RESEARCH BLOCK III • TECHNICAL CONCEPT REPORT

CYC Photon Pro Architecture and Flat-Terrain Thermal Integration

Low-profile hardtail e-mobility concept: propulsion evidence, road-load modelling, battery sizing, environmental hardening, and verification planning

Design objective. Evaluate whether a compact 4 kW / 180 N.m mid-drive concept can be integrated into a Cannondale Habit HT 2 for sustained flat-terrain operation without exceeding structural, thermal, electrical, braking, packaging, or legal constraints.

> **Evidence boundary:** CYC currently publishes specifications for Photon Gen 2 and X1 Pro Gen 4. The supplied 4 kW / 180 N.m “Photon Pro” specification is not supported by a current official product specification located during this revision, so it remains a concept input pending manufacturer documentation or prototype test evidence.

DESIGN BASIS

4.0 kW SUPPLIED PEAK PROPULSION TARGET	**72 V / 84 V** NOMINAL / FULL-CHARGE BUS
0.86-1.40 kWh PACK OPTIONS ANALYSED	**73 mm BSA** THREADED DRIVE INTERFACE

DESIGN BASIS • Visual, analytical, and engineering-consistency revision • July 2026

Executive summary

1.1 Concept boundary and evidence status

The supplied report proposes a “Photon Pro” system that combines the small external envelope associated with CYC’s Photon family with a 4,000 W peak-power and 180 N.m torque target. That specification is treated here as a design requirement, not as a verified production motor. Current manufacturer material instead identifies Photon Gen 2 as the compact published platform and X1 Pro Gen 4 as the high-power published benchmark.

This revision separates four evidence classes throughout the report: published manufacturer data, values carried forward from the supplied concept, transparent engineering calculations, and tests still required. The distinction prevents a target from being presented as demonstrated performance and exposes the decisions that must be resolved before procurement or construction.

1.2 Design objective and operating context

The operating case is sustained travel on flat, exposed routes in the Richmond and Vancouver region. Flat terrain removes the low-load descents that normally cool a high-output mid-drive, while rain, road spray, coastal contamination, fine silt, and crosswinds increase electrical, drivetrain, braking, and stability demands. The platform therefore needs continuous-duty thermal evidence rather than only short burst ratings.

Table 1. Design basis, evidence status, and release implication

Requirement	Value used in this report	Evidence class	Release implication
Compact high-power motor	4.0 kW peak / 180 N.m	Supplied concept assumption	Obtain official datasheet or dyno evidence before design freeze
Compact published baseline	Photon Gen 2: 1.2 kW peak / 130 N.m	Current manufacturer data	Useful size baseline; not equivalent to the target motor
High-power published baseline	X1 Pro Gen 4: 5.0 kW / 250-280 N.m	Current manufacturer data	Performance benchmark with a larger package
Battery bus	72 V nominal / 84 V full charge	20-series Li-ion calculation	Every controller, BMS, fuse, connector and auxiliary must tolerate full-charge voltage
Pack envelope	20S2P to 20S3P; 0.86-1.40 kWh	Calculated from published cell data	Pack-level current, heat, protection and weight must be validated
Vehicle speed envelope	60-75 km/h	Supplied design target	Closed-course only until vehicle-level braking, stability and classification are resolved
Operating environment	Wet coastal, silt, gravel and exposed flat routes	Design context	Ingress, corrosion, contamination and thermal-soak tests are mandatory

Published product figures are current manufacturer values located in July 2026. Concept targets are retained from the supplied report and are explicitly labelled as unverified.

> **Public-road boundary:** British Columbia’s motor-assisted-cycle category limits continuous motor output to 500 W and speed capability to 32 km/h. The performance targets in this report exceed that category and must be treated as a closed-course engineering concept unless a different vehicle class is lawfully certified, registered, insured, equipped, and operated.

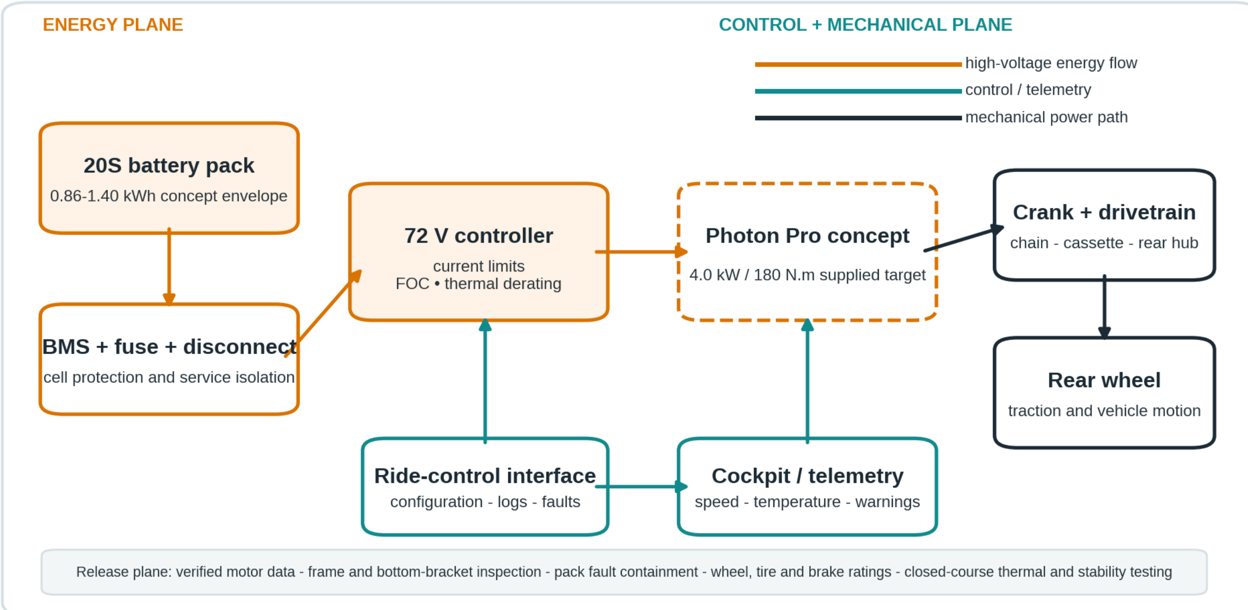

Figure 1. *Integrated energy, control, and mechanical architecture.*
Functional architecture only. It is not a wiring schematic, and the dashed motor block denotes the unverified Photon Pro concept input.

