Task 16
"Competitive
Energy Services"
www.ieadsm.org

in co-
operation
with:

IEA DSM Task 16 + Sattler

Simplified M&V + Quality Assurance Instruments for Energy, Water and CO_2 Savings. Methodologies and Examples

by **Bleyl, Jan W.; Bareit, Markus; Sattler, Peter** (presenter)

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Confederation

Swiss Federal Office of Energy SFOE

ENERGETIC SOLUTIONS

JAN W. BLEYL

ECEEE 2014 Industrial Summer Study

Papendal, Arnhem, the Netherlands, June 5th 2014

Outline

1. **Motivation**: From **N**Wh to savings cash flows. Simplified?
2. Proposed solution:
   Simplified M&V + Quality assurance instruments (QAI)
3. **Savings**: Basics and overview of M&V methodologies
4. M&V + **Quality assurance instruments** (QAI)
5. **Examples: M&V + QAI**
   - ⇨ Electricity and thermal saving measures
   - ⇨ Opel, Austria with very actual and astonishing results
   - ⇨ (CO_2-compensation in Switzerland)
6. **Conclusions** and **discussion**

Motivation: From '**N**Wh' to saving cash flows. How to simplify?

M&V is a prerequisite to:

1. assess the **quantitative outcomes** of saving measures,
2. translate physical savings into **cash flows**, e.g. for **financing**

But in reality, **M&V** is

1. (perceived as) **complicated**: lack of data, ressources and comparability between baseline and reporting periods …
2. a full scale M&V plan is not suitable, e.g. for **smaller projects**
3. often **not done at all** (particularly with in-house projects)
4. not applied for **individual saving measures** (IPMVP options A&B) in ESCo markets (e.g. Germany, Austria)

Proposed solution: Simplified M&V + QAI

A **compromise between 'no M&V at all'** and the effort and (perceived) accuracy of a '**full scale IPMVP'** approach:

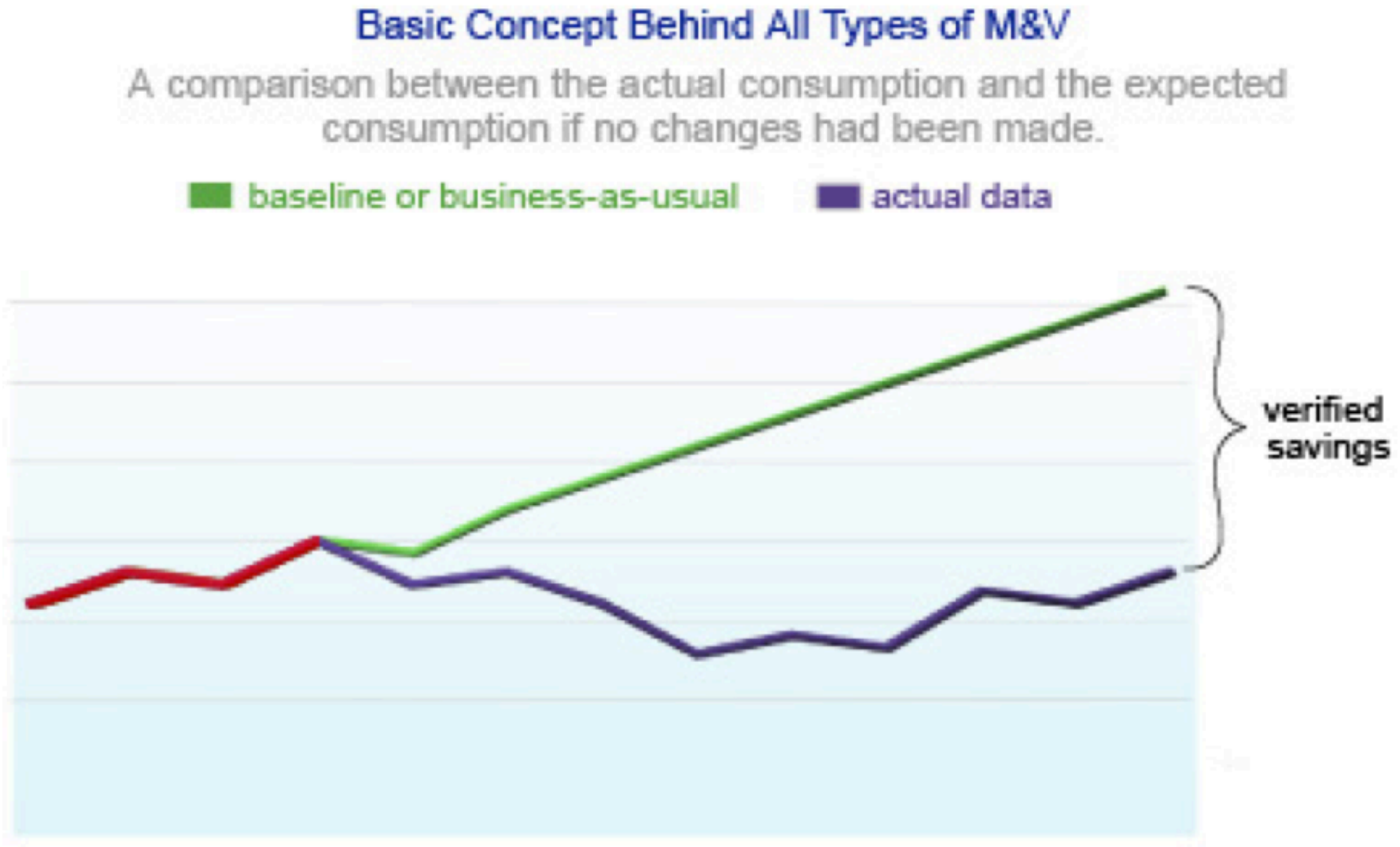
1. **Simplified M&V approaches** for **individual measures**, e.g. **measurement of key performance parameter** (= IPMVP Option A) or
   savings calculations **+** backed by
2. **Quality assurance instruments (**QAI) to **verify the functionality and quality** of a particular measure

