

PRE-SEED · ROBOTICS, PHYSICAL AI & AI INFRASTRUCTURE

The autonomy that sets the cost of *lunar helium-3*

Ithil decides where to dig, and keeps machines digging where no one can repair them.

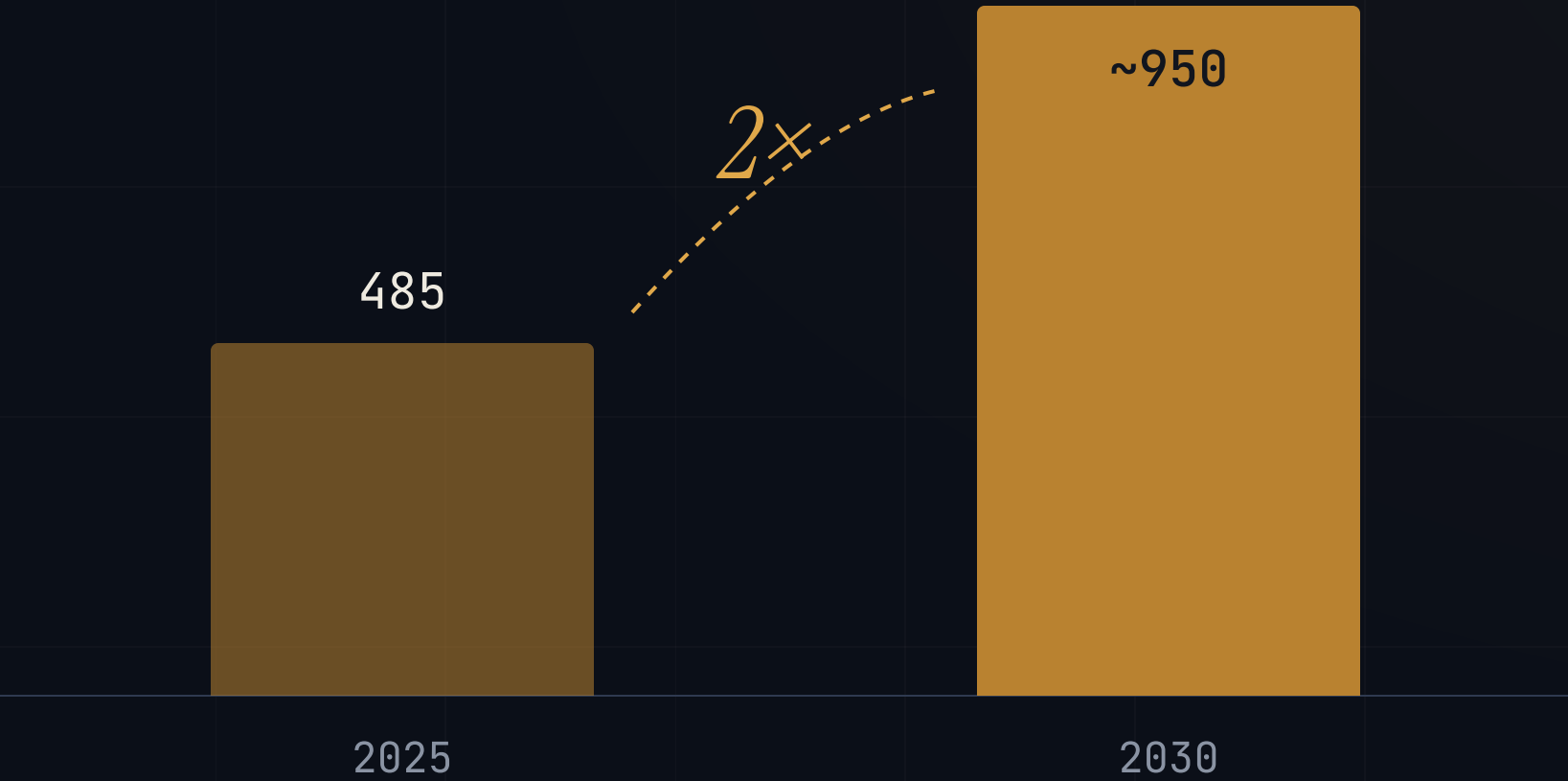
BENJAMIN LEE, FOUNDER · ITHILENERGY.IO



WHY NOW

AI needs clean, firm power *faster than the grid can deliver it*

GLOBAL DATA-CENTER ELECTRICITY, TWH



+17%

Data-center electricity growth in 2025

200 MW

Google's fusion offtake with Commonwealth Fusion Systems (2025)

