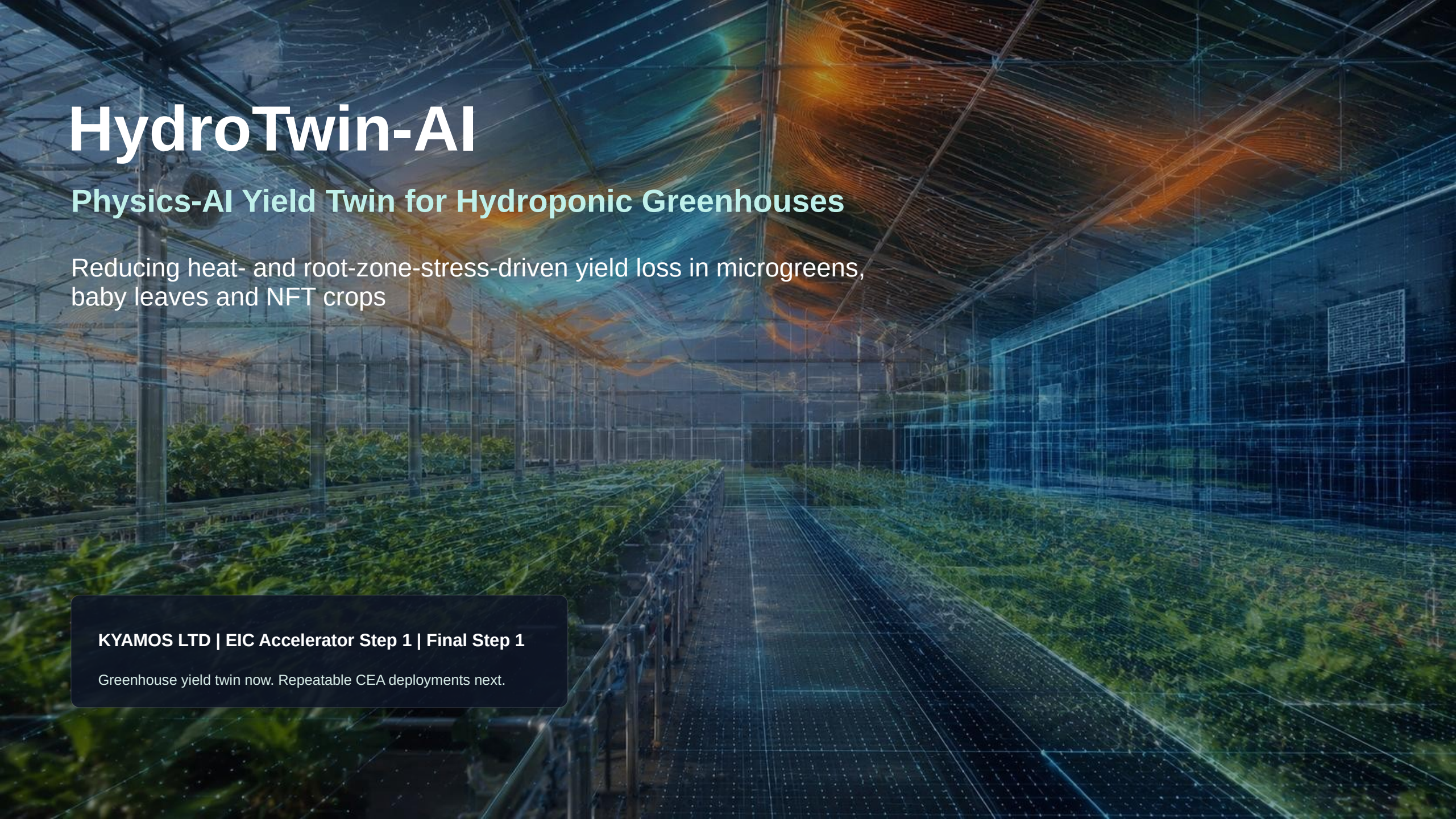


# HydroTwin-AI

## Physics-AI Yield Twin for Hydroponic Greenhouses

Reducing heat- and root-zone-stress-driven yield loss in microgreens, baby leaves and NFT crops

**KYAMOS LTD | EIC Accelerator Step 1 | Final Step 1**

Greenhouse yield twin now. Repeatable CEA deployments next.

