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CONCEPTUAL DEVELOPMENT OF ELECTROMOBILITY IN CONDITIONS OF SLOVAK MUNICIPALITIES

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Abstract: Development of electromobility depends on several factors. Framework conditions are usually defined at the national level, typically by government, but sometimes the national conditions are also affected by the European framework. The national framework has been developed in Slovakia in recent years in the form of a package of strategic documents that are successively practically realised. The problem is that the framework does not have an adequate response at regional and local levels. The development of electromobility in the conditions of the municipalities will have a relevant impact mainly on the infrastructure. Therefore, the municipalities would be prepared for the development of electromobility. Generally, it should be a document typically covering the medium-time period that defines measures of the municipality and is interconnected with other relevant municipality documents. The paper analyses the benefits and barriers of electromobility and typical car user behaviour generally and specifically in electromobility environment. Then the typical aspects regarding the development of Local action plan for electromobility are presented. Thereafter the process of the plan development and experiences gained during the plan development are described. Finally, the particular measures of Local action plan of e-mobility for Municipality of Senec are stated.

1 Introduction

After a long hesitant attitude, the issue of electromobility has recently become more dynamic in the Slovak Republic. In the past, despite the existence of an initial concept, the approach of competent authorities was without any vision and continuity. At present, thanks to the influence of the European Commission, the situation has changed and Slovakia has developed a comprehensive strategic framework for alternative fuels and, in particular, the Action Plan for the Development of Electromobility in the Slovak Republic. These documents [1-4] create framework conditions and define specific measures at the national level.

To achieve this more effectively and to bring it closer to the citizens, it is also necessary for the self-government to be prepared for these challenges. A conceptual material may be a suitable tool at the municipality level as it can be understood not only by an official of the municipal office but also by a member of the local council and also by a citizen. To fulfil and implement the elaborated material, it should have defined objectives, tools, responsibilities and timeframe - typically it should be a local action plan of electromobility (LAP).

2 Benefits and barriers of electromobility

The issue of electromobility was assigned by the Government of the Slovak Republic to the Ministry of Economy of the Slovak Republic. It addresses the national framework for electromobility in the form of changes to the related legislation, preparing the strategic materials and defining specific measures to support the development of electromobility (e.g. grant schemes) [1-4].

In line with sustainable transport trends, alternative fuels [3-5] are now increasingly preferred, with electricity probably playing a major role in the future. In the case of the deploying of battery electric vehicles (BEV), a significant reduction of local emissions will be achieved (the reduction of total emissions will depend on the way of production of electricity - energy mix) which is very important considering the agglomerations and settlements that are found in poorly ventilated basins and valleys.

Thus, in the case of the use of BEVs, these vehicles (except emissions from tire wear, brake linings and the road itself) do not produce emissions at the local level (at the point of the electric vehicle use), however, emissions are generated at the point of electricity generation. The overall balance is directly related to the greenness of energy sources and it should be noted that there are countries in the EU where the use of an electric vehicle is worse than of a conventional one (e.g. in terms of the balance of CO2 production).

In the previous period, experts discussed the issue of starting a more massive development of electromobility, especially the relation ("vicious circle") between the lack of charging infrastructure and a commercially insignificant number of electric vehicles. However, the obstacles from point of view of users are several [6].

The principal barriers to the development of electromobility are [7]:

- purchasing costs of an electric vehicle,
- insufficient charging infrastructure,
- the lifetime of the electric vehicle's energy storage device,
- usable range on a single charge and charging time,
- unsolved interoperability,
- energy storage security.

Considering the economic aspects (the price of electric vehicles, investments in charging infrastructure), the effort is to start electromobility with support and grant tools. The price of electric vehicles has been steadily declining over time and it can be assumed that in the medium-term horizon these will be competitive with conventional vehicles (also due to their increasing technological regulation). The charging infrastructure is still insufficient and in the city conditions (manly in the high-density settlements with block of flats) the new approaches will have to be found (e.g. application of layer-based solution [8] or energy hubs [9]). Technological advances are also gradually bringing solutions that address the endurance distance of electric vehicles and charging speed. The solution of the historical problem of incompatibility of charging systems is also being solved, e.g. National policy for the implementation of infrastructure for alternative fuels in the conditions of the Slovak Republic [4], but it remains to solve payment and information interoperability. The safety of electric vehicles is still a problem, although, not so significant. The problem is the energy storage device (i.e. the accumulator, although the battery designation is generally accepted at the professional level), which is usually lithium-based and which can ignite (not only when damaged) and cannot be extinguished conventionally.

