

The Seam and the Mesh

What the Vacuum Net Offers the Battery

J. Konstapel, Leiden

Version 1 — 16 October 2026

© 2026 J. Konstapel, Constable Research, Leiden. All rights reserved. Quotation with attribution is permitted; reproduction of the whole requires written permission.

Abstract

Europe wants its own batteries. Its gigafactories run on Chinese machines and lose 15 to 30 percent of their cells to scrap. This essay reads the battery through the vacuum net. In the net, energy is a winding, not a stock. A battery is therefore a hold state on a ladder of hold times, not a container.

Every current line of cell research meets the same limit. That limit is the seam between two differently closed structures. The net's window rule describes such a seam as an open window under tension.

From this follow six directions:

- asking less of the cell;
- designing the seam;
- making without a heat step;
- replacing the operator's hand with a loop;
- holding in three states;
- replacing stock with passage.

Each direction is set beside the research already under way. The arithmetic is given in full. A status ledger separates what is measured, derived, read and hypothetical.

1. The occasion

On 16 October 2026 *Het Financieele Dagblad* described Europe's attempt to make batteries without China. The article followed three threads.

The first is LeydenJar, a Dutch company. It grows a pure silicon anode by plasma deposition and is building a cell factory in Eindhoven for drones and defence.

The second is the European gigafactories: ACC, Verkor, PowerCo and Northvolt. All bought most of their machines in China. All struggled to run them.

The third is a plan of the Battery Competence Cluster Netherlands. It wants to assemble a production line from Dutch machines that already exist: coaters, foil laminators, packaging lines.

Behind the article stands one fact. On 9 October 2025 China placed several items under export licence (Decision No. 58):

- cells of 300 Wh/kg and above;
- dense LFP cathode material;
- artificial graphite;
- the machines for winding, stacking, filling, hot pressing and formation.

The licence was suspended until 10 November 2026. On 28 September 2026 a wider US-China arrangement was extended to 10 January 2027. Whether Decision No. 58 falls under that extension has not been stated.

The article asks how Europe can copy the battery. This essay asks a different question. What does a battery look like in the vacuum net, and what follows for how it is made and used?

2. The net in a few rules

Picture a fishnet. Strands run through it and cross. Where windings hold each other, there is a knot. Between strands there are meshes: openings with a size and a direction.

The vacuum net theory reads the vacuum as such a net under tension. Five axioms carry it:

1. **Strand.** There is one strand. Every distinction is the strand touching itself.
2. **Closure.** A configuration persists only if it closes on itself in phase. Tension that does not close moves on to neighbouring meshes.
3. **Memory.** The net keeps the orientation of what was laid down first.
4. **Context.** Constants are state functions of the local vacuum.
5. **Scale.** The same winding appears at every depth.

Three objects follow from these rules:

- A **winding** is a strand that returns on itself in phase. It is energy, with dimension T/S .
- A **knot** is windings holding each other in three directions. It is mass, with dimension T^3/S^3 .
- A **mesh** is an opening between strands. It has no matter, but it has a size S .

Power. Power is energy per unit of time: $(T/S)/T = 1/S$. Power through a mesh therefore scales with one over its open size. Nothing in this rule refers to a reservoir.

Trits. Each crossing carries one of three values: $+1$, 0 or -1 . Three neighbouring crossings form a window.

The window rule. A window closes when the sum of its three values is divisible by three. Of the 27 possible windows, 9 close:

- three are homogeneous: $(-1, -1, -1)$, $(0, 0, 0)$ and $(+1, +1, +1)$. They are static and crystal-like.
- six are heterogeneous: the orderings of -1 , 0 and $+1$. They rotate and carry life-like motion.

The other 18 windows are open. An open window stands under tension. The boundary between a homogeneous and a heterogeneous closure is always an open window. What closes, stays.

