MOBILE EQUIPMENT PRODUCING ELECTRIC ENERGY USING RENEWABLE SOURCES

Peter LIPTÁK[1] – Ivan KOPECKÝ[2]*

[1]*Assoc. Prof. Peter Lipták, Faculty of Special Technology, Alexander Dubček University of Trenčín, Pri Parku 19, 911 06 Trenčín, Slovakia*

[2]*Dipl. Eng. Ivan Kopecký, PhD., Faculty of Special Technology, Alexander Dubček University of Trenčín, Pri Parku 19, 911 06 Trenčín, Slovakia*

*Corresponding author E-mail address: peter.liptak@tnuni.sk, ivan.kopecky@tnuni.sk

Abstract

Renewable sources of electric energy are prospective sources; they are cheap, available and prospective. Decrease of an intensity of energy supply can be substitute through a mutual combination with other source. The paper deals with a situation when wind, water sources and solar energy are used. The possibility and intensity of supplies is monitored with PC in form of user software based on which the sources are being switched on for operation. In case of a dropout they are substituted with diesel electric sources of energy. Energy can be stored in accumulators and regulated with regulators and converters. The whole equipment is placed in containers, it means, that it is mobile and applicable in any conditions.

The equipment has been designed in a prototype based on a project and currently it is measured and tested. The paper provides preliminary results of such operation.

Keywords: mobile equipment, container, photovoltaic collector, wind turbine, an electric source plant.

1 Introduction

At present the use of renewable sources of electric energy has still been an up-to-date subject. This trend permeates also into mobile equipment and its application would be beneficial also in ISO 1C containers being used as mobile logistic means. Using non-conventional sources a mobile logistic means would be independent on outer power system, but also on electric source aggregate and it would have an own variant solution in gaining electric energy. With the constant growth of energy consumption and the gradual drawdown of non-renewable resources, an increasing ratio of renewable energy is obvious.

The renewable sources include:

- Sun,
- water,
- wind,
- biomass, biogas, bio-oil,
- geothermal energy,
- sea energy – tides, streams, sea waves, surf.

Water and wind energy is used the most, their operational costs for production of electric energy are low. Currently they contribute with about 22 % into a global installed capacity. The photovoltaic – direct transition of a solar energy in electrical one is the most expensive. Use of biomass is cost demanding as well, especially because of transportation of the mass scattered in a large area.

Using of geothermal energy to produce electricity in a larger scale is not feasible, as the sources temperature are insufficient for a production of an overheated steam for a turbine.

Other perspective sources of energy can be taken into consideration, namely using of resin slates and tarred sands, using of tides, sea streams, difference between temperatures of surface waters in tropics and colder deeper waters as well as using the energy produced from waste. Helium is considered as a fuel of the future. More used will also be the energy gasses (for example propane and butane). Research of fuel cells has been developing hopefully as well as biological transformations of energy using microorganisms for the production of methane and hydrogen.

Although Slovakia has undertaken to gradually increase the share of electricity produced from renewable sources, this is happening very slowly. Hydro power plants has been lagging due to drought and solar business is hampered by government. Most electricity in our country is still produced by nuclear power plants.

***Table 1** Informative overview of electric energy sources and its ratio in a total amount produced in Slovakia [2]*

Production from nucleus (in %) 53,8	**Annual output* (2012, in TWh) 7,4244**	**Installed capacity** (2012, in MW) 1940**
Production in thermal plants (in %) 18,1	**Annual output (2012, in TWh) 2,4978**	**Installed capacity (2012, in MW) 3418**
Production from water (in %) 15,1	**Annual output (2012, in TWh) 2,0838**	**Installed capacity (2012, in MW) 2534**
Production from solar energy (in %) 2	**Annual output (2012, in TWh) 0,2760**	**Installed capacity (2012, in MW) 524**
Other production (in %) 11	**Annual output (2012,in TWh) 1,3248**	**Installed capacity (2012, in MW) 15**

