COCIR SELF-REGULATORY INITIATIVE
FOR MEDICAL IMAGING EQUIPMENT

MAGNETIC RESONANCE EQUIPMENT MEASUREMENT OF ENERGY CONSUMPTION 2025

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1. Introduction

COCIR's methodology for measuring energy consumption in MRI was originally published in 2012 to meet the demands of healthcare providers about comparable energy measurements. Since then, significant technological advances have been made in both hardware and software of MRI systems which warranted a revision of the procedure to measure and disclose energy consumption for a representative set of scanning sequences used in the majority of clinical use cases in 2025. In addition, significant increases in clinical operating hours are being implemented in response to economic challenges. This version of the methodology covers both average and high productivity use scenarios.

2. Scope

The methodology described in this document can be used to measure energy consumption for any MRI system type.
The method uses vendor-provided sequences that are subject to regular system validation (i.e. judged to be sufficient to enable radiologists to establish a diagnosis in the majority of clinical use cases) and are part of the basic configuration of the system-as-installed.
The energy consumption for additional SW options, innovative or niche applications cannot be derived from the measurement results obtained with the procedure described in this document.
Optional HW equipment and accessories, or customer-provided equipment, such as optional MR coils, patient vital signs accessories, contrast injectors, facility-provided cooling water equipment and hardware for advanced medical applications, are outside the scope of this procedure.
The methodology is not suited for the measurement of technologies combining MRI with other imaging modalities, such as MRI/CT, MRI/PET or MRLinac.

3. Disclaimer

Recommendation For Manufacturers Using the Methodology
This methodology has been defined using the best knowledge, assumptions, data and expertise of COCIR Members and has been approved by all COCIR Members manufacturing MRIs. The methodology enables manufacturers to declare the energy consumption in a standardized way. Nonetheless real-world usage of MRIs by healthcare providers can differ from the result of this methodology quite significantly, depending on how the measurements are taken in real settings and how the MRI is used.
COCIR recommends manufacturers to always add a disclaimer to their declarations, provided in marketing material, websites or in the documentation supplied for tenders, clarifying that the COCIR methodology provides an estimation based on most common configurations and exams, whilst operating the system per the instructions for use, but does not intend to provide a perfect forecast of energy usage for hospital-specific clinical optimized practices over the life time of the MRI.

4. Definitions

1. **ENERGY**: The capacity to do work. In this document, the unit of energy is kilowatt-hours (kWh).
2. **OFF Mode**: The system is shut down with ac mains off. The system consumes no energy.

   Note: COCIR changed the definition of the previous methodology to align with the new EPA Energy Star specification. This mode does not play any role in this methodology as MRI cannot be switched off.
3. **LOW-POWER Mode**: This mode applies to non-operating hours. It is manually or automatically activated by the user and represents the minimum energy consumption state that the user can select according to the user manual. The power consumption is lower than READY-TO-SCAN and POWER-SAVE MODE. In case this mode requires (optional) manual activation this must be disclosed as part of the COCIR measurements.

   Note: the superconductive magnet is working and consuming energy to maintain the helium liquid
4. **POWER-SAVE Mode:** This mode, if present, applies to operating hours and is automatically activated by the product to consume less energy than READY-TO-SCAN MODE while maintaining the ability for the product to quickly re-enter READY-TO-SCAN MODE.
5. **READY-TO-SCAN Mode**: This mode represents the state of the system between individual sequences and at the end of a scan, before the automatic POWER SAVE MODE engages.
6. **AVERAGE READY-TO-SCAN Mode power:** it is the average power between READY-TO-SCAN MODE and POWER SAVE MODE, weighted over the time spent by the system in both modes during the day. It is calculated by the COCIR MRI spreadsheet and is to be used in the User Calculator.
7. **AVERAGE POWER-SAVE Mode:** The average power save mode calculated over the day for MRIs with multiple modes engaging in sequences. It is calculated by the template.
8. **SCAN Mode:** The MRI is actively scanning the patient to generate images by sending and receiving RF energy and switching the magnetic field gradients, which may include waiting for a breathing command or trigger to commence. The computing system interprets the data and generates the image.
9. **SCAN PAUSES:** pauses in between sequences, assumed to be 20 seconds; this may include some system calibration steps to be executed
10. **SEQUENCE DURATION**: Sequence duration is the time the system is actively scanning during an exam. As the duration is determined by the details of the MRI scan prescription and product capabilities, each sequence's duration has to be determined on a per-product basis.

11. **DELAY TIME**: the time required for the MRI to switch from READY-TO-SCAN Mode to POWER-SAVE Mode after the last scan.
12. **PROCEDURE TYPE**: An examination is a collection of scans for an individual patient. "Procedure Type" refers an exam for a specific anatomy or type of examination (e.g. Abdomen or Brain).
13. **PATIENT PREPARATION TIME:** time required to prepare patient and equipment between individual patient's examinations. Assumed to be 20 minutes.
14. **MRI WATER HEAT EXCHANGER:** MRI Equipment subsystem which transfers heat from the MR cooling water to the facility-provided cooling water. It is necessary that the cooling water in the MRI system is separated from the cooling water provided by the facility to protect MRI components that are water cooled.
15. **NON-OPERATING HOURS:** Daily times/hours outside of operating hours as defined by end users.
16. **OPERATING HOURS:** Daily times/hours that a business provides for pre-scheduled and walk-in appointments, including emergency care, where the use of medical imaging equipment can be expected

5. System Power Modes

The energy consumption differs between the modes. The transition between modes occurs automatically or by operator selection.

