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## 1 General

To assist the discussion on the charging aspects of energy efficiency, we collect the charging related service requirements by SA1 in TS 22.261 [1], the charging related potential solutions by SA2 in TR 23.700-66 [2] and the energy related KPI collected by SA5 OAM in TS 28.554 [3].

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## 2 References

[1] 3GPP TS 22.261: "Service requirements for the 5G system; Stage 1"

[2] 3GPP TR 23.700-66: "Study on Energy Efficiency and Energy Saving"

[3] 3GPP TS 28.554: "Management and orchestration; 5G end to end Key Performance Indicators (KPI)"

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## 3 Charging related service requirements by SA1

According to the service requirements defined in Clause 6.15a TS 22.261 [1], there are four types of requirement that have potential relevance to the charging aspect of saving network energy.

- Req #1: Associate energy consumption information with charging information or apply energy credit limit policy.

- Req #2: Report energy related information as part of charging information.

*"The 5G system shall provide a mechanism to include Energy related information as part of charging information." Clause 6.15a.2.2*

- Req #3: Support different charging mechanisms based on the different energy states.

*"The 5G system shall support different charging mechanisms based on the different energy states of network elements and network functions." Clause 6.15a.3*

- Req #4: Collect charging information associated with serving UEs of other operators for the purpose of saving energy.

*"Subject to regulatory requirements and operators' policies, the 5G system shall enable an operator to temporarily serve UEs of other operators within a geographical area for the purpose of saving energy of the other operators. It is assumed that the 5G system can collect charging information associated with serving UEs of other operators." Clause 6.15a.6*

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## 4 Charging related potential solutions by SA2

SA2 study is still ongoing with the following three key issues:

- Key Issue #1: Network energy related information exposure
- Key Issue #2: Subscription and policy control to support energy efficiency and energy saving as service criteria
- Key Issue #3: 5GS enhancements for network energy saving and efficiency

According to the approved 32 solutions in TR 23.700-66 [2] by SA2#161 in February 2024, we identified 7 solutions that are relevant to the charging aspect. Here is a list of solutions with brief introduction (for information only).

- Solution #9 proposes to let CHF controls the available energy credit limit of subscribers and is responsible to notify PCF to trigger policy update for a subscriber when credit limit is exceeded. The energy credit may be the daily/monthly energy consumption reaches XX J/WH, or daily/monthly energy expenses/phone billings reached XX dollars, or energy efficiency reached a threshold. Nchf\_SpendingLimitControl service shall be enhanced to support this solution. How the CHF track the spending related to energy credit limit is FFS.
- Solution #12 proposes to enhance NWDAF for energy related analytics and expose the output to consumers (e.g. AF, SMF, CHF). If the consumer is CHF, the CHF may record the energy consumption information for charging. The energy consumption information is at various granularity (e.g. UE, PDU Session, Network Slice) over a period of time which can be a value (e.g. in Wh) or a class (e.g. low, medium, high).
- Solution #14 proposes to enhance the subscription information in the UDR by having an Energy Credit Profile and PCF could manage the balance of energy credit units per UE. When UE's energy credit balance is empty, the UE is either rejected PDU session establishment or being charged at higher service rate based on operator policy. The credit control at PCF is to be justified vs CHF.
- Solution #17 proposes that CN can further process energy related information retrieved from OAM in either fine or coarse granularity. The NWDAF is responsible for the calculation of the energy consumption information for coarser granularities (e.g. per area, per application, per group of UEs, etc.). The SMF is responsible for the finer granularity and relative accurate collection of energy consumption information with the granularity of a PDU Session (or even a QoS Flow). The CHF can receive fine granular and relative accurate energy consumption information a PDU Session (or even a QoS Flow) and can provide energy credit/budget control information to the SMF.
- Solution #19 proposes to allow NG-RAN calculates the PDU session / QoS flow level NG-RAN EC and reports the corresponding energy consumption related information to SMF. SMF reports to the CHF the NG-RAN energy consumption related information. The CHF may use the information for credit limit control or charging purpose.
- Solution #20 proposes to allow RAN reports to the UPF the energy related information per PDU session level. The UPF provide the information to SMF. SMF perform information summarization and report to CHF. The CHF may use the information to generate billing information that takes energy related information into account. The CHF can run an Energy Credit Conversion Algorithm that can enable an energy-credit-based handling of subscribers. The CHF and NWDAF can also classify a UE in different classes of UE Energy Behaviour to determine how to handle the UE from a charging or system behaviour perspective. The CHF and NWDAF can expose information to customers also.

