MAKING VIRTUAL PIPELINES PAY

Unlocking Economic Hydrogen Distribution Today

ROAD FIRST. FINANCEABLE. SCALE-READY.



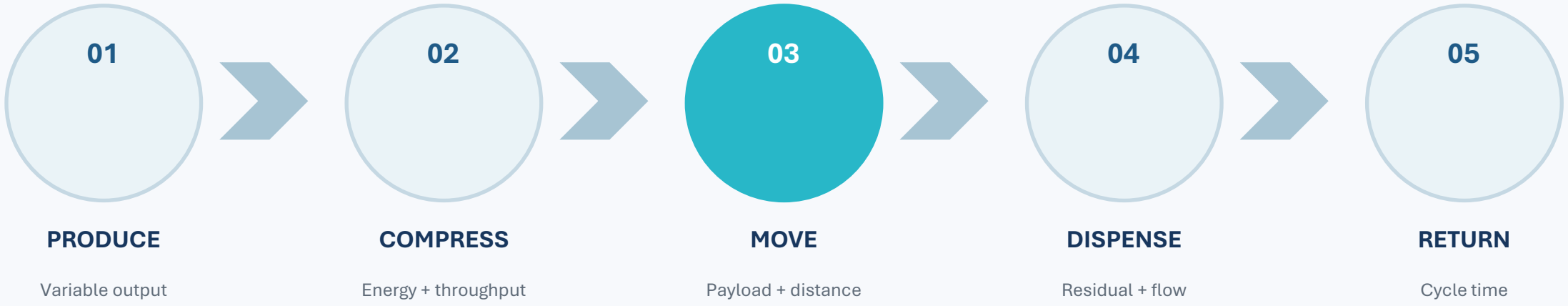
LUXFER
GAS CYLINDERS

Keith Croysdale | Business Development Manager
18 November 2026 | Hydrogen Ireland

The economic question is not “road or pipeline?”

It is: how do we move hydrogen now without locking in tomorrow’s cost base?

Virtual pipelines bridge the infrastructure timing gap



Profitability comes from optimising the whole cycle, not simply buying the lowest-cost trailer.

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Delivered cost is a system outcome

Six economic levers determine whether the virtual pipeline makes money.

