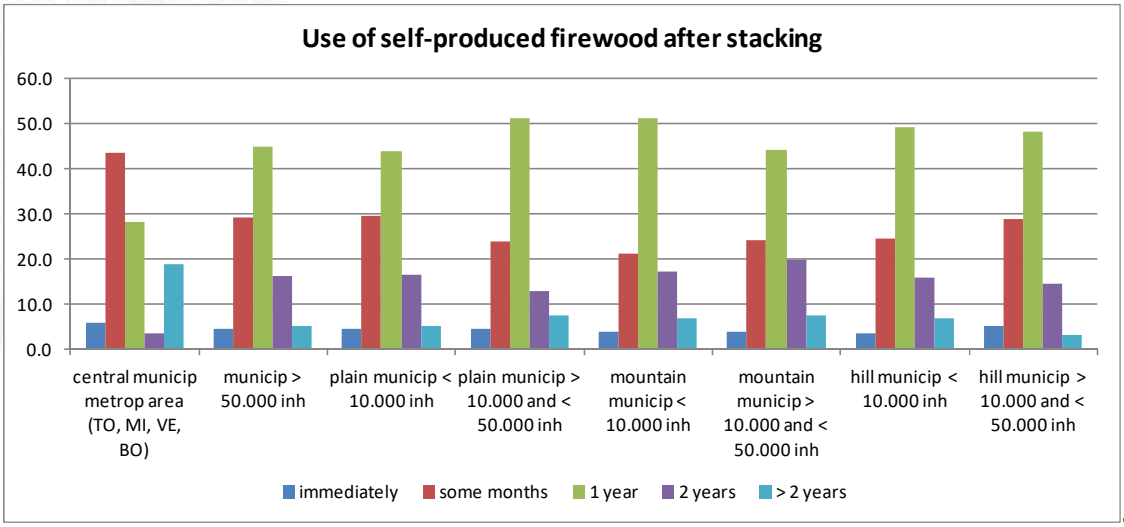


Figure 15: Type of firewood used in burning devices at regional/provincial level (%)

When it is self-produced or collected, firewood is mainly burnt within the first year; when it is purchased its consumption occurs more frequently within a few months (Figure 16 a and b).
All biomass (whether purchased or self-produced and recovered) are mainly preserved in closed places such as cellars and garages or in warehouses or at home (for a total of 64%). The stacking outdoors with top cover is limited to 36% (Figure 17).

The best conservation and aging practice consists in outdoor storage (with a top stack coverage to protect against precipitation), and use after two years of seasoning; this allows the wood to reduce its moisture content to obtain a better performance in the combustion process.



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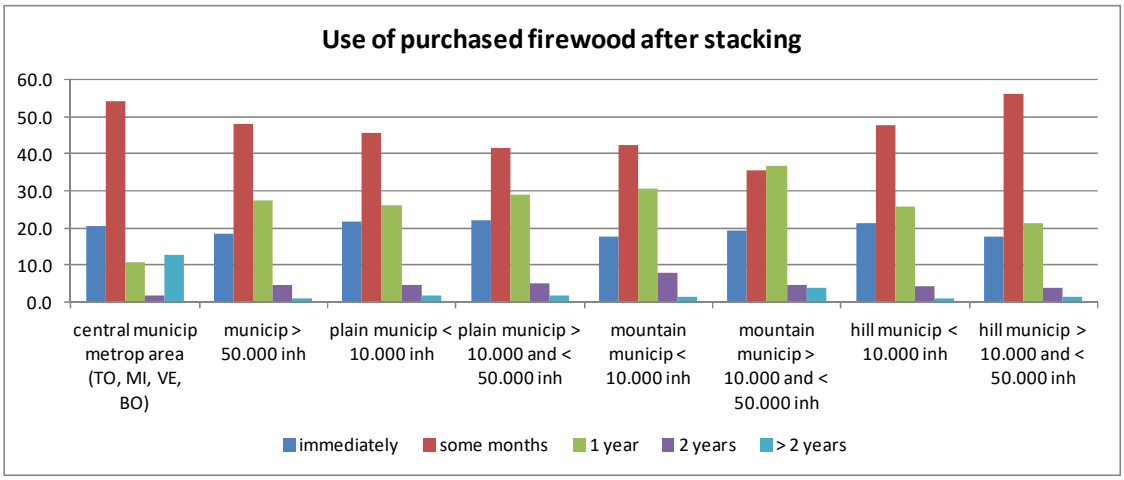


b)

Figure 16: Times o fuse of self-produced (a) and purchased (b) firewood after stacking (%).

