GHG EMISSION REDUCTION METHODOLOGIES and GOOD PRACTICES

Cities involved in LAKS project collected some relevant policies/actions they proposed in their mitigation and adaptation plans (MAP) to reduce GHG emissions. The good practices should serve as an example and possible inspiration for other local authorities – inside and outside the project - to replicate. The information on them were collected using a template in which each city should describe:

- title of action as reported in MAP
- area/s of intervention as reported in MAP
- responsible and contact persons details, in order to allow future exchanging of information
- description of the policies/actions implemented and their objectives
- methodology used to calculate and/or estimate the emission reduction
- indicators used
- lessons learned

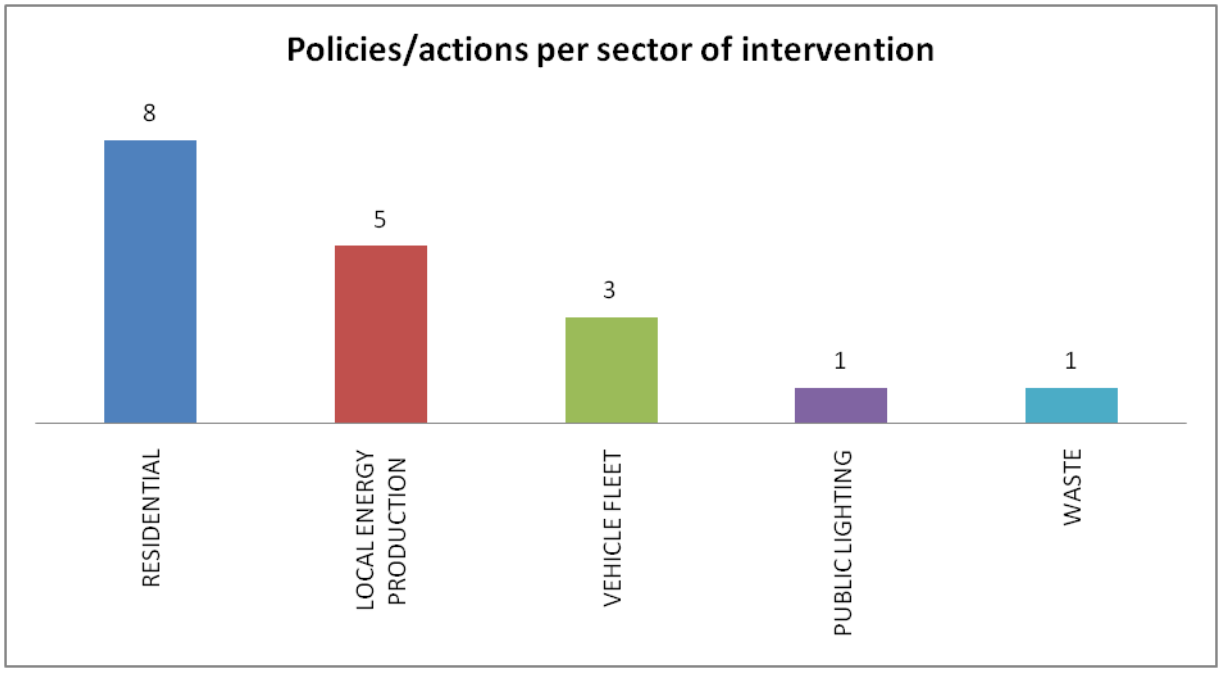
The opportunity is to give advice that can be usefully applied on future projects by the cities involved in LAKS project and other local authorities interested in implementing the LAKS process in their cities.

The template was distributed to the LAKS cities and 18 forms were collected. The results are showed in the table below, summarized per sector, description and type of action.

