The clean-tech revolution led by China

And why the latest Chinese tech moves may change everything in the energy sector, forever.

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China as the leading technological nation on Earth in both scale and quality

"A complete railway station, including a new high-speed line, was rebuilt overnight in just 8 hours by 1,500 workers."

"A new generation of hospitals operates without on-site doctors. They work remotely via high-bandwidth telemedicine platforms."

"Everyday transactions are now handled through QR codes or facial recognition; credit cards are considered outdated."

"12 million university graduates per year (more than the entire population of Belgium), **including 3.5 million engineers**."

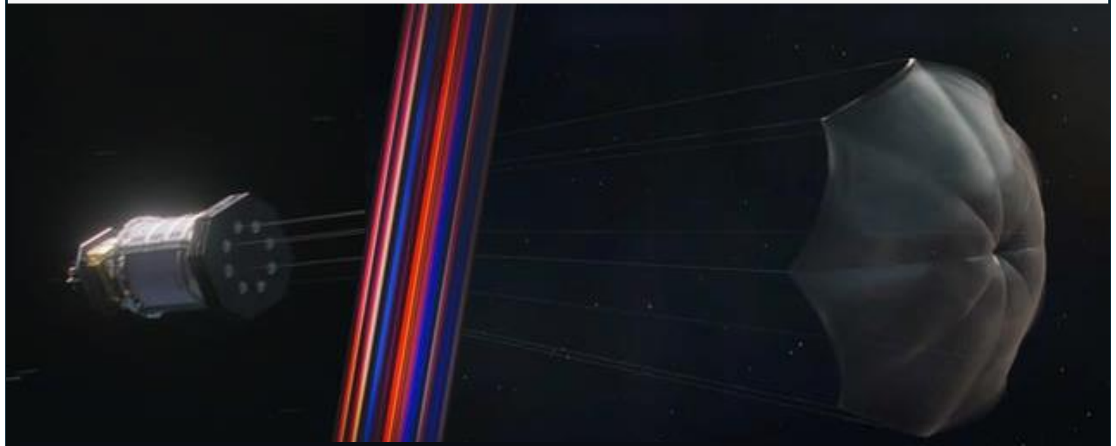
"China trains 50% of the world's AI engineers and develops 70% of all large language models currently deployed."

More information and analysis in: Coppens, P. (2025). *Keynote on China's race for technology supremacy* [Video]. Nexxworks.

From fiction to reality: the 3 Body Problem

Pushing science and technology to their absolute limits is deeply rooted in modern Chinese culture. You even find it reflected in their major works of fiction.

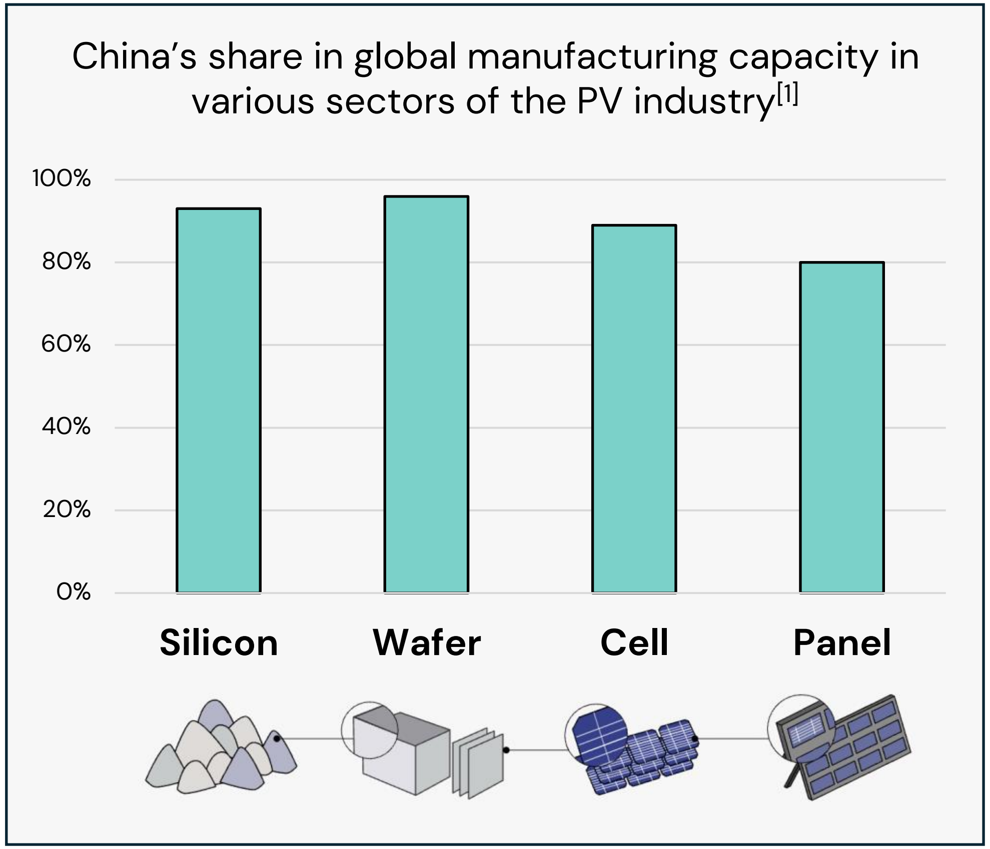
The 3 Body Problem tells the story of how humanity, confronted with an extremely advanced extraterrestrial civilisation, pools its resources, reinvents its research methods, and launches engineering projects of unprecedented scale.



