EMFAC-HK

Model Operation

January 18, 2017

What is *EMFAC-HK*?

- A mobile source emissions model that calculates emission rates and emission inventories for motor vehicles operating on roads in Hong Kong.
- Adaptation of the California Air Resources Board (CARB) **EM**ission **FAC**tors (EMFAC) with modifications to cater for local factors such as local vehicle fleet characteristics.

Model Introduction/Overview

- What you'll learn
  - Step by step tutorial to demonstrate examples of emission data routinely run by EMFAC-HK
  - Overview of what pollutants and processes are modeled
  - Editing fundamental data
  - Review sample output files

Reference Materials

- Software
- User's Manual
- Guideline on Modeling Vehicle Emissions, EPD, January 2016

EMFAC-HK

Model Overview

Model Overview

- Introduction
- Pollutants and Processes Modeled
- Overview of Basic Terminology
- Scenario Data
- Modeling Modes
- Editing Fundamental Data
- Exercises

Introduction

- **Emission inventory**: ‘product of an emission rate (e.g. grams per pollutant emitted over a mile or km) and vehicle activity (e.g. miles or km driven per day)’

Emission Factor X Source Activity = Emissions

Introduction (cont.)

- Vehicle tailpipe emissions are sensitive to driving patterns (In EMFAC, they are characterized by average vehicle speeds, ambient conditions, etc.)
- A common set of fleet-averaged vehicle emission factors, irrespective of driving patterns, are no longer accepted by advanced countries like the EU and the USA.

History Of *EMFAC-HK*

- History
  - EMFAC-HK Version 1.2
    - Used from 2005-2012
    - Adapted from EMFAC2002 by CARB
  - EMFAC-HK Version 2.1
    - Released April 3, 2012
    - Adapted from EMFAC2009 by CARB
  - EMFAC-HK Version 2.6
    - Released January 2015
  - EMFAC-HK Version 3.1 & 3.1.1
    - Released on January 2016 with refinement on February.

EMFAC-HK Version 1.2

- Consisted of Two Sub-models:
  - MC
    - 9 vehicle classes
  - TAXI
    - 7 vehicle classes
- 2003 calendar year baseline activity data

EMFAC-HK Version 2.1

- Released April 3, 2012
- Replaced EMFAC-HK Version 1.2
- Adapted from EMFAC 2009 from the California Air Resources Board (EMFAC2007)
- Modification of Vehicle Classes
  - Merged EMFAC-HK Version 1.2 MC and Taxi sub-models into single version.
- Base Year 2010
- Increased Exhaust Technology Groups
- Update of Hong Kong-Specific Data
- Increased Speed Distribution Bins

EMFAC-HK Version 2.6

- Released January 2, 2014
- Replaced EMFAC-HK V2.5.2
- Updated TG fractions for tentative Euro VI implementation
- Included catalytic converters and oxygen sensors replacement program for LPG/petrol taxis and LPG light bus.
- Revised I/M programme implementation date using remote sensing and dyno testing to Apr 2014
- Implemented mandatory retirement of pre-Euro IV diesel commercial vehicles
- Updated survival rates and revised methodology
- Removed new sales limits in the population forecast.

EMFAC-HK Version 3.1.1

- Released on February 2016
- Replaces EMFAC-HK V2.6
- Base Year 2002-2013
- Reorder of Vehicle Classes
- Revised INP format (SI Units, Header)
- Single Scenario limitation
- Alternate baseline forecasting algorithm and GUI

Pollutants

- Hydrocarbons (HC) – can be expressed as the following:
  - TOG (**T**otal **O**rganic **G**ases, regardless of reactivity)
  - VOC (**V**olatile **O**rganic **C**ompounds), also known as **r**eactive **o**rganic **g**ases (**ROG**)
  - THC (**T**otal **H**ydro**C**arbons, compounds with H and C atoms only, carbonyls and halogens are not included)
  - CH4 (methane)
- Carbon monoxide (CO)
- Nitrogen oxides (NOx)

Pollutants (cont.)

- Carbon dioxide (CO_2)
- Particulate matter (PM)
  - PM estimates are provided either as total suspended particulate (30 microns or less), particulate matter 10 microns or less in diameter (PM_{10}), or particulate matter 2.5 microns or less in diameter ($PM_{2.5}$).

Exhaust

Evaporative (Evap)

Other

EMISSIONS PROCESSES

Emission Processes

- Running Exhaust
- Starting Exhaust (petrol/LPG only)
- Diurnal Evap (partial day, multi-day)
- Resting Loss Evap (partial day, multi-day)
- Hot Soak Evap
- Running Evap

Running Exhaust Emissions

- emissions that come out of the vehicle tailpipe while it is traveling on the road, including at speed, and idling that occurs as part of normal driving, such as at intersections.

Starting Exhaust Emissions

- tailpipe emissions that occur as a result of starting a catalyst-equipped vehicle when the catalyst is cold.
- These emissions are independent of running exhaust emissions and can be thought of as a slug of emissions associated with starting a vehicle .
- The magnitude of these emissions is dependent on how long the vehicle has been sitting prior to starting.

Diurnal Evaporative Emissions

- Hydrocarbon (HC) emissions that occur when rising ambient temperatures cause fuel evaporation from vehicles sitting throughout the day.

- These losses are from leaks in the fuel system, fuel hoses, connectors, and as a result of breakthrough of vapors from the carbon canister.

- If a vehicle is sitting for a period of time after running, emissions from the first 35 minutes are counted as hot soak and emissions from the remaining period are counted as diurnal emissions, provided that the ambient temperature is *increasing* during the remaining period of time.

Resting Loss Evaporative Emissions

- HC emissions from fuel permeation through rubber and plastic components while vehicle is sitting.
- Emissions are counted as resting loss emissions if the vehicle has not been operated for 35 minutes and vehicle is still stationary, but the ambient temperature is either constant or *decreasing*.

