UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

Efficiency Valuation Organization

Energy Efficiency Performance Measurement and Data Due-Diligence in ISO 50001 and IPMVP: the Key to De-Risking Energy Efficiency Investments

Intensive Learning Session

21 May 2018

EE Global 2018

Copenhagen 21-22 May 2018

Agenda - 1

Time	Topic
13:00-13:10	**Marco Matteini and Pierre Langlois** Introduction
PART 1	**Implementing energy management systems**
13:10 -13:30	**William "Liam" McLaughlin** Energy performance measurement and indicators best-practices in the context of EnMS-ISO-50001 implementation
13:30-13:50	**Pierre Langlois** Energy performance measurement and verification: working with common references and guidance documents such as the IPMVP.
13:50-14:10	**Rajvant Nijjhar** Facilitating the implementation of ISO 50001 series of standards with the IPMVP framework.
14:10-14:30	**Panel discussion + Q&A**
14:30-15:00	**Break**

Agenda - 2

Time	Topic
PART 2	**Data due diligence and independent performance assessment**
15:00-15:15	**Tom Dreessen** The need for independent performance verification and certification of savings estimates by qualified individual professionals.
15:15-15:30	**Zlatko Gjurchinoski** Real-life examples of energy and non-energy benefits achieved by companies as result of greater data-due-diligence and analysis best-practices.
15:30-15:50	**Panel discussion + Q&A**

Energy Performance measurement and indicators in the context of ISO 50001

Liam Mc Laughlin

Lead International Expert in energy management systems

UNIDO

Intensive Learning Session – Energy Efficiency Performance Measurement and Data Due-Diligence in ISO 50001 and IPMVP: the Key to De-Risking Energy Efficiency Investments

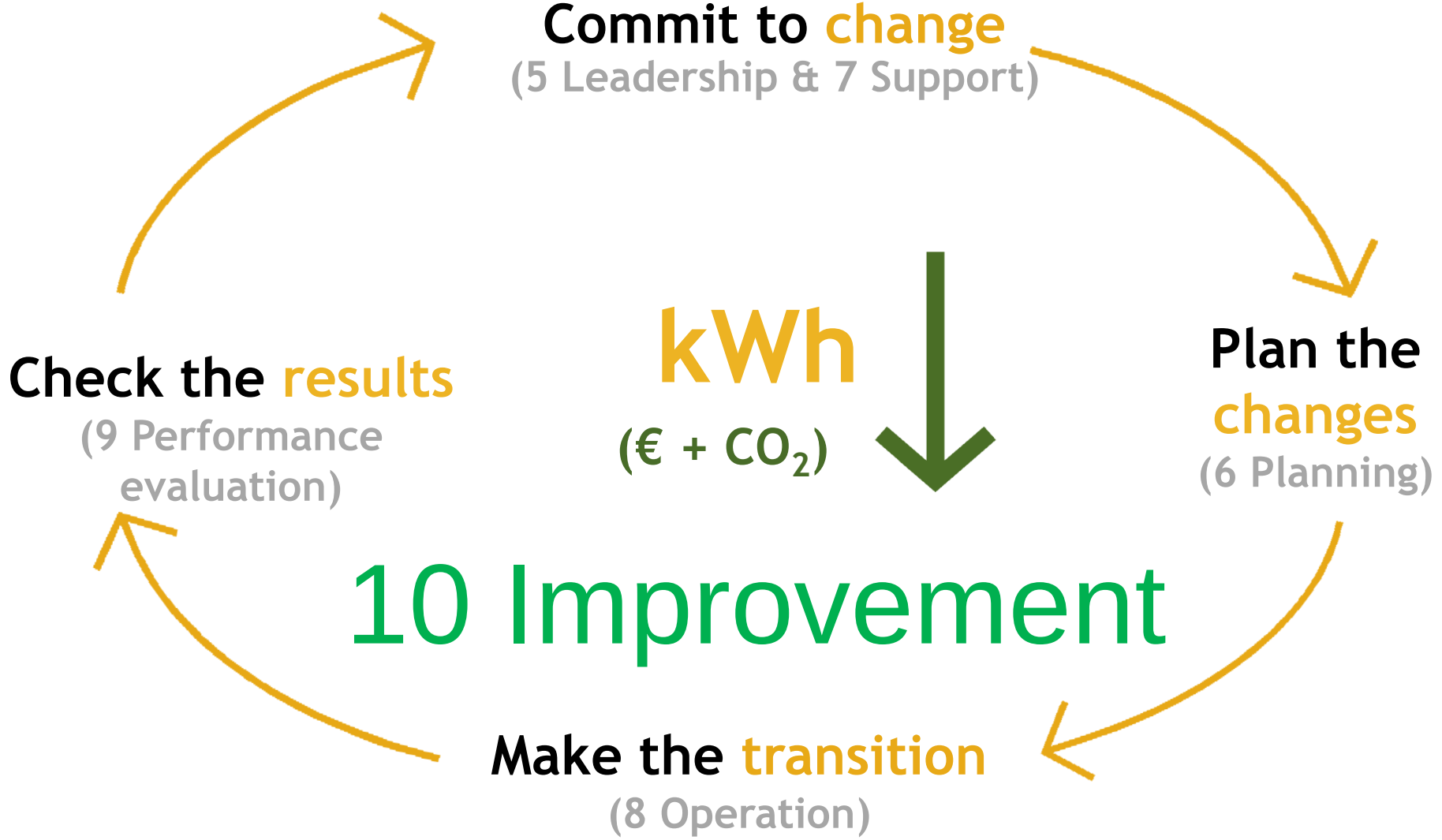
21 May 2018

EE Global, Copenhagen, Denmark

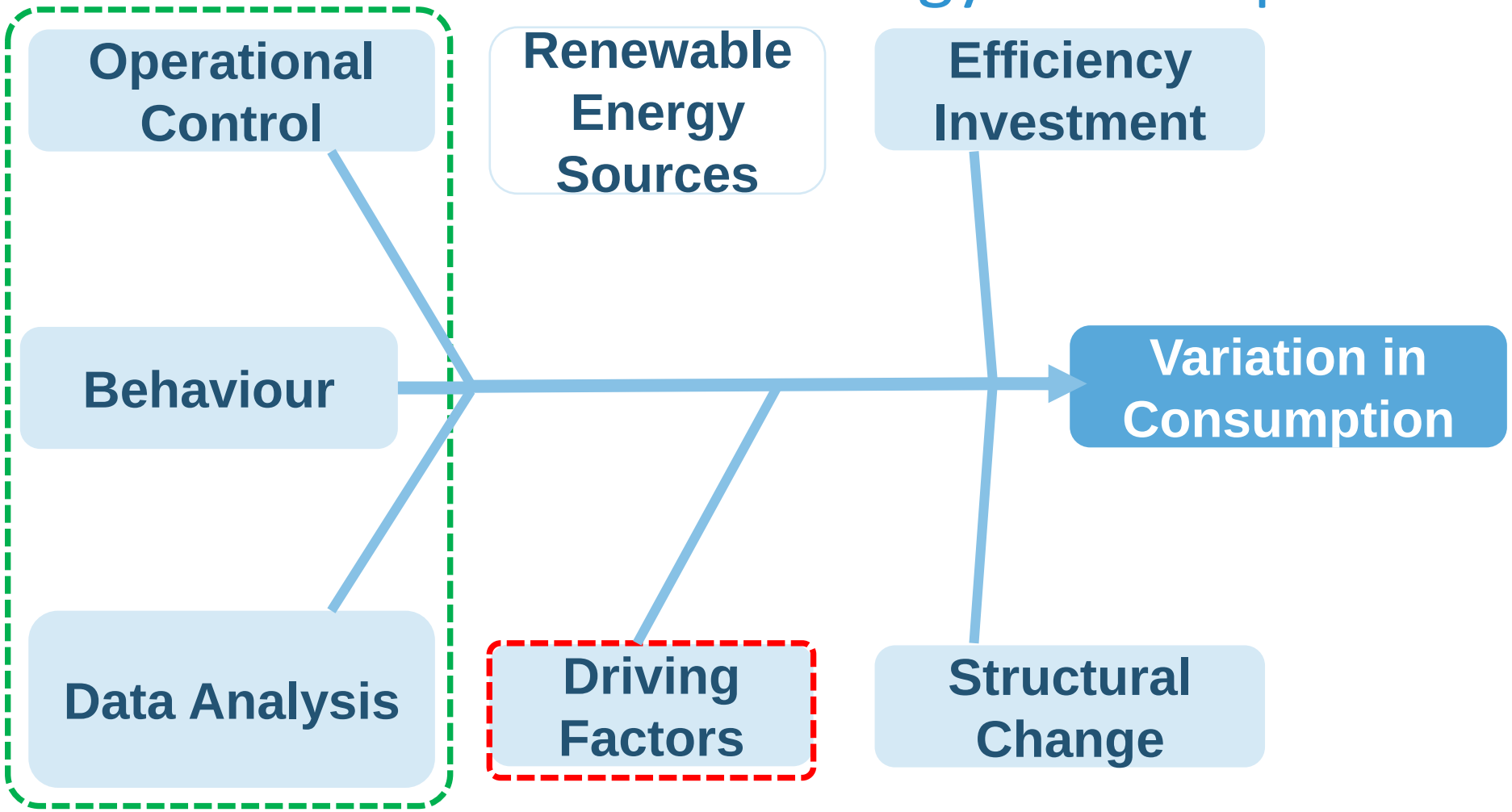
- What is ISO 50001?
- Energy performance improvement (=energy savings)
- Relationship to Benchmarking
- Relationship to measurement & verification (M&V)

"It ain't what you don't know that gets you into trouble. It's what you know for sure that just ain't so."
Mark Twain


SUSTAINABLE DEVELOPMENT GOALS
1 NO POVERTY
2 ZERO HUNGER
3 GOOD HEALTH AND WELL-BEING
4 QUALITY EDUCATION
5 GENDER EQUALITY
6 CLEAN WATER AND SANITATION
7 AFFORDABLE AND CLEAN ENERGY
8 DECENT WORK AND ECONOMIC GROWTH
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
10 REDUCED INEQUALITIES
11 SUSTAINABLE CITIES AND COMMUNITIES
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
13 CLIMATE ACTION
14 LIFE BELOW WATER
15 LIFE ON LAND
16 PEACE, JUSTICE AND STRONG INSTITUTIONS
17 PARTNERSHIPS FOR THE GOALS
SUSTAINABLE DEVELOPMENT GOALS


Commit to change
(5 Leadership & 7 Support)
Plan the changes
(6 Planning)
Make the transition
(8 Operation)
Check the results
(9 Performance evaluation)
kWh
(€ + CO_2)
10 Improvement

Causes of variation in energy consumption



TECHNICAL OPERATIONS

RENEWABLE SOURCES?

EFFICIENCY INVESTMENT

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?"

