

2 + 2 = 3?

Why energy savings don't always add up and how International Standards may help

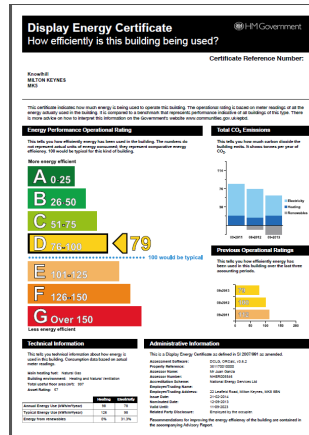
2 + 2 = 3 – Everyone likes energy savings



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

2 + 2 = 3 – Energy Accounting

- 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

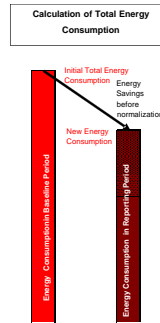
- Primary energy is underlying source energy
 - May include on-site sources
 - Gas is a simple example
 - Useful for comparing operations between multiple locations
- UK tends to work on delivered energy
 - Ties in with billing information more easily
 - Electricity
 - Also refined fuels, steam, heat, 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

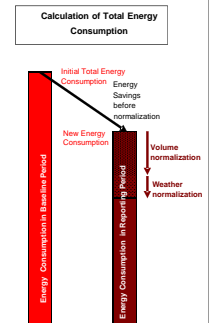
2 + 2 = 3 – Periods and Baselines

- 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

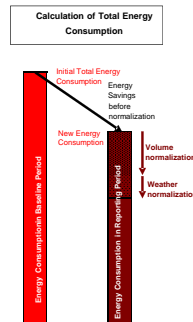
- Don't try and normalise for every possible variable – will add to uncertainty
- Beware of losing real savings (or hiding inefficiencies)
- Care needed over models – not all relations are linear!
- Can try and express as a general formula:

$$E = f(V, \theta, a, \dots)$$

where E = energy consumption

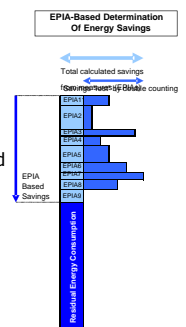
V, θ , a are relevant variables (such as product volume, temperature, floor area...) and

f() represents some function of the variables



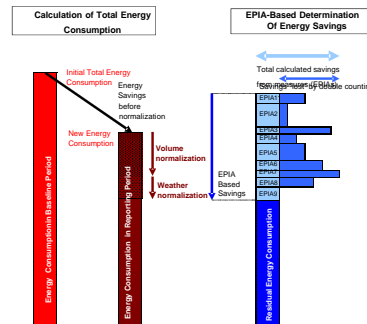
2 + 2 = 3 – Savings calculations

- 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):
- $Energy\ Savings = \sum_j (E_{b,j} - E_{r,j}) - \sum_j \sum_k e_{j,k}$
 - 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

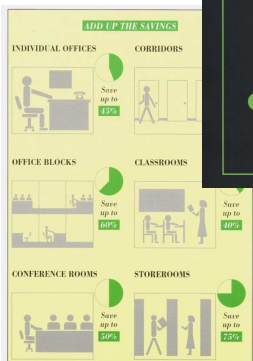


2 + 2 = 3 – Measurement errors/uncertainty

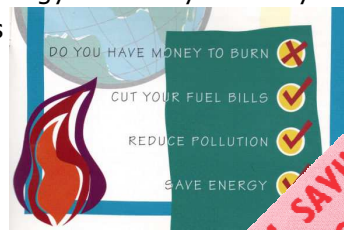
- Many measurements depend on estimates, especially where no direct meters
- If savings are expected to be around 2% (say), but the possible measurement error is 1% it could wipe out or double reported savings
- Meters may need to be calibrated

This product pays for itself over and over again

price changes (taxation), the energy efficiency industry can also...



Energy savings once and forever & ev



* UP TO 15% REDUCTION IN FUEL CONSUMPTION

* IMPROVED COMFORT CONDITIONS

* SHORT PAYBACK PERIOD

**GUARANTEED FUEL SAVINGS
INCREASED COMFORT LEVELS**

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!



NEMEX/Sustainability Live!
2 April 2014



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

NEMEX/Sustainability Live!
2 April 2014



2 + 2 = 3 – Rebound effects

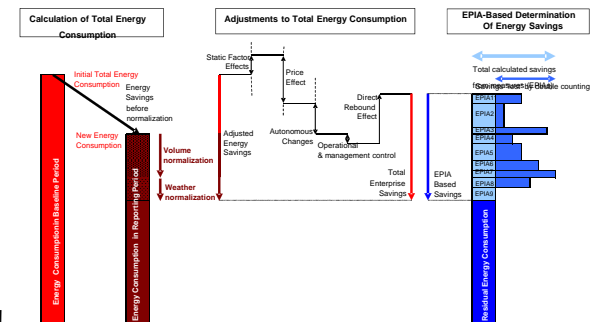
- Classic rebound effect – people use more because they know that new kit is energy saving:
 - Perhaps more common in domestic situations
 - Leaving lights on 24/7 as they are “low energy”
 - Not switching off PC flat screens at lunchtime
 - Turning up thermostat to take “savings” in comfort
- Jevons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



NEMEX/Sustainability Live!
2 April 2014



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
- Ian Byrne – ian.byrne@nef.org.uk – www.nef.org.uk

NEMEX/Sustainability Live!
2 April 2014

