الأكاديمية العربية للعلوم والتكنولوجيا والنقل البحري
Arab Academy for Science, Technology & Maritime Transport

Innovative Photovoltaics Envelopes for adaptive energy and comfort management of Harsh Climate Areas in Upper Egypt toward nearly zero energy buildings

Short Title or Acronym: PVENVOLPNZEB

Keywords: Thermal comfort, Indoor air quality BIPV, Harsh climate.

- **Funding and Duration:**

Total cost: 500,000 pounds for 12 Months.

Research Theme: Renewable Energy

1. Proposal Summary in English

Nine years ago, Egypt experienced one of its most serious energy crises for decades. Hence, the Egyptian government and the Ministry of Electricity and Renewable Energy (MoERE) are committed to maximizing Egypt's renewable energy potential to meet the growing demand and to enhance the environmental and climate footprint of the power sector. To stimulate the development of renewable energy, Egypt has introduced an overarching regulatory framework to secure 20% of its energy generation from renewable sources by 2022.

Over the past few decades, worldwide population expansion, economic growth, and prompt industrialization development caused substantial rises in building energy consumption bills. The residential and commercial buildings' energy consumption is between 20-40% of total energy utilization [1,2]. Hence, cutting building energy expenditure, building materials, and energy technologies must be boosted. While beneficial in many ways, constraints exist concerning the reserves that can be attained by renovating buildings, with findings average energy-conserving deficits to level from 14 % to 98 %.

Aswan Governorate has the highest ambient temperature and solar radiation in Egypt. Moreover, Aswan is considered as Africa and the Middle East energy capital, as it has the largest solar PV farm in Banban city. However, the energy requirements of the buildings and the indoor thermal comfort are very sensitive in harsh climates such as the Aswan government that has tough and harsh weather conditions during summertime.

Since the façades essentially are involved in the building's heating and cooling processes, buildings' façades retrofitting is considered as an efficient technique to reduce cooling and heating requirements in already instituted buildings. In this project, a photovoltaic separate panels building envelope will be constructed in the Aswan branch of the AASTMT campus as a case study. The proposed system provides adaptive energy and thermal comfort management of harsh climate such as Aswan towards zero-net-energy construction (ZNEB). The new plan addresses multi-disciplinary research areas and requires a mix of numerous promising ideas for energy and construction. First, during the current work, the condition of

photovoltaic solar energy technologies will be applied as the thermal insulation of the building façade. This is one of the powerful ways to convey more indoor thermal comfort to decrease energy consumption. The installed photovoltaic panels in the building façade are off-grid electricity sources which guarantees an extra reduction of the electricity bills. By the current project, solutions will be provided regarding the main challenge of Egyptian regions with a harsh climate. An innovative building integrated photovoltaic (BIPV) will be employed to produce electricity and provide satisfactory indoor thermal comfort. Moreover, a blueprint of this promising combination will be completed by applying analytical, experimental, and mathematical work approaches to complete the framework and introducing it the Egyptian society.

In conclusion, the proposed study aims to design and construct an energy-efficient, economical building for thermal comfort and energy saving. An innovative BIPV for the NZEB and zero-carbon buildings would be in operation without relying on conventional energy sources. This latest integration is of direct relevance to the existing call priority field of concern at present (i.e., energy and building cooling systems).

2. Proposal Summary in Arabic

من أجل تلبية الطلب المتزايد وتنويع مزيج الطاقة الوطني وتحسين البصمة البيئية والمناخية لقطاع الطاقة ، تلتزم الحكومة المصرية ووزارة الكهرباء والطاقة المتجددة (MoERE) باستغلال إمكانات الطاقة المتجددة في مصر. منذ ثماني سنوات ، شهدت مصر واحدة من أخطر أزمات الطاقة منذ عقود. لتحفيز تطوير الطاقة المتجددة ، أدخلت مصر إطارًا تنظيميًا شاملاً بهدف تأمين 20٪ من توليد الطاقة من مصادر متجددة بحلول عام 2022. في نفس السياق ، على مدى العقود القليلة الماضية ، التوسع السكاني في جميع أنحاء العالم والنمو الاقتصادي ، وتسبب التطور الصناعي السريع في حدوث زيادات كبيرة في فواتير استهلاك الطاقة في المباني. يتراوح استهلاك الطاقة في المباني السكنية والتجارية بين 20-40٪ من إجمالي استخدام الطاقة [1،2]. ومن ثم ، يجب تعزيز خفض نفقات الطاقة في المباني ومواد البناء وتقنيات الطاقة. على الرغم من كونها مفيدة من نواحٍ عديدة ، إلا أن هناك قيودًا تتعلق بالاحتياطيات التي يمكن الحصول عليها من خلال تجديد المباني ، مع نتائج متوسط العجز في الحفاظ على الطاقة إلى مستوى من 14٪ إلى 98٪.

