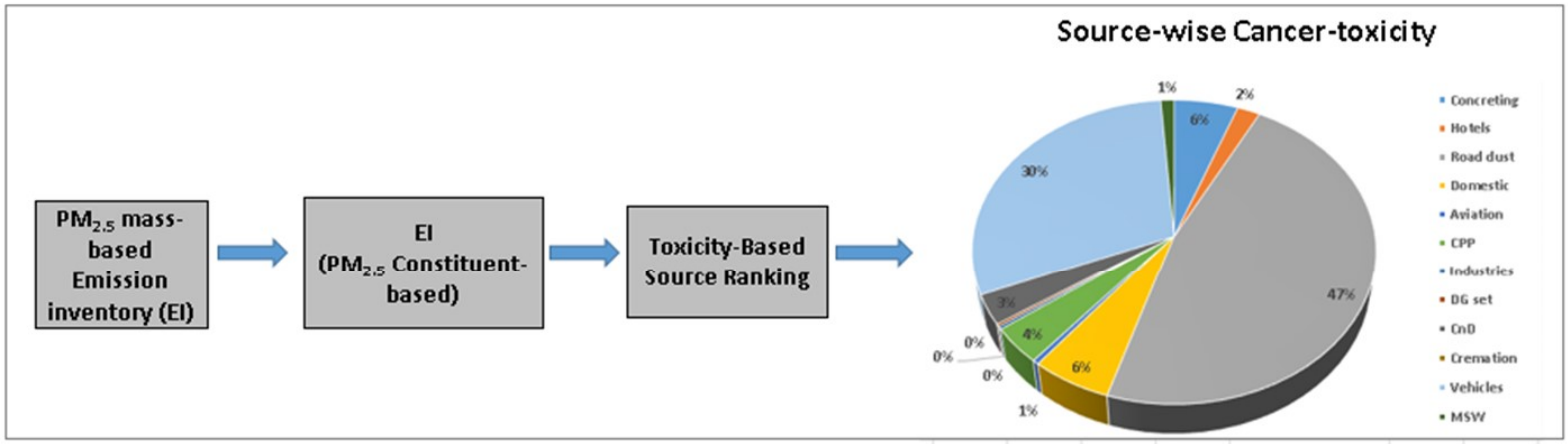
$PM_{2.5}$
Moving from Mass to Constituents Source Toxicity

CSE Orientation Workshop, June 26th 2020



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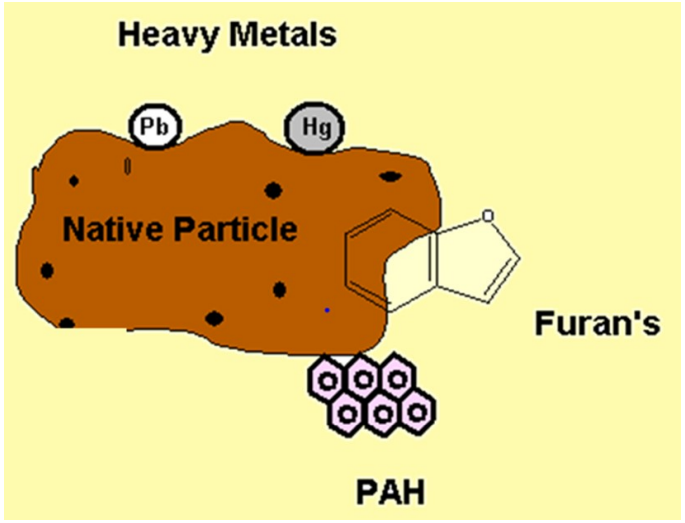
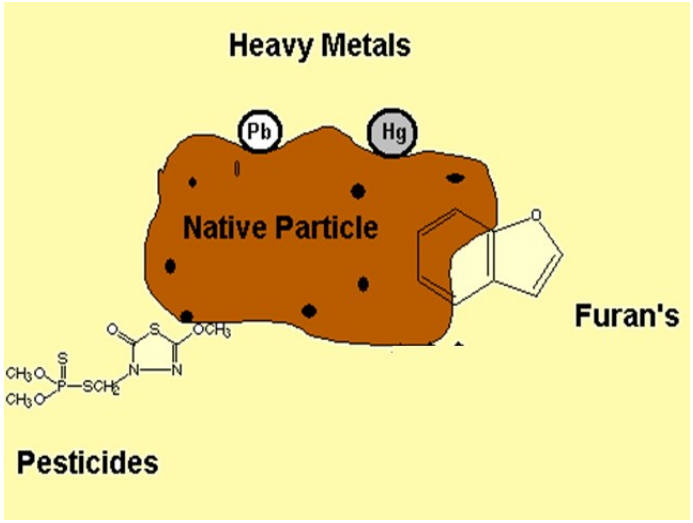
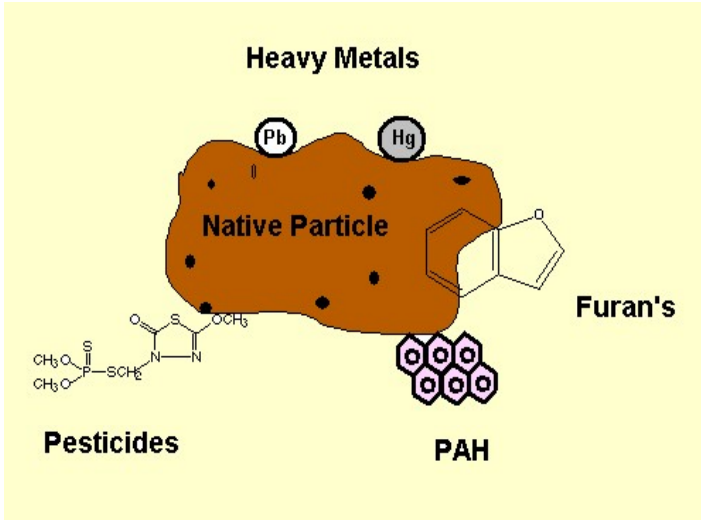
Insight into $PM_{2.5}$







