

ENERGY EFFICIENCY IN TELCO NETWORKS

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ROHDE & SCHWARZ

Make ideas real





Energy efficiency in telco networks

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Telco networks facing multiple challenges to ensure climate neutrality & resilience

Managing a highly distributed infrastructure with mix of equipment for different services & requirements

- All sites providing floor space, energy, cooling, connectivity
- Continuously adapted to conversion from phone to IP based service company
- IT centricity – cloudification, virtualization, disaggregation as main drivers of change

Climate change imposes new threats and risks

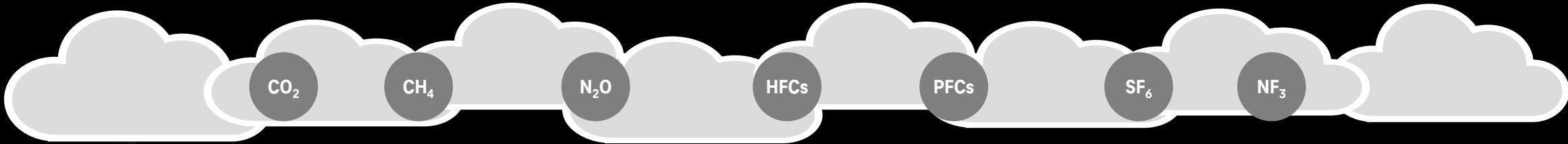
- Flooding, storms increase risk of service disruption
- Heat waves challenge established cooling models
- Not considered in network design

Turning from consumer to active participant in energy markets

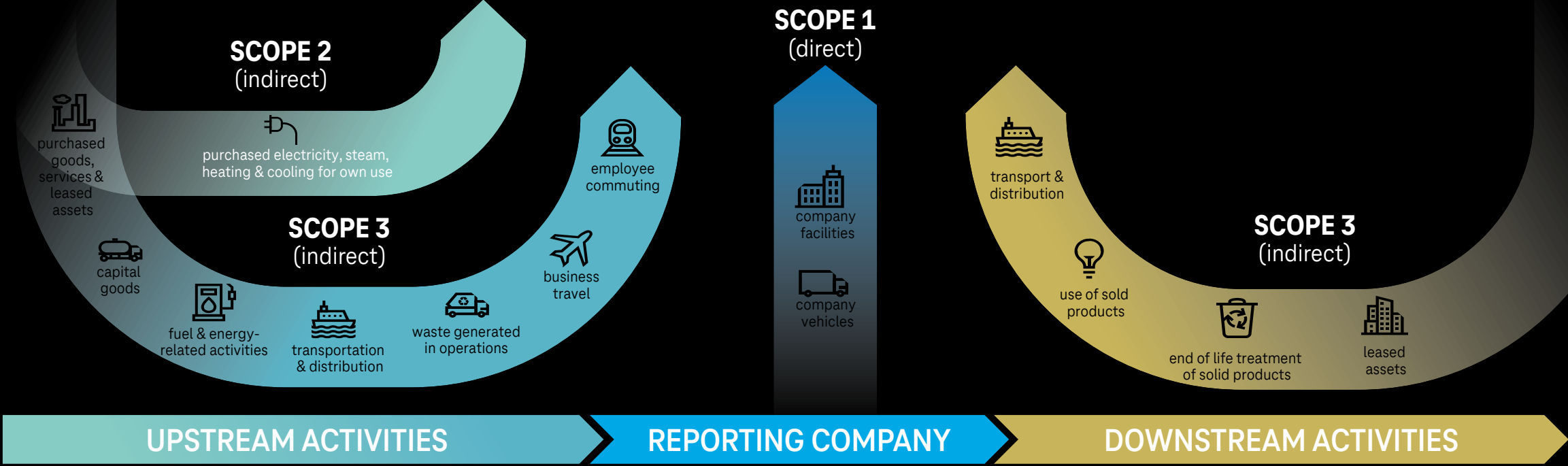
- Energy → heat → reuse
- Decentralization of energy production, storage, consumption

Greenhouse Gas emissions segmented by scope

– measured in CO₂e¹



GHG is any gas² that can absorb emitted infrared radiation from earth and remit the radiation, contributing to the GHG effect.



