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Subsea All- Electric – Architecture and system solutions

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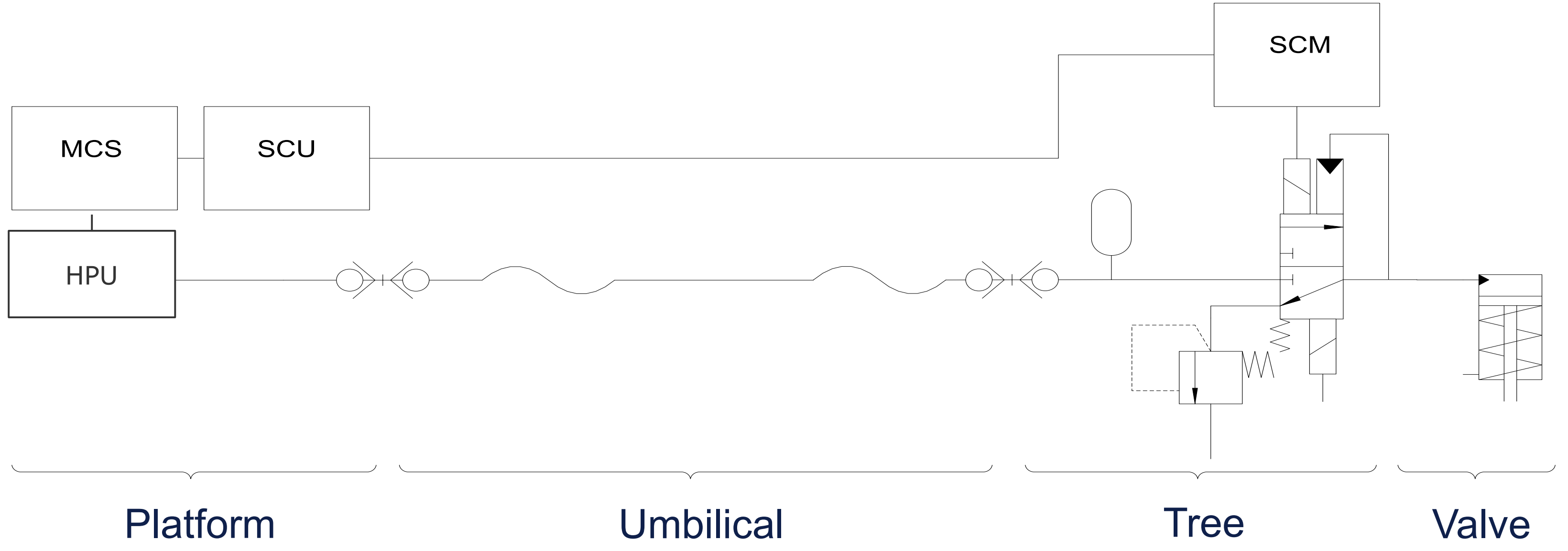
Subsea All- Electric – Architecture and system solutions

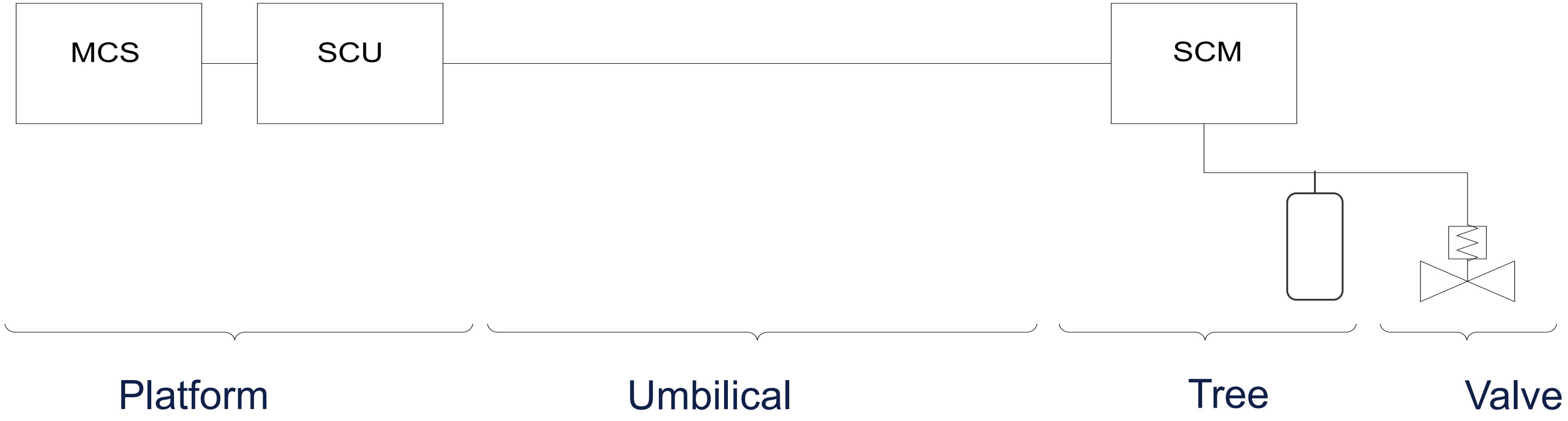
- In the light of technology advances in subsea technology, as with subsea compression, all-electric building blocks have proven their performance with accumulated hours of fault free operations, **why are well barrier systems still hydraulically operated?**

