How Siemens Energy Enables the Global Energy Transition

MATLAB EXPO 2023

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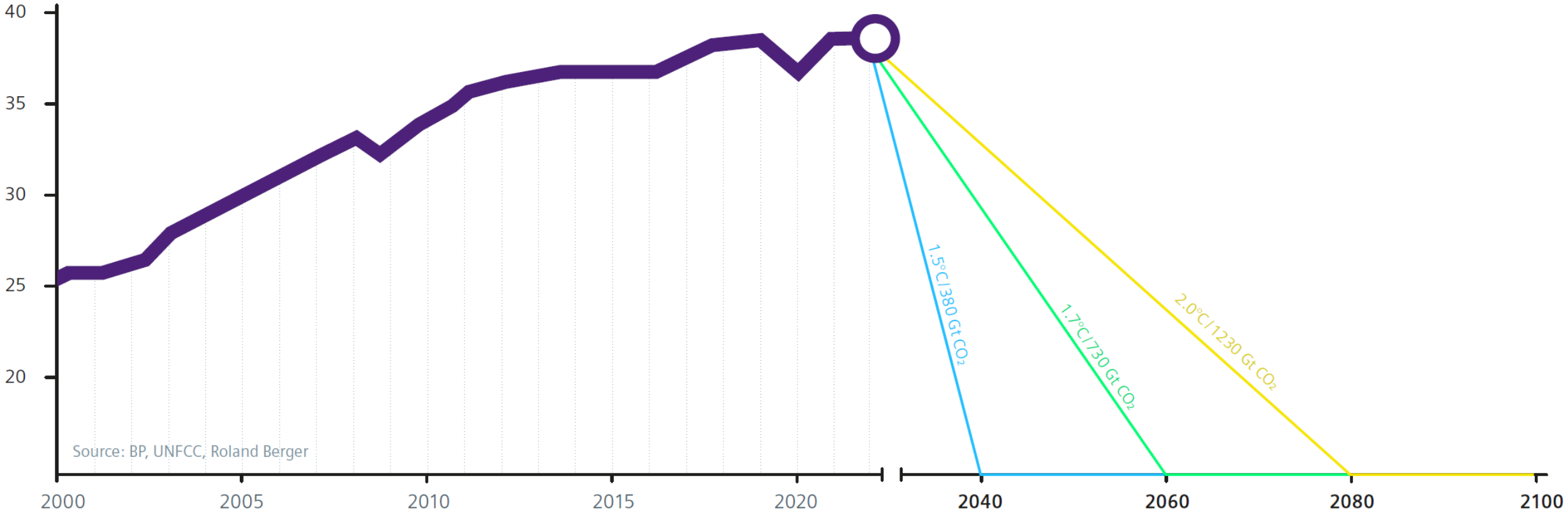
Limit global warming = Reach net zero

No more CO_2 emission by 2040, latest 2080

Pathways to limit global warming –
Energy-related CO2 emissions [Gt CO2]



CO_2 pathways to limit global warming according to Intergovernmental Panel on Climate Change (IPCC), showing remaining carbon budget with a 50% likelihood to limit global warming to 1.5°C, 1.7°C and 2.0°C

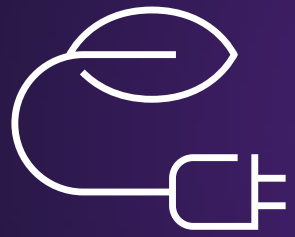
Reference: Siemens Energy Global Energy Transition Readiness Report, 2023

The “energy trilemma“
Solving three problems at the same time

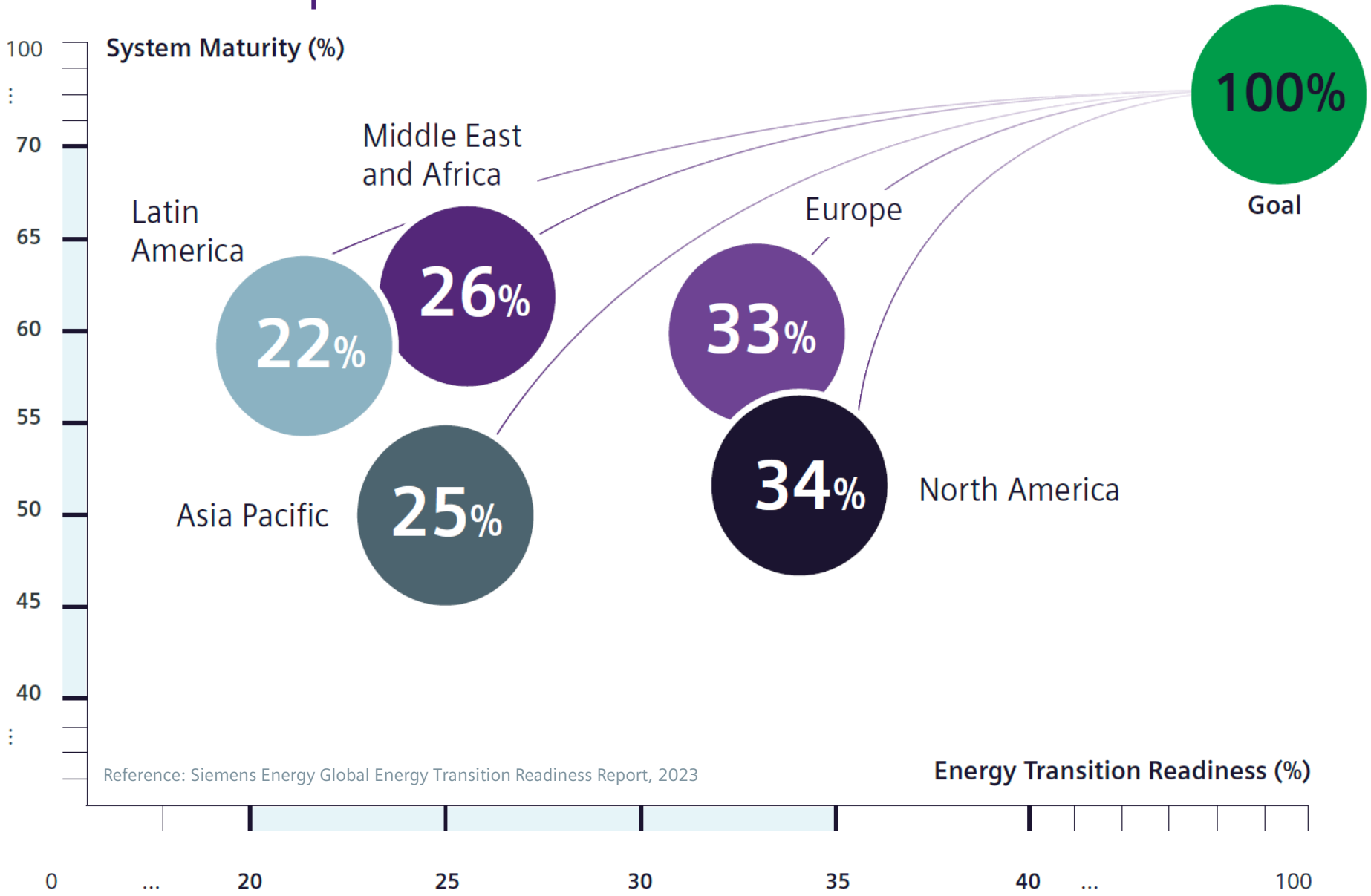
Energy Security
How to keep the lights on?

