Grid digitalisation: Opportunities and pitfalls for efficient grid operations and development

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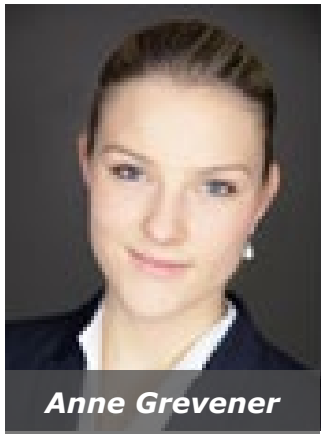
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Electricity system operators are facing several challenges – Grid digitalisation is a key enabler

Key investment drivers in DSO grids (by share of total CAPEX) [1)]

ELECTRIFI-CATION	MODERNI-SATION	RENEW-ABLES	SMART METERS	RESI-LIENCE	DIGITALI-SATION	STORAGE &OTHERS
27%	25%	23%	8%	8%	7%	2%

>€100 bn investments in digital modernisation of grid, substation automation and monitoring until 2030 [1)]

510 GW new RES capacity will be connected to European electricity grids by 2030 [1)]

Increase of energy storage capacity to be integrated in the grid in Europe by >800% until 2030 [4)]

Total EU electricity demand will rise by +1.8% per year by 2030 [1)]

Approx. 30% of low voltage lines older than 40 years [1)]

€41 bn are needed to achieve a smart meter penetration rate of 92% by 2030 [3)]

Development of area-wide communication infrastructure as essential requirement for smart grid [2)]

1) Eurelectric: Connecting the dots (2021); 2) AFRY analysis; 3) Eurelectric: Distribution Grids in Europe (2020); 4) statista: Forecasted energy storage capacity in Europe from 2020 to 2040

The objective of grid digitalisation is to create substantial savings, increased quality, as well as accelerating the green transformation of energy systems

