ALGORITHM TO CHOOSE ENERGY GENERATION MULTIPLE ROLE STATION

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Abstract *- This paper proposes an algorithm that is based on a complex analysis method that is used for choosing the configuration of a power station. The station generates electric energy and hydrogen, and serves a "green" highway. The elements that need to be considered are: energy efficiency, location, availability of primary energy sources in the area, investment cost, workforce, environmental impact, compatibility with existing systems, meantime between failure.*

Keywords: algorithm, multiple role station, solar and wind energy.

INTRODUCTION

The algorithm proposes an analyze method for the selection of an energy producing system that generates electricity and hydrogen, by considering the determinant elements. This satisfies both criteria, like the concept of globalization by introducing generally accepted criteria available worldwide, but aims to meet the concept of sustainable development, in that it stimulates ecological methods which is based on renewable energy, like process of selection with a low degree of pollution and minimal negative impact on the environment. Over the time, results in this area have been centralized in databases. These are quantified and tabulated according to certain criteria. Basing on them it can be obtained determinant scores for choosing of a particular configuration of the power generation station in a given area.

Importance stems from the fact that the proposed method is fast, cheap and determined in the initial selection process.

Currently, are highways at worldwide which have been implemented hydrogen fueling stations and electricity for hybrid and electric cars, in various configurations. This is exemplified in references [1], [2], [3], [4] and [5]. Also there are the famous manufacturers in the automotive field which produce performance proper equipment this goal: [6], [7], [8] and [9]. Legislation and it comes in support of this idea by introducing the bonus for stimulating sales of this kind of auto, and by restrictive rules on pollution. There are, however, problems in producing and selling hybrid and electric car due mainly insignificant infrastructure, for alimentation with energy , designed in unique worldwide standardized mod.

The novelty of the proposed method, results from the fact that is reduced the selection time for configurating energy producing station, in addition at enforce a framework standardization, beneficial for both vehicle manufacturers and producers of equipments for power generation and hydrogen.

THE MULTIPLE ROLE STATION CONCEPT

We will define multiple role station as the station that produces electricity and hydrogen from conversion of renewable energy (solar and wind) and water electrolysis, both to meet their needs and to power electric and hybrid vehicles.

Flowchart of this type of stations is shown in fig. 1.

Constructively station will have elements to capture and conversion of renewable energy in electricity, as solar panels and wind turbines. The electric energy thus obtained is stored in own batteries and batteries for electric or hybrid cars. With a part of the electricity will be supplied to the electrolysis cells to obtain hydrogen. Hydrogen thus obtained will be stored as gas or metal hydrides in containers. It will be used by vehicles with internal combustion engines compatible to hydrogen or electric cars with fuel cells.

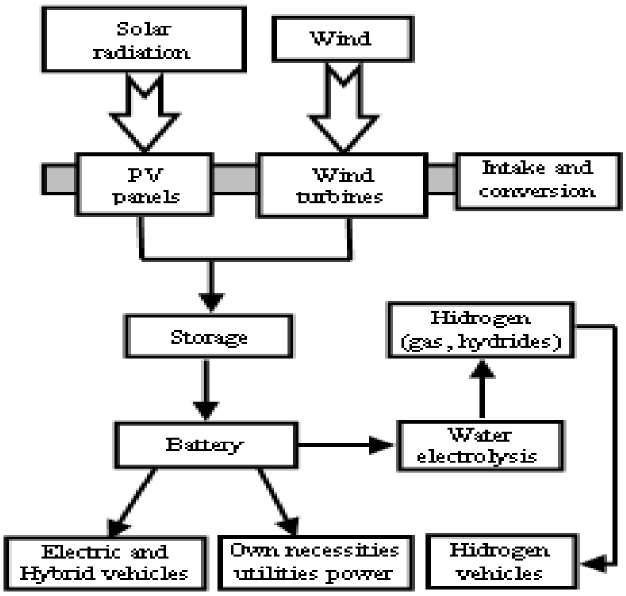

Fig. 1. Logic diagram of multiple role station which serving a 'green' highway

It can be seen that such a multiple role station covers energy needs for a wide range of vehicle types.

This type of station presume a high degree of autonomy and a negative environmental impact as low as possible. They will be located on existing highways making them "green" or new highways to be built, as "green" highways.

The role of the proposed algorithm is to select the most efficient solution based on the analysis of initial conditions (location, emplacement, primary energy sources, methods of capture and conversion energy, etc.) and final conditions (delivery electricity and hydrogen) and the determinants of collateral factors (pollution, workers-employees, etc.) to following a bigger autonomy and high technical performance in exploitation.

METHOD OF ANALYSIS

The method of analysis presume defining selection criteria based on the analysis of important determinant factors for each echelon set. In this signification, as key factors are listed below possible viable options:

F_1 - energy efficiency of source of energy production;
F_2 - installations (equipment) prices;
F_3 - availability of primary energy sources in the area;
F_4 - taking over existing components already in production;
F_5 - costs of design new equipment;
F_6 - costs of new equipment testing;
F_7 - cost of installation and putting into operation of equipments;
F_8 - employment for service (taking into account the readiness);
F_9 - wastes results;
F_{10} - environment impact (due to the operation, and consequences from exploitation of primary sources);
F_{11} - compatibility with existing systems;
F_{12} - life use;

These criteria are most important. List is perfectible and can be completed in case of apparition at new criteria whose importance can play a significant role in the final decision. Below is presented the table for a specific award criterion score (F_i).

