1. The Approach of the WG on Energy Strategies and Technologies

The Working Group (WG) continues to be guided by its mandate which is to provide advice to the CCICED on energy strategies and technologies which are aimed directly at satisfying the energy needs of China over the next decades, and at the same time furthering achievement by China of its Agenda 21 goals. The approach of the WG has been evolved over the past three years and continues to be effective, we believe, is to pursue a twofold strategy of internal expert study and reporting, and external promotion and running of workshops on key advanced sustainable technologies and strategies. The workshops are expressly aimed at encouraging demonstration projects utilizing technologies on both the demand and the supply side that in the WG’s opinion merit wide recognition and application in China. The WG relies on its extensive international and Chinese contacts to achieve as broad as possible representation of presenters and attendees from interested organizations. The WG strictly resists being drawn into any hands-on project development and management.

The role of the Working Group with respect of demonstration projects is therefore that of advisor and broker. By convening and chairing Workshops, the WG itself gains valuable insights into the merits/demerits of specific technologies and strategies, and is brought into contact with the practical realities of achieving higher standards of sustainability. The WG maintains a close interest in the outcome and follow-up of these initiatives.

Recognizing China’s abundant domestic energy resources, the WG seeks to find optimum ways of developing an energy supply mix which takes full advantage of those resources, including conventional and unconventional resources wherever it appears that meeting the objectives spelled out in China’s Agenda 21 can be aided.

2. Developments from the 1995 Report

2.1 Integrated Resource Planning

A combination of Integrated Resource Planning (IRP), and DEFENDUS analytical methodology was used by Professor Qiu Daxiong, Institute for Techno-Economics and Energy System Analysis (ITEESA) at Tsinghua University, to generate important new insights into China’s long term energy future. His report entitled “Development and Dissemination of Efficiency-Oriented and Environmentally Constrained Alternative Energy Scenarios (EASES) in China” after being discussed at length at the 7th meeting of the WG, was issued in April, 1996, and discussed at the 8th meeting of the WG. The conclusions of the report and comparisons with other major studies relating to this topic are summarized below in section 3 (see also the documents accompanying this report).

Additional scenarios will be developed this year by Tsinghua University which will explore the possible effect of the higher performing technologies delivering their full potential in terms of greenhouse gas efficiencies in critical areas, thus giving rise to a wider range of scenario outcomes. On the supply side, it is also suggested that renewable energy sources could make a much larger contribution in favorable circumstances over the timeframe considered (1990-2020).

IRP continues to be better understood and is gaining acceptance in China after the two major Seminars held under the auspices of the WG and the International Energy Initiative. The methodology is now being applied in several provinces, cities and companies by the participants in the Seminars. It is usefully filling a gap in the macro-planning area, particularly in the methodology for optimizing the inter-relation between the supply and demand side of the energy sectors. A third IRP Seminar, for 40 attendees, to be run by the WG in cooperation with Tsinghua University and the International Energy Initiative, is planned in conjunction with the 9th Meeting of the WG in Beijing in late 1996.

2.2 Developments from Earlier Workshops and Proposed Demonstration Projects

2.2.1 Steelmaking
Follow-up on the Workshop on energy-efficient steelmaking held in May 1995 indicated that good progress was being made on the establishment of energy-efficient Co mpact Strip Production (CSP) technology in China by a participating company at the May Workshop. This is encouraging for the WG and for the furthering of efficiency in this energy-intensive industrial sector. However, the WG's main aim to promote interest in establishing state of the art, integrated, new technology involving iron-making, steel-making and steel processing so far remains a goal rather than a reality. It is also recognized in the WG that they are not as fully informed as would be desirable on the overall developments in the steel-making sector, including import vs domestic capacity utilization, and it remains an objective for 1996/7 to improve this situation.

2.2.2. Fuel cell buses

The workshop in May 1995 on this theme generated sufficient interest in Beijing for the promotion of a highly visible demonstration of this ultra-clean transport technology in the capital. UNDP has responded favorably to a proposal by the Beijing Public Transportation Company for feasibility study funding. The most promising area for fuel cell application are in the transportation sector, which is addressed in this report.

