ELECTRIC VALVE
Integrated solution

JV between ATV S.p.A and INNOVA A/S.

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Eirik Ravnås

Goal

- Provide the best solutions for the customer
  - Cost
  - Reliability
  - Ease of integration
  - Predictability
  - Control

Why Electric?

- Marked exist
  - Extend range of subsea production systems (deeper, longer step-out)
  - All-electric subsea systems have the potential to reduce CAPEX and OPEX
  - Case studies report CAPEX saving in the range of 10-30%
  - Environmental benefits
- Electric systems are maturing
  - Ormen Lange Subsea Compression Pilot
  - Åsgard Subsea Compression
  - K5F All-electric tree
- Electric actuators are reliable
  - Equinor reports 8M running hours accumulated
  - No retrievals due to failures in actuator

Why Electric?

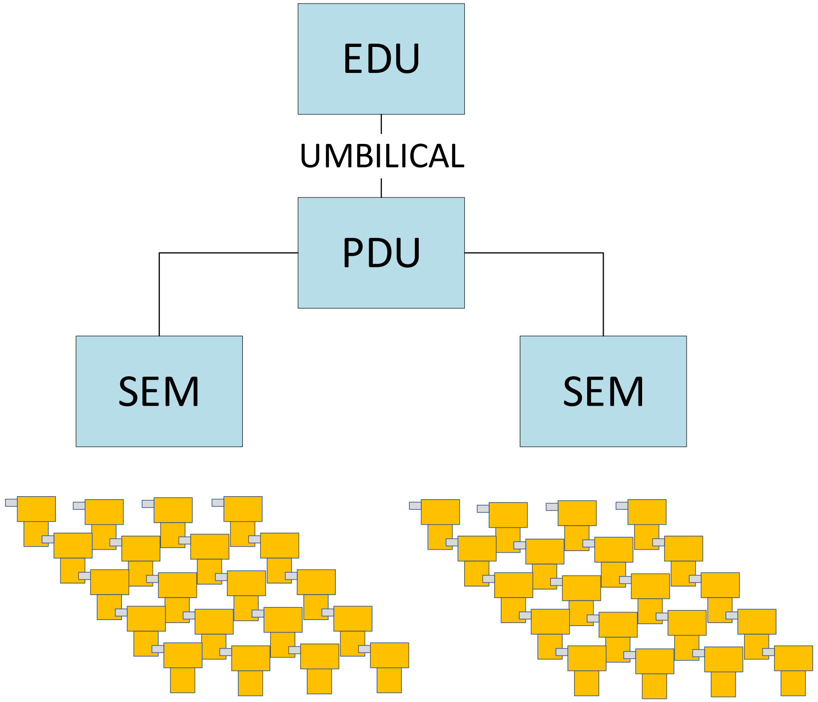
- Better regulation
  - Smooth, controlled motion
  - Position accuracy
  - Feedback
- Condition monitoring
  - Predictive / Planned maintenance

