

Open Walk Assist

A lightweight, open, repairable hip-assist concept for voluntary walking

Human initiates movement. OWA detects intention and gait phase, provides limited mechanical assistance, and the human remains in control.

RESEARCH CONCEPT — NOT A CERTIFIED PRODUCT · NOT A MEDICAL DEVICE

Maturity: CONCEPT

Risk class: TC-R3 (high)

Evidence: E0-E1

No human testing

Older adults who can still walk often walk less than they want to

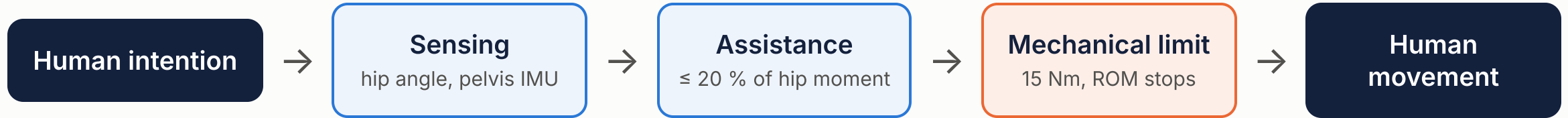
Walking gets tiring and slow, so people walk less, lose fitness, and walking gets harder still. The hip muscles provide much of the positive work in walking, and their capacity declines with age.

OWA asks whether a **small, user-controlled torque at the hips** could make a person's own walking ability more useful, without a heavy robotic exoskeleton.

EXISTING OPTION	GAP FOR THIS GROUP
Stick, rollator	Balance support only, no propulsion
Rehab exoskeletons	10–25 kg, clinic-bound, very expensive
Consumer hiking exos	Light and affordable, but closed, not repairable, no published safety case
Medical hip devices	Evidence in older adults, but closed and limited availability

Gap: no **open, documented, repairable** hip-assist platform with a **published safety case**.

The human stays in command. OWA only adds limited torque.



~~Never: robot command → forced human movement~~

The human is responsible for

Balance, foot placement, direction, starting, stopping, all voluntary movement.

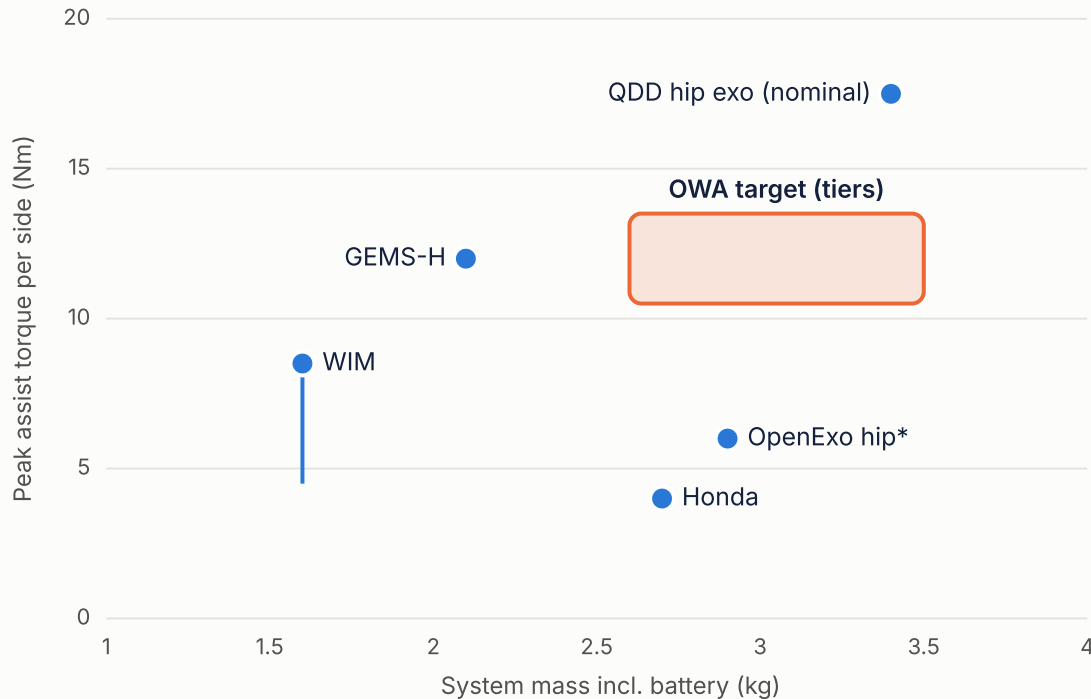
OWA does

Detects walking and gait phase, then adds small sagittal hip torque. Automation may only **reduce** assistance, never increase it.

