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Abstract *This study applies data envelopment analysis (DEA) to compute the efficient energy-saving ratios for 23 administrative regions in Taiwan from 1999–2005. One output (total income) and seven inputs (local government expenditure, employment, processed trash, household and commercial electricity consumption, industrial electricity consumption, gasoline sales volume, and diesel sales volume) are considered in the DEA models. It is found that most of the 23 administrative regions do not efficiently use household and commercial electricity, industrial electricity, gasoline, and diesel, even with respect to Taiwan's own efficiency frontier. Our results suggest that improving energy efficiency in household and commercial electricity use is a priority for non-metropolitan regions. There is still much room to improve the efficiency of electricity use for industries, especially for regions where manufacturing and high-tech industries concentrate, by means of cleaner production, energy-saving technology and equipment, etc. Motor vehicle energy efficiency is the key factor for saving gasoline. The energy efficiency of farming machines and carrying equipment should be continuously improved, especially for rural regions.*

Keywords data envelopment analysis (DEA), efficient energy-saving ratios, total-factor energy efficiency (TFEE)

1. Introduction

Taiwan is insufficient in natural resources and constrained by a limited environment carrying capacity (Ministry of Economic Affairs, 2008). Since 97.9% of Taiwan's total energy consumption is imported (Bureau of Energy, 2008), foreign market fluctuations or policy changes can easily affect its energy supply and security. Since energy has great impacts on economic development and the ecological environment, whether energy use is efficient is an important issue for Taiwan.

The Energy White Paper published by Taiwan's Bureau of Energy (2005) declares six policy guidelines focusing on stabilizing energy supply, improving energy efficiency, opening up the energy industry, paying attention to environmental protection, enhancing research and development, and boosting educational dissemination. In 1998, 2005, and 2009, Taiwan held national energy councils to address energy-related policies and suggestions and how to improve energy efficiency was one of the key topics in all three councils. In 2008, the Ministry of Economic Affairs announced the Framework of

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Taiwan's Sustainable Energy Policy, which states that sustainable energy policies should improve the efficient use of limited energy resources in order to create a win-win-win solution for energy, the environment, and the economy. In summary, energy efficiency is one of the most important issues in Taiwan's energy policy.

According to the main conclusions of Taiwan's national energy council in 2005, restructuring the energy mix and coordinating policy across different departments are must-do approaches to improve Taiwan's energy efficiency. The Framework of Taiwan's Sustainable Energy Policy (Ministry of Economic Affairs, 2008) requires government agencies to formulate concrete action plans in accordance with the framework, and quantitative objectives should be established for each task to measure the performance and facilitate implementation.

This study attempts to compute and compare the energy efficiency of Taiwan's different administrative regions. It will be helpful if we can understand the differences of energy efficiency in different areas of energy use (such as household and commercial electricity, industrial electricity, gasoline use, etc.) among different administrative regions. More public efforts for improving energy efficiency should be put on those administrative regions with lower energy efficiency, and policies should focus on the energy-use areas with low efficiency in these administrative regions. Each administrative region should establish quantitative objectives aiming at improving the efficiency of the energy-use areas appearing to be less efficient than other regions.

Energy inefficiency is conventionally measured by energy intensity, which is a direct ratio of the energy input to gross domestic product (GDP) (Patterson, 1996; Renshaw, 1981). However, in recent years many studies criticize this commonly-used indicator of energy inefficiency, because it is only a partial-factor energy efficiency indicator with energy input as the only input-considered factor. Furthermore, some studies argue that this partial-factor ratio is inappropriate to analyze the impact of changing energy use over time (APERC, 2002). Instead of the partial-factor ratio approach, this study computes the energy efficiency within a total-factor framework, which includes not only the energy input but also other inputs such as labor and capital.

This study calculates the total-factor efficiency indicators, or the efficient energy-saving ratios, for 23 administrative regions in Taiwan from 1999–2005 by utilizing the data envelopment analysis (DEA) approach. One output (total income) and seven inputs (local government expenditure, employment, processed trash, household and commercial electricity consumption, industrial electricity consumption, gasoline sales volume, and diesel sales volume) are employed in our DEA models. The DEA first generates the target energy inputs for each region in Taiwan for each year, and then from that the efficient energy-saving target ratios for regions in Taiwan are computed.

