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## TECHNOLOGY AND TECHNOLOGY INFORMATION NEEDS

### Comments from a Party

#### Note by the secretariat

By its decision 7/CP.2 (FCCC/CP/1996/15/Add.1), the Conference of the Parties, at its second session, requested the Convention secretariat to give high priority to the development and completion of a survey of the initial technology needs, as well as technology information needs, of Parties not included in Annex I to the Convention, with a view to providing a progress report to the Subsidiary Body for Scientific and Technological Advice at its fourth session. The COP also urged non-Annex I Parties to communicate initial information to the Convention secretariat not later than 1 December 1996 regarding technologies and know-how required to address climate change and its adverse effects that could be compiled by the secretariat into a detailed list of technology needs required by developing country Parties, taking into account that more elaborate technology needs would be included in their initial national communications.

In regard to the latter request, the secretariat has received a submission from China. In accordance with the procedure for miscellaneous documents, this submission is attached and reproduced in the languages in which it was received without formal editing. Any further submissions from Parties will be issued in an addendum to the present document.

In regard to the first request, the secretariat has initiated a survey of the technology needs of 20 Parties not included in Annex I, to obtain preliminary information and to test a survey instrument. The secretariat will provide information on the results of this survey at the fifth session of the SBSTA.

## 技术清单

- 一、整体煤气化联合循环
- 二、直接还原技术
- 三、循环流化床煤气化技术
- 四、有机化合物蒸汽释放控制系统
- 五、生物质气化和燃气净化技术
- 六、利用南方速生薪炭林发电技术
- 七、燃料电池
- 八、熔融还原技术
  
- 九、禽畜场废弃物生产有机复合肥成套技术
- 十、南方人工林实行免耕法技术
- 十一、森林生态系统管理技术
- 十二、工矿废弃地复垦造林技术
- 十三、真空管太阳能热水器
- 十四、稻壳能源转换器
- 十五、减少酸雨对南方马尾松森林危害的技术

# 一、整体煤气化联合循环

## 1. 技术名称

整体煤气化联合循环 (Integrated Gasification Combined Cycle)

## 2. 技术特征

整体煤气化联合循环是一种先进的发电技术。其工作原理是先将煤气化，再以气化和净化后生成的洁净煤气作为燃气轮机的燃料，并将该燃气轮机与蒸汽轮机组成联合循环发电装置。它的结构原理主要由煤前期处理装置、煤气化装置、煤气净化装置和联合循环发电装置四部分组成，它具有以下几个主要特征：(1) 效率高，比一般煤粉电厂高10%以上，有的可达40-50%，单位发电煤耗310gce/kw.h；(2) 适用煤种广，可充分利用资源；(3) 商业化前景好。

## 3. 经济特征

该电站的早期单位建设费用偏高，如Cool Water电站，单位造价为2538美元/千瓦。商业化后一个500兆瓦电站的单位建设费用只有900美元/千瓦。它的运行成本，按运行20年计算，运行电价大约在4-4.5美分/千瓦时。

## 4. 环境效果

整体煤气化联合循环电站低污染、环保性能优良。由于电站采用了较彻底的净化手段，控制了SO<sub>2</sub>、NO<sub>x</sub>和烟尘的排放，其脱硫率为90-99%，NO<sub>x</sub>的排放可减少25-60%，使其排放水平与燃烧天然气相当，并通过效率的提高减少了CO<sub>2</sub>的排放，约为0.3公斤/kw.h左右。

## 5. 市场容量

随着中国社会经济的发展，现有的火电装机还将成倍的增长。整体煤气化联合循环是把高效的联合循环总能系统和洁净的燃煤技术结合起来的先进的发电系统，有可能逐步取代现有汽轮机电站，成为跨世纪火电动力的一个主要发展方向。中国的电力工业部门已充分认识到持续发展中的问题，非常重视老电站改造和新的火电发展模式，已进口了十多套烧油、气的联合循环装置，并将整体煤气化联合循环发电技术研究列入中长期电力科技发展规划的重点项目计划，因此，通过引进国外先进的整体煤气化联合循环技术，并建立示范电站，将为中国大规模推广应用该项技术提供了基础。

## 6. 其他

(1) 引进方式建议采用技术合作和技术引进相结合。中外双方合作研究新热力循环及系统和系统一体化等领域，引进煤气化、高温净化和先进的燃气轮机等技术。

(2) 在技术合作和引进的基础上，利用GEF的赠款和有关金融机构的低息贷款建设200MW级的IGCC示范电站，将首套引进的大型IGCC电站建成具有良好推广价值的示范电站。

## 二、直接还原技术

### 1. 技术名称

直接还原技术 (Direct Reduction)

### 2. 技术特征

直接还原生产海绵铁技术是以气体和液体燃料以及非焦煤作能源和还原剂，在铁矿石(或含铁球团)呈固态的温度下进行还原获得金属铁的一种炼铁方法。直接还原法根据使用的还原剂不同，可分为气基法和煤基法两大类。若按所采用的还原装置区分，则有竖炉法、反应罐法、流态化床法、回转窑法等多种方法。1994年全球年产量为28.20百万吨，设备利用率平均为73%。目前在工业上应用最为广泛的是气基Midrex和HYL法，以及煤基的SL/RN和戴维的DRC法等。戴维公司(DAVY)直接还原铁厂是采用煤基直接还原回转窑法工艺(DRC)。据报道，该厂产品的金属化率为93%，铁产率为96%，吨直接还原铁消耗固定碳为0.425吨，耗电为90-120kWh(其中直接还原厂为65%，料场占26%，辅助消耗占9%)。

### 3. 经济特征

中国首家直接还原铁生产厂辽宁省喀左县海棉铁冶炼厂项目的总投资为5292万元，建成的生产能力为2.5万吨，每万吨生产能力投资为2117元。委内瑞拉的生产费用为每吨122.87美元，而欧洲为161.20美元。

### 4. 环境效果

直接还原技术能耗低，仅是高炉炼铁工艺的40-50%，因此，吨钢可减排二氧化碳约为50-60%。

### 5. 市场容量

考虑到中国电炉钢产量仅占钢总产量的22%，而发达国家已达30-40%，意大利占56%，随着中国社会上钢蓄积量的增多，废钢的回收量也将增大，在目前电力供应比较宽松的情况下，以废钢为原料的短流程工艺将有一个较大的发展，因此对杂质少的海绵铁需求量也将会有较大幅度的增长。

### 6. 其他

(1) 由于中国煤多，天然气资源有限，引进煤基作还原剂的技术可能更符合国情，技术引进内容包括工艺技术、生产软件、主体设备的关键部件、电器仪表自动控制等。

(2) 引进直接还原海绵铁生产线，主要是资金问题。因此需要得到GEF的支持，给项目总投资1/3以上的赠款和低息贷款。项目成立后，中国冶金工业部将项目纳入总体规划，并帮助企业落实国内配套资金和各项条件。

(3) 该项技术的引进工作由中国冶金部统一负责，在中国西宁钢厂等单位组织实施。

## 三、循环流化床煤气化技术

### 1. 技术名称

循环流化床煤气化技术 (CFB Coal Gasification for Amonia Synthesis)

### 2. 技术特征

循环流化床煤气化技术是近年来研究开发的用固体燃料生物质、煤和垃圾等生产燃料气、城市煤气和合成气粗气的一种工艺方法。该项技术特别适用于150 MWth以下, 较小规模工厂的技术改造。第一座商业规模的常压流化床气化技术的工厂于1986年在奥地利投入运行, 是用树皮制低热值燃料气, 其规模为27 MWth, 气体用于一造纸厂的石灰煅烧, 但目前尚未有生产合成气的商业工厂投入运行。

### 3. 经济特征

由于常压循环流化床煤气化炉在0.15M Pa以下操作, 转鼓喂料气连续加料和排灰, 省去许多加压气化装置所必须的锁闭仓系统。在间歇式煤气化炉上改用循环流化床气化技术后, 只要在压缩机之前配氮, 气体成份和改造前相差不大, 所以老系统的脱硫等工段都可以保持不变, 只需新建一套年产10万吨的总氮能力的流化床气化装置即可, 因此相对节省了改造费用, 较大幅度地降低生产成本。

### 4. 环境效果

气化炉日处理量500万吨, 相当年产10万吨总氮的生产能力, 按小时生产13.39吨氮、耗煤20.3万吨、平均吨氮耗煤1.497吨。中国以煤为原料生产合成氨占总量的61%, 绝大多数还是采用间歇式煤气化技术, 每吨氮要排出吹风气约4000立方米, 其中含二氧化碳量约为12%, 约1吨, 如用循环流化床煤气化替代生产尿素或碳氨, 正常生产时无废气排放, 排渣的含碳量低于5%, 如果替代一半, 每年可减少二氧化碳排放量780万吨。

### 5. 市场容量

中国中小型化肥厂占全国氮肥总产量的80%, 其中以煤为原料厂的能力也占80%, 而且基本是以无烟煤为原料, 采用常压固定床间歇气化的方式生产合成气。中国无烟煤的产地比较集中, 而氮肥企业分布在全国各地, 必然造成长距离的运输, 而且由于资源有限使化肥装置能力不能全部发挥, 加上常压间歇气化技术落后, 煤炭损失较大, 造成的环境污染严重, 因此迫切寻求一种既能改善环境又能利用当地煤种的气化技术, 这是中国合成氨工业的普遍性问题。因此, 循环流化床气化技术在中国有着较大的示范推广价值。

### 6. 其他

(1) 目前该技术在生产燃料气、城市煤气上已工业化, 但在世界上还没有一家用来生产氨或甲醇合成气的工厂, 虽鲁奇公司可保证生产合成气绝无问题, 但仍需做一些细致的工作。

(2) 该项技术建议从德国鲁奇公司引进, 由中国化工部统一负责, 在河北省宣化化肥厂组织实施。

## 四、有机化合物蒸汽释放控制系统

### 1. 技术名称

有机化合物蒸汽释放控制系统 (Vapour Emission Control System)

### 2. 技术特征

在液货船进行装卸作业时，对港口、装卸站和船舶上所产生的蒸汽加以收集，并在船上或输送到岸上进行处理，防止有机化合物蒸发扩散到大气中，以确保作业安全及防止对环境的污染的控制系统。该系统由蒸汽收集系统和蒸汽处理系统组成，蒸汽收集系统包括闭式液位测深系统、货舱(罐)液位报警系统、高低压报警系统和收集管道系统。蒸汽处理系统是将收集的蒸汽进行复原回收、摧毁和转化消散，该系统目前采用的技术有多种方法：如吸附法，溶剂吸收法等。

