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Energy Saving and Carbon Reduction Policy in Taiwan

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1. Introduction

As the international energy situation undergoes sharp changes, greenhouse gas emissions and the safety of energy supplies become the most pressing challenge of energy supply and demand. In this era of the Kyoto Protocol and high oil prices, all countries in the world have put forward reduction strategies for CO₂ emissions, including such as developing high-value and low-carbon industrial structures, increasing the energy utilization efficiency of various sectors, and constructing reasonable and effective policy tools for the sustainable development of energy sources, environmental protection and the economy.

As the post-Kyoto Protocol era looms ahead, even though Taiwan is not yet a signatory and is presently free from the pressure of being subjected to a greenhouse gas reduction time limit, as a member of the global village, it still needs to exhibit a sense of responsibility to the international community in protecting the earth. In recent years, Taiwan has referred to the energy balance sheet and the statistical data in the websites of the Environmental Protection Administration and the Ministry of Economic Affairs under the Executive Yuan, and uses the IPCC method to estimate data on greenhouse gas emissions based on reference and sector methods. The Environmental Protection Administration of the Executive Yuan is the present competent authority for the statistics of greenhouse gas emissions, but the statistics of CO₂ emissions derived from energy use are estimated by the industry competent authority, the Bureau of Energy of the Ministry of Economic Affairs before being compiled by the Environmental Protection Administration of the Executive Yuan.

Table 1 show that the total greenhouse gas emissions of Taiwan increased gradually from 150 million MT CO₂ equivalents in 1990 to 300 million MT CO₂ equivalents in 2007, and then decreased to 270 million MT CO₂ equivalents in 2009. The CO₂ emissions accounted for about 90% which increased from 120 million in 1990 to 270 million MT in 2007. It has been decreasing each year since 2008, and it was 250 million MT in 2009, a decrease of 4.7%. That derived from energy use (fuel combustion) accounted for a large proportion, and the emission was 240 million MT, a decrease of 4.9%.

Unit: ktCO₂

Year	CO ₂	CH ₄	N ₂ O	HFCS	PFCS	SF ₆	CO ₂
1990	147,109	122,399	11,974	12,736	NE*	NE	NE
1991	156,609	131,853	11,219	13,537	NE	NE	NE
1992	166,759	141,259	12,116	13,383	NE	NE	NE
1993	181,420	152,725	13,424	13,679	1,592	NE	NE
1994	189,900	160,162	14,000	13,937	1,802	NE	NE
1995	198,445	167,308	15,545	13,902	1,689	NE	NE
1996	208,218	175,754	15,495	14,217	2,752	NE	NE
1997	219,873	188,951	15,447	12,360	3,115	NE	NE
1998	229,788	198,340	15,149	11,908	4,391	NE	NE
1999	237,440	207,130	14,660	12,258	3,392	NE	NE
2000	256,651	224,661	11,028	12,443	5,639	2,386	494
2001	260,193	230,576	9,200	12,437	5,412	2,021	546
2002	267,565	239,593	7,250	12,205	5,415	2,509	593
2003	274,665	248,599	6,196	11,205	4,920	2,776	969
2004	283,565	257,279	5,920	11,734	4,494	2,852	1,285
2005	287,303	263,819	4,979	11,461	1,647	2,505	2,893
2006	294,611	271,774	4,486	11,674	1,028	2,657	2,993
2007	296,801	274,973	4,127	11,429	1,031	2,309	2,933
2008	284,515	263,606	4,727	10,839	1,001	1,498	2,844
2009	272,401	251,149	4,489	10,741	3,619	1,143	1,260

Source: Environmental Protection Administration; Council of Agriculture; Bureau of Energy; Bureau of Industry, ROC

*Note: NE (NOT ESTIMATED)

Table 1. Greenhouse Gas emissions

Table 2 shows the CO₂ emission intensity in Taiwan, the CO₂ emissions per one million NT dollars of real gross product of Taiwan in 2009 was 19.6 MT, a decrease of 0.6 MT as compared with the figure for 2008; the CO₂ emissions per capita were 10.9 MT, a decrease of 0.6 MT.

Year	CO ₂ Emissions		Emissions Per person	CO ₂ Emissions Intensity ratios
	Kiloton	Growth rate (%)	(Per-person-kt CO ₂)	(kg CO ₂ /NT\$)
1990	122,399	2.10%	6	0.023
1991	131,853	7.72%	6.4	0.023
1992	141,259	7.13%	6.8	0.0229
1993	152,725	8.12%	7.3	0.0232
1994	160,162	4.87%	7.6	0.0226
1995	167,308	4.46%	7.9	0.0222
1996	175,754	5.05%	8.2	0.0221
1997	188,951	7.51%	8.7	0.0225
1998	198,340	4.97%	9.1	0.0229
1999	207,130	4.43%	9.4	0.0225
2000	224,661	8.46%	10.1	0.0231
2001	230,576	2.63%	10.3	0.0241
2002	239,593	3.91%	10.7	0.0238
2003	248,599	3.76%	11	0.0238
2004	257,279	3.49%	11.4	0.0232
2005	263,819	2.54%	11.6	0.0227
2006	271,774	3.02%	11.9	0.0222
2007	274,973	1.18%	12	0.0212
2008	263,606	-4.13%	11.5	0.0202
2009	251,149	-4.73%	10.9	0.0196

Source: Environmental Protection Administration, ROC(2010)

Table 2. CO₂ Emissions from Fuel

The energy supply/demand has grown rapidly in Taiwan over the past two decades. The total CO₂ emissions of fuel combustion in Taiwan in 1990 calculated by the sector method was 122,399 thousand MT; it was 224,661 thousand MT in 2000 and 274,973 thousand MT in 2007, but it decreased to 263,606 thousand MT in 2008 and even further to 251,149 thousand MT in 2009. It decreased by 4.13% in 2008 from 2007, marking the first decrease. It decreased by 4.73% in 2009 from 2008. The figure 1 illustrates the trends of CO₂ emissions from 1990 to 2009.

