THE ROLE OF BUS TRANSPORTATION IN REDUCING GREENHOUSE GAS (GHG) EMISSIONS

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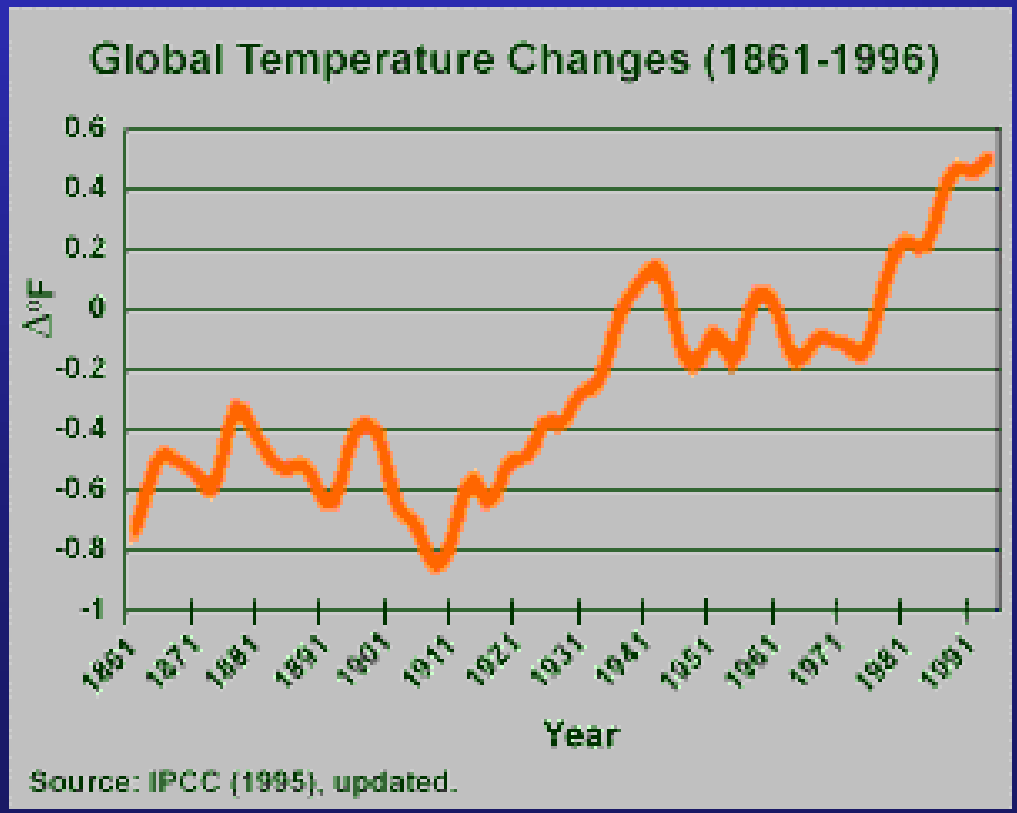
PRESENTATION OVERVIEW

- Introduction
- Research objective, scope and methodology
- GHG emissions associated with transportation in Canada
- Present situation in the National Capital Region
- Mode choice strategy for reducing GHG emissions
- Energy and emission estimation for proposed scenarios
- Conclusions and recommendations

INTRODUCTION

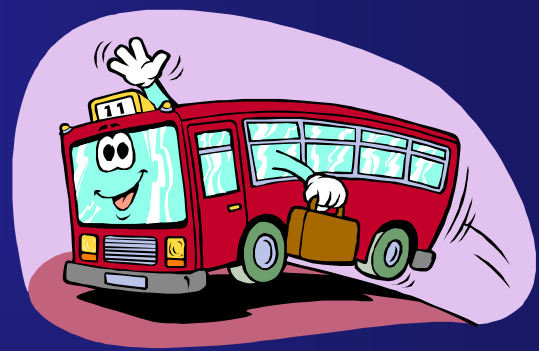
Each Canadian produced 20 tones of GHG emissions in 1995



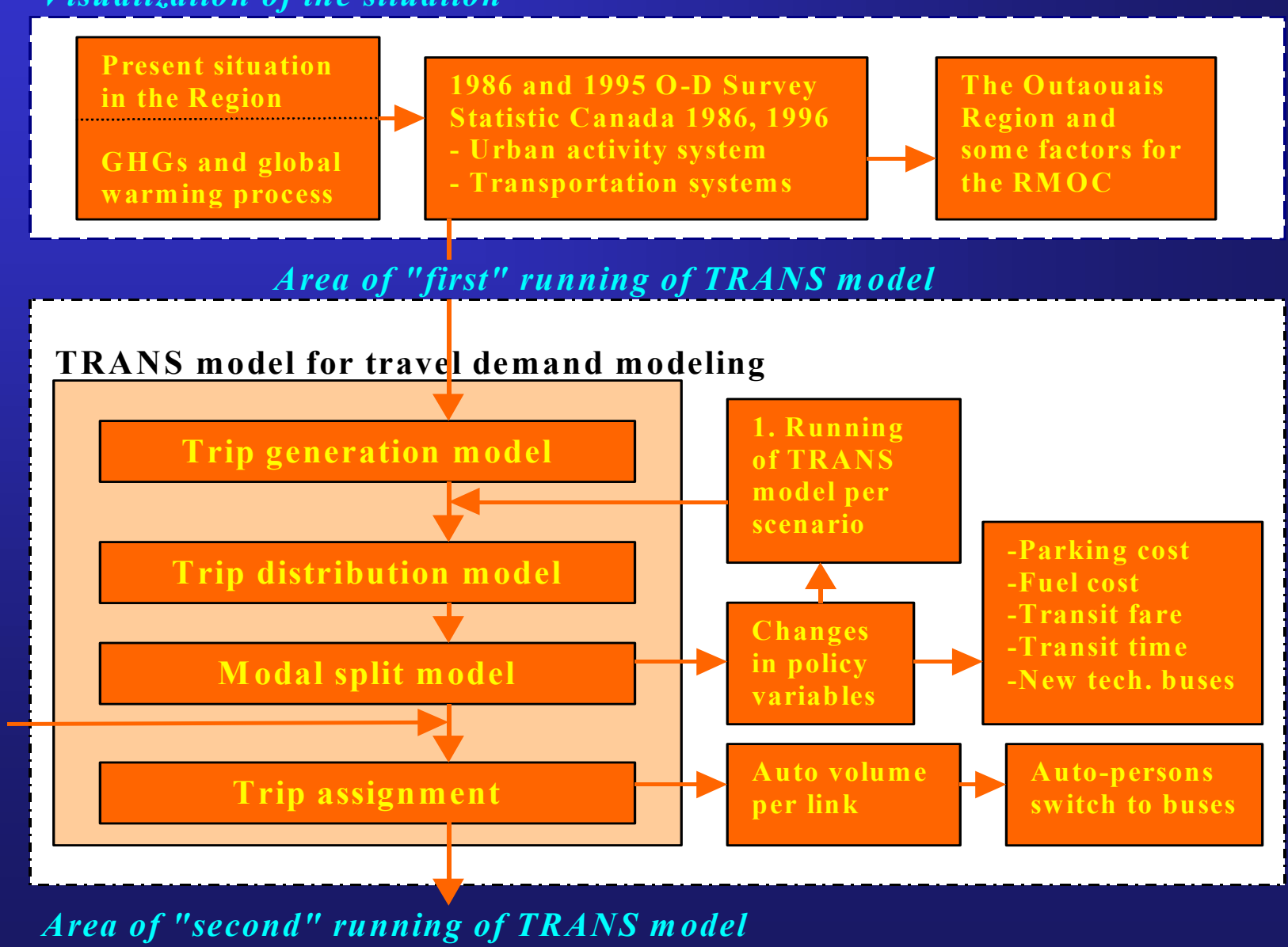
- Globally, the sea level has risen 4-10 inches
- Precipitation over land has increased by 1%
- Temperature could rise 1.6-6.3°F by 2100

RESEARCH OBJECTIVE AND SCOPE

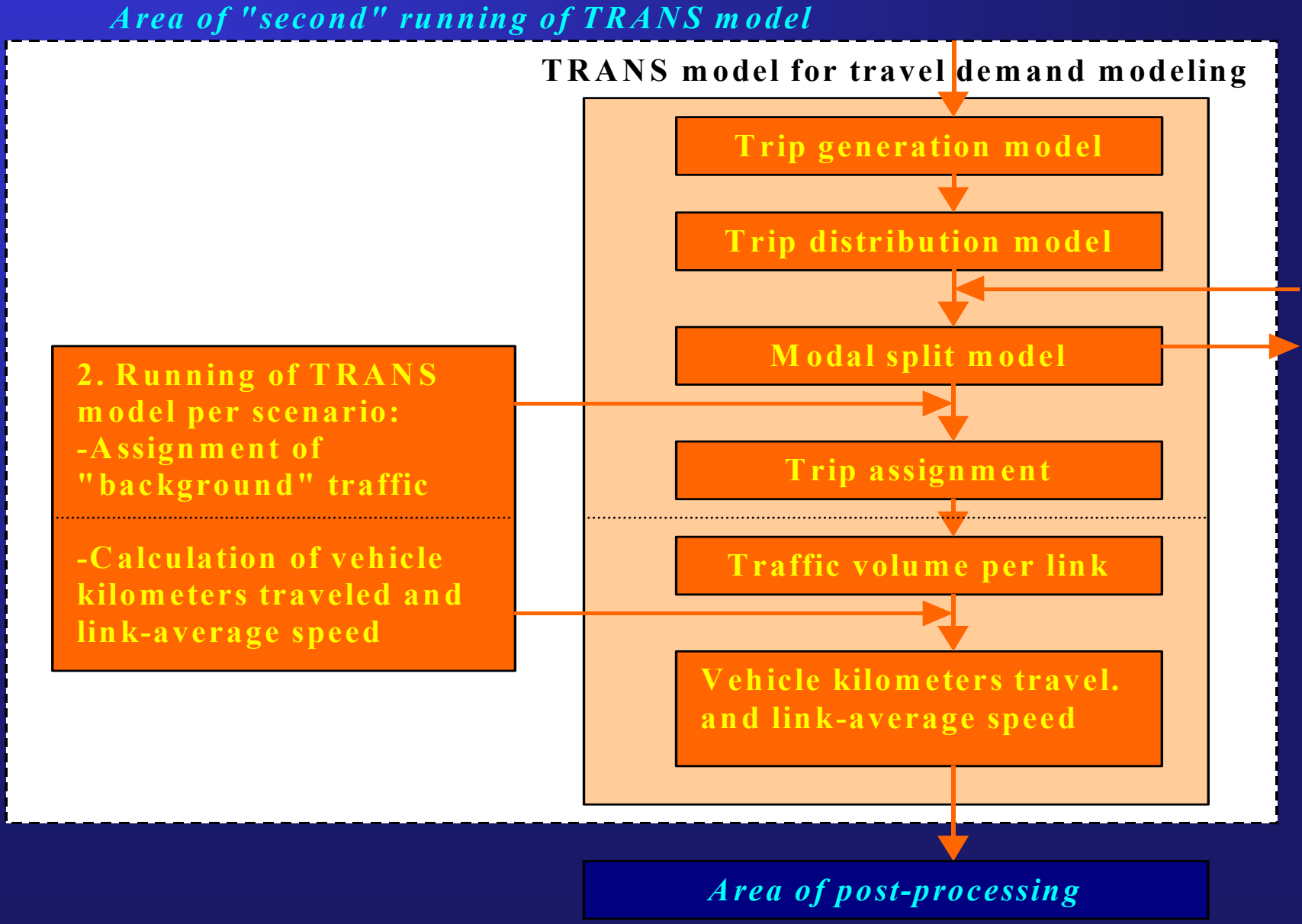
- **OBJECTIVE**
  - **To assess the role of bus transportation in reducing GHGs through the modal shift and new technology**
- **SCOPE**
  - **The NCR is used as case study**
  - **Diesel, hybrid and fuel cell buses**



RESEARCH METHODOLOGY (I)

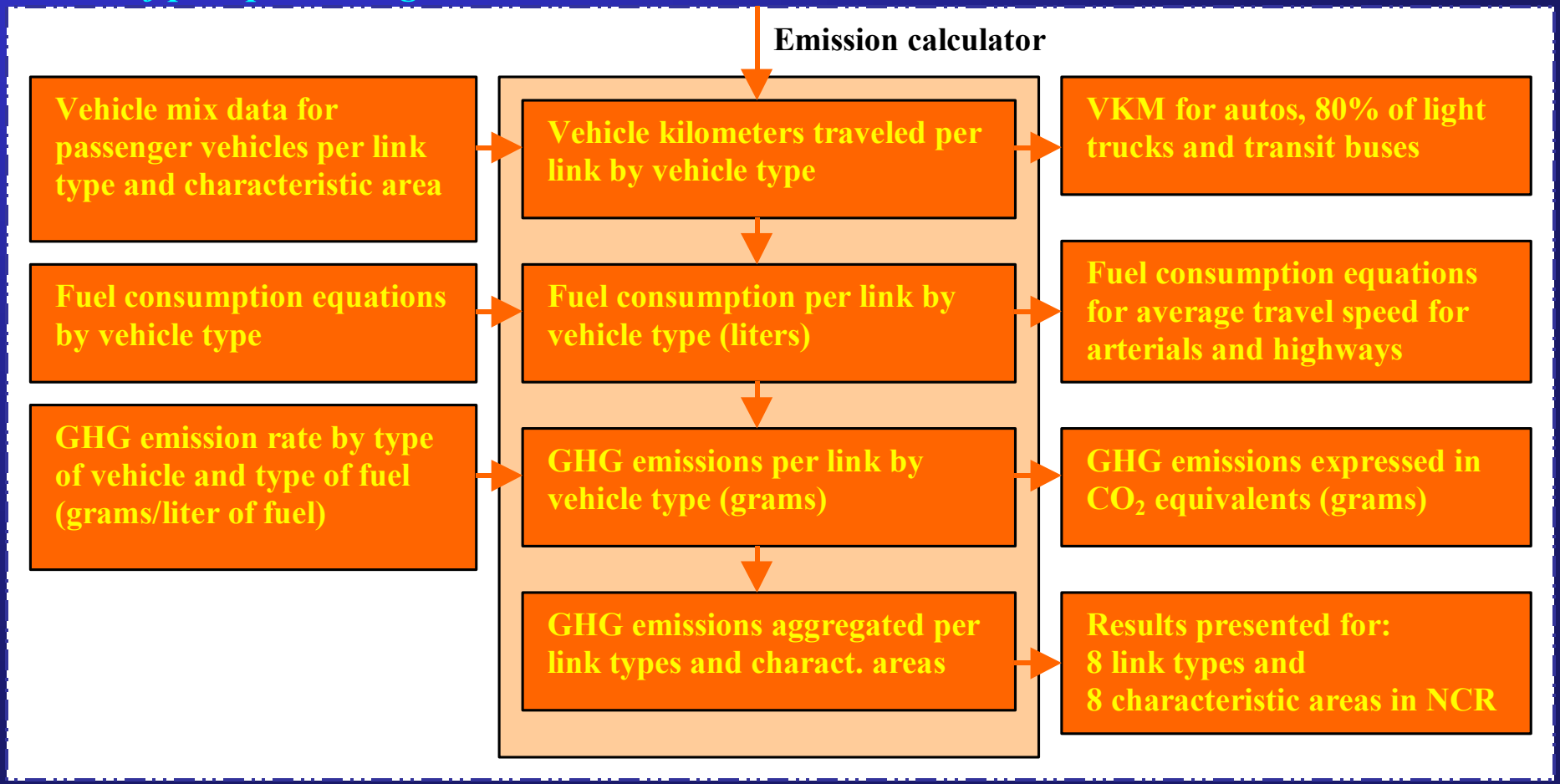


RESEARCH METHODOLOGY (II)



