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SUBSTANTIATION OF PARAMETERS OF A MOBILE CHARGING STATION FOR ELECTRIFIED MACHINERY UNDER AGRICULTURAL PRODUCTION CONDITIONS

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The article considers the substantiation and selection of the main parameters of a mobile charging station intended to support the operation of electrified machinery under agricultural production conditions. The relevance of the study is determined by the gradual expansion of electric and hybrid machinery in modern agriculture, including compact electric tractors, robotic platforms, unmanned aerial vehicles, battery-powered tools and various types of auxiliary electrical equipment. For agricultural enterprises, an important issue is not only the availability of reliable charging infrastructure, but also the possibility of transporting it directly to fields, farms and other locations where technological operations are performed.

A calculation scheme of a mobile charging station is proposed, which includes a battery energy storage unit, photovoltaic modules, an inverter-charger, a charge controller and the possibility of backup connection to the electrical grid or a diesel generator. Such a combined configuration increases the autonomy and flexibility of the charging system and makes it possible to use renewable energy directly at the place of operation. Based on the accepted daily energy demand of electrified agricultural machinery, the required capacity of the battery unit, the installed power of the photovoltaic system, the power of the charging equipment and the expected reduction in electricity consumption from an external source were determined.

The calculations show that, to satisfy a daily energy demand of 45 kWh, it is reasonable to use a battery unit with a nominal capacity of 76.8 kWh, charging equipment with a rated power of 22–25 kW and a photovoltaic system with an installed capacity of 8 kW. With an average daily specific photovoltaic output of 3.2 kWh/(kW·day), the expected daily electricity generation reaches 25.6 kWh, which can cover approximately 51% of the station's energy demand. During 180 days of seasonal operation, the reduction in electricity consumption from an external source may reach 4608 kWh.

The obtained results provide a basis for the further design and optimization of mobile charging stations for agricultural applications. The proposed approach can contribute to increasing the autonomy of electrified machinery, reducing dependence on stationary power infrastructure, lowering operating energy costs and expanding the use of renewable energy sources in agricultural production.

***Keywords**: mobile charging station, electrified machinery, battery energy storage, photovoltaic system, agricultural production, energy saving, charging infrastructure.*

Eq. 4. Fig. 5. Table 2. Ref. 16.

1. Problem formulation

The electrification of machinery in agricultural production is no longer limited to individual experimental machines. Battery-powered sprayers, electric transport platforms, robotic monitoring devices, unmanned aerial vehicles, electric tools, and the first models of small and medium-power electric tractors are gradually appearing on farms. For large-scale field operations, diesel machinery will remain the mainstay for

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a long time to come, but in the niches of horticulture, vegetable growing, greenhouse farming, livestock complexes and precision farming, electric machines have clear prospects.

The problem, however, lies not only with the machine itself. It lies in the energy supply. Agricultural production is spatially dispersed: machinery operates not near a fixed charging point, but in the field, in the orchard, at a remote production site, or near a temporary location where a specific operation is being carried out. This is precisely why a fixed charging infrastructure does not always solve the problem. In many cases, a mobile charging station is required, which can be moved to where the machinery is operating.

The global growth of electric mobility is accompanied by the rapid development of charging infrastructure [1]. According to the IEA, scenarios for the development of electric transport predict a significant increase in the number of charging points by the end of 2030, with the majority of charging taking place not only at public stations but also at private and industrial locations. This is particularly important for the agricultural sector, where charging often needs to take place on the premises of the enterprise or directly in the work area.

NREL research also shows that the use of battery energy storage systems at charging points helps to reduce peak load on the grid and maintain the operation of chargers even when external power supply is limited [2]. This is particularly relevant for agricultural enterprises: in the field or at remote sites, there is often no robust power grid, and connecting a new line may not be economically viable.

Consequently, a practical challenge arises: to determine the parameters of a mobile charging station so that it can ensure the daily operation and charging of electrified agricultural machinery, partially meet demand using solar energy, have sufficient battery reserve, and not require excessively high installed capacity for the charging equipment.

2. Analysis of recent research and publications

Analysis of the current state of the issue shows that the electrification of agricultural machinery is gradually moving from the level of individual experimental solutions to the level of practical engineering systems. The main attention of researchers is focused on electric and hybrid tractors, robotic platforms, battery-powered auxiliary machines, unmanned aerial vehicles and electric drives of agricultural implements. In such systems, the electric drive is considered not only as a replacement for the internal combustion engine, but also as a means of improving controllability, reducing local emissions, simplifying power transmission and integrating agricultural machinery with renewable energy sources. Scolaro et al. emphasize that the electrification of agricultural machinery is most actively developing in the direction of hybrid and fully electric tractors and implements, while the practical effectiveness of such machines is strongly determined by battery capacity, operating cycle and charging infrastructure [3].