2.0 Flat-terrain operating environment

2.1 Continuous road-load model

On level ground, aerodynamic drag becomes the dominant continuous load as speed rises. The model used here is P = 0.5 rho CdA v^3 + Crr m g v. With a 120 kg combined vehicle-and-rider mass, air density of 1.225 kg/m³, CdA of 0.60 m², rolling coefficient of 0.008, level pavement, and still air, the mechanical road load is approximately 1.86 kW at 60 km/h and 3.52 kW at 75 km/h.

Those values exclude controller, motor, reduction-drive, chain, and tire losses. A 4 kW electrical target may therefore support the upper speed target only under favourable aerodynamic, thermal, tire-pressure, wind, and gearing conditions. Headwinds are especially punitive because the drag term depends on airspeed rather than ground speed.

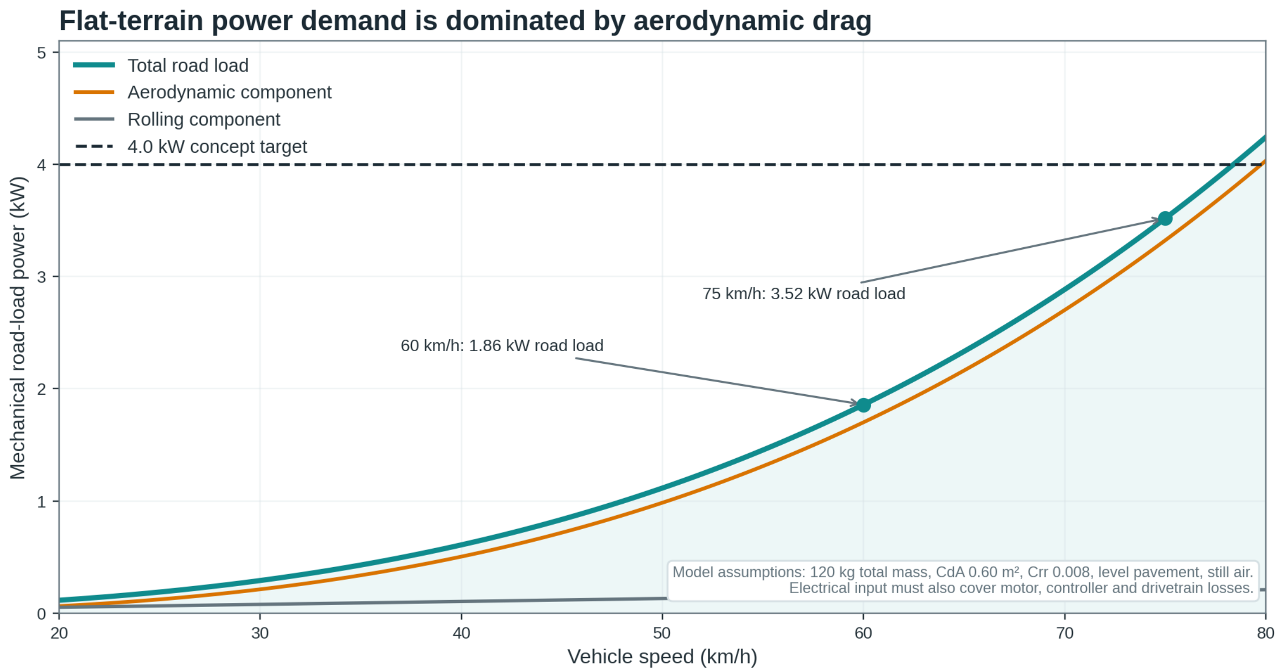

Figure 2. *Calculated flat-terrain road-load power versus speed.*

Analytical model using stated assumptions. This is not a coast-down test or a prediction of guaranteed top speed.

2.2 Environmental stress and hardening priorities

Repeated rain and conductive road spray demand more than an isolated ingress rating on individual components. Water can be driven along cables, through connector interfaces, and into frame-bag seams. The system needs drip loops, downward-facing service connectors, strain relief, fuse access, drainage, conformal protection where appropriate, and separation between energy storage and heat-producing electronics.

Coatings can reduce corrosion exposure, but they should not be described as hermetic or assumed to improve heat rejection without measurement. Any refinishing process must preserve bearing fits, threaded interfaces, ground paths, serial markings, and frame integrity. Dissimilar-metal joints need suitable isolation compounds and an inspection schedule.

Table 2. Environmental stress matrix for sustained wet coastal operation

Stress	Primary mechanism	Design response	Verification evidence
Sustained aerodynamic load	Continuous motor and controller heat soak	Temperature sensors, current derating, airflow path, logged duty cycle	Instrumented thermal run at target power and ambient conditions
Rain and road spray	Connector leakage, tracking, corrosion and brake contamination	Sealed connectors, drip loops, drainage, dielectric management and service access	Spray test before and after vibration; insulation and function checks
Saline aerosol / dissimilar metals	Galvanic corrosion at steel-aluminium interfaces	Barrier compounds, coatings, isolated fasteners and scheduled inspection	Coupon or component exposure plus torque-retention inspection
Fine silt and gravel	Abrasive drivetrain paste and seal wear	Protected routing, dry-state lubrication option, cleaning interval and wear gauges	Contamination cycle followed by chain, bearing and connector inspection
Crosswind and exposed routes	Steering disturbance and rider workload	Conservative geometry interpretation, stable tires and closed-course handling tests	Repeatable crosswind and lane-change protocol with speed escalation
Cool ambient air	Improved heat rejection but possible cold-cell sag	Temperature-aware current limits and battery preconditioning criteria	Cold-soak discharge and voltage-sag test

3.0 Airframe geometry and mechanical integration

3.1 Cannondale Habit HT 2 design characteristics

The current Habit HT 2 specification provides several useful integration features: SmartForm C2 Alloy construction, a 64-degree head angle, a BSA 73 mm threaded bottom bracket, Boost 148 rear spacing, a published 55 mm chainline, a UDH hanger, and an unobstructed hardtail frame triangle. These are packaging advantages, not certification for the proposed motor power, speed, battery mass, or braking duty.

A hardtail reduces the number of pivots and frees frame volume, but it also transmits more shock into the rider, battery, controller, and wiring. High-speed suitability must be established from the complete system: frame, fork, wheels, tires, brake mounts, rider position, mass distribution, and controls, not from head angle alone.

