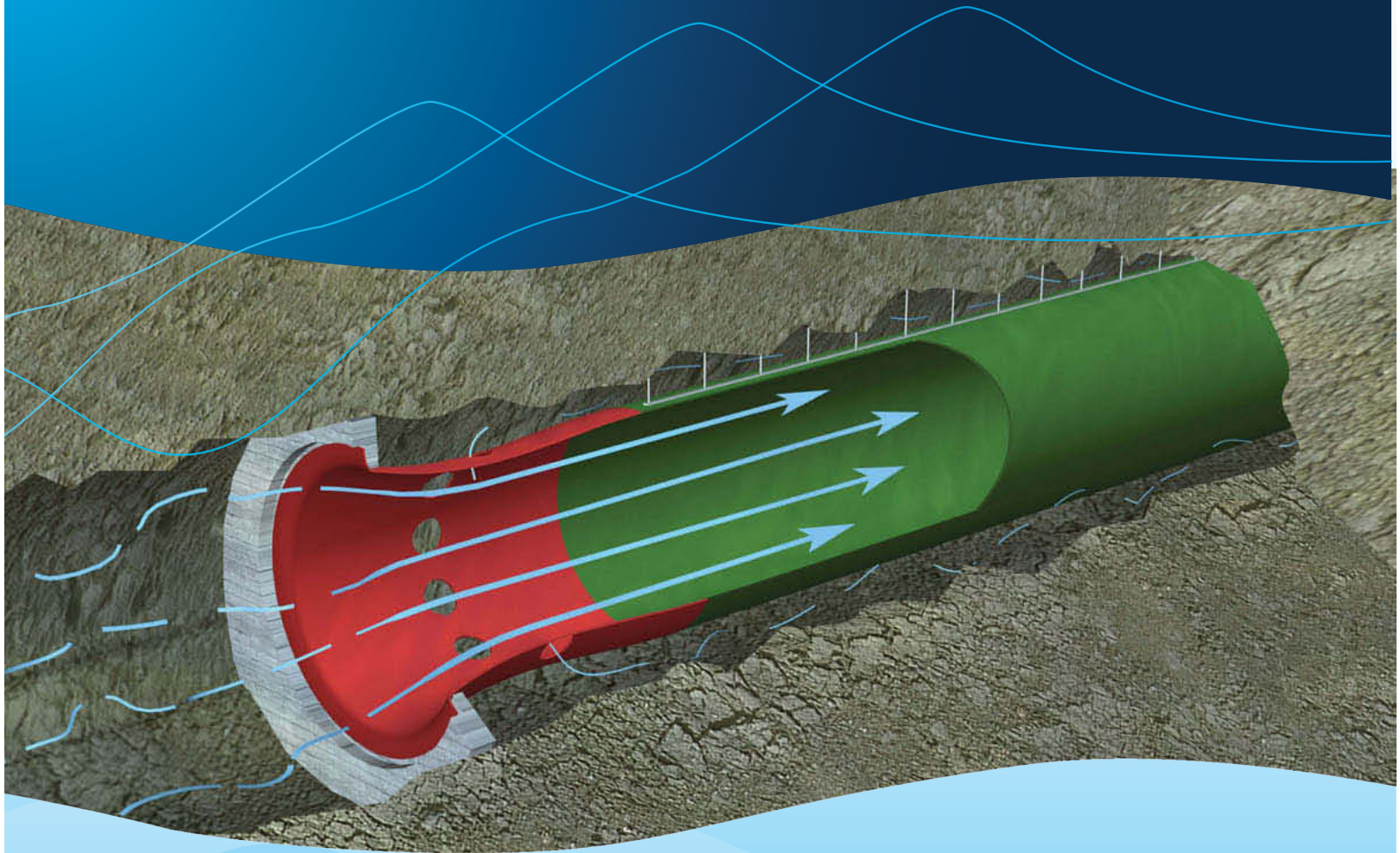




G-Flow as

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The Groner membrane:

innovative lining giving
new energy from old tunnels

Rapid and lightweight installation heavy duty research, development and technology

- A revolutionary and patented Norwegian concept
- Mathematical and numerical models by Sintef and Flow Design Bureau
- **Physical models at Sintef Hydraulic laboratory**
- Laboratory and field deterioration tests at Norwegian Building Research Institute and Steinfoss Hydropower plant
- Unique membrane strength tests at NTNU with a custom made jack enabling 30 kN/metre tension combined with inner pressure
- Full scale field installation at Haaen near Trondheim



The Groener membrane handles situations such as sudden shut down and start-up, reverse currents, downfall of rocks and rupture on the membrane without problems

