

Research and Engineering

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Complex Energy and Automotive Powertrain Systems

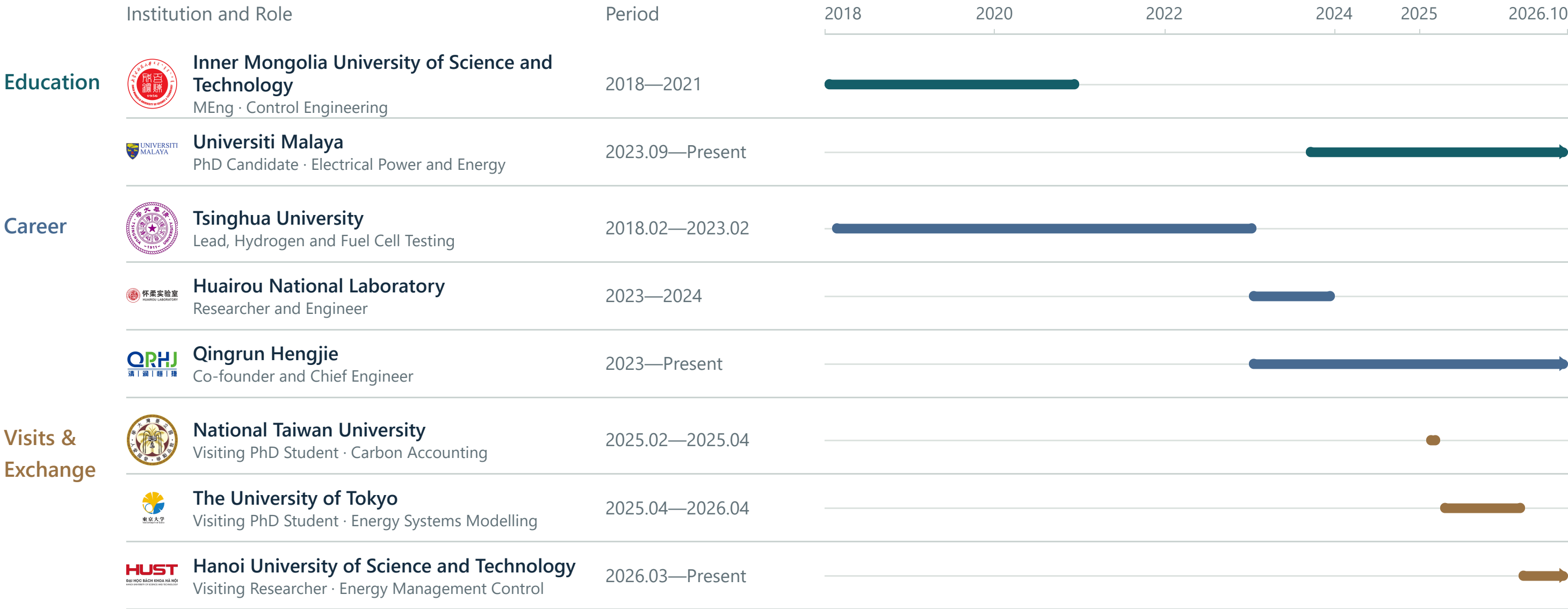
Intelligent Testing
Virtual–Physical Validation
and Engineering Optimisation

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Education, Career and Academic Exchange

Education, R&D and academic exchange on a shared timeline.



Research and Engineering Outputs

Outputs spanning test systems, operational data and engineering methods.

5	7	13	1	7
Selected Publications	Invention Patent Filings	Software Copyrights	Textbook Contribution	Public Datasets
3 journal articles 2 conference papers	3 granted patents 4 published applications	Registered Testing, modelling and data software	Powertrain Testing Technology 2nd edition · Chapter adaptation	Hydrogen operating data and model outputs

Research Communication	Engineering Implementation	Knowledge and Resources
Papers and Methods	Patents and Software	Textbook and Data
Research questions, mechanisms and validation	Technical solutions and working systems	Sharing experience and enabling further research

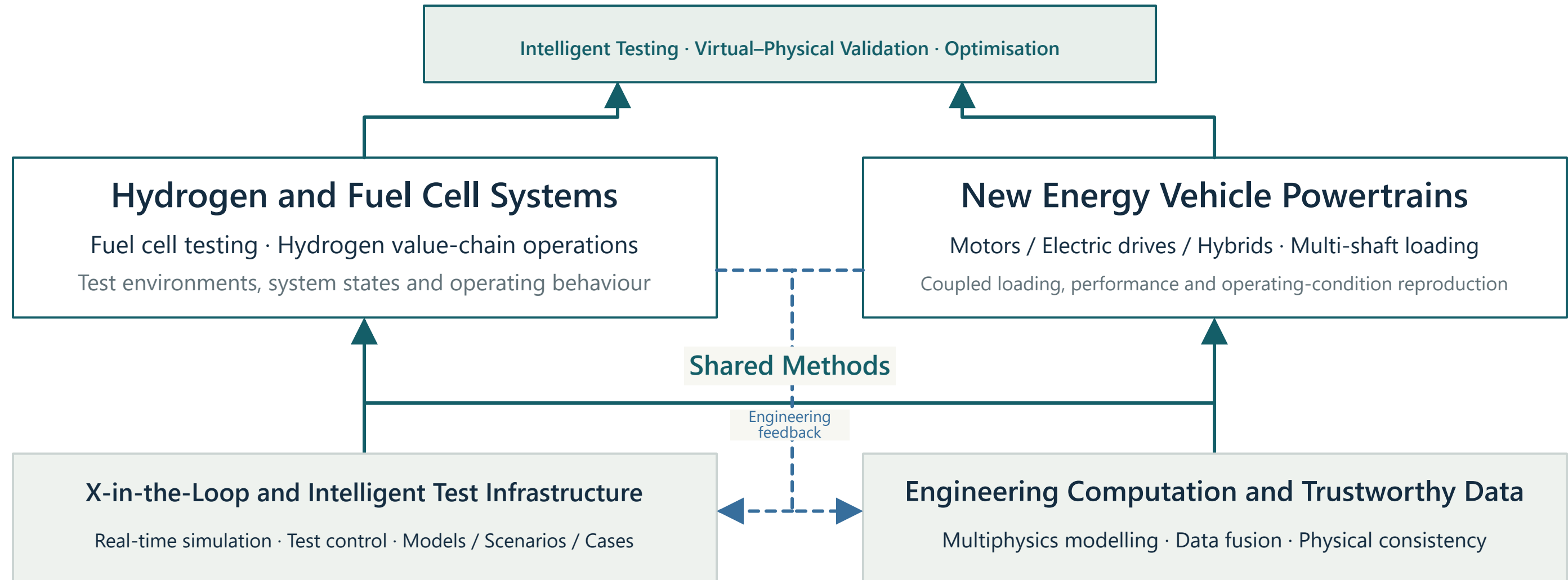
A further 6 papers are submitted or under review; 3 conference abstracts are public or accepted.