This total-factor energy framework was developed by Hu and Wang (2006) to compute the efficient energy-saving targets for regions in China, and has been used to study the regions in Japan (Honma and Hu, 2008) and the economies in Asia-Pacific Economic Corporation (APEC) (Hu and Kao, 2007). A total-factor efficiency indicator can reveal more information and provide a realistic comparative base to examine the de facto situation across regions in an economy such as Taiwan.

2. Methodology and Data Sources

We foumd input targets for each administrative region in Taiwan by comparing its actual position to the annual efficiency frontier constituted by all the administrative regions for each year. Since the focus is input-reducing, input-orientated measures are used,

following Farrell's (1957) original ideas. The constant returns to scale (CRS) DEA model is employed to obtain the overall technical efficiency (OTE) with energy inputs (Charnes et al., 1978).

A description of our model is given as follows. Assume that there are K inputs and M outputs for each of N objects. The inputs and outputs of the ith object are represented by the column vectors x_i and y_i, respectively. The $K \times N$ input matrix X and the $M \times N$ output matrix Y represent the data for all N objects. The input-oriented CRS DEA model solves the following linear programming problem for object i in each year:

$$\begin{aligned} D(y_i, x_i) &= \mathrm{Min}_{\theta,\lambda}\theta \\ \text{subject to} \quad & -y_i + Y\lambda \geq 0, \\ & \theta x_i - X\lambda \geq 0, \\ & \lambda \geq 0, \end{aligned} \tag{1}$$

where θ is a scalar and λ is a $N \times 1$ vector of constants. The value of θ is the efficiency score for the ith object, with $0 \leq \theta \leq 1$. The weight vector λ serves to form a convex combination of observed inputs and outputs.

The target inputs of an object in a year are found by comparing its actual inputs to the efficiency frontier in that year. The target inputs are found by DEA model by considering energy input as well as other non-energy inputs. The total-factor energy efficiency (TFEE) formula proposed by Hu and Wang (2006), Hu and Kao (2007), and Honma and Hu (2008) is:

$$\mathrm{TFEE}_{(i,t)} = \text{Target Energy Input}_{(i,t)} / \text{Actual Energy Input}_{(i,t)} \tag{2}$$

for the ith region in the tth year. Note that the value of TFEE is always between 0 and 1. The higher the TFEE is, the higher the total-factor energy efficiency will be.

The data sources are the Taiwan Statistical Data Book (Council for Economic Planning and Development, 2008), Taipower Company, Bureau of Energy, and Directorate General of Budget, Accounting and Statistics of the Executive Yuan in Taiwan. Taipower Company has complete statistics for the electricity consumption of each administrative region in Taiwan. Moreover, there are two categories in accordance with two different fare rates in Taipower Company's statistics, called "the electric lamp" and "the electric power," respectively. The electric lamp fare rate applies to household and commercial sectors, whereas the electric power fare rate applies to industries. Therefore, the regional amount of the electric lamp consumption is used to measure the household and commercial electricity consumption and the regional amount of the electric power consumption is used to measure the industrial electricity consumption. All nominal variables are transformed into real variables at the 1999 price level by Taiwan's GDP deflators. The data are annual from 1999–2005. Table 1 shows the summary statistics of all inputs and the output. Table 2 shows that all inputs have positive correlation coefficients with the output, indicating that the isotonicity property (the output does not decrease with an increase in any input) is satisfied.

3. Empirical Findings

The empirical findings are shown in Tables 3–6. Generally speaking, most of Taiwan's 23 administrative regions are not efficient in the use of household and commercial electricity,

Table 1
Descriptive statistics of variables

Variable	Mean	Standard deviation	Minimum	Maximum	Unit
Total real income (y)	343,788.0	377,836.6	20,254.6	1,595,579.3	Constant 1999 NTD in millions
Real local government expenditure (x_1)	32,531.6	35,510.9	1,903.3	264,267.3	Constant 1999 NTD in millions
Employment (x_2)	416,223.6	352,763.4	31,000	166,400	Persons
Solid waste (x_3)	297,293.6	272,100.1	26,305.6	1,379,137.9	Tons
Household and commercial electricity consumption (x_4)	2,133,636.4	2,136,725.1	142,877.6	10,368,362.8	Kilowatt hours
Industrial electricity consumption (x_5)	89,305.0	58,106.8	8,014.7	263,401.7	Kilowatt hours
Gasoline sales (x_6)	426,139.9	340,890.9	16,102	1,559,655	Thousand liters
Diesel sales (x_7)	141,300.8	100,781.5	3,189	482,469	Thousand liters