Hot Soak Evaporative Emissions

- HC emissions that occur immediately after a trip end due to fuel heating and the fact that the engine remains hot for a short time after being switched off.
- In older, carbureted vehicles these emissions are attributed to vapor losses from the carburetor float bowl. In newer, fuel-injected vehicles, these vapor losses come from leaky fuel injectors or from fuel hoses.

Running Losses Evap Emissions

- evaporative HC emissions that occur when hot fuel vapors escape from the fuel system or overwhelm the carbon canister while the vehicle is operating.

Vehicle Fleet and Vehicle Class

Fuel Type

Technology Group

Model Year

Activity

Population

VKT

Trips

BASIC TERMINOLOGY

Vehicle Fleet / Vehicle Class

- "Vehicle Fleet"
  - "Vehicle fleet" refers to the mixture of all the different types of motor vehicles operating on roads in Hong Kong.
- "Vehicle Class"
  - The fleet is broken into multiple categories called "vehicle classes" (for example, class 1, or private cars). These classes are based on the type of vehicle, but they also take weight class, fuel type (i.e. gas, diesel, or LPG), and usage into account.
  - EMFAC-HK contains 16 vehicle classes, plus 5 unused "placeholders" for a total of 21 vehicle classes.

Fuel Type

- petrol vehicles (exhaust, evap)
- diesel vehicles (exhaust)
- **L**iquified **P**etroleum **G**as (LPG) vehicles (exhaust)

EMFAC-HK Version 3.1

Vehicle Classification Chart (Classes 1-10)

Index	Vehicle Class Description	Fuel Type*	Gross Vehicle Weight (tonnes)	Code
1	Private Cars (PC)	ALL	ALL	PC
2	Taxi	ALL	ALL	TAXI
3	Light Goods Vehicles (<=2.5t)	ALL	≤ 2.5	LGV3
4	Light Goods Vehicles (2.5-3.5t)	ALL	2.5-3.5	LGV4
5	Light Goods Vehicles (3.5-5.5t)	ALL	3.5-5.5	LGV6
6	Medium & Heavy Goods Vehicles (5.5-15t)	ALL	5.5-15	HGV7
7	Medium & Heavy Goods Vehicles (≥15t)	ALL	≥ 15	HGV8
8	Public Light Buses	ALL	ALL	PLB
9	Private Light Buses (≤ 3.5t)	ALL	≤ 3.5	PV4
10	Private Light Buses (>3.5t)	ALL	> 3.5	PV5

* All: petrol, diesel, or LPG.

EMFAC-HK Version 3.1

Vehicle Classification Chart (Classes 11-21)

Index	Vehicle Class Description	Fuel Type*	Gross Vehicle Weight (tonnes)	Code
11	Non-franchised Buses (<6.4t)	ALL	< 6.4	NFB6
12	Non-franchised Buses (6.4-15t)	ALL	6.4-15	NFB7
13	Non-franchised Buses (>15t)	ALL	>15	NFB8
14	Single Deck Franchised Buses	ALL	ALL	FBSD
15	Double Deck Franchised Buses	ALL	ALL	FBDD
16	Motor Cycles	ALL	ALL	MC
17	Placeholder (P1)	--	--	P1
18	Placeholder (P2)	--	--	P2
19	Placeholder (P3)	--	--	P3
20	Placeholder (P4)	--	--	P4
21	Placeholder (P5)	--	--	P5

Technology Groups

- represents vehicles from the same class but have distinct emission control technologies; have similar in-use deterioration rates; and, respond the same to repair.
- can represent vehicles whose emissions standards (i.e., pre-Euro, Euro-I) are the same, or those that have specific equipment installed on them (e.g., multi-port fuel injection, three-way catalyst, adaptive fuel controls, etc.) which makes them behave the same.
- Separate technology groups for exhaust and evap

Exhaust Tech Group Indexes (Example Only)

Diesel Heavy Goods Vehicles with GVW >15 t (HGV8)

Vehicle Class	Fuel Type	Vehicle Emission	Tech Group Index
HGV8	Diesel	pre-Euro	153
HGV8	Diesel	pre-Euro DOC Retrofitted	155
HGV8	Diesel	Euro I	154
HGV8	Diesel	Euro II	157
HGV8	Diesel	Euro III	159
HGV8	Diesel	Euro IV	160
HGV8	Diesel	Euro IV - DPF	163
HGV8	Diesel	Euro IV - SCR	164
HGV8	Diesel	Euro V	161
HGV8	Diesel	Euro V - DPF	165
HGV8	Diesel	Euro V - SCR	166
HGV8	Diesel	Euro VI	162

Model Years

- Within each vehicle class, each model year is represented by a combination of technology groups (“phase-in” schedules).
- model calculates emission rates for 1965 to 2040 model years.

Calendar Years

- EMFAC-HK estimates calendar years from 1997 to 2040.
- Only one calendar year/scenario can be run at a time

Age

- How old a particular model year vehicle is relative to the calendar year
- Difference between the calendar year and model year, plus 1

Activity

- for each vehicle class and fuel type, these terms are commonly referred to as vehicle activity:
  - Vehicle population
  - Accrual
  - Odometer
  - Vehicle Kilometers/Miles Travelled (VKT/VMT)
  - Trips

Population

- determined through an analysis of traffic census data. These data are used in developing vehicle age matrices for the base year, as well as forecast/backcast of population to other calendar years
  - EMFAC-HK v3.1.1: 2002-2013 base years

Accrual

- Vehicle accrual is the annual mileage a vehicle travelled against its age.
- Newer vehicles driven more than older ones

Vehicle Kilometers Traveled (VKT)

- represents total distance travelled on a weekday
- calculated based on vehicle population and vehicle accrual
- from regional estimates of VKT by vehicle type. These VKT estimates matched by modifying the accrual rates.