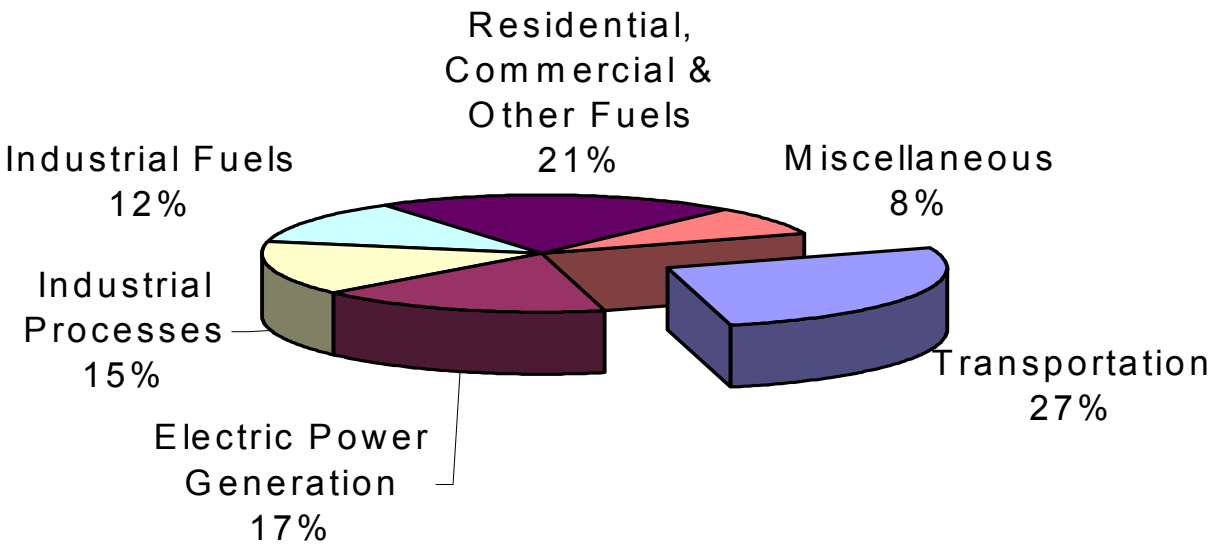
RESEARCH METHODOLOGY (III)

Area of post-processing



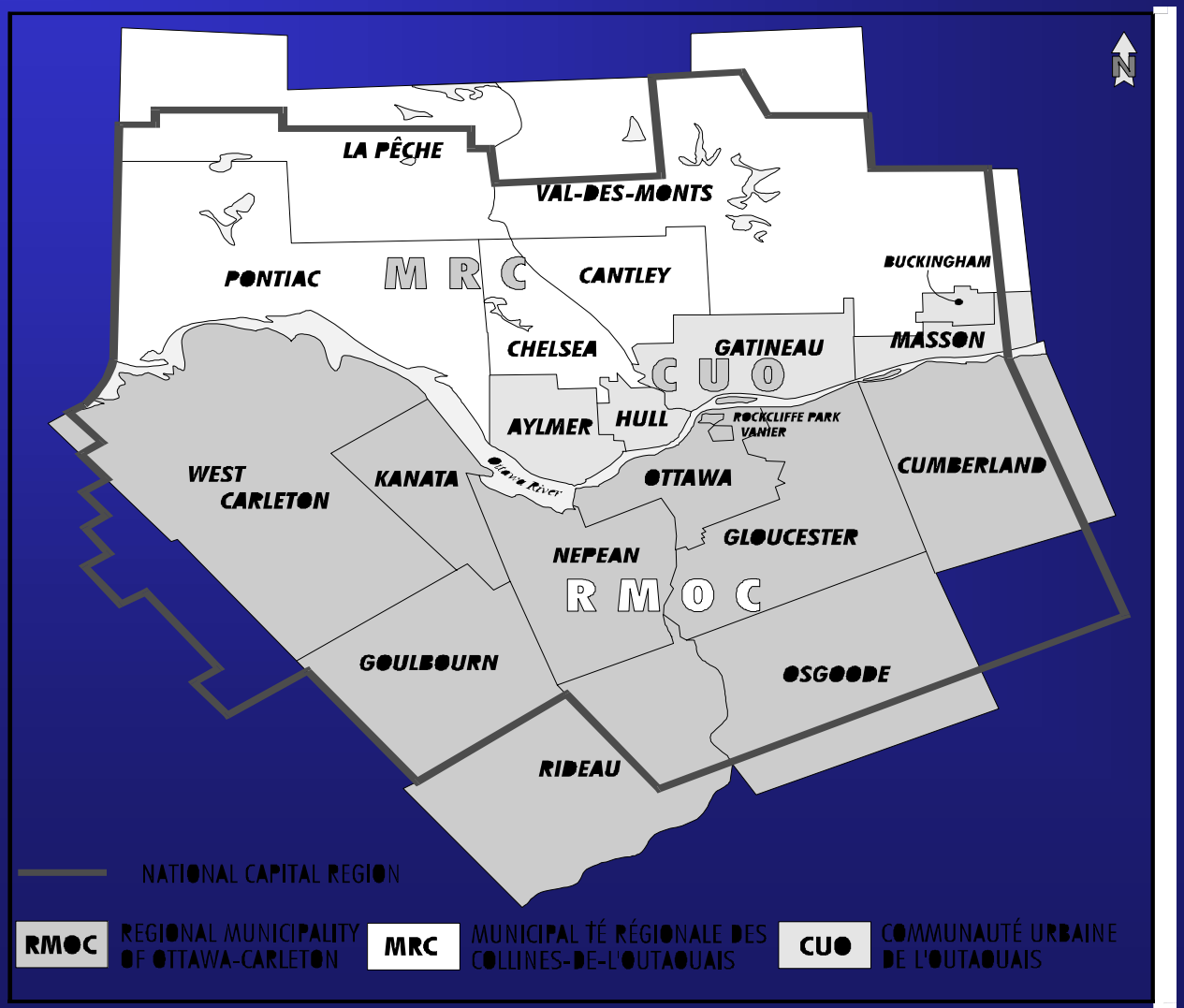
GHG EMISSIONS ASSOCIATED WITH TRANSPORTATION IN CANADA

GHG emissions in Canada per sector of activity



- **42% of transportation related GHGs comes from automobiles**

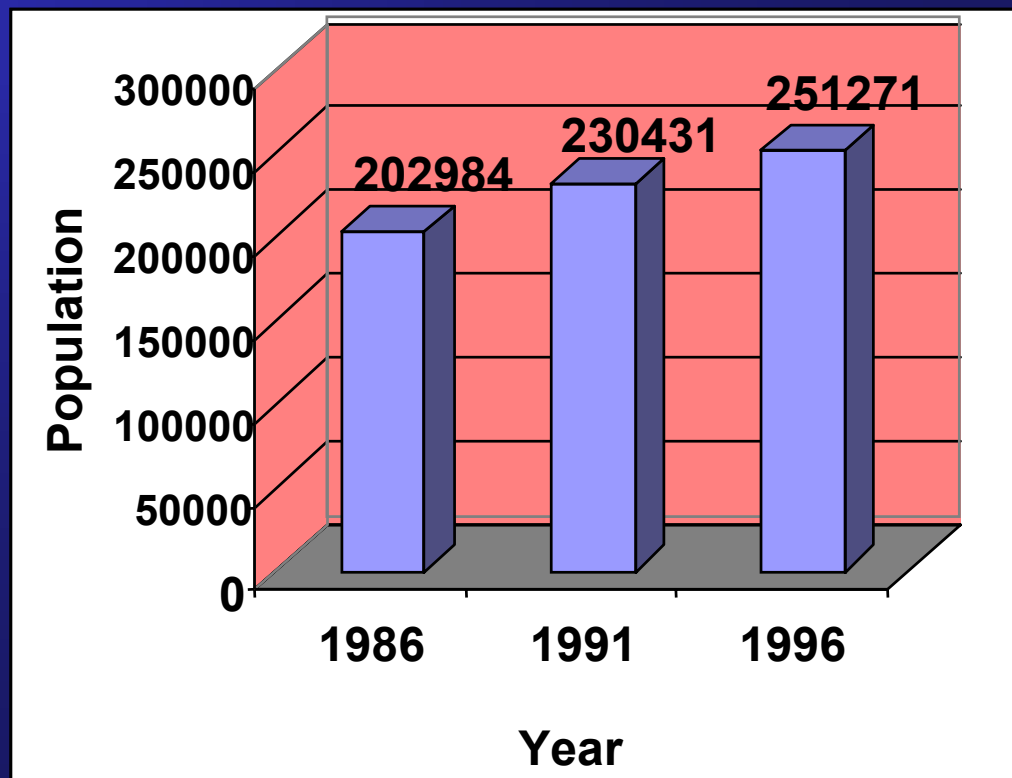
STUDY AREA: THE NATIONAL CAPITAL REGION



PRESENT SITUATION IN THE OUTAOUAIS REGION

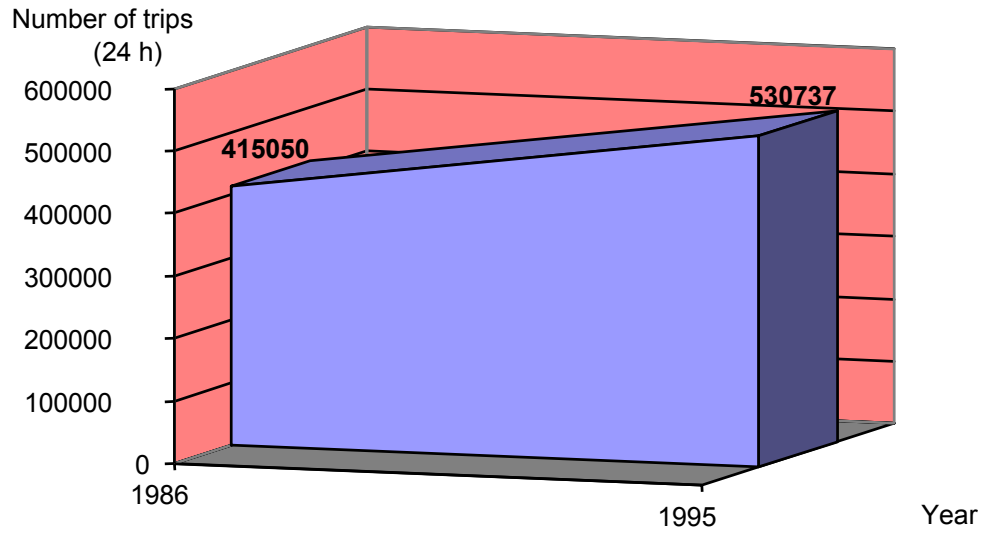
Population trends (1986-1996)

- Persons/h.h. (2.85-2.59)
- Number of households increased by about 35%
- Trips/per./day (2.14-2.35)
- Inc./h.h. ($35122-$48324)
- Vehicles/h.h. (1.29-1.30)

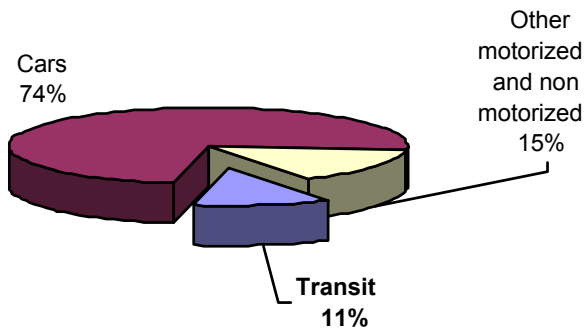


Trips originated in the Outaouais Region during the 1986-1995 (24 hours)

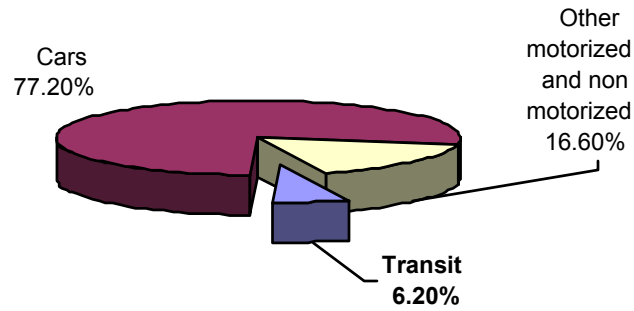
Transit participation decreased from 11% to 6.2%



