Carbon tax: Practices and impacts
EE 376Theory

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Outline

- State of carbon taxes
- Implementation of carbon taxes
- Carbon tax systems
- Applications of carbon taxes
- Impact assessment of carbon tax for Thailand

State of carbon tax: World Bank (2020)

- There have been 61 initiatives either to implement or to schedule carbon pricing for implementation.
- This consists of 31 emission trading systems in regional, national and subnational jurisdictions
- 30 carbon taxes, primarily applied on a national level.
- Carbon taxes are used worldwide and mostly implemented in the Scandinavian, some provinces of Canada and the United States of America. The Scandinavian has applied carbon taxes since the 90's.

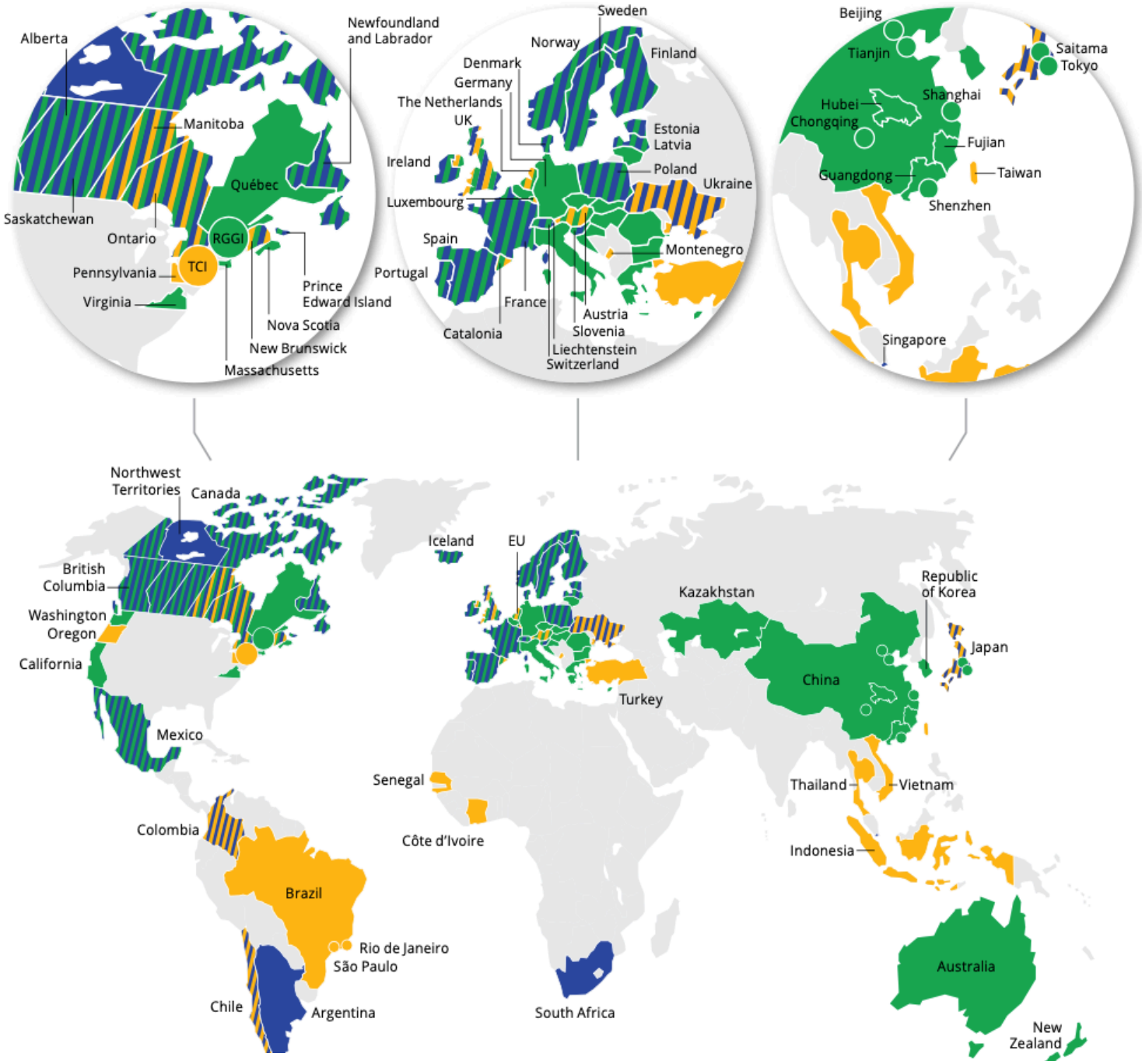


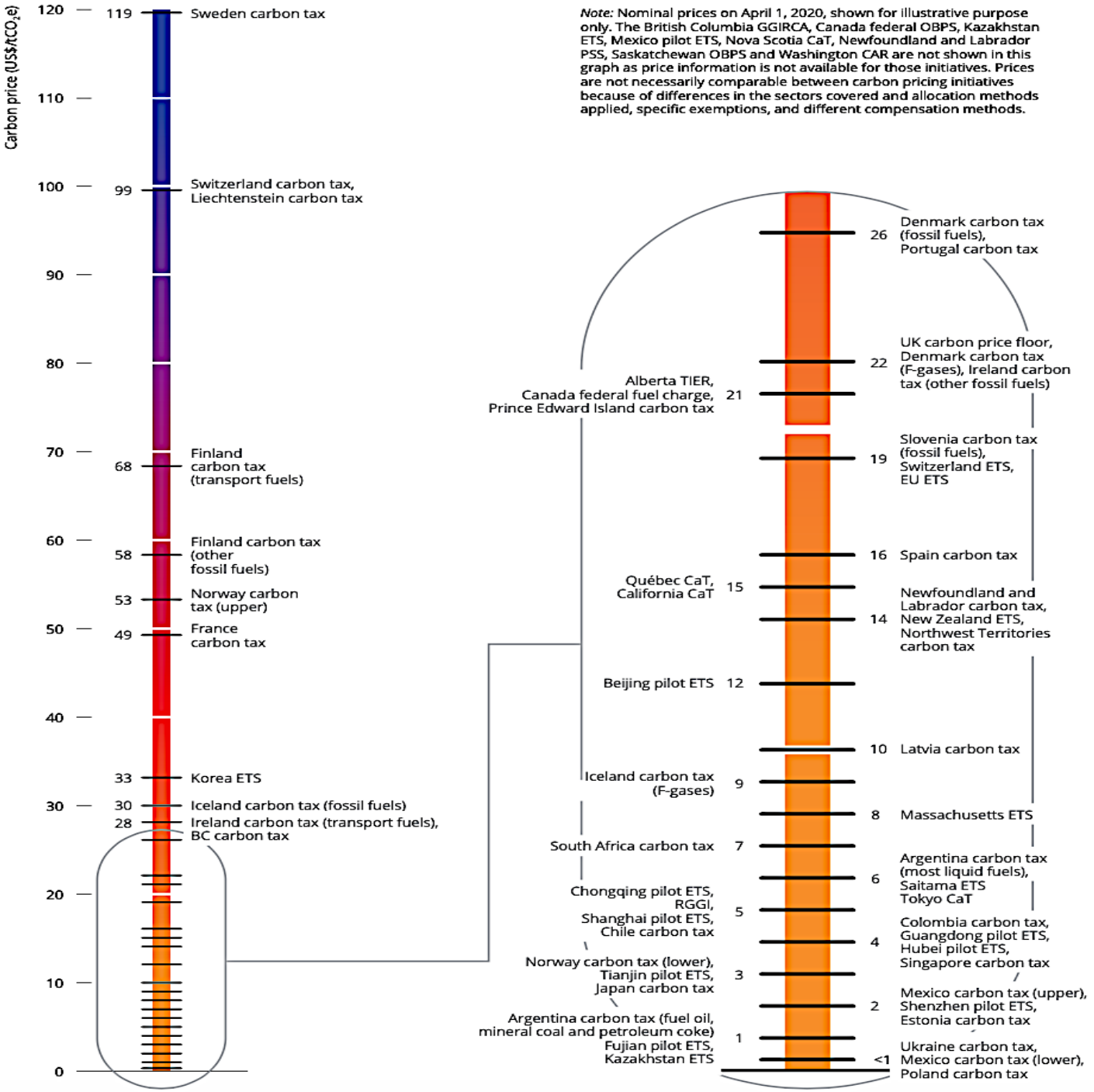
Figure ES.1 / Carbon pricing initiatives implemented, scheduled for implementation and under consideration (ETS and carbon tax)

