Energy Forecasting, Based on ANN Machine Learning, for Domestic Properties in Dry Hot Arid Regions: A Case Study in Baghdad

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***Abstract*—This paper uses MATLAB-Artificial Neural Networks (ANNs) to predict the current and future energy consumption of new-builds in the domestic sector. This research simulates a prototype neighbourhood block, using multiple prototype domestic sectors across Baghdad, to predict the future energy use of urban projects and assess the potential use of renewable sources. This will identify how sustainable solutions, such as solar energy, may impact on urban development compared to the conventional methods currently used. To construct the ANNs, data from one prototype block from six which were assessed was used. Variables that directly or indirectly impact on energy consumption were used. The trained ANN revealed that the use of sustainable solutions, such as PV systems, can save energy in that there was a 33% reduction in energy consumption when comparing conventional and sustainable energy scenarios.**

***Index Terms*—ANN, energy simulated, predict energy, urban sustainable development.**

I. Introduction

The application of urban sustainable development has faced significant challenges in developing countries because of the rapid urbanization, high energy consumption, a lack of attention paid to environmental issues, traffic congestion and a decline in infrastructure services. The degradation of public services and utilities has also been recognized as a key issue, particularly in war-torn countries such as Iraq [1], where cities have suffered from devastation, severe damage to the infrastructure and economic deterioration Despite this, in many of these countries, a number of new urban development projects are currently underway or in the planning stage [2]. However, these projects lack effective strategies to tackle current problems and meet future requirements with reference to economic development, including population growth, high energy and transport demands and environmental pollution. Urban sustainable development frameworks are often utilised to guide these kinds of developments. These frameworks can be defined as a method of finding a balance between the use of resources and humans' well-being [2], in order to reduce pollution, [3]-[6], costs and the impact on the environment by undesirable effects.

However, current conventional urban development frameworks are insufficient to overcome the challenges faced by developing countries [4], many current projects lacking effective planning and scientific vision regarding future pressure on cities and undesirable effects on the environment. Thus, new, more sophisticated methodologies are required, which include paying attention to local housing factors, including housing patterns [5], and updating housing requirements, such as area of dwelling units, and reductions in the number of rooms to meet future requirements with respect to land use, a decrease in energy consumption and the introduction of renewable energy sources [6]-[10].

Currently, conventional energy production in these regions depends on burning fossil fuels, this causing an increase in CO2 emissions. 47% of CO2 emissions originate from conventional power production in Iraq [7], the highest percentage in the Middle-East. Transportation in Iraq, specifically in Baghdad, has increased gas emissions by 36.7%, this the second highest in the Middle East, after Cairo, nearly 50% of these gasses produced by vehicles (AlFaris et al. 2016; The United Nations 2014) [7]-[9]. The population of Baghdad is predicted to double by 2030, so the demand for energy and its consumption will only increase. Most energy is consumed by the domestic sector worldwide, accounting for 80-83% of energy consumed in Iraq [9]. Therefore, the need to predict energy needs plays a key role in the future of the existing cities and new development projects (Hague 2010; Al-hafiz *et al*. 2017) [9]-[10]. Current conventional power production and operational practices consume an excessive amount of fossil fuels, causing a negative impact on the environment.

Due to the growth in population in Iraq, particularly in Baghdad, there are increasing concerns about energy consumption. A gap exists between demand and power production in Iraq for example, in 2017 [9], the total peak load was 22,000 MW, while the total peak of power production was 14,000 MW, according to recent government reports. Current projections predict that Baghdad's population will reach 12 million by 2030 [10]. It is accepted that the city will not withstand such an increase in se in population density due to the need to provide housing, infrastructure services and because of traffic congestion. Privatizations has been implemented in certain areas across the capital to reduce the huge difference between the increasing demand for electricity and its production. This is specifically an issue during summer which lasts approximately seven months of the year, peaking in July and August, where the daily temperature exceeds 50 degrees Celsius in most cities in Iraq, including Baghdad (Almusaed 2011; Al-hafiz et al. 2017) [9]-[10]. Even if privatization is adopted throughout the country, there are obstacles and

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problems with the local population, including the rise in electricity bills for the residential sector [9], especially during the hot summer months, as Iraqi families look to meet their needs for a comfortable temperature. Therefore, it is necessary to plan for sustainable solutions for the near future such as the inclusion of solar energy among the priorities of new development projects. Positive impacts on the environment include a reduction in carbon emissions, and an increase individuals' awareness of energy conservation and the utilization of solar energy.

