DRIvE
Unlocking DR Potential

DRIvE and Flexibility 2.0
How we unlock(ed) Demand Response Potential with Digital Twins

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Research and innovation programme
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CONTENT

- What and who is DRIVE?
- What we are doing?
- How we do it and why digital twins?
- General benefits of digital twins?
- Into the future!

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CONTENT: based on ↓

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PART 1:
WHAT AND WHO IS DRIVE?

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PART 1: WHAT IS DRIVE?

Demand Response Integration tEchnologies:
unlocking the demand response potential in the distribution grid

https://www.h2020-drive.eu/

A project is about developing a cloud+gateway infrastructure for aggregating residential and tertiary buildings, making them controllable for Demand Response programs and for providing ancillary services (frequency and voltage regulation, power quality support, etc.)

EU contribution: € 3 955 258,75

DRIVE is ending in November 2020 and we are in the stage of final validation activities, result assessment and wider uptake of project technologies (commercial and additional innovation).

PART 1: WHO IS DRIVE?

PART 2:
WHAT ARE WE DOING?

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PART 2: WHAT ARE OUR GOALS?

Objective 1: make available average 20% of load in residential and tertiary buildings for use in DR, resulting in up to 30% cost-saving (price-based DR) and also maximizing revenue for prosumers (incentive-based DR)

Objective 2: allow a minimum 25% increase of renewable hosting capacity (distribution grid) and up to 30% of overall reduction of CAPEX and OPEX costs for DSOs.

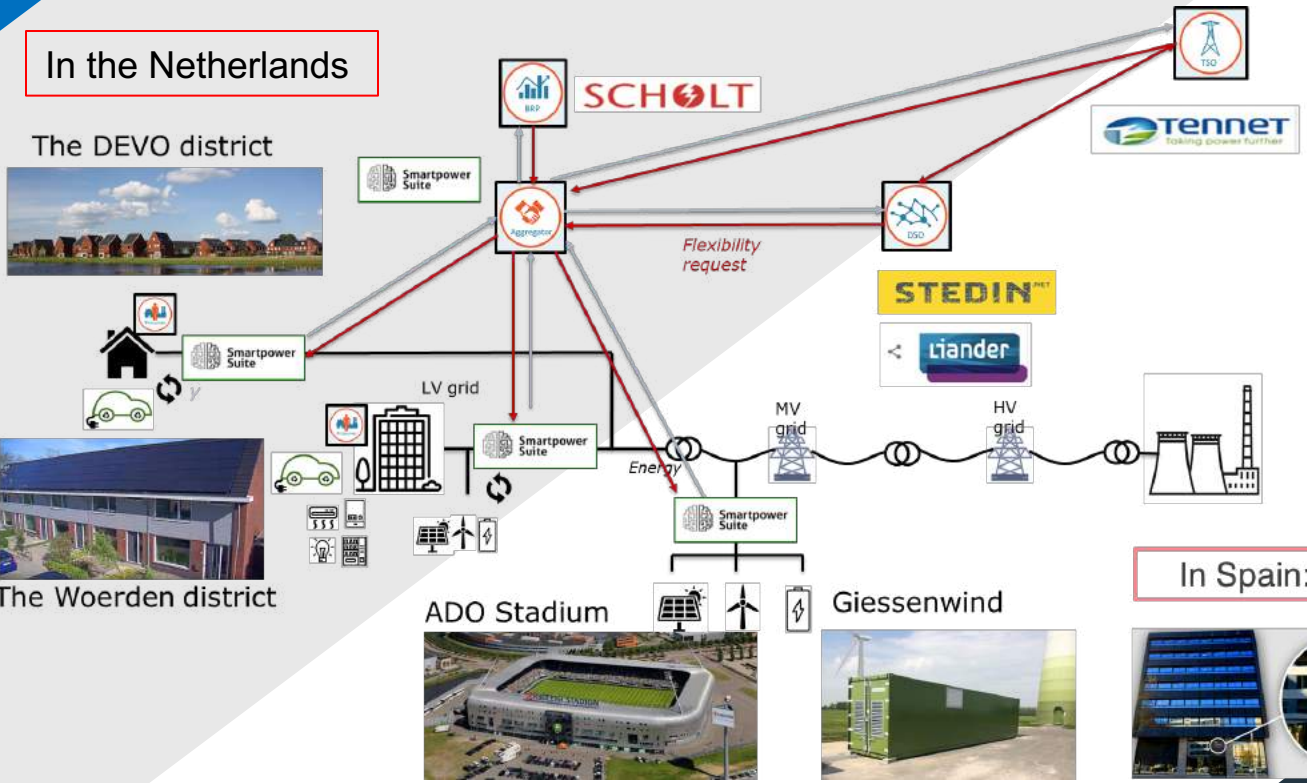
PART 2: WHAT SPECIFICALLY DO WE DO?

