COUPLED SYSTEMS
MOBILITY & ENERGY & ICT

Heiko Lehmann, T-Labs, February 2017

AGENDA

Telekom **Innovation Laboratories**

MOBILITY NEEDS POWER (OLD)
ONE-PURPOSE DEDICATED SUPPORT SYSTEM

supply chain

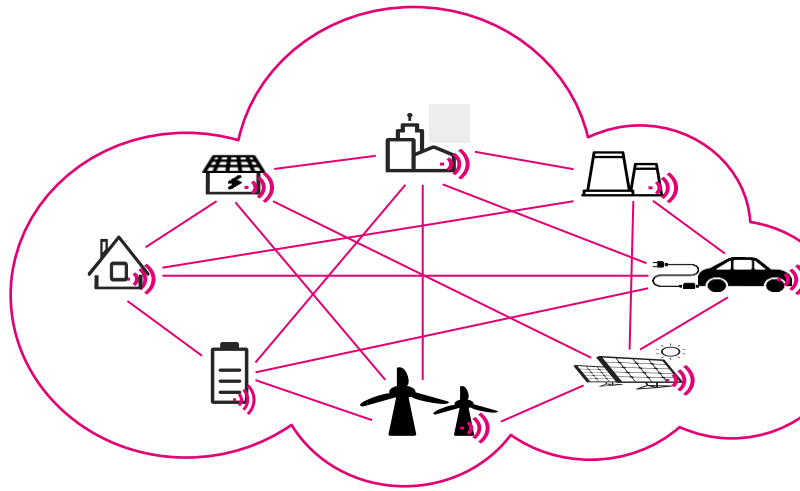unilateral coupling

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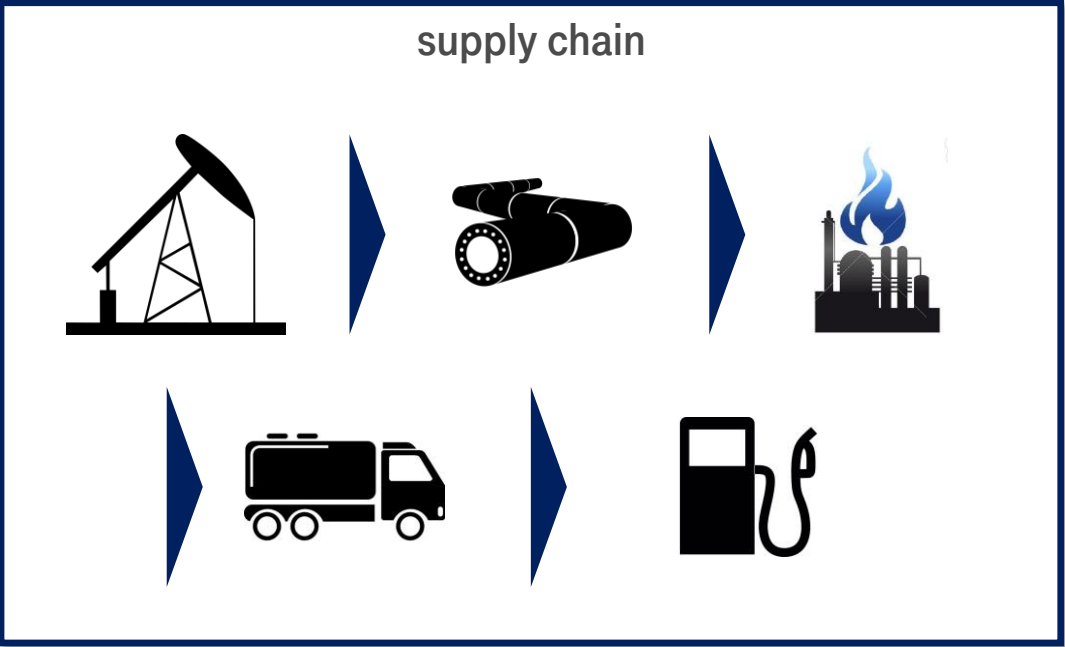
MOBILITY NEEDS POWER (E)
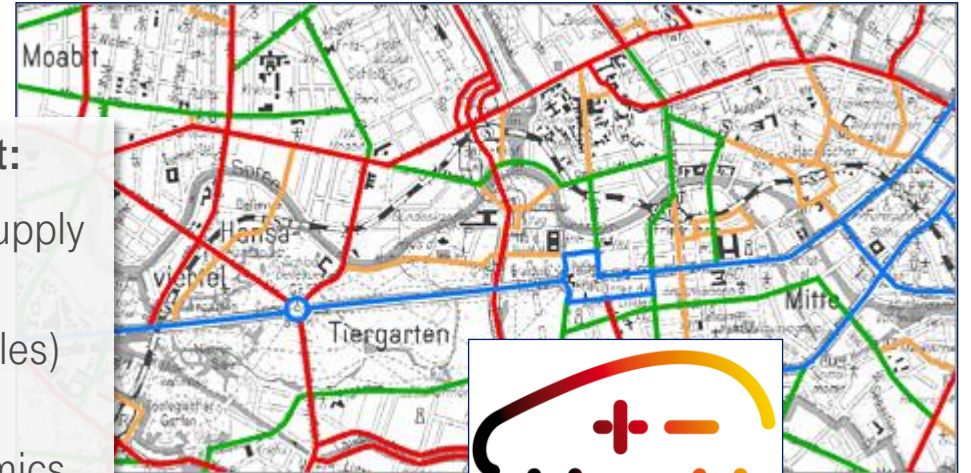## MULTIPLE CONTROL CRITERIA MANAGED BY ICT

