

PLANNING PHASE

Bethlehem Space & Exploration Center

Master plan and first research pass (not a professional feasibility study)

Explore more. Learn more. Share knowledge. Help one another. Enjoy being alive.

Version

v0.3 · 2026-10-19

Status

Planned — main location
being finalized; nothing is
built yet

Proposer

David Fischbarg

Nothing has been secured.

No land, building or lease; no zoning, building, environmental or FAA permit applications yet; no funding, grant or donation; no legal entity; no partnership, agreement or expression of interest from any organization named here; no launch license, site or operation. Aethon has not established, funded or committed to this center. Prepared with AI research assistance; not yet reviewed by an independent expert. Facts carry numbered sources (Appendix B); design ideas are labelled as assumptions; every drawing is Planning phase.

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1. Executive vision

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Help build a world where people can explore more, learn more, share knowledge, help one another, and enjoy being alive. The center would make space science and engineering accessible — especially to young people in Bethlehem — create meaningful local work, and contribute in honest, small steps to long-term exploration.

- **Programs before buildings.** Free star nights, mission-simulation workshops, balloon-payload builds and school missions in borrowed venues come first.
- **Working location idea (an assessment).** A walkable public front door and first small space in South Bethlehem, near Third Street, and a research home at Lehigh's Mountaintop Campus only if Lehigh invites it; otherwise the research home stays undecided. Every site is still studied, not selected.
- **For the world and its people.** Everything the center does is for the world and its people, and it takes care of the people, animals, land, water and air it touches. Every site and event has sorting points for recycling, compost and reuse; materials are salvaged when a building is redeveloped or adapted, and food and garden waste is composted where possible.
- **No launch site.** A Lehigh Valley spaceport rates very low; flight work happens at licensed ranges elsewhere through eligible partners.
- **2030 target.** A credible early milestone — a registered nonprofit, one hosted or leased program space, free monthly public programs, one student flight-hardware project — with no land owned, no new building and no launches.

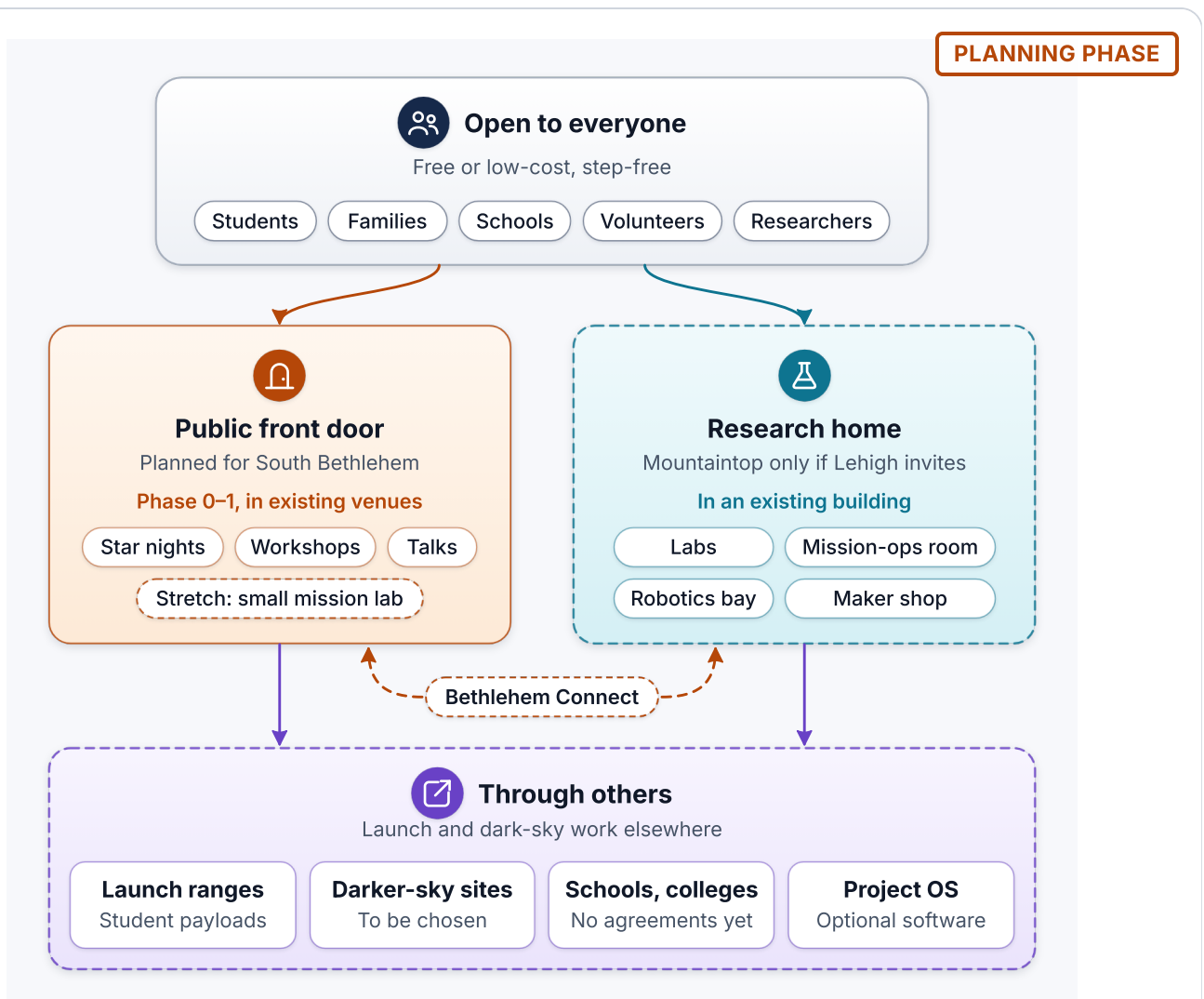


Figure 1. Executive vision — programs first, a public front door and a research home only if invited

v0.3 · 2026-10-19 · Diagram — not to scale

The plan in one picture, as a working idea: programs open to everyone, starting in Phase 0-1 in existing venues; a walkable public front door planned for South Bethlehem; a research home in an existing building at Lehigh's Mountaintop Campus only if Lehigh invites it (otherwise undecided); a possible transit link between the two; and launch ranges, darker-sky sites, schools and colleges and Project OS reached through others, with flight and dark-sky work done off site.

- Public front door: South Bethlehem near Third Street, walkable and near buses.
- Public front door, Phase 0-1: star nights, mission-simulation workshops and talks in existing venues.
- Public front door, stretch: a small street-level mission lab, only if a unit is documented and funded.
- Research home: an existing building at Lehigh's Mountaintop Campus only if Lehigh invites it. No invitation exists. Otherwise the research home stays undecided, with no site assumed.
- Bethlehem Connect (planned) is the possible transit link between the two homes.
- Launch and dark-sky work never happen in Bethlehem.
- Licensed launch ranges: student payloads through accredited programs (for example at Wallops, VA).
- Darker-sky sites: research-grade observing away from city lights. Sites are still to be chosen.
- Schools and colleges: shared programs only under written agreements. None exist yet.
- Project OS: the proposer's separate coordination software. Not yet public; optional.

Public, walk-in Research and engineering Through others Possible transit link (planned)

--- Dashed edge: conditional

No site, host, partner or route has been selected or agreed. Sources: ^[7,25,33,63,133,189] Planning phase.

2. Geographic context

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The South Side and South Mountain sit about 3.3–5 nm from the runways of Lehigh Valley International Airport, which is surrounded by Class C airspace (its radii were not confirmed). Skies are bright. The South Side is walkable and served by LANta buses, though service was cut twice in 2026; South Mountain is steep and wooded. ^[33,35,158,172]

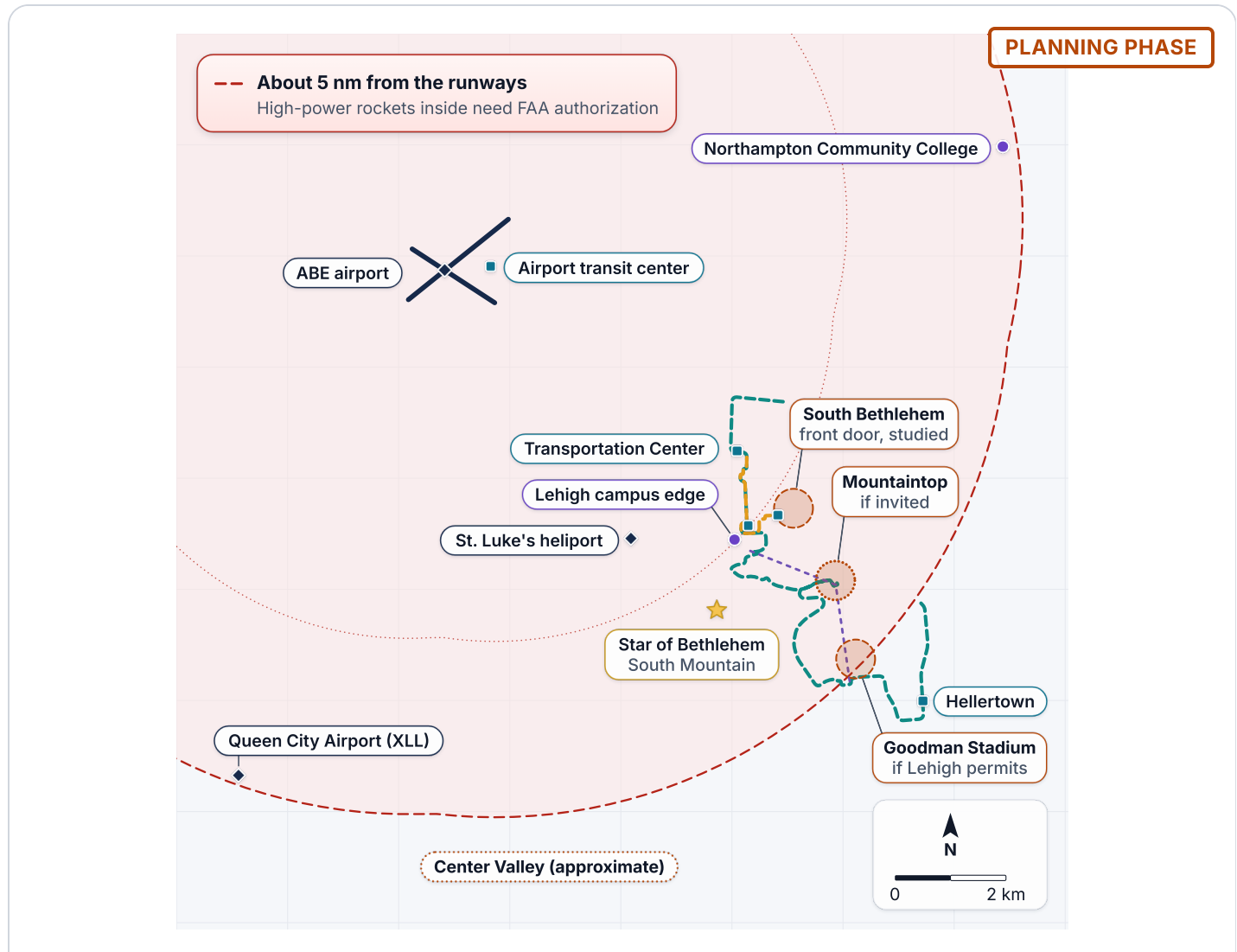


Figure 2. Geographic context map (approximate, sourced points)

v0.3 · 2026-10-19 · Approximate — not a survey. Graphic scale shown (2 km grid; 1 mi ≈ 1.6 km)

A map of the greater Bethlehem area: the studied places (approximate areas, or labels where the location is approximate), transit stops, institutions, the Star of Bethlehem and airports, the proposer's Bethlehem Connect transit plan (planning phase), and the band about 5 nm around the airport runways where high-power rockets need FAA authorization. Most of Bethlehem, including the South Side and South Mountain, lies inside it.

- Red dashed line: within ≈5 nm (9.3 km) of the ABE runways. High-power rockets need FAA authorization inside it; the rule measures from the airport boundary, which is closer.

- Thin dotted red line: the 20,000 ft Part 77 notice distance.
- South Bethlehem front door: the study area near Third Street. Mountaintop Campus: a research home only if Lehigh invites it. Both are studied, not selected.
- Goodman Stadium (Lehigh's Goodman Campus): occasional events only, if Lehigh permits. Studied, not selected.
- Center Valley: Lehigh-listed land nearby (studied). Its location is approximate, so it is a label, not an area.
- Short names: ABE airport is Lehigh Valley International Airport, St. Luke's heliport is PA80, and Lehigh campus edge is the edge of Lehigh's Asa Packer campus. Hellertown is in the Saucon Valley.
- Unlabeled stops: Southside Station beside the front-door area, and the Farrington Square / Lehigh University Center area beside the Lehigh campus edge.
- Not marked, to keep the map clear: the National Museum of Industrial History, beside the front-door area; Stabler Arena, beside Goodman Stadium on Lehigh's Goodman Campus; and Downtown and North Bethlehem, beside the Transportation Center.
- Not drawn (no sourced position yet): Forest Park and the South Mountain Park trailhead on Mountain Drive.

🌀 Study area, no site selected (approximate area, not a pin)

🌀 Candidate site (planning phase) (approximate area, or a dotted label where the location is approximate)

■ Transit stop (LANta data) ● Institution ■ Airport or heliport ● Landmark

--- About 5 nm from ABE runways --- Bethlehem Connect Spine: Planned transit line (planning phase)

--- Bethlehem Connect River Line: Planned transit line (planning phase)

--- Gondola option: Planned transit line (planning phase)

Point markers: Public place from open data or an official list (source and date shown); not checked by Project OS.

