WOODY BIOMASS IN SOUTH TYROL: FEEDSTOCK AVAILABILITY AND CHARACTERIZATION OF DIFFERENT CONVERSION PROCESSES FOR ENERGY PRODUCTION

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ABSTRACT: In the last years, European and international protocols have been set to force the member states to gradually switch from fossil to renewable energy sources. Among the different renewable energy sources, South Tyrol has an interesting potential on the woody biomass. According to a preliminary study conducted in South Tyrol, a considerable share of biomass from forest is already used in the energetic chain and there is still margin of improvement. Also the riparian vegetation is already used, but its contribution is considerably small and it could be improved. Furthermore, considering the biomass in a larger perspective, agricultural residues could be considered as potential energy sources. In the framework of a project financed by the Autonomous Province of Bolzano (Sustainable use of biomass in South Tyrol: from production to technology), a preliminary assessment has been conducted for some feedstocks locally available, i.e. Norway spruce (*Picea abies*), willow (*Salix* spec.), apple logs and apple pruning. The preliminary results highlight that the pollutant emissions are slightly higher for apple residues compared with the other feedstocks. Nevertheless, most of the emissions are within the limits set by EN 303-5. However, further analyses have to be completed in order to define its suitability for the energy chain.
Keywords: wood pellet, agricultural residues, potential, combustion, emissions

1 INTRODUCTION

The inversion from fossil energy sources to renewable energy supplies has been fostered by the Renewable Directive [1] and the Energy Efficiency Directive [2]. In the EU, by 2020 there will be an increase up to 20 % of the energy consumption derived from renewable resources.

On this basis, different studies have become to spread with the aim of estimating the amount of biomass that could be used as energy source. In particular, agricultural residues achieve considerable interest due to the compliance to the cascade principle (i.e., biomass utilization with the following order of priority; wood based products, re-use, recycling, bioenergy and disposal). In accordance with some studies reported by Prando et al. in [3], the agricultural biomass potential in the EU by 2020 is between 0.73 EJ y^{-1} and 1.43 EJ y^{-1} (i.e., 10^{18} J y^{-1}). The wide range of estimations is due to different calculation techniques, different parameters as sustainability indicators, economical aspects, local conditions and legislation of the considered countries. Besides the biomass potential assessment, several studies discuss the suitability of woody and non-woody biomass for energy production. Carvalho et al. [4] investigate several agricultural fuels highlighting an higher fouling of the heat exchanger with this type of biomass. Furthermore, straw and sorghum have particularly high dust emissions. Verma et al. [5] confirm the critical behavior of straw, in particular due to the high ash content and low melting point. Picchi et al. [6] carried out a comparison between vineyard residues and spruce. The main outcomes show high CO emissions for vineyard residues that could be tackled with some modification to design and settings of the boiler. Moreover, the authors stated that agrochemicals – used for the treatment of the plants − are not increasing air pollution during combustion. Serrano et al. [7] and Carvalho et al. [4] emphasized the importance of proper settings of the boiler, according with the characteristics of the fuel, in order to reduce the pollutant emissions.

In South Tyrol, a large share of forest biomass is already used for energy purpose, but a further share could be exploited. Furthermore, other types of biomass could potentially be used to raise the amount of biomass-derived energy. In this study, selected feedstock from forest, agriculture, industry and riparian vegetation were assessed. Forest biomass potential was assessed on the basis of several studies that were carried out in northern Italy. The estimations were adjusted considering the environmental, management and economic constraints of the South-Tyrol region. Concerning the agricultural biomass, the assessment focused on woody residues of apple orchards and field measurements were carried out for their quantification. For the estimation of the biomass that could be derived from riparian vegetation, diameters and heights of all the individuals, present inside selected sampling plots, were checked and the annual biomass increment rate was calculated. Industry biomass, mainly from sawmills, was assessed on the basis of some studies carried out in the north-east of Italy. Nevertheless, the estimations strongly depend on the technology processes adopted by the industries.

A further objective of this study was the thermal characterization of the four different feedstocks (i.e. Norway spruce, apple pruning, apple logs and willow) in order to evaluate the suitability for the energy chain. Combustion tests have been carried out for the four considered feedstock by means of a small pellet boiler.

