WORK REPORT OF THE WORKING GROUP ON ENERGY STRATEGIES AND TECHNOLOGIES

1. The Rationale and Objectives

The rationale for the Working Group on Energy Strategies and Technologies stems from the dual observation that energy is fundamental to both development and socioeconomic growth, and presently is a major contributor to environmental degradation. The present path of energy system development worldwide is not sustainable from an environmental point of view, nor is it compatible with the social, economic and environmental goals of China, as spelled out in, for example, China's Agenda21. This conclusion has been elaborated on in earlier reports of the Working Group to CCICED. A major change in energy system development in China is required to meet the social, economic and environmental goals of China, which is summed up as sustainable development. To achieve such development will require a considerably longer time period than the five years of Phase II of CCICED; however, as outlined in the report on activities and in the workplan, the Working Group believes that significant contributions can be made during Phase II.

Therefore, in order to realize the social, economic and environmental goals and objectives of China, a new approach to energy needs to be developed and implemented. Such an approach is referred to here as a sustainable energy approach. The Working Group's role is to provide, in this context, independent analysis and balanced advice to the Government of China through the CCICED. By offering solid technical and logical justification for the adoption of a sustainable energy approach in China, and by providing realistic concrete examples and suggestions for such an approach, the Working Group can contribute to a process in China where energy developments will contribute to and strengthen sustainable development. The emphasis is on recommending technically feasible and economically viable activities.

The Working Group observes that this approach to energy development will also strongly support other efforts to alleviate poverty and improve the situation of the disadvantaged, particularly women. While conventional approaches to energy tend not to be conducive to such objectives, elements of a sustainable energy approach contain the means for reaching objectives in these and other needful areas.

2. Focus of the Work

The process of modernization of China involves creating step-by-step a socialist market economy. This economy will operate in a world characterized by globalization and liberalization of markets. These overriding processes will create the setting in which the development of China's energy system will largely take place.

Investments in the energy system make up a significant fraction of total investments in any rapidly growing economy. They are projected to increase, as the economy continues to grow. However, traditional sources of finance (e.g., government finance), are not likely to be able to meet increasing demands for capital. Realistically, only private financial markets, domestic and foreign, will be able to contribute the major parts of the needed capital in the future. Foreign direct investment has been an important and rapidly growing new source of capital in China in recent years. In addition, China has an
enormous potential for establishing private domestic capital markets based on domestic private savings.

This leads to a need to create conditions that will attract mobile private capital. China has already moved in this direction, as witnessed by the foreign investments that are being made. From the point of view of overall development of China, however, it is necessary but not sufficient those capital investments should grow. This capital must flow to investments that are compatible with sustainable development in a broad sense.

A fundamental issue in energy for China is in fact the design of a facilitating environment for such investments to happen. A system of incentives and disincentives that lead market actors to make economically attractive investments in socially and environmentally positive areas is needed. The Working Group has accepted the challenges of developing ideas in this context, as reported below.

The major elements in a sustainable energy approach are (i) more efficient use of energy, especially at the point of end use, (ii) increased utilization of renewable sources of energy, and (iii) developing and implementing a new generation of cleaner fossil-fuel using technologies (UNDP, 1997).

The Working Group has analyzed the situation of China in its earlier reports to the CCICED, and concluded that all three elements are relevant and applicable to China's conditions. Detailed analysis in these areas may be found in the underlying reports that have been prepared for the Working Group, and attached to the Working Group reports to the CCICED.

In Phase I of CCICED, the Working Group also analyzed and made recommendations concerning the important contributions to sustainable development that may be obtained in China from an increased utilization of natural gas from conventional gas sources. The Working Group has also discussed and made recommendations regarding nuclear power in China. For the time being the Working Group is not pursuing new analyses in these areas.

The work of the Working Group in phase II of CCICED will continue to focus on a continued rapid improving of energy efficiency in all sectors in China, and on expanding the modernization and utilization of renewable sources of energy, especially biomass, wind and solar energy.