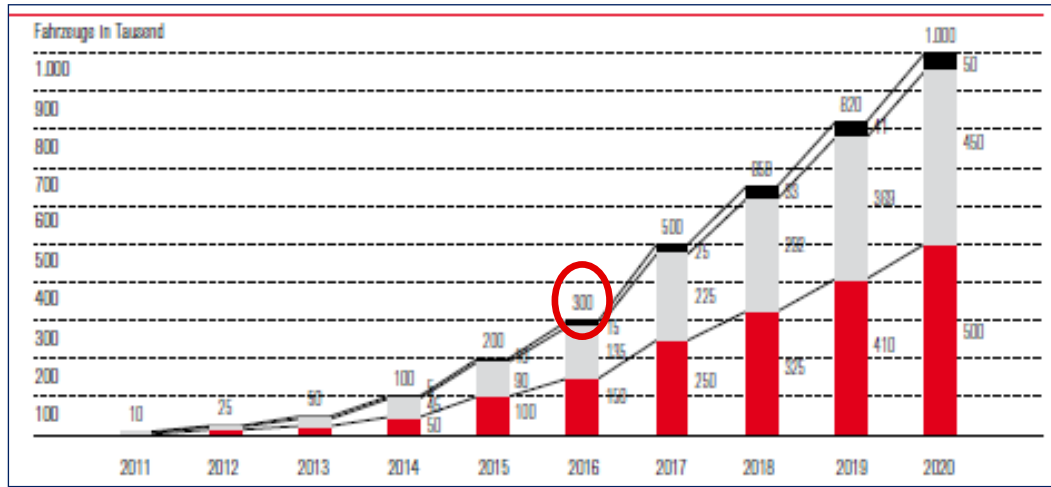**self-withstanding system**

ICT

to take into account:

➜ volatile energy supply

➜ grid stability

⬅ limited reach (miles)

⬅ migrating loads

⬅ recharge economics

▪ ...

two-way coupling

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A LITTLE HISTORY
I) EUPHORIA: NUMBERS

NEP, second report 2011

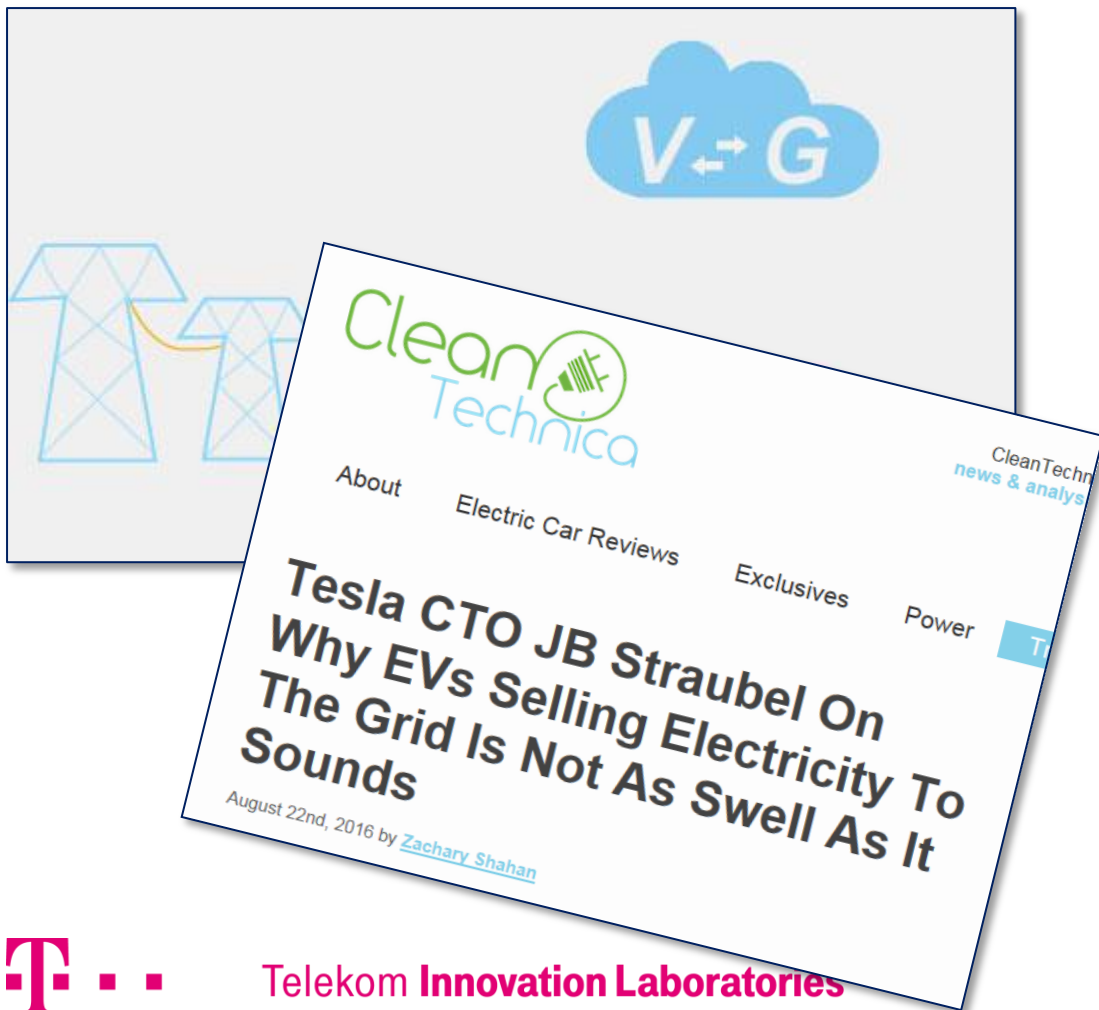Anzahl der Elektroautos in Deutschland von 2006 bis 2016
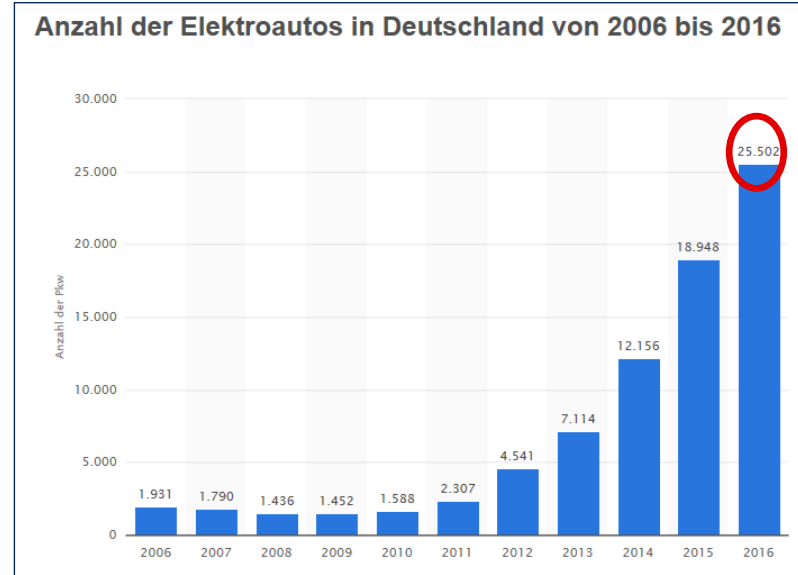
statista – das Statistik-Portal

Recently 2014, there were 24.879 Trabant vehicles licensed in Germany.

