A Study of Electricity Tariff Policy for Promoting Energy Conservation and Renewable Energy Development

By the Electricity Tariff Policy Taskforce

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Executive Summary

Ever since reform and opening to the outside world, China's electricity tariff policy has, on the whole, met the requirements of national economic and social development, attracted investments in conventional power generation, highlighted energy conservation, and boosted support for renewable energy. The existing tariff policy, however, cannot avoid the supply and demand imbalance in conventional energy based power generation. Also, it does not have well-defined measures to regulate short-term supply and fails to single out energy conservation as the core objective. Up to now, there hasn't formed a systematic policy framework in support of renewable energy based power generation. Therefore, there is still necessity and scope for further readjustment and refinement.

The electricity tariff policy framework for sustainable development mainly includes:

1. The guiding principle of accommodating the sustainability of energy and national economic competitiveness

The Chinese economic and social development has entered the phase of mass energy consumption. Given the scarcity of energy on our own and the growing complexity of international politics and economic environments centered on energy, we must highlight energy, and support renewable energy. Only this way can we realize the sustainability of energy consumption.

On the other hand, however, promoting energy conservation is not tantamount to say the fewer the highly energy consuming industries the better. Renewable energy development does not mean the more the better, let alone "an all-front rush out". "Energy waste" and "energy consuming economy" are two different issues. The former refers to low energy utilization efficiency that can be measured in such indices as "unit product energy consumption". The latter refers to an economic structure that needs to be bolstered by more energy consumption and measured in such indices as "unit GDP energy consumption". Therefore, while alluding to energy waste and the extent of waste in China, it is fine to use “unit product energy consumption” to make international comparison, but it is inadvisable to leverage the difference of “unit GDP energy consumption” between China and developed Euro-American economies to make case. The difference of “unit GDP energy consumption” between China and developed Euro-American economies can be used only to prove our economic structure is more energy consuming than theirs, no more no less. First of all, the highly energy consuming economic structure in China is ascribed to our low technological level and poor labor force quality. For an economic structure like USA dominated by high-tech and service industries, the unit GDP energy consumption is low indeed. But do we have that capability? Secondly, our economic growth is primarily driven by FDI and foreign trade in the present phase. The impressive performance of FDI and foreign trade is directly related to the low-end labor resources that are ample in supply and cheap in price. However, foreign investments and export products are concentrated in the manufacturing industry that unavoidably raises the “unit GDP energy consumption” in China. Therefore, the highly energy consuming economic structure in China is, generally speaking, an outcome of natural selection in the current condition of international division of labor, and has its own historical necessity.

Therefore, the current electricity tariff policy in China must promote energy conservation, support renewable energy, and make energy consumption sustainable. Moreover, it also must pay equal attention to the sustainability of national economic competency. It is imperative to respect the historical necessity of forming a highly energy consuming economic structure in China in the present phase, and it is inadvisable to pursue unit GDP energy consumption minimization in a blind manner.

2. Overall consumer tariff level timely reflecting changes in electricity cost and demand

In the past two years, the overall consumer tariff increase has been lagging behind the magnitude of fuel price rise and demand upsurge without inhibiting the overall demand as expected primarily because i) the National Development and Reform Commission sets a tight ceiling on price hike across all localities for fear of sparking excess inflation, and ii) the related rules are defective as to when to adjust tariff and how to determine the extent of adjustment.

(1) *It is imperative to overturn the traditional concept of keeping the overall consumer tariff level relatively stable*. From the perspective of minimizing social and transactional costs, the overall consumer tariff level should be kept relatively stable instead of making frequent readjustments given the lack of marked changes in electricity cost and demand. In light of the fuel price spike and demand upsurge in the past two years, the overall tariff level must be adjusted on a timely basis. If we still pursue tariff stability at this time, the inevitable upshot is to cause a relative contraction in short-term supply, a more burgeoning market demand, a further decline in power supply reliability, and an increased instability in the overall power system. Additionally, macroeconomic instability reflects the problem of total economic volume relationship, while the electricity tariff policy is intended to resolve local imbalance. Even with electricity tariff frozen, it is still unlikely to suppress the inflationary momentum. The primary reason for investment control especially since last year is related to the existence of resource constraint as indicated by the insufficient supply of coal, electricity and oil. If the overall electricity tariff level has to be kept stable in such a circumstance, it does a disservice to effectively stimulating energy supply and suppressing irrational energy demand. The current practice goes against the macro-control objective! Evidently, we have to follow the dialectic method instead of mechanical tariff suppression even if the electricity tariff policy is required to dovetail with macro-control. It is advisable to inhibit demand and relieve resource constraint by means of raising electricity tariff.

(2) Establishing and refining the regulatory rules and methods for timely tariff adjustment. At present, the key breakthrough of resolving the practical operability difficulty is to make a pertinent revision of the coal and electricity tariff linkage magnitude. According to the prevailing “Coal and Electricity Tariff Linkage Proposal”, the power generation enterprises shall absorb 30% of coal price increase. The regulation works if coal price rises by 8% or 10% in the short term (i.e., 1 year). How could the power generation enterprises absorb 30% of price hike given a magnitude of 20%, 30% or several sessions of 8% price increase in a row? This is exactly what coal price has been moving since last year. The electricity tariff regulatory authority has unavoidably been trapped in a dilemma. This is one of the major reasons why electricity tariff rose by the largest magnitude while criticisms abounded last year.

Our recommendation for amendment is called: "**keeping road and bridge separate with disparate functionality**". *The so-called "road" refers to the normal requirement by the regulator for the regulated enterprises to "constantly raise efficiency*. This requirement has been met through the generally adopted practices of adding an efficiency coefficient in the tariff adjustment formula in foreign countries (for example, X in the British price adjustment formula "RPI-X" is called an efficiency factor). Currently, the Chinese government only adopts an electricity pricing formula yet without any electricity tariff adjustment formula in place, and the rules await refinement. To regulate and legislate electricity tariff adjustment, it is recommended to formulate a tariff adjustment formula as early as it may. In our prospective tariff adjustment formula, we should also follow the generally adopted international approach to set an "efficiency increase coefficient" or "cost decrease coefficient", and it is advisable to resolve the general cost increase that enterprises are required to absorb through this "road".

The so-called "bridge" is a solution to special (ad hoc) cost increase. The cost increase after offsetting/deducting "the rate of efficiency increase" or "the rate of cost reduction" (mainly referring to significant fuel price hike for thermal power generators) in the tariff adjustment formula can be considered a special cost increase. Such special cost increase is a price the society must pay to maintain the existing size of energy consumption. It is imperative to keep consumers aware of the extent of energy scarcity. Therefore, any such cost increase shall be completely passed through to electricity tariffs.

3. Establishing a consumer tariff structure compatible with power supply cost

The so-called consumer tariff structure refers to the unit price differential and proportional relationship between consumers as a result of the difference in the manner, time, and voltage of power usage etc. The unit price differential and proportional relationship between consumers arises from the different requirements by the manner, time, and voltage of power usage for the power system. Therefore, the rationality of an electricity tariff structure directly dictates whether a reasonable power consumption structure can be formed. Furthermore, it not only has a bearing on energy conservation performance, but also affects a series of resource allocation efficiencies. Consequently, the sustainable development tariff policy structure must include “establishing a consumer tariff structure compatible with the power supply costs so incurred”. Proceeding from the actual circumstances of China at the present stage, we should get the following work well done so as to fulfill this mission:

(1) *Reclassifying consumers and adjusting their price differentials*. In general, the present consumer classification and price relationship is still out of step with actual power supply costs although they are adjusted to different extents in all localities, resulting in excess “cross subsidization”. For example, cross subsidization is obviously reflected in the virtually indifference of tariff between residential and industrial consumers. In addition, commercial consumers are charged the highest tariff, which is more than 70% above the average rate. Apparently, this deviates from the actual costs incurred by consumers on the power system. Therefore, we should reclassify consumers based on the voltage level and user load characteristics. Especially in the several power shortage areas, it is advised to seize the opportunity to raise residential tariff and completely resolve the issue of excess cross-subsidization between residential and other consumers.

(2) Improving the time-of-day tariff structure. China has completely implemented the peak/valley tariff system from 2003, and the system should be improved as follows at the present stage:

- Further expanding the scope in which the peak/valley tariff system is implemented;
- Adjusting time-of-day price differentials according to the “unique circumstances of each locality”;
- Implementing “seasonable tariffs” in the areas with strong load seasonality;
- Encouraging the use of “peak tariff”;
- Completely implementing “high water/low water tariffs” in the hydropower dominated areas.

4. Internalizing external costs

Power generation consumes approximately 50% of total national coal production in China, and coal fired power plants emit 56% of industrial SO_2. As estimated by experts, the cost of desulfurization is approximately RMB 0.88—2.8/kg for installing flue gas desulfurization units in 300 MW coal fired units, based on the actual sulfur content of coal for power generation. The state levied SO_2 emission charges, however, are merely RMB 0.21--0.63/kg. Therefore, the environmental costs are far from being included in the accounting costs of power generation enterprises. As a result, the power generation enterprises are mostly reluctant to install desulfurization units, and some units, even if installed, are left idle. To fundamentally hold back the exacerbating momentum of thermal power generation polluting environments, we must resolutely adopt measures of internalizing external costs.

(1) *Significantly increasing emission charge rates*. To fundamentally solve the emission and acid rain problems in China, the SO_2 emission charging rate should be set at a level in excess of the costs incurred by enterprises to reach the governmental control target. As calculated, the emission SO_2 charging rate should be raised 4~10 times, that is, to RMB 1—2.8/kg. China boasts of a huge territory with marked differences between areas in weather, population density and cultural relics distribution etc. With a significant difference in the extent of SO_2 hazard come different SO_2 emission control targets in different localities. For example, a relatively high charging rate should be imposed in populous east China and humid yet acid rain plagued southwest China. The SO_2 emission charging rate can be set lower in Inner Mongolia, Xinjiang and some northern coastal areas with sparse population and dry weather so as to promote the rational distribution of power structure.

(2) Power grid tariff must cover the reasonable costs of desulfurization. While significantly raising emission charging rates, the associated policies should be in place to allow enterprises to recover through normal channels their costs of installing and operating desulfurization units so as to encourage their additional investments in environmental protection. In the current stage when the grid tariff is set by government, the power grid tariff should cover the reasonable costs of desulfurization. The National Development and Reform Commission has recently released the 1.5 *fen*/kWh uniform desulfurization cost recovery rate in China. This rate is appropriate for newly built turbo-generators but insufficient to compensate for old generators. Old generator refurbishing, however, is a key measure to reduce SO_2 pollution. To this end, we recommend setting a separate rate appropriate for old generators based on the higher costs of old generator refurbishing, and allow for appropriate elasticity in implementation.

5. Gradually introducing competitive mechanism

The market mechanism is the most effective means of saving resources in any competitive arena. Based on the international practices and experiences in electric power market operation, the competitive pressure from "unilateral" or "bilateral" trade compels power generation enterprises to employ all available means to minimize fuel consumption and directly benefit energy conservation. If the "bilateral" trade system is adopted, a demand factor can be incorporated into the tariff formation mechanism to generate a more evident effect in energy conservation. Moreover, the Chinese power industry has basically separated power plants from grids. Without introducing a competitive mechanism, it will increase transactional costs while frustrating the effort to optimize resource allocation. Therefore, we must introduce the competitive mechanism, and employ the market mechanism to achieve the sustainable economic and social development. The following near-term measures are advanced for consideration:

(1) Speeding up the "large account user direct purchase" trial endeavor. At present, Jilin Carbon Factory is the only large account enterprise approved by the National Development and Reform Commission and the State Electricity Regulatory Commission for direct power purchase. In the future, all the large account consumers around any big energy base should be allowed to trade directly with power generation enterprises and thus minimize power transmission losses. According to the previous experiences of countries in electric power system restructuring, the supply of electricity from power generation enterprises to large account users pertains to the "bilateral" approach of electricity trade. In essence, power generation enterprises trade directly with large account power users most of which are power distribution and sales companies. Therefore, in piloting the "bilateral trade" in the power market, it should not be limited to the direct trade between power generation enterprises and large end-users. Instead, it should be targeting the direct supply from power generation enterprises to independent power supply companies for future development. These independent power supply companies may have many forms of ownership structure available to choose, extending from the joint venture between an existing provincial power company with other investors to the wholly owned private enterprises. The power supply operation can be entrusted to the provincial power

companies or undertaken by the independent power supply companies. The requirements for the load characteristics of users in a “direct purchase” area should be based on those for the high power usage rate enterprises. As for the “direct purchase” approach, the “direct purchase” through grids is preferred, without excluding private line “direct purchase”.

