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Thailand's Fuel Economy Policy Development for Passenger Cars and Light Trucks

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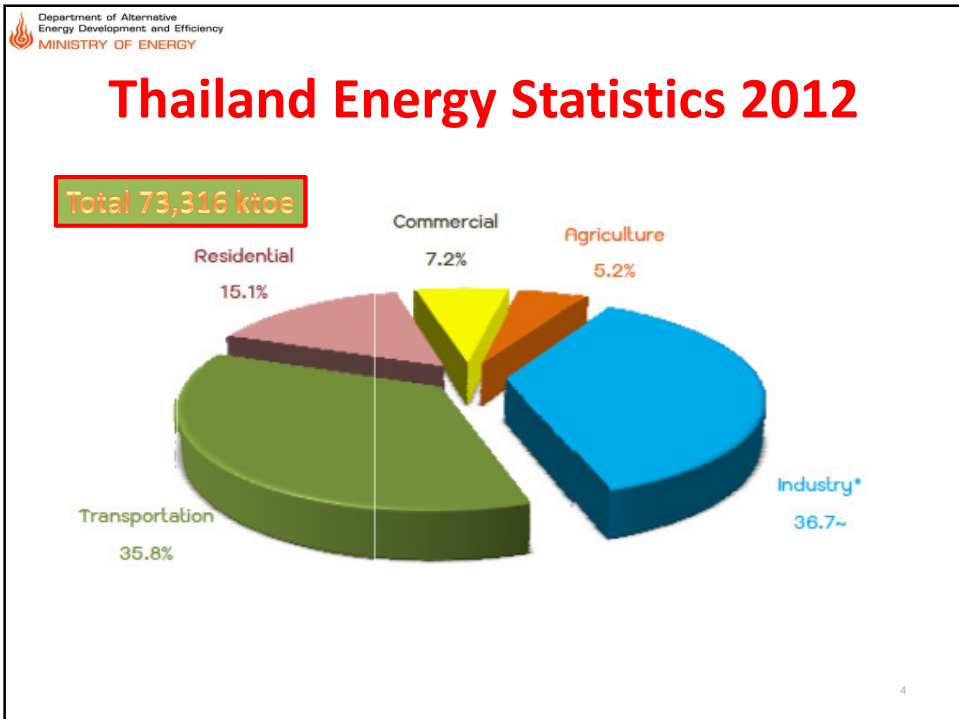
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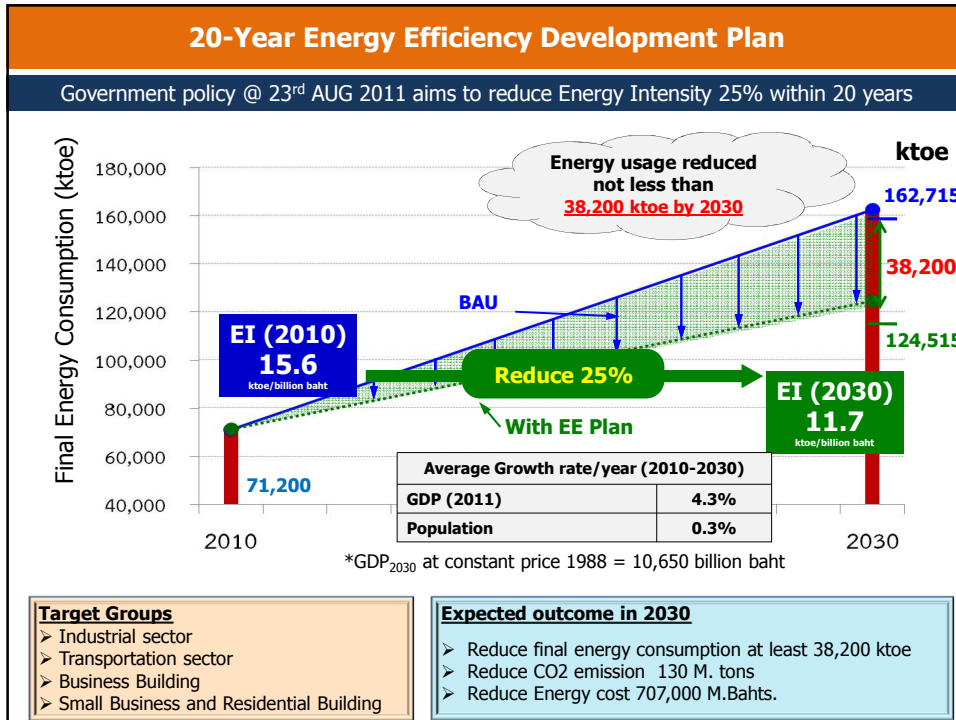
- Thailand Energy Situation & Policies
- Automotive Industry Trend
- Development of Draft Fuel Economy Standards
- Draft Fuel Economy Standards