Starts/Trips

- Number of trips or starts is the number of times a vehicle is started for separate trips made per weekday
- Petrol and LPG emissions are affected by starts/trips.

Geographic Area

Calendar Year

Alt. Baseline Year (optional)

Season or Month

Title

Model Years Included

Emissions Mode

Output Options

BASIC DATA FOR A SCENARIO

Basic Data for a Scenario

- Geographic area (Hong Kong)
- Forecast Year (i.e., “Calendar” Year)
- Alternate Baseline Year (2013 or newer)
- Title
- Month or Season
- Model Years Included in calculation
- Emissions mode (Burden or EMFAC)
- Output formats, and
- Output options (frequency, pollutant form)

Mode Comparison

BURDEN

- Emissions estimates
- total emissions as tonnes per period (weekday or hour) for each pollutant, by vehicle class and the total vehicle fleet
- emission factors--corrected for ambient conditions and speeds--combined with vehicle activity to calculate emissions in tonnes per day

EMFAC

- Emission Factors (EFs) in terms of grams of pollutant emitted per vehicle activity
- Calculates matrix of EFs at specific values of T (0^{o}C to 40^{o}C), RH (0% to 100%), and vehicle speed (10 kph to 130 kph) for each vehicle class/technology combination.

BURDEN Output Options

- **Detailed Planning Inventory (CSV)** - a comma-separated file (with a “csv” extension) which can be read by any spreadsheet program. It contains emission estimates for all 16-vehicle classes by fuel type. It is recommended that new users select this as an output option to get an idea of the entire emissions.

BURDEN Output (cont.)

- **MVEI7G (BCD) File** - This is also a comma-separated file but it has a “bcd” extension. This file is in the same format as that produced by the MVEI7G model. This file has the same information as “Detailed Planning Inventory“ but in columnar format, which makes it suitable for sorting using spreadsheets.

BURDEN Output (cont.)

- Weighted Model Year Activity Output **(*.WT)** Gives the activity components like population, VKT, Trips, Accrual Rate and Odometer by model year.

BURDEN Output (cont.)

- **Detailed Outputs (BDN) File** - gives the Burden output for each vehicle class and emissions process by Model year and Tech groups in a columnar, record-style format, which makes it suitable for importing to a spreadsheet or database. This format is useful for the air pollution modeling and planning communities.

Burden Report Output Types

Report Type	Description	Format	File Extension
Detailed Planning Inventory (CSV)	Contains emission estimates for all 16-vehicle classes by fuel type.	comma-separated	*.CSV
MVEI7G (BCD) File	Emissions Database for Planning.	comma-separated	*.BCD.CSV
Detailed Outputs (BDN)	Gives the Burden output by Model year, Tech groups and Speed bin.	comma-separated	*.BDN.CSV
Weighted Model Year Activity Output (WT)	Gives the Activity components like population, VKT, trips, accrual, and odometer by model year.	No delimiters	*.WT

Detailed Planning Inventory (*.csv)

HK_2030_Burden.csv

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1	Title : Hong Kong SAR Annual CYr 2030 Default Title																				
2	Version : Emfac-HK V3.09 beta V3.0.9.beta 151008 Sp: Beta Version Pr: Emfac-HK HK3.0.9.beta																				
3	Run Date : 2015/11/10 11:18:08																				
4	Scen Year: 2030 -- All model years in the range 1986 to 2030 selected																				
5	Season : Annual																				
6	Area : Hong Kong SAR																				
7	I/M Stat : HK I/M CY2013+ program in effect																				
8	Emissions: Tonnes Per Day																				
9	**********																				
10		PC-NCAT	PC-CAT	PC-DSL	PC-LPG	PC-TOT	TAXI-NCAT	TAXI-CAT	TAXI-DSL	TAXI-LPG	TAXI-TOT	LGV<=2.5t	LGV<=2.5t	LGV<=2.5t	LGV<=2.5t	LGV<=2.5t	LGV2.5-3.5	LGV2.5-3.5	LGV2.5-3.5	LGV2.5-3.5	LGV2.5-3.5
11	Vehicles	3	790870	277	0	791151	0	0	0	18204	18204	0	2	1003	0	1005	0	1058	53842	0	54900
12	VKT	51	22087438	5777	0	22093266	0	0	0	7670384	7670384	14	96	74300	0	74410	7	67137	3550588	0	3617731
13	Trips	4	1186420	416	0	1186840	0	0	0	72821	72821	1	7	4013	0	4021	1	4231	215391	0	219622
14	VOC Emissions																				
15	Run Exh	0.00009	0.06256	0.0004	0	0.06305	0	0	0	0.16034	0.16034	0.00002	0.00007	0.00114	0	0.00123	0.00001	0.00285	0.05605	0	0.05891
16	Start Ex	0.00004	0.05779	0	0	0.05783	0	0	0	0.03817	0.03817	0.00002	0.00003	0	0	0.00005	0.00001	0.00116	0	0	0.00117
17	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
18																					
19	Diurnal	0.00003	0.30319	0	0	0.30322	0	0	0	0	0	0.00001	0	0	0	0.00001	0	0.00067	0	0	0.00067
20	Hot Soak	0.00002	0.19507	0	0	0.19509	0	0	0	0	0	0.00001	0.00001	0	0	0.00002	0	0.00137	0	0	0.00137
21	Running	0.00009	0.30161	0	0	0.30171	0	0	0	0	0	0.00004	0.00002	0	0	0.00007	0.00001	0.00436	0	0	0.00437
22	Resting	0.00004	0.51523	0	0	0.51527	0	0	0	0	0	0.00001	0	0	0	0.00001	0	0.00105	0	0	0.00105
23	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
24	Carbon Monoxide Emissions																				
25	Run Exh	0.00122	3.85113	0.00243	0	3.85477	0	0	0	10.43512	10.43512	0.00014	0.00112	0.01836	0	0.01961	0.00006	0.17308	0.8737	0	1.04684
26	Start Ex	0.00021	1.34459	0	0	1.3448	0	0	0	0.18225	0.18225	0.00004	0.00025	0	0	0.0003	0.00002	0.03595	0	0	0.03597
27	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
28	Oxides of Nitrogen Emissions																				
29	Run Exh	0.00016	0.36871	0.00086	0	0.36973	0	0	0	2.0571	2.0571	0.00006	0.00007	0.02986	0	0.02999	0.00003	0.00139	1.50595	0	1.50736
30	Start Ex	0.00003	0.01248	0	0	0.01251	0	0	0	0.05446	0.05446	0	0.00003	0	0	0.00003	0	0.00057	0	0	0.00058
31	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
32	Carbon Dioxide Emissions (000)																				
33	Run Exh	0.00001	4.84702	0.00124	0	4.84827	0	0	0	1.78523	1.78523	0	0.00002	0.02227	0	0.02229	0	0.01223	1.06443	0	1.07666
34	Start Ex	0	0.08693	0	0	0.08694	0	0	0	0.00572	0.00572	0	0	0	0	0	0	0.00031	0	0	0.00031
35	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
36	PM10 Emissions																				
37	Run Exh	0	0.06703	0.00008	0	0.06712	0	0	0	0	0	0	0	0.00023	0	0.00023	0	0.00024	0.01329	0	0.01353

