Research, Businesses and Innovation in French Overseas Territories



Smart Grids and Energy Transition

From full-scale experimentation to territorial transformation in islands and non-interconnected regional systems (NIZ)

Prof. Philippe Poggi — University of Corsica · Laboratory SPE UMR CNRS 6134

Context

The stakes: autonomy, blue & green economy, sovereignty

A Dual Strategic Imperative: Autonomy & Diplomacy

Achieving autonomy in **energy production** and **food supply** → combined **blue economy** and **green economy**: Coupling clean power production with local water and food security)

Scientific diplomacy: essential to French sovereignty within the geographical basins,

A **basin-based strategy**: cooperation between overseas territories and the countries of their regional oceanic basins — with **overseas universities in a pivotal role driving regional technology cooperation,** anchoring French research excellence across oceanic regional basins

Université de Corse, UMR SPE CNRS 6134: committed to ZNI research and teaching

Context
Island grids expose tomorrow's system challenges today

Limited interconnection

Make flexibility observable

Variable renewable supply

Design for resilience

Climate & supply exposure

Coordinate investment

Constraints are **concentrated** — so learning cycles can be faster and more visible

The same constraints create a **full-scale laboratory for robust, transferable solutions**

The transition accelerates when four systems move together: **research → qualified field solutions → aligned technology/markets/governance → robust pathways**

The structuring role of research

Supporting businesses: from laboratory to field



Research: reducing uncertainty, securing choices

Research transforms **complex energy questions** into robust, exploitable and transferable knowledge

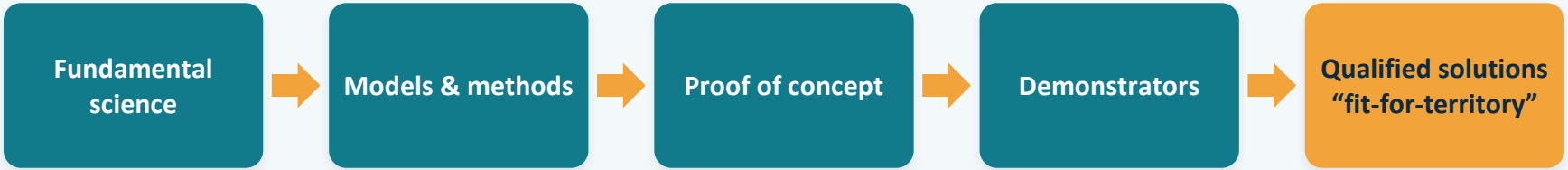
It provides **models, methods and proof** to evaluate resilience, sufficiency and efficiency **in real conditions**

It characterises operating regimes, dependencies and side effects — especially under variable production

The key output is not only a publication — it is a validated, transferable body of evidence for companies and public actors

Scientific models evaluate resilience, sufficiency, and efficiency in real operating conditions before locking in costly capital investments.

From Lab TRL to “fit for territory”: multi-scale modelling by validation under real tropical climate and grid stress



Components: protections, converters, power interfaces

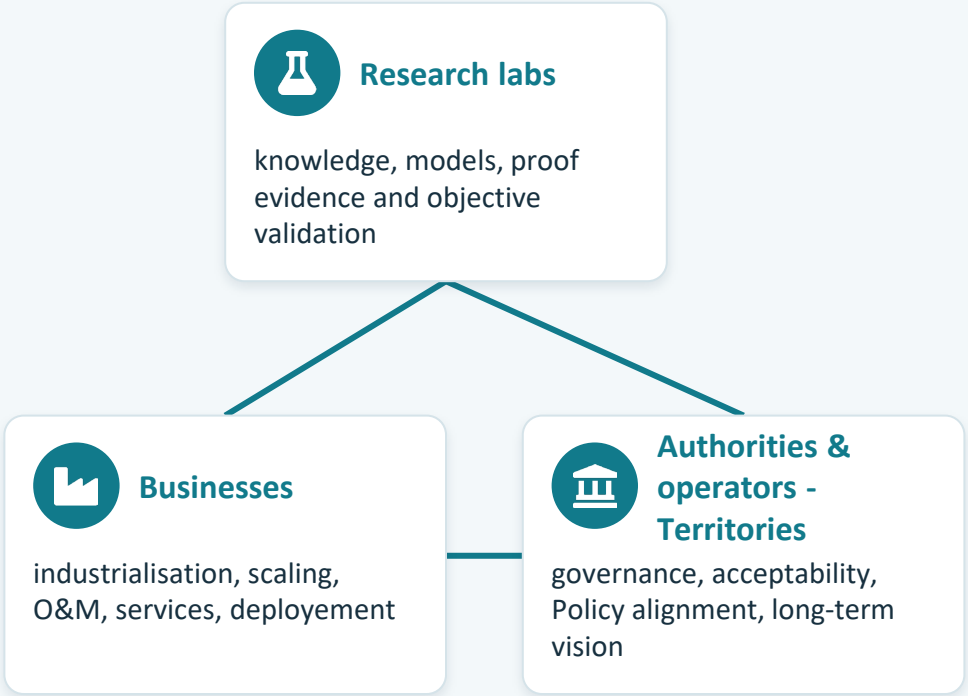
System: architectures, algoritms and simulation, flows, stability, quality of service