On any failure

Power loss → free passive motion.
The joint is backdrivable; motor phases open; nothing holds the leg.

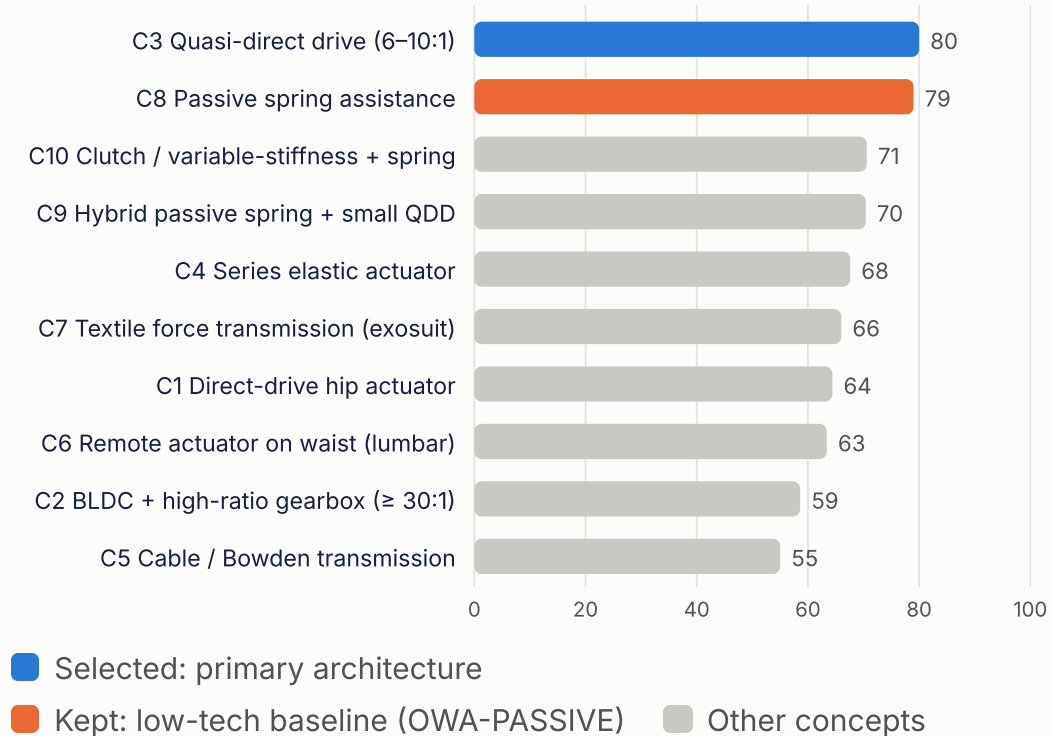
Light hip devices already exist. OWA's gap is openness and safety, not mass.



*OpenExo: 6 Nm benchtop step. WIM bar: 4–8.5 Nm (inconsistent in source). Consumer devices (Dnysys X1, Hypershell) publish motor watts, not torque, so they are not plotted.

- Commercial hip devices sit at **1.6–2.7 kg and 4–12 Nm**.
- **Hip angle alone is enough** in products: GEMS-H and WIM use delayed-output-feedback control. No EMG, no insoles.
- **No product publishes its hazard analysis.** This is OWA's clearest contribution.
- OpenExo, the open-source reference, is a lab platform: $\approx$ 35 min hip runtime and $\approx$ \$2,000–2,500 hardware.
- GEMS-H pilot ($n = 12$, > 65 y, uncontrolled): faster walking, no device-related adverse events. Encouraging, not conclusive.