The domestic sector consumes high amounts of energy, particularly in hot, dry and arid countries such as the Arab Gulf [3], countries and Iraq (Aldossary et al. 2014; Aldossary et al. 2015) [3]-[4]. Developing countries such as Iraq, have been influenced by climate change and global warming, this putting increasing pressure on all sectors, including residential building and energy consumption. There is the need to implement strategic approaches to develop the sustainability of the built environment, while protecting natural resources e.g. oil fossil fuels. However, these technologies are still restricted in many ways in developing regions as despite the availability of rich solar energy and abundant sunshine, these regions remain restricted to the use of conventional methods.

The urban sustainability framework is a plan to achieve balance between current challenges and to meet future requirements, including updating housing criteria. It is important to consider land use requirements, area of housing units, urban sustainability indicators, and innovation solutions in terms of energy consumption, particularly renewable sources including solar energy when creating such a framework.

Previous studies have focused on the theoretical aspects of sustainable frameworks relating to emerging challenges, such as rapid urbanization, high energy consumption and environmental pollution. However, a number of researchers have designed sustainable assessment tools that are dependent on re-reviewing and surveying global indicators that were not originally designed for developing regions such as LEED-US, BREEAM-UK and CASBEE (Alyami et al. 2015; Aldossary et al. 2014; Ameen et al. 2015) [7], [8]. These global/local frameworks are not ideally suited for developing countries due to the differences between developing and developed countries. However, some sustainability frameworks are suitable for hot [8], dry and arid regions as they utilize a set of urban sustainability indicators to re-assess global assessment tools according to specific climatic regions and the local context. This study aimed to identify a suitable set of urban sustainability indicators by surveying the goals of urban sustainable development through the administration of a nationwide questionnaire. This survey aimed to identify community priorities, standards of living and social awareness regarding urban development goals. New urban development frameworks can, however, be adapted to allow future projects to address these issues. Examples of this include reducing CO2 emission levels and high energy consumption while increasing social satisfaction and well-being. To achieve this, it is necessary to move towards more sustainable solutions. Secondly, to increase social satisfaction, it is essential to include the views, priorities, standards of living and social awareness of the community concerned. Finally, the recommendations of experts regarding housing factors and lifestyle requirements are important input for future development projects. Consultation with experts has also been highlighted as a means of achieving a scientific consensus about sustainable solutions [4], including the use of renewable sources and the identification of community priorities e.g. housing factors. These factors include using solar energy PV cells and selecting suitable areas for future housing units within new domestic sector/districts. These factors impact directly on the energy consumption in the domestic sector context and, as such, require more up-to-date local housing criteria to meet future needs. A new framework will involve the findings of energy prediction for the domestic sector as one of the most important challenges in Arab Gulf countries including Iraq, because these countries are known to have high energy consumption [4]. Therefore, making predictions by adopting sustainable solutions like solar energy and reduced energy consumption will be recommended for future urban projects. This study presents the predictions regarding energy consumption in terms of electricity bills for residential houses to show how significant certain variables, such as the area of houses, occupants, temperature, humidity, and solar radiation can be, then adding PV cells as a second scenario, [5]-[6], in order to reduce energy consumption for future development projects.

This paper focuses on the prediction of energy consumption, due to the significant value of energy forecasting, particularly in hot dry and arid regions including Iraq, which are known as high energy consumption regions with high CO2 emissions, as a result of burning fossil fuels for energy production by informing the decision-making, designer, and investment sector the benefit of energy forecasting in different scenarios and techniques to identify the best ways for the development projects. There is, therefore, an urgent need to investigate the differences in energy usage using simulated models through MATLAB-Simulink when the data are driven into the ANNs tool to forecast energy consumption for new development projects, in order to reduce energy consumption for new-builds.