2.1 Users behaviour

One of the above barriers is still perceived by the optics of the experiences of conventional car drivers who are used to range up to 1,000 km. On the other hand, there is the aspect of typical vehicle use (Fig. 1) and also the specific use of an electric vehicle with a relatively lower range (sufficient for supply purposes, service systems, etc.). Thereafter it is clear that currently available electric vehicles fulfil a significant part of the use cases.

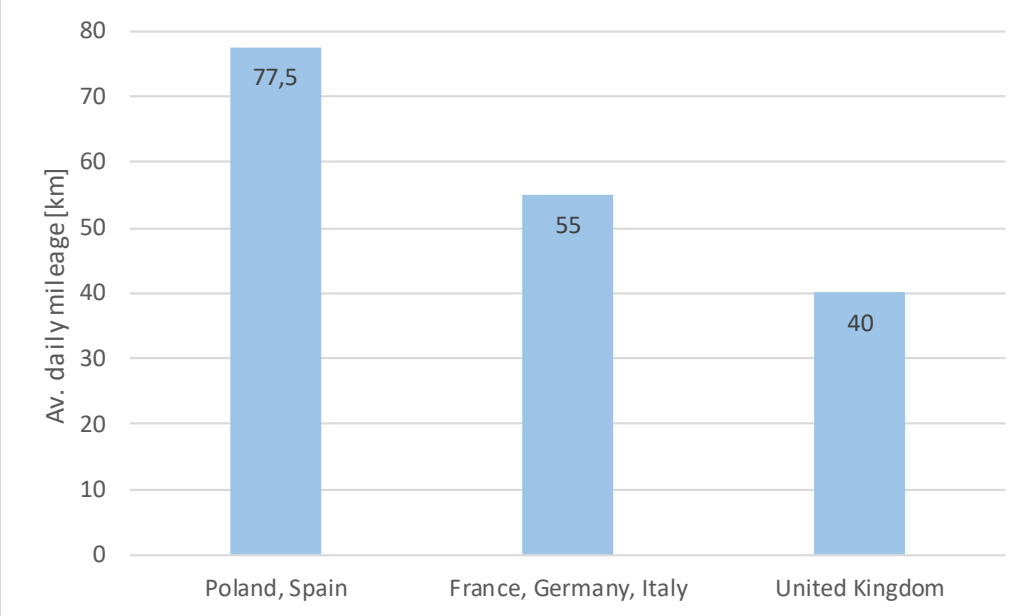

Figure 1 Average daily mileage of vehicles in specific countries (all vehicles, i.e. mostly conventional) [7]

Considering the perspective of the charging infrastructure, it is important to understand the behaviour (needs) of electric vehicle users. Typical user behaviour at the charging stations in the developed market (Netherlands), i.e. the effective use (charging) ratio and the inactivity ratio depending on the daytime are shown in the following Fig. 2. It follows that more than half of the time an electric vehicle was connected to a charging point the vehicle was not being recharged but only occupied a parking place equipped with charger. Certainly, this phenomenon is not desired because decreases efficiency of charging points utilisation.