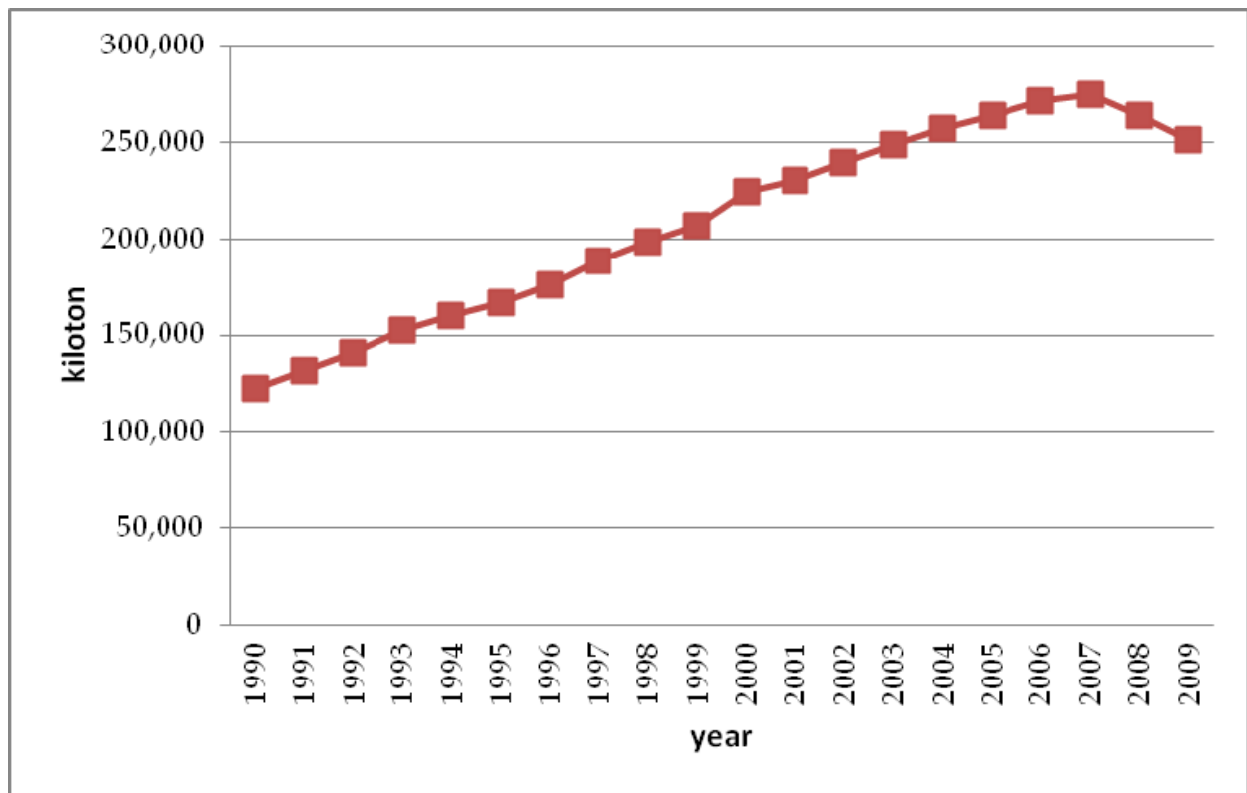


Figure 1. The trends of CO₂ emissions from 1990 to 2009

The emission decrease of the most recent years resulted from the financial storm in 2008 which reduced industrial activity, although the energy consumption of various major industries recovered gradually as prosperity revived in 2009. The government has been promoting energy-saving measures since 2008, with energy consumption continuing to evince negative growth. The annual growth rate of 10.29% in 2000 was the highest between 1990 and 2009, followed by the figure of 8.2% in 1991, whereas the positive growth rate of 1.36% in 2007 was the lowest.

According to the data of the Directorate General of Budget, Accounting and Statistics, CO₂ emission rate per capita was about 6.0 MT in 1990, 10.1 MT in 2000, and 12 MT in 2007; it decreased to 11.5 MT in 2008, and further decreased to 10.9 MT in 2009. The figure 2 shows the trends of CO₂ emissions per capita. The average growth rate of emission per capita between 1991 and 2009 was about 3.4%, but in 2009 it decreased by 5.2% from 2008. In addition, the CO₂ emission intensity (i.e., CO₂ emission per unit GDP) was 0.023 kg in 1990, 0.0231 kg in 2000, 0.0212 kg in 2007, 0.0202 kg in 2008, and 0.0196 kg in 2009. The emissions in various years and related indexes accounted for about 1% of global emissions, for Taiwan a ranking of 22nd in the world. The figure 3 shows the CO₂ emissions intensity form 1990 to 2009.