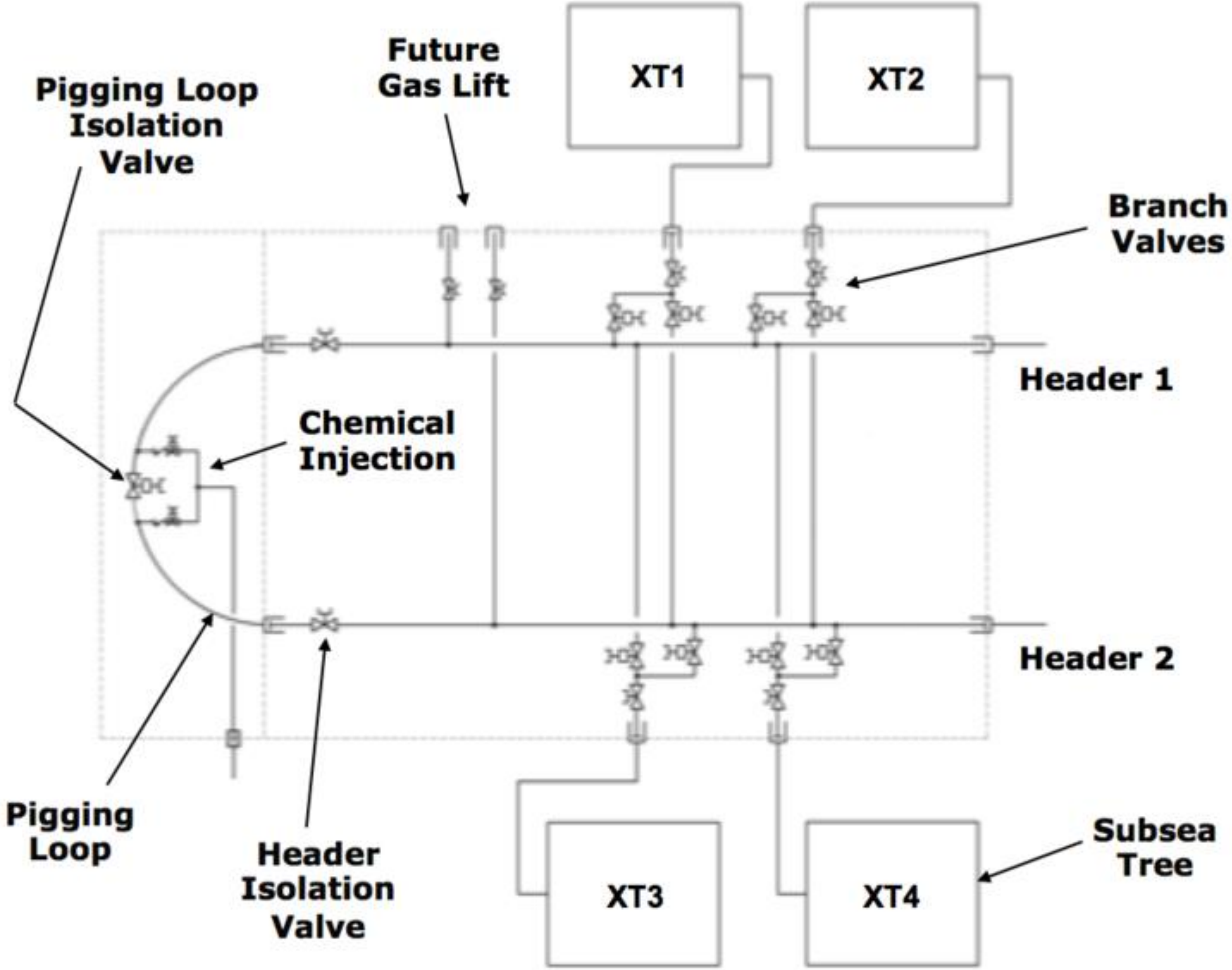
Challenges

- Concern of the unknown
- Standards written around existing solutions
- Need for system understanding across different disciplines

