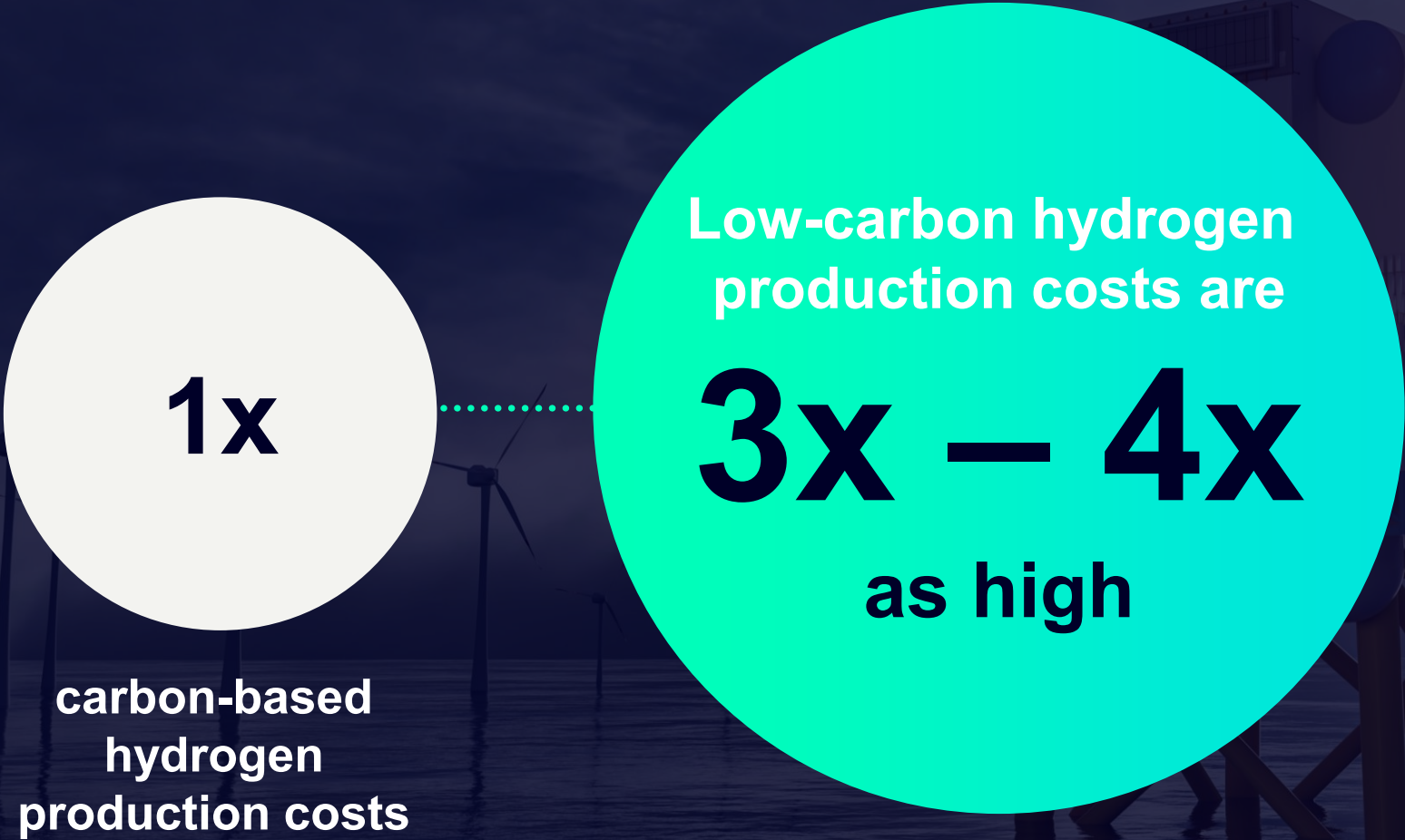


Digital Twins and Real-Time Insights

The path to Competitive LCOH



Low-carbon hydrogen remains expensive and lacks competitiveness compared to carbon-based hydrogen



