Session 1: The Role of Digitalization in Grid Modernization and Utility Performance Improvement

PART A: Utility Digitalization

Session Content

- What is Digitalization?
- Strategy, Building Blocks and Roadmap for Digitalization
- Key Areas for Digitalization – Operational Technologies (OT) and IT Systems
- Challenges and Facilitators of Digitalization
- Utility Business Case for Digitalization
- Select Utility Examples

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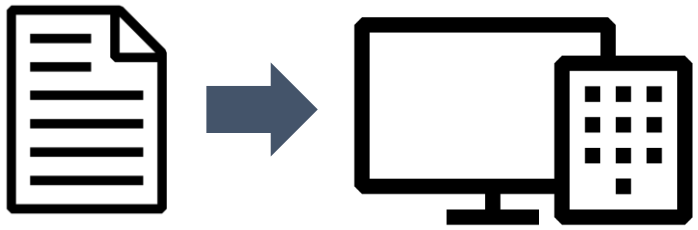
What is Digitalization?

- **Digitization** is the process of collecting information about the electricity grid using sensors, control equipment and IT systems - collecting some information for the first time and converting analogue information into digital data that can be processed by computers for digitalization: **COLLECTING DATA**
- **Digitalization** means using digital technologies to fundamentally change how utilities develop and operate the electricity network to deliver an economic and efficient service for their customers: **USING THE DIGITAL DATA**
- All DATA are presumed to be **Open Data** which can be shared across the organization and its customers/stakeholders unless stated otherwise for privacy, security, commercial or confidentiality reasons

Digital data and digitalized solutions help the utilities understand where a generator or transformer is best placed on the network or how to integrate an EV charger

Digitization v/s Digitalization

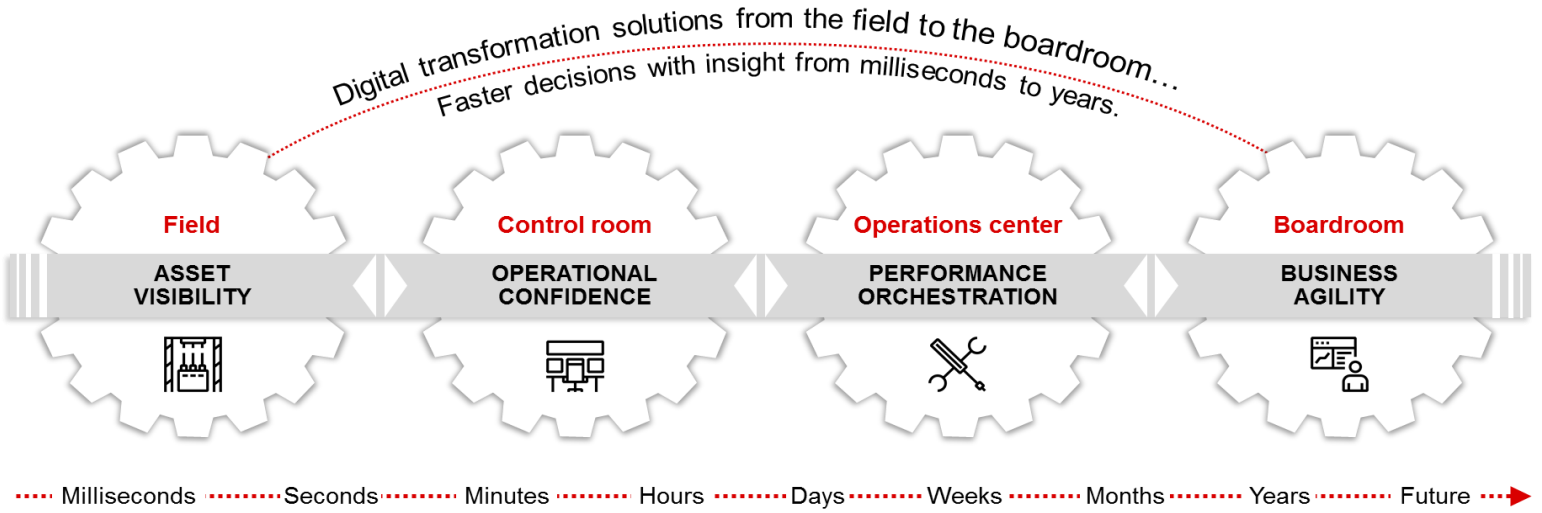
Digitization



Analog Digital

- Converting data from analog documents to a digital format
- Collecting digital data from sensors

