



Enabling Future Smart Grid Capability

JRC Annual Seminar - 2018

London, 4th of October 2018

AGENDA

1. EDP in brief

2. Energy System Challenges

3. Connect Program – Empowering transformation

4. 5G Converged opportunity

5. Final Remarks

EDP Group has grown from a local integrated incumbent utility to a global energy player with business operations in 14 countries

Wind & Solar Power

39% of EBITDA
(17% North America; 9% Spain; 6% Portugal; 2% Brazil; 6% Other)
Listed subsidiary: EDP Renováveis (EDP has 82,6%)
IPO in Jun-08
Wind & Solar Power: 10.7GW
A worldwide renewable market leader



CANADÁ
E.U.A.



PORTUGAL

REINO
UNIDO



POLÓNIA
ROMÉNIA

FRANÇA
BÉLGICA
ITÁLIA



CHINA



ESPAÑA



ANGOLA



Portugal

32% of EBITDA
Privatization in 1997 (IPO)
Single electricity distributor
Power generation: 10,1GW (ex-wind)
(from which 6,7GW is hydro)

MÉXICO



EDP Brasil

17% of EBITDA
Listed subsidiary: EDP Brasil (EDP has 51%)
Presence since 1996
Power generation: 2.5 GW (hydro and coal)
2 electricity distribution concessions
5 transmission lines (under construction)

BRASIL



Spain

12% of EBITDA
Presence since 2001
Power generation 3.4 GW (ex-wind)

MEMBER OF
**Dow Jones
Sustainability Indices**
In Collaboration with RobecoSAM

2017 **WORLD'S MOST
ETHICAL
COMPANIES**
WWW.ETHICSPHERE.COM

**2017 Global
Top 100 Green
Utilities** report

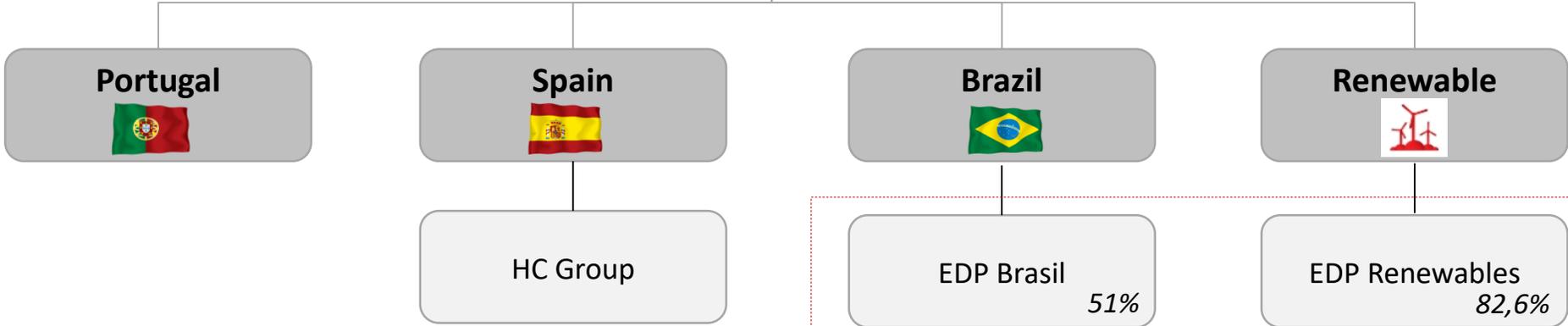
Note: Data as of Dec-17

Business portfolio covers several activities in the energy value chain, in different geographies

- Generation
- Electricity distribution
- Retail
- Renewables

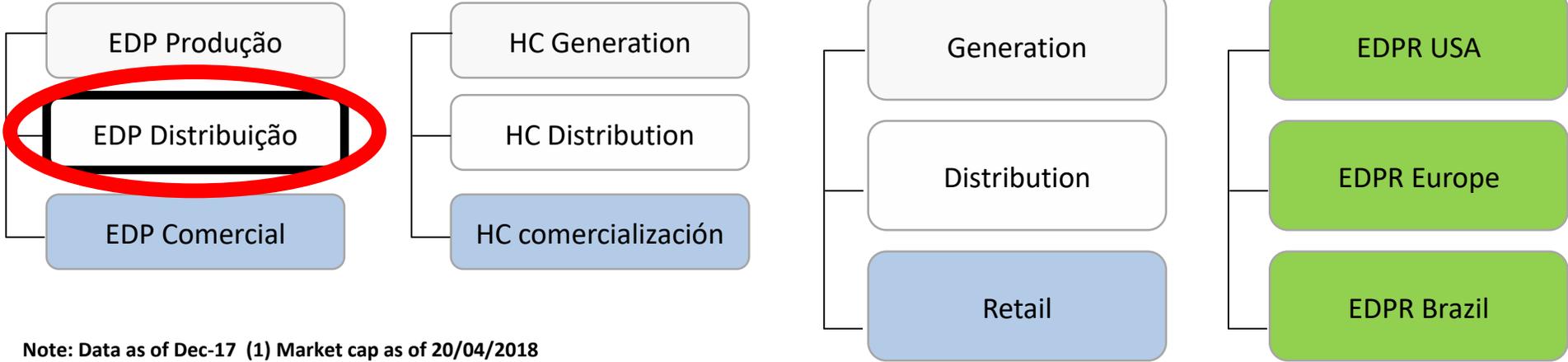


Employees: 11 657
Market cap: €10.6BN¹



Business operations

Listed companies



Note: Data as of Dec-17 (1) Market cap as of 20/04/2018

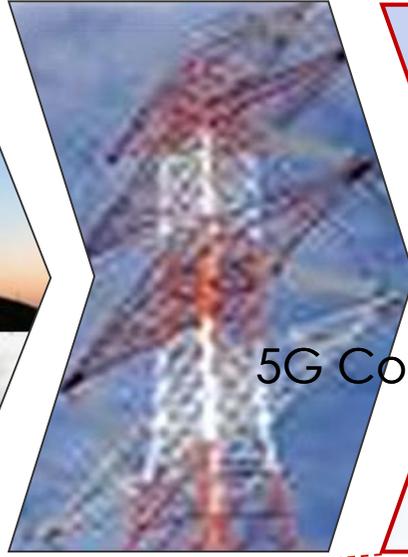


EDP Distribuição operates 278 Low Voltage concessions and one High/Medium voltage concession in Portugal mainland

Generation



Transmission



Distribution



Retail



Low Voltage Concessions

- Granted by the 278 Municipalities for a period of 20 years (next concessions are subject to public tender)
- Payment of concession fees to the municipalities

