BASE

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White Paper

From measurement to investment: how MRV can help finance energy efficiency



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A BASE White Paper
Raphaël Mosca, Yannick Heinrich, Dimitris Karamitsos

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BASE is a Swiss not-for-profit foundation and a Specialised Partner of the United Nations Environment Programme (UNEP), with the mission to develop innovative, actionable financial strategies and market-driven solutions to unlock investment in climate change solutions.

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Executive summary

- **Meeting global climate commitments requires a large increase in clean-energy investment, yet an annual investment gap of about USD 3.5 trillion remains, even though many energy efficiency measures are cost-effective.** The building sector accounts for about a third of global final energy demand and 20 per cent of global greenhouse gas (GHG) emissions. Retrofits could reduce energy use by 10-20 per cent but adoption remains slow due to high upfront capital costs, split incentives between owners and occupiers, and lack of information combined with risk aversion. Performance-based business models (also called servitisation models), where payment depends on measured outcomes, can address these barriers by shifting upfront investments to providers while aligning incentives with efficiency outcomes.

- **Measurement, reporting, and verification (MRV) relies on the counterfactuality principle to establish trustworthy energy savings calculations.** By measuring consumption against an adjusted baseline (what energy use would have been without the upgrade), MRV isolates the true impact of an efficiency measure from other influences and reports it through standardised methodologies. In this way, estimated savings become verified ones.

- **MRV enables servitisation by making performance-based contracts enforceable and answering key investor concerns.** Verifying promised savings turns theoretical projections into measurable outcomes, making service-based models reliable and aligning the incentives of building owners, tenants, service providers, and financiers. It also gives investors what they have lacked: real-time performance validation, standardised comparison across projects, early warning of performance degradation, and audit-grade data for Environmental, Social, and Governance (ESG) and regulatory disclosure.

- **Widespread MRV adoption faces barriers including historical data quality issues, standardisation challenges, and resource constraints that require targeted policy interventions.** Legacy buildings often lack comprehensive metering infrastructure and historical records, undermining baseline accuracy, while proliferation of different MRV protocols creates market fragmentation and increases implementation costs. Organisations typically lack internal capabilities for complex data management and MRV protocol navigation, particularly among SMEs. Policymakers should introduce phased incentive structures starting with voluntary programmes offering enhanced subsidies, develop education and training programmes addressing the current expertise gap, and strengthen legal and financial frameworks for performance-based contracts through clear guidelines, standardised dispute resolution mechanisms, and public guarantee schemes.

1. Introduction

Meeting global climate commitments will require far more investment in clean energy and energy efficiency. According to BloombergNEF, global energy transition investment would need to average USD 5.6 trillion each year from 2025 to 2030 to get on track for global net zero by 2050. Although investment in the energy transition reached USD 2.1 trillion in 2024, this still leaves an annual investment gap of about USD 3.5 trillion.[3]
In particular, global spending in building energy efficiency is stagnating - from USD 270 billion in 2023 to USD 275 billion in 2024, and the gains in energy efficiency remain insufficient.[4,5]

Energy efficiency measures are among the most cost-effective decarbonisation solutions. The building sector accounts for about a third of global final energy demand and 20 per cent of global GHG emissions.[6] At the same time, building retrofits can lower energy use by 10-20 per cent.[7]

Many measures also pay for themselves quickly. Data on more than 15,000 projects in the De-risking Energy Efficiency Platform of the Energy Efficiency Financial Institutions Group (EEFIG) show median payback periods of roughly 2-6 years for commercial investments such as heating and cooling upgrades, pumps, refrigeration and efficient lighting, although the economics vary considerably by technology, building and local energy prices. However, the adoption of energy efficiency measures remains too slow.

Many barriers can explain the energy efficiency gap, i.e., the gap between the energy reduction that could be achieved by cost-effective measures and their lack of uptake, such as:

- **High upfront capital costs:** homeowners and small and medium enterprises (SMEs) may have limited access to capital to invest in expensive energy efficiency projects.

