Japan's Ethanol Introduction and Outstanding Issues
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<Summary>

1. Trends of motor-fuel ethanol and major producing-countries' export potential

In pursuit of ① energy security, ② environmental preservation and ③ agricultural promotion, among others, ethanol introduction is under way as a policy advocated by many governments worldwide. In 2005 the world fuel ethanol output amounted to 33.60 million kiloliters (KL), which could reach an estimated 100 million KL by 2015 according to some projections. On ethanol made from food crops, we, at the IEEJ, have formed an outlook regarding the supply-demand balance for each of four countries, including Brazil, the U.S., China and India, for the next several decades. Our outlook results show the U.S. and China will fall short of supply in meeting their domestic ethanol needs for producing blended gasoline (with 10% ethanol), because a greater portion of the feedstock crops must be allocated for the food and feed uses in reflection of their growing populations and economic development. India is projected to have export potential of an estimated million KL in 2010. Yet, given that Indians' efforts to introduce 5%-ethanol-blended gasoline is just onset and that India is a net oil importer comparable to Japan, the real size of the country's surplus export capacity needs to be examined closely.

2. Brazil's export potential and Japan's response

Based on our outlook results, Brazil, having plenty of room for developing arable lands and boosting harvests, is expected to have export potentials of around 6.00 million KL in 2010, though ethanol supply and demand is feared to tighten worldwide in the event of changing conditions in Brazil, notably an energy policy change and a poor harvest. Even if Brazil commits to ethanol exports to Japan alone, the risks associated with such uncertainties and the need for building transport infrastructure (incl. shipping terminals and chartered tankers) to allow shipments from Brazil require prudent examinations. For the time being, it appears pragmatic for Japan to consider introduction of Brazilian ethanol as conservative as covering exact needs for around 3% ethanol blending (some 1.80 million KL in absolute terms) as a maximum target.

3. Japan's home-made ethanol supply potential

In making ethanol domestically, Japan currently has few choices but to depend on food-derived energy crops (e.g. rice, sugar cane, sweet potato, beat). Even if these crops are grown in currently mothballed farming land, the annual ethanol output should remain at around a million KL at best, which barely covers ethanol requirements for blending it with gasoline by 1~2%. The idea to use cellulose-based ethanol as a feedstock must be dismissed for the present, as it still remains at the R&D stage and how to cut its high production cost, among others, involves stepped-up research efforts ahead. Such being the situation, it appears appropriate for Japan to make ethanol from such farm products as off-specs food crops, with the resultant ethanol being consumed within the region it is produced (locally-produced-and-locally-consumed).

4. CO_2 reductions by ethanol-blended gasoline and its cost/benefits

In case ethanol is imported from Brazil, ethanol-blended gasoline in either form of E-3 (ethanol directly blended with gasoline by 3%) or ETBE-7 (ETBE synthesized from E-3 blended with gasoline by 7%) could curb CO_2 emissions by around 4.20 million tons on a LCA basis. However, with the crude oil price assumed at $60/bbl, incremental costs incurred in ethanol imports amount to some ¥90 billion, causing a higher E-3 price at service stations by ¥1.4/liter. This means to slash a ton of CO_2 in Japan costs some $190, several times dearer than the EU carbon price level set for its emissions trading.

5. Outstanding issues for ethanol introduction

The world population, now some 6.5 billion, is projected to reach about 9 billion by 2050 (a UN forecast in 2004) and likely to be combined with rapidly swelling food demand. Moreover, biomass introduction involves contentious negative effects on the environment, typically water resource issues, shrinking forests (lands) and genetic modification. For these reasons, to make cellulose-based ethanol from any feedstock not conflicting with food and feed seems imperative, while considering a well-balanced introduction of a wide variety of CO_2-cutting options, like hybrids (incl. electric vehicles) and the diesel shift, with their cost/benefits taken into account.

