[CL3]

Athens International Airport

Το Σύστημα Διαχείρισης Ενεργείας (ΣΔΕ) του ΔΑΑ κατά ISO 50001:2011

AIA's ISO 50001:2011 compliant Energy Management System (EnMS)

Presented to: Energy Efficiency Conference 2019
Presented by: Konstantinos Malakassis
Date: 22/5/2019

Principle European & National Energy Legislation

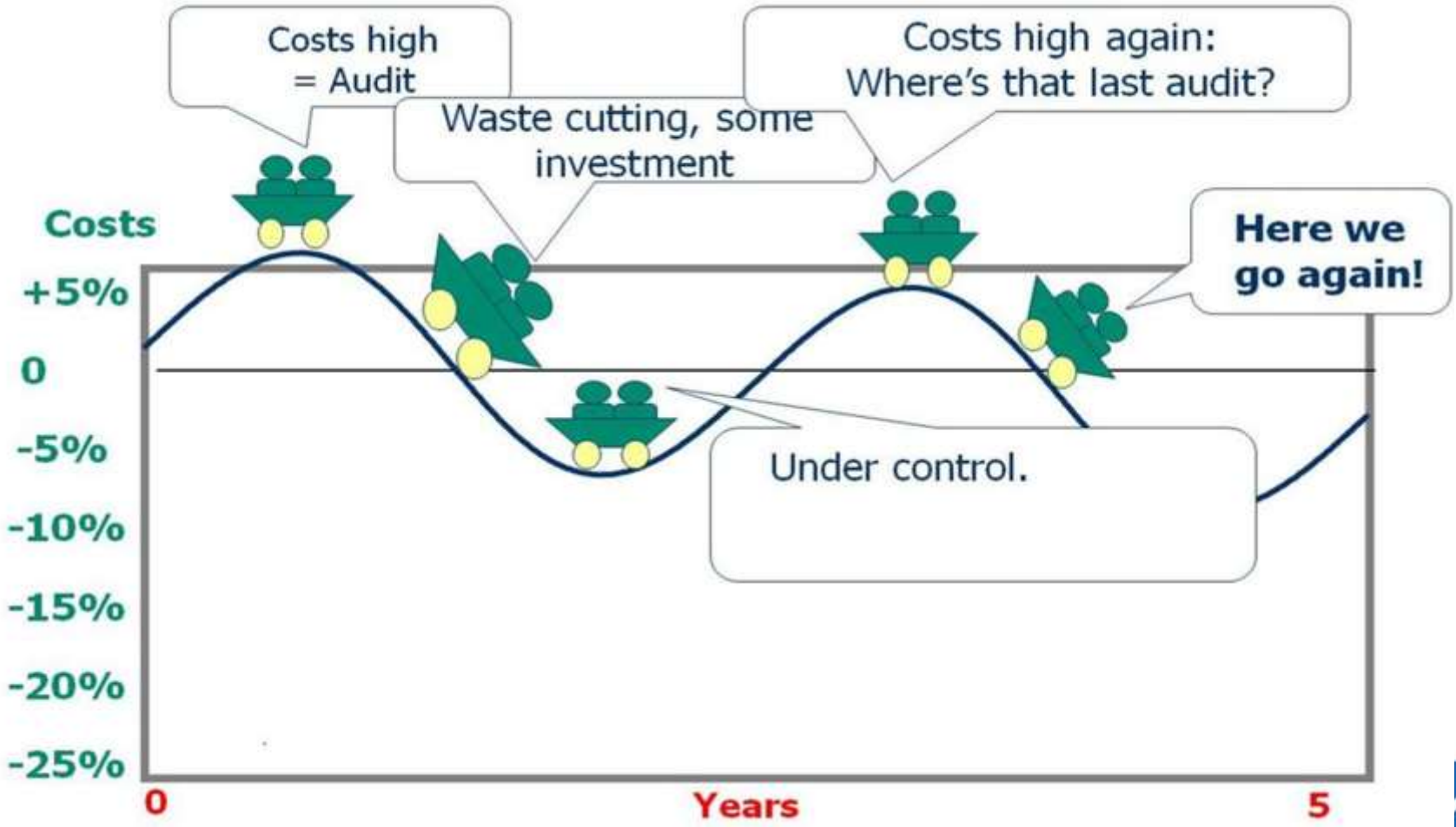
EUROPEAN

- **Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC Text with EEA relevance.**
- **Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings.**
- **Directive 2009/125/EU of the European Parliament and of the Council of 21 October 2009 establishing a framework for the setting of ECOdesign requirements for energy-related products, recast of Directive 92/42/EEC and Directives 96/57/EC and 2000/55/EC of the European Parliament and of the Council.**
- **Commission Delegated Regulation (EU) No 244/2012 of 16 January 2012 supplementing Directive 2010/31/EU of the European Parliament and of the Council on the energy performance of buildings by establishing a comparative methodology framework for calculating cost-optimal levels of minimum energy performance requirements for buildings and building elements.**

NATIONAL

- **Greek Law 4342 (ΦΕΚ 143, 09/11/2015) on Energy Efficiency;**
- **Ministerial Decision 1830 (ΦΕΚ 2337, 10/07/2017) on Systems for the recognition and certification of Energy Auditors – Energy Auditors Register; Energy Auditors Register and Energy Audits file;**
- **Ministerial Decision on Building Energy Performance Regulation (ΚΕΝΑΚ), Αριθμ. ΔΕΠΕΑ/οικ. 178581, Έγκριση Κανονισμού Ενεργειακής Απόδοσης Κτιρίων, (ΦΕΚ2367, 12/07/2017)**

