Deployment Guidelines – Buildings and Construction Sector

April 2024

EUROPEAN GREEN DIGITAL COALITION

Funded by the European Union

EUROPEAN GREEN
DIGITAL COALITION

Deliverable name: Deployment Guidelines – Buildings and Construction Sector

Dissemination Level: Public

Published: April 2024

Lead Author:

Beatriz Fialho da Silva, Carbon Trust

Supporting Authors:

Veronika Thieme, Carbon Trust

Felix Prettejohn, Carbon Trust

Aleyn-Smith Gillespie, Carbon Trust

Anna Jezewska, Carbon Trust

Anaelle Gomez, Carbon Trust

Liam Fitzpatrick, Carbon Trust

Diane Mouradian, Deloitte

Jack Simpson, Deloitte

Pim Oudejans, Deloitte

Heather Grant, Deloitte

Ines da Costa Ramos, Deloitte

Editors/Reviewers: European DIGITAL SME Alliance (Déborah Goll, Lina Nardone)

The European Green Digital Coalition (EGDC) is an initiative of companies, supported by the European Commission and the European Parliament, based on the request of the EU Council, which aims to harness the enabling emission-reducing potential of digital solutions to all other sectors.

The secretariat of the European Green Digital Coalition is managed by the consortium of the European Parliament Pilot Project for the EGDC, funded by the European Commission, namely the leading associations GeSI, the European DIGITAL SME Alliance, DIGITALEUROPE, ETNO and GSMA, working together with Carbon Trust, Deloitte, Sustainable ICT.

This deliverable has been produced by the consortium of the European Parliament Pilot project for the EGDC.

Global Enabling Sustainability Initiative (Coordinator)

DIGITALEUROPE

European Telecommunications Network Operators' Association

European DIGITAL SME Alliance

SUB-CONTRACTORS

Carbon Trust

Deloitte

GSMA

Sustainable ICT Consulting

EUROPEAN GREEN
DIGITAL COALITION

Table of Contents

1 Introduction

To help maximise the benefits of ICT solutions with the potential to enable a positive net carbon impact[1], the European Green Digital Coalition (EGDC) European Parliament (EP) Pilot Project has developed a set of Deployment Guidelines. These guidelines provide recommendations for solution developers and providers, as well as considerations for buyers/users of ICT solutions, investors, and policy makers to:

1. Maximise carbon, resource, and energy savings enabled by ICT solutions
2. Minimise solutions' emissions
3. Define metrics and track them to understand solutions' impact
4. Going further: Designing the solution to broaden its reach; and
5. Appropriately consider other sustainability impacts beyond carbon

Six separate sets of guidelines have been developed to cover the six sectors identified as priority areas by the EGDC: Energy/Power; Transport; Construction/Buildings; Manufacturing; Agriculture; and Smart Cities. This specific guidance document focuses on the ***Buildings and Construction Sector***.

To ensure that the Deployment Guidelines bring benefits to all involved parties and reflect the needs of each sector, the EGDC EP Pilot Project has consulted relevant stakeholders via a series of sectorial workshops, involving parties from each priority sector, including solution developers, end-users, and decision makers.

It should be noted that any reference to carbon or carbon emissions designates emissions of all greenhouse gases.

[1] ICT solutions with the potential to enable a positive net carbon impact are technologies that can help users avoid or reduce climate-harming greenhouse gas emissions, usually through a reduction or avoidance of resource use (e.g. fuel, electricity, raw materials, etc.).

1.1 Buildings and Construction Sector – A Call for Decarbonisation

Decarbonising the Buildings and Construction sector is of crucial importance to mitigating climate change given that they are significant contributor to greenhouse gas emissions, accounting for around 26% of global GHG emissions[2]. Decarbonisation of this sector promotes resource and energy efficiency, reduces waste generation, and encourages the utilisation of more sustainable materials. Sustainable buildings and construction can also better interact with and help decarbonise other sectors, such as the integration with renewable energy systems (e.g. on-site solar panels on building roofs), reducing emissions in the energy sector and those of the use phase of buildings.

