Electrification, Automation, Digitalization

Customer Event Steam Turbine and Generators 2023

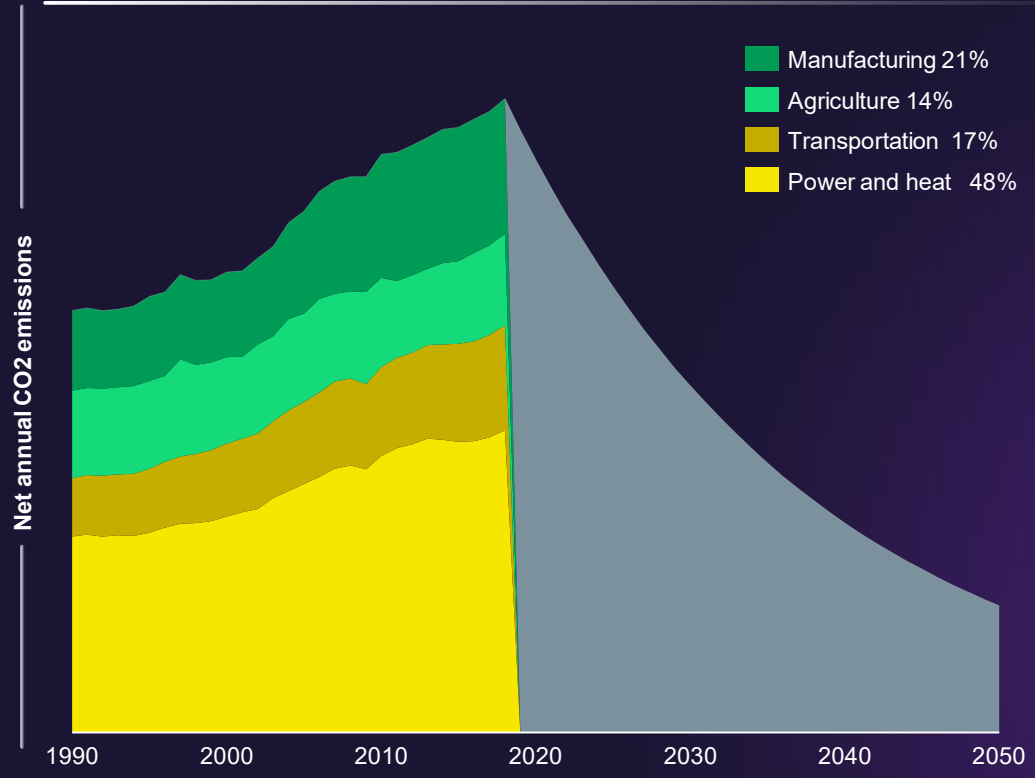


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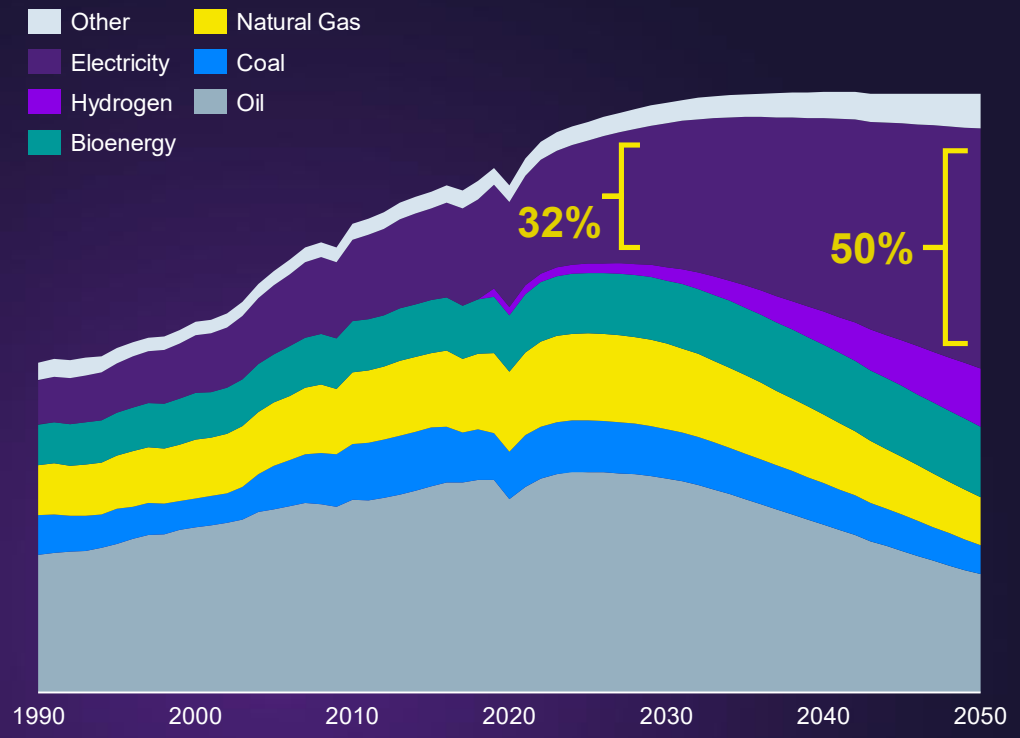
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The global energy transition is the greatest opportunity of our lifetime…

The **energy transition is touching all sectors …**



… and the energy mix is increasingly **electrifying** [2)]



Source: BlackRock, May 5, 2022

1) Graphic created using data from World Resources Institute. 2) DNV, Energy Transition Outlook 2021. The chart represents the world primary energy supply by source and uses historical data from the IEA WEB (2020)

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As it undergoes major push towards decarbonization

~1/3rd

Share of **industrial sector** in **global CO_2** equivalent **emissions**

Source: Energy innovation and EPA, USA (Total reported direct emissions from Chemicals, 2019; "Greenhouse gas emissions" Our world in Data, Ritchie, Hannah; Roser, Max (2020)