(2) Attaching top priority to designing an electric power market model in line with domestic situations. This round of electric power system restructuring is centered on introducing a competitive mechanism. The common international practice is first to determine electricity trade model and related rules, and then design the corresponding industry breakdown and corporate restructuring options. Once power plants and grids are completely separated, the power generation side or user side competitive market is set rolling immediately. Our practice is quite the opposite: over a year after “power plant/grid separation” (separation still incomplete, for example, the power grid companies still own a considerable size of conventional power generation capacity, and “core/supplementary operations” still not separated), the related decision-making authority is still researching and debating about the core reform issue of the basic electricity market form and distribution. In addition, given the vast expanse of China in territory, the power grid structure and electricity market must be regional. In consideration of the uneven regional social and economic development at the present stage, “competitive bidding” (a “unilateral” market method) may not apply in all areas as an approach to introduce competition into the power industry. Therefore, it is required to well design the electric power market model in line with the domestic situations before being able to actually solve the sustainable power development issue through the market mechanism in China.

6. Regulating and consolidating tariff based government funds

At the present stage, public funds are required to promote energy conservation (i.e., supply side management) and support renewable energy development. Raising such funds through tariff surcharges is in congruence with the principle of fairness and efficiency. In this respect, there are successful international experiences, and China has the experiences of operating the “Electric Power Construction Fund”, the “Three Gorges Fund” and the “Reservoir Area Immigration Support Fund”. These government funds based on tariff can be regulated and consolidated to lend a policy support to sustainable energy development. The scope of “regulation and consolidation” mainly includes:

(1) Fund made true to its name: Currently, there are many tariff based governmental funds raised for the public interests. To avoid consumer misunderstanding, these funds should be made true their name and uniformly called “Electricity Public Interest Fund”.

(2) Expanding the scope of application by increasing the expenditure items of energy conservation and renewable energy development.

(3) Funds changed from price inclusive to price exclusive. The current government funds are collected price inclusive, and included in the sales revenue of each power company in many localities, making it difficult to make regional transfer of payments, and doing a disservice to forming a “social sharing” mechanism. Such funds should be collected exclusive of price, and directly become governmental revenue.

(4) Funds borne by power consumers. The sources of money for promoting energy conservation and supporting renewable energy development are naturally the payments from power consumers. Power consumers, however, may have different responsibilities for fossil energy consumption if they consume power in a different manner. Consumers consume fossil energy primarily through the quantity of electricity consumed. However, higher electricity bill does not necessarily mean more electricity consumed. Therefore, from the perspective of fairness and energy conservation, the major “payers” should be the actual electricity output consumers instead of capacity consumers. Consequently, it is inadvisable to link governmental funds for supporting energy conservation and renewable energy development to total electricity charges. Instead, such funds should be levied on a unit basis.

(5) Adopting a two-tier central and provincial fund sharing mechanism. Based on the central and provincial renewable energy development programs; the funds within the scope of central strategic planning and subject to approval by central government, should be shared nationwide; for funds under local planning and subject to approval by local government, the amount of funds under the “target price” should be shared

nationwide while the amount above the “target price” should be shared in the localities; we recommend setting up central and provincial escrow treasury accounts; keeping “revenue and expenditure separate”; the energy regulatory authority consults the electricity tariff regulatory counterpart in reviewing fund approval, determining the funds allocation proposal, and make disbursement after review by the treasury department.

7. Establishing standardized renewable energy based electricity tariff administrative measures

Given the vast expanse of territory in China, and the substantial difference across regions in the reserve of and demand for resources, there should be a reasonable price differential for electric power generated in different regions using different kind of renewable energy. The question is how to set a reasonable price differential. If government still regulates the tariff of electricity to power grids, we recommend:

1). Setting a price differential for electricity generated from different kinds of renewable energy based on normal cost differences. Normal costs shall be determined with the technology recognized by the project regulatory authority as a precondition and considering: universal equipment purchase price; uniform equipment installation standards; uniform per capita salary level; and uniform financial expense and ROI standards.

2). The principle of public fund efficiency maximization should be observed in setting a regional price differential for electricity generated from renewable energy. According to the requirements of the Law of Renewable Energy, the governmental authorities concerned are considering setting the base price of electricity from renewable energy per regions. Most renewable energy based power plants are connected to the standalone local power grid or low voltage distribution grid because they are mostly small in scale. If the central government directly sets the base price for electricity generated from renewable energy, information support is absent, workload is excessive, and it deviates from the hierarchical tariff management system currently in use. Therefore, it is advisable to consider that the central government only prescribes a uniform standard for the price differential between renewable energy generated electricity and conventional energy generated electricity. On the basis of the uniform standard, the local electricity tariff regulatory authorities can decide on the specific base price for electricity generated from renewable energy in their respective localities.

8. Granting local governments with considerable latitude to raise DSM short-term funds

The demand side administration is in dire need of funds support. In the near term, however, the central government does not have any policy to make a stable channel of funds. To prevent its demise halfway, the local government should be empowered with considerable latitude to raise DSM short-term funds. For example, in the areas where peak tariff is set, the revenue so increased by the power grid company can be used to support demand side administration.

Master Report

A Study of Electricity Tariff Policy for Promoting Energy Conservation and Renewable Energy Development

The Chinese government has always been promoting energy conservation and renewable energy development. With energy shortage exacerbating from 2002, the Chinese government has time and again paid due attention to energy conservation and renewable energy development. Through a review of the track record of energy conservation and renewable energy development in China, it is evident that we have never been able to achieve the government planned and public expected objectives for the mission in spite of significant accomplishments already made. To make a complete turnaround from the unsatisfactory situation, it is imperative to align planned objectives with required measures, and provide the corresponding policy assurance. The government still regulates electricity tariff in a pervasive manner, especially at the present stage. In a market economy, however, price is the most effective regulatory mechanism. A rational tariff policy still plays the pivotal role in changing the excess consuming and heavy polluting pattern in our power generation and consumption, and promoting renewable energy development. To such an end, this report assumes sustainable development as its objective, elaborates on certain issues of understanding on electricity tariff policy formulation, and thereby makes a tariff policy framework design accordingly.

I. Existing Tariff Policy Review

Ever since reform and opening to the outside world, the Chinese electricity tariff system has always in the midst of restructuring, and the tariff policy has been gradually readjusted. To resolve the chronic power shortage issue, China has launched a series of policies and measures to stimulate supply, especially after 1985. In the past two years, more tariff policies and measures have been initiated in concert with the "Electricity System Restructuring Scheme" of the State Council. How about the performance of the existing policies? The correct evaluation of such policies will provide a basis for further improvement and perfection. Therefore, this paper hereby evaluates the performance of existing tariff policies from the perspectives of ensuring conventional energy generated power supply, promoting energy conservation, and supporting renewable energy based power generation.

(I) Existing Tariff Policies Versus Conventional Energy Generated Power Supply

1. The existing tariff policies provide an adequate stimulus for investments in conventional energy based power generation. The "debt service based tariff" is the most influential method of setting power grid tariff still in force. The "debt service tariff" not only allows investors to make money but also enables them to pay off the debt principals and interests within the term of loans (mostly within 10 years), and it is easy to gauge the return on investment in conventional energy based power generation. The "debt service based tariff" method deserves top credit in turning China from grave power shortage into power excess in a decade from 1985 to 1996. After 1998, the "operating period tariff" was initiated as an improvement of the "debt service based tariff". By the new tariff method, the debt service base period was extended, and investors could not recover investments in power stations just in several years, thereby putting an end to usurious profitability from conventional energy based power generation. As a result, the power grid tariff level has been dropping in areas where the "operating period tariff" method is adopted. The "operating period tariff" is still attractive enough because it allows investors to pay off their loans and garner a net income 2-3% higher than the long-term bank lending interest rate for equal maturity.

2. The existing tariff policies cannot avoid the supply and demand imbalance in conventional energy based power generation. How comes the power shortage situation from 2002 if the existing tariff policies are attractive enough for investments in conventional energy based power generation? In addition to the unexpected demand upsurge and the drought weather in south China (such factors beyond control), the principal system drawbacks are as follows:

(1) Electricity tariff policy inconsistent with investment project approval policy. China suffered an obvious power supply surplus in the four years of stagnation from 1998 to 2001, thereby resulting in the tight control on investment projects approval.

(2) The electricity tariff system out of sync with the existing electric power market

structure. At present, the Chinese electric power market structure features transmission and distribution integrated monopolistic operations, diversified power generations, and a competitive market landscape. The transmission and distribution integrated monopolistic market structure calls for stringent governmental control on price and investment. The power generation diversification entails a pivotal role of the market mechanism, and the independent investment/pricing authority of power generation enterprises. The competitive market structure, price and stringent/centralized investment control contradiction of the power generation industry will inevitably lead to power supply variation. As long as the above contradiction continues to exist, the supply and demand imbalance is unavoidable in the conventional energy based power generation sector. Statistics show that the power generation projects pending approval from the National Development and Reform Commission exceed 400 GW, and it is expected to repeat the erstwhile power supply excess situation in 2007.

3. The existing tariff policies do not have well defined measures of regulating short-term supply from conventional energy based power generation. The current power shortage is, in general, characterized by inadequate power generation capacity. Along with the rapid addition of new turbo-generators, power shortage will shift from capacity shortage to output shortage. In addition to reduced water flow from upstream for some hydropower stations, the output shortage is primarily due to the reluctance of coal producers to supply coal as required by power generators. For example, 80% of state coordinated power stations in Guizhou had less than 3 days of coal inventory in early 2005. The power stations were shut down or downsized for lack of coal have reached 3,000 MW, accounting for 38% of the state coordinated power generation capacity in Guizhou Province. The power generation decreased by 1,964 GW in January and February or 33,290 MW on a daily basis. While boosting the magnitude of planning power usage, the Guizhou Power Grid had been forced to take power control measures. In the past two months, there were 51 days under power control, and the maximum capacity shortage reached 2,736 MW. Under the utmost coordination of the Provincial Government, the power supply situation improved in the first half of March. The losses from shut down or production cut for lack of coal still reached 266 GW or 26,600 MW on a daily basis. Coal producers are reluctant to supply coal as required primarily because of the failure of both parties to reach an

agreement on coal price. Both parties failed to agree on coal price because the tariff does not allow for adequate coal price hike. Therefore, the short-term assurance mechanism is still imperfect even though the existing tariff policies are attractive enough to stimulate investment in conventional energy based power generation.

(II) Existing Tariff Policy Versus Energy Conservation

1. The existing tariff policy is tilted towards energy conservation. The most important means for the tariff policy to promote energy conservation is to align consumer's tariff with the costs thus incurred on the power system. The tariff level has been on a steady rise from 1985. By 2004, the average consumer tariff had risen 4.5 times from RMB 0.08/kWh to RMB 0.45/kWh, more than doubling the magnitude of inflation in the same period. The price hike has played a significant role in promoting rational electricity consumption. To mitigate power shortages, the government has, since last year, initiated a series of measures to further promote rational electricity consumption, for example, raising the endpoint tariff level, reclassifying users based on price hike, fully implementing peak/valley and time-of-day tariffs, adopting seasonal tariffs in some areas where seasonable demand is evident, setting peak/valley tariffs in areas where "peak/valley differentials" are prominent, and compensating users for avoiding peak hour consumption etc. Some of the above measures have made tangible effects. For example, the last four measures designed to raise system load efficiency, have basically achieved the expected targets. The effects of the first two measures, however, are still under observation.

2. The existing tariff policies have not singled out energy conservation as the core policy objective. In general, the Chinese tariff policy has been tilted to boosting power generation side supply capacity in most of time after reform and opening to the outside world. After the last two years of power shortage, the governmental authority has started to pay attention to the impact of price on demand and sustainable development. The urgent matter, however, is to stimulate investments in power generation, and the policy framework centered on sustainable development has yet to evolve. For example, the current power shortage has been shifting from capacity shortage to output shortage, and the problem cannot be solved only by means of "peak/valley tariffs". An overall tariff hike is the most principal means of inhibiting demand. The National Development and Reform Commission, however, has imposed

stringent control on endpoint tariff hike across all localities for fear of sparking excess inflation, and this is not enough to generate an obvious effect of suppressing power demand. In addition, the hydropower tariff in most areas is based on the single fixed output system, without any seasonal or time of day differences. Consequently, at the time of high water and low demand, hydropower stations do not discard water, while thermal power stations are still burning coal. .