To keep on track for a net zero world, greenhouse gas emissions from the operations of buildings must reduce by more than 50% by 2030. This primarily necessitates substantial efforts to decrease energy demand across all end-uses through the adoption of clean and efficient technologies, including leveraging the potential of behavioural change.[3]

At the heart of this transformation lies the recognition that ICT solutions poss the ability to optimise resource consumption, minimise waste generation, and enhance energy efficiency across various sectors. By harnessing advanced technologies such as the Internet of Things (IoT), artificial intelligence (AI), and cloud computing, we can unlock new avenues for sustainability and drive substantial positive change.

2 Maximising net carbon impact from the implementation of ICT solutions

ICT solutions hold great potential for enabling decarbonisation across sectors. Their integration can revolutionise industries, optimise processes, and reduce carbon emissions. However, it is crucial to emphasize that simply adopting ICT solutions is not enough to achieve maximum decarbonisation potential. The development, deployment, and use of these solutions must be done strategically and purposefully to ensure their effectiveness, maximising co-benefits to the wider community. This requires a

[2] Report: Current technologies can halve built environment emissions, https://www.edie.net/report-current-technologies-can-halve-built-environment-emissions/?regwall=success&advance_login=success
"The buildings and buildings construction sectors combined are responsible for 30% of total global final energy consumption and 27% of total energy sector emissions." https://www.iea.org/topics/buildings
[3] IEA Buildings Tracking Report 2022, https://www.iea.org/reports/buildings

comprehensive approach that considers factors such as scalability, performance tracking, and post-sale support to demonstrate results in line with financial and policy-maker expectations. Below, you will find five key areas to consider and explore in order to help maximise the potential of ICT solutions:

Monitoring and tracking performance
- To quickly troubleshoot any issues
- To allow for an understanding of performance under different circumstances
- To inform future improvements

Post-sale Training
- Plan for adequate training and support resources to assist users in adopting and troubleshooting the solution.
- Provide documentation, tutorials, and a support system to assist users and address their queries.

Post-sale Support
- Carbon benefits may decrease over time without adequate maintenance and support; support should be provided to ensure lasting positive impacts.

Integration
- Determine how the solution will integrate with existing systems or third-party services
- Consider data exchange to ensure smooth integration

Performance Optimisation and Automation
- Consider the potential of automation.

2.1 Monitoring and tracking performance

To maximise the emissions-reducing benefits of an ICT solution, it is essential to implement robust monitoring and tracking mechanisms to assess its performance. By continuously monitoring the solution's effectiveness, potential issues can be quickly identified and addressed, minimising disruptions and maximising reductions.

Monitoring and tracking also provide valuable insights into the solution's performance under different circumstances, allowing for a more comprehensive understanding of its strengths and limitations. For solution developers and buyers, this knowledge can serve as a basis for informed decision-making and helps identify areas for future improvement.

On the other hand, providing solution users with access to usage and performance data empowers them to better understand their consumption patterns and make more informed decisions. Solutions should therefore aim to measure and analyse relevant data and generate feedback that highlights the environmental impact of users' actions and behaviours. This feedback serves as a valuable tool for raising awareness and promoting behavioural change towards more sustainable practices, with an even greater potential to inform and enable automation to make behavioural changes obsolete. With clear information about their consumption habits, users can identify improvements such as reducing energy usage, optimising resource utilisation, or adopting eco-friendly alternatives.

Building and Construction Sector

Example – *residential tenants with smart meters and ICT solution which analyses their consumption data and provides specific insights on energy use*:

Through data analysis, users can receive personalised feedback on their energy usage and its environmental impact. This feedback can highlight areas where improvements can be made, such as identifying energy-intensive appliances or inefficient systems. With this knowledge, users can take proactive measures to reduce emissions by adjusting their behaviour, such as turning off appliances when not in use, optimising heating and cooling settings, or scheduling energy-consuming activities during off-peak grid hours.

2.2 Post-sale training

In the context of maximising the benefits of an ICT solution for emissions reduction, post-sale training provided by both the solution developers and buyer plays a key role. Without proper training, users may struggle to fully grasp the solution's features, leading to suboptimal usage and missed opportunities for emissions reductions.

The availability of comprehensive documentation, tutorials, and a responsive support system during the solution rollout and installation, significantly enhances users' ability to troubleshoot issues and address queries. By prioritising the provision of post-sale training, solution developers/providers and solutions buyers help users have the necessary knowledge and resources to optimise the solution's performance. Collaboration with higher education institutions to encourage training of green technology engineers could support a sustained supply of skilled labour.

