Estimation of CO2 Reduction with LCA

Application of the Concept of Extended Life Cycle Environmental Load (ELCEL) for BRT in Bangkok

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In urban area, CO_2 emission from automobile has increased and its reduction is urgently needed.

introduction of public transport is strongly needed to reduce CO_2 emission from automobile.

However, change of land use, construction of buildings, construction of transportation facility, production of transportation system, etc. might increase CO2 emission.

Background of this research

Estimation of CO_2 emission reduction for Transportation Sector by applying Extended Life Cycle Environmental Load (ELCEL) Concept

CO_2 emission reduction by Public Transport Use in Transport Sector

Divert

LCA（Life Cycle Assessment）
In Industry Sector

Raw material production
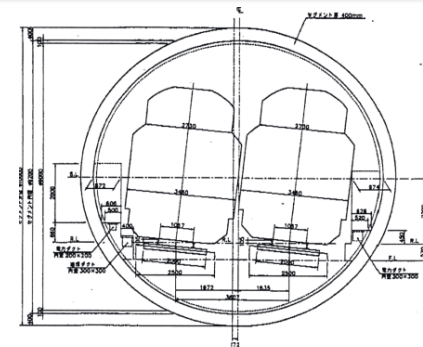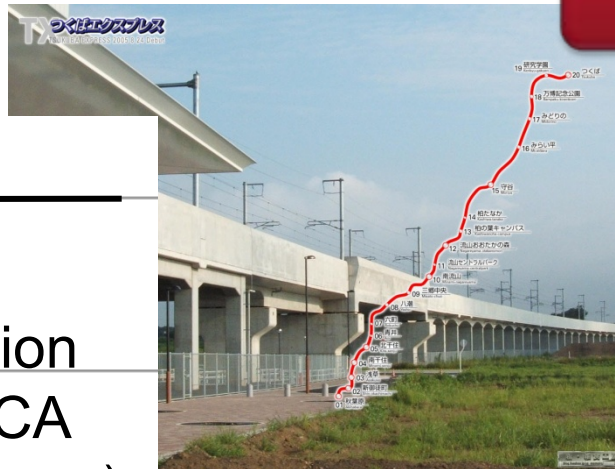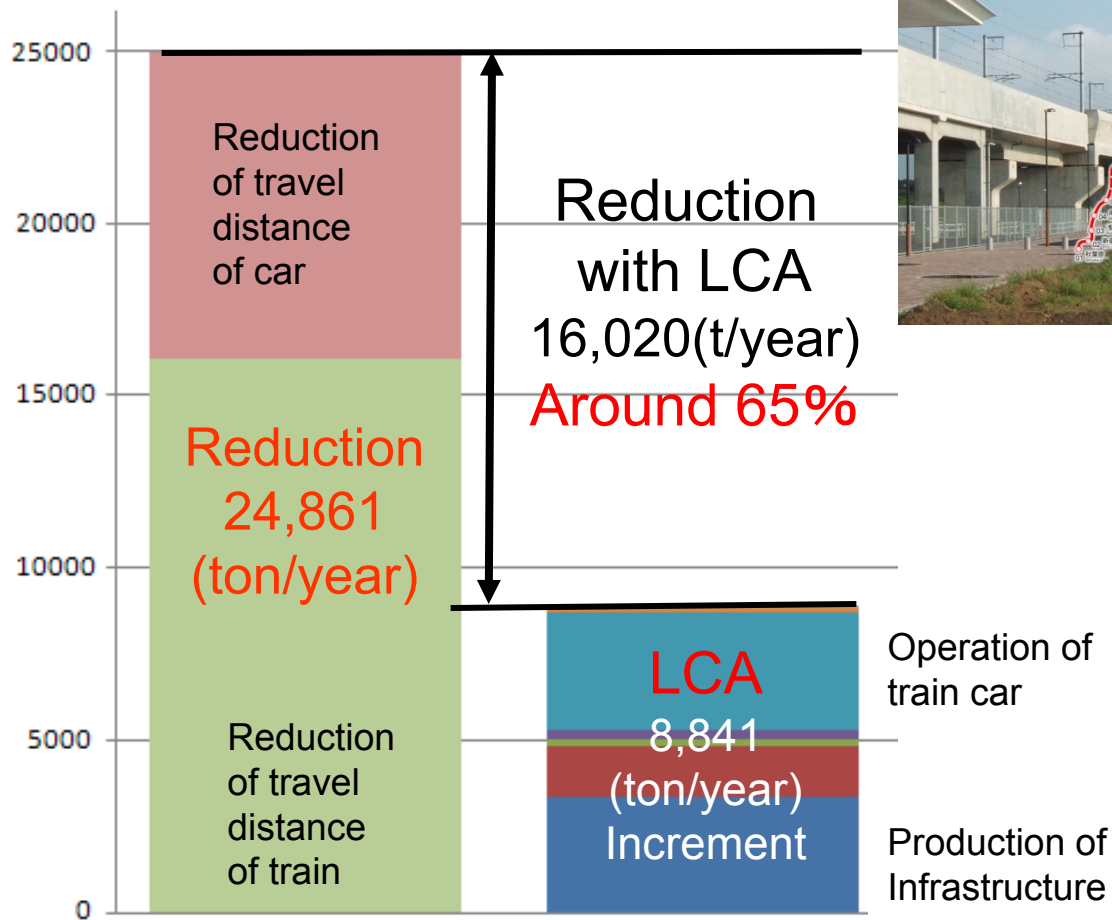
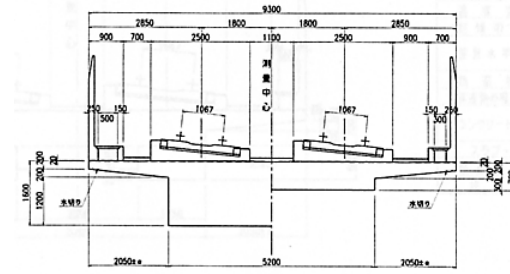Manufacture/construction