ISO 50001:2011 EnMS vs Ad-hoc approach Energy Management



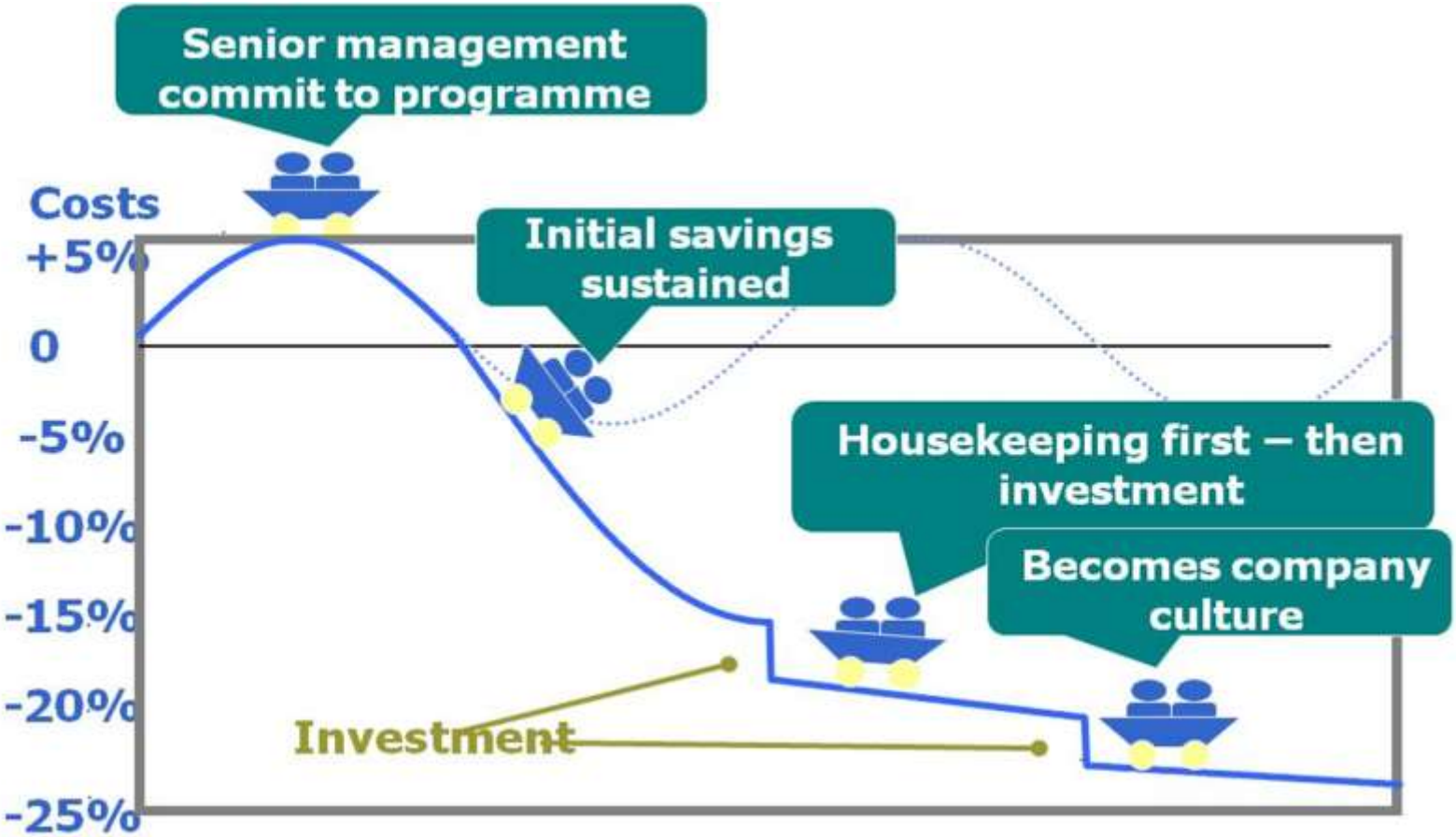
Advantages of adopting an EnMS based on ISO 50001:2011

The benefits of developing and implementing ISO 50001:2011 EnMS can effectively help organizations organizations achieve greater energy savings and measurable energy efficiency improvements.

In addition, EnMS:

- Helps organizations to develop momentum and commitment to **continuous improvement**
- It **does not set restrictions** as it does not specify specific reductions in energy consumptions and CO_2 emissions and is voluntary
- It **does not set any specific performance levels**, only indicators and targets to improve (set by the same the organization)
- Ensures and promote **continuous improvement** through:
  - ✓ Organized **Energy Policy and Practices**;
  - ✓ Identifying **Energy aspects and Performance Indicators** that will be the areas to improve the energy performance;
  - ✓ Defining **Energy goals and Objectives and programs (Action Plans);**
  - ✓ Developing an **appropriate organizational structure for controlling and managing energy performance;**
  - ✓ **Communication and engagement** of staff;
  - ✓ **Measurement and monitoring** of all energy parameters;
  - ✓ Continuous **monitoring of legislation;**
  - ✓ Corporate engagement in **evaluation of the effectiveness of the EnMS and decision making**

ISO 50001:2011 EnMS vs Ad-hoc approach Energy Management



Energy Management Systems
ISO 50001:2011 Structure

ISO 50001:2011 is based on the Plan – Do – Check Act (PDCA) continual improvement framework

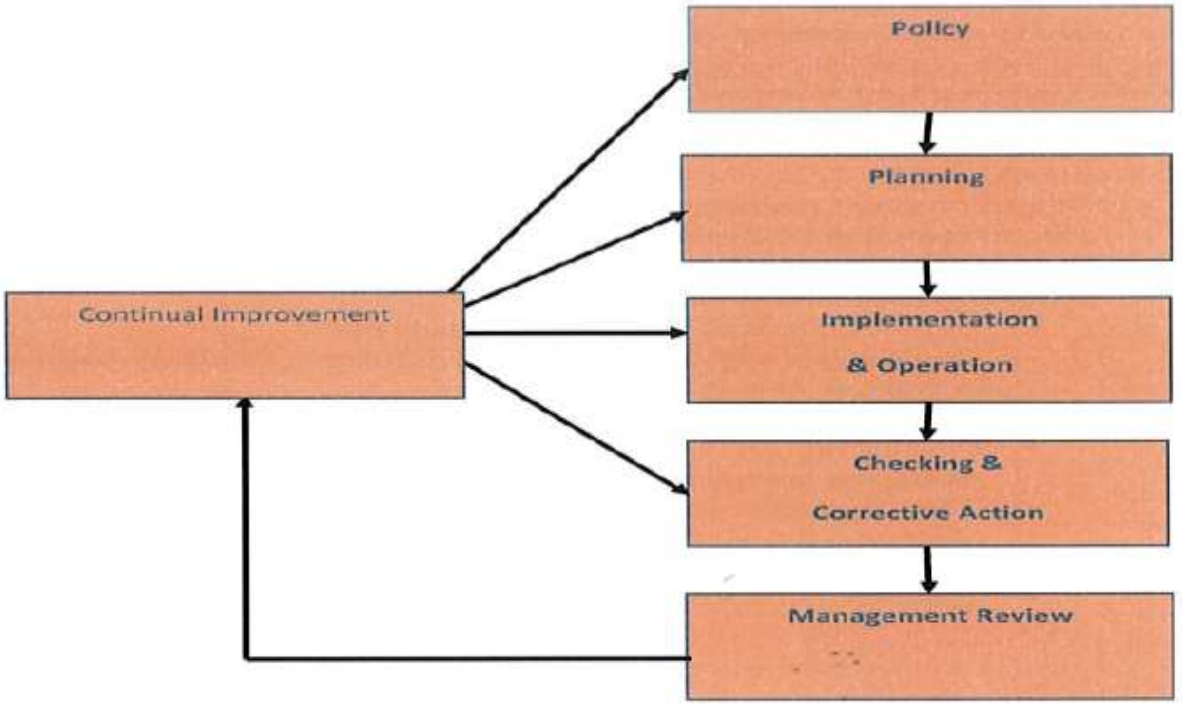


Figure: ISO 50001 Model

ISO 50001:2011 General Structure

The requirements of an EnMS according to ISO 50001 presented is as follows:

- 1: Scope
- 2: Normative references
- 3: Terms and definitions
- Clause 4.1: General requirements
- Clause 4.2: Management responsibility
- Clause 4.3: Energy Policy
- Clause 4.4: Energy planning
  - ✓ Clause 4.4.1: General
  - ✓ Clause 4.4.2: Legal requirements and other requirements
  - ✓ Clause 4.4.3: Energy review
  - ✓ Clause 4.4.4: Energy baseline
  - ✓ Clause 4.4.5: Energy performance indicators
  - ✓ Clause 4.4.6: Energy objectives, energy targets and energy management action plans
- Clause 4.5: Implementation and operation
  - ✓ Clause 4.5.1: General
  - ✓ Clause 4.5.2: Competence, training and awareness
  - ✓ Clause 4.5.3: Communication
  - ✓ Clause 4.5.4: Documentation
  - ✓ Clause 4.5.5: Operational control
  - ✓ Clause 4.5.6: Design
  - ✓ Clause 4.5.7: Procurement of energy services, products, equipment and energy
- Clause 4.6: Checking
- Clause 4.7: Management review

ATHENS INTERNATIONAL AIRPORT

4.4 Energy Planning – PLAN
4.4.4 Energy Review

To develop the energy review, AIA:

- **analyzes energy use and consumption;**
- **identifies current energy sources;**
- **evaluates past and present energy use and consumption;**
- **identifies the facilities, equipment, systems, processes and personnel working for, or on behalf of AIA that significantly affect energy use and consumption;**
- **AIA SEUs are identified as those energy uses in buildings, equipment systems and processes that:**
  - ✓ **correspond to more than 1% of the respective total annual energy having significant energy performance impact;**
  - ✓ **have potential for further improvement.**
  - ✓ **influenced by AIA**
- **identify other relevant variables affecting the significant energy uses; (eg. PAX, Ambient temperatures and other meteorological data, aircraft movements)**
- **determines the current energy performance of facilities, equipment, systems and processes related to identified significant energy uses; (e.g. MTB, STB, BHS, HVAC kWh)**
- **estimates future energy use and consumption; (e.g. forecast next year monthly and yearly consumptions based on projected PX and weather data well as planned changes – construction projects)**
- **Identifies, prioritizes and records opportunities for improving energy performance (opportunities can relate to the use of renewable energy, other alternative energy sources, such as waste energy or free cooling and use of energy efficient technologies)**
- **AIA performs Energy Review during Q1 of every year. Management Representative presents the Energy Review Report to the BoE (AIA's top management). Energy Review Report is also uploaded in AIA INTRANET**
- **AIA's energy review is updated every year (as well as in response to major changes in facilities, equipment, systems, or processes).**

SIGNIFICANT ENERGY USES - ELC CONSUMPTION - 2018 BUILDING AND OUTDOOR SERVICES / SYSTEMS AND PROCESSES	2018 kWh	Estimated % of AIA Total Energy Consumption	SEU
Building and Outdoor Services			
MTB & STB – HVAC	20.624.219	35,39%	YES
MTB & STB - Indoor Lighting & Power supply	14.428.788	24,76%	YES
MTB & STB - People Movers	774.230	1,33%	YES
Other Buildings – HVAC	3.323.419	5,70%	YES
Other Buildings – Indoor Lighting & Power supply	2.505.319	4,30%	YES
Power Supply (B65, B65C)	255.276	0,44%	NO
Dormant Buildings (B15a & 56)	754.701	1,30%	YES
Airport Railway Station (B35)	1.639.048	2,81%	YES
Fence Lighting (C.S. 11.1, 11.2, 11.3, 11.5, 11.6, 11.7, 12.1, 12.2, 12.3)	508.714	0,87%	YES
Street / Park. Lighting (C.S. 10.1, 10.2, 10.3, 10.4)	1.894.205	3,25%	YES
Other & losses	250.183	0,43%	-
Building and Outdoor Services TOTAL	**46.958.102**	**80,58%**	
Systems and Processes			
Baggage Handling System	2.240.366	3,84%	YES
400Hz (MTB, STB, B019)	2.216.938	3,80%	YES
400Hz (C.S. 10.2.1 & C.S. 10.3.1)	1.580.222	2,71%	YES
APRON Lighting (MTB, STB, B18, B19, B25, B33, C.S. 10.2.1 & C.S. 10.3.1)	1.137.236	1,95%	YES
Airfield Lighting (B66, B67, B68 & B69)	1.348.109	2,31%	NO
Passenger Bridges	256.439	0,44%	NO
Pre-Conditioned Air (PCA)	1.030.033	1,77%	YES
Water Supply Plant - Irrigation & Pottable (B63)	241.752	0,41%	NO
Sewage Treatment Plant (B21a)	992.888	1,70%	YES
Industrial Waste Water Treatment Plant (B52a)	34.447	0,06%	NO
Other Processes (Radar - C.S. 11.6.7)	240.063	0,41%	NO
Processes & Systems TOTAL	**11.318.492**	**19,42%**	
AIA ELC SUM	**58.276.594**	**100,00%**	

4.4 Energy Planning – PLAN
4.4.4 Energy Baseline

One of the main objectives of the energy review process is the development of the EnBs' energy consumption models per energy use (Electricity and Natural Gas). For every SEU, energy consumption data for a minimum of twelve months is collected. Energy data for all SEUs is collected on a monthly basis.

Any correlation of external variables that may affect energy consumption of each SEU is examined. The main external variables that affect SEUs are:

- **monthly PAX;**
- **monthly average air temperatures**

EnBs' models are then developed using statistical regression techniques and a statistical program (subroutine "Regression" in EXCEL). Such task complies with "EnB Model Development Method" which is presented in the "Energy Audit Guideline" (published by Hellenic Ministry of Environment and Energy).

To succeed increased linearity of the models (therefore improved predictability), two EnB models are used for each energy use:

- for the **Cooling Period** (May, June, July, August, September and October) and
- for the **Heating period** (January, February, March, April, November and December).

