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Potential of optimization of the collection of municipal waste from the environmental viewpoint
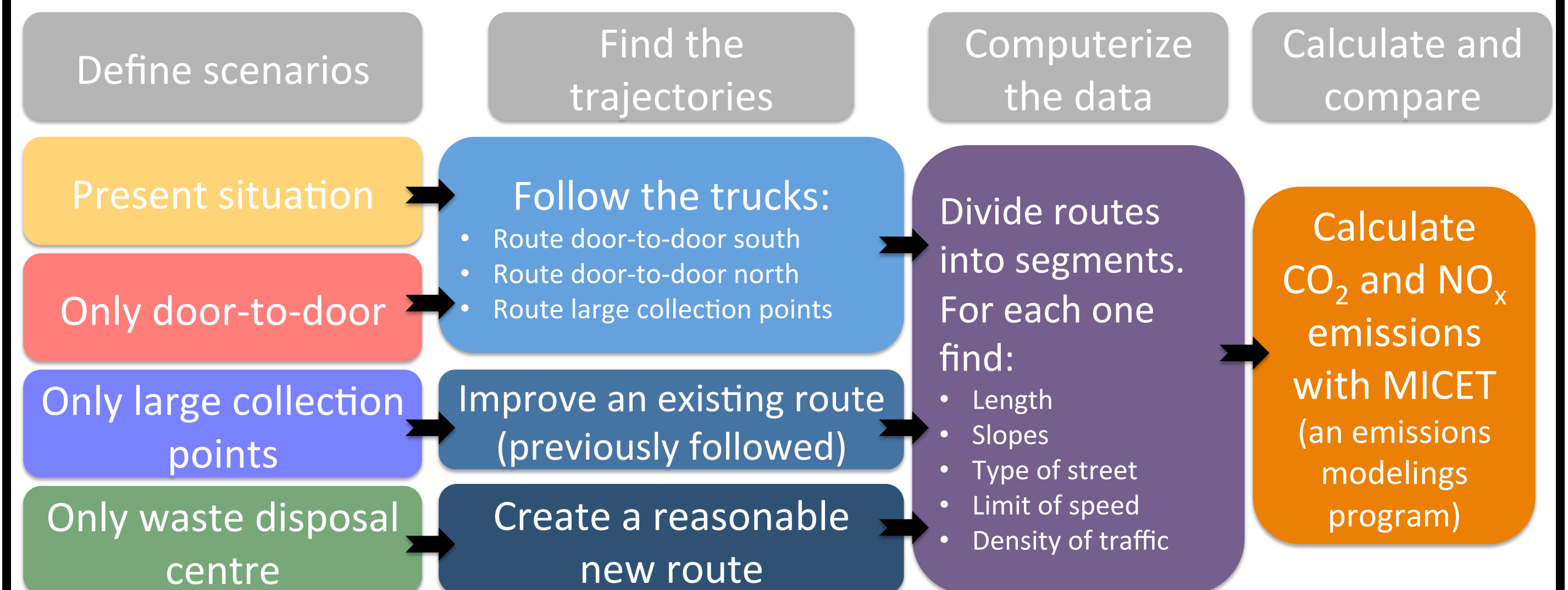
CONTEXT

