



IEA Technology Collaboration Programme

COUNTRY REPORT FRANCE – update 2026

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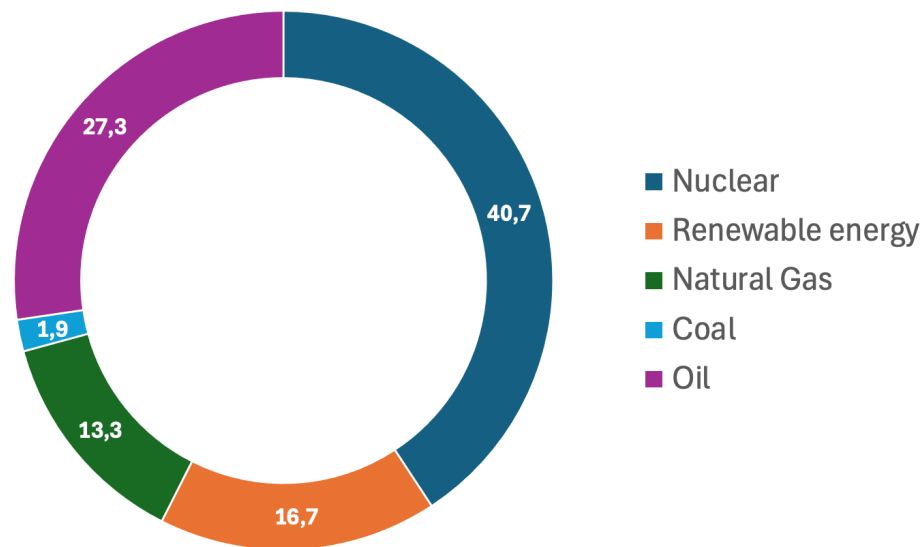
ESTCP XC101 - June 2026

Technology Collaboration Programme

by **iea**

Country Specific Information

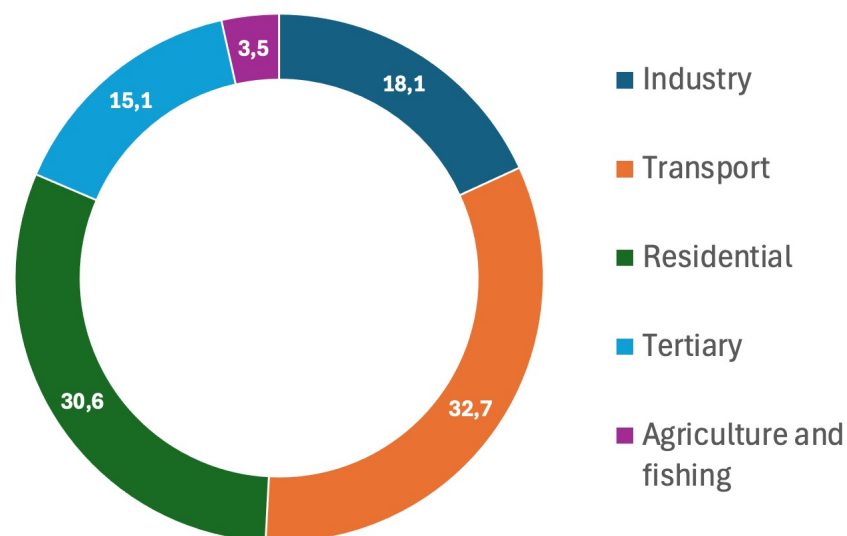
- Population : 69 082 000, January 2026
- Primary energy consumption (2024) : 2,577 TWh +6% compared to 2022



Primary energy repartition [%] 2024 - *not adjusted for climate variations*

Country Specific Information

- Final energy consumption by sector (2024) : 1570 TWh
- 3.842 tCO₂ / capita (EU aver. 4.812)