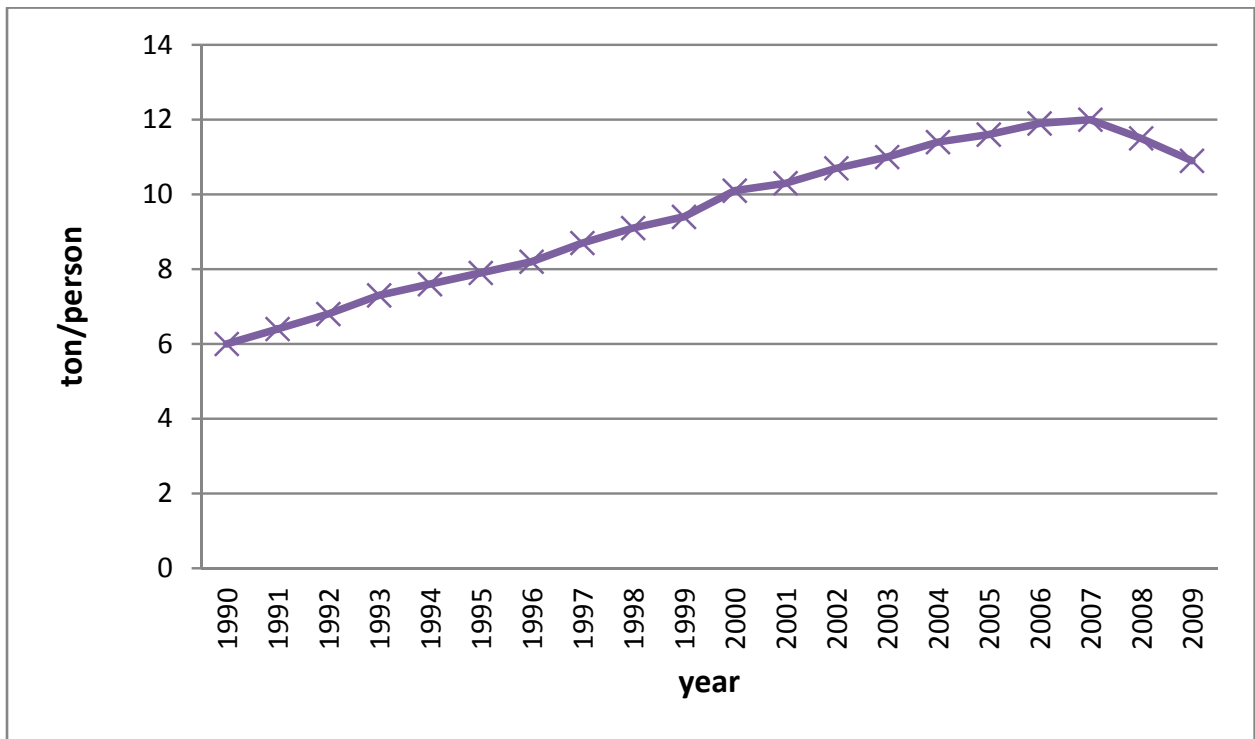


Figure 2. CO₂ emissions per capita from 1990 to 2009

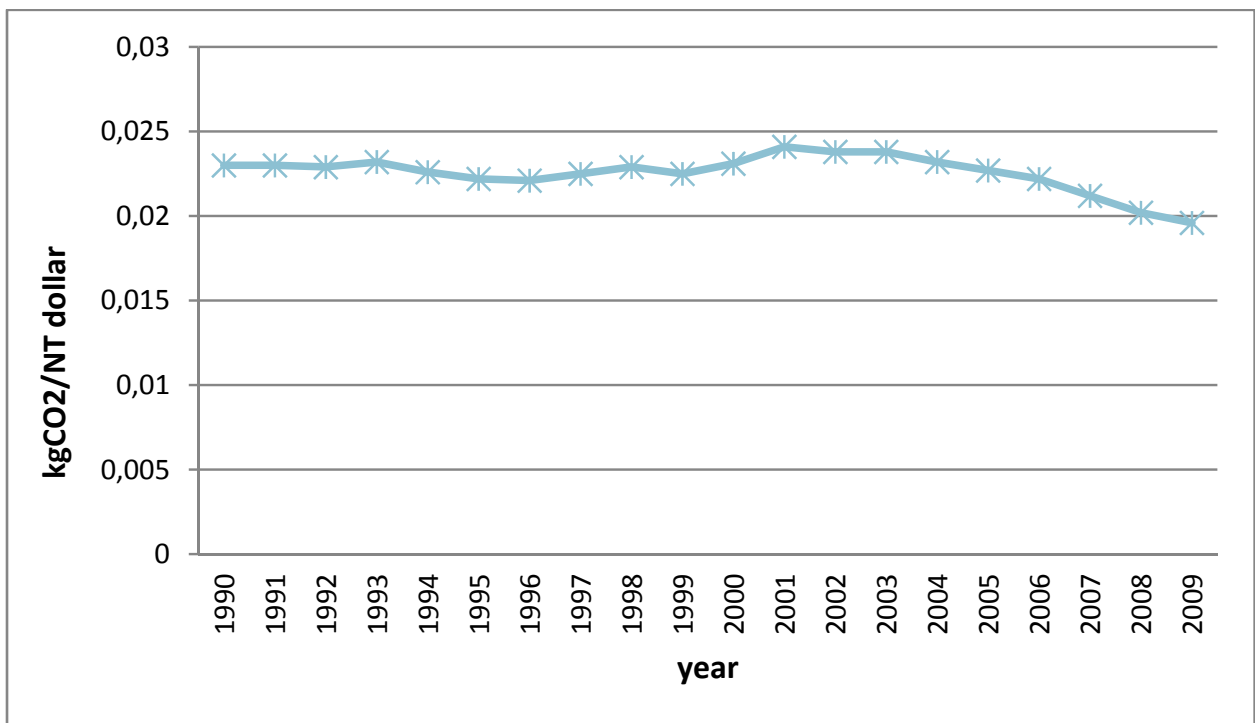


Figure 3. CO₂ emissions intensity from 1990 to 2009

Although energy use decreased as a result of the implementation of various policies in this period, the outcome was not as good as expected for the following reasons: (1) the energy structure has changed, with the proportion of coal with a high carbon content of the overall energy supply continues to increase; (2) the energy price adjustment and tax review policy failed to be implemented effectively, the industrial energy-saving inducement was reduced, and the improvement of energy productivity was obstructed; (3) with respect to energy use and greenhouse gas emission baseline investigation and verification systems, though expected goals were realized, the overall effect still needs to be improved; (4) due to policies promoting the liberalization of the energy industry during the last two decades, many private enterprises in the oil refining and power generation industries have emerged; these enterprises usually use low-cost coal in consideration of their costs, so that the CO₂ emissions have markedly increased.

The fuel combustion CO₂ emission rates of different sectors of Taiwan in 1990 are shown in Table 3 with the energy sector accounting for 45.74%, the industrial sector for 27.26%, transportation for 17.55%, agriculture for 2.63%, housing for 3.59%, and the service industry for 3.23%. In 2009, the energy sector accounted for 65.94%, the industrial sector accounted for 15.90%, the transportation accounted for 13.96%, the agriculture accounted for 0.41%, the housing sector accounted for 2.07%, and the service industry accounted for 1.72%, with the energy sector having the maximum growth rate of energy consumption. Although the carbon emissions of the other sectors all increased, the carbon emission ratios of the sectors other than the energy sector decreased.

Figure 1 shows the data for CO₂ emissions derived from energy consumption in Taiwan for the period 1990-2009. Basically, the emission rate has been increasing linearly since 1990; the annual growth rate is about 11 million MT, even at several key points in time. For example, when the Kyoto Protocol was signed in 1997, and when the Kyoto Protocol went into effect in 2005, the greenhouse gas growth curve of Taiwan continued to develop as before without showing any effect. It is obvious that energy saving and carbon reduction measures undertaken in Taiwan remain inconspicuous.

2. The existing circumstances of energy consumption of various industries in Taiwan

The economic development trend in Taiwan of recent years shows the structural changes of tertiary industry, with the gross product of the industrial sector decreasing year after year, uniting for only 31% of gross product of Taiwan in 2008, whereas the proportion of the service industry has increased continuously, rising to 68% in 2008.

2.1 The structure of energy consumption in Taiwan

The structure of energy consumption in Taiwan is as follows: 98% of Taiwan's energy is imported. Imported petroleum is higher than 99.9%. The energy consumption ratios of different sectors in 2009 are: industry 52.5%, service industry 11.5%, transportation 13.2%, housing 11.6%, energy 7.2%, agriculture 0.9% and non-energy use 3.1%. Figure 5 illustrates the structure of total domestic consumption.

Year	Energy Sector Own Use		Industrial		Transportation		Agricultural		Service		Residential		Total	
	Kt	%	kt	%	kt	%	kt	%	kt	%	kt	%	kt	%
1990	50,705	45.74	30,213	27.26	19,450	17.55	2,917	2.63	3,582	3.23	3,985	3.59	110,851	100
1991	57,187	47.68	31,697	26.43	20,679	17.24	2,673	2.23	3,491	2.91	4,216	3.52	119,943	100
1992	61,268	47.78	33,136	25.84	23,792	18.56	2,646	2.06	2,954	2.30	4,424	3.45	128,220	100
1993	68,944	50.10	33,390	24.26	25,842	18.78	2,648	1.92	2,465	1.79	4,337	3.15	137,626	100
1994	73,930	50.75	34,355	23.58	27,265	18.72	2,694	1.85	2,985	2.05	4,439	3.05	145,669	100
1995	79,925	52.18	34,976	22.83	28,533	18.63	2,749	1.79	2,419	1.58	4,574	2.99	153,176	100
1996	85,546	52.93	35,926	22.23	29,503	18.25	2,776	1.72	3,143	1.94	4,730	2.93	161,624	100
1997	96,476	55.44	37,583	21.60	30,230	17.37	2,451	1.41	2,457	1.41	4,827	2.77	174,024	100
1998	105,773	57.05	38,240	20.63	31,525	17.00	2,021	1.09	2,917	1.57	4,927	2.66	185,403	100
1999	113,262	57.97	39,152	20.04	32,444	16.61	2,020	1.03	3,123	1.60	5,383	2.76	195,384	100
2000	129,737	60.21	42,023	19.50	32,875	15.26	2,338	1.08	3,188	1.48	5,328	2.47	215,488	100
2001	134,875	61.35	40,950	18.63	32,914	14.97	2,430	1.11	3,525	1.60	5,160	2.35	219,855	100

Year	Energy Sector Own Use		Industrial		Transportation		Agricultural		Service		Residential		Total	
2002	138,911	60.97	43,755	19.20	34,197	15.01	2,434	1.07	3,458	1.52	5,081	2.23	227,836	100
2003	149,175	62.89	42,247	17.81	34,164	14.40	2,783	1.17	3,852	1.62	4,992	2.10	237,213	100
2004	155,211	63.27	42,554	17.35	35,501	14.47	2,947	1.20	3,989	1.63	5,101	2.08	245,303	100
2005	161,983	64.36	41,335	16.42	36,478	14.49	2,600	1.03	4,100	1.63	5,203	2.07	251,699	100
2006	169,404	65.34	42,655	16.45	36,406	14.04	1,630	0.63	4,125	1.59	5,046	1.95	259,265	100
2007	173,047	65.85	44,442	16.91	35,071	13.35	1,080	0.41	4,067	1.55	5,080	1.93	262,787	100
2008	167,410	66.42	41,086	16.30	33,103	13.13	1,356	0.54	4,090	1.62	4,997	1.98	252,042	100
2009	158,011	65.94	38,093	15.90	33,447	13.96	994	0.41	4,112	1.72	4,957	2.07	239,615	100