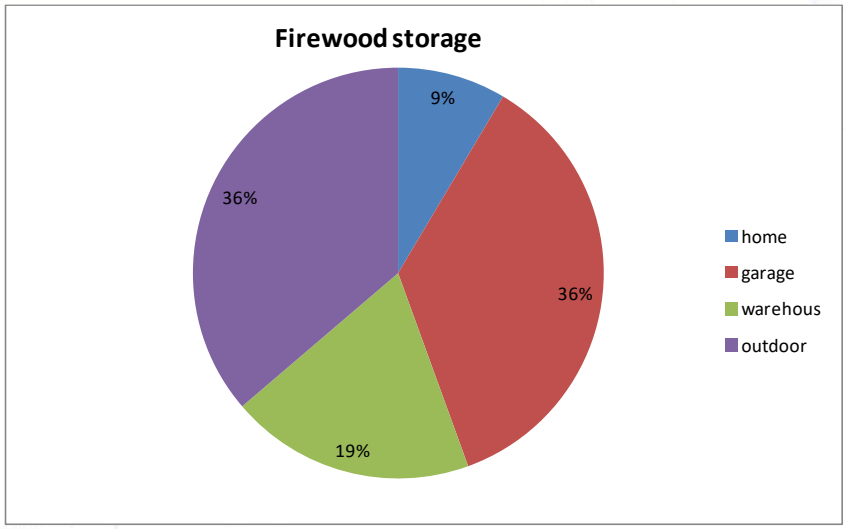


Figura 17: Place of firewood storage

In the Po Valley there is a clear prevalence of the use of certified pellets (in 90% of cases), followed by briquettes (67%) and about half of the wood chips, while in 68% of the firewood used does not have certification, coming mainly from recovery and self-production (see Figure 18).

The final section of the questionnaire aims to ascertain the level of information and awareness of users (see Figures 19 and 20).

The analysis of the responses highlighted the need to increase the knowledge on the topic, both on how to use the appliances and on financial incentives that can encourage the replacement of the more obsolete ones.

Particular attention should be paid to the less populated municipalities (<10,000 inhabitants) where it is lower the awareness on the investigated topics.

However, even if in large urban centers of the Po Valley (Milan, Turin, Venice, Bologna) there is a higher level of awareness or inclination replace older wood-burning appliances with cleaner and more efficient home heating systems, the financial incentives are very little known.