- **Split incentives between owners and occupiers:** building occupiers would benefit from the energy savings and associated financial benefits, but generally cannot engage in large retrofit projects.

- **Lack of information and risk aversion:** households may not be aware of the environmental and financial benefits of energy efficiency projects. In addition, they may be reluctant to invest in technologies they know little about and with uncertain energy savings.

Performance-based business models can help close the energy efficiency gap by addressing key investment barriers. Energy efficiency business models are evolving towards service-based structures, where payment depends on measured outcomes, a process called servitisation. In Efficiency-as-a-Service (EaaS) models, equipment providers retain ownership of systems (e.g., lighting, batteries, heat pumps, ventilation) and charge clients based on consumption, verified energy savings, comfort metrics, or other measurable outcomes.

[3] BloombergNEF, 2025. Energy Transition Investment Trends
[4] United Nations Environment Programme & Global Alliance for Buildings and Construction. 2025. *Not just another brick in the wall: The solutions exist - Scaling them will build on progress and cut emissions fast. Global Status Report for Buildings and Construction 2024/2025*.
[5] International Energy Agency, 2025. World Energy Investment 2025 and IEA, 2025. Energy Efficiency Progress Tracker
[6] IPCC, 2022. Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Chapter 9: Buildings
[7] Hondeborg et al. 2023. The effectiveness of building retrofits under a subsidy scheme: Empirical evidence from Switzerland. *Energy Policy*, 180, 113680.

Performance-based business models: a) remove large upfront investments from customers; b) align provider incentives with efficiency outcomes, encouraging optimised design, maintenance, and equipment longevity; and c) shift technical and operational risks from users to providers, who then have a business incentive to operate the asset as efficiently as possible.

Servitisation is a well-established model. Firms have paid for outcomes rather than equipment for decades: in Rolls-Royce's 'Power by the Hour', the airline pays per flight-hour while Rolls-Royce owns and maintains the engines[8]; Xerox has a pay-per-page programme called 'Managed Print Services' where businesses pay a fixed cost per printed page, while given access to printers, ink, monitoring, technical support, etc.[9]; solar power purchase agreements billed per kWh are some familiar examples. In energy efficiency, the same logic takes two main forms: Efficiency-as-a-Service (EaaS) and energy performance contracting. Under Lighting-as-a-Service, for instance, a provider installs and owns efficient LED systems and is paid for the light delivered, so it profits only if the equipment runs efficiently.[10]

The Energy Service Company (ESCO) industry has delivered verified savings through such contracts for decades, across thousands of projects.[11,12] In a guaranteed-savings contract, the provider compensates the customer if savings fall short, which places the performance risk on the party best placed to manage it.

Still, performance-based business models fundamentally depend on measuring and verifying energy savings. Since the revenue of providers is linked to future outcomes instead of direct sales, they incur a higher financial risk. The energy savings and financial benefits of energy efficiency projects are sometimes overestimated, for example due to the rebound effect: the increased energy efficiency lowers the cost of energy, which paradoxically can lead to higher consumption levels. In turn, realised savings fall below estimations. Hence, energy providers and investors need trustworthy methods to estimate, measure, and verify energy savings.

This paper examines how MRV tools can help finance energy efficiency by enabling servitisation. In section 2, we introduce the concept of MRV and its link with performance-based business models. In section 3, we discuss how organisations and policymakers can act to foster the adoption of MRV. Finally, we conclude in section 4.

[8] Rolls-Royce, 2012 Rolls-Royce celebrates 50th anniversary of Power-by-the-Hour

[9] Xerox, 2025 PagePack™ 3.0 Managed Print Services Program

[10] See more detail under: EaaS Case Study of Lighting as a Service

[11] Boza-Kiss, B., Bertoldi, P. and Economidou, M., 2017. Energy Service Companies in the EU: Status review and recommendations for further market development with a focus on Energy Performance Contracting, Publications Office of the European Union JRC106624.

