2 + 2 = 3?

Why energy savings don’t always add up and how International Standards may help
2 + 2 = 3 – Everyone likes energy savings

We need to save money on energy costs. We are going to do this £50,000 on their annual energy bill. 

...but can he do his sums correctly?

Source: Budget Speech 2014
2 + 2 = 3 – the problem

- Energy Savings don’t add up
- Energy Managers expect (or are promised) savings to justify their investments, but although the capital costs are right – savings are not – and finance directors don’t like it!
- Many buildings also have a performance gap – the EPC says one thing, but the meters disagree
- Why is this?
2 + 2 = 3 – how to approach the problem

- It’s easy to blame the building (or the energy manager) but are our expectations at fault?
- Perhaps the real reason is that we haven’t looked hard enough at how energy savings are made up...
- The presentation will look at draft international standards
  - ISO 17743 – Definition of a methodological framework applicable to calculation and reporting on energy savings
  - ISO 17741 – General rules...for energy savings of projects
  - ISO 17747 – Determination of energy savings in organizations
  - ISO 17742 – General calculation methods...for countries, regions & cities
  - ISO 50015 – Monitoring, measurement, analysis & verification of organizational energy performance
2 + 2 = 3 – start with scope and boundaries

- The first thing to do is work out what we’re assessing

- **Scope**
  - Why are we doing this? (legal, reporting, ROI, EnMS)
  - All energy sources, or just major ones?
  - Energy used outside boundaries (less common than with carbon accounting)?

- **Boundaries**
  - Reflect the organisation
  - One plant, one function, one building, one site, many sites, the company, the group...
  - May include transport energy
Accurate organisational savings need all sources
  But may omit minor sources if use doesn’t vary much

Ideally use metered readings (accuracy?)

Need to account for energy stocks (solid/liquid fuels)

Invoices can be a suitable source

May need to look at exothermic/endothermic reactions

Convert to common energy units (MJ, kWh, Mtoe, MBE)
  Seasonal adjustments only rarely needed
  Think about blended biofuels
2 + 2 = 3 – Primary & Delivered Energy

- Primary energy is underlying source energy
  - May include on-site sources
  - Gas is a simple example
  - Useful for comparing operations between multiple locations

- UK tends to work on delivered energy
  - Ties in with billing information more easily
  - Electricity
  - Also refined fuels, steam, heat, compressed air...

- Convert back to primary if needed
  - Multipliers can be national, provided by suppliers, site specific or (if all else fails) default values
  - How to treat renewables?
**2 + 2 = 3 — Energy Savings General Principles**

- **Comparable periods of use**
  - Two equivalent time periods
  - Before and after improvement actions
  - With & without improvement actions
    - Typically used for estimated savings, comparing with similar organisations elsewhere or for measures that are reversible (can be reset)

- **Make necessary adjustments (normalisation)**

- **Can approach from two directions:**
  - Start with total energy consumption (top down) = 3
  - Build up savings from different measures (bottom up) $2 + 2$
2 + 2 = 3 – Periods and Baselines

- Make sure period is representative
- One year is most common, longer or shorter possible
  - Allow for seasonal demand or weather variations
- Establish baseline period
  - Can use average from a number of years
  - May keep fixed, or moving
    - Moving is useful for looking at year on year continuous improvements
    - Fixed often required by Governments
2 + 2 = 3 – Normalisation

- But things happen – need to adjust for:
  - Relevant variables
    - Changes in production volume, opening hours, etc.
    - External factors, such as weather (use degree days)
    - Static factors (relevant variables that don’t often change, eg. floor area)
  - Three types:
    - Forecast normalisation (adjusting the baseline period)
    - Retrospective normalisation (return to fixed conditions of the baseline)
    - Reference condition normalisation (adjust both baseline and actual to some ideal situation)
2 + 2 = 3 – Normalisation

- Don’t try and normalise for every possible variable – will add to uncertainty
- Beware of losing real savings (or hiding inefficiencies)
- Care needed over models – not all relations are linear!
- Can try and express as a general formula:

\[ E = f(V, \theta, a...) \]

where \( E \) = energy consumption

\( V, \theta, a \) are relevant variables (such as product volume, temperature, floor area...) and

\( f() \) represents some function of the variables
2 + 2 = 3 – Savings calculations

- Really simple, once we have the underlying assumptions

  **Energy Savings** = \( E_b - E_r \)

  where \( E_b \) = (Normalised) Energy consumption of baseline period
  \( E_r \) = (Normalised) Energy consumption of reporting period

- Of course we can complicate by adding various summations (fuels, operations) *or by*

- Summing the savings from measures (Energy Performance Improvement Actions):

  \[ \text{Energy Savings} = \sum_j (E_{b,j} - E_{r,j}) - \sum_j \sum_k e_{j,k} \]

  where \( e_{j,k} \) is the double counting effect in the reporting period of EPIAs j and k
2 + 2 = 3 – But these don’t give the same answer

- Partly due to overlaps
  - Fabric and systems
  - Losses from lighting may reduce heating demand
- Analyse differences – why don’t they add up?
  - Unrealistic savings claims
  - Measurement errors/uncertainty
  - Normalisation errors
  - Autonomous & price effects
  - Behaviour & management
  - Rebound effects
2 + 2 = 3 – Measurement errors/uncertainty

• Many measurements depend on estimates, especially where no direct meters
• If savings are expected to be around 2% (say), but the possible measurement error is 1% it could wipe out or double reported savings
• Meters may need to be calibrated
price changes (taxation), the energy efficiency industry can also make optimistic claims.

Energy savings once and forever & even...

* UP TO 15% REDUCTION IN FUEL CONSUMPTION
* IMPROVED COMFORT CONDITIONS
* SHORT PAYBACK PERIOD

DO YOU HAVE MONEY TO BURN
CUT YOUR FUEL BILLS
REDUCE POLLUTION
SAVE ENERGY

GUARANTEED FUEL SAVINGS
INCREASED COMFORT LEVELS

MK Energy Club
25 June 2014
2 + 2 = 3 – Normalisation errors

• These can also be as a result of measurement errors (eg. estimating volumes of production)

• The model may be wrong – over-simplified (eg. straight line $E = mV + c$ may not be appropriate)

• Static factors may not have been identified for normalisation (eg. small changes to occupied building area or opening hours)

• Normalisation use slightly wrong factors (eg. degree days for a weather station with a different micro-climate)

• Normalisation is as much an art as a science!
$2 + 2 = 3$ – Autonomous effects

- Things ain’t what they used to be!
2 + 2 = 3 – Management & Behaviour effects

- Management & operations (good and bad) can affect expected savings:
  - Is equipment kept properly maintained?
  - Is there proper handover & training for new equipment?
  - Are instructions clear and not too complex?
  - Do users even know that controls have changed?
  - Is there a new energy manager?
  - Do energy saving campaigns work – and for how long?

- Price effects
  - Can be an unprompted focus on saving energy in response to publicity about higher energy prices
2 + 2 = 3 – Rebound effects

- Classic rebound effect – people use more because they know that new kit is energy saving:
  - Perhaps more common in domestic situations
  - Leaving lights on 24/7 as they are “low energy”
  - Not switching off PC flat screens at lunchtime
  - Turning up thermostat to take “savings” in comfort

- Jevons paradox
  - A macro-economic theory that if we save money on energy, we will spend it (or reinvest) on something else that adds to total energy demand
  - Maybe just says that increasing GDP generally means higher energy use
2 + 2 = 4 – At last the sum adds up!

- Thank you!
  - More information on draft International Standards from BSI website – if you disagree with what I have said you can submit formal comments
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