# Impact of Road Intersection on Fuel Economy and Greenhouse Gases Emission on Dhaka-Chittagong National Highway, Bangladesh

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# BANGLADESH

COUNTRY PROFILE

Total Population **159.9** Million

Total Area **147,570** $km^2$

GDP per capita **$1384**

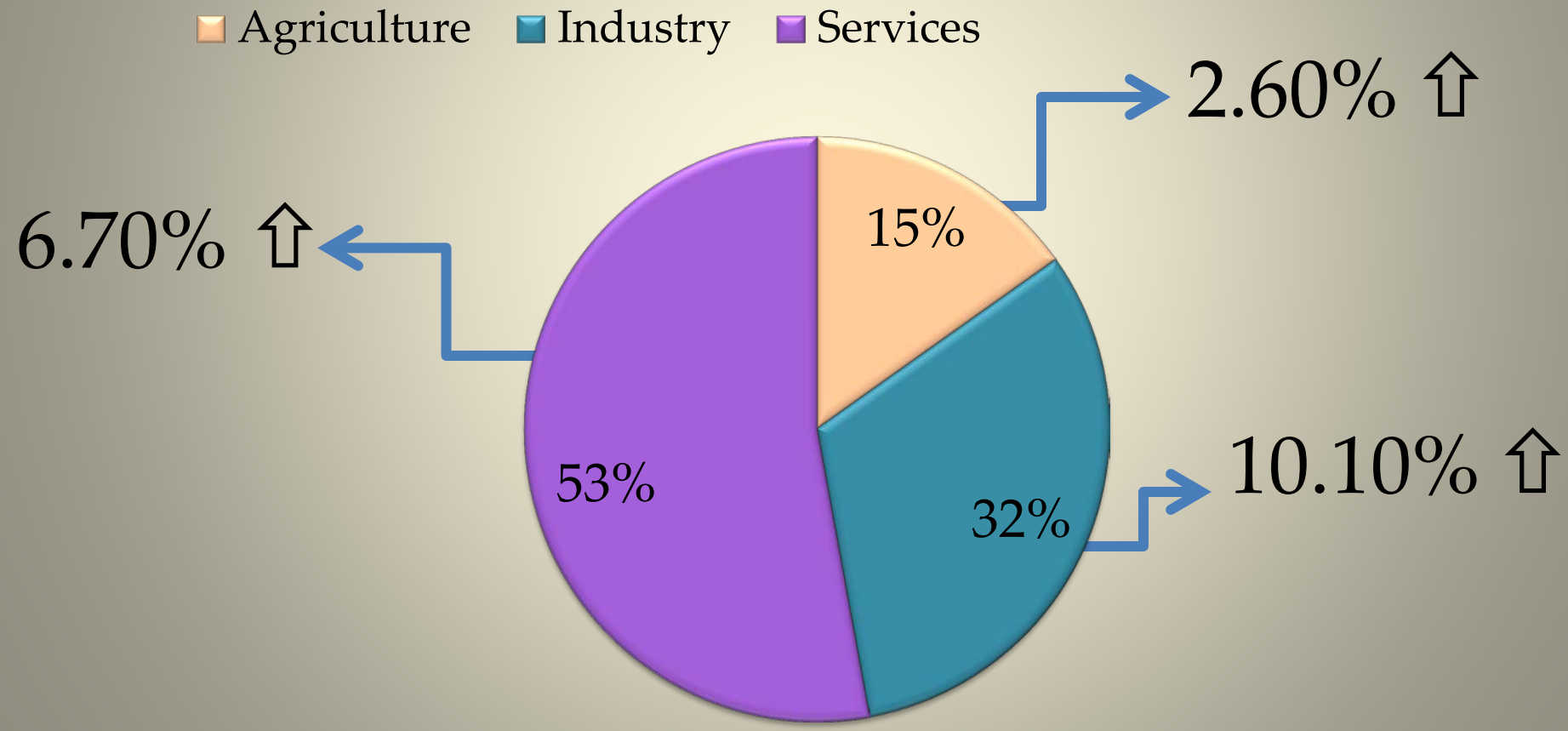
Annual GDP **$212.29** billion

Current market price (2015-16)[1]

GHG contribution per capita < **0.35%**[2]

[1]*Ministry of Finance, 2016*
[2]*MoEnvironment and Forests, 2015*

## Sector Wise Contribution in Economy[3]




[3]*Alam et al.*, (2013)