The huge majority municipalities have a big potential of improving their system of collection, in terms of emissions of polluting components, like CO_2 and NO_x. Using this potential would also cost them less, because consumption of fuel by the trucks and emissions of CO_2/NO_x are directly linked. Moreover, optimizing a waste collection system must also mean satisfying the population as much as possible; which comes to compromising, when the population is not necessarily satisfied at most by the less pollution-emitting system.
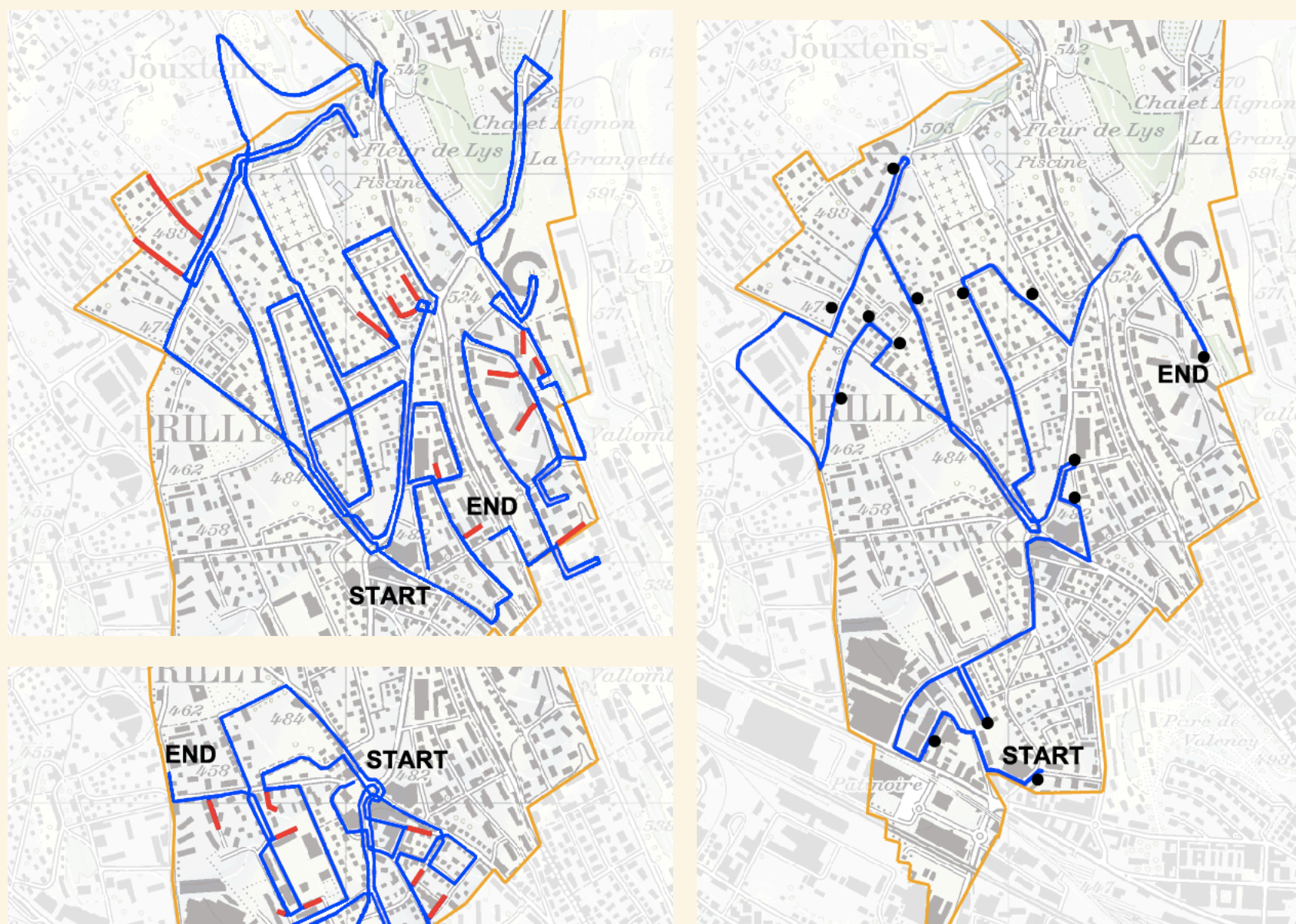
OBJECTIVES

- Compute the total CO_2 and NO_x emissions created by the collection tours, focusing on paper and domestic waste for the municipality of Prilly.
- Propose 3 different scenarios of possible collection systems and compute the corresponding CO_2 and NO_x emissions created by the collection tours done by the trucks.
- Measure the satisfaction of the population in each scenario, thanks to a survey.
- Find, from the results, if there is a potential of optimization for Prilly and propose it.