HK_2030_Burden

MVEI7G CSV file (*.bcd.csv)

HK_2030_Burden.bcd.csv

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	CALYR	START MYI	END MYR	REGION	SAR	STARTS	POPULATI	VKT	VEH TYPE	VEH TECH	POLLUTAN	PROCESS	EMISSION	BASIS
2	2030	1986	2030	SAR Avera	Hong Kon	4	3	51	PC	NCAT	CO	Run Exh	0.001218	Day
3	2030	1986	2030	SAR Avera	Hong Kon	4	3	51	PC	NCAT	NOx	Run Exh	0.000157	Day
4	2030	1986	2030	SAR Avera	Hong Kon	4	3	51	PC	NCAT	PM	Run Exh	0.000001	Day
5	2030	1986	2030	SAR Avera	Hong Kon	4	3	51	PC	NCAT	VOC	Run Exh	0.00009	Day
6	2030	1986	2030	SAR Avera	Hong Kon	4	3	51	PC	NCAT	CO2	Run Exh	0.011113	Day
7	2030	1986	2030	SAR Avera	Hong Kon	4	3	51	PC	NCAT	CO	Start Ex	0.000213	Day
8	2030	1986	2030	SAR Avera	Hong Kon	4	3	51	PC	NCAT	NOx	Start Ex	0.00003	Day
9	2030	1986	2030	SAR Avera	Hong Kon	4	3	51	PC	NCAT	PM	Start Ex	0	Day
10	2030	1986	2030	SAR Avera	Hong Kon	4	3	51	PC	NCAT	VOC	Start Ex	0.000038	Day
11	2030	1986	2030	SAR Avera	Hong Kon	4	3	51	PC	NCAT	CO2	Start Ex	0.000884	Day
12	2030	1986	2030	SAR Avera	Hong Kon	4	3	51	PC	NCAT	CO	Hot Soak	0	Day
13	2030	1986	2030	SAR Avera	Hong Kon	4	3	51	PC	NCAT	NOx	Hot Soak	0	Day
14	2030	1986	2030	SAR Avera	Hong Kon	4	3	51	PC	NCAT	PM	Hot Soak	0	Day
15	2030	1986	2030	SAR Avera	Hong Kon	4	3	51	PC	NCAT	VOC	Hot Soak	0.00002	Day
16	2030	1986	2030	SAR Avera	Hong Kon	4	3	51	PC	NCAT	CO2	Hot Soak	0	Day
17	2030	1986	2030	SAR Avera	Hong Kon	4	3	51	PC	NCAT	CO	Running	0	Day
18	2030	1986	2030	SAR Avera	Hong Kon	4	3	51	PC	NCAT	NOx	Running	0	Day
19	2030	1986	2030	SAR Avera	Hong Kon	4	3	51	PC	NCAT	PM	Running	0	Day
20	2030	1986	2030	SAR Avera	Hong Kon	4	3	51	PC	NCAT	VOC	Running	0.000094	Day
21	2030	1986	2030	SAR Avera	Hong Kon	4	3	51	PC	NCAT	CO2	Running	0	Day
22	2030	1986	2030	SAR Avera	Hong Kon	4	3	51	PC	NCAT	CO	PD Rest	0	Day
23	2030	1986	2030	SAR Avera	Hong Kon	4	3	51	PC	NCAT	NOx	PD Rest	0	Day
24	2030	1986	2030	SAR Avera	Hong Kon	4	3	51	PC	NCAT	PM	PD Rest	0	Day
25	2030	1986	2030	SAR Avera	Hong Kon	4	3	51	PC	NCAT	VOC	PD Rest	0.000036	Day
26	2030	1986	2030	SAR Avera	Hong Kon	4	3	51	PC	NCAT	CO2	PD Rest	0	Day
27	2030	1986	2030	SAR Avera	Hong Kon	4	3	51	PC	NCAT	CO	MD Rest	0	Day
28	2030	1986	2030	SAR Avera	Hong Kon	4	3	51	PC	NCAT	NOx	MD Rest	0	Day
29	2030	1986	2030	SAR Avera	Hong Kon	4	3	51	PC	NCAT	PM	MD Rest	0	Day
30	2030	1986	2030	SAR Avera	Hong Kon	4	3	51	PC	NCAT	VOC	MD Rest	0.000002	Day
31	2030	1986	2030	SAR Avera	Hong Kon	4	3	51	PC	NCAT	CO2	MD Rest	0	Day
32	2030	1986	2030	SAR Avera	Hong Kon	4	3	51	PC	NCAT	CO	Resting	0	Day
33	2030	1986	2030	SAR Avera	Hong Kon	4	3	51	PC	NCAT	NOx	Resting	0	Day
34	2030	1986	2030	SAR Avera	Hong Kon	4	3	51	PC	NCAT	PM	Resting	0	Day
35	2030	1986	2030	SAR Avera	Hong Kon	4	3	51	PC	NCAT	VOC	Resting	0.000039	Day
36	2030	1986	2030	SAR Avera	Hong Kon	4	3	51	PC	NCAT	CO2	Resting	0	Day
37	2030	1986	2030	SAR Avera	Hong Kon	4	3	51	PC	NCAT	CO	PD Diurn	0	Day