[12] Bertoldi, P. and Boza-Kiss, B., 2017. Analysis of barriers and drivers for the development of the ESCO markets in Europe, ENERGY POLICY, pp. 345-355; JRC102642.

2. The MRV-servitisation nexus

2.1 MRV and the counterfactuality principle

The term MRV[13] stands for:

- **Measurement:** Gathering data on energy consumption, GHG emissions, and efficiency improvements through sensors, meters, and audits.
- **Reporting:** Communicating results clearly and credibly to stakeholders, investors, and regulators.
- **Verification:** Ensuring data accuracy and comparability, typically via standardised methodologies such as IPMVP (International Performance Measurement and Verification Protocol)[14] or the GHG Protocol.[15]

MRV relies on the principle of counterfactuality to address a critical challenge: how can we be sure that energy savings result from an efficiency upgrade?

Imagine a restaurant that installs new energy-efficient ovens. Comparing energy bills before and after the upgrade is not enough to determine the savings. Indeed, the energy consumption also depends on other factors such as outdoor temperature, customer traffic, changing menu offerings, kitchen operating hours, staff cooking behaviours, etc.

Counterfactuality solves this by creating a "what-if" scenario, illustrated in Figure 1. It establishes a detailed baseline that accounts for all relevant factors affecting energy use - such as customer numbers, seasonal variations, and operational patterns - before the upgrade. After implementation, the same factors are carefully tracked to isolate the true impact of the energy-efficient system. This method allows project funders and stakeholders to confidently verify the actual energy savings, distinguishing between improvements from the new technology and other potential influences.

Counterfactuality also helps deal with the rebound effect, where consumption rises as energy has become cheaper: because robust MRV compares consumption with an adjusted baseline, any rebound shows up directly in the results. The remaining question is contractual, namely how a contract allocates the cost of savings that do not materialise:

a) a **shared-savings contract** splits this risk between the parties;

b) a **guaranteed-savings contract** places it mainly on the provider;

and c) a **pay-per-consumption contract** also places it on the provider, while giving the user better visibility of actual consumption.

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[13] We use the climate-policy term MRV rather than the narrower efficiency-industry term M&V (measurement and verification, as codified in IPMVP and American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Guideline 14). The difference is the added "R": M&V establishes, technically, whether the promised savings were achieved, while MRV adds a formal reporting step that communicates those verified results to the people who act on them - investors, lenders, and sustainability-disclosure regimes.

[14] Efficiency Valuation Organization (EVO), *IPMVP Core Concepts* (EVO 10000-1).

[15] WRI & WBCSD, The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard (revised edition).

The Greenhouse Gas (GHG) Protocol is the most widely used international standard for measuring and reporting greenhouse-gas emissions, developed by the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD); its Corporate Standard defines how organisations account for emissions across Scopes 1, 2 and 3.