Source: Environmental Protection Administration; Council of Agriculture; Bureau of Energy; Bureau of Industry, ROC

Kt* : Kiloton

Table 3. The fuel combustion CO₂ emissions of different sectors of Taiwan unit: kiloton CO₂ %

2.2 Energy consumption structure by sectors

Energy-intensive industries in the sectoral structure of the manufacturing industry still occupy an important position: energy-intensive industries have a high industry correlation effect, and support the development of other middle and downstream knowledge-intensive industries; they represent a stable raw material supply source for various industries, so they profoundly influence the development of Taiwan's industries. For example, the industrial sector still accounted for 52.5% of energy consumption in 2009. The energy consumption of the industrial sector was 23,145,782 Kl. oil equivalents in 1990, and 59,350,964 Kl. oil equivalents in 2009, an increase of 256% times. The energy consumption of energy-intensive industries was 14,305,778 Kl. oil equivalents in 1990, and 41,040,183 Kl. oil equivalents in 2009, an increase of 286%.

The achievement of voluntary greenhouse gas reduction in energy-intensive industries with assistance of the government has been outstanding in recent years. The six major energy intensive industries jointly signed a greenhouse gas reduction protocol in 2005, expecting to reduce 4.02 million MT CO₂e between 2004 and 2008. The accumulated reduction performance was 3.806 million MT CO₂e between 2004 and 2007, or 1.1% of total emissions.

Over the past 10 years national energy intensity has edged down from 9.43 to 8.82 liters of oil equivalent (LOE) per NT\$1000. This shows that the efforts on various fronts to conserve energy have reaped results. But because energy intensive industries (including petrochemicals, steel, textiles and paper) have continued to expand, their 23% growth in energy intensity from 2000 to 2009 has offset improved efficiency in other sectors. The figure 4, 5 and 6 depict the energy consumption by different sectors.

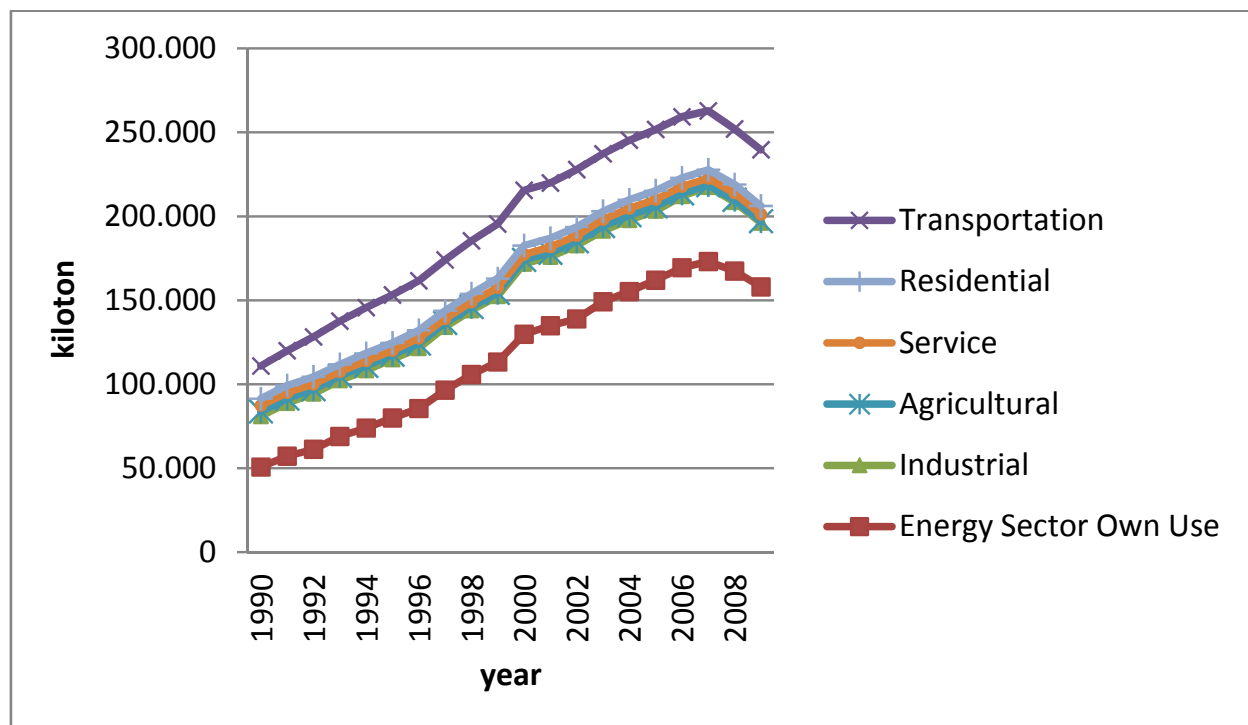


Figure 4. The fuel combustion CO₂ emission of different sectors of Taiwan

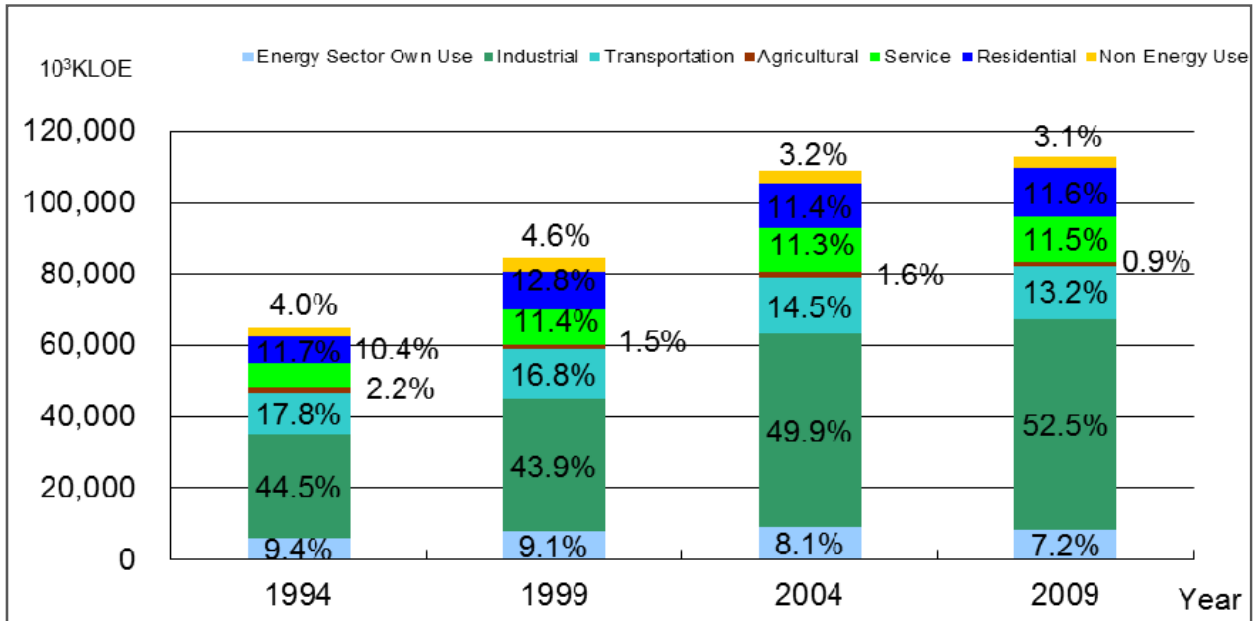


Figure 5. Structure of Total Domestic Consumption (by Sector)

