

New Year Special 2019

Former astronaut hopeful for commercial space travel

The year 2019 marks 50 years since the first humans landed on the moon in 1969 as part of NASA's Apollo 11 lunar mission. In an interview with Managing Editor **Sayuri Daimon**, former Japanese astronaut Naoko Yamazaki shares her experience in space in 2010 and her views on space development in the coming years.

Former astronaut Naoko Yamazaki hopes to open Asia's first spaceport, which will serve as a hub for space planes for travelers, in Japan as early as 2021. She believes that a new age of space tourism where ordinary people, not only astronauts, will be able to travel beyond Earth is just around the corner.

In July, she co-founded the Space Port Japan Association, an organization to support efforts to open spaceports in Japan through collaboration with companies, groups and government institutions. Member companies include Airbus Japan K.K., ANA Holdings Inc., Marubeni Corp., Mitsui Fudosan Co. and SKY Perfect JSAT Corp.

"There are rocket launching sites in Japan, but what we are envisioning is a spaceport where tourists will be able to leave for space, just like hopping onto an airplane to travel abroad, and return to Earth," Yamazaki, who is one of 11 Japanese astronauts who have been to space, told The Japan Times in a recent interview.

Although such spacecraft is still under development, Virgin Galactic, a spaceflight company under Richard Branson's Virgin Atlantic group, has succeeded as the fourth spaceflight experiment aiming to operate commercial spaceflight in the future, she said.

"A commercial space travel service will soon start in the United States and if that happens, there will be a move to open spaceports in other countries. So we'd like to create Asia's first spaceport in Japan," said Yamazaki, 48, who now serves as the organization's representative director, adding that Virgin Galactic is likely to obtain approval from the U.S. Federal Aviation Administration as early as this year.

To qualify as a spaceport, a facility has to have a runway of 3,000 meters or more, the ability to store fuel for space planes and hangers for maintenance. This means most existing international airports can be converted to spaceports.

But to realize such space travel, Yamazaki said Japan lacks a legal framework to enable

manned spaceflight as existing laws only cover unmanned space probes. The country also needs to scrutinize safety and costs involved in such space travel.

"People who go to space will be different from passengers on airplanes. They must agree on the mission and participate based on the principle of self-responsibility. If people who are not astronauts are to participate in such spaceflights, we need to drastically improve the safety of those commercial operations," she said.

Yamazaki is the second Japanese female and Japan's first mother to go into space. In 1999, she joined the National Space Development Agency of Japan, currently the Japan Aerospace Exploration Agency, and participated in an International Space Station (ISS) assembly and resupply mission aboard the Space Shuttle Discovery in April 2010.

"To be an astronaut was my dream from my childhood," Yamazaki said. She was a girl who liked to stargaze and loved the TV anime series "Uchu Senkan Yamato" ("Space Battleship Yamato"), which became the TV animation series "Star Blazers" in the U.S. in the late 1970s.

When she was in junior high school, she saw the Space Shuttle Challenger disaster on TV, which broke apart 73 seconds into its flight, killing all seven crew members, in 1986. Though it came as a shock to the teenager, she realized at that time that space travel is not something that only exists in science fiction, and she eventually felt that she wanted to fulfill the mission of those who died in the accident.

However, it took 11 years before she was selected as an astronaut candidate to go into space.

She had to go through an extensive training program to prepare for her space mission, and she said 90 percent of the training was how to deal with unexpected accidents.

One part of the program was survival training in Russia during a bitterly cold winter on the assumption that a Russian Soyuz spacecraft had landed in a snowy field 100 kilometers away from the planned landing site.



"Under such circumstances, a rescue team would not be able to reach us quickly, and we had to survive for three days with just items from the spacecraft," Yamazaki said.

Using an axe from the Soyuz capsule, Yamazaki and her fellow astronauts chopped wood and made a small fire. They were also told not to consume any food on the first day as they only had three days worth of food and they might have to survive for longer. The temperature was about minus 20 degrees Celsius and it was freezing cold, she said.

Another requirement for astronauts was to swim at least 75 meters while fully clothed and tread water for 10 minutes while also clothed.