Challenges

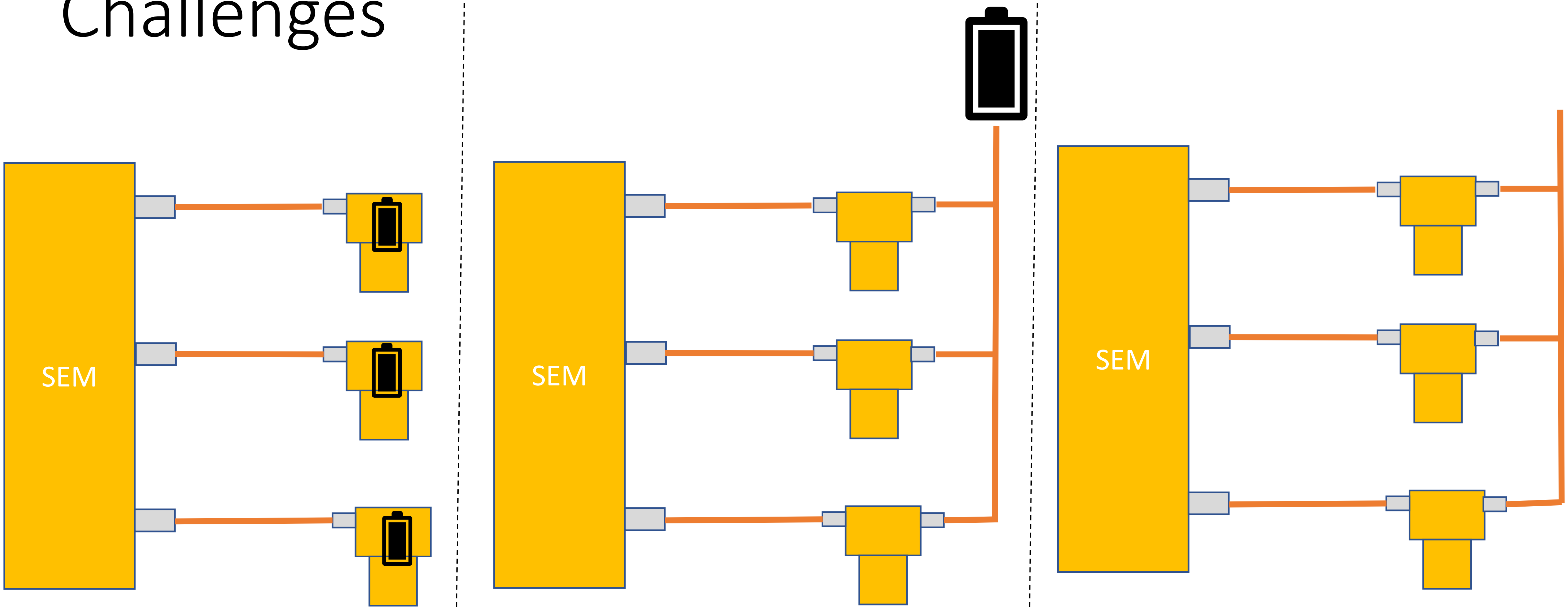
Power infrastructure





EVERY WATT COUNTS!

Challenges



Local energy storage

Central energy storage

Direct powered

Challenges

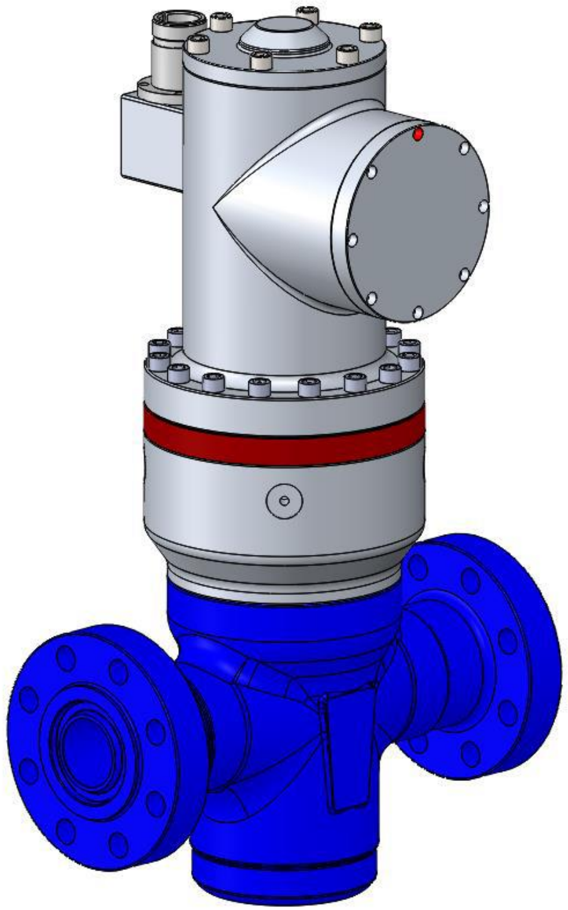
- Power management raises “new” questions
  - Valve torque profile (Energy)
  - Operation time (Power)
  - Frequency of operation (Recharge time)
- Valve actuation times are high
  - Fail-safe (XT, HIPPS)
  - Gate valves
  - Large Ball valves

Challenges

- Transitional phase from hydraulic -> electric
  - Incremental approach (Risk reduction)
- Not taking advantage of new functionality
  - Valves and their configuration selected for hydraulic system
  - Valve forces and energy demand are high
  - Fail-safe functions sometimes specified due to removal of one **hydraulic** control line

Integrated electric valve

- Unique possibility for close integration of actuator and valve.
  - Power efficiency
  - One qualification
  - Targeted condition monitoring
  - Smaller physical size
  - Less weight
  - Less cost