Also, because of the large resources of coal in China, and new long term options to use coal in ways compatible with sustainable development, the Working Group is developing and will contribute new ideas concerning the development of a long-term, sustainable coal strategy for China, based on recently developed and emerging energy technologies.

3. Methodology

The Working Group 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 service needs of China over the next decades of economic development, and at the same time furthering achievement by China of its Agenda 21 goals.
Recognizing China's abundant domestic energy resources, the Working Group 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 Agenda21, and satisfying China's economic development, can be aided.

The approach that the Working Group has evolved over phase I of CCICED and which continues to be effective we believe, is to pursue a four-fold strategy of

(i) internal expert study and reporting,

(ii) external promotion and running of workshops on key advanced sustainable technologies and strategies as well as new institutional arrangements, that in the Working Group’s opinion merit wide recognition and application in China, and

(iv) direct efforts to build human capacity to analyze and manage energy issues in a sustainable development perspective.

The Working Group relies on its extensive international and Chinese to achieve as broad as possible a representation of presenters and attendees from interested organizations. The Working Group strictly resists being drawn into and hands-on project development and management, since it has neither the financial nor the human resources required.

The role of the Working Group with respect to demonstration projects is therefore that of an adviser and facilitator. By convening and chairing Workshops, the Working Group itself gains valuable insights into the merits/demerits of specific technologies and strategies, and is brought into contact with the practical realities in China of achieving higher standards of sustainability. The Working Group maintains a close interest in the outcome and follow-up of these initiatives, and seeks always to be kept informed.

The Working Group has recently established a liaison office at Tsinghua University, with financial support from the CCICED secretariat in Canada. The office is intended to help keeping the Working Group informed about energy related developments in China, and to make the outcome of the Working Group’s efforts more widely available in China. The office will also be helpful in keeping the Working Group informed about the advancements of various projects the Working Group has helped to initiate.


4.1 General Status of Activities

This year has proven to be an active one for the Working Group, in all its main areas of activity, namely studies, workshops, demonstration projects and capacity building.

Furthermore, there has been an important focus on

- policies to save and make more efficient conversion and use of energy by encouraging the introduction of up to date technology and institutional development,
• continued promotion of renewable energy resource development,
• promotion of technologies to make better use of coal,
• studies of new technologies such as those based on hydrogen, and those involving the underground utilization and disposal of CO2.

In all these aspects, work is in progress and will continue for some time. Specific progress during the past year is summarized below, and ongoing and planned work is outlined in Chapter 6.

4.2 Studies and Research Work

A report on the current energy situation, and the program for renewable energy development in China was presented by Professor Zhou Fengqi. While the potential contribution of renewable energy in China is recognized to be large, the cost per unit of installed capacity is still high relative to current conventional energy systems. It is clear that the increase in number of units manufactured needed to bring down the cost, but it can't be achieved without initial subsidies.

A study by Professor Zhou Fengqi on the growth of the wind power industry in China provided useful background for the ongoing work on the Wind Resource Concession project (see below).

Professor Li Jingjing of the Center reported on a thorough assessment of China's biomass resources from agricultural residues, province by province, for Renewable Energy Development of the SPDC.

Professor Wu Zhongxin presented a study made in Tsinghua University forecasting various oil products by 2000-2020. The study concludes total oil demand in China will reach 171 million tonnes of oil equivalent (Mtoe) in 2000 and 371 Mtoe in 2020, up from 150 million tonnes in 1996.

Dr. Robert Williams presented important first contributions of an ongoing study towards a strategic vision on coal utilization, in which a wide range of super-clean energy and chemical products are produced from "syngas" (a mixture of CO and H₂). New developments in this area are potentially of the utmost importance to China's longer term energy situation, since they offer clean fuels for power, distributed combined heat and power, and transportation based on China's huge coal resource, and the potential for reduced dependence on imported petroleum. In addition, the strategic vision on coal offers, for the first time, an effective pathway to solving part of the CO2 emissions problem at the same time as extracting value in enhanced recovery of deep coal bed methane and oil resources (see Appendix I). The Working Group's recommendations in this area are presented in Section 5.1.