METHODOLOGY

Define scenarios	Find the trajectories	Computerize the data	Calculate and compare
Present situation	Follow the trucks: • Route door-to-door south • Route door-to-door north • Route large collection points	Divide routes into segments. For each one find: • Length • Slopes • Type of street • Limit of speed • Density of traffic	Calculate CO_2 and NO_x emissions with MICET (an emissions modelings program)
Only door-to-door			
Only large collection points	Improve an existing route (previously followed)		
Only waste disposal centre	Create a reasonable new route		

RESULTS

Present situation

|	Door-to-door		Large collection points	
	Domestic waste	Paper	Domestic waste	Paper
Frequency	Twice a week	Once every 2 weeks	Once a week	Once every 2 weeks
Collection time	3h30 North 4h South	8h	4h	4h
Quantity of waste collected per year	2300t	500t	220t	100t
Necessity to empty the truck during the collection route	No	Yes, 3 times	No	No
Kilometers travelled per tour	17,5	17,5	7,5	7,7
CO_2 emissions per week [kg]	138,173	42,055	21,348	11,669
NO_x emissions per week [kg]	1,092	0,33	0,14	0,071

Prilly's current collection system for paper and domestic waste is composed of 5 different tours: for collection of domestic waste we have door-to-door in the south, door-to-door in the north and large containers in the whole city; to collect paper there are two methods, door-to-door and containers in the whole city.