A LITTLE HISTORY
## II) EUPHORIA: SCI-FI

- a hype topic 10 years ago (as all of the *Energiewende*, then...)

- concerted action of an ensemble of probabilistic elements
- degradation risk for the battery (low-power discharge)
- installation cost for bidirectional power flows
- installation cost for control ICT
- contractual insecurities
- meanwhile, utilities have found loads of flexibility elsewhere

STARTING POINT DECENTRALIZATION
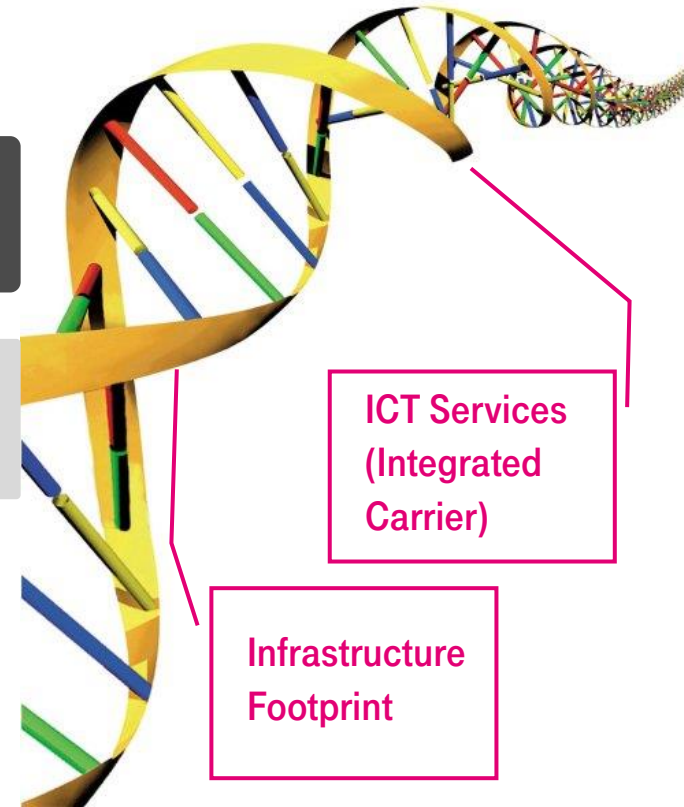## SYSTEM-COVERING INFRASTRUCTURE AND POWER DEMAND

Power Consumption Germany

≈ 529 TWh*
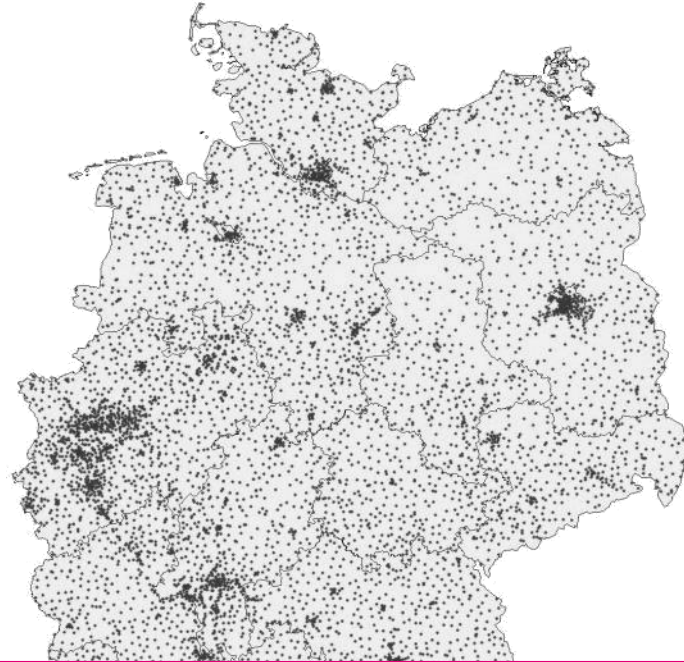
Power Consumption Deutsche Telekom

≈ 2,9 TWh**

ICT Services (Integrated Carrier)

Infrastructure Footprint

App. 0.55 % of German power consumption are caused by Deutsche Telekom and run up costs in the three digits million area.

