Report of the Working Group on Energy Strategies and Technologies Sustainable Energy for China

1996-09-26

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 aplication 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 gainsvaluabld insights into the merits/demerits of specific technologiex and strategies, and is brought into contact with the practical realities of achieving higher standards of sustainability.The WGmaintains a close interest in the outcome and follow-up of these initiatives.

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

2. Developments from the 1995 Report

2.1 Integrated Resoutcer Planning

A combination of Integrated Resource Planning (IRP),and DEFENDUS analytical meth odololgy was used by Professor Qiu Daxiong ,Institute for Techno-Economics and Energy System Analysis(ITEESA) at Tsinghua University,To generate important mew insights into China's long term energy future.His report entitled"development an d Dissemination of Efficiency-Oriented and Environmentally Constrained Alternat ive 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 8thmeeting of t he WG .The conclusions of the report and comparisons with other major studies re lating to this topic are summarized below in section 3(see also the documents ac companying this report).

Additional scenarios will be developed this year by Tsinghua University which wi ll explore the possible effect of the higher performing technologies delivering their full potential im[acts om ter,s pf jeogjtemed emergu efficiencies in criti cal 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 eimeframe considered(1990-2020).

IRP continues to be better understood and is gaining acceptance in China after t he two major Seminars held under the auspices of the WGand the International Ene rgy 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 i n the macro-planning area,particluarly in the metodology for optimizing the int er-relation between the supply and demand side of the energy sectors.A third IRP Seminar,for 40attendees,to be run by the WG in coopetation with Tsinghua Univer sity and the Inrernational Energy Initiative, is planned in conjunction with the 9th Meeting of the WGin Veijing 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 1995indica ted that good progress was being made on the establishment of energyefficient Co mpact Strip Production(CSP) technology in China by a participating company at th e May Workshop.This is encouraging for the WG and for the furthering of efficie ncy in this energy intensiveindustrial sector. However,the WG's main aim to prom ote interest in establishing state of the art,integrated ,new technology involvi ng iron-making ,steel-making and steel processing so far remains a goal rather t han a reality. It is also recognized in the WG that thdy are not as fully inform ed as would be desirable on the overall developments in the steel-making sector, including import vs domestic capacity utilization,and it remains an objective fo r 1996/7to improve this situation.

2.2.2. Fuel cell buses

The workshop in May 1995 on this theme gemerated sufficient interst in Beijing f or the promotion of a highly visible demonstration of this ultra-clean transport ation technology in the capital. UNDP has responded favorably to a proposal by t he 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 WGwishes to bring to the attention of CCIC ED. Independently of the fuel-cell project,there is another Bejijing -based elec tric bus project,involving a China Yuanwang/Northrop-Grumman joint venture. It i s further down the track than the fuel-celldemonstration,and intends to deployba ttery-powered buses with electric drivetrains,In principle,the fuel cellpropulsi on unit,which is the key innovation in thenew demonstration,could,in due course, replace the batteries in such vehicles,Like battery-powered vehicles,fuel cell v ehicles would have zero or near-zero emissions,But once fuel cells are establish ed in transport markets.they are expected to be lighter ,less costly,andrequire much less time for refueling,In any case,to be successful the fuel-cell initiati ve will require the utilization of a new generation ofbuses with electric drive trains,Thus the battery dldctric 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 ITEESAPeport,prepared ujder the direction of Professor Qiu Daxiong,furnishes three energy scenarios,All scenarios assume a GDP growth between 1990and 2020by a faceor of 8.3,corresponding to an average growth rate of 7.3%per year,and a p er capita GDPgrowth of a faceor of 6.6,corresponding to 6.5%per year,The scenari os 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 u pon 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 repres ents a major improvement in energy efficiency.

The "Aggressive Efficiency"(AE)scenario opts for more energy-efficient technolog y than BAU,and has a primary energy demand of 71 EJ in 2020.26wimes that of 19 90.The level of energy intensity improvements assumed in the economy is very lar ge,from 73KJ/US$ in 1990 to 26KJ/US$ in the ECE scenario in 2020.For comparison ,the energy intensity of the USA is approximately 16KJ/US$ and for Japan 8KJ/US $.These numbers refer to economies being compared on a market exchange rate basi s,which is a questionable method,since it assumes that there is a free market fo r currency exchange,and that all goods and services are exchangeable,including s uch as land,electric power ,transportation.Abetter way of comparing involves the purchasing power parities (PPP)instead of market exchange rates.AGDP expressed with PPPprovides a correction for the differences between domesticand internatio nal prices.For India using PPPreduces the energy intensity of the economy with a factor of 3,white it does not significantly affect the industrialized countries .If the same factor between market exchange rate and PPPas for India applies to China,the energy intensity of 1990 would be reduced to 24KJ/US$.

