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Energy Management Optimizing in Multi Carrier Energy Systems Considering Net Zero Emission and CHP Temperature Effects

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Authors' contributions

This work was carried out in collaboration between both authors. Author SMM designed the study, wrote the protocol, and wrote the first draft of the manuscript. Author SMM managed the literature searches, analyses of the study performed the spectroscopy analysis and author GS managed the experimental process and identified the species of plant. Both authors read and approved the final manuscript.

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ABSTRACT

Aims: The aim of the paper is to create two different models of integrated energy systems (HUBs) that improve combined approach of CHP temperature and net zero emission (NZE) effects.
Study Design: The design model includes two energy HUBs with different characteristics in one hour and twenty-four hours. The cost function of these models are composed of two parts: Part one is related to generation cost and part two is related to emission cost.
Place and Duration of Study: IAU, Iran, January 2015 - January 2016.
Methodology: The model scenario is obtained through MINLP solver of GAMS software version 24.1.2, MATLAB software version 2013 and Excel software version 2010.
Results: The simulation results have shown existence of NZE constraint can that use amounts of carriers that include pollution reduction then and in addition, with costs reduction caused by pollution reduction.

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Conclusion: This paper studies the optimization in energy HUB. Also, the paper has improved combined approach of temperature and emission effects for HUB. The cost function of paper models are composed of two parts; Generation cost and emission cost. The emission penalties caused by change of carriers and generation of toxic gas. Then, combined heat and power (CHP), NZE, ambient temperature equations and constraints on models equations have been investigated. In addition, the innovations of paper are pollution calculation and optimization of the entries in terms of output, weighted coefficient of pollution, adding temperature effect on CHP performance and it's optimization with optimization in generation by minimizing pollution, adding NZE constraint and finding the optimum economic capacity for equipment purchase without paying to additional costs.

Keywords: Ambient temperature effects of CHP; net zero emission (NZE); energy carriers; energy HUB; GAMS software.

1. INTRODUCTION

Climate changes and energy security are among the central parameters that will shape the energy systems world-wide. The built environment stands for close to half of all energy use and emissions. Therefore, this sector will be the central importance for finding solutions to the grand challenges ahead [1]. Integrated energy systems (HUBs) are similar to integrated and interconnected energy systems where multiple energy carriers can be converted, conditioned and stored [2]. Energy carriers such as electricity, natural gas, hydrogen and district heat are significant in commercial, industrial and residential use. Increasingly HUBs have recently received much attention for their environmental benefits against controversial, conventional power plants with their dependency on fossil fuels [3]. Energy HUBs are a relatively new concept and most of the simulation literature in the past has focused only on energy generation systems including independent energy carriers. A few studies have included multi-generation energy systems [2,4,5]. The main advantage of the HUB is improve the overall system performance and reliability by eliminating the intermittency problems of wind and solar energy. Another advantages of the HUBs are through the entry units, energy HUBs consume electricity, heat and chemicals at the same time, they could produce electricity, heat, compressed air and by-products, such as hydrogen at their outputs [2]. Energy HUBs have the potential to offer many advantages compared to the existing conventional energy systems. Motivations and benefits of establishing energy HUBs are due to reliability of supply, increase in the system performance, utilization of various forms of energy, optimization of supply and improvement in the efficiency [2].

Today's economists and strategists, however employ a linear economy model which does not give proper credit to energy and exergy efficiencies together and generally results in a considerable amount of waste and exergy destruction [6].

However, in a HUB when all pollution be zero using renewable energy source, this is called zero emission effect. To achieve this goal the sum of emission cost with negative cost of produced energy from renewable energy must be zero. In this way, the total emission cost would be zero only when it is said net zero emission (NZE). The amount of net zero emission that is different for each hour and it based on the amount of emission cost will be determined at that time. From NZE amount can be use directly to reduce system costs and or to sell excess electricity to the network, or total emission cost can be zero locally. In fact, this constraint for system economic performance is intended its task is zero emission costs, or by creating a mechanism such as operation of solar thermal annealing, etc. Also thermal load alternative has provided in network. Through this action, sum of generated emission amount in network has come zero. In reality, the paper discussed energy HUB optimization by introducing two models with different properties. The paper has improved combined approach the effects of temperature and emission for HUB. The paper has introduced two models with different specifications that the cost function of this models are composed of two parts. The first part is related to the generation cost. The second part of the cost function is related to emission penalties caused by change of carriers and generate of toxic gas. Then, combined heat and power (CHP), NZE ambient temperature equations and constraints on models equations have been investigated.

