J. Basic. Appl. Sci. Res., 3(3)325-333, 2013
ISSN 2090-4304
Journal of Basic and Applied Scientific Research
www.textroad.com

Modeling of a City with Fixed Speed Breaker at Streets as Electrical Generators and its Legal Aspects

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ABSTRACT

The increasing trend of world energy consumption cause to an active movement to find new resources of energies. The wasted energy in speed breakers at streets can be one of these options. In this paper, modeling of a city in view of speed breakers is carried out. Moreover, due to novelty of such new resource of energy, suitable energy laws were discussed. An electrical circuit analysis approach for modeling of a city with fixed speed breaker generators (SBGs) at its streets is proposed, but also. In this model, each street with fixed SBG at it modeled as a branch with a resistor while the flow of vehicles is considered as electrical current in the resistor. Output electrical energy the SPGs in the modeled is estimated using parametrical approach. A case study includes SBGs with rated power of 2kW which are fixed at three streets, was studied. The comparison between obtained results and the estimations confirms the effectiveness and validity of proposed model.

KEYWORDS: SBG, branch, speed breaker, node. Energy law

INTRODUCTION

Renewable energies refer to wind, solar, biomass and marine current which are less harmful to environment. These energy resources attract researcher attention in design and development of many types of energy converters. Although improvement of renewable energy technology is in a fast development, the system to extract wasted energy in conventional energy conversion systems is not developed as level as it is necessary.

In many systems and processes, like speed breakers, dissipation of energy is inevitable, whatever we use renewable or conventional energies. For instance, to ensure security of populated areas of the streets, speed breakers are required, whatever we use electrical cars or conventional cars. There are many similar cases that such vast energy is wasting: such as an elevator during going down, a car during going down on a sloppy street, which systematically energy is wasting while it doesn't refer to efficiency of used system or which type of energy is used. It mainly is refer to the operation process of the systems.

Although there are many cases such problem is exist, in this paper we focused on the speed breakers fixed on the street for reduction of cars speed in populated areas. There are several southbound streets with fixed speed breaker on them. The wasted energy in this street is enough to power the streets lightning system. One way is converting the absorbed kinetic energy of vehicle by the speed breaker to electrical energy.

In [1], to extract the wasted energy in the speed breakers we proposed a speed breaker generator (SBG). SBG will be installed instead of speed breaker in the street. As a car passes over the SBG, the SBG converts the absorbed kinetic energy to the electrical energy. This SBG has three stationary parts (stators), and two moving part (translators) shown in Fig.1.

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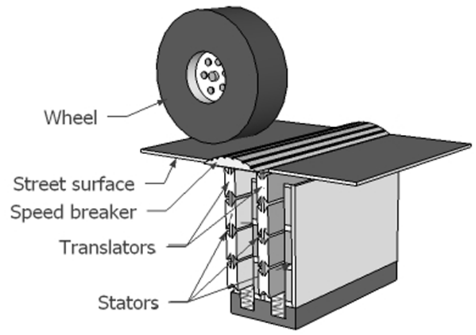

Figure.1 Side view representation of the SBG

By passing car over the SPG due to kinetic energy of the vehicle wheels will press the translator into down which cause to inductance of voltage in stator winding which lead to flow electrical current, is providing electrical power at it output terminals. The principle of working of other generators presented in [3] and [4] also is similar SBG.

Scientific contribution of this paper

1.Modeling approaches for a city winch fixed using electrical circuit analysis is presented.
2. Suitable energy laws for such resource of energy were discussed.

This paper starts by modeling of the streets, vehicle and vehicle flow. Based on the proposed model for the streets and vehicles flow, a city is considered as a network of oriented branches and modeled. Then, the city is divided to several areas. For each area, extract power is estimated using equivalent resistance. Furthermore the total extract power is estimated for a complete city. Finally the needed energy laws for such new resources of energy s discussed and presented.

MODELLING

Circuit

Each city simply can be model as oriented graphs. In this graph, each branch presents a street. Each branch limited to two junctions as shown in Fig.2. Due to laws vehicle should be move in determined direction we used oriented graph to show this direction of car flows.