A: $PM_{2.5}$ mass: 1.5 mg

B: $PM_{2.5}$ mass: 1.5 mg

C: $PM_{2.5}$ mass: 1.5 mg

Toxicity: C > B > A

PAHs

Sources

Forest fires

Volcanic eruptions

Natural

Automobiles

Coal burning

Smoking

Industries

Garbage and biomass burning

Anthropogenic

PAHs and health…

Eye irritation

Vomiting

Diarrhea

Nausea

Headache/Confusion

Acute

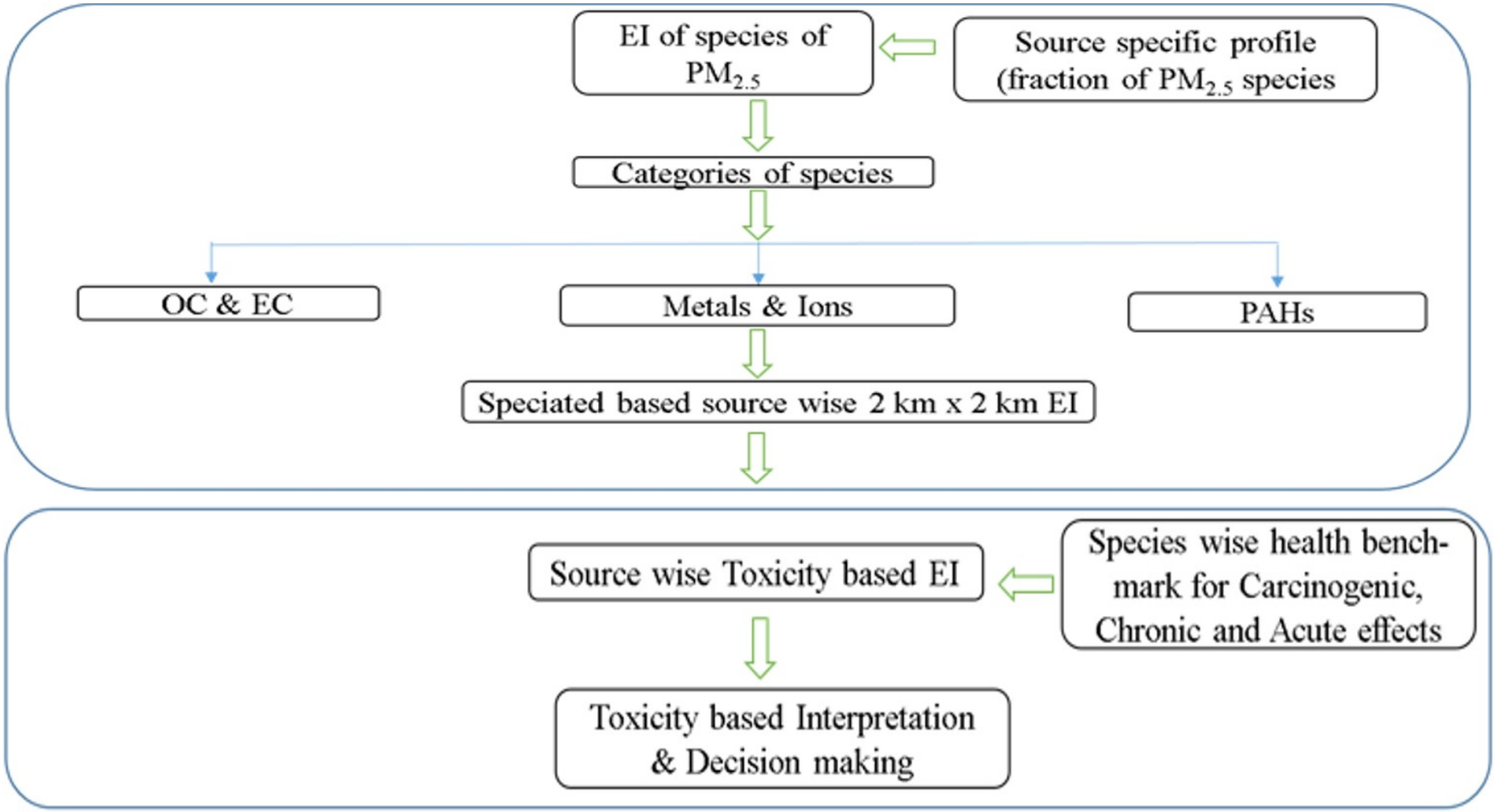
Lung Cancer

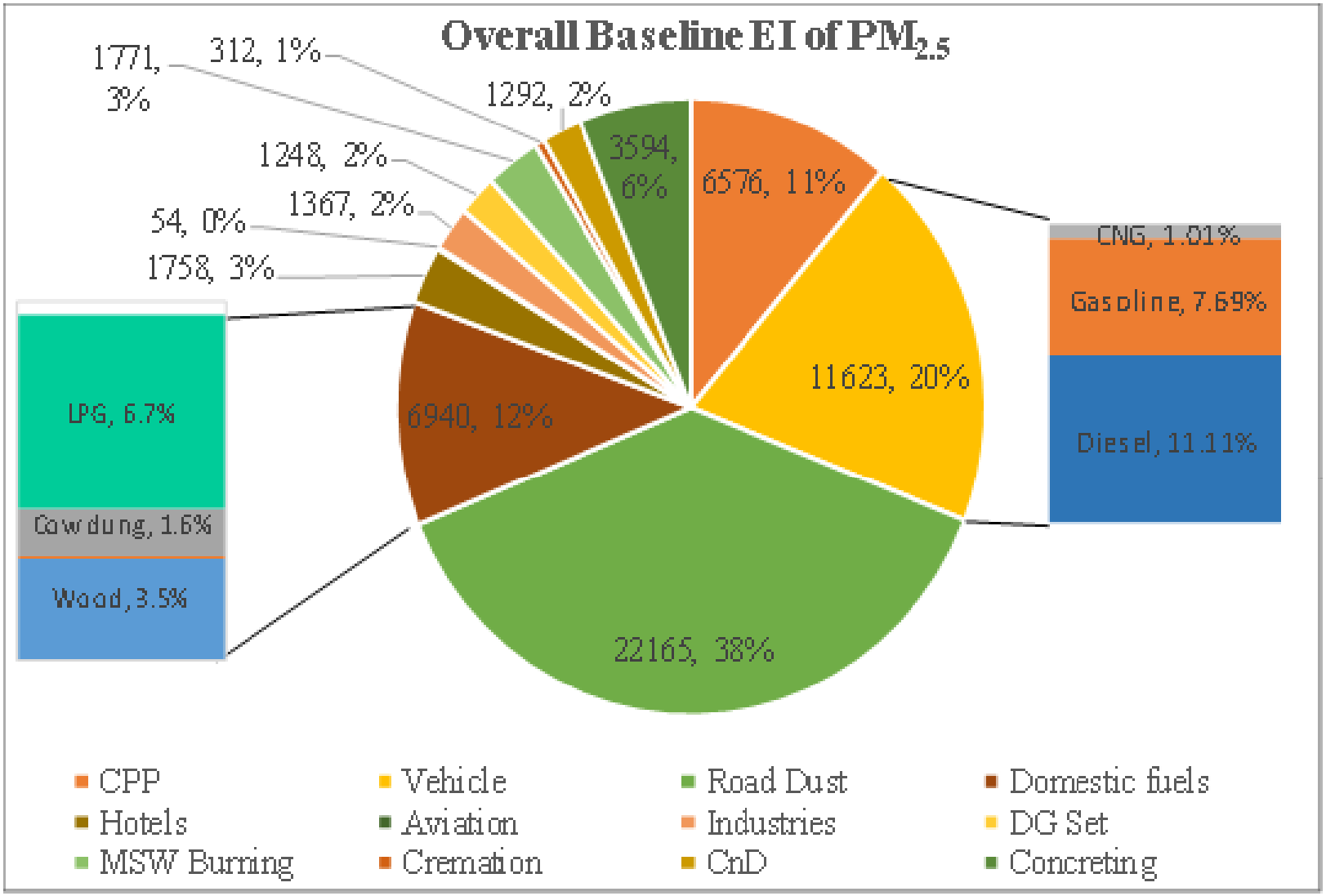
Skin Cancer

