



Sustainable Competence  
in Advancing Healthcare



## COCIR SELF REGULATORY INITIATIVE FOR MEDICAL IMAGING EQUIPMENT

### **EXAMPLE OF THE SRI AT WORK: SETTING TARGETS FOR MRI**

*James Vetro, P.E.  
Ecodesign Steering Committee vice-chair  
Global Engineering RoHS Manager – GE Healthcare*



# Clinical Value of Imaging Systems

Critical  
Information for  
Doctors

Accurate  
diagnosis for the  
patients

Energy targets  
must not  
compromise  
clinical value





# MEASURING ENERGY CONSUMPTION

- To define improvement targets on energy consumption the Steering Committee defined a standard procedure to measure such consumption.
- No harmonized standards are available and Companies use internal procedures that could differ quite much in particular regarding systems boundaries and use scenarios.
- The procedure ensures data comparability.
- The Steering Committee decided to measure also for each model the number of patient that can be examined per day according to the given scenario.



# MEASUREMENT OF ENERGY CONSUMPTION

To define a procedure to measure the energy consumption of equipment which allows comparability and repeatability of results the following elements needs to be defined:

- Systems boundaries
- Definitions (i.e. operating modes)
- Product categories
- Use scenario (typical examination)
- Ranges for parameters and configurations



# MAGNETIC RESONANCE IMAGING

- System boundaries
  - **In Scope:** 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 (facility cooled water is provided), patient table, magnet, helium-conservation equipment.
  - **Out of scope:** Any equipment and accessories 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 and hardware for advanced medical applications.



# MAGNETIC RESONANCE IMAGING

Mode	Description	Typical time in mode per day (hours)	Estimate of % Energy over Life
Off	Lowest power state; requires interaction to make system ready; system circuit breakers on.	12	45
Ready to measure	System on, ready to scan, gradient system quiescent.	7 (varies)*	30
Scan	System is activating gradient system and capturing image data.	5 (varies)*	25

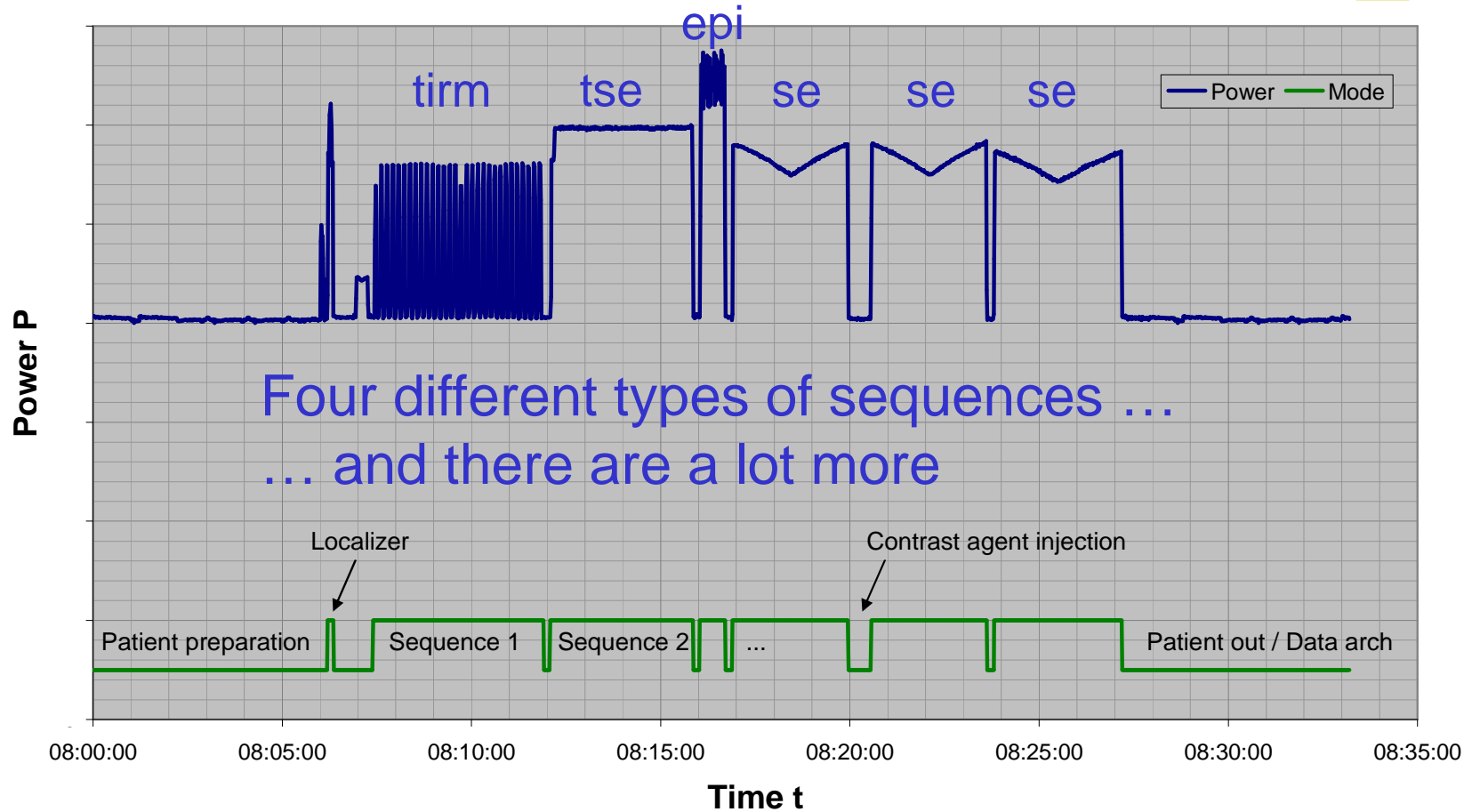
Diagnostic Application	IMV © Market Distribution	Normalized Distribution
Head	25%	24%
Spine	26%	25%
Abdomen	25%	24%
Knee	20%	19%
Angio	9%	9%



