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A Vision Future for Application Artificial Intelligent in Solar Energy

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ABSTRACT

This research paper aims to review the applications of artificial intelligence in energy and to develop a future vision for new applications. The research methodology focuses on clarifying the basic concepts of approaches to artificial intelligence (AI) and renewable energy and developing a visualization of the link between them.

Keywords: Artificial Intelligent (AI), Solar Energy (RE).

1. Introduction

Currently, Artificial Intelligence (AI) has become a science intertwined with other sciences, it is no longer limited to certain applications in computer science, multiple computer software has become tools that support applications of AI in the other sciences, and the concept of AI has overlapped with other sciences, such as engineering, medicine, physics, biology, astronomy, energy in all its forms, and the applications of AI have had a great impact on the transition from the third industrial revolution to the fourth industrial revolution, and it is now a major driver of the fifth industrial revolution.

Energy is one of the most affecting factors in the industrial revolution and sharing in parallel with artificial intelligence in the progress of industry. So far the energy is supposed its the essential engine for the development of human civilization and industrial development, the integrated of energy science with industrial intelligence will make the path of civilization development more powerful in the fields of industrial development, so the main aim of the present work is to study a vision futuristic for the applications between solar energy (SE) and (AI). The overlap between both of (SE) and (IA) sciences requires studying in-depth for the transformation process in managing the energy system in general that includes SE production, energy transfer, and energy distribution through AI, to achieve these goals, it is necessary to review the basics of AI, tools for applying AI, applications of AI, the mechanism of the SE system from production to distribution.

2. Artificial Intelligent

This part of the study will include a historical view of AI, theories of AI, and tools for applying AI.

2.1 Historical Review

Artificial intelligence (AI) defined as the ability of machines to think and understand instead of doing things automatically. AI is a science that is found by three generations of researchers; it can be illustrated as follows:

The first generation, its the stage of the emergence of the science of artificial neural networks (ANN): the first generation extended from the time period (1943AD-1956AD), where "McCulloch and Walter Pitts" in 1943 mixed the mathematical logic with the neural logic of brain cells and they proposed a model of ANN in which each neuron was postulated as being in a binary state, that is, in either on or off condition, which can be illustrated by Figure 1.

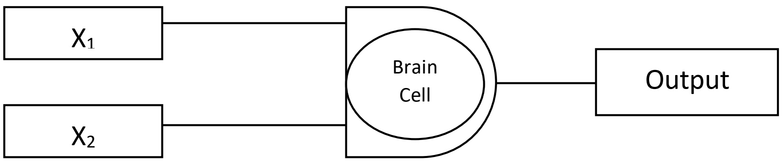


Figure 1. First Logic of AI by Cell Brain Logic

Despite the simplicity of this logic in Figure 1, it is a gateway to the launch of artificial intelligence science, this logic with multi-layout given the main step to treat big data. Which is shown in Figure 2.

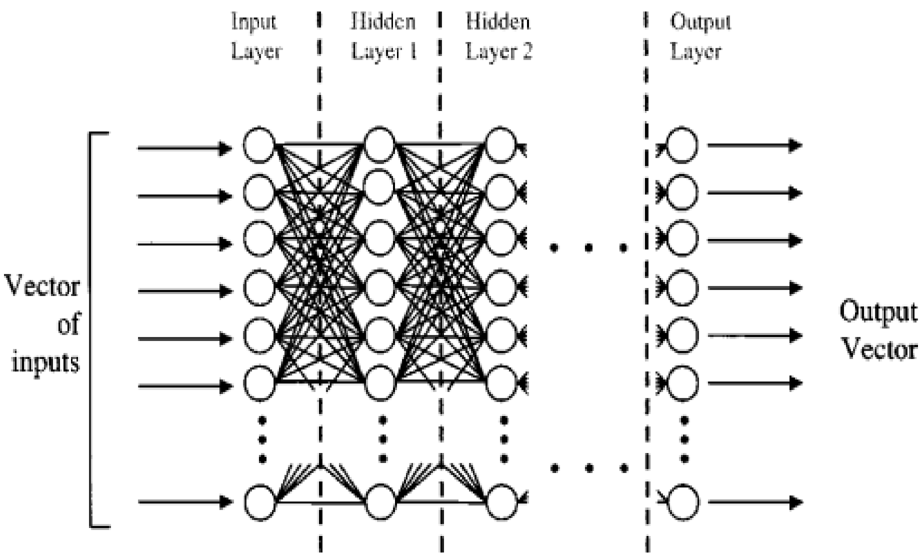


Figure 2. Neural Network with Multi layers

The previous logic also gives us mathematical forms that include matrices and the process of processing the evidence for these matrices within multiple layers

