Energy Management System (EnMS)

2 Day User Training, Day 2

Expert Training Module 1, Day 2

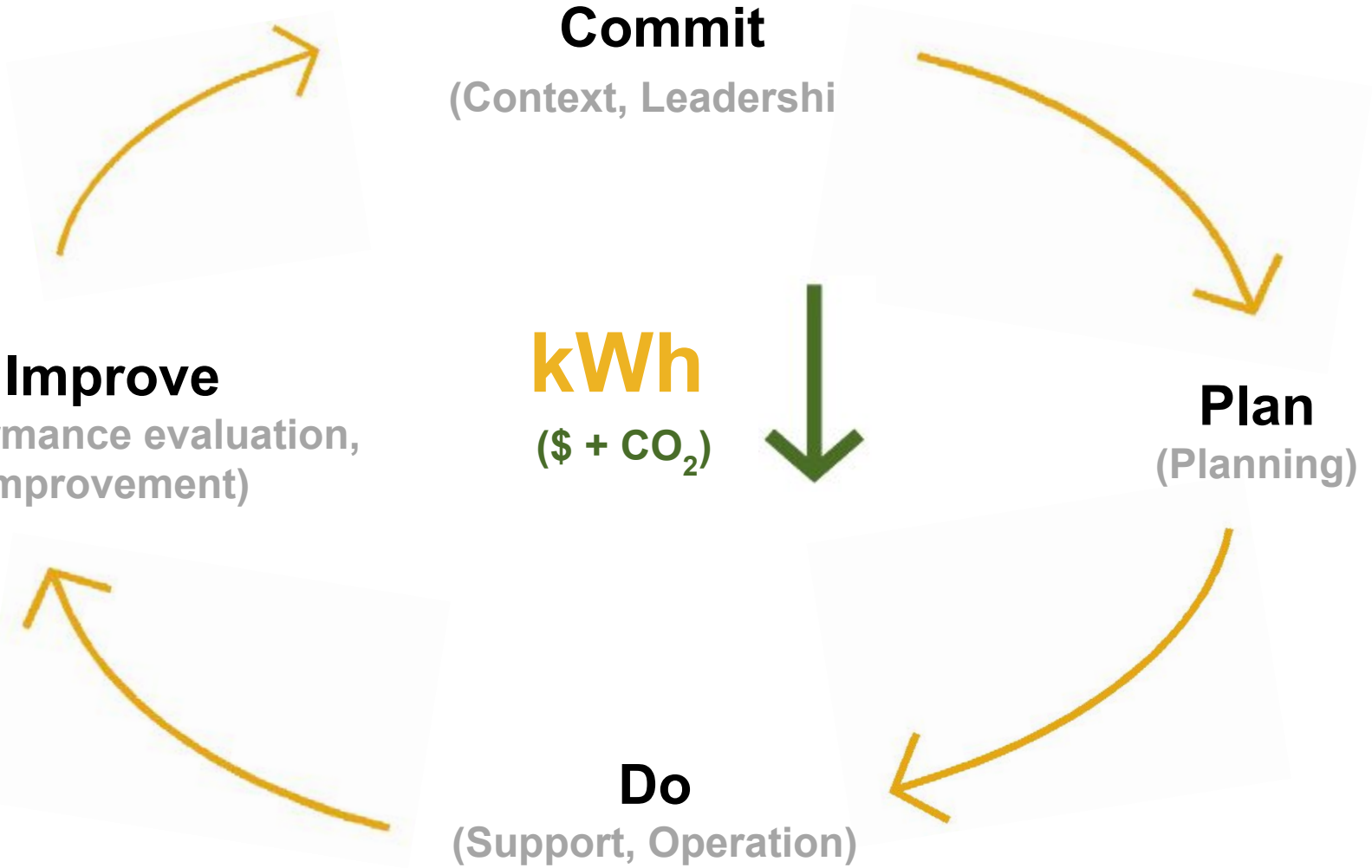
Context, leadership and support

Topic	Duration (hours)	Exercise	Break duration	Start Time	End Time
DAY 2 - Overview of EnMS and EnPMIs					
Review Day 1	10			09:00	09:10
Operation	25	5		09:10	09:40
Performance Evaluation and Improvement	25	5		09:40	10:10
Break			15	10:10	10:25
Non-energy benefits (co-benefits)	20	20		10:25	11:05
Energy Performance Measurement and Indicators (EnPMI) - delusions and barriers	30	15		11:05	11:50
Overview of good practice in EnPMI	45			11:50	12:35
Lunch			60	12:35	13:35
Overview of good practice in EnPMI		30		13:35	14:05
Project Plan	15			14:05	14:20
Introduction to statistics	55			14:20	15:15
Break			10	15:15	15:25
Behaviour change and change management	30			15:25	15:55
Risks and barriers	5	45		15:55	16:45
Next Steps and closure		15		16:45	17:00
TOTAL	4.3	2.3	1.4	**8.0**	

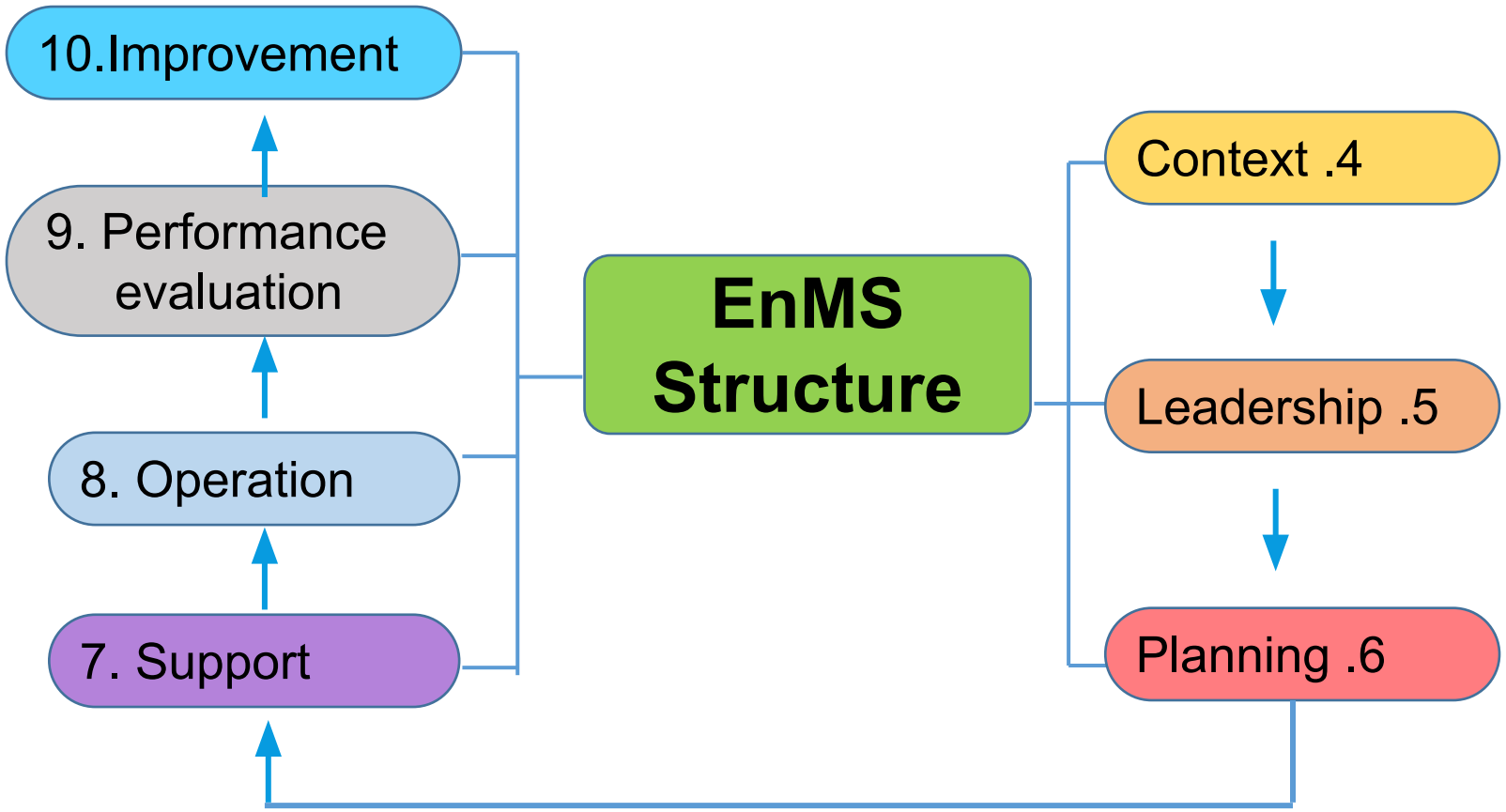
Review day 1

What did you learn?

Any items requiring clarification?


Commit
(Context, Leadershi
Plan
(Planning)
Do
(Support, Operation)
Improve
(Performance evaluation, Improvement)
kWh
($ + CO_2)

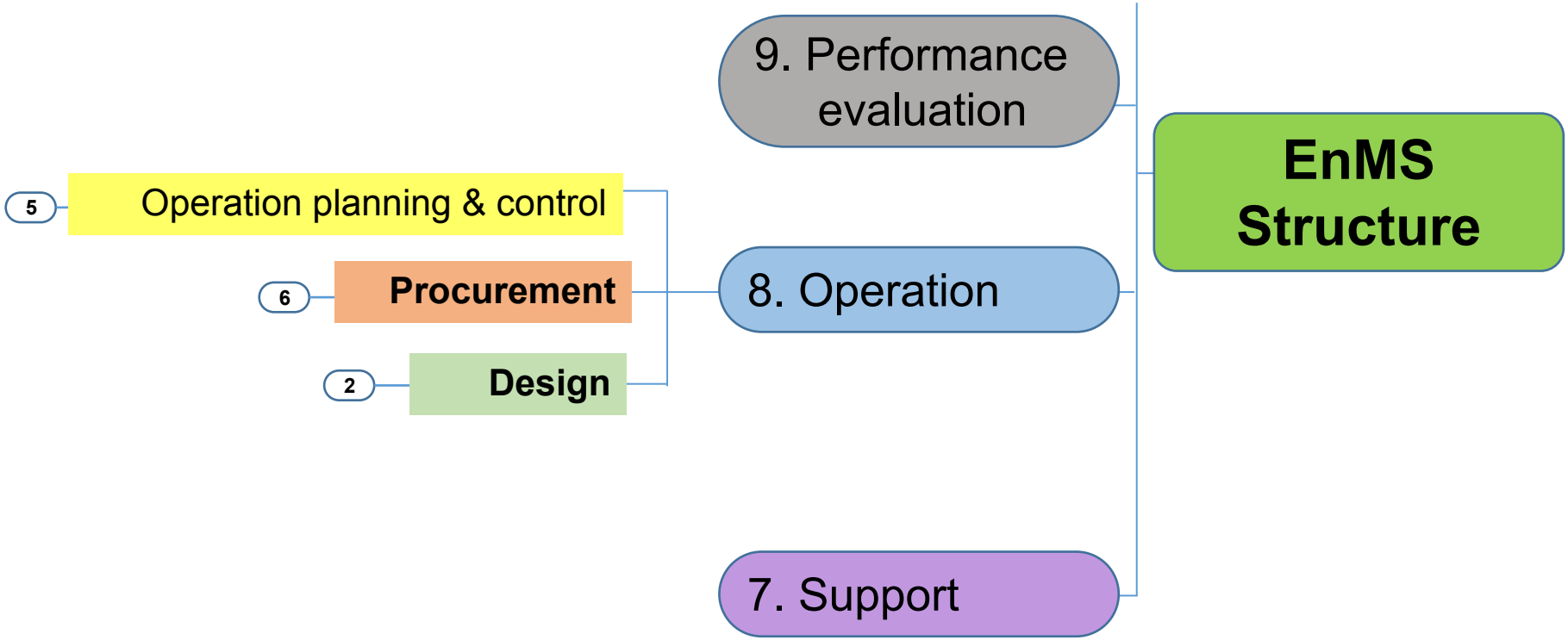
Structure of ISO 50001:2018 (EnMS)



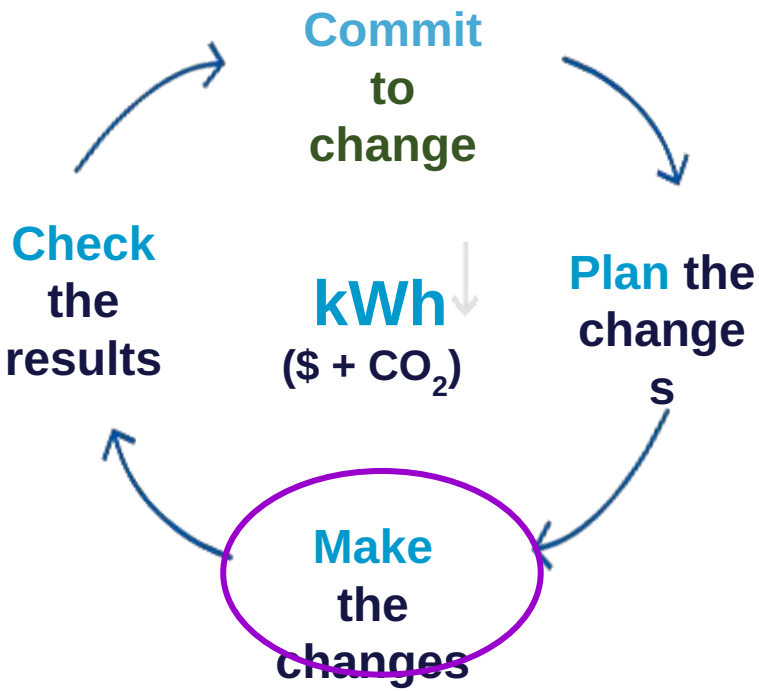
Operations

Operational control, design and procurement

Operation


9. Performance evaluation
EnMS Structure
5
Operation planning & control
6
Procurement
8. Operation
2
Design
7. Support

Implementation & Operation



- Operational control
- Design
  - ✔ Energy Efficient Design (EED)
- Purchasing energy, services, goods
- Implement action plans

What is this step ?

- **Doing -** Daily activities to improve energy performance
- We have a policy with management support, resources, strategic direction and committed team members
- We also have objectives, targets and action plans
- Now, we must implement the action plans, day to day control and continual improvement of our energy consumption

Implementation & Operation

- This is a continuous daily process – not a project
- It needs to be part of day to day habits
- This is the part where energy savings and energy performance improvements are actually made
  - ✔ All other parts of the system support this
- This may be a major change for your organisation
- It may be a major change for you!!!
- Change is always difficult to manage
- Needs involvement, support and communication
- If you don't change you can't improve

" If you want to make enemies, try to change something"

~Woodrow Wilson

Operational Control

- This is a very critical part of the EnMS
  - ✔ Only a small part of ISO 50001 and others

Operation of SEUs	**Maintenance of SEUs**
• Operating parameters • Operating procedures • Logging (electronic and manual)	• Maintenance procedures and schedules • Training of external

Monitoring of operations, records, action plan & EnPIs

It is critical that all significant energy uses are operated and maintained in the most energy efficient way feasible.

This area is very commonly neglected

It is not difficult

Behaviour Change – operation control

- "We have always been operating (maintaining) things this way"
- "Why do we need to change?"
- "Production is critical – if we change something we may affect production"
- Change is uncomfortable
- It is difficult to sustain
- Communication is very important
- Discuss difficulties and solutions

re: operation control

Causes of failure to complete action items

Lack of real commitment

Lack of focus, failure will not be poorly viewed

Lack of technical ability

Need good ability to overcome other barriers

"I'm too busy"

= lack of commitment

Lack of finance

Should have been agreed at planning stage

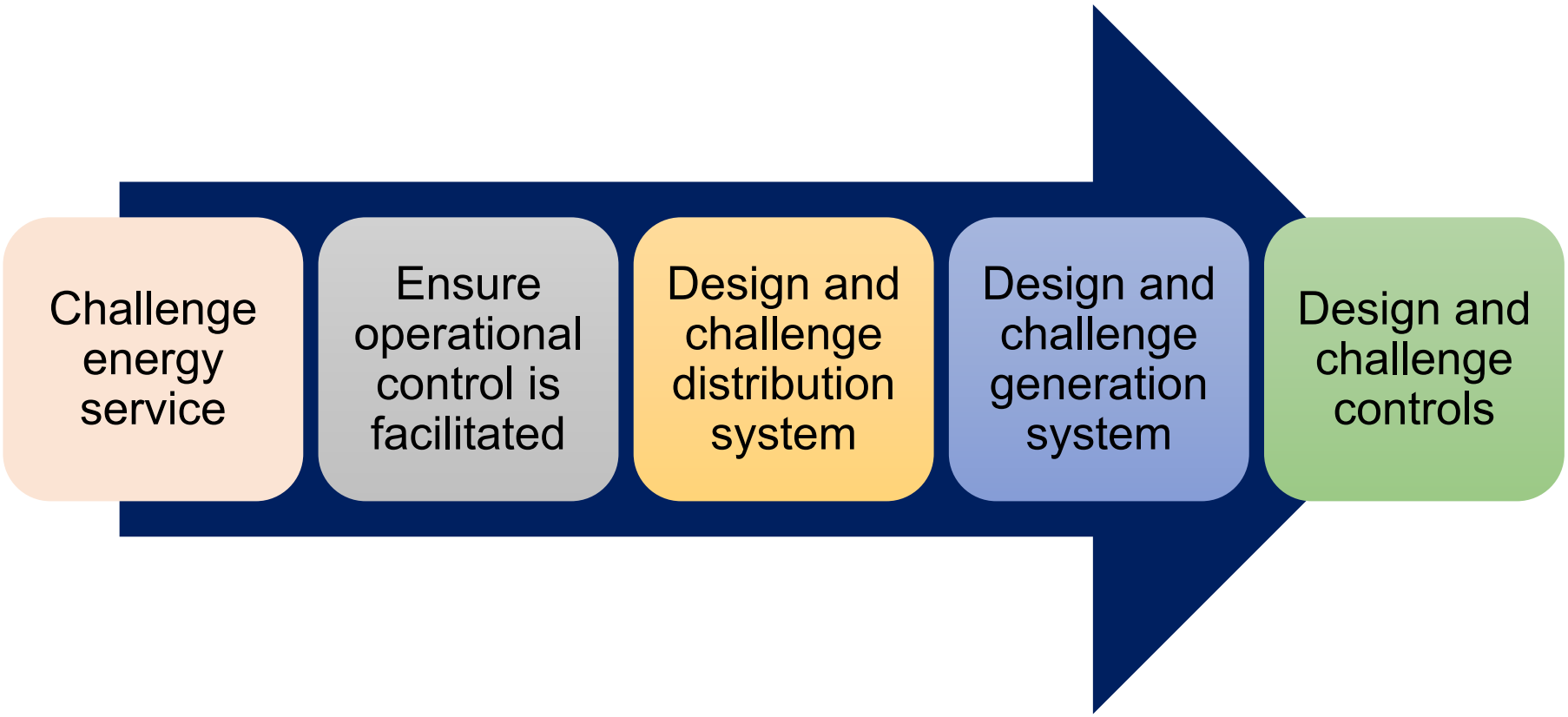
Lack of communication

Need to understand expectations
Need to understand role

Monitoring operational control

- It is a day to day activity to ensure that equipment and systems are operating efficiently
- Give most attention to SEUs
- Someone should be completing operational checks on a regular (daily?) basis
- These form the basis of the operator logs or other monitoring process
- These logs need to be checked routinely and regularly
- Also check maintenance activities
- Importance of checking critical operating parameters

EED


Challenge energy service
Ensure operational control is facilitated
Design and challenge distribution system
Design and challenge generation system
Design and challenge controls

Procurement

- Can have a significant impact on your energy performance
- Inform vendors that you have an EnMS that requires energy performance to be assessed as appropriate when purchasing
- Ask vendors how they can help with your energy performance
- You need to be able to assess the energy performance and impact of items that you purchase
- Need to move towards Life Cycle Costing (LCC)

Procurement

Services

- Maintenance
- Designers and architects
- Constructors
- Energy advisors

Equipment

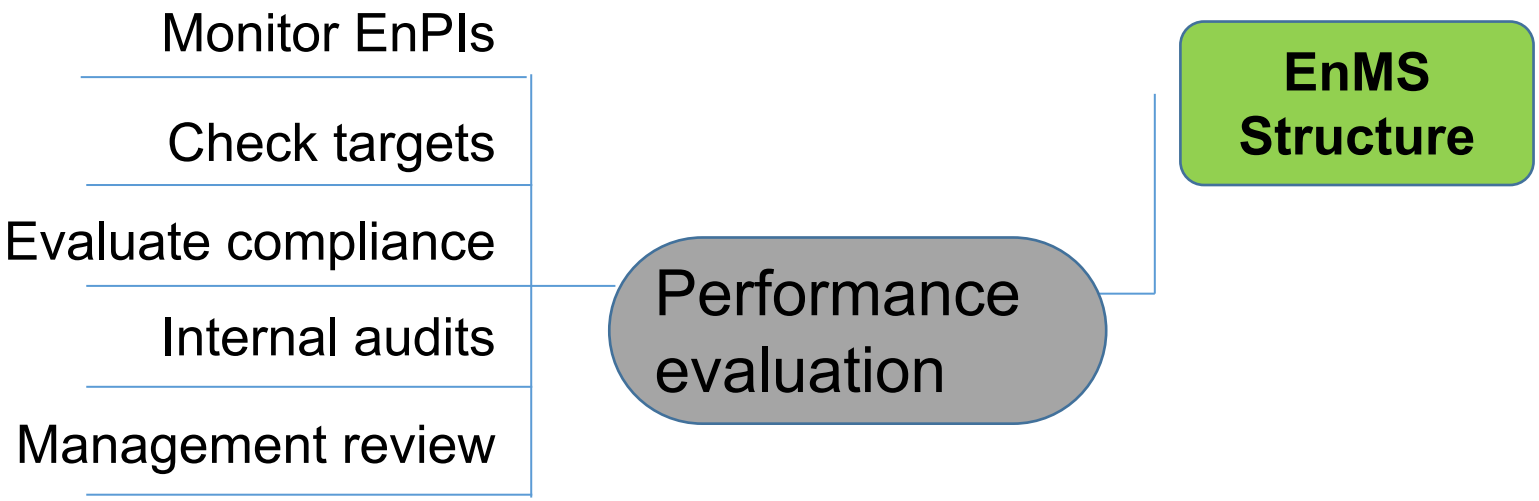
- Boilers, chillers, compressors, etc.
- Production equipment
- Spare parts; lamps, fan belts, lubricants, etc.