Table 2
Correlation coefficients of the output and inputs

	y	x_1	x_2	x_3	x_4	x_5	x_6	x_7
y	1.000							
x_1	0.827	1.000						
x_2	0.950	0.715	1.000					
x_3	0.901	0.637	0.955	1.000				
x_4	0.971	0.739	0.980	0.918	1.000			
x_5	0.846	0.657	0.928	0.853	0.886	1.000		
x_6	0.899	0.646	0.964	0.905	0.946	0.923	1.000	
x_7	0.440	0.228	0.635	0.581	0.545	0.718	0.751	1.000

industrial electricity, gasoline, and diesel, even with respect to Taiwan's own efficiency frontier.

From Tables 3–6, we can find that cities are more energy efficient than countries in Taiwan. For example, Taipei City and Taichung City are the best performers with TFEE of 1 of all kinds of energy inputs over the study period. Taipei City is the biggest city in Taiwan with most of the public and business service activities. Taichung City is the biggest city in Taiwan's central area. Their high energy efficiency indicates that these two cities create more value added by using the same resources and energy inputs.

Table 3 shows that, generally speaking, the counties in Taiwan's south, central, and east areas can save more than 20% of their household and commercial electricity consumption on average. For the efficiency of household and commercial electricity use, Taipei City and Taichung City are on the frontier among all regions with TFEE scores of 1. Chiayi City and Tainan City, two cities in south area with higher average temperature, have lower energy efficiency compared to the cities in north and central

Table 3
1999–2005 TFEE in household and commercial electricity for regions in Taiwan

Region	ID	Area	1999	2000	2001	2002	2003	2004	2005	Average
Taipei County	1	N	0.784	1.000	1.000	1.000	1.000	1.000	1.000	0.969
Yilan County	2	E	0.883	0.912	0.810	0.725	0.796	0.717	0.805	0.807
Taoyuan County	3	N	0.824	1.000	1.000	0.957	1.000	0.923	1.000	0.958
Hsinchu County	4	N	0.919	1.000	0.917	0.907	0.936	0.863	0.962	0.929
Miaoli County	5	C	0.763	0.791	0.796	0.742	0.745	0.695	0.706	0.748
Taichung County	6	C	0.756	0.841	0.659	0.803	0.794	0.675	0.762	0.756
Changhua County	7	C	0.618	0.777	0.666	0.779	0.809	0.675	0.752	0.725
Nantou County	8	C	0.942	0.838	0.769	0.743	0.744	0.785	0.809	0.804
Yunlin County	9	S	0.751	0.752	0.814	0.732	0.707	0.686	0.645	0.727
Chiayi County	10	S	0.735	0.845	0.775	0.664	0.683	0.708	0.737	0.735
Tainan County	11	S	0.752	0.863	0.810	0.763	0.872	0.726	0.741	0.789
Kaohsiung County	12	S	0.727	0.883	0.799	0.802	0.804	0.705	0.827	0.793
Pingtung County	13	S	0.712	0.815	0.766	0.794	0.801	0.670	0.782	0.763
Taitung County	14	E	0.753	0.791	0.742	0.732	0.701	0.711	0.672	0.729
Hualien County	15	E	0.779	0.876	0.832	0.723	0.739	0.718	0.653	0.760
Penghu County	16	S	0.669	0.734	0.661	0.651	0.627	0.726	0.651	0.674
Keelung City	17	N	0.954	0.995	0.881	0.819	0.821	1.000	0.936	0.915
Hisnchu City	18	N	0.934	1.000	1.000	0.941	1.000	0.923	0.969	0.967
Taichung City	19	C	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Chiayi City	20	S	0.673	0.763	0.758	0.785	0.761	0.598	0.797	0.733
Tainan City	21	S	0.271	1.000	1.000	0.852	0.876	0.738	0.789	0.789
Taipei City	22	N	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Kaohsiung City	23	S	0.967	0.960	0.973	0.863	0.902	0.916	0.956	0.934

Note: N = North area, C = Central area, S = South area, E = East area. Shade highlights efficiency score of 1.

areas. Nevertheless, Kaohsiung City, the biggest city in the south area, has a relatively higher average energy efficiency score of 0.934. These results indicate that improving household and commercial electricity energy efficiency is a priority for Taiwan's non-metropolitan regions, especially in the south area.