BEHAVIOUR

REDUCTION IN CONSUMPTION

ANALYSIS AND MONITORING

DRIVING FACTORS

STRUCTURAL CHANGE

Case Study – Brewing Industry: SEC

$$\textbf{Specific energy consumption} = \frac{\text{Unit of Energy Used}}{\text{Physical Unit of Output/Service}} = \frac{kWh}{ton}$$

Month	Production (khl)	Electricity consumption [MWh]
Jan-12	170.8	1,262.2
Feb-12	305.4	2,143.9
Mar-12	480.1	2,947.8
Apr-12	497.5	2,990.0
May-12	576.5	3,683.8
Jun-12	724.4	4,781.0
Jul-12	565.1	4,046.1
Aug-12	478.4	3,511.5
Sep-12	300.1	2,475.8
Oct-12	226.0	1,713.1
Nov-12	318.7	2,113.0
Dec-12	445.4	2,587.8
TOTAL	**5,088.4**	**34,256.0**

$$\textbf{SEC} = \frac{34{,}256}{5{,}088.4} = \textbf{6.7322}\ \frac{\text{kWh}}{\text{hl}}$$

$$\textbf{Elec.} = \textbf{6.7322} * \textbf{Production}$$

Case Study – Brewing Industry: SEC line

$$\textbf{Specific energy consumption} = \frac{\text{Unit of Energy Used}}{\text{Physical Unit of Output/Service}} = \frac{kWh}{ton}$$

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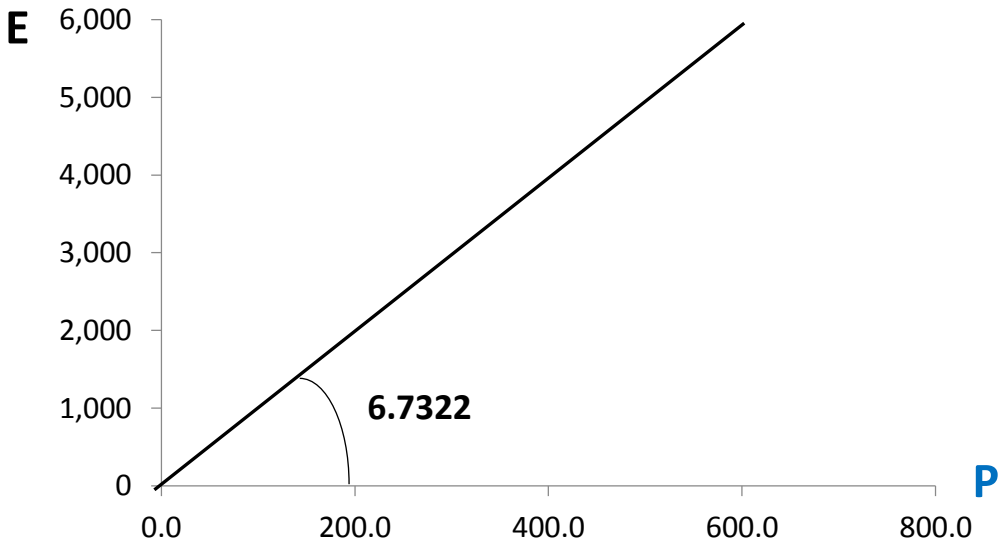

Case Study – Brewing Industry: scatter

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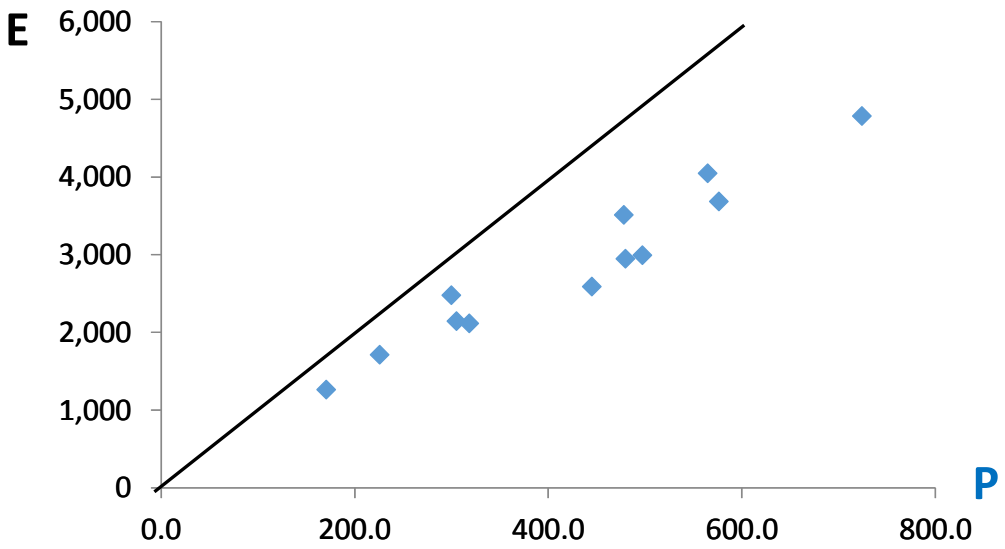

Case Study – Brewing Industry: baseline

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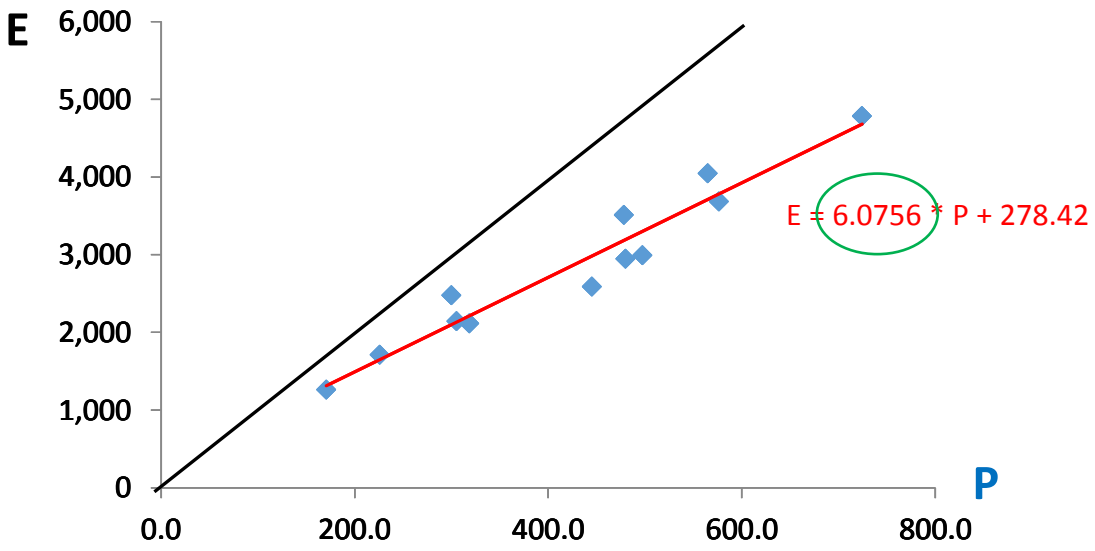

Case Study – Brewing Industry: baseload

$$\textbf{Specific energy consumption} = \frac{\text{Unit of Energy Used}}{\text{Physical Unit of Output/Service}} = \frac{kWh}{ton}$$

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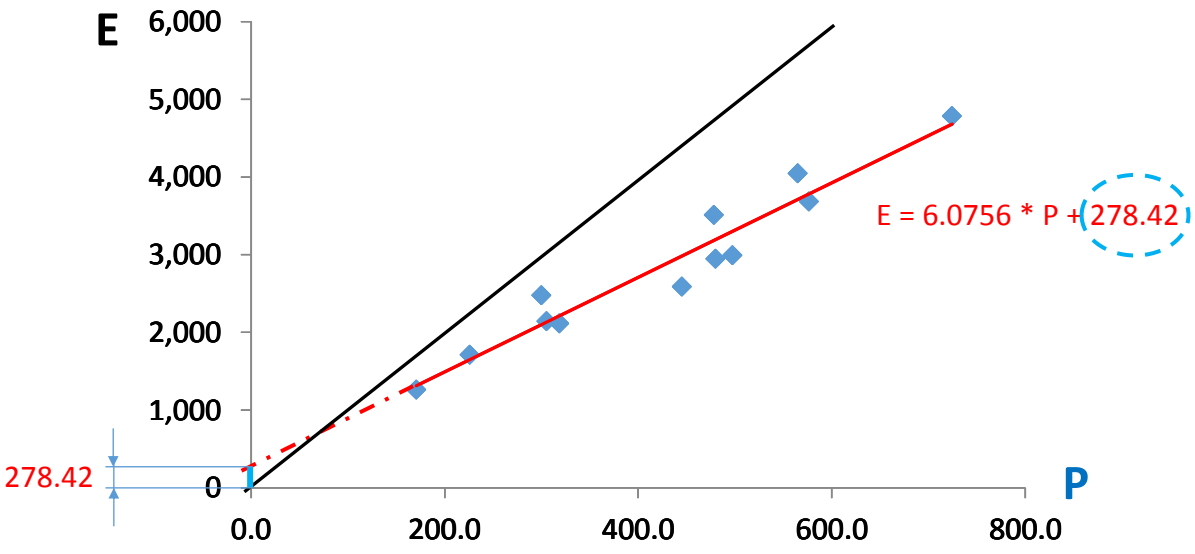
Elec. = 6.7322 * Production



Case Study – Brewing Industry: performance

$$\textbf{Specific energy consumption} = \frac{\text{Unit of Energy Used}}{\text{Physical Unit of Output/Service}} = \frac{kWh}{ton}$$

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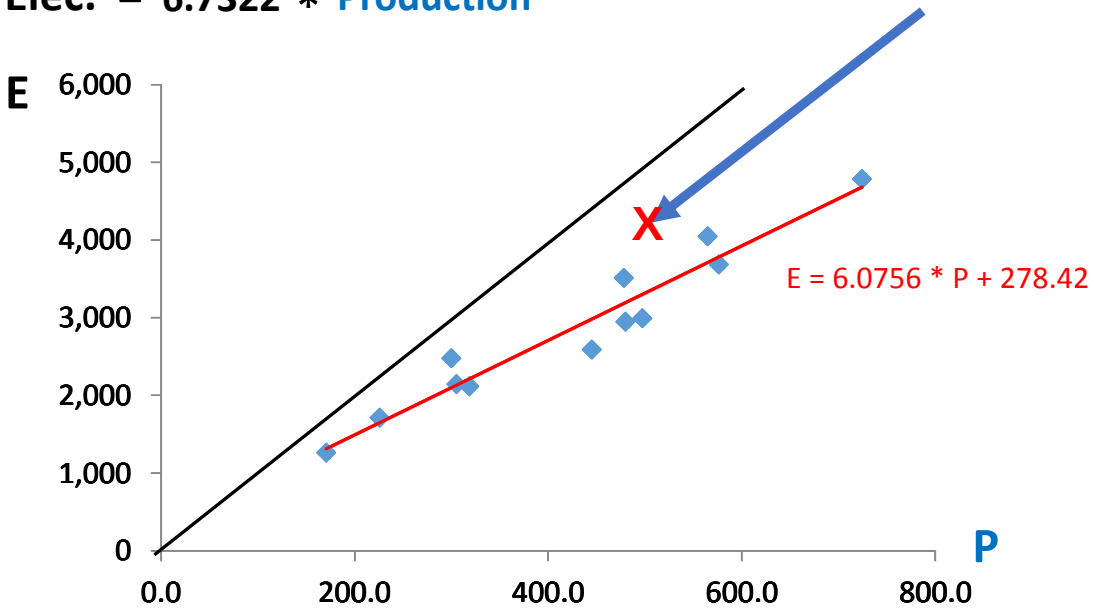
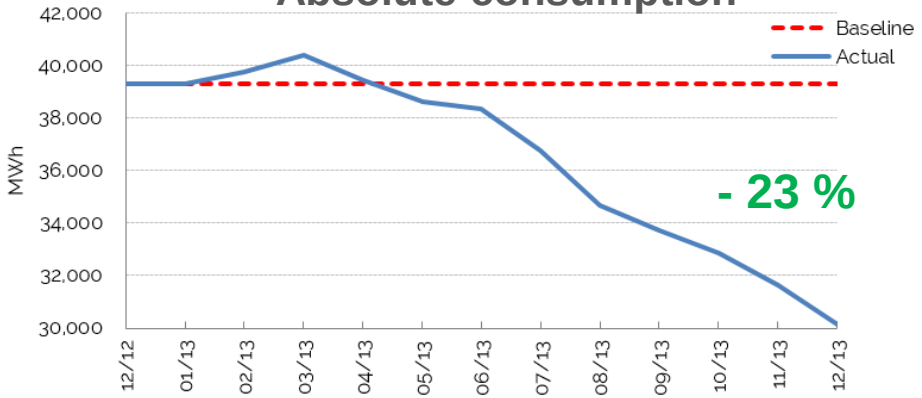
Good or bad?

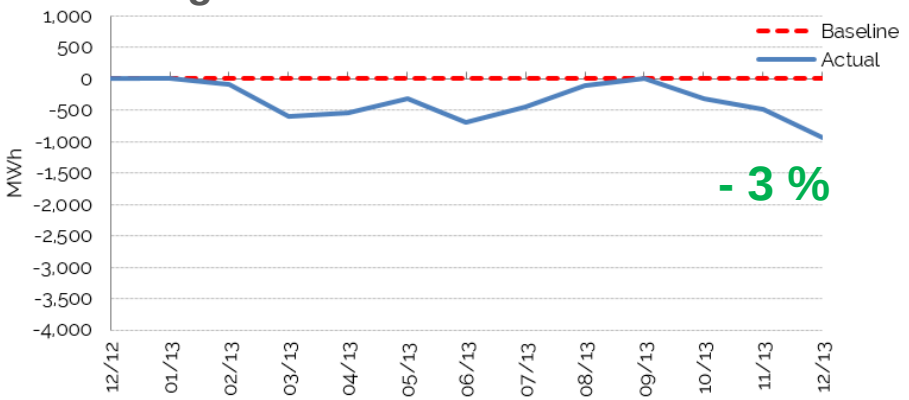


Energy performance in Industry – Which is right?

