

USDA Foreign Agricultural Service

# GAIN Report

Global Agricultural Information Network

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Required Report - public distribution

**Date:** 7/26/2019

**GAIN Report Number:** CH19047

## **China - Peoples Republic of**

### **Biofuels Annual**

#### **China Will Miss E10 by 2020 Goal by Wide Margin**

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**Report Highlights:**

China's race to improve air quality is emerging as the major driver for expanded fuel ethanol production and use. Despite public announcements from more than a dozen Chinese central government ministries and Chinese Premier Li Keqiang, China's ethanol policy in 2019 remains a patchwork of provincial and municipal-level policies. Meanwhile, China's central and provincial authorities have not renewed subsidies for ethanol production. Without clear incentives and enforceable compliance measures, China's ethanol industry will struggle to raise the level of biofuels use in transportation fuels to meet China's E10 goal by 2020. As a result of restrictive ethanol investment and trade policies, Post estimates a 2.5 percent blend rate in 2019, a near recovery to blend rates achieved 10 years ago. China will most likely achieve a blend rate of 3.0 to 3.5 percent by 2020. Biodiesel remains neglected except for a limited program in Shanghai.

## **Acronyms**

Chinese Academy of Sciences (CAS)  
Carbon Emission Footprint (CEF)  
Carbon Emissions Trading System (ETS)  
China Association of Automobile Manufacturers (CAAM)  
China National Cereals, Oils and Foodstuffs Corporation (COFCO)  
China National Offshore Oil Company (CNOOC)  
China National Petroleum Corp (CNPC)  
China National Petroleum Corp, Publicly listed-arm (PetroChina)  
China National United Oil Corp, CNPC Trading-arm (Chinaoil)  
China Petroleum and Chemical Corporation (Sinopec)  
China Petroleum and Chemical Corporation, Trading-arm (Unipecc)  
Chinese People's Political Consultative Conference (CPPCC)  
Dried Distiller's Grains with Solubles (DDGs)  
Electric Vehicle (EV)  
Ethyl Tert-Butyl Ether (ETBE)  
Five-Year Plan (FYP)  
General Administration of China Customs (GACC)  
Greenhouse Gas (GHG)  
Ministry of Ecology and Environment (MEE)  
Ministry of Environmental Protection (MEP)  
Ministry of Finance (MOF)  
Ministry of Public Security (MPS)  
National Development and Reform Commission (NDRC)  
National Energy Administration (NEA)  
National People's Congress (NPC)  
New Energy Vehicles (NEV)  
Particulate Matter (PM)  
Renminbi (RMB)  
State Council Tariff Committee (SCTC)  
Used Cooking Oil (UCO)

## **Executive Summary:**

China is an expansive country where several generations of industrialization coexist, spanning from megacities to remote hamlets and villages. Additionally, scarce water and land resources limit China's corn and feedstock production to a relatively limited area and further restricts the economical range of possible destinations for bulk ethanol distribution. Implementing a national ethanol fuel standard across such a complex landscape will require significant infrastructure investments to expand capacity for ethanol storage, ground and maritime transportation, and blending into refined gasoline fuels.

To significantly expand ethanol use, China's central planners must liberalize their energy and trade policies. China's top-down approach to develop its ethanol market is falling short of its goal to adopt 10 percent ethanol-gasoline blend use nationwide by 2020. Rigid energy policies restrict fuel ethanol production, as well as critical investment in ethanol blending and distribution. Current foreign investment rules limit foreign ownership to cellulosic ethanol production. Without an enforceable national fuel standard for ethanol blend use, energy investors lack certainty to expand investments into ethanol storage, distribution, and blending infrastructure. High tariffs on U.S. ethanol limit demand for larger volumes of lower cost ethanol imports, especially in South China where grain-based ethanol production is especially limited. Lastly, China's major commodity exchanges lack futures contracts for fuel ethanol products to improve price discovery and manage risk.

Over the past year, Chinese ethanol producers boosted national production capacity by 258 million liters to a total of 5,258 million liters. Meanwhile, environmental and agricultural policy concerns have also restricted further growth. Policy makers have also restricted imported supplies from the United States due to ongoing trade tensions.

In 2019, the estimated ethanol blend rate will be 2.5 percent. This is down from peak blend rates achieved 10 years ago. China will most likely achieve a blend rate of 3.0 to 3.5 percent by 2020, well short of the central government's effort to achieve E10 use nationally by 2020. Furthermore, based on the International Energy Agency's long-term projections through 2030, China will need to boost annual fuel ethanol consumption to reach E10 nationally through 2030.

After missing its previous 12<sup>th</sup> Five Year Plan (FYP) production goal by a wide margin, China announced in 2017 a renewed national plan to expand fuel ethanol use to 10 percent of refined gasoline products by 2020 (See Policy and Programs Section). More than two years later, China still lags far behind its ambitious goal. In terms of policy-driven demand expansion, China has stitched together a patchwork of pilot blending mandates across nearly half of its provinces, special administrative regions, and municipalities. This decentralized approach has more than doubled the number of provinces, special administrative regions, and municipalities adopting the official E10 adoption rate.

## **Commodities:**

Corn

### **I. Policy and Programs**

Biofuels are part of China's long-run strategic plan to protect the environment, conserve resources, and reduce dependence on imported energy. However, ethanol is the only biofuel receiving significant attention. With ambitious emissions targets and policies, China's ethanol programs support several national initiatives to manage air pollution. Support for biodiesel (most importantly mandates) which can deliver similar benefits remains essentially non-existent.

For more details, see GAIN reports [CH16058](#), [CH16067](#), [CH17048](#), and [CH18041](#).

### **Environmental Commitments**

In 2006, China elevated Energy Efficiency and Pollution Abatement as a national policy, positioning it on par with other key pillars of Chinese domestic policy. In 2012, China released its National Clean Air Five-Year Plan (FYP, 2013 to 2018) to improve air quality. It proposed several measures including: (1) limiting or closing production at industrial facilities, (2) restricting personal vehicle traffic; and (3) replacing coal with clean energy.

In November 2015, China's State Council unveiled the 13<sup>th</sup> FYP for Economic and Social Development (2016-2020) focusing on: energy consumption reduction; environmental protection; and renewable and biomass energy use. The State Council also released "The Energy Development Strategy Action Plan (2016-2020)" which aimed to cap annual energy use and set a goal of reaching 15 percent of non-fossil fuel-based energy usage in the country's primary energy mix by 2020. Biofuels are considered a critical component of this plan.

#### *Blue Sky Protection Plan 2018*

On July 3, 2018, China's State Council released a three-year "Blue Sky Protection Plan (2018-2020)" to reduce emissions for sulfur dioxide and nitrogen oxides by at least 15 percent from 2015 levels, and an 18-percent reduction in the density of particulate matter by 2020. The announcement proposed new restrictions on sales of fuel blending components such as methyl tert-butyl ether (MTBE), and the blending of chemical feedstocks in refined oil products. This was the first time that petrochemical feedstock blend use was restricted in refined oil products, which would further boost demand for fuel ethanol as a transportation fuel additive in China.

In 2018, China's Ministry of Ecology and Environment (MEE) announced more stringent air pollution abatement measures across Beijing, Tianjin, and Hebei province, one of China's most populous urban areas. The plan called for lowering the average intensity of PM<sub>2.5</sub>—a major air pollutant—and the number of "heavy pollution" days by 3 percent from October 1 to March 31 across this area. In April 2019, MEE announced that during the fall and winter of 2018 and 2019, this target was not reached. As a result, the authorities say they will strengthen their efforts to tackle air pollution in the future.

Air quality efforts promote lower emissions and support expanded of fuel ethanol use. At the same time, environmental measures, like air and water effluent management programs also contribute to greater restrictions on expanded industrial output, including ethanol production. See Ethanol Policy section below.

#### *New China VI Vehicle Emissions Standards*

As part of the Blue Sky Protection Plan, on June 28, 2018, MEE announced that higher fuel emissions standards for all new passenger vehicles and heavy trucks will enter force nationwide beginning on July 1, 2020. Heavily polluted areas including the Pearl River Delta region, Sichuan Province, and the city of Chongqing are subject to early implementation plans.