Developmental malformations

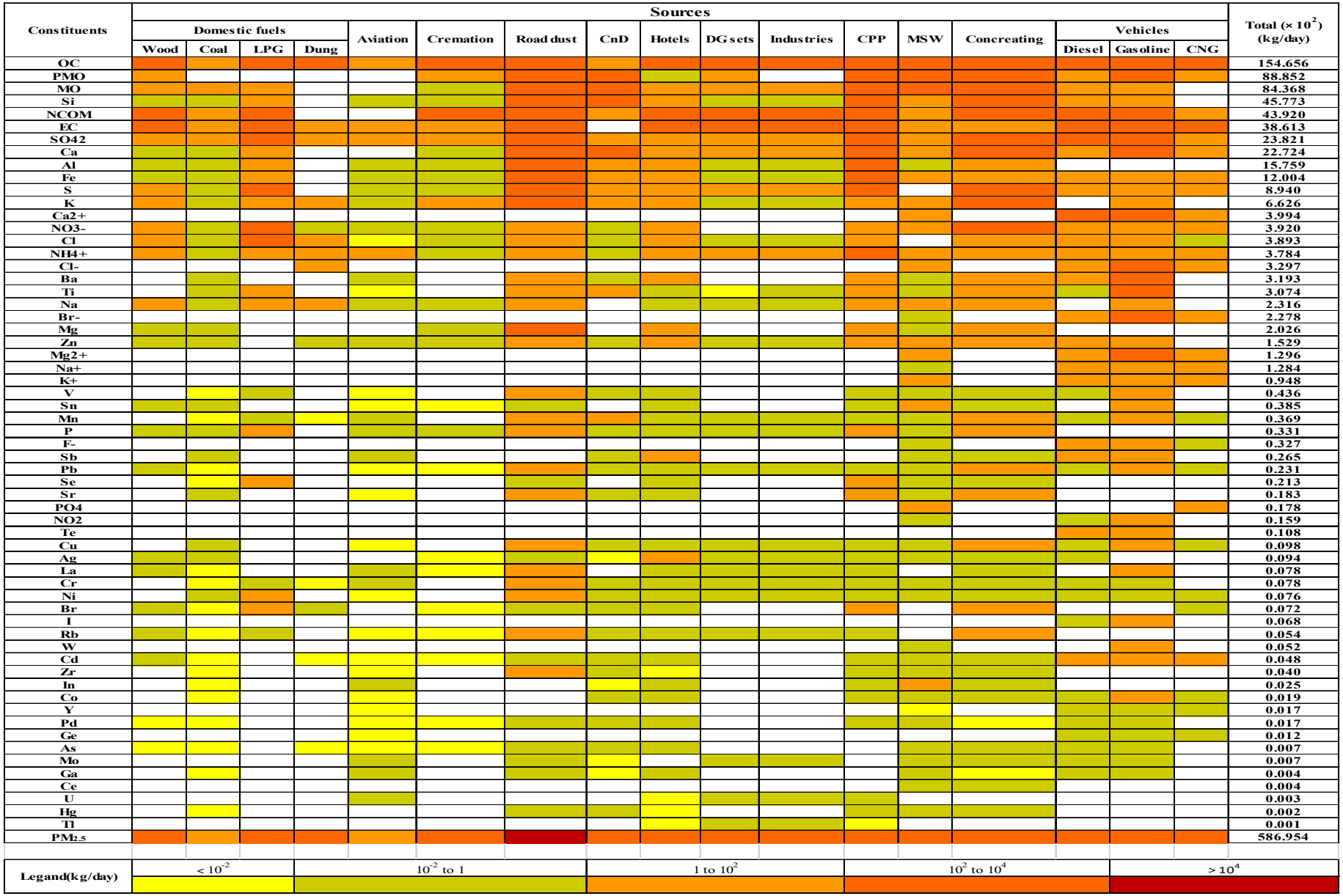
Chronic

A new Approach to assess Source-Toxicity




Overall Baseline EI of PM2.5
1771, 3%
312, 1%
1292, 2%
3594, 6%
6576, 11%
1248, 2%
1367, 2%
54, 0%
1758, 3%
6940, 12%
11623, 20%
22165, 38%
CNG, 1.01%
Gasoline, 7.69%
Diesel, 11.11%
LPG, 6.7%
Cowdung, 1.6%
Wood, 3.5%
CPP
Vehicle
Road Dust
Domestic fuels
Hotels
Aviation
Industries
DG Set
MSW Burning
Cremation
CnD
