

Maintenance management for energy rationalization in modern buildings

By:

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Maintenance definitions

- **Maintenance**, *combination of all technical, administrative and managerial actions during the life cycle of an item intended to retain it in, or restore it to, a state in which it can perform the required function. (Source: EN 13306)*
- **Required function**, *function or combination of functions of an item which are considered necessary to provide a given service. (Source: EN 13306).*

Example required function for a pleasure boat:

"... providing safe and pleasant conditions at sea ..."



Maintenance standards

- EN 13306, *Maintenance terminology*, CEN April 2001.
- EN 13460, *Maintenance – Documentation for maintenance*, CEN
- EN 15341:2007, *Maintenance Key Performance Indicators*
- EN 13269:2006, *Maintenance – Guideline on preparation of maintenance contracts*

Maintenance management in buildings deals with:

- Equipments availability and efficiency
- Safety
- Human comfort and IAQ
- Energy rationalization
- Operating economy
- Image

... and can induce significant energy economy through: 1.equipment efficiency; 2.improvement maintenance and 3. energy management.

EU Directive 2002/91/CE requirements for maintenance

- Maintenance according to good practices
- Certified engineer (TRF) & certified personnel (TIM)
- Coverage of IAQ and energy management and auditing
- Energy consumption monitoring and analysis

Facts and figures ...

- Well maintained equipment lasts 30/40% more.
- Proactive maintenance reduces energy 5 - 11%.
- Costs: about 50 % manpower / 50 % materials.
- Reduce downtime / Improve efficiency.
- Corrective maintenance costs 2 / 4 times more.
- Target: Preventive / Corrective at 80 % or more.
- Implementation: Usual 3 to 5 years. Target less.

Objectives & Targets

- Objective = colloquial expression of *what we want*; e.g. “minimum no.of failures”, “min. repair times”, “accomplish EEI requirements.”
- Target = *analytical expression* of the objective; e.g. for above:
 - Indicator operating time T17 = total operating time / no. failures < 2920 hours
 - Indicator restoration time T21 = total restoration time / no. failures < 2 hours
 - EEI = Energy consumed / Net area < 45 kgep/m².year

Set your Objectives & Targets

- Year One
 - Implement maintenance plan = ability to produce reliable Maintenance Indicators. (Remember that the difficulty is to gather the information.)
- Year Two (based on appraisal of Year One):
 - T17 = total operating time / no. failures < 2920 hours
 - T21 = total restoration time / no. failures < 2 hours
 - EEI = Energy consumed / Net area < 45 kgep/m².year
- Cruising speed:
 - Set some realistic ambitious targets – improvement maintenance.

Setting up management

- Full speed first class maintenance management can take 3 years ...
- ... but results should be showing after 1 month

Illustrations along use application **InnWinWin** by:



Step 1 – organize your plant

- Define:
 - Cost centres and/or clients
 - Technical intervention area
- Establish:
 - Rules for coding and technical datasheets
 - Functional organization
 - Work types

Step 2 – register maintenance items

- Start with the most important
 - Energy & water meters
 - HVAC equipments
- But do not forget:
 - Safety equipments
 - Lifts, escalators, etc.
 - Premises, rooms, shops, etc.

Item [Close]

Structure: V01 - 0001 [...]

Item Type: V01 - SPLIT AC SET

Code: V01-0001

Description: SPLIT SET TEC.LIBRARY

IN UP STATE

Downtime

Identification | Particulars | Operational Data | Complementary Info. | Notes

System TL.09 - AUTONOMOUS AIR CONDITIONNING

C. Centre 9998 - TECHNICAL LIBRARY (ENG)

Operator

Operator []

Since 01-01-2000 09:00

Supplier 99999 - INDISCRIMINADO

Date: 01-01-2000 Record (H): 0 Amount: 1.000,00

Picture: C:\Users\Cabral\Pictures\GrandeBD\AC-0000.JPG []

File: [] []

29 / 35

OK **Cancel** **Apply**

Register equipment

Step 3 – Spares and materials

- Establish appropriate coding standard
- First: register lubricants
- Second: “broad sense” spares:
 - Air filter, bearing, belt, valve, etc... to acquire sensitivity of the general nature of your materials consumption
- Later (cruising speed):
 - Organize a comprehensive materials standard. To get an accurate picture of your materials consumption and manage effectively your maintenance logistics.