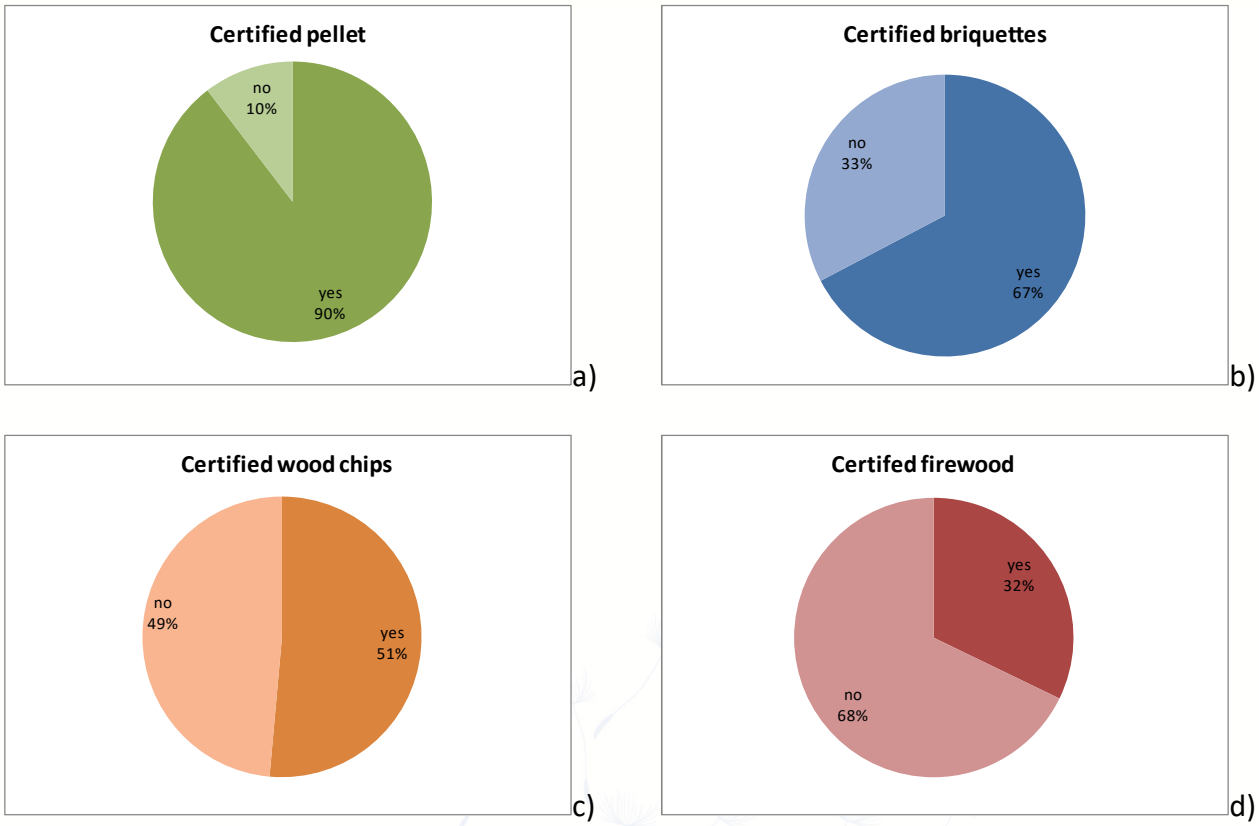
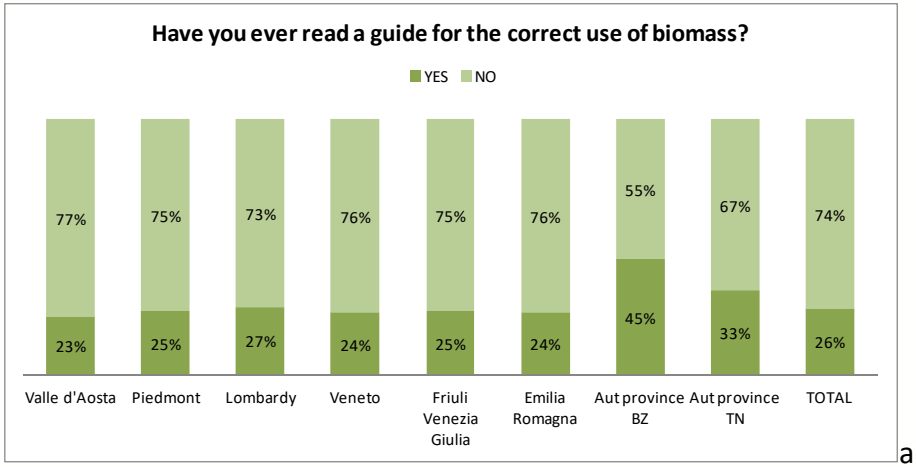


Figure 18: Use of certified woody biomasses in the Po Valley: a) pellet, b) briquettes, c) wood chips, d) firewood

The majority of users (74% of respondents in the Po Valley area) have never read a guide for the correct use of this fuel to heat their home. Only the Autonomous Provinces of Trento and Bolzano differ from this value, with a higher percentage of informed users, so that the "uninformed" share is equal to 67 and 55% respectively.
Considering the type of municipality, there is a higher percentage of positive responses in the central municipalities of the four metropolitan areas (Milan, Turin, Venice and Bologna) and in mountain municipalities with more than 10,000 inhabitants.
Most respondents (72%) state that they accurately follow the information and advices read when using biomass combustion home appliances, while the 28% only in part.
Most aware users (78%) live in the Autonomous Province of Bolzano, while in the four metropolitan areas there is slightly lower percentage than the overall average value.
52% of users answering to the question stated that they are willing to change their old appliance with the help of a financial incentive.
Percentages are slightly lower for users in the Friuli Venezia Giulia Region (46% propensity to replace) and in the Autonomous Province of Bolzano (45%).
Less than 30% of users are aware of the incentives provided by the Thermal Account, with a slightly higher percentage only in the Autonomous Province of Bolzano (37%).
With reference to the incentives provided by the Regions or autonomous Provinces, only 6% of users have already participated in regional incentive calls, with slightly higher percentages in the Valle d'Aosta (13%) and Autonomous Province of Trento (8%).
Finally, 40% of users are aware of the limitation measures connected with air quality for the winter season, foreseen by the Po Valley Agreement, with significantly higher percentages in Emilia-Romagna (50%) and Lombardy (45%) regions.