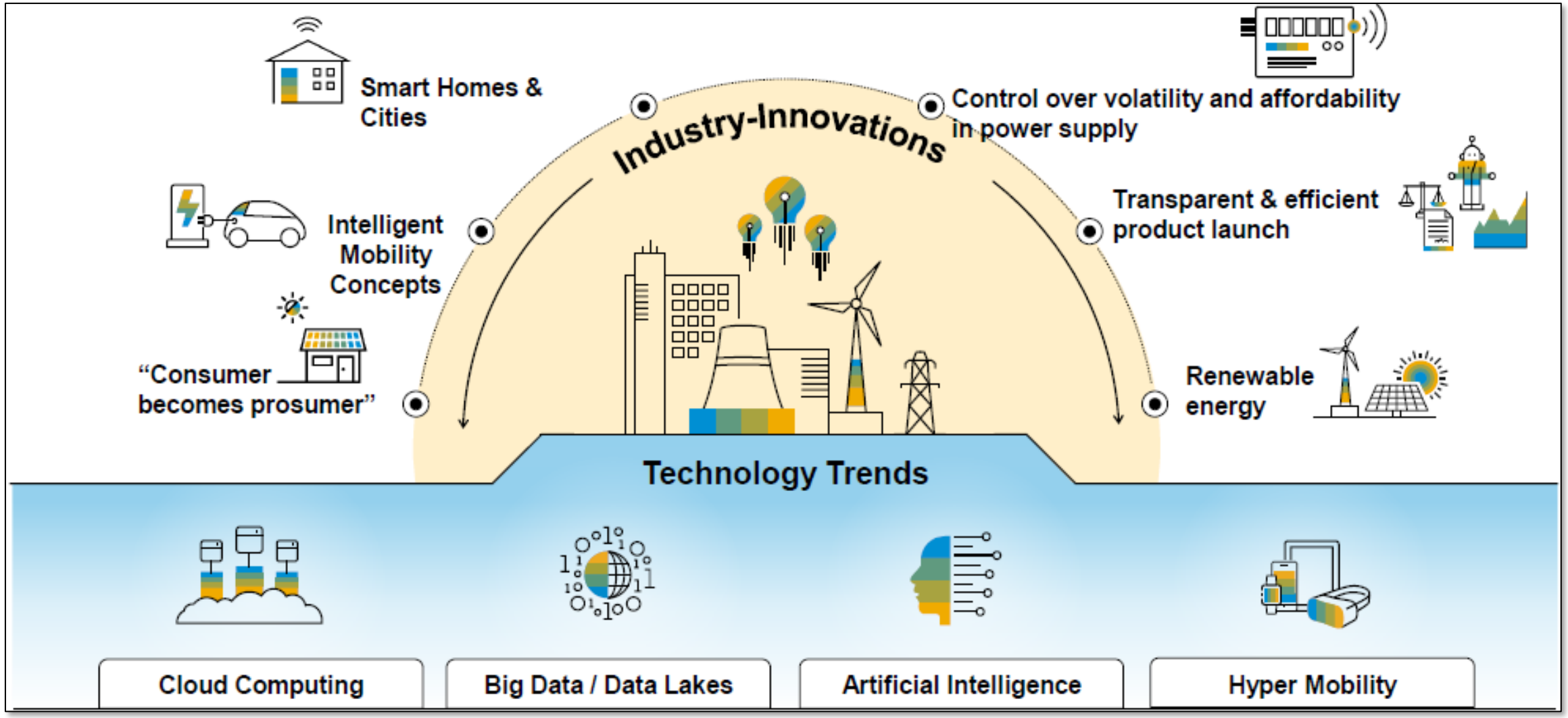
Digitalization



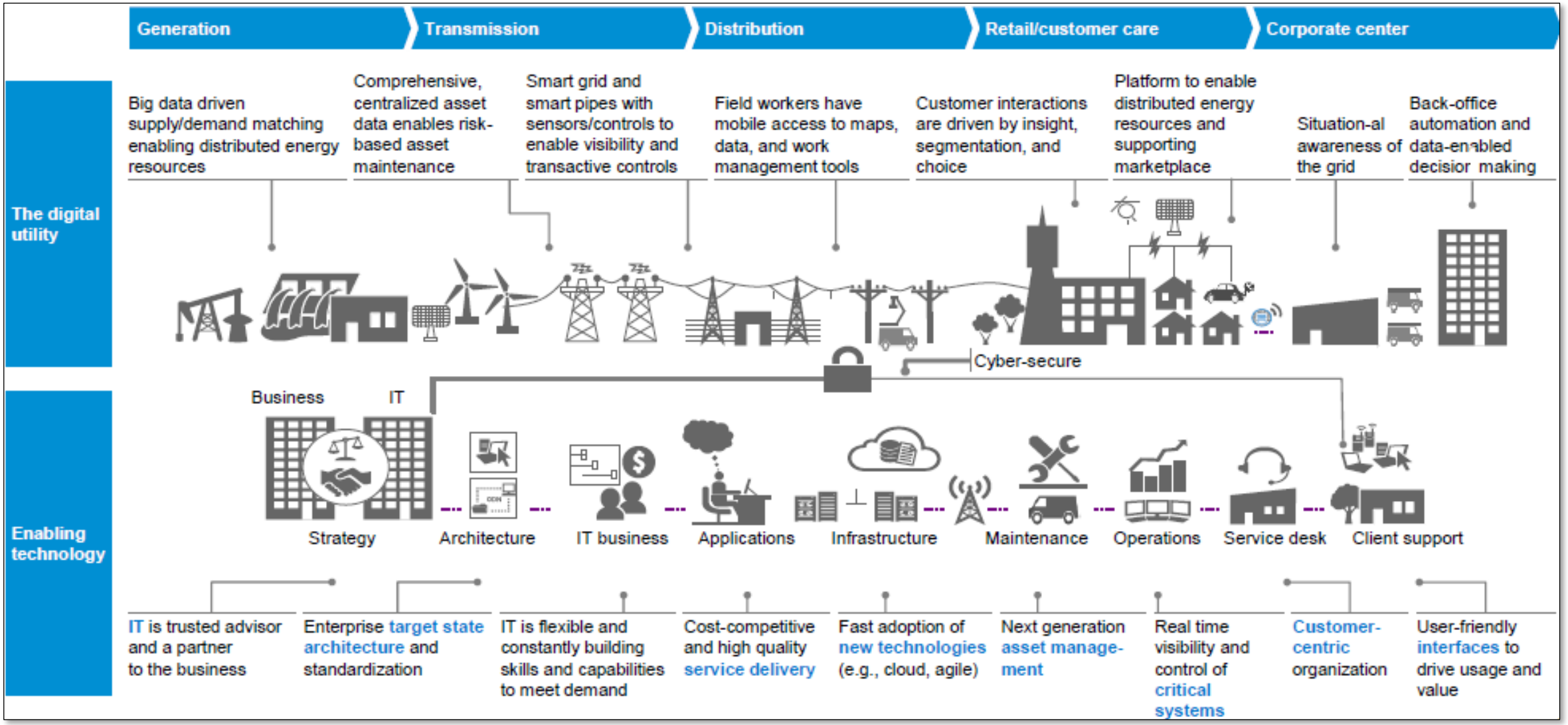
- Creation of new **value** through the digital **transformation** of an end-to-end **business process**
- Enabled by digitization of assets and availability of digital data