DT Carbon Footprint & Targets

CLIMATE AMBITIONS

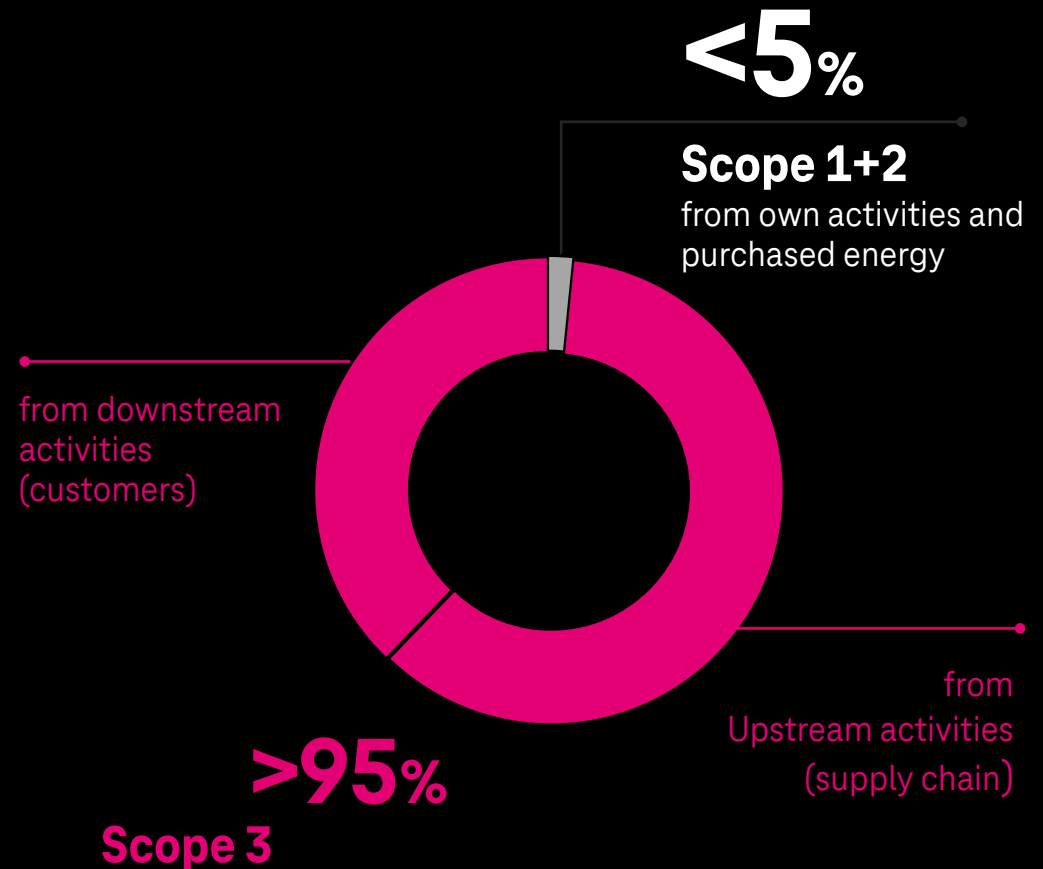
2021 Renewable electricity for DT Group as of 2021



2025 Reduction **direct and indirect emissions** from within our company to net-zero (Scope 1-2)

2040 **Climate-neutral company**
Total elimination of DT's carbon footprint (Scope 1-3)

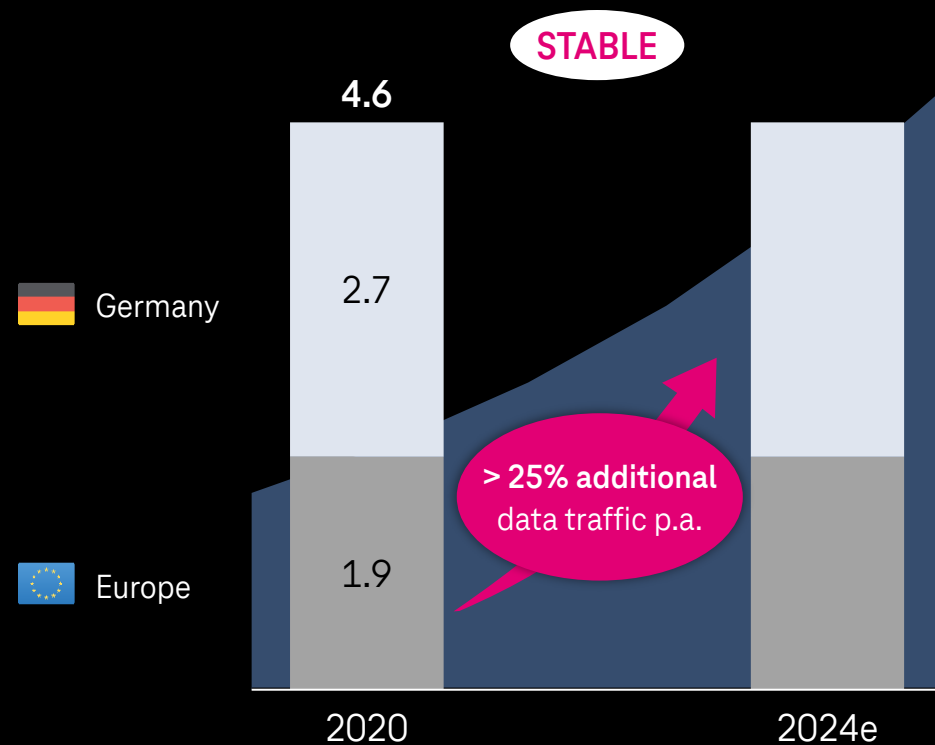
DRIVERS OF CO₂ EMISSIONS



Stable energy consumption across the entire infrastructure based on continuous optimization

Long-term stable energy consumption ...