(III) Existing Tariff Policy Versus Renewable Energy Based Power Generation

1. The Chinese tariff regulatory authority has been gradually boosting support of sustainable energy development. Only with the approval of the governmental price regulatory authority can renewable energy generated electricity be fed into the public power grids. The approval from the National Development and Reform Commission is required for feeding into provincial power grids, while the approval from provincial price regulatory authorities is required for feeding into municipal or county level independent power grids. The tariffs for small-sized hydropower stations are mostly regulated by local governments because such power stations are mostly connected into municipal/county level independent power grids. The tariffs for pubic funded wind power stations are mostly regulated by the National Development and Reform Commission because these power stations are mostly connected into provincial level power grids due to their experimental nature. The renewable energy generated power pricing method is consistent with conventional energy power generation tariff, that is, by means of “debt service based tariff” in the past and “operating period tariff” now. Additionally, the bidding system has been recently initiated in the wind power industry. Accordingly, several Greenfield wind power stations have adopted the bidding mechanism in supplying electric power to the grids. So far, all the renewable energy based power generation projects approved by the National Development and Reform Commission (or the former State Planning Commission) are subject to the “operating period tariff” or “debt service based tariff”, and the average tariff so determined is much higher than that for conventional energy. While the tariff recently determined through the bidding system for several wind power stations declines significantly, it is still RMB 0.5/kWh, which is 50% higher than the average power grid tariff.

2. Systematic policy framework has yet to evolve. It is proposed in the "Electricity Tariff Reform Scheme" approved by the State Council in 2003 that renewable energy (i.e., wind and geothermal heat) based power generation enterprises are exempted from participating in market competition for the time being. "When conditions are met", the "green certificate trade" method can be adopted as a solution. The problem involves the fledging market system, market underdevelopment, and weak legal foundation of China relative to developed market economies. The conditions for "green certificate trade" are unlikely to be met in the short run. The newly enacted "Renewable Energy Law" also includes such supportive measures as "mandatory quota" for renewable energy based power generation, "power grid tariff standards set by regions", and "the allocation of the cost differential between renewable energy and conventional energy" in the society as such etc. However, specific measures are to be worked out about how to determine and implement "mandatory quota", how to formulate power grid tariffs by regions, and how to allocate the cost differential between renewable energy and conventional energy" in the society as such.

In view of the above, the Chinese tariff reform has, in general, met the requirements of national economic and social development. With an emphasis on energy conservation, the existing tariff policy has been gradually boosting support to renewable energy. The existing tariff policy, however, cannot avoid the supply and demand imbalance in conventional energy based power generation, does not have perfect measures to regulate short-term supply, fails to single out energy conservation as the core objective, and has yet to form a systematic policy framework in support of renewable energy based power generation. Therefore, there is still necessity and scope for further readjustment and refinement.

II. The premise of understanding for shifting tariff policy objective to sustainable development

With energy shortage exacerbating and sustainable development highlighted, the Chinese government attaches an overriding importance to energy conservation and renewable energy development. As for the regulatory authority in charge of energy price, it is undoubtedly a matter of top priority to align the energy price policy with the core objective of sustainable development. Based on our observation, however, the industry experts still have differing opinions on certain key issues, and some basic concepts have yet to be clarified. This is to say, there are hurdles of understanding that remain to be cleared before the tariff policy can be actually shifted to the objective of sustainable development.

(I) The relationship of electricity consumption rationality to tariff rationality

1. What is electricity consumption rationalization?

Many people hold China to blame for the irrationality of its electricity consumption at the present time. So, what kind of electricity consumption is rational? By now, critics have yet to define the criteria of rationality. Therefore, any such criticisms and policy measures are apparently "off the mark". We believe the rationality of electricity consumption can be evaluated from the perspective of technical economy and economics.

(1) Technical criteria. Technical evaluation can proceed from both long-term criteria and short-term criteria. Long-term criteria shall mean the sustainability of consumption. Consumption can be considered sustainable if sufficient resources are available to maintain the expected level of electricity consumption. Under the current conditions, any judgment on the sustainability of China's electricity consumption scale and pattern etc. shall be made with reference not only to the resources available in China but also to the effects of global economic integration. Of course, it is also imperative to consider the constraints of international economic and political environments going forward while emphasizing the effect of global economic integration. Short-term criteria shall mean the security and reliability of the energy system. In the short run, however, the rationality of electricity consumption quantity and pattern shall judged on the basis of the security and reliability of the entire electricity system.

(2) Economic Criteria. By economic criteria, we mean optimal resource allocation. Given the finite quantity of resources, how much should be consumed? How should consume more or less? The criteria of judgment should be overall social benefit maximization. Specifically, it is to maximize the total value added from existing resources.

2. In the final analysis, electricity consumption rationality hinges on the congruence of price and cost

Technical economic criteria are relatively intuitive since they emphasize system reliability, while the economic criteria are relatively secondary because they stress the internal mechanism of consumption formation. How to assess the relationship of technical criteria to economics criteria?

Logically, both criteria are consistent under the market economic conditions. The optimal resource allocation is basically manifested as market equilibrium under the market economic conditions, and its material content is the overall electricity system security and reliability. This is consistent with the definition of technical criteria. The basis of market equilibrium is, however, the linkage of price to cost (including normal cost of capital or normal profitability). In reality, market demand always means the demand with purchasing power (affordable demand). Why do so many people consider fabulous technical innovations inapplicable? For example, solar energy cars, though free of pollution and with inexhaustible sources of energy, do not have any market demand in the real sense at the present time. Why? The major reason relates to the hefty costs of such vehicles that the society cannot afford to consume now. As a result, low cost products can be consumed more in the society, while high cost products should be consumed less or not consumed at all. Therefore, the costs of a product eventually dictate whether it should be consumed and how much shall be consumed. In this sense, price must be congruent with cost if it can actually play the role of optimizing resource allocation.

In reality, they are also inconsistent in certain respects. The inconsistency stems from the incompleteness of costs reflected in price to the society. That is, the price does not include the total value of natural resources consumed, or it does not contain the costs of environmental damage incurred to society. So, the external costs are internalized. If price not only reflects the recurrent internal costs of enterprises but also includes the external costs of environment and resource etc., that is, price reflects the social costs of products, consumption will eventually be adjusted to a reasonable level at which the society can afford to consume.

So, electricity consumption rationalization must rest on electricity price rationalization. The rational tariff, however, should be in line with cost. From the perspective of market economy, it is not difficult to balance electricity supply and demand as long as price really reflects the social costs of electricity.

(II) The relationship between tariff policy and macro-control

The electricity tariff policy has recently assumed more responsibilities. To achieve the inflation control target, the normal adjustment of overall electricity tariff is inhibited under the conditions of severe power shortage and coal price upsurge by 100%. The electricity tariff structure has also become a means of macro-control. For example, the "differential electricity tariff" policy for high energy consumption industries was initiated to dampen the pace of investment. Obviously, there still exists an understanding that equates energy price regulation, especially electricity tariff control to macro-control (or equating price policy to macroeconomic policy) in the course of policy formation in China. Therefore, in order to really achieve the adjustment of energy price policy towards the core objective of sustainable development, it is imperative to make it clear that energy price regulation and macro-control are two strikingly different governmental functions.

What is tariff regulation? Simply put, it is the restriction imposed by the regulator on the behavior of power utilities pursuant to certain rules. In foreign countries, the economics of regulation is specialized in the study of economic regulation. Based on disciplinary classification, the economics of regulation is incorporated into the category of microeconomics. Tariff regulation and macro-control differ at least in the following three respects:

(1) Different objects to which they apply：The objects of tariff regulation are one or more power utilities. In contrast, the objects of macro-control are the overall price level, economic growth rate, employment rate, and balance of payments that pertain to gross economic quantity.

(2) Different expected targets：The expected target of tariff regulation is to accommodate the interests of all parties between enterprises and consumers, between enterprises and enterprises, and between consumers and consumers to further promote

the efficiency and equity of production and consumption. The expected target of macro-control is the stability of the economy as such.

(3) Different means used：The tariff regulation is achieved mainly by means of setting rules and penalizing violations. The primary means of macro-control are monetary policy and financial policy.

The price regulatory function of government has long been incorporated into the category of governmental macro-control in China. This makes more sense in the era of planned economy because all goods and services were then priced by government. At that time, price did not change as long as government refrained from price adjustment. In addition, ownership was then highly concentrated, production was subjugated to directive plan, consumption was mainly quota-based, price had a limited effect of regulating micro-entities, and the economy as such was by no means divided into macro and micro sectors. As a result, the so-called regulatory mechanism did not have any discernible distinction between macro and micro sectors.

Now, it is different. One of the major objectives for economic restructuring is to let the market mechanism play a fundamental role in resource allocation in China. Through over two decades of market oriented reform, the commodities and services priced by government now accounts for less than 10% of GDP. The change of government set prices has a minimal impact on the price index. The overall price stability is ultimately subject to monetary and financial policies. What really matters in the requisite administrative macro-control means is rather investment approval than price control. Moreover, it has been proved through recent years of practice that even if governmental price adjustment does influence price index movement, such a movement is only statistically significant, and it will not exert any substantial impact on the direction of macro-economy. In 1997 when stagflation was raging, the price of such public utilities as water, gas, public traffic, education, medical care and public housing rental was raised consecutively across China. Despite the aggressive magnitude of price hike for some public utilities, the consumer price index remained modest, and stagflation continued to rage in that year.

With price regulation moved from the micro-category where it resides to the category of macro-control, the macroeconomic issues are left unresolved, and the market dislocation situation are exacerbated in the related industries, resulting in the further decline in the efficiency of resource allocation. For example, many countries used to freeze electricity tariff and oil price in a bid to hold down the price index. While different countries pursued different approaches, the result is the same: the price index remained out of control, energy supply became tighter, the resource constraint for total supply was by no means mitigated, and macro-economy turned out to be more instable.

(III) Efficiency and equity of tariff regulation

As indicated above, the issue of macroeconomic stability cannot be resolved by including tariff in the category of micro-regulation. The role of tariff regulation is to achieve efficiency and equity within its scope of responsibilities. What is the expected efficiency for tariff regulation? How to understand equity? We are of the opinion that the core thought or starting point either for efficiency or equity is sustainable social development.

1. Efficiency. A comprehensive understanding should include the following three aspects:

(1) Power utilities' efficiency. The tariff regulation should drive power utilities to further trim production costs, for example, saving investment, and reducing coal consumption.

(2) Power system's efficiency. The tariff regulation should help optimize the power generation structure and achieve highly efficient system operation so as to minimize the operating costs of the entire system. For example, during the high water season, the power grids should be compelled to place top priority on hydropower operation so as to reduce the coal consumption of coal-fired power stations. As for coal-fired power stations, low coal consumption units should take precedence over high coal consumption units.

(3) Power consumption efficiency. First of all, the electricity tariff should keep the overall quantity of power consumption at an appropriate level, that is, making the

society pay what the consumption deserves. Secondly, it should help form a rational consumption structure, and keep the tariffs of consumers in congruence with the costs they incurred on the power system based on their different power usage features and voltage levels. It should also let consumers choose the quantity of power consumption they deem worthwhile. The power consumption efficiency can be optimized by aligning consumers' power consumption with their judgment on electricity "performance/price ratio", thereby resulting in a reasonable industrial structure.

2. Equity. On the one hand, it should take care of the underprivileged group, or promote universal power services. On the other hand, it also includes the principle that obligates "the beneficiary to pay" or "those responsible to pay" for such costs. For example, the society is required to pay for the excess of renewable energy power generation costs over conventional energy power generation costs at the present stage, with a view to support renewable energy based power generation. Who should pay for the excess? From the principle that obligates "the beneficiary to pay" for it, the excess should apparently be covered by those who consume more conventional energy. It follows that i) the major sources of fund to support renewable energy should be the payment from power consumers rather than the treasury (state coffer); ii) if the power consumers "pay for it", the major contributors should be the "output" consumers rather than "capacity" consumers.

