Gas quality tracking tools for integration of biomethane and hydrogen in gas networks

Paul Dickerson
Customer Success Ambassador, DNV

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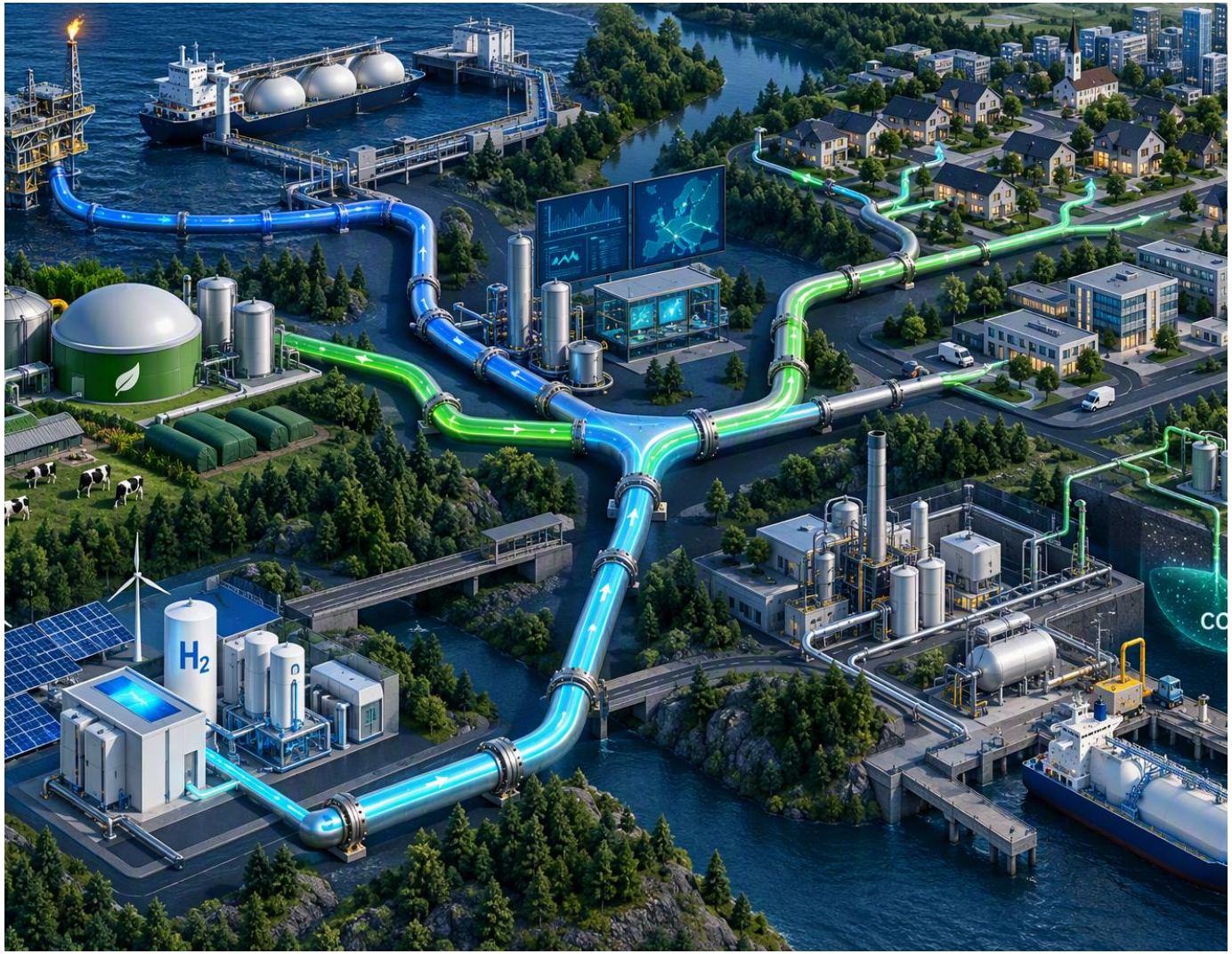
What gas reaches each customer, and when?

