WRO
WORLD ROBOT OLYMPIAD ™

FUTURE INNOVATORS
WORLD ROBOT OLYMPIAD ™

Team Name:

SCIGIT

# Future Building


Prepared by the Syrian senior team:

Shahd Asaad Hasan Mohamad

Supervised by:

Ahmad Alshaar

Table of contents:

# Our Team: SCIGIT

- From Homs governorate.
- I have an adequate 2 years-long experience of SOLIDWORKS.
- Earned the bronze medal in the ARC Sumo competition.
- Also an impeccable creativity when it comes to 3D creation and drawing.
- so I worked in the design department

**Shahd Asaad**

- From Hama governorate.
- Responsible for the supervision of the Artificial Intelligance model in this project.
- Into coding and robotics for 3 years.
- Learning a lot about HTML, CSS & JS.

**Hasan Mohamad**

**Ahmad Alshaar**

# Summary project idea:

The world is facing a dual crisis of energy and water waste within buildings, due to the inefficiency of traditional systems, resulting in the loss of up to 40% of energy and 30% of water. We chose this problem because of its economic and environmental significance and the urgent need for comprehensive solutions. The "Building of the Future" project offers an integrated solution using robotics and artificial intelligence to transform buildings from resource consumers to resource producers. The solution includes smart staircases that convert kinetic energy into electricity and pump water, rotating solar panels on windows to save energy and provide shade, innovative windows that extract water from the air, a solar heater, a smart alarm bracelet, a lighting system, and an adaptive sound system that responds to users' psychological states. When implemented, this system will reduce operating costs by 40% and significantly reduce carbon footprints, making it a revolutionary solution for sustainable future cities, transforming environmental challenges into opportunities for innovation and green growth.

# Presenting robotic solution

## General aspects:

The "Building of the Future" project emerged from addressing critical gaps in sustainable construction, where traditional solutions failed to comprehensively manage energy and water waste. While examining existing approaches, we explored traditional solar energy systems and basic automation, but found them fragmented and ineffective. Unlike existing partial solutions, our integrated system uniquely combines kinetic energy harvesting from smart stairs, atmospheric water generation from innovative windows, solar panels that provide shading during high temperatures to reduce air conditioning energy consumption, and music tailored to the user's mood—all synchronized via a central smart platform. This holistic approach not only transforms buildings into self-sufficient entities but also achieves unprecedented savings of 40% in energy and 30% in water, while adapting to both environmental conditions and human needs, setting a new standard for sustainable architecture.

## Future Building System Design

During the development process, we conducted a comprehensive comparative analysis of traditional and modern solutions for energy and water management in buildings. Traditional systems such as conventional water pumps and fixed solar panels demonstrate limitations in energy efficiency and an inability to adapt to changing conditions, making them unsuitable for future smart buildings. Conventional lighting and control systems perform acceptably under standard conditions through basic energy consumption optimization. However, these systems often face difficulties in integrating with emerging technologies, where compatibility and technical complexity challenges may arise.

We also evaluated similar smart systems such as conventional home automation systems and basic consumption optimization solutions. Although these systems provide a certain degree of automated control, they are inherently expensive and complex to implement. Additionally, these systems primarily rely on centralized

infrastructure, leading to high energy consumption that is impractical for long-term applications.

Our Future Building system, designed to adapt to various environmental conditions and usage scenarios, incorporates advanced engineering for the integration of energy, water, and smart control systems. It features components compatible with modern construction standards that ensure efficiency and reliability. The system structure is equipped with smart sensors and cameras for automated monitoring, while its robust modular design withstands diverse operating conditions and provides flexibility for future expansion and development.

**Unique Design Features:**

- Unprecedented integration of energy production and water management systems

- Modular design allowing customization according to each building's requirements

- Reliance on IoT technologies for remote control and monitoring

- Use of sustainable and environmentally friendly materials in manufacturing

- Design that balances technical complexity with user-friendliness

**Smart Stairs: A Revolution in Building Resource Management**

The mechanical architecture of the "Building of the Future" system seamlessly integrates multiple subsystems to create a cohesive operational framework. The smart staircase incorporates precision gears, axles, and hydraulic pistons that convert the energy of the steps into dual outputs: electricity generation and water pumping.

The solar panels are mounted on angle-adjustable motorized structures that optimize energy capture while providing intelligent shading for the room. Window-mounted atmospheric water generators feature advanced hydrogel panels with microchannel networks beneath each window to efficiently collect condensed moisture.