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1. Thailand Energy Situation & Policies






Framework of EES&L Measures

MEPS: Minimum Energy Performance Standard


- Both voluntary and mandatory program
- Collaboration between DEDE and TISI
- Draft standards are set up by DEDE, but they are regulated by TISI.

HEPS: High Energy Performance Standard


- Voluntary program
- Collaboration between DEDE and EGAT
- Standards are set up by DEDE, and labelling programs are responsible by DEDE and EGAT




voluntary certification mark



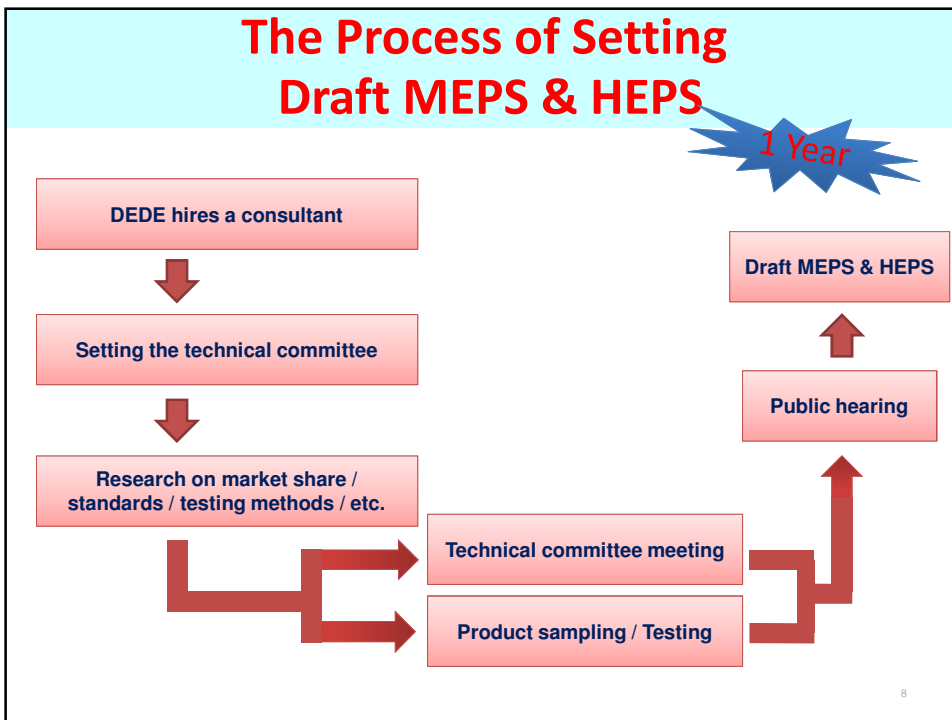
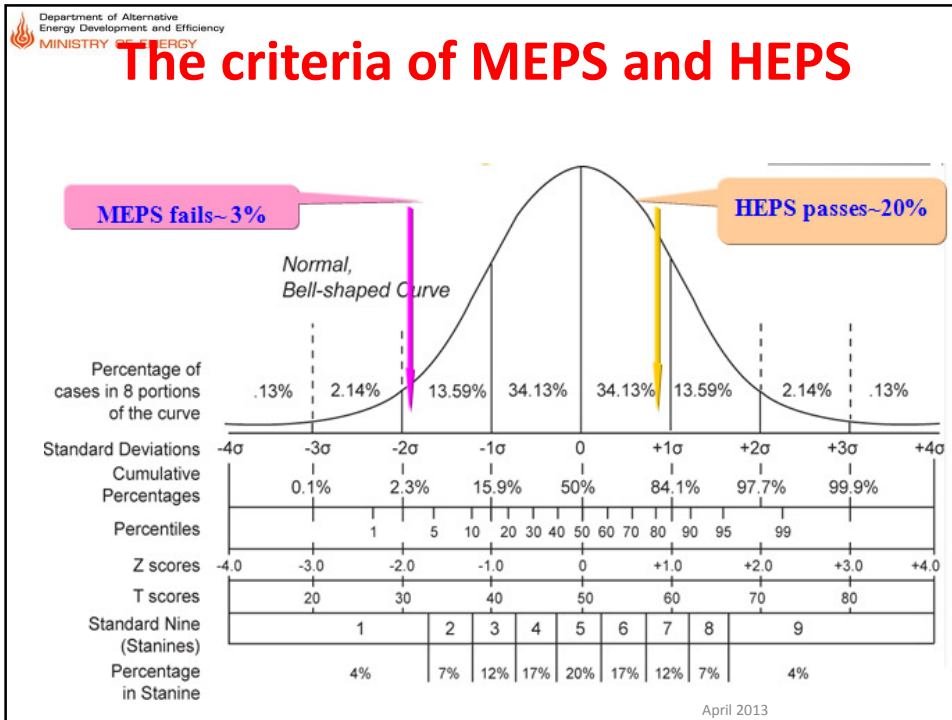
mandatory certification mark