- A more diverse network changes the question
  - From “is gas available?”
  - to “what gas is reaching each customer, and when?”
- Multiple entry sources at multiple pressure tiers
- Changing composition and energy content
- Dynamic demand and mixing boundaries
- Operational, billing and compliance consequences



Gas quality is dynamic

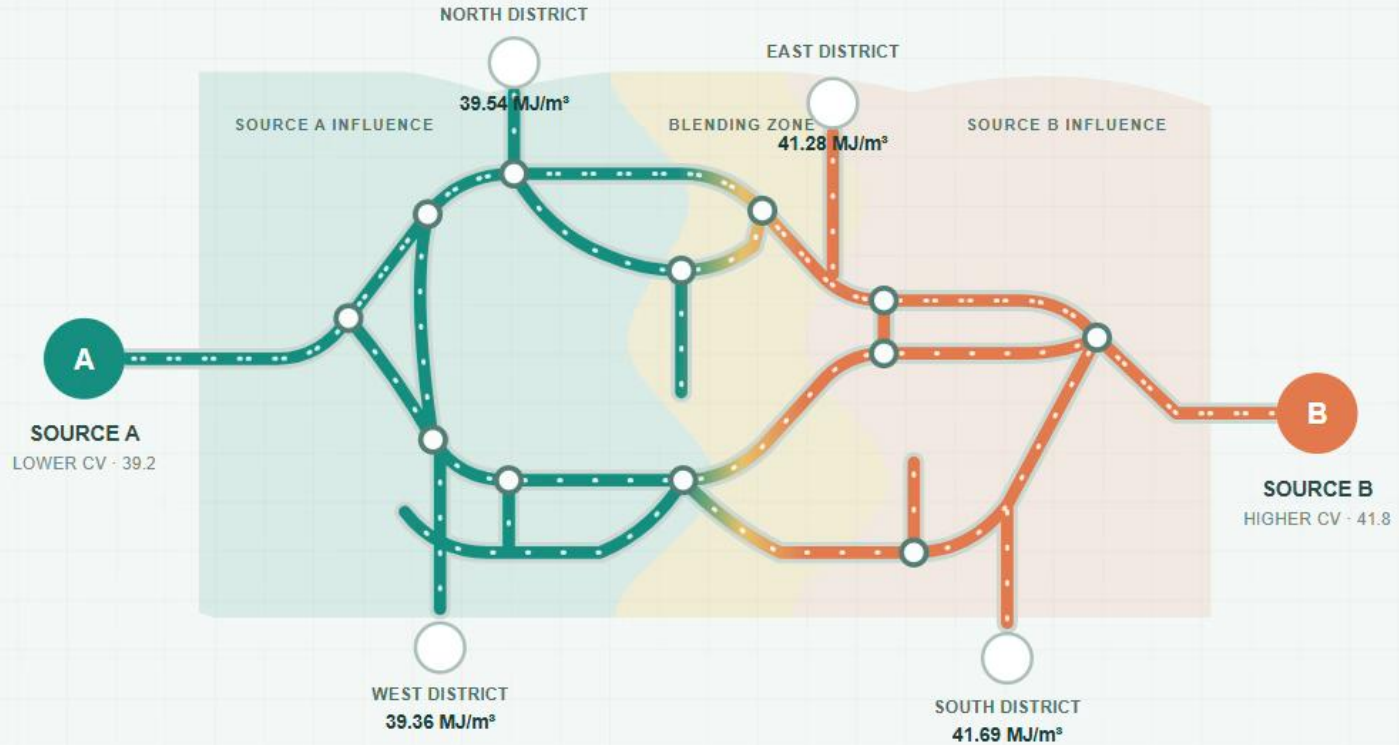


- **Composition enters**
  - Natural gas, biomethane (proponated or unproponated) and hydrogen
- **Track properties or individual gas streams**
  - Heating value, specific gravity and component composition
- **Hydraulics transport it**
  - Flow direction, pressure and linepack govern propagation
- **Demand moves the boundaries**
  - Seasonal and intraday loads change mixing zones
- **Customers receive energy**
  - Quality affects operability, appliances and allocation

A practical tracking architecture

- Measure pressure, flow, gas quality and temperature at each network entry point.
- Model how gas flows blend and mix across the pipeline network.
- Determine the gas quality and energy content delivered to each customer.
- Support transparent allocation and billing based on the energy and, where relevant, the gas type delivered to each customer.





Lower CV influence — Higher CV influence · MJ/m³

DEMAND SCENARIO

Change network demand to see source contributions and composition zones respond.