تعد متطلبات الطاقة للمباني وحجم الراحة الحرارية الداخلية حساسة في المناخات القاسية مثل مناخ أسوان الذي يحتوي على إشعاع شمسي شديد مع درجات حرارة قاسية خلال فصل الصيف. نظرًا لأن الواجهات تشارك بشكل أساسي في عمليات التدفئة والتبريد في المبنى ، فإن التعديل التحديثي لواجهات المباني يعتبر تقنية فعالة لتقليل متطلبات التبريد والتدفئة في المباني القائمة بالفعل. في هذا المشروع ، سيتم تركيب غلاف المبنى من الألواح الكهروضوئية المنفصلة في إحدى واجهات AASTMT الشفافة في أسوان. يوفر النظام المقترح طاقة تكيفية وإدارة مريحة للمناخ القاسي نحو مبنى الطاقة الصافي الصفري (ZNEB). يغطي الاقتراح الحالي موضوعات بحثية متعددة التخصصات ويتضمن مجموعة من الطاقة الواعدة المختلفة وحلول البناء. أولاً ، سيتم تنفيذ حالة تقنيات الطاقة الشمسية للخلايا الكهروضوئية أثناء العمل الحالي كعزل حراري لواجهة المبنى. هذا هو أحد الحلول الفعالة لتوفير المزيد من الراحة الحرارية الداخلية لتقليل استهلاك الطاقة. الألواح الكهروضوئية المركبة في واجهة المبنى خارج الشبكة ومصدر للكهرباء وهذا التخفيض الإضافي الكبير لفواتير الكهرباء.

من خلال المشروع الحالي ، سيتم تقديم الحلول فيما يتعلق بالتحدي الرئيسي للمناطق المصرية ذات المناخ القاسي. سيتم استخدام مبنى مبتكر متكامل من الخلايا الكهروضوئية (BIPV) لإنتاج الكهرباء وتوفير راحة حرارية داخلية مرضية. علاوة على ذلك ، سيتم الانتهاء من مخطط لهذه المجموعة الواعدة من خلال تطبيق مناهج العمل التحليلية والتجريبية والرياضية لإكمال الإطار وتقديمه.

في الختام ، يهدف هذا العمل المقترح إلى تصميم وتطوير مبنى اقتصادي موفر للطاقة من أجل الراحة الحرارية وأغراض توفير الطاقة. بدون الاعتماد على مصادر الطاقة التقليدية ، سيكون BIPV المبتكر في اتجاه NZEB والمباني الخالية من الكربون. يرتبط هذا التكامل الجديد ارتباطًا مباشرًا بمجال أولوية المكالمة الحالية (مثل أنظمة تبريد الطاقة والمباني).

3. Introduction/Background

Over the past few decades, worldwide population expansion, economic growth, prompt industrialization development caused substantial rises in building energy consumption bills. The residential and commercial buildings' energy consumption is between 20-40% of total energy utilization [1,2]. Substantial annual growth in worldwide energy consumption has been evident in recent years with the rapid evolution of current modernization and industrialization technologies [3]. According to the projections of the Annual Energy Outlook (AEO2020) [4], energy consumption between 2017 and 2050 is expected to increase by approximately 0.4% per year in the reference case that considers improvements in current technologies. Besides, heating, ventilation, and air conditioning (HVAC) represent the largest portion of the total building energy consumption. A typical system accounts for around 40% of total building consumption. Therefore, there is a sense of urgency concerning mitigating the environmental problems caused by the energy sources in active use [5]. It can be stated that there is a critical need for reliable, sustainable, and clean energy resources. One of the promising solutions to these challenges is to attain the principle of near-zero-energy buildings. Therefore, buildings construction in harsh climates (hot and humid) involves high-energy demands typically for air conditioning due to higher thermal loads.

Building thermal management and energy-saving particularly in the buildings sector is commendable of the scientific community attention [3]. Cutting building energy expenditure, building materials, and energy technologies must be boosted. On the other hand, the interactions between energy, and building regard to economic and environmental consequences under situations of climate-changing are essential to be considered. The buildings have not to be new to became energy competent and have an acceptable value of sustainability. Hence, building retrofitting is an essential procedure and measure for reducing energy consumption. Furthermore, building retrofitting is a promising solution to the high building consumption over the last few years to word more thermal effectual and sustainable buildings. It generally entails alternatives, modifications, and renovations of existing buildings to improve energy efficiency, conservation, and savings. Besides, it also allocates the deployment of distributed production in the building intended for remaining energy efficient. The current constructions can be retrofitted for then deliver enormous eco-friendly impact as compared to an emphasis just on green principle and building strategies. Efficient retrofitting of the existing building reduces the energy consumption amounts is of equivalent value due to its economic impact. The building envelope is the physical boundary amid the indoor and outdoor of a building. Furthermore, the energy balance that ensues in the building is one of the envelopes' principal functions. Building fronts, façades, and windows deliver the largest amount of thermal energy transmittance in buildings and account for 20-30% [4,5]. Consequently, the nature of the materials and designs of the façades is a significant aspect in defining the energy routine of a building and subsequently the level of sustainability.

Figure 1 Building envelope separator between the conditioned and unconditioned environments such as air, water, heat, light, and noise.