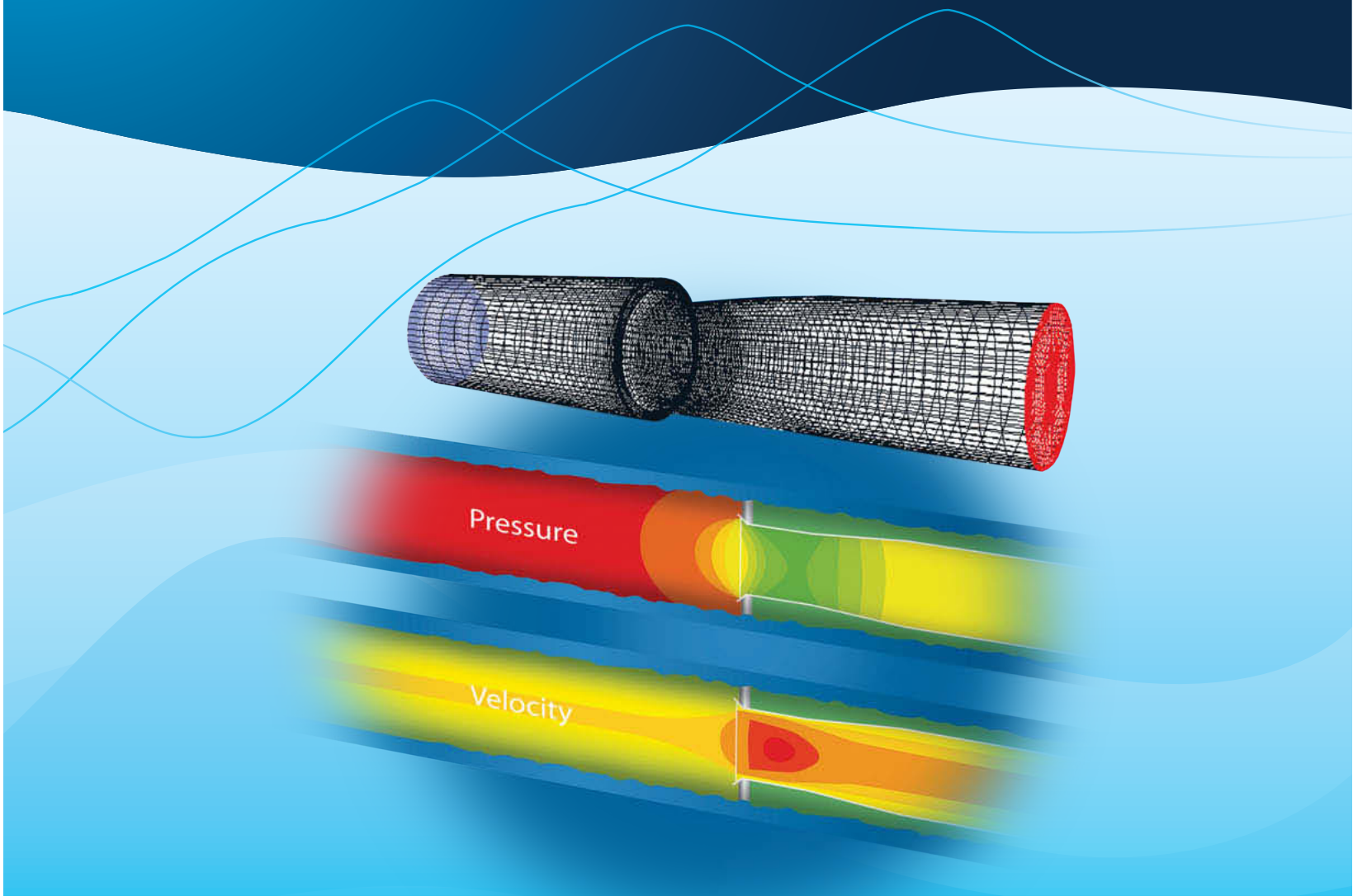
The Groner-membrane is an inflatable lining which turns any tunnel into a completely hydraulic smooth waterway reducing energy loss losses dramatically.