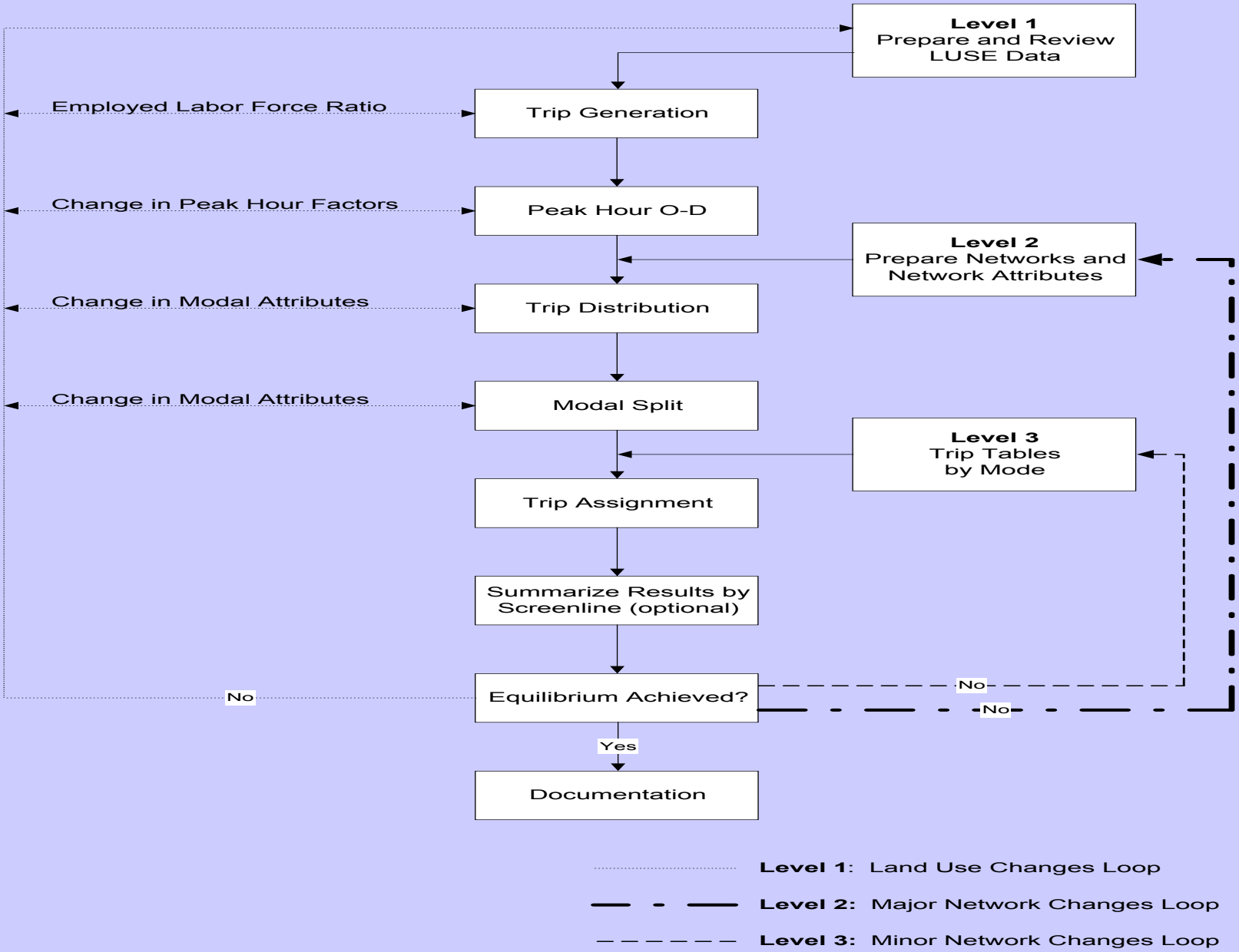
Transit and car participation in 1986



Transit and car participation in 1995



TRANS Model, EMME/2 Software



MODE CHOICE STRATEGY FOR REDUCING GHG EMISSIONS

Mode split model - h.b.w. trip logit model

Mode	Tra. cost	Tra. time	Veh./h.h.	Province	Constant
Auto pers.	-0.8641	-0.0096			
	(-27.9)	(-2.14)			
Transit	*-0.8641	-0.0096	-1.738	-0.8367	0.9091
	**(-27.9)	(-2.14)	(-15.6)	(-5.64)	(-5.41)

- Travel cost for auto increased (parking and fuel cost)
- Transit fare decreased by 10%
- Transit travel time decreased by 10% and 50%
- New technology buses (hybrid and fuel cell buses)

ENERGY AND EMISSION ESTIMATION

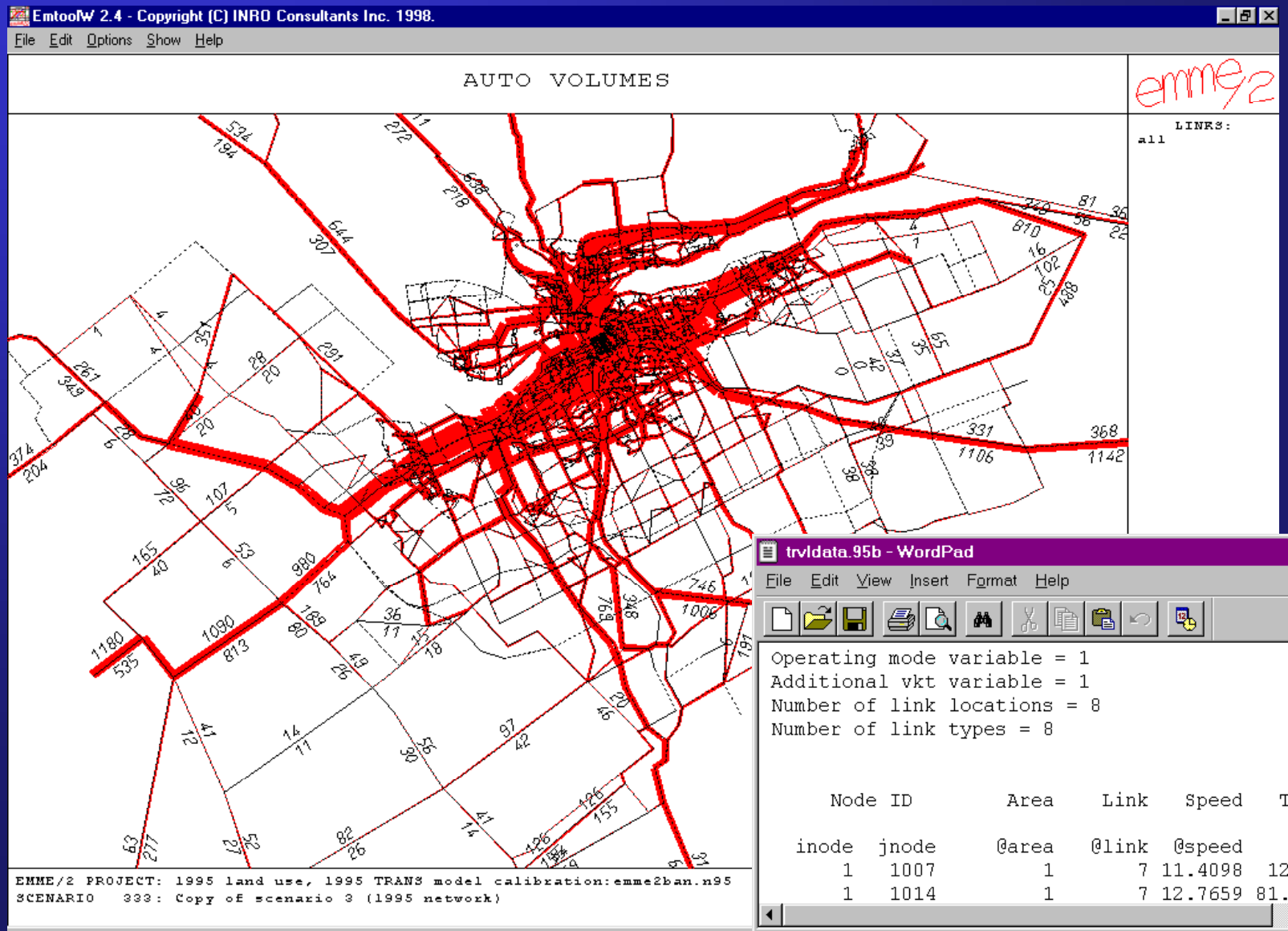
Link by link analysis (1995-2021)

1 EMME/2 MODELING => auto volume (cars)
EMME/2 MACROS => link average speed, vkm

2 EMISSION CALCULATOR => fuel consumption and GHG emission estimation

ENERGY AND EMISSION ESTIMATION

Auto volume-1995 => link average speed, vkm



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```
Operating mode variable = 1
Additional vkt variable = 1
Number of link locations = 8
Number of link types = 8