Source: World Bank (2020) State and Trends of Carbon Pricing 2020

State of carbon tax: World Bank (2020)

- Mostly countries charge the tax on CO_2 more than other GHGs
- Mostly on all fossil fuels or liquid and gaseous fossil fuels
- Most countries base the tax on these sectors: Power, Industry, Building, Transportation, All Sectors
- The tax rate varied dramatically ranging from $0.08 (Poland) – $119.43 (Sweeden), though mainly cluster in the range between $40 - $80

Figure ES.3 / Prices in implemented carbon pricing initiatives



Source: World Bank (2020) State and Trends of Carbon Pricing 2020

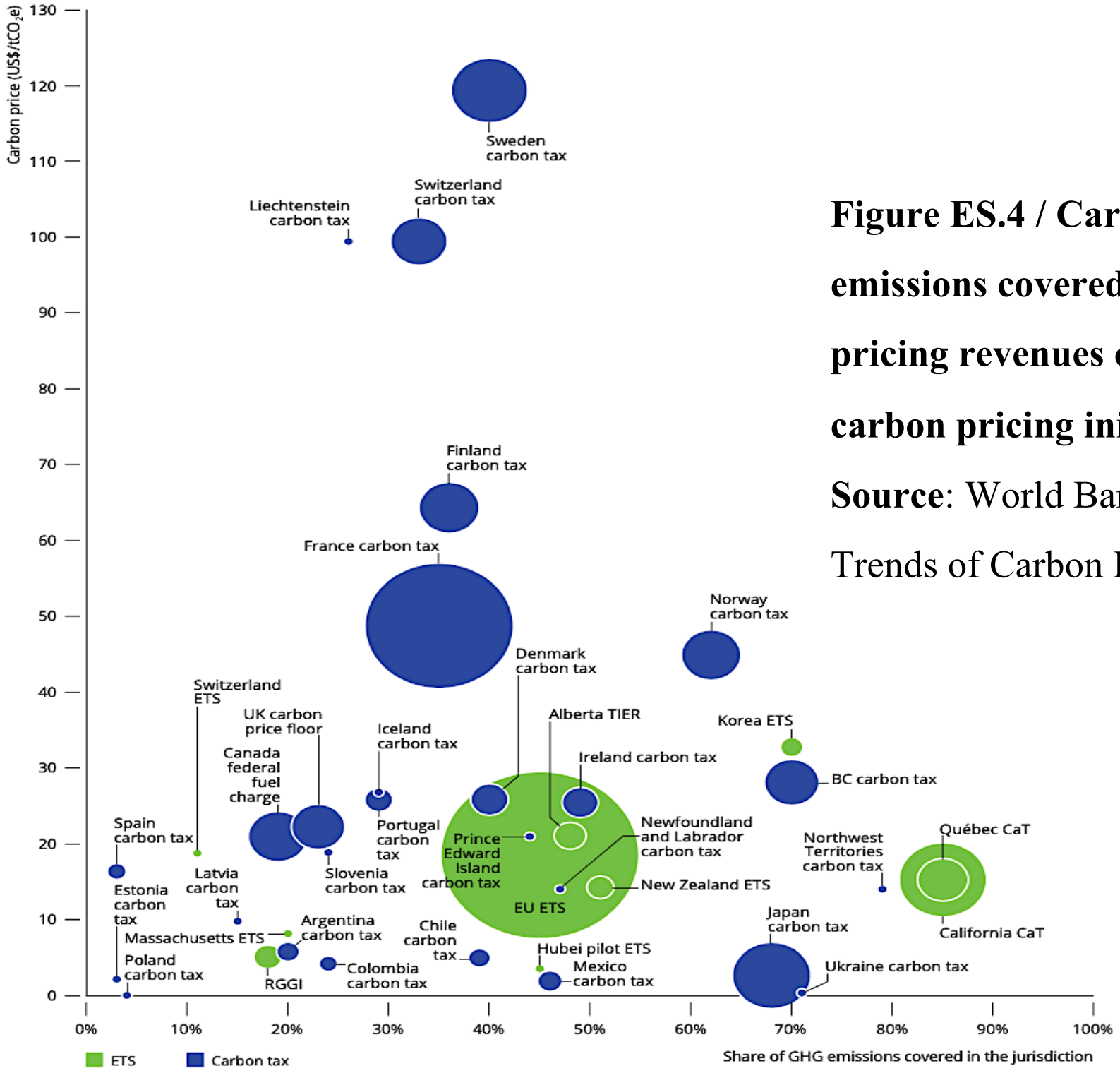
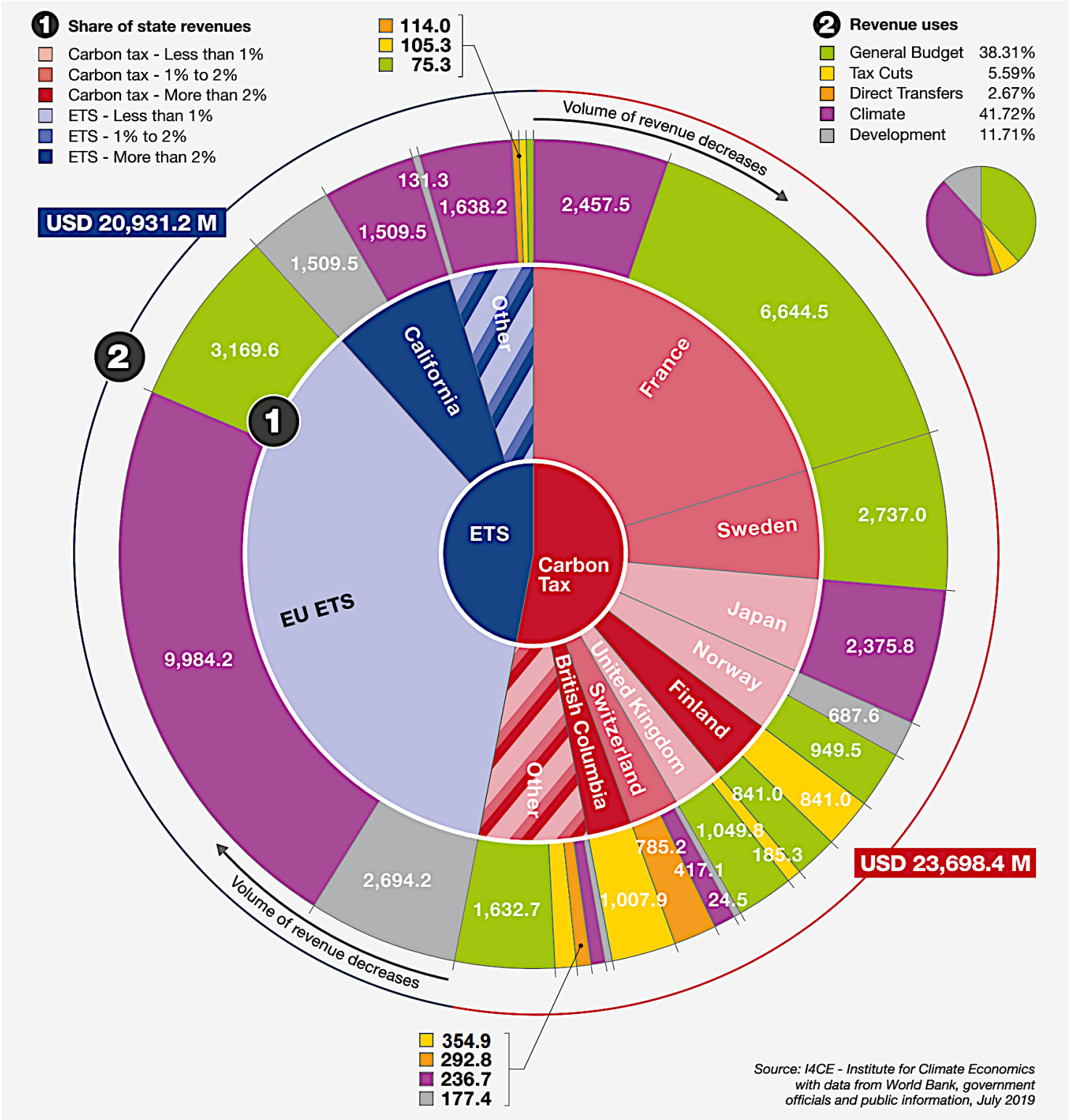