This study presents an Artificial Neural Network for predicting energy in the domestic sector as an essential part of a sustainability framework, using the findings about energy consumption predicted in KWH as one output. Hence, a new framework, involving multiple dimensions of urban development goals, including a practical knowledge of energy simulation, has been considered in this study to develop future urban projects by avoiding placing more pressure on the environment and extensive energy consumption. In this paper, energy consumption is predicted using two scenarios for energy prediction without involving solar energy. Second, ANN models, including adding a PV system to find the prediction of energy consumption for a block neighbourhood within a domestic sector, in order to recognize the differences between the conventional methods and the adoption of renewable solutions, like solar energy.

The paper will (a) present a simulation model using MATLAB- Artificial Neural Network for energy prediction for residential sectors as one practical aspect within a sustainability framework. The output in KWH can be predicted by utilizing a prediction tool such ANN. This tool defines ANNs as machine learning, which can be applied to a number of engineering problems, and has been utilised in past studies successfully for energy modelling. Here, it has been selected as a significant tool to feed into a new framework predicted energy consumption levels, e.g. 20%, 30%, etc., for future years; (b) identify how renewable solutions such as a solar energy (PV) cells-based ANN model can be adopted to predict energy consumption for future applications with respect to sustainable practices involving solar energy for the residential sector. There are two main scenarios in this study. First, the ANN model is used to predict energy for new-builds without involving solar energy, and there is a second simulation model for energy forecasting that entails the addition of a PV system in each house unit within a domestic sector, in order to identify the reduction in electricity bills in both scenarios; and (c) provide background and related work in the context of the MATLAB- ANN tool. In section 4, the methodology is summarized and justified, based on the following chart of the ANN model. Section 5 is related to the results and discussion about the predicted energy consumption by describing the experimental model and a set of data have selected for 25-houses units details driven into ANN tool. The final section includes the concluding remarks and summarizes the ANN simulation model outlined in this study. The aim is to present the process of energy prediction for the current domestic sector in the area being considered. This will include investigation of a wide range of parameters regarding energy use by implementing a data-driven approach into machine learning using ANN.

II. Background of Using Matlab-Artificial Neural Network (ANNs)

Artificial Neural Networks (ANNs) can be conceptualised as learning machines and are considered an important branch of artificial intelligence used in numerous engineering applications [1]. Karatasou et al. (2006) [2] found that MATLAB, particularly ANNs, have also been used for a range of applications in energy modeling. A number of studies related to the time series of regression analyses are covered in the literature, which also states that the main advantage of conducting simulations using ANN is the potential to analyse non-linear processes, such as whole loads or individual models [3]. ANNs have been used to simulate reductions in conventional fuel consumption, operational costs, material waste and global warming. Many studies have examined artificial intelligence simulations of design and operational energy costs [4], including, for example, effective and efficient heating, ventilation, and air-conditioning HVAC control systems [5]-[7].

Other studies have focused on reducing the energy demand during "peak" periods, thereby maximising the use of renewable sources (PV and wind turbines), while at the same time reducing the reliance on grid energy. Numerous parameter optimisations have been carried out for both ANN and GA to identify any significant combinations, which result in optimum weekly schedules. In the domestic context, artificial intelligence techniques involve a holistic understanding of the (near) real-time energy demand and supply in order to simulate optimised energy usage with minimum energy needs [7].

A number of researchers [8], have recognized that, with Artificial Neural Networks, ANN-based insulation solutions can also be used instead of simulation tools, to create fast, rapid solutions to prediction and control problems. Simulation system-based solutions require a long period of processing time to achieve energy-saving objectives. ANN models do not require any prior knowledge of the relationships between the inputs and outputs because of the choice of learning techniques available to map the correct relationship. The weighting system is an important factor in promoting the accuracy of the results.

In this study, ANNs were used to predict the energy consumption of a passive solar building. This simulation was applied to a building consisting of one room with an inclined roof. Two cases were examined; whole building insulation and a building with one wall made of masonry the other of part masonry and part thermal insulation [9].