The electricity monthly consumption against monthly PAX and monthly average air temperatures models for cooling and heating period:

$$\widehat{E}_{kELC\_Cool} = 938.138{,}089 + 66.318{,}599\ (Ta) + 1{,}166\ (PAX)$$

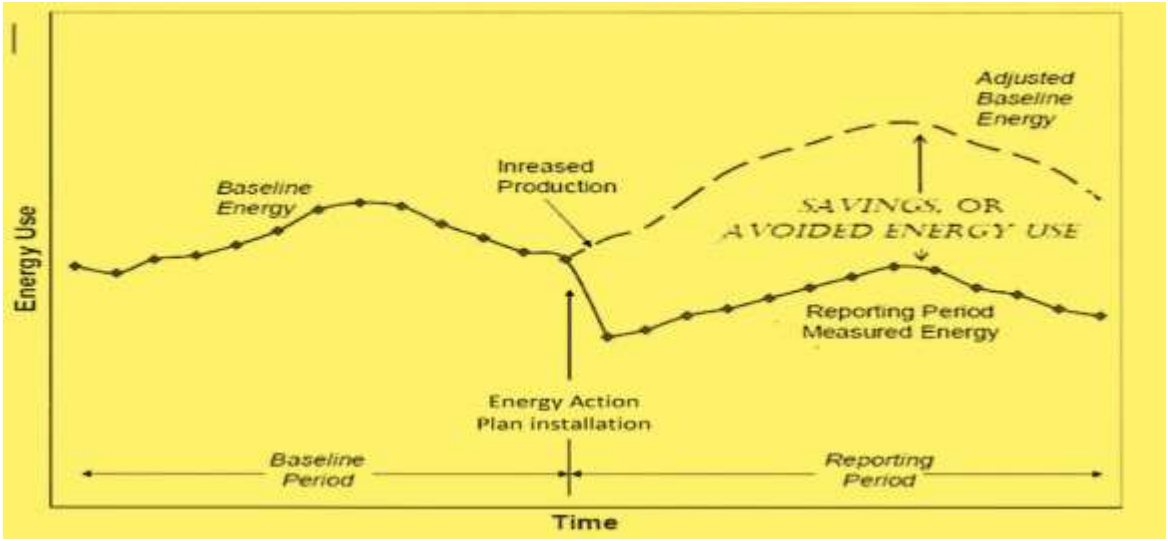
$$\widehat{E}_{kELC\_Heat} = 3.580.352{,}44 - 28.561{,}646\ (Ta) + 0{,}472\ (PAX)$$

4.4 Energy Planning – PLAN
4.4.4 Energy Baseline

"Adjusted" EnB energy consumption is the energy that would have been consumed without implementing Energy Saving Measures (ESM) and is estimated by using the EnB model and the measured values of variables affecting energy consumption during **reporting period**. Therefore, the calculation of the **"adjusted EnB" is the application of a normalization process with the variables of the Reporting Period.**

In the following figure, the typical model Energy (E) versus a relevant variable (RV) of production (i.e. PAX) is developed for a certain SEU. The model is given in a mathematical form E=F(RV) and is developed using data from the **Baseline Period** (the period before an ESM is applied).

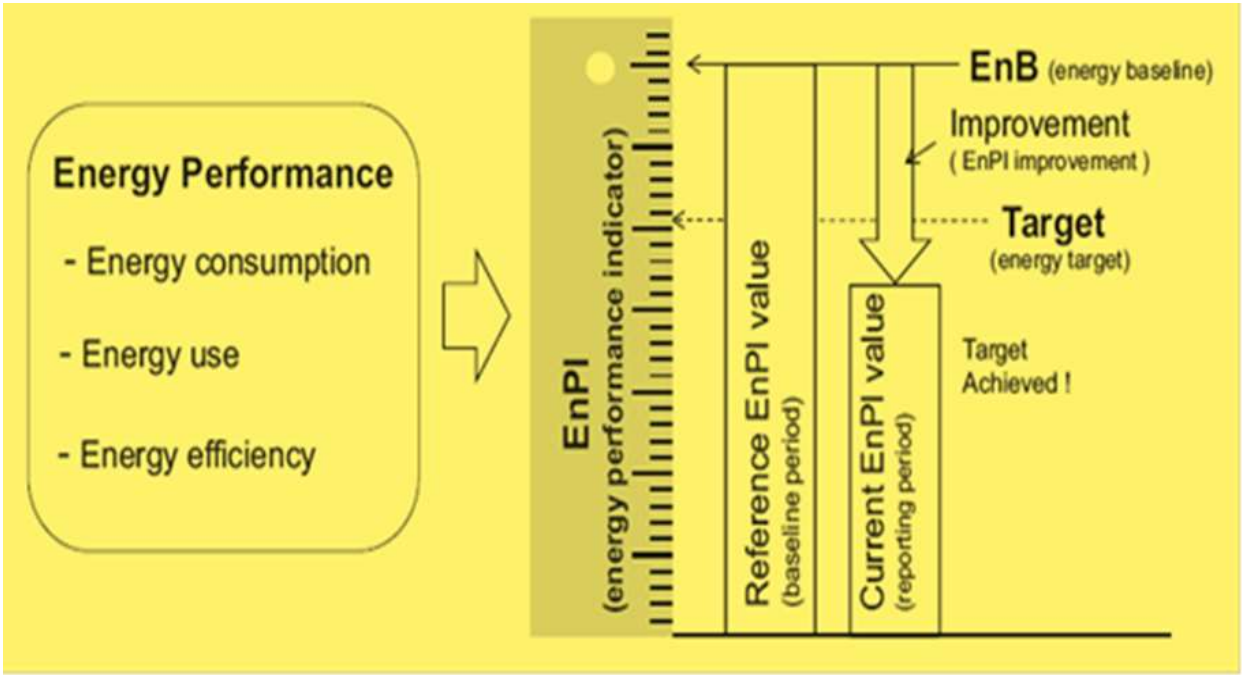
- Using this model, during the **Reporting Period**, (the period after the implementation of ESM), the estimated energy consumption is **predicted.**
- The "adjusted EnB" predicts the energy consumption that would have resulted without implementing any ESM.