The "Environmentally Constrained Energy"(ECE)scenario selects a higher proportio n of cleaner technologies,in satisfying the same energy demand as for AE,but the higher comtributions from non-coal energy resources would reduce carbon emissio ns 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 partic ulates by a factor of 2.3 compared to 1990.

Interestingly,it emerges that the overall cost of energy supply in AEis less tha n in BAU,which means that the net cost of reducing CO2 emissions withinthese par ameters is negative.The same is true if the ECE scenario were to satisfy the sam e economic goal as BAU.

ECE struggles to boost the share of cleaner electricity from hydroelectricity, n uclear power,and renewables,the last mentioned occupying a very minor role under these assumptions .It is an priority 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 ma rket competition.For this reason the WG have asked that additional scenario(s) b e constructed to embrace a wider range of outcomes,reflection a realistic varian ce between failure to achieve the optimism of BAU and the not unreasonable possi bility of outdoing the successes of AE and ECE.

HOW wide the quantitative divergence of scenarios could be is reflected on the s pread of forecasts published in a number of scenarios on China's energy demand u p till2020,see Table1.By 2020,the spread of energy demand forecasts differ by 40 %.

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

Renewable energies hardly feature in current energy scrrent energy scenarios,onl y 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 miscalcu lation in current thinking in energy forecasting .In a 20 year timeframe the rel ative share of remewables probably has the greatest potential for surprise on th e upside.

Given the fact that emission in all of the studies quoted in Table 1are projecte d to increase significantly over the present levels,that are already considered high ,it is not clear that these present projections display future energy syste ms that are compatible with China's Agenda 21.This creates strong stimulus to co ntinue the search for energy systems that are economically and environmentally m ore 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 la rger potential for developing its natural gas industry than is suggested by very low contribution(2%) to national energy needs presently being made by this envi ronmentally friendly fuel.Atenfold increase in thia parameter would plaed Chines e gas in a position closer to the role of natural gas in the world (21).Developm ent 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,une qual competition with abnormally low priced coal,which is the main competing fue l 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 gasfields and the proximity of a highly populated local market has enabled these difficulties to be over come.

The situation is now radically changing ,as the on and offshore petroleum and na tural gas corporations are now stimulating aggressive in-house exploration and S ino-foreign joint ventures,the results of whichare now beginning to augment the nation's meager gas production statisties.

Institutional changes to the relative pricing regimes for natural gas and coal c ould further enhance the prospects for additions to the national inventory of de veloped gas fields.

Notwithstanding the current encouraging trends in the supply -wide industries,th e scale of the challenge,physically,geologically and financially;can easily be u nderestimated,The forecast outlook for the gas supply over the next 20years (Sta te 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 w ith at least one major import project of 40billion m3 of pipeline gas and/or LNG .

Forecasting future gas availability is inherently subject to serious uncertainti es,The geological uncertainty surrounding domestic gas avaukabukuty can be reduc ed by sustained investment in surveys and drilling and this should lead to a bet ter inventory of the recoverable reserves,and assist natinal planning for this r esource.The eventual contribution from imports has no resource uncertainty ,exce pt in the short rerm for LNG since most of the international supply sources are committed elsewhere.The remaining uncertain ties are commercial,political and fi nancial 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 fr om 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 ca ndidates where the benefits of this clean fuel could be gained in the power gene ration,industrial and residential sectors.LNG coexists happily with pipeline nat ural 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 forecas t 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 operaton 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 whole is the reduction in vented greenhouse gas , methane being a powerful member of that group of gases .Figures for the total vo lume of CBM are large,taking all China's coal mines into account.How much commer cial CBM can be ralistically recovered is not available.It would be unwise to as sume that this contribution must be negligible,although this cannot be excluded. Nearly 300 CBM wells were drilled in the United States in 1994.A promising edvel opment is the possibility that a demonstration plant may take shape soon under t he auspices of APEC cooperation ,The WG gas study supporting this report draws c onclusions based upon a more optin\mistic vuew of the potential contribution of natural gas from exploration , imported pipeline gas ,imported LNG,and domestic CBM.A future total availability from all these sources could reach 220 billion cubic meters in 2010 and 410 billion cubic meters in 2020,corresponding to 15%an d 22%of SPC projected energy demand in 2010 and 2020.