III. Related Work

MATLAB, particularly Simulink (the Artificial Neural Network tool) can be adopted as alternative practices for a number of engineering problems. In terms of the various simulations models and energy prediction [1], ANNs are widely used as machine learning without having any relationship with the inputs variables (Ahmad et al. 2017). In fact, significant experimental models can refer to non-linear equations even in the case of missing data [2]. A number of researchers have utilised several efficient implementations of ANN for simulation models, optimization, energy forecasting, and so on. Moreover, ANN is one of the most important tools used to simulate energy forecasting, including several methods such as intelligent systems, the correlation of the climatic parameters, and control systems [3]. Li et al. focused on energy prediction at a district level based on ANN for the evaluation of the inputs and outputs variables [1]-[3], in order to provide information about the simulation energy model and optimization. Further, Baris *et al.* [4] presented an ANN model to predict energy and identify the thermal comfort level in an indoor swimming pool. In this case, several data parameters were simulated and these data impacted, directly or indirectly, on the objective (output), trained a number of times to recognize the correlation amongst a set of inputs and two outputs of energy consumption and thermal comfort [5]. An ANN was utilised to save energy through multiple scenarios designed to test the regression and performance of the data and so identify any the reduction based on ANN models. A few researchers have presented an Artificial Neural Network (ANN) to predict energy consumption based at the district level by developing a smart electricity grid to reduce energy and proposing a new framework that is dependent on several experimental practices to determine the optimum ANN performance. The results of the simulation model, which comprises six buildings with a varying range of occupants, their findings have revealed that the average percentage of accurate, was 96% to describe the efficiently for implementation/adoption this technique in the framework [6]. An ANN tested the energy efficiency and prediction models in buildings as the performance was evaluated and informed decisions were made to improve energy efficiency based on using data-driven models to simulate the required data and so predict the energy consumption of a case study [7]-[9], represented by a hotel, which is located in Spain, incorporating social variables, such as the number of guests, which increased the prediction accuracy in this case.

In this study, an ANN-based simulation model for a block neighbourhood at the district level is proposed to predict energy consumption for a new development framework in the following section.

Following the background and related work that informed the use of machine learning for predicting energy consumption, the methodology is to present the process of predicting energy for the current domestic sector in the area being considered. A neighborhood is the main part of a city level, so it is important to investigate a wide range of parameters regarding energy usage by implementing a data-driven approach into machine learning by ANNs as simulated models to predict energy consumption for new development practices. This is followed by the results and discussion of the experiments practices. At the end, the conclusion, recommendations and suggestions for future work are presented.

IV. Methodology

The research is developed in the context of MATLAB -ANN as a tool for predicting energy consumption within two scenarios: 1) predicting future electricity bills (outputs) for new builds-without involving renewable practices, such as solar energy, and 2) introducing of time series such as 2018,2019,2020, etc., by adding extra inputs data such as PV systems for the same scale of city level, in order to investigate the differences between these two scenarios by using multiple-inputs factors in the ANN model to create more benefits for the existing and future applications, e.g., by illustrating more effective variables, including zooming at the scale of the city level like a block neighbourhood, a case study in Baghdad, then analysing the components of this scale, including houses unit with No. of occupants, No. of rooms, No. of floors, area of houses, temperature HDD, relative humidity (Rh%), and solar gain. These inputs variables will be driven into a model in order to evaluate the energy consumption scenario for the existing applications and future new-builds, in order to achieve the desired energy prediction and evaluate the reduction in future years [2]-[4], as informed by a real data-driven approach, using the ANNs tool. To analyse energy consumption, it is essential to simulate a range of housing units within a neighbourhood block as a set of inputs parameters driven by the ANNs tool. The ANNs model can be affected by several variables as internal and external factors, control ANNs nodes, control regression, and so on. These inputs variables can be defined within two main scenarios for the prototypes of 25 house units in the case study block selected for this research.

In a block neighbourhood, which is a basic part of a district/domestic sector as shown in fig 1, several experimental practices have been developed for the energy prediction of a 25 house unit within a simulation model of a block neighbourhood.