### 3. 经济特征

联合国IMO为协调世界各国在海洋航运中共同关心的“安全航运和海洋环保”问题，制定了防止船舶造成海洋污染的MARPOL 73/78公约，中国是该公约的缔约国。根据IMO组织推行的港口管理国制度，港口方面有义务阻止不符合规定的船舶离港，直至该船舶符合规定要求为止。在MARPOL 73/78公约附则六执行之前，个别发达国家已经执行类似规定，如美国1990年10月1日版联邦规则条例46条(46CFR)第一章已对蒸汽释放控制系统做出明确的规定。因此该项技术不仅关系到国内航运减少和环境污染，而且涉及到中国船舶能否进入其他国家港口和其他国家港口能否为中国港口接纳的问题，而国际上该装置价格昂贵。

### 4. 环境效果

中国石油类运输量的三分之一为国际贸易，所以由此造成的污染也为全球性的。采用该项技术措施之后，液货船舶运输的装卸作业均处于封闭系统之中，可以达到排放标准，甚至可以达到零排放，并在防止蒸汽溢散造成环境污染的同时，可以对蒸汽进行回收，节约能源，减少货物的损失。同时这种有效、可靠、安全的装备通过引进技术组织生产和推广后，除了满足船舶运输外，还可以在其他陆上领域使用和推广。

### 5. 市场容量

船用设备的特点是必须与国际接轨，这些船用设备在其他国家的港口使用时必须能与岸上设施匹配，因此这些设备需符合国际公约中的有关规定标准要求，并满足船舶检验机关制订的法则要求；反之岸上的设施也同样需要与其他国家船舶上的设施相匹配，所以不论船用或港口使用均需有相应的当局机关根据国际制订的法规进行认可。因此对该系统的成熟技术引进是短期内解决问题的最佳措施。目前中国该项技术应用可谓是空白，市场容量是非常大的。

### 6. 其他

(1) 该技术拟利用GEF赠款，采用技术许可证的方式，引进国外已有的生产技术、工艺和主要生产设备，在国内组织生产和推广。

(2) 该项技术拟由交通部负责引进，由上海船舶运输科学研究所组织实施。

## 五、生物质气化和燃气净化技术

### 1. 技术名称

生物质气化和燃气净化技术(Biomass Gasification & Gas Cleaning)

### 2. 技术特征

生物质气化技术是将木柴、秸秆和其它不易直接利用的生物质固体燃料转换为使用方便的气体燃料，将燃气净化后可用于炊事、发电和其它工业用途。它包括空气气化法、氧气气化法、热解法、蒸汽气化法等。其技术关键为生物质气化设备和燃气净化设备。据统计，1993年全球生物质气化热电厂已有343座，在该领域具有领先水平的国家有瑞典、美国等，加拿大已投放市场的若干型号的生物质气化炉产品，以锯末、木片、纸浆、果壳等为燃料，制取煤气，驱动内燃机发电。发达国家生物质气化装置的气化效率可达60~90%，可燃气体热值为 $1.7\sim 2.5 \times 10^4/\text{m}^3$ 。

### 3. 经济特征

目前发达国家研制的生物质气化装置一般规模较大，自动化程度高，工艺较复杂，以发电和供热为主，造价较高。中国生物质气化主要应用于烘干供热供暖和发电系统，利用生物质气化发电的装置主要有两种形式，稻壳煤气和油气双燃料发电机组，适宜于企业小规模发电，发电成本和电站单位投资均下降30%左右。

### 4. 环境效果

由于生物质资源的可再生性，它的大量高效利用可带来明显的环境和生态效益。每气化1吨生物质原料，可减少1.3~1.5吨二氧化碳的排放和节省0.5吨标煤的矿物能源。

### 5. 市场容量

目前中国生物质气化设备研究与制造均属起步阶段，气化技术研究水平还比较低，尤其是在提高燃气热值和燃气净化程度方面，还存在着技术障碍。可以预见，随着中国农村整体经济实力增强，对高品位的洁净气化能源的需求增大，生物质气化将作为一种用能方式成为农村能源开发与利用的重点之一，其市场覆盖面会十分广阔。重点需求市场包括：(1) 生物质原料丰富而又相对集中的林区。以全国年产木材6000万立方米计，约有废弃物2500万立方米以上。(2) 农作物秸秆资源量大、质优的农区。据测算，中国农作物秸秆年产量6亿吨以上，折合标煤约3亿吨。(3) 用能紧张的农林产品加工行业。中国每年有木材加工边角废料达2000万立方米，稻壳5000万吨左右。(4) 缺煤或无煤的草原和山区。

### 6. 其他

(1) 选择适合中国农村特点和技术经济水平的气化装置和净化技术，引进设备规模应以中小型为主，一般的气化炉直径1000mm以内，小时产气200立方米以内。采用合作开发或许可证贸易的形式引进技术，在国内组织设备生产和示范推广。

(2) 该项技术拟由中国农业部负责引进，由山东省科学院能源研究所组织实施。

## 六、利用南方速生薪炭林发电技术

### 1. 技术名称

利用南方速生薪炭林发电技术(Fuel Forest-Fired Power Generation in South China)

### 2. 技术特征

利用中国南方速生薪炭林作为替代能源进行发电，是一种生物质能转化为电力的技术。生物质能发电主要有直接燃烧生物质、联合燃烧和特定原料供应系统(DFSS)。目前最常用的生物质发电技术是凝气式汽轮机，另一种是利用燃汽轮机，燃料是通过生物质热化学气化产生的煤气。最有可能的生物质发电技术是生物质综合气化炉/燃气轮机循环(BIG/GTs)，这种技术有可能在本世纪内就会成为商业化发电技术，利用速生薪炭林发电，属于特定原料供应系统，在技术上现已不存在什么问题，在印度尼西亚、危地马拉已有实验性先例。

### 3. 经济特征

利用速生薪炭林发电这一技术虽已有先例，但经济效益的问题并没有完全解决，固体生物质燃料的投入产出比现在还比较高，运输成本也比较高，致使发电成本较高。因此急需开展试验性研究，尽快降低发电成本，使该项技术不仅有良好的环境效益，而且有较好的经济效益，容易被人们广泛接受。

### 4. 环境效果

利用速生薪炭林发电每年的二氧化碳的减排量取决于每年的薪柴总的使用量，即决定于发电站的规模。按五个小流域串联起来的一个小电网计算，如果每个小流域为500公顷，每公顷的生物年增长量为10立方米(18吨碳)，则每年减排的碳约为22500吨碳。虽然薪柴燃烧时也放出CO<sub>2</sub>，但可以同薪炭林生长过程中吸收的CO<sub>2</sub>相抵消，因此薪炭林燃烧发电不会增加大气中CO<sub>2</sub>的含量。同时，木材中几乎不含硫元素，对降低大气中SO<sub>2</sub>浓度，控制酸雨也有一定的作用。

### 5. 市场容量

薪炭林是以生产燃料为主要营林目的，以短轮伐期平茬采薪为基本经营方式的能源林。薪炭林具有收益快、产柴量高、适应性强、成本低等特点。中国南方气候温暖、雨量充沛，森林资源丰富，利用当地乡土速生树种发展的薪炭林生产周期短，产量大，利用速生薪炭林作为替代能源进行发电，是一种很有希望的减少碳排放的途径。随着人们环境意识的增强，越来越多的人接受生物质能，因此该技术将会有广阔的市场。

### 6. 其他

(1) 希望该项技术的引进能得到GEF的部分赠款。同时为降低运输成本，应该以小流域为基本单位，在山口建立小发电站，并将若干小发电站联结起来，建立地区小电网。

(2) 该项技术拟由中国林业部负责引进，由林业部热带林业研究所和广东省林业厅共同组织实施。



## 七、燃料电池

### 1. 技术名称

燃料电池 (Fuel Cells)

### 2. 技术特征

燃料电池是一种将燃料的化学能直接转变为电能的装置。它的主体有两种不同的极性物质和与之相匹配的电解质构成，经由辅助装置将燃料和助燃物分别导入电池的两极，在极性物质材料和电解质（有时还包括催化剂）的共同作用下发生化学反应过程直接转换而产生电能。燃料电池的发电效率可达40-60%，是火力发电的两倍左右。排出的热量还可继续利用，总效率可达80%左右。该类电池可以使用多种燃料，其规模及用途可以选择。当前国际上已有一些比较成熟的燃料电池，如澳大利亚发明了一种属于第三代的陶瓷电极的燃料电池，美国生产的磷酸型燃料电池，即利用磷酸作电解质的电池，在日本已有规模为1.1万千瓦的燃料电池在较稳定运行，总装机容量已达1.8万千瓦。日本还研制出了80℃左右即可发电的金属燃料电池，最近报道三洋公司研制出使用压缩氢气的便携式燃料电池，功率已有百瓦左右，预测该技术可在96年商品化，成为主流技术。

### 3. 经济特征

从基建投资看，据报道先进的大型设备投资约为600美元/kw，加上排污投资升至1400美元/kw。技术落后的小型电厂的投资还要高。在目前条件下，由于技术比较复杂因而燃料电池造价较高，约为2500美元/kw。目前达到的容量为2万千瓦，而当燃料电池的容量达到20-30万千瓦的规模时，这种技术将是经济的。从运行成本看，燃气轮机综合循环成本为0.077美元/千瓦时，燃煤循环发电成本0.083美元/千瓦时，燃料电池发电成本为0.073美元/千瓦时。从输配电成本看，工业发达国家输配电成本500美元/千瓦，用电分散的欠发达地区成本更高，而燃料电池因为可省去输配电任务，从而可以大大节省输配电成本。

### 4. 环境效果

燃料电池基本上不产生CO<sub>2</sub>一类可能使地球气候变暖的温室气体，基本不排放SO<sub>x</sub>和NO<sub>x</sub>，不象发电厂那样占用大片土地，是一种对环境危害很小的清洁能源。现有应用范例表明，使用燃料电池可减少40-60%的CO<sub>2</sub>排放，减排SO<sub>x</sub>、NO<sub>x</sub>约90%。

### 5. 市场容量

由于燃料电池适用范围广泛，因此有着很大的市场容量。在目前情况下它可以适用于一些特定用途，当其经济性良好时，它可以应用于十分广泛的场合。

### 6. 其他

(1) 建议采用“应用起步，项目带动”的方式，根据需要首先引入使用常规能源的燃料电池，建设示范点。在此基础上引入与生物质气化机组配套的燃料电池，开展单元型或社区型生物质能发电、供热的热电联产。

(2) 该项技术拟由中国电力部和农业部共同负责引进和组织实施工作。

## 八、熔融还原技术

### 1. 技术名称

熔融还原技术 (Smelting Reduction)