# 1. Problem: yield reliability beats energy-only optimisation

## Energy costs matter, but commercial crop determines profitability.

### 1 EUR 60k/yr energy context

Planty electricity cost: approx. EUR 5,000/month. Energy savings alone are too small as the main EIC story.

### 2 10-20% validation target

On approx. EUR 1.2M production baseline: if validated, +10-20% improvement in affected high-stress crop lines/peak-summer loss pool = material annual value target.

### 3 2x only long-term upside

Not a measured claim. Only a larger Planty scenario based on unused capacity, reduced summer rejection and crop-mix optimisation.

### Customer pain

- Short crop cycles amplify small stress windows
- Rejection, non-uniformity and timing delays hit revenue
- Dashboards show values; they rarely explain crop outcome risk

**Target: reduce climate/root-zone-driven yield loss and improve crop-cycle reliability.**

Validation target, not a claimed measured result.

# 2. Solution: advisory yield twin platform

## A measured crop-production process, not another sensor dashboard.

**1 Crop records**
sowing, harvest, quality, rejection

**2 COTS sensors**
climate, light, root-zone, EC/pH, flow

**3 Physics-AI model**
high-fidelity reference + fast surrogate

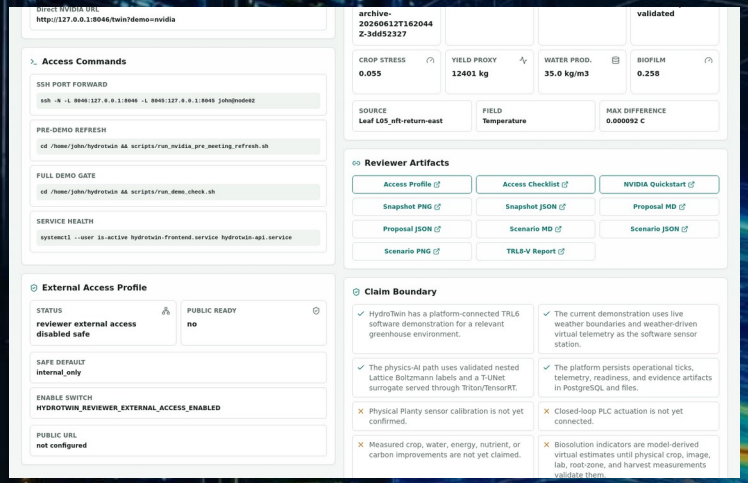
**4 Scenario advice**
shade, misting, oxygenation, density, timing