The paper has been categorized as follows; the second section deals with the problem of paper and modeling. Description simulation algorithm has been done in section three. Simulation results and its analysis have been presented in section four. Finally, conclusion has been presented in section five.

2. THE PROBLEM MODEL

In this section, the problem model is divided into two parts as follows:

2.1 The First Model: System Performance in One Hour

In the first model, energy HUB as shown in Fig. 1.

Fig. 1 (first model of proposed energy HUB) including a CHP, transformers and thermal furnaces. The system entries are electric power (energy), natural gas, different fuels and electricity, heat achieved in output. In the first model, the performance time amount has considered one hour (unit commitment).

First model equations have defined as follows in equations 1-8 [1]:

$$L^e = \left\{ \eta^T P^e + \eta^{CHP^e} P^g \right\} \tag{1}$$

$$L^h = \left\{ (\eta^{CHP^h} P^g) + (\eta^{HE} P^h) \right\} \tag{2}$$

If equations 1 and 2 will be written in matrix form, then equations 1 and 2 are defined as follows in equation 3:

$$\begin{bmatrix} L^e \\ L^h \end{bmatrix} = \begin{bmatrix} \eta^T & \eta^{CHP^e} & 0 \\ 0 & \eta^{CHP^h} & \eta^{HE} \end{bmatrix} \begin{bmatrix} P^e \\ P^g \\ P^{gasoline} \end{bmatrix} \tag{3}$$

In equation 3, coefficients P^e, P^g and $P^{gasoline}$ respectively are represented the electric, gas and fuel carriers. As well as, η^T, η^{CHP^e}, η^{CHP^h} and η^{HE} are indicated respectively transformer efficiency, electric efficiency, thermal efficiency and thermal efficiency of the furnace. Also, L^e and L^h are indicated electrical load and heat load, respectively.

2.1.1 Cost functions of first model

The cost function of first model is composed of two parts. The first part is generation cost. The generation cost including purchasing electricity cost from the grid with determined prices by the network, generation energy cost by CHP plant and needed fuel cost to burn in the furnace which can be expressed as follows in equation 4:

$$GenerationCost_1 = \left\{ (\mathrm{a} + \mathrm{b} \times \mathrm{P}^g(\mathrm{t}) + \mathrm{c} \times \mathrm{P}^{g\,2}(\mathrm{t})) + P^e(\mathrm{t}) \times \mathrm{ElectricalCost(t)} + \mathrm{P}^{gasoline}(\mathrm{t}) \times \mathrm{FuelCost} \right\} \tag{4}$$

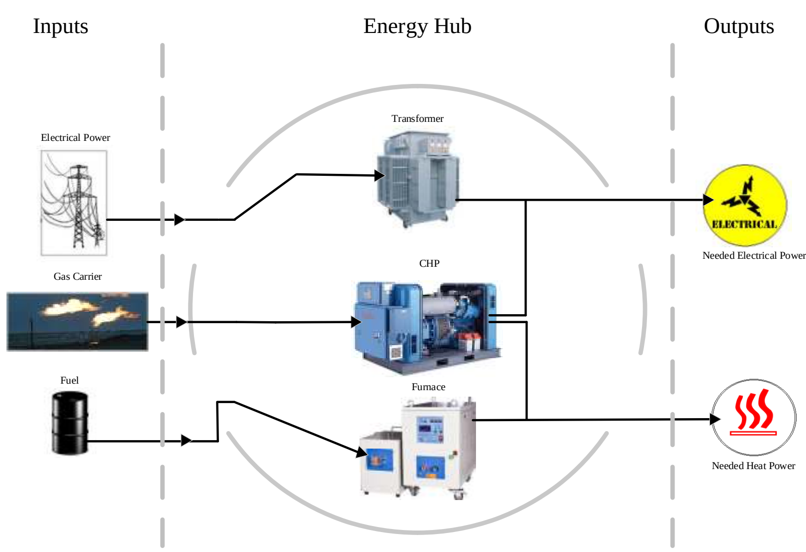

Fig. 1. First model of energy hub

In equation 4, a , b and c respectively are represented fixed costs, variable and operation costs of CHP. $\mathrm{ElectricCost}$ is electric energy carrier price in per unit (p.u.) which purchased from grid and $\mathrm{FuelCost}$ is carrier fuel price in terms of p.u. on fuel unit which used to burn in the furnace. The second part of the cost is specified pollution and emissions of toxic carriers of change in equation 5:

$$EmissionCost_1 = \left\{\alpha + \beta P^{g} + \gamma P^{g2} + \alpha + \beta P^{gasoline} + \gamma P^{gasoline^2}\right\} \quad (5)$$

In which, α , β and γ are apply coefficients of emission cost and determined by air quality controller institute.