Digitalization can fundamentally change how utilities develop and operate the electricity network to deliver economic and efficient services to customers

Technology Trends Supporting Digitalization of Utilities



Digital Utility – Innovations across the Value Chain



Source: SAP

Digitalization - Strategy and Roadmap (1/2)

DIGITALIZATION STRATEGY:

- **SINGLE SOURCE of the TRUTH** for the **DATA** that provide greater detail for ALL stakeholders
- Convert the DATA into useful INFORMATION to benefit customers, deliver insight for network planning and launch new services
- Digitalization Strategy to be aligned with the **Business Strategy, Innovation Strategy, Digital Strategy** and **IT Strategy**
  - Using the Business Strategy as a foundation to develop solutions to meet the changing business and customer needs
  - Leveraging innovation programs to develop next level of data and digitalization solutions
  - Future IT developments are suitably aligned to the needs of future business operations
  - As the volume of data increases, the digital strategy has to be aligned to facilitate the changes
  - Present the information in the right format and timescales

Digitalization - Strategy and Roadmap (2/2)

ROADMAP:

- Data Visibility
- Infrastructure and Asset Visibility
- IT-OT Integration and Operational Optimization
- Open Markets
- Agile Regulations

BUILDING BLOCKS:

- Data Catalogues
- Single Registration Platforms
- Digital Systems Map

Key Areas of Digitalization in Electric Utilities

A. OPERATIONAL TECHNOLOGIES (OT) SYSTEMS

1. SCADA/EMS/DMS (ADMS)
2. Geographical Information System (GIS)
3. Distribution Automation (DA) and Sub-station Automation (SA)
4. Advanced Metering Infrastructure (AMI)
5. Wide Area Monitoring Systems (WAMS)
6. Demand Response (DR)
7. Robotics
8. DERMS and other Digital Tools for DER Management

B. IT SYSTEMS

1. Enterprise IT Systems
2. Billing and Customer Care Systems
3. Customer Portal
4. Enterprise Resource Planning (ERP)
5. Outage Management System (OMS)
6. Mobile Crew Management System
7. Call Centre – Chat Bots and Voice Bots
8. AI/ML/Advanced Analytics
9. Robotic Process Automation (RPA)
10. Blockchain Applications

Challenges of Digitalization (1/2)

- **SKILLED WORKFORCE**
  - **Training and Reskilling** of workforce across the organization on new systems
  - **Retaining Trained Personnel** in respective functions – despite promotions/retirements until next in line are capable of maintaining the systems
  - Adequate **Budget for Training** and capacity building to be provisioned in the project estimate
  - For Commercially available Off the Shelf (COTS) software trained personnel available in the market
- **CUSTOMER ENGAGEMENT**
  - Customers to be trained and engaged in using new systems and programs
- **AWARENESS** – across the organization
  - Understanding the **Benefits of Digital Technologies**
  - Need for a **Smart Grid Roadmap** for Digital Utility Transformation
  - **IT - OT Integration Architecture** and Business Process Realignment
  - Global Practices – what worked well and what did not

Challenges of Digitalization (2/2)

- **POLICY AND REGULATORY SUPPORT**
  - Strong **MANDATE** from Governments and Utility Management to undertake Digitalization in a well planned manner
  - Regulatory support for pilot projects – **Regulatory Sandboxes**
  - **Business Models** for Return on Investments in New Technologies
- **TECHNOLOGY**
  - **COTS** v/s **home grown** or **proprietary systems**
  - **Legacy Systems** – retire or retain ?
  - How to **integrate legacy systems** with proprietary protocols? In most cases APIs may not help end to end integration
  - Integration of **OT-IT** systems
  - **IT Architecture** – Service Oriented Architecture with micro-services and state-of-the-art middleware and data historians
  - **Communication Systems** – ubiquitous and secure communication systems to connect different devices on the grid, customer premises, field offices, regional offices and the corporate office
  - **Own Data Centre** v/s **Cloud Services** v/s **Hybrid Models**
  - **Analytical Tools** - appropriate tools to analyze the humungous data generated from digitization
  - **Cyber Security** – by design

Facilitators of Digitalization

- **IT Systems – to be rationalized and modernized**
  - Replacing and upgrading ad-hoc legacy applications; embracing and investing in new technologies, integration tools and common data platforms. **IT Systems will also need to be further integrated with operational technologies related to power delivery systems**
  - IT systems have traditionally been focused on the core principles of **security, reliability and resilience**; but now must **move to a culture of open data and digitalisation** - make systems more accessible, agile and adaptable to change, whilst continuing to **enhance Cyber Security controls**.
  - **The Cloud Architecture** utilising infrastructure as a service **(IaaS**), platform as a service **(PaaS)** and software as a service (**SaaS**)
- **Telecommunication - modern, robust and secure telecoms systems**
  - As the **numbers of assets and equipment connected to the network increase**, the cost and capability of managing, monitoring and control using **traditional telecoms will become restrictive**
  - The **communication infrastructure for future network need to be scalable for future growth and data demands,** whilst ensuring efficiency, effectiveness in operation, **resilient to power failure and to be at the point of need**
  - **Coordination between digitalisation, innovation and telecoms** to ensure that the solutions **meet the needs of today, tomorrow and beyond!**

Utility's Business Case for Digitalization (1/2)

Digitalization of Utilities facilitates integration of **Distributed Energy Resources (DERs)** and **Electric Vehicles (EVs)** to achieve **Emission Reduction/NDC** targets

Digital Utilities can **Optimize Asset and Operations** with Advanced Analytics supported by AI and ML leading to:

- ***Granular estimation of demand to avoid excess generation capacities/PPAs***
- ***Visibility of power flows in real-time to avoid overloading and excess capacities***
- ***Defer costly system upgrades through efficient management of existing resources***
- ***Engaging customers through digital platforms for innovative programs***

Digital Utilities can balance Demand and Supply in real-time through **Demand Response, TOU Tariffs,** and other innovative programs

Digitalization is key to increase **Power System Flexibility –** Energy Storage Systems (ESS), Smart Microgrids, EV Integration, Virtual Power Plants (VPP) etc require advanced digital solutions – Distributed Energy Management Systems (DERMS)

Utility's Business Case for Digitalization (2/2)

New Market Opportunities Enabled by Digitalization of Utilities

PHYSICAL ASSETS DEPRECIATE…..

