Energy Efficiency in Reverse Osmosis Systems

Murray Thomson

CREST
Centre for Renewable Energy Systems Technology
Loughborough University, UK

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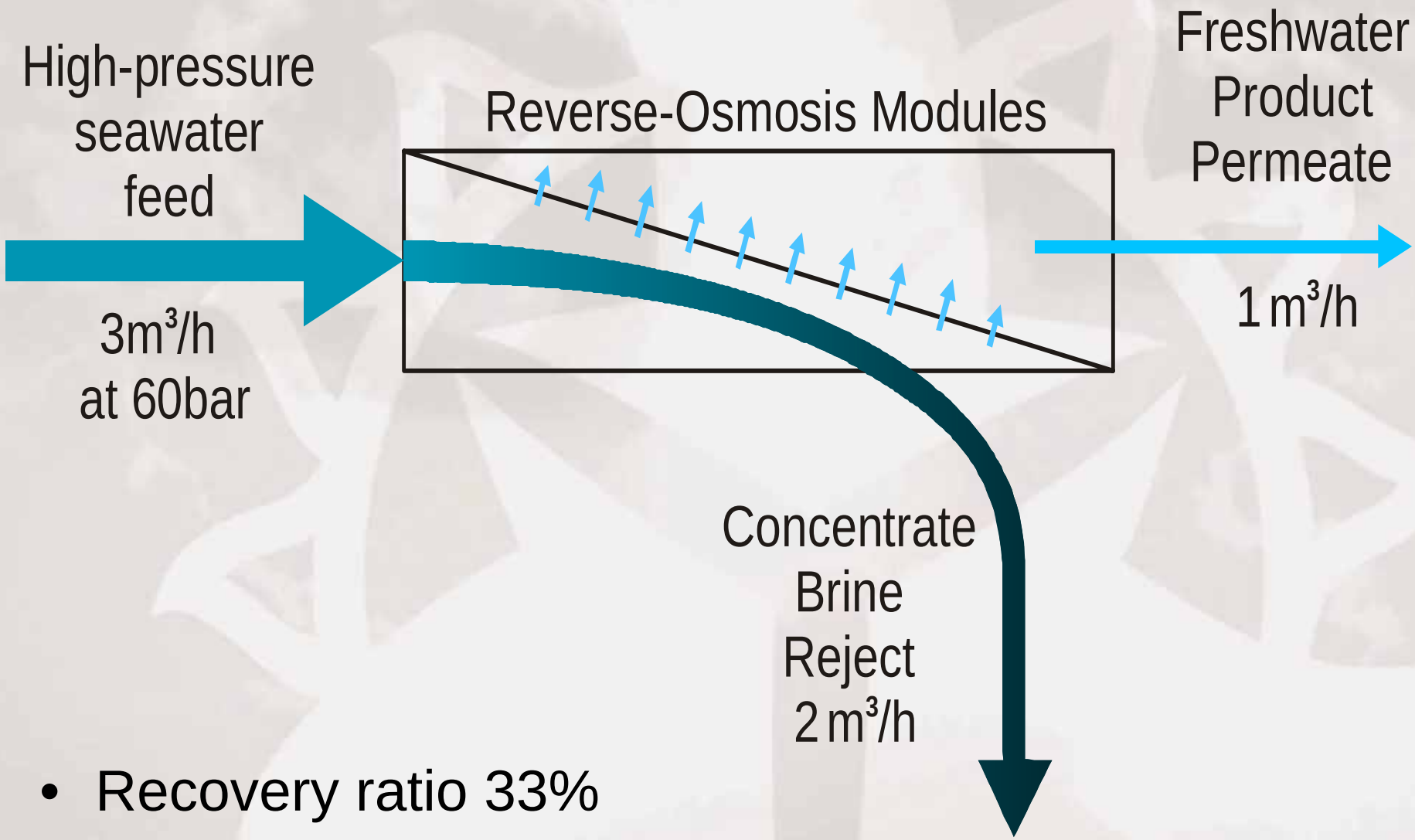
Energy required to desalinate seawater

- Theoretical minimum: ~ 1 kWh/m³
- Simple distillation (theoretical): ~ 627 kWh/m³