Energy

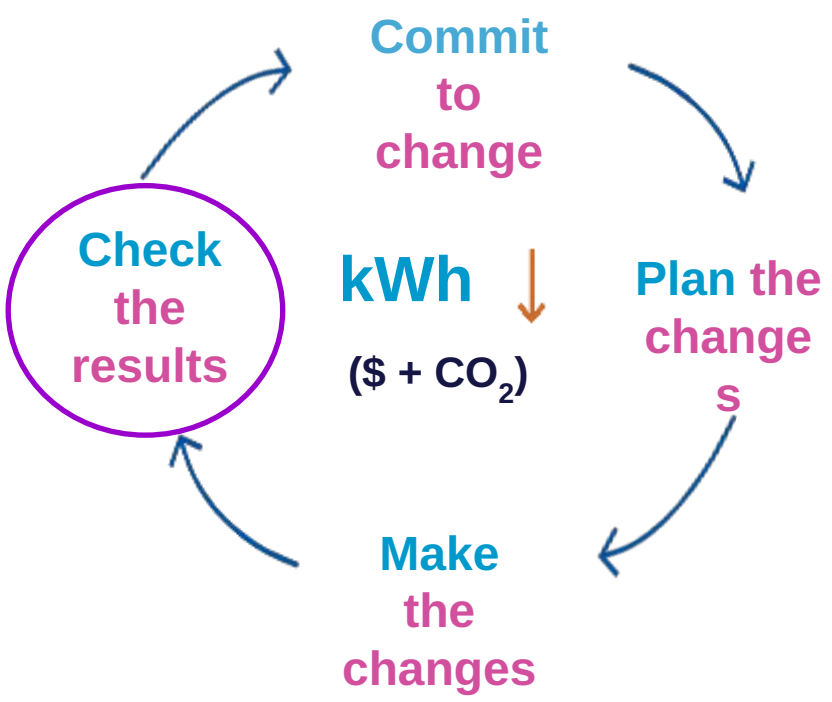
- Check tariffs for electricity and natural gas
- Check specifications for fuels

Performance evaluation and Improvement

Checking and continual improvement


Monitor EnPIs
Check targets
Evaluate compliance
Internal audits
Management review
Performance evaluation
EnMS Structure

Performance evaluation and improvement



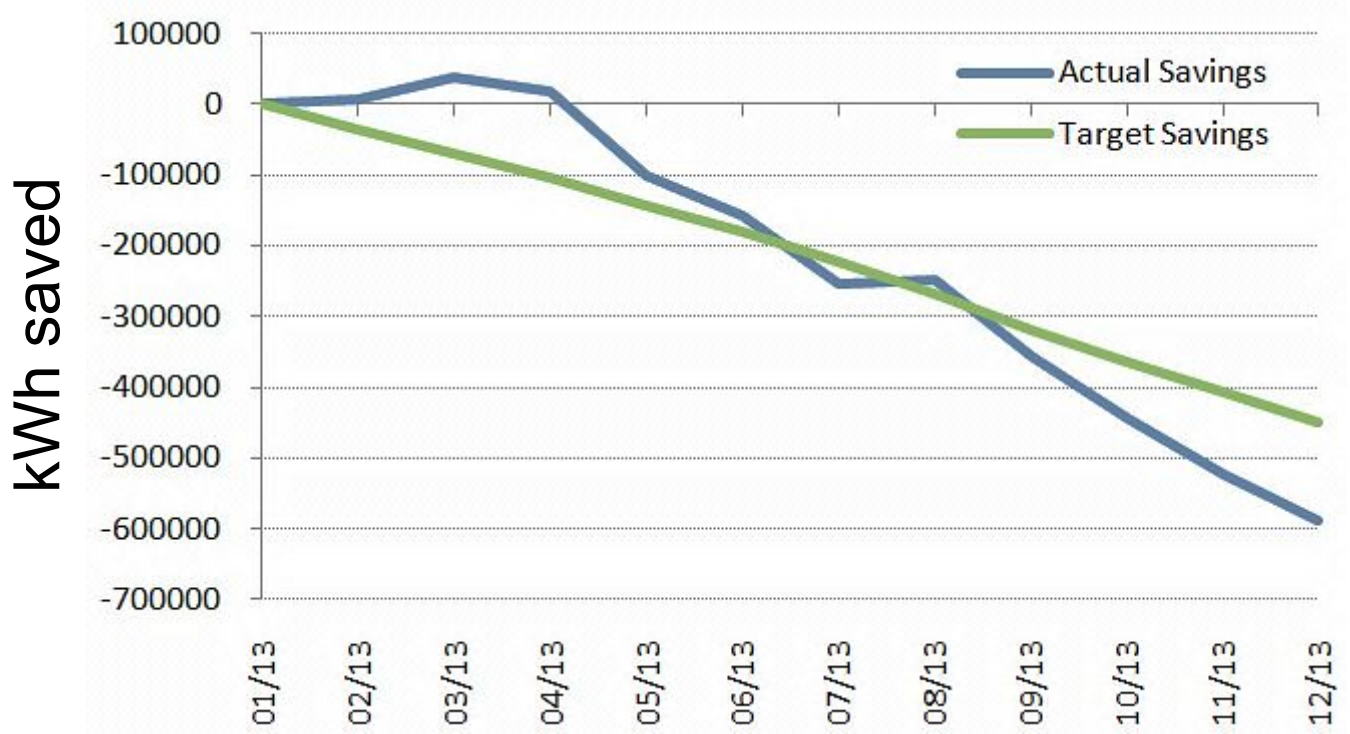
- Monitor energy performance
- Are targets being achieved?
- Check legal compliance
- Carry out internal audits
- Hold the management review

- Non-conformity management
- Continual improvement

Performance checking

- We have a baseline energy performance
- We have targets for performance improvement
- We need to know if we are meeting our performance improvement targets
- We have Energy Performance Indicators (EnPIs)
- This can be a complex topic depending on your industry and your energy drivers
- You need to regularly compare actual EnPIs with expected values
- If possible, at least one EnPI per SEU
- One EnPI for each energy source

Cumulative savings



System checking and improvement

Non-Conformity (NC)	• **Not fulfilling a requirement** • **Beware of excessive numbers of NCs** • **Critical part of continual improvement**
Corrective action	• **Action including prevention of recurrence of a non-conformity** • **Removing the cause of the non-conformity**
Internal Audit	• **Check that the system is being run in accordance with its requirements**

What is an internal audit?

- Independent review of part or all of the EnMS
- The purpose is to determine if the EnMS is being used effectively
- Is everyone fulfilling their roles
- Is the EnMS effective in improving energy performance?
- Is it achieving its objectives?
- Does the EnMS meet the requirements of a standard if certification is being sought, e.g. ISO50001
- It is an essential part of continual improvement

What is reviewed

- Objectives, targets and action plans
- Legal and other requirements
- Policies, documentation and operational controls including;

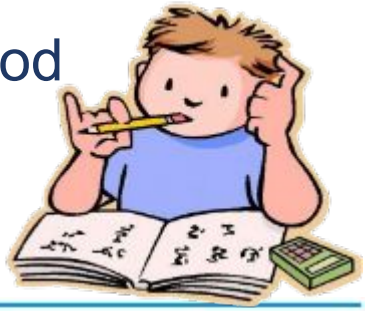
Context	Communication
Risks and opportunities	Document control
Energy review	Internal audits (yes!) and non-conformances
Compliance with legal and other requirements	Management reviews
Awareness, training and competence	**Performance improvement (EnPIs)**

Management review

- It is part of building commitment and leadership.
- Usually happens once a year (can be more often).
- Top management and people involved in RnR should attend it.
- Review the organisation's EnMS to ensure it is continually improving.
- Review energy savings to ensure they are continually improving.
- Alignment with strategic direction
- They look at the past and future of the EnMS.

Management review: Inputs

- Follow up actions from previous management reviews
- Changes in external and internal issues and risks and opportunities
- Review of the energy policy
- Review of energy performance and related EnPIs
- Compliance with legal requirements and changes
- Objectives and targets have been met?
- EnMS audit results
- Status of non-conformities and corrective actions
- Projected energy performance for the following period
- Recommendations for continual improvement



Management review: Outputs

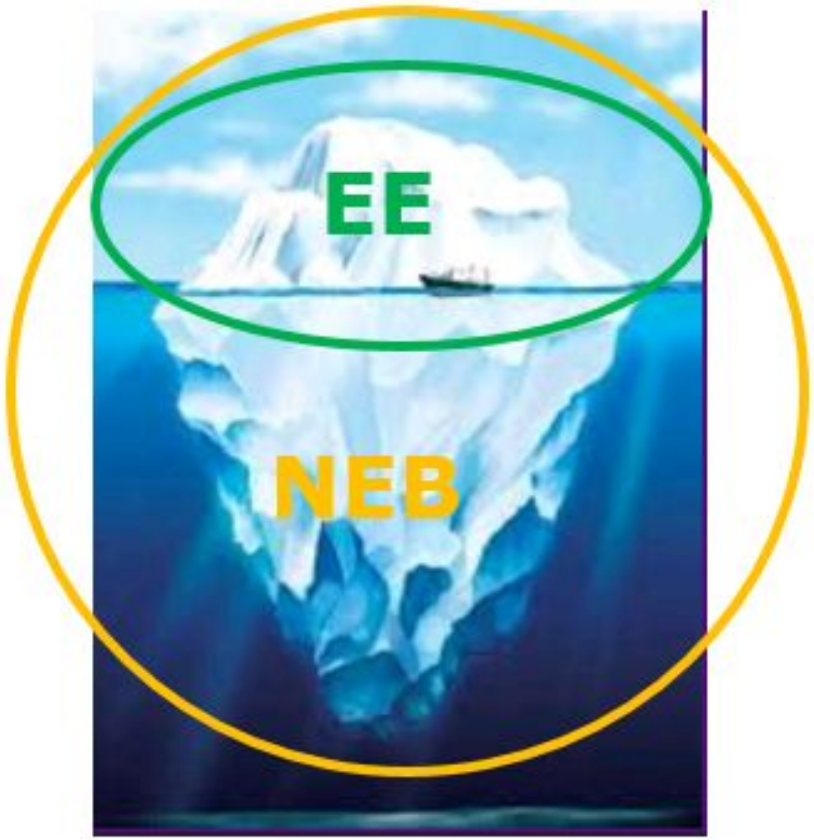
- Opportunities to improve energy performance
- Changes to the energy policy
- Changes to the EnBs and EnPIs
- Changes to objectives, targets or other elements of the EnMS
- Improvements in integration with business processes
- Changes to allocation of resources
- Improvements in competence, awareness and communications

See you in 15 minutes!

Non-energy or co-benefits

There is more to be gained than only energy savings

There is more to EnMS than ENERGY



What are NEBs ?

Non-energy benefits from efficiency improvements

Waste

- Use of waste fuels ,heat, gas
- Reduced product waste
- Reduced water waste
- Reduced hazardous waste
- Material reduction

Emissions

- Reduction of dust emissions
- Reduced CO, CO2, Nox, Sox emission

Operation & Maintenance

- Reduced need for engineering control
- Lowered cooling requirements
- Increased facility reliability
- Reduced wear and tear on equipment \ machinery
- Reductions in labor requirements

production

- increased product output\ yields
- Improved equipment performance
- Shorter process cycle times
- Improved product quality \ purity
- Increased reliability in production

Working environment

- Reduced need for personal protective equipment
- Improved lighting
- Reduced noise levels
- Improved temperature control
- Improvement air quality

Other

- Decreased liability
- Improved public image
- Delaying or Reducing capital expenditures
- Additional space
- Improved worker morale

How can they be assessed?

- Use the values from research = energy saving X 2.5

Non energy benifiets from commercial & industrial energy efficiency programs:
Energy efficiency may not be the best story

Nick P. Hall, TecMarket Works
Johna A. Roth, TecMarket Works

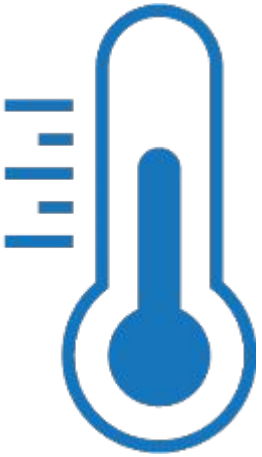
The results indicate that business significant importance on the non energy benefits associated with the installed technologies, and that the value of these benefits are equal to about 2.5

- Questionnaire

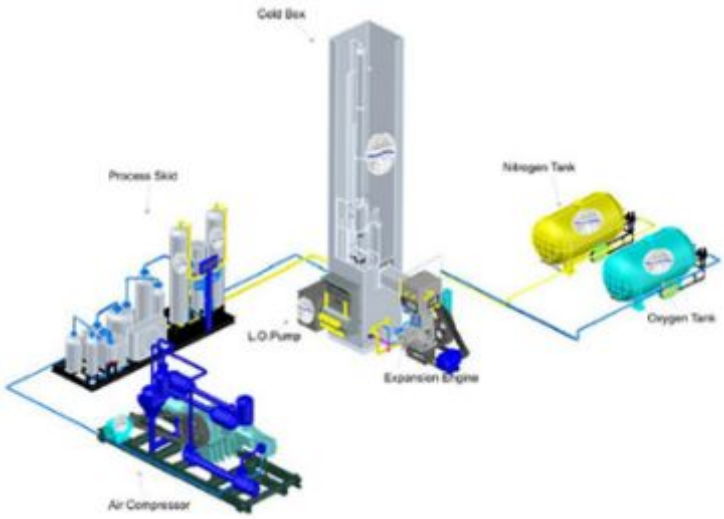
- Calculation

Production of liquid gases

- If the temperature of the cooling water goes up, it increases the energy consumption in the production of liquid gasses.
- Systematic metering introduced in connection with the implementation of EnMS, indicated rising temp over time, due to fouling of the heat exchanger.
- In spite of chemical treatment of the cooling water.
- Special investigation pointed towards an ozone unit together with a sand filter
- Result: temp decreased with 1-2 degrees



Production liquid gases

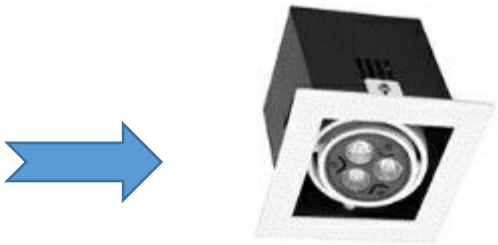


- Savings -energy:
  - ✔ 153.000 kWh/year or 12.000 US dollar
- Payback 3.6 years

- NEBs
  - ✔ Chemicals 50.000 US dollar/year
  - ✔ Corrosion inhibiter 12.000 US dollar/year
  - ✔ Reduced corrosion 20.000 US dollar/year
  - ✔ Reduced labour cost not calculated
  - ✔ Reduced down time not calculated
  - ✔ Reduced environmental influence not calculated
  - ✔ Better working environment not calculated

Payback less than half a year

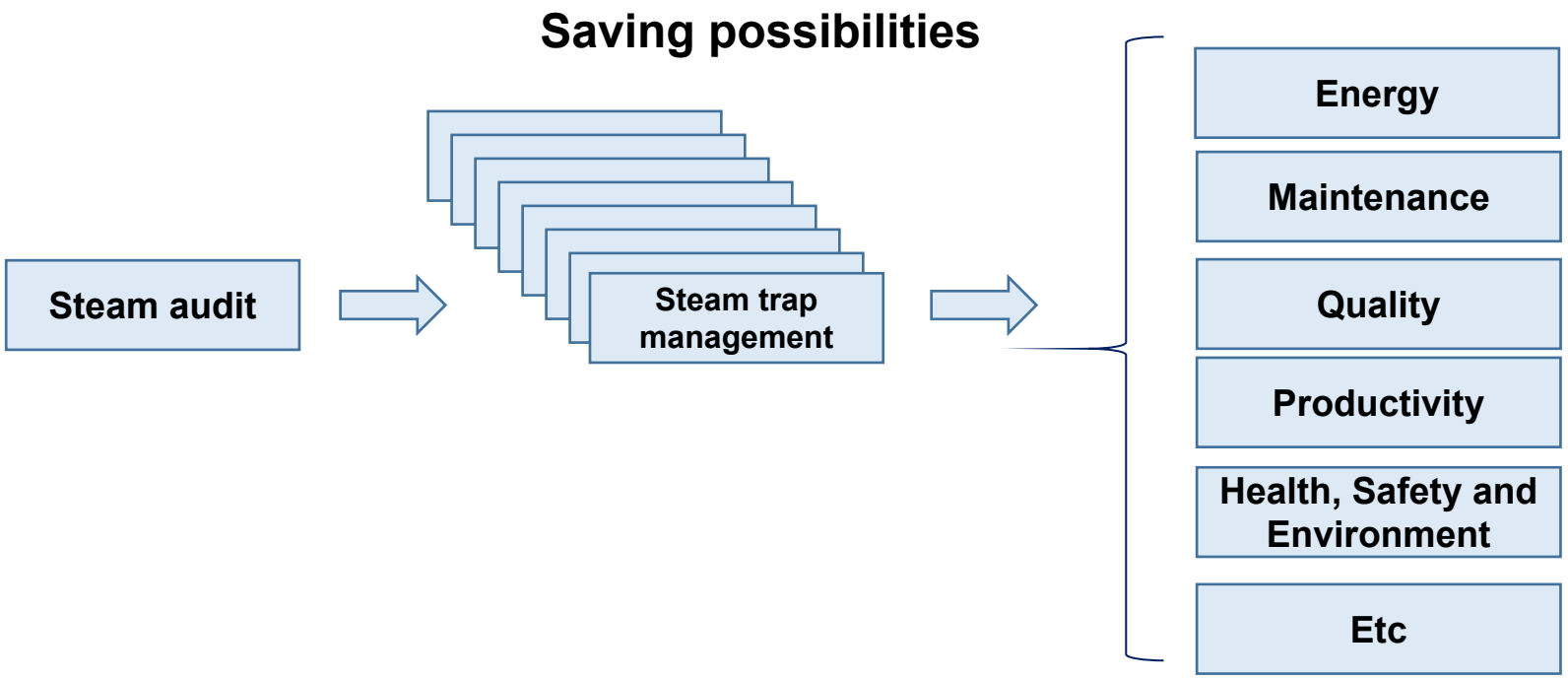
So what do we achieve besides saving electricity, if we go from halogen to LED in a shop?