\$20B

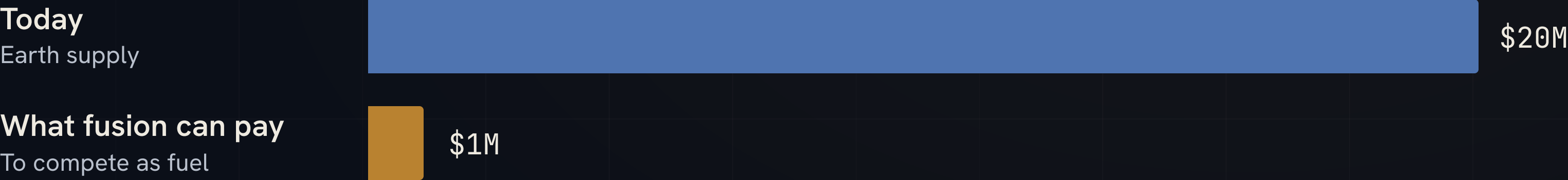
NASA's Moon Base program over seven years, announced March 2026

Sources: IEA, Energy and AI (2025 update); Google and CFS announcement; NASA

THE FUEL

Helium-3 is already scarce. *Fusion would make it the bottleneck.*

PRICE PER KILOGRAM OF HELIUM-3



5–8 kg

Demand today: quantum cooling, neutron detection

3–4 kg

Earth's supply a year, rationed by DOE

88 GWh

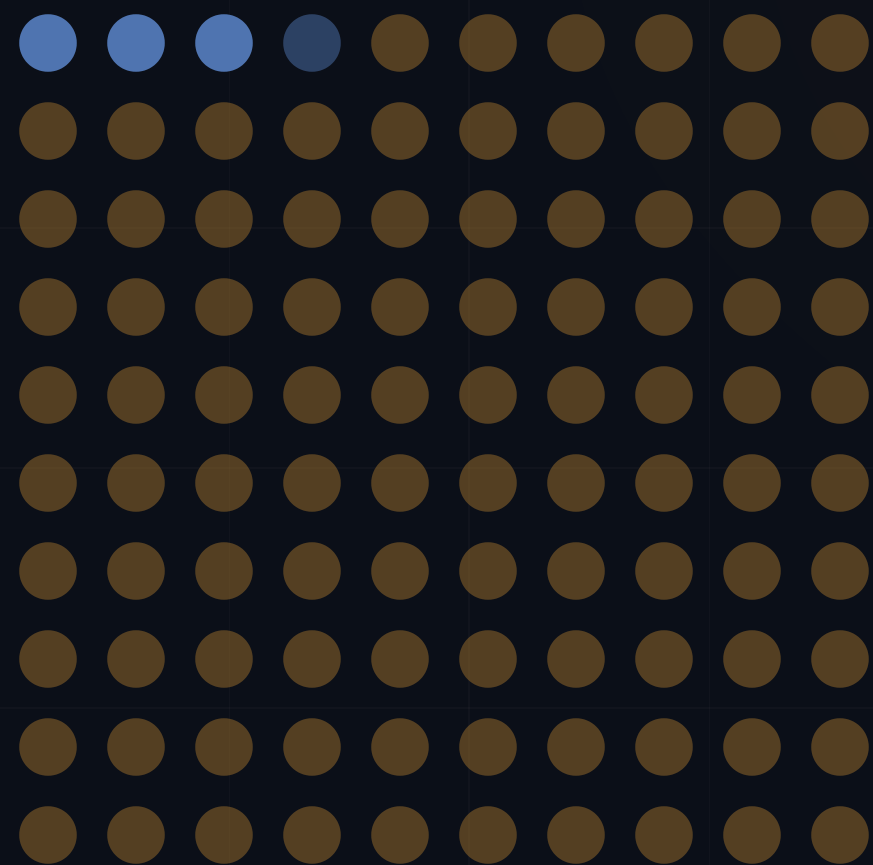
Electricity per kilogram in fusion

Sources: DOE National Isotope Development Center (22–30k L supplied vs 40–60k L demanded a year); market pricing



THE SUPPLY

One 1-GW helium-3 power plant burns *~100 kg a year*. Earth makes 3–4.