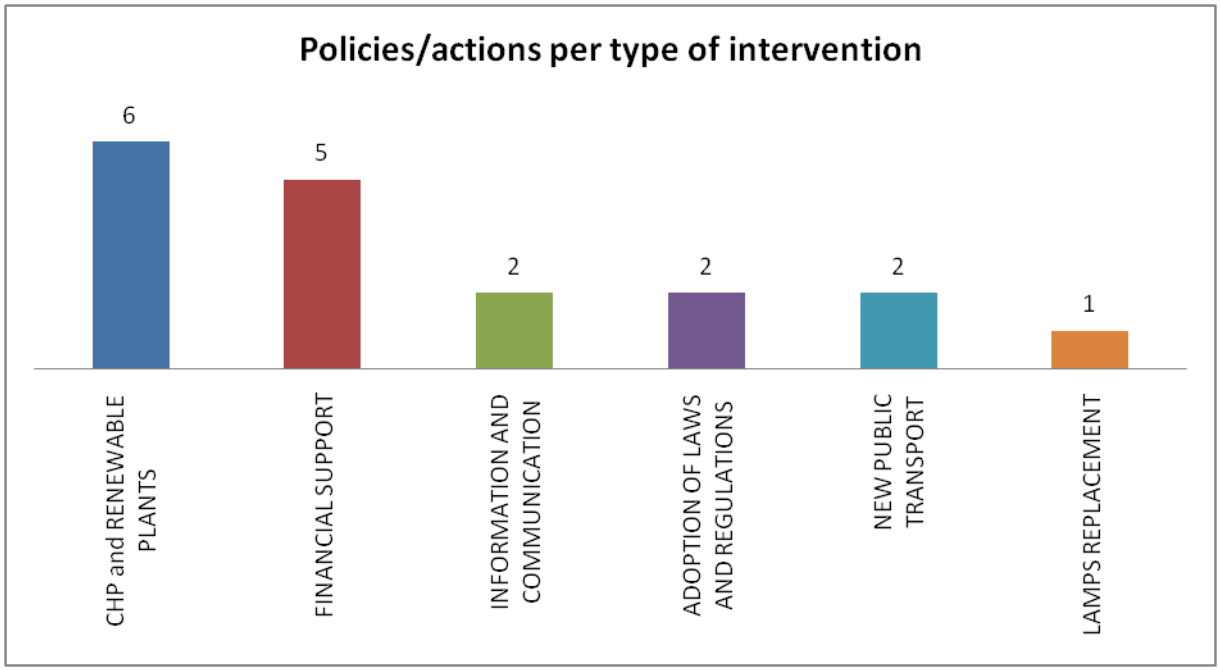
SECTOR	DESCRIPTION OF POLICY/ACTION	TYPE
LOCAL ENERGY PRODUCTION	Construction of small photovoltaic power stations with power <20 kW	CHP and RENEWABLE PLANTS
LOCAL ENERGY PRODUCTION	Building of PV plants (total 5 MW) on roof and lands owned by the Municipality	CHP and RENEWABLE PLANTS
LOCAL ENERGY PRODUCTION	Building of PV plants (total 5 MW) on roof and lands owned by private sector (industry, agriculture, residential and tertiary sectors)	CHP and RENEWABLE PLANTS
LOCAL ENERGY PRODUCTION	Adoption of microturbines and CHP in industry	CHP and RENEWABLE PLANTS
LOCAL ENERGY PRODUCTION	Adoption of CHP in civil sector	CHP and RENEWABLE PLANTS
PUBLIC LIGHTING	Replacement of mercury lamps with high pressure sodium lamps in public lighting	LAMPS REPLACEMENT
RESIDENTIAL	Gas boilers – financial support for investments	FINANCIAL SUPPORT
RESIDENTIAL	Financial support of the energy saving equipment purchase	FINANCIAL SUPPORT
RESIDENTIAL	Support mechanisms for citizens through the financing of solar collectors for heating domestic hot water.	FINANCIAL SUPPORT
RESIDENTIAL	Retort boilers – financial support for investments	FINANCIAL SUPPORT
RESIDENTIAL	Elaboration of existing mechanisms of supporting housing sector through the residential thermal modernization works financing	FINANCIAL SUPPORT

SECTOR	DESCRIPTION OF POLICY/ACTION	TYPE
RESIDENTIAL	Support to the private initiatives on buildings for energy efficiency	INFORMATION AND COMMUNICATION
RESIDENTIAL	Adoption of voluntary energy efficiency protocol Ecoabita by households subjected to important refurbishment and new constructions	ADOPTION OF LAWS AND REGULATIONS
RESIDENTIAL	Adoption of mandatory national and regional laws on energy savings in the civil sector	ADOPTION OF LAWS AND REGULATIONS
VEHICLE FLEET	Introduction of eco-driving as part of trainings for public transport drivers and local government within their own duties	INFORMATION AND COMMUNICATION
VEHICLE FLEET	Implementation of the Transport Programme - Replacement of buses	NEW PUBLIC TRANSPORT
VEHICLE FLEET	City Metrotram line	NEW PUBLIC TRANSPORT
WASTE	Construction of a waste incineration plant	CHP and RENEWABLE PLANTS

As we can see from the chart below, the main sector of intervention is the residential sector, with 8 actions described, followed by the local energy production and vehicle fleet (with 5 and 3 actions repectively).