2 BIOMASS QUANTIFICATION IN SOUTH-TYROL

2.1 Forest sector assessment

The territory of the Autonomous Province of Bolzano is classified as mountainous, where more than 40 % on the entire surface is over 2000 m (a.s.l.). Here, the forest plays an important role in the local economy, covering about 50 % of the entire surface (Figure 1). The forest is managed by means of principles that ensure the sustainability and avoid the risk of hydrological hazards.

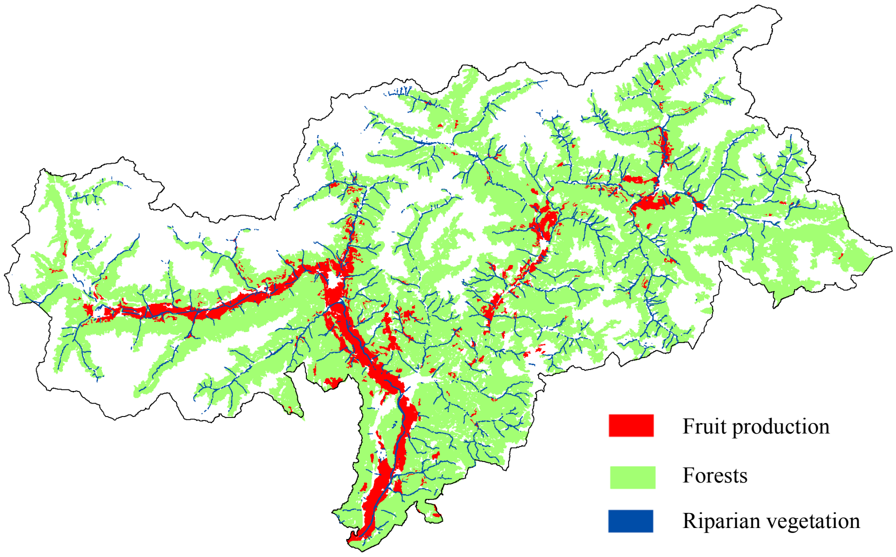

Figure 1: Land use in the Autonomous Province of Bolzano based on CORINE land-cover survey (2006)

The forest grows on 372,174 ha; 90 % of this area is covered by high forest (i.e., forest originated from seed) [8]. The species distribution is reported in Figure 2.

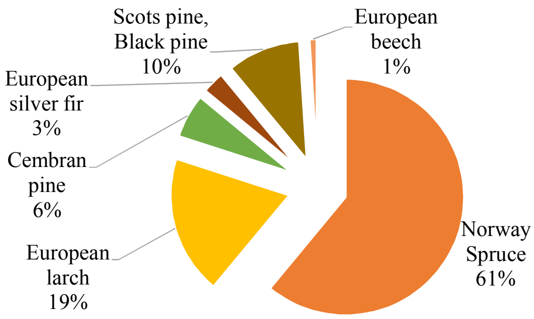

Figure 2: Distribution of the main species of trees in South Tyrol

The forest biomass assessment has been performed by means of the estimation of the potential biomass availability, from which the real biomass availability was calculated. Indices and coefficients from literature, as well as personal communication from the Provincial Forest Department were applied.

To perform this assessment, the sustainable forest management approach was applied. This approach considers the net annual increment (NAI), reported on the second National Forest Inventory [9], as the maximum limit of harvesting wood. Therefore, if every year only the growth stock increment is exploited, the processes of degradation does not start [10]. The potential biomass assessment has taken into account the volume of the stem as well as the branches. To do that, the total annual increment must be multiplied by the Biomass Expansion Factors (BEF), specific for every tree species [11-13]. Therefore, using the value of the NAI it is possible to estimate the total annual biomass – stem and branches and crown tops – available to be harvested from the forest in a sustainable way. For this assessment, the BEF indexes, which include the leaf's volume component [13], were used.