Step 4 – Set maintenance plan for each item

- Start by using standard work schedules
 - The CMMS may carry some
 - Obtain from technical literature (e.g. ref. 6)
- Later:
 - Study manuals and adjust to the equipment
 - Adjust to actual operating conditions
- Do not forget: Plan energy and IAQ audits

Maintenance Schedule

Item: V01-0001 - SPLIT SET TEC.LIBRARY

Work Type: A - PREDETERMINED

Code: A-01 Description: Routine inspection 3M Plan. TM (H): 1.00

Periodicity

Calendar: 3 Months Records (H):

Next MSch: A-01

Tasks: Man-Hours Stock Items Other

SAFETY & ENVIRONMENTAL PRECAUTIONS

- Prior to work in unit cut energy supply
- Remember that a dirty filter reduces air flow, increases energy requirement and may contaminate the environment
- Adjust this schedule to actual conditions and results of inspections
- This schedule is orientative; you should refer to the equipment Manual and adjust this WO.

TASKS (INTERNAL UNIT)

- Remove grille and filter
- Vacuum clean, wash with fresh water and detergent, then rinse with water
- Clean accessible areas with moisted cloth
- When dry remount filter and grille
- Run test and check noise.

1 / 2

OK Cancel Apply

Prepare comprehensive work schedules

Step 5 – Implement Work Orders (WO) and reporting

- Remember:
 - Every maintenance job needs one WO
 - There is no management without reporting
 - Maintenance people do not like to report
(Example InnWinWin: WO 000135)
- Therefore:
 - Implement WO and train personnel
 - Keep it simple but disciplined

Work Orders

- Scheduled
- In Progress
- Terminated
- [-] Maintenance Work Types
 - [+] A - SYSTEMATIC
 - A - Predetermined
 - Q - Audit / Certification
 - [+] B - CONDICIONNED
 - [+] C - CORRECTIVE
 - [+] M - IMPROVEMENT

Work Orders List

WO	Description	Entity	Performer	Status	Scheduled	Start	End
000003	Revisão 3A	GE-0001 - GRUPO ...	MAN.031 - Electrom...	Scheduled	15-02-2008		
000006	Inspecção 1A	GE-0001 - GRUPO ...	MAN.031 - Electrom...	Scheduled	01-01-2008		
000064	Rotina semanal Operador	GE-0001 - GRUPO ...	MAN.031 - Electrom...	Scheduled	07-01-2008		
000088	Rotina 3M	AC-0002 - SPLIT DE...	MAN.010 - TIM 3	Scheduled	20-12-2007		
000106	Revisão 12M	AC-0005 - SPLIT DE...	MAN.019 - Técnico ...	Scheduled	14-12-2009		
000112	Revisão 12M	AC-0004 - SPLIT DE...	MAN.019 - Técnico ...	Scheduled	20-12-2009		
000113	Revisão 12M	AC-0002 - SPLIT DE...		Scheduled	20-12-2009		
000114	Rotina 3M	AC-0004 - SPLIT DE...		Scheduled	20-06-2009		
000115	Rotina 3M	AC-0005 - SPLIT DE...		Scheduled	14-06-2009		
000119	Revisão 12M	AC-0006 - SPLIT DE...		Scheduled	12-09-2007		
000120	Rotina 3M	AC-0003 - SPLIT DE...		Scheduled	20-03-2008		
000124	Revisão Anual - 1A	VT-0001 - Ventilador...		Scheduled	12-03-2007		
000132	Rotina Semestral - 6M	VT-0001 - Ventilador...		Scheduled	14-03-2007		
000133	Rotina Trimestral - 3M	VT-0001 - Ventilador...		Scheduled	15-12-2006		
000134	Rotina Mensal 1M	VT-0001 - Ventilador...		Scheduled	19-10-2006		
000135	Routine inspection 3M	V01-0002 - SPLIT S...	MAN.011 - TIM 2	Scheduled	20-04-2009		

- Plant
- Work Orders**
- Materials
- Costs

Manage Work Orders

Step 6 – Implement periodical readings

- Electricity, gas, water, fuel ...
 - All need to be read at least once a month
 - Preferably at the end of each month
- Other equipments such as:
 - Chillers, boilers, compressors
 - Also need to have running records to forecast maintenance dates