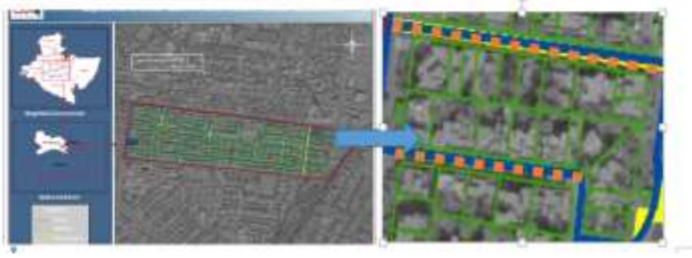

Fig. 1. A prototype of a block neighbourhood within a district/sector of Baghdad [source: CSO, Iraq 2017].

Two scenarios are mainly focused on (a) predicting energy without involving renewable solutions, e.g. solar energy, and (b) using a simulation model to undertake energy forecasting involving renewable practices, like PV solar systems. There are two steps in each scenario. One shows a regression analysis and builds a correlation for the existing application/district. The second step in scenario 1 presents an ANN model as a prediction tool for future new-builds. e.g. 2018, without using renewable sources, such as PV systems. This step must simulate new-builds followed by the updating of the area of houses to meet future requirements according to the local experts/consultations/recommendations. The second scenario assumes that solar energy is utilized in terms of the existing applications represented by a block neighbourhood, and so also for new build applications as future practices, involving sustainable solutions such as PV systems, as shown in Fig. 2.

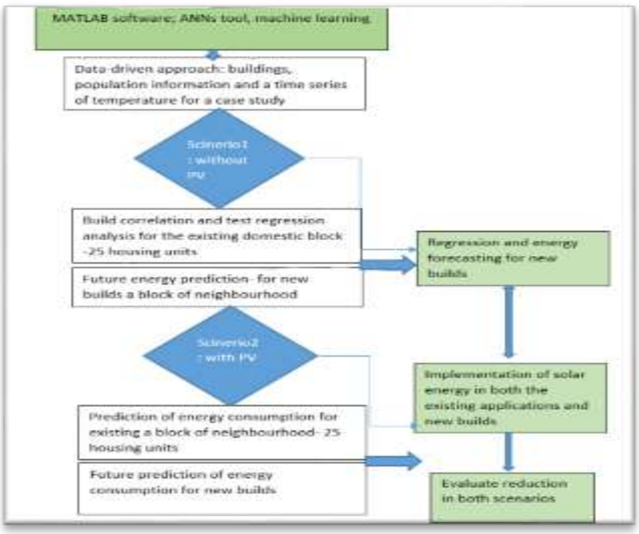

Fig. 2. Flow chart of the MATLAB, ANN tool process.

The energy simulation in each step proposed a number of variables as a data-driven approach to MATLAB, ANN, including the simulation of a number of dwelling buildings - 25 units in the existing neighbourhood block. Each housing unit has several parameters, such as the number of occupants, area of a house, and number of rooms/spaces, which are gathered from the Ministry of Planning, Central Statistical

Organization (CSO), and Iraq. In terms of climatic parameters including Heat Degrees Day (HDD), relative humidity (Rh %) and solar radiation, which affect directly and indirectly the outputs represented by energy consumption (electricity bills) (KWH) for a year (July 2016-July 2017). The first scenario of energy prediction without involving solar energy practices includes two steps: 1) a simulation model for the existing 25 housing units within a domestic sector by simulating a number of inputs variables, like population information and climatic parameters, in addition to electricity bills gathered from the Ministry of Electricity and Energy, Iraq into an ANN, to achieve the correlation and regression analysis. ANN is used to predict energy consumption for new-builds, e.g. 2018, by updating several variables, such as various ranges of housing units, involving PV systems in a case study of the neighbourhood to predict energy for the same year as previously mentioned, thus analysing the energy forecasting, e.g. 2018, for new-builds, including the updating of the houses area as above.

