



HeatSpot
— OFF - GRID —

Autonomous solar-powered spot heating for critical thermal protection



GROUP
PG21



PRESENTATION
ELETRO DAY



LOCATION
**TECNICO
INNOVATION
CENTER**



Protect what matters. Exactly where it matters.





THE PROBLEM

One cold night
can **reduce yield**
before the fruit
even forms.



Cold stress can damage sensitive reproductive stages in greenhouse crops.



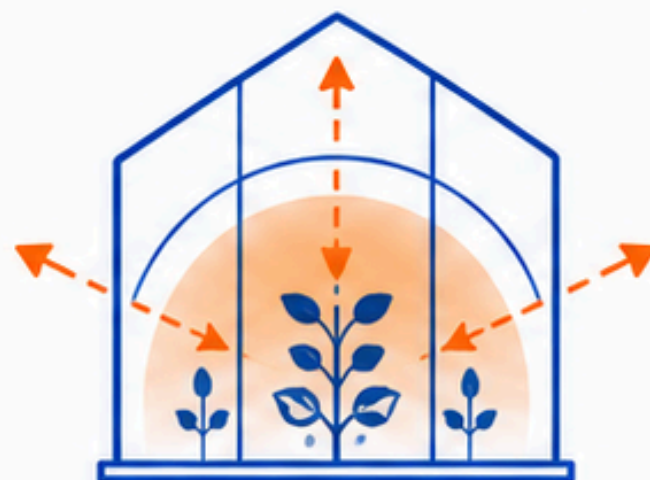
Why current solutions fail

Traditional approaches are not designed for localized, energy-aware thermal protection.



Grid-dependent heating

Requires fixed electrical infrastructure.



Heating too much volume

Energy is spent beyond the critical zone.



Too much energy wasted

High consumption limits off-grid viability.



Heat only what matters.

The thermal problem is **local**.
The solution should be **local** too.



Heating everything

Wastes energy.
Low efficiency.



Heating only the critical zone

Saves energy.
Protects what matters.



Local protection. Maximum efficiency.
Better outcomes.



HeatSpot
— OFF-GRID —

The Solution: HEATSPOT OFF-GRID

A modular off-grid system for localized thermal protection.



Solar-powered



Battery-backed



Localized heating



Smart control



Built to protect the **critical zone**,
not the whole environment.



Off-Grid Reliability
Works independently.



Energy Efficient
Heat only what matters.



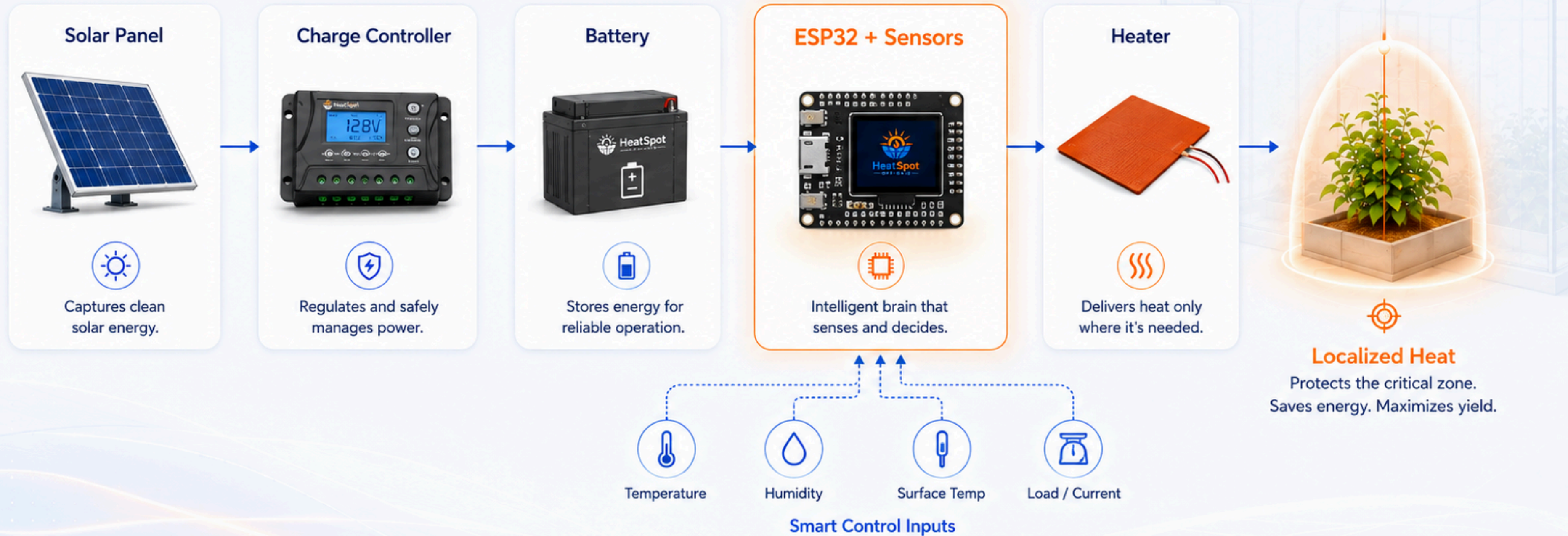
Critical Zone Protection
Protects crops, ensures yield.