There is an important development the WG wishes to bring to the attention of CCIC ED. Independently of the fuel-cell project, there is another Beijing-based electric bus project, involving a China Yuanwang/Northrop-Grumman joint venture. It is further down the track than the fuel-cell demonstration, and intends to deploy prototype electric-powered buses with electric drivetrains. In principle, the fuel cell propulsion unit, which is the key innovation in the new demonstration, could, in due course, replace the batteries in such vehicles. Like battery-powered vehicles, fuel cell vehicles would have zero or near-zero emissions. But once fuel cells are established in transport markets, they are expected to be lighter, less costly, and require much less time for refueling. In any case, to be successful the fuel-cell initiative will require the utilization of a new generation of buses with electric drive trains. Thus the battery electric bus project is timely and harmonizes well with the efforts to introduce efficient, ultra-clean, and affordable buses in China.

3. Alternative Energy Scenarios for China

The ITEESAP report, prepared under the direction of Professor Qiu Daxiong, furnishes three energy scenarios. All scenarios assume a GDP growth between 1990 and 2020 by a factor of 8.3, corresponding to an average growth rate of 7.3% per year, and a per capita GDP growth of a factor of 6.6, corresponding to 6.5% per year. The scenarios are distinguished by three degrees of emphasis placed on energy efficiency by the energy industry and consumers, and separately, on the supply mix and emission control.

In the “Business As Usual” (BAU) scenario energy demand is projected on the basis of present trends, such that the present conventional supply mix continues, and upon which are imposed only “inertial” efficiency improvements made in response to regulatory moves such as environmental protection laws. Energy demand grows only by a factor of three, from 27 to 82 exajoules (EJ) per year, 1990-2020, which represents a major improvement in energy efficiency.

The “Aggressive Efficiency” (AE) scenario opts for more energy-efficient technology than BAU, and has a primary energy demand of 71 EJ in 2020, a 26 times that of 1990. The level of energy intensity improvements assumed in the economy is very large, from 73 KJ/US$ in 1990 to 26 KJ/US$ in the ECE scenario in 2020. For comparison, the energy intensity of the USA is approximately 16 KJ/US$, and for Japan 8 KJ/US$. These numbers refer to economies being compared on a market exchange rate basis, which is a questionable method, since it assumes that there is a free market for currency exchange, and that all goods and services are exchangeable, including such as land, electric power, and transportation. A better way of comparing involves the purchasing power parities (PPP) instead of market exchange rates. AGDP expressed with PPP provides a correction for the differences between domestic and international prices. For India using PPP reduces the energy intensity of the economy by a factor of 3, while it does not significantly affect the industrialized countries. If the same factor between market exchange rate and PPP as for India applies to China, the energy intensity of 1990 would be reduced to 24 KJ/US$.

The “Environmentally Constrained Energy” (ECE) scenario selects a higher proportion of cleaner technologies, in satisfying the same energy demand as for AE, but the higher contributions from non-coal energy resources would reduce carbon emissions by 7% relative to AE by 2020. However, this is still an increase over the 1990 level by a factor of 2.4. Sulphur emissions are up by a factor of 1.35, and particulates by a factor of 2.3 compared to 1990.

Interestingly, it emerges that the overall cost of energy supply in AE is less than in BAU, which means that the net cost of reducing CO2 emissions within these parameters is negative. The same is true if the ECE scenario were to satisfy the same economic goal as BAU.

ECE struggles to boost the share of clean electricity from hydroelectricity, nuclear power, and renewables, the last mentioned occupying a very minor role under these assumptions. It is an important aim of the WG to change perceptions on the potential contribution achievable by renewable energies, particularly over this scale of timeframe. History teaches us that cost barriers quickly come down once new technologies become sufficiently accepted to ignite large production and market competition. For this reason the WG have asked that additional scenario(s) be constructed to embrace a wider range of outcomes, reflecting a realistic variance between failure to achieve the optimism of BAU and the not
unreasonable possibility of outdoing the successes of AE and ECE.

HOW wide the quantitative divergence of scenarios could be is reflected on the spread of forecasts published in a number of scenarios on China's energy demand up to 2020, see Table 1. By 2020, the spread of energy demand forecasts differ by 40%.

All scenarios agree, however, in the key matter of the continuing huge dominance of coal in the Chinese economy under any scenario in this timeframe. Even so, opinions differ as to the proportionate share of coal, hydro, nuclear, and gas used in making electricity.