Electrification

- Share of electricity in final energy consumption of industry from ~22% in 2020 to ~37% in 2040

Fuel Shift

- Substitution of fossil fuels with zero/low-carbon electricity and green H2 / clean fuels

Process Optimization

- Industry demands techno-economic optimization of their processes and related energy provision; growing decarb regulation and funding schemes

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Customer proximity
Integration experience
Diverse EAD Portfolio
Regional presence
Procurement expertise
Process know-how
Because the future must be **sustainable,** we lead our customers through the **energy transformation** by turning innovative **iDEAs** into reality!
iDEAs: Integrated Digital, Electrical & Automation solutions

EAD offers integrated, industry specific solutions, value added services and consultancy

SIEMENS energy

Portfolio

- Integrated EAD systems, solutions, services and consultancy for Process Industries and Maritime & Offshore

Installed base

- Installed base: ~800 vessels, ~1.600 fiber plants, ~700 offshore plants, ~400 onshore plants, ~225.000 connectors, ~25.000 sensors

Customer value proposition

Industry specific know-how

- Customer intimacy
- Market specific requirements and regulations
- Safety and environmental aspects
- Insights into customer ecosystems (including New Energy Value Chain)
- Dedicated EAD portfolio & integration expertise
- Deep PM, engineering, procurement & sourcing expertise



Process Industries



Maritime & Offshore



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EAD key enabler for decarbonization of industries

Global trends



Energy transition is touching all sectors:
Industries with ~33%[1] of all global CO_2 equivalent emissions



Future energy mix is increasingly electrifying:
electricity consumption to rise from ~22% (2020) to ~50% (2050)[2]



Energy efficiency[3] to be a critical lever:
Increasing commitments & measures towards future industrial net zero operations



100+ Trillion to be invested over next 30years:
750bn invested in energy transition in 2021[4]

1| IEA CO2 Emissions in 2021 Report; 2| DNV Energy Transition Outlook 2021
3| IRENA World Transition Outlook 2021; 4| BloombergNEF in Energy Transition Investment Trends, 2022

Our role as EAD

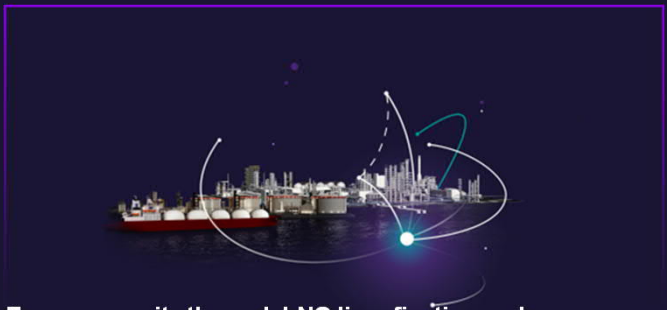
- Lead our industrial customers through the energy transformation by turning innovative iDEAs into reality
- Dedicated portfolio for electrification of assets and operations
- Proven automation & digital solutions for optimizing plant design and process operations
- Joint co-creation with customers and partners to deliver holistic solutions and capture market growth

#iDEAs: Integrated Digital, Electrical & Automation solutions

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EAD Transformational Growth: Key Market Trends, EAD Positioning, Growth Fields (1/2)

LNG



Energy security through LNG liquefication and regasification solutions

Growth Fields

1 LNG - Receiving Facilities

- Offering comprehensive solutions (EAD, modules, Terminal management systems, etc.) for small LNG, LNG onshore Regasification terminals, FSRU Jetty Topside…

2 LNG - Liquefication Facilities

- Providing complex drive based electrical systems and automation optionally including rotating equipment

PtX & eFuels



Industrial integration of H2, and reliable eFuels transport, storage & utilization

Growth Fields

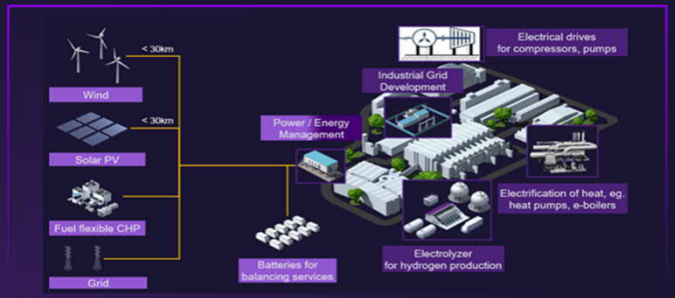
3 Industrial H2 and eFuel production

- EAD packages for selected industrial H2 and eFuels production projects (SES in lead for PtX)

4 Transport, Storage, Utilization

- Leverage existing EAD onshore expertise in tank terminals & pipelines
- Utilization applications, such as Backup Power based on fuel cell technology, mixing systems, etc.

Industry Electrification



Electrification solutions for decarbonized heat and process and integrated sustainable power

Growth Fields

5 Heat Electrification / Decarb. Heat

- Integration of Heat Pumps and electrical heaters / boilers in industrial applications and other decarbonized heat offerings

6 Electrification of Industrial Processes

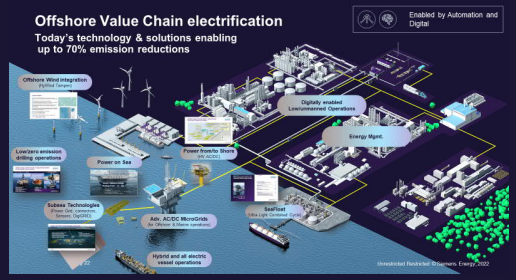
- Mechanical drive replacements with electrical systems decreasing fossil fuel consumption
- On-site renewable power integration
- Industrial el. grid modifications and expansions
- Power management and balancing(e.g., industrial BESS)