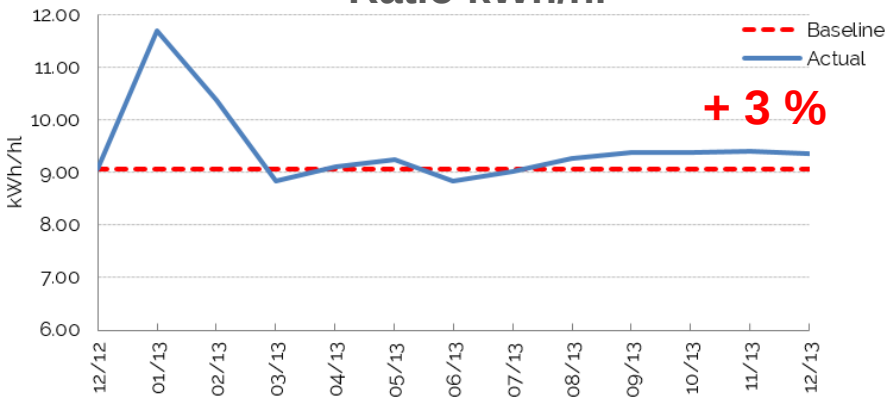
Absolute consumption



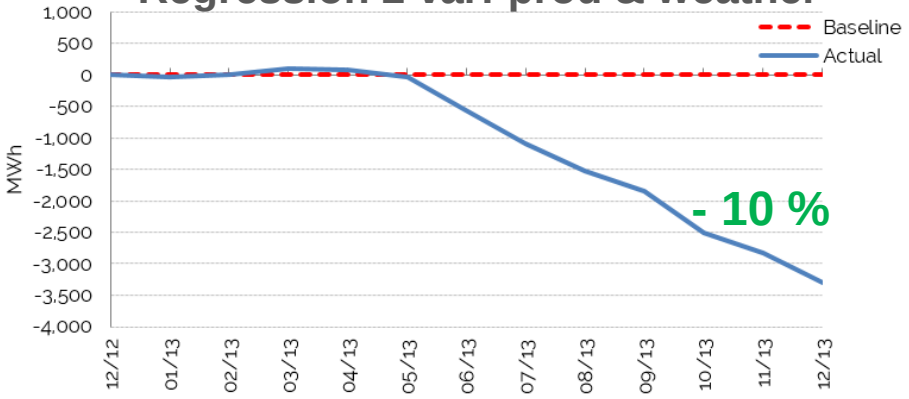
Regression 1 variable: Production



Ratio kWh/hl



Regression 2 var: prod & weather



Source: UNIDO

Brewing industry

Significant Energy Use Performance

Target Savings: 5%

End Date: 20/03/2018

SERVICE	TARGET	ACTUAL	SAVINGS			COST		AVERAGE
	last week	last week	YTD		last week	YTD	last week	last week
Chilled Water	3,007 kWh	1,971 kWh	-48%	-€ 3,706	-€ 128	€ 4,055	€ 211	12 kW
Compressed Air	79,557 kWh	82,587 kWh	-1%	-€ 919	-€ 124	€ 97,031	€ 8,822	492 kW
Cold Glycol	39,899 kWh	43,683 kWh	3%	€ 1,445	€ 180	€ 48,724	€ 4,666	260 kW
Steam	42,691 Nm^3	38,367 Nm^3	-8%	-€ 22,229	-€ 2,852	€ 267,684	€ 4,098	228 Nm^3/h

Utility Electricity	**-2%**	**-€ 3,180**	**-€ 71**	**€ 149,810**
Utility Gas	**-8%**	**-€ 22,229**	**-€ 2,852**	**€ 267,684**

What does ISO 50001 require

ISO 50001

- Requires energy savings
- Requires demonstration of savings
- Normalised for drivers
  - Production, weather, etc.
- **MAJOR** non-conformity (ISO 50003)

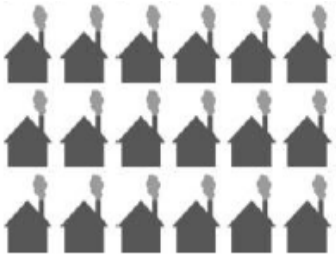
Good business

- Requires cost savings
- CSR & Sustainability
- Should require demonstration of savings
- Should be objective, quantified and normalised

Neither requires compromise of safety, quality, productivity, comfort

Impact of UNIDO-GEF EnMS-ISO 50001-ESO Program

7,500 GWh of final energy savings **=**

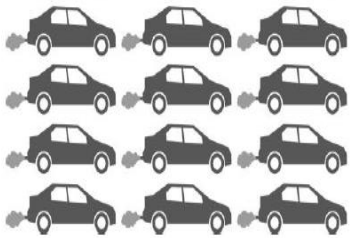


Annual energy consumption of 1,230,000 EU households

OR

5 years energy production of 400 1 MW wind turbines

OR



CO2 emissions of 1,875,000 middle class cars (running 12,500 km per year)

- Organization-wide energy savings in first 1-2 years range from 4% to 15%, with little or no capital investments
- Cumulative cost savings of beneficiary companies estimated to exceed ***USD 250 mio*** without considering non-energy benefits
- Direct GHG emission reductions of more than ***4.8 million*** **tCO2**
- Sustainable pipeline of IEE investments generated

- Operational control knowledge
- Lack of leadership
- *"we are already the best"*

- Specific Energy Consumption (SEC) based goals
- Practical knowledge
- *"we already know this"*

- Practical experience
- Non-energy benefits
- "energy efficiency is expensive"

THANK YOU!

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****.*

Energy performance measurement and verification Working with common references and guidance documents the role of IPMVP.

Pierre Langlois, P. Eng, CMVP
Chairman of the Board
EVO

ENERGY EFFICIENCY PERFORMANCE MEASUREMENT AND DATA DUE DILIGENCE IN ISO 50001 AND IPMVP: THE KEY TO DE-RISKING ENERGY EFFICIENCY INVESTMENTS

EE Global

Copenhagen, Denmark

May 21 2018

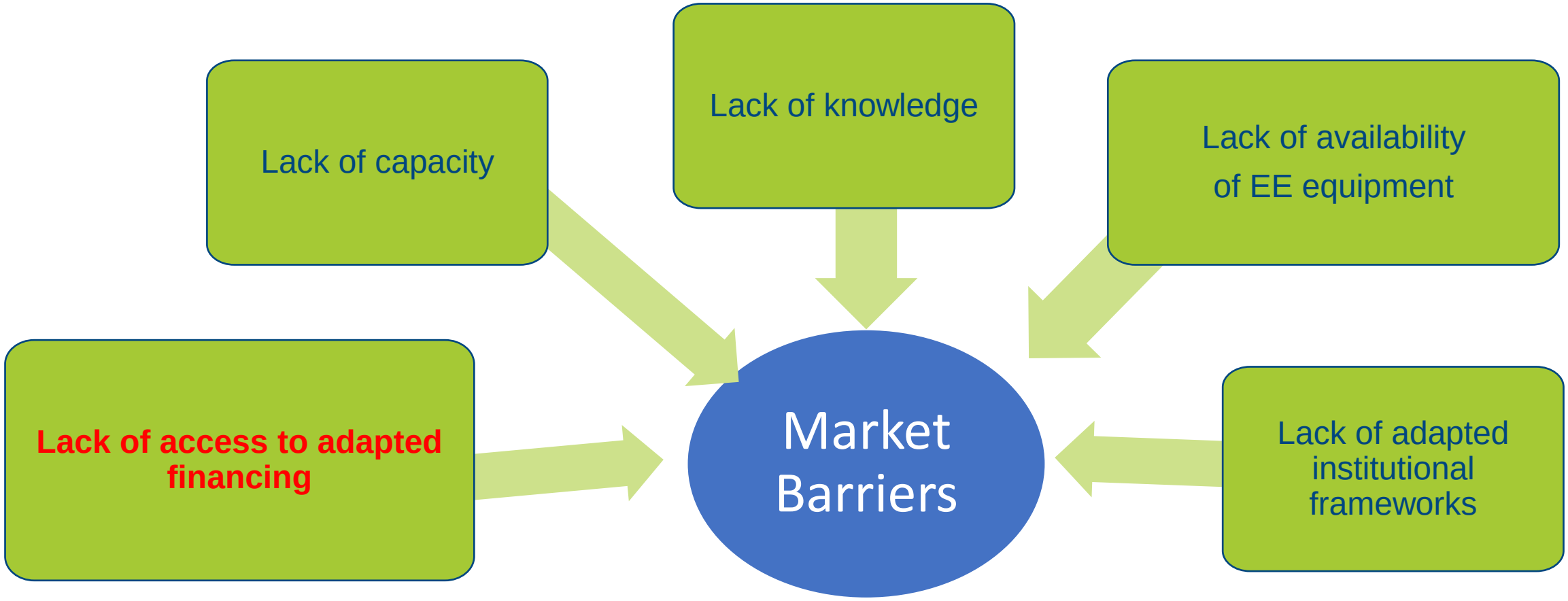
ENERGY EFFICIENCY

One of the quickest, greenest, and most cost-effective ways of addressing climate change, energy security, and ensuring economic growth. *(IPEEC, 2010)*

A central pillar of a cost-effective strategy to mitigate climate change and achieve peaking in global GHG emissions by 2020. *(IEA, 2015)*

Increased collaboration on EE can drive economic activity and productivity, strengthen energy security and improve environmental outcomes. *(G20, 2016)*

MARKET BARRIERS



EE PROJECTS VS OTHER INVESTMENTS

- Key Differences
  - Risk Perception
  - Quality of Collateral

Project finance issues related to
the actual cash flow generating capacity of a project

MEASURE SAVINGS?

- Savings are the absence of energy use.
- We can not measure what we do not have.
- We do **not** ‘measure’ savings!

- We **do** measure energy use.
- We analyze measured energy use to **determine** savings.

MEASUREMENT AND VERIFICATION OF ENERGY SAVINGS

"Measurement & Verification (M&V) is
the process of using measurements
to reliably determine actual saving
created within an individual facility
by Energy Conservation Measure (ECMs)."

PURPOSES OF M&V

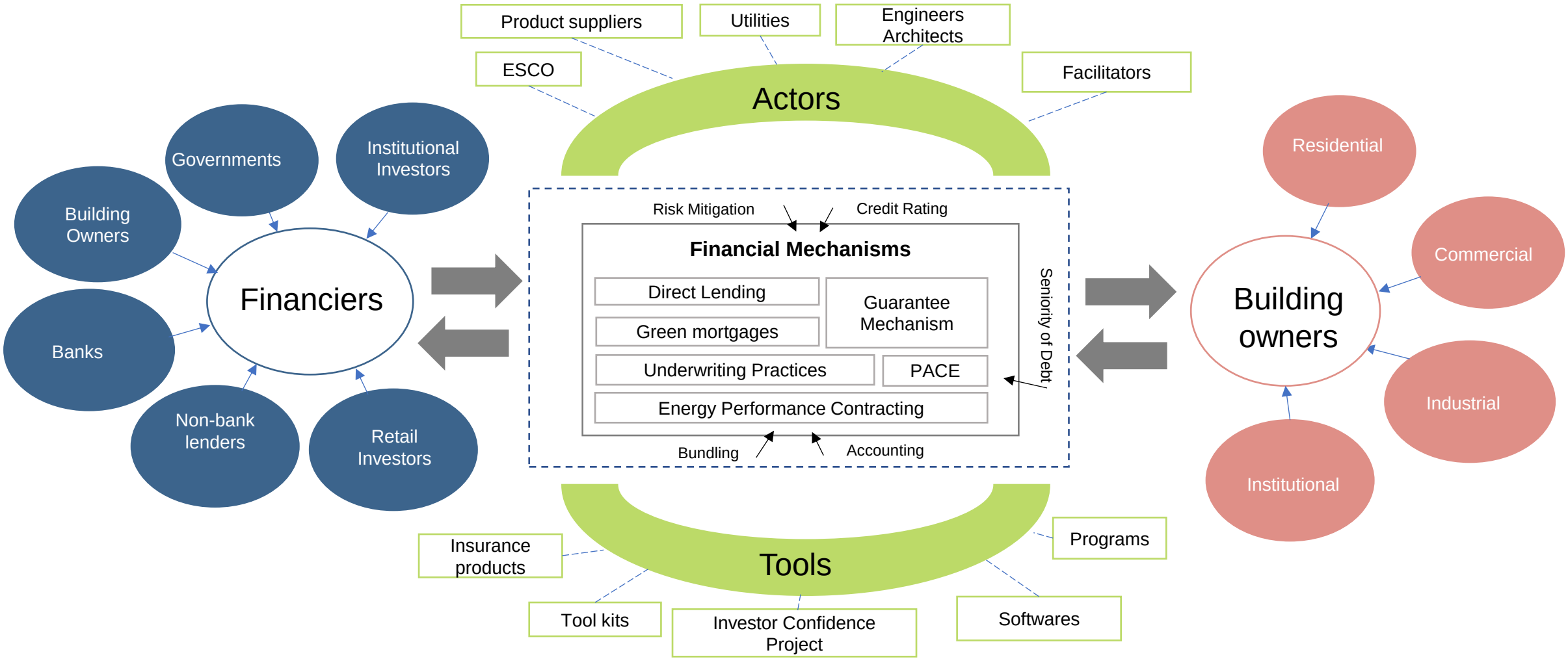
Fundamental purpose

- Demonstrate Energy Savings realized
- Guarantee sustainability of savings
- Enable financing for efficiency projects

Other benefits

- Improve design, operations and maintenance
- Educate facility users about their energy impacts
- Support evaluation of efficiency programs

THE EE COMMUNITY IN NEED OF STANDARDIZED M&V



STANDARDIZATION OF M&V

The EE community has to speak out of one voice

The need is not to develop new protocols!

