Modelling emissions from mobile sources with GAINS

Dr. Jens Borken-Kleefeld
IIASA

Overview

- Scope:
  - motorized road transportation
  - Non-road modes
  - Off-road machinery

Objective

- Past and present (national) pollutant emissions
- Emission scenarios w/wo further control measures
- Input to air quality calculations (space and time resolved)

Approach, here road transport

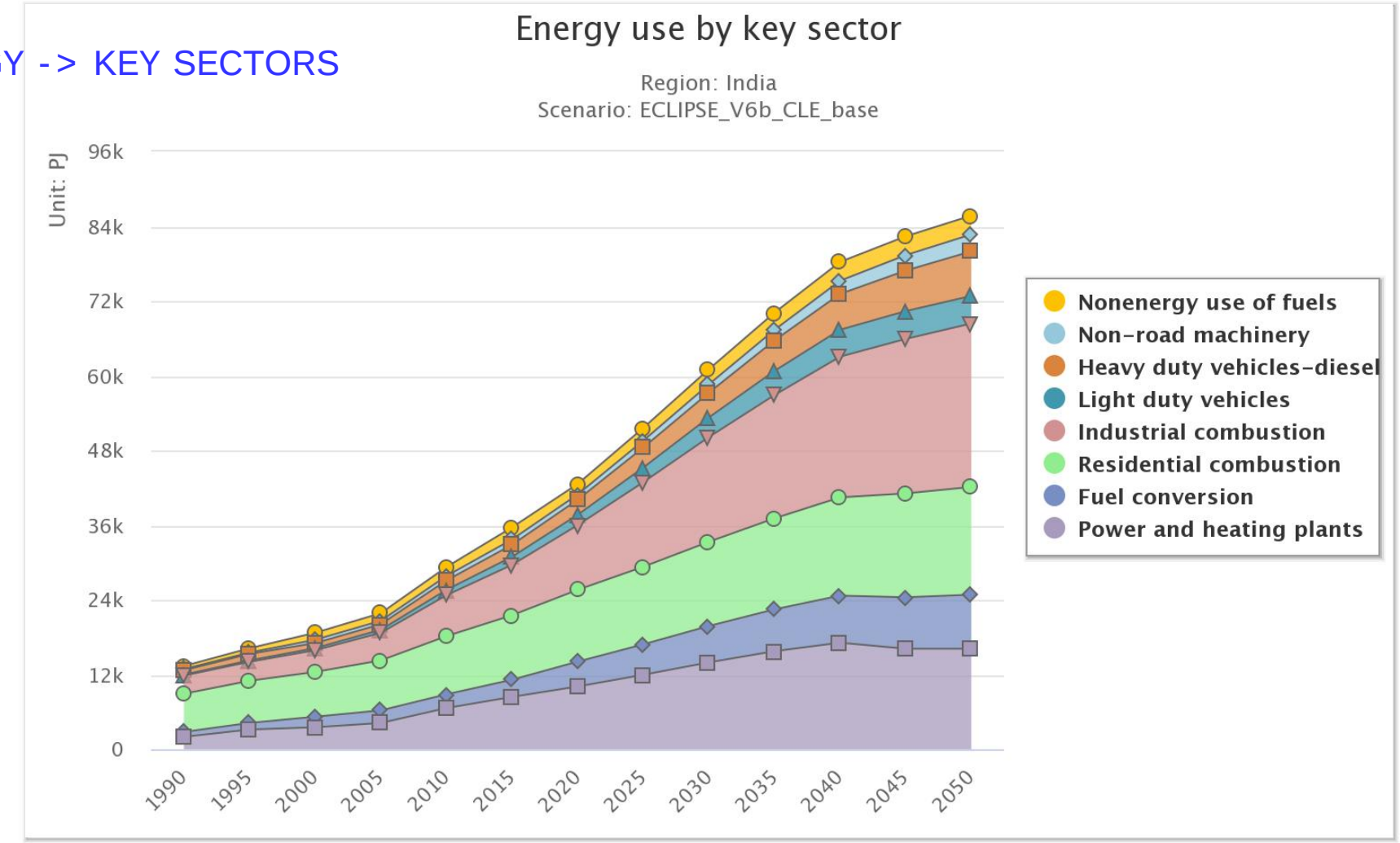
1. Establish activity structure:
   How much is driven by what vehicles?
   Cars, trucks, motorcycles,….

