Towards Setting Environmental Requirements for 5G

Sustainable green 5G powering ETSI+ITU-T workshop

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Chairman of ETSI EE/EE2 power, earthing/bonding, control monitoring interface
Associate rapporteur of ITU-T SG5 Question 6 Smart Energy and EE KPI
Summary

• What would be 5G? Performances, services, infrastructure …

• Which smart green resilient power for 5G, risks to manage and standards?

• Details on standards
What would be 5G?
Performances, services and architectures
5G performances and services targets

Very ambitious Energy target -90% saving... per service*

* https://ieeekerala.org/7-things-you-need-to-know-about-5g/
5G use cases and related performance specification: which infrastructure?
5G media everywhere
Infrastructure for dense BB radio coverage need power everywhere
AC grid is not sufficient
5G infrastructures and technics
Macro to Femto/Pico cells need end to end powering coherence

Smart and connected - the communication of tomorrow with 5G
Toward 5G network (research view)
Much more cells requiring green and resilient power

Namyoon Lee expert in future wireless communication systems using multi-antenna and machine learning algorithms. (Samsung Advanced Institute of Technology (SAIT), Nokia Research Center at Berkeley, Wireless Communications Research (WCR) Intel Labs, awards in IEEE ComSoc and Wireless Communications Letters)
Not only one vision and path to 5G, but Powering solutions should be agnostic and reuse part of existing equipment

Unified New Radio (NR) approach or not?

- **Pure unified 5G NR**: R&D, academics and some operators target an ideal 5G for 2020 with « no » latency for critical communications cellular network for all services, backed by a universal core network (NFV) “sliced” between use-cases.

- **Pragmatic 5G approach**: Some semiconductor, network and carriers companies in 3GPP RAN aim at step deployment enabling 3Gs target Capacity, Cost, and Carbon dioxide → Incremental phases proposed for minimising the R&D risk:
  - **Phase 1 (2018)**: focus of development for defined use cases
    - core enhanced Mobile BroadBand (eMBB) for low-cost low-band spectrum, e.g. in emerging countries
    - “massive” M2M (scalability, low power sensors) and “critical” communications (high QoS, low latency).
  - **Phase 2 (2020)**: next development step on emerging use cases: autonomous cars, Vehicle to Vehicle (V2V), drones, higher band frequency.

→ **convergent network rather than unified 5G NR**: 4G core network in non standalone (NSA) + new 5G core in SA

https://www.telco2research.com/articles/EB_The-Path-to-5G
5G smart green resilient powering
Risk to manage, and standardization work
Network risks to manage, works, tracks (1/3)

1) Higher bandwidth, dense coverage with higher frequency band imposes high effort to reduce energy consumption:
   - **More Efficient and Linear amplifier** (research on higher efficiency RF amplifiers (PAE and PAPR*) by components (GAN, AsGa, FD SOI) and electronic structures e.g. enhanced Doherty, envelop detection, …**
   - **More Efficient radio**: beam forming, massive MIMO, segmented polarization**

2) Architecture with many low energy Small Cells (SC) complementing Macro Cells (MC)
   \(\rightarrow\) understanding is basis of good joint 5G powering ETSI/ITU-T standards

<table>
<thead>
<tr>
<th>For example which power requirement and where:</th>
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<tbody>
<tr>
<td>- 0.1 km(^2) SC rather than 1 km(^2) MC</td>
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<td>- 90% Energy Saving target</td>
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<td>- assuming a mean MC power consumption = 2 kW</td>
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*PAE= Power Added Efficiency  PAPR=Power to Average Power Ratio
Standards are required for:

- Verification of Energy savings in general:
  - Power monitoring / Energy metering standards (EE2 in liaison with 3GPP)
  - EE Modelisation, metrics, analysis for feedback
    it may included new technics of Big Data + A.I. ? to be considered in EE+ ITU-T SG5