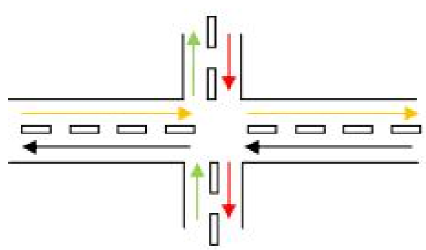

Fig. 2. Two directional streets

The corresponding oriented graph shown in Fig.2. As seen, in this graph the junctions are shown as nodes.

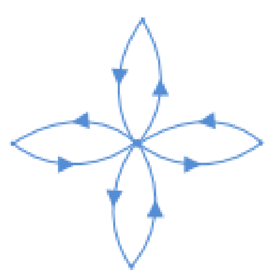

Fig. 3. The oriented graph of the street

Voltage

In a circuit, voltage provides a magnetic field in conductor, causing the electron to move. Similarly there is a factor causes the drivers to move to a specific location. For instance a factory causes to an alternative flow of worker, who have car, from home to factory every day. We need to define a quantity cause to flowing of vehicles in street in volt. We can consider an electric field around a specific point which attracts peoples. Thus, electric field can be expressed as:

$$E = K \, {}^{q}/_{r^2} \qquad (1)$$

By definition of electric field, we can define 1 volt as the needed energy to attract a unit-vehicle from home to a specific location in the unity electric field. Unit-vehicle will be defined in proceeding of this paper in the next section. For instance, the voltage over a street is total voltages produced by office, shopping center, and a park which attracts the drivers to them for it demands.

Since centers which attracts the people, like park and shopping centers and office or air condition of the street or view of the street, we can defined enhancement factor for them can be simply presented as a voltage source E_P shown in Fig.4.

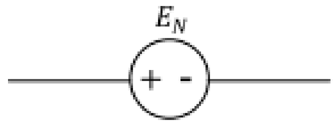

Fig. 4 Positive voltage enhancing the current in street

In contrast, for example a bad air condition of a street or its unpleasing view can be presented as negative voltage source of E_N shown in Fig.5 which decreases the vehicle flow.

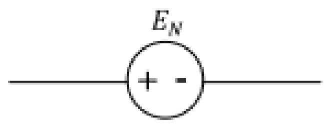

Fig. 5 Negative voltage source reducing the current

Such definition will able us to calculate voltage of each point in a city to a reference value. It is possible when the resistance and current are being defined. Then, we can measure potential of each point for flowing the driver in street with experimental, and statistic data.

Current

Statistic data of numbers of the crossed vehicles in a street in a small city can be obtained using an electronic counter with a sensor as shown in Fig.6 positioned on streets. The counter not only counts the number of vehicles, but also it measures the length of the vehicle which able us to estimate the weight of vehicle by determination type of vehicle and looking up in data base.

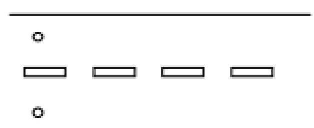

Fig. 6 The positioned sensor in the street

The received signals by the counter can be as shows in Fig.7. The interval time of $t_0 - t_1$ refers to a small length cars while the $t_2 - t_3$ refers to a long length cars. For instance, a small car has average length of 2.5m while a truck has average length of 10m, and a bus has average length of 15m. We consider the vehicles are not completely occupied with load or passengers.

