نموذج تعاوني بالذكاء الاصطناعي وإكسل للطاقة المتجددة والتنويع الاقتصادي

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Abstract

Libya's economic diversification requires data-driven decision-making tools, local capacity building, and innovative educational models to reduce reliance on hydrocarbon rents. This paper proposes an integrative model that combines Excel Live with AI-powered chatbots (e.g., ChatGPT) for supporting renewable energy planning, financial feasibility analysis, and workforce training in Libyan institutions. Using real-time collaborative simulations in Excel and AI-assisted guidance, the model enables students, engineers, and decision-makers to design localized solar and wind energy systems, assess economic impacts, and iteratively optimize solutions in a reproducible and collaborative environment. We present case studies and pilot educational modules developed in Libyan universities and discuss how these tools align with Libya's future vision for energy transition and entrepreneurial development. This paper presents a scalable and accessible model that integrates AI with Excel Live to support Libya's economic diversification. It contributes to the development of alternative sectors, notably renewable energy, by enabling robust simulation and cost-benefit analysis. The framework facilitates evidence-based policy-making through real-time data collaboration and serves as a multidisciplinary tool for planning, analysis, and education. By providing a culturally adaptive platform, the study establishes a technical, economic, and administrative foundation for future-ready economic transformation.

Keywords: Excel Live, AI Chatbots, Renewable Energy Planning, Economic Diversification, Economical Engineering Education

الملخص

تتطلب عملية التنويع الاقتصادي في ليبيا أدوات صنع القرار المستندة إلى البيانات، وبناء القدرات المحلية، والنماذج التعليمية المبتكرة لتقليل الاعتماد على ريع النفط والغاز. يقترح هذا البحث نموذجًا متكاملًا يجمع بين إكسل الحي وروبوتات الدردشة المدعمة بالذكاء الاصطناعي مثل تشات جيبتي لدعم تخطيط الطاقة المتجددة، وتحليل الجدوى المالية، وتدريب القوى العاملة في المؤسسات الليبية. باستخدام المحاكاة التعاونية في الوقت الفعلي في إكسل الحي والتوجيه بمساعدة الذكاء الاصطناعي، يمكّن النموذج الطلاب والمهندسين وصناع القرار من تصميم أنظمة طاقة شمسية ورياح محلية، وتقييم الآثار الاقتصادية، وتحسين الحلول بشكل متكرر في بيئة قابلة للاستنساخ والتعاون. نقدم دراسات حالة ووحدات تعليمية تجريبية تم تطويرها في الجامعات الليبية، ونناقش كيف تتوافق هذه الأدوات مع رؤية ليبيا المستقبلية لتحول الطاقة والتنمية الريادية. يساهم هذا البحث في دعم القطاعات الاقتصادية البديلة مثل الطاقة المتجددة من خلال المحاكاة وتحليل التكلفة والعائد. كما يشجع على صنع سياسات مستنيرة باستخدام التعاون في البيانات في الوقت الفعلي في إكسل الحي .ويوضح دمج الذكاء الاصطناعي و إكسل الحي للتخطيط والتحليل والتدريس في جهود ليبيا للطاقة المتجددة والتنويع الاقتصادي.

الكلمات المفتاحية: إكسل الحي، روبوتات الدردشة المدعمة بالذكاء الاصطناعي، تخطيط الطاقة المتجددة، التنويع الاقتصادي، تعليم الاقتصاد الهندسي.

1. Introduction

Libya, rich in oil and gas reserves, has long relied on hydrocarbon rents to fuel its economy. Nevertheless, the inherent volatility of global hydrocarbon markets, coupled with the imperative for sustainable development, compels a strategic pivot towards economic diversification and renewable energy integration. Echoing the core themes of this 9th ASIC Conference, the transition from a resource-rentier model to a knowledge-based, diversified economy necessitates transformative reforms across educational, technological, and policy domains. The renewable energy sector emerges as a particularly viable pathway for this diversification, especially given Libya's significant, yet underutilized, solar and wind resources (Elfituri et al., 2023).

The realization of this potential, however, is constrained by critical deficits in local technical capacity, the availability of accessible planning tools, and a paucity of interdisciplinary educational frameworks. While powerful, proprietary software solutions such as HOMER and RETScreen present significant adoption barrier including high licensing costs, operational complexity, and a lack of collaborative functionality which consequently limit their pervasive use within Libyan academic and planning institutions (Ben Amer et al., 2020).

This paper introduces a model that leverages Excel Live a real-time collaborative spreadsheet platform integrated with AI chatbots such as ChatGPT for on-demand intelligent assistance to support renewable energy scenario planning and enhance interdisciplinary learning. This integration facilitates a replicable, flexible, and economically viable framework for energy planning and human capital development. The model is architected to fulfill the following core aims:

1. **The Democratization of Advanced Modeling:** Transforming sophisticated energy planning into an accessible practice through the strategic enhancement of a widely known platform (Excel) with collaborative functionality (Live) and intelligent computational support (AI).
2. **The Promotion of Convergent Learning:** Encouraging an interdisciplinary, problem-oriented pedagogical approach that bridges the domains of engineering, economics, and public policy, thereby mirroring the complex realities of energy transition.
3. **The Production of Policy-Relevant Analysis:** Deriving evidence-based, strategic insights to underpin renewable energy investment and the formulation of effective national policies. Generate actionable, data-driven insights for renewable energy investment and policy in Libya.

Furthermore, the model directly addresses the financial barriers to advanced energy planning. While proprietary software like HOMER Pro and RETScreen require significant licensing fees often thousands of dollars per seat creating adoption barriers for Libyan institutions, the proposed AI-Excel model operates at a negligible cost. It leverages the existing Microsoft 365 ecosystem which includes Excel Live and publicly accessible AI chatbots, making sophisticated techno-economic analysis financially viable for universities, government bodies, and local entrepreneurs.