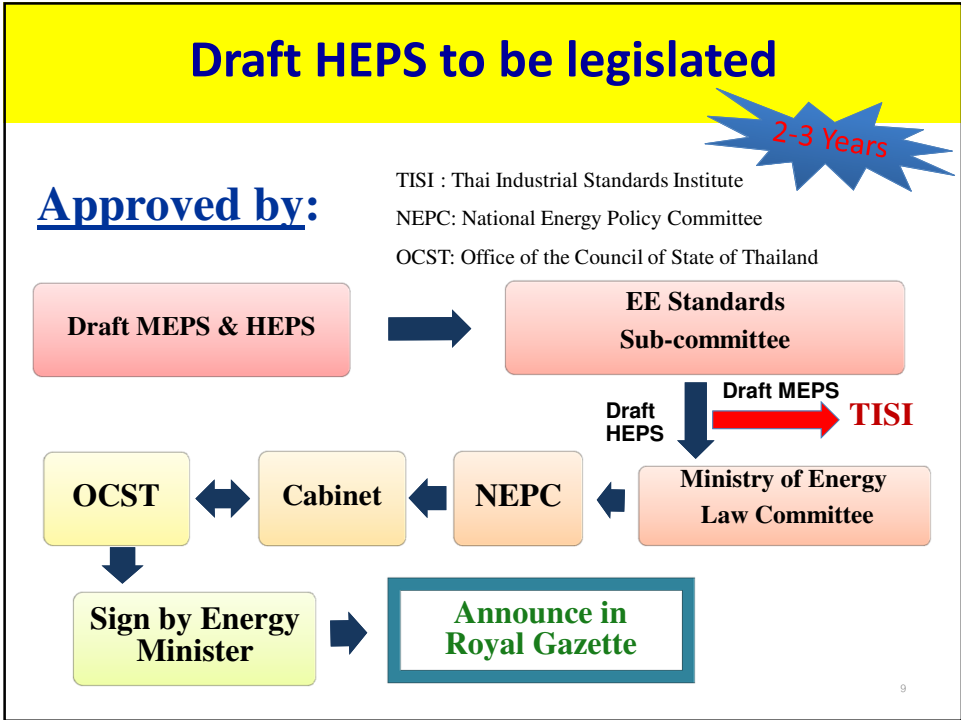


Electric Label



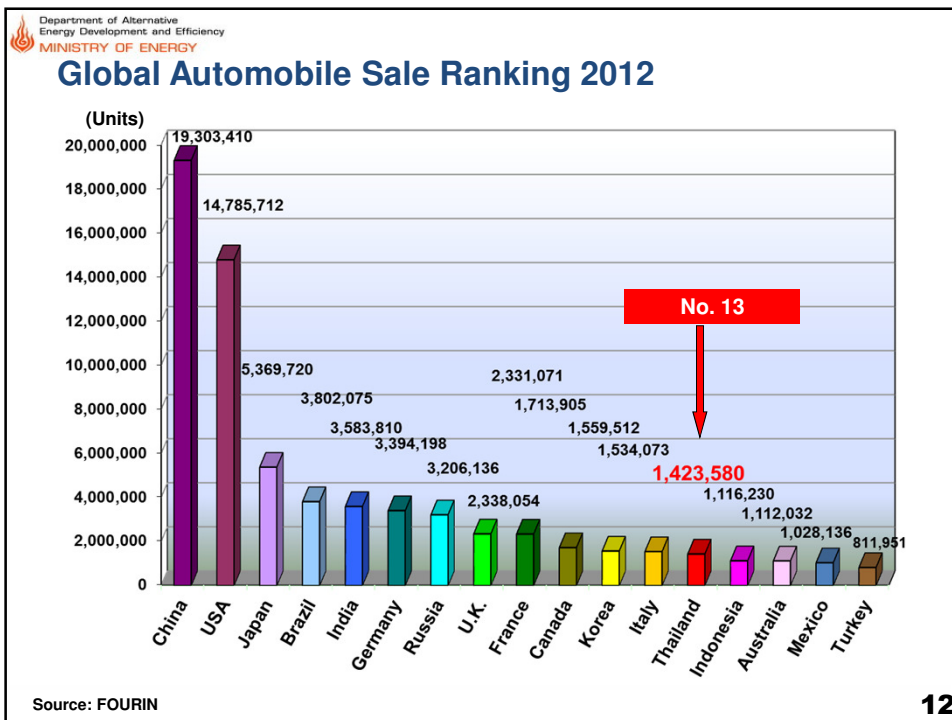