Upon implementation, the new emission standards will reportedly be among the world's most stringent emissions standards. Compared to the current China V emissions standards, implemented in January 1, 2016, vehicles will be subject to further limitations for particulate and greenhouse gas emissions. See GAIN report [CH16067](#).

China's new emissions standards (GB 17691-2018) for diesel heavy-duty trucks will be based on the Euro VI emission standard, and are scheduled to go into effect on January 1, 2020. Thus will occur in a phased roll out across major cities and provinces. China is the world's largest heavy-duty truck market. Regulators from MEE and engineers at the China Automotive Technology and Research Center have been researching how to improve emissions from heavy-duty diesel trucks in mountainous and environmentally-sensitive regions like Southwest China. In 2019, they concluded that heavy trucks road tested in Yunnan province using biodiesel fuel blends emitted fewer particulates and greenhouse gases without any disadvantage to fuel cost and engine performance in comparison to diesel formulations meeting the China VI emission standard.

### **National Ethanol Production and Blending Targets**

At this time, Chinese law restricts fuel ethanol processing to licensed facilities that produce and supply fuel ethanol to national refiners and fuel marketing companies. Provincial Development and Reform Commissions (DRCs) are responsible for the distribution of franchise licenses for fuel production, refining, and marketing. (See Section III. Ethanol Production). It is forecast that current ethanol expansion plans will result in a fuel ethanol supply gap below China's E10 target of more than 14,039 million liters in 2020. See Section II. Gasoline and Diesel Pools.

### **Aspirational Goal of Reaching E10 by 2020**

On September 13, 2017, China's National Development and Reform Commission (NDRC), the National Energy Administration (NEA), the Ministry of Finance and 12 other Ministries jointly announced an "Implementation Plan Regarding the Expansion of Ethanol Production and Promotion for Transportation Fuel." According to the plan, China will achieve nationwide use of 10 percent ethanol (E10) by 2020. By 2025, China plans to shift renewable fuel production to commercial-scale production of cellulosic ethanol.

On August 22, 2018, Chinese Premier Li Keqiang addressed China's State Council, and reiterated the central government's commitment to expand ethanol use nationwide, and to lower government inventories of grain in an orderly manner. State media reported that Premier Li announced a commitment to limit annual biofuels use to 12,670 million liters (10 million tons).

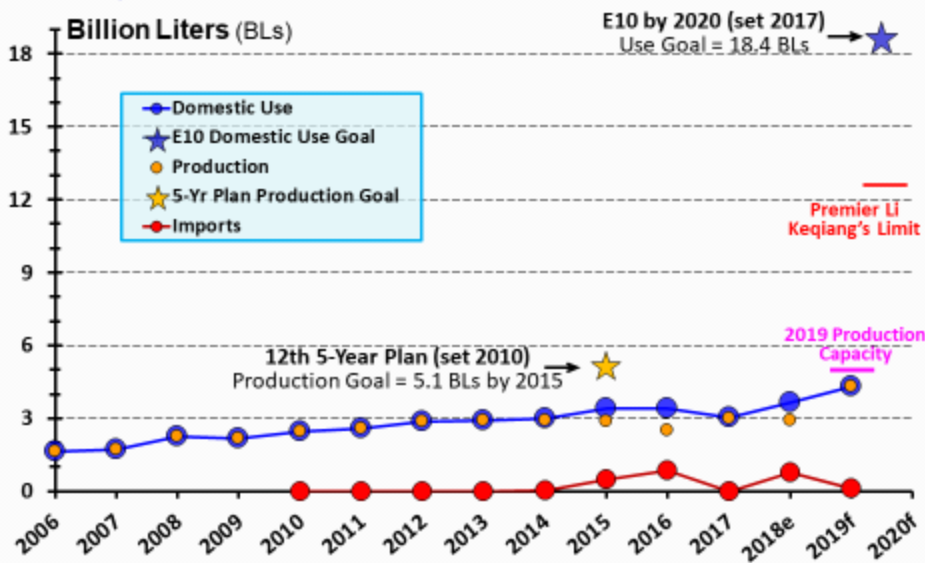
### *E10 Production Projections by 2020*

To meet domestic demand, without relying on imports, China would need to expand fuel ethanol production from 12,670 to 19,005 million liters (10 to 15 million tons). Even if China’s existing approved fuel ethanol projects boost capacity by 2,661 million liters per year (2.1 million tons), and begin operation in 2020, the additional output will not meet E10 demand nationally by 2020.

If China fully implements a national E10 fuel ethanol and gasoline blending program by 2020, then IEA and China’s National Energy Administration project that China will consume 19,000 million liters (15 million tons) of fuel ethanol in 2020, or five and a half times greater than 2017 consumption (3.4 million liters).

### China Fuel Ethanol Market - Past & Current Goals

E10 by 2020 requires a 5-fold increase in domestic use in the next 2 years and is beyond reach due to limited production capacity, high import duties on U.S. ethanol, and distribution bottlenecks.



Source: USDA and FAS China estimates

#### Phased Adoption and Actual Implementation of E10 Varies by City and Province

Since 2006, China has expanded in a piecemeal fashion the number of cities and provinces adopting E10 blending mandates. Following Premier Li Keqiang’s remarks to encourage ethanol use in August 2018, several provinces officially announced new policies or expanded policies to implement fuel gasoline ethanol blending programs by 2020. However, actual rates of fuel ethanol blended into gasoline supplies, reportedly, varies city-by-city and province-by-province due to varying levels of enforcement. The level of implementation often reflects the volume of fuel ethanol produced in each region.

#### Transition from Partial Implementation to Full Implementation

In 2018, 7 provinces and cities fully implemented mandatory E10 fuel ethanol blending. These were Anhui, Guangxi, Heilongjiang, Henan, Jilin, Liaoning, and Tianjin provinces. Another 5 provinces partially implemented E10 at varying levels. These were Hebei, Shandong, Jiangsu, Inner Mongolia, and Hubei provinces.

In 2019, 3 provinces (Shanxi, Zhejiang, and Guangdong) launched pilot programs in a select few cities. Shanxi, Shandong, Hebei, Zhejiang provinces have officially announced that they will begin implementing E10 in 2020. Industry sources report that Shanghai, Hubei, and Hunan provinces are projected to unveil policies to adopt E10 province-wide by 2020.

#### *Beijing-Tianjin-Hebei Region*

Beijing will delay implementation of an E10 program due to concerns over the uncertain impact on nitrogen oxide emissions. Officially, Tianjin started fully implementing E10 citywide on September 30, 2018; however, industry sources report that fuel ethanol-gasoline blends are far below 10 percent. Tianjin province's E10 demand is estimated at nearly 330 million liters (260,000 tons) per year. Hebei province is projected to expand its E10 program incrementally. In June 2019, Hebei province doubled the number of cities offering E10. Industry sources report that Hebei province will offer E10 province-wide by 2020 with an estimated demand of more than 760 million liters (600,000 tons) each year.

#### *Yellow River Plain Region*

Shandong province is on track to implement E10 province-wide by 2020. Officials aim to more than double the number of cities participating in the pilot program in 2019, achieving province-wide coverage by 2020.

In 2019, Shanxi province launched a pilot E10 program. Officials plan to extend the program province-wide by 2020. At this time, Shanxi province has no government-sanctioned fuel ethanol producer. Shanxi province remains a major methanol producer and administers a pilot program, which promotes methanol blend use in transportation fuels. Industry sources report that they project that Shanxi province will procure ethanol supplies from neighboring provinces. They estimate that Shanxi province currently consumes about 475 million liters (375,000 tons) of E10 annually.

#### *Yangtze River Delta Region*

Shanghai is one of China's largest gasoline fuel markets. Industry sources report that Shanghai authorities are examining a plan to roll out E10 gasoline blends in late 2019, and transition towards citywide coverage in 2020. Since 2016, Jiangsu province partially implemented E10, and is projected to begin transitioning towards full implementation in 2020. Industry sources also report that Hubei provincial officials aim to fully implement E10 province-wide by 2020. In 2019, Zhejiang province launched an E10 program in two cities, and is projected to transition to a province-wide program by 2020.

#### *Pearl River Delta Region*

Officials in Pearl River Delta Region have not yet announced new expansion plans in 2019. The Pearl River Delta in South China is grain-deficit, and has very high costs of ethanol production and blending. If provincial mandates are adopted, South China will be import dependent.