As for the type of intervention, the development of CHP (Combined Heat and Power) and renewable plants (mainly photovoltaics) is the most suggested with 6 actions. Also financial support for improvement of energy efficiency action has a relevant weight in the overall context.



Based on the 18 policies/actions suggested, these guidelines report 8 of them which were chosen for their relevance, taking into account both the sector they address and the type of the intervention:

- Construction of small photovoltaic power stations with power <20 kW
- Adoption of microturbines and CHP in industry
- Replacement of mercury lamps with high pressure sodium lamps in public lighting
- Elaboration of existing mechanisms of supporting housing sector through the residential thermal modernization works financing
- Support to the private initiatives on buildings for energy efficiency
- Adoption of voluntary energy efficiency protocol Ecoabita by households subjected to important refurbishment and new constructions
- Introduction of eco-driving as part of trainings for public transport drivers and local government within their own duties
- City Metrotram line

The template for the chosen policies/actions are reported in the next pages.

MUNICIPALITY	*Bydgoszcz*

DESCRIPTION of POLICY/ACTION	
TITLE of POLICY/ACTION	*B 1.3.3 Construction of small photovoltaic power stations with power <20 kW*
AREA/S of INTERVENTION	*LOCAL ENERGY PRODUCTION*
RESPONSIBLE and CONTACT DETAILS	*Municipality of Bydgoszcz, Poland* *Ms. Katarzyna Napierala* *Mr Grzegorz Boroń* *E-mail: k.napierala@um.bydgoszcz.pl* *gboron@um.bydgoszcz.pl* *Web: http://www.um.bydgoszcz.pl*
DESCRIPTION	*Construction of small photovoltaic power stations with power <20 kW*

METHODOLOGY

Assumption data:
Number of facilities: 1000
Number of panels: 3 per 100m^2
Panel area: 2m^2,
Energy production per unit: 126-325kwh/m^2/year
Total area:
P=2x3x1000=6 000m^2

Electric energy from collectors:
E=(6000x175)/1000=1 050MWh

Ef=1050x0.982=1 031 $MgCO_2$
Where $0{,}982\ \frac{MgCO_2}{MWh}$ – is the index of electric energy network consumption

DATA	UNIT	NOTES
Number of panels	-	
Panel area	m^2	
Energy production per unit	kWh/m^2/year	126-325 kWh/m^2/year

LESSONS LEARNED

MUNICIPALITY	*Reggio Emilia*

DESCRIPTION of POLICY/ACTION	
TITLE of POLICY/ACTION	*Sviluppo della micro-cogenerazione nel settore industriale*
AREA/S of INTERVENTION	*Produzione di energie rinnovabili e generazione distribuita di energia*
RESPONSIBLE and CONTACT DETAILS	*Lorena Belli – Dirigente servizio edilizia* *Lorena.Belli@municipio.re.it*
DESCRIPTION	*Creazione di impianti di micro-cogenerazione nel settore industriale nei prossimi 3 anni*

METHODOLOGY

List of data needed to calculate co2 reduction

DATA	UNIT	NOTES
assumptions made		Adoption of microturbines and CHP in industry
data source used		expected production coherently with LIFE LAKS and PEC procedures
result indicators (CO2 saved)		indicators: CO2 saved, Mwh_p saved
methodology		specific energy balance + emissions computation – please see Municipality Energy Plan 2010
results	[tons CO2 saved]	2.500 tons CO2/year increasing yearly period 2009-2020
results	[Mwh_p saved]	4.150 Mwh_p saved / year increasing yearly period 2009-2020

LESSONS LEARNED

MUNICIPALITY	*Bydgoszcz*

DESCRIPTION of POLICY/ACTION	
TITLE of POLICY/ACTION	*A4.1.2 Replacement of mercury lamps with high pressure sodium lamps in public lighting*
AREA/S of INTERVENTION	*PUBLIC LIGHTING*
RESPONSIBLE and CONTACT DETAILS	*Zarząd Dróg Miejskich i Komunikacji Publicznej (Administration of City Roads and Public Communication)*
DESCRIPTION	*A4.1.2 Replacement of mercury lamps with high pressure sodium lamps in public lighting (along the transportation routes).*

METHODOLOGY

Before:

Assumption data:
Number of lamp posts: 25 168
average power:217 W
Operation time: 3600h/year
Number of replaced lamps:
2 073 440 units

Power installed before replacement:

Me=(217x2073440x3600)/1 000 000=
16 197 [MWh]

After:

Assumption data:
Number of lamp posts: 25 168
Average power:100W
Operation time: 3600h/year
Number of replaced lamps:
2 073 440 items.