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EAD Transformational Growth - Key Market Trends, EAD Positioning, Growth Fields (2/2)

Offshore Electrification & FoW (Floating Offshore Wind)



Decarb. and improve efficiency and availability of offshore installations



Enable integration of floating offshore wind power for offshore installation

Growth Fields

7 Blue Power

- Electrical and automation integration for decentralized floating power hub including CCUS

8 Energy Mix Integration

- Offshore value chain electrification based on AC/DC micro grids – topside, subsea, incl. integration of e.g., Renewables, BESS, electrolysis

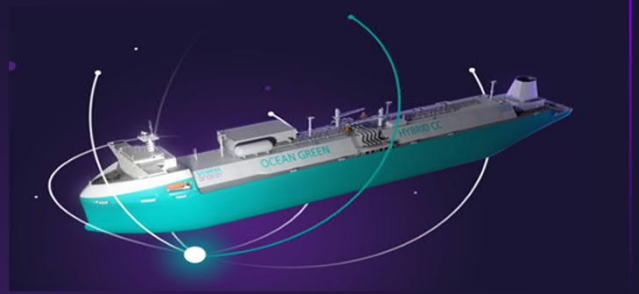
9 Subsea Power Network for FOW

- Offshore wind power integration via connectors and plug & power hubs

10 Blue Wind

- Renewable power integration for offshore facilities, off-grid/partial off-grid (Power Management System, BlueDrive, BlueVault, transformer, switchboard)

Low Carbon Maritime



Electrify vessels with hybrid, fully electrical and alternative fuels solutions

Growth Fields

11 Ocean Green

- Innovative power generation for LNG carriers Our contribution to the next generation of LNG & hydrogen carriers

12 Sustainable Vessels

- Electrical Propulsion based on high temperature and low temperature PEM fuel cells driven by
  1. Methanol for e.g. yachts / containers / cruise vessels
  2. Hydrogen with daily filling for short distances
- Fully electric vessels

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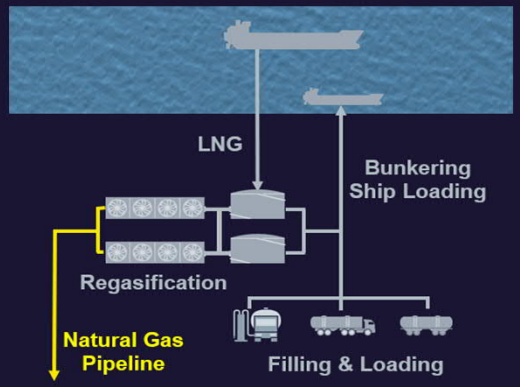
Safe and flexible LNG receiving terminal operation: Fast track project delivery

Customer Challenges

- Fast track project execution in FSRU terminals
- Fuel flexibility e.g., ammonia, hydrogen (LNG considered as bridge energy carrier)
- High efficiency particularly for terminals which are in competition with pipeline gas
- Flexibility of operation (regasification, LNG truck, ship, rail-car loading, bunkering)
- Transparency on inventories
- Management of transactions and orders, field-to-ERP[2)] integration

LNG Receiving Facilities

Onshore



Offshore (FSRU[1)])



TI EAD Value Proposition

- Proven fast track execution FSRU jetty topsides
- Optimization of terminal operation, e.g., traffic management
- Field to ERP integration
- Field-proven interfaces, seamless interoperability
- Main Automation and Electrical Contractor Model for execution
- Integrated solutions from planning , delivery and Life-Cycle services

- Bridging energy supply to a decarbonizing world
- Reducing emissions substantially in comparison to coal

TI EAD Portfolio

- Integrated solutions and services covering electrification, automation and digitalization
- Jetty topside solutions typically containerized
- E-Houses and skids (e.g., for metering, pumping, blending)
- Terminal management systems – field to ERP integration
- Power management system

Experience / Successes

- FSRU jetty topside successes (Turkey, Germany, Croatia, Philippines)
- Numerous references in tank terminals including truck, railcar ship loading and bunkering

1) FSRU = Floating Storage Regasification Unit
2) ERP = Enterprise Resource Planning

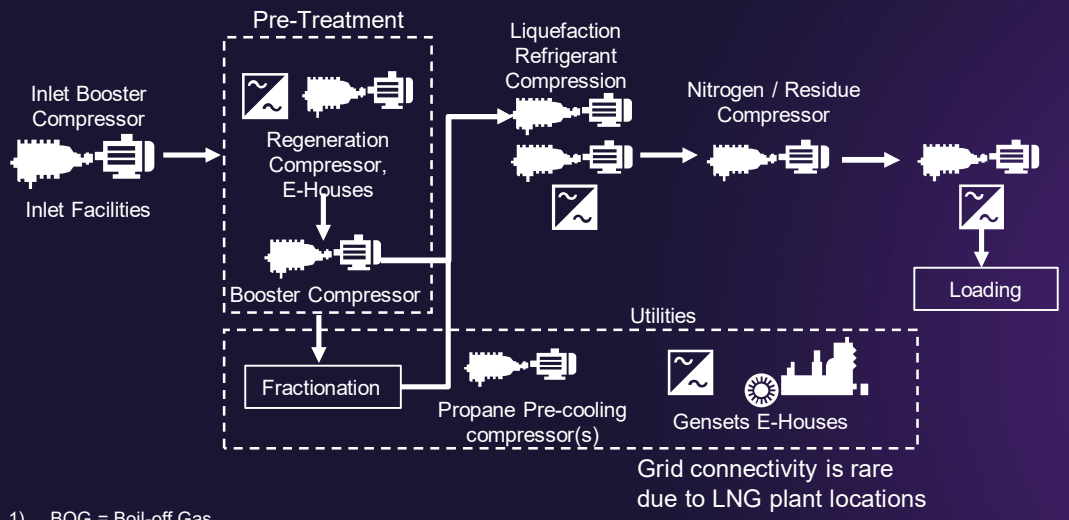
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Fully Integrated solutions to incorporate renewable energy for LNG Liquefaction process