Inventing a nuclear propulsion system to propel a spacecraft out of the solar system.

China is championing all sectors of the PV industry

China dominates every segment of the photovoltaic (PV) supply chain, from polysilicon to wafers, cells, and panels.



[1] Figure adapted from: Zissler, R. (December 2024). *Progress in Diversifying the Global Solar PV Supply Chain.* Renewable Energy Institute.

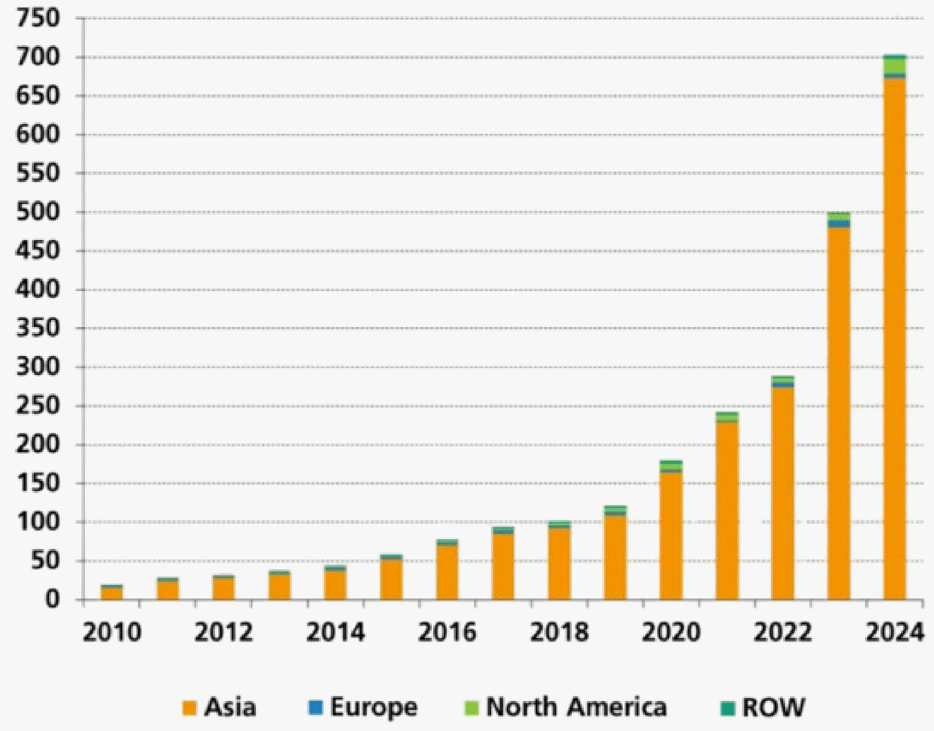
Excellent Chinese PV technology produced in large quantities

In 2024 alone, China produced over **650 GWp** of PV modules.

