

Mobility initiatives

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Abstract

It has been said for a long time that we have entered a once-in-a-hundred-years era of transformation. In this document, we will introduce what sort of thinking JATCO should adopt and what actions JATCO should take regarding mobility initiatives given this environment, and what sort of initiatives JATCO should implement based on such thinking.

1. Environmental changes and directionality aims of JATCO

In recent years, there has been demand globally for initiatives from the perspectives of environment, society, economy and companies to achieve a sustainable world. And in particular, it has become important for companies positioned in the manufacturing industry to take great responsibility for carbon neutrality and the circular economy.

Next, looking at the real world, individual trends are forming within each country/region due to moves to prioritize economics and materials/energy policies. And in the automobile market, in addition to electrification, there is a shift to new value such as the experience of using a vehicle rather than the vehicle itself (mobility hardware). Due to such environmental changes, we believe that JATCO has to respond to issues and needs such as the following:

- Contribution to sustainability
- Stable regional supply chains
- Creation of new values
- Electrification response

In response to these, we believe that it is necessary to take advantage of JATCO's strengths developed during the conventional era to address the social issues mentioned above and contribute to the automobile market as we look to the future (Fig. 1):

- Component and system designs
- Production engineering
- Global production and after-sales service

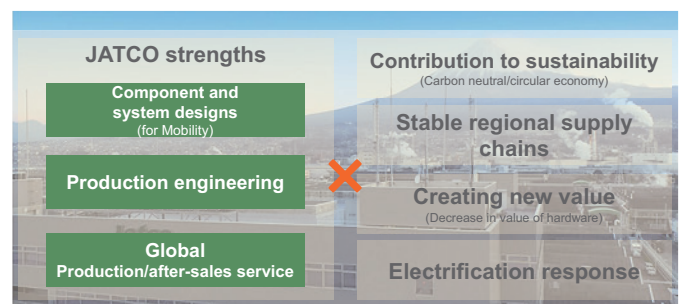


Fig. 1 Directionality aims of JATCO

2. ePT technology trends and initiatives

In the era of electrification in the automobile market, it is necessary not simply to replace the transmissions represented by CVTs with e-Axles and advance planning, development, production, and sales but to take advantage of the aforementioned strengths of JATCO to create new needed values. We will introduce several of these.

In the conventional era, to improve fuel efficiency, approaches such as transmission efficiency improvement and optimization of engine operating points have been realized by CVT. However, with an electric PT, the efficiency of an e-Axle itself is already high and there is no room for significant improvements.

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On the other hand, energy wasted as heat is considerable, and improvements in energy efficiency at the vehicle hierarchy level is important in order to efficiently use the limited electric energy stored in the battery and to extend the driving distance, which is a concern for electric vehicles.

Therefore, JATCO has expanded its technological development not only into the development of the e-Axle but also into the energy management field, which is positioned upstream in the V-process.

Focusing on the e-Axle, downsizing and weight reduction are still required as in the transmission era. Therefore, we are aiming at downsizing through higher motor rotation and higher reduction ratio using the gear technology developed by JATCO.

In this way, we have been making initiatives to improve competitiveness of the electric PT, including the vehicle hierarchy. However, with the decrease in the value of hardware itself, it is becoming important not only to sell out goods but also to expand into service businesses.

Therefore, we are also taking on challenges in new areas such as customer experience (CX), aiming at improvement of serviceability through utilization of market data, and user experience (UX) technology, where driver's conditions are detected and incorporated in driving performance.

3. New business initiatives

We have thus far focused on automobiles, but due to major changes in the environment, the value chain that was conventionally completed by automobiles alone has recently become part of a larger value chain (Fig. 2) such as Big Data and infrastructure in the name of mobility. And, in such a value chain, what kind of businesses JATCO takes on in this new value chain has become important.

On the other hand, when we jump into a new value chain, we must design the cycles of competencies and assets such as what are our strengths and where we should start to increase our strengths and continue to grow as mentioned above (Fig. 3).

