

Islands of resilience: What European municipalities can learn from off-grid systems

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Blackouts in Europe are no longer hypothetical

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Recent outages show how wide and how long grid failures can be

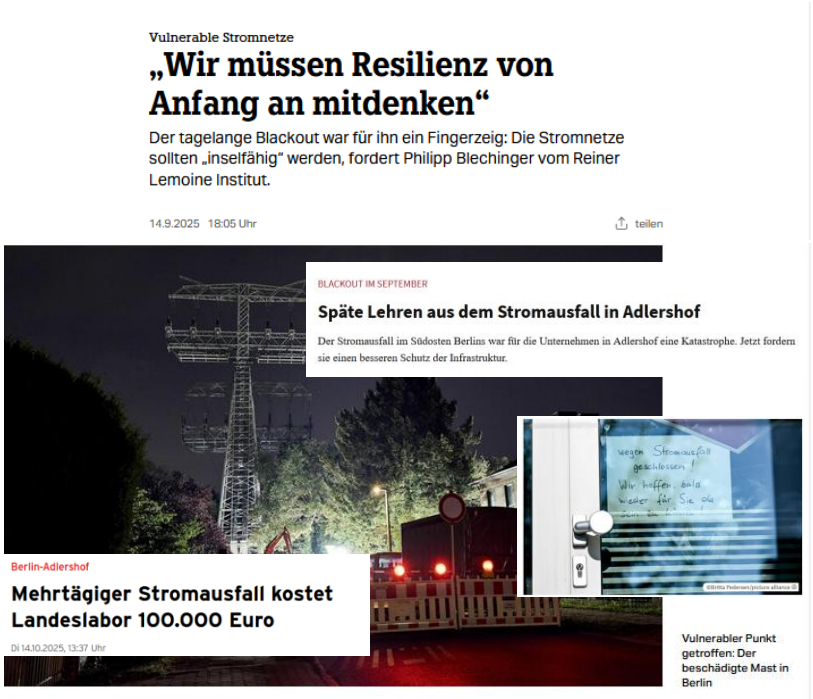
28 April 2025 · Iberian Peninsula
Almost 60 million people affected; >99 % restored after ~18 h; mobile networks down

Sept. 2025 · Berlin-Adlershof (sabotage)
~50,000 customers cut off; outage lasted several days; businesses and labs hit

January 2026 · Berlin South-West (sabotage)
45,400 households + 2,200 businesses; up to 5 days in freezing winter; 74 care facilities, 6 hospitals

What still works when the grid is gone?

Sources: AFP/Red Eléctrica; Stromnetz Berlin; Senate of Berlin (2026)


Vulnerable Stromnetze

„Wir müssen Resilienz von Anfang an mitdenken“

Der tagelange Blackout war für ihn ein Fingerzeig: Die Stromnetze sollten „inselfähig“ werden, fordert Philipp Blechinger vom Reiner Lemoine Institut.

14.9.2025 18:05 Uhr teilen

BLACKOUT IM SEPTEMBER

Späte Lehren aus dem Stromausfall in Adlershof

Der Stromausfall im Südosten Berlins war für die Unternehmen in Adlershof eine Katastrophe. Jetzt fordern sie einen besseren Schutz der Infrastruktur.

Berlin-Adlershof

Mehrtägiger Stromausfall kostet Landeslabor 100.000 Euro

Di 14.10.2025, 13:37 Uhr

Vulnerabler Punkt getroffen: Der beschädigte Mast in Berlin

taz.de/Vulnerable-Stromnetze/!6110102/ (14.9.2025)

Off-grid is everyday reality

Same building blocks at every scale – from one house to a whole region

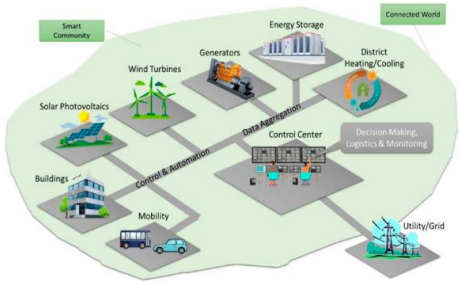
500+ million

people already rely on off-grid solar – from solar home systems to mini-grids

Source: Off-Grid Solar Market Trends Report 2022



Solar mini-grid (SEforALL, 2020)



Smart energy community (Zaidan, 2022)