Renewable energies hardly feature in current energy scenario energy scenarios, only rising above a generally assumed fraction of 1% in the ERI study for the World Bank, where 3.8% is achieved in 2020. This may be the single most common miscalculation in current thinking in energy forecasting. In a 20 year timeframe the relative share of renewables probably has the greatest potential for surprise on the upside.

Given the fact that emission in all of the studies quoted in Table 1 are projected to increase significantly over the present levels, that are already considered high, it is not clear that these present projections display future energy systems that are compatible with China's Agenda 21. This creates strong stimulus to continue the search for energy systems that are economically and environmentally more efficient.

Table 1. Some recent energy projections to 2020 for China.

4. New WG Work

4.1 Reports on studies by Working Group members

4.1.1 Natural Gas

To repeat a conclusion already expressed in previous reports, China has a much larger potential for developing its natural gas industry than is suggested by very low contribution (2%) to national energy needs presently being made by this environmentally friendly fuel. A tenfold increase in this parameter would place China's gas in a position closer to the role of natural gas in the world. Development of natural gas has been hampered by greater attention that has been historic ally paid to oil development in periods when resources have been scarce. Also, unequal competition with abnormally low priced coal, which is the main competing fuel in the potential markets for natural gas, has created obstacles to the orderly growth of a gas industry. The main exception has been in the province of Sichuan, where the abundance of gas fields and the proximity of a highly populated local market has enabled these difficulties to be overcome.

The situation is now radically changing, as the on and offshore petroleum and natural gas corporations are now stimulating aggressive in-house exploration and Sino-foreign joint ventures, the results of which are now beginning to augment the nation's meager gas production statistics.

Institutional changes to the relative pricing regimes for natural gas and coal could further enhance the prospects for additions to the national inventory of developed gas fields.

Notwithstanding the current encouraging trends in the supply of gas, the scale of the challenge, physically, geologically and financially, can easily be underestimated. The forecast outlook for the gas supply over the next 20 years (State Planning Commission, ERI, April 1996) shows a threefold increase in the share of gas, which involves a fivefold increase in production by the year 2020, coupled with at least one major import project of 40 billion m^3 of pipeline gas and/or LNG.

Forecasting future gas availability is inherently subject to serious uncertainties, the geological uncertainty surrounding domestic gas avakuabukuty can be reduced by sustained investment in surveys and drilling and this should lead to a better inventory of the recoverable reserves, and assist national planning for this resource. The eventual contribution from imports has no resource uncertainty, except in the short term for LNG since most of the international supply sources are committed elsewhere. The remaining uncertainties are commercial, political and financial and these are all clearly linked. If these can be clarified and resolved there is, in principle, no limit to the physical availability of pipeline gas from the FSU. Thus the assumptions on gas import by pipeline reflect opinion on the resolvability of these problems, and the range of possibilities remains wide.

LNG is a specialized gas fuel with particular relevance to large, industrialized municipalities close to the sea. Guangzhou, Hong Kong and Shanghai are typical candidates where the benefits of this clean fuel could be gained in the power generation, industrial and residential sectors. LNG coexists happily with pipeline natural gas, since when regasified it is the same substance, methane. LNG has a part to play in China, probably mainly in the south and it is conservative to forecast that by 2020 probably all three cities will be partly supplied by this means.

Methane can also be recovered and utilized from coal seams, to the advantage of the mining operator as risks of explosion and fire is thereby reduced. Power can also be obtained where sufficient coal bed methane (CBM) can be gathered. A third benefit to the community as a
4.1.2 Industrial-Scale Wind Energy Development in China

While China has some of the best wind energy resources in the world, many of these resources are concentrated in regions that are remote from electricity demand centers, and they remain at present virtually unutilized. For example, good wind resources are available over about 80,000 km² (0.9% of the total land area of China) of Inner Mongolia. Wind farms based on the use of modern wind turbines in this region could provide about 1800 TWh/year of electricity, more than twice the total rate of electricity generated from all sources in China in 1993. But in Inner Mongolia the population density is so low that a tiny fraction of the wind resource could be adequate to service future local electricity needs.