Simplified M&V + QAI approaches are proposed **as additional M&V options**, e.g. for **in-house** or **smaller ESCo projects**
- not against utility meter or other options where suitable + desired

Research questions

- ? What approaches are available to compromise between no M&V at all (as is common practice in many in-house implemented projects) and the (perceived) accuracy of a full scale M&V effort?
- ? How can efforts for M&V be reduced but a sufficient level of verification maintained?
- ? How can performance-based energy services be made better accessible for smaller projects through simplified M&V approaches?
- ? And last but not least: What is an understandable and sufficient level of M&V for a facility owners needs?

Basic Concept: **Indirect appraisal only** => **Savings can only be calculated/estimated**



Source: Institute for Building Efficiency 2011

M&V options (overview)

Scope of application		Calculation method (M) and Calculation formula (F)	Examples of use *Notes & IPMVP options*
I. **Whole Facility** (or site sections with utility meters)	M I-**1**	**Suppliers invoices** or **utility meter readings** before and after saving measures	Standard EPC method in Europe *Corresponds to IPMVP Option **C***
	M I-**2**	**Computer simulation**	*Corresponds to IPMVP Option **D***
II. **Individual, isolated measures** (or sections/ systems) that can be metered or calculated separately)	M II-**1**	**Sub-meter**	Submeters for the boiler room or air conditioning system … *Corresponds to IPMVP Option **B***
	M II-**2**	**Measurements of all key parameters**	Metering of power savings and operating hours of ventilator *Corresponds to IPMVP Option **B***
Simplified M&V approaches	M II-**3**	**Measurement of 1 key parameter + computational factors**	Power saving of new light system *Corresponds to IPMVP Option **A***
	M II-**4**	Accepted **computational verifications**	Pump simulation programme *Not covered or compliant with IPMVP ('lack of measurement')*
	M II-**5**	**Feed-in sub-meter** (electricity or heat)	For on-site generation e.g. solar or CHP systems, heat recovery …

Savings calculations + QAI: 2 examples

1. Savings of a **thermal insulation measure** are quantified through a (static or dynamic) heat-demand calculation before and after retrofit and factored into a flat-rate cash flow.
   QAIs: Implementation quality is verified using a **blower-door-test** + a **thermographic analysis** of the building after retrofit.
2. **Street** or **indoor re-lighting** project: Power demand is measured in representative once-off tests before and after retrofit. (Average) reduction in power demand is multiplied by previously measured or deemed operating hours and factored into a flat-rate remuneration.
   QAIs: **Proof of function** of new system & compliance with the **illuminance specifications** is measured.