The presence of several environmental and management as well as economic constraints do not allow to exploit the entire biomass potential. In this assessment, only environmental and management constraints were considered. These restrictions consider the forest accessibility for the mechanization. Furthermore, a certain amount of biomass has to be released in loco in order to ensure the protection function from debris flow and from soil erosion [14], the soil fertility [15] and the protection of site biodiversity [16]. Thanks to the specific coefficients from scientific literature, personal communication from provincial forest managers and GIS elaborations, it was possible to quantify the maximum amount of biomass that could be used in the local energy chain.

2.2 Agricultural sector assessment

The agricultural sector constitutes the main economic pillar of the Province [17]. Apple (*Malus domestica*) production constitutes the principal agricultural activity [18], holding the national production supremacy. With its 18,700 ha, South Tyrol is the largest intensive apple producing region in Europe. Apple orchards mainly stretch along the banks of the Adige river for a length of about 110 km and within an altitudinal range of 220 m to 1,000 m a.s.l. (Figure 1). Oltradige-Bassa Atesina, in the southern part of Adige valley, Burgraviato and Venosta valley represent the three main intensively cultivated areas of the Province. Also along the Isarco valley and in the area around Bressanone apple orchards were installed [8]. Orchards require annual and cyclical cultural operations (i.e. pruning and tree removals), which produce woody biomass such as branches and trunks, which could be used to supply the local energy chain. Currently, the pruned branches are grinded and left on the field. The trunks are used to feed house-stoves or boilers in the farmers´ houses, or they are sent to compost plants or to the landfill, together with the rootstocks.

In order to determine the real biomass potential for bioenergy production from woody residues from orchards in this Province, a detailed quantification assessment has been carried out in winter 2013. The main four cultivated varieties of apple have been investigated in the three main cultivation areas (Table I).

Table I: Cultivars, areas and other parameters investigated for the woody agricultural biomass quantification

Cultivation areas	Oltradige-Bassa Atesina Burgraviato Venosta valley
Cultivars	Gala Golden deliciouse Red deliciouse Braeburn
Age class (year)	less than 10 over 10
Cultivated area (ha)	18,700
Renewed orchards (ha)	748
Harvesting losses (% weight)	40
Mechanical limitation (% area)	10

To investigate the potential effect of plant age on pruning-biomass production, orchards of various ages were compared. Two different age class were established: younger and older than 10 years old.

Thus, totally 24 different orchards with the aforementioned characteristics were selected for weighting the pruning residues. All of them present the same training system (Slender Spindle), carry out irrigation and they are integrated managed orchards [19].

In each orchard, four sampling plots were chosen randomly. The plots consist of an imaginary rectangle between two tree rows, delimited by four cement poles of the training system. The plot´s surface was about 17 m^2 (2,8 m large and 6 m long). To reduce the edge effects, a margin of 6 m along all the perimeter of the orchard field was excluded by the assessment. Usually, apple pruning is made manually and the operator prunes one side of the tree per time. This means that half of the prunings from one row and half of the prunings of the adjacent row fall in the same inter-row, where the plot-area lied. However, since on each of the longer sides of this imaginary rectangle there were the same number of trees (usually from 6 to 8, depending of the length of the poles distance), the amount of pruned branches that falls into the plot could be consider the same of the ones belonging only to the whole trees of one row.

The pruned branches cut in the plot were manually collected and weighted with a digital dynamometer with an accuracy of 0.02 kg. The weighting was carried out at the same day of the pruning. The pruning season in winter 2013 was carried out from January to February in the Province.

In order to determine the quantity of wood available with the orchards replacement process, 40 trees of different varieties have been weighted. Branches, trunk and rootstock´s weight was assessed.

Once the average wood per hectare was calculated, the real availability of this biomass at local level was estimated, taking into account the total surface cultivated, the yearly average surface renewed, the orchards not accessible by mechanization (with a slope higher than 25 %) and the harvesting losses during the mechanized pruning harvesting [18], as reported in Table I.