NEBs of LED lights

- Reduced maintenance LED life 25,000 hours, halogen 1,000 hours
  - ✔ Reduced procurement and installation cost
- Reduced cooling
  - ✔ Less heat from LED, less cooling, that leads to less energy consumed by aircon, less time for aircon means less maintenance and extended life of aircon
- LEDs does not change colour of clothing, that means less clothing has to be sold at sale prices
- LEDs reduce fire risk
- LEDs do not give off heat: maybe people stay longer, shop more ☺
- LEDs gives shop green image
- Less hazardous waste disposal on replacement

NEB assessment process



NEB in the ESO List

H	I	J	K	L	M	N
Technical and financial appraisal of each ESO						
Non-energy benefits (NEB)	NEB Value ($ per year)	Estimated electricity saving (kWh p.a.)	Estimated Gas Savings (kWh p.a.)	Estimated Water saving (m3 p.a.)	Estimated cost savings ($ per year)	Estimated CO2 Saving (Ton p.a.)

Discussion

- What NEBs are there for the following:
  1. Steam trap management program
  2. Improved steam insulation in a boiler house
  3. Implement a leak repair program for compressed air
  4. Improve building insulation (envelope)
  5. Use of automatic lighting control systems
  6. Use of solar shading on buildings

Energy performance measurement and Indicators (EnPMI)

Delusions and barriers

How do you measure energy performance?

Absolute Values?

- Actual cost compared with budget?
- kWh last month compared with the same month last year?
- Moving total of 12 months kWh

Ratios?

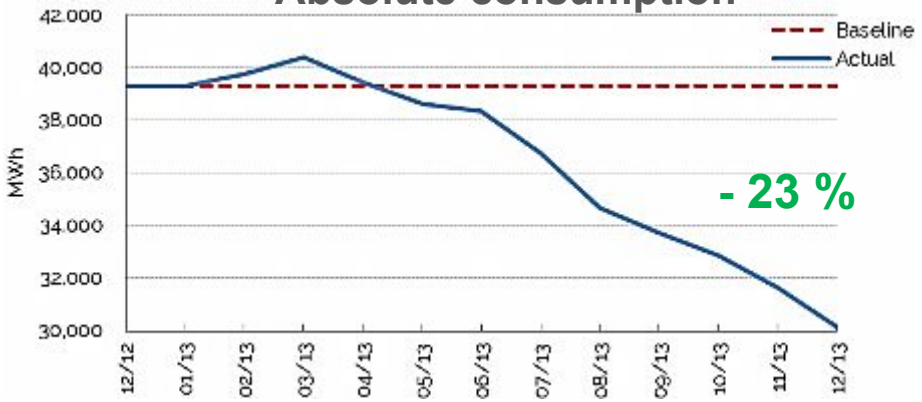
- kWh/m2 compared with another facility
- kWh/unit of production
- Coefficient of performance
- Energy efficiency (out/in)
- Energy intensity (GJ/$)

More complex and precise methods?

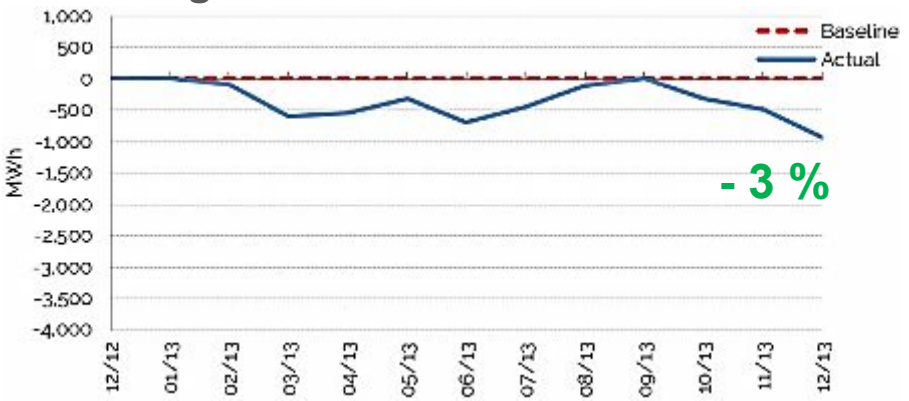
- Normalized consumption taking into account relevant variables

Energy performance in Industry – Which is right?

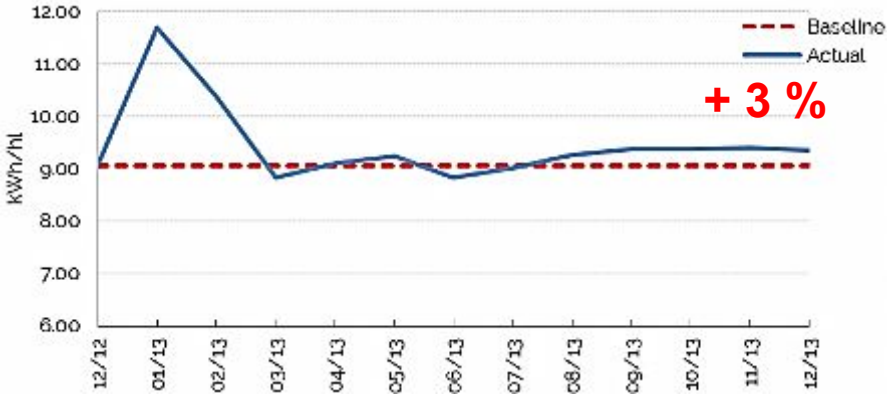
Absolute consumption



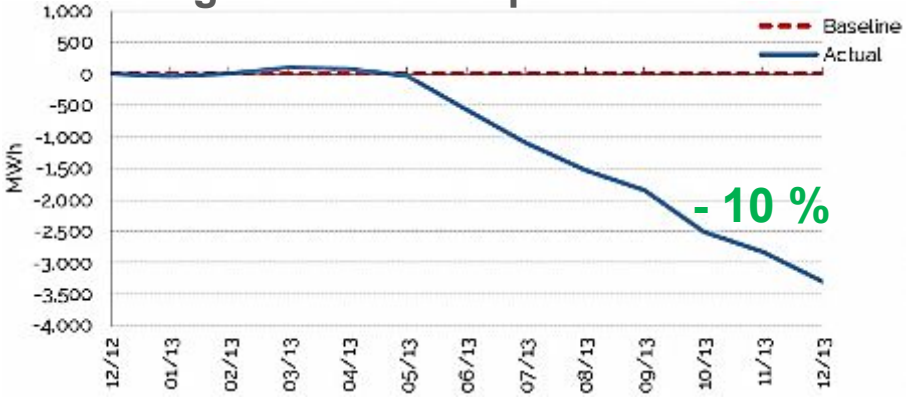
Regression 1 variable: Production



Ratio kWh/hl



Regression 2 var: prod & weather



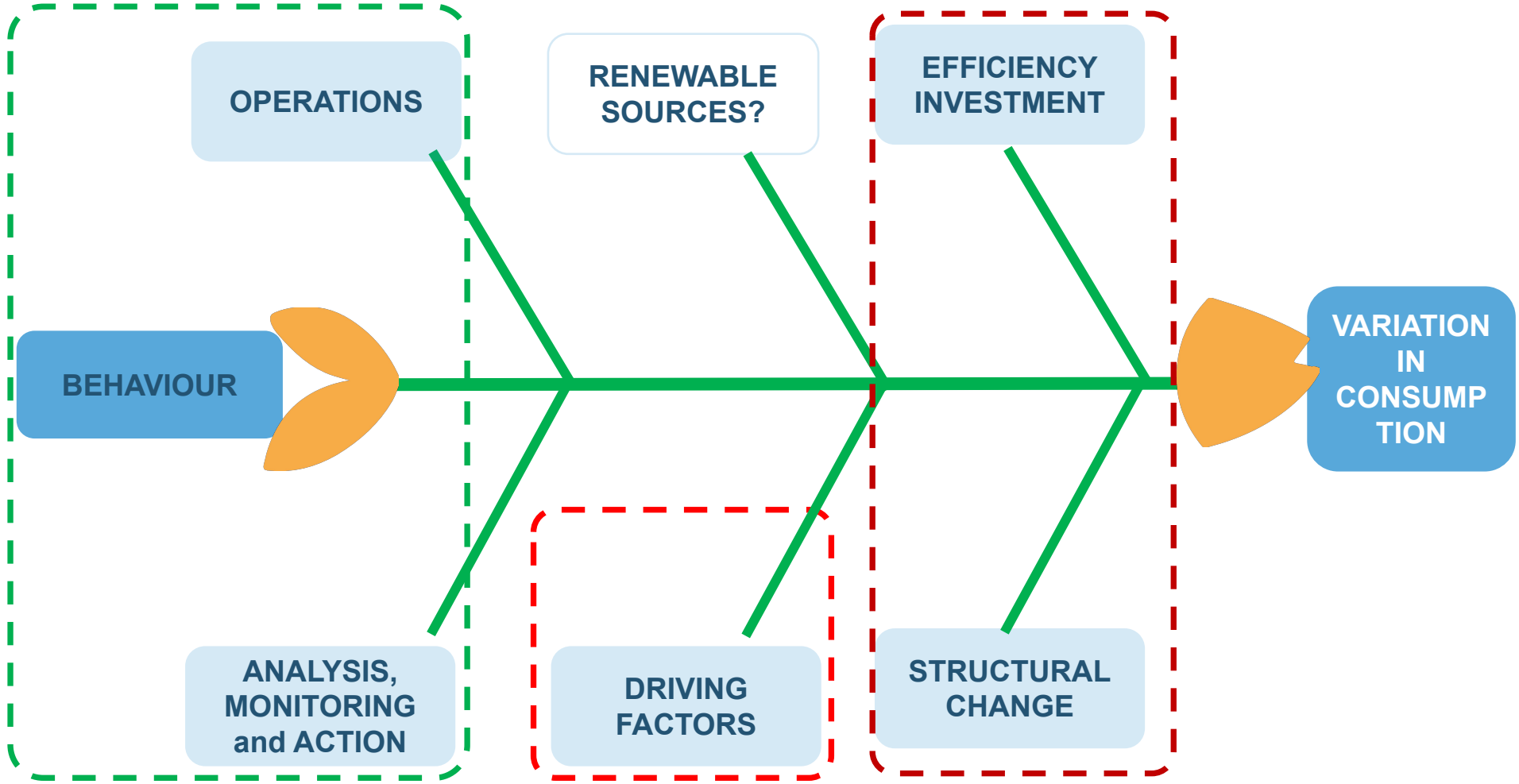
Beverage industry

"How many managers have been told by their staff that bad coal consumption was due to low output?

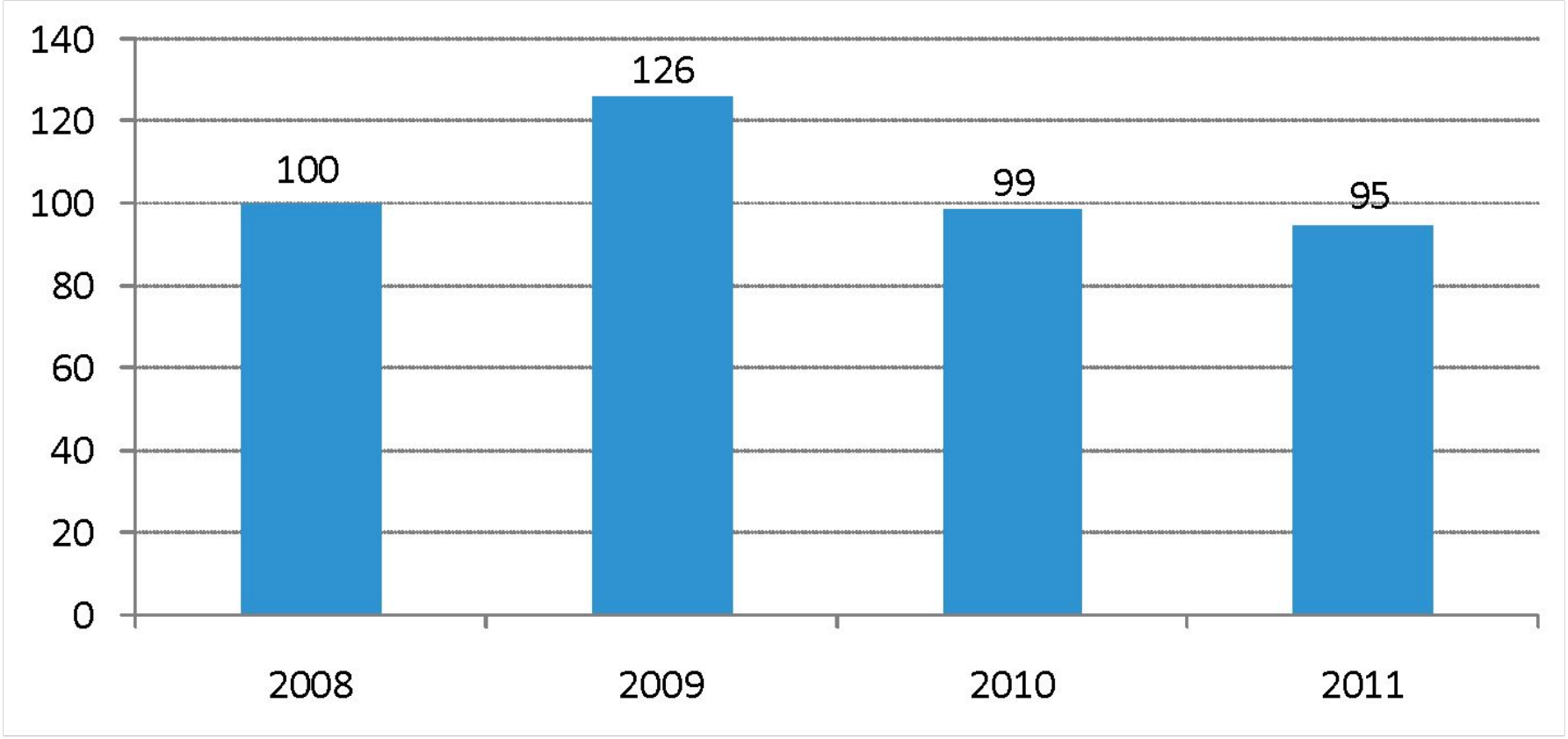
How is it possible for them to judge whether this is an excuse or a reason?"

- These are the opening words from a fuel efficiency bulletin, published in 1943 by the Ministry of Fuel and Power, which criticises the "ton of coal per ton of output" metric as a misleading indicator of fuel efficiency.
- The author was Oliver Lyle, managing director of the eponymous sugar refinery, a very knowledgeable and eminent engineer who had no time whatever for the Specific Energy Ratio. Any works engineer today will know that SERs vary continuously for reasons nothing to do with energy efficiency.