The glass is commonly exploited in office buildings and large headquarters building. Glass or any transparent materials supplies the natural light to the building [6]. The façades envelope shields the indoor from the outdoor environment different loads (temperature, humidity, and pressure) [7] (Figure 1). Even supposing the glass façades bear the entire of the needed light during the daytime, which completely cut lighting energy consumption, but this increases heating loads in harsh environments. Robust and durable considerations must be directed to the selection of glassing and building envelopes as the transparent façades are very sensitive to surrounding weather as they cannot endure solar radiation transmittance and thermal leakage. The Heat leakage over openings and transparent windows is one of the dominant aspects of the energy efficiency of low-carbon and energy building [8]. Therefore, comprehensive energy investigation is mandatory to systematically investigate the existence of glass façades cases and find innovative solutions. Retrofitting the existing buildings' glass façades to balance between providing daylight and drop of thermal energy leakage is one of the main challenges of the building sectors.

Extensive research investigations were directed to close the gap between energy consumption and the existing building designs [9]. Enormous research studies were conducted regarding the energy-saving potential and performance of a wide range of building envelopes for energy-saving technologies [10,11]. Since then the building large-scale openings that convey transparency and the façade openings contribute to substantial thermal transmittance in buildings, several research studies have focused on building retrofitting with special regard to openings glazing types [12], U-value[13,14], the window-to-wall ratio [15], and thermal insulation material such as phase change material (PCM) [16]. Further research studies were directed to investigate thermal insulation such as double glazing [17], vacuum glazing [18], window shutter with PCM [19], and liquid-filled smart window with PCM [18,20] instead of traditional and single glazing windows to reduce the thermal transmittance inside the buildings. Even the aforementioned glazing windows and other smart windows technologies have many promises but yet those technologies are still costly [21,22]. Furthermore, those technologies have not reached global recognition for commercial applications. A unique alternative to the existing glazing is using a Low-E and economically reasonable material for the renovation of the current windows. Offering and assessing feasible and achievable windows glazing material is an insistence issue nowadays.

Solar shading devices are a significant part of numerous energy-effective building policies and strategies. The most common solar control and shading techniques include external fins, light shelves, low shading coefficient glass, interior shine control appliances such as adjustable louvers, and landscape concerns such as trees or windbreak strips [21]. Although those procedures significantly cut cooling energy consumptions, yet these strategies just offer glare control only. Moreover, numerous concerns restrict the potential use of the existing tools. For current buildings, the obligatory frame modifications will increase costs, unfortunately. An innovative alternative to the existing façade envelopes is the building-integrated PV (BIPV). The BIPV not only provides the required solar shading but also produces solar electricity. Similar to the selective solar shading feature the BIPV arrangements are innovative and promising insulation technology that has the potential to alter traditional low-performance insulation technology. The BIPV is broadly considered in the open literature for wide applications [23–25]. However, to the best of the authors' knowledge, the BIPV insulation concept has not been considered for windows insulation as semi-dynamic structure systems generally and for Aswan city specifically. For that reason, the current study introduces a mathematical model along with an experimental verification test section for energy simulation of innovative BIPV systems. Moreover, a further improvement on the subject of the overall conversion efficiency and economical point of view cost must be done. In the current work, the feasibility and achievability of the newly introduced BIPV of windows insulation is considered. The thermal performance of BIPV and its influence on interior thermal comfort will be considered in the current work. The indoor and outdoor conditions will be considered in the thermal simulations and experimental work. A wide range of various conditions will be evaluated. The construction investigation will be contacted for assessment of the influence of the installation of the BIPV plates in the building structure.

4. Questions and Objectives

OVERALL OBJECTIVE
To boost the sustainable development of Egyptian relegated due to historical problems of quantity, quality, and energy-saving through a novel PV building integrated system. This system will guarantee thermal comfort with only a solar shading system to façade openings that contribute to substantial thermal transmittance in buildings along with a new source of electricity.

SPECIFIC OBJECTIVES	
Objective	***Quantification***
To improve the thermal comfort of the glazing façade by sustaining the existing building with a novel shading system.	*Direct measurements of the indoor condition*
Energy-saving is the main concern worldwide. This system will have a profound impact by generating fair jobs and increasing the productivity of electricity and reduce the thermal load of the building consequently the energy consumption.	*A detailed economic survey of social acceptance, economic benefits analysis, and impact on the environment will be conducted via analysis of farmers' perception, local communities, end-users private sector, and governmental entities.*
The system will allow managing energy efficiently and will promote good practices es in Egypt.	*A Standard Operating Procedures (SOP) document to building-an integrated PV system in an Egyptian building will be created. The full set of application parameters of the system will be carefully determined and measured to establish its optimal use.*
Improving the quality and extending the durability of the indoor air quality and thermal comfort.	*Direct measurement of thermal loads on the specific buildings before and after installation of the proposed system and a comparative study of the typical loads to conventional methods.*

5. Project Description

5.1. Overall research Approach and Methodology

To accomplish the objective of the current proposal, the research work generally has the following main four stages:

Stage 1. Data collecting and data analyses.