2.3 Riparian vegetation sector assessment

The riverine network of the Autonomous Province of Bolzano is spread over a length of approximately 9,560 km and riparian forests cover an area of about 2,319.4 hectares that range among three different elevation zones (valley, mountain and subalpine zones). The mountain zone is the most covered by riparian vegetation with 1,148.4 hectares, while riparian vegetation occupies 893.4 and 277.6 hectares respectively in the valley zone and the subalpine zone.

The management of the riparian vegetation is in care of the Department of Hydraulic Engineering of the Autonomous Province of Bolzano, which developed a maintenance program based on Adige River that, for its accuracy and completeness, is taken as a model for the whole Province.

The original program interests a stretch of 62.5 km of Adige River, between the cities of Merano and Salorno, and has the aim to avoid flood risk by balancing landscape and environmental protection. The stretch was divided into 200 sections of 300 m of length each with the purpose of carry out maintenance works alternatively among the sections on a yearly basis, in order to avoid an excessive vegetation removal.

The types of maintenance works can be divided into three categories, i.e. mowing, maintenance of vegetation with thin diameters and plant thinning. The mowing of herbaceous vegetation is performed several times through the year in hydraulically harmful traits, as in bridges closeness proximity or along very narrow sections. In reaches not particularly prone to flood risk, only vegetation with a maximum trunk diameter of 5 cm is maintained. In the sections where the flow is assured, a four years program of plant thinning is carried out. All the woody biomass derived from riverside maintenance works is used for energy production.

In order to determine stand volume and productivity of the riparian vegetation of the whole Province, 7 sampling plots were performed at an elevation comprised between 220 and 1,000 m above sea level. Ash, spruce and alder forests were sampled in mountain and subalpine zones, whilst willow and poplar forests were sampled in the valley zone. Diameters and elevations of all the individuals present inside the plots were recorded.

Furthermore, tree cores were effected for assessing forest age of the sampling plots and the biomass increment (expressed in m^3 per year) was calculated.

Riparian vegetation height along the main rivers of the province was determined by GIS software (EsriArcGIS10). A raster file was created and divided into height classes (0-5 m, 5-10 m, 10-15 m, 15-20 m, 20-25 m and 25-30 m). The volume of biomass present along each river was estimated by applying the relationship between stand volume and canopy height calculated on the basis of the data collected from the sampling plots.

2.4 Industry sector assessment

In South Tyrol, the by-product from sawmills is another source of biomass for the energy chain. This material is characterized by having very good features to become biofuel for thermal plants, mainly due to its size and its moisture content, but also for its good availability and easy possibility of transportation [20]. These by-products are in strictly relationship with local forest production and local trade strategies. It is fed by round-wood, bark, shaving, wood remains, etc. The amount of the by-products depends on the technology processes as well as on the economical convenience to employ it in the energy chain. With this biomass it is possible to supply other productive chains as medium-density fibreboard MDF panels, plywood, fibreboard, etc. [21, 22], or sold to other, more profitable energy chains. On average, the ratio between by-products production and input sawn timber ranges from 24 % to 26 % in northeast Italy [22]. Therefore, for this assessment the value of 25 % was taken into account.

3 PELLETTIZING AND COMBUSTION TESTS

3.1 Biomass pelletizing

The four feedstocks, selected for the quantification study, were collected and used to test their suitability for the energy sector. The materials (i.e., Norway spruce, apple pruning, apple logs and willow) were collected from the field after cutting and chipping processes. The material were available under different forms − i.e., logs rather than prunings −, therefore a proper pre-treatment was necessary in order to test the material in the same boiler. For the considered feedstocks, a pelletizing pre-treatment was selected as suitable to obtain the same geometry and moisture content among the different raw materials. A set of operations was necessary to obtain the final pellets. All the considered materials were chipped on the field with different woodchippers; hammer mill for apple logs and prunings, and flywheel with knives for spruce and willow. The materials were than comminuted and pelletized by *Holzforschung Austria and OFI Technologie & Innovation*. A small fraction of binding additive (i.e., mais-starch) was used in the pelletizing phase in order to improve mechanical durability of pellets [23].

