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LPG Emissions Reduction Programme in Hong Kong

The need of the LPG taxis

The protection of Hong Kong's public health is our major concern to both citizens and political representatives. However, air quality standards, as established by the Environmental Protection Department (EPD) of the Hong Kong Government, are often exceeded. Numerous studies during the past decade have documented that vehicle exhaust is a significant contributor to health problems. Excessive and unregulated exhaust from petrol vehicles is carcinogenic. Exhaust from diesel vehicles accounts for the majority of respirable suspend particulates (RSP) which contribute to respiratory problems. Since LPG produces less particulates as well as NOx than diesel, it is considered as a good alternative fuel to diesel vehicles. However, since the maximum number of existing and possible new sites for the LPG refilling stations may be limited to 60 (due to the geographic structure in Hong Kong), other light duty vehicles using LPG may not be feasible.

Control of Air Pollution

It takes clean fuel, effective emissions tests, skilled technicians, advanced technology, and regular maintenance to improve the air quality in the territory. Manwhile, a successful LPG taxis program has to be economical and convenient as well.

- **Clean Fuel:**

LPG is considered, as a Clean Fuel" because it produces lower PM-10 compared to diesel and lesser volatile organic compounds (VOC) and toxic than petroleum.

- **Emissions Test**

Because of the similar nature between LPG vehicle and petrol, emission test data on 12,000 Hong Kong petrol vehicles will be adopted as reference. In general, LPG vehicles produce CO, NOx and HC, therefore, it is important to monitor the emission level on LPG vehicles as well. Currently, low-speed idling

test has been performed on LPG taxis in Hong Kong, we recommend that AFR (Air to Fuel Ratio), CO_2 as well as O_2 should also be tested. Vehicles with high AFR that pass the low speed idle test (see appendix 1) may produce excessive NOx with poor fuel efficiency as well as horsepower.

- **Skilled Technicians**

In Hong Kong, most garages do not have diagnostic equipment to inspect vehicles due to the lack of space, equipment, or the knowledge to repair the latest technologies. While vehicle pollutants were reduced tremendously with proper repair, more than 65% of retested vehicles showed disappointing results from improper repair, (see appendix 2.) Up-to-date technologies are ineffective without well-qualified mechanics. The Government must provide more advanced on-going education courses to the trade, especially to the diesel repair workshops to ease them into the LPG taxis repair industry.

- **Advanced Technology**

It is the fact that the technology of LPG taxis is somewhat lower than the petrol vehicles. Hence, we have to put more emphasis on the adequacy of tune-up and regular maintenance on LPG taxis to control emissions.

The Practicability

In order to make LPG taxis economical and convenient, the following issues must be resolved before the introduction of LPG taxis widely to the public. The government should consider who should bear the following costs and make it known to the public as soon as possible:

- Fuel tax:o
  $2,000/month/taxi X 12 months X 18,000 taxis
  =$432,000,000/year
  or $432 million/year

- LPG filling stations:
  $8 million (set-up costs) X 60 (estimated no. of stations required)

=$480 million

- Equipment set-up costs for repairing workshops:
  $200,000 (estimated set-up costs) X 200 (total no. of workshops)
  =$40,000,000
  or $40million

The above estimate of set-up costs will affect the LPG retail price directly.

To make the LPG taxis program a success, we also need the interdisciplinary cooperation among involved departments:

- Transportation Department:
  to conduct effective emission tests

- Environmental Protection Department:
  to set up and upgrade effective emission guidelines and standards

- Vocational Training Council:
  to provide a more up-to-date repairing courses for technicians and mechanics

- Revenue Department:
  to decide the level of fuel taxes on alternative fuel

Summary

In conslusion, air quality can only be improved with the total effort from the Government, the trade and the public support.