Stage 2. Design, optimization, and fabrication of the BIPV

Stage 3. Experiment setup and experimental verification of the CFD modeling.

Stage 4. Dissemination, communication, and diffusion plan.

5.2. Approach and Methodology:

This is a multidisciplinary project where the active participation of the partners is essential. In particular.

This research work has two main parts:

I. **Improving building overall energy efficiency.**
II. **Designing innovative building envelopes to improve the indoor thermal comfort of dwellers.**

There are six tentative work packages (WP) to achieve within 12 months.

- **WP1: Statistics of the local weather and terrestrial conditions.**
- **WP2: Design of the BIPV.**
- **WP3: Laboratory scale fabrication and testing of the optimized BIPV.**
- **WP4: Optimization of the BIPV.**
- **WP5: Pilot-scale fabrication of a complete BIPV system and evaluation of its performance.**
- **WP6: Dissemination, communications, and studies of commercial exploitation.**

5.3. Main tasks and subtasks and summary tasks in Project.

Main Task 1 : Data collecting and data analyses	
Sub 1.1: Sub Task 1.1	Statistics of the local weather and terrestrial conditions
Sub 1.2: Sub Task 1.1	Procurement of the required equipment, instrumentation, and materials
Sub 1.3: Sub Task 1.1	Analytical approaches studies of the proposed design

Main Task 2 : Design, Optimization and fabrication of the BIPV

Sub 2.1: Sub Task 2.1	Modeling and simulation work following the input analytical data and determination of the characteristic data of the local weather conditions.
Sub 2.2: Sub Task 2.2	Design of the BIPV.
Sub 2.3: Sub Task 2.3	Optimal the designed BIPV system.

Main Task 3: Experimental verification of the CFD modeling.	
Sub 3.1: Sub Task 3.1	Finalizing the design the experimental unit.
Sub 3.2: Sub Task 3.2	Laboratory scale Construction and fabrication of the experimental set up.
Sub 3.3: Sub Task 3.3	Experimental investigation of the main parameters and data collection.
Sub 3.4: Sub Task 3.4	Comparing the experimental and mathematical results and writing the conclusions.

Main Task 4: Project communication, dissemination and exploitation	
Sub 4.1: Sub Task 4.1	Page on AASTMT website
Sub 4.2: Sub Task 4.2	Organization of information workshops and seminars
Sub 4.3: Sub Task 4.3	Publication of periodical hard copies materials
Sub 4.4: Sub Task 4.4	The communication platforms

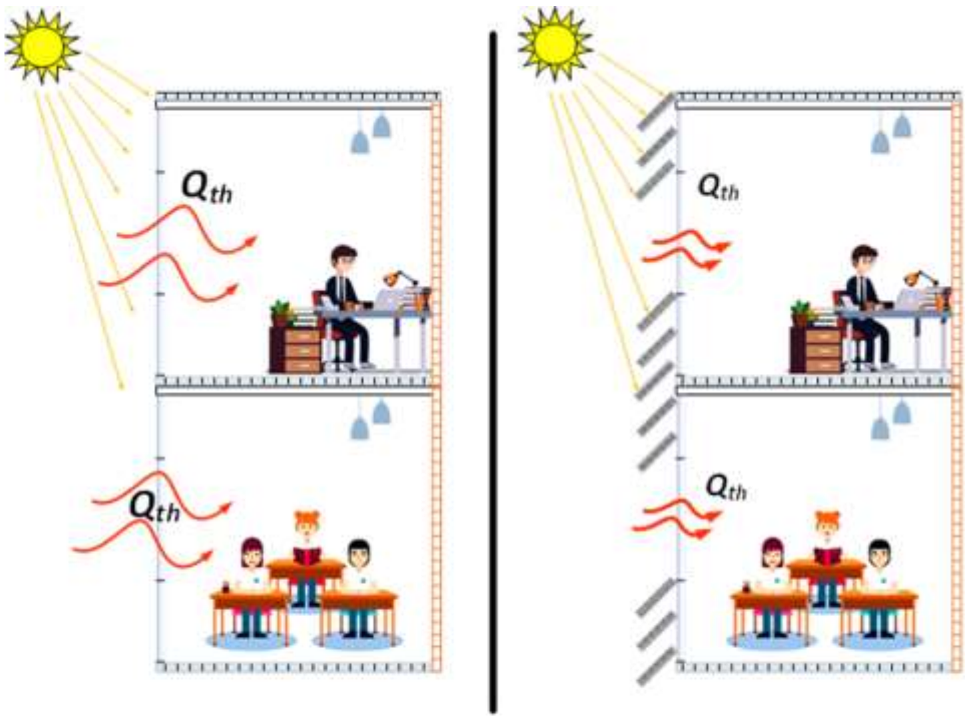

Figure 2 the concept of the PV shading

6. Research Design and Methods

This unit will be used for the practical application of an innovative unit for thermal insulation and solar shading as shown in Figure 2. To accomplish the objective of the current proposal, the research work generally has the following main tasks:

1. **Procurement of the required equipment, materials, and instruments, and data collection.**

2. **Developing and design of an innovative building envelopes system to achieve optimum thermal comfort requirement of a specific building will be carried out through two main steps:**

   a) Modeling and simulation work of the suggested designs according to the input analytical data and find out the characteristic data of the cell such as average-and-local cell temperatures, etc. In this step, several computational software such as ANSYS, MATLAB, etc. will be implemented.

   b) Construction and fabrication of the outdoor experimental setup and PV thermal insulation unit to investigate the main parameters controlling its performance such as:
      - The installation of PV panels angles
      - The orientation of the PV and the distance between the PV and the building windows.