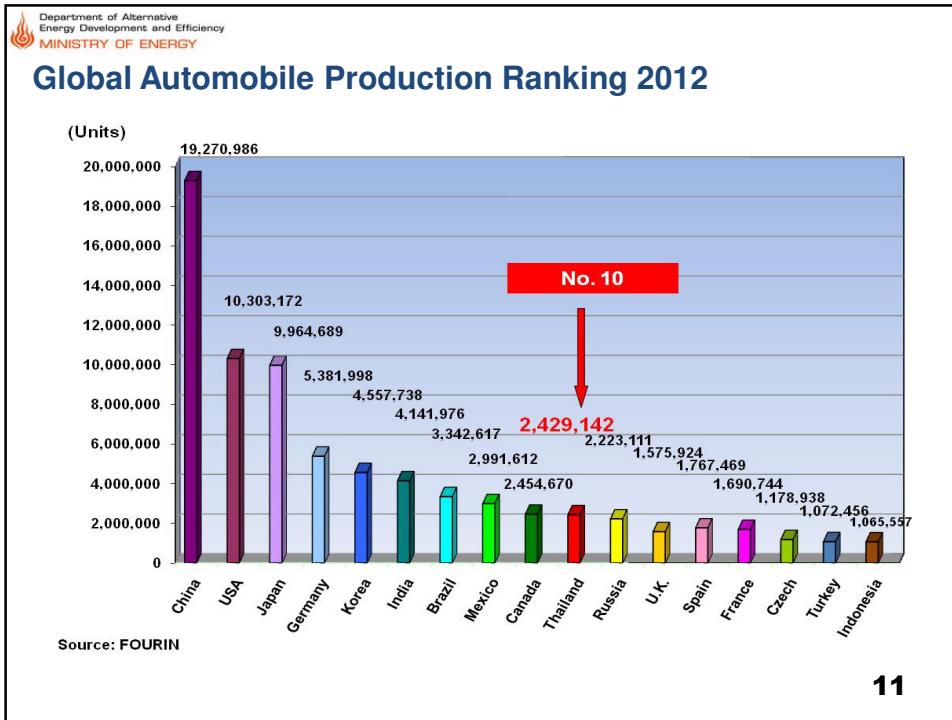
Non-Electric Label