Figure ES.4 / Carbon price, share of emissions covered and carbon pricing revenues of implemented carbon pricing initiatives

Source: World Bank (2020) State and Trends of Carbon Pricing 2020

Usage of revenue from carbon tax



Source: World Bank. 2019. Using Carbon Revenues.

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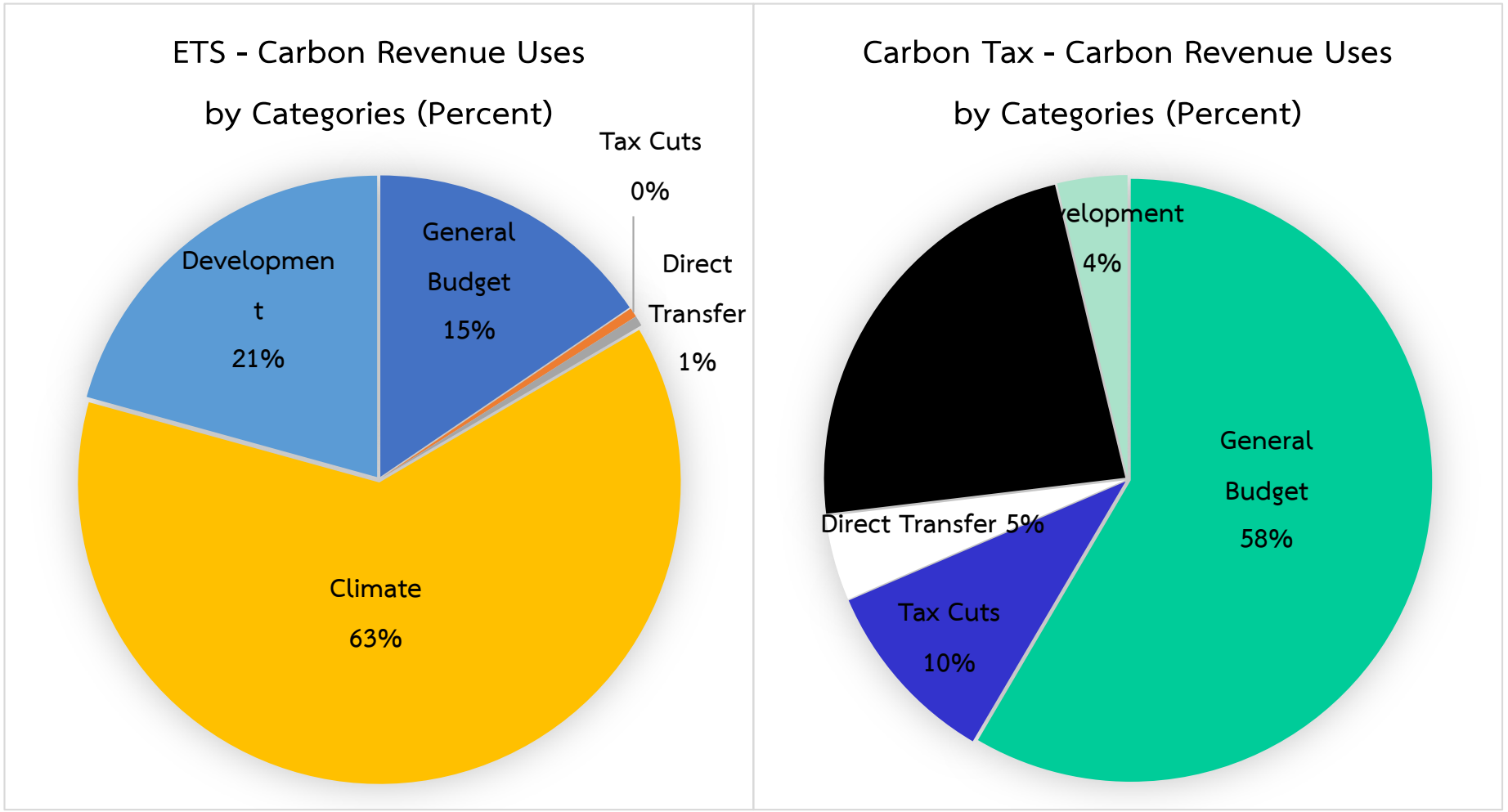
Usage of revenue from carbon tax



Source: World Bank. 2019. Using Carbon Revenues.

