



Computed Tomography (CT) – Study on the potential for environmental improvement by the aspect of energy efficiency

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Agenda



1. Objectives
2. Understanding CTs
3. Measurements, Energy Consumption and Improvement Potentials
4. Summary and Conclusions





1. Objectives

Objectives

- **Goal**
 - Provide a target reflecting improvement potentials for CT that goes beyond BAU – is realistic – is ambitious
- **Objective**
 - Analyze improvement potentials for CTs
 - Quantify improvement potentials for CTs
 - derive possible target
- **Tasks**
 - Define CT products (for the SRI)
 - Define function and functional unit
 - Interview each company
 - results from measurements
 - Technical explanations
 - Discuss and understand technical improvements
 - Analyze, calculate, summarize and report

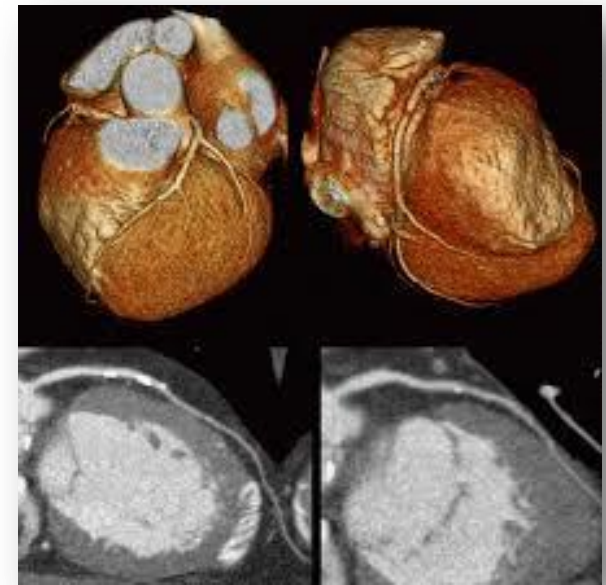
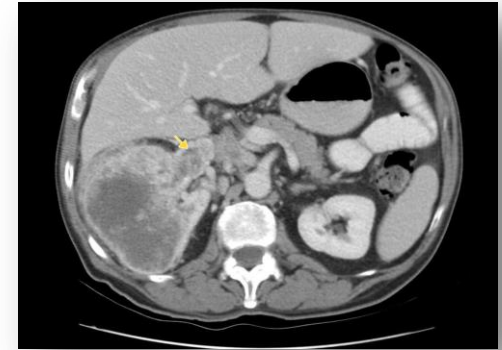




2. Understanding CTs

Complexity of CTs

- **Function of CTs**
 - the principle is always “providing an image”
- **Complexity of CTs**
 - which image of which part of the body and in which time,
 - frequency,
 - resolution and quality,
 - colored or black and white,
 - fast or slow,
 - dynamic of moving elements or static,
 - CT technology in combination with other investigation or interventional methods,
 - new functions,
 - New performances and new developments.



General Options for Improvements - Efficiency

Decrease of
power
consumption/
Increase of
efficiency

- **Numerous individual modules** and functional devices
- Separate individual, **highly complex sub-products**
- **Total efficiency factor not applicable**
- **Average efficiency factor not feasible:** Devices do not follow a general efficiency pattern, such as computing, power transforming, converting, inverting, cooling, moving etc.

Examples for which single efficiency factors work:

external power supply units, electric motors, transformers, TV sets. Though watching TV is not a single functional unit - aspects such as screen size, quality of picture, number of pixels, contrast range are influencing the efficiency but are difficult to get reflected quantitatively



General Options for Improvements – Time

Faster examination
(even by increased energy per day)
→ **less power** per examination

- time is important, but not the only performance factor
- **value is given by detail of information** given to medical experts
- Imaging depends on type, quality, perspective, resolution, static or dynamic visuals, material and concentration and many aspects more
- Impossible to compare and track timing of the **numerous options possible and numerous combinations**

Examples for increased performance resulting into shorter times:

functional unit is **clearly quantified** such as dishwashers, washing machines or dryers; the faster function is provided the less energy is consumed

General Options for Improvements – Synergies

Combination of existing functions / adding new functions into one product avoiding several independent devices (MFD)

- functions providing images by
 - new developments
 - innovations
 - combination with other medical examination disciplines
- Complex set of performance requirements and new, non-comparable functions
- Identifying synergies quantitatively by allocation is not possible with CT, because of missing clear boundary conditions or system boundaries for applying allocation

Examples of combination of functions having synergies: multi-function devices (MFD) e.g. printing and imaging.

Combination of clearly identifiable functions such as printing, faxing and scanning, for which discrete products also exist. Comparison and allocation can take place



General Options for Improvements – Mode

Modes reflecting more precise the function of the product during this mode

- Idle within an examination routine
- Idle in between patient's examination
- Ready to scan immediately
- Ready to scan during longer intervals of (possible) no-use
- Power off is not LowPower mode

Examples of newly introduced modes:

During the investigation of complex settop boxes it was differentiated between terms of “stand-by” and “stand-by with network access”. **Both modes are called stand-by but provide totally different functions**, thus it was proposed to introduce new modes to reflect power consumption on different levels





3. Measurements, Energy Consumption and Improvement Potentials

Project Procedure

Definition of product CT (system description)

