Technical Deep Dive

Tech Deep Dive

The aim of today:

- What you need to understand
- What you will need to decide
- What you will need to own moving forward

- What the system does
- Why this matters in the 3 markets (SHP, O&G, water)
- What can break?
- What is proven and what remains open?

What the HydroFoamer System Actually Does

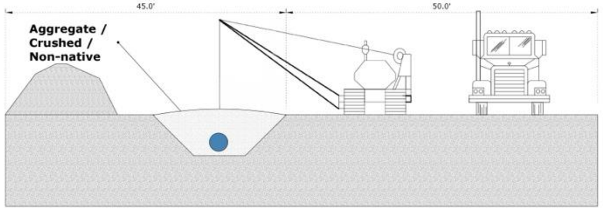
1. Creates a Stable, Protected Pipeline Using Native Soil
- Forms a continuous PU-foam cradle around (GRP) pipe
- Replaces granular / concrete bedding with foam & local soil
- Handles vertical, lateral and axial loads

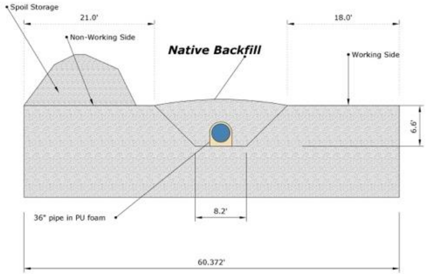
2. Enables Fast, Repeatable Installation
- Robotic spraying sets exact foam geometry every cycle
- ~10-minute install rhythm per pipe
- Predictable output in steep, remote terrain

3. Eliminates Traditional Failure Modes
- Prevents point loading and differential settlement
- Improves freeze protection and thermal insulation
- Reduces machinery, traffic and environmental disturbance

4. Works as a Mobile, Low-Footprint System
- Entire process delivered from containerised equipment
- Operates on narrow access roads and difficult terrain
- Can integrate with mobile GRP production for true on-site delivery

5. Cuts Cost, CO_2 and Logistics at Scale
- Fewer trucks, fewer operators, faster trench close
- Massive reduction in imported materials
- Strong permitting and ESG profile





HydroFoamer turns pipeline installation into a controlled, repeatable manufacturing process — in the trench.

Why This Matters in the Three Markets

1. Norway – Hydropower (SHP)

Bottleneck is terrain + cost, not pipe.

- Steep, remote mountain corridors make granular logistics the dominant cost.
- Native backfill + robotic foaming removes 30–50% of install cost and weeks of schedule.
- Allows developers to build in areas previously written off as too steep or too expensive.
- Strong fit with Norway's ESG and biodiversity restrictions (less disturbance, fewer trucks).

2. US / Canada / Others – Run-of-River (Indigenous Partnerships)

Bottleneck is access + permitting.

- Tight forestry roads, remote valleys, and First Nations land require ultra-low footprint methods.
- HydroFoamer enables "containerised construction" — fast, quiet, minimal disturbance.
- Supports local Indigenous employment with mobile GRP + foam rigs deployed on their land.
- High-value proposition: unlocks 30%+ more viable ROR sites by eliminating granular dependence.

3. Alberta / Northern Canada – Oil & Gas Pipelines

Bottleneck is cost per kilometre + freeze protection.

- Foam cradle provides insulation, bedding, and soil stabilisation in one pass.
- Reduces trench width, reduces imported materials, accelerates lay rate — massive capex impact.
- Fits long-distance economics: repeatable 10-minute cycle enables industrialised installation.
- Provides a credible decarbonisation and cost-down story for operators under CERF scrutiny.

What can break?