STANDARDIZATION OF THE PRACTICE OF M&V

- Dissemination of knowledge and importance of M&V best practices and concepts through all stakeholders
- Capacity building and certification of experts
- Presence of independent verifiers

IPMVP - OVERVIEW

- Presents a framework and defines terms used in determining ‘savings’ after implementation of a project.
- Specifies the topics to be addressed in a project’s M&V Plan.
- Allows flexibility in creating M&V Plans while adhering to principles: accuracy, completeness, conservativeness, consistency, relevance and transparency.

IPMVP

- IPMVP is the most recognized M&V protocol worldwide.
- It is referred to by most reference documents and other protocols developed.
  - Is a reference document in the upcoming ISO standard in energy management.
- Incorporated into several frameworks in Europe and North America including the Investor Confidence Project (supported by the European Commission in Europe).

EVO

Efficiency Valuation Organization (EVO)

www.evo-world.org

- A non-profit corporation
- The home of the IPMVP
- Led by volunteers around the world

EVO

Vision

Create a world that has confidence in EE
as a reliable and sustainable energy resource.

Mission

Ensure that the savings and impact of EE and
sustainability projects are determined
through appropriate measurement and verification.

EVO

Protocols

- IPMVP

Training, Certification

- Certification (CMVP)
- Advanced training and certification (CESV)

Building Community, Promoting Efficiency

- Subscriber services through www.evo-world.org: newsletter, library, discounts
- Partnerships for communication, training and development
- Institutional support to develop best M&V approaches

EVO and IPMVP

can contribute to offer the needed world's EE meter

CONTACT INFORMATION

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Chairman of the board, EVO

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- mail: planglois@econoler.com

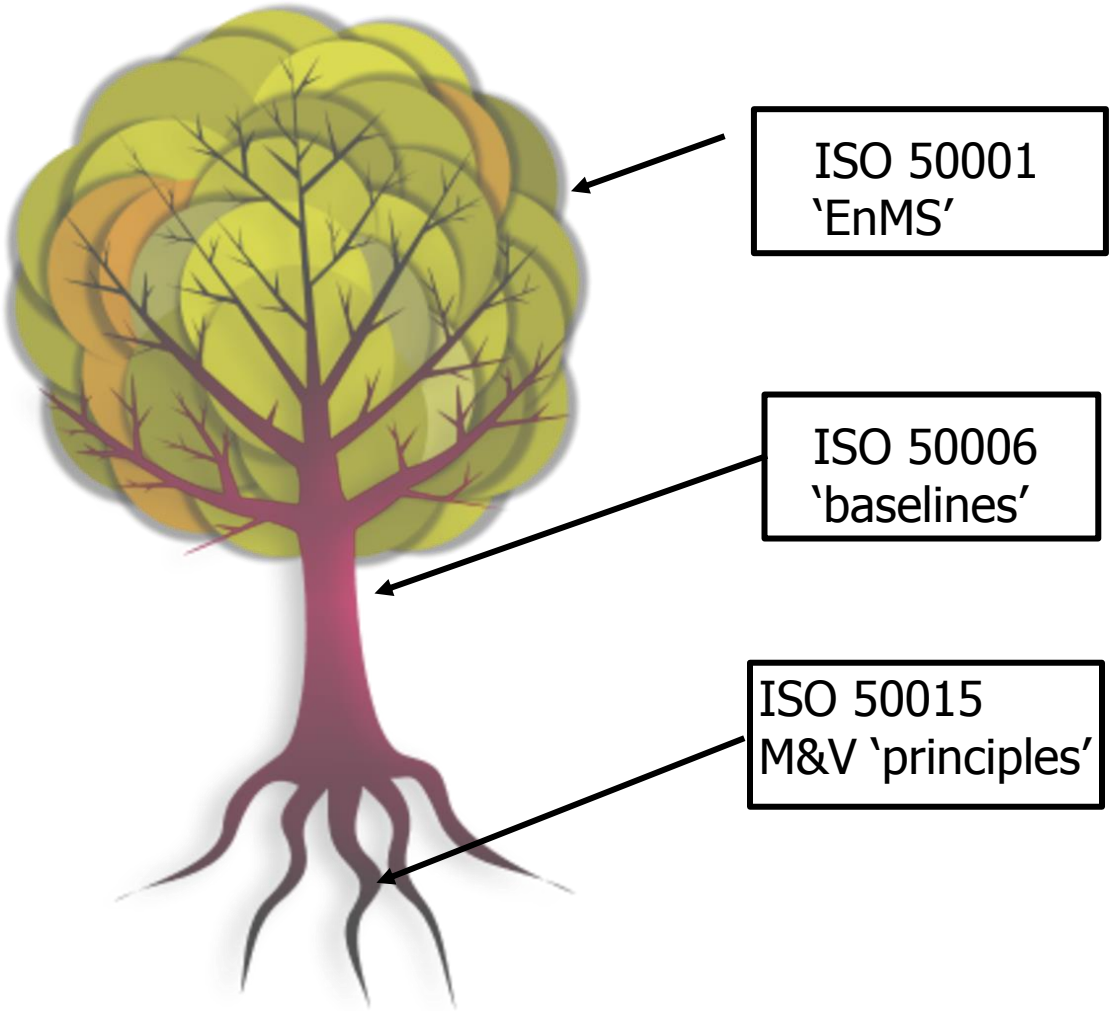
ISO 50000 suite of standards & The IPMVP:

How They Fit For Best Practise

RAJVANT NIJJHAR - Director, iVEES®

UK M&V Expert at ISO meetings, TC301
VP (Former President) UK Chapter of AEE
UK Level 2 & 3 CMVP trainer
CMVP International Board Member

Agenda:



- Overview of ISO 50001 and key changes in 2018
- Overview of other ISO suite of standards
- How combined with IPMVP this encourages best practise

What is ISO 50001?

Energy Management System Standard (EnMS)

" A structured approach to the management of energy to enable energy improvement opportunities to be assessed and appropriate measures to be instigated and monitored for improvement on an on-going basis".

Ref Rajvant Nijjhar!

Fundamental tenants of ISO 50001

- Appealing to SMEs
- EnMS needs to be designed and implemented to deliver the policy to ensure energy performance improvement
- Good document management

Key success factor of ISO 50001

Top leadership or Management support!

Why the update to 2011 version?

- ISO HQ Directive – ‘’Annex SL’’
- All MSS must have the same High Level Structure (HLS)
- Integrated audits with other MSS’
- Commonality identified
- Earlier than usual change: 7 years of implementation since July 2011

FDIS March 2018 – 34 pages (compared to 2011 – 22 pages)

Contents

Page

Clarification on existing terminology and new terminology

- E.g. What is meant by energy performance improvement and does it include renewables?

energy use
application of *energy* (3.5.1)

EXAMPLES: Ventilation; lighting; heating; cooling; transportation; data storage; production process.

energy performance
measurable result(s) related to *energy efficiency* (3.5.3), *energy use* (3.5.4), and *energy consumption*

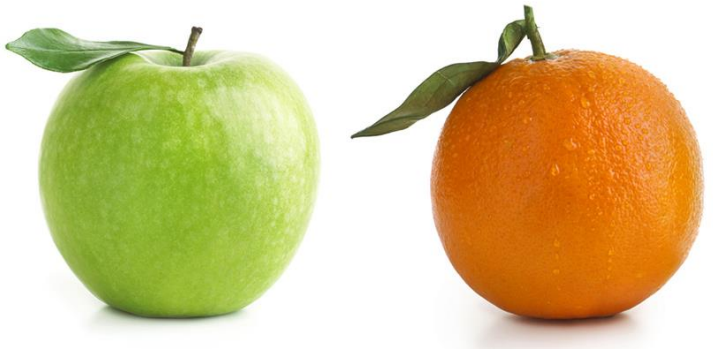
NEW:

energy performance improvement
improvement in measurable results of *energy efficiency* (3.5.3), or *energy consumption* (3.5.2) related to *energy use (3.5.4)*, compared to the *energy baseline* (3.4.7)

FDIS March 2018 cont.

Introduction of new terms and concepts

- Energy performance indicator (EnPI) and energy baseline (EnB) clarified to provide a better understanding of these concepts.
- Normalization of EnPIs and associated EnBs
- With consideration to SMEs



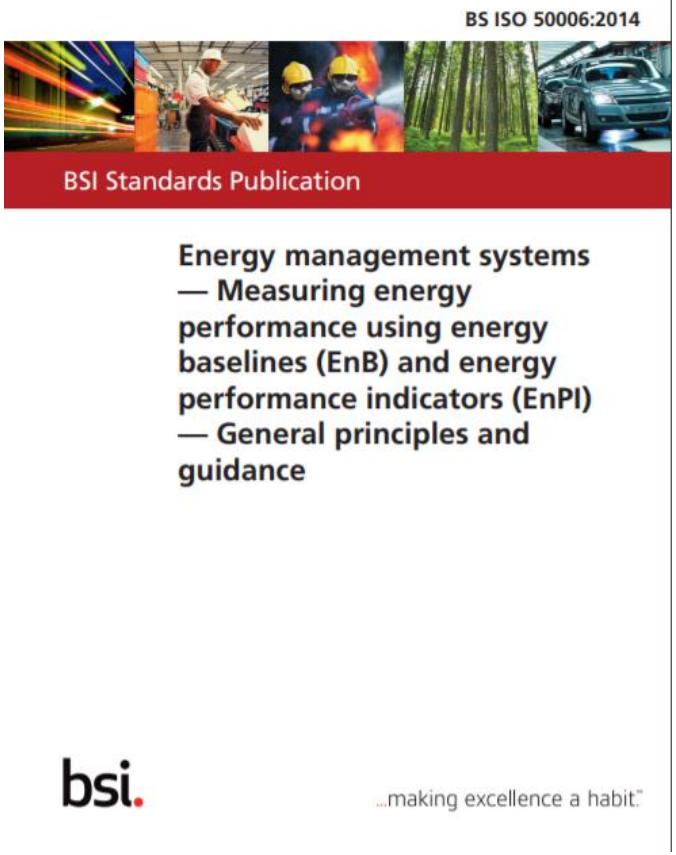
Where the organization has data indicating that relevant variables significantly affect energy performance, the organization shall carry out normalization of the EnPI value(s) and corresponding EnB(s).

NOTE 1: Depending on the nature of the activities, normalization can be a simple adjustment, or a more complex procedure.

FDIS March 2018 cont.