3. What a battery is in the net

In everyday speech a battery “contains” energy. In the net it does not. Energy is a closed motion, not a substance in a jar. A battery is a state that is held for a time.

That reading gives a battery four phases:

1. load;
2. hold;
3. discharge;
4. rest.

The public grid knows only two of them, fused into one. What is generated is used at the same instant. The grid’s hold time τ is zero.

Hold times form a ladder. Each rung has its own carrier:

Hold time	Carrier	State of the art, 2026
seconds	flywheel, supercapacitor	30 MW flywheel on the grid; supercapacitors with a million cycles
hours	lithium-ion, sodium-ion	commercial
days	iron-air, sand, heat	first grid systems (Form Energy, Ore Energy, Polar Night)
months	molecules (hydrogen)	salt-cavern pilots

No rung replaces another. A cell asked to cover days is a cell asked to do the work of another rung. That is why it grows heavy, dear and dependent on scarce material.

A 200 MW battery in Winschoten holds 4 hours, that is $200 \text{ MW} \times 4 \text{ h} = 800 \text{ MWh}$. It is one hold on one rung. It does not make the ladder.

4. The seam

4.1 One wall for every line

The current lines of cell research differ in chemistry. They share one limit. Every gain in energy density comes from an electrode that changes shape. The boundary layer has to follow that change without breaking.

Line	What happens at the boundary
silicon anode	volume grows by more than 300%; the solid-electrolyte interphase cracks and re-forms every cycle
lithium metal, anode-free	lithium plates unevenly and grows along cracks and grain boundaries
solid state	solid-solid contact is lost; lithium filaments grow along grain boundaries
lithium-sulfur	intermediate products dissolve and leave the cathode
magnesium, calcium	the boundary layer seals and no longer passes the ion
quantum battery	the coupling that charges also discharges

4.2 The seam in the net

Each boundary in the table joins two structures that close in different ways: a crystal and a liquid, a metal and a ceramic, a lattice and a film. By the window rule such a boundary is an open window. It stands under tension. It does not stay unless something keeps closing it.

This is a correspondence, not a mechanism. The window rule does not say why a seam breaks. It says which configurations persist and which do not.

The correspondence turns into three design questions for every cell:

1. Where is the seam?
2. Can it be laid so that fewer windows stay open?

3. Can the motion take place in a mesh, an open space, rather than in the seam?

4.3 Answers that already exist

Several results in the literature fit these questions.

Room instead of grip. LeydenJar grows silicon as columns on copper foil. The gaps between the columns absorb the swelling. E-magy does the same with pores. LionVolt builds a three-dimensional structure. In the image of the fishnet: the motion goes into the mesh, not into the knot.

One direction. Zheng, Archer and colleagues grew zinc epitaxially on a thin layer of graphene (*Science*, 2019). The deposition became reversible. Under grid-scale surges the number of stable cycles rose from about 200 to more than 2,000. The underlayer sets the direction and the deposit follows it.

The net has the same rule for rings. In “One Direction or None” a wall or seed with the right direction yields only the fitting ring. A flask without direction yields a mixture.

Homogeneous closure. Cathode particles grown as single crystals of NMC532 outlast polycrystalline ones by a wide margin. A Dalhousie-Tesla group projected lifetimes approaching a century at 25 °C (*Journal of the Electrochemical Society*, 2022). A single crystal has no grain boundaries, so it has no internal seams. It corresponds to the homogeneous, crystal-like closure of the window rule.

No seam that must hold. In a nickel-hydrogen cell one side is a gas meeting a catalyst. There is nothing to crack. EnerVenue rates such cells for 30,000 cycles.

4.4 What the rule does not yet give

The window rule counts open windows. It does not yet convert a count into a number of cycles. The register of tension that would carry magnitudes beside the trit cube is still open.

The rule does make one ordering prediction. Take a series of boundary layers, count their open windows by the rule, and measure their life. The order of life should follow the order of the count. That measurement has not been made.