Selected outputs · Updated 16 October 2026

[Output catalogue ↗](#)

Research Themes and Supporting Methods

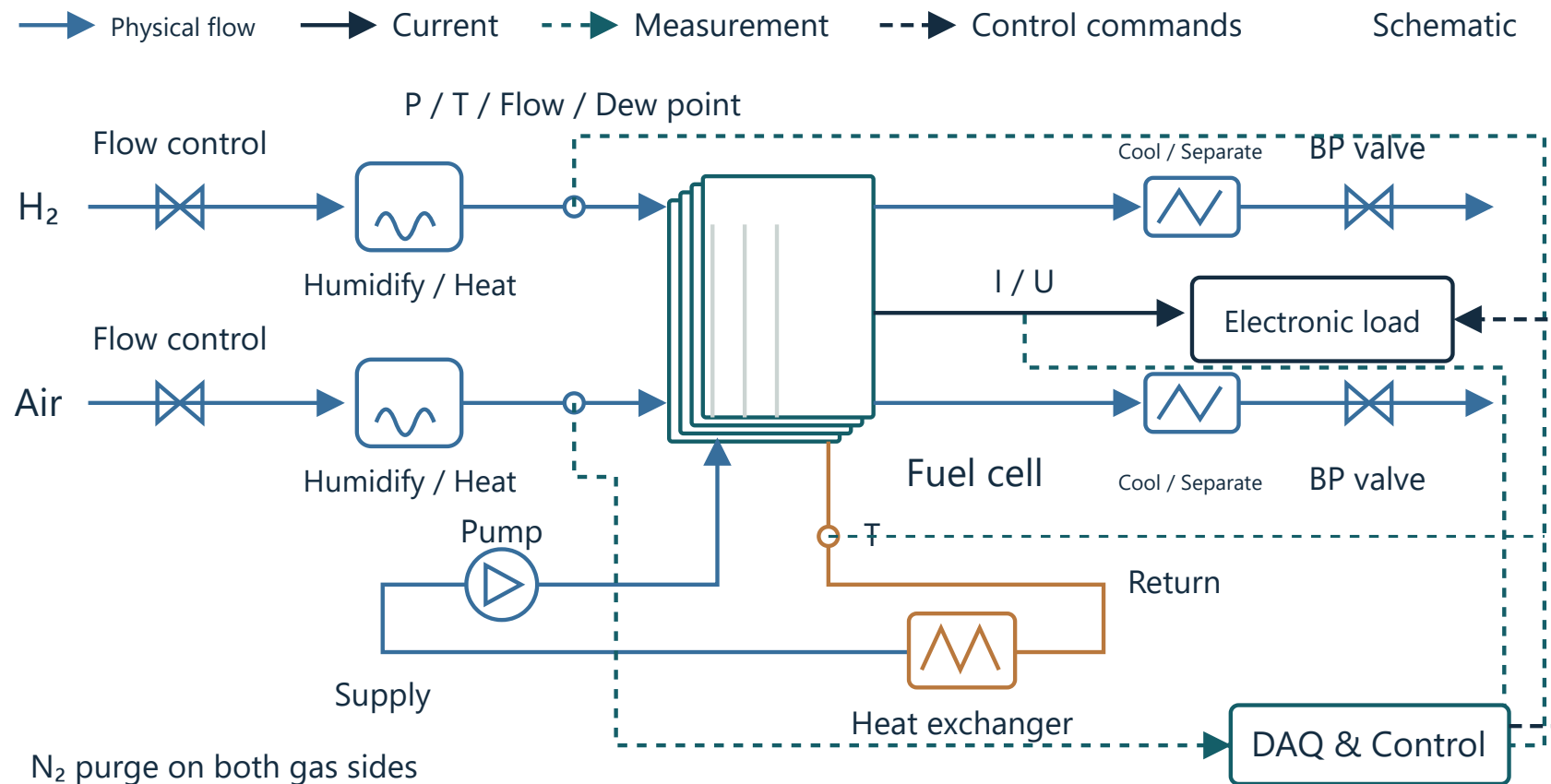
Two application areas define the questions; shared methods and engineering feedback advance the work.



Research pathway: application questions → methods → testing and analysis → engineering feedback

Fuel Cells: Controlled Dynamic Testing

Studying test conditions and stack response through gas supply, pressure, humidity, temperature and load.



Schematic

Boundary Conditions

Coordinating gas, electrical and thermal conditions with test tasks.

Measurement and Control

Linking commands, measurement feedback and safety interlocks.

Dynamic Response

Observing tracking and coupling under changing conditions.