III. The tariff policy framework for promoting energy conservation and renewable energy development

(I) The guiding principle of taking an equal account of the sustainability of energy and the sustainability of state economic competitiveness

The so-called new era refers to the new historical period on which the Chinese energy supply and consumption have embarked, with the following prominent characteristics:

(1) China's economic and social development have entered the phase of massive energy consumption。In the recent couple of years, the electric power elasticity coefficient has risen from less than 1 to a constant level in excess of 1. The double-digit growth of coal, electric power and oil consumption is by no means haphazard: i) China has really stepped into the so-called heavy industrialization phase,

the hefty growth of manufacturing has become the driving force of rapid economic growth, while manufacturing is the most energy consuming industry; ii) China is now in the phase of garnering a per capita GDP in excess of USD 1000 (higher if adjusted per purchasing power parity), and the economic development history of developed economies shows that this is an important phase of spending increase whether for westerners or for oriental people. The spending upsurge in this phase is primarily manifested in the qualitative change in people's requirements for housing conditions and traffic means. Simply put, people demand bigger houses that are warm in winter and cool in summer, and wish to own cars. Big houses, air conditioners and various home appliances and cars all pertain to highly energy consuming goods.

(2) China's resource reserves are not sufficient to bolster the expected economic growth. China has not only changed from a net oil exporter to the second largest net oil importer, but its coal reserve once considered extremely abundant is now predicted to be unable to last 20 years at the current rate of consumption. Therefore, energy scarcity will become one of the major constraints for China's social and economic development on the ongoing basis.

(3) China has been merged into the process of global economic integration. China registered USD 1154.74 billion of import and export in 2004, with its dependence on foreign trade exceeding 70%. China has thus entered into the process of global economic integration regardless of people's subjective will. While exporting a large volume of manufactured products, it also imports raw materials and energy. This has become one of the basic features for China to participate in the international division of labor and sustain economic development. On the one hand, the channel of our energy supply has been greatly widened because we are no longer limited to domestic resources. On the hand, the degree of energy security for China has declined because of the complexity of international politics and economic relationship evolved around energy. Given the entry of our economic and social development into the phase of heavy energy consumption, the energy scarcity on our own, and the complicated international political and economic environments evolved around energy, it follows that we can sustain energy consumption only by promoting energy conservation, and supporting renewable energy. On the one hand, however, promoting energy conservation is not tantamount to saying the less high energy consuming industries

the better. Renewable energy development does not mean the more the better; let alone "an all-front rush out". It shall be noticed that "energy waste" and "energy consuming economy" are two different issues. The former refers to low energy utilization efficiency that can be measured in such indices as "unit product energy consumption". The latter refers to an economic structure that needs to be bolstered by more energy consumption and measured in such indices as "unit GDP energy consumption". Therefore, while alluding to energy waste and the extent of waste in China, it is fine to use "unit product energy consumption" to make international comparison, but it is inadvisable to leverage the difference of "unit GDP energy consumption" between China and developed Euro-American economies to make case.

The difference of "unit GDP energy consumption" between China and developed Euro-American economies can only be used only to prove our economic structure is more energy consuming than theirs, no more no less. First of all, the present highly energy consuming economic structure evolved in China was ascribed to our low technological level and labor force quality. For an economic structure like USA dominated by high-tech and service industries, the unit GDP energy consumption is low indeed. But do we have that capability? Secondly, our economic growth is primarily driven by FDI and foreign trade in the present phase. The impressive performance of FDI and foreign trade is directly related to the low-end labor resources that are ample in supply and cheap in price. However, foreign investments and export products are concentrated in the manufacturing industry that unavoidably raises the "unit GDP energy consumption" in China. Therefore, the present highly energy consuming economic structure in China is, generally speaking, an outcome of natural selection in the current condition of international division of labor, and has its own historical necessity.

Therefore, the current energy price policy in China must promote energy conservation, support renewable energy, and attain the sustainability of energy consumption. Moreover, it also must pay an equal attention to the sustainability of national economic competency. It is imperative to respect the historical necessity of forming a highly energy consuming economic structure in China in the present phase, and it is inadvisable to pursue unit GDP energy consumption minimization in a blind manner.

The trend of moving some high-energy consumption industries like electrolyzed aluminum, cement and steel from developed economies to developing ones is unlikely to change. The issue whether China should develop such industries and to what extent shall we develop them, shall be primarily dictated by such factors as environmental protection, market demand, and raw material supply. The responsibility or function of government shall be mainly reflected in the internalization of external costs. As for electricity tariff, it is sufficient to align the electricity bills paid by such industries with the costs of power supply. If external costs are internalized, it is easy to make an international comparison for the comprehensive costs of high energy consumption industries. Enterprises are fully competent to make a right choice that conforms both to national interests and to the common interests of mankind. So, it is unnecessary to mobilize forces to enact so complicated industrial policies. It is highly probable that any blind pursuit of unit GDP energy consumption minimization causes excessive and even erroneous state interventions. This will jeopardize state economic competency without benefiting energy saving and sustainability of the world economy as such.

(II) Overall consumer tariff level timely reflecting changes in electricity cost and demand

The overall tariff level dictates the rationality of the total power consumption volume. As far as tariff is concerned, the top priority is to align the overall consumer tariff level with the overall cost of power supply, and make timely reaction in response to cost and demand changes, in a bid to promote energy conservation. In the past two years, the overall consumer tariff increase has been lagging behind the magnitude of fuel price rise and demand upsurge to fail to inhibit the overall demand as expected primarily because i) the National Development and Reform Commission sets a tight ceiling on price hike across all localities for fear of sparking excess inflation, and ii) the related rules are defective as to when to adjust tariff and how to determine the extent of adjustment. Therefore, to make the overall consumer tariff level reflect changes in electricity cost and demand, it is necessary to carry out further conceptual and system changes.

1. *It is imperative to overturn the traditional concept of keeping the overall consumer tariff level relatively stable*. From the perspective of minimizing social and transactional costs, the overall consumer tariff level should be kept relatively stable

instead of making frequent readjustments given the lack of marked changes in electricity cost and demand. In light of the fuel price spike and demand upsurge in the past two years, the overall tariff level must be make timely reaction. If we still pursue tariff stability at this time, the inevitable upshot is to cause a relative contraction in short-term supply, a more burgeoning market demand, a further decline in power supply reliability, and an increased instability in the overall power system. Additionally, macroeconomic instability reflects the problem of total economic volume relationship, while the electricity tariff policy is intended to resolve local imbalance. Even with electricity tariff frozen, it is still unlikely to suppress the inflationary momentum. The primary reason for investment control especially since last year is related to the existence of resource constraint as indicated by the insufficient supply of coal, electricity and oil. If the overall electricity tariff level has to be kept stable in such a circumstance, it does a disservice to effectively stimulating energy supply and suppressing irrational energy demand. The current practice goes against the macro-control objective! Evidently, we have to follow the dialectic method instead of mechanical tariff suppression even if the electricity tariff policy is required to dovetail with macro-control. It should not be simply construed to keep the overall tariff level stable.

(2) Establishing and refining the regulatory rules and methods for timely tariff adjustment. The issue of timely adjusting overall electricity tariff has been addressed in the “Electricity Tariff Reform Proposal” approved by the State Council in 2003, the “Coal and Electricity Tariff Linkage Proposal” issued by the National Development and Reform Commission and ratified by the State Council in 2004, and the three “Administrative Measures for Electricity Tariff” promulgated by the National Development and Reform Commission in April 2005. The “Electricity Tariff Reform Proposal” has established the system and basic principles of linking end-user power price and ex-works grid bidding tariff after the latter is floated in the market. The “Coal and Electricity Tariff Linkage Proposal ” and the three “Administrative Measures for Electricity Tariff” have further cemented the relevant system and basic principles before the ex-works grid bidding tariff is floated in the market. We can say the direction of reform is clear, and the main principles are also viable. On the operating dimension, however, some specific rules need to be further refined in order to really realize timely adjustment of overall electricity tariffs. Currently, the key point

of breakthrough in solving actual operating difficulties is to revise the regulation on the magnitude of “Coal and Electricity Tariff Linkage”

According to the prevailing “Coal and Electricity Tariff Linkage Proposal”, the power generation enterprises shall absorb 30% of coal price increase. The regulation works if coal price rises by 8% or 10% in the short term (i.e., 1 year). How could the power generation enterprises absorb 30% of price hike given a magnitude of 20%, 30% or several sessions of 8% price increase in a row? This is exactly what coal price has been moving since last year. The electricity tariff regulatory authority has unavoidably been trapped in a dilemma. This is one of the major reasons why electricity tariff rose by the largest magnitude while criticisms abounded last year. However, what we are concerned is that the tariff hike was insufficient to match the increase of recurrent power generation costs, and thus failed to play the due role of damping the overall power demand. Therefore, it is imperative to revise the rules of coal and electricity tariff linkage.

Our recommendation for amendment is called: “**keeping road and bridge separate with disparate functionality**”.

The so-called “road” refers to the normal requirement by the regulator for the regulated enterprises to “constantly raise efficiency. This requirement has been met through the generally adopted practices of adding an efficiency coefficient in the tariff adjustment formula in foreign countries (for example, X in the British price adjustment formula “RPI-X” is called an efficiency factor). Currently, the Chinese government only adopts an electricity pricing formula yet without any electricity tariff adjustment formula in place, and the rules await refinement. To regulate and legislate electricity tariff adjustment, it is recommended to formulate a tariff adjustment formula as early as it may. In our prospective tariff adjustment formula, we should also follow the generally adopted international approach to set an “efficiency increase coefficient” or “cost decrease coefficient”, and it is advisable to resolve the general cost increase that enterprises are required to absorb through this “road”.

The so-called “bridge” is a solution to special (ad hoc) cost increase. The cost increase after offsetting/deducting “the rate of efficiency increase” or “the rate of cost reduction" (mainly referring to significant fuel price hike for thermal power generators) in the tariff adjustment formula can be considered a special cost increase. Such special cost increase is a price the society must pay to maintain the existing size of energy consumption. It is imperative to keep consumers aware of the extent of energy scarcity. Therefore, any such cost increase shall be completely passed through to electricity tariffs.

(III). Establishing a consumer tariff structure compatible with power supply cost

The so-called consumer tariff structure refers to the unit price differential and proportional relationship between consumers as a result of the difference in the manner, time, and voltage of power usage etc. The unit price differential and proportional relationship between consumers arises from the different requirements by the manner, time, and voltage of power usage for the power system. Therefore, the rationality of an electricity tariff structure directly dictates whether a reasonable power consumption structure can be formed. Furthermore, it not only has a bearing on energy conservation performance, but also affects a series of resource allocation efficiencies. Consequently, the sustainable development tariff policy structure must include "establishing a consumer tariff structure compatible with the power supply costs so incurred". Proceeding from the actual circumstances of China at the present stage, we should get the following work well done so as to fulfill this mission:

(1) *Reclassifying consumers and adjusting their price differentials*. In general, the present consumer classification and price relationship are till out of step with actual power supply costs although they are adjusted to different extents in all localities, resulting in excess "cross subsidization". For example, cross subsidization is obviously reflected in the virtually indifference of tariff between residential and industrial consumers. In addition, commercial consumers are charged the highest tariff, which is more than 70% above the average rate. Apparently, this deviates from the actual costs incurred by consumers on the power system. Therefore, we should reclassify consumers based on the voltage level and user load characteristics. Especially in the several power shortage areas, it is advised to seize the opportunity to raise residential tariff and completely resolve the issue of excess cross-subsidization between residential and other consumers.

(2) Improving the time-of-day tariff structure. China has completely implemented the peak/valley tariff system from 2003, and the system should be improved as follows at the present stage: i) further expanding the scope in which the peak/valley tariff system is implemented; ii) adjusting time-of-day price differentials according to the "unique circumstances of each locality"; iii) implementing "seasonable tariffs" in the areas with strong load seasonality; iv) encouraging the use of "peak tariff"; v) completely implementing "high water/low water tariffs" in the hydropower dominated areas.

(IV) Internalizing external costs

Power generation consumes approximately 50% of total national coal production in China, and coal fired power plant s emit 56% of industrial SO_2. The state levied SO_2 emission charges, however, are merely RMB 0.21--0.63/kg. As estimated by experts, the cost of desulfurization is approximately RMB 0.88—2.8/kg for installing flue gas desulfurization units in 300 MW coal fired turbo-generators, based on the actual sulfur content of coal for power generation. Therefore, the environmental costs are far from being included in the accounting costs of power generation enterprises. As a result, the power generation enterprises are mostly reluctant to install desulfurization units, and some units, even if installed, are left idle. To fundamentally hold back the exacerbating momentum of thermal power generation polluting environments, we must resolutely adopt the following two measures of internalizing external costs.