Modular & Scalable
Designed to grow with you.

How it works

Sense. **Decide.** Protect.



→ Energy Flow - - - - - Smart Control

 Senses conditions. **Decides** in real time. **Protects** what matters.

HEATSPOT OFF-GRID System Architecture

 Off-Grid Operation

 Smart Control

 Critical Zone Protection

1 ENERGY GENERATION & STORAGE



Solar Panel
50W




PWM Controller
12/24V 10A
(LCD & USB)




AGM Battery
12V 14Ah


12V MAIN BUS (WITH FUSE PROTECTION)




LM2596
DC-DC Step-Down
Converter
(12V to 5V)




ESP32
Development Board
with Local Display
(System Brain)




DHT22
Temperature &
Humidity Sensor



DS18B20
Temperature Sensor
(Critical Zone)




ACS712
Current Sensor
(Load Monitoring)



SMART CONTROL LOGIC


Decides heating level based on temperature and available energy.

3 POWER ACTUATION



LR7843
MOSFET Power Module
(High Efficiency)

4 HEATING OUTPUT (LOCALIZED)



Heating Pad
12V 36W
Adhesive Heating Pad

CRITICAL ZONE ONLY

Localized heating protects only the sensitive area, not the entire greenhouse.

5 OPTIONAL MONITORING / DASHBOARD



HeatSpot Dashboard

Temperature: 23.6 °C
Humidity: 62 %
Battery: 12.6 V 85 %
Current: 1.24 A
Heating Output: 48 %
System Status: Normal



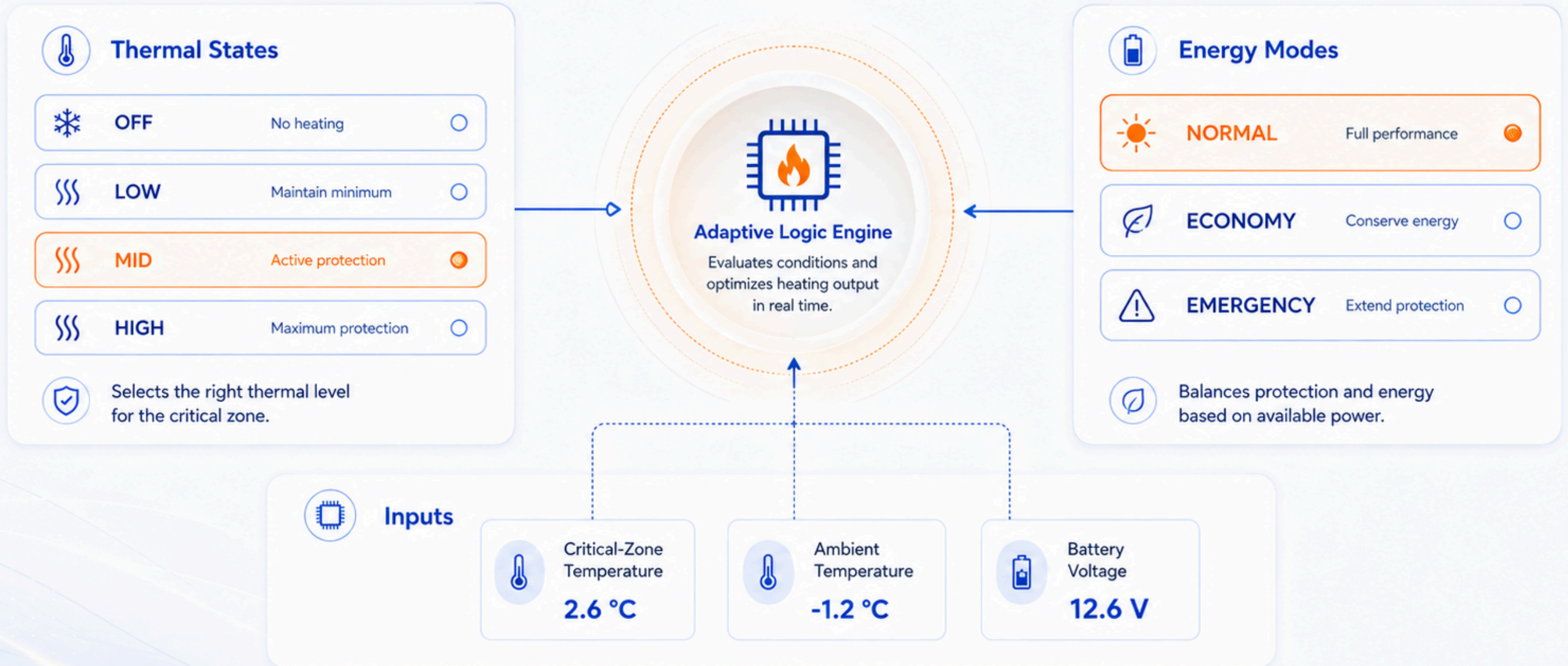
Local Dashboard /
Wireless Monitoring
(Optional)