A study is underway for the Working Group in Tsinghua University of the potential, the costs and benefits of energy conservation in buildings, the obstacles and regarding implementing standards in conservation.

A report prepared by the Energy Research Institute of SDPC for the Working Group and introduced by Professor Wand Zhongying presented the current status of energy consumption and relative energy inefficiency in TVEs. The report highlighted key
concerns and proposed a number of institutional and technological remedies. Given the large energy consumption for this sector of the economy, the subject deserves to remain a high priority in the short term. The Working Group's recommendations in this area appear in Section 5.3.

A list of publications and papers appear in Section 8 of this Report.

4.3 Workshops on Technology/Demonstration Projects

A small workshop on Energy Efficiency in Buildings was organized in Changchun, Jilin Province, in January 1998. Dr. Huang Yu of Lawrence Berkeley Laboratory, California, Proposed two demonstration projects to be built in Jilin Province, one a residential building with an incremental investment of $ 1.3 million, the other a commercial building with an incremental investment at $ 4 million. The concept is to work with the Government and the relevant authorities on buildings that are already in the pipeline, with funding to be raised to cover incremental costs of the analysis and design work, and the energy efficiency components. Proposals are in preparation for these projects.

A two-day workshop on Small-Scale Power Generation from Biomass was also held in January 1998, in Changchun. There were 50 attendees, including several Chinese and two international experts on biomass technology, officials from the central and local governments, and Working Group members. The topic was comprehensively treated, with an overall resource review, presentations of proven technologies in actual Chinese and international rural settings, and longer term technology development options. The workshop concluded with firm commitments to take the next three steps to establish demonstrations of modernized biomass utilization in Jilin Province based on biomass gasification: (i) the production of cooking gas, (ii) small-scale cogeneration of heat and electricity based on the use of commercially available reciprocating engines, and (iii) small-scale gas turbine cogeneration systems. Proceedings from the workshop are available, see Section 8. The recommendations of the Working Group in this area appear in Section 5.4.

4.4 Demonstration Projects

Work continues, with UNDP funding, to develop the institutional framework for the Wind Resource Concession Approach to Wind Energy Development. Initially focused on a concrete opportunity in Jilin Province, as discussed in the previous Working Group meeting in mid-1997, following reorganization of the power sector the project is now considered open-ended with respect to siting, as the framework, once developed, is applicable to any site. An initial candidate for application now appears to be Zhangbei in Hebei Province, where the concept has support from the North China Power Network. The project consists of two collaborative elements: (i) concept development in the context of international analogues and with consultation with potential bidders, and (ii) relating the concept to the realities of the concrete opportunity to develop large wind resources in Northern Hebei Province. It is anticipated that this enabling framework should be ready for consideration and potential application by the end of 1998.

The Fuel-Cell Bus demonstration project has moved on from its stage of direct promotion and involvement with the Working Group, through the feasibility study (funded by UNDP) to the bidding stage, the closing date for which was June 30, 1998. There will
follow a period of negotiations with the successful bidder before the implementation of the specific demonstration activities commences. A team from China visited the United States, Germany, and Canada to assess at first hand the realities of the first trials of this new technology.

4.5 Progress on Capacity Building

A workshop on Mechanisms of Resource Allocation for Sustainable Development of the Energy Sector was conducted in Beijing on June 23-24, 1998. Two Chinese experts, Professor Mao Yu-shi and Professor Ding Ningning of the Development and Research Center, State Council, for international experts, Working Group members Professor Mark Jaccard and Dr. Robert Williams, and Trent Berry of Compass Resource Management, and Hao Liu of Monenco AGRA, addressed 39 participants from 7 institutions and 5 provinces in China. The subjects addressed included the principles and methods of social costing in energy planning, and the relevant instruments available for incorporating societal concerns about external social costs in market transactions. In a plenary discussion, progress was made in raising awareness of the relevance of China's institutional and markets structure in the energy sector for achieving China's major goals in social, economic and environmental terms. Potential pathways to achieving specific environmental objectives through market-based instruments were also explored. For proceedings from the Workshop, see Section 8.