4.1.2 Industrial-Scale Wind Energy Developmem in China

While China has wome of the best wind energy resources in the world,many of thes e resources are concentrated in regions that are remote from electricity demand centers,and they remain at present virtually unutilized.For example,good wind re sources①are available over about 80,000km2(0.9% of the total land area of China)of Inner Mongolia Wind farms based on the use of modern wind turbines in this r egion 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 Mo ngolia the population density is so low that a tiny fraction of the wind resour ce would be adequate to rserve future local electrcity needs.

In the WG's opinion,wind energy should not be neglected as a potential majorsour ce of primary energy, wince it is in China's interest for all domestic energy re sources to be tapped to the extent that it is technically and commercially feasi ble.In a study carried out by the WG a strategy is developed for harnessing a la rge fraction of such remote resources②.The basic concept is to build large wind farms and transmit the produced electricity via long-distance transmission line s to distant markets. To keep the cost per unit of delivered electricity low, tr ansmission should be via large-capacity(≥1 GWe)lines,and a particular line shou ld be matched to a much large wind farm capacity,and in some instances energy st orage as well.When this is done,the capacity utilization factor for the transmis sion line can be high(＞50%)and greater than the capacity factor for the wind ar m itself.With commercially proven electric storage technologies(e.g.pumped hydro power or compressed air energy storage),even steade"baseload wind power"can be d elivered to remote electricity markets this way.This study estimatde that electr icity produced in such large wind farms in Northern China could potentially be c ost-competitive with electricity from coal ,if the wind turbines were mass-produ ced in China(e.g.viainternational joint ventures).

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

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

The obstacles to realizing the potential offered by this strategy are institutio nal rather than technological;all the technologies are commercially available,an d China could quickly develop the industrial capacity to harness its wind resour ces this way and ,at the same time,demonstrate economic feasibility of wind powe r.But to bate,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 rega rded as large,and vendors are not accustoned to devdloping wind farms with capac ities of 1000 MWe or more.

However,an institutional mechanism is already well established in the oil and ga s area in China,which could be used for implementing this wind development strat egy;the resource development concession ,an instrument that has proved to be ver y effective in developing resources in the mineral extrcaction industries(e.g.pe troleum,natural gas ,metals).This instrument applied to wind power development m ight work as follows .In a delieated region of high quality wind resources ,the government would offer concessions to venture company partnerships(for example,b etween 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 in volve ownership of national resources ,but rather,under the agreement,the conces sionaire would assume all the upfront technical and finacial fisks associated wi th the uncertinties relating to initial developmental activities,in exchange for rights to share in the benefits that would arise from the sale of the product,e lectricity.

In this way China would be in the forefront of making new, large-scale wind powe r a commercial reality at little or no domestic fisk.Wind cenrgy can be develope d this way only if a well-defined regulatory/legal framework is in place that de fines how concessions would be offered and enforced.Such a framework might be pu t in place relatively quickly ,by drawing on experience in ,for example ,the pet roleum sector with modifications appropriate to the unique attributes of the win d resource.

The Working Group recommends to CCICED that China establish the needed regulator y/legal framework for wind development concessions and begin,via the wind resour ce edvelopment concession,large-scale wind energy development in wind -rich regi ons such as Inner Mongolia,(See also the report on the workshop on wind energy,s ection 4.2.1 below.)

4.1.3Geothermal Energy

Geotyermal energy accounts today for a small fraction(less than one percent)of t he energy supply at the world level.Although its development is rather rapid,its ultionate contribution-at least based on present technologies-is not expected t o become substantially higher,due to the limitation of the resource basis ,which makes it technically and ceonomically applicable only in a limited number of ge ographical areas.New techology-in particular the hot dry rock (HDR)technology,ma y extend this applicability,but the status of HDR development does not at this t ime allow any reliable prediction.