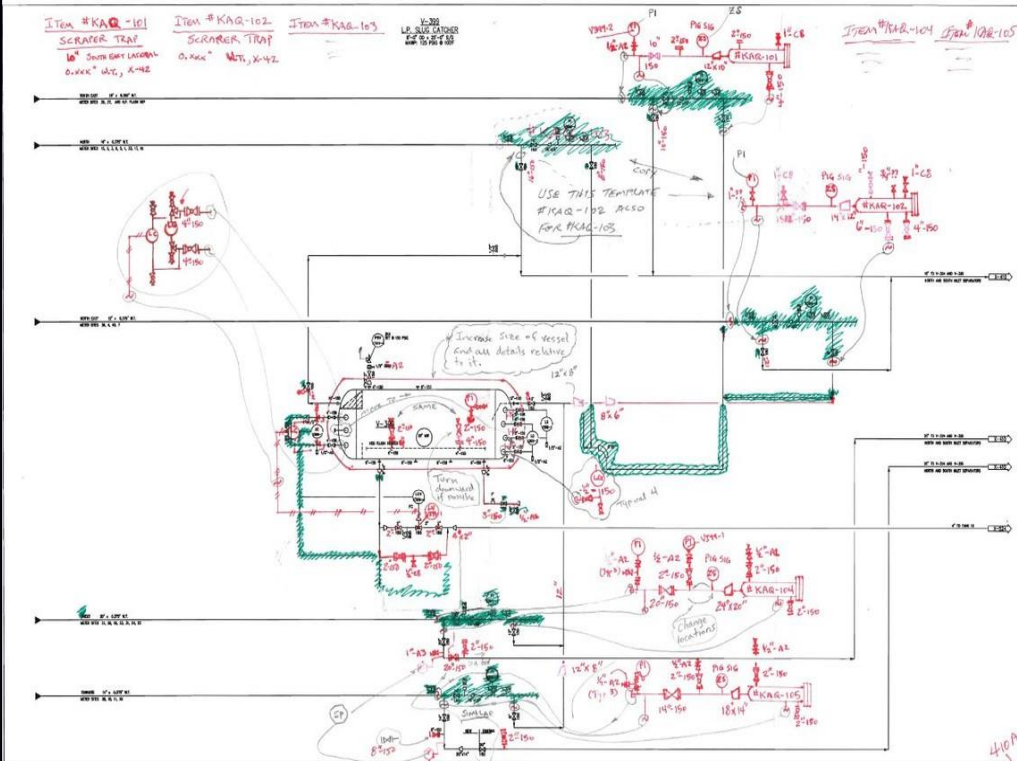
However...