Table 4 shows that Taipei County, Taoyuan County, Hisnchu City, Taichung City, and Taipei City have TFEE scores higher than 83.9%. The energy-intensive industries account for smaller proportions of industries in these five regions. Hsinchu County and Taichung County have TFEE scores of 0.523 and 0.544, respectively. These two counties are characterized by concentrations of manufacturing and high-tech industries. These results indicate that industrial regions may improve efficiency in electricity for industrial use by changing their industrial structures, introducing energy-saving manufacturing process and technology, using alternative energy source such as renewable energy, etc. The estimation results show that the industrial electricity of Chiayi County, Penghu County, and Hualien County can be saved the most, up to 72.1%, 71.2% and 70.5% on average, respectively. These three counties are characterized by agriculture and tourism with less manufacturing activities.

From Tables 3 and 4, we can find that Taiwan's regions on average have higher efficiency in household and commercial electricity use than in industrial electricity use. An explanation is that the industry sector has weaker motivation to improve its energy efficiency because the price of electricity in industrial use is lower than in household consumption. For energy efficiency in Taiwan's industrial electricity use there is still

Table 4
1999–2005 TFEE in industrial electricity for regions in Taiwan

Region	ID	Area	1999	2000	2001	2002	2003	2004	2005	Average
Taipei County	1	N	0.840	1.000	1.000	1.000	1.000	1.000	1.000	0.977
Yilan County	2	E	0.450	0.647	0.537	0.363	0.427	0.358	0.391	0.453
Taoyuan County	3	N	0.627	1.000	1.000	0.715	1.000	0.923	1.000	0.895
Hsinchu County	4	N	0.373	1.000	0.520	0.388	0.490	0.450	0.439	0.523
Miaoli County	5	C	0.312	0.603	0.404	0.300	0.310	0.333	0.276	0.363
Taichung County	6	C	0.509	0.639	0.520	0.498	0.550	0.600	0.493	0.544
Changhua County	7	C	0.461	0.738	0.646	0.535	0.755	0.675	0.473	0.612
Nantou County	8	C	0.473	0.548	0.393	0.372	0.351	0.368	0.366	0.410
Yunlin County	9	S	0.309	0.496	0.448	0.284	0.296	0.299	0.248	0.340
Chiayi County	10	S	0.248	0.505	0.303	0.222	0.223	0.224	0.228	0.279
Tainan County	11	S	0.261	0.552	0.374	0.266	0.398	0.382	0.246	0.354
Kaohsiung County	12	S	0.290	0.427	0.392	0.323	0.428	0.473	0.332	0.381
Pingtung County	13	S	0.407	0.695	0.577	0.431	0.511	0.507	0.412	0.506
Taitung County	14	E	0.355	0.545	0.327	0.318	0.296	0.281	0.247	0.339
Hualien County	15	E	0.278	0.482	0.345	0.258	0.251	0.239	0.214	0.295
Penghu County	16	S	0.325	0.344	0.302	0.288	0.238	0.274	0.244	0.288
Keelung City	17	N	0.474	0.432	0.414	0.362	0.391	1.000	0.412	0.498
Hisnchu City	18	N	0.664	1.000	1.000	0.687	1.000	0.845	0.681	0.839
Taichung City	19	C	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Chiayi City	20	S	0.374	0.591	0.588	0.429	0.529	0.442	0.418	0.482
Tainan City	21	S	0.485	1.000	1.000	0.525	0.548	0.633	0.494	0.669
Taipei City	22	N	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Kaohsiung City	23	S	0.686	0.934	0.741	0.636	0.647	0.642	0.663	0.707

Note: N = North area, C = Central area, S = South area, E = East area. Shade highlights efficiency score of 1.

room for improvement by means of cleaner production, energy-saving technology and equipment, etc.