A number of recommendations arose from the two-day workshop. These formed important input in the Working Group's formulation of recommendations to CCICED, see Section 5.2.

The Integrated Resource Planning promotion Network is continuing its work, with the responsibility on the Chinese side being assumed by Professor Wu Zhongxin, following the tragic death of Professor Qiu Daxing. The next Workshop is planned for the fall of 1998, pending funding.

5. Recommendations to CCICED

Following the request from the CCICED secretariat for suggested specific recommendations in a standard format for the CCICED to consider for its recommendations to the Government of China, the Working Group puts forward below specific proposals in 4 areas:

5.1 Long-Term Coal Utilization in China and Sustainable Development Background

China has vast, low-cost resources that will be exploited to support Chinese energy needs for a long time to come.

The challenge is to identify and pursue a path for expanding coal production, transport, conversion, and use in economical, environmentally friendly, and flexible ways that are consistent with sustainable development objectives. Under the present approach, the exploitation of coal is not being carried out in ways that are consistent with sustainable development objectives. Evidence for this is seen in severe environmental problems, especially the effects of local, regional, and global emission of air pollutants and greenhouse gases.
China must strive to find economical and environmentally friendly ways to use coal so as to satisfy its evolving energy needs. China must also develop the capacity to use coal to meet needs, which other countries satisfy with oil and natural gas, because these are relatively scarce in China. Some present "clean coal" technologies under development will be helpful but will be inadequate to meet the sustainable development challenges posed by China's daunting present and future needs.

Theoretical basis and feasibility

The Working Group has identified four key elements of a sustainable long-term vision for coal use in China. The key enabling technologies needed for realizing this vision are available in China, primarily in the chemical industry.

Syngas for primary coal conversion A coal development strategy emphasizing the production of synthesis gas (or "syngas") would make it possible for China to exploit its coal resources in ways that are consistent with sustainable development objectives and at the same time providing the flexibility to pursue a wide range of alternate energy products as well as chemical products that are "super-clean."

Hydrogen and fuel cells One key long-term non-polluting option under a syngas strategy involves the production of H2 and its use by fuel cells for small-scale combined heat and power (CHP) in commercial and residential buildings and for transportation applications as an alternative to petroleum-fueled internal combustion engines.

CO2 resource management The syngas strategy leads to the production of hydrogen or hydrogen-rich products. The accompanying CO2, which is normally produced in dilute streams along with other combustion products and vented in stack gases at coal burning facilities, is available in concentrated streams as a byproduct of these products. This byproduct CO2 can be used for enhanced oil recovery and methane production from deep beds of unminable coal. In the recovery of these resources the CO2 remains sequestered in the reservoirs. It is also feasible to sequester this concentrated CO2 at low incremental cost in deep aquifers.

Rationalizing the logistics of coal mining / transport / conversion / use The system of coal mining and conversion and the coal energy transport links between mining and conversion should be optimized in a manner consistent with a transition to the production of syngas for primary coal conversion.

These elements are elaborated upon in the Appendix I of this Working Group Report.

Expected economic and environmental benefits

Development of coal utilization along the lines indicated here would reduce the environmental problems with coal significantly. Such development is likely to be competitive overall, when prices of conventional coal technologies more truly reflect the full costs of their operations, and some newer technologies more truly reflect the full costs of their operations, and some newer technologies have moved down their learning curves. Prospective costs and environmental benefits would be especially favorable for large centralized coal processing facilities that co-produce multiple products (e.g., fluid fuels, electricity, process heat, and industrial chemicals).
Essential measures for implementation

The implementation of a long-vision is highly dependent upon continued studies leading to demonstration projects and market incentives, and on building of bridges between the different sectors of the economy involved. It is also important to focus on the "next steps" indicated in the Appendix to the Working Group report.

