In an area adjacent to Abu Dhabi International Airport, construction is underway of Masdar City, one of the world’s most advanced smart communities. It is a hugely ambitious project to create a city of the future in a desert where daytime temperatures can reach around 50°C. In this city of the future, EVs are under the control of an EV control center, the product of an EV pilot project launched by Masdar in collaboration with MHI in January 2017. The EVs are used for intra-urban transportation and also for travel to Abu Dhabi International Airport and neighboring areas.

**A Pioneer in Intra-Urban Transportation Infrastructure**

How did MHI come to be involved in the Masdar City transportation infrastructure project? Akihiko Tsuchida, General Manager of MHI Middle East, reflects on how it began: “MHI and Masdar first came to the table over an EDR (Enhanced Oil Recovery) project that used MHI’s CCS (Carbon Dioxide Capture and Storage) technology. However, the UAE — one of the world’s leading oil producers — is now rapidly moving toward greater diversification of its economy. As a state-owned enterprise whose goals include becoming a global hub for renewable energy and clean technologies, Masdar’s interest did not stop with the EDR project. “After the EDR project, Masdar became interested in MHI’s transportation infrastructure technology as well. We proposed our EV control center — an essential feature for creating sustainable cities that aims to achieve a low-carbon footprint — and it arrived to good fit with the orientation of the smart community that Masdar was working toward, and so the pilot project was adopted.”

**Three Months to Start of Service**

Excitement at the project’s adoption was tempered somewhat by an extraordinarily ambitious goal: the pilot operation was to begin in less than three months. To achieve this, the EV control center had to install a charging infrastructure and the communications system necessary to implement the EV control center. Moreover, as this was the UAE’s first official EV pilot project, there were numerous problems to overcome, including integration with existing infrastructure, leading to issues that would work in the intensely hot environment, as well as acquiring official registration to run the EVs, which were not available on the market in the Middle East, on public roads.

According to Kyoko Oshima, who oversees the wireless and electronic technologies, “MHI had already completed development of an invisible device used for communication between the EVs and the EV control center, but then came a change of plan to use smartphones, which were already in widespread use. The aim of this change was to build a user-friendly system that anyone could easily enjoy in the future. However, this meant we had to build a completely new system and that alone made the whole process a series of hurdles to overcome.”

Unexpected problems also arose getting the project underway. “One example was the installation of the mobile antennas to allow communication between the EVs and the EV control center. UAE has different environmental factors compared to Japan, such as the uniquely high temperatures and humidity, as well as the sand and dust. System adjustment for the local climate was a constant process of trial and error,” explains Masato Kato, who supervised equipment control.

Ahmed Aladzi, who coordinated the on-site construction, ran up against an unacceptable charging outlet type. “We had confirmed beforehand the type officially used in the UAE, but in practice there were multiple plug types in use, and they did not fit the cable outlets we had procured. In principle, it is not a good idea to use adapters for EV outlets due to high-voltage electrical current, but we could not delay the start of the test runs, so we made it through the period by continuously monitoring the adapters until we could replace them.”

Kentaro Kawaguchi from the Strategic Business Development Department says: “In a new field like smart communities, difficulties arise once product specifications do not yet exist. You have to start by defining exactly what it is you will be creating. You have to visualize what society will need when they operate the product and nail down the specifications with these assumptions in mind. It is astounding that we managed to make everything happen in less than three months.” This was how the first official EV pilot project in the Middle East came into existence.

**Secretary-General Ban Ki-moon and Chancellor Merkel Visit**

Completed with astonishing speed in time for the opening of the WFES, the EV control center is a pragmatic scheme that contributes to global environmental conservation, and it was received with great interest by the WFES attendees. The electricity in Masdar City is generated by photovoltaics and the goal is to build a smart community for its 40,000 residents and 50,000 commuters. It is a truly groundbreaking project, and the world leaders had lined up to tour the Masdar City, including Secretary-General Ban Ki-moon of the United Nations and Chancellor Angela Merkel from Germany.

Maki Kominato, in charge of the EV pilot project office in Masdar City says, “For us to meet the requirements, improvement is mandatory and we reflect the ideas and needs regarding the EV control center on a daily basis. As a result the number of users tripled in six months. At present, each vehicle travels around 100km per day, or approximately 2,000km per month. Yet so far we haven’t encountered any major problems. MHI’s EV control center is proving itself in the extreme climate here in Abu Dhabi.”