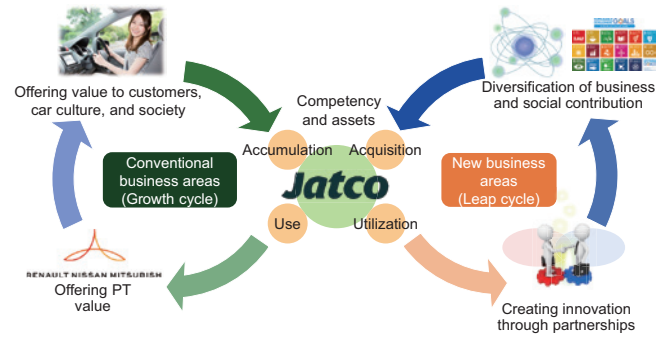


Fig. 3 Competency and asset cycle

In this way, it is important to design businesses that combine changes in the value chain with JATCO's competencies and assets and consider what business paths to take. Therefore, we will draw up visions for the future and business paths that JATCO envisions, such as the following.

- Realize clean energy and its supply to support life
- Realize environmentally friendly, comfortable, and safe mobility and movement
- Provide parts and systems that expand the possibilities of society in the future

Doing so, we will take on new business challenges that leverage our strengths (Fig. 4).

In terms of energy, it is the realization of wind power generation including the reuse of electric vehicle parts. In terms of mobility, it is equivalent to e-Axles of electric vehicles and drive units of electric bicycles. And, it is a form to offer parts and systems to realize them.

Next, we will cover individual products.