- Is it the simplicity with well controlling equipment?
- Is it the few functions required?
- Or the respect for messing with well barriers?

- ***All-electric SPS challenges traditional thinking***

All electric is it simple or complicated?





How to evaluate the complexity of a technology?

- By number of ***functions***?
- By number of ***programmable units***?
- By having different ***technologies*** working together?
- By having different ***physics*** working together?

- Or by the number of ***professions*** needed in managing the technology?

The evolution of control system driven by needs

System Type	Cost	Maintenance /reliability	Flexibility	Step out	Depth
Direct Hydraulic	Low	Low technical threshold. Most components topside.	Limited	Short	Shallow
Piloted Hydraulic	Low	Low technical threshold. Most components topside.	Limited	Short	Shallow
Electro Hydraulic Multiplex	High	More complex, subsea equipment.	Expandable	Long	Deep
All Electric	High*	More complex, subsea equipment.	Expandable	Very Long	Ultra Deep

Cost comparison will depend on:

- No. of wells
- Tie-back distance
- Water depth
- Subsea architecture
- Models for CAPEX/OPEX
- RiskEx
- Field design life

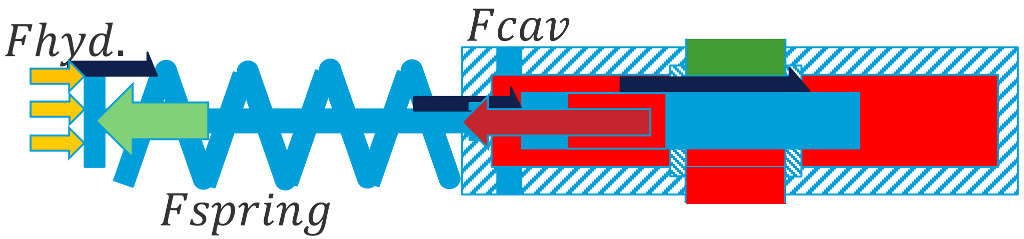
*Operators evaluating 'all-electric' require a competitive CAPEX and OPEX with traditional system

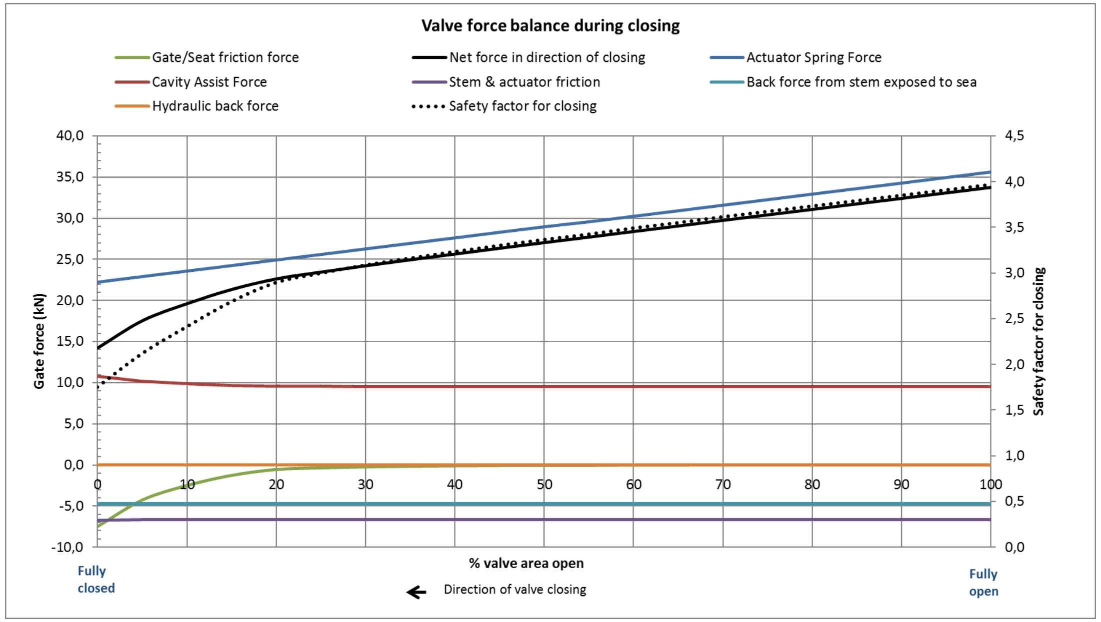
Make sure you handle the physics right!