                                                        Vehicle Kilomete
     Node ID          Area     Link    Speed    Total    Start

  inode   jnode      @area    @link   @speed      ul1   @start   @e
      1    1007          1        7 11.4098   122.91   122.91   99
      1    1014          1        7 12.7659 81.6556 81.6554   99
```

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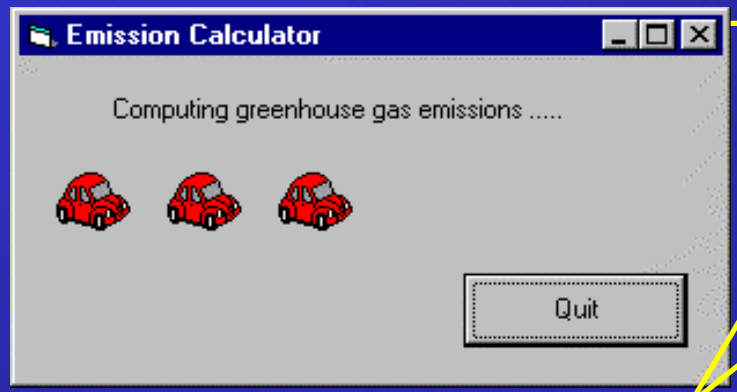
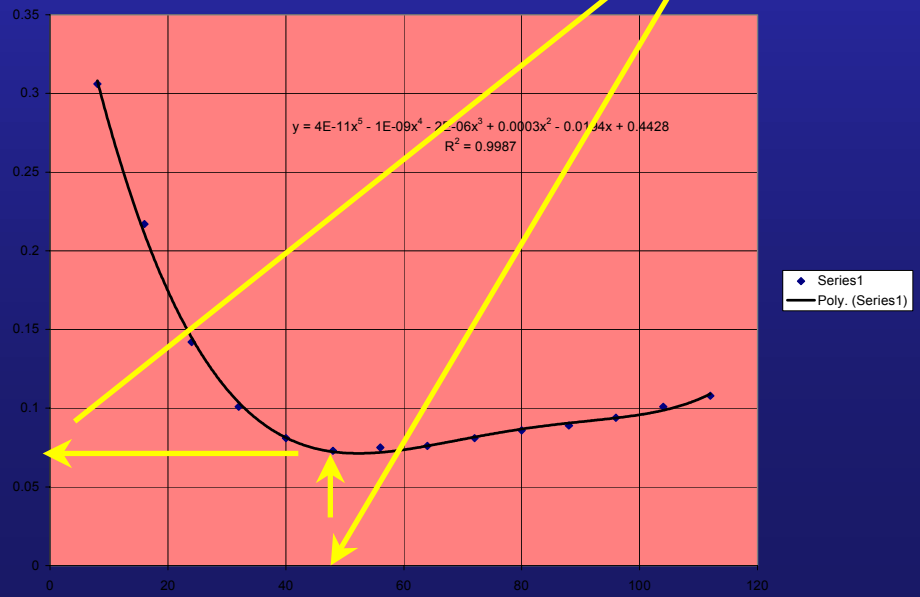
ENERGY AND EMISSION ESTIMATIONS

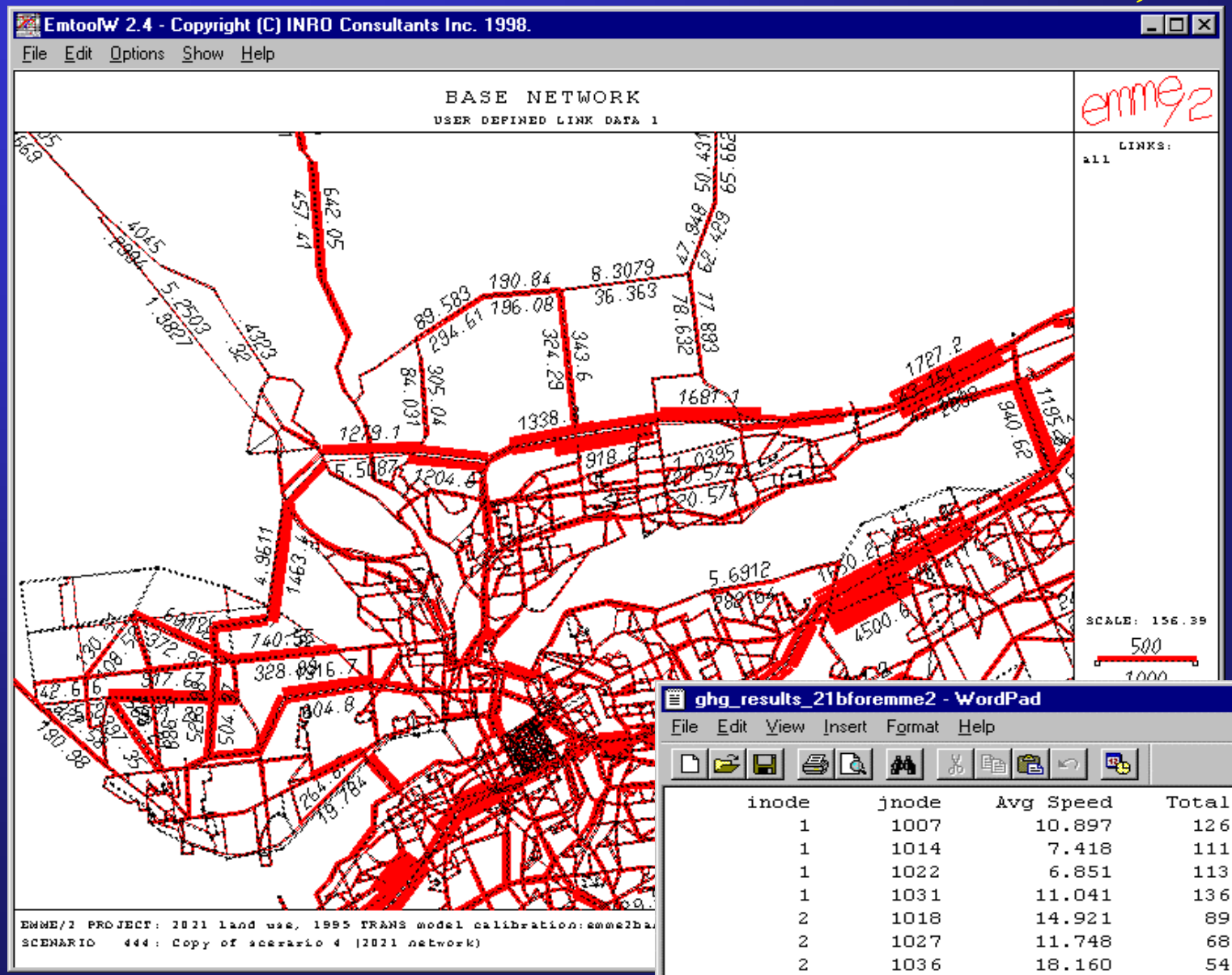
Calculation procedure





- Link average speed and vkm (for 9317 links)
- fuel consumption (l/km) * vkm * GHG emission rate (g/l) = GHG emiss. per link (grams)
- Results are aggregated per characteristic areas (core, urban, suburban and rural), and per link types (8 types)

GHG EMISSIONS IN THE NCR, 2021



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inode	jnode	Avg Speed	Total VKT	GHG
1	1007	10.897	126.333	73729.116
1	1014	7.418	111.320	78706.755
1	1022	6.851	113.090	82611.607
1	1031	11.041	136.055	78799.695
2	1018	14.921	89.274	42706.660
2	1027	11.748	68.259	38107.684
2	1036	18.160	54.358	22665.774
2	1044	13.411	122.725	63041.874

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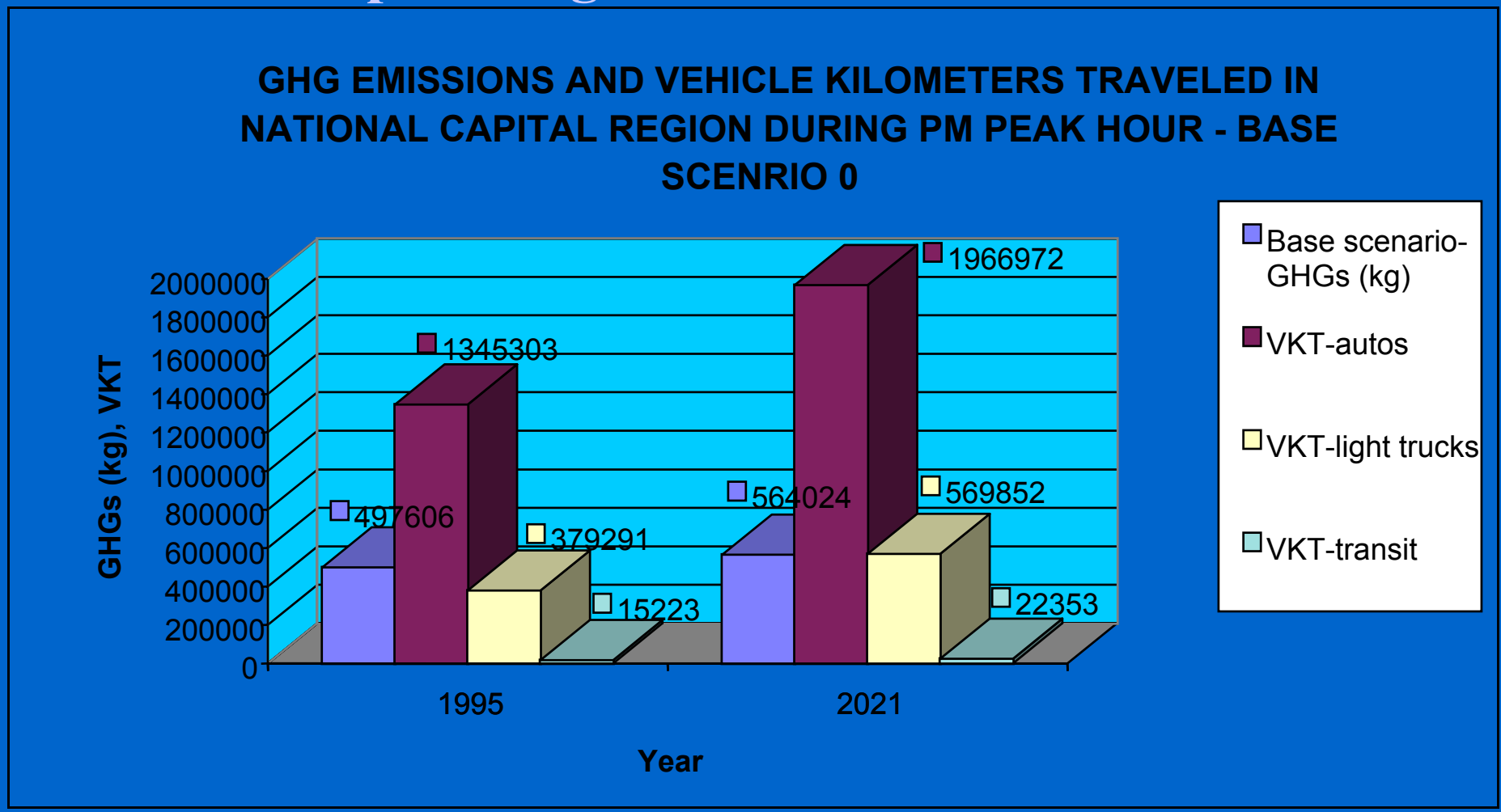
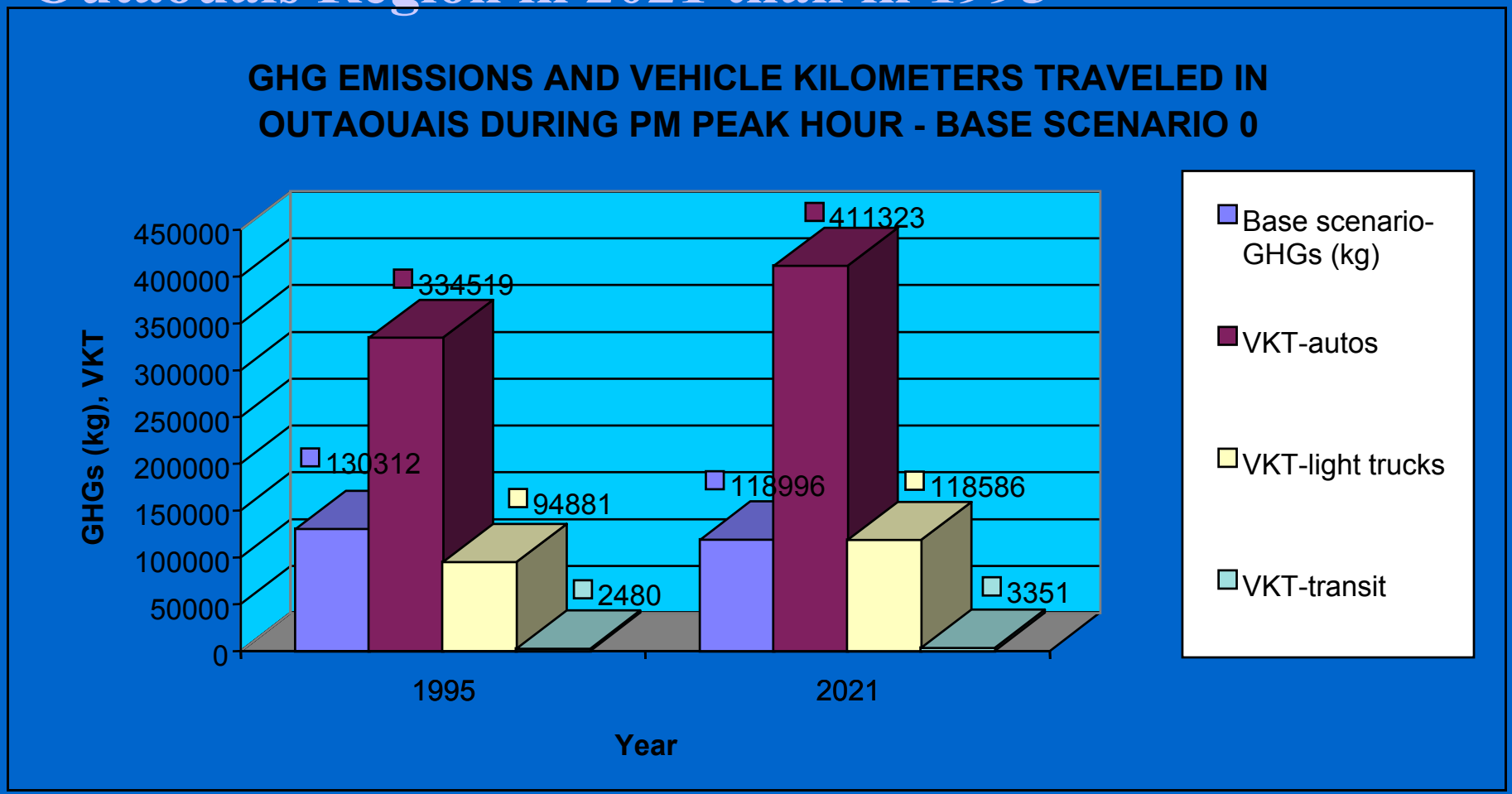
PROPOSED SCENARIOS FOR REDUCING GHG EMISSIONS (NCR)