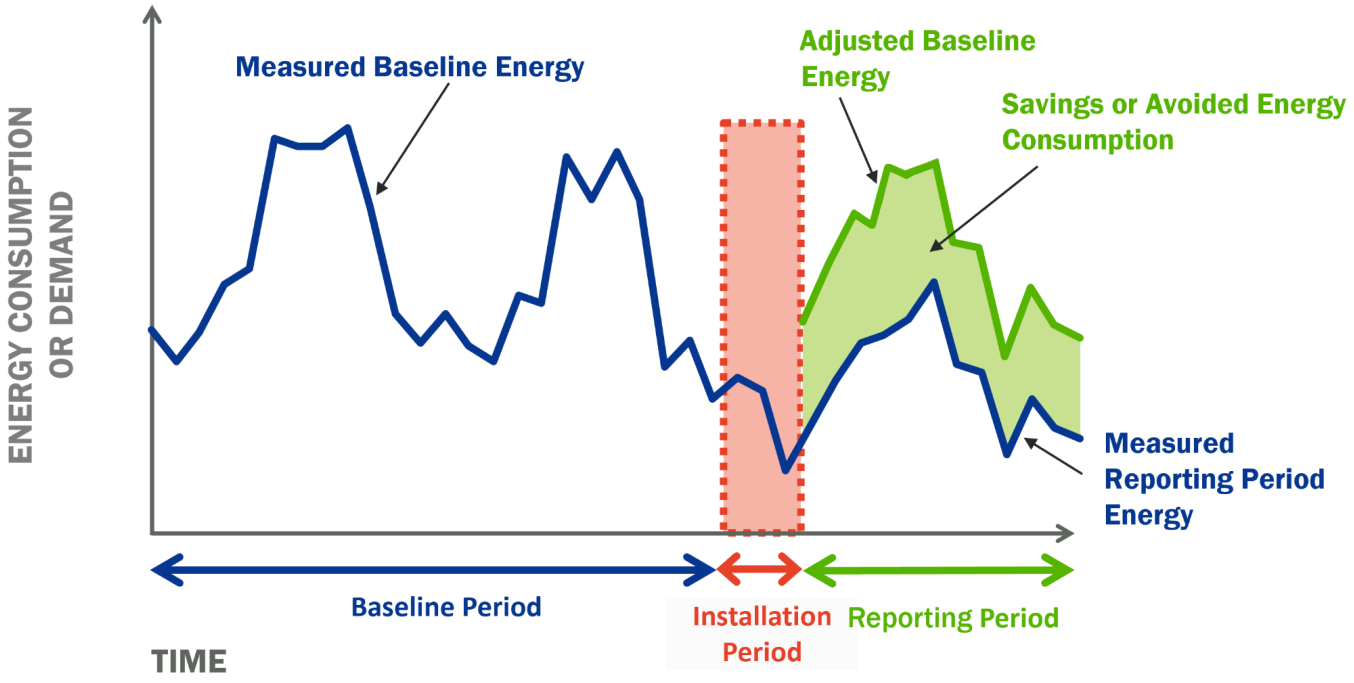


Figure 1. Efficiency Valuation Organization (EVO), 2022. International Performance Measurement and Verification Protocol (IPMVP)

2.2 How does MRV enable servitisation?

By verifying the promised energy savings, MRV makes performance-based contracts enforceable. In servitisation business models, the remuneration of providers is correlated with the efficiency of the system: either the efficiency is mentioned in the contract if a customer pays depending on consumption, or the contract defines a shared-savings or guaranteed-savings approaches, in which case the payment to the provider is linked to the savings achieved.

Without robust measurement frameworks, these contracts are difficult to enforce, limiting market growth. MRV addresses this: its protocols track baseline consumption, measure post-installation performance and calculate savings using standardised methodologies such as IPMVP. Continuous monitoring gives savings estimates an evidence base.

This makes performance-based business models more reliable, aligning incentives among building owners, service providers, and financiers.

Moreover, MRV addresses key investor concerns that have historically constrained energy efficiency financing. The EEFIG, convened by the European Commission and United Nations Environment Programme Finance Initiative (UNEP FI), brought together over 100 financial and industry organisations and identified standardisation, risk perception, data availability and challenges with aggregation among key drivers of the supply of and demand for energy efficiency finance[16]; these concerns are still underlined by EU institutions today.[17]

[16] EEFIG 2015. Energy Efficiency - the First Fuel for the EU Economy: How to Drive New Finance for Energy Efficiency Investments. Final Report, Brussels.
[17] European Commission 2026. EUR-LEX 536 and EUR-LEX 537 on energy efficiency guidance for investment and one-stop shops services for energy efficiency and the energy performance of buildings.

