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Tehran emission inventory development using a new bottom-up emission inventory calculation and reporting system

Hossein Shahbazi, Amin Hassani, Vahid Hosseini

Sharif university of technology

Mechanical Engineering Department

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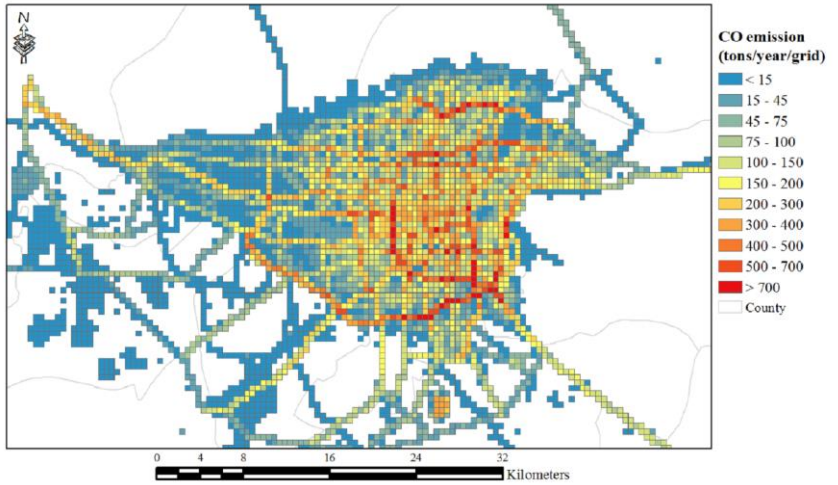
History of Emission Inventory in Tehran

History of Emission Inventory in Tehran

- **1st: As a joint project between Japan International Cooperation Agency (JICA) & Tehran AQCC, (Base year: 1994)**

- **2nd: Tehran Air Quality Control Company (AQCC), (Base year: 2014)**

- **Developing Tehran emission inventory system (2016-Present)**

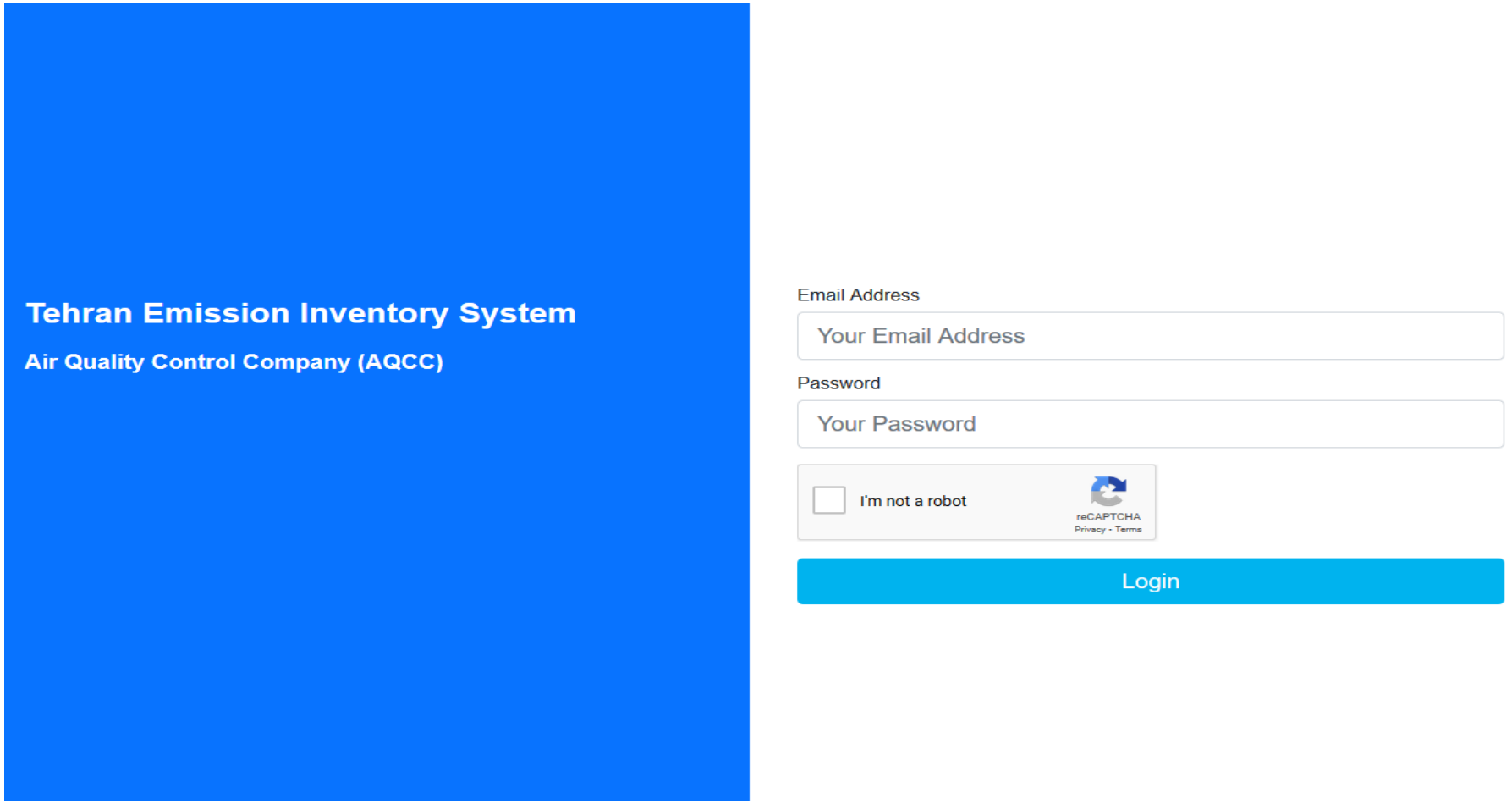


- **3rd: Current study, Funded by Tehran Air Quality Control Company (AQCC), (Base year: 2018)**

Shahbazi et al. (2016). A GIS based emission inventory development for Tehran, Urban Climate, 17, 216-229.
Shahbazi et al. (2016).The Relative Contributions of Mobile Sources to Air Pollutant Emissions in Tehran, Iran: An Emission Inventory Approach, Emission Control Science Technology, 2(1), 44-56.

Tehran Emission Inventory System

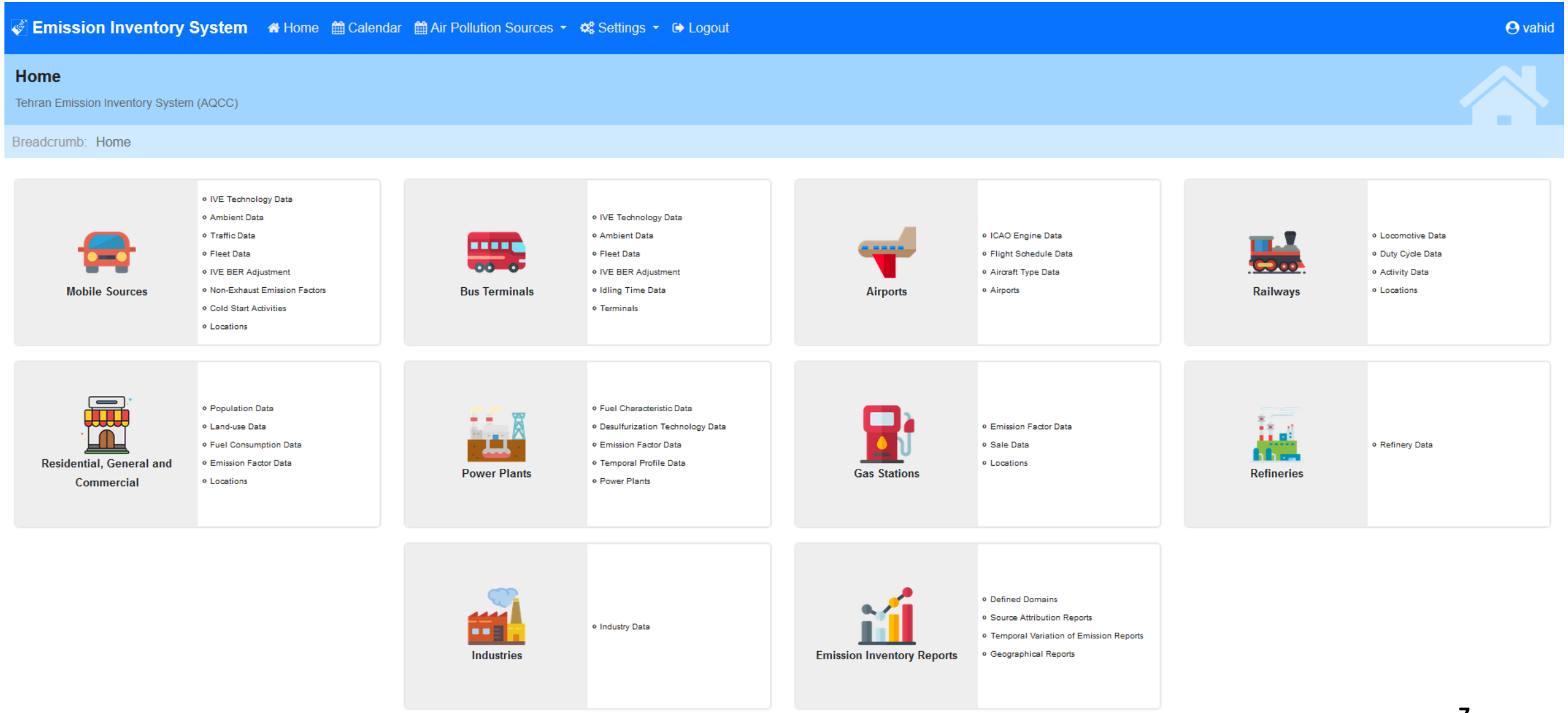
Web-based Emission Inventory System



Secure log-in page for each airshed, city, industrial source to log-in for data input and report generation

Emission Inventory System

Main data input menu



Emission Inventory System

Air pollution sources

Air Pollution Sources Covered by Emission Inventory System:

1- Mobile Sources (exhaust, non-exhaust, evaporative and cold start emission)

2- Power plants

3- Bus Terminals

4- Airports

5- Residential, general and commercial

6- Refineries

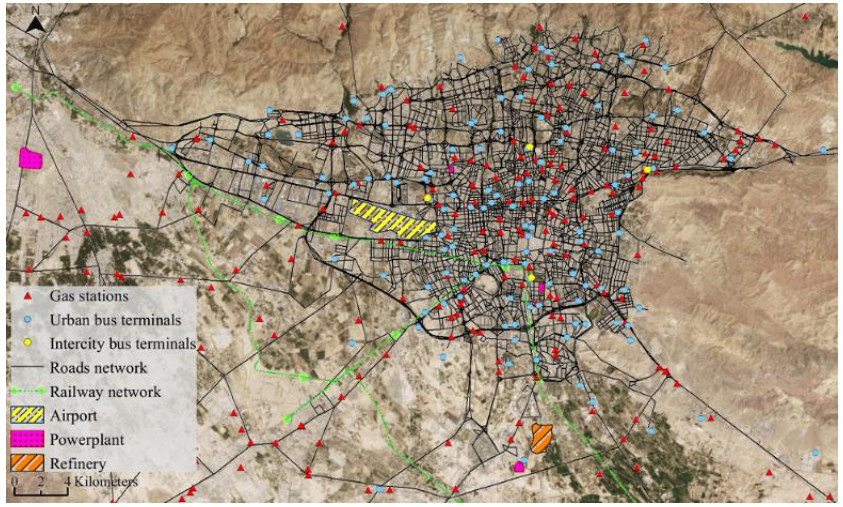
7- Railways

8- Petrol Stations

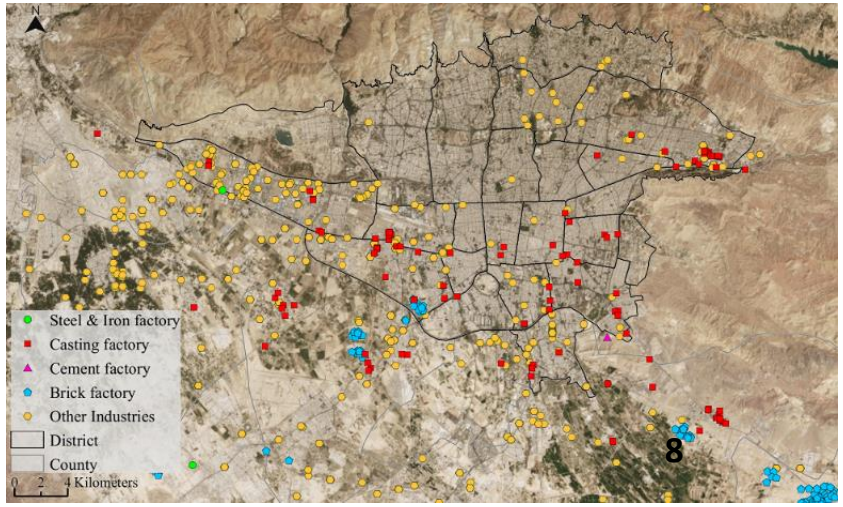
9- Industries

10- Reporting tool

Tehran pollution sources



Industrial units



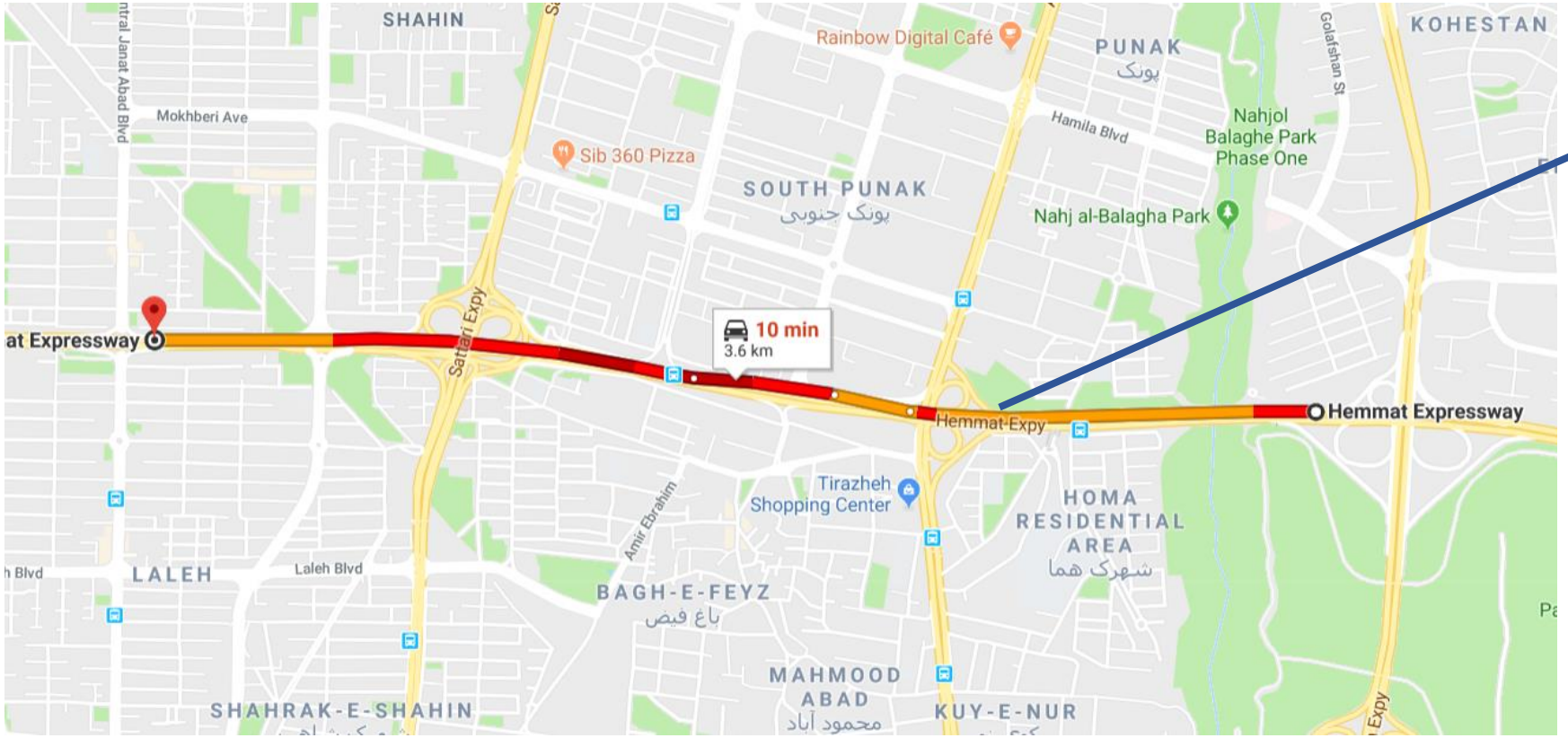
Emission Inventory System

Applications

- Tracking emission rates for regulatory purposes and police making
- Running if-then scenarios
- Permitting and compliance
- Providing data for national programs
- Tracking GHGs and GHG mitigation activities
- Easy to use system with minimum technical background
- Capabilities of generating various types of reports
- Custom-made to regional and local needs
- Preparing emission input data for air pollution photochemical models

Emission Calculation Methodology:
Mobile sources

Calculation Methodology



Emission = EF * Activity

EF (gr/km)
Activity (VKT)

Emission factors

Mobile Sources:

- Exhaust Emissions (Hot & Cold): IVE Model
- Evaporative Emissions: IVE Model
- Non-exhaust Emissions: European Emission Inventory Guide Book (COPERT model)

Input Data

Mobile Sources:

- Temporal Profile for Traffic Activity (easy input by xlsx files)
- Geographical Traffic Distribution (GIS shape file)
- Fleet Composition

Calculation methodology: Mobile Sources

Input data:

- Road location
- Road specification
- Link-base Traffic volume (rush hour)
- Temporal profiles

Emission inventory system

Output:

Hourly link-base traffic volume for different vehicle categories during a year

Input data:

- Ambient data
- Fuel quality
- Fleet composition
- Driving pattern

Emission inventory system

(IVE model)

Output:

Emission factor (gr/km)

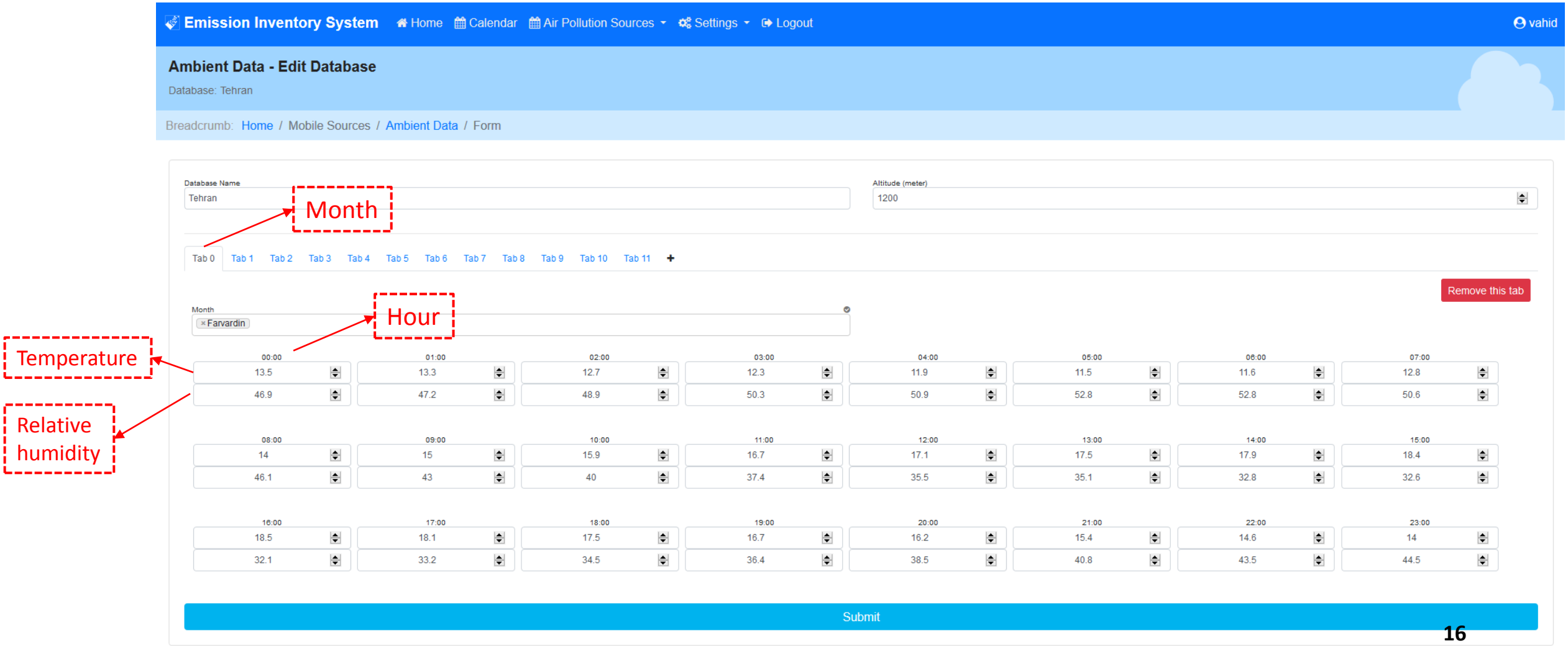
For different vehicle category, driving behavior and ambient condition