Economic: market mechanisms, flexibility signals

Uses: behaviours, mobility, consumption practices

Prospective modelling to test **transition scenarios** and identify resilient pathways under climatic, economic and geopolitical uncertainties

Cooperation: the tripartite cooperation model : the researcher–industry–territory triangle



A **cooperation model** reduces locks faster and accelerates industrialisation

Innovation must also be **socio-technical**: concertation, acceptability, training, integration into the local ecosystem

Support goes **beyond technology transfer**: comprehensive modelling of technical, economic and societal dimensions of insularity

Holistic innovation: smart grids, storage — four platforms in action



Interconnection smart grid ↔ storage — a holistic, five-layer system

- **Technological**: generation, networks, storage, buildings, mobility
- **Digital**: data, forecasting, control, interoperability, cybersecurity
- **Economic**: investment, total cost, markets, business models
- **Institutional**: regulation, governance, standards, public strategy
- **Societal**: skills, acceptance, equity, behaviour, local capacity



Optimization at one layer can create fragility in another — integration is the design task. Overcoming intermittency and stability constraints requires a systemic approach, not technology alone.

Demonstrators: full-scale laboratories in the French overseas territories
A pan-oceanic network — one innovation model



Guadeloupe, FWI

BEPOSDOM Tropical positive-energy building & energy platform



French Polynesia

Isolated grid solarHydrogen platform at UPF (TE FARE ITO)



French Guiana

HyMAZONIE hydrogen platform : Autonomous off-grid hydrogen microgrids.



La Réunion

Regional energy platform (project): Biomass, SWAC & island transition modeling

Demonstrators, experimental platforms and partnerships (labs ↔ businesses ↔ authorities ↔ operators) **structure innovation ecosystems** — island territories as **relevant full-scale laboratories** for replicable energy models.

Each platform addresses a **specific insularity profile**; together: a **replicable experimental network** — a basin-based scientific diplomacy asset

Prospective: from "project" innovations to **system architectures** · anticipate mixes, costs, market frameworks, climate risks · from pilot → validation → scale-up → industrialisation · island autonomy within coming decades — **island models foreshadow the future of large continental power systems**

🏝️ Platform 1 — BEPOSDOM, Guadeloupe (Caribbean)

Scale-1 experimental platform for positive-energy buildings in a humid tropical climate

- Test cells & modular envelope: materials, construction processes
- Solar PV & thermal production on-site
- Storage + smart energy management: self-consumption, possible reinjection
- Electric mobility & charging infrastructure
- Monitoring, energy & comfort data acquisition

A **translation device**: scientific results → professional decisions (architects, control offices, material distributors)

Part of the **AUDACIA Caribbean Technopôle** (Baie-Mahault, ~18 ha)

Potential for **industrialisation, local jobs and innovation** — exportable know-how

🌊 Platform 2 — TE FARE ITO, University of French Polynesia (Pacific)

Experimental platform for isolated electrical networks — GEPASUD laboratory

- **6 PV technologies** deployed side by side
- Electrolyser: hydrogen from **water + solar energy** (RECIF)
- H_2 storage + **fuel cell** — first in French Polynesia
- Cold storage / heat pump — tri-generation: power, heat, cooling
- **Weather station + 60 sensors**, real-time monitoring