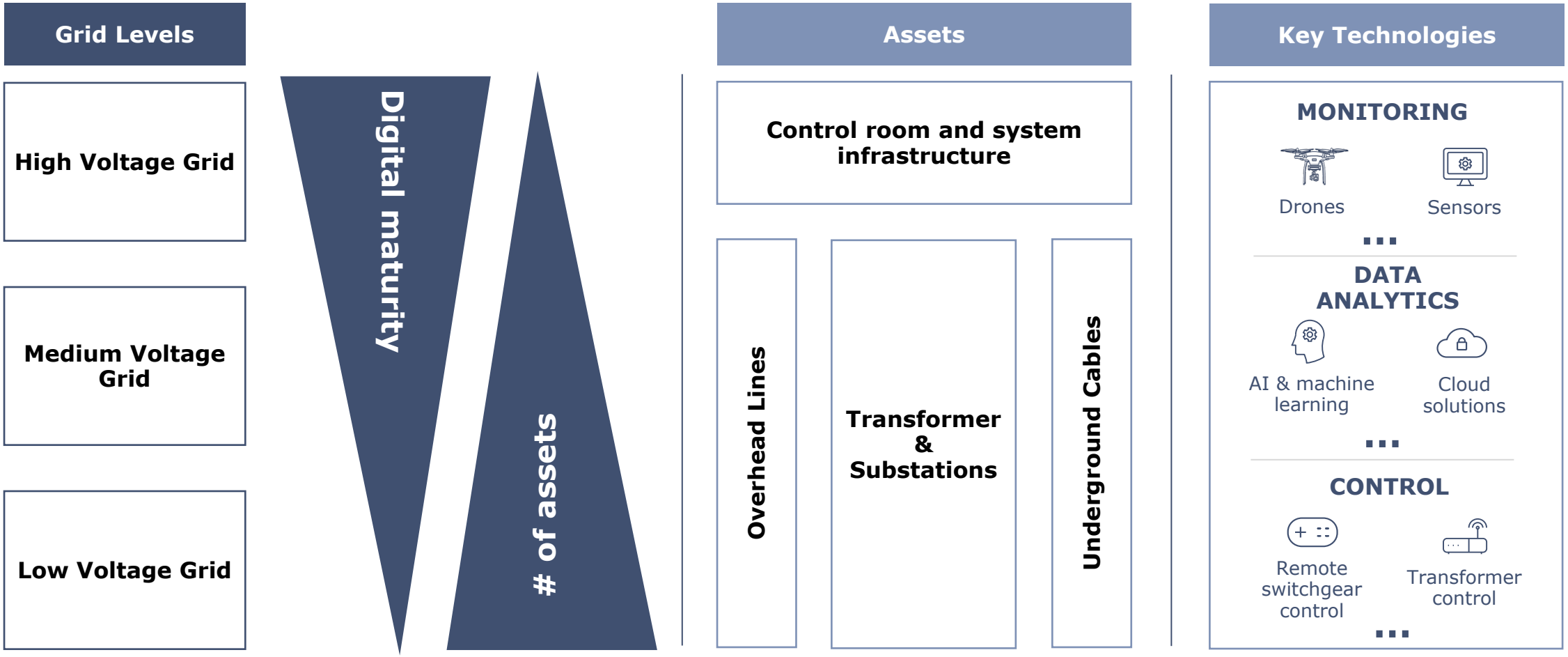
BENEFITS OF GRID DIGITALISATION

- Avoided investments
- Reduced costs for planned and unplanned maintenance
- Reduced costs for system operation

- Shorter and fewer outages
- Lower SAIDI
- Increased safety

- Efficient use of existing capacity
- Integration of local flexibility and DSM

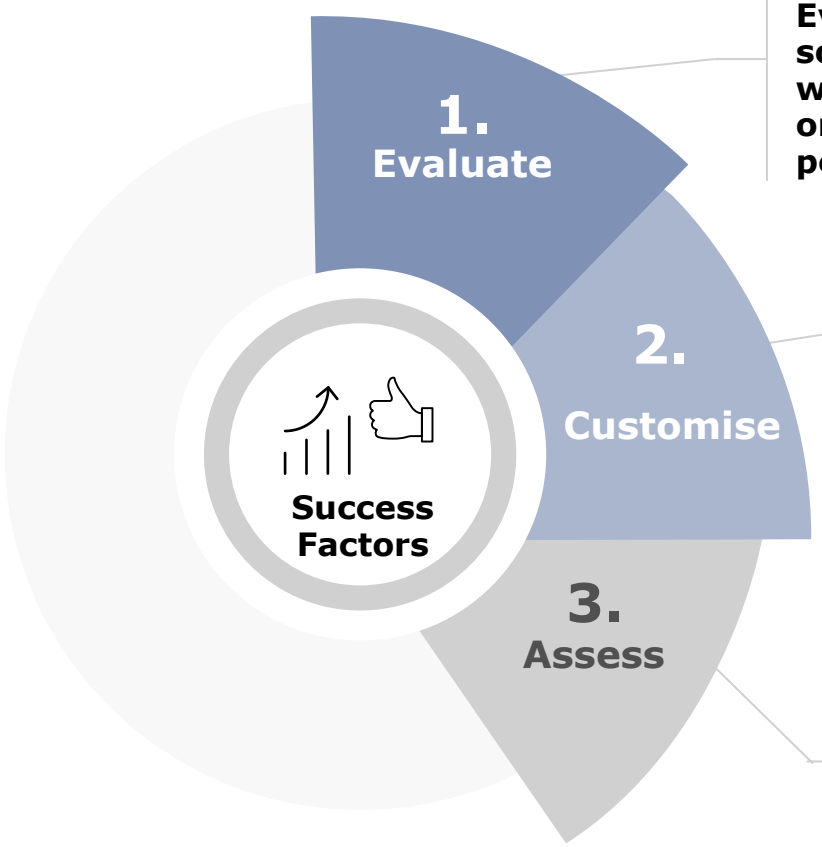
Digital solutions are being implemented across voltage levels as well as across all key assets of the electricity grid



Definition of medium voltage level can vary between countries

KEY SUCCESS FACTORS IN GRID DIGITALISATION

Deployment of grid digitalisation should consider evaluation, customisation and assessment of a range of options from several perspectives