Transport/distribution

Use and disposal

ELCEL for Tsukuba Express Line

Reduction with LCA
16,020(t/year)
Around 65%

Reduction of travel distance of car

Reduction 24,861 (ton/year)

Reduction of travel distance of train

LCA 8,841 (ton/year) Increment

Operation of train car

Production of Infrastructure
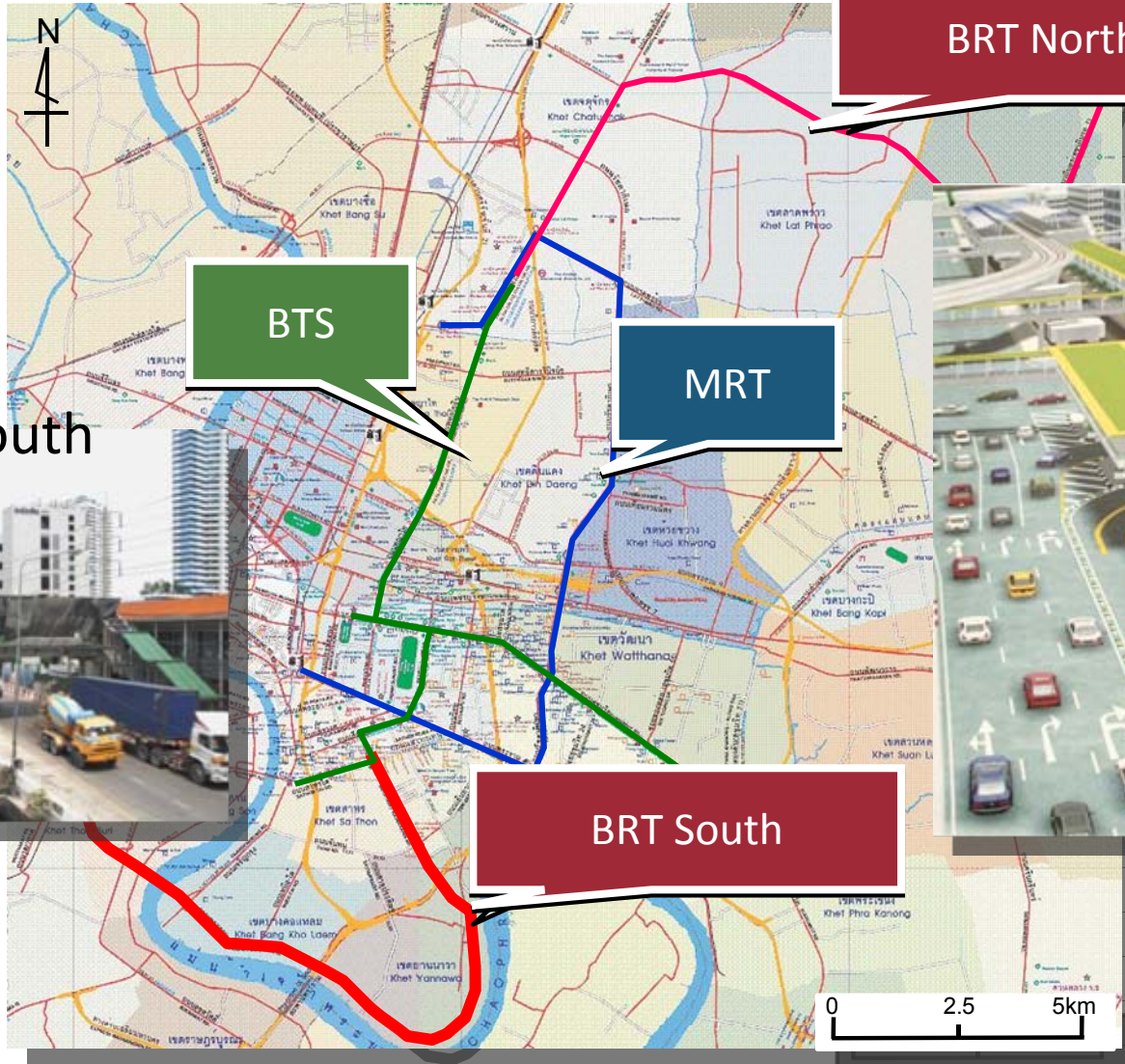
The shield method (double track)
3,670（t-c/km）

The arch slab Elevated structure
1,975（t-c/km）

Souse: Shibahara, et al.（2003）
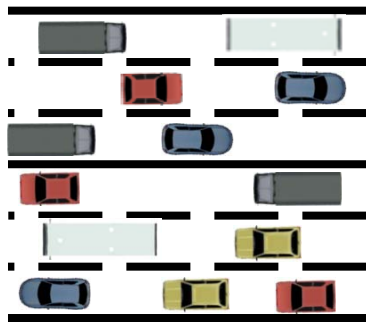
Targeted BRT and Study Area