Recommendations

The Working Group proposes that CCICED recommends that the Government of China:

1. endorse the necessity of developing a long-term strategy for using coal in ways compatible with sustainable development, in light of the significance of coal as a domestic resource and of the role of coal utilization in environmental degradation at the local, regional, and global levels,

2. create a taskforce involving concerned Commissions, Ministries, Agencies, Administrations, and Academia to discuss and develop the proposed vision,

3. evaluate the proposed "next steps" carefully with a view to early implementation,

4. conduct an in-depth study of the overall life-cycle economics and environmental impacts of "conventional" vs. "syngas" coal strategies, and

5. identify via investigations the optimal logistics for production, transport, and conversion for the proposed coal vision vs. conventional coal strategies.

5.2 Institutional and Market Strategies for Sustainable Energy Policies

Background

China's institutions and markets are evolving rapidly. However, the externality costs of energy production and use are still inadequately dealt with in the market place. Reforms and innovations are possible for the key institutions and markets that have high external costs, such as the energy markets. Such reforms should take into account the evolutionary path of these markets, yet lead to the incorporation of social and environmental externalities as internalized costs that are taken into account in the development of energy policy, in energy supply investment decisions and in decisions by firms and households for energy-using equipment.

Theoretical basis and feasibility

It is well recognized that there are no perfect markets. A key market failure, which affects the relative viability of energy products is caused by pricing that does not reflect the full costs of production, distribution and use, nor reflect their negative and positive effects on society and the environment. Inadequacy of information and incentives for market actors and various institutional barriers are implicated in other market failures. Given the social and environmental challenges facing China, it is critical that the emerging market
oriented system creates market conditions for the participants in these markets that fully reflect all relevant costs and benefits.

Market conditions can be altered in a positive direction: through measures affecting price (e.g., taxes or duties), through regulations on procedures to ensure access to markets, through fair competition among participants, by performance standards for energy efficiency.

Expected economic and environmental benefits

It is expected that the level playing field that would be created by applying the above measures would lead to an energy system that performs better from an overall point of view, with much reduced environmental impact at the local, regional and global levels. It is a matter of creating the system that leads to optimal investments from the integrated perspective of standard economic accounting and social and environmental concerns.

Essential means for implementation

At the Government level, the methodology of Integrated Resource Planning (IRP) is useful to identify the more optimal energy systems rather than conventional systems. IRP integrates energy efficiency with energy supply, considering social and environmental externalities, thereby seeking minimum overall cost for energy services.

Recommendations

The Working Group proposes that CCICED recommends that the Government of China:

1. use IRP at all levels to
   a) establish a sense of the proper balance of investments between the supply and demand sides at the level of the energy-economy,
   b) determine their energy-related investments
   c) set policies for energy-related investments by private energy supply firms
   d) set policies for energy utilities
   e) set policies to regulate or influence energy related consumption decisions by firms and households

2. make the relationship between government and publicly owned industrial activities more distinct. Corporatization of industrial activities is important.

3. further develop its use of market instruments to match the expanding role of the market-place in determining energy investments, especially energy-using technologies. Gradually incorporate environmental cost into energy pricing. However, currently China's price system of energy products is distorted, under such a condition, environmental pricing does not make much sense. But in project feasibility studies, to adopt shadow
price and shadow environmental cost will be beneficial for the development of renewable energy and other environmentally friendly energy products.

4. continue to phase out subsidies to environmentally undesirable energy sources/forms process that is already well underway.

5. continue to seek lending agencies and foreign interests in new, environmentally desirable energy technologies.

6. gradually introduce competition in price setting, especially in electric power sector and oil sector to remove price distortions and enhance economic efficiency. Remove all artificial monopoly. All energy producers have to be in equal status to compete each other, especially in coal sector, i.e. small miners should have the same access to capital, market, technology, information, etc. For oil sector, several oil companies is better than one big oil company. For natural monopoly business, governmental regulation and public monitoring should be applied.