Make sure you have the required ***force*** to do all required safety functions!

Make sure you have enough stored ***energy*** locally to do all closing actions required to fulfil the well barrier function

Make sure you have enough ***power*** to do all required closing actions within reasonable time





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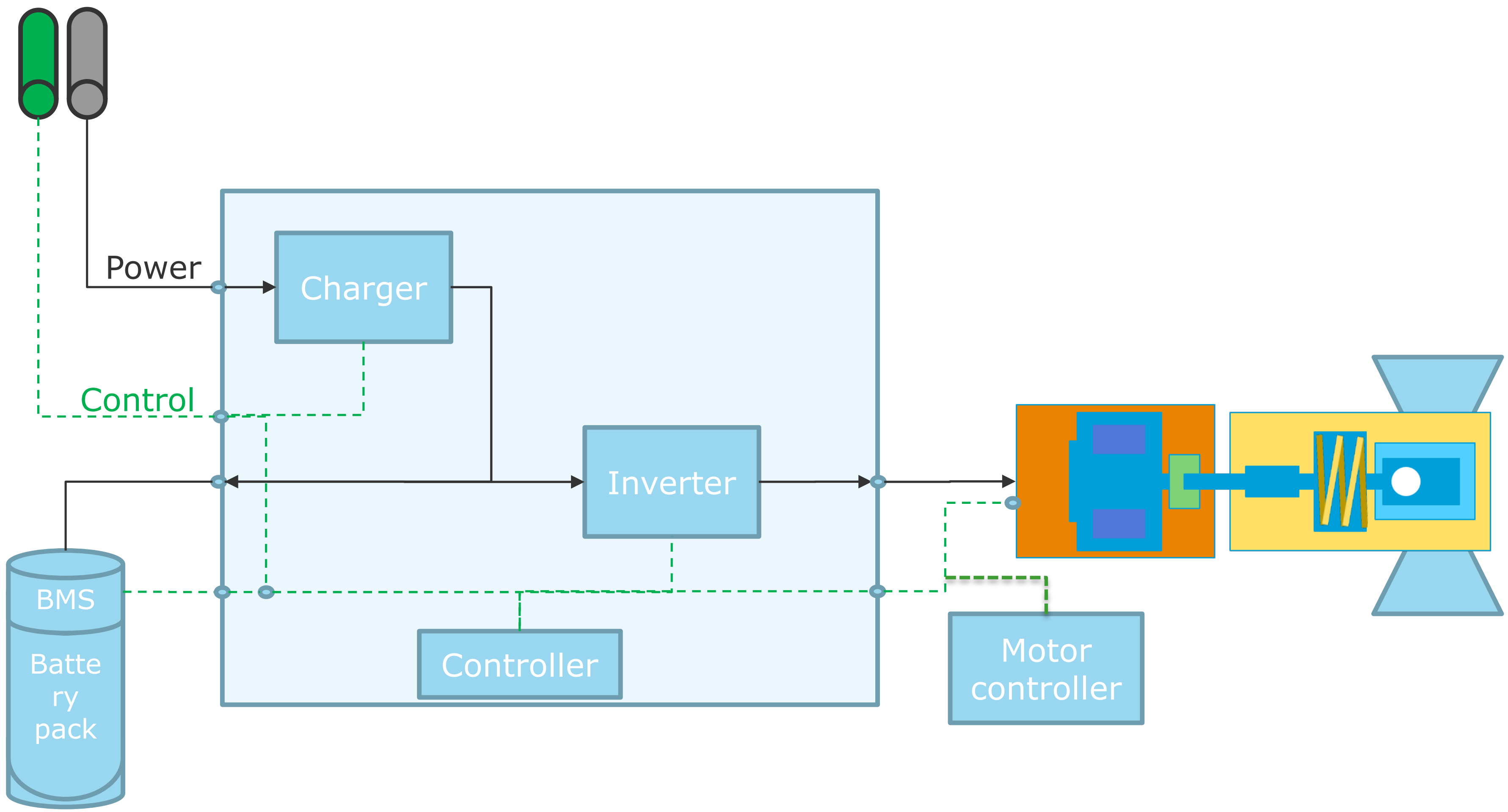
Basic Anatomy of 'all-electric'