3.2 Biomass combustion tests

The combustion tests were carried out at the laboratory of *Bioenergy 2020+*. The experimental test setup is described in details in [4]. The facility enables the determination of both energy performance and pollutant emissions of each feedstock. The setup involves a domestic boiler fed by pellet with a nominal capacity of 15 kW. The pellets are fed horizontally with a feeding screw. The combustion takes place on a sliding grate that automatically cleans itself and moves the ash in the box placed below the grate. Primary air is supplied below the grate while pre-heated secondary air is supplied above the fuel bed. The boiler was equipped with lambda sensor that enables the regulation of fuel capacity in every output range according to the quality of the fuel.

The boiler was operated at nominal load for a time span between 1 h and 2 h depending on the time required to reach steady-state conditions. The tests were repeated 4 times for Norway spruce, apple logs and apples pruning, and 3 times for willow due to lack of feedstock. The boiler was connected to a heat dissipation circuit; the return temperature was maintained at 65 °C and the supply temperature depends on the generated heat.

Various parameters were monitored during the tests with a time step of one second and subsequently the average values were computed for each trial. Flue gases temperature was measured with a thermocouple (K type) in order to calculate the flue gases loss. The water temperatures of the dissipation circuit − both supply and return − were measured by means of a resistance thermometer (PT 100) in order to calculated the average output heat. A gas analyzer (NGA 2000) was used to measure O_2 (with paramagnetic cell), CO and CO_2 (with non-dispersive infrared sensor), and NO_x (with ultraviolet cell) in the flue gases. The composition of the flue gases allow the calculation of the losses due to incomplete combustion and the excess air ratio (λ). The boiler was placed on a balance (Mettler Toledo PTA) in order to measure the input pellet for the time span in which the boiler is operated at steady-state condition. The dust was sampled iso-kinetically from the flue gases and collected in a cartridge filter of quartz wool in order to be weighted. Ash and unburned residues were collected and weighted for each test.

4 RESULTS

4.1 Forest biomass quantification

In South Tyrol, about 865,000 m^3 of biomass – considering stem, branches and tops – are harvested every year. The 75 % of those have commercial purpose as timber (55 %) or firewood (20 %), while the other 25 % are branches and tops. From the actual forest management the branches and crown tops were not harvested, because released in the harvesting site. The potential biomass available in South Tyrol were calculated multiplying the NAI and the BEF. These evaluations were done for the most representative tree species in the Province: it results to be 2,650,000 m^3 yr^{-1}. Due to the application of the several environmental and management constraints, which do not permit the exploitation of the potential stock of biomass, the available biomass amounts to 1,085,000 m^3 yr^{-1}, 41 % of the potential biomass. Considering a scenario equal to the actual, so using the above mentioned purpose rates, the destinations of the available biomass were estimated. Summarizing, the stock of biomass coming from the forest, available every year and exploitable in a sustainable way is about 597,000 m^3 yr^{-1} for timber production, 217,000 m^3 yr^{-1} for firewood production and 271,000 m^3 yr^{-1} of branches and tops for woodchips production to supply the thermal plants. These estimations refer to round wood. Considering a volume conversion coefficient, from round wood to woodchip, of 2.75 (G30-G50), the results in terms of woodchip are the following; 1,070,000 m^3 yr^{-1} already used in the energy chain and 275,000 m^3 yr^{-1} as potential further share.

4.2 Riparian vegetation quantification

The survey showed that conifer forests (spruce) reach major heights and stand volume of biomass values (expressed by m^3 ha^{-1}) compared to broadleaves and mixed forests, where both canopy height and stand volume are similar. The percentage of increment varies between 1.1 % and 5.0 % (Table II), with higher values in forests with willow presence, meaning that those kind of trees have a fast growth. Spruce trees are the ones with the lower increment (1.1 %), but due to their high height, they have an important annual production in biomass.