Input Data:
Mobile sources

Mobile sources

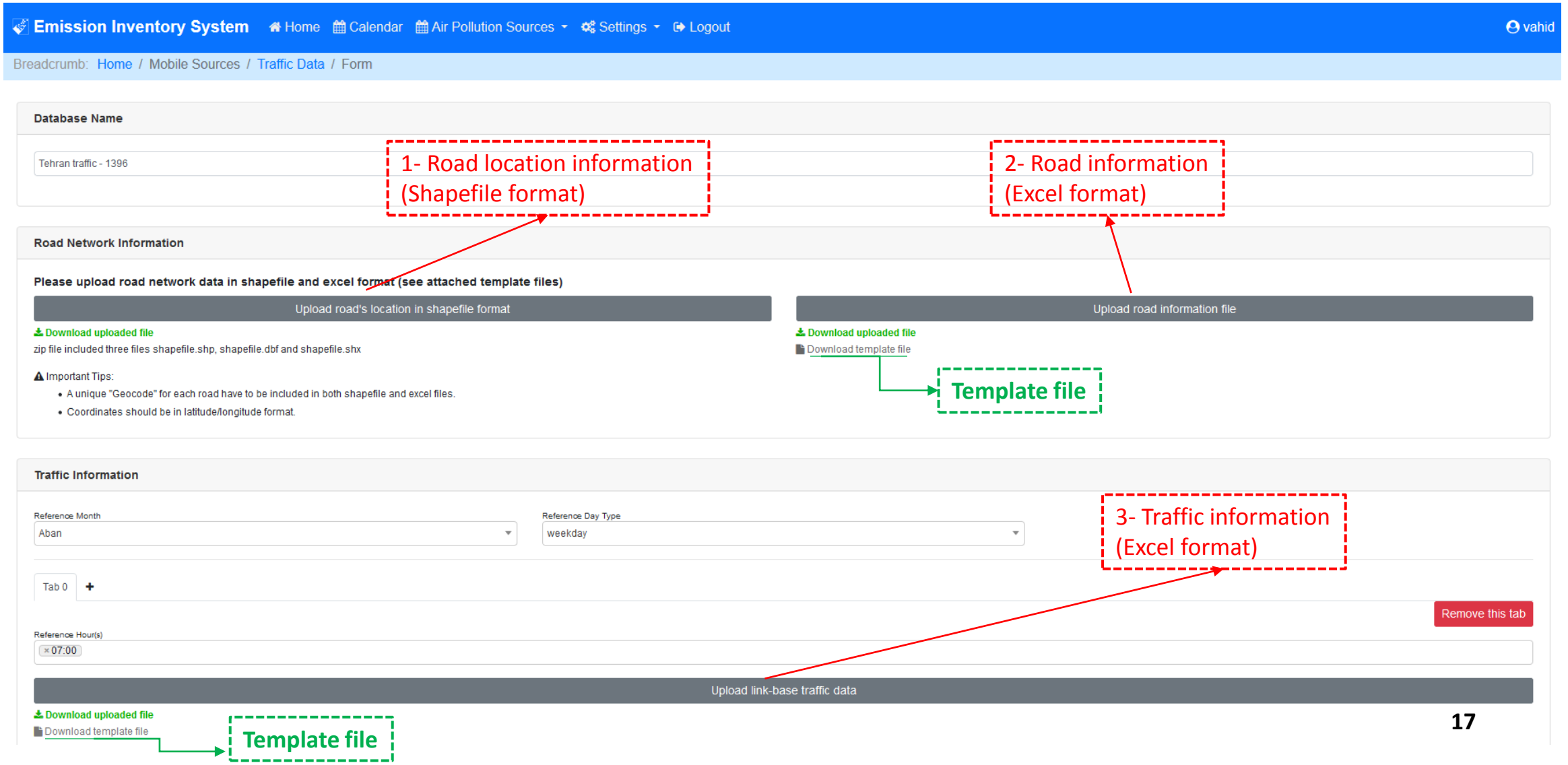
System required input data – (1) Ambient data

- Hourly average temperature and relative humidity for each month
- Altitude (in meter)



Mobile sources

System required input data – (2) Traffic information



Mobile sources

System required input data – (2) Traffic information

- Geocode is a unique code for each road which use for linking different file with each other

Road information

G14

	A	B	C	D	E	F
1	Geocode	Road Grade	Road Type	Municipality District	Within Odd-Even zone	Within Traffic zone
2	10010196200001	downhill	شرياني درجه ١	12	1	1
3	10010196200002	downhill	جمع كننده	12	1	1
4	10010196200003	flat	شرياني درجه ١	12	1	1
5	10010196200004	flat	شرياني درجه ١	12	1	1
6	10010196200005	flat	شرياني درجه ١	12	1	1
7	10010196200006	flat	شرياني درجه ١	12	1	1
8	10010196200007	uphill	شرياني درجه ١	12	1	1
9	10010196200008	downhill	شرياني درجه ١	12	1	1
10	10010196200009	flat	جمع كننده	12	1	1
11	10010196200010	flat	شرياني درجه ١	11	1	1
12	10010196200011	flat	شرياني درجه ١	11	1	1
13	10010196200012	uphill	شرياني درجه ١	11	1	1
14	10010196200013	downhill	شرياني درجه ١	11	1	1
15	10010196200014	uphill	جمع كننده	12	1	1
16	10010196200015	flat	دسترسي محلي	12	1	1
17	10010196200016	flat	جمع كننده	12	1	1
18	10010196200017	flat	شرياني درجه ٢	12	1	1
19	10010196200018	uphill	شرياني درجه ١	12	1	1
20	10010196200019	downhill	شرياني درجه ١	12	1	1