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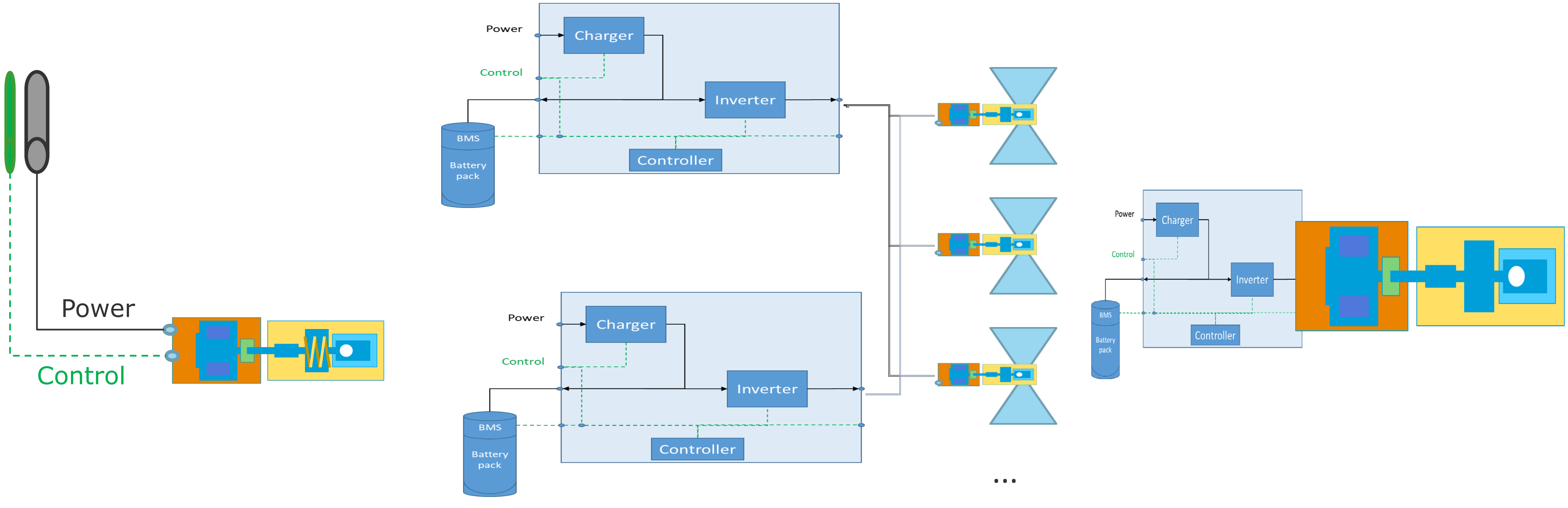
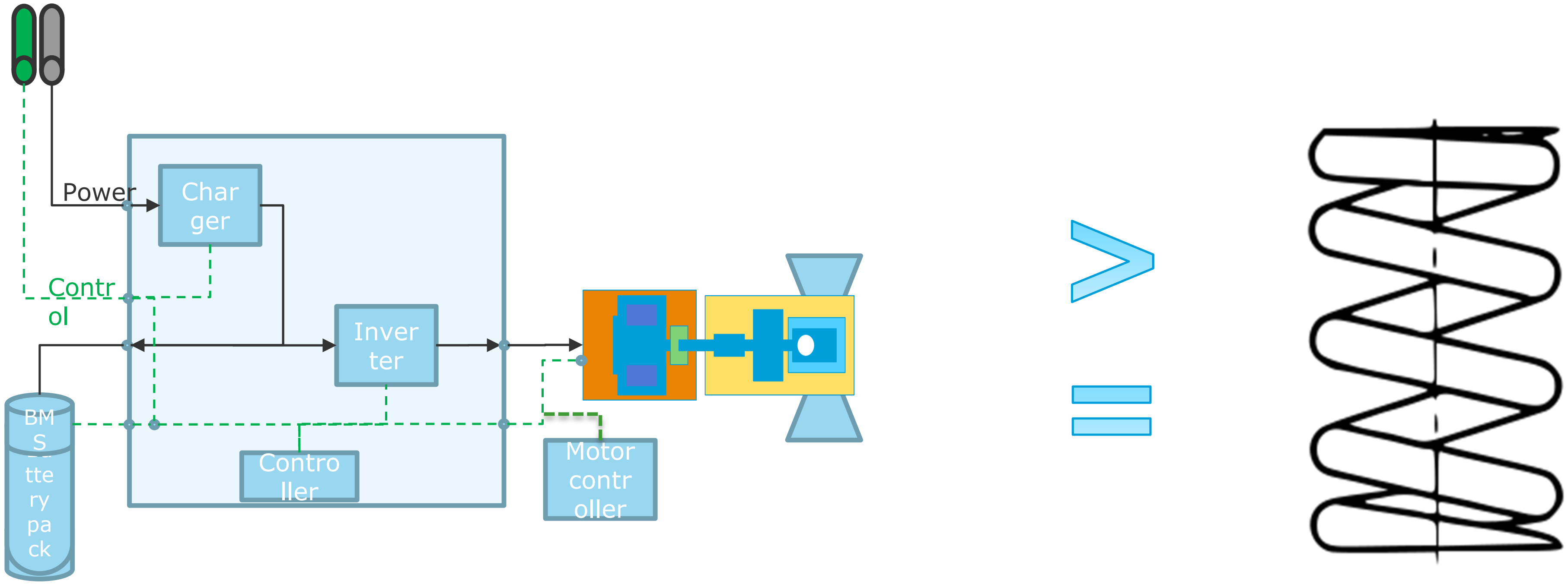
Your choice of concept!