Implementation of carbon taxes

- They should be implemented as Specific Excise Taxes base on fuel carbon contents
- May be applied on either production or consumption
- Most studies proposes carbon taxes on consumption since the tax revenue will be collected by the petroleum exporting countries when they are applied on production and the it will raise the burden for petroleum importing countries

Implementation of carbon taxes

- There should be some burden relief mechanism for low income households since the tax is regressive
- The initial tax rate should be small and gradually increased according to pre-specified plan covering a sufficiently long period of time, say 10 years:
  - Consumers and specially producers to have sufficient times to adapt and make proper investment plans
  - Stable tax revenue for the government and adjustment to new tax base

Thailand excise tax rates on cars (Sep 16, 2016)

Vehicle Category	non CO2-based tax structure (before 2016)						CO2-based (MSRP price) (effective 16 Sep 2017)						
	Engine Displacement	Tax Rate (%)					CO2 (g/km)	Tax Rate (%)					
		E10	E20	E85	NGV	xEV		E10,E20	E85,NGV	HEV, PHEV / BOI		BEV, FCEV / BOI	
Passenger car							≤ 100	25 *	20 *	8 / 4 *			
	≤ 2,000 cc	30	25	22***	20	10	101-150			16 / 8			
	2,001 - 2,500 cc	35	30	27			151-200	30	25	21 / 10.5		8 / 2	
	2,501 - 3,000 cc	40	35	32			> 200	35	30	26 / 13			
	> 3,000 cc	50	50	50	50		> 3,000 cc	40	40	40			
Eco Car (E10/E20/Diesel) / (E85, B10)													
	1,300 - 1,500 cc (Eco car II)						≤ 100	12* / 10 *					
	1,300 - 1,400 cc (Eco car I)	17					101-120	14					
		PPV	DC	SC	NC	Other		PPV	DC	SC	NC	BEV	Other
Pick up (PPV/ Double cab / Space cab / No cab)	≤ 3,250 cc	20	12	3	3	18	≤ 175	18 * (HEV)	8 * (HEV)			10	
							≤ 200	20 *	10	4	2.5		15
							> 200	25	13	6	4		17
	> 3,250 cc	50	50	50	50	50	> 3,250 cc	40	40	40	40		40
3 Wheel							สกายแลป	0					
							สามลอ, เครื่องยนต์ จยย.<250 cc	4					
Battery		5					ในประเทศ	8					
							ส่งออก	0					

Thailand excise tax rates on cars (Sep 16, 2016)

Type	CO^2 (g/KM)	Tax rate (%)
Electric motorcycle	-	1
Fuel-based or hybrid motorcycle		
	< 10	1
	11 - 50	3
	51 - 90	5
	90 - 130	9
	> 130	18
Prototype motorcycles for R&D		0
Others		20

Carbon taxes on transport fuels: Thailand case

โครงการศึกษานโยบายภาษีกับทิศทางพลังงาน

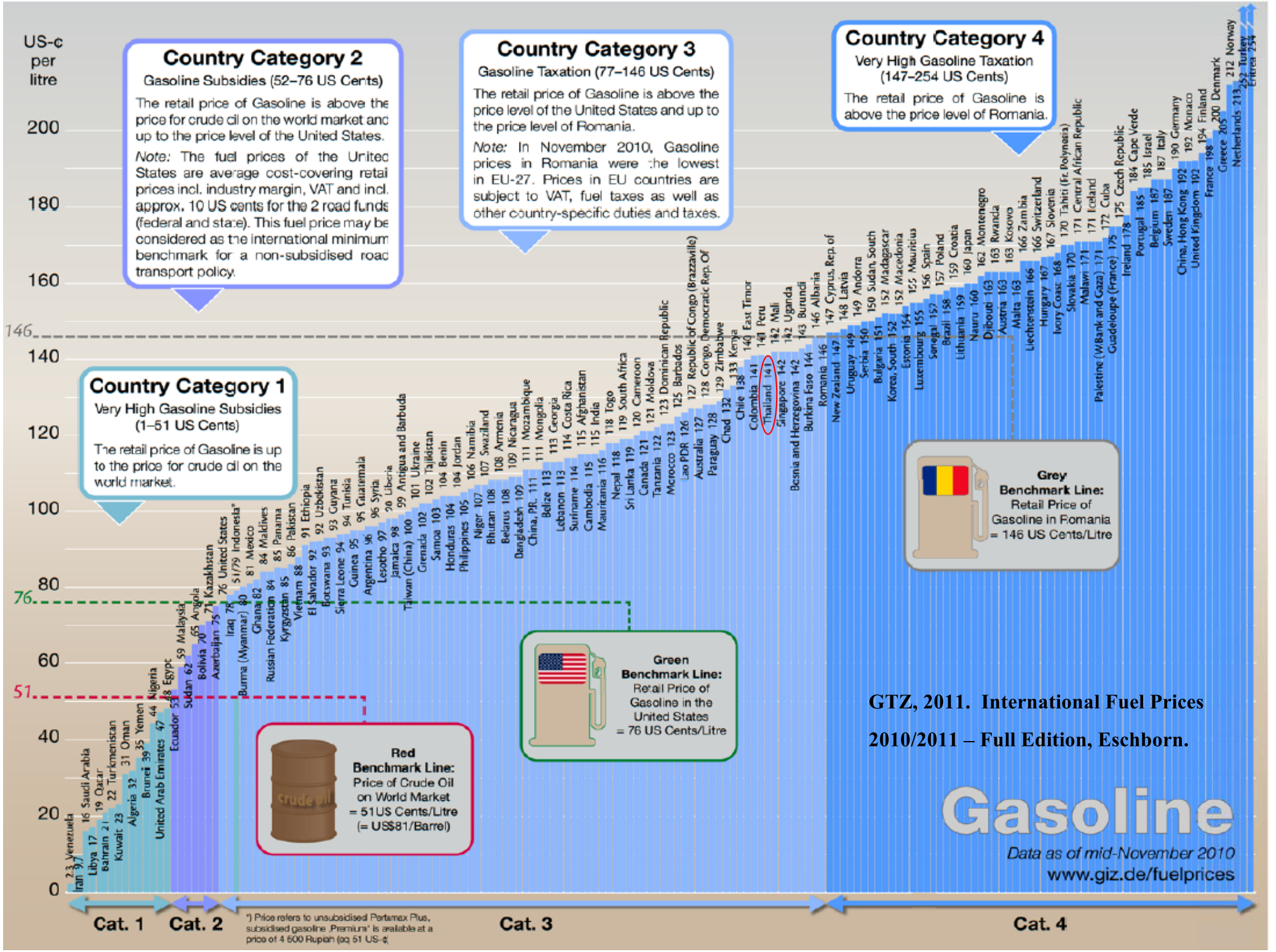
(Excise Tax Policy for Energy and Environment)

