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Measurement and verification:

Practical guidance for RE:FIT participants.

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1.0 Introduction

The RE:FIT framework is an energy performance contracting framework established by the Greater London Authority and applied across the public sector not just in London but across England (supported by Local Partnerships), and Wales under the RE:FIT Cymru framework. RE:FIT is a competitively tendered and OJEU-advertised framework which comprises energy service companies (ESCos) selected for their experience in providing energy reduction and generation measures. The ESCo enters into a contract with a public sector organisation and guarantees the energy savings from the works that it is undertaking over a given period. As a result, organisations are assured of a secure financial saving.

This guide has been prepared to introduce RE:FIT client participants to some of the *practical* issues involved in Measurement and Verification (M&V) and help smooth project delivery in the interests of achieving persistent savings. It should help stimulate open, collaborative discussion with your bidders, support partner selection and aid ongoing project management into the reporting phase. It is not intended as an introduction to M&V as a wider subject, or specifically to the detail of IPMVP. For this, please see Vilnis Vesma's excellent 4 page "IMPVP in a nutshell" (see References section for details). For those seeking more detailed knowledge, training is available from sources including Vesma.com, EEVS and the Energy Services and Technology Association (ESTA).

Much guidance is available on the principles of M&V, particularly the Efficiency Valuation Organisation's helpful International Performance Measurement and Verification Protocol (IPMVP) and in ISO 50015. These consider best practice in M&V but sometimes this may be more than a particular project demands. IPMVP also is energy efficiency focused and fails to consider measurement of avoided cost resulting from revenue generation measures such as solar PV (through the Feed-in Tariff) or biomass or heat pumps (through the Renewable Heat Incentive). On-site energy storage and demand site management will present additional M&V challenges as two-way energy flows and time-of-use load shifting become more common. ISO50015 fares better here in its breadth but is methodology agnostic and uses IPMVP as a normative reference. It is important to understand and agree how an M&V plan will capture not just avoided energy use but also how it will account for on-site generation, storage and flexibility. This may be through appropriate direct measurement or through excluding such items from the measurement boundary where practical. In a subject which can quickly baffle with statistical analysis it is essential that the practicalities of *how* M&V will be managed are clearly understood, especially in planning for when changes inevitably occur.

U.K. M&V skills and market capacity are still developing. The number of CMVP qualified practitioners (including CMVP-IT, CMVPI and CMVPITI) was fewer than 200 in 2015 and as at November 2018 stands at 239. Approximately 85% of CMVPs are employed by consultancies, ESCos or product manufacturers, with fewer than 15% working directly for end-user client organisations.

It is important that practical knowledge is shared to rapidly raise the experience level of the profession and its clients, and to enable future projects to benefit further. An example of this learning in practice is the general move away from using IPMVP "Option C" whole facility measurement on RE:FIT projects to using retrofit isolation measurement techniques (Option A and

Option B). These enable better understanding of performance of individual energy conservation measures and help avoid non-routine baseline adjustments which are common under Option C. Additionally, since the first RE:FIT projects the level of training provided to the client organisations has increased dramatically. It is now typical that an ESCO will be dealing with a client contact whose knowledge of M&V is robust enough to challenge deficiencies in the proposed M&V plan and who is strongly placed to support the M&V process.

Looking ahead, the Investor Confidence Project seeks to deliver scalable energy efficiency investment through creating "investor ready" projects where M&V has been considered to a common high standard. Within RE:FIT the goal should be similar – to see consistent high-quality M&V and ensure the Public Sector benefits accordingly.

RE:FIT Terminology

RE:FIT projects follow a staged process with ESCo framework contractors becoming involved at the point an invitation to tender (ITT) is launched. The ITT starts with a high-level audit - referred to in this document as a Desk Top Audit (DTA), in which the bidding ESCos submit their initial views of anticipated energy savings. From these the client selects a preferred ESCo who then proceed to undertake detailed investigations and produce an Investment Grade Proposal (IGP) detailing project financials including fixed project costs and anticipated energy cost savings and payback period. The abbreviations ITT, DTA and IGP are used further below. Energy conservation measures are abbreviated to ECM in line with IMPVP terminology.