4.4 Energy Planning – PLAN
4.4.5 AIA's Energy performance indicators (EnPIs)

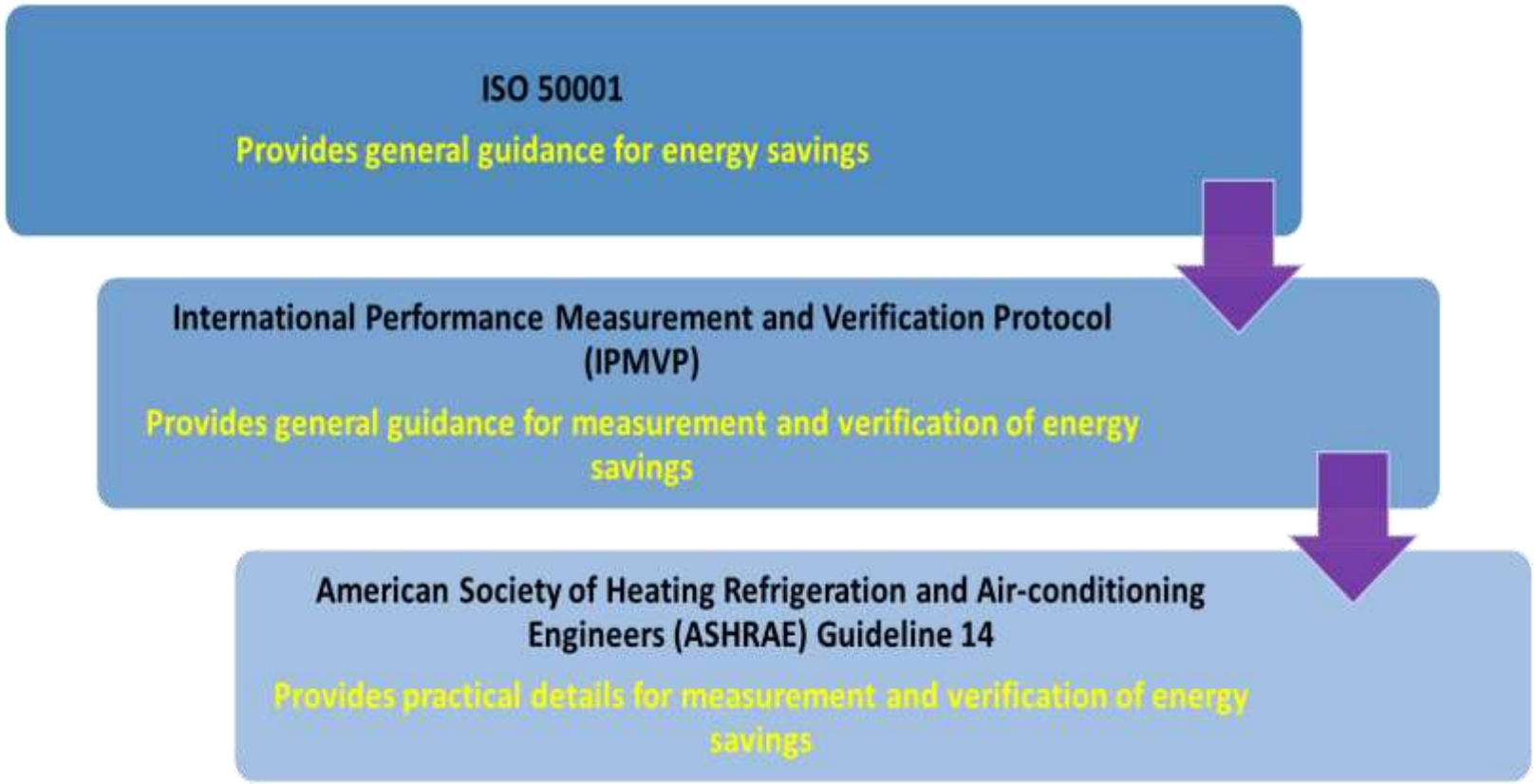
AIA has 4 EnPIs presented at the Monthly and Annual Energy Review Reports:

1. **AIA's monthly / yearly Electricity Energy consumption EnPI (in MWh)**
2. **AIA's monthly / yearly Natural Gas Energy consumption EnPI (in MWh)**
3. **The ratio monthly / yearly Electricity / PAX (kWh/PAX)**
4. **The ratio monthly / yearly Natural Gas / PAX (kWh/PAX)**



4.4 Energy Planning – PLAN
4.4.6 Energy management actions plans - verification

AIA achieves both energy saving and verification of the energy saving by using the following guidelines:



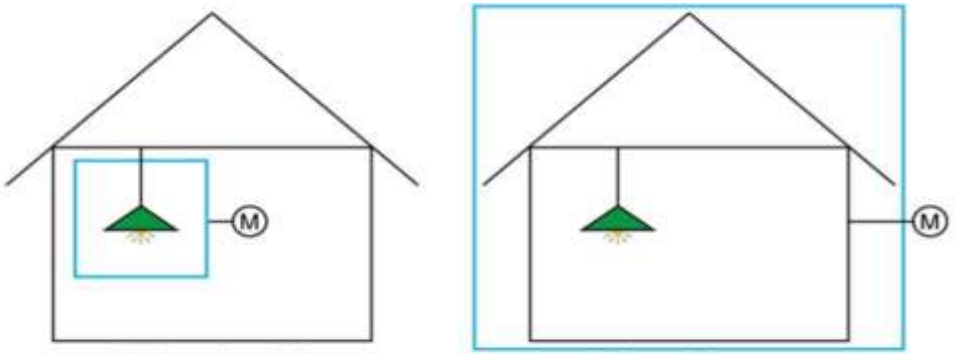
4.4 Energy Planning – PLAN
4.4.6 Energy management actions plans - verification

Three options are defined for M&V (**Options A**, **B** and **C)**.
The above-mentioned M&V techniques are divided into two general types:

- ✓ **retrofit isolation (A and B);**
- ✓ **whole facility (C)**;

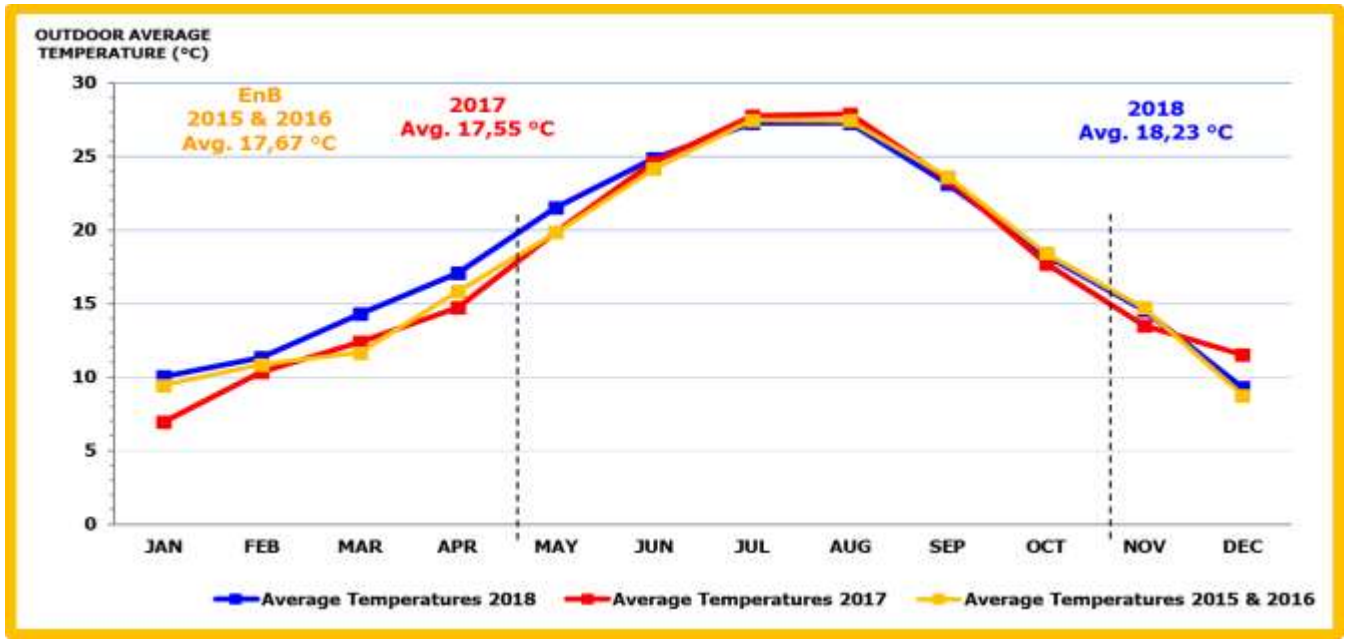
Retrofit isolation (system level) methods consider only the affected equipment or system isolated from the rest of the facility.
Whole facility methods consider the overall facility and not the specific equipment's or system's energy consumption.
The primary difference in these approaches is where the **boundary** is drawn (figure 1).
Each M&V method examines all energy consumption **within the boundary** to determine energy savings.