Energy* consumption per region, TWh



*here: electricity

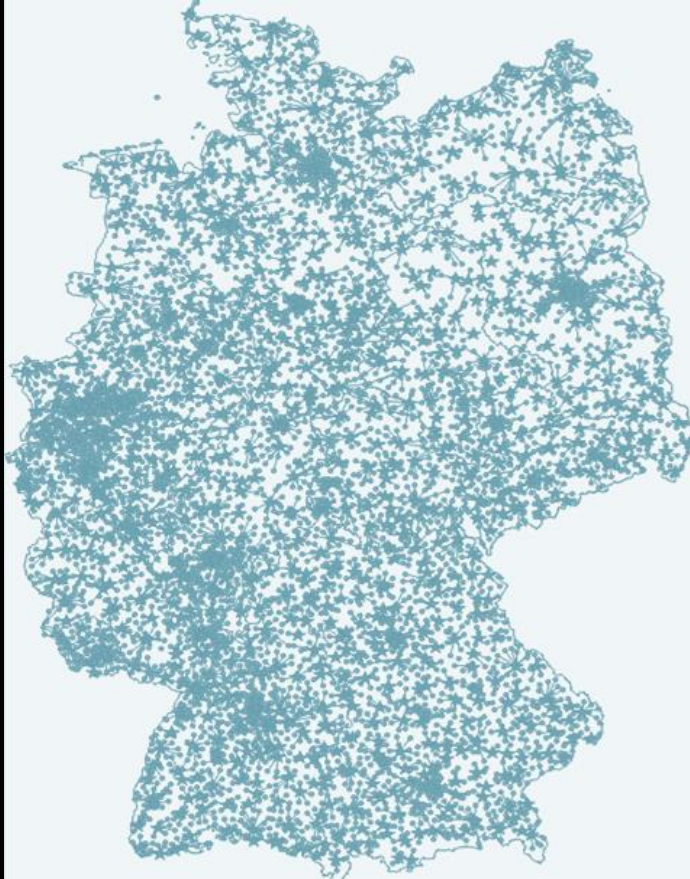
... with efficiency levers offsetting additional demands

- We will retire legacy platforms¹ to counterbalance other trends such as rise in data traffic, network densification & rollout of more active network components
- In addition, efficiency from ...
 - Network measures & modernization
 - Introduction of FTTH and potential copper retirement
 - Energy efficient data centers
 - In addition, innovation in packaging, materials, and decentral energy production

Where do we spend our energy?

Telecommunications network

Site classification: Example Telekom Germany



	Type	No#	Power (in kW)	Energy (GWh/a)
Indoor-site	Core Nodes	20	~ 1000	~140
	Aggregation nodes	900	< 100	~620
	Access node	6982	< 10	~350
Outdoor-site	Outdoor cabinet	177000	< 0,5	~350*1
	Cellular base station	33000	< 5	~950*1
Total				~2450

*1 estimation by author

Highly distributed infrastructure with varying granularity

Each site connected to power grid

Local installation to guarantee resilience

Domains of optimization to save energy?

Energy-aware architecture

The overarching network architecture must be designed to be energy efficient.

Optimization of the entire protocol stack , optics, transport , access , service , core incl resilience. Options for traffic&load management

Energy-aware systems

Newer generations of systems designed with more focus on energy consumption, progress of chip technology allows more efficient solutions, support of energy management algorithm and protocols.

Energy-aware planning

Network planning and network rollout-planning must consider energy consumption during entire live time. Optimization of redundant capacity and systems.

Energy-aware operation

In the best case “zero watt for zero bit”

Measures to save energy?

We identified three clusters of efficiency levers

RETIRE

Recently legacy voice (PSTN), near-term future legacy transport (SDH), long-term switch to fixed access disaggregation and potential copper platform retirement

MODERNIZE

...after accelerated Fiber rollout and Technology updates, e.g., rectifiers, 3G frequency re-use for 4G/5G or Cloud transformation in NT/IT

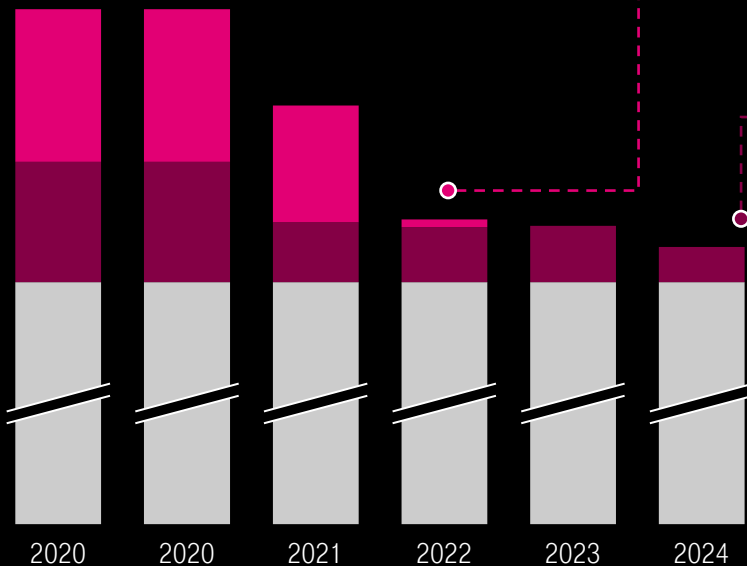
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Network measures, including site sharing & AI steering
ORAN based approaches

Significant reduction achieved via legacy retirement but one-off effect

Retirement boosts electricity savings...