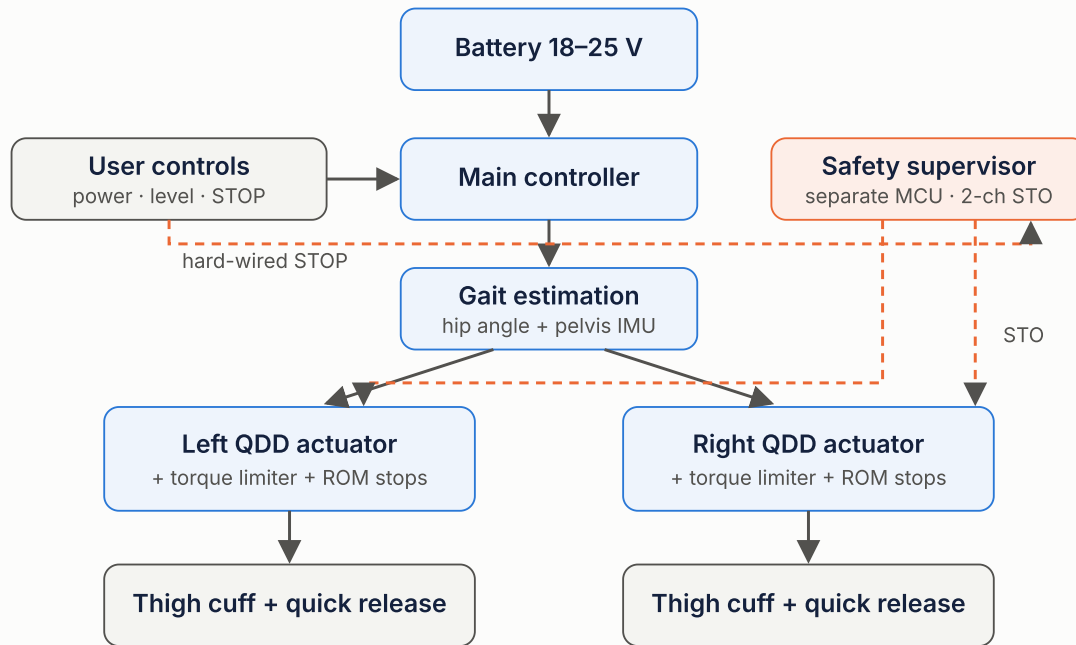
Quasi-direct drive wins; a passive spring is a close second



Weighted score 0–100. 12 criteria, safety-first weights (safety 18 %, backdrivability 12 %), after knock-out checks (free on power loss, user can switch off, torque bounded mechanically).

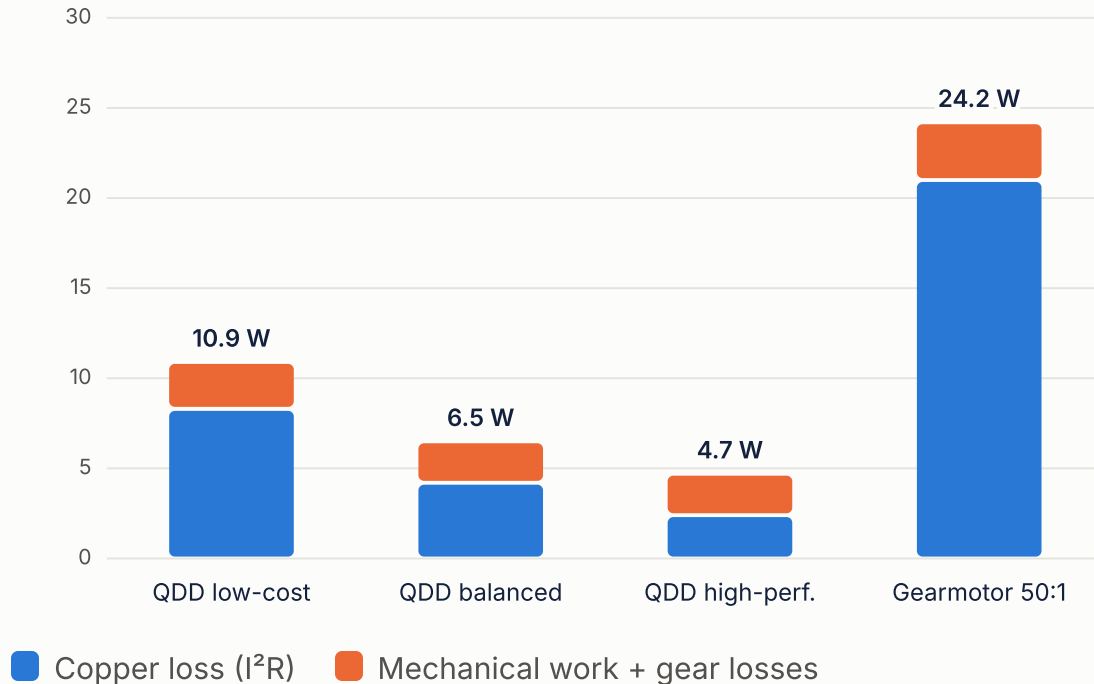
- **QDD (~9:1) at each hip** ranks 1st or 2nd under every weighting tested.
- The **passive spring** wins under cost-driven and equal weights. That is the project's core question in numbers: *how little technology is enough?* It is built as a comparator, not dismissed.
- High-ratio gearmotors fail on backdrivability and jam risk.
- Hybrid spring + QDD and clutch-based designs are the evolution path.