Causes of variation in consumption

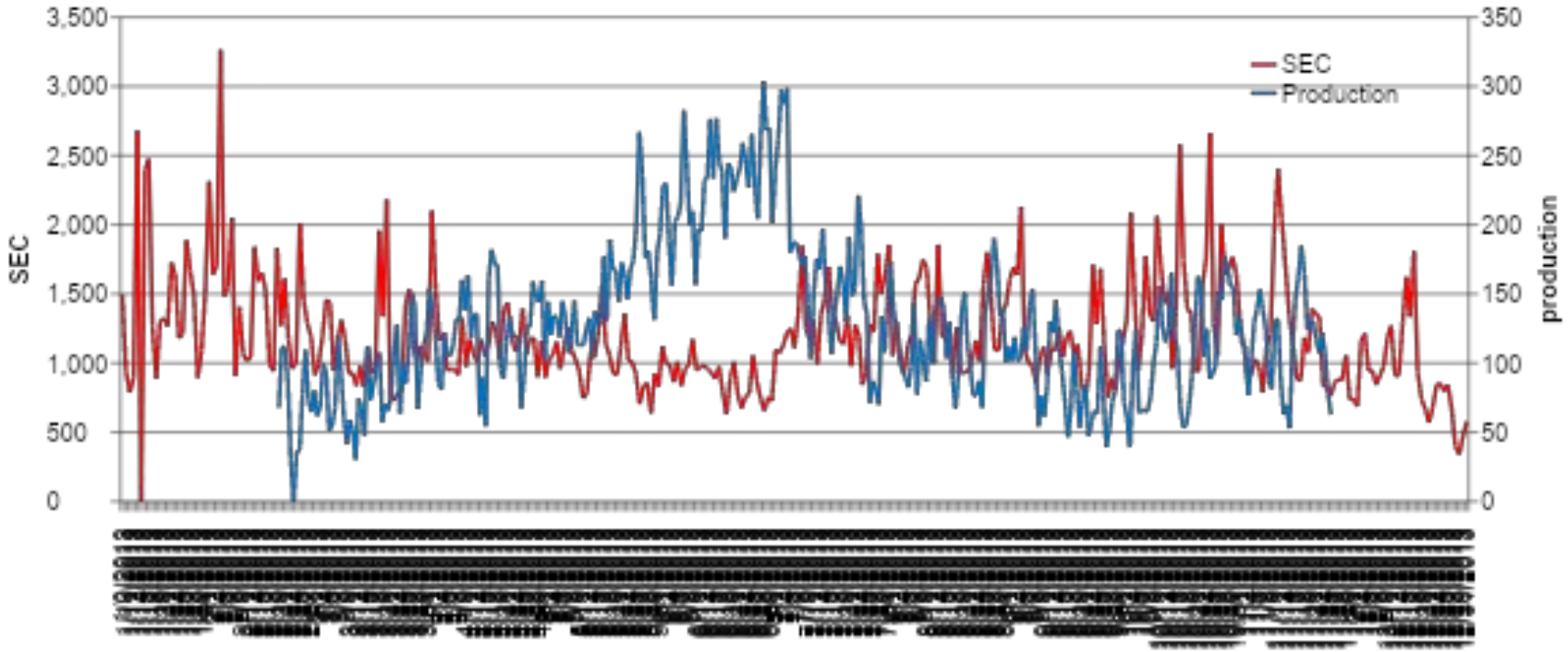


Energy per unit of production



Car assembly industry

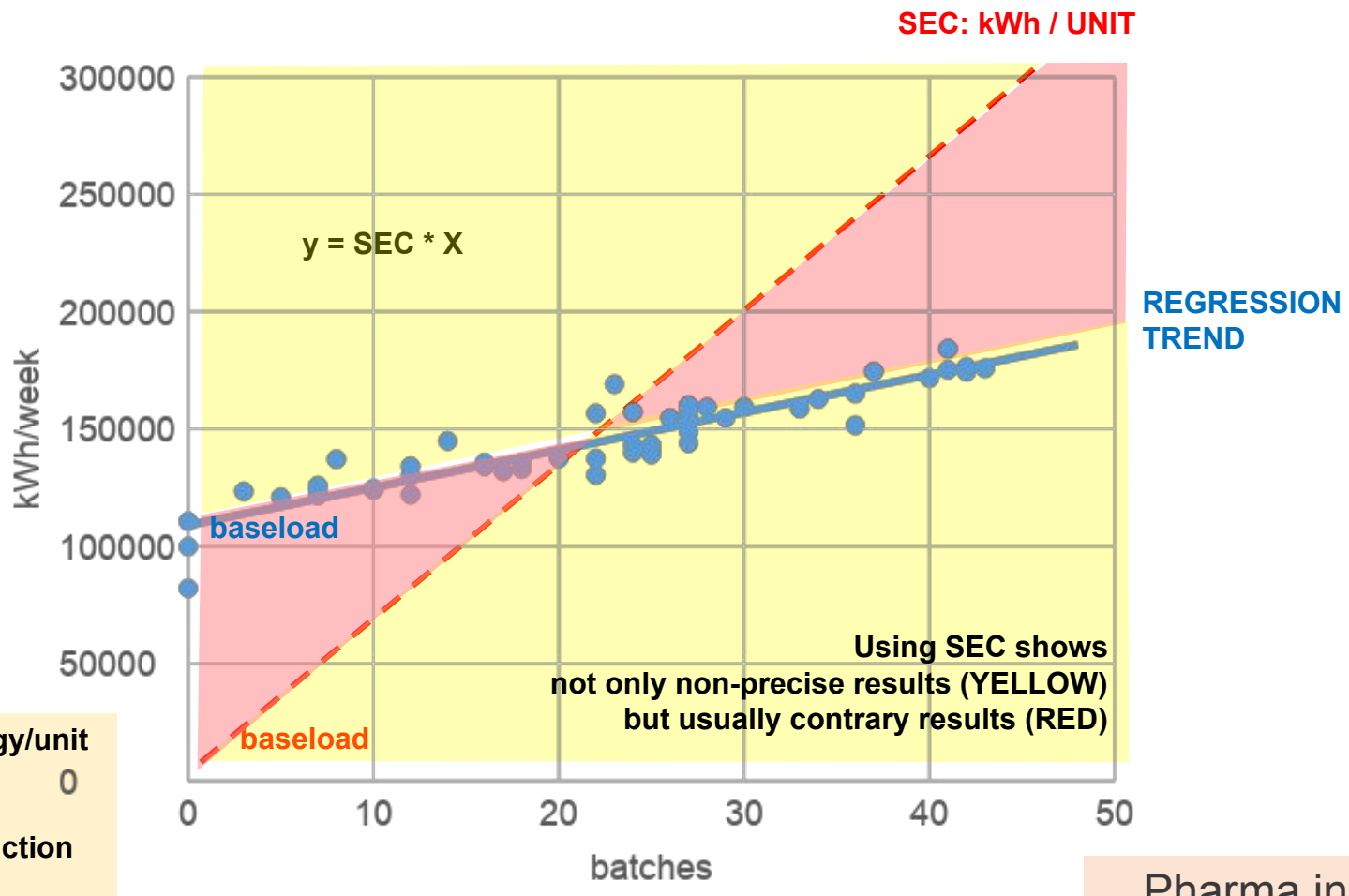
SEC: Up and down



- When production goes UP, SEC goes DOWN
- When production goes DOWN, SEC goes UP

Drink industry

Regression vs SEC



SEC = Specific Energy/unit product

X= Quantity of production

Pharma industry

Energy performance indicators: Criteria

Only responds to changes in energy performance

Unaffected by weather, production outputs or other relevant variables

Direction and magnitude of change consistent with change of performance

Discussion

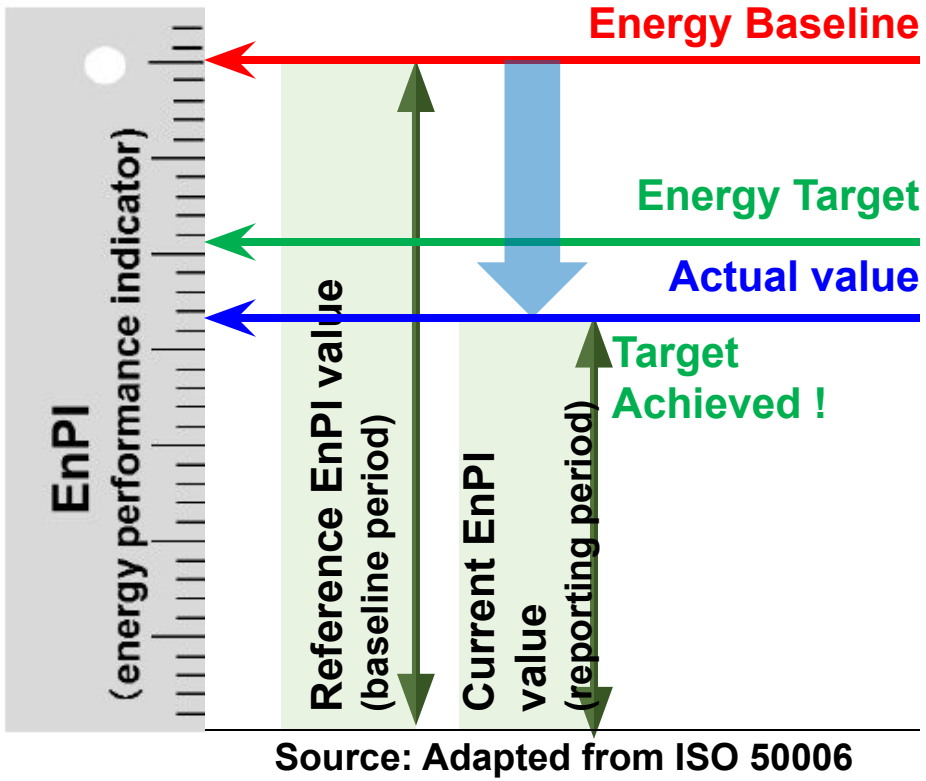
Is Specific Energy Consumption (SEC) useful in the EnMS context?

In fields of specialized knowledge, we aim to render an account that is plain and simple, yet does no violence to the difficulty of the subject, so that the uninformed reader can understand us while the expert cannot fault us. We try to keep in mind a saying attributed to Einstein—that everything must be made as simple as possible, but not one bit simpler.

Overview of good practice in energy performance measurement

Basic terminology

- ✔ Energy performance indicator (EnPI)
- ✔ Energy Baseline (EnB)
- ✔ Energy Target
- ✔ Energy Improvement



Source: Adapted from ISO 50006

EnPI & EnB

	A	B	C	D	E	F
1		ELECTRICITY				
2		CDD5	Cured	Cooked	Sliced	Total Consumption
3	01/11	26	164.59	1481.63	694.09	1531228
4	02/11	49	180.89	1526.45	694.98	1450494
5	03/11	83	212.56	1624.06	757.15	1560932
6	04/11	209	169.59	1425.18	692.53	1466743
7	05/11	290	209.68	1685.38	799.97	1692976
8	06/11	346	235.66	1531.36	780.59	1692700
9	07/11	396	214.72	1566.15	793.54	1671369
10	08/11	486	240.99	1529.46	750.53	1820530
11	09/11	402	210.34	1446.36	764.36	1746080
12	10/11	229	152.22	1462.95	714.92	1534139
13	11/11	122	206.57	1567.48	761.59	1532500
14	12/11	23	180.19	1164.1	638.54	1430632

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.9324154
R Square	0.86939848
Adjusted R S	0.84037592
Standard Err	50514.6317
Observation	12

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	1.52879E+11	7.6439E+10	29.9559534	0.00010514
Residual	9	22965552186	2551728021		
Total	11	1.75844E+11			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	1163449.22	124441.2278	9.34938717	6.2458E-06	881943.6041	1444954.83
CDD5	517.273212	121.9425858	4.24194065	0.00216808	241.4199189	793.126505
Cured	1594.81428	701.8919392	2.27216498	0.04918865	7.024408189	3182.60416

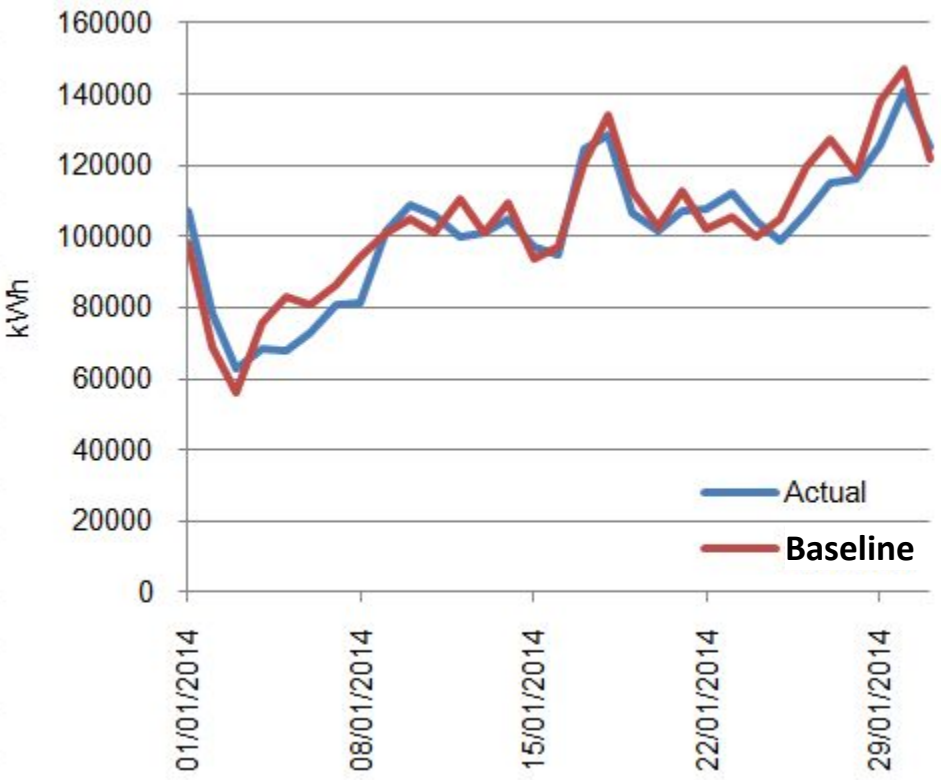
EnB: Expected consumption = 1,163,449+(517*CDD5)+(1595*Cured)

EnPI: A comparison of baseline (expected consumption) and actual consumption

Different views, same story

Day	KWh	Expected	Act-Exp	Act-Exp CUSUM	EnPC
31/12/2013		0	0	0	0
01/01/2014	107423	98376	9,047	9,047	1.09
02/01/2014	78543	69251	9,292	18,339	1.13
03/01/2014	62766	56042	6,724	25,063	1.12
04/01/2014	68589	75803	-7,214	17,849	0.90
05/01/2014	68019	82903	-14,884	2,964	0.82
06/01/2014	72858	80875	-8,017	-5,052	0.90
07/01/2014	80909	86417	-5,508	-10,561	0.94
08/01/2014	81574	94189	-12,615	-23,175	0.87
09/01/2014	101414	101077	337	-22,839	1.00
10/01/2014	109003	104834	4,169	-18,669	1.04
11/01/2014	106208	101084	5,124	-13,546	1.05
12/01/2014	100070	110332	-10,262	-23,808	0.91
13/01/2014	100870	101218	-348	-24,156	1.00
14/01/2014	104885	109333	-4,448	-28,604	0.96
15/01/2014	97125	93507	3,618	-24,985	1.04
16/01/2014	94610	97057	-2,447	-27,433	0.97
17/01/2014	124637	120398	4,239	-23,194	1.04
18/01/2014	128703	134224	-5,521	-28,715	0.96
19/01/2014	106501	112781	-6,280	-34,995	0.94
20/01/2014	101758	102596	-838	-35,833	0.99
21/01/2014	107399	112698	-5,299	-41,132	0.95
22/01/2014	107817	102179	5,638	-35,495	1.06
23/01/2014	112199	105480	6,720	-28,775	1.06
24/01/2014	104549	100088	4,460	-24,315	1.04
25/01/2014	98829	104897	-6,068	-30,383	0.94
26/01/2014	106536	119637	-13,100	-43,483	0.89
27/01/2014	115323	127389	-12,067	-55,550	0.91
28/01/2014	116232	117619	-1,387	-56,937	0.99
29/01/2014	125486	137932	-12,446	-69,382	0.91
30/01/2014	141070	146880	-5,810	-75,192	0.96
31/01/2014	124989	122034	2,954	-72,238	1.02

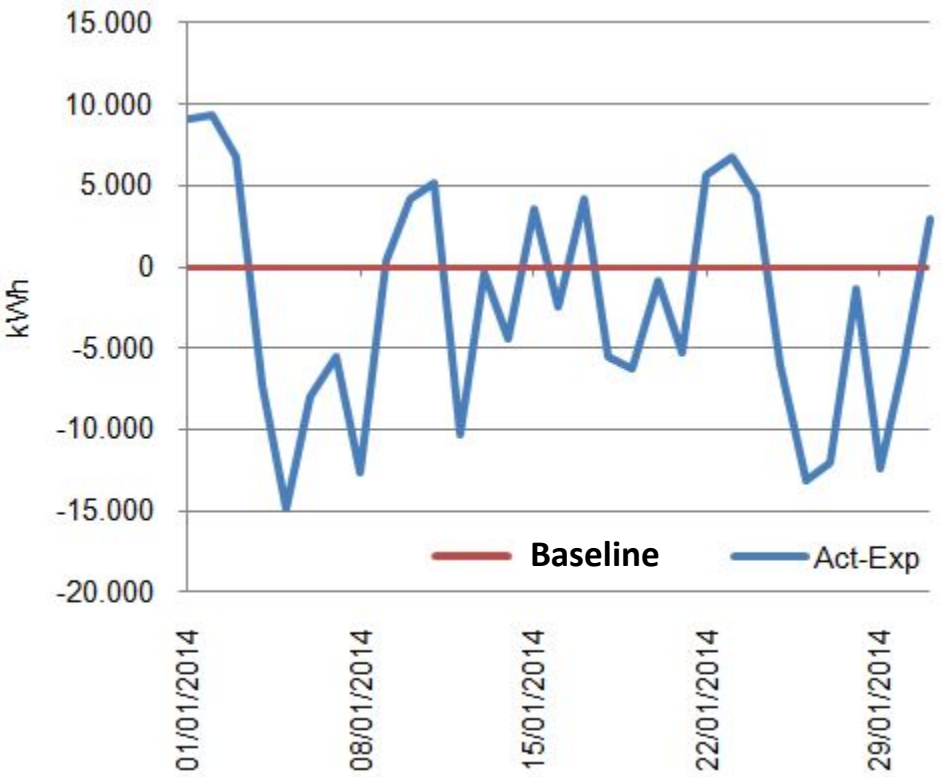
Drinks industry (12 variables)



Different views, same story

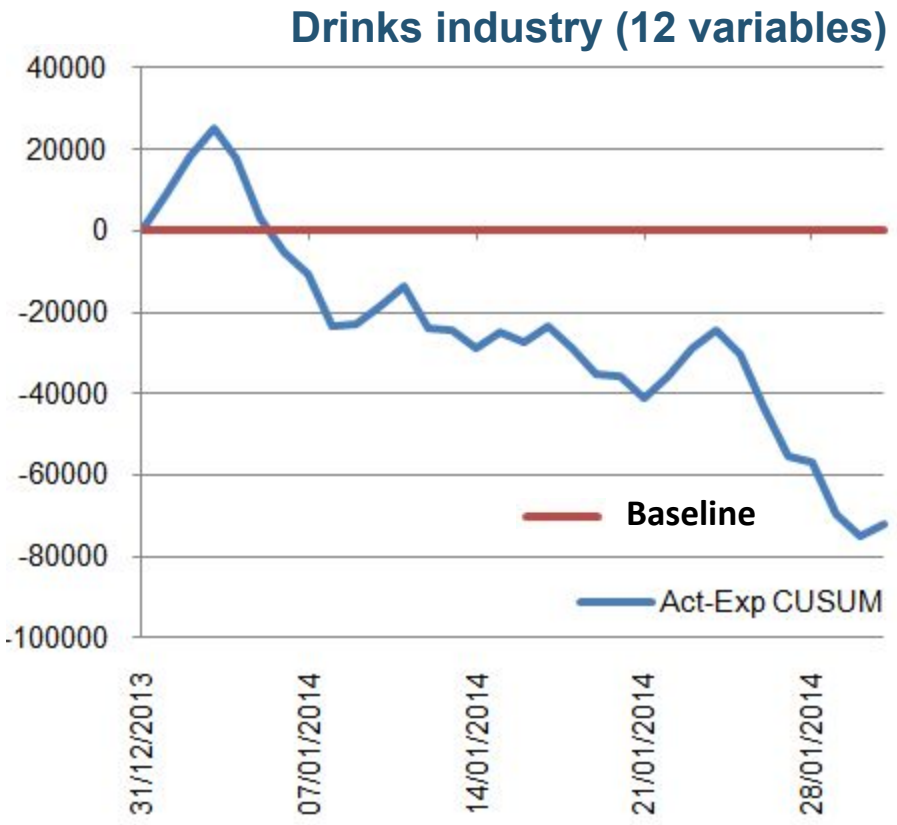
Day	KWh	Expected	Act-Exp	Act-Exp CUSUM	EnPC
31/12/2013		0	0	0	0
01/01/2014	107423	98376	9,047	9,047	1.09
02/01/2014	78543	69251	9,292	18,339	1.13
03/01/2014	62766	56042	6,724	25,063	1.12
04/01/2014	68589	75803	-7,214	17,849	0.90
05/01/2014	68019	82903	-14,884	2,964	0.82
06/01/2014	72858	80875	-8,017	-5,052	0.90
07/01/2014	80909	86417	-5,508	-10,561	0.94
08/01/2014	81574	94189	-12,615	-23,175	0.87
09/01/2014	101414	101077	337	-22,839	1.00
10/01/2014	109003	104834	4,169	-18,669	1.04
11/01/2014	106208	101084	5,124	-13,546	1.05
12/01/2014	100070	110332	-10,262	-23,808	0.91
13/01/2014	100870	101218	-348	-24,156	1.00
14/01/2014	104885	109333	-4,448	-28,604	0.96
15/01/2014	97125	93507	3,618	-24,985	1.04
16/01/2014	94610	97057	-2,447	-27,433	0.97
17/01/2014	124637	120398	4,239	-23,194	1.04
18/01/2014	128703	134224	-5,521	-28,715	0.96
19/01/2014	106501	112781	-6,280	-34,995	0.94
20/01/2014	101758	102596	-838	-35,833	0.99
21/01/2014	107399	112698	-5,299	-41,132	0.95
22/01/2014	107817	102179	5,638	-35,495	1.06
23/01/2014	112199	105480	6,720	-28,775	1.06
24/01/2014	104549	100088	4,460	-24,315	1.04
25/01/2014	98829	104897	-6,068	-30,383	0.94
26/01/2014	106536	119637	-13,100	-43,483	0.89
27/01/2014	115323	127389	-12,067	-55,550	0.91
28/01/2014	116232	117619	-1,387	-56,937	0.99
29/01/2014	125486	137932	-12,446	-69,382	0.91
30/01/2014	141070	146880	-5,810	-75,192	0.96
31/01/2014	124989	122034	2,954	-72,238	1.02

Drinks industry (12 variables)



Different views, same story

Day	KWh	Expected	Act-Exp	Act-Exp CUSUM	EnPC
31/12/2013		0	0	0	0
01/01/2014	107423	98376	9,047	9,047	1.09
02/01/2014	78543	69251	9,292	18,339	1.13
03/01/2014	62766	56042	6,724	25,063	1.12
04/01/2014	68589	75803	-7,214	17,849	0.90
05/01/2014	68019	82903	-14,884	2,964	0.82
06/01/2014	72858	80875	-8,017	-5,052	0.90
07/01/2014	80909	86417	-5,508	-10,561	0.94
08/01/2014	81574	94189	-12,615	-23,175	0.87
09/01/2014	101414	101077	337	-22,839	1.00
10/01/2014	109003	104834	4,169	-18,669	1.04
11/01/2014	106208	101084	5,124	-13,546	1.05
12/01/2014	100070	110332	-10,262	-23,808	0.91
13/01/2014	100870	101218	-348	-24,156	1.00
14/01/2014	104885	109333	-4,448	-28,604	0.96
15/01/2014	97125	93507	3,618	-24,985	1.04
16/01/2014	94610	97057	-2,447	-27,433	0.97
17/01/2014	124637	120398	4,239	-23,194	1.04
18/01/2014	128703	134224	-5,521	-28,715	0.96
19/01/2014	106501	112781	-6,280	-34,995	0.94
20/01/2014	101758	102596	-838	-35,833	0.99
21/01/2014	107399	112698	-5,299	-41,132	0.95
22/01/2014	107817	102179	5,638	-35,495	1.06
23/01/2014	112199	105480	6,720	-28,775	1.06
24/01/2014	104549	100088	4,460	-24,315	1.04
25/01/2014	98829	104897	-6,068	-30,383	0.94
26/01/2014	106536	119637	-13,100	-43,483	0.89
27/01/2014	115323	127389	-12,067	-55,550	0.91
28/01/2014	116232	117619	-1,387	-56,937	0.99
29/01/2014	125486	137932	-12,446	-69,382	0.91
30/01/2014	141070	146880	-5,810	-75,192	0.96
31/01/2014	124989	122034	2,954	-72,238	1.02



Accumulative difference between actual and expected consumption. It is typically used for monitoring change detection and taking corrective action.