<Main Text>

1. Trends of motor-fuel ethanol

(1) Ethanol production in 2005 (demand trends)

In 2005 ethanol output (for both fuel and industrial uses) amounted to 16.10 million KL in Brazil, 16.20 million KL in the U.S., 3.80 million KL in China, 2.20 million KL in the EU and 1.70 million KL in India. When combined, these five regions are responsible for 90% of the world output. The world ethanol fuel production, which totaled 33.60 million tons in 2005, is on a sharp rise and some analysts say it will reach 100 million KL by 2015.

(2) Ethanol production cost

Brazil is able to produce ethanol at the price of as low as ₵30/liter (using sugar cane as a feedstock), followed by the U.S. at ₵60/liter (corn). In the EU, the cost is as high as over ₵80/liter (wheat, beat and others).

(3) Ethanol policies in major countries

Many governments across the world are unrolling the policy to put ethanol introduction forward in their efforts on ① energy security, ② environmental preservation, ③ agricultural promotion, and so on. However, because farm products are firstly allocated to the higher-priced uses such as food and feed preferred atop, those usable for ethanol production may be in short supply in the long run. There are high expectations for commercialization of cellulose-based ethanol by reducing its high production cost in order to avoid this situation.

2. Ethanol supply capacity outlook

(1) Brazil, the U.S., China and India

For the four countries of Brazil, the U.S., China and India, which are likely to produce even greater ethanol than now, ethanol supply-demand balances were calculated. According to the calculation results, despite crop output increases predicted for the U.S., China and India, ballooning needs for food and feed uses are likely as well due to these countries' growing populations and economic development. As a result, the U.S. and China will find they are unable even to fully cover their domestic needs for ethanol for making ethanol-blended gasoline (with 10% ethanol blended). India's export potential, put at an estimated a million KL for 2010, must be examined more carefully, seeing that it has just started introduction with 5% ethanol blended and is a net oil importer like Japan.

Meanwhile, Brazil, having a lot of room for expanding arable land and harvests, is expected to maintain its ethanol export capacity. Brazil's export capacity is projected at: 6.00 million KL for 2010; 12.00 million KL for 2030; and 11.00 million KL for 2050.

In theory, Brazil is predicted to have an export capacity of around 6.00 million KL in 2010. Yet, such uncertainties as Brazil's energy policy change, poor crop harvests worldwide, varying areas of farming land and inconstant yields, if any come about, are feared to tighten ethanol supply and demand worldwide. This risk of tightening demand and supply is pushing Japan to prepare effective measures for securing supplies: long-term sales agreements with Brazil, ethanol stockpiling, flexibility in varying the ratio of ethanol blends depending on feedstock availability, and transport infrastructure (incl. shipping terminals, chartered tankers) built in Brazil to allow shipments from the country.

(2) Japan

The Ministry of Agriculture, Forestry and Fisheries (MAFF) estimates Japan's ethanol production at some 6.50 million KL as a possibility. The problem is that the MAFF assumes nearly 80% of the estimated output could be made from cellulose-based feedstock, which is still at the R&D stage and requires a lower production cost, among other problems. Thus, Japan has no alternatives to food-derived energy crops (e.g. sugar cane, sweet potato, beat) for the time being and its supply potential would be limited to around a million tons/year at best, or no more than what's needed for 1-2% ethanol blended.

In Japan, farming land is fractionalized into as small as an average of 2.4ha per farming family, which results in a higher feedstock cost. Even with off-specs wheat in use, Japan's ethanol production cost exceeds ¥100/liter, several times higher than abroad; in Brazil, about 80% of farming families possess farmland of 100 ha or larger each.

Thus, given the high production cost and feedstock supply restraints, Japan for the present is recommended to make ethanol from such farm products as off-specs food crops, and consume resultant ethanol in the region that they are produced, a practice known as "locally-produced-and-locally-consumed."

3. CO_2 reductions by ethanol-blended gasoline and cost/benefits of the introduction

(1) LCA (life cycle assessment) of ethanol blended gasoline

Ethanol blended gasoline, if introduced, would be either E-3 or ETBE-7, which is originated from Brazilian ethanol, and would allow Japan to reduce its CO_2 emissions by around 4.20 million tons on a LCA basis (from well to wheel).