Final energy consumption by sector 2024 [%] - *adjusted for climate variations*

Country Specific Information – decarbonization by 2050

- Target: decarbonization of energy by 2050 => budget about € 54 bn
- 2 roadmaps:
 - SNBC, *Stratégie Nationale Bas-Carbone*, The climate roadmap to net-zero across all sectors
 - SNBC 3 draft released for consultation, end of 2025
 - Sector targets: transport, buildings, industry, agriculture, energy
 - PPE, *Programmation Pluriannuelle de l'Énergie*, The energy-supply counterpart to the SNBC
 - PPE 3 published in Feb. 2026
 - Drives low-carbon energy production

Country Specific Information - decarbonization by 2050

■ Demand Side:



Transport

France's largest emitting / most fossil-dependent end use (~90% fossil). Lever: mass electrification of road transport — EVs near 20% of new-car sales in 2025.



Buildings

Heating dominates: fossil fuels still ~43% of residential and ~68% of tertiary heating energy. Lever: renovation + electrified (heat-pump) heating.



Industry

Steepest new effort under SNBC 3: the 2029–2033 emissions cap was cut by ~20%. Lever: electrification of process heat + efficiency.



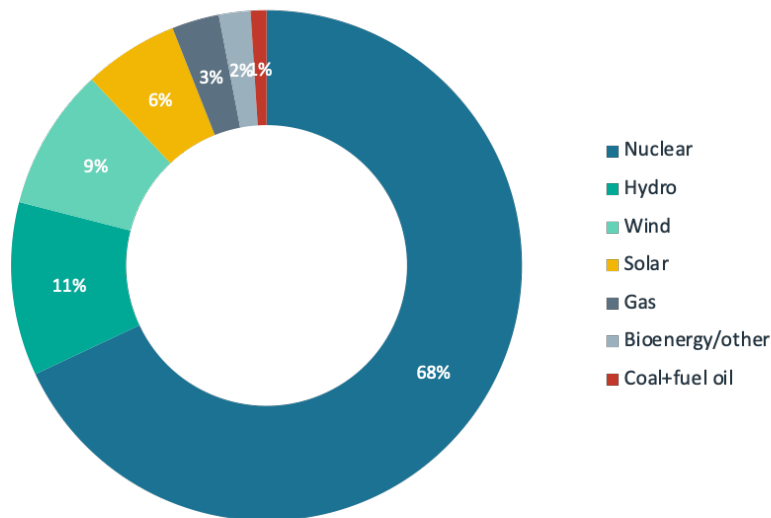
Energy / Power

Already ~95% low-carbon. Role: stay decarbonised and expand clean supply to absorb new electrified demand.

Country Specific Information - decarbonization by 2050

■ Supply Side: Nuclear + Renewables

Electricity generation mix — 2025 (547.5 TWh)



Nuclear relaunch

- Extend existing reactors beyond 50–60 years
- Build 6 new EPR2 reactors, with 8 more (~13 GW) under study
- Flamanville 3 (1.6 GW) connected to the grid in Dec 2024



Renewables scale-up

- Solar reached 30.4 GW in 2025 (+5.9 GW), overtaking hydro 25.7 GW
- Target: ≥91 GW of renewable capacity by 2030
- Offshore + onshore wind capacity continuing to grow

Source: RTE 2025 Electricity Review PPE 3 (2026).

Energy Storage Landscape

(final energy consumption 1570 TWh 2024)



Pumped hydro (STEP)

~5 GW

6 plants; ~4.2 GW turbinning / 4.9 GW pumping. The backbone of French storage.
(about 103.5 GWh)



Grid-scale batteries

~1.3–1.5 GW

Li-ion BESS; from <50 MW in 2019. Mostly short-duration, fast-growing.
(excluding 1,132,210 100% electrical vehicles on 01/01/2025)



Underground gas

~130 TWh

15 underground sites (aquifers, salt caverns, depleted fields), run by Storengy & Téréga
Max capacity 2/3 demand



Hydrogen

Pilot scale

No commercial bulk storage yet; salt-cavern demonstrators (HyPSTER, Etrez).