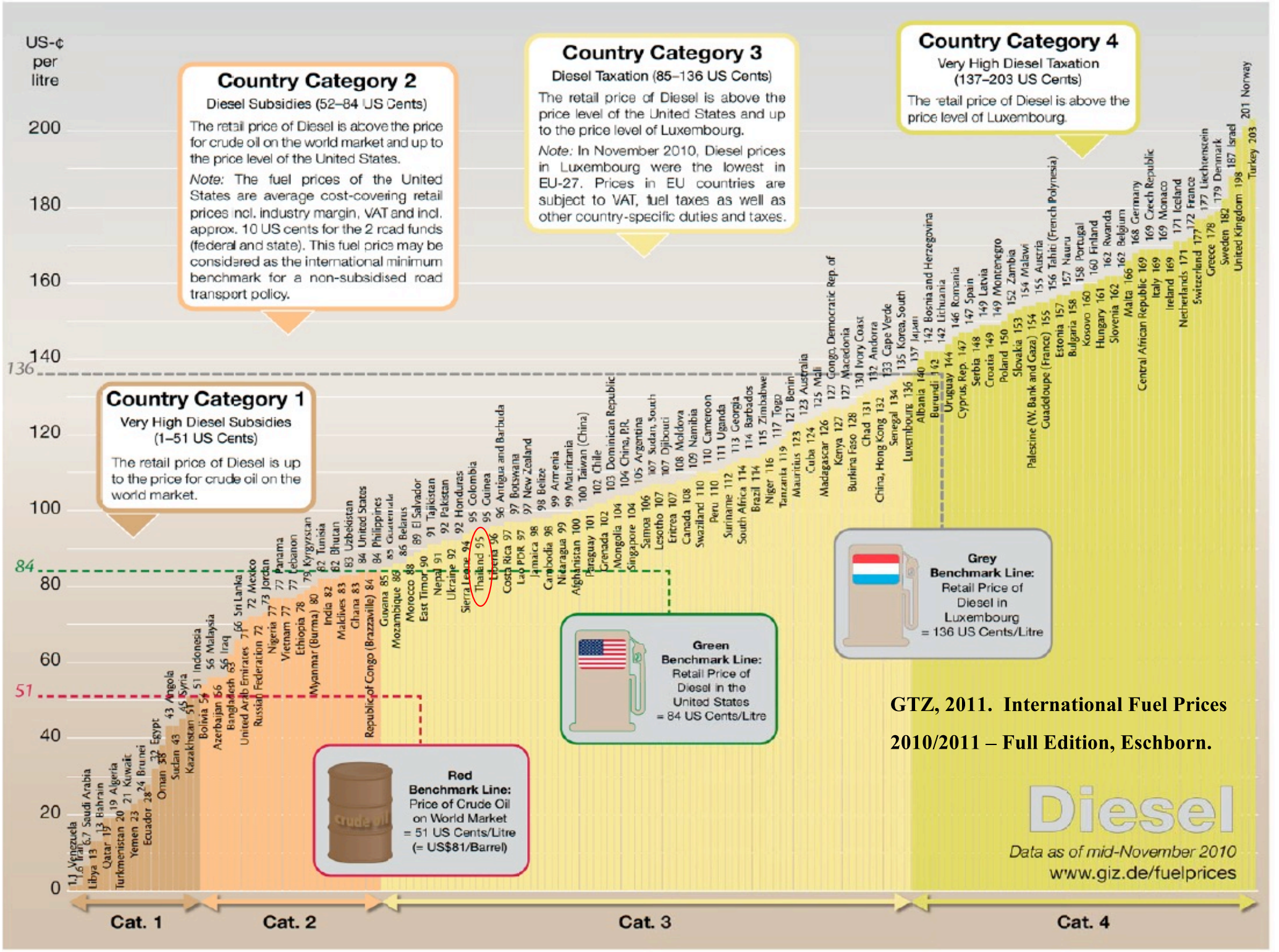
summitted to Excise Department

By Economic Research and Training Center (ERCT)

Faculty of Economics, Thammasat University

March 2014


US-¢ per litre
Country Category 2
Gasoline Subsidies (52–76 US Cents)
The retail price of Gasoline is above the price for crude oil on the world market and up to the price level of the United States.
Note: The fuel prices of the United States are average cost-covering retail prices incl. industry margin, VAT and incl. approx. 10 US cents for the 2 road funds (federal and state). This fuel price may be considered as the international minimum benchmark for a non-subsidised road transport policy.
Country Category 3
Gasoline Taxation (77–146 US Cents)
The retail price of Gasoline is above the price level of the United States and up to the price level of Romania.
Note: In November 2010, Gasoline prices in Romania were the lowest in EU-27. Prices in EU countries are subject to VAT, fuel taxes as well as other country-specific duties and taxes.
Country Category 4
Very High Gasoline Taxation (147–254 US Cents)
The retail price of Gasoline is above the price level of Romania.
Country Category 1
Very High Gasoline Subsidies (1–51 US Cents)
The retail price of Gasoline is up to the price for crude oil on the world market.
146
76
51
Grey Benchmark Line: Retail Price of Gasoline in Romania = 146 US Cents/Litre
Green Benchmark Line: Retail Price of Gasoline in the United States = 76 US Cents/Litre
Red Benchmark Line: Price of Crude Oil on World Market = 51US Cents/Litre (= US$81/Barrel)
crude oil
Cat. 1
Cat. 2
Cat. 3
Cat. 4
*) Price refers to unsubsidised Pertamax Plus, subsidised gasoline „Premium" is available at a price of 4 500 Rupiah (ca 51 US-¢)
GTZ, 2011. International Fuel Prices
2010/2011 – Full Edition, Eschborn.
Gasoline
Data as of mid-November 2010
www.giz.de/fuelprices



GTZ, 2011. International Fuel Prices 2010/2011 – Full Edition, Eschborn.

Excise Tax Policy for Energy and Environment

- **Objective 1**: To have an excise tax system that reflects the externalities of carbon emission from fuels while maintaining the same tax revenue
  - **Case 1:** replace the existing excise taxes with carbon taxes such that the tax revenue is the same as projected under the business as usual (BAU) trend
  - **Case 2:** the same as case 1, but maintains a constant share of excise tax revenue to GDP at 1.2%

Excise Tax Policy for Energy and Environment

- **Objective 2**: To utilize the fuel carbon tax to mitigate carbon dioxide by 7% from BAU
  - **Case 1:** an immediate decrease by 7%
  - **Case 2:** a gradual decrease until 7% is achieved, starting at 1% in 2014 with a 1% incrementation per year until it is 7% in 2020
- **Objective 3**: To utilize the fuel excise tax to mitigate GHGs at different tax rate from 5 – 30 Baht/kg C

Calculation method for carbon dioxide emission

- 1996 IPCC Guidelines on National Greenhouse Gas Inventories is used:
- CO_2 conversion factor from fuel type k combustion is given by

$$co_k = CEF_k * OF_k * 44/12$$

co_k = Carbon dioxide Conversion factor for fuel k (tCO_2/toe or Mtonne CO_2/Mtoe, toe = tonne of oil equivalent)

CEF_k = Carbon Emission Factor or carbon emission coefficient/ energy unit of k fuel (t Carbon/TJ, TJ = terajoule, trillion 10^{12})

OF_k = Oxidation Fraction or the fraction that fuel k being combusted with exigent (no unit)

44/12 = the coefficient for converting the carbon weight to the carbon dioxide weight (tonne CO_2 /tonne Carbon)

Conversion factors for each fuel's carbon and carbon dioxide calculation

Fuels	Gasoline (Th.Liters)	Diesel (Th.Liters)	LPG (Th.Liters)	NGV (Th.KGs)	Fuel oil (Th.Liters)
Net Calorific Value (TJ/unit)	0.03148	0.03642	0.02662	0.03793	0.03977
Carbon Emission Factor (tC/TJ)	18.9	20.2	17.2	15.3	21.1
Oxidation fraction	0.99	0.99	0.995	0.995	0.99
Overall Conversion Factor (tC/unit)	0.58902	0.72833	0.45557	0.57737	0.83076
Overall Conversion Factor (tCO_2/unit)	2.15975	2.67053	1.67044	2.11702	3.04610