Yamazaki said that she didn't have any problems at all during the training and in space as a female astronaut, but as a mother, how to manage astronaut training and child-rearing could sometimes be difficult.

"I had to get a lot of support from my husband, colleagues and friends in the neighborhood, as well as people in JAXA and NASA

to take care of my daughter," she said, adding that it would not have been possible without their support. Thanks to NASA's family support program, she often used their consulting service to discuss family-related issues.

After such a lengthy training period, her longtime dream finally came true on April 5, 2010.

Asked how she felt when she left the Earth, she said it only took eight and a half minutes after launch to reach space.

"As soon as we reached space, I looked through the window and saw the Earth shining," she said. "It was blue and shining, and I felt like the Earth itself was alive. I could see blue in the ocean in contrast with very white clouds during the day, and they shone more in the sunlight. It was more beautiful than I had imagined."

During the 15 days in space, her main job was to send necessary supplies to the ISS, which was nearing completion. She operated the robotic arms to install the logistics module called Leonardo carried on the space shuttle. After installation, she delivered equipment for experiments to the station.

She said the space shuttle orbits the Earth every 90 minutes.

"You see the sunrise and sunset 16 times each day, and it was hard to keep track of



Astronauts Naoko Yamazaki and Satoshi Furukawa inside the Kibo laboratory at the International Space Station in April 2010. Top left: Naoko Yamazaki after her interview at The Japan Times in Tokyo on Dec. 14, 2018. NASA, JAPAN AEROSPACE EXPLORATION AGENCY VIA KYODO / SATOKO KAWASAKI

time," the former astronaut said.

Yamazaki, who is now involved in policy-making as a member of the Cabinet Office's Space Policy Committee, said space development activities by Japan will further increase this year and beyond.

In 2017, the Japanese government adopted a policy package "Space Industry Vision 2030," in which Japan aims to double the market scale of the domestic space industry by as early as the 2030s.

Yamazaki said compared to other countries, Japan has comprehensive strength in space development with its advanced rocket launching technology, experience in sending astronauts to the ISS for long periods and space probes like the Hayabusa2, which is an asteroid sample-return mission operated by JAXA.

The latest success in bringing back experiment results from the ISS using a capsule ejected from space cargo vessel Konotori

was also a significant step for Japan's space industry, she said.

"If we can apply this technology to a larger manned mission, this may enable us to send people to space and bring them back to Earth," she said.

The U.S., Russia and China already have such technology to collect individuals and objects from Earth's orbit and send them back to Earth.

"But it is only Lockheed Martin Corp. and Japan that have the ability to collect objects from the moon, Mars and asteroids beyond the Earth's orbit, and that's why this Japanese technology stands out," she said.

Yamazaki hopes that more and more companies and people will be able to utilize space and its assets such as images and data captured by satellites in the future.

"We are now exchanging opinions with people in different industries, including those in agriculture, distribution and marine products, where we didn't have close contact before," she said. "It's an exciting time."

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Global collaboration needed for future space missions **PAGE 9**

'You see the sunrise and sunset 16 times each day, and it was hard to keep track of time.'
NAOKO YAMAZAKI

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new year special

See, shop and play to start off 2019

Even in icy winds, going out in the Tokyo area around New Year's can warm people's hearts and light up their souls. Many events that can only be experienced at this time of the year will be happening across the city. Below are some places people of all ages can enjoy visiting whether on their own or with family or friends.

Hamarikyu Gardens

Hamarikyu Gardens offers a demonstration of falconry, Japanese traditional games and photography inside the Tsubame-no-ochaya (Swallow teahouse) on Jan. 2 and 3.

One-hour Japanese falconry performances will be held at the inner moat square twice a day from 11 a.m. and 2 p.m. The park was originally a field exclusively for the Tokugawa shogun's family to practice falconry. Guests can also enjoy aikido performances after each falconry session.

At the open square, both children and adults can learn about and enjoy playing traditional Japanese New Year's games such as *koma-mawashi* (top spinning) and *hanetsuki* (similar to badminton, but played with wooden paddles and no net) from 10 a.m. to 3:30 p.m.

