ElectroCap Project Proposal

Integration of solar blinds in AC installations

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TÉCNICO LISBOA

1. Advisors and Mentor

- **Scientific Advisor:** Prof. João Filipe Pereira Fernandes
- **Scientific Co-advisor:** Prof. Duarte Mesquita e Sousa
- **Coordinator:** Prof. Duarte Mesquita e Sousa
- **Mentor:** Ricardo Lameirinhas

2. Problem definition

The specific issue or challenge that needs to be resolved is the energy inefficiency of traditional AC systems in buildings. The reliance on conventional power sources contributes to high energy consumption, leading to increased utility costs and a significant carbon footprint. The goal is to address this challenge by integrating solar blinds into AC installations, utilizing solar energy to power or complement these systems. In fact, building regular blinds represent major energy loss and heat gain. Solar blinds could dynamically adapt to optimize energy efficiency. So, by replacing old fashioned blinds with solar blinds, the amount of energy used from electrical providers will be reduced by the amount of electricity generated by the blinds.

Current solutions: Basic static blinds for heat controlling and/or solar panels that require a significant surface area.

3. Solution beneficiaries

Buildings where there is economic or physical constrains to the installation of solar panels (such as not accessible roofs) and where the amount (and thereby the cost) of energy used from electrical providers can be high. Examples:

- Schools and Universities;
- Offices;
- Shopping Centers;
- Other professional and commercial settings.

The energy produced can be used on projectors, computers, lighting and other eventual devices that need energy.

4. Technological solution

Technology Used:

1. Photovoltaic Cells:

High-efficiency, transparent PV cells will be embedded in the solar blinds, capturing sunlight and converting it into electrical energy;

2. Inverter (DC-AC) and/or MPPT:

DC-AC inverter will be employed to convert the DC electricity generated by the PV cells into the AC electricity needed to power the building's electrical appliances and AC system. MPPT will track and adjust the voltage and current to maximize the power output of each panel;

3. Smart Metering and Controls:

Smart metering technology will monitor the electricity production from the solar blinds and the overall energy consumption of the building. Smart controls can then optimize the distribution of electricity, prioritizing solar-generated power when available;

4. Microcontroller and Electrical Motor:

A microcontroller will be integrated into the solar blind system. This small computing device will act as the brain of the system, controlling the movement of the blinds based on real-time data and predefined algorithms. An electrical motor will control the movement of the blinds;

5. Structure that supports the photovoltaic cells.

4. Technological solution

How the Solution Addresses Restrictions and Constraints?

1. Energy Efficiency:
By harnessing solar energy, the solution reduces the reliance on traditional power sources, leading to increased energy efficiency;

2. Cost Savings:
Over time, the investment in solar blinds can lead to cost savings as the building relies more on the free and abundant solar energy, and decreasing dependence on grid electricity, lowering electricity bills;

3. Environmental Impact:
The integration of solar technology contributes to a more sustainable and environmentally friendly solution, reducing the carbon footprint associated with conventional power generation;

4. Seamless Integration:
The transparent and flexible nature of solar blinds allows for easy integration into existing windows without significant alterations to the building's aesthetics or structure;

4. Technological solution

How the Solution Addresses Restrictions and Constraints ?

5. Increased Energy Harvesting Efficiency:
The microcontroller, equipped with sensors such as light intensity and direction sensors, can continuously assess the angle of sunlight and adjust the blinds accordingly. The microcontroller can adapt the tilt angle in real time to optimize energy production. This ensures that the blinds are positioned to capture the maximum amount of solar radiation, thereby increasing energy harvesting efficiency;

6. User-Friendly Control:
The system can provide user-friendly controls, allowing occupants to manually adjust the blinds if needed. Additionally, automated modes can be implemented, allowing the blinds to operate autonomously based on preset preferences or environmental conditions.

