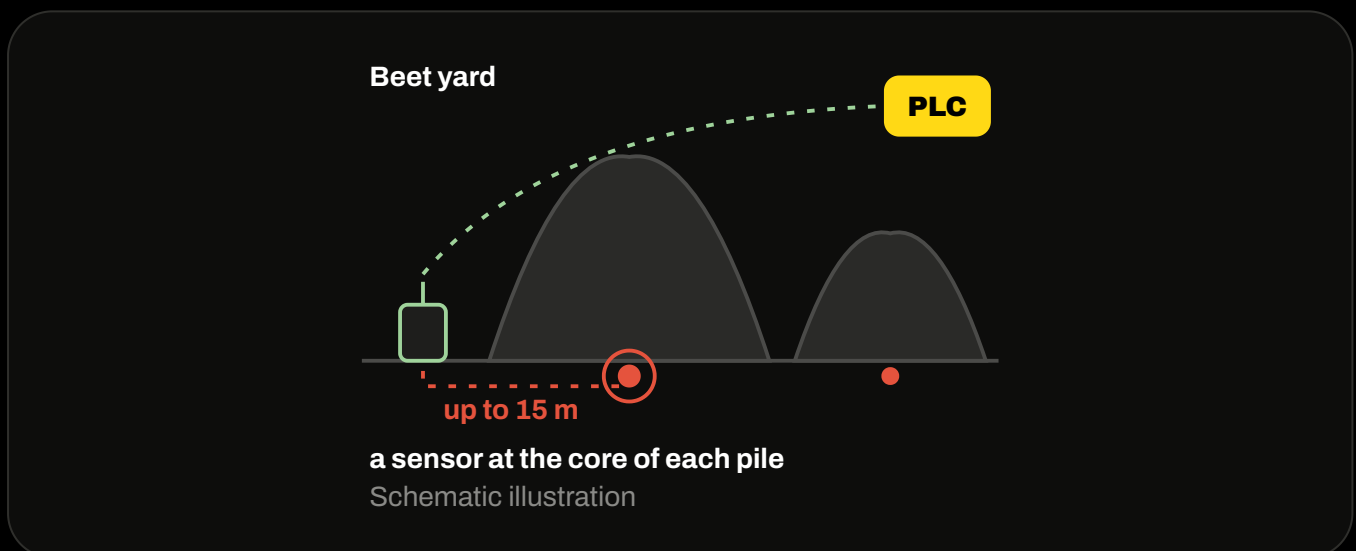


SUGAR INDUSTRY · RASPBERRY PLC

Beet piles spoil from the inside. A buried sensor watches the core.

Battery radio nodes report the core every hour.

[Read the interactive case study online ›](#)**15 m**

at most, from the node box to the sensor at the base of the pile

1 h

between two readings; the node sleeps in between

2 years

almost: the expected time before a node needs new batteries

2 bands

2.4 GHz for data rate or 868 MHz for range

THE CHALLENGE

Find the warm beets before they rot.

Before the beets go into the factory, they wait outdoors in very large piles. In this case the beets at the bottom centre of the piles spoiled before they were removed for sugar production. Part of the raw material had to be discarded, and the losses added up to a significant amount every year. The manufacturer wanted a system that detects when the beets are about to rot, so they can be taken out in time.

01

The problem starts inside

The beets inside a pile are more affected by heat and moisture than the beets on the outside. A walk around the pile does not show it. The measurement has to be at the bottom centre.

02

Bulldozers move the pile

The beets are removed with bulldozers. A sensor on the surface would be destroyed. The sensor is buried at the base, out of reach of the blades, but still close to the beets.

03

Outdoors, all season

The system works in the open, in the rain and the cold of the season. The electronics stay in a closed electrical box at the edge of the pile. Only the sensor cable goes under the beets.

04

No cables between piles

The piles are spread over the yard and they change as the season goes on. Each node runs on batteries and sends its data by radio. The batteries are expected to last almost 2 years.