Payload 1

Usable kg per movement



Utilisation 2

Cycles and days earning



Distance 3

Driver, tractor, fuel



Compression 4

Power and fill throughput



Residual pressure 5

Saleable gas recovered



Finance 6

Cost of capital + term

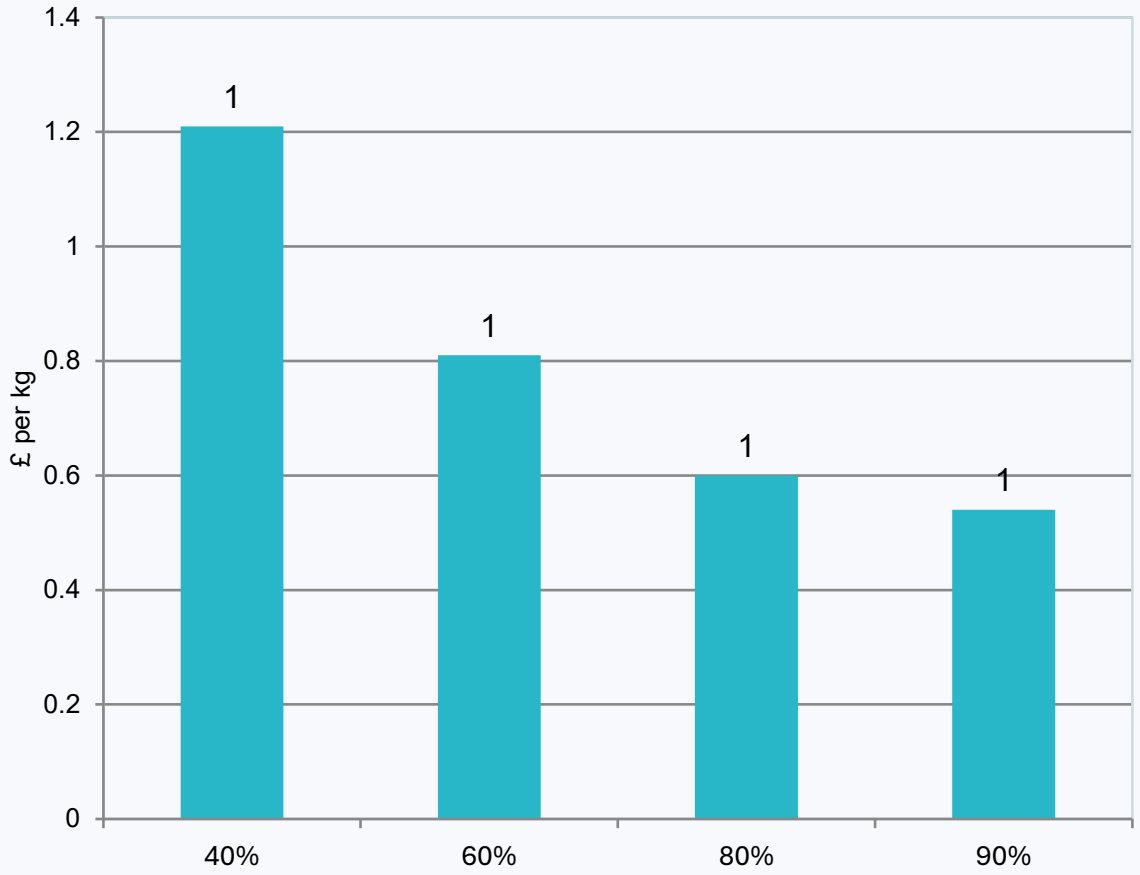


COST PER DELIVERED KG = TOTAL ANNUAL COST / SALEABLE KG

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Utilisation is the silent profit killer

A high-capacity asset only wins when the operating cycle keeps it productive.



The utilisation trap

Fixed capital and compliance costs continue while the MEGC waits.

Design for the cycle

Balance fill rate, journey time, dispense rate and swap strategy.

Commercial implication

Contract for minimum throughput or availability, not ad-hoc trips alone.

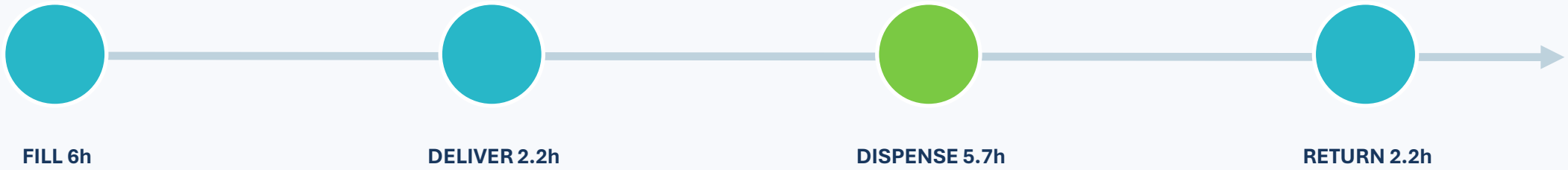
Illustrative assumptions: £749k asset, 10-year finance at 8%, £45k annual service, £9,962 annualised compliance, 941.5 kg usable payload, one cycle/day.

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Worked case: short-haul, 10MW Production Site 4 tonnes per day production

The model highlights where operational decisions dominate equipment selection.

4.0 t/day Hydrogen output	**50 km** One-way distance	**1077 kg** Usable 45 ft payload
4 MEGCs required	**€4000/day** Logistics cost	**€1.00/kg** Logistics component including MEGC TCO



16.1-hour total cycle: improving fill or dispense time can avoid extra assets before route distance becomes the constraint.

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Payload compounds through the value chain

More usable hydrogen per movement reduces trips, labour exposure and fleet size.

Daily Output Tonnes	Fill Time hours	Dispensing speed kg/h	Average speed miles/h
4	6	200	30

40ft MEGC with c.800kg capacity

Logistics		Duty Cycle												
One way miles	Cost	Fill	Deliver (journey +30 mins waiting and connection)	Dispense	Return (journey +30 mins waiting and connection)	Total Cycle Time	Number Cycles available per day per MEGC	No. of Journeys	No. of MEGCs required	Daily Logistics Cost	Daily MEGC Lease Costs	ADR - 20 year Compliance Costs - Daily	Total Distribution Cost Daily	Distribution Cost per kg
20	£500	6	1.2	3.9	1.2	12.3	1.00	6	6	£3,000	£1,188	99	£4,287	£1.07
50	£500	6	2.2	3.9	2.2	14.3	1.00	6	6	£3,000	£1,188	99	£4,287	£1.07
100	£780	6	3.9	3.9	3.9	17.7	1.00	6	6	£4,680	£1,188	99	£5,967	£1.49
120	£800	6	4.5	3.9	4.5	18.9	1.00	6	6	£4,800	£1,188	99	£6,087	£1.52
200	£1,600	6	7.2	3.9	7.2	24.3	0.99	6	7	£9,600	£1,386	115.5	£11,101	£2.78
300	£1,800	6	10.5	3.9	10.5	30.9	0.78	6	8	£10,800	£1,584	132	£12,516	£3.13