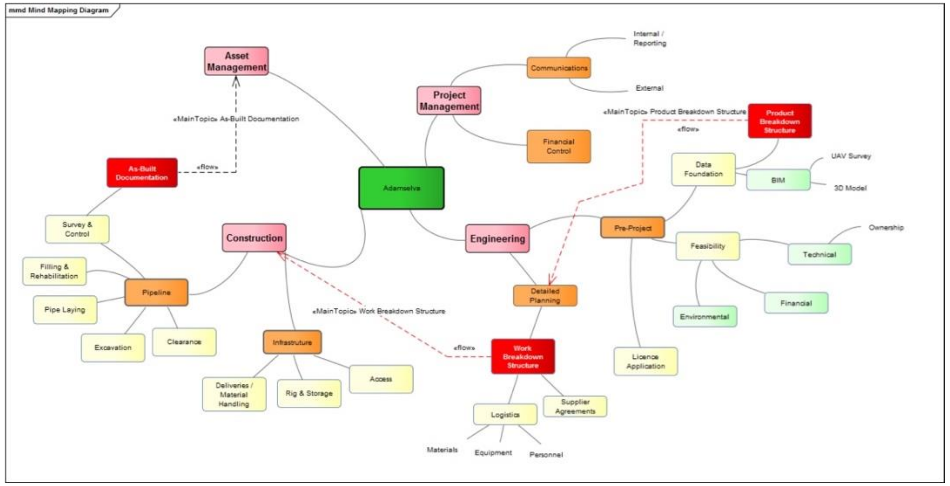
1. Foam Behaviour (Material Risk)
- Long-term creep in bends — needs full validation (Nestaan + FEA).
- Shear/compression interaction under point loads in incorrect / rough backfill.
- Cold-weather sensitivity during spray, rise and adhesion.

2. GRP Interface & Geometry (Supplier Risk)
- Wrong pipe delivered (wrong stiffness class, wrong wall thickness).
- Bad muffle lamination or incorrect register → misalignment & leakage

3. Robotics & Sensing (Operational Risk)
- LiDAR/TDC alignment failures in fog / dust.
- Sensor drift or calibration errors affecting foam thickness.
- Crane/sled stability on steep grades or loose substrate.

4. Site Conditions & Logistics (Environmental Risk)
- Wet, collapsing or highly variable soils altering foam/soil interaction.
- Access road limitations restricting system mobility.
- Trench excavation rate becoming the bottleneck for install speed.
- Transport damage to pipes / muffles.

5. Supply Chain & Integration (Commercial Risk)
- GRP & foam logistics not ramping in sync with foam teams.
- Single-supplier dependency (GRP, chemicals, nozzles, LiDAR assemblies).
- Regulatory delays (CERF, BC permitting, Norwegian nature restrictions).



What Is Proven and What Remains Open?

1. Proven in the Field (Real Projects & Tests)
- **Hydropower performance validated** – Adamselv confirms stability, load transfer, settlement behaviour.
- **Foam–soil interaction** – load dispersion, shear/compression envelope, and point-load resistance confirmed in practice.
- **Native backfill feasibility** – shown to eliminate granular / concrete bedding without settlement issues.
- **Operational workflow** – trench, spray, place, backfill rhythm proven on steep, remote terrain.

2. Proven in Engineering (Models & Labs)
- **2D and early 3D FEA** showing correct stiffness behaviour, foam anisotropy averaging, and sector load distribution.
- **Material properties** (E, G, ν, density, rise behaviour) validated to engineering accuracy for hydropower use.
- **Foam rise & cold-weather chemistry** robust within operational temperature bands.

3. What Remains Open (2025–2027 Validation Path)
- **Long-term creep in bends** – Nestaan test + full 3D FEA required for long-duration confirmation.
- **Robotic spraying works** – repeatable foam geometry, reliable 10-minute cycle, stable in cold and wet conditions.
- **Full bend behaviour under varying soil profiles** – especially in mixed wet/rocky ground.
- **O&G conditions** – hydrocarbon compatibility, pressure/temp cycles, freeze–thaw under CERF load cases.
- **Logistics for mobile rigs** – multi-rig deployment, generator sizing, and hardstanding requirements.

4. What Is Unknown Until We Build Full Scale
- **True install rate ceiling** (peak metres/day).
- **Crew learning curve** in difficult access corridors.
- **Actual bottleneck between trenching output vs foam team output**.
- **Regulatory acceptance timelines** (BC/Alberta permitting + CERF engineering review).