- Earth's entire annual supply, 3–4 kg
- One dot per kilogram a 1-GW plant burns in a year

0.7–1.7 Mt

Estimated helium-3 on the Moon, deposited by solar wind

Helion plans to breed its own helium-3 from deuterium. Mined supply has to beat that on cost, so our plan doesn't depend on fusion demand: it's the upside.

1 GW-year = 8.76 TWh ÷ 88 GWh per kg. Lunar inventory: published estimates, e.g. Fa & Jin (2007)

THE PROBLEM

Every kilogram means moving *100,000 tonnes* of lunar soil

At 4–15 parts per billion, cost per kilogram is set by two things nobody has solved.

01

Finding the richest ground

Grade varies several-fold from site to site and has never been measured on the Moon itself. Every dig in the wrong place burns power and machine life.

02

Keeping machines working

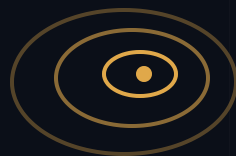
No humans, abrasive dust, 14-day nights and a signal delay. No excavator has ever operated there. Apollo's seals failed after two EVAs; a commercial plant needs 5,000 hours.

Both are AI and robotics problems.

THE SOLUTION

Ithil decides where to dig, *and keeps the machines digging*

Vendor-neutral autonomy software. It runs on anyone's excavator, rover or processing plant.



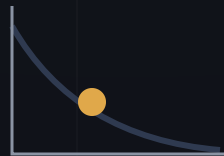
Find the richest ground

Orbital titanium and soil-maturity maps, fused with grade measured from processed samples. Active learning picks the next site to sample.



Keep machines working

Remaining life estimated from force, current, vibration and thermal telemetry. Faults recovered on board. Work scheduled around the 14-day night.



Optimize both at once

The richest ground is often the rockiest and furthest from power. Ithil trades grade against wear and energy to maximize kilograms over the fleet's life.

PRODUCT

One planner for grade, wear and power



RUNS ON

NASA's cFS and F Prime flight frameworks. Ithil sits on top; it doesn't replace them.

LEARNS

From Earth fleets first. Every processed batch becomes a ground-truth grade measurement.

THE TECHNICAL CORE

The hard part: *learning without breaking machines*

Formally, constrained stochastic control over a mixed fleet, where each machine's wear is hidden, irreversible and depends on how it's run.

Wear can't be measured, only inferred

Remaining life is estimated from force, current, vibration and thermal telemetry, a prognostics problem with training data on Earth.

The wear model changes by site

Tool-soil interaction in low gravity is poorly characterized, so the controller adapts online instead of running fixed gains.

Failure can't be explored

Failure is permanent and fleets are tiny. That rules out standard reinforcement learning: we use conservative policy improvement.

Open-loop digs; it doesn't optimize

Open-loop control is enough for site preparation. It can't trade output against remaining life under a power cap.

MARKET

The business is autonomy. *Helium-3 is the prize.*

NOW • EARTH AUTONOMY

\$5B

Autonomous mining equipment, 2026,
growing ~20% a year

\$2B

Nuclear-decommissioning robotics, 2026

NEXT • LUNAR SURFACE

\$20B

NASA Moon Base program over seven
years: rovers, power and surface
operations from 2026

PRIZE • HELIUM-3

~\$100M/yr

Fuel for each 1-GW plant at a fusion-viable
~\$1M/kg. Today's market is supply-capped
at 3–4 kg a year.

Our plan: \$2.8M revenue in 2029, from 80 licensed machines on Earth plus NASA and partner contracts.

Sources: Fortune Business Insights; Market Intelo; NASA (March 2026); ~100 kg per GW-year at \$1M/kg

COMPETITION

Everyone else optimizes *one machine or one fleet*

	VENDOR-NEUTRAL	PICKS SITES BY GRADE	PLANS FOR WEAR	BUILT FOR THE MOON
Ithil	◇ Designed	◇ Designed	◇ Designed	◇ Designed
Interlune, with Vermeer	○ No, own fleet	● Own sites	– Not public	● Yes
Magna Petra	○ No, own hardware	– Not public	– Not public	● Yes
Pronto, ASI Mining (retrofit)	● Yes	○ No, haulage	– Not public	○ No
OEM autonomy (Cat, Komatsu)	○ No, own fleet	○ No	– Not public	○ No

Moat: neutrality plus cross-fleet wear data that no single vendor can collect. NASA's cFS and F Prime aren't competitors; Ithil runs on them.