2. Determine emission characteristics of fleet:
   Proxy is age structure

3. Determine emission factors by emission technology

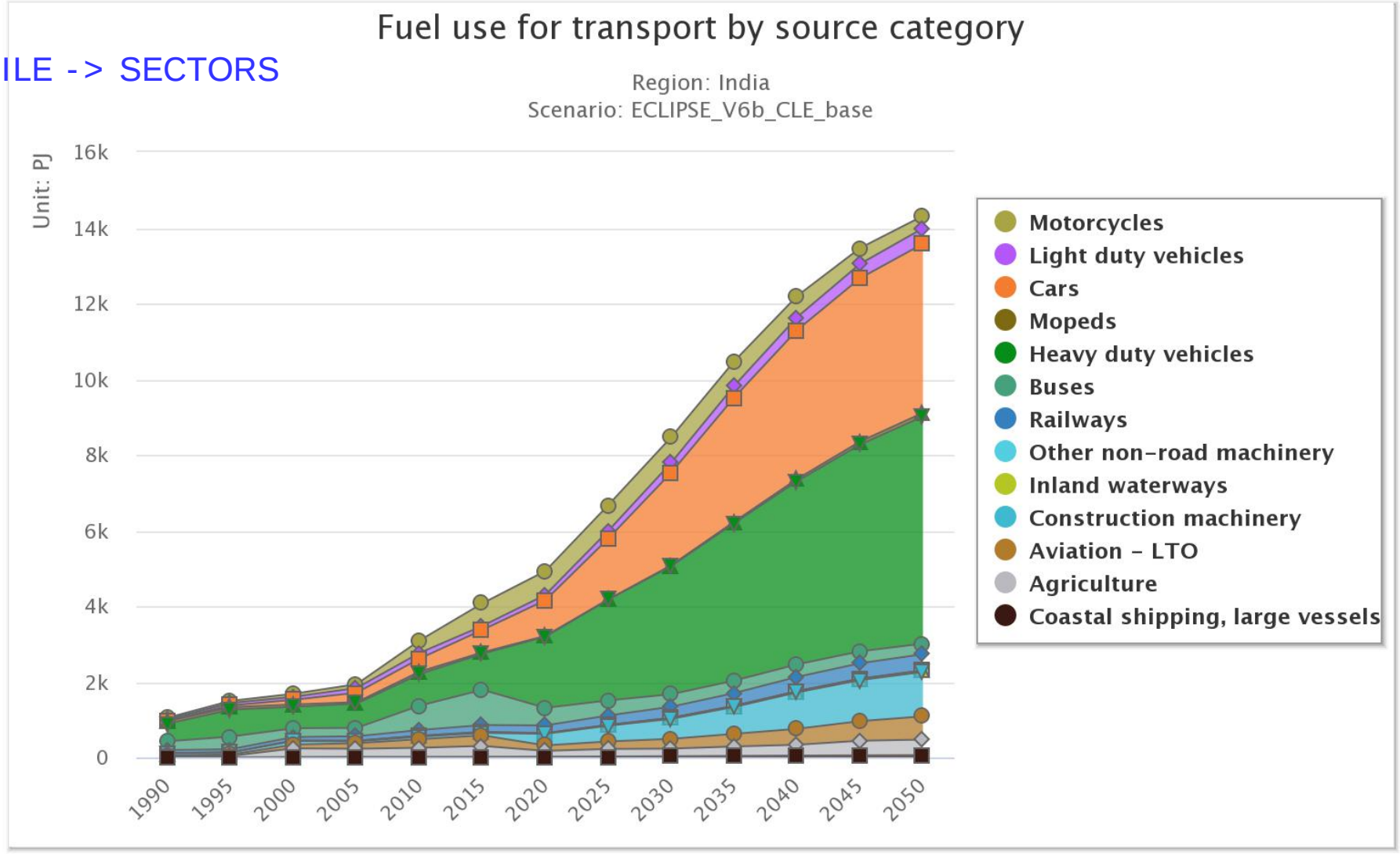
Overview: Activity structure