Fig. 2 Changes in value chains

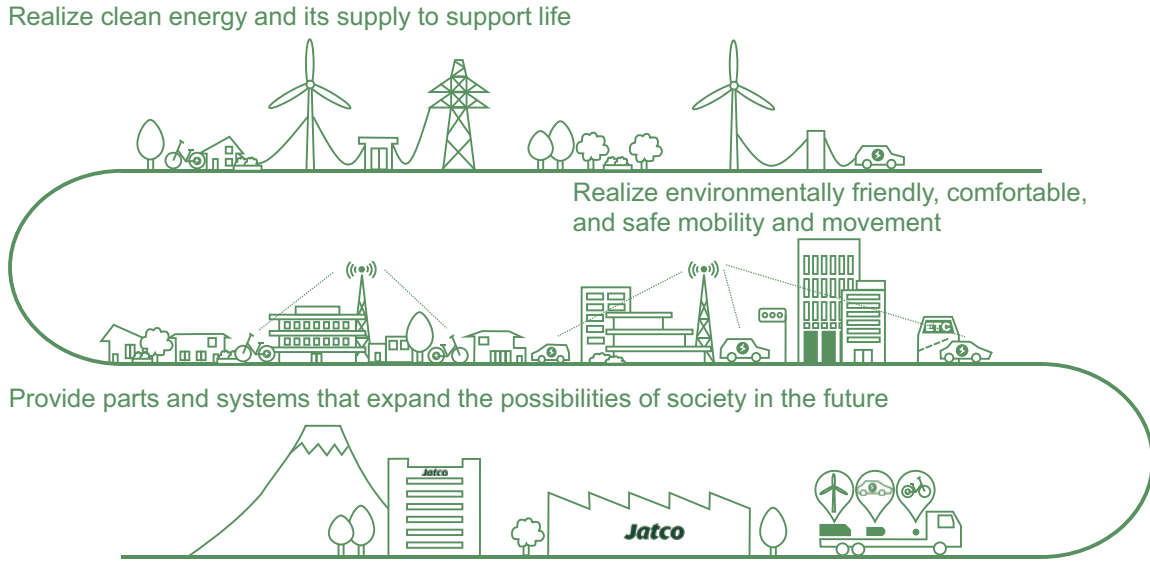


Fig. 4 JATCO's vision for business in the future

4. Mobility initiatives

4.1 Nacelles for medium-sized wind power generators

There is a movement of self-consumption of renewable energy mainly by RE100 member companies and local governments aiming at carbon neutrality. In addition, having experienced Japan's first prefecture-wide blackout due to the Hokkaido Eastern Iburi Earthquake that occurred on September 6, 2018, distributed power supplies have garnered attention from the viewpoint of regional disaster prevention and the rationalization of power transmission infrastructure for remote islands and depopulated areas. These power supplies are installed relatively close to the areas in which people live. Therefore, JATCO is developing a nacelle for a

medium-sized wind power generator which is expected to be positively accepted by society.

Business purpose and values

By combining motors of electric vehicle motors with gears (step-up gears) in which JATCO specializes, it is possible to repurpose these motors as generators for medium-sized wind power generators. Doing so helps realize wind power generators with lowers cost, greater reliability, and strong social acceptance. We will contribute to regional disaster prevention and carbon neutrality for companies and municipalities, mentioned above, and contribute to the circular economy by reusing parts from used electric vehicles (Fig. 5).

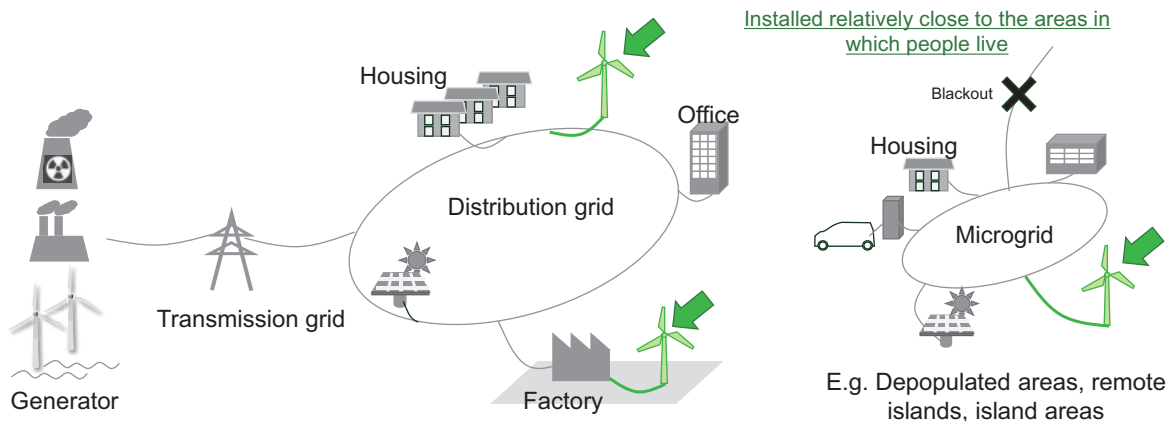


Fig. 5 Assumed markets

This business not only contributes to solving recent social issues but also expands the possibilities of mobility, our purpose.

Product overview (nacelle)

A wind power generator mainly consists of blades, a rotor, a nacelle, and a tower. Wind causes the blades to rotate the rotor, and the nacelle converts the rotation into electricity. JATCO is in charge of the nacelle.

A nacelle is composed of a main shaft which receives the rotor rotation, a step-up gear which transmits accelerated rotation to a generator, the generator which converts rotational energy into electricity, a main shaft brake which prevents rotation during maintenance, a yaw mechanism which changes the direction of the wind turbine according to the wind direction, and a nacelle base on which these components are placed.

The concept of this nacelle is cost reduction and ensuring high reliability by using automotive parts, and these are realized by repurposing electric vehicle motors as generators and adopting gears with high speed increase ratios developed by JATCO for wind power generators. In addition, automotive parts are planned to be used for generator cooling systems, brakes, etc., and used automotive parts are also planned to be used.