The ANN models in both simulation models for the existing block neighbourhood and new-builds selected a varying range of inputs variables, as mentioned previously, in addition to the output of the central PV system, which is located in the area being considered (Baghdad), These data were gathered from the online monitoring system of the Ministry of Electricity and Energy, for the same year. The outputs predicted using both scenarios will be evaluated to identify the benefit in regard to reduced energy consumption (electricity bills) in KWH. To conclude, two comprehensive scenarios have been developed using a range of simulation data, including MATLAB Simulink, in order to achieve a real reduction in the objective of the outputs (electricity bills). Two future energy forecasting techniques, involving renewable solutions such as PV systems, have been explored and used in a block neighbourhood. First, an existing application/a block including 25 existing houses including a set of parameters with a PV system in each house to predict energy for the following year e.g. 2018; second, an ANN model for the new builds including the updating of certain parameters, such as the area of the houses, to identify the percentage of savings between these two models and before using renewable solutions solar energy models.

V. Result and Discussion

In the previous section, the simulations models were presented in four steps. The first two steps were related to the scenario of energy prediction without involving renewable solutions, such as solar energy. Second, a further two steps were introduced, involving renewable solutions, such as PV systems. In both cases the ANNs predict energy for the existing district/domestic sector and future energy forecasting for new-builds. However, the simulation model shows both scenarios for the existing application and future new-builds to predict energy, so the saving and reduction in the amount of energy consumption in KWH (electricity bills) when using both methods with and without using solar energy techniques, like PV systems, are recognized. Therefore, an ANN tool was found to be more efficient for energy prediction compared to other simulation models, such as control and management systems [6], and ANNs can deal with non-linear and complex problems with a range of various parameters accurately with respect to the training and learning process. In this study, the use of ANN is applied to the outputs of a block neighbourhood, represented by multiple energy consumption predictions for the 25-housing units within a district/domestic sector.

In this section, ANN is utilized, as the data-driven approach of multiple selected parameters can be affected directly by energy consumption. The selected parameters have been driven into MATLAB ANN to predict the monthly energy consumption in KWH, dependent on a set of inputs, such as daily climatic parameters and building details, such as Heat Degree Days (HDD), Relative humidity (Rh%), solar radiation for the period July 2016-July 2017, in addition to occupancy, an area of the housing building unit, the number of rooms/spaces, and the number of floors. Moreover, the objective (output) is selected as the energy consumption in this study. Several training practices have been tested with the first and second scenario. In this section, the simulation models given in multiple data for a block neighbourhood have been analysed and tested for use in future energy prediction with and without involving renewable solution such as solar energy, as mentioned in the previous section. The use of ANN models entailed using several different parameters during the first experiment of building correlation and testing the significant inputs variables for the existing applications within a district/domestic sector. The first group of data-driven approaches to the ANN model utilised such training and simulated the neural network with a number of inputs variables, estimated by 7 main factors and one objective (output). In the simulation model, as the inputs variables of various housing buildings have been driven into ANN as shown in table I, a number of variables including x1= area/house, x2= No. of floors, x3= occupants, x4= No. of rooms/spaces, x5= a range of Heat Degrees Days (HDD) for the period July 2016-July 2017, x6= Relative humidity (Rh%) for the same period, and x7= solar radiation for the year period, as previously mentioned. In this context, the neural network shows that the number of inputs variables are 97 factors and ten-hidden layers with one objective (output), as electricity bills in (KWH) for the existing applications to build the correlations as shown in Fig. 3.

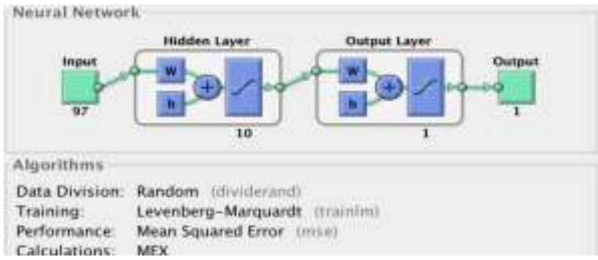

Fig. 3. ANN model-neural network.