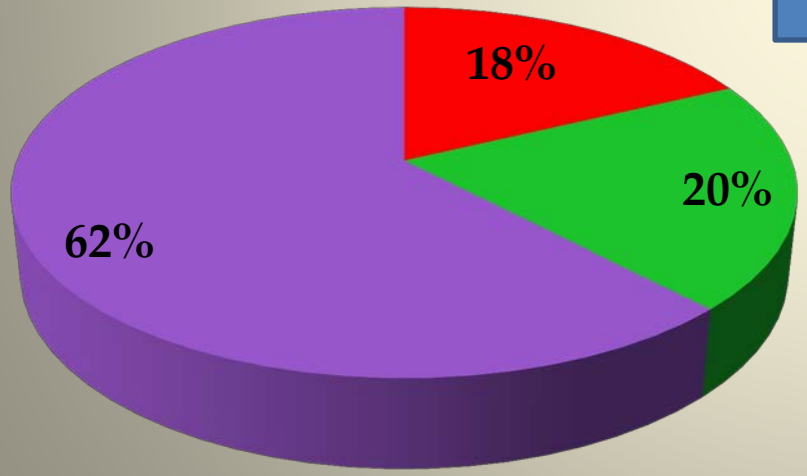
BACKGROUND

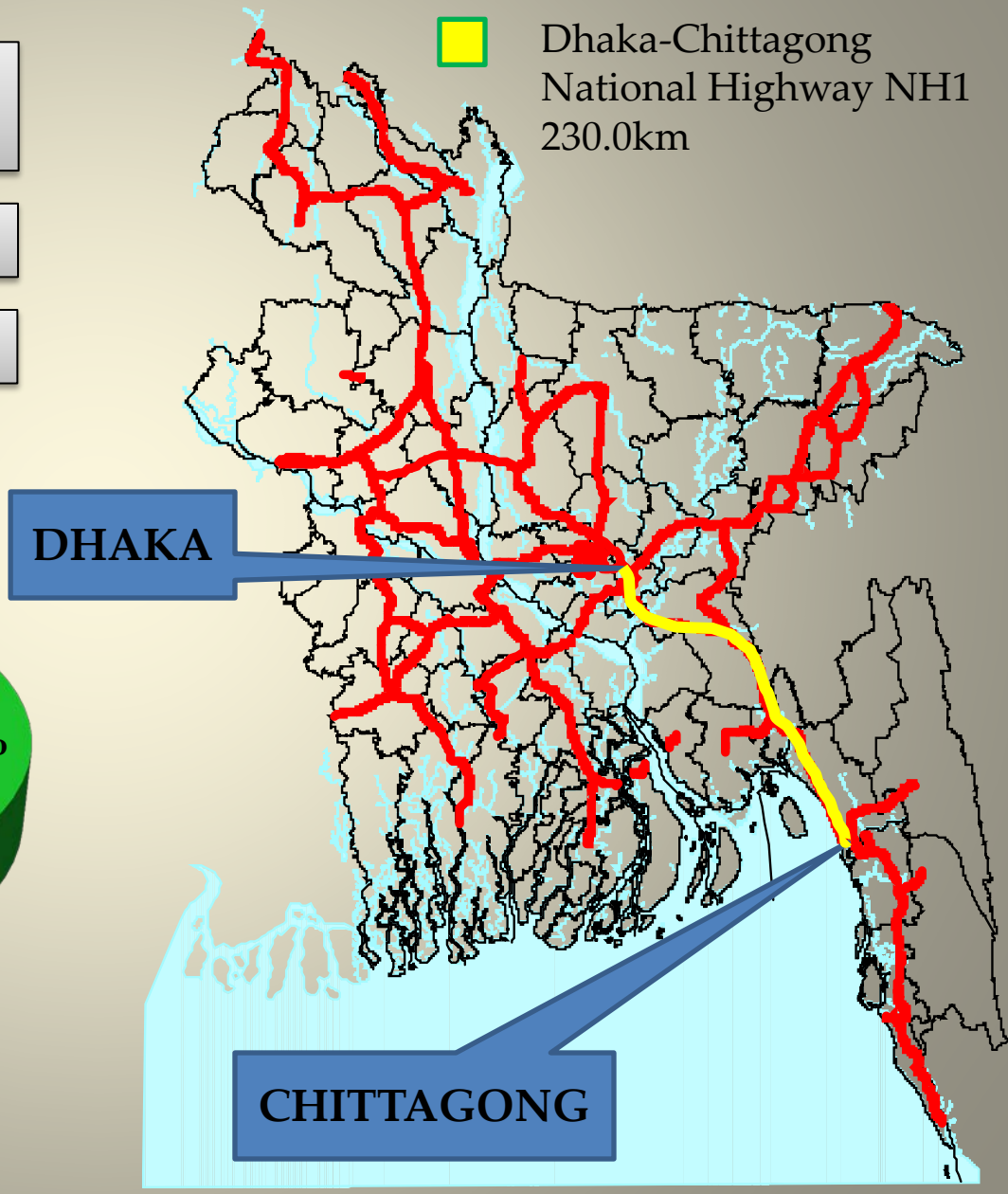
**Roads and Highways Department**
**ROAD NETWORK**[4]