A solar water heater is made of several reflective panels that can be moved in alignment with each other at different angles. The rays are reflected and fall at a single point on a metal plate that can withstand high temperatures, thus serving as an electric water heater for home use.

The smart wristband combines miniature vibration motors, multicolor LEDs, and a central control unit, all encased in a comfortable silicone shell for user comfort. All components are interconnected using durable, lightweight materials, ensuring structural integrity and scalability for a variety of architectural applications.

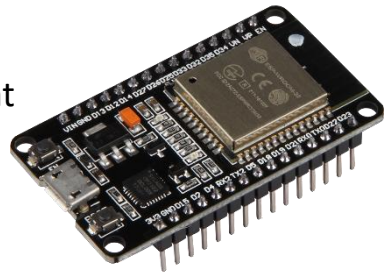
## System Architecture

The proposed system consists of three main layers: the sensing and field control layer, the processing and analysis layer, and the presentation and user interaction layer.

- **The Sensing and Field Control Layer**

This layer consists of several tightly interconnected hardware components:

- Central Control Unit (ESP32): Acts as a data collection point from various sensors and executes control commands for electromechanical components.



- Dual IR Sensor System: The system relies on two IR sensors placed horizontally at the entrance to the room. The direction of movement (entry or exit) is determined based on the sequence of sensor activations. If the first sensor is activated followed by the second, this is counted as a person entering the room, and vice versa when exiting.


- Electric Current Sensor: Measures energy consumption in real time.

- Water Flow Sensor: An integrated system for accurately monitoring water consumption, operating on technology similar to an electricity monitoring system, with the ability to measure flow rate and calculate the amount consumed.

- Servo motor for window control: Automatically controls the opening and closing of windows based on multiple factors.

- Automatic sink: Integrated water flow control system with an automatic shut-off function to avoid wastage.

- Smart lighting system: Includes controllable LED lights with an automatic on-off function when people are in the room, with a manual off button for use when desired.

- Cooling and ventilation system: Includes a built-in fan with precisely controlled air conditioning based on sensor data.

- Smart bracelet (using ESP8266 due to its small size): A wearable device that connects to the system's network and receives instant vibration notifications in emergency situations.

**-Processing and Analysis Layer**

This layer consists of:

- Raspberry Pi 4 Server: Acts as the core of the central processing system and receives data from the ESP32 module via the secure MQTT protocol within the local network.

- Data Storage System: Stores electricity, water, and historical consumption data in a local database while maintaining efficiency.

- Smart Forecasting Model: Uses the advanced Prophet algorithm to accurately predict energy and water consumption for the next day, week, and month.

### - Presentation and User Interaction Layer

This layer includes:

- An interactive user interface: Designed using the Node-RED dashboard, with an intuitive and easy-to-use interface.

- An intelligent conversational system: Supports voice and text interaction.

- A dynamic graphical display: Displays historical data and future projections via spreadsheets.

## Key System Features

#### 1. Smart Environmental Control System

The system features advanced control capabilities that automatically adapt to room conditions and user needs:

- Smart Lighting System: The system automatically turns on lights when it detects a person in the room, with the ability to turn them off manually via a dedicated control button in the user interface. This feature supports intelligent logic that ensures lights are not turned on when sufficient natural light is available.

- Integrated Cooling and Ventilation System: The system integrates a fan and air conditioner into a single control unit, with advanced algorithms that adjust the temperature based on the number of people in the room and the outside temperature. The system improves energy efficiency by dynamically adjusting the cooling level.

- Servo Motorized Window Control: The system automatically controls the opening and closing of windows based on the temperature, with manual control via the user interface.

- Automatic Sink: The system provides a smart handwashing function that automatically opens the water flow when it detects hands under the tap, automatically shutting off after a specified period to avoid wastage.