The anticipated power of these modes, from high to low, is:

SCAN > READY-TO-SCAN > POWER SAVE > LOW POWER

Nominal daily system operation hours in average productivity use profile are as follows:

Mode	Duration
Operating Hours	12 hours
Non-operating hours*	12 hours

** If 12 hours of low power during non-operating hours is dependent on practitioners manually transitioning the device in this mode this must be disclosed as part of the COCIR measurements.*

While this methodology is provided with a User Calculator Tools that allows to estimate the energy consumption in different use scenarios, including the number of exams per day, the approximation deviates from reality in case the number of exams is far from the decided average defined in this methodology (20 patients per day). For this reason, in addition, Companies are encouraged to also provide the energy consumption data, on a voluntary basis, regarding a high productivity scenario (see Appendix I.4).

Please note that this scenario may produce results that might not be comparable between manufacturers but can help the healthcare providers to have a more realistic use estimation.

Manufacturers are required to provide a clear disclaimer when using the "High productivity" scenario to make sure users do not misunderstood how to use the declared values.

POWER-SAVE mode
Duration is not constant, and it depends on several factors, for instance the DELAY TIME required by the MRI to switch from READY-TO-SCAN mode to POWER-SAVE mode, after the last scan. In case the MRI is not manually switched to LOW-POWER mode during NON-OPERATING hours, such time will be spent in POWER-SAVE mode, if available.

SCAN and READY-TO-SCAN mode
During operating hours, the system is assumed to transition between the two modes: READY-TO-SCAN and SCAN.
In between sequences the machine works in READY-TO-SCAN mode and each pause is assumed to be 20 seconds.

PATIENT PREPARATION TIME
Patient preparation time is the time in between scans. It is assumed constant and equal to 20 minutes. During such interval the machine is assumed to be in READY-TO-SCAN mode for the DELAY TIME and then enter in POWER-SAVE mode if such function is equipped. In case several POWER-SAVE Modes engage in series, reducing the energy consumption, the template provides a tool to consider such situation and calculating the resulting values.

6. MRI EXAMINATION CHARACTERISTICS

MRI usage covers all body parts with different degrees of adoption. This document covers consensus routine clinical use, with the most prevalent scan scenarios for Knee, Brain, L-Spine and Liver (Abdomen).
Extrapolation to other anatomies is not supported and the measurement results are not representative of power consumption in specialized clinics focusing on for example cardiac imaging or neuroscience applications.
Manufacturers provide example sequences as part of the product, which have been validated to provide adequate image quality to enable clinical use without further customization. The energy measurement procedure uses these manufacturer-supplied sequences that can be run in the basic (SW) configuration of the equipment.
Appendix I provides the use distribution of applicable body regions and sequence types and voxel resolutions for the different system types covered in this document: superconducting systems 0.55T, 1.5T/3T, 7T and Permanent Magnets. It also provides the number of patients-per-day for each system.
The duration of each examination is unique per product (and field strength) and is the sum of the sequences' duration, patient handling times and administrative time.

For this methodology, only the scan time or sequence time is considered when determining the energy used in SCAN mode (which includes time spent waiting for a breathing trigger to commence). The remaining time (in between sequences) is covered as READY-TO-SCAN mode. The total sequence duration time must be measured for each equipment and documented in connection with the measured energy use.

To ensure comparability of measurements, a range of acceptable voxel resolutions is defined for each examination. Scan time is the result of voxel resolution and SNR and CNR deemed necessary by the Clinical Expert responsible for the validated factory-delivered sequences. A minimum total Examination Time is specified in Appendix I to reflect generally acknowledged State-of-the-Art and Consensus Recommendations.
Each manufacturer is responsible for determining the duration (sum of the sequences) for each examination. **If the examination duration is less than the reference values in Appendix I, the manufacturer shall disclose this fact in the reporting.**

7. Resources

Power measurement requires interaction with high-voltage / high-current installations. Adequate safety provisions are essential and the responsibility of the organization performing the testing.
The following personnel are recommended:

- An engineer or technician familiar with the power distribution of the system and power electronics safety.
- An engineer or applications specialist familiar with scanner operation and the prescribing of clinical protocols**.**

8. Unit under Test (UUT)

System Configuration: System configuration should be recorded in terms of field strength and gradient performance level: max amplitude, max slew rate (as disclosed on the "About" function of the MRI system per IEC 60601-2-33). The system shall be configured in the minimum-available commercial SW option configuration to perform the set of specified clinical procedures, using appropriate RF receiving coils.