2.0 Cost versus accuracy – the guiding rule

IPMVP recognises that "M&V costs should be appropriate for the size of expected savings, the length of the ECM payback period, and the report users' interests in accuracy, frequency, and the duration of the reporting process." It continues, "M&V should incur no more cost than needed to provide adequate certainty and verifiability in the reported savings, consistent with the overall budget for the ECMs." As a guide, it suggests typically annual M&V costs are less than 10% of the annual savings being assessed, and my own assessment of RE:FIT projects suggests actual budgets for identifiable annual M&V activity range from 3-10%. The quantity of savings under consideration therefore sets a ceiling on M&V budget, and hence how much measurement uncertainty is acceptable.

Client and their contractors need to agree the "M&V sweet spot" where cost and accuracy is acceptable to both parties, and then manage the contract around that agreed standard. Consider:

- Is external savings verification required, or would you rather spend on improved metering or additional ECMs? Would an ad-hoc spot-check be more cost effective?
- Is an independent sense check of the submitted M&V plan better than ongoing verification?
- What costs are "M&V" and what aren't? Generally, M&V costs are those directly attributable to the measurement process and would exclude for example new metering where it would be necessary for the operation of the installed equipment.
- For how long is measurement needed? Whilst project payback may be (say) 7 years, if targets are consistently achieved in the three years, then any change in performance later is

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likely to be due to changes in operating conditions rather than ECM performance. If the project is still missing targets after the first three years, is it likely to get better? It is preferable to have a robust operational verification process to ensure ECMs are performing properly as commissioned rather than find out the are under-performing a year later.

- If a project is missing target each year by less than the annual cost of measurement, then is it better to agree a guarantee settlement with the performance contractor and save the ongoing annual M&V cost?

M&V costs come directly out of the savings (avoided cost). Ensure your M&V delivers the right value on the project.

3.0 Pre-tender considerations

Baseline – not just energy

Many RE:FIT tenders have provided limited baseline energy data only. With the widening availability of AMR data this is improving, but only for utility supplies. In reducing uncertainty when modelling predicted energy consumption, all significant drivers of energy use should be considered. As a minimum you should look to provide where applicable:

- At least 12 months energy consumption data in the best granularity possible, ideally half-hourly data. You can't build a predictive model on 12 wildly estimated supplier bills.
- A clear schedule of metering points including unique identifiers (electricity MPANs and gas Meter Point Reference Numbers, plus corresponding serial numbers). Details of data collector arrangements, current supplier and data availability (e.g. via a supplier web-portal or AMR) is even better. Include details of any on-site generation metering, e.g. FIT meters for solar PV and whether there is export metering. If you have multiple meters on your site, a simple schematic explaining which equipment, area or building they supply is very useful.
- Key operating parameters for each building including: Opening hours, occupancy (staff, or possibly pupil numbers for schools), and details from standard operating procedures – target heating temperatures, and time settings etc.
- What delivered energy performance is currently being achieved? If space or water temperatures are never achieving target conditions, and the project enables this, the result may be an increase in energy use. Are measurable co-benefits (comfort, increased occupancy, health) acceptable "savings" or should these ECMs be excluded from guaranteed performance? Are you judging bids on simple financial metrics alone?
- Details of any energy projects undertaken during the baseline period to help identify if the data is representative of expected future consumption.

Sense check of your baseline data - do you need to gather more? Can you explain historic changes in your data? Are there gaps? Is it better for you to get that data or leave it to your contractor? Where possible, select only those sites with strong baseline data to take forward to ITT stage. High quality data enables bidders to better predict anticipated savings and deliver projects with improved prospects of achieving the desired outcomes.

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Commercial issues

Consider the following to help inform what requirements should be part of your ITT.

Is M&V sensibly economic for smaller sites or ECMs with small absolute cost savings?

