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METHODS OF CHARGING ELECTRICAL VEHICLES

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Abstract

The article analyzed the current situation of charging mobile devices in the world and the issues of wide introduction of charging stations in the conditions of the Republic of Uzbekistan. The possibility of creating an infrastructure for charging agricultural machinery in the field was considered. Appropriate calculations were made for the electrical parameters of the mini tractor. Examples of stationary and mobile options of charging stations based on renewable energy sources are given.

Key words: *electric transport, charging stations, charging methods, charging modes, infrastructure of charging stations, renewable energy, mobile power stations.*

Introduction. The economic potential of renewable energy sources is great, and their share in global energy consumption is increasing exponentially. The natural and climatic conditions of Uzbekistan allow maximum use of solar energy more than 300 days a year, the presence of large areas with constant wind blowing means that the use of solar and wind energy in our republic is promising. In this regard, the issues of ensuring a uniform approach to the application of tax legislation on the benefits provided, introducing a mechanism for identifying organizations specializing in the production of energy production devices from renewable sources, as well as including their products in the category of energy production devices from renewable sources are always in the eyes of the government.

With the increase in the share of electric vehicles in the agricultural sector, their charging infrastructure should also be developed in parallel. Along with the continuous improvement of accumulator batteries, the charging stations that are integrated with them are also improving. The main problem is that charging facilities are located in remote areas. The solution to this problem is the introduction of mobile power stations based on renewable energy sources for areas far from power grids[1].

Improvement of infrastructure. Improving the technologies for the development of accumulator batteries is very important, and many scientific institutions and laboratories in the world are conducting research on the solution of this problem. In general, in the developed countries of the world, the base of all the structural elements for creating the infrastructure of charging stations has been created, and there is currently no need for new developments[3]:

- Electricity;
- Charging stations;
- Space for charging vehicle;
- Direct charging station.

By now, mass opening of charging stations has begun in developed countries. With the emergence of fast charging technologies, the increase in battery capacity and the increase in the network of charging points, electric vehicles are creating an increasingly strong competitive environment for vehicles running on organic fuel in the near future.

Statement of the problem. In the conditions of the Republic of Uzbekistan, the work of introducing electric vehicles is currently in its initial period, and the work of transferring agricultural equipment to electric vehicles has not yet started at all. This situation does not meet the requirements of the present time for mastering new innovative technologies. In order to eliminate such negative indicators, it is necessary to determine the measures that should be implemented in 2023 for the transfer of agricultural machinery to electric operation, and to develop a plan for their systematic implementation on a scientific basis. In this regard, special attention should be paid to the implementation of fundamental, practical and innovative projects, project-design for the creation of electric agricultural machinery, direct production, organization of service services, training of skilled personnel[2].

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Methods. Types of electric vehicle charging. Currently, manufacturers are continuing their research on improving the technology of charging electric vehicles.

Electric vehicle charging can be done in one of four ways:

1. Using a normal 220 V socket.

2. From the household electrical network through which alternating current passes. This method is preferable to the previous one, because the cable purchased with the machine has special protection.

3. Three-phase charging, which is the safest. Its main advantage is the ability to fully control the process.

4. Fast charging of an electric car. Charging stations have been developed that allow you to charge the battery in a short time (about half an hour). The method has strengths and weaknesses. In some models (for example, Nissan Leaf), the battery can be charged to 80% in 30 minutes, but in this case, the next full charge will take a little longer than usual.

The Eco Synergy solar and wind stationary charging station can autonomously charge e-bikes and scooters, and has the option of connecting to the electrical system for cars. Envision Solar has created a mobile version of its Solar Tree solar panel charging stations.

The mobile version of Envision Solar's Solar Tree solar panel charging stations for car storage consists of 2.3 kW compact solar cells measuring 2.7 x 4.8 meters, with a 22.5 kW battery have.

In the following years, high-capacity lithium-ion batteries began to be used in hybrid cars and electric cars. They have a small weight and a large relative volume, and allow full use of their nominal capacity, unlike lead-acid batteries. It is reliable and has a long service life. Energy efficiency increases by 90% in full cycle. In lead-acid batteries, this indicator is much lower.

A little behind electric cars, agricultural machinery is being switched to electric drive, starting from small power ones to high power ones. Accumulator batteries are one of the main elements. These devices have the following

requirements:

1. Security; 2. Reliability; 3. Convenience.

Figure-1. Mobile charging stations equipped with solar panels

Based on the characteristics of electrochemical technology for mobile devices, the following modern current sources can be cited.

1. (SLA)-lead-alkaline sealant; 2. (NiCd)-nickel-cadmium; 3. (Li-Ion)-lithium-ion; 4. (Li-Pol)-lithium-polymer.

