Status and progress of fuel ethanol in China

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Nutrition and Healthy Research Institute, COFCO
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Overview of COFCO

- **Over 69 years**
  - Founded in 1949

- **25 years**
  - Consecutively ranked among the Fortune Global 500 companies (Ranks 122 in 2018)

- China National Cereals, Oils and Foodstuffs Corporation (COFCO), guided by its integrated value chain, COFCO is a leading supplier of agri-products with an annual business volume of 150 million tons of commodities in the world. Meanwhile, COFCO ranks the top in its total asset and the third in its total revenue in agri-industry all over the world.

- COFCO is the leader in grain and oil products in China and creates a wholly-new business model to build a fully-integrated value chain covering all links from the farmland to the dining table.

- One of the 53 Large state owned key enterprises.

- To create lasting true value for customers, shareholders and employees.
Ethanol production and R&D of COFCO
Agenda

• Features and benefits of biofuel ethanol

• Status of fuel ethanol production globally

• Technological route of biofuel ethanol production

• Summary
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1.1 Biofuel ethanol
--- a high efficient, renewable and clean energy

- Good replacement of fossil fuel.
- Be able to mix with gasoline at any ratio.
1.2 Fuel ethanol’s benefits on environmental protection

- Increasing olefins and aromatics in gasoline.
- Decreasing toxic (e.g., benzene and 1, 3-butadiene) and PM2.5.
- Decreasing CO$_2$ and greenhouse gas.

**Benefits of ethanol gasoline:**

<table>
<thead>
<tr>
<th>Plant Type</th>
<th>Percent Reduction (gCO$_2$/MJ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal Fired Ethanol Plant</td>
<td>-7%</td>
</tr>
<tr>
<td>Natural Gas (Newer Plants)</td>
<td>-59%</td>
</tr>
<tr>
<td>Alternative Energy (Projected)</td>
<td>-72%</td>
</tr>
<tr>
<td>Cellulosic Ethanol (GREET, Wang)</td>
<td>-86%</td>
</tr>
</tbody>
</table>
1.3 Fuel Ethanol’s benefit on agriculture and energy safety

**Agriculture**
- The total yield and consumption of fuel ethanol has been up to 20 million tons since 2000 in China.
- More than 60 million tons grains has been consumed, which promoted agriculture production significantly.
- More than 15 million tons of non-digestive corn, rice, wheat, etc was used accompanied by the 12.4 million tons by-product of high-protein feed. It improved grain sales and employ 50 thousand of people, which directly benefited 5 million agricultural population.

**Energy safety**
- In 2014, the apparent gasoline consumption in China has reached 100 million tons. Considering the increase of natural gas, electric and other new energy cars in the coming years, the growth of gasoline consumption will slow down, The gasoline consumption in 2020 will be about 150 million tons, according to annual increment of 7%.
- The production of E10 ethanol gasoline needs about 15 million ton of fuel ethanol, whose output value is about 150 billion Yuan. The import of crude oil would reduce 24 million tons, which reduce oil external dependency 2% to 58.8%. 
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• USA: In order to promote the development of agriculture, especially corn industry, The USA government began to promote fuel ethanol in the 1980s. A series of legal principles on finance and taxation were issued to support the development of fuel ethanol.

• Brazil: The fuel ethanol industry started since the two oil crises in the 1970s, which also stimulated sugar cane cultivation and sugar industry at the time of the downturn of sugar price.
# 2.1 Global fuel ethanol production and consumption

**Fuel ethanol yield in 2017**

<table>
<thead>
<tr>
<th>Country</th>
<th>Yield/10000 ton</th>
<th>Ratio, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA</td>
<td>4,718</td>
<td>57.7</td>
</tr>
<tr>
<td>Brazil</td>
<td>2,108</td>
<td>27.6</td>
</tr>
<tr>
<td>EU</td>
<td>423</td>
<td>5.4</td>
</tr>
<tr>
<td>China</td>
<td>261</td>
<td>3.2</td>
</tr>
<tr>
<td>Canada</td>
<td>134</td>
<td>1.7</td>
</tr>
<tr>
<td>Thailand</td>
<td>118</td>
<td>1.3</td>
</tr>
<tr>
<td>Argentina</td>
<td>93</td>
<td>0.8</td>
</tr>
<tr>
<td>India</td>
<td>83</td>
<td>0.8</td>
</tr>
<tr>
<td>Others</td>
<td>139</td>
<td>1.5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>8,078</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