MRV bears directly on several of these: by standardising how savings are measured, verified and reported, it strengthens investor confidence in the following ways:

- **Performance validation:** Real-time monitoring reduces the uncertainty around projected savings. Projects with comprehensive MRV demonstrate actual savings rather than theoretical potential, reducing technology and implementation risk.

- **Standardised comparison:** Consistent measurement protocols allow investors to compare efficiency projects across different buildings, technologies, and geographies using common metrics.

- **Ongoing monitoring:** Continuous verification identifies performance degradation early, protecting investment returns and helping sustain efficiency gains over the contract's life.

- **Sustainability reporting:** Many investors and lenders must disclose the sustainability impact of their portfolios, for example under the EU Sustainable Finance Disclosure Regulation, and large companies remain subject to the Corporate Sustainability Reporting Directive, although its scope was narrowed in 2026. Both need reliable, auditable data. MRV can help provide it: verified energy-savings and emissions data can feed into ESG and regulatory disclosures and be integrated into existing financial models.

CASE STUDY – Dr. Oetker

South Africa

ENERGY PARTNERS REFRIGERATION



"Not having to invest a substantial amount of capital, on top of the cost savings we were able to achieve, has allowed us to complete the project in its entirety."

Ekan Yağar - Project Manager, Dr. Oetker



Context

The customer was planning for a plant expansion in Johannesburg. The barriers for the project retrofit included: uncertain project returns, high upfront CAPEX, system complexities, unreliable grid and risky operation and maintenance

EPR selling point

No upfront CAPEX, improved OPEX, reliable energy supply, lower risk for the customer and remote monitoring and verification.

Solution

- *15-year Cooling-as-a-Service (CaaS) contract*
- *Ammonia refrigeration plant (1,671 kW, 475.2 tons of refrigeration) with waste heat recovery*
- *MRV: a highly reliable MRV mechanism to track the Project performance*
- *Price: fix and variable component*

Benefits

- *+30% energy savings*
- *1,200 tonnes of CO_2 avoided per year*

Financing

- *Debt-equity financing into SPV set-up by Energy Partners & Investec*

Play case study video

Figure 2. Energy Partners' Dr. Oetker Case Study

Figure 2 shows how MRV supports a servitisation offer in practice. Dr. Oetker, a multinational food company, contracted Energy Partners Refrigeration (EPR) to deliver a Cooling-as-a-Service retrofit at its plant in South Africa, with an agreed MRV mechanism built into the contract.[18] The client pays a monthly fee for the refrigeration it uses, while the provider owns, operates and maintains the equipment for the 15-year contract term. The project has delivered energy savings of 30 per cent, added waste-heat recovery and avoids around 1,200 tonnes of CO_2 a year. Although the case comes from industrial cooling rather than building retrofits, it shows how an agreed measurement mechanism allows a service promise to be financed.

Closer to most building owners, a Lighting-as-a-Service contract at a secondary school in Waregem, Belgium, cut lighting electricity use by more than 70 per cent, with the provider guaranteeing performance and checking it in yearly inspections.[19]

Verification makes savings credible, but credibility alone does not make a cash flow bankable; the residual performance risk must be allocated or absorbed. This is where risk-mitigation instruments complete the chain: performance guarantees, reserve or escrow accounts, and savings-insurance mechanisms, such as BASE's Energy Savings Insurance (ESI), that compensate the client if verified savings fall short of contracted levels.[20] By capping downside risk, these instruments convert a verified-but-uncertain savings stream into a credit-enhanced, investable cash flow.

[18] SET Alliance, 2024. *State-of-the-Art Ammonia Cooling Service for South African Frozen Food Producer*. Accessed 20 August 2026.

[19] EaaS Initiative, 2023. Circular Light-as-a-Service at Sint-Paulus school, Campus Hemelvaart, Waregem, Belgium: case study.

[20] ESI, 2024. Energy Savings Insurance (ESI). See also: https://esi-europe.org/how-it-works/.