Tsubame-no-ochaya was rebuilt in 2015 to look as it originally did when it was a resting room for shogun. Inside this small house, 24 pieces of *kugikakushi*, objects that conceal nailheads — in the motif of swallows — are used. It is usually closed to the public, but guests can enter the room to take photos from 10 a.m. to 3:30 p.m.

Admission to the gardens is ¥300 for adults, ¥150 for seniors aged 65 or over and free for middle school students who live in Tokyo and primary school students or younger. URL: <https://www.tokyo-park.or.jp/teien/en/>

Roppongi Hills

Roppongi Hills will be open from New Year's Day, offering a series of free events, seasonal restaurant menus, as well as sales at about 65 shops, mainly between Jan. 1 and 3.

On New Year's Day from noon to 3:00 p.m. at the Roppongi Hills Arena, there will be *wadaiko* drum performances, a *shishimai*



Traditional Japanese New Year's games such as *koma-mawashi* and *hanetsuki* can be enjoyed at Hamarikyu Garden's open square.

HAMA-RIKYU GARDENS

lion dance, and *furumaizake*, a New Year's celebratory sake that will be served to the first 200 guests.

On Jan. 2 and 3, people can enjoy trying traditional Japanese games such as *kendama* (cup and ball) and *otedama* beanbags as well as watching *wadaiko*, *shishimai* and *koto* performances, and a *koto* workshop between 11 a.m. and 4 p.m.

A winter sale at the Roppongi Hills complex will start from New Year's Day for two weeks at about 65 shops, offering discounts up to 70 percent. From 11 a.m. on New Year's Day until Jan. 3, about 55 shops will sell lucky bags called *fukubukuro*, each containing bargains on such items as clothes, food and other goods. URL: <http://www.roppongihills.com/en/>

Ueno Zoological Gardens

Ueno Zoo will be open from Jan. 2 and a variety of New Year events will be staged on Jan. 2 and 3.

Staff in animal costumes will welcome guests at the Benten Gate from 9:30 a.m. to 10 a.m. and the first 500 visitors on each day can receive a rice cracker with an illustration of a wild boar, the Chinese zodiac animal for 2019. A *shishimai* lion dance will proceed through the zoo from 11 a.m. to noon.

In front of the five-storied pagoda in the east garden, 200 *ema* plaques (traditional Shinto tablets made of wood to write wishes on) are available for guests to make original *ema* with zodiac animal stamps from the zoo, from 2:30 p.m. to 3:30 p.m.

Admission for those aged between 16 and 64 is ¥600, ¥300 for seniors (65 and above), and ¥200 for students aged 13, 14 and 15. Children aged under 12 are free of charge. URL: <http://www.tokyo-zoo.net/english/ueno/index.html>

Shibamata

Shibamata is a nostalgic neighborhood in Kat-

sushika Ward on the eastern end of Tokyo. The area is best known as the setting for a famous Japanese film series, "Otoko wa Tsurai Yo" ("It's tough being a man") directed by Yoji Yamada.

It is the hometown of Tora-san, the main character of the movies who is a warm-hearted, lovable vagabond, always helping others but unlucky in love. The streetscape is preserved just the way it was in the long-running movie series that started in 1969, as if Tora-san was about to storm out of his old house at any second.

Along the main pedestrian shopping street that leads to Taishakuten Temple, many stalls will be set up to welcome visitors from New Year's Day to Jan. 3, and the local stores that remind one of Tora-san's world, as well as Taishakuten Temple and the Tora-san Museum, will also be open from New Year's Day. URL: https://sp.jorudan.co.jp/newyear/spot_0045.html

Traditional activities to ring in the new year

Shogatsu, or New Year's holidays, are a special time for Japanese, who typically revisit and take part in long-standing traditions. It's a time when those who left their hometowns go back to visit their families, invite relatives and friends to their homes and wear kimono. It's also a time for foreigners spending the holidays in Japan to get a taste of the country's traditions. Below are some of the traditions Japanese participate in over the New Year's holidays.