7. continue to encourage foreign direct energy investments, provided that such investments are consistent with China's long term environmental and economic development goals. Ensuring greater independence and long-run consistency of regulators of financial markets, securities markets, energy networks and environmental regulators would facilitate this.

8. use targeted sector-sector-specific mechanisms, to shift the market toward environmentally desirable technologies to achieve maximum economic benefits:

- introduce competition-inducing instruments such as the Renewable Portfolio Standards or the Non-Fossil Fuel Obligation to efficiently "buy-down the price" of new renewable energy technologies and establish their industries in power sector markets,
- use marginal cost pricing incorporated with environmental external cost for infrastructure expansion
- the future of district heating has to be reconsidered according to its overall economic and environmental benefit. The emerging smaller-scale combined heat and power technologies that require much less investment in distribution infrastructure is a promising development, but this is different from the old system of district heating. Introducing central air conditioning in high building to replace the household air conditioning should catch the public attention.

9. continue to apply the polluter pays principle. This improves the competitiveness of environmental cleaner options. It can be done in several ways. Wherever possible, the Chinese government should try to use its own expenditures as a lever to advance environmentally sound technologies, and promote

- research and development
- demonstration projects
- information-dissemination and education, and
• efforts to buy down the cost of environmentally desirable technologies Whenever there are substantial mutual benefits there activities should be pursued international collaborations.

10. experiment with resource development concessions as they pertain to environmentally sound energy technologies using solar, wind, micro-hydro and biomass energy.

5.3 Energy Efficiency in TVE

Background

The township and village enterprises (TVEs) account for one quarter of the Chinese GDP, employing nearly 130 million people. In 1995, TVEs consumed 334 Million tonnes of coal equivalent (Mtce). The largest energy consumers among TVE industries are among the least energy efficient: brick making, cement, coking and metal casting. In 1995, the energy consumption of these four sectors of TVEs, which accounted for 58% of the whole China’s TVE energy consumption, contributed only 13. 7% of value added in TVE.

At the present, the outstanding problems faced by the development of China’s TVE are the environment protection problems caused by the use of backward technologies and ignorance on how to use energy efficient technologies.

Lack of skilled personnel, constrained availability of capital and lack of evidence of economic viability of energy-efficient technologies in the current, economic, institutional and policy environment aggravate these problems.

Theoretical basis and feasibility

Comparison with the performance of state owned enterprises (SOEs) show that TVEs have a large scope for improving energy (and therefore economic) efficiency, where typically they lag behind SOEs by 20-60%. By international standards they have an even larger potential for improvement. The energy saving potential via retrofitting using well proven technologies, e.g. by changing the structure of products (e.g., from solid to hollow bricks) and by changing procedures (retaining oven and kiln warmth) is very large and achievable. Technical feasibility is assured, but the problems to be overcome also concern finance, institutional barriers, and capacity building.

Expected economic and environmental benefits

Increased energy efficiency will improve the economic situation of TVEs and the communities where they operate. Demand for centrally provided electrical power will be relatively less. Improved economic conditions will enhance TVE’s capacity to raise environmental awareness and performance in complying with the necessary higher environmental standards.

Essential means for implementation
The following means are essential for the government and non-governmental organizations, and experts to consider:

1. Capacity building

- enhance the knowledge of TVE's on the availability of more energy efficient technologies through the provision of information, advisory services, technology demonstration, and training by industrial organizations and other non-governmental organizations, state, provincial, city, township and village governments,
- encourage the dissemination of information on the available energy efficient and environment friendly technologies through industrial organizations and other nongovernmental organizations, state, provincial, city, township and village governments and the cooperation among them,
- disseminate the information of successful cases, and
- organize workshops to demonstrate the available energy efficiency technologies for selected TVE sectors.