Traffic information

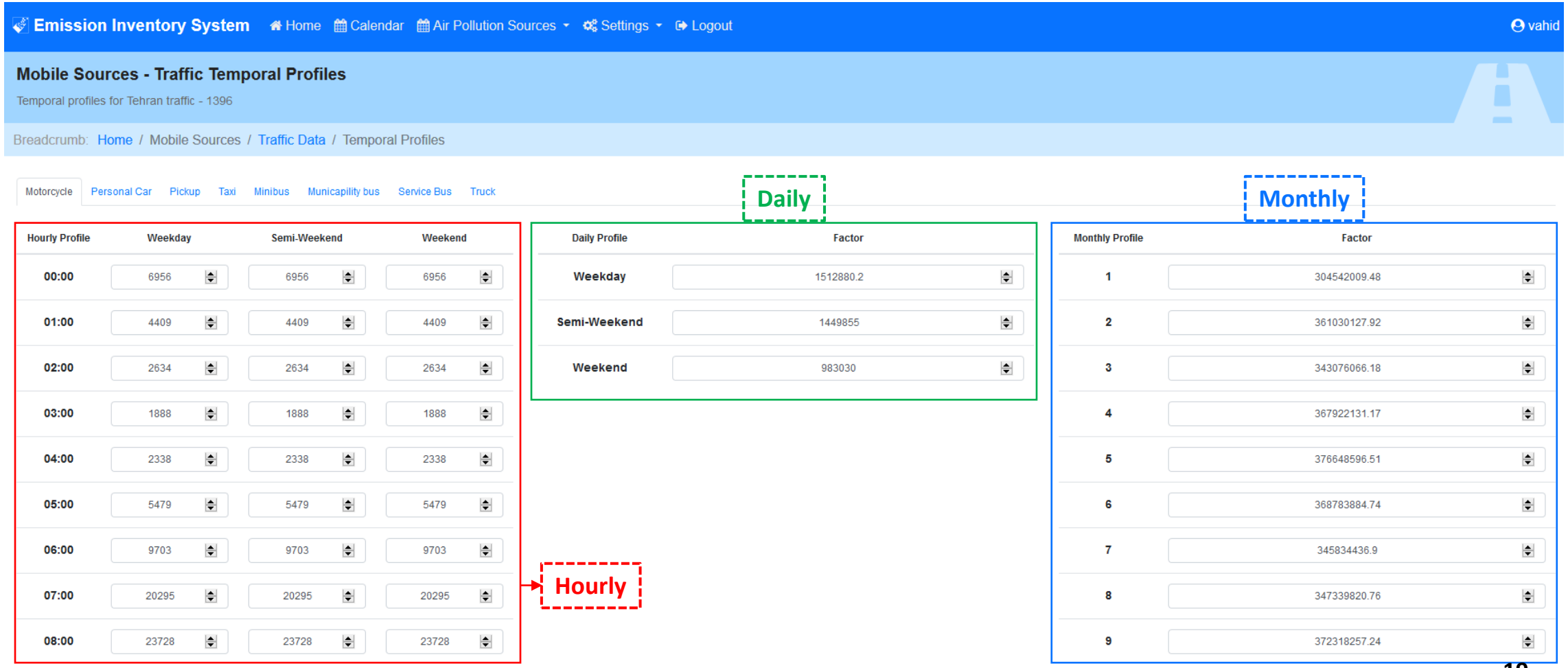
M11

	A	B	C	D	E	F	G	H	I
1	Geocode	Motorcycle	Personal Car	Pickup	Taxi	Minibus	Municapility bus	Service Bus	Truck
2	10010196200001	1030.65	3504.67	171.324	780.614	32.7	5.95238	17.7438	3.2613
3	10010196200002	239.452	323.683	39.2363	130.596	10.7941	5.95238	1.12673	0.86723
4	10010196200003	796.075	1396.67	176.49	407.049	19.5388	0	10.3844	1.53702
5	10010196200004	196.589	286.149	38.5466	110	7.51761	0	0.40205	0.99465
6	10010196200005	0	0	0	0	0	0	0	0
7	10010196200006	2062.62	2975.03	491.184	722.378	45.4919	64.5374	25.9813	8.48929
8	10010196200007	1391.57	2606.38	410.117	734.371	50.1598	51.4276	28.8252	9.65333
9	10010196200008	85.4079	109.599	9.60043	51.1153	6.35026	51.4276	0.30029	0.0107
10	10010196200009	509.665	870.749	73.6181	232.859	10.8624	0	6.12575	1.3173
11	10010196200010	0	0	0	0	0	21.2736	0	0
12	10010196200011	412.868	983.071	82.3237	312.742	22.8712	21.2736	3.01799	4.56835
13	10010196200012	0	0	0	0	0	55.3568	0	0
14	10010196200013	533.132	1378.06	109.947	440.54	47.4687	21.2736	3.66915	4.46103
15	10010196200014	562.59	640.541	55.7167	222.486	26.4775	0	3.07477	0.04956
16	10010196200015	15.3381	14.6516	0.65133	11.1707	1.2215	0	0.02104	0
17	10010196200016	974.066	909.165	113.572	317.895	33.5465	0	5.77245	0.49444
18	10010196200017	390.989	2278.89	85.914	484.397	17.6056	10.5448	12.6412	0.73132
19	10010196200018	1118.51	1331	193.753	457.192	28.7981	17.9131	7.07601	0.77156
20	10010196200019	0	0	0	0	0	17.9131	0	0

Mobile sources

System required input data – (2) Traffic information

Temporal profiles



Mobile sources

System required input data – (3) Fleet composition

- 1300 vehicle technologies are supported (IVE vehicle technologies)

Fleet composition

O8

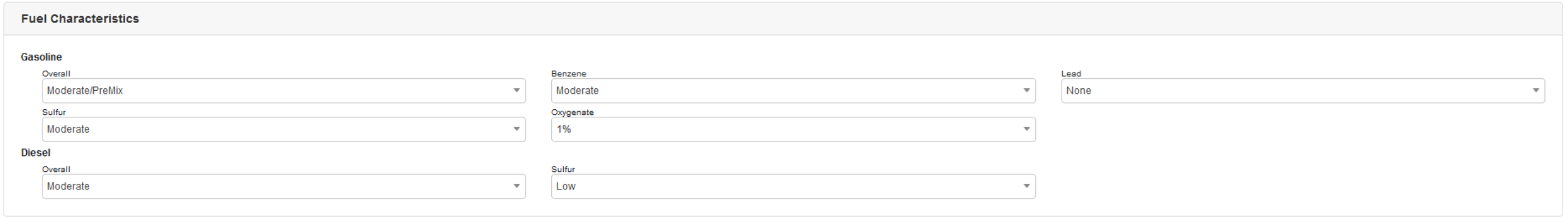
	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Category	System	Type	Model Year	Product	Total Numbers	AC Numbers	IVE Description	IVE Fuel	IVE Weight	IVE Air/Fuel Control	IVE Exhaust	IVE Evaporative
2	سواري	جيپ	نامشخص	1338	Domestic	1	0	Auto/Sml Truck	Petrol	Heavy	Carburetor	None	PCV
3	سواري	پيکان	1600	1346	Domestic	10	0	Auto/Sml Truck	Petrol	Medium	Carburetor	None	PCV
4	سواري	پيکان	دولوکس	1346	Domestic	7	0	Auto/Sml Truck	Petrol	Medium	Carburetor	None	PCV
5	سواري	پيکان	ساده کار	1346	Domestic	4	0	Auto/Sml Truck	Petrol	Medium	Carburetor	None	PCV
6	سواري	پيکان	کارلوکس	1346	Domestic	1	0	Auto/Sml Truck	Petrol	Medium	Carburetor	None	PCV
7	سواري	بيوک	پي ۲	1346	Domestic	1	0	Auto/Sml Truck	Petrol	Heavy	Carburetor	None	PCV
8	سواري	آريا	نامشخص	1347	Domestic	4	0	Auto/Sml Truck	Petrol	Heavy	Carburetor	None	PCV
9	سواري	پيکان	1600	1347	Domestic	6	0	Auto/Sml Truck	Petrol	Medium	Carburetor	None	PCV
10	سواري	پيکان	آونجر	1347	Domestic	1	0	Auto/Sml Truck	Petrol	Medium	Carburetor	None	PCV
11	سواري	پيکان	دولوکس	1347	Domestic	11	0	Auto/Sml Truck	Petrol	Medium	Carburetor	None	PCV
12	سواري	پيکان	ساده کار	1347	Domestic	5	0	Auto/Sml Truck	Petrol	Medium	Carburetor	None	PCV
13			کارلوک	1347	Domestic	1	0	Auto/Sml Truck	Petrol	Medium	Carburetor	None	PCV
14			شاه	1347	Domestic	4	0	Auto/Sml Truck	Petrol	Medium	Carburetor	None	PCV
15			نامش	1348	Domestic	2	0	Auto/Sml Truck	Petrol	Heavy	Carburetor	None	PCV
16	سواري	پيکان	1600	1348	Domestic	8	0	Auto/Sml Truck	Petrol	Medium	Carburetor	None	PCV
17	سواري	پيکان	دولوکس	1348	Domestic	11	0	Auto/Sml Truck	Petrol	Medium	Carburetor	None	PCV
18	سواري	پيکان	ساده کار	1348	Domestic	16	0	Auto/Sml Truck	Petrol	Medium	Carburetor	None	PCV
19	سواري	جيپ	آهو	1348	Domestic	2	0	Auto/Sml Truck	Petrol	Heavy	Carburetor	None	PCV
20	سواري	ژيان	نامشخص	1348	Domestic	1	0	Auto/Sml Truck	Petrol	Light	Carburetor	None	PCV