Energy equity
Can we still afford it?

Energy sustainability
Does it contribute to net zero?



There is a long way ahead of us!
We need to implement solutions now.



Reference: Siemens Energy Global Energy Transition Readiness Report, 2023

It is time to act now!

The issue now is not with identifying problems but with implementing solutions.

It is time to act!
Fields of action for Siemens Energy

#1 Expand renewables

Drastically expand the share of renewables in energy mix.

Solar, biomass, hydrogen and wind energy.

Especially offshore wind on the rise in Europe and North America.

Latest Siemens Gamesa offshore turbines with up to 15MW.

The winds of change. Stronger than ever!

The offshore SG 14-236 DD

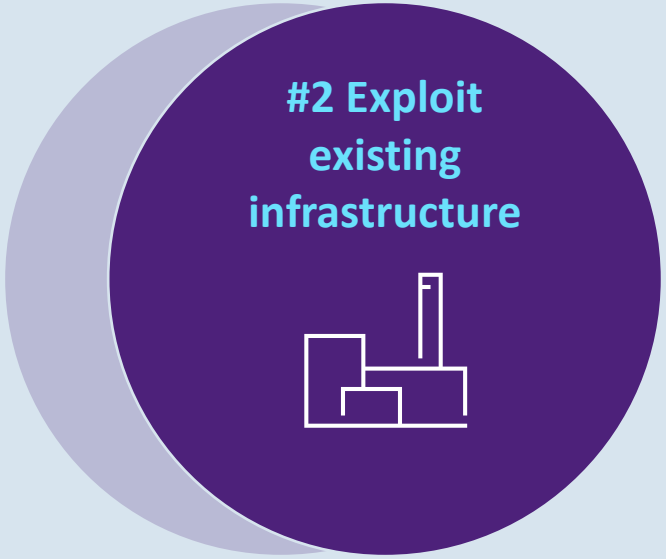
During a 25-year lifespan, one single turbine SG 14-236 DD ensures close to **1.5 million tons of CO2** avoidance compared to coal

… equaling the CO2 absorption of 9,000 hectares of forest, an area 26 times bigger than Central Park in New York City

Up to **15 MW with Power Boost**

+30 % annual energy production in-crease versus SG 11.0-200 DD

It is time to act!
Fields of action for Siemens Energy



Bridge the gap with improvement of conventional technologies.

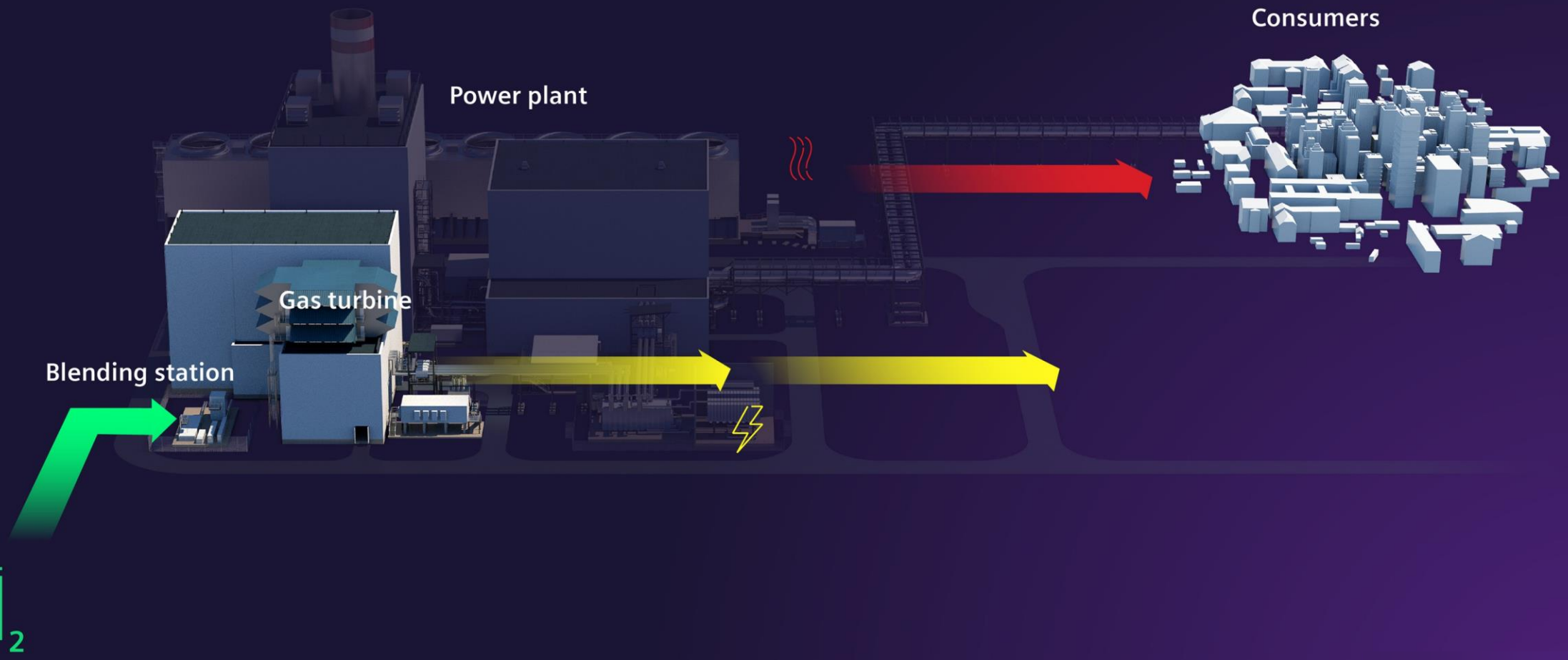
Refitting of power plants for higher efficiency.