- ✓ **Options A** and **B** are **retrofit-isolation (system level)** methods therefore the boundary is the isolated system itself;
- ✓ **Option C** is a **whole-facility** method therefore the boundary is the whole facility including the system;

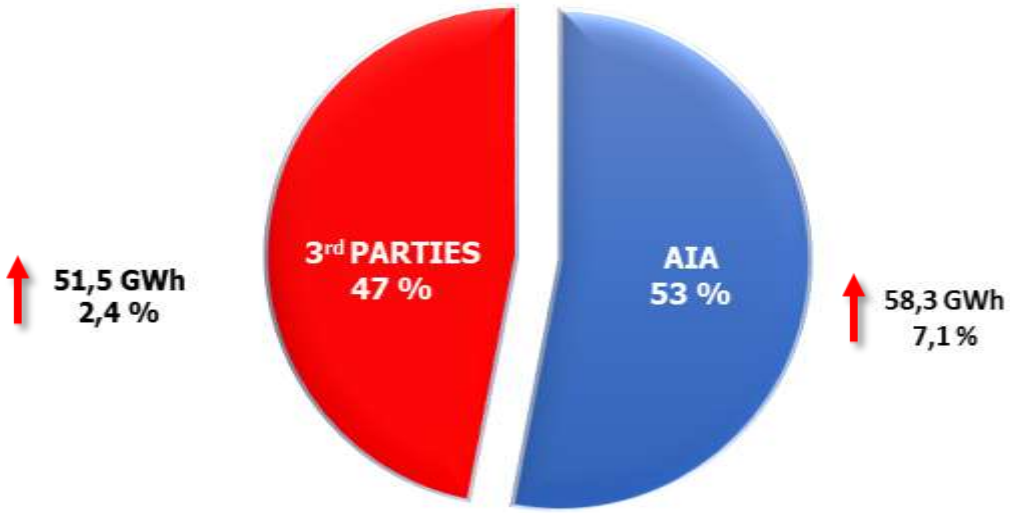


Traffic and weather drive consumption

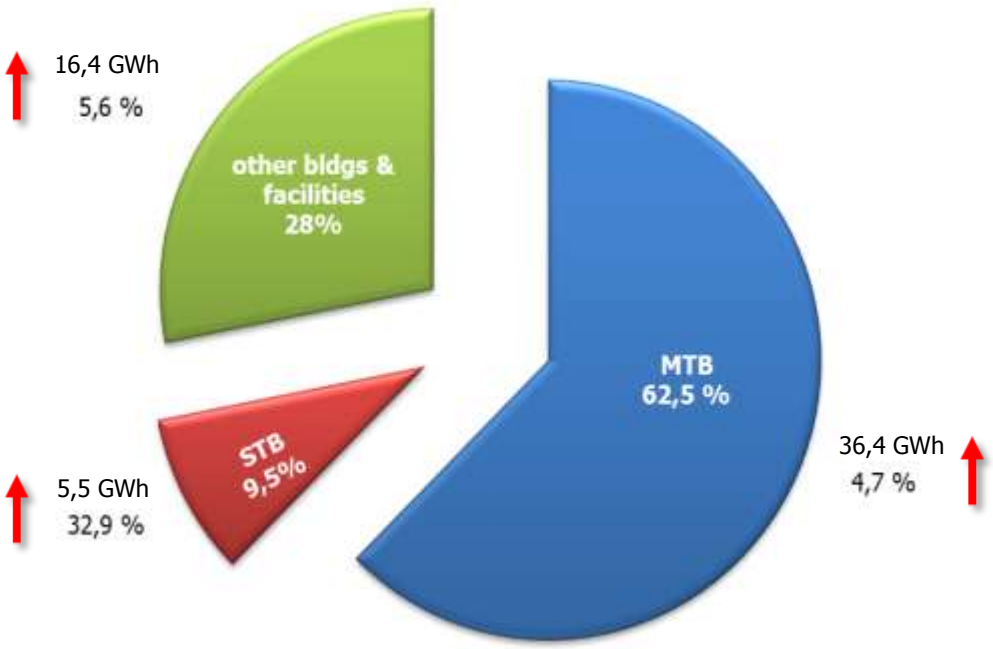
2017		2018		EnB 2015 & 2016 Avg. PAX & MOV.		2018		2017
21.736.466	+11%	24.135.736	+26,7%		+19,8%	211.998	+11,5%	190.123



Total Airport ELC consumption of 109,8 GWh (+4,9% vs. 2017)

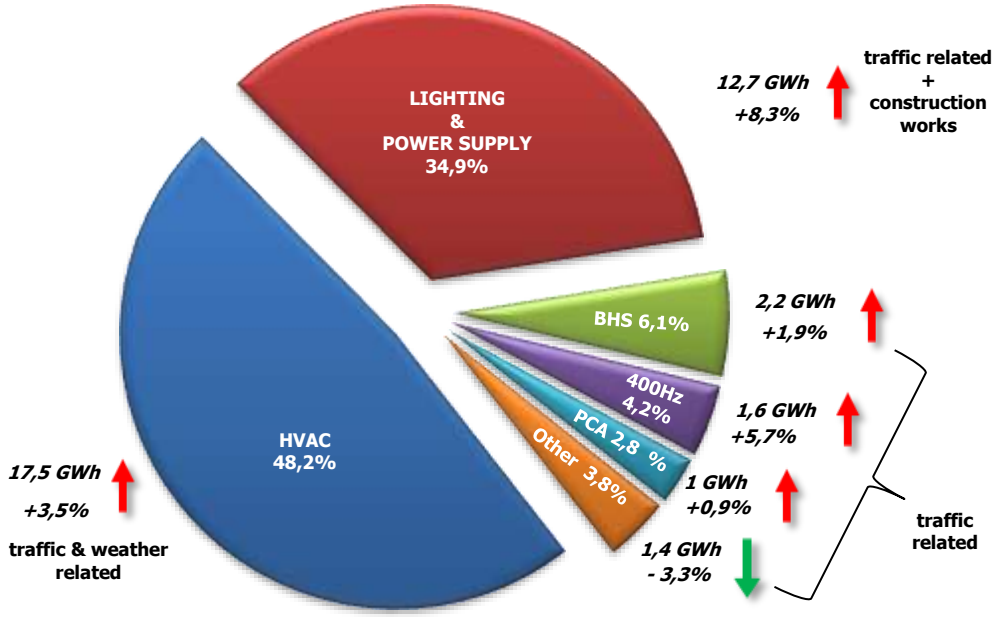


AIA's ELC consumption of 58,3 GWh (+7,1% vs. 2017)