Demand for fuels

- The demand function for fuel k is given by

$$Q_k = AP_k^{-\varepsilon_k} P_i^{\eta_{ik}} P_j^{\eta_{jk}} \qquad (1)$$

- P_k, Q_k = retail price, quantity demanded of fuel k at initial excise tax rate or BAU
- P_i, P_j = retail prices of fuel i and j at BAU
- ε_k, η_{ik}, η_{jk} = price elasticity of demand for fuel k, cross price elasticity of fuel k by the change in price of i and j respectively

Carbon taxes impacts on fuel demands

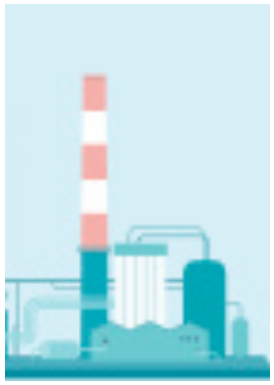
- The quantity demanded at new prices with carbon taxes, Q_{tk}, is given by

$$Q_{tk} = AP_{tk}^{-\varepsilon_k} P_{ti}^{\eta_{ik}} P_{tj}^{\eta_{jk}} \qquad (2)$$

- P_{tk}, P_{ti}, P_{jk} = retail prices of fuel k, i, j after the initial excise tax is replaced by the respective carbon tax rate
- Divide (2) by (1) and rearrange to get

$$Q_k = A\left(\frac{P_k}{P_{tk}}\right)^{\varepsilon_k} \left(\frac{P_{ti}}{P_i}\right)^{\eta_{ik}} \left(\frac{P_{tj}}{P_j}\right)^{\eta_{jk}}$$

Fuel price structure



Ex-refinery price

+

Excise tax and municipal tax

+

Oil Fund

+

Energy Conservation Fund (0.25 Baht)

+

Marketing margin

+

=

Retail price

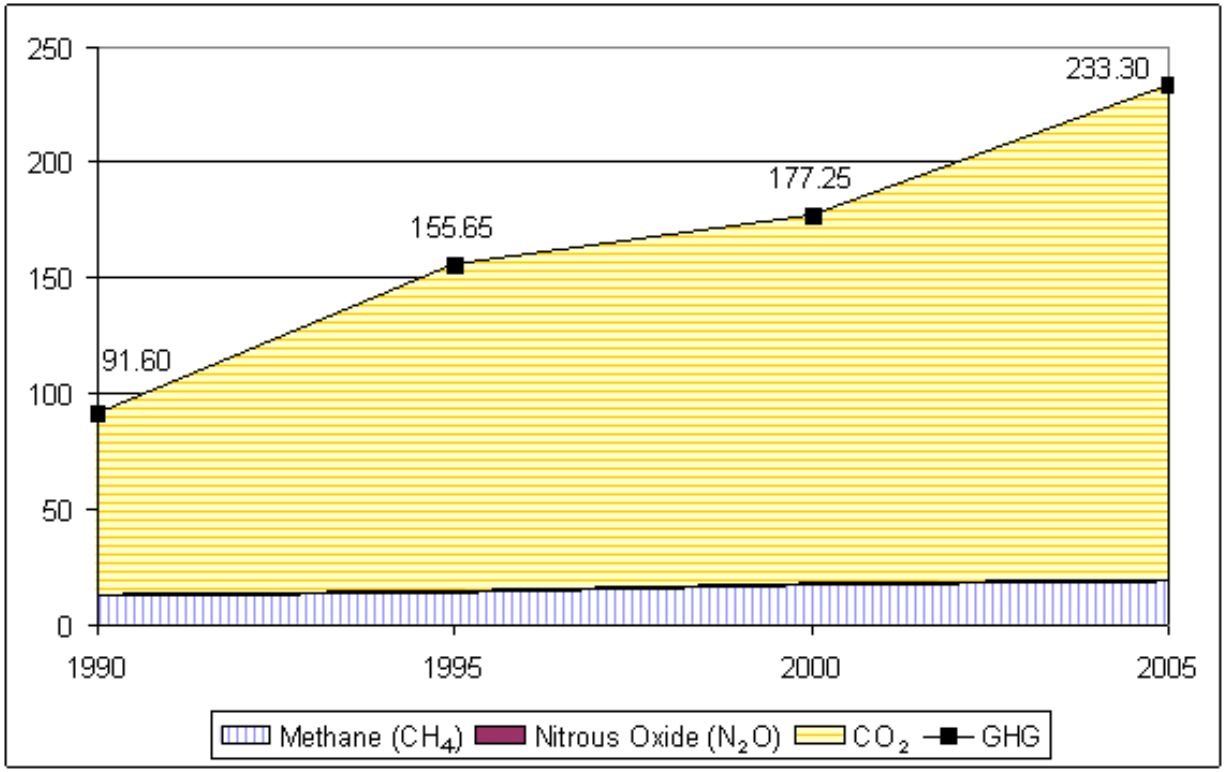
http://www.eppo.go.th/index.php/th/petroleum/price/structure-oil-price

Fuel price structure on May 7, 2013

UNIT : BATH/LITRE	EX-REFIN. (AVG)	TAX B./LITRE	M. TAX B./LITRE	OIL FUND (1)	CONSV. FUND	WHOLE SALE PRICE(WS)	VAT	WS& VAT	MARKETING MARGIN	VAT	RETAIL PRICE
ULG	21.7900	7.0000	0.7000	9.7000	0.2500	39.4400	2.7608	42.2008	2.0086	0.1406	**44.35**
GASOHOL95 E10	22.3984	6.3000	0.6300	3.8000	0.2500	33.3784	2.3365	35.7149	1.3226	0.0926	**37.13**
GASOHOL91	22.1888	6.3000	0.6300	1.7000	0.2500	31.0688	2.1748	33.2436	1.3425	0.0940	**34.68**
GASOHOL95 E20	22.9244	5.6000	0.5600	-0.4000	0.2500	28.9344	2.0254	30.9599	1.1403	0.0798	**32.18**
GASOHOL95 E85	25.5300	1.0500	0.1050	-10.9000	0.2500	16.0350	1.1225	17.1575	3.9463	0.2762	**21.38**
H-DIESEL	22.4083	0.0050	0.0005	4.0000	0.2500	26.6638	1.8665	28.5302	1.3643	0.0955	**29.99**
FO 600 (1) 2%S	18.7551	1.0215	0.1022	0.0600	0.0700	20.0088	1.4006	21.4094			
FO 1500 (2) 2%S	18.3038	0.9814	0.0981	0.0600	0.0700	19.5133	1.3659	20.8792			