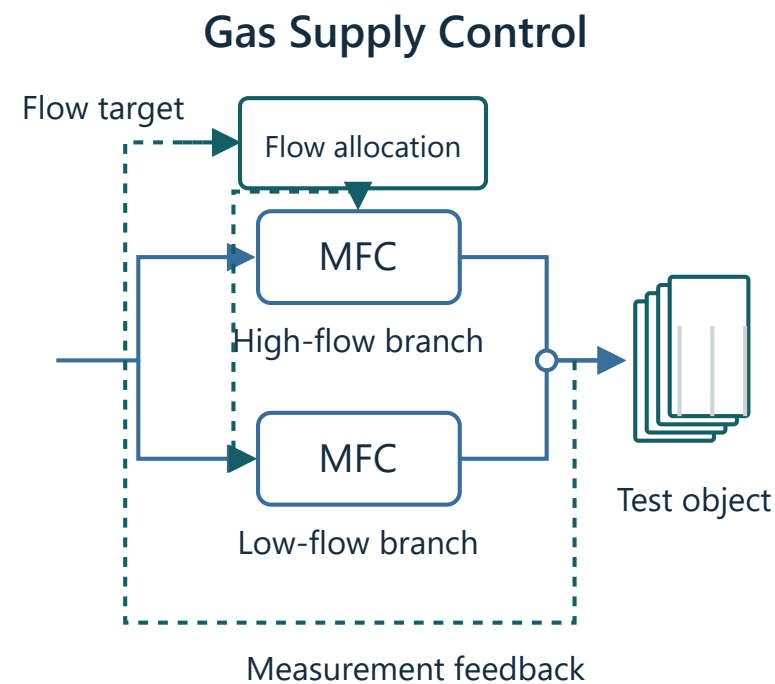
1 kW fuel cell test bench · Actual system

Project Basis Development and delivery of a 1 kW fuel cell test bench

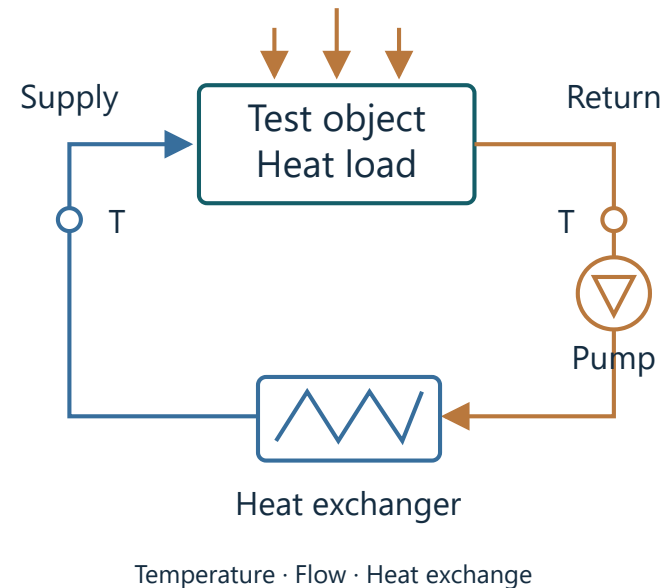
Core engineer contributing to the design, control development and validation of the 1 kW fuel cell test bench.

Auxiliary Systems: Test Boundary Control

Gas supply and thermal management together shape the test environment.



Thermal Boundary Control



Adjustable and observable test boundaries

Gas Supply Control

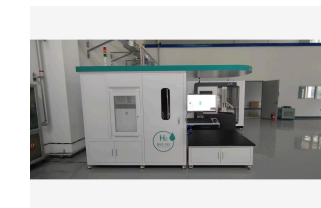
Flow allocation, measurement feedback and setpoint accuracy.

Thermal Boundary Control

Circulation, heat exchange and temperature response.

Research Aim

Making test conditions adjustable, observable and analysable.



Thermal management test platform · Actual system

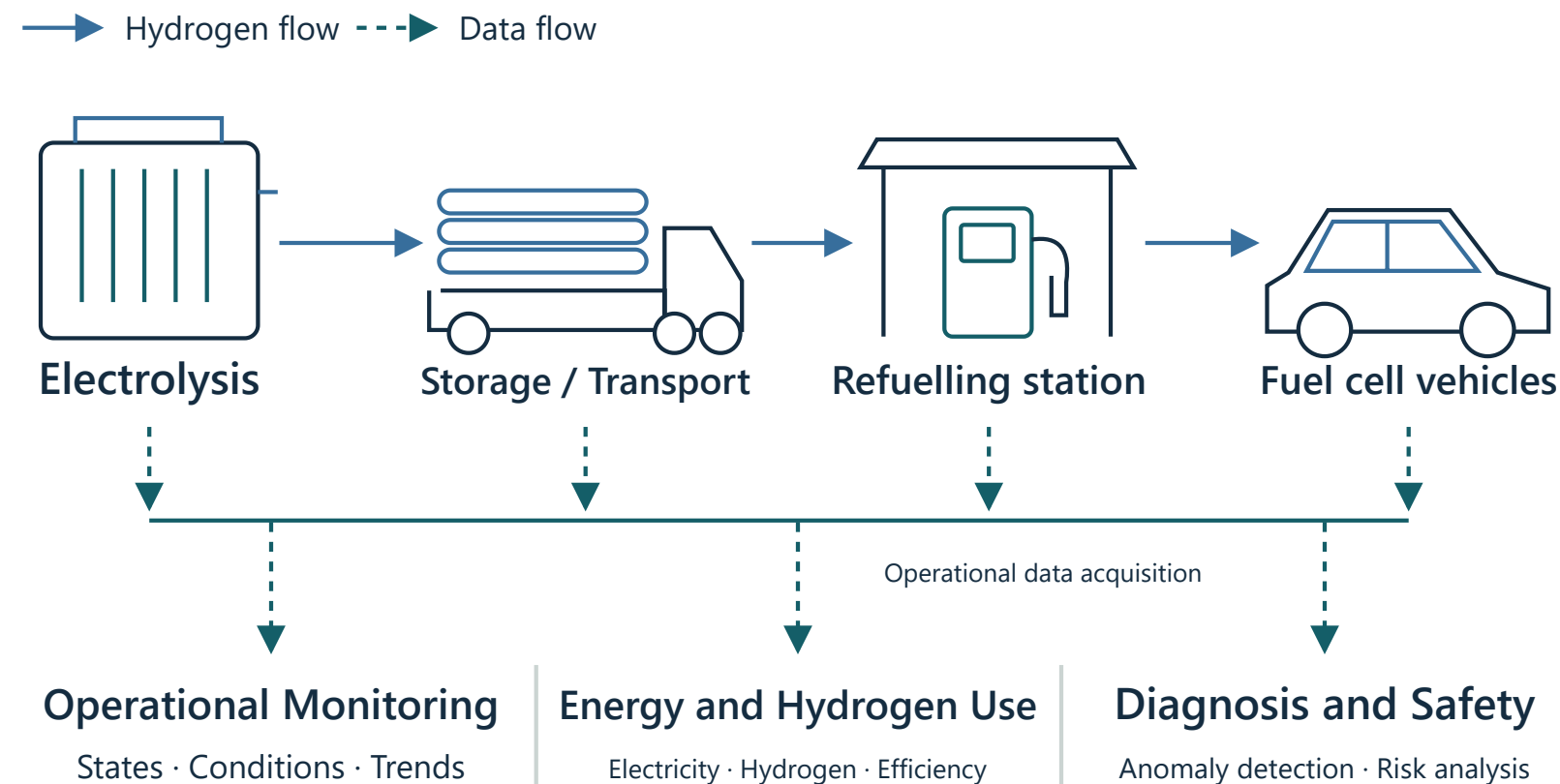
Gas and thermal control schematics · Separate studies and platforms