(1) *Significantly increasing emission charge rates*. To fundamentally solve the emission and acid rain problems in China, the SO_2 emission charging rate should be set at a level in excess of the costs incurred by enterprises to reach the governmental control target. As calculated, the emission SO_2 charging rate should be raised 4~10 times, that is, to RMB 1—2.8/kg. China boasts of a huge territory with marked differences between areas in weather, population density and cultural relics distribution etc. With a significant difference in the extent of SO_2 hazard come different SO_2 emission control targets in different localities. For example, a relatively high charging rate should be imposed in populous east China and humid yet acid rain plagued southwest China. The SO_2 emission charging rate can be set lower in Inner Mongolia, Xinjiang and some northern coastal areas with sparse population and dry weather so as to promote the rational distribution of power structure.

(2) Power grid tariff must cover the reasonable costs of desulfurization. While significantly raising emission charging rates, the associated policies should be in place to allow enterprises to recover through normal channels their costs of installing and operating desulfurization units so as to encourage their additional investments in environmental protection. In the current stage when the tariff is set by government, the power grid tariff should cover the reasonable costs of desulfurization. The National Development and Reform Commission has recently released the 1.5 *fen*/kWh uniform desulfurization cost standard in China. This rate is appropriate for newly built turbo-generators but insufficient to compensate for old generators. Old generator refurbishing, however, is a key measure to reduce SO_2 pollution. To this end, we recommend setting a separate rate appropriate for old generators based on the higher costs of old generator refurbishing, and allow for appropriate elasticity in implementation. Regarding the issue of reasonably determining the cost of desulfurization for Chinese power utilities, we undertook a special survey (see Annex 1).

(V) Gradually introducing competitive mechanism

The market mechanism is the most effective means of saving resources in any competitive arena. Based on the international practices and experiences in electric power market operation, the competitive pressure from "unilateral" or "bilateral" trade compels power generation enterprises to employ all available means to minimize fuel consumption and directly benefit energy conservation. If the "bilateral" trade system is adopted, a demand factor can be incorporated into the tariff formation mechanism to generate a more evident effect in energy conservation. Moreover, the Chinese power industry has basically separated power plants from grids. Without introducing a competitive mechanism, it will increase transactional costs while frustrating the effort to optimize resource allocation. Therefore, we must introduce the competitive mechanism, and employ the market mechanism to achieve the sustainable economic and social development. The following near-term measures are advanced for consideration:

(1) Speeding up the "large account user direct purchase" piloting endeavor. At present, Jilin Carbon Factory is the only large account enterprise approved by the National Development and Reform Commission and the State Electricity Regulatory

Commission for direct power purchase. In the future, all the large account users around any big energy base should be allowed to trade directly with power generation enterprises and thus minimize power transmission losses. According to the previous experiences of countries in electric power system restructuring, the supply of electricity from power generation enterprises to large account users pertains to the "bilateral" approach of electricity trade. In essence, power generation enterprises trade directly with large account power users most of which are power distribution and sales companies. Therefore, in piloting the "bilateral trade" in the power market, it should not be limited to the direct trade between power generation enterprises and large end-users. Instead, it should be targeting the direct supply from power generation enterprises to independent power supply companies for future development. These independent power supply companies may have many forms of ownership structure available to choose, extending from the joint venture between an existing provincial power company with other investors to the wholly owned private enterprises. The power supply operation can be entrusted to the provincial power companies or undertaken by the independent power supply companies. The requirements for the load characteristics of users in a "direct purchase" area should be based on those for the high power usage rate enterprises. As for the "direct purchase" approach, the "direct purchase" through grids is preferred, without excluding private line "direct purchase".

(2) Attaching top priority to designing an electric power market model in tandem with domestic situations. This round of electric power system restructuring is centered in introducing a competitive mechanism. The common international practice is first to determine electricity trade model and related rules, and then design the corresponding industry breakdown and corporate restructuring options. Once power plants and grids are completely separated, the power generation side or user side competitive market is set rolling immediately. Our practice is quite the opposite: over a year after "power plant/grid separation" (separation still incomplete, for example, the power grid companies still own a considerable size of conventional power generation capacity, and "core/supplementary operations" still not separated), the related decision-making authority is still researching and debating about the core reform issue of basic electricity market form and distribution. In addition, given the vast expanse of China in territory, the power grid structure and electricity market must be regional. In

consideration of the uneven regional social and economic development at the present stage, “competitive bidding” (a “unilateral” market method) may not apply in all areas as an approach to introduce competition into the power industry. Therefore, it is required to well design the electric power market model in line with the domestic situations before being able to actually solve the sustainable power development issue through the market mechanism in China.

(VI) Regulating and consolidating tariff based government funds

At the present stage, public funds are required to promote energy conservation (i.e., supply side management) and support renewable energy development. Raising such funds through tariff surcharges is in congruence with the principle of fairness and efficiency. In this respect, there are successful international experiences, and China has the experiences of operating the “Electric Power Construction Fund”, the “Three Gorges Fund” and the “Reservoir Area Immigration Support Fund”. These government funds based on tariff can be regulated and consolidated to lend a policy support to sustainable energy development. The scope of “regulation and consolidation” mainly includes:

1. Renaming: Currently, there are many tariff based governmental funds raised for the public interests. To avoid consumer misunderstanding, these funds should be made true their name and uniformly called “Electricity Public Interest Fund”.

2. Adding expenditure items. Expanding the scope of applicability by increasing the expenditure items of energy conservation and renewable energy development.

3. Expanding the scope of fund sharing/contribution, and instituting a central and provincial two tier sharing system. Encouraging energy conservation and promoting renewable energy development are related to the public interests of the society as such, and pertain to public goods with regional spillover effects. As prescribed in the “Renewable Energy Law”, every citizen is obligated to support renewable energy development, and the money required should be contributed by the entire society. Therefore, the scope of contribution for such funds must exceed the current coverage of power sales. The funds should be managed in a centralized manner, by means of the two tier central and provincial systems, so as to facilitate trans-regional transfer of

payments. The key points include:

(1) Based on the central and provincial renewable energy development programs;

(2) The funds under the scope of central strategic planning and subject to approval by central government should be levied or contributed nationwide;

(3) As for the funds under the scope of local planning and subject to approval by local government, the amount under the “target price” should be contributed nationwide, while the amount above the “target price” contributed locally;

(4) Setting up central and provincial escrow treasury accounts;

(5) Keeping “revenue and expenditures separate”;

(6) The energy regulatory authority consults the electricity tariff regulatory counterpart in reviewing fund approval, determining the funds allocation proposal, and making disbursement after review by the treasury department.

4. Funds collected price exclusive. The current government funds are collected price inclusive, and included in the sales revenue of each power company in many localities, making it difficult to make cross-regional transfer of payments, and doing a disservice to forming a “social sharing” mechanism. Such funds should be collected exclusive of price, and directly become governmental revenue.

5. Funds borne by power consumers. The sources of money for promoting energy conservation and supporting renewable energy development are naturally the payments from power consumers. Power consumers, however, may have different responsibilities for fossil energy consumption if they consume power in a different manner. Consumers consume fossil energy primarily through the electric quantity consumed. However, more electric charges paid does not necessarily mean more electric quantity (kWh) consumed. Therefore, from the perspective of fairness and energy conservation, the major “payers” should be the electric quantity consumers instead of capacity consumers. Consequently, it is inadvisable to link governmental

funds for supporting energy conservation and renewable energy development to total electricity charges. Instead, such funds should be levied on a unit basis.

(VII) Establishing standardized renewable energy based electricity tariff administrative measures

Given the vast expanse of territory in China, and the substantial difference across regions in the reserve of and demand for resources, there should be a reasonable price differential for electric power generated in different regions using different kind of renewable energy. The question is how to set a reasonable price differential. If government still regulates the power grid tariff, we recommend:

1. Setting a price differential for electricity generated from different kinds of renewable energy based on normal cost differences. Normal costs shall be determined with the technology recognized by the project regulatory authority as the precondition and considering: i) universal equipment purchase price; ii) uniform equipment installation standards; iii) uniform per capita salary level; and iv) uniform financial expense and ROI standards. As long as the normal cost differential is set, there will be a reliable basis for determining the price differential.

2. The principle of public fund efficiency maximization should be observed in setting a regional price differential for electricity generated from renewable energy. According to the requirements of the Law of Renewable Energy, the governmental authorities concerned are considering setting the base price of electricity from renewable energy per regions. Most renewable energy based power plants are connected to the standalone local power grid or low voltage distribution grid because they are mostly small in scale. If the central government directly sets the base price for electricity generated from renewable energy, information support is absent, workload is excessive, and it deviates from the hierarchical tariff management system currently in use. Therefore, it is advisable to consider that the central government only prescribes a uniform standard for the price differential between renewable energy generated electricity and conventional energy generated electricity. On the basis of the uniform standard, the local electricity tariff regulatory authorities can decide on the specific base price for electricity generated from renewable energy in their respective localities. The advantages of this approach are as follows:

(1) It can raise the efficiency of allocating renewable energy based power generation across regions. Undoubtedly, as far a specific region is concerned, the lower the cost of power generation from renewable energy, the better the chance of getting the tariff approved. However, the principle is apparently limited if applied across regions. For example, the cost of wind power generation is higher in Zhejiang and Guangdong than that in Xinjiang and Inner Mongolia, and so is the electricity tariff. Does this mean the cost and tariff of wind power in Zhejiang and Guangdong are unacceptable? Not necessarily so because the cost/price at which the power grid purchases conventional energy generated electricity (also considered the long-term marginal cost of conventional power generators) is also higher than that in Xinjiang and Inner Mongolia. Given an equal amount of wind power, the consumers in Zhejiang and Guangdong may pay less incremental costs than those in Xinjiang and Inner Mongolia. Therefore, as far as the cross-regional resource allocation efficiency is concerned, it does not mean a region shall be allocated more resources if its cost of power generation from renewable energy is lower. The location and number of construction projects shall be based on the cost differential between renewable power energy based power generators and conventional power generators. The less the differential, the less subsidies the society is obligated to pay, and the higher the efficiency of capital utilization the society used for such a purpose.

(2) It can reasonably solve the relationship between central and local governments. As indicated above, it is inconsistent with the present hierarchical tariff management system if the central government directly sets the base price of power generation from renewable energy in each region. Since the electricity tariff policy is based on a mandatory market quota system for power generation from renewable energy, it is systematically out of order if the central government directly sets the base price of electricity generated from renewable energy, from the perspective of aiding each locality in addressing its own issues or instituting a “green certificate trade” system. According to our recommendation, however, the basic principles and methods can be unified across China. Moreover, each local electricity tariff regulatory department can make more practical decisions within the scope of the uniform standards based on the specific circumstances of the locality. By so doing, it will be more conducive to supporting the implementation of renewable energy policies and making it more

efficient.

(VIII) Granting local governments with considerable latitude to raise DSM short-term funds

The demand side administration is in dire need of funds support. In the near term, however, the central government does not have any policy to make a stable channel of funds. To prevent its demise halfway, the local government should be empowered with considerable latitude to raise DSM short-term funds. For example, in the areas where peak tariff is set, the revenue so increased by the power grid company can be used to support demand side administration.

Sub-Report 1

A Tentative Study of Natural Gas-Fired Power Generation Pricing Principles and Methods

Natural gas is the generally recognized clean energy. The appropriate development of natural gas-fired power generation is conducive to minimizing the extent of environmental pollution caused by the power industry, improving the overall energy utilization efficiency of the power system, and promoting social and economic sustainability. The natural gas-fired power generation has been soaring in recent years in China. With the west-to-east gas pipeline project basically completed, the gas turbine power stations along the pipeline will become on-stream one after another, and the gas-fired power generation will assume a growing proportion in the power generation mix. Gas turbine power generation will be burgeoning especially in East China, Gunagdong, and Central China. Apparently, the gas-fired power generation and other thermal power generation should not apply a uniform tariff standard under the current circumstances given their differences in utility and cost attributes. To this end, the paper is intended to offer some preliminary opinions on how to scientifically determine the on-grid tariff for gas turbine power stations.