ACTIVITY DATA -> ENERGY -> KEY SECTORS



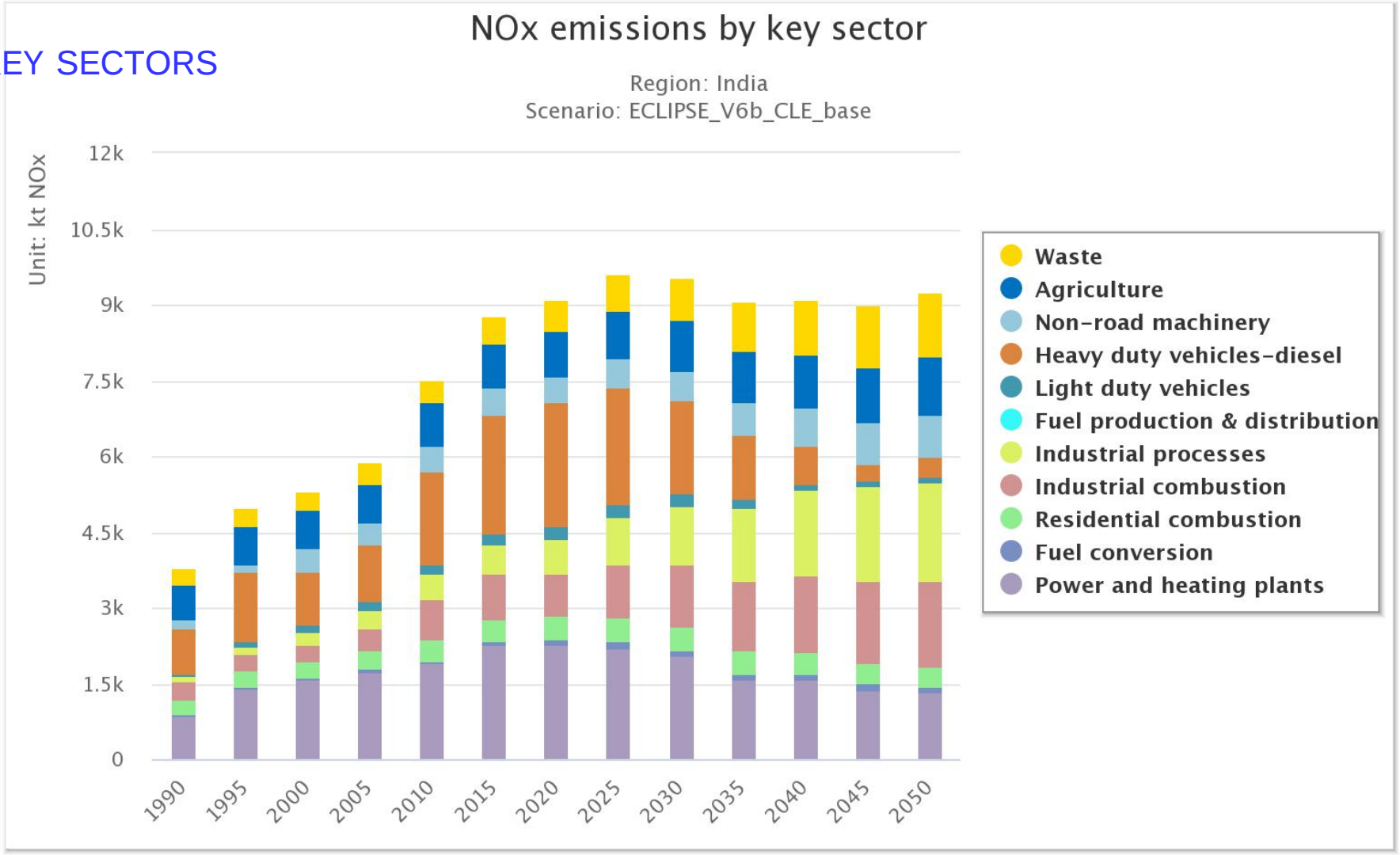
Overview: Activity structure

ACTIVITY DATA -> MOBILE -> SECTORS



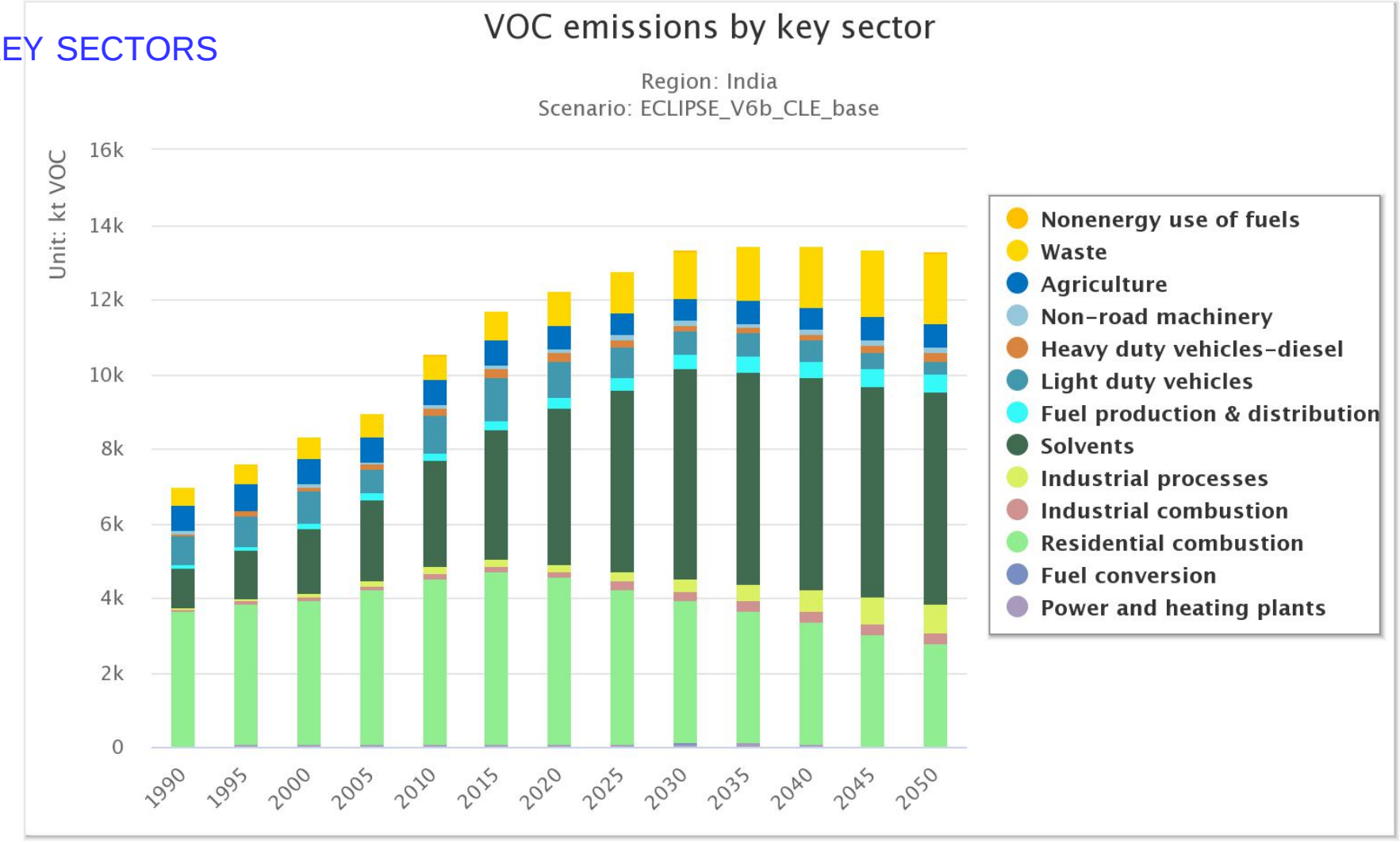