High/Medium Voltage Concession

- Granted by the government until 2043
- No concession fee payment

AGENDA

1. EDP in brief

2. Energy System Challenges

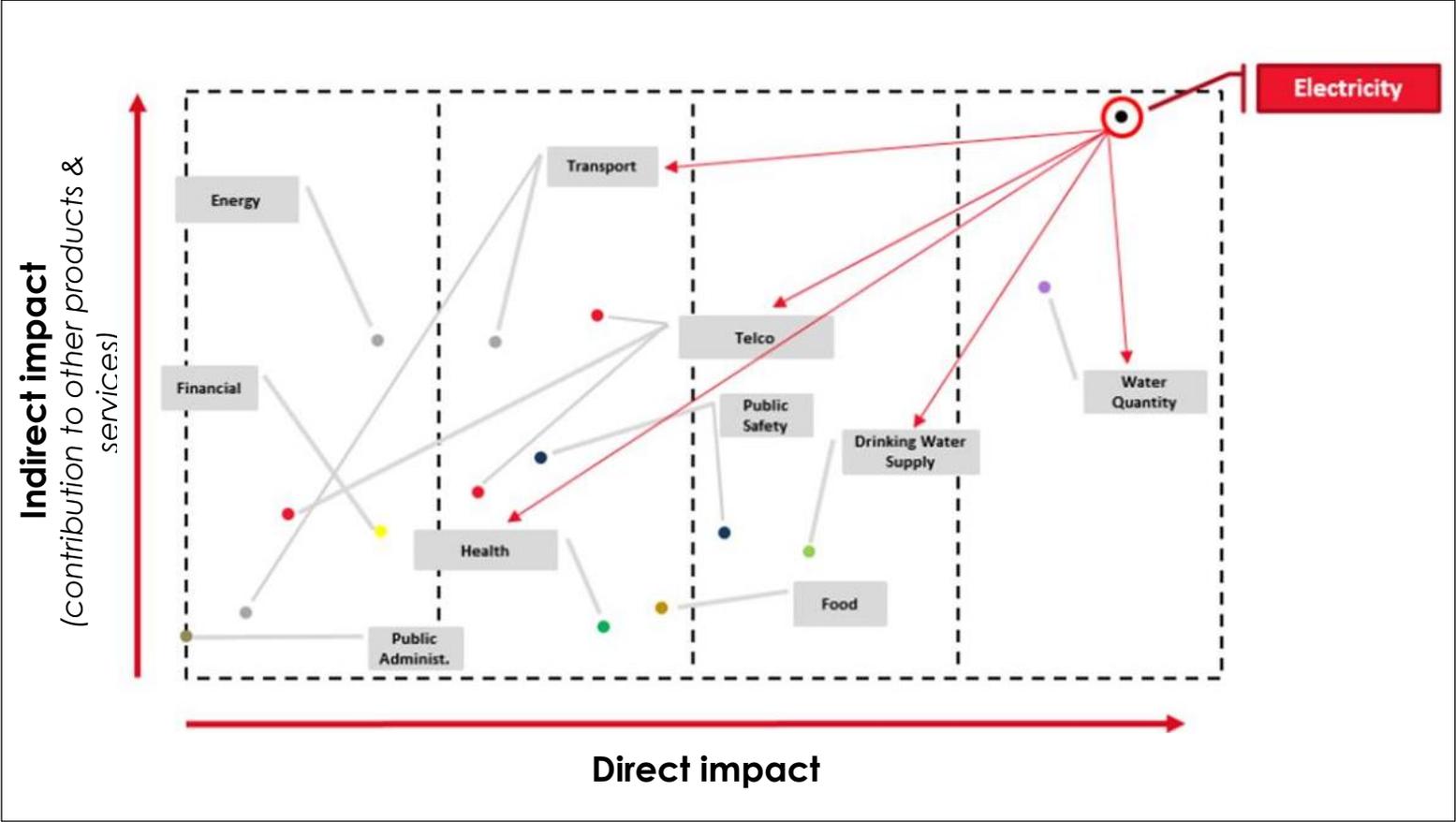
3. Connect Program – Empowering transformation

4. 5G Converged opportunity

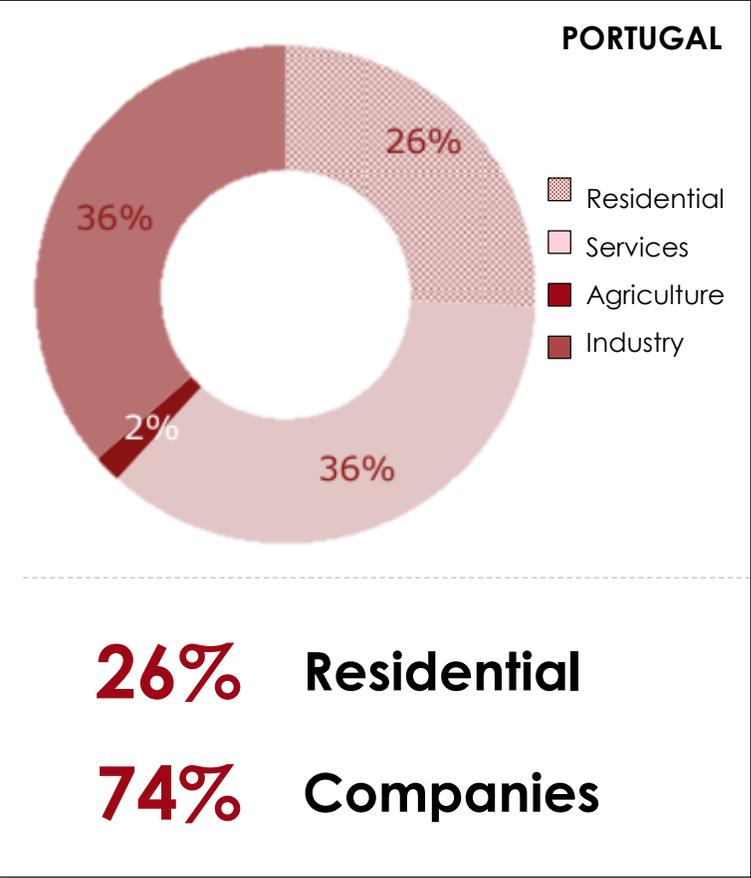
5. Final Remarks

Within the Energy domain, Electricity is a key pillar for society and economic growth