Evaluate solutions from a wider organisational perspective

Customise solutions to specific challenges (Not "one size fits all")

Assess the integration of the solution in existing systems and processes

Case examples

1 **Technology Scoping**

2 **Sensor Market Study**

3 **Extreme weather modelling**

4 **Smart secondary sub-stations**

5 **System integration & operational model**

6 **Digital Use Cases**

STRUCTURED APPROACH TO GRID DIGITALISATION

Grid digitalisation initiatives can run through several phases that require a combination of engineering, digital and operational expertise

Scope	Initiation	Analysis	Design	Implementation
Engineering	Technology Scoping	Modelling & Cost Benefit Analysis	System Design	Tool / system selection
Digital				
Operational	Company profile and strategy		Organisational Design	Resource Planning
	...	...	...	...

Project & Change Management

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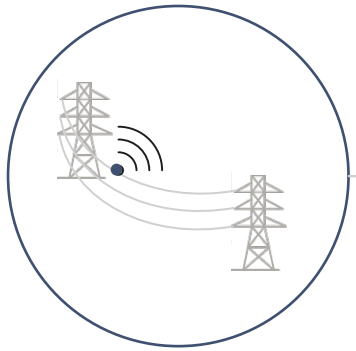
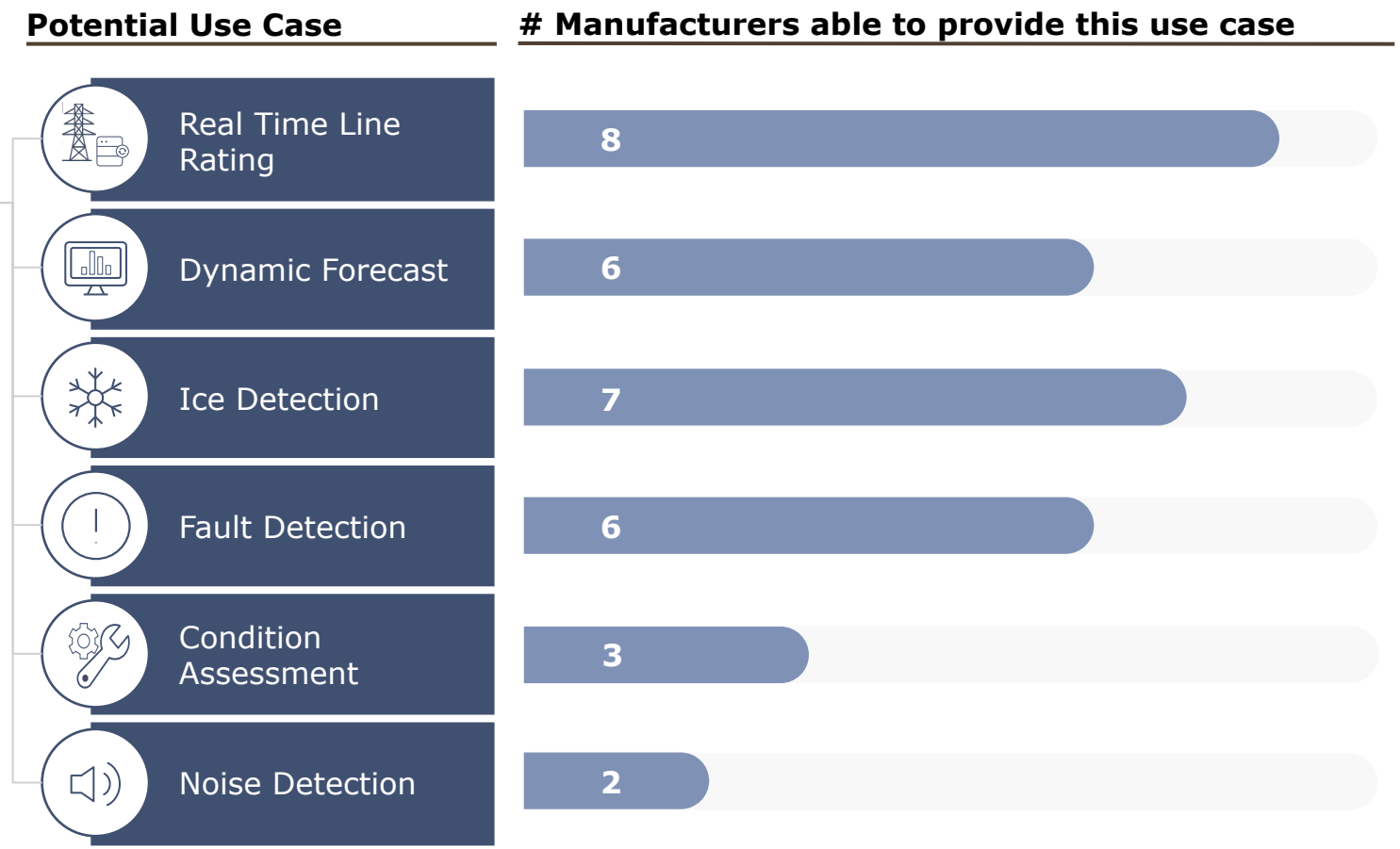
CASE EXAMPLE: TECHNOLOGY SCOPING FOR OVERHEAD LINE SENSORS