I. The Status Quo and Trend of Natural Gas-Fired Power Generation in China

Gas turbine is the fastest growing dynamic technology in the world over the past two decades. Gas turbine has made a substantial breakthrough in unit capacity and thermal efficiency, and it is subject to various classifications. Classified by fuel types, it is divided into oil-fired and gas-fired. For example, the 100 MW gas turbines of Shanghai Zhadian Ranji Power Station, Zhejiang Zhenhai Power Stations and Wenzhou Longwan Power Station are all heavy oil fired. The gas-fired power stations include Chongqing Jiangbei Ranji Power Station, and many gas-fired turbo-generators will become operational this year. Classified by gas supply types, it is divided into LNG and pipeline gas turbines. LNG is widely used in Guangdong and Fujian, while the gas turbo-generators along the west-to-east pipeline are fed with pipeline gas. Classified by turbine types, it can be divided into E and F turbines. Currently, gas turbines are growing in the fastest pace in the world, and the latest F turbine garners over 50% of heat exchange efficiency. Classified by operating modes, it can be divided into combined cycle gas turbine (CCGT) and single cycle turbine. In consideration of turbine economics and for the purpose of improving efficiency, most gas turbines are operating in the CCGT mode to fully leverage its functionality. Gas turbine can also be divided into pure power generation unit and combined heat/power (CHP) unit. To our knowledge, China plans to develop an installed CCGT capacity of 55 GW by the year 2020, which is equivalent to 25 times of the total capacities of 50 years before 2000. Why will there be so many gas turbines introduced into the power generation sectors?

First of all, China takes the initiative to vigorously develop gas turbine-based power generation in concert with the “west-to-east gas pipeline”. The “west-to-east gas pipeline” refers to the long distance gas pipeline project of supplying natural gas from Xinjiang to Shanghai. The pipeline starts from Lunnan of Xinjiang Tarim Basin, goes through 9 provinces/municipalities to reach east China, and ends at Baihezhen, Shanghai. With a total length of 4200 kilometers, the first phase project is estimated to cost RMB 120 billion. Following the completion of the first phase project, the annual gas supply capacity will reach 12 billion cubic meters for a period of 30 years. To secure a long-term stable customer base for the project and promote grand west development, the central government then decided to build a series of gas-fired power stations along the pipeline.

Secondly, natural gas features high efficiency and cleanness. Natural gas combustion is free of residue, dust, hazardous gas, and heavy metal elements harmful to human health. It generates far less volatile hydrocarbon, sulfide, carbon dioxide, and nitrogen oxide than coal and oil do. Moreover, natural gas is convenient to use. Along with the heightened awareness of environmental protection, the environmental protection advantage of gas-fired power generation has been moving into the radar screen of the public and government at all level.

Thirdly, gas-fired power stations are typical of short construction cycle, small land coverage and water conservation, and they are naturally well received in eastern, central and northwestern China where land and water are in grave scarcity.

Fourthly, natural gas-fired power generation is free of transportation bottlenecks. The rail bottleneck of coal shipment from north to south China has not been mitigated for a long time. As a result, natural gas-fired power generation is of great interest to the southeastern coastal areas that has long been plagued with power shortage. The central government has thus included it in the strategic plan for rational energy distribution.

Fifthly, natural gas helps boost power system reliability. With the strength of operating flexibility, strong load modulation, and fast startup/shutdown, CCGT can effectively improve the power generation mix, realize optimal operation, simplify operating maintenance, lower costs, and maintain high reliability.

II. The principles and methods of pricing for natural gas-fired power generation

The gas turbine generated electricity pricing mechanism includes three parts: pricing methods, pricing parameters and on-grid tariff types. As a comprehensive index, tariff is also closely related to turbine types etc.

(I) Basic Principles

1. Based on the purchase costs and operating costs of representative turbines. The gas turbine generated electricity tariff is closely related to the turbines in use. Currently,

the global CCGT heavy equipment market is monopolized by 5~6 foreign companies with related design and manufacturing technologies, including Siemens, GE, Mitsubishi, and Alstom. To break foreign monopoly, China has adopted the market/technology swap strategy, bundling equipment purchase with technological introduction. Siemens and Shanghai Electric Group has, through partnership, won orders from 4 Chinese CCGT power stations to supply 9 gas turbines. Meanwhile, China has imported GE 9F gas-steam combined cycle units in a bundled manner. Therefore, we can take 9F turbine as the benchmark in setting gas turbine generated electricity tariff. That is, we should use 9F turbine technical parameters to the best extent possible so as to facilitate analysis and comparison.

According to the national industrial policies, the tariff for gas turbine generated electricity should, in principle, be set based on the combined cycle operating mode.

2. Smooth linkup with the existing tariff system. Given the initial gas turbine development stage in China, and for the purpose of promoting the development of gas turbine manufacturing technology, the tariff should be set primarily by government in due consideration of market factors at the present stage. Based on the function of gas turbines in power generation, CCGT can use a single uniform tariff model, and the government should also observe the generally adopted "operating period tariff" method in this respect. Single cycle units can use the "dual system" tariff method subject to consultation by and between buyers and sellers.

(II) Evaluated Parameters Selection and Description

1. Purchase Costs. As shown in Table 1, the international 9F gas turbine unit cost is approximately USD 355/kW or RMB 2950/kW. The price of 9F turbines imported in China is as follows: RMB 4096/kW (total investment: RMB 3.195 billion) for Shanghai Caojing 2 x 390 MW Power Station; RMB 3300/kW for three gas-fired power stations newly built in Putian, Jinjiang and East Xiamen of Fujian Province; RMB 3289/kW for Huaneng expansion project in Shanghai; RMB 3090/kW (total dynamic investment: RMB 2.41 billion) for Wangting 2 x 300 MW gas turbine expansion project. In general, the price is much higher than the international level.

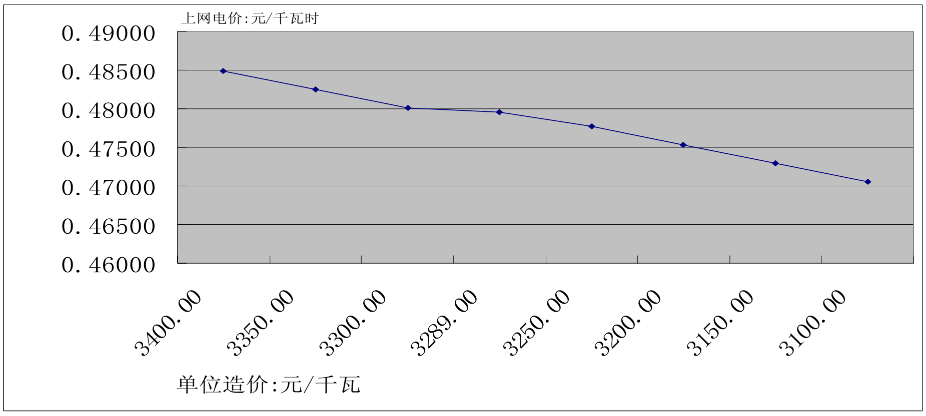
Table 1: The Basic Technical & Economic Parameters for 300MW CCGT

Plant Model	Net Plant Output	LHV Heat Rate	Net Plant Efficiency	No.Gas Turbine	No.Steam Turbines	Budget Price	$per kW
S-109FA (GE)	390.8 MW	6020 Btu	56.7%	1×Fr9FA	1×142MW,3P,R	$139100000	$356
MPCP1-701F (Mitsubishi)	397.7 MW	5988 Btu	57.0%	1×M701F	1×132MW,3P,R	$139200000	$350
KA26-1 (Alstom)	378.0 MW	5985 Btu	57.0%	1×GT26	1×140MW,3P,R	$140500000	$372
GUD1S94.3A (Siemens)	385.5 MW	5980 Btu	57.1%	1×V94.3A	1×120MW,3P,R	$138000000	$358

Of course, the high purchase prices are not without cause. For example, the introduction fees etc. are included in such costs though they merely account for a small proportion. Therefore, it is recommended the on-grid tariff be set based on a purchase cost higher than the international level, for example, RMB 3000/kW, to facilitate investment cost control.

Assuming a power station has a total installed capacity of 1200 MW, a total investment of RMB 3.95 billion (including 25% registered capital), an operating period of 20 years, 150 employees, gas consumption: 0.1913 cubic meter/kWh (gross calorific value: 37505 kilojoule/cubic meter), gas price: RMB 1.35/cubic meter, overall depreciation rate: 6.67%, overhauling frequency: 3.5%, annual operating hours: 3500 hrs, internal power consumption: 3%, IRR: 8%, the on-grid tariff of the power station should be RMB 0.479/kWh. Under the above conditions, the effect of unit purchase cost on tariff is shown in Figure 1.

Figure 1: Unit Purchase Cost Versus On-grid Tariff



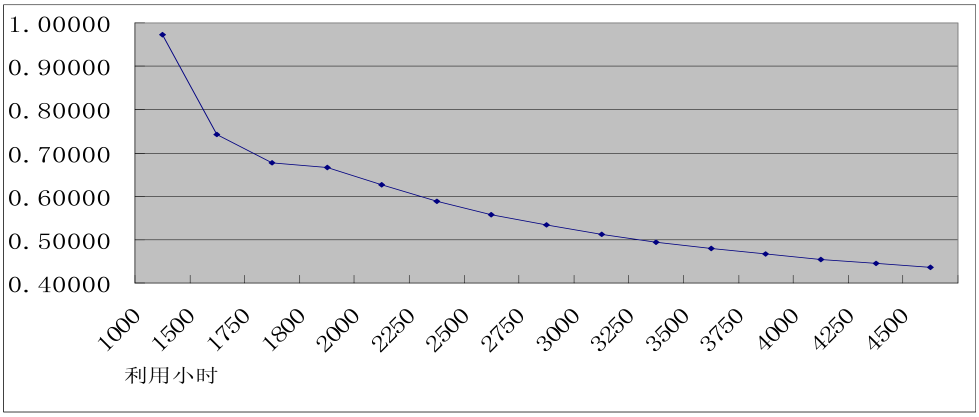
2. Equivalent operating hours. According to international practices, every gas turbine power station signs a take or pay contract with its gas supplier, and the contract directly affects the equivalent operating hours of gas turbine. However, gas turbine operating hours are closely related to the power grid operating mode and power supply/demand. To solve this issue, it is imperative to secure support from power grid companies. In setting on-grid tariff, we recommend the National Development and Reform Commission to use 3500 equivalent operating hours because gas turbines operate in the CCGT mode at the peak/valley time intervals of day. Gas turbine power stations may not always operate at 100% capacity at these time intervals. In consideration of gas turbine throughput variation, scheduled maintenance (approximately 30days/year) and ad hoc repairs etc. it is viable to use 3500 annual operating hours in the CCGT mode.

The gas purchase agreement has not yet been finalized for the west-to-east gas pipeline. To our knowledge, gas supply to power stations will be arranged at the relatively critical (unfavorable) time intervals. Gas-fired power stations will face higher pressures if gas is mainly supplied in the night. In such a scenario, power stations will be forced to generate at the mercy of gas supply or build their own gas storage facilities. The former option will be not welcomed by power stations, and the tariff will not be high from the perspective of pricing based on value. The latter option will add investment costs.

According to the needs of power grids, CCGT can also be conveniently converted into single cycle units for load modulation operation only. The equivalent operating hours will then be further reduced. Since such conversion is made at the request of power grids and with the consent of power stations, the tariff should then be set through consultation based on the principles of "ensuring equal profitability and encouraging power stations to participate in load modulation". By "equal profitability", we mean the profitability of power stations in the CCGT mode should be basically consistent with its profitability in pure load modulation operations.

Other conditions being equal, the effect of annual operating hours on tariff is shown in Figure 2.

Figure 2: Operating Hours Versus On-grid Tariff



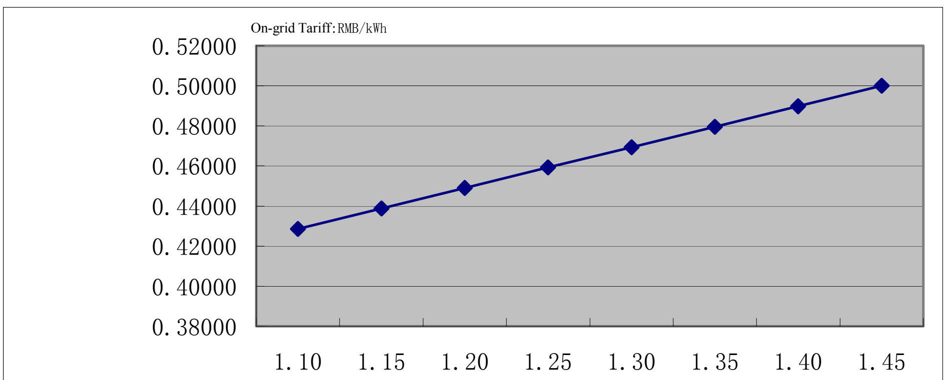
3. Variable Costs. CCGT variable costs include fuel, water, power purchase and material fees, while single cycle gas turbine variable costs only include fuel, water, and power purchase costs only. The west-to-east pipeline gas price should comply with the prescriptions in the "Circular of the National Development and Reform Commission on West-to-East Pipeline Gas Price" (NDRC Price [2003] No. 1323 Document); LNG CIF price: RMB 1.4/cubic meter (Fujian: RMB1.425/cubic meter; Jiangsu Rudong: RMB 1.4/cubic meter). The tariff should be adjusted in the event of any adjustment of west-to-east pipeline gas price or government-set price for LNG. Every gas purchaser should take reasonable measures in the gas purchase contract to mitigate gas price volatility risks.