This ANN logic came as a result of re-describing the work of the brain cell through simple mathematical logic, and it is an innovation in extracting knowledge through the integration of science to build a new science. The re-description of the work of brain cells through describing mathematics has become an introduction to the application of the mechanism of the work of the brain cell in other areas, and this interference can be illustrated in Figure 3.

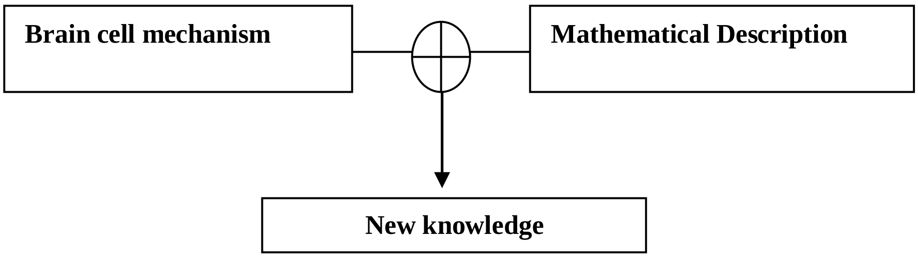


Figure 3. Mechanism of Action and Mathematical Description

It is clear that the initial visualization was simple in both directions, the descriptive direction of cell work within a binary range, in addition to the descriptive direction through mathematics. This limited perception had a negative effect that contributed to the slow development of artificial intelligence in other sciences at that time. The third founder of AI was "John von Neumann", he played a key role in the Manhattan Project that built the nuclear bomb, he helped to design the Electronic Discrete Variable Automatic Computer (EDVAC) (Gluck, 1953), a stored program machine. In addition, he supported and encouraged both "Marvin Minsky and Dean Edmonds", when they built the first neural network computer in 1951 (Wang, 2019).

The second generation in the stage of the development of artificial intelligence included the interaction of artificial intelligence with inferential logic: where machine intelligence was combined, between the artificial neural nets, and the automata theory (Burks & Wang, 1957)., this period technically spanned a short period (1956AD - 1960AD). In this generation, John McCarthy, the inventor of the term AI (Amisha et al., 2017), defined the high-level language LISP (Israel, 2012), which is still in current use. In 1958, he presented a paper, ‘Programs with Common Sense’, in which he proposed a program called the Advice Taker to search for solutions to general problems of the world (McCarthy,, 1958).

Most importantly, the program was designed to accept new axioms, or in other words new knowledge, in different areas of expertise without being programmed. Thus the Advice Taker was the first complete knowledge-based system incorporating the central principles of knowledge representation and reasoning. The third generation of the development of artificial intelligence stages, its represented by the expansion towards computer software: this stage spanned over the sixth decade of the last century when giant computers appeared and provided the opportunity to perform complex mathematical operations.

This progress aroused the enthusiasm ofscientists and researchers for research and development of new industrial solutions in the field of artificial intelligence, despite the modest results, but it was promising and encouraging. The interesting and growth in ideas and applications have been evident through many achievements such as neural computing, artificial neural networks (Buscema, 2002), improve learning methods and proved the perceptron convergence theorem by Frank Rosenblatt (Dreyfus, 1990), general problem solver by "Allen Newell" (Newell, 1958), developed a program to simulate human problem-solving method (Newell, 1958), learning algorithms (Li, 1959), all these achievements in the 1960s have been hampered by the limited capacity of computers to handle and process data.