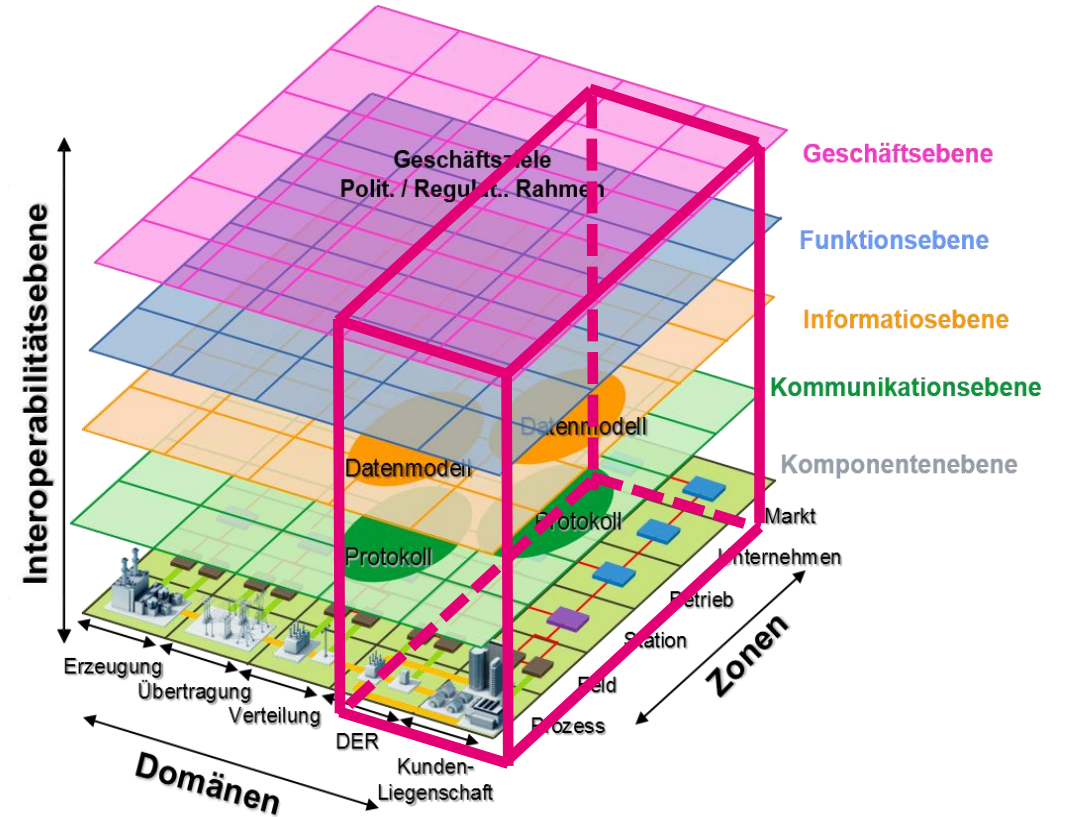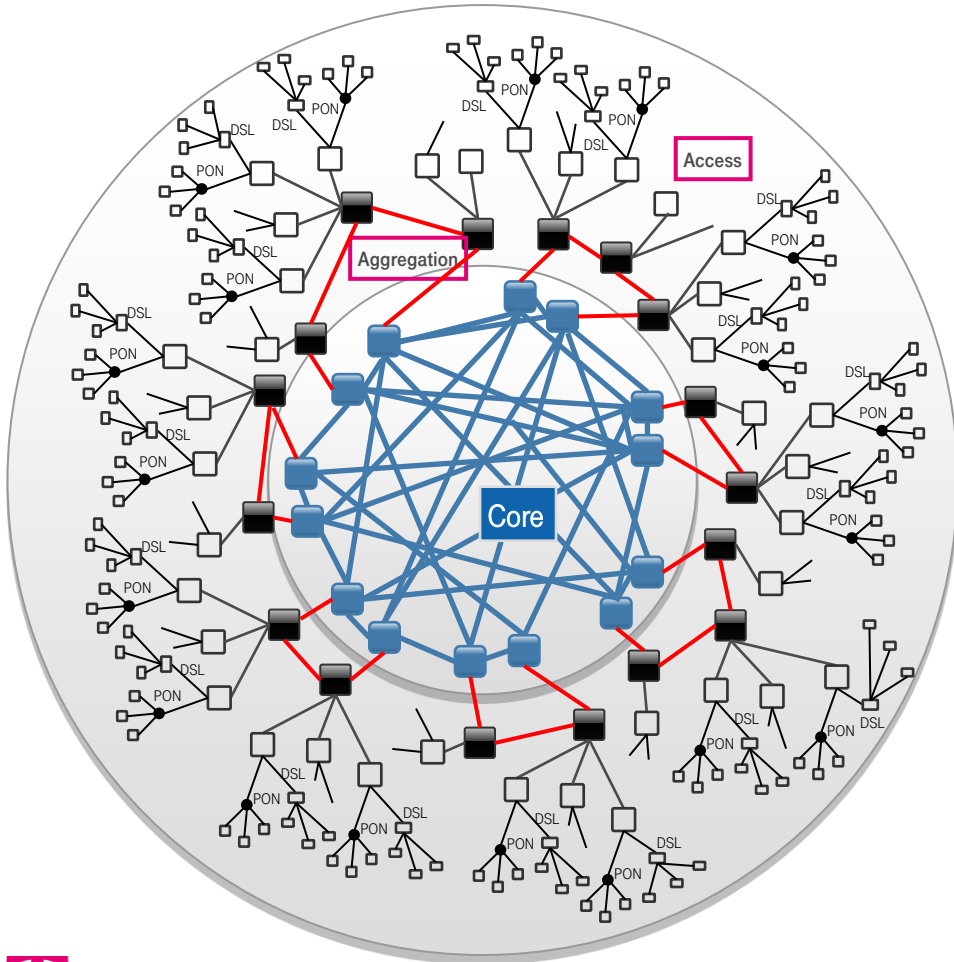*)http://de.statista.com/statistik/daten/studie/164149/umfrage/
netto-stromverbrauch-in-deutschland-seit-1999/
(2013)

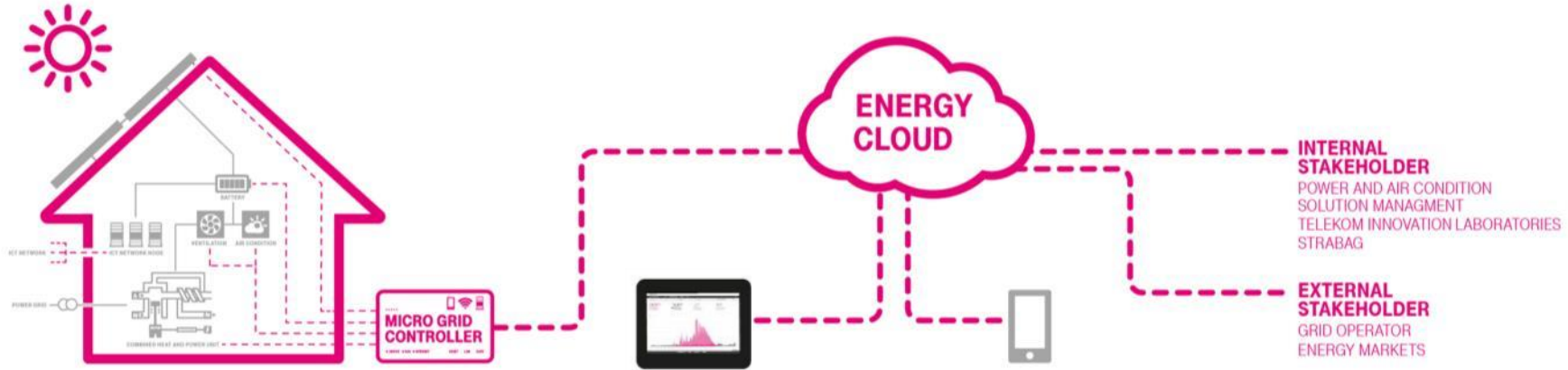**) http://www.cr-bericht.telekom.com/site15/kennzahlen_tool/?typ=1&country=15&kennzahl=57&lang=de
(2013)

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STARTING POINT DECENTRALIZATION
EVERYTHING PIVOTS AROUND THE PREMISES