At the same time, the use of electrified machinery in agriculture has a specific feature that distinguishes it from road electric transport. Agricultural machinery works under variable load, often far from stationary energy infrastructure, and its energy demand depends not only on installed power but also on the technological operation being performed. For example, light transport, monitoring or auxiliary operations require significantly less energy than soil tillage or heavy traction work. Therefore, the selection of charging infrastructure parameters cannot be based only on the rated power of the machine. It should be based on the daily energy balance, charging time, permissible depth of battery discharge and the availability of local renewable energy generation.

Taking into account the operating conditions of agricultural machinery, the mobile charging station should combine several energy sources and several groups of consumers within one controlled system. The implementation of technological innovations in storage, processing and related agricultural operations also increases the need for flexible energy supply systems capable of supporting mobile, auxiliary and battery-powered equipment [4]. The general structure of such a station includes photovoltaic modules, a battery energy storage unit, an inverter-charger, a charge controller, an external grid or diesel generator input, and output charging lines for electrified machinery [6–7].

The development of charging infrastructure is one of the key conditions for the further spread of electrified machinery. According to the International Energy Agency, more than 1.3 million public charging points were added worldwide in 2024, increasing the global stock by more than 30% compared with the previous year [1]. However, for agricultural production, the simple increase in the number of public charging stations does not solve the problem completely, because the charging point must be located near the place where the machine actually operates. In this context, mobile charging stations become a technically justified option for farms, field camps, remote storage facilities, livestock complexes and production sites with limited grid capacity [5].

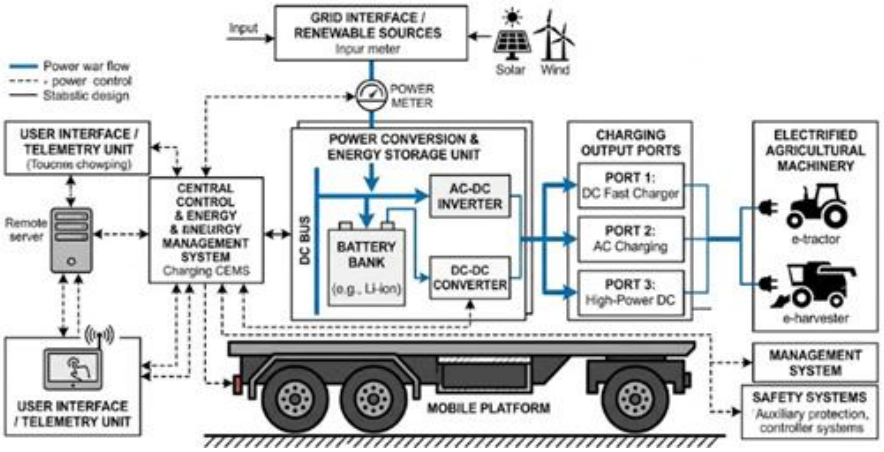


Fig. 1. General structure of a mobile charging station for electrified agricultural machinery
Source: developed by the authors

The use of battery energy storage systems in charging infrastructure is also actively studied. According to NREL, battery energy storage can support electric vehicle fast charging infrastructure, especially where grid capacity is limited or peak power demand must be reduced [2]. For agricultural production, this conclusion is particularly important. A mobile charging station should not be considered only as a “large power bank”; in fact, it performs the function of an intermediate energy buffer between the external power source, photovoltaic modules and the charging load of electrified machinery. Such a buffer makes it possible to reduce peak loads, accumulate energy during periods of low demand and supply power to machinery during field operations.

The interaction between the energy sources, battery storage unit and charging load can be represented as an energy flow diagram. This diagram is used as the basis for further calculation of the station parameters, since it shows how energy is supplied from photovoltaic modules and an external source to the DC bus, accumulated in the battery unit and then transferred to electrified machinery through the charging equipment.