Table 2: 300MW CCGT Gas Consumption in ISO（Independent System Operation）Mode

Plant Model	Gas Consumption per Hour （kNM^3）	Daily Consumption of Gas （kNM^3）	Annual Consumption of Gas （billion NM^3）
S-109FA	66.8	1335.6	0.301
MPCP1-701F	68.3	1364.9	0.307
KA26-1	68.2	1364.1	0.309
GUD1S94.3A	67.3	1344.9	0.303

Other conditions being equal, the relationship between gas price and tariff is shown in Figure 3.

Figure 3: Gas Price Versus Tariff

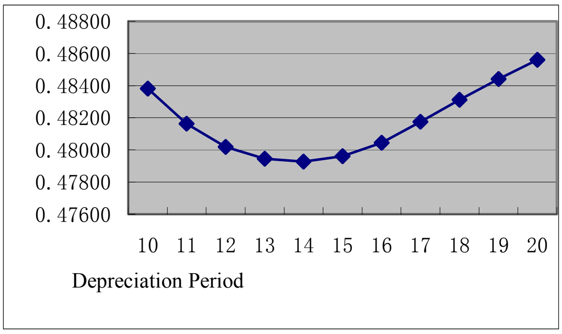


Water and power purchase fees should be determined based on the rate set in the feasibility report and the standard unit price prevailing in the locality.

4. Fixed Costs.

Depreciation. Currently, Chinese power stations normally adopt a short depreciation period of 12~15 years. In contrast, foreign gas turbine generators are maintained at a longer time interval. For example, the primary and secondary rotors of 9361E gas turbine in UK London Power Station are maintained once every 48000 hours (approximately 13.7 years), while the tertiary rotor is maintained once every 70000 hours. Therefore, the depreciation period can be extended. In consideration of the unique circumstances in China, however, we recommend adopting a depreciation period of 20 years. Other conditions being equal, the relationship between depreciation periods and on-grid tariff is shown in Figure 4.

Figure 4: Depreciation Period Versus On-grid Tariff



Maintenance fees. Based on international experiences, CCGT maintenance fees (including material fees) are generally USD 30/kW or RMB 250/kW. In consideration of the actual technological and labor cost conditions in our gas turbine manufacturing and maintenance industries, we recommend adopting the rate of RMB 250/kW for maintenance fees.

Labor expenses. CCGT staffing number as prescribed in the feasibility study report; average salary based on the upper medium level in the locality; fringe benefits at 14%

of basic salaries.

Other expenses: including travel expense, pension, and medical care etc. The local standards should apply for such expenses. The equipment insurance premium should be based at the prime rate.

5. Financial expenses. Chinese funded power stations should comply with the interest rates set by the state, while foreign funded power stations should observe contractual provisions at a level not higher than domestic bank foreign investment loan interest rates.

6. Taxes. Should comply with state regulations. Sino-foreign joint ventures are entitled to preferential income tax policies.

7. Return on investment (registered capital). Based on the principles of Document 701 and the present circumstances, we recommend adopting 8.5% of ROI.

8. About " Two Fund". Statutory accumulation fund can be set at 10% and public welfare fund can be set at 5%.

III. **Simulated Computation** Results and Recommendations for Related issues

(I) Simulated Computation Results

To make an adequate description of issues, we performed simulated computation on a gas-fired power station. Assuming the power station has an installed capacity of 2*390MW, a total investment of RMB 2.565 billion (cost: RMB 3289/kW) including 25% registered capital, ROI: 8.5%, interest rate: 6.36%, internal power consumption 3%, loan repayment period: 15 years, income tax: 33%, surtax: 10%, VAT: 17%, Percent of Accrued depreciation for debt repayment: 80%, and CIF price of gas: RMB 1.32/cubic meter. According to the “operating period tariff” method, the tariff calculated is RMB 0.481/kWh (tax inclusive). Evidently, the tariffs in the above two scenarios are similar.

Given the outstanding contradiction of supply and demand in east China and even nationwide, the CCGT power stations based on the west-to-east gas pipe line could extend their debt repayment period to 15 years (at the same interest rate), while controlling purchase costs /CIF price of gas, and ensuring gas supply at appropriate time intervals. In such a circumstance, the on-grid tariff (from 11AM to 17PM) of RMB 0.481/kWh is a price well affordable in most cities of east China. The gas turbine tariff is not excessive in consideration of environmental protection factors.

(II) Recommendations for related issues

1. On-grid Tariff for LNG Power Stations. The effects of LNG on costs are modest given its quality (heat value) superiority over west-to-east pipeline gas despite higher price. Other things being equal, the on-grid tariff should not exceed that for conventional gas-fired power stations.

3. Uncertainties about "West-to-East Gas Supply". Given the restrictive gas supply timing, the take or pay precondition then ceases to exist, and there will be conflicts with power grid demand. The government should make necessary coordination, for example, using the existing storage tanks to regulate. The pipeline transmission fees from gas station to power station should be subject to stringent governmental control.

4. The issue of subsidizing heat with power in heat/power cogeneration CCGT power stations. The method of subsidizing heat with power (by raising power tariff to compensate for heat product losses) should be abolished because i) heat/power co-generators often base power generation on heating production, thus affecting the timing of power generation. The quality of electricity is considerably correlated with timing. Therefore, the quality of electricity generated based on heat production is inferior. It would be more irrational to set higher average tariff for such electricity; ii) heat supply and power supply are intended to meet different market demands. Each demand should be based on the requisite costs of supply. By raising tariff to reduce heat price, we allow power consumers to subsidize heat consumers. It is neither fair nor consistent with the principle of rational resource utilization.

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Sub-Report 2

A Survey of Flue Gas Desulfurization Costs of Thermal Power Station in Shandong Province

I. Background

On January 27, 2005, the State Administration of Environmental Protection released the progresses of key thermal power station flue gas desulfurization projects for SO_2 and acid rain control. In general, the results were unsatisfactory: there were 91 projects built or still in progress, accounting for 66.4% of total projects, and there were 46 projects not yet started, accounting for 33.6% of total projects. As the major air polluter, thermal power stations emitted 11 million metric tons of SO_2 in 2003, accounting for 50% of total SO_2 emission. It follows that China's thermal power stations will emit 21 million metric tons of SO_2 in 2020, 2.8 times more than the target amount. According to environmental protection planning, China will control its annual SO_2 emission under 12 million metric tons, including 5.5 million metric tons of SO_2 emission from thermal power stations.

According to the findings of an industrial survey, China is currently the second largest greenhouse gas emitter and the largest SO_2 polluter in the world. There are approximately 1/3 of cities suffering from severe air pollution, 1/3 of land severely eroded with acid rain, and 2/5 of rivers flowing Class V water. Pollution is more exacerbating in economically developed areas. For example, the frequency of acid raining is 12% in Jiangsu, and the acid rain coverage is 100% in Zhejiang. As estimated by the Chinese Academy of Sciences, the losses caused by environmental pollution and ecological damage now account for approximately 15% of GDP in China. Therefore, some foreign scientists predict that the largest destruction stemming from unexpected environmental crises may first occur in China if it does not swiftly change the mode of production and lifestyle.

At present, coal is the heaviest polluter in China's non-reusable energy, accounting for 72% of total pollution. Along with the soaring energy demand in recent years, coal consumption has been expanding rapidly. In 2004, China consumed 2 billion metric tons of coal, accounting for 30% of total world consumption. In contrast, China's GDP was only 5% of the world total. In the environment sustainable index released by the Davos Economic Forum, China was ranked No. 133 in 144 countries (regions). As predicted by industry experts, China will consume 3 billion metric tons of coal in 2020, thereby causing huge pollutions. Therefore, it is imperative to take forceful control measures.

In Shandong Province--the largest SO_2 emitter in China, the price regulatory authority has raised the on-grid tariff of Huangtai Power Station, Jining Power Station, Yunhe Power Station, Liyan Power Station, Nanding Power Station and Baiyanghe Power Station (with flue gas desulfurization units installed) by RMB 0.015/kWh (higher than similar power stations without installing flue gas desulsurization units). As for the recent used thermal power stations uniformly dispatched by Shandong Power Grid, those equipped with flue gas desulsurization units are entitled to a on-grid tariff of RMB 0.015/kWh higher than those without installing such units. Meanwhile, the SO_2 charging rate will be raised from July 1, 2005. The construction of flue gas desulsurization projects has thus been effectively accelerated through the function of price lever.

In the government released list of 46 power stations without kicking off flue gas desulsurization projects in 2005, there are 9 power stations in Shandong, ranking the first in the nation. This matter received topmost attention from Shandong Provincial Government after the list was released. On February 2, 2005, it convened a dispatching meeting of power stations without kicking of flue gas desulsurization projects, and organized all municipal environmental protection bureau directors and the persons in charge of environmental protection from Huadian Group, Huaneng Group, Luneng Group and Qilu Petrochemical Complex as well the responsible officials of the 9 power stations on the black list to research measures of rectification. Following the meeting, all group corporations and their affiliates formulated flue gas desulsurization plans. Meanwhile, the Provincial Administration of Environmental Protection has boosted effort in law enforcement, and changed provincial flue gas desulfurization project dispatching from quarterly into monthly. During March 3~11, it made a concentrated inspection on key areas, and inspected 14 projects on site.

Through the proactive effort and earnest coordination of all parties, all the thermal power stations found through governmental or self-inspection without kicking off flue gas desulfurization projects have been proceeding in a rapid and orderly manner. By June 2005, the key flue gas desulfurization projects of Zouxian Power Station Phase III, Dezhou Power Station Phase II and Qilu Petrochemical Complex Heat/Power Project had been kicked off; the key flue gas desulfurization projects of Shiheng Power Station and Yunhe Power Station were under site clearing preparation; the key flue gas desulfurization projects of Shiliquan Power Station, Tengzhou Thermal Power Station, Bainian Power Station, Laicheng Power Station and Xindian Power Station had completed the feasibility study reports; and the key flue gas desulfurization projects of Rizhao Power Station, Nanding Power Station and Laiwu Power Station were under feasibility study.

II. The Cost Composition of Flue Gas Desulfurization

In face of the severe environmental protection landscape, the only way out is to undertake flue gas desulfurization renovation on thermal power stations. Based on the status quo and condition of domestic and foreign technological development, there are five methods of flue gas desulfurization available for thermal power stations: dry method, semi-dry method, wet method, semi-wet method and electronic method. The semi-wet method is the relatively matured and generally adopted approach.

(I) Major factors affecting the costs of flue gas desulfurization renovation for thermal power stations

At present, there are three factors that exert a significant impact on the costs of flue gas desulfurization renovation for thermal power stations.

1. Huge equipment costs. The flue gas desulfurization renovation project requires a one-time investment of approximately RMB 400/kW. The high initial investment is ascribed to the importation of core technology and critical equipment.

2. High operating costs. The normal operating expenses of desulfurization units are RMB 0.006-0.009/kWh primarily for limestone or gypsum shipment and storage,

sulfur containing waste water treatment, front chimney heating facilities, boiler's blower capacity expansion etc.

3. Site restriction. Since desulfurization renovation was not considered in the original design of old turbo-generators, there is no site reserved for renovation. Therefore, site restriction is prevalent in old power station renovation projects. To accommodate site conditions, most power stations have to choose inferior processes and plants. In addition, there are also safety evaluation problems for flue gas desulfurization renovation of old power generation units.

(II) Desulfurization Cost Composition

The costs of desulfurization include the following two major components:

1. Material expenses. The limestone calcium desulfurization technology is generally adopted in most thermal power stations in Shandong, and limestone is the key feedstock in chemical reaction. Accordingly, it is the most direct cost element of desulfurization. Limestone must be up to standard though not expensive. Sometimes, it should be crushed and baked into gypsum. Otherwise, it may adversely affect the efficiency of desulfurization. The important materials consumed in thermal power station flue gas desulfurization also include tap water, circulating water, electricity, fuel coal, and fuel oil relevant to and added directly by flue gas desulfurization. Some materials are desulfurization specific, while others are mixed for mass production purposes. The materials consumed in both cases can be calculated separately to evaluate material consumption in each case.