Current status and future prospects

We are currently working on verifications using prototype No. 1, which was built in March 2023 (Fig. 6). We are working to achieve further weight and cost reductions, with an aim to start sales in FY 2025. In the future, we aim to achieve sales in FY 2025 (start of new business) and implement field verification using a vending machine.

Unlike our previous product developments, this development will not be completed by the start of sales; verifications and development will be carried out on site and using actual machines, such as by acquiring data from the actual machines sold.



Fig. 6 Prototype No. 1

4.2 Unit for electric-assisted bicycle

Among the various forms of mobility that exist, electric-assisted bicycles are attracting attention as a mean to enable a wide range of users of all ages to travel relatively long distances with low CO₂ emissions relative to the distance traveled. JATCO is developing drive units and smartphone apps for electric-assisted bicycles.

Business purpose and values

An integrated unit that combines a motor and a transmission mechanism that utilizes JATCO's specialty gear and transmission technology will improve the design and convenience of electric-assisted bicycles. In addition, combining this with the use of a smartphone app will provide value in the form of joy from riding and safety.

This business aims to expand the scope of contributions JATCO's technology can make and create added value not only through hardware but also through software. In cooperation with Fuji City, through this business, we are also looking to take on the service business while contributing to solving local problems through the utilization of bicycles (Fig. 7).



Fig. 7 Creating new values through units (hardware) + software

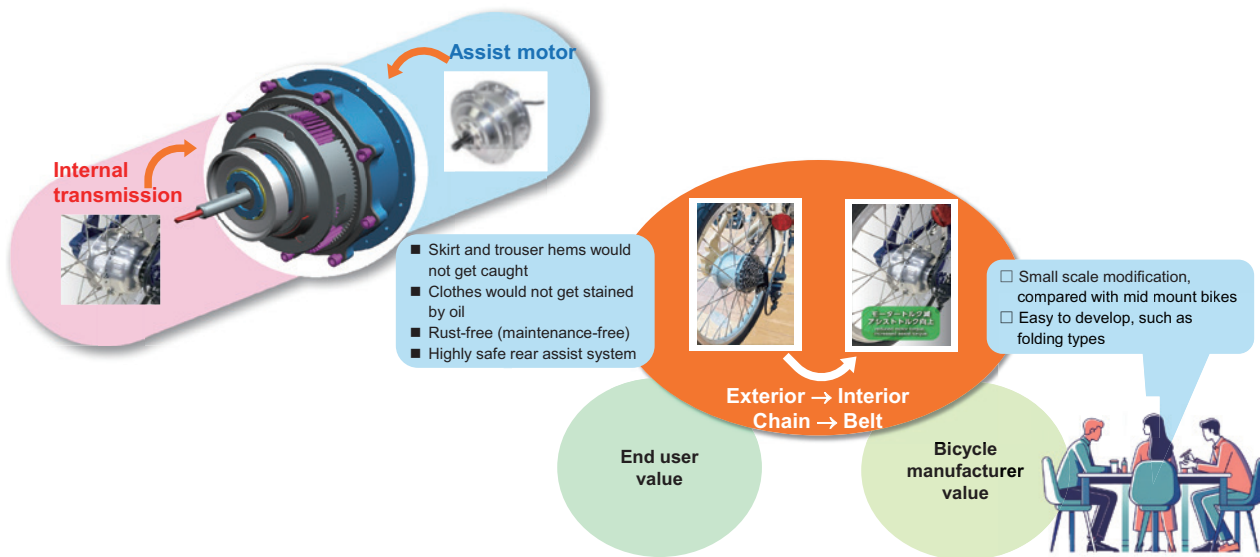


Fig. 8 Unit overview and customer values

Product overview (unit)

This product is a two-in-one unit which integrates the motor assist and transmission functions. An integrated unit with three speeds is an unprecedented industry first product. Since it is not necessary to mount the unit on a pedal shaft like conventional products making visible clearly around the pedal, it is possible to improve bicycle designs and to have the option of belt drive as well as chain drive, thereby meeting various user needs (Fig. 8).