BRT North
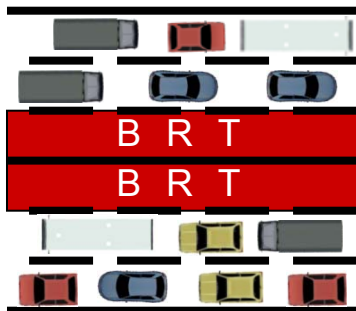
BTS

MRT

BRT South

BRT South

0   2.5   5km

Objectives and scopes

1   Development Inventory Data to apply LCA

2   Portion of increased CO_2 emission by LCA in the case of BRT

3   Develop the methodology to evaluate an impact introducing priority measures for BRT and reducing parallel bus service
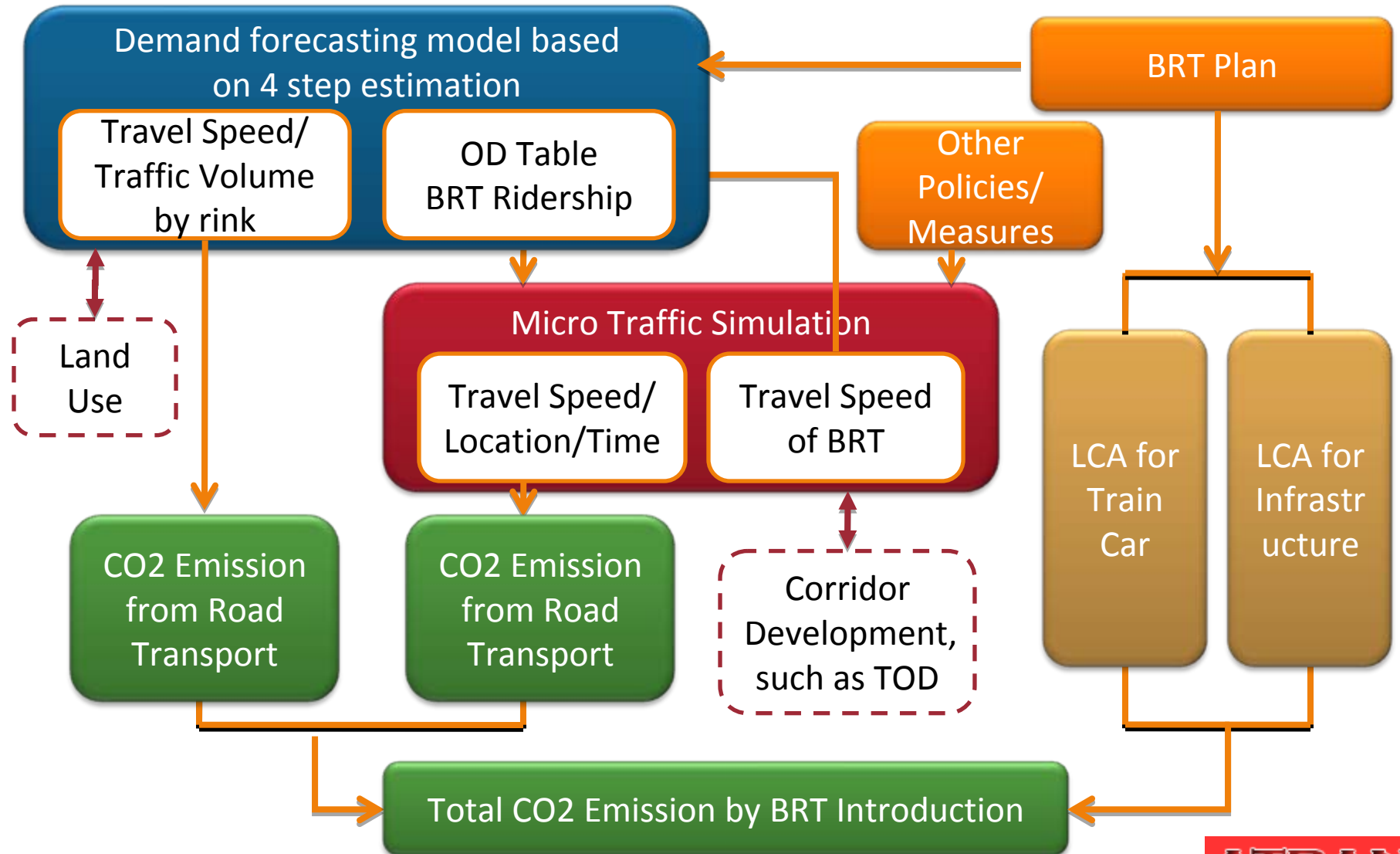