### **Government Financial Support for Ethanol Production**

Past central government subsidies for fuel ethanol production supported both feedstocks and inputs. Accounting for all ethanol production methods, subsidies have fallen to zero. From 2016 to 2018, provinces in North East China offered corn processors including ethanol facilities generous subsidies. Central government production subsidies for grain-based ethanol were eliminated in 2016. (See GAIN

report [CH9059](#) and Annex 1). In 2019, national and provincial authorities did not renew corn-processing subsidies. (See GAIN report [CH16058](#).)

On June 30, 2019, NDRC and MOFCOM jointly released the 2019 Catalogue of Encouraged Foreign Investment in Industries, which includes fuel ethanol development and production. However, the Catalogue specifically restricts foreign investment into grain-based ethanol production.

2018 was a banner year for newly announced synthetic gas projects to produce fuel ethanol in China. Deals and agreements totaling several billions of U.S. dollars were signed to fund a total of seven synthetic gas-to-ethanol and waste gas-to-ethanol projects in Shanxi, Henan, and Xinjiang provinces. Total name plate capacity for the group of projects is estimated to reach nearly 3.0 billion liters. The projects will begin operating over the period from 2019 to 2035. Feedstock sources include municipal sewage waste, industrial flue gas, and fossil fuels like coal.

Industry sources project that by 2020 or 2021 China's acetic acid and waste gas-to-ethanol projects under construction could contribute an additional 3,294 million liters (2.6 million tons) of annual production capacity.

## **Import Tariffs**

Additional tariffs on U.S. origin imports to China undercut the competitiveness of these products.

### *Denatured Ethanol (HS 220720)*

On December 19, 2016, the State Council Tariff Committee (SCTC) released the 2017 Tariff Adjustment Plan, which adjusts applied tariff rates in 2017. On January 1, 2017, the tentative tariff rate for denatured ethanol (HS 22072000) rose from 5 percent to the World Trade Organization (WTO) Most-Favored Nation (MFN) bound rate of 30 percent.

On April 2, 2018, China levied an additional 15-percent tariff on U.S.-origin denatured ethanol, raising the tariff from 30 percent to 45 percent.

On July 6, 2018 China imposed an additional 25-percent tariff on imports of U.S. denatured ethanol in response to the U.S. 301 Investigation, raising the effective tariff to 70 percent. (See GAIN reports [CH18017](#) and [CH18018](#)). The additional tariffs firmly closed the arbitrage window of opportunity for U.S. exports to China.

### *Undenatured Ethanol (HS 220710)*

MFN tariff rates on undenatured ethanol have remained unchanged at 40 percent. On August 3, 2018, MOFCOM announced an additional tariff on U.S.-origin undenatured ethanol, raising the tariff by 5 percent from 40 to 45 percent. (See GAIN report [CH18047](#)).

### *Biodiesel (HS 27102000 and HS 382600)*



On August 23, 2018 China imposed an additional 25-percent tariff on U.S.-origin petroleum oils containing 1 to 30 percent biodiesel (HS code 27102000, Petroleum oils containing up to 30 percent biodiesel by volume), which effectively raised the tariff from 6 percent to 31 percent (See GAIN report [CH18034](#)).

### **Tax Benefits**

In 2017, China's General Department of Taxation lowered the effective VAT applied to exported ethanol products from 13 percent to 11 percent. (See GAIN report [CH18022](#)). Biodiesel exports made from used animal and vegetable oils enjoy a 70-percent VAT rebate. Qualified producers also benefit from a 90-percent discount on taxable income from relevant products. To support domestic biodiesel use, tax authorities have issued policies to waive consumption taxes on B100 biodiesel produced using used cooking oil (UCO).

#### **I. Gasoline and Diesel Pools**

China recognizes the strategic value of energy independence. Biofuels reduce dependence on imports of fossil fuel supplies. China's ballooning crude oil imports and a domestic appeal to improve air quality are driving the adoption of expanded fuel ethanol consumption, and demand for alternative transportation options like New Electric Vehicles (NEVs).

In 2009, China's gross crude oil imports were only half of the current volume, or 4 million barrels per day. Today, China is the world's top destination for crude oil. In 2018, China's gross crude oil imports rose to 461.9 million tons, up 9.2 percent from 2017. According to the General Administration of Customs of China, during the first half of 2019, China imported 245 million tons of crude oil, up 8.8 percent year-on-year.

With significant overcapacity, China is among the world's largest exporters of refined oil products. Over the first half of 2019, China exported nearly 8,515 million liters (6.78 million tons) of gasoline, down 8.8 percent year-on-year, and 11,141 million liters (11.98 million tons) of diesel, up 18.2 percent year-on-year.

China's gasoline market is now the second largest in the world, exceeding demand in the European Union in 2012. It is only exceeded by the United States. But unlike the U.S. market, where growth has slowed to very low rates, China's gasoline market continues to expand rapidly with year-to-year growth surpassing all other markets. China's transport diesel market is the third largest in the world although less than half the size of U.S. and EU markets. In the medium- to long-term, energy analysts forecast that China's rapid expansion of gasoline demand will slow due to flatter economic growth, saturated automotive markets, and introduction of NEVs.

According to NDRC, from January to June 2019, China's national refined oil consumption rose to 29.73 million tons, up 8 percent compared with the same period in 2018. Gasoline consumption was up 13 percent and diesel consumption was down 4.6 percent. The Fuel Use Table below covers the entire fuel pools of refined fossil fuels and additives in finished fuel products including biofuels.

**Fuel Use History (Million Liters)**

Calendar Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
<b>Gasoline Total</b>	96,913	105,738	113,592	130,015	135,660	157,237	167,460	170,310	172,063	176,291
<b>Diesel Total</b>	156,103	166,044	180,179	182,138	182,292	184,363	178,830	180,503	174,999	171,499
On-road	92,030	100,828	114,028	116,085	117,385	118,661	117,658	119,627	117,056	114,715
Agriculture	12,827	13,520	14,196	15,323	15,860	15,870	15,901	16,442	15,949	15,630
Construction & Mining	5,211	5,513	5,506	5,921	5,868	5,907	5,967	6,337	6,146	6,024
Shipping & Rail			450	346	246	237	227	215	209	204
Industry	20,900	18,243	17,477	16,759	15,953	15,164	14,129	14,599	14,161	13,878
Heating	38	24	24	26	47	62	61	59	57	56
<b>Jet Fuel Total</b>										
<b>Total Fuel Markets</b>	253,016	271,782	293,771	312,153	317,952	341,600	346,290	350,813	347,062	347,790

Source: 2010-2019 Gasoline and Diesel Total estimates are based on OECD data in million liters. All other estimates are Post calculations based on the NBS series. Note: These data cover the entire fuel pools of refined fossil fuels and additives in finished fuel products. The “gasoline” pool includes methanol, MTBE, and ethanol, while the “diesel” pool includes very small biodiesel volumes. The average conversion rate for gasoline is 1,388 liters per metric ton, as used by China’s Customs and Taxation Bureau; the average conversion rate for diesel ranges from 930 to 1,195 liters per ton.

### World’s Largest Light-duty Vehicle Fleet

In 2010, China surpassed the United States as the world’s largest light-vehicle (passenger) market, and leads the world in total new passenger vehicle sales. Despite several decades of continuous growth, China’s automotive market faces headwinds in the long-term. Automakers face several challenges including slowing economic growth, increasingly strict environmental controls, and market saturation in major cities. The China Association of Automobile Manufacturers (CAAM) projects that new "China VI" emission standards and buyer incentives will aid future sales (See Policy and Programs section).

According to the Ministry of Public Security (MPS), China’s national passenger vehicle fleet growth rate slowed in 2018. By the end of 2018, China’s national fleet reached 327 million vehicles, up 0.6 percent from 2017. In 2019, growth fell 4 percent due to weakening demand.