Concreting

Year 2014

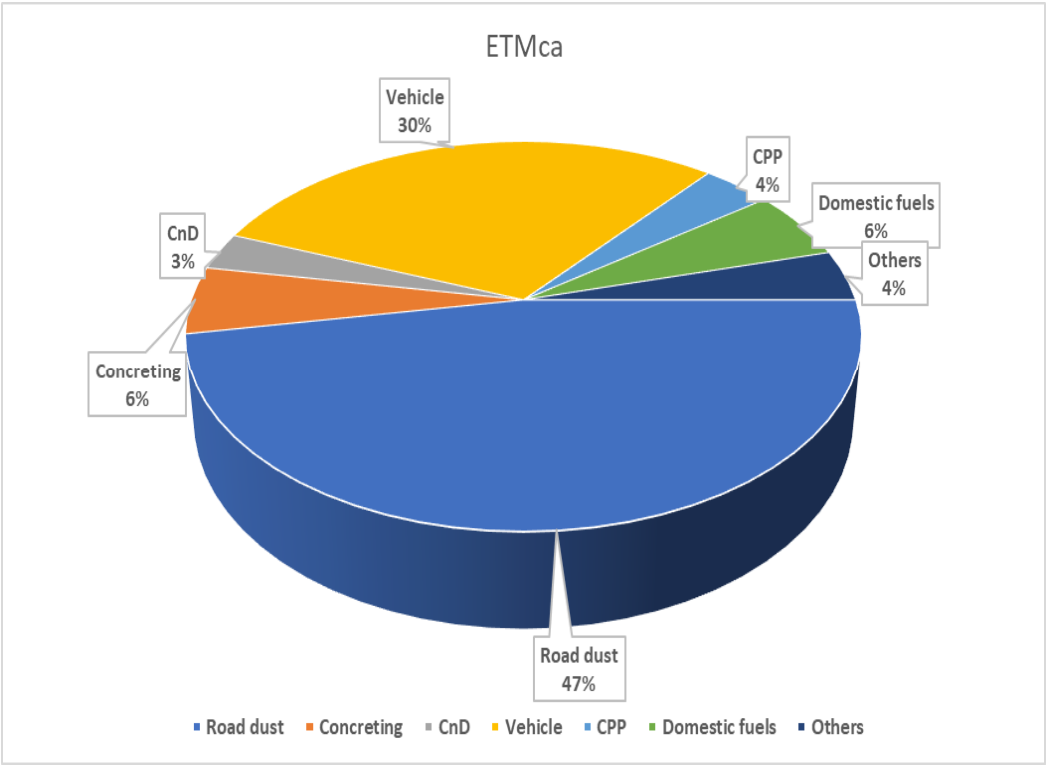

Constituents
Sources
Domestic fuels
Wood
Coal
LPG
Dung
Aviation
Cremation
Road dust
CnD
Hotels
DG sets
Industries
CPP
MSW
Concreating
Vehicles
Diesel
Gasoline
CNG
Total (× 10^2) (kg/day)
OC 154.656
PMO 88.852
MO 84.368
Si 45.773
NCOM 43.920
EC 38.613
SO42 23.821
Ca 22.724
Al 15.759
Fe 12.004
S 8.940
K 6.626
Ca2+ 3.994
NO3- 3.920
Cl 3.893
NH4+ 3.784
Cl- 3.297
Ba 3.193
Ti 3.074
Na 2.316
Br- 2.278
Mg 2.026
Zn 1.529
Mg2+ 1.296
Na+ 1.284
K+ 0.948
V 0.436
Sn 0.385
Mn 0.369
P 0.331
F- 0.327
Sb 0.265
Pb 0.231
Se 0.213
Sr 0.183
PO4 0.178
NO2 0.159
Te 0.108
Cu 0.098
Ag 0.094
La 0.078
Cr 0.078
Ni 0.076
Br 0.072
I 0.068
Rb 0.054
W 0.052
Cd 0.048
Zr 0.040
In 0.025
Co 0.019
Y 0.017
Pd 0.017
Ge 0.012
As 0.007
Mo 0.007
Ga 0.004
Ce 0.004
U 0.003
Hg 0.002
Tl 0.001
PM2.5 586.954
Legand(kg/day)
< 10^-2
10^-2 to 1
1 to 10^2
10^2 to 10^4
> 10^4