Product overview (smartphone app)

In order to improve value through software, we are also developing apps for smartphones. As specific value improvements through apps, we have been developing products that lead to the values of pleasure, health, and safety for end users, such as the following:

- Ride comfort is adjustable according to preferences of the end users (function to adjust assist force)
- Fat burning mode setting (function to automatically adjust the assist force to make the value of the user's heart rate optimum for burning fat)
- Hazard alarms in areas where bicycle accidents occur frequently and at intersections with poor visibility (utilization of data in cooperation with local governments)

Added user value is created by combining not only the units (hardware) but also smartphone apps (software).

Current status and future prospects

At present, we are carrying out joint development of a unit while communicating with several customers in Japan and overseas. And regarding smartphone apps, we are crafting interfaces and functions required by customers jointly, and we plan to start businesses with these customers and launch them to the market by the end of FY 2024.

The specifications of the unit introduced in the Product Overview (Unit) are such that it is positioned to be an upfront market launch model, and as the first generation, to learn about the market. It can be mounted on bicycles with a wide rear frame, but it is too large to be mounted on city bicycles (so-called mamachari models). Therefore, we are also carrying out advance development of the second generation unit, which can be mounted on city bicycles. We will offer value to more users by integrating what we have learned through the market of the first generation to the second generation. We plan to launch the second generation to the market in FY 2026 or later.

4.3 Conversion EVs

Conversion EVs are expected to be an item that solves social problems such as resource circulation and decarbonization, which are requirements for a sustainable society. As an electric powertrain manufacturer, JATCO is also promoting studies for commercialization of conversion EVs.

Business purpose and values

This business is related to Contributing to a Sustainable Global Environment, one of JATCO's important issues (materiality). Conversion EVs realize reduced CO₂ emissions and the reuse of resources by modifying existing gasoline vehicles into electric vehicles. These initiatives are attracting attention as options that are environment friendly. Compared with the purchase of new EVs, they ensure improved performances while reducing costs. In Japan, the transition to a circular economy is under way based on the initiatives of the 3Rs (Reduce, Reuse, Recycle), which are essential for enhancing the sustainability of business activities of companies. And in Europe, job creation through stimulation of the maintenance, reuse, recycle, refurbish, repair, and used goods markets is garnering attention (Fig. 9).

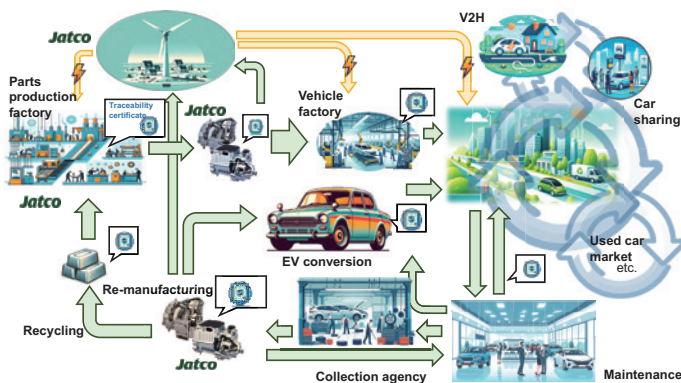


Fig. 9 Conceptual drawing of recycling-oriented society

Product overview

One of the features of JATCO's EV conversion unit is that it uses a transmission. By using a transmission, it is possible to generate higher torque with a smaller motor. This can reduce the use of rare metals and reduce geopolitical risks.

Current status and future prospects

Establishment of a growth-oriented, resource- autonomous economy is a major issue in achieving a circular economy, and ensuring feasibility of business is also an issue in initiatives related to conversion EVs. In particular, it is necessary to promote technological development, including services and software, as well as partner formation, because of the high costs required and the challenges of creating a sustainable market.