HK_2030_Burden.bcd

Weighted Model Year Activity Output (*.WT)

HK_2030_Burden.wt

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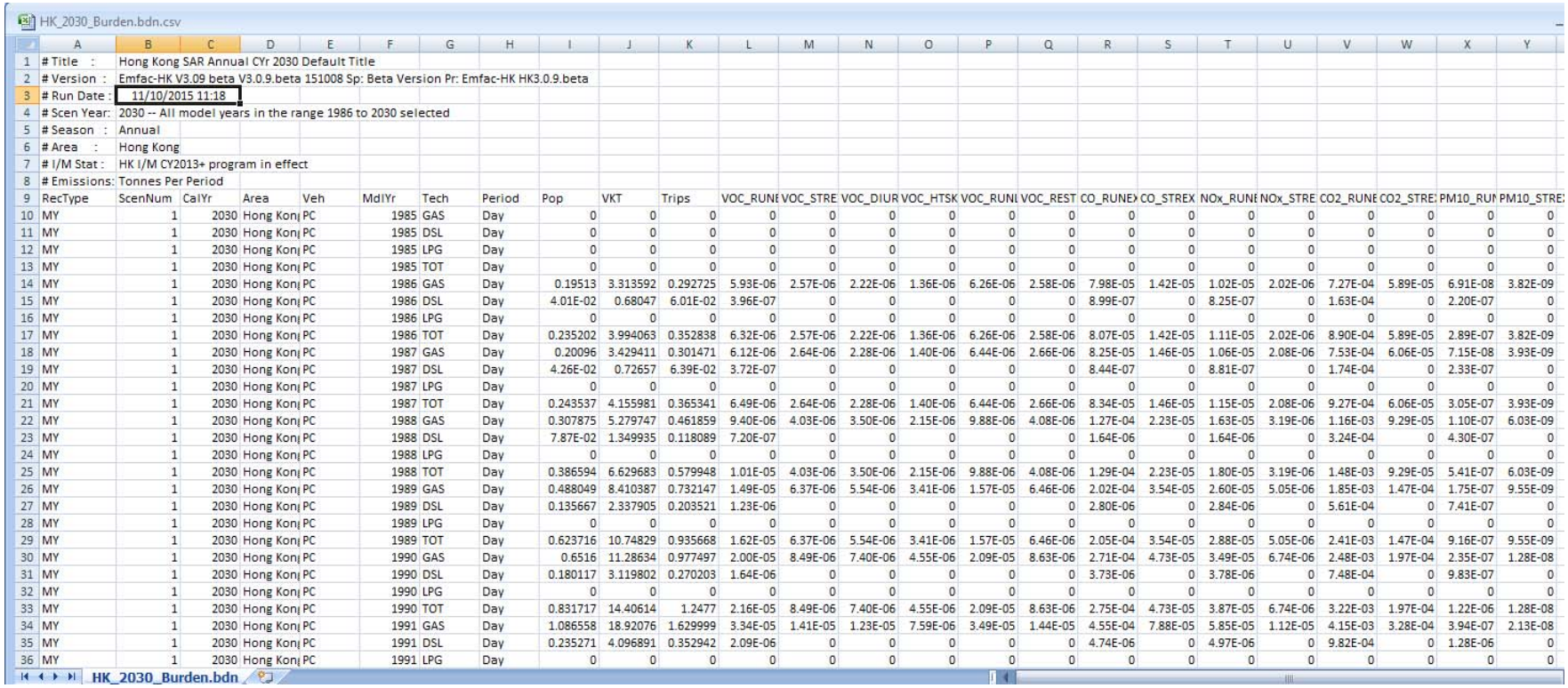
 ----------------------------------------------------------------------------------
 Calendar Year: 2030
   Model Years: 1986 to 2030
         Title: Hong Kong SAR Annual CYr 2030 Default Title
          Area: Hong Kong
       SubArea: Average
       Program: Emfac-HK V3.09 beta V3.0.9.beta 151008 Sp: Beta Version Pr: Emfac-HK HK3.0.9.beta
      Run Date: 2015/11/10 11:18:08

 SCEN  VEH                      VEH POP             VKT          TRIPS          ACCRUAL        ODOMETER
 YEAR  CLS TECH  MYR            (number)        (km/day)       (per day)     (km/yr/veh)       (km/veh)