2.1.2 Constraints

The nature of the HUB to optimize the use of energy carriers based on the constraints in system is active. Therefore, constraints should identify limits of the variables be attention. Including used constraints in first model consist of equations 6 - 8:

$$\begin{cases} 0 \le \mathrm{P}^{i} \le P^{i^{Max}} \\ i \in e, g, gasoline \end{cases} \quad (6)$$

In which in it, P^i is entries energy carriers. Also, i, e, g and $gasoline$ are carrier, electrical carrier, gas carrier and fuel carrier respectively. And most constraints are the variable values in the relationship between coupling matrix parameters and entry and output be truth:

$$L_e = \eta^{T} \times P^{e} + \eta^{CHP_e} \times P^{g} \quad (7)$$

$$L^e = \eta^{CHP_h} \times P^{g} + \eta^{HE} \times P^{h} \quad (8)$$

2.2 Second Model: The System Performance in during 24 Hours

In this section, second model of proposed energy HUB in form of Fig. 2 has intended.

This model is including a CHP, transformer, electrical, thermal storage and heat furnace. The electrical energy system entries are natural gas, different of fuels and also electrical energy system outputs are electricity and heat. As well as, a battery as saver in electric output and an isolated water tank as stored thermal saver inside on HUB's output have located. This system is connected to a solar power plant and a part of its daily energy supply from this power plant.

2.2.1 The cost function of second model

In this section, second model has defined in equation 9.

$$GenerationCost_2 = \left\{\sum_{t=1}^{24}(\mathrm{a} + \mathrm{b}\times \mathrm{P}^{g}(\mathrm{t}) + \mathrm{c}\times \mathrm{P}^{g2}(\mathrm{t})) + P^{e}(\mathrm{t})\times\left(\mathrm{ElectricalCost(t)}\right) + \mathrm{P}^{gasoline}(\mathrm{t})\times\left(\mathrm{FuelCost}\right)\right\} \quad (9)$$

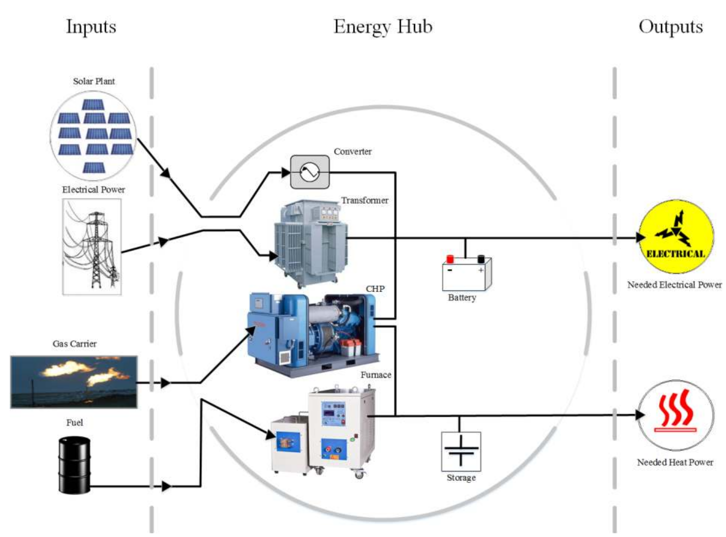

Fig. 2. Second model of energy hub

In equation 9, a, b and c respectively are represent fixed costs in generate energy, variable costs and operation from CHP.

2.2.2 Emission cost function

Second model emission function has known in equation 10.

$$EmissionCost_2 = \left\{ \sum_{t=1}^{24} (\alpha + \beta P^g + \gamma P^{g2} + \alpha + \beta P^{gasoline} + \gamma P^{gasoline2}) \right\} \tag{10}$$

In here parameter as a percentage of the emission cost impact of pollution has attended.