### 2. 技术特征

熔融还原生产铁水技术是利用煤粉和氧气，对矿粉进行高温液态状态下还原，使大部分反应在液态氧化物相中发生，直接生产铁水的炼铁方法。熔融还原法将成为21世纪钢铁冶炼的新工艺。该技术最早由联邦德国于1977年在钢包内进行试验，1985年南非从奥钢联引进了一套年产30万吨铁水的熔融还原工艺及设备(Corex装置)，于1989年底交付工业性生产，年产铁水34万吨，吨铁耗氧640立方米，耗煤1183公斤，同时附产大量高热值煤气，产出的铁水成分及其温度与高炉生产的铁水基本相同。韩国浦项钢铁厂已建成了一座年产60万吨铁水的Corex装置。目前有希望成为工业规模生产的还有日本DIOS法、澳大利亚的HISmelt法、俄罗斯ROMELT法、德国Lurgi法和美国的AISI法等。

### 3. 经济特征

熔融还原技术由于省略了焦炉和烧结生产车间，基建投资比高炉法约节省20-30%左右。由于熔融还原法能较大幅度减少劳动定员，因而使生产经营费用减少，加上工序节能降耗，从而降低了产品的成本，约低于高炉法的10-20%。

### 4. 环境效果

熔融还原法生产铁水技术能减少对环境的污染，灰尘、二氧化硫和氮化氮等有害物质的排放能大幅度地减少。由于省掉了烧结和炼焦工序，可使吨钢排放粉尘量减少40%，特别是炼焦产生的多环芳烃的污染，使吨钢治理污染的投资减少了25%以上。同时，由于省去了烧结、炼焦的能耗，可使吨钢能耗节约35%左右，使吨钢减排二氧化碳25%左右。

### 5. 市场容量

中国是一个发展中国家，1994年钢产量达到9100多万吨，但人均钢产量仅为世界人均的60%。据预测，到2000年，即使届时中国的钢产量达到1亿吨，还仍有2000万吨钢材的缺口。另外，由于中国钢铁工业工艺技术落后，装备水平低，产品结构不合理等不仅造成物耗高，环境污染严重，在品种质量上也不能满足国民经济发展的要求，因此，也需要采用新技术改进老企业，使之在改善品种和质量的同时，降低能源和原材料的消耗，保护和改善环境。同时，由于焦煤资源有限，成为制约钢铁工业发展的重要因素，因此，不使用焦炭炼铁更有利于钢铁生产的发展。因此，熔融还原生产铁水技术在中国有着广阔的应用前景。

### 6. 其他

(1) 中国引进熔融还原技术，GEF的资金支持是必不可少的。

(2) 以目前达到的技术经济水平看，熔融还原以Corex法比较成熟，因此中国需要全套引进Corex法的技术与设备。

(3) 该项技术的引进工作由冶金部统一安排。

## 九、禽畜场废弃物生产有机复合肥成套技术

### 1. 技术名称

禽畜场废弃物生产有机复合肥成套技术 (Family Animal wastes Produce Organic Compound Fertilizer)

### 2. 技术特征

禽畜场废弃物生产有机复合肥成套技术是将禽畜场粪水先进行固液分离，分离出的液体部分经过厌氧好氧发酵处理，达国家排放标准后排放。而分离出的固体部分则进行二次发酵，加上沼气发酵后的沼渣，添加辅料后烘干制成有机复合肥销售。该技术目前比较成熟的有日本、俄罗斯、台湾等国家和地区，他们的处理方法各有所长，通过研究和技术经济比较，台湾的设备和技術比较适合大陆的情况。

### 3. 经济特征

解决大中型禽畜场粪水污染的最好办法是搞综合利用，这样才能既大幅度减轻环境污染，又克服经济效益差的不足。有机复合肥料特别适用于果树、蔬菜和温室大棚内的作物，它不仅能促进植物的生长，而且能改善植物的产品品质，其价格比化肥低，效果比化肥好。据测算，大型禽畜场建此类工程动态回收期在四年左右，投资利率在30%以上。

### 4. 环境效果

该项技术变废为宝，使污染源变成了可利用的资源，节约了能源，改善了环境，它不仅解决了水污染、空气污染，而且将固体废物制成了优质的有机复合肥料，形成了整个生态农业的良性循环。沼气是一种高品位能源，经过净化后可直接用于生活生产，此技术的应用和沼气工程的兴建，会进一步缓解广大农村能源短缺的状况，从而有效地保护植被和减少林木的毁坏，这对改善局部区域的气候变化和减少有害气体的排放有着十分重要的意义。

### 5. 市场容量

目前中国大中型禽畜场粪水处理没有得到完全解决，有关二次发酵的技术和设备的研究也很不够，没有形成一套可用的设备和技術。因此，该项技术的市场容量极大，几乎所有禽畜场都可以采用此技术。据有关部门统计，中国大中型禽畜场仅鸡和猪年排粪便达5.81亿吨，加上其他粪便，总量可达7亿吨，其中绝大部分没有处理，只有部分采用沼气工程进行了处理。

### 6. 其他

(1) 利用GEF部份赠款，拟在北京郊区某大型养猪场建一个示范点，引进全套禽畜场废弃物生产有机复合肥成套技术生产线，包括生产设备和技術。

(2) 该项技术拟由中国农业部负责引进，由中国农业部规划设计研究院组织实施。

# 十、南方人工林实行免耕法技术

## 1. 技术名称

南方人工林实行免耕法技术 (No-tillage for Artificial Forest in South China)

## 2. 技术特征

对中国南方人工林实行免耕法技术，即林木采伐后不清林、不整地，将枝桠留在林地，树苗栽在树桩间隙中或枝桠空隙中。将传统的“烧山-整地-造林”改变为免耕免烧的方法，以提高土地的生长力，增加生长量，减少土壤碳流失，提高对大气二氧化碳的吸收。据报道欧美国家有关皆伐、林地清理、及造林等对林地土壤碳损失平均约为21%，其变动范围依整地清林的方式而异，碳的损失量为1%-69%，其中以在陡坡地上伐后焚烧采伐剩余物并进行全垦整地的造林方式所造成的土壤碳损失最大。

## 3. 经济特征

免耕法由于造林时未清理林地，也未焚烧采伐剩余物，必然会给造林带来诸多的不便，提高了造林的成本，造林后为防止杂草欺负幼树所需的抚育费用也要高于普通造林。因此，免耕法造成的成本肯定要高于普通造林。而其早期的生长力水平则可能不如普通造林，但其后期生长和总生长量将远远超过普通造林，所以总的经济效益将是收入远远大于投入的成本。

## 4. 环境效果

免耕法的采用将大大减少林地水土流失和有机质的损失，极大地提高土壤的有机碳含量及土地的生长力，增加热带、亚热带森林的生长量，增加对大气二氧化碳的吸收，还可能减少其它温室气体的排放，非常有利于全球环境的改善。它的减排潜力主要表现在三方面：A. 减少有机质的流失，其数量现在还不能准确地确定；B. 免除焚烧所造成的直接排放；C. 由于减小了地力衰退，可使森林生长率提高，从而增加对大气二氧化碳的吸收。如果80%杉木林和马尾松林实行免耕法，按土壤碳损失减少20%，森林生长量增加20%计算，中国南方杉木林区总计可净增加对大气碳吸收200百万吨碳。这种情况可以维持约30年，即一个森林轮伐期，所以在此期间平均每年能多吸收大气碳约7500万吨（碳）。

## 5. 市场容量

中国亚热带杉木、马尾松林区占森林总面积的1/4左右，杉木面积约900万公顷，马尾松面积约1400万公顷，目前这些林区普遍实行烧山整地造林方式，即把造林地中的采伐剩余物以及草类、灌木类全部砍倒晒干后烧掉，进行全垦或带垦后造林。由于中国南方降雨充沛，林地多位于山地陡坡，这种作业方式，造成林地养分和土壤碳大量流失，土地生产力不断下降。因此在中国南方人工林中，为了提高土壤的有机碳含量，减小地力衰退现象，实行免耕法技术是非常必要的。而且中国是一个木材短缺的国家，所以该项技术的市场容量是非常大的。

## 6. 其他

- (1) 建议从美国引进该项技术，造林所需主要费用希望能从GEF得到无偿资助。
- (2) 该项技术拟由中国林业部负责引进，由林业部森林生态环境所组织实施。

# 十一、森林生态系统管理技术

## 1. 技术名称

森林生态系统管理技术(Forest Ecosystem Management Systems)

## 2. 技术特征

利用现代的信息系统，通过对森林生态系统实行现代化管理，从而提高森林的生长量，减少资源的浪费，增加对大气中二氧化碳的吸收。森林生态系统管理技术是一项较新的技术，也是难度较大的技术。要提高森林的生产力和吸收大气中二氧化碳的能力，从根本上说则是要提高对森林生态系统的管理技术水平。目前，集约经营的人工林，其生产力要比天然林高数倍至数十倍。但某些集约经营的人工林存在土地退化问题，造成水土流失和有机质的损失。要使森林的生产力大幅度提高并且减少地力衰退现象，必须用现代化的森林生态系统管理技术。

## 3. 经济特征

本项目是通过对森林生态系统实行现代化管理，从而提高森林的生长量，减少资源的浪费。因此本项目的经济投入集中在局部的信息中心，从大范围来看经济投入很小而效益很高。对森林生态系统实行现代化管理是实现资源可持续利用的关键，对林业的长期稳定高产有长远而根本性的影响。

## 4. 环境效果

对森林生态系统实行现代化管理将大幅度增加森林生长量，减少对森林资源的不合理利用和浪费，保护森林资源，改善生态环境，增加对大气二氧化碳的吸收，非常有利于中国及全球的环境改善。本项技术的增产增效决定于这一系统运行的好坏，如果按最保守的估计每公顷林地的木材产量增加30%，则全国的森林生长量将增加8500万立方米，相当于多吸收二氧化碳2000万吨碳。

## 5. 市场容量

中国是一个木材短缺的国家，木材的市场需求量很大，故本项目的市场容量可认为是不受限制的。

## 6. 其他

(1) 目前澳大利亚在森林生态系统管理技术上比较先进，因此拟从澳大利亚引进该项技术，可通过技术合作方式，共同投资，以尽早引进此项技术。

(2) 该项技术拟由中国林业部负责引进，由林业部森林生态环境研究所和森林资源信息研究所共同组织实施。

## 十二、工矿废弃地复垦造林技术

### 1. 技术名称

工矿废弃地复垦造林技术(Waste land Reforestation for Mine Area)

### 2. 技术特征

通过在工矿废弃地复垦营造森林，恢复土地和植被，以吸收大气中的二氧化碳，改善环境。实践表明，废弃矿造林绿化工程是多快好省地恢复生态环境的有效方法。受现有采矿工艺及底植被复盖率(4.2-9%)所决定，中国废弃地开发应以林业土地土壤复垦为主，这方面国际上有许多技术方法可以借鉴，例如德国在褐煤矿废弃矿地造林前，用几种不同改良措施改善土地微生物活性；前苏联在露天煤矿开采场的强毒土堆造林，施用石灰和废料等，降低了土壤酸度，促进了林木的生长。在西墨西哥州和亚利桑那州，利用灌溉法可在一些废弃矿地成功地种植植被。在复垦造林技术方面，美国比较先进，技术也较成熟。