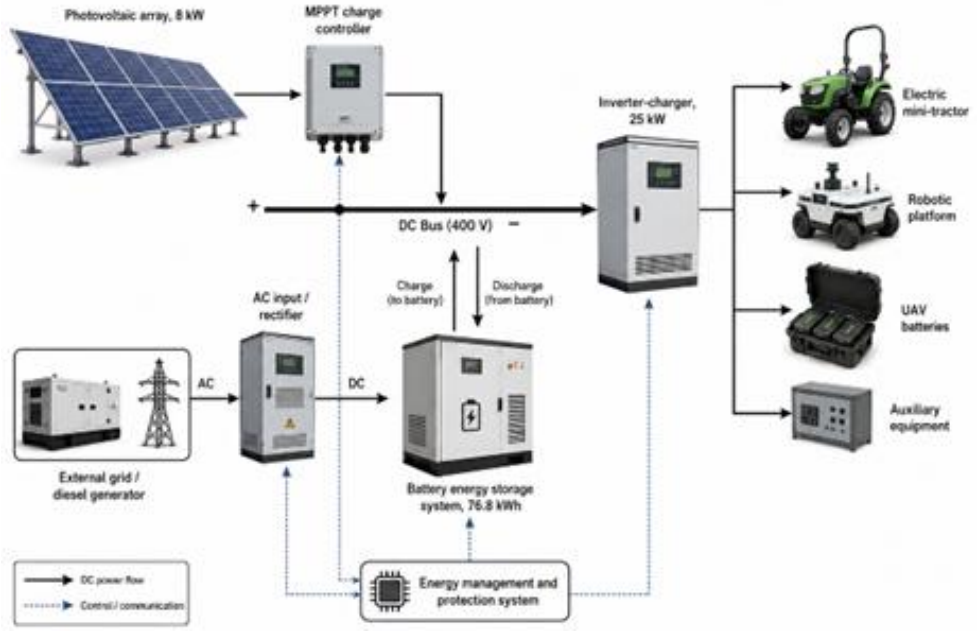


Fig. 2. Energy flow diagram of the mobile charging station
Source: developed by the authors

A separate area of research concerns photovoltaic charging systems. The use of photovoltaic modules in combination with battery storage allows partial coverage of the charging station energy demand from renewable sources [6–8]. For Ukraine, the feasibility of such solutions can be assessed using solar resource and photovoltaic potential data provided by the Global Solar Atlas, which includes maps and GIS data for the country [9]. These data are sufficient for preliminary engineering calculations of photovoltaic capacity,

although detailed design should also take into account the exact location, season, tilt angle of modules, shading and degradation of photovoltaic panels.

Despite the active development of research on electric agricultural machinery, photovoltaic charging systems and battery-buffered charging infrastructure, the issue of substantiating the parameters of a mobile charging station for agricultural production remains insufficiently detailed. Most existing studies focus either on the machine itself, or on stationary charging infrastructure for electric vehicles. Much less attention is paid to the case when the charging system must be mobile, seasonally operated and adapted to the uneven energy demand of agricultural machinery.

Given this, the working hypothesis of the study is that the rational parameters of a mobile charging station for electrified agricultural machinery can be determined through the energy balance of daily operation. The determining parameters are the daily energy demand of machinery and auxiliary consumers, the required charging time, the permissible depth of discharge of the battery energy storage system, the efficiency of power conversion and the possible contribution of photovoltaic generation.

As a calculation model of the mobile charging station, it is proposed to use a system consisting of a battery energy storage unit, photovoltaic modules, a charge controller with maximum power point tracking, an inverter-charger, protective equipment and output charging connectors for agricultural machinery [10–12]. The general energy flow of such a station can be represented as follows: photovoltaic modules and an external power source supply energy to the DC bus, the battery storage unit accumulates and releases energy depending on the operating mode, and the inverter-charger provides the required charging power for electrified machinery.

The daily energy demand of the station is determined by the sum of energy consumed by all electrified machines and auxiliary devices:

$$E_d = \sum_{i=1}^{n} P_i\, t_i, \tag{1}$$

where E_d is the daily energy demand, kWh; P_i is the average power of the i-th consumer, kW; t_i is the operating or charging time of the i-th consumer, h; n is the number of consumers.

The required nominal capacity of the battery energy storage unit is determined taking into account the reserve coefficient, permissible depth of discharge and efficiency of energy conversion:

$$E_{\text{bat}} = \frac{E_d k_{\text{res}}}{DOD \cdot \eta_{\text{bat}}}, \tag{2}$$

where E_{bat} is the nominal battery capacity, kWh; k_{res} is the reserve coefficient; DOD is the permissible depth of discharge; η_{bat} is the efficiency of the battery and power conversion system.

The required charging power is determined from the amount of energy that must be transferred to the main consumer within the accepted charging time:

$$P_{\text{ch}} = \frac{E_{\text{ch}}}{t_{\text{ch}}\eta_{\text{ch}}}, \tag{3}$$

where P_{ch} is the required charging power, kW; E_{ch} is the energy required for charging the machine, kWh; t_{ch} is the permissible charging time, h; η_{ch} is the charging efficiency.