At the end of the 1960s, is the beginning of a project DENDRAL program (Rapaka, 2017), Dendral was a project in AI of the 1960s, and the computer software expert system that is produced. Its primary aim was to study the hypothesis formation and discovery in science. DENDRAL was developed at Stanford University in 1965 (Greek, 2017) to analyze chemicals, the project was supported by NASA because an unmanned spacecraft was to be launched to Mars and a program was required to determine the molecular structure of Martian soil, and, based on the mass spectral data provided by a mass spectrometer. Therefore, this project faced failure due to a lack of algorithms for mapping the mass spectrum into its molecular structure. However, analytical chemists, such as "Lederberg", could solve this problem by using their skills, experience, and expertise (Novak, 2017). This case alerted researchers in the field of artificial intelligence to the need for experts, it is the integration of knowledge and human competence with software. Such programs were later called expert systems.

The third stage is characterized by a strong correlation between computer science and artificial intelligence (Minsky, 1970) but it did not neglect the role of experience in other sciences, as software solutions come from the computer, but the software is based on mathematical perceptions of other sciences. Through the foregoing, it becomes clear that mathematical interpretation represents a process of transformation of knowledge in other sciences into mathematical logic that can be programmed and used in machine learning.

The fourth generation, in this stage the witnessed failures was in the applications of artificial intelligence clearly appears, and spanned the seventh decade of the last century: This phase constituted the localization of expert systems and their relationship to artificial intelligence, although expert systems have formed an important turning point in the stages of AI development (Gupta & Nagpal, 2020) they are not sufficient to ensure the success and expansion of applications. The following gaps were found in expert systems:

i. Lack of full integration of data and effects.

ii. Difficulty in verifying the validity of expert systems, particularly in applications that rely on specific data for a wide application environment.

iii. Difficulty in verifying data with inaccurate descriptions or unclear definitions. This type of data increases the likelihood that expert systems will fail.

iv. Difficulty in applying the systems of experts in science, which include conflicting theories and opinions or are still in an early stage of cognitive expansion.

v. There is a lack of data or an accurate interpretation of the data and its correlations in the applied environment.

vi. Increase the knowledge weight of specialists in the field of artificial intelligence due to their need to diversify scientific competence in accordance with the applied situation.

vii. Expert systems have limited explanation capabilities. It can show the sequence of the rules they applied to reach a solution, but cannot relate accumulated, heuristic knowledge to any deeper understanding of the problem domain.

viii. Expert systems take a long time to build a database and rely on complex backlogs and overlaps.

Despite all these difficulties, expert systems have made the breakthrough and proved their value in a number of important applications. It is noteworthy that the new view of the method of application of artificial intelligence successfully requires multi-directional knowledge, knowledge of computer science, algorithms, mathematical logic, and knowledge of other sciences.

The seventh decade of the last century represents a setback in the growth and application of the ideas of artificial intelligence developed in the decades preceding it. Not all ideas were feasible and the possibilities of supporting those ideas were unavailable, and their limited impact on the economy and knowledge contributed to limiting the growth of the trend towards artificial intelligence in the 1970s., but these achievements took an accelerated growth curve later and formed a platform for scientific building and achievement in the field of AI.

From 1940 AD - 1980AD as a part of the age of AI, the following important points can be drawn:

i. It turns out that the logic of AI is a case of re-description of data through mathematics in order to allow for the obtaining of broader data from the previous database based on the construction of mathematical relationships, this interrelationship made the mathematics intertwined with the functional description of human mental and physical abilities as a path to start research in this area.

ii. The most significant factor in the relapse of AI in the seventies of the last century was the direction of researchers and developers towards the search for general solutions and ignore the process of fragmentation of tasks and diversity in methods.

iii. Supporters of AI projects aspired to achieve instant results in complex problems, this vision weakened the methodology of research and planning in the mechanism of application of AI in that period.

iv. The research objectives in the field of artificial intelligence were based on military objectives that serve military industrialization. This aspect has created limitations in knowledge sharing and support for research in the field of artificial intelligence.