Specification of typical patient examination routines

Functional unit via typical examination routines during a day

Data collection

Modularization

Application of data to modules

Technical improvements per module

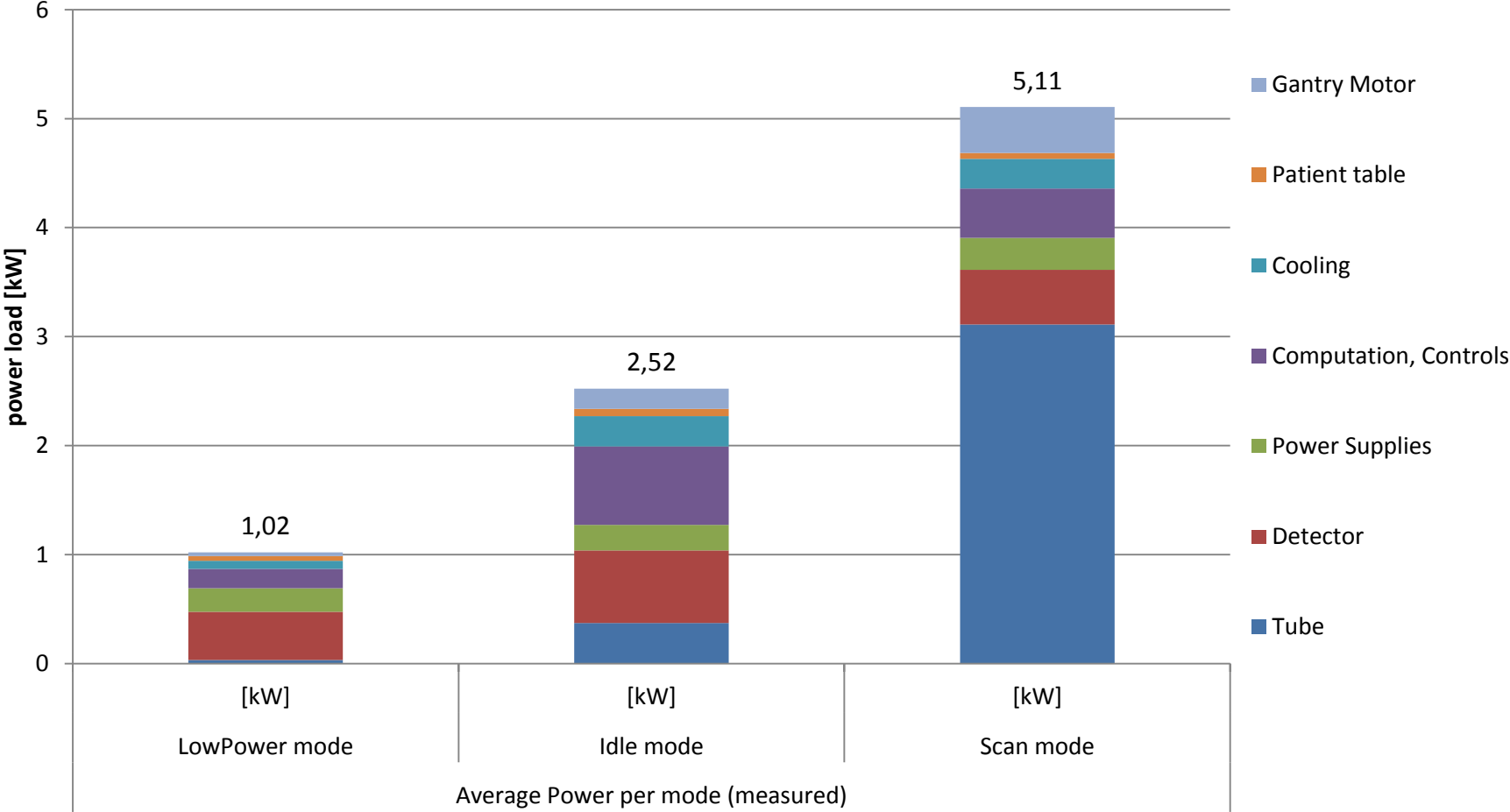
Improvements by use behavior

Calculation of scenarios

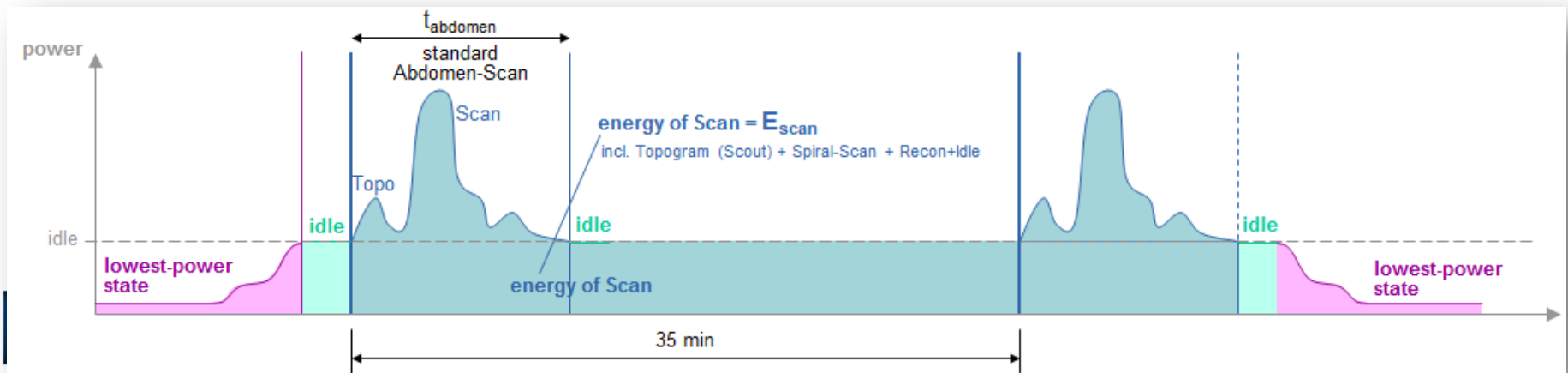
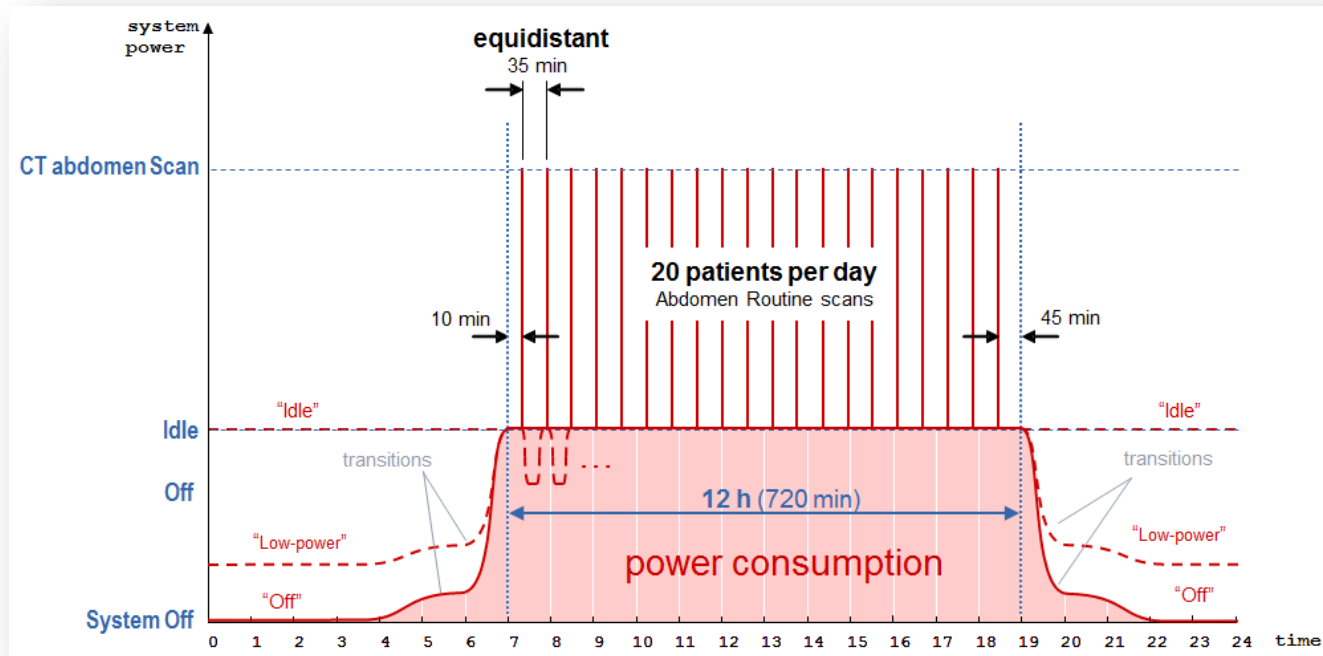


Average Power Load of CTs

Average power load per mode (measured)