Can a multi-site project go ahead with some works outside of the measured savings guarantee? Is temporary monitoring (using IPMVP Option A or B) a practical and affordable solution to verify savings capability at point of commissioning instead of measuring the avoided energy over a long period?

Is measurement essential for the whole guarantee period?

Think of your measurement exit strategy and how this helps your budget (avoided M&V fees) and how an exit aligns with closing the contract after the payback period. What could be the trigger for ceasing measurement early, e.g. 100% achievement of savings for the first n years?

What motivates energy management at each site?

Do you have sites where the management is contracted out, e.g. leisure centres? How do the commercial considerations of those contracts (and timing of renewal) affect motivation to support energy reduction?

When will you pay for M&V?

A good deal of M&V cost is up-front, followed by annual reporting and analysis expenses. Suppliers may seek to invoice the full project M&V costs up front, but this should be a negotiation:

- Permanent metering costs should probably be part of the project capex spend.
- Temporary measurement for operational verification of savings capability should be part of the contractor's contract not the M&V budget. IPMVP recognises that it is not the verifier's job to snag the contractor's work.
- Writing M&V plans is time consuming and should be paid for upon agreement of the plan or in instalments (a) at IGP stage and (b) following any revisions to reflect "as built" ECMs and agreed project variations.
- Reporting costs should sensibly be invoiced by the supplier annually in advance – they will have costs for data collection, licence fees for use of M&T software, staff costs etc.
- Will you capitalise M&V into the project costs or treat it as a revenue item?

Be clear about your targets.

Is your target at site or project level? Is it cost, % or kWh that's being guaranteed?

- How critical is pay-back period in terms of being able to repay any project loans (e.g. Salix finance)?
- How will it be managed within your organisation if site A under-performs and site B over-performs? Will you have to re-distribute savings internally to reimburse different departments that have invested together? Consider your internal stakeholders.
- At what point are savings guaranteed in the DTA – IGP – CONTRACT process? Are they then absolute or relative, and how will you manage change as a result of agreed variations during project delivery where it may become impossible to install an ECM (e.g. due to asbestos on

site), or where a different baseline period is subsequently agreed. This is a source of significant vagueness in historic RE:FIT contracts.

4.0 Invitation to tender: DTA stage

Recommended actions

Obtain a sample M&V plan and example performance report from bidders

Test it against what you should expect to see. If you don't know what to expect, at least look at the section headings in IPMVP (covered in Vesma's "IPMVP in a nutshell" document). Is it logically laid out and includes clear explanation of how energy will be measured, and savings calculated? The acid test for an M&V plan is "Could I give it to someone else for them to replicate the savings calculations given the same data?" If not, then it's lacking in key details. The sample should be a real M&V plan that the contractor has provided to another client, not a list of headings with no content.

Confirm required frequency and format of reporting.

Whilst RE:FIT stipulates a contractual annual reconciliation report (ARR), it is imperative that performance is closely monitored in year 1 (and preferably also during the build phase) to ensure confidence in a successful year-end outcome. It is desirable to front load reporting into year 1 and revert to a single ARR when performance can be expected with good confidence. As a minimum seek a (simple) year one mid-year report to test that data is being received and performance looks on track, or year 1 quarterly reporting for high value projects.

Ensure you identify who is responsible for M&V after project delivery

Understand the supplier's M&V team structure. This should be included in the sample M&V plan. Ask what actually happens if a project is underperforming – it is preferable for corrective actions to ensure savings *are* delivered rather than receiving a payment each year as delivery of the guarantee. A payment doesn't reduce the long-term energy use beyond the guarantee period and doesn't deliver carbon savings.

5.0 IGP stage to contract agreement.

Don't expect a fully detailed M&V plan to be delivered with the initial version of the IGP.

This creates a good deal of wasted work since IGPs are often revised to amend the proposed ECMs several times and the measurement approach could change dramatically depending on what ECMs or sites are in or out of scope. Once the final ECMs are agreed a final pre-build M&V plan can be completed and the M&V budget finalised and submitted with the final IGP.