MHI is exploring various energy management technologies to make better smart communities. Already, in addition to demonstrating different types of energy management technology in Andalusia and Kyushu, discussions are getting underway with local government agencies in China and India. Through the EV pilot project in Masdar City, the world of smart communities has begun to transition from the conceptual stage to the realization stage, and MHI leads the field by a wide margin.
Most people associate turbo engines with high horsepower sports cars. However, the engines of most trucks, buses, construction machinery, generators and ships are also powered by turbochargers. The future development of car engines depends heavily on turbochargers. Turbochargers are essentially supercharging systems that efficiently burn fuel in a piston chamber by pumping large amounts of compressed air to the engine. As such, they are now attracting keen attention as formidable responses to current economic and environmental issues because of the increased engine power, improved fuel consumption and reduced emissions that they are capable of delivering in downsized engines.
The development of turbochargers faces never-ending challenges due to the vital role they play in defining engine performance. For example, developers of turbochargers for car engines are expected to satisfy strict criteria in terms of performance, quality, cost and delivery dates, while also liaising closely with the automakers during their engine development process. This also involves providing expert engineering support to enable them to meet their own customers’ demanding requirements regarding engine output characteristics and positioning within the vehicle. They must also have a flair for identifying the needs of their time as is evident in marine turbocharger (MET) development. This development attitude is epitomized by hybrid turbochargers that use engine exhaust gas to generate electricity and by VTI turbochargers that are fitted with an innovative variable mechanism.

PRODUCTS THAT DEFY EXPECTATIONS

Development and production of turbochargers require experience, resources and creativeness

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Exploiting craftsmanship of man and machine

With an annual production level of passenger car engine turbochargers in excess of 4.5 million units, accounting for more than 22% of the global market, MHI is aiming to capture the world’s top share. This growth has been supported by complete automation in the production of cartridges*, the core heart-like component of a turbocharger.

By deploying automated production lines at overseas plants and standardizing production techniques, MHI has created a global mass production structure that consistently delivers extremely high quality. At the other end of the spectrum, the production of huge marine turbochargers that can stretch beyond 3.5m requires elaborate craftsmanship that draws on the techniques and experience of experts. MHI’s unique harnessing of the creative capabilities of man and machine allows it to produce turbochargers of all sizes and for all purposes.

* The core portion of the turbocharger that houses the turbine rotor — with rotation powered by the engine’s waste heat, and the compressor wheel, which pressurizes the inflow air.

The labyrinth seal fins prevent gas from entering the turbine rotor. The fins, rotating at high speeds and temperatures, engage within the slightest clearance of less than 1mm. Experienced workers manage the assembly precision to 0.01mm levels, using special measuring tools and clearance gauges that they themselves have refined.

Nagasaki Shipyard & Machinery Works, Nagasaki Prefecture
High Hopes for Heightened Turbocharger Technology around the World

Turbochargers are assuming increasing significance at a time of mounting concern over environmental protection and energy conservation. The amplified power of turbo-fitted engines allows them to become more compact without diminishing basic engine performance. The current downsizing of turbochargers, particularly for engines of European cars, has been driven by reduced fuel consumption and the environmental benefits derived from the reduction in the amount of toxic exhaust gas. Although turbochargers have always been indispensable for marine diesel engines, the increased demand for fuel efficiency is also shining the spotlight on next-generation marine turbochargers that can deliver longer sailing distances. Furthermore, both the automotive and shipping industries are facing stricter environmental regulations. In the automotive industry, for example, it is generally believed that passenger cars not fitted with a turbocharger will fail to meet the next European emissions standard (Euro VII) for diesel vehicles that will be implemented by 2015. Turbochargers can only benefit from this backdrop of tightening regulations.

Turbochargers Continue MHI’s Vibrant Tradition of Reliability in Rotating Mechanisms

MHI boasts a lineup of turbochargers covering a wide variety of engines for passenger cars and commercial vehicles to ships and aircraft, with each one carrying its own history. However, the basic structure of turbochargers shares many similarities with the gas turbine and the jet engine, two products that belong to MHI’s realm of expertise. You only have to look at MHI’s aerodynamically designed turbine rotors and compressor wheels to realize that MHI has condensed its wealth of experience and knowledge of high-speed rotating machines into its turbochargers. The low incident rate of its turbochargers after they have been fitted in cars and ships provides further evidence of their quality. This quality is also validated by users’ high praise of the turbochargers. MHI’s tradition of reliability lives on.