- Base scenario: There will be 13.3% more GHGs in the National Capital Region in 2021 than in 1995



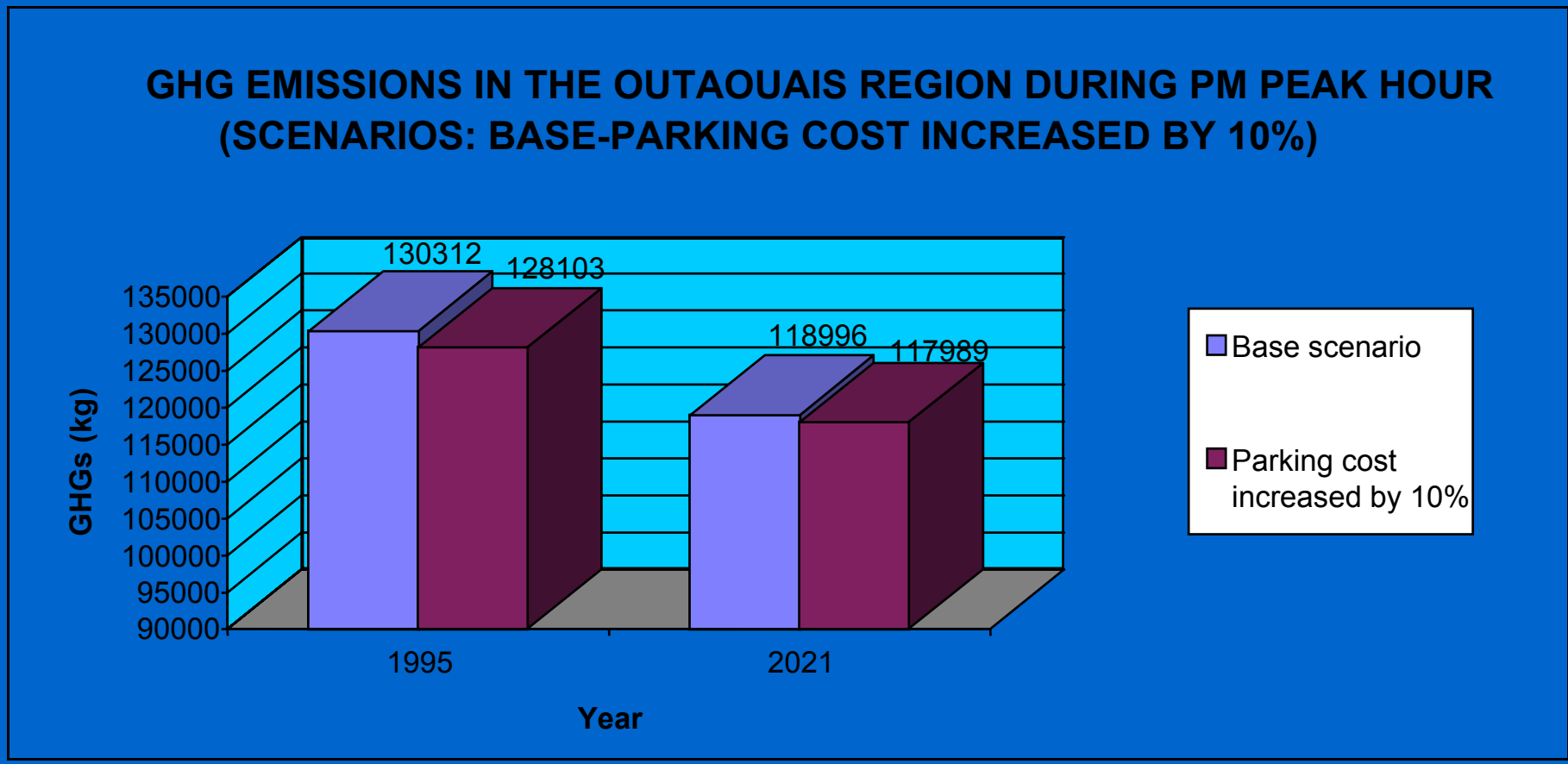
PROPOSED SCENARIOS FOR REDUCING GHG EMISSIONS (Outouais Region)

- Base scenario: There will be 8.7% less GHGs in the Outaouais Region in 2021 than in 1995



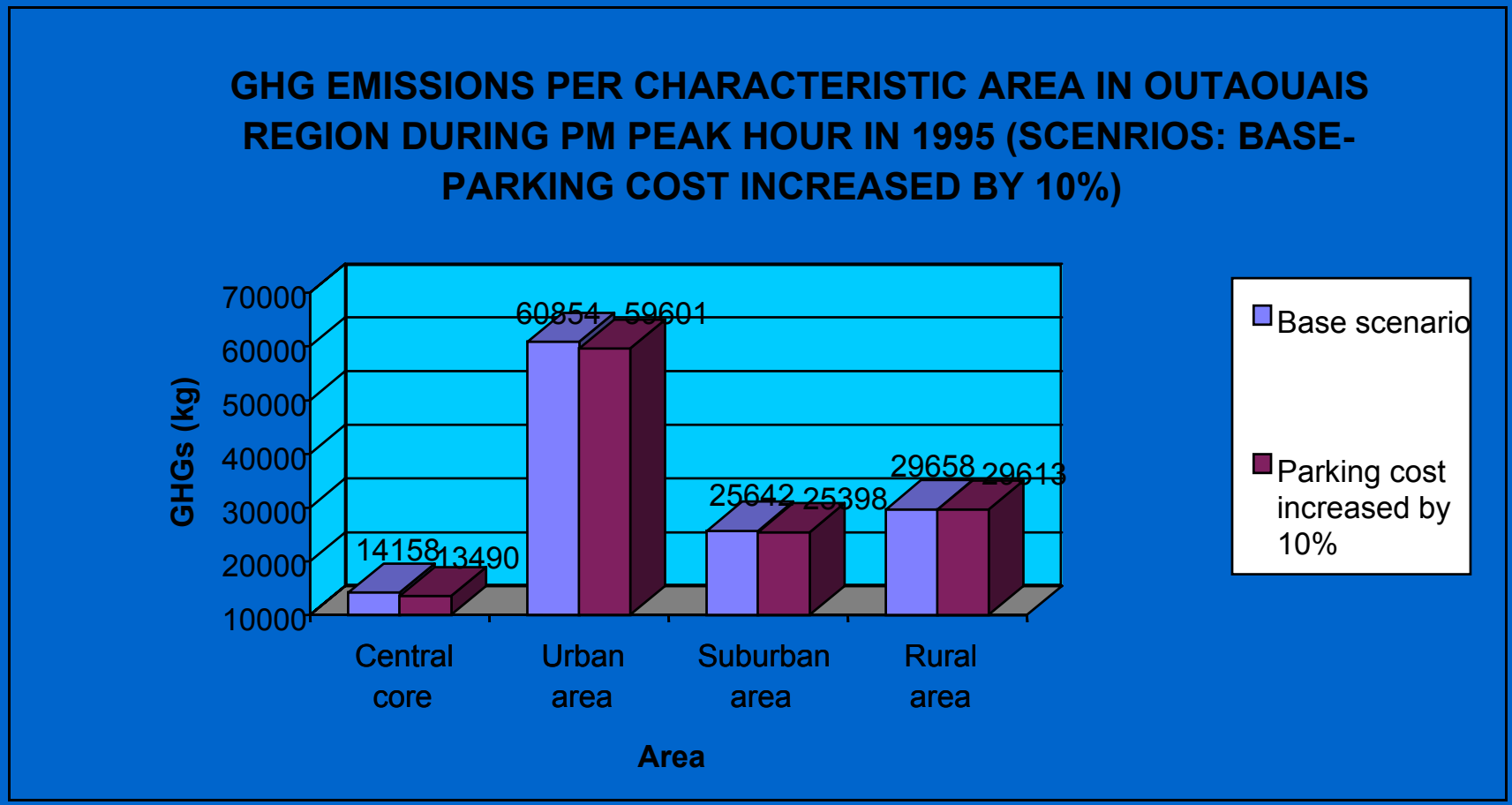
PROPOSED SCENARIOS FOR REDUCING GHG EMISSIONS

- **Scenario 1 -parking cost increased by 10%**
- **1495 auto persons (0.7%) in NCR switch to transit. As a result, GHGs are reduced by 1.7% in the Outaouais-1995**



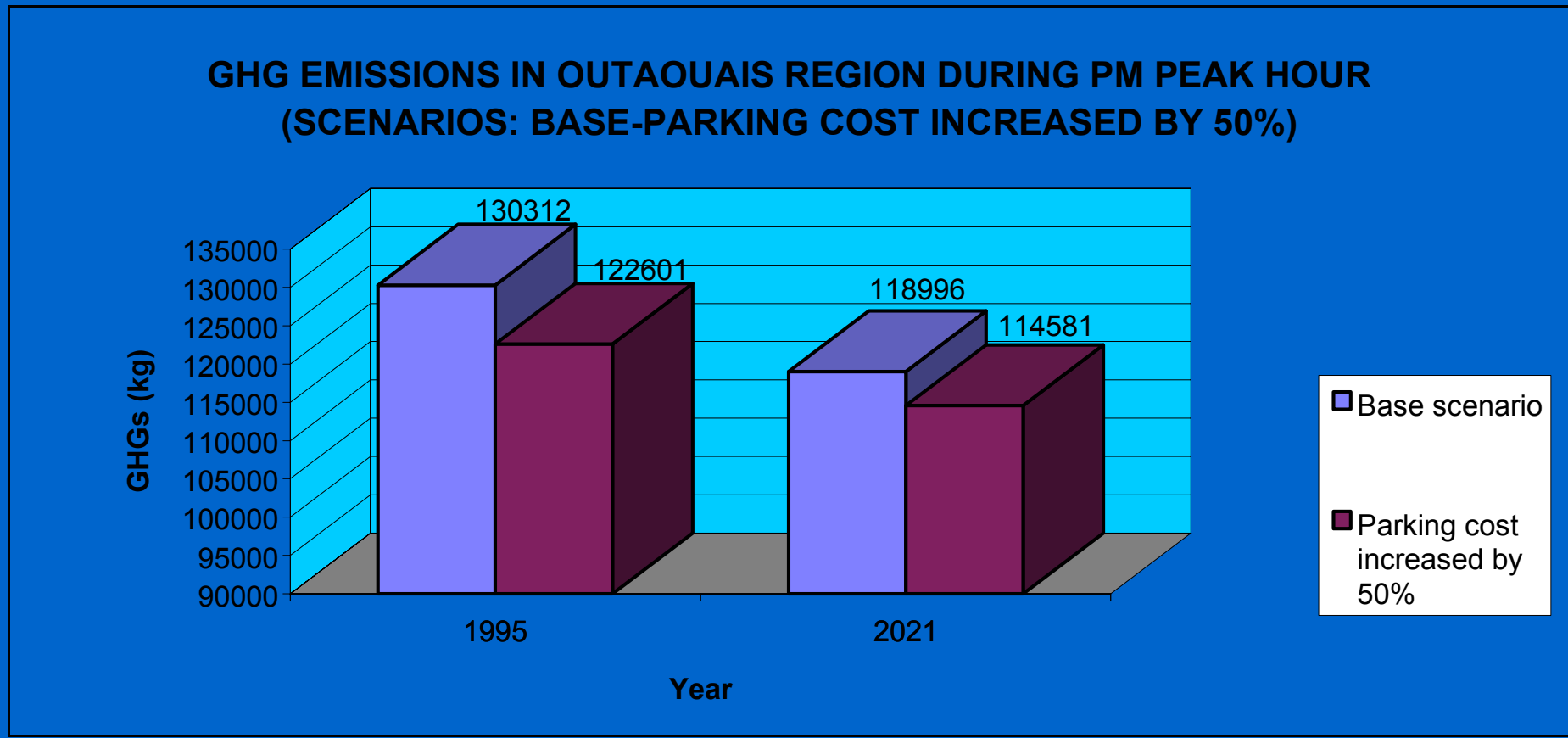
PROPOSED SCENARIOS FOR REDUCING GHG EMISSIONS

- Scenario 1:GHG emissions per characteristic areas-1995



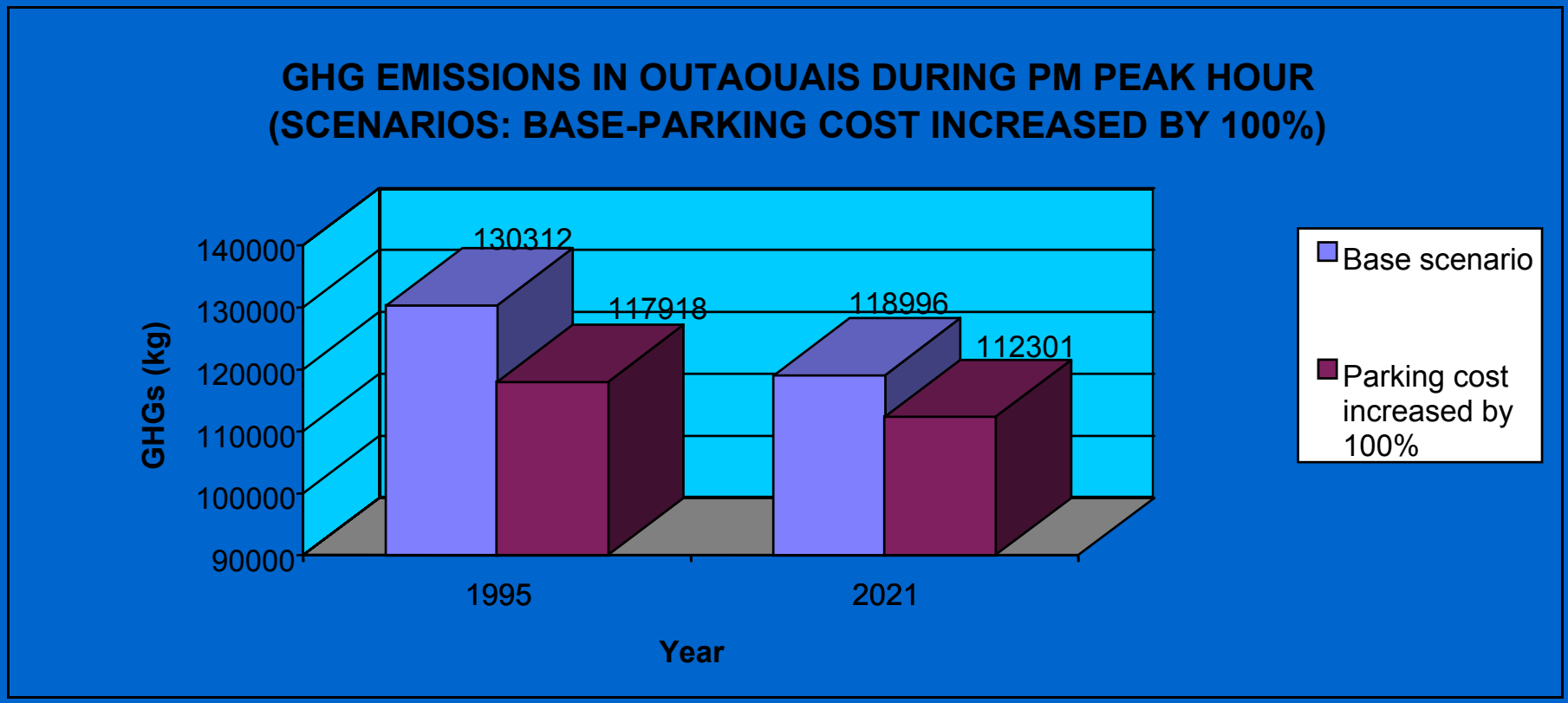
PROPOSED SCENARIOS FOR REDUCING GHG EMISSIONS

- **Scenario 2 -parking cost increased by 50%**
- **7114 auto persons (3.1%) in NCR switch to transit. As a result, GHGs are reduced by 5.9% in the Outaouais-1995**



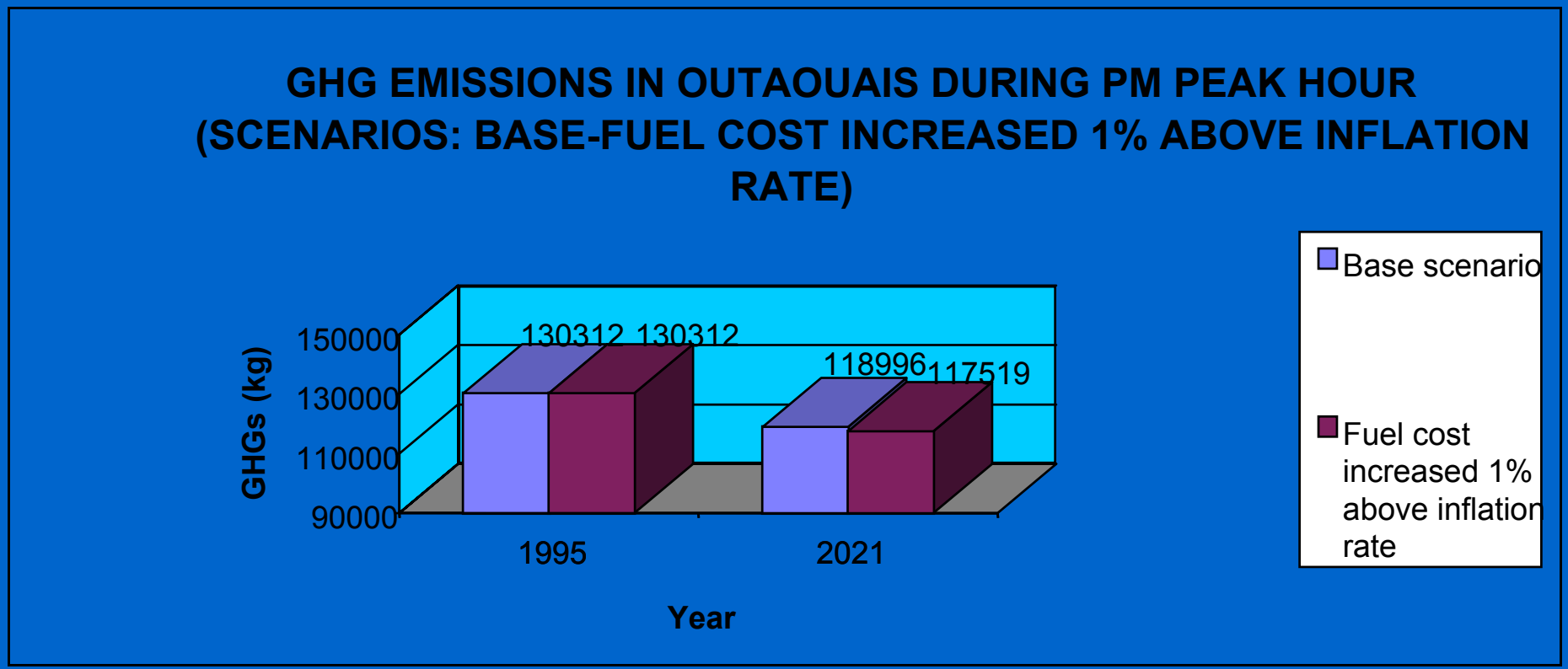
PROPOSED SCENARIOS FOR REDUCING GHG EMISSIONS

- **Scenario 3 -parking cost increased by 100%**
- **11436 auto persons (5%) in NCR switch to transit. As a result, GHGs are reduced by 9.5% in the Outaouais-1995**



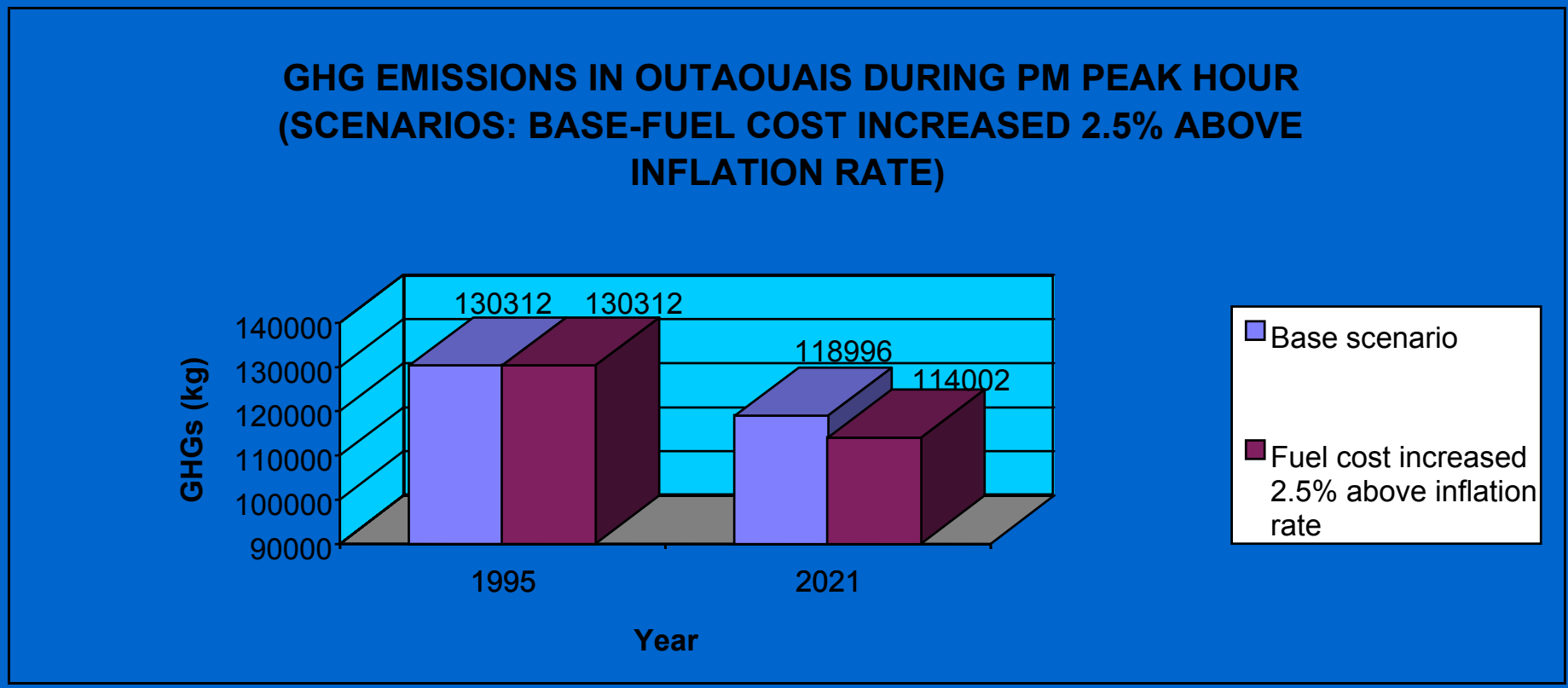
PROPOSED SCENARIOS FOR REDUCING GHG EMISSIONS

- **Scenario 4 -fuel cost increased 1.0% above inflat. rate**