Electricity saving measures: Simplified M&V + QAI examples

Electricity saving measure	**Verification method** and **calculation examples**	**Quality assurance** (QAI) ***Comments***
Lighting retrofit	**Power demand reduction of lights combined with computational factors** + QAI $\Delta E_{RP} = (P_{Base} - P^*_{RP}) \times t^*_{RP} \times Number\ of\ lights$ - Measure demand of three representative lights before and after replacement => average per light - Estimate 1,800 hours of operation per year	Lux measurement before and after replacement + proof of replacement of all lights + annual audit *Alternative: manufacturer data for power demand (⇨ M II-4a)*
Equip fan with variable-frequency drive	**Measurement of electricity demand combined with computational parameter** + QAI $\Delta E_{RP} = P_{Base} \times t_{Base} - E^*_{RP}$ - Representative measurement before replacement - 1,500 full load hours (based on operating records) - New sub-meter for fan	Visual inspection + operational verification of equipment
Pump optimization in boiler room	**Metered difference in electricity use** + QAI $\Delta E_{RP} = E_{Base} - E_{RP}$ - Measurement of E_{Base}, E_{RP} from sub-meter	Annual audit with functional tests

sattler energie consulting

- Managing partner: DI Peter Sattler
- 16 employees
- Experience in over 3000 projects with energy savings of more than 500 GWh since 1995
- Knowledge-based services for enterprises and industry in
  - Energy efficiency
  - Purchase of energy
  - Energy management and controlling
  - Academy of energy – Knowledge and Awareness

Quality assurance from an operational perspective

In practice with industrial companies two types of quality assurance criteria are required for each energy saving measure to be realised.

1. First in many cases you have to assure and convince the people, that the functionality of the system to be changed according to the needs of the company will not be worse after the savings measure
2. Second – and this is the core of the paper - an approach for quantifying the energy savings is needed for controlling the set modification

best practice example

Company goal is to make the compressor system more energy efficient and parallel take advantage of the potential heat recovery

- two new compressors and a flexible over all controlling system were installed in 2013
- parallel a heat recovery system was implemented to the compressors

Experiences with simplified M&V + QAI

1. Determination of the energetic baseline of the compressed air system using the energy monitoring system
2. Development of energy performance indicators for the compressed air system kWh/Nm³ (over all)
3. Verifying the effect with measurements of the energy demand and the produced compressed air after implementing the two new compressors;
4. Result:

– Measured air-flow data showed a very strongly reduced consumption, assumed to be due to demand side measures by the employees,

– electricity should be reduced due to the change in compressor system, but did not take place!

– → increase of EnPI which means that the measure did not work! In fact we measured an degradation of energy efficiency !

Experiences with simplified M&V +QAI

Two main influences occurred, after **detailed analysis/measurement:**

I. Soiling of the hot-wire anemometers → shows too little volume flow
II. Electricity saving could not be measured in the overall system!

What to do?

I. cleaning of the Sensors to get correct air flow Data
II. More detailled analysis of electricity consumption showed: Another big compressor with decreased efficiency running for Baseload has more additional consumption than the savings by our system change!
III. This fact could not be detected by measuring the entire compressed air system.

Fact : with the planned settings for Simplified M&V method our energy savings could not be detected!

Experiences with simplified M&V +QAI

But:

1. by estimating the result of our changed 2 compressors by the way of Run-Time data of control system and nominal efficiency of the new system leads us back to a simplified M&V System, which - as well as the detailled measurement - delivers a correct result!

2. By being forced to make an detailled measurement and Verification we were able to find another new Measure:

   the Replacement of another inefficient compressor is planned now!