Different languages are supported

Mobile sources

System required input data – (4) Fuel quality

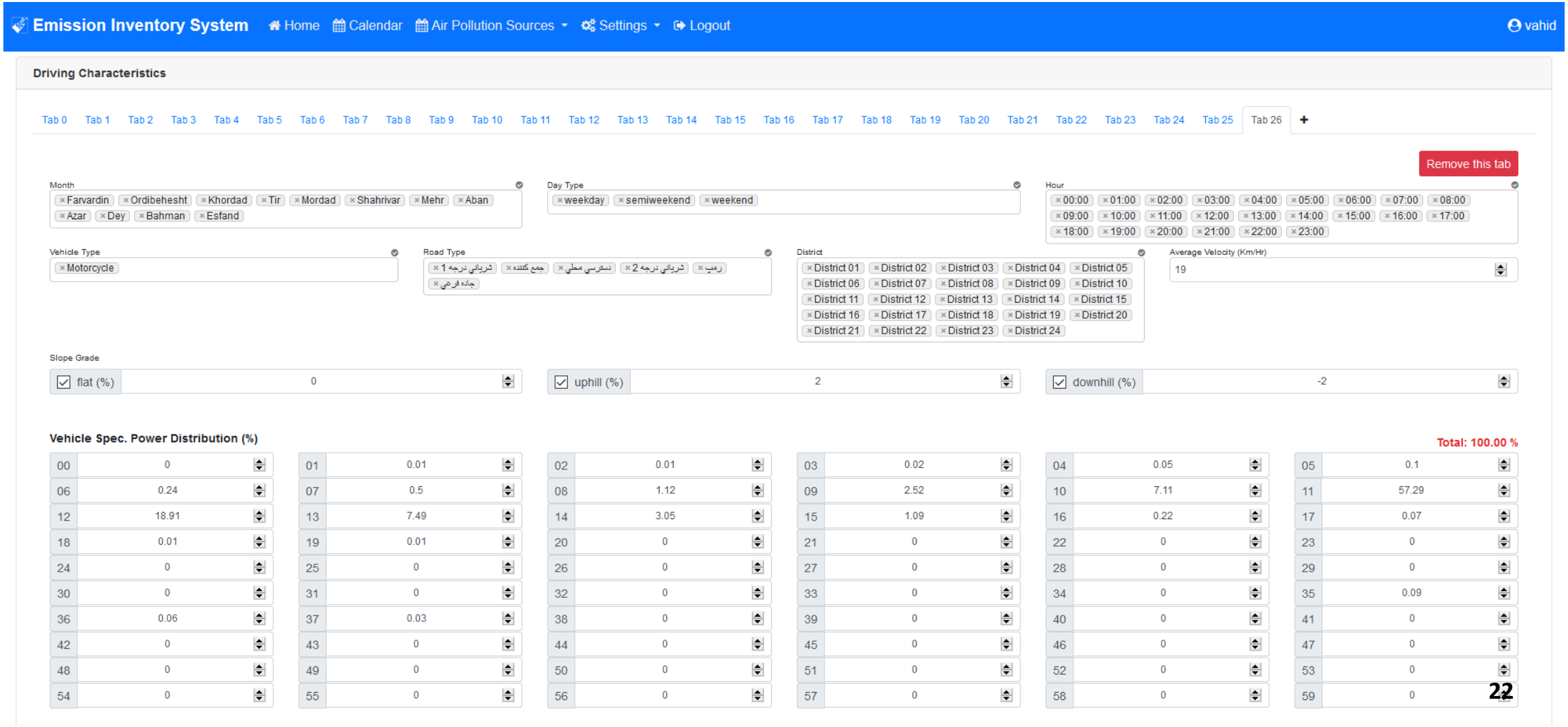
Fuel quality



Mobile sources

System required input data – (5) Driving pattern

Driving pattern



Calculation Methodology & Input Data: Other sources

Input Data: Other Sources

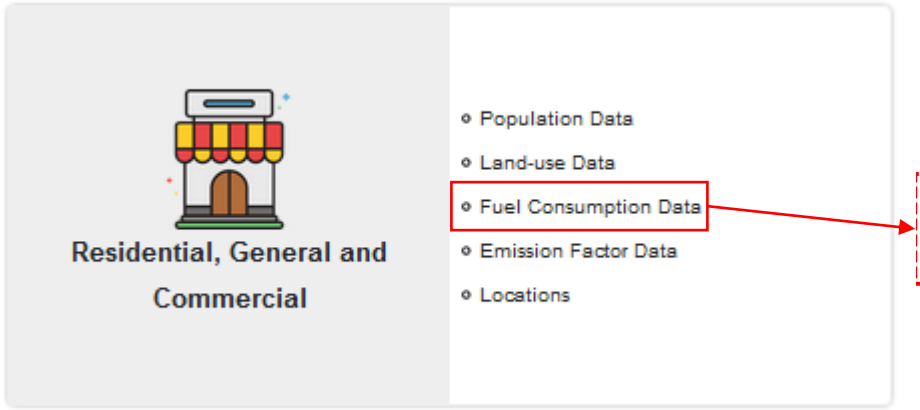
Stationary Sources:

- Residential / Commercial sector:
  - ✓ Geographical Location (area source)
  - ✓ Land use distribution (e.g. residential, commercial, hospital, ….)
  - ✓ Activity (e.g. Fuel Consumption)
  - ✓ Activity Temporal Profile for each Land use

Residential, general and commercial sources

System required input data

- Natural gas is the dominant fuel used in Residential, general and commercial sector in Iran



Spatial monthly fuel consumption (Shapefile + Excel file)

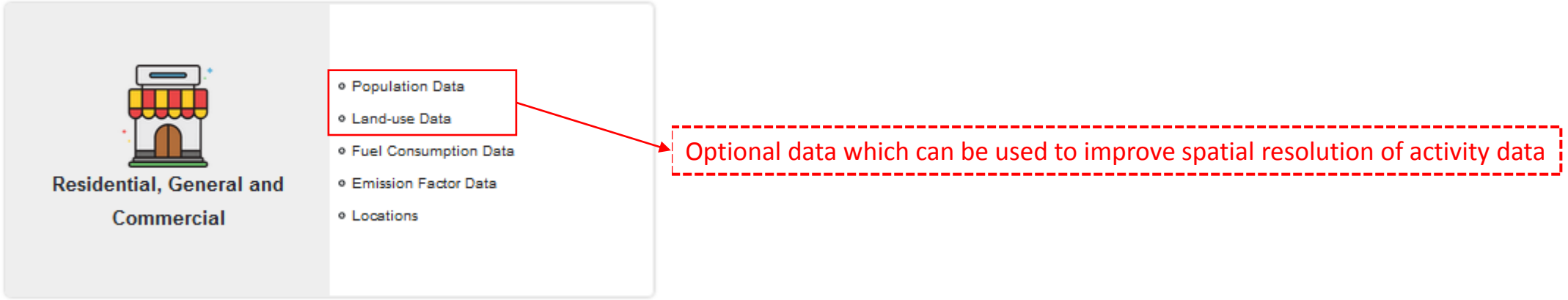
F17 | 65988

	A	B	C	D	E	F
1	geocode	usage	fuel type	unit	month	fuel consumption
2	98060610130000	40 - خانگي بدون چيلر	Natural Gas	m3	1	56491603
3	98060610130000	40 - خانگي بدون چيلر	Natural Gas	m3	2	29592689
4	98060610130000	40 - خانگي بدون چيلر	Natural Gas	m3	3	17908978
5	98060610130000	40 - خانگي بدون چيلر	Natural Gas	m3	4	15761051
6	98060610130000	40 - خانگي بدون چيلر	Natural Gas	m3	5	15051607
7	98060610130000	40 - خانگي بدون چيلر	Natural Gas	m3	6	16480547
8	98060610130000	40 - خانگي بدون چيلر	Natural Gas	m3	7	23338285
9	98060610130000	40 - خانگي بدون چيلر	Natural Gas	m3	8	47124895
10	98060610130000	40 - خانگي بدون چيلر	Natural Gas	m3	9	81055794
11	98060610130000	40 - خانگي بدون چيلر	Natural Gas	m3	10	94120495
12	98060610130000	40 - خانگي بدون چيلر	Natural Gas	m3	11	92838178
13	98060610130000	40 - خانگي بدون چيلر	Natural Gas	m3	12	60152698
14	98060610130000	41 - موتورخانه بدون چيلر	Natural Gas	m3	1	214374
15	98060610130000	41 - موتورخانه بدون چيلر	Natural Gas	m3	2	124064

Residential, general and commercial sources

System required input data

- Natural gas is the dominant fuel used in Residential, general and commercial sector in Iran



Residential, general and commercial sources

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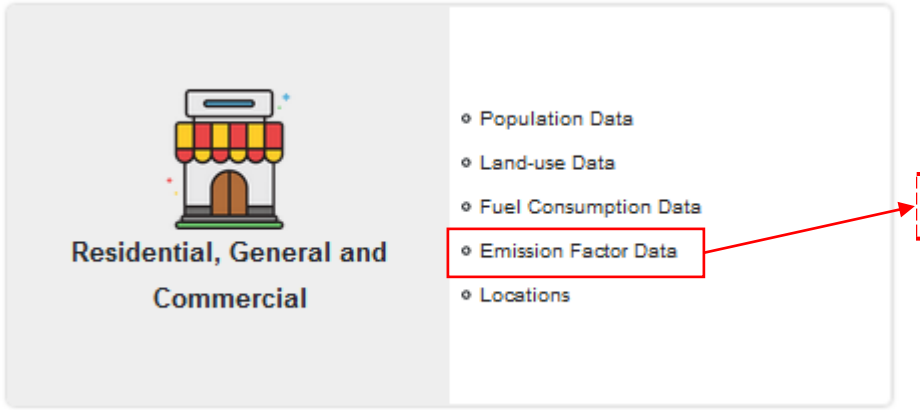
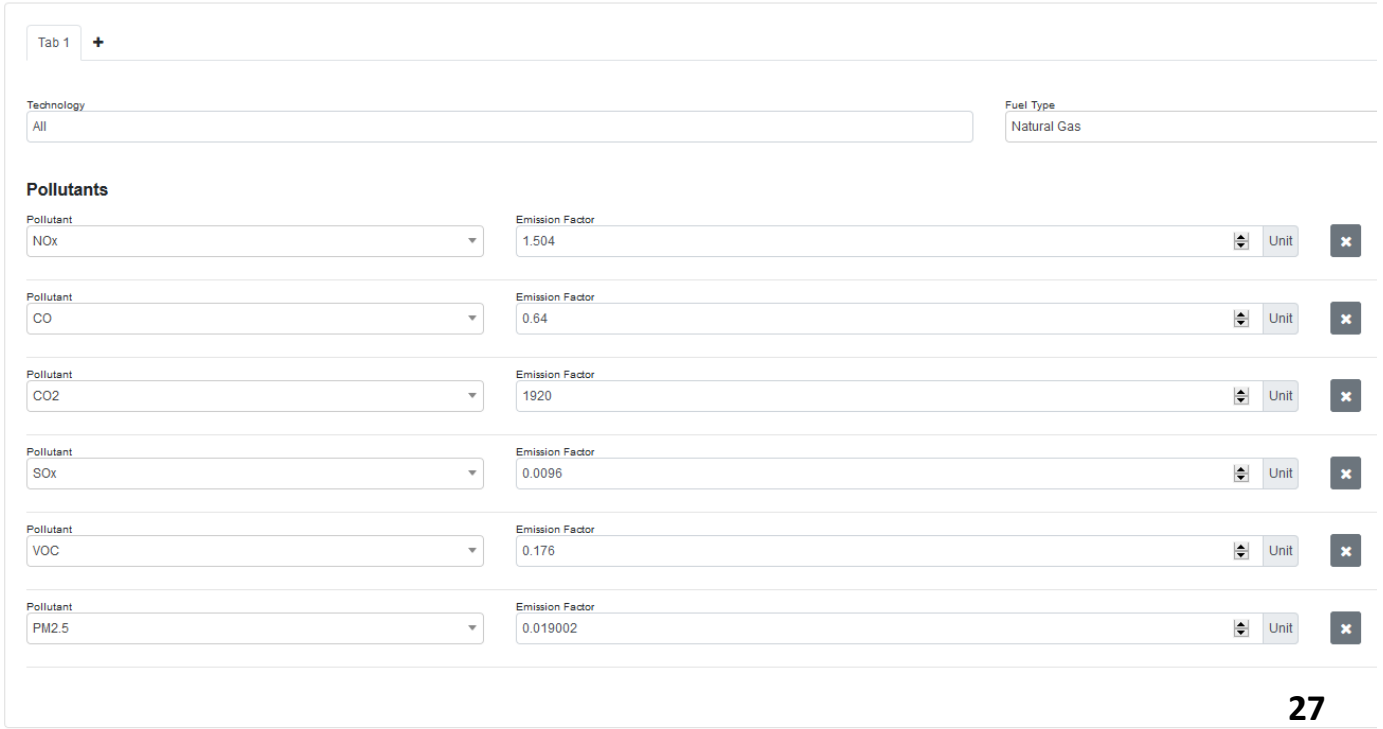