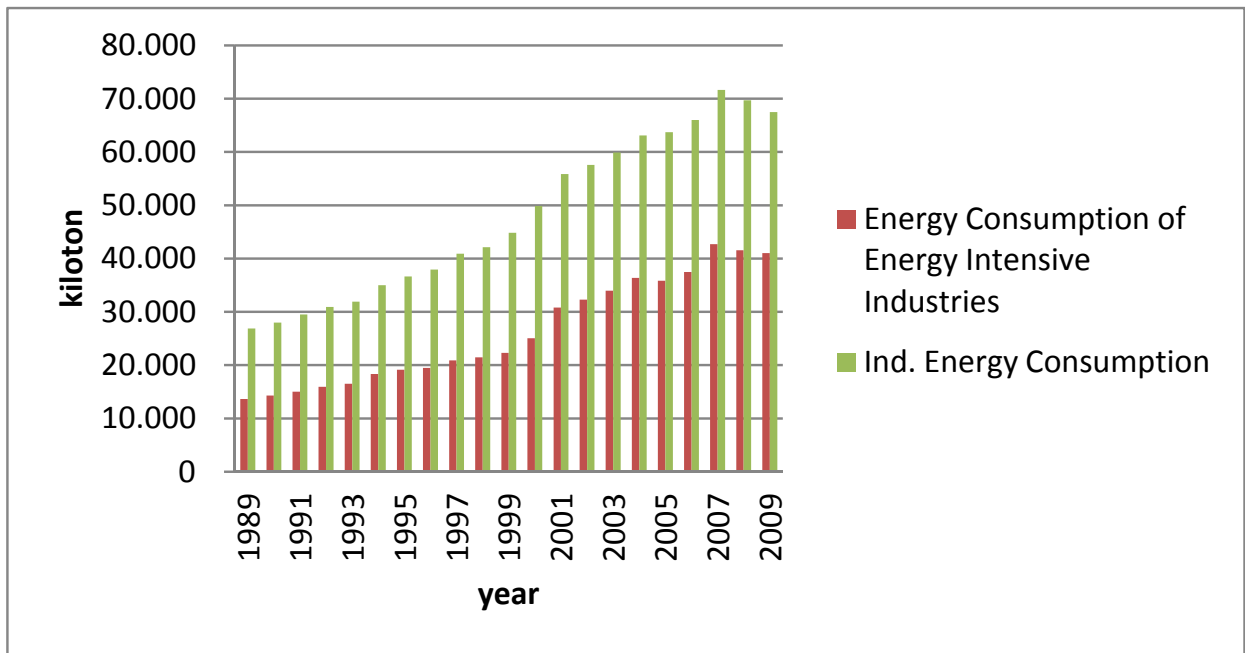


Figure 6. Energy Consumption (by Sector)

3. Current problems in various sectors of Taiwan

International reduction strategies and high oil prices promote energy saving and carbon reduction. A number of advanced countries have developed national reduction strategies based on international commitments since the Kyoto Protocol went into effect. A consensus on reducing at least fifty percent of global greenhouse gas emissions by 2050 was reached at the G8 Summit in July 2008. The international consensus on carbon reduction applies

pressure on Taiwan. Taiwan shares the responsibility for reducing emissions and has taken actions in this regard. Furthermore, international oil prices have risen sharply in recent years, and high oil prices have become a long-term trend, making energy efficiency an indicator of inter-industry competitive power. The implementation of measures for energy saving and carbon reduction has come under internal and external pressures.

3.1 Energy efficiency improvement problems in the industrial sector

- The industrial sector has the maximum energy consumption ratio.
- Since the industrial sector has promoted energy saving for a long time, the energy-saving potential of existing equipment is limited.
- The inducement of a voluntary energy conservation agreement is not enough as energy prices are low.
- There are no energy conservation standards of design, construction and the use of business sites and factory buildings.
- There have been no energy efficiency standards of important power equipment (e.g., air compressors, fans, pumps, et al.).

3.2 Energy efficiency improvement problems in the transportation sector

- Transportation demand increases continuously with economic development and population growth.
- Green energy is not yet popular; fuel alternatives are limited.
- Low-carbon transport is difficult to implement in the short term due to high costs.
- The external cost of private transport has not been sufficiently disclosed; the inducement of cost differentials between private transport and public transport remain insufficient.
- The quantity and quality of public transport service still need to be improved.

3.3 Energy efficiency improvement problems in residential and commercial sectors

- Power demand increases continuously with economic development and population growth.
- The energy efficiency of electrical equipment is not clearly indicated.
- The standby power of electrical equipment lacks effective management.
- There is no inducement to invest in green buildings.
- Making energy conservation improvements in old buildings is lacking in incentives.
- No energy conservation standards exist for the design and construction of new buildings.
- High costs make it difficult to equip buildings with renewable energy.
- Inducements for buying energy-saving building materials and appliances still need to be increased.
- The low recovery rate of building materials influences source-reduction performance.

4. Current policy measures in Taiwan

The Executive Yuan of Taiwan adopted the “Sustainable Energy Policy Convention” on June 5, 2008 to construct a “high efficiency”, “high value”, “low emission” and “low dependence” energy consumption pattern and supply system, so as to realize the three-win vision of

energy, environmental protection and economy. The specific measures cover energy saving and carbon reduction of the five major sectors of energy, industry, transportation, environment and life. Regulations and relevant supporting mechanisms have been completed in the hope of attaining the following goals of energy conservation: an increase in the energy efficiency by more than 2% annually to reduce energy use in 2015 by more than 20% from levels in 2005. In terms of carbon reduction the goal is to reduce CO₂ emissions in Taiwan between 2016 and 2020 to levels in 2008, and reduce the levels of emissions in 2025 to those in 2000.

Generally speaking, the energy supply side works on “clean sources” and the energy consumption side works to “reduce expenditures.” Energy conversion efficiency must be stressed on the energy conversion side, such as the generating efficiency of power plants and the oil refining efficiency of oil refineries. Higher energy conversion efficiency means “cleaner sources.”

Regarding the energy supply side, Taiwan's primary energy supplies are derived mainly from coal, crude oil, natural gas, nuclear energy, and renewable energy. Coal and crude oil are high-carbon energy, whereas natural gas, nuclear energy and renewable energy are classified as low-carbon energy. In terms of clean sources, the ratio of low-carbon energy in the overall primary energy structure must be increased.

Secondly, energy conversion efficiency must be increased, such as increasing the generating efficiency of power plants. High efficiency means using the least primary energy (e.g., coal) to yield the most end-use energy (e.g., electricity) for consumption. Increasing energy conversion efficiency is one of means of developing “clean sources.”