Green field & Significant optimization potential

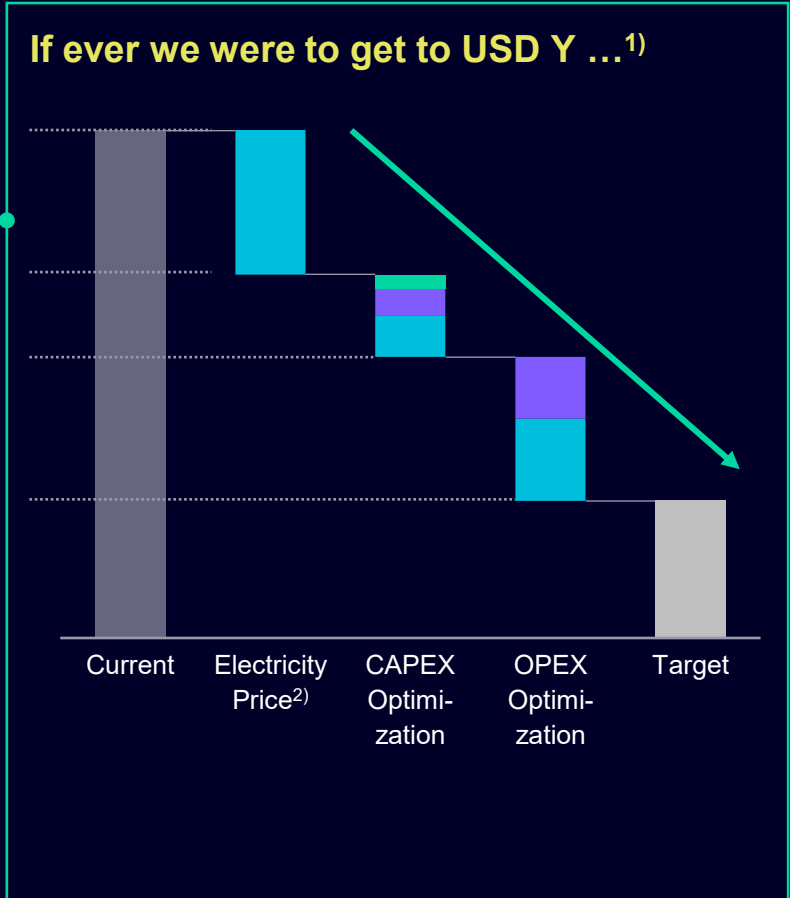
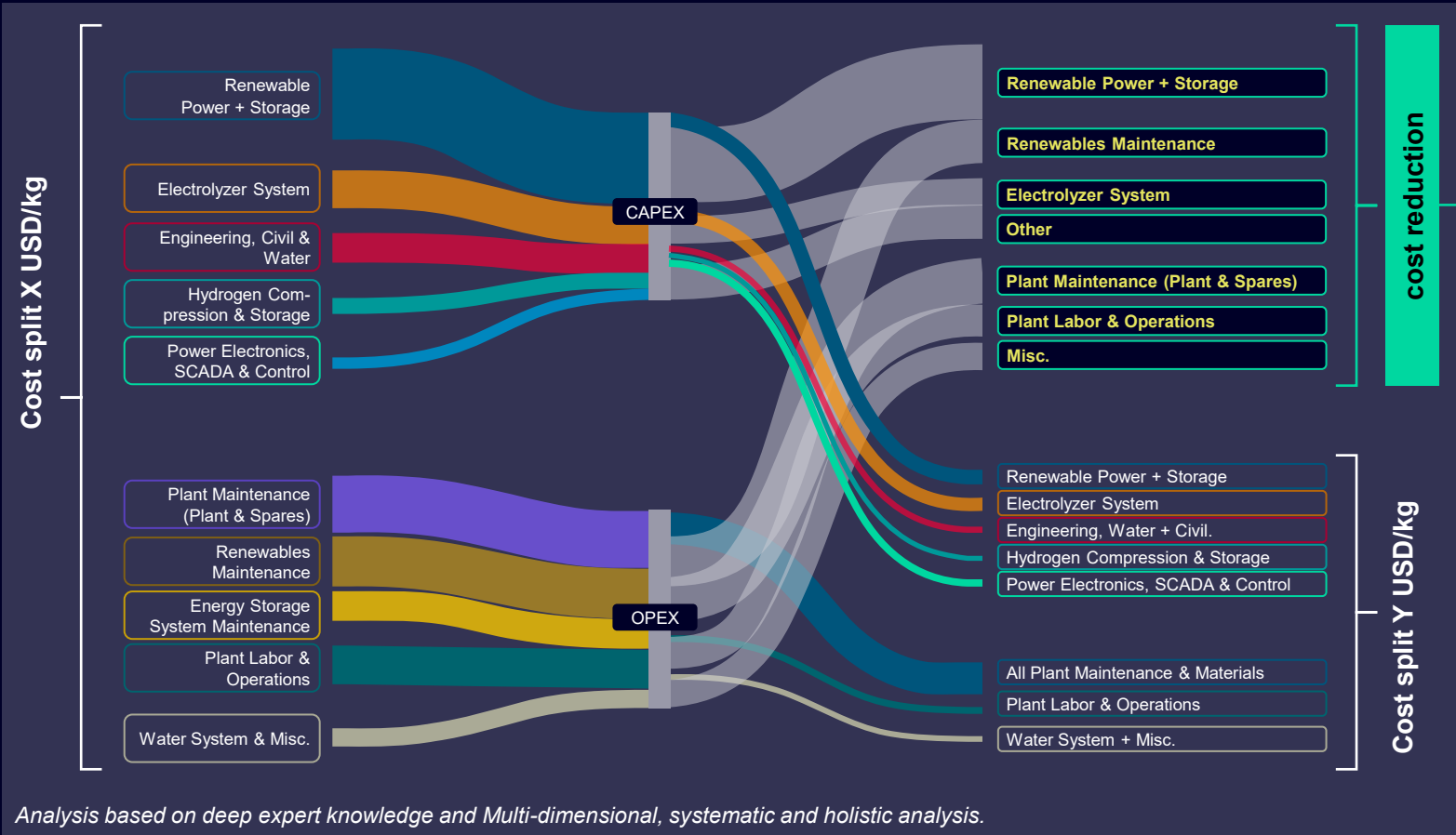