1. Power Plants
2. Transmission and Distribution Network Equipment
3. Offices, Buildings, etc.
4. Computer and Communication Hardware

…..DIGITAL ASSETS APPRECIATE

1. Customer Data
2. Billing and Collection System
3. Smart Meter Data and Energy Consumption Profile
4. GIS Map indexing Electrical Network and Customers – cover all buildings and roads
5. Automation Systems - SCADA/DMS, DA and SA, DR, DERMS…
6. Outage Management System and Mobile Workforce Management System
7. Call Centers and Call Data Archives

Selected Utilities Examples

Data and Data Users in the Utility Ecosystem

Figure 5: Data personas mapped to most relevant data types

Key
Little relevance | Some relevance | Most relevant

Customer Personas	Personal Data	Customer Data	Operational Data	Static Asset Data	Dynamic Asset Data	Fault Data
Disengaged Energy Consumer (Domestic or Commercial)	●	●	●	●	●	●
Energy Conscious Domestic	●	●	●	●	●	●
Academic and Research Establishments	●	●	●	●	●	●
Connected DER (Generation or Demand)	●	●	●	●	●	●
Potential connection (Generation or Demand) customers, Developers and LCT	●	●	●	●	●	●
Electricity Suppliers	●	●	●	●	●	●
OFGEM	●	●	●	●	●	●
Local Authorities and Community Energy Groups (incl. Aggregators)	●	●	●	●	●	●
Supply Chain	●	●	●	●	●	●
Alternative commercial services providers, e.g. IDNOs and ICPs	●	●	●	●	●	●
Other Electricity and Gas Networks	●	●	●	●	●	●
Non-Energy Networks (incl. water and telecoms) and Infrastructure Owners	●	●	●	●	●	●

Source: UK Power Networks Digitalization Strategy and Action Plan 2021

Digitalization Roadmap of Western Power Company, UK (2020)

Where we are and where we're going

As is
End ED-1
End ED-2

	Ad hoc	Foundational	Competitive	Differentiating	Breakaway
Digitalisation of the Energy System	No strategy of digitalisation, conflicting views within the organisation.	Basic high level data and digitalisation strategy outlined, often reactive to new data demands.	Strategy is continuously refined listening to the needs of multiple stakeholders, with defined use cases and output.	Strategy is driving continuous change with the use of data, exceeding the requirements of the regulator and others.	Whole organisation believes in the strategy, trailblazing change internally as well as externally.
Maximising the Value of Data	Limited use of data in the organisation, low visibility of data in the silos. Re-active data decisions.	Data is visible and understood in silos, with minimal cross silo interactions. Data is used to manage the business.	Data is driving operational improvements across multiple parts of the organisation.	Data is fully understood and feeds investment decisions. Common value standards are used across all parts of the organisation.	Extensive use of internal and external data, driving conscious value decisions across the whole organisation. Data is being used to drive new revenue streams that are not currently understood.
Visibility of Data	No visualisation of information, organisation struggles to identify datasets.	Limited understanding of data, basic metadata and data stored in silos.	Organisation has a view of large parts of its data, and the establishment of data governance and best practices. Organisation has a detailed understanding of the next steps needed.	Organisation has a common internal data catalogue with governance in place, has metadata standards and information management best practices.	Data is in a common data catalogue that allows for open data, enabling comparison of capabilities and performance with similar organisations. he organisation actively supports demand-based prioritisation for open data.
Coordination of Asset Registration	No Co-ordination of different assets within the organisation, no clear asset strategy.	Assets are registered in silos without coordination across some silos.	Assets are registered to a common register across the organisation, use of external asset data also takes place.	Assets are driving new value stream within the organisation, use of internal and external asset data.	Internal and external asset data is known and shared, driving value across different organisations. Coordinated asset strategy across the ecosystem.
Visibility of Infrastructure and Assets	No digital map of the organisation, some functions have basic digital mapping of assets.	Some mapping available for internal decision making and presented externally. Some minor investment decisions driven from this detail.	Digital system maps are used across the whole organisation and inform internal investment decisions.	Digital system mappings in coordination with similar organisations is used to create new markets and common investment decisions.	Sector leader in digital system mapping, driving sector benefits. Common sector visibility of infrastructure and assets.