5. Making without fire

5.1 How much heat a cell carries

A conventional electrode is a slurry of powder, binder and solvent. It is coated on foil and dried in ovens tens of metres long. Then it is pressed, cut, stacked, filled with electrolyte and charged for the first time. That first charge is called formation.

The energy cost of these steps can be followed from one published figure. Schütte, Degen and Walter (*Batteries*, 2024) give 11.02 kWh of drying energy per kWh of cell capacity. In their study drying is 27 percent of all factory energy.

- Total factory energy per kWh of cell: $11.02 / 0.27 = 40.8$ kWh.
- Other studies put drying at 47 to 48 percent. Then the total is $11.02 / 0.47 = 23.4$ kWh.
- The range is therefore about 23 to 41 kWh per kWh of cell.

Scrap raises this. If 70 percent of cells pass, each good kWh carries $40.8 / 0.70 = 58.3$ kWh of factory energy.

A cell of 1 kWh must therefore be fully discharged 23 to 58 times before it has returned the energy of its own factory. Raw materials are not yet counted.

Formation adds time. It takes three to seven days, followed by up to two weeks of ageing. It can occupy a quarter of the floor and up to 30 percent of manufacturing cost. Artificial graphite, the usual anode, is baked for weeks at up to 3,000 °C.

5.2 Processes without the oven

Several process families avoid the heat step or shorten it:

Process	What it removes	State, October 2026
dry electrode (Tesla, LEAD, Dürr)	solvent and drying oven	in production in China and the US; pilot in Europe
plasma deposition (LeydenJar)	slurry, binder, oven	factory planned for 2027
spatial atomic layer deposition (TNO Holst Centre)	layer-by-layer at low temperature, about 1 nm per second	pilot equipment
electrodeposition of cathode material (Xerion)	calcination	pilot
carbon network from refinery residue (CarbonX)	graphitisation at 3,000 °C	scale-up

5.3 Soften, write, harden

The net describes making as a three-step cycle:

1. **Soften.** Bring the local state close to its tipping point.
2. **Write.** Impose a mesh: a shape, a size, a layering, an asymmetry.
3. **Harden.** Return the state, so that only closing windings remain.

Hardening selects among configurations that can close. It does not place an object. The cycle sets the state so that the target is the only thing that stays.

Formation fits the third step. During the first charge the boundary layer forms. What closes stays; the rest is consumed. Fast-formation protocols at Oak Ridge cut the step at least sixfold. In the language of the cycle, that is a shorter hardening.

6. The loop instead of the hand

6.1 The machine carries the knowledge

The FD article names the real difficulty. A machine does not run by itself. The knowledge sits in the people who tune it.

Northvolt. It bought about 1,200 machines from Wuxi Lead. It needed hundreds of Chinese technicians to run them. Some worked up to 70 hours a week, for which their employer was fined in Sweden. After four years Northvolt reached about 70 percent yield. A Chinese executive said his factories reach 96 percent within four months.

ACC. Scrap is the plant's main problem. In September 2026 Stellantis halted two French car plants for lack of ACC cells. ACC brought in a team of experts from China.

The cost. Fraunhofer FFB gives 15 to 30 percent scrap in the first years and about 10 percent after five. Each percentage point costs about €30,000 per day. That is $30,000 \times 365 =$ €10.95 million per year. At 20 percent scrap the loss is $20 \times 10.95 =$ €219 million per year.

6.2 A loop that finds its fixed point

Applied Vacuum Theory, Part Three describes a self-tuning mesh. A loop moves one setting until the output is at its maximum, then holds it there. It corrects drift. It reads no place, no time, no operator and no material. The loop replaces the hand of the maker. This loop is designed, not yet built.

Carried over to a production line, the weight shifts from the machine to measurement and control. Where the state of each layer is measured inline and the setting follows, the knowledge sits in the loop. It no longer sits in the operator.