HIERACHICAL CONTROL ARCHITECTURE (DT VIEW)
ADAPT TO SITES, ABSTRACT UPSTREAM

Use Cases	Business Rationale	€ Potential
Energy Monitoring & Reporting	process and energy efficiency: detect hidden consumption, peak load capping, compliance.	+
Load and Storage Control	transmission fee and tariff reduction by optimization over yearly cycles active load management.	++
Use Case Virtualization	site aggregation, swift adaptation to changes in incentivations, (e.g. flexible loads, „Strommarkt 2.0", or, altered transmission fee regimes).	++
Local Generation Management	optimization of local power & heat generation, district heat sales.	+++
Coupling to External Markets	spot market participation, control energy provisioning (CHP or stoage units), direct marketing PV	+

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SHOWTIME: CENTURY-OLD INDUSTRY ARCHITECTURE

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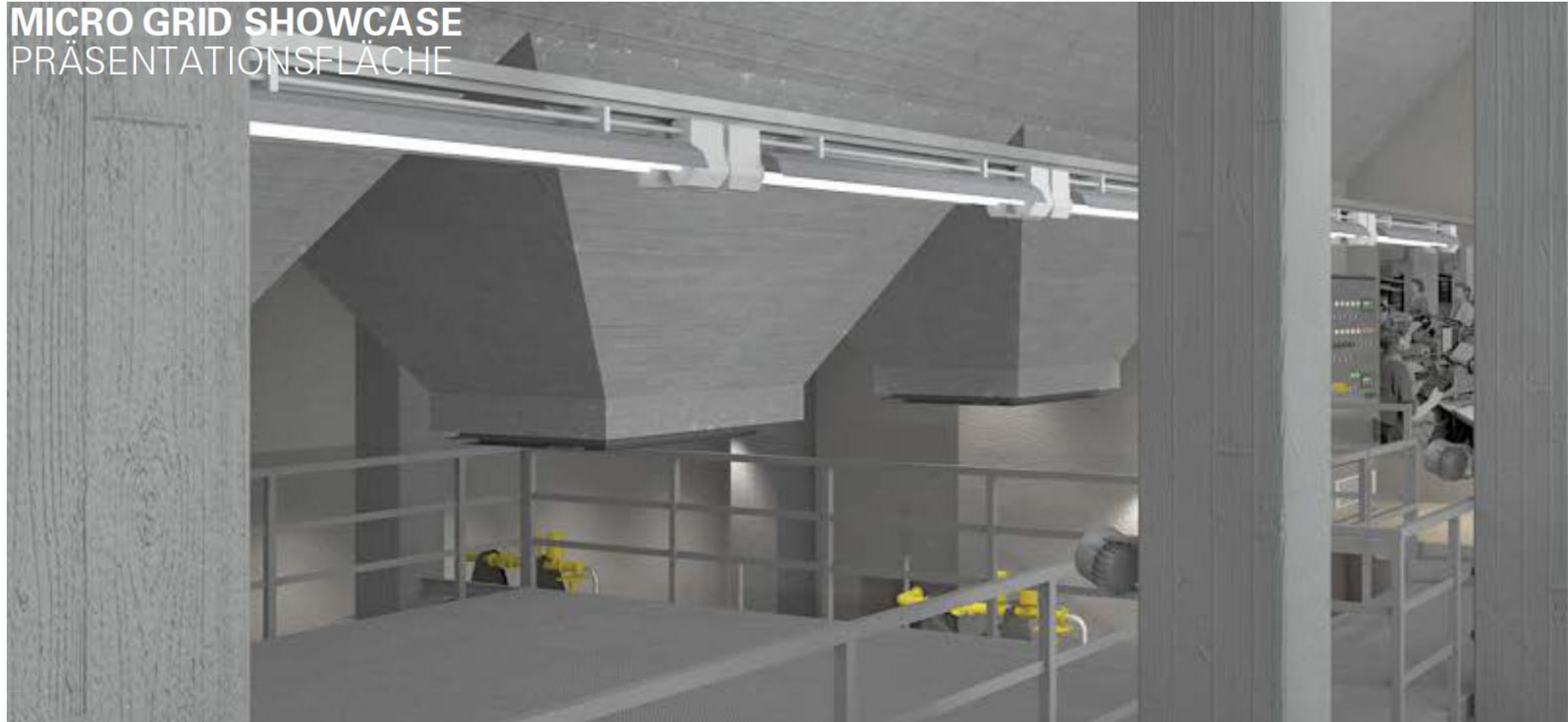
DIMENSIONING
OPTIMIZATION POWER
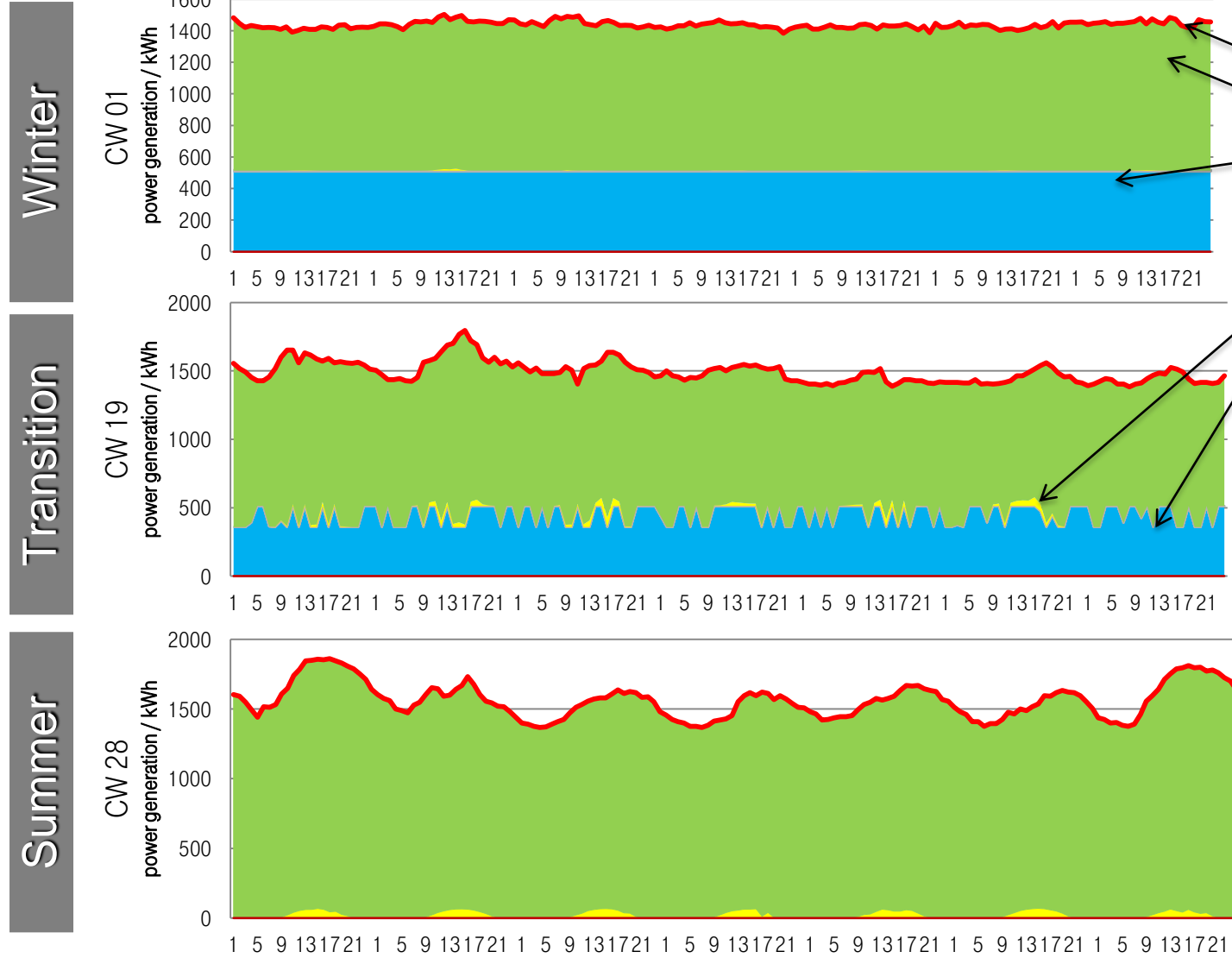
Winter — CW 01 — power generation / kWh
- site load
- grid delivery
- self-provisioning CHP