<b>China’s National Passenger Vehicle Fleet (Total Units)</b>				
	2015	2016	2017	2018
Local Production, Completed Cars	24,597,600	28,028,000	29,015,000	27,809,000
New Energy Vehicle Production	340,471	517,000	794,000	1,500,000
Exports of completed cars	755,500	708,000	1,063,800	1,041,000
Imports of completed cars	1,101,900	1,041,000	1,246,800	1,140,000
Market Size	24,944,000	28,361,000	29,198,000	27,908,000

Sources: Global Trade Atlas, Ministry of Industry and Information Technology, China Association of Automobile Manufacturers

### Shift from New Energy Vehicle (NEV) Buyer Subsidies to Production Quotas and Public Investment

China defines New Energy Vehicles (NEVs) as plug-in electric and gasoline/diesel-electric hybrid vehicles. Currently, NEVs make up less than 1 percent of China’s passenger vehicle market. Although the rate of NEV growth is impressive, the actual market impact on ethanol demand will remain very small for many years to come.

In October 2018, MPS reported that China's national NEV fleet reached 2.61 million vehicles, or less than 0.1 percent of total vehicles. Industry sources report that at the consumer-level generous government subsidies and buyer incentives such as road and parking access continue to support China's NEV market. In December 2016, a number of Chinese ministries jointly issued a policy to phase out all NEV buyer subsidies by 2020. In 2018, China continued to be the world's largest NEV producer and consumer market. In 2018, China produced 1.27 million units and sold more than 1.26 million units, expanding year-on-year by nearly 60 percent and 61 percent, respectively.

"Made in China 2025" is a central government initiative to upgrade its national industrial base from a low-cost, mass production manufacturer to higher value-added, advanced production manufacturer. The plan prioritizes 10 sectors, including the automotive and NEV sectors.

The initiative's objectives are both supply and demand based. On the supply-side, China has established a production quota for manufacturers to produce 1 million units of pure electric and plug-in hybrid cars in China by 2020, and raise the market share of domestically produced NEVs to at least 70 percent of national demand. On the demand-side, China's Ministry of Industry and Information Technology (MIIT) targets national vehicle sales at 35 million vehicles by 2025, of which 20 percent will be NEVs. In 2018, the China Association for Science and Technology projected that NEV sales would account for 30 percent of China's total vehicle sales by 2030.

On July 9, 2019, MIIT released Draft Revisions to "The Measures for Parallel Administration of Passenger Vehicle Enterprise Average Fuel Consumption and New-Energy Vehicle Credits." MIIT proposes to raise the manufacturing quota of NEV targets from 2019 and 2020 targets to 14 percent, 16 percent and 18 percent in 2021-2023, and closer towards an ultimate target of 20 percent of total automobiles in 2025. Automakers that fall short of their quota are required to purchase credits from other manufacturers that exceed their quota. Also proposed is a revision of the definition of "traditional energy vehicles" to include alcohol ether fuel powered vehicles.

## **II. Ethanol**

### **Overview**

China is the world's fourth largest fuel ethanol producer and consumer after the United States, Brazil, and the European Union. Until recently, China's fuel ethanol market has remained insular. Imports were banned until as recently as 2015, and China rarely produced surplus volumes to export. As additional duties were implemented earlier this year, China's fuel ethanol market retreated further from the global market.

China produces a broad variety of ethanol products at a commercial-scale, including potable alcohol, industrial chemicals, as well as fuel ethanol. Unlike other major ethanol producing countries, China's major end use market for ethanol is to refine or process it into industrial chemicals and not fuel ethanol. Historically, China's ethanol output has followed national policy priorities. Since 2016, China's corn processors, including fuel ethanol and industrial chemical producers, have enjoyed the benefit of corn processing subsidies based on throughput volumes. Additionally, China is expanding ethanol-gasoline blending on a nationwide basis by doubling the number of administrative regions implementing E10, as well as government-supported investments to expand production capacity.

Despite strong central government support through policies and financial-backing, China's ethanol sector faces near-term structural challenges and long-term feedstock supply challenges to produce sufficient fuel ethanol to meet ambitious E10 goals. Most experts consider China's E10 consumption target to be nearly unattainable at the current pace of market development.

<b>Ethanol Used as Fuel and Other Industrial Chemicals (Million Liters)</b>										
Calendar Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019f
<b>Beginning Stocks</b>	0	0	0	0	0	0	0	0	0	0
Fuel Begin Stocks	0	0	0	0	0	0	0	0	0	0
<b>Production</b>	4,135	4,619	5,286	5,795	6,921	7,868	8,071	9,211	9,770	10,747
Fuel Production	2,479	2,566	2,858	2,934	2,951	2,914	2,534	3,041	2,914	4,311
>of which fossil-based synthetic	0	0	0	0	0	0	0	0	0	0
>of which biobased	2,479	2,566	2,858	2,934	2,951	2,914	2,534	3,041	2,914	4,311
>of which biobased cellulosic	0	0	0	25	25	38	40	30	20	0
<b>Imports</b>	4	5	15	0	27	687	890	24	1,035	103
Fuel Imports	3	5	3	0	26	477	871	8	759	103
<b>Exports</b>	156	43	45	40	33	25	34	135	79	20
Fuel Exports	12	8	7	2	2	0	1	3	35	20
<b>Consumption</b>	3,983	4,581	5,256	5,755	6,915	8,530	8,927	9,100	10,726	10,830
Fuel Consumption	2,470	2,563	2,854	2,932	2,975	3,391	3,404	3,046	3,638	4,394
<b>Ending Stocks</b>										
Fuel Ending Stocks	0	0	0	0	0	0	0	0	0	0
<b>Total BalanceCheck</b>	0	0	0	0	0	0	0	0	0	0
Fuel BalanceCheck	0	0	0	0	0	0	0	0	0	0
<b>Refineries Producing First Generation, Bio-based Fuel Ethanol (Million Liters) 1/</b>										
Number of Refineries	5	5	6	6	7	7	10	11	12	14
Nameplate Capacity	2,500	2,600	3,000	3,000	3,200	3,200	3,600	4,200	5,000	5,257
Capacity Use (%)	99%	99%	95%	97%	91%	90%	69%	72%	58%	82%
<b>Refineries Producing Cellulosic Fuel Ethanol (Million Liters) 2/</b>										
Number of Refineries	1	1	1	3	3	1	1	1	1	1
Nameplate Capacity	13	13	13	129	129	65	65	65	65	65
Capacity Use (%)	0%	0%	0%	19%	19%	58%	61%	46%	31%	0%
<b>Co-product Production (1,000 MT)</b>										
DDGs	1,930	1,998	2,103	2,107	2,120	2,239	1,942	2,657	2,655	2,972
<b>Feedstock Use for Biomass-based Fuel Ethanol (1,000 MT)</b>										
Corn Kernels	6,166	6,383	6,717	6,732	6,775	7,154	6,203	7,489	6,981	8,994
Wheat Kernels	0	0	0	0	0	0	0	1,000	1,000	500
Cassava (dried chips)	1,009	1,009	1,177	1,514	1,514	1,562	1,652	2,868	2,748	1,424
Rice (kernels)	0	0	0	0	0	0	0	0	500	0
Sweet Sorghum	0	0	71	71	71	0	0	0	0	0
Cellulosic Biomass	0	0	240	250	260	400	450	na	na	na

<b>Market Penetration (Million Liters)</b>										
Fuel Ethanol Use	2,470	2,563	2,854	2,932	2,975	3,391	3,404	3,046	3,638	4,394
Gasoline Use	96,913	105,738	113,592	130,015	135,660	157,237	165,083	170,310	172,063	176,291
Blend Rate (%)	2.5%	2.4%	2.5%	2.3%	2.2%	2.2%	2.1%	1.8%	2.1%	2.5%

Notes: f = forecast

1/ Covers grain-based ("Generation 1.0") and non-grain, non-cellulosic feedstock ("Generation 1.5") ethanol.

2/ Covers cellulosic ("Generation 2") ethanol only.

Sources: Post estimates and industry sources

## Consumption

Overall Chinese fuel ethanol demand is rising due to both policy incentives and economic factors. At this time, IEA projects slower long-term growth, compared to previous decades, in the ethanol-gasoline transportation fuel pool. This is due to a slowing pace of economic activity and increasingly stringent environmental measures that aim to phase-out the use of conventional gasoline-only vehicles, and promote further expansion of NEVs. China's market potential for ethanol use has global implications for benchmark prices for refined fossil fuel products, corn, fuel ethanol, and industrial chemicals, including MTBE and other fuel additives.