The durable membrane is subject to a small inner water pressure and “floats” in the surrounding water. The patented design therefore transfers hydraulic forces instead of containing them

The result is a reliable and durable lining that substantially increases output with an absolutely marginal environmental impact:

- Tunnel friction loss: up to 75 % reduction
- Installed capacity: may be increased with up to 100 %
- Power production: 20 % increase can be achieved

→ **New renewable energy with minimum environmental impact**



The principle: A smooth pipe is created by introducing slight super-pressure into a flexible pipe

Proven efficiency

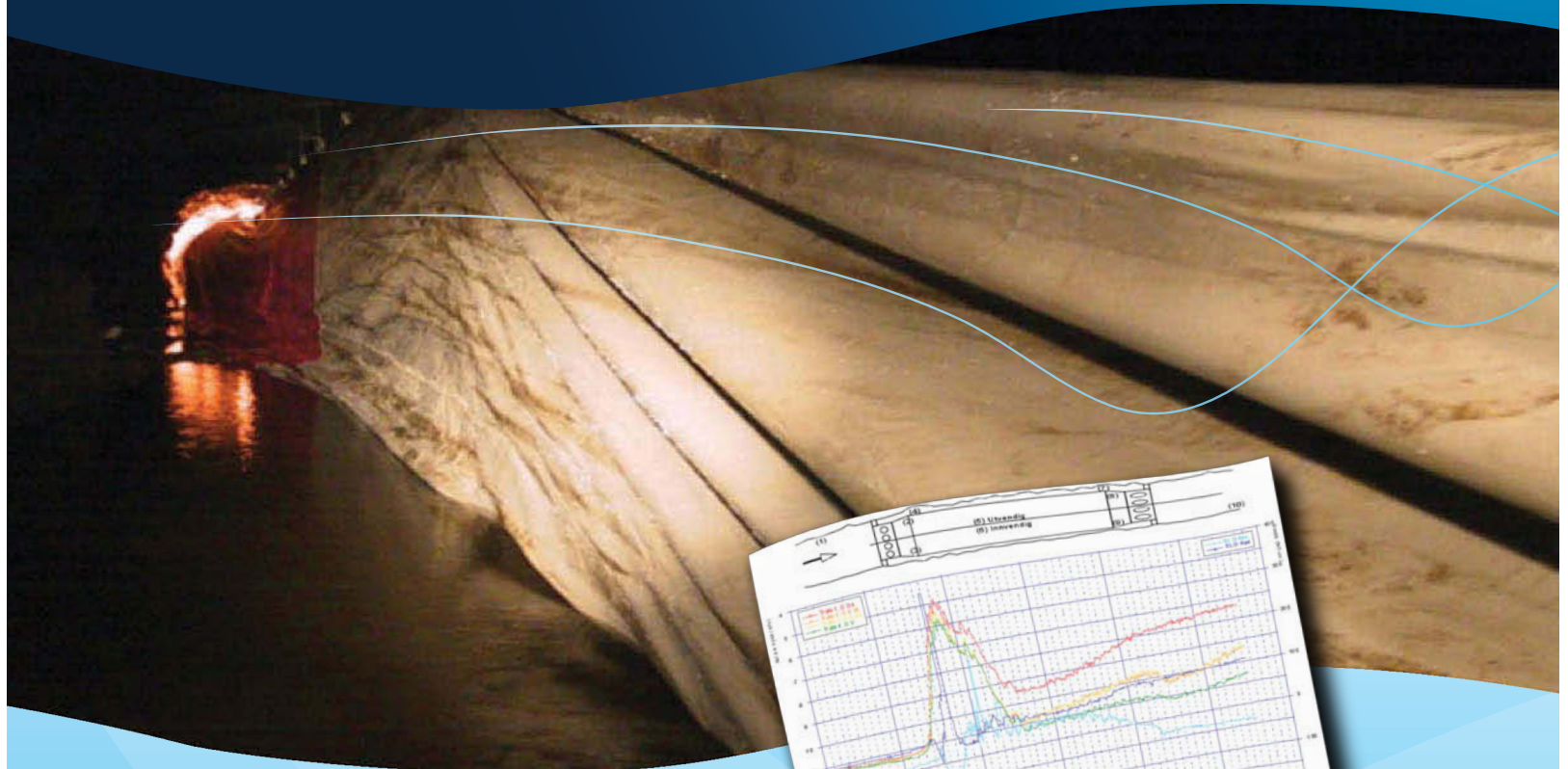
Advanced monitoring during the pilot test verified that head loss is reduced with 75 % and that the technology is extremely reliable

Rapid installation

The Groner Membrane can be installed in short time, kilometers can be installed in few weeks.

All kinds of tunnels

The Groner membrane reduces friction loss in all kind of tunnels. In TBM-drilled and lined tunnels friction loss can be reduced with up to 50 %. The economical benefits are normally largest in old lined tunnels.



*Sudden start-up of Haaen power plant
from 0-28 MW. Measured differential pressure*



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