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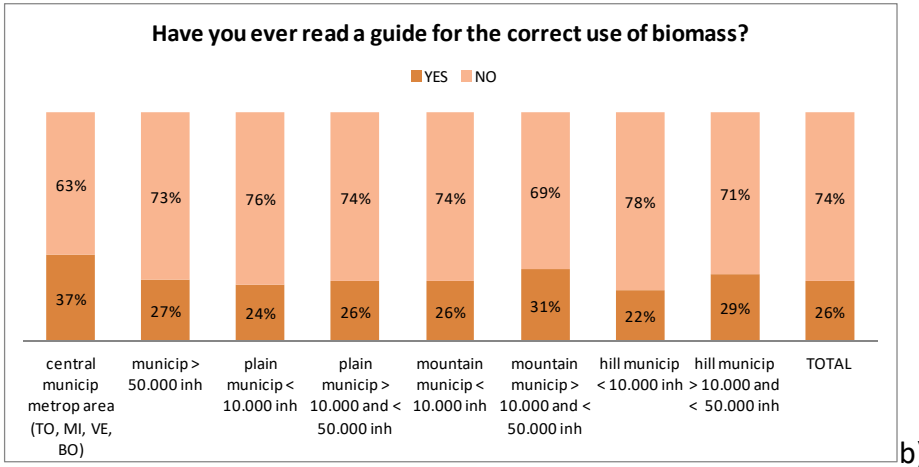

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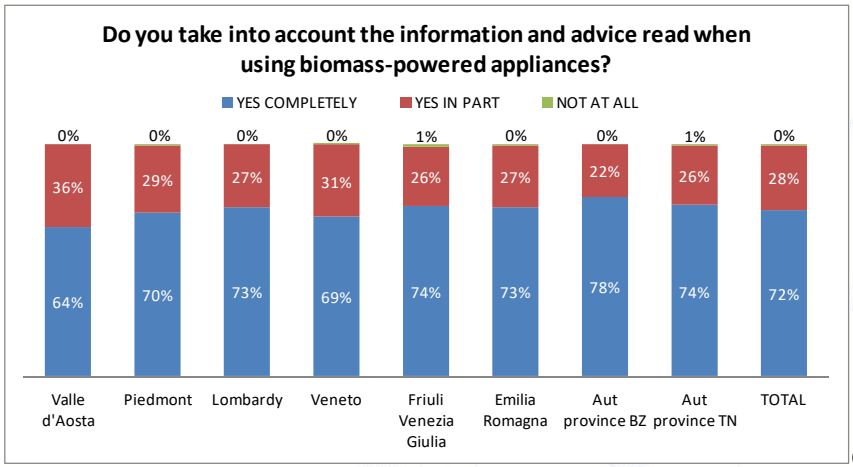

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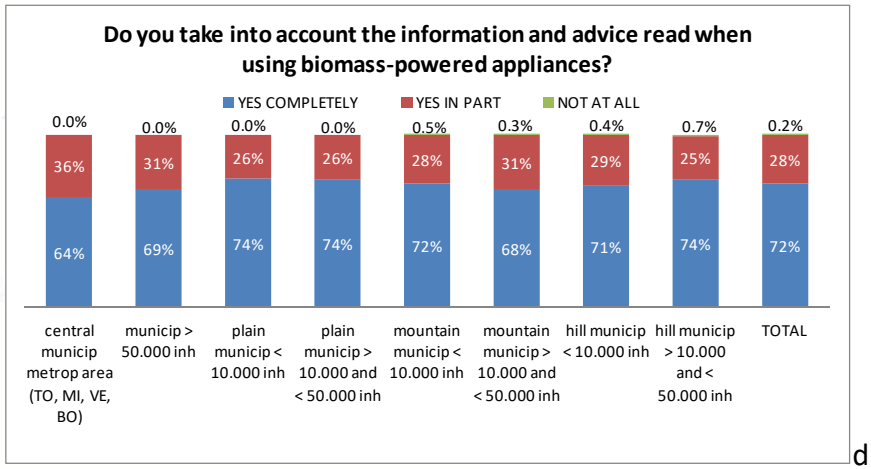