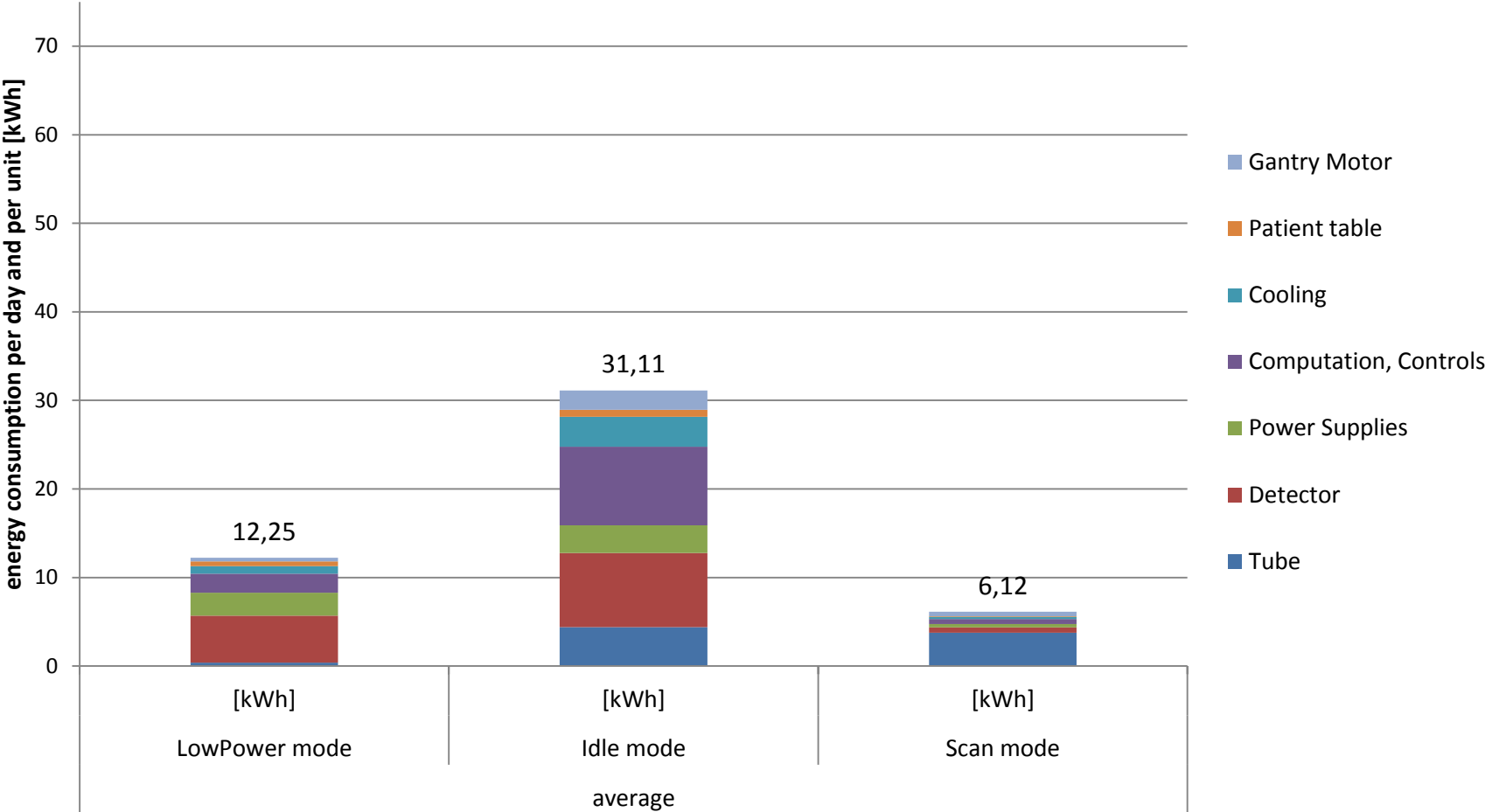


Specified Typical CT Business Day



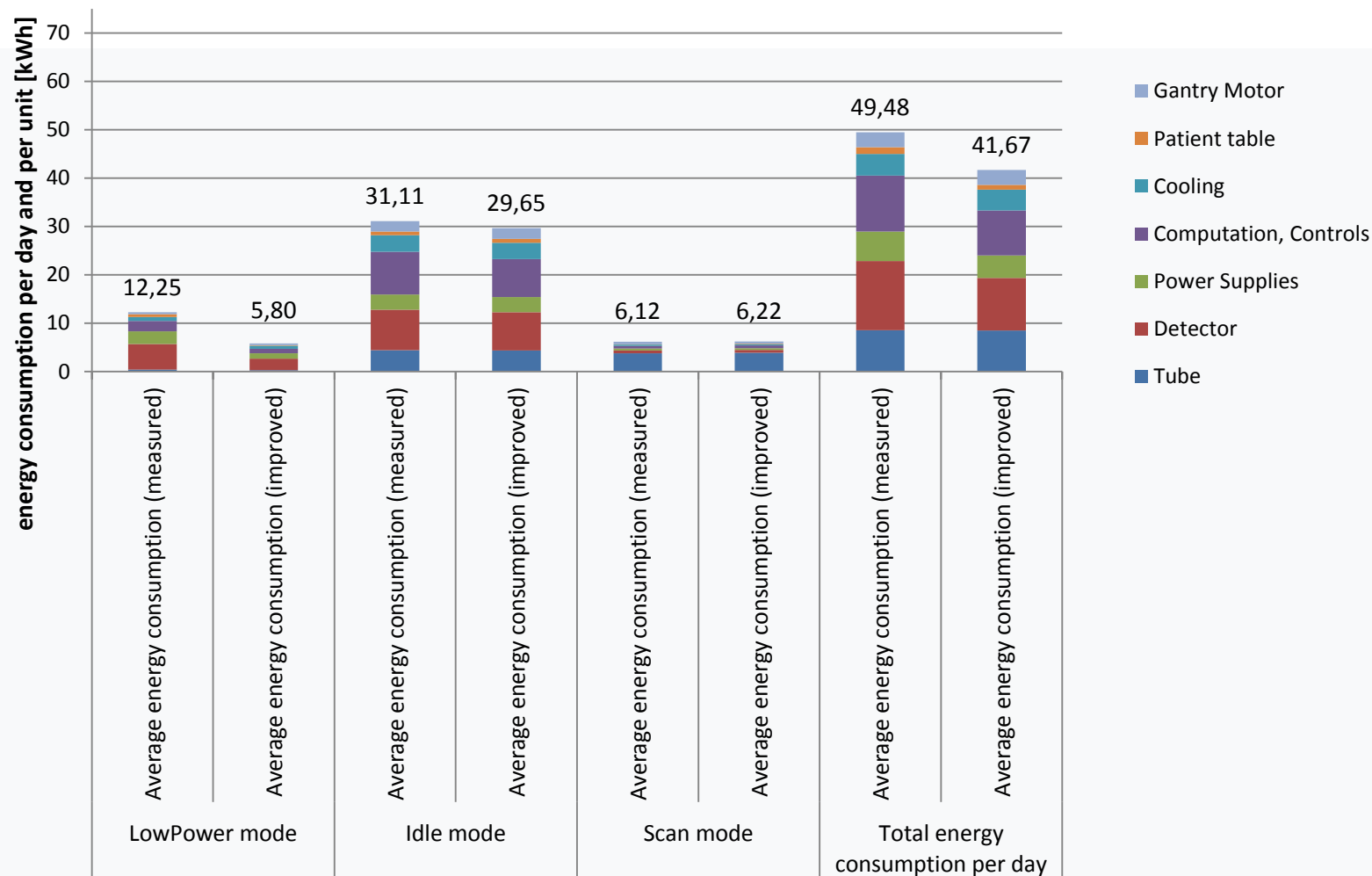
Average Energy Consumption per Day

Average energy consumption - standardized theoretic use day

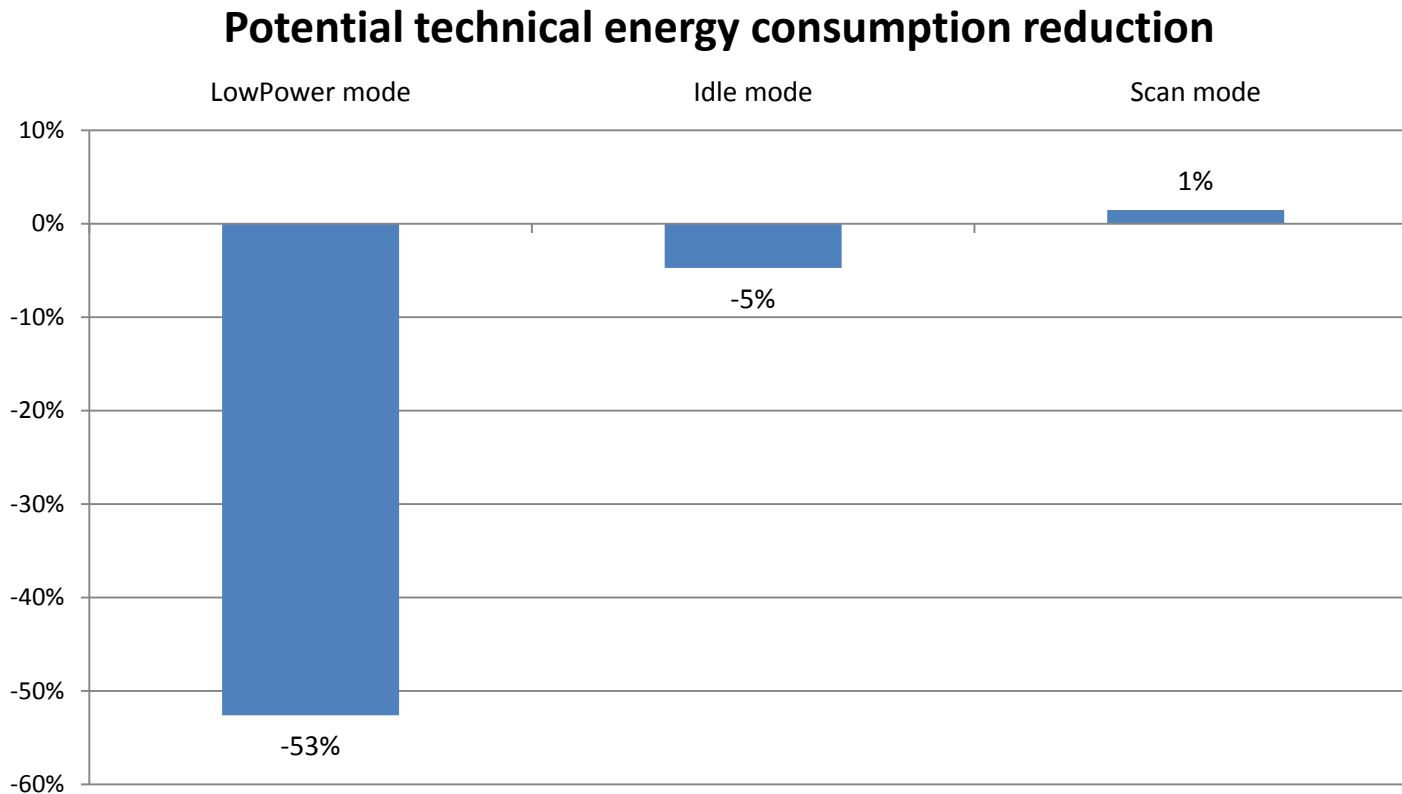


Energy Consumption and Technical Improvements

Average energy consumption - measured vs. after technical improvements