Building and Construction Sector

Post sales training should ensure that ICT solutions are properly integrated into existing systems and that the solution buyers and users have adequate resources to implement and use the solutions. For example, for solutions in buildings, solution developers should provide support to buyers for proper installation of the solution (considering variabilities, such as building type, size, energy sources, and type of tenant) and brief the buyer on how changes in circumstances can impact the performance of the ICT solution. Solution developers should also provide guidance to users (either directly or via the buyer) to train them on how to appropriately

use the solution to maximise the enabled benefits. This might include prompting solution buyers to engage with staff/tenants and develop appropriate policies (e.g. 'what is the acceptable ambient temperature?') and best practice behaviour. In addition, solution developers should consider providing any learning materials in the user's native language for ease of communication. Barriers and Challenges: There is no guarantee that those trained will be the ones to continue operating the solution. Important to create a culture of training and have materials than can be passed on to the new users. The onus should be on the solution developers to provide materials that can be easily shared (e.g. don't require in-person training, and aren't materials that have a time limit), and the onus should be on solution buyers and users to ensure the new users are properly trained. Users, such as facilities managers, that have had an ICT solution integrated into their work by solution buyers may be resistant to change. Training should take this into account and strive to be delivered in an inclusive and engaging manner, showcasing to the users the direct benefits to them and positive overall impacts. Lastly, there may also be barriers associated with the cost and time commitment of training. For example, in the case of construction, if a buyer pushes its employees to implement a specific ICT solution this might impact the employees' timeframes to deliver existing project plans. Whilst there is a short-term burden to a continued training expense, a sustained training programme ensures the workforce is kept up to speed with updates made to software and ensures that potential workforce turnover does not result in reduced understanding of the solution's features over time or reduced efficiency of the solution implementation. Solution buyers should take this into account and adjust the timeframes for employees to ensure the burden is not passed on to them.

2.3 Post-sale support

Post-sale support provided by the Solution Developer after the installation of the ICT solution is another component which can help maximise savings. Without ongoing support, the carbon benefits achieved through the initial implementation may decrease over time.

Adequate maintenance and support are necessary to ensure the solution continues to operate optimally, adapt to evolving needs, and deliver lasting positive impacts on emissions reduction. Post-sale support includes addressing technical issues, offering guidance on best practices, assisting in system updates and upgrades, and providing the appropriate replacement parts. This ensures that the ICT solution remains effective and efficient throughout its lifespan, sustaining the desired emissions reductions and maximising the long-term environmental benefits.

Building and Construction Sector

Examples:

Equipment or System Malfunction in Buildings: Over time, building equipment and systems may experience malfunctions or performance degradation. Ongoing support helps avoid these issues going unnoticed or unresolved, by identifying and addressing equipment malfunctions promptly, ensuring that the ICT solution continues to operate and provide optimal savings.

Changes in Building Usage: Buildings are dynamic environments, and changes in occupancy patterns, operational hours, or space utilisation can impact energy consumption. Without ongoing support, the ICT solution may not adapt to these changes effectively, leading to energy inefficiencies and reduced savings.

Technological Advancements and Updates: The Buildings and Construction sector is continuously evolving, with advancements in technology and software updates. Without post-sale support, the ICT solution may become outdated or incompatible with newer technologies, limiting its effectiveness and potential savings. Ongoing support can help ensure that the solution remains up-to-date, compatible with the latest advancements, and capable of leveraging new features or functionalities that enhance energy efficiency.

Barriers and Challenges:

Post-sale support can have an associated cost. Policy and government have a role to play providing support for these services, maintenance guarantees, and in preventing obsolescence.

Opportunity:

This support, along with post-sale training, can be seen as an opportunity for companies to extend their portfolio of services.

2.4 Integration

ICT solutions are usually integrated into complex systems. Implementing ICT solutions therefore requires careful consideration of how these solutions will interact with existing systems or third-party services. An important step in the integration process is determining how the solution will seamlessly fit into the current infrastructure, minimising disruptions, and maximising efficiency gains. Solution developers should assess solution compatibility, identifying potential dependencies, and designing interfaces for smooth interaction between different systems. They should engage with solution buyers and users to understand the case-by-case circumstances and provide guidance accordingly. Solution buyers and users should work collaboratively with developers and providers to provide insight into their systems and highlight any potential issues or roadblocks.