The fifth-generation, which was represented by the expansion of applications again in artificial intelligence, this stage was spanned throughout the eighties of the last century: In the mid-1980s a new turning point in artificial intelligence was formed by the return of interest in neural networks, though most of the basic ideas and concepts necessary for neural computing had already been formulated in the 1960s (Cowan, 1990), where the modern computing devices with high computational capabilities emerged. This coincided with the increase in financial support directed to research, these positive factors contributed to the optimism in the future of artificial intelligence applications. The following titles include the most significant achievements in neural networks in the 1980s:

i. Grossberg established a new principle of self-organization (adaptive resonance theory), which provided the basis for a new class of neural networks (Grossberg, 1980).

ii. Hopfield introduced neural networks with feedback – Hopfield networks, which attracted much attention in the 1980s (Hopfield, 1982).

iii. Rumelhart and McClelland in 1986 They reinvented the learning algorithm (Rumelhart and McClelland, 1986).

iv. Broomhead and Lowe in 1986, they found a procedure to design layered feedforward networks using radial basis functions, an alternative to multilayer perceptron's (Broomhead and Lowe, 1988).

The turning point in the 1980s was not limited to expert systems but extended to widespread interest in evolutionary computation, where it resulted from a combination of three main techniques:

i. Genetic algorithms: Genetic algorithms are the technique inspired by the logic of human chromosomes and natural selection introduced by John Holland in the early 1970s. It is based on five phases within a sequential scheme: initial population, fitness function, selection, crossover, and mutation (Stender,1993).

ii. Evolutionary strategies: This technique appeared in the early 1960s by "Rechenberg and Schwefel", where it was designed for solving parameter optimization problems in engineering. This technique is based on the use of random changes to the selection and identification of parameters (Fonseca & Fleming, 1995).

iii. Genetic programming: programming is the turning point from the theoretical technical perspective to the practical perspective of data simulation within a virtual environment. Genetic programming technique (Whitley, 2001), it appeared in 1988 embodied in a system called the 'invention machine' was patented by Stanford University computer scientist John Koza in 1988. It represented a link between gene algorithms and programming science that contributed to the rapid growth of AI.

The sixth generation that represents the revolution in the applications of artificial intelligence, this stage extends from the nineties of the last century until the present day: The last three strategies, which emerged over a three-decade period from the 1960s to the 1980s, together served as supportive tools for AI applications. At the beginning of the nineties of the last decade, the trend towards neural networks returned to address the defects of expert systems. The lack of clarity and accuracy of data in expert systems contributes to the failure of intelligent applications, so neural networks work to extract more accurate data from the available data set.The 1990s also saw the introduction of fuzzy logic in data handling. The process of dealing with fuzzy data formed a large area for the development of AI applications. Although the logic of fuzzy appeared in the mid-1960s by Lotfi Zadeh" (Zadeh, 1996), its applications in the field of artificial intelligence came three decades later.

Since the nineties of the last century, the field of artificial intelligence has been growing rapidly, and in the present time artificial intelligence has become the most extensive circle in industrial production in many industrial fields, and it is noteworthy that industrial intelligence did not arise as an independent science in itself, but a mix between behavior and matter and between thinking and various sciences.

2.2 Artificial Intelligent Applications

At the dawn of the current millennium, interest in the fields of industrial applications for industrial intelligence has been the focus of many researchers, manufacturers, and customers in most sectors.

i. Military Industries (Hoadley, 2018).

ii. Medical applications (Agah, 2013).

iii. Manufacturing Industrial Applications (Lee et al., 2018).

iv. Applications in technological industries (Özdemir & Hekim, 2018).

v. Applications in communication (Guzman & Lewis, 2020).

vi. Agricultural applications (Drury et al., 2017).

vii. Applications in energy (Zahraee, 2016).

viii. Applications in Agriculture (Bajaj & Sharma, 2018).

ix. Applications in Education (Tran et al., 2017).

x. Planning and Scheduling (Tran et al., 2017).

xi. Applications of AI in robots (Ivanov & Webster, 2019).

xii. Application of AI in maintenance (Özdemir & Hekim, 2018).

These applications depend on the ability of specialists in the field of AI to link the phenomena and techniques available in the field of artificial intelligence to ensure the success and expansion of applications.