Installation: The system shall be installed and calibrated according to its specification, including all system-critical items needed to perform a basic scan, e.g. gradient amplifiers, RF unit, MR coils needed for the specific measurements, reconstruction engine(s), required electronics such power supplies, controllers, console/computer, cryogen compressor, water heat exchanger, patient table, magnet and helium-conservation equipment.
Any equipment, accessories and SW options beyond basic product offering and not required for a basic scan, or customer-provided equipment, e.g. optional MR coils, patient vital signs accessories, facility-provided cooling water equipment, room air conditioning and hardware for advanced medical applications shall not be included in the measurement.

Environmental Conditions: The measurements are to be taken at a steady-state operating temperature, and within manufacturer's specified ambient temperature and humidity limits.

Measurement: Prior to each mode's measurement, the equipment shall remain in that mode for sufficient time to allow temperature and other pertinent transient conditions to stabilize.

Emulated System: For sequence duration determination, it is permissible to use a device that emulates the hardware capabilities of the system, and uses the product software, to ensure the same prescription restrictions as a full system.

9. Power Measurement Device

A properly calibrated device capable of measuring 3-phase voltage and current and calculating the integral of power with respect to time (energy) or a power meter able to sample average power ratings.

10. Measurement of power and energy

The measured values resulting from this procedure are:

- Power in LOW-POWER mode (kW)
- Power in POWER-SAVE mode (kW) or for multiple POWER-SAVE modes where present
- Power in READY-TO-SCAN mode (kW); note that the system shall not switch to POWER-SAVE mode during this measurement
- Energy (kWh) and duration (seconds) for each scan sequence

The data above, obtained according to the described methodology, must be filled in the appropriate template spreadsheet that can be downloaded from the COCIR website to calculate the daily and annual energy consumption while reducing chances for errors. A company specific template may also be used once validated by COCIR.

The COCIR spreadsheet calculates the following values resulting from this procedure:

- Power in AVERAGE-READY-TO-SCAN (kW) as time-weighted average over READY-TO-SCAN power (kW) and POWER-SAVE power (kW), to be used for the User Calculator Tool
- Power in AVERAGE-POWER-SAVE mode that is required under EPA Energy Star
- Energy consumption per scan per body region (kWh)
- Daily Energy consumption (kWh)
- Annual Energy Consumption (kWh)

10.1. Installation of Power Measurement Device

The power measurement device shall be installed onto the input to the mains disconnect panel of the system to ensure that all energy consumption of the MRI equipment is captured, including the cryogen compressor and the MRI water heat exchanger.

If multiple mains connections are used, the total power shall be evaluated with simultaneous power meters.

10.2. Low-Power mode

1) Ensure that the power meter is on and functioning.
2) Shutdown the system to the minimum energy consumption state that the user can invoke.
3) Wait to ensure that all system elements have established LOW-POWER mode operation.
4) Measure the average power draw, for a period of at least 5 minutes. If the system has a variable power usage in this mode, the measurement duration shall be amended to at least three complete power usage cycle, which shall be taken to be the cycle from minimum to maximum usage.
5) Record the average value, in kilowatts (kW).
6) Report the value in the COCIR template.

10.3. Power-Save Mode

1) Ensure that the power meter is on and functioning.
2) Wait for the machine to switch in POWER SAVE MODE automatically.
3) Wait to ensure that all applicable system elements have adapted to this mode.
4) Measure the average power draw (rate of energy consumption), for a period of at least 5 minutes. If the system has a variable power usage in this mode, the measurement duration shall be amended to three complete power usage cycle, which shall be taken to be the cycle from minimum to maximum usage.
5) Record the average value, in kilowatts (kW).
6) Report the value in the COCIR template.

If the MRI has further automatic power save levels engaging in sequence after the delay time, each further level shall be measured according to the procedures indicated above. The measured values must be entered in the spreadsheet with their respective durations and the correct power will be calculated and entered automatically in the formulas.

In case the MRI is not able to automatically switch to POWER-SAVE mode, the READY-TO-SCAN mode power has to be used in the COCIR Spreadsheet for the POWER-SAVE power draw.
In case the delay time is higher than patient preparation (set at 20 minutes), the delay time must be set at 0 seconds, and the POWER-SAVE power draw set to READY-TO-SCAN value. More instruction in Chapter 12

10.4. Ready-to-scan Mode (Steady State)

1) Ensure that the power meter is on and functioning.
2) Prescribe a patient and execute any scan to ensure that the system is functioning.
3) After the scan completes, record the average power draw (rate of energy consumption), for a period of 5 minutes. Ensure the device does not enter any power

saving mode during the measurement.
4) Record this value, in kilowatts (kW).
5) Report the value in the COCIR template.

10.5. Average-Ready-To-Scan

The AVERAGE-READY-TO-SCAN value for the equipment is calculated automatically in the COCIR template, as a time-weighted average between the power draw of the automatic POWER-SAVE MODE(s) and the power draw of the regular READY-TO-SCAN MODE. This value is displayed in the "Summary" sheet.