Only waste disposal centre

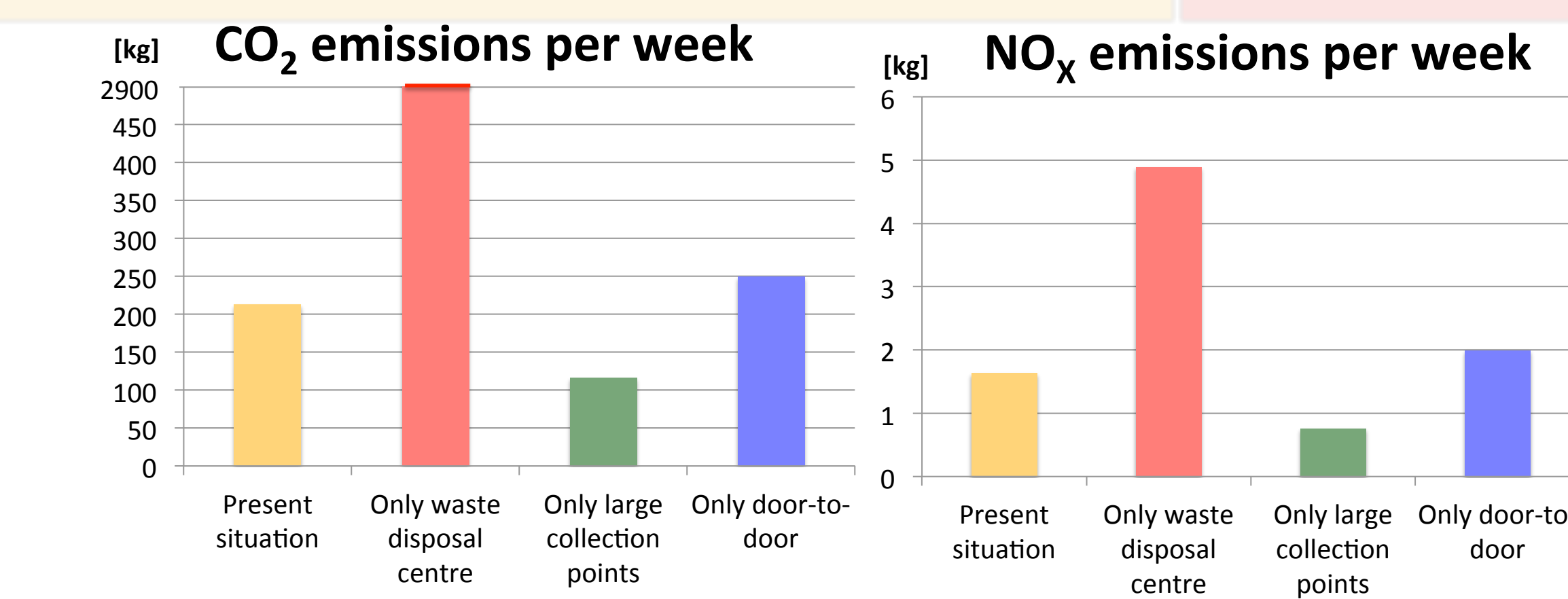|	Voluntary provision
Frequency	twice a week
Kilometers travelled per route	3,9
Travels per week per household	2
Number aproximated of families (population/4)	2906
Total travels per week	5812
CO_2 emissions per week [kg]	2931,496
NO_x emissions per week [kg]	4,889
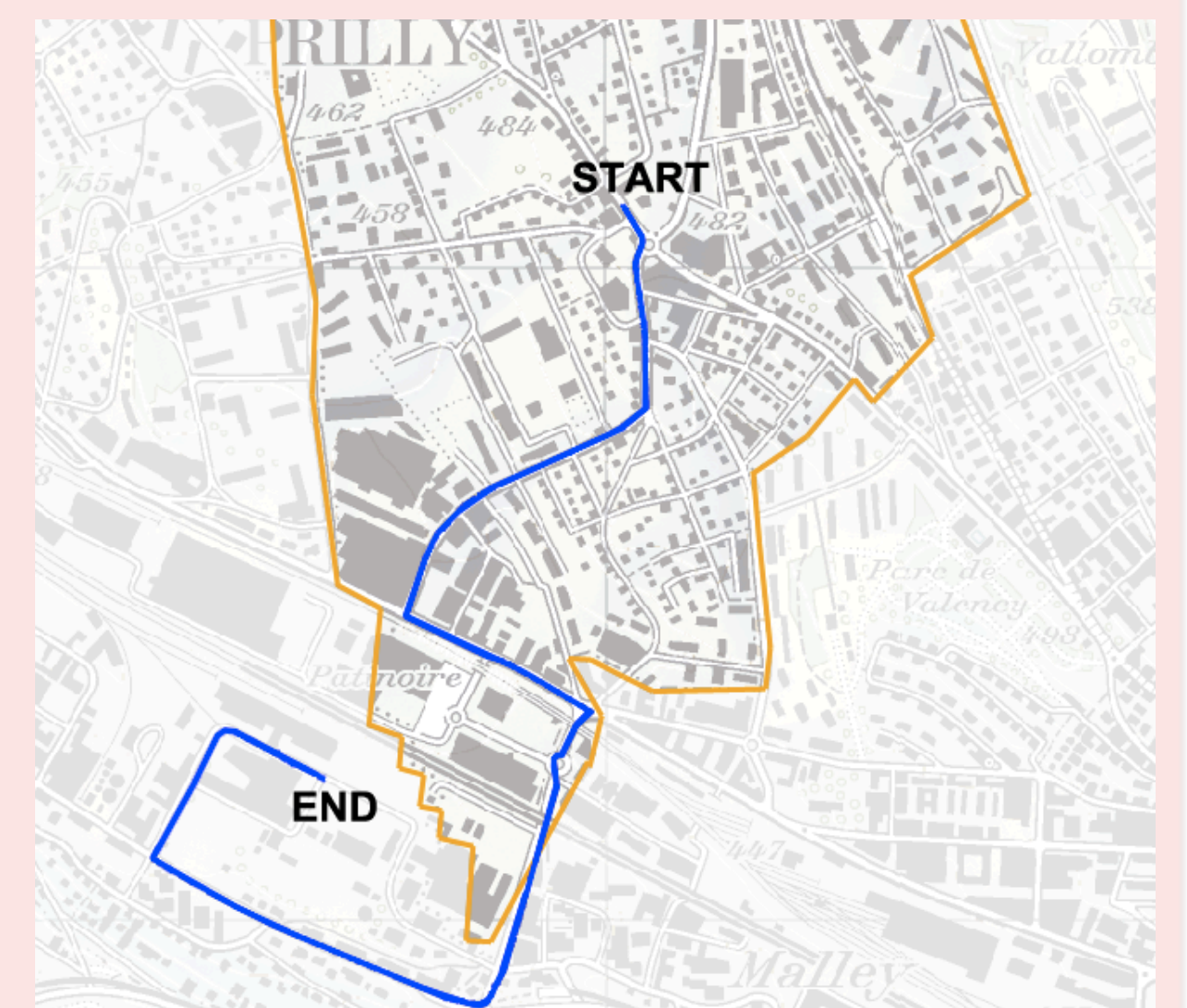
In this scenario all the collection systems are suppressed. Each household has to go to the waste disposal centre to