Solar home system
single household

Mini-grid
village, island

Switchable microgrid
hospital, water works, district

Energy cells
interconnected microgrids, region

From permanently off-grid → islandable on demand

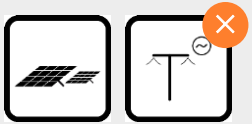
Without the grid, most PV goes dark

Islanding needs grid-forming inverters and batteries – not just PV



Today: diesel backup

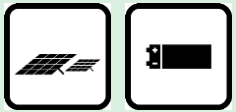
Proven – but needs fuel, maintenance and test runs; only at a few sites



Grid-tied PV

Disconnects automatically when the grid fails (anti-islanding protection)

No power for the building – even in full sun



Islandable PV + battery

- Grid-forming inverter sets voltage and frequency
- Battery buffers and enables black start
- Transfer switch separates from the grid
- Energy management serves priority loads first

16 GWh stationary batteries in Germany (2024) – about 10× more than in 2020, mostly home storage. In a blackout, only systems with backup function help.

Source: RWTH Aachen, battery-charts.de, via Agentur für Erneuerbare Energien (10/2024)

Four lessons from off-grid systems

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What off-grid practice teaches us about resilience

1 Plan for services, not kWh

Decide which services must keep running – light, communication, heat, water, cold chain. Off-grid planning works in service tiers (Multi-Tier Framework).

2 Grid-forming is the bottleneck

Someone has to set voltage and frequency. Without grid-forming inverters, PV and batteries stay off.

3 Start modular, grow into cells

Begin with one critical building, then extend to clusters and neighbourhoods. Standard components scale.

4 Operation and business model decide

Systems fail on maintenance, skills and finance – rarely on technology. Dual use pays for backup.

How much autonomy makes sense?

Tiered by criticality – not autarky for everyone



Das Geschäft mit Generatoren brummt Stromausfall im Berliner Südosten macht Baumärkte glücklich

Der Stromausfall in Berlins Südosten hat die Nachfrage nach allem angekurbelt, was Strom erzeugt. Wir haben uns bei denen umgehört, die Abhilfe im Angebot haben.

Nothilfe mit Fahrzeugakku

Was macht ein E-Auto im Blackout? Strom liefern

HOUSEHOLDS

Hours

Light, communication, fridge, heating control

e.g. home battery with backup function, bidirectional EV

COMMUNITY RESILIENCE HUBS

Days

Warmth, information, charging, drinking water, first aid

e.g. town halls, schools, fire stations, sports halls

CRITICAL INFRASTRUCTURE

72 h +

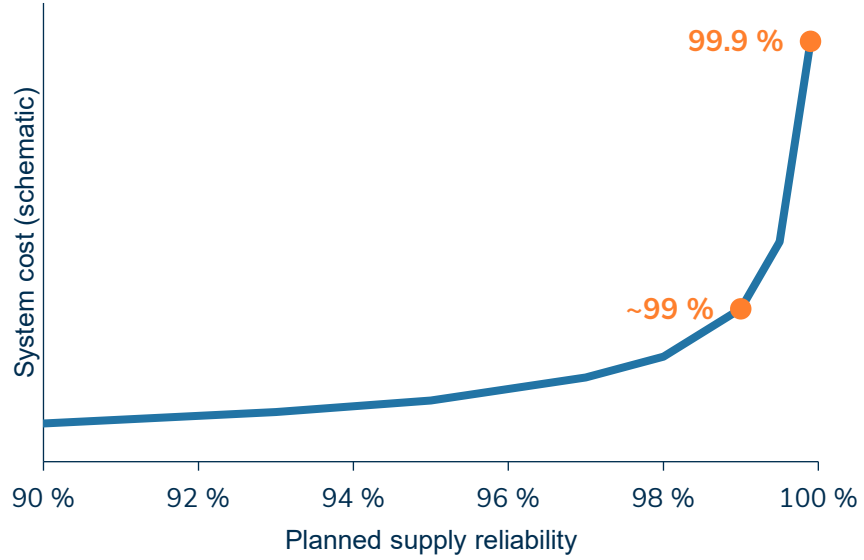
Hospitals, care homes, water supply, control centres

72 h is a common benchmark – Berlin 2026 lasted up to 5 days

The more critical the service, the longer the autonomy – resilience is not autarky

The last percent of reliability costs the most

A lesson from PV-battery off-grid systems that applies to municipalities



Schematic: cost of a PV-battery off-grid system vs. planned reliability

Three ways to avoid oversizing

1. **Accept ~99 %** – and define which loads may fail
2. **Add a small backup** – generator, CHP or fuel cell for long dark spells
3. **Use flexible loads** – shift or shed demand to reach 99.9 %

Define service levels first – then size storage, backup and flexibility

Energy communities as an additional fallback

Promising – if technology, rules and roles are prepared in advance

What they bring

- Local generation and storage
- People who know each other and their neighbourhood
- Existing organisation and trust
- A business case in normal times (energy sharing)