When the coefficient value is one, means industrial unit must not pay any penalty for pollution, but when the coefficient value is zero, means pollution penalty has attended and the pollution subject is very important. The main application of this factor in the large industrial cities with large buildings and factories. When pollution has located in warning status can be controlled this factor to obtain the desired output and by increasing penalties amount have reduced pollution amount and its required output with lower pollution coefficient provided quickly. Therefore, final objective function of the first and second models can be defined as follows in equation 11:

$$\text{TotalCost} = \{(\text{W} \times GenerationCost_{1+2}) + ((1-W) \times EmissionCost_{1+2})\} \tag{11}$$

In which, W is weighting factor. Also, energy hub equations can be defined in form of equation 12, where actually an equality constraint. The equations between the entry and output in form of matrix L = CP have obtained.

$$\begin{bmatrix} L^e(t) \\ L^h(t) \end{bmatrix} = \left(\begin{bmatrix} \eta^T & \eta^{CHP_e} & 0 \\ 0 & \eta^{CHP_h} & \eta^{HE} \end{bmatrix} \times \begin{bmatrix} P^e(t) \\ P^{PV}(\text{t}) \\ P^g(t) \\ P^h(t) \end{bmatrix} \right) \tag{12}$$

When the saver has added to the system, matrix of equation 12 to be converted equations 13 and 14.

$$\text{L(t)} = \left(C \times P(\text{t}) - S(\text{t}) \times \dot{E}(\text{t}) \right) \tag{13}$$

$$\begin{bmatrix} L^e(t) \\ L^h(t) \end{bmatrix} = \begin{bmatrix} N^e & N^{PV} & N^{CHP_e} & 0 \\ 0 & 0 & N^{CHP_g} & N^h \end{bmatrix} \times \begin{bmatrix} P^e(t) \\ P^{PV}(\text{t}) \\ P^g(t) \\ P^h(t) \end{bmatrix} - \begin{bmatrix} S^e(t) & 0 \\ 0 & S^h(t) \end{bmatrix} \times \begin{bmatrix} \dot{E}^e(t) \\ \dot{E}^h(t) \end{bmatrix} \tag{14}$$

In which N_e , N_{CHP_e} , N_{CHP_g} and N_h are transformer conversion coefficient, the percentage efficiency of generate electricity of the CHP, percentage efficiency of generation heat of the CHP and generation heat efficiency respectively. As well as, the parameters P, L and C are hub entries matrix, hub outputs matrix and coupling matrix expresses the relationship between the operations on entry carriers to achieve the desired output.

Matrixes values of $\dot{E}$ and S have obtained as follows in equation 15:

$$\begin{bmatrix} S^e(t) & 0 \\ 0 & S^h(t) \end{bmatrix} \times \begin{bmatrix} \dot{E}^e(t) \\ \dot{E}^h(t) \end{bmatrix} = \begin{bmatrix} \frac{1}{E^e(t)} & 0 \\ 0 & \frac{1}{E^h(t)} \end{bmatrix} \times \begin{bmatrix} E_t - E_{t-1} + E_{establish} \\ h_t - h_{t-1} + h_{establish} \end{bmatrix} \tag{15}$$

Actually $\dot{E}$ represents stored energy amount in the battery at hour t. Also, $E^e(t)$ and $E^h(t)$ represents transferred energy amount in time t caused by charge or discharge of battery, respectively. In the optimization process with using innovative method amounts of $E^e(t)$ and $E^s(t)$ from equations 16 and 17 have obtained.

$$E_e(t) = \left(I_c(t) \times e^+_{e\,charge} + \frac{(1 - I_c(t))}{e^-_{e\,discharge}} \right) \tag{16}$$

$$E_h(t) = \left(I_d(t) \times e^+_{h\,charge} + \frac{(1 - I_d(t))}{e^-_{h\,discharge}} \right) \tag{17}$$

Where $e^+_{e\,charge}$ and $e^-_{e\,discharge}$ respectively amounts of the electric saver charge and discharge capacity and $e^+_{h\,charge}$, $e^-_{h\,discharge}$

indicates the thermal tank charge and discharge capacity for energy exchange respectively. Also, the constraints are related to bounds defined in forms of equations 18 - 23.

$$0 \le P^i \le P^{i_{\max}}, \quad i \in e, g, gasoline \quad (18)$$

$$L^e = \left(\eta^T \times P^e + \eta^{CHP_e} \times P^g - \left(\frac{E_t - E_{t-1} + E_{establish}}{E^e(t)}\right) \right) \quad (19)$$

$$L^h = \left(\eta^{CHP_h} \times P^e + \eta^{gasoline} \times P^h - \left(\frac{h_t - h_{t-1} + h_{establish}}{E^h(t)}\right) \right) \quad (20)$$