Table II: Sampling plots and sampled trees with their annual biomass increment

Sampling Plot	Biomass (m^3/yr)	Increment %
1-Alders	15.0	3.3
2-Alders	6.0	2.0
3-Alders	3.5	2.5
4-Ashes	8.6	3.3
5-Spruces	8.4	1.1
6-Willows-Alders	7.6	5.0
7-Willows-Poplars	13.5	4.0

Table III: Biomass volume along each investigated river and their stand volume per river length and per hectare of riparian vegetation

River	Biomass volume (m^3)	Stand volume (m^3 km^{-1})	Stand volume (m^3 ha^{-1})
Adige	5,851	158	92
Ram	3,187	359	64
Puni	342	13	48
Carlino	12	1	3
Saldura	521	24	43
Solda	1,265	58	41
Plima	1,046	81	47
Senales	1,782	63	68
Valsura	6,741	177	70
Talvera	1,792	81	124
Isarco	1,936	56	75
Mareta	2,200	137	63
Vizze	916	43	55
Fleres	659	50	68
Rienza	7,651	387	221
Aurino	2,635	125	122
Anterselva	809	42	36
Casies	797	35	42
Gardena	769	30	64
Ega	315	25	43
Passirio	2,656	75	50
Gadera	3,109	95	67
TOTAL	46,991	2,115	1,506

Results from GIS calculations show that the most represented height class is 0-5 m that occupies more than 600 hectares, followed by the 5-10 m class with nearly 200 hectares. All the remaining classes show minor values. The volume of biomass present along each river (Table III) was estimated by applying the relationship between stand volume and canopy height calculated on the basis of the data collected from the sampling plots. The total amount of biomass present along the main rivers of the province is 46,991 m^3, and the results of the stand volumes show no correspondence between high values of stand volume per river length and stand volume per hectare and vice-versa. The riparian vegetation present along the not investigated rivers is negligible for the biomass calculation as they are 4^{th} and 5^{th} order rivers usually flowing at high altitudes where woody biomass is not present.

As estimated from the Department of Hydraulic Engineering of the Province [24], an annual woodchip amount of 20,000 m^3 that can be collected and used in the energy chain, against a value of 46,991 m^3 of standing biomass.

Further analysis is needed for the quantification of the extension of the different forest types in the whole Province, in order to better evaluate the biomass increment of each river divided by vegetation typology and height and to gain a better understanding of the feasible amount of riparian biomass that could enter the energy chain each year.

4.3 Agricultural biomass quantification

The average pruning weight was 1.03±0.58 t_{dw} ha^{-1}, with an average moisture content of 56.2±12.2 %. Considering the losses during harvesting and excluding the fields where the mechanization could represent a limit, the pruning residues are available at a rate of 10,098 t_{dw} yr^{-1} (weight on dry basis) in the whole Province.

The wood from explanted plant was estimated to be 29.7 t_{dw} ha^{-1} yr^{-1}. Since in 2013 the renewed surface was 748 ha [8], the available wood from explanted trees reached the 22,200 t_{dw} yr^{-1}.

On the whole, the usable wood from apple orchards was calculated to be about 32,200 t_{dw}. Considering the feedstock as woodchip with an average apparent density on dry basis of 350 kg m^{-3}, apple orchards potential is about 92,000 m^3 yr^{-1}. This amount could fulfill the 10 % of the local biomass request, replacing the 16 % of the imported wood.

4.4 Industrial biomass quantification

Nowadays, no official data about the volumes of timber imported and exported from the industry sector of the Autonomous Province of Bolzano are present. From the ISTAT database (Italian National Institute of Statistics), in 2012, the trade of raw timber is respectively 8,900,000 EUR yr^{-1} for importations and 9,800,000 EUR yr^{-1} for the exportations. Considering a trading price around 90 EUR m^{-3}, the fluxes in volume of timber in the Province range between 100,000 m^3 yr^{-1} for importation, and 110,000 m^3 yr^{-1} for exportation. Therefore, for the actual situation the amount of timber for sawmill supplying ranges between 461,000 m^3 yr^{-1}, which could increase 580,000 m^3 yr^{-1} if the potential biomass stock is considered. Consequently, the rate of by-product employable to supply the local energy chain amounts to 115,000 m^3 yr^{-1}, and it could be increased up to 145,000 m^3 yr^{-1} considering the potential biomass stock.