# MAGNETIC RESONANCE EQUIPMENT

Head Measurement (schematic)

fB4



## Slide 7

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**fB4**

**Graph inserted**

Franz Bömmel, 09/09/2011





# MAGNETIC RESONANCE IMAGING

- Energy measurement test procedure\*

Starttime	Action	Endtime	Sequence duration	Power / kW	Time / h	Energy / kWh/sequence
9:05:20	Recorded start time					
	patient preparation and positioning; patient data entry; use head and neck coils					
	localizer		00:00:10	43,70	0,0028	0,12
	slice planning / adjustments					
	t2_tirm_tra_dark-fluid_320		00:04:32	32,88	0,0756	2,48
	adjustments					
	t2_tse_sag_512		00:03:45	55,62	0,0625	3,48
	adjustments					
	ep2d_diff_3scan_trace_p2		00:01:39	73,47	0,0275	2,02
	adjustments					
	t1_se_tra_320		00:02:53	42,86	0,0481	2,06
	contrast agent injection					
	t1_se_tra_320		00:02:53	42,81	0,0481	2,06
	adjustments					
	t1_se_cor_320	9:32:25	00:02:25	45,77	0,0403	1,84
	patient out and data archiving (average)					
		0:06:00				
	Calculated end time					
		9:38:25				

Start	Action	End	Total time	kW	Time	kWh
9:05:20	average head examination total	9:38:25	0:33:05			
	sum scan time		0:18:17	46,15		14,06
	sum ready to measure time		0:14:48	15,00	0,25	3,70
	control calculation		0:33:05	32,21	<b>Total</b>	<b>17,76</b>

\* Typical **brain** measurement - exemplary data



# MAGNETIC RESONANCE IMAGING

Ranges for key parameters that could influence the results have been defined to allow full comparability.