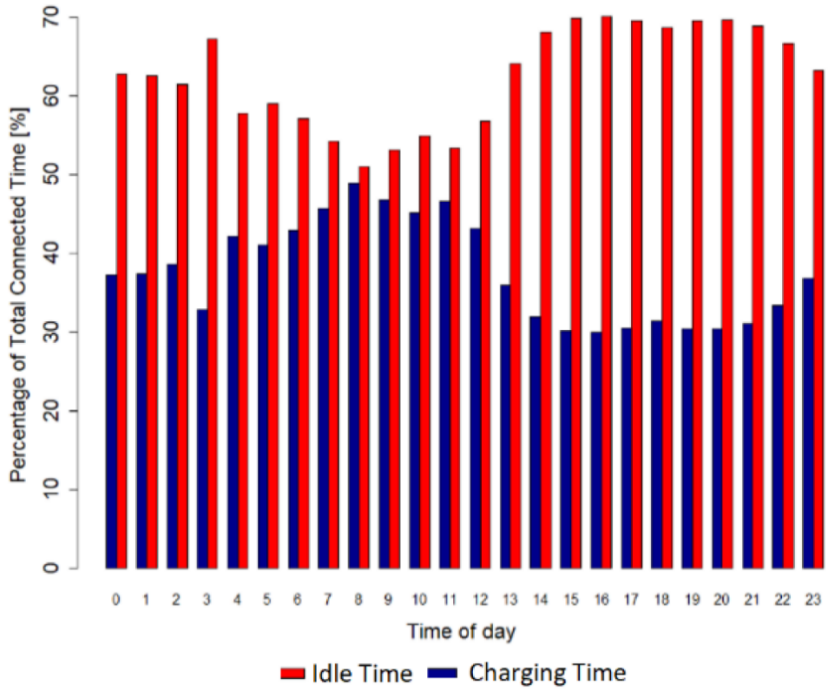

Figure 2 Users behaviours at the charging stations [10]

The requirements of users are time-dependent and are typically different on weekdays and weekends (Fig. 3).

Each point represents the initial time of charging process. It is obvious that utilisation of the charging points during working days and weekends differs. During weekdays two narrow peaks can be observed (7:30 and 17:30) and between these two periods the relatively stable trend can be seen. On the other hand, most of the charging sessions start at midday and the peak is much wider at weekends.

The analyses of extensive data from charging stations point to a clear segmentation of users. However, it is possible to identify groups of users who charge a battery electric vehicle (BEV) or a plug-in hybrid vehicle (PHEV):

- at home,
- at work,
- charging related to other activities (shopping, culture, sports, ...),
- travelling purposes (i.e. for distances which are longer than the range of an electric vehicle, typically intercity journeys).

Typical usage of the charging infrastructure on working days is shown in the following Fig. 4, which shows the number of transactions categorized by arrival and departure times (rounded to hours). The size of the circle is proportional to the number of transactions in a given hour, and the colour of the circle indicates the charging rate (ratio of charge time and connection time).