Application of BRT

BRT
BRT
} BRT Lanes

Traffic Demand Forecasting

OD Table Development

Estimation of BRT Ridership

Within 1% error

Micro Traffic Simulation Along BRT Route

Estimation of BRT Operating Speed
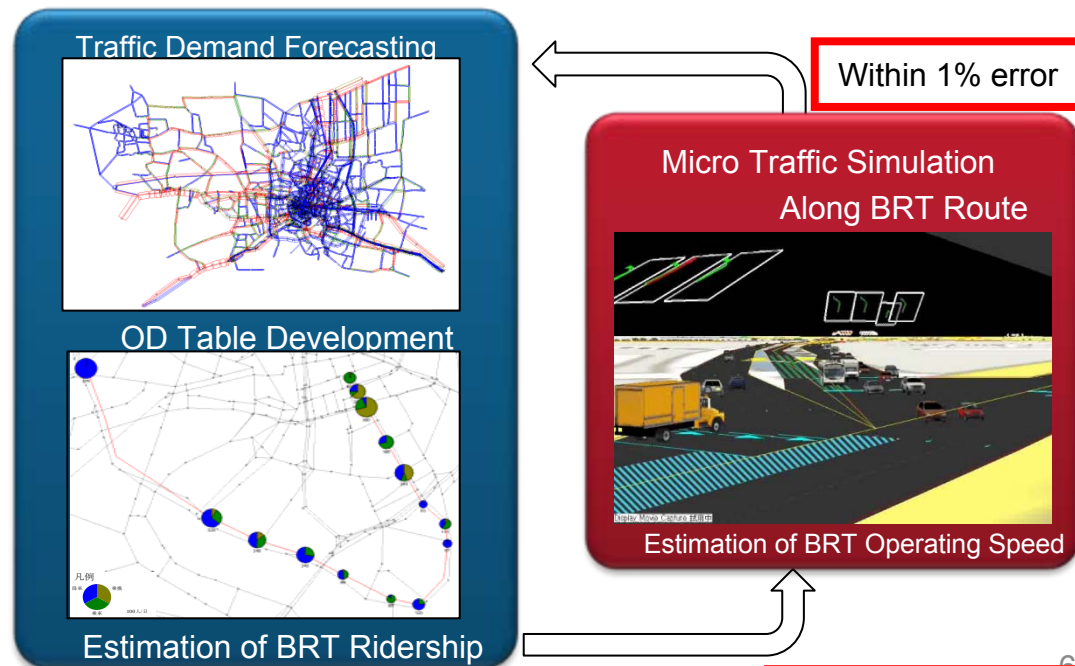
Basic Framework of estimation

Demand forecasting model based on 4 step estimation
- Travel Speed/ Traffic Volume by rink
- OD Table BRT Ridership

BRT Plan

Other Policies/ Measures

Land Use

Micro Traffic Simulation
- Travel Speed/ Location/Time
- Travel Speed of BRT

LCA for Train Car

LCA for Infrastructure

CO_2 Emission from Road Transport

CO_2 Emission from Road Transport

Corridor Development, such as TOD

Total CO_2 Emission by BRT Introduction

ATRANS
ASIAN TRANSPORTATION RESEARCH SOCIETY

Conducting LCA

System boundary; BRT cars, BRT stations, Incidental facilities, flyover which will be constructed and produced as a part of BRT project

Life time; 10 yrs for BRT cars, 60 yrs for facilities, 60 yrs for all

Based on Japanese data, available data were replace by data which mainly obtained from I/O Table in Thailand

|	Unit by AIJ-LCA	Unit from I/O Table
Electricity (kg-CO2/KWh)	0.564	0.557
Cement (Kg-CO2/'000 yen)	77.062	173.251
Concrete (Kg-CO2/'000 yen)	8.681	0.807
Soil and gravel (Kg-CO2/'000 yen)	8.797	30.246
Steel (Kg-CO2/'000 yen)	22.009	36.549