- More dynamic local and network power savings:
  - EE network feedback control for less active nodes with higher average load
e.g. through self organization (SON), function virtualisation (NFV/SDN) under work
  in Q6 + EE e.g. Green Abstraction Layer standards (GAL2), …

- New deep level radio protocol optimization: out of scope, but it is key input to
  EE and SG5 for an optimal 5G power solutions and EE KPI


** for example refer to Eu project e.g. Soogreen https://www.celticplus.eu/project-soogreen
Risks to manage, works, tracks (3/3)
Some words on new 5G device energizing

More smart device with more performance and use in 5G

• **smart resilient stationary connected objects** (pico-cells, sensors, actuators):
  – Test standards on energy storage (battery, supercap) adapted to 5G ICT use cases → EE2 + Q6 for example avoiding primary batteries and e wastes by longer lifetime solutions
  – Energy harvesting (EE2 + Q6/5) e.g. by renewable energy and capillar DC nanogrid
  – Efficient radio, saving modes (ETSI + ITU-T and ITU-R)

• **self-charge robot, drone, self driving cars, smart city IoT equipment:**
  which possible mutualized/shared energy infrastructure for 5G network?
  → Q6 + EE2 standards on smart building resilient green power

• **and finally smart terminals and connected objects/IoT energizing:**
  5G require higher performance/energy ratio, D2D, …
  but what to do, if not sufficient EE and breakthrough in batteries in 2020 for 5G?
  fast energy refuelling solutions ? mutualized recharging point and infrastructure in smartcity ?
  →to include new EE and SG5 standardization ?
Details on some ETSI EE and ITU-T SG5 standardization work useful for smart, sustainable, green & resilient 5G powering
Main standards useful for 5G powering
ETSI EE/EE2 and joint WI with ITU-T Q6/5

• **5G network Powering**
  - smart green resilient 5G powering solutions: (EE2 + Q6/5) based on:
    • **EE2 EN 300 132-x, Q6 L.1200 series**: local and remote powering in existing ICT/network context: power interface, migration to 400VDC with PV and smart DC micro/nanogrids, dual ICT power supply inputs (-48, AC, 400VDC)
    • **EE2 ES 202 336-1 to 12**: smart Energy-Environment remote management interface and data model → Power/Cooling optimized consumption, dynamic and optimal settings and learning
    • **EE2 EN 302 099**: Access Network powering solutions including 48VDC and 400VDC remote powering → local grid connection delay/cost avoided, no battery costs, more Renewable Energy
    • **Q6 L.1220, EE2 TS 103 553**: Innovative stationnary Energy Storage evaluation and tests method for ICT → adapted battery, supercapacitor, … to ICT use-cases

• **5G smart device and cells powering (green and anywhere in smart city)**
  - **TR 102 121 (EE2)** Home renewable energy + battery and powering DC network for resilience → **L.1000 ITU-T series** on universal powering solutions for stationary device and mobile/portable device refers to this ETSI TR, as DC universal detachable cable and plugs enable its use and **it can simplify 5G powering**

→ All WI references on web Work Program of ETSI EE TC WG or of ITU-T SG5
## Summary of works(*) and (pre)publications