Table 5 indicates that Nantou County has the lowest gasoline efficiency, an average of about 38.6%. Chiayi County, Taitung County, and Miaoli County also have much to save for gasoline consumption, up to more than 50% on average. Since these regions are where motor vehicles are needed for long-distance movement with incomplete public transit infrastructure, motor vehicle energy efficiency should be the key factor for saving gasoline. Only four regions, including Taipei County, Taoyuan County, Taichung City, and Taipei City have TFEE scores of 1 in 2005; all other gasoline use efficiency for the 19 regions are lower than 76% in the same year. The major cause may be the low gasoline price policy in Taiwan. Therefore, improving gasoline use efficiency is a priority issue for Taiwan's local administrations for all regions. Policies such as retiring inefficient, old motor vehicles, encouraging energy-saving vehicle models, and promoting public transit systems should be more actively supported in order to reduce gasoline consumption.

As Table 6 shows, Taiwan's cities are more diesel-efficient than the counties. Yilan County, Miaoli County, Nantou County, Chiayi County, Taitung County, and Hualien County can improve their diesel use more than 86.3% on average. These counties are dominated by agriculture activities. Diesel machines are used for farm activities and diesel trucks for long-distance hauling in these regions. Energy efficiency of farming machines and trucks should be continuously improved, especially for Taiwan's rural regions.

Table 5
1999–2005 TFEE in gasoline sales for regions in Taiwan

Region	ID	Area	1999	2000	2001	2002	2003	2004	2005	Average
Taipei County	1	N	0.766	1.000	1.000	1.000	1.000	1.000	1.000	0.967
Yilan County	2	E	0.630	0.912	0.810	0.486	0.575	0.478	0.516	0.630
Taoyuan County	3	N	0.534	1.000	1.000	0.573	1.000	0.576	1.000	0.812
Hsinchu County	4	N	0.388	1.000	0.577	0.409	0.533	0.383	0.430	0.531
Miaoli County	5	C	0.422	0.791	0.549	0.384	0.405	0.378	0.351	0.468
Taichung County	6	C	0.598	0.841	0.601	0.615	0.794	0.556	0.762	0.681
Changhua County	7	C	0.412	0.777	0.663	0.517	0.796	0.481	0.506	0.593
Nantou County	8	C	0.462	0.547	0.366	0.344	0.309	0.339	0.335	0.386
Yunlin County	9	S	0.450	0.752	0.743	0.450	0.509	0.402	0.339	0.521
Chiayi County	10	S	0.414	0.845	0.521	0.320	0.314	0.327	0.330	0.439
Tainan County	11	S	0.384	0.863	0.618	0.374	0.623	0.386	0.350	0.514
Kaohsiung County	12	S	0.507	0.883	0.799	0.565	0.804	0.530	0.579	0.667
Pingtung County	13	S	0.480	0.815	0.741	0.493	0.597	0.421	0.452	0.571
Taitung County	14	E	0.471	0.720	0.427	0.414	0.402	0.415	0.375	0.461
Hualien County	15	E	0.502	0.876	0.622	0.436	0.430	0.442	0.391	0.529
Penghu County	16	S	0.742	0.799	0.686	0.690	0.878	0.780	0.678	0.750
Keelung City	17	N	0.755	0.995	0.808	0.667	0.673	1.000	0.610	0.787
Hisnchu City	18	N	0.734	1.000	1.000	0.642	1.000	0.634	0.649	0.809
Taichung City	19	C	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Chiayi City	20	S	0.436	0.663	0.725	0.526	0.699	0.434	0.532	0.574
Tainan City	21	S	0.756	1.000	1.000	0.763	0.802	0.639	0.680	0.806
Taipei City	22	N	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Kaohsiung City	23	S	0.665	0.920	0.746	0.592	0.622	0.638	0.643	0.689

Note: N = North area, C = Central area, S = South area, E = East area. Shade highlights efficiency score of 1.

4. Conclusions

This study employs the DEA approach to compute the total-factor efficiency indicators for 23 administrative regions in Taiwan from 1999 to 2005. We find that, in general, Taiwan's cities are more energy-efficient than counties. For household and commercial electricity consumption, the regions in north area are more efficient than others. The efficiency in industrial electricity use has much room to improve, especially in energy-intensive industries. Improving efficient gasoline use is a priority for Taiwan's local administratiors of all regions. Energy efficient diesel use is an important issue for rural regions.