Upgrade existing plants to operate net zero.

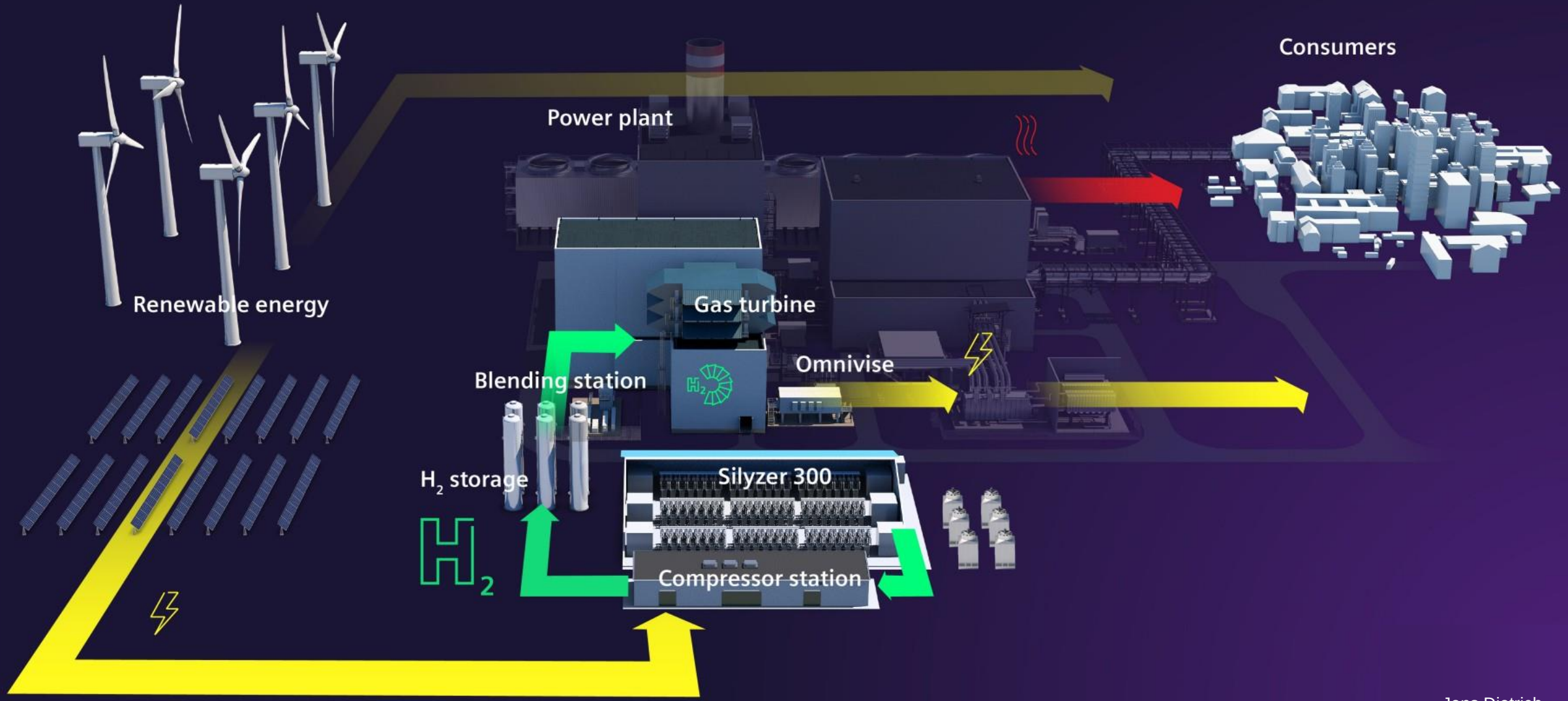
Hydrogen ready gas turbines and hydrogen power plants

Exploit existing infrastructure

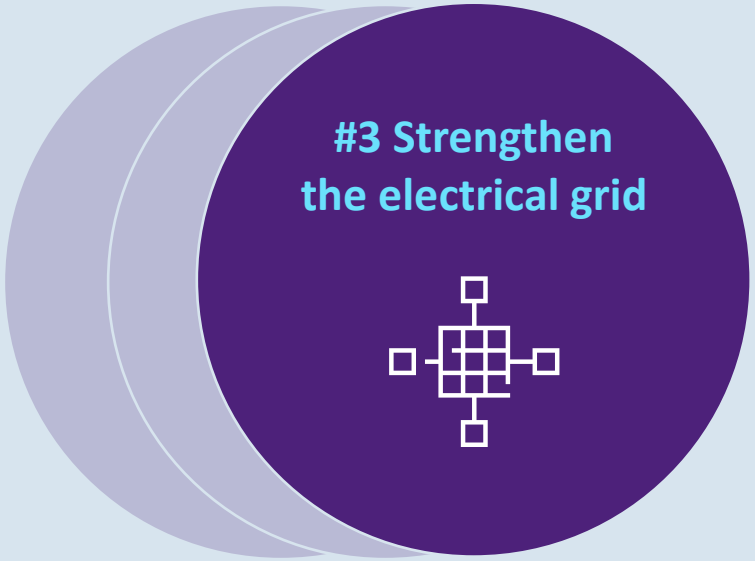
Hydrogen ready gas turbines



Exploit existing infrastructure
Hydrogen fueled gas turbines



It is time to act!
Fields of action for Siemens Energy



Compensating fluctuating infeed and regional power imbalances.

Build new transmission lines and upgrade existing infrastructure.