4.5 Biomass suitability for the energy chain

The pelletizing of the four considered feedstocks were carried out without any problem for willow and Norway spruce. On the other hand, an additional treatment with hammer mill was required for apple logs and apple pruning. It is due to the fact that apple feedstocks were processed on fields with a shredder based on the hammer mill principle and the obtained material was smashed rather than properly reduced to small chips.

As concerns the thermal characterization, the main pollutant emissions (i.e., CO, NO_x and dust), due to combustion of biomass, are reported in Figure 3. The emissions are reported as concentration of the pollutants in the flue gases at normal conditions; the values are normalized at 10 % of O_2 in the flue gases. The EN 303-5 [25] reports the emission limits for CO and dust depending on the class of the boiler; the limits are defined at normal conditions (273.15 K and 101300 Pa) at 10 % O_2 in the flue gases. No limit is defined for NO_x. CO emission limits are set at 3,000 mg Nm^{-3} (class 3 boiler), 1,000 mg Nm^{-3} (class 4 boiler) and 500 mg Nm^{-3}

(class 5 boiler). Dust emission limits are set at 150 mg Nm^{-3} (class 3 boiler), 60 mg Nm^{-3} (class 4 boiler) and 40 mg Nm^{-3} (class 5 boiler).

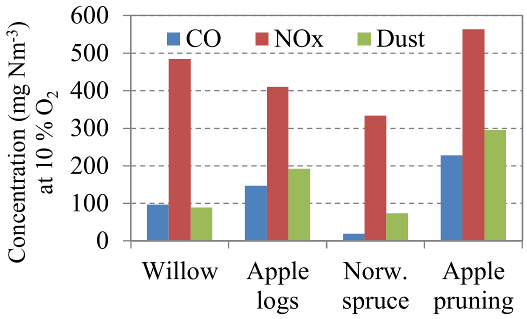

Figure 3: Concentration of CO, NO_x and dust in the flue gases

As concerns CO emissions, all the feedstocks are within the strictest limit defined for "class 5" boiler. Nevertheless, apple residues (i.e., both logs and pruning) have values slightly higher than spruce and willow. The largest limit for dust emissions (i.e., class 3 boiler) is respected only by spruce and willow. Apple pruning has the highest dust emission with a value that is twofold compared to the limit for "class 3" boiler. As above-mentioned, no NO_x limit is set by EN 303-5. However, as order of magnitude, the NO_x local limit – provincial law for air quality protection [26] − for boiler of 1-3 MW is 550 mg Nm^{-3} at 10 % O_2 in the flue gases. The highest NO_x emissions refer to apple pruning while the lowest refer to Norway spruce. The discussion about the emissions will be further developed once the elemental analysis of the pellets will be completed. It will allow finding out why apple residues have higher emissions and if modification of the boiler could reduce the emissions.

5 CONCLUSIONS

The results are reported in terms of woodchip volume. The main share of biomass for energy purpose comes from forest (1,070,000 m^3 yr^{-1}) with an un-exploited share around 275,000 m^3 yr^{-1}. The industrial by-products are used for a share of 115,000 m^3 yr^{-1}, with an additional un-exploited share around 30,000 m^3 yr^{-1}. The riparian vegetation is the smallest share (20,000 m^3 yr^{-1}) with an additional share of 27,000 m^3 yr^{-1} that could be further used for energy purpose. Wood from orchards (both pruning residues and explanted trees) is not used so far for energy production due to local restrictions, but it could represent a significant additional wood biomass for bioenergy production (92,000 m^3 yr^{-1}). These results have to be considered as preliminary, further analyses have to be completed to confirm the estimations. The thermal characterization of the different feedstocks highlights higher emissions for the agricultural residues. In particular, dust emissions were above the limit set in the EN 303-5. Nevertheless, NO_x emissions for apple-logs residues were smaller than willow. However, further analyses are necessary to have a complete overview of the suitability of the fuels for energy purpose. Ash content, fusibility, and the possible presence of agrochemicals residues should be carefully assessed.

A future development of this work foresees the characterization of pellets in order to calculate the efficiency of the boiler when it is operated with considered feedstocks. It would give a complete overview of the impact that the use of these fuels would give in South Tyrol.

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