Sensitive crops are protected in the critical zone, not the entire greenhouse.

Smart Control

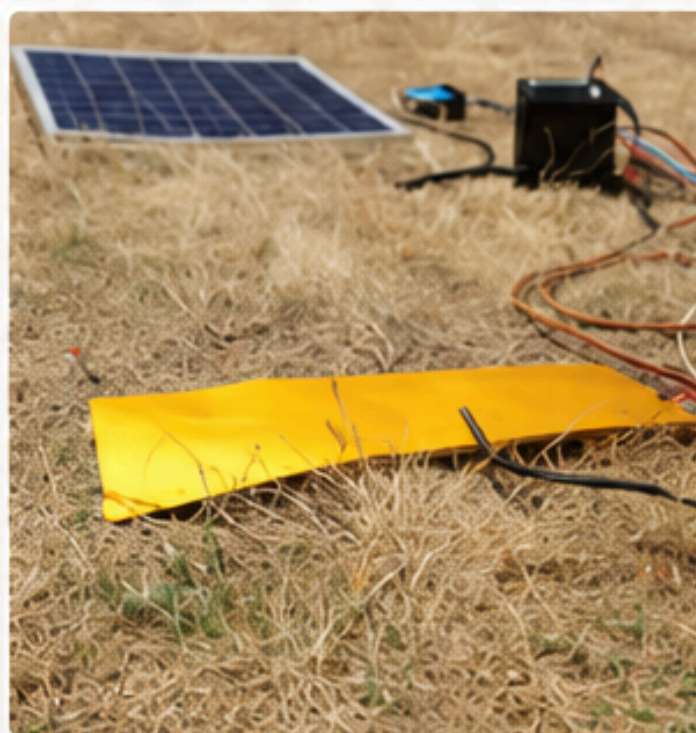
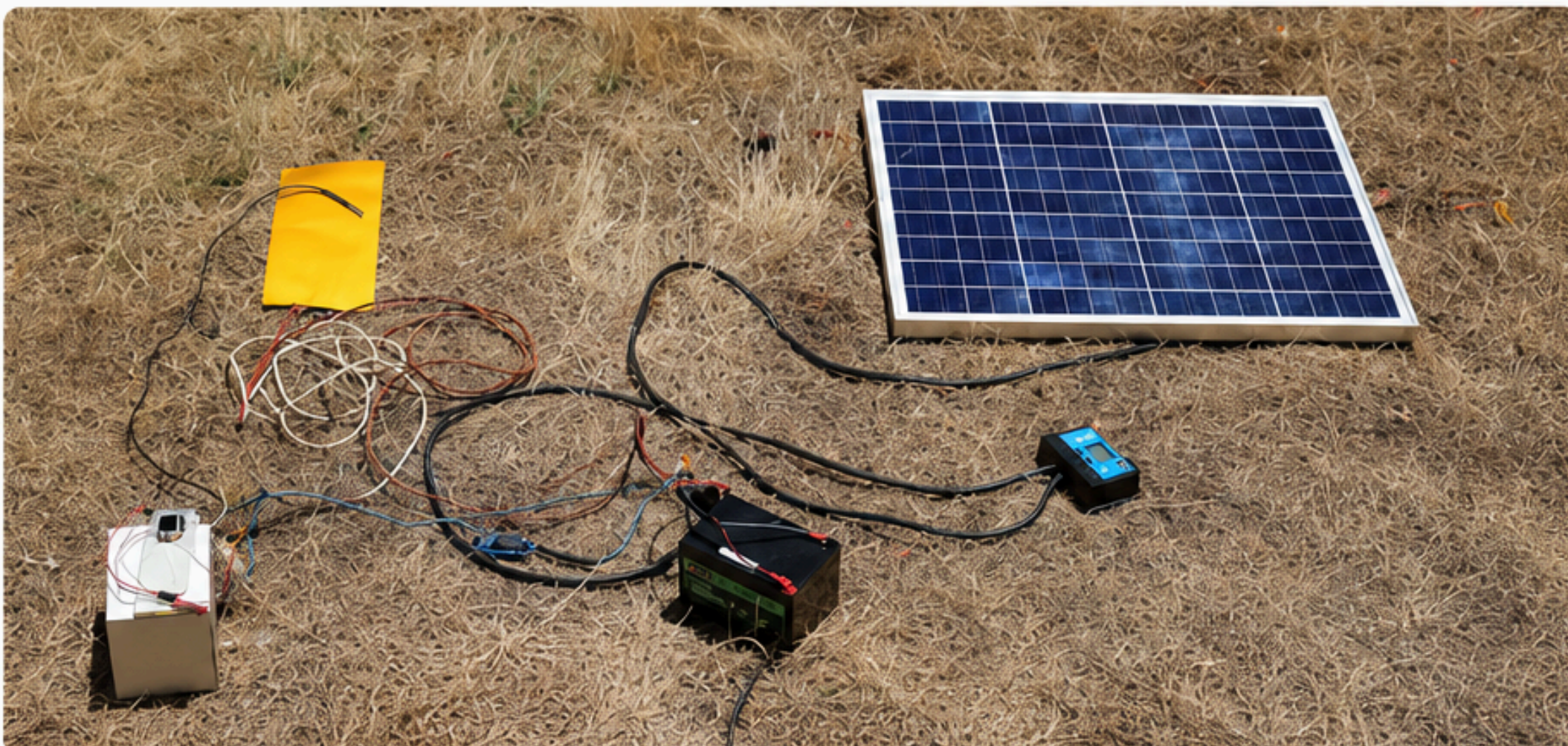
Adaptive thermal logic based on real conditions.