**National Road -- 3,813 km**

**Total Roads -- 21,302 km**

National Regional District




[4]*http://www.rhd.gov.bd/newweb_main.asp*

## Yearly traffic growth[5]

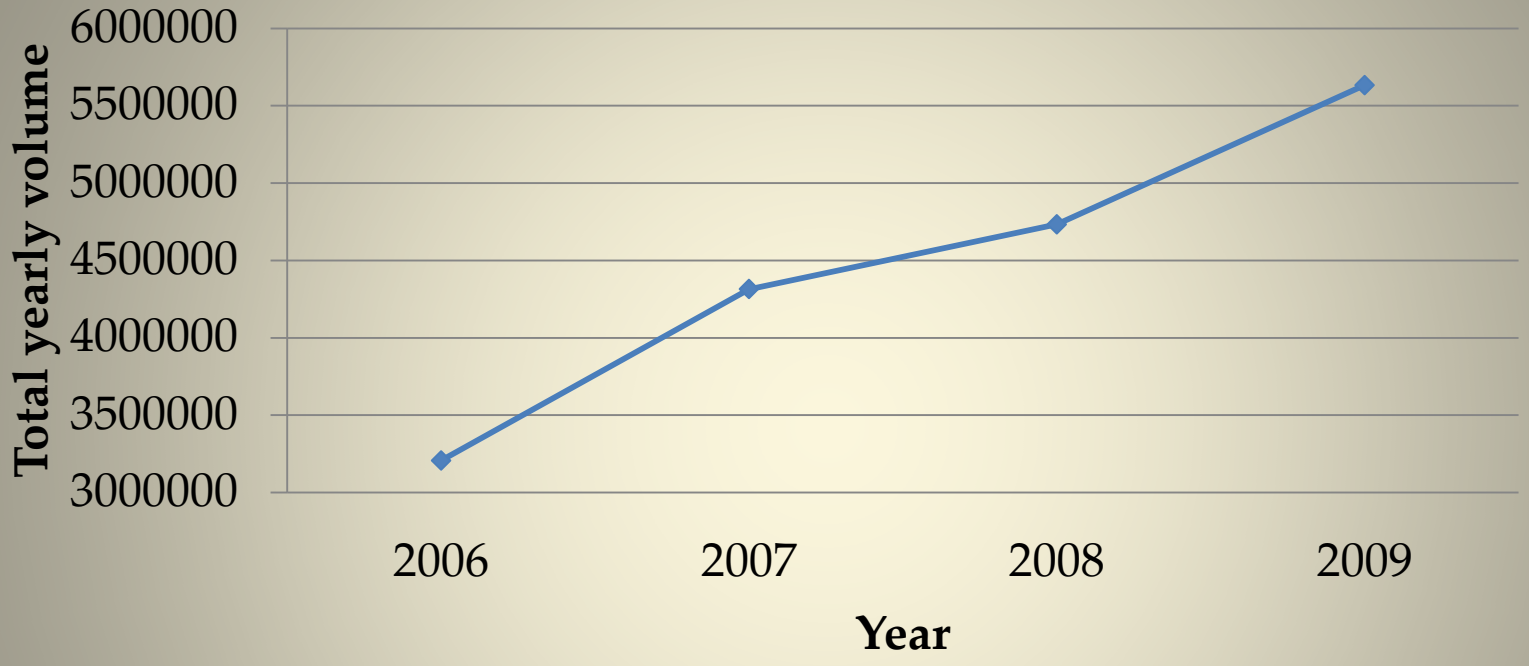



**Table 1 Yearly Growth Rate of Total Traffic[7]**

| Year | Growth Factor | Average Growth Factor |
|---|---|---|
| 2006 | - | 21.03% |
| 2007 | 34.370 | |
| 2008 | 9.716 | |
| 2009 | 19.012 | |

[5]*Ullah et al.*, (2013)

# BACKGROUND

Dhaka-Chittagong National Highway (NH1) is crucial to the Bangladesh Economy

81% of Bangladesh's total export earnings from Ready-made-garment (RMG) industry through the Port of Chittagong using the NH1[6]

Chittagong port handles 92% of all of the country's imports and exports with the bulk of this trade being transported by road using the NH1 with few or no alternatives[6]

Prospective route for Regional Connectivity (Bangladesh-Bhutan-India-Nepal (BBIN) and Bangladesh-China-India-Myanmar (BCIM)

[6]*Routh, S.K., Superintending Engineer, Roads And Highways Department, Bangladesh, PPTX on* ***Dhaka Chittagong Expressway on PPP Basis Chittagong Stakeholders' Meeting****, (2013)*

# BACKGROUND

Bangladesh imported 3.6 million ton of petroleum fuel costing US $1.99 billion[8]