MODES OF VALIDATION ACTIVITIES PER SERVICE AND TEST SITE		DEVO Residential District (PS2)	ADO Stadium (PS3)	Giessenwind (PS4)	Woerden site (PS5)	COMSA head office (PS6)
In-building services for the Prosumer	ToU optimisation (UC01)					• HYB/PHY
	kWmax Control (UC02)		• PHY		○ EM/HYB	• HYB/PHY
	Consumer portal (UC03)	• PHY	• PHY	• PHY	• PHY	• PHY
Community services	Community optimisation (UC04)	• PHY			• HYB/PHY	
Flexibility services for the BRP	Portfolio management (UC05)	○ HYB • PHY	• PHY	• EM/HYB	• HYB/PHY	
Flexibility services for the DSO	Congestion management (UC06)	○ HYB ○ PHY	• PHY	○ EM /HYB	•HYB/PHY	
	Voltage control (UC07)			• EM/HYB/PHY		○ EM/HYB
	Power quality support (UC08)			• EM/HYB/PHY		○ EM/HYB
Flexibility services for the TSO	Frequency Containment Reserve (UC9)		• PHY	○ EM/HYB/PHY • HYB/PHY		○ EM/HYB
	Frequency Restoration Reserve (UC10)	○ HYB/PHY	• PHY	○ EM/HYB/PHY • PHY		○ EM/HYB

EM = Emulation, HY = HYbrid, cyber-physical testing, PHY = PHYsical testing; • = obligatory, ○ = optional

PART2: WHERE ARE WE DOING IT PHYSICALLY?

In the Netherlands



SITES WITH DIGITAL TWINS

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SITES WITH DIGITAL TWINS

The Woerden Site

- **39 smart, energy efficient houses in the Woerden district** (built by BAM)
  - ~ 3 kW PV with controllable inverters in each house
  - 5 kW controllable heat pump in each house
  - 3 houses have a 5 kW Alfen battery each
- **500 kW district battery (Alfen)**

The ADO Stadium Site

- **A traditional stadium with 3 types of DER:**
  - 750 kW / 754 kWh Alfen The Battery energy storage system
  - 20 x 22 kW EV Charging pole
  - Photovoltaic system (~600 kW peak)

The Giessenwind Site

- **A combined battery + wind power tertiary site:**
  - 3x 3MW Enercon E-82
  - 1 MW Alfen Sopra 40-04 Energy Storage System

The COMSA HQ Building

- **An office building with three types of DERs:**
  - HVAC units totaling about 20 kW per floor (ground + 6 floors)
  - Battery storage (10 kW)
  - PV panel façade (~15 kW)

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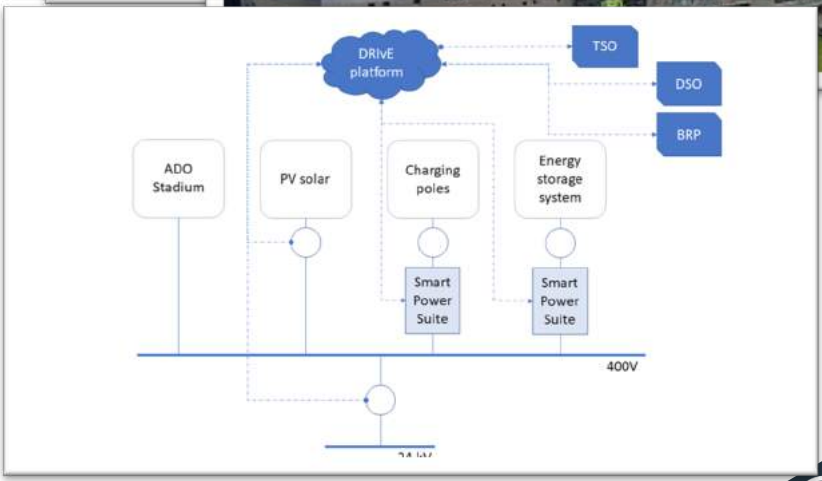