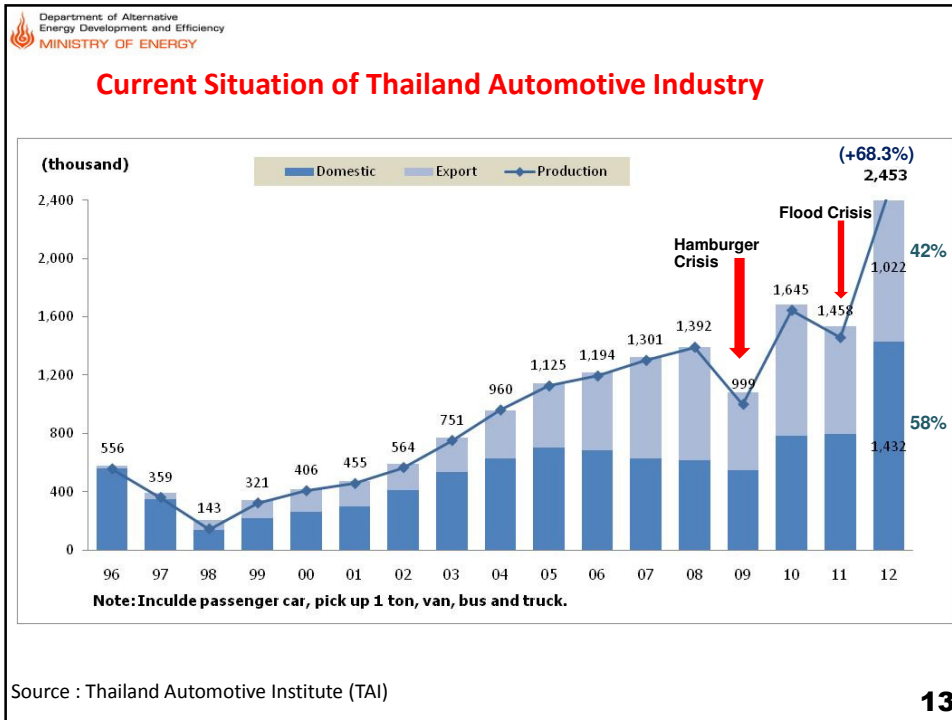




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2. Automotive Industry Trend





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Emission standard

Country	2009	2010	2011	2012	2013	2014	2015	2016	2017
THAILAND	Euro3			Euro4					
INDONESIA	Euro2							Euro 4 (Tentative)	
MALAYSIA	Gasoline	Euro2		Euro 3 (Tentative)			Euro 4 (Tentative)		
	Diesel	Euro1		Euro 2 (Tentative)					
PHILIPPINES	Euro2							Euro 4 (Tentative)	
VIETNAM	Euro2			Euro4 (Under Study)					
SINGAPORE	Gasoline	Euro2		Euro 4 (Tentative)					
	Diesel	Euro4		Euro 5 (Tentative)					

Source : Thailand Automotive Institute (TAI) 14


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3. Development of Draft Fuel Economy Standards


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Emission Standards from

Year	EU Reference Standard	TIS Standard
2540 (1997)	Euro 1	TIS 1440-2540 Gasoline
		TIS 1435-2540 Diesel
2542 (1999)	Euro 2	TIS 1870-2542 Gasoline
		TIS 1870-2542 Diesel
2549 (2006)	Euro 3	TIS 2160-2546 Gasoline
		TIS 2155-2546 Diesel
2555 (2012)	Euro 4	TIS 2540-2554 Gasoline
		TIS 2550-2554 Diesel


Development of Draft Fuel Economy Standards

- 1st Draft MEPS & HEPS of FE standards based on EURO 3
- Set in 2009 but terminated in 2012
- 2nd Draft MEPS & HEPS of FE standards based on EURO 4 (Finished in Oct 2013)


The Calculation of Fuel Consumption from Emission of Gasoline and Diesel

Gasoline Engine; FC =

$$(0.1154/D)*((0.866*HC)+(0.429*CO)+(0.273*CO_2))$$

Diesel Engine; FC =

$$(0.1155/D)*((0.866*HC)+(0.429*CO)+(0.273*CO_2))$$

FC = Fuel Consumption (L/100 km) **CO = Carbon monoxide (g/km)**
D = Fuel Density **CO₂ = Carbon Dioxide**
HC = Hydro Carbon (g/km) (g/km)

Reference IIS 2335-2550 (Refer to UN-ECE Reg. 101)

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Testing Lab at Thailand Automotive Institute

Accredited Lab complying with
ISO/IEC 17025

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Driving Mode

****Ref. New European Driving Cycle (NEDC)****

NEDC

Mode	Urban Cycle	Extra-Urban Cycle
Cycle	4	1
Average Speed (km/h)	19	62.6
Maximum Speed (km/h)	50	120
Distance / cycle (km)	1.013	6.955
Distance / Total Cycle (km)	4.052	6.955
Total Distance (km)	11.007	
Time/cycle (sec)	195 (3 min 15 sec)	400 (6 min 40 sec)

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Automobiles are classified into 22