- about 1.96 % of the country's GDP
- 16 % of current account balance

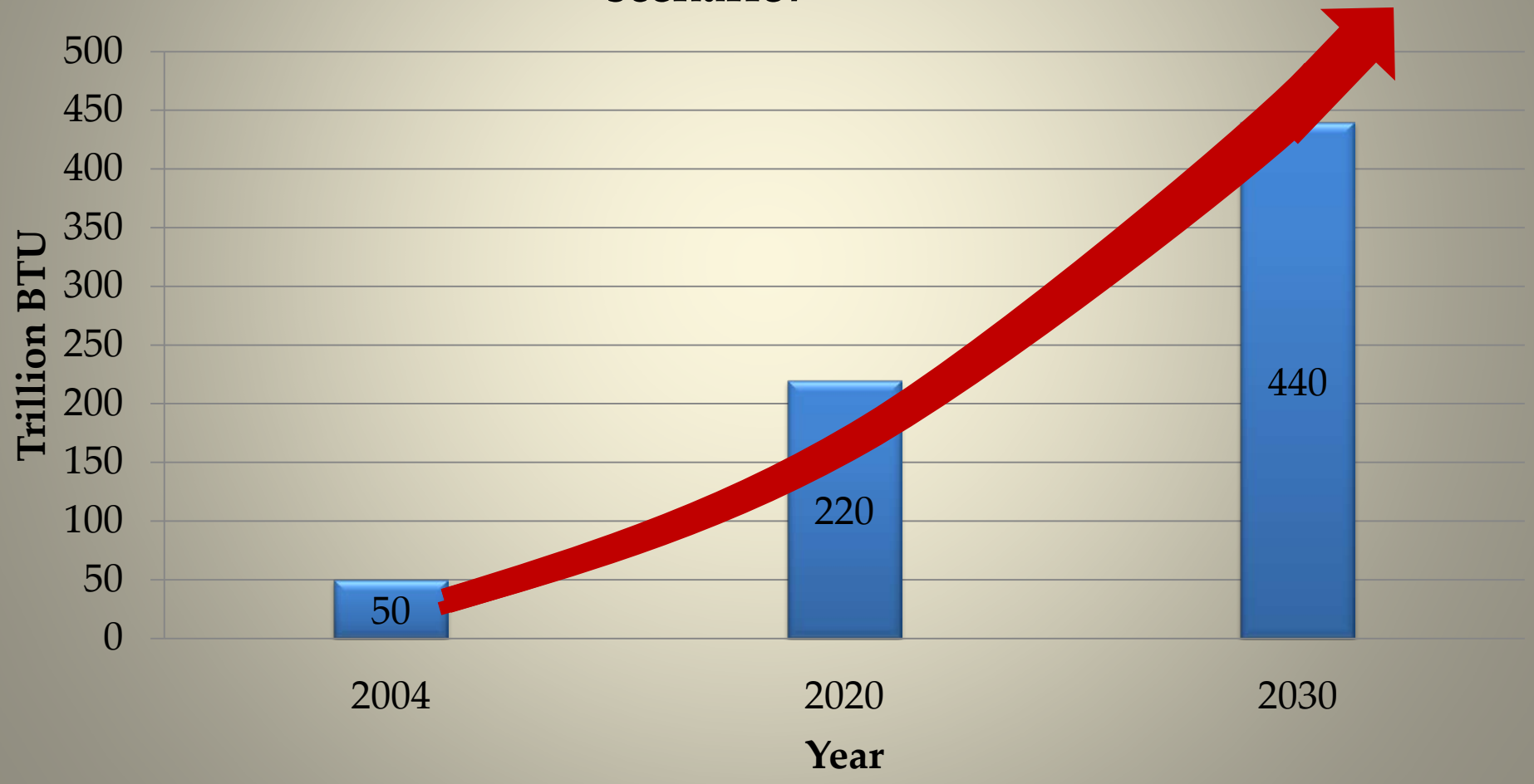
Total consumption of petroleum is about 3.78 million ton (MT)[8]

- 2.03 million ton is for transport sector

[8]*Bangladesh Petroleum Corporation, (2009)*

BACKGROUND

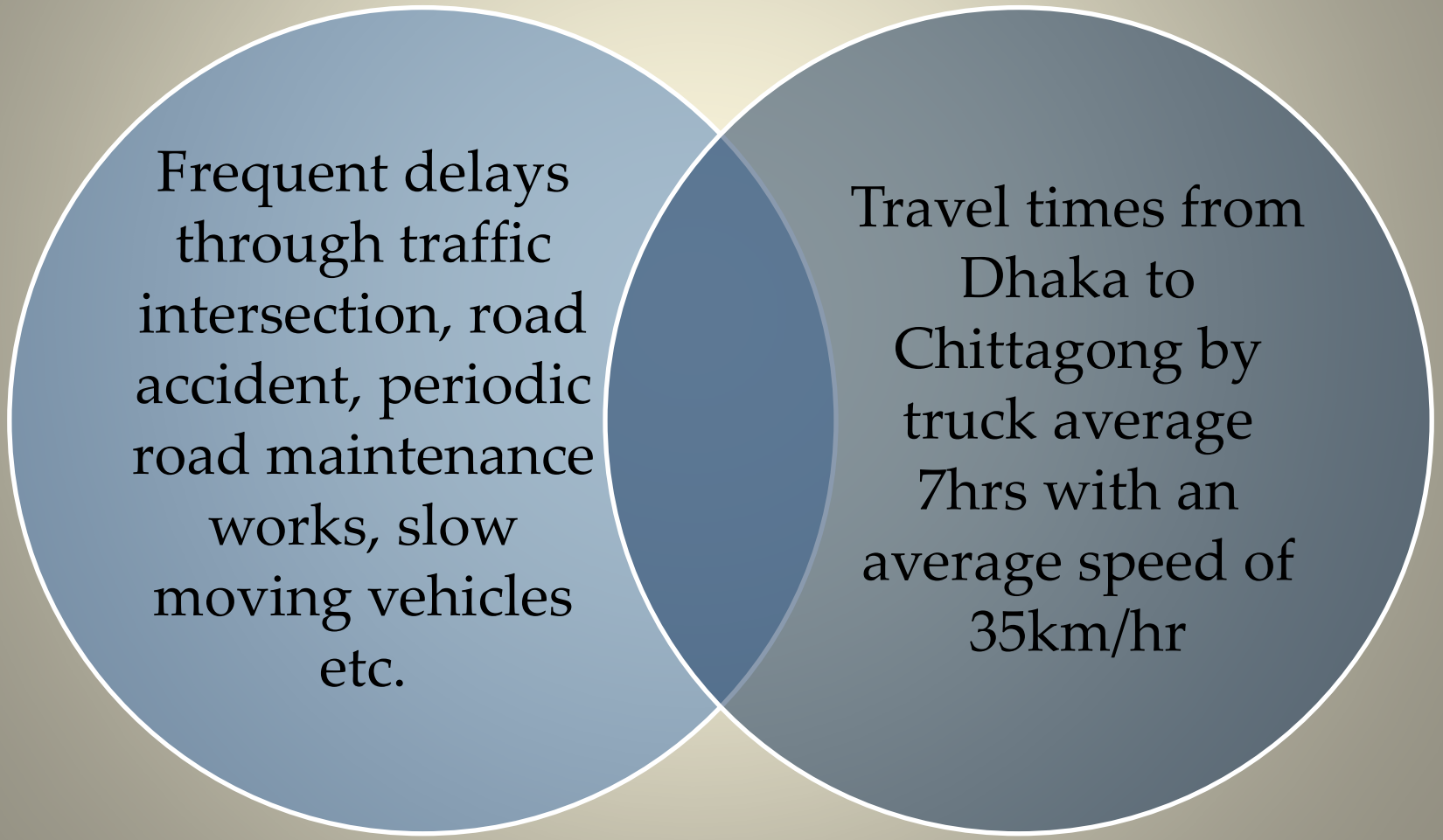
## Road sector fuel demand under Business-as-Usual scenario7