10.6. Scan Mode Energy Measurement

Sequence duration determination
The exact prescription of each sequence is to be determined by the individual manufacturers, using their factory-delivered clinical sequences to match the contrast type and resolution range specified in Appendix I (i.e., PD, T1, or T2-weighted).

Record the duration of each sequence in the COCIR template, as calculated by the system's software and displayed in the system's user interface.

Setting up Scan Programs
Prepare a scan program for each exam type according to the user manual using the appropriate factory-delivered sequences matching the requirements laid out in Appendix I. If the total examination time is less than the minimum examination time in Appendix I, this shall be noted and disclosed in the report.
If it is not possible for the MRI system under test to use a certain sequence specified in the Appendix I, use a sequence as close as possible to the sequence specified which is judged by a Clinical Expert to deliver the same contrast and diagnostic results.

> *<u>NOTE</u>:*
> *To ensure comparability and consistency of measurements, if for an MRI there is a need to use different sequences from the ones in Appendix I, values should be adapted to the existing number of sequences in the COCIR template rather than changing the template.*

Store the scan programs for later usage on the same MRI system or MRI system type.

Measurement during scan with equipment actively scanning

Method nr. 1 - Energy Measurement of each sequence
1) Set the equipment to READY-TO-SCAN mode.
2) For each exam type and for each sequence E_n:
   a. Take time "t_s" and energy reading "e_s" and start scan program
   b. After completion of each sequence: take time "t_e" and energy reading "e_e"
   c. The energy consumption of each sequence is "e_e-e_s"
3) Data to be reported in the COCIR template

a. For each sequence, the associated energy consumption in kWh
b. For each sequence the duration in the COCIR template, as calculated by the system's software and displayed in the system's user interface.

Method nr. 2 – Energy Measurement of each sequence (power sampling)

1) Set the equipment to READY-TO-SCAN mode.
2) For each exam type E_n, start scan program and sample the average power consumption within short intervals of time dt (e.g., every second). Pt is the sample at time t.
3) After completion of scan program, for each sequence: calculate total energy consumption E_s for the sequence:

$$E_s = \sum_{t=ts}^{te} (dt * Pt)$$

t_s: Start time of sequence; t_e: End time of sequence
Consistency check: t_e - t_s shall not deviate from the sequence duration as calculated by the system's software and displayed in the system's user interface.

4) Data to be reported in the COCIR template
   a. For each sequence, the associated energy consumption in kWh
   b. For each sequence, the duration, as calculated by the system's software and displayed in the system's user interface.

11. Information To Be Provided To Users

Information that must be communicated when required by tenders to be able to state that the measurements are performed according to the COCIR methodology:

- Daily/Annual energy consumption according to the COCIR predefined scenarios, as output by the COCIR template.
- Power consumption in kW for the following modes: LOW-POWER, POWER-SAVE, READY-TO-SCAN as measured.
- Power consumption for AVERAGE–READY-TO-SCAN as output by the COCIR template
  Note: the AVERAGE READY TO SCAN power draw must be used by the user with the COCIR MRI User Calculator Tool.
- Energy consumption (kWh) for each examination in Appendix 1: Knee, Head, Spine, Liver
- Total examination duration for each examination in Appendix 1: Knee, Head, Spine, Liver.
- Optionally, the daily/annual energy consumption in a high productivity scenario, providing also the number of patients per day used in the scenario and the number of hours in operating hours. This information must be clearly distinguished from the one provided under the COCIR scenario.

Table 1: information to be communicated if required by tenders to claim the measurements have been performed in accordance with the COCIR methodology

COCIR Predefined Scenario		
Daily Energy Consumption [kWh]	Value	
Annual Energy Consumption [kWh]	Value	
Disclaimer about manual switching to Low Power during non-operating hours	Text	
COCIR high productivity scenario		
Daily Energy Consumption [kWh]	Value	
Annual Energy Consumption [kWh]	Value	
Number of patients per day	Value	
Hours in operating mode	Value	
Disclaimer about High Productivity Scenario lack of comparability	Text	
Body Region	Scan Mode	
	Time per Scan [min]	Energy per scan [kWh]
Head	value	value
Spine	value	value
Liver	value	value
Knee	value	value
POWER DRAW PER MODE	Power per mode [kW]	
LOW POWER	value	
POWER SAVE	value	
READY TO SCAN	value	
AVERAGE READY TO SCAN	value	

*Cells in **orange** are mandatory
Cells in **green** are optional

12. HOW TO USE THE COCIR EXCEL TEMPLATE

The methodology is complemented by an excel spreadsheet template where the measured data must be filled in. The spread excel sheet is already equipped with formulas that return the results.
Once the measured values have been reported in the COCIR template, the template outputs the following values:

- Daily energy usage (kWh) in LOW-POWER, READY-TO-SCAN, POWER-SAVE and SCAN mode
- Total Daily Energy Consumption (kWh)
- Total Annual Energy Consumption (kWh) and per mode
- Average READY-TO-SCAN Mode

12.1. SCAN SHEET

The Scan-sheet contains one box for each body region
Orange cells: to be filled with measured data
Grey/white cells: data derived by formulas

STEP 1: the correct MRI category must be selected as this choice automatically selects parameters in the other sheets. The spreadsheet automatically adapts the number of patients per day and other values.