- The wind speed, ambient temperature, and other weather conditions.

c) Experimental results will be used to validate the computational and mathematical model results.

3. Simulation work

Energy simulation software package of ANSYS Simulation program will be employed. ANSYS will estimate the output of the subsystem by connecting the components that constitute the system. ANSYS provides the program great tractability because of ANSYS library contains several components that are generally found in thermal and electrical energy systems such as the proposed system of the current work, as well as component procedures to insert input of weather data or and other time-dependent functions. ANSYS will estimate the overall system output results, which will be exploited for indoor and outdoor experimental work. A computational fluid dynamic (CFD) model will be developed to estimate the required data.

4. Experimental work, design of experimental system assembly, and fabrication

Indoor experimental work will be conducted to validate the developed thermal models and ANSYS results. An indoor test rig will be constructed for the verification process as shown in Figure 3. A wood room (2 x 2 x 2 m) will be built to study the impact of the PV shading system experimentally. The indoor conditions such as (temperature, humidity, etc.) will be examined. As shown in the figure the PV panels will be fixed on the glass window side.

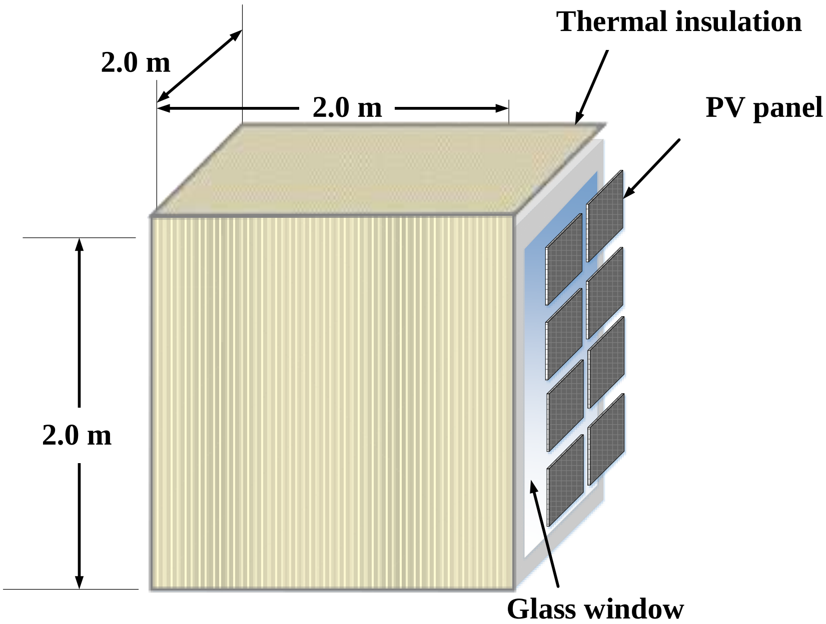

Figure 3 Design of experimental system

5. Conclusions and recommendations for the obtained results

A concrete conclusion will be extracted from the obtained results and major recommendations will be suggested.

6. Manuscript and report writing.

Research publications will be considered for publication in scientific international ISI engineering journals.

7. Anticipated Results and Evaluation Criteria

As the thermal insulation of the building façade, renewable energy and particularly photovoltaic solar energy technologies will be used. This is one of the strong ways to communicate more indoor thermal comfort and minimize energy consumption. The main objective of the proposed project is to improve indoor thermal comfort in the Harsh climate as Aswan city.

We strongly ask the AASTMT funding agency to help our research project, which will open doors for all faculty members to attempt to obtain research projects and collaborate massively with various national or foreign universities/institutes. This is very important for the environment, while in AASTMT, Aswan Branch, there is no possible laboratory focusing on the application of renewable energy.

8. Expected Project Outcomes and Impact to AASTMT

AASTMT, nowadays, has attention for Renewable energy resources to support Egyptian government's for new directions especially in South valley region. Consequently, We must bring our understanding of multidisciplinary sciences to a higher level.

I- Technical output and Impact:

a) One of the goals of the proposal is to provide technical assistance and engineering consulting to international and national companies operating at Africa's largest solar PV Park (Banban, Aswan, Egypt.).
b) At least one Ph.D. student will participate in this project and maybe one master student.

II- Financial feasibility & Socio-economic Impact:

a) One of the implications of this Proposal is the first Solar Energy Hub in Aswan and Upper Egypt. And these are the needs required in these regions.
b) As Egypt is a partner in the Paris Climate Agreement, this proposal aims to minimize carbon emissions.