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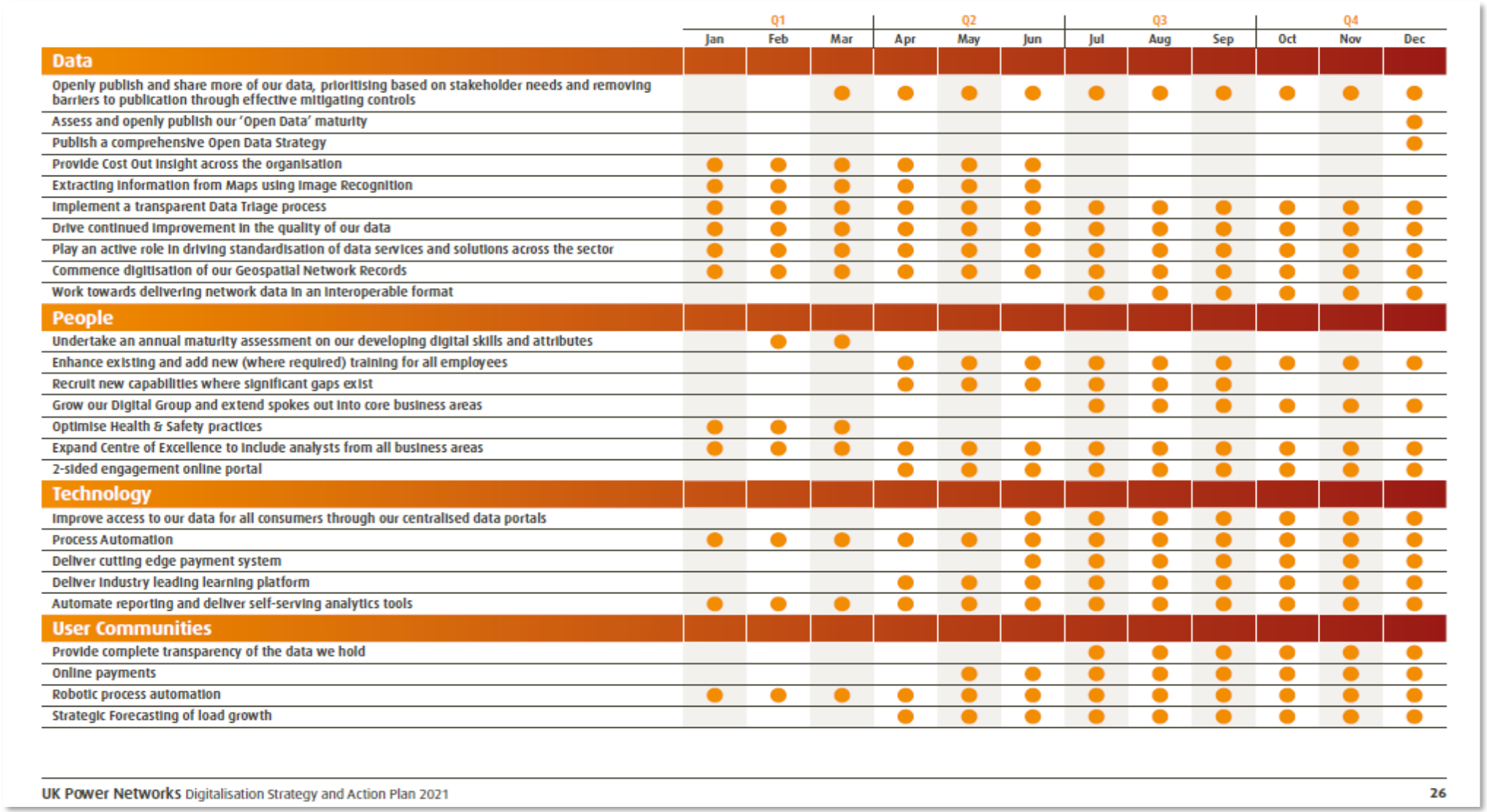
Digitalisation Strategy

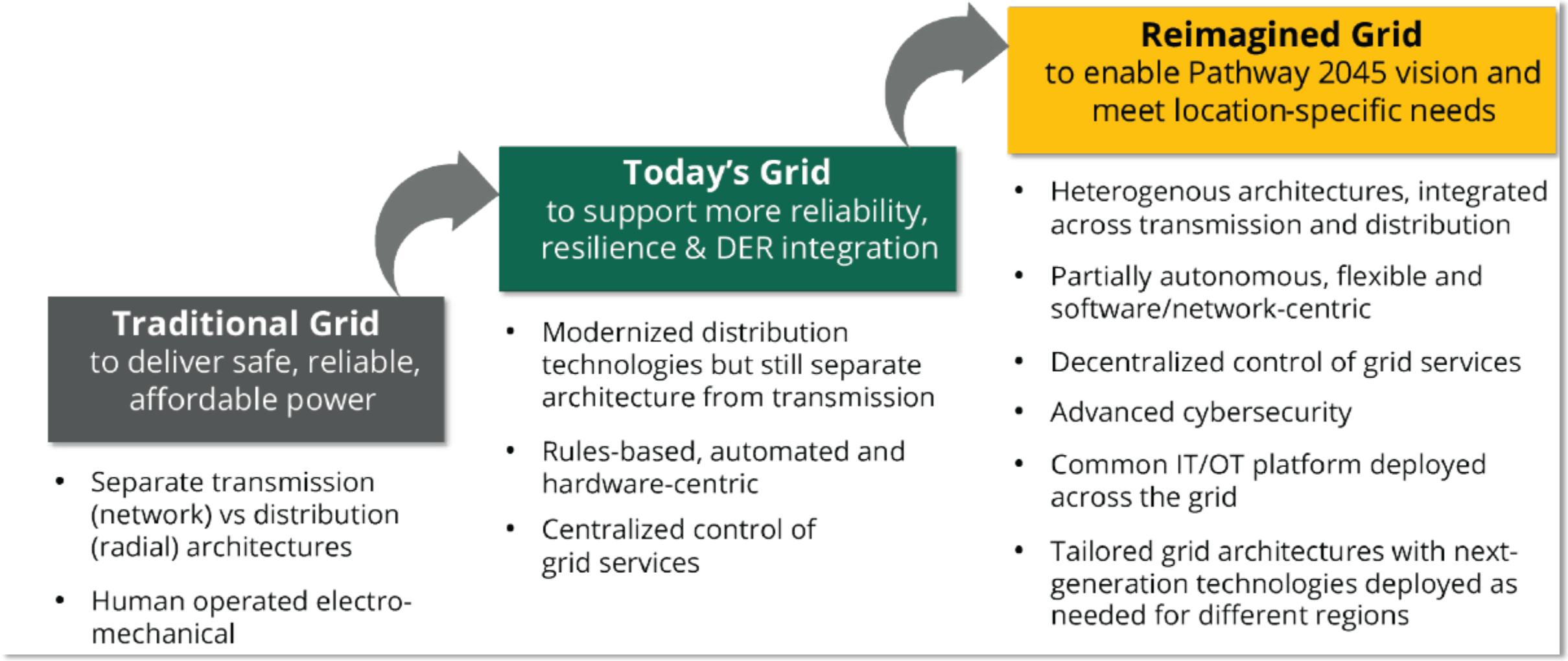
Digitalization Strategy and Action Plan of UK Power Networks