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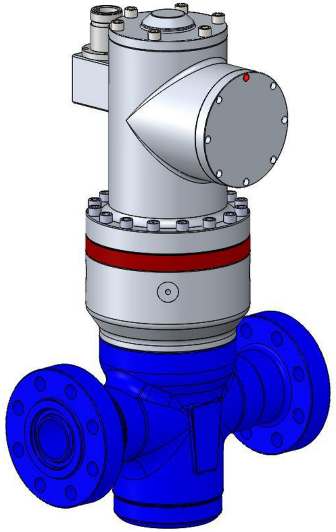
Condition monitoring

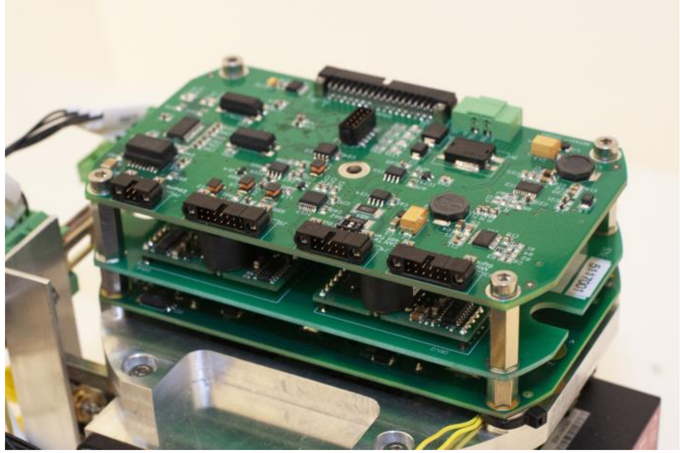
- Actuator as a platform
  - Valve signature
  - Vibration
  - Valve internal leakage monitoring
  - Hydrate jamming
  - External load
  - Shutter position
  - Other pipeline parameters can be conveyed through electric actuator

Building blocks - modularity

- Battery/BMS
- Charger
- Motor drive
- Motor
- Gearbox/Screw

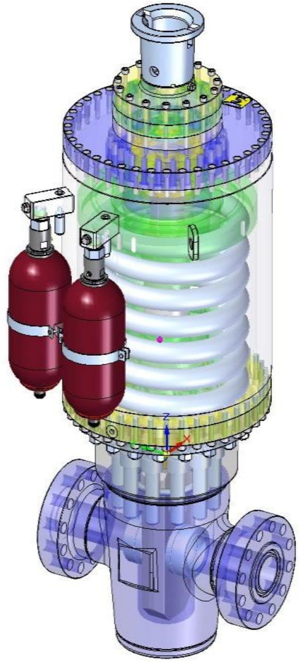
- Electric actuators
- Subsea HPUs

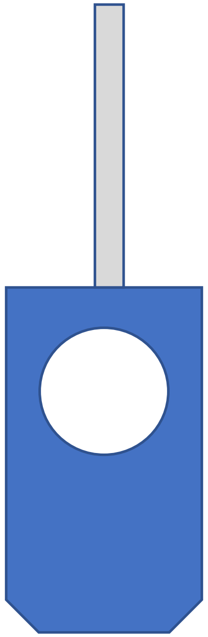




Case Study I

Example 5 1/8” - 15ksi Gate valve

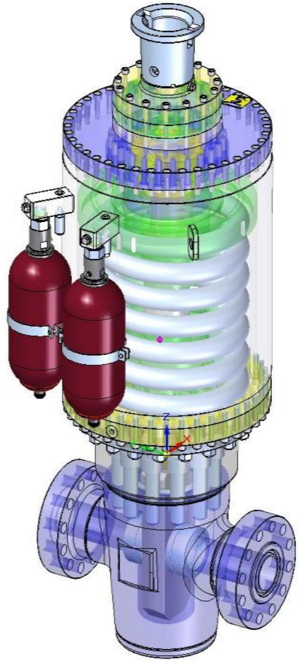




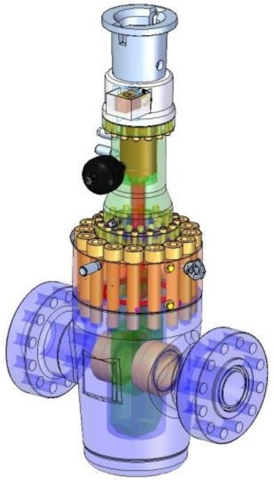
Forces:
- Gate drag
- Ejection force
- Hydrostatic force
- Friction force stem seal