HEAD	Slices		FoV / mm x mm			Slice thickness / mm			Resolution / mm			Bandwidth / Hz/Px		Sequence duration	Leitlinien BAEK 2000.pdf	
	S/P	BÄK	Max	Min	BÄK	Max	Min	BÄK	Max	Min	Max	Min	BÄK	Table	Subtopic	
localizer	1		290x280	240		8	6		1,1	0,6	83,3	290				
t2_tirm_tra_dark-fluid_320	28	≤ 250	230 x 200	220x220	≤ 6	5	5	≤ 1	0,8	0,7	31,3	191	< 00:05:00	Tabelle 2	Schädel	
t2_tse_sag_512	27	200..250	250 x 225	220x220	5..6	5	5	≤ 1	0,5	0,5	195	31,3	< 00:05:00	Tabelle 1a	MRA	
ep2d_diff_3scan_trace_p2	23	≤ 250	240	210		5	5	≤ 1	1,9	1,2	1305	250,0	< 00:05:00	Tabelle 2		
t1_se_tra_320	28	200..250	230 x 230	220x220	5..6	5	5	≤ 1	0,9	0,4	163	25	< 00:05:00	Tabelle 1a		
t1_se_tra_320	28	200..250	230 x 230	220x220	5..6	5	5	≤ 1	0,9	0,4	163	25	< 00:05:00	Tabelle 1a		
t1_se_cor_320	32	200..250	230 x 230	220x220	5..6	5	5	≤ 1	0,9	0,4	163	25	< 00:05:00	Tabelle 1a		
<b>SPINE</b>	Slices		FoV / mm x mm			Slice thickness / mm			Resolution / mm			Bandwidth / Hz/Px		Sequence duration	Leitlinien BAEK 2000.pdf	
	S/P	BÄK	Max	Min	BÄK	Max	Min	BÄK	Max	Min	Max	Min	BÄK	Table	Subtopic	
localizer	5		450x450	240		8	8		1,8	0,6	290	83,3				
t2_tse_sag_512	16	≤ 350	300x300	260	≤ 4	4	3	≤ 1	0,8	0,5	244	41,67	< 00:05:00	Tabelle 2	BWS/LWS	
t1_tse_sag_512	15	≤ 350	300x300	260	≤ 4	4	3	≤ 1	0,8	0,5	250	62,5	< 00:05:00	Tabelle 2	BWS/LWS	
t2_tse_tra_512	20	≤ 350	230 x 230	150x150	≤ 4	4	4	≤ 1	0,7	0,4	195	250	< 00:05:00	Tabelle 2	BWS/LWS	
t1_tse_tra_448	20	≤ 350	230 x 230	150x150	≤ 4	5	4	≤ 1	0,7	0,4	228	25	< 00:05:00	Tabelle 2	BWS/LWS	
<b>ABDOMEN</b>	Slices		FoV / mm x mm			Slice thickness / mm			Resolution / mm			Bandwidth / Hz/Px		Sequence duration	Leitlinien BAEK 2000.pdf	
	S/P	BÄK	Max	Min	BÄK	Max	Min	BÄK	Max	Min	Max	Min	BÄK	Table	Subtopic	
localizer	5		500x500	380		8	6,0	1,7	2,0	0,989583	450	83,3				
t1_fi2d_opp-in_tra_p2_mbh	30	300..400	380	330x350	≤ 6	8	6	≤ 2	1,5	1,1875	977	83,3	< 00:00:45	Tabelle 1b		
t2_truff_cor_p2_bh	25	300..400	420	350x300	≤ 6	10	5	≤ 2	1,4	1,0	651	125	< 00:05:00	Tabelle 1b		
t2_tse_tra_p2_mbh_320	30	300..400	380	330x350	≤ 6	8	5	≤ 2	1,2	1,1	651	62,5	< 00:05:00	Tabelle 1b		
t1_vibe_fs_tra_p2_320_bh_pre	64	300..400	400	330x350	≤ 6	4	3	≤ 2	1,25	1,1	488	166,7	< 00:00:45	Tabelle 1b		
t1_vibe_fs_tra_p2_320_bh_arterial	64	300..400	400	330x350	≤ 6	4	3	≤ 2	1,25	1,1	488	166,7	< 00:00:45	Tabelle 1b		
t1_vibe_fs_tra_p2_320_bh_venous	64	300..400	400	330x350	≤ 6	4	3	≤ 2	1,25	1,1	488	166,7	< 00:00:45	Tabelle 1b		