In 2019, fuel ethanol consumption is estimated at a record 4,311 million liters (3.4 million tons), up 1,397 million liters (1.1 million tons) from 2018 due to newly implemented provincial and municipal government directives to expand fuel ethanol blending into gasoline supplies.

All fuel ethanol in China's transportation fuel supply must meet national standard GB18350 for denatured fuel ethanol. However, China does not administer a national standard for ethanol inclusion rates in retail gasoline formulations. Industry sources report that although many provinces and cities have adopted E10 in full, actual compliance and the standardization of retail gasoline fuel formulations vary greatly within a given transportation fuel market. As a result of these differences, China's 2019 national fuel ethanol blend rate is forecast at 2.5 percent, up from 2018, yet slightly lower than peak fuel blend rate levels of 2.5 to 2.8 percent achieved 10 years ago.

MTBE competes with ethanol as a gasoline oxygenate for improved engine performance in China. Recent regulations under the "Blue Sky Protection Plan (2018-2020)" restrict the use of MTBE, which further supports expanded ethanol demand. China does not produce ethanol-derived bio-ETBE (ethyl tert-butyl ether) in commercial volumes. Fuel blending formulations incorporating ETBE require additional processing, which have not been adopted in China.

## Production

2019 fuel ethanol production is forecast to jump to a record 4,311 million liters (3.4 million tons), up 1,412 million liters (1.1 million tons), due to new production facilities beginning operations in 2018 and 2019.

Operating capacity remains below name plate capacity as existing facilities struggle to manage high production costs, and new facilities progress towards full operating capacity. Industry sources report that an additional 2 facilities or about 258 million liters (204,000 tons) of capacity will launch in 2019, raising the number of China's licensed bio-based fuel ethanol processors to 14, and total production capacity to 5,258 million liters (4.1 million tons).

North East China has the most rapid investment expansion of both new construction and upgrades to fuel ethanol production capacity. As the location of China’s Corn Belt and the Songliao Basin, a major oil and gas producing region, North East China is dotted with corn and oil fields, ethanol processors, and oil refiners.

In 2018, industry sources reported that 87 percent of China’s fuel ethanol production was corn-based, 11 percent was cassava-based and sugar cane-based, and the remaining 2 percent relied on cellulosic feedstocks. In 2018 and 2019, nearly all fuel ethanol expansion is attributed to higher throughput and greater production from China’s 8 major corn-based ethanol production facilities.

Industry sources report that sugar- and molasses-based ethanol producers remain under pressure to market their products for industrial and pharmaceutical use. Due to limited supplies of sugarcane and industry-lagging productivity, the margins for fuel ethanol production are too low.

A select few ethanol facilities in China are designed to produce ethanol using non-food feedstocks; however, their use of non-food feedstocks like cassava, sweet sorghum, and molasses depends on pricing. From 2015 to 2019, dried cassava chips have consistently been priced higher than corn in China. Nevertheless, in 2019, China constructed and opened two new cassava-based production facilities. The operating capacity of these two facilities is unknown.

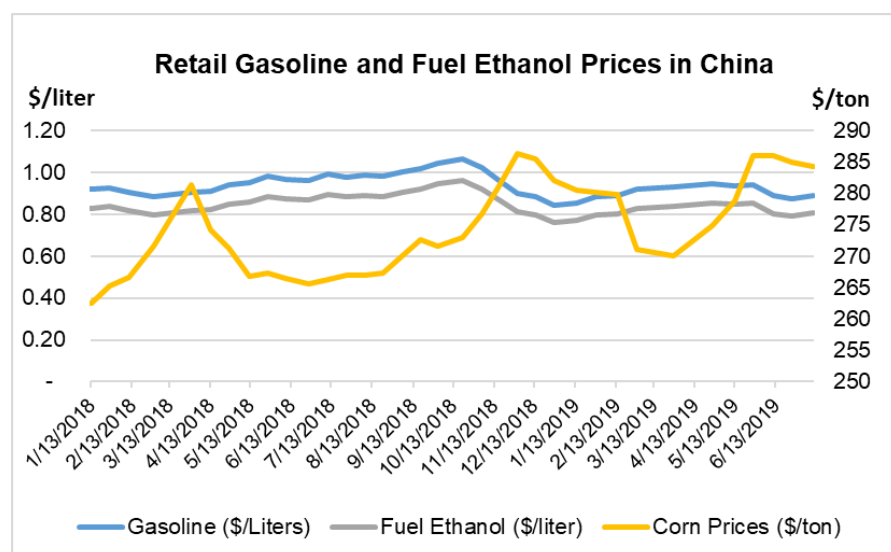
SDIC has at least four new ethanol production facilities planned. Each has a nameplate production capacity of around 380 million liters (300,000 tons), or a combined total of 1,500 million liters of additional capacity. Additional fuel ethanol projects in Hailun, Bei’an, Fujin in Heilongjiang province, are scheduled to come on line in 2020. Other projects remain in the early stages of development.

<b>Production Capacity of China’s Fuel Ethanol Licensed producers (2019 estimates)</b>			
	<b>Producers</b>	<b>Production Capacity</b>	<b>Feedstock</b>
1	SDIC Jilin Alcohol	887 million liters (700,000 tons)	Corn
2	Henan Tianguan	887 million liters (700,000 tons)	Wheat, Corn, Cassava
3	COFCO Biochemical (Anhui)	798 million liters (630,000 tons)	Corn, Cassava
4	COFCO Bioenergy (Zhaodong)	507 million liters (400,000 tons)	Corn
5	SDIC (Zhanjiang)	190 million liters (150,000 tons)	Cassava
6	Shandong Longlive	65 million liters (51,300 tons)	Corn Cob
7	COFCO Bioenergy (Guangxi)	253 million liters (200,000 tons)	Cassava
8	Zonergy (Inner Mongolia)	38 million liters (30,000 tons)	Sweet Sorghum
9	SDIC (Tieling)	380 million liters (300,000 tons)	Corn
10	Liaoyuan Jufeng Biochemical	380 million liters (300,000 tons)	Corn
11	Jilin Boda Biochemistry	507 million liters (400,000 tons)	Corn
12	Jiangsu Lianhai Biotechnology	152 million liters (120,000 tons)	Corn
13	Shandong Fu’en Biochemical	152 million liters (120,000 tons)	Cassava
14	Jiangxi Yufan	127 million liters (100,000 tons)	Cassava
15	Shougang LanzaTech	58 million liters (46,000 tons)	Synthetic Gas
	<b>TOTAL</b>	<b>5,390 million liters (4.2 million tons)</b>	

Source: Industry Sources

China’s industrial alcohol producers, which produce precursors for industrial solvents and chemical intermediates, are expected to convert some of their idled production capacity to fuel ethanol. This will

help to fill China’s shortfall in fuel ethanol production as it strives to reach the nationwide E10 goal. However, the precise details of timing and volume of production for the conversion of industrial chemical production to fuel ethanol production is unclear.



Sources: NDRC and JCI

In effect, China’s fuel ethanol prices are partly defined by prevailing benchmark crude prices and U.S. dollar-Chinese Renminbi foreign exchange rates, rather than the cost of production of fuel ethanol.. In China, fuel ethanol prices are fixed at 91.1 percent of the retail gasoline price, which is set by NDRC according to a basket of global benchmark crude prices.

Rigid pricing rules have led China’s petroleum refiners to seek ethanol as a substitute to offset high production costs for refined oil products. Since 2016, benchmark crude oil prices doubled, rising from \$31 per barrel in January 2016 to \$62 per barrel in July 2019. Meanwhile, retail gasoline prices in China rose less than 19 percent over the same period, and refining margins have fallen to 16-year lows. The industry is going under restructuring as some refiners curtail production or shutter their operations. Refiners have also turned to blending ethanol as a means to partly offset rising input costs.

In comparison, the costs of ethanol production for all feedstocks remain relatively low. Industry sources report that as new production capacity has come online in 2019, the total cost of production has fallen by nearly 20 percent.