Where $E_{establish}$ is vector of storage standby energy losses and S is storage coupling matrix. The constraints related to the storage in equations 21 - 23 have been identified.

$$\mathrm{M}^e = \left(\frac{E_t - E_{t-1} + E_{establish}}{E^e(t)} \right) \quad (21)$$

$$\mathrm{M}^h = \left(\frac{h_t - h_{t-1} + h_{establish}}{E^h(t)} \right) \quad (22)$$

$$-\mathrm{M}^{i_{\min}} \le M^i \le M^{i_{\max}}, \quad i \in e, h \quad (23)$$

Where M keeps all output side storage powers, in addition M^e and M^h are corresponds to the output-side storage power of electrical and heat respectively.

2.3 The Ambient Temperature Effects on CHP Performance

For considering temperature effect in the CHP performance must is obtained CHP performance information at different temperatures for each CHP specific model. Then, in form of statistical should be in the temperature changes information monthly ranges in different days in different seasons through meteorological organization or relevant departments have achieved. Now, with verification this two graph has obtained CHP efficiency in different hours of day with approximate temperature. Or the thermometer has added to system which the system with reading temperature information at any hours related to value to CHP efficiency read from its resource and has located in the system. In here by default, temperature and working efficiency changes of CHP before have determined because changes occurred in 24 hours. Then, the changes in following assumption have been considered. For example in figure 3, this is assumption that every ambient temperature be higher, therefor CHP efficiency be less.

The CHP efficiency has defined as the specified number in equations and a factor can be obtained from the figure 3 as a number in the original efficiency multiplied. The efficiency is one, it means CHP can be used its all practical efficiency capacity for example is 75 percent.

2.3.1 Describe CHP ambient temperature effects on equations

To add the temperature effect on the equations in objective function of system are multiplied a new parameter (RAND) in the CHP main efficiency and converted in form of equation 24:

$$GenerationCost = \left\{ \sum_{t=1}^{24} \mathrm{RAND}\left(\mathrm{a} + \mathrm{b} \times \mathrm{P}^g(\mathrm{t}) + \mathrm{c} \times \mathrm{P}^{g2}(\mathrm{t})\right) + P^e(\mathrm{t}) \times \left(\mathrm{ElectricalCost(t)}\right) + \mathrm{P}^{gasoline}(\mathrm{t}) \times \mathrm{FuelCost} \right\} \quad (24)$$

This work requires to constraints are related to its own. In the paper, the cost subject has examined.

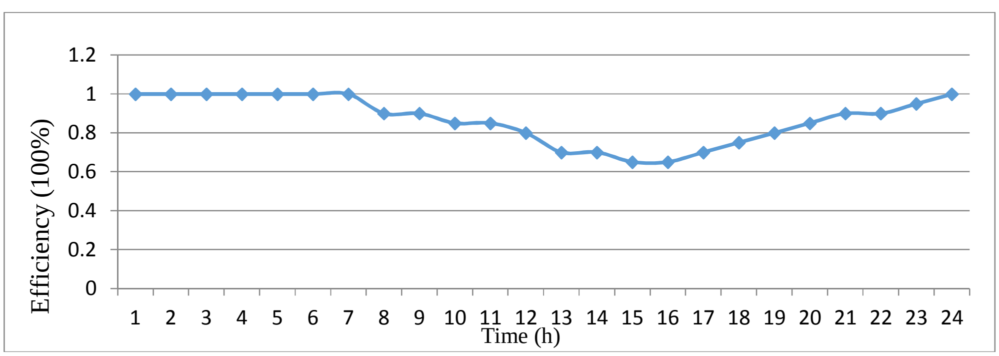

Fig. 3. Evaluation of efficiency factor changes at different hours of a summer day

2.4 The NZE Effects

In equations 25 and 26, objective and constraints functions of NZE have specified. In these relations, net zero emission for brevity with NZE has shown.

$$EmissionCost = \left\{ \sum_{t=1}^{24} (\alpha + \beta P^{g} + \gamma P^{g2}) + (\alpha + \beta P^{gasoline} + \gamma P^{gasoline2}) + NZE \right\} \tag{25}$$

Which in it as constraints:

$$\left((\alpha + \beta P^{g} + \gamma P^{g2}) + (\alpha + \beta P^{gasoline} + \gamma P^{gasoline2}) + NZE \right) = 0 \tag{26}$$

3. DESCRIBE SIMULATION ALGORITHM

To solve this scenario has used GAMS software version 24.1.2, MATLAB software version 2013 and Excel software version 2010. In the following description about them and their relationships with each other are given.