### 3. 经济特征

在工矿废弃地营造森林，其目的是改善矿区生态环境条件并吸收大气中的二氧化碳。这一项目并不以经济赢利为目的，没有直接经济效益，只有间接的环境效益，其对环境改善的间接效益，需通过环境的经济效益评价来估算。

### 4. 环境效果

工矿废弃地复垦造林可显著改善矿区生态环境条件，并对中国的生态环境条件改善也有很显著效益，而且林木绿化后，由于根深叶茂，能较快地形成绿色实体，在较少经济投入情况下，无需很大的整地工程，安全稳定，容易实现治理目标，而且能较好地发挥固土、净化功能，防止水土流失、减少尘埃和提供绿化景观，生产工农业用材、果品等，且具有再生产功能。如按现有待复垦的工矿废弃地资源1400万公顷全部造林，每公顷森林年生长率为8立方米计算，每年可吸收2500万吨碳。

### 5. 市场容量

在工矿废弃地营造森林，是重建和恢复矿区及废弃地生态环境的行为，中国现有待复垦的工矿废弃地资源为1400万公顷，每年以2万公顷的速度增长，造林潜力很大。因此，如果从美国引进成熟复垦造林生态工程技术在中国进行全面废弃地造林，不仅可获得近21亿立方米木材，而且可显著改善矿区生态环境条件。

### 6. 其他

(1) 建议从美国、德国和英国等国引进复垦造林技术及其机械设备。同时中国政府将设置废弃地复垦造林技术研究项目，包括林木良种、造林方式、集约管理等研究，提出适合中国不同矿区及废弃矿地的绿化工程的配套、实用的营林技术组合。

(2) 该项技术拟由中国林业部负责引进，由林业部森林生态环境研究所组织实施。

## 十三、真空管太阳能热水器

### 1. 技术名称

真空管太阳能热水器 (Solar Hot Water Heater--Evaluated Tube)

### 2. 技术特征

真空管太阳能热水器是将太阳能直接转化为热能的一种新型太阳能集热装置。由于运用了真空技术，大幅度地降低了集热器的热损失，因而使其在高工质温度或低环境温度的运行条件下仍具有良好的热性能，具有防冻、系统承压高、易于安装和维修等优点。热管式真空管集热器是这一家族中的佼佼者，由于运用了热管技术，被加热工质不直接流经真空管，具有热容量小、热二极管效应等优点。真空管太阳能热水器的日平均吸热效率 $>50\%$ ，在北方地区亦可全年使用，比常规的平板式产品增加热量20%左右。

### 3. 经济特征

真空管太阳能热水器运行中不耗能源，没有新的开支，据测算，三年内仅节省下的电费或煤气费即相当于全部投资。对一个3—5口之家而言，拥有一台1.2平方米真空管热水器即可满足全家一年四季的洗澡热水，北方地区即使在冬季，2个晴天也可晒热一箱水，每周保证全家人洗1—2个热水澡是不成问题的，全年节省量折合约400 kg标准煤。

### 4. 环境效果

工作过程中，没有环境污染，没有 $\text{CO}_2$ 、 $\text{SO}_x$ 、 $\text{NO}_x$ 等废气排放。

### 5. 市场容量

目前，北京市太阳能研究所研制生产的热管式真空管太阳能集热器已通过鉴定并批量生产。从国外情况看，荷兰的Philips公司和英国Thermomax公司均拥有太阳能热利用技术比较先进和成熟的产品，以色列的真空管太阳能利用普及率较高，技术水平也非常先进。中国有2亿多户家庭，现普及率不足5%，距世界发达国家差距较大（以色列为20%，日本为15%），若达到5%，则每年需求量在200万平方米左右，可见市场容量巨大。

### 6. 其他

(1) 建议引进真空管加工关键技术的生产线，或关键技术的技术转让，配套的水箱和支架加工由国产化解决。

(2) 该项技术拟由中国农业部负责引进，由山东省科学院能源研究所组织实施。

## 十四、稻壳能源转换器

### 1. 技术名称

稻壳能源转换器 (Rice Husks Energy Transfer)

### 2. 技术特征

稻壳能源转换器是将稻壳的生物质能转化为热能或电的装置。该炉适用于不同规模的稻壳能量转化器，最终用于发电、供热或干燥物料。在控制燃烧下，可以得到干净的热气流，且可控制稻壳灰的含碳量，这对提高燃烧效率及提供可销售的稻壳灰具有重要的意义。KC炉属稻壳燃烧发电，由于它能部分利用（直接可控）稻壳中的固定碳热值，炉内色相为桔红色，温度约为1100℃，炉内为氧化气氛，化学不完全燃烧程度比较低，因此燃料燃烧效率比较高，排出的稻壳灰中的含碳量可控制在10~30%。由于KC炉的排灰形式为干排灰，因此稻壳灰不必烘干即可利用。

### 3. 经济特征

过去用稻壳作为饲料并无多大营养价值，仅作为一种填充剂而已。随着中国粮食生产的发展，稻壳将不再成为一种饲料，而稻壳作为燃料加以利用具有更大的现实性和社会效益。对于中国水稻地区，在燃料缺乏、电力紧张的具体情况下，在大中型碾米厂附近建立相应的稻壳电站、稻壳供应站或稻壳干燥加工厂是综合利用稻壳的可取途径，同时减少废弃物排放。

### 4. 环境效果

中国1991年稻谷产量为1.76亿吨，约占世界稻谷产量的40%，折算稻壳就有3130万吨。中国缺少能源的地区（如浙江省），煤炭、石油等大都依靠外省调入，而浙江省又是以大米为主要的地区，省内农村大都生产水稻，以稻壳作为电站燃料可在一定程度上解决本省燃料缺乏问题，特别是非铁路沿线的燃料缺乏地区，这对保护森林及节约运输的能源消耗也有重要的意义。

### 5. 市场容量

中国国内机组基本属于成堆干馏制气发电，因此相对较少利用稻壳中的固定碳热值，炉内色相呈清红色或初红色，炉温约为500~700℃，属中性或还原气氛，所以化学不完全燃烧程度较大，排出的稻壳灰中未燃尽的含碳量占灰的40~50%，而该项技术在美国则已是成熟技术（美国PRM碾米公司），同时由于中国有许多从事多年稻壳燃烧技术研究的专家，能够消化、吸收该项技术，研制出适合中国国情的稻壳燃烧炉，因此该项技术在中国有着广泛的市场前景。

### 6. 其他

- (1) 组成专家小组考察生产和使用情况，引进一台具有代表性的KC燃烧炉。
- (2) 该项技术拟由中国农业部负责引进，由农业部规划设计研究院组织实施。



## 十五、减少酸雨对南方马尾松森林危害的技术

### 1. 技术名称

减少酸雨对南方马尾松森林危害的技术 (Pony-tail Pine Protection in Acid Rain Area)

### 2. 技术特征

二氧化硫引起的酸雨对中国南方马尾松森林危害很大，造成许多树木枯死。减少酸雨对南方马尾松森林危害的技术，可增加森林生长量，加快吸收大气中的二氧化碳。

### 3. 经济特征

本项目可以以较低的经济投入降低马尾松受酸雨危害的程度，增加林木生产量，改善生态环境，有明显的经济效益。研究发现，中国南方马尾松森林受酸雨的危害比较严重，据不完全统计，每年由此造成的采籍材积损失约为60万立方米，林业损失约为三亿元。由森林损失所引起的对二氧化碳吸收的减少量是很大的。

### 4. 环境效果

这一技术能减少酸雨对南方马尾松森林的危害，扩大二氧化碳吸收源，增加对二氧化碳的吸收量，减缓温室效应，有利于全球环境的改善。由于中国南方马尾松的分布极为广泛，受酸雨的危害又相当严重，因此引进这一技术，不仅能增加马尾松的蓄积量，改善造林绿化的效果，而且将大大增加对二氧化碳的吸收量，从而达到减少二氧化碳排放的目的。按每年损失材积生长量60万立方米计算，由于这一项目的实施，每年将多吸收约11万吨碳。

### 5. 市场容量

马尾松是中国松属树种中分布最广泛的一种，也是中国亚热带东部湿润地区典型的针叶树代表树种。马尾松适应性强、生长迅速、天然人工更新容易，其木材用途广泛，经济效益高，在亚热带山地开发利用及恢复森林生态系统中具有十分重要的地位。由于中国以燃煤为主的能源结构特征在短期内不会得到改变，大气污染有进一步恶化的趋势，因此这一技术具有广阔的应用前景。

### 6. 其他

(1) 欧洲对酸雨的研究比较深入，各种控制酸雨危害森林的技术比较先进和完备。尽管欧洲没有对马尾松森林危害进行过专门的研究，但可从欧洲转让或引进减少酸雨对森林危害的技术。

(2) 该项技术拟由中国林业部负责引进，由林业部森林生态环境研究所和广西、四川、贵州省林业厅共同组织实施。

中华人民共和国外交部条约法律司  
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14 November 1996


Mr. Michael Zammit Cutajar  
Executive Secretary  
Climate Change Secretariat  
PO BOX 260124  
D-53753  
Bonn  
Germany

Dear Mr. Cutajar,

I have the honour to communicate to you the initial information regarding technologies and know-how required to address climate change and its adverse effects, in accordance with the decision taken at COP2 on development and transfer of technologies. Please find enclosed a List of Technologies for that purpose.

With regards.

Yours sincerely,

  
CHEN SHIQU  
Director General

## LIST OF TECHNOLOGIES

1. Integrated Gasification Combined Cycle (IGCC)
2. Direct Reduction
3. CFB Coal Gasification for Ammonia Synthesis
4. Vapour Emission Control Systems
5. Biomass Gasification & Purification
6. Fuel Forest-Fired Power Generation in South China
7. Fuel Cells
8. Smelting Reduction
9. Poultry/Livestock Wastes for the Production of Organic Compound Fertilizer--Complete Technology
10. No-tillage for Man-made Forest in South China
11. Forest Ecosystem Management Systems
12. Waste Land Afforestation for Mine Area
13. Solar Hot Water Heater--Vacuum Tube
14. Rice Husk Energy Transfer Instrument
15. Pony-tail Pine Protection in Acid Rain Area

# **1. Integrated Gasification Combined Cycle**

## **1.1 Technology Name**

Integrated Gasification Combined Cycle

## **1.2 General Characteristics**

Integrated Gasification Combined Cycle (IGCC) is an advanced power generation technology. The fundamental of IGCC is uses the cleaning gas produced from gasification and purification as fuel for the turbine, combines the gas turbine with steam turbine. It consists of coal pre-process, coal gasification, gas cleaning, and combined cycle power generation. The main advantages of IGCC are as follows: First, it offers high thermal efficiency, reached from 40 percent to 50 percent is 10 percent higher than of pulverized-coal (PC) fired power generation. The unit coal consumption is 310 gce/kWh. Second, it is relative insensitive to feedstock, allowing all types of coal to be fired. Third, it has a good commercial market.