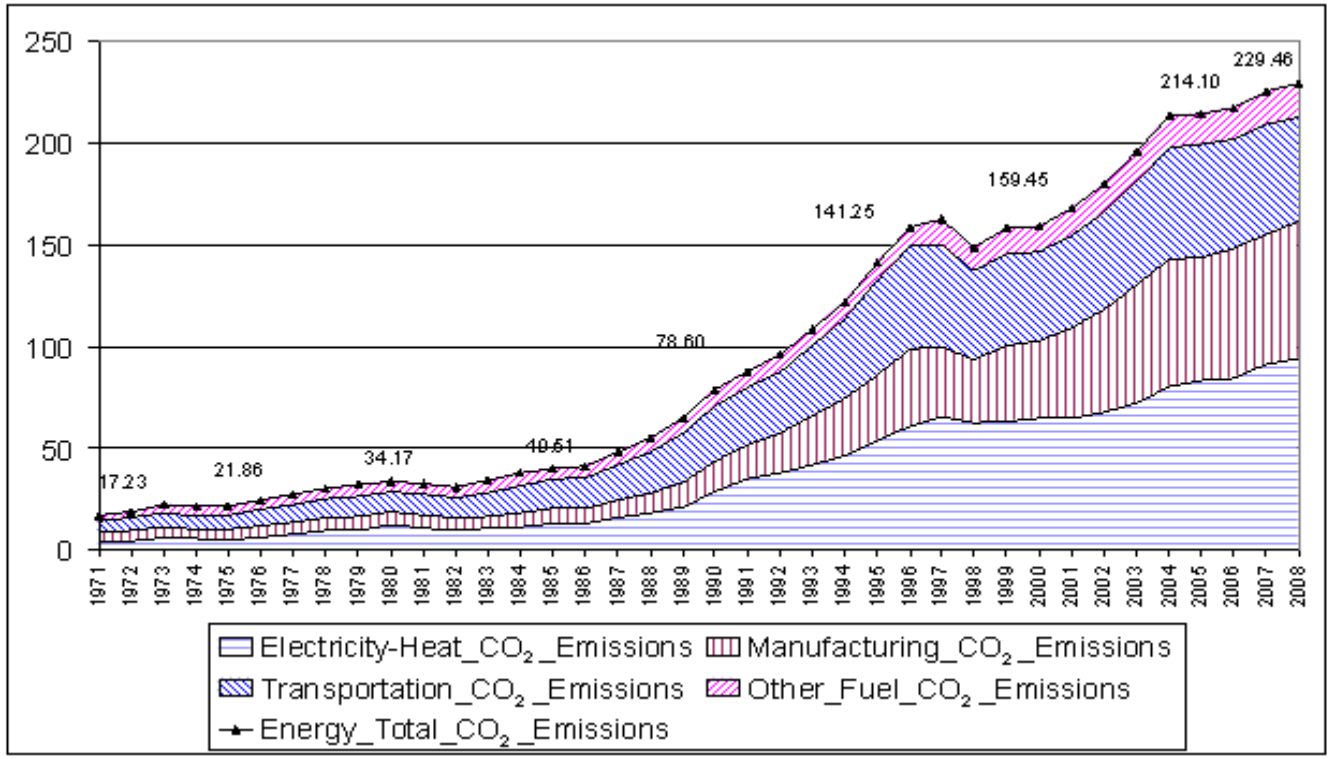
Elasticity estimation of petroleum products

Fuel	Income elasticities	Price elasticities			
		Gasoline 91	Gasoline 95	Diesel	Gases
Gasoline 91	0.5319	-0.5321	-0.5787	-0.0256	0.2034
Gasoline 95	1.3409	-0.3059	-1.1507	-0.0434	0.2345
Diesel	0.5302	-0.0961	-0.308	-0.6816	0.6134
Gases	1.8015	0.9342	2.0374	-0.2494	-1.0513



Changes in GHGs emission from energy in Thailand during 1990 – 2005

Carbon dioxide emissions from energy by sector in Thailand during 1990 – 2005



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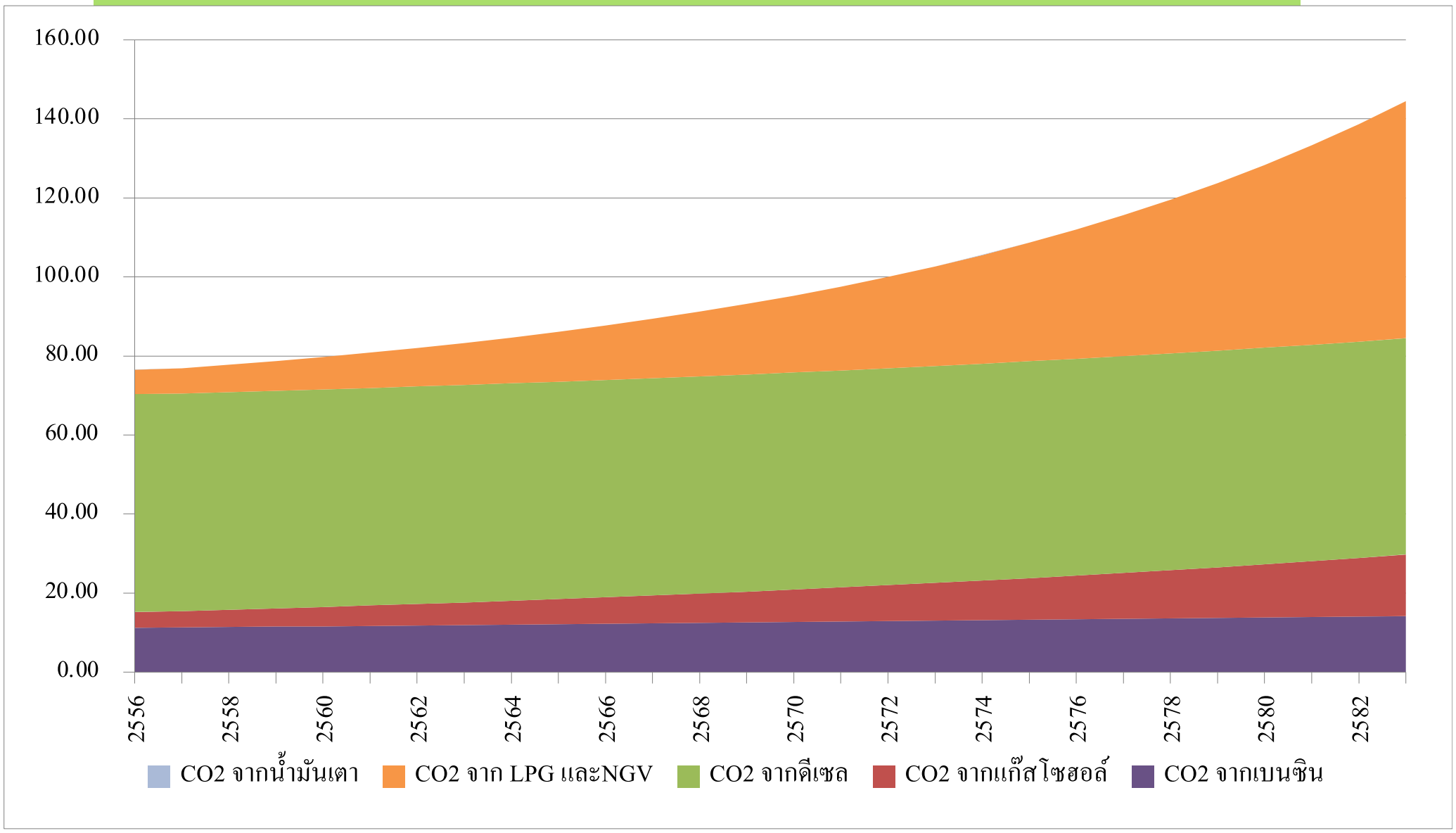
Forecast of CO_2 emission under BAU during 2013 – 2040 (2556-2583 BE)