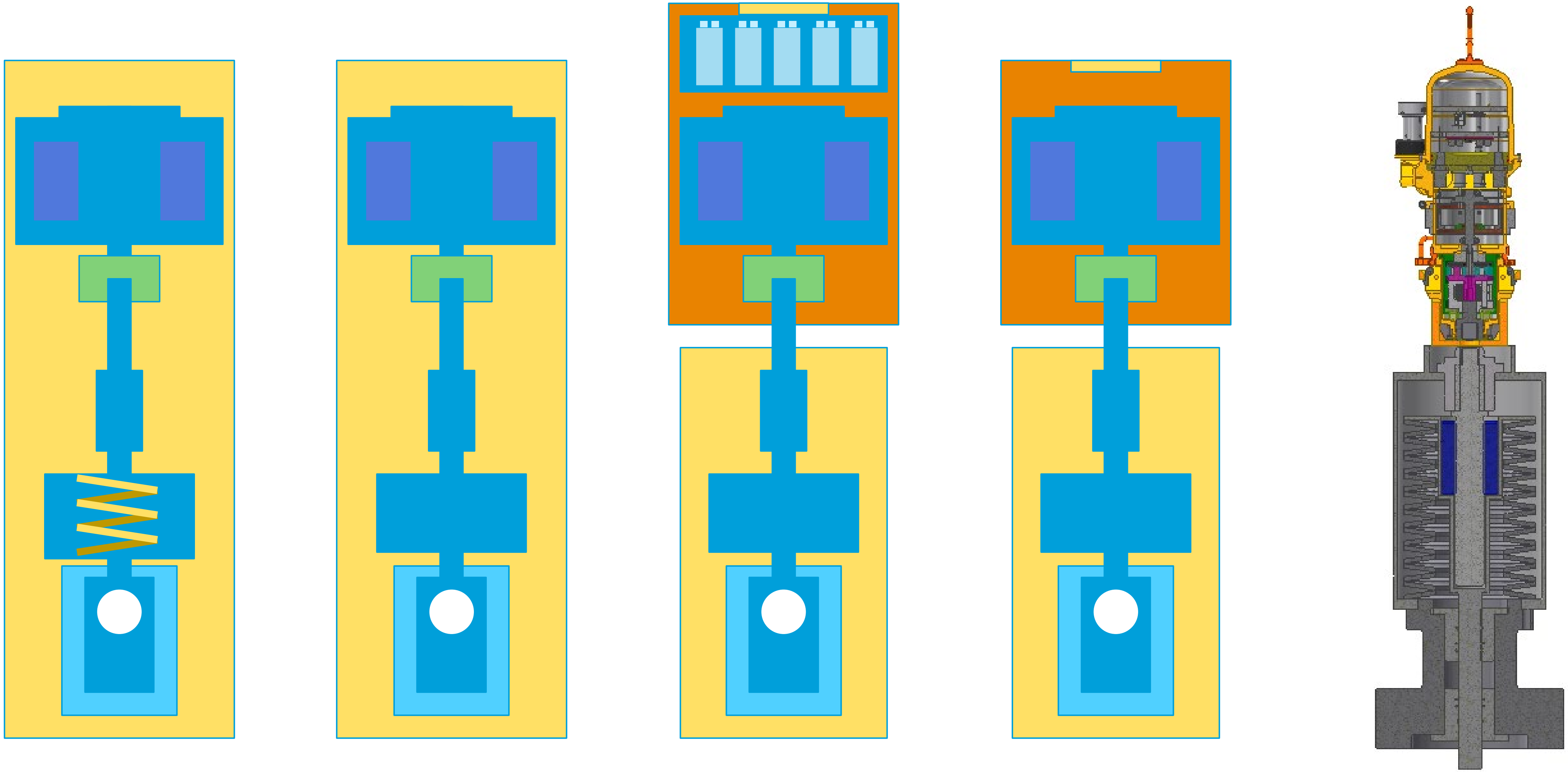
When this is solved and proven, then AE is simple!