- ✓ **All Buildings (included SEUs of >1% of total consumption)**
  - ✈ **MTB, STB, B17, B11, B35, B33 and B21a**

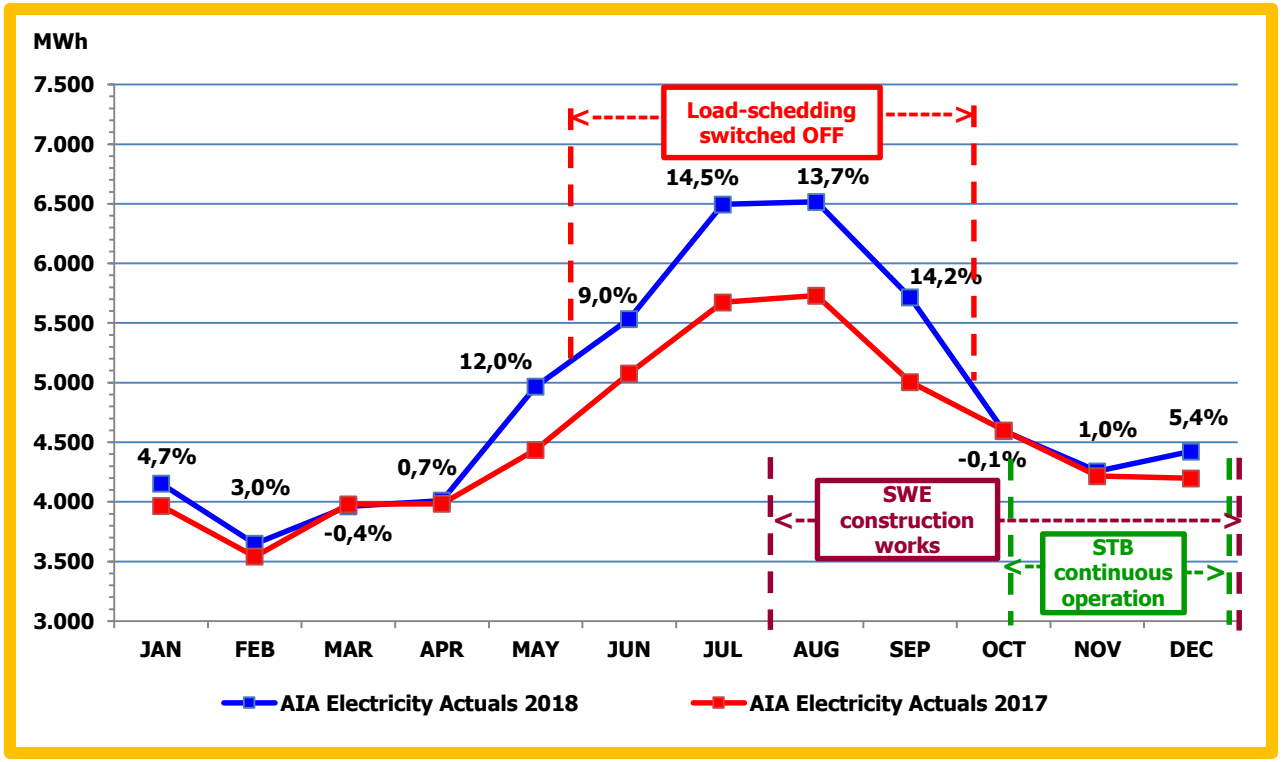
MTB ELC consumption of 36,4 GWh (+ 4,7% vs. 2017)



Other: People Movers, PBBs & APRON Lighting

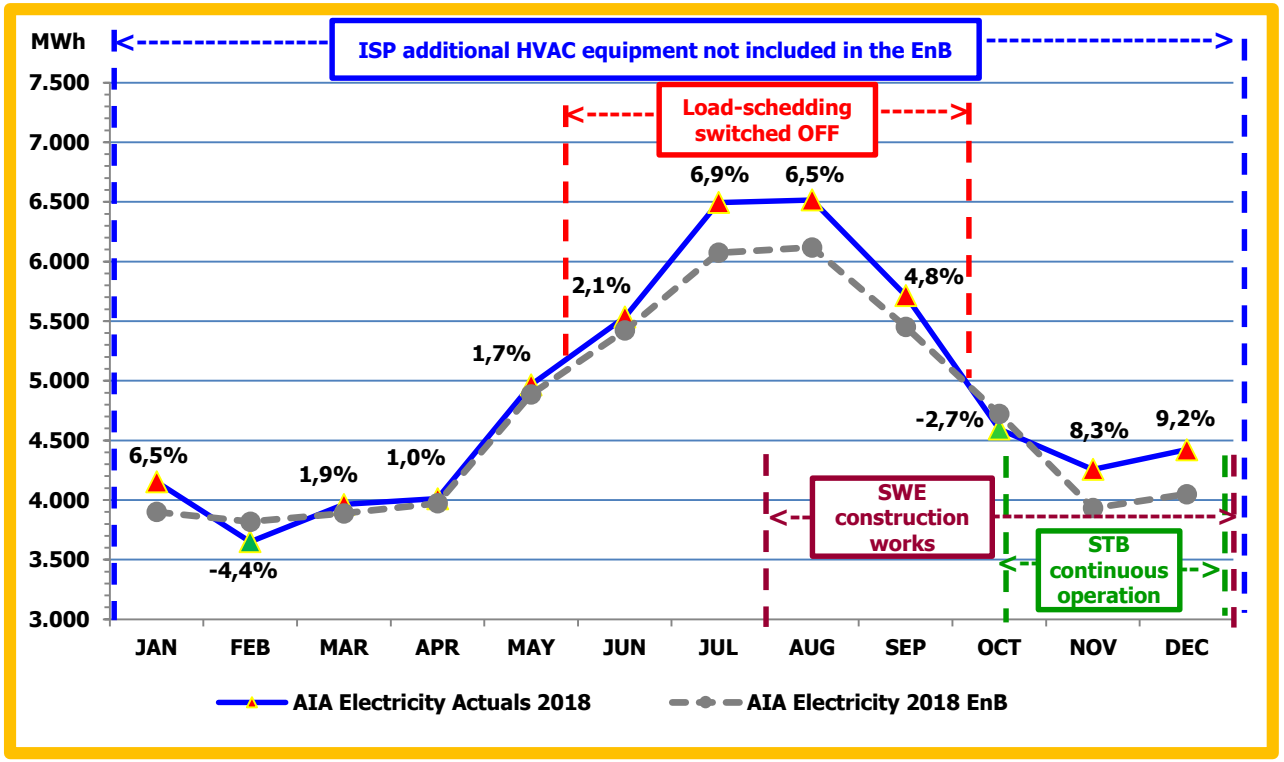
↑	↓
increased traffic	LED at MTB/STB Apron Lighting
enhanced indoor conditions	
new equipment	
construction activities	