Monitoring Performance

	A	B	C	D
1				
2		CDD5	Cured	Total Consumption
3				
4	01/11	26	164.59	1531228
5	02/11	49	180.89	1450494
6	03/11	83	212.56	1560932
7	04/11	209	169.59	1466743
8	05/11	290	209.68	1692976
9	06/11	346	235.66	1692700
10	07/11	396	214.72	1671369
11	08/11	486	240.99	1820530
12	09/11	402	210.34	1746080
13	10/11	229	152.22	1534139
14	11/11	122	206.57	1532500
15	12/11	23	180.19	1430632
16	01/12	20	160.75	1450461
17	02/12	30	144.00	1414145
18	03/12	132	201.63	1526610
19	04/12	68	149.44	1340280
20	05/12	286	189.17	1641128
21	06/12	411	186.50	1544644

Data from 2011 used to develop the expected consumption formula

Expected consumption = 1,163,449.22+(517.27*CDD5)+(1594.81*Cured)

Monitoring Performance

	A	B	C	D
1				
2		CDD5	Cured	Total Consumption
3				
4	01/11	26	164.59	1531228
5	02/11	49	180.89	1450494
6	03/11	83	212.56	1560932
7	04/11	209	169.59	1466743
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15	12/11	23	180.19	1430632
16	01/12	20	160.75	1450461
17	02/12	30	144.00	1414145
18	03/12	132	201.63	1526610
19	04/12	68	149.44	1340280
20	05/12	286	189.17	1641128
21	06/12	411	186.50	1544644

Actual consumption in 2012

Expected consumption = 1,163,449.22+(517.27*CDD5)+(1594.81*Cured)

Monitoring Performance

	A	B	C	D	E
1					
2		CDD5	Cured	Total Consumption	Expected
3					
4	01/11	26	164.59	1531228	
5	02/11	49	180.89	1450494	
6	03/11	83	212.56	1560932	
7	04/11	209	169.59	1466743	
8	05/11	290	209.68	1692976	
9	06/11	346	235.66	1692700	
10	07/11	396	214.72	1671369	
11	08/11	486	240.99	1820530	
12	09/11	402	210.34	1746080	
13	10/11	229	152.22	1534139	
14	11/11	122	206.57	1532500	
15	12/11	23	180.19	1430632	
16	01/12	20	160.75	1450461	1430161
17	02/12	30	144.00	1414145	1408621
18	03/12	132	201.63	1526610	1553292
19	04/12	68	149.44	1340280	1436953
20	05/12	286	189.17	1641128	1613080
21	06/12	411	186.50	1544644	1673481

Expected consumption is the BASELINE. It is the consumption that we should have if the performance is the same as last year, based on the relevant variables

Expected consumption = 1,163,449.22+(517.27*CDD5)+(1594.81*Cured)

Monitoring Performance

	A	B	C	D	E	F	G
1							
2		CDD5	Cured	Total Consumption	Expected	EnPC	Actual Savings (Act-Exp)
3							
4	01/11	26	164.59	1531228			
5	02/11	49	180.89	1450494			
6	03/11	83	212.56	1560932			
7	04/11	209	169.59	1466743			
8	05/11	290	209.68	1692976			
9	06/11	346	235.66	1692700			
10	07/11	396	214.72	1671369			
11	08/11	486	240.99	1820530			
12	09/11	402	210.34	1746080			
13	10/11	229	152.22	1534139			
14	11/11	122	206.57	1532500			
15	12/11	23	180.19	1430632			
16	01/12	20	160.75	1450461	1430161	1.014	20300
17	02/12	30	144.00	1414145	1408621	1.004	5524
18	03/12	132	201.63	1526610	1553292	0.983	-26682
19	04/12	68	149.44	1340280	1436953	0.933	-96673
20	05/12	286	189.17	1641128	1613080	1.017	28048
21	06/12	411	186.50	1544644	1673481	0.923	-128837

The actual savings are the difference between actual consumption and expected consumption

For example, in January we saved 26682 kWh

Monitoring Performance

	A	B	C	D	E	F	G	H
1								
2		CDD5	Cured	Total Consumption	Expected	EnPC	Actual Savings (Act-Exp)	Actual Savings CUSUM
3								
4	01/11	26	164.59	1531228				
5	02/11	49	180.89	1450494				
6	03/11	83	212.56	1560932				
7	04/11	209	169.59	1466743				
8	05/11	290	209.68	1692976				
9	06/11	346	235.66	1692700				
10	07/11	396	214.72	1671369				
11	08/11	486	240.99	1820530				
12	09/11	402	210.34	1746080				
13	10/11	229	152.22	1534139				
14	11/11	122	206.57	1532500				
15	12/11	23	180.19	1430632				0
16	01/12	20	160.75	1450461	1430161	1.014	20300	20300
17	02/12	30	144.00	1414145	1408621	1.004	5524	25824
18	03/12	132	201.63	1526610	1553292	0.983	-26682	-857
19	04/12	68	149.44	1340280	1436953	0.933	-96673	-97530
20	05/12	286	189.17	1641128	1613080	1.017	28048	-69483
21	06/12	411	186.50	1544644	1673481	0.923	-128837	-198320

The actual savings CUSUM are the cumulative savings from the beginning

For example, from January to June we saved 198320 kWh

Monitoring Performance

	A	B	C	D	E	F	G	H	I
1									2.5%
2		CDD5	Cured	Total Consumption	Expected	EnPC	Actual Savings (Act-Exp)	Actual Savings CUSUM	Target consumption
3									
4	01/11	26	164.59	1531228					
5	02/11	49	180.89	1450494					
6	03/11	83	212.56	1560932					
7	04/11	209	169.59	1466743					
8	05/11	290	209.68	1692976					
9	06/11	346	235.66	1692700					
10	07/11	396	214.72	1671369					
11	08/11	486	240.99	1820530					
12	09/11	402	210.34	1746080					
13	10/11	229	152.22	1534139					
14	11/11	122	206.57	1532500					
15	12/11	23	180.19	1430632				0	
16	01/12	20	160.75	1450461	1430161	1.014	20300	20300	1394407
17	02/12	30	144.00	1414145	1408621	1.004	5524	25824	1373405
18	03/12	132	201.63	1526610	1553292	0.983	-26682	-857	1514459
19	04/12	68	149.44	1340280	1436953	0.933	-96673	-97530	1401029
20	05/12	286	189.17	1641128	1613080	1.017	28048	-69483	1572753
21	06/12	411	186.50	1544644	1673481	0.923	-128837	-198320	1631644

The target consumption is the consumption we want to have.

For example, the target here is to save 2.5%

Monitoring Performance

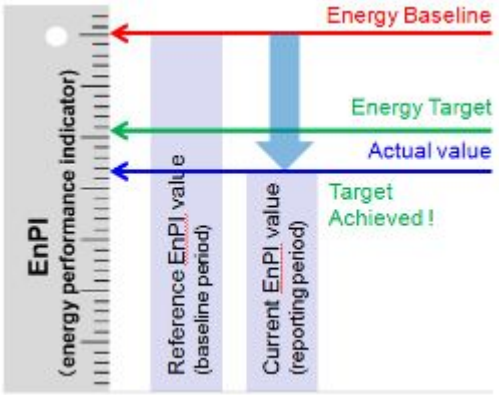
	A	B	C	D	E	F	G	H	I	J	K
1									2.5%		
2		CDD5	Cured	Total Consumption	Expected	EnPC	Actual Savings (Act-Exp)	Actual Savings CUSUM	Target consumption	Target Savings (Tgt-Exp)	Target Savings CUSUM
3											
4	01/11	26	164.59	1531228							
5	02/11	49	180.89	1450494							
6	03/11	83	212.56	1560932							
7	04/11	209	169.59	1466743							
8	05/11	290	209.68	1692976							
9	06/11	346	235.66	1692700							
10	07/11	396	214.72	1671369							
11	08/11	486	240.99	1820530							
12	09/11	402	210.34	1746080							
13	10/11	229	152.22	1534139							
14	11/11	122	206.57	1532500							
15	12/11	23	180.19	1430632				0			0
16	01/12	20	160.75	1450461	1430161	1.014	20300	20300	1394407	-35754	-35754
17	02/12	30	144.00	1414145	1408621	1.004	5524	25824	1373405	-35216	-70970
18	03/12	132	201.63	1526610	1553292	0.983	-26682	-857	1514459	-38832	-109802
19	04/12	68	149.44	1340280	1436953	0.933	-96673	-97530	1401029	-35924	-145726
20	05/12	286	189.17	1641128	1613080	1.017	28048	-69483	1572753	-40327	-186053
21	06/12	411	186.50	1544644	1673481	0.923	-128837	-198320	1631644	-41837	-227890

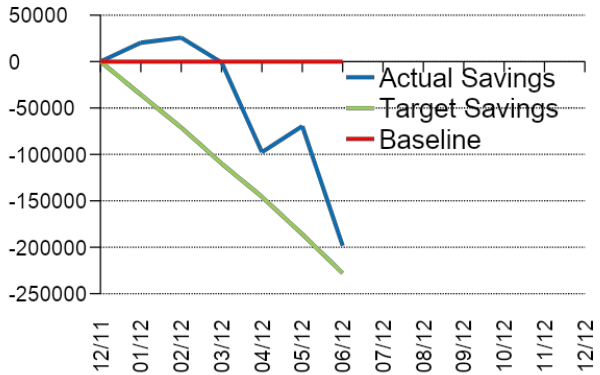
We can also compare our consumption with the target.

For example, from January to May the target savings were 227890 kWh and we have saved 198320 kWh, so it is less than the target.

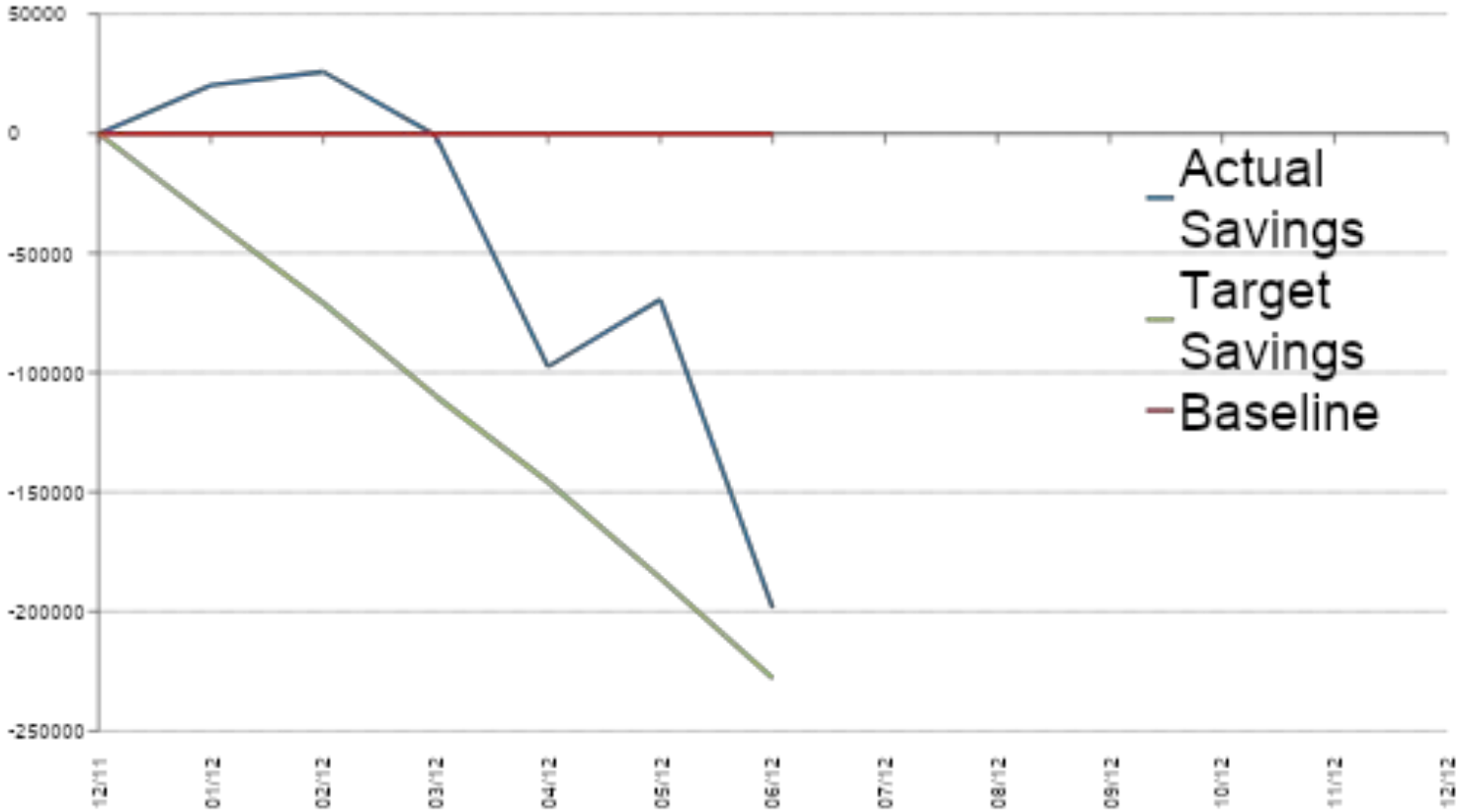
Monitoring Performance

	A	B	C	D	E	F	G	H	I	J	K
1									2.5%		
2		CDD5	Cured	Total Consumption	Expected	EnPC	Actual Savings (Act-Exp)	Actual Savings CUSUM	Target consumption	Target Savings (Tgt-Exp)	Target Savings CUSUM
3											
4	01/11	26	164.59	1531228							
5	02/11	49	180.89	1450494							
6	03/11	83	212.56	1560932							
7	04/11	209	169.59	1466743							
8	05/11	290	209.68	1692976							
9	06/11	346	235.66	1692700							
10	07/11	396	214.72	1671369							
11	08/11	486	240.99	1820530							
12	09/11	402	210.34	1746080							
13	10/11	229	152.22	1534139							
14	11/11	122	206.57	1532500							
15	12/11	23	180.19	1430632				0			0
16	01/12	20	160.75	1450461	1430161	1.014	20300	20300	1394407	-35754	-35754
17	02/12	30	144.00	1414145	1408621	1.004	5524	25824	1373405	-35216	-70970
18	03/12	132	201.63	1526610	1553292	0.983	-26682	-857	1514459	-38832	-109802
19	04/12	68	149.44	1340280	1436953	0.933	-96673	-97530	1401029	-35924	-145726
20	05/12	286	189.17	1641128	1613080	1.017	28048	-69483	1572753	-40327	-186053
21	06/12	411	186.50	1544644	1673481	0.923	-128837	-198320	1631644	-41837	-227890





Savings CUSUM



See you in 1 hour!

Exercise

- Consider a family car
- What are the relevant variables affecting fuel consumption?
- Which are practical to measure and monitor?
- Which are economical to measure and monitor?

Implementation plan

Project plan

“project libre”

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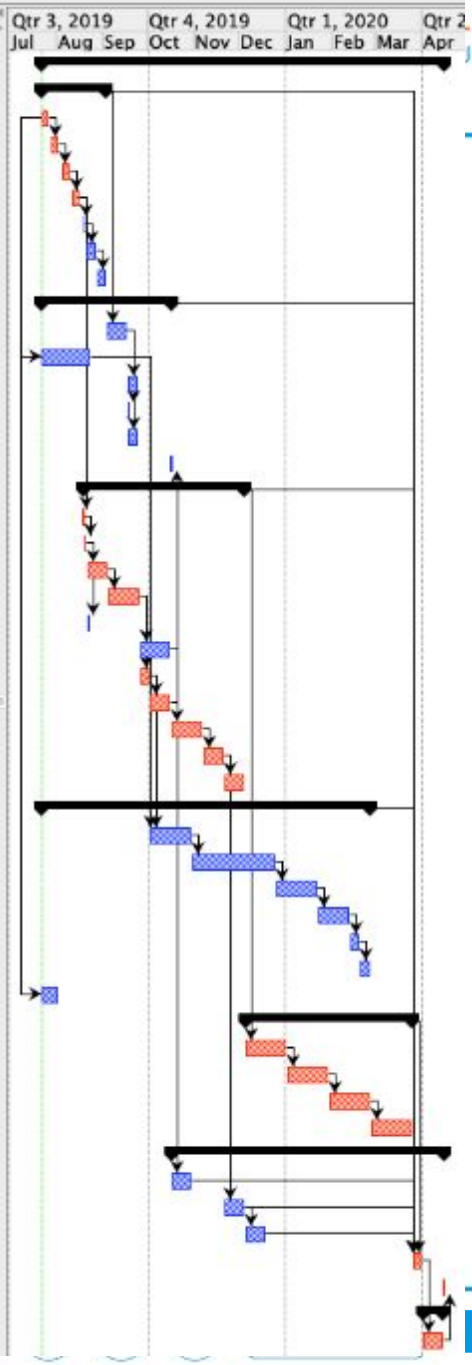
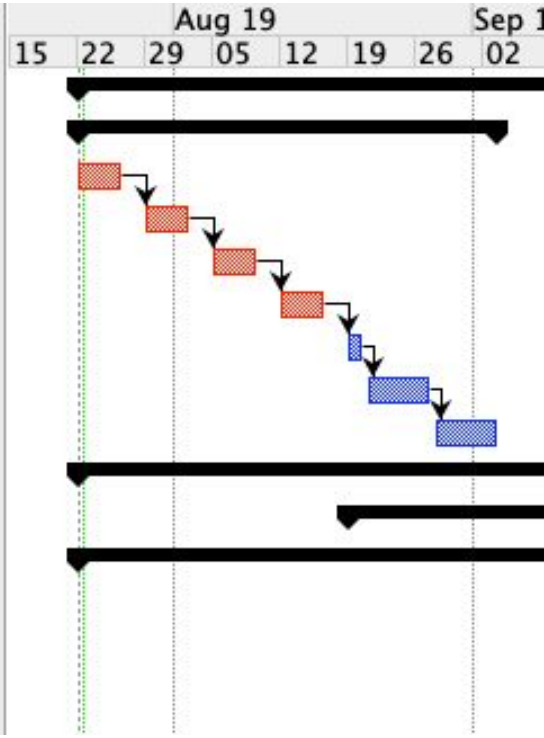
	Name	Duration
1	Implement EnMS	194 days
2	4. Context	32 days
3	Review External Context	5 days
4	Review Internal Context	5 days
5	Review Interested Parties	5 days
6	Develop Risks and Opportunitites	5 days
7	Identify all legal requirements applicable to the use of energy	2 days
8	Define the boundaries of the EnMS	5 days
9	Define the scope of the EnMS	5 days
10	5. Leadership	64 days
11	Develop, publish and periodically review the energy policy	10 days
12	Define the different roles and responsibilities in the EnMS	25 days
13	Ensure resources are available	5 days
14	Top management will communicate the importance of the EnMS	2 days
15	Integrate energy management system and its activities into normal business processes	5 days
16	Report EnMS and energy performance to top management	1 day
17	6. Planning	78 days
18	Consider context, risks and opportunitites in planning	1 day
19	Develop the methodology used for the energy review and what criteria are used	2 days
20	Collect energy data and develop consumption trends	10 days
21	Complete an energy balance and select the SEUs	15 days
22	Develop the energy saving opportunities (ESO) list	2 days
23	Develop the baseline and EnPIs for each energy source and each SEU.	15 days
24	Identify the personnel affecting energy use and consumption	5 days
25	Investigate opportunities to reduce energy consumption in your technical systems	10 days
26	Develop action plans from the ESO list	15 days
27	Set the objectives and energy targets taking account of the action plans	10 days
28	Develop energy data collection plan	10 days
29	7. Support	158 days
30	Ensure personnel understand their roles and are competent in those roles	20 days
31	Implement training plans and maintain training records	40 days
32	Ensure people are aware of the EnMS and its benefits	20 days
33	Ensure energy performance and the EnMS are communicated internally	15 days
34	ommunicate hoe personnel can make improvement suggestions	5 days
35	Decide if there will be external communication."	5 days
36	Develop a process to manage and control documented information	10 days
37	8. Operation	80 days
38	Ensure operational and maintenance criteria for SEUs are met	20 days
39	Ensure that new projects are evaluated from an energy perspective	20 days
40	Ensure procurement of services and equipment take account of energy impact	20 days
41	Investigate opportunities related to the procurement of energy	20 days
42	9. Performance evaluation	131 days
43	Monitor and evaluate energy performance	10 days
44	Ensure that the objectives and energy targets are being achieved	10 days
45	Evaluate compliance with legal and other requirements	10 days
46	Schedule and organise internal audits of the EnMS	5 days
47	Attend the management review meeting	1 day
48	10. Improvement	10 days
49	Manage non-conformities and corrective actions related to the EnMS.	10 days