One of the very practical software in the optimization and engineering equations solving field is GAMS software. GAMS is divided problems into categories and for each solver has identified a group; including linear, roughly linear, non-linear, mixed integer technique, etc. The solution method of the paper is part of mix integer nonlinear programming (MINP) due to the presence of non-linear program (NLP) and some of constraints have used from this method. The main method used in this solver is BONMIN method. BONMIN (basic open-source non-linear mixed integer programming) is an open source code for solving general MINLP problems. In GAMS software has many limitations and to overcome these limitations need to connect to other software. In among most important applications interact with GAMS software is MATLAB software. In figure 4, GAMS to MATLAB flowchart connect in the paper is shown.

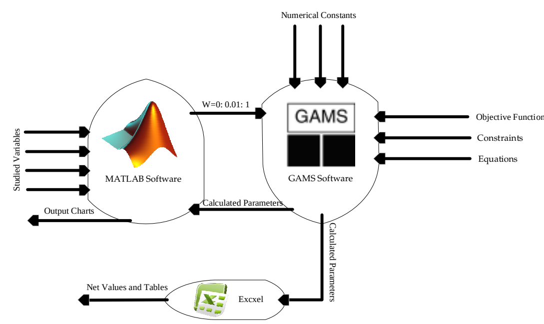

Fig. 4. GAMS to MATLAB connection flowchart

4. SIMULATION RESULTS

In this section, simulation results have expressed.

4.1 Investigation of Saver Effects

In this section, the storage effects have investigated. In the first case, the saver of system has been removed. Then, all the equations, without of storage by GAMS software investigated. The results in Table 1 have been recorded. Then, in the second case, saver has added to the system.

Table 1. Investigation of saver effects

Amount of W	Without of saver			With of saver		
W	Total cost ($/h)	Emission (g/kwh)	Cost ($/h)	Cost+ saving	Emission with saving	Total cost with saving
0.00	0.00	1249.98	1249.98	0.00	1152	1152
0.10	110.65	1126.08	1236.74	97.2	1036.8	1149.12
0.20	196.45	1003.86	1200.32	194.4	921.6	1146.24
0.30	305.22	882.57	1187.79	291.6	806.4	1143.36
0.40	399.15	761.45	1160.61	388.8	691.2	1140.48
0.50	492.15	639.81	1131.96	486	576	1137.6
0.60	589.66	516.93	1106.60	583.2	460.8	1134.72
0.70	689.35	392.16	1081.52	680.4	345.6	1131.84
0.80	785.51	264.83	1050.35	777.6	230.4	1128.96
0.90	890.16	134.32	1024.48	874.8	115.2	1126.08
1.00	995.14	0.00	995.14	972	0.00	1123.2

The saver could have a very good impression in the generation cost, emission cost and total cost. Actually, the saver can to take action for its charge in the hours carrier price cheaper than during other hours and the saver is rising to take action for its discharge in the hours generation cost. This act always makes saver in smart form work and it reduces overall system cost. To further reduction the saver costs should be used more in this case, therefore purchase and over hall costs subject to be taken into consideration.

4.2 Evaluation of Gas Price Changes in the Costs (fixed value of W = 0.6)

In this section, in fixed W, adding the gas price effect has measured on other expenses. According to Table 2, the gas price has been changed gas carrier price amount. As can be seen in Fig. 5, gas prices rising increases the costs but from somewhere longer by the gas carrier prices changing, the generation cost graphs trend is not rising. Because whatever increase price amount, then there are amounts of heat load needs to meet the minimum gas carriers amount. So, even if all the alternative carriers used with full capacity, don't able to meet load demand. The rising gas prices on the emission cost sector in the first takes descending trend, but from the point after it these changes has been constant almost and slope of the graph is very soft. At first, the reason for the phenomenon with increasing gas carrier price, the system automatically reduces the use value of its carrier and consequently reduces emission of generation from CHP plant, thus the emission cost comes down. But the cost never reach to zero, because fuel power plant is active still and there are some of heat load despite rising prices, still the system has to be used for supply gas carrier thermal load.