Taiwan held national energy councils in 1998, 2005, and 2009. While the topic of efficient energy use was addressed in these three councils, our empirical results reveal a worsening trend in Taiwan's energy efficiency over the period of 1999–2005. Taiwan being an economy relying mostly on imported energy should affect the energy efficiency issue seriously, and more public efforts and better policy coordination are necessary.

To achieve better policy outcomes in improving energy efficiency, administrative regions with lower energy efficiency should receive more attention, and policies should focus on the areas of energy use with poor energy-saving performance in these regions. Based on the empirical findings, we have come up with the following energy efficiency policy suggestions:

1. It is a priority for non-metropolitan regions to improve the efficiency of electricity and petroleum consumption. For these regions, green buildings and energy-saving

Table 6
1999–2005 TFEE in diesel sales for regions in Taiwan

Region	ID	Area	1999	2000	2001	2002	2003	2004	2005	Average
Taipei County	1	N	0.235	1.000	1.000	1.000	1.000	1.000	1.000	0.891
Yilan County	2	E	0.063	0.328	0.282	0.076	0.085	0.056	0.069	0.137
Taoyuan County	3	N	0.131	1.000	1.000	0.265	1.000	0.326	1.000	0.675
Hsinchu County	4	N	0.054	1.000	0.249	0.110	0.180	0.132	0.136	0.266
Miaoli County	5	C	0.040	0.443	0.153	0.061	0.066	0.111	0.052	0.132
Taichung County	6	C	0.127	0.579	0.249	0.251	0.616	0.364	0.587	0.396
Changhua County	7	C	0.060	0.561	0.358	0.207	0.481	0.298	0.244	0.316
Nantou County	8	C	0.074	0.265	0.057	0.058	0.054	0.069	0.061	0.091
Yunlin County	9	S	0.045	0.383	0.323	0.125	0.132	0.092	0.051	0.164
Chiayi County	10	S	0.047	0.537	0.154	0.047	0.043	0.050	0.050	0.132
Tainan County	11	S	0.054	0.812	0.397	0.121	0.297	0.226	0.128	0.291
Kaohsiung County	12	S	0.077	0.639	0.587	0.249	0.558	0.361	0.253	0.389
Pingtung County	13	S	0.105	0.729	0.601	0.211	0.276	0.285	0.206	0.345
Taitung County	14	E	0.056	0.384	0.056	0.055	0.051	0.058	0.059	0.103
Hualien County	15	E	0.041	0.319	0.113	0.051	0.044	0.050	0.044	0.094
Penghu County	16	S	0.315	0.324	0.242	0.269	0.214	0.213	0.148	0.246
Keelung City	17	N	0.092	0.326	0.199	0.120	0.151	1.000	0.122	0.287
Hisnchu City	18	N	0.354	1.000	1.000	0.492	1.000	0.613	0.654	0.731
Taichung City	19	C	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Chiayi City	20	S	0.096	0.434	0.551	0.287	0.443	0.327	0.325	0.352
Tainan City	21	S	0.628	1.000	1.000	0.833	0.918	0.807	0.719	0.844
Taipei City	22	N	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Kaohsiung City	23	S	0.192	0.960	0.358	0.169	0.142	0.159	0.153	0.305

Note: N = North area, C = Central area, S = South area, E = East area. Shade highlights efficiency score of 1.

facilities should be encouraged. Energy-demand management for residential community and industry manufacturing should be developed. Effective education for energy saving in schools, communities, and businesses is necessary. Restructuring the industry is an alternative policy to improve energy efficiency.

2. It is a priority for regions where manufacturing and high-tech industries concentrate to achieve more efficient use of industrial electricity. Firms should be encouraged with incentive measures and administrative schemes to engage in cleaner production and adopt energy-conserving technology and equipment. The industrial sector can be restructured towards a high value-added and low energy-intensive structure.
3. It is a priority for all regions to improve motor vehicle energy efficiency in order to improve gasoline efficiency. Both the central and local governments should put more effort into retiring inefficient, old motor vehicles, encouraging energy-saving vehicle models, providing convenient mass transportation systems to reduce the usage of private vehicles, and building the user-oriented and green-oriented municipal transportation environment.
4. It is a priority for rural regions to improve diesel use efficiency. Energy efficiency of farming machines and diesel trucks should be continuously improved, especially for these regions. The local administratiors of these regions should encourage upgrades to hybrid energy systems by using financial incentives such as tax reductions and subsidies.

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