CO-0001 - E. ELEC. (HP) HORAS PONTA "HOTEL UNIVERSO"

Data	Registro Unid.	Operador
31-07-2007	1.046,00 KWH	09152 - Carlos Fernandes
31-08-2007	7.314,00 KWH	09152 - Carlos Fernandes
30-09-2007	12.583,00 KWH	09152 - Carlos Fernandes
31-10-2007	18.021,00 KWH	09152 - Carlos Fernandes
30-11-2007	27.495,00 KWH	09152 - Carlos Fernandes
31-12-2007	37.820,00 KWH	09152 - Carlos Fernandes
31-01-2008	47.802,00 KWH	09001 - Maria Helena Tomaz
29-02-2008	57.336,00 KWH	09001 - Maria Helena Tomaz
31-03-2008	65.439,00 KWH	09001 - Maria Helena Tomaz
30-04-2008	70.692,00 KWH	09001 - Maria Helena Tomaz
31-05-2008	75.943,00 KWH	09001 - Maria Helena Tomaz
30-06-2008	81.618,00 KWH	09001 - Maria Helena Tomaz
31-07-2008	89.985,00 KWH	09001 - Maria Helena Tomaz
31-08-2008	98.434,00 KWH	09001 - Maria Helena Tomaz
30-09-2008	105.879,00 KWH	09001 - Maria Helena Tomaz
30-09-2008	105.879,00 KWH	09001 - Maria Helena Tomaz
31-10-2008	113.223,00 KWH	09001 - Maria Helena Tomaz

Record energy readings

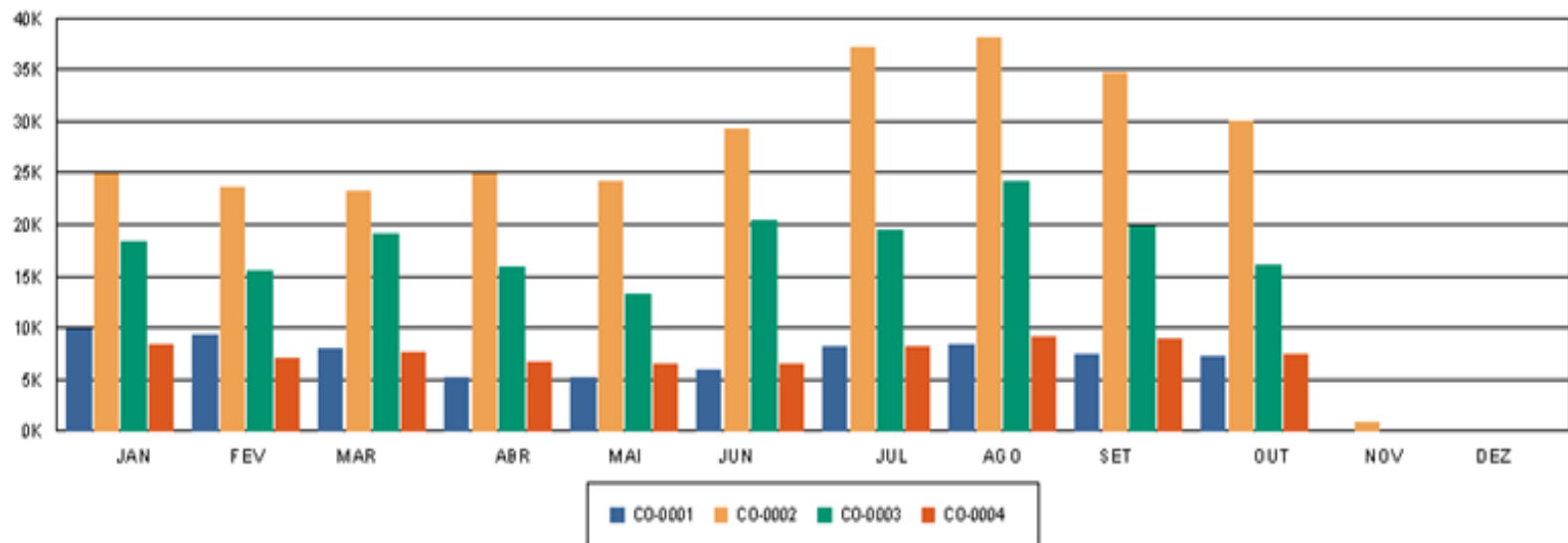
Step 7 – Look critically at consumptions

- Energy
- Water
- Costs
- Sound possible interactions:
 - Consumptions x plant utilization
 - Costs x maintenance types, etc.