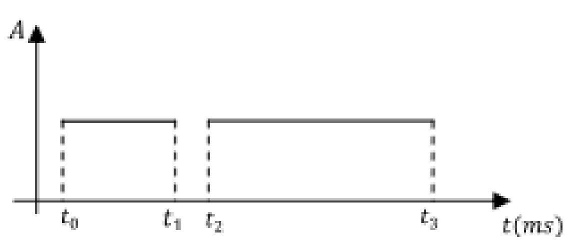

Fig. 7. The output signals of the sensors

Since the vehicles are different in speed and mass, we should define a unite-vehicle. An unite vehicle is a vehicle with mass of 1kilogram and speed of 1m/s. Thus, kinetic energy of the unit-vehicle is:

$$K_{unite} = {}^{1}/_{2} \, M_{unit} V_{unite}{}^{2} \qquad (2)$$

$$= 0.5 jouls$$

The average number of unite vehicle is in a street is:

$$n_{unite} = \frac{\sum_{i=1}^{n} {}^{1}/_{2} M_i V_i^{2}}{K_{unite}} \tag{3}$$

Also, average flow of kinetic power in street is defined as:

$$I = \frac{n_i K_{unite}}{T} \tag{4}$$

It should be noted that, to control the traffic lately a new electronic device is used in the cars [2]. This system sends and receives messages from ahead and back cars which cause to a lighter traffic. Application of this system will change the pattern of vehicles flow. Since in most countries such device is not widely used, in this research we considered the natural flow of cars which are not equipped with the system.

Street Resistance

Resistance of each street relates mainly to the width of street. As the street is wider, the flow of cars increases as shown in Fig.8. Another factor is type of material which is covering the street. For instance, for a paved street, speed of car is more respect to a dirt street. Another factor is numbers of installed speed breaker at the street which can influence on the flow of cars. But, we did not accommodate them in resistance of street. It independently will be calculate and presented in the next section. The third factor refers to driving rules in specific street limits the speed in urban areas.

Thus, resistance of each street can be found by:

$$R_s = \rho \frac{K_s}{W} \tag{5}$$

Where W is the windth of street in meter and $K_s = K_Q K_{en}$ is dimensionless coefficient of street is multiplication of three factors of coverage material K_c and environmental coefficient K_{en}.The ρ is resistivity of a street with widths of 1meter and K_s of 1.

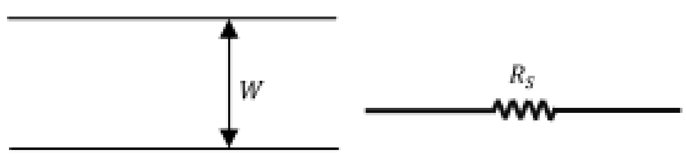

Fig. 8 Modeling of street with a resistor

Therefore, $R_S I^2$ is the kinetic power dissipated as heat, and sound due to street friction in the street.

Speed Breaker Resistance

As mentioned, the flow of the car in a street is affected by number of speed breakers reduce the speed of the cars. In other word, the speed breakers decrease the current. Thus, the speed breakers can be modeled as R_{SBG} which is shown in Fig.9.

Fig. 10 Modeled speed breaker as resistor

Therefore, the term$R_{SBG} I^2$ is refers to the kinetic power dissipated as heat and sound in the speed breaker. Resistance of a speed breaker can be found be statistic data.

Finally each branch or street can be model as two series resistors and the two voltage sources shown in Fig.11

By definition of resistance and current, the relation between the current and voltage will be:

$$R = \frac{V_S}{I} \tag{6}$$

Consequently voltage of each site will be:

$$V_{site} = RI \tag{7}$$

Since R_{SBG} is more effective thanR_S; $R_{SBG} \gg R_S$ we can neglect the R_S thus each branch simply can be shown as Fig.11.

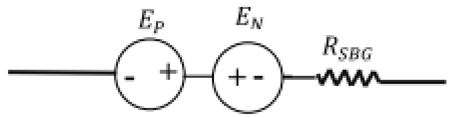

Fig. 11 Street model which street resistance is neglected

And it become simpler when two voltage sources of the branch represented by net voltage denote as E. Then each branch can be shown as Fig.12