Several landmarks are shown by their nearest official LANta stop. Sites that were studied and ruled out are not drawn (shared map key v0.7.4); the site list names them. Roads, rivers and parcel lines are not drawn; use the interactive map for streets. Sources: ^[31,35,148,185,186,187,188,189] Planning phase.

3. Candidate-site comparison

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Figure 3. Candidate-site comparison — three scoring lenses v0.3 · 2026-10-19 · Chart — scores 0–100

Ten sites, all studied and none selected, in three groups by working role, each with one AI-assisted 0 to 100 bar per lens: mission and community, deliverability and risk, and science and engineering.

- Scores are AI-assisted judgments made in this research workflow, not facts and not reviews by outside experts.
- Each white track runs from 0 at its left end to 100 at its right end. The highest score under each lens is in full color. A score that rests on an unmet condition is drawn as a pale dashed bar instead, even when it is the highest.
- Highest scores: mission and community, South Bethlehem (80); deliverability and risk, Mountaintop Campus (66, assumes a Lehigh invitation); science and engineering, Mountaintop Campus (77).
- Rows follow the working idea's role order, not the scores.
- South Bethlehem, near Third Street. Working idea — public front door and first space. Community 80, deliverability 45, science 32 (average 52).
- Lehigh Mountaintop Campus. Working idea — research home, only if Lehigh invites it. Community 42, deliverability 66 (assumes a Lehigh invitation), science 77 (average 62).

- Lehigh-listed land on Center Valley Parkway. Later option (after 2030). Community 32, deliverability 46, science 57 (average 45).
- Lehigh Goodman Campus (Goodman Stadium, Stabler Arena). Occasional events only, if Lehigh permits. Community 47, deliverability 38, science 45 (average 43).
- Lehigh Forest Park / South Mountain trail corridor. Trail programs only, by written agreement. Community 60, deliverability 34, science 17 (average 37).
- Airport-area business parks (Route 22). Not pursued. Community 28, deliverability 50, science 55 (average 44).
- Lehigh Valley International Airport (LNAA) land. Not pursued. Community 28, deliverability 22, science 55 (average 35).
- Bethlehem Commerce Center (former Steel land). Not pursued. Community 26, deliverability 16, science 33 (average 25).
- Former Martin Tower site. Excluded — already committed to other uses. Community 10, deliverability 5, science 5 (average 7).
- Queen City (XLL) and Braden (N43) airports. Excluded — already committed to other uses. Community 18, deliverability 14, science 22 (average 18).

■ Mission & community
 ■ Deliverability & risk
 ■ Science & engineering

--- Dashed bar: assumes a Lehigh invitation

Every site is 'studied, not selected'. Mountaintop's deliverability score assumes Lehigh invites a hosted program; no invitation exists and Lehigh's plan assigns Mountaintop to its own uses, so without an invitation it is not deliverable.

Sources: ^[7,8,10] Planning phase.

Fact summary and assessment. Every site: studied, not selected.

Site	Documented availability (reported; not confirmed as current)	Assessment (AI-assisted design judgment)
South Bethlehem, near Third Street	No building or unit documented as available.	Working idea — public front door and first space. A walkable public front door and the first small space. Free programs start in existing venues, each with that venue's permission. A small leased street-level space in an existing building follows only if a unit is documented as available, the community supports it and money exists. This is the public front door and program space, not the research home: if Lehigh does not invite one, the research home stays undecided. No rocket flights here, and no tall structures without an FAA no-hazard determination: it is about 3.3–3.5 nm from the airport runways (a project rule).
Lehigh Mountaintop Campus	None offered. Lehigh announced its own developer discovery phase for graduate housing in fall 2025; no RFP found. ^[8]	Working idea — research home, only if Lehigh invites it. Research home, only if Lehigh chooses to invite it: a hosted program or tenant inside Lehigh's own innovation district. Lehigh has not been asked to host it, and no invitation exists. Lehigh's plan already assigns Mountaintop to its own innovation, housing and partnership uses. If Lehigh is asked and gives no written invitation within six months, the research home stays undecided; no other research site is assumed.

Site	Documented availability (reported; not confirmed as current)	Assessment (AI-assisted design judgment)
Lehigh-listed land on Center Valley Parkway	The only property found publicly offered (undated listing pages, reported): a 10+ acre (4+ ha) ground lease or build-to-suit (Enterprise zoning), two R-2 parcels for sale (8.3 ac / 3.4 ha and 5.8 ac / 2.3 ha), and an industrial building for lease. Size, availability and zoning were not verified. ^[43]	Later option (after 2030). Lehigh-listed property in Center Valley is looked at again only if the listings are still current and a funded plan exists. The listings are not targets and imply no interest in this project. Programs continue in borrowed venues meanwhile.
Lehigh Goodman Campus (Goodman Stadium, Stabler Arena)	None offered.	Occasional events only, if Lehigh permits. Lehigh's plan makes it the athletics and wellness district, so only occasional events, and only if Lehigh permits. It sits just inside 5 nm of the airport's runways (about 4.92 nm, estimate), so no rocket flights here without FAA authorization, and no tall structures without an FAA no-hazard determination (a project rule).
Lehigh Forest Park / South Mountain trail corridor	None offered; only the opened trail loops are public.	Trail programs only, by written agreement. Light-touch trail programming (night-sky walks, a scale 'planet walk') by written agreement only. No buildings.
Airport-area business parks (Route 22)	Unverified: broker listings seen use 'office/research' wording (unverified); no dated vacancy or rent was verified.	Not pursued. The center does not go here: public family programs stay away from truck yards, battery storage and fuel (our judgment); there is no Bethlehem Connect service; and labs there may need conditional-use approval.
Lehigh Valley International Airport (LNAA) land	No LNAA parcel offered for development in 2024–26 as found; LNAA commits land by direct deals. ^[45]	Not pursued. The center does not go here: large tracts are committed to other deals, and non-aviation use would need LNAA agreement and FAA review.
Bethlehem Commerce Center (former Steel land)	Not found.	Not pursued. No documented availability; industrial setting; RCRA history.
Former Martin Tower site	No.	Excluded — already committed to other uses. An approved revised master plan is under way.
Queen City (XLL) and Braden (N43) airports	None offered.	Excluded — already committed to other uses. Active airports with federal obligations.

4. Compact research center

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The compact center (S1) uses 7,000–15,000 sq ft (650–1,394 m²) inside an existing building — interior fit-out only. The 2030 target space is smaller still: 3,000–7,000 sq ft (279–650 m²).

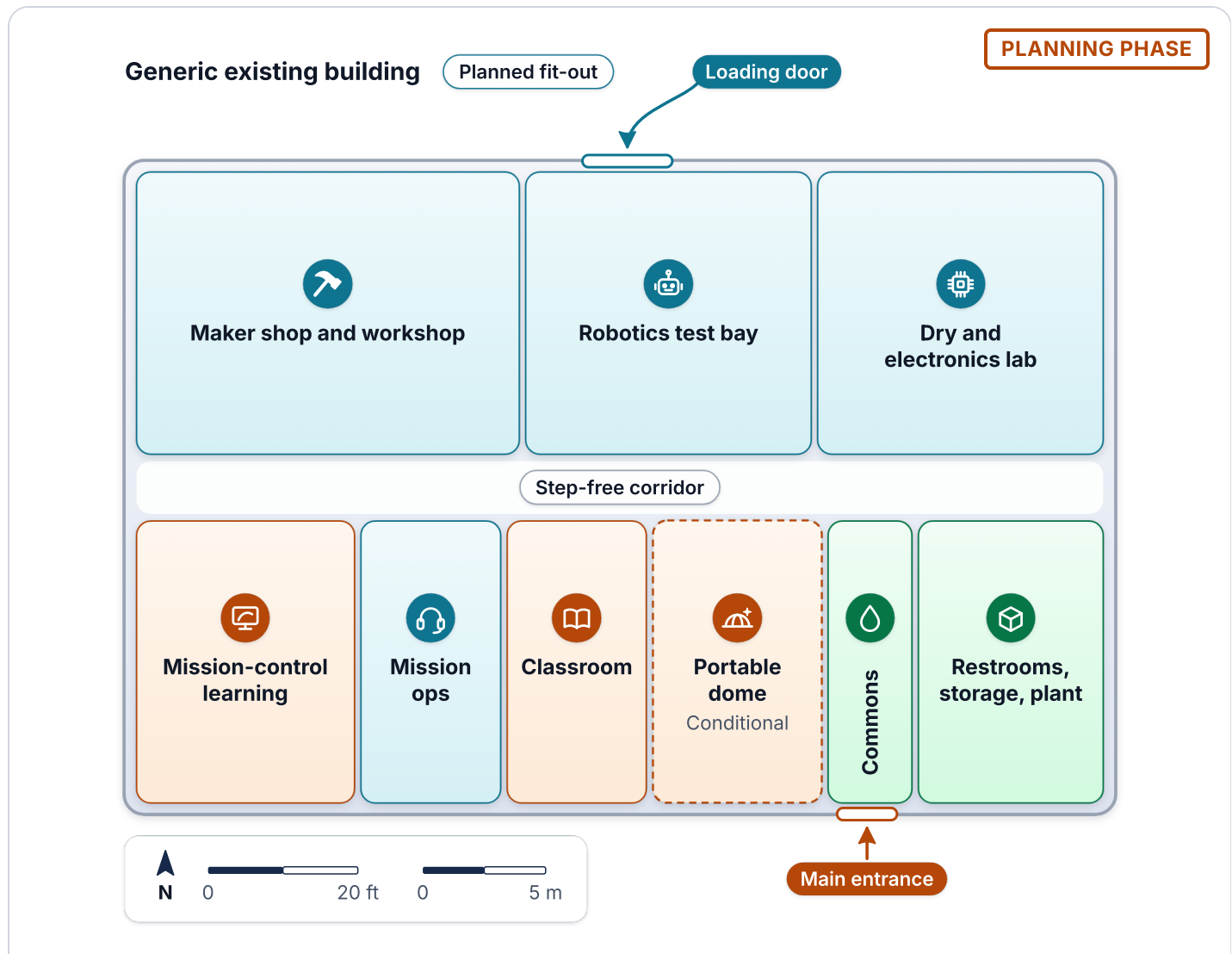


Figure 4. Compact research center (S1) — rooms in an existing building

v0.3 · 2026-10-19 · Plan — graphic scale shown (feet and metres)

A test fit of about 11,050 sq ft (1,027 m²) gross inside a generic existing building, 130 × 85 ft, drawn as a planned interior fit-out: a dry and electronics lab, a robotics test bay and a maker shop to the north; across a step-free corridor, mission-control learning, mission ops, a classroom, a conditional portable dome room, a commons at the main entrance, and restrooms, storage and plant to the south.

- The building is 130 × 85 ft. Gross area is about 11,050 sq ft (1,027 m²): rooms about 10,010 sq ft and the corridor about 1,040 sq ft.
- North rooms: maker shop and workshop, about 2,002 sq ft (186 m²), where machine-shop roles need a guide and sign-off; robotics test bay, about 1,502 sq ft (140 m²), with a roll-up door; dry and electronics lab, about 1,502 sq ft

(140 m²).

- South rooms: mission-control learning, about 1,155 sq ft (107 m²), for school missions; mission ops, about 751 sq ft (70 m²); classroom, about 751 sq ft (70 m²); portable dome, about 901 sq ft (84 m²), conditional: only if it would not duplicate existing domes or the Da Vinci Science Center's plans; commons, about 462 sq ft (43 m²), with free water; restrooms, storage and plant, about 986 sq ft (92 m²).
- The corridor is step-free and 8 ft (2.4 m) wide. The main entrance is step-free too.
- The loading door is on the north wall.

 Engineering (gated roles)  Public learning  Commons and support  Conditional room

Generic building; not any real address. Areas are design assumptions within the S1 range (7,000–15,000 sq ft). Sources:
^[3,5] Planning phase.

5. Educational and engineering campus

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A campus (S2) of 55,000–95,000 sq ft (5,110–8,826 m²) on 8–15 acres (3.2–6.1 ha) would be considered in the 2030s only with site control, zoning, environmental clearance, a capital plan and community support.