### ETSI EE2 & ITU-T Q6 documents useful for 5G

<table>
<thead>
<tr>
<th>Relevant standard for 5G powering solutions</th>
<th>ETSI EE2</th>
<th>ITU-T Q6/5</th>
<th>joint EE2+Q6</th>
<th>joint EE+SG5</th>
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<tbody>
<tr>
<td><strong>Smart green and resilient 5G network Powering</strong></td>
<td>agreed at EE#51*</td>
<td>L.5Gpower*</td>
<td>2018</td>
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<td><strong>ICT equipment power interface</strong></td>
<td>EN 300 132-3</td>
<td>L.1200 L.1202 L.1204 L.1206</td>
<td>2016</td>
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<td>- reliability &amp; efficiency</td>
<td>TS 103 531 EN 301 605 (2016)</td>
<td>2017</td>
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<tr>
<td>- architecture</td>
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<td>- dual power input</td>
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<tr>
<td>- earthing &amp; bonding</td>
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<td><strong>Coupling local renewable energy and microgrid to 400VDC</strong></td>
<td>ES 203 474</td>
<td>L.1205</td>
<td>2017</td>
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<tr>
<td><strong>Migration towards 400VDC</strong></td>
<td>DES 0260</td>
<td>L.400migration</td>
<td>2018</td>
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<td><strong>Access network power solution (including remote feeding)</strong></td>
<td>REN 302 099* (2018)</td>
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<td>2017/18?</td>
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<tr>
<td><strong>Energy Storage for stationary ICT: selection and new adapted test method</strong></td>
<td>ES 103 553 DES0259-2 battery* -3 supercapacitor*</td>
<td>L.1220 L.ENST2* L.ENST3*</td>
<td>2017 2018 2018</td>
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<tr>
<td><strong>Control/monitoring/energy metering for O&amp;M services, KPI + Optimization control BB analytics, IA (EEPS and Q6)</strong></td>
<td>ES 202 336-1 to -11 RES 202 336-12*</td>
<td>5G EE* metrics/KPI*</td>
<td>GAL2 (2018) 2018 NWI?</td>
<td>2018 NWI?</td>
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Example of network power using EE2 & Q6/5 documents
Applicable to 5G & allowing partial use of existing infrastructures

**Telecom site with remote powering**

- Rectifiers
- PV controller
- Green fuel Generator option
- Local 400VDC
- 48V
- EE2 EN 300 132 series
- Q6 L.1200 series
- Power interfaces
- Remote Powering
- EE2 EN 302 099
- PV coupling or DC nanogrid option
- ETSI EE2 TS ES 203 474 / Q6 L.1205
- Hybrid line (optical fiber+power)

**Options**

- Sustainable green 5G Powering EE2 + Q6/5
- EE2 ES 202 336 series for remote management
- AC grid (+- smart)
- 5G (Urban, rural, road, Rail)
- FTTx, street/building massive IoT,...
- Capilar DC PV+battery EE2 TR 102 121, ITU-T L.1001
- C2S: Cabinet to Street Equipment
- Roof Macro cells
- Tower Cells
Monitoring/Metering and remote management/analysis with ETSI ES 202 336 series

- Multisite, multivendor XRMS
  - Real Time O&M assistance
  - Control/monitoring + Energy Metering
  - Data Analysis & Storage
  - (Energy, EE, performance KPI)

- Telecom/ICT site e.g. 5G RAN site
  - Building, Cooling, Power Systems, control monitoring
  - ES 202 336-1 to 11

- ICT Equipment
  - Power, Energy, Environment (PEE)
  - ES 202 336-12

- PEE data
  - ES 202 336-12

- Optional Monitoring

- TMN protocol

- Domain Manager & Network Manager (3GPP model)

- Control protocol not specified in ES 202 336-12

- Out of the scope of the ES 202 336-12 (liaison with 3GPP)

- Interoperable and unified protocol
  - TCP/IP http(s) REST XML over Ethernet, GPRS, etc.

- True RMS electric sensors
- Temperature/humidity sensors

- PEE data export
  - ES 202 336-12

- Non Real Time Power/Energy Analysis Services:
  - Energy Report Edition
  - Correlation Analysis Energy/Telecom
  - Optimisation control
  - etc.
Thank you
Merci
Questions ?
Back-up slide
5G frequencies and cells

Low frequency cells 700 MHz
High frequency cells 3.4-3.8 GHz
Millimetre wave cells 26 GHz

… 300 GHz ?

Large scale events
Thousands of users
Vehicle communications
Transport infrastructure
Environmental monitoring &
Smart cities
Transport &
infrastructure
Improved residential
connections, Smart energy