*Source: RFA*

**Consumption of fuel in 2017**

<table>
<thead>
<tr>
<th>Country/area</th>
<th>Fuel ethanol, Billion liter/M ton</th>
<th>Gaslion, Billion liter/M ton</th>
<th>Ratio of ethanol, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA</td>
<td>54.9/43.4</td>
<td>577.6/439</td>
<td>9.5</td>
</tr>
<tr>
<td>Brazil</td>
<td>28.8/22.8</td>
<td>59/44.25</td>
<td>48.8</td>
</tr>
<tr>
<td>EU</td>
<td>5.2/4.1</td>
<td>100/75</td>
<td>5.2</td>
</tr>
<tr>
<td>China</td>
<td>3.08/2.4</td>
<td>145/108</td>
<td>2.1</td>
</tr>
</tbody>
</table>

*Source: EIA, RFA, USDA, UNICA*

- USA is the No. 1 on both yield and consumption of fuel ethanol.
- Brazil has the highest ratio of fuel ethanol addition in gasoline, ~50%.
- China has the biggest potential of fuel ethanol consumption.

The gap will be ~9M tons if E10 is mandatory around China.
2.2 Fuel ethanol production and development in China

- Since 2002, fuel ethanol started to be added in gasoline in China.
- In 2016, annual consumption around 2.5 million tons, and the material change to non-grain.

In 2002, ethanol gasoline was promoted in Heilongjiang and Henan mandatorily. 5 other provinces were involved in 2004.

In 2007, advanced non-grain fuel ethanol was initiated to develop and received support from government.

In 2008, COFCO built the first non-grain, 2million tons cassava fuel ethanol factory in Guangxi.
In 2012, Henan Tianguan built its first 10k-ton cellulosic fuel ethanol pilot program.
In 2013, Shandong Longlive built its 50k-ton corn cob fuel ethanol production line.
In 2014, Zonergy built its 30k-ton sweet sorghum fuel ethanol factory.
2.3 Vision of fuel ethanol in China

By 2020—
Ethanol gasoline will be promoted throughout China. Fuel ethanol production will be enlarged by 5-6 times on the base of present scale. A commercial demonstration of cellulosic fuel ethanol plant will be constructed at the capacity of 50,000 ton/y.

By 2025—
Efforts will be made to realize large-scale production of cellulosic fuel ethanol. The overall development of advanced biological liquid fuel technologies, equipment and the industry will reach an international advanced level, and an improved market-oriented operating mechanism will be established.
2.4 Fuel ethanol market area and suppliers in China

- Ethanol gasoline has been popularized in 12 provincial areas, which is supplied by 7 companies. COFCO is the largest fuel ethanol producer in China.
2.5 COFCO --- the leader of China fuel ethanol industry

- COFCO is the largest fuel ethanol production enterprise, owning three holding enterprises and one equity participation enterprise.
- COFCO is the earliest fuel ethanol production enterprise, owning the first corn-based, cassava-based and cellulose-based fuel ethanol plant.
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3.1 Technological route of biofuel ethanol production

Corn fuel ethanol process: dry process, wet process and Chinese semidry process

G1
- Corn
- Wheat
- Rice
- Cassava
- Smash and pretreatment → Liquification → Saccharification and fermentation → Ethanol refining → Residues and liquid waste treatment

G1.5
- Sweet Sorghum
- Sugar cane
- Squeezing and Pretreatment → Sugar juice → Fermentation → Ethanol refining → Residues and liquid waste treatment

G2
- Corn stover
- Wheat straw
- Bagasse
- Pretreatment → Hydrolysis → Fermentation → Ethanol refining → Residues and liquid waste treatment
3.2 Diversified Development in Raw Materials of China Ethanol Industry

- The raw material of China ethanol industry include corn, cassava, molasses, overdue wheat and overdue rice.
3.3 COFCO R&D on fuel ethanol

- Based on the existing cellulosic ethanol demonstration plant, COFCO will further explore the feasible route for the industrial production of cellulosic ethanol and build a plant of 50k tons cellulosic ethanol.

- **Corn ethanol**: 4 million tons
- **Cassava ethanol**: 0.2 million tons
- **Cellulosic ethanol**: Several 50k tons demonstration plant
A leading sugar platform based on lignocellulose has been built up after R&D for more than 8 years and the industrialization of cellulose ethanol has been on processing.

A series of technical problems have been solved, such as feedstock storage and transportation, pretreatment, hydrolysis, C5/C6 co-formation, wastewater treatment, etc. The technical package of 50,000 ton cellulose ethanol per year has been finished and over 50 patents have been submitted or authorized.

The relevant cellulose technology, such as organic acids (malic acid and lactic acid) and amino acid (lysine), has also been developed.
3.4 Biofuel R&D center of NHRI COFCO

- Pretreatment
- Fermentation
- Strain development
- Analysis
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• There are good opportunities for biofuel ethanol development in China.
• Cellulosic ethanol has big potential, but also great challenge on technology development.
• Sugar platform is the future direction.
Thanks