Thermal

**Residential
water storage**

12 M homes
18 GW
About 111 TWh

Policies & Market

■ A market shaped by a Nuclear Capacity

- **Low volatility, historically:** ~95% low-carbon grid (nuclear + hydro) meant lower flexibility needs than peers — so storage stayed small for years.
- **Solar is rewriting the curve:** 513 hours of negative prices in 2025 (vs 352 in 2024); ~1.6 TWh of solar lost.
- **Storage is the answer**

~1.5 GW

batteries installed (end-2025)

6 GW

expected by 2030

TURPE 7

grid-tariff reform from 2025–26

Policies & Market

- *Four moving pieces define the rules of the game for storage in France*



Capacity mechanism

TSO-paid availability for firm capacity; being redesigned to better value storage's contribution to security of supply.



TURPE 7 grid tariffs

In force since 1 Aug 2025. New optional injection–withdrawal tariff (from Aug 2026) rewards batteries that operate counter-cyclically across ~3,000 grid zones.



PV + storage scheme

CRE proposing a dedicated support scheme co-locating storage with solar; co-location mandated in select 2025–26 CRE auctions.



EU framework

Affordable Energy Action Plan + future-proof network-charge guidelines (Jul 2025); EU permitting package expected to streamline deployment.

& Accelerate EU April 2026

Sources: CRE (TURPE 7, deliberation 4 Mar 2025); Energy-Storage.News (Nov 2025); Paul Hastings (Oct 2025); ESS-News.

Policies & Market

■ *How Batteries Make Money*

The French “revenue stack” is shifting from ancillary services toward wholesale arbitrage as durations grow.

FCR

Frequency Containment Reserve

Fast frequency response; the first revenue source for early French batteries.

aFRR

automatic Frequency Restoration Reserve

Now market-based (energy Nov 2023; capacity auctions Jun 2024). Prices & volumes up sharply; France joined PICASSO (Apr 2025).

Wholesale arbitrage

Day-ahead & intraday spreads

The growth area: buy cheap midday solar, sell the evening ramp. TB2 spread +27% in 2025 vs 2024.

Capacity payments

Capacity mechanism

Availability revenue from the TSO; redesign underway to better reward storage.

“Stacking” these streams — services + arbitrage + capacity — is how projects reach bankability. Source: Modo Energy; Rabobank (2025).

Policies & Market

■ Emerging Trends

Where the French storage market is heading next.



Co-location by default

Hybrid renewables-plus-storage tenders becoming the standard procurement model for new solar & wind.



Behind-the-meter aFRR

Industrial BTM batteries (e.g. Storio Energy) now reaching the aFRR* market, once exclusive to grid-connected systems.



Second-life & grid-forming

EV second-life packs cut BTM costs 15–25%; grid-forming inverters add synthetic inertia & black-start as nuclear share falls toward 50% by 2035.



Longer durations

From minute-scale ancillary tools toward ~2h arbitrage assets — then longer, as wholesale signals strengthen.

Sources: IndexBox (2026); pv magazine (Jan 2026); Modo Energy (2025).