The installed capacity of the photovoltaic system is determined by the required share of renewable energy in the daily balance of the station:

$$P_{PV} = \frac{E_{PV}}{Y_{PV}}, \tag{4}$$

where P_{PV} is the installed photovoltaic capacity, kW; E_{PV} is the daily energy that should be generated by photovoltaic modules, kWh; Y_{PV} is the average daily specific photovoltaic output, kWh/kW.

Thus, the proposed calculation model makes it possible to move from a general description of mobile charging infrastructure to the substantiation of specific technical parameters: battery capacity, charging power, photovoltaic capacity and expected reduction in energy consumption from an external source. The numerical implementation of the proposed model and the discussion of the obtained results are presented in the next section.

3. The purpose of the article

The purpose of the study is to substantiate the parameters of a mobile charging station for electrified agricultural machinery, taking into account the daily energy demand of consumers, the required battery capacity, the charging power and the possibility of partial energy supply from photovoltaic modules.

To achieve this purpose, the study provides for determining the structure of energy consumers typical for agricultural production, calculating the daily energy demand of electrified machinery and auxiliary equipment, and substantiating the nominal capacity of the battery energy storage system. The research also

involves determining the required power of the charging equipment, calculating the installed capacity of the photovoltaic system and estimating the share of renewable energy in the total energy balance of the mobile charging station.

The final stage of the study is aimed at evaluating the expected reduction in electricity consumption from an external power source or diesel generator during seasonal operation. This makes it possible to determine the practical applicability of the proposed mobile charging station configuration for agricultural enterprises that use electrified machinery, robotic platforms, unmanned aerial vehicles and battery-powered auxiliary equipment.

4. Results and discussion

To substantiate the parameters of the mobile charging station, a typical daily operating mode of electrified machinery and auxiliary equipment in agricultural production was considered. The calculation was based on the assumption that the station should provide energy for an electric mini-tractor or electric transport vehicle, a robotic platform, UAV batteries and auxiliary battery-powered equipment. Such a set of consumers reflects the practical conditions of using electrified machinery in farms, where the charging station must serve not one machine, but several types of electrical loads with different operating cycles.

This approach makes it possible to take into account the uneven nature of energy consumption in agricultural production. Unlike stationary industrial consumers, agricultural machinery usually operates according to a variable schedule that depends on the type of technological operation, field location, season, weather conditions and duration of the working day. Therefore, the daily energy demand of the station was determined not as a constant load, but as the total energy required for several groups of consumers that may be charged or powered during one operating cycle.

The selected combination of consumers is also justified by the current direction of agricultural electrification. Electric transport vehicles and compact tractors can be used for light field, transport and service operations; robotic platforms are increasingly used for monitoring and precision farming tasks; UAV batteries require regular recharging during crop monitoring; and auxiliary battery-powered equipment is needed for maintenance, sensor systems and field measurements. Thus, the proposed calculation scheme reflects not a single isolated charging case, but a more realistic model of energy supply for a modern agricultural enterprise using electrified machinery.

The initial data for determining the daily energy demand are presented in Table 1.

Table 1.

Initial data for determining the daily energy demand of electrified agricultural machinery and auxiliary equipment

Consumer	Average power, kW	Operating or charging time, h	Daily energy demand, kWh
Electric mini-tractor / electric transport vehicle	12.0	3.0	36.0
Robotic platform or electric cart	2.5	2.0	5.0
UAV battery set	—	—	1.5
Battery-powered tools, sensors and auxiliary equipment	—	—	2.5
Total	—	—	**45.0**

According to the data in Table 1, the total daily useful energy demand of electrified machinery and auxiliary equipment is 45.0 kWh. Taking into account the efficiency of charging and power conversion, the amount of energy that must be supplied to the station is higher than the useful energy consumed by the machinery. For the accepted charging efficiency ($\eta_{ch} = 0.90$), the daily input energy demand is:

$$E_{in} = \frac{E_d}{\eta_{ch}} = \frac{45.0}{0.90} = 50.0 \text{ kWh}.$$

Thus, the mobile charging station should be designed to provide approximately 50.0 kWh of input energy per day, of which 45.0 kWh is transferred as useful energy to electrified machinery and auxiliary consumers.