5. Competitors and previous work

In our field, there are 2 types of competitors:

- Very similar concepts and products (such as SolarGaps);
- Other products that harvest energy from the sun, mostly solar panels used in varied occasions;
- Research related to the project called : “Solar Powered Window Blinds” done by University Central of California.

6. Solution requirements

When integrating solar blinds into Alternating Current (AC) installations, there are several solution requirements to consider to ensure a successful implementation. Here are key aspects to address:

1. Safety and Compliance:

The solution must comply with relevant electrical safety standards to ensure the safety of users and to meet legal requirements. Check for certifications from regulatory bodies to ensure that the solar blinds meet industry standards for electrical safety and performance.

2. Reliability and Durability:

Ensure that the blinds are designed with sufficient fault tolerance mechanisms to handle variations in sunlight, resistance to weather elements such as rain, wind, and sunlight exposure, potential electrical fluctuations, and other operational challenges. Include requirements related to the environmental impact of the materials used in the solar blinds

3. Scalability:

If the AC installation is part of a larger system, ensure that the solution can scale effectively to meet the needs of larger setups.

6. Solution requirements

In Portugal, the legal requirements to produce energy for self-consumption change according to the power installed:

1. There is exemption for who has installed power equal or less then 700 W if there are no injection of the remaining power on the electrical network (RESP);
2. If the power is superior to 700 W and equal or less then 30 kW, it will be needed to make a prior communication. Only after obtaining the proof of presentation of prior communication, the interested is allowed to proceed the installation;
3. Prior registration and the operating certificate are applied to the production of electricity for self-consumption with an installed power greater than 30 kW and equal or less than 1 MW, and to the autonomous storage of electricity with an installed power equal to or less than 1 MW.

After that, it’s needed a bidirectional consumption meter. If not, E-REDES must be requested to replace it.

7. Technical challenges

There are many challenges that arise from this project:

- Impossibility to predict firmly whether this solution will be or not efficient in 10 years (flexible and durable to withstand the bending and folding that blinds typically undergo) ;

- Embedding solar cells seamlessly into the blind material without compromising their efficiency;

- Lightweight Design that can support the photovoltaic cells;

- Control Systems - Adjusting of blinds based on sunlight intensity;

- Designing a system that is scalable for different window sizes.

8. Partners

For this project we consider that there are several potential partners, such as:

- Energy distribution companies: EDP Commercial, E-Redes, REN;
- Companies or startups focused on solar energy/renewable energy: Barcosolar, Prosolia Energy;
- Companies that install solar panels: Galp Solar, Bling Energy.

9. Testing and validation metrics

Here are some key testing and validation metrics to consider:

1. **Automation and Control Testing:**

Evaluate the functionality and reliability of any automation features, such as sensors for adjusting blinds based on sunlight intensity or user preferences. Test manual controls;

2. Electrical Performance:

Measure the electrical output of the solar panels on the blinds to ensure they are generating the expected amount of power;