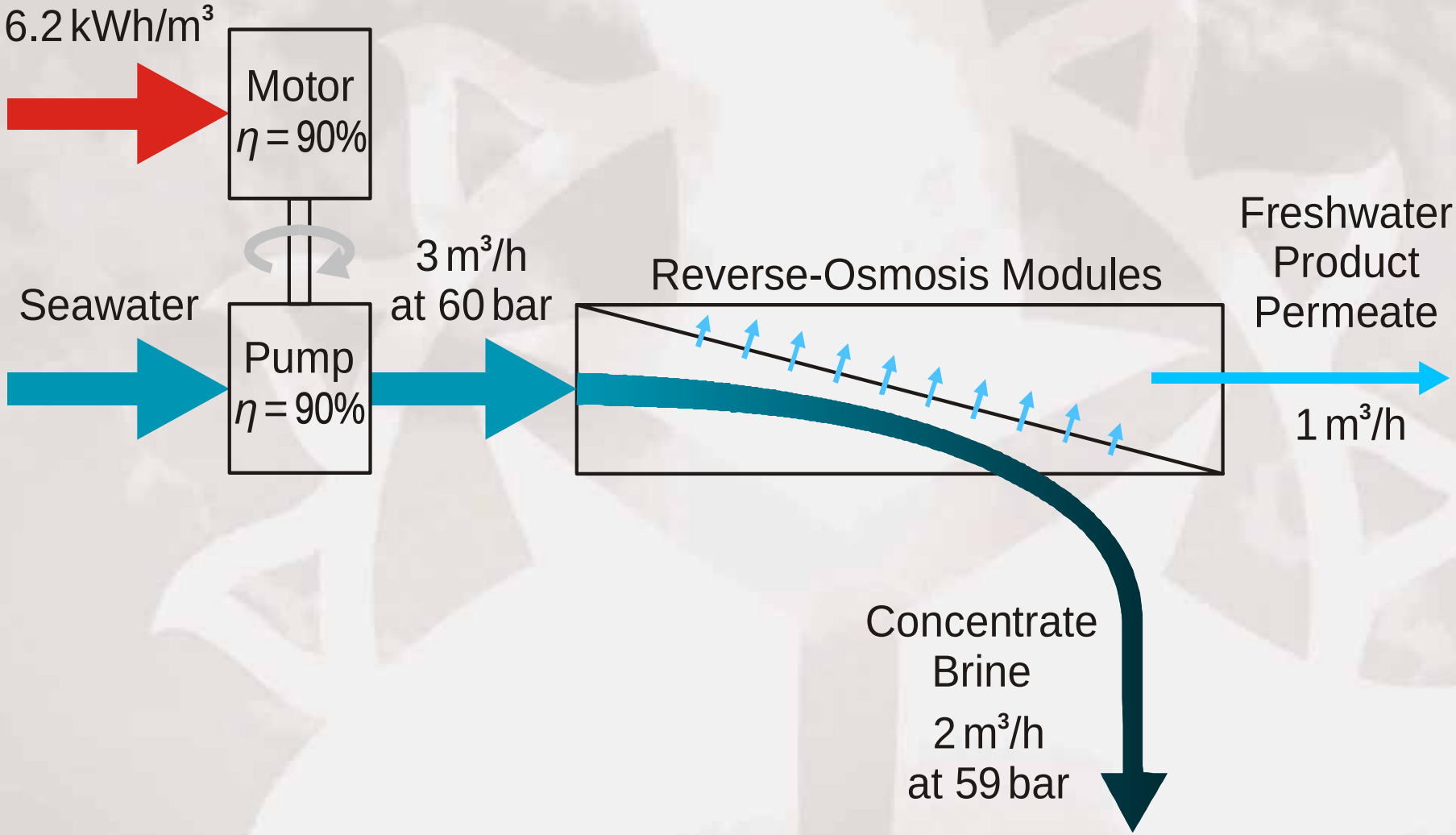
- Thermal desalination (Large MED, MSF & VC): 6 - 16 kWh/m³
- Typical RO: 3 - 8 kWh/m³
- Best practice RO: 2 kWh/m³