Select the MRI category	1,5/3T
Head	

STEP 2: Fill in the orange cells with the measured duration of each sequence and the measured energy consumption for each sequence.
The cell summing up the duration of all sequences "TOTAL" turns red if the value is lower than the minimum scan time, as indicated in the first line for each body region.
In such a case parameters should be tweaked to reach at least the minimum time.

Sequence duration

Energy consumption per sequence.

L-Spine		
Min. Duration [ss]:	960	
Step	**Duration [ss]**	**Energy [kWh]**
localizer	90	0.1
TSE T1W (SAG)	90	0.1
TSE T2W (SAG)	130	0.1
STIR TSE T2W (SAG)	90	0.1
TSE T2W MultiStack (TRA)	90	0.1
Total	**490**	**0.5**

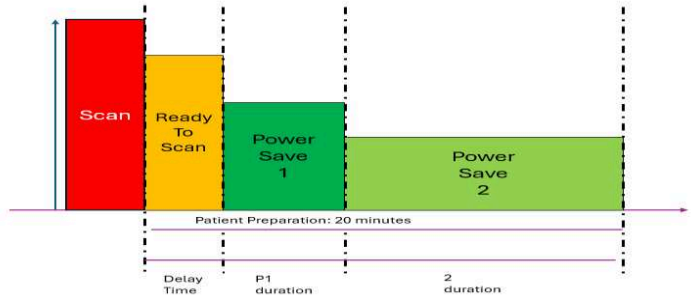
12.2. Inactive Modes Sheet

STEP 3: Fill in the orange cells with measured values for LOW-POWER and READY-TO-SCAN power.

Mode	Average Power [kW]	Time / Day [min]
Low Power	7.0	720.00
Ready to scan	17.9	91.33
Power Save	11.3	442.17
Delay Time [min]	3.0	

STEP 4: fill in the POWER SAVE modes. In case more power save modes are present, as illustrated below each mode must be entered in the calculator (see below).

Example: 20 exams/day, 20 minutes for patient preparation



The template can manage up to 5 different levels of POWER SAVE mode calculating a

time-weighted average that is then reported in the below table.

Calculator, in the "Inactive Modes" sheet. 1 to 5 levels of Power save mode can be entered, each one with its duration. The total time cannot exceed the maximum value equal to "20 minutes minus the delay time". In the current example, it is 17 minutes (3 minutes delay time)

Average Power Save during patient preparation (<20 minutes)		
Power save mode	Duration (min)	Power
1	5	12.1
2	12	11
3	0	0
4	0	0
5	0	0
Max value	17.0	11.32

STEP 5: The methodology allows for a short time to be available at the end of the day where the MRI is not used (accounting also for lunch breaks, etc.). In such period, more levels of POWER SAVE modes can engage allowing even more savings. The levels in the previous calculator should appear also in this one. The cell turns red in case the total time allocated is different from "max value"

Average Power save at the end of the day		
1	5.00	12.1
2	12.00	11
3	87.17	9
4	0.00	0
5	0.00	0
Max value	104.17	9.38

In case the MRI is not equipped with automatic POWER-SAVE mode the following must be input in the template

- Set DELAY TIME to zero
- Set "power duration" to 20 minutes and POWER-SAVE equal to READY-To-SCAN power. See red squared cells below.

Mode	Average Power [kW]	Time / Day [min]
Low Power	7.0	720.00
Ready to scan	17.9	31.33
Power Save during operating hours	17.9	502.17
Delay Time [min]	0.0	

Average Power Save during patient preparation (<20 minutes)		
Power save mode	Duration (min)	Power
1	20	17.9
2	0	0
3	0	0
4	0	0
5	0	0
Sum	20	
Max value	20.0	17.90

This way the spreadsheet calculates that for 20 minutes the MRI is in READY-TO-SCAN mode.

Similarly, the calculator for the "End of the day" must be compiled accordingly with READY-TO-SCAN power for the entire duration

Calculator: Average Power save at the end of the day		
1	218.67	17.9
2	0.00	0
3	0.00	8
4	0.00	0
5	0.00	0
Sum	218.67	
Max value	218.67	17.90

In case the MRI has a delay time higher than the 20 minutes patient preparation time, the template automatically accounts for the fact that the POWER SAVE MODE will not engage in between scans

Average Power Save during patient preparation (<20 minutes)		
Power save mode	Duration (min)	Power
1	0	0
2	0	0
3	0	0
4	0	0
5	0	0
Sum	0	
Max value	0.0	17.90
Average Power save at the end of the day		
1	72.17	11
2	0.00	0
3	0.00	0
4	0.00	0
5	0.00	0
Sum	72.17	
Max value	72.17	11.00

The values become irrelevant as the power draw is set automatically. Just to set the "Max value" cell to green, values can be put equal to zero.