 2030    1 NCAT 1986                  0.            3.31              0.            6198.          352005.
 2030    1 NCAT 1987                  0.            3.43              0.            6228.          345808.
 2030    1 NCAT 1988                  0.            5.28              0.            6259.          339580.
 2030    1 NCAT 1989                  0.            8.41              1.            6289.          333321.
 2030    1 NCAT 1990                  1.           11.29              1.            6322.          327032.
 2030    1 NCAT 1991                  1.           18.92              2.            6355.          320710.
 2030    1 NCAT 1992                  0.            0.00              0.               0.               0.
 2030    1 NCAT 1993                  0.            0.00              0.               0.               0.
 2030    1 NCAT 1994                  0.            0.00              0.               0.               0.
 2030    1 NCAT 1995                  0.            0.00              0.               0.               0.
 2030    1 NCAT 1996                  0.            0.00              0.               0.               0.
 2030    1 NCAT 1997                  0.            0.00              0.               0.               0.
 2030    1 NCAT 1998                  0.            0.00              0.               0.               0.
 2030    1 NCAT 1999                  0.            0.00              0.               0.               0.
 2030    1 NCAT 2000                  0.            0.00              0.               0.               0.
 2030    1 NCAT 2001                  0.            0.00              0.               0.               0.
 2030    1 NCAT 2002                  0.            0.00              0.               0.               0.
 2030    1 NCAT 2003                  0.            0.00              0.               0.               0.
 2030    1 NCAT 2004                  0.            0.00              0.               0.               0.
 2030    1 NCAT 2005                  0.            0.00              0.               0.               0.
 2030    1 NCAT 2006                  0.            0.00              0.               0.               0.
 2030    1 NCAT 2007                  0.            0.00              0.               0.               0.
 2030    1 NCAT 2008                  0.            0.00              0.               0.               0.
 2030    1 NCAT 2009                  0.            0.00              0.               0.               0.
 2030    1 NCAT 2010                  0.            0.00              0.               0.               0.
 2030    1 NCAT 2011                  0.            0.00              0.               0.               0.
 2030    1 NCAT 2012                  0.            0.00              0.               0.               0.
 2030    1 NCAT 2013                  0.            0.00              0.               0.               0.
 2030    1 NCAT 2014                  0.            0.00              0.               0.               0.
```

Detailed Output File (*.BDN.CSV)



HK_2030_Burden.bdn.csv

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y
1	# Title :	Hong Kong SAR Annual CYr 2030 Default Title																							
2	# Version :	Emfac-HK V3.09 beta V3.0.9.beta 151008 Sp: Beta Version Pr: Emfac-HK HK3.0.9.beta																							
3	# Run Date :	11/10/2015 11:18																							
4	# Scen Year:	2030 -- All model years in the range 1986 to 2030 selected																							
5	# Season :	Annual																							
6	# Area :	Hong Kong																							
7	# I/M Stat :	HK I/M CY2013+ program in effect																							
8	# Emissions:	Tonnes Per Period																							
9	RecType	ScenNum	CalYr	Area	Veh	MdlYr	Tech	Period	Pop	VKT	Trips	VOC_RUNE	VOC_STRE	VOC_DIUR	VOC_HTSK	VOC_RUNI	VOC_REST	CO_RUNEX	CO_STREX	NOx_RUNE	NOx_STRE	CO2_RUNE	CO2_STRE	PM10_RUN	PM10_STRE
10	MY	1	2030	Hong Kon	PC	1985	GAS	Day	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	MY	1	2030	Hong Kon	PC	1985	DSL	Day	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	MY	1	2030	Hong Kon	PC	1985	LPG	Day	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	MY	1	2030	Hong Kon	PC	1985	TOT	Day	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	MY	1	2030	Hong Kon	PC	1986	GAS	Day	0.19513	3.313592	0.292725	5.93E-06	2.57E-06	2.22E-06	1.36E-06	6.26E-06	2.58E-06	7.98E-05	1.42E-05	1.02E-05	2.02E-06	7.27E-04	5.89E-05	6.91E-08	3.82E-09
15	MY	1	2030	Hong Kon	PC	1986	DSL	Day	4.01E-02	0.68047	6.01E-02	3.96E-07	0	0	0	0	0	8.99E-07	0	8.25E-07	0	1.63E-04	0	2.20E-07	0