Table 3. Updated Habit HT 2 integration characteristics and corrected interpretation

Airframe characteristic	Published specification	Integration benefit	Engineering limitation
Frame construction	SmartForm C2 Alloy hardtail	Direct load path and large internal triangle	Human-powered frame is not automatically qualified for motor reaction torque or added mass
Head angle	64°	Lower steering sensitivity and greater trail tendency	Does not guarantee freedom from weave, wobble, fork flex, or tire instability
Bottom bracket	BSA 73 mm threaded	Positive axial location and common fit standard	Motor still needs a verified anti-rotation / torque-reaction system
Rear standard	Boost 148, 12 mm thru-axle	Wide hub support and common wheel ecosystem	Hub, spokes, freehub and axle must be validated for drive and braking loads
Chainline	55 mm published frame target	Clear datum for fit analysis	Motor chainring offset and chainstay clearance require a 1:1 template and physical build check
Derailleur hanger	SRAM UDH	Replaceable and widely available	Designed as a sacrificial service part, not as reinforcement against extreme chain load
Frame triangle	Unobstructed hardtail volume	Supports internal battery and controller packaging	Enclosure must preserve cooling, drainage, serviceability and secure retention

Frame details are based on Cannondale's current Habit HT 2 product specification. Final production year, size, fork, wheel and component substitutions must be rechecked before purchase.

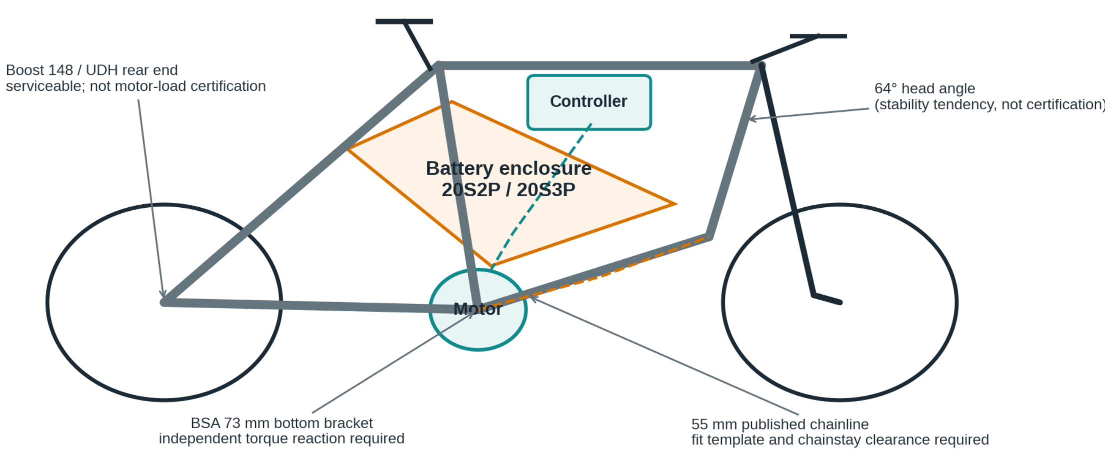

Figure 3. *Conceptual airframe packaging and interface map.*
Not to scale. Resolve fit, chainline, torque reaction, routing, and service access with the actual frame and motor template.

3.2 Bottom-bracket fit, torque reaction, and fatigue

The threaded bottom bracket prevents the cups from simply sliding in the shell, but it does not by itself absorb motor reaction torque. The motor mount, anti-rotation feature, contact pad, fastener preload, and local frame contact geometry must form a controlled load path. A compliant EPDM interface may spread contact pressure and reduce impact, but it can also creep, loosen preload, trap water, and conceal fretting.

Release work should include a 1:1 motor template, shell-face and thread inspection, chainring-to-chainstay clearance, crank symmetry, chainline measurement, static reverse-torque loading, witness marks, fastener-retention checks, and periodic non-destructive inspection of the bottom-bracket and downtube region. Frame and fork manufacturer limits remain controlling even when the motor hardware itself fits.

4.0 Propulsion architecture and evidence-backed comparison

4.1 Published products versus the supplied Photon Pro target

The original report presents the Photon Pro as a fifth-generation compact motor with 4,000 W peak output and 180 N.m of torque. Current CYC documentation located for this revision instead lists Photon Gen 2 as the compact platform and X1 Pro Gen 4 as the high-power platform. No current official Photon Pro product page or datasheet was located.

This does not make the concept analytically useless; it changes the design state. The 4 kW motor becomes an interface requirement whose mass, dimensions, efficiency map, winding construction, controller, thermal limits, chainline, and mounting reaction must remain open until evidence is supplied.

Table 4. Current propulsion comparison and verification status

System	Power figure used	Peak torque used	Voltage range	Status and implication
CYC Photon Gen 2	750 W rated / 1.2 kW peak	130 N.m	36-72 V	Published compact baseline; insufficient evidence for the 4 kW target
“Photon Pro” concept	4.0 kW peak	180 N.m	72 V concept bus	Supplied report assumption; mass, controller, thermal map and fit remain unverified
CYC X1 Pro Gen 4	5.0 kW benchmark	250-280 N.m published range	36-72 V	Published high-power benchmark with greater package and drivetrain burden