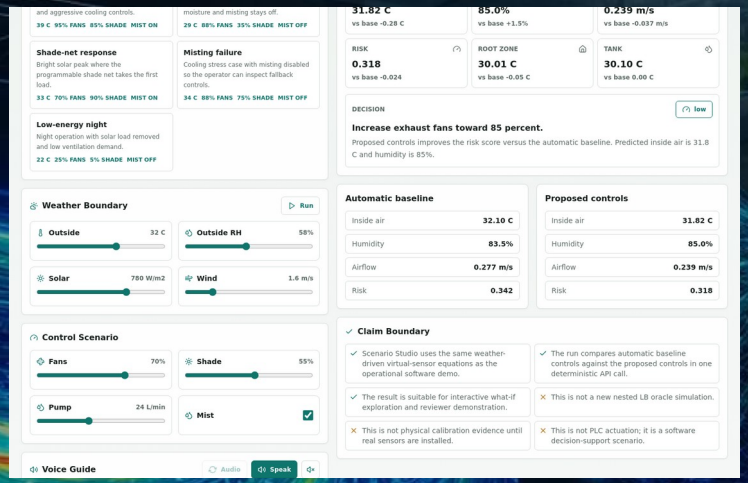
### Operator questions answered

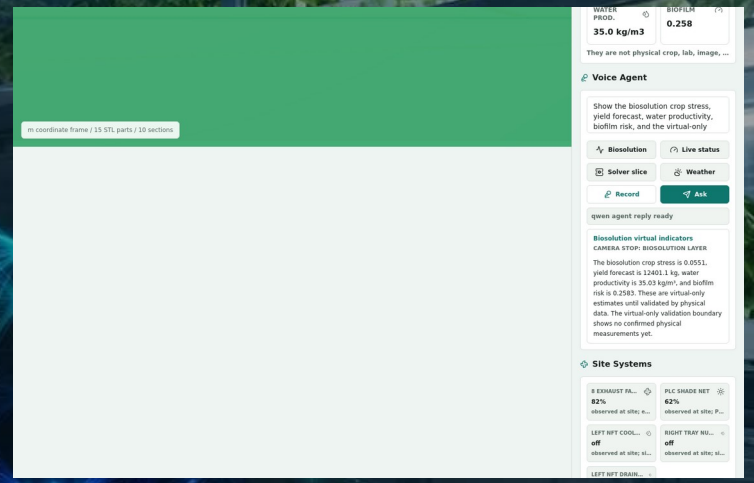
- Which zone/crop line is underperforming?
- Are roots being stressed by temperature, DO, EC/pH or flow?
- Does misting/shade help yield or only add cost?

**Human-supervised advisory product. No autonomous control during the EIC project.**

# Not starting from a concept.



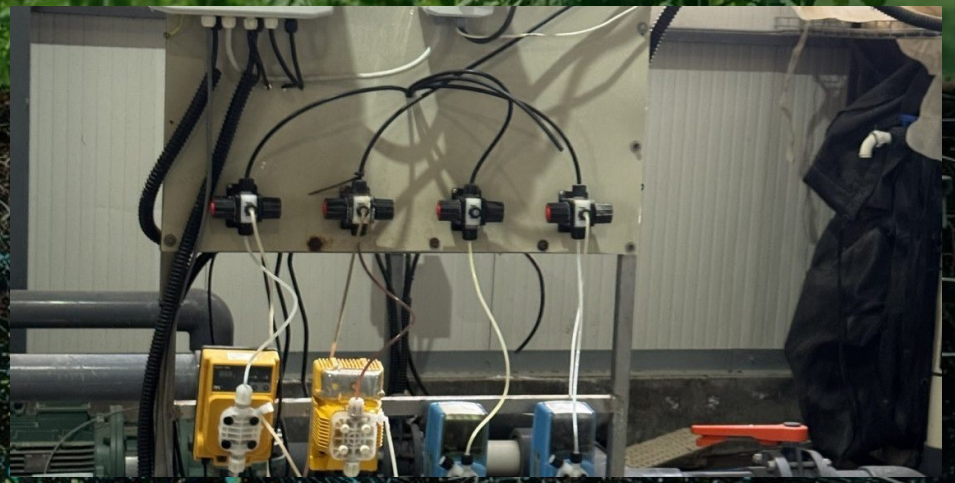

- Live dashboard + reviewer pages + TRL6-relevant demo evidence
- Interactive 3D Visual Twin + Scenario Studio
- Running integrated physics-AI stack (Triton/TensorRT), benchmarked and validated against high-fidelity physics references
- Boundary: virtual crop/root-zone indicators are not measured Planty yield outcomes yet

**EIC funds the transition: virtual-sensor software twin → physically calibrated advisory yield twin.**

## Planty is the LOI-supported strategic validation environment.

- 10,000 m² commercial greenhouse
- 5,000 m² NFT hydroponics + 5,000 m² microgreens
- Around 35 crop/product types
- pH/EC, PLC/control panels, met station, 8 fans
- Fogging/misting, automatic roof/side windows, fertigation infrastructure
- Fillipos Alexandrou: Planty agronomy / greenhouse-validation overseer

Signed non-binding LOI already in place. Planty is not an EIC beneficiary; pilot-access/data-sharing remain Step 2 / due-diligence items.



# From virtual sensors to measured yield twin

### Phase 1 - minimum viable yield twin

- Crop/batch + harvest labels
- Climate + VPD
- PAR under shade net
- Root-zone / tank temperature
- EC/pH, flow, tank level
- Fan/shade/misting/window feedback

### Phase 2 - root-zone validation

- Dissolved oxygen at strategic points
- ORP and biofilm/disinfection proxy
- Leaf wetness / condensation
- Nursery substrate humidity
- Airflow proxy near canopy
- Crop camera / richer image labels

**100% COTS sensor integration via API/data connectors**

**No custom hardware R&D**

**Outcome proof: commercial kg, rejected kg, quality grade, cycle duration, kWh/kg, litres/kg.**

# Physics generates auditable labels where historical greenhouse data are sparse.

**1** **High-fidelity physics reference / oracle**

LB-MRT thermal-flow simulation produces stress-scenario behaviour and labels.