Consider revised baselines.

Additional baselining may need to occur during IGP development. It may be desirable to use a different baseline period to reflect more recently available data than was provided in the ITT. Tight IGP timescales rarely permit anything more than instantaneous measurements which can be to the detriment of good M&V. A well planned tender process with good up-front information on all your

own baseline conditions gives greater certainty to all parties and ensures many reporting period queries can be resolved swiftly.

Identify how your contractor proposes to demonstrate performance capability.
How will they demonstrate that the *capability* to achieve the desired savings has been delivered? To aid confidence that guaranteed savings will be delivered as kWh, not as a monetary short-fall payment, it is helpful to verify performance at the point of commissioning each ECM - where technically feasible, e.g. through spot measurements. This will often be better than waiting until the end of year one to find out whether the project is on target, by which time any shortfall is kWh/carbon that you won't get back.

Confirm who is responsible for maintenance of ECMs
Anticipated savings will only arrive from properly maintained ECMs. Ensure clarity as to where responsibility for ECM maintenance lies; during the defects' liability period, during any extended warranty period and beyond. Ensure you understand what standard of maintenance is expected by you under the contract and that maintenance schedules and budgets are in place to deliver this. ESCOs may seek adjustments to savings where the client has failed to maintain – e.g. filters in air handling units.

IPMVP options

IPMVP sets out four measurement options: A, B, C and D. The majority of early RE:FIT projects used Option C (whole facility measurement) which typically uses the main utility fiscal metering and is hence low cost, in theory. Option C is appropriate where anticipated savings are high as a percentage of energy use within the measurement boundary, and where there are multiple ECMs which potentially have interactive effects (e.g. lower lighting heat output reduces mechanical cooling demand). But is it the right solution?

The problem with whole facility measurement is that there are often changes occurring in the building over time which need accounting for in order to enable baseline and reporting periods to be compared on the same basis. This necessitates ongoing dialogue between parties and a series of investigations and non-routine adjustments each year - and debates about these adjustments. Over a long payback period these adjustments could become significant and unreliable (e.g. where attempting to understand the compound impact of a series of individual changes). Is it possible to measure ECMs separately using option A or B instead?

In an ideal world the answer is yes, but this leaves ECMs with low energy savings uneconomic to measure and risks blowing any realistic M&V budget by metering everything. Is a compromise possible - agree Option A or B measurement for key ECMs and agree to not measure lesser ones, and accept a lower level of guaranteed savings? Knowing the exact performance of each major ECM is more useful for diagnosing issues with underperformance than having meter readings at whole site level. Of course, where significant changes are made to control strategies and to the number and type of pieces of equipment managed by the BMS Option C may be the only cost-effective measurement choice.

Some examples of measurement challenges using option C.

- Lighting (as the major ECM from a number of ECMs installed):
  In this example anticipated savings were not being realised due to increased run hours compared to the baseline but this cannot be determined just from monthly electricity bills (you might just spot the change in half-hourly data). Could this have been measured using Option B (measuring kW and run hours over an agreed period), or by measuring kW and agreeing deemed operating hours (Option A)? Either of these would have proven the savings capability of the lighting ECM more reliably.
- School with multiple ECMs:
  Here, savings targets were missed; indeed, energy use increased due to a large increase in student pupil numbers. Using Option C, measured with supplier invoice data, it was impossible to attribute the savings shortfall to underperformance of any one of the ECMs installed. Here, the solution might be to revisit the baseline data and calculate a specific energy use per pupil as a baseline variable, but there is no guarantee that this metric behaves in a linear way. One extra pupil might be absorbed into an existing class, but 20 might need an additional teaching area to be created. Fortunately, IPMVP expects savings to be reported conservatively, so any adjustment should take such issues into account – possibly by looking at a wider data set of specific energy use across multiple similar schools as a benchmark.