This *kakizome* calligraphy shows the word "yume," which means "dream." GETTY IMAGES

Kakizome

Kakizome, the direct translation of which is "first writing," is the first calligraphy written in the new year, typically on Jan. 2. Jan. 2 was traditionally the first day for people such as farmers, merchants and others to go back to work and *kakizome* is said to be in line with this. In traditional practice, *kakizome* are burned at a *dondo yaki*, or bonfire, where *kakizome*, *shimenawa* (rice straw ropes), *kado-matsu* (bamboo and pine decorations) and other items unique to *shogatsu* are burned around Jan. 15.

However, writing was not for everybody until the Edo Period (1603–1868) when ordinary people began learning writing, reading and mathematics. At *terakoya* (a term for schools in the Edo Period), children first learned calligraphy and thus performed *kakizome*, and schools in the Meiji Era (1868–1912) and later eras carried on this custom.

In earlier years, educated adults used to write ancient Chinese poems with many kanji characters for their *kakizome*. Nowadays, writing just a few kanji is the common form of *kakizome*, but not many adults engage in it.

However, most Japanese schools, from elementary through high school, still teach calligraphy and *kakizome* is often homework during the winter break.

Every year on Jan. 5, some 3,000 calligraphers gather at the Nippon Budokan in Tokyo's Chiyoda Ward for a *kakizome* event.

Fukuwarai

Fukuwarai, a Japanese word combining "luck" and "laughter," is a game played typically during the o-*shogatsu* period. *Fukuwarai* players don blindfolds or close their eyes and put paper facial feature cutouts — eyes, eyebrows, nose, mouth and so on — onto a blank paper face.

The resulting face with the features randomly placed in the wrong places elicits laughter from those playing the game.

The face used for *fukuwarai* is typically called *okame* or *otafuku*, a woman with puffy cheeks — a look that was considered the epitome of beauty in medieval Japan, but comical today.

The origin of *fukuwarai* is unclear, but it is said that people began playing it in the late Edo Period and it became popular o-*shogatsu* entertainment during the Meiji Era. These days, with smaller households, grandparents living apart from their children and the emergence of modern board and video games, *fukuwarai* has fallen out of favor.

Fukuwarai is considered a lucky game because it is played by family members and makes them laugh during o-*shogatsu*. Also, Japanese associate the game with a proverb, "*Warau kado niwa fuku kitaru*" ("Luck comes to a house with lots of laughter") as the game and the proverb both have the kanji character "*fuku*" (luck) in common.



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new year special

Global collaboration needed for future space missions

Combining homegrown technology with that of other nations may offer expanded exploration

KYODO

Japan is launching multiple missions to explore the mysteries of the solar system in the coming years, joining hands with the European Union and countries such as India to compete with space superpowers such as the United States and Russia.

The ultimate goal of space exploration is "to expand the areas of activities for humans and find another habitable planet. I believe there is a possibility that we can colonize Mars," said Hitoshi Kuninaka, a vice president of the Japan Aerospace Exploration Agency (JAXA).

In 2018, Japan made history by landing two small rovers from the space probe Hayabusa2 on the surface of an asteroid 300 million kilometers from Earth. Hayabusa2's touchdown on the Ryugu asteroid is expected in late January this year.

The probe's aim is to collect a sample of sand on the asteroid that scientists believe could include some of the "raw materials" of the stars. This is based on the fact there is no atmosphere on the asteroid so its surface is thought to have remained almost unchanged since the birth of the solar system.

In October, the Japanese space agency worked with its European counterpart and successfully launched a spacecraft as part of efforts to explore Mercury. The probe is now on a 9 billion-kilometer voyage in space that will take seven years to complete.