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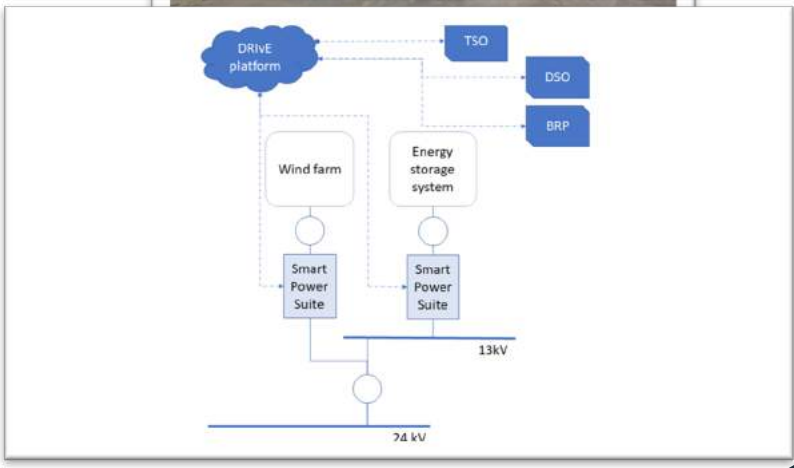

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PART 3:
HOW ARE WE DOING IT?
WHY DIGITAL TWINS?