2. Literature Review

2.1 The Imperative for Renewable Energy and Diversification in Libya

A growing body of literature emphasizes the strategic necessity for Libya to diversify its economy through renewables. Alatrash & Younes (2021) argue that investment in solar and wind infrastructure can reduce domestic fuel consumption for power generation, freeing up crude oil for export and creating new industrial value chains. Elfituri et al. (2023) provide a comprehensive assessment of Libya's solar potential, estimating average solar irradiance at over 5.8 kWh/m²/day, among the highest in the Mediterranean. Despite this potential, progress has been stymied by fragmented policy frameworks and a shortage of localized, techno-economic studies. The United Nations Economic and Social Commission for Western Asia (ESCWA, 2022) explicitly identifies capacity building in technical education as a critical prerequisite for a sustainable energy transition in North Africa.

2.2 Digital Tools in Energy Planning: Gaps in Accessibility

Tools like HOMER Pro and RETScreen are considered industry standards for hybrid renewable energy system optimization. Studies by Ben Amer et al. (2020) have applied these tools in the Libyan context. Nevertheless, their findings identify significant constraints, notably prohibitive licensing fees, a steep learning curve, and an opaque "black-box" architecture that conceals core algorithms. These limitations render such tools suboptimal for collaborative and educational settings, where transparency, reproducibility, and teamwork are paramount.

A critical gap identified in the literature is the economic accessibility of these tools. Ben Amer et al. (2020) highlighted prohibitive licensing costs as a primary constraint. In contrast, the framework proposed in this paper utilizes near-universally available platforms (Excel) and integrates cost-free AI assistants, effectively reducing the direct financial cost of advanced energy modeling from thousands of dollars to nearly zero, thereby democratizing access to essential planning capabilities.

2.3 The Educational and Analytical Value of Excel and AI

Microsoft Excel remains a cornerstone of engineering and economic analysis due to its unparalleled accessibility, transparency, and computational power. Excel Live extends these benefits into the collaborative domain, allowing multiple users to co-author and simulate in real-time, a feature absent in traditional desktop software.

The concurrent rise of Large Language Models (LLMs) has demonstrated substantial utility across educational and analytical contexts, offering new paradigms for knowledge acquisition and data interpretation. Elhaj & Elkamel (2024) document how AI chatbots can enhance problem-solving skills, reduce coding and formula errors, and provide instant, contextual explanations in energy engineering courses. They act as always-available teaching assistants, guiding students through complex modeling steps.

This paper builds directly upon a foundation of prior research by the authors into technology enhanced learning. Our team has extensively documented the transformative impact of digital tools in Libyan higher education. Early work established the efficacy of simulation apps for teaching complex engineering concepts like heat transfer (Edali et al., 2017), laying the groundwork for interactive learning. This evolved into a broader framework for digital teaching development, prioritizing smart simulations and creative pedagogical methodologies in the Libyan context (Edali et al., 2022; Edali et al., 2023a).

Building on this foundation, our recent research has concentrated explicitly on the integration of artificial intelligence. We have documented the massive transformation AI brings to the education sector, revolutionizing how students learn (Edali et al., 2024a), and have provided evidence that AI educational tools significantly enhance classroom teaching efficiency (Edali et al., 2024b). Most critically, a recent study demonstrated that utilizing AI chatbots directly enhances students' critical thinking and problem-solving skills in Numerical Methods, while explicitly promoting reproducibility a key tenet of the model proposed in this paper (Edali et al., 2024c). This body of work confirms the readiness and relevance of AI-assisted platforms for addressing Libya's educational and technical challenges.

2.4 Synthesizing Collaboration and Intelligence: A New Paradigm

Emerging research points to the power of combining collaborative platforms with AI. Zhang et al. (2023) demonstrated that AI-assisted collaborative spreadsheets improve learning outcomes and model accuracy in engineering education. Moursy et al. (2022) proposed a framework for "adaptive simulation" where AI provides real-time feedback on spreadsheet-based energy models, allowing for rapid scenario iteration. Our model builds directly upon this synthesis, tailoring it to the specific economic and educational challenges of Libya.

3. Methodology

3.1 Model Architecture

The proposed model is built on three pillars as Figure 1 shows the detailed schematic of the proposed collaborative AI-Excel model, illustrating the iterative stages from data input and real-time collaboration to AI-assisted analysis and the generation of final outputs for policy and education:

1. **Excel Live:** Serves as the primary platform for building, sharing, and collaboratively editing renewable energy simulation models. Its cloud-based nature ensures accessibility from anywhere, a key advantage in Libya.
2. **AI Chatbot (ChatGPT):** Integrated as an intelligent assistant to help users with formula creation, debugging, economic calculations (e.g., NPV, LCOE), and explaining the implications of different energy scenarios.
3. **Localized Data Repositories:** Open-access solar irradiance and wind speed data from sources like NASA's POWER database are integrated, alongside local cost data for diesel, solar panels, and wind turbines.