HydroFoamer IP – The Three Patent Pillars

1. Hydropower + Foam Embedment Pipeline System (Granted)
(2015 patent family)
- Protects GRP pipelines embedded in **in-situ PU/PIR foam**.
- Covers pillows, trench breakers, full trench foam filling, and use of native soil.
- Enables accelerated installation, reduced costs, and velocity-based hydropower architecture.
- Includes tapered ducts, laminar-flow dimples, and intermediate turbine stations.

2. Inclinometer Belt for Real-Time Pipe Geometry & TDC (2025 Provisional)
(P102531NL)
- Segmented **self-aligning belt** with dual inclinometers.
- Real-time determination of **TDC**, **radius**, **pitch**, **yaw**, and **misalignment**.
- Integrated **marker system** (paint apertures or prism).
- Feeds data directly into robotic systems for accurate TCP path planning.
- This is the key enabling technology for **robotic foaming and automation**.

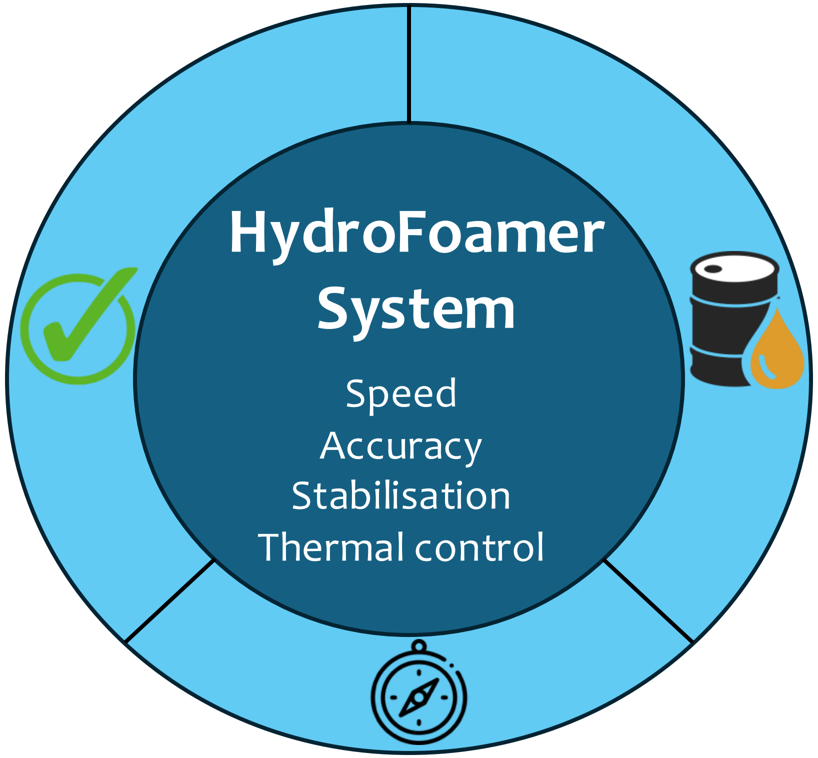
3. O&G Composite Pipeline + Foam Stabilisation/Insulation (2025 Provisional)
(P103632NL)
- Composite GRP pipeline in a trench with **in-situ PU/PIR foam** applied around it.
- Foam provides **mechanical stabilisation**, **thermal insulation**, and **impact protection**.
- Maintains hydrocarbon temperature above **WAT/HFT**, preventing wax and hydrate formation.
- Unlocks long-distance GRP for oil & gas with lower pumping energy and no steel.
- Compatible with mobile robotic foam application.

HydroFoamer IP Moat

No competitor can copy our method, our alignment system, or our foam-insulated GRP pipeline architecture in either hydropower or O&G.

Hydropower / Foam Embedment
GRANTED

- Foam embedment & backfill
- GRP + foam stabilisation
- Velocity-based hydropower
- Tapered ducts & dimples



O&G GRP Pipeline + Foam
PROVISIONAL

- In-situ insulated foam layer
- WAT/HFT protection
- GRP for hydrocarbons
- Long-distance thermal stabilisation

Inclinometer Belt / TDC System
PROVISIONAL

- Real-time TDC
- Radius / pitch / yaw
- Marker → robot path planning
- Spatial referencing system