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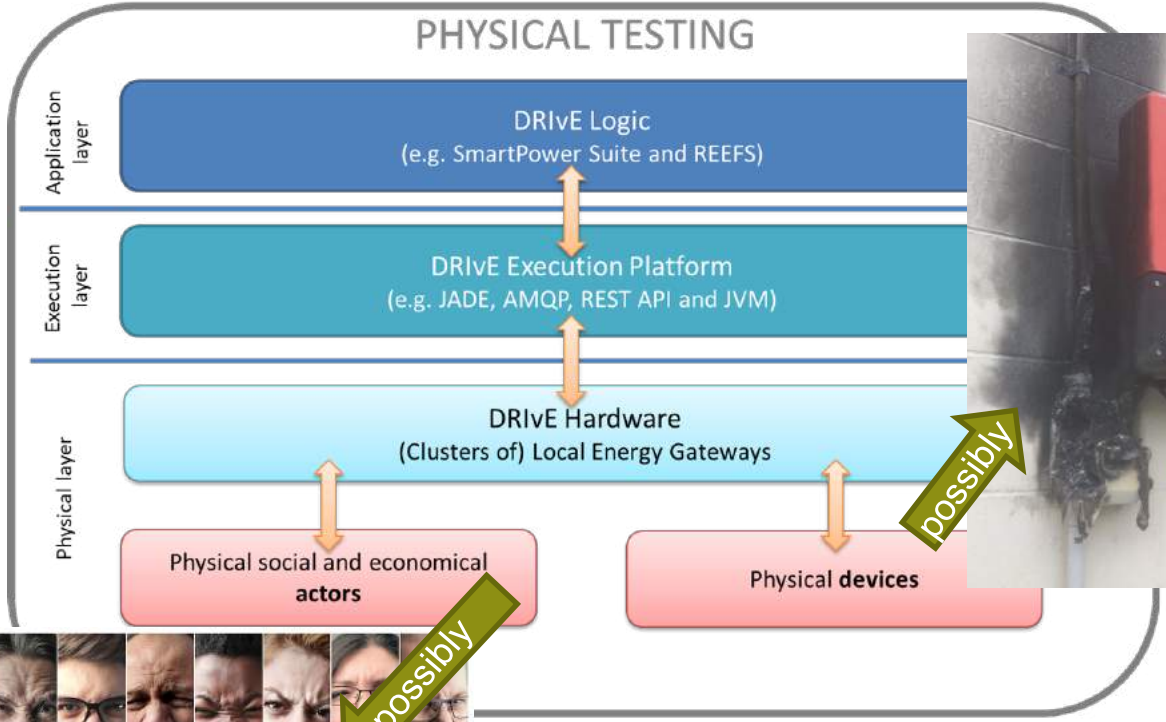