**2** **T-UNet AI surrogate**

Fast prediction of temperature, humidity, airflow and risk fields.

**3** **Measured calibration**

Real Planty sensors, crop images and harvest records challenge the model.

**4** **Scenario Studio**

Operators test shade, misting, oxygenation, flow, density and timing before acting.

## Automated pipeline

Geometry → physics references → AI surrogate → calibrated advisory product. Designed to scale beyond one-off CFD consulting.

**Defensibility: proprietary physics-AI stack, software copyright, simulation workflows, IP-protectable data/model pipelines and trade secrets.**

# 7. Market, competition and business model

## Market signal

**Third-party estimate: Hydroponics USD 6.8B in 2026 → USD 11.1B by 2031**

## Beachhead

Mediterranean/EU hydroponic leafy greens, microgreens and NFT operators.

## Revenue model

Setup + annual licence + calibration + scenario modules + integration.

## Competitive map

| | | |
|---|---|---|
| **Priva / Hoogendoorn / Ridder** | Climate control incumbents | Control and setpoints; limited crop-output-linked physics prediction |
| **AgriTwins** | Decision-intelligence digital twin | IoT and predictive analytics; no physics-generated reference layer for data-sparse regimes |
| **Koidra** | Hybrid physics-informed AI | Autonomous climate/irrigation control; couples physics to control action, not to measured crop-output validation, no human-supervised advisory layer |
| **Source.ag / iUNU / Artemis** | Crop analytics platforms | Analytics; limited high-fidelity physics reference layer |
| **30MHz / Autogrow-style tools** | Sensor dashboards | Monitoring and alerts; less scenario-driven yield risk modelling |
| **CFD consultants** | One-off studies | Manual engineering; not repeatable software product |

**HydroTwin-AI integrates with existing controllers and differentiates through physics simulation + AI surrogate + measured crop-output labels + operator scenario engine.**

# 8. 24-month EIC plan and budget logic

**TRL5-completed software twin → Planty operational greenhouse validation → TRL8 target**

| M1-3 | M2-8 | M4-14 | M6-18 | M10-22 | M16-24 |
|---|---|---|---|---|---|
| Protocol + LOI/data design | COTS sensor/data integration | Physics-AI calibration | Crop/yield validation | Product hardening | Commercial package |

## Budget is not for one-site sensorisation

- COTS data integration + crop/harvest data capture
- Agronomic validation + physics-AI calibration
- GPU/HPC runtime, software hardening, cybersecurity
- IP/FTO, QA, commercial/agronomy hiring and deployment packaging

## Success gate

**Measured sensor/crop validation evidence: commercial kg/m²/week, rejection %, crop-cycle reliability, crop uniformity, kWh/kg and litres/kg.**

# KYAMOS has the software team. Planty supports validation under a signed LOI.

## Project leadership

• Antonis Papadakis - CEO, physics-AI, HPC, digital-twin architecture
• Cambridge PhD – Trinity College Full Time Scholarship · CERN/CMS Participation in discovery of Higgs Particle in 2012· Scopus h-index 34 · 14 HPC/deep-tech projects with KYAMOS, Erasmus Coordinator, ESA Coordinator, Horizon-EU Teaming Phase 1 Coordinator

## Validation + commercial

• Fillipos Alexandrou - Planty agronomy / validation contact
• Andreas Georgiou - Commercial & Customer Engagement Lead
• EIC adds CEA agronomy and business-development capacity, prioritising female candidates to strengthen team gender balance

## EIC ask: EUR 2.4M indicative grant

• Convert virtual HydroTwin into measured yield twin
• Physical sensor/crop validation at Planty
• Product hardening, cybersecurity, IP protection/FTO
• Repeatable commercial deployment package

# Greenhouse yield twin now. Repeatable CEA deployments next.