Power installed after replacement:
Me=(100x2073440x3600)/1 000 000=
7 464[MWh]

Energy saving:
Me=16 197- 7 464=8733 MWh

CO_2 emission reduction
E_f =8733x0.982 =8576 MgCO_2

where
E_f: 0.982Mg CO_2/MWh – is the index of the consumption of electric energy network

Data sources:
KASHUE ETS DATA FOR 2005, [POLAND, NIR2010], (GUS) CENTRAL STATISTICAL OFFICE, PHILIPS LIGHTING-AUTUMN 2010

DATA	UNIT	NOTES
Number of lamp posts	-	
Average power	W	
Operation time	h/year	
Number of replaced lamps	-	

LESSONS LEARNED
Power consumption saved up to 40% due to simple reduction interventions. Currently there is a possibility of replacing the old lamps with both energy saving compact fluorescent lamps and LEDs (2-9 W) – as far as the costs are concerned, the suggestion is to replace old lamps with regular compact fluorescent lamps (CFL).

MUNICIPALITY	*Bydgoszcz*

DESCRIPTION of POLICY/ACTION	
TITLE of POLICY/ACTION	*Elaboration of existing mechanisms of supporting housing sector through the residential thermal modernization works financing (B.10.2).*
AREA/S of INTERVENTION	*RESIDENTIAL*
RESPONSIBLE and CONTACT DETAILS	*Municipality of Bydgoszcz, Poland* *Ms. Katarzyna Napierala* *Mr Grzegorz Boroń* *E-mail: k.napierala@um.bydgoszcz.pl* *gboron@um.bydgoszcz.pl* *Web: http://www.um.bydgoszcz.pl*
DESCRIPTION	*Implementation of measures contained in the detailed implementation plan of Air Protection Programme (POP) for the agglomeration of Bydgoszcz (December 2008): Removal of coal-fueled boilers, connections to the district heating systems, replacement of old coal-fueled boilers with : gas, retort, biomass, oil and electrically heated ones (accumulation).* *Calculation example - retort boilers, number of investments: 99.*

METHODOLOGY

To determine the energy savings achieved, the indicators used are: EF = 0.338-corresponding to the thermal energy and Ef = 0.982 corresponding to electricity (when using retort boilers replacement of thermal energy) .

Before:

Assumption data:
Numer of apartments:135 893
Area of apartments: 7 739 927[m^2]
Average energy demand: 18 [GJ/resident]]
Average area of an apartament in the city: [57 m^2/apartment]
Energy demand per apartment- 48 GJ/apartment

Emission indicators
Base emission indicator:
Apartment 94 000 [g/GJ]
Assumption data: 23 % apartments will be subjected to thermal modernization works:31 844 items.

Example of final calculations - base emission before the thermal modernization works E_{CO2}=(31 844x94 000x48.6)/1000 =
140 088 124 [kg/year]= 140 088[Mg/year],

Where: 31 844 - number of insulated apartments

After:

Emission indicators
emission indicator after thermal modernization works:
47 218,605 gCO_2/m^2/year]
Assumption data:
23 % apartments have been subjected to thermal modernization works
:31 844 items

Example of final calculations - emission after the thermal modernization works:

$$E_{CO2} = \frac{(31\,844 \times 47\,218{,}6 \times 48{,}6)}{1\,000} =$$

$= 84\,052\,875 \frac{kg}{rok} = 84\,052 \frac{Mg}{rok}$

Ecological effect:

$\boldsymbol{E_{CO2} = 140\,088 - 84\,052 =}$**56 037**

DATA	UNIT	NOTES
Area of apartments	m^2	
Energy demand per apartment	GJ/apartment	
Number of insulated apartments	-	

LESSONS LEARNED

Reduction of CO2 emission can be achieved by reducing the demand for heat by thermal modernization works performed in housing sector. According to the publication entitled "Improving the efficiency of residential heating use as part of the implementation of the sustainable development principles" through the use of thermal insulation, new windows, doors, heat demand of the building (premises, offices) will decrease by about 30-40%.