Customer Challenges

- Reduce CO2 footprint of LNG liquefaction process by utilizing renewable energy
- Ensuring high availability of the electrical supply required for the liquefaction process
- Ensuring effective management of power demand, utilization and availability with inherent instability in renewable energy networks

Typical Liquefaction Process



1) BOG = Boil-off Gas

TI EAD Value Proposition

- Fully integrated electrification process across the entire value chain of the LNG liquefaction facility
- HV utility supply and distribution / MV distribution network and substation control / Electrification of LNG Compression trains for solutions with large drives and electrical motors suitable for LNG

Developed Power Management system uniquely designed to address the challenges of an all-electric LNG approach with low emission footprint from renewable energy sources

TI EAD Portfolio

- Electrification, E-houses, power management system
- E-drive solutions
- Automation solutions
- Digital solutions
- Tank terminal management system

Experience / Successes

- Canada: E-LNG scope, E-houses, e-drives, compression (main refrigerant, boil-off gas, feed gas booster)
- Mozambique: Gensets (SGT-800), e-driven BOG[1)] compression
- Numerous e-drive and electrical solutions
- Market leader in e-driven BOG compression

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EAD for CO2 emission free hydrogen and eFuels in industry

Customer Challenges

- Competitiveness against fossil-based ammonia, methanol, synfuels
- Optimization across different sites, roll-out lessons learnt
- Achieve process and technology maturity
- Integrate technologies: Renewable power, hybrid grids, hydrogen electrolysis and handling, carbon capture, synthesis, storage, loading, transportation
- Optimization of operation, (e.g., intermittency of renewables vs. degradation of electrolysis; optimum trading and purchasing of products and energy)



TI EAD Value Proposition

- Value chain optimization e.g., power management, digital twin, simulation, asset performance management
- Uniform modular and scalable technologies across different sites and EPC packages
- Field-proven interfaces
- Main Automation and Electrical Contractor Model for execution
- Life-Cycle services

CO2 emission free PtX value chain

TI EAD Portfolio

- Integrated solutions and services covering electrification, automation and digitalization (incl. digital twins, simulation)
- Power management for conventional and renewable sources
- E-Houses and modular structures
- Process modules e.g., gas mixing skids, metering skids
- Compressor & pump strings integration

Experience / Successes

- FlagshipONE (under execution) with integrated electrolyzer, compression ICSS, electrification, digital twin
- Integrated electrolyzer in chemical industry (under execution)

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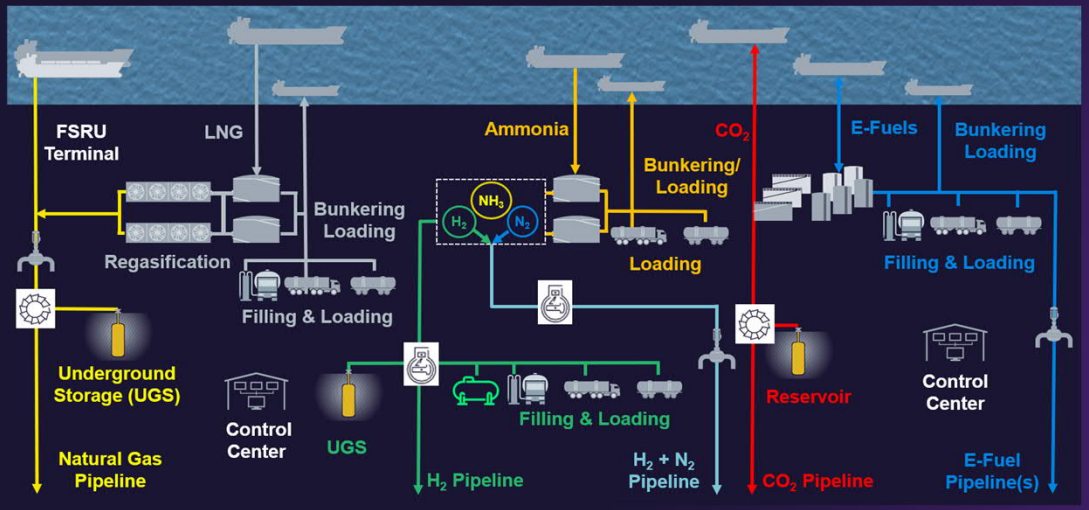
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Solutions to ensure a CO2 emission free transport, storage and utilization value chain

SIEMENS energy

Customer Challenges

- Reliable and safe operation of terminals / pipelines
- Efficient operation with high throughput
- Minimum waiting times for vessels, trucks, railcars
- Transparency on inventories
- Management of transactions and orders, field-to-ERP integration
- Profitability in changing markets
- Flexibility to cover changing requirements and legislation



1) FSRU = Floating Storage Regasification Unit
2) ERP = Enterprise Resource Planning

TI EAD Value Proposition

- Advanced pipeline, storage and tank terminal management & control
- Uniform modular and scalable across different sites & EPC packages
- Field-proven interfaces, seamless interoperability

Enabling the transformation with integration and optimization CO2 emission free value chain

TI EAD Portfolio

Integrated solutions from planning, delivery and life-cycle mgmt: Electrical, automation, telecom & security, digital including digital twins, simulation, terminal management system, power management system

- Control centers for pipelines, tank terminals, storage
- E-Houses and modular structures
- Process modules e.g., metering, blending, gas mixing skids
- Compressor strings, pump strings

Experience / Successes

- Several fast-track jetty topsides for FSRU terminals
- Tank terminals including railcar-, truck-, ship-loading/-unloading
- Gas and liquid pipelines globally

