Prospects and Impacts of Biofuel Development in China

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Energy Status in China

- Energy demand increase with rapid economy development
  
  Energy needs rose 47% since 2000 and will rise at 3-5% annually between 2005-2020 with quadrupling of 2000’s GDP in 2020.

- Second largest consumer of primary energy
  
  ~1429 Million TCE (Ton of standard Coal Equivalent)

- Second largest importer of oil
  
  about 40% and 50% in 2004 and 2006
Liquid Fuels Shortage

Petroleum Consumption and Local Production in China

Year
2005
2003
2001
1999
1997
1995

Petroleum Consumption
Petroleum Local Production

Petroleum / M tce

Petroleum Consumption and Local Production in China
## Prediction of Available Energy Reservation in China

<table>
<thead>
<tr>
<th></th>
<th>Coal</th>
<th>Petroleum</th>
</tr>
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<tbody>
<tr>
<td>Available reservation</td>
<td>114.5-189.2 B tons</td>
<td>15 B tons</td>
</tr>
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<td>Years affording</td>
<td>60-100 years</td>
<td>until year 2040</td>
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* Predicted at the energy consumption rate of 2004.
** Reference: Gansheng Wang, 2005
Renewable Energy Law in China in 2007

The government encourages clean and high efficient utilization of Bioenergy and the development of energy crops……….

The government encourages the application of liquid biofuels, ......will permit the liquid biofuels, which reach the national fuel standards, into fuels market.
Renewable Energy Structure in China in Recent Years

- Hydro and wind power: 30%
- Solar, geo, and ocean energy: 9%
- Modern BioEnergy: 2%
- Household stove fuel: 59%

Bioenergy in Renewable Energy
Bioenergy Approaches in China

- **Direct combustion**
  - stove combustion
  - boilers/burners
  - Briquetting
  - garbage combustion

- **Physical conversion technology**
  - wood carbonization
  - Gasification by hydrogenation
  - oil by hydrogenation (BTL)

- **Chemical conversion technology**
  - landfill and composting
  - biogas fermentation
  - ethanol technology
  - oil from energy-plants

Heat
Electricity
Solid Fuel Products

Charcoal
Liquid Biofuels
Gas Fuel Products

Biogas
Liquid Biofuels
Resources for Bioenergy Production

- Unused organic existence from agricultural, forest and industrial sectors:
  - crop residues/stalks
  - animal manure
  - organic waste from processing industries
  - wood processing wastes

- Energy crops
  - fire woods
  - biofuel plants

- Municipal solid waste (MSW)
Biomass Materials (Energy Crops Excluded), M tce

Total Amount: 365 M tce
Bioenergy Structure (Mtce) in 2006

- Bioethanol: 1.95 Mtce, 1%
- Biogas: 4.5 Mtce, 2%
- BioElectricity: 1.05 Mtce, 0%
- Household stove fuel: 259 Mtce, 97%
Approach 1: Direct Combustion

Household Stoves
Gasification
Direct Combustion for Electricity

Pellets from plant residues

Biomass Gasification
China’s first BioPower plant in Shandong in 2007

- 100% of crop straw
- Mixture of coal (as high as 20%) and crop straw

- Peanut shells
- Mixed fuels

- Installed Capacity: 25 MW
- 500 tons of stalks consumed per day
- Farmers get 5 M USD per year
- CO2 Emission Reduction: 100 K tons annually
Approach 2: Biogas

Potential households for biogas utilization: 146 million
Total Households in rural area: 254.05 million
Large and Medium Biogas Plants in China

8671 Plants for the year of 2010
Approach 3, Liquid Biofuels: ethanol, Diesel

1986 - Bioethanol technologies available
1999 - Four ethanol factories approved
2001 - Four ethanol plants built and operated
2002 - First test of blending ethanol into gasoline (10%) in Henan and Heilongjiang
2003 - Use of blending gasoline in Anhui, Henan, Heilongjiang, Jilin, Liaoning; and some cities in Hubei, Jiangsu and Shandong
2003 - 18% of total gasoline (10 M tons of E10) consumption in China
Actions for Promoting New Bioenergy

- 2003-2004, Former president of China Agricultural University first proposed to Government to invest in new bioenergy R&D
- 2004, New bioenergy R&D was listed in the National Long and Medium S&T Plan
- 2005, National Renewable Energy Development Strategy
- 2006 Long and Medium Renewable Energy Develop Strategy
- 2006 NDRC planning on Liquid BioFuels, Bioethanol
- Up to Now—About 1 billion US$ has been put into biomass energy development through Ministries of Agriculture, S&T, NDRC and Forest Bureau as well as SEPA
Bioethanol Production

The four plants were designed initially for outdated grains consumption.