(example InnWinWin:EE Analysis – print consumptions)

2008-CEE - Consumo energia eléctrica - Año: 2008

Consumos Energéticos (Eléctrica)

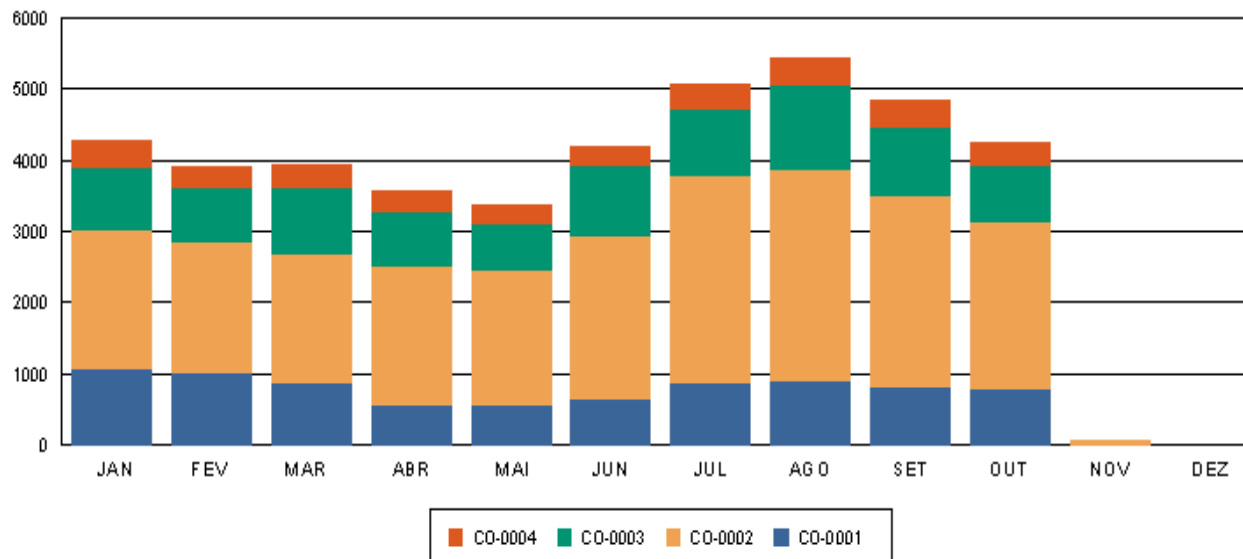


	JAN	FEV	MAR	ABR	MAI	JUN	JUL	AGO	SET	OUT	NOV	DEZ	TOTAL
CO-0001 - E. ELEC. (HP) HORAS PONT	9989	9467	8017	5247	5277	5935	8176	8425	7434	7344	0	0	75311
CO-0002 - ENERG.ELÉCTRICA (HC) HO	24960	23674	23293	24966	24239	29315	37260	38173	34747	30156	973	0	291755
CO-0003 - ENERG.ELÉCTRICA (HV) HO	18319	15502	19207	15939	13400	20485	19473	24242	19856	16130	0	0	182552
CO-0004 - ENERG.ELÉCTRICA (HS V) S	8415	7151	7726	6755	6453	6570	8165	9112	8961	7408	0	0	76716