ESI is a mechanism developed by BASE with the Inter-American Development Bank, providing exactly this type of credit enhancement: an insurer validates the savings methodology and covers the shortfall if verified savings fall below the contracted level, converting a verified-but-uncertain savings stream into a bankable cash flow.

3. MRV deployment: challenges and solutions

3.1 Key steps and requirements for MRV implementation

MRV is a systematic, multi-phase process that runs in three phases:

1. **The baseline period establishes the measurement foundation upon which all future savings calculations depend.** This phase begins by defining project objectives and stakeholder requirements, considering both accuracy needs and budget constraints. The baseline energy consumption is monitored, and key factors influencing it are identified. An MRV plan is developed to specify measurement boundaries, data collection protocols, calculation methodologies, and performance thresholds. Finally, measurement infrastructure - including sensors, smart meters, and data integration systems - is designed and installed to support both baseline documentation and ongoing monitoring.

2. **The installation period maintains measurement continuity while efficiency measures are implemented** by monitoring for changes in site conditions (temperature setpoints, operating schedules, occupancy patterns) that could affect savings calculations. Once installation is complete, an operational check confirms that all systems work as designed before the performance measurement begins.

3. **In the reporting period, measurement data is transformed into verified savings by:** (a) collecting energy and operating data; (b) determining savings for each period - accounting for changes in influencing factors; (c) reporting verified performance for contractual and regulatory requirements; and (d) tracking energy performance and savings to enable rapid response to any performance degradation.

MRV also requires solid measurement and analytical capabilities. Factors that influence energy consumption call for different monitoring approaches: continuous tracking for variables such as weather and occupancy, and periodic checks for equipment specifications and building characteristics. Where direct measurement is impractical or too costly, mathematical models and computer simulations calibrated against real measurements can provide accurate savings calculations. System integrators must connect MRV systems to existing building management systems while meeting the data quality standards that contracts require. This is what turns MRV from simple energy monitoring into a measurement system capable of supporting financial transactions.

3.2 Overcoming common barriers

Historical data quality issues undermine MRV accuracy and contract enforceability in performance-based business models. Legacy buildings often lack comprehensive metering infrastructure, with infrequent data sampling, dysfunctional equipment, or absence of historical energy consumption records. This creates challenges in establishing accurate baseline scenarios - the foundation upon which all future savings calculations depend.

Organisations can address these challenges by implementing retrofit metering programmes with 6-12-month data collection periods before major efficiency investments, deploying smart meters and sensors for continuous monitoring, and establishing minimum data quality standards before project initiation. While these solutions delay project implementation, properly establishing the baseline is crucial for long-term project success.

Standardisation challenges create fragmentation that prevents scalable MRV adoption across the energy efficiency market. The proliferation of different MRV protocols, methodologies, and reporting formats complicates cross-project comparison and increases implementation costs. Furthermore, each MRV project is unique: different energy efficiency projects and building types require different MRV tools, as data collection differs since variables affecting energy consumption vary across contexts. This demands custom protocol selection and tool development, requiring significant investments and specialised consultants.

The solution lies in adopting internationally recognised standards such as IPMVP, implementing flexible data collection systems that can generate multiple report formats, and developing sector-specific MRV templates for common building types.

Standardisation also makes aggregation possible. By generating consistent, verifiable performance data across projects, it is a precondition for aggregating individually small efficiency projects into portfolios of institutional scale.[21] Such aggregation can help overcome the fragmentation and small ticket sizes that often limit investor appetite, giving access to larger pools of capital through portfolio-based or securitised structures.[22]

Resource constraints and technical expertise gaps prevent widespread MRV adoption, particularly among SMEs. Organisations may lack the internal capabilities for complex data management, analysis of large volumes of monitoring data, and navigation of complex MRV protocols. The high costs associated with hiring specialised consultants and implementing comprehensive monitoring systems create additional barriers. Companies offering energy efficiency solutions could therefore partner with energy utilities, which often already have the technical expertise, data infrastructure and access to consumption data.