Overview: NOx emissions

EMISSIONS -> NOx -> KEY SECTORS



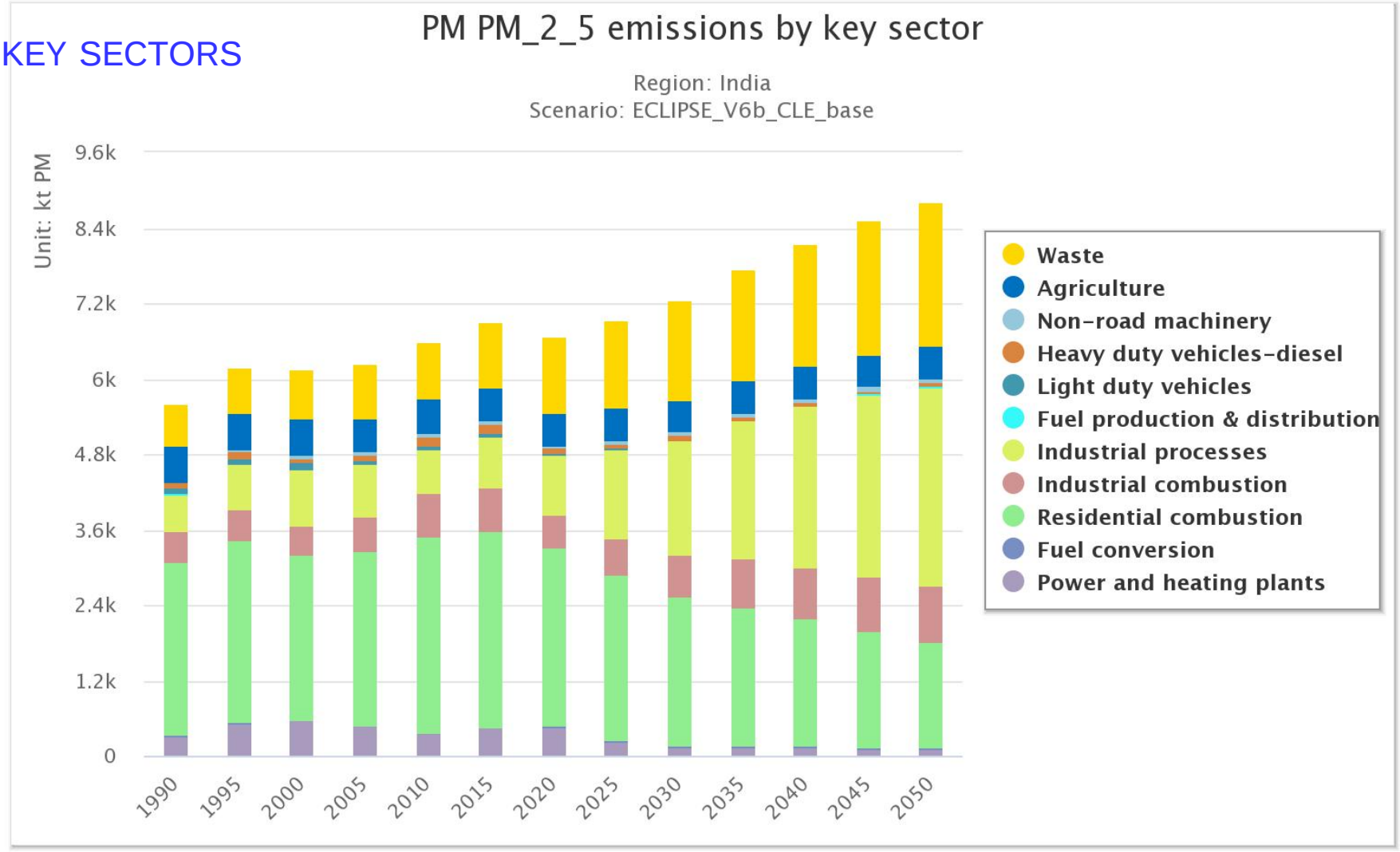
Overview: VOC emissions

EMISSIONS -> VOC -> KEY SECTORS



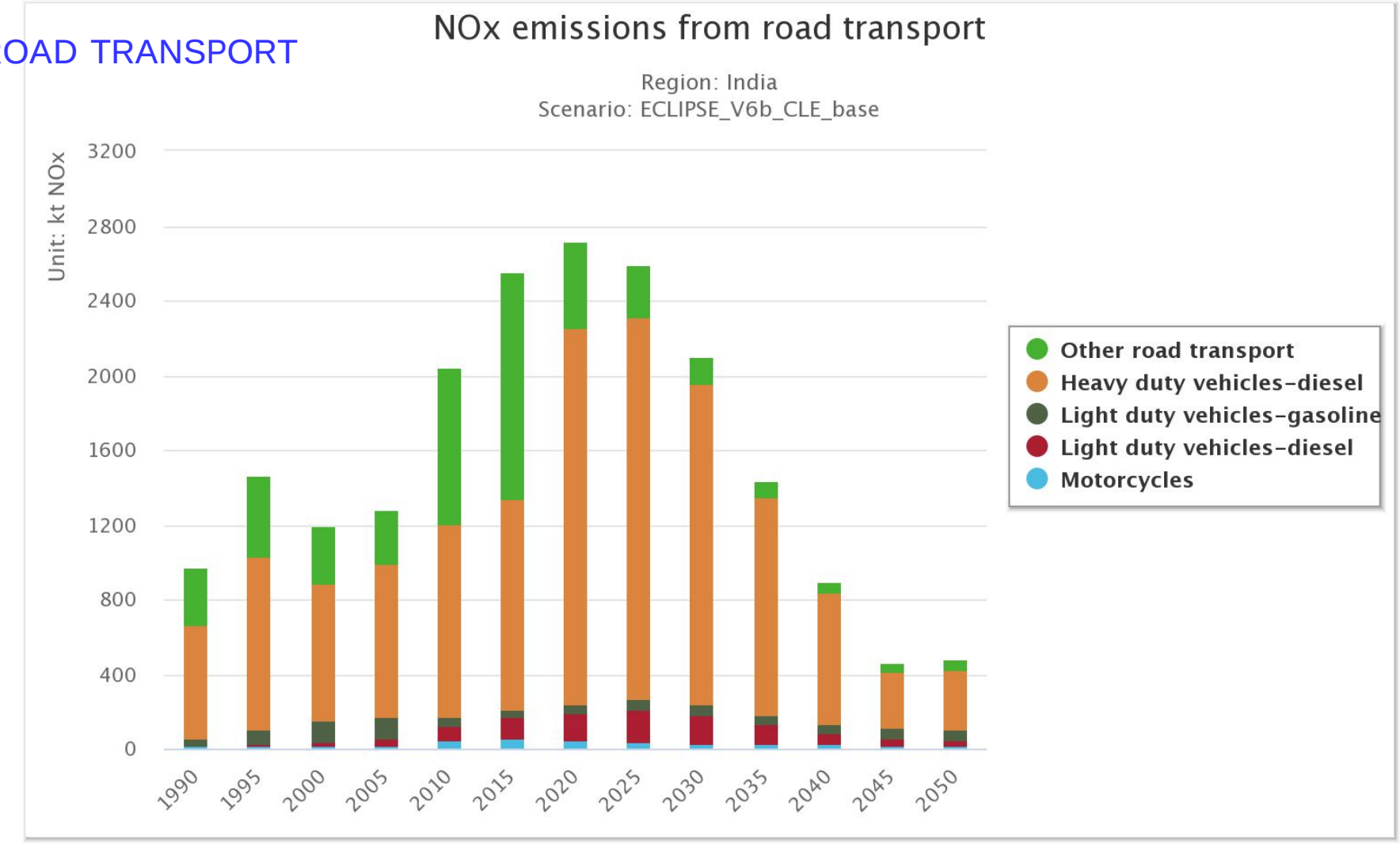