Building and Construction Sector

For the successful implementation of ICT solutions, coordinating the deployment of infrastructure and devices is essential. Ideally, the selection and implementation of clean technologies in buildings should be synchronised with the design and implementation of building facilities management and systems, such as those heating, ventilation, and air conditioning (HVAC).

Pre-sale support plays a role in this, helping buyers and users to identify and select the optimal solution that integrates best into their building or construction type and location.

2.5 Performance Optimisation and Automation

Lastly, performance optimisation and automation are components of maximising the potential benefits of ICT solutions. Automation plays a key role in this process by reducing human intervention and streamlining operations, by enabling real-time monitoring, predictive analytics, and intelligent decision-making. This allows for timely adjustments and optimisations to minimise energy and resource waste. By limiting human intervention, the potential for errors and inefficiencies decreases.

Building and Construction Sector

Energy management in buildings can help facilities managers to make decisions more effectively and centrally manage consumption. With access to data intelligence, these managers are empowered to not only make informed choices but also to engage with staff and establish appropriate policies. However, where improvements based on the tracked data are not automated and instead left up to manual adjustments and human intervention, the savings may be limited.

Leveraging AI in the decision-making process can aid in selecting the best possible conditions – for example, understanding when the blinds should be closed and lights turned on, and having this process by done automatically. By embracing automated solutions, energy savings can be increased, ensuring a more efficient and sustainable decision support process/system.

3 Minimising emissions

As the focus is often on maximising the net carbon impact potential of an ICT solution, it is critical not to forget the need to minimise the 'cradle to grave' emissions resulting from the deployment and use of that same ICT solution. While digital can be a force for good, the digital transformation of sectors has the potential to inadvertently contribute to environmental harm. By prioritising emission reduction strategies, solution developers/providers, buyers, and users can ensure that the benefits derived from an ICT solution are not offset by its carbon footprint. This section of the Deployment Guidelines, therefore, focuses on the need to actively mitigate and reduce emissions associated with the creation, adoption, utilisation, and disposal of ICT solutions.

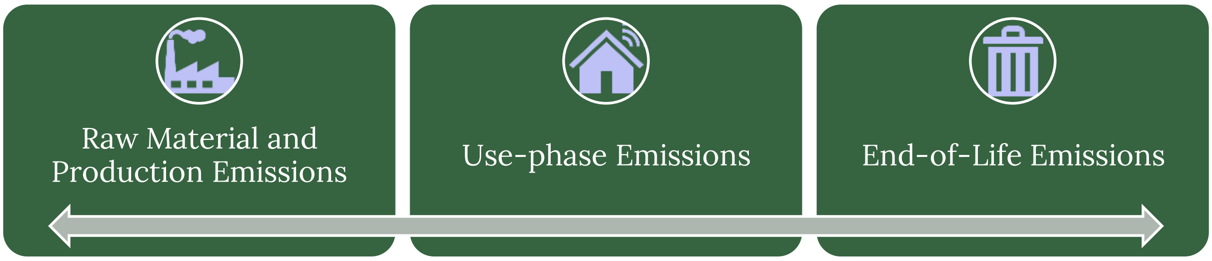
3.1 Negative direct effects from the solution itself

While emissions from the solution itself may not always be significant compared to the savings it enables, they remain something to be aware of and to minimise. Typical hotspots of emissions of an ICT solution include the following:

- **Hardware and its manufacture**: ICT solutions often have physical hardware components. The production of these components involves the extraction and processing of raw materials, manufacturing processes, and assembly. Emissions hotspots in this phase of a solution's lifecycle include the energy consumption in factories, emissions from chemical processes, and the extraction of materials (including rare earth metals, such as lithium for batteries).
- **Use phase – hardware and software**: During the use phase, ICT solutions consume energy when in operation. This includes charging, data processing, and network connectivity. The emissions hotspots in this phase of a solution's lifecycle are primarily associated with electricity consumption.
- **Use phase – network infrastructure**: ICT solutions do not often operate as a standalone. The operation of data centres, telecommunications networks, and other ICT infrastructure requires a significant amount of energy. Data centres, in particular, consume large amounts of electricity for cooling, server operation, and data storage.