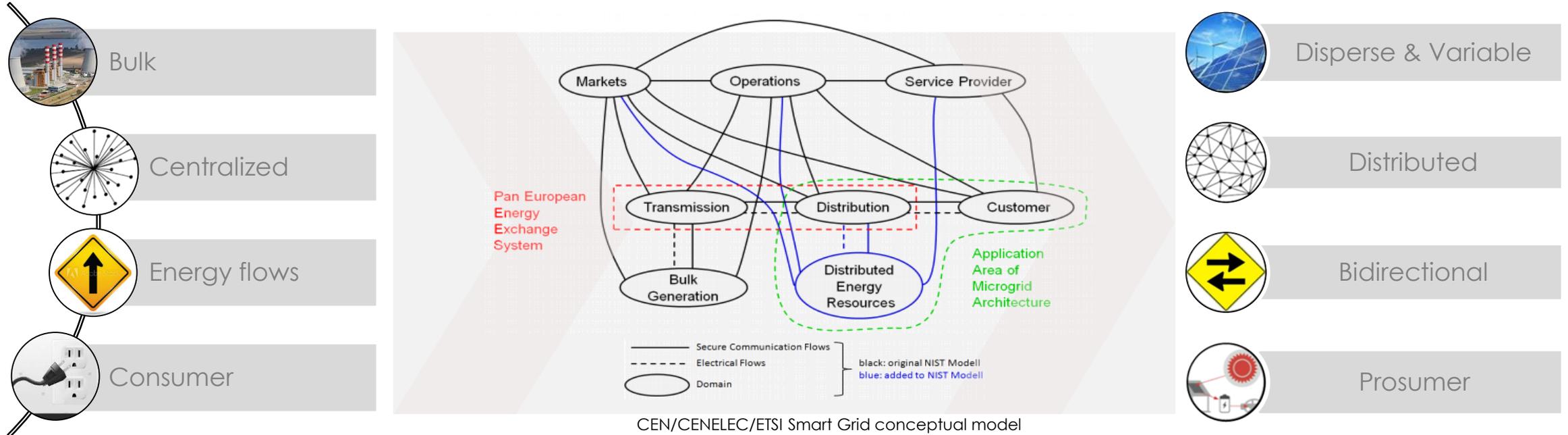
Interdependency & potential impact of different critical societal/ economic infrastructures ...



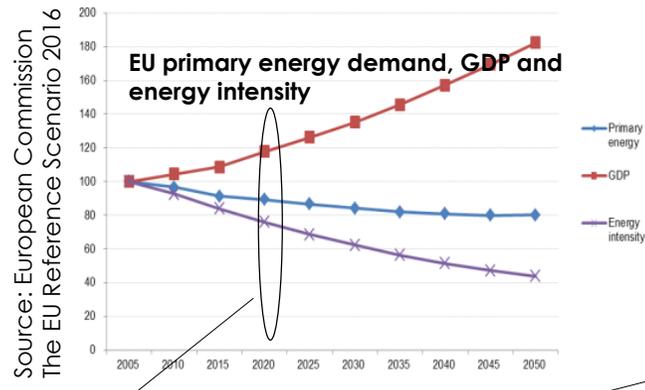
... is intensified by energy needs of medium to large companies



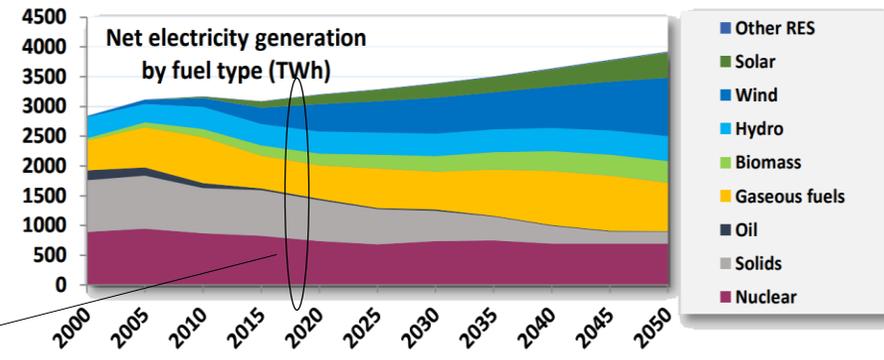
The path to a secure, affordable, competitive and sustainable energy is being supported by a profound System transformation



CEN/CENELEC/ETSI Smart Grid conceptual model



Source: European Commission The EU Reference Scenario 2016



Continuous efficiency gains and innovative market models strongly depend on digitalization and Servitization



Digitalization untaps fundamental capabilities, such as small scale and variable renewables, flexibility and smart demand response

“The Energy Internet”

Connectivity and electrification are required to transform the way electricity is supplied and consumed

Aggregators etc

Real time Flexibility Management

Virtual power plants

Business Models

Digital Enablers

IoT / 5G / NFV / SDN

Risk and resilience frameworks

Cloud Computing / Edge Computing

Big Data / AI / Analytics

Cyber & Physical security / Trust technologies

Example I

1/3 Global Energy Consumption

Real-time data control can capture 10% of efficiency

Billions of participating connected appliances by 2040

Buildings Efficiency (>>> Millions)

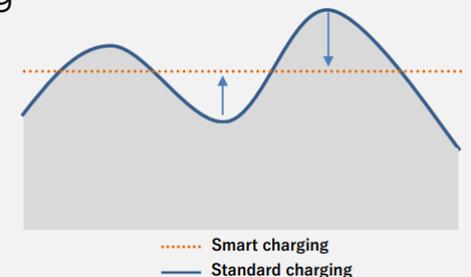
- PV / Storage
- Demand response
- Smart Thermostats
- Occupancy sensors
- Remote adaptive control
- Flexibility management
- Smart appliances

Example II

Estimates point to a reduction of 40% of peak demand from EV can be achieved by smart charging

Electric vehicle (EV) Smart Charging (>> Millions)