Global installed PV capacity reached just above 2.2 TW that same year.

This means that in a single year, China manufactured nearly one-third of all PV capacity installed worldwide.

Global annual PV module production (in GWp) by region[1]



[1] Figure from: Fraunhofer Institute for Solar Energy Systems. (31 October 2025). *Photovoltaics Report.*

China collapsing PV prices

China forced PV prices to collapse as a result of three main elements:

(i) **Excellent technology**, driven by the world's largest pool of engineers and scientists;

(ii) **Mass-manufacturing capacity**, unmatched anywhere else;

(iii) **Intense competition** within China's own domestic market.

As a result, global mainstream PV module prices have fallen to **0.10 €/Wp**.

Module class	Global PV module price (€/Wp)[1]		
	October 2025	January 2025	October 2016
High efficiency	**0.12**	0.13 (**-8%**)	0.60 (**-400%**)
Full black	**0.13**	0.13 (0%)	0.54 (**-315%**)
Mainstream	**0.10**	0.11 (**-5%**)	0.46 (**-360%**)
Low cost	**0.05**	0.06 (**-15%**)	0.34 (**-580%**)

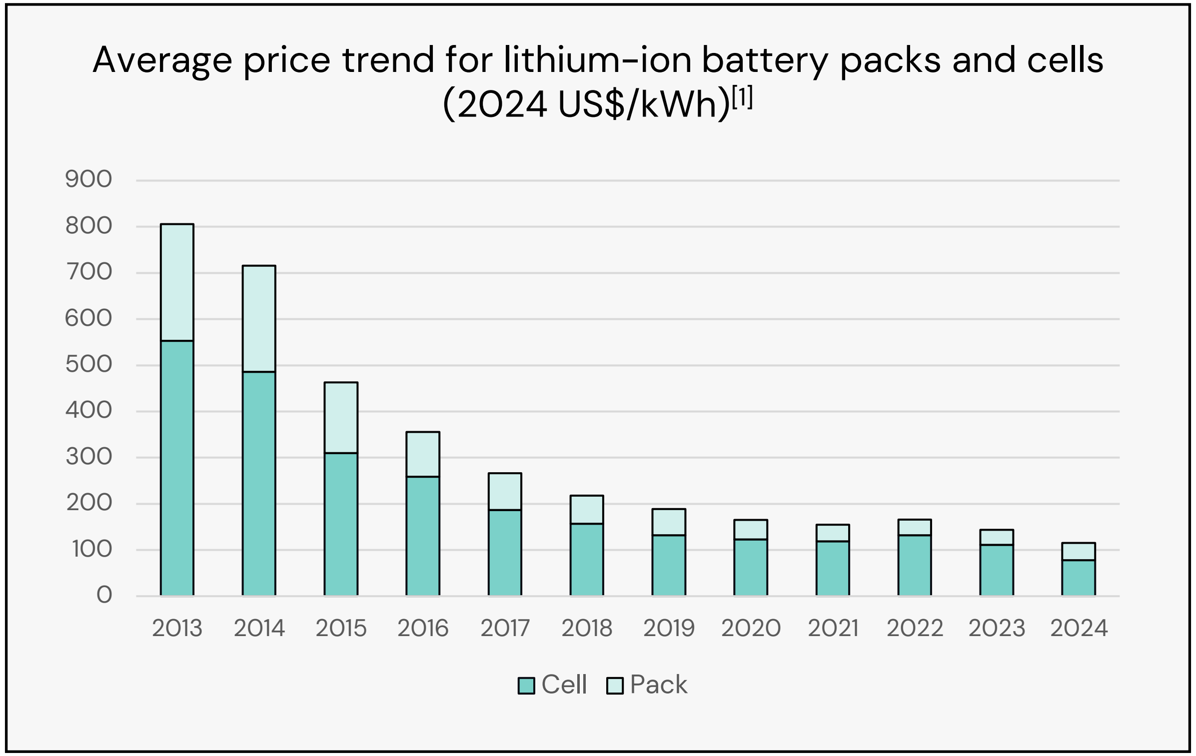
[1] Data from: PV Magazine International. (n.d.). *Module Price Index.*

China is also the world leader in battery manufacturing

Among the many battery manufacturers in China, several firms stand out: CATL, BYD, CALB, Gotion, EVE Energy, and more. These are large-scale cell and pack producers supplying both electric-vehicle (EV) makers and grid storage.