The technology scoping revealed what manufacturers are able to provide overhead line sensor use cases envisioned by the network operator



1

- Joint definition of envisioned use cases for line sensors with a wide range of functions within the network company
- Identification of 6 potential use cases



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- Assessment of the capabilities of the different technology vendors for Overhead line sensors
- Identification of 9 separate vendors

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CASE EXAMPLE: EUROPEAN OVERHEAD LINE SENSOR MARKET STUDY

A European Case Study for overhead line sensors helped to shed light on use cases and their utilisation across different network operators

Market Facilitation

Dynamic Line Rating

- **Increase the capacity** of existing lines **up to 25%***
- TSOs utilise DLR on **up to 50%** of their overhead lines
- DSOs start using DLR on high voltage lines (**5-15%**)

System Operation

Ice Detection

- Identify ice build up before it becomes critical
- In some regions useful in **5-15%** of the grid

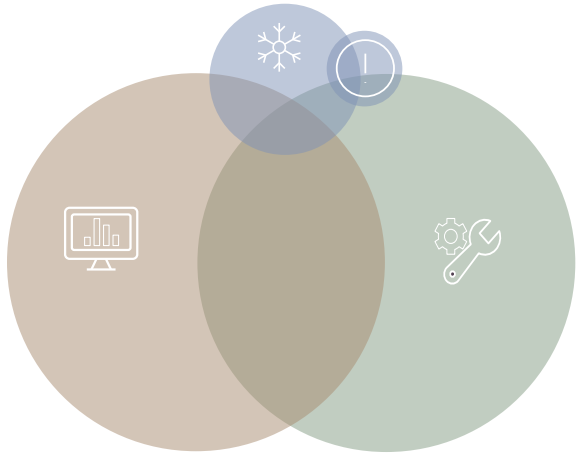
Fault Detection

- Reduce failure identification in remote grid sections
- Could affect over **10%** of overhead lines

Asset Management

Condition Assessment

- Reduce shutdown times and physical conductor analysis
- Could affect **up to 50%** of overhead lines in grids of advanced age structure



If at all the overlap of use cases is only relevant in a small section of the grid

*Compared to static line rating

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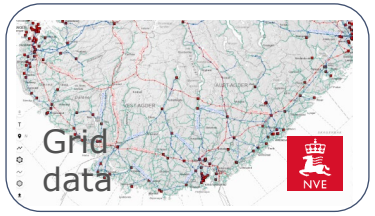
CASE EXAMPLE: EXTREME WEATHER MODELLING

Critical areas are determined combining data about grid location, components, weather and forestry in a simulation model

– Grid location & physical components (GIS extraction, vector data coordination)