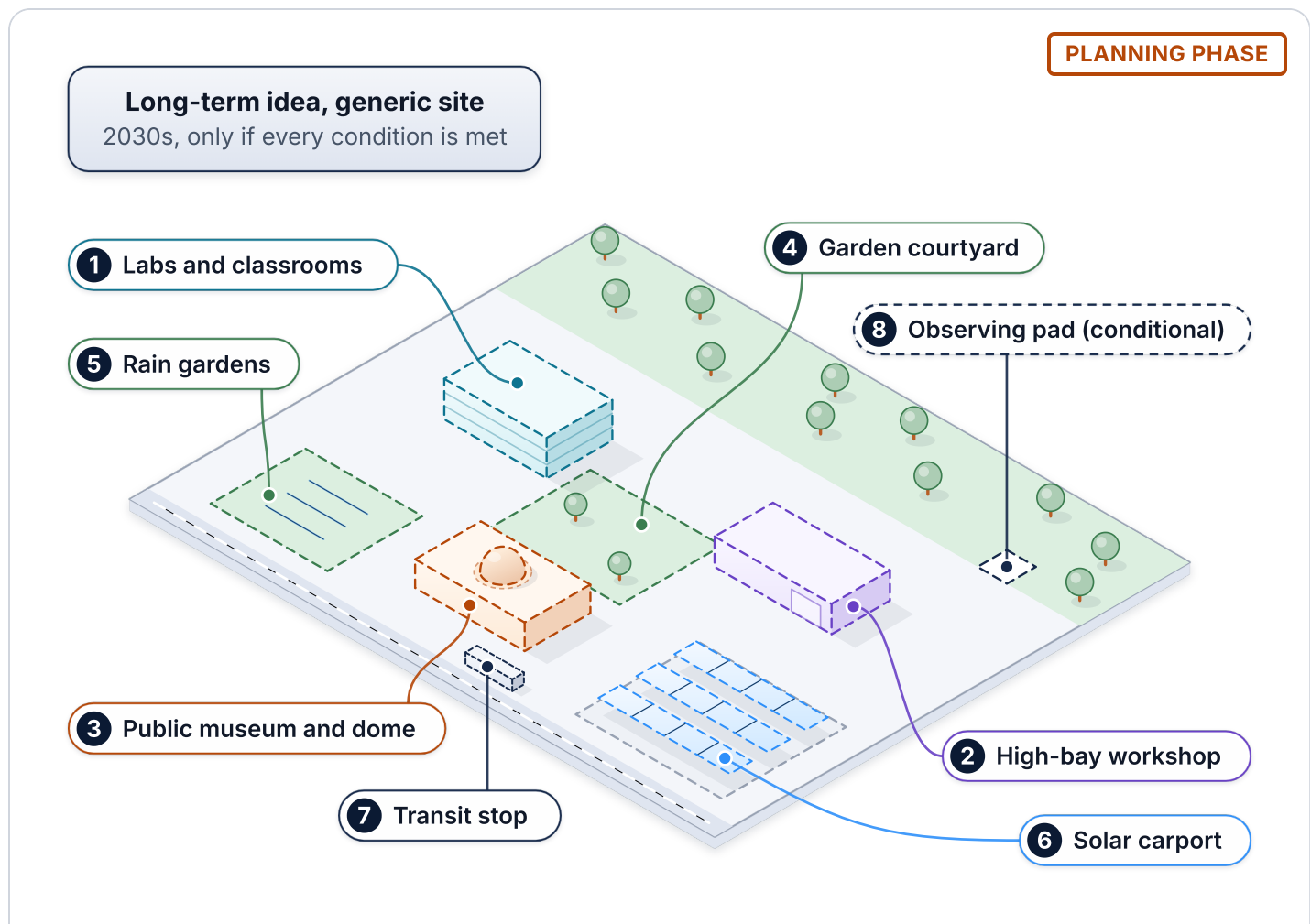


Figure 5. Campus (S2) — a long-term massing idea on a generic site

v0.3 · 2026-10-19 · Axonometric, approx. — site 800 × 650 ft (244 × 198 m)

An illustrative axonometric massing of about 70,600 sq ft (6,560 m²) on a generic 12-acre (4.9 ha) site, with eight numbered labels: a three-story lab building, a tall single-story high-bay workshop, a public museum with a 40-ft dome, a garden courtyard, rain gardens, a solar carport, a transit stop and a conditional observing pad. Planned buildings and areas have dashed edges, because nothing is designed, approved or built.

- The campus is a long-term idea: Phase 2+ (2030s), only if every condition is met.
- The generic site is 12 acres (4.9 ha). The buildings total about 70,600 sq ft (6,560 m²), within the S2 range.
- 1. Labs, mission ops and classrooms: 3 stories, about 37,800 sq ft (3,512 m²).
- 2. High-bay workshop and test bay: 1 tall story, about 12,800 sq ft (1,189 m²).
- 3. Public museum, 40-ft dome, commons and library: about 20,000 sq ft (1,858 m²).

- 4. Garden courtyard and outdoor learning: about 0.6 ac (0.23 ha).
- 5. Rain gardens: no infiltration where karst is found.
- 6. Solar carport over about 100 parking spaces.
- 7. Transit stop and bike parking.
- 8. Outreach observing pad: only if measured sky brightness supports it.

Labs, mission ops, classrooms
 High-bay workshop and test bay
 Public museum and dome

Gardens, woods, rain gardens
 Solar carport
 Planned or conditional (dashed edge)

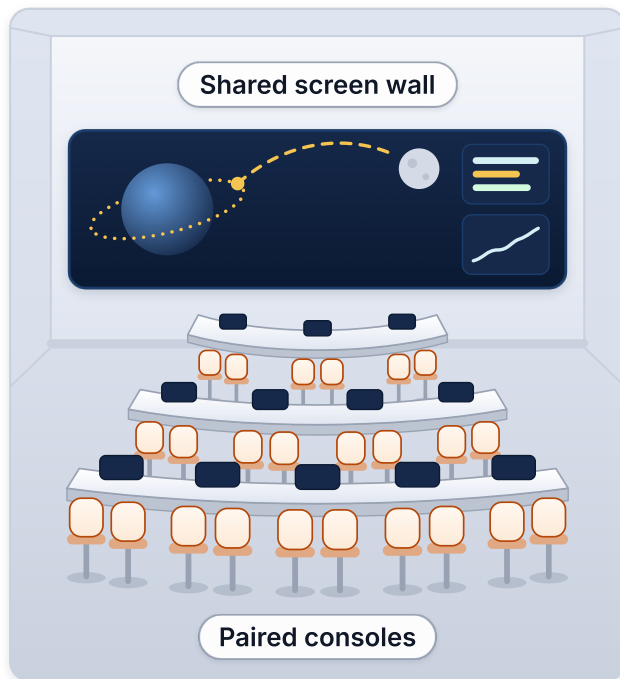
Not a design and not a real parcel. Massing only, to test whether the S2 program (55,000–95,000 sq ft) fits 8–15 acres. Design assumption; no external source. Planning phase.

6. Laboratory and workshop interiors

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Mission-control learning room

Planned · for simulated missions



Maker and robotics lab

Planned · for hands-on building



Figure 6. Lab and workshop interiors

v0.3 · 2026-10-19 · Perspective sketches — not to scale

Two planned rooms, sketched in perspective. Left: a mission-control learning room, where a class runs a simulated mission at paired consoles facing a shared screen wall. Right: a maker and robotics lab with open benches, a tool library, a gated machine area and a free water station.

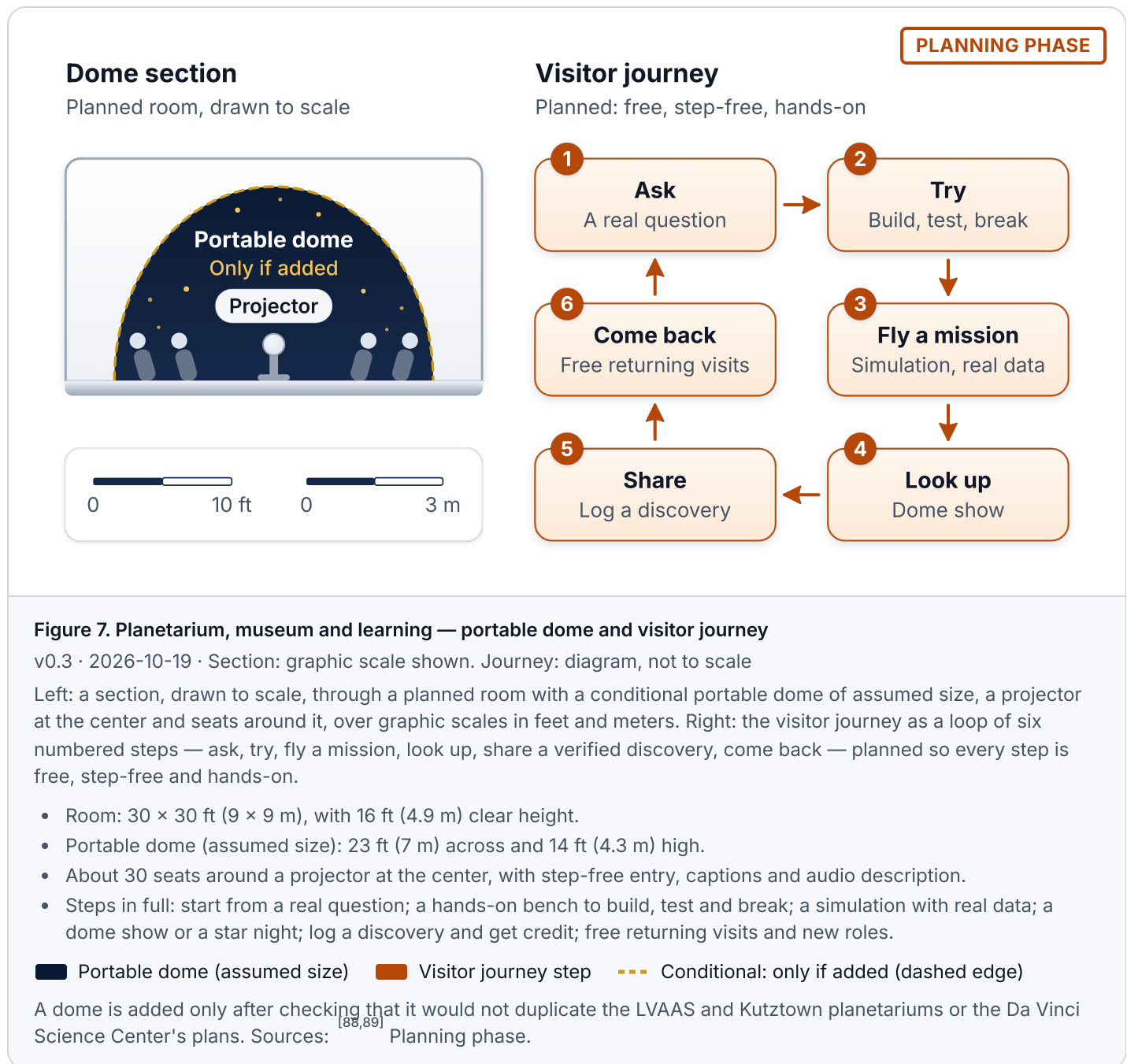
- Mission-control learning room: about 1,150 sq ft (107 m²), 24 seats.
- Maker and robotics lab: about 2,000 sq ft (186 m²).
- Tool library: tools are lent and returned.
- Machines: sign-off only, after a guide and supervised days.

○ Open to everyone (no training) ⚙️ Gated: guide, supervised days, sign-off

Illustrative drawings written as code — not photoreal, not made with an image-generation model, and not a design. Design assumption; no external source. Planning phase.

7. Planetarium, museum and learning

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8. Sustainability and energy

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Everything the center does is for the world and its people, and it takes care of the people, animals, land, water and air it touches.

What it protects

- **People:** Free, safe and accessible programs; a youth-safety policy and Pennsylvania clearances for every adult working with minors; water, food and restrooms at every gathering.
- **The night sky:** Shielded, warm-colored outdoor lighting on anything the center builds or leases.
- **Water:** Free refill instead of bottled water; rain gardens away from karst sinks; no open ponds near the airport.
- **Land and wildlife:** Existing buildings before new ones; no work on restricted brownfield ground; anything disturbed is restored.
- **Air and climate:** All-electric buildings and natural energy only: solar on site, and wind, geothermal, heat recovery and permitted hydro for the rest.

Recycle, compost and reuse

- **Sorting points everywhere:** Every site and event has sorting points for recycling, compost and reuse, with clear signs.
- **Salvage first:** Redeveloping or adapting a building starts by salvaging its materials for reuse; what can't be reused is recycled.
- **Compost:** Food and garden waste is composted where a compost option exists (to confirm locally), and the produce gardens use it.
- **Clean up:** Every place is left cleaner than we found it. An event isn't done until its cleanup is.

The facts that shape the plan

Estimate Fixed-tilt solar in the Lehigh Valley is estimated at roughly 1,150–1,300 kWh per kWdc per year. This is a planning estimate; a site-specific NREL PVWatts run is required.^[167]

Estimate Lehigh's 3.1 MWdc single-axis tracker array at Goodman (June 2024) works out to about 1,600–1,650 kWh per kWdc per year — an upper bound that rooftop and carport arrays will not reach.^[18,19]

Reported Under P.L. 119-21 (signed 2025-07-04), solar loses the 45Y/48E credits if placed in service after 2027 unless construction began by 2026-07-04. That window has closed, so this plan assumes no federal solar credit.^[162,165]

Reported Energy storage keeps the full 48E credit for construction starting through 2033, then 75% (2034) and 50% (2035). Commercial geothermal heat pumps keep \$48 at 30% through 2032, then 26% (2033) and 22% (2034). Foreign-entity and material-assistance rules apply.^[162]

Reported Elective (direct) pay survived the 2025 law, so a tax-exempt nonprofit could still receive eligible credits — mainly storage and geothermal heat pumps — by filing Form 990-T.^[164]

Reported The §179D efficient-buildings deduction ended for construction beginning after 2026-06-30, so it is not available to this project.^[163]

Reported Pennsylvania net metering allows non-residential systems up to 3 MW (5 MW under conditions); year-end excess is paid at the price to compare; virtual meter aggregation is allowed within 2 miles in one utility territory.^[109,166] Bethlehem is PPL Electric territory and PPL's tariff controls the details.

Natural energy only

- **Natural sources only:** Solar, wind, geothermal and heat recovery, and hydro only where it is permitted, with fish passage and environmental reviews.
- **Stored for reuse:** Energy is stored to be used again: batteries, thermal storage, and pumped storage where the land allows.
- **Regional hubs:** Supply would come through Energy & Logistics Hubs, the proposer's separate idea for hubs that repeat region by region. None is sited, funded or built yet.
- **The grid's rules:** Power crosses the grid only under the utility's and the state's rules: here, PPL Electric's tariff and Pennsylvania's net-metering rules.