## **1.3 Cost Information**

The capital cost of early IGCC technology for the Cool Mater plant is much higher, and reached \$2,538 kW. Now for the commercial IGCC plants (500 Mw), the capital cost is approximately \$900 kW. The operating and maintenance cost for this plant amount to about 4 to 4.5 cents/kWh, which design lifetime expected 20 years.

## **1.4 Environmental Effects**

The IGCC plant has low emissions of pollutants, and good environmental characteristics. Its desulphurization efficiency reached from 90 percent to 99 percent used a cleaning measure, and SO<sub>2</sub>, NO<sub>x</sub> and particulate emissions had been controlled. It reduces the formation of NO<sub>x</sub> to levels from 25 percent to 60 percent lower than that from a conventional PC plant, as the same of burning natural gas. Increased thermal efficiencies result in lower carbon dioxide emissions per unit electric generation, is about 0.8 kg/kWh.

## **1.5 Market Potential**

With the development of society and economy of China, the present thermal power capacity will need to be expanded further. IGCC is an advanced power generation system that combines a higher coal-electricity production of efficiency with clean coal combustion technology. It is anticipated that IGCC technologies have the capacity to

replace the steam turbine in the fossil-fired power plant, as a key development direction in this field.

China fully recognizes the problems of sustainable development and pays much attention to the retrofiting of aged power plants by introducing advanced technologies and new models of power generation. China has already imported more than ten sets of oil-fired or gas-fired combined cycle units. In addition, China's Ministry of Electric Power has emphasized the power generation technology of IGCC by placing it on the agenda of its plan for middle-term and long-term development of electric power. So, it can serve as the foundation for a large-scale application and diffusing of IGCC technology in China by introducing advanced technology of IGCC and constructing a demonstration power plant.

### **1.6 Other Information**

- For the form of introducing, it is suggested to combine cooperative research (such as on new thermal cycle and system, integrity of system) with technology imports (such as gasification, hot dry cleaning, and advanced gas turbine).
- Based on the technical cooperation and imports, it is proposed to construct a 200 Mwe IGCC demonstration power plant with good values for spreading by using the GEF grants and loans of low interest from financial organizations.

## **2. Direct Reduction**

### **2.1. Technology Name**

Direct reduction

### **2.2 General Characteristics**

The direct reduction technique of producing sponge iron is one of iron-smelting processes, which uses gas or liquid fuel and non-coking coal as energy and reducer, reduces metal iron at the temperature condition that iron ore (or include iron pellet) is solid. Considering the different reducer used, the direct reduction technique can be generally classified into two sub categories: gas-based process and coal-based process. Based on the difference reductive device, it can be divided into vertical furnace process, reaction pot process, fluidized-bed process, and rotary kiln process, etc. The output around the world in 1994 was 28.2 million tons, and the average utilization rate of the device was 73 percent. The widest processes used in industry now are Midrex and HYL in gas-based process, as well as SL/RN and DAVY's DRC in coal-based process. It was reported that the process used in DAVY's Direct Reduction Plant was rotary kiln, which reduce directly using coal-based as reducer. The metallization rate was 93 percent, iron rate was 96 percent, per ton direct reduction iron consumed 0.425 ton solid carbon, and 90-120 kWh electricity (of which 65 percent in direct reduction plant, 26 percent in material plant, 9 percent was auxiliary consumption).

### **2.3. Cost Information**

The first direct reduction iron plant, named Kazuo County's Sponge Iron Smelting Plant in Liaoning province of China, invested 52.92 million yuan, the capacity was 25,000 tons, the average 10000 tons capacity investment was 2117 yuan, this number is \$122.87 in Venezuela and \$161.20 in Europe.

### **2.4 Environmental Effects**

The energy consumption of the direct reduction technique is low, which is only from 40 percent to 50 percent of that of iron-melting in blast furnace, so it can reduce from 50 to 60 percent CO<sub>2</sub> emissions per ton steel.

### **2.5. Market Potential**

The output of electric steel only occupies 22 percent of the whole steel output in China, while this share in developed country has reached from 30 percent to 40 percent, 56 percent in Italy. With the increase of steel accumulating in China, the retrieve amount of scrap steel will be going up, and electricity is relatively plenty, so

the short process used scrap steel as material will develop rapidly, therefore, the requirement of sponge iron with little impurity will grow rapidly.

## **2.6 Other Information**

- To introduce the technique of coal based as reducer is more conformable with the actual situation in China with an abundant coal and a limited nature gas resource. The contents of technique introduced include process technique, production software, key parts in the main device, and automatic control unit in instruments and meters.

- The main problem in introducing the line of sponge iron production is funds. It is necessary for China to obtain the help from GEF, to gain donation accounting for more than 1/3 of the total funds for projects, and loan with lower interest rate. After the projects being founded, China's Ministry of Metallurgical Industry will bring it into line with the country's overall plan, and help the enterprises to put into effect the funds and equipment's domestic.

- China's Ministry of Metallurgical Industry will be in charge of introducing affairs, and put them into practice in Xining Steel Plant and other plants.

## **3. CFB Coal Gasification for Ammonia Synthesis**

### **3.1 Technology Name**

CFB Coal Gasification for Ammonia Synthesis

### **3.2 General Characteristics**

The technology of CFB coal gasification is a new process under R&D to convert a wide variety of solid fuels--biomass, coal, wastes into crude gas for fuel, town, and synthesis gas production in recent years. This technology is very suitable for replacing the old low efficiency UGI gasification process in small size ammonia plants which gasifier capacity limit is around 150 MwtH. The first commercial scale plant based on CFB gasification (27 MwtH) which produced low-Btu gas from bark was put into operation in Austria in 1986, and the gas is used in a paper mill for lime calcining. Up to now, there is no commercial plant for ammonia synthesis that has been in operation.

### **3.3 Cost Information**

The CFB gasifier is operated at pressure less than 0.15 Mpa (called "quasi-atmospheric"). This pressure level allows continuous fuel feeding and ashes removing by using rotary feeders, obviating the necessity for lock hopper systems like with most pressure gasification temperature. Since both CFB and UGI gasifier are operated at the same pressure level, the existing UGI gasification plant can be replaced by CFB that need introduce  $N_2$  to system prior to compression to keep the almost same content in the crude gas generated from CFB and UGI. So, it only needs to construct a CFB gasifier which corresponds to about 100,000 TPY of  $NH_3$  capacity, without the necessity to renew the whole existing down stream compression and purification units. It also can reduce a lot of investment and the operation cost obviously.

### **3.4 Environmental Effects**

It is the appropriate range of capacity for one atmospheric CFB gasifier (500 TPD of coal feed) which corresponds to about 100,000 TPY of  $NH_3$  capacity. It uses 20.8 tons of coal to produce 13.89 tons of in one hour, and the average coal consumption for per ton of  $NH_3$  is 1.497. It accounts for 64 percent of the total output of ammonia synthesis in China, which used coal by UGI gasifier. This process emits about 4000  $m^3$  of purge gas for per ton of  $NH_3$  which the  $CO_2$  content is 12 percent, that is 1.0 tons. If we use CFB gasifier to replace UGI gasifier to generate urea or ammonium



bicarbonate, it is zero emissions under normal conditions, and the carbon content of ash is lower than 5 percent. So, if the 50 percent of UGI gasifier were replaced by CFB gasifier, it will reduce 7.8 Mt of CO<sub>2</sub> emissions.

### **3.5 Market Potential**

In China, the output which produced from the middle and small size ammonia plants amounts to 80 percent of the total output of nitrogenous fertilizer, among which, about 80 percent of the total capacity need to be fed with coal. These plants were almost use anthracite coal to generate gas by the conventional UGI gasifiers. The production of anthracite coal is relative concentration, but the ammonia plants is distributed around country. This not only result in a long distance transport of coal, but also affects the utilization ratio of ammonia plant capacity by limited resources. Meanwhile, the UGI gasifier is disadvantageous for its low efficiency, low carbon conversion rate, and difficulty with pollution control. For all these aspects, it is very necessary for China ammonia industry to seek a gasification process which both improved environment and used local coal resources, this issue also is a common problem. So, the CFB coal gasification for ammonia synthesis has good values for spreading.

### **3.6 Other Information**

- At present, the CFB coal gasification which generated fuel and town gas has reached industrialization, but no one can be used for ammonia synthesis. So, it needs to do more detailed work, though the Lurgi had operated in its Research and Development Center.
- It is suggested that introduce this technology from Lurgi company by the Ministry of Chemical Industry of China, and which will be applied in the Xuanhua Ammonia Plant in Hebei province.

## **4. Vapour Emission Control Systems**

### **4.1 Technology Name**

Vapour Emission Control Systems

### **4.2 General Characteristics**

Vapour Emission Control Systems are designed to collect vapours of flammable cargoes from tanker cargo tanks, and process vapours onboard or at shoreside terminal during cargo loading and unloading operations, in order to reduce the flammable vapours emit to the atmosphere, promote the operation safety, and protect the environment pollution. It includes the vapour collection system and the vapour processing unit. The vapor collection system consists of closed gauging device, liquid overfill protection system, vapour overpressure and vacuum protection system, and vapour line connection system. The vapour processing unit means the components of a vapour control system that recovers, destroys, or disperses vapour collected from a tanker, at present, this system uses many different technologies, such as carbon bed absorption and lean oil absorption.

### **4.3 Cost Information**

In order to coordinate the issues of interest to each other on "safety transportation and environment protection " in ocean shipping, International Maritime Organization (IMO) draw up a convention (MARPOL 73/78) on preventing ocean pollution from shipping, China is a signed country. According to the management regulation under port' country recommended by IMO, it is the duty for the port administration to allow ship leave, until the ship is in accord with the demands. Before the implementation of the annex 6 of the convention, some developed country had already carried out similar regulation, such as USA, in the chapter one of the 46 CFR, published in October 1, 1990, had provided a clear definition on the vapour emission control systems. So this technology not only concerns the reduction of the amount of ocean shipping and environment pollution, but also relate the problem whether China's ship can enter other country's port and other country's ship will be allow making port in China or not. At the moment, this system is expensive in the international market.