PAHs Source-wise and Number of Aromatic Ring distribution

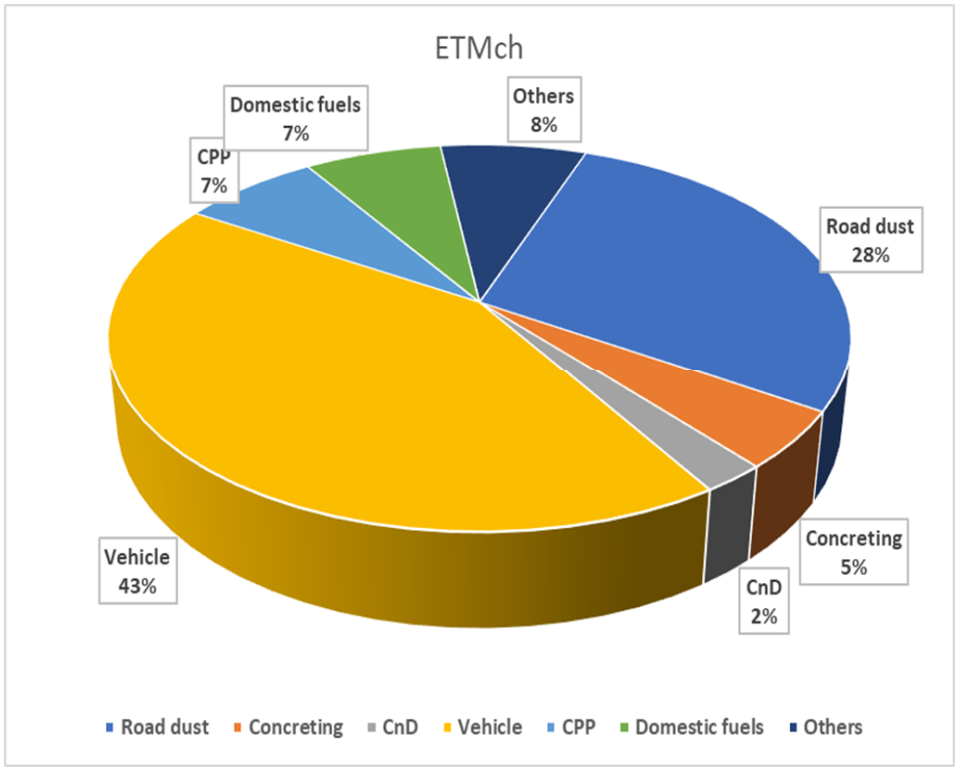
Species/Sources		2 ring	3 ring	4 ring	5 ring	6 ring	Sum χ 10^{-2} (kg/day)
Domestic fuel	Wood						1.3
	Coal						2.4
	LPG						0.5
	Dung						4.0
Aviation							0.0
Cremation							0.2
Road dust							105.0
Hotels							70.0
DG sets							34.0
Industries							38.0
CPP							234.0
MSW							0.4
Vehicles	Diesel						2070.0
	Gasoline						1261.0
	CNG						493.0