Reads conditions. **Adapts output.** Protects efficiently.

MVP Architecture

From concept to working prototype.



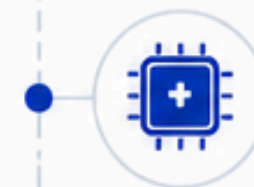
12 V Architecture

Safe, practical, and field-ready.



Solar + Battery

Independent, reliable energy.



ESP32 Control

Smart logic and local display.



Thermal Sensors

Real-time temperature monitoring.



PWM / MOSFET Actuation

Efficient and precise power control.



Localized Heating

Heat only the critical zone.



Built, tested, and ready

for functional validation.



Demonstration / Validation

What the MVP is built to prove.



1. Temperature Sensing

Reads thermal conditions accurately.



2. Heater Activation

Triggers protection when needed.



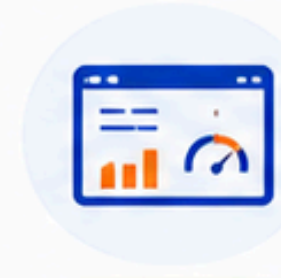
3. Power Levels

Adjusts output by operating mode.



4. Off-Grid Operation

Runs independently from the grid.



5. Local Display / Dashboard

Shows key system information in real time.



Focused testing. **Clear proof.** Confident validation.



Use Cases

Localized thermal protection across multiple critical applications.

1



Greenhouse Agriculture
Protect sensitive crop stages.