Architecture: mass at the pelvis, safety independent of software



- **Actuators lateral at the hip axis;** battery and controller at the back of the belt. ≤ 0.2 kg per thigh.
- **Passive abduction hinge** and rotational compliance absorb misalignment with the human ball joint.
- **Two-channel Safe Torque Off:** gate-driver disable plus phase disconnect. Safe state is phases **open**: shorting the windings would brake the leg with ≈ 7 Nm at walking speed.
- Bus ≤ 26 V. CAN between controller and drivers; supervisor listens and checks.
- **No machine learning inside any safety function**, which keeps them testable and out of stricter Machinery Regulation / AI Act categories.

Hip assistance is a torque problem, not a power problem



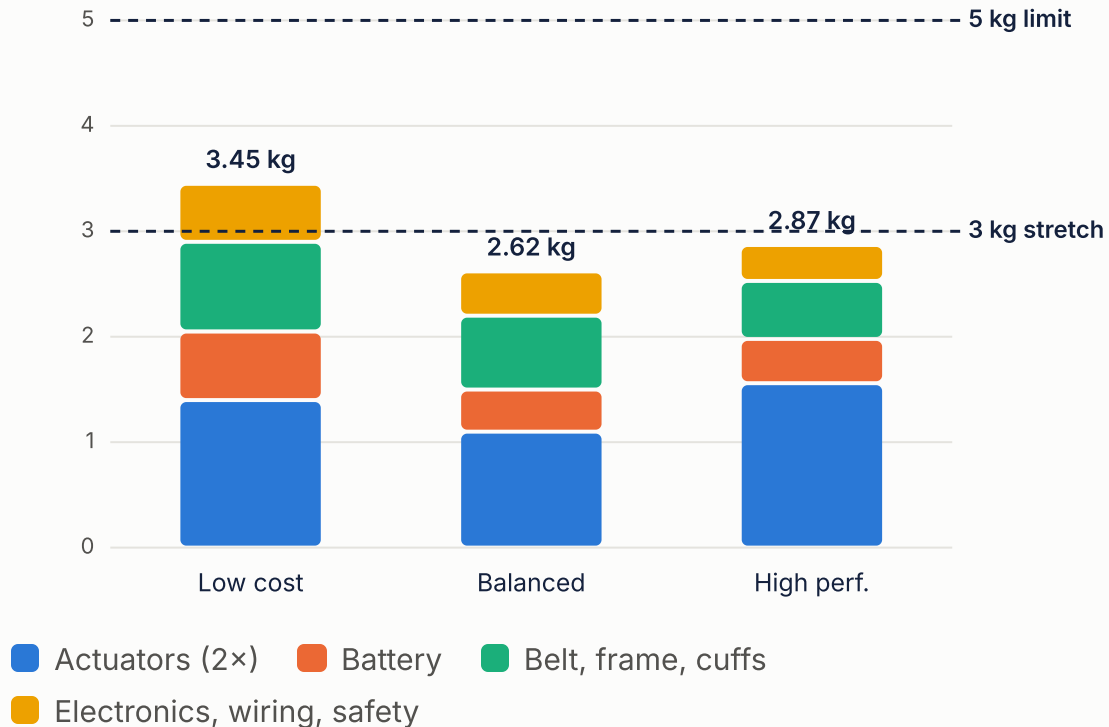
Mean electrical power per side, 75 kg user, ~1.0 m/s, 12 Nm peak, assist only in positive-work phases.