Electricity consumption Region Germany (in TWh)



> -10%

...no short-term lever

✓ PSTN Retirement

Completed in **2022**

✓ SDH Retirement

To be completed in **2025**

Potential future levers include...

🚲 Copper to fiber migration (Cu2F)

Long term chance but focus currently on FTTH rollout to build proper coverage

Access disaggregation

Long term effect to be evaluated

So what:

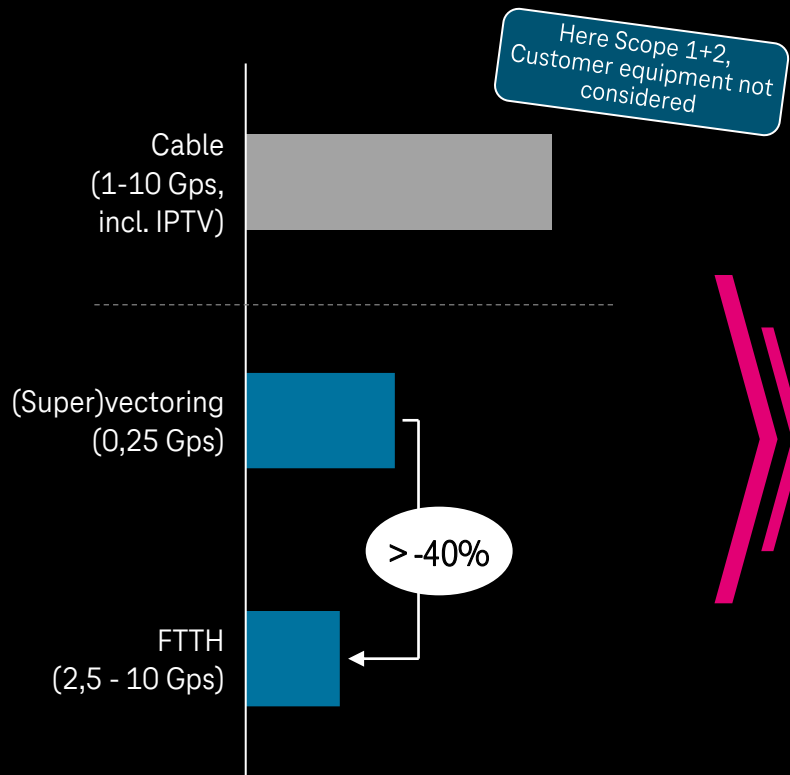
- » 'One-off' effect
- » PSTN retirement effect harvested in EU already
- » Needs strategic decision and significant lead time (~10years)
- » Operationalization challenging and requires forced migration

Migration from copper to more efficient fiber potential long-term lever

RETIRE

MODERNIZE

FTTH most efficient fixed access technology...



...but migration requires fiber coverage

Increase of FTTH adoption

- » Significantly adding FTTH homes passed
 - » c. 2.5...3.0 mn p.a. in GER
- » Increase take-up rates in FTTH areas (from “homes passed” to “subscriber”)
 - » Requires additional effort and resources
- » Government claims to offer FTTH to every customer in GER by 2030

Develop concepts to retire copper

- » Requires full FTTH availability in envisaged retirement areas
- » Customer migration strategies ranging from natural to forced migration
- » Lead time typically ranging from few up to 10+ years to complete migration

So what:

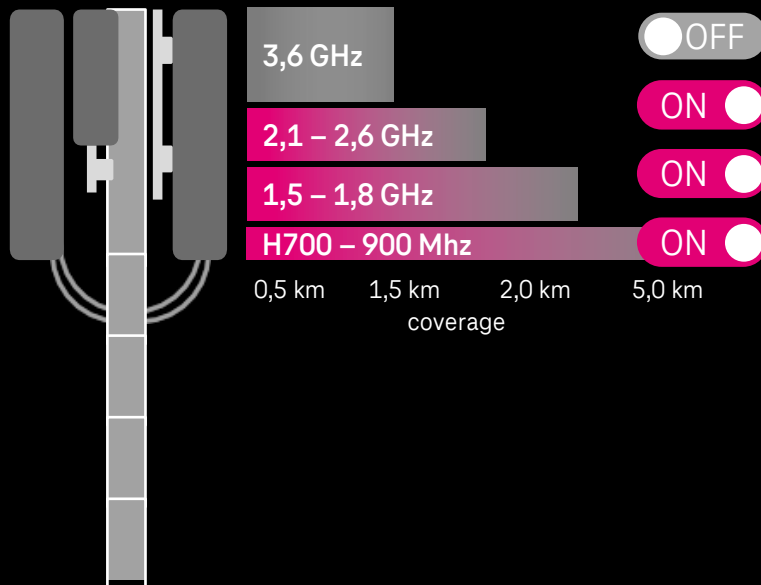
- » Needs (forced) migration of customers in FTTH areas (incl. Wholesale)
- » Gradual savings starting with customer migration ending with full dismantling of cabinet/MfG (‘Parallelbetrieb’ until then)
- » Maximum energy saving potential requires full swap (DE earliest 203x)

Innovative saving features based on dynamic AI steering soon ready for implementation

INNOVATE

Innovative features increase saving potential...