Reference: TIS 2560-2554 Emission

Rang	Testing Method Reference Mass (kg)
1	<480
2	>480-540
3	>540-595
4	>595-650
5	>650-710
6	>710-765
7	>765-850
8	>850-965

Rang	Reference Mass (kg)
9	>965-1,080
10	>1,080-1,190
11	>1,190-1,305
12	>1,305-1,420
13	>1,420-1,530
14	>1,530-1,640
15	>1,640-1,760
16	>1,760-1,870
17	>1,870-1,980
18	>1,980-2,100
19	>2,100-2,210
20	>2,210-2,380
21	>2,380-2,610
22	>2,610

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Sampling

Stratified Sampling & Allocation of sample size

$$n_b = \left(\frac{t \cdot \sigma \cdot CV}{e} \right)^2 \rightarrow n = \frac{n_b}{1 + \frac{n_b}{N}} \rightarrow w_i = \frac{n_i}{N} \rightarrow n_i = W_i n$$

The diagram shows a population of N units (represented by black rectangles) being divided into three strata. From each stratum, a sample of size n_1 , n_2 , and n_3 is drawn respectively. The total sample size is n .

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Sampling

Gasoline engine					Gasoline engine				
Range	Reference Mass (kg)	Total Population (N)	Required Population (n)	Analyzed Population (n)	Range	Reference Mass (kg)	Total Population (N)	Required Population (n)	Analyzed Population (n)
1	>40-50	0	0	0	9	>659-1080	10	6	10
2	>50-55	0	0	0	10	>1,080-1,190	10	6	10
3	>55-60	0	0	0	11	>1,190-1,305	8	5	8
4	>60-65	0	0	0	12	>1,305-1,420	11	7	8
5	>65-70	0	0	0	13	>1,420-1,530	8	5	7
6	>70-75	0	0	0	14	>1,530-1,640	11	7	10
7	>75-80	0	0	0	15	>1,640-1,760	8	5	8
8	>80-95	0	0	0	16	>1,760-1,870	2	1	2
					17	>1,870-1,980	3	2	2
					18	>1,980-2,100	1	1	1
					19	>2,100-2,210	1	1	1
					20	>2,210-2,380	0	0	0
					21	>2,380-2,610	0	0	0
					22	>2,610	2	1	2
					Total		69	43	63

Remark

- Confidence Level 95%
- Coefficient of Variation (CV) 0.15
- Error ≤ 3%

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Sampling

Diesel engine					Diesel engine				
Range	Reference Mass (kg)	Total Population (N)	Required Population (n)	Analyzed Population (n)	Range	Reference Mass (kg)	Total Population (N)	Required Population (n)	Analyzed Population (n)
1	>40-50	0	0	0	15	>1,420-1,530	0	0	0
2	>50-55	0	0	0	16	>1,530-1,640	0	0	0
3	>55-60	0	0	0	17	>1,640-1,760	0	0	0
4	>60-65	0	0	0	18	>1,760-1,870	0	0	0
5	>65-70	0	0	0	19	>1,870-1,980	11	7	11
6	>70-75	0	0	0	20	>1,980-2,100	11	7	11
7	>75-80	0	0	0	21	>2,100-2,210	7	5	7
8	>80-95	0	0	0	22	>2,210-2,380	4	3	4
9	>95-1,080	0	0	0	23	>2,380-2,610	3	2	3
10	>1,080-1,190	0	0	0	24	>2,610	2	2	2
11	>1,190-1,305	0	0	0					
12	>1,305-1,420	0	0	0					
13	>1,420-1,530	0	0	0					
14	>1,530-1,640	0	0	0					
					Total		48	33	48

Remark

- Confidence Level 95%
- Coefficient of Variation (CV) 0.15
- Error ≤ 3%

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The example of testing result from a

Emission (g/km)		
HC	CO	CO2
0.060	0.355	172.381

Benzene Engine; $FC = \frac{0.1154}{D} \times ((0.866 \times HC) + (0.429 \times CO) + (0.273 \times CO_2))$

0.05

↓

0.12%

0.15

↓

0.32%

47.06

↓

99.56%

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The example of testing result from a

ของต่างประเทศ

ปริมาณก๊าซไอเสีย (กรัม/กิโลเมตร)		
HC	CO	CO2
0.012	0.025	223.854

Diesel Engine; $FC = \frac{0.1155}{D} \times ((0.866 \times HC) + (0.429 \times CO) + (0.273 \times CO_2))$