- **1928 auto persons (0.6%) in NCR switch to transit. As a result, GHGs are reduced by 1.2% in the Outaouais-2021**



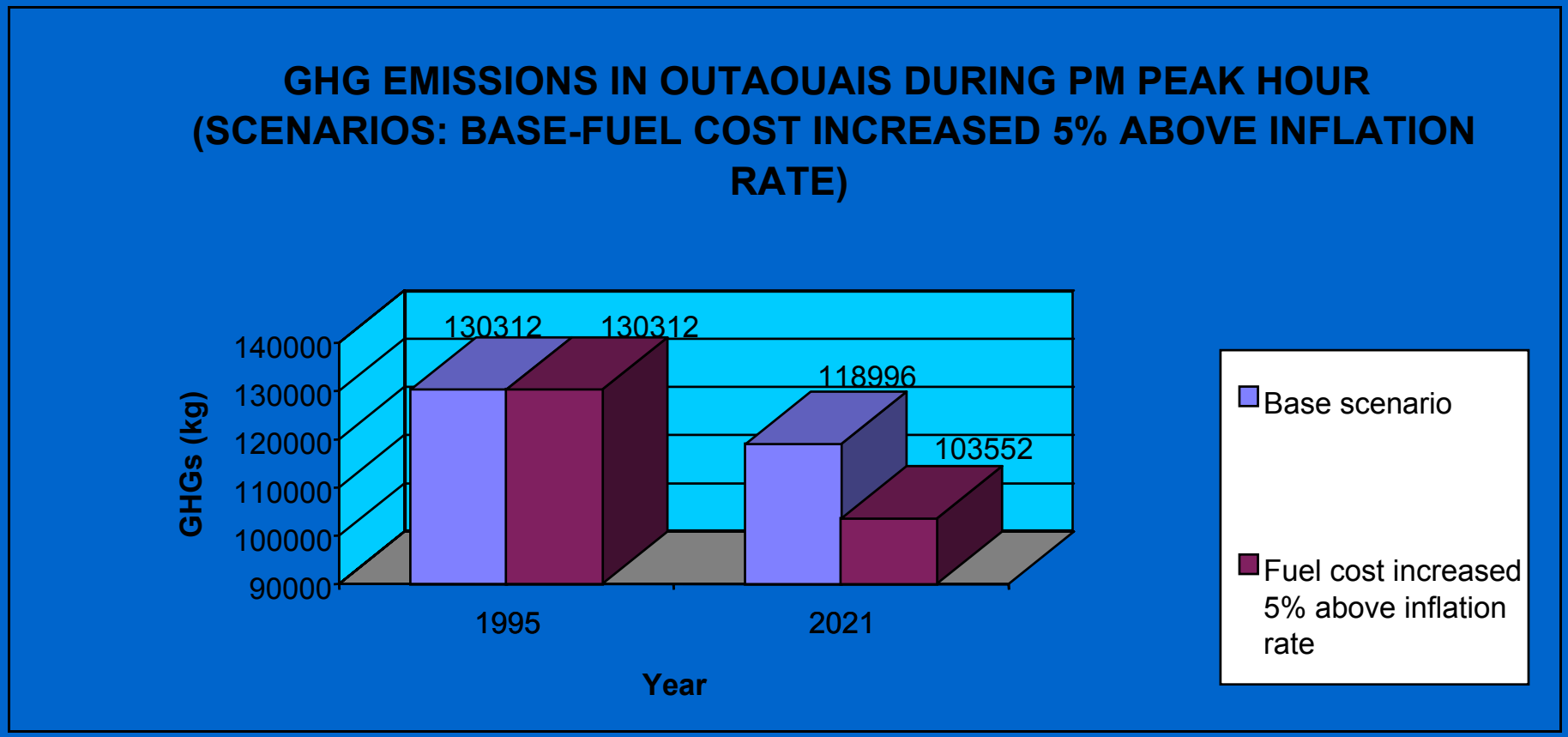
PROPOSED SCENARIOS FOR REDUCING GHG EMISSIONS

- **Scenario 5 -fuel cost increased 2.5% above inflat. rate**
- **6143 auto persons (1.8%) in NCR switch to transit. As a result, GHGs are reduced by 4.2% in the Outaouais-2021**



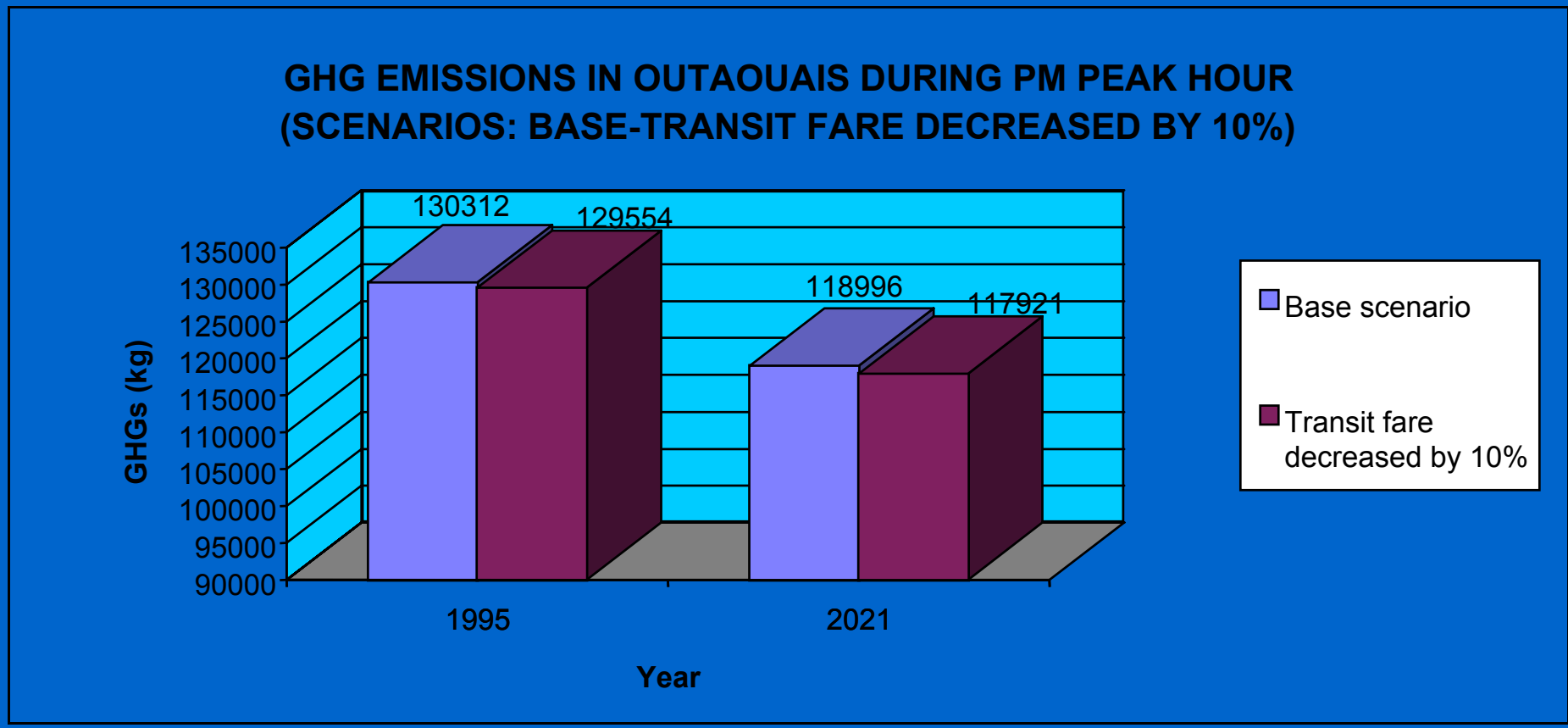
PROPOSED SCENARIOS FOR REDUCING GHG EMISSIONS

- **Scenario 6 -fuel cost increased 5.0% above inflat. Rate**
- **19161 auto persons (5.7%) in NCR switch to transit. As a result, GHGs are reduced by 13% in the Outaouais-2021**



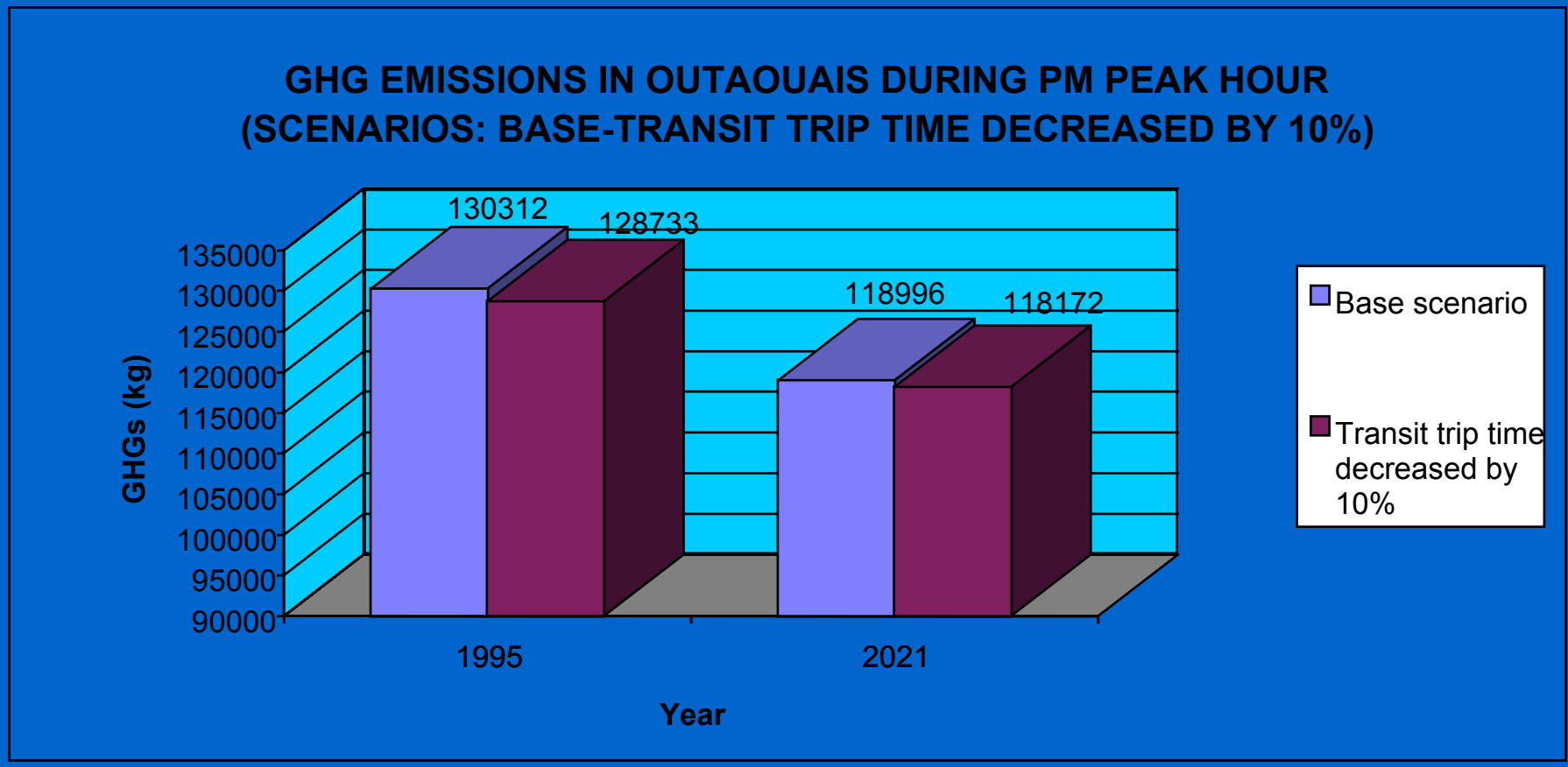
PROPOSED SCENARIOS FOR REDUCING GHG EMISSIONS

- **Scenario 7 - transit fare decreased by 10%**
- **949 auto persons (0.4%) in NCR switch to transit. As a result, GHGs are reduced by 0.6%in the Outaouais-1995**



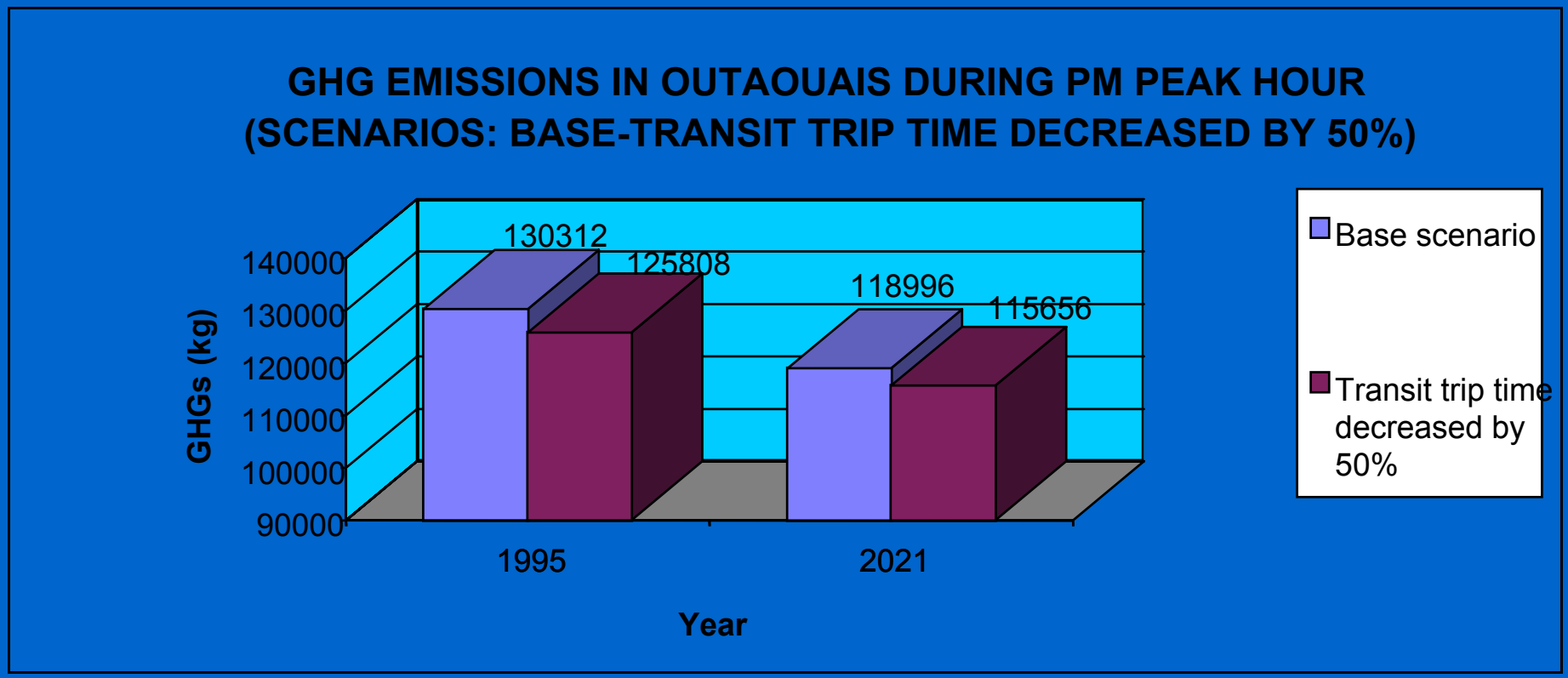
PROPOSED SCENARIOS FOR REDUCING GHG EMISSIONS

- **Scenario 8 - total transit trip time decreased by 10%**
- **1427 auto persons (0.6%) in NCR switch to transit. As a result, GHGs are reduced by 1.2%in the Outaouais-1995**



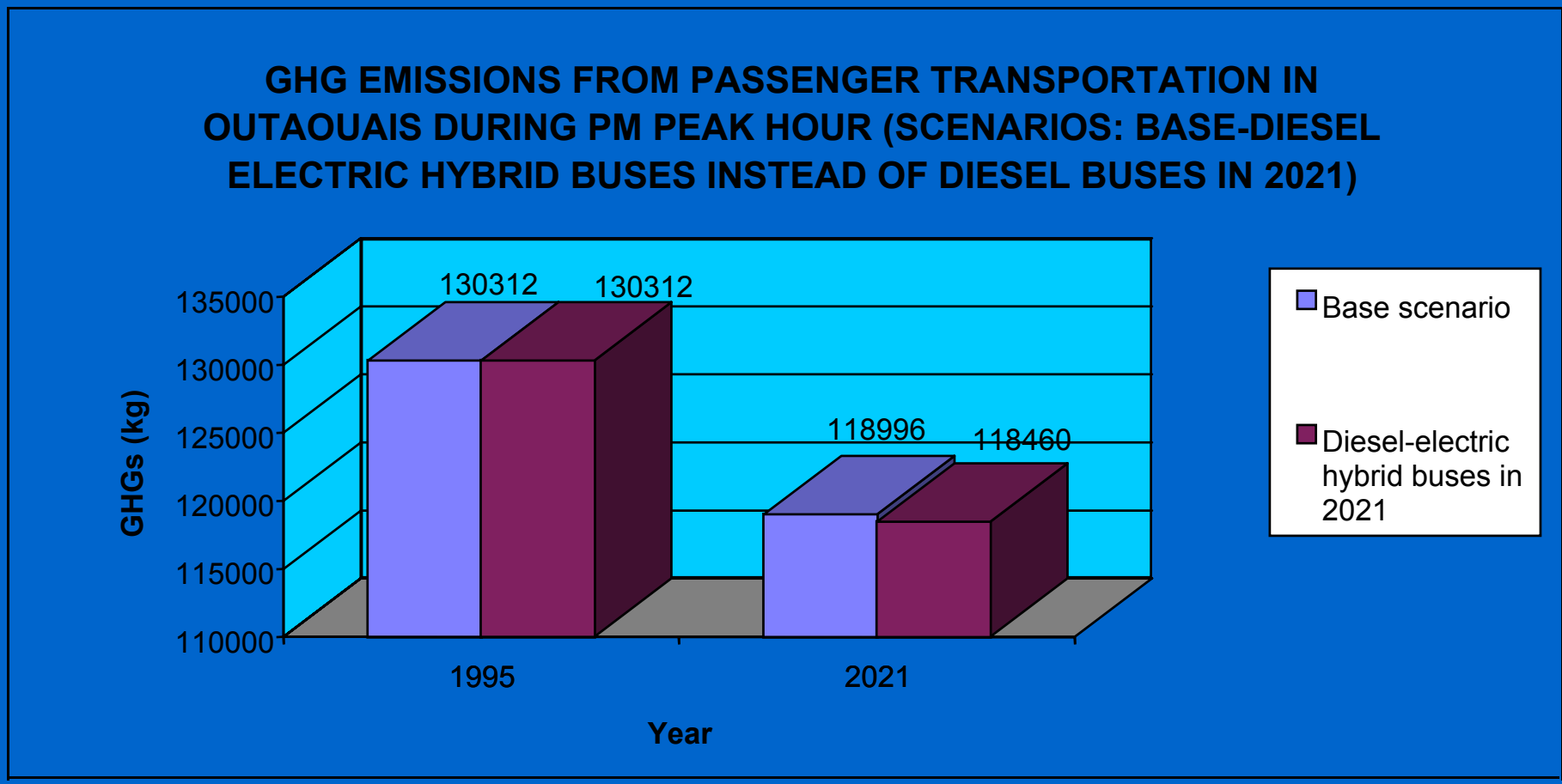
PROPOSED SCENARIOS FOR REDUCING GHG EMISSIONS

- **Scenario 9 - total transit trip time decreased by 50%**