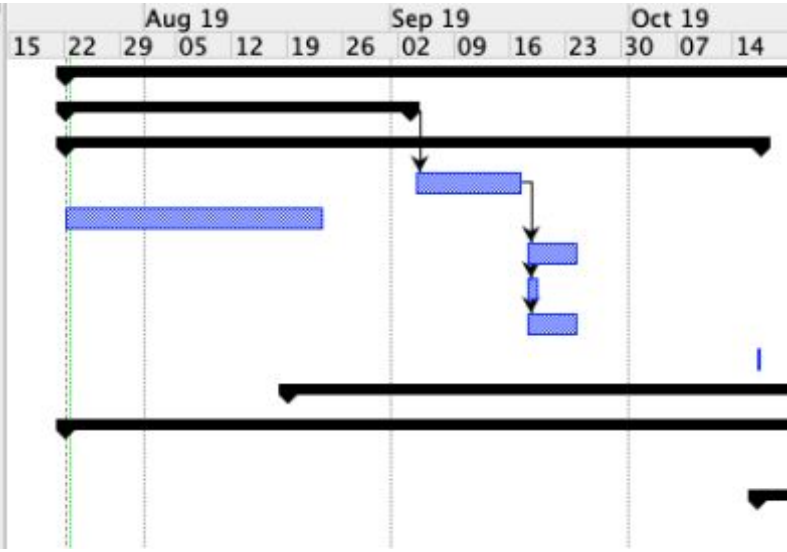
4. Context

Name	Duration
Implement EnMS	194 days
4. Context	32 days
Review External Context	5 days
Review Internal Context	5 days
Review Interested Parties	5 days
Develop Risks and Opportunitites	5 days
Identify all legal requirements applicable to the use of energy	2 days
Define the boundaries of the EnMS	5 days
Define the scope of the EnMS	5 days
5. Leadership	64 days
6. Planning	78 days
7. Support	158 days
8. Operation	80 days
9. Performance evaluation	131 days
10. Improvement	10 days



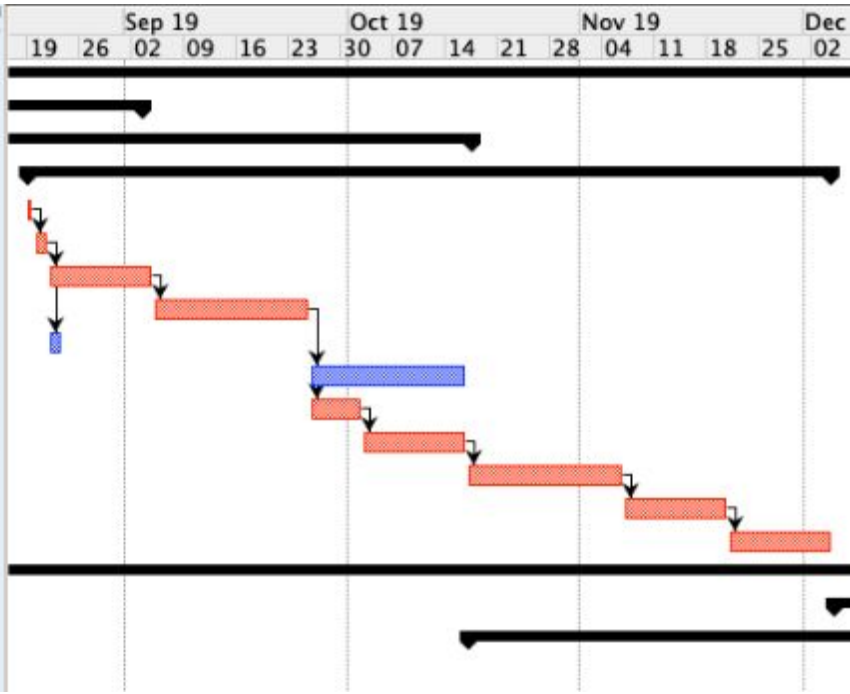
5. Leadership

Name	Duration
Implement EnMS	194 days
4. Context	32 days
5. Leadership	64 days
Develop, publish and periodically review the energy policy	10 days
Define the different roles and responsibilities in the EnMS	25 days
Ensure resources are available	5 days
Top management will communicate the importance of the EnMS	2 days
Integrate energy management system and its activities into normal business processes	5 days
Report EnMS and energy performance to top management	1 day
6. Planning	78 days
7. Support	158 days
8. Operation	80 days
9. Performance evaluation	131 days
10. Improvement	10 days



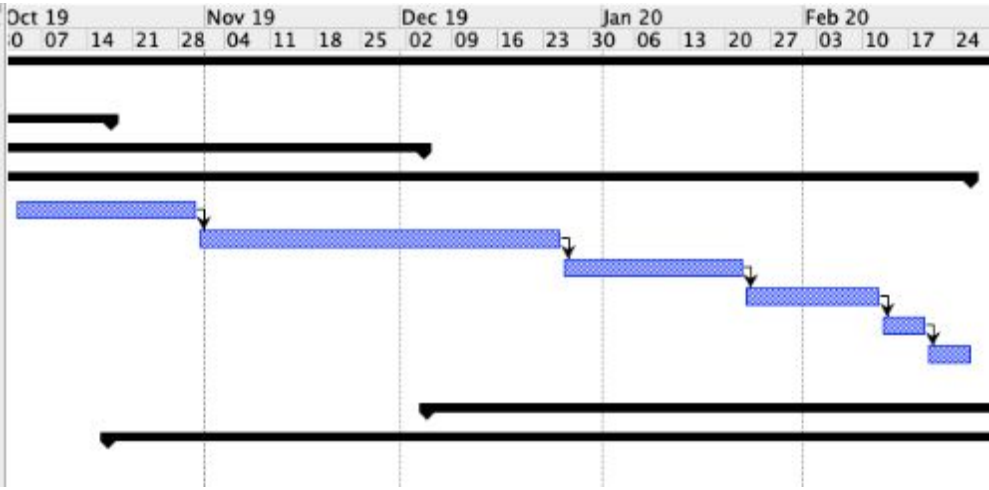
6. Planning

Name	Duration
⊟Implement EnMS	194 days
⊞4. Context	32 days
⊞ 5. Leadership	64 days
⊟6. Planning	78 days
Consider context, risks and opportunitites in planning	1 day
Develop the methodology used for the energy review and what criteria are used	2 days
Collect energy data and develop consumption trends	10 days
Complete an energy balance and select the SEUs	15 days
Develop the energy saving opportunities (ESO) list	2 days
Develop the baseline and EnPIs for each energy source and each SEU.	15 days
Identify the personnel affecting energy use and consumption	5 days
Investigate opportunities to reduce energy consumption in your technical systems	10 days
Develop action plans from the ESO list	15 days
Set the objectives and energy targets taking account of the action plans	10 days
Develop energy data collection plan	10 days
⊞7. Support	158 days
⊞8. Operation	80 days
⊞9. Performance evaluation	131 days
⊞10. Improvement	10 days



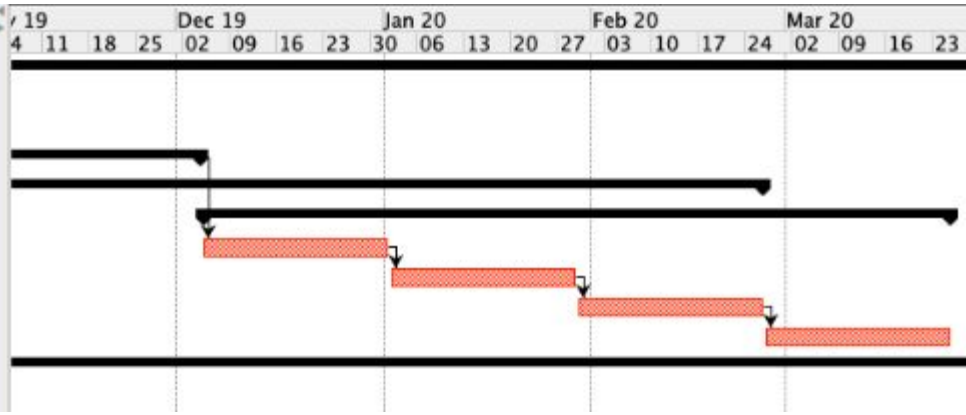
7. Support

Name	Duration
Implement EnMS	194 days
4. Context	32 days
5. Leadership	64 days
6. Planning	78 days
7. Support	158 days
Ensure personnel understand their roles and are competent in those roles	20 days
Implement training plans and maintain training records	40 days
Ensure people are aware of the EnMS and its benefits	20 days
Ensure energy performance and the EnMS are communicated internally	15 days
ommunicate hoe personnel can make improvement suggestions	5 days
Decide if there will be external communication."	5 days
Develop a process to manage and control documented information	10 days
8. Operation	80 days
9. Performance evaluation	131 days
10. Improvement	10 days



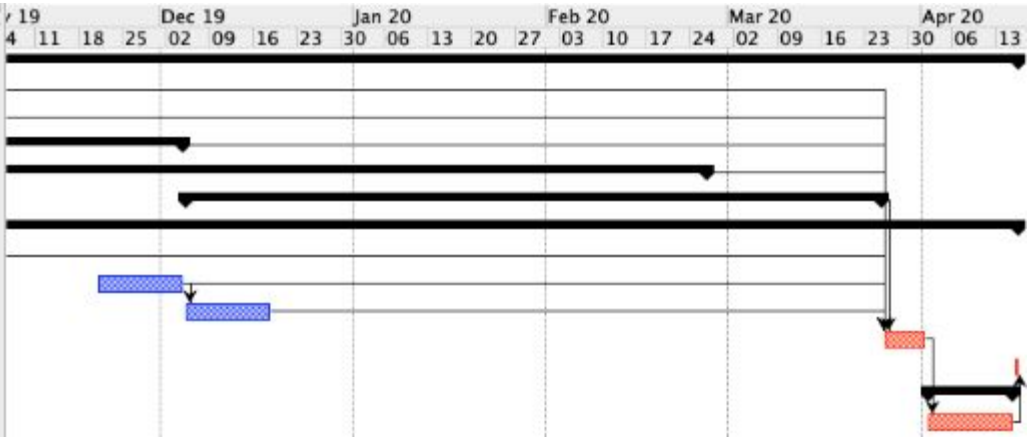
8. Operation

Name	Duration
⊟Implement EnMS	194 days
⊞4. Context	32 days
⊞ 5. Leadership	64 days
⊞6. Planning	78 days
⊞7. Support	158 days
⊟8. Operation	80 days
Ensure operational and maintenance criteria for SEUs are met	20 days
Ensure that new projects are evaluated from an energy perspective	20 days
Ensure procurement of services and equipment take account of energy impact	20 days
Investigate opportunities related to the procurement of energy	20 days
⊞9. Performance evaluation	131 days
⊞10. Improvement	10 days



9. Performance evaluation & 10. Improvement

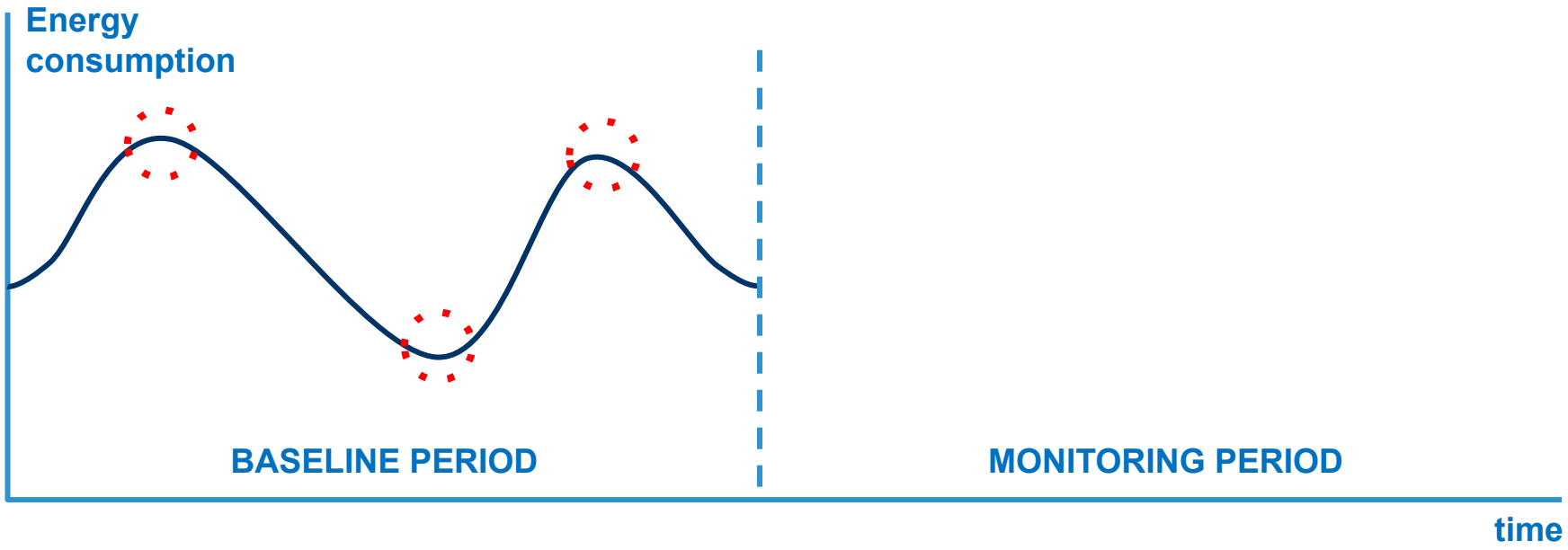
Name	Duration
⊟Implement EnMS	194 days
⊞4. Context	32 days
⊞ 5. Leadership	64 days
⊞6. Planning	78 days
⊞7. Support	158 days
⊞8. Operation	80 days
⊟9. Performance evaluation	131 days
Monitor and evaluate energy performance	10 days
Ensure that the objectives and energy targets are being achieved	10 days
Evaluate compliance with legal and other requirements	10 days
Schedule and organise internal audits of the EnMS	5 days
Attend the management review meeting	1 day
⊟10. Improvement	10 days
Manage non-conformities and corrective actions related to the EnMS.	10 days



Introduction to statistics

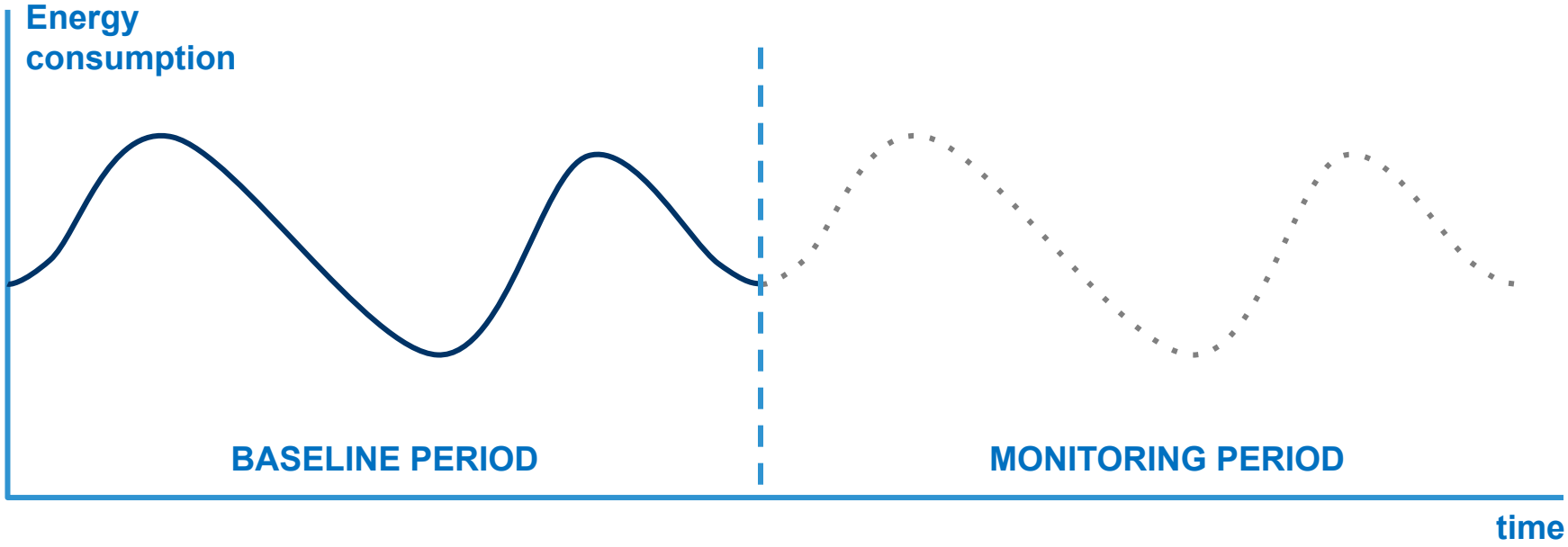
Purpose of energy metrics

DETECT SAVING OPPORTUNITIES (1)