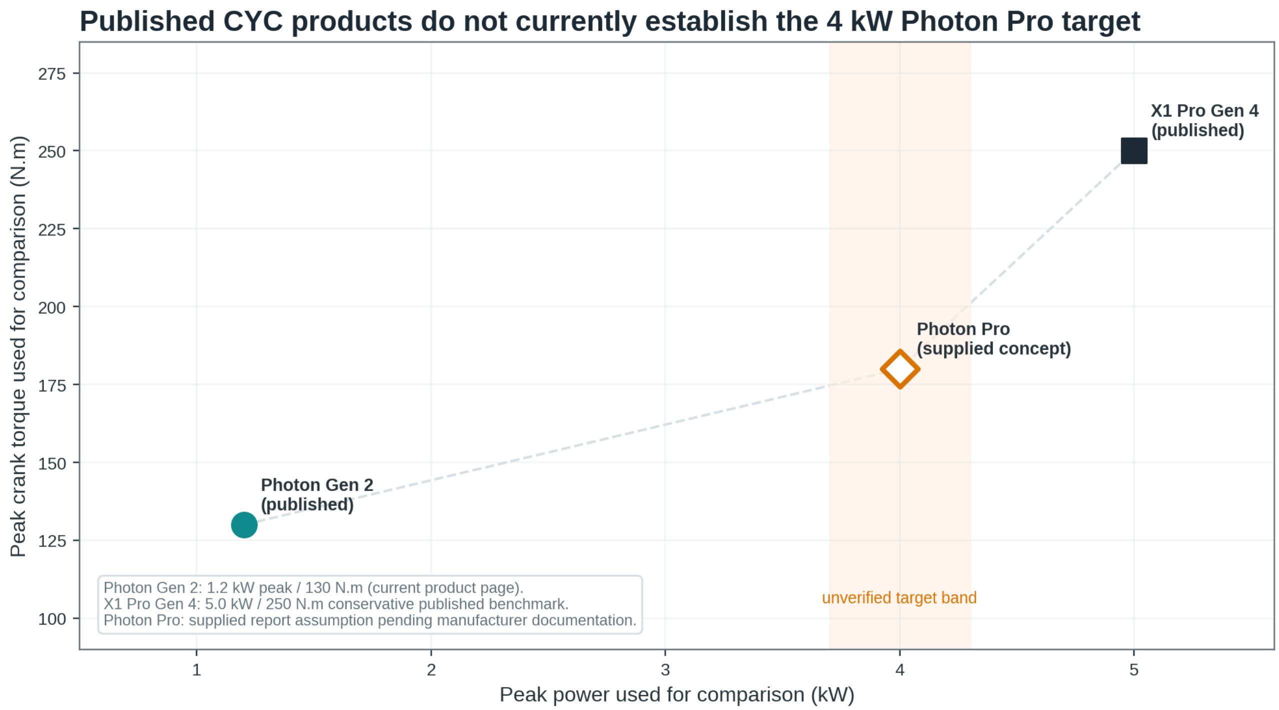

Figure 4. *Published CYC propulsion baselines versus the supplied Photon Pro target.*

The open orange marker denotes an unverified report target. Published CYC figures are used as comparison anchors, not as proof that the concept motor exists or fits the proposed frame.

4.2 Thermal architecture, control, and fail-safe behaviour

The supplied report attributes the concept motor’s thermal capability to flat copper hairpin windings. Current CYC material for Photon Gen 2 describes a redesigned inrunner and thermal protection, but it does not establish the hairpin-winding claim used in the source document. Winding geometry, copper fill, phase resistance, thermal path, temperature-sensor location, and derating curve therefore require a manufacturer cross-section, datasheet, or controlled prototype measurement.

Field-oriented control can improve torque smoothness and acoustic behaviour, but control quality does not remove mechanical or thermal limits. The release configuration needs hard battery-current limits, phase-current limits, temperature plausibility checks, brake cut-offs, throttle plausibility, overspeed handling, event logging, and a conservative limp mode. Field weakening should remain disabled until the base thermal map is established.

Table 5. Controller functions, benefits, primary risks, and required safeguards

Function	Intended benefit	Primary risk	Required safeguard
Battery-current limit	Protects pack and connectors	Incorrect setpoint or voltage-dependent overcurrent	Calibrated shunt, independent fuse, logged peak and RMS current
Phase-current control	Produces crank torque	Motor, controller or gearbox overload	Dyno-based torque map and conservative current ceiling
Temperature derating	Prevents heat damage	Sensor detachment, bias, or slow response	Dual-sensor plausibility, rate-of-rise limit and fail-safe derate
Throttle mapping	Direct rider torque request	Abrupt launch, wheel slip or stuck input	Deadband, progressive ramp, dual-channel plausibility and brake cut-off
Field weakening	Extends speed above base RPM	Efficiency loss, high current and rotor heating	Disabled for baseline; closed-course enable with hard limits only
Fault logging / limp mode	Supports diagnosis and controlled recovery	Silent intermittent fault or unsafe reset	Latched critical faults, visible warning and power-cycle criteria

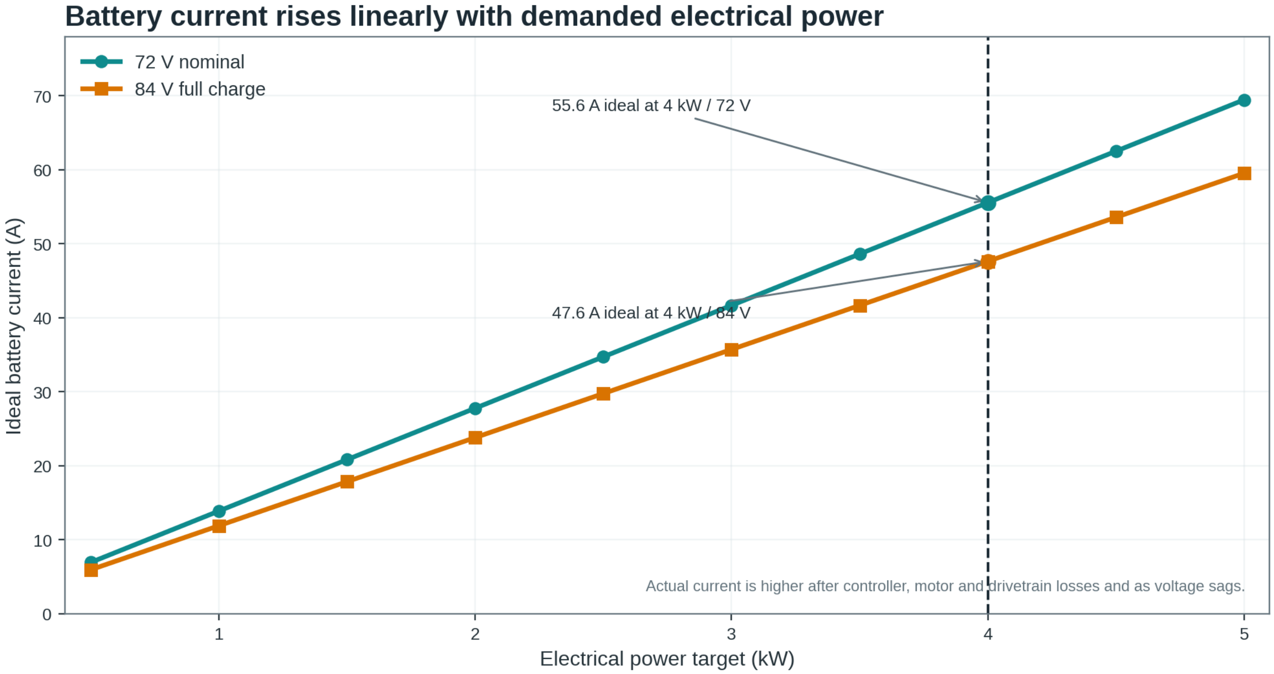

Figure 5. *Ideal battery current for the 72 V concept bus.*
Electrical calculation only. Actual current will be higher after losses and may increase further with voltage sag, temperature, current ripple, and auxiliary loads.