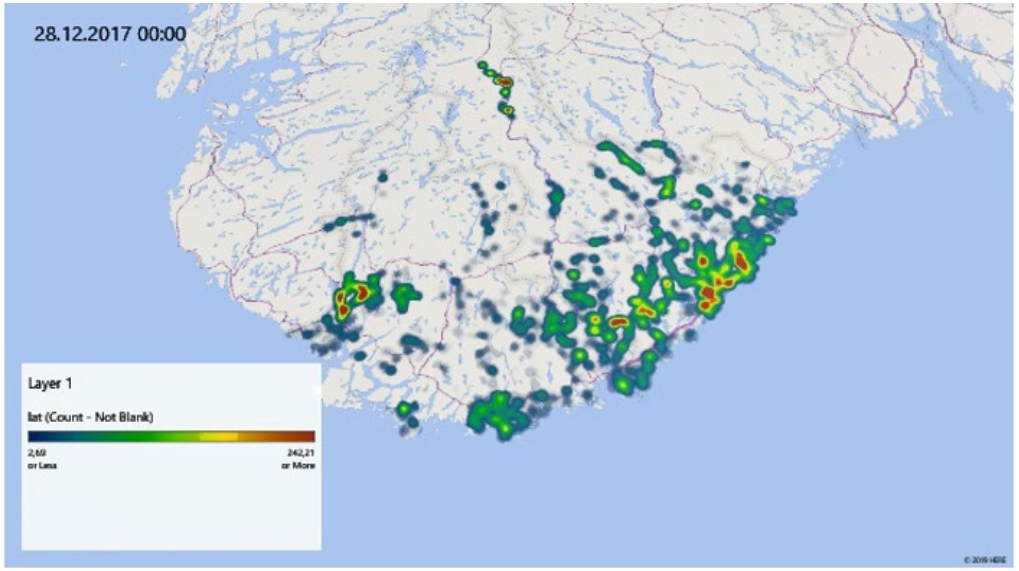
Weather data including snow, temperature and wind

Other relevant data like different type of forestry

python™

THE MODELLING PROCESS INVOLVED DIFFERENT DATA TYPES

THE RESULTING SIMULATION IDENTIFIES CRITICAL AREAS



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CASE EXAMPLE: SECONDARY SUBSTATION

Characterisation of the grid and Cost-Benefit Analysis of smart secondary substation functionalities as base for design of configurations

Identification of grid characteristics

- Assessment of **pre-conditions and characteristics** of the grid
- **Clustering of secondary substations** to reasonable sub-groups (e.g. based on grid topology)

	Prioritisation (Rating from 1 to 10)			
Criteria	No. of substations in cluster	Historical fault rate in cluster	Importance of clients in cluster	Topography – complexity of fault mgmt

Illustration of cluster assessment

Cost-Benefit Analysis

- **Monetisation** of direct **energy economic value** and quantification of costs
- **Qualitative assessment** of indirect benefits as enabler of energy transition

		Monitoring			Control
		Fault indicator	MV measure-ments	LV measure-ments	Switchgea control
Economical	Benefit 1	x		x	
	Benefit 2		x		
Environ-mental	Benefit …	x			x
Security of supply	Benefit …		x		
Safety	Benefit …			x	
Social impact	Benefit n	x			x

Illustration of benefit assessment matrix

Design of smart secondary station configurations

- Design of **smart secondary station configurations** considering monitoring and control
- **Decision rules** for deployment within the grid based on energy economic value