Transition — CW 19 — power generation / kWh
- self-provisioning solar
- partial duty ops CHP

Summer — CW 28 — power generation / kWh

scale: one week[h]

- CHP unit dimensioned on heat load (power potenital is higher).
- Solar generation is roughly analogous to cooling peaks in summer – efficient at any level.
- Load management for a site of this load delivers hefty cost reductions.
- All generation, consumers and storage should be integrated into an overarching load management.
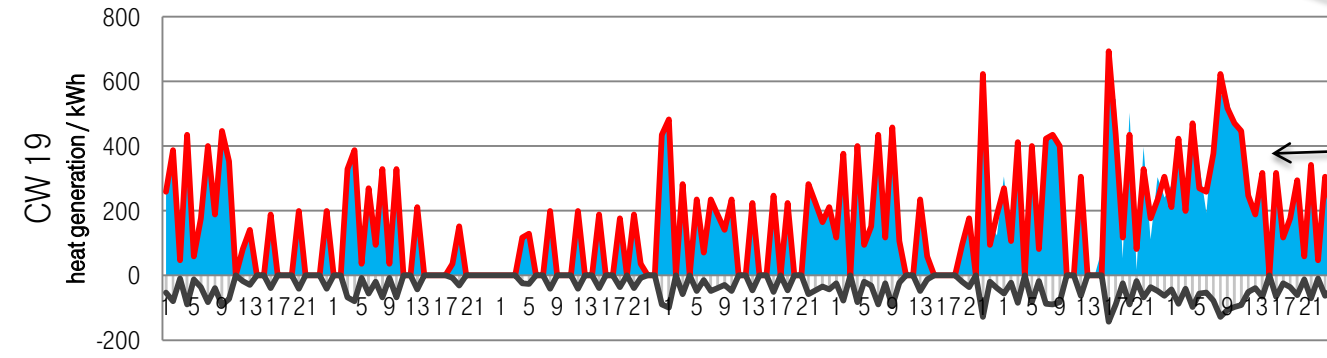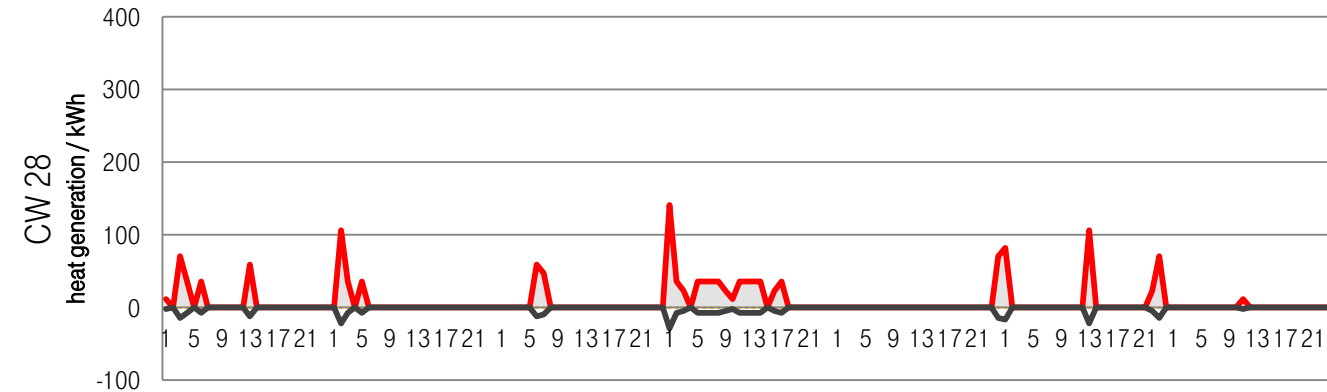
DIMENSIONING
OPTIMIZATION HEAT

scale: one week[h]

LADESTATION

ENERGIEHAUS

SPREEWALDSCHULE

WINTERFELDSTR. 27

WINTERFELDSTR. 21

27,1 %
EIGENVERSORGUNG

1.449 kW Netzbezug
476 kW Erzeugung
1925 kW Verbrauch
0 kW Netzeinspeisung

63,4 %
WÄRME AUS BHKW

2778 kW Gasbezug
1778 kW Erzeugung
1471 kW Verbrauch
307 kW Wärmelieferung

209 t
CO_2 EINSPARUNG

Seit Jahresbeginn 2017.
11,7 % höhere Einsparung im
Vergleich zu konventioneller
Energieversorgung ohne
Eigenstromlösung.