In 2024, the average worldwide battery-pack price was estimated at 115 US$/kWh.

By late 2024, Chinese battery manufacturers achieved a historic low, with pack prices falling to **94 US$/kWh**.



[1] Figure adapted from: BloombergNEF. (2024, 10 December 2024). *Lithium-Ion Battery Pack Prices See Largest Drop Since 2017, Falling to $ 115 per Kilowatt-Hour.*

Example of an impressive champion in the battery sector: CATL

From January to October 2025, global EV battery installations reached 933.5 GWh. CATL ranked first with 355.2 GWh, representing **38 %** of the world market.

CATL is also a global leader in battery recycling. The company has developed a “mine-to-battery-to-recycling” model, with lithium recovery rates exceeding 90 %.

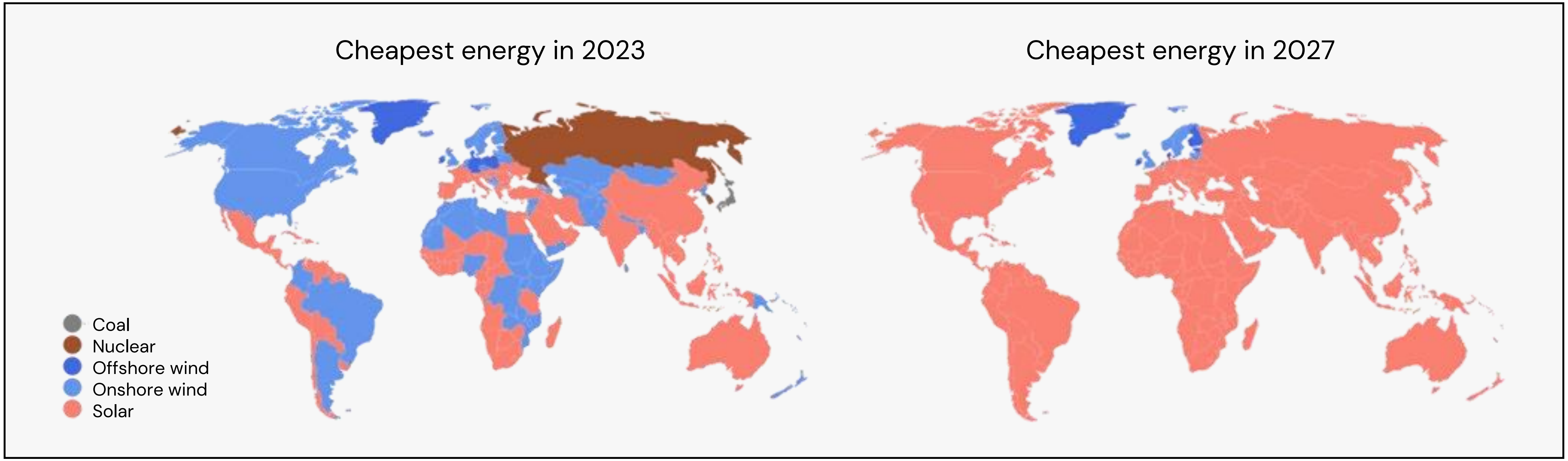
CATL unit Brunp achieves over 96% recovery rate for recycled battery materials

Phate Zhang • Oct 22, 2025, 9:16 AM GMT+2 0 5

- Brunp achieves recovery rates of 99.6 percent for nickel, cobalt, and manganese, and 96.5 percent for lithium from recycled power batteries.
- In 2024, Brunp processed over 120,000 tons of waste batteries, equivalent to reusing batteries from up to 300,000 EVs.

A first consequence of clean-tech advances: PV modules will soon dominate global electricity production

A recent study published in Nature Communications[1] reinforces that solar PV is expected to become the cheapest source of electricity in most parts of the world, even when both short-term lithium-ion storage and long-term hydrogen storage are included in the system costs.