40ft MEGC with c.1010kg capacity

Logistics		Duty Cycle												
One way miles	Cost	Fill	Deliver (journey +30 mins waiting and connection)	Dispense	Return (journey +30 mins waiting and connection)	Total Cycle Time	Number Cycles available per day per MEGC	No. of Journeys	No. of MEGCs required	Daily Logistics Cost	Daily MEGC Lease Costs	ADR - 20 year Compliance Costs - Daily	Total Distribution Cost Daily	Distribution Cost per kg
20	£500	6	1.2	5.1	1.2	13.5	1.00	4	4	£2,000	£1,387	66	£3,453	£0.86
50	£500	6	2.2	5.1	2.2	15.5	1.00	4	4	£2,000	£1,387	66	£3,453	£0.86
100	£780	6	3.9	5.1	3.9	18.9	1.00	4	4	£3,120	£1,387	66	£4,573	£1.14
120	£800	6	4.5	5.1	4.5	20.1	1.00	4	4	£3,200	£1,387	66	£4,653	£1.16
200	£1,600	6	7.2	5.1	7.2	25.5	0.94	4	5	£6,400	£1,734	82.5	£8,217	£2.05
300	£1,800	6	10.5	5.1	10.5	32.1	0.75	4	6	£7,200	£2,081	99	£9,380	£2.35



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CAPACITY → FEWER MOVEMENTS → LOWER COST

Fewer fills
Less time at the production plant

Fewer trips
Reduced tractor, driver and energy cost

Fewer assets
Lower capital and maintenance base

Lower disruption
Faster, simpler customer operations

Compare on usable delivered kg at the customer's minimum pressure, not headline storage capacity.

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Finance the service life, not just the purchase

The right structure converts a specialist asset into a bankable logistics service.

BUY

ECONOMIC CASE

Lowest lifetime financing cost

PRIMARY RISK

High upfront capital

WHEN IT FITS

Best for proven, stable demand

LEASE / HP

ECONOMIC CASE

Matches cash flow to revenue

PRIMARY RISK

Term and residual assumptions

WHEN IT FITS

Best for scalable contracted demand

PAY-PER-USE

ECONOMIC CASE

Transfers utilisation risk

PRIMARY RISK

Higher unit price

WHEN IT FITS

Best for uncertain ramp-up

Recommended commercial principle: align asset term, minimum throughput and maintenance obligations with the offtake contract.

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ROAD FIRST.
RAIL SELECTIVELY.

Road wins on flexibility

- Short and medium distance
- Variable demand and destinations
- Direct plant-to-customer delivery