Item	Energy saving and carbon reduction mode	Sector	Measures
Energy supply	Clean sources	Energy sector	Adjust energy structure, adopt low-carbon energy (nuclear energy, renewable energy)
		Industrial sector	Adjust industrial structure, encourage low-carbon industries
Energy conversion	Clean sources	Energy sector	Increase generating efficiency of power plants
Energy consumption	Reduce expenditure	Industrial sector	Increase energy utilization efficiency, conserve energy
		Transportation sector	Increase energy utilization efficiency, conserve energy
		Residential and commercial sector	Conserve energy (e.g., ten major measures for energy saving and carbon reduction)
		Government sector	Carbon neutral
		The public	Nationwide energy saving and carbon reduction movement

Table 4. Existing circumstances of the division of work, measures and promotion of energy saving and carbon reduction in Taiwan

Energy consumption is closely related to the daily lives of ordinary people (consumers); it is the starting point from which the general public practices energy saving and carbon reduction, which are the ultimate goals of the “ten major measures for energy saving and carbon reduction” promoted by the government. We usually divide energy consumption into sectors such as transportation, and residential, commercial and industrial sectors for convenience in applying data statistics and policy implementation. This part of energy saving and carbon reduction starts with “reducing expenditures.”

The following table summarizes initiatives in carbon reduction and the implementation of primary measures with respect to energy supply, conversion and consumption.

4.1 For “clean sources,” reconstruct the energy structure and improve efficiency

- Develop carbon-free renewable energy sources; make effective use of renewable energy development potential, in order to accounts for more than 8% of the generating system by 2025. The total installed capacity of renewable energy is 3.328 million kW, equivalent to 11.1 billion kWh per year, which can reduce about 6.9 million MT CO₂ emissions. The installed capacity of renewable energy is planned to be 8.45 million kW in 2025, accounting for 15.1% of total installed capacity.
 1. Photovoltaic power generation: promote the installation of solar roofs, solar campus, remote off-island emergency disaster prevention, revitalizing the economy; the total installed capacity is 22.4 thousand kW, equivalent to generating 26.91 million kWh per year, so that about 16.7 thousand MT of CO₂ emissions can be reduced.
 2. Wind power generation: the total installed capacity of wind power generation is 518.7 thousand kW (268 units), and the annual power generation is about 1.296 billion kWh, which can serve about 324.2 thousand households and reduce 807.9 thousand MT of CO₂ emissions.
 3. Biodiesel: the estimated annual reduction of CO₂ emission is about 330 thousand MT, equivalent to the CO₂ volume absorbed by about 343 Daan Forest Parks; as for the industrial benefit, there were 10 qualified biodiesel plants up to December 2010, the total annual output is 130 thousand Kl., the accumulated industrial investment of about 1 billion NTD has been driven, when 2% biodiesel is added in, the estimated annual output value is about 3 billion NTD.
- Reduce the carbon footprint of electric power: in order to reduce the CO₂ emissions resulting from the power consumption of other sectors, low-carbon and non-carbon energy generation shall be a primary objective in short-term planning; the efficiency of existing power plants shall be increased in medium-term planning, and the structure of power-generating resources shall be adjusted in long-term planning.
- Improve the overall energy efficiency and energy conservation: energy use was 8.47 liter oil equivalent/thousand NTD in 2010; it was reduced by 3.97% (8.82 liter oil equivalent/thousand NTD) from 2009. Taiwan I energy conservation goal to increase its energy efficiency by more than 2% annually has been attained.

- Accelerate the renewal of power plants; improve the overall efficiency of power plants, and require new power plants to reach an optimal feasible power generation conversion efficiency level consistent with world standards.
- Introduce clean coal technology and developing carbon capture and storage through international research and development; reducing the carbon emissions of generating systems.
- Rationalize energy prices; short-term energy prices reflect internal costs external costs are adjusted progressively in the medium and long term.

4.2 “Reducing expenditure” by promoting substantial energy savings and carbon reduction measures in all sectors

4.2.1 Industrial sector

- Strengthen energy management and increase energy efficiency: according to the “Energy Management Law” passed on July 8, 2009, large-scale productive investment production plans shall be managed in advance, and a mandatory energy label system shall be established.
- Expand energy conservation services: a “comprehensive energy conservation center” is to be established; provide 4,712 energy users with energy conservation guidelines between 2009 and 2012; assist in industrial energy conservation of 525 thousand Kl. oil equivalents (equivalent to reducing energy costs by 10.7 billion NTD).
- Promote voluntary energy conservation in the service industry: a convention at which telecom and communication producers and 3C household appliance groups signed a voluntary energy conservation agreement was held on August 9, 2010. The goal of energy conservation through 2012 is set at 5%. Estimated energy conservation potential is 50 million kWh. Convenience stores, hypermarkets, hospitals, hotels, department stores, supermarkets, shopping centers, telecom and communication producers and 3C household appliance groups of ten major industries (102 group enterprises) signed a voluntary energy conservation agreement effective between 2006 and 2010; the signed groups reduced energy use by 11.9% on average from 2006 to 2009, for a total reduction of 717 million kwh.
- Urge the industrial sector to develop high-added value and low-energy consumption; reduce the carbon emission intensity of unit output value by more than 30% by 2025.
- Check and allocate enterprise carbon credits; assign responsibility for carbon reduction; urge enterprises to promote production and sales systems for energy saving and carbon reduction. Promote voluntary greenhouse gas reduction plans in the energy industry: 33 plants, including Tunghsiao Power Plant of Taiwan Power Co., Ltd. were given assistance in devising voluntary reduction plans up to December 2010; 20 plants were given assistance in gaining approval of their reduction plan designs; 17 plants were given assistance with "ISO 14064-2" verification. Total reduction was more than 6.48 million MT CO₂ equivalents, which shall be used as reference for emission offset or trading of total greenhouse gas control and protecting the preliminary efforts of firms.

- Help small and medium-sized enterprises strengthen their ability to save energy and reduce carbon emissions. Establish inducement measures and management systems and encourage clean production. Energy-saving technology service was provided to 997 enterprises through December 2010. The energy conservation potential of 151.8 thousand Kl. oil equivalent was explored; it was estimated that 80 thousand Kl. oil equivalent could be conserved.
- Encourage popularizing energy saving and carbon reduction and renewable energy and other green energy industries; create a new energy economy.

4.2.2 Transportation sector

- Build seamless urban public transport services; strengthen the accessibility of township public transport systems; take care of remote places.
- Provide real-time traffic information and public transport change information; improve the convenience of public transport and strengthen traffic control functions.
- Build a bicycle path network all over Taiwan; improve the safety, connectivity and continuity of bicycle paths.
- Popularize urban bicycle path networks; provide bicycle parking facilities; establish bicycle rental and riding control systems and facilities; strengthen systematic measures for change in public transport terminal yards.
- Strengthen transport management measures; consider the social cost of private transport in a reasonable manner.
- Internalize the external cost of private transport; promote levying a fuel tax on oil; enlarge the gap of public transport costs.
- Promote ride sharing and safety mechanisms.
- Increase the efficiency level of new cars for private transport by 25% in 2015.
- Promote the reasonable use of biomass fuel in automobiles.
- Promote low-carbon electric vehicles.

