SUSTAINABLE PLACES 2018
June 27-29,2018
Aix-les Bains, France

Case study: combining solar roofs and electric mobility in intermediate cities of Colombia

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ABSTRACT

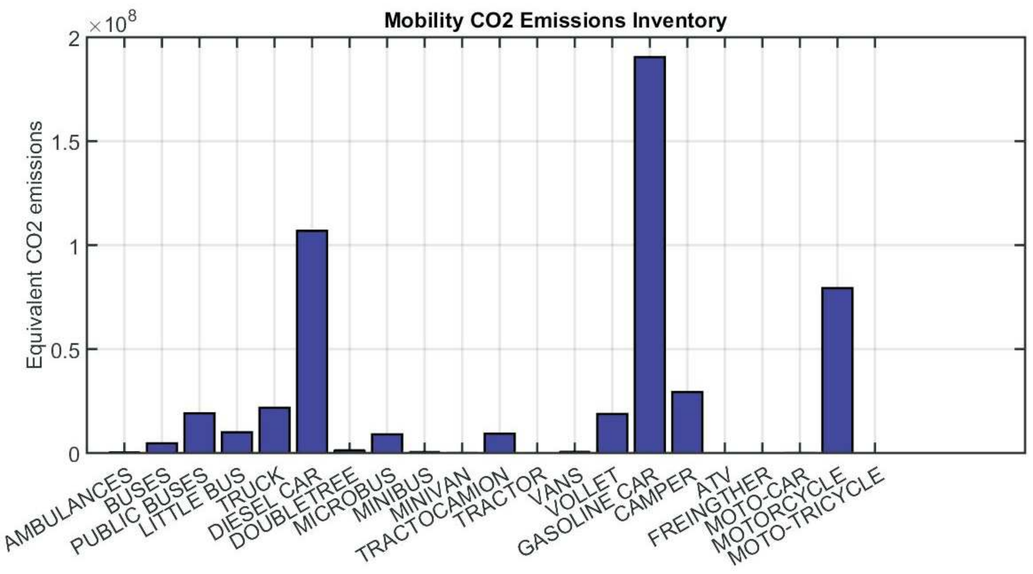
The international GHG reduction targets are set at 20% by 2030 even though every year motorized conveyance growth and mobile emissions represent more than half of the total in intermediate cities. In the city of Pasto in southeastern Colombia, CO2 emissions have grown more than 15% between 2013 and 2017, a situation that concerns local authorities and requires effective action.

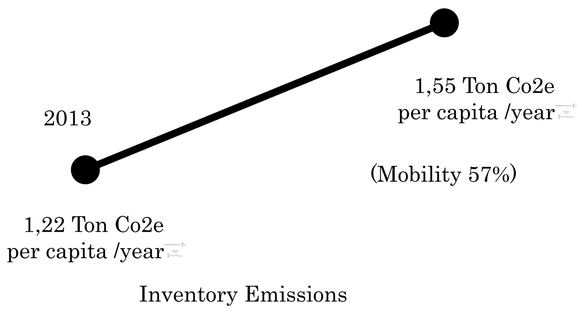
Local renewable sources of energy and energy efficiency programs are important topics in the agenda of most of cities and organizations, its use in transport and integration with the public bike system intend to face these challenges in a city with 450.000 inhabitants. The "Campus Verde Initiative" at Narino University is a project that combines an electric bicycle fleet, a photovoltaic charge system in bicycle parking, and a grid injection system of the remaining energy for self-consumption. The bicycles uses a photovoltaic charging system in a parking place, which works while the students go to class, taking advantage of the sunny hours.Benefits per ton of CO2 avoided by lower consumption of fossil fuel and generated energy reach 13,48 per year of use.

This previous experience is the base proposal for the implementation of a public bicycle system in the city with the support of the Swiss Government. The impact of this decarbonisation strategy with sustainability approach is analyzed for the city with a set of bicycle stations, solar roofs and bicycles fleet.

