

SMARTTECH

# Battery-Free Smart Locking System

*De-Risking Critical Infrastructure Security  
Through Integrated Manufacturing*



- SOLUTIONS:
- Mold Fabrication
  - Plastics
  - Metals
  - In-Mold Electronics
  - Insert Molding
  - PCBA
  - Precision Assembly
  - Design Engineering
  - Functional Testing

## The Challenge

Critical infrastructure operators – including telecommunications towers, utility networks, transportation systems, and water treatment facilities – require secure, reliable access control that can operate for years without maintenance in harsh outdoor environments.

A European pioneer in digital locking technology developed an innovative battery-free, energy-harvesting electronic lock. Unlike conventional electronic locks that require batteries or wired power, this system generates the energy needed for authentication and unlocking directly from the kinetic motion of inserting a key into the lock cylinder – with no batteries in the lock, no batteries in the key, and no dependency on Wi-Fi or internet connectivity for basic operation.

The lock performs electronic authentication and access-right verification using AES-256 encrypted communication between key and cylinder – with resistance to credential copying and secure digital credential management. This unique energy-harvesting architecture means every authentication event depends on real-time power generation from a mechanical act, making manufacturing precision and long-term mechanical reliability mission-critical.

The device must perform reliably in unattended outdoor locations, demanding resistance to temperature extremes, moisture, dust, corrosion, and physical tampering – while housing sensitive electronics and encrypted authentication components.

The challenge lay not just in design, but in scaling production with zero defects while ensuring consistent performance of both electronic authentication and mechanical durability across millions of cycles.

## Beyonics Solutions

### Engineering Precision for Battery-Free Authentication

Beyonics supplies precision-engineered components and high-value product solutions to the world's leading SmartTech companies. Our in-house tooling, precision manufacturing, automation expertise, materials knowledge, and R&D capabilities enable Beyonics to create a vertically integrated solution to optimize efficiency.

### Co-Development from Concept to Commercialization

Beyonics' engineering team collaborated closely with the customer's design team from the earliest stages – translating innovative energy-harvesting technology into a manufacturable, production-ready system.

## Key Manufacturing Innovation

- Precision mold design and fabrication for complex plastic geometries requiring sub-millimeter tolerances
- In-Mold Electronics (IME) process to encapsulate sensitive NFC and electronic components within molded parts while maintaining full post-molding functionality
- Customized tooling to ensure even material flow and minimal stress on embedded components during injection molding



## Product Accomplishments

- ✓ Developed precision molds and IME encapsulation processes to achieve unique design requirements
- ✓ Validated the entire assembly process, including injection molding, IME integration, and sub-assembly with detailed process mapping
- ✓ Manufactured high-density printed circuit board assemblies from Beyonics' Malaysian flagship facility
- ✓ Integrated metal stamping and insert molding for durable smart key components with reliable electrical contact
- ✓ Performed final assembly and functional testing – including NFC verification and energy harvesting validation
- ✓ Consolidated over 100 parts through vertical integration, shortening supply chain and lowering production costs