The next stage of the calculation was the determination of the required nominal capacity of the battery energy storage system. For this purpose, a reserve coefficient of ($k_{res} = 1.20$), permissible depth of discharge

($DOD = 0.80$) and battery system efficiency ($\eta_{bat} = 0.92$) were accepted. Under these conditions, the required nominal battery capacity is:

$$E_{bat} = \frac{45.0 \cdot 1.20}{0.80 \cdot 0.92} = 73.37 \text{ kWh}.$$

Since battery systems are usually formed from standard modules, it is advisable to accept the nominal capacity of the battery energy storage system at the level of 76.8 kWh. This value exceeds the calculated minimum and provides an additional reserve for uneven load, temporary reduction of photovoltaic generation and auxiliary energy losses.

The useful energy that can be supplied from the accepted battery energy storage system is:

$$E_{use} = 76.8 \cdot 0.80 \cdot 0.92 = 56.52 \text{ kWh}.$$

The obtained value confirms that the selected battery capacity is sufficient to cover the accepted daily useful energy demand of 45.0 kWh. The reserve between the useful battery output and the daily demand is 11.52 kWh, which increases the reliability of the station during field operation.

The dependence shown in Fig. 3 confirms the proportional relationship between the daily energy demand of electrified agricultural machinery and the required battery capacity. For the accepted daily energy demand of 45.0 kWh, the calculated minimum battery capacity is 73.37 kWh, while the selected design value is 76.8 kWh. This confirms that the proposed battery configuration is technically justified and does not create an excessive oversizing of the system.

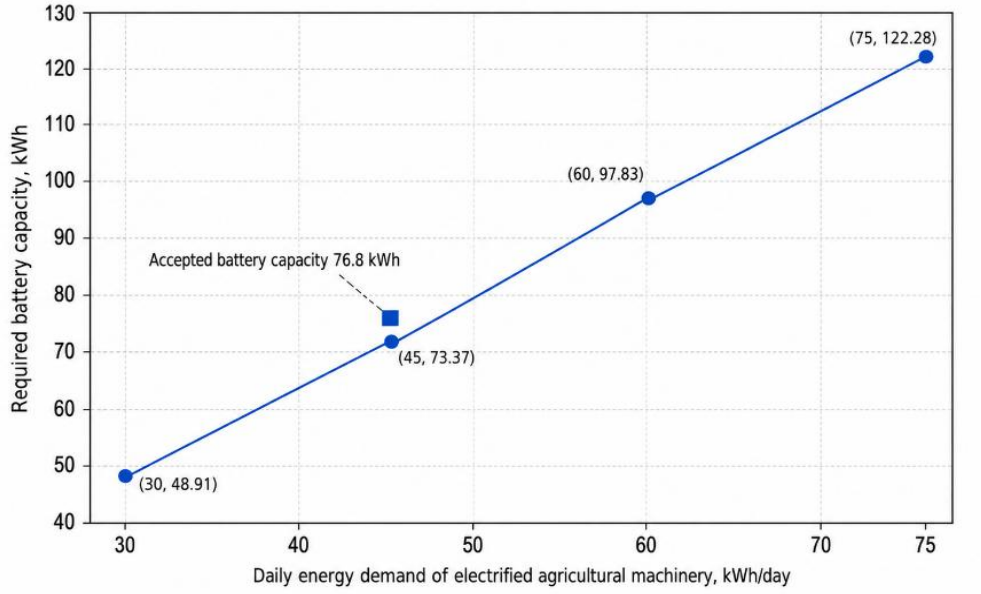


Fig. 3. Dependence of the required battery capacity on the daily energy demand of electrified agricultural machinery

Source: developed by the authors

To determine the required charging power, the most energy-intensive consumer was considered. In this case, the electric mini-tractor or electric transport vehicle requires 36.0 kWh of energy per day. If the permissible charging time is accepted as 2.0 h and charging efficiency is ($\eta_{ch} = 0.92$), the required charging power is:

$$P_{ch} = \frac{36.0}{2.0 \cdot 0.92} = 19.57 \text{ kW}.$$

Taking into account the need for reserve power and possible simultaneous charging of auxiliary consumers, it is reasonable to accept a charging unit with a rated power of 22 kW. The total power of the inverter-charger should be not less than 25 kW. This provides a margin for peak loads and allows the station to operate more stably when several consumers are connected.

For checking the current load of the DC bus, a bus voltage of 400 V and inverter efficiency of 0.95 were accepted. The current at the maximum power of 25 kW is:

$$I_{DC} = \frac{25000}{400 \cdot 0.95} = 65.8 \text{ A}.$$

Therefore, the DC part of the mobile charging station should be designed for a continuous current of at least 66 A. Taking into account operational reserve and possible short-term overloads, it is advisable to select conductors, switching equipment and protection devices for a current of not less than 80 A.