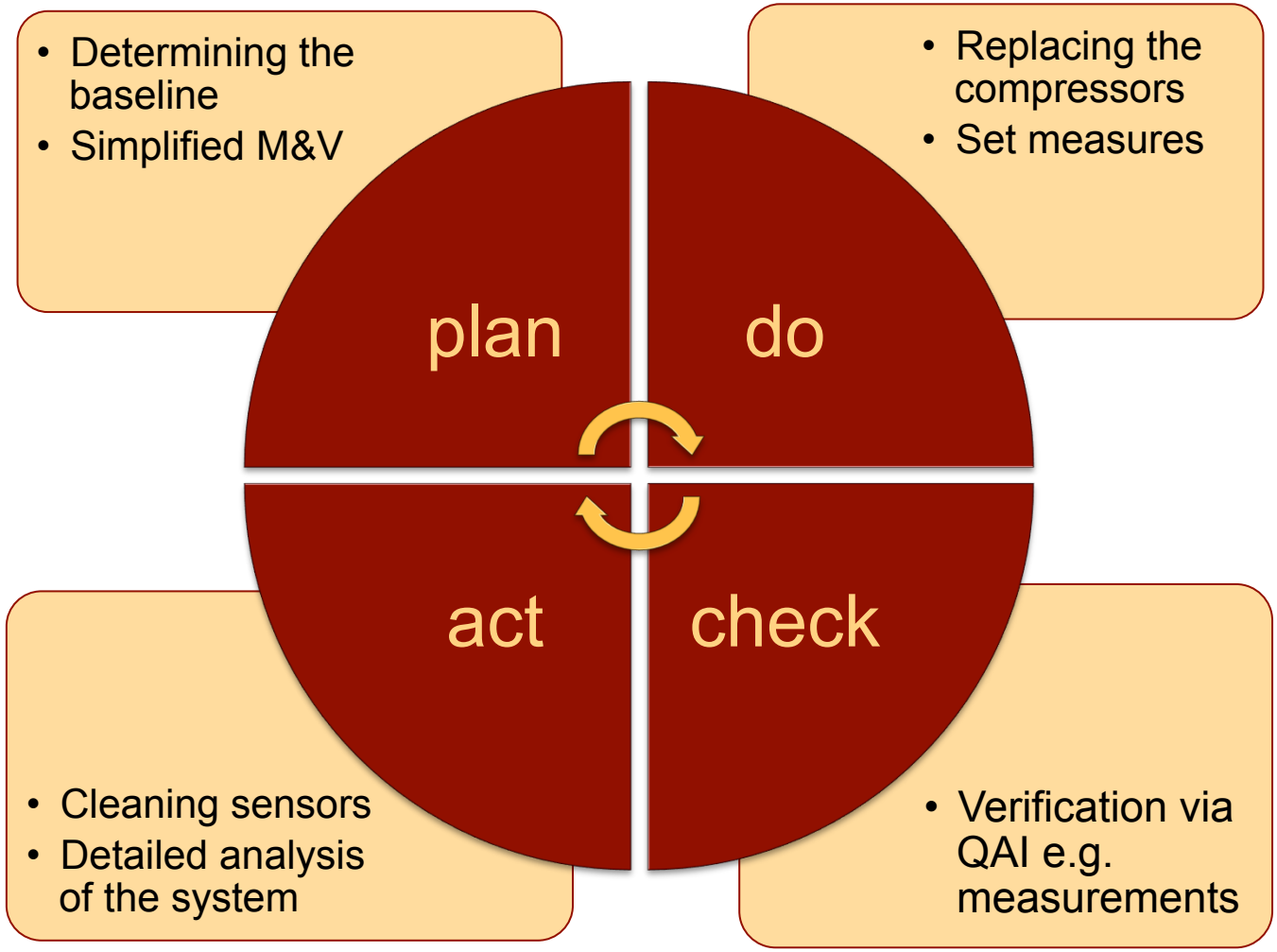
3. What we will do in this step as **simplified M&V+QAI** is

   a) Still measure the over all efficiency of the compressed air system

   b) force the provider to a witnessed test of the new compressor after installation in the site

   c) Additionally control the run time of the new machine

This lead us to ….



Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Eidgenössisches Departement für Umwelt, Verkehr
Energie und Kommunikation, UVEK

General requirements for CO_2 compensation projects in Switzerland

Conclusions

1. M&V is a prerequisite for all **performance-based projects** and to **assess savings cash flows**, e.g. **for EE financing**
2. Simplified M&V + QAI approach provides additional options e.g. for performance-based **in-house** or **smaller** EPC projects
3. The **QAI concept** is also applicable for other M&V methods
4. Many **industrial examples** but also **public funding programs** (CO_2 Switzerland) use savings calculations + QAI
5. Also **experience** from about 10 real world **Integrated Energy Contracting** projects in Austria is successful
6. **dena** (German Energy Agency) has decided to promote the concept and is preparing a guidebook

Discussion and Outlook

1. Are simplified M&V approach sufficient for **finance institutes**?
2. **How much M&V** do facility owners want, understand and want to spend money and time with?
3. **Simplified M&V + Quality assurance** vs. **savings guarantee**: => Is e.g. a class “A“ building certificate, a thermographic analyses or a key performance measurement enough?
4. How to better evaluate the trade-off between (perceived) accuracy vs. simplified M&V (**margin of error** vs. **effort**)?
5. Why are M&V requirements on **ESCo** projects much higher than on in-house implementation?
6. **NEB**s are often more important project drivers than savings

Thank you very much for your attention. Questions and remarks welcome.

by **Bleyl, Jan W.; Bareit, Markus; Sattler, Peter** (presenter)

ECEEE 2014 Industrial Summer Study

Papendal, Arnhem, the Netherlands, June 4th 2014

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Confederation

Swiss Federal Office of Energy SFOE

ENERGETIC SOLUTIONS

JAN W. BLEYL