t1_vibe_fs_tra_p2_320_bh_delayed	64	300..400	400	330x350	≤ 6	4	3	≤ 2	1,25	1,1	488	166,7	< 00:00:45	Tabelle 1b		
t1_vibe_fs_cor_p2_bh_288_post	128	300..400	400 x 345	350x315	≤ 6	4	1,6	≤ 2	1,4	1,1	600	166,7	< 00:00:45	Tabelle 1b		
<b>KNEE</b>	Slices		FoV / mm x mm			Slice thickness / mm			Resolution / mm			Bandwidth / Hz/Px		Sequence duration	Leitlinien BAEK 2000.pdf	
	S/P	BÄK	Max	Min	BÄK	Max	Min	BÄK	Max	Min	Max	Min	BÄK	Table	Subtopic	
localizer_tra	3		500x500	280		8	5		2,0	0,7	250	83,3				
localizer_sag+cor+tra	3		350	215x231		8	5		1,4	0,7	250	83,3				
t1_se_sag_512	32	≤ 250	160 x 160	160x160	3,0	4	3	≤ 0,5	0,5	0,3	244	31,25	< 00:07:00	Tabelle 2	Kniegelenk	
t2_tse_fs_sag_320	30	≤ 250	160 x 160	160x160	3,0	4	3	≤ 0,5	0,5	0,5	244	41,67	< 00:07:00	Tabelle 2	Kniegelenk	
pd_tse_fs_cor_p2_512	30	≤ 250	160 x 160	140	3,0	4	3	≤ 0,5	0,5	0,3	195	41,67	< 00:07:00	Tabelle 2	Kniegelenk	
<b>ANGIO</b>	Slices		FoV / mm x mm			Slice thickness / mm			Resolution / mm			Bandwidth / Hz/Px		Sequence duration	Leitlinien BAEK 2000.pdf	
	S/P	BÄK	Max	Min	BÄK	Max	Min	BÄK	Max	Min	Max	Min	BÄK	Table	Subtopic	
I_Localizer_feet	7		500x500	400 x 400		8,0	7		2,0	1,6	558	244				
II_Localizer_legs	7		500x500	400 x 400		8,0	7		2,0	1,6	558	244				
III_Localizer_upper_legs	7		500x500	400 x 400		8,0	7		2,0	1,6	558	244				
IV_Localizer_abdomen	7		500x500	400 x 400		8,0	7		2,0	1,6	558	244				
IV_Angio3D_abdomen_pre	96	≤ 400	400 x 350	330x350		2,6	1,3	≤ 2	1,4	1,1	680	488	< 00:05:00	Tabelle 2	V. cava	
III_Angio3D_upper_legs_pre	96	≤ 500	400 x 350	330x350		2,6	1,3	≤ 2	1,4	1,1	680	488	< 00:05:00	Tabelle 2	Extremitätengefäße	
II_Angio3D_legs_pre	88	≤ 500	400 x 350	330x350		2,2	1,1	≤ 2	1,3	1,0	690	488	< 00:05:00	Tabelle 2	Extremitätengefäße	
I_Angio3D_feet_pre	96	≤ 500	400 x 350	330x350		2	0,9	≤ 2	1,3	0,9	490	488	< 00:05:00	Tabelle 2	Extremitätengefäße	
IV_Care_bolus	1		450 x 365	330x350		20,0			1,8		400					
IV_Angio3D_abdomen	96	≤ 400	400 x 350	330x350		2,6	1,3	≤ 2	1,4	1,1	680	488	< 00:01:00	Tabelle 2	V. cava	
III_Angio3D_upper_legs	96	≤ 500	400 x 350	330x350		2,6	1,3	≤ 2	1,4	1,1	680	488	< 00:01:00	Tabelle 2	Extremitätengefäße	
II_Angio3D_legs	88	≤ 500	400 x 350	330x350		2,6	1,1	≤ 2	1,3	1,0	690	488	< 00:01:00	Tabelle 2	Extremitätengefäße	
I_Angio3D_feet	96	≤ 500	400 x 350	330x350		2	0,9	≤ 2	1,3	0,9	490	488	< 00:01:00	Tabelle 2	Extremitätengefäße	