[7] *Alam et al.*, (2013)

RATIONALE

## PROBLEM STATEMENT



# Study Area Layout Plan

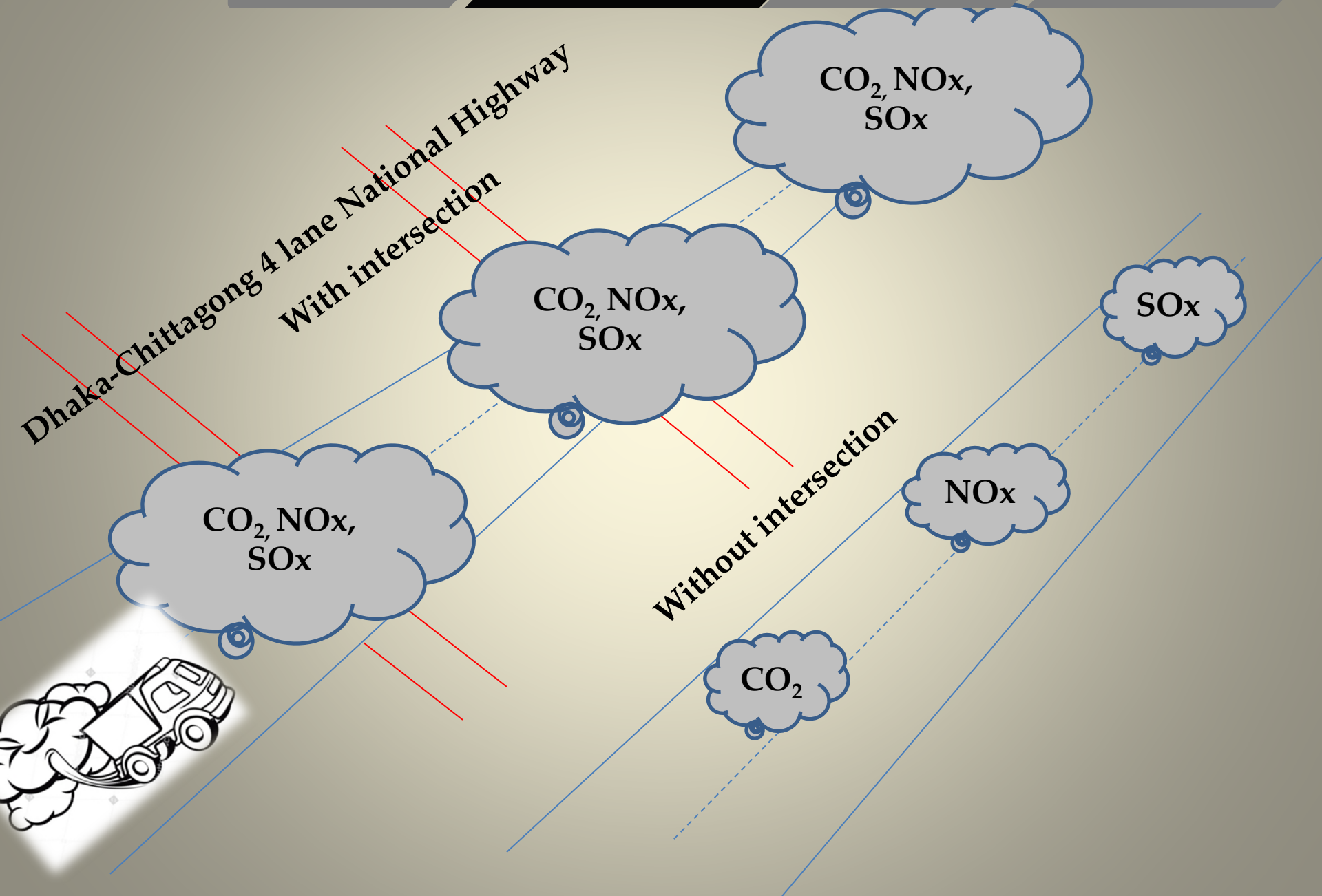

## Dhaka-Chittagong National Highway[9]

number of traffic congestion hotspots

- Study Area length 230.0 km
- Major traffic congestion hotspots

[9]Routh, S.K., Superintending Engineer, Roads And Highways Department, Bangladesh, PPTX on ***Dhaka Chittagong Expressway on PPP Basis Chittagong Stakeholders' Meeting***, (2013)

# METHODOLOGY



# METHODOLOGY

Calculating total delay time for vehicles at an intersection

Calculating cruise time for non-intersection road section

Calculation of fuel loss for AADT (2009) based on vehicle speed during the loss time