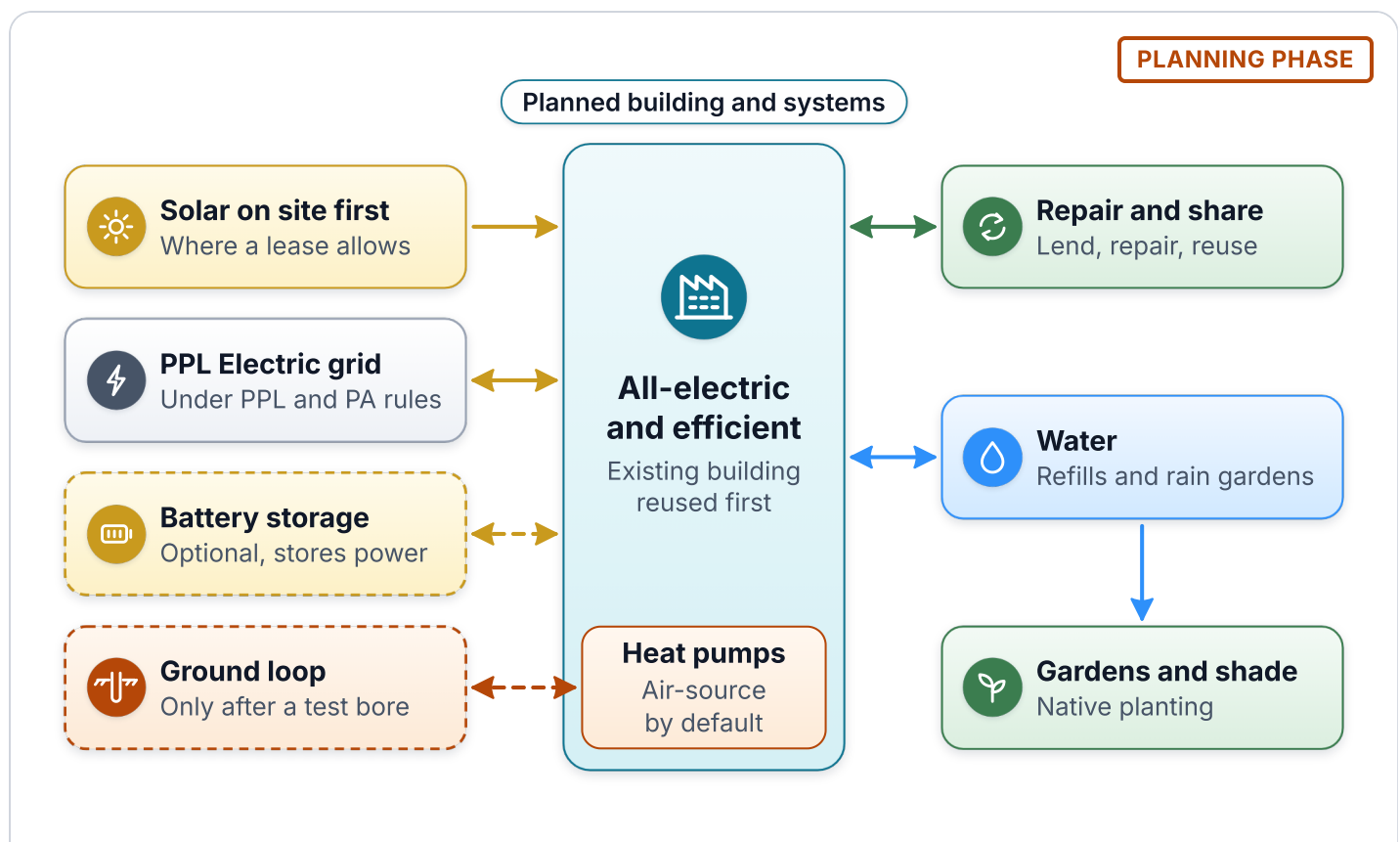


Figure 8. Sustainability and energy systems — flows and loops

v0.3 · 2026-10-19 · Diagram — not to scale

In the middle is a planned all-electric, efficient building (an existing building reused first) with heat pumps inside. Energy comes in from the left: solar on site first, the PPL grid both ways under PPL and Pennsylvania rules, optional battery storage and, only after a test bore, a ground loop for the heat pumps. On the right, materials and water run in loops: a repair-and-share library, and water for refills and the gardens. One label marks the building and all its systems as planned.

- Solar on site comes first: rooftop or carport arrays, only where a lease allows.

- The PPL Electric grid works both ways. Pennsylvania net metering allows up to 3 MW, and excess is paid at the price to compare (tariff details to confirm).
- Battery storage is optional: an NFPA 855 room with listed equipment, modeled with and without the 48E storage credit.
- The building is all-electric and efficient: an existing building reused first, heat pumps and heat recovery, ventilation-first lab design, LED and shielded warm lighting, and step-free, quiet rooms with daylight.
- Heat pumps are air-source by default. A ground loop for ground-source heat pumps comes only after a test bore and thermal response test, never in karst sinks and never through restricted brownfield ground.
- Water: free refill stations, and rain gardens and cisterns for the gardens. No ponds near ABE.
- Gardens and shade: native planting, a community garden and outdoor learning.
- Repair and share: a tool and telescope library (lend and return), repair days and reused exhibit parts. A gift policy comes first.

— Electricity
 — Heat
 — Water
 — Materials and reuse
 - - - Optional, or only after a test bore

Planning yield 1,150–1,300 kWh/kWdc/yr for fixed solar is an estimate; no federal solar credit assumed. Sources: [109,162,166,167,169] Planning phase.

9. Transit connection alternatives

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Bethlehem Connect is the proposer's separate transit plan. Planning phase. Stage P0: conversations and data. No agency review, funding, engineering or ridership forecast exists.^[189]

Connect Spine (Phase 1 plan): An electric bus rapid transit line from the I-78 Park & Ride through Hellertown / Saucon Valley, Goodman / Stabler Arena, Mountaintop / Iacocca Hall, the Lehigh University Center, Farrington Square, Downtown / Broad Street and Moravian to North Bethlehem (Linden & Elizabeth): about 16.5 km and 35 minutes end to end.

River Line (Phase 1 plan): An upgrade of LANta's existing Enhanced Bus core from Downtown via Farrington Square to Third Street / SteelStacks: about 2.5 km.

Options and later steps: A gondola for the South Mountain climb (Goodman – Mountaintop – Asa Packer, about 3.4 km); a Valley Express bus; extensions to Wind Creek or Bethlehem Square only if demand supports them; a long-term rail-ready valley corridor.

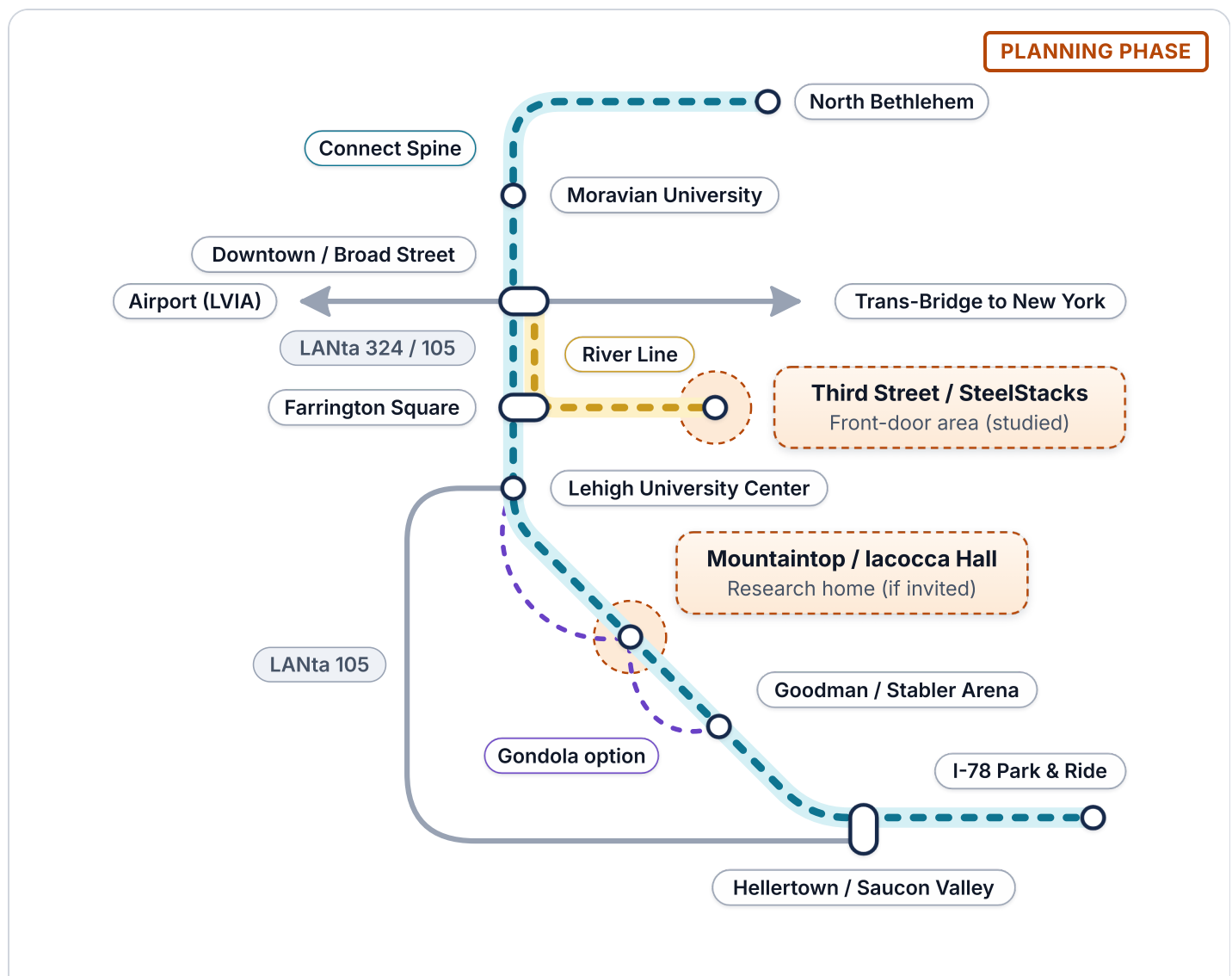


Figure 9. Transit connection — the studied places and Bethlehem Connect

v0.3 · 2026-10-19 · Schematic — not to scale; positions simplified

A schematic of Bethlehem Connect, the proposer's separate transit plan, with its planned lines dashed and today's buses in solid grey, and the two studied center places shown as approximate areas near its planned stops.

- Connect Spine: about 16.5 km and 35 min end to end.
- River Line: about 2.5 km, from Downtown via Farrington Square to Third Street / SteelStacks. That stop would be rail-ready (planned).
- Gondola option: Goodman – Mountaintop – Asa Packer, about 3.4 km. It is drawn to the nearest Spine stops.
- Research home at Mountaintop / Iacocca Hall: labs and high-bay space, only if Lehigh invites it. Goodman / Stabler Arena: occasional events, only if Lehigh permits.
- LANta 105 runs Hellertown – Lehigh University – Southside – City Hall – BTC – LVIA. Its run beside the Spine is not drawn. It does not serve Mountaintop, which has no public transit today.
- Downtown / Broad Street is the Transportation Center stop. North Bethlehem is at Linden & Elizabeth.
- Airport (LVIA): the LANta transit center, reached today by LANta 324 and 105.

- Existing bus service, today (LANta, Trans-Bridge) - - - Connect Spine — electric BRT (planned)
- - - River Line — upgraded bus core (planned) - - - Gondola option (planned) ○ Planned stop
⊗ Center place, approximate area (studied, not selected)

Bethlehem Connect is in its planning phase, not funded or engineered by any agency, and the center does not depend on it. Sources: ^[172,173,189] Planning phase.

Where the center's places meet the plan (Bethlehem Connect's own estimates).

Center place	Nearest Connect stop (planned)	Note
Public front door — South Bethlehem, near Third Street	Third Street / SteelStacks (River Line)	On the plan's rail-ready corridor; the industrial history museum is about a 6-minute walk.
Research home — Mountaintop, only if Lehigh invites it	Mountaintop / Iacocca Hall (Spine; gondola option)	About 8 minutes on Connect to Farrington Square; the hill is about 190 m above it, too steep for a conventional train.
Occasional events, if Lehigh permits — Goodman	Goodman / Stabler Arena (Spine)	About 9 minutes to a rail-ready stop.
Visitors from the south — Hellertown and the I-78 Park & Ride	Hellertown / Saucon Valley; I-78 Park & Ride (Spine)	The plan's southern terminus; its park-and-ride site is still to be determined.