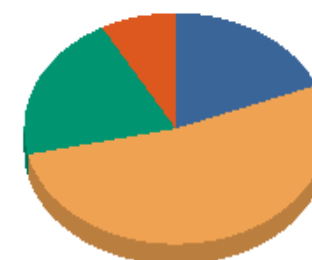
Look at your energy consumption and mix

2008-CEE - Consumo energia eléctrica - Ano: 2008

Custos Energéticos Mensais



Custos Energéticos Totais

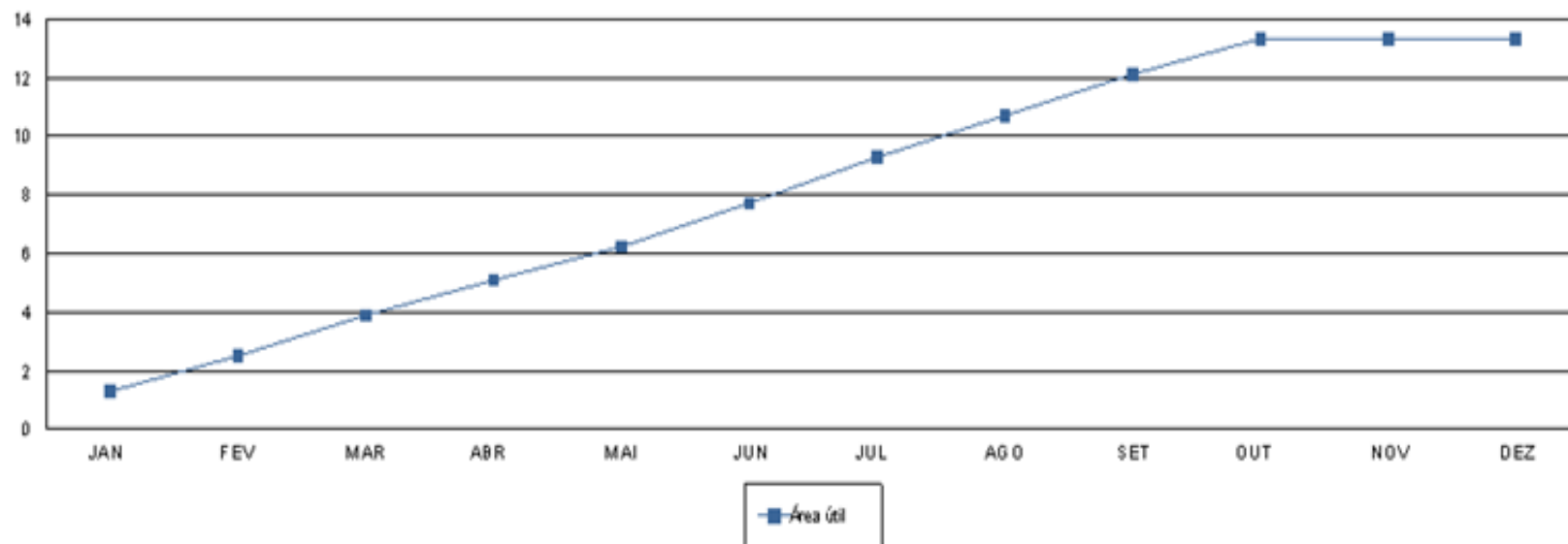


	JAN	FEV	MAR	ABR	MAI	JUN	JUL	AGO	SET	OUT	NOV	DEZ	TOTAL
CO-0001 - E. ELEC. (HP) HORAS PONT	1.071,79	1.015,77	860,19	563,03	566,24	636,78	877,30	903,96	797,70	788,06	0,00	0,00	8.080,83
CO-0002 - ENERG.ELÉCTRICA (HC) HO	1.941,89	1.841,83	1.812,23	1.942,32	1.885,78	2.280,74	2.898,81	2.969,86	2.703,33	2.346,11	75,88	0,00	22.698,58
CO-0003 - ENERG.ELÉCTRICA (HV) HO	886,86	750,30	929,80	771,44	648,56	991,47	942,49	1.173,31	961,01	780,89	0,00	0,00	8.835,54
CO-0004 - ENERG.ELÉCTRICA (HSV) S	378,88	321,77	347,86	303,98	290,37	295,84	367,44	410,04	403,25	333,36	0,00	0,00	3.452,21

... and your costs pattern ...