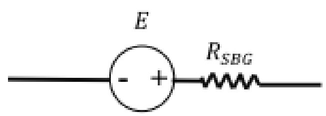

Fig. 12 Simplified model of street

OBTIANED FEATURES

Interesting advantage of using such models is that we can find total extracted energy of two series streets by equivalent circuit. In series mode the equivalent resistance is:

$$R_{SBGeq} = R_{SBG\,1} + R_{SBG\,2} \tag{8}$$

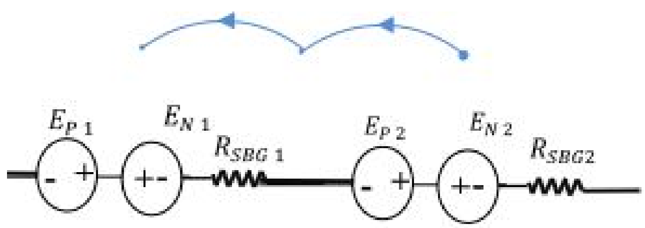

Fig. 13. The series streets and equivalent resistance

In paralleled street with common ends the equivalent resistance which is shown in Fig.14 is:

$$\frac{1}{R_{SBGeq}} = \frac{1}{R_{SBG\,1}} + \frac{1}{R_{SBG\,2}} \tag{9}$$

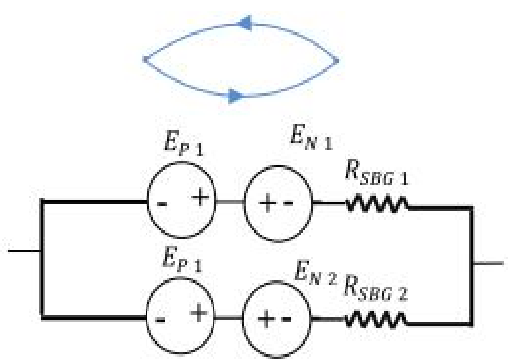

Fig. 14 The parallel streets and equivalent resistance

ESTIMATION OF EXTRACT ENERGY IN A CITY

Consider a city which due to connection of SBGs in each area of city is dividing to several areas as shown in Fig.15. The SBGs in each area are connected together. The next propose is to estimate the total extract energy in the city. It should be noted that solar cell can be positioned on the SBG can highly increase the output power.

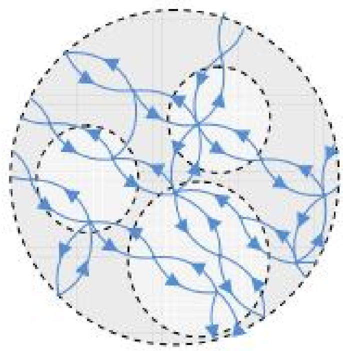

Fig. 15. The modeled city with branch and node

We require modeling the city with electrical circuit for estimation of total extracted energy by SBGs in the city shown in Fig.16

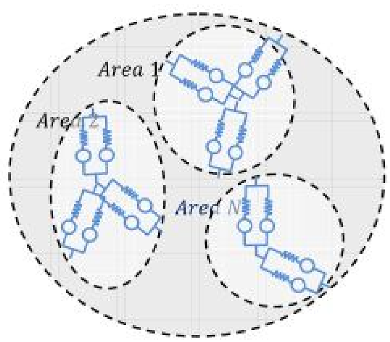

Fig. 16 The electrical model of the city with its sections

To estimate extracted energy in each area we need equivalent resistance of each area. Using cut set around each area realized that entered current into the areas is equal to output current of the area.

Thus, the estimate power for $Area.1$, $Area.2$..., and $Area.N$ are:

$$P_{Area\ 1} = R_{eq-1} I^2 \tag{10}$$

$$\dots$$

$$P_{Arean} = R_{eq-n} I^2 \tag{11}$$

Where, $R_{SBG.eq}$ is the equivalent resistance of each of area.

For complete city the extracted energy is:

$$P_{city} = \sum_{i=1}^{N} P_{Areai} \tag{12}$$

CASE STUDY

To verify validation of the proposed model, especially accuracy of equivalent circuit relations in parallel and series modes, three streets in a small city are selected. As shown in Fig.17, the first and second streets are parallel to another one while both of them are series with third one Three SBG are installed on the chosen streets as seen in Fig.16.