Project Basis Gas supply control R&D; delivery of a thermal management subsystem test bench

These projects supported parallel-MFC accuracy optimisation (Processes, 2026) and thermal management testing (GSETS, 2025), respectively.

Hydrogen Value Chain: Monitoring and Analysis

Studying hydrogen production, storage, transport, refuelling and vehicle operations as a connected system.



Schematic

Value-Chain Data

Linking operational states and timestamps across the chain.

Models and Analysis

Analysing energy and hydrogen use, carbon accounting and safety.

Beijing Winter Olympics

A value-chain data platform and operational analysis for hydrogen mobility demonstrations.



Hydrogen monitoring platform · Actual system

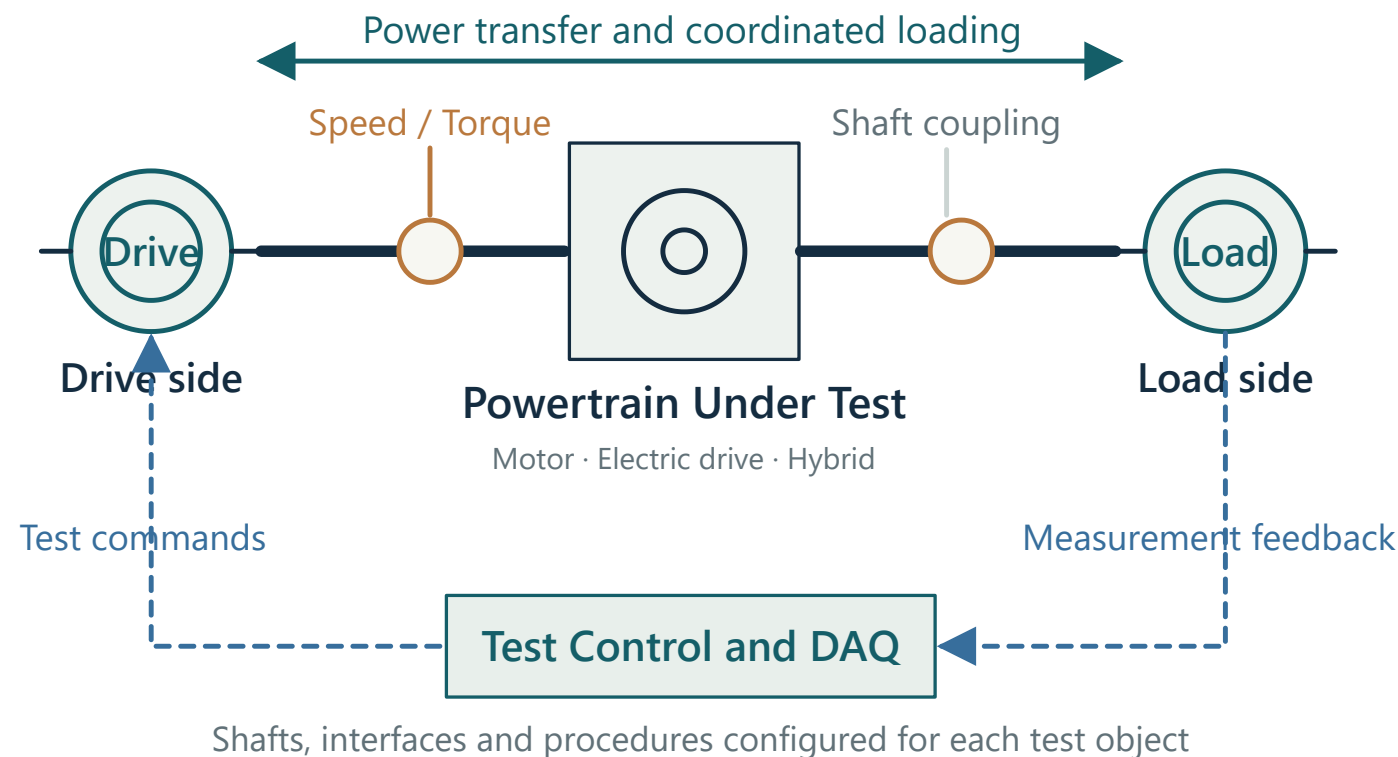
Project Basis National Key R&D Programme · Science and Technology for the Winter Olympics: Hydrogen Mobility R&D and Demonstration

2020–2023 · Core engineer contributing to the hydrogen data platform and demonstration analysis; related outputs include 7 public datasets.