Source: Capgemini x Siemens (2024)

Digitalization drives efficiency and value and isn't just an infrastructure problem



Tremendous cost savings for green hydrogen imply a complex optimization task, which requires a native Digital Plant to enable intelligent use of data in engineering and operation

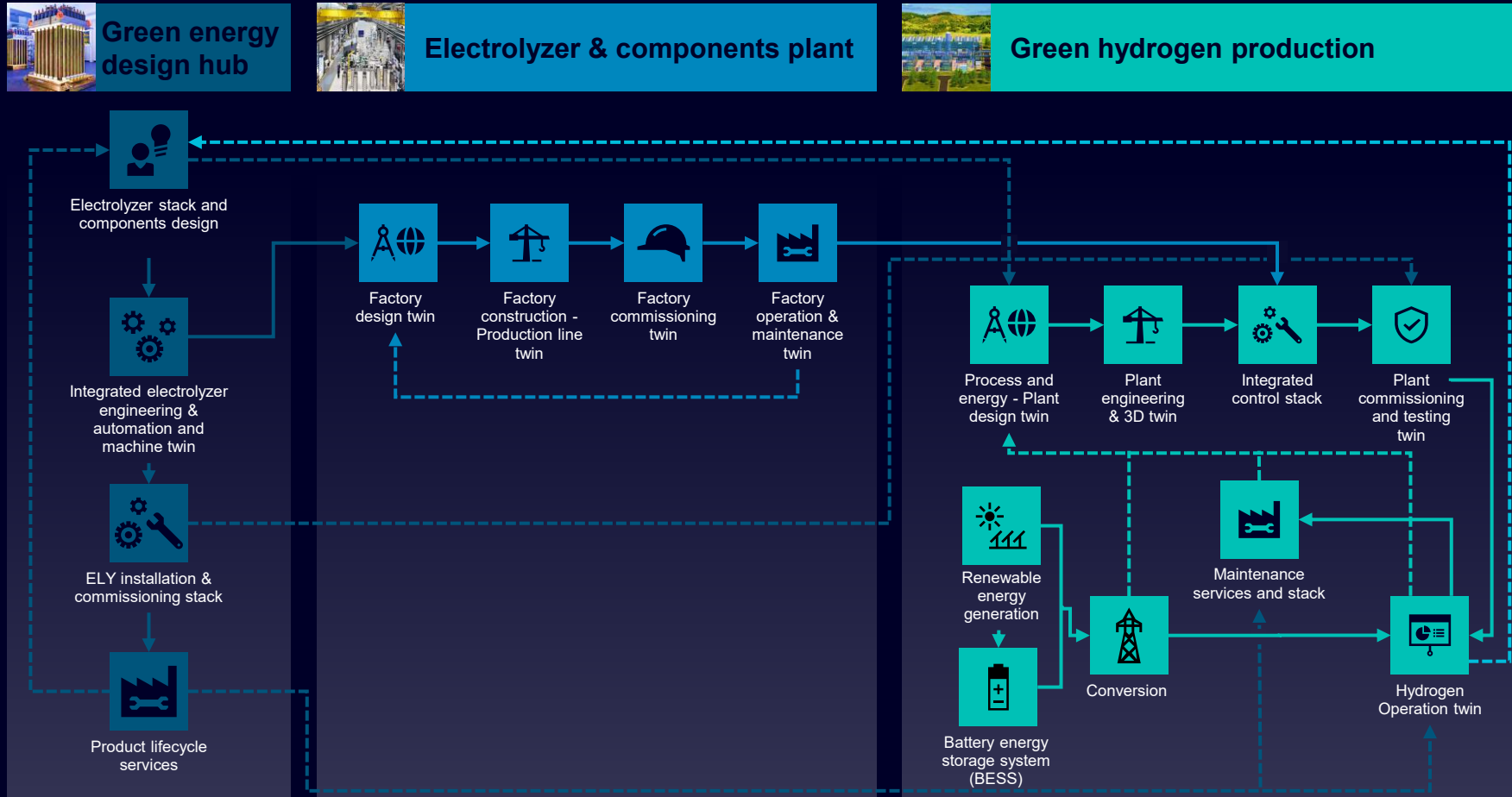


■ Electrolyzer design hub
 ■ Electrolyzer & components plant
 ■ Green H₂ production
 ■ Power-to-X and H₂ derivatives

1) Proportions built of simulation, but are to be identified in concrete scenario

2) Some of the Electricity Price cost is included in CAPEX and OPEX optimization. Also including pumped-hydro and associated storage requirements

Siemens' holistic approach and integrated digital capabilities optimize the entire hydrogen value chain, cutting costs and making green energy accessible



Key Takeaways

Feedback loops between stages are not always aligned with company boundaries.



One source of truth is critical for data integrity



Front end loading of digital strategy will reduce LCOH

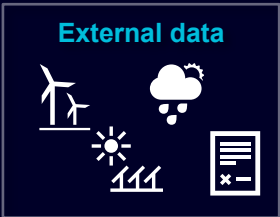


Source: Siemens