ELC consumption 2018 vs. 2017 actuals: 7,1%



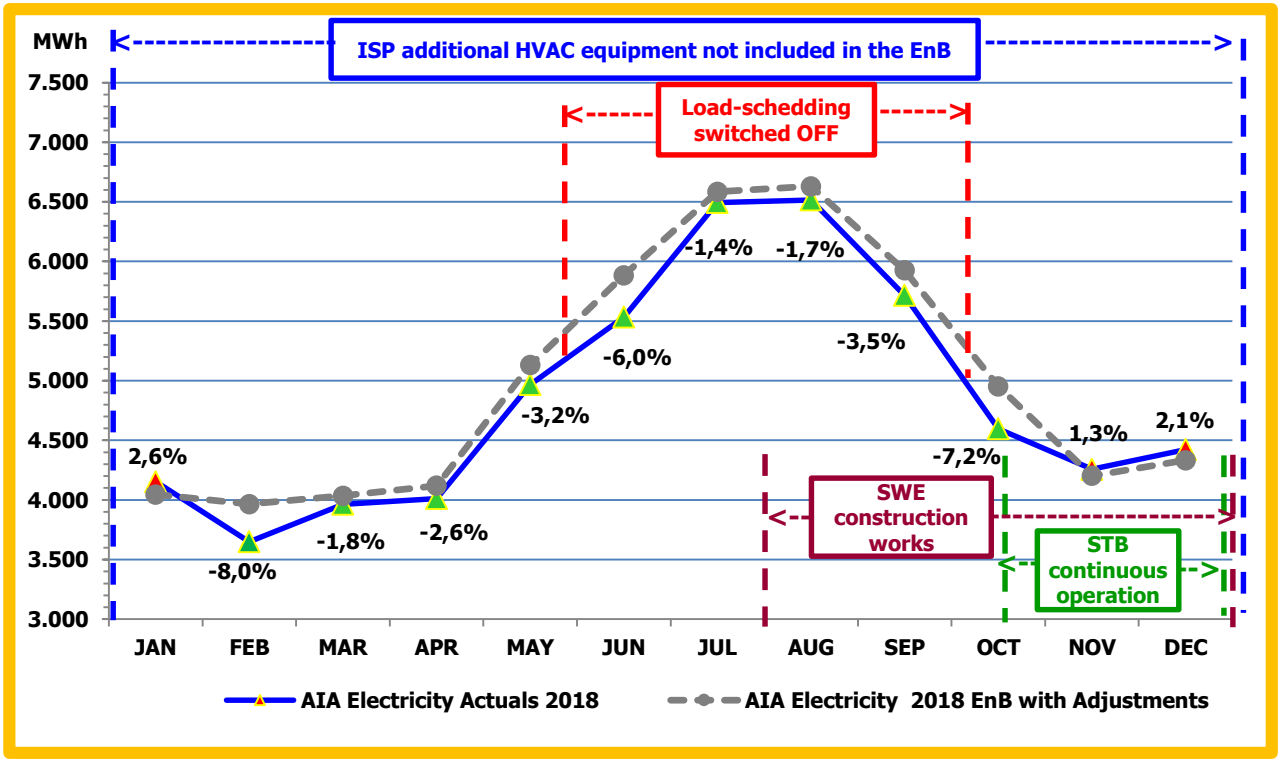
- ✓ Higher ambient temperatures + traffic increase
- ✓ STB utilization (continuous use)
- ✓ Enhanced ventilation during summer
- ✓ SWE construction works as of August 2018

ELC consumption
2018 actual vs. EnB: 3,6%



✓ **normalization of traffic & weather effect**

ELC consumption
2018 actual vs. adjusted EnB: 2,6%



✓ **Improved final ELC energy performance absorbing ad-hoc variables**

4.5 Implementation and operation – DO
4.5.5 Operational control

AIA has identified and plans the operations and maintenance activities which are related to its significant energy uses and that are consistent with its

- energy policy,
- objectives, targets and
- action plans,

In order to ensure that they are carried out under specified conditions, by means of the following:

establishing and setting criteria for the effective operation and maintenance of significant energy uses, where their absence could lead to a significant deviation from effective energy performance;

operating and maintaining facilities, processes, systems and equipment, in accordance with operational criteria;

appropriate communication of the operational controls to personnel working for, or on behalf of, the organization.

4.5 Implementation and operation – DO
4.5.5 Operational control

Document Ref No	Type of document	Document Title
TES-050301-XP	Cross Departmental Procedure	Energy Management System Operational and Maintenance Controls
TES-050301-WI 1	Work Instruction	Energy Management of Air Handling Units
TES-050301-WI 2	Work Instruction	Energy Management of Cooling Plants
TES-050301-WI 3	Work Instruction	Energy Management of Heating Plants
TES-050301-WI 4	Work Instruction	Energy Management of Lighting

4.5 Implementation and operation – DO
4.5.6 Design – Life Cycle Cost considerations in design

AIA considers Life Cycle Cost in the Design & Procurement:

- The expected operating lifetime (useful life of purchase) of a piece of equipment, system etc. is **N** years,
- the annual **O&M cost** is **A** €,
- the annual **energy cost** is **B** €,
- The offered **purchase cost** (piece of equipment, system etc.) is **C** €
- The prevailing **interest rate** for AIA (cost of borrowing money from the bank or at a min interest offered by the banks) is **r**

Then the successful bidder should be the one achieving the least offered price according to the following formula:

NET PRESENT VALUE OF ACTUAL PURCHASE COST = C + (A+B) * S

where $S = \{1 - 1 / (1+r)^N \} / r$

4.5 Implementation and operation – DO
4.5.6 Design – Life Cycle Cost considerations in design

NET PRESENT VALUE OF ACTUAL PURCHASE COST = C + (A+B) * S

where $S = \{1 - 1 / (1+r)^N\} / r$

4.7 Management review – CHECK & DO
4.7.1 General

AIA's top management at least once a year reviews the EnMS to ensure its

- **continuing suitability,**
- **adequacy and**
- **Effectiveness**

Records of management review are maintained.