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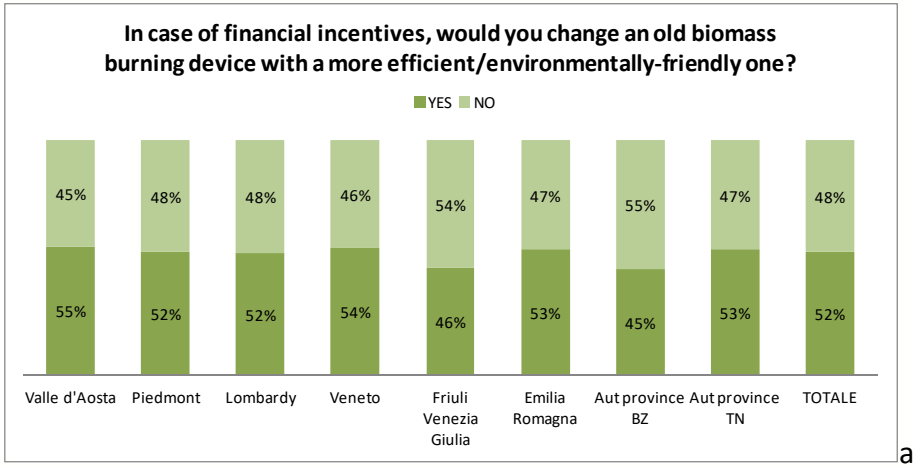
Figure 19: Level of users know-how of best practices



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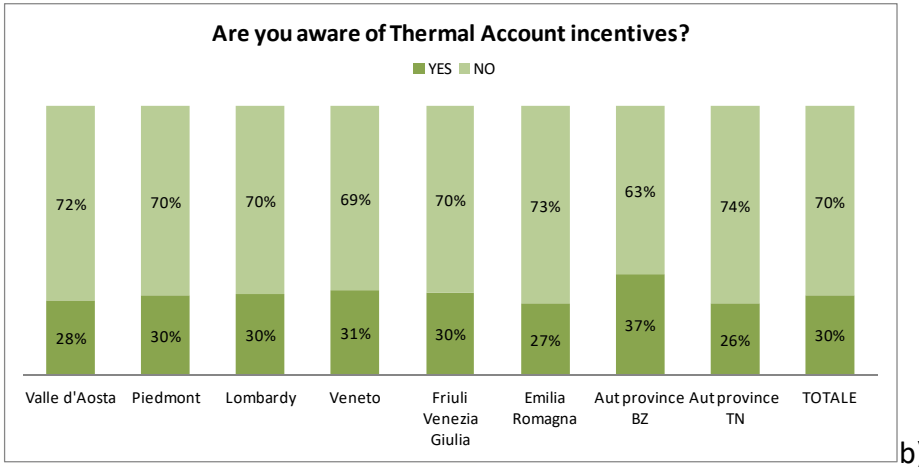

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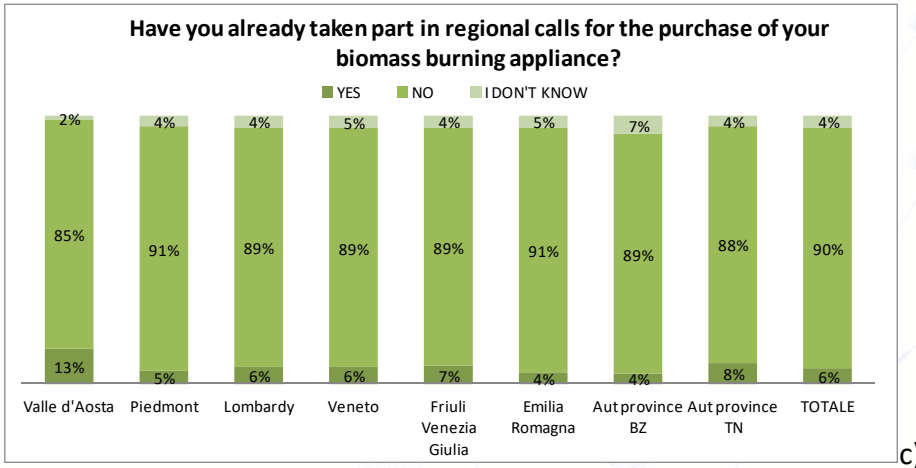