--- Closed-loop integration

Integrated Engineering Workflow

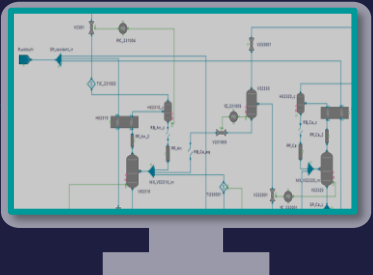
Integration of simulation and visualization packages



Production Performance Suite (Hydrogen Performance Suite)

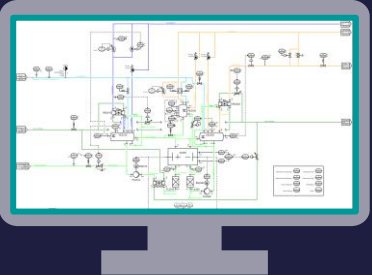
- Real-time production optimization
- AI predictive maintenance
- Soft-sensing

Process Design Simulation (gProms)



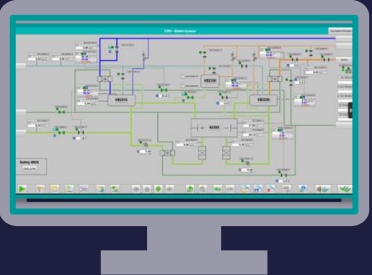
- Process & material data
- Design parameters
- Block flow diagrams

Plant Engineering (COMOS)



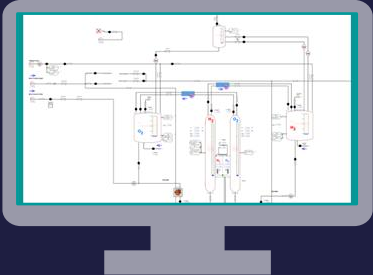
- Process & material data
- Design parameters
- Block flow diagrams
- P&IDs, EI&C, Automation

Process Automation (PCS 7)



GUI (Graphical User Interface) design

Plant Simulation (SIMIT)



- Virtual commissioning
- Operator training

Key Takeaways



Digital Data Transparency – right time, right place, right systems & people



Integration and single point of truth – data needs to be trusted. AI has the potential to both help & complicate this!



Front-end load the digital strategy

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