- **End-of-life**: Due to limited waste management process and sometimes a lack of understanding of appropriate waste practices by users, e-waste is often disposed of incorrectly causing harm to the environment and costing society valuable natural resources. When ICT solutions reach the end of their life, they need to be adequately disposed of or recycled. Emissions can occur during the disposal process, especially if electronic waste is incinerated or ends up in landfill. If not conducted properly, recycling processes can also generate emissions than would be saved by the reuse of the materials.

3.1.1 Minimising emissions



Embodied Carbon:

- **Life cycle assessment**: Ideally, developers should conduct life cycle assessments of their solutions to identify and address emissions across the entire life cycle, from production to disposal. This can help optimise the environmental performance of the solutions. Developers should follow leading global standards (such as the GHG Product Life Cycle Accounting and Reporting Standard) or, if there are no in-house capabilities, consult third parties to support. Companies should share life cycle data of their products openly for down-stream supply chain actors to build on these.
- **Raw material and production emissions**: Developers should select and work with suppliers that provide sustainable raw materials. They should measure and manage their Scope 3 emissions to reduce the associated production emissions.
- **End-of-Life emissions**: Developers should be designing ICT solutions to be circularity-ready. Integrating circularity involves two key steps: designing for reuse/refurbishment and implementing effective e-waste management systems. This includes incorporating the possibility for components of the solution to be refurbished or maintained to extend the end of life of devices, as well as establishing collection and recycling programs to ensure proper disposal and recovery of valuable materials. Actions to tackle end-of-life of devices should be incorporated as part of post-sale support.

Funded by
the European Union

- Important note: As far as software updates are concerned, while some might indeed allow to improve efficiency or compatibility of the solution with other technologies, updates could also lead to early obsolescence of devices. Solution developers and providers should be conscious of this when rolling out updates.

Overall, minimising solution emissions can be quite resource and cost intensive. However, solution developers and providers do not need to be doing of this alone. Solution developers and providers should strive to develop B2B partnerships to work together with other organisations. Policy and industry bodies also have a role to play incentivising data sharing and providing support for developers/providers to do these assessments and help facilitate B2B and industry wide engagements.

Operational Carbon:

Use-phase emissions:

- **Energy-efficient design**: Developers should prioritise energy efficiency in the design of their solutions, ensuring that the solutions consume minimal energy while delivering the desired functionalities. This can include optimising algorithms, reducing standby power, and using energy-efficient components.
- **Partners:** When developing a solution, it is important to consider who to partner with and the impact of their contribution. If your solution will use the cloud/data centres, what is the impact of this? Do the cloud/data centres run on renewable energy?

Building and Construction Sector

On-site renewable energy or demand side energy management can be integrated into buildings to decrease the carbon intensity of the electricity consumed.

Excessive use of digital technologies can lead to an unnecessary increase in energy consumption and emissions. For example, ICT solutions increasingly incorporate elements of Artificial Intelligence (AI) to enhance performance. However, as AI can greatly increase the energy intensity of a solution, solution developers/providers should assess the gained benefits (e.g. fuel and energy reductions in a fleet) enabled by AI, against the increase in direct energy use of running the AI.

3.2 Minimising rebound (negative indirect) effects and other potential negative impacts on the climate

Increases in emissions from the introduction of a solution can come not only directly from the solution itself but can be the result of unintended consequences of the introduction of the solution. These negative impacts are known as Rebound Effects, and typically occur as effects that cause an increase in consumption due to improved efficiency of resource use, for example, an efficient product is cheaper to operate, and hence more is consumed. The improved efficiency is not limited to cost, but can be any resource, such as materials, time, cost, or space.

This subsection considers circumstances where the positive climate impacts of the solution could be diminished or reversed and will provide guidance on how to address this.

Building and Construction Sector

A rebound effect is the increase in emissions occurring as result of the introduction of the ICT solution, often driven by behavioural changes in demand for carbon-intensive goods or activities .

Common rebound effects to look out for are outlined below.