Seawater RO – Example

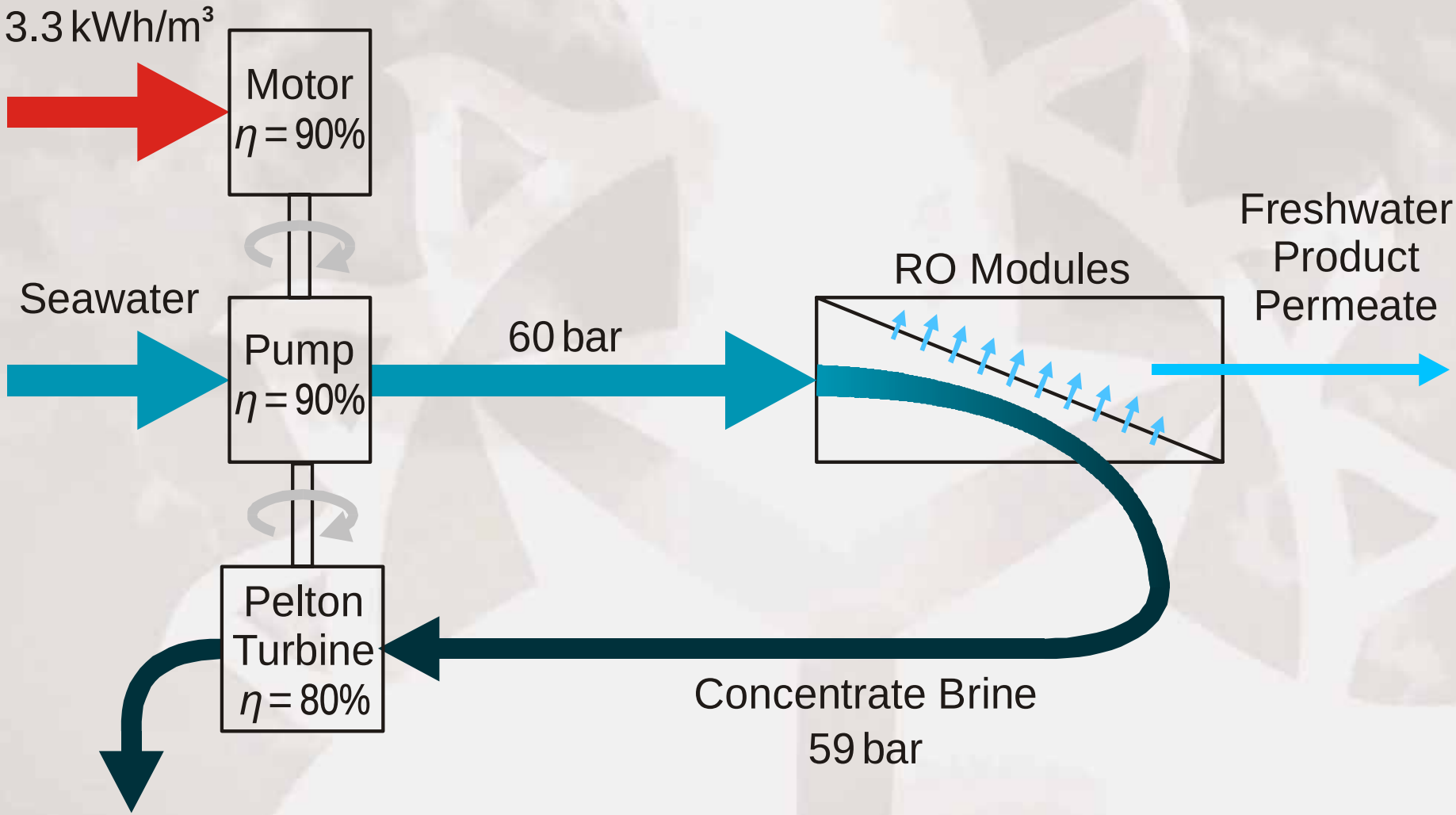


- Recovery ratio 33%

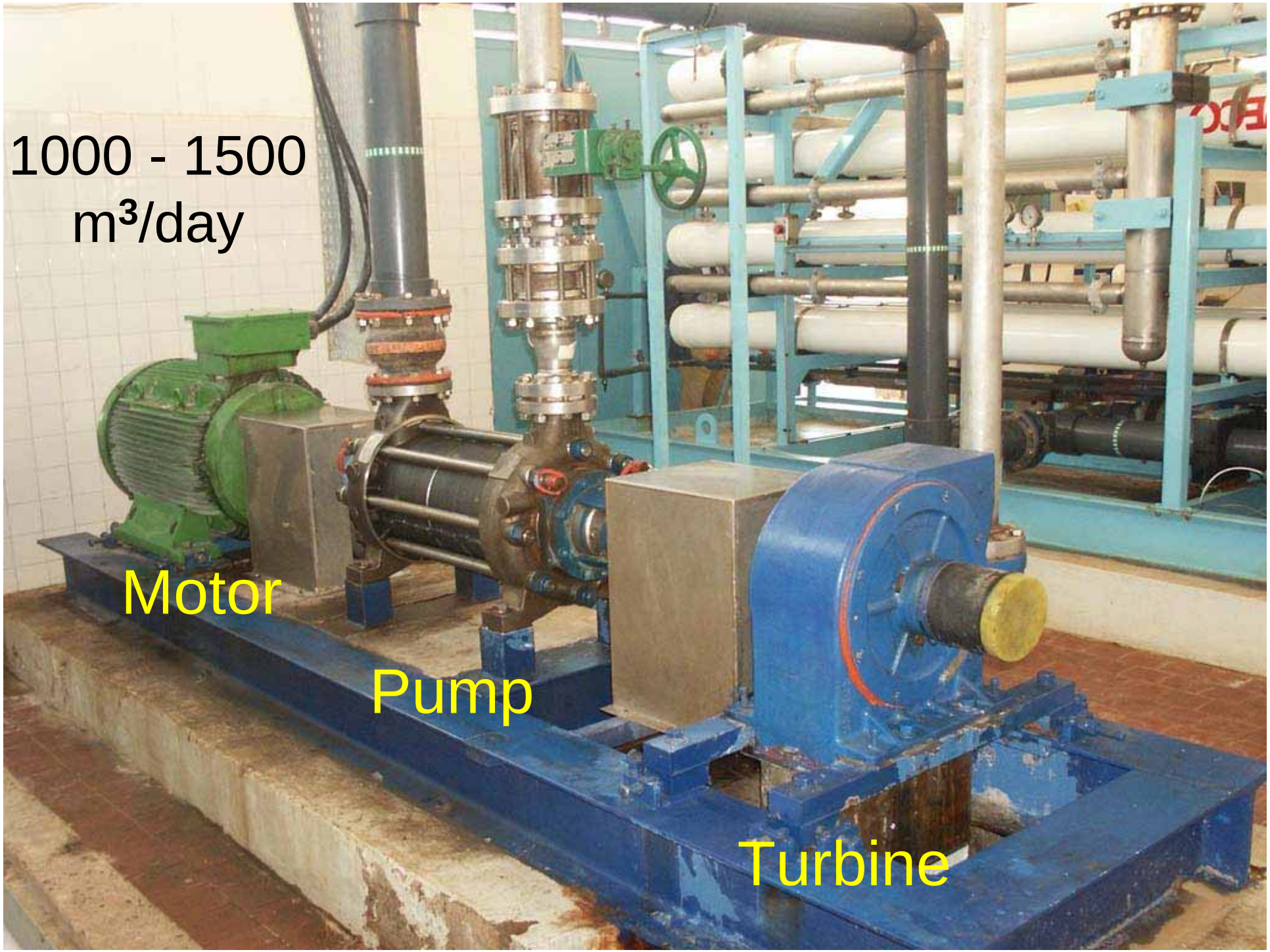
Pumping requirements