### **4.4 Environmental Effects**

In China, about 1/3 of the freight volume of the petroleum is used international trade, and resulting in a worldwide environment pollution. If we use the vapour emission

control systems, it will operate in the closed condition for cargo loading or unloading, and meet emission standards, even realize zero emission. It also will recover the vapour, save energy, and reduce the loss of cargo. Meanwhile, besides cover the shipping transport need, this system is efficient, reliable and safety, which will be manufactured and spread domestically, and can also been used in land area based on introducing technology.

#### **4.5 Market Potential**

The characteristics of the shipping equipment have to be consistent with international standards, these devices have to accord the demands for the shoreside facilities at port of the other country, also, these devices should meet the requirements of standards of international convention. It's the same the other way round. So, for the equipment located both onboard and shoreside terminal need to be approved by the local administrations based on the regulation recommend by the international organization. At present, there are no user for vapour emission control systems in China, and its market potential also is very large. It's the best way for China to meet this issues by introducing the commercial technology.

#### **4.6 Other Information**

- It is suggested that adopt technology license to introduce the commercial techniques and process, and manufacture key equipment domestically, supported by the GEF grants.
- It is suggested that this technology will be responsible for technology introducing by the Ministry of Communications of China, and which will be carried out by the Shanghai Ship & Shipping Research Institute.

## **5. Biomass Gasification & Purification**

### **5.1 Technology Name**

Biomass Gasification & Purification

### **5.2 General Characteristics**

Biomass gasification technology is a method of converting woods, stalks and some other solid biomass fuels which are not appropriated for direct use into convenient gas fuels used for cooking, generating, as well as for some industrial purpose after cleaning. It includes air gasification, oxygen gasification, thermolysis, steam gasification, etc. The key technology of process is biomass gasification equipment and fuel-purification equipment. By statistics in 1993, there were 343 biomass gasification thermal-power plants in the world, and the countries holding the leading technology in this field are Sweden, USA, etc. Canada also has put some products of biomass gasification furnace in different specification into market. Which use wood-dusk and paper or not waste as a fuel, and produce coal gas to drive internal combustion engine for electricity generation. The gasification efficiency at biomass gasification equipment in advanced countries have reached from 60 percent to 90 percent, the caloric values of fuel gases are ranged from  $1.7 - 2.5 \times 10^4$  KJ/m<sup>3</sup>.

### **5.3 Cost Information**

The current biomass gasification equipment developed by the advanced countries are general large scale with high automation and complex technical process, merely for power generation and heating supply, the costs are rather higher. The utilization of biomass gasification in China are mainly on drying or space heating and power system, the biomass gasification equipment used for power generation have two kinds, they are grain husks coal gas and oil gas double fuels generator units which is suitable for enterprise's small-scale power generation, the cost of Electricity generation and the per investment of power station are both reduced about 30 percent.

### **5.4 Environmental Effects**

Because of biomass resource's renewable property, large quantities and high efficient utilization can bring about an obvious benefit of environment and ecosystem. Gasifying one ton of biomass fuel can reduce 1.3-1.5 tons of CO<sub>2</sub> emission and is equivalent to 0.5 tce of fossil energy resource.

## 5.5 Market Potential

At present, China's biomass gasification equipment R&D is still on the original stage, the level of gasification technology research is relatively lower, especially on the aspects of increasing fuel gas caloric value and its cleaning degree, we still have some technical barrier. It is prospected that the demand for high quality cleaning - gasification energy will increase, as China countryside overall economic growth, the biomass gasification, being a way of energy end-use, will become one of the main issues for rural energy development and utilization. Its market has big potential. The key demand markets are as follows: (1) Forest areas with rich and concentrated biomass resource. In terms of country's total wood output of 60 Mm<sup>3</sup>, the waste will be above 25 Mm<sup>3</sup>. (2) Farm area with abundant and high quality grain crops stalks. It is calculated that the annual yield of grain crops stalks in China has exceeded 600 Mt which is equivalent to 300 Mtce of energy. (3) Agriculture and forest products processing industries with energy short. Each year China has wood waste of wood processing industries about 20 Mm<sup>3</sup> and grain crops husks waste about 50 million tons. (4) No-coal or short coal prairie and mountain areas.

## 5.6 Other Information

- Selecting appropriate gasification equipment and cleaning technology suited to characters and tech-economic level of China's rural areas. The introduced equipment scale should be small or middle size with gasification furnace diameter under 1000 mm and gas output of 200 m<sup>3</sup>. Adopting the forms of cooperation development or trade license introduced technology, organizing equipment production and demonstration spread domestically.
- The Ministry of Agriculture will be charge of technology introducing, this project will be coordinated the implementation by Institute of Energy under Shandong Academy of Science.

## **6. Fuel Forest-Fired Power Generation in South China**

### **6.1 Technology Name**

Fuel Forest-Fired Power Generation in South China

### **6.2 General Characteristics**

As an alternative energy, fuel forest-fired power generation in south China is a conversion process from biomass energy to electricity power. Biomass energy power generation has several systems, such as direct combustion of biomass, combined combustion and DFSS. The current prevalent biomass power generation technology use condensing turbine, another choice is gas turbine, its coal gas fuels are produced by biomass thermal-chemical gasification. The most possible biomass power generation technology can be BIG/GTS which will probably become a commercial power generation in this century. Fuel forest-fired power generation is belong to specific feedstock supply system, it's also no technical problems existed. There have been some experimental examples in Indonesia and Guatemalan.

### **6.3 Cost Information**

Although we have some examples of fuel forest-fired power generation, the economical benefit problem still remains unsolved. The solid biomass fuels have relatively higher ratio of input and output transportation cost and power cost. So, the urgent need is in order to develop an experimental research, reduce power cost and make this technology have both environment and economical benefit.

### **6.4 Environmental Effects**

The CO<sub>2</sub> emission reduction by using fuel forest--fired power generation determined by how much firewood used. It depends on the power station scale. Taking an example of small network severed by five sub-regions. Supposing each sub-region has 500 ha, the annual biomass output would be 40m<sup>3</sup> (about 18 tons carbon), the carbon emission would reduce 22500 tons per year. The amount of CO<sub>2</sub> emission caused by burning firewood also can be offset by CO<sub>2</sub> absorption during firewood growing, so, the fuel-fired power generation will not increase CO<sub>2</sub> emission. Meanwhile, woods usually do not contain sulfur element. It also can have some impact on atmospheric SO<sub>2</sub> emission and acid rain controlling.

### **6.5 Market Potential**

The operation purpose of firewood plantation is to produce biomass fuel, among the energy forest operated by the means of short rotation, the firewood plantation process has certain good features of rapid profit, high output, good adaptability, low cost, etc. The South of China shares a warm climate with abundant rain and forest resources, so the firewood plantation by utilizing local fast-growing tree feeds would achieve a short production period and a larger yield. It's really an expected way to reduce carbon emission by using fuel forest-fired power generation. As the increasing realization of environment issues, more and more people would like to accept biomass energy. Therefore, the market for this technology will be promising.

## **6.6 Other Information**

- Expecting get some funds from GEF for the technology introducing. In order to reduce transportation expenses, the small power station should be built beside mountains in the scale of sub-region unit, and connecting several these small power station forming a regional network.
- The Ministry of Forest will take responsibility for technology introducing, this project will be coordinated the implementation by both Tropical Forest Research Institute, Ministry of Forest and Guangdong Forest Bureau.

## **7. Fuel Cells**

### **7.1 Technology Name**

Fuel Cells

### **7.2 General Characteristics**

Fuel cell is a device which can transfer chemical energy of the fuel into electric energy. Its main body is composed of two different kinds of polar materials and the matching electrolyte. When fuel and burning-rate accelerator are piped into two poles separately by an aiding device, chemical reaction will occur in the electrolyte under the affections of both polar materials and electrolyte (including catalyst sometimes), and then power energy will directly be generated. The efficiency of power-generating of fuel cells can be from 40 percent to 60 percent, which is two times of that of thermal power generation. Total efficiency can reach 80 percent, for the heat blown off can also be used. Fuel cell can use a great number of kinds of fuel, and the scale and application of the cell can be chosen. Now there are some advanced fuel cells in some countries, for example, the fuel cells invented in Australia is the third generation of ceramic polar fuel cells, and phosphoric acid type fuel cells made in America used phosphoric acid as the electrolyte. In Japan the fuel cells with 11,000 kW have been working smoothly, and the total installment capacity of the cells has reached 18,000 kW. Japan also invented metal fuel cells which can generate electricity only at 80 °C or so. It is reported recently that Sanyo Electric Corp. Limited had developed portable fuel cells using compressed hydrogen, whose power has been about 100 kW. It can be predicated that this technique will be commercialized and become dominating technique in this filed in 1996.

### **7.3 Cost Information**

From the view of the investment of capital construction, it is reported that the cost for advanced large device is about \$600 per kW, if added with waste disposal cost, it would reach \$1400 per kW. The investment to the small power plants whose technique is not advanced will be higher. Under current conditions, the producing cost of fuel cells is much higher — about \$2500 per kW due to the complicated techniques, and the capacity is 20,000 kW. Nevertheless, when the capacity can reach 20,000 to 30,000 kW, this technique will be economical. For the operation cost, comprehensive circulation cost of combustion turbine is \$0.077 per kWh, the cost of coal-burning power generation is \$0.083 per kWh, and the cost of fuel cells is 0.073\$ per kWh. From the view of the cost of electricity transmission and distribution, the cost of



electricity transmission and distribution in developed countries is \$500 per kW. While in developing countries, power consumer is more scattered, and the cost is more high. However, fuel cells can save this cost, for they do not need electricity transmission and distribution.

#### **7.4 Environmental Effects**

Fuel cells almost neither produce greenhouse gases such as CO<sub>2</sub> which can cause the global warming nor blow off SO<sub>x</sub> or NO<sub>x</sub>. They are clean energy resources, polluting environment very little, and not like power plants which will consume great lands. Present examples indicate that using fuel cells can reduce the emission of CO<sub>2</sub> at 40 percent to 60 percent, SO<sub>x</sub> and NO<sub>x</sub> at about 90 percent.

#### **7.5 Market Potential**

Because of the wide range of application, fuel cells have very large market capacity. Now they can be applied in some special fields. When being economical, they can be applied in extensive circumstances.

#### **7.6 Other Information**

- It is suggested that the way of “Starting from Application, Developed by Projects” should be adopted. First, it is necessary to introduce fuel cells consuming common energy resources and set up typical examples according to the need, and then to introduce fuel cells matching with biomass gasification unit and to develop apartment or district type co-generation by biomass energy.
- The Ministry of Electric Power and the Ministry of Agriculture are planned to take charge of the work of introducing and implementing the technique.