5.0 Energy storage and 2026 cell-selection update

5.1 Corrected high-power 21700 comparison

The source report's cell table contains several unsupported status claims and materially overstates the published Tenpower 50XG continuous-current figure. Tenpower's current portfolio lists the 50XG and 60XG at 50 A continuous, not 90 A and 60 A respectively. Molicel officially announced the P60B at 6.0 Ah and 90 A in 2025, and its current P60C product page lists 6.0 Ah and 100 A. These figures still require pack-level thermal and life-cycle qualification.

Cell current is only one selection axis. A compact high-power pack also depends on genuine-cell sourcing, lot traceability, capacity matching, impedance matching, interconnect resistance, vent direction, propagation barriers, BMS behaviour, fuse coordination, enclosure crash protection, cooling, and the duty cycle used to define "continuous."

Table 6. Updated 21700 cell matrix using current manufacturer information

Cell	Capacity	Published discharge figure	Energy-density figure	Design interpretation
Molicel P60C	6.0 Ah	100 A	284 Wh/kg	Current ultra-high-power benchmark; application and procurement qualification required
Molicel P60B	6.0 Ah	90 A	Not stated in announcement	Officially announced high-power e-bike / LEV cell; confirm datasheet and supply channel
Tenpower 60XG	6.0 Ah	50 A	~296 Wh/kg calculated from 3.6 V and 73 g	Balanced energy and power; published current is lower than the source report claimed
Tenpower 50XG	5.0 Ah	50 A	~257 Wh/kg calculated from 3.6 V and 70 g	Power-oriented option; corrects the source report's unsupported 90 A figure

Cell	Capacity	Published discharge figure	Energy-density figure	Design interpretation
Molicel M65A	6.5 Ah	26 A	325 Wh/kg	Energy-oriented option; requires sufficient parallel count and thermal margin

Manufacturer values are used for comparison only. They do not establish safe pack current, cycle life, availability, authenticity, or suitability for a custom bicycle battery.

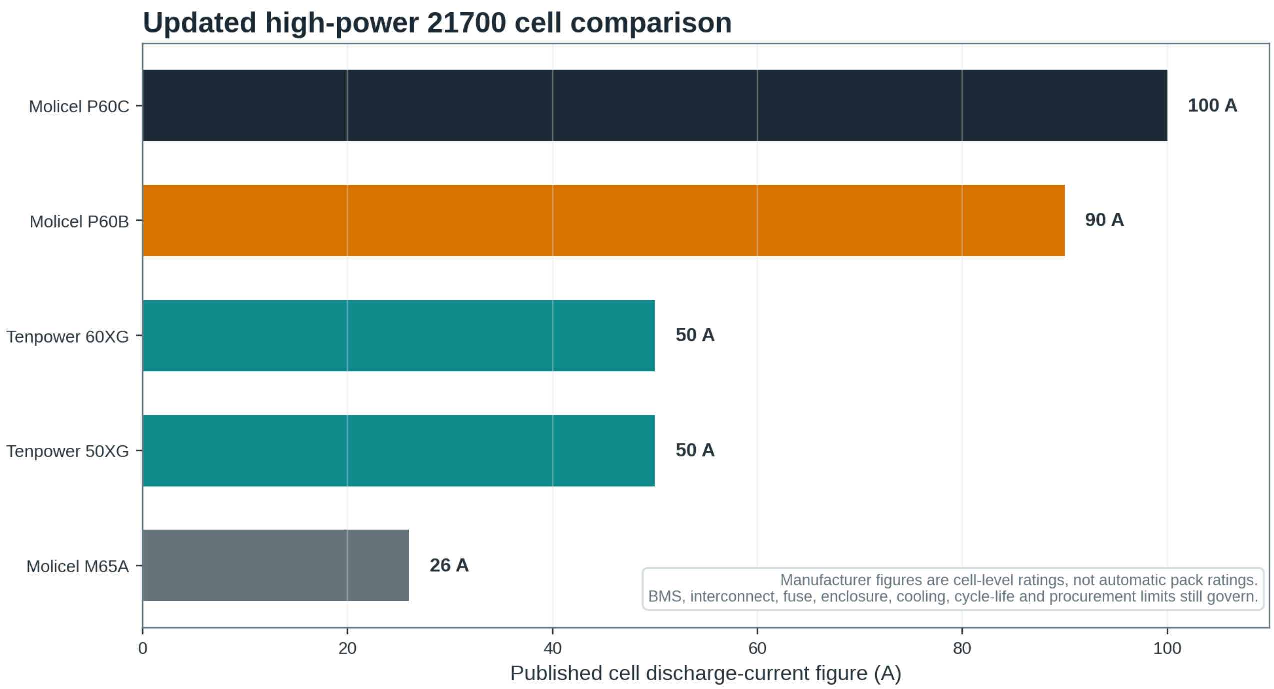

Figure 6. *Updated manufacturer-level discharge-current comparison for selected 21700 cells.*
The chart replaces the original high-drain matrix and distinguishes current product data, announced product data, and energy-oriented alternatives. Pack limits are always lower than a simple sum of cell ratings unless independently demonstrated.

5.2 Pack sizing, current margin, and realistic mass

A 20S3P pack of 5.0 Ah cells provides 72 V nominal, 15 Ah, and 1.08 kWh. With 70 g cells, the cells alone weigh approximately 4.2 kg; BMS, interconnects, insulation, fusing, enclosure, connectors, and mounting hardware push complete pack mass above that figure. The source report's approximate 4.5 kg total is therefore an aggressive lower bound rather than a reliable finished-pack estimate.

At 4 kW and 72 V, ideal pack current is 55.6 A. In a 3P pack this is about 18.5 A per cell before losses, which is well below the published 50 A cell figure for Tenpower 50XG or 60XG. That apparent margin is useful, but it must not be converted into a blanket claim that the pack will run "completely cold." Internal heating, enclosure insulation, sustained duty, cell aging, contact resistance, and BMS losses remain measurable design constraints.

Table 7. Illustrative 20-series pack options and cell-only calculations

Pack option	Nominal capacity / energy	Simple cell-current sum	Cell count / cell mass	Integration trade-off
20S2P Molicel P60C	12 Ah / 0.864 kWh	200 A	40 cells / 3.0 kg	Highest power density; shortest range and demanding fault containment
20S3P Tenpower 50XG	15 Ah / 1.080 kWh	150 A	60 cells / 4.2 kg	Balanced source-concept option with corrected 50 A cell rating
20S3P Tenpower 60XG	18 Ah / 1.296 kWh	150 A	60 cells / 4.38 kg	More energy at similar cell-level current capability
20S3P Molicel M65A	19.5 Ah / 1.404 kWh	78 A	60 cells / ~4.3 kg	Energy-biased option; narrower current margin and stronger need for thermal evidence

"Simple cell-current sum" is parallel count multiplied by the published cell figure. It is not a safe pack rating. All masses exclude busbars, BMS, fuses, insulation, enclosure, wiring, connectors, potting, and mounting hardware.