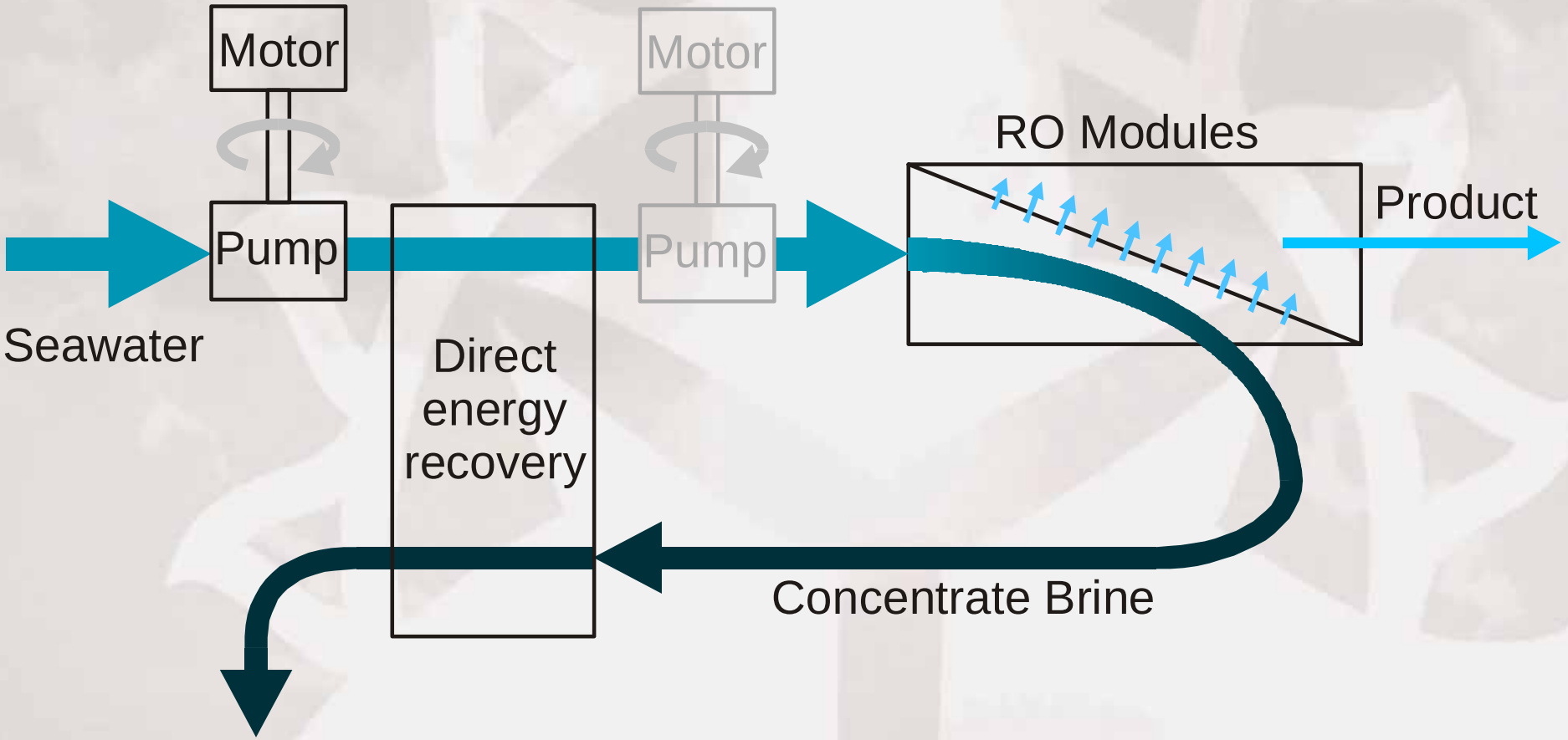
Pelton turbine energy recovery



- Only for medium and large scale

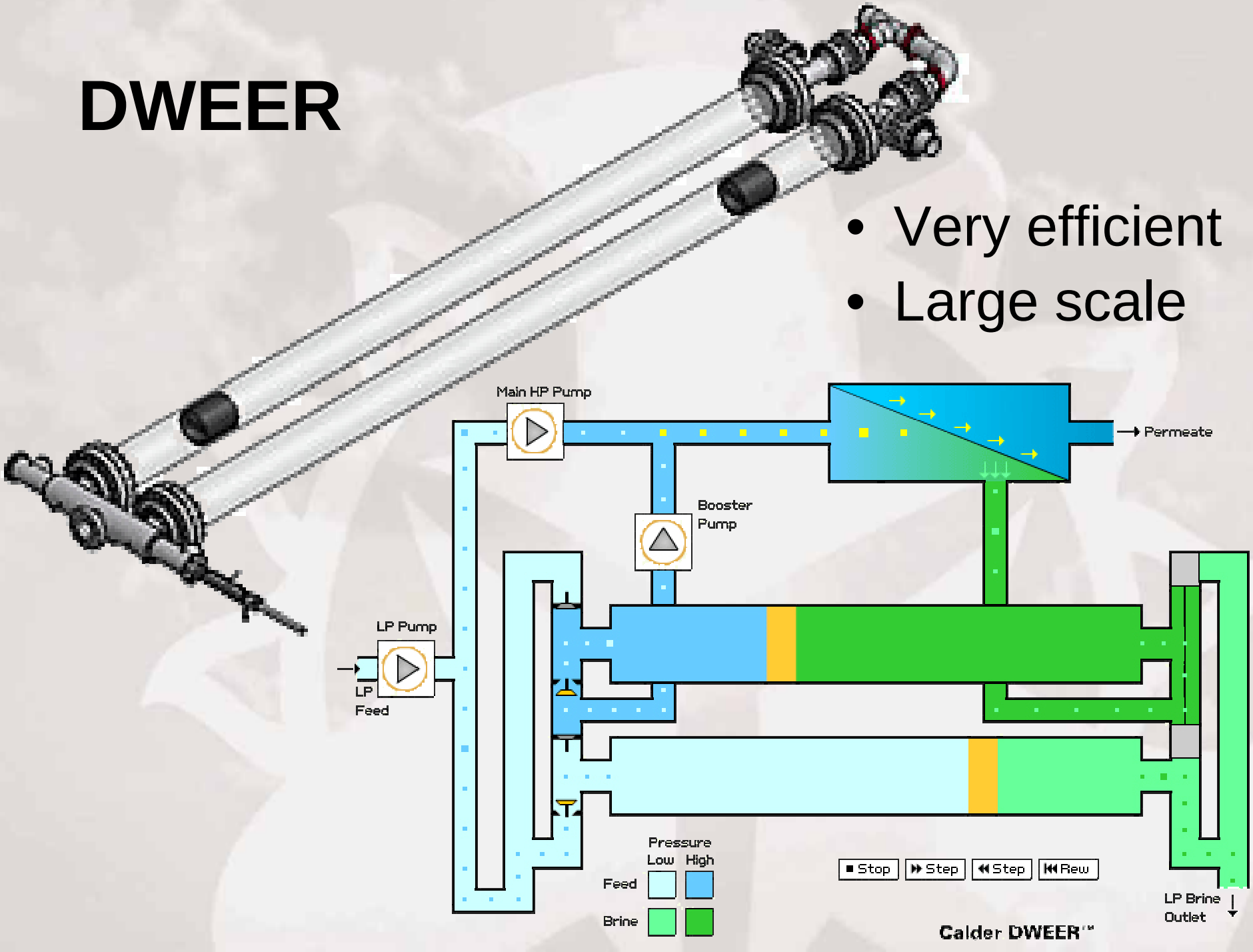

1000 - 1500
m³/day