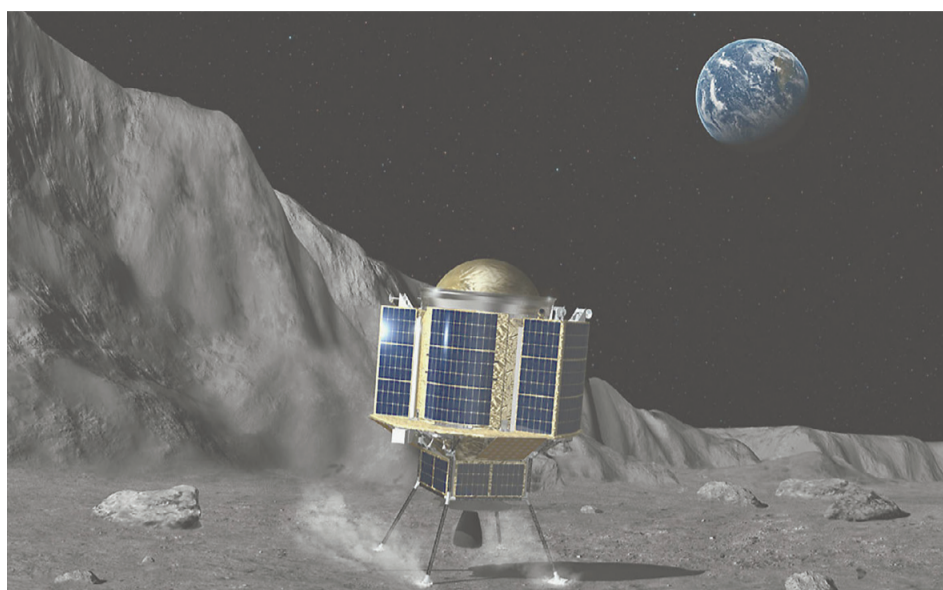
The Mercury project is aimed at observing the planet's atmosphere, magnetic field and surface to shed light on how the planet was formed.

"If we can compare Earth to Mercury, which has an environment inhospitable to life, we may discover the prerequisites for life to start," said Go Murakami, assistant professor at JAXA.

In fiscal 2021, Japan plans to launch DESTINY+ (Destiny Plus) to observe dust in space that delivered organisms to Earth. JUICE, a craft that will orbit Jupiter and its moons, and MMX, designed to bring back materials from a Mars moon, are slated for launch in fiscal 2022 and 2024, respectively.

Though contributions made by Hayabusa2 and other missions last year have given momentum to Japan's space exploration, the country went through a series of bitter failures in the late 1990s and early 2000s. Its first Mars explorer was trouble-ridden and could not enter the planet's orbit, while a Japanese Venus explorer also failed its first attempt to enter orbit and took another five years to get back on course. In the meantime, China launched a probe to the moon and India to Mars, leaving Japan lagging behind.

Following these failures, Japanese researchers have worked hard to improve technologies. In 2010, Hayabusa2's predecessor, Hayabusa, returned to Earth with surface samples from an asteroid for the first time ever. This paved the way for more missions.



An illustration of Japan's Smart Lander for Investigating the Moon, or SLIM. The moon lander is scheduled to launch in fiscal 2021. COURTESY OF AKIHIRO IKESHITA VIA KYODO

Space missions require highly advanced technologies and a massive amount of funds, creating the need for more international collaboration. Japan has been exploring ways to work together with different partners, rather than just following the United States.

Johann-Dietrich Wörner, director general of the European Space Agency (ESA) welcomed the collaboration with Japan on exploring Mercury, saying it is very valuable. Japan has also decided to work with India to study ice on the moon, said Hiroshi Sasaki, head of the JAXA Space Exploration Center.

Yet the competition is growing fierce. The moon, some 380,000 kilometers away

from Earth, has been studied by researchers worldwide, especially since the 1969 Apollo 11 moon landing. After 50 years, the moon is now attracting renewed attention for research since the possibility has emerged that the ice found on both its south and north poles can be used as fuel and energy.

"China in particular is accelerating its efforts to explore the moon," said Atsushi Uchida, a researcher at the Mitsubishi Research Institute.

It is thought the ice on the south and north poles of the moon can be used as fuels for rockets after being broken down into hydrogen and oxygen. It could also be utilized for

drinking water on a future lunar base.

While countries such as the United States, Russia, China, India and South Korea, as well as the European Union, are attempting to launch a lander dubbed SLIM in fiscal 2021.

The aim is to establish an accurate landing technology, so a lander can touch down at a location where solar cells can get sufficient sunlight. SLIM is expected to be able to check real-time images from a camera against a map of the surface of the moon, enabling the lander to self-estimate its location.