In order to train the ANN, the simulated model generated from MATLAB- Simulink for the sample of future new-builds as a second step in scenario-1 for predicting energy without adding solar energy as given in the previous section, the model was run for a year, as previously mentioned. The data for future new-builds will update based on experts-consultations through three-rounds of surveys to update the local standard in terms of buildings' criteria according to future challenges including the area of housing units, the number of rooms/space to suit an Iraqi family's requirements, e.g. assuming the average family size in Iraq is six persons. In response to this, the data-driven into the ANN model was generated for new-builds in a block neighbourhood with a varied range of housing units, ranging in size from 150-200 sq. meters and the assumption of a number of rooms as a semi-automatic standard for the average Iraqi family size of 7-8 rooms/spaces, based on primarily local experts' recommendations, as previously surveyed in round-1 of this research. However, the simulation produced data for predicting energy for the following next, which significantly affected the output and appeared to be a highly accurate simulation, as shown in the regression model in Fig. 4.

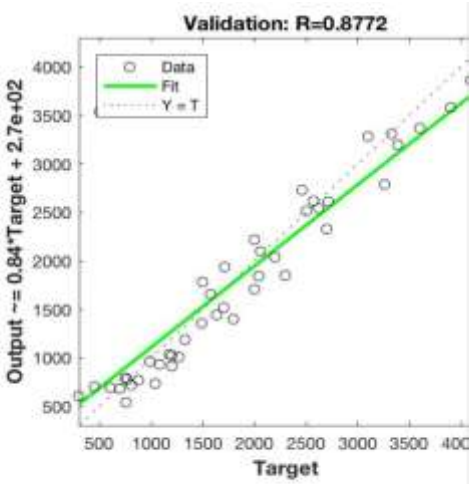

Fig. 4. Regression analyses for the sample energy consumption.

The regression for future energy prediction shows a significant result, as reflected by the key parameters given in the definition of the scenario when these variables were selected as the inputs of ANN. The outputs of the ANN model were used as electrical energy consumption, with these inputs parameters impacting directly or indirectly on individual outputs. In sequence, the number of occupants, area of the buildings, number of rooms and floors, temperature HDD, relative humidity, and solar radiation can affect the energy consumption in both steps of scenario 1 without adding renewable solutions e.g. PV systems. Therefore, these objectives (outputs) can be predicted using a similar ANN model so, with the performance test of the ANN model scenario-1, coinciding with the training process, the network topology has been used previously for all selected functions in the first and second steps of scenerio1: number of inputs= 7, number of outputs=1, thus the number of hidden-layers=10, the transfer function for both the hidden and output layers= [levenberge-Marqurdat], the maximum number of epochs=1000, error rate= 0.001, the learning rate= 0.02, and the momentum coefficient =0.84. The function's parameters of the topology network were chosen, followed by numerous test findings, and can be adopted for the significant performance of the comparison steps in the next scenario.

Similarly, in the second scenario, there are also two steps: 1) the ANN model predicts energy for the existing application, represented by a block of the neighbourhood within a district/domestic sector based on offering renewable solutions, such as PV systems; and 2) as this section highlighted, the ANN model is used to predict energy for new-builds, as mentioned in the previous description for the first and second steps of scenerio1 to predict the outputs more effectively. As highlighted previously, a number of experiments have been conducted with the ANN model by adding one value represented by the PV system to the same case study has been used in this paper (a block neighbourhood) with a same year period, these data on the PV system have been gathered from online monitoring data, in the capital Baghdad. As mentioned above, the same procedures were applied to both existing and future builds, e.g. 2018, involving solar energy as the objective (output). Several experiments were conducted using the ANN model, including the same parameters and adding the outputs of the PV monitoring system. The dataset, although the same Heat Degree Days (HDD) details with the date of a period of a year (July 2016-July 2017), training time and designated as the several results to given the errors when each step of scenario was trained individually. The results revealed that the tests in both steps for the existing applications and future new-builds showed significant results with a regression R=0.91 for the step of predicting energy for future builds with the addition of PV systems, which contained a number of PV cells system assumed for each building/existing housing building within a domestic sector. Thus, the second step in scenario 2 entailed adding a PV system to future new-builds to recognize the reduction in both scenarios for the existing and future applications when implementing this technique. The performance of each ANN model, the training error rate, and the number of the epoch to show the acceptance level, demonstrated 0.001, 0.02, and the maximum epoch is 1000, respectively. The given methodologies showed that the ANN neural network has the same number of inputs, also the layers=10. The test results for electricity for the function-based ANN were similar to the previous stages when this process was carried out for all other training parameters, and the results showed that the ANN-based model led to better performance by the given neural network. Further investigation might identify the best performance for the proposed scenarios to recognize the reduction amount in KWH and identification the saving percentage for the two main scenarios, including with and without the use of solar energy. This paper focuses on presenting the total saving for the current scenario, which normally does not involve solar energy and the future scenario assumption for the same block prototype with the adoption of a PV system for each housing unit; however, the total bills for the existing 25 houses within a neighbourhood block for the year 2016-2017, without involving a solar PV system, was 537967 kWh. Meanwhile, a sample of prediction energy for the same period for the existing sample followed by adding 25 PV systems to the buildings showed that the total bills were 404000 kWh/year. The reduction between the two steps is 133967 kWh/year, so that there was almost a 33% reduction between the two scenarios for the existing and future applications.