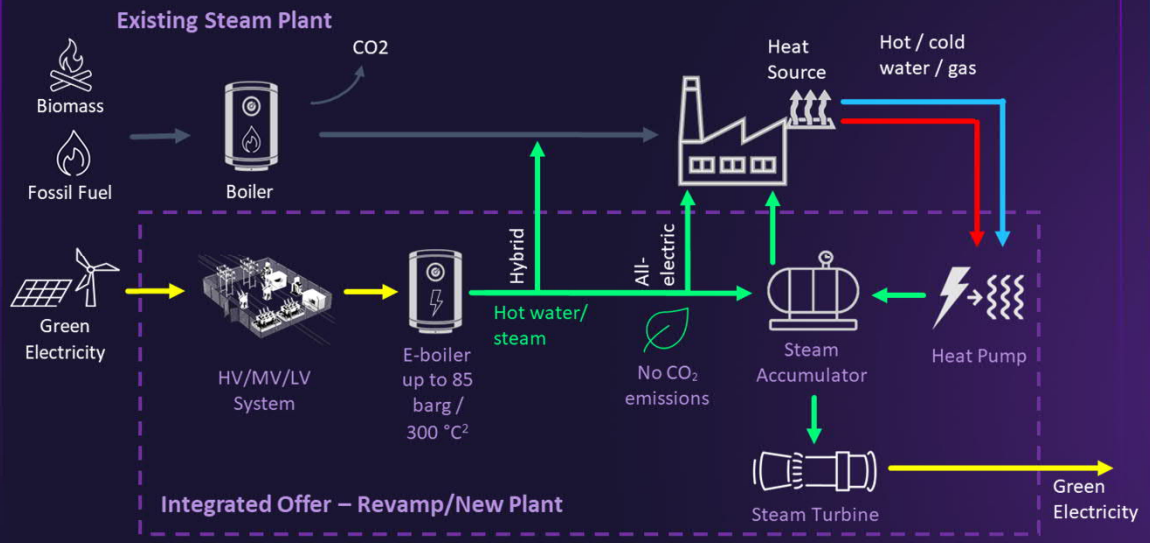
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Electrification of Heat Can Reduce Industrial Carbon Footprint Substantially

Customer Challenges

- Urgency to reduce GHG emissions
- High availability of steam production and fuel flexibility
- Unrestricted area available for installation
- Increase overall plant energy efficiency
- Manage intermittencies of renewable power supply
- Flexibility to cover changing requirements and legislation



TI EAD Value Proposition

- Cost efficiency with Hybrid solution (fossil vs electricity)
- Fast startup
- High Efficiency – up to more than 99% for e-boilers and COP > 3.0 for heat pumps
- Compact design – up to 75 MW in one unit[2]

- Substantial reduction in carbon footprint (Up to 80% CO2eq considering whole value chain)
- No CO_2 emissions in the process
- Strong savings in gas consumption in hybrid plants
- Estimated reduction of 100 kt / y of CO_2 for a 60 MW E- boiler[3]

TI EAD Portfolio

- One-stop shop for electrical system and equipment
- Combined hot water & steam in one unit
- Grid balancing services with steam accumulators
- Full integration with existing process plants[1]

Experience / Successes

- Siemens Energy is a major OEM of electrical products and systems
- More than 20 years offering and supplying of heat pumps
- E-boilers suppliers with extensive track record of HV equipment

1) Excluding mechanical assembly 2) Utilizing e-boilers 3) When compared to a natural gas heater

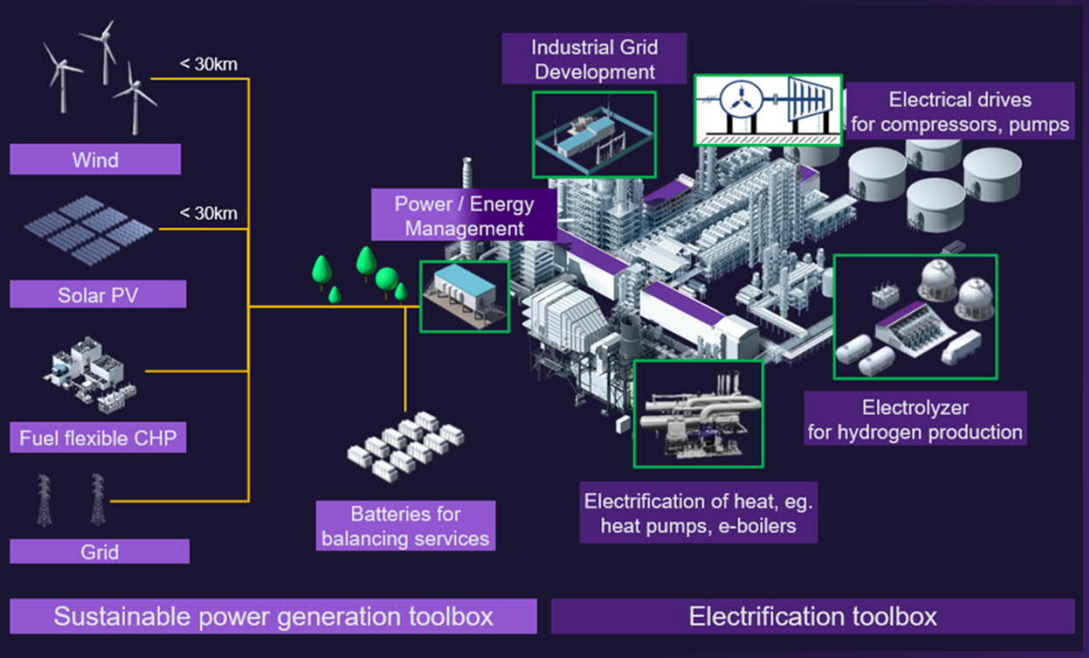
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Sustainable onsite power and industrial electrification solutions