Motor
Pump
Turbine

Direct energy recovery

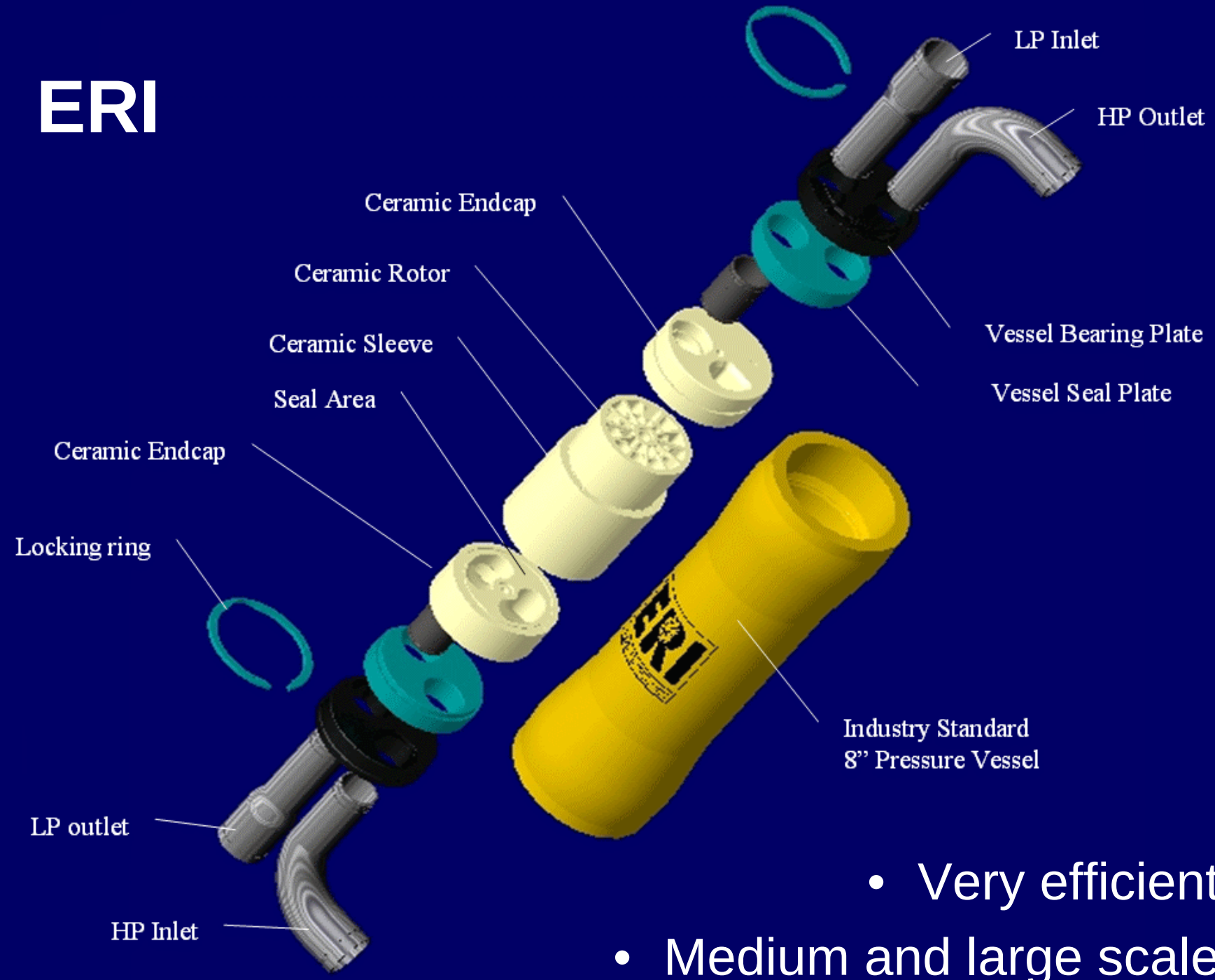


DWEER

- Very efficient
- Large scale



ERI

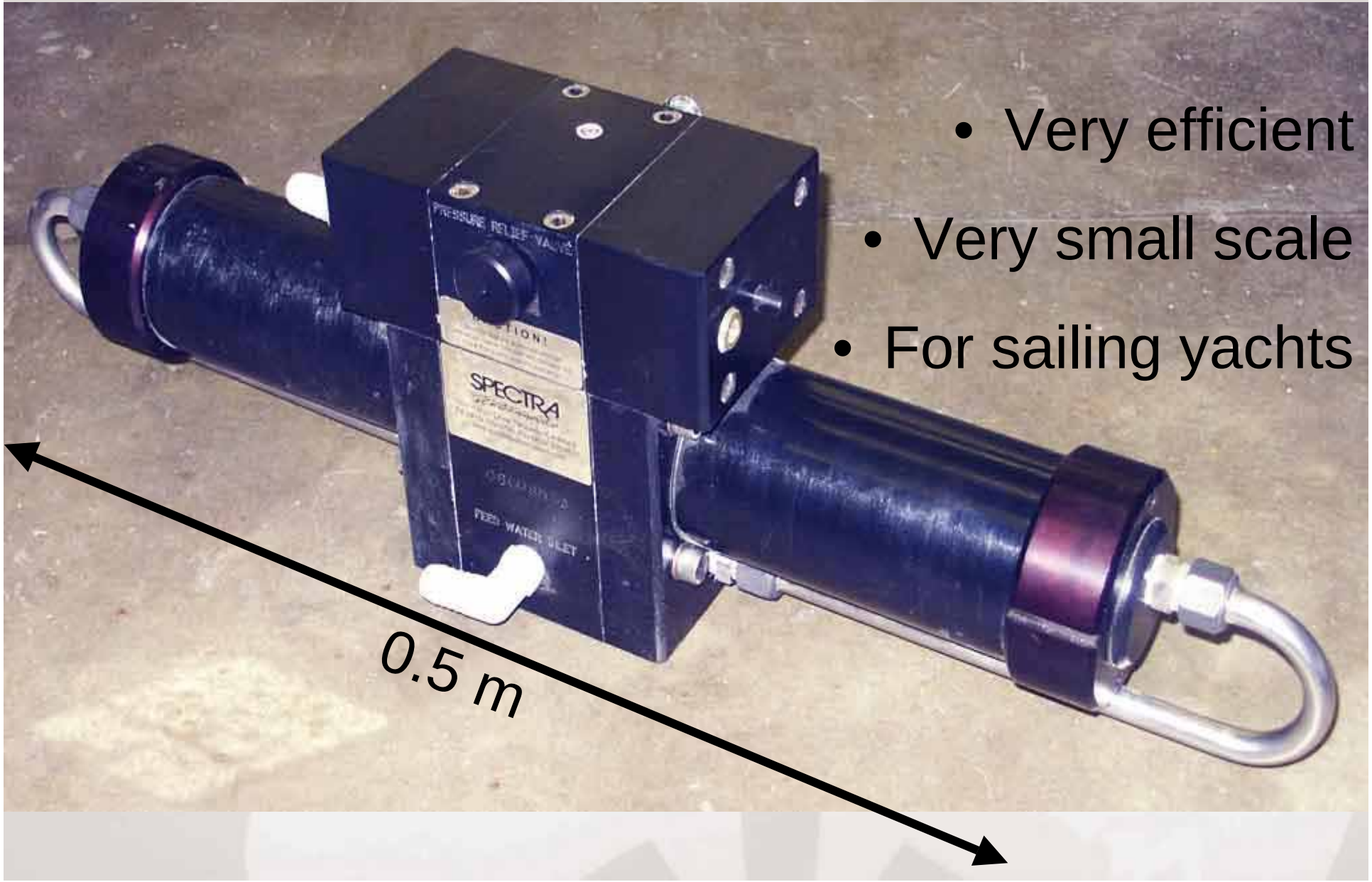


- Very efficient
- Medium and large scale

Scale

- The Pelton turbine, DWEER and the ERI devices, and their similar competitors, help to achieve very low energy consumptions:
  - sometimes approaching 2 kWh/m^3
  - **in medium and large-scale systems**.
- We now turn our attention to small-scale systems.