2.3 Artificial Intelligent Mechanism

The AI application mechanism relies on several components:

i. Correct and accurate understanding of similar behavior in nature: This understanding includes ANN, and expert systems, and includes consideration of data uncertainty, all of which depends on the collection of big data.

ii. Transforming this behavior into mathematical logic: This transformation is related to mathematical theories that include prediction, analysis, deduction, and digital transformation such as set theory, uncertain, fuzzy logic, game theory, graph theory, topology, and probability theories.

iii. The use of computer software in the implementation of mathematical logic: This use requires a broad understanding of the software capable of mining data and transferring it to orders and decisions, and requires the linking of data sequences in the form of algorithms commensurate with the goal expected to be achieved.

iv. Technical connection between machines and software: This includes the ability to transfer data and decisions and transfer them to mechanical or thought logic in application.

The effectiveness of any smart system increases as it is more able to absorb more data, analyze it more accurately and transfer it to more apparent results.

2.4 Artificial Intelligent as a Hybrid System

In view of the development of industries, the overlap between tools for applying artificial intelligence has become a necessity required, this intervention produces smart systems within several forms, including:

i. Neural Network with the expert systems.

ii. Expert systems with fuzzy logic.

iii. Expert systems with uncertainty.

iv. A neural network with fuzzy logic.

v. A neural network with uncertainty.

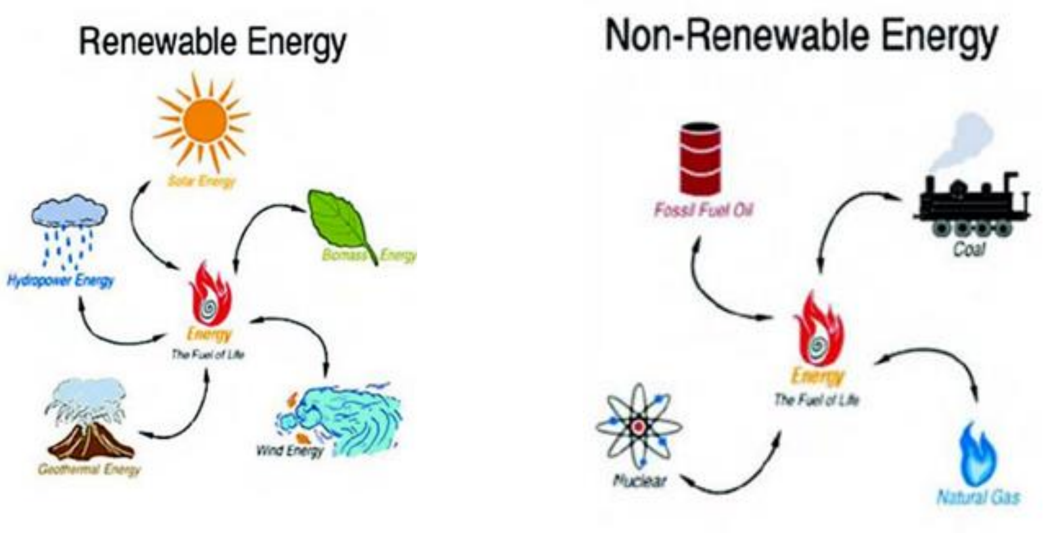
2.5 Artificial Intelligent Programs

The programming process for data in industrial intelligence in our time has become the easiest step from the previous steps in the process of building smart systems. Programs previously it was a profound problem facing ideas and facing the owners of different disciplines, but today the world has various solutions that can Obtain it through programming experts. In this advanced stage which AI reached, ideas became more important than tools. Availability of tools was in the last century a dilemma, but today it is available within multiple options.

3. Renewable Energy

Energy can be divided into two types, namely non-renewable energy and renewable energy. Non-renewable energy does not regenerate itself at a sufficient rate for sustainable economic extraction in the human timescale . Examples of the sources of this type of energy include petroleum, natural gasoline, coal and nuclear energy as shown in Figure 4(a). Unfortunately, these carry many issues. For example, harnessing nuclear energy is highly risky, while traditional fossil fuels are very quickly depleting. The world needs to find substitutes for these energy sources, which should be pollution free and abundantly available. Therefore, the attention concentrated on non-renewable energy sources has now shifted to renewable energy sources, particularly efficient renewable energy sources.