SIEMENS energy

Customer Challenges

- Decarbonization & emission reduction targets
- Optimize safety, availability and asset efficiency
- Remote operation and maintenance
- Finding the right partner for electrification programs
- Modifications during operation, zero unplanned shutdowns
- Maintainability, flexibility and protection of investment



TI EAD Value Proposition

- Optimized electrical infrastructure for greenfield or brownfield
- Power Management System uniquely designed to address the challenges of industrial plants with low emission footprint
- Fuel savings through advanced generation management
- Integration of extensions with existing infrastructure
- Life-cycle management, technology partnership

CO2 emission reduced / free industrial plants

TI EAD Portfolio

Industrial electrification solutions from concept to delivery including after sales services covering

- On-site power generation and industrial hybrid grids
- Power distribution and e-houses
- Power management with renewables & conventional sources
- Drivers for compressors and pumps (e-drives)
- Electrical integration of various decarbonization technologies

Experience / Successes

Numerous references in industrial electrification including

- Electrical drives solutions incl. gas and steam turbine replacements
- Industrial power management systems
- Power distribution and e-houses

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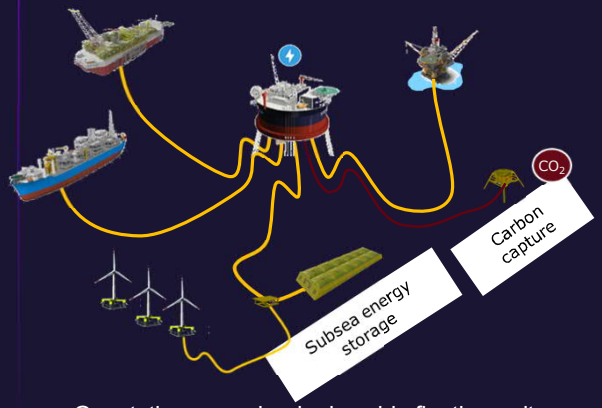
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Floating Power Generation with Carbon Capture

Customer Challenges

- Decarbonization & emission reduction targets
- Optimizing safety, availability and efficiency of the assets
- Space and weight constraints
- Remote operation and maintenance
- Finding the right partner for electrification programs
- Modifications during operation, zero unplanned shutdowns
- Maintainability, flexibility and protection of investment

Offshore



- Geostationary and redeploy able floating units
- Floating or fixed platforms possible
- CO2 injected into nearby geological formation

Near shore



- Barge (designed for near shore locations)
- Fast and flexible deployment possible

TI EAD Value Proposition

- Floating unit w/ 100-750MW combined cycle power generation plant with CO2 Capture
- Use of known and well proven technology
- High efficiency & emission reduction
- Flexible backup power (e.g., to renewables)

- 90 – 95% of the CO2 may be captured and stored
- Decarbonized power generation

TI EAD Portfolio

Electrification, automation and digital solutions from concept to delivery including. after sales services covering

- On-site power generation suppling power to offshore assets or to the onshore grid
- Power distribution and e-houses, power / energy management
- Electrical and automation integration of decarbonized technologies

Experience / Successes

Numerous references in oil & gas electrification including

- Electrical drives solutions incl. gas and steam turbine replacements
- Industrial power management systems
- Power distribution and e-houses

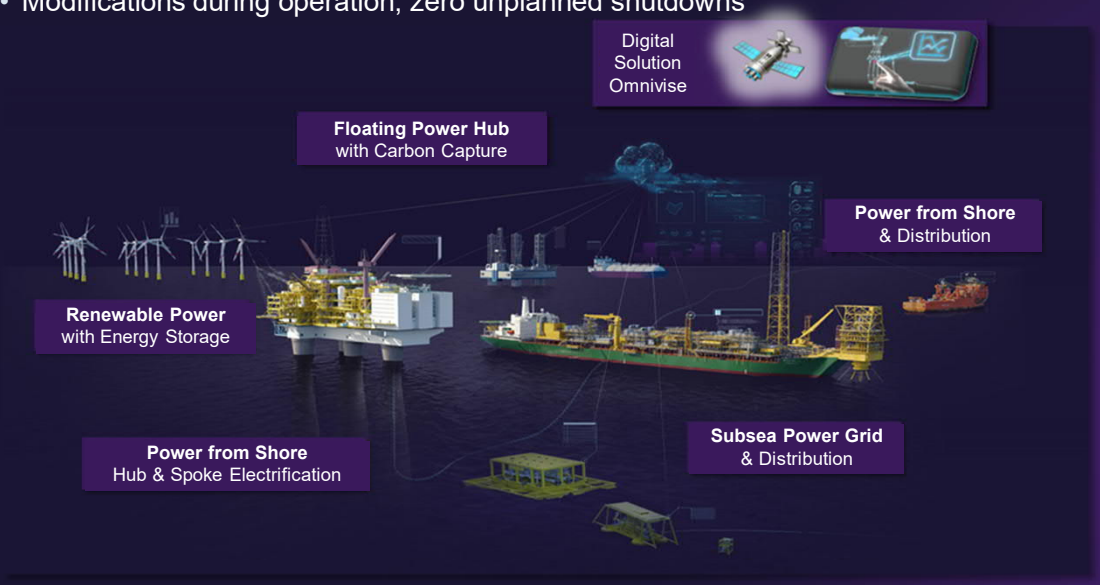
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The Largest Technology Portfolio for Offshore Electrification and Decarbonization

Customer Challenges

- Decarbonization & emission reduction targets
- Availability of sustainable energy from shore
- Optimize asset safety, availability and efficiency
- Space and weight constraints
- Remote operation and maintenance
- Finding the right partner for electrification programs
- Modifications during operation, zero unplanned shutdowns