The leftover time at the end of the day is calculated as "max value".
Orange cells can be filled for time and power, as long as the sum of time is equal to "max value" (green cell, or red otherwise)

12.3. Summary Sheet

The summary sheet provides the results based on the data filled in the 2 previous sheets. In the **green cells** the energy consumption on a daily and annual basis are returned, including the consumption per mode.

The **orange cell** must be completed with the name of the MRI model being measured.

2	Product Name	
3	Category	1,5/3T
4–5	Number of Patients per Day	20

	Procedure	Time per exam	Time for pauses daily [min]	Energy per exam [kWh]	Average Power [kW]	Patient Time [min]	Scans / Day
8	Scan Mode: Typical Head Measurement	720	14.00	7.0	35.00	140.00	7
9	Scan Mode: Typical L-Spine Measurement	530	9.33	5.4	36.68	140.00	7
10	Scan Mode: Typical Abdomen Measurement	220	2.67	3.4	55.64	40.00	2
11	Scan Mode: Typical Knee Measurement	500	5.33	5.4	38.88	80.00	4
12–13						Time end of the day: 102.17	

	Operation Mode	Average Power [kW]	Duration Minutes / Day [min]	% of Day	Energy per Day [kWh]	No. of Workdays / Year	No. Days per Year non-operating (weekends)	Energy Consumption per Year [kWh]	Energy Consumption Distribution [%]
15	Off								
16	Low Power	7.0	720.00	50%	84	260	105	39480	40.6%
17	Ready to scan	17.9	91.33	6%	27	260	105	7084	7.3%
18	Power Save	11.3	442.17	31%	80	260	105	20836	21.4%
19	Scan		186.50	13%	115	260	105	29952	30.8%
20	Total Energy Consumption per Day and per Year [kWh]				307			97352	
21	Average Ready-to-Scan	12.08							

The table also provides the AVERAGE-READY-TO-SCAN mode power draw that needs to be communicated to purchasing organizations or users so they can use it in the COCIR MRI User Calculator Tool.

APPENDIX I.1 – 0.55T SUPERCONDUCTIVE MAGNETIC RESONANCE EQUIPMENT

MRI CONFIGURATION

This table provides an overview of the minimum requirements for clinical protocols, as delivered by the manufacturer and part of system IQ validation, for 1.5T and 3T superconductive MRI scanners. The selected protocols shall be runnable with a basic SW configuration of the selected scanner type (unique commercial configuration). The table is also present in the COCIR excel template.

MRI PARAMETERS FOR SCAN ENERGY MEASUREMENT									
	Number of slices	Field of View	Slice Thickness	Gap	TR	Meassured resolution	Bandwidth Readout (Hz/pixel)	Minimum Scan Time [min]	Minimum Exam Time
	min	max	max	max % of slicethickness	min	max		min	
Knee (no REST)									≥ 14 min
Localizer									
TSE Proton Density Fatsat (SAG)	28	no rest. (160)	3	10	2200	≤0.65x1	>210	3.5	
TSE Proton Density Fatsat (TRA)	28	no rest. (160)	3	10	2200	≤0.65x1	>210	3.5	
TSE Proton Density Fatsat (COR)	30	no rest. (160)	3	10	2200	≤0.65x1	>210	3.5	
TSE T1W (SAG)	30	no rest. (160)	3	10	400	≤0.65x1	>230	3.5	
Brain/Head									≥ 16.5 min
Localizer									
TSE T2W-FLAIR (TRA)	22	250	5	20	6800	≤0,9x1	>150	3.5	
Diffusion EPI (TRA) b1000, TE < 90 ms	22	250	5	20	4000	≤1.7x1.5	>900	1.5	
TSE T2W (SAG)	22	250	5	20	3000	≤0.9x1	>200	2	
(T)SE T1W TRA	22	250	5	20	400	≤0.9x1	>100	2.5	
(T)SE T1W TRA	22	250	5	20	400	≤0.9x1	>100	2.5	
MP-RAGE (SAG)	190	250	1.5	50	1500	≤1.0x1,2	>200	4.5	
L-Spine									≥ 13.5 min
Localizer									
TSE T1W (SAG)	15	320	4	10	400	≤0.9x1.0	>200	3	
TSE T2W (SAG)	15	320	4	10	2000	≤0.9x1.0	>200	3	
STIR TSE T2W (SAG)	15	320	4	10	3000	≤1.0x1	>200	4	
TSE T2W MultiStack (TR	3 stacks a 5	250	4	10	3000	≤0.9x1	>250	3.5	
Liver (no REST)									≥ 3.25 min
Localizer									
single-shot TSE T2W (C	30	no rest.(400)	6	20	1000	≤1.5x1.5	>400	1	
single-shot TSE T2W fa	30	no rest.(400)	6	20	700	≤1.5x1.5	>400	1	
3D GRE T1W, 4 time-po	72	no rest.(400)	3	20		≤1.8x2	>400	1	
3D GRE T1W, 1 time poir	72	no rest.(400)	3	20		≤1.8x2	>400	0.25	

Table 2

BODY REGIONS DISTRIBUTION

Given the predefined number of exams per day (see below), the distribution of exams between body regions is indicated in the table below

Based on COCIR data regarding average number of patient per day in different regions Patients/Day = **15**

Body Region	Percentual distribution	Number of exams/d
Brain/Head	36%	5
Spine	37%	5
Knee	17%	3
Liver	10%	2

Table 3

WORKING HOURS

	No. of Workdays per Year	**No. Days per Year with System in Low Power (weekends)**
Low Power	260	105
Ready to scan	260	n.a.
Scan	260	n.a.