4.4 Wheelchair with transfer mechanism

The idea of a wheelchair with a transfer mechanism was conceived three years ago based on the theme of solutions to future social problems making use of JATCO's manufacturing capabilities and entry into industries outside the automobile industry. Up until now, through repeated principle prototyping, acquisition of VOC for actual nursing site, etc., we have been working toward commercialization.

Business purpose and values

The idea of this product was conceived based on a discussion on what to do with JATCO's manufacturing capabilities in the field of nursing given the aging society, which will accelerate at a greater rate going forward.

The hardest work in the nursing field is helping elderly individuals to move from a bed to a wheelchair and from a wheelchair to a bed. Because of this transfer work, more than 80% of caregivers are said to suffer from lower back pain. Sexual harassment is also a potential problem because of the transfer actions involved with holding the elderly person close to a worker's body (Fig. 10).

JATCO is working to realize nursing equipment which reduces mental and physical burdens on caregivers with these problems and which allows elderly individuals who use the equipment to entrust their bodies safely with comfort. This is done by utilizing our ability to improve, which has been developed at manufacturing sites, and the advanced control system used in CVT.



Fig. 10 Physical burden using transfer assistance

Source: Industrial safety information website (the Ministry of Health, Labour and Welfare)

Product overview

Wheelchair with a transfer mechanism is an innovative form of mobility in which the transfer and movement functions are packaged in one. This function lifts the waist of an elderly person who is sitting on the bed off the bed surface using the transfer mechanism in the front, and allows the elderly person to sit on the wheelchair by setting the seat surface of the chair. It is a form of mobility that makes movement in a wheelchair as is possible.

Regarding the transfer mechanism, by combining the motions of two actuators, a rising and sitting trajectory that reduces the physical burden on the elderly individual is derived, allowing for the trajectory to be controlled by a robot (Fig. 11).



Fig. 11 Transfer mechanism motions

Current status and future prospects

At present, the third generation prototype is being trialed by elderly individuals through the cooperation of a care facility in Fuji City, and the facility has also expressed their considerable hopes. However, there are many issues such as making it compact and reducing costs in order to actually use it.

We would like to focus on solving these problems and making our products better by incorporating the opinions of our customers. Prioritizing to bringing the products to market, we plan to launch them to the market in FY 2024.

4.5 Application to parts

JATCO has been working to develop not only electrified units but also parts targeting electrification.

Downsized 48V motor winding structure for an EV powertrain

Recent initiatives for carbon neutrality have increased the need for electrification of vehicles. At the same time, the increased cost of electric vehicles must be controlled.

When we consider the use of low voltage systems for cost reductions, a large current would be required to achieve the target outputs. In order to realize the high power and low voltage system, a 48V system was examined as an example.

However, as it is a low voltage system, sufficient attention is necessary for the winding wire structure of the motor, which can handle the large electric current required for the high motor outputs. In this development project, a motor parallel winding wire structure has been adopted in combination with the transmission, and by exerting sufficient suppression effect and suppressing motor enlargement, installation to the vehicle was made possible.

Development of steel materials and manufacturing methods for gear at high rotation conditions

Miniaturizing is required for e-Axles from the viewpoint of aerodynamic performance and collision safety to vehicles.

To miniaturize e-Axles, it is necessary to miniaturize the motors. Therefore, reduced torque as a result of miniaturization is compensated for by higher speed rotation to ensure output.

As the motor rotates at higher speeds, the reduction gears also rotate at higher speeds, which may result in insufficient lubrication and a poor lubrication environment. In a poor lubrication environment, sliding surface metal contact portions increase, meaning there is a risk of seizure occurring.

Therefore, we developed a seizure preventative method which is less expensive than the existing seizure resistance method.

We report specific cases as follows.

- 1)Development of a nacelle for a medium-sized wind power generator
- 2)Downsized 48V motor winding structure for an EV powertrain
- 3)Development of steel materials and manufacturing methods for gear usable at high rotation conditions

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