TI EAD Value Proposition

- Optimized electrical infrastructure for greenfield or brownfield extensions
- Power Management System uniquely designed to address the challenges of industrial plants with low emission footprint
- Integration of extensions with existing infrastructure
- Life-cycle management, technology partnership

- Enabling the transformation with integration & optimization
- Decarbonized power generation

TI EAD Portfolio

Electrification, automation and digital solutions from concept to delivery including after sales services:

- Energy mix suppling power to offshore assets and/or to the onshore grid. Grid connection is used as back up power
- Power distribution and e-houses, power / energy management
- Electrical and automation integration of decarbonized technologies

Experience / Successes

Numerous references in O&G electrification including:

- Electrical drives solutions for gas and steam turbine replacements
- Industrial power management systems
- Power distribution and e-houses

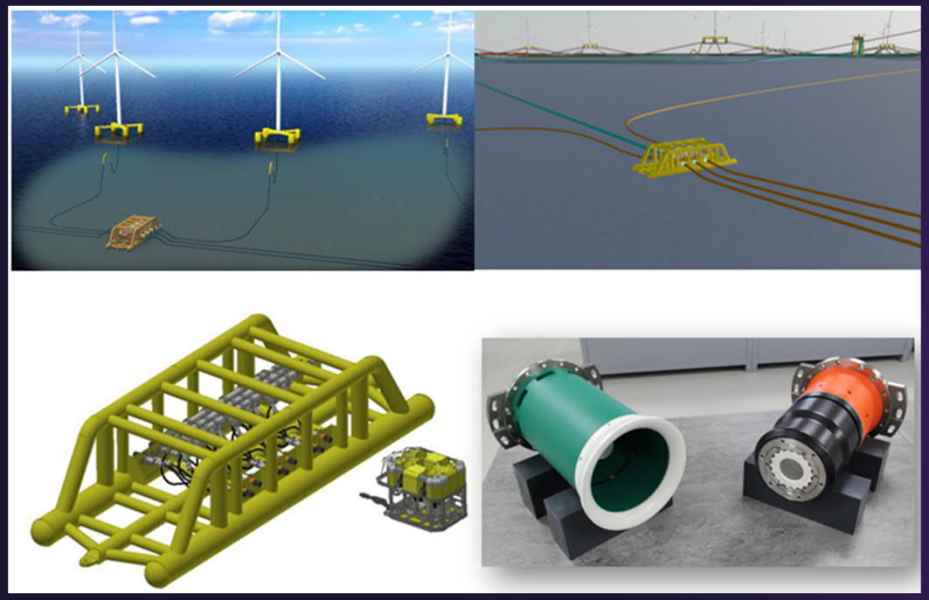
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Subsea Power Network for Floating Offshore Wind integration

Customer Challenges

- Maximize turbine up time
- Efficient installation to combat smaller weather windows
- Incorporate tow to port requirement
- Supply Chain Capacity
- Reducing the levelized cost of energy (LCOE)

Subsea Value Chain



TI EAD Value Proposition

- Reduced loss of production as turbines can be isolated from the others in the string
- Cable cross sections can be reduced and standardised
- Reduces the required amount of cable and cable accessories in half
- Cable and connector terminations are undertaken onshore
- Solution uses existing field proven wet mate connector technology from other subsea industries
- Reduces amount of time required to be on the floater
- Turbines can be installed in stages

TI EAD Portfolio

Today

- SpecTRON66 Wet mate connector
- 66kV Subsea busbar technology
- DigiTRON optical wet mate connector

Tomorrow

- Increased voltages up to132kV Wet mate connectors

Experience / Successes

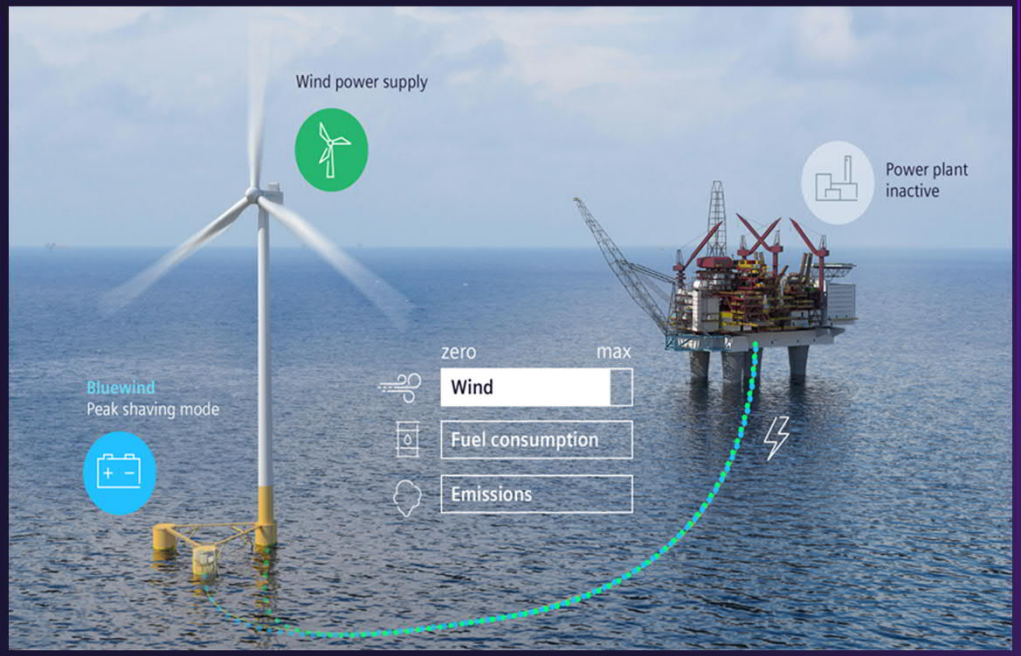
- High-profile industry demo project failure have opened developer's eyes to subsea connection systems
- Key industry developers exploring alternative solutions with our products / solutions resulting in positive feedback