Conducting LCA

45 BRT Cars; Assuming that CO2 emission is in proportion to weight of a car.

Facilities including Stations, Incidental facilities & flyover;

13 stations

4 flyovers

Elevated structure

Level Section   Slop Section

4%

7m

t-CO2/60yrs
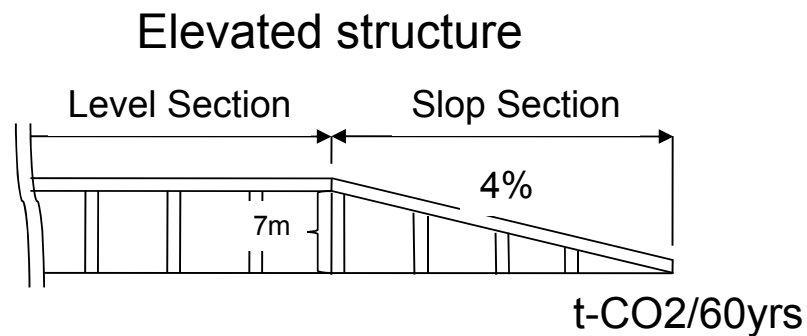
Production & maintenance of BRT car	Construction & maintenance of stations	Installment & maintenance of Incidental facilities	Construction & maintenance of flyover	Total
9,027.30	480,069.05	16,405.18	1,416.98	506,918.51

※Reduction from BRT car operation was not included.

around 500,000 t-CO_2 will be exhausted

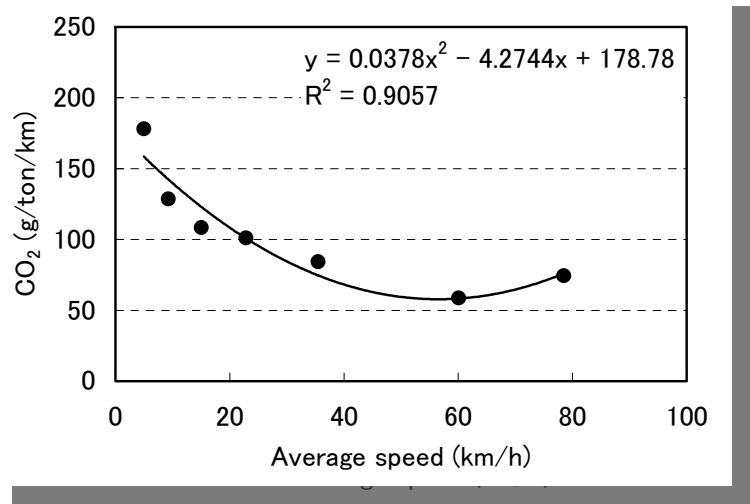# CO2 emission from car driving and BRT operation

Whole urban area

$$E_j = K_v \times Q_j$$

E_j: CO_2 emission (g-CO2) at link j,
K_v: CO_2 emission factor by speed v,
Q_j: Traffic volume at link j

$y = 0.0378x^2 - 4.2744x + 178.78$
$R^2 = 0.9057$

(Chart: CO_2 (g/ton/km) vs Average speed (km/h))

Along BRT line

$$E = 0.3K_C T + 0.028K_C D + \sum_{k=1}^{K} \delta_k (v_k{}^2 - v_{k-1}{}^2)$$

E: CO_2 emission (g-CO2), K_c: CO_2 emission factor, T: Travel time,
D: Travel distance, K: Sample size, σ_k: accelerate=1, constant, decelerate=0,
v_k: driving speed at sampling cycle k

Source: Oguchi, et al. (2002)