Should be imported by user



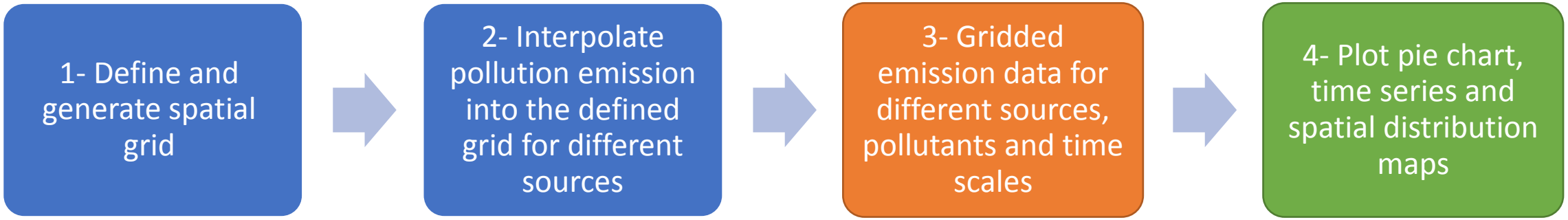
Calculation methodology: Other Sectors

- ✓Geographical Location (point source)
- ✓ Activity (e.g. fuel consumption)
- ✓ Temporal Profile for Activity
- ✓ Emission Factor (based on fuel consumption)

Emission gridding and reporting tool

Emission Inventory System

Reporting tool



Emission Inventory System

Grid generation

Emission Inventory System Home Calendar Air Pollution Sources Settings Logout

Emission Inventory Reports - Spatial Allocation Grid - List

The grids are listed as below

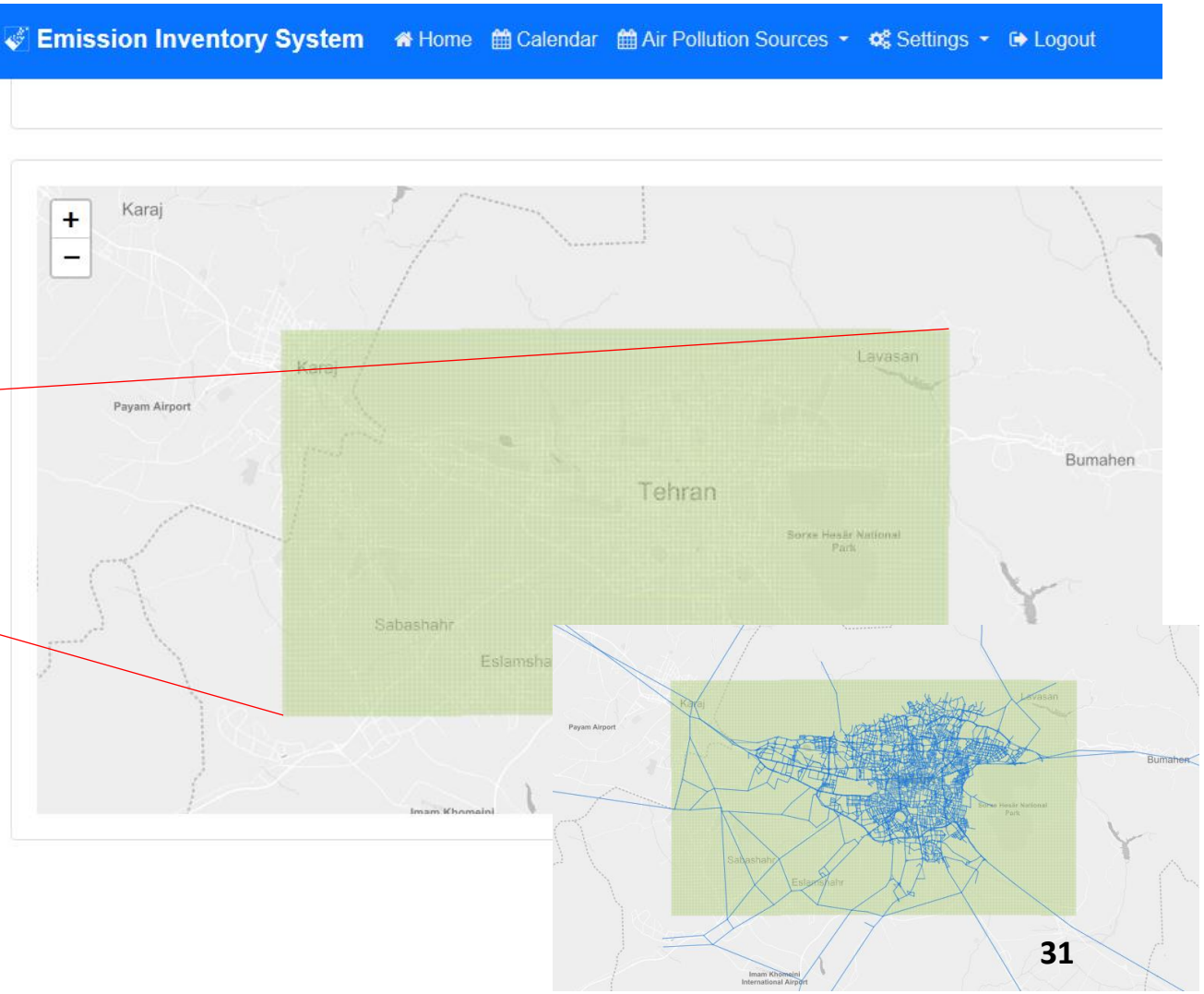
Breadcrumb: Home / Emission Inventory Reports / Spatial Allocation Grids

+ Create New Grid

Tehran domain - 1396

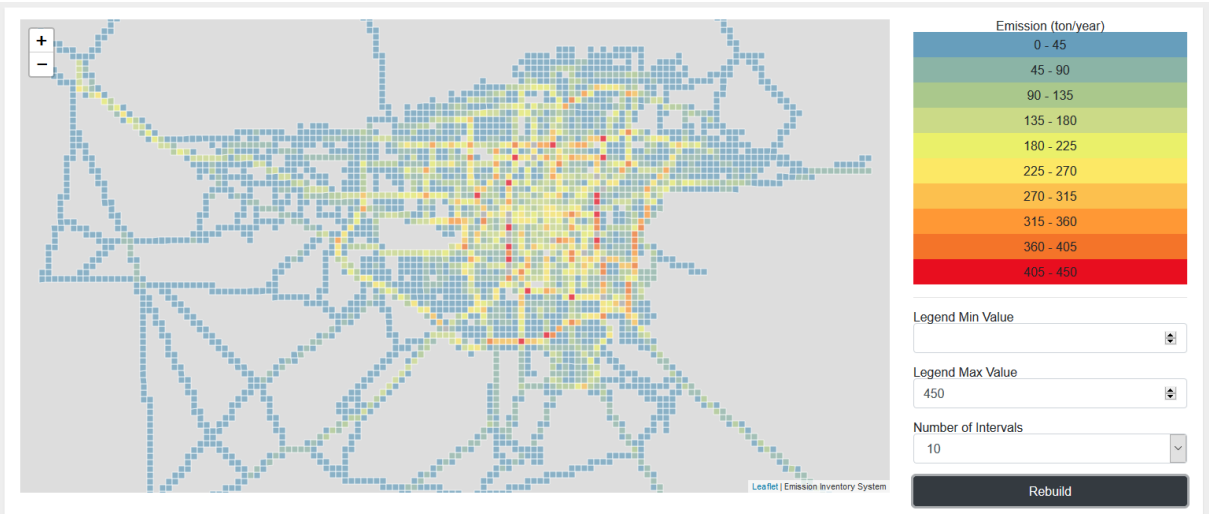
Southwest Corner X (km): -39
Southwest Corner Y (km): -22
Delta X (m): 500
Delta Y (m): 500
Number of Cells (X direction): 132
Number of Cells (Y direction): 76
Central Latitude: 35.7
Central Longitude: 51.4
Status: cells_generated
Created at: 2019-04-14 08:45
Updated at: 2019-05-19 09:44

Emission Calculation

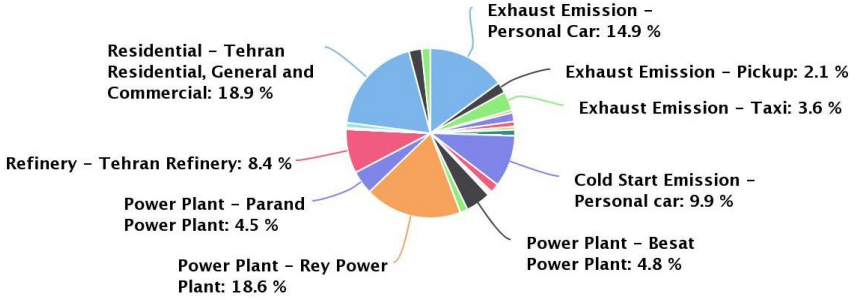


Emission Inventory System

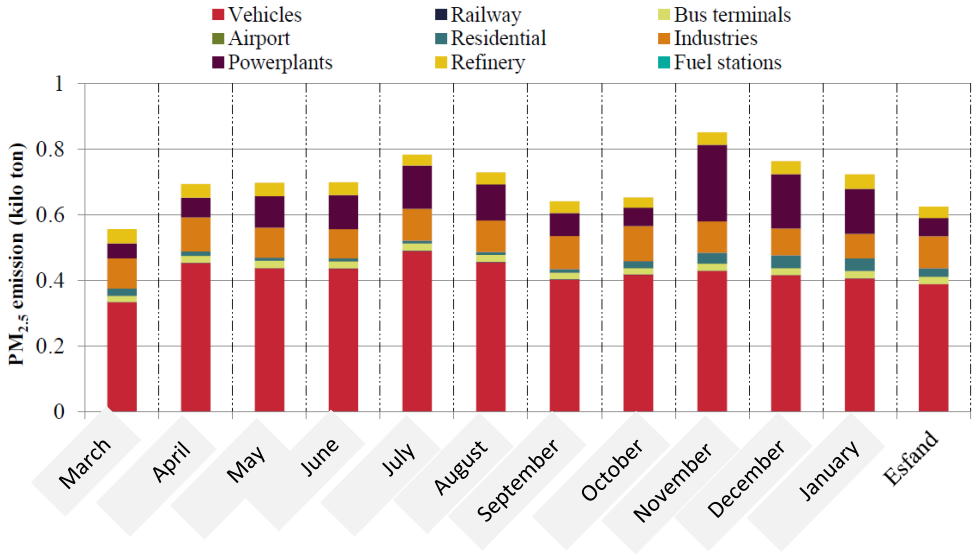
Sample reports



Study case: Tehran, Year 2018, Annual VOC Emission (grid 500m × 500m)