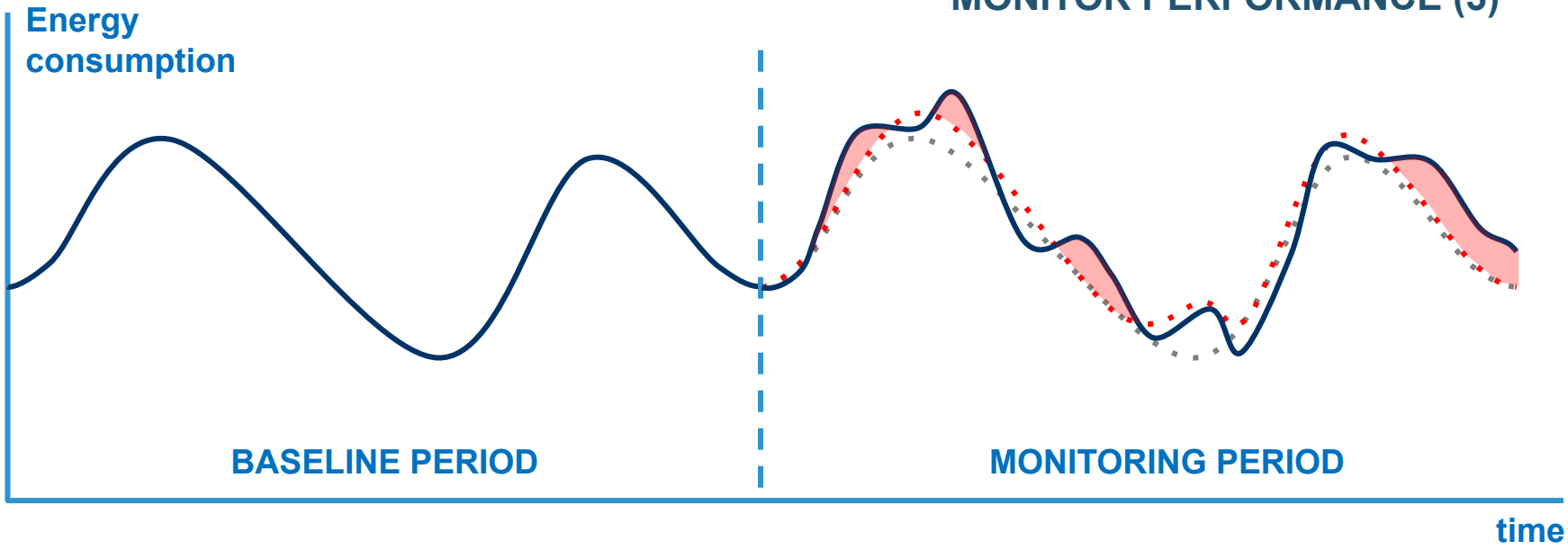
Purpose of energy metrics

DETECT SAVING OPPORTUNITIES (1)
FORECAST (2)



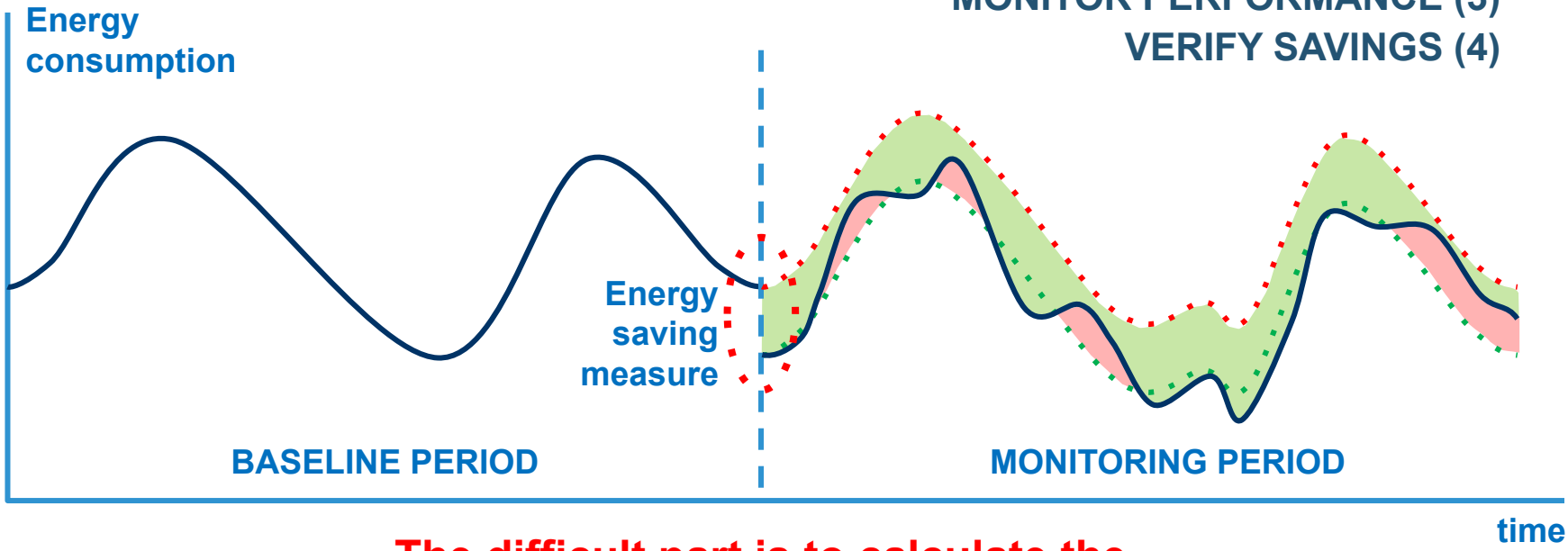
Purpose of energy metrics

DETECT SAVING OPPORTUNITIES (1)
FORECAST (2)
MONITOR PERFORMANCE (3)



Purpose of energy metrics

DETECT SAVING OPPORTUNITIES (1)
FORECAST (2)
MONITOR PERFORMANCE (3)
VERIFY SAVINGS (4)

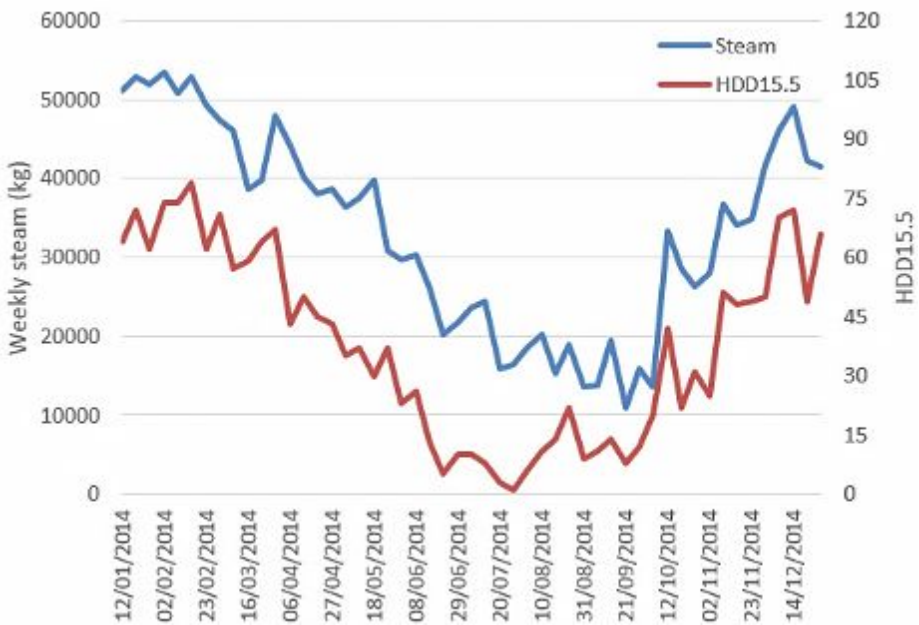


The difficult part is to calculate the red line (expected consumption).

Statistics can help.

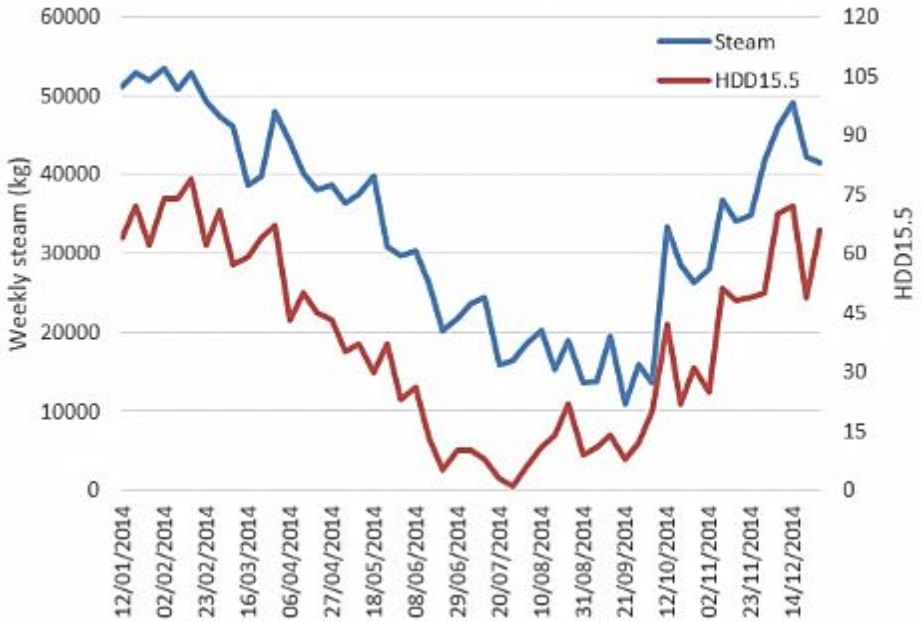
EXPECTED CONSUMPTION
ACTUAL CONSUMPTION
TARGET CONSUMPTION

This is not statistics

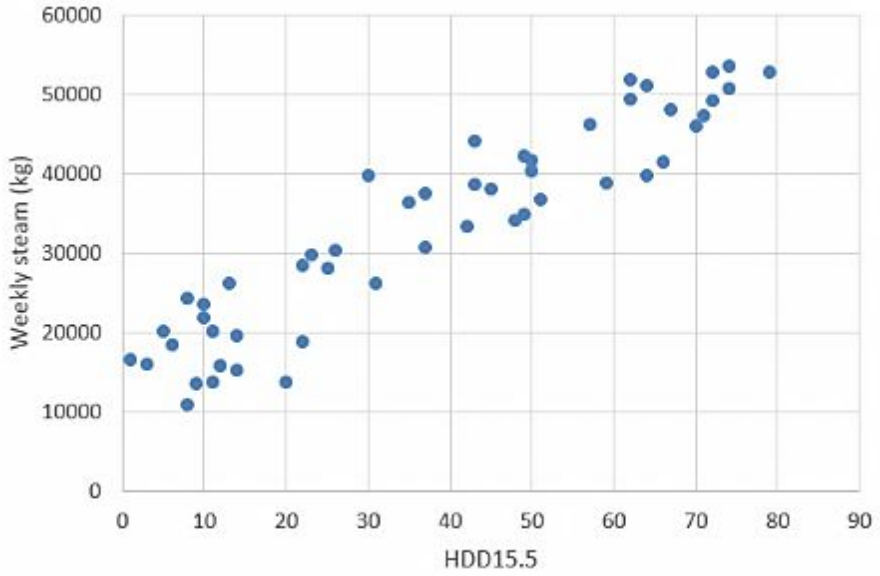


- This is just showing consumption and weather trends
- This is just real data.
- We can see they are similar…

This is not statistics



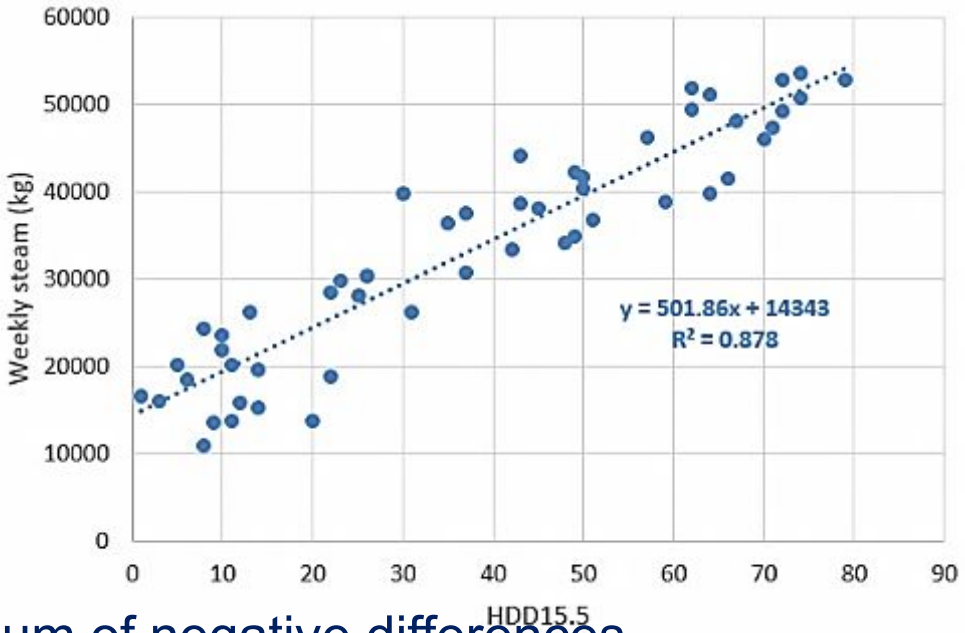
- This is just showing consumption and weather trends
- This is just real data.
- But we can see they are similar…



- This is showing exactly the same information in a different way
- Again, this is just real data.
- But now we can see the correlation more clearly

We can draw the line that best fits

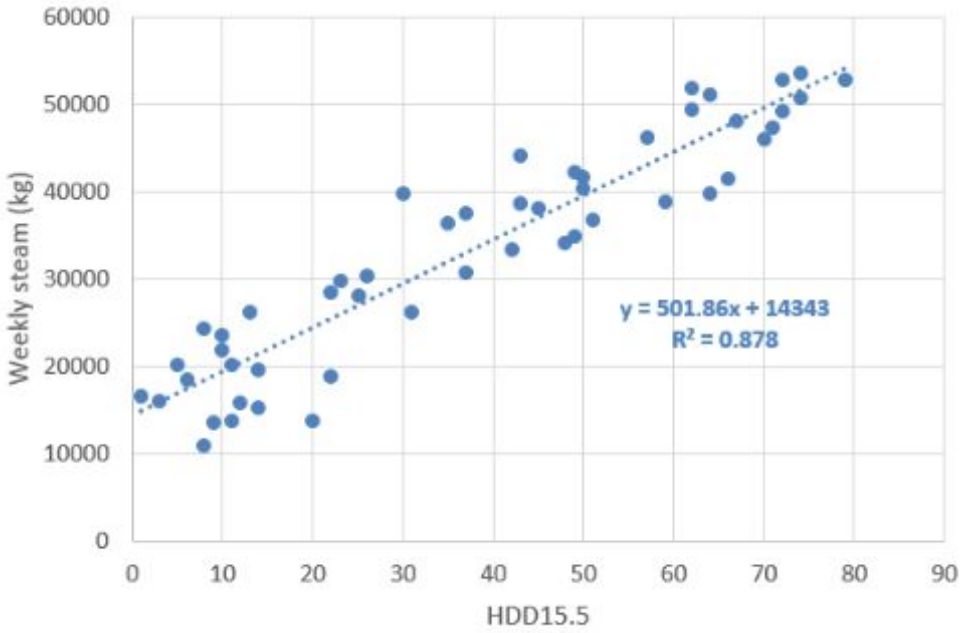
- We can draw the trend
- It is the line that best fits with all the points



- Sum of positive differences = Sum of negative differences
- We are creating a representative trend from real data.
- This is statistics!

We can draw the line that best fits

- **You can also use formulae in excel**
  - ✔ c: =INTERCEPT (known_y's,known_x'
  - ✔ m: =SLOPE (known_y's,known_x's)
  - ✔ R2: =RSQ(known_y's,known_x's)



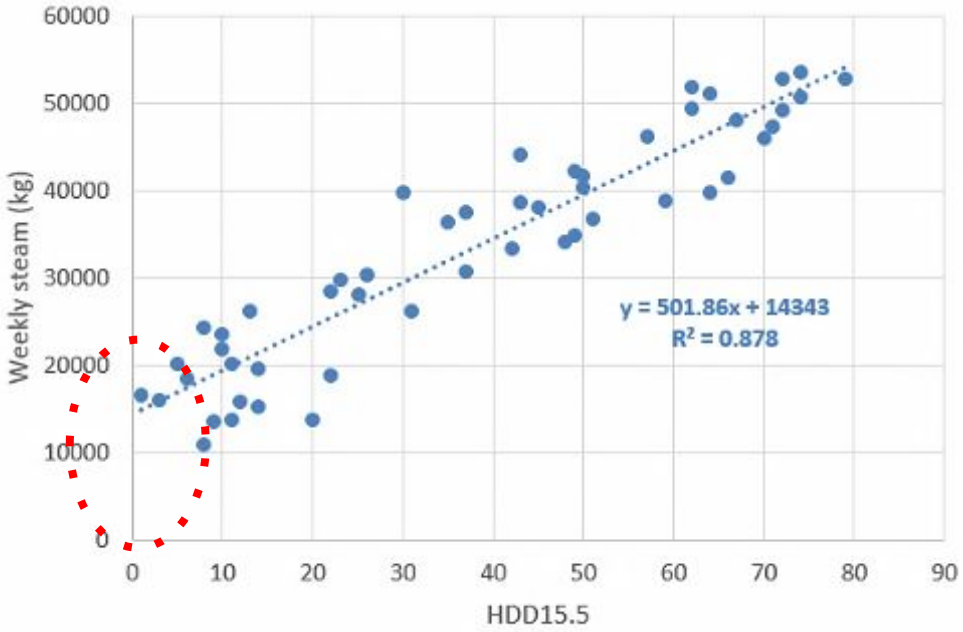
✔ Remember: Y= mX + c

- c and m are constants
- X is a measured "relevant variable"

Statistical values

Intercept :

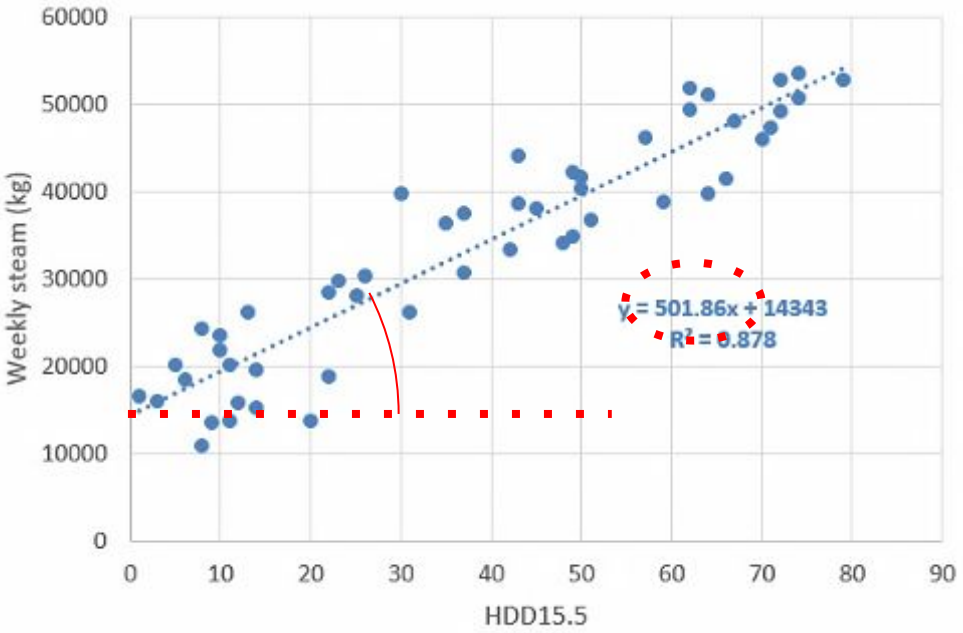
- Consumption when the variable is 0.
- It is the baseload in some cases.
- It can also be considered as “waste”



Statistical values

Slope:

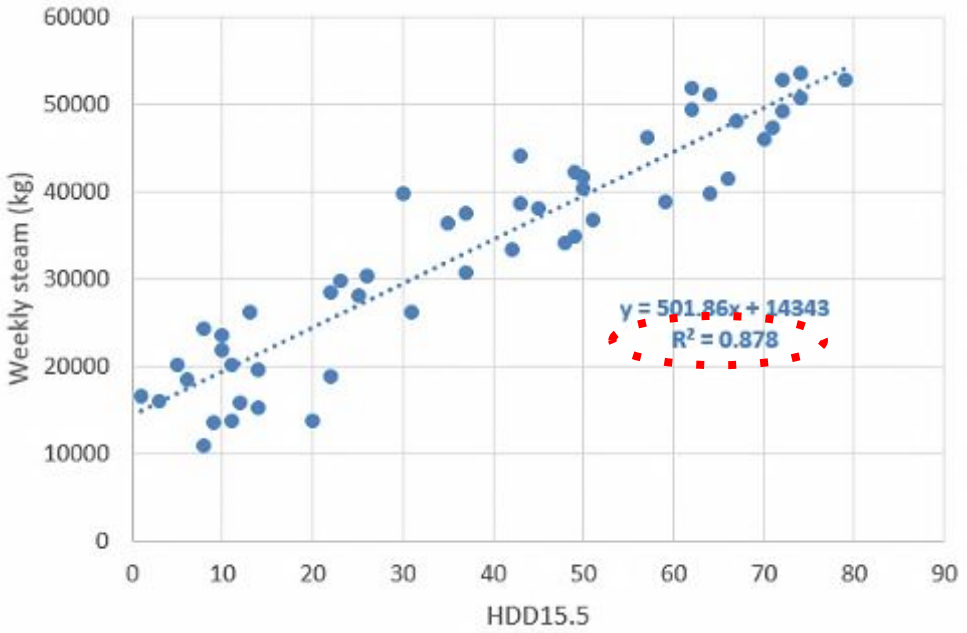
- In this case, kg of steam needed per HDD15.5
- Statistically, each additional HDD15.5 will make us consume that amount of energy.