TOPOLOGY CONVERGENCE
5G: ICT NETWORKS ADAPT TO BUSINESS PROCESSES
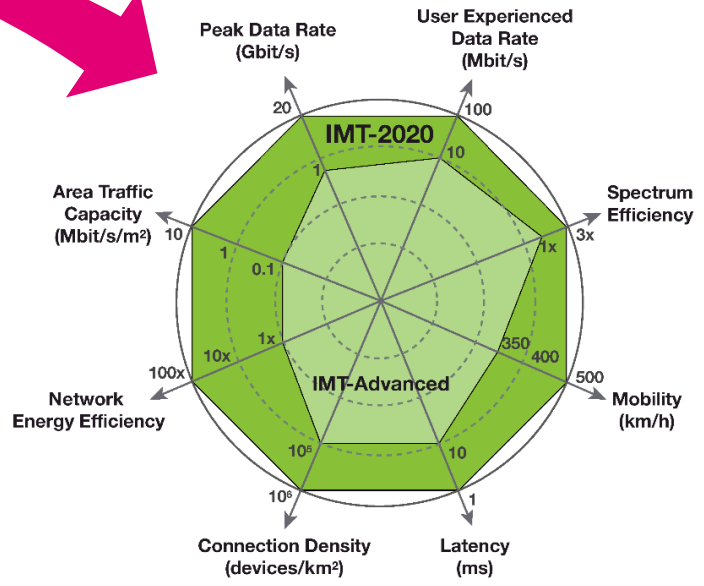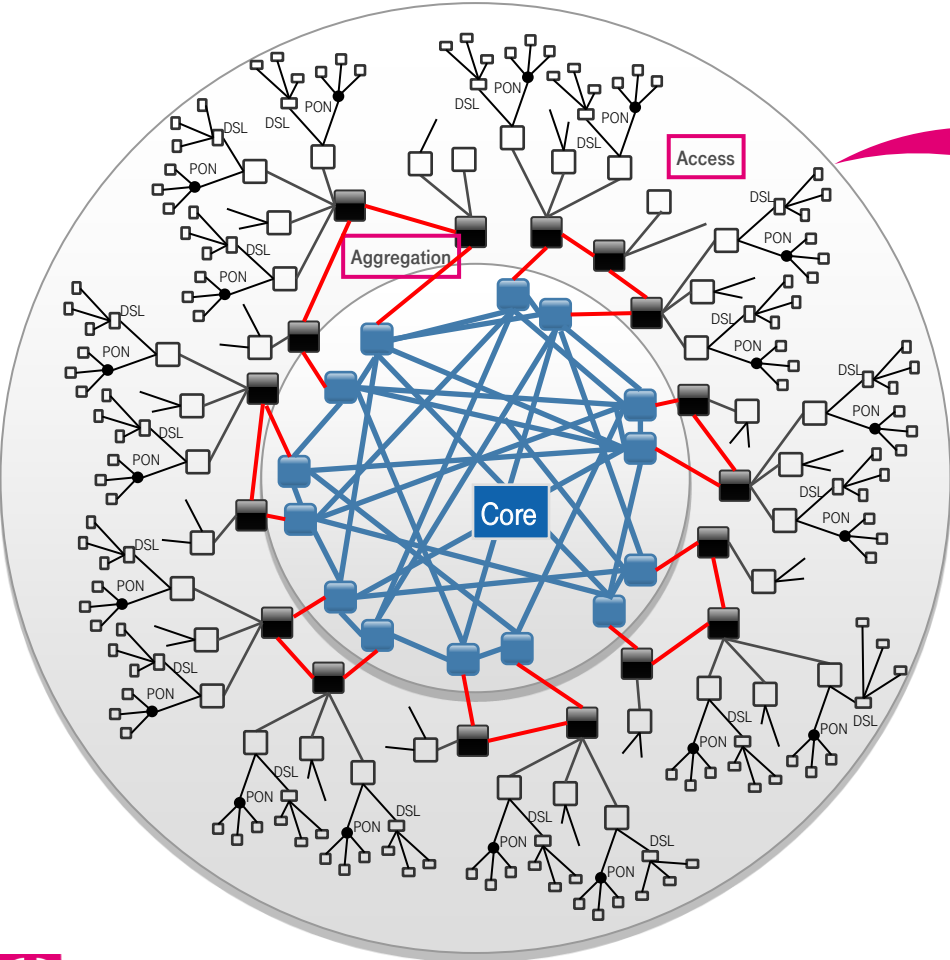
5G

- Network Slicing
- Data Integrity
- Distributed Edge Cloud
- CAPEX Minization for Field Layer Leverage