Legand	< 10^{-1}	10^{-1} to 1	1 to 10	> 10

Source- Toxicity



Cancer



Chronic

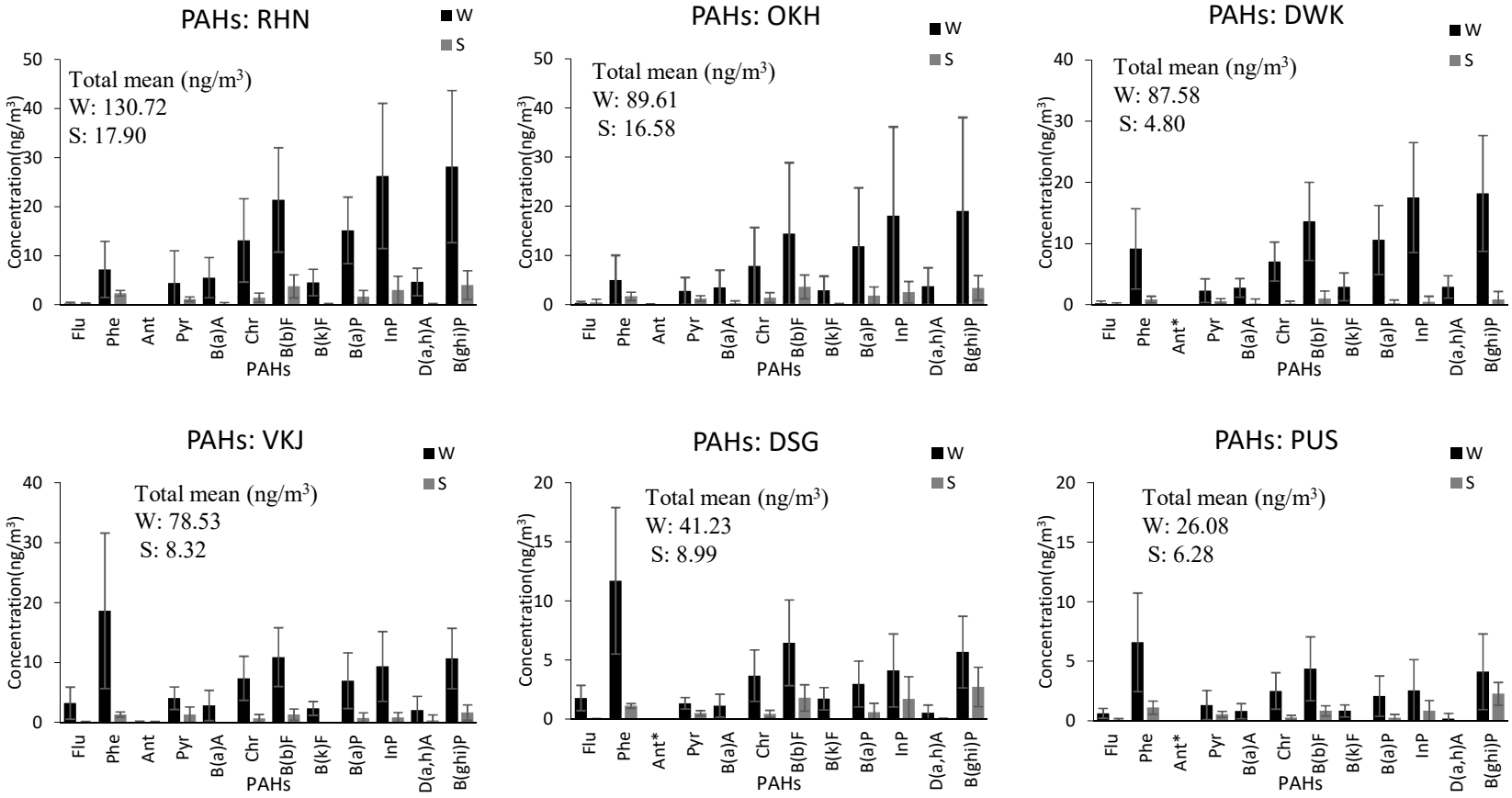
PAHs and Vehicles

Objectives

- Source apportionment analysis of ambient air PAHs in Delhi which includes identification and quantification of combustion related emission sources contributing to the ambient PAHs concentration in Delhi.
- Risk assessment of potential carcinogenic PAHs and their subsequent source apportionment.