[1] Reference to the study: Nijsse, F.J.M.M., Mercure, JF., Ameli, N. et al. (2023). *The Momentum of the Solar Energy Transition*. Nature Communications,14, 6542.

A second consequence of clean-tech advances: Surface mobility will be fully electric

Thanks to batteries that are becoming extremely cheap, electric vehicles are rapidly becoming affordable, especially in China. An example is the EV maker BYD, which launched the 500-km-range Qin Plus EV in early 2024 in China at a price of **US $15,000**.

BYD's industrial model that explains this performance:

(i) BYD manufactures nearly 75% of a vehicle's components in house;

(ii) The BYD Xi'an factory operates at around 97% automation;

(iii) A new EV rolls off the production line every 51 seconds.

The last barrier before the fall of fossil fuels

With electricity becoming very cheap and batteries enabling full electrification of surface mobility, only a few sectors cannot be electrified and therefore still require molecules. These molecules are currently produced from fossil-fuel resources.

Heavy industry

Methane,
for iron ore reduction

Agriculture

Ammonia,
for nitrogen fertilizers

Chemical industry

Methanol,
for plastics

Air transport

Saturated hydrocarbon,
for kerosene

We believe that Chinese clean-tech is now approaching the point where these molecules can be synthesised directly from electricity at costs competitive with today's fossil fuel-based production.

How will it happen?

Step 1	Producing cheap electricity in sunny regions with PV modules

As mentioned earlier, PV combined with batteries is the cheapest way to produce electricity in sunny regions. But how cheap is it really? Let us consider a 1 MWp PV solar plant located in a very-high-irradiation region and equipped with batteries

We adopt the following assumptions:

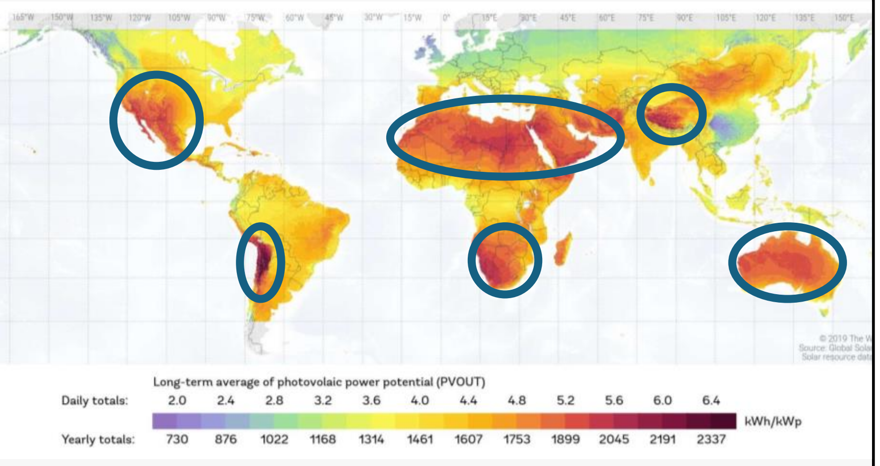
(i) The capacity factor is 25%;

(ii) The production profile of each day is constant throughout the year;

(iii) The battery system should store half of the daily power output to ensure constant supply of electricity;

(iv) The costs of PV and batteries are estimated at 0.10 €/Wp and 100 €/kWh, respectively.

High photovoltaic power potential regions



Since a 1 MWp PV solar plant produces:
1 × 0.25 × 24 = 6 MWh/day, we size the battery system at 3 MWh.

The total investment cost (CAPEX) for the solar plant and the battery system is therefore:
(0.10 × 1,000,000) + (3 × 1,000 × 100) = 400,000 €.

Assuming there are no battery losses, the total electricity generated over 20 years is:
1 × 8,760 × 20 × 0.25 = 43,800 MWh.

This yields an average CAPEX cost of:
400,000 / 43,800 ≈ **9 €/MWh**.

A CAPEX cost of 9 €/MWh for electricity produced by a PV+battery installation in sunny regions is extremely competitive when compared with current energy-market prices.