What runs today

Bethlehem Transportation Center (BTC): LANta's hub at 635 Guetter St (Broad & Guetter). Some Route 324 trips to the airport start or end here from 2026-06-15.^[63,172]

South Bethlehem / SteelStacks: LANta's Enhanced Bus Service Green Line (Route 100) and Blue Line share a core between downtown Allentown and the South Side; Southside Station eastbound moved to E 2nd St at Fillmore in August 2024. No stop is named 'SteelStacks'.^[172]

Downtown Bethlehem: Enhanced Bus stops moved from Broad St to Walnut St at New St on 2025-11-20; the Route 601 downtown shuttle stops at the Walnut Street Garage.^[172]

Hellertown / Saucon Valley to the airport: LANta Route 105 runs Hellertown – Lehigh University – Southside – City Hall – BTC – LVIA; some evening trips were cut on 2026-06-15.^[63,172]

Funding pressure: LANta made funding-driven service reductions on 2026-01-26 and 2026-06-15 after warning of route eliminations in its FY2026 budget.^[172]

Lehigh University buses: Hub-and-spoke from Asa Packer; the Mountaintop Connector runs on 30-minute headways on weekdays (Spring 2026). Since 2026-01-20 there is no transit between Goodman and Mountaintop. Whether non-affiliates may ride was not found.^[24,25]

Intercity bus: Trans-Bridge Lines runs scheduled service from the BTC to New York's Port Authority Bus Terminal (schedules effective 2026-07-10) and added Newark Airport service in 2025, reportedly on its separate Wind Creek schedule rather than from the BTC (unverified).^[173]

10. Partnerships and workforce

PLANNING PHASE

Learn, build, earn credentials, work locally

Dashed: what the center would add

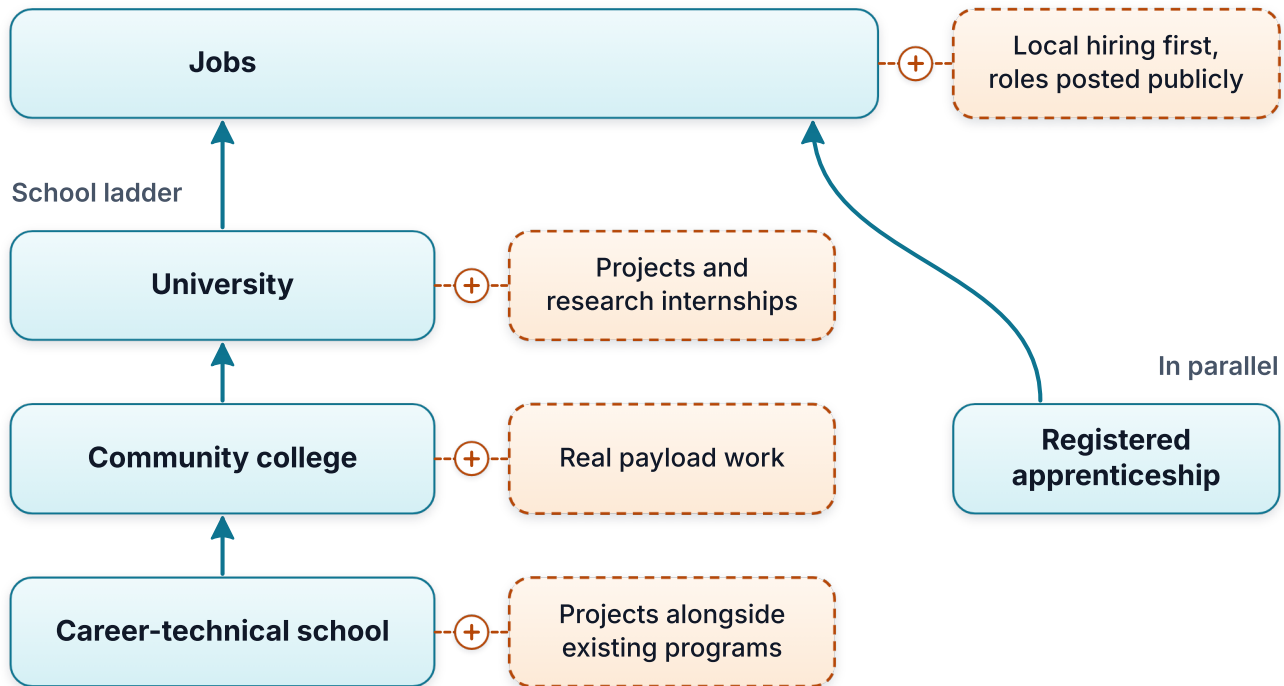


Figure 10. Workforce pathways — a ladder anyone can climb

v0.3 · 2026-10-19 · Diagram — not to scale

A three-step school ladder (career-technical school, community college, university) and, in parallel, registered apprenticeship, both leading up to jobs. Dashed boxes show what the center would add at each school step and at jobs. The organizations in the caption are examples of what exists nearby; none has been contacted, and none is a partner.

- Career-technical school: hands-on mission and hardware projects alongside existing programs. Nearby example: Bethlehem AVTS (electronics, mechatronics, machining).
- Community college: machining, electromechanical and aviation pathways, with real payload work. Nearby examples: NCC (electromechanical, machining) and LCCC (aviation).
- University: engineering, physics and data projects; research internships. Nearby examples: Lehigh (aerospace MS), Penn State LV and Moravian.
- Registered apprenticeship, in parallel: mechatronics, machining and electronics, through existing programs. Nearby example: the iTEC registered apprenticeship consortium.
- Jobs: local hiring first; every role posted publicly; paid internships wherever possible.
- Verified credits by name and role, and clearances for adults working with minors.

Pathway step

+
 What the center would add (planned)
 Pathway route

Potential partners only — none contacted, none committed:

Universities: Lehigh University: a new MS in Aerospace and Space Systems Engineering (launched 2025–26; sources disagree on the start term), the AIR robotics lab, the ATLSS structural testing lab, student rocketry and space groups.^[6,84,85,86] Penn State Lehigh Valley: four-year engineering BS. Moravian University: 4/1 engineering program with Lehigh.^[77,106] Nearby Kutztown University (Berks County): an 85-seat planetarium.^[88] Lehigh is the only Lehigh Valley school seen on Pennsylvania Space Grant Consortium affiliate lists.^[79]

Workforce system: iTEC, a registered manufacturing apprenticeship consortium with Workforce Board Lehigh Valley (as of about December 2024).^[92]

Industry with relevant capability: Air Products: NASA liquid-hydrogen supply award(s), reported February 2026.^[94] Lehigh Heavy Forge (\$15M Department of Defense award, 2024) and Safran's wheel-and-brake repair station in Bethlehem.^[95,96] LVEDC's target sectors do not include aerospace, so the center would not assume an aerospace cluster.^[97]

Community colleges and career-technical schools: Northampton Community College: Electromechanical Technology AAS and a Precision Machining and Tool Design Center (August 2026).^[90] Lehigh Carbon Community College: FAA Part 141 pilot training at the airport.^[64] Bethlehem Area Vocational-Technical School: electronics, mechatronics, precision machining and welding programs.^[91]

Community science: Lehigh Valley Amateur Astronomical Society (Salisbury Township): a NASA Night Sky Network club with a 21-ft planetarium and public star parties.^[89] A Summer Science Program astrophysics session ran at Lehigh in 2026 with Space Grant support.^[80] The Da Vinci Science Center at PPL Pavilion in downtown Allentown (about 67,000 sq ft) opened in May 2024.^[170] Pennsylvania's first Challenger Learning Center, at Montgomery County Community College's Pottstown campus, was announced in 2021; Challenger Center's network has more than 30 locally hosted centers.^[171]

Health research (space medicine only with qualified partners): St. Luke's University Health Network runs its own Institutional Review Board; human-subject research needs a Federalwide Assurance and a registered IRB.^[98,99]

Assumption (design) — paid roles. Build-phase roles end when their job is done; only a few positions stay.		
Role	Horizon	Ends
Design team: licensed architect and engineers (contracted)	Build phase	When permits are issued and construction drawings are done

Role	Horizon	Ends
Owner's representative for construction or fit-out	Build phase	At the certificate of occupancy
Licensed trades for fit-out (electrical, plumbing, mechanical)	Build phase	At fit-out sign-off
Setup and commissioning: equipment, exhibits and software	Build phase	When every system passes commissioning
Training lead for staff and volunteers	Build phase	After the first season's training, handed to the safety supervisor
Opening coordinator	Build phase	About three months after opening (assumption)
Director and operations lead, reporting to an independent board	Long term	Kept
Safety and facilities supervisor: present whenever shop, lab or flight activities run	Long term	Kept; required by safety
Education and youth-safety coordinator with Pennsylvania clearances	Long term	Kept; required by law for youth programs

Scheduling, inventory, records, reminders, reports and paperwork run in Project OS or other software, not by hand. Automation never replaces the people that safety or the law requires: trained supervisors, licensed trades, youth-safety staff and the staff needed during opening hours. The long-term positions are sized to at least that.

Every role, open, trained or qualified, has a one-screen quick guide on the website's Project OS page (planning phase). Volunteer shifts last 2 hours at most; leaderboards are by category and opt-in; hours worked, speed on safety-critical work and risk-taking are never scored.

11. Launch feasibility (separate from campus planning)

PLANNING PHASE

- The center aims for real flights, in steps, none of them from Bethlehem itself. It will not build or advertise a launch site in Bethlehem, and will not take launch reservations.
- It will run mission simulation, payload design, integration and test, and its own mission control (Option A).
- Payloads built with the center's help could fly on licensed launches elsewhere, through programs that a partner school or college, or the center once it is an eligible nonprofit, qualifies for. Selection never guarantees a flight. It could apply to NASA's CubeSat Launch Initiative itself once it is an education nonprofit (Option C).
- Real flights nearby, flown by experienced, insured partners until the center holds its own insurance: exempt-weight high-altitude balloons, Class 1 model rockets and drones, only at suitable fields with written permission and the notices the rules require (Option B). No rocket flies within 5 nm of ABE without FAA authorization (a project rule). High-power flights go only to existing club fields that already hold FAA waivers.
- A spaceport in the region is a long-term idea only, and other organizations' decision: it would need an airport owner who wants it, an FAA site license with a flight path away from people, community review and a launch company. A vertical launch site in Bethlehem is not credible.
- Bethlehem is planned as a training, visitor and mission hub connected to licensed spaceports elsewhere. A launch or reentry site needs an FAA license and very large safety areas that a dense city cannot offer, so any on-site pad is only a speculative long-term idea.
- Liquid propellants have no on-site role.

The path to real launches (steps 1–3 are targets with conditions; step 4 is a long-term idea only)

STEP 1 · PHASE 0–1, THROUGH AN ELIGIBLE SCHOOL OR, ONCE INCORPORATED, THE CENTER

Real space contact from Bethlehem

- A scheduled radio contact with the International Space Station crew through ARISS: about 10 minutes, while the station is overhead. Schools and education organizations apply, and ARISS approves the equipment plan. The station is planned to operate through 2030, so this window is limited.
- A satellite ground station on the SatNOGS open network, used only to receive, so students hear and decode real satellites. Transmitting needs an FCC amateur license; whether a receive-only station needs any FCC filing is unverified.

Needs: An eligible applicant (a school or education organization; the center only once incorporated), a host venue, volunteer radio operators or a relayed contact, and an accepted ARISS proposal. Within 5 nm of ABE, an antenna mast also needs an FAA no-hazard determination (a project rule).
[218,219,220,221]

STEP 2 · AFTER GATE 3 (INSURANCE AND A YOUTH-SAFETY POLICY); FLOWN BY AN EXPERIENCED, INSURED PARTNER UNTIL THE CENTER HOLDS ITS OWN INSURANCE. THE 2030 MILESTONE INCLUDES NO LAUNCH ACTIVITY RUN BY THE CENTER.

Real flights nearby, with permission

- Exempt-weight high-altitude balloons that carry student payloads to near space, as university programs such as Maryland's do several times a semester. Larger balloons need cut-downs, a notice to air traffic control and position reports.
- Class 1 model rockets and drones at large fields; high-power rockets only at club fields that already hold FAA waivers.

Needs: A landowner's written permission, a launch point clear of the airport's controlled surface area, rockets only beyond 5 nm of ABE unless the FAA authorizes the flight (a project rule), the notices the rules require, and insurance. ^[152,216,217,156,159]

STEP 3 · PHASE 1 AND LATER, THROUGH A PARTNER SCHOOL OR COLLEGE, OR AS AN ELIGIBLE NONPROFIT WHERE A PROGRAM ALLOWS IT

Student payloads on real launches elsewhere

- Sounding rockets from NASA Wallops, about 184 miles to the Wallops airfield (the launch pads are a few miles farther): RockOn and RockSat take college teams, and programs for younger students have flown small experiments on NASA rockets or balloons.
- Balloon platforms such as NASA's HASP, which carries student payloads to about 120,000 ft, and NASA's TechRise challenge, where school teams get a flight on a commercial provider's balloon.
- Orbit: NASA's CubeSat Launch Initiative is open to informal education institutions such as science centers. Selection does not guarantee a launch, and no new call was found for 2025 or 2026.

Needs: An eligible team (a partner school or college, or the center once it is an education nonprofit), program fees and travel, and a payload team. Mission control can run from Bethlehem. ^[35,133,211,212,213,214,215,210,145]

STEP 4 · LONG TERM; AN IDEA, NOT A TARGET. IT WOULD BE AN AIRPORT OWNER'S, A LAUNCH COMPANY'S AND THE FAA'S DECISION, AND THE CENTER WOULD AT MOST USE IT.

A spaceport in the region (long-term idea, speculative)

- The only form that is even conceivable is a runway site: a carrier aircraft or rocket plane takes off and the rocket ignites far away, over open water in the examples found. In FAA counts (an FAQ copy about 18 months old and a report to Congress), 9 of 14 licensed spaceports were licensed for horizontal launch, most at existing airports; the current count was not confirmed.
- An airport can also be licensed for spacecraft landings: Huntsville became the first commercial-service airport with a reentry site license, in 2022.
- A vertical launch site in Bethlehem is not credible: the South Side and South Mountain sites are about 3.3–5 nm from the airport's runways, parts of west and north Bethlehem are closer, and any corridor would cross dense population and New York and Philadelphia airspace.