Table 1

Score	Classification by importance
10	Most favorable option
9	
8	
7	
6	
5	Medium favorable option
4	
3	
2	
1	Least favorable option

These scores are the elements of performance vector. For more accuracy of obtained result the elements of performance vector will be corrected by a scalar product with share vector elements. I mean, from a mathematical perspective we have the relation:

$$A = \vec{P} \cdot \vec{F} \qquad (1)$$

where: A – Total algorithm score,

$$\vec{P}\,(P_1, P_2, P_3, P_4, P_4, P_5, P_6, P_7, P_8, P_9, P_{10}, P_{11}, P_{12})$$

– share vector,

$$\vec{F}\,(F_1, F_2, F_3, F_4, F_4, F_5, F_6, F_7, F_8, F_9, F_{10}, F_{11}, F_{12})$$

– performance vector

Principle of analysis is as follows.

Is chosen the method of energy production based on primary sources. Then sets the location (emplacement) of power station. Having established that primary things is move on to award scores based on evaluation tables. Applying that algorithm we obtain a certain amount of score. Next it will review other options beginning from initial method of energy production and continuing with possible variants for other criteria. The result with the highest score is the one that will enforce the final scheme of multiple role station.

CASE STUDY

To analyze the opportunity of achieving a multiple role station which produce hydrogen from water electrolysis using the electricity power supply from renewable energy sources (solar and wind) we start from a real scheme of installation as shown in Fig 2.

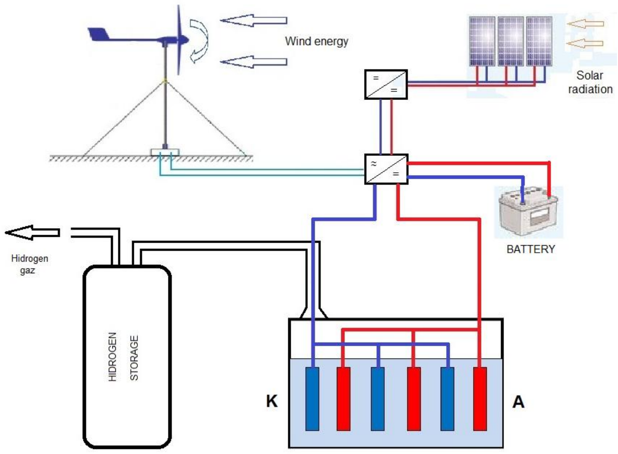

Fig. 2. The schematic diagram of hydrogen production plant using renewable energy converted in electricity

As initial data we have:

- Renewable energy sources: solar energy and wind energy;
- Source of obtaining hydrogen - water: local river system, the method of obtaining hydrogen - electrolysis;
- Most components of installations are in mass production;
- The new introduced systems are compatible with the classic systems, from a technical standpoint;
- The workers for equipment maintenance will be provided by personnel performing self commuting, with the possibility of subsequent use of local staff;
- The environmental impact is minimal, both in terms of operation, and subsequently resulting products.

In a first step one can take the value of score vector:

$$\vec{P}\ (0.83, 0.83, 0.83, \dots, 0.83, 0.83, 0.83, 0.83) \qquad (2)$$

There are tables with scores which corresponding to different above criteria(are just a few examples).

F_1 - energy efficiency of source of energy production

Score	Classification by importance
10	> 90%
9	80% ÷ 90%
8	70% ÷ 80%
7	60% ÷ 70%
6	50% ÷ 60%
5	40% ÷ 50%
4	30% ÷ 40%
3	20% ÷ 30%
2	10% ÷ 20%
1	< 10%

F_3 - availability of primary energy sources in the area

Score	Classification by importance
10	Local primary energy sources (<1km)
9	
8	
7	
6	
5	Far away primary energy sources (require road or railway transport)
4	
3	
2	
1	Very far away primary energy sources (require shipping or air transport)

F_8 - employment for service (taking into account the readiness)

Score	Classification by importance
10	Employees residing in the area
9	
8	
7	Employees require road or railway transport
6	
5	
4	Employees require shipping or air transport
3	
2	
1	Employees requiring accommodation space and canteens

F_9 - wastes results

Score	Classification by importance
10	Insignificant wastes results
9	
8	Minor wastes results and recyclable
7	
6	
5	
4	Minor wastes results and partially recyclable
3	
1	Wastes results are not recyclable

F_{10} - environment impact

Score	Classification by importance
10	System fits very well in the environment
9	
8	
7	Relatively compatible system environment (minor negative impact)
6	
5	
4	System partially compatible with the environment (significant negative impact)
3	
2	
1	System incompatible with the environment

F_{11} - compatibility with existing systems

Score	Classification by importance
10	System fully compatible with existing
9	
8	
7	System partially compatible with existing (require minor adaptations)
6	
5	
4	System partially compatible with existing (require significant adjustments)
3	
2	
1	System incompatible with that existing

The result for the above case is:

$$A = 0.83 \cdot 5 + 0.83 \cdot 7 + 0.83 \cdot 10 + 0.83 \cdot 9 + 0.83 \cdot 8 + 0.83 \cdot 8$$
$$+ 0.83 \cdot 6 + 0.83 \cdot 9 + 0.83 \cdot 9 + 0.83 \cdot 9 + 0.83 \cdot 10 + 0.83 \cdot 7$$

Final result: A = 80.51

For other cases we obtain values corresponding to the new elements values of the two vectors. Subsequently compare the final results obtained and choose the method with the highest result.

So even if the process of obtaining hydrogen from water by electrolysis have relatively small efficiency if compared to other processes, the fact that raw material that we have at hand, and electricity which is almost free, this method will have primacy over other methods, as shown by the obtained result.

CONCLUSIONs

The advantage of the proposed method is that as with this method the analysis of selections can be chosen a way which technically is not listed with the highest yield, but overall proves to be the most efficiency. In addition the method is rapid and efficient and have low costs, with measurable results. This algorithm makes it clear whether the proposed solution is viable or not.

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