Spring failsafe:
- Springs are difficult to produce to required quality
- Springs are big
- Balanced valve cannot be used with spring failsafe! (XT’s)

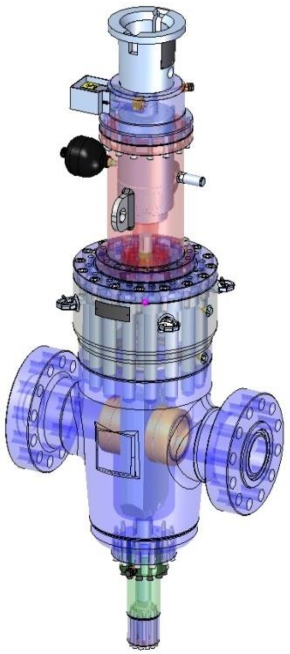
Size/weight T.C Slab Gate 5 1/8" – 15ksi (3000m)



T.C. Gate Valve 5 1/8"-15k
Hydraulic Actuated
Spring Return Fail to Close
Weight = 4550 kg



T.C. Gate Valve 5 1/8"-15k
Mechanical Operated
Suitable for drop-in Electric Actuator
Fail As Is
Weight = 1400 kg



T.C. Gate Valve 5 1/8"-15k Mechanical Operated Double stem
Suitable for drop-in Electric Actuator for configuration Fail as Is, Fail Close and Fail Open (with battery)
Weight = 1850 kg

Energy efficiency

	Standard	Balanced
Actuator	**2.7 kNm**	**2.7kNm**
Max torque	**1900 Nm**	**1200 Nm**
No. turns	**26**	**8**
Time to open	**13 min 25 s**	**2 min 27 s**
Time to close	**7 min 28 s**	**1 min 49 s**
Energy to open	**266 kJ**	**20 kJ**
Energy to close	**92 kJ**	**10 kJ**
Time to recharge (open)	**2h 15 min**	**10 min**
Time to recharge (close)	**47 min**	**5 min**

- Implications:
  - Less power demand
  - Frequent operation/ testing

Case Study II

22” ball valve

Standard(Worm gear):

- 62 turns

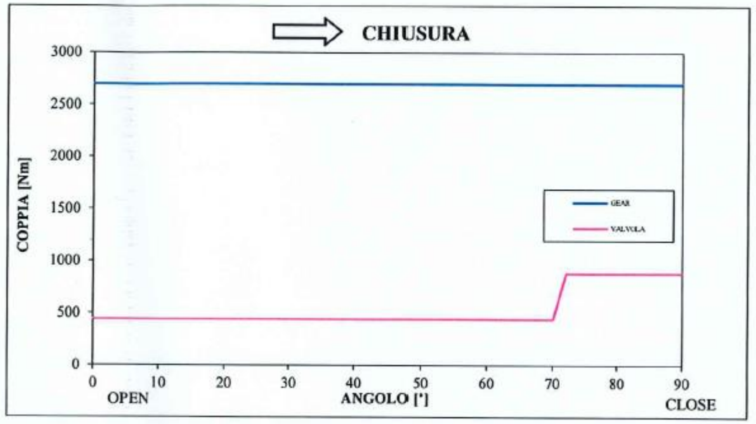
Alternative(Spur gear):

- 19 turns

SAME TORQUE!

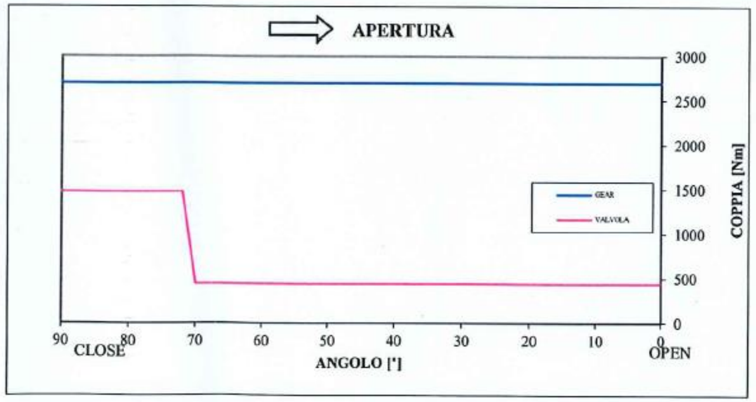
closing

	GEAR IN OPEN	VALVOLA APERTA
0	2700	443
10	2700	443
20	2700	443
30	2700	443
40	2700	443
50	2700	443
60	2700	443
70	2700	443
70	2700	443
72	2700	886
90	2700	886
	CLOSE	CHIUSA