IEE-2008 - Eficiência energética 2008 - Ano: 2008

Índices Eficiência Energética (Kgep/Área útil)



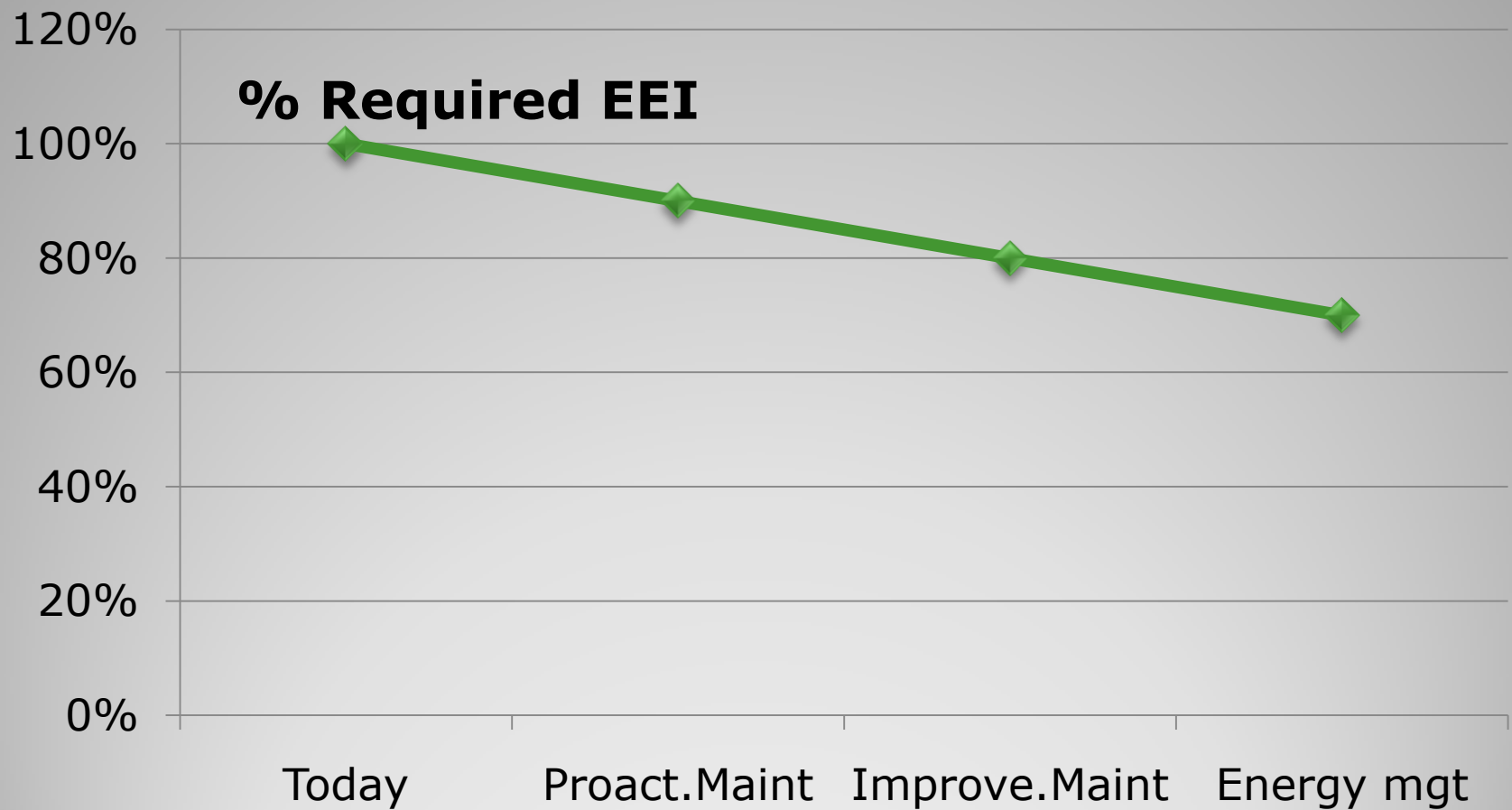
Unidade Referência	JAN	FEV	MAR	ABR	MAI	JUN	JUL	AGO	SET	OUT	NOV	DEZ	TOTAL
Área útil	1,30	2,51	3,91	5,10	6,24	7,73	9,29	10,72	12,12	13,33	13,33	13,33	13,33

Watch the evolution of your EEi

Conclusion

Step by step energy rationalization:

- *Proactive* maintenance – economize 10 % kW
- *Improvement maintenance* on equipments – economize + 10 % kW (?)
- *Manage energy mix* – economize 10 % kW and/or € (?)



Target energy economy

Bibliography

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END OF PRESENTATION

Thank you for your attention!

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