Why it matters

Every beet that rots in the pile is raw material that never becomes sugar. The case reports that the system reduced the losses from spoiled beets, kept the product in good condition and cut the work of handling and disposing of bad beets. It does not publish figures.

HOW IT WORKS

Three jobs: read the core, sleep between readings, warn in time.

Job 1 · Read the core

One sensor where the heat builds up.

The sensor sits at the base of the pile, under the bottom centre, up to 15 m from the node box at the edge. The air around the pile goes up and down with day and night. The core changes slowly. A steady rise in the core, while the air does not explain it, is the sign to look for. Pick a pile and watch the trend.

- Sensor buried at the base, under the bottom centre
- Up to 15 m from the box at the edge

Job 2 · Sleep between readings

Wake, read, send, sleep. Once an hour.

Beets do not spoil in minutes, so one reading per hour is enough. The node sleeps the rest of the time. It wakes, reads the DS18B20 through a level shifter, because the sensor runs at 5 V and the radio board at 3.3 V, sends the value to the master and goes back to sleep. This is how the batteries are expected to last almost 2 years. Change the interval and the band.

- One wake-up per hour in the case
- 2.4 GHz: less range, more data rate

Job 3 · Warn in time

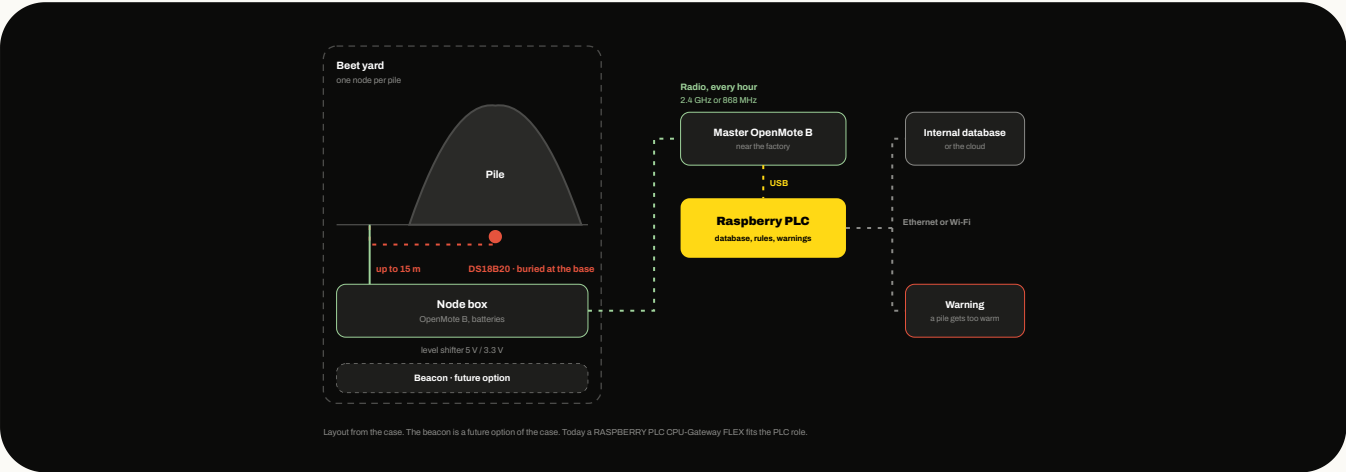
From a warm core to a planned removal.

The master radio board near the factory passes every message to the Raspberry PLC over USB. The PLC stores the data in a database or sends it to the cloud over Ethernet or Wi-Fi. When the heat in a pile goes too high, it sends a warning, so the yard can remove that pile first. Break something and read the log.

- Warning signal on high heat in a pile
- A silent node is found by its missing messages

How do you monitor the temperature inside a beet pile?

Bury a temperature sensor at the base of the pile, under the bottom centre, and run its cable to a radio node in a closed box at the edge of the pile. In this case each pile has one OpenMote B node with a DS18B20 sensor, a level shifter and batteries. Every hour the node wakes up and sends its reading by radio, on 2.4 GHz or 868 MHz, to a master OpenMote B near the factory. The master is connected by USB to a Raspberry PLC, which stores the data in an internal database or sends it to the cloud over Ethernet or Wi-Fi, and raises a warning when a pile gets too warm.