Study case: Tehran, March 2018, Monthly NOx Emission



Study case: Tehran, Year 2018, Monthly PM2.5 from all anthropogenic sources

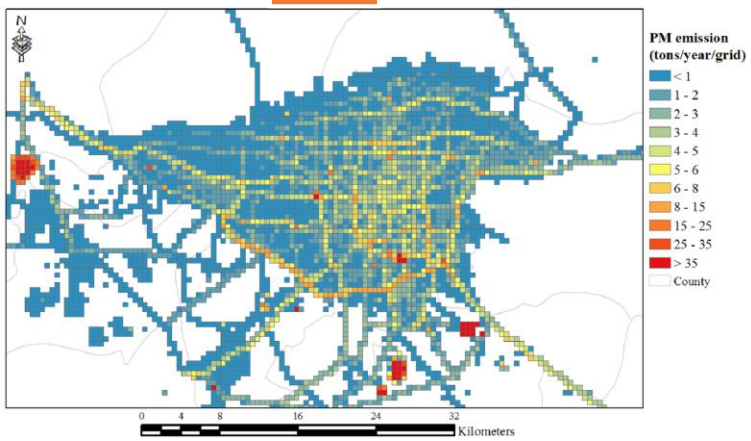
Study case: Tehran emission inventory

Study case: Tehran, Year 2018

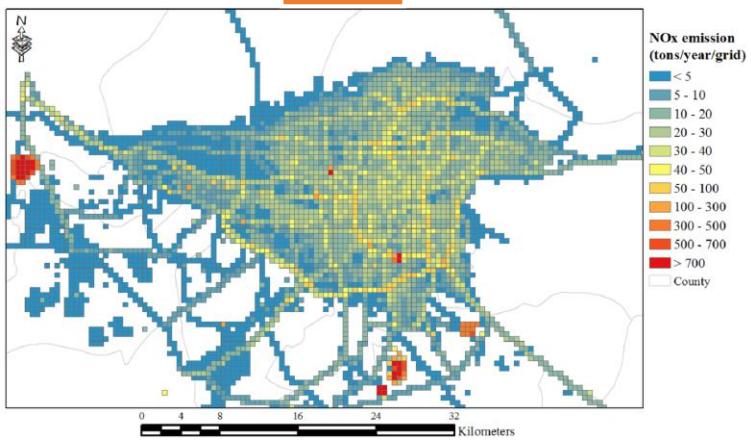
Yearly pollution emission

Sector (tonnes/year)	TSP	NOx	CO	VOCs	CO_2
On-road transportation	6338	36150	463446	71882	13384
Energy conversion	1721	41117	4916	3615	9215
Industries	1858	8639	1962	448	5781
Residential	182	14365	6113	1681	18339
Terminals	279	2407	1521	344	352
Gas stations	-	-	-	13071	-
Total	**10377**	**102678**	**477958**	**91041**	**47071**