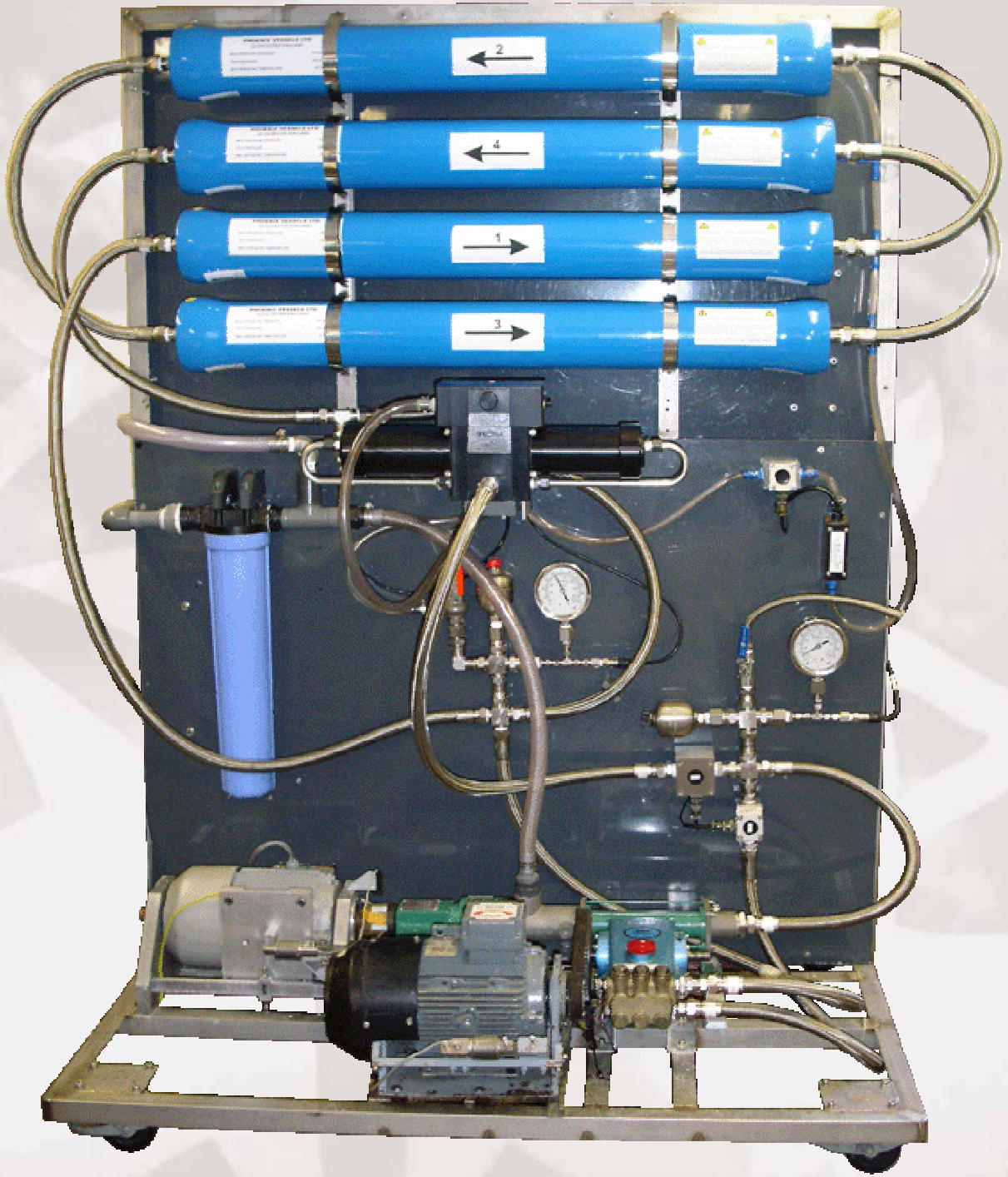
Clark Pump - Pressure Intensifier



- Very efficient
- Very small scale
- For sailing yachts

CREST
RO Test Rig

- PV or wind powered
- “Seawater”
- Energy recovery
  - Clark pump
- No batteries
- Variable flow



Sea Recovery - Ultra Whisper

Hydraulic Motor
eg: Danfoss Nessie

- Provides shaft power
- Swash plate
- Axial-pistons

Renewable energy powered RO

- Various researchers and companies worldwide have built demonstration systems employing these energy recovery devices in renewable energy powered RO systems, with varying success.
- Many small systems are still built without any energy recovery.

Enercon

- Sorry no picture!
- Energy recovery for seawater RO
- Three pistons
- Oil coupled
- Pressure intensifier

Brackish water

- Typically uses higher recovery ratio
- Smaller proportion of energy in brine
- Energy recovery less critical
- Notable exception: SOLCO:
  - 16% recovery ratio
  - Energy recovery integrated in pump

Conclusions

- Energy recovery
  - critical for efficient seawater RO
  - but does make designs more complex
- Proven devices available at large-scale
- Less so at small scale

Thank you