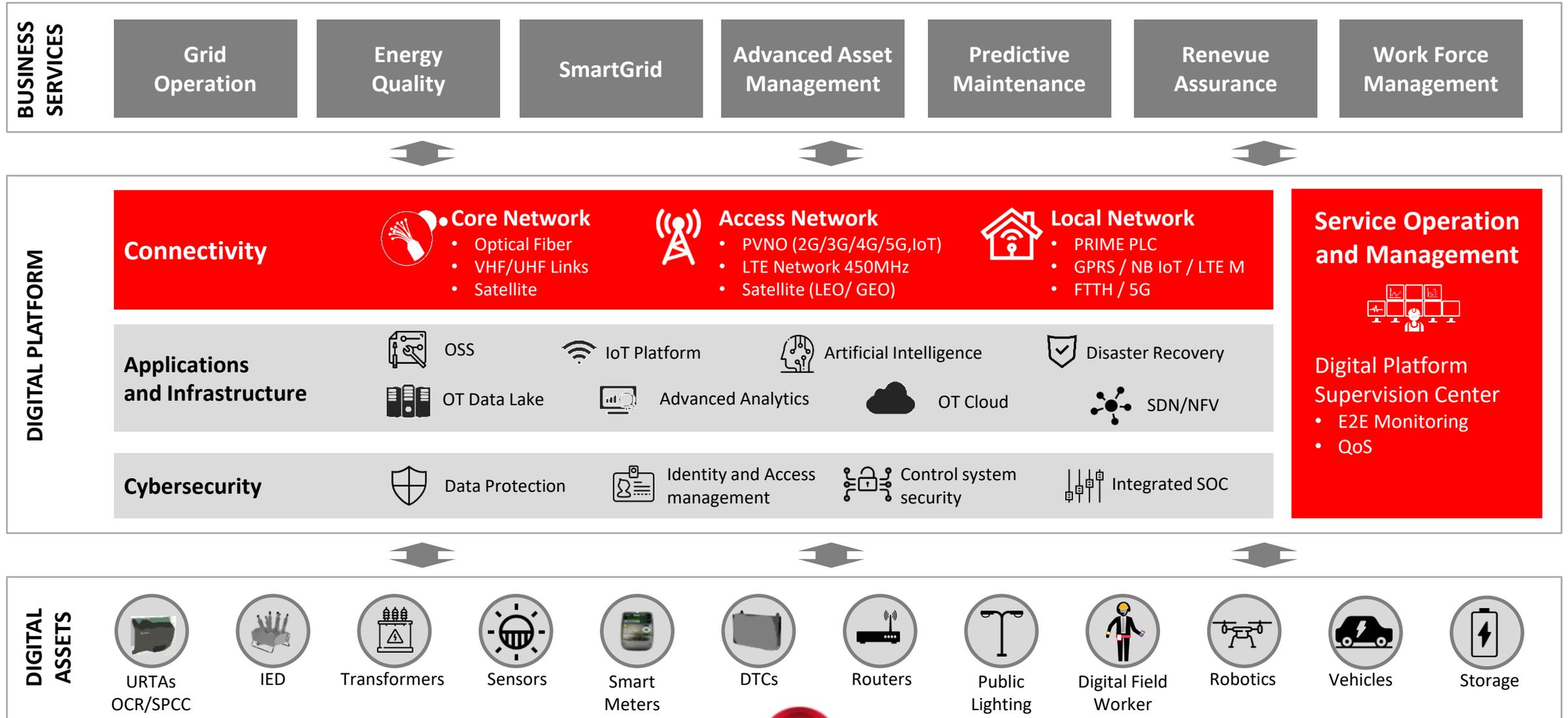
- Smart Charging
- EV2G
- EV2Home



AGENDA

1. EDP in brief
2. Energy System Challenges
- 3. Connect Program – Empowering transformation**
4. 5G Converged opportunity
5. Final Remarks

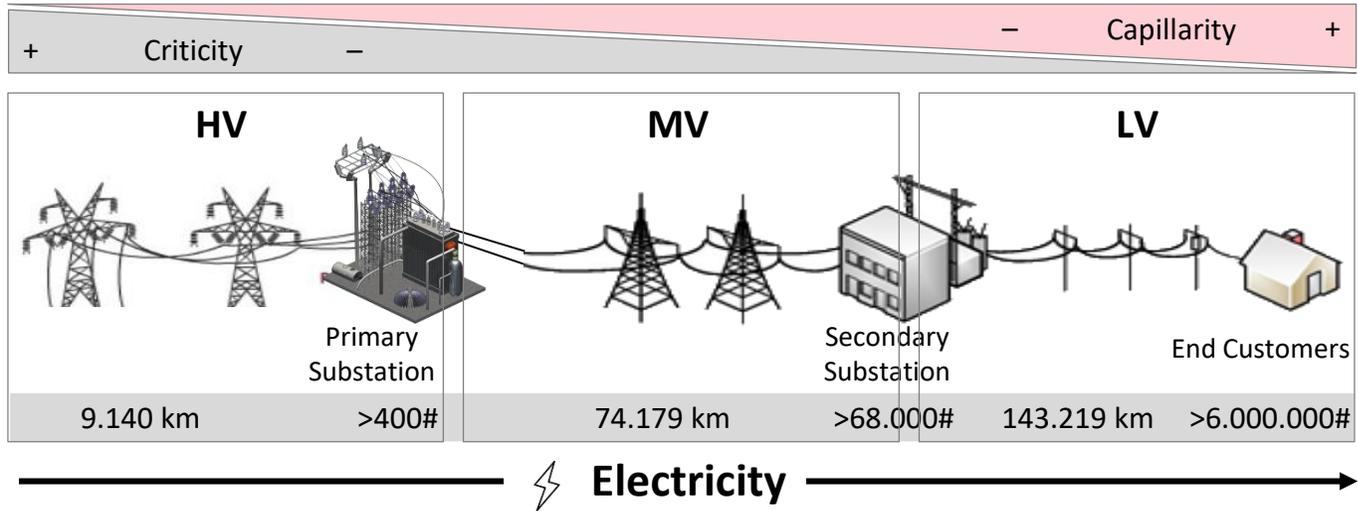
The challenge requires an integrated approach, through a Digital Platform, not just satisfying a necessity, but an opportunity – CONNECT Program



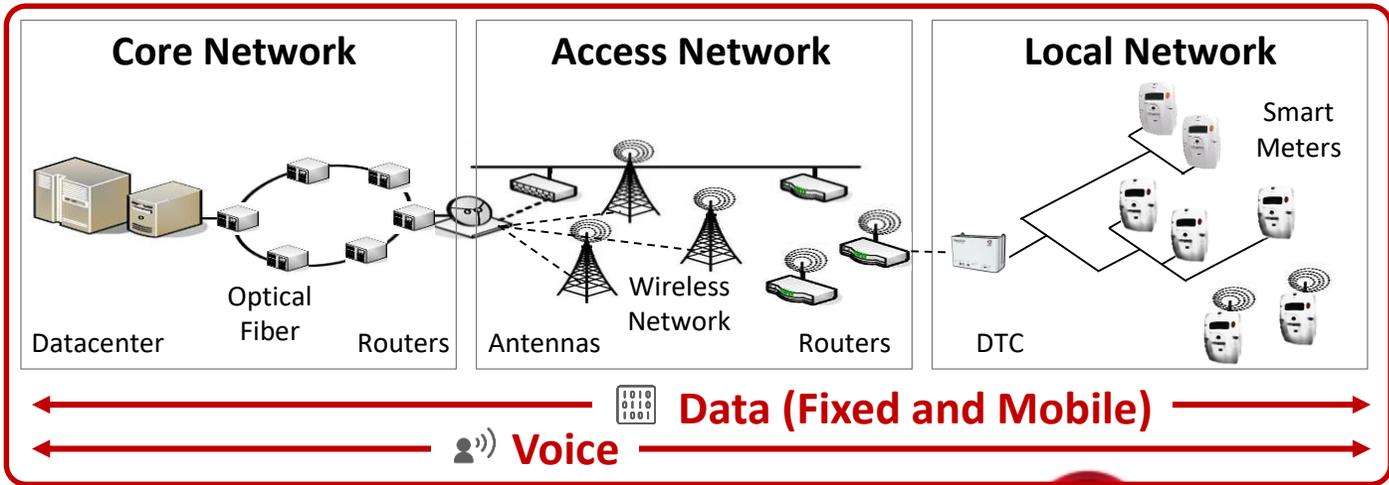
The Grid Digitalization implies a Connectivity Layer, ensuring high resiliency, availability, performance, service and risk control