Residential and commercial sectors

- Promote mandatory energy efficiency grade labeling: since the announcement of regulations on air-conditioners, refrigerators, cars and motorcycles for energy efficiency grade labeling on July 1, 2010, energy efficiency grade labeling shall be pasted or placed on all such items for sale. Increase the energy efficiency of various power consuming appliances by 10%~70% by 2011, and raise the standard in 2015; popularize high-efficiency products.
- Promote a revolution in energy-saving lighting; promote the "LED traffic signal lamp energy conservation project plan": 17 county and city governments including New Taipei City were given assistance in replacing 135,238 LED traffic signal lamps in 2009 and 2010; 3 municipalities directly under the central government including Taipei City and 11 counties and cities including Keelung City replaced all their signal lamps by 2010. It is estimated that 91% of the 700 thousand traffic signal lamps in Taiwan have been replaced.
- Accelerate the promotion of green buildings; establish systems to encourage their design; assist in providing existing buildings with green building features; provide incentives and rewards.

- Stipulate energy conservation standards of shell energy consumption, air conditioning and lighting systems in the design or construction of new buildings.
- Accelerate the promotion of voluntary agreement of large congregated residential houses; meet the energy conservation potential of the residential sector.
- Provide financial and tax incentives for buying and using green buildings, green building materials and recycled building materials.
- The regulations of buildings shall specify that buildings above a certain scale shall be equipped with renewable energy consuming facilities to increase the use ratio of renewable energy in buildings.

4.2.3 Government sector

- Promote energy conservation in government offices and schools: implement “overall energy saving and carbon reduction measures for government offices and schools”; set negative growth targets for annual power and oil consumption; the overall reduction for 2015 should be 7% of the 2007 figure; help government offices and schools introduce an “energy technology service industry” to improve energy conservation. The energy-saving technology service was implemented in 168 government offices and schools from January to December 2010; the energy potential of 23 thousand Kl. oil equivalents was conserved.
- There shall be a “carbon neutral” concept in policy planning; carbon is to be controlled by putting into practice precautionary, pre-warning and screening principles.

4.2.4 The public

- Promote a nationwide energy saving and carbon reduction movement; encourage the public to “reduce 1 kg carbon footprint per day.”
- Promote the policy “discounts for electricity costs for encouraging energy-saving measures”: 6,452 households received discounts for electricity costs from July 2008 to January 2011; a total of 10.54 billion kWh was conserved; it was 44% higher than the total power consumption (7.3 billion kWh) of all the households in Taipei City in 2009. The total electric cost deduction was 17.52 billion NTD; CO₂ reduction was about 6.70 million MT. The “county-city electricity saving competition” was carried out three times in 2010 since its implementation on July 1, 2010. The first-place winners of the three competitions were Hsinchu City, Chiayi City and Kaohsiung County, respectively. The electricity saving rates was 4.48%, 7.16% and 4.58%, respectively.

5. Taxation tools for energy saving and carbon reduction in Taiwan

There have never been taxes such as a “carbon tax”, an “energy tax” or a “green tax” in Taiwan. Taxes related to the environment or energy sources have been levied for the existing policy purposes of energy conservation, environmental protection, maintaining health and rectifying external effects, including an energy tax, a transportation tax, a pollution tax and a tax on resources.

Natural resources may be put in production for economic development, or the manufacturing process may produce wastes or emissions; if the waste of resources and the creation of emissions are not suppressed properly, environmental resources will be exhausted and the environmental quality will deteriorate. For a sustainable utilization of environmental resources, the government can adopt direct administrative control measures for environmental protection and resource management and utilization, and can use economic tools such as an environmental tax, environmental fees, tradable emission permits or quotas, a deposit system and environmental subsidies for environmental protection, so as to carry out the principle by which the environmental media or resource users, or polluters are required to pay fees.

Since the use of environmental taxes tends to be diversified, such taxes benefit both the environment and economy, making it an important policy tool. Acquiring environmental tax data and making comparisons with other countries are feasible steps to take. International organizations are currently discussing the issue of environmental taxes. For example, the OECD makes use of basic statistics; the EU has a statistical handbook; the EU and SEEA have 2003 manuals which define environmental taxes as taxes levied on physical units which have been proved harmful to the environment in a statistical structure. The definition of "tax" is similar to the concept of national income statistics in referring to compulsory and voluntary payments to individual governments.

Environmental tax statistics are divided into four major types in the world, including an energy tax, a transportation tax, a pollution tax and a tax on resources. An energy tax base includes the energy products of transportation and fixed use. A transportation tax is based on the possession and use of motorized vehicles. A pollution tax aims at the discharge of air and water and the management of solid waste and noise. A resources tax aims at water extraction, sandstone, primary raw materials and the exploitation of forest resources; it excludes natural gas and petroleum exploitation (which is regarded as resource rent instead of tax).

Statistical items of the environmental tax in Taiwan include an energy tax, a transportation tax and a pollution tax, but no resources tax. The energy tax includes an energy tariff, oil and gas excise tax and a petroleum fund of energy resources. The transportation tax includes a transport tariff, a vehicle excise tax, a vehicle license tax and a charge for use of automobile fuel. The pollution tax includes air pollution prevention and control fees, soil and ground water contamination regulation fees and recovery and treatment fees.

The present environment-related tax items, competent authorities, sources of law, taxpayers and coverage of taxation in Taiwan are shown in Table 5.

Table 6 illustrates the environmental tax rates in Taiwan. Table 7 shows the environmental tax revenues and composition of Taiwan; it also shows that tax revenues totaled 227.89 billion NTD in 2009, an increase of 0.2% from 2008. The transportation tax of 132.12 billion NTD accounted for 58.0%; the energy tax of 84.86 billion NTD accounted for 37.2% for a combined total of 95.2%. The pollution tax was 10.9 NTD, accounting for 4.8%.

The energy tax was 84.86 billion NTD in 2009, an increase of 9.8% from 2008; the oil gas excise tax of 84.29 billion NTD accounted for 99% of the energy tax. The petroleum fund was

330 million NTD, accounting for only 0.4%. In addition, imported energy decreased greatly as a result of the economic recession. Revenue from the petroleum tariff decreased to 230 million NTD, a sharp decrease of more than 75%; its proportion decreased to 0.3%.

Revenue from the transportation tax was 132.12 billion NTD, a decrease of 4.4% from 2008. Revenue from the vehicle license tax was 53.05 billion NTD, accounting for 40.2% of the transportation tax. Automobile fuel fees totaled 43.24 billion NTD, accounting for 32.7%; in addition, the vehicle excise tax decreased 17.6% from 2008 as a result of poor motorcycle sales in Taiwan; its proportion decreased to 21.0%.

The pollution tax generated revenues of 10.9 billion NTD in 2009, a decrease of 9.7% from 2008. The “Recycling, Clearance, and Disposal Fees” resulted in 6.01 billion NTD, accounting for 55.1% of pollution tax revenues. The “Air Pollution Control Fee” in Pollution Control accounted for 39.3%, and the “Soil and Groundwater Pollution Remediation Fee” oil and Groundwater accounted for only 5.6%.