Widening the Global Expansion of High-Quality Turbochargers

Turbochargers are global products with worldwide demand, and MHI’s turbochargers have seen remarkable growth in recent years. The client base for its turbochargers for car engines now extends to automakers in Europe, America and Asia, with foreign companies accounting for more than 80% of the demand. A global network of offices and production centers is essential for maintaining close cooperation with clients during the development process and for the fulfillment of just-in-time delivery and cost requirements. MHI has therefore set up production centers in the Netherlands (MEE), Thailand and China and also built a network of parts suppliers in peripheral regions. This amounts to a global production and distribution structure capable of consistently delivering products of the same high quality as Japanese plants. With its marine turbochargers now being supplied to the top three manufacturers of marine diesel engines (including MHI’s UE engine), MHI has concluded licensed production agreements with major Korean companies in order to supply high-performance turbochargers created using Japanese technology. MHI is also dedicating itself to the development and production of ground-breaking higher value-added turbochargers, such as variable two-stage turbochargers for diesel engine cars that provide all-speed performance, and hybrid turbochargers that meet the growing demand for eco-ships in the shipping industry. These innovative products are expected to make significant contributions towards the creation of a more environmentally conscious and energy-saving society. MHI even hopes that the turbocharger itself accelerates the advent of a sustainable society.

CARVING OUT A BRIGHT FUTURE

The compressor wheel of the brand new MET53MA that rotates at high speeds. During sailing, it operates at 17,800 rpm; in other words, the leading edge of its blades maintains a speed of 480 meters/sec, surpassing the speed of sound. Nagasaki Shipyard & Machinery Works, Nagasaki Prefecture
As economies develop and standards of living improve, demand for electricity inevitably increases. This phenomenon is now causing major problems around the world, problems related to both energy resources and the environment. And while some power is generated from renewable energy sources, such as hydro, nuclear, wind, solar and geothermal, most is still generated using fossil fuels — coal, oil, and natural gas — all of which emit CO2 and thus contribute to global warming. Moreover, the supply of fossil fuels is limited: as the demand for electricity increases, the price of power generation systems must be operated efficiently. But it is also vital to secure fuel and accurately transmit power to areas where there is demand. Through the RMS, MHI can monitor peripheral areas, including fuel and transmission, as well as actual turbine operating conditions. If anomalous activity is detected, it is immediately reported and countermeasures are taken. At the heart of this system is a “spirit of good service,” which could be described as the Japanese virtue of heartfelt hospitality. European and American electric companies think highly of it, regarding such complete service as leading to more efficient operation and better reliability.

The gas turbines supplied to Tuas Power have a combustion temperature of 1,350°C class. MHI has already developed 1,500°C class turbines and is about to launch 1,600°C class turbines onto the market. Since there is a direct connection between increased combustion temperature and improved energy utilization efficiency, these advanced GTCC will help power companies operate even more efficiently, as well as promote the effective use of natural resources globally. Moreover, reduced CO2 and other emissions will prove useful in resolving global environmental issues. For these reasons too, MHI looks forward to further global adoption of the GTCC/LTSA business model.

Lau Tai Hwee, Message to MHI

Tuas Power has had a long and positive relationship with MHI in power generation, beginning with the decision to invest in an MHI gas turbine combined cycle (GTCC) power project in Singapore. MHI was selected based on the proven reliability of its generation equipment. When we first considered a GTCC system, MHI was very hands-on in providing us with technical information and helping us to solve specific problems. During the execution of the project, MHI’s team of experienced managers and engineers achieved on-schedule completion with high quality of work. After the plants commenced commercial operation, MHI has continued its strong support to us as an on-site resident engineer, and providing 24/7 remote monitoring service.

The GTCC system supplied by MHI has been in operation now for a decade and we have been very pleased with its performance — both in terms of its high energy utilization efficiency and actual operating conditions — and with MHI’s outstanding support. Reliability has proved to be above 99%, with very few accidental shutdowns. This is especially important for us because Singapore is an actively traded market where the price of electricity is set every 30 minutes, so any downtime costs money.

In the area of support, our needs have been comprehensively met by MHI’s Long Term Service Agreement (LTSA). Central to our operations is a remote monitoring system (RMS) that notifies us to take appropriate action in the event of a fault or any condition surrounding which to contact should an issue arise. Moreover, annual inspections and maintenance of gas turbine use handled by a team of MHI’s specialist engineers coordinated by the on-site resident engineer, working closely with engineers of Tuas Power. We are confident that this combination of RMS and on-site engineering process provides us with a very high level of reliability and reduced maintenance costs.

Moreover, in our current global warming need to be considered even in the face of rising demand for power in Singapore, and for this reason, Tuas Power is planning to increase its use of GTCC power plants. We are also looking forward to the emergence of new generation of GTCC that is able to operate with wider variations in gas composition and higher plant efficiency during both full load and part-load operation.

Lau Tai Hwee Senior Vice President Generation Business Tuas Power Generation Pte., Ltd.