APPENDIX 1

vehicle year	AFR (idling)	NOx	CO	CO2	HC	O2	AFR (2500rpm)	NOx	CO	CO2	HC	O2	mileage
92	16.1	196	0.16	12.6	275	2.2	15.9	568	0.18	12.1	279	1.6	26873
92	16.1	0	0.03	13.3	6	1.9	15.1	0	0.03	14.3	14	0.3	68632
92	16.1	43	0.00	13.3	7	1.8	15.2	7	0	14.1	7	0.5	67037
92	16.2	263	0.18	12.5	151	2.1	15.5	641	0.17	12.1	239	0.4	65925
92	16.3	38	0.06	12.7	33	2.1	15.2	63	0.8	11.6	102	0.7	55028
92	16.4	90	0.01	13.1	9	2.4	14.7	351	0.01	14	54	0	73510
92	16.4	13	0.00	12.9	8	2.2	16.6	42	0.01	12.6	10	2.4	106628
92	16.5	1	0.01	13.1	4	2.3	16.3	11	0.04	13.2	5	1.2	37601
92	16.6	175	0.24	12.3	69	2.4	14.5	367	1.47	12.8	59	0.7	24394
92	16.8	102	0.00	12.8	29	2.7	16	96	0.22	12.7	44	2	85931
92	16.9	0	0.00	12.5	16	2.4	15	21	0.2	13.9	29	0.1	93853
92	17.3	114	0.34	11.8	67	3.3	15.9	5.3	0.62	12.3	71	1.9	49448
92	17.9	20	0.01	12	16	4	15	38	0.01	13.7	24	0.5	42983
92	18.5	30	0.19	11.1	310	4.8	19.3	235	0.26	11.4	65	4.4	78490
92	18.8	56	0.08	11.2	115		16.8	172	0.19	13.3	27		24846
92	19.1	1	0.00	11.3	10	5	19	0	0	11.3	7	4.9	61005
92	19.2	35	0.17	10.5	121		16.4	275	0.14	12.9	60		39710
92	19.2	11	0.00	11.2	9	4.9	20.9	0	0	10.1	9	6.4	10075
92	19.3	72	0.02	10.9	63	5	18.5	11	0.04	11.3	16	4.5	48332
92	19.4	76	0.27	10.5	168	5.2	15.5	180	0.16	13.6	54	1.2	84865
92	20.1	45	0.10	10.3	491		16	62	0.3	13.1	104		66225
92	20.8	0	0.01	10.2	22	6	15.5	18	0.09	13.3	11	1.2	36336
92	23	6	0.03	10.2	34	7.8	14.9	16	0	14.3	7	0.3	83070
93	16.1	69	0.20	12.8	89		14.7	350	0.68	13.4	107		51808
93	16.2	100	2.90	9.8	270		17.2	345	1.75	9.5	254		52604
93	16.3	13	0.61	12.8	42	2.2	16.1	7	0.05	13.2	5	1.9	28558
93	16.5	67	0.31	13.3	218		17.5	180	0.18	13.2	19		54625
93	16.5	210	0.30	145	12.8		15.8	1200	0.4	9.5	939		38582
93	16.5	78	0.00	13	9	2.2	16.1	480	0	12.2	13	1.8	29656
93	16.6	174	0.20	12.7	140		16.5	392	0.26	12.6	55		17826
93	17.1	78	2.27	11	289		14.6	312	1.29	12.7	146		33043
93	17.1	20	0.00	12.8	9	2.1	14.7	18	0.7	14.6	10	0.2	26953
93	17.3	90	0.48	11.8	151		15	293	0.31	13.7	60		23384
93	17.3	45	0.10	12.8	157	2.4	15.2	1052	0.3	13.6	99	0.9	38760