Fuel Ethanol Costs of Production in China		
Feedstock	\$ per Liter	RMB per Ton
Corn	\$0.63	5,480
Cellulosic	\$0.74	6,450
Synthetic (Waste Gas)	\$0.46	4,000

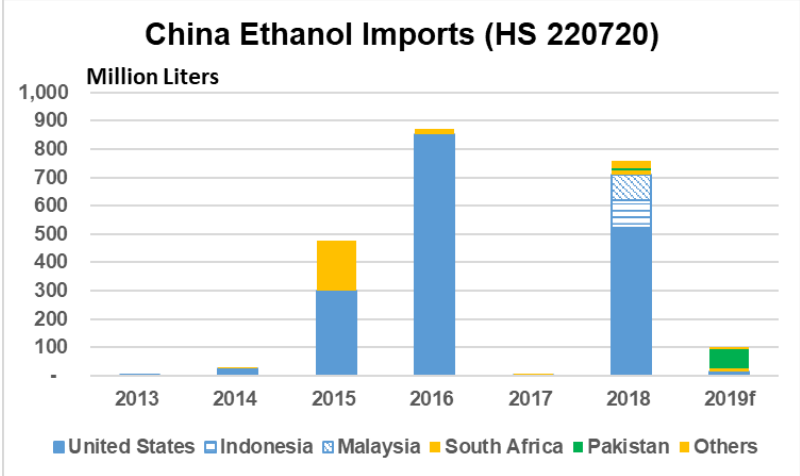
Source: Industry Sources

Although, spot corn prices have gradually risen to three-year highs at about \$286 per ton (1,974 RMB), or up about 17 percent, corn-based ethanol margins remain relatively viable. China’s retail ethanol price settled to about \$0.80 per Liter in July 2019.

Although the cost of inputs have risen, the overall rising efficiency of national production capacity has lowered the average cost of production nationally. Shougang Lanzatech began operation in March 2019 as the world’s first synthetic industrial flue-gas fermentation plant producing synthetic fuel ethanol. Industry sources report that it is currently operating at about 30 percent capacity.

**Trade**

2019 fuel ethanol imports are forecast at 100 million liters (789,000 tons), precipitously falling to a fraction of imports in 2018 due to higher tariffs on U.S. ethanol and greater domestic production. From January to May 2019, trade data indicate that China imported a mere 20.7 million liters (16,364 tons) of denatured ethanol.



Sources: Global Trade Atlas, General Administration of China Customs, and FAS China estimates

China has historically banned ethanol imports. China opened its market to imports in 2015. In 2018, higher tariffs on U.S. imports and greater volumes of domestic production resulted in significant substitution of imports.

Higher tariffs shut off trade at the beginning of 2017. Trade resumed at the close of 2017 as U.S. ethanol prices reached a 12-year low, and continued into 2018. Additional tariffs on U.S. ethanol further diminished arbitrage opportunities for Chinese ethanol importers. In the second half of 2018, media reports chronicled how Malaysia and Indonesia shipped an estimated 100 to 150 million tons of ethanol to China, taking advantage of duty-free market access for ASEAN ethanol exports to China.

2019 fuel ethanol exports are forecast at 36 million liters. Although small, China has already shipped a record volume of denatured ethanol (likely for fuel use) to Vietnam in 2019, as that country moves forward to implement its fuel ethanol mandate. As of June 2019, China has not shipped additional volumes. It is uncertain if further sales will continue during the remainder of 2019.



## IV. Biodiesel

### Overview

Today, increasingly stringent environmental measures are driving prospects for expanded biodiesel use in the world's largest heavy-duty truck market. Based on fuel use, a modest B5 mandate for on-road use alone would currently require 6,500 million liters (See the Biodiesel Table below). Beyond that, the potential is greater still, as China's biodiesel applications also include maritime and other non-transport sectors.

With the exception of a few tax breaks, and no other financial support and no prospects for provincial or a nationwide blending mandate, China's biodiesel market will remain extremely limited and subject to competition from typically lower priced fossil-based diesel. A long list of energy and trade policies undermine further development of China's biodiesel sector. Limited tax incentives, limited opportunities for discretionary blending, and the lack of a national mandate continue to stymie market development. This has resulted in anemic prospects for the biodiesel sector.

From 2013 to 2014, biodiesel demand expanded when benchmark crude oil prices hovered above \$100 per barrel. At the time, biodiesel consumption reached a record 2.1 billion liters (1.8 million tons) evenly supplied by domestic production and imports. However, in 2015 crude oil prices collapsed, margins inverted into negative territory, and discretionary blending disappeared. Chinese demand for biodiesel in 2018 and 2019 has returned but remains below peak levels in 2013 and 2014. While oil prices have not returned to the pre-2014 oil price collapse, palm oil prices have continued falling and created a non-mandate driven demand situation for palm oil-based biodiesel.

Adoption of a nationwide or sectoral emissions trading program could support an expanded biodiesel market if managed to promote fuel switching from fossil fuels to lower carbon-intensity bio-based fuels. Alternatively, China could implement policy measures such as subsidies or greater tax incentives to narrow the gap between biodiesel and fossil diesel prices, but even then, success would be limited without a biodiesel blend use standard or mandate.

Biodiesel (Million Liters)										
Calendar	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019

Year										
<b>Beginning Stocks</b>	0	0	0	0	0	0	0	0	0	330
<b>Production</b>	568	738	927	1,079	1,133	787	909	1,043	834	900
<b>Imports</b>	0	0	31	446	1,000	33	8	18	853	400
<b>Exports</b>	0	0	0	0	32	23	76	194	357	580
<b>Consumption</b>	568	738	958	1,525	2,101	797	841	867	1,330	1,050
<b>Ending Stocks</b>	0	0	0	0	0	0	0	0	0	0
Balance Check	0	0	0	0	0	0	0	0	0	0
<b>Production Capacity (Million Liters)</b>										
Number of Biorefineries	45	49	52	53	53	53	48	46	44	40
Nameplate Capacity	2,556	3,400	3,600	4,000	4,000	4,000	2,680	2,680	2,680	2,680
Capacity Use (%)	22%	22%	26%	27%	28%	20%	34%	39%	31%	34%
<b>Feedstock Use for Fuel (1,000 MT)</b>										
Used Cooking Oil	556	722	907	1,055	1,108	771	891	1,022	816	881
<b>Market Penetration (Million Liters)</b>										
Biodiesel, on-road use	170	221	270	324	340	236	273	313	410	430
Diesel, on-road use	100,179	111,546	126,150	133,718	141,742	144,663	135,035	136,230	133,302	130,636
Blend Rate (%)	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.3%	0.3%
Diesel, total use	185,952	181,470	182,769	183,544	180,958	184,453	174,991	177,090	171,690	168,256

Notes: f = forecast

Sources: Post estimates and industry sources

## Consumption

2019 biodiesel consumption is estimated at 1,022 million liters (900,000 tons), nearly unchanged from 2018, and below record domestic use in 2014. In China, in contrast to most other countries, biodiesel is used to fuel electrical power generation, fishing vessels, and farm equipment. Industry sources report that on-road transport accounts for about one-third of total demand.

At this time, Shanghai is the only local authority implementing a biodiesel program. In October 2017, Sinopec Shanghai began offering B5 diesel at a \$0.05 per liter (0.3 yuan) discount to regular diesel as part of a pilot program. With full market penetration of B5, Shanghai would consume as much as 682 million liters (600,000 tons) of B5 (or 34 million liters of pure B100 biodiesel) today. The Shanghai program aims to buck a historical precedent where previous efforts to adopt local and provincial

biodiesel blending mandates failed. By the end of 2018, Shanghai reported over 200 stations were supplying B5 diesel and over 110 million liters (80,000 tons) of B5 were consumed in the city.

**Production**

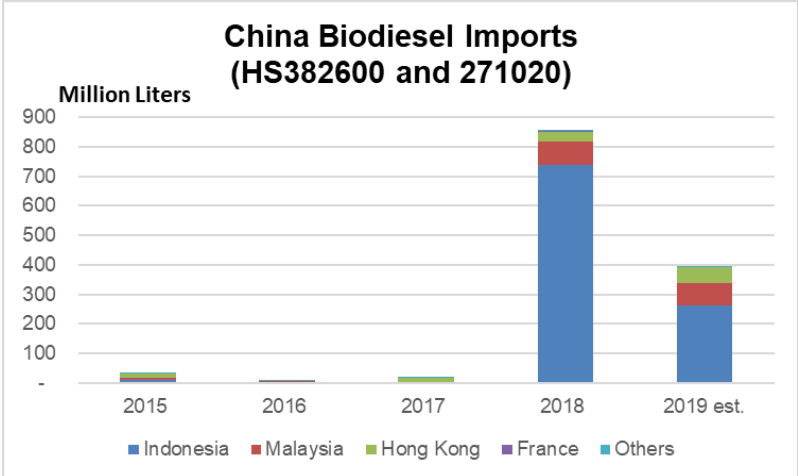
2019 biodiesel production is forecast at 900 million liters (792,000 tons), similar to 2018, and slightly below record domestic production in 2013 and 2014. Cheaper imported biodiesel from Indonesia and Malaysia have undermined the financial viability of domestic producers.