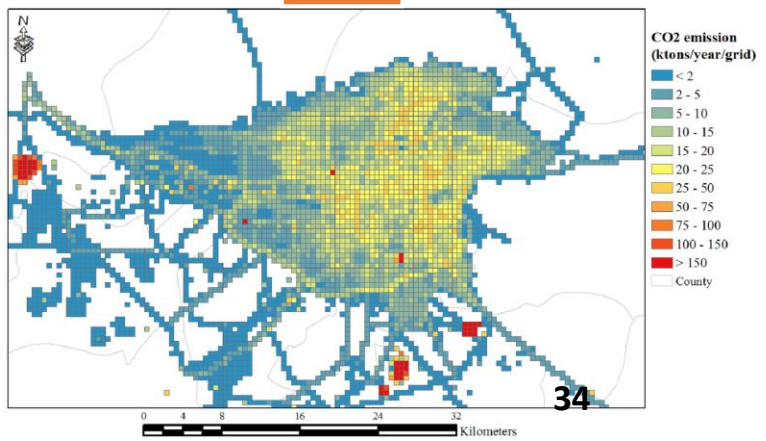
TSP



NOx

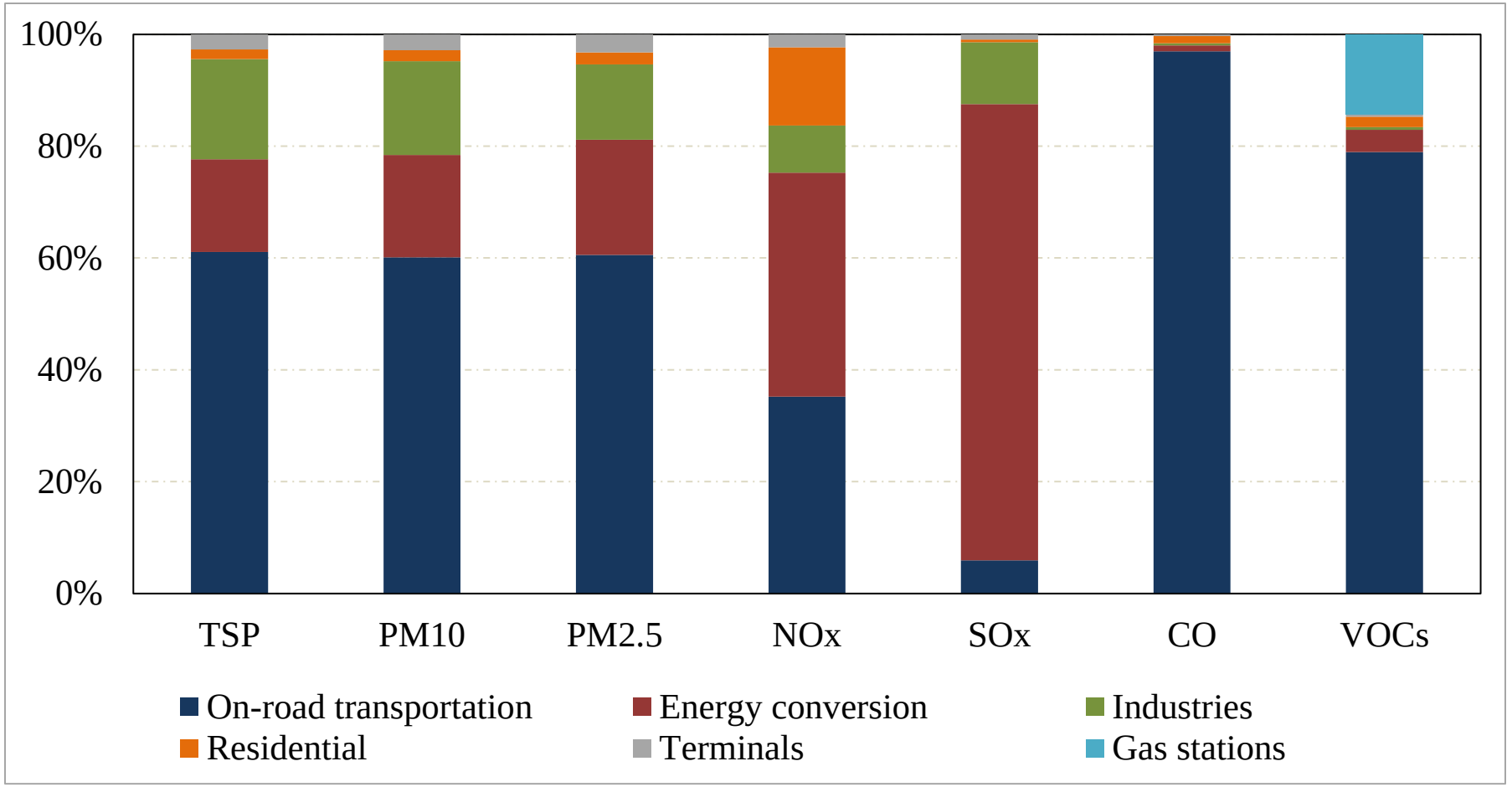


CO2



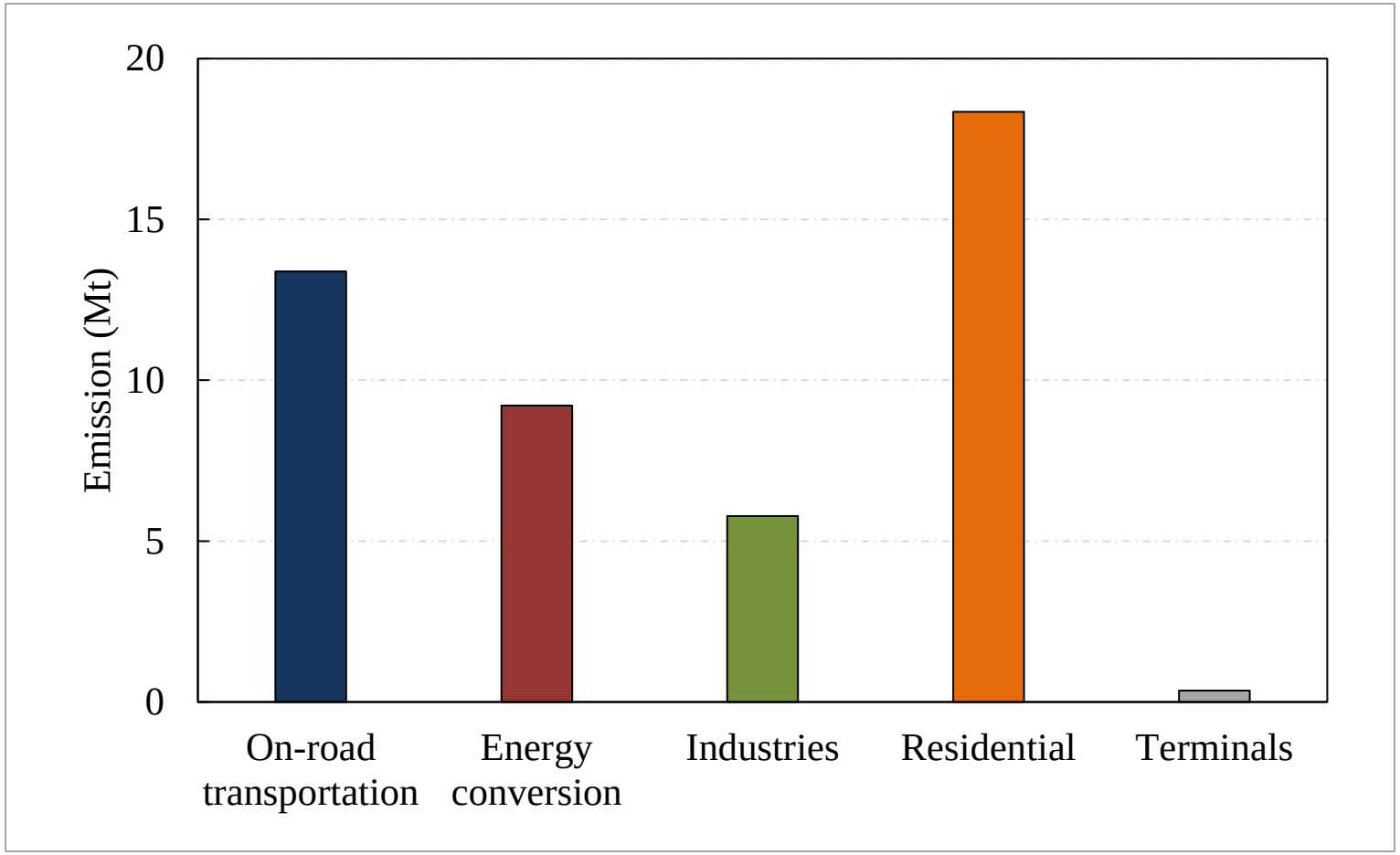
Study case: Tehran, Year 2018

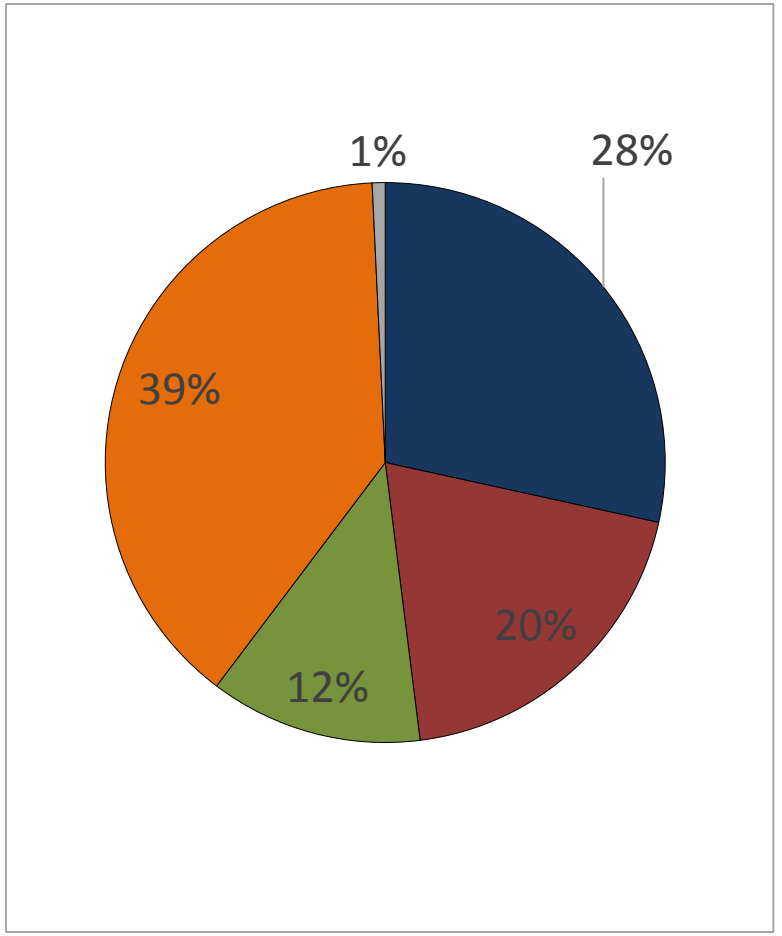
Source attribution - Pollutants



Study case: Tehran, Year 2018

Source attribution – CO2

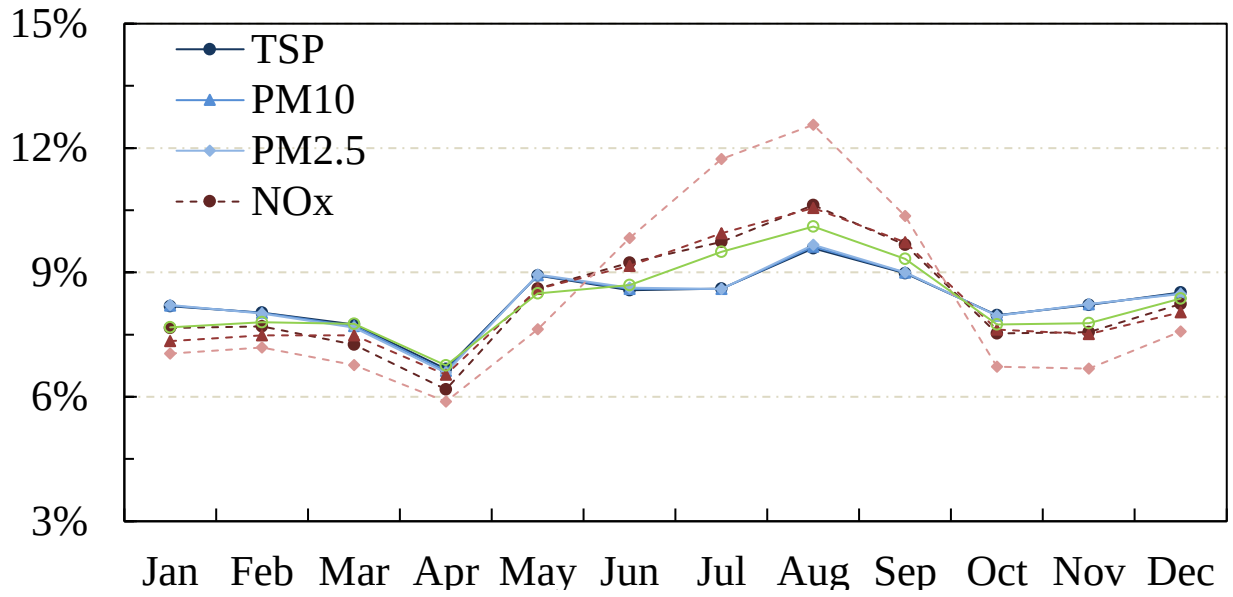


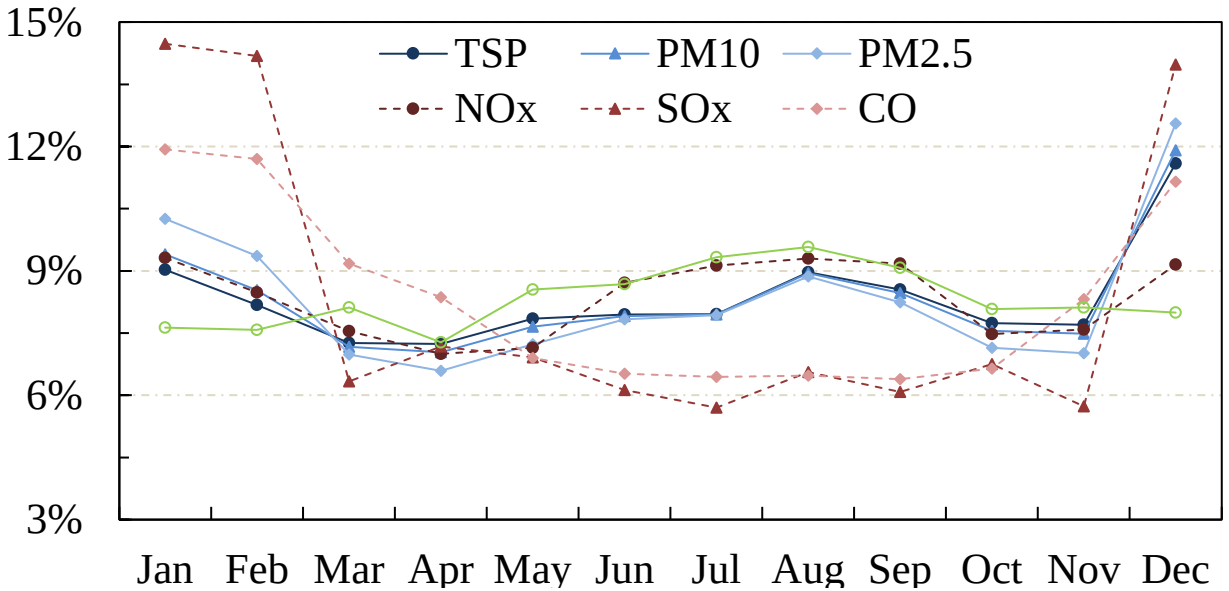


Study case: Tehran, Year 2018

Monthly emission variation

Mobile sources





Stationary sources

Acknowledgement

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Thank you for your attention