New active grid elements to control the energy flow.

HVDC* converter technology.

* High-Voltage Direct Current

Our old world
A linear energy landscape

Large Generation

Passive Transmission

Consumer

Our new world

A Complex and Interconnected Energy Landscape

HVDC technology connects around 7 million households

Customer reference: BorWin3

900 MW

Total transmission capacity

1 Million

Households can be powered by this link

160 km

Cable connection to onshore station

± 320 Kilovolts

DC connection voltage via modular multilevel converter (MMC)

Customer
TenneT

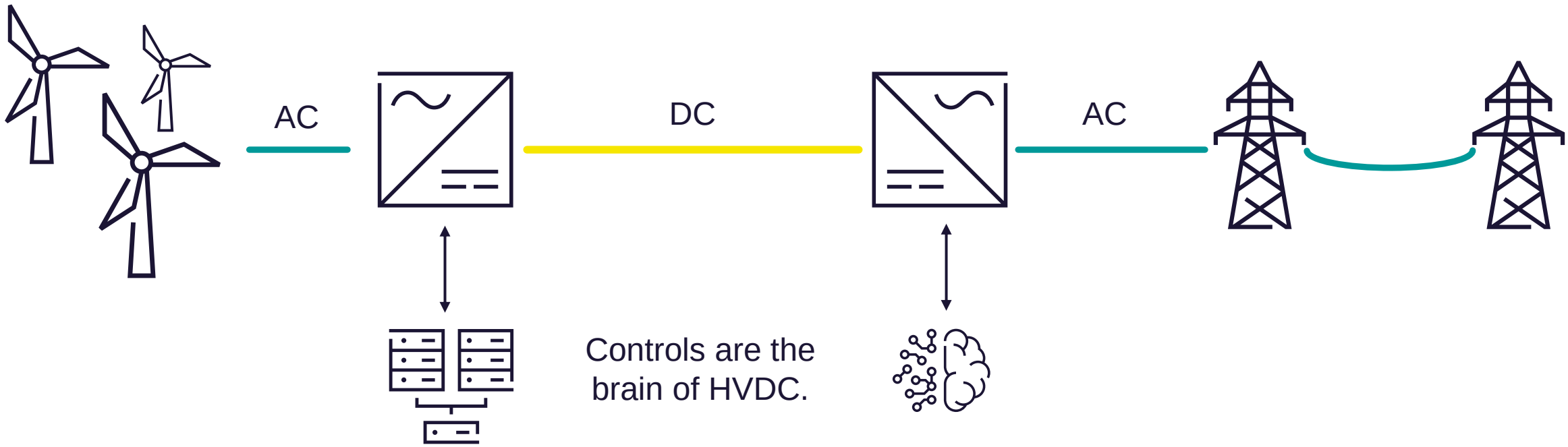
Location
Emden – Germany

Completion
2020

High-Voltage Direct Current Transmission

Connects grids - Controls Power flow - Minimizes losses

Power Source | **HVDC System** | **Transmission Grid**



Digitalizing control development

Qualities for a state-of-the-art engineering environment

Allow Hardware Independence

1

Deploy the original control software unchanged on different (hardware) platforms.

Focus on System Engineering

2

Engineer and simulate the control software together with the electrical simulation on a local PC.

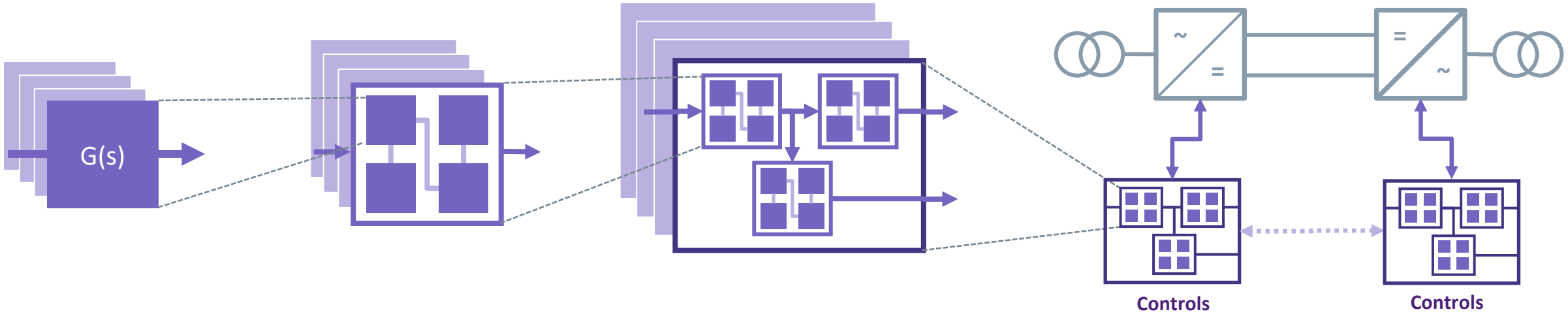
Put Automation at the center

3

Use automated builds and regression testing to run & evaluate all system tests nightly on cloud infrastructure.

Model-Based Design enables us to build anything
from simple control functions to whole transmission systems