The photovoltaic subsystem was calculated as an additional energy source intended to reduce the load on the external grid or diesel generator. Since the daily input energy demand of the station is 50.0 kWh, the target share of photovoltaic generation was accepted at the level of 50%. Therefore, the required daily photovoltaic energy generation is:

$$E_{PV} = 0.50 \cdot 50.0 = 25.0 \text{ kWh}.$$

For the average daily specific photovoltaic output $(Y_{PV} = 3.2) kWh/kW$, the required installed photovoltaic capacity is:

$$P_{PV} = \frac{25.0}{3.2} = 7.81 \text{ kW}.$$

According to the calculation, it is advisable to accept the installed photovoltaic capacity of the mobile charging station at the level of 8 kW. The expected daily generation of such a photovoltaic system is:

$$E_{PV.fact} = 8.0 \cdot 3.2 = 25.6 \text{ kWh}.$$

The share of daily input energy demand covered by photovoltaic generation is:

$$\alpha_{PV} = \frac{25.6}{50.0} \cdot 100 = 51.2\%.$$

The dependence shown in Fig. 4 confirms that the required photovoltaic capacity increases almost proportionally with the selected share of energy demand covered by solar generation. For the accepted target level of approximately 50%, the calculated photovoltaic capacity is 7.81 kW, which justifies the selection of a standard 8 kW photovoltaic subsystem.

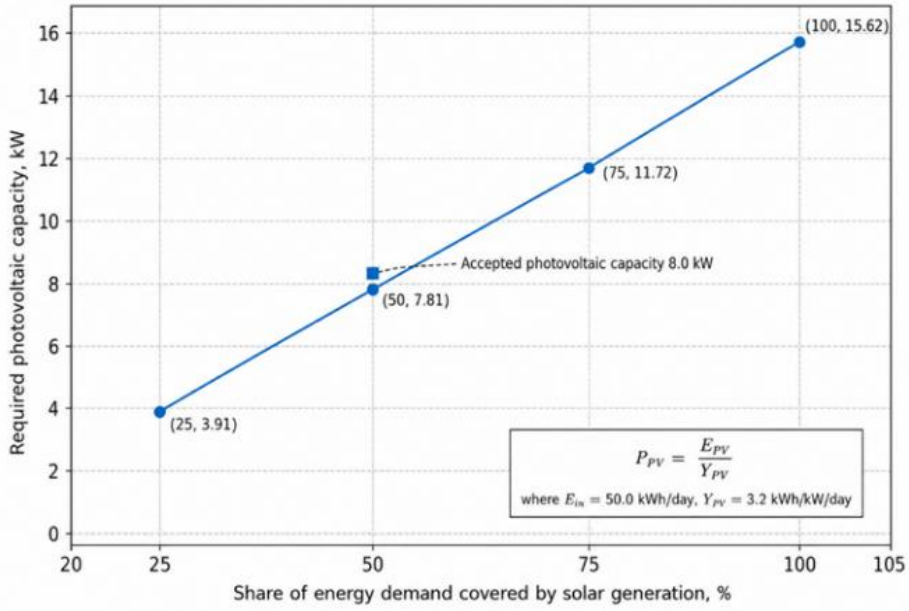


Fig. 4. Dependence of the required photovoltaic capacity on the share of energy demand covered by solar generation

Source: developed by the authors

The seasonal energy effect was estimated for 180 days of active agricultural operation. In the variant without photovoltaic generation, the entire daily input energy demand of 50.0 kWh must be supplied from an external source. In this case, the seasonal energy consumption is:

$$W_1 = 50.0 \cdot 180 = 9000 \text{ kWh}.$$

In the variant with an 8 kW photovoltaic system, the daily energy demand from an external source decreases by the amount of photovoltaic generation:

$$E_{ext} = 50.0 - 25.6 = 24.4 \text{ kWh}.$$

Accordingly, the seasonal energy consumption from the external source is:

$$W_2 = 24.4 \cdot 180 = 4392 \text{ kWh}.$$

The seasonal reduction in external energy consumption is:

$$\Delta W = 9000 - 4392 = 4608 \text{ kWh}.$$

The data presented in Fig. 5 confirm that the integration of photovoltaic generation into the mobile charging station significantly changes the seasonal energy balance. In the variant without photovoltaic modules, the entire seasonal demand of 9000 kWh must be supplied from an external source. After adding an 8 kW photovoltaic system, this value decreases to 4392 kWh, while the calculated energy saving reaches 4608 kWh.