*Automatic frequency restoration reserve

Policies & Market

■ A political wish to structure the electrical storage

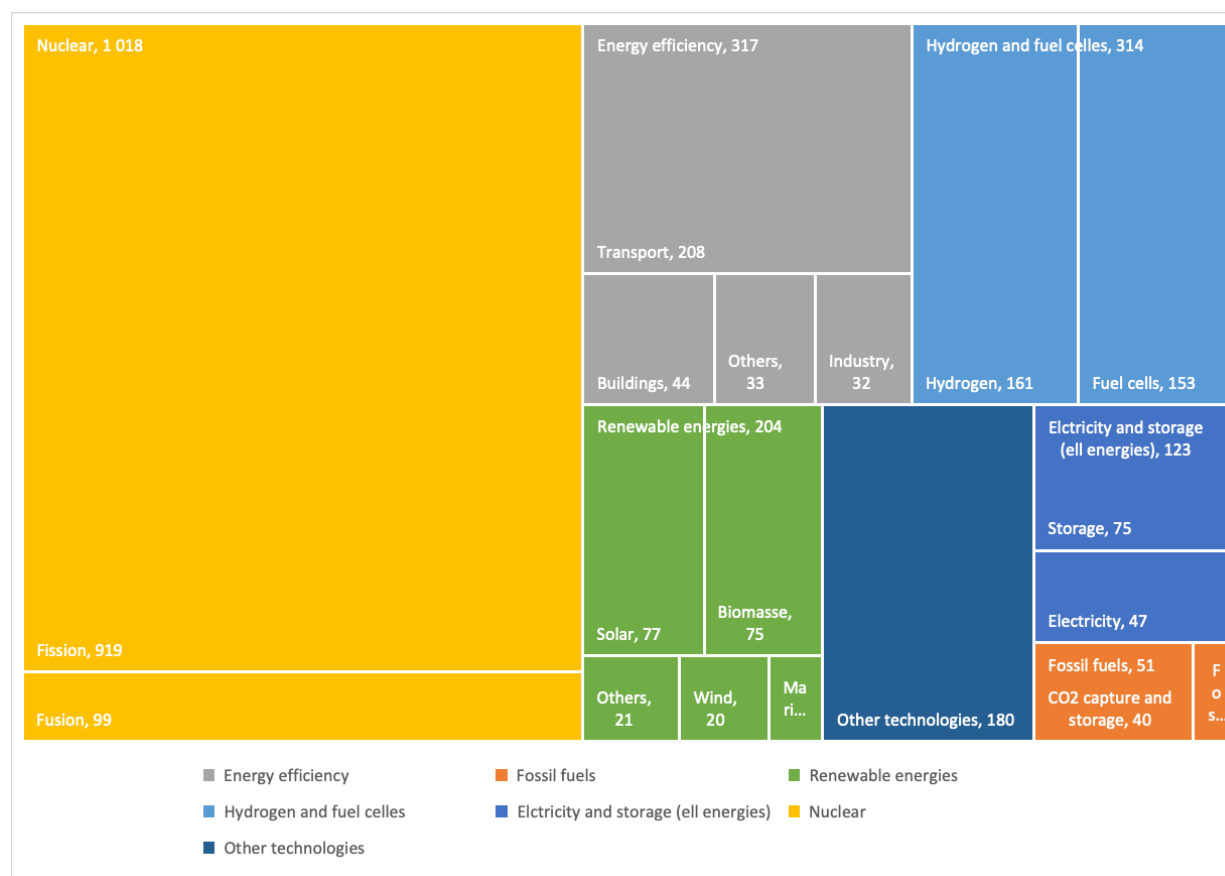
- A specific plan since 2019 “Battery Autonomy and Power”
PIA calls for example which founded demonstrators (EUR 3,3 bn) since 2010
- Development of Gigafactory: total planned 100-120 GWh by 2030
 - Operational 3: Billy-Berclau 13 GWh + Douai 9 GWh + Bourbourg 16 GWh
 - Under construction 2 : including ProLogium (Dunkirk) solid state 4 GWh
 - Planned 1-2

■ The French green hydrogen plan 2020-2030

- Production – Storage - Usage
- IPCEI* €1.6bn + demonstrators €0.6bn *(*important projects of common European interest)*

R&D Information

- French energy R&D expenditure (2024): 2206 M€ = 0,8% of GDP - storage about 3%



■ French National Research Agency (ANR)

- Generic Call for Proposals: Energy transition (Axe H.8: science for energy, Axe H.9: A sustainable, clean, sure and efficient Energy)
- Specific call for proposals
- TRL up to 4

■ Agency for Ecological Transition (ADEME)

- 1 main programme: Sustainable energy: production, management and efficient use
- TRL > 4
- Ecodesign and ecoefficiency for production systems
- Energy vectors from renewable resources: production, management and storage
- Waste and materials: waste collection, sorting, recycling and recovery of valuable materials
- Industry decarbonization

Energy Storage Industrial Landscape

France's storage industry is organised in stacked layers, concentrated in the "Battery Valley" of the Hauts-de-France region.