Needs: An airport owner who wants it, an FAA site license with a flight corridor away from people, a separate license for every flight, a launch company, environmental and community review, and money. This plan names no airport for it, and it does not propose the airport or Route 22 corridor for the center.^[192,194,195,199,201,202,200,35]

Regional spaceports: what the record shows

Not found in public sources No FAA-licensed launch or reentry site was found in Pennsylvania, New Jersey or New York; the nearest is the Mid-Atlantic Regional Spaceport at Wallops, Virginia.^[133]

Reported Wallops is an active commercial spaceport: Rocket Lab has launched Electron there since 2023 and opened a Neutron launch complex in 2025; Neutron's first launch is now expected in 2027. These are commercial launches, not student programs.^[207,208,209]

Reported Many licensed spaceports host few or no launches. GAO found that 7 of the 12 licensed sites had not hosted an FAA-licensed launch from 2015 to 2020.^[193]

Reported Airport spaceports have struggled: Cecil (licensed 2010) had not hosted a launch by 2019; Midland's planned anchor operator went bankrupt in 2017; Houston's became an aerospace business park instead; Virgin Orbit's air launches from Mojave reached orbit but the company closed in 2023.^[196,198,197,199]

Reported Most commercial launches are vertical: 92% in the three fiscal years before the FAA's report to Congress (undated, c. 2022–2023).^[194]

Reported In August 2026 the FAA asked for input on siting new spaceports (comments due in late October 2026). A law-firm summary lists criteria including launching over open water and discusses candidates in Florida, Georgia, Puerto Rico and offshore; it mentions none in the Northeast.^[203,204]

Estimate The nearest open ocean, the Atlantic shore near Sandy Hook, New Jersey, is about 120 km (75 miles) from central Bethlehem in a straight line, across central New Jersey (our calculation from map coordinates).

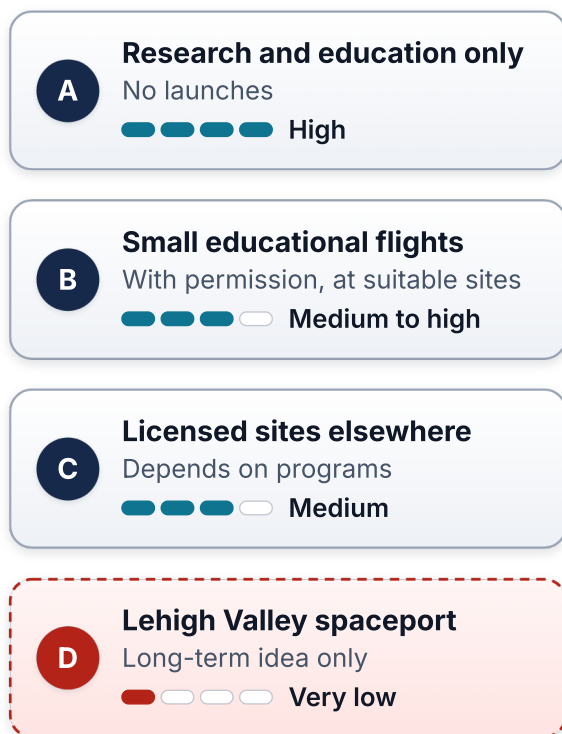
Reported A 2019 New Jersey bill proposed a feasibility study for a spaceport at Atlantic City International Airport; its outcome was not found. In 2025 the Maine Space Corporation was pursuing

1005 0001

sea-based launch, partly to avoid opposition on land; no signed agreement was found.^[203,206]

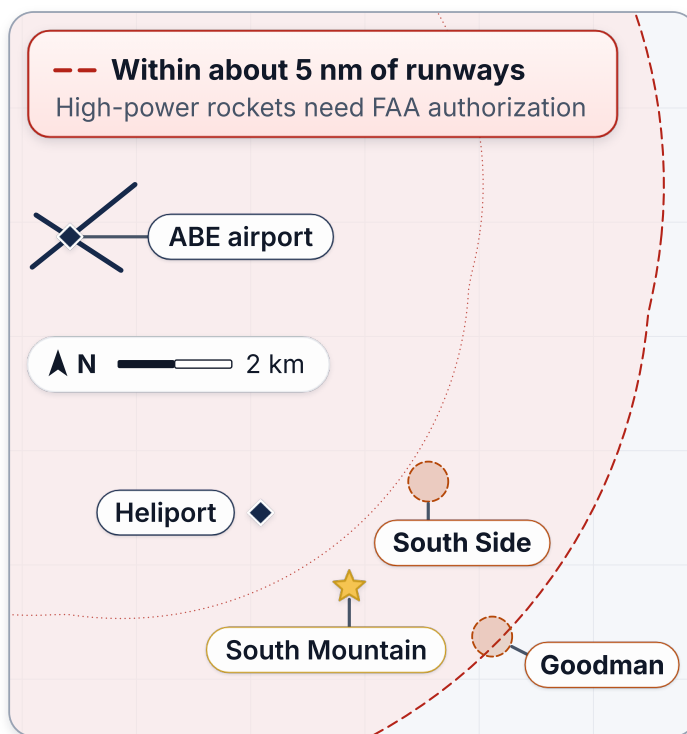
Reported Blue Origin paused New Shepard suborbital flights in January 2026 for at least two years, so some commercial payload rides are on hold.^[222]

Four launch options, by feasibility



Airspace near ABE airport

PLANNING PHASE



No launch site is planned in Bethlehem

Figure 11. Launch feasibility — separate from campus planning

v0.3 · 2026-10-19 · Ratings: qualitative. Map inset: approximate, 2 km grid (1 mi ≈ 1.6 km)

Four launch options rated from high (A, research and education, no launches) to very low (D, a long-term Lehigh Valley spaceport idea), beside a map of the band about 5 nm around the ABE runways where high-power rockets need FAA authorization, which takes in the South Side, South Mountain and, just inside its edge, Goodman; no launch site is planned in Bethlehem.

- Option A, no launches — research and education only: high feasibility.
- Option B, permitted low-risk educational activities at suitable sites: medium-high for model rockets, small balloons and drones; low for high-power rockets inside Bethlehem.
- Option C, partnerships with existing licensed launch sites elsewhere: medium — depends on program calls and eligibility.
- Option D, a future Lehigh Valley spaceport (long-term idea): very low. A vertical launch site is not credible; a runway (horizontal) site at an airport is legally conceivable but very low and long-term, and would be other organizations' decision (our judgment).
- Red dashed line: within about 5 nm (9.26 km) of the ABE runways. High-power rockets (Classes 2 and 3) need FAA authorization inside it; the rule measures from the airport boundary, which is closer.
- Thin dotted red line: the 20,000 ft Part 77 notice distance, as in Figure 2.

- Map labels: ABE airport is Lehigh Valley International Airport, South Side is the South Bethlehem front-door study area, Goodman is Goodman Stadium on Lehigh's Goodman Campus (occasional events only, if Lehigh permits; studied, not selected), South Mountain is marked by the Star of Bethlehem, and Heliport is St. Luke's hospital heliport (PA80).
- Queen City Airport and Hellertown, shown in Figure 2, are left out of this inset to keep it clear.

■ Feasibility rating
 ■ Very low rating
 --- About 5 nm from ABE runways
● Study area, no site selected (approximate area)
■ Airport or heliport
● Landmark

Ratings are an AI-assisted planning judgment from the cited rules and airspace facts, not an FAA determination and not expert-reviewed. Sources: ^[129,131,133,139,145,148] Planning phase.

Option	Rating	Requires
A. No launches — research and education only	High feasibility	No launch licensing. FCC licensing and possible FAA notice for antennas; within 5 nm of ABE, no antenna mast without an FAA no-hazard determination (a project rule); normal building approvals. ^[57]
B. Permitted low-risk educational activities at suitable sites	Medium-high for model rockets, small balloons and drones; low for high-power rockets inside Bethlehem	Written landowner permission, NAR site sizes, ATC notice where required, LAANC near ABE, no rocket flights within 5 nm of ABE without FAA authorization (a project rule), insurance, youth clearances; balloon recovery planning (prevailing winds are a design judgment, not modelled). ^[148,152,153,156,159]
C. Partnerships with existing licensed launch sites elsewhere	Medium — depends on program calls and eligibility	An eligible lead: Student Launch and RockSat require colleges or schools; CSLI also accepts nonprofits with an education component and informal education institutions. Teams fund their own hardware; selection does not guarantee a launch. ^[133,143,144,145]
D. A future Lehigh Valley spaceport (long-term idea)	Very low. A vertical launch site is not credible; a runway (horizontal) site at an airport is legally conceivable but very low and long-term, and would be other organizations' decision (our judgment)	Part 420 corridor and risk analysis over dense population, Part 450 risk limits, airspace agreements with New York and Philadelphia traffic, environmental review, insurance and local consent. Precedent: Spaceport Camden won an FAA site license in 2021, then a 2022 county referendum (upheld by Georgia's Supreme Court in 2023) stopped the land purchase. For a runway site: the airport owner's decision, FAA Office of Airports review of the Airport Layout Plan, and a carrier-aircraft route to open water about 120 km away across central New Jersey. ^[131,129,139,140,141]

Rule summaries from search extracts (October 2026); check the live text before use.

Rule	Requires (summary)
14 CFR 101.22	Class 1 model rocket: ≤ 125 g of slow-burning propellant, $\leq 1,500$ g total, paper/wood/breakable plastic, no substantial metal. Class 2 high-power: total impulse $\leq 40,960$ N·s. Class 3 advanced high-power: above that, still suborbital and unmanned within FAA limits. ^[147]
14 CFR 101.23 and 101.25	No hazard to people, property or aircraft. For Class 2 and 3: no flights into cloud or with more than five-tenths cover or under 5 miles visibility; FAA authorization needed at night, within 5 nm (9.26 km) of any airport boundary, or in controlled airspace; stand-off from the public of the greater of $\frac{1}{4}$ of maximum altitude or 1,500 ft (457 m); an adult (18+) in charge of safety. ^[148]

Rule	Requires (summary)
14 CFR 101.27 and 101.29	For anything above a Class 1 model rocket, tell the nearest FAA ATC facility 24 hours to 3 days ahead. When a waiver or authorization is needed, file the required information at least 45 days ahead (FAA Form 7711-2 to the Air Traffic Organization). ^[149,150,151]
14 CFR 101.1 (Subpart D)	Exempt from Subpart D below all of: a 4-lb package with more than 3 oz per sq in, a single 6-lb package, 12 lb total, and a suspension needing more than 50 lb to separate. Exempt balloons must still not be flown hazardingously. ^[152]
14 CFR 101.33–101.39	Not below 2,000 ft over an airport's Class B, C, D or E surface area without ATC authorization; two independent payload cut-downs and radar-reflective material; notice to the nearest ATC facility 6 to 24 hours before launch; position records at least every two hours. ^[217]
14 CFR Part 107	ATC authorization (LAANC) in Class B, C or D airspace or a Class E surface area; 400 ft ceiling; Remote ID in force since March 2024. Recreational and educational flying under 49 U.S.C. 44809 has its own conditions (unverified). ^[153,154,155]
NAR safety codes	Model rockets: minimum site 1,000 ft for E–G motors. High power: smallest site dimension the greater of half the maximum altitude or 1,500 ft; 1,500 ft from occupied buildings and busy highways. ^[156,157]
14 CFR Part 77	FAA notice above a 100:1 slope within 20,000 ft of a qualifying runway (Form 7460-1, at least 45 days ahead); antennas also under FCC rules. Our estimate, not an FAA finding: ridge land within 20,000 ft of a runway would already rise above that surface. ^[56,57]
14 CFR Part 420	A flight corridor analysis (Appendix A or B) with an overflight exclusion zone, a risk analysis where people live under the corridor, an explosive site plan with separation distances; a 5-year license that authorizes no launch by itself. ^[131]
14 CFR Part 450	Public risk limits per launch: $\leq 1 \times 10^{-4}$ expected casualties collectively, $\leq 1 \times 10^{-6}$ for any individual, and aircraft hazard areas with $\leq 1 \times 10^{-6}$ probability of a casualty-capable impact. Pre-application consultation (14 CFR 413.5); a decision within 180 days of an accepted application (51 U.S.C. 50905). ^[129,130,146]
14 CFR Part 440	Insurance set by a maximum probable loss determination, capped at \$500 million third-party and \$100 million U.S. Government property per launch. ^[132]
NEPA and FAA Order 1050.1G	An environmental assessment within 1 year or an EIS within 2 years (2023 law). FAA's NEPA order was replaced in July 2025; a July 2026 FAA proposal would waive several environmental statutes for launch licensing (not final as of October 2026). ^[134,135,136]
Executive Order 14335 (2025-08-13)	Directs DOT to expedite environmental reviews and to reevaluate Part 450; five Part 450 proposals were published on 2026-10-05 (comments due 2026-11-04). ^[137,138]