3.3 Policy recommendations

Policymakers should introduce a phased incentive structure to drive MRV adoption while avoiding additional barriers to the energy transition. Initially, voluntary programmes could offer enhanced subsidies or bonus credits for energy efficiency projects that integrate robust MRV protocols, particularly for larger projects. This would create market pull and allow time for the development of MRV expertise and infrastructure. In subsequent phases, as capacity grows, MRV integration could transition to a mandatory requirement for specific project types or investment sizes.

Education and training programmes are essential to address the current lack of MRV expertise, which requires both domain knowledge in energy science and data science skills, including causal inference methods. MRV competency demands multidisciplinary education that combines energy systems understanding with advanced statistical methods beyond traditional predictive modelling and machine learning.

Training programmes should target energy service companies, facility managers, and technical professionals through certification curricula developed in partnership with universities and technical schools.

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[21] Neusel, L, Rohde, C, Glenting, C and Mouzakitis, S. 2026. Return of the DEEP: One platform to benchmark
them all. eceee Summer Study proceedings, 1(1): 32, pp. 1-14. ;

[22] PV Magazine, 2018. Raising capital in very large chunks: The rise of solar securitization. Accessed 20 August 2026.

For example, the Efficiency Valuation Organization has created IPMVP certification programmes that can serve as models and should be encouraged to provide structured MRV education pathways.

Finally, policymakers should strengthen the legal and financial framework for performance-based contracts. Clear guidelines and protocols for MRV verification standards and performance measurement are needed to provide legal certainty for both service providers and financiers when disputes arise over energy savings.

Establishing standardised dispute resolution mechanisms and clear liability allocation frameworks would reduce risks associated with MRV system failures or conflicting measurement results. Public guarantee schemes could further reduce risks for service providers, making performance-based contracts more attractive to market participants.

What this means for building owners

- **Upgrade without the upfront investment.** Under Efficiency-as-a-Service or an energy performance contract, the provider finances and owns the equipment and is paid from measured results.
- **Agree the MRV plan before you sign.** It should set out the baseline period, the factors used to adjust it (such as weather, occupancy and operating hours), the IPMVP option applied and who verifies the results.
- **Start collecting data now.** Twelve months of metered consumption data, ideally at hourly or 15-minute intervals, makes it quicker and cheaper to establish a baseline.
- **Know who carries the risk.** Shared-savings, guaranteed-savings and pay-per-consumption contracts treat a shortfall in savings differently.
- **Use the data twice.** The verified savings that settle the contract can also support sustainability reporting and access to green finance.

In Switzerland, BASE's Servetia initiative, run with E4S and supported by Fondation Valery, helps owners of energy-intensive building sites (such as hospitals, commercial and industrial) adopt sustainable and efficient service-based energy solutions.

4. Conclusion

MRV can help unlock the investment needed to close the energy efficiency gap. By transforming energy efficiency projects from capital expenditures with uncertain returns into performance-based investments with verified outcomes, MRV enables the servitisation business models that address the sector's fundamental financing barriers. This shift from ownership to service models removes upfront capital constraints, aligns provider incentives with efficiency outcomes, and transfers technical risks to parties best equipped to manage them.

The path forward requires coordinated action across technical, policy, and market dimensions. While MRV protocols like IPMVP provide the technical foundation, widespread adoption depends on addressing data quality challenges, developing standardised implementation approaches, and building the specialised workforce needed for complex measurement and verification systems. Policymakers must create enabling frameworks through phased incentive structures, education programmes, and legal certainty for performance-based contracts.

Success in scaling MRV could significantly increase and accelerate energy efficiency's role in the energy transition. Because building retrofits are a cost-effective way to decarbonise, reliable measurement and verification of their performance is essential to meeting global climate commitments.