**2. Innovative Monitoring and Alert System**

The system features an advanced monitoring mechanism that ensures safety and improves efficiency:

- Integrated Smart Bracelet: The smart bracelet (using an ESP8266 for its small size and convenience for daily use) is connected to the system network and receives instant vibration notifications in specific situations, such as:

Abnormally high electricity consumption

Detecting a tap that has been open for a period exceeding the normal usage limit

Other pre-programmed emergency conditions

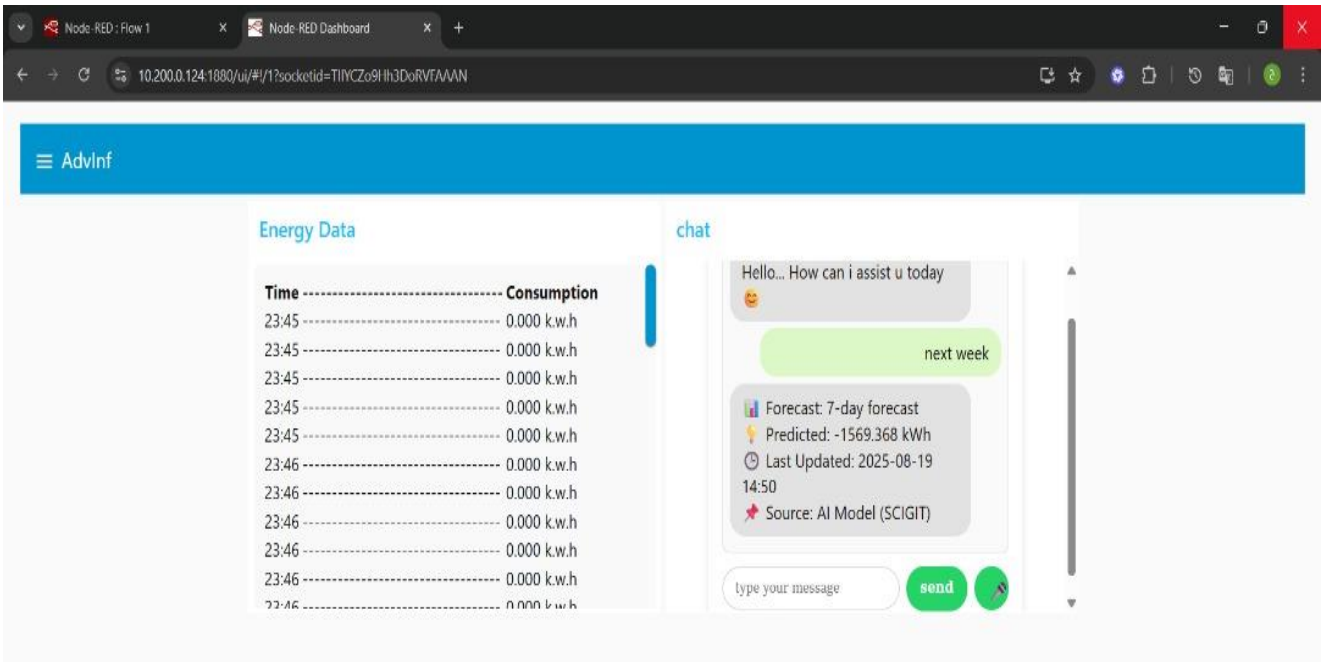
- Early Detection System: The system analyzes consumption patterns in real time to detect any abnormal behavior that may indicate potential malfunctions or resource waste.

**3. Intelligent Resource Consumption Forecasting System**

This system is one of the project's most notable features, as it:

- Uses an advanced predictive model based on the Prophet algorithm to forecast energy and water consumption for multiple time periods (daily, weekly, monthly).

- Forecasts are automatically updated daily via a cron task.



- Forecasts are stored in a local database (knowledge.db) for easy access without the need to connect to external models.

- The system provides interactive reports that display historical data and future forecasts through tables.

- The system offers a unique user experience that combines simplicity and professionalism:

- Innovative interface design: The system separates display elements (such as the people counter) and control buttons (such as the fan and lighting) into two separate halves of the screen, providing a clear and easy-to-use experience.

- Real-time data updates: Status is displayed accurately and instantly (such as "a room is empty" or "X people are there now").

- Voice and text interaction: The system allows the user to interact via chat to obtain forecasts or immediate information without having to navigate through menus.