Powertrains: Loading and Performance Testing

Repeatable loading and measurement for motors, electric drives, hybrid powertrains and coupled shafts.

Target conditions → Controlled loading and synchronised measurement



Powertrain test schematic

Loading and Coupling

Coordinating speed, torque and operation across shafts.

Measurement and Evaluation

Supporting performance, durability and energy-flow analysis.

Road and Laboratory

Translating operating requirements into bench tests.



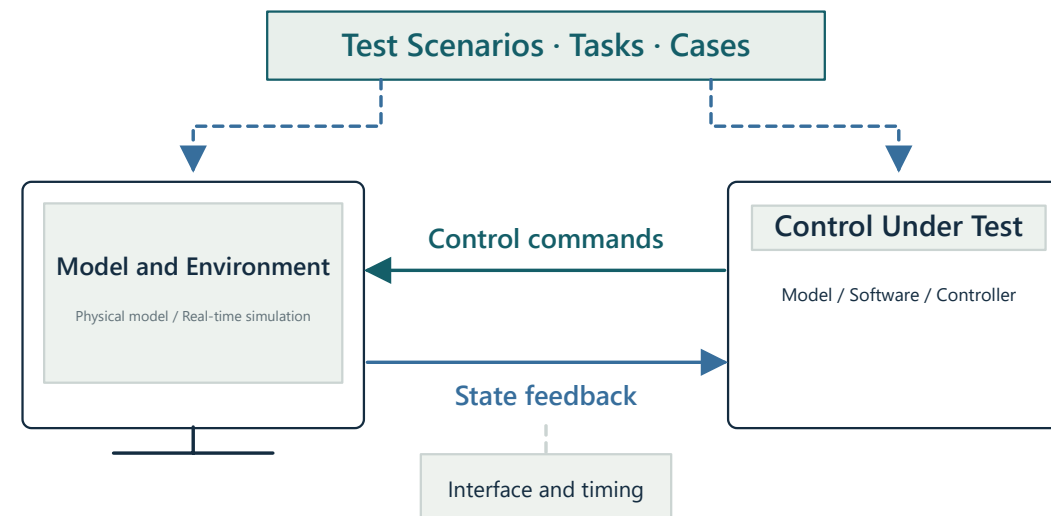
Multi-shaft powertrain test bench · Actual system

Project Basis Delivery of hybrid powertrain test benches for a leading new energy vehicle manufacturer

Project Lead; responsible for system design, control architecture and core software, with 22 production-ready systems delivered.

X-in-the-Loop Validation

Connecting models, software and physical systems for feedback tests that answer specific validation questions.



Clear test questions and criteria across different validation objects

MIL

Model-in-the-Loop

Checking models and control logic

SIL

Software-in-the-Loop

Validating software and interfaces

HIL

Hardware-in-the-Loop

Connecting real controllers to real-time simulation

General validation framework · Components selected for each project

Define Tests → Execute and Measure → Record and Analyse

Feed results back into models, parameters and test cases

Applications Fuel cell control tests, powertrain testing and general SIL/HIL platforms, covering models, interfaces, scenarios and results.

Software Outputs Test control software (2025SR0697142, first contributor); fuel cell model library (2024SR0302142, second contributor).

Models and Data Quality



Multiphysics models and physical consistency checks support data assessment, prediction and parameter optimisation across distinct engineering tasks.

Research Data Sources	Bench Measurements	Operational Monitoring	Model Outputs
01 Data Checks Channels, units and time alignment Physical consistency and quality assessment	→ 02 Predictive Modelling Quality-informed sample weighting Next-window bench-temperature prediction	+ 03 Parameter Optimisation Targets, constraints and parameters Parallel flow-control accuracy	
Methods and Targets	Physical Consistency Checks	Bench-Window Prediction	Gas-Supply Optimisation
CG-DQI · Applied Sciences, 2026 ↗		Data quality assessment and sample weighting for dynamometer bench-window prediction.	
PSO-MFC · Processes, 2026 ↗		Particle swarm optimisation for improving parallel mass-flow-controller accuracy.	
Beijing Winter Olympics	The hydrogen data platform supported Games-time monitoring and demonstration analysis; see slides 15–18.		

Coordinated Fuel Cell Control and Layered Testing

Fuel cells convert hydrogen into electricity through coordinated air supply, hydrogen supply, cooling and electrical control.



80 kW component-in-the-loop platform: vehicle components with instrumentation and control

Air supply | Hydrogen recirculation | Cooling | Electrical control

Challenge: coordinated component response

Air, hydrogen and cooling must follow power demand. Startup, operation and shutdown also require coordinated actions.

Approach: introduce physical hardware in stages

Check control logic, connect the physical controller, then test components or the stack to assess interfaces and physical responses.

Purpose: real components with adequate instrumentation

Retain vehicle component characteristics while providing measurement, control and recording for integration and calibration.

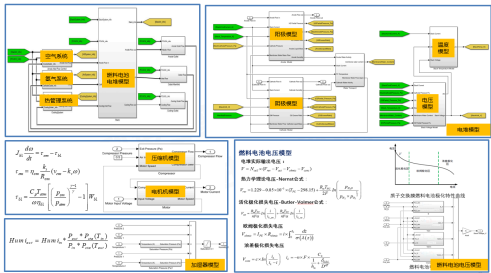
Platform value: observable, recorded control actions and physical responses feed back into system development.

Models, Controllers and Physical Tests

Each layer has a defined test object; measured data feeds back into control development and calibration.