Going from a system with few failure modes

- to a system with many failure modes

Provided your concept choice, also the valve offers wide variety of options



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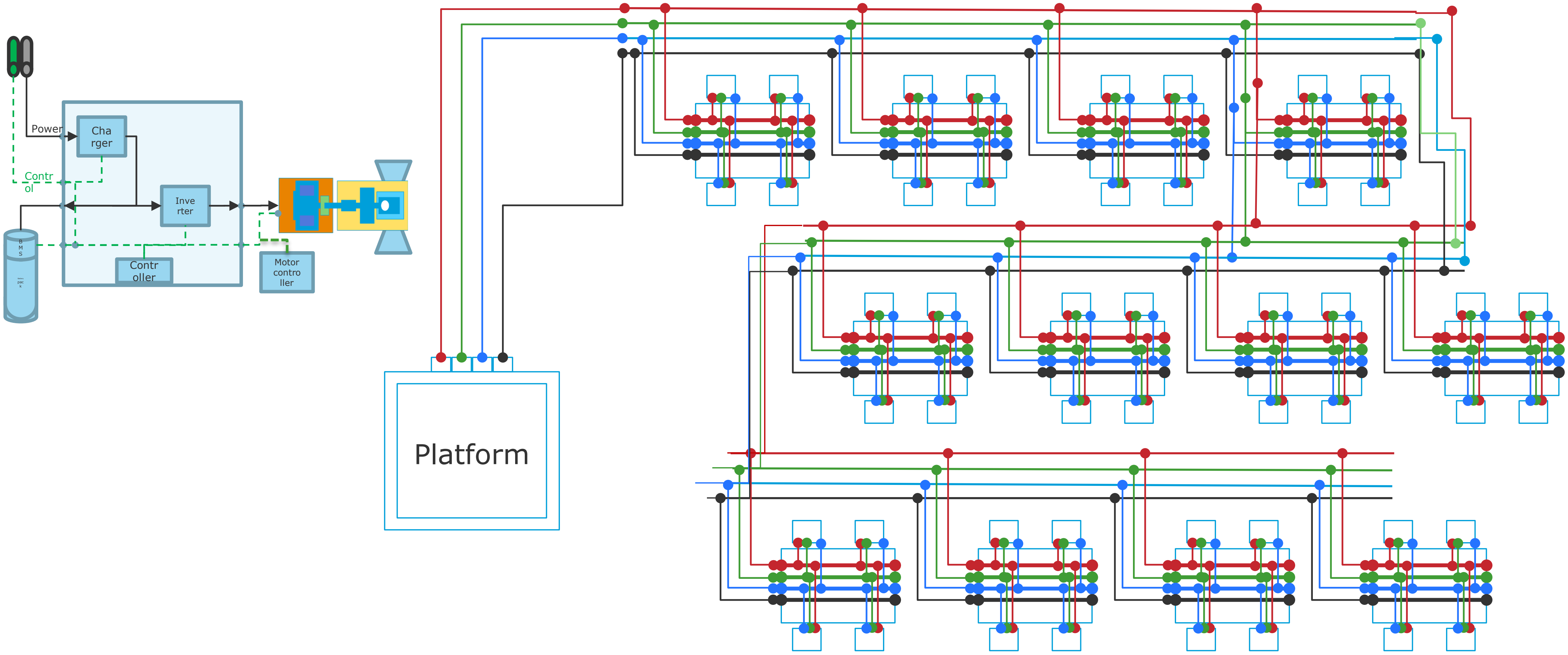
Important to revisit the rules and requirements

- The rules and requirements must be revisited. The requirements are based on current technology, and some functions are fulfilling the requirements by 'default' and having less attention in design. For all-electric will that not necessarily be the case.