# MAGNETIC RESONANCE EQUIPMENT

Summary to calculate patients per day in given mix				Please fill in orange cells													
		Minutes															
	Potential exam time per day (12h)	720		<b>Product</b>		<b>1.5 Tesla</b>											
<i>minus</i>	Non-Availability (equals to 2h fixed stand-by)	120		<b>Product category</b>		<b>B</b>											
	<b>Available potential scanning time</b>	<b>600</b>															
Start	Action	End	Duration	Distribution	Normalized	Min per day	optimized patients that can be treated within this timeshare	Time per patient / h			Energy per patient / kWh			Energy per day			
								scan	stand by	total	scan	stand by	total	Total energy per day (10h)			
9:00:00	average head examination total	9:33:00	0:33:00	25	24%	143	4,329	00:18:17	00:14:43	00:33:00	18,28	3,68	21,96	95,08			
10:00:00	typical spine measurement (lumbar spine)	10:30:00	0:30:00	26	25%	149	4,952	00:15:03	00:14:57	00:30:00	15,05	3,74	18,79	93,04			
11:00:00	typical abdomen measurement	11:29:00	0:29:00	25	24%	143	4,926	00:03:58	00:25:02	00:29:00	3,97	6,26	10,23	50,37			
12:00:00	typical knee measurement	12:25:00	0:25:00	20	19%	114	4,571	00:09:24	00:15:36	00:25:00	9,40	3,90	13,30	60,80			
13:00:00	typical angio measurement	13:23:00	0:23:00	9	9%	51	2,236	00:04:40	00:18:20	00:23:00	4,67	4,58	9,25	20,68			
				105	1,0000	600	<b>21,015</b>							<b>319,97</b>			

	Time in Min	kW	kWh
Energy for non-availability (2h for service, reliability etc. in which system runs in standy-by) <i>fixed</i>	120	15,00	30,00
Off-time (12h) <i>fixed</i>	720	10,00	120
<b>Per day:</b>	<b>Time</b>	<b>Energy</b>	
	min	kWh	
Off	720,00	10,00	120,00
Ready to measure <b>fb5</b>	493,37	15,00	123,34
Scan	226,63	60,00	226,63
<b>Sum of Energy per day for max. exams in given distribution</b>	<b>1440,00</b>	<b>19,58</b>	<b>469,97</b>
<b>Average kWh/Patient</b>			<b>22,36</b>

Category	Percentage
Scan	16%
Stand by	34%
Off	50%

Category	Percentage
Scan	48%
Stand by	26%
Off	26%

## Slide 10

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**FB5**

use "Ready to measure" instead of "Stand By"

Franz Bömmel, 09/09/2011



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# ECODESIGN TARGETS FOR MRI



# MRI CATEGORIZATION

- Product Categorization
  - Member companies have recognized that MRI equipment has different design intents, for specific applications.