Forecast of excise tax revenue with the initial rates under BAU during 2556-2583 BE

หน่วย : พันล้านบาท

ปี	เบนซิน	แก๊สโซฮอล์	ดีเซล	LPG และNGV	น้ำมันเตา	รายรับภาษีรวม
2556-2563	17.48	406.46	876.04	154.36	0.003	1,454.35
2564-2573	20.81	634.13	1,092.57	382.16	0.004	2,163.48
2574-2583	14.70	837.40	1,089.86	971.22	0.004	2,913.18
รวมทุกปี	52.99	1,877.99	3,058.47	1,507.74	0.01	6,531.01

Carbon tax rates for equivalent tax revenue as under BAU

หน่วย: บาท/ลิตร

(เฉพาะ NGV หน่วย: บาท/กิโลกรัม)

ปี	เบนซิน 95	แก๊สโซฮอล์ 91	แก๊สโซฮอล์ E10	แก๊สโซฮอล์ E20	แก๊สโซฮอล์ E85	ดีเซล	LPG	NGV	น้ำมันเตา
2556-2563	4.57	4.11	4.11	3.66	0.69	5.65	3.53	4.48	6.44
2564-2573	4.39	3.95	3.95	3.52	0.66	5.43	3.40	4.31	6.20
2574-2583	4.11	3.70	3.70	3.29	0.62	5.08	3.18	4.03	5.80

Retail price changes by the carbon tax

ปี	เบนซิน 95	แก๊สโซฮอล์ 91	แก๊สโซฮอล์ E10	แก๊สโซฮอล์E20	แก๊สโซฮอล์ E85	ดีเซล	LPG	NGV	น้ำมันเตา
2556-2563	-2.86	-2.57	-2.57	-2.29	-0.43	0.40	1.61	5.27	6.43
2564-2573	-3.07	-2.76	-2.76	-2.45	-0.46	0.15	1.61	5.07	6.14
2574-2583	-3.40	-3.06	-3.06	-2.72	-0.51	-0.27	1.61	4.74	5.67

Carbon tax rates for maintaining tax revenue share to GDP at 1.2%

หน่วย: บาท/ลิตร

(เฉพาะ NGV หน่วย: บาท/กิโลกรัม)

ปี	เบนซิน 95	แก๊สโซฮอล์ 91	แก๊สโซฮอล์ E10	แก๊สโซฮอล์ E20	แก๊สโซฮอล์ E85	ดีเซล	LPG	NGV	น้ำมันเตา
2556-2563	4.34	3.90	3.90	3.47	0.65	5.36	3.35	4.25	6.12
2564-2573	6.33	5.70	5.70	5.07	0.95	7.83	4.90	6.21	8.93
2574-2583	8.25	7.42	7.42	6.60	1.24	10.20	6.38	8.09	11.64

Retail price changes by the carbon tax

ปี	เบนซิน 95	แก๊สโซฮอล์ 91	แก๊สโซฮอล์ E10	แก๊สโซฮอล์E20	แก๊สโซฮอล์ E85	ดีเซล	LPG	NGV	น้ำมันเตา
2556-2563	-3.13	-2.82	-2.82	-2.51	-0.47	0.06	1.39	5.00	6.04
2564-2573	-0.78	-0.71	-0.71	-0.63	-0.12	2.97	1.39	7.31	9.36
2574-2583	1.47	1.32	1.32	1.18	0.22	5.76	1.39	9.52	12.54

Carbon tax rates for 7% CO_2 reduction target

บาท/ลิตร

(เฉพาะ NGV หน่วย: บาท/กิโลกรัม)

ปี	เบนซิน 95	แก๊สโซฮอล์ 91	แก๊สโซฮอล์ E10	แก๊สโซฮอล์ E20	แก๊สโซฮอล์ E85	ดีเซล	LPG	NGV	น้ำมันเตา
2556-2563	6.64	5.97	5.97	5.31	1.00	8.21	5.13	6.51	9.36
2564-2573	5.74	5.16	5.16	4.59	0.86	7.09	4.44	5.62	8.09
2574-2583	3.20	2.88	2.88	2.56	0.48	3.95	2.47	3.14	4.51

Retail price changes by the carbon tax

ปี	เบนซิน 95	แก๊สโซฮอล์ 91	แก๊สโซฮอล์ E10	แก๊สโซฮอล์ E20	แก๊สโซฮอล์ E85	ดีเซล	LPG	NGV	น้ำมันเตา
2556-2563	-0.43	-0.38	-0.38	-0.34	-0.06	3.41	3.49	7.66	9.86
2564-2573	-1.49	-1.34	-1.34	-1.19	-0.22	2.10	2.67	6.62	8.37
2574-2583	-4.47	-4.03	-4.03	-3.58	-0.67	-1.60	0.36	3.69	4.15

Impacts on tax revenue under 7% CO_2 reduction target

หน่วย: พันล้านบา

ปี	เบนซิน	แก๊สโซฮอล์	ดีเซล	LPG และ NGV	น้ำมันเตา	รายรับภาษีรวม
2556-2563	285.37	114.71	1,274.95	352.52	0.03	2,027.58
2564-2573	340.34	207.39	1,412.70	811.70	0.03	2,772.16
2574-2583	213.91	208.60	829.40	1,073.24	0.02	2,325.18
2556-2583	839.62	530.71	3,517.05	2,237.46	0.08	7,124.92

Carbon tax rates for each fuel at 7 Baht/Kg C

หน่วย: บาท/ลิตร

(เฉพาะ NGV หน่วย: บาท/กิโลกรัม)

ปี	เบนซิน 95	แก๊สโซฮอล์ 91	แก๊สโซฮอล์ E10	แก๊สโซฮอล์ E20	แก๊สโซฮอล์ E85	ดีเซล	LPG	NGV	น้ำมันเตา
2556-2583	4.02	3.61	3.61	3.21	0.60	4.97	3.11	3.94	5.66

ผลต่อการเปลี่ยนแปลงราคาขายปลีก

ปี	เบนซิน 95	แก๊สโซฮอล์ 91	แก๊สโซฮอล์ E10	แก๊สโซฮอล์ E20	แก๊สโซฮอล์ E85	ดีเซล	LPG	NGV	น้ำมันเตา
2556-2583	-3.51	-3.16	-3.16	-2.81	-0.53	-0.41	1.10	4.63	5.51

Carbon tax rates for each fuel at 30 Baht/Kg C

หน่วย: บาท/ลิตร

(เฉพาะ NGV หน่วย: บาท/กิโลกรัม)

ปี	เบนซิน 95	แก๊สโซฮอล์ 91	แก๊สโซฮอล์ E10	แก๊สโซฮอล์ E20	แก๊สโซฮอล์ E85	ดีเซล	LPG	NGV	น้ำมันเตา
2556-2583	16.06	14.46	14.46	12.85	2.41	19.86	12.42	15.75	22.66

Retail price changes by the carbon tax

ปี	เบนซิน 95	แก๊สโซฮอล์ 91	แก๊สโซฮอล์ E10	แก๊สโซฮอล์ E20	แก๊สโซฮอล์ E85	ดีเซล	LPG	NGV	น้ำมันเตา
2556-2583	10.67	9.60	9.60	8.53	1.60	17.13	12.07	18.53	25.51