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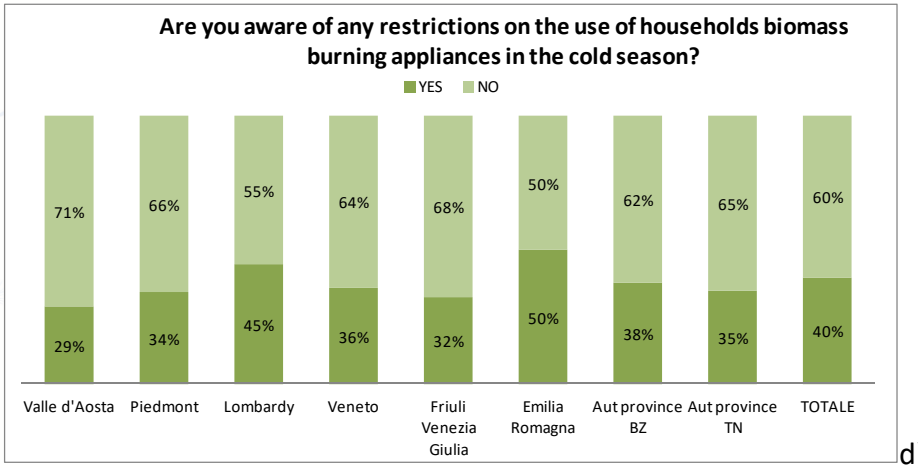

d)

Figure 20: Propensity to replace the wood biomass devices and knowledge of the financial incentives and limitation measures for the use of wood biomass in winter

The survey highlights the prevalence of the use of certified pellets (in 90% of the cases), followed by briquettes (67%) and about half of the wood chips (51%), while 68% of firewood used, coming mainly from self-production, does not have certification.

Only the 25.8% of users in the Po Valley area have read a guide for the correct use of woody biomasses: the 71.9% of this share follow the information and advices read, while the 27.9% only in part.

52.1% of users are willing to change their old appliance with the help of a financial incentive.
Less than 30% of users are aware of the incentives provided by the Thermal Account that is an incentive scheme which incentivise the installation of energy saving improvements in public and private sector buildings.
With reference to financial incentives provided by Regions or Autonomous Provinces, only 5.8% of users have already participated in regional incentive calls, with higher percentages in the Valle d'Aosta Region (12.9%) and in the Autonomous Province of Trento (7.9%).

40% of users are aware of the limitation in the use of oldest biomass burning devices for air quality protection reasons, with significantly higher percentages in Emilia Romagna (50%) and in Lombardy (45%).

The information provided by these sections of the questionnaire put the attention on the need of increasing the awareness of biomass users on the best practices, specifically for the ignition methods and firewood storage. Also the use of financial incentives should be more encouraged and promoted.

ANNEX 1 – QUESTIONNAIRE

SURVEY ON THE USE OF WOODY BIOMASSES IN THE PO BASIN
AS AN ENERGY SOURCE FOR HOUSEHOLDS HEATING IN THE WINTER 2018/2019

PREREQUISITE FOR THE ADMINISTRATION OF THE QUESTIONNAIRE
Is the dwelling where you normally live equipped with an heating system? Consider also fireplaces, stoves, wood or pellet stoves; electrical appliances such as electric heaters and electric convector heaters should not be considered.

SECTION 1 - DWELLING

1.1 Dwelling geographic location (identification of the municipality)

1.2 Your dwelling is located:
- in a residential area
- in a dispersed settlement

1.3 What is the type of the housing unit?
- terraced house
- single or multi-family detached house
- flat in a 1-2 storey residential building
- flat in a 3 (or more) storey residential building

1.4 When was the dwelling built?
- 2006 - today
- 2001-2005
- 1991-2000
- 1981-1990
- 1971-1980
- 1961-1970
- 1946-1960
- 1919-1945
- before 1918

1.5 How much is the total heated floor-space of the dwelling?
- 0-40 m^2
- 40-80 m^2
- 80-120 m^2
- 120-200 m^2
- more than 200 m^2

1.6 What is the total number of rooms in the dwelling (*do not consider corridors and entrances*)?

1.7 Is the dwelling Energy Performance Certified (EPC)? (*do not consider certifications at condominium level*)

1.8 What is the Energy Efficiency class of your dwelling?

- A
- B
- C
- D
- E
- F
- G

SECTION 2 – SPACE HEATING AND HOT WATER SUPPLY INFORMATION

2.1 Type of space heating system in the dwelling. *If you have more than one system, you can mark more answers, as long as more systems are used in the dwelling*.