empty its weekly waste. With the average weight of one sack of domestic waste, the number of sacks of per household and per week. It is assumed that people go to the waste sorting centre every two full sacks of domestic waste; all the same time they bring their paper. The trajectory of the trips was mapped, assuming the start at the centre of gravity of Prilly, and the end at the *Déchetterie Intercommunale de Malley*.
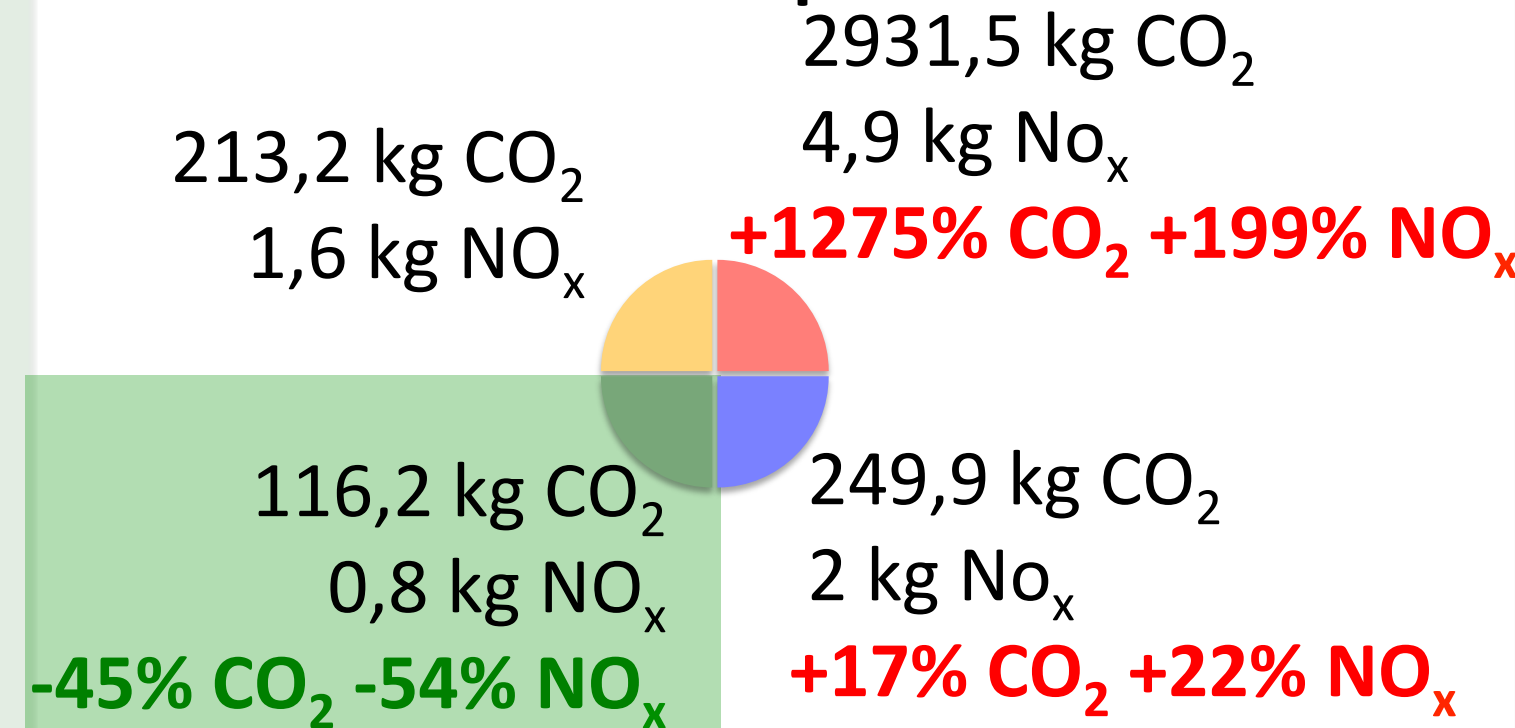
CO_2 emissions per week