2



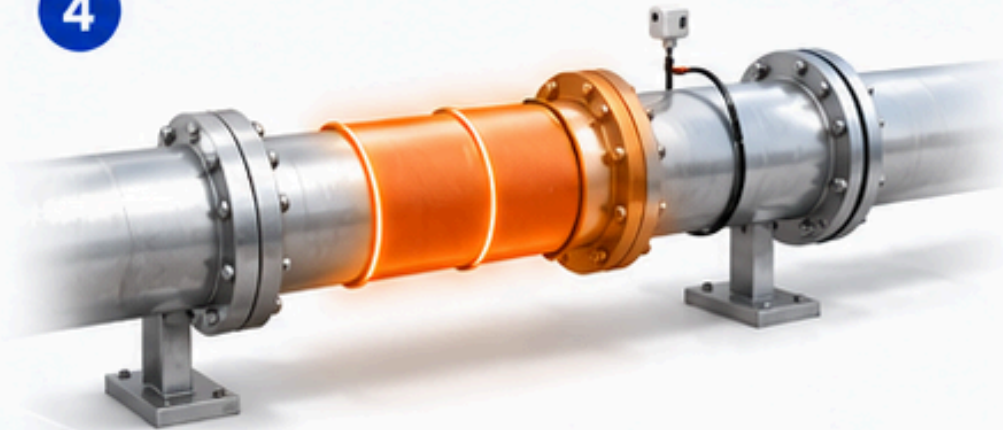
Battery Systems
Safeguard temperature-critical storage.

3



Telecom Equipment
Maintain operation in cold conditions.

4



Piping Protection
Prevent freezing at critical points.

5



Beekeeping
Support hive thermal stability.

6



Future Applications
Extend to other critical assets.



One control logic. **Multiple applications.**

Roadmap

From MVP integration to full commercial deployment.



Structured execution. Clear next steps.

Meet the Team

A multidisciplinary team building the **HEATSPOT OFF-GRID** system.

Catarina

IoT • Database • Comunicação



Leonel

Power Electronics (Heater Driver •
Protocolos)



Nicolias

Energy Systems (PV • Battery •
BMS • Otimização de energia)



Vasco

Embedded Control (Firmware •
Estados • Low-power)

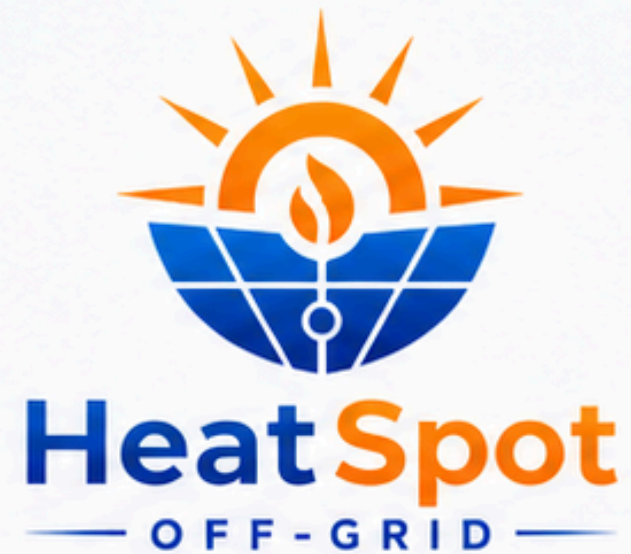


Sébastien

Project Manager • App Dashboard
Integração • Base de dados



Engineering, integration, validation, and execution.

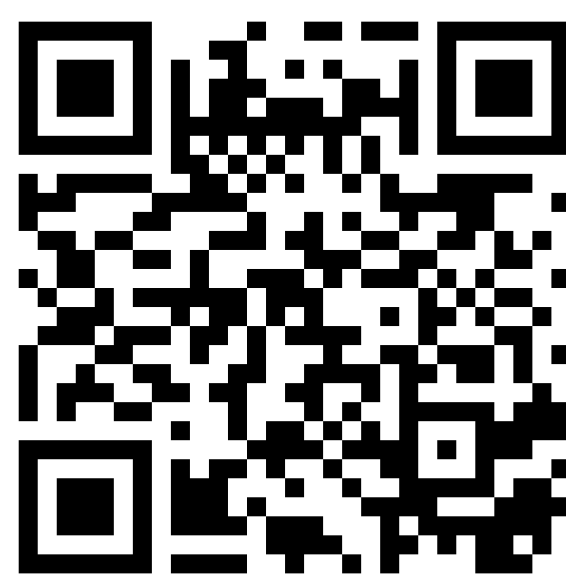


Explore the project



Demo Video

Scan to watch the demo



Project Website

Scan to learn more



HEATSPOT OFF-GRID — **Protect** what **matters**. Exactly **where** it **matters**.



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TÉCNICO
UNIVERSIDADE
DE LISBOA