Researchers aim to establish technology that enables the lander to land at a certain location with an accuracy of hundreds of meters as a margin for error. The United States has already succeeded in landing to an accuracy of several to a dozen kilometers.

"We are aiming for an accuracy that has never been achieved by anyone," said Shin-ichiro Sakai, associate professor at JAXA.

MMX, a space probe set to start traveling to one of Mars' moons in about five years, will collect a sample of rock there and bring it back to Earth. Researchers say that by analyzing its composition, they could estimate where the moon was formed.

Mars is known to have traces of water, but it remains a mystery if a large amount of water could exist in liquid form on a planet that has such a thin atmosphere that it would be unable to retain water vaporized by the heat of the sun.

If MMX research results show that the moon was likely formed in a distant location with lower temperatures where water would have existed as ice before traveling to

its current position, it would suggest the possibility that another astral body containing ice, similarly from far away, may have come into collision with Mars, supplying water to it. It could eventually explain why Earth, which is close to Mars on a galactic level, has water, according to researchers.

MIO, a probe developed in a joint project between JAXA and ESA, will observe the weak magnetic field that covers Mercury. The idea is to understand how strong a magnetic field needs to be for life to exist by comparing Mercury and Earth. "If we can figure out what the prerequisites are for life to exist, we will also know what we should prepare for when humankind make it to space in the remote future," said Ichiro Yoshikawa, professor at the University of Tokyo.

JAXA's Kuninaka said that Japan's exploration of Venus has made progress, while its study on Mercury in collaboration with Europe has seen a good start. He expects further progress in the exploration of the solar system, including Mercury and Jupiter, over the coming decade.

The most recent challenge, he added, is to "establish technologies to safely land on the moon or Mars," where the gravity is more powerful than on asteroids, making it harder to approach and land.

In the 2030s, one of Japan's goals in space is to study Saturn, said Kuninaka.

"It takes longer to get there, while there is less sunlight to generate electricity for communication and observation. So we need to establish an energy-saving technology, which I believe will also help our lives on Earth," he said.

Hydrogen touted as clean energy

Producing only steam and water, fuel offers power alternative

KYODO

As the world tackles global warming, hydrogen has gained attention as a clean-energy alternative to earth-polluting fossil fuels.

Some hydrogen-powered cars and buses, which do not emit carbon dioxide, are already on public roads, and the government is hoping to display its technology by using hydrogen as a fuel for the Olympic torch and a power source for the athletes village for the 2020 Olympic and Paralympic Games in Tokyo.

Hydrogen, which does not exist on Earth as a gas, has the advantage of being produced from various energy sources such as sunlight, biomass and petroleum. A large volume of hydrogen, when compressed, can be easily stored for long periods and transported over long distances. Hydrogen fuel cells generate electricity through chemical reaction with oxygen in the air, with water and heat as the only byproducts.

In September, the world's first passenger train powered by hydrogen fuel cells began operation in Germany. The zero-emission train, Coradia iLint, with a bright blue body painted with a motif of the chemical symbols H for hydrogen and O for oxygen, was developed by French rail manufacturer Alstom. "The emission-free drive technology of the Coradia iLint provides a climate-friendly alternative to conventional diesel trains, particularly on non-electrified lines," said

Bernd Althusmann, Lower Saxony's minister of economy and transport, in a statement to celebrate the train's world debut a day before the launch of its commercial service.

Two of the hydrogen trains, capable of maximum speeds of 140 kilometers per hour, entered service in Lower Saxony, northwestern Germany. They produce very little noise and have no smell of exhaust or diesel, emitting only steam and condensed water, according to Alstom.

Covering more than 40 percent of its total power generation with renewable energy sources, the state government decided to introduce the hydrogen-powered trains in anticipation of phasing out diesel trains within the next 30 years.

In Japan, the government adopted a basic hydrogen strategy in 2017, in consideration of the 2015 Paris climate accord obliging each signatory country to submit a progress report on cutting greenhouse gas emissions.

In the strategy to promote wider hydrogen use, Japan calls for global collaboration to lower costs and ensure stable supplies. In line with such policy, a range of verification tests of hydrogen fuel cells and hydrogen stations have been conducted nationwide in efforts to make better use of the technology.