Demonstrator sized to power **~5 houses** — designed for the humid Polynesian climate

Partners: FEMTO-ST, PROMES (CNRS), Energy4Climate, H2SYS, ANR

Feeds the **HyLES** project: hydrogen pathways for energy independence in Corsica, Réunion and Polynesia

🌳 Platform 3 — HyMAZONIE, University of French Guiana (Amazonia)

Smart hydrogen hub — Campus Troubiran, Cayenne — autonomous microgrids for isolated sites

- Renewable primary source (PV) → power electronics
- Low-temperature **hydrogen chain**: electrolyser + H_2 storage
- **Fuel cell 30 kWe** + **lithium battery 20 kWh** for peaks
- **Heat + cooling: tri-generation** — multi-energy demonstrator
- Smart grid: consumption management, quality & reliability of supply

Target applications: **autonomous supply of off-grid sites** (relay antennas, isolated villages) and **backup for sensitive loads** (data centres, hospitals)

Led by **UMR Espace-Dev** with CNES-ESA; platform funded by ADEME

Research, **training (Master, BUT)** and validation in a humid tropical environment; replicability to other isolated territories

🌋 Platform 4 — La Réunion: towards a regional energy platform

A regional platform supporting research and businesses — prefiguration stage

- High renewable penetration: PV self-consumption, biomass, SWAC/marine thermal
- Multi-level storage: batteries + **hydrogen** (electrolyser + fuel cell)
- Smart grid: supervision & optimisation of distributed building microgrids (**GYSOMATE**)
- Prospective modelling of island transition scenarios

Priority themes: **PV, hydrogen, tropical buildings, smart grids**

PIMENT laboratory (University of La Réunion): HTC reactor for H_2/CH_4 from agri-waste (H2RUN, BIOfairNET)

Island-scale hydrogen tenders (PV + 10 MW electrolyser + 2 MW fuel cell) — first of this scale in the DROM

Collaboration, training, technology transfer, connection to national & international R&D networks

Islands as living laboratories

Real-scale systems — small, bounded grids reach high renewable shares early: effects are visible in months, not decades

Short learning loops — operator, regulator, university and industry sit around one table: test, measure, adjust

Stress-test conditions — weak grids, cyclones, humid tropics, fuel-import dependence reveal failure modes early

Observable and attributable — clear system boundaries and dense monitoring give **measurable, comparable evidence**

Islands do not predict the future grid — they **reveal its failure modes early** and test the answers

Limits of replicability to continental grids

Scale and inertia — continental grids rely on large synchronous inertia and meshed networks: island dynamics do not scale linearly

Interconnection and markets — cross-border exchanges, wholesale markets and reserves differ from isolated, regulated systems

Economics — high island generation costs create business cases for storage and hydrogen that may not hold on the continent

Local context — climate, land, supply chains, skills and social acceptability are **territory-specific**

Replicate the **approach, not the solution**: methods and validation protocols, re-qualified at each scale

Local development is part of the energy transition

Skills ecosystem: training, maintenance, engineering, operation — anchored to energy projects

Skilled, non-relocatable jobs · technological sovereignty · control of local energy expenditure

Structuring of **new industrial sectors** and increased attractiveness of island innovation ecosystems

Governance grounded in **data and co-construction** — durability of storage (life cycles, land, maintenance) and social acceptability

Objective: a transition that is **safer, more efficient and more just** 🌍 ⚡

Conclusion — three messages

Research must be connected to real operating conditions and measurable evidence, and reduces uncertainty

Platforms and business support turn science into experimentation, transfer and collaboration, and create evidencebusinesses turn evidence into deployable solutions

Territories need holistic, adaptive ecosystems linking technology, skills and governance. territories provide the real operating context

Islands & NIZ are not the periphery of the energy transition — they are its laboratory.

Exporting Island Expertise to Continental Networks

"Island power systems prefigure the future challenges of large continental networks operating under high renewable variability."

Thank you — Prof. Philippe Poggi · University of Corsica · SPE UMR CNRS 6134