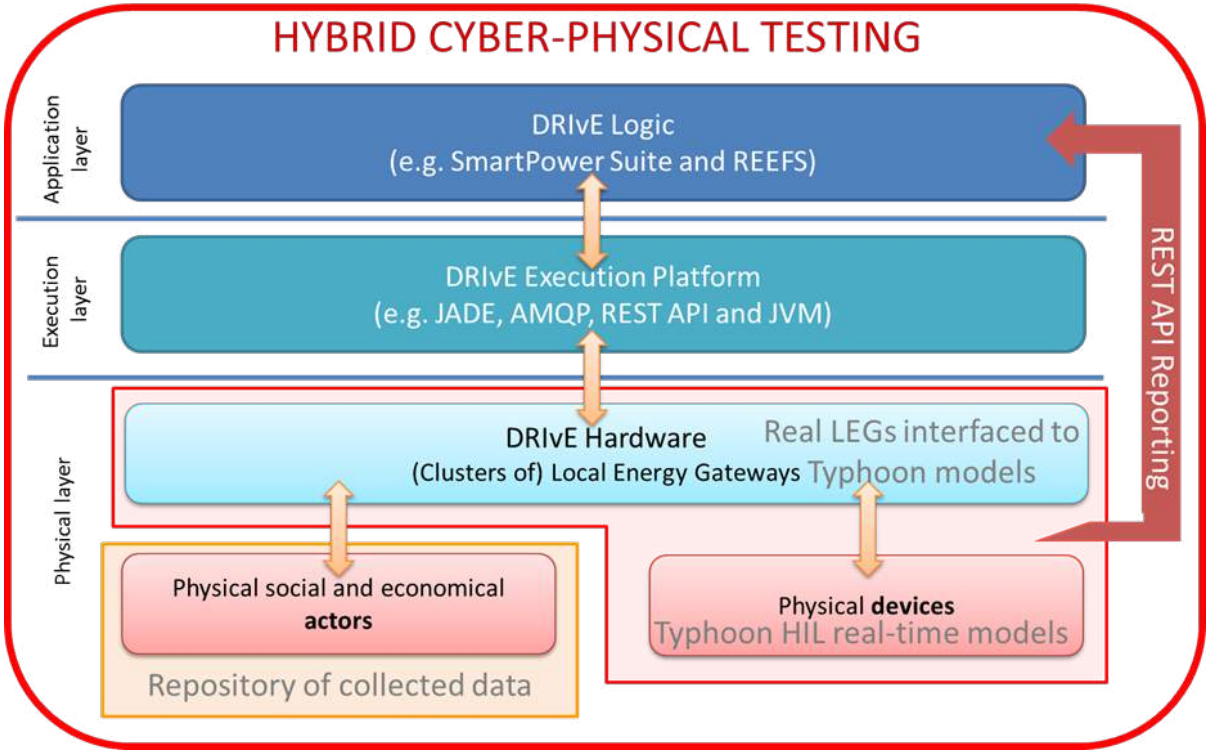
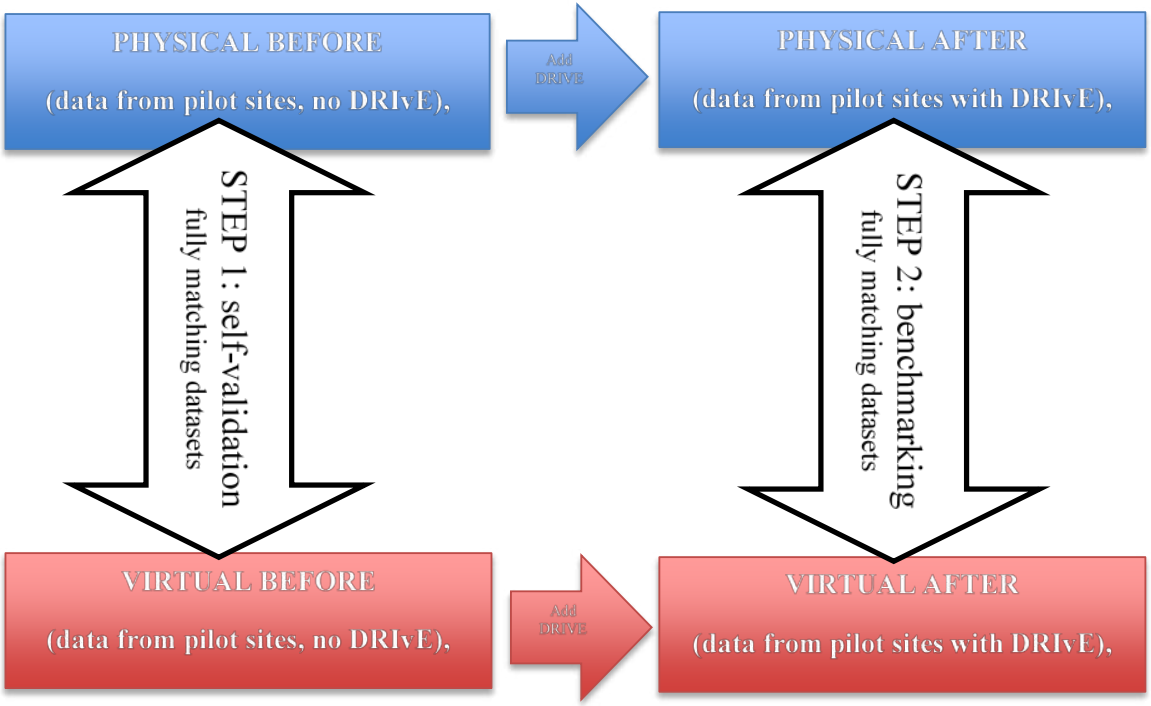
DIGITAL TWINS ARE USED TO DERISK PHYSICAL TESTING