The leading Chinese plants already work this way. CATL reports defects at parts-per-billion level, with inspection at 1.7 seconds per cell.

The Netherlands is strong in exactly this segment: measuring, positioning and closed-loop control, from the lithography supply chain to metrology firms. That is a different strength from the paint robot in the newspaper's headline.

7. Holding in three states

A ferroelectric wall such as barium titanate has three polarisation states: P^+ , P^0 and P^- . “A Wall with Three States” reads them as a trit. The sign of the perovskite tolerance factor minus one gives the same three values:

- +1: the centre gives up closure (ferroelectric);
- 0: rest (cubic);
- -1: rotation absorbs the misfit.

Two lines of research hold energy in such a wall, without an ion that has to move house.

Dielectric storage. Relaxor ferroelectric films store 182 J/cm^3 at 78 percent efficiency in the laboratory (*Nature Materials*, 2022). There is no seam that moves with each cycle.

Quantum batteries. Molecules coupled together to a light field charge faster as their number grows. CSIRO and partners showed the first electrical discharge from such a device in March 2026, at room temperature. Storage lasted about a million times longer than charging. The limit is that the coupling which charges also discharges. The working answer is a dark state: one side that does not radiate back.

The vacuum net uses the same asymmetry for its generator element. It has a closed side and an open side with deliberately different boundary conditions.

Neither line yields energy per kilogram from the net. The correspondence is in the structure, not yet in the numbers.

8. Passage instead of stock

8.1 The question

A battery is needed because generation and use do not coincide in time or place. If a mesh delivered continuously at the place of use, the role of the battery would change completely. It would no longer bridge energy. It would only catch peaks.

8.2 The energy of one mesh

The energy between two parallel walls at distance L is given by the Casimir count. Per unit area it is $\pi^2\hbar c/(720 L^3)$. For one mesh, the area is L^2 . The energy of one mesh is then $\pi^2\hbar c/(720 L)$.

Step by step:

1. $\hbar = 1.0546 \times 10^{-34} \text{ J}\cdot\text{s}$ and $c = 2.9979 \times 10^8 \text{ m/s}$, so $\hbar c = 3.1615 \times 10^{-26} \text{ J}\cdot\text{m}$.
2. $\pi^2 = 9.8696$, so $\pi^2\hbar c = 3.1203 \times 10^{-25} \text{ J}\cdot\text{m}$.
3. Divided by 720: $4.3337 \times 10^{-28} \text{ J}\cdot\text{m}$.
4. The natural mesh size of the net is $S_0 = 45.588 \text{ nm} = 4.5588 \times 10^{-8} \text{ m}$.
5. $E_{\text{mesh}} = 4.3337 \times 10^{-28} / 4.5588 \times 10^{-8} = 9.51 \times 10^{-21} \text{ J}$.

The natural unit of time is $T_0 = 1.5207 \times 10^{-16} \text{ s}$. One passage per T_0 gives $9.51 \times 10^{-21} / 1.5207 \times 10^{-16} = 6.25 \times 10^{-5} \text{ W}$ per mesh. This is the full rate. What leaves the mesh as current is a fraction of it.

8.3 The measured device

Garret Moddel's group at the University of Colorado placed an optical cavity on one side of a metal-insulator-metal junction. They measured a current at zero applied voltage (*Symmetry*, 2021). Eight tests for artefacts came back negative. The current rose as the cavity grew thinner.

The patent (US 12,166,434) gives a maximum power of 1.4 pW. The active junction area measured by electron microscope is $0.02 \pm 0.006 \mu\text{m}^2$.

- Power per area: $1.4 \times 10^{-12} \text{ W} / 0.02 \times 10^{-12} \text{ m}^2 = 70 \text{ W/m}^2$.
- With the area margin: 54 to 100 W/m².

Compare that with the net. One mesh of 45.588 nm covers $(4.5588 \times 10^{-8})^2 = 2.078 \times 10^{-15} \text{ m}^2$.