NO_x emissions per week

(bar charts: Present situation, Only waste disposal centre, Only large collection points, Only door-to-door)

- Prilly's system of collection is not the worst of all the scenarios. There is even only one better case: the *Only large collection points scenario*. Indeed, this situation would reduce the system's emissions by 45% for CO_2 and by 54% for NO_x, significant differences.
- If Prilly wants to use only the door-to-door option of collection, its present emissions would be increased by 17% for CO_2 and 22% for NO_x.
- The most harmful to the environment is the system corresponding to the *Only waste sorting centre* scenario. There would be emitted 1275% more CO_2, and 199% more NO_x.

Total amount per week

213,2 kg CO_2
1,6 kg NO_x

2931,5 kg CO_2
4,9 kg NO_x
+1275% CO_2 +199% NO_x

116,2 kg CO_2
0,8 kg NO_x
-45% CO_2 -54% NO_x

249,9 kg CO_2
2 kg NO_x
+17% CO_2 +22% NO_x

Only large collection points

	Large collection points	
	Domestic waste	Paper
Frequency	3 times per week	Once a week
Collection time	~8h	~8h
Quantity of waste collected per year	2520t	600t
Necessity to empty the truck during the collection route	Yes, once	Yes, once
Kilometers travelled per tour	7,5	7,7
CO_2 emissions per week [kg]	84,554	31,606
NO_x emissions per week [kg]	0,543	0,215

In this scenario the door-to-door collections, for both paper and domestic waste, are totally suppressed. This means an increase of the amount of 5m³ containers. It is assumed that collection has to be done when the containers are 75% full. The results are: 39 containers for paper, with one collection per week, and 48 containers for domestic waste, with 3 collections per week. On the map of Prilly, the new collection points are placed not further than 150m from each household, covering the whole territory. The result is a total of 31 collection points. To calculate the emissions a new route has been created optimizing the tour.