2. Monitoring and auditing

- monitor ad audit the energy consumption in energy intensive TVE's and analyze causes of high energy consumption,
- monitor and audit performance of TVE's in solid, liquid and gaseous waste measurement and management,
- make best use of the "Energy Conservation Act" to enhance the monitoring of energy use in key energy intensive TVE's, and
- set bench marks for performance.

3. Incentives

- TVEs should be given equal status in competition for funding, technology and labor,
- eliminate energy pricing distortion which will discourage less efficient energy use,
- give financial and tax incentives to TVE's which will adopt the advanced energy efficient technologies following the advice provided by certified experts,
- introduce a system of combining an incentive to the best performer with a disincentive to the worst performer in energy efficiency and waste control, and
- encourage the government's financial institutions to give preferential treatment for the credible energy efficiency projects to be undertaken by the TVE's.

Recommendations

The Working Group proposes that CCICED recommends that the Government of China:

1. enhance capacity building in TVEs on energy efficiency,
2. facilitate the creation of monitoring and auditing functions,
3. provide balanced incentives for TVE development.
5.4 Modernizing Village-based Biomass for Energy

Background

Traditional biomass utilization provides 61% of the energy for living for China’s almost 900 million people in the rural areas, and a substantial part of the energy for Township and Village Enterprises (TVE). The main biomass resources at present are residues from agriculture and forestry, fuel wood, and animal husbandry. Crop straw and stalk output alone corresponds to 300 million tonnes of coal equivalent (Mtce) per year, of which the annually available amount of agricultural residues used for energy is approximately 170 Mtce. Much of this is used with a conversion efficiency of only 10-20%. In addition, 80 Mtce of animal husbandry wastes are generated annually. Considerable amounts of residues are burnt in the fields.

The projected amount of sustainably available straw and stalks for energy in the year 2010 is essentially the same as at present, approximately 170 Mtce. If this was used for electricity production, and process and space heating in conjunction with the provision of gaseous fuels for cooking and daily living, there is a potential for 120 GW of power generation producing 450 TWh (corresponding to 42% of 1996 total electricity generation in China).

Theoretical basis and feasibility

The Working Group arranged a two-day workshop in January 1998 on the theoretical, technical, and economic feasibility of modernizing the use of agricultural residues through small-scale power generation from biomass.

Small, commercially available biomass gasifiers could provide gas for cooking and for use in engines for combined heat and power (CHP) generation. Recovery and use of engine waste heat via the CHP option makes it possible to avoid burning fuel to provide heat needs, thereby freeing up more residues for power generation via CHP.

At present, spark-assisted diesel engines are available in China that could be adapted to biomass power generation when coupled to gasifiers that produce low levels of tars. More advanced biomass power generation technologies that offer the potential for higher efficiencies as well as lower capital and/or maintenance costs are being developed in several countries.

The report from the workshop provides further details, see Section 8.

Expected economic and environmental benefits

It is the intention to realize more of the economic value of agricultural residues as a fuel than is currently the situation for the benefit of the rural population, thereby also saving on investment of centrally generated electricity. In Jilin province available residues are sufficiently abundant that this bioenergy strategy could have major economic impacts. Village-scale residue conversion facilities could provide cooking gas to households via pipeline plus hot water from engine waste heat via village-scale district heating plus electricity for household electric needs. The produced electricity would often exceed local needs and could be exported to urban users, thus earning villagers income by wire.
The environment benefits include: (i) reduced outdoor air pollutant emissions resulting from substituting small, clean biomass gasifier/CHP power plants for large, dirty coal power plants, (ii) reductions in indoor air pollutant emissions (and associated reduced exposures to smoke, esp. for women and children) associated with replacing polluting coal or biomass cook stoves with stoves operated on clean biomass-derived gas, and (iii) reduced local and regional air pollution associated with the burning of crop residues in the field.