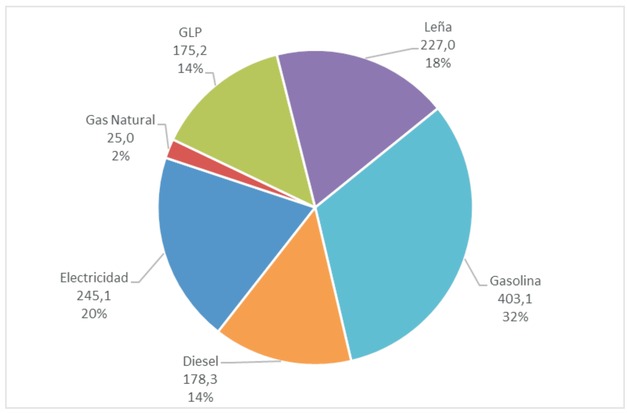
INTRODUCTION

The Global Protocol for Community-Scale Greenhouse Gas Emission Inventories was applied in Pasto as part of the Emerging and Sustainable Cities Initiative (ESCI), this program is suported by the Inter-American Development Bank (IDB) and aim to contribute to the envi-ronmental, urban and fiscal sustainability of the cities. The results in 2017 show high level of emissions by mobility that represent more than half of the inventory with a strong growth of the automotive fleet in recent years.





The Energy City Program ("Energiestadt") initiated in Switzerland 25 years ago – and known among European countries as the European Energy Award (EEA)– provides a direct response to the energy challenges faced by cities and municipalities. The EEA approach shall be adapted to Colombia in three pilot cities: Pasto, Montería and Fusagasugá.



Paraámeterro	Valuecor	Unitydad
Municipalitie Surfaceperficie el Municipio	1.181	[km²]
Numberúmero deof in habitantes	450.645	[inhabitantes]
Number of householdsúmero de viviendas	109.681	[householdsviviendas]
Number of vehiclesúmero de vehículos	144.185	[vehículesculos]
Consumo energía eléctricaElectric energy consumption	245,1	[GWh/yearaño]
Thermal energy consumptionConsumo energía térmica	427,1	[GWh/yearaño]
Energy consaunption in transportConsumo energía transporte	581,4	[GWhyear/año]
Total Energy ConsumptionConsumo total de energía	1253,6	[GWh/yearaño]

	Total Energy Consumption per unit area of territory	1,06	[GWh/km²/year]
	Energy consumption per inhabitant (residential sector)	1,21	[MWh/inhab/year
	Energy consumption per household (residential sector)	4,98	[MWh/home/year]
	Fuel consumption per motorized vehicle	113,3	[gal/year]

METHODOLOGY

Our analysis aims to evaluate the impact of electric mobility immersion and solar roofs over CO2 emissions inventory in the city. First, we introduce emissions mathematical modeling and future scenarios with emissions reductions due to e-mobility and solar roofs.

$$Mobility\ Emissions = \sum_{i=1}^{N} C_i x_i$$

Where, C_i describe coefficients of anual CO2e emissions in i-th vehicle and x_i describe i-th vehicle type

Then, we established the constraints over vehicles type in the new model with reduced emissions. Electric vehicles, bikes, electric bikes and pedestrian was added and a specific constraint that represents current area availability in the city was involved

$$Reduced\ Mobility\ Emissions = \sum_{i=1}^{N+4} C_i x_i$$

$$Constraints:$$

$$x_i \leq b$$

$$\sum_{i=1}^{N+4} Area_i x_i \leq Area_{availability}$$

RESULTS

Number of diesel and gasoline car and motorcycles hould be reduced in 25%. Only in this way, the goal of reducing emissions by 20% will be achieved.

An important aspect to be considered is the public space recovered close to 2%.

ACKNOWLEDGEMENT

This work was suported by Universidad de Nariño, Electronic Departament and GIIEE. In collaboration with EBP, ENCO and CORPOEMA as part of Energy City Program in Colombia