Frequency bands (schematic)



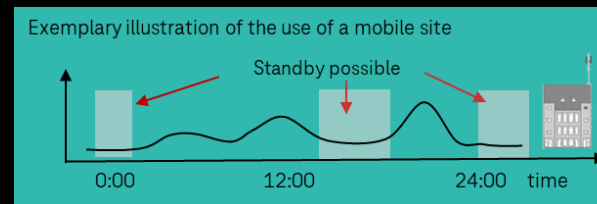
Facts:

- Typical power consumption of a mobile site is 1-4 kW
- More active frequencies = the more energy consumption

...but need implementation push

Static capacity-layer switch-off

- » Live in all EU NatCos and GER
- » Saving: up to 10% of mobile access network consumption
- » Site-individual



Dynamic AI steering*

- » Novel dynamic forecast and temporary reduction schemes

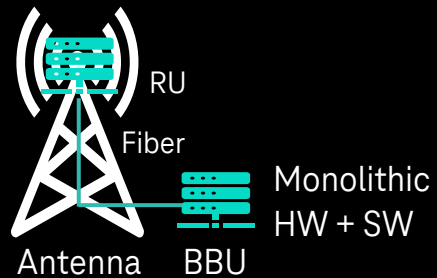
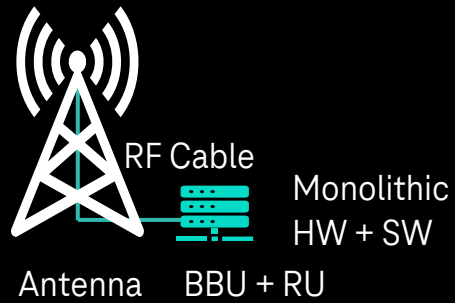
Requirements for operationalization:

- » **Scale** field trials and MVPs to country-wide solutions
- » **Balance** customer experience vs energy savings
- » **Ensure** legal/regulatory obligations
- » **Assess** impact on benchmark results and network tests