III – Publication:

a) A significant number of papers were written by all team members in the Q1 Web of Science and Scopus journals. In particular, the Renewable Energy Topics written by PI and Co-PI.
b) We are scheduled to publish at least two papers from this project in high-impact factor journals.

c) At the end of experimental investigations, the authors expect to record a new patent from optimized design and the results reported.

9. Resources

Dr. Aly Hassan Elbatran has good expertise in project management through his previous experience as PI and Co-PI and member for several local and international projects. Also, He has an academic background and deep research in the fields of renewable energy,

Facilities: the infrastructure of the lab, Office and Computer Facilities: laboratory space and computer facilities with Origin software are available in ASST.

Dr. Essam M. Abo-Zahhad has been working on projects for energy systems and solar energy storage, such as solar chimney power plants, parabolic and PV/thermal systems.

Facilities: have workstation computer and Energy, PV Programs

10. Team Information

Dr. Aly Hassan Elbatran (PI) is currently Associate Professor at Marine and Mechanical Engineering Dept., and the Head of Mechanical Engineering Department, Engineering and Technology College, South Valley Campus, Arab Academy for Science and Technology. He obtained BSc and MSc from Marine Engineering Dpt., AASTMT, Alexandria, Egypt, and Ph.D. from mechanical Engineering, Universiti Teknologi Malaysia (UTM), Malaysia. He had participated in many European funds as well as works for ten years in the design and research of mechanical and marine engineering fields. He has an academic background and deep research in fields of renewable energy, marine hydrodynamics, CFD, and material science.

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3. L Aboud, **AH Elbatran**, A Mehanna, M.F. Shehadeh. Experimental Study on the Effect of Impingement Angles and Velocities on Erosion-Corrosion Behavior of API 5L-X42 Carbon Steel in Eroded Flow Medium. International Review of Mechanical Engineering (IREME) 14 (8), 493-503.

Dr. Essam M. Abo-Zahhad (Co-PI)

Essam is an Assistant Professor for the Faculty of Energy Engineering, Aswan University. Over a 7 -year career, Essam has been working on energy systems and solar energy harvesting projects such as solar chimney power plant, parabolic through, and PV/Thermal systems. Essam participated in many activities for the development of higher education and attained up to seven different training and workshops for leadership and developing and renovating higher education in Egypt. Furthermore, over the last three years, Essam successfully made more than three different research consortiums with more than six international institutions in (Japan, Spain, Jordon, China, Greece, and the UK. Besides, Essam was involved in many held volunteer positions at Aswan university.

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Professor. Mohamed Shehadeh is currently the Dean of Engineering and Technology College, South Valley Campus. and a professor in the Marine Engineering Department, at the Arab Academy for Science and Technology and Maritime Transport (AASTMT). He obtained his BSc and MSc from the Marine Engineering Department at AASTMT, Alexandria, Egypt. He obtained his Ph.D. from the mechanical engineering, Heriot-Watt University, UK. He has participated in many European funds. He has more than twenty years of experience in the field of research in Mechanical, Material, and Marine engineering.

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Mohamed Taha, as an assistant lecturer in Mechanical Engineering Department at AASTMT, Aswan Branch. Taha has an MSc in Mechanical Engineering and specific in biomedical applications. Among master research, he got a scholarship in Denmark as working an assistant researcher at a southern university in Denmark for six months in the research group of “Drug Transport and Delivery" supervisor prof / Martin Brandel one of the leading scientists in that field and Editor-in-Chief of European Journal of Pharmaceutical Sciences in Elsevier publisher. Moreover, he got a scholarship from the Embassy of France/French Institute of Egypt fellowships program for the year 2019. this is given for the excellence of my project about “Effect of Nano-cellulose on the properties of Biocompatible Polymeric composite”. supervisor prof / Alain Dufresne. In 2020 he got a highly prestigious scholarship in France "Eiffel excellence scholarship” program for Study the doctoral. In the lab LGP2 at Grenoble INP-Pagora, the Graduate School of Engineering in Paper, Print Media and Biomaterials is one of the best labs in France and Europe and third-ranked in the world in his specialization.

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11. Research Team Information Table

Name of Res. Team Member in English	Name of Res. Team Member in Arabic	University / Institute in English	Position / Title	% of time spent on project	No. of months	Incentive per month (LE)	Number of other projects and their IDs	Total % of time spent on other projects	Contact No
Aly Hassan Elbatran	على حسن البطران	AASTMT (PI)	Associate Professor	30%	12	2100	-	-	01111228845
Essam M. Abo-Zahhad	عصام محمد ابوزهاد	Aswan University (Co-PI)	Assistant Professor	35%	12	2100	-	-	01000175533
Mohamed Shehadeh	محمد فهمى شحادة	AASTMT	Professor	20%	12	1950	-	-	01006156000
Mohamed Taha	محمد طه عبده	AASTMT	Assistant Lecture	25%	12	1800	-	-	01148581181