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BlueWind for Off-grid: Decarbonization and electrification of existing O&G assets

Customer Challenges

- Reduction of greenhouse gas emissions
- Safety of assets and operation
- High availability and efficiency



TI EAD Value Proposition

- Reduction of CO2 footprint in offshore production units
- Consistent grid stability with wind power supply
- Designed for unmanned operation with minimum maintenance and remote monitoring & control
- Significant fuel and maintenance cost saving

Decarbonization (up to 70%) and electrification (up to 55%) of offshore O&G assets

TI EAD Portfolio

Wind turbine generation (WTG) + battery energy storage system (BESS) controlled as a combined unit

- Minimal need for adaptations on O&G asset power management system
- Back-up capability in case of WTG shut down, loss of wind or gas/diesel gensets
- Grid forming control, peak shaving, black start function
- System engineering and integration
- Life Cycle Services

Experience / Successes

- > 60 references of marine offshore energy storage systems
- Peak shaving for a semi-submersible in the North Sea reducing the runtime of onboard diesel engines by 42% - lowering CO2 and Nox emissions by 15% and 12% respectively

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Ocean Green: Innovative power plant for LNG & Hydrogen carriers

Customer Challenges

- Reduction of greenhouse gas emissions
- Reduced unit freight cost
- Reduce cost and time for operation and maintenance
- Maximize cargo capacity
- Low noise and vibration



TI EAD Value Proposition

- Compact machine room design increasing cargo capacity
- Simplification by removing auxiliary systems
- Improved maneuvering capabilities
- Reduced operational cost
- Significant reduction of maintenance time

- Reduction of green house gas emissions
- Low noise and vibration

TI EAD Portfolio

Hybrid combined cycle power and propulsion plant using

- Gas turbine as the main engine (SGT-400, H_2 ready)
- Steam turbine and Heat Recovery Steam Generator
- Energy storage (e.g. BlueVault)
- Electrical propulsion
- Power distribution, switchboards, UPS, energy management
- Steam system balance of plant
- System engineering and integration
- Condition and performance monitoring
- Life Cycle Services

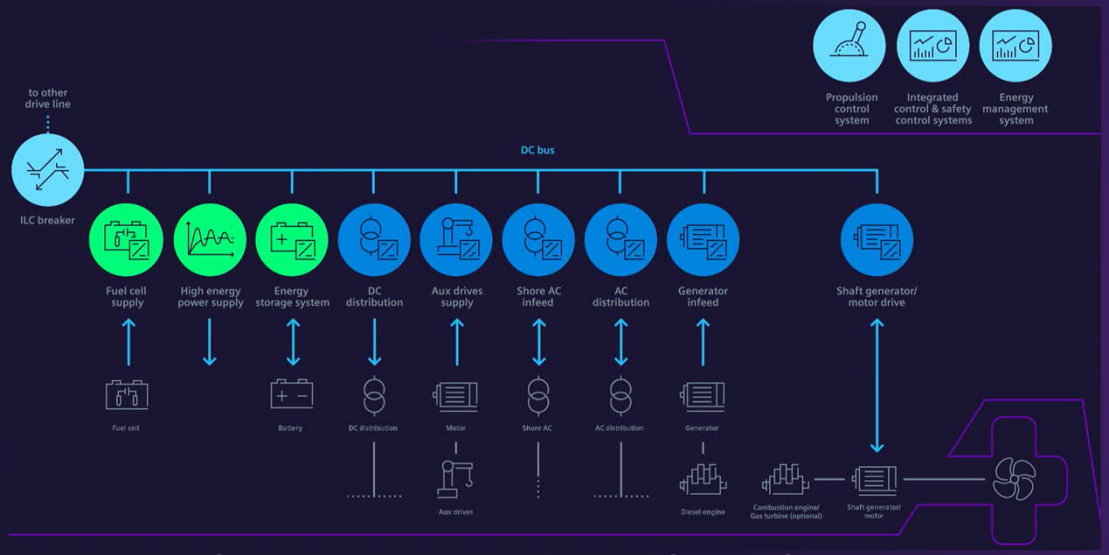
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Sustainable and Clean Vessel Propulsion Solutions

Customer Challenges

- Carbon reduction due to IMO regulation
- Governmental emission reduction programs
- Safety of operation: E.g., explosivity, toxicity, handling of new fuels
- Selection of optimum fuel (hydrogen, e-methanol/-ammonia, e-LNG, bio-fuels)
- Energy density, cost, availability
- Infrastructure (ports for bunkering, fleet of bunker ships)
- Recruiting of experts for e-fuels

Sustainable Vessel Propulsion System



TI EAD Value Proposition

- CO2 and NOX emission free energy conversion, distribution and propulsion
- Low noise propulsion systems
- System responsibility for energy conversion and propulsion
- Global service network
- Optimization of operation and maintenance

CO2 and NOX emission free low noise vessel propulsion

TI EAD Portfolio

Integrated propulsion solutions and services covering

- Fuel-cells and battery
- BlueDrive PlusC for energy conversion and propulsion
- Automation for energy management and waste heat recovery
- (Podded) propulsion

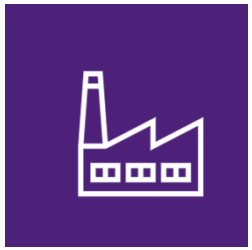
Experience / Successes

- > 60 references of marine offshore energy storage systems
- > 500 references with BlueDrive PlusC
- > 150 references with waste heat recovery

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Key Take Away:



Electrification, Automation, Digitalization.
We energize industry



We deliver low-carbon solutions for maritime, offshore and process industries, across the globe



Challenge us with your projects!

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Contact

Electrification
Automation
Digitalization



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