Ithil's capabilities are designed, not yet built; competitors' entries describe shipped or announced products, from public information.

BUSINESS MODEL

Software revenue on Earth first. *A royalty on every kilogram later.*

FROM 2027

Paid Earth pilots

\$100k each, in nuclear decommissioning and mining, designed to convert into licenses.

FROM 2028

Software license

\$25k per machine-year. A large mining machine costs ~\$2-3M a year to run; a 3% output gain is worth \$60-90k. We price at about a third.

2028 → 2030+

Lunar contracts, then royalty

NASA and partner contracts from 2028; a per-kilogram royalty once helium-3 is produced.

Gross margin rises from 40% to 73% by 2029 as licenses (~85% margin) outgrow services (~40-45%).

GO - TO - MARKET

Earth first, *then the Moon*

NOW - 2027

Earth pilots

Paid pilots in nuclear decommissioning and mining: revenue plus the wear and energy data the models need.

Design partner: [Name]

Channel: sold through hardware makers as their autonomy layer, and directly to mission operators.

2027 - 2029

Lunar missions

NASA and partner contracts from 2028: prospecting and single-machine autonomy on Moon Base missions. NASA SBIR funds early work.

2030+

Lunar extraction

License plus royalty with helium-3 operators as production scales.

TRACTION

The system is *already architected*

Designed as a Johns Hopkins systems engineering project, with design feedback from lunar hardware engineers.

- ✓ A full model-based systems engineering architecture for a lunar helium-3 extraction plant, in SysML
- ✓ Requirements traced to verification, including 5,000-hour operation and fault detection in under 5 s
- ✓ Trade studies, interface definitions, risk register and test plan

DESIGN FEEDBACK FROM

Kris Zacny, Honeybee Robotics
Dr. George Sowers, Colorado School of Mines
A former Blue Origin architect

NEXT BUILD

[e.g. wear estimator trained on public excavator telemetry, run on a DEM regolith simulation]

TEAM

Benjamin Lee, *Founder*

Systems engineer and data scientist. Ithil's two problems are a decision under uncertainty and a reliability problem. He has shipped both.

Reliability from telemetry

Built telemetry and reliability analytics for Microsoft Copilot at production scale.

Decisions under uncertainty

Pricing and revenue optimization with statistical models.

The system, designed

Johns Hopkins M.S. in Systems Engineering; designed a lunar helium-3 extraction architecture end to end.

Hiring next

Founding robotics and controls engineer with field-autonomy experience. [\[Name\]](#)

FINANCIALS · PROSPECTIVE

Three-year plan: *\$2.8M revenue in 2029*

	2027	2028	2029
Revenue	\$0.10M	\$0.95M	\$2.80M
Earth pilots, \$100k each	1 · \$0.10M	2 · \$0.20M	3 · \$0.30M
Software licenses, \$25k per machine-year	–	20 · \$0.50M	80 · \$2.00M
NASA and partner contracts	–	\$0.25M	\$0.50M
Gross margin, by revenue mix	40%	65%	73%
Operating expenses (headcount)	\$1.50M (4)	\$2.80M (8)	\$4.45M (13)
NASA SBIR grants, non-dilutive	\$0.15M	\$0.40M	\$0.45M
Net burn	\$1.31M	\$1.78M	\$1.96M

Prospective. Margins: licenses 85%, pilots 40%, contracts 45%. \$250k per head. If revenue slips a year, the raise lasts ~20 months.

THE ASK

Raising \$3.0M pre-seed

~23 months of runway on plan, ~20 if revenue slips a year. It reaches first licenses and a seed round in 2028.

USE OF FUNDS

✓	Engineering, incl. robotics and controls hire	65%
✓	Simulation and bench rig	20%
✓	Pilots and partnerships	15%

18-MONTH MILESTONES

✓	Wear estimator validated on Earth fleet data
✓	First paid Earth pilot
✓	NASA SBIR award or hardware-partner LOI

APPENDIX · ENERGY CHECK

Extraction uses *under 1%* of the energy the fuel returns

ENERGY PER KILOGRAM OF HELIUM-3



Not counted: separating helium-3 from helium-4 and returning it to Earth, which dominate cost. Process heat isn't the constraint; moving 100,000 t of soil per kilogram is.

Source: University of Wisconsin Fusion Technology Institute, Mark II/III lunar miner design (heat to 700 °C, 85% recuperation)