Scope of ISO 50006

- **Introduction**
- **Scope**
- **Normative references**
- **Terms and definitions**
- **Measurement of energy performance**
  - General overview
  - Obtaining relevant energy performance information from the energy review
  - Identifying energy performance indicators
  - Establishing energy baselines
  - Using energy performance indicators and energy baselines
  - Maintaining and adjusting energy performance indicators and energy baselines
- **Informative Annexes**



Fit with ISO 50006

- Overlaps with both IPMVP and ISO 50015:

  baselines, setting boundaries, choosing a suitable baseline period, adjusting for changes

  - Enhances the concept of EnPIs or Energy Performance Indicators from 50001:
    - Measured energy value
    - Ratio derived such as energy efficiency
    - Model derived using statistics e.g. regression
    - Engineering based model or simulation

Scope of ISO 50015 (in comparison to IPMVP)

ISO 50015

1) Scope
2) References
3) Terms and Definitions
4) M&V Principles
5) Measurement and Verification Plan
6) Implementation of the M&V Plan
7) Uncertainty
8) M&V Documentation
9) Informative Annexes

IPMVP Core 2016*

1) Scope
2) Normative References
3) Terms & Definitions
4) M&V Principles
5) IPMVP Framework
6) IPMVP Options
7) M&V Plan
8) M&V Reports
9) Adherence with IPMVP
10) Informative Annexes

Separate document on Statistics & Uncertainty

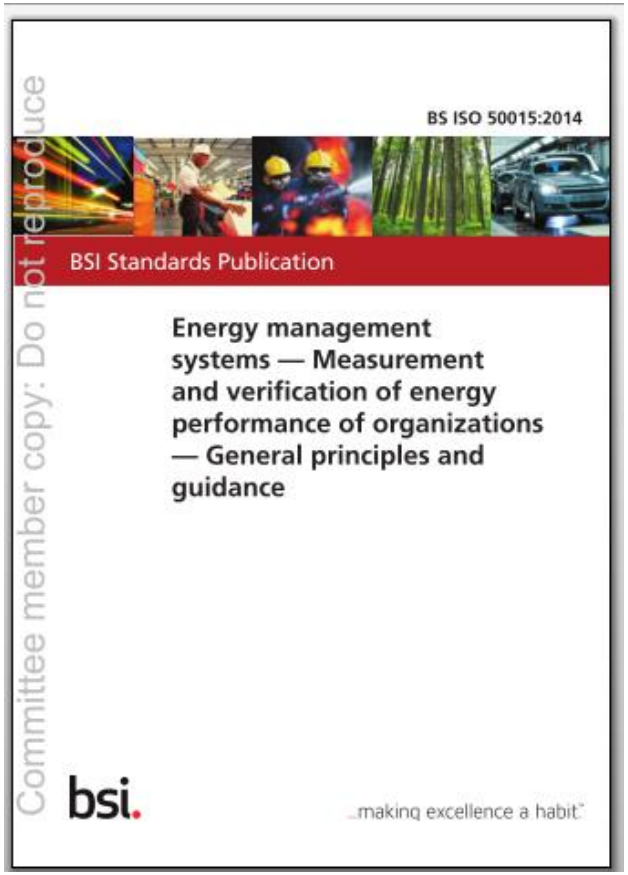
Fit with ISO 50015

Scope of ISO 50015

- Part or all of an organization
- M&V of Energy Performance, or Energy Performance improvement

– Importantly,

- ISO 50015 is method agnostic
- Purpose is to increase credibility of M&V savings
- Therefore, more statement-orientated

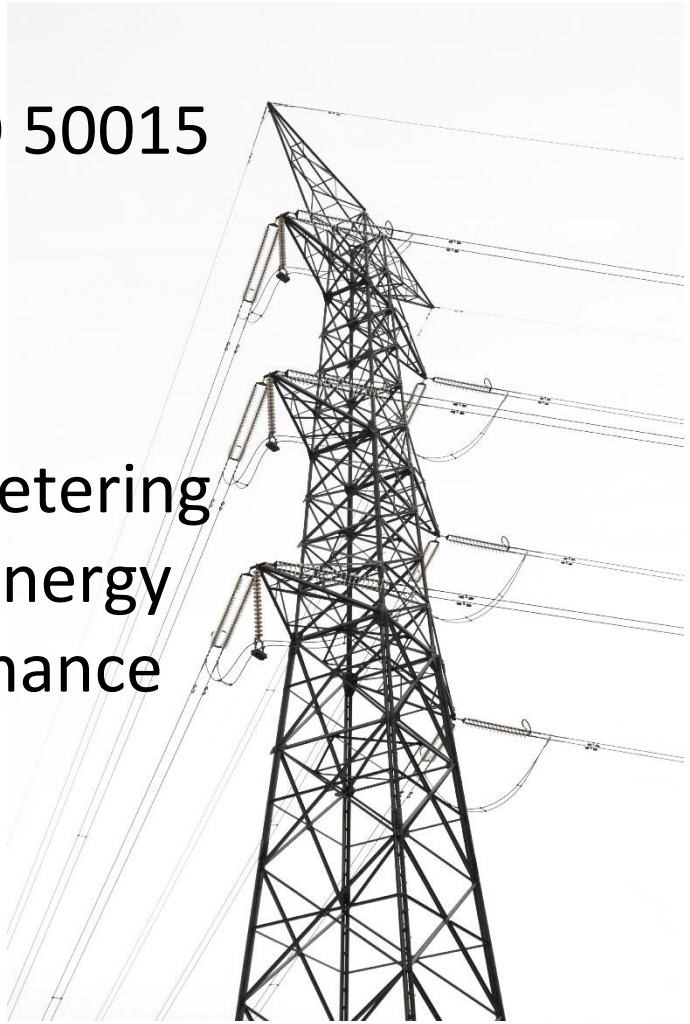


ISO 50015 Principles in Brief

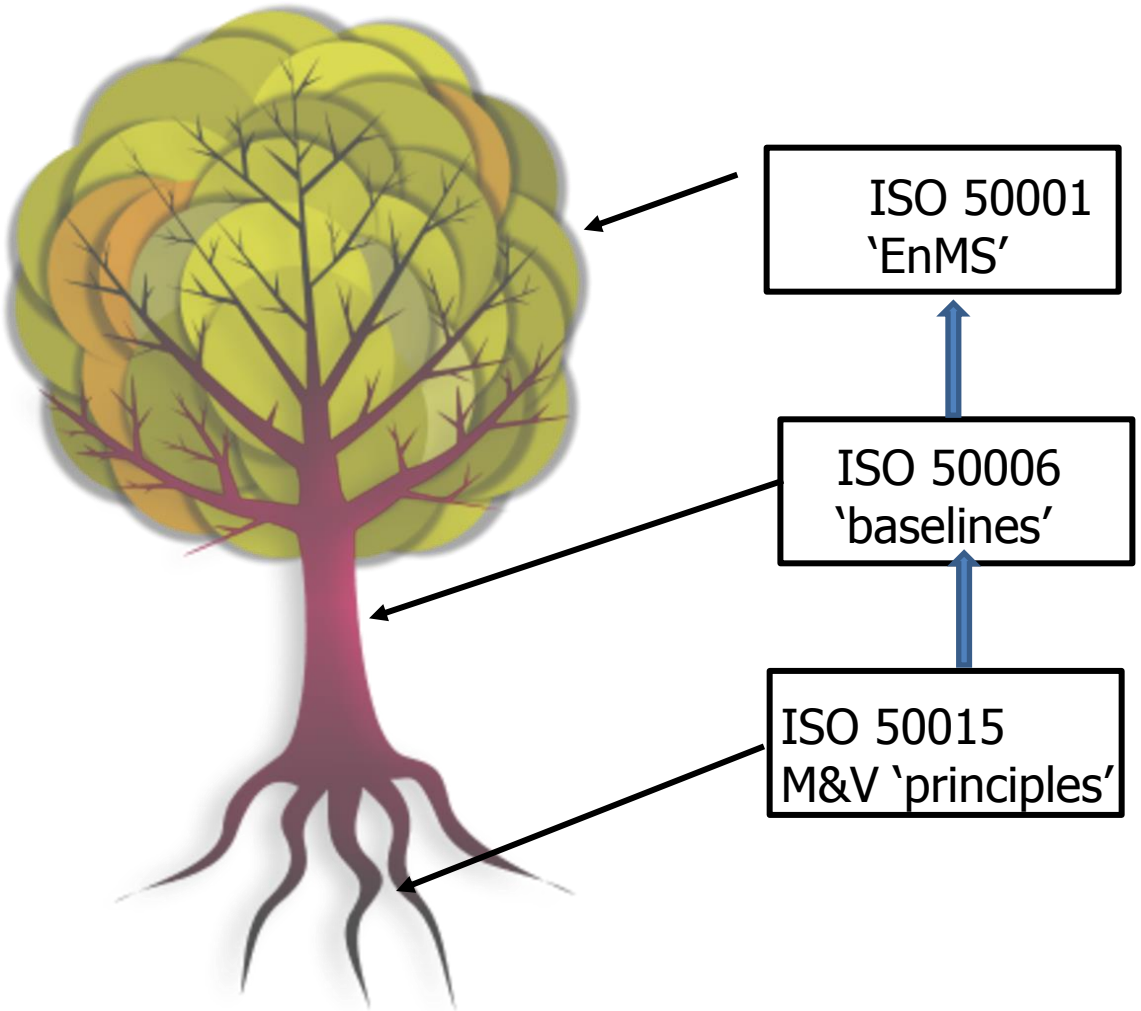
- **Appropriate accuracy** and management of uncertainty
- **Transparency and reproducibility** of M&V process(es)
- **Data management** and measurement planning;
- **Competence & impartiality** of the M&V practitioner
- **Confidentiality** of data.
- **Use of appropriate methods**

IPMVP Core Concepts

- Protocol that gives guidance on:
  - Principles of M&V aligned to ISO 50015
  - Gives you methods and Options
  - Advises on baselines
  - Advises on uncertainty
  - Advises on measurement and metering
  - Is fundamentally about driving energy efficiency measures and performance improvement
  - Gives M&V plan examples



Conclusions: ISO standards supporting IPMVP



IPMVP supports the fundamentals of ISO 50001 on delivery of Energy performance improvement. 2018 strengthened but not overburdened on normalisation

50006 provides the basis of 4 different types of baselines like IPMVP Options A to D

50015 is in alignment with IPMVP; strengthened on credibility of savings.

'Our M&V Plan and Savings Report adhere to ISO 50015, and we used Option B of IPMVP."

Thanks for Listening

Rajvant Nijjhar
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www.ivees.co.uk

www.evo-world.org
Search courses on:
‘’IPMVP and ISO 50015”

De-Risking Energy Efficiency (EE) Investments with Independent Verification of Savings

Thomas K. Dreessen
EVO Past Chairman and Current Treasurer

ENERGY EFFICIENCY PERFORMANCE MEASUREMENT AND DATA DUE DILIGENCE IN ISO 50001 AND IPMVP: THE KEY TO DE-RISKING ENERGY EFFICIENCY INVESTMENTS

EE Global

Copenhagen, Denmark

May 21 2018

Long-Standing Energy EE Project Market Barriers

- Small, Diverse, Complex Transactions
- No '***silver bullet***' solution to ***'scale-ability'***
- No ***'Attractive'*** financing (corporate vs. project)
- In many developing markets, subsidized low rates result in low returns & low penetration that create:
  - ***Low EE Knowledge***
  - ***Limited Technical & Financing development capacity***
  - ***No Confidence in savings being realized or measured***
- Barriers of Facility Owners (***Gate Keepers!!***)

EE Project Barriers with Facility Owners

- Viewed as low priority ***Infrastructure*** vs. ***Core Business*** investment (***don't fix if not broken***)
- Reluctant to use current 'Corporate Financial Capacity' to fund (or borrow for) EE Projects
- Benefits too small to get on CEO 'radar screen', or justify inherent complexities and 'perceived' risks that include estimated savings not being achieved
- ***Lack of Confidence in EE Technologies*** working ***and*** in the estimated ***Savings*** being achieved or able to be measured and verified

Limited Confidence in EE Savings

- Limited confidence can be caused by prior bad experience, low EE knowledge (in developing markets) and complexities in the Calculation and Measurement &Verification (**M&V**) of savings
- A huge M&V capacity gap exists GLOBALLY of not being able to accurately verify EE savings at all 3 major levels: Policy, Program and Project
- Solving the Global M&V Gap will increase confidence in certainty of savings being achieved and significantly ***De-Risk*** EE investments

Solution to Global M&V Gap

- ***Solution is not more protocols or standards!***
- Need a new global class of independent M&V experts to verify estimated and actual savings of EE Projects who are certified to have competencies to:
  - Estimate, evaluate and measure achieved savings of EE Projects that apply multiple types of technologies in multiple types of facilities and processes
  - Prepare and evaluate M&V Plans that follow IPMVP's generally accepted principles
- EVO has created a Global ***Solution*** with its new Certified Energy Savings Verifier ***(CESV)*** training and certification program

CESV Training & Certification Program

- CESV is a new high-grade certification provided by EVO and a local certifying body to individual engineers who have demonstrated their technical competence to independently certify the estimated and achieved savings of EE Projects
- Same as Certified Public (or Chartered) Accountants who independently certify the accuracy of diverse types of financial statements, CESVs will provide an ***'independent'*** evaluation and certification of savings of typical diverse/complex EE Projects

CESV 'Certified' Capabilities

CESVs must pass a rigorous examination ***(Exam)*** that demonstrates their ability to evaluate and certify the following on an EE Project:

- ***Pre-Installed*** estimated energy savings are materially correct;
- ***Pre-Installed*** M&V Plan complies with IPMVP generally accepted principals
- ***Post-Installed*** reported energy savings: i) were calculated according to the certified Pre-Installed M&V Plan and ii) materially reflect the actual savings achieved.