Still reeling from the 2011 nuclear accident at the Fukushima No.1 nuclear power plant, Fukushima Prefecture is pinning its hopes on one of the world's largest hydrogen-producing plants under construction there as a push toward its reconstruction efforts.

On a hill facing the Pacific, the Fukushima Hydrogen Energy Research Field is scheduled to start trial runs soon after its completion in October and launch operations in July 2020 after final confirmation tests in

time for a plan to burn the Olympic torch during the Games with hydrogen produced in Fukushima.

It would be the first time for an Olympic torch to burn the environmentally friendly fuel.

The 10,000-kilowatt facility, sitting on grounds 10 times as large as the 47,000-square-meter Tokyo Dome, has many solar panels to generate electricity for producing up to 900 tons of hydrogen annually.

The site in the town of Namie, where the government's six-year evacuation order was lifted in March 2017, was planned for the construction of a nuclear power station by Tohoku Electric Power Co. The plan was abandoned due to the disaster and replaced by the hydrogen plant project.

"We are hoping to erase the negative image of the nuclear accident," a Namie town official said.

Hydrogen produced and stored at the facility will be used to power fuel cell vehicles and support factory operations. It will also be delivered to waterfront areas along Tokyo Bay by trailers for use as a power source at the Olympic athletes village.

Other research is also taking place at a water purification plant in Sendai, Miyagi Prefecture, to incorporate hydrogen into renewable energy systems.

As part of projects by the state-run New Energy and Industrial Technology Development Organization, the research involves a hybrid energy storage system, which makes hydrogen through the electrolysis of water using surplus electricity from solar power, to store the clean energy for future use.

The system is expected to make up for weaknesses in photovoltaic power genera-



A Fukuoka government official at one of the city's sewage treatment plants on Oct. 19, 2018. When processed, sewage can produce hydrogen. KYODO

tion, the output of which varies depending on the weather.

In the fall, Kyushu Electric Power Co. asked photovoltaic businesses to reduce their output for fear that the demand-and-supply balance might be disrupted due to surplus of electricity. Many of the businesses complied with the request.

"Excess electricity can be thrown away, but it can also be converted into hydrogen for long-term storage," said Makoto Tsuda, professor of electrical energy systems at Tohoku University. "The system will enhance the effective use of renewable energy," said Tsuda, who heads the ongoing research.

Elsewhere, the city of Fukuoka is carrying out a project to produce hydrogen with bio-

gas extracted from sewage sludge. The produced hydrogen is used for fuel cell vehicles.

Masaki Tajima, a research collaborator and professor of environmental energy at Tottori University of Environmental Studies, sees huge potential in utilizing sewage treatment plants.

"Sewage treatment plants across the nation have the potential to power up to 1.86 million fuel cell vehicles with hydrogen," Tajima said.

In this regard, hydrogen has a promising future as a key player in using renewable energy that would otherwise be wasted and as a clean-energy source itself, emitting no greenhouse gases when used. But challenges remain for hydrogen energy, mainly in the

high production cost, distribution and storage due to the current low use.

Producing hydrogen from fossil fuels is the most common and least expensive method, but results in CO2 emissions. Therefore, this method requires an improvement in the technology to collect and store CO2. Another common method of producing hydrogen is through the electrolysis of water, using electricity from solar and wind power, along with other renewable energy sources. But zero-emission electrolysis is expensive.

Experts say as an important energy carrier and a high-efficiency, pollution-free fuel, hydrogen requires further technology and infrastructure development to become more widely used in the future.

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new year special

Agriculture innovating to secure future

Farms rethinking hiring, benefits in bid to attract and retain employees

KYODO

Decades ago, small family operations dominated Japan's agriculture industry, but today, the gradual shift to large-scale farming is creating many new challenges.

Facing a labor shortage and a rapidly aging workforce, the industry is trying to make its business more attractive to newcomers, attempting to cast aside the deep-rooted image that farming is all hard work.

To bring in new blood, farms are reforming work practices, nurturing an entrepreneurial spirit, automating with robotic innovation and taking advantage of evolving information technology.