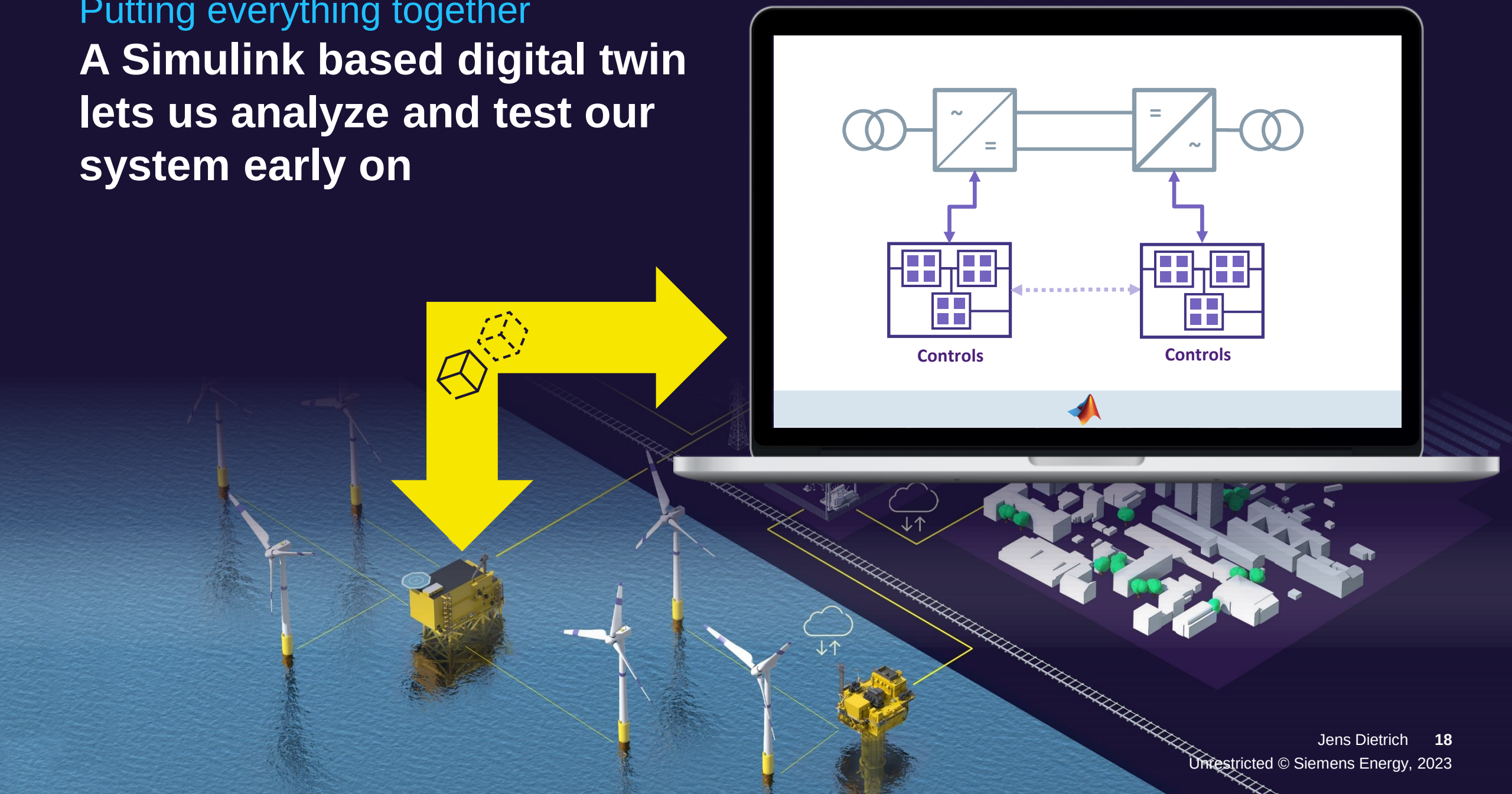
Blocks | **Modules** | **Components** | **System**



Blocks for basic functions *e.g.* **PI-Controller**	Modules for advanced domain specific functions *e.g.* **Current Control**	Components for systemic control tasks *e.g.* **Closed-Loop Control**	The whole system including controls and electrical network *e.g.* **HVDC Plus Grid Access**