However,geothermal energy maybe of great importance in particular areas or hitua tions,by supplying power or teat at reasonable cost and with limited environment al impacts where other options are not available ,or are too expensive ,or risk to bamage 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 plac e at the world level.The role of geothermal energy in China may become crucial i n some areas ,in particular in Tibet,where abundant resources are present,the ec osystem 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 hydroe lectric resources in a dispersed manner,and which enhances the scope for using g eothermal energy.

China has abumdant geothermal resources in different areas:the south-west (Tibet autonomous region,high temperature);the south-east coast and the north-east coa st(Sandong-Liaoning,medium-low temperature).The total potential of geothermal po wer generation for the Himalayan belt has been estimated at 1700 MWe(conservativ e)to 6700MWe(optimistic).The presently installed capacity is only 32 MWe.Large p otential for direct heat uses have been identified,and more than 4000 features a nd 181 geothermal systems have been mapped.China annually uses over 5.5 TWhth ge othermal direct heart,henaing more than 1.3 million square meters,mostly in nort herm China ,and more than 1 million square meters of greenhouses and 1.6 million square meters of fish ponds.

Grothermal energy has a role to play in the future egergy scenario of China,that ,although quantitatively limited,is important in addressing local problems and m ay be able to alleviate environmental problems in cities by providing a clean al ternative for space heating .Attention is already given in China ,and this ahoul d continue,to legislative aspects,property regimes,concessions for exploration a nd production drilling,environmental aspects,and exploration and evaluation of g eothermal resources.

4.2Reports from Workhops run by the WG

4.2.1Large Scale Wind Energy Development in China

The WG convened a Workshop on Large-scale Wind Energy Development in China,in Be ijing,6-7 November 1995.The Workshop was attended by 15 participants in abbition to WG members .The chinese participants included representatives of the Ministr y of Electric power power ,the inner Mongolina wind Energy Group ,the Fujian Ele ctric power Bureau ,the chiana Fulin windpower Development corpoation,the China corporation for consulting and Engi-neering of Hydropower ,the Beijing Academy o f Electrica power sciences ,the chinese Academy of Meteorological sciences ,and Tsinghua University.inter -national paricipants ofthe than WG members included r epresentatives of Westinghouse and Bechtel power corporation.

Prsesentation by international participandts were given by Dr.Robert williams (W G member).Mr,Fred sperry (President of Westinghouse ,china)Mr Raymond Dracker (Head of Research and Development ,Renewable Engrgy Programs at Bechtel Power Cor poration ,California ,USA),and Mr,Gavin gaul (senior Project Engineer ,Westingho use ,Florida,USA)and Mr,Gavin Gaul (Senior project Engineer ,Westinghouse ,Floid a,USA)On the China side ,presentations were given by Mr,Shi pengfei (Chief of the New Emergy Division ,Hydropower and Water Resourcs planning and Designing i nstitute,Ministry of Electric power),and Mr.chen Tongmo (senior engineer,Instit ute,Ministry of Electric power),and Mr,Tongmo(senior Engineer,inner MOngolian w ind energy corp).

The international presentations by williams ,Dracker ,and Gual focused on as-pec ts of the novel aspproach for exloiting china'slarge remote wingd energy resourc es described in the paper discussed in sdection 4.1.2-adraft of which was prepar ed by williams .All these talks pointed out that the obstacles to re-alizing th potential offered by this strategy are institutional rather than tech-nological, Dracker,who formerly managed the pacific Gas and Electric com-pany electricity s upplies from large wind farms in california,told worlshop participants that larg e wing power inputs to electric utility grids are readily manageable with existi ngtechniques .Moreover ,all the technologies needed form large -scale "base loa d wind power development"are commercially avail-able -including compressed air energy storage,which was discussed in the presentation by Gual.