This study will accomplish an energy reduction between both the existing application without solar energy and the future model new-build prototypes with and without the implementation of PV systems for the coming years, e.g. 2018, 2019, etc. as the new-builds followed the experts/ consultations to use the update information/assumption will receive through the experts- consultations to update the new-builds criteria, in order to improve the current Challenges and meet the future requirements through survey-rounds as a next step.

VI. Conclusion

In this paper, ANN-based energy prediction was proposed for the area under consideration; namely, a prototype block neighbourhood within a district/domestic sector. The methodology entailed the flow chart steps for predicting energy and simulating an ANN model for a block prototype in the case study area (Baghdad, Iraq). The proposed ANN models of the two scenarios approach utilized the ANN models, ones without involving a renewable solution as a solar energy and another step with adding a PV system. A set of input and output parameters, driven into ANN, have been named in the case study scenarios, in order to train and test the ANN-model. A MATLAB-Simulink dependent model has been identified to generate a set of data. A number of ANN practices have been tested, and the input variables have effectively demonstrated the best performance of ANN experiments, so the variables' tuning was achieved based on the implementation of the process in hidden layers. In terms of the benefits of energy forecasting as part of a new framework, the global frameworks and national criteria focus on the scientific viewpoint, the government's view and professional decisions, but a predictive model was used to evaluate the prediction of the energy consumption scenario for the existing application and develop the model for the future scenario. This paper hopefully answered the research question regarding how a set of inputs variables that previously mentioned them driven into the ANN model to achieve the prediction of energy consumption step by step, based on the following chart.

This paper has presented an Artificial Neural Network for predicting energy in the domestic sector as part of a sustainability framework, using energy consumption and predicted in KWH as one output. Therefore, a new framework involves multiple dimensions of urban development goals, including a practical knowledge of energy simulation, which has been considered in this study to develop future urban projects by avoiding placing more pressure on the environment and extensive energy consumption. To conclude this, a neighbourhood is a basic part of a city level, so that it is essential to investigate the differences in energy use through simulated models using machine learning such as ANNs to forecast energy consumption for development projects.

The proposed ANN model will be used as a reduction function in terms of saving energy consumption in KWH for the coming years, in order to develop the future practices towards a sustainable framework including making progress in renewable solutions and achieving reductions in energy consumption, CO2 emissions and environmental pollution, and the cost function.

TABLE I: The Results of the ANN Models

ANN-models	(KWH)/year	The training error of each ANN (%)	ANN no. of layers	Regression analysis (validation) accuracy (R)
Energy consumption for existing a block/prototype without PV systems (25 houses)	537967	0.001	10	0.87
Future energy forecasting with adding 25 PV systems for the same block (25 houses)	404000	0.02	10	0.91

It would be useful to develop a sustainable framework with a different quantity indicator, e.g. water consumption. It is hoped that this work will help identify a scheduled timetable to implement a set of urban sustainability indicators, including renewable energy indicators, in the coming years.

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