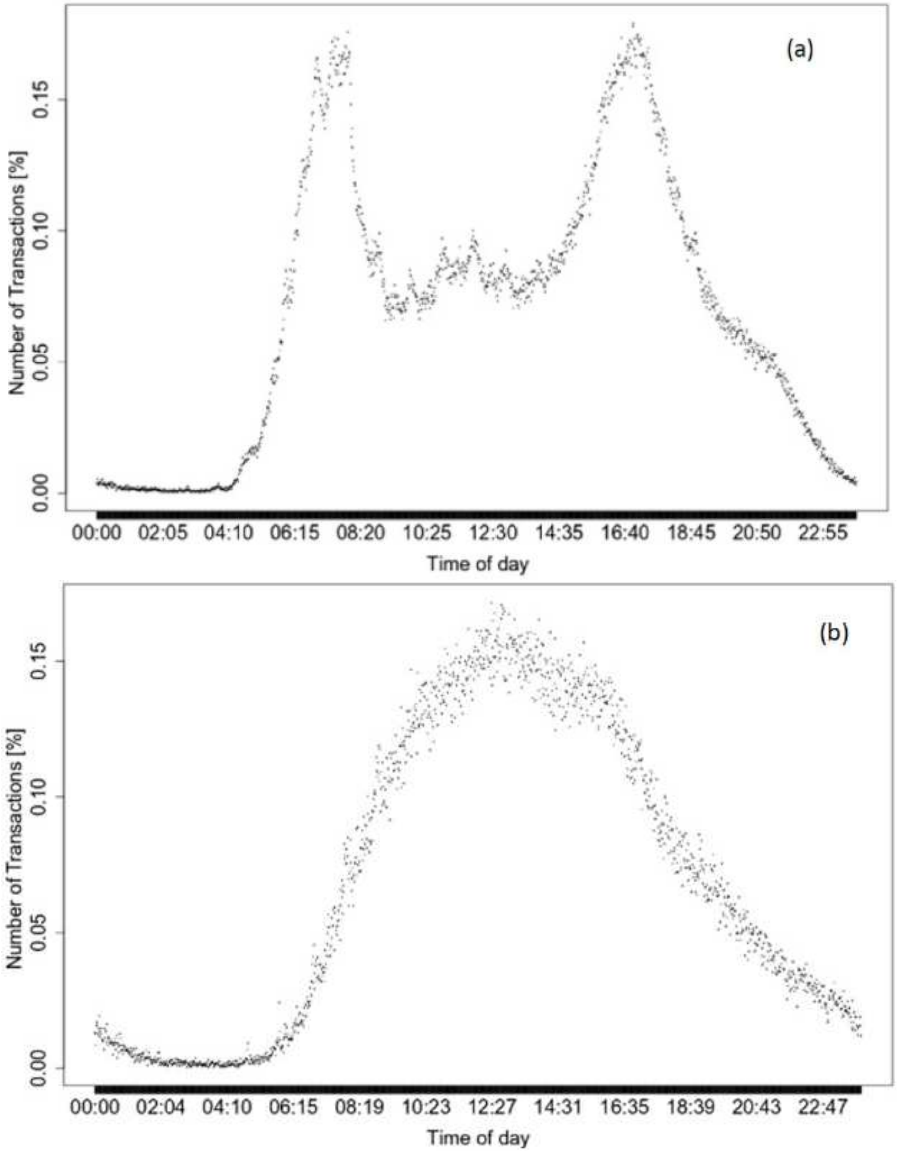

Figure 3 Initial charging time a) working days, b) weekends [10]

Such analyses are important from practical and business point of view, e.g. clustering of the transactions can help to dimension (power and number of charging points), allocate and set up the business model.

3 Local electromobility action plan

Regarding to the above mentioned, it is clear that a significant proportion of BEV and PHEV users use the infrastructure at their place of residence, work or facilities. Furthermore, taking into account that available electric vehicles are suitable for urban or regional transport, whether for individual car transport or urban public transport (e-bus), service systems, etc., it is obvious that electromobility has its merit in urban conditions. The self-government should, therefore, respond to this trend and address it within its competences conceptually taking into account its specificities.

3.1 Local electromobility action plan in general

In terms of transport and mobility problems, smaller towns in the Slovak Republic are under-sized in terms of personnel, and often this area of competence is attached to the section dealing with construction issues. In many cases, they do not have professionally trained capacities and the activity itself usually focuses on permitting procedures, road maintenance and public transport services in the city.

It is therefore in the interest of the city to address the issue with solving the electromobility in the city in cooperation with external capacities that will bring a different perspective on the state, problems and processes in the city.

The quality of the output - LAP depends not only on the expertise of the involved persons and subjects but also on the available database. The availability of data for LAP development is usually closely related to the availability of

other high quality and relevant documents of the city and region, covering mainly transport, economic and social aspects (Plan of economic and social development, Transport master plan, Spatial plan, Sustainable urban mobility plan, Sustainable energy action plan, Cycling strategy, City logistics conception, ... [11,12]).