* Not reflected in any segment iPF for now

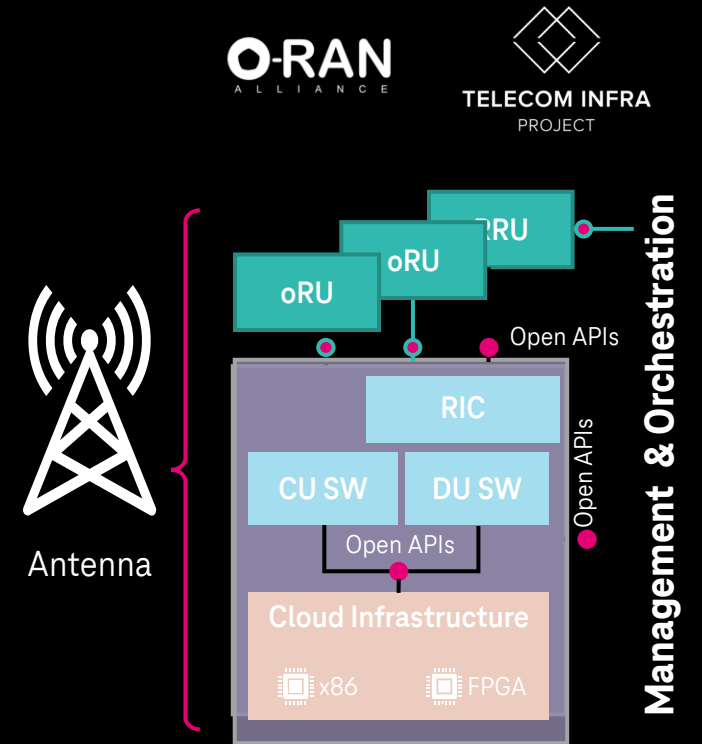
Radio Access: Benefit of oRAN

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Legacy RAN

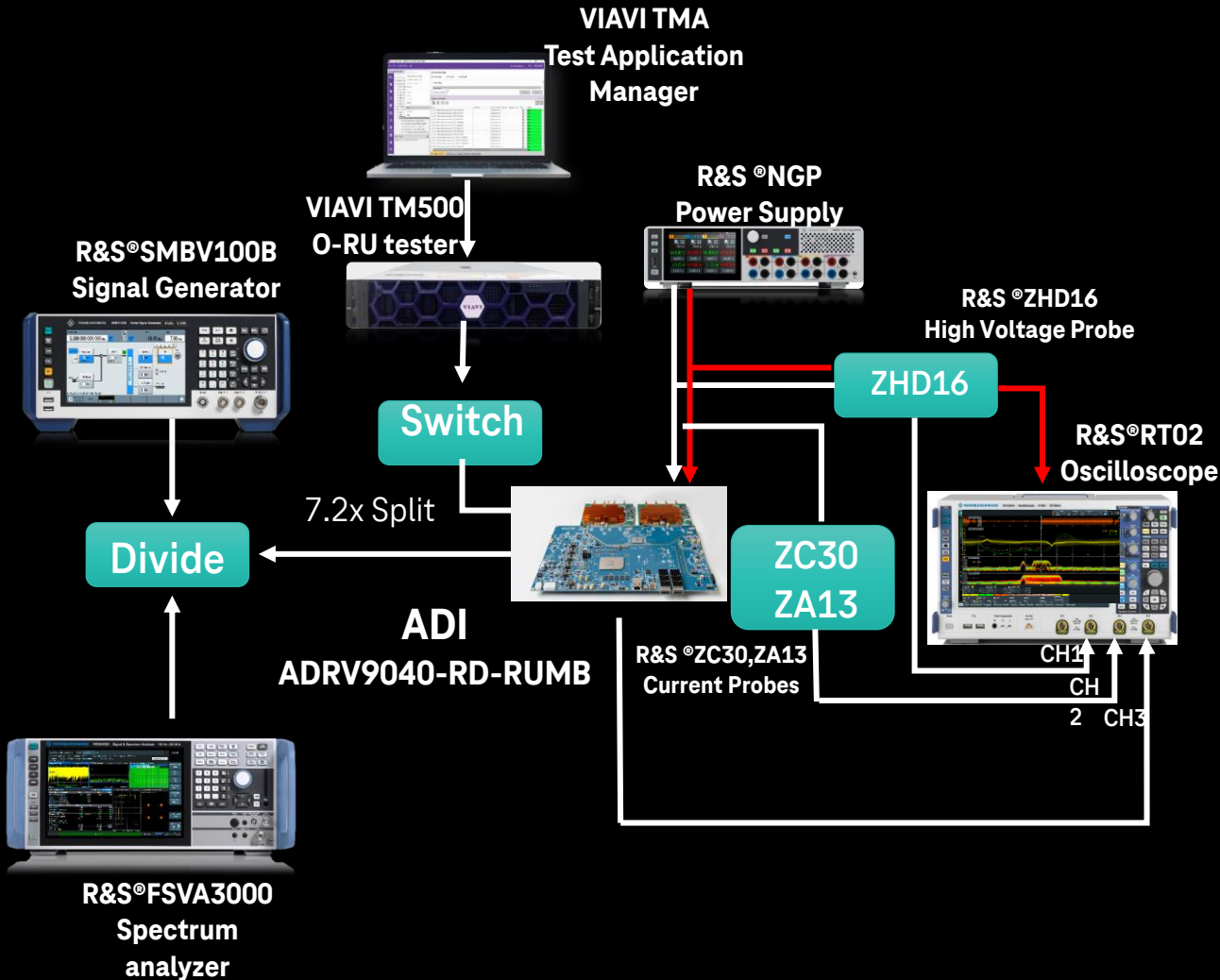
- Modular | decomposed
- Cloudified | software-based
- Open APIs & ecosystem
- Automated



Disaggregated RAN

Results Latest Plugfest

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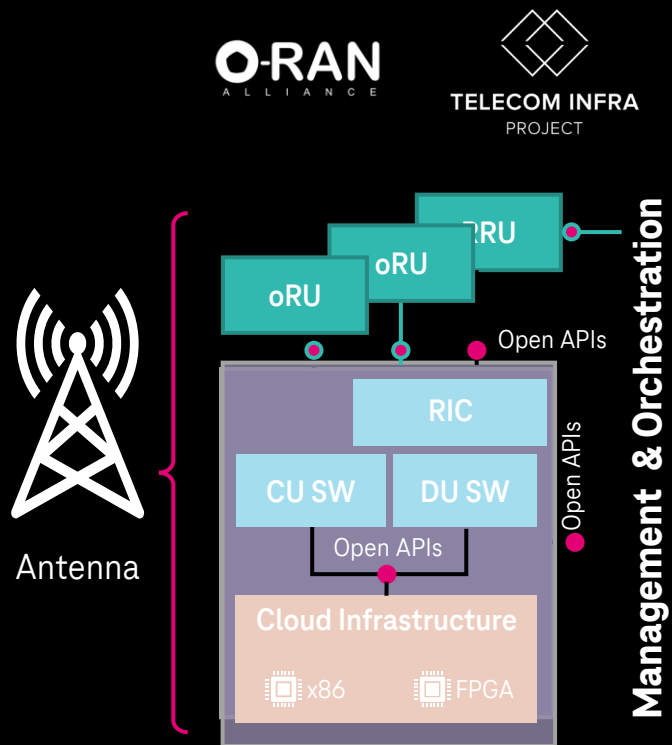


- » ADI oRU tested
- » VIAVI and R&S O-RU Tester Solution
- » Configuration for WG4.CONF and Energy Efficiency testing

FH Load	DTX Feature	Total Power	Savings	
		Power (W)	Power (W)	Percentage (%)
FULL (100%)	OFF	55.65		
	ON	51.76	3.89	6.98
BUSY (50%)	OFF	55.41		
	ON	47.01	8.40	15.16
MEDIUM (30%)	OFF	55.41		
	ON	46.16	9.25	16.69
Low SSB only	OFF	55.31		
	ON	44.00	11.31	20.45