"I can take a day off, as well as a longer holiday, so it's like working at an ordinary company," said Shizuka Ninomiya, 24, who has worked for over a year at a tomato farm in Saitama Prefecture.

The farm is one of those run by Aeon Agri Create Co., based in Chiba Prefecture, that grows vegetables for retail giant Aeon Co., its holding company, and group stores.

In March, the company introduced a system to enable workers to flexibly arrange their work hours weeks or months in advance. For instance, workers can take more days off during a rainy week and make up the hours later when the weather improves.

The system aims to be flexible to take into account the fact that farmers are at the mercy of the weather.

According to the company, the total working hours of its employees fell by some 25 percent after the introduction of the system.

The company also offers employee benefits on par with those at the holding company and its employees can take child care leave, maternity leave and long paid holidays, according to a public relations official.

Ninomiya said she joined the company "because I want to continue farming long-term."

Yasuaki Fukunaga, president of Aeon Agri Create, said, "It's no good if only agriculture has a unique way of working."

"We should change how farmers work so that agriculture is a viable career option for young people," Fukunaga said, referring to the fact that farming is partly exempt from the Labor Standards Law, which is not applied in areas such as work hours and non-working days on farms.

The number of agricultural operations, including family and incorporated farms, fell from around 2 million in 2005 to about 1.37 million in 2015 and is expected to continue to decline, according to the Ministry of Agriculture, Forestry and Fisheries.

However, reflecting moves to consolidate abandoned land into existing working farms, the size of the area under cultivation per operation, as well as the cattle and pig head count reared per farm is trending upward. The number of agricultural corporations also increased from 19,000 in 2005 to 27,000 in 2015.

Still, the farming industry remains severely short-handed with people tending to shun agriculture as a career due to the assumed difficult working conditions.

In Nagano Prefecture, more than 20 young aspiring farmers work at Topriver, a company that supports people who are attempting to start their own farming businesses. The company provides not only expertise in cultivating crops, but also managerial skills.

Topriver produces vegetables such as lettuce and cabbage for restaurants and conve-



Naoto Myokan who works at Topriver, a company which supports people who are attempting to start their own farming business, harvests lettuce in Nagano Prefecture on Oct. 13, 2018. Left: Yoshitaka Nakao of Nakao livestock farm in Mie Prefecture, holds a smartphone at his farm on Sept. 28, 2018. KYODO

nience stores.

The company divides its employees into several groups that are put in charge of their respective farms.

Employees learn farming practices in their first two years and afterward take responsibility for making a cultivation plan, as well as managing staff turnover, assignment and recruitment. After about six years, their training and preparation is complete.

Since the company was established in 2000, more than 30 workers have gone on to set up their own farms.

Naoto Myokan, 29, entered the company five years ago and plans to start his own farm next year in Nagano Prefecture.

Despite having no experience in the industry, Myokan pursued farming in order to fulfill his dream of running a company. He said at the start, that he was worried about whether or not he could make a living.

But, by gaining experience, Myokan said he realized he can turn a profit by using the experience gained at Topriver.

"Institutional farming will replace family-run agriculture in the future," Topriver President Hideki Shimazaki said. "It's important for the managers of farming entities to consider how to hire and cultivate both full- and

part-time employees."

Efforts to utilize advanced technology to reduce farmers' workload are also underway.

An Utsunomiya University research team in Tochigi Prefecture has a robot under development that can pick strawberries off the plant without damaging them.

Masaru Kashiwazaki, associate professor of agricultural engineering, and other team members launched the program 10 years ago to enhance the commercial value of the industry in Tochigi, which produces the most strawberries in Japan.

Strawberries degrade when touched by human hands and lose their taste accordingly. A robot under development is designed to select ripe strawberries using a camera to judge their size and color, determine the position of their stems, pinch the stems with one of its arms, remove them from the plant without touching the fruit and place them in a container. This allows the fruit to be kept fresh longer and sold as a higher grade.

The team aims to put the robot into operation by 2022. Fruit quality is expected to significantly improve if strawberries are picked at night and immediately refrigerated.

Simple calculations estimate the technol-

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