Essential measures for implementation

The government of Jilin Province has been working with the Working Group in developing projects on modernized biomass utilization on a village scale to demonstrate the technology and to investigate the economic feasibility and institutional arrangements in the practical situation of village conditions. A demonstration project funded by Jilin Province of gasification for the provision of gas for cooking and heating will be in operation late summer of 1998. In addition, a proposal for international funding of a demonstration of gasification for combined heat and power generation has also been developed and submitted for funding.

Recommendations

The Working Group proposes that CCICED recommend that the Government of China:

1. endorse the modernization of biomass energy conversion technology to support the development of rural areas,

2. endorse demonstrations of village-scale biomass gasification for the generation of cooking gas and combined heat and power applications, and

3. encourage the cooperative development of grid connected rural electrical power schemes using biomass.


6.1 General Considerations

The following workplan is based on the approach outlined in Sections 1 through 3 above, and the Five-Year Workplan advanced in last year report from the Working Group to CCICED. In the overall context outlined there, the Working Group will contribute to the development of market rules for sustainable energy development in China, including contributions to the discussion of the role of government in shaping these rules. Further, the Working Group will identify and analyze important new technologies for sustainable energy, propose demonstration projects for new technologies and new institutional arrangements, and discuss the institutional and human capacity issues that are crucial for making full use of sustainable energy options in China.

With the time limitation of two meetings per year, at which studies are reported, technological and capacity-building workshops are convened and demonstration projects are followed up, it is necessary to be selective in what the Working Group hopes to
achieve in the next few years. Human resources and funding also exert constraints upon what can be effectively tackled.

As workshops stem from mature studies, and the choice of studies is arrived at through an ongoing discussion of priorities, it follows that the portfolio of these activities remains dynamic. The Working Group's attention will continue to be directed into those areas and themes that seem most important to Chinese members, seeking at the same time to ensure a balanced attention over the twin concerns of socio-economic development and the environment. The international members will strive to ensure that the most appropriate, clean and efficient technologies, and the most efficient institutional arrangements experienced worldwide, are brought to the attention of the Working Group.

6.2 Studies

During the next year, studies will address

1. the potential for cogeneration in China, both with and without a syngas oriented energy future. The study will include cogeneration in district heating networks, industrial cogeneration, and decentralized cogeneration. Modern technologies characterized by high electricity to heat ratios will be explored.

2. the pollution situation and mitigation options in the city of Chongqing, in cooperation with the Working Group on Pollution

3. the wind resource concession, the focus of an ongoing studies being carried out under a UNDP project by Working Group members Professor Ni and Dr. Brennand. If possible, the idea will be explored for other forms of renewable energy as well,


6.3 Technology-oriented Workshops

For its January 1999 meeting, the Working Group is planning a one-day workshop on recovery of coalbed methane via both conventional technology and via the injection of CO2 into the coalbed, to be followed by a one-day workshop on a coal/coal-bed methane-based hydrogen economy for China, based on the analysis in the coal vision presented in the Appendix of this report.

In mid-year 1999, there will be at last one workshop, the subject(s) of which have still to be selected.

6.4 Demonstration Projects

During the coming year, the Working Group intends to focus on the already initiated demonstration projects, the biomass project in Jilin, the fuel cell bus, the wind resource concession, and energy-efficient buildings, see Section 4 above, and the initiation of
additional steps on modernized biomass in Jilin Province. By mid-year 1999, it is to be expected that studies/workshops may have generated an additional demonstration project, or projects.

6.5 Capacity Building

The Integrated Resource Planning Promotion Network is planning a Third Workshop that has had to be postponed until the fall of 1998.

7. Report on Funding

The costs of meetings of the Working Group have been funded by the Canadian secretariat of the CCICED, covering the participation of the international members and direct local costs. Funding for workshops and other local activities has been identified by the Working Group during Phase I from other sources. For the last year these costs have been covered by the Canadian secretariat of the CCICED, using grants from Canada and Norway. A large number of contributors have been supportive, as acknowledged in the reports of the Working Group to the CCICED. In the judgment of the Working Group, a larger contribution to total activities from CCICED funds would be desirable.