Energy Storage Industrial Landscape: focus on 8 companies



Company	Technology	Role / positioning
SAFT	Li-ion & Ni batteries	Long-established maker (1918), TotalEnergies subsidiary. Stationary storage (Intensium Max), defence, industry.
TotalEnergies	Batteries (via Saft)	Energy major; owner of Saft (2016) and co-shareholder in ACC. Drives the group's storage strategy.
EnerSys	Industrial batteries	US group with industrial presence in France; lead & Li batteries for backup power, telecoms, motive power.
Batscap	LMP battery & supercapacitor	Bolloré subsidiary; lithium-metal-polymer battery and supercapacitors. The technology base of Blue Solutions.
Bolloré / Blue Solutions	Solid-state battery (LMP)	Industrialises the Batscap technology; solid-state batteries. "Top industrial project in France 2024" per the group.
Alstom	Batteries & hydrogen (rail)	Battery and hydrogen fuel-cell trains (Coradia). On-board storage for decarbonised mobility.
Kemiwatt	Organic redox-flow battery	Rennes-based start-up (2014); non-corrosive organic electrolytes. Long-duration stationary storage.
newHeat	Solar heat & thermal storage	France's solar-heat leader (Bordeaux, 2015). Short- & long-term thermal storage for industry/district heating.

Colour = family: blue = established batteries · cyan = Bolloré/solid-state · mint = flow · grey = thermal · dark = H₂ mobility.

Energy Storage Research Landscape

Organized by national networks



RS2E

Electrochemical

Batteries & supercapacitors. ~20 CNRS-university labs, 3 applied centres, 15 industry partners. Coordinated by Tarascon & Simon. “Hub of Energy”, Amiens. Spun out Tiamat (Na-ion).



FRH2

Hydrogen

~30 labs, 300 researchers + 300 PhDs. Electrolysis, H₂ storage, conversion to power/heat. Directed from IMN Nantes; partners CEA, Mines.



PROMES + solar

Thermal / CSP

CNRS solar lab (Perpignan/UPVD). Odeillo 1 MW solar furnace, Thémis 5 MW tower. Thermocline & high-temp heat storage.

Institutional backbone: CNRS (academic labs) + CEA / CEA-Liten & INES (applied research, prototyping, transfer). Funding via ANR and LabEx STORE-EX / France 2030. Plus IFPEN, EDF R&D and university labs nationwide.

Energy Storage Research Landscape

Seven institutions, mapped to the storage technology each is best known for.



INSA Lyon

Thermal & battery materials

CETHIL energy systems; MATEIS materials (EDF lab).



UPVD Perpignan

Solar / CSP thermal

PROMES; Odeillo furnace & Thémis tower.



Savoie Mont Blanc

Thermochemical heat

LOCIE; sorption seasonal heat storage.



Pau (UPPA)

Storage materials

IPREM; materials & thermodynamic storage.



Institut Néel

Magnetic (SMES)

Superconducting magnetic energy storage.



Grenoble Alpes

Multi-technology hub

LEGI, CEA-Liten, Néel; electro/thermal/mech.



Paris-Saclay

Battery electrochemistry

ICMMO & RS2E labs; solid-state materials.



+ National networks

RS2E · FRH2 · PROMES

Federate all the above under CNRS–CEA.

Top 3 cases/projects

01 Electrochemical



Li-ion battery

Chevire (Nantes)

100 MW / 200 MWh — 2nd largest BESS. Fast grid services (FCR, aFRR), hourly arbitrage.



02 Mechanical / hydraulic



Pumped storage

Grand'Maison (Isère)

1,800 MW / ~14 GWh usable. Daily/weekly load-shifting; the largest pumped-storage plant in France and Europe.