— Sensor cable in the pile — Radio, 2.4 GHz or 868 MHz — USB and Raspberry PLC — Ethernet or Wi-Fi

Signals and data

Signal	Between	Type	Purpose
Pile temperature	DS18B20 → node	Digital, 1-Wire	Sensor buried at the base, up to 15 m from the node box
Level shift	DS18B20 (5 V) ↔ OpenMote B (3.3 V)	Level shifter	Adapts the data line between the two voltages
Humidity	Pile → node	Not named in the case	The case monitors heat and humidity; it names only the DS18B20, which measures temperature
Hourly reading	Node of each pile → master	Radio, 2.4 GHz or 868 MHz	The node wakes every hour, sends and sleeps again
Battery	In the node box	Batteries	Expected to last almost 2 years
Collected data	Master OpenMote B → Raspberry PLC	USB	All the piles reach the PLC near the factory
Uplink	Raspberry PLC → database or cloud	Ethernet or Wi-Fi	Internal database, or the cloud directly
Warning	Raspberry PLC → yard team	Warning signal	Sent when a high level of heat and humidity is detected
Visual alert	Node box → yard	Beacon (future option)	Planned in the case to show a pile above its limits; not installed

The PLC today. The nodes of the case.



Current equivalent RASPBERRY PLC CPU-Gateway FLEX

Role in this design	Receives the master radio board on USB, stores the data, sends it on and raises the warnings
Compute	Raspberry Pi 4, quad core 64-bit, 1.8 GHz, 2, 4 or 8 GB RAM
Ports	1 x Gigabit and 1 x 10/100 Ethernet, Wi-Fi, Bluetooth LE, 2 x USB 2.0, 2 x USB 3.0, 2 x RS-485
Expansion	One optional board: CAN, LoRa or 4G (LTE-M/NB-IoT or LTE Cat 4)
Software	Debian 64-bit preinstalled; runs Python, Node-RED and C/C++
Power and mounting	12 to 24 Vdc, UPS with supercapacitors, real-time clock, DIN rail TS35, IP20, 0 to 50 °C

[See the CPU-Gateway FLEX >](#)



OpenMote B (image from the original case)

Sensor	DS18B20 digital temperature sensor, buried at the base of the pile
Voltages	Sensor at 5 V, radio board at 3.3 V, level shifter between them
Radio	2.4 GHz or 868 MHz
Cycle	Sleep, wake every hour, send to the master
Power	Batteries, expected to last almost 2 years

[Ask about the nodes >](#)

Measure where it starts

The damage starts at the bottom centre of the pile. A buried sensor reads that point directly, instead of guessing it from the surface.

Electronics out of the pile

Only the sensor and its cable go under the beets. The radio board and the batteries stay in a closed box at the edge, where the bulldozers do not work and the batteries can be changed.

A rhythm that matches the beet

Spoiling takes hours and days, not minutes. One reading per hour shows the trend and lets the node sleep almost all the time.

A band for each yard

With 2.4 GHz you get more data rate and less range. With 868 MHz you get more range and less data rate. A large yard with a few bytes per hour is a good fit for the lower band.

A Linux PLC at the end

The Raspberry PLC takes the data on USB and does the rest in software: database, cloud, rules and warnings. See an [MQTT to SQL Server bridge in Python](#) and a [Node-RED MQTT concentrator](#).

Open and modular

There are no licence fees. A new pile is one more node and one more line in the rules. The same network can grow with the yard.

STORING A CROP OUTDOORS?

Tell us about your piles. An engineer will answer.

Tell us how many piles you have, how far they are from the plant, what you want to measure and where the data must go. We will propose the sensors, the radio, the PLC and the software.

FULL CASE STUDY ONLINE

industrialshields.com/case-study-sugar-beet-pile-monitoring-wireless-sensors

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