Total demand 414 ×10³ m³/h

120 · low — 700 · peak

II Pause cycle | Reset

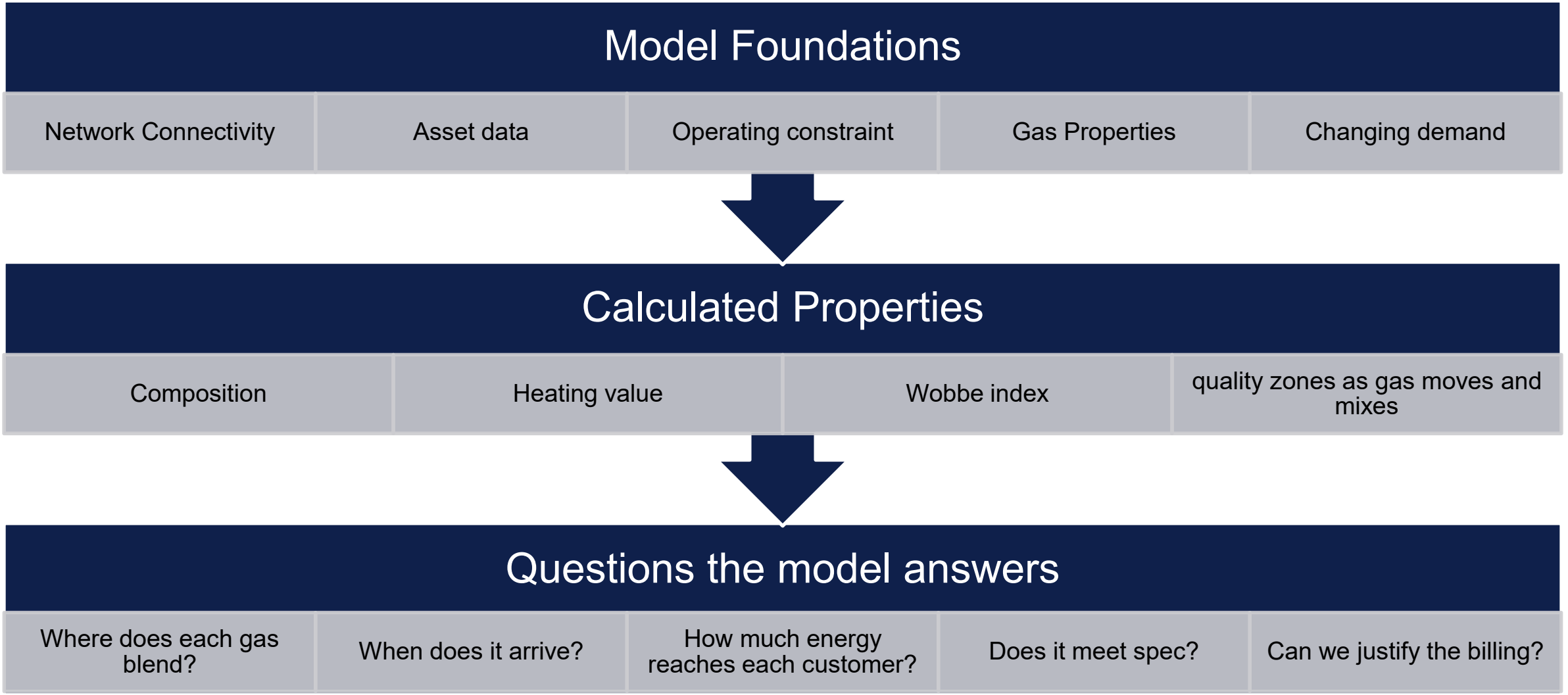
NETWORK AVERAGE CALORIFIC VALUE

40.48 MJ/m³

Flow-weighted blend across both supply sources

- Source A · 39.2 — 51%
- Source B · 41.8 — 49%

Deterministic simulation backbone



Better data and quantified uncertainty

Hydraulic model

Better inputs improve predictions

- Calculate the network state using mass, momentum and energy balances.
- Input errors and data gaps create uncertainty in the predictions.
- Improve pressure, flow, composition and demand data to reduce uncertainty.

Statistical analysis

Quantify the remaining uncertainty

- Test how uncertain inputs affect model predictions.
- Calculate prediction ranges and identify the most influential data gaps.
- Use the results to support validation and anomaly detection.

Validation creates confidence



BUILD A DEFENSIBLE DIGITAL TWIN

- **Validate predictions**
  - Compare predictions with new measurements
- **Refine the model**
  - Resolve data gaps and revise assumptions
- **Repeat as data improves**
  - Update the twin and revalidate its predictions
- **Build a stronger evidence base**
  - Document each cycle to make results more defensible

Choose the operating model to match the decision

OFFLINE, ONLINE OR HYBRID



OFFLINE

Planning, design, sensitivity studies and regulatory justification

ONLINE

Day-to-day quality tracking, operations, billing and customer communication

HYBRID

One consistent core model used across planning and operations

Lessons from practical deployment

01 **Instrument strategically**

Composition at entries and blends; pressure and flow at critical boundaries, in network sensors and validation

02 **Model demand credibly**

Especially where customer flows are not directly metered in real time

03 **Validate before scaling**

Use historical replay to explain yesterday before predicting tomorrow

04 **Make results inspectable**

Maps, individual locations, source contributions and reports provide evidence behind the result.

The objective is to create a trusted, auditable link between network physics, measurement and decisions.

MEASURE

the right data

MODEL

how quality propagates

VALIDATE

against the network

DECIDE

with confidence

References

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