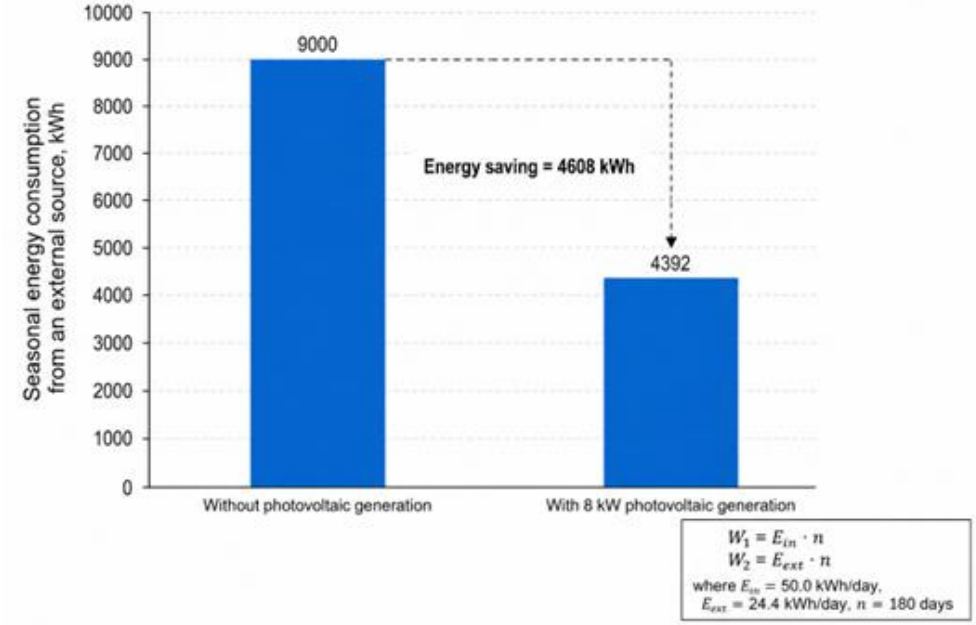


Fig. 5. Comparison of seasonal energy consumption from an external source with and without photovoltaic generation

Source: developed by the authors

This result indicates that the photovoltaic subsystem performs not only an auxiliary function, but also directly increases the energy autonomy of the mobile charging station. Under agricultural production conditions, this is particularly important because electrified machinery often operates at a considerable distance from stationary charging infrastructure. Therefore, the proposed configuration can reduce dependence on the external grid or diesel generator and improve the practical applicability of mobile charging systems in seasonal field operations.

The generalized calculation results are presented in Table 2.

Table 2

Calculated parameters of the mobile charging station

Parameter	Calculated value
Daily useful energy demand of consumers	45.0 kWh
Daily input energy demand considering losses	50.0 kWh
Calculated minimum battery capacity	73.37 kWh
Accepted nominal battery capacity	76.8 kWh
Useful energy supplied by the battery system	56.52 kWh
Required charging power	19.57 kW
Accepted charging unit power	22 kW
Recommended inverter-charger power	25 kW
DC bus voltage	400 V
Calculated DC current at 25 kW	65.8 A
Recommended current rating of DC equipment	not less than 80 A
Accepted photovoltaic capacity	8 kW
Daily photovoltaic generation	25.6 kWh
Share of demand covered by photovoltaic generation	51.2%
Seasonal consumption without photovoltaic generation	9000 kWh
Seasonal consumption with 8 kW photovoltaic generation	4392 kWh
Seasonal energy saving	4608 kWh

The obtained results show that the proposed configuration of the mobile charging station is balanced in terms of battery capacity, charging power and photovoltaic generation. The accepted battery capacity of 76.8 kWh is sufficient to cover the daily energy demand of the selected group of consumers, while the 22 kW charging unit provides an acceptable charging time for the main electrified machine. The photovoltaic subsystem with an installed capacity of 8 kW allows more than half of the seasonal energy demand from an external source to be replaced by renewable generation [13–16].

Therefore, the proposed mobile charging station can be considered technically feasible for agricultural enterprises that use electrified machinery for transport, monitoring, auxiliary and light field operations. At the same time, for heavy traction operations or continuous operation of high-power electric tractors, the parameters of the station should be recalculated according to the actual load schedule and energy consumption of specific machines.

5. Conclusion

The study substantiates the main parameters of a mobile charging station for supplying and charging electrified machinery under agricultural production conditions. The proposed approach is based on the daily energy balance of consumers and takes into account the operation of an electric mini-tractor or electric transport vehicle, a robotic platform, UAV batteries and auxiliary battery-powered equipment.