2. Other Expenses. The elements of cost include asset depreciation expenses, equipment maintenance fees, interest expenses, and labor expenses etc. The depreciation, maintenance and interest expenses for desulfurization are often intertwined with generic production, and should be allocated according to an appropriate ratio. Such expenses can be easily singled out in the event of old power station refurbishing. For new turbo-generators, however, it should be determined according to a material allocation ratio and base. Labor expenses mainly refer to the salaries, fringe benefits and allocated administrative expenses for those employees dedicated to flue gas desulfurization units. According to the findings of our survey on Shandong desulfurization projects, the salaries and fringe benefits are naturally listed

separately given a separate staffing for flue gas desulfurization units. Otherwise, it should be determined with comprehensive management plan.

The three survey samples in Shandong show that new environmental protection turbo-generators have a narrower scope of cost composition and lower unit cost than old system renovation given the use of similar flue gas desulfurization processes, because renovation not only needs additional staffing but also requires additional facilities at the removal site, resulting in extra costs. Meanwhile, new flue gas desulfurization units for old turbo-generator refurbishing are subject to an accelerated depreciation based on the period of depreciation calculated per the remaining life of power stations. In contrast, new environmental protection units are lower in cost. The ratio of new turbo-generator versus old turbo-generator desulfurization costs is 1:1.37. For detailed data, refer to the table attached below.

III. Typical Case Analysis

(I) Typical case of flue gas desulfurization for new turbo-generators

The Huaneng International Jining Power Station is located off the Weishan Lake in the outskirt of Jining City, Shandong Province. After kicking off construction in 1973, 2 x 50 MW and 2 x 110 MW coal-fired units had consecutively put into operation. In 2003, it added 2 x 135 MW circulating fluidized bed (CFB) environmental protection units. As of 2004, the power station had 1700 employees, total assets: RMB 1.102 billion, total installed capacity: 595 MW, annual power generation: 2805 million kWh, total power supply to grids: 2530 million kWh, annual operating hours: 4714, equivalent coefficient: 93.58%, internal power consumption: 9.8%, coal consumption: 340.88 grams/kWh (power generation)/, 377.93 grams/kWh (power supply), unit cost: RMB 0.262/kWh, and average tariff (net of tax): RMB 0.2999/kWh.

With an original cost of RMB 726.46 million, the 2 x 135 MW CFD environmental protection units were “made domestically” in Shanghai. The theory of desulfurization is to add limestone in the course of operation to generate calcium sulfate through chemical reaction with SO_2 resulting from coal combustion. The calcium sulfate is discharged from the residue cooler to achieve a 90% efficiency of desulfurization. Given the two characteristics of low combustion temperature (∠900℃) and small air throughput of turbo-generators, the overhead SO_2 emission can be effectively controlled to improve the natural ecological environments. With the advantages of using inferior coal as feedstock, modulating load at ease and utilizing slag effectively, CFD units are the most practical coal-fired units featuring high efficiency, low pollution, and cleanness in China.

The key feedstock for CFD desulfurization is limestone. Compared with general pulverized coal boilers, there is an absolute increase in limestone, power and water consumption.

(1) Limestone cost. With an hourly limestone consumption of 7.3 metric tons, the annual limestone cost is RMB 3.01 million based on 5000 operating hours per year and RMB 75 per ton of limestone.

(2) Electricity cost. Power consumption increases by 3.2% because of the required addition of CFD blower and residue cooler, resulting in an annual reduction of 24.06 million kWh in power sales and a cost increase of RMB 7.22 million.

(3) Water cost. Compared with conventional turbo-generators, CFD units increase water consumption by 112,000 metric tons per annum, resulting in an additional cost of RMB 78,000 per year based on the price of RMB0.7/ton.

(4) Fuel cost. Given the defective design of large capacity Circulating Fluidized Bed boilers made in China, coal and fuel consumption has increased relative to conventional pulverized coal boilers. As a result of large coal particle size and incomplete combustion, Circulating Fluidized Bed (CFD) boilers discharges fly ashes containing 6~8% of carbon, approximately 3 times more than pulverized coal boilers. Consequently, boiler efficiency declines by 1.2%, unit coal consumption increases by 5 grams/kWh compared with pulverized coal boilers, and coal costs increase by RMB 560,000 on average per annum. CFD boilers are difficult to start up, and each startup requires 30-40 metric tons of heavy oil/diesel, which are 25-30 metric tons more than that for pulverized coal boilers per time. Based on the current price, the additional consumption of 114.2 metric tons of heavy oil/diesel results in an annual cost increase of RMB 1.14 million as the number of start ups increase.

(5) Depreciation expenses. Compared with pulverized coal boilers, the large capacity CFB boilers incur more depreciation and maintenance expense because of their operating complexity. The purchase cost of each CFB boiler is RMB 61.76 million more than that of a conventional pulverized coal boiler, resulting in an annual increase of RMB 4.26 million in depreciation.

(6) Maintenance expenses. As a result of the large fly ash particle size, high flow speed, wider heating coverage, fast heating surface wear/tear, short maintenance cycle and high overhauling frequency, CFB boilers necessitate additional times and costs of maintenance. The annual cost increases by RMB 3 million for boiler specific abrasion proof coatings.

(7) Administrative expenses increase by RMB 130,000 on an annual basis mainly in the form of salaries/fringe benefits and administrative fees.

In view of the above, the 2 x 135 MW CFD units of Huaneng International Jining Power Station incurs an additional cost of RMB 19.19 million for flue gas desulfurization, resulting in an increase of RMB 0.0145/kWh in the costs of power generation based on 1320 million kWh of power supply to grids. For detailed data, refer to the table attached below.

(II) Typical case of flue gas desulfurization for old turbo-generators

The Huangtai Power Station is located in the southern outskirt of Jinan, the capital city of Shandong Province. With construction kicked off in 1958, it is both the first high voltage power station in Shandong and the key power station in the Shandong Power Grid. At present, the power station has a portfolio of 3 x 25 MW, 1 x 50 MW, 2 X 100 MW and 2 x 300 MW coal fired units. As of 2004,it had 2332 employees, total assets: RMB1.8 billion, total installed capacity: 925 MW, annual power generation: 5028 million kWh, power supply to grids: 4619 million kWh, annual operating hours: 5094, internal power consumption: 7.88%, equivalent coefficient: 92.7%, coal consumption: 349 grams/kWh (power generation)/375.5 grams/kWh (power supply), unit cost: RMB 0.2853/kWh, and average tariff (net of tax): RMB 0.2432/kWh.

To mitigate air pollution, the power station has recently undertaken a desulfurization renovation of the 2 X 300 MW units. With a total investment of RMB 194.4 million (20% self financed/80% loaned), Unit 7 was completed in November 2004. With a total investment of RMB 198.2 million (20% self financed/80% loaned), Unit 8 was completed in December 2003. With 80% of equipment made in China, the renovation project features domestic design, independent construction and proprietary intellectual property rights. The project cost is RMB 650/kW, 46% lower than importation. The wet limestone-gypsum process is used in desulfurization. In trial operation, the project has reached the advanced domestic or international levels for each major economic index, resulting in a reduction of 38,400 t/a SO_2 emission and 1800 tons of dusts per year.

Trial operating costs of flue gas desulfurization: The total operating cost of Unit 7 amounts to RMB 34,509,300 and the total unit cost (including tax and debt service) amounts to RMB 0.0425 /kWh based on average cost RMB 0.023 per KWH; The total operating cost of Unit 8 amounts to RMB 33,214,300 and the total unit cost total unit cost (including tax and debt service) RMB 0.0426 /kWh based on average cost RMB 0.022 Per KWH. Additional cost is incurred because: i) as a large national flue gas desulfurization demonstration project, it faces heavy debt service pressure because of the early and large investments; ii) in spite of its high efficiency (up to 95%), the wet desulfurization process consumes more materials, labor, water and electricity etc.; iii) as a renovation project, the term of debt service and depreciation is shortened because Units 7 and 8 have been in service for 18 and 25 years respectively.

The specific bases of calculation are as follows:
(1) Material expenses. Annual limestone cost: RMB 3.45 million based on an annual consumption of 69,000 metric tons at the price of RMB 50/ton; annual tap water cost: RMB 960,000 based on an annual consumption of 300,000 metric tons at the expected price of RMB 3.2/ton; annual circulating water cost: RMB 230,000 based on an annual consumption of 450,000 metric tons at the unit effluent treatment cost of RMB 0.5/ton; annual electricity cost: RMB 17.58 million based on an annual consumption of 60 million kWh at the tariff of 0.285/kWh.

(2) Labor expenses. Total number of employees: 46, annual average salary per

employee: RMB 28,000, total annual salaries: RMB 1,288,000; annual fringe benefits per employee: RMB 18,000, total fringe benefits: RMB 818,000; total annual labor expenses: RMB 2.11 million.

(3) Depreciation expenses. According to the 30-year depreciation policy, it is decided that Units 7 and 8 will be depreciated in 15 years because they have a remaining life of 13 and 16 years respectively after 17 and 14 years of service. Based on the 6.7% depreciation rate, the annual depreciation amounts to RMB 13.025 million and RMB 12.006 million respectively for Unit 7 and Unit 8 upon the desulfurization projects go into operation.

(4) Maintenance expenses. The annual maintenance expenses are RMB 4.86 million and RMB 4.48 million for Units 7 and 8 respectively based on the policy of accruing such expenses at 2.5% of asset costs.

(5) Financial expenses: The 2 x 300 MW flue gas desulfurization renovation project was financed with a 10-year maturity/8-year repayment term loan repayable in annual installments at an interest rate of 5.76% per annum. With a loan of RMB 155 million, Unit 7 needs to repay RMB 19.375 million principal and RMB 4.464 million interest per annum. With a loan of RMB 158.6 million, Unit 8 needs to repay RMB 19.825 million principal and RMB 4.568 million interest per annum.

The above 2 x 300 MW units add an annual flue gas desulfurization cost of RMB 67.5 million, resulting in a unit cost increase of RMB 0.0225/kWh based on 3 billion kWh of power supply to grids. For detailed data, refer to the table attached below.

IV. Recommendation for Tariff Compensation

(I) Basic Principles

The costs of flue gas desulfurization must be compensated for in full amount. Currently, the cost cannot be fully compensated because of the inadequate increase in tariff for desulfurization. Take Shandong Huangtai Power Station as an example.

Despite the tariff increase in 2005 as a result of coal gas cogeneration, the adjusted on-grid tariff of the power station is still the lowest in Shandong, and the plant-wide average tariff is RMB 0.048/kWh lower than the average price in the province. The tariff for the desulfurization renovation project of the power station is RMB 0.019/kWh lower than that of new desulfurization units in the province, causing the power station to lose RMB 17 million for its desulfurization units and bleed a total of RMB 131 million. As a consequence of adopting such a policy, some power stations fail to operate their installed desulfurization units at the designed capacity or shut them down from time to time if uncaught.

(II) Compensation rate set per class

Based on the above findings of survey and especially the typical case analysis, the tariff compensation rate for flue gas desulfurization cost should be set on a per-class basis. Our preliminary opinions are as follows:

If actual efficiency ≤94%，RMB 0.012/kWh for new units; RMB 0.015/kWh for old units;

If actual efficiency ≥95%, RMB 0.015/kWh for new units; RMB 0.020/kWh for old units.

Table The composition and size of flue gas desulfurization costs for different coal-fired turbo-generators in Shandong in 2004

Costs	Unit	Jining New Unit 2×135mw	Huangtai Old Uint 2×300mw	Weifang Old Unit 2×300mw	Old Unit Renovation Evaluation
Limestone	RMB 10,000/year	301	345	450	795
Coal	RMB 10,000/year	56	—	19	19
Fuel oil	RMB 10,000/year	114	—	—	—
Pure water	RMB 10,000/year	—	96	38	134
Electricity	RMB 10,000/year	722	1758	1378	3136
Depreciation	RMB 10,000/year	426	2503	2353	4856
Maintenance	RMB 10,000/year	300	934	739	1673
Interests	RMB 10,000/year	—	903	88	991

Labor expense	RMB 10,000/year	—	211	100	311
Annual output	100 million kWh	13.2	30.0	30.0	60.0
Unit cost	RMB/kWh	0.2360	0.2715	—	—
on-grid Tariff	RMB/kWh	0.3209	0.2429	0.3061	0.2888
Desulfurization expenses	RMB 10,000/year	1919	6750	5165	11915
Desulfurization costs	RMB/kWh	0.0145	0.0225	0.0172	0.0199