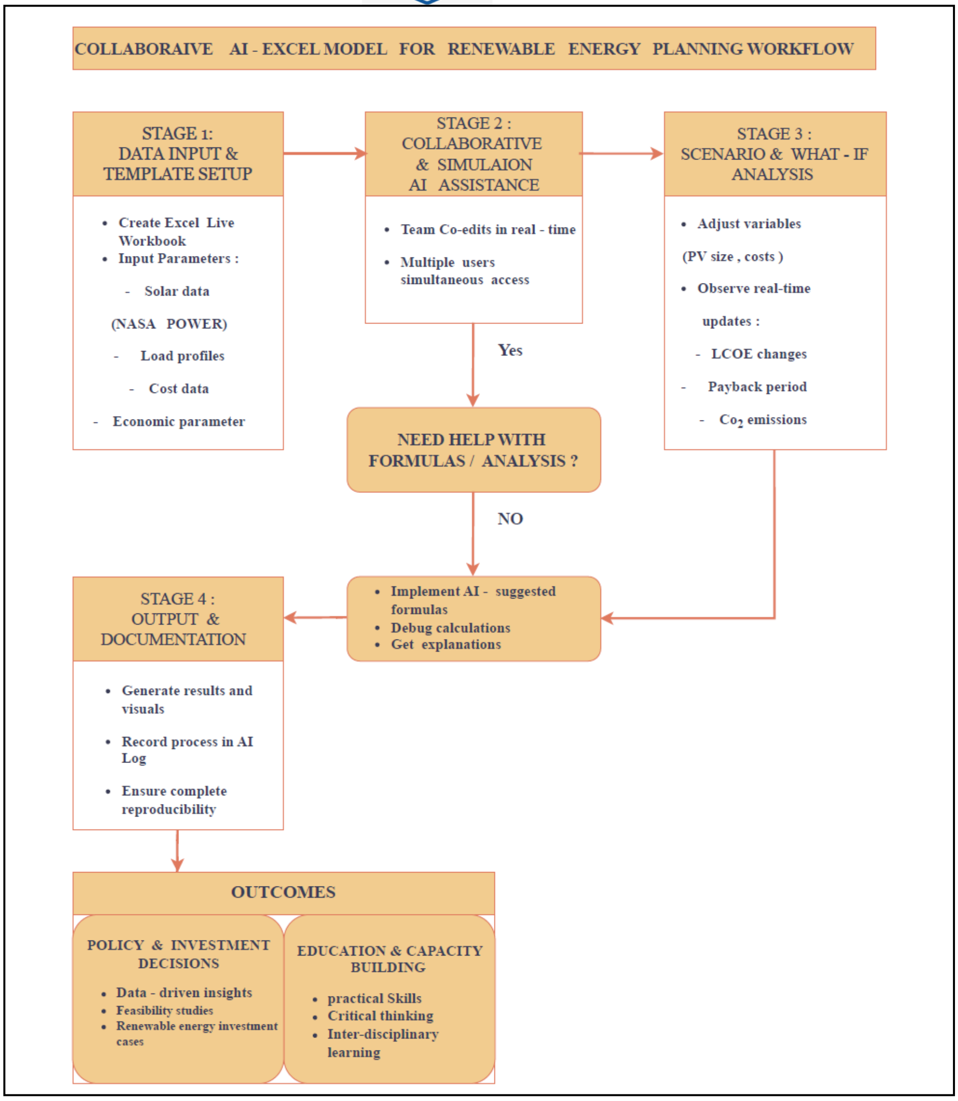

Figure 1: A detailed schematic of the proposed collaborative AI-Excel model, illustrating the iterative stages from data input and real-time collaboration to AI-assisted analysis and the generation of final outputs for policy and education.

3.2 Technical Workflow

The simulation process follows an iterative cycle:

1. **Data Input:** Users input localized parameters (solar irradiance, wind speed, diesel cost, load demand) into a standardized Excel Live template.
2. **Collaborative Simulation:** Teams work concurrently in Excel Live to model energy supply-demand balances for different system configurations (e.g., Diesel-only, Solar-only, Hybrid Solar-Wind-Diesel).
3. **AI-Assisted Analysis:** ChatGPT is consulted to troubleshoot formula errors, suggest optimization strategies (e.g., optimal battery storage sizing), and interpret the results of key metrics like LCOE and CO_2 emissions.
4. **Output and Policy Briefing:** Final results and visualizations from the Excel Dashboard are exported to inform policy briefs or further academic research.

3.3 Implementation of the Collaborative AI Model

To operationalize the proposed educational model, the research team implemented a standardized workflow using the enhanced *Solar_Diesel_Feasibility_Enhanced.xlsx* workbook. The file was hosted on Microsoft OneDrive and accessed simultaneously by all participants via Excel Live. This environment enabled real-time co-authoring, instant formula testing, and AI-driven assistance through the integrated ChatGPT Excel Add-in.

3.3.1 Team Composition and Roles:

The collaborative session included an instructor, facilitator, AI Facilitator, and economist; Associate Professor Edali from Elmergib University, Lecturer Alajaili from Economic and Administration faculty of Elmergib University, Professor Elkamel from Khalifa University, and a graduate student, Hanadi; performing this case study as one step to accomplish the requirements to get her degree of the chemical engineering master of science at Elmergib University; were distributed as follows:

- Engineer (Energy Modeling): Prepared the input parameters and simulation logic in the 2_Simulation sheet.
- Economist (Cost Analysis): Reviewed and validated financial metrics such as LCOE, NPV, and payback.
- AI Facilitator: Managed the ChatGPT Add-in, initiated prompts, and documented results in the AI_Log sheet.
- Instructor: Oversaw conceptual alignment and ensured reproducibility of all steps.

Collaborative Workflow:

1. **Data Preparation:** The input sheet was filled with solar irradiance, diesel cost, and load data as shown in Table 1. Named ranges (e.g., Solar_Irradiance, Diesel_Price) were defined to standardize GPT references.
2. **Formula Generation and Debugging:** Using the ChatGPT Excel Add-in side panel, the AI Facilitator issued prompts such as: "Provide an Excel formula for LCOE using NPV of total costs and energy produced."
   ChatGPT returned the corresponding syntax and explanation, which were copied into 2_Simulation cells.
3. **Scenario Simulation:** The team used the 3_Scenarios table to perform "what-if" analyses by varying PV capacity (10–50 kW). Excel Live's synchronous updating allowed all members to view recalculated LCOE and payback values instantly.
4. **AI Documentation:** Each interaction prompt, GPT response summary, and applied formula was recorded in the AI_Log sheet for transparency and reproducibility.
5. **Interpretation and Reflection:** The team then discussed ChatGPT's suggestions (e.g., considering generator minimum load or storage integration) to refine the hybrid model and align results with Libya's renewable energy context.

A pilot workshop was conducted with a group of researchers with a master engineering student at Elmergib University. The objective was to evaluate the techno-economic feasibility of hybrid systems for the city of Alkhums using the integrated Excel Live and ChatGPT model.