## Competitive Advantages and Innovation

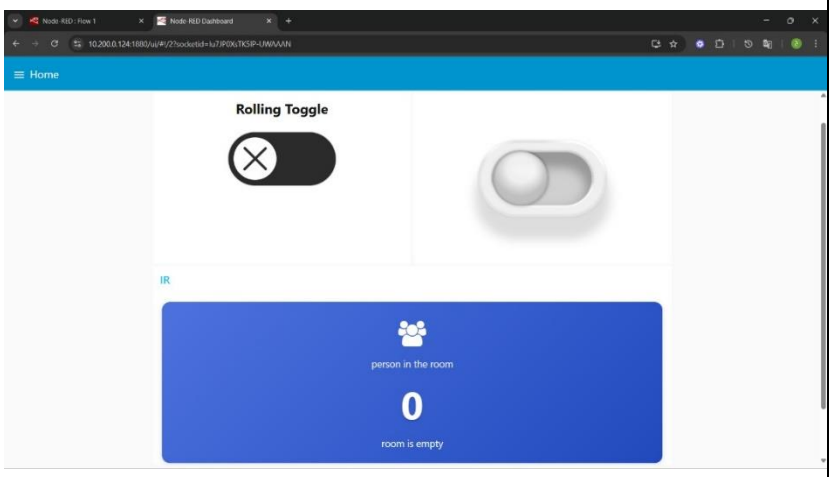
The presented system boasts several competitive advantages that make it a leader in its field:

- Integrated integration: The system combines multiple functions into a single, unified platform, rather than relying on separate, disconnected systems.

- Resource efficiency: The system optimizes energy and water consumption through intelligent algorithms that reduce waste without compromising user comfort.

- Scalability: The system is designed to be easily expandable to add new devices or indicators as needed.

- Complete autonomy: The system operates locally without relying on cloud services or external API keys, ensuring efficiency, speed, and complete autonomy.



## Social Impact of the Future Building Project:

**1) Reducing Environmental Damage:**

- Saving energy by 40% and water by 30%, reducing the depletion of natural resources.
- Reducing carbon emissions through integrated renewable energy systems.
- Reducing pollution from traditional power generation processes.

**2) Improving Community Health:**

- Reducing diseases associated with air and water pollution.
- A more comfortable and healthier living environment for residents.
- Reducing diseases caused by climbing traditional stairs.

**3) Participation in the Economy:**

- Reducing citizens' energy and water bills by up to 40%.
- Providing job opportunities in green technologies and installation.
- Encouraging a circular economy through resource reuse.

**4) Promoting Environmental Awareness:**

- A practical model of sustainable architecture that encourages emulation.
- Visible systems that demonstrate the effectiveness of rationalizing consumption.

**5) Achieving Social Justice:**

- Accessible technologies at affordable prices.
- Improving the quality of life in urban and rural areas.
- Contributing to achieving the Sustainable Development Goals.

The project represents a qualitative shift in the concept of sustainable architecture. Green architecture, which combines environmental, economic, and social benefits into a single integrated solution, contributes to building more sustainable and prosperous cities for future generations.

## Applications of the Future Building Project in Entrepreneurship:

Our project offers smart solutions for multiple sectors:

**1) Smart Buildings**

- Cuts utility costs by 40% in residential/commercial buildings
- Automated energy and water management systems

**2) Industrial Use**

- Smart sensors reduce factory energy/water consumption
- Hotels save significantly on operational costs

**3) Agriculture**

- Water condensation systems for irrigation
- Solar integration for farm self-sufficiency

**4) Research & Development**

- Universities study carbon reduction impact
- Tech companies develop derived smart systems

**5) Green Investment**

- Solutions for sustainable city projects
- Startup opportunities using our platform

A unique green business opportunity combining profitability and sustainability.

## Innovation in the Future Building Project:

Our project features innovative and unique characteristics that represent a technological leap in the field of sustainable architecture. It integrates renewable energy technology and artificial intelligence into a comprehensive system, ensuring unprecedented efficiency in resource management.

Smart sensor systems and automated control work to automatically improve energy and water consumption efficiency. Solar panels that provide shading to reduce electricity consumption for air conditioning, energy-generating stairs that enable building self-sufficiency, solar heaters that eliminate electricity usage for heating, and windows that generate water from ambient humidity all contribute to this innovative system. The system also stands out for its ability to adapt to various environmental conditions and user needs.

The project offers a scalable solution tailored to specific needs, from individual homes to large residential complexes, with customization options according to each project's requirements. It also represents a unique investment opportunity in the growing sustainable building market, combining economic feasibility with positive environmental impact.

Resor:

Our research for the project was based on numerous reports found on the websites of specialized international agencies and bodies:

1. IEA – International Energy Agency - IEA
2. U.S. Environmental Protection Agency | US EPA
3. Technical Resources | ashrae.org
4. World Health Organization (WHO)