Table 3 shows the relationship between the generation cost, the total cost and emission cost. If there are no coefficients W, graphs within 24 hours were obtaining in form of linear graph because the costs are constant usually. In here, the relationship in the form of a graph in each W has shown. As well as, best mode has known for finding economic working point in system. For example, in it was observed in W is 0.8 the generation cost is equal to 17.28 and the emission cost is 5.184. For industries have higher value generation amount of emission, it can be more W considered but in industries produce hazardous and toxic gases W is fewer, always. With less of W usage carrier producing toxic substances reduced but the use of alternative carriers such as clean renewable energy like solar and wind power increases.

4.3 Base Curves for Calculations in per Unit

In the second model, due to multiple parameters existence in input, from a certain pattern for all values have been helped. In this regard, Figs. 5 - 7 have intended as reference graphs.

Table 2. The effect of gas price variations on costs

	Price × 0.125	Price × 0.25	Price × 0.5	Base price	Price × 2	Price × 2.5	Price × 3.5
Cost ($/h)	3.09	3.19	6.38	6.38	25.49	48.26	48.28
Emission (g/kwh)	16.02	15.90	10.73	10.73	8.13	7.59	7.59
Total cost ($/h)	11.27	13.81	16.99	23.37	36.12	45.26	70.26

Table 3. The effects of W variations on generation cost, emission cost and total cost of the objective function during 24 hours period

W	W× generation cost ($/h)	(1-W)×emission cost (g/kwh)	Total cost ($/h)
0.00	0.00	25.92	25.92
0.10	2.20	23.33	25.49
0.20	4.32	20.74	25.06
0.30	6.90	18.14	24.62
0.40	8.64	15.55	24.19
0.50	10.80	13.00	23.76
0.60	13.00	10.37	23.39
0.70	15.12	7.78	22.90
0.80	17.90	5.18	22.46
0.90	19.44	2.60	22.03
1.00	21.60	0.00	21.60

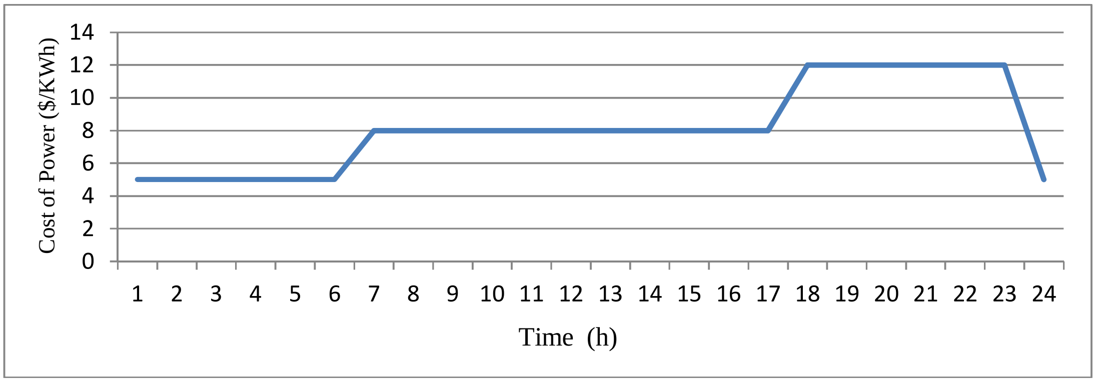

Fig. 5. Trend of electricity carrier price changes

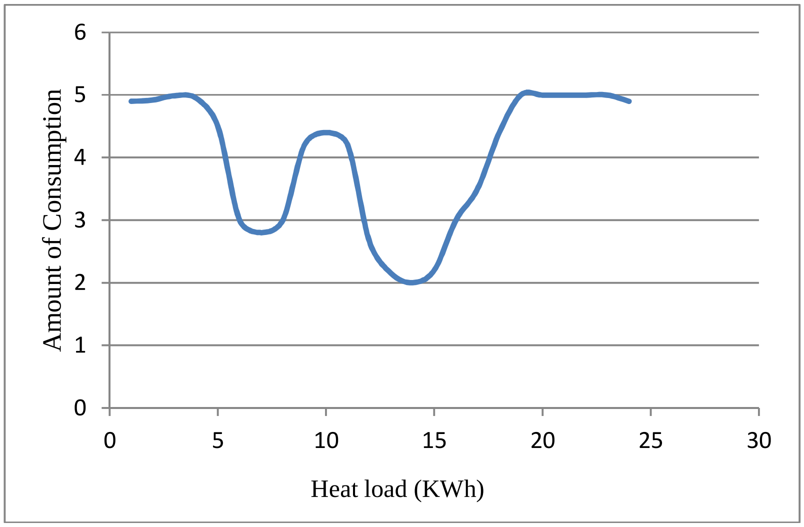

Fig. 6. Trend of thermal load changes

The Figs. 5-7 are related to consumption and price is carrying on a summer day (these figures express trend of electricity carrier price changes, trend of thermal load changes and trend of electric load changes), respectively. Originally, these figures are basic graphs.