- The junction holds $0.02 \times 10^{-12} / 2.078 \times 10^{-15} = 9.6$ meshes.
- Each delivers $1.4 \times 10^{-12} / 9.6 = 1.45 \times 10^{-13} \text{ W}$.
- Against the full rate: $1.45 \times 10^{-13} / 6.25 \times 10^{-5} = 2.3 \times 10^{-9}$.

This fraction η is the coupling of the open side: the share of what the mesh closes that leaves as current.

A second device. Casimir Inc. in Houston specifies a chip of $5 \times 5 \text{ mm}$ giving 1.5 V at 25 μA . That is 37.5 μW on 25 mm^2 , or 1.5 W/m^2 . This is a specification, not a published measurement. Per area it is $70 / 1.5 = 47$ times below Model's junction.

8.4 What it would mean

The following holds only if two things are true: 70 W/m² is reproduced, and layers add.

- **A house.** A dwelling needing 1,450 W continuously needs $1,450 / 70 = 20.7 \text{ m}^2$ of one layer. With 100 layers that becomes $1,450 / 7,000 = 0.21 \text{ m}^2$, a plate of about $45 \times 45 \text{ cm}$.
- **Compared with a battery.** Such a plate gives $1.45 \text{ kW} \times 24 \text{ h} = 34.8 \text{ kWh}$ per day. A battery of 250 Wh/kg holding one such day weighs $34,800 / 250 = 139 \text{ kg}$.
- **A drone.** A drone needing 1 kW needs $1,000 / 70 = 14.3 \text{ m}^2$ of one layer, or 0.14 m^2 with 100 layers.
- **Weight of one layer.** One element is 232 nm thick. At densities between 2.7 and 12 g/cm³ it weighs 0.6 to 2.8 g/m². That is 25 to 112 kW per kilogram of film. On a 25 μm polyimide carrier (35.5 g/m²) it is about 1.9 kW/kg.

8.5 What must hold

Five points decide whether this arithmetic counts.

1. **Reproduction.** No second group has yet reproduced Model's measurement.
2. **The slope.** The net derives that power scales as $1/L$. Model's Figure 4b shows current, with a slope of -0.9 . Power goes with current squared, so its slope is about -1.8 . Current matches the derived exponent; power does not yet.
3. **Stacking.** That N layers give N times the power of one has never been measured. It carries a factor of 100 in the figures above.
4. **The mechanism.** Maclay (*Physics*, 2024) argues that the mechanism Model proposed predicts a current in the opposite direction. He does not dispute the measurement.
5. **The open side.** The coupling η is the experimentally unknown parameter of the whole design.

The order of the decisive measurements follows from these points:

- the output against cavity size, on fixed stacks from 10 to 1,000 nm;
 - then a stack of two layers against one.
-

9. The list and the route

The machines China placed under licence belong to one process order: mix, coat, dry, press, wind or stack, fill, form.

Four process families do not appear on that list:

- plasma deposition;
- spatial atomic layer deposition;
- thin-film cells;
- electrodeposition.

Formation does appear on the list.

The Dutch plan in the newspaper follows the existing order with existing machines. It builds a line from coaters, foil laminators and packaging. That order contains the steps under licence.

A second route is possible. It chooses processes that do not need those steps (section 5). It puts Dutch strength in measurement and control into the loop (section 6). It is less mature. It touches the Chinese list less. The Netherlands already has its pieces: LeydenJar's plasma line, E-magy's porous silicon, TNO Holst Centre's spatial ALD, LionVolt's three-dimensional cell and the pilot plant OBIC in Helmond.

10. What changes for people

A battery is made and used by people.

In Eindhoven laboratory staff in white coats assemble LeydenJar's test cells by hand, all day long. About 95 percent pass. Their skill is what the new machines must carry.