MUNICIPALITY	*Comune di Padova*

COMUNE di PADOVA
SETTORE AMBIENTE

DESCRIPTION of POLICY/ACTION	
TITLE of POLICY/ACTION	17. Support to the private initiatives on buildings for energy efficiency
AREA/S of INTERVENTION	A greener and more efficient city
RESPONSIBLE and CONTACT DETAILS	Comune di Padova – Environment Dept.
DESCRIPTION	The Comune commits to support and promote all the initiatives that concur to reduce energy consumption of private buildings, in particular through: ▪ the modification of the city's building Regulation in order to provide stricter energetic criteria for new buildings starting from 2015; ▪ information on potential future fiscal opportunities offered by different institutional levels; ▪ sensitisation on a more aware use of domestic energy; ▪ promotion of good examples benchmarking

METHODOLOGY

List of data needed to calculate CO2 reduction

The National Agency for new technologies, energy and the sustainable economic development (ENEA), in its 2007 repost, gives statistics at regional level about savings of Mwh through works on energy efficiency in private buildings thanks to the 55% discount on Income Taxes of the costs payed to improve the energetic quality of private buildings.
In Veneto Region energy savings according the the 55% initiative on Income Taxes adds up to 115.795 Mwh.
With a Top-Down proportion between the houses of our Region and the houses of our municipality we can assess the Mwh saved in our community thanks to the action, that is 3.364,99 Mwh.
According to the Emission Factor given by ENEA (0,21 tonCO2/MWh), with the simple multiplicaiton 0,21X3.364,99 we can asses the CO2 reductions of this 2007 measure, that are 701,4 tonsCO2.
ENEA has as well provided 2008 figures: according to the the comune di Padova reduced its CO2 emission by 1.662 tonnes. The 2008 data have been used to asses the annual reductions of emissions up to 2020.
Therefore the reductions assessed for the period 2005-2020 are 22.307,72 tonnes of CO2

DATA	UNIT	NOTES
n. of authorisations in the region to install solat thermal panels on private roofs	n.	
n. of buildings in the municipality, and in the Region	n.	
Savings of MWh with the installations on the Region	MWh	
Emission Factor	tCO2/MWh	

LESSONS LEARNED

MUNICIPALITY	*Reggio Emilia*

DESCRIPTION of POLICY/ACTION	
TITLE of POLICY/ACTION	*Progetto Ecoabita*
AREA/S of INTERVENTION	*Settore residenziale*
RESPONSIBLE and CONTACT DETAILS	*Lorena Belli – Dirigente servizio edilizia* *Lorena.Belli@municipio.re.it*
DESCRIPTION	*progetto per l'adozione su base volontaria della certificazione Ecoabita da parte dei cittadini nella costruzione di nuovi edifici privati, con l'obiettivo di raggiungere una diminuzione del 25% di emissioni di gas serra da parte dei nuovi edifici privati*

METHODOLOGY

List of data needed to calculate co2 reduction

DATA	UNIT	NOTES
assumptions made		Adoption of voluntary protocol Ecoabita by a number of households yearly subjected to important refurbishment and new constructions
data source used		expected benefits coherently with LIFE LAKS and PEC procedures
result indicators (CO2 saved)		indicators: CO2 saved, MWh_p saved
methodology		specific energy balance + emissions computation – please see Municipality Energy Plan 2010
results	[tons CO2 saved]	250 tons CO2/year increasing yearly period 2009-2020
results	[MWh_p saved]	1.400 Mwh_p saved increasing yearly period 2009-2020

LESSONS LEARNED

MUNICIPALITY	*Bydgoszcz*

DESCRIPTION of POLICY/ACTION	
TITLE of POLICY/ACTION	*A3.1.8 Introduction of eco-driving as part of trainings for public transport drivers and local government within their own duties*
AREA/S of INTERVENTION	*VEHICLE FLEET*
RESPONSIBLE and CONTACT DETAILS	*Department of Municipal Utilities and Environmental Protection , Energy Management Unite (in future), Zarząd Dróg Miejskich i Komunikacji Publicznej (Administration of City Roads and Public Communication), All organizational units mentioned in LAKS*
DESCRIPTION	*Training in Eco-driving provided to MZK employees as well as municipal staff – training, Support and promotion of sustainable transport amongst workers, e.g. carpooling, free public transportation schemes for municipality staff - training provided to 1 200 people.*

METHODOLOGY

Calculations based upon the planned results of trainings on eco-driving rules

Assumption data:
Number of vehicles:659
Number of km covered: 24 212 156
Average petrol saving 1.4l/100km
Number of drivers: 2 people per vehicle
Average distance covered by drivers:18 370 km
Number of trainees: 1200