- **8228 auto persons (3.6%) in NCR switch to transit. As a result, GHGs are reduced by 3.5%in the Outaouais-1995**



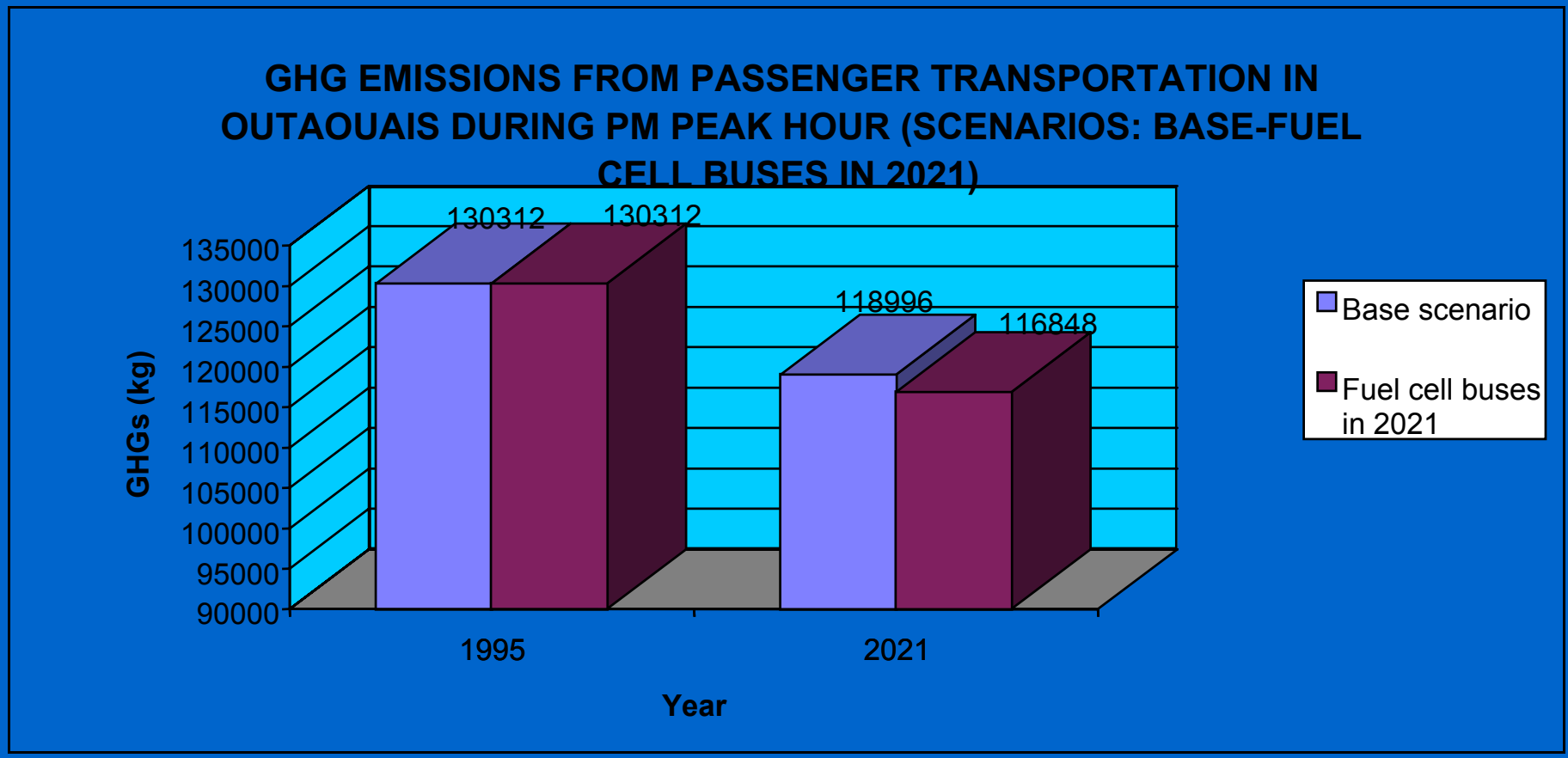
PROPOSED SCENARIOS FOR REDUCING GHG EMISSIONS

- **Scenario 10 - diesel electric hybrid buses in 2021**
- **There is no switching to transit; 0.5% less GHGs in the Outaouais in 2021 (36% less GHGs from transit)**



PROPOSED SCENARIOS FOR REDUCING GHG EMISSIONS

- **Scenario 11 - fuel cell "Ballard" buses in 2021**
- **There is no switching to transit; 1.8% less GHGs in the Outaouais in 2021 (100% less GHGs from transit)**



CONCLUSIONS AND RECOMMENDATIONS

- Bus transportation can play very important role in reducing GHG emissions. Increase in parking and fuel costs are very effective in terms of switching people to transit and reducing GHGs.
- Reduction of transit travel time is less effective than disincentives for the use of car. This scenario could be combined with other measures in order to reduce more GHGs. Decreasing transit fare has little effect.
- Hybrid buses produce 36% less GHGs than diesel buses, and fuel cell buses produce no emissions (the assumption is that hydrogen is produced from a regenerative process). The scenarios with these buses can be combined with other measures.