In Skellefteå a town of about 75,000 built its future on Northvolt. In one round of cuts alone, Northvolt let 1,600 people go in Sweden, 1,000 of them there. Next to them worked technicians from Wuxi who lived in their own camp and tended the machines.

In Debreceen residents raised concerns about CATL's plant. Early in 2026 the authorities closed parts of it after nine employees were exposed to nickel.

In Ukraine the drones that soldiers carry still run mostly on Chinese cells. A licence decision in Beijing reaches their front line.

Each of the six directions moves the work. Asking less of the cell moves storage from a remote gigafactory to the street, the house and the district. Making without fire makes plants cleaner and smaller, so they fit in cities rather than on the edge of the

country. The loop instead of the hand changes what a factory worker does: from tuning by feel to reading a state that holds itself.

Passage instead of stock, if it holds, changes the most. A household would no longer depend on a cable, a substation or a battery park for its base load. The battery would become a small buffer in the meter cupboard.

11. Status ledger

Statement	Status
Energy is a winding; power = $1/S$	derived within the theory
A battery is a hold state; four phases; τ -ladder	derived construct of the theory
The window rule: 9 of 27 windows close	counted (exact)
A boundary layer in a cell is an open window	reading
Room instead of grip, one direction, homogeneous closure, no seam	correspondences with measured results (sources in references)
Order of life follows the count of open windows	hypothesis, unmeasured
Factory energy 23–41 kWh per kWh of cell; formation 3–7 days	measured (sources); recomputed here
Formation as hardening	reading
Self-tuning loop	designed, not built
Scrap cost €10.95 million per point per year	measured (Fraunhofer FFB); recomputed here
Ferroelectric wall as trit	counted; correspondence a reading
Mesh energy 9.51×10^{-21} J; full rate 6.25×10^{-5} W	derived; recomputed here
Moddel 1.4 pW on $0.02 \mu\text{m}^2 = 70 \text{ W/m}^2$	measured by one group; not reproduced
Open-side coupling $\eta = 2.3 \times 10^{-9}$	computed here from the above
Power slope -1 against measured -1.8	open
N layers give N times the power	hypothesis, never measured
House plate, drone surface, weight per kW	conditional on the two lines above
	from the text of the decision

Statement	Status
Process families outside Decision No. 58	

References

Konstapel, J. (2026). "Wat is er Mis met een Batterij? / The Grid That Cannot Hold." constable.blog, 31 August. <https://constable.blog/2026/08/31/the-grid-that-cannot-hold-what-is-wrong-with-the-electricity-system-the-thinking-errors-behind-it-and-the-simple-net-alternative/> *Why read?* The four-phase cycle, the hold time τ and the ladder of hold times. The basis of section 3.

Konstapel, J. (2026). "The Vacuum.Net Theory: Complete Derivation." constable.blog, 28 September. <https://constable.blog/wp-content/uploads/vdefThe-Vacuum.Net-Theory.pdf> *Why read?* Axioms, definitions, natural units and the mesh energy. Read the status table at the end first.

Konstapel, J. (2026). "Applied Vacuum Theory, Parts Two to Four." constable.blog, 25-27 September. <https://constable.blog/2026/09/25/applied-vacuum-theory/> *Why read?* Part Two gives soften-write-harden. Part Three gives the self-tuning loop. Part Four gives power = $1/S$ and the order of measurements. Reading advice: Part Four, the section on energy without a reservoir.

Konstapel, J. (2026). "One Direction or None." constable.blog, 10 October. <https://constable.blog/2026/10/10/one-direction-or-none-mirror-molecules-the-2026-nobel-prize-in-chemistry-and-the-closure-rule-of-the-vacuum-ne/> *Why read?* The seam rule and the seed with a direction. The basis of section 4.

Konstapel, J. (2026). "A Wall with Three States." constable.blog, 12 October. <https://constable.blog/wp-content/uploads/v2A-Wall-with-Three-States-Perovskites-the-Trit-Cube-and-the-Open-Side-of-the-Mesh.pdf> *Why read?* The ferroelectric wall as trit and the correction of the power slope.