16	MY	1	2030	Hong Kon	PC	1986	LPG	Day	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	MY	1	2030	Hong Kon	PC	1986	TOT	Day	0.235202	3.994063	0.352838	6.32E-06	2.57E-06	2.22E-06	1.36E-06	6.26E-06	2.58E-06	8.07E-05	1.42E-05	1.11E-05	2.02E-06	8.90E-04	5.89E-05	2.89E-07	3.82E-09
18	MY	1	2030	Hong Kon	PC	1987	GAS	Day	0.20096	3.429411	0.301471	6.12E-06	2.64E-06	2.28E-06	1.40E-06	6.44E-06	2.66E-06	8.25E-05	1.46E-05	1.06E-05	2.08E-06	7.53E-04	6.06E-05	7.15E-08	3.93E-09
19	MY	1	2030	Hong Kon	PC	1987	DSL	Day	4.26E-02	0.72657	6.39E-02	3.72E-07	0	0	0	0	0	8.44E-07	0	8.81E-07	0	1.74E-04	0	2.33E-07	0
20	MY	1	2030	Hong Kon	PC	1987	LPG	Day	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	MY	1	2030	Hong Kon	PC	1987	TOT	Day	0.243537	4.155981	0.365341	6.49E-06	2.64E-06	2.28E-06	1.40E-06	6.44E-06	2.66E-06	8.34E-05	1.46E-05	1.15E-05	2.08E-06	9.27E-04	6.06E-05	3.05E-07	3.93E-09
22	MY	1	2030	Hong Kon	PC	1988	GAS	Day	0.307875	5.279747	0.461859	9.40E-06	4.03E-06	3.50E-06	2.15E-06	9.88E-06	4.08E-06	1.27E-04	2.23E-05	1.63E-05	3.19E-06	1.16E-03	9.29E-05	1.10E-07	6.03E-09
23	MY	1	2030	Hong Kon	PC	1988	DSL	Day	7.87E-02	1.349935	0.118089	7.20E-07	0	0	0	0	0	1.64E-06	0	1.64E-06	0	3.24E-04	0	4.30E-07	0
24	MY	1	2030	Hong Kon	PC	1988	LPG	Day	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	MY	1	2030	Hong Kon	PC	1988	TOT	Day	0.386594	6.629683	0.579948	1.01E-05	4.03E-06	3.50E-06	2.15E-06	9.88E-06	4.08E-06	1.29E-04	2.23E-05	1.80E-05	3.19E-06	1.48E-03	9.29E-05	5.41E-07	6.03E-09
26	MY	1	2030	Hong Kon	PC	1989	GAS	Day	0.488049	8.410387	0.732147	1.49E-05	6.37E-06	5.54E-06	3.41E-06	1.57E-05	6.46E-06	2.02E-04	3.54E-05	2.60E-05	5.05E-06	1.85E-03	1.47E-04	1.75E-07	9.55E-09
27	MY	1	2030	Hong Kon	PC	1989	DSL	Day	0.135667	2.337905	0.203521	1.23E-06	0	0	0	0	0	2.80E-06	0	2.84E-06	0	5.61E-04	0	7.41E-07	0
28	MY	1	2030	Hong Kon	PC	1989	LPG	Day	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	MY	1	2030	Hong Kon	PC	1989	TOT	Day	0.623716	10.74829	0.935668	1.62E-05	6.37E-06	5.54E-06	3.41E-06	1.57E-05	6.46E-06	2.05E-04	3.54E-05	2.88E-05	5.05E-06	2.41E-03	1.47E-04	9.16E-07	9.55E-09
30	MY	1	2030	Hong Kon	PC	1990	GAS	Day	0.6516	11.28634	0.977497	2.00E-05	8.49E-06	7.40E-06	4.55E-06	2.09E-05	8.63E-06	2.71E-04	4.73E-05	3.49E-05	6.74E-06	2.48E-03	1.97E-04	2.35E-07	1.28E-08
31	MY	1	2030	Hong Kon	PC	1990	DSL	Day	0.180117	3.119802	0.270203	1.64E-06	0	0	0	0	0	3.73E-06	0	3.78E-06	0	7.48E-04	0	9.83E-07	0
32	MY	1	2030	Hong Kon	PC	1990	LPG	Day	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33	MY	1	2030	Hong Kon	PC	1990	TOT	Day	0.831717	14.40614	1.2477	2.16E-05	8.49E-06	7.40E-06	4.55E-06	2.09E-05	8.63E-06	2.75E-04	4.73E-05	3.87E-05	6.74E-06	3.22E-03	1.97E-04	1.22E-06	1.28E-08
34	MY	1	2030	Hong Kon	PC	1991	GAS	Day	1.086558	18.92076	1.629999	3.34E-05	1.41E-05	1.23E-05	7.59E-06	3.49E-05	1.44E-05	4.55E-04	7.88E-05	5.85E-05	1.12E-05	4.15E-03	3.28E-04	3.94E-07	2.13E-08
35	MY	1	2030	Hong Kon	PC	1991	DSL	Day	0.235271	4.096891	0.352942	2.09E-06	0	0	0	0	0	4.74E-06	0	4.97E-06	0	9.82E-04	0	1.28E-06	0
36	MY	1	2030	Hong Kon	PC	1991	LPG	Day	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

HK_2030_Burden.bdn

EMFAC Output Options

- Impact Rate Detail (RTL). This file generates detailed emission factors for each vehicle class and technology group by speed bin. 9 different emission factor tables are provided, described in next slide. This file has an “RTL” extension, but is in a CSV format. Hence, any spreadsheet program can read this file. It is recommended that new users output this file to get a feel for the type of information generated in *EMFAC* mode.

EMFAC Output Options (cont.)

- Impact Rate Detail (RTL). The tables contained in the RTL file include:
  - Table 1: Running Exhaust Emissions (grams/km)
  - Table 2: Starting Emissions (grams/trip)
  - Table 4: Hot Soak Emissions (grams/trip)
  - Table 5a: Partial Day Diurnal Loss Emissions (grams/hour)
  - Table 5b: Multi-Day Diurnal Loss Emissions (grams/hour)
  - Table 6a: Partial Day Resting Loss Emissions (grams/hour)
  - Table 6b: Multi-Day Resting Loss Emissions (grams/hour)
  - Table 7: Estimated Travel Fractions
  - Table 8: Evaporative Running Loss Emissions (grams/minute)

EMFAC Report Output Types

Report Type	Description	Format	File Extension
Impact Rate Detail (RTL)	generates detailed emission factors by activity (i.e., g/km, g/trip) for each vehicle class and technology group by speed bin.	comma-separated	*.RTL.CSV

EMFAC Impact Rate Detail Format (*.RTL)

HK_2030_EMFAC.rtl.csv

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X
1	Title : Hong Kong SAR Annual CYr 2030 Default Title																							
2	Version : Emfac-HK V3.09 beta V3.0.9.beta 151008 Sp: Beta Version Pr: Emfac-HK HK3.0.9.beta																							
3	Run Date : 2015/11/10 12:17:33																							
4	Scen Year: 2030 -- All model years in the range 1986 to 2030 selected																							