3. Model Validation:

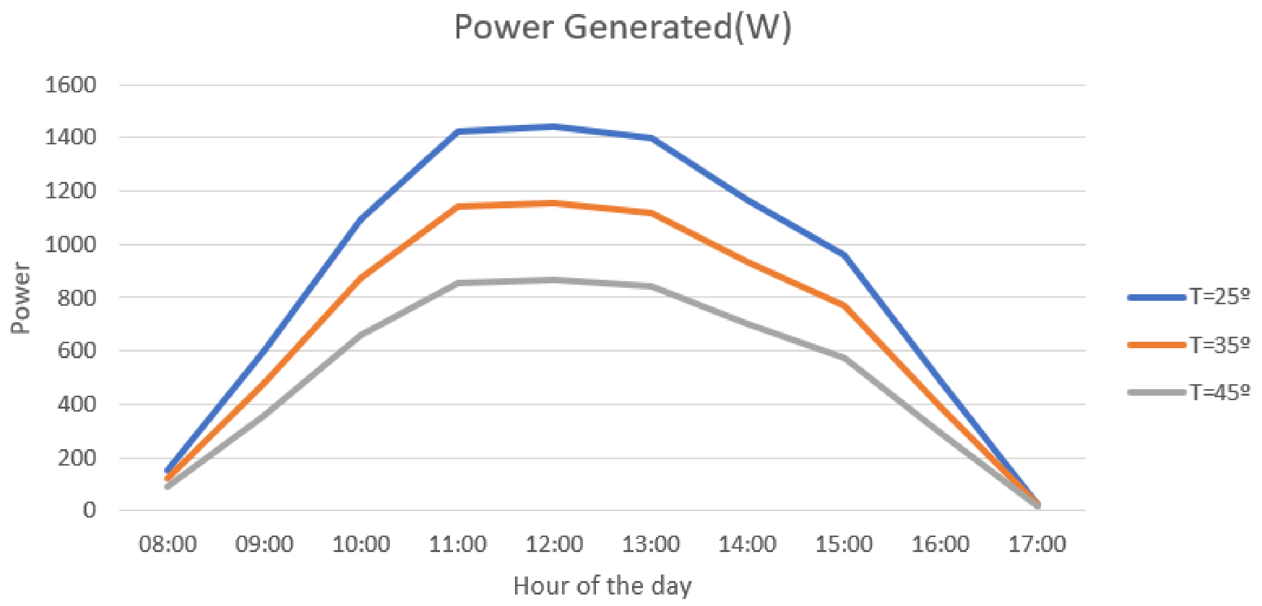
Check if the prototype verifies the analytical model implemented.

9. Testing and validation metrics

A practical way to test the project built can be studied with collected data.

Here is an exemple with data collected from external sources:

The efficiency of this project can be calculated using a simple exercise where we consider a block of offices. In an area of 20 m², solar panels are installed (office blocks typically have 20-30% of their wall area occupied by windows). The windows are equipped with generic solar cells (characteristics of the generic cells are represented next to the graph).



A=20 m^2, Efficency=18%,
Temperature coefficent=0.2%,
Reference temperature= 25º,
Irradiation=2400W/m^2(sunny day in Lisbon)