Comparable repeatable energy efficiency (EE) testing

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Disaggregated RAN

Component level measurements

exchange real devices/software to test individual elements EE/EC which can be fed to large-scale testing

Global/feature-based testing

test features/RIC/App, with a simulated environment to do large-scale testing to verify/compare App performance

Deployment view for EE testing

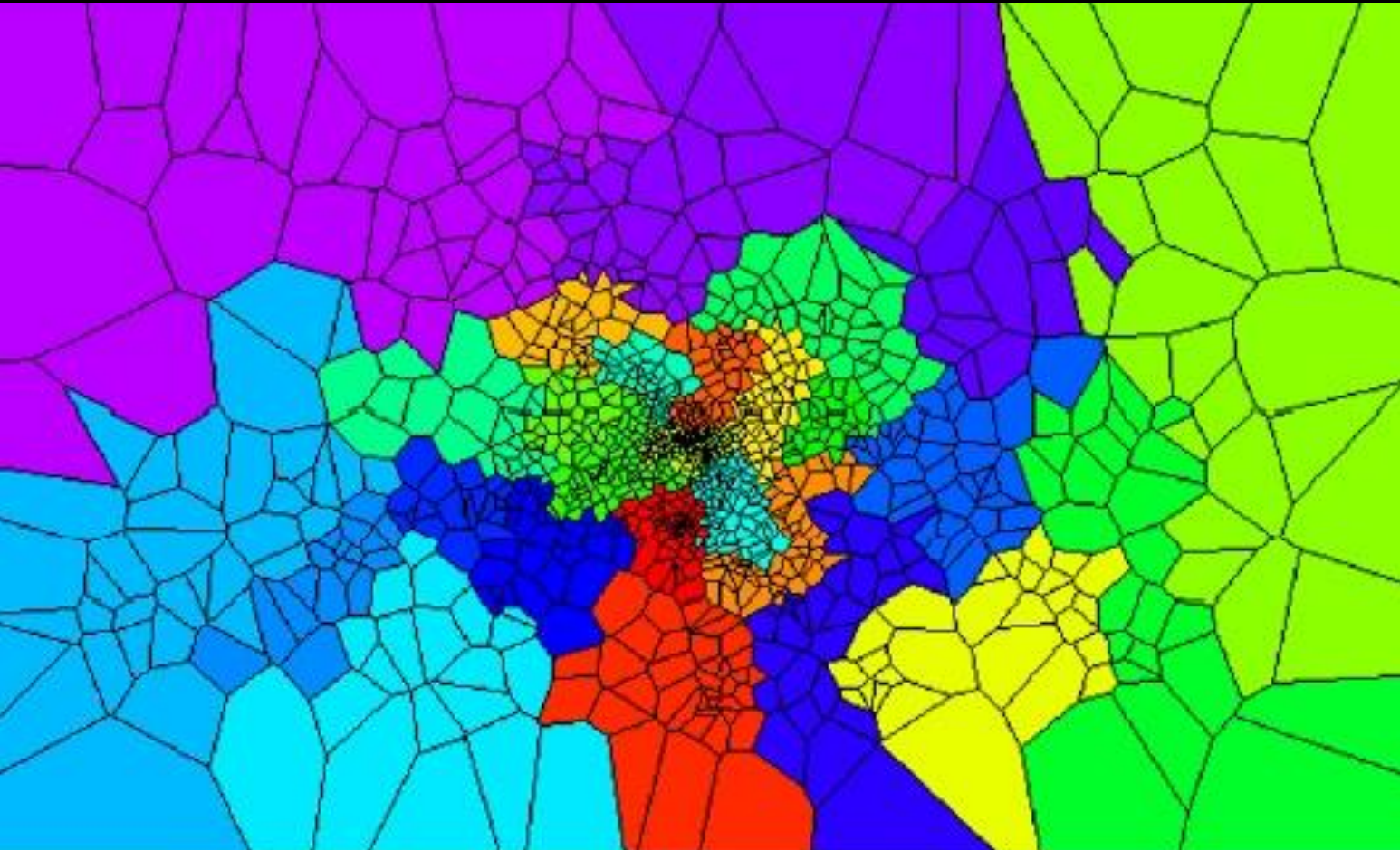
elements deployed on various locations in various configurations e.g. different cloud resources for CU/DU, different for RIC/App, remote locations for CN/AS

Multi-link/wide network testing

large-scale network with all real components and various deployments (i.e., combining all previous).

ORAN based optimization of radio network architecture & topology at scale

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Real based optimization exercise to minimize cost by clustering of CU/DU and exploiting pooling gains

- » **Scale** from single base station to >1000 base stations
- » **Balance** pooling gains against transport cost
- » **Assess** impact of different cluster sizes, cost variations etc.

The Interplay with the energy grid

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PASM is building energy storage sites

Münster, Hanover, Bamberg and
Munich

Total capacity of 66 megawatt hours
(MWh).

Telekom and PASM aim to store a total
of 300 MWh of energy by 2030.