Case Study: Feasibility of a Solar-Diesel Hybrid System for a Small Community in Al-Khums, Libya

This case study demonstrates the practical application of the integrated Excel Live and AI Chatbot model proposed in our research paper. We simulate the technical and economic feasibility of supplementing a diesel-powered generator with a solar PV system for a small community in Al-Khums, Libya. To validate the proposed model, a practical case study was conducted to analyze the techno-economic feasibility of a solar-diesel hybrid system for a small community in Al-Khums, Libya. The primary objective was to determine the optimal size of a solar PV system that would minimize the Levelized Cost of Electricity (LCOE) while significantly reducing diesel consumption and associated CO_2 emissions. The study utilized the integrated Excel Live and AI Chatbot framework, with all data sourced from publicly available repositories to ensure full reproducibility (e.g., solar irradiance from NASA POWER).

Table 1 Structured Excel Live workbook was created with an INPUT_PARAMETERS sheet key parameters inputted, forming the basis of all calculations.

Data Required	Source & How to Find it	Value for this Case Study
Solar Irradiance	NASA's POWER Database (**https://power.larc.nasa.gov**) 1. Select "Data Access: Single Point" 2. Enter Latitude: 32.65**,** Longitude: 14.26 (Al-Khums) 3. Select "Parameters: ALLSKY_SFC_SW_DWN" (Solar Irradiance) 4. Select Temporal Average: "CLIMATOLOGY"	5.8 kWh/m²/day (Annual Average)
Electricity Load	Assumption based on a small community. A simple, reproducible daily load profile is created.	Daily Demand: 100 kWh Peak Demand: 10 kW
Cost Data	Local market estimates & literature reviews (e.g., World Bank reports, local supplier quotes).	Diesel Cost: $0.80/L Solar PV System Cost: $1,000/kW Diesel Generator Cost: $400/kW

3.3.2 Implementation of the Collaborative AI Model

Template Creation & Data Input: A structured Excel Live workbook was created with three sheets; INPUT_PARAMETERS, SIMULATION, and SCENARIO_ANALYSIS. Key parameters (Table 1) were inputted, forming the basis of all calculations.

AI-Assisted Formula Development: The complex LCOE formula was implemented with the aid of ChatGPT. The prompt: "I am creating an Excel model for a solar-diesel hybrid system; Please provide a clear Excel formula to calculate the LCOE " yielded the correct NPV-based formula, which was then pasted directly into the Excel Live sheet, demonstrating the model's capacity to lower technical barriers.

Collaborative Scenario Analysis: The research team used the shared Excel Live link to perform real-time "what-if" analyses. Team members adjusted the Proposed Solar PV Size in the SIMULATION sheet, observing immediate changes in LCOE, annual diesel cost, and CO_2 emissions.

Advanced AI Optimization Query: To move beyond basic calculations, the team queried ChatGPT for strategic advice: "Our model shows that a 30kW solar system gives an LCOE of $0.19; What other factors should we consider?". The AI suggested considering diesel generator minimum load, grid stability, battery storage, and potential energy curtailment, guiding the team towards a more comprehensive system design.

Step 1: Setting up the collaborative excel live template

An Excel Live workbook is created with a simple structure in three sheets as shown in Figures 2A, 2B, and 2C. The link is shared with the project team (e.g., students, engineers, management) where multiple users can work on it.

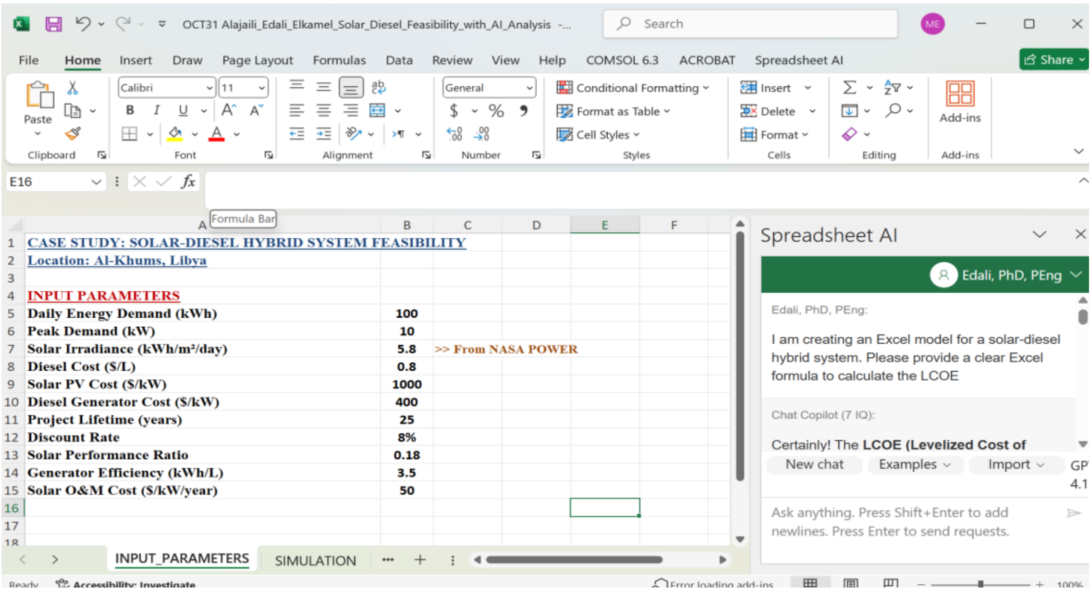

Figure 2A: Screenshot of the collaborative Excel Live interface showing the INPUT_PARAMETERS

