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Impact of a renewable biomass energy power plant in urban landscape with complex terrain in Central Italy: modelling assessment and suggestions for monitoring site

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Power plants fuelled with natural biomass are regarded as advantageous with respect to traditional thermo-electric plants, because of their reduced impact on the environment. The main advantage is the use of non-fossil biomass fuels that, in principle, do not allow for additional emission of greenhouse gases (including carbon dioxide, CO2) to the atmosphere during the plant life cycle (from offspring to burning), i.e. they are "carbon neutral". Recently, the carbon neutrality of renewable biomass energy system has been questioned, because one must account for products from incomplete combustion and effects of land use changes. For example, the greenhouse effect of intermediate oxidation products such as methane and carbon monoxide, having a lifetime much shorter than CO2, is not taken into account and yield an overestimation of climate benefits. Another example is forest clearing finalized at establishment of new crops for energy production, which is a net CO2 source. From the air quality point of view, a biomass power plant certainly emits short-lived substances from combustion (nitrogen oxides, volatile organic compounds, particulate matter) which are likely to affect the surrounding pollutant levels.

Here we investigate the effect of a renewable biomass power plant that will be installed nearby a city on the Central Apennines in Italy, L'Aquila. The city stands at 700 m a.s.l. in a valley closed on the North-East and on the South-West borders by the mountains. The local circulation is dominated by mountain-valley breeze and by ventilation from the NNW sector. Night-time thermal inversions capped at a few hundred meters above ground are typical under both anticyclonic and cyclonic conditions, especially in the cold season. The industry in charge of building the plant has already communicated (via blog) results from a private modelling study assessing the impact on air quality. From project design, the emissions from smokestack are declared to be 30 to 20% less than European legislation limits, depending on the substance. The effect on local air quality is assessed by means of the CALPUFF system (as recommended by EPA) and predicts a small maximum differential impact on three regulated species: +16 μg/m3 of NO2, +0.96 μg/m3 of PM10, and +6.3 μg/m3 of SO2. No pollutant thresholds are surpassed during the simulated period. The concentrations of emitted compounds are reported to decay very fast away from the plant and they are reduced to undetectable traces before reaching nearest residential areas (which are less than 1 km away).

The aim of this work is two-fold: (1) assess the impact on pollutant levels due to new emissions from the power plant, and (2) define an optimal location to place a monitoring station. We will present an independent modelling evaluation of pollutant levels and distribution to be directly compared with results claimed by the industry. We make use of both CALPUFF model and an high-resolution Eulerian chemistry-transport model, fed with high-resolution meteorological simulation able to reproduce the main features of the valley circulation. Based on simulations, we will look for an optimal location for a monitoring station to be installed as soon as possible (before power plant operation) and then used to check pollutants levels during future plant operation. Future developments of this work will focus on the impact on air quality and local climate of land use changes induced by the power plant operation.