Result; CO_2 emission by Scenario
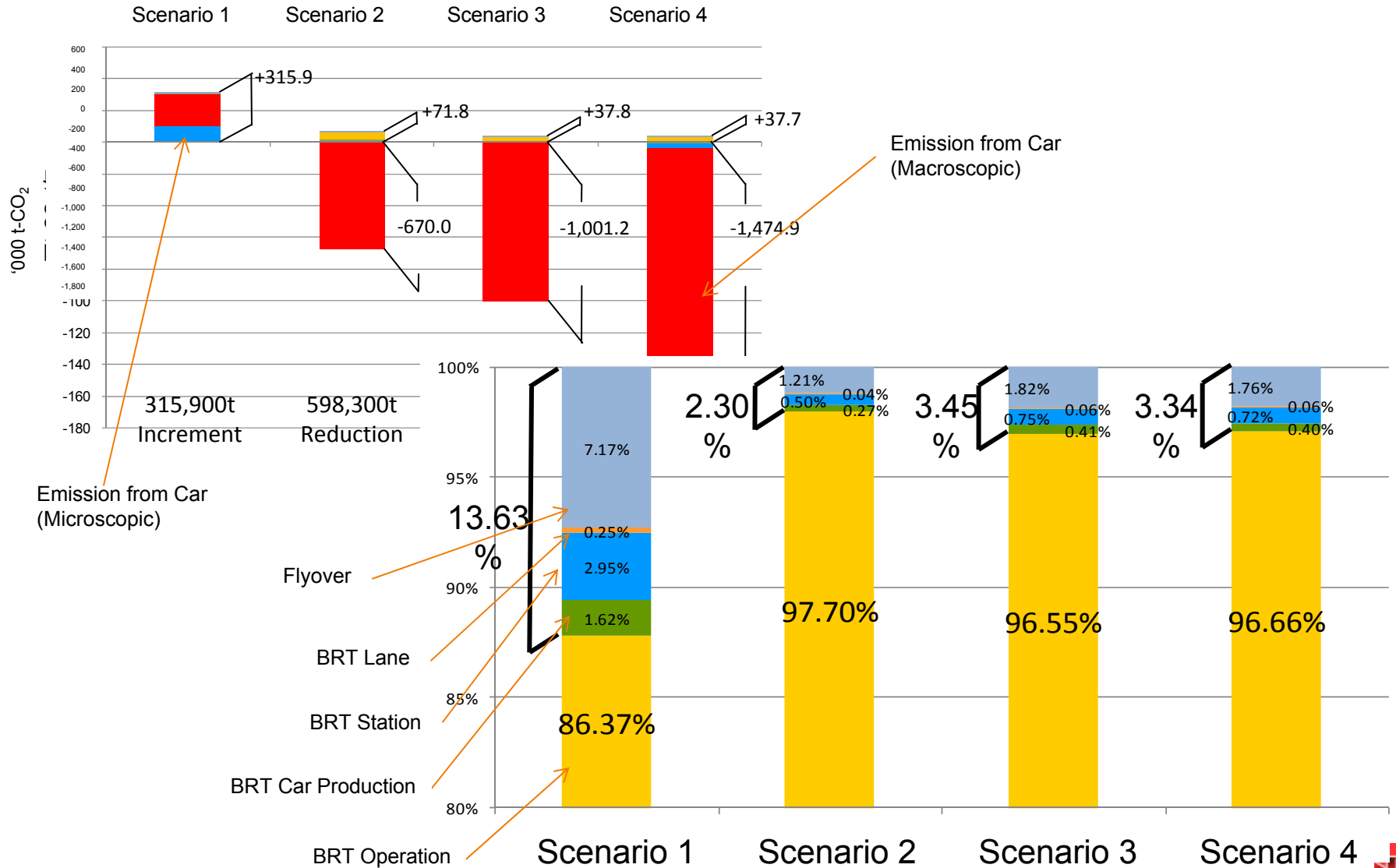
Concussion

Inventory Data for LCA could be obtained partially by using I/O Table

CO_2 emission estimated through LCA became 2 %-14 % of total CO_2 emission because constructed facilities are not huge in the case of BRT

Reduction of the number of bus on the parallel road is compulsory to reduce CO_2 after introducing BRT.