	Q1			Q2			Q3			Q4		
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Data												
Openly publish and share more of our data, prioritising based on stakeholder needs and removing barriers to publication through effective mitigating controls			●	●	●	●	●	●	●	●	●	●
Assess and openly publish our 'Open Data' maturity												●
Publish a comprehensive Open Data Strategy												●
Provide Cost Out Insight across the organisation	●	●	●	●	●	●						
Extracting information from Maps using Image Recognition	●	●	●	●	●	●						
Implement a transparent Data Triage process	●	●	●	●	●	●	●	●	●	●	●	●
Drive continued improvement in the quality of our data	●	●	●	●	●	●	●	●	●	●	●	●
Play an active role in driving standardisation of data services and solutions across the sector	●	●	●	●	●	●	●	●	●	●	●	●
Commence digitisation of our Geospatial Network Records	●	●	●	●	●	●	●	●	●	●	●	●
Work towards delivering network data in an interoperable format							●	●	●	●	●	●
People												
Undertake an annual maturity assessment on our developing digital skills and attributes		●	●									
Enhance existing and add new (where required) training for all employees				●	●	●	●	●	●	●	●	●
Recruit new capabilities where significant gaps exist				●	●	●	●	●	●			
Grow our Digital Group and extend spokes out into core business areas							●	●	●	●	●	●
Optimise Health & Safety practices	●	●	●									
Expand Centre of Excellence to include analysts from all business areas	●	●	●	●	●	●	●	●	●	●	●	●
2-sided engagement online portal				●	●	●	●	●	●	●	●	●
Technology												
Improve access to our data for all consumers through our centralised data portals						●	●	●	●	●	●	●
Process Automation	●	●	●	●	●	●	●	●	●	●	●	●
Deliver cutting edge payment system						●	●	●	●	●	●	●
Deliver industry leading learning platform				●	●	●	●	●	●	●	●	●
Automate reporting and deliver self-serving analytics tools	●	●	●	●	●	●	●	●	●	●	●	●
User Communities												
Provide complete transparency of the data we hold							●	●	●	●	●	●
Online payments					●	●	●	●	●	●	●	●
Robotic process automation	●	●	●	●	●	●	●	●	●	●	●	●
Strategic Forecasting of load growth				●	●	●	●	●	●	●	●	●

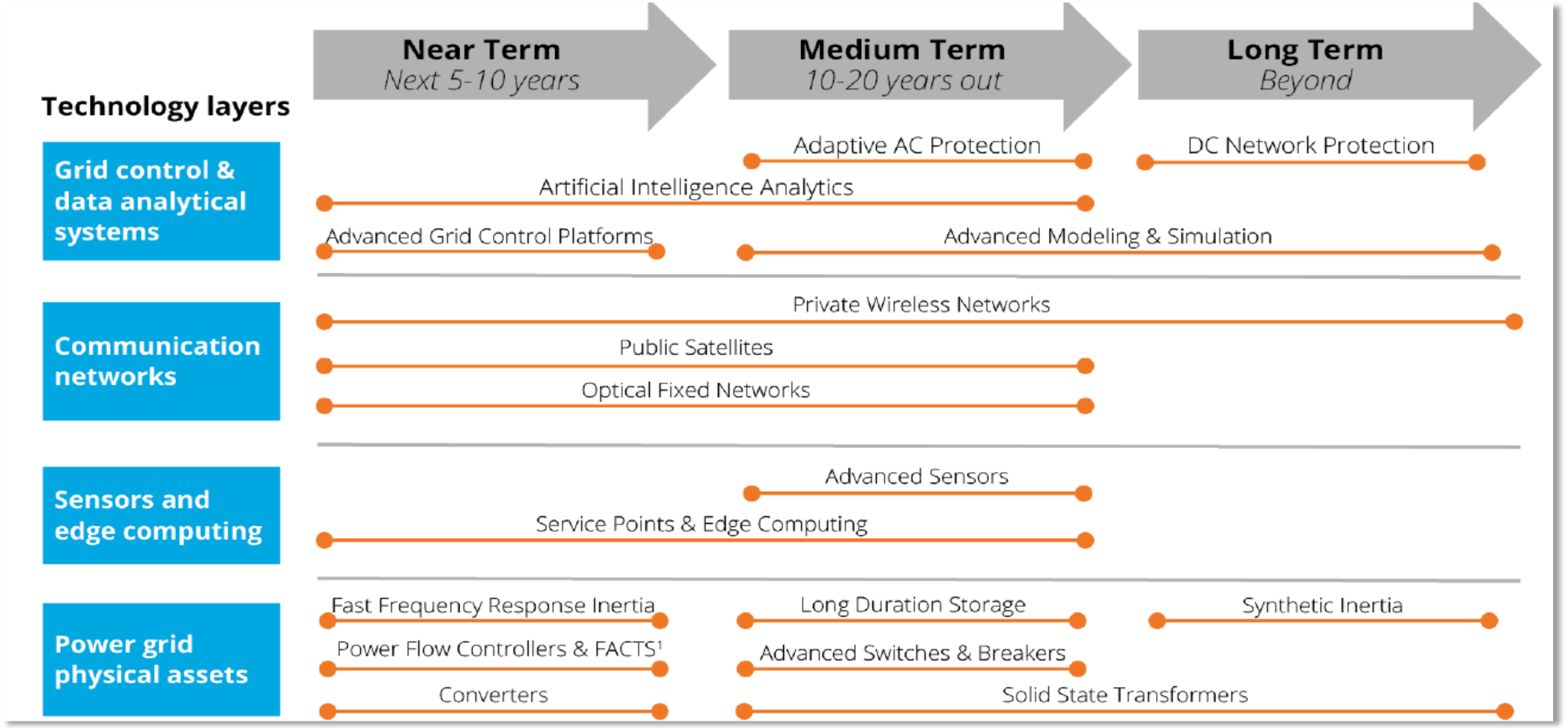
Southern California Edison (SCE)'s Reimagined Grid 2045 (1/6)