opening

	GEAR IN CLOSE	VALVOLA CHIUSA
90	2700	1477
80	2700	1477
72	2700	1477
70	2700	443
60	2700	443
50	2700	443
40	2700	443
30	2700	443
20	2700	443
0	2700	443
	GEAR IN OPEN	VALVOLA APERTA



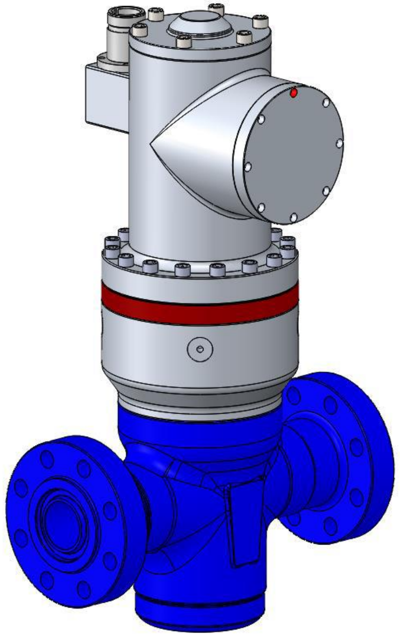
Energy efficiency

	Standard	Alternative
Actuator	**2.7 kNm**	**2.7kNm**
Max torque	**1477 Nm**	**1477 Nm**
No. turns	**62**	**19**
Time to open	**23 min**	**7 min 8 s**
Time to close	**19 min**	**5 min 44 s**
Energy to open	**352 kJ**	**108 kJ**
Energy to close	**262 kJ**	**80 kJ**
Time to recharge (open)	**2h 58 min**	**54 min**
Time to recharge (close)	**2h 12 min**	**40 min**

- Implications:
  - Less power demand
  - Frequent operation/ testing

Integrated electric actuator

- Power interfaces:
  - SIIS L2/L3
  - 400 VAC
  - 400 VDC
- Communication interfaces:
  - SIIS L2
  - Modbus RTU
  - SIIS L3
- Control system redundancy
  - Single
  - Dual



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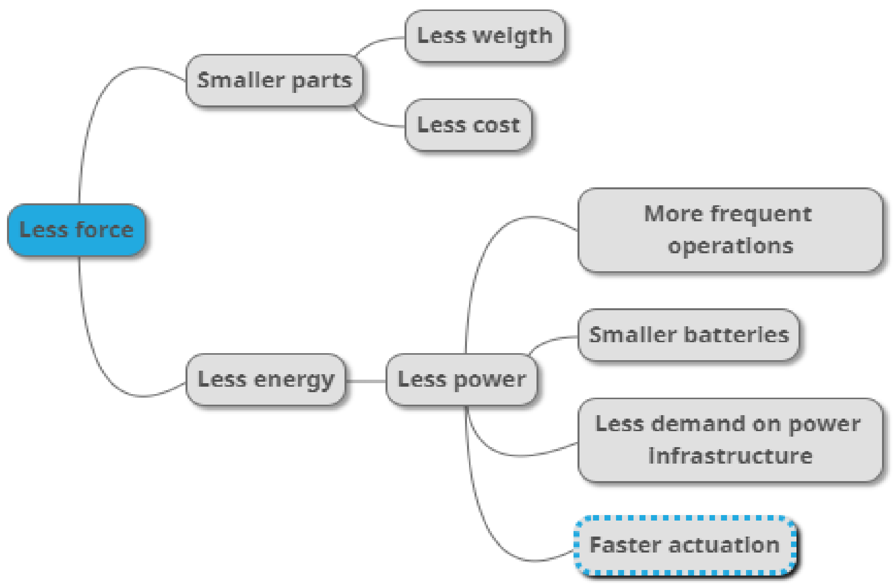
Conclusion



- Energy efficiency is essential
- “Smart Valve” enables predictive maintenance
- Integrated electric valve is the way to accomplish this

Questions?