(2) CO_2 reductions and its cost and benefits

To introduce ethanol-blended gasoline would cost some ¥90 billion for E-3 (about 1.80 million KL) and as much as about ¥120 billion for ETBE-7. Because the ethanol price is closely linked to the crude oil and sugar prices, CO_2 reduction cost may vary greatly depending on the volatility of the prices. With major parameters assumed at current levels, namely crude oil priced at $60/bbl, sugar priced at ¢15/lb, tariffs set at 23.8% and gasoline tax set at ¥53.8, the price of ethanol-blended gasoline (E-3) posted at service stations will go up by ¥1.4/liter. This puts the CO_2 reduction cost at an estimated some $190/ton, several times more expensive than the EU carbon price set for its emissions trading (around $20~30/ton).

In fuel quality terms, ETBE-7, blended at refineries, is believed to be less problematic. However, if the entire amount of domestic gasoline is put into ethanol-blended gasoline with ETBE-7 alone, its production requires massive imports of butane as feedstock on top of the use of refinery's byproducts.

4. Outstanding issues for ethanol introduction

Introduction of ethanol-blended gasoline, which is very significant as a means to help CO_2 reductions, still faces many outstanding issues. Major ones are described below:

(1) Sustainable supplies

a. Domestic supply potential at present

The calculation results put the limit of Japan's ethanol production at about a million KL/year on the precondition that ethanol would be made from food crops grown in idle farming lands at home. Moreover, in reflection of the high feedstock cost in Japan, the cost of domestic ethanol production is found to be higher by several times or more than abroad.

From now on, to push the cost of energy crops down essentially requires extensive-farming management with flat arable land. It means Japan could hardly establish a domestic ethanol supply-chain as long as her agricultural system remains unchanged.

b. Ethanol supply capacity from Brazil

In Brazil, projects are now under way to expand shipping capacity, which include construction of a new pipeline and shipping terminal. These infrastructure projects, if they make favorable progress, are believed to be helpful in securing constant shipments to Japan. However, there is a problem not to readily solvable. That is, since there are few tankers specifically designed for ethanol transport right now, ethanol tankers have to be newly built, but given the worldwide tanker construction boom these days, it won't be before 2010 that the shipbuilding industry could initiate ethanol tanker construction.

Also, because Japan-bound exports are worried about being constrained by such factors as ① rivalry with EU/US-bound exports, ② poor harvests attributable to unseasonable weather, and ③ ethanol production undermined by rising food prices like sugar, Japan is required to take some response measures, such as signing long-term sales contracts, expanding/upgrading stockpiling facilities, and having flexibility in varying ethanol blends depending on feedstock availability.

On these accounts, it is pragmatic for Japan to consider introduction of ethanol of as much as about 1.80 million KL for around 3% blending as a yardstick.

c. Conflicts with food requirements and commitments to biotechnology

The world population is projected to reach some 9 billion by 2050 (a U.N. forecast in 2004), up from about 6.5 billion today, and likely to cause food demand to surge. This, combined with mounting ethanol demand, may result in a deficiency of arable land to grow crops, whereby tightening supply is feared.

As a result, it is essential to make ethanol not from food crops, but a cellulose-based feedstock that does not conflict with food and/or feed uses.

(2) Impacts on environment

Ethanol, positioned as carbon neutral, plays a key role in CO_2 reductions. Even so, there are problems peculiar to biomass production such as water resources, disappearing forests (lands) and genetic modification, so this process too has aspects not necessarily thought of as "environment-friendly." Although some of them are not directly related to ethanol production or hardly verifiable in scientific or quantitative terms, these issues should be given full consideration.

a. Water resources and soil problems

To grow sugar cane in Brazil, most of its farming lands require no irrigation (with annual rainfalls outstripping 1,200mm). Growing energy crops in general, however, involves agricultural irrigation that conflicts with living and industrial water needs. From the global perspectives, 70% of the intake is destined to agriculture, 20% to industrial activity and 10% to living needs, with a gradually increasing weight claimed by the last two these days.