Technical Improvements per Mode



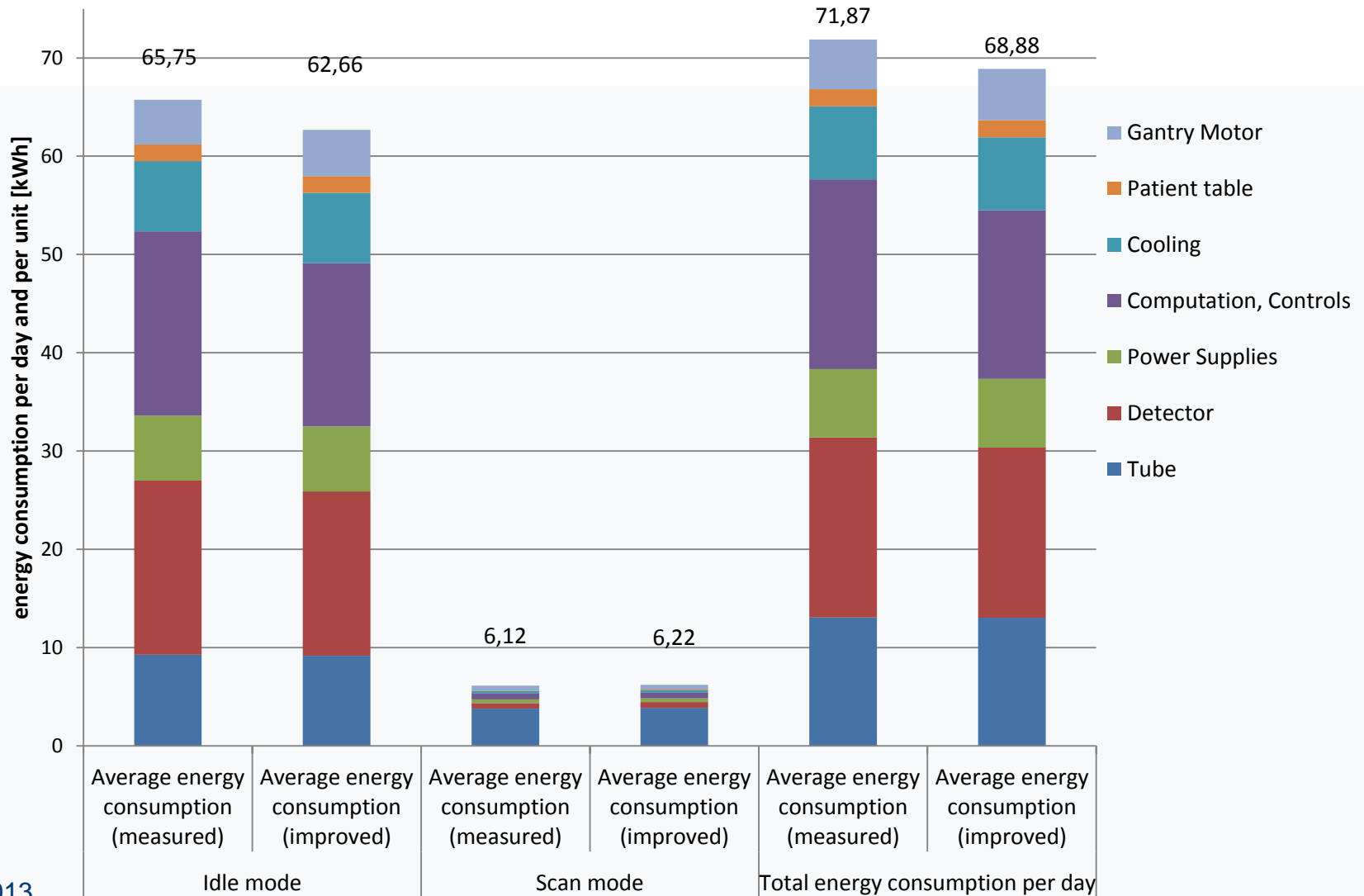
- **Improvements Resulting per Day**

- With 12h LowPower mode during night there is a **16%** improvement