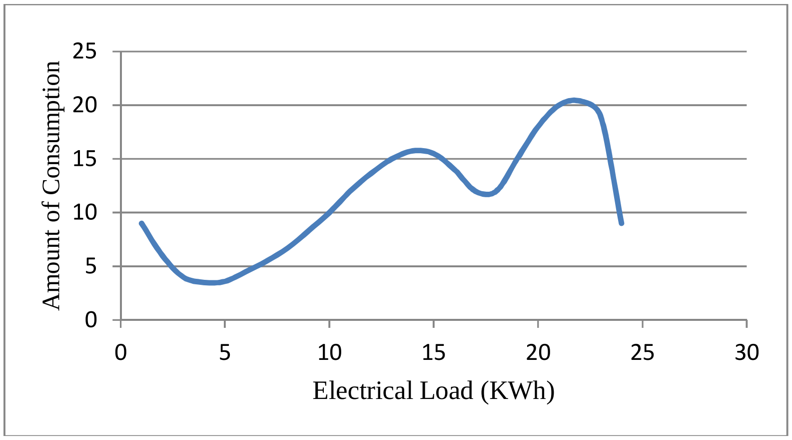

Fig. 7. Trend of electric load changes

4.4 Equations Result Interpretation on Consumption Gas Changes

In this section, the equations results on consumption gas changes have mentioned. In this direction, Fig. 8 and Table 4 have mentioned respectively, compared to the gas price with consideration NZE mode and without of NZE mode, and numerical results compare with NZE mode and taking into account without NZE mode.

Table 4. Comparison modes the gas price by taking into account NZE and without NZE

Hour	Without NZE	With NZE
2 A.M.	0.2128	0.3962
4 A.M.	0.1455	0.4762
6 A.M.	0.0783	0.3692
8 A.M.	0.1779	0.0021
10 A.M.	0.1796	0.0960
12 P.M.	0.1417	0.0803
14 P.M.	0.1420	0.0733
16 P.M.	0.1880	0.1082
18 P.M.	0.2871	0.6007
20 P.M.	0.2744	1.0570
22 P.M.	0.3053	0.7163
24 A.M.	0.2130	0.5700

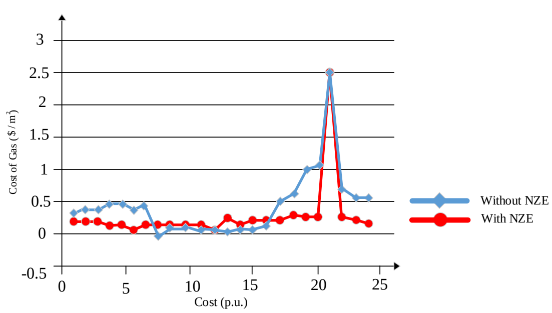

Fig. 8. Comparison modes the gas price by taking into account NZE and without NZE

It is clear in Fig. 8, in the early hours of the day to take advantage of solar power plant is not possible, whatever number of solar power plants is higher, then it does not reduce the consumed gas volume. But, in the hours around noon, slowly added on the solar energy generation and natural gas declined. This process continues until the evening and then reduced the use of solar power plant. Then, with sunlight reducing, the energy generation amount goes towards to zero. Also, the results interpret in Table 4 shows the presence of NZE constraint that uses the network can still significantly reduce pollution in addition to lower costs, reduction pollution be made.

5. CONCLUSION

The paper has improved the combined approach of temperature and emission effects for proposed two models of energy HUBs. These models are including two energy hubs with different characteristics in during one hour and twenty-four hours. Also, the innovations of the paper is pollution calculation and optimization of the entries in terms of output, weighted coefficient of pollution, adding temperature effect on CHP performance and it's optimization with optimization in generation by minimizing pollution, adding indicating zero emission and finding the economic optimum capacity for purchase of equipment without additional costs. The results have shown existence of NZE constraint can be use amount of carriers including pollution reduced again, and in addition to reduction costs caused by reduction pollution again. In addition, the results of paper show the presence of NZE constraint that use the network can still significantly reduction pollution in addition to lower costs, reduction pollution be made.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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