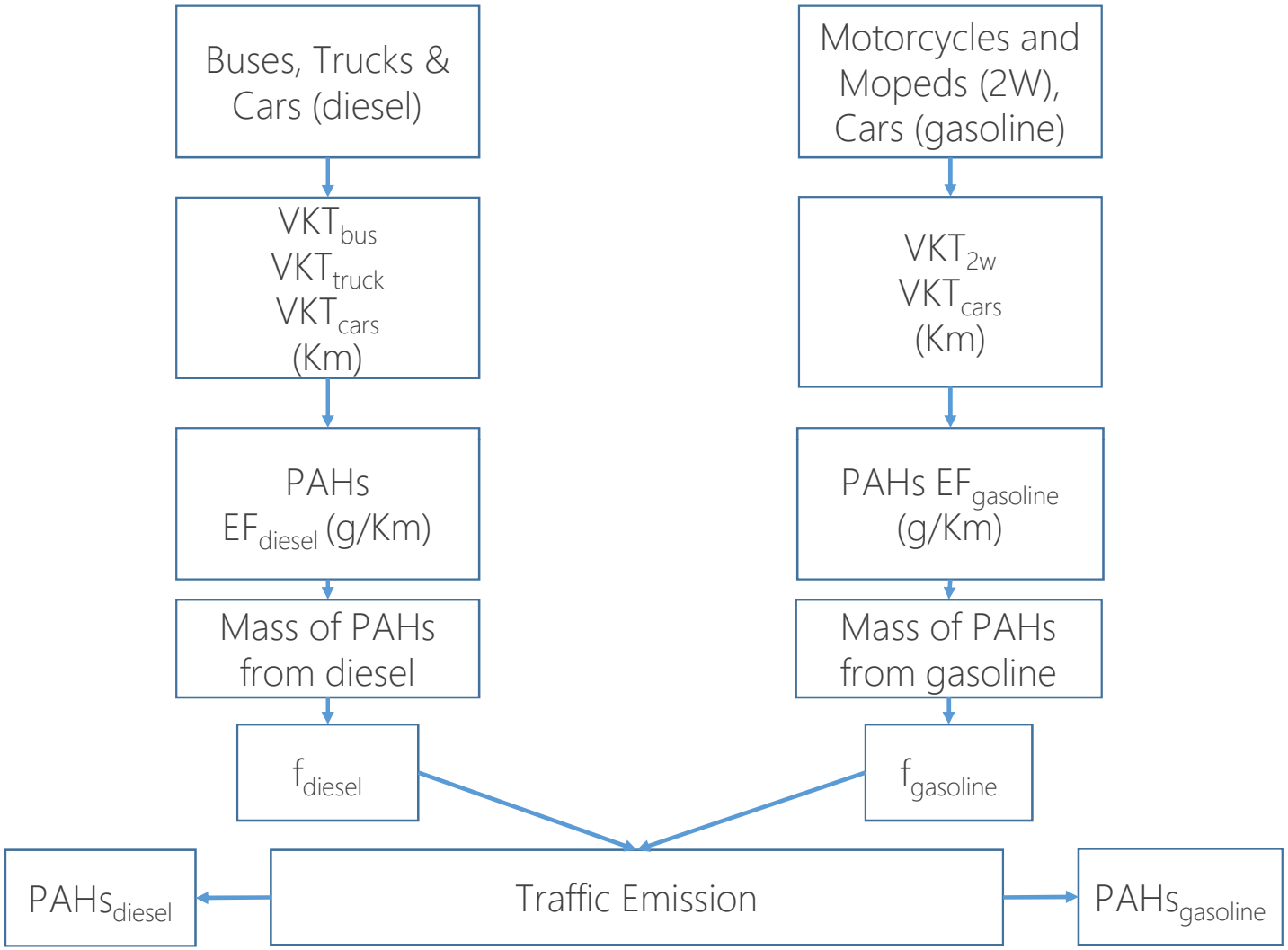
Results and discussion

Measured PAHs concentration at six locations during winter(W) and summer(S)



As part of a major study at IIT Kanpur (Sharma and Dixit, 2016)

Diesel and gasoline vehicle contribution



Conclusions

- We need an approach which is a blend of toxicity and the mass emission of PM 2.5 so that we effectively control the toxicity and mass emissions.
- Health standpoint pollution assessment needs to be mass based, chemical constituent based and source toxicity based.
- Traffic emission is the largest source for $PM_{2.5}$ bound PAHs in Delhi (over 65%).
- The highest life-time risk is from diesel burning which is one order higher than all other sources.

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Way Forward

- BEV: Battery imports charging infrastructure
  - Start and accelerate with two wheelers
- HEV in use requires no infrastructure
- 4-W Smooth Transition to PHEV, BEV
- Largest emissions from Trucks and buses
  - FCEV way forward, challenges: Produce hydrogen, storage, safety, Green hydrogen, infrastructure
  - Green Hydrogen: Biomass, Solar (massive Opportunity)
- BS VI will bring real-world driving emissions compliance (RDE). Different weather conditions and driving patterns in India means the RDE protocol needs to be different than other regions and countries leveraging RDE. Therefore, the engines and emissions control systems must be able to meet regulations under these unique conditions.
- Cities will also have to upgrade their on-road surveillance, bus and truck operators need sensitization on the supervision of advance and complex emissions control technologies and efforts which are needed to prevent entry of fraud devices to defeat the stringent operational requirement.
- Think and do Make in India