- 12h LowPower per day is unrealistic, thus improvement might drop down to **5%** or lower



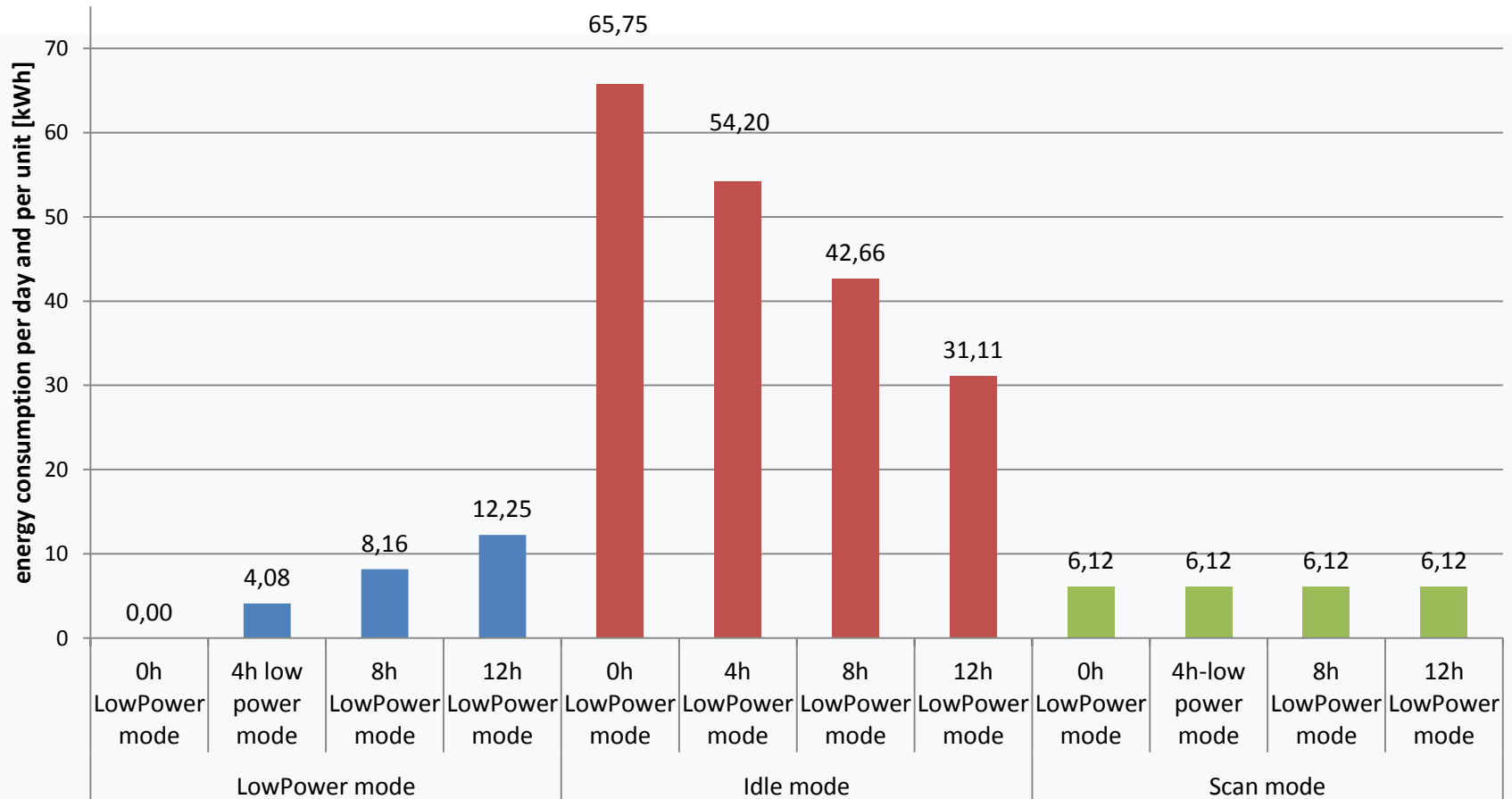
Technical Improvements in Case of LowPower Mode