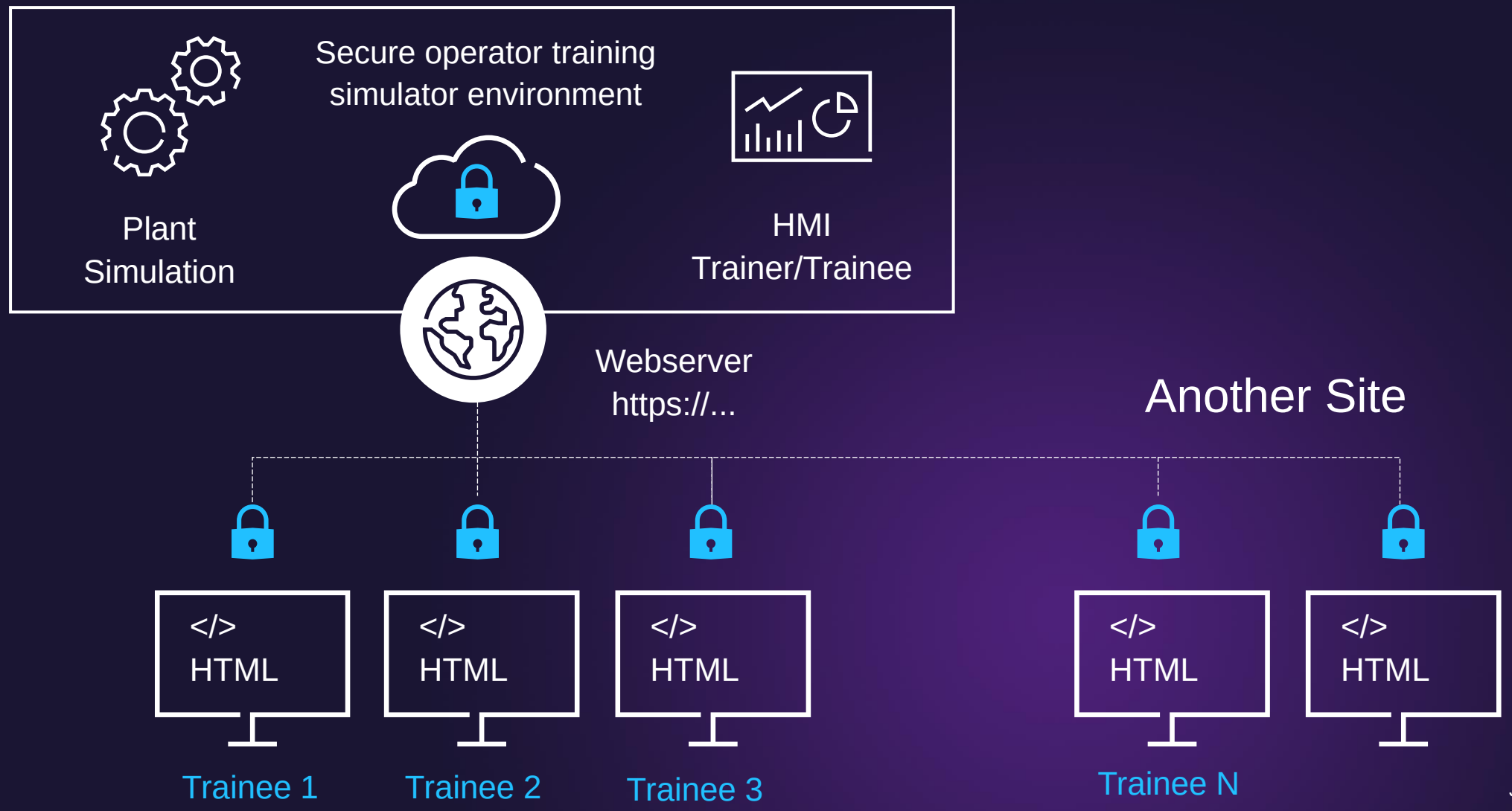
Putting everything together

A Simulink based digital twin lets us analyze and test our system early on

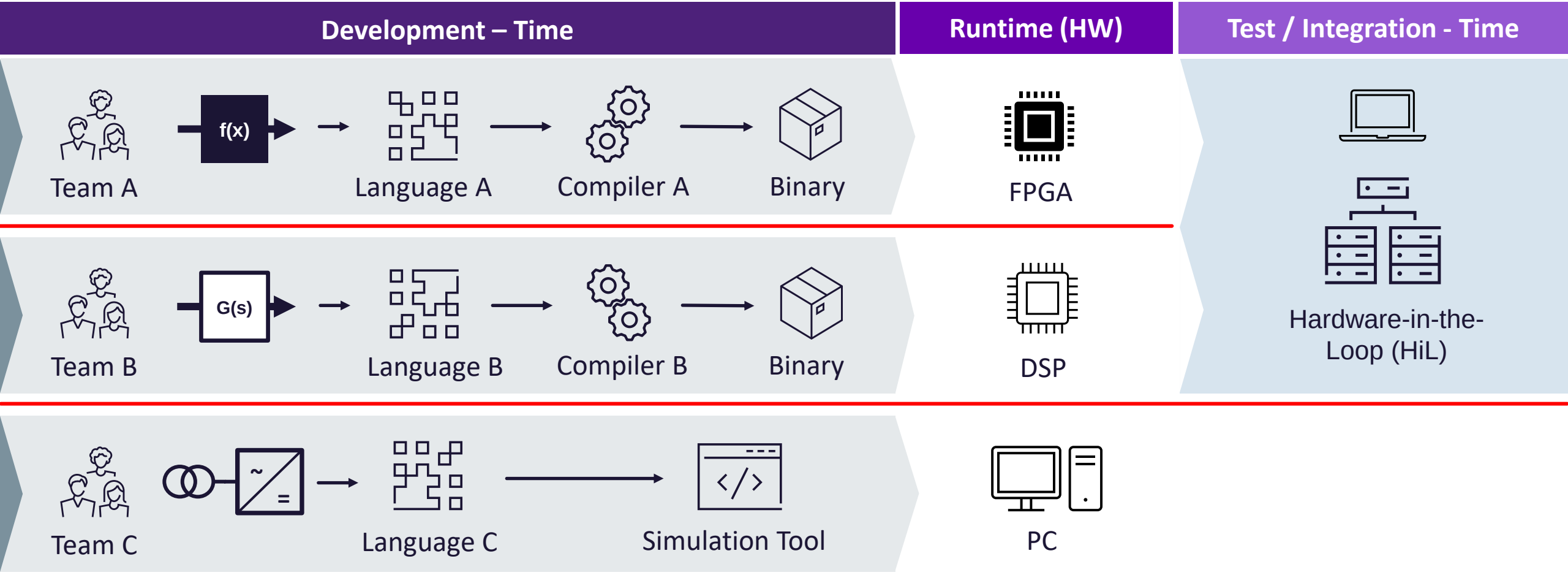


SensOTS

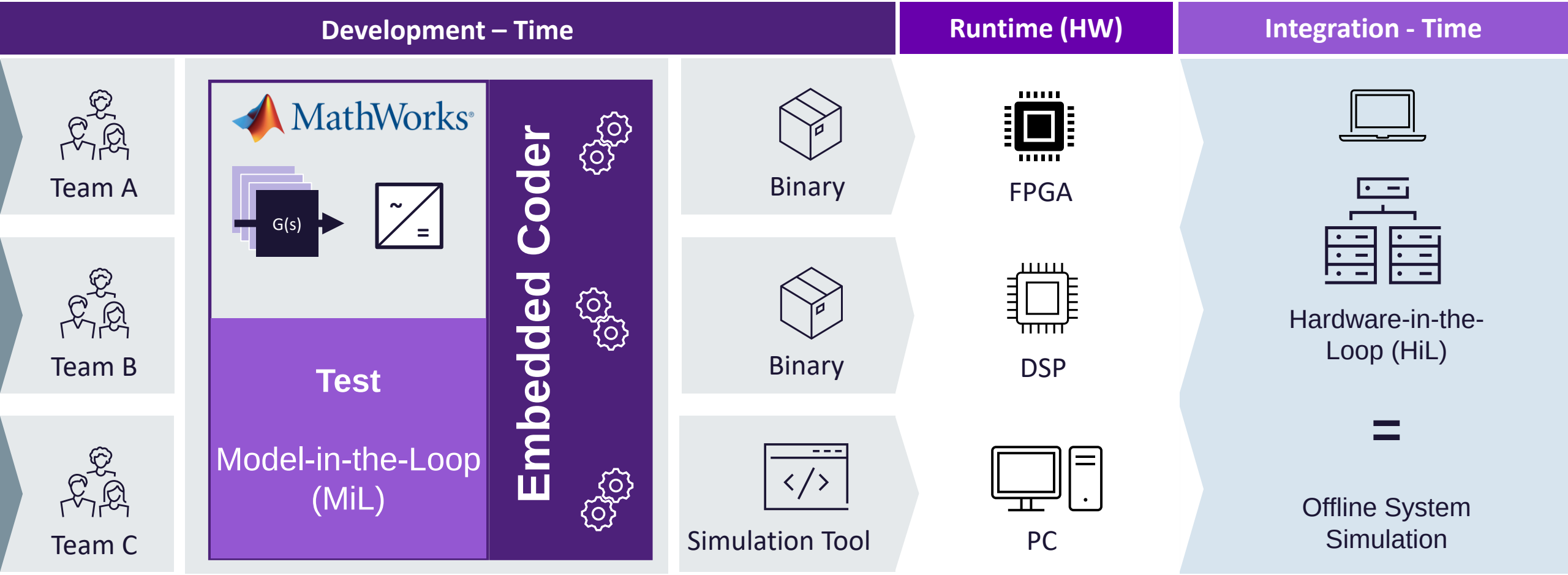
Cloud-based operator training simulator leveraging digital twins