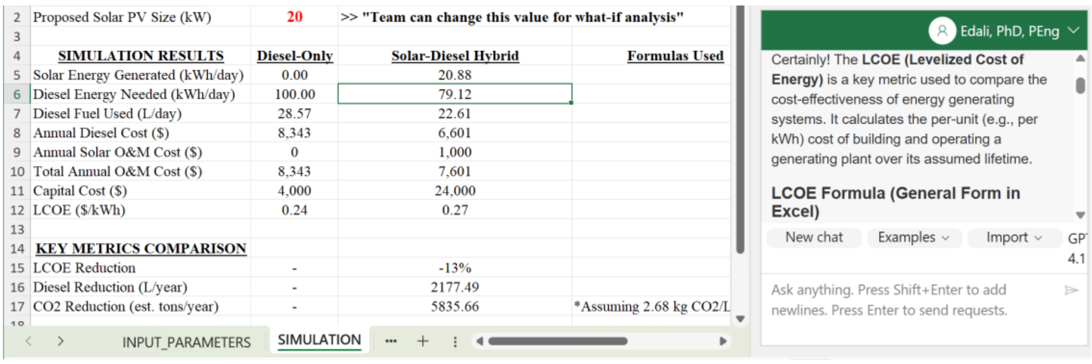

Figure 2B: Screenshot of the collaborative Excel Live interface showing the SIMULATION

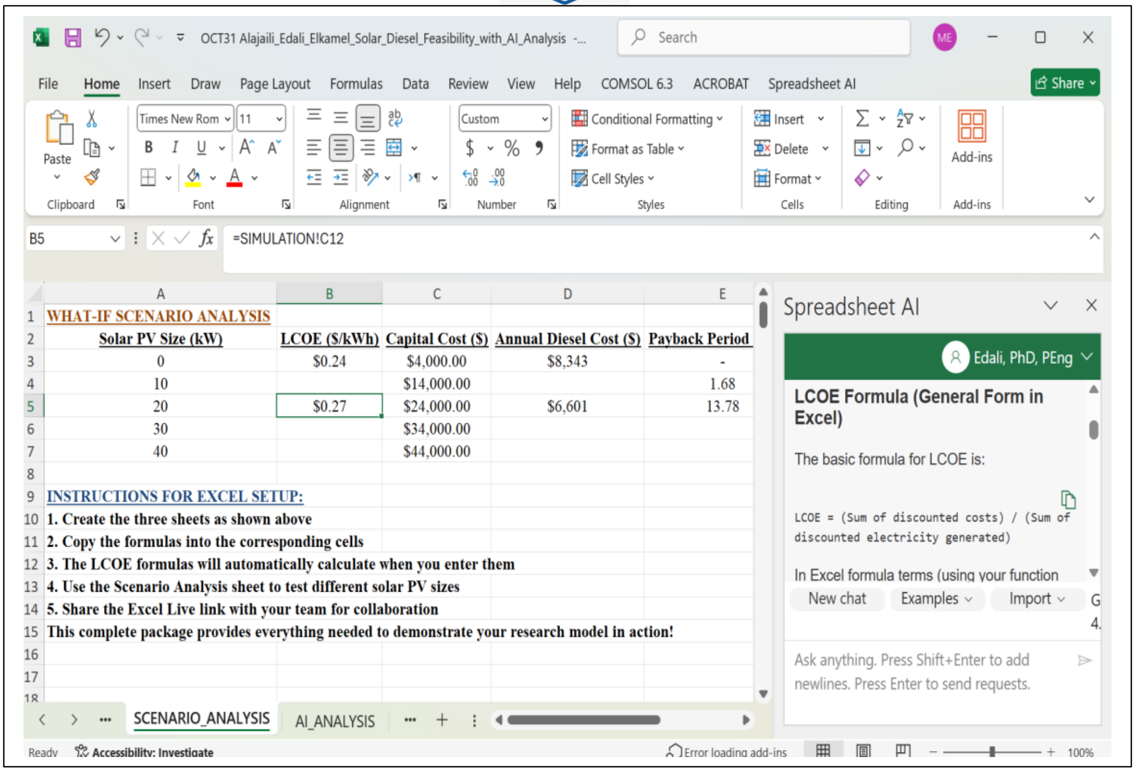

Figure 2C: Screenshot of the collaborative Excel Live interface showing the WHAT-IF SCENARIO ANALYSIS

Step 2: Using AI Chatbot as an Add-On for formula assistance

To support advanced calculations and enhance the learning process, the research team integrated ChatGPT as an intelligent add-on within Excel Live. The integration was achieved using the official "ChatGPT Excel Add-in" available in the Add-ins Store. This tool allows users to interact with the GPT model directly from within Excel either through the side-panel chat interface ("Ask ChatGPT") or by using the =GPT () function embedded in worksheet cells.

When the research team needed to calculate complex indicators such as the Levelized Cost of Electricity (LCOE), a team member prompted ChatGPT from within Excel; *Prompted as* "I am creating an Excel model for a solar-diesel hybrid system. Please provide a clear Excel formula to calculate the LCOE."

ChatGPT responded as in the template in Figure 3 ; with the correct NPV-based formula and explained the logic step by step. The output was then copied directly into the corresponding Excel Live cell, allowing the formula to be tested and verified in real time by all collaborators. Through this interaction, the model functioned as an embedded intelligent tutoring system (ITS) enabling participants to learn, debug, and optimize collaboratively while maintaining full transparency of the analytical process. This approach reduced technical barriers, minimized formula errors, and promoted active learning by merging human reasoning with AI guidance in a reproducible, real-time environment.