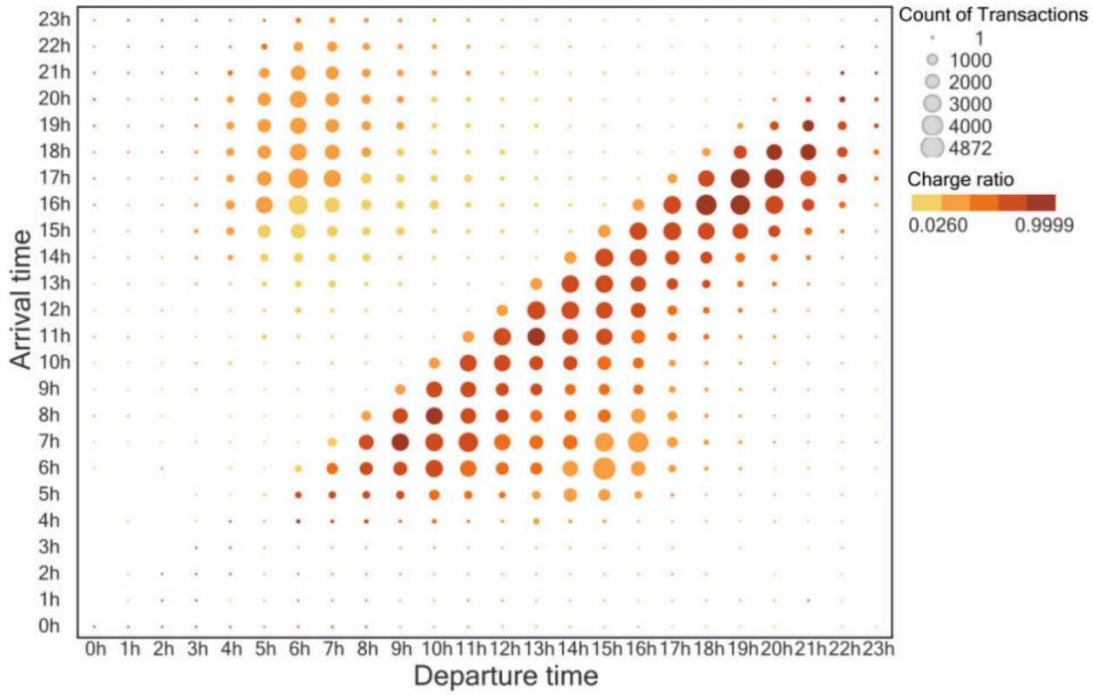

Fig. 4 Arrival and departure times (plug-in and unplug of eV) portraying the charging ratio and number of transactions [13]

3.2 Local electromobility action plan in Senec

The Municipality of Senec is actively involved in the Interreg Danube Transnational Program by the project devoted to the Electric, Electronic and Green Urban Transport Systems (eGUTS) [14], which aimed to develop a local electromobility action plan for Senec.

Senec (approx. 20,000 inhabitants) is a district town situated in the south-west part of Slovakia, 25 km north-east far from the capital Bratislava. It has a flat character and very good traffic position. The motorway D1 Bratislava - Žilina is passing nearby and the main railway line Bratislava - Štúrovo passes directly through the city. The M. R. Štefánik Airport in Bratislava and the border crossings to Austria and Hungary are also relatively close.

The LAP process consisted of several areas:

- an analysis of relevant documents at the national, regional and local levels,
- an analysis of the current state in the area of (e-) mobility, transport infrastructure and related areas,
- meetings, training, brainstorming,
- communication (telephone, e-mail, teleconferencing).

It should be noted that at the time of LAP preparation only Plan of economic and social development and partially Spatial plan were available in Senec. The development of the Transport Master Plan was interrupted at that time due to major infrastructure changes in the surroundings of the town, so a lot of necessary current data and transport forecast absented [12]. For that reason, personal meetings with the responsible staff of the Municipal Office were important, as they provided information that was not captured by any documents and materials to the investigators.

The LAP was prepared for the municipality as a document with two parts - analytical and proposal one - and annexes [15].

The following topics were parts of the analytical part:

- electromobility in the European context, trends in the EU, EU legislative and strategic frameworks,
- electromobility in Slovakia, policy framework and strategic documents of Slovakia,
- municipality of Senec, general characteristics of the town and its surroundings, statistic indicators,
- transport in the municipality, the fleet of the municipality Senec, public transport of the Senec,
- traffic in Senec and its surroundings, basic data on the road transport, accessibility in the town, road network load, the prognose of the road network load,
- externalities caused by transport, the contribution of electromobility to the emissions reduction,
- development of electromobility, analysis of economics of electric vehicle.

Within the proposal part, framework measures were identified (update of the town policy; indirect electromobility support; electromobility education, information and promotion; green public procurement principle of the town and town entities; promotion of electromobility infrastructure and services), each consisting of sub-actions that specify individual activities. The description of each measure was defined by the format agreed within the eGUTS project consortium; the description of each measure was realized in the following extent:

- Reference number
- Action/project name
- Strategic document identification
- Action/project description
- Timeframe
- Cost estimation/budget
- Financing sources
- Potential risks and barriers
- Mitigation measures
- Estimated impact
- Project phases
- Action/project holder/responsible department
- Project custodian

Each measure is briefly described by its name with a description of the corresponding actions (sub-measures).