General information on categories included	<ul style="list-style-type: none"> <li>– matrix columns represent key differentiation characteristics that contribute to the energy consumption of a system</li> <li>– each characteristic results in a designated amount of points</li> <li>– total score of all characteristics will determine the overall category that a system belongs to</li> </ul>			
Key characteristics	<u>Field strength</u>	1.5T	50	points
		3.0 T	100	points
	<u>Bore size</u>	< 60 cm	10	points
		≥ 60 & < 70 cm	20	points
		≥ 70 cm	30	points
	<u>Maximum Gradient Amplitude per axis</u>	< 35 mT/m	40	points
		≥ 35 mT/m	80	points
	<u>Maximum Slewrate per axis</u>	< 100 mT/m/s	20	points
		≥ 100 mT/m/s & < 150 mT/m/s	30	points
		≥ 150 mT/m/s	40	points
	<u>Patient table</u>	fixed table	10	points
		mobile table	20	points
	<u>Maximum channels</u>	< 16 channels	15	points
≥ 16 channels & < 64 channels		35	points	
≥ 64 channels		45	points	
<u>Useable FOV cm<sup>2</sup></u>	< 40 cm	25	points	
	≥ 40 & < 50 cm	35	points	
	≥ 50 cm	45	points	
Final company model category	<b>Total points</b>			
	Clinical model - Category A		< 220	points
	Hospital model - Category B		≥ 220 & < 315	points
	Research model - Category C		≥ 315	points



# SCOPE: CATEGORY B

## Exclusion of category A

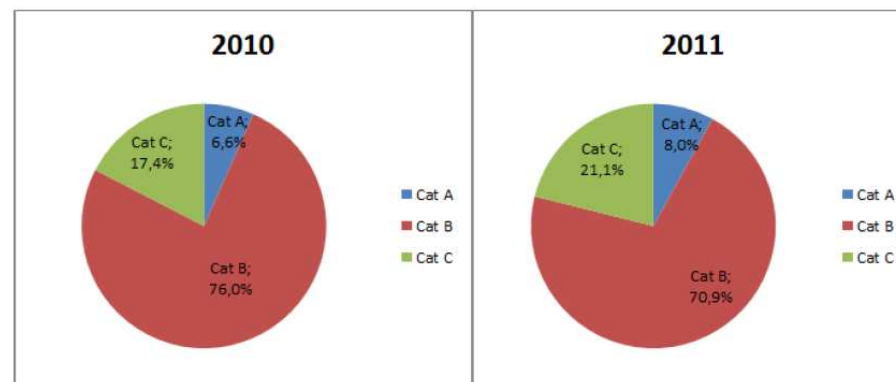
Category A products represent a small percentage of the whole sales in EU as shown in the chart. Most of category A MRI are open models, equipped with permanent magnets that do not require power to generate the magnetic field (no cryo-cooling system). Therefore contribution of category A to the energy consumption of MRI is very limited and the absence of the cryo-cooled magnet reduces also the potential for improvement.

## Exclusion of category C

The required high level performances involve higher energy consumption, due to the 3 Tesla magnetic field and its stability. For this reason the potential for improvement is extremely limited and should be investigated with extreme care to avoid that possible technical solutions to reduce the energy consumption (adopted for category B equipment) could compromise or reduce the performances.

	Units sold* 2010	Units sold* 2011
Category A	41	59
Category B	471	521
Category C	108	155
<b>Total Units</b>	<b>620</b>	<b>735</b>

\*Open magnet units are not included in the figures as they are not in the scope of the SRI





# METRIC: kWh/day<sub>off+ready-to-scan</sub>

The measurements run on **14** models and the results of the study on MRI potential for improvement have shown that:

- Power consumed in the actual scanning mode was determined by the imaging physics protocols and could not be changed directly.
- New technologies with new scan sequences would need to be developed and accepted by the Medical Device Regulators and Customers to ensure that the clinical and diagnostic value proven and acceptable.
- Off mode and ready to scan mode were the only viable modes to reduce energy.

Therefore the Ecodesign Steering Committee **decided to adopt as metric for setting the target for MRI the energy usage per unit per day (kWh/unit day) in off and ready-to-scan mode to perform a certain number of examinations according to the use scenario.**

**The target is to be expressed as the average daily consumption per model in off and ready-to-scan mode:**

kWh/unit day<sub>off+ready-to-scan</sub>





# INNOVATION CYCLE

The innovation cycle is defined as the time needed to develop new or enhanced products and place them on the market. For medical devices it could vary from 3 years to 7, depending on the complexity of the innovation being brought to market.