≈ 2 W

mean mechanical assist power per side

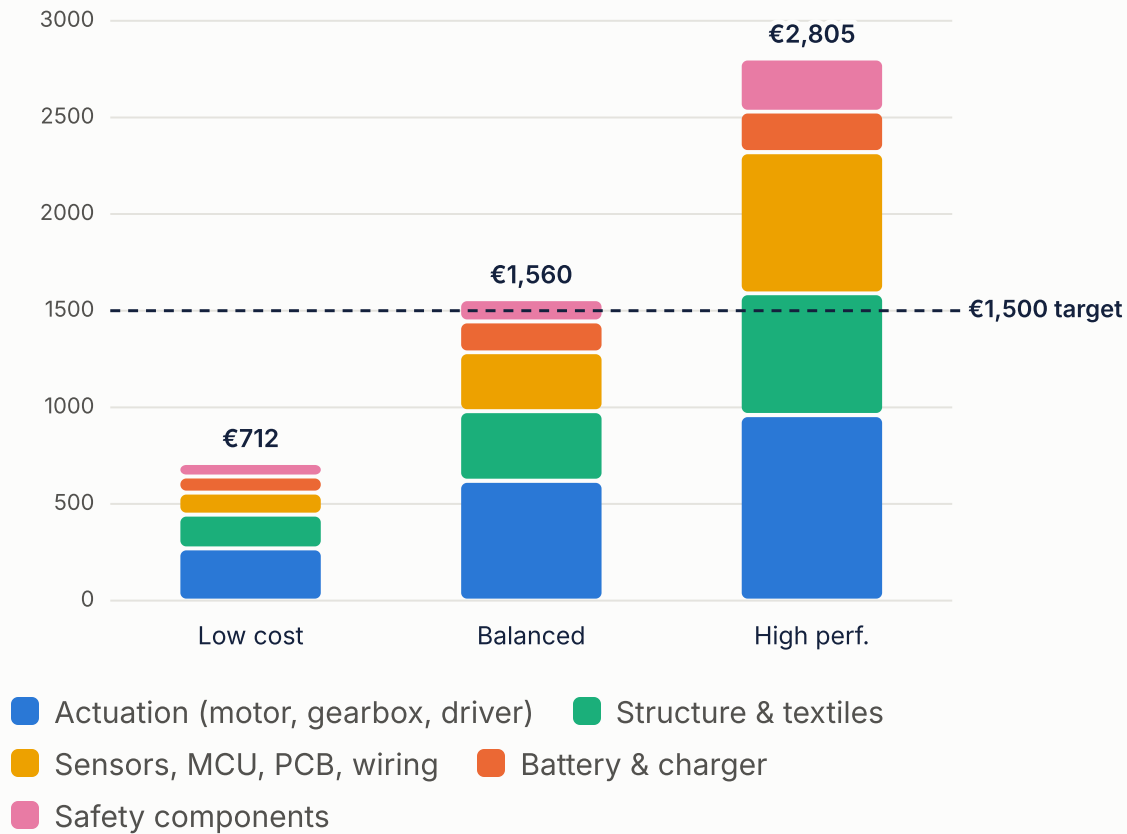
- Copper loss is **2–21 W per side** and dominates. Choose motors by **Km (torque per $\sqrt{W}$)**, not by watts. The "800–1,000 W" figures in consumer marketing are irrelevant here.
- A high-ratio gearmotor uses **2–3.5× more energy** and is not backdrivable.
- Battery for 2 h: **≈ 30–85 Wh**. An 18 V 4 Ah power-tool battery covers the low-cost tier.
- Main uncertainty: motor heating in the low-cost tier (≈ 8–13 W per side). This is the first bench test.

Mass: under 5 kg is easy; under 3 kg needs the balanced tier



- All three tiers land at **2.6–3.5 kg**. $\geq 85\%$ of the mass sits at the pelvis.
- The low-cost tier is heavier because of printed gearboxes and the tool battery. A 6S pack and metal gear parts would take it below 3 kg for $\approx$ €60–100.
- Commercial devices reach 1.6–2.7 kg. Going below 2 kg would need less torque (6–8 Nm) or a single motor for both legs. Decide only after users show what they need.

Cost: €712 to €2,805 BOM; balanced tier is €60 over target



- **Actuation chain = 38–40 %** of BOM in the low-cost and balanced tiers. It is the main cost driver.
- To close the €60 gap: laser-cut frame instead of CNC, power-tool battery instead of a custom pack.
- **Safety components (7–10 %) are not to be value-engineered away.**
- BOM ≠ total cost. Bench (€1.5–3k), pressure mapping, EMC pre-compliance and an independent safety review belong in funding proposals.