Average energy consumption - no use of LowPower mode



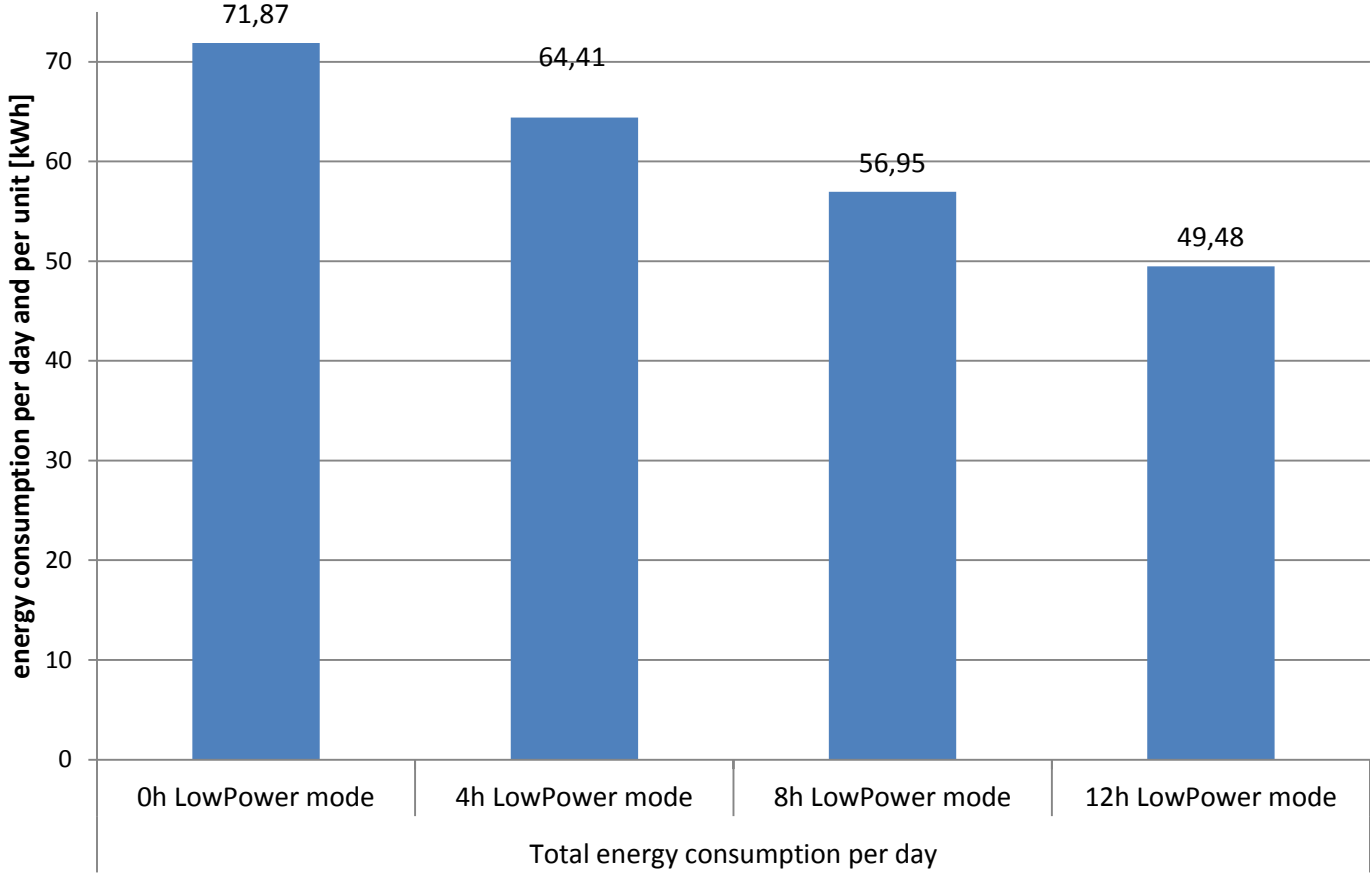
Energy Consumption for Different Use Scenarios – per Mode