Models and Control

Virtual plant + control (MIL)



System, air, hydrogen and thermal models

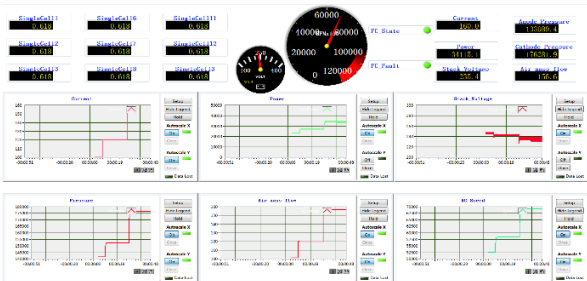
- Tech** Plant and control models
- Use** Check logic and dynamics

Models /
conditions
Control
software



Controller HIL

Physical controller + real-time plant model



Physical controller HIL responses

- Tech** Real-time model + CAN/I/O
- Use** Check I/O and responses

Interface
definitions
Control
commands



Physical Testing

Choose CIL or stack testing to suit the task

80 kW CIL



Real air, hydrogen recirculation and cooling parts

- Tech** Parts + instrumentation
- Use** Calibrate and integrate

80 kW Stack Bench



Real stack with gas supply, cooling and load

- Tech** Gas supply, cooling and load
- Use** Enable stack tests

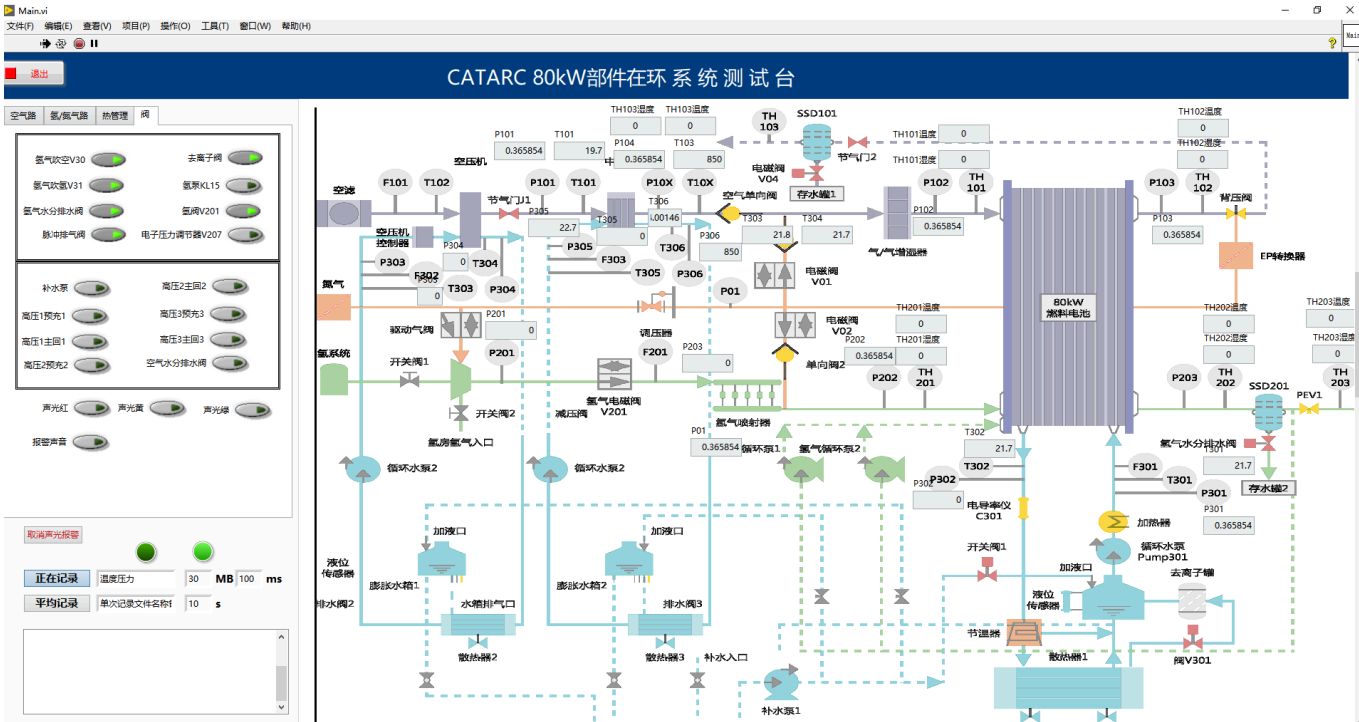
↑ Model and control updates

← Calibration and test feedback

Measured data ↓

Implementing the 80 kW CIL Platform

Sensors measure states, the controller commands components, and supervisory software manages operation, monitoring and recording.



States, measurements and actions displayed by subsystem



Built the platform, supervisory software and acquisition interfaces; commissioned air and cooling subsystems.

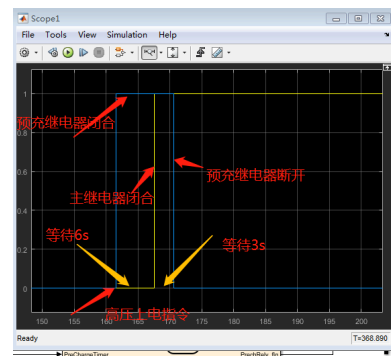
Engineering role: Project lead responsible for the overall design, virtual–physical test architecture and core control-system development; contributed to integration and onsite commissioning.

Control Validation and Calibration

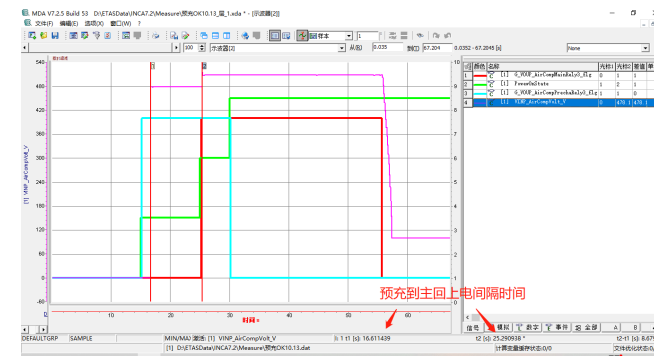
Check action sequences and physical responses; use observed differences to refine controls and parameters.