Overview: PM2.5 emissions

EMISSIONS -> PM2.5 -> KEY SECTORS



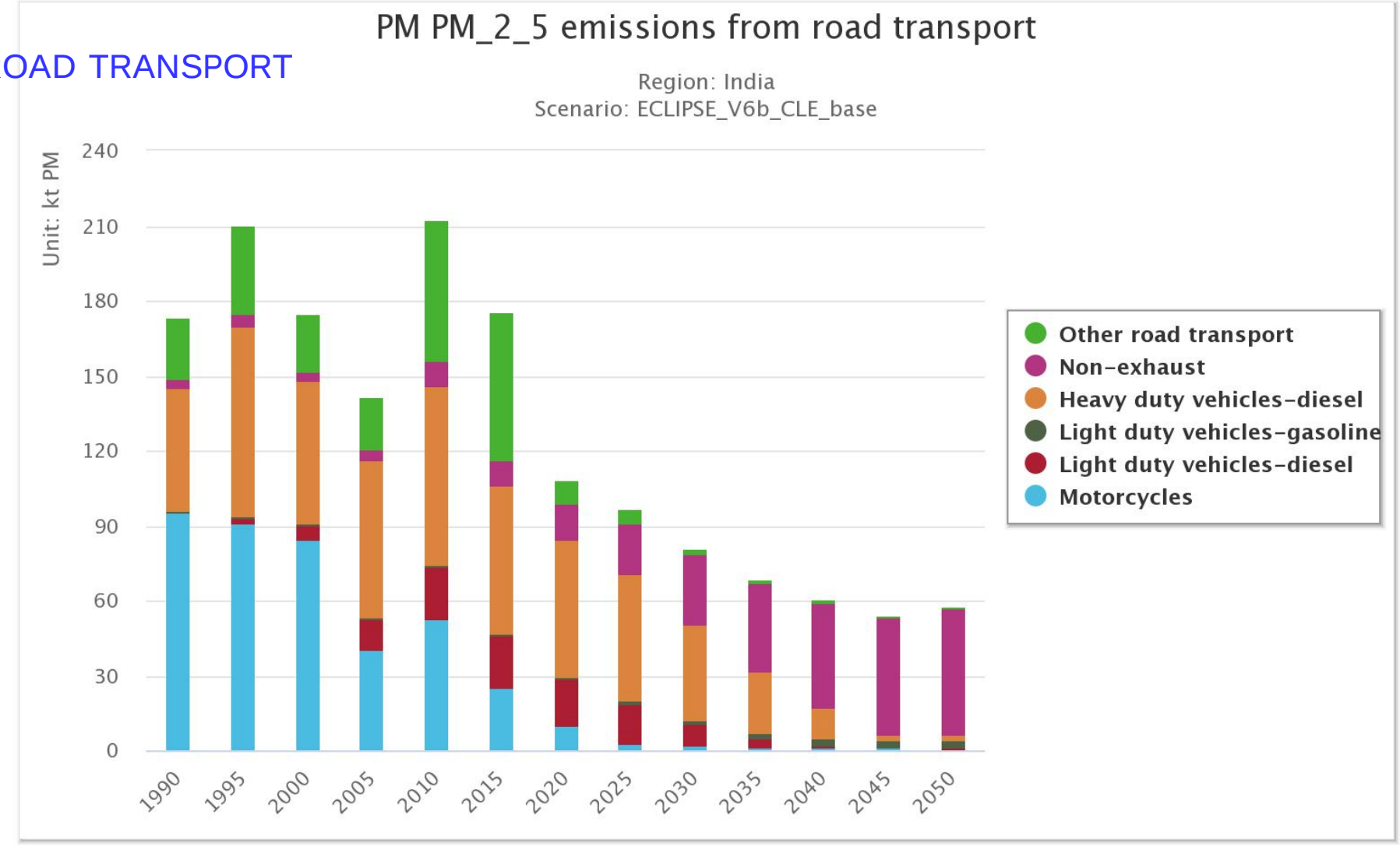
Overview: NOx emissions -> Road

EMISSIONS -> NOx -> ROAD TRANSPORT