12. Phasing, governance, budgets and risks

PLANNING PHASE

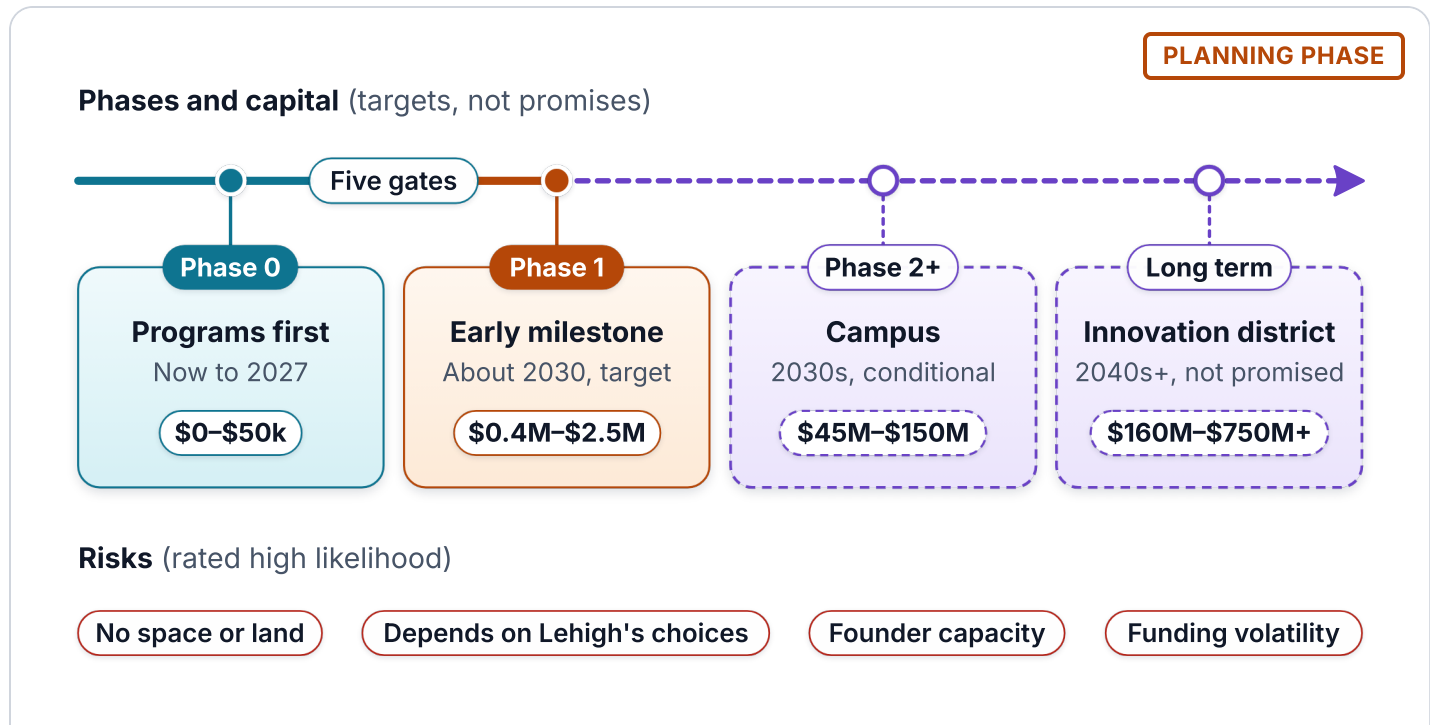


Figure 12. Phasing, gates, preliminary budgets and risks

v0.3 · 2026-10-19 · Timeline not to scale; capital in US dollars (2026), order of magnitude

A not-to-scale timeline of four phases, with the five undated gates on the way to the 2030 target, the capital range in each phase's card, and the four risks rated high likelihood.

- Phase 0, now to 2027: research, relationships and programs without a building.
- Phase 1, target about 2030: a credible early research, education or partnership milestone.
- Phase 2+, the 2030s only if conditions are met: an educational and engineering campus.
- Long term, the 2040s and beyond with no date promised: a regional innovation district.
- Gates are undated, in order, between now and 2030; each is a target, not a promise.
- Gate 1: Name and trademark search; nonprofit incorporated with an independent board.
- Gate 2: IRS Form 1023 filed; Pennsylvania charitable registration (or documented exemption).
- Gate 3: First pilot program run in a borrowed venue, with insurance and youth-safety policy in place.
- Gate 4: First written agreement with a school or partner organization.
- Gate 5: Host or lease agreement for S1-minimum space, with a funded first-year budget.
- Capital ranges, order of magnitude. Each card shows its phase's range; S1 compact is not drawn.
- Phase 0 (no building): \$0-\$50k.
- S1-minimum (2030 target space, 3,000-7,000 sq ft): \$0.4M-\$2.5M.
- S1 compact (leased or hosted): \$1.8M-\$8.5M.
- S2 campus: \$45M-\$150M, excluding land.
- S3 district: \$160M-\$750M+, many parties.
- The six top risks, likelihood / impact. The drawing shows the four rated high likelihood.
- No space or land becomes available: High / High.
- Dependence on Lehigh's choices: High / High.

- Founder capacity (the proposer is a full-time student running other projects): High / High.
- Funding volatility (federal STEM budgets unresolved for FY2027): High / Medium.
- Charity-law mistakes: Medium / High.
- Conflicts of interest (Aethon, Project OS, Lehigh Leagues): Medium / High.

■ Under way / next
 ■ Target, not a promise
 --- Only if conditions are met

Budgets are early-planning placeholders that could be half or double; no completion date is promised for any campus or launch capability. Design assumption; no external source. Planning phase.

Phase 0 — research, relationships and programs without a building (Now–2027): Re-check every decision-critical fact against primary sources. Form a Pennsylvania nonprofit with an independent board and a related-party policy. Hold South Side listening sessions before proposing any space. Inventory existing domes and programs (the Da Vinci Science Center at PPL Pavilion, LVAAS, Kutztown, the Challenger Learning Center announced at Montgomery County Community College, a middle-school mission-control center in Allentown, the Lehigh Valley Space Fest) and avoid duplicating them. Run small pilots in borrowed venues: star nights, mission-simulation workshops, balloon-payload builds. Keep this website honest: an interest list by email only. Recruit an operations lead so the work never depends on one student's schedule.

Phase 1 — a credible early research, education or partnership milestone (Target ~2030): The 2030 milestone below. Possible written agreements with schools and partners (none exist today).

Phase 2+ — educational & engineering campus (2030s, only if conditions are met): A decision on a campus site, only with site control, zoning, environmental clearance, a capital plan and community support.

Long term — regional innovation district (2040s and beyond, no date promised): The center as one participant in a wider district, if one ever forms. Launch only through licensed partners elsewhere.

2030 milestone (target, not a promise)

1. An incorporated Pennsylvania nonprofit with IRS 501(c)(3) recognition, charitable registration (or a documented exemption) and an independent board.
2. One signed host or lease agreement for an 'S1-minimum' program space of about 3,000–7,000 sq ft (279–650 m²; assumption): leased space in an existing building in South Bethlehem, or a hosted space at Mountaintop if Lehigh invites it.
3. A recurring free public program in South Bethlehem — at least monthly, weekly as a stretch goal — first in existing venues.
4. A free school-mission program under written agreements with schools.
5. At least one student flight-hardware project (for example an exempt-weight balloon payload, a CubeSat or a NASA-challenge entry) completed through an accredited partner.
6. A due-diligence package for any long-term site: environmental assessment, zoning use confirmation, utility capacity, FAA Part 77 screening and measured sky brightness.
7. No land owned, no new building or land development, and no launch activity. Interior fit-out happens only by the host or landlord, or under a permitted tenant improvement.

Gates (undated): Gate 1 — Name and trademark search; nonprofit incorporated with an independent board. Gate 2 — IRS Form 1023 filed; Pennsylvania charitable registration (or documented exemption). Gate 3 — First pilot program run in a borrowed venue, with insurance and youth-safety policy in place. Gate 4 — First

written agreement with a school or partner organization. Gate 5 — Host or lease agreement for S1-minimum space, with a funded first-year budget.

Building it right: specifications and materials come later

Nothing here is designed for construction yet. Detailed drawings, specifications and a materials list are written only when a space or building is real: a host or site chosen, approvals in view and money in place.

- A licensed architect and engineers, hired for that job, write the drawings and specifications, materials included, and check them against the building code (UCC), zoning and historic rules before any permit.
- Materials follow this plan's rules: reused, local and low-carbon first (salvaged steel and brick, wood where code allows), with all-electric systems and dark-sky lighting.
- Space ideas, such as structures at a Lagrange point, get engineering specifications only if a real mission with qualified partners ever takes them up.

Order-of-magnitude ranges; could be 20–50% lower or 30–100% higher.		
Scale	Capital	Operating
Phase 0 (no building)	\$0–\$50k	\$10k–\$75k a year (volunteer-led)
S1-minimum (2030 target space, 3,000–7,000 sq ft)	\$0.4M–\$2.5M	\$0.25M–\$0.8M a year (2–5 staff + rent)
S1 compact (leased or hosted)	\$1.8M–\$8.5M	\$0.6M–\$1.8M a year (4–10 staff + rent)
S2 campus	\$45M–\$150M, excluding land	\$3M–\$8M a year (assumption; see the ASTC benchmark below)
S3 district	\$160M–\$750M+, many parties	Not modelled; this project's share undefined

Risk	Likelihood / impact (AI-assisted judgment)	Mitigation
No space or land becomes available	High / High	Programs first; lease or host; three-tier site plan.
Dependence on Lehigh's choices	High / High	Without an invitation the research home stays undecided rather than moving to an assumed site; borrowed-venue programs and partner payload projects work without Lehigh.
Founder capacity (the proposer is a full-time student running other projects)	High / High	Operations lead; independent board; volunteer roles anyone can pick up.
Funding volatility (federal STEM budgets unresolved for FY2027)	High / Medium	Federal money as upside only; local and earned revenue base.
Charity-law mistakes	Medium / High	No solicitation until registered; interest list only.

Risk	Likelihood / impact (AI-assisted judgment)	Mitigation
Conflicts of interest (Aethon, Project OS, Lehigh Leagues)	Medium / High	Independent board; written fair-market terms; an attorney confirms software ownership.
Youth safety	Medium / High	Clearances, youth-safety policy, guardian rules, two-adult rule.
Flight and aviation safety	Low if rules followed / High	No launch site; Part 101 and Part 107 compliance; FAA screening for structures and lasers.
Contamination and site physics (RCRA history, karst, flood, slopes)	Medium / High	Phase I environmental site assessment; avoid restricted parcels; geotechnical checks.
Community harm or displacement on the South Side	Medium / High	Listen first; small, reversible footprint; no acquisition of homes; local hiring.
Duplicating existing domes and programs	Medium / Medium	Inventory first; focus on mission simulation and hardware.
Overclaiming (implying partners, launches or Aethon involvement)	Medium / High	Sourced-claims files; status labels; tests that block forbidden wording.
Implied Lehigh affiliation (the proposer is a Lehigh student; Lehigh land is studied)	Medium / High	No Lehigh marks or images; a non-affiliation line on every page; a project email address once the domain exists.
Insurance availability and cost for youth, rocketry and balloon programs	Medium / High	Broker quotes before any flight program; programs only through insured partners until then.
Name conflict for 'Bethlehem Space & Exploration Center' or 'Bethlehem Connect'	Medium / Medium	Trademark and Pennsylvania entity-name searches before choosing a domain or incorporating.

13. Worldwide replication and long-term vision

PLANNING PHASE

An aim, not a plan

PLANNING PHASE

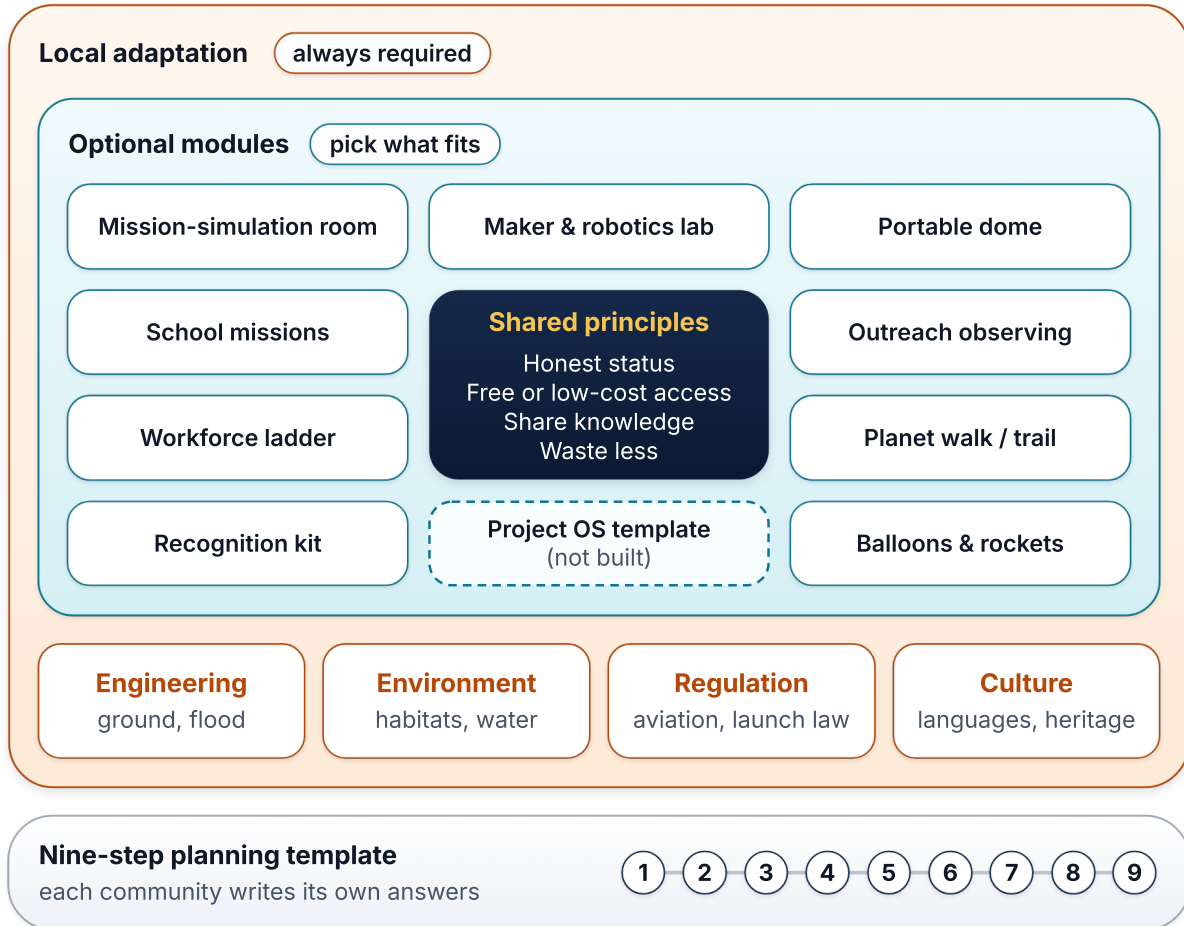


Figure 13. Long-term worldwide replication framework

v0.3 · 2026-10-19 · Diagram — not to scale

An aim, not a plan: three nested layers, with four shared principles at the center, ten optional program modules around them (one, the Project OS template, is not built) and an outer frame of local adaptation (engineering, environment, regulation, culture). Below them, a nine-step template where each place writes its own answers.