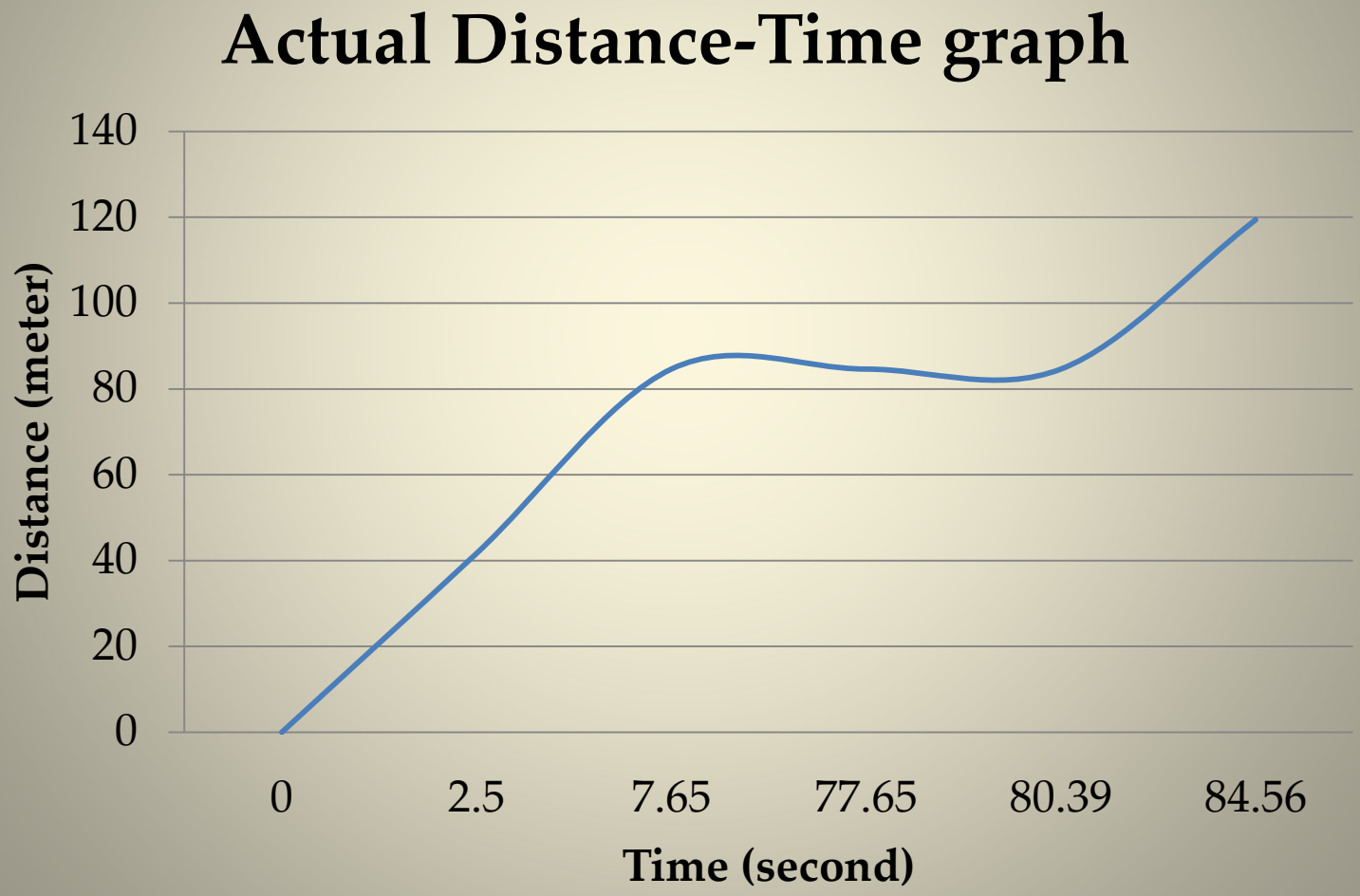
Calculating GHG emission for different driving condition

Comparing GHG emission for engine type during the stopping time (vehicle idling)