Only door-to-door

	Door-to-door	
	Domestic waste	Paper
Frequency	3 times per week	Once a week
Collection time	3h30 North 4h South	8h
Quantity of waste collected per year	2300t	500t
Necessity to empty the truck during the collection route	Yes, 2 times	Yes, 2 times
Kilometers travelled per tour	17,5	17,5
CO_2 emissions per week [kg]	179,936	69,917
NO_x emissions per week [kg]	1,435	0,561
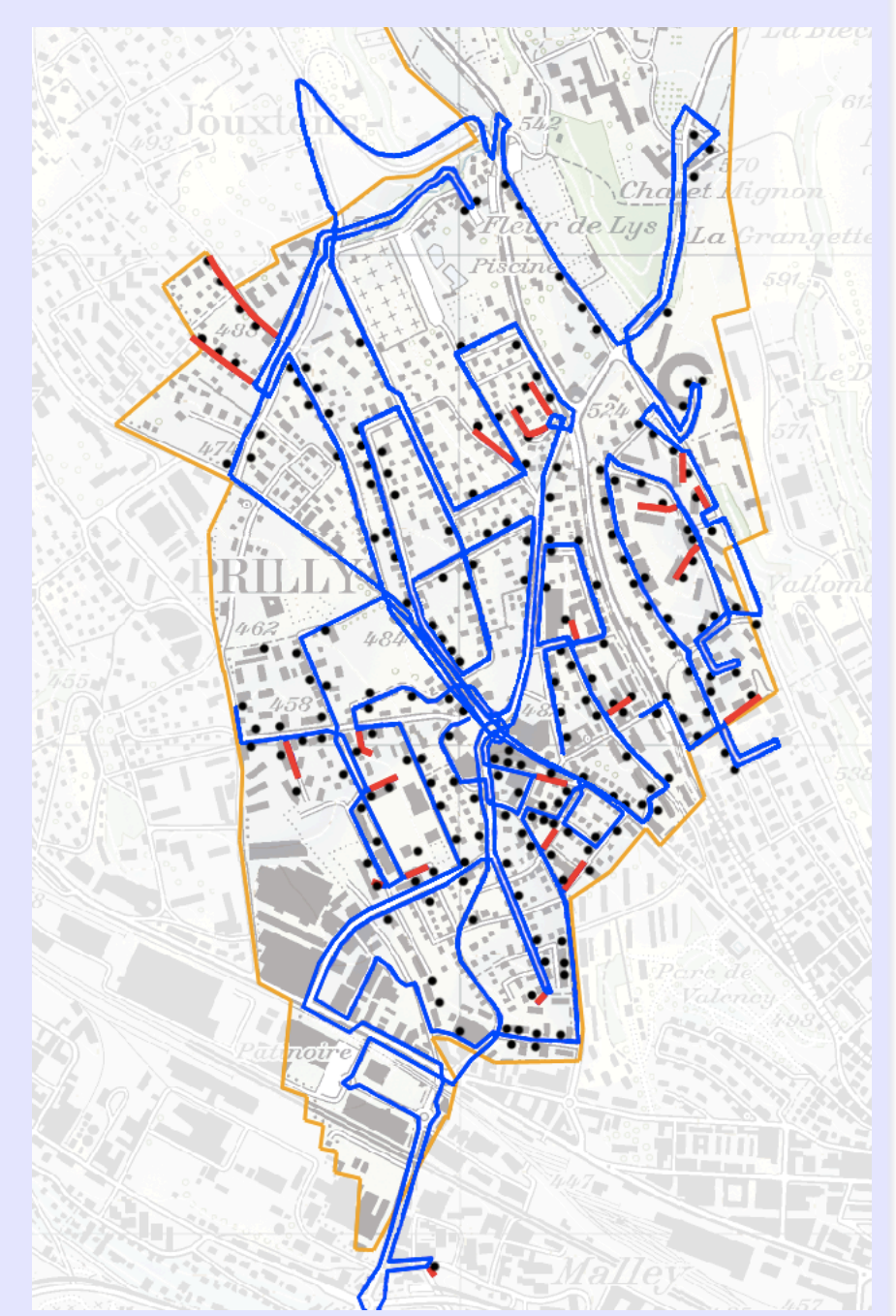
In this case, there is no large containers collection, for both paper and domestic waste. It is assumed that the same door-to-door route is kept but is increased the frequency of collections and the size of the rubbish bins is maximised. For this scenario it is considered that the collection has to be done when the containers are full. The new calculated frequency for paper is once a week and 2 times emptying during collection. On the other hand, for domestic waste and to avoid a high number of collections per week, it is necessary to change some rubbish bins to guarantee a capacity of 800L. With that condition, the frequency can be 3 times per week, emptying twice during each collection.

CONCLUSIONS

The best hypothetical waste collection system for Prilly, in terms of being less harmful to the environment is the case where the waste is only fetched in large collection points to which the inhabitants bring their waste. It is a reduction of 45% of CO_2 emissions, and 54% of NO_x emissions, compared to the actual collection system in Prilly. However, this is unfortunately not the system that the population would prefer according to the survey; it is way more comfortable to have one's waste sacks collected directly from home, than having to bring it to a collection point, even when it just means going 150m away. Nevertheless, since 73% of the population interrogated said they would not mind living with the latter option, we can reasonably say it is a good solution for Prilly. On the other hand, the proposition of *Only containers in collection points* proposition could have some limits:
- Are the new emplacements for the large collection points in the proposed optimised system really available? Will the change cost so much that the project might be rejected?
- What if people start going to these points by car, emitting CO2 and NOx and maybe offsetting significantly the benefits of the proposed system?
- If this suggested system is realistically applicable, since disabled and old people sounded terrified by the simple idea of this new system during the inquiry, how will they deal with it?