Swimlane Engineering
When the organization shapes development



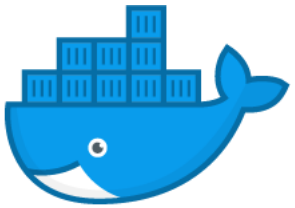
Centralized Engineering Ecosystem
When development extends across the organization



Automated Pipelines

Pushing the ecosystem into the cloud with CI/CD

Development Engineer



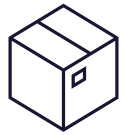
docker

Develop & Check-in

Trigger automated jobs

Build, Test & Deploy

Consume artifacts



Test Engineer

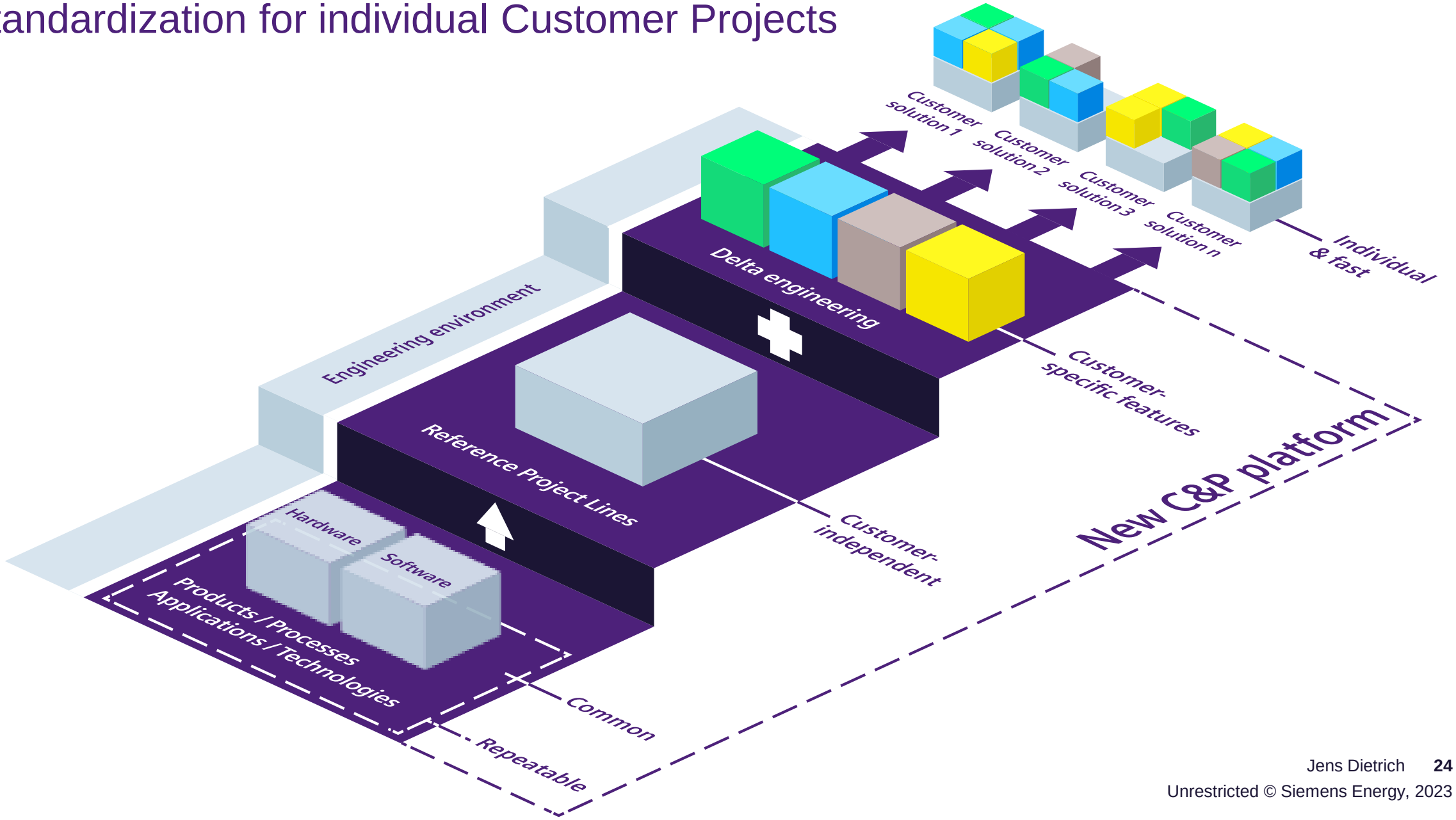
GitLab

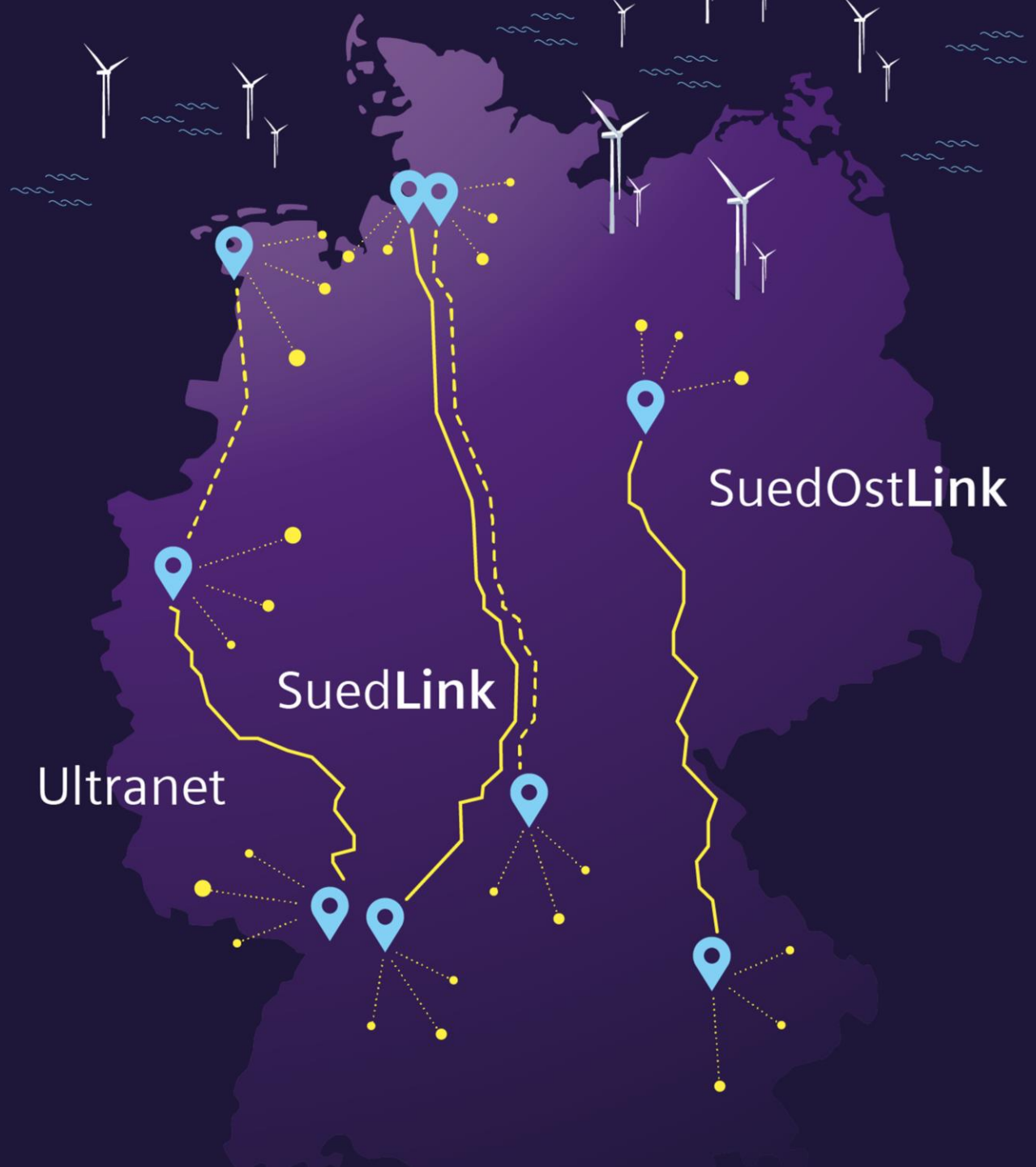
JFrog Artifactory

Project Engineering at Scale

Using Model-Based Design for parallel project execution.

Reference Project Lines
Standardization for individual Customer Projects





Onshore connections in Germany

Ultranet
2GW

Multiterminal *
> 340 km hybrid AC/DC overhead line

SuedLink
2GW

>700 km underground cable