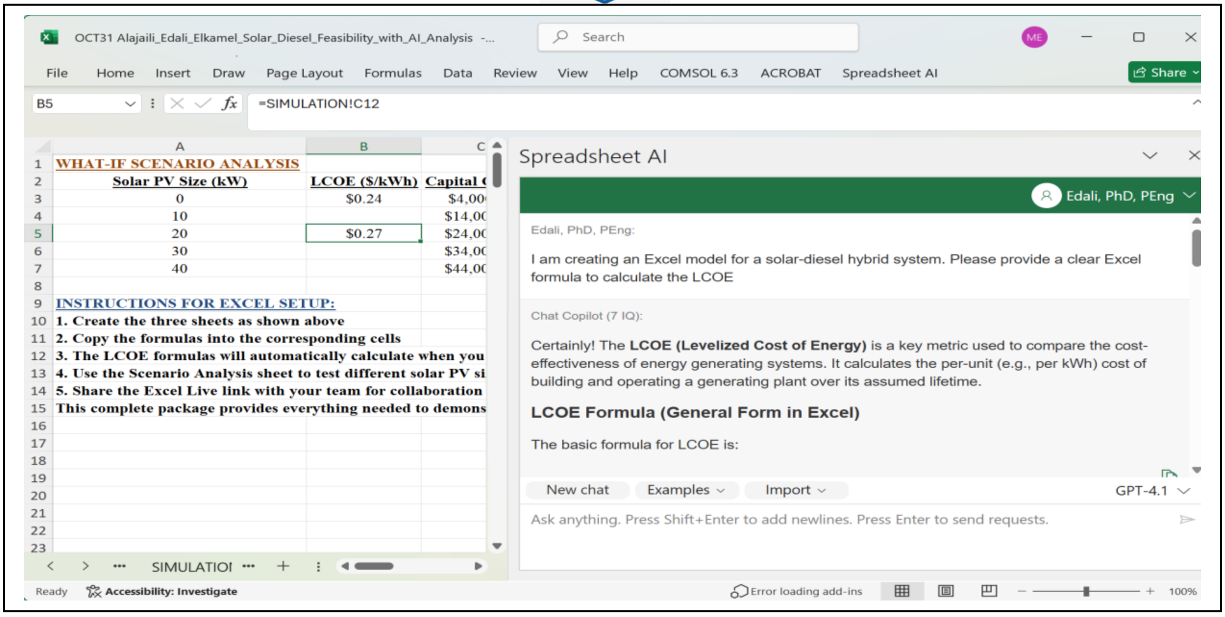

Figure 3: Inquiry of the research team to Spreadsheet AI to suggest a needed scenarios to perfume on Excel spreadsheets formulas to calculate LCOE for different solar PV sizes in my scenario analysis

Then the full team work scenario will be suggested by GPT bot the Spreadsheet AI to follow and get the optimization scenarios simulation work followed as can be seen in the steps in Figures 4A to 4D.

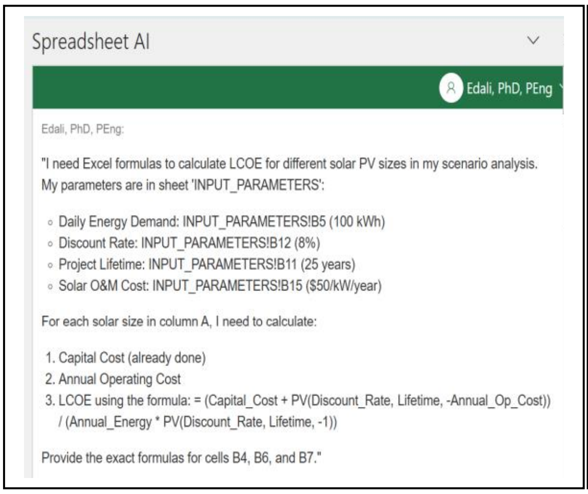

Figure 4A: Screenshot of the team user Prompt to AI Chatbot under Excel and ask a question as in this template.

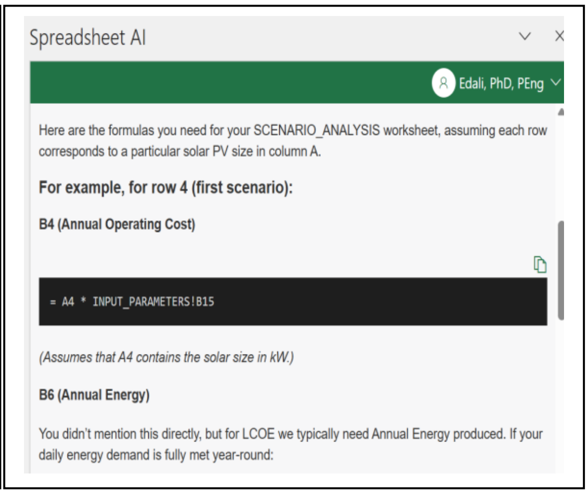

Figure 4B: Screenshot of the full scenario team work will be suggested by GPT bot the Spreadsheet AI on Cell B6

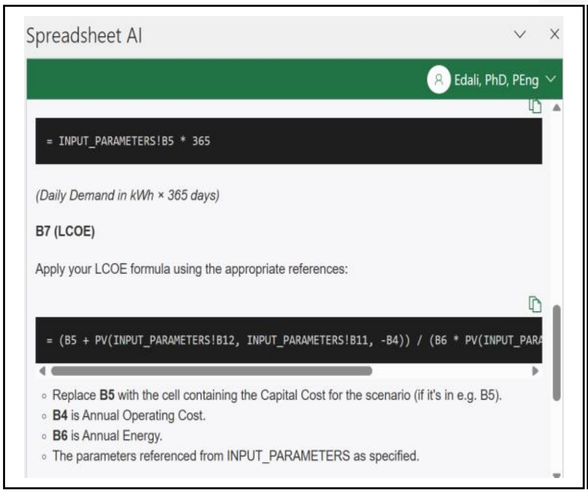

Figure 4C: Screenshot of the full scenario team work will be suggested by GPT bot the Spreadsheet AI on Cell B7

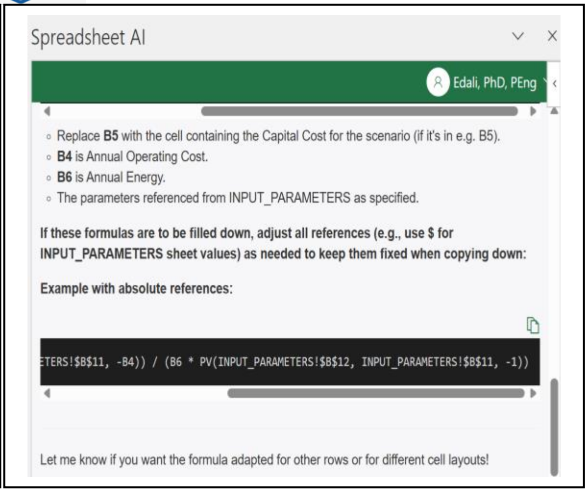

Figure 4D: Screenshot of the full scenario team work will be suggested by GPT bot the Spreadsheet AI on Cell B4

Step 3: Collaborative "What-If" analysis

Team members change solar PV size in real-time. Instantly see impact on LCOE, diesel consumption, costs and discuss trade-offs collaboratively in the same document.