Average energy consumption in different usage scenarios



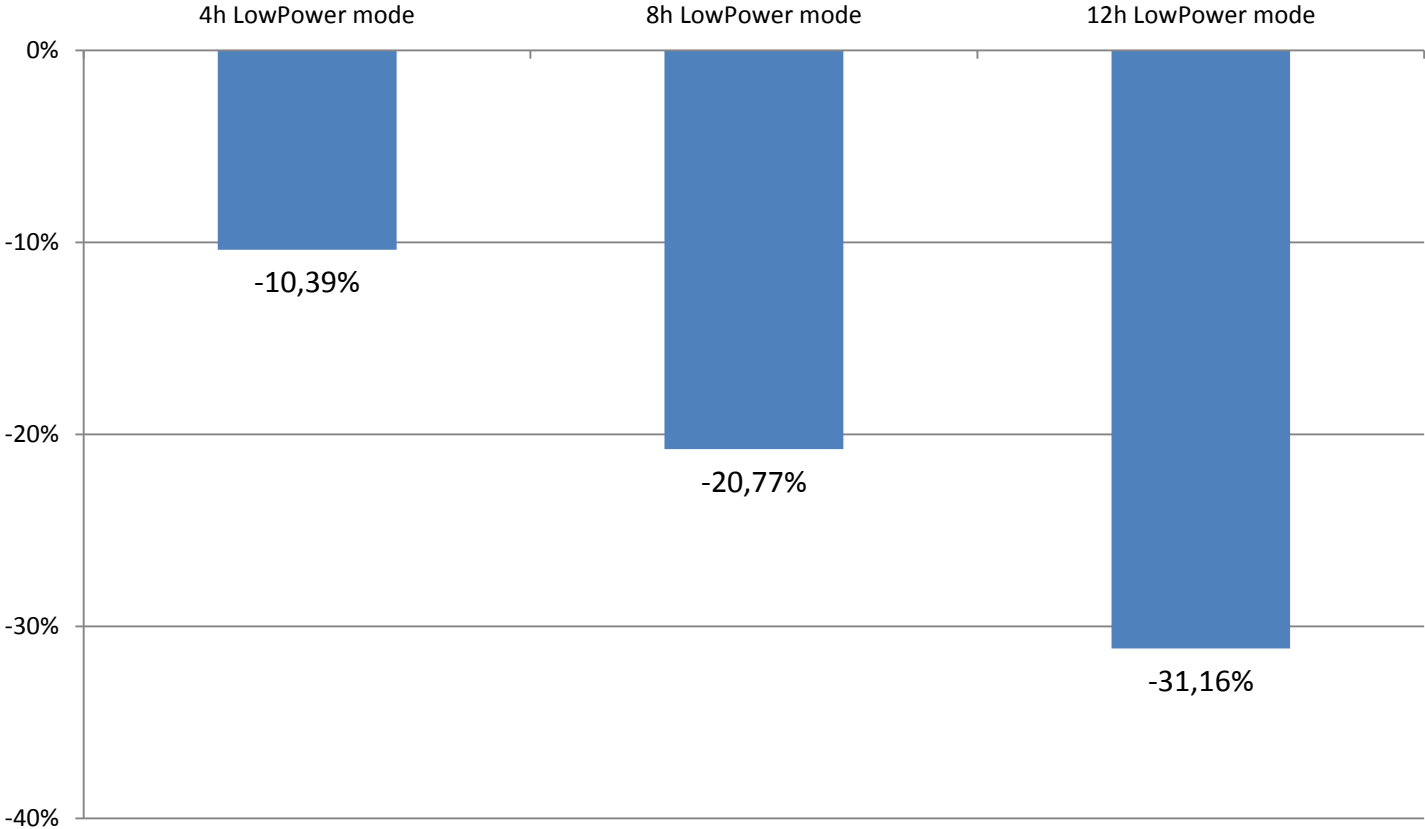
Energy Consumption for Different Use Scenarios – per Total Day

Average total energy consumption per day seperated by scenario



Scenarios of Improvements Reflecting Use Behaviour

Energy consumption reduction potential





4. Summary and Conclusions

Summary

- 3 different modes – all consume energy: LowPower, Idle and Scan
- Highest technical improvement potential provides LowPower mode with ca. 50%
- Specified Business Day (necessary for Measurements) considers 12h LowPower during night
- Surveys allow assumptions, that use behavior avoids LowPower mode, thus technical improvement potentials are **not** applicable



Conclusions

- When LowPower mode is not applied, technical improvements drop down to ca. 5%
- Influencing use behavior to apply LowPower mode shows improvement potentials of 10%, 20% or 31% (without any technical improvement first) for 4h, 8h or 12h application of LowPower mode compared to 0h LowPower mode
- Single target is not applicable due to uncertainty of use behavior data
- In any case, each hour of application LowPower mode is positive up to an improvement of 31%
- Proposal to motivate and enable use of LowPower mode following article 14 of ErP directive (consumer information) e.g. via
 - manuals,
 - training offers,
 - information campaigns