In the WG’s opinion, wind energy should not be neglected as a potential major source of primary energy, since it is in China’s interest for all domestic energy resources to be tapped to the extent that it is technically and commercially feasible. In a study carried out by the WG a strategy is developed for harnessing a large fraction of such remote resources. The basic concept is to build large wind farms and transmit the produced electricity via long-distance transmission lines to distant markets. To keep the cost per unit of delivered electricity low, transmission lines should be of large capacity (≥1 GWe), and a particular line should be matched to a much larger wind farm capacity, and in some instances energy storage as well. When this is done, the capacity utilization factor for the transmission line can be high (>50%) and greater than the capacity factor for the wind farm itself. With commercially proven electric storage technologies (e.g., pumped hydro power or compressed air energy storage), even steady baseload wind power can be delivered to remote electricity markets this way. This study estimates that electricity produced in such large wind farms in Northern China could potentially be cost-competitive with electricity from coal, if the wind turbines were mass-produced in China (e.g., via international joint ventures).

1. With average wind speeds at 10 m/s at least 7 m/s.

2. Debra L. Lew, Robert H. Williams, Xie Shaokiong, and Zhang Shihui, "Industrial-Scale Wind Power for China".

The obstacles to realizing the potential offered by this strategy are institutional rather than technological: all the technologies are commercially available, and China could quickly develop the industrial capacity to harness its wind resources this way and, at the same time, demonstrate economic feasibility of wind power. But to date, wind power development has not been carried out at such scales. In most regions where wind resources are being developed, a 50 MWe wind farm is regarded as large, and vendors are not accustomed to developing wind farms with capacities of 1000 MWe or more.

However, an institutional mechanism is already well established in the oil and gas area in China, which could be used for implementing this wind development strategy: the resource development concession, an instrument that has proved to be very effective in developing resources in the mineral extraction industries (e.g., petroleum, natural gas, metals). This instrument applied to wind power development might work as follows: In a delineated region of high quality wind resources, the government would offer concessions to venture company partnerships (for example, between local government and private sector entities), to explore and develop wind energy in the region over a specified period of time. Such concessions do not involve ownership of national resources, but rather, under the agreement, the concessionaire would assume all the upfront technical and financial risks associated with the uncertainties relating to initial developmental activities, in exchange for rights to share in the benefits that would arise from the sale of the product, electricity.

In this way China would be in the forefront of making new, large-scale wind power a commercial reality at little or no domestic risk. Wind energy can be developed this way only if a well-defined regulatory/legal framework is in place that defines how concessions would be offered and enforced. Such a framework might be put in place relatively quickly, by drawing on experience in, for example, the petroleum sector with modifications appropriate to the unique attributes of the wind resource.

The Working Group recommends to CCICED that China establish the needed regulatory/legal framework for wind development concessions and begin, via the wind resource development concession, large-scale wind energy development in wind-rich regions such as Inner Mongolia. (See also the report on the workshop on wind energy, section 4.2.1 below.)

4.1.3 Geothermal Energy

http://www.cciced.net/enciced/policyr/Taskforces/phase1/wgest9296/200802/t20080202_145324.htm
Geothermal energy accounts today for a small fraction (less than one percent) of the energy supply at the world level. Although its development is rather rapid, its ultimate contribution—at least based on present technologies—is not expected to become substantially higher, due to the limitation of the resource basis, which makes it technically and economically applicable only in a limited number of geographical areas. New technology, in particular the hot dry rock (HDR) technology, may extend this applicability, but the status of HDR development does not at this time allow any reliable prediction.

However, geothermal energy may be of great importance in particular areas or situations, by supplying power or heat at reasonable cost and with limited environmental impacts where other options are not available, or are too expensive, or risk to damage the environment.

China has an important potential geothermal resource. It is already exploiting it on a fairly large scale for direct uses, which sees China at the very first place at the world level. The role of geothermal energy in China may become crucial in some areas, in particular in Tibet, where abundant resources are present, the ecosystem is fragile, and other energy sources are not easily available apart from hydropower and solar energy. However, it has been noted that religion in Tibet att ributes a sacred status to water, which makes it more difficult to exploit hydrotectic resources in a dispersed manner, and which enhances the scope for using geothermal energy.