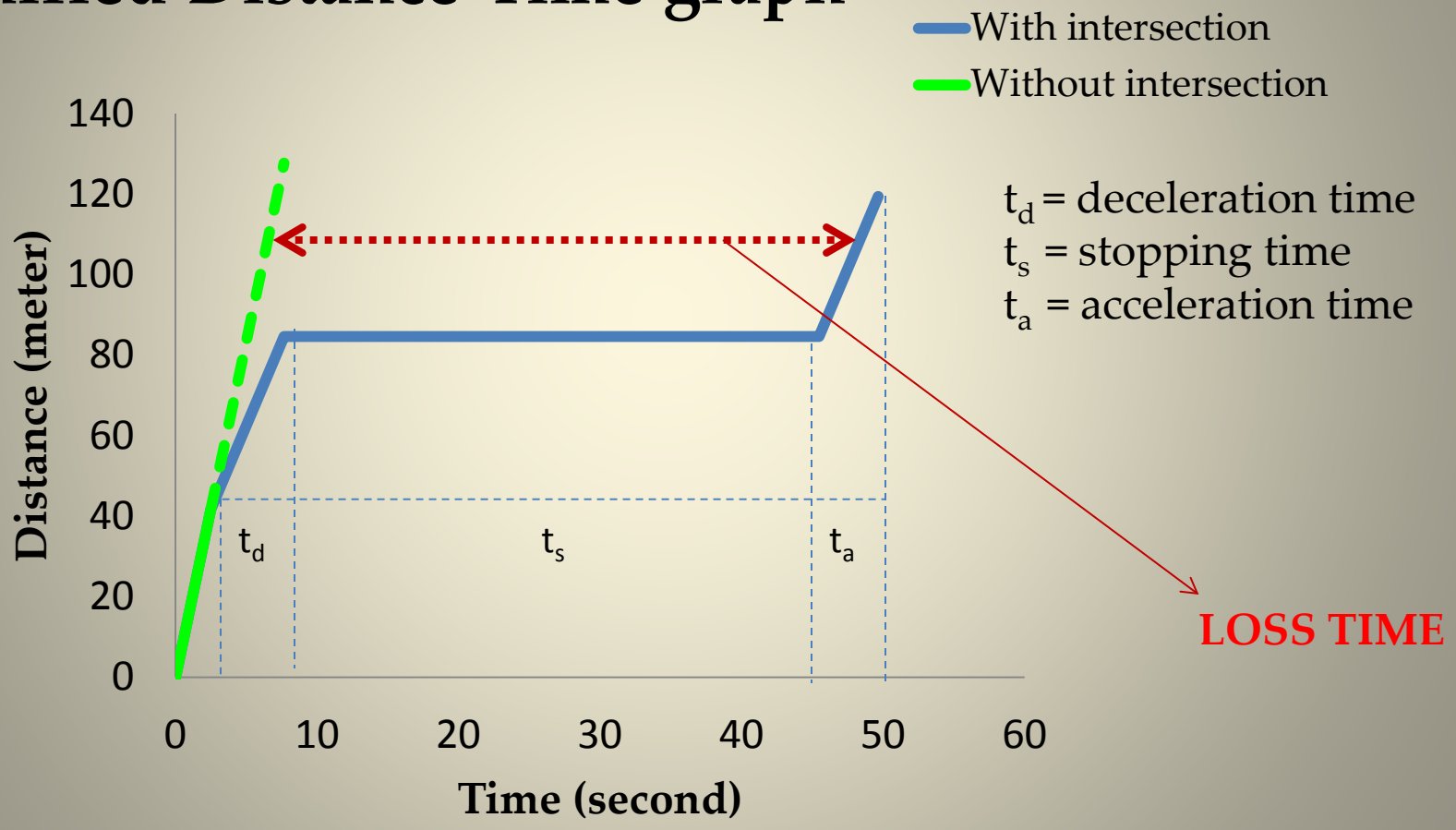
## Table 2 Time and Distance covered during before, at and after crossing the intersection

| | Time (Second) | Distance (meter) |
|---|---|---|
| Perception reaction | 2.5 | 41.675 |
| Deceleration | 5.16 (avg) | 42.949 |
| Complete Stopping | 70.0 | 0 |
| Incremental delay | 2.74 (avg) | 0 |
| Acceleration | 4.17 (avg) | 34.778 |

RESULT


Actual Distance-Time graph
Distance (meter)
140
120
100
80
60
40
20
0
0
2.5
7.65
77.65
80.39
84.56
Time (second)

# Modified Distance-Time graph



## Table 3 Total Fuel Loss Calculation during Loss Time

| Vehicle Mode | Number of Vehicle[10] | Time Loss/10 intersections | Total time loss | Velocity | Fuel efficiency[11] | Fuel Loss |
|---|---|---|---|---|---|---|
| | Nos | hr/veh | hr/year | Km/hr | Km/liter | Liter |
| Motor Cycle | 46,896 | 0.215 | 10082.64 | 60.0 | 52.5 | 11,523.02 |
| Scoter | 291,080 | 0.215 | 62582.2 | 60.0 | 42 | 89,403.14 |
| Car/Jeep | 756,199 | 0.215 | 162582.79 | 60.0 | 9.82 | 93,377.51 |
| Micro/Pickup | 994,568 | 0.215 | 213832.12 | 60.0 | 7.64 | 1,679,309.84 |
| Mini Bus/ Coaster | 535,970 | 0.215 | 115233.55 | 60.0 | 3.23 | 2,140,561.30 |
| Bus | 788,149 | 0.215 | 169452.04 | 60.0 | 2.8 | 3,631,115.04 |
| Truck | 1,876,198 | 0.215 | 403382.57 | 60.0 | 2.62 | 9,237,768.78 |
| Trailer | 115,995 | 0.215 | 24938.925 | 60.0 | 2.62 | 571,120.42 |
| Toll free | 227,743 | 0.215 | 48964.745 | 60.0 | 2.62 | 1,121,330.04 |
| Total | 5,634,807 | | | | | 19,475,509.08 |

[10] *Ullah et al., (2013)*

[11] *RHD Road User Cost 2004-2005*

## Table 4 Measured Vehicle Emission by Driving Mode

| | Mode | Time | Modal emission | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | CO | | NO | | HC | |
| | Total Time Required | Sec | Rate[12] (mg $sec^{-1}$) | Total (ton) | Rate[12] (mg $sec^{-1}$) | Total (ton) | Rate[12] (mg $sec^{-1}$) | Total (ton) |
| **With intersection** | Perception Reaction (Cruise) | 2.5 | 10 | 1.408 | 1.25 | 0.507 | 0.6 | 0.084 |
| | Deceleration | 5.15 | 7.5 | 2.176 | 0.5 | 0.145 | 0.4 | 0.116 |
| | Idle, Delay | 72.74 | 1.5 | 6.148 | 0.1 | 0.409 | 0.25 | 1.024 |
| | Acceleration | 4.17 | 22.5 | 5.286 | 1.5 | 0.352 | 1.1 | 0.258 |
| **Time Required** | | 84.56 | | 15.02 | | 1.414 | | 1.483 |
| **Without intersection** | Cruise | 7.16 | 10 | 4.036 | 1.25 | 0.505 | 0.6 | 0.242 |
| **Excess Emission** | | 77.40 | | 10.986 | | 0.91 | | 1.24 |