It was established that the total daily useful energy demand of the accepted group of consumers is 45.0 kWh. Taking into account charging and conversion losses, the required daily input energy demand is 50.0 kWh. Under the accepted reserve coefficient of 1.20, permissible depth of discharge of 0.80 and battery system efficiency of 0.92, the calculated minimum battery capacity is 73.37 kWh. Therefore, the use of a battery energy storage system with a nominal capacity of 76.8 kWh is technically justified.

For the main energy-intensive consumer, the required charging power is 19.57 kW. Taking into account reserve power and possible simultaneous charging of auxiliary consumers, it is reasonable to use a charging unit with a rated power of 22 kW and an inverter-charger with a power of not less than 25 kW. The calculated DC bus current at 25 kW and 400 V is 65.8 A; therefore, the current rating of the DC equipment should be selected not less than 80 A.

The required photovoltaic capacity for covering 50% of the daily input energy demand is 7.81 kW. Therefore, it is advisable to accept an 8 kW photovoltaic system, which can generate approximately 25.6 kWh per day and cover about 51.2% of the station's daily energy demand.

For 180 days of seasonal operation, the use of photovoltaic generation reduces external energy consumption from 9000 kWh to 4392 kWh. The calculated seasonal energy saving is 4608 kWh. This confirms that the photovoltaic subsystem increases the energy autonomy of the mobile charging station and reduces dependence on the external grid or diesel generator.

The proposed configuration can be considered technically feasible for agricultural enterprises that use electrified machinery for transport, monitoring, auxiliary and light field operations. For heavy traction operations or continuous operation of high-power electric tractors, the station parameters should be recalculated according to the actual load schedule and the characteristics of specific machines.

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ОБҐРУНТУВАННЯ ПАРАМЕТРІВ МОБІЛЬНОЇ ЗАРЯДНОЇ СТАНЦІЇ ДЛЯ ЕЛЕКТРИФІКОВАНОЇ ТЕХНІКИ В УМОВАХ СІЛЬСЬКОГОСПОДАРСЬКОГО ВИРОБНИЦТВА

У статті розглянуто обґрунтування основних параметрів мобільної зарядної станції, призначеної для забезпечення роботи електрифікованої техніки в умовах сільськогосподарського виробництва. Актуальність дослідження зумовлена поступовим поширенням електричних і гібридних машин у сучасному сільському господарстві, зокрема компактних електротракторів, роботизованих платформ, безпілотних літальних апаратів, акумуляторних інструментів та різноманітного допоміжного електрообладнання. Для сільськогосподарських підприємств важливим завданням є не лише створення доступної зарядної інфраструктури, але й забезпечення можливості її оперативного переміщення безпосередньо до місця виконання польових, транспортних або допоміжних технологічних операцій.

Запропоновано розрахункову схему мобільної зарядної станції, до складу якої входять акумуляторний накопичувач енергії, фотоелектричні модулі, інвертор-зарядний пристрій, контролер заряду та система резервного підключення до централізованої електромережі або дизельного генератора. Така комбінована структура дає змогу підвищити автономність і гнучкість енергозабезпечення, а також забезпечити більш широке використання відновлюваних джерел енергії. На основі прийнятої добової потреби в електроенергії визначено необхідну ємність акумуляторного блоку, встановлену потужність фотоелектричної системи, потужність зарядного обладнання та очікуване зниження споживання енергії від зовнішнього джерела.

Розрахунки показали, що для забезпечення добової потреби в енергії на рівні 45 кВт·год доцільно використовувати акумуляторний блок номінальною ємністю 76,8 кВт·год, зарядне обладнання потужністю 22–25 кВт та фотоелектричну систему встановленою потужністю 8 кВт. За середньодобового питомого виробітку 3,2 кВт·год/(кВт·добу) добове виробництво електроенергії становить близько 25,6 кВт·год, що покриває приблизно 51 % енергетичних потреб станції. Упродовж 180 днів сезонної експлуатації зниження споживання електроенергії від зовнішнього джерела може досягати 4608 кВт·год. Отримані результати можуть бути використані для подальшого проєктування та оптимізації мобільних зарядних систем для потреб аграрного виробництва.

Ключові слова: *мобільна зарядна станція, електрифікована техніка, акумуляторне накопичення енергії, фотоелектрична система, сільськогосподарське виробництво, енергозбереження, зарядна інфраструктура.*

Ф. 4. Рис. 5. Табл 2. Літ. 16.

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