What's more, the world's cultivated areas for cereals have kept shrinking in the past 30 years. Food output increases are attributable to better production per unit area (yields). To increase the yields, on top of variety improvements and irrigation, fertilizers have been input in large quantities, which is warned to make soil deteriorated and runoff-prone.

b. Disappearing forests

Due to such activities as food crop cultivation and mine development, the area of forests (CO_2 sinks) has been depleting worldwide. Given that forests are cleared to grow energy crops in some cases, the use of biomass involves an aspect not necessarily counted as carbon neutral.

c. Genetic modification

Plants of a high-yield type, if introduced by virtue of genetic modification, could increase biofuel output. But, it is pointed out that their presence can cause changes to nutrients within soils, carbon circulation and nitrogen circulation. Also, there is an argument that warns of adverse impacts on the ecosystem overall.

(3) Cost and benefits

① Ethanol production cost

The cost of ethanol production, the cheapest in Brazil (sugar cane used as a feedstock) at about ￠30/liter, is much lower than the ¥100/liter in Japan where ethanol is made from confectionery-making rice and the like. A recently commissioned demonstration plant, designed to make cellulose-based ethanol from demolition waste, reportedly marked a production cost of as high as a few hundred yen per liter, which suggests a number of challenges to face before commercialization.

② National consensus-building on the extra cost burden

The extra cost incurred in ethanol introduction (imports from Brazil) for producing blended gasoline amounts to some ¥90 billion when E-3 is deployed nationwide. Dividing the ¥90-billion extra cost by Japan's total gasoline demand (60.00 million KL) results in a higher gasoline cost by about ¥1.4/liter. Given that CO_2 reductions total some 4.20 million tons on a LCA basis (about 5.00 million tons on a national basis), the cost of CO_2 turns to be $190/ton, several times higher than the EU carbon price level.

(4) Others

① Clear-cut objectives of introduction

For Japan the objectives of having ethanol mixed with gasoline are twofold: ① CO_2 reductions and ② oil substitution (energy security). Ethanol will surely prompt oil substitution and leads to diversification of Japan's energy procurement sources, but, in the sense that Japan remains fully dependent on imports from overseas without any choices for the time being, there are few hopes for ethanol introduction to help alleviate Japan's reliance on overseas energy. What is more, the likelihood is that ethanol won't have enough potential to fully replace petroleum fuel consumption of the current size even in the years ahead, that is, the role of ethanol will be limited to replacing part of the petroleum fuels. For these reasons, while strengthening the ties with ethanol suppliers and attempting diversification of procurement sources, Japan is required to keep steadily committing to various measures to ensure stable energy supplies and energy security.

② Need for a well-balanced choice

From the standpoint of CO_2 reductions, ethanol is counted as a pragmatic option with such advantages as ① being a liquid energy at normal temperature, ② usable with conventional infrastructure, and ③more convenient and safer than other forms of new energy. Yet, there are a variety of CO_2-cutting options, from hybrid (incl. electric) vehicles to the diesel shift, all expected to be upgraded by technology advances ahead. Thus, Japan needs to consider a well-balanced introduction of ethanol by taking such factors as cost and benefits into consideration.

③ Outstanding issues for increasing domestic supply potential

Ethanol imports from overseas are advantageous in price competitiveness but constrained by a limited number of supply sources, poorly-installed transport infrastructure and, therefore, need to be complemented by increasing Japan's supply capacity at home.

From the viewpoint of CO_2 reduction, among others, biofuels of the so-called "locally-produced-and-locally-consumed" type, characterized by proximity between producing and consuming areas and limited energy losses, are believed to offer a basic model for this sort of fuel. Namely, in hopes to ensure adequate quantities and avoid conflicts with food uses, Japan is required to maintain an adequate balance between ethanol imports and domestic supplies through commitments to (i) reducing the cost to grow energy crops, and (ii) developing home-grown cellulose-based ethanol, or butanol (rather free from two-phase separation when moisture gets mixed).

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