I. Central heating system that serves several flats (*excluding district heating*)

2.1.1 Energy used by this system:

- natural gas (distributed for use through the pipe network)
- gasoil
- LPG (Liquefied petroleum gas)
- fuel oil
- woody biomasses
- other *(specify)*

II. Single heating system, which distributes heat in several rooms of the dwelling

2.1.2 Energy used by this system:

- natural gas (distributed for use through the pipe network)
- gasoil
- LPG (Liquefied petroleum gas)
- fuel oil
- woody biomasses
- other *(specify)*

III. District heating

IV. Geothermal energy

V. One/more fixed appliance heating one/more rooms (fireplaces, stoves, wood/pellet cook stoves, ,…)

2.1.3 Energy used by this system:

- woody biomasses
- other (*specify*)

VI. Other (*specify*)

2.1.3 Energy used by this system:

- (*specify*)

2.2 What is the dwelling's annual energy consumption of:

- natural gas (m^3)

- gasoil (l)
- LPG (l)
- fuel oil (l)
- other (*specify*)

2.3 What is last year expenditure for this fuel?

SECTION 3 - USE OF WOODY BIOMASSES

3.1 Woody biomasses used by the dwelling heating system. *If you use more than one system, please mark more than one answer:*

- log wood
- wood pellets
- wood chips
- briquettes
- other (*specify*)

3.2 Can you quantify annual consumption of woody biomasses (in quintals)?

3.3 How much did you spend for this/these fuel/s in the last year?

3.4 How many biomass burning appliances are installed in the dwelling?

3.5 Do you use woody biomasses in (*you can mark more than one answer*):

- pellet stove
- closed or insert pellet fireplace
- pellet cooker
- pellet heating stove or cooker (connected to radiators)
- pellet boiler
- open wood fireplace
- wood stove
- closed or insert wood fireplace
- wood-burning cooker
- tiled stove
- wood-burning heating stove or cooker (connected to radiators)
- wood-fired boiler
- woodchips boiler
- other (*specify*)

3.6 When did you purchase this appliance?

- <2 years
- 2-5 years
- 5-10 years
- 10-15 years
- 15-20 years
- 20-25 years

- > 25 years

3.7 Do you know the environmental class of the appliance/s (n. of stars)? *These data can be found in the appliance's handbook.*

3.8 How often do you maintain your appliance?

- on a scheduled basis (every 1-2 years)
- occasionally (if needed)
- ever

3.9 When did you have your chimney cleaned?

- in the last year
- 1 to 2 years ago
- 3 to 5 years ago
- more than 5 years ago
- ever

SECTION 4 - USE OF THE WOODY BIOMASS APPLIANCE

4.1 The woody biomass appliance heats:

- the entire dwelling
- part of the dwelling

4.2 How much is the total floor-space of the dwelling heated by the woody biomass appliance/s?

4.3 How many rooms of the dwelling are heated using biomass?

4.4 Are you using this/these appliance/s more than 4 times a year?

4.5 During the winter season, how often do you use the biomass appliance/s?

- every day/almost every day
- 3-4 days a week
- once a week
- less than 4 times a month

4.6 During the spring and autumn seasons, how often do you use the biomass appliance/s?

- every day/almost every day
- 3-4 days a week
- once a week
- less than 4 times a month

SECTION 5 – CONDITIONS OF USE OF THE WOODY BIOMASSES APPLIANCE/S

5.1 How do you light the appliance?

- from above
- from below
- other (*specify*)

5.2 What materials are used to light the appliance?

- dry twigs
- firelighters
- paper
- other (*specify*)
- nothing

5.3 If required, do you usually close the appliance's door during its use?

SECTION 6 – BIOMASSES SUPPLY AND STORAGE

6.1 Woody biomasses used in the last year were:

- all purchased
- partly self-produced / recovered and partly purchased
- all self-produced / recovered