The American company Envia Systems has created a battery with a volume of up to 400 W-hours per 1 kg of mass. With such a battery, an electric car can travel up to 500 km. The price of such an accumulator can be around $25,000-$30,000. This project is supported by General Motors, Pangaea Ventures, Redpoint Ventures, Japan's Asahi Kasei and the US Department of Energy.

Lithium-ion batteries charge faster and provide large currents, but this feature is not the first priority for long-term work methods. Lithium-ion batteries can be considered the most promising batteries with high energy capacity and other optimal parameters. They can provide 15,000 charge-discharge cycles up to 20% capacity loss. Their percentage of useful work can reach 95%.

Result. Calculation of the capacity of the charging station. To calculate the charging power, we need to know the number of phases (one or three), the voltage value (Volts), the current (Amperes) and the design of the power connector of your charging station.

The way the charging station is connected to the network is also important in a three-phase connection. Depending on the connection scheme, the voltage will have values of 230 or 380 Volts. Based on this information, we can perform calculations using the appropriate formulas:

• Charging power (single-phase alternating current):

• Charging power (3.7 kW) = number of phases -1, voltage - 230 V, current 16 A.

• Charging power (three-phase alternating current):

• Charging power (22 kW) = number of phases -3, voltage - 230 V, current 32 A.

In order for the charging power to be 22 kW, our power station must be adapted to three-phase charging with a voltage of 32 A. The weakest link in the chain determines the total charging capacity of the station. However, all connector types support maximum power. The picture below shows information on fully charging the Renault ZOE electric car at various capacities.

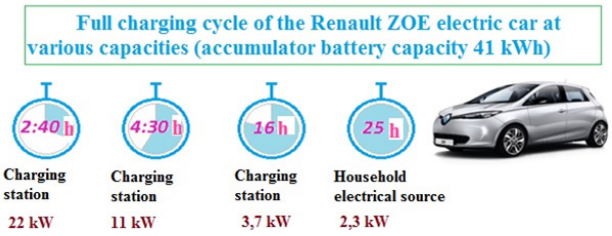

Figure 2. Full charging cycle of the Renault ZOE electric car at various capacities.

Charging time for electric vehicles. To calculate the charging time, it is enough to divide the battery capacity by the charging capacity. In the example of a Tesla electric car, we divide 85 kW*h by 22 kW*h and get T_{charge} = 3.9 hours of charging time. However, the condition of the battery may limit the charging power when charging, so the charging power cannot be constant. And so in the calculations we add at least half an hour.

$$T_{charging\ time} = \frac{P_{accumulator\ battery\ capacity}}{P_{energy\ intensive}} = \frac{85\ kW{\cdot}h}{22\ kW{\cdot}h} = 3{,}9\ hour; \quad (1)$$

Analyze. *Reserve distance covered on one charge.* To calculate the distance covered on one charge, it is enough to divide the battery capacity by the energy consumption required for this distance and multiply by 100. However, this only gives approximate values, since the actual range depends, among other things, on the driving style, the road surface and the use of electrical consumers. (electric heater or air conditioner). However, in order to protect the battery, the available power is often not fully used.

$$T_{distance} = \frac{P_{accumulator\ battery\ capacity}}{P_{energy\ intensive(for\ 100\ km)}} = \frac{85\ kW{\cdot}h}{18{,}1\ kW{\cdot}h} \cdot 100 = 469\ km; \quad (2)$$

The table below provides information on charging methods for popular models of electric cars [4].

Discussion. Modern electric vehicles are adapted for charging in two ways: from an alternating current source and from a constant current source. Charging an electric car directly from a direct current source means "quick charging". AC charging of an electric vehicle is done using a charger installed in every electric vehicle and is "slow charging".

Mode 1 - The most common and easiest way to charge an electric vehicle is to charge it from a regular outlet.

Table 1

Information on charging methods for well-known brand electric cars

Name of electrocar	Model	Accumulator battarey capacity (kWt·h	Distance in one charge (km)	Charging station capacity AC (kW)	Full charging time AC (h)	Charging station capacity AC (kW)	Full charging time DC (minute)	Full charging time from household source DC (h)	Charging device model
BMW	i3 (60 A·h)	18,8	190	4,6	4,5	50	30 (80%)	8,5	Typ 2
Mercedes-Benz	EQC 400	81	410	7,4	3	110	10 (80%)	41	Typ 2
NISSAN	Leaf e+	62	385	7	11,5	50	90 (80%)	33	Typ 2
Porsche	Taycan Turbo	93,4	450	11	9 (0-100%)	270	22,5 (5-80%)	41	Typ 2
Tesla	Model S Standard-Reichweite	75	450	16,5	4,5	118	35 (80%)	32,5	Typ 2
Volkswagen	ID 3	77	550	11	7	125	40	34	Typ 2

All Euro standard power sockets are designed for 220/230 Volts, 16 Amps, which allows for safe connection of consumers up to 3.5 kW, respectively. The electric vehicle charging cable, the charging process, is designed for approximately these parameters. Charging mode 1 includes charging directly from the power of the alternating current source without additional protection devices, which does not guarantee protection against overload, overheating and short circuit in modern electric vehicles. . In this method, the full charging time is 10-12 hours based on the battery capacity of 30-35 kWh.