0.01

↓

0.02%

0.01

↓

0.02%

61.13

↓

99.96%

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Part of the Process of Developing Draft FE

A Classify

กลุ่ม	น้ำหนักตัว (กก.)	น้ำหนักตัว (กก.)	group	weight	concomp
	<480		1		
	>480-540		2		
	>540-595		3		
	>595-650		4		
	>650-710		5		
	>710-765		6		
	>765-850		7		
	>850-965		8		
1	G-01	1,020	9	1,020	16.69
2	G-02	1,055	9	1,055	15.95
3	G-51	1,065	9	1,065	17.89
4	G-63	970	9	970	17.33
5	G-03	1,125	10	1,125	15.87
6	G-19	1,160-1,165	1,160	1,165	15.41
7	G-20	1,122-1,174	1,122	1,174	13.39
8	G-21	1,122-1,174	1,122	1,174	13.48
9	G-22	1,145-1,195	1,145	1,195	14.95
10	G-23	1,120-1,150	1,120	1,150	15.77
11	G-46	1,144	10	1,144	20.45
12	G-56	1,182	10	1,182	19.28
13	G-60	1,150	10	1,150	17.54
14	G-64	1,143	10	1,143	17.06

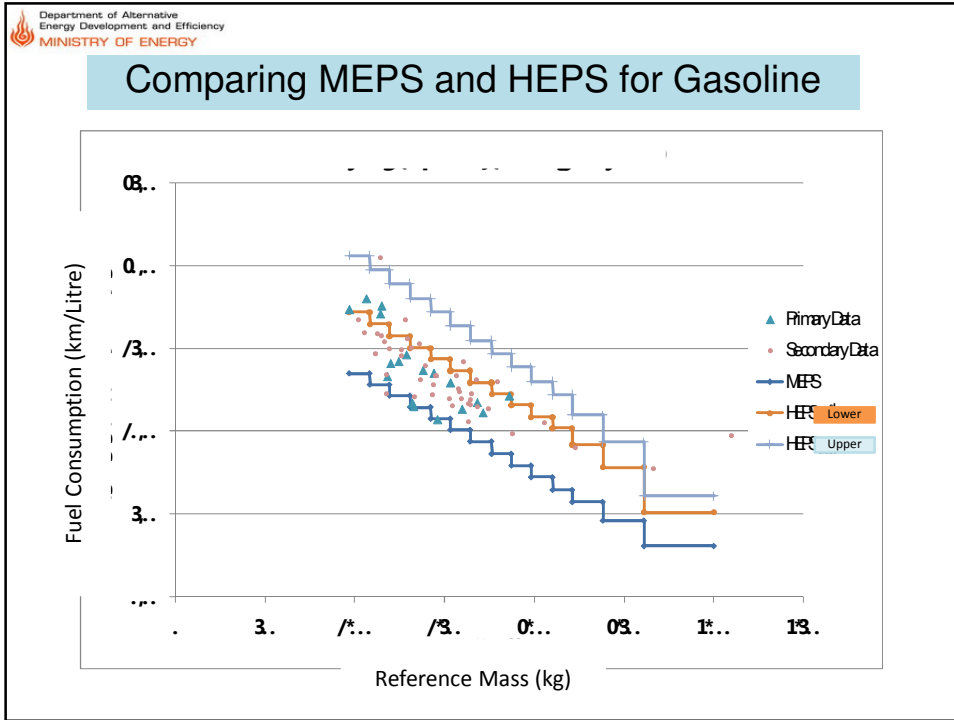
B Scatter Plot and Cut

C Develop Draft FE for Automobiles Using Simple Regression Analysis

MEPS /

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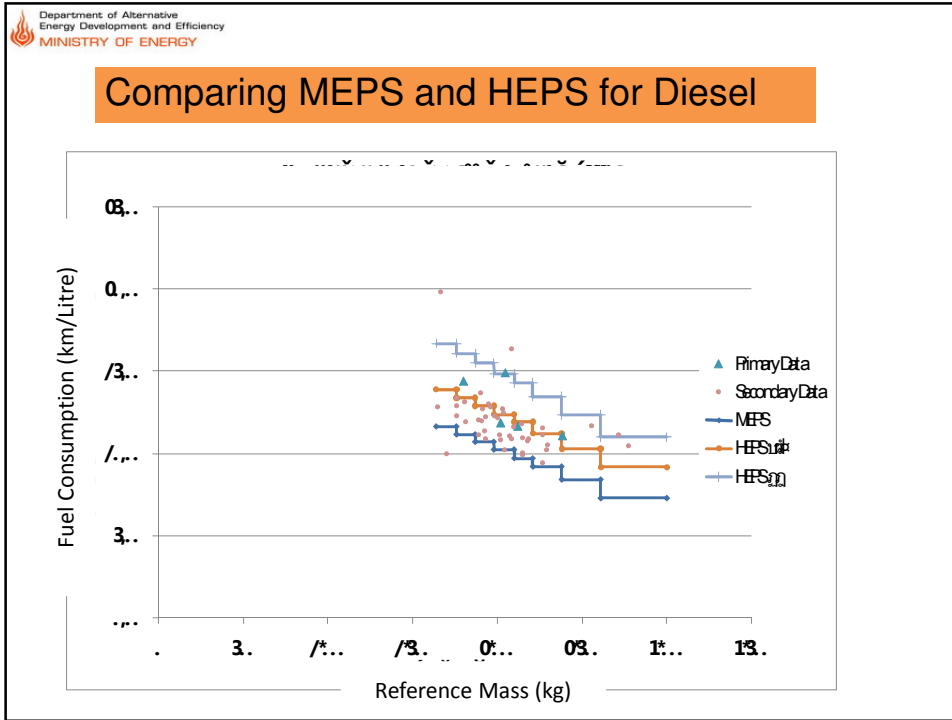
4. Draft Fuel Economy Standards



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Comparing MEPS and HEPS for Gasoline


Unladen Mass (kg)		MEPS (km/L)	Lower HEPS (km/L)	Upper HEPS (km/L)
More than	Less than or Equal			
-	380	-	-	-
380	440	-	-	-
440	495	-	-	-
495	550	-	-	-
550	610	-	-	-
610	665	-	-	-
665	750	-	-	-
750	865	-	-	-
865	980	13.49	17.19	20.63
980	1,090	12.81	16.48	19.78
1,090	1,205	12.15	15.75	18.91
1,205	1,320	11.45	15.03	18.04
1,320	1,430	10.75	14.34	17.21
1,430	1,540	10.07	13.66	16.39