CESV Benefits

- Solves Global M&V Gap resulting in increased confidence in certainty of savings being achieved
- ***De-Risks*** EE Project investments resulting in the scaling up of global EE implementation
- Becomes a Global solution for Clean Energy funds and EE Certificate programs that need a common standard or basis to verify estimated and achieved savings for their EE investments.

EVO's CESV Development Plan

- EVO's CESV Committee, chaired by Tom Dreessen, will lead development of the CESV
- A CESV will be created in the '***developing country***' of Indonesia and in the '***developed countries'*** of France, Canada and others where qualified energy auditors, certified by a reputable Local Certifying Board ***(LCB)*** exist
- EVO will create/provide a '***Global***' CESV Exam and Training Program to be localized by each local training partner and the LCB

CESV – Indonesia Development Plan

- EVO will develop the CESV in Indonesia with MASKEEI as one of the 5 modules in its Energy Efficiency Training and Certification **(EETC)** program to be provided in Indonesia in partnership with EPS Capital Corp.
- MASKEEI is an Indonesian non-profit organization comprised of individual and organizational members whose common vision and mission focuses on achieving national energy security and resilience for sustainable growth in Indonesia through the implementation and practice of energy conservation.

CESV Program in Indonesia

1. Trainees: Individuals already holding a Certified Investment Grade Auditor **(CIGA)** certificate
2. Benefiting Stakeholders: Facility Owners, ESCOs, Consultants, Government staff, banks and other EE Service Providers
3. Length: 4 Days with a **CESV Certification Exam on Day 4** requiring preparation of a M&V Plan and Evaluation of Saving estimate in a ***'Case Study'*** Investment Grad Audit
4. Certification Criteria: CESV Exam Score of 70 or higher

CONTACT INFORMATION

Thomas K. Dreessen
EVO Past Chairman

- Phone: +62 8787 7658 5005
- Email: tkd@epscc.com

Real-life examples of energy and non-energy benefits achieved by companies as result of greater data-due-diligence and analysis best-practices

Zlatko Gjurchinoski
UNIDO qualified Expert
in Energy Management System Implementation

Intensive Learning Session – Energy Efficiency Performance Measurement and Data Due-Diligence in ISO 50001 and IPMVP: the Key to De-Risking Energy Efficiency Investments

21 May 2018

EE Global, Copenhagen, Denmark

Company Overview

- Company name: Vardar Dolomit dooel
- Location: Gostivar – Republic of Macedonia
- Core Business: Refractories Production
- Annual Production: 44 000 tons
- Annual Heavy Fuel Oil Consumption
  - ✓ 2 950 000 kg
- Annual Light Fuel Oil Consumption
  - ✓ 700 000 lt
- Annual Electricity Consumption
  - ✓ 3 840 MWh
- .
  - ✓ .

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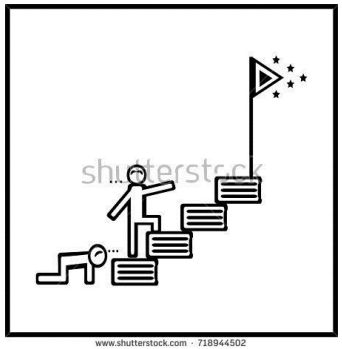
  - ✓ 2 950 000 kg = 33 646 MWh
- Annual Light Fuel Oil Consumption
  - ✓ 700 000 lt = 7 027 MWh
- Annual Electricity Consumption
  - ✓ 3 840 MWh
- Annual Total Energy Consumption
  - ✓ 44 513 MWh

Chronological Order Of EnMS Implementation – year 2015

- Start with implementation – second half of the year
- Energy Policy
- Building energy awareness
- Defining roles and responsibilities
- Stuff cost = 300 labor hour
- Investment cost 0 EUR

Chronological Order Of EnMS Implementation – year 2016

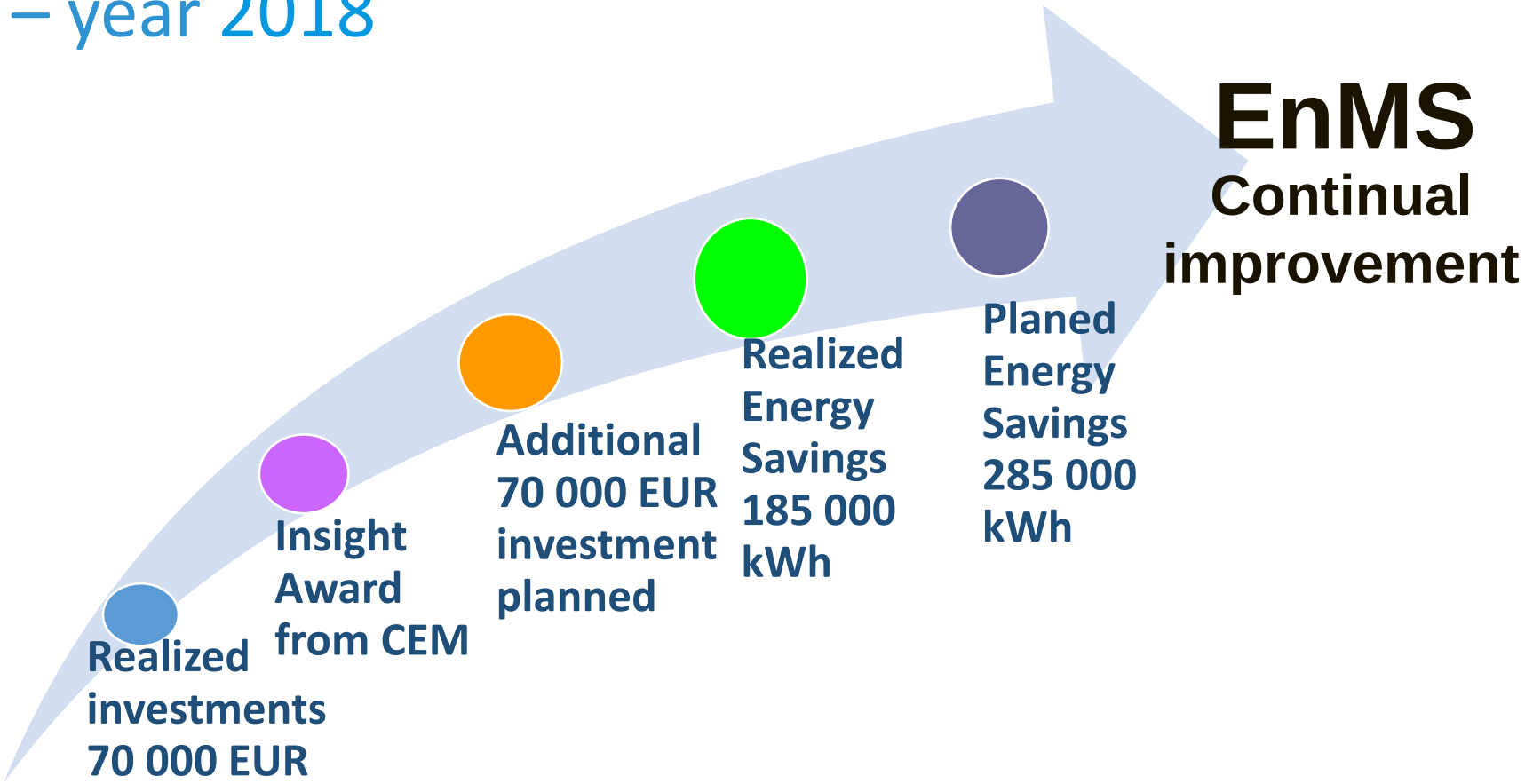


- Implementation was successfully finished
- Achieved energy savings 50 000 kWh of electricity (1,5% from previous year consumption)
- Achieved 30% electricity price reduction due to better energy supply contract 70 000 EUR annual savings
- Non Energy Benefits

Chronological Order Of EnMS Implementation – year 2017

- EnMS successfully certified
- Total Energy Performance improvement **3%**
- Total Energy Savings **3 527 GJ**
- Total Energy Cost Savings **57 530 EUR**
- Total cost (investm. + labor) **15 520 EUR** – payback **0.27**years
- Non Energy Benefits

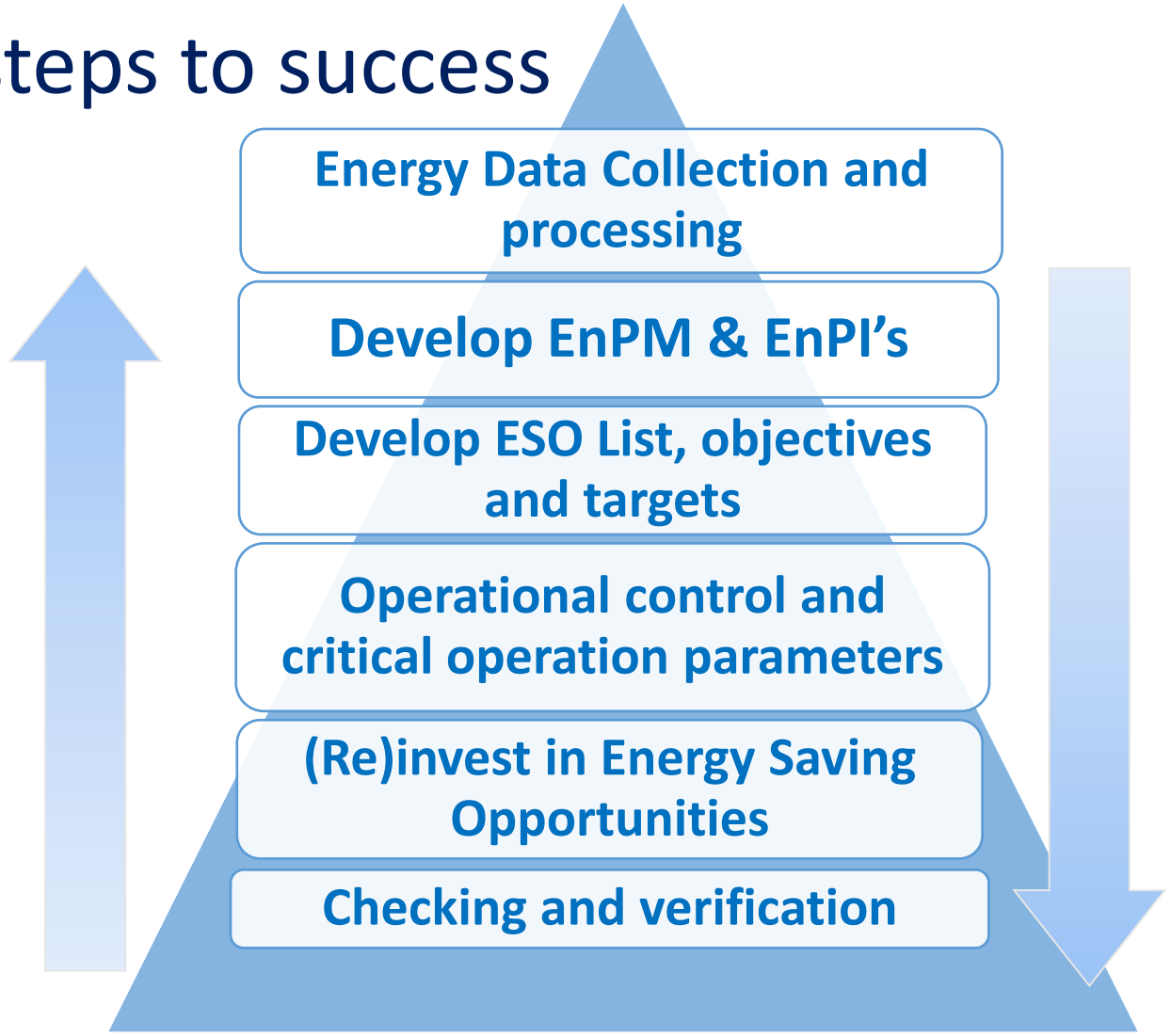
Chronological Order Of EnMS Implementation – year 2018