Energy	Price	Source	Date
Natural gas (Dutch TTF Futures)	**≈ 27 €/MWh**	ICE Endex	08/12/2025
Electricity (CAL-26)	**≈ 76 €/MWh**	elexys.be	08/12/2025
Crude oil (US Brent)	**≈ 33 €/MWh**[1]	oilprice.com	08/12/2025

[1] With a barrel of oil priced at 62 US$, an energy content of 1.62 MWh per barrel, and an exchange rate of 1 € = 1.16 US$, the cost per MWh is computed as follows: (62/1.16)/1.62 ≈ 33 €/MWh.

Step 2	Transforming this cheap electricity into energy-rich molecules

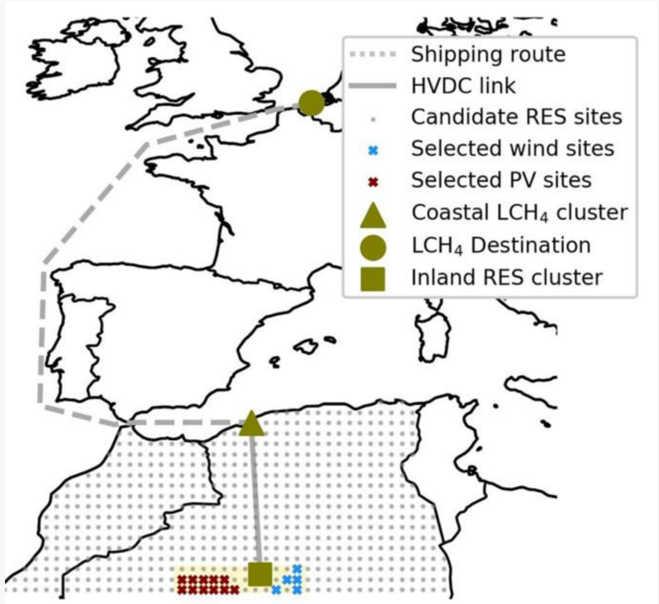
Abundant and high-quality renewable resources in regions located far away from load centers can be harvested at very low cost. This low-carbon energy can then be converted into energy-rich molecules and transported over long distances to supply large load centers.

An example of step 2:

(i) Solar and wind energy is harvested in the Algerian desert;

(ii) It is transported to the coast via an HVDC link;

(iii) It is converted into e-methane and then shipped to Belgium for consumption.[1]



[1] Energy could also be transported using battery ships. More information in this paper: Dachet, V., Maio, A., Counotte, P., & Ernst, D. (2025). *Remote Renewable Energy Hubs in the High Seas: A battery-based fully-electric ecosystem.* ORBi-University of Liège.

Step 3	Using these energy-rich molecules in load centers as a substitute of fossil molecules