Mode 2 - the 2nd mode of electric car charging is the same as the first mode, but in this mode, a charging cable with a special protection block located on the cable itself is used Cables with such a protective block are designed for 220/230V~ for European countries and 110/120V~ for the USA.

Mode 3 - means high-power AC charging. This mode is considered the most common charging mode used in parking lots, gas stations and other public places. Mode 3 charging is performed using special charging stations capable of delivering high-power alternating current, which cannot be achieved in normal household conditions due to the limited power sources of 16 Amps (3.5 kW).

These special charging stations are capable of delivering power from 7.2 to 43 kW, depending on the connection (single-phase or three-phase). In this mode, the time to fully charge the battery is from half an hour to 4 hours.

Mode 4-is the fastest way to charge an electric car. Recall that each electric car is equipped with its own (factory installed) charging station, which is supplied with alternating voltage, and from which the battery is directly charged with direct current. is charged. But mode 4 has its own feature - it uses constant current. It charges an electric vehicle with a high-power direct current, radically different from previous modes of alternating current. Here, the connectors have a special design, the most popular of which is the standard CHAdeMO(charging system). In this way, an electric vehicle can be charged very quickly, in about 30 minutes. But there are still very few charging stations of this type. One of the reasons for this is their still high price.

Another feature of fast charging of an electric vehicle is that in this mode, the battery charge reaches 80% quickly, and the remaining 20% of the charge lasts for a longer time. It is related to the technological processes of charging and is aimed at increasing the service life of the battery.

A number of agricultural machinery manufacturers around the world started their research on electrification of tractors in the last century.

Currently, electric tractors and other electro technological equipment are being rapidly introduced to agriculture in developed countries.

The Monarch MK4 model was created in California. This tractor can work with a variety of agricultural equipment, equipped with a 55 kW electric motor, which has twice the torque of a similar diesel engine.

MK4 can be used not only for working with agricultural equipment, but also as an autonomous power source for a small quad bike or household power tools and equipment (for example, welding, shearing equipment). The Monarch electric tractor also has an autopilot mode, which ensures more stable and economical agro technical activities in agriculture.

This electric tractor can work autonomously for up to ten hours, depending on the type of work, after a five-hour

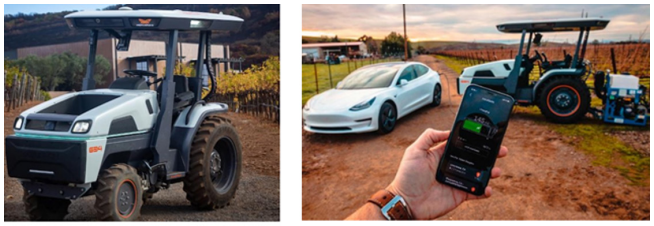

Figure 3. Monarch MK4 electric tractor.

charge. The tractor is equipped with a wide array of sensors that can detect livestock and crops, as well as a collision avoidance system that allows it to work around people and other equipment[8].

Figure-4. Charging of electric tractors in field conditions using the mobile power station "Solar Wind".

1-"Solar-wind" mobile power station, 2 - Artesian tower, 3 - Photo panels, 4 - Pump control cabinet, 5 - Drip irrigation system, 6 - Electric tractor charging.

Conclusions and suggestions. Modifications of the type of mobile charging EV ARC (solar charging station) - the best option for remote areas in Uzbekistan where there is no "centralized electricity network". The price of EV ARC varies from 40 to 60 thousand dollars, depending on the configuration. However, in the USA, up to 50% of the cost of a station can be covered by government advertising programs.

Based on the conducted research, the authors developed an experimental model of the mobile power station "Sun-wind" with a nominal capacity of 5.4 kW. (Fig. 4.)

With the correct organization of measures for the introduction of modern techniques and technologies, the "Sun-wind" power plant proposed by the authors is in high demand and can be used in all regions of the Republic of Uzbekistan. Since the above problems are specific to the neighboring republics, the export of these products can be gradually organized.

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