4.2.2Energy -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 thebuildings sector,i t is of high priority to make new buildings highly energy efficient,when it is m uch easier done than as a retrofit. The enerfy-intensive commer-cial buildingsec tor poses both a challenge and an opportunity in this respect.This is because th e latest energy efficient buildings technologies are available to China at a tim e when there is a huge buildings programme,ane the oppor-tunity exists to leapfr og in this area over industrialized countries that have a legacy of older energy -inefficient buildings

A workshop pn demonstration of energy-efficient commercial buildings was therefo re organized inBeijing,November 7-8,1995.The workshop was at-tended by about 30 participants,including representatives fromMinistry ofConstruction,State Plannin g Commission,Finance and Trade DevelopmentGeheralCompany,Shanghai,China Investme nt Company for Energy Conser-vation,Tsinghua University.State Economic and Trade Commission,BeijingEnergy Efficiency Center,Beijing Institute for Constructuon D evelopment and Resegrch,China ConstructionGeneral Company,Beijing Construction G roup,and Institute of Cohstruction Science.

Presentations were given by Mr.Dale Sartor and Mr.Joe Huang,Lawrebce BerkeleyLab kratory,Berkeley,California,Mr.Richard Bourne,Davis EnergyGroup,Davie,California ,and Mr.Lee Eng Lock, Supersymmetry,Singapore,from the international side,and by Mr.Miao Tianjie,China Investment Com-pany for Energy Conservation,Mr.Yang Weich ing,Beijing Institute for Con-struction Development and Research,Mr.Wu Yuanwei,C hina Academy of Building Research,Mr.sho Guohua,lujiazui Planning and Constructi on De-signing Institute,and Mr.Jiang Yi,Tsinghua University,from the Chinese sid e.

The presentations by the international ecperts illustrate thevery large possible reductions in energy use in new commercial buildings that have been demon-strat ed in recentyears,and the analytical techniques and specific building com-ponent s and systems that have contributed to this development.

It was generally agreed that these opportunities should be made visible in Chi-n a through demonstration projects.The demonstrations should focus on build-ing ty pes where the growth of the stock is rapid,and which contribute signifi-cantly t o 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 d emonstrations 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 installa tions properly.

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

Careful evaluation at the design stage must de made If the systems aspect of the fu

nctioning of a building.Analytical tools are now available to facilitate this(fo r example the DOE-2computer code),and should be used.Likewise,tools are avrilabl e to track and optimize long term performance.Performance monitoring will be esp ecially important for the demonstration projects.

The demonstration projects should emulate energy effucuency standards compa-rabl e to the best available today in the world.Key technologies shojld be iden-tifie d for different buildings and climate conditions using design tools such as thos e mentioned above.Importation of some efficient technologies for key functions(f rom an energy efficieney perspective)should be considered when necessary for the demohstrations.Such technology areas sre likely to include lighting,windows,air conditioning,and control technologies.The importation of specific technologies should be made with a view to creating domestic pro-duction,for ecample through joint ventures.

Demonstrations must also be followed by policy measures to give players in-centi ves to make full use of technological opportunities.Studies should be made of po tential policies in areas where market imperfections should be given incentives to invest in energy efficiency to the degree this is economi -cally rational in anational perspective ,tor example by introducing hook -up fees that reflect the required addditional capacity in vestment in the power sys-tem ,i.e.the capital cost of power plant should be included in the tariff.

Strong interest in participating in the demonstrations were expessed from the Ch ina Investment Company for Energy Conservation ,Tsinghua University and Finance and Trade Development General Company, Shanghai.Aproject proposal is being prepa red underthe direction of professor Zhou Fengqi.

4.2.3Changing Roles of Governkent and Enterprises for Sustainable De-velopment

A workshop on the "Changing role of Government and Energy Enterprises ofr Sustai nable Development"was organized in Beijing ,MAY 5-8.1996.

The purpose of the Workshop was to help Chinese government organizations and ene rgy enterprises improve the orientation of ther administration and management to ward sustainable developmdent .China's economy is still under transition ,and th e role of government is to change from owner manager to that of a supervisory ro le and to provide public stewardship .However ,such change is not easy ,and in c ertain areas government still works as owner of en-terprises,and enterprises do not yet have their independent righes to manage-ment .In addition

,enrgy enterpr ises are often monopoly business and produce pollution that market foorces canno t regulate .Government has a new role to play in creating the regulatory framewo rk that will lead to sustainable devel-opment ,such as expressed in China's Agen da21.

There were nineteen Chinese participants, among them two mayors,one direc-tor of a provincial planningcommission ,energy researchers ,and senior engi-neers.

Chinese leecturers discussed the theory of property rights,the transaction costs ,the dexternallycosts ,the origin of government and dthe problems associat-ed wi th the relationship between government and energy enterprises in cur-rent Chines e economy.