1 M ethanol production capacity

- Jin Yu Inc., Heilongjiang Province, built in 1996, corn-based, 100,000 t/y
- Jilin Fuel Ethanol Co., built in 2001, corn-based, 600,000 t/y
- Henan Tian Guan Fuel Ethanol Co., built in 2004, wheat-based, 200,000 t/y
- Fengyuan Group, Anhui Province, built in 2005, corn-based, 320,000 t/y
Biodiesel Production

- Still very limited in China in 2006
  - 20 small plants; 500 Kton/y
- Materials
  - Edible oil mostly
  - Some mixed with
    - Waste edible oil
    - Acidified oil
    - Oil bottoms
- Leading companies
  - COFCO
  - Sinopec
  - PetroChina
Impact on Corn Price with the Production of Bioethanol
Soybean: Import and Export in China, 1983 to 2006

10,000 ton

Import: 28 million ton from USA, Brazil and Argentina in 2006. China produced only 15.5 million tons. 8.26 million ton ordered from USA in May this year.
New Policy on Bioenergy Production

- No competition with food for people
- No competition with land for crops

New producers: Non-food feedstocks
Current producers: Switch to non-food feedstocks
Cellulose biomass-to-liquids (BTL)
New Factory of Bioethanol Production

China Resources Alcohol Co., Hebei Province, built in 2007, sweet potato, corn-based, 230,000 t/y

COFCO: 1 M ton/y non-grain based ethanol in southern China Cooperating with Thai and Myanmar

COFCO partnering with Sinopec built cassava-based plant in 2007. 110 K ton/y, targeting 200 K ton/y
Regions for Biofuels Materials

- Corn
- Sugar cane
- Cassava
- Sweet sorghum
Regions for Sugar Cane

Sugar Cane: 6-8 tons of bioethanol per hectare, 2 times higher than corn.
Suitable for grow in south China
Regions for Cassava

Cassava: 6-8 tons of bioethanol per hectare, 2 times higher than corn. Suitable for grow in south China.
Regions for Sweet Sorghum

Sweet Sorghum: 5-6 tons of bioethanol per hectare, 1.5 times higher than corn. Suitable for almost whole China

Corn
Sugar cane
Cassava
Sweet sorghum
Other Biofuels Materials

Oily trees: 150 species of oily trees seeds containing 40% oil. Jatropha and Pistacia, Cornus, etc.

Fire woods: 4-5 tce productivity per hectare on 50 M hectare marginal lands available.
More Technology Required for Bioenergy

- **Energy crops breeding**
  - High-quality/high-yield
  - Region specific/environment appropriate

- **Cellulose derived bioethanol**

- **Agricultural Engineering Innovation**
  - Agricultural machinery systematic innovation
  - from field preparation to biofuels generation
  - LCA for biofuels production
  - for positive energy and environment benefit analyses

- **Engineering for Biogas and utilization**
  - /Pellets/Gasification and power generation
Challenges of Biofuel Development in China

- **Motivation**
  - Technology availability
  - Economic value

- **Water**

- **Plant Diversity**

- **Uncertainties**
  - GHGs emission reduction
  - Positive energy generation

- **Food/Fuel Balance**

  No Meals for Wheels
CAU Biomass Engineering Center (BEC)

2004 Biomass Engineering Center (BEC) established in China Agricultural University

2004 BEC was funded with National 985 Program

Four main researches
National Strategy
Cellulous Pretreatment for Conversion
Energy Crops Breeding
Biogas and Wastewater Treatment

International Training Programs for renewable energy promotion in developing countries
Biofuels Prospect in China

- **Bioethanol** $M$ tons
  - 2005: 1.02\(^1\)
  - 2010: 6
  - 2020: 15

- **Biodiesel** $M$ tons
  - 2005: 0.06\(^1\)
  - 2010: 5

15% transportation fuel in 2020

Investment estimated\(^1\) between 2000-2020

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<th>biomass thermal use</th>
<th>bioethanol</th>
<th>biodiesel</th>
<th>biogas</th>
<th>B USD</th>
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<td>27.8</td>
<td>5.1</td>
<td>1.4</td>
<td>1.2</td>
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\(^1\) Azure International Technology & Development (Beijing) Ltd.
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