China has abundant geothermal resources in different areas: the south-west (Tibet autonomous region, high temperature), the south-east coast and the north-east coast (Shandong-Liaoning, medium-low temperature). The total potential of geothermal power generation for the Himalayan belt has been estimated at 1700 MW (conservative) to 6700 MW (optimistic). The presently installed capacity is only 32 MW. Large potential for direct heat uses have been identified, and more than 4000 features and 181 geothermal systems have been mapped. China annually uses over 5.5 TWh of geothermal direct heat, heating more than 1.3 million square meters, mostly in northern China, and more than 1 million square meters of greenhouses and 1.6 million square meters of fish ponds.

Geothermal energy has a role to play in the future energy scenario of China, that although quantitatively limited, is important in addressing local problems and may be able to alleviate environmental problems in cities by providing a clean alternative for space heating. Attention is already given in China, and this should continue, to legislative aspects, property regimes, concessions for exploration and production drilling, environmental aspects, and exploration and evaluation of geothermal resources.

4.2 Reports from Workshops run by the WG

4.2.1 Large Scale Wind Energy Development in China

The WG convened a Workshop on Large-scale Wind Energy Development in China, in Beijing, 6-7 November 1995. The Workshop was attended by 15 participants in addition to WG members. The Chinese participants included representatives of the Ministry of Electric Power, the Inner Mongolia Wind Energy Group, the Fujian Electric Power Bureau, the Chiana Fulin Windpower Development Corporation, the China Corporation for Consulting and Engineering, and the Beijing Academy of Electrification (optimistic). The presently installed capacity is only 32 MW. Large potential for direct heat uses have been identified, and more than 4000 features and 181 geothermal systems have been mapped. China annually uses over 5.5 TWh of geothermal direct heat, heating more than 1.3 million square meters, mostly in northern China, and more than 1 million square meters of greenhouses and 1.6 million square meters of fish ponds.

The international presentations by Williams, Draker, and Gual focused on aspects of the novel approach for exploiting China’s large remote wind energy resources as described in the paper discussed in session 4.1.2—a draft of which was prepared by Williams. All these talks pointed out that the obstacles to realizing the potential offered by this strategy are institutional rather than technological. Draker, who formerly managed the Pacific Gas and Electric company in California, said large remote wind energy development “are commercially available—including compressed air energy storage, which was discussed in the presentation by Gual.”

4.2.2 Energy-Efficient Commercial Buildings

Owing to the high growth rate and massive scale of building construction and the long-term implications on energy demand being generated by the building sector, it is of high priority to make new buildings highly energy efficient, when it is much easier done than as a retrofit. The energy-intensive commercial-crial-building sector poses both a challenge and an opportunity in this respect. This is because the latest energy efficient buildings technologies are available to China at a time when there is a huge buildings programme, and the opportunity exists to leapfrog in this
area over industrialized countries that have a legacy of older energy-inefficient buildings

A workshop on demonstration of energy-efficient commercial buildings was therefore organized in Beijing, November 7-8, 1995. The workshop was attended by about 30 participants, including representatives from Ministry of Construction, State Planning Commission, Finance and Trade Development General Company, Shanghai, China Investment Company for Energy Conservation, Tsinghua University, State Economic and Trade Commission, Beijing Energy Efficiency Center, Beijing Institute for Construction Development and Research, China Construction General Company, Beijing Construction Group, and Institute of Construction Science.

Presentations were given by Mr. Dale Sartor and Mr. Joe Huang, Lawrence Berkeley Laboratory, Berkeley, California; Mr. Richard Bourne, Davis Energy Group, Davis, California, and Mr. Lee Eng Lock, Supersymmetry, Singapore, from the international side, and by Mr. Miao Tianjie, China Investment Company for Energy Conservation, Mr. Yang Weiching, Beijing Institute for Construction Development and Research, Mr. Wu Yuanwei, China Academy of Building Research, Mr. Shu Guohua, Lujiazui Planning and Designing Institute, and Mr. Jiang Yi, Tsinghua University, from the Chinese side.

The presentations by the international experts illustrate the very large possible reductions in energy use in new commercial buildings that have been demonstrated in recent years, and the analytical techniques and specific building components and systems that have contributed to this development.

It was generally agreed that these opportunities should be made visible in China through demonstration projects. The demonstrations should focus on building types where the growth of the stock is rapid, and which contribute significantly to the growth rate of China's electricity demand. Commercial buildings in general were considered to be such an area, and office buildings a suitable segment for demonstrations as this part of the industry is "taking off." Demonstrations should be in areas and locations with high visibility.