2 Electric sources for mobile repair shops in ISO 1C containers

Electric source plants in ISO 1C containers are assigned for a production and distribution of electric energy as a back-up power supply to ensure an operation of electrical facilities in field conditions. They include a drive unit, an energy producing unit, a transformer and a supply wiring network. The power block is installed on an ISO 1C container, it is sound- and heat proofed, tempering and airing is provided by an embedded draining fan and through orifices for airing with closing blinds. The container´s flood is designed as a leak-proof tub collecting possible leakages of operating liquids. Part of the container is also a handy storage for power supply cables and for power unit accessories. The ISO 1C container is equipped with a large door with a visor and detachable panels for an easy access for an everyday maintenance. [4]

***Fig. 1** Electric source plant MP-250, P_n =200 kW (ISAF military mission in Afghanistan)*

2.1 Requirements for electric sources for mobile repair shops

One of the most important requirements for electric sources for mobile repair shops is their applicability in macro climate area with a clime defined in N 14 (STN 03 8206):

- Temperatures ranging from -35 °C up to +55 °C,
- Air relative humidity up to 30% at +25 °C temperature,
- Air speed up to 20 m.s^{-1} from all directions,

  Atmospheric precipitations in form of a rain and with intensity of 3 mm.min^{-1} falling under an angle of 30° in all directions. [4]

They need to be made out so that several kinds of distribution systems can be plugged in.

- TN – C, 3 + PEN, 400/231 V – the most common four-wire power supply system.

- TN – S, 3 + PE + N, 400/231 V –a power supply system being used in the world,

- TT, 3 + PE + N, 400/231V – a power supply system, being rarely used, however it can be found in power supply systems in special equipment,

- IT, 3 + PE + N, 400/231 V –an isolated system, being used mainly in special or medical equipment and in power supply facilities for island power supply facilities. [4].

3 Technical specifications for sources of electrical energy in ISO 1C container

A source or a set of sources of electric energy must be able to manage with a load through deliveries of a stable frequency and voltage. For impedances of inductive and capacity types it is needed to take into consideration an increased demand when launched, for example for example a starting input is 1 up to 1,5 times higher for series engines than for a common input; a starting input for inductive or asynchronous engine is usually even 2,5 times to 5 times higher. The most exact way how to define a starting input is by measuring an input of a load at launching and a common input is measured during an operation with an inductive ampere-meter. Therefore the output should be defined in such a way, that a starting input does not exceed a maximum capacity of the electric energy source. Otherwise, the appliances, especially engines could be overheated and damaged due to poor input, especially when engines start too long due to insufficient power supply. In addition, an anticipated frequency of switching on/off for such kind of load should be taken into consideration and adequately a source or a set of sources of electric energy with a sufficient reserve in a capacity to be chosen.

Table. 2 *Electric parameters of some logistic container working places*

Designation of logistic assets	**Mains system**	**Maximum electric input (kW)**	**Output of own source (kW)**
Container ISO 1C – social	TN.S 3+N+PE 400/230V AC 50Hz	18,2	0
Container ISO 1C – water tank	TN.S 1+N+PE 1x 230V, 50Hz	1,25	0
Container ISO 1C – accommodation, 2 beds	TN.S 3+N+PE 400/230V AC 50Hz	5,5	0
Container ISO 1C – accommodation, 4 beds	TN.S 3+N+PE 400/230V AC 50Hz	5,5	0
Container ISO 1C – briefing, folding, 3-wall	TN.S 3+N+PE 400/230V AC 50Hz	7,5	0
Container ISO 1C - office	TN.S 3+N+PE 400/230V AC 50Hz	6	0
Container ISO 1C – cooling assets for deceased	TN.S 3+N+PE 400/230V AC 50Hz	5,1	0
Container ISO 1C – cooling, two chambers	TN.S 3+N+PE 3x 400V, 50Hz	4,8	Combustion engine
Container ISO 1C – surgery	TN.S 3+N+PE 400/230V AC 50Hz	9,5	
Container ISO 1C – mobile shop of „A", "B" and "C" type	TN.S 3+N+PE 400/230V AC 50Hz	15	5,1

3.1 Technical equipment of mobile container assets

Technical equipment of mobile repair assets may differ depending on their assignment. Table 2 provides an overview of the mostly used logistic working places in overseas missions of the Slovak Armed Forces and their electrical parameters.