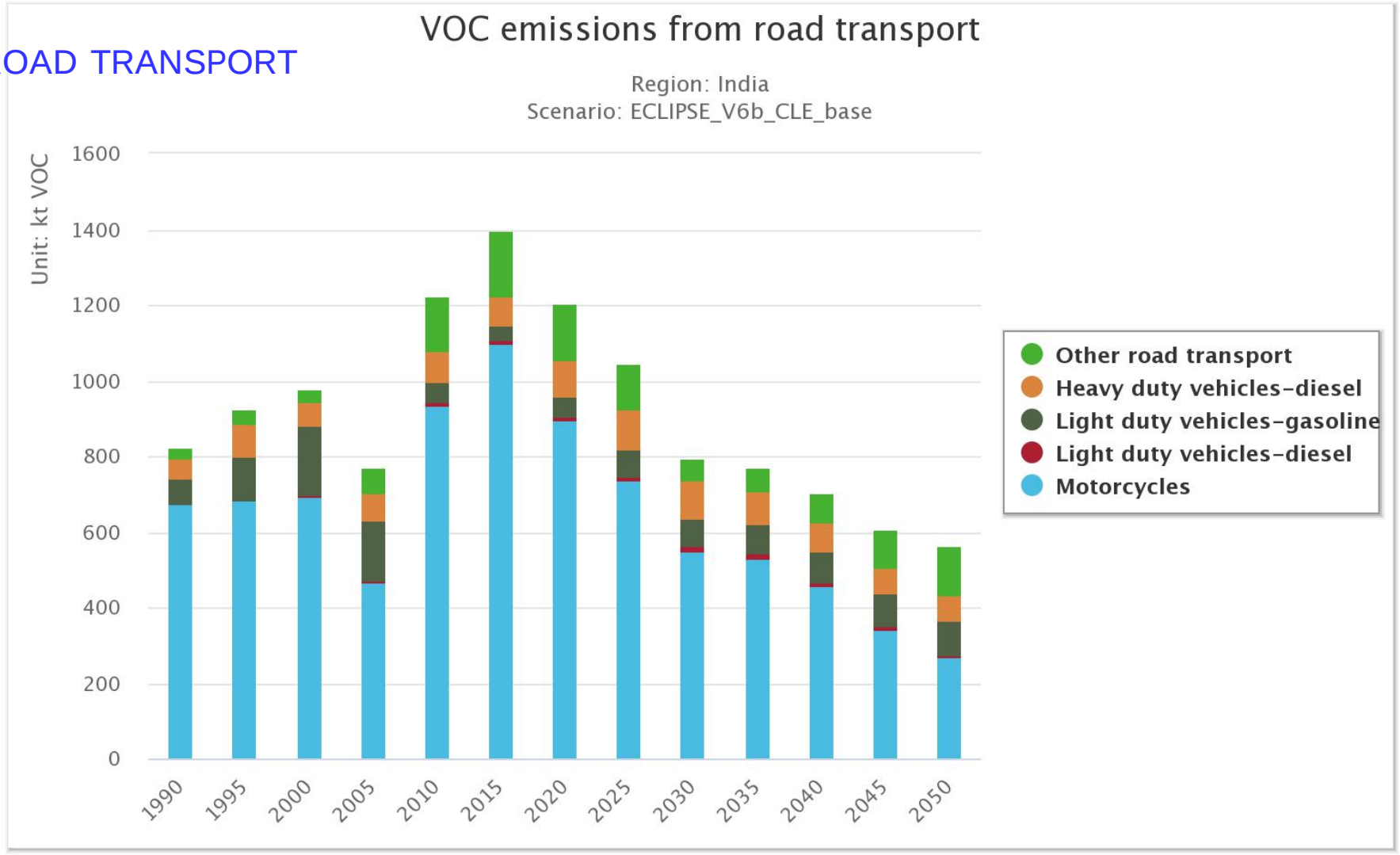
Overview: PM2.5 emissions -> Road

EMISSIONS -> PM -> ROAD TRANSPORT



Overview: VOC emissions -> Road

EMISSIONS -> VOC -> ROAD TRANSPORT



Hands on!