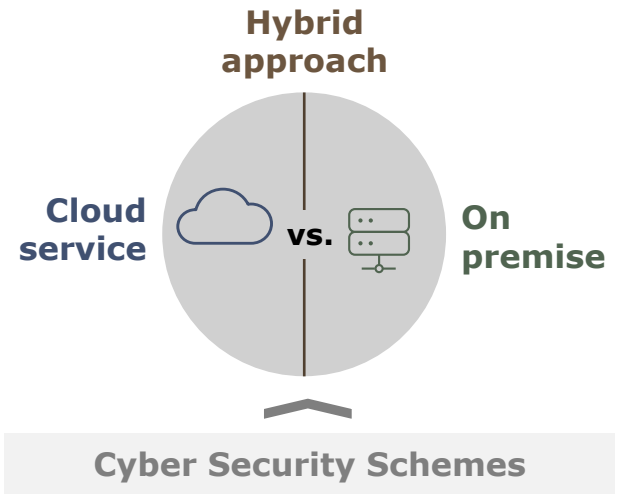
Five-level system approach

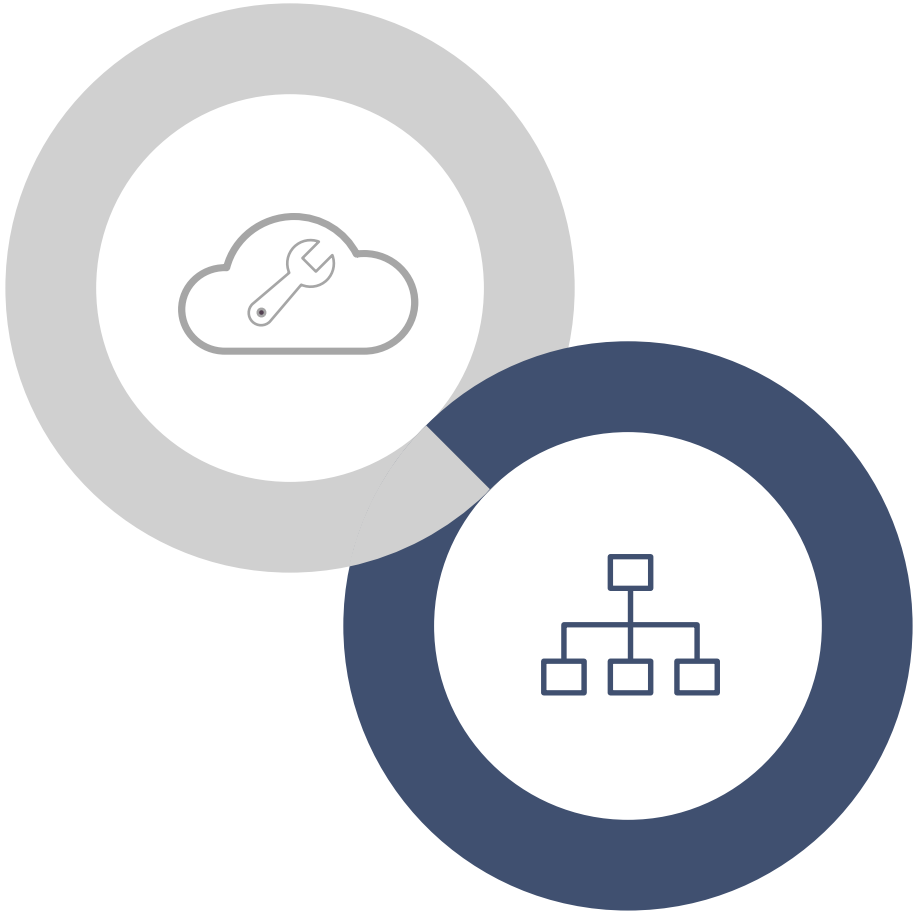
CASE EXAMPLE: SYSTEM INTEGRATION & OPERATIONAL MODEL

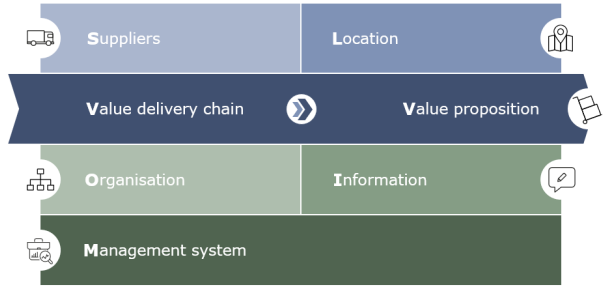
During implementation phase system integration requirements are considered to determine the new operating model

SYSTEM INTEGRATION

- Integration of the solution in existing systems
- Anticipation of future changes to ensure interoperability of technologies