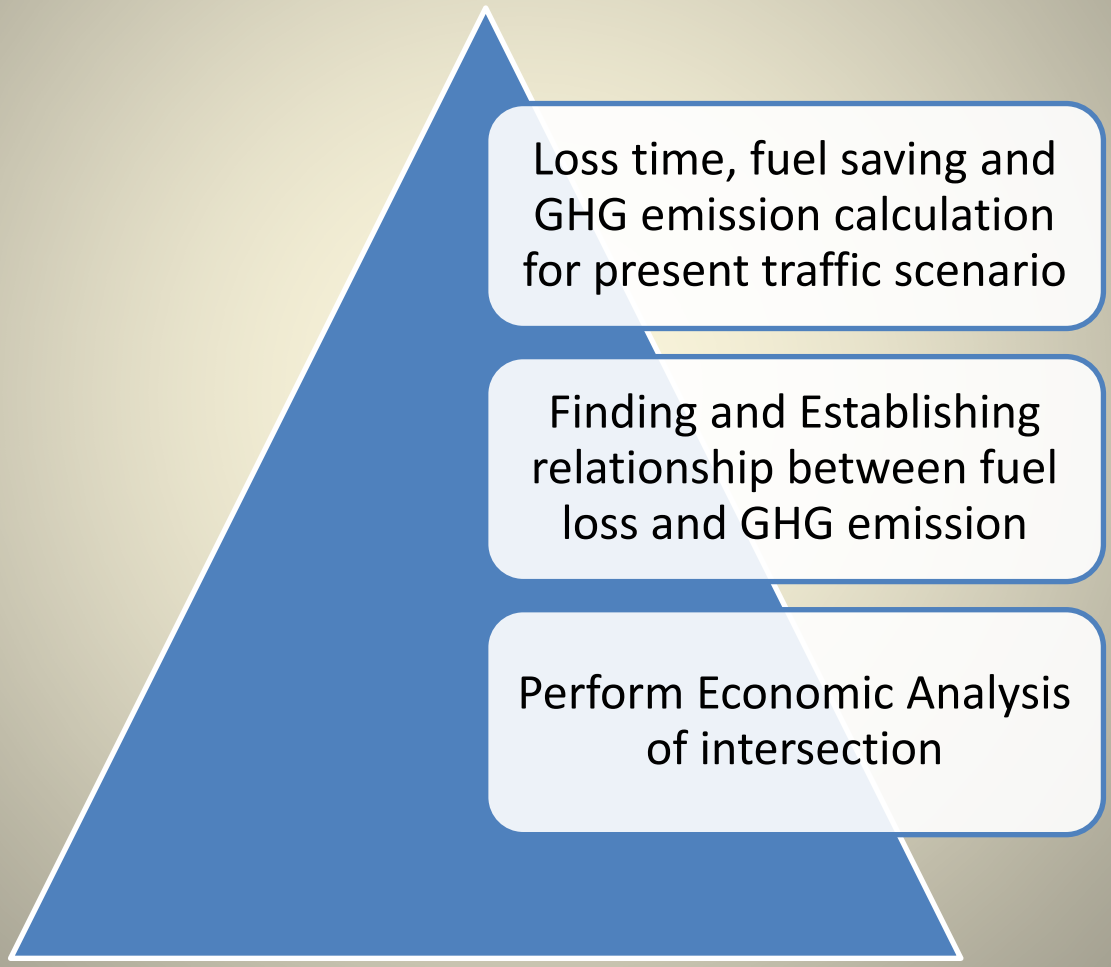
[12]*Frey et al., (2013)*

## Table 5 Idling Emission Calculation for Heavy Vehicles

| Emissions | Unit | Mechanical Fuel Ignition (MFI) | | | Electric Fuel Ignition (EFI) | | | Effect of change from MFI to EFI | |
|---|---|---|---|---|---|---|---|---|---|
| | | Rate | gm/veh | Total emission tonne | Rate | gm/veh | Total emission tonne | | |
| CO | gm/hr | 35 | 3.5 | 24.57 | 20 | 2 | 14.04 | -43% | DECREASE |
| HC | gm/hr | 23 | 2.3 | 16.14 | 6 | 0.6 | 4.21 | -74% | DECREASE |
| $NO_x$ | gm/hr | 48 | 4.8 | 33.70 | 86 | 8.6 | 60.38 | 79% | INCREASE |
| PM | gm/hr | 4 | 0.4 | 2.80 | 1 | 0.1 | 0.70 | -75% | DECREASE |
| $CO_2$ | gm/hr | 4484 | 448.4 | 3148.27 | 4636 | 463.6 | 3255.00 | 3% | INCREASE |

[13] *Kirchstetter et al., (1999)*

# FUTURE WORK


Loss time, fuel saving and GHG emission calculation for present traffic scenario
Finding and Establishing relationship between fuel loss and GHG emission
Perform Economic Analysis of intersection


Think