12. Project Management

Team Members	Role
Senior Personnel:	
Aly Hassan Elbatran (PI)	The PI will be responsible about he will manage the teamwork, and he will be responsible for the following tasks. 1.Specification of the equipment required. 2.Design the BIPV envelopes. 3.Participation in all meetings and research writing and reporting. 4.Dissemination, communications, and studies of commercial exploitation.
Essam M. Abo-Zahhad (Co-PI)	The Co-PI will be responsible for the modeling and simulations of the cooling system. He will be responsible for the following tasks. 1. Incorporates electric, thermal, and radiative effects in the solar cells, and the conjugate heat transfer between the PV and heat transfer fluid. 2. Design and optimize the BIPV envelopes. 3. Experimental verification of the CFD modeling. 4. Writing international peer-reviewed papers will be taken into his account.
Mohamed Shehadeh	Researcher A is responsible for the following tasks: 1. Managing and guiding the proposed research project and selection of the used materials and plaining of their preparations. 2. Participation in all meetings and research writing and reporting. 3. Dissemination, communications, and studies of commercial exploitation.
Mohamed Taha (Ph.D. student and Researcher B)	Researcher A is responsible for the following tasks: 1. Managing and guiding the proposed research project and selection of the used materials and plaining of their preparations. 2. Design and fabrication of the BIPV 3.Optimization of BIPV. 4.Experimental verification of the CFD modeling. 5.Writing international peer-reviewed papers will be taken into his account.

13. Allowable Project Costs

Device name	uses	Estimated price (EGP)
1. Data logger and K-type thermocouples	For temperature measurement	75,000
2. High-performance workstation	For the mathematical calculations which will be implemented using ANSYS software	100,000
3. Multiple Parameter Weather Station	For weather measurements data for the proposed prototype during experimental work	75,000
4. Prototype for a BIPV.	To validate mathematical results and provide electricity and distilled water	50,000
5. Humidity meter	Humidity measurement	**4,000**

14. Breadown of Costs Other Grant(s)

Eligible costs	Break downs		AASTMT support (L.E.)
(A) Staff Cost	PI		25,200
	Co-PI		25,200
	Researcher A1		23,400
	Researcher B		21,600
	Technicians and/or Labour		1000
	Consultation fees		3600
	Total		100,000
(B) Equipment	Equipment		304,000
	Spare parts		-
	Total Equipment		304,000
(C) Expendable Supplies & Materials	Stationary		5000
	Miscellaneous Laboratory, Field supplies, Materials		50,000
	Total expendable Supplies & Materials		55,000
(D) Travel	Internal Transportation		10,000
	Accommodation		15,000
	Total travel		25,000
(E) Other Direct Costs	Services	Manufacture of specimens & prototypes	10000
		Acquiring access to specialized reference sources databases or computer software	
		Computer services	
	Report preparation		2000
	Publications & patent Costs		
	Workshops organization or Training		4000
	Others (explain)		
	Total other direct costs		
(G) Total Costs			**500,000**

15. Plans for Disseminating Research Results / Sustainability of the action

Dissemination is a key factor affecting the success of this research project. It aims to increase the visibility of the research project ideas and the accompanied achievements. One of the major milestones is the design of well-structured dissemination strategy and the organization of outstanding lectures, workshops and information seminars. The present research project aims to the proper dissemination measures to disseminate the information and research deliverables to the related wider community; education scientists, engineers, researchers, governmental agencies representatives and public especially in Upper Egypt. This also will focus on the favor of the discussion of aspects related to public dimension studies in terms of needs, emerging and "hot" topics, to further develop the knowledge on energy-efficient, economical building for thermal comfort and energy saving.

The dissemination plan is based on combination of different measures. Communication tool will be developed to disseminate the results, reports…etc. Web communication tool server of AASTMT will be used for internal and external dissemination. All project documents will be saved on the server to make them available for each member. E-mail group will be used to disseminate results, news and events. Page on the AASTMT website will be developed and regularly updated. Designing data base with a number of institutions in Egypt. Ease and variety of dissemination channels. Constituting a dissemination group by including researchers and students from AASTMT and Aswan University. Dissemination Activities through one-day seminars and workshops in AASTMT branches and Aswan university with the concerned researchers. Introducing E-newsletters, flyers posters and video materials, handouts and brochures of the research project. Speakers from research and scientists from universities in EG will be invited to the events.

The target groups are HE institutions, undergraduate students and researchers will be one of the main dissemination tools. They will spread the idea through the outside community of AASTMT.The interaction among the project team of the AASTMT and Aswan University will disseminate the idea automatically through the personal contacts, beside the role of holding proposed workshops and seminars. The enterprise sector like Banban companies is highly targeted in the dissemination strategy. So, advertising visits, regular invitations for these largest companies are key actions to attract new interests and beneficiaries.

The project sets up different standard dissemination channels, as:

• Page on AASTMT website
• Organization of information workshops and seminars
• Publication of periodical hard copies materials (newsletters, leaflets, posters ….etc)
• The communication platforms

The sustainability aims to assure reinforcing energy-efficient, economical building for thermal comfort and energy saving with zero-carbon buildings would be in operation without relying on conventional energy sources. The research gives great attention to design a concrete sustainability strategy, especially with the compatibility trend in Egypt higher education policies. It comprises visibility, networking, policy consensus, users' feedback, funding and competent staff and human resources commitments.