EDP Distribuição's Infrastructure Ecosystem

Electrical Grid
Energy Distribution



Digital Platform
Connectivity

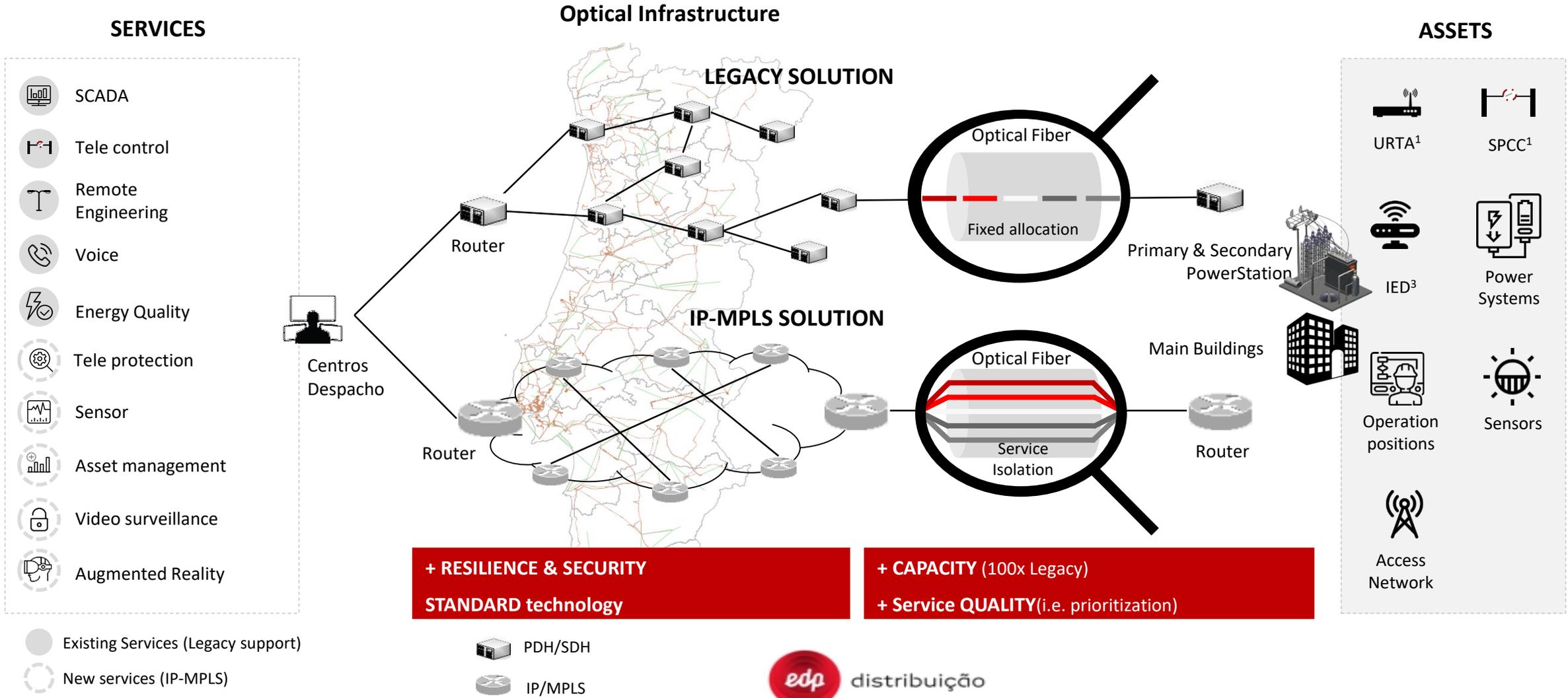


Drivers for the Connectivity Transformation

 "Always on" Commitment	<ul style="list-style-type: none"> High resiliency and availability (99.99%) to support critical services Emergency support to ensure Business Continuity (data and voice) Ensure coverage in any region of the country
 Service Management	<ul style="list-style-type: none"> Greater service control for Cost optimization (eg with SIM card exchange) Flexibility and scalability to support future services, or regulatory changes
 Risk Management	<ul style="list-style-type: none"> Support for critical infrastructures Increased security in information transfer Avoid lock-in situations and manage contract migration

An IP-MPLS Core Network leverages existing fibre and establishes full service capabilities that can excel existing offers by specialization and detailed management

CORE NETWORK



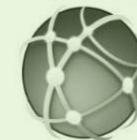
Existing core network was/is reaching its end of life, with new services and requirements pushing for a new solution: an IP-MPLS network

CORE NETWORK

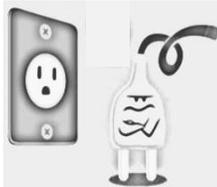
Legacy network



New network



Flexibility and electrical grid services support



- Support critical electric grid services and data (e.g. SCADA, Remote Metering) **without prioritization**
- **Does not support new interfaces** for new substation equipment

- **Flexible to adapt to new services**, e.g. teleprotection during investment horizon (~15years) and adjust QoS per service
- **Support new and old substations equipment** (can replace old network)

Vendors support and lifecycle



- **Vendor support its reaching the end**, especially for PDH
- **Risk of not able to maintain** this network in the near future

- **Mainstream technology** used in several industries maximizing the vendor ecosystem
- Recent technology with continuous investments and **future support**

Remote operations and supervision



- **Limited ability to remotely operate and maintain** the networks systems
- Provide **few supervision features** to monitor services and electric grid

- State-of-the-art technology **designed to optimize remote operations**
- **Decrease field forces operations** and interventions on-site

Support access (and local) networks



- **Solution not scalable** (product is reaching end-of-life)
- **Legacy technology not compatible** with new standards and technology

- **Scalable solution**, can growth accordingly to traffic needs and services
- **Compatible with new technologies being studied for access network** and can cope with future local network traffic

EDPD considers a combination of various network parties and technologies as the best Access strategy, reinforcing the need to assure “no lock-in” architectures

ACCESS NETWORK

Wireless technologies –
multi-technology drivers & conceptual
solution

Key question

How to support business evolution with the most suitable and cost effective telecom solutions?