5	Season : Annual																							
6	Area : Hong Kong																							
7	**********																							
8	Year:	2030		-- Model Years		1986	to	2030	Inclusive --			Annual												
9	Emfac-HK V3.09 beta Emission Factors: V3.0.9.beta 151008 Sp: Beta Version Pr: Emfac-HK HK3.0.9.beta																							
10																								
11	SAR Average					Hong Kong						SAR Average												
12																								
13					Table 1: Running Exhaust Emissions (grams/km)																			
14																								
15	Pollutant Name: Volatile Org Cpds				Temperature: 25C		Relative Humidity: 40%																		
16																								
17	Speed	PC	PC	PC	PC	PC	TAXI	TAXI	TAXI	TAXI	TAXI	LGV3	LGV3	LGV3	LGV3	LGV3	LGV4	LGV4	LGV4	LGV4	LGV4	LGV6	LGV6	LGV6
18	km/hr	NCAT	CAT	DSL	LPG	ALL	NCAT	CAT	DSL	LPG	ALL	NCAT	CAT	DSL	LPG	ALL	NCAT	CAT	DSL	LPG	ALL	NCAT	CAT	DSL
19																								
20	10	4.1273	0.0081	0.1724	0	0.0082	0	0	0	0.0317	0.0317	2.3043	2.6258	0.0306	0	0.0344	2.2355	0.0647	0.0316	0	0.0322	0	0	0.1551
21	20	2.8786	0.0052	0.1289	0	0.0052	0	0	0	0.023	0.023	2.0723	2.5913	0.0236	0	0.0273	1.9492	0.0636	0.0243	0	0.025	0	0	0.0713
22	30	2.1658	0.0036	0.0997	0	0.0036	0	0	0	0.0188	0.0188	1.8835	2.5846	0.0189	0	0.0225	1.7162	0.0633	0.0194	0	0.0202	0	0	0.0327
23	40	1.7489	0.0028	0.0798	0	0.0028	0	0	0	0.0165	0.0165	1.7379	2.5829	0.0156	0	0.0193	1.5365	0.0633	0.0161	0	0.017	0	0	0.0281
24	50	1.506	0.0023	0.0661	0	0.0023	0	0	0	0.0152	0.0152	1.6354	2.5808	0.0134	0	0.017	1.4102	0.0632	0.0138	0	0.0147	0	0	0.0245
25	60	1.3747	0.002	0.0566	0	0.0021	0	0	0	0.0145	0.0145	1.5761	2.5772	0.0119	0	0.0155	1.3371	0.0632	0.0122	0	0.0132	0	0	0.0215
26	70	1.3241	0.0019	0.0501	0	0.0019	0	0	0	0.0142	0.0142	1.56	2.5734	0.0108	0	0.0144	1.3172	0.0631	0.0111	0	0.0121	0	0	0.0191
27	80	1.343	0.0019	0.046	0	0.0019	0	0	0	0.0141	0.0141	1.587	2.5714	0.0102	0	0.0138	1.3505	0.063	0.0104	0	0.0114	0	0	0.0174
28	90	1.4357	0.002	0.0436	0	0.002	0	0	0	0.0143	0.0143	1.6572	2.5735	0.0098	0	0.0134	1.437	0.063	0.0101	0	0.011	0	0	0.0163
29	100	1.6231	0.0021	0.0428	0	0.0021	0	0	0	0.0148	0.0148	1.7705	2.5935	0.0097	0	0.0133	1.5769	0.0632	0.0099	0	0.0109	0	0	0.0158
30	110	1.7527	0.0023	0.0429	0	0.0023	0	0	0	0.0151	0.0151	1.8373	2.638	0.0097	0	0.0134	1.6592	0.0635	0.0099	0	0.0109	0	0	0.016
31	120	1.7527	0.0023	0.0429	0	0.0023	0	0	0	0.0151	0.0151	1.8373	2.638	0.0097	0	0.0134	1.6592	0.0635	0.0099	0	0.0109	0	0	0.0168
32	130	1.7527	0.0023	0.0429	0	0.0023	0	0	0	0.0151	0.0151	1.8373	2.638	0.0097	0	0.0134	1.6592	0.0635	0.0099	0	0.0109	0	0	0.0182
33																								
34																								
35	Pollutant Name: Carbon Monoxide				Temperature: 25C		Relative Humidity: 40%																		
36																								
37	Speed	PC	PC	PC	PC	PC	TAXI	TAXI	TAXI	TAXI	TAXI	LGV3	LGV3	LGV3	LGV3	LGV3	LGV4	LGV4	LGV4	LGV4	LGV4	LGV6	LGV6	LGV6

Other Output Options

- Output Frequency (BURDEN mode Only)
  - Daily (average weekday), or
  - hourly (values for all 24-hours, and includes daily total). Note: hourly generates 25 times more output, which can lead to very large output files.
- Output Particulate As…
  - User selects either total PM, PM_{10} (or RSP), or $PM_{2.5}$
- Output Hydrocarbon As..
  - User selects either TOG, THC, VOC, or CH4

Exhaust Tech Fractions

Evap Tech Fractions

Population (Calendar or Alternate Baseline)

Accrual

Trips

VKT

RVP

Speed Fractions

Temperature

Relative Humidity

EDITING FUNDAMENTAL DATA

Editing Fundamental Data – Tech / IM

! **SEQUENCE** of edits
Scenario Model

- **Exhaust Technology Fraction**
  - *Apply to model year / model year range*
  - *Apply to other vehicle classes*
  - *Technology specific*
- **Evaporative Technology Fractions**
  - *Petrol vehicles only*

Editing Fundamental Data - Activity

! **SEQUENCE** of edits
Edits applied proportionally

- **Population (Alt. Base Year or Calendar Year)**
  - Edits applied proportionally
  - Edits by vehicle, fuel, and age
  - Age distributions

- **Accrual** (defn.) *annual distance driven*
  - Population weighted accrual rates
  - Edits by vehicle class, fuel and age

- **Trips** *based on the number of engine on to off events*
  - Edits by vehicle class, fuel and hour (hourly model!)

- **VKT**
  - Edits by vehicle class, fuel and hour

Editing Fundamental Data - Profile/Speeds

- **RVP** *(evap emissions for petrol vehicles only)*
- **Speed Fractions**

  - Edits by vehicle class, hour and speed bin

  - Apply changes to this hour / vehicle class

  - Apply to others

Editing Fundamental Data - Temperature/RH Profiles

- **Temperature**
  - ***Edits by hour***
  - ***Modify for range of hours***
- **Relative Humidity (RH)**
  - ***Edits by hour***
  - ***Modify for range of hours***

END OF MODEL OVERVIEW