03 Chemical



Hydrogen (salt cavern)

HyPSTER (Etrez, Ain)

Demonstrator: ~3 t H₂ stored (cavern capacity up to 44-50 t). The route to seasonal and long-duration storage.



Cheviré — the large battery storage



Port of Nantes-Saint-Nazaire — commissioned in 2025 on a former thermal-power-plant site

100 MW

installed power

200 MWh

capacity (2-hour duration)

~170,000

homes powered for 2 hours

Key facts

- Developer: Harmony Energy (UK), using Tesla Megapack + Autobidder — acquired by Alpiq in January 2026.
- Site: former Cheviré coal/gas/oil power station (1954–1986), repurposed — a brownfield-to-clean-energy conversion.
- Inaugurated in December 2025, full operation by end-2025.
- Connected to the RTE transmission grid at 63 kV — the optimal configuration for grid-balancing services.
- France's first large-scale 2-hour battery (most earlier BESS had shorter durations).

Role in the system

Fast grid services (FCR, aFRR), hourly arbitrage between midday solar troughs and evening peaks, and participation in the capacity mechanism.

Illustrates the scale-up of batteries in France: ~1.5 GW installed by end-2025, vs <50 MW in 2019.

Sources: Harmony Energy; Alpiq (press release, 22 Jan. 2026); pv magazine (Aug. 2025); ESS-News.

Grand'Maison — the pumped-storage giant



Isère, French Alps — commissioned in 1987, owned by EDF — the most powerful pumped-storage plant in France and Europe

1,800 MW

installed power (12 units)

~14 GWh

usable stored energy

~1,420 GWh

annual generation

Key facts

- 12 pump-turbine units, including 8 reversible Pelton and 4 reversible Francis units — a unique architecture in Europe.
- Hydraulic head: ~920 m between the upper and lower reservoirs — one of the highest in the world.
- Reaches full power in about 3 minutes — a critical response time for grid balancing.
- Part of the French pumped-storage fleet: ~5 GW in total (6 large plants), unchanged for decades.
- No new large pumped-storage project is planned in France; activity now focuses on refurbishment (e.g. Revin, La Coche).

Role in the system

Bulk inter-day and weekly storage: pumping at night and on weekends (cheap nuclear power), turbinning at peak times.

Delivers energy + reserves + grid inertia. Still the backbone of French electricity storage.

Sources: EDF; Encyclopédie de l'énergie; ANDRITZ Hydro; Wikipedia. GWh capacity is approximate (depends on reservoir level).

HyPSTER — underground H₂ demonstrator



Etrez (Ain), near Bourg-en-Bresse — inaugurated in September 2023, led by Storengy (ENGIE)

~3 t H₂

stored during testing

44 t

potential cavern capacity

€15.5 M

budget (€5 M EU support)

Key facts

- First EU large-scale demonstrator of renewable-hydrogen storage in a salt cavern, supported by the Clean Hydrogen Partnership.
- Consortium of 9 European companies coordinated by Storengy; H₂ produced by electrolysis powered by renewables.
- Initial programme: 100 injection/withdrawal cycles to validate technical, economic and environmental feasibility.
- Etrez site: potential for 4 caverns at 1,300 m depth, each holding up to ~6,700 t H₂ — large-scale expansion planned.
- Storengy target: ~1 TWh of underground H₂ storage across France, UK and Germany by 2030.

Role in the system

The route to seasonal and very large-capacity storage: electrolyser → cavern → industrial and mobility end-uses.

Not yet competitive vs gas or short-duration batteries, but essential for a 2050 target with high renewable penetration (~8 TWh estimated need).

Sources: Storengy / ENGIE; HyPSTER consortium; Clean Hydrogen Partnership; Hydrogen Council.



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The Energy Storage TCP Thank you for your attention

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