6.2 Self-produced / recovered wood comes from:

- rural areas (like rows, hedges or rural thickets)
- forests
- other (*specify*)

6.3 What species of wood is used predominantly?

- hardwood (beech, oak, hornbeam, ash, chestnut)
- soft wood (fir, pine, larch, locust, birch)

6.4 After its stacking, self-produced / recovered wood is used:

- immediately
- within few months
- within 1 years
- within 2 years
- after more than 2 years

6.5 After its stacking, purchased wood is used:

- immediately
- within few months
- within 1 years
- within 2 years
- after more than 2 years

6.6 According to your knowledge, purchased woody biomasses' provenance is:

- local (<10 km)
- regional (*if possible, indicate the name of the Region*)
- national
- foreign (*if possible, indicate the name of the Country*)

6.7 Where do you usually store woody biomasses?

- at home
- in the cellar or in the garage
- in a warehouse or in an indoor cabin
- outdoors, covered on the upper side

6.8 Do you use certified wood pellets?

6.9 Do you use certified log firewood?

6.10 Do you use certified woodchips?

6.11 Do you use certified briquettes?

SECTION 7 - OTHER INFORMATION

7.1 Have you ever read a guide for the correct use of biomass?

7.2 Do you take into account the information and advice read when using biomass-powered appliances?

- yes completely
- yes in part
- not at all (*explain why*)

7.3 In case of financial incentives, would you be willing to change an old biomass burning device with a more efficient and environmentally-friendly one?

7.4 Are you aware of Thermal Account incentives?

7.5 Have you already taken part in regional calls for the purchase of your biomass burning appliance?

7.6 Are you aware of any restrictions on the use of households biomass burning appliances in the cold season? (*air quality measures envisaged by the Po valley agreement*)

7.7 Do you have one or more second houses equipped with a heating system in the following Regions? (*please take into account fireplaces and stoves; do not consider appliances powered by electricity such as electric heaters and electric convector heaters*)

- Valle d'Aosta
- Piedmont
- Lombardia
- Veneto
- Friuli-Venezia Giulia
- Emilia-Romagna
- Trentino-Alto Adige

If so, re-submit the questionnaire for all second houses.

THE PROJECT PREPAIR

The Po Basin represents a critical area for the quality of air, as the limit values of fine powders, nitrogen oxides and ozone set by the European Union are often exceeded. The northern Italian regions re included in this area as well as the metropolitan cities of Milan, Bologna and Turin.

This area is densely populated and highly industrialized. Tons of nitrogen oxides, powders and ammonia are emitted annually into the atmosphere from a wide variety of polluting sources, mainly related to traffic, domestic heating, industry, energy production and agriculture. Ammonia, mainly emitted by agricultural and zootechnical activities, contributes substantially to the formation of secondary powders, which constitute a very significant fraction of total powders in the atmosphere.

Because of the weather conditions and the morphological characteristics of the basin, which prevent the mixing of the atmosphere, the background concentrations of the particulate, in the winter period, are often high.

In order to improve the quality of the air in the Po Valley, since 2005 Regions have signed Program Agreements identifying coordinated and homogeneous actions to limit emissions deriving from the most emissive activities.

The PREPAIR project aims at implementing the measures foreseen by the regional plans and by the 2013 Po Basin Agreement on a wider scale, strengthening the sustainability and durability of the results: in fact, the project involves not only the regions of the Po valley and its main cities, but also Slovenia, for its territorial contiguity along the northern Adriatic basin and for its similar characteristics at an emissive and meteoclimatic level.

The project actions concern the most emissive sectors: agriculture, combustion of biomass for domestic use, transport of goods and people, energy consumption and the development of common tools for monitoring the emissions and for the assessment of air quality over the whole project area.

DURATION

From February 1st 2017 to January 31 2024.

TOTAL BUDGET

17 million euros available to invest in 7 years: 10 million of which coming from the European Life Program.

COMPLEMENTARY FUNDS

PREPAIR is an integrated project: over 850 million euros coming from structural funds and from regional and national resources of all partners for complementary actions related to air quality.

PARTNERS

The project involves 17 partners and is coordinated by the Emilia-Romagna Region – General directorate for the territorial and environmental care.

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