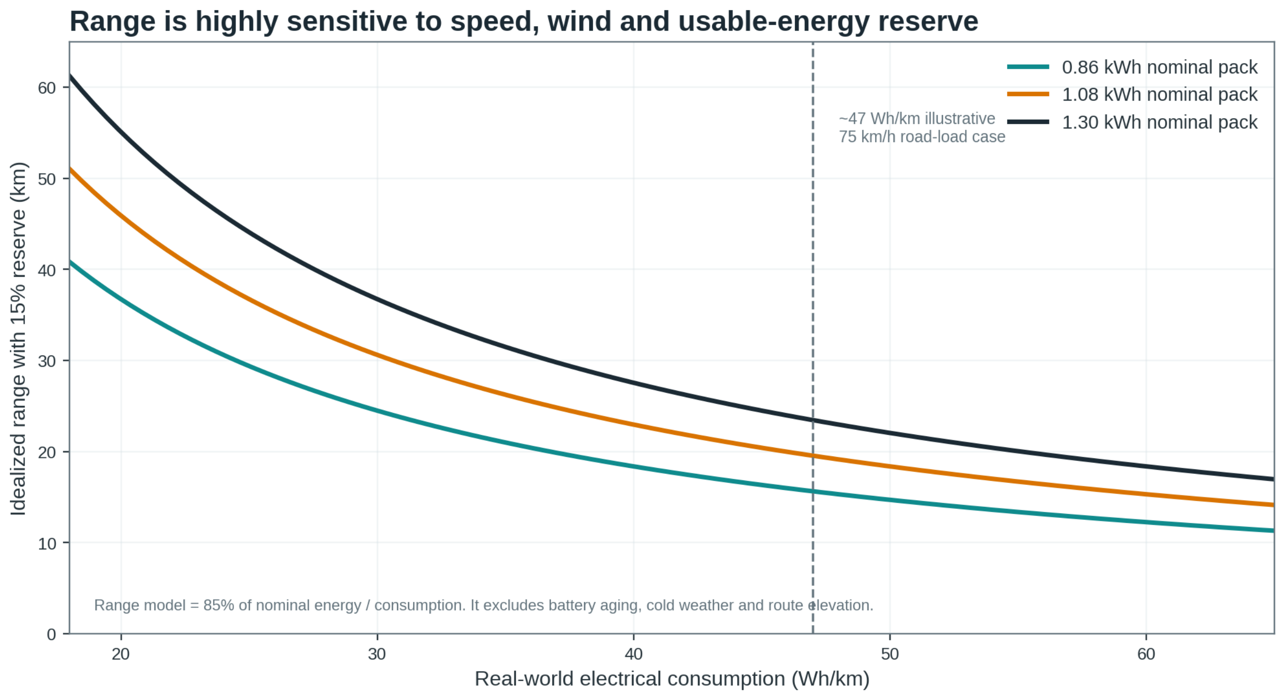

Figure 7. *Idealized range sensitivity for three compact pack-energy options.*
Range is calculated from 85% of nominal energy divided by real-world consumption. High-speed wind, cold weather, acceleration, tire pressure, battery aging, and route conditions can reduce it materially.

6.0 Drivetrain, wheels, braking, and traction

6.1 Drivetrain load management

The drivetrain remains the most exposed mechanical fuse in the architecture. The current Habit HT 2 is already sold with a 10-speed Shimano CUES / Linkglide drivetrain, which provides a useful durability-oriented baseline, but no bicycle derailleur system should be assumed to accept 180 N.m motor torque during shifts. The control system needs shift detection or a rider-enforced unload strategy, progressive torque application, chainline control, and wear inspection.

A stronger chain and thicker cassette do not protect the freehub, spokes, rim, axle, hanger, chainring, motor reduction, or frame. Validation must follow the complete torque path. Wax-based lubrication may reduce particulate adhesion, but it requires disciplined cleaning and rewaxing and does not eliminate corrosion or shock-load failures.

6.2 Braking energy and tire constraints

The source report correctly identifies braking as a thermal problem but incorrectly equates good lever modulation with anti-lock braking. A rider-modulated hydraulic system is not ABS. At a 120 kg combined mass, the vehicle carries about 26 kJ of kinetic energy at 75 km/h before rotational energy is added. Repeated stops accumulate heat in the rotors, pads, calipers, fluid, hubs, spokes, rims, and tires.

Hope Tech 4 V4 calipers, large rotors, and speed-rated tires may be candidates, but final release depends on fork and frame rotor limits, adapter stiffness, pad compound, wheel build, tire load and speed ratings, wet stopping distance, fade behaviour, brake cut-off function, and stability under maximum deceleration.