HYBRID, CYBER-PHYSICAL TESTING WITH DIGITAL TWINS

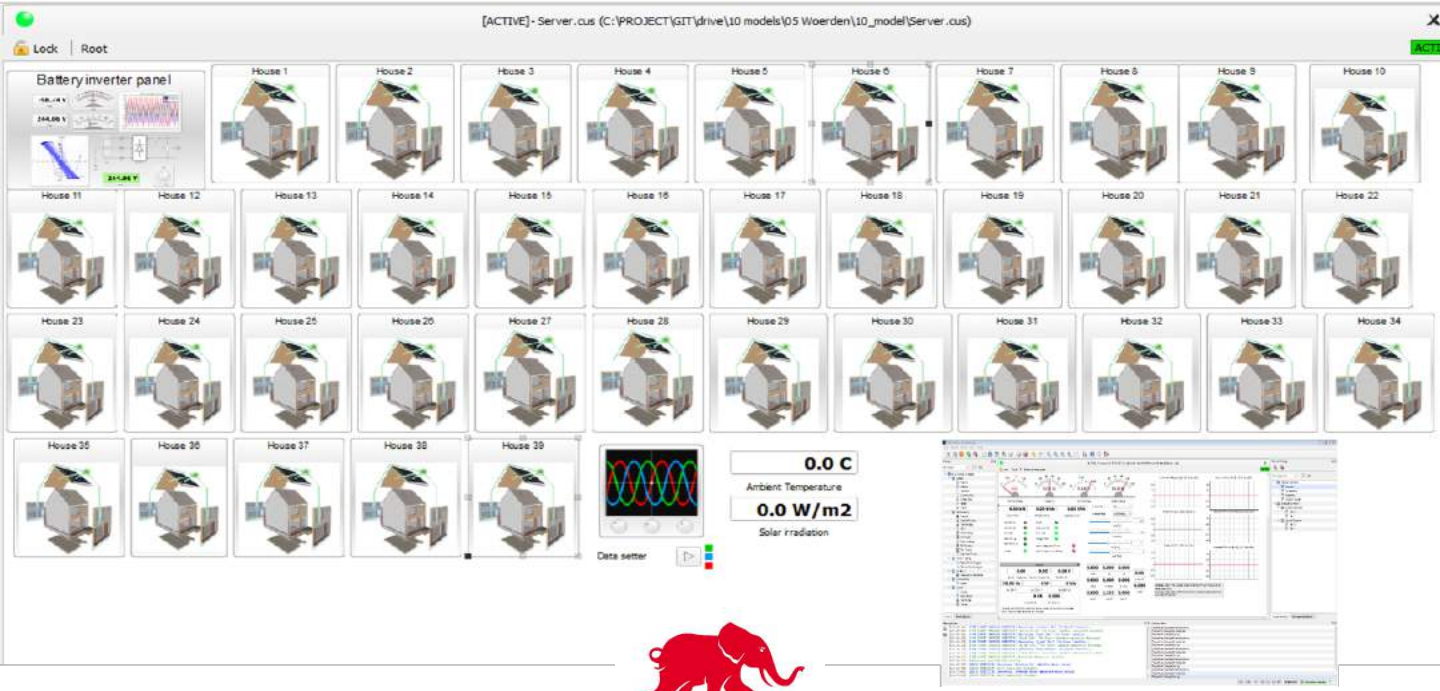


HOW DO WE ENSURE FIDELITY OF DIGITAL TWINS?