93	17.8	10	2.40	9.4	155		18.6	196	1.2	10.3	104	31209
93	17.9	68	1.80	9.6	140		14.3	530	1.9	11.8	151	55881
93	18.6	0	0.03	10.4	17	4.4	18.6	150	2.96	9.9	110	4.5 61380
93	18.8	16	0.01	14.2	14	4.6	18.9	7	0.14	11.3	10	4.4 30388
93	19	72	1.80	9.4	195		19.5	201	0.8	10.2	114	29621
93	19	114	0.60	11.3	146		18.3	430	0.7	11.3	262	26110
93	19.1	99	0.10	11	99		18	203	1	10.7	58	21881
93	19.8	41	1.08	9.8	164		18.9	209	1.08	10.1	103	51052
93	20.1	62	0.10	10.4	126		17.9	186	1.1	10.3	162	22138
93	20.1	31	0.00	10.3	15	6.3	15	40	0.02	10.9	26	5.6 29131
93	20.1	41	0.00	10.6	12	5.6	19.8	19	0	10.7	12	5.4 24460
93	20.6	39	0.14	10.6	178		13.7	304	3.18	12.1	192	14076
93	21.1	20	0.00	9.9	97		15.3	67	0.9	10	84	35817
93	22.6	10	0.00	8.6	112		14.1	120	0.2	12.7	189	17025
94	16	5	0.00	13.4	10	1.7	15.9	11	0	13.4	8	1.7 26014
94	16.1	88	1.61	11.2	239		15.8	153	1.8	10.8	153	20031
94	16.1	136	0.14	128	144		14.8	313	0.8	13.4	90	7448
94	16.2	105	0.38	12.9	140	2.8	14.8	259	0.49	13.9	72	0.5 30303
94	16.2	0	0.02	13.4	11	2.1	16.5	0	0.02	13	9	2.3 21019
94	16.2	4		13.3	6	2	15.8	0	0.01	13.5	7	1.5
94	16.3	0	0.00	12.8	158		14.7	0	0	14.4	140	37576
94	16.3	0	0.00	13	10	2.2	16.3	107	0	13	10	2.2 28863
94	16.4	77	0.00	13	17	2.2	14.3	93	1.42	13.3	224	1 38571
94	16.5	260	0.10	12.6	206		16.4	16.9	0.4	12.5	210	
94	16.5	10	0.10	13.2	60		16.1	40	0	13.6	33	25515
94	16.7	73	0.40	10.2	252		13.2	96	6.8	9.2	228	26690
94	16.7	342	0.00	14	15	2.1	14.4	62	0.34	14.4	72	0 27710
94	16.8	25	0.00	13.1	14	1.4	14.9	66	0	14.2	13	0.9 39236
94	16.9	26	0.10	12.6	24	2.8	14	55	1.62	13.1	30	0.4 47554
94	17.1	125	0.46	11.8	258		14.3	356	1.65	12.9	187	59899
94	17.2	58	0.00	12.5	17		16.8	43	0.3	12.5	62	14819
94	17.3	10	0.62	11.8	153	3.5	15.1	413	0.92	11.5	214	1.2 62608
94	17.9	45	0.01	11.7	18	3.7	14.9	66	0.01	13.9	14	0.3 24181
94	18	44	0.00	10	3		17.8	5	0	11.5	0	23011
94	18.3	56	1.70	10	100		20.1	39	0.1	10.5	34	25448
94	18.4	34	1.40	9.8	270		14.2	55	2.26	11.9	255	17124
94	19.2	32	0.00	11.1	54		15.2	28	2.88	11.7	219	14892

94	19.6	10	0.00	11	8	5.3	19.3	24	0	11.1	10	5.2	12646
94	20.6	71	0.07	8.1	118	5.7	17.2	308	1.66	10.6	95	4.2	40398
94	22.8	6	0.03	9.3	119		22.6	7	0.1	9.4	80		27320
95	16.1	103	0.01	13.2	190		14.5	1264	0.28	14.2	28		29320
95	16.4	263	0.40	12.5	102		15.1	343	0.3	13.5	67		29149
95	16.8	0	0.03	13.4	11	2.2	15.5	581	0.33	13.8	33	0.5	25415
95	17.3	64	0.20	12.1	17		16.8	43	0.3	12.5	62		17490
95	17.3	24	0.00	12.3	10		16.9	68	0	12.5	24		14032
95	17.6	41	1.75	10.4	178		19.1	117	0.2	11.2	83		
95	19.3	10	0.10	10.9	96		19.7	205	0.1	10.5	133		23561
95	20	6	0.10	10.6	68		19.9	15	0.02	10.8	23		27220
95	20	0	0.02	10.2	154		18	369	13	8.9	208		54120
96	16.3	79	0.00	12.9	10		14.7	156	0	14.3	12		22274
96	16.4	165	0.08	12.9	134	2.3	15.2	730	0.53	138	93	0.8	15068
96	16.7	74	0.08	12.8	155		15	507	0.55	13.6	140		23176
96	16.7	74	0.08	12.8	155		15	507	0.55	13.6	140		23176
96	16.7	0	0.00	12.7	16		14.7	45	0.01	14.3	13		2363
96	16.8	0	0.00	14.3	17		14.8	83	0.1	14.4	128		14372
96	17.5	0	0.01	12.2	8		17.3	0	0	12.3	7		10587
96	17.5	0	0.00	12.3	90		14.7	10	0	14.5	66		4751
96	17.7	4	0.00	12.1	12		17.7	1	0	12	10		8431
96	17.9	0	0.00	12.3	10		17.8	65	0	11.8	38		12354
96	18	20	0.00	12.1	94		17.9	15	0	12	15		6576
96	18.1	32	0.37	11.2	122	3.6	18.2	107	0.25	11.2	143	4.3	5165
96	25.4	0	0.01	8.5	15	9.5	14.8	60	0	14.4	13	0	25.4
97	16.4	0	0.00	13.1	0		14.7	0	0.02	14.4	21		2847
97	18.5	0	0.00	11.8	8		18.5	5	0	11.5	9		207
97	19	21	0.10	11.1	175		18.9	121	0.2	11.2	153		6729