DECENTRAL POWER SUPPLY INCL. STORAGE

INNOVATE

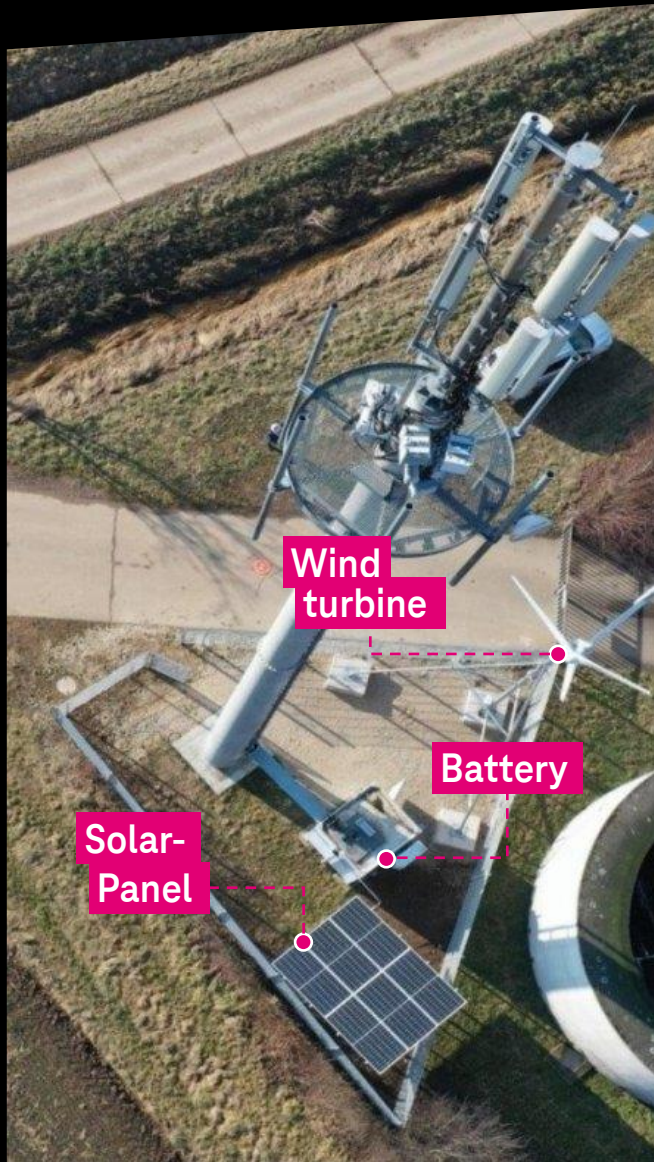
... TO BE RESILIENT AND SHAPE DEMAND PEAKS

INTEGRATION OF SOLAR, WIND, BATTERY AND FUELCELL

Trials ongoing

LEVERAGING AI WE ADJUST SUPPLY AND DEMAND SMARTLY
together with leading partners

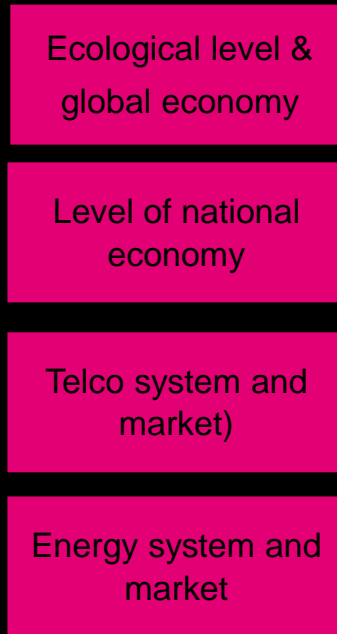
Requires integrated energy and ICT
and demand management



CO 2030 in a nutshell



System levels



Overarching view

- Adaptation to climate change,
- Adaptation to regulation
- Resilient infrastructure

Telco NW Transformation

- Cloudification Virtualization
- Becomes more DC like
- Load adaptive operation
- FTTH

Grid Transformation

- Renewable energy
- Smart Grid control
- New technologies (storage heat waste)

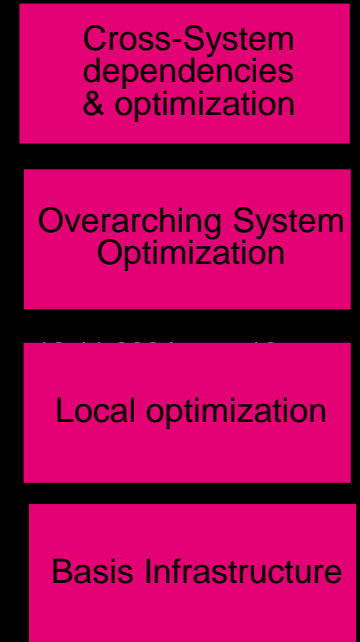
Telco sites

- Highly distributed
- 40 years old design
- Lazy assets

Support of energy system

- Production consumption
- Cost optimization
- Adaptive operation
- Keep grid stable

Data and control





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Test. Measure. Innovate

THANK YOU
VERY MUCH

ROHDE & SCHWARZ

Make ideas real