Cr.Claus Brendow ,who directs the East -West Energy Program for the World Energy Council ,reported on the case of the economies in transition in Central and Eas tern Europe ,with focus on the institutional and legislative changes in electric power systems from the state managed dystem towards the privatized and competit ive electricity generation.He showed the differing pace of progress among countr ies and a set of basic institutional requirements,such as legal property protect ion including intellectual property rights and foreign investments ,to facilitat e such changes.He also acknowledged the existence of several obstacles for smoot h transition to include the social and economic un-rest or instability ,the poli tical and social sensitivityassociated with certain en-ergy activities,and the l ackof capital for modernization.

Mr.Claude Dubois ,an expert from Electricite de France, presented the role of th e French state-owned electricity monoply in the integrating Guropean mar-ket.He recalled the heavier weighet of the public sector in the French economy(10%of em plyment,20% of GDP)against which the role of the EDF shorld b onsidered.He also reasoned the state-ownership ad the public ser-vice characteristics of lectricit y.My Dubois explained amulti-year contract plan system with the French authoriti es under ohich certain socio-economic targets are set tor the EDF.

Mr.Keiichi Yokobori,a WG member,reported on the riole of the government in the J apanese energy sector.He pointed out the state-owned energy firms did not play a key role in the Japanese energy markets and that ahe close com-mujications betwe en the government and energy sector were widely ob-served.Besides regulatory act ions,advisory councils provide various opportuni-ties for information exchange a nd formulations of common perrceptions on the energy situation between the gover nment and the industry.He also reported on the on-going deregulation in the Jaop apanese energy markets.While greater competition would emedrge in energy markets in gereral,it appeared uncertain how far electricirty sector deregulation would go because of public utilty con -cerns.

The discussions dwelt largely on the electric sector leaving the other energy se ctors(oil,coal,and gas)almost untouched.The perceived public service as-pect of electricfty nd the economy of scale as discussed dabove would explain this bias towards electricity. Further,many Chinese participants appeafred to fedl the sup ply shortfall more acute in electricity than among the other energy sectors.

The Workshop was very informative,however,too much attention was given topower s upply relative to other energy industries and enetgy efficiency,and too little a ttentionwas given to the issue on how to achieve sustainable development in a ma rkeg-oriented economy,In hindsight ,thescope of the original workshop was perhap s too wide,Accordingly,to focus more directly on the importance of sustainable d evelopment,a seclnd 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 ca n be greatly improved.In addition ,there is no lack of funds in China because Ch inese people currently deposit trillions of yuan into bank accounts at a negativ e interest rate,This money now pooduces much less of a profit than if it had bee n invested in plantation of trees,The reason why capital not now working to comb ined labor and land to plant trees lies the weak nes of the institutional arrang ements,for example ,insecure ownership,long time neededto recover capital,and th e 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 mar ket for young trees,and that an insurance business be created for plantation ris ks,Such a policy could help relirve poverty in remote areas.the current trend of labor flows to coastal areas for emoployment creates many social problems.This can be reduced.The fundamental policy to relieve poverty in remote areas is to g enerate 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 cont ract and more capital can be introduced.

4.3.2 Transportation

A preliminary study on China's transportation sector and its energy use was conc luded,The main findings in the Transportation Report are:

Elasticities of transportation relative to GNP growth are identified both for fr eight and passenger,and future increase of transport is predictedbased uponassum ed growth rate,The expected volume of transport in the year 2004 may be double t han that in 1994.

Transport intensity in GNP was discussed and international compariwon was made,A lso the change of mode split of freight and passenger transport along time was a nalyzed;the future development was discussed;high speed railway seems necessary.

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

The pricing with the transport sector involves compoicated problems and is now h eavily 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 haw to be studied.

5. Workplan 1996-97

5.1 Integrated Resource Planning

The WGwill continue its cooperation with Tsinghua University(Professor Qiu Daxio ng)on the application fo the Integrated Resource Planning approach to the analy sis of Chinese energy options,A third workshop in IRP is planned for December 19 96.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 don e in China on near-and medium-term options to improve and clean up the use of co al,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 techno logical developments,It was felt that rechnological opportunities are now emetgi ng to use coal without the present environmental penalties,Many technological co ncepts 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 WGcelieves it has a contribution to make in this vital fi eld.