A corrective coefficient forms a part of a project of an energy source from an installed capacity of all appliances in stable electric mains, adjusting an installed capacity. Nowadays the standard recommends the following coefficients:

Table 3 *A corrective input coefficient*

Number of powered appliances / rooms	2	3	4	5	6	7	10	16	20
Coefficient	0,77	0,66	0,60	0,56	0,53	0,50	0,45	0,40	0,38

The designers may define their own coefficients based on their own experience and knowledge. [1]

For example:

The 1st multifunctional engineering unit of the Slovak Armed Forces, ISAF Afghanistan. In a camp 2 there were in 2011 year the following appliances installed:

Containers, accommodation 15 pcs...............about 82,5 kW
Containers, social 2 pcs...............about 36,- kW
Containers, water tanks 2 pcs........... .. about 2,5 kW
Containers, three-wall 2 pcs............. about 12,- kW
Other appliances .... about 2,- kW
In total: **135,-** kW

A real electric input was measured in June 2011 at an external temperature of 42 ºC amounting **34 kW.**
The electrical input per 1 container was calculated equal to 1,62 **kW,** representing a value of an input coefficient equal to **0,25.**

The 2nd multifunctional engineering unit of the Slovak Armed Forces, ISAF Afghanistan. In camp1 there were in 2011 the following appliances installed:

Containers, accommodation 23 pcs............ about 126,5 kW
Containers, office 5 pcs ....about 30.- kW
Containers, social 3 pcs ....about 58,5 kW
Containers, for briefings 4 pcs ..... …....about 30,- kW
Containers, special 5 pcs..............about 31,- kW
Other appliances................................... about 4,- kW
In total: **280,- kW**

A real electric input was measured in June 2011 at an external temperature of 42 ºC amounting **75 kW.**
The electrical input per 1 container was calculated equal to **1,88 kW**, representing a value of an input coefficient equal to **0,27.**

Fig. 2 *Container dressing station with an island power plant based on renewable source of energy*

4 Conclusion

Rapid growth of commercial deployment of power technologies using renewable technologies has recently shifted this energy alternatives into the economic and political focus. The a hybrid set of power sources suitable for mobile container resources are proposed in combination with external power system and a complementary photovoltaic system, in case when diesel electricity generating assets are not available. Mobile container logistic assets, where an electric energy plant is a source of energy can be easily noticed because of a noise, generated heat and exhausted gases. On contrary, application of photovoltaic system is noiseless, with no heat or exhausted gases, whereby the operational costs are minimal. Just a photovoltaic system can be used in a proposed set of electric energy sources, however only with a limited output. This set of electric energy sources has been proposed for mobile container assets being currently produced with a possible application of comparable container working places and systems.

Acknowledgements
This publication was created in the frame of the project Research of a technological base for draft of application of renewable sources of energy in practice, ITMS code 26220220083, of the Operational Program Research and Development funded from the European Fundof Regional Development.

References

[1] http://referaty.atlas.sk, [11.1.2012],
[2] Hospodárske noviny, štvrtok 26.septembra 2013,
[3] Počty použitých kontajnerov v Slovenských operáciách NATO. Dostupné z ministerstva obrany Slovenskej republiky, zo dňa 17.5.2013,
[4] Lipták, P. - Kopecký, I. – Galeta, A.: Špeciálna technika, časť Stroje a zariadenia Trenčín, 2005, ISBN 80-8075-053-X,
[5] Vojenský opravárenský podnik Trenčín, a.s.: Technický popis návod na obsluhu a opravy - Kontajner ISO 1C Energetický blok,
[6] Solárne (fotovoltaické) články, Cez.cz [2012-01-30], dostupné na http://www.cez.cz/edee/content/microsites/solarni/k32.htm.