High-voltage precharge: from logic to hardware

Precharge before closing the main circuit to reduce inrush current



Model: sequence and delays

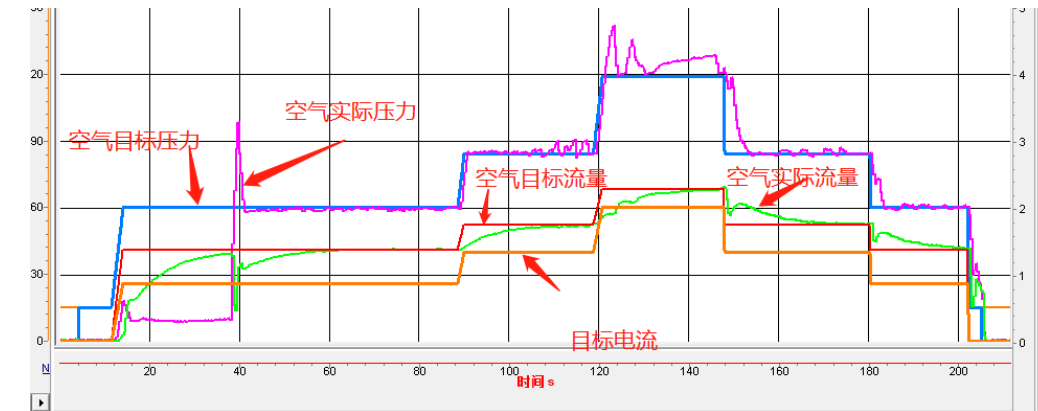


Bench: commands, states and voltage responses

Result Models check timing; bench tests record relay commands, power-up states and compressor voltage responses.

Air supply: measurements guide calibration

Adjust target flow and pressure with load demand; control the compressor and back-pressure valve



Target and measured air pressure and flow

Result Recorded responses support control calibration and recalibration of valve command–feedback relationships.

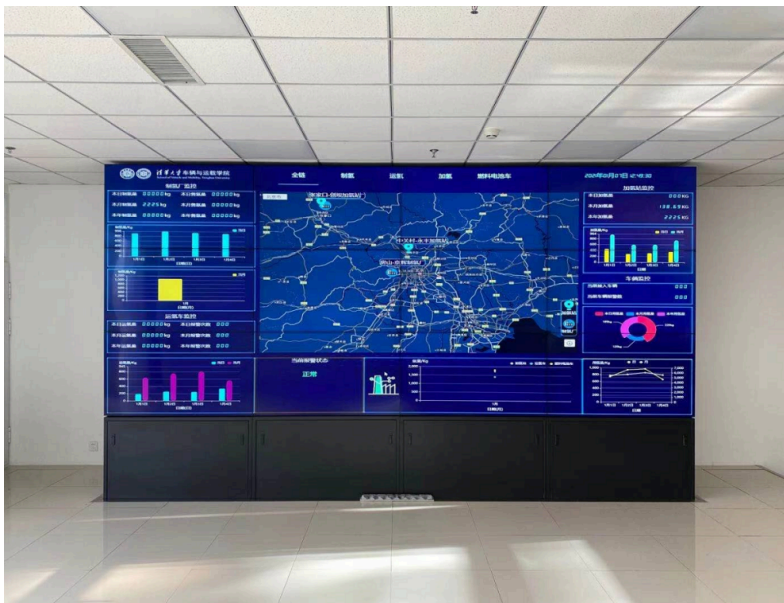
Engineering value: testable hardware actions, measured responses for calibration, and a platform and software foundation for system development.

Related outputs: [Fuel Cell Test Bench Supervisory Control System](#) · [Fuel Cell Model Library Software](#)

Beijing 2022 Deployment and Research Use

Deployed at the Zhangjiakou Hydrogen Energy Research Institute to monitor hydrogen mobility during the Winter Games.

117 buses
25 hydrogen transport trucks
2 hydrogen refuelling stations
1 hydrogen plant production equipment monitored



Platform deployment at the Zhangjiakou Hydrogen Energy Research Institute (project completion material)

Application: operating states, analysis and alerts

Monitor operations and equipment, analyse performance and safety, and display results and fault alerts at the institute and vehicle manufacturer.

Continued value: evaluation and research

Operating records support service, safety and benefit evaluation. Software, public datasets and evaluation outputs support further hydrogen research.

The platform passed independent functional and data-ingestion stress tests.

Related outputs: [Information Monitoring System](#) · [Data Acquisition, Statistics and Analysis Software](#)

Supply-chain data supported Games-time operations and subsequent demonstration evaluation and research.

Monitoring the Hydrogen Supply Chain

Hydrogen vehicles need a continuous supply. Production, storage, transport, refuelling and use must be monitored together.



Hydrogen transport, refuelling and vehicle operation (project diagram)

Challenge: multiple supply-chain operators

Vehicles, stations, transport fleets and production equipment have separate data systems; one link cannot show the whole chain.

Production



Storage and transport



Refuelling



Vehicle use

Objective: a shared view of operations

Connect enterprise and equipment data, consolidate operating states, and support monitoring, alerts and analysis.

Purpose: operational support and evaluation

Operators track supply and demand; researchers and managers use recorded data to evaluate the demonstration.

Platform value: turn dispersed records into supply-chain operating information and analysis for hydrogen mobility.

Layered Processing of Hydrogen Data

Data ingestion, organisation and layered processing turn equipment records into information for monitoring and analysis.