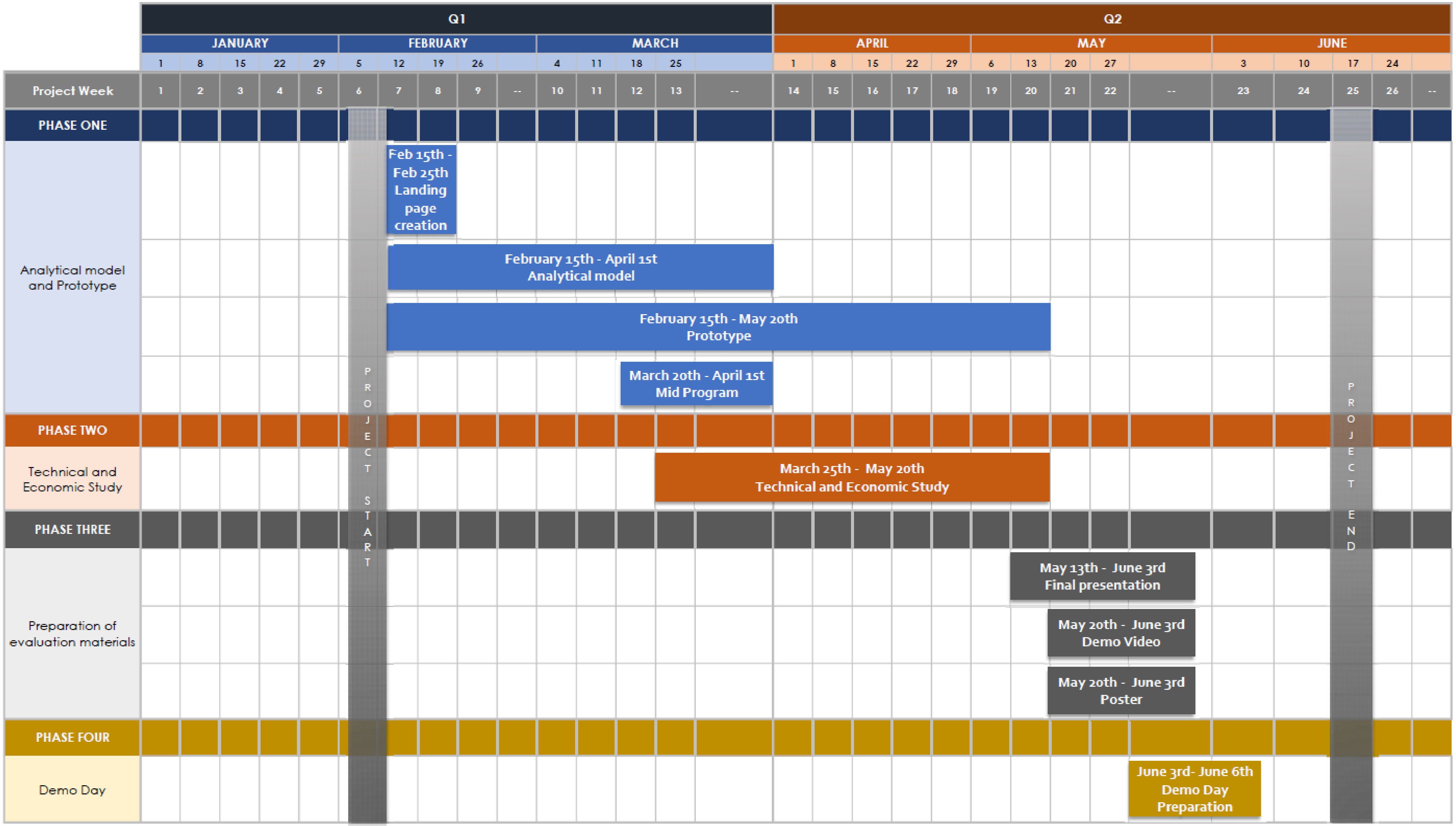
10. Division of labor (I)

Lucas Santos	Neelam Visueshcumar	João Ribeiro
Analytical model	**Analytical model**	**Prototype**
Demo video	Demo video	Poster
Final presentation document	Final presentation document	Final presentation document
Research & Development (R&D)	Research & Development (R&D)	Software developer

11. Division of labor (II)

Miguel Roça	Miguel Gonçalves	Jorge Assis
Prototype	**Technical and Economic Study**	**Technical and Economic Study**
Poster	Landing Page & Communication	Landing Page & Communication
Mid Program - Pitch Deck	Mid Program - Pitch Deck	Mid Program - Pitch Deck
Software developer	Market Knowledge	Market Knowledge

12. Schedule


Q1
Q2
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
1 8 15 22 29 5 12 19 26 4 11 18 25 1 8 15 22 29 6 13 20 27 3 10 17 24
Project Week
1 2 3 4 5 6 7 8 9 -- 10 11 12 13 -- 14 15 16 17 18 19 20 21 22 -- 23 24 25 26 --
PHASE ONE
Analytical model and Prototype
Feb 15th - Feb 25th Landing page creation
February 15th - April 1st Analytical model
February 15th - May 20th Prototype
March 20th - April 1st Mid Program
PROJECT START
PHASE TWO
Technical and Economic Study
March 25th - May 20th Technical and Economic Study
PHASE THREE
Preparation of evaluation materials
May 13th - June 3rd Final presentation
May 20th - June 3rd Demo Video
May 20th - June 3rd Poster
PROJECT END
PHASE FOUR
Demo Day
June 3rd- June 6th Demo Day Preparation