SuedOstLink
2GW

> 500km hybrid cable / overhead line

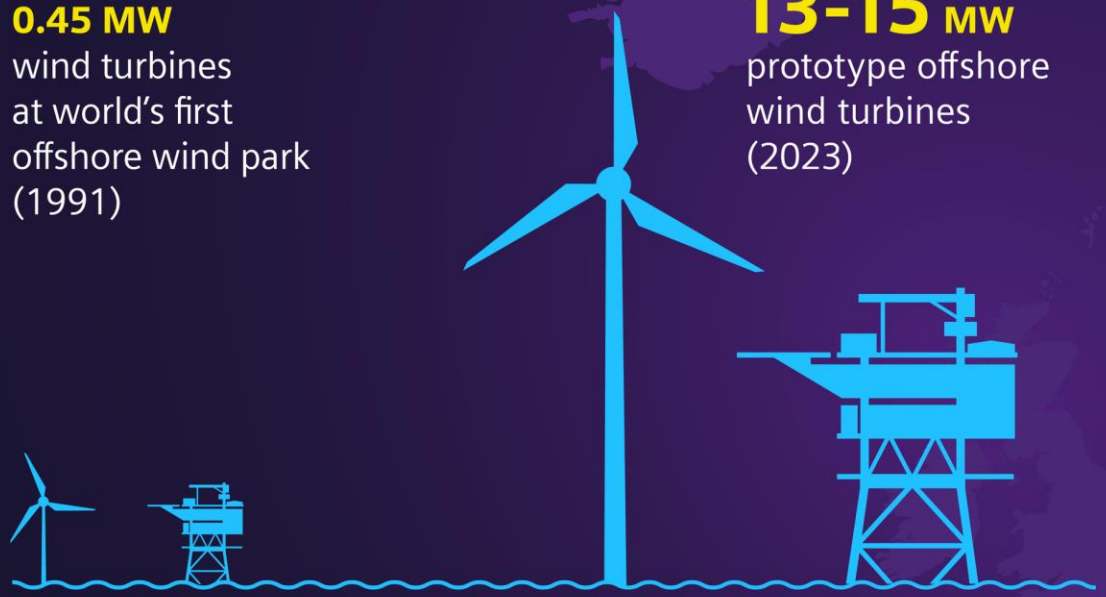
6 GW
Total transmission capacity

* as part of future extension

Offshore wind on the rise in Europe

0.45 MW
wind turbines
at world's first
offshore wind park
(1991)

13-15 MW
prototype offshore
wind turbines
(2023)



576 MW
transmission capacity
of early HVDC*
offshore grid
connections
(2015)

2,000 MW
transmission capacity
of today's HVDC*
offshore grid
connections
(2023)

*HVDC = high-voltage direct current

Annual **new offshore wind installations** in Europe, 2012-21

Installed and targeted offshore wind capacity in the EU

14.6 GW in 2021

60 GW in 2030

300 GW in 2050

Honestly, we can‘t do it alone!

It’s time to get real – we must join forces and make this a global endeavor.

We can do this, but we can’t do this alone.

Vielen Dank.
Thank you.