What it takes

T **Technical**
Islanding capability: grid-forming inverter, transfer switch, protection, priority circuits

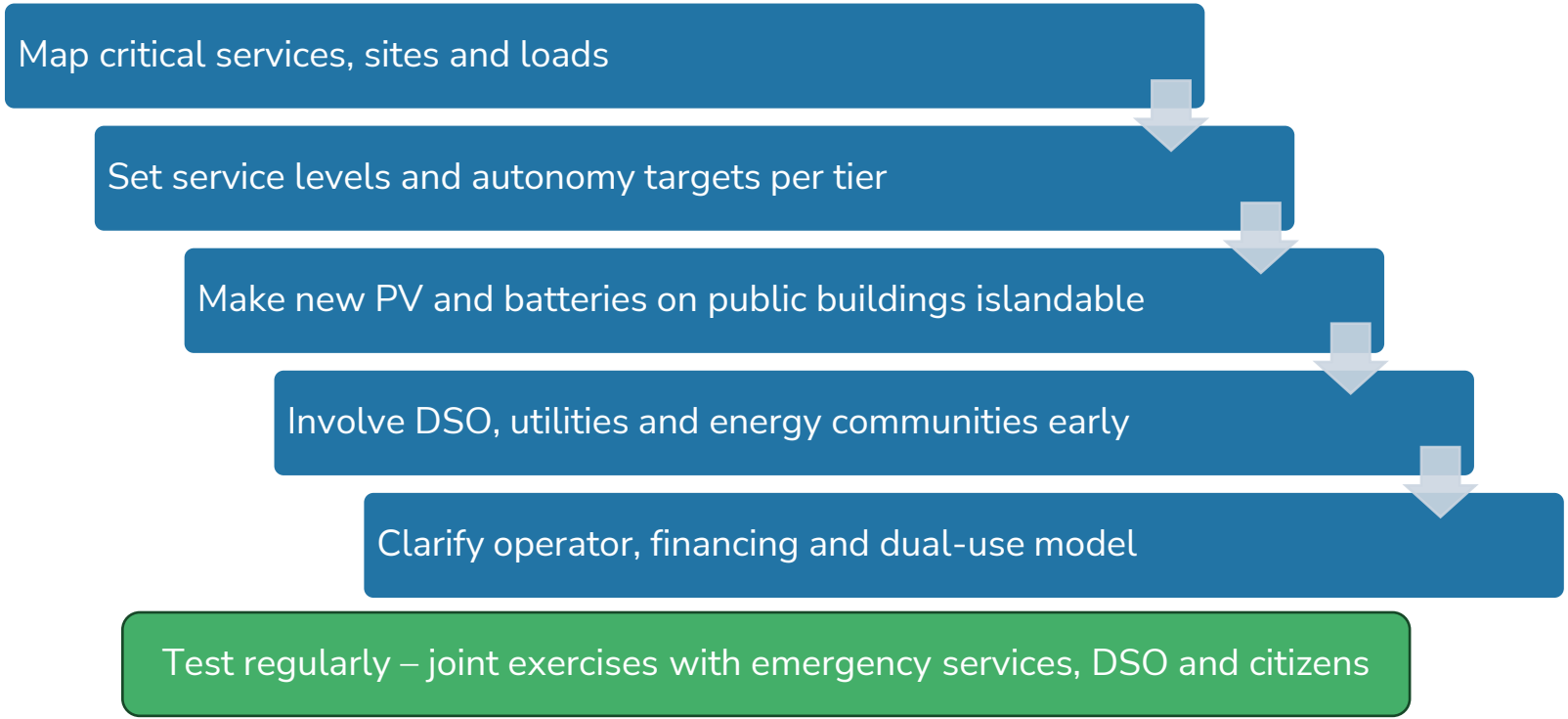
R **Regulatory**
Public grid sections are run by the DSO – islanded operation is hardly covered by today's rules

O **Organisational**
Who operates, decides and pays in an emergency? Agree roles with DSO and civil protection

Real-world example in this workshop: Energizing Borders (Görlitz/Zgorzelec)

Acting together: what municipalities can do now

Five steps from resilience strategy to islandable infrastructure



Take-aways and discussion

Resilience is not autarky: keep critical services running locally

- Off-grid practice shows: the technology is mature – planning, rules and operation are the bottleneck
- The energy transition is building the components anyway – make them islandable
- Tiered autonomy beats full autarky – technically and economically

Which building in your municipality would be your first energy island – and who would run it?

Thank you for your attention!



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