Saving of fuel consumption per person

$$Z_1 = \frac{1{,}4 \times 1\,837}{100} = 257{,}18 \frac{l}{osoba}$$

Saving of fuel consumption after trainings for 1200 ppl:

$$Z_{1200} = 257{,}18 \times 1\,200 = 308\,616\ l$$

Energy saving:

$$E = \frac{308\,616}{1\,000} \times 0{,}8 = 246{,}89\ m^3$$

$$E = \left(\frac{246{,}89 \times 750 \times 44{,}8}{1\,000}\right) = 8{,}29\ TJ$$

Ecological effect

$$\boldsymbol{E_f = 8{,}29 \times 71{,}389 = 592{,}2\ MgCO_2}$$

$$\boldsymbol{E_e = \frac{592{,}2}{0{,}257} = 2\,304\ MWh}$$

where:
$0{,}257 \frac{MgCO_2}{MWh}$ – is the petrol index

Data sources: KASHUE ETS DATA FOR 2005,[POLAND, NIR2010], CENTRAL STATISTICAL OFFICE (GUS), CITY OF BYDGOSZCZ

DATA	UNIT	NOTES
Number of vehicles	-	
Number of km covered	km	
Number of trainees	-	
Average petrol saving per person	l/km	1.4l/100km
Average distance covered by drivers	km	18 370 km
Diesel oil calorific value	MJ/kg	44.8 MJ/kg
Diesel oil CO_2 emission factor	kg/GJ	71.38kg/GJ
Diesel oil Density	kg/m^3	750 kg/m^3

LESSONS LEARNED
Calculations based upon the planned results of trainings on eco-driving rules

MUNICIPALITY	*Comune di Padova*

COMUNE di PADOVA
SETTORE AMBIENTE

DESCRIPTION of POLICY/ACTION	
TITLE of POLICY/ACTION	XI. We completed the first City Metrotram line (SIR 1) that covers the north-south axis (from Pontevigodarzere district to Guizza district).
AREA/S of INTERVENTION	A CITY THAT MOVES BETTER
RESPONSIBLE and CONTACT DETAILS	Councillor for Mobility – Mr. Ivo Rossi Traffic and Mobility Dept. Director – Mr. Daniele Agostini
DESCRIPTION	Fulfillment of the first Tram line SIR 1, for a total lenght of 10.3 km

METHODOLOGY

The Sustainability Report on the SIR 1 (2009) made by the local mobility Utility APS Holding, gave the information we use in the following calculations.
The MetroTram south terminal - Railway Station, implemented in 2007 is 6,7 km long.
In 2008 the MetroTram was used by 3.742.552 passengers.

CAR EMISSIONS
The consumption expressed in tonnes of oil equivalent TOE/1000 car drivers in the route Guizza-Railway Station is 0,3. This consumption, multiplied for the conversion factor given by the Agenda 21 for Kyoto Methodology (3) gives the CO2 emissions of 1000 car drivers that cover the distance Guizza-Railway Station. This emission is 0,9 kg.

TRAM EMISSIONS
he consumption expressed in Toe/1000 tram passengers is 0,17. This consumption, multiplied for the conversion factor given by the Agenda 21 for Kyoto Methodology (2,65) gives the CO2 emissions of 1000 tram using passengers. This emission is 0,4505 kg.

CALCULATION OF EMISSIONS' REDUCTION
% Emissions' reduction in the comparison car/tram is 49%: the reduction of emission each tram passenger generates (if compared to a car user) is (900-423)/1000= 0,477 kg
The multiplication of 0,477 kg for the number of tram users of 2008 (3.742.552) – given the assumption all the tram passengers renounced the use of the car – gives the kg of reduced CO2 with the creation of the SIR1, that is 1.785.197 kilos (1.785,197 tonnes of CO2).
If a proportion between the length of the SIR1 and the other future lines of Tram is done (SIR 1 2nd part, SIR 2, 3, 4...) - given a constant effect on passengers usage - it is possible to asses the CO2 emissions reduction generated by such an infrastructure.

List of data needed to calculate co2 reduction

DATA	UNIT	NOTES
Consumption of a car from the Guizza Tram Terminal to the Railway Station	TEP	
Emissions CO2/1000 car Passengers kg	Kg	
Consumption of the Tram from the Guizza Tram Terminal to the Railway Station	TEP/1000 Passengers	
Yearly N. of Metrotram Passengers	n.	
t CO2 / tep (Rif NIR Italy 2009)	tCO2	

LESSONS LEARNED