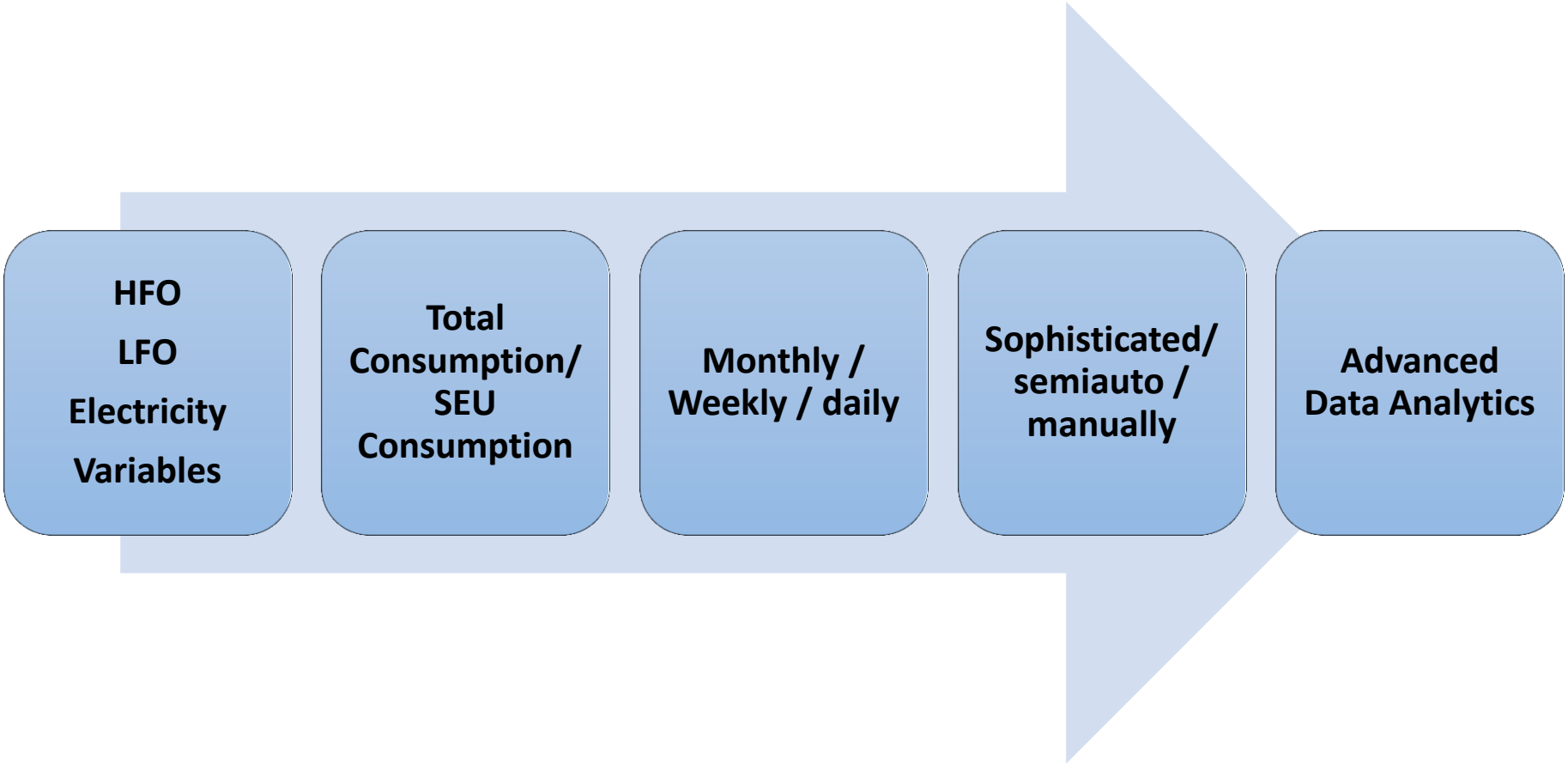
Non Energy Benefits – "Cherry at the top of the dessert"

- Developed Energy Performance Metrics and Energy performance indicators (EnPI's)
- Better understanding of Energy Forecasting
- Increased overall productivity and competitiveness
- Avoided fire risk at Oven as result of regular monitoring of Energy Performance Indicators
  - ✓ It is difficult to accurately determine how much the damage caused by a fire would be, but it would certainly be greater than the amount of all the savings and investments so far.

Key steps to success



Energy Performance Data Collection



Energy Performance Data Collection

- Necessary Energy Data end their collection
  - ✓ Fuel data prior to EnMS implementation
    - 2 heavy fuel oil meters with manual data collection
    - Monthly light fuel oil bill
  - ✓ Fuel data after EnMS implementation
    - 4 light fuel oil with manual data collection were installed
    - 2 new heavy fuel oil meters were installed (with possibility for automatic data collection)
  - ✓ Electricity data collection
    - Prior to EnMS - Software for automatic data collection of electricity consumption with 16 measuring points
    - After EnMS – this year integration of heavy fuel oil meters in existing software for electricity data collection is planned and next wear integration of light fuel oil meters

Energy Performance Data Collection

- Necessary additional Relevant Variable Data and their collection
  - ✓ Production quantity for every product
    - They were collected before EnMS implementation
  - ✓ Heating Degree Days and Cooling Degrees Days
    - Available online www.degreedays.net
  - ✓ Advantages/Disadvantages of Manual data collection
    - Cheap and simple
    - Someone must read them on exact time (even on public holidays)
  - ✓ Advantages/Disadvantages of Automatic data collection
    - More expensive at the beginning
    - More accurate and reading intervals can be changed retroactive
  - ✓ Be aware that even most sophisticated data collection software need someone to analyze that data and to make decisions
    - In Vardar Dolomit every week 4-8 hours are spend for Data Due Diligence

Energy Performance Measurement and EnPI's

- Steps for Energy Performance measurement with regression analysis
  - ✓ Collect energy data from Baseline period (e.g. previous year)
  - ✓ Collect all relevant variables that affect energy consumption
    - Level of production of product/products
    - HDD/CDD
    - Night length etc.
  - ✓ Made REGRESSION ANALYSIS with all this data
  - ✓ Calculate BASELINE with equation from regression analysis
  - ✓ Compare Consumed with Calculated Baseline Energy = SAVINGS
  - ✓ CUSUM Cumulative SUM savings

Energy Performance Measurement and EnPI's

Regression Statistics	
Multiple R	0.98588
R Square	0.97196
Adjusted R Square	0.970515
Standard Error	3079.403
Observations	103

- Example of Regression Analysis in Microsoft EXCEL

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	5	3.19E+10	6.38E+09	672.4724	1.32E-73
Residual	97	9.2E+08	9482720		
Total	102	3.28E+10			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	17686.05	2860.332	6.183217	1.49E-08	12009.08	23363.02	12009.08	23363.02
Product No1	0.039997	0.007463	5.359619	5.63E-07	0.025185	0.054808	0.025185	0.054808
Prod.No2&3	0.041872	0.003747	11.17469	3.99E-19	0.034435	0.049309	0.034435	0.049309
HDD 15,5	124.9639	13.9359	8.96705	2.28E-14	97.30501	152.6228	97.30501	152.6228
Night Length	409.6934	278.0966	1.473205	0.143933	-142.251	961.6381	-142.251	961.6381
Sh.Kiln w.days	2684.9	542.9266	4.945237	3.19E-06	1607.341	3762.459	1607.341	3762.459

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Energy Performance Measurement and EnPI's

Electricity consumed kWh	Electricity expected kWh	EnPC consumed. / expected	Achieved savings (Con-Exp)	Achieved Savings CUSUM	Target Consum-ption	Target Savings (Tar.-Exp)	Target Savings CUSUM	3.00%	
83087.144	90251.46	0.92061823	-7,164.3	-7,164.3	87,543.9	-2,707.5	-2,707.5		1
94849.246	94111.2	1.00784225	738.0	-6,426.3	91,287.9	-2,823.3	-5,530.9		-1
93005.285	93276.03	0.99709737	-270.7	-6,697.0	90,477.7	-2,798.3	-8,329.2		0
99094.989	99491.68	0.99601287	-396.7	-7,093.7	96,506.9	-2,984.8	-11,313.9		0
88398.772	89738.96	0.98506575	-1,340.2	-8,433.9	87,046.8	-2,692.2	-14,006.1		0
90766.106	90680.08	1.00094866	86.0	-8,347.9	87,959.7	-2,720.4	-16,726.5		-1
93524.308	92903.56	1.00668167	620.8	-7,727.1	90,116.4	-2,787.1	-19,513.6		-1
91780.035	90467.3	1.01451064	1,312.7	-6,414.4	87,753.3	-2,714.0	-22,227.6		-1
94873.282	96781.26	0.98028562	-1,908.0	-8,322.4	93,877.8	-2,903.4	-25,131.0		0
70657.861	69941.71	1.01023929	716.2	-7,606.2	67,843.5	-2,098.3	-27,229.3		-1
80669.042	84227.58	0.95775096	-3,558.5	-11,164.7	81,700.7	-2,526.8	-29,756.1		1
87744.101	90152.34	0.97328705	-2,408.2	-13,573.0	87,447.8	-2,704.6	-32,460.7		0
86639.673	82942.23	1.04457854	3,697.4	-9,875.5	80,454.0	-2,488.3	-34,949.0		-1
80498.537	84647.6	0.95098428	-4,149.1	-14,024.6	82,108.2	-2,539.4	-37,488.4		1
80498.537	81505.64	0.98764374	-1,007.1	-15,031.7	79,060.5	-2,445.2	-39,933.6		0
81250.196	85340.23	0.95207382	-4,090.0	-19,121.7	82,780.0	-2,560.2	-42,493.8		1
79273.601	83259.1	0.9521314	-3,985.5	-23,107.2	80,761.3	-2,497.8	-44,991.5		1