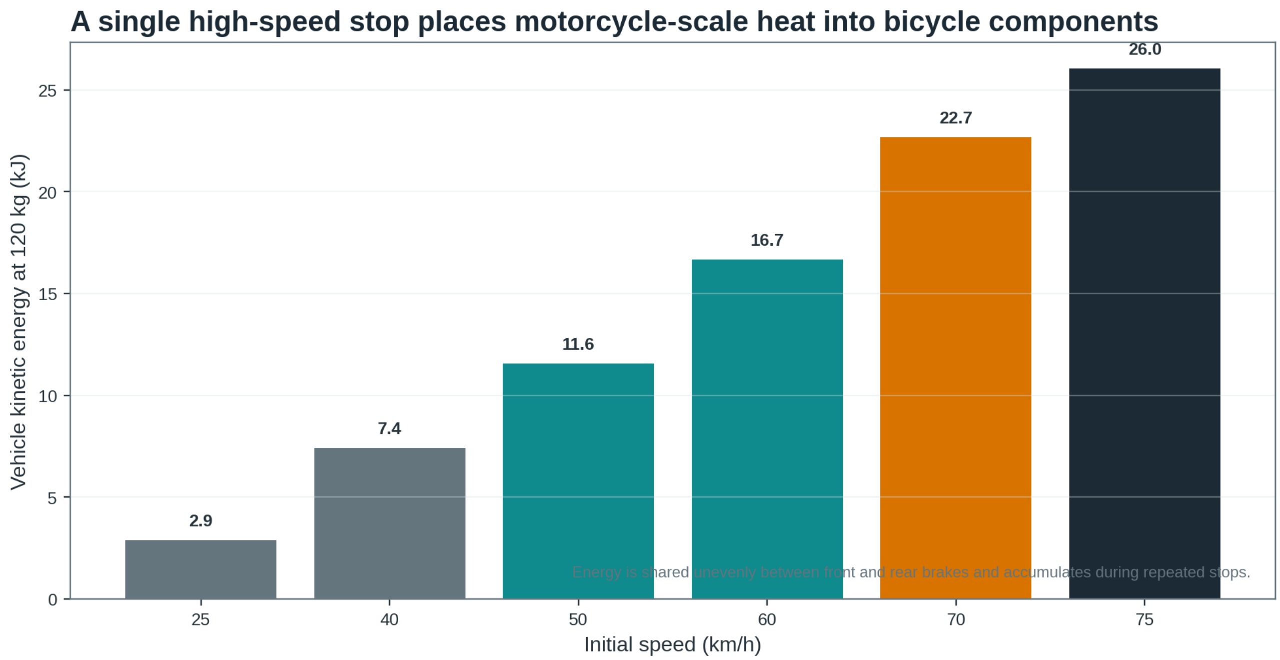

Figure 8. *Vehicle kinetic energy across the proposed speed envelope.*
Absolute energy is calculated for 120 kg and excludes wheel rotational energy. The chart does not predict stopping distance, rotor temperature, grip, or brake balance.

Table 8. Drivetrain, wheel, braking, and traction hardening matrix

Subsystem	Proposed direction	Primary failure mode	Release criterion
Chain / cassette	10-speed CUES or Linkglide with e-bike chain	Elongation, tooth deformation, loaded shifting	Measured wear, unloaded-shift strategy and repeated full-torque endurance cycle
Chainline / chainring	Fit to published 55 mm frame datum	Derailment, side loading and chainstay contact	Measured alignment through usable gears and full-suspension-free frame flex checks
Freehub / rear wheel	Heavy-duty hub, spokes and rim	Pawl failure, spoke fatigue, rim cracking	Torque endurance, spoke-tension retention and periodic non-destructive inspection
Hydraulic brakes	Four-piston downhill-oriented system	Fade, boiling, seal damage and poor modulation	Wet and dry stopping-distance, fade and lever-consistency test
Rotors / adapters	Large rotor subject to fork and frame limits	Mount failure, warping and overheating	Manufacturer-compatible size, torque audit, temperature and runout limits
Tires	Appropriate load, speed and wet-grip rating	Heat, bead failure, puncture and traction loss	Documented rating, pressure window and closed-course heat / handling test
Brake cut-offs	Dual brake inputs to controller	Motor torque during braking or sensor fault	Fail-safe motor inhibit verified under single-fault conditions

7.0 Low-profile packaging, telemetry, and serviceability

7.1 Enclosure architecture

Visual integration should serve weather protection, theft deterrence, cable protection, mass centralization, and service access, not conceal an unlawful vehicle classification or suppress safety information. A custom frame bag or rigid inner enclosure must restrain the battery in every direction, prevent abrasion, separate high-voltage components from low-voltage electronics, provide drainage, and allow rapid isolation after a fault.

The controller should not be buried against the battery inside an insulated fabric volume. It needs a defined thermal path, temperature sensing, protected airflow or conduction, and clear separation from cells. High-current connectors should be keyed, shrouded, strain-relieved, and accessible without disturbing the cell enclosure.

7.2 Cockpit and data path

A compact display, phone, or head-up interface can reduce handlebar clutter, but the telemetry chain must be proven end to end. Speed, battery state, motor temperature, controller temperature, fault state, and derating status are safety-relevant. A disconnected phone, failed Bluetooth link, or depleted smart-glasses battery must not remove critical warnings or prevent a safe shutdown.

Table 9. Low-profile packaging and cockpit integration requirements

Element	Low-profile approach	Critical requirement	Verification
Battery enclosure	Internal triangle, custom rigid inner shell or reinforced bag	Multi-axis retention, crush protection, vent strategy, drainage and service isolation	Static pull, drop / shock surrogate, spray and thermal propagation assessment
Controller	Frame-adjacent heat spreader or ventilated protected bay	No direct heat soak into cells; temperature and airflow path	Sustained-load thermal map with enclosure installed
High-voltage wiring	Short routed loom inside frame envelope	Fuse coordination, abrasion protection, bend radius and strain relief	Current, vibration, insulation and connector-temperature test
Low-voltage / telemetry	Separated twisted or shielded routing as required	EMI immunity and no shared high-current return path	Motor-under-load data-integrity and fault-injection test
Cockpit display	Compact local display plus optional phone / HUD	Critical warnings remain visible after wireless or phone failure	Loss-of-link, low-battery and sunlight / rain usability tests
Lighting and road equipment	Integrated only after classification decision	Must not be omitted for visual simplicity	Compliance checklist for the intended operating class

8.0 Integration safety and evidence-gated verification

The system must be released as a vehicle, not as a collection of individually capable parts. The most important unresolved item is the motor itself: the design cannot be frozen around an unverified 4 kW compact drive. Once propulsion evidence is available, the remaining work proceeds through fit, electrical, structural, thermal, contamination, braking, handling, control, and classification gates.

Table 10. Recommended integration verification matrix

Verification item	Method	Minimum acceptance evidence	Stop condition
Motor evidence	Official datasheet, dimensional drawing, controller manual and dyno map	Verified mass, mounting, voltage, current, torque, efficiency and derating curve	No build release without a traceable propulsion specification
Mechanical fit	1:1 template and physical dry fit	Chainline, crank clearance, chainstay clearance and service access documented	Any frame interference or uncontrolled preload
Torque reaction	Static forward / reverse load with witness marks	No slip, fretting, local yielding or fastener relaxation	Movement, coating crush, crack indication or preload loss
Battery protection	Bench fault, fuse and BMS tests	Controlled overcurrent, short-circuit, over/undervoltage and temperature response	Uncoordinated fuse/BMS operation or unsafe reset
Electrical thermal soak	Sustained current on instrumented bench	Stable cell, connector, BMS and controller temperatures with margin	Runaway trend, hotspot, derating oscillation or insulation damage
Ingress and contamination	Spray, vibration, silt exposure and post-test teardown	No water path to cells, no tracking, corrosion or connector damage	Moisture, insulation loss or hidden contamination accumulation
Braking	Wet/dry stopping and repeated fade sequence	Repeatable control, stopping distance, temperatures and lever feel	Fade, boiling, rotor instability, tire loss or mount movement
Stability and handling	Speed escalation on closed course	No uncontrolled weave/wobble; predictable steering and crosswind response	Oscillation, tire instability, fork/wheel concern or rider control loss

Verification item	Method	Minimum acceptance evidence	Stop condition
Control fail-safe	Throttle, sensor, brake, comms and temperature fault injection	Torque removed or conservatively limited with clear warning	Any single fault causing unintended sustained drive
Service / inspection	Timed isolation, enclosure access and periodic audit	Battery isolated rapidly; high-wear zones visible and measurable	Service requires disturbing cells or conceals critical damage
Classification release	Legal and insurance review for intended use	Documented operating category, equipment, registration and insurance path	No lawful category or missing required equipment

Evidence-gated validation workflow

No road or customer release occurs merely because components fit or the motor spins.