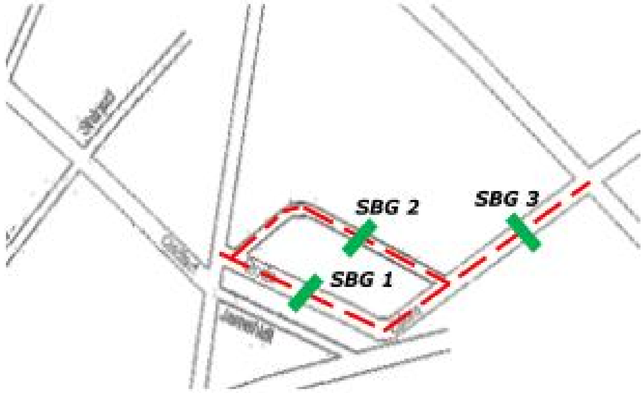

Fig. 17. Three street with fixed SPGs

Fig.18 shows the modeling of the case study with oriented graph. The selected streets are denoted as doted lines.

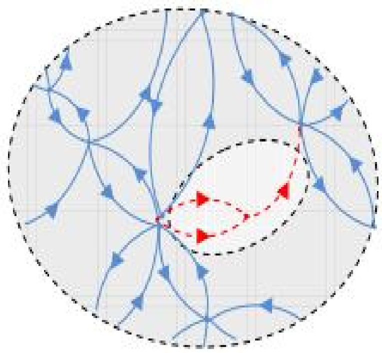

Fig. 18. The modeled city oriented graph

The corresponding electrical circuit model is shown in Fig.19.

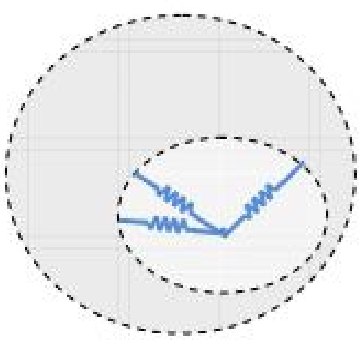

Fig. 19 The electrical model for the specific area including the three streets

Finally to estimate the total extract power of this area including the three SBGs, the derived equivalent resistor is shown in Fig.20.

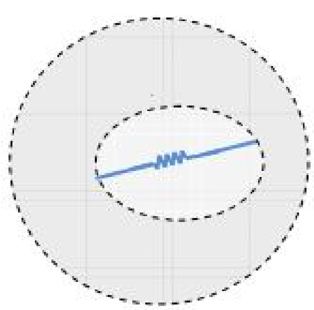

Fig. 20. The equivalent circuit of the area

The voltage over this area regard to located shopping center and a park at the end of the parallel streets is estimated about 160 volts. By calculation of resistance and voltage division result presented in Table.1.

Table 1

Street	Calculated resistance	Calculated current	R_{SBG} Calculated	Calculated power (w)
Street 1	**1200**	**8**	**620**	**155.7**
Street 2	**1330**	**6**	**56**	**140.165**
Street 3	**800**	**14**	**170**	**220**

Real data from output power of three SBGs as well as the current measured with the counters are given in Table.2

Table 2

Street	Measured current (W)	Measured resistance (w)	R_{SBG}	Measured power (w)
Street 1	9	1800	650	200
Street 2	5	1500	100	150
Street 3	17	1200	120	230

To validate the proposed equivalent resistance relation for series and parallel streets, the compassion between the obtained experimental data and the predicted data are carried out summarized in Table.3

Table 3

Street	Calculated Power (w)	Measure Power (w)	Error%
Street 1, 2	295.7	350	-0.18
Street 1, 3	375.7	430	-0.12
Street 2, 3	360.167	380	0.05
Street 1,2, and 3	514.865	580	-0.12