Energy Performance Measurement and EnPI's

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90766.106	90680.08	1.00094866	86.0	-8,347.9	87,959.7	-2,720.4	-16,726.5	-1
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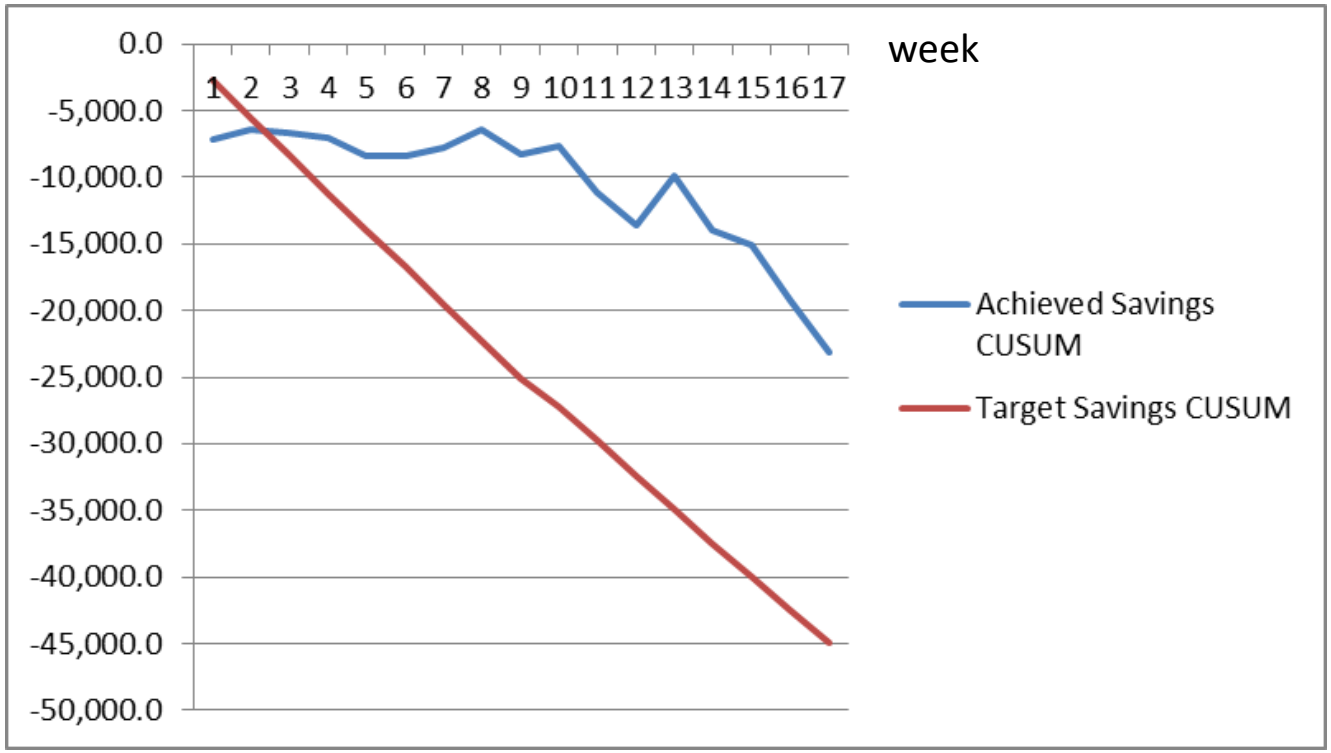
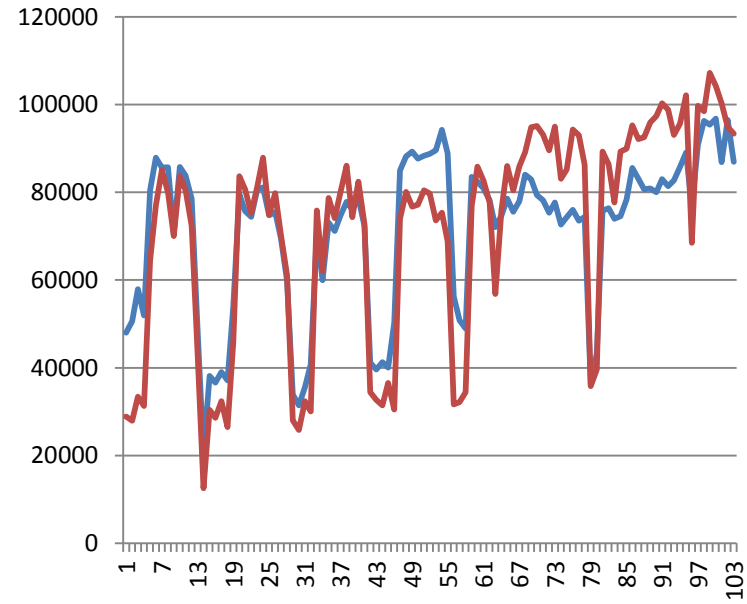
Energy Performance Measurement and EnPI's

Electricity kWh

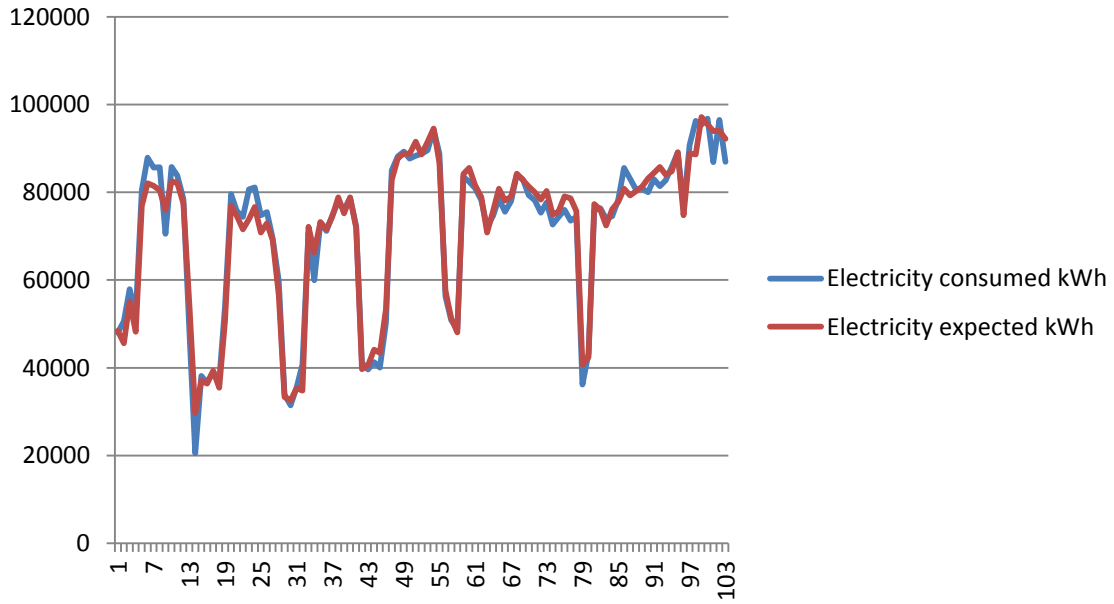


Energy Performance Measurement and EnPI's

- Why to spend so much time on data analysis when SEC is much easier?



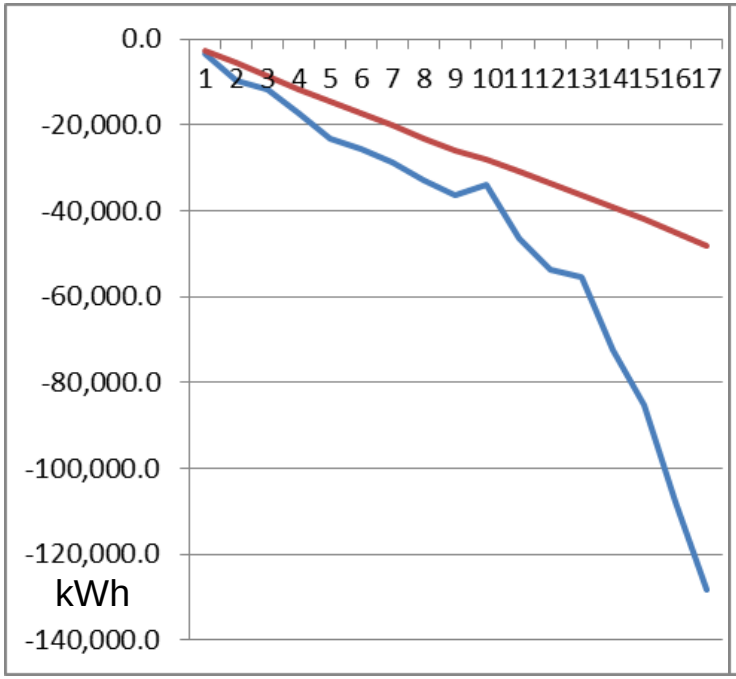
Expected Energy Using SEC



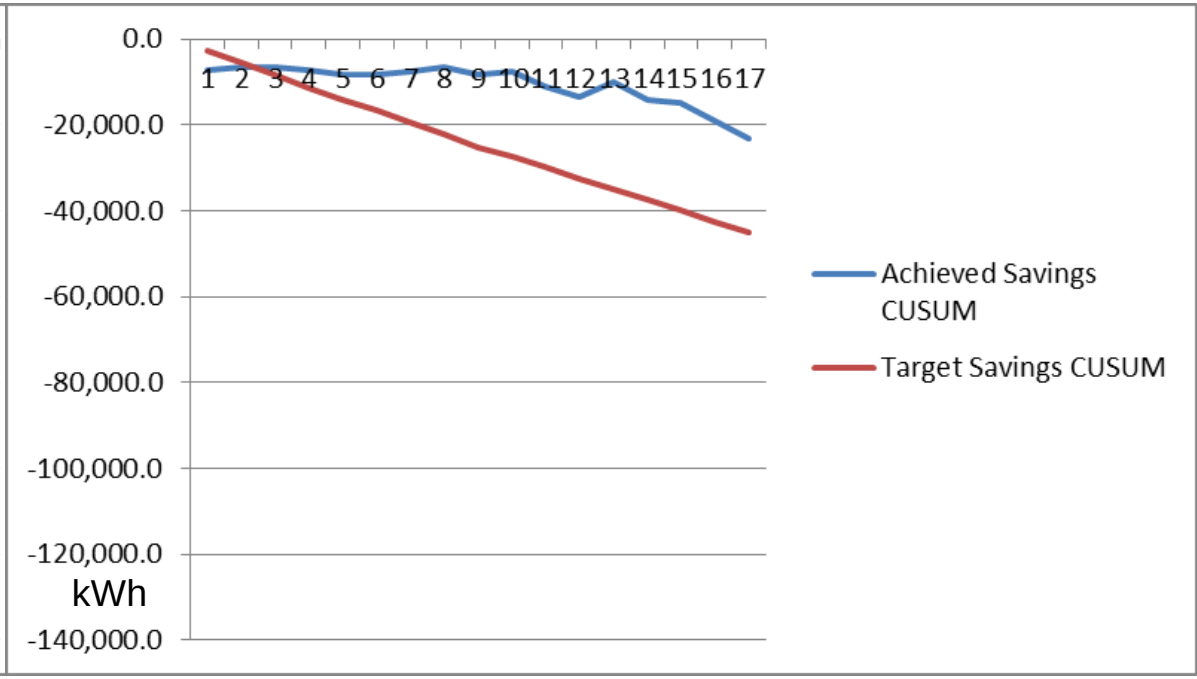
Expected Energy Using Regression

Energy Performance Measurement and EnPI's

- Why to spend so much time on data analysis when SEC is much easier?



CUSUM Using SEC

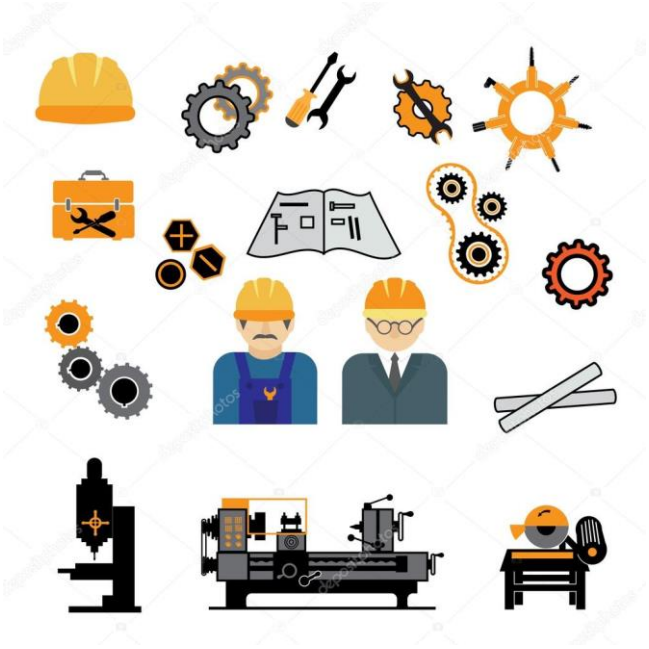


CUSUM Using Regression Analysis

ESO List, Objectives and Targets

- All energy saving opportunities should be put in one place
  - ✓ Give priority to no/lo cost opportunities
  - ✓ Consider implementation duration and complexity
- Chose which and how many opportunities to implement regarding of Objectives, Targets and Resources
- Focus od System efficiency instead of each component efficiency

Operational Control



- What is operational control
  - ✓ Checking insulation
  - ✓ Regular bearings greasing
  - ✓ Regular cleaning/changing filters
  - ✓ Combustion optimization
  - ✓ Checking conveyor belts …
  - ✓ With one word Regular Maintenance – considering energy efficiency
- Operational control is, not modern, boring day to day work that brings energy savings without any investments!

Critical Operational Parameters

- What if we decrease room temperature for 1 degree???
  - ✓ Probably our body will not feel difference
  - ✓ But our energy meter will
- Usually operation parameters are set to some value and nobody knows why
  - ✓ Ask who set that value?
  - ✓ Who knows why that value
  - ✓ Can we changed it in order to save energy?
  - ✓ What will be if we try?
- Finding answers to this questions is also big possibility for no cost energy savings!

Investments in Energy Efficiency

- There are lot of useful energy saving opportunities that need investment
- Prior to invest in Energy Efficiency be sure to check
  - ✓ That all no/lost opportunities for that area are already used
  - ✓ Understand the process well
  - ✓ Calculate or estimate real needs for product from that investment
- Trust to your suppliers but never underestimate the cunning of experienced salespersons
  - ✓ They can bigger or more expensive equipment that you actually need
  - ✓ Take care of life cycle costs
- Calculate expected savings before investment and measure and verify them after!
- Investment Risk is always lower if you invest money already saved with no cost measures!

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  - ✓ Implemented by UNIDO @ REC Macedonia
  - ✓ Funded by GEF – Global Environment Facility

- Thank You for Your attention!

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