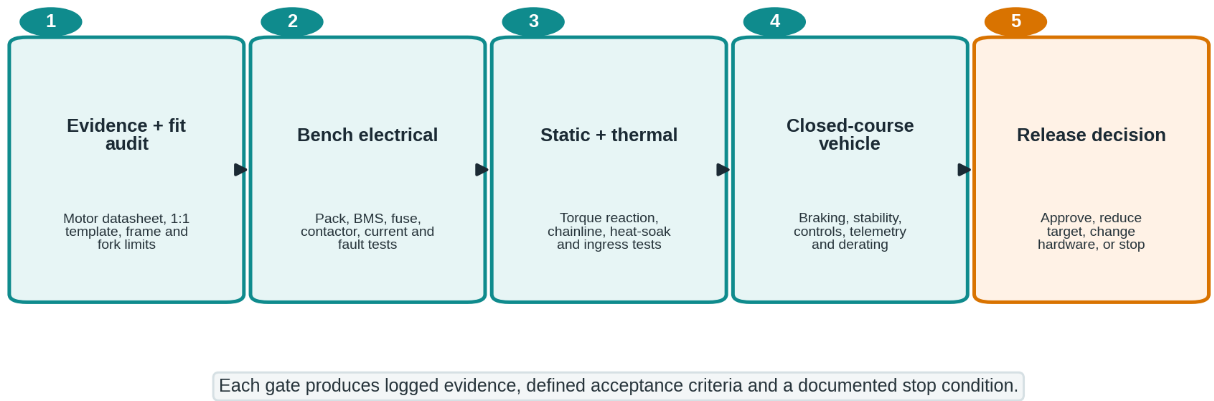

Figure 9. *Evidence-gated validation workflow from concept to release decision.*
Every stage produces logged evidence and explicit acceptance criteria. Failure at any gate requires redesign, target reduction, hardware change, or project stop rather than informal acceptance.

> **Release rule:** Component fit, a successful no-load spin, or a brief acceleration run is not a release test. The vehicle remains a concept until the motor evidence, battery fault containment, structural load path, thermal duty cycle, braking, tire and wheel ratings, control fail-safes, and legal operating category are all documented.

9.0 Conclusion

The supplied architecture contains a coherent systems-integration idea: combine a hardtail frame with a large internal triangle, a compact mid-drive, a high-voltage battery, protected packaging, durable transmission components, and restrained cockpit instrumentation. Flat-terrain operation, however, makes continuous heat rejection and aerodynamic power demand more important than dramatic peak figures.

The central conclusion of this revision is evidentiary. Current published CYC material supports Photon Gen 2 as a compact 1.2 kW-peak platform and X1 Pro Gen 4 as a 5 kW high-power benchmark, but it does not currently establish the 4 kW / 180 N.m Photon Pro assumed by the source report. That motor must remain an unverified interface requirement rather than a procurement item.

The battery analysis is also corrected. Tenpower publishes 50 A continuous figures for both 50XG and 60XG, while Molicel has announced or published higher-current P60-series cells. A 20S3P pack can provide substantial current margin at a 4 kW nominal-bus load, but complete pack temperature, mass, fault containment, BMS behaviour, and cycle life still require instrumented validation.

With those corrections, the report becomes a practical design-control document rather than a performance claim. The next rational step is not component purchase; it is a propulsion evidence package, a full-size fit model, and a quantified validation plan.

10.0 Procurement and design-freeze checklist

Table 11. Updated procurement status and design-freeze actions

Subsystem	Candidate / basis	Current status	Design-freeze action
Airframe	Cannondale Habit HT 2, correct size and production year	Published current platform	Confirm exact frame, fork, wheel, rotor limits, geometry and warranty implications
Target motor	“CYC Photon Pro” 4 kW / 180 N.m	Unverified concept	Hold procurement; require official datasheet, dimensions, controller and dyno evidence
Compact fallback	CYC Photon Gen 2	Published current product	Use only if the project accepts materially lower output
High-power benchmark	CYC X1 Pro Gen 4	Published current product	Use for performance comparison; complete separate fit and structural assessment
Controller	72 V / 84 V-capable matched controller	Not defined for concept motor	Verify full-charge rating, current sensing, thermal protection, brake inputs and logs
Cells	Molicel P60C/P60B, Tenpower 50XG/60XG, Molicel M65A	Manufacturer data available; supply varies	Select genuine authorized channel and build pack-specific thermal / life model
Battery pack	20S2P or 20S3P custom assembly	Calculated concept only	Professional pack design, BMS, fuse, enclosure, venting and certification strategy
Drivetrain	Shimano CUES / Linkglide 10-speed plus e-bike chain	Frame baseline is compatible	Define torque-unload strategy and validate complete drive path
Brakes / wheels / tires	Downhill-oriented brakes, compatible large rotors, rated wheel and tire system	Candidate hardware only	Confirm all manufacturer limits and complete wet/fade/stability tests
Enclosure / telemetry	Custom protected frame enclosure and local safety display	Concept	Freeze only after thermal, ingress, service and loss-of-link testing
Operating category	Closed-course prototype pending classification	Not road released	Complete legal, insurance, equipment and registration review before any public operation

10.1 Reference basis (official sources, accessed July 2026)

1. CYC Motor, Photon Gen 2 product page
2. CYC Motor, X1 Pro Gen 4 product page
3. CYC Motor, product FAQ and current system specifications
4. Cannondale, Habit HT 2 product specification
5. Tenpower, current cylindrical-cell portfolio
6. Molicel, P60B announcement
7. Molicel, P60C product page
8. British Columbia, Motor Assisted Cycle (E-Bike) Regulation

Product specifications, availability, regulations, and component compatibility can change. Revalidate all sources immediately before procurement, fabrication, testing, or operation.