Renewable energy is energy that comes from sources that are naturally renewing itself on a human timescale. Examples of renewable energy are wind energy, solar energy, tidal energy, geothermal energy, gravitational energy and biomass energy as shown in Figure 4(b). Renewable energy is an alternative energy that is clean, nontoxic and abundantly available in nature. The strategy of many nations is to supply energy from renewable sources, especially when there are numerous environmental sustainability concerns that must be addressed appropriately (Johnson, 2006).



(a) (b)

Figure 4. Types of Energy; (a) Nonrenewable Energy and (b) Renewable Energy Types

There are many advantages of using renewable energy, such as sustainability (cannot be depleted), ubiquity (found everywhere across the world in contrast to fossil fuels and minerals), generally non-polluting and carbon free. Non-renewable energy sources can be acquired from almost all over the world, which is in contrast to fossil fuels and minerals. Non-renewable energy is also environmental friendly as it does not contaminate its surroundings. For wind energy, it does not need water in the production of electricity, and this gives much advantage in dry areas across the world, such as at the southwest and most of the west of the United States of America (Nelson & Starcher, 2015).

However, there are also disadvantages of renewable energy, including its variability, low density, and generally higher initial cost. To add, renewable energy sources may cause visual pollution, odor (from biomass), perceived avian issues (for wind plants), and large land requirements (for solar plants) (Foster et al., 2009).

Energy is the artery of industrial development, and improving energy management processes is extremely important, such as this management includes: production management, transportation management, distribution management, and each of these stages has different components and is influenced by different factors, as it differs in different types of stations. The most common examples include SE, wind energy, geothermal, biomass, and hydropower.

Solar energy (SE) is an important alternative energy source that likely will be more utilized in the future. One main factor which limits the application of solar energy is that it is a cyclic time-dependent energy resource. Therefore, solar systems require energy storage to provide energy during the night and overcast periods (Dincer & Rosen, 2002). SE is considered one of the most growing sources of energy in the world, this growth will make it in the future a major source of energy that many countries depend on, this increases the importance of studying these stations and attempts to raise its efficiency in all forms available, including applications of AI in RE.

Many researchers they are focused to using different computers software in simulation of solar energy (SE) processes and relatively recent development such as (Sheridan et al., 1967) used an analog computer in simulation studies of operation of solar water heaters. (Gupta and Garg, 1968) developed a model for thermal performance of a natural circulation solar water heater with no load, represented solar radiation and ambient temperature by Fourier series, and were able to predict a day's performance in a manner that agreed substantially with experiments. (Close, 1967) used numerical modeling and a factorial design method to determine which water heater system design factors are most important.

CombiSys is a special version of the system simulation program TRNSYS. This program simulates a solar ''CombiSystem'' that supplies heat for both a house heating system and a domestic hot-water system. A diagram of the energy flows in a solar CombiSystem as shown Figure 5.