LEGAL ASPECTS AND THE NEED TO NEW REGULATIONS AND INCENTIVES

Nation-states have an obligation under the Rio Declaration[1] to pursue sustainable development [4]. Regardless of whether this principle is merely "soft" law or is a ripening form of customary law, it seems rather unassailable to declare that the current generation has a moral and ethical obligation to use the earth's resources in such a way that the quality of life of future generations is not compromised. There is various kinds of policy initiatives and the conditions that are necessary to spur more movement to renewable forms of energy.
Many countries to meet the dual goals of environmental sustainability and energy security adopted codes, regulations and incentives[2] to encourage the use of renewable energies.[5] These codes primarily govern the transactional legal and policy issues that surround the development, implementation and commercialization of renewable sources energy [6].
The Scope of these regulations, however, solely includes recognized form of renewable energies such as wind power and solar energies. For example the German renewable energy act 2000, Renewable Energy Law of The People's Republic of China 2005, Australia Renewable Energy Act 2000, Philippine Renewable Energy Act 2008, there is no indication to Fixed Speed Breaker at Streets as Electrical Generators (Which can be considered as a new renewable energy source). Thus, new studies are required as to whether or not this resource of energy is viable and efficient one to be implemented Therefore the unsatisfactory nature of the legal framework to protect use of speed

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[1] The **Rio Declaration on Environment and Development** is adocument produced at the 1992 United Nations "Conference on Environment and Development" (UNCED) consisted of 27 principles intended to guide future sustainable development around the worlds.

[2] American renewable energy policies, for instance, may loosely be categorized as either regulation-based or incentive-based. Regulation-base policies set performance requirements, while incentive-based policies offer inducements without requiring certain behavior.

breakers energies still remains. The analysis of the credible but controversial possibility of resorting to GATT Article XX to justify certain subsidies is one of the examples in point [7].

Contracts for siting, extraction, taxation, licenses for the acquisition and ownership rights in street and speed breakers before installment and after its capture all raise significant legal issues so the regulation of such Laws in this regard is essential. The laws can define means of exploiting, protecting, and developing such wealth in the interests of the city, its security and economy. Energy taxes and preferential measures should specifically be the matter of concern.

Providing Energy Laws for Speed Breakers Energy can help to regulate the amount of energy generated by the producer. It also creates an incentive to encourage technological advancements. Energy Efficiency Standards for SBG also can provide affordable energy by sustaining competitive markets, while protecting the economic, environmental, and security energy in cities.

CONCLUSION AND PERSPECTIVE

The paper devoted to modeling of a city with installed SBGs at its streets. The propose model is based on electrical circuit analysis. The advantage of employment of the model is shown. It has been shown that extract power in each area can be estimated using equivalent resistance of the area. To confirm the effectiveness of the proposed model three streets as a case study are selected. Based on obtained experimental data, validity and effectiveness of the proposed model was confirmed.

REFERENCES

[1] Mohsen Partodezfoli, Abbas Rezaey, Zahra Baniasad, Horieh Rezaey “Design on a novel speed breaker generator”, J. Basic. Appl. Sci. Res., 2(6) 6285-6292, 2012

[2] ABC NEWS. Accessed: Oct 2011.[Online]. Available: www. bcnews.go.com/Technology/PCWorld/story?id=4630544

[3]R. Hassanshahi, M. Fathipour "Design of a New Microfluidic Fuel Cell for Enhanced Current Density and Performance", pp. 649-654, no. 11, 2012

[4] Rio Declaration on Environment and Development, United Nations Environmental Programs (UNEP), Accessed: Feb. 2013 [Online]. Available: www.unep.org/Documents.Multilingual/Default.asp?documentid=78&articleid=1163

[5] Professor Wang Mingyuan, Andreen William L.,” Commentary on Government Incentives to Promote Renewable Energy in the United States” Temp. J. Sci. Tech. & Envtl. L. 351 (2005)

[6] Karen N. Scott, Tilting at Offshore Windmills: Regulating Wind Farm Development within the Renewable Energy Zone, J Environmental Law 2006 18: 89-118

[7] Luca Rubini ,Ain’tWastin’ Time No More: Subsidies for Renewable Energy, The SCM Agreement, Policy Space, and Law Reform, J Int Economic Law 2012 15:p. 525.