AN EXAMPLE OF THE DIGITAL TWIN

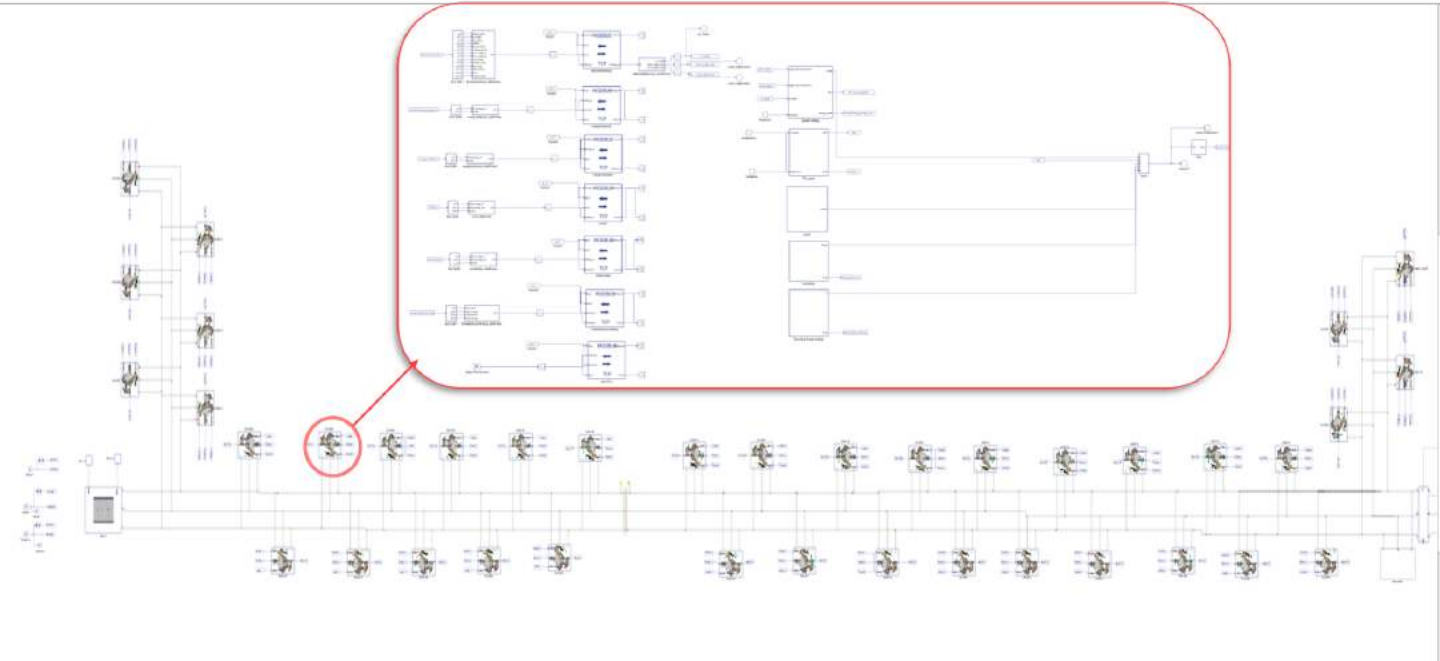
The Woerden Site Digital Twin



Typhoon HIL

DRIVE

The Woerden Site Digital Twin



THE ACTUAL SETUP OF DIGITAL TWINS

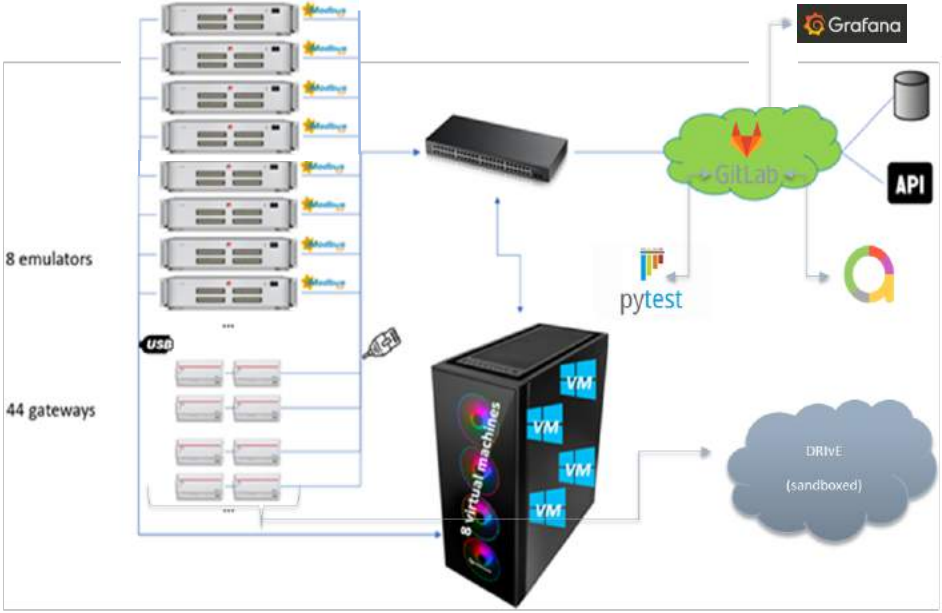
The Digital Twin Setup at Enervalis

- 8 FPGA-powered emulators by Typhoon HIL and interface boxes for 44 ABB gateways