Technological demonstrations must be accompanied with measures to build domestic capacity to design, build, operate and maintain the building and all its installations properly.

As climatic conditions vary dramatically in China, and because of the size of the country, demonstrations projects should be encouraged in several locations covering different climatic conditions.

Careful evaluation at the design stage must be made if the systems aspect of the functioning of a building. Analytical tools are now available to facilitate this (for example the DOE-2 computer code), and should be used. Likewise, tools are available to track and optimize long term performance. Performance monitoring will be especially important for the demonstration projects.

The demonstration projects should emulate energy efficiency standards comparable to the best available today in the world. Key technologies should be identified for different buildings and climate conditions using design tools such as those mentioned above. Importation of some efficient technologies for key functions (from an energy efficiency perspective) should be considered when necessary for the demonstrations. Such technology areas are likely to include lighting, windows, air conditioning, and control technologies. The importation of specific technologies should be made with a view to creating domestic production, for example through joint ventures.

Demonstrations must also be followed by policy measures to give players incentives to make full use of technological opportunities. Studies should be made of potential policies in areas where market imperfections should be given incentives to invest in energy efficiency to the degree this is economically rational in an national perspective, for example by introducing hook-up fees that reflect the required additional capacity in investment in the power system, i.e., the capital cost of power plant should be included in the tariff.

Strong interest in participating in the demonstrations were expressed from the China Investment Company for Energy Conservation, Tsinghua University and Finance and Trade Development General Company, Shanghai. A project proposal is being prepared under the direction of professor Zhou Fengqi.

4.2.3 Changing Roles of Government and Enterprises for Sustainable Development

A workshop on the "Changing role of Government and Energy Enterprises for Sustainable Development" was organized in Beijing, MAY 5-8, 1996.

The purpose of the Workshop was to help Chinese government organizations and energy enterprises improve the orientation of their administration and management to ward sustainable development. China's economy is still under transition, and the role of government is to change from owner manager to that of a supervisory role and to provide public stewardship. However, such change is not easy, and in certain areas government still works as owner of enterprises, and enterprises do not yet have their independent rights to manage. In addition.
energy enterprises are often monopoly business and produce pollution that market forces cannot regulate. Government has a new role to play in creating the regulatory framework that will lead to sustainable development, such as expressed in China's Agenda 21.

There were nineteen Chinese participants, among them two mayors, one director of a provincial planning commission, energy researchers, and senior engineers.

Chinese lecturers discussed the theory of property rights, the transaction costs, the external costs, the origin of government and other problems associated with the relationship between government and energy enterprises in current Chinese economy.

Mr. Claude Dubois, an expert from Electricité de France, presented the role of the French state-owned electricity monopoly in the integrating European market. He recalled the heavier weight of the public sector in the French economy (10% of employment, 20% of GDP) against which the role of the EDF should be considered. He also reasoned that the state-ownership and the public service characteristics of electricity. My Dubois explained an multi-year contract plan system with the French authorities under which certain socio-economic targets are set for the EDF.

Mr. Keiichi Yokobori, a WG member, reported on the role of the government in the Japanese energy sector. He pointed out that the state-owned energy firms did not play a key role in the Japanese energy markets and that close com-munications between government and energy sector were widely ob-served. Besides regulatory actions, advisory councils provide various opportunities for information exchange and formulations of common perceptions on the energy situation between the government and the industry. He also reported on the on-going deregulation in the Japanese energy markets. While greater competition would emerge in energy markets in general, it appeared uncertain how far electricity sector deregulation would go because of public utility concerns.

The discussion dwelt largely on the electric sector leaving the other energy sectors (oil, coal, and gas) almost untouched. The perceived public service aspect of electricity and the economy of scale as discussed above would explain this bias towards electricity. Further, many Chinese participants appeared to feel the supply shortfall more acute in electricity than among the other energy sectors.

The Workshop was very informative, however, too much attention was given to power supply relative to other energy industries and energy efficiency, and too little attention was given to the issue on how to achieve sustainable development in a market-oriented economy. In hindsight, the scope of the original workshop was perhaps too wide. Accordingly, to focus more directly on the importance of sustainable development, a second workshop was suggested.