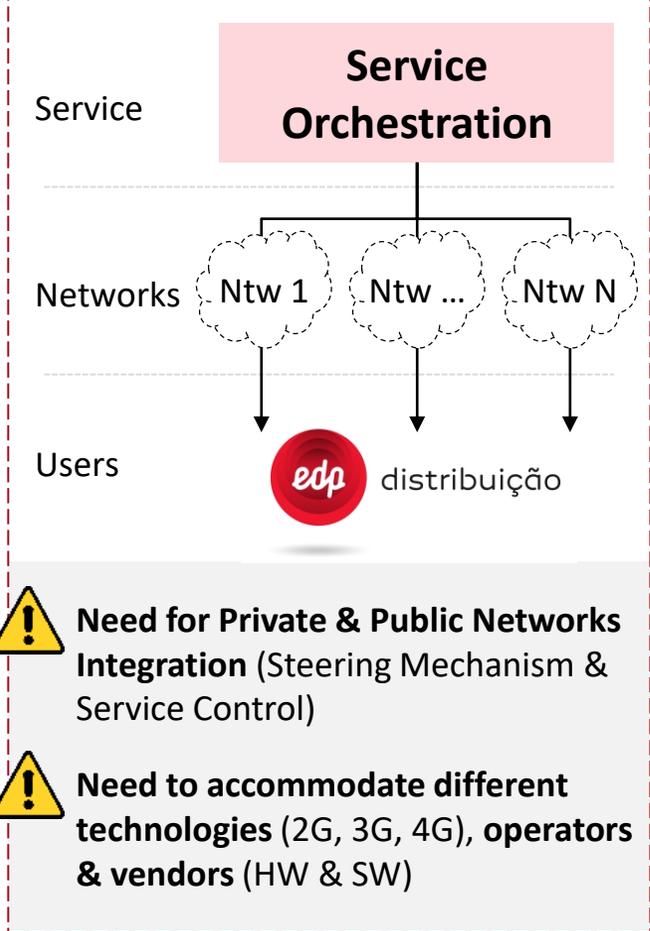
And

Adequate accountability and risk profile ?

Main drivers

- Fulfill requirements:**
 - High resiliency, availability, coverage and performance (latency)
 - Emergency support, high security and control
 - Grid flexibility for evolving services
- Improve service of public operators' offers:**
 - Leverage on existing good coverage (e.g. urban areas)
 - Increase resilience, using various operators
- Update/enhance private means:**
 - Ensure service in critical and underserved areas
 - Optimize investments & costs

Conceptual solution



EDPD is developing an integrated private and public managed service delivery platform, enhancing resilience and coverage through RAN diversity

ACCESS NETWORK

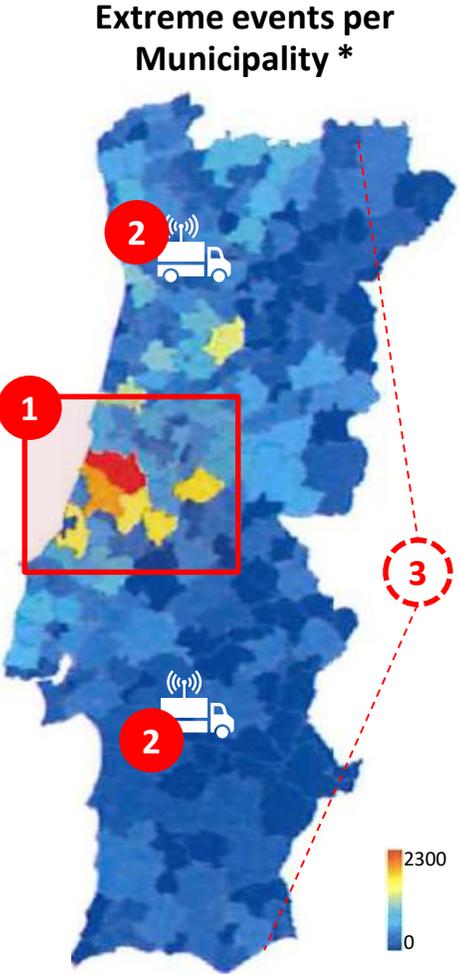


Legend: ● Existing ○ Future

(1) Private Virtual Network Operator



With the required frequencies, EDP's Private Access Network will follow a phased roll-out, first targeting specific risk regions and tactical capability



* Jan 2000 to Apr. 2013

Rollout initial phase

1 High risk regions

+ extreme events
+ MNO prolonged outages

52

11%
10.037 km²

13%
10.250

2 Tactical capability

4 Mobile Stations (~300km² potential coverage per antenna)

Analyze and justify network expansion

3 Max hypothetical scenario
(80% de cobertura)

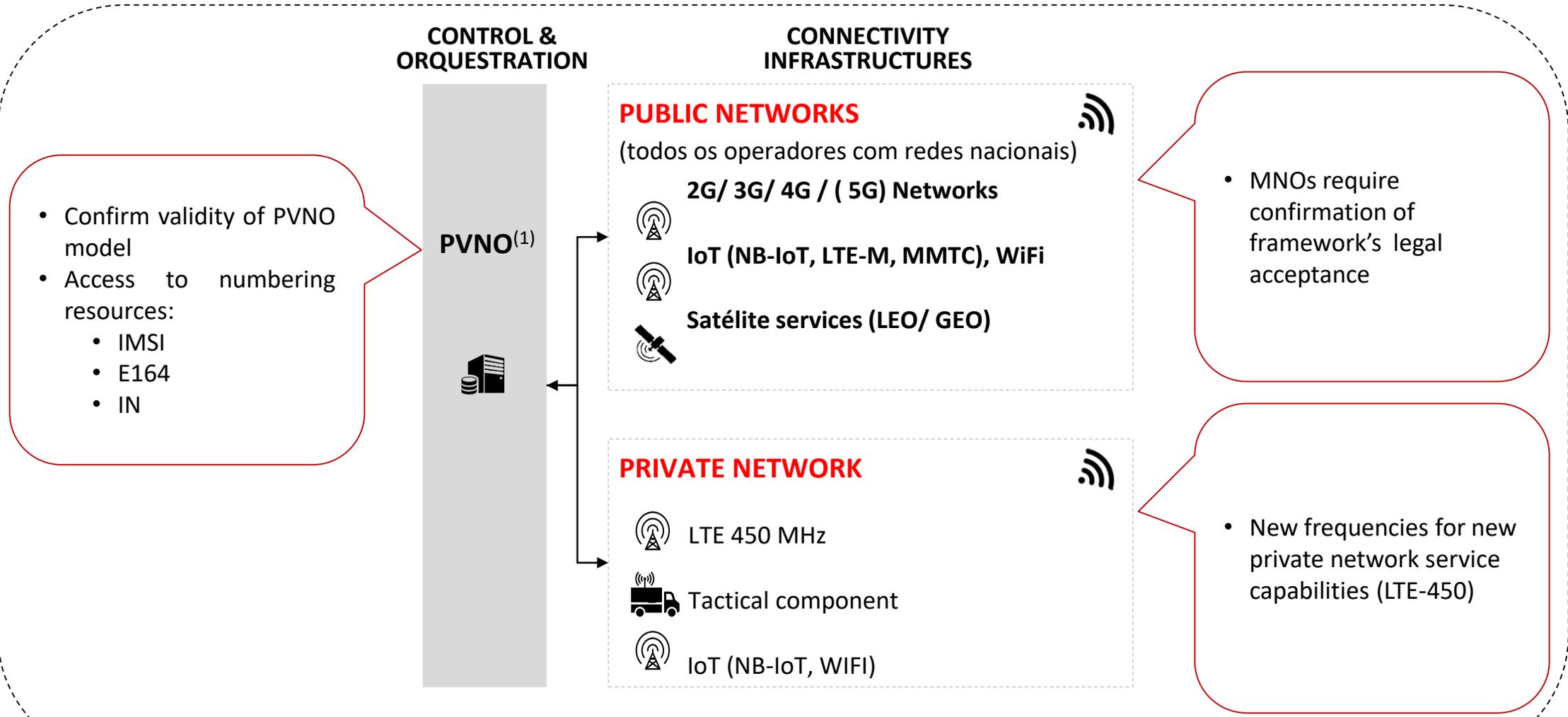
By regional risk score
Maximize asset coverage