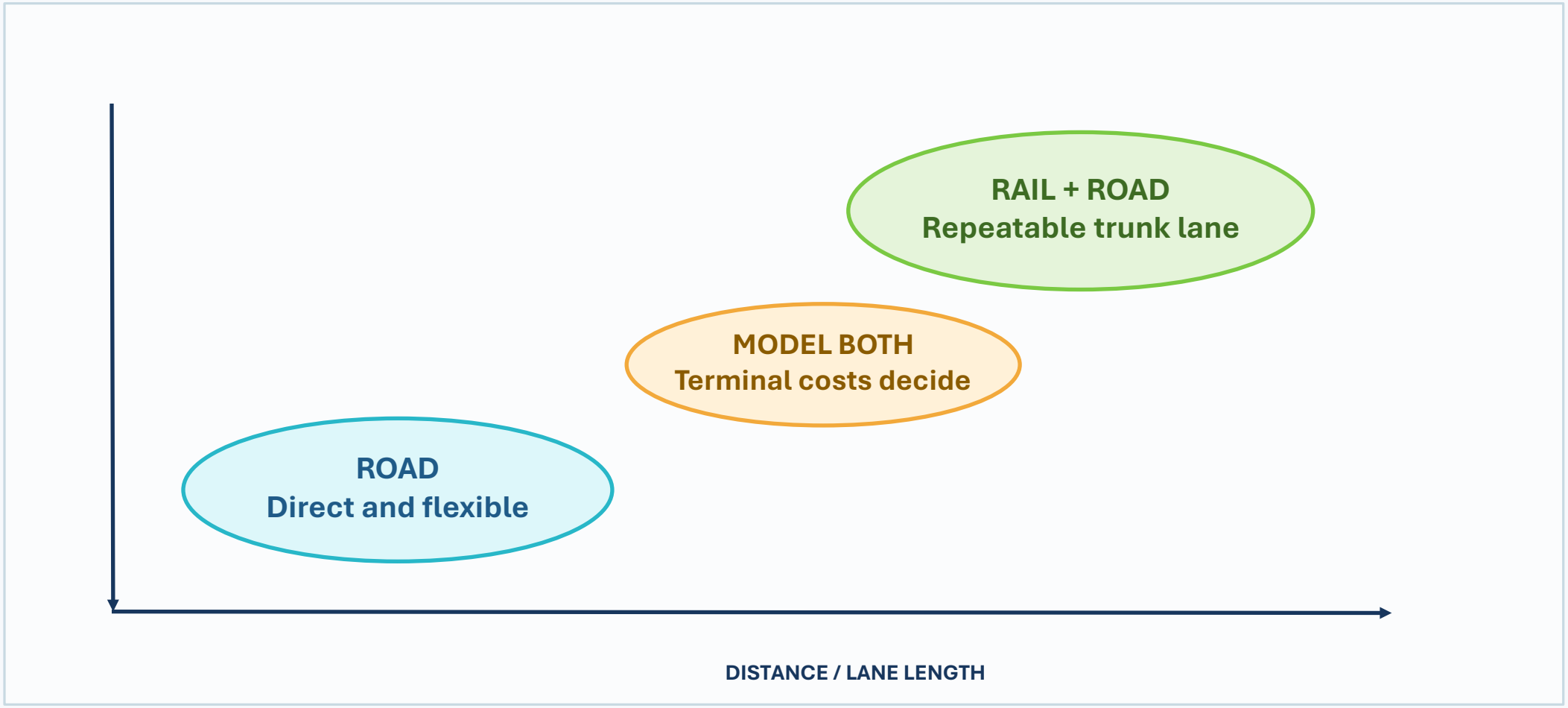
Rail complements at scale

- Long distance, repeatable lanes
- High aggregate volume
- Intermodal terminals at both ends



Choose the mode with a decision map

Volume and lane stability matter as much as distance.

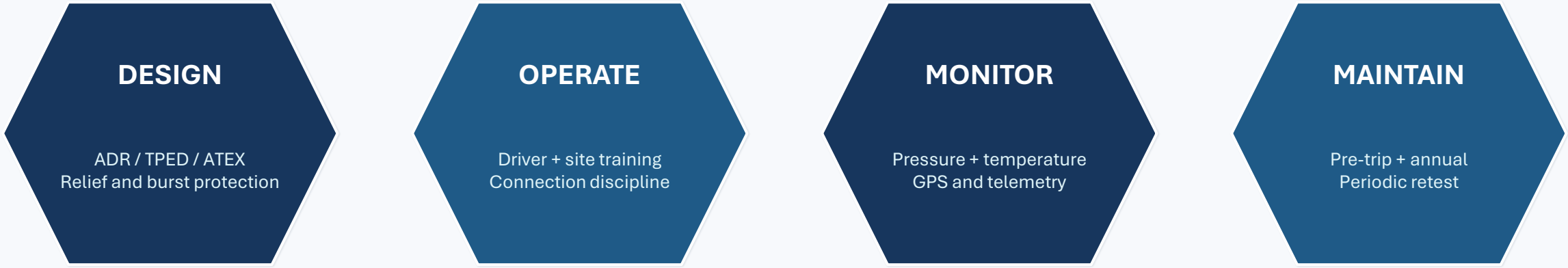


Do not force a single break-even distance. Test the actual lane, terminal access, backhaul and utilisation.

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Safety is an economic control, not a compliance add-on

Well-designed safety reduces downtime, operating variability and financing risk.



ECONOMIC EFFECT

Higher availability • Fewer incidents • More predictable insurance and finance • Stronger customer confidence

The cheapest unsafe operating model is never the lowest-cost model.

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A five-step bankability playbook

Build the operating model before committing to the fleet.

01	**Define demand**	Daily profile, pressure, purity
02	**Model the lane**	Distance, cycle, site constraints
03	**Size the fleet**	Payload, redundancy, growth
04	**Structure finance**	Term, utilisation, residual
05	**Contract performance**	Throughput, availability, service

MODEL → VALIDATE → CONTRACT → SCALE

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VIRTUAL PIPELINES PAY WHEN THE SYSTEM PAYS.

1. Maximise usable payload
2. Protect utilisation
3. Match finance to demand
4. Use rail only where the lane earns it
5. Treat safety as uptime



Road enables the market today. Smart economics make it scalable tomorrow.

Keith Croysdale | Luxfer Gas Cylinders