Tax item	Tariff	Excise tax	Vehicle's Fuel Charge	Air pollution fee	Soil pollu
Competent authority	Ministry of Finance	Ministry of Finance	Ministry of Transportation and Communications	Environmental Protection Administration	Environn Protection Administration
Source of law	Customs Law	Excise Tax Regulations	Highway Law	Air Pollution Control Law	Soil and Groundw Pollution Remediat
Taxpayer and coverage of taxation	Imported dutiable goods shall be levied on according to tariff regulations.	Taiwan made or imported dutiable goods shall be levied on according to excise tax regulations.	All vehicles on highways or in urban area, excluding the tax-exempt vehicles specified in Article 4 of Highway Law.	Mobile pollution sources: the distributors or users are levied on according to the variety and quantity of discharged air pollutants, and the distributors or importers are levied on according to the composition and quantity of oil fuels.	Makers a importers: specified chemical substance levied on according output qu and input quantity.

Source: Ministry of Finance, Directorate General of Budget, Accounting and Statistics, Executive Yuan, 1

Table 5. Taiwan's Environment-related Taxes

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Taiwan's taxation policies for various environment-related taxes in the future: The "Regulation for Energy Tax (draft)" is being scheduled for legislative review.

The fundamental aspects of the Energy Tax are as follows:

- Implement an energy tax to maintain a financial balance.
- According to the conclusions of the Tax Reform Committee, Executive Yuan, the implementation of a green tax system will integrate the present oil gas excise tax, automobile fuel fee and petroleum fund. The increased tax revenues after implementation will be used to subsidize low-income households and public transport first; untimely items of excise tax, stamp duty and amusement tax systems will be reformed to reduce their impact on the public.
- As the energy tax system will exert a significant influence on industry and the economy, the Ministry of Finance will study the influence of the energy tax on the economy, industry and the environment as well as the opinions of all circles of society before drafting and planning the tax system, which will be implemented at a proper time.

Item	Import Tariff			Trade Promotion Service Fee	Excise Tax	Petroleum Fund	Soil and Groundwater Pollution Remediation Fee	
	Column I	Column II	Column III					
Crude Oil	0%	0%	2.50%	0.04%	(Free)	109 NT \$ /KL	0NT \$ /T	
Fuel Oil	5%(2.5%)	0%	5%	0.04%	0.11NT \$ /L	137 NT \$ /KL	12NT \$ /T	
Kerosene	0%	0%	15%	0.04%	4.25NT \$ /L	133NT \$ /KL	0NT \$ /T	
Kerosene Type Jet Fuel	0%	0%	15%	0.04%	0.61NT \$ /L	133NT \$ /KL	0NT \$ /T	
LPG	0%	0%	2.50%	0.04%	0.69NT \$ /KG	151NT \$ /T	(Butane)12NT \$ /T	
Gasoline	0%	0%	15%	0.04%	6.83 NT \$ /L	169 NT \$ /KL	22NT \$ /T	1s 2nd 3rd
Diesel Oil	0%	0%	15%	0.04%	3.99NT \$ /L	144NT \$ /KL	22NT \$ /T	1s 2nd
Natural Gas	0%	0%	7.50%	0.04%	0	0	0	
Steam Coal	0%	0%	0%	0.04%	0	0	0	
Coking Coal	0%	0%	0%	0.04%	0	0	0	
Electricity	-	-	-	-	0	-	0	

Source: Ministry of Finance, Directorate General of Budget, Accounting and Statistics, Executive Yuan,
 Note: The import tariff rate is divided into three columns. The first column applies to goods imported from countries or areas that have reciprocal agreements with the Republic of China. The second column applies to goods imported from specific underdeveloped or developing countries or areas, or from countries or areas that have a Trade Agreement with the Republic of China. When the rates in the first and second column are not applicable, the third column shall apply.

Table 6. Energy-Related Tax Rates

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Unit: million NTD; %

Year	2007		2008		2009	
	amount	%	amount	%	amount	%
Total	253,801	100	227,517	100	227,886	100
Energy Tax	89,324	35.19%	77,290	33.97%	84,859	37.24%
Import Tariff	910	0.36%	964	0.42%	233	0.10%
Oil Gas Excise Tax	87,560	34.50%	75,735	33.29%	84,293	36.99%
Petroleum Fund	854	0.34%	591	0.26%	333	0.15%
Transportation Tax	152,219	59.98%	138,157	60.72%	132,124	57.98%
Import Tariff	10,816	4.26%	7,419	3.26%	8,091	3.55%
Vehicle Excise Tax	43,953	17.32%	33,677	14.80%	27,741	12.17%
Vehicle License Tax	53,271	20.99%	53,255	23.41%	53,050	23.28%
Vehicle Fuel Charge	44,179	17.41%	43,806	19.25%	43,242	18.98%
pollution tax	12,258	4.83%	12,070	5.31%	10,903	4.78%
Air Pollution Control Fee	4,810	1.90%	4,946	2.17%	4,282	1.88%
Soil and GW Pollution RD Fee	711	0.28%	575	0.25%	612	0.27%
Recycling, Clearance, Disposal	6,737	2.65%	6,549	2.88%	6,009	2.64%

Source: Ministry of Finance, Directorate General of Budget, Accounting and Statistics, Executive Yuan, R.O.C (2011).

Table 7. Energy-related Tax Revenues and Composition

6. Conclusion

Taiwan is encountering the global environmental crises related to global warming and faces continuing challenges from the environmental deterioration stemming from economic development. Taiwan is deficient in conventional energy resources and highly dependent on energy imports, with nearly 90% of its greenhouse gas (GHG) emissions coming from carbon dioxide emitted from energy use. The annual growth of GHG emissions has been slowing in recent years, with negative growth reported for the first time in 2008. Taiwan is currently not a signatory to the United Nations Framework Convention on Climate Change; however, as a member of the global village Taiwan has committed itself to sharing the obligations of common but differential responsibility in accordance with the basic principles of the UNFCCC. In order to maintain national competitiveness and limit the consumption of high-priced energy, the government will continue to implement energy conservation and carbon reduction measures for national sustainable development.

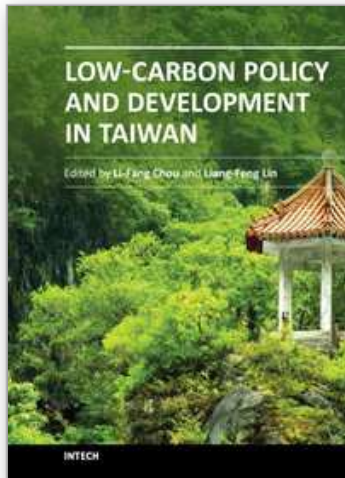
But if we truly want to reshape the nation's industrial structure through imposed controls, effective means should include both the imposition of energy taxes and the passing of a Greenhouse Gas Emissions Reduction Act. Energy conservation and carbon reduction in Taiwan will never be just a slogan, but a new lifestyle in action.

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Taiwan a typical small Asian country with few energy resources is well known for its high-tech industry in the last 20 years. However as a member of the global village Taiwan feels the responsibility to reduce carbon emissions. The book tells you how Taiwan transforms itself from a high-tech island to become a low carbon island. The book address Taiwan's low-carbon developmental policies of the past 10 years, applies an econometric approach to estimate Taiwan's sector department CO₂ emissions, shows how environmental change affects the economic growth of Taiwan, and provides two successful examples of low-carbon pilot regions in Taiwan. Stephen Shen, the Minister of the Environment Protection Agency of Taiwan, believes that the book arrives at the right time, because this is the time to educate the people of Taiwan, about the necessary action for achieving a low carbon society.

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