① Multi-source ingestion

Connect vehicles, hydrogen transport vehicles, stations and production equipment; decode their messages.
Output: connected data channels

② Data organisation

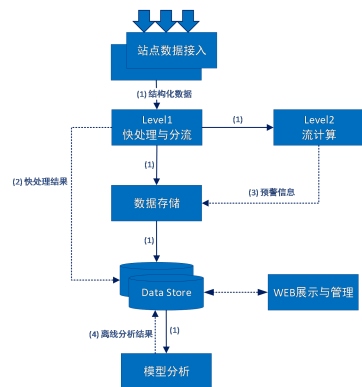
Register equipment and business information; store static, dynamic and display data in separate layers.
Output: queryable operating records

③ Layered processing

Rapid processing detects anomalies, real-time processing computes operating metrics, and offline analysis examines historical records.
Output: alerts, metrics and analysis

④ Monitoring and analysis

Display supply-chain states and alerts; use analysis to evaluate the demonstration.
Output: monitoring and evaluation data



Original architecture: ingest—process—store—display

Why layered processing?

Anomaly detection needs prompt feedback; statistics and more complex analyses use separate processing paths.

From records to analysis

Clean and organise samples for each task, then convert speed, distance and hydrogen records into operating metrics.

Supply-Chain Monitoring and Transport Alerts

A shared interface shows supply-chain states; dedicated functions turn location and operating records into monitoring information.

Supply-chain monitoring: supply and use



Supply-chain monitoring interface (project material)

Equipment data → States and metrics → Shared display

Combine production, transport, refuelling and vehicle information to review operations, alerts and performance analysis.

Transport monitoring: records inform alerts



Hydrogen transport route monitoring and alert interface

Location and operating data → Route / geofence checks → Alerts

Combine routes, geofences and vehicle information to monitor hydrogen transport and identify anomalies.

Engineering role: Core engineer responsible for platform development and deployment, monitoring metrics, data analysis and data submission.

Engineering AI and Test Control

Building on test control, data and optimisation methods to integrate engineering AI with test systems.



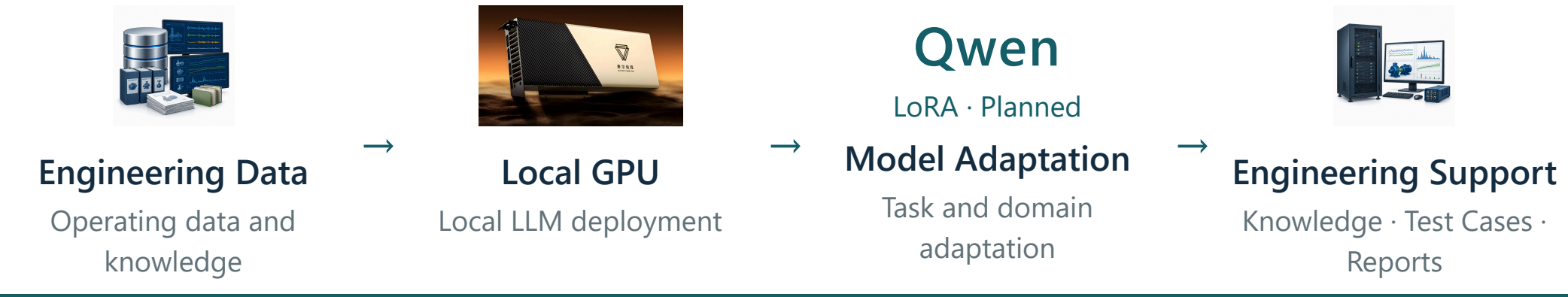
Powertrain test platform

Models · Equipment · Test Control

Engineering and research foundations

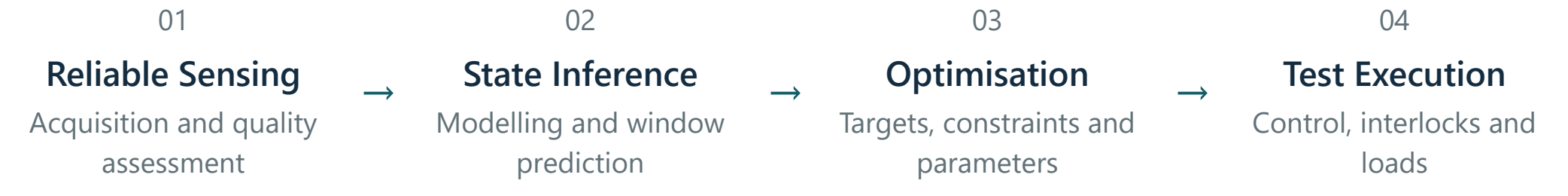
Engineering AI Development

Research and adaptation directions



Established Methods and Test Control

Data—Models—Optimisation—Execution



Virtual–Physical Validation MIL / HIL / CIL / Hardware → Measurement Feedback ↻ Data, Model and Parameter Refinement

Integration framework: engineering AI provides assistance; test control handles real-time control and equipment protection.

Research in Vietnam: Testing and Engineering AI

Research exchange during a visit to Hanoi University of Science and Technology, with a focus on local testing needs, energy management and engineering AI.

Application Context

- Electric two-wheelers, electric drives and controllers
- Local conditions: heat, humidity and urban stop–start operation

Methods and Tools

- Test configuration, supervisory software and data analysis
- AI assistance with engineering knowledge, test cases and reports

Research Opportunities

- Local operating conditions and test methods
- Model–measurement comparisons and evaluation of AI support

Engineering Foundation

Experience in fuel cell and automotive powertrain test platforms, supervisory software, operational data analysis and modelling.

Current Activity

The research visit and academic exchange are ongoing. Model adaptation and local validation are directions for further collaboration, to be defined for individual research tasks.

Thank You

Let's Connect

Intelligent testing, virtual–physical validation
and engineering optimisation for complex
energy and automotive powertrain systems

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