## **8. Smelting Reduction**

### **8.1 Technology Name**

Smelting reduction

### **8.2 General Characteristics**

The smelting reduction technique of producing molten iron is one of direct iron-smelting process, which use pulverized coal and oxygen, reduce with ore powder in the condition of high temperature and liquid state, and make most of the reactions happened in the liquid oxidize phases. Smelting reduction will be the new technique of iron and steel smelting in the 21 century. The first time to do technique experiment was in steel ladle in West Germany in 1977, South Africa imported a set of smelting reduction technique and device (Corex device) from Austria Iron & Steel Union in 1985, which can produce 0.3 million ton molten iron per year, and put it into production in the end of 1989, producing 0.34 million ton molten iron per year, per ton iron average consumed 640 cubic meters oxygen, coal 1183 kg, and meanwhile, produced lots of high calorific value gas as by-product, the compositions of the molten iron and its temperature are almost same as that of the production from the blast furnace. Puxiang Iron and Steel Plant in South Korea has constructed a set Corex device which can produce 0.6 million tons molten iron per year. At present, the following process would become the process in a scale of production: Japan's DIOS process, Australia's HIS melt process, Russia's ROMELT process, Germany's Lurgi process and America's AISI process, etc.

### **8.3 Cost Information**

Smelting reduction technique cuts down the coke oven and sintering workshops, so its construction cost is less about 20 percent to 30 percent than that of blast furnace process. It can reduce a lot of employees, therefore, lessen the operation cost; the processes can reduce energy consumption, the cost of the products will be down, the cost is about 10 percent to 20 percent lower than that of the blast furnace process.

### **8.4 Environmental Effects**

The smelting reduction technique of producing molten iron can cut down environment pollution, it can obviously reduce the emission amount of poisonous gas, such as dust, SO<sub>2</sub> and NO<sub>x</sub>. 40 percent of dust emission in steel production can be reduced because of omitting sintering and coking process, especially, the investment of controlling pollution in a ton steel production dropped over 25 percent because of reducing pollution from polycyclic aromatic hydrocarbon in the coking. Meanwhile, because of omitting energy consumption in sintering and coking process, 35 percent of energy

consumption amount for per ton steel can be saved, and about 25 percent of CO<sub>2</sub> emission amount per ton steel can be reduced.

### **8.5 Market Potential**

China is a developing country, the steel output in 1994 reached more than 91 million tons, but the average steel output possessed by per capita was only 60% of that of the world. It's predicted that the steel output in 2000 in China will reach 100 million, there is still a gap of 20 million ton steel. Due to the process technique falls behind the developed countries, the production structure is not reasonable, all of these make material consumption high and environment pollution serious, the quantity and quality of the products could not satisfy demand of the national economic development, therefore, we should adopt new techniques to improve old enterprises so that they can improve both quantity and quality of products, and make the consumption of energy and raw materials lower, protect and improve the environment. It is one of important factors of restricting China's iron and steel industry that the coke resource is limited, so iron-melting using non-coke will be useful to the development of iron and steel industry. So, smelting reduction technique has a vast vista in China.

### **8.6 Other Information**

- It is necessary for China to get funds assistance from GEF to introduce smelting reduction technique.
- According to the level of the technique and economy, Corex process is more ripe in smelting reduction technique. China needs to import Corex's whole set of technique and device.
- The Ministry of Metallurgical Industry of China will be in charge of the introducing affairs.

## **9. Poultry/Livestock Wastes for the Production of Organic Compound Fertilizer--Complete Technology**

### **9.1 Technology Name**

Family Animal wastes Produce Organic Compound Fertilizer

### **9.2 General Characteristics**

This technique is to separate liquid from solid wastes, ferment the separated liquid through anaerobic and aerobic procedures, and then drain when accomplished the national standard. While the separated solid wastes will be fermented again, added dregs of the fermented biogas and supplementary ingredients, and then parched to organic compound fertilizer for sale. Now this technique in Japan, Russia and Taiwan is relatively mature, each has its own advantage, through research and technical and economical comparison, the technique and equipment in Taiwan are more suitable for China's situation.

### **9.3 Cost Information**

The best way to resolve the wastes in the large and middle scale animal farm is comprehensive utilization, only this way can reduce the environment pollution greatly and overcome the poor economic benefit. Organic compound fertilizer is very suitable for fruit, vegetable and greenhouse plant, it not only can promote the growth of plant, but also can improve the products quality, its price is lower than chemical fertilizer but its effect is better. As calculated, the dynamic return period of such technique in large-scale animal farm is about 4 years, the investment interest rate is above 30 percent.

### **9.4 Environmental Effects**

This technique converted wastes into fertilizer, changed the pollution source into usable resources, conserved energy, improved environment. It not only resolved the water and air pollution, but also produced high-quality organic compound fertilizer from solid wastes, formed a healthy cycle of the whole eco-agriculture. Biogas is a kind of high-quality energy, can be used directly in life and manufacture when cleaned. With the application of this technique and building biogas engineering, it will further alleviate the condition of lack of energy in rural areas, and effectively protect the plant and decrease woods damage, it is significant to improve local climate and decrease the emissions of harmful gas.

### **9.5 Market Potential**

Now the disposition of wastes of China's large and middle scale animal farm has not been resolved completely, the research on the double fermentation technique is not mature, has not formed a series of usable equipment and technique. So this technique's market capacity is very large, almost all the animal farm can use this technique. According to statistics, the excreta of chicken and pig produced per year will be 581 million tons, together with other excreta, the total will be 700 million tons, mostly indisposed, only a small part disposed with biogas engineering.

### **9.6 Other Information**

- Plan to build a demonstration project in large scale pig farm in Beijing rural areas with the money presented by GEF, import all the assembly line, including equipment and technique.
- The Ministry of Agriculture is responsible for the import, organized by the Institute of Planning and Design of the Ministry of Agriculture.

## **10. No-tillage for Man-made Forest in South China**

### **10.1 Technology Name**

No-tillage for Man-made Forest in South China

### **10.2 General Characteristics**

No-tillage for Man-made Forest in South China, i.e., do not clear the woods when logged, leave the stumps and branches in the woods, plant the saplings in the space between the stumps. convert the conventional method which burn hill, till land, and plant forest to no-tillage and no-burning method, in order to increase the yield of the land, decrease the carbon loss of the land, promote the absorption of CO<sub>2</sub> in the atmosphere. As reported, logging, tillage and plant cause the carbon loss of about 21 percent average in Europe and America, the range will varied according to the method, the carbon loss ranges from 1 percent to 69 percent, in which the logging-burning-tillage method will cause the greatest loss.

### **10.3 Cost Information**

With the no-tillage method, the land will not be cleared, so it will be inconvenient and more expensive when planting. The weed mowing will increase the cost relatively to the common forest. So, the cost of no-tillage will be higher than common forest planting method. While the earlier productivity level maybe lower than the common forest, but the later growth and overall yield will surpass the common forest, so the gross economic benefit is that the income will be much larger than the cost invested.

### **10.4 Environmental Effects**

No-tillage method will decrease greatly the soil erosion and the organic substances lost, increase the organic carbon content in land and the land productivity, especially in tropics and subtropics. increase the absorption of CO<sub>2</sub> in the atmosphere, decrease other greenhouse gases emissions, and will benefit to the world environmental improvement. The potential can be showed in three aspects, (1). decrease the loss of organic substances, the quantity can not be calculated by now, (2). obviate the direct emissions caused by burning, (3). increase the forest productivity, increase the absorption of CO<sub>2</sub> in the atmosphere because of the decrease of the land degradation. If the no-tillage method implemented on the 80 percent of fir forest and pony-tail pine forest, and presume that the carbon loss decrease by 20 percent and forest yield increase by 20 percent, the fir forest in South China can increase the absorption of carbon in the atmosphere 200 million tons. Such situation can last 30 years, i.e. a

forest logging period, so in this period the absorption of carbon in the atmosphere can be increased 75 million tons per year.

### **10.5 Market Potential**

The fir forest and pony-tail pine in China are a quarter of the whole forest area, the fir forest is 9 million hectares, the pony-tail pine is 14 million hectares, presently all these forest zones carry out the burning—tillage—plant method. Because South China is full of rainfall, and the forest zones are located mostly in steep slopes, this kind of operation will cause nutrients and carbon lost, land productivity constantly decreased. So in the South China artificial forest, in order to increase the organic substances content and decrease land degradation, to implement the no-tillage method is very necessary. And China is a country lacking wood, so the market of this technique is very large.

### **10.6 Other Information**

- Advise importing this technique from the USA, the expenditure expected to get from GEF.
- The Ministry of Forestry is responsible for the import, organized by the Forest Eco-environment Institute of the Ministry of Forestry.

# **11. Forest Ecosystem Management Systems**

## **11.1 Technology Name**

Forest Ecosystem Management Systems

## **11.2 General Characteristics**

By utilizing modern information systems and implementing modern management to forest ecosystem, the forest yield can be increased and resources dissipation can be decreased and the absorption of CO<sub>2</sub> in the atmosphere can be promoted. Forest Ecosystem Management Systems is a new technique, meanwhile a relatively difficult technique. In order to increase forest yield and ability to absorb CO<sub>2</sub>, the radical approach is to increase the standard of forest ecosystem management. Now, the yield of intensively managed artificial forest is larger than that of natural forest by several times or even several tenfold. But some intensively managed artificial forest has the problem of land degradation, giving rise to the soil erosion and organic substances loss. To promote the yield of forest generously and depress the land degradation, modern Forest Ecosystem Management Systems must be adopted.

## **11.3 Cost Information**

This project is by implementing modern management to forest ecosystem, to increase the forest yield, decrease resource dissipation. So the investment will focus on local information center, and comprehensively the amount of investment is small and the profit is high. To implement modern management to forest ecosystem is a key step to realize sustainable utilization of resources, and will create significant effect on long-term stability and productivity of forestry.

## **11.4 Environmental Effects**

To implement modern management to forest will greatly increase forest yield, decrease improper utilization and dissipation of forest resources, protect forest resources, improve ecological environment, promote the absorption of CO<sub>2</sub> in the atmosphere, and benefit to China and world environmental improvement. The effect on production increase is determined by quality of the operation, if by most conservative estimate about wood increase of 30 percent per hectare forest, the increase of the whole country's forest will be 85 million m<sup>3</sup>, is equivalent to an increase of the absorption of CO<sub>2</sub> about 20 million tons

## **11.5 Market Potential**



China is a country lacking wood, the wood market is very large, so the market capacity of this technique can be regarded as unlimited.

### **11.6 Other Information**

- Now the Forest Ecosystem Management Systems in Australia are relatively advanced, so the technique can be imported from Australia by technique cooperation method, investing jointly, in order to use this technique as soon as possible.
- The Ministry of Forestry is responsible for the import of the technique, the Eco-environmental Research Institute and Forest Resources Information Institute of the Ministry of Forestry should organize the implementation.