- Solution #30 proposes to perform energy saving in network slice granularity by re-using the NSAC mechanism to adjust the maximum number of UEs or PDU sessions based on the monitored or collected energy state or consumption per S-NSSAI. The NSACF may expose energy related information to CHF and other NFs, including: whether the NSAC energy threshold is exceeded for a network slice, which NSAC energy threshold is exceeded/the next NSAC energy threshold if the current one is exceeded.

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## 5 Energy related KPI collected by SA5 OAM

The network energy related KPI that can be collected by OAM is summarized in Table A.1.1-1 TR 23.700-66 [2].

**Table 1: Network energy related information collected by OAM**

KPI category	Description	Reference in TS 28.554 [3]
Energy consumption	Energy Consumption of a gNB	6.7.3.4.2
related information	Energy Consumption of the NG-RAN	6.7.3.4.1
reflected by Energy	Energy Consumption of the 5GC	6.7.3.2.1
Consumption (EC)	Energy Consumption of a 5G Network Function	6.7.3.1.1
	Estimated Energy Consumption of a Virtualized Network Function	6.7.3.1.2
	Energy Consumption of a Physical Network Function (PNF) as well as other Power, Energy, Environmental (PEE) measurements	Clause 5.1.1.19.2 of TS 28.552 [10]
	Energy Consumption of a network slice	6.7.3.3
Energy efficiency	Energy Efficiency of the NG-RAN data	6.7.1
related information	Energy Efficiency of the 5GC	6.7.4.1
reflected by Energy Efficiency KPIs	Energy Efficiency of a network slice	6.7.2

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## 6 Discussion for SA5 Charging Group

**Observations:**

Based on the current progress of SA1, SA2 and SA5 OAM, the following aspects may be considered by the charging of energy efficiency.

1. The type of energy related information, e.g. energy consumption, energy efficiency, energy credit, renewable energy ratio, carbon emission.
2. The unit type for energy consumption, e.g. a value (e.g. in Wh or J) or a class (e.g. low, medium, high).
3. The granularity of energy consumption information.
  - various granularities that are being studied by SA2, e.g. Application, Area, group of UEs, UE.
  - several granularities that can be collected by SA5 OAM, e.g. gNB, NG-RAN, 5GC, 5G NF, Virtualized NF, Network Slice.
4. The mechanism of energy credit limit control is still debatable.

**Feedback Form 1: Is there any other observations on energy efficiency that may be considered by the charging group?**

**Identified Gaps:**

Based on the observations, we identified a few key issues that requires study from the charging perspective.

1. The SA5 Charging group shall study the type of energy related information that can be used for charging purpose.
2. The SA5 Charging group shall study the unit type and granularity of energy consumption that can be used for charging purpose.
3. Whether the energy credit limit control should be studied depends on SA2 conclusion.

**Feedback Form 2: Is there any other gaps that may be studied by the charging group?**

**1 – MATRXXX Software**

Whether the energy credit limit control should be studied: this would rather be a decision by SA5 charging, independent from SA2 conclusion (the SA2 scope is more the Policy)

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## 7 Study Objectives

The objective of the study item is to investigate the following charging aspects of energy efficiency:

**WT-1: Identify the charging scenarios and requirements for energy efficiency.**

**WT-2: Identify the key issues derived from charging scenarios, including, but not limited to:**

- WT-2.1 The type of energy related information to be collected as charging information from different CTF for different scenario.
- WT-2.2 The unit type and granularity of energy consumption in charging information.
- WT-2.3 Whether energy credit limit is needed.

**WT-3: Study the potential charging solutions for energy efficiency.**

Note: The charging work will keep alignment with SA2 and SA5 OAM Rel-19 conclusions.

**Feedback Form 3: Is there any other aspects that may be studied in the study item?**

**1 – MATRXXX Software**

I am not in favor of such WT levels split (I could not find such WT in the WID template), it is useless. this is more the usual structure of our TR

**2 – MATRXXX Software**

It is premature to start the SA2 part for SA5 Charging study before any SA2 TR conclusion. I understand there are OAM specified aspects before Rel-19, there is also a TS 28.310, which could be considered. Also SA5 Ch could have the study based on SA1 requirements independently from SA2 study/wid

**3 – Nokia**

In SA1 section, please make sure to have a reference to TS22.261, cl 6.15a

- 5GS shall support a means to associate energy consumption information with charging information based on subscription policies for services without QoS criteria
- Subject to operator's policy, the 5G system shall support a mechanism to perform energy consumption credit limit control for services without QoS criteria.

NOTE: Credit Control compares against a credit control limit. Its assumed charging events are assigned a corresponding energy consumption and this is compared against a policy of energy credit limit. Its assumed there can be a new policy to limit energy consumption allowed