  - Open / Close
  - Keep open / Keep closed
  - In installation mode
  - In production mode
  - In workover mode
  - Production shut down
  - Emergency shutdown
  - Well recovery for securing well in the event of tree / system failure

Rigid on micro level – flexible on makro level



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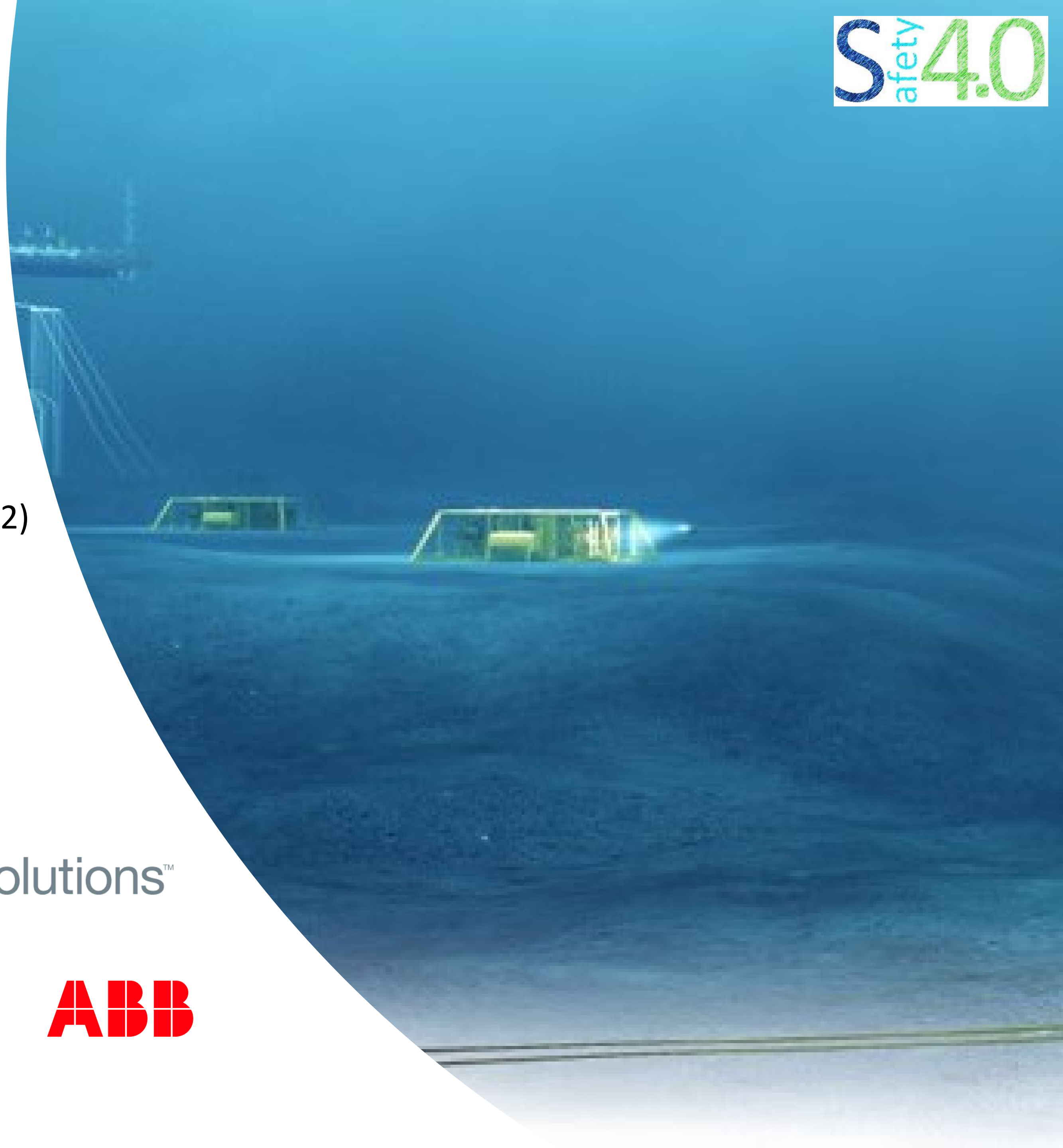
Prediction Models for Reliability (Safety) and Availability (Cost)