4.3 Work in Progress

4.3.1 Greening China Action

China has approximately one hundred million of surplus labor in the rural areas, and vast wasteland and barren hills. If these resources can be combined to plant trees, income can be created (forest products and bioenergy) and the environment can be greatly improved. In addition, there is no lack of funds in China because Chinese people currently deposit trillions of yuan into bank accounts at a negative interest rate. This money now produces much less of a profit than if it had been invested in plantation of trees. The reason why capital is not working to combine labor and land to plant trees lies in the institutional arrangements, for example, insecure ownership, long time needed to recover capital, and the high risks in the plantation industry (pest, fire, theft). The WG suggests that a legal system be developed that can improve ownership security, to establish a market for young trees, and that an insurance business be created for plantation risks. Such a policy could help relieve poverty in remote areas. The current trend of labor flows to coastal areas for employment creates many social problems. This can be reduced. The fundamental policy to relieve poverty in remote areas is to generate jobs by investing capital in these areas.

A recent development in this regard is that several types of contracts have been designed and are being tested for their effectiveness in creating investment in afforestation in Shanxi Province. The implementation of the agreements will be watched. If the system works well, the contract can be designed as a standard contract and more capital can be introduced.

4.3.2 Transportation

A preliminary study on China's transportation sector and its energy use was concluded. The main findings in the Transportation Report are:
Elasticities of transportation relative to GNP growth are identified both for freight and passenger, and future increase of transport is predicted based upon summed growth rate. The expected volume of transport in the year 2004 may be double than that in 1994.

Transport intensity in GNP was discussed and international comparison was made. Also the change of mode split of freight and passenger transport along time was analyzed; the future development was discussed; high speed railway seems necessary.

The energy consumed by transport sector takes only about 10% which is very low as compared with other countries, developed and developing. The share of energy consumption by transport sector will increase, and energy conservation will become more important.

The pricing with the transport sector involves complicated problems and is now heavily distorted that leads mis-allocation of resources and great waste.

Highway private car transport is not a major means for inter-city transportation, but will increase, so its policy has to be studied.

5. Workplan 1996-97

5.1 Integrated Resource Planning

The WG will continue its cooperation with Tsinghua University (Professor Qiu Daxiong) on the application for the Integrated Resource Planning approach to the analysis of Chinese energy options. A third workshop in IRP is planned for December 1996, bringing together the growing community of IRP analysts in China.

5.2 Coal

Given China’s very large resources of coal, and the present dominance of coal in energy supply with all its associated problems, a great deal of work has been done in China on near-and medium-term options to improve and clean up the use of coal. Far less attention has been given to medium-to long-term strategic approaches to the utilization of coal.

The WG discussed the longer-term strategic options in the light of recent technological developments. It was felt that technological opportunities are now merging to use coal without the present environmental penalties. Many technological concepts are being discussed in many countries. However, there are large differences between these concepts from a strategic point of view as to the implications of near-term choices. The WG believes it has a contribution to make in this vital field.

In a longer-term strategy coal could be the basis for non-polluting electricity generation, the production of liquid and gaseous fuels for transportation, and other uses, fertilizers, and petrochemicals. The common denominator for these applications is thermochemical gasification of the coal. The gas would be used as a fuel for combined cycle power generation, and also for other applications by transferring the energy content of the gas to hydrogen-rich energy carriers, for application in distributed heat and power generation in fuel cells, or as a transport fuel for fuel cell powered vehicles. The strategic issue at present is the gasification, the first key step is oxygen-blown gasification of the coal. This provides an opportunity to remove the sulphur with scrubbers (Hot-gas clean-up, that would be required to remove the sulphur in the gas from air-blown gasification, is not yet available.)

The oxygen-blown gasification provides great flexibility in the follow-on applications, and is clearly an attractive first step. It was noted that coal gasification is already taking place in China in the petrochemical industry. The conversion of coal energy to clean hydrogen rich energy carriers also provides an opportunity for carbon sequestering in depleted oil or natural gas fields, or in saline aquifers, as the conversion process provides a concentrated stream of CO2. These key interrelations need to be discussed in a clear manner and with quantification.

There will be other key interrelations. For example, imports of natural gas and bringing advanced clean coal technology to domestic manufacturing in China, in particular combined-cycle power generation technology; this will be a key technology both for clean coal utilization and for natural gas based power generation. An early introduction of natural gas imports could generate the market for domestic manufacturing of advanced combined cycle equipment, that are necessary for the integrated coal gasification, combined-cycle power generation technology. Later, natural gas delivery systems could be utilized by coal-derived gas.