From its inception, China’s biodiesel production plan has aimed to divert UCO away from food use and allay concerns about food safety. Nonetheless, China’s biodiesel industry continues to wholly rely on used cooking oil (UCO) for feedstock. Some smaller food-grade oil brokers blend waste cooking oil, commonly known as "gutter oil," with food-grade oil to resell for restaurant use. Industry reports that China’s produced about 10 million tons of gutter oil in 2018, of which about 10 percent was used to produce biodiesel. About 0.97 tons of UCO can produce 1 ton of biodiesel.

According to the Chinese Academy of Sciences (CAS), China’s name plate biodiesel capacity in 2015 was between 3,420 to 3,990 million liters (3 to 3.5 million tons). However, industry sources report that many of China’s largest biodiesel processors are idled and national production capacity is now near 1,140 to 1,710 million liters (1.0 to 1.5 million tons). Current capacity is likely near 2,700 million liters with a capacity utilization rate a little over 30 percent.

**Trade**

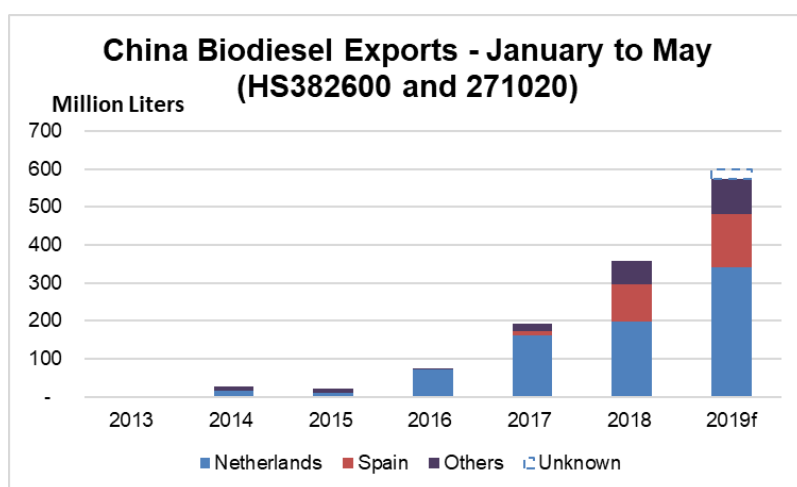
2019 biodiesel imports are forecast to decline to 400 million liters (350,000 tons) from 2018’s level of 853 million liters, the highest imports since 2014. Industry sources report that more than 90 percent of the imports are palm oil-based biodiesel from Indonesia and Malaysia.



Sources: Global Trade Atlas and General Administration of China Customs

Recently, China’s biodiesel exports have risen steeply. The vast majority is shipped to the EU, landing primarily in the Netherlands and Spain, EU policy incentivizes demand for waste-based biofuels. Reportedly, some of this could be Indonesian palm oil-based biodiesel shipped to China, and then redirected to Europe and re-labeled as Chinese biodiesel.

Industry sources report that China exported 300,000 tons of UCO in 2018 and is projected to export 500,000 tons in 2019. This will be used as an input for biodiesel production. Driving this are both export rebate policies from China, as well as EU policies that incentivize demand for biofuels processed from waste, including UCO-based biodiesel. As a result, profit margins for UCO feedstocks are higher in Europe than China.



Sources: Global Trade Atlas and General Administration of China Customs

Note: All product trade under HS 3826.00 is assumed to be pure B100 biodiesel; All product under HS 271020 as petroleum oil, containing biodiesel up to 30 percent, is assumed to contain on average 10 percent biodiesel by volume, converted and reported as B100 equivalent.

### III. Advanced Biofuels

In China, fuel ethanol is mainly produced from corn. However, the industry is investing significant resources to transition feed stock from corn and cassava feedstock to bio-based cellulosic feedstock, and coal- and industrial flue gas-based methanol feedstocks for synthetic ethanol production.

#### Bio-Based Fuel Innovation

The government actively promotes demonstration and pilot projects. On May 10, 2017, China's central government announced its 13<sup>th</sup> FYP for Biological Innovation. The plan focuses on promoting innovation in biological-based technologies, including new energy sources using bio-based feedstocks like cellulosic ethanol.

#### *Generation 1.5 Biofuels - Defined as Non-food Grain, Non-Cellulosic Biofuels*

Ethanol from non-food grain feedstocks is considered an advanced biofuel in China. After 2010, and until just recently, China limited the growth of corn use as a feedstock for fuel ethanol production with restrictions throughout the value chain. China also phased-out national production supports.

Cassava- and sweet sorghum-based ethanol production remain in research and exploratory phases of commercialization. High operating costs have limited expansion of production capacity using these feedstocks. China depends on imported cassava for most of its non-food grain ethanol production. High-costs and logistics have hampered full-scale operations in the past, leading to their closure. China's sweet sorghum ethanol production operations in Inner Mongolia are limited by the year-round availability of sweet sorghum as well as limited local market demand and government incentives for transportation fuel refiners, blenders, and consumers. China discontinued ethanol production subsidies for non-food grain, non-cellulosic feedstock use after 2017, further diminishing commercial viability for these production systems.

In 2008, China National Cereals, Oils and Foodstuffs Corporation (COFCO) established its first cassava-based 253-million-liter-per-year (200,000 ton) capacity fuel ethanol demonstration plant in Guangxi Province only to later shutter the plant when it faced soaring raw material costs and resistance from fuel retailers. Cassava-based ethanol producers relied on imports for 80 percent of their feedstocks. In 2016, Thailand restricted exports of cassava to China, resulting in the closure of several processors. As a result, future expansion plans for cassava-based plants in Zhejiang and Guangdong provinces never materialized.

The plan to use jatropha oil as a biodiesel feedstock never materialized. Jatropha plantations covering hilly regions Southwest China were abandoned years ago because they failed to pollinate and lacked sufficient water resources.

#### *Generation 2 Biofuels – Defined as Biofuels Made From Cellulosic Feedstocks*

According to the 12<sup>th</sup> Five Year Plan (2011-2015) for strategic emerging industries, China aimed to use biomass energy sources to develop Generation 2 biofuels. This included production of 5,068 million liters (4 million tons) of cellulosic fuel ethanol, and 1,136 million liters (1 million tons) of algae-based biodiesel.

Cellulosic ethanol is prominently featured in the joint announcement by China's NDRC and other ministries in the September 2017 "Implementation Plan for the Expansion of Ethanol Production and Promotion for Transportation Fuel."

Early cellulosic ethanol projects failed to meet expectations. COFCO reports that the viability of cellulosic ethanol depends on crude oil prices, which must exceed \$100 per barrel. In late June 2019, benchmark crude oil prices hovered around \$70 per barrel.

In 2012, Henan Tianguan established a 12.7-million-liter (10,000 tons) capacity cellulosic ethanol pilot project. It reportedly suspended production several years ago. In 2013, Shandong Longlive established a 63-million-liter (50,000 ton) per year capacity corn stover-based fuel ethanol production line. This facility recently ceased operations. Cellulosic projects in Shandong and Heilongjiang were on the cusp of commercial viability six years ago with high crude oil prices, but still remain in development phase, as demonstration projects, or have entirely ceased operations. In March 2018, Jilin province solicited investment capital for the relaunch of a 126.7-million-liter-per-year (100,000 ton) cellulosic ethanol plant. The project was originally a joint venture between DuPont Pioneer and Jilin Province New Tianlong Industry. However, progress on the project has stalled.