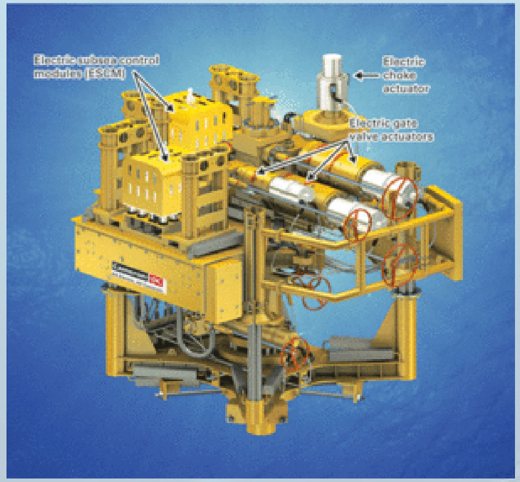
	Traditional design	All-electric
Field data (e.g. OREDA)	Available, but not always of high quality	Available only for (most) sub-systems ⇒ Block diagram models necessary ⇒ Failure adaptation to subsea may be necessary ⇒ Diagnostic Coverage must be estimated
Reliability estimation	From generic data sources (or better) from Proof Test and Demand reports	Since diagnostics dominates the reliability calculation, the demonstration that Safety Integrity Level (SIL) 2 is reached can be solid. Total reliability can be better than typical traditional valve dangerous failure rate values.
Availability estimation	Availability is not only dependent on the single valve (failure), but also on the maintenance strategy and the availability of required vessels. Therefore the availability is dependent at least on the whole field	
	Field data should at least in principle be available, but estimation may still be complex	In addition to an availability model of the single valve (based on a block diagram of sub-systems), a field model is necessary, together with a maintenance strategy and vessel availability sub-model

Key project data

- Schedule: 2018-2021 (3,5 years)
- Budget: 19 MNOK (9 MNOK from the NRC, PETROMAKS2)
- PTIL : Observer
- Funding one PhD (NTNU) and one postdoc (UiS)



Use case 1
All-electric safety systems



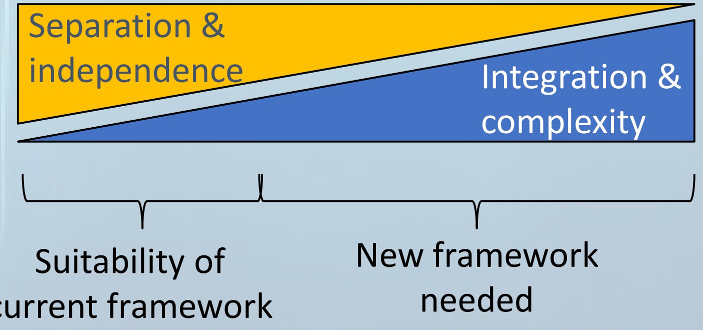
Concept/technology

- Replacing hydraulic systems with all-electric solutions is estimated to generate significant savings, while also reducing the risk of spills
- All-electric solutions provide novel opportunities for diagnostics that may enhance safety, but may challenge existing fail-safe principles

Use case focus

- Define example high-level all-electric solutions
- Develop alternative safety philosophies for achieving safety equivalent to hydraulic solutions
- Identify evidence needed for safety demonstration, and develop reusable safety arguments based on the example solutions

Use case 2
Integration of process control and safety



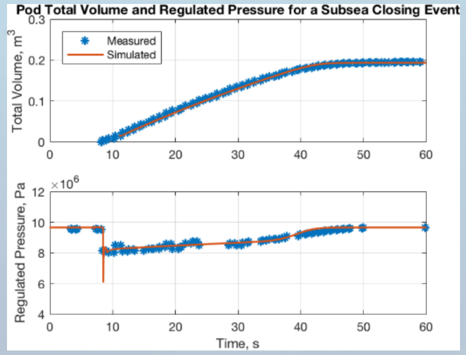
Concept/technology

- Separation and independence of process and safety control system is a key safety principle applied in the industry
- More compact and integrated solutions has the potential to reduce complexity and cost

Use case focus

- Develop new safety philosophies and better understanding of ways to achieve independence, hardware vs. software separation, and distributed vs. centralized safety functions
- Demonstrate safety for a subsea processing solution where sensors and control elements (hardware and software) are shared between process and safety systems.

Use case 3
Advanced use of sensors and data analytics



Concept/technology

- Improved sensors, communication technology and software opens up new opportunities for safety management in operations
- The risk associated with sensor reliability, data and model quality becomes important
- Installing and maintaining subsea sensors remains expensive

Use case focus

- Demonstrate how monitoring can contribute to more effective and cheaper safety validation
- Develop a deeper understanding of the application of subsea sensors and the impact of model and data quality
- Develop operational strategies for responding to sensor failure and performance degradation

Summary

All-electric SPS challenge traditional thinking

- Diagnostics must be accepted as part of safety systems
- Diagnostics must be implemented in the lifecycle (specification, production, operation,…)
- Introduction of controllers with both safety and control functions in same controller.

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