- Every module is an option a place may pick; none is built.
- Engineering: ground, climate, flood, utilities and building codes.
- Environment: contamination, habitats, sky brightness and water.
- Regulation: aviation, launch law, drones, child protection, charity and privacy.
- Culture: languages, who is left out, heritage and existing institutions.
- The nine steps: 1 status page, 2 site dossier, 3 program modules, 4 regulatory pack, 5 transit and access, 6 energy and materials, 7 partners (listed honestly), 8 budget and risks (no gifts assumed), 9 recognition kit.
- Beyond Bethlehem is an aim, not a plan or a promise: no other place is chosen, contacted or funded.

■ Shared principles ■ Optional modules ■ Local adaptation (always required)

--- Dashed edge: Project OS template (software, not built)

No single design fits every place. Precedent to study: Challenger Center's network of locally hosted learning centers.
Sources: ^[171] Planning phase.

Reuse it anywhere: what another place can copy

- The method: status labels, the honesty rules and the nine-step planning template.
- The checklists: the site dossier, the regulatory pack, youth safety, the planet-and-people rules and the quick guide for every role.
- The layouts for pages, drawings and documents, with every number kept in data so it changes in one place.

What stays local

Land and owners, permits and laws, climate and ground, language, currency, units and time zone. Each copy checks these on the spot; none is copied from Bethlehem.

- Places are data, never page code: each place is one entry in src/content/places.ts (Bethlehem is the first), with its settings in one config file (site.json) and its facts in its own data files. A new town means a new entry, not a new site.
- Templates carry no people, contacts or private data.
- A copy starts at "idea", with every approval "not requested".
- Projects share methods, never data.

Beyond Bethlehem. An aim, not a plan or a promise: if the Bethlehem pilots work, the same method could be reused in other Pennsylvania towns, in communities across the US such as the Midwest, and by towns and campuses worldwide, each with its own local answers. No other place is chosen, contacted or funded.

Long-term ideas, each tagged by how real it is today. None is a project, commitment or guaranteed outcome.

Idea	Tag	Why
Test reusable local approaches in Bethlehem — education, research, energy, transport, recreation, food and community participation	Existing technology	The tools exist today (heat pumps, solar, shuttles, shared equipment). Project OS, the proposer's separate software project, is not public yet. ^[18]
Planning templates other cities, campuses and towns can adapt (never one design for everywhere)	Plausible long-term	No templates exist yet; this is a design goal (our judgment).
Connect cities to airports and seaports	Existing technology	Bus service already links Bethlehem's transportation center and the airport (LANta 324). ^[63]
Links from research centers to licensed spaceports	Plausible long-term	Licensed sites exist (the Mid-Atlantic Regional Spaceport at Wallops is about 184 miles away); any link would be through partners' programs. ^[35,133]
Orbital research	Existing technology	Lehigh faculty experiments flew to the International Space Station on SpaceX CRS-31 (launched 2024-11-04). ^[126,128]

Idea	Tag	Why
Orbital manufacturing	Experimental research	Only small demonstrations exist (unverified).
Space solar-energy systems	Experimental research	Research and studies only; a 2024 NASA policy-office report found it would need improvements in key space capabilities to compete on cost and emissions. An orbital energy market is highly speculative. ^[230]
Space resource logistics	Experimental research	Commercial lunar landers are only now flying; Astrobotic's Griffin-1 was being prepared for testing in mid-2026. ^[127]
Lunar research stations	Plausible long-term	National lunar programs plan them (unverified); none exists today.
Any coordinating role for this center at a lunar station	Highly speculative	No such role exists or is planned; at most education and open software.
Sustainable bases on Mars and other destinations	Highly speculative	No base exists or is funded anywhere.
Off-world habitats, recycling, resource management, energy storage and transport	Experimental research	Ground analog habitats and ISS life-support systems exist (unverified); off-world versions are research.
Science beyond the solar system, first through robotic missions	Highly speculative	Interstellar travel is not possible today; this center could at most help people learn from and share mission data.
Aethon sharing ocean and subsurface robotics knowledge	Plausible long-term	Conditional: Aethon's public site says it builds software and data today and does not own exploration hardware. ^[123]
Any Aethon planetary contribution	Highly speculative	Aethon's own public site places ocean worlds in its far future, 'only if the work here earns it'. ^[123]

Lagrange points: a long-term research topic

In a two-body system such as the Sun and Earth there are five Lagrange points, where a spacecraft can keep pace with both bodies. That can reduce, not remove, the work of keeping it in place: L1, L2 and L3 are unstable, so spacecraft there fire their thrusters now and then, while L4 and L5 are stable in the idealized model.^[225,226] The center would study each location's engineering advantages and limits, and would not assume any Lagrange point suits a permanent base. This is long-term research and teaching, not a plan to build or launch anything. Specifications and materials for any hardware would come only with a real mission and qualified partners.

Lagrange-point topics, each tagged by how real it is today.		
Location and use	Tag	Why

Location and use	Tag	Why
Sun–Earth L1: solar observation and space-weather research	Existing technology	Used today: SOHO watches the Sun from L1, and NOAA's DSCOVR monitors the solar wind there for space-weather warnings, because the wind reaches L1 before Earth. ^[225,226,227]
Sun–Earth L1: energy-related research	Highly speculative	Space-based solar power is at the study stage, with nothing built at L1 or anywhere else; a 2024 NASA policy-office report found it would need improvements in key space capabilities to compete. ^[230]
Sun–Earth L2: astronomy observatories	Existing technology	Used today: the James Webb Space Telescope orbits L2, about a million miles from Earth, with small thruster burns to stay on station. ^[228]
Sun–Earth L2: communications or shared research infrastructure	Plausible long-term	L2 already hosts observatories; infrastructure shared between missions there would be a new step (our judgment).
Sun–Earth L4 and L5: large-scale orbital infrastructure and logistics	Highly speculative	Stable in the idealized model, which is why dust and asteroids collect there; large infrastructure is far beyond today's capability. ^[225,226]
Earth–Moon Lagrange regions: orbital pathways and staging for lunar exploration	Plausible long-term	Orbits there are already used: China's Queqiao relay worked from an Earth–Moon L2 halo orbit for the Chang'e 4 far-side landing. Staging concepts are still proposals. ^[229]
Orbital industry: solar power, manufacturing, research stations and transport logistics	Highly speculative	Long-term only; each would need its own engineering case for the location chosen.

Appendix A — Preliminary area schedule

Assumption (design) — preliminary areas in sq ft with metric equivalents. Planning phase.					
Facility	Phase	S1 Compact research center	S2 Educational & engineering campus	S3 Regional aerospace innovation district	Conditions
Space exploration and engineering labs (dry and electronics)	1–2	1,000–2,000 sq ft (92.9–186 m ²)	8,000–12,000 sq ft (743–1,115 m ²)	40,000+ sq ft (3,716+ m ²)	Wet labs only with a qualified partner and a chemical-hygiene plan.
Autonomous robotics and software lab / test bay	1–2	1,000–2,000 sq ft (92.9–186 m ²)	5,000–8,000 sq ft (465–743 m ²)	20,000+ sq ft (1,858+ m ²)	Campus scale includes a high-bay.
Satellite research, communications and mission operations	1	500–1,000 sq ft (46.5–92.9 m ²)	2,000–3,000 sq ft (186–279 m ²)	5,000+ sq ft (465+ m ²)	Antennas need FCC licensing and may need FAA notice (14 CFR 77.7). Within 5 nm of ABE, no antenna mast or other tall structure without an FAA no-hazard determination (a project rule). ^[57]
Astronomy observatory — where light conditions support it	0–2	None on site (portable telescopes)	0–1,000 sq ft (0–92.9 m ²)	None in Bethlehem (darker sites elsewhere)	Portable telescopes only at first; a small outreach deck only if measured sky brightness supports it; research observing at darker sites elsewhere. ^[33]
Planetarium and public space museum	1 to long term	0–900 sq ft (0–83.6 m ²)	8,000–14,000 sq ft (743–1,301 m ²)	20,000–40,000 sq ft (1,858–3,716 m ²)	Portable dome first, only after checking existing domes (LVAAS, Kutztown) and the Da Vinci Science Center at PPL Pavilion (open since May 2024; no dome confirmed) to avoid duplication. ^[88,89,170]
Engineering workshops and maker spaces	1	1,500–2,500 sq ft (139–232 m ²)	6,000–10,000 sq ft (557–929 m ²)	20,000+ sq ft (1,858+ m ²)	Machine-shop roles require a guide, supervised days and sign-off.
Student and community classrooms	1	600–900 sq ft (55.7–83.6 m ²)	4,000–6,000 sq ft (372–557 m ²)	15,000+ sq ft (1,394+ m ²)	

Facility	Phase	S1 Compact research center	S2 Educational & engineering campus	S3 Regional aerospace innovation district	Conditions
Simulation, visualization and mission-control learning	1	800–1,500 sq ft (74.3–139 m ²)	3,000–5,000 sq ft (279–465 m ²)	8,000+ sq ft (743+ m ²)	The likely regional gap — to be confirmed against Da Vinci's exhibits the Challenger Learning Center announced at Montgomery County Community College in Pottstown, and a middle-school mission-control center in Allentown (unverified), not assumed. [170,171,190]
Testing and prototyping, appropriate to the chosen site	1–2	Bench-level, inside the workshop	2,000–5,000 sq ft (186–465 m ²)	Shared district facilities	Bench-level testing inside the workshop at compact scale. No propellants or motor storage except as the fire code and the landlord allow.
Space medicine and human-performance research	2+	None	0–1,500 sq ft (0–139 m ²)	Partner-defined	Only if qualified institutional partners lead it, under their IRB and Federalwide Assurance. [98,99]
Research library, public lectures and events	1–2	Shared with the gathering space	1,500–3,000 sq ft (139–279 m ²)	5,000+ sq ft (465+ m ²)	Shared with the gathering space at compact scale.
Affordable café, free water refill, accessible gathering	1	300–600 sq ft (27.9–55.7 m ²)	2,000–3,000 sq ft (186–279 m ²)	5,000+ sq ft (465+ m ²)	Free water always. Step-free access everywhere.
Internships, apprenticeships, jobs and community participation	0 to long term	Program, no dedicated room	500–1,000 sq ft (46.5–92.9 m ²)	Program	A program first; a small office at campus scale.

Facility	Phase	S1 Compact research center	S2 Educational & engineering campus	S3 Regional aerospace innovation district	Conditions
Renewable energy, gardens and green space	1 to long term	Rooftop solar only if the lease allows	1–3 ac (0.4–1.2 ha) outdoors	District open space	Renewable energy, gardens and green space: rooftop solar only where a lease allows at compact scale; at campus scale, 1–3 acres of gardens (including produce for the food and water hub), outdoor learning, a park with themed playgrounds and a dog park, built to playground-safety and animal-welfare rules. Pets are welcome outdoors where safe.
Gross building area (incl. 25–35% circulation, storage, restrooms, plant)		7,000–15,000 sq ft (650–1,394 m ²)	55,000–95,000 sq ft (5,110–8,826 m ²)	200,000–500,000 sq ft (18,581–46,452 m ²)	
Site area		0.5–1 ac (0.2–0.4 ha) 0 acres owned (existing buildings); 0.5–1 acre only if ever stand-alone.	8–15 ac (3.2–6.1 ha) Includes parking, green space and stormwater management, with room to grow and space for a large Bethlehem Connect station (a separate plan).	30–100 ac (12.1–40.5 ha) Many owners; this project would be at most one participant.	

Food and water hub (planned)

Free water refill and a shared kitchen corner with fridges and freezers, so food from programs and events is saved instead of wasted. Every gathering plans water and food for everyone who comes.

- A named food-safety lead, with dated labels and temperature logs for shared fridges and freezers.
- Any food license or inspection the City's health bureau requires (to confirm).
- No store or food bank is named as a partner until it agrees in writing.

Restrooms (planned)

Modern, clean and accessible restrooms in every public space the center runs, including all-gender single rooms and family rooms with changing tables.

- Fixture counts and accessibility under the building code and the ADA Standards, designed by licensed professionals.
- Open whenever the public space is open, with a cleaning schedule.

Recycling, compost and reuse points (planned)

Sorting points with clear signs in every space the center runs and at every event, a reuse shelf for parts and materials, and compost for food and garden waste.

- Collection through the City's program or a licensed hauler (to confirm).
- Compost only where a compost option exists (to confirm).
- A volunteer or staff lead for each event's cleanup; an event isn't done until its cleanup is.

Space playground (planned)

A free outdoor play area next to the center, with space-themed climbing structures such as a rocket and planets, and later other play areas themed on the center's buildings. It goes only on land whose owner agrees in writing; no spot is selected.

- Built to the CPSC Public Playground Safety Handbook and the ASTM F1487 standard for public playground equipment.
- Accessible play under the 2010 ADA Standards for play areas (sections 240 and 1008).
- Inspected by a certified playground safety inspector before opening, and on a schedule after.
- The landowner's written permission and the City's permits.
- Low structures only: within 5 nm of ABE, nothing tall without FAA review (a project rule).

Standards named by the plan; editions to confirm.^[223,224]

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