1,540	1,660	9.38	12.92	15.50
1,660	1,770	8.62	12.24	14.69
1,770	1,880	7.92	11.57	13.88
1,880	2,000	7.21	10.84	13.01
2,000	2,110	6.44	10.18	12.22
2,110	2,280	5.71	9.17	11.00
2,280	2,510	4.59	7.80	9.37
2,510	-	3.05	5.08	6.10



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Comparing MEPS and HEPS for Diesel

Unladen Mass (kg)		MEPS (km/L)	Lower HEPS (km/L)	Upper HEPS (km/L)
More than	Less than or Equal			
-	380	-	-	-
380	440	-	-	-
440	495	-	-	-
495	550	-	-	-
550	610	-	-	-
610	665	-	-	-
665	750	-	-	-
750	865	-	-	-
865	980	-	-	-
980	1,090	-	-	-
1,090	1,205	-	-	-
1,205	1,320	-	-	-
1,320	1,430	-	-	-
1,430	1,540	-	-	-
1,540	1,660	11.62	13.88	16.65
1,660	1,770	11.14	13.38	16.06
1,770	1,880	10.69	12.89	15.47
1,880	2,000	10.22	12.37	14.85
2,000	2,110	9.69	11.91	14.29
2,110	2,280	9.19	11.20	13.44
2,280	2,510	8.40	10.28	12.34
2,510	-	7.27	9.17	11.00

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Conclusion

- **1st Draft MEPS & HEPS of FE standards based on EURO 3**
- **Set in 2009 but terminated in 2012**
- **2nd Draft MEPS & HEPS of FE standards based on EURO 4 (Finished in Oct 2013)**
- **The Calculation of Fuel Consumption from Emission of Gasoline and Diesel Engines: Reference TIS 2335-2550 (Refer to UN-ECE Reg. 101)**
- **Driving Mode: Reference New European Driving Cycle (NEDC)**
- **Testing Method: Reference TIS 2560-2554 (Refer to ECE R 83)**

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*Thank
you...*

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