## **12. Waste Land Afforestation for Mine Area**

### **12.1 Technology Name**

Waste Land Afforestation for Mine Area

### **12.2 General Characteristics**

Afforestation on waste land for mine area to recover the land and vegetation can absorb CO<sub>2</sub> in the atmosphere and improve the environment. It has been confirmed by practice that afforestation on waste land for mine area is a very effective way to recover ecological environment. Confined by the present technology of mining and the low percentage of vegetation (from 4.2 percent to 9.0 percent), the exploitation of waste land in China should be based on afforestation. There are many technical examples to be referred to, for example, in Germany, before reforesting on waste land of lignite coal mine, several ways were adopted to improve the soil microbial activity, in the Former Soviet Union, lime and waste material are scattered on poisonous land of open coal mine area to reduce soil acidity, which has promoted the growth of forest, in New Mexico and Arizona of the USA, planting vegetation by irrigation has been succeeded in waste land of mine area. On afforestation, the techniques of the USA are much more advanced.

### **12.3 Cost Information**

The goals of afforestation on waste land of mine area are to improve ecological environment and to absorb CO<sub>2</sub> in the atmosphere. The project does not intend to gain economic profit, so there is no direct economic beneficial result, but there is indirect environmental benefit, which should be estimated by cost-benefit analysis of the environment.

### **12.4 Environmental Effects**

Afforestation on waste land for mine area can notably improve the condition of ecological environment, which is also beneficial to that in China. Moreover, woods can be formed quickly, so there is no need to renovate the land greatly, and only with a little economic investment, the goal of land renovating can be achieved easily and safely. The woods will stand the soil, clean up the air, prevent water loss and soil erosion and reduce the dust considerably. Another goal of afforestation is to provide timbers and fruits, which has a re-generative function. If all the 14 million hectare land is reforested, 25 million tones carbon will be absorbed each year, providing that

the annual growth rate of every hectare forest is 8 cube metre.

### **12.5 Market Potential**

Reforestation is a feasible way to regain and reestablish the ecological environment in waste mine area. There are about 14 million hectares of waste land in China with growing at a speed of 20,000 hectare per year which has not been reforested, it has great potentiality for reforestation. Therefore, China can not only obtain nearly 2.1 billion cube metre timbers, but improve ecological environment in mine area greatly, by importing the advanced reforestation technology from the USA and applying it throughout China.

### **12.6 Other Information**

- It is suggested to import reforestation technology and mechanical equipment from America, Germany, British etc.. Meanwhile, Chinese government will establish research projects of waste land reforestation, including improved varieties of woods, reforestation pattern, intensive management and so on, and will put forward comprehensive practical technology combinations of reforestation fit for different mine area and waste land.
- The technology is planned to be imported by the Ministry of Forestry, and carried out by Eco-environmental Research Institute of the Ministry of Forestry.

## **13. Solar Hot Water Heater--Vacuum Tube**

### **13.1 Technology Name**

Solar Hot Water Heater--Vacuum Tube

### **13.2 General Characteristics**

Solar hot water heater--vacuum tube is a new type of solar heat collecting device which can transfer solar energy directly into thermal energy. The adoption of vacuum technique can reduce heat loss of the collector greatly, which makes itself to be with a sound thermal behavior even at high working medium temperature or at low environmental temperature. This device has good performances such as anti-freezing, high bearing strength, easy fixing and maintaining and so on. Heat pipe type vacuum tube solar collector is an outstanding one in its family. Because of the adoption of heat pipe technique, the heated working substance does not flow through vacuum tube directly, and has the advantages of small heat capacity and therm-diode effect. The average efficiency of absorption of heat for vacuum tube solar collector per day is above 50 percent. The collector can be used all the year in northern China, and can provide heat more than 20 percent that of normal plate absorber.

### **13.3 Cost Information**

Solar hot water heater-vacuum tube do not consume energy resources during working, and do not need new investment. It is estimated that only the saving of charges for electricity or gas in three years would be equal to total investment. For a family of three to five members, there is enough water to bath all the year if they have a 1.2 square metre vacuum tube collector. In northern China, even in winter two sunny days can provide enough energy to heat a case of water, so it is no problem for every member to have one or two bathes each week, saving about 400 kilogram coal equivalent.

### **13.4 Environmental Effects**

There is neither pollution to the environment during working, nor emissions of waste gases such as CO<sub>2</sub>, SO<sub>x</sub>, NO<sub>x</sub> etc..

### **13.5 Market Potential**

By now, heat pipe type vacuum tube solar collectors manufactured by Beijing Institute of Solar Energy have been appraised and been in lots producing. In foreign countries,

Holland's Philips Co. Limited and British Thermomax Co. Limited both have advanced productions taking use of solar energy. Israel's application of vacuum tube solar energy is very popular, and its technique is very advanced. China has more than 200 million families, but the popularity is no more than 0.5 percent, so there is a huge market capacity of 2 million square metre or so each year.

### **13.6 Other Information**

- It is suggested that the production line or the transferring for key technique should be imported. Water tanks and supporting frames necessarily should be manufactured domestically.
- This technique is planed to be imported by the Ministry of Agriculture, and to be implemented by Institute of Energy of Shandong Academy of Science.

## **14. Rice Husk Energy Transfer Instrument**

### **14.1 Technology Name**

Rice Husk Energy Transfer Instrument

### **14.2 General Characteristics**

Rice husk energy transfer instrument is a furnace which can transfer biomass energy of rice's husk into thermal or power energy. It suits to different scales of rice husk energy converter, and the energy transferred will be used to generate power energy, providing heat or dry materials. When its burning is controlled, clean hot gas flow can be obtained, and the carbon content of rice husk can also be controlled, which are significant to increase burning efficiency and provide rice husk on sale. KC furnace generates power by burning husk, because it can partly make use of (directly controllable) the calorific value of fixed carbon of rice husk, the color is tangerine in furnace, and the temperature is about 1100 °C. Chemical incomplete combustion degree is much lower in oxidative environment of the furnace, so combustion efficiency of fuel is much high, and the carbon content of rice husk disposed can be controlled between 10 to 30 percent. The dust of rice husk can be used immediately without drying, for the dust extracted from KC furnace is dry already.

### **14.3 Cost Information**

Rice husk as feed can only be a kind of filler, without much nutritive value. With the development of Chinese grain production, rice husk will not be used as feed, but as a source of fuel, which has important practical significance and social economic benefit. For Chinese rice production area, in the case of lacking fuel and electricity power practically, building relevant rice husk power station, supply center, or drying plant near large or middle rice pearlier factories is a feasible way to comprehensively utilize the resource of rice husk, meanwhile the disposal of the husk can be reduced.

### **14.4 Environmental Effects**

Chinese production of rice is 176 million tones in 1994, about 40 percent of the world's, if converted to rice husk, there would be 34 million tones. Chinese area lacking energy resources (like Zhejiang province), depends on the transported coal, oil and so on from other provinces. Zhejiang province's dominating grain is rice, and most of the rural areas produce rice, so making use of rice husk as power fuel can solve the problem of lacking fuel at a certain degree, especially to those area which is

not crossed by railway. Moreover this is an important to protect forest and reduce the energy consumption for transport.

#### **14.5 Market Potential**

China's generating sets mostly belong to stacking retort gas power generating, so the calorific value of fixed carbon of rice husk is relatively less used. In furnace, the color is light red, and the temperature is about 500 to 700 °C. Chemical incomplete combustion degree is much large in neutral or reduction environment of the furnace, so the carbon content not burned in rice husk disposed is about 40 to 50 percent of the dusk. This technique in America is advanced ( American PRM Rice Pearlier Corporation), meanwhile China has many experts having study rice husk combustion technique for some years, who can fully assimilate the technique and develop rice husk combustion furnace suits according to Chinese condition. Thus this technique surely has a wide market capacity and a bright future

#### **14.6 Other Information**

- Expert group should be organized to investigate the situation of manufacturing and applying, and should be imported a typical KC furnace.
- This technique is planed to be introduced by the Ministry of Forestry, and to be implemented by Planing and Designing Institute of the Ministry of Agriculture.

## **15. Pony-tail Pine Protection in Acid Rain Area**

### **15.1 Technology Name**

Pony-tail Pine Protection in Acid Rain Area

### **15.2 General Characteristics**

Acid rain caused by SO<sub>2</sub> can do great harm to pony-tail pines of southern China, and has killed many trees. Pony-tail pine protection in acid rain area can promote the growth of forest and speed up absorbing CO<sub>2</sub> in the atmosphere.

### **15.3 Cost Information**

This technique can reduce the harm suffered by pony-tail pines from acid rain, increase the woods, improve ecological environment, and have great economic benefit. It is pointed out by research that, a great number of pony-tail pines in southern China suffer severely from acid rain. By incomplete statistics, the woods lost for this reason are about 600,000 cubic meters each year, that is, the loss of 0.3 billion Yuan. The reduction of the absorption of CO<sub>2</sub> caused by forest lost is great.

### **15.4 Environmental Effects**

This technique can reduce the harm of acid rain to the southern pony-tail pines, increase absorbing resources of CO<sub>2</sub>, slow down the pace of greenhouse effect, and devote to the improving of global environment. Because the distribution of pony-tail pines in southern China is very extensive, and the pines suffer severely from acid rain, the importing of this technique can not only expand the storing of pony-tail pines, and improve the condition of afforestation, but increase the absorption of CO<sub>2</sub> greatly, thus, the goal of reducing the blowing off CO<sub>2</sub> is attained. It is calculated that the woods lost are 600,000 cubic meter per year, this project (if having been carried out) can absorb 140,000 tones CO<sub>2</sub> a year more than before.

### **15.5 Market Potential**

The distribution of pony-tail pines is extensive in China, and they are the typical kind of coniferous trees in humid area of Chinese eastern subtropical zones. Because pony-tail pines have the advantages of adapting environment easily, growing rapidly, and reforesting naturally or artificially without difficulties. Moreover, the timbers of them are widely used, and with high economic benefit, so they play an important role in exploiting subtropical mountain areas and the recovering forest ecosystem. Because the energy structure of China, which is dominated by coal, can not be changed in a short term, and the air pollution tends to be more serious, this technique surely has a good prospects.

### **15.6 Other Information**

- Europe has studied acid rain deeply and thoroughly, so its technique of controlling the harm of acid rain



to forest is much advanced and completed. Although Europe have not studied the harm to pony-tail pines specially, we can import and transfer the technique of reducing the harm of acid rain to forest from Europe.

- This technique is planned to be imported by the Ministry of Forestry and carried out by Eco-environment Research Institute of the Ministry of Forestry together with the Forestry Bureau of Guangxi, Sichuan and Guizhou Provinces.