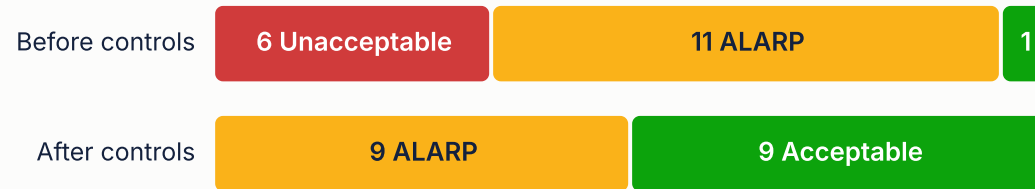
Prices are planning estimates (EUR, small quantities, 2026), not quotes.

Safety is layered so that no serious hazard depends on software alone

LAYER	MEASURE	INDEPENDENT OF
L0 Inherent	Assist $\leq \sim 20\%$ of the biological moment · backdrivable QDD · $\leq 26\text{ V}$	everything
L1 Controller	Torque and rate limits · gait-confidence gating · automation may only reduce assist	—
L2 Motor driver	Hardware current limit, set separately	main software
L3 Supervisor	Separate MCU: heartbeat, plausibility, overspeed, temperature $\rightarrow \text{STO} \leq 20\text{ ms}$	main MCU
L4 Mechanical	Torque limiter slips at 15 Nm (never > 18 Nm) · hard ROM stops $-25^\circ / +110^\circ$	all electronics and software
L5 User	Hard-wired STOP button · one-hand quick release $\leq 5\text{ s}$	electronics
L6 Information	Contraindications · no medical claims · training	—

Every analysed failure (power loss, sensor, encoder, controller crash, driver, communication, battery, cable, overheating, sensor disagreement, wrong gait detection) ends in the same state: **free passive motion**.

Risk picture: no unacceptable risk left for supervised research use



18 hazards, ISO 14971 approach. Severity × probability: ≥ 10 unacceptable, 5–9 ALARP, ≤ 4 acceptable. 28-line DFMEA: 8 lines with high action priority.

Key finding: unsuitable-user risk (H-13) reaches ALARP only with **clinical screening and supervised use**. For unsupervised public use it stays **unacceptable**. A future release needs a supervised model, e.g. lending through physiotherapy practices.

Highest risks

- **Mistimed torque below the limiter** passes the mechanical layer by design. The balance-disturbing threshold is an open research question.
- **Gait misclassification** in irregular older-adult gait → open validation dataset.
- **Gearbox jam** (printed gears) → stress analysis, metal ring gear option.
- **Battery fire** → listed, certified packs only; fused adapter.

Intended purpose decides the legal path

Research prototype

Not placed on the market. No CE marking, but ethics approval for any human study and general liability apply.

← OWA-00 to OWA-04

Consumer / fitness

No medical claim. **Machinery Regulation (EU) 2023/1230** from 20 Jan 2027, GPSR, EMC, RED (BLE), Batteries Regulation. Key standard: EN ISO 13482.