The WG decided to undertake a strategic study of medium-to long-term options for advanced coal utilization. It is believed that there are strategic options of great value to China that will emerge.

5.3 A Bio-Energy strategy

The WG will undertake to develop a bio-energy strategy for China. The WG will examine prospective biomass supplies (residues from agriculture, forestry, and municipalities) and energy plantation, technologies for conversion to electricity and liquid and gaseous fuels, and end uses.
The possibility of restoring land through bio-energy strategy for China. The WG will examine prospective biomass supplies (residues from agriculture, forestry, and municipalities) and gaseous fuels, and end uses.

The possibility of restoring land through bio-energy work should be addressed, as well as the availability of such land. The project on Greening China Action (above) is important in this context.

It is of fundamental importance to assess the availability of degraded land in China that potentially could be restored through biomass plantations. Using modern machinery, quite steep hill sides can now be harvested.

One outcome will be to identify an area for a workshop that might lead to the initiation of work on a demonstration project, perhaps focusing on cogeneration in the sugar cane industry.

5.4 Transportation

The WG has noted the strategic role of the public sector for direction the transport system, through infrastructure investment. Public transportation is gene rally more efficient and less polluting than automobiles. Pricing policies have considerable limitations with respect to transportation's modal distribution. Careful price adjustments to reflect full costs and new technologies for pricing, e.g., road pricing and congestion pricing, provide important opportunities to improve the efficiency and sustainability of transportation system.

The WG has also noted that the combined impact of urban planning and new technologies for vehicles and traffic handling can produce much improved situations with respect to time required for transport, costs, effectiveness, and pollution. Success stories exist from several cities, including Curitiba in Brazil. Subject to how the CCICED determines to address transportation issue in its totality, the WG reached preliminary agreement to organize a workshop on urban planning and transportation and energy issues, with participation of representatives from major cities in China.

Professor Mao presented an outline of a study he is planning to carry out in support of the WG: "Policy Research on China's Transportation". The main objective is to identify the efficiency loss due to various policy distortions and the measures that are required to ensure the sustainable development of transportation in China, especially in terms of environmental protection. The study would be completed within one year, and focus on the following issues: market demand for transportation, cost accounting, impact of monopoly, administrative measures to improve efficiency, improving inter-mode transportation efficiency, and energy conservation and environmental impact. The WG found the project very interesting, provided some comments, and supported the proposal.

5.5 Institutional issues to support TVE for energy efficiency

The number of Township and Village Enterprises (TVE) is rising. Although the energy intensity is not well known, indications are that it is higher than for other enterprises, for example a survey of energy use in TVE in 22 counties indicated an energy intensity in light industry 2.6 times higher than the average in China. TVEs often lack access to capital, technical know-how, and qualified management, necessary to improve energy efficiency consultancy. After discussing these issues, the WG decided to undertake work to formulate a strategy for this and to identify relevant steps.

5.6 Follow-up on workshops/demonstration projects

The WG will continue to follow developments in the areas where workshops have taken place, and be available to advise if called upon. A second workshop on the "Governmental Regulation For Sustainable Development on Energy Industry" is planned for December 1996.

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List of supporting documents prepared as part of the WG activities:

* Geothermal Energy in the Wolfe and its Perspectives in China by Professor Ugo Farinelli.

* An Overview of The Mis-term Development of The Natural Gas Industry in China by Professor Qin Tongluo and Dr. T. P. Brennand.

* Development and Dissemination of Efficiency-Oriented and Environmentally-Constrained Energy Strategy Scenarios (EASES) in China by the Institute for Techno-Economics and Energy Systems Analysis (ITEESA), Tsinghua University, under the direction of Professor Qiu Daxiong.

* Industrial-scale Wind Power in China by Dr. Debra J. Lew, Dr. Robert H. Williams, Professor Xie Shaohong, and Dr. Xiang Shihui.
"China's Transportation and its Energy Use" by Professor Mao Yushi and Mr. Li Qunre n.

"Concessions for Windfarms: A New Approach to Wind Energy Development" by Dr. T. P. B. Reannon.

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