Explore the features yourselves, e.g.

- Check out other pollutants
- look into different sub-sectors
- Compare different emission scenarios
- Zoom into individual (sub) regions

FEEDBACK at 14:33 local time

How to calculate emissions from road?

Method: Emissions from mobile sources

Road transport is disaggregated as follows:

Road categories

- Passenger cars;
- Light commercial veh. (<3.5 tons GVW);
- bus & coach;
- medium & heavy-duty truck;
- 2-stroke moped/scooter; motorcycle;
- other, e.g. 3-wheeler

- Fuel types: Gasoline, diesel, CNG, LPG, H_2, electric

- DATA MANAGEMENT -> DOWNLOAD: ACTIVITY DATA

Method: Emission calculation (road = more detailed)

Activity data

Fuel sales by fuel from (national) statistics match the bottom-up calculation:

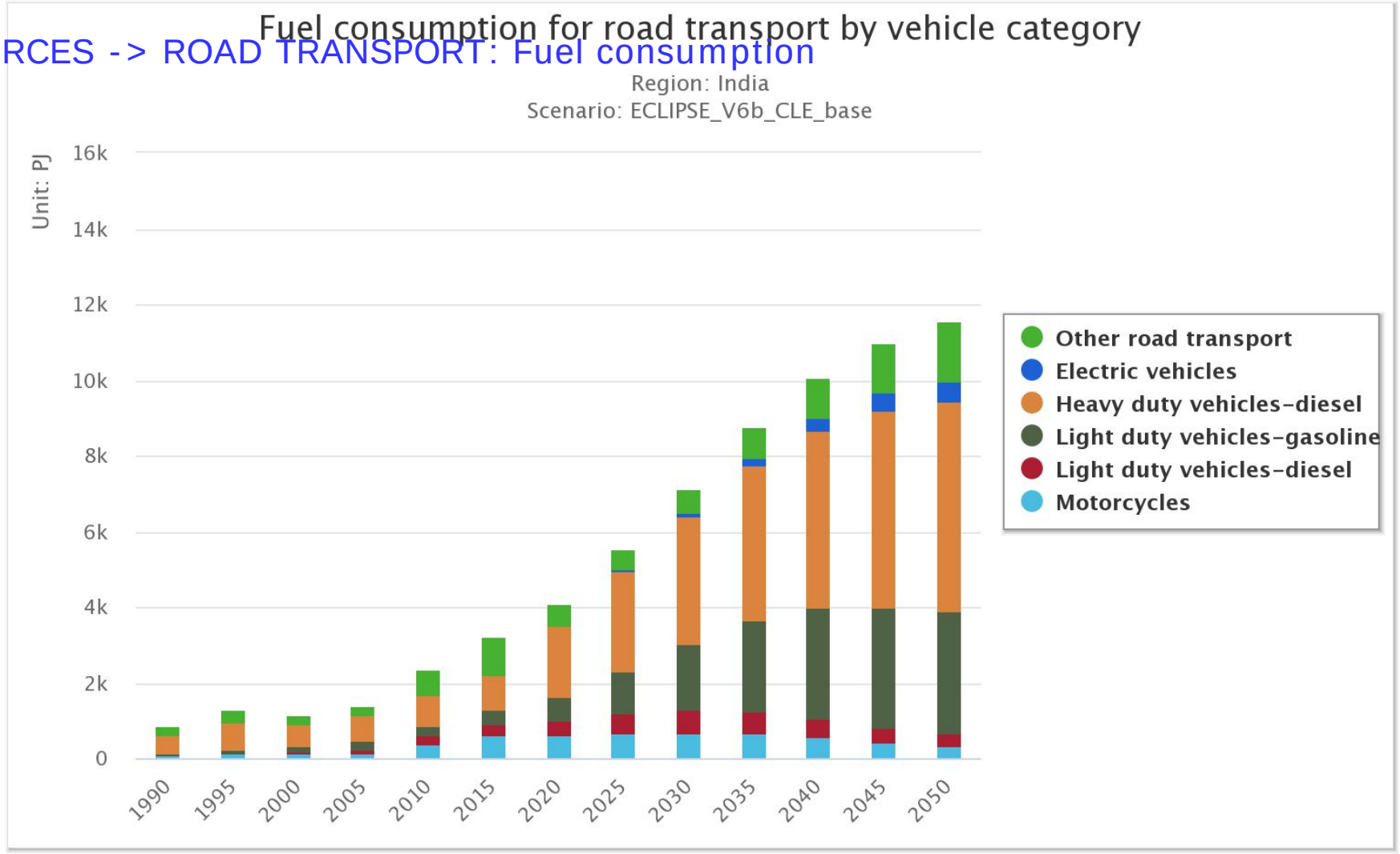
Fuel sales :=
 # active vehicles x ann. mileage x spec. fuel consumption

This establishes the activity data by vehicle and fuel type.