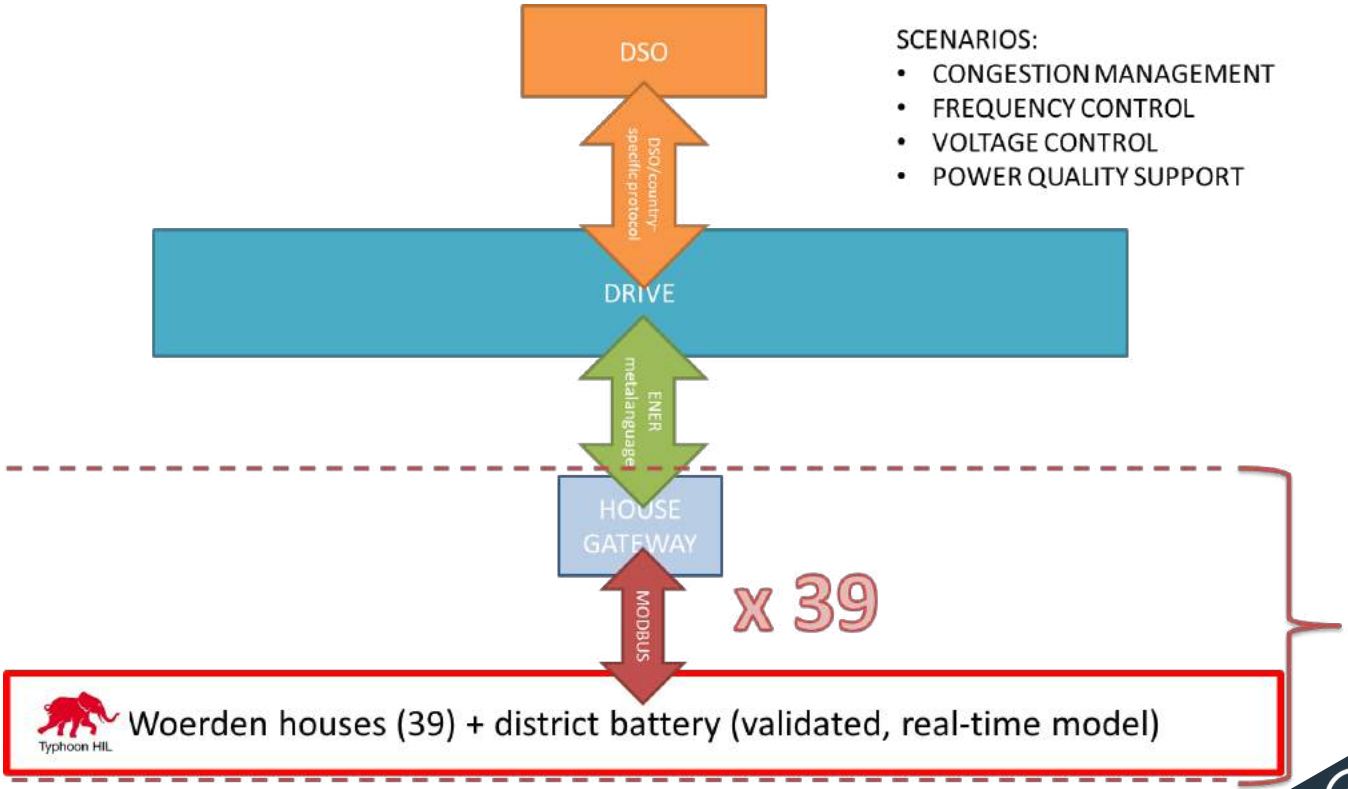
Enervalis

'Enabling a 100% green society'

How does the setup actually work?



HOW DO WE USE THE DIGITAL TWIN?



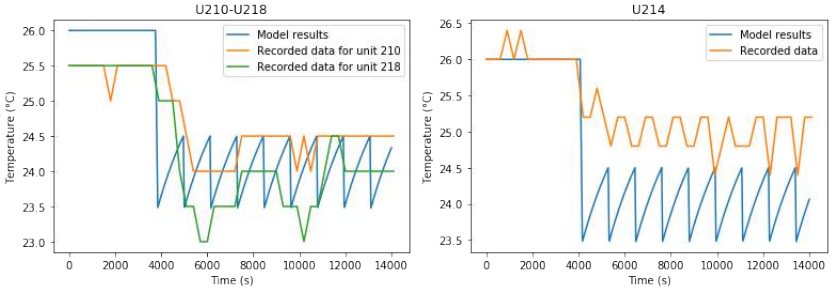
SCENARIOS:

- CONGESTION MANAGEMENT
- FREQUENCY CONTROL
- VOLTAGE CONTROL
- POWER QUALITY SUPPORT

Examples of digital twin test runs (Grafana)

Giesenwind digital twin

COMSA HQ digital twin (early model validation runs)



PART 4:
GENERAL BENEFITS OF DIGITAL TWINS?

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DIGITAL TWIN BENEFITS IN DR

- **Derisking implementation (and investment)**
  - exhaustive testing and validation of control algorithms in the emulation
  - full confidence in final implementation of new services at a physical pilot site
  - Interoperability issues solved in the emulated domain (including real and emulated protection relays: e.g. MODBUS registers)
  - standardized tests for pre-certification and adherence to grid codes
- **Benchmarking and qualification of suppliers/vendors**
  - Parametrize automated test scripts and do A/B or what-if tests, either from the technological or financial perspective
  - Week- or month-long test runs for assessing e.g. DR services, ancillary services, trading in the flexibility market

PART 5:
INTO THE FUTURE!

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DIGITAL TWIN FOR DR IN THE NEAR FUTURE

- **Exploring new business opportunities**
  - Using digital twins to explore new/additional services for DSOs/BRPs/TSOs, e.g. power quality support (THD mitigation, reactive power support, etc.)
  - Modeling of financial benefits of various services for various types of portfolios
  - Safe and fast demonstration to stakeholders and prospects (DSOs/BRPs/TSOs)
- **New applications of DR digital twins**
  - Using digital twins of DR sites to generate clean data as training sets for ML/AI cyber-security
  - Streamlining the work of system integrators and aggregators: with easily parametrizable digital twin models, system integrators and aggregators can do digital integration first and be confident in 100% error-free commissioning at the physical site
  - Digital shadows for lifecycle management of DR assets/sites

THANK YOU

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https://twitter.com/DRIvE_EUproject

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