In a loger-term strategy coal could be the basis for non-polluting electricity g eneration,the production of liquid and gaseous fuels for transportation and othe r uses,fertilizers,and petrochemicals,The common,denominator for these applicati ons is thermochemical gasification of the coal.The gas would be used as a fuel f or combined cycle power generation,and also for other applications by transferri ng the energy content of the gas to hydrogen-rich energy carriers,for applicatio n 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 gasificatio n,The key first step is oxygen-blown gasification of the coal,This provides an o portunity to remove the sulphur with scrubbers(Hot-gas clean-up,that would be re quired to remore the sulphur in the gas from air-blown gasification,is not yet a vailable.)

The oxygen-blown gasification provides great flexibility in the follow-on applic ations,and is clearly an attractive first step.It was noted that coal gasificati on is already raking place in China in the petrochemical industry,The conversion of coal energy to clean hydrogen rich energy carriers also provides anopportuni ty for carbon sequestering in depleted oil or natural gas fields,or in saline aq uifers,as the converston process provides a concentrated stream of CO_2.These key interrelations need to be discussed in a clear manner and with quantification.

There will be other key interrelations,For example.inports of natural gas and br inging advanced clean coal technology to domestic manufacturing in China, in Chi na, in particular combined-cycle power generation technology; this will be a key technology both for clean coal utilization and for natural gas based power gene ration. An early introduction of natural gas imports could generate the market f or domestic manufacturing of advanced combined cycle equipment, that are necessa ry for the integrated coal gasification, combined-cycle power generation technol ogy. 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 gr eat 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 ex amine prospective biomass supplies (residues from agriculture, forestry, and mun icipalities) and energy plantation, technologies for conversion to electricity a nd 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 restouing land through bio-enetgy work should be addresscd ,a s well as the availability of such land,The project on Greening China Action (ab ove)is important in this context.

It is of fundamental importance to assess the availability of degraded land in C hina 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 in itiation 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 trans portation syste, through infrastructure inrestment,Public transportation is gene rally more efficient and less polluting than automobiles,Pricing policies have c onsiderable limitations with respect to transportation's modal distribution,Care ful 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 WGhas also noted that the combined impact of urban planning and new technolo gies for vehicles and traffic handing 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 rea ched preliminary agreement to organize a workshop on urban planning and transpor tation and energy issues,with participation of representatives from major cities in China .

Professor Mao presented an ourline of a study he is planning to carry out in sup port of the WG:"Policy Research on China's Transportation",The main objestive is to identify the efficiency loss due to various policy distortions and the measu res that are required to ensure the sustainable development of transportation in China,especially in terms of environmental protection.The study would be comple ted within one year,and focus on the following issues:market demand for transpor tation,cost accounting ,impact of monopoly,administrative measures to improve ef ficiency,improving inter-mode transportation efficiency,and energy conservation and environmental impact. The WG found the project very intersting,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 energ y intensity is not well known,indications are that it is higher than for other e nterprises,for example a survey of energy use in TVE in 22counties indicated an energy intensity in light industry 2.6 times higher than the average in China.TV Es often lack access to capital,technical know-how ,and qualified management,nec essary to improve energy efficiency consultancy interstingm,and decided to under take 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 ta ken place,and be available to advise if called upon.A second workshop on the "Go vernmental Regulation For Sustatinable Development on Energy Industry" is planne d for December 1996.

Acknowledgments:

The Working Groupwould like to acknowledge financial and in kind support from CC ICED,ENEA,the International Energy Initiative,the Rockefeller Foudation,Sarec,an d UNDP ,Dr.Williams would like to acknowledge support from the W.Alton Jones Fou ndation and the Merck Fund.

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

"Geothermal Energy in the Wofle and its Perspectives in China "byprofessor Ugo F arinelli.

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-Constr ained Energy strategy Scenarios(EASES)In China "by the Institute for Techno-Eco nomics and Energy system Analysis(ITEESA),Tsinghua University,under the directio n of Poofessor Qiu Daxiong.

"Industrial-scale Wind Power in China "by Dr.Debra J?Lew,Dr.Robert H/Williams,Pr ofessor Xie Shaoxiong,and Dr.Xhang Shihui, "China'sTransportation 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 rennand.

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