1 Update of the town policy

1.1. Consideration of the issue of electromobility in the strategic and planning documents of the town with specific emphasis on new territories

1.2 Consideration of aspects that support the development of electromobility (construction of public charging stations, electric car parking, etc.) when developing projects (e.g. public buildings, transport infrastructure construction/reconstruction, underground services construction/reconstruction) and suggesting new building areas

2 Indirect electromobility support

2.1 Motivational parking system

- reserved parking places for BEV / PHEV
- reduced pricing policy for BEV / PHEV
- reserved parking at the BEV / PHEV operator's residence

2.2 Regulation of the entry of service transport systems into the reserved areas of the town within the specified time (peak hours)

- without limitation for BEV / PHEV

2.3 Preference of e-TAXI

3 Education, information and promotion of electromobility

3.1 Active organization, engagement and support of the information and awareness-raising actions on electromobility and green transport (European Mobility Week - 16-22.9; Car-free day - 22.9.; (E-)Bike to Work (every year in May), mobility day, schools, support of third-party information actions)

3.2 Integration of available information on electromobility (static and dynamic data on charging infrastructure within the town, information on indirect support for electromobility, information on support schemes, etc.) into a single site, together with related traffic information

3.3 Building of a public-private platform to support electromobility in the town using the information and experience from the eGUTS project.

4 The green procurement principle of town and town entities

4.1 Optimization of the fleet tailored to the needs of the town and its entities (increase the vehicle utilization and thus its economic efficiency; possibly reduce their number)

4.2 When renewing the fleet of vehicles, consider replacing by an electric vehicle or another transport mean using the principles of green procurement

4.3 Use of support and subsidy schemes for legal entities and public sector to support electromobility (electric vehicles, charging infrastructure, education, etc.)

5 Support for electromobility infrastructure and services

5.1 Building of a basic scheme of public charging stations (managed by the town or by a partner), including the installation of 1-2 charging stations from the eGUTS project.

5.2 Based on the results and experience gained from the eGUTS pilot project on electric bicycles, consider further extending of the e-bike-sharing scheme (electric bicycles, charging stations)

5.3 Assessment of the scope of public transport and an adaption of timetables to the needs of passengers (the needs of passengers arise from the general plan of transport and these requirements need to be adapted mostly from the time point of view - coordination within the integrated transport, beginning and end of classes at schools, nursery schools, etc.)

A part of the proposal section is also a description and an explanation of each measure together with a proposal for the implementation of the measure up to the individual project phases.

In case of adoption of other strategic documents that may have an impact on the LAP (Transport master plan, Sustainable urban mobility plan, Sustainable energy action plan, Cycling strategy, etc.), the LAP needs to be updated so that these documents form a complex but coherent ecosystem.

4 Conclusions

The primary role in fulfilling the defined measures and objectives of the LAP is played by the self-government – Municipality of Senec. Of course, the Municipality itself

cannot create the necessary framework ("ecosystem") at the local level. This framework interacts with many entities similarly as it is in the Smart City concept. To implement the framework successfully, it is necessary to cooperate with all participants who can help the town to achieve the goal - public, third sector, education institutions, private sector.

The result will then be an increase in awareness (Smart People in the Smart City concept) and a continuously balanced increase in electromobility in the town without significant excesses (e.g. excess demand for charging compared to supply or vice versa, or insufficient energy infrastructure for charging infrastructure needs).

Considering the rapidly changing world of electromobility, not only the political national framework but especially technological development, it will be necessary in the future to update the LAP and adapt it to current needs. The update period should be 2 years.

The town Senec is interested in continuing in the strategy of development of electromobility in the European Union and in the Slovak Republic and aims to build an "ecosystem" with a gradual reduction of emissions from the perspective of local transport as an ecological alternative which contributes to increase in the quality of life in cities by eliminating emission burden and acoustic smog. In the recent past, several strategic documents defining the electromobility framework have been developed in the Slovak Republic at the national level, and they should be subsequently transformed into specific implementation and support measures. However, it can be assumed that the overall ecosystem will be substantially affected by the consistency of national policy and the promotion of electromobility.

The Municipality of Senec has been actively involved in projects and support actions related to electromobility and it also intends to continue to act. It has also initiated the e-mobility Local Action Plan for the town Senec and considers it seriously. It is aware of the dynamic environment not only in terms of technological progress in the field of electromobility but also in the regulation of the automotive industry and it is therefore essential to be fully prepared for the rapid development of electromobility in the medium-term horizon.

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