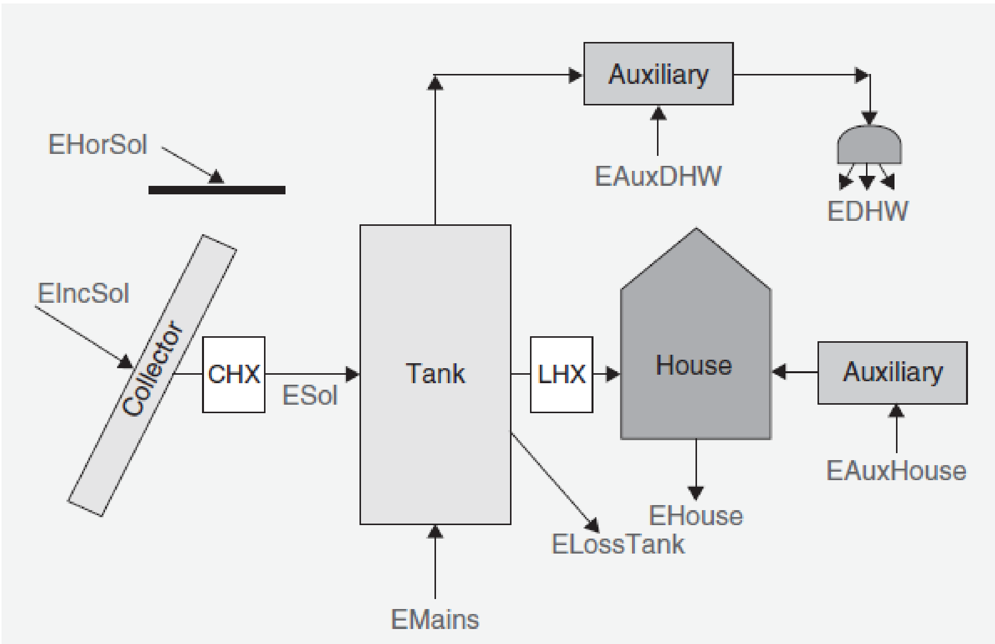


Figure 5. A diagram of the energy flows in a solar CombiSystem.

4. The Artificial Intelligence Gate to Solar Energy

According to previous studies, understanding the behavior of the application field is the first step for start applying artificial intelligence in any field, and accordingly, understanding and characterizing solar energy is the main approach to applying AI in SE.

As mentioned earlier, solar power stations are connected to three main phases:

i. Production (Electric generation), is the process of generating electric power from sources of primary energy. This stage includes: managing the reception process for the power source, and for managing the receive of solar radiation, this requires: (Determination of radiation time, determination of factors affecting the arrival of radiation, and determine the path of motion of the radiation source).

To ensure the effectiveness of the smart system applied in the future, all cases of radiation must be taken into account and the data be diverse and comprehensive, including the time path that includes seasonal diversity, daily diversity, diversity according to hours during the day. This type of data is considered within the big data range according to several variables including time, geography, and weather. This data is scheduled through continuous monitoring and through historical data, and then it is analyzed within an average of radiation within the most accurate time division. This data, through software processors, can be used to construct accurate prediction models that contribute to making decisions regarding the sun's reception mechanism.

This type of data is directly related to the intelligent control mechanism of the movement and distribution of solar cells in the station.

Where the movement of cells is linked with smart movement regulators that rely on previous data and are connected to the instantaneous state through sensors. Here the intelligent systems used within expert systems and foggy logic overlap. Predictive data is always foggy, so increasing data volume reduces blurring and creates more coherent digital matrices.

ii. Electric transmission is the process of delivering generated electricity, and usually over long distances to the distribution grid located in populated areas.

To ensure the effectiveness of the smart system in the electrical transmission process, accurate data must be collected about the number of electrical products in parallel with the order quantity, and within considerations that include the type of the transmission network and the distribution points of the network directions, these data go beyond the generating station to include factors that may be fuzzy, such as the nature of consumption and uncertainty in the amount of production. This kind of data is directly related to the intelligent control mechanism of electric transmission management.

ii. Electrical distribution is the final stage in the delivery of electric power; it carries electricity from the transmission system to individual consumers.

To ensure the effectiveness of the AI system in the electrical distribution process, accurate data must be collected about the amount of electricity produced in parallel with the order quantity, and within considerations that include the type of distribution points for the network directions, the size of the grid, this data contributes to determining the grid control options, and it can be linked to the electrical generation to make decisions about the need for electrical generation, it is also possible through the distribution points to determine the quantities of waste, storage and control them through AI systems.

5. Conclusion

From the foregoing, the concept and history of both artificial intelligence and energy, especially solar energy, were recognized. Also an overview of renewable energies, their types, benefits and disadvantages was presented. The mating of artificial intelligence and solar power is also listed.

In this research, a set of applications that could be used to manage the solar energy system within its three phases, electric generation, and electrical distribution were identified, and the study showed that each stage includes diversity in the available application mechanism and that the smart systems that can be used are diverse and include hybrid systems that can It is effective in raising performance in the management and regulation of solar energy.

This study will be contributed to develops future ideas that can be implemented through applied field studies or through computer simulations of different power stations.

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