- Let’s review the respective categories in the input file

Fuel consumption -> Road

ACTIVITY -> MOBILE SOURCES -> ROAD TRANSPORT: Fuel consumption



Method: Emission calculation (road = more detailed)

Emissions

Total Emission =

Fuel consumption$_{[\text{by veh x fuel x control stage}]}$ x Emission factor

Age structure (from new registrations – retirements) determines mix of emission control technologies
⇔ fleet average emission factor

Method: Emissions from mobile sources

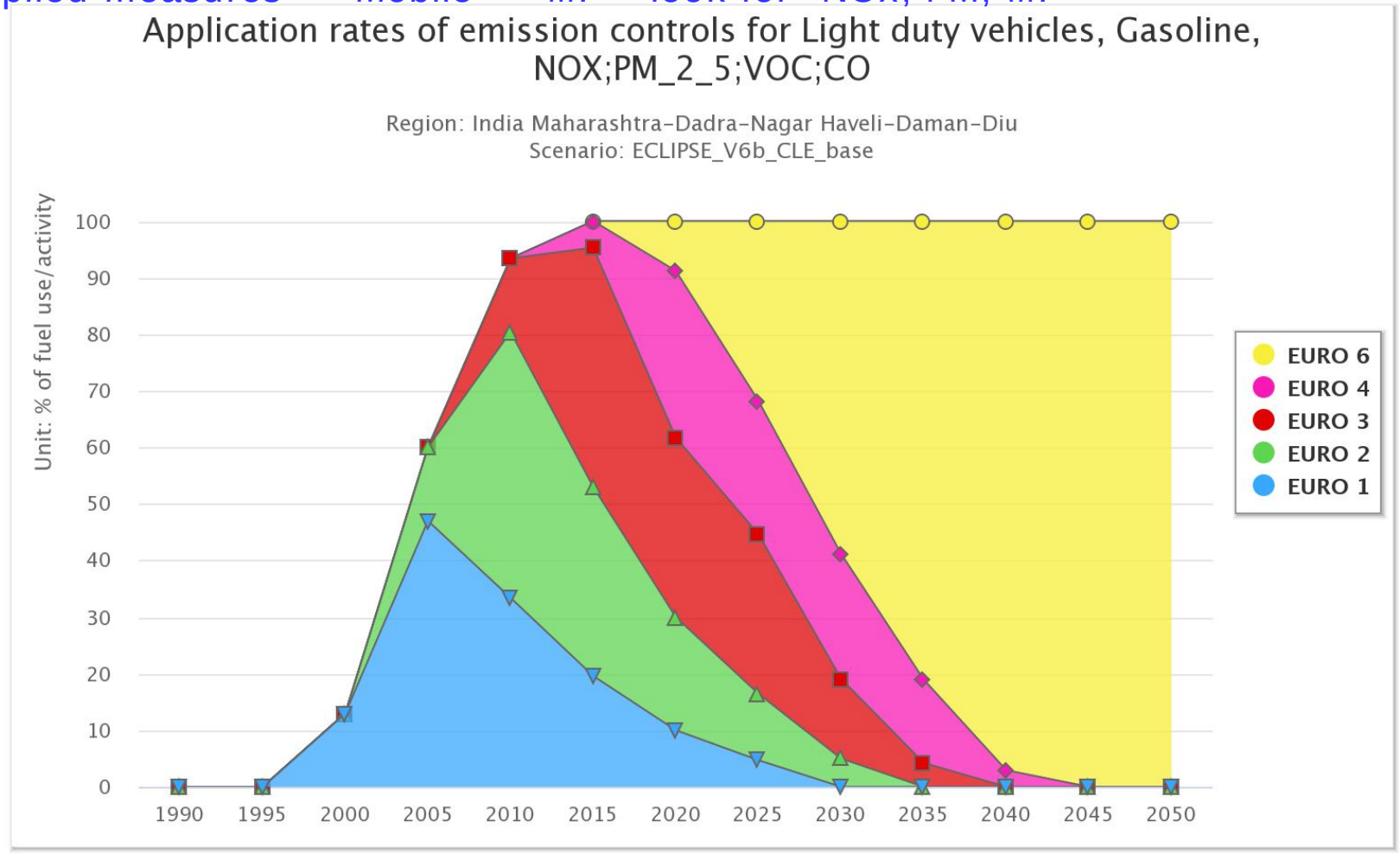
Road transport is disaggregated as follows:

- Emission control technology ⇔ emission control legislation ⇔ emission factor average over class & all driving situations:
  - preEURO,
  - EURO 1...6d (LDV),
  - EURO I....VI (HDV)

[most world regions follow EURO system; but anyhow filled with representative emission rate from respective region.]

A look at age structure

- EMISSION CONTROLS -> Applied measures -> Mobile -> ….-> look for “NOx, PM, ….”



A look at cost factor

- COSTS -> drop down: NOx ->

Method: Emissions from non-road vehicles

Non-road categories:

- Agricultural & forest machinery; Construction machinery;
- Handheld machinery (incl. domestic appliances);
- Railways;
- Aircraft;
- Pipeline compressors;
- Inland vessels; Ocean going-vessels: medium and large.

- Fuel types: Heavy fuel oil, diesel, gasoline, CNG, LPG, H_2, electric
- Emission control legislation ⇔ emission factor average over operating conditions: uncontrolled, EURO Stage I...V
  [no limitation as most globally harmonised; anyhow filled with representative emission rate from respective region.]

Method: Emissions from non-road vehicles

Activity data

Fuel sales / estimate from statistics (IEA)

(uncertainty in distribution)

Age structure (estimated from average lifetime) determines mix of emission control technologies ⇔ fleet average emission factor

=> Fuel consumption$_{[\text{by veh x fuel x control stage}]}$ x Emission factor = Total Emission