Evolutionary Steps Toward the Reimagined Grid



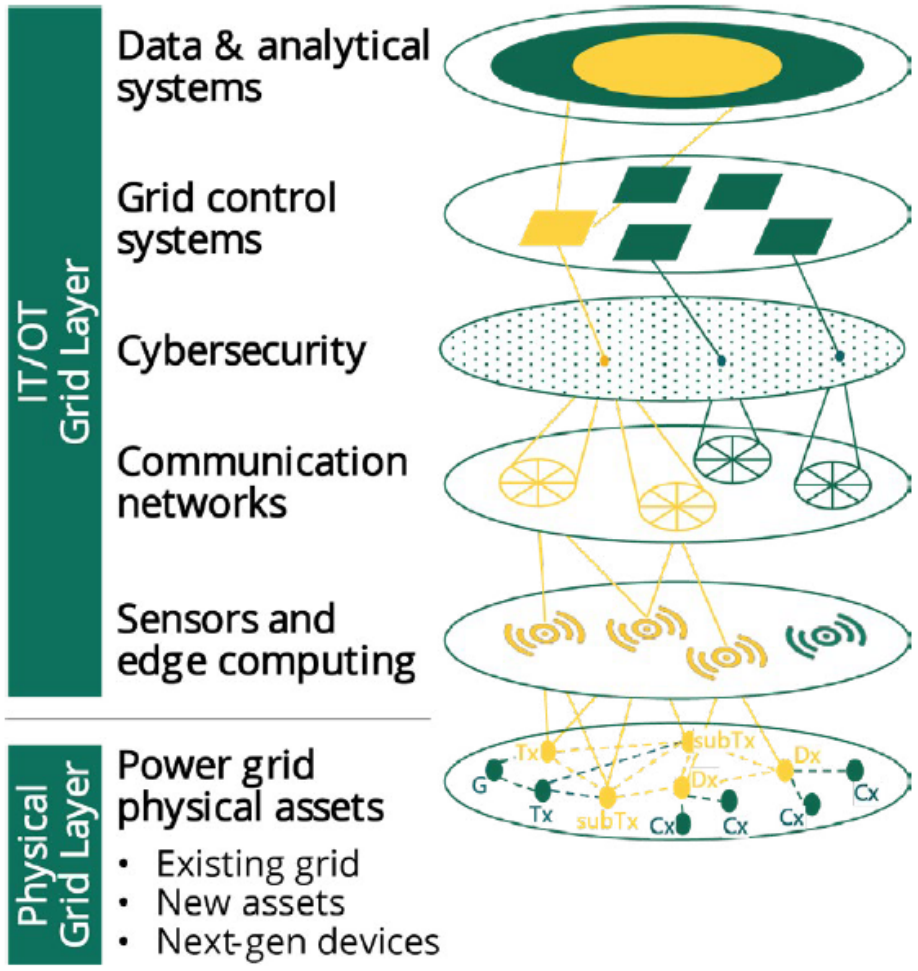
Southern California Edison (SCE)'s Reimagined Grid 2045 (2/6)

Estimated Commercialization Timeframes for Critical Grid Technologies



Southern California Edison (SCE)'s Reimagined Grid 2045 (3/6)

Grid Technology Layers



SCE will examine the different technology layers (see Figure 4) that the reimagined grid will need to address these challenges, grouping them into two categories:

1. A common digital platform of information and operational technologies (IT/OT) that includes communications, sensing, analytics, control and advanced cybersecurity
2. Physical assets and devices that enable use-specific solutions, built on top of the IT/OT platform and the existing grid infrastructure

SEC will then define a broad set of grid capabilities that leverage these technology layers, consisting of a cluster of *foundational* capabilities working together to enable systemwide integration and operation of grid technologies and a set of *situational* capabilities that will address location-specific challenges and planning.

Southern California Edison (SCE)'s Reimagined Grid 2045 (4/6)

Overview of Foundational Capabilities

	Capabilities	Description
Ⓣ Ⓓ	**Ultra low-latency communications**	Communications between grid and customer devices that are real time (milliseconds), high peak throughput (1+ GBps), high density (2M+ devices), high coverage and cybersecure
Ⓣ Ⓓ	**Ubiquitous situational awareness**	Integrated, high-fidelity measurement and monitoring of grid state and assets (from generation to customer levels) with high spatial and temporal resolution
Ⓣ Ⓓ	**End-to-end advanced simulations and analytics**	Prediction and optimization of grid systems and assets, leveraging virtual representation of the grid and its components with standardized data protocols
Ⓓ	**Localized & edge control**	Hierarchical and distributed grid control, complementing centralized optimization of resources with delegation of local control decisions to edge devices through policy-based settings
Ⓓ	**Adaptive protection**	Protection settings updated remotely to adapt to bidirectional power flow requirements and potential changes in grid topology to preserve safety of operations

Ⓣ Transmission and Subtransmission Ⓓ Distribution

Southern California Edison (SCE)'s Reimagined Grid 2045 (5/6)