AFRY methodology: The target operating model canvas

OPERATIONAL MODEL

- Development of target roles model for installation, operation and maintenance of technical solution
- Prioritisation and structuring of rollout
- Support in implementing new ways of working and change management

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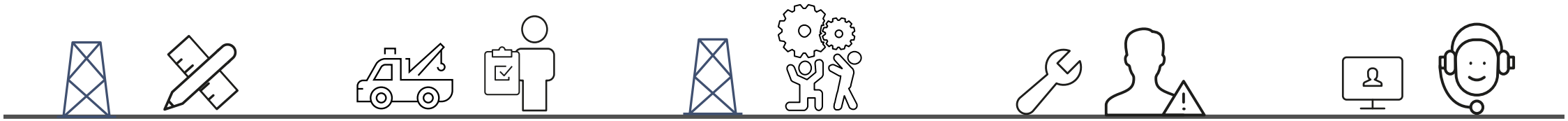
CASE EXAMPLE: DIGITAL USE CASES

Big challenge is not only to involve, but also to create visibility of digital initiatives across the different functions of grid operators

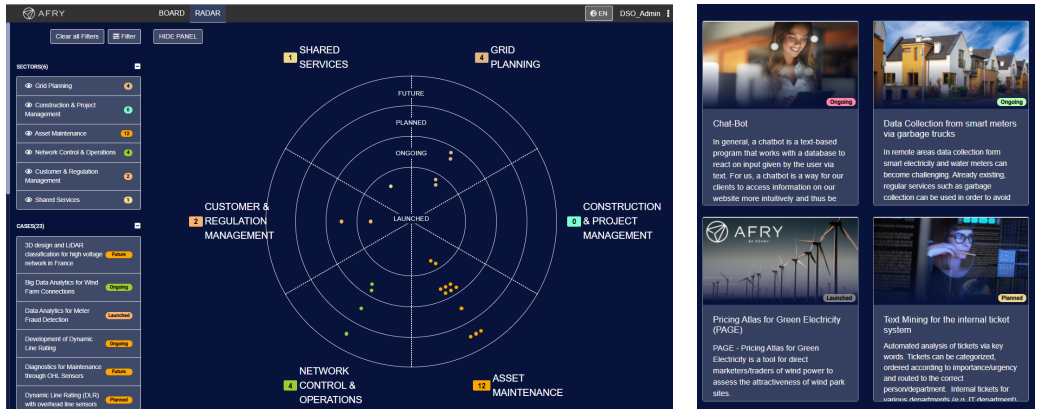


Grid Planning | Construction and Project Management | Network Control & Operations | Asset Maintenance | Customer Regulation & Management