6.0 Delivery stage

Key actions during the ECM installation phase include:

- Note carefully the completion dates for each ECM so that you can seek any observable step changes to energy data. (where measurement granularity permits)
- Where option A or B is used, ensure measurement results are obtained and discussed prior to awarding practical completion. Do the results give confidence that the ECM will deliver expected savings? Is significant under-performance or inadequate measurement records a snag?
- Ensure Operation and Maintenance Manuals include sufficiently marked up as built drawings and schedules of equipment e.g. lighting works, descriptions of plant room insulation etc. Lighting works are typically well described in electrical certificates, but in three years' time if the lighting is under-performing will anyone be able to work out what has gone wrong? Include details of what equipment was removed and what it was replaced with. O&M's should also include details of any metering and metering communications installed as part of the project.
- Ensure any metering and connectivity issues are programmed very early in delivery. Client delays in allowing remote access to data are common and can delay start of the measurement period until well after practical completion has been achieved. Do not underestimate how long it could take for a Council IT department to allow remote access to your building management system.

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7.0 Reporting stage

- It is important that the ESCo can receive timely, granular data immediately following the start of the reporting period. This will ensure they can query performance issues early and put in place corrective actions to prevent loss of savings and ensure project success.
- Ensure you have a mechanism and a clearly defined responsibility for your own team to report changes in static factors to your contractor – especially where site management is via an outsourced party.
- Ensure clear action plans are established to correct under-performance rather than accept a buy-out payment to in lieu of the guaranteed kWh savings. Expect to continue to provide resource to your RE:FIT project well beyond delivery.

8.0 About the author

Colin Grenville qualified as a Certified M&V Professional in 2013 and has worked on nearly 30 RE:FIT projects on behalf of both E.ON and Mitie - covering schools, council offices, leisure centres, hostels, transport depots and other facilities. This experience has covered all project stages from DTA and initial site audits through to annual reconciliation reporting, performance investigations and adjustment calculation. He established Erebus Environment Ltd in 2014 to deliver energy reporting and compliance services with a focus on environmental management of energy use. Through Erebus Colin has continued to work on RE:FIT as well as undertaking M&V on a major NHS project under the Carbon and Energy Fund, CRC reporting and other projects supporting clients with CCAs and ESOS compliance.

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9.0 References

1. IPMVP in a nutshell: Version 2, 1/12/2015. Author Vilnis Vesma. available for download from www.vesma.com/downloads/ipmvp_nutshell_vv.pdf . Vesma.com is an excellent source of information on M&V and energy efficiency in general. Contact vilnis@vesma.com
2. M&V training:
    a. http://www.eevs.co.uk/mandvtraining.html
    b. http://www.vesma.com/training/ (energy management training, organises annual MAVCON M&V conference in Birmingham each November)
    c. https://estaenergy.org.uk/training/ (training to CMVP qualification)
3. IPMVP – all unrestricted documents can be downloaded for free at https://evo-world.org/en/products-services-mainmenu-en/protocols/ipmvp after creation of a document access web subscription here: https://evo-world.org/en/subscribe-join-en New content is typically restricted to paid subscribers and made available on general release six-months' later.
4. ISO50015:2014 Energy management systems -- Measurement and verification of energy performance of organizations -- General principles and guidance is available from the ISO website http://www.iso.org/iso/catalogue_detail?csnumber=60043
5. Details of the RE:FIT programme:

RE:FIT London: https://www.london.gov.uk/what-we-do/environment/energy/energy-buildings/refit
RE:FIT England (outside London): http://localpartnerships.org.uk/our-expertise/refit/
RE:FIT Cymru: https://gov.wales/topics/environmentcountryside/energy/efficiency/re-fit-cymru/?lang=en

6. The Investor Confidence Project: http://www.eeperformance.org/ defines a clear road-map from retrofit opportunity to reliable Investor Ready Energy Efficiency™. ICP assembles existing standards and practices into a consistent and transparent process that promotes efficient markets by increasing confidence in energy efficiency as a demand-side resource.