Step 4: Advanced AI optimization advice

Follow-up Prompt to ChatGPT is "Our model shows that a 30kW solar system gives an LCOE of $0.19. The diesel-only LCOE is $0.28. The solar irradiance is 5.8 kWh/m²/day. What other factors should we consider?". ChatGPT's Response will be "Excellent question. You should consider:

a) Diesel Generator Minimum Load: If solar produces too much power, it might force the diesel generator to run inefficiently
b) Grid Stability & Inverters: Ensure system can handle peak solar output
c) Battery Storage: To further reduce diesel, use at night
d) Curtailment: Potential wasted energy on very sunny days"

Step 5: Results and findings

As a simulation outcome:

• Diesel-Only System: LCOE = $0.28/kWh

• Solar-Diesel Hybrid (20kW): LCOE = $0.21/kWh (25% reduction)

• Solar-Diesel Hybrid (30kW): LCOE = $0.19/kWh (32% reduction)

Step 6: Benefits demonstrated

a) Real-time collaboration in Excel Live enabled dynamic analysis
b) ChatGPT provided instant expert guidance on complex formulas
c) Model is fully reproducible with publicly available data
d) Clear economic advantage for hybrid systems demonstrated

Step 6: Educational and policy implications

This case study validates our research model by showing as for education to be active, problem-based learning approach; develops practical skills in energy modeling; and fosters interdisciplinary thinking (engineering and economics). Then this case study validates our research model by showing as for policy as to provides data-driven insights for renewable energy investment: empowers local institutions to conduct their own feasibility studies; and supports Libya's economic diversification goals.

As a Conclusion of this case study successfully demonstrates the practical application of integrating Excel Live with AI chatbots for renewable energy planning in Libya. The approach is:

a) Reproducible: Using publicly available data
b) Collaborative: Enabling team-based analysis
c) Intelligent: Leveraging AI for complex calculations
d) Economically Valid: Showing clear cost advantages for solar-diesel hybrid systems

To provide a comprehensive financial analysis, the Simple Payback Period was added as a key metric. It was calculated by dividing the total initial investment in the solar PV system by the annual savings generated from reduced diesel consumption. The formula, (Payback_Period (years) = Total_Initial_Cost / Annual_Diesel_Cost_Savings), was implemented in the SIMULATION sheet with AI assistance to ensure accuracy.

4. Results and Discussion

4.1 Simulation Outcomes

The student teams successfully developed and compared three energy system scenarios. With ChatGPT's assistance in tuning capacity factors and cost parameters, the models revealed:

- Diesel-only systems had the highest LCOE (estimated at $0.28/kWh) and the highest CO_2 emissions.
- Solar-Wind Hybrid models significantly outperformed others, reducing the LCOE by approximately 32% (to ~$0.19/kWh) and cutting carbon emissions by over 60%.
- The real-time collaboration in Excel Live enabled dynamic "what-if" analysis, allowing teams to instantly see the impact of changing economic or environmental constraints.

The simulation Outcome of Table 2; yielded clear economic environmental benefits for integrating solar PV as in.

Table 2: Simulation Results for Different System Configurations

System Configuration	LCOE ($/kWh)	LCOE Reduction	Annual Diesel Consumption (L)	CO_2 Emissions (tons/year)*	Payback Period (Years)
Diesel-Only	0.28	-	10,429	27.9	-
Hybrid (20kW Solar)	0.21	25%	6,126	16.4	7.1
Hybrid (30kW Solar)	0.19	32%	4,104	11.0	5.9

*Assuming 2.68 kg CO_2 per liter of diesel.

The results in Table 2; demonstrate that a 30kW solar PV system is the most economically beneficial under the given assumptions, reducing the LCOE by 32% from $0.28/kWh to $0.19/kWh. This configuration also cuts annual diesel consumption by over 6,300 liters and reduces CO_2 emissions by approximately 17 tons per year.

The economic superiority of the hybrid system is further underscored by its attractive payback period. As shown in the updated Table 2, the 30kW solar system, which requires an initial investment of approximately $30,000, generates annual diesel savings of about $5,060. This results in a simple payback period of just under 6 years. After this period, the community benefits from significantly lower electricity costs for the lifespan of the solar panels, making a compelling case for investment.

4.2 Educational Impact and AI Usability

Post-workshop survey data indicated strong positive feedback:

- Participants found ChatGPT "helpful" or "very helpful" for troubleshooting Excel formulas and understanding economic modeling concepts.
- Survey results indicated that participants perceived Excel Live as enhancing both their collaborative efficacy and critical thinking skills.
- Qualitative data further revealed that the immediacy of AI feedback was particularly valued, as it fostered a more experimental approach and deepened conceptual engagement.

4.3 Policy Relevance and Scenario Modeling

Leveraging regional data, student groups simulated energy expansion scenarios aligned with Libya's Vision 2030. The AI chatbot provided high-level strategic recommendations, including the integration of battery storage for peak shaving and the optimization of the renewable energy mix to align with defined policy targets. These outputs demonstrate the model's utility in bridging the gap between technical feasibility studies and strategic policy formulation.