Support

Communicate

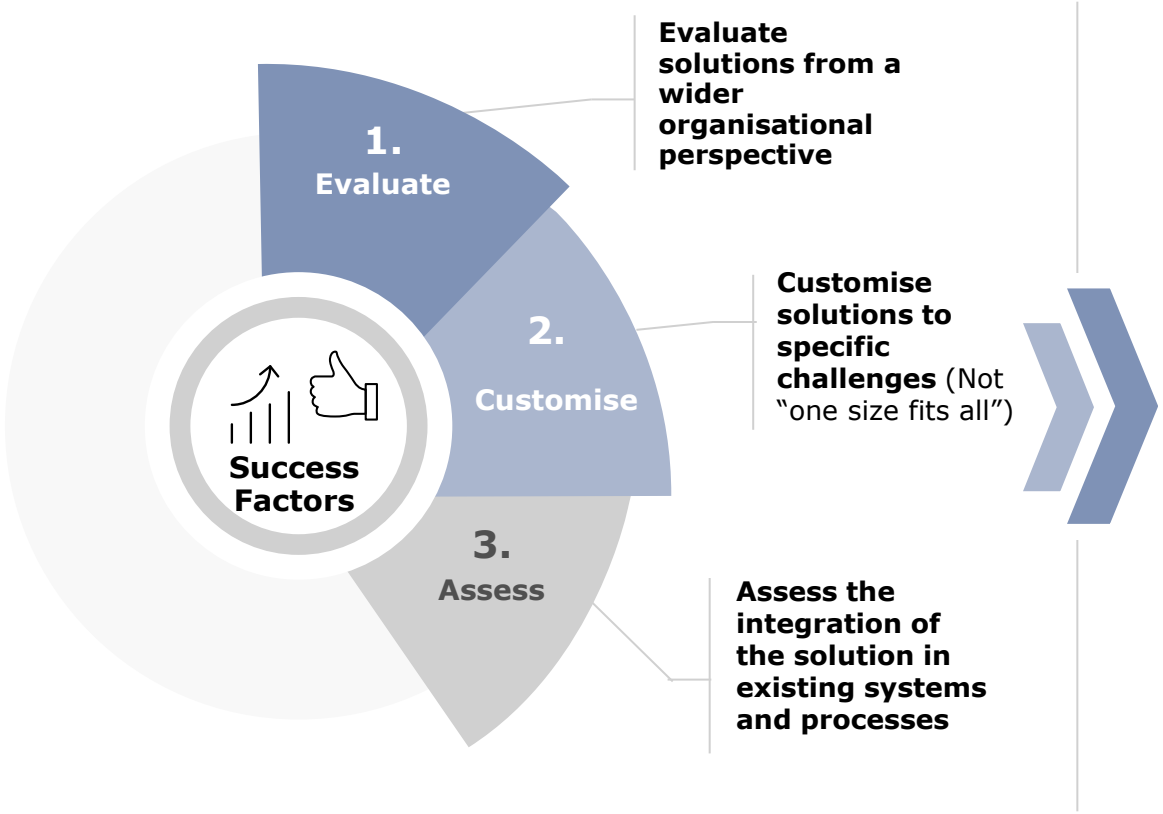
Grid Digitalisation Initiatives



AFRY's Digital Use Case Online Tool

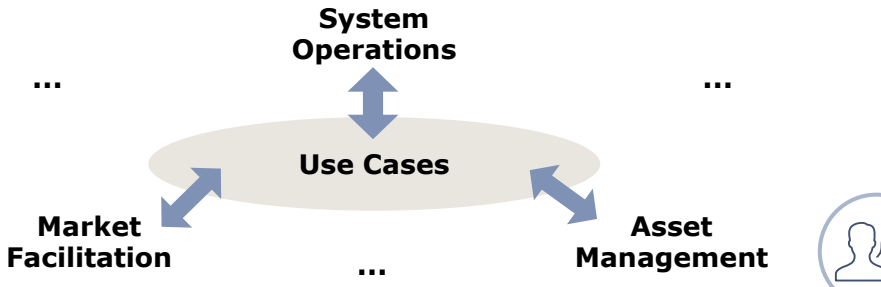
WRAP UP

Grid digitalisation benefits from coordination within the organisation as well as collaborations with other system operators



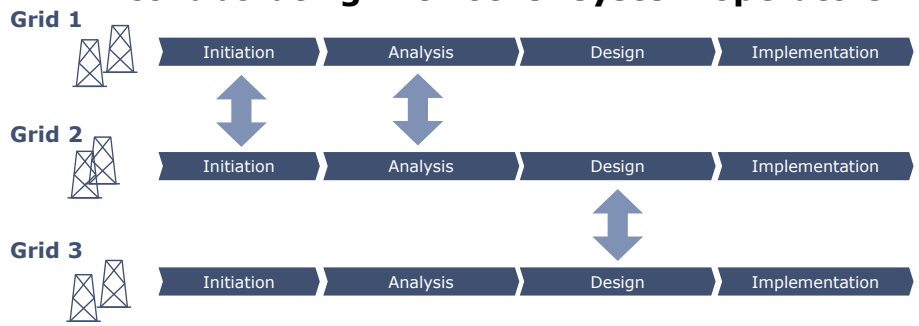
Realising full energy economic value and increasing efficiency of grid digitalisation by....

... coordinating use cases within the organisation



&

... collaborating with other system operators



CONCLUDING REMARKS

Contact us

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- **More webinars** will follow with relevant topics, and any update on the evolving situation.

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