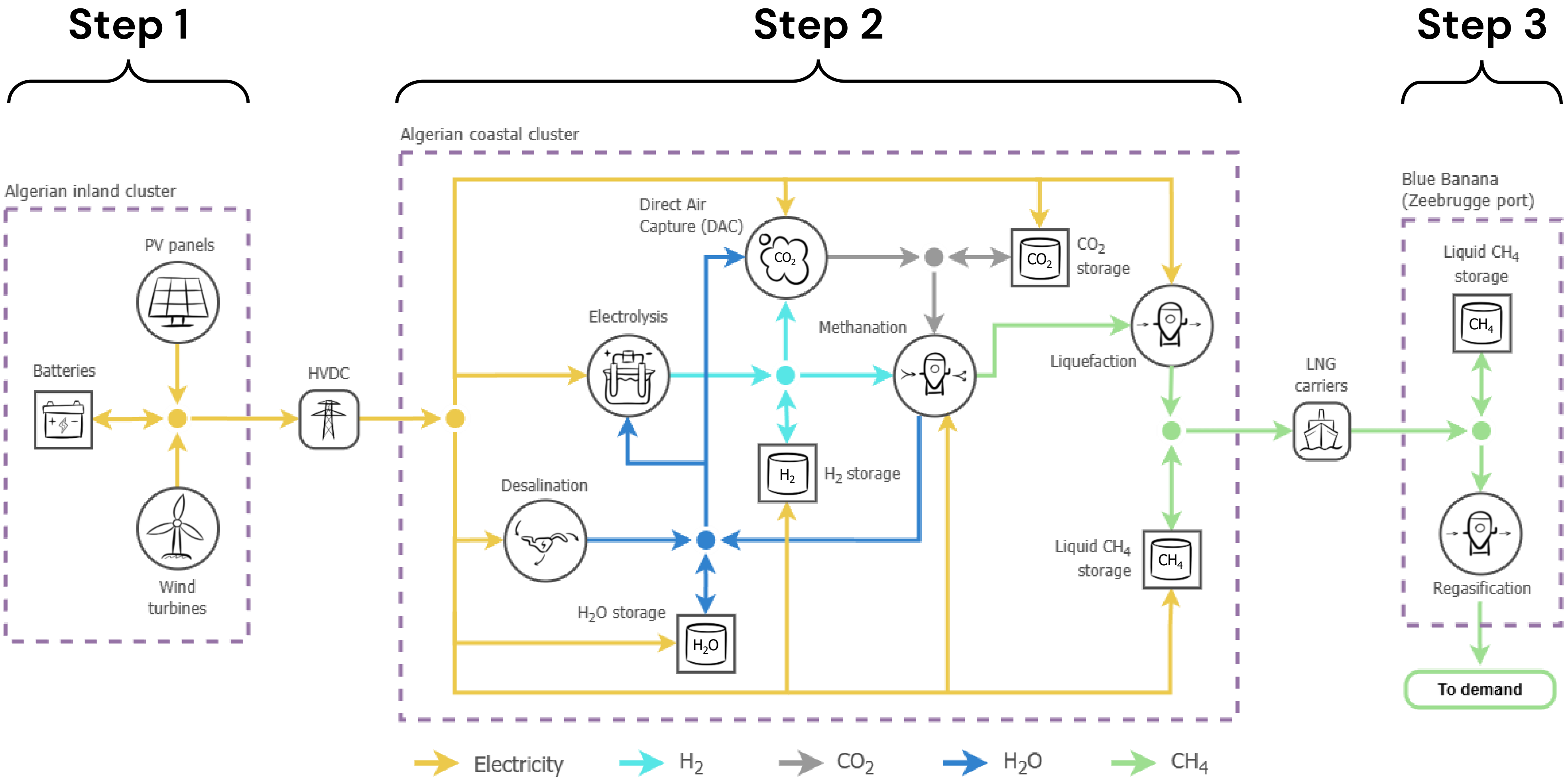
Physico-chemical properties of e-molecules are identical to those of their conventional fossil-based counterparts; only the production process differs.

E-molecules therefore serve a dual role:

(i) **Low-carbon fuels**: They act as drop-in substitutes for conventional hydrocarbons;

(ii) **Energy carriers**: They enable the storage and long-distance transport of low-carbon energy.

The three-step process which forms the basis of the Remote Renewable Energy Hub (RREH) concept



[1] The term Remote Renewable Energy Hub (RREH) is defined in: Dachet, V., Dubois, A., Miftari, B., Fonteneau, R., & Ernst, D. (19 December 2024). *Remote Renewable Energy Hubs: a Taxonomy.* Energy Reports, 13, 3112–2120.

China is already leading the race for RREHs

The Chinese have already understood the strategic value of harvesting cheap renewable energy in remote regions. They transmit power generated in the western regions of China back to the major load centers on the eastern coast through long-distance transmission lines (Step 1).

One of their latest tech moves consists of investing investing heavily in all the technologies needed to synthesise energy-rich molecules at very low cost (Step 2).

Electricity generated at the Xinjiang PV farm (3.5 GW, 2024) and the Gansu wind farm (10.45 GW, 2025) is transmitted over more than 3,000 km.

Final words

The clean-tech industry has already won the economical battle for the production of electricity and for electrifying several loads traditionally powered by fossil fuels (surface mobility, heating through heat pumps, etc.).

It is now on its way to fully collapsing the fossil fuel industry thanks to the concept of remote renewable energy hubs for synthesising energy-rich molecules.

Laboratory references on RREHs (1/2)

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