- There is a need for an analysis of all modes of transportation. Scenarios with increased fuel and parking costs should be further analyzed (eg. implication on business and the role of “park&ride” service).
- Land use should be planned with transportation and in favor of transit buses.

TIME FOR QUESTIONS

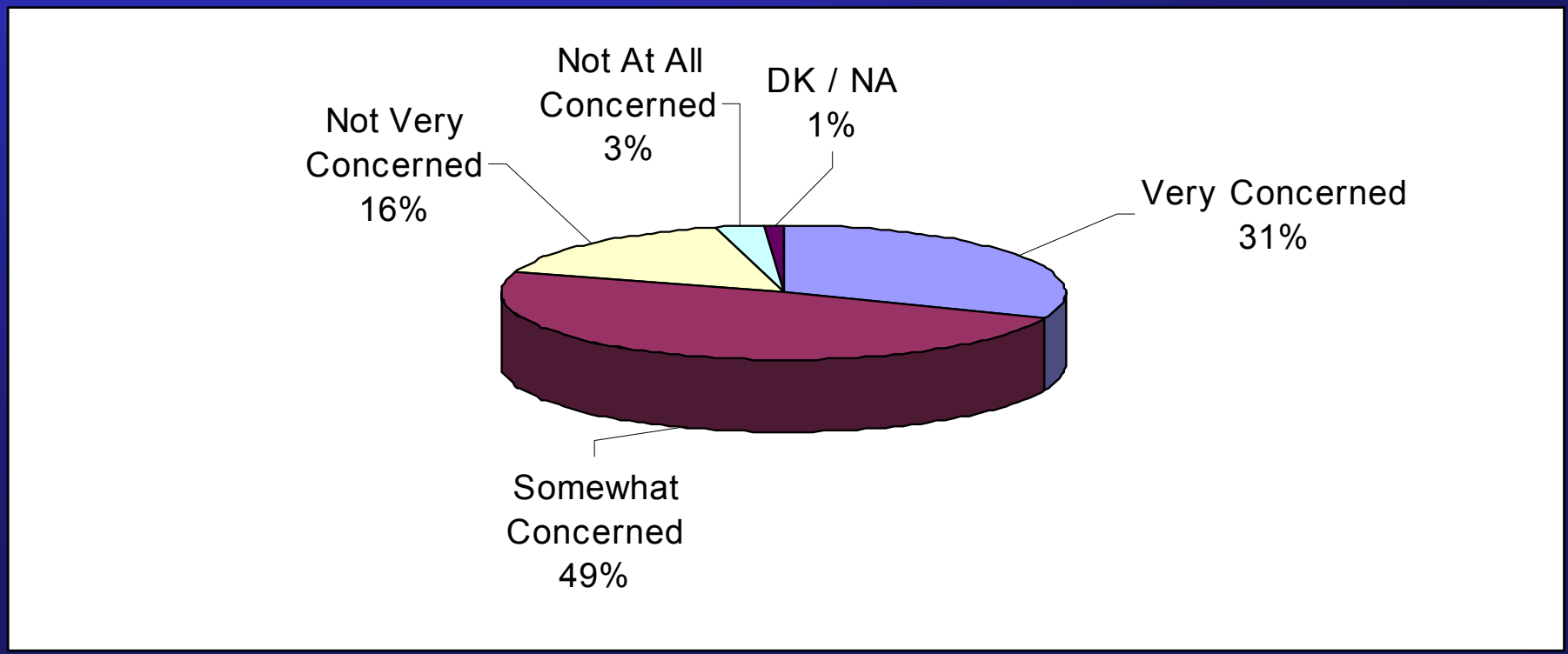
Slide in reserve: TRANSPORTATION CLIMATE CHANGE TABLE AS STARTING POINT:

GHGs can be reduced through different parts of transportation system, including:

- **Vehicles (fuel efficiency)**
- **Fuel (lower gas emission)**
- **Infrastructure (maintenance)**
- **Carriers (load factor)**
- **Changes in travel behavior as most promising measure**

Slide in reserve: GHG EMISSIONS ASSOCIATED WITH TRANSPORTATION IN CANADA

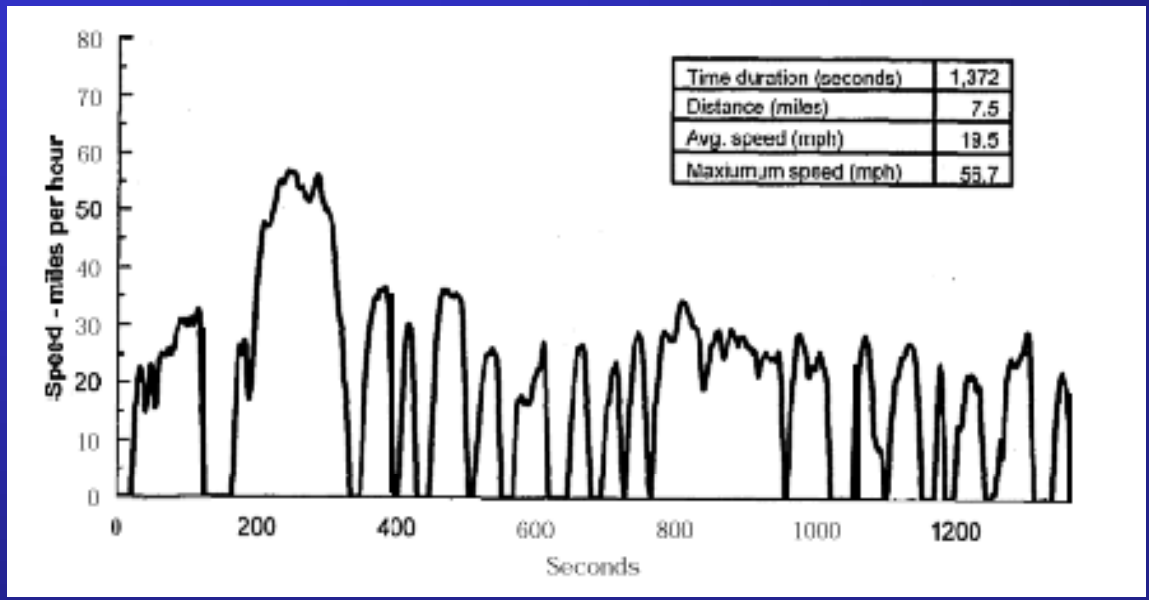
Concern over automobile emissions in household with at least one car (1992 survey)



- 71% of people think that more should be spent on transit

Slide in reserve: ENERGY AND EMISSION ESTIMATIONS

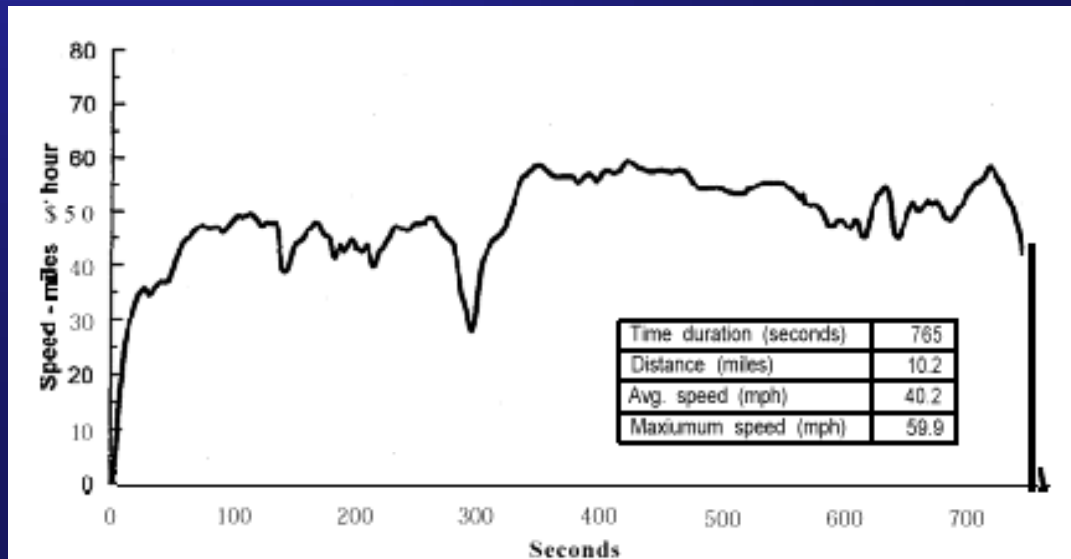
Urban driving cycle



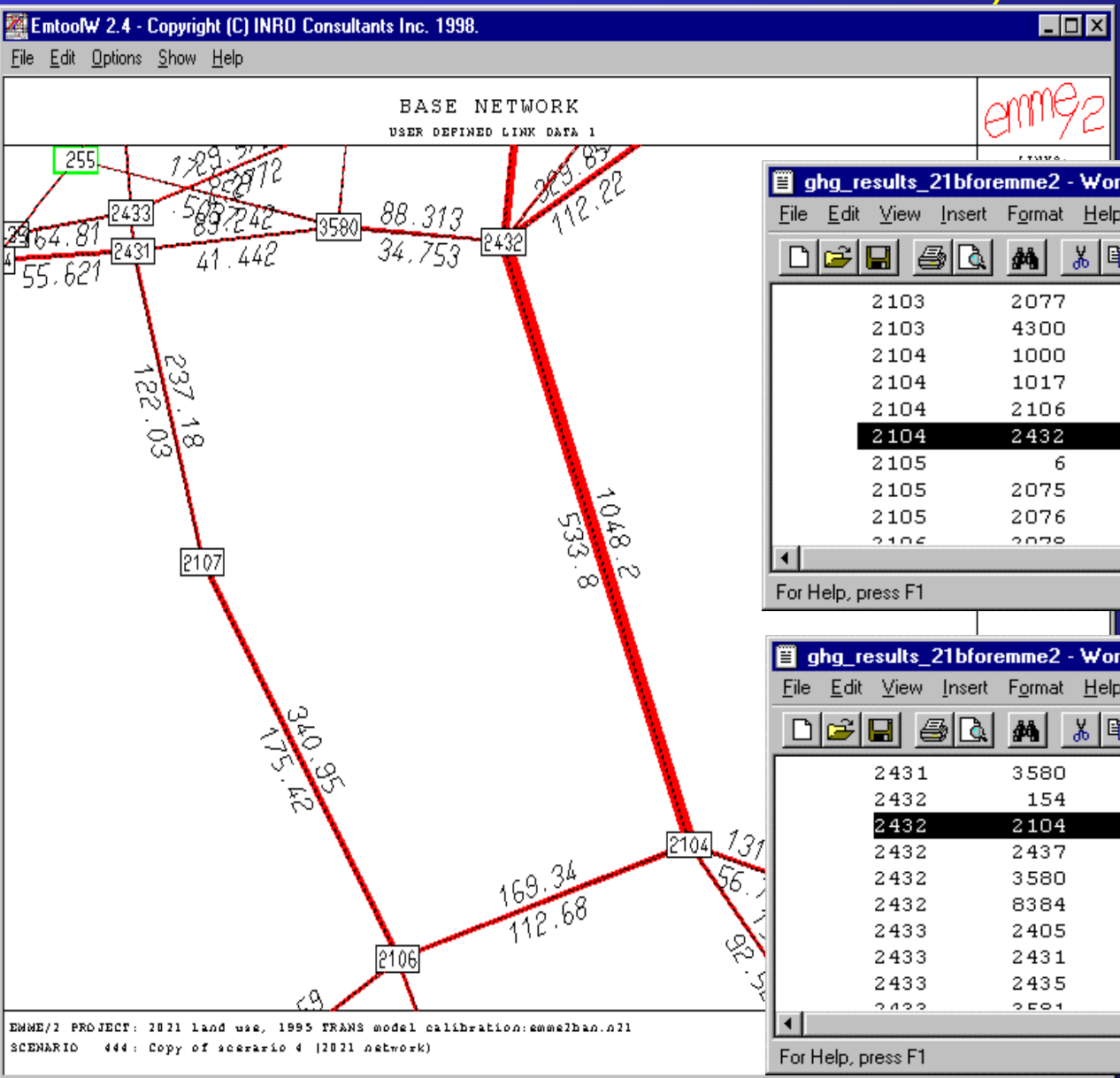
Highway driving cycle

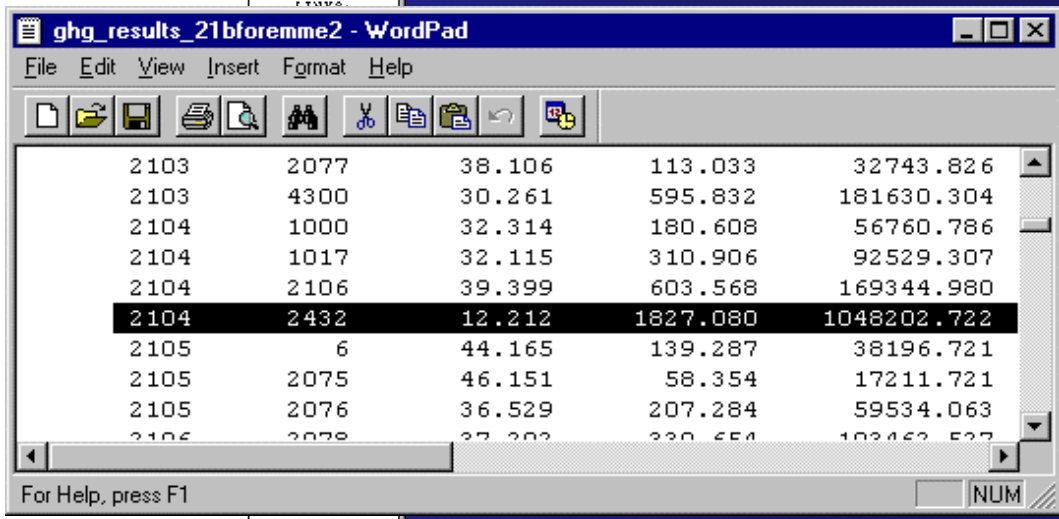
GHG EMISSION RATE

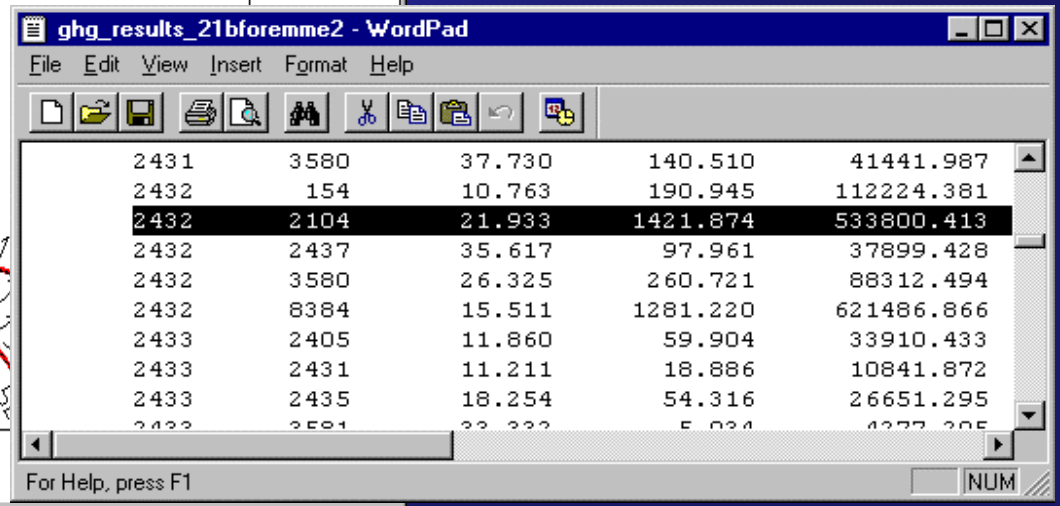
- Autos = 2490.5 (g/l)
- Light trucks = 2553.9 (g/l)
- Buses = 2763.8 (g/l)



Slide in reserve: GHG EMISSIONS ON PORTAGE BRIDGE, PMPH, 2021







Slide in reserve: PRESENT SITUATION IN THE OUTAOUAIS REGION

STO (bus) ridership