Table 4

SCAN PAUSES

Ready to Scan: Notes		
Breath holds, adjustments, slice planning, contrast injection and other **scan pauses** during the examinations are **not** included within the times registered in chapter 11. Duration and number of pauses per examinations are listed below.		
Average Duration of Scan Pauses during Exam [s]		20
# Short Scan Pauses within	Head Exam	6
	L-Spine Exam	4
	Liver Exam	7
	Knee Exam	4

Table 5

APPENDIX I.2 – 1.5/3T SUPERCONDUCTIVE MAGNETIC RESONANCE EQUIPMENT

MRI CONFIGURATION

This table provides an overview of the minimum requirements for clinical protocols, as delivered by the manufacturer and part of system IQ validation, for 1.5T and 3T superconductive MRI scanners. The selected protocols shall be runnable with a basic SW configuration of the selected scanner type (unique commercial configuration). The table is also present in the COCIR excel template.

MRI PARAMETERS FOR SCAN ENERGY MEASUREMENT (1.5T and 3T)									
Sequence: Contrast Type	Number of slices #	Field of View (X, mm)	Slice Thickness (mm)	Gap	TR (ms)	Meassured resolution (mm x mm)	Bandwidth Readout (Hz/pixel)	Minimum Scan Time [min]	Minimum Exam Time (min)
	min	max	max	max % of slicethickness	min	max		min	
Knee (no REST)									≥ 6 min
Localizer									
TSE Proton Density Fatsat (SAG)	≥27	≤160	≤3	10	≥3000	≤0.65x1	>210	1.5	
TSE Proton Density Fatsat (TRA)	≥27	≤160	≤3	10	≥3000	≤0.65x1	>210	1.5	
TSE Proton Density Fatsat (COR)	≥27	≤160	≤3	10	≥2400	≤0.65x1	>210	1.5	
TSE T1W (SAG)	≥27	≤160	≤3	10	≥600	≤0.65x1	>230	1.5	
Brain/Head									≥ 10 min
Localizer									
TSE T2W-FLAIR (TRA)	≥22	≤250	≤5	10	≥8000	≤0,9x1	>150	2.0	
Diffusion EPI (TRA) b1000, TE < 90 ms	≥22	≤250	≤5	10	≥2500	≤1.7x1.5	>1100	0.5	
TSE T2W (SAG)	≥22	≤250	≤5	10	≥3000	≤0.9x1	>200	1.5	
(T)SE T1W TRA	≥22	≤250	≤5	10	≥550	≤0.9x1	>100	1.5	
(T)SE T1W TRA	≥22	≤250	≤5	10	≥550	≤0.9x1	>100	1.5	
MP-RAGE (SAG)	≥140	≤260	≤1.1	50	≥3000	≤1.0x1,2	>200	3.0	
L-Spine									≥ 8 min
Localizer									
TSE T1W (SAG)	≥15	≤300	≤4	10	≥400	≤0.9x1.0	>200	2.0	
TSE T2W (SAG)	≥15	≤300	≤4	10	≥2500	≤0.9x1.0	>200	2.0	
STIR TSE T2W (SAG)	≥15	≤300	≤4	10	≥2500	≤1.0x1	>200	2.0	
TSE T2W MultiStack (TRA)	5x≥5	≤300	≤3	10	≥3000	≤0.9x1	>250	2.0	
Liver (no REST)									≥ 1.16 min
Localizer									
single-shot TSE T2W (COR)	≥40	≤450	≤5	10	≥350	≤1.5x1.5	>400	0.33	
single-shot TSE T2W fatsat (TRA	≥40	≤450	≤5	10	≥350	≤1.5x1.5	>400	0.33	
3D GRE T1W, 4 time-points	>68	≤450	≤3	20	≥2.5	≤1.8x2	>400	0.25	
3D GRE T1W, 1 time point	>68	≤450	≤3	20	≥2.5	≤1.8x2	>400	0.25	

Table 6

BODY REGIONS DISTRIBUTION

Given the predefined number of exams per day (see below), the distribution of exams between body regions is indicated in the table below

Based on COCIR data regarding average number of patient per day in different regions Patients/Day = **20**

Body Region	Percentual distribution	Number of exams/d
Brain/Head	36%	7
Spine	37%	7
Knee	17%	4
Liver	10%	2

Table 7

WORKING HOURS

	No. of Workdays per Year	**No. Days per Year with System Low Power (weekends)**
LOW POWER MODE	260	105
READY TO SCAN MODE	260	n.a.
Scan	260	n.a.