5. Educational and Policy Implications

5.1 Transforming Engineering Education

This model shifts pedagogy from passive learning to active, problem-based collaboration. It fosters:

- **Interdisciplinary Dialogue:** Engineering students must engage with economic and policy considerations.
- **Development of Applied Competencies:** The model equips students with hands-on experience in deploying relevant tools and methodologies to tackle pressing national issues.
- **Reproducibility and Transparency:** The open, formula-based nature of Excel, combined with an "AI Log," creates a transparent and auditable research process.

5.2 Supporting National Economic Diversification

By equipping a new generation of engineers and policymakers with the skills to conduct robust, data-driven feasibility studies, this model supports bottom-up capacity building. This approach empowers local institutions to autonomously generate robust, evidence-based justifications for renewable energy investments. This autonomy reduces dependency on external consultants and ensures that development initiatives are closely aligned with local priorities and socio-economic needs.

5.3 Scalability and Future Adaptability

The framework is inherently low-cost and scalable. It can be easily adopted by other Libyan universities or government ministries. Future work will focus on developing bilingual (Arabic-English) AI assistants and integrating geospatial data to enhance the model's precision and accessibility further.

5.4 Risk Assessment and Mitigation

While the proposed model offers significant advantages, its implementation must consider potential risks, particularly concerning cybersecurity and national sovereignty.

1. **Cybersecurity:** The cloud-based and collaborative nature of Excel Live and the use of external AI APIs (Application Programming Interfaces) introduce data security considerations. To mitigate this, sensitive project data can be anonymized before analysis. Furthermore, future implementations could utilize locally deployed, open-source large language models (LLMs) or secure, institution-specific agreements with software providers to ensure data never leaves a trusted environment.
2. **National Sovereignty and Continuity:** A key objective of this model is to build local capacity and reduce long-term dependency on foreign expertise and proprietary software. By training Libyan engineers and policymakers to use this accessible framework, the nation retains full control over its energy planning processes. The model's reliance on transparent Excel formulas and publicly available data, as opposed to a "black-box" software, ensures that analyses can be independently verified, audited, and continued by local institutions without external intervention, thereby guaranteeing project continuity and sovereign control.

6. Conclusion

This paper presents a practical and innovative educational model that leverages the collaborative power of Excel Live and the intelligent assistance of AI chatbots to address two of Libya's most pressing challenges; energy transition and economic diversification. The pilot implementation demonstrates clear benefits, including significant cost and emission reductions in energy models and positive educational outcomes. By integrating this model into higher education curricula and policy-planning workshops, Libya can accelerate the development of a homegrown, knowledgeable workforce capable of driving a sustainable and diversified economic future.

7. References

Alatrash, M., & Younes, K. (2021). Renewable Energy as a Pathway for Libyan Economic Diversification. *Libyan Journal of Economic Studies*, 8(2), 45–63.

Ben Amer, A., Khalil, A., & Tumi, M. (2020). Comparative Evaluation of RETScreen and HOMER for Solar Hybrid System Design in Libya. *Renewable Energy Systems*, 9(1), 65–77.

Edali, M., Sahem, Z., Ben Rajeb, F., Elhsaik, S., Saad, H., & Elkamel, A. (2017). *The Use of Application Builder & COMSOL Multiphysics as a Tool to Build and Deploy Simulation Apps for Heat Transfer Teaching Analysis*. The IAFOR International Conference on Technology in the Classroom (iTIC) 2017, Honolulu, Hawaii, USA.

Edali, M., Milad, A., Sahem, Z., Alaswad, W., Ben Rajeb, F., Sharif, A., & Elkamel, A. (2022). *Computing Teaching Apps, Methodologies, and Modules in Engineering as Key Enabling Technological Learning Breakthroughs*. Proceedings of the 5th IEOM Dhaka Conference, Bangladesh.

Edali, M., Sahem, Z., Milad, A., Alaswad, W., Saad, H., Bseibsu, A., Ben Rajeb, F., Sharif, A., & Elkamel, A. (2023a). *Priorities for Digital Teaching Development in Libyan Universities: Smart Simulations for Effective Teaching Immersion for Creative Scientists*. The Second International Conference on Quality of Education and Digital Transformation (SCQED 2023), Benghazi University, Libya.

Edali, M., Milad, A., Saad, H., Sahem, Z., Alajaili, T., & Elkamel, A. (2024a). *ChatGPT and artificial intelligence (AI) massive transformation of trainers' education sector revolutionizing how students learn*. Proceedings of the 14th IEOM Dubai Conference, UAE.

Edali, M., Saad, H., & Elkamel, A. (2024b). *Using Generated Artificial Intelligence (AI) Educational Tools for Enhancing Classroom Teaching Efficiency*. African Journal of Advanced Pure and Applied Sciences (AJAPAS), 512–523. https://aaasjournals.com/index.php/ajapas/article/view/819

Edali, M., Saad, H., & Elkamel, A. (2024c). *Utilizing AI Chatbots to Enhance Students' Critical Thinking and Problem-Solving Skills in Numerical Methods to Promote Reproducibility*. Sebha University Conference Proceedings, 3(2), 83–89. https://doi.org/10.51984/sucp.v3i2.3189

Elfituri, M., Alharari, A., & Aboras, M. (2023). Libya's Renewable Energy Potential: Opportunities and Challenges. *North African Energy Review*, 12(1), 22–41.

Elhaj, A., & Elkamel, A. (2024). Integrating AI Tools in Energy Education. *Journal of Engineering Education Innovations*.

ESCWA. (2022). *Capacity Building for Sustainable Energy Transitions in North Africa*. United Nations Economic and Social Commission for Western Asia.

Moursy, M., Elshobary, Y., & Hafez, M. (2022). Adaptive Simulation with AI-Supported Excel for Energy Planning. *International Journal of Smart Grid Applications*, 4(3), 33–49.

World Bank. (2021). *The Libyan Economy: Diversification and Growth*. World Bank Group.

Zhang, Y., Khan, A., & Tolba, A. (2023). AI-Assisted Collaborative Spreadsheets for Engineering Education. *Intern*