The sustainability mechanism considers long-term future scenarios, funding and business oriented scenarios and analysis of opportunities and threats related to sustainability including

1) Financial and Business Oriented Regime

• Trainng and Consultancy services and training developed by PV shading lab including equipment.

• Sponsorship through universities, companies or financial entities

2) Institutional

The involvement of Ministry of Electrical, Engineering syndicate and largest enterprises (Banban) will ensure the institutional sustainability

16. Key Publications and references

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17. Declaration of original submission and Other Grant(s)

The PI and Co-PI declare that this proposal is original, has not been submitted before and any part of it is not currently being considered elsewhere. The PI would like to confirm that the current proposal has been read and approved by all named members and that there are no other persons who satisfied the criteria for membership but are not listed.

The PI hereby certify that this proposal is an original work and it does not include any copied parts without the appropriate citation. Further; the PI certify that this work is free of plagiarism and all materials appearing in it have been properly quoted and attributed.

We confirm that our proposal did not and will not be submitted in whole or part for funding; twice within the same cycle, or to other funding programs within AASTMT, or other funding agencies. Also, all members here have not any previous projects related to this proposal in the last three years.

Signed by the PI on behalf of the all other members

Dr. Aly Hassan Elbatran (PI)
Associate Professor at Marine and Mechanical Engineering Dept,.
Head of Mechanical Engineering Department, Engineering and Technology College, South Valley Campus, Arab Academy for Science and Technology.
Email: a.elbatran@aast.edu
Tel: 01111228845

Date & Signature__________________ 14/03/2021

18. Acknowledgment Form:

By signing below, I acknowledge that I have read, understand and accept to comply with all the terms of the foregoing application, mentioned in AASTMT general conditions and guidelines for submitting a research proposal, including, but not limited to:

- The total number of the application pages should not exceed **30 pages** excluding a cover page, as well as all sections of the proposal (as mentioned in AASTMT General Conditions and Guidelines for Submitting Research Proposal).
- At any time, a contracted AASTMT project team member should only be participating in a maximum of one project.
- Allowable budget maximum limit should be strictly adhered to in the project proposal. In all cases, requested budget has to be justified in detail.
- AASTMT guidelines, IPR rules, code of ethics, etc. (www.aast.edu), should be read carefully and adhered to. These are integral parts of the contract.
- All proposals – in addition to PI and other data - must be uploaded to the AASTMT website by the designated deadline. Uploaded PI data should conform to the corresponding data in the application form.

Applications will not be considered eligible and will be discarded in the following cases:

- Proposals submitted by e-mail or sent as hard copies or uploaded to the AASTMT website after the deadline.
- Proposals not conforming to the designated format.
- Proposals whose uploaded PI data does not conform to PI data in the proposal file.
- Proposals in which the allowable budget maximum limit has been exceeded.
- Proposals in which maximum allowable contracted AASTMT project participation limit has been exceeded.
- Proposal letter does not include a scanned copy of the signed and stamped PI institution endorsement letter in case of team member work outside AASTMT.
- Proposal does not include a scanned copy of the signed acknowledgment form.

Dr. Aly Hassan Elbatran (PI)

Associate Professor at Marine and Mechanical Engineering Dept,.
Head of Mechanical Engineering Department, Engineering and Technology College, South Valley Campus, Arab Academy for Science and Technology.
Email: a.elbatran@aast.edu
Tel: 01111228845

Date & Signature________________ 14/03/2021 :

19. GANTT CHART

The tasks are mentioned before (Section 5.3) in details.

DETAILED PLAN ON PROJECT'S ACTIVITIES (*GANTT CHART*):

Activity Name	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12
Main 1: **Data collecting and data analyses**												
Sub 1.1: Statistics of the local weather and terrestrial conditions												
Sub 1.2: Procurement of the required equipment,instrumentation,and materials												
Sub 1.3: Analytical approaches studies of the proposed design												
Main 2: **Design, Optimization and fabrication of the BIPV**												
Sub 2.1: Modeling and simulation work following the input analytical data and determination of the characteristic data of the local weather conditions.												
Sub 2.2: Design of the BIPV.												
Sub 2.3: Optimal the designed BIPV system.												
Main 3: **Experimental verification of the CFD modeling.**												
Sub 3.1: Finalizing the design the experimental unit.												
Sub 3.2: Laboratory scale Construction and fabrication of the experimental set up.												

Sub 3.3: Experimental investigation of the main parameters and data collection.												
Sub 3.4: Comparing the experimental and mathematical results and writing the conclusions.												
Main 4: **Project communication, dissemination and exploitation**												
Sub 4.1: Page on AASTMT website												
Sub 4.2: Organization of information workshops and seminars												
Sub 4.3: Publication of periodical hard copies materials												
Sub 4.4: The communication platforms												