Van Wijnen, J. F. (2026). "Europa maakt batterijen desnoods met een verfrombot om los te komen van China." *Het Financieele Dagblad*, 16 October. <https://specials.fd.nl/europa-maakt-batterijen-desnoods-met-een-verfrombot-om-los-te-komen-van-china> *Why read?* The occasion. LeydenJar, the gigafactories and the Dutch machine plan in one story.

Zheng, J., Zhao, Q., Archer, L. A. et al. (2019). "Reversible epitaxial electrodeposition of metals in battery anodes." *Science* 366, 645. <https://news.cornell.edu/node/315386> *Why read?* The clearest case of an underlayer that sets the direction of growth. Ten times more stable at low rate.

Dalhousie University / Tesla Advanced Battery Research (2022). "Li[Ni_{0.5}Mn_{0.3}Co_{0.2}]O₂ as a Superior Alternative to LiFePO₄ for Long-Lived Low Voltage Li-Ion Cells." *Journal of the Electrochemical Society*. <https://electrek.co/2022/05/24/tesla-battery-research-paper-high-energy-density-battery-last-100-years/> *Why read?* Single-crystal cathodes and their life. A crystal without internal seams.

Schütte, A., Degen, F. & Walter, L. (2024). *Batteries* 10(2), 64. <https://www.mdpi.com/2313-0105/10/2/64> *Why read?* Energy per production step per kWh of cell. The source of the 11.02 kWh in section 5.

Fraunhofer FFB. "The ramp-up of a gigafactory in battery cell production." <https://www.ffb.fraunhofer.de/en/press/news/the-ramp-up-of-a-gigafactory-in-battery-cell-production.html> *Why read?* Scrap rates and their cost per day.

KrASIA. "Northvolt's fall: how hubris and blunders shattered Europe's battery ambitions." <https://amp.kr-asia.com/northvolts-fall-how-hubris-and-blunders-shattered-europes-battery-ambitions> *Why read?* What it means when the knowledge sits in the operators of someone else's machines.

TNO Holst Centre. "Spatial ALD." <https://holstcentre.com/expertise/materials-technologies/spatial-ald> *Why read?* A Dutch process family outside the licensed machine list.

Moddel, G., Weerakkody, A., Doroski, D. & Bartusiak, D. (2021). "Optical-Cavity-Induced Current." *Symmetry* 13, 517. <https://arxiv.org/abs/2101.03085> *Why read?* The measurement behind section 8, with its eight controls. Reading advice: Figure 4b, and note that it shows current.

Moddel, G. US Patent 12,166,434, "Enhanced quantum vacuum energy devices." <https://patents.google.com/patent/US12166434B2/en> *Why read?* The 1.4 pW and the measured active area of 0.02 μm^2 .

Maclay, G. J. (2024). "Modeling Electronic Devices with a Casimir Cavity." *Physics* 6(3), 1124-1131. <https://doaj.org/article/31210466294848b0b30d3380b0056c2c> *Why read?* A critique of the proposed mechanism that leaves the measurement standing.

Hymas, K. et al. (2026). "Superextensive electrical power from a quantum battery." *Light: Science & Applications*. <https://arxiv.org/abs/2501.16541> *Why read?* The first full cycle of a quantum battery, and why the coupling that charges also discharges.

IEA (2026). *Global EV Outlook 2026 — Electric vehicle batteries*. <https://www.iea.org/reports/global-ev-outlook-2026/electric-vehicle-batteries> *Why read?* The primary source for who makes which share of the world's cells.

China Prospect (2026). "China's export controls on rare earths and battery materials." <https://chinaprospect.com/china-export-controls-rare-earths-battery-materials/> *Why read?* Why 10 November 2026 still stands in law, and what Decision No. 58 covers.