Medical device

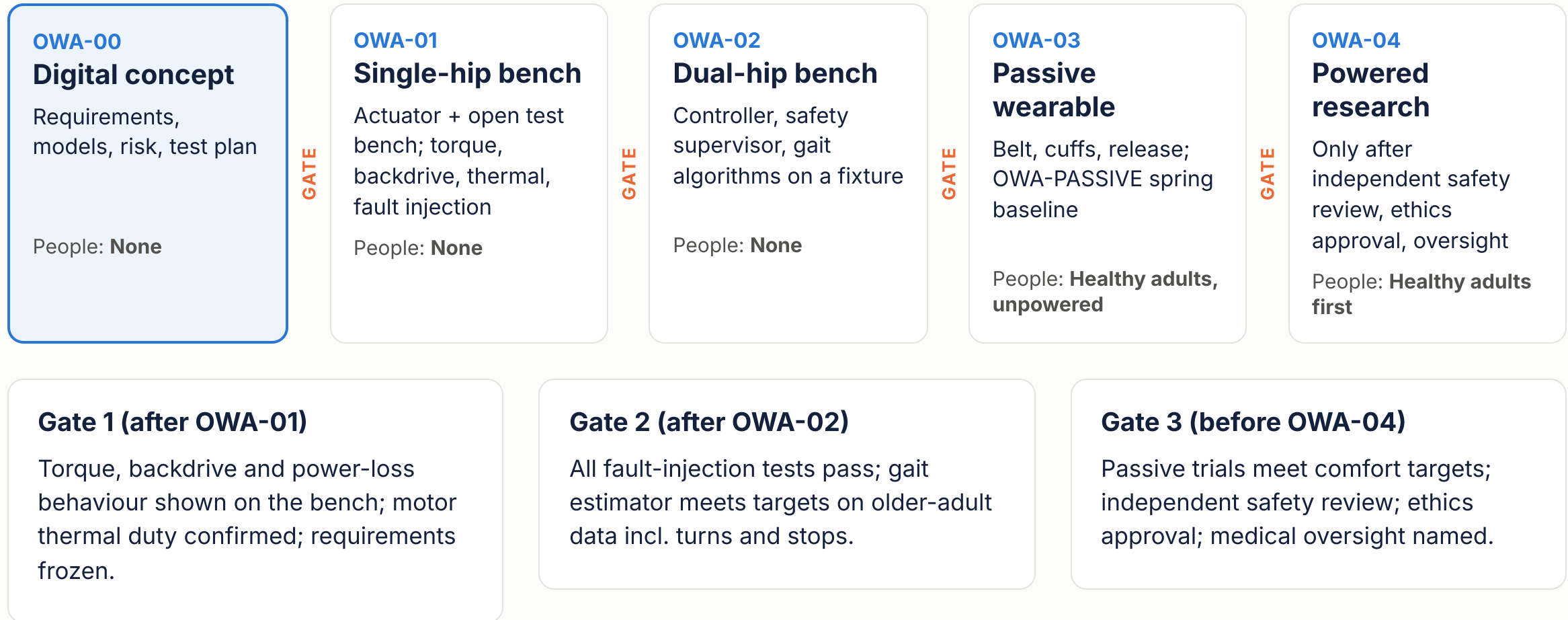
Claims to compensate for a disability or to rehabilitate → **MDR 2017/745** + ZMedPri-1, JAZMP. Likely Class I or IIa; IIa needs a Notified Body.

Proposal: keep the research phase explicitly non-medical. *"An open engineering research platform for studying lightweight hip assistance during walking. Not intended to diagnose, treat, alleviate or compensate for any disease, injury or disability."*

Choose a medical route only with a partner who can carry an ISO 13485 QMS.

Engineering orientation, not legal advice. Status checked 12 Oct 2026.

Roadmap: test on benches and dummies before anyone wears power



What we know, what we estimate, what is still unknown

Known (published)

- Hip devices of 1.6–2.7 kg with 4–12 Nm exist.
- Hip-angle-only control works in products.
- QDD hip actuators reach ≈ 0.4 Nm backdrive.
- One small uncontrolled pilot in older adults reported benefit and no device-related adverse events.

Estimated (E1 calculation)

- 2.6–3.5 kg system mass.
- €712 / €1,560 / €2,805 BOM.
- 30–85 Wh for 2 h of assist.
- Copper loss dominates energy use.
- Cuff pressure ≈ 6 kPa at 12 Nm.

Unknown

- What older adults actually want: no interviews yet.
- Useful vs. unsafe torque for this group.
- How much a passive spring delivers.
- Gait-estimation robustness in irregular gait.
- Thermal duty of low-cost motors.

Evidence scale: E0 hypothesis · E1 calculation · E2 simulation · E3 bench · E4 system · E5 field · E6 independent · E7 regulatory/clinical. No OWA claim is above E1 today.

Gate 0: decisions needed and next steps

Decisions for Gate 0

1. Confirm QDD as primary architecture and OWA-PASSIVE as baseline.
2. Approve the risk policy (acceptability matrix) with the clinical advisor.
3. Decide research-phase intended-purpose wording.
4. Decide licences: CC BY-SA 4.0 docs · CERN-OHL-S v2 hardware · GPL-3.0 firmware, plus a trademark policy for the OWA name.
5. Approve the OWA-01 budget and bench lab safety assessment.

Next 6–8 weeks

1. VOC interviews: 8–12 older adults, physiotherapists, carers (Gorenjska).
2. Check the ethics route for interviews with KME RS.
3. Order OWA-01 long-lead parts: two motor variants, drivers, encoders, load cell.
4. Start OWA-BENCH design.
5. Collect public older-adult gait datasets for the estimator.
6. Freedom-to-operate screen on hip control and single-motor drives.