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IoT
Distributed Cloud

Smart Grid
Mgmt Appl

Rules

Public 4G
Network

SmartGrid
Adlershof, Berlin

25389

25389

Utility NW Slice
5G-enabled
Network

5G
Core

Smart Grid
Mgmt Appl

Rules

Virtual
SM

25389

25389

SmartGrid
Deutsche Telekom, Bonn

TOPOLOGY CONVERGENCE
5G: ICT NETWORKS ADAPT TO BUSINESS PROCESSES

WEB

LOCAL

DT Platform

Platform Socket

Local Controller

Field layer leverage

External data sources, Applications

④ Edge-Apps   DEM   QoE

E2e management & orchestration

Security & Privacy

Sense > Analyze > Decide > Act

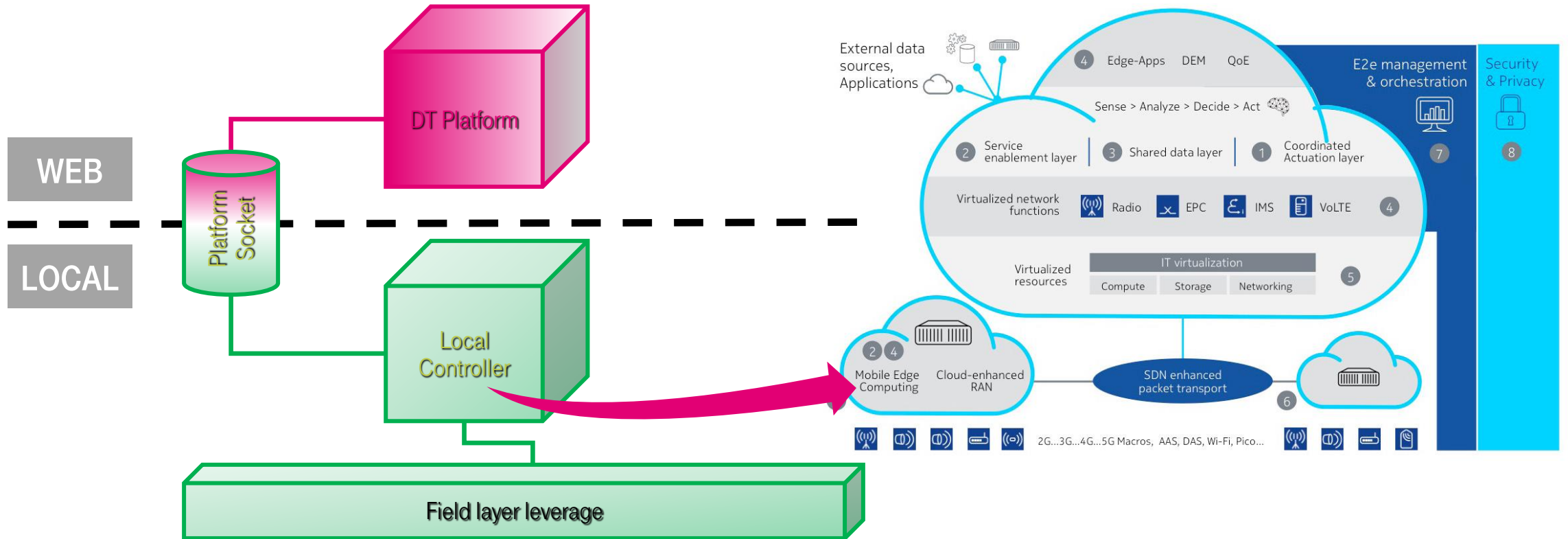② Service enablement layer | ③ Shared data layer | ① Coordinated Actuation layer

Virtualized network functions   Radio   EPC   IMS   VoLTE   ④

Virtualized resources

IT virtualization

Compute   Storage   Networking   ⑤

② ④ Mobile Edge Computing   Cloud-enhanced RAN

SDN enhanced packet transport

⑥

2G...3G...4G...5G Macros, AAS, DAS, Wi-Fi, Pico...

⑦

⑧
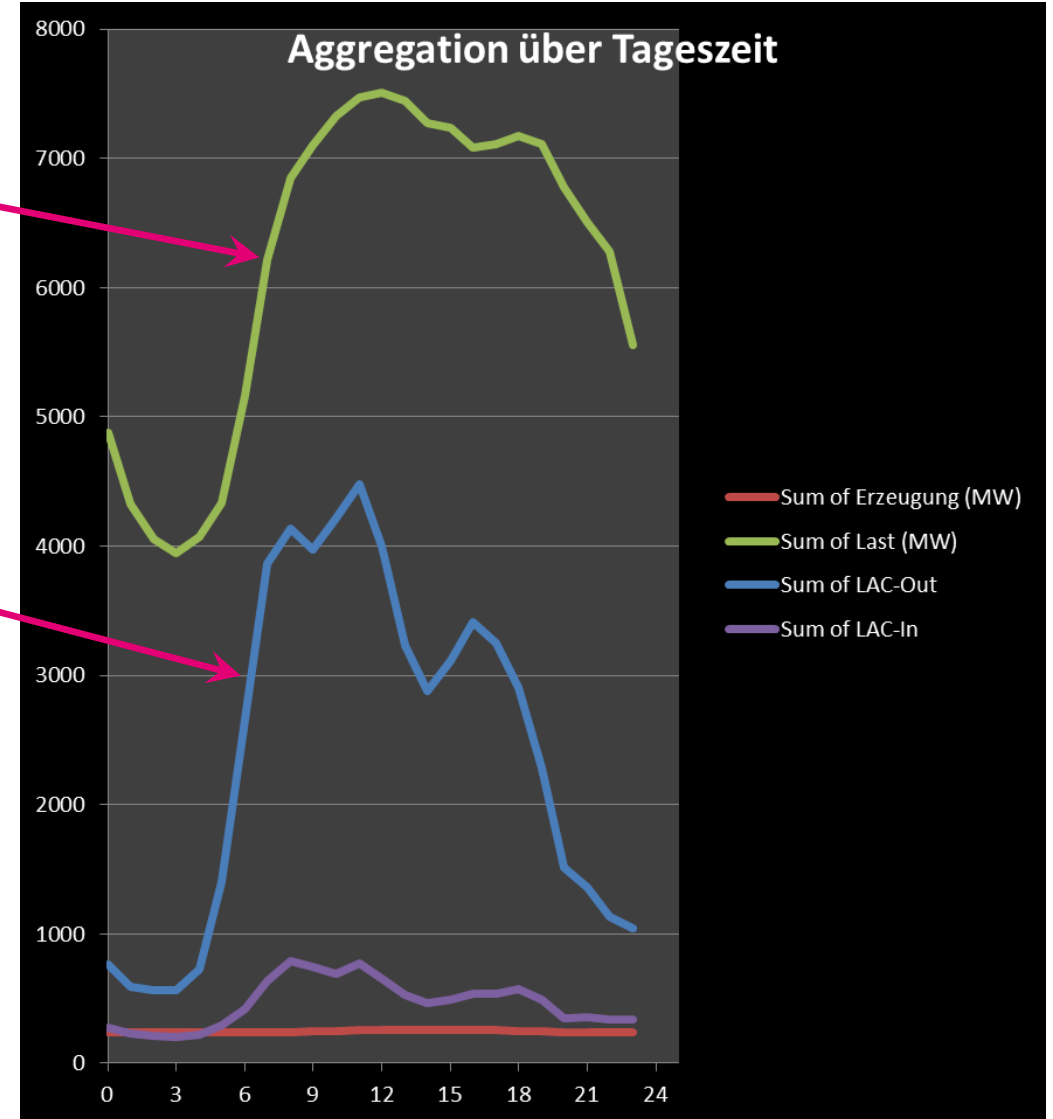
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DATA COUPLING
CROSS-DOMAIN CORRELATIONS

- Mobile networks cell occupation correlates to a manifold of domains which are determined by human behaviouristics.

- They are statistically significant.

-

Hamburg utility open data portal

aggregate migration in mobile network cells

Aggregation über Tageszeit

Sum of Erzeugung (MW)
Sum of Last (MW)
Sum of LAC-Out
Sum of LAC-In

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THX