Since 2009, COFCO has pledged to build several 63-million-liter (50,000 ton) capacity cellulosic fuel ethanol plant; however, actual production operations have yet to materialize. In March 2018, Songyuan Guanghe Energy in Jilin province proposed the construction of a 1.6-million-ton-throughput-capacity agricultural waste bio-refinery project that would have annual capacity to produce 253 million liters (200,000 tons) of cellulosic ethanol.

According to Asiachem's 2018 Fuel Ethanol Annual Report, China's cellulosic fuel ethanol production capacity (including projects operating and under construction) was forecast to reach 3,928 million liter (3.1 million tons) in 2018.

Cellulosic ethanol projects face logistics challenges to supply reliable volumes of feedstock at low cost, and the technology conversion to commercial scale. China's cellulosic ethanol industry, like those found elsewhere, face challenges including finding high levels of foreign matter in bales of stalks, straw, and stover, and optimizing the use of enzymes to convert cellulosic material to energy. As elsewhere, processors struggle to comply with local regulations for air and water waste management.

Bio-energy is commonly cited as a preferred option for the disposal of large volumes of crop residues in China. China's estimated national crop straw and stalks resources are between 800 million tons and 1.1 billion tons. In 2015, corn stover was estimated to account for 225 million tons of China's annual production of crop residues. Jilin province reportedly produces 23 million tons alone. Each ton of corn as grain yields about 1.1 tons of corn straw residues.

In China, growers customarily either burn crop residues in the fields, or gather and bundle these residues to use as heating fuel for the winter. Since 1999, local authorities have announced strong enforcement measures to lower particulate matter emissions and air pollution and curb the practice. In 2017, MOF offered subsidies as high as \$1.5 million to \$3.0 million (10 to 20 million RMB) for each city and county pilot project to utilize straw as an energy feedstock. Qualified projects include procurement of stalk processing equipment, such as baling machines, straw and stalk-based bioenergy electrical power generation, and construction of straw and stalk buying points (receiving, grading, storage, and marketing). Farmers face cash penalties and detention if they fail to comply with burning rules. However, the economic cost of gathering and transporting biomass for cellulosic processing exceeds the subsidy value offered by local authorities. A recent economic study reported that straw collection is limited by low economies of scale, lack of public awareness, and limited access to equipment.

#### *Aviation Biofuel*

In September 2012, Sinopec partnered with Airbus to develop a Chinese national standard “#1 bio-jet fuel,” based on proprietary processing technology at its Hangzhou refinery. In November 2017, Boeing and Sinopec partnered with China's Hainan Airlines to power an 11,000 kilometer Boeing 787 Dreamliner flight using UCO-derived jet fuel. Hainan Airlines previously conducted a biofuels-based flight in 2015. Currently, there are no “off-take” agreements in China to supply commercial flights on a regular ongoing basis.

#### *Synthetic Fuel Ethanol*

China's efforts to reduce air particulate matter include projects that convert coal and industrial waste gas into synthetic ethanol. At the same time, China's adoption of more stringent environmental standards constrain further expansion of existing synthetic gas-to-ethanol processing facilities. In 2019, several industrial ethanol producers in Jiangsu province that use synthetic fermentation technology closed in the wake of weakening demand for industrial chemicals, and the implementation new environmental and safety requirements.

## **Annex I**

### **China's Long March towards National Biofuel Market Development: Production/Consumption Targets and Feedstock Priorities.**

#### **10<sup>th</sup> FYP (2001-2005) – Corn Surplus Period**

China implemented fuel ethanol programs starting in the early 2000's in response to abundant grain supplies. In MY1998/99, USDA ending stocks estimates reached record highs at 123.8 million tons. During this time, China's rapid growth in consumer demand outpaced productivity gains. Although, China adopted a long-standing ban on the use food-grains for fuel ethanol production, and the promotion of non-food feedstock (non-grains) for fuel ethanol, the vast majority of domestic ethanol production relied on existing corn supplies. Beginning 2005, as global grain prices soared, the Government of China promoted non-food fuel ethanol production as Generation 1.5 ethanol.

#### **11<sup>th</sup> FYP (2006-2010) – Corn Surplus Moderated**

China's 11<sup>th</sup> Five-Year Plan (2006-2011) was the first targeting the production of biofuel from non-grain materials, including sweet sorghum, potatoes, and cassava for ethanol, and jatropha trees for biodiesel. (See Section VI, Advanced Biofuels).

Beginning in 2006, 11 provinces (Heilongjiang, Henan, Jilin, Liaoning, Anhui, Guangxi, Hebei, Shandong, Jiangsu, Inner Mongolia and Hubei) were selected as pilot zones for fuel ethanol production and mandatory E10 blend use. Many fuel retailers have argued in courts and protested against state-owned petroleum giants that China's implementation of biofuels blending targets restrict their ability to respond to market prices, undercutting their profitability and the long-term sustainability of their businesses. As a result of these concerns, some regions do not strictly enforce province-wide E10 blending requirements.

In August 2007, NDRC published a "Mid- to Long-term Renewable Energy Development Plan" that targets annual fuel ethanol use to exceed 12,670 million liters (10 million tons) by 2020, effectively expanding production by five-fold from 2017 to 2020.

During a period of high corn prices in 2008, China restricted construction of new ethanol facilities. Starting in 2010, central government subsidies for conventional ethanol plants began to be phased out, falling from \$0.03 per Liter (RMB 2,000 per ton) in 2009 to zero in 2016. Ethanol production subsidies using non-food grain feedstocks were also phased out by 2018. Afterwards, China limited the growth of corn use for fuel ethanol when rising domestic grain prices triggered food price concerns. During this same period, China became a net corn importer.

#### **12<sup>th</sup> FYP (2011-2016) – Corn Surplus Period**

In 2010, the government set ambitious targets for ethanol and biodiesel in its 12th FYP, including a goal of producing 5,068 million liters (4.0 million tons) of fuel ethanol and 1,136 million liters (1.0 million tons) of biodiesel by 2015.

Despite significant investments in research and development, government efforts to expand production of non-grain conventional fuel ethanol never materialized into commercial-scale projects. (See Section VI, Advanced Biofuels).

The 12<sup>th</sup> FYP goal for biodiesel was met early in 2014. However, both biofuel production targets fell short in 2015. In 2015, fuel ethanol production reached just 2,914 million liters (2.3 million tons), or less than two-thirds of the original 5,068 million liter (4.0 million ton) 12<sup>th</sup> FYP goal.

### **13<sup>th</sup> FYP (2016-2020) – Corn Stocks Drawdown**

On October 24, 2016, China's State Council announced its 13<sup>th</sup> FYP goal to produce 5,068 million liters (4 million tons) of ethanol and 2,272 million liters (2.0 million tons) of biodiesel by 2020. While the goal projects ethanol production to rise four-fold from current levels, underlying economic fundamentals and the lack of national or provincial government support undermine large-scale efforts to expand production.

Government policies introduced in 2016 paved the way for a fuel ethanol industry revival through the elimination of the temporary reserve policy for corn; more stringent vehicle fuel efficiency and emissions standards; and the reinstatement of the VAT refund on ethanol products. Industry sources report that China's provincial corn processing subsidies and a nationwide blending policy are supporting margins for ethanol producers.

In January 2017, China launched the world's first coal-to-ethanol production facility in Shaanxi province. The Shaanxi Yanchang Petroleum facility has a single production line which converts coal to synthetic gas, and then into ethanol. The facility uses technology developed by CAS and Dalian Institute of Chemical Physics in Liaoning province to produce 99.17 percent anhydrous ethanol, and is on track to expand annual production to 1,268 million liters by 2020. The project has a name plate capacity of about 126.8 million liters. Yanchang's 634-million-liters-per-year synthetic fuel ethanol project is scheduled to begin production before 2020.

On September 13, 2017, NDRC, NEA, Ministry of Finance (MOF) and 12 other ministries jointly announced a plan to expand ethanol production and promotion for transportation fuel. This includes a nationwide target of implementing 10-percent ethanol blending into gasoline fuel by 2020, and a proposed shift to commercial-scale cellulosic ethanol by 2025. To date, the Government of China has not proposed a volumetric target for commercial-scale cellulosic ethanol production.

To date, pace of fuel ethanol production capacity expansion has accelerated, but currently faces a number of headwinds related to environmental regulations and technical limitations (See Section III, Ethanol and Section IV, Advanced Biofuels).