+ 263

80%

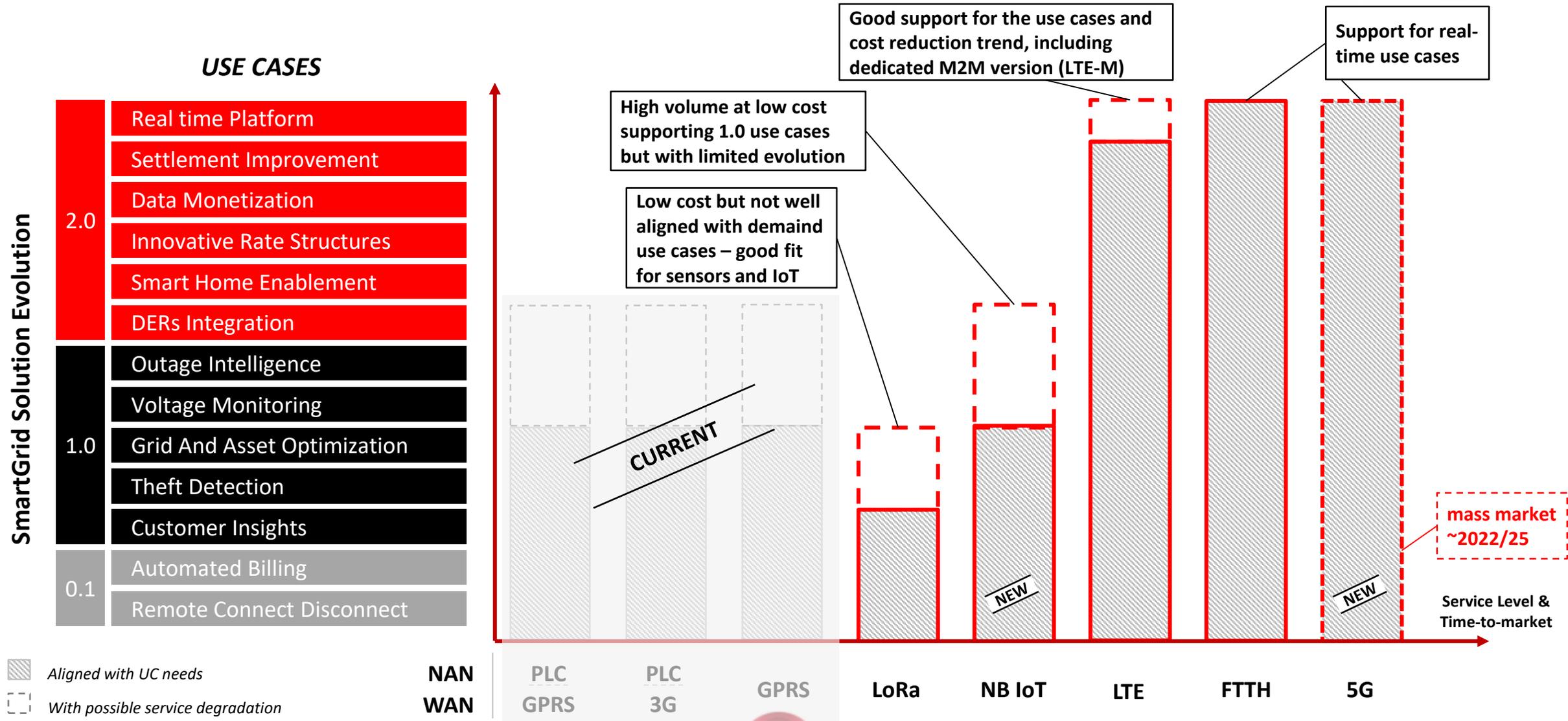
81%

Regulation plays a fundamental role, assuring critical resources and validating overall framework



(1) Private Virtual Network Operator

Being ready for a second wave of connectivity for “Local Networks” requires permanent technological surveillance and a good understanding of the real needs



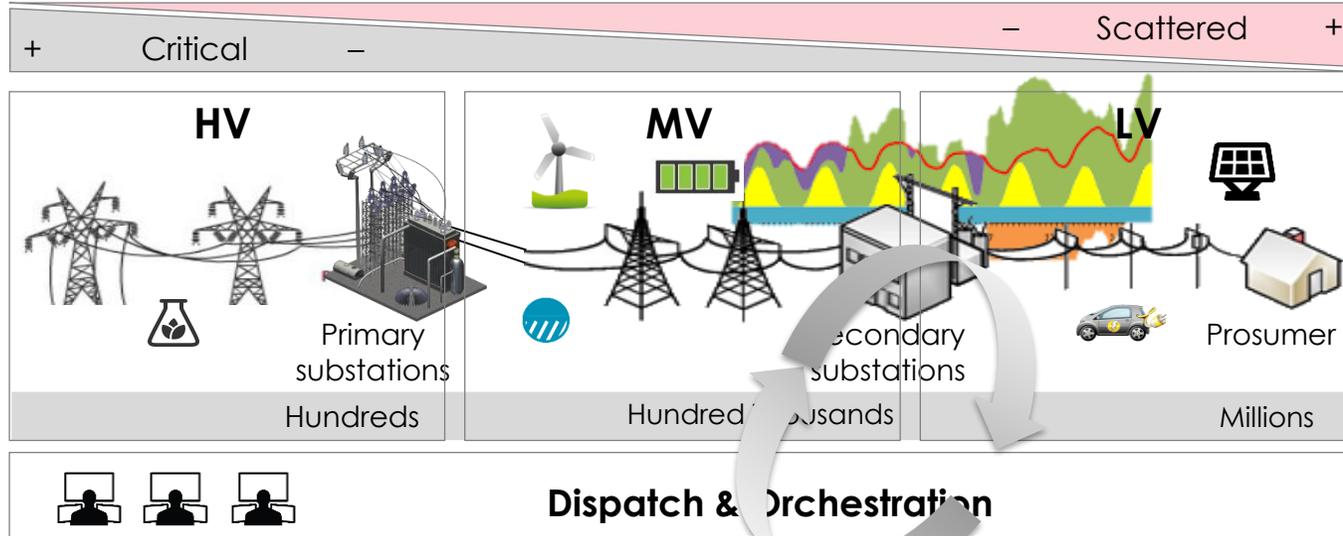
AGENDA

1. EDP in brief
2. Energy System Challenges
3. Connect Program – Empowering transformation
- 4. 5G Converged opportunity**
5. Final Remarks