Table 8

SCAN PAUSES

Ready to Scan: Notes		
Breath holds, adjustments, slice planning, contrast injection and other **scan pauses** during the examinations are **not** included within the times registered in chapter 11. Duration and number of pauses per examinations are listed below.		
Average Duration of Scan Pauses during Exam [s]		20
# Short Scan Pauses within	Head Exam	6
	L-Spine Exam	4
	Liver Exam	7
	Knee Exam	4

Table 9

APPENDIX I.4 – 7T SUPERCONDUCTIVE MAGNETIC RESONANCE EQUIPMENT

MRI CONFIGURATION

List of parameters to be used to configure the MRI for each specific sequence and minimum scan times for each sequence and for the examination. The table is also present in the COCIR excel template.

	Number of slices	Field of View	Slice Thickness	Gap	TR	Measured resolution	Bandwidth	Minimum Scan Time [min]	Minimum Scan Time [min]
	min	max	max	max % of slicethickness	min	max		min	
Knee									≥ 7.15 min
t2 fs sag	30	no rest. (160)	2.5	10	5000	0.5x0.5		1.5	
pd fs sag	30	no rest. (160)	2.5	10	3000	0.5x0.5		1.5	
pd fs tra	28	no rest. (160)	2.5	10	3000	0.5x0.5		1.5	
pd fs cor	30	no rest. (160)	2.5	10	3000	0.5x0.5		1.5	
t1 cor	30	no rest. (160)	2.5	10	500	0.5x0.5		1.5	
Brain/Head									≥ 19 min
3D MP-RAGE Sag	190	250	0.8	0	3200	0.8x.08		5	
3D T2FLAIR Sag	190	250	0.8	0	6000	0.8x.08		5	
t2 fse ax	40	220	3	10	7000	0.5x0.5		4	
3D SWAN/SWI Ax	100	220	1.2	0	25	1x1		4	
dwi	40	260	3	10	5000	1x1		1	

Table 10

BODY REGIONS DISTRIBUTION

Given the predefined number of exams per day (see below), the distribution of exams between body regions is indicated in the table below

Based on COCIR data regarding average number of patient per day in different regions Patients/Day = **4**[1]

Body Region	Percentual distribution	Number of exams/d
Brain/Head	50%	2
Knee	50%	2

Table 11

WORKING HOURS

	No. of Workdays per Year	**No. Days per Year with System Low power (weekends)**
Low Power	260	105
Ready to scan	260	n.a.
Scan	260	n.a.

Table 112

SCAN PAUSES

Ready to Scan: Notes		
Breath holds, adjustments, slice planning, contrast injection and other **scan pauses** during the examinations are **not** included within the times registered in chapter 11. Duration and number of pauses per examinations are listed below.		
Average Duration of Scan Pauses during Exam [s]		
# Short Scan Pauses within	Head Exam	**6**
	L-Spine Exam	**4**

Table 13

[1] 7-T MRI: Providing hope by seeing the previously unseen - Mayo Clinic

APPENDIX I.3 – 0,2/0,4T PERMANENT MAGNET MAGNETIC RESONANCE EQUIPMENT

MRI CONFIGURATION

List of parameters to be used to configure the MRI for each specific sequence and minimum scan times for each sequence and for the examination. The table is also present in the COCIR excel template.

BODY REGIONS DISTRIBUTION

Given the predefined number of exams per day (see below), the distribution of exams between body regions is indicated in the table below

Based on COCIR data regarding average number of patient per day in different regions Patients/Day = **tbd**

Body Region	Percentual distribution	Number of exams/d
Brain/Head		
Spine		
Knee		
Abdomen		

Table 15

WORKING HOURS

	No. of Workdays per Year	**No. Days per Year with System low power (weekends)**
Off		
Low Power		
Ready to scan		
Scan		

Table 16

SCAN PAUSES

Ready to Scan: Notes		
Breath holds, adjustments, slice planning, contrast injection and other **scan pauses** during the examinations are **not** included within the times registered in chapter 11. Duration and number of pauses per examinations are listed below.		
Average Duration of Scan Pauses during Exam [s]		
# Short Scan Pauses within	Head Exam	
	L-Spine Exam	
	Abdomen Exam	
	Knee Exam	

Table 17

APPENDIX I.4 – HIGH PRODUCTIVITY SCENARIO

For high productivity scenarios, manufacturers are required to use the following data

Patients/Day = **30**

Mode	**Duration**
Operating Hours	16 hours
Non-operating hours	8 hours

Table 18

Body Region	**Percentual distribution**	**Number of exams/d**
Brain/Head	36%	11
Spine	37%	10
Knee	17%	6
Abdomen	10%	3

Table 19

	No. of Workdays per Year	**No. Days per Year with System Low power (weekends)**
LOW POWER MODE	310	55
READY TO SCAN MODE	310	n.a.
SCAN	310	n.a.

Table 20