The below listed activities for MRI requires:

Research and development	-	1 year
Realization, Verification and Validation	-	3 years
Regulatory Approvals	-	1 year

The innovation cycle for MRI therefore corresponds to **5 years**.



# SCENARIOS

The SC Secretariat collects from Companies the measurements of all MRI models and, on the basis of the reduction potentials determined by the PE INTERNATIONAL study on MRI, calculates the following target scenarios:

- Baseline today
- Business as usual (BAU)
- Best not yet available technology (BnyAT)
- Beyond Business as usual.

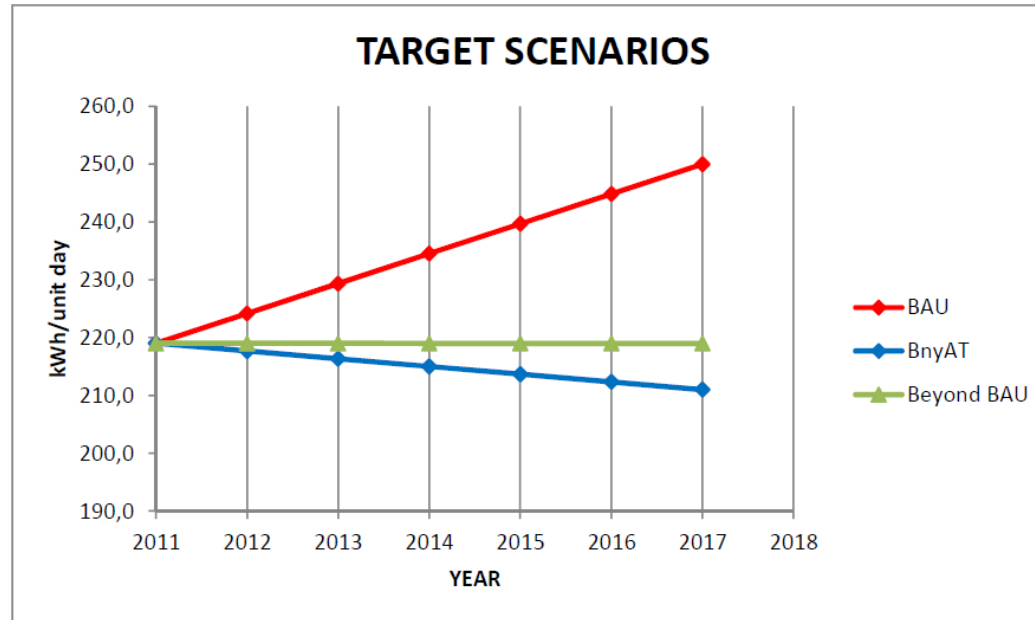


# TARGET SCENARIOS

Scenario (kWh/unit day)	Company					Average daily consumption in off and ready- to-scan per unit (kWh/d)	Range for setting targets compared to baseline
	A	B	C	D	E		
<b>BASELINE 2011</b> (kWh/d)	XX	XX	XX	XX	XX	<b>219</b>	baseline today
<b>BAU 2017 according to SRI methodology</b>	XX	XX	XX	XX	XX	<b>181</b>	
<b>BAU 2017</b> (kWh/d)	XX	XX	XX	XX	XX	<b>250</b>	<b>+14,3%</b>
<b>BnyAT 2017</b> (kWh/d)	XX	XX	XX	XX	XX	<b>211</b>	<b>-3,65%</b>
<b>Beyond BAU 2017</b> (kWh/d)	XX	XX	XX	XX	XX	<b>219</b>	<b>0%</b>



# TARGET SCENARIOS



	Sold units	Total daily energy consumption (kWh)	Average daily energy consumption per unit	Beyond BAU	BAU
<b>2011</b>	735	160.965	219		
<b>2012</b>				219	224,2
<b>2013</b>				219	229,3
<b>2014</b>				219	234,5
<b>2015</b>				219	239,7
<b>2016</b>				219	244,8
<b>2017</b>				219	250,0



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# SELF REGULATORY INITIATIVE FOR MEDICAL IMAGING EQUIPMENT

Thank you very much