3D Utility: Distributed Resources, Decarbonization, Diverse Assets demand improved monitoring and automation of energy flows

EDP Distribuição infrastructure ecosystem

Electric Grid



5G CHALLENGE

TECHNICAL

- **High resilience**, with power survivability
- **High availability**, with resources reservation
- **Ultra Reliable Low latency**
- **Increase Quality** of service
- Geographic **Ubiquity**
- **Massive M2M**
- **Always on**

Market Enabler

Enabling Local Energy Grids

Enabling Flexibility Management

Device to Device Comms

Orchestration of Supply/Demand

Loads & Producers Local Self-Balancing

Real Time Flexibility Market

Decentralized Grid Control

Smart Contracts

BlackStart from Islanded LEN

Balance & Settlement Improvement

GOVERNANCE

- **No Lock in** with provider steering and portability
- **High control** with E2E visibility
- **Accountability** for service provider
- **Resource exclusive** grant
- **Energy M2M network standards**

Since 4G, 3GPP capabilities roadmap converge with Utility's evolving requirements, contributing to digitalization and new sourcing models

From 4G, 3GPP core capabilities align with service requirements of utilities, now within 5G wave

Convergence synergies, Utilities can benefit from Global Scales and new sourcing arrangements

TECHNICAL

- **mMTC**, required in a Smart Grid concept that will expand to all actors, humans and machines
- **URLLC**, enables time a jitter sensitive Grid control functions
- **Slicing**, enabling network as-a-service concept and use-case compartment
- **Increased bandwidth**, required for specific use cases and underlying distributed computing and orchestration and control algorithms
- Multi frequency bands & non-3GPP for increased **Service Coverage**
- **SDN and NFV** should flex deployment and ownership models

OPPORTUNITIES & CHALLENGES

5G Technology / private&hybrid infrastructure

- Build to Fit
- Spectrum harmonization
- Slicing could support hybrid private/public network, infrastructure and spectrum as-a-service

5G Services by MNO

- MNO infrastructure sharing
- Resilience and service segregation regulation
- Transparency regulated practices
- Capacity management
- Business margins vs Resources

- Service management
- Improved OSS
- Service and Network Slice Portability
- Cyber Security
- Life Cycle

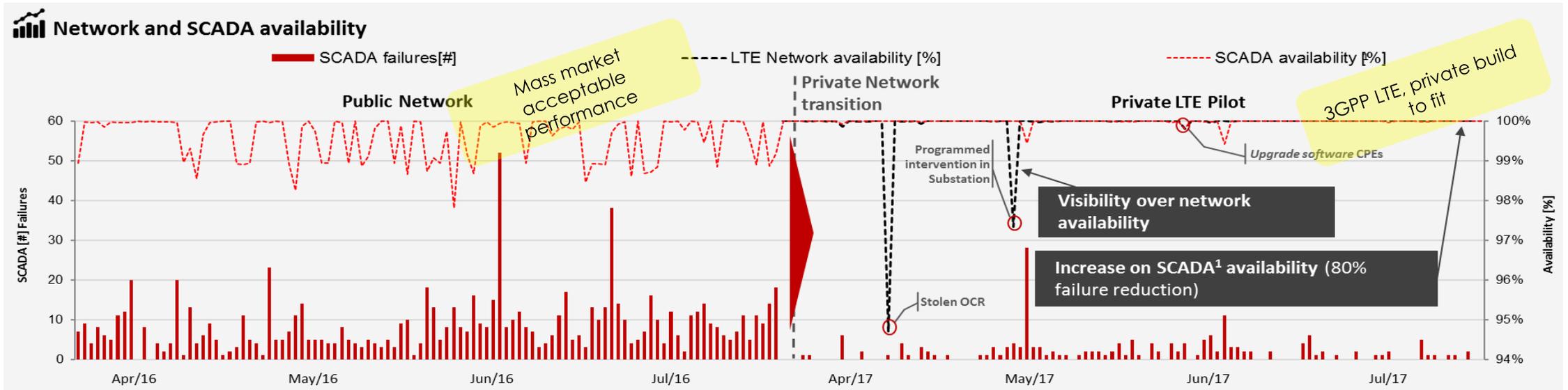
Lessons learned show that mass market dynamics and regulation framework can lead to under fulfillment of professional user expectations by providers

4G forecasts (2010)

- Improved Service Coverage
- QoS service capabilities
- Repeaters for coverage extension
- Massive M2M support
- Significant M2M module cost reduction
- Low-cost standardized solutions
- New business models in M2M space

4G 2018, still maturing for industrial fit

- Mass market drive and business margins
- Neutrality versus QoS differentiation
- Still maturing
 - Repeaters for coverage improvement
 - Assurance capabilities
 - Massive M2M support / offers
- Under grade Availability, risk and cybersecurity



AGENDA

1. EDP in brief
2. Energy System Challenges
3. Connect Program – Empowering transformation
4. 5G Converged opportunity
- 5. Final Remarks**

M2M services need advanced capabilities to allow Utilities to monitor, measure and secure comms

WHAT IS EXPECTED

1

Provide support for distributed and real-time services (ultra-low latency)

2

Service prioritization and Utilities assets coverage

3

Highly responsive, robust, and scalable monitoring and control solution

4

Platform governance and service management

5

Common framework for end-to-end security (authentication, encryption, ...)

6

Secure large scale, low power equipment as well as legacy interfaces

ADVANCED CAPABILITIES ON SERVICE MANAGEMENT AND GOVERNANCE

MONITORING CAPABILITIES

- Allow visibility on network and service status (along network nodes to the eNB)
- Provide connectivity KPIs (focused on latency & packet loss)
- Service management with traffic slicing /prioritization
- Ensure coverage over the scattered grid assets

PLATFORM GOVERNANCE

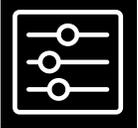
- Defined governance to ensure responsibilities over service management
- Inherent procedures to control personnel access & config.
- Risk management for critical situation and emergencies

E2E SECURITY

- Authentication model for all connected grid equipment (e.g. Smart meters, DER, EV, storage)
- Availability of information and protocol suites
- Data confidentiality and security

Final Remarks

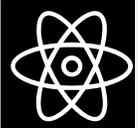
It's not just about technology – it's also a lot about **ACCOUNTABILITY**



Utility's Grid digital transformation need high available, secure and performant communications



MNOs service based on current technologies **does not provide an effective service control/monitoring capability**



M2M services need **advanced capabilities** to allow Utilities to monitor, measure and secure comms



Utilities manage **critical services that require low risk profile**, which lead to private infrastructure investments



5G can play an important role if it delivers adequate functionalities on operating governance and control of service performance

An extensive cellular usage will increase **dependency on mobile networks, pushing the infrastructure and operations to fulfill Utilities critical requirements for accountability**



a better energy, a better future, a better world