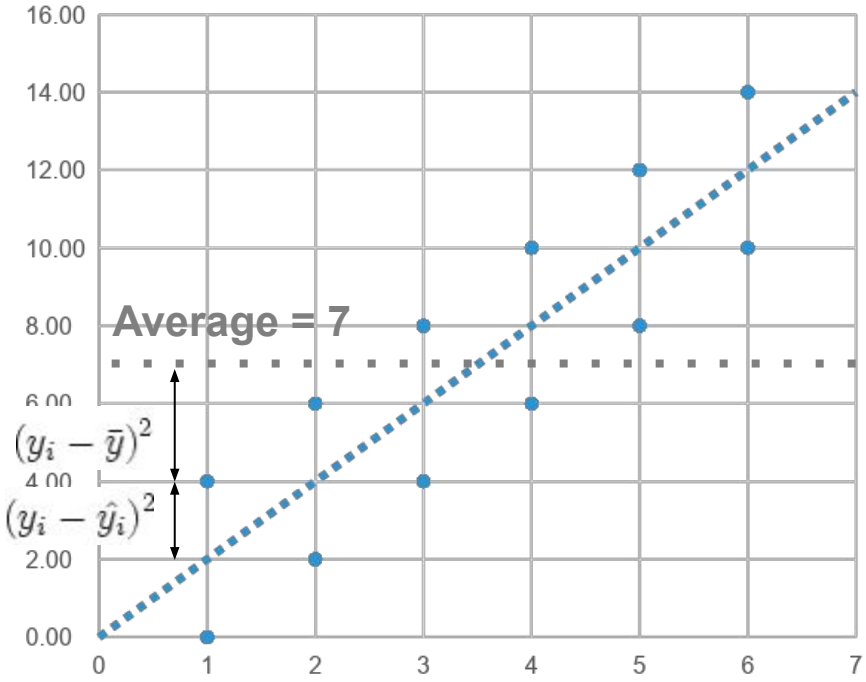
Statistical values

R^2:

- **% of variation explained by variables**
- **High R^2:**
  a) Strong correlation.
- **Low R^2:**
  a) The variable is not so relevant.
  b) There are other variables.
  c) Saving Opportunities in operational control.



What is R2?



$$R^2 = 1 - \frac{\sum (y_i - \hat{y}_i)^2}{\sum (y_i - \bar{y})^2}$$

$$R^2 = 1 - \frac{12*(2^2)}{(4*1^2)+(4*3^2)+(2*5^2)+(2*7^2)}$$

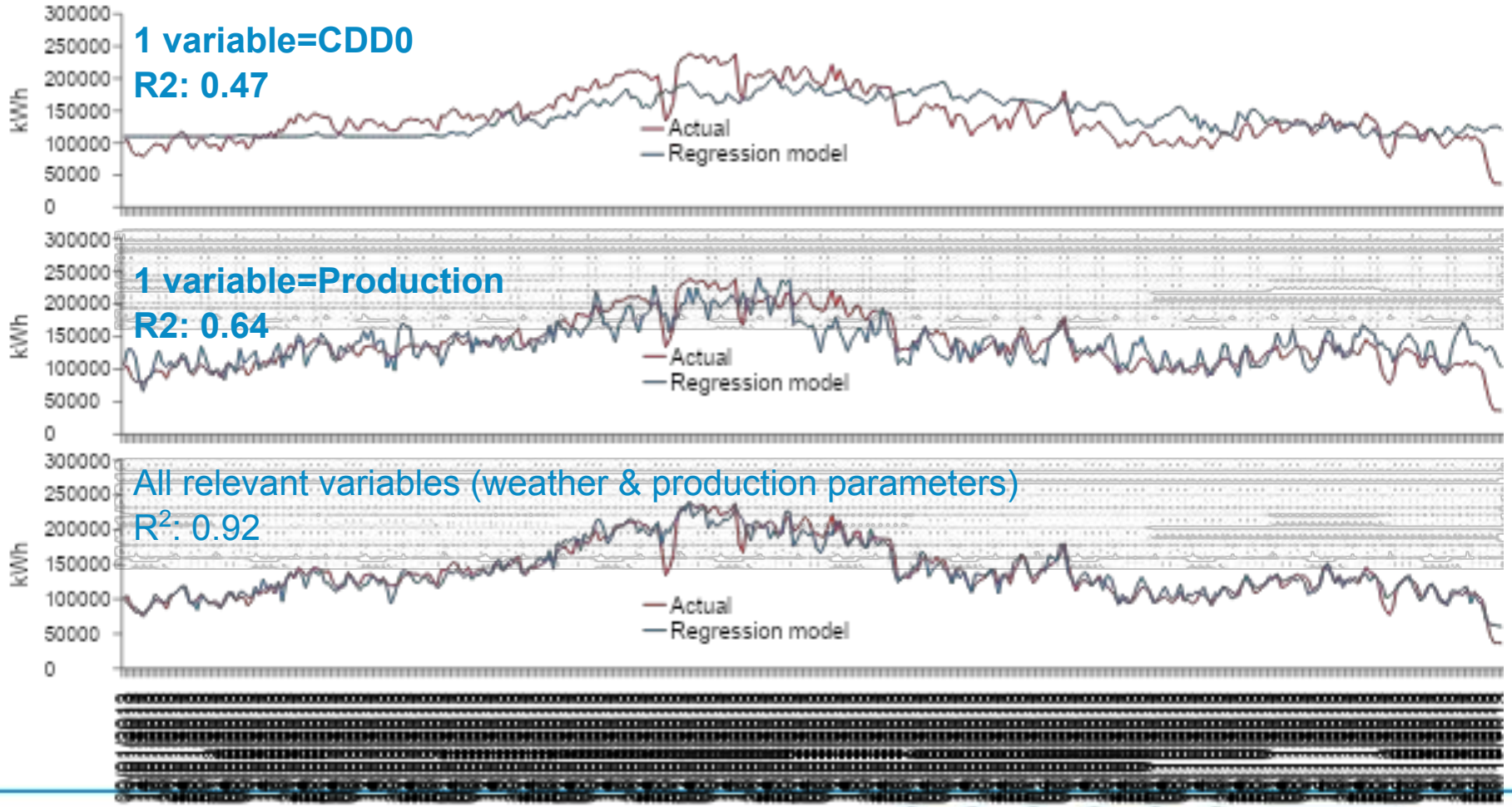
$$R^2 = 1 - \frac{48}{188}$$

$$R^2 = 1 - 0{,}2553$$

$$R^2 = 0{,}7447$$

Example: R^2

Drink industry



Statistical values

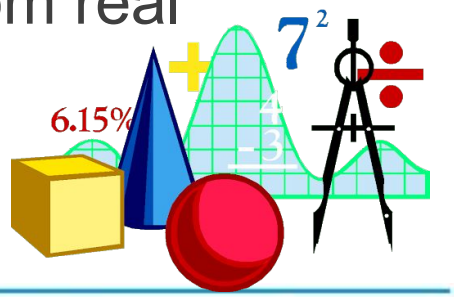
- There will be other statistical values that will help us to calculate a proper baseline.
- **P-value**
- We will see them during the planning module

Limits of statistics

- Statistics are not perfect. There is always a margin of error

But...

- Do we have a more precise method to calculate baselines?
  - ✔ This method takes into account the impact of relevant variables.
  - ✔ It also takes into account the baseload.
  - ✔ It is built using our own data. It comes from real results.



See you in 10 minutes!

Behaviour change

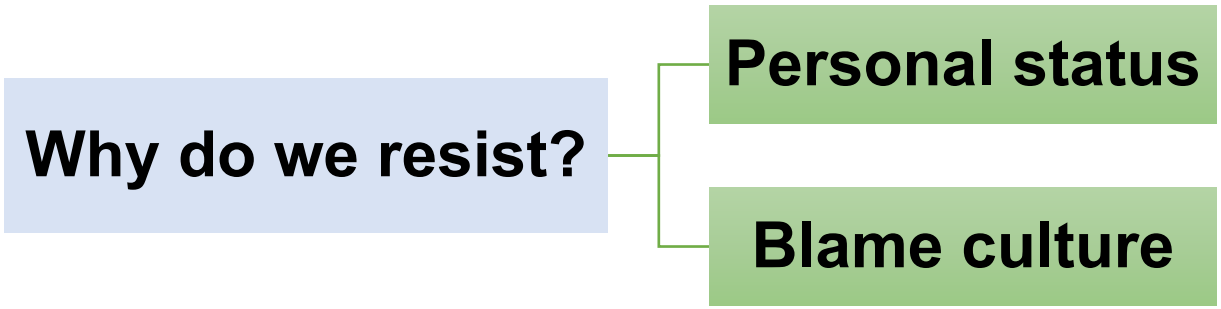
Change management

Idle Electricitydl

- Total electricity use reduced by 25%
- Idle electricity use reduced by 57%
- The total energy saving of 20.1 GWh
- Saved more than 1,260 tons of CO_2 emissions
- Energy bill in 2015 was 2.1 million euros lower compared to 2014
- Many “Non- Energy benefits” (NEB’s)

Where do we need behaviour change?

- Top management need to support and make decisions
- Middle management are often a barrier to change
- Operational control requires changing work practices
- Energy reduction is one of the few costs in an organisation which does not have personal impact



Change Management Process

Eight step change model (*John P. Kotter :* Leading Change)

1. Create a sense of urgency
2. Build support from key influencers
3. Create a vision of what can be achieved
4. Communicate the vision
5. Remove obstacles
6. Create short term wins
7. Build on the improvements
8. Anchor the change in your culture

This process can be aligned with your EnMS development

1 Create a sense of urgency

Drivers

- External or internal context (PESTLE analysis)
- Cost Reduction
- Carbon Emissions
- Competition
- Changes to the market
- Security of supply
- Price rises
- etc.

2 Build support from key influencers

Support

- **Management**
- **Employees**
- **About bringing people with you on change journey**
- **Momentum**
- **Communication**
- **Emphasise urgency**

Key Personnel

- Influencers of change
- Senior Management
- Production
- Quality
- Engineering
- Employee Representatives

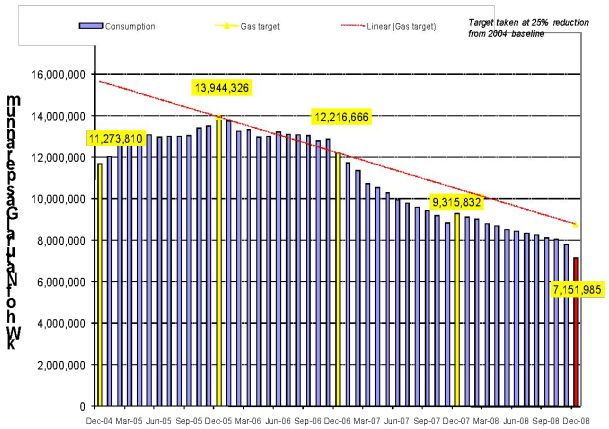
3 Create a vision of what can be achieved

What is possible

- Long Term
- Use Examples e.g. 50% reduction achieved elsewhere
- Previous success in UNIDO programs
- What are competitors doing?
- Goal Alignment

Do not accept

- They are different
- It's easy for them
- etc.



4 Communicate the vision

The 5 W's

Who

When

What

Where

Who

- Who should be told
- When to communicate
- What is the message
- Where will it be delivered
- Who is responsible

- Non Verbal

The message

- Urgency
- Benefits
- What others have achieved
- Your plans
- What success looks like

5 Remove obstacles (link to Risks and Opps)

What barriers?

- Weakness and threats from SWOT analysis
- Resistance to change
- Lack of commitment
- Knowledge
- Existing procedures and practices

What solutions?

- Communication
- Negotiation
- Urgency
- Benefits (including non-energy benefits)

6 Create short term wins

Opportunities

- Easily implemented
- Highly visible
- Large impact
- Low cost (operational control)
- Use data where possible

What kind?

- Compressed air leaks
- PIR on lighting
- Boiler house noise reduction
- Reduced heat in process area
- Win over the non believers

7 Build on the improvements

Action plans

- Communication the successes
- Continual improvement
- Stakeholder involvement
- More technical projects
- Larger teams
- Relentless focus

Focus on vision

- Regular engagement
- Take on bigger improvements
- Engage with more personnel
- Continue communicating
- Not a project

8 Anchor the change in your culture

Relentless Focus

- Re-evaluate the vision
- Communication
- Not a Project
- Need to make it the new culture
- Make the switch to sustainability permanent
- Integrate into business

Change Management

"It is not the strongest of the species that survives, nor the most intelligent; it is the one that is the most adaptable to change"

Charles Darwin

Source: *John P. Kotter* **Leading Change**

Consider your risks and barriers

Risks and Opps tab

Drivers and opportunities

Drivers and Opportunities	importance	lans to address opportunitie	Resp for opportunitiy plans	Target date	mpletion da	Notes regarding completion
From PESTLE and SWOT analysis results, list the positive factors that will help you to develop an effective EnMS. These will be P,E,S,T,L,E,S,O,Ts	How important is this factor in helping WAJ to developits EnMS	How will this opportunity be taken?	Who is responsible	When will ithe plan be completed	When was it actually completed	

Risks and barriers

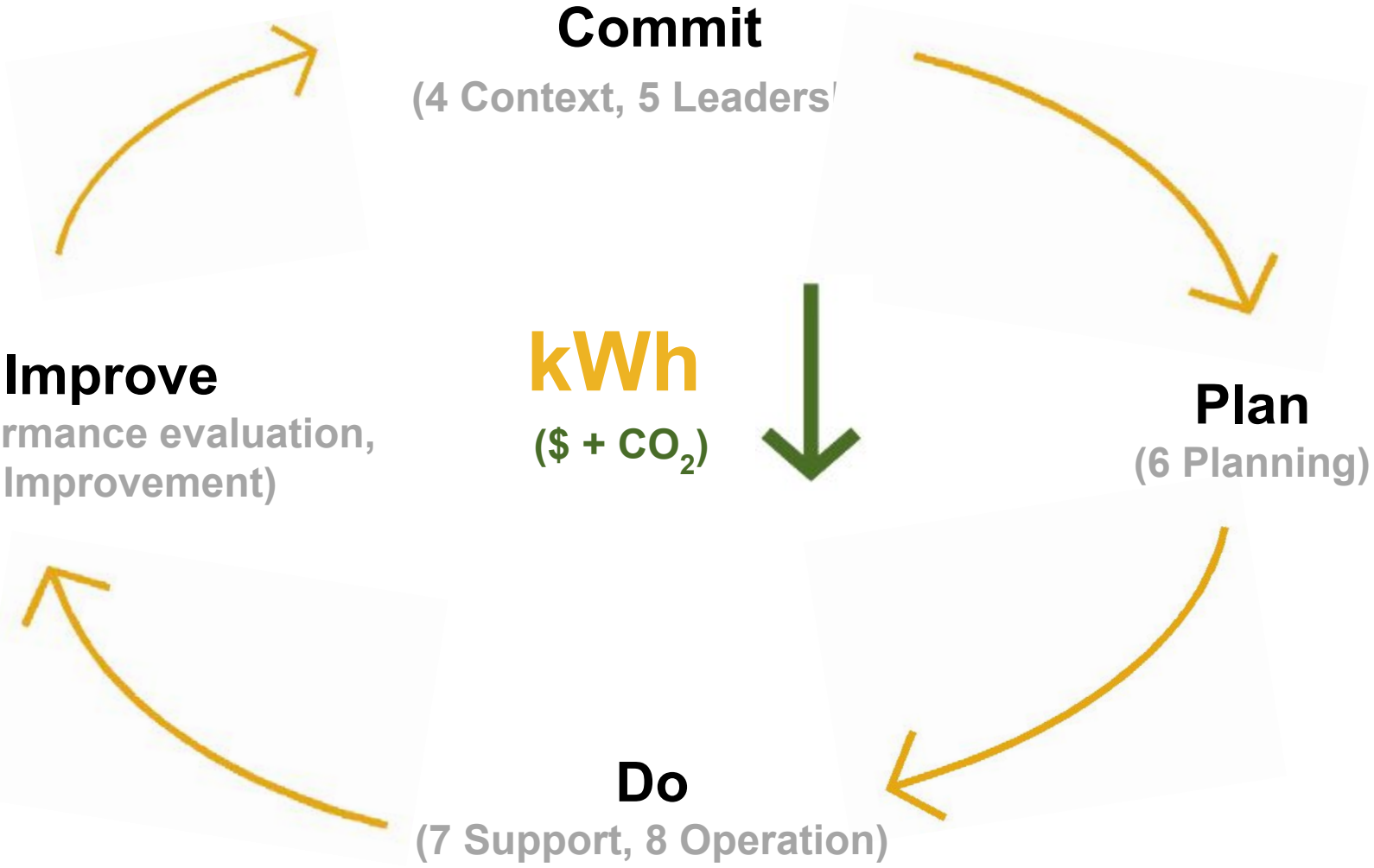
Risks and barriers	Severity (L/M/H)	Chance of occuring (L/M/H)	Plans to adress barriers	Resp for Barrier plans	Target date	Completio n date	Notes regarding completion
From PESTLE and SWOT analysis results, list the isks and barriers that will hinder you to develop an effective EnMS. These will be mostly related with Weaknesses from SWOT	How important is this factor as a barrier to WAJ to develop its EnMS	How likely is this issue to occur?	What action will be taken to address this risk or barrier?	Who is responsible	When will ithe plan be completed	When was it actually completed	

Add more risks and barriers?

- Describe the risks or barriers clearly
- Consider external risks from PESTLE analysis
- Consider weaknesses and threats from SWOT analysis
- Grade each from (Low/medium/high) in terms of importance or severity

✔ Prioritise the most serious ones

Next steps


Commit
(4 Context, 5 Leaders
Plan
(6 Planning)
Do
(7 Support, 8 Operation)
Improve
(9 Performance evaluation,
10 Improvement)
kWh
($ + CO_2)

Key Concepts

1. Commitment
   - ✔ Leadership and support
   - ✔ Integration into normal roles
2. Clear roles and responsibilities
   - ✔ Resourced and competent
3. ESO List is the main continual improvement tool
4. Energy Performance Indicators (EnPIs)
5. Communication
6. Change management

Thank you!

Workshop tomorrow about context, leadership and support