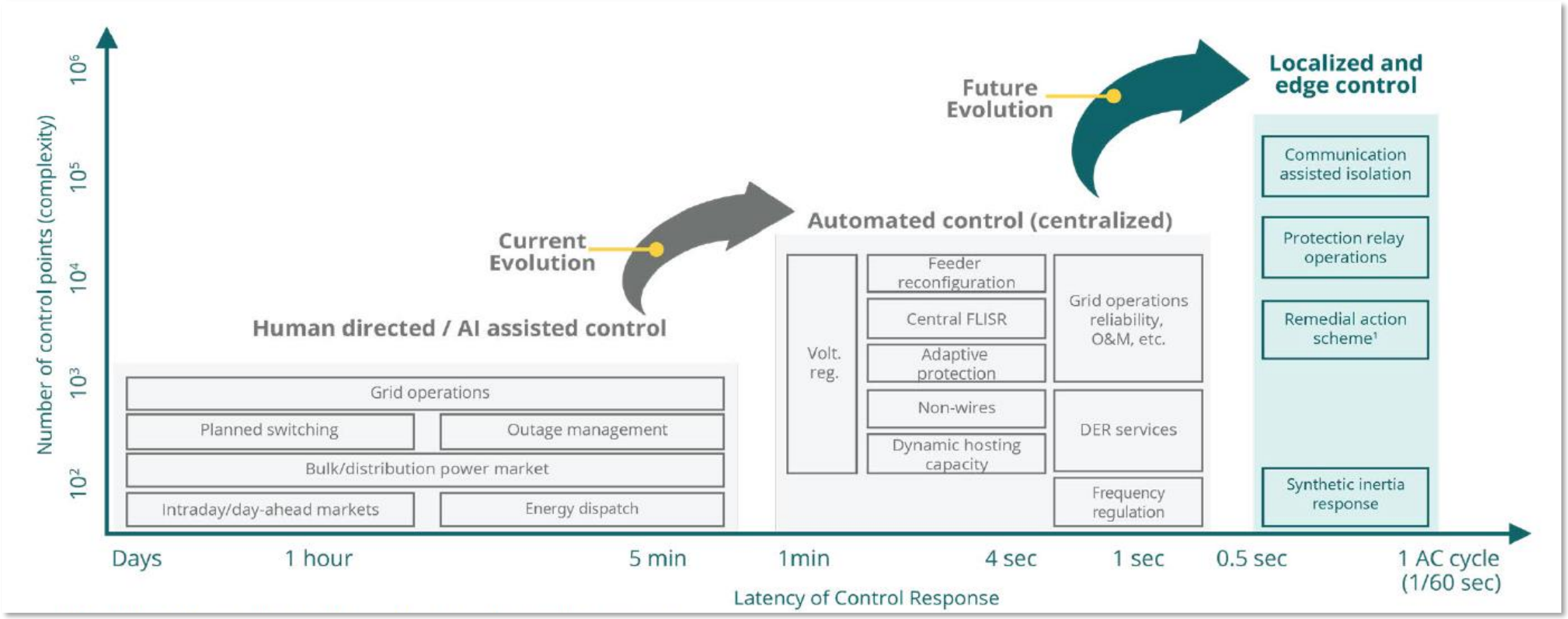
Overview of Sustainable Capabilities

	Capabilities	Description
T D	**High capacity throughput (& protection)**	Augmented power supply and delivery capacity to serve new demand from transportation electrification or other load while ensuring power system stability and safety
T D	**Islanding & reconfigurability**	Control and operation of interconnected loads and DERs independently from bulk power system, dynamically adapting electrical boundaries (e.g., microgrids) to optimize economic performance and reliability
T D	**Energy buffering**	Alternate energy sources, located as close to the load as possible to compensate variable/ intermittent power output of renewables
T D	**Inertia substitution**	Novel sources of inertia and other grid reliability services to ensure power system frequency response and stability, given rising level of renewable resources connected to the grid
D	**Seamless grid flexibility**	Seamless adjustment of the grid to rapid changes in load and supply to ensure grid balancing (supply/demand), and economic and reliable performance
D	**Customer load flexibility**	Controls/signals to interact with customer devices and harness the full potential of customer load flexibility
D	**Bidirectional power flow control**	Management of power flow direction between DERs and the grid

T Transmission and Subtransmission D Distribution

Southern California Edison (SCE)'s Reimagined Grid 2045 (6/6)

Evolution of Grid Control Requirements



Smart Grid Roadmap for PT.PLN, Indonesia (1/3)

	2021-2025	2026 →
Purposes	**Reliability, efficiency, customer experience and grid productivity**	**Resiliency, customer engagement, sustainability and self healing**
Main Initiatives	**Power plant Digitalization** for improving efficiency **Sub-Station Automation and Digitalization** selectively for improving power quality **Distribution Grid Management** for improving reliability and faster respond **EV Charging Station and *e-mobility*** for EV ecosystem development **Smart Micro Grid** for increasing RE penetration and decreasing LCOE at some isolated areas **AMI implementation** by clustering approach	**Upgrading SCADA to *Wide Area Monitoring, Protection and Controlling System (WAMPAC)*** for improving the system resiliency **Interconnecting Distributed Energy Resources** to the grid **Integrating Energy Storage** for VRE penetration and system stability **Implementing Dynamic Line Rating** for improving the system resiliency and self healing capability **Demand response** for customer engagement to increase the system efficiency

Source: PLN (2020)

Smart Grid Roadmap for PT PLN, Indonesia (2/3)

Initiative 1: Power Plant Digitalization

Program	Sub-Program	2021	2022	2023	2024	2025
Roll out Advanced Analytics	Plant Heat Balance Monitoring dashboard	16	16	10	10	10
	Performance Index & Forecast dashboard	16	16	13	13	13
	Combustion Optimization Monitoring dashboard	9	9	7	7	7
	Plant Heat Balance & Combustion Optimization	10	10	7	7	7
Digital Control Room	-	18	17	1	1	1
Digitized O&M Procedure	-	18	17	7	7	7
Productivity through IoT/Automation	-	13	12	7	7	7
Predictive / Proactive Maintenance	-	13	10	7	7	7

Smart Grid Roadmap for PT PLN, Indonesia (3/3)

Initiative 2: Grid Distribution Management

Program	Indicator	2021	2022	2023	2024	2025
Distribution Automation for Zero Down Time Program	Unit PLN	5	15	20	25	25
Real-Time Losses Monitoring	Power plant	23	120	120	120	120
	Sub-Station	41	511	512	512	512
	Feeder	320	1885	1885	1885	1885
	Distribution Transformer	15.225	142.150	142.150	142.150	142.150
Fault Detection and Automation	Unit PLN		10	27	39	50

Thank You

Any questions?

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