	Year	AFR(L)	NOx	CO	CO2	HC	O2	AFR(H)	NOx	CO	CO2	HC	O2	Mileage
A	90	12.1	76	6.8	10.1	249	0.3	14.4	391	0.74	13.4	88	1	72200
A	90	12.2	97	6.42	10.5	213	0.3	14.6	312	2.35	13	136	0.6	76821
B	92	12.6												30008
B	92	15	0	0.02	14.2	11	0.4	14.8	45	0.44	13.8	15	0.5	32859
C	93	12.3	339	2.77	13.1	40	0.4	13.4	66	2.01	12.5	10	0.2	42025
C	93	15.7	73	0	14.2	0	1	15	40	0	14	0	0.5	44997
D	93	11	30	10.4	8.1	494	0.6	11.6	300	6.8	13.6	143	0.5	42783
D	93	11	78	9.2	6.3	430	0.4	12.5	130	5.4	10.8	310	0.3	42890
D	93	11.9	8	6.34	10.6	345	0.1	11.6	13	5.24	10.4	108	0	43946
E	93	13.8	0	1.8	13.3	78	0	10.5	30	10.8	7.7	148	0	55761
E	93	14	2	1.6	13.4	68	0	10.6	46	10	8.4	116	0	56266
F	90	19.3	111	0.39	10.8	121	5.2	14.9	189	2.66	10.7	120	2.6	52464
F	90	20.1	133	0.42	9.9	121	6.1	14.7	0	0.01	14.6	20	0	52521
F	90	21.8	51	0.12	9.2	216	6.9	15.5	260	0.81	12.6	100	1.6	52594
G	91	12	111	6.03	10.1	552	0.5	12.9	304	4.28	11.2	283	0.3	36173
G	91	11.2	10	6.07	10.4	464	0	13.5	484	2.21	12.7	236	0.5	36451
H	93	12	39	6.4	10.1	253	0	12	109	5.5	10.7	199	0	49853
H	93	14.8	23	0.04	14.2	12	0.1	14.5	130	0.47	14.1	5	0.2	50431
I	94	13.5	50	1.72	11.6	290	0.1	14.4	402	1.6	12.8	75	0.1	71321
I	94	14.2	4	0.91	13.8	182	0.1	13.9	96	1.41	13.4	131	0.3	71350
I	94	14.9	39	0.18	13.8	127	0.5	14.7	0	0.02	14.2	21	0	73009
J	95	15.4	100	0.01	13.9	22	1	15.6	444	0.01	13.9	21	0.12	17342
J	95	15.9	79	0.01	13.9	16	1.5	15.5	352	0	13.9	13	1.1	18862
K	94	14.2	102	0.13	12.1	325	0	12.6	247	2.89	11.9	153	0	13839
K	94	15.3	240	0	14.2	38	0.8	14.7	34	0.01	14.7	61	0	14777