- ***Increased energy consumption due to extended use and overcompensation for energy savings:*** ICT solutions that improve energy efficiency, such as smart thermostats or energy management systems, result in energy savings. However, occupants or building operators might respond to these savings by increasing their energy consumption in other areas or running their heating/cooling for longer, offsetting some or all of the initial gains.
- ***Increased comfort expectations:*** ICT solutions in buildings can provide enhanced comfort and convenience to occupants. This may lead to higher expectations and demands for indoor climate control, lighting, and other amenities. If occupants increase their energy usage to achieve higher comfort levels facilitated by ICT solutions, it can result in rebound effects. Marketing should provide information to consumers and solution users that encourages them to prevent increasing their comfort expectations. Solution providers should collect baseline data and prevent the increase of comfort levels beyond those observed prior to the installation of the solution. Solution providers should employ nudge strategies to move consumers towards lower comfort expectations and building operation.
- ***Technological upgrading***: The introduction of ICT solutions can create a situation where occupants or building owners become dependent on the technology and subsequently upgrade or add new devices more frequently. If frequent upgrades or additions are made

without considering the environmental impact, it can result in increased emissions associated with the production, disposal, and recycling of these digital devices.

- ***Behavioural changes and increased demand for carbon-intensive activities***: ICT solutions may inadvertently lead to behavioural changes, such as increased use of energy-intensive amenities or activities within buildings. For example, the introduction of home automation systems may encourage occupants to utilise energy-consuming devices more frequently or engage in energy-intensive activities like streaming, gaming, or operating home cinemas. Marketing should provide information to consumers and solution users that encourages them to prevent increasing the use of energy-using devices. Solution providers should collect baseline data and notify about increases in the number of connected devices operated in a building (e.g. based on identification of device MAC addresses). Solution providers should employ nudge strategies to steer consumers away from the purchase of additional devices.

It is important to note that rebound effects are impacted by their specific context. Factors impacting them include user behaviour, and the design and implementation of ICT solutions. Solution developers/providers, buyers and users should carefully consider these rebound effects and adopt measures to mitigate them through energy-efficient practices and user awareness and education.

3.2.1 How can rebound effects or negative impacts be avoided or mitigated?

While rebound effects will often be outside of the direct control of solution developers, it is important for prevention and mitigation processes to be put in place. Developers, providers, buyers, and users of ICT solutions should consider how to minimise rebound effects throughout the solution lifecycle. Not considering this can lead to the diminishing or reversal of savings enabled by the ICT solution.

Building and Construction Sector

Tracking of Rebound Effects:
Tracking rebound effects in the context of ICT solutions deployed in buildings requires collaboration and shared responsibility among different stakeholders. The responsibilities can be divided as follows:

1. ***Solution developers/providers***: Developers and providers of ICT solutions have a primary responsibility to design and offer solutions that prioritise energy, fuel and

Funded by
the European Union

resource efficiency. However, it can be this very efficiency that drives the rebound effect. Developers and providers should therefore conduct thorough assessments of potential rebound effects during the development and deployment phases of their solutions. This includes evaluating the potential behavioural changes and impacts on energy consumption that could result from the use of their solutions. And guard against these when possible. How to do this depends on the concrete circumstances and solutions. Developers should also provide guidance and information to solution buyers and users regarding the optimal use of their solutions to minimise rebound effects.

2. ***Solution buyers (including deployers such as public bodies, cities, companies):*** Solution buyers, such as public bodies, cities, and companies, play a role in ensuring the effective monitoring and management of rebound effects. They should consider the possible ways in which rebound effects may materialise in the different circumstances for which they are purchasing the ICT solutions. Buyers should then engage with users to establish clear performance indicators to track and mitigate rebound effects over time.
3. ***Solution users (including tenants and building managers):*** The users of ICT solutions in buildings, including occupants and facility managers, have an important responsibility to monitor and manage their energy use. Users should understand the features and functionalities of the ICT solutions in place and make informed choices to minimise rebound effects. They should actively engage in energy monitoring, adopt energy-efficient practices, and utilise the solutions in a manner that aligns with sustainability goals. Users should also provide feedback to solution developers/providers and solution buyers regarding any observed rebound effects or opportunities for improvement. Observation of rebound effects is challenging, as it requires the identification of an increase in consumption of a service relative to levels prior to the rebound effect, and attribute that increase to a rebound, and not as the consequence of the behavioural context. E.g. A user might reliably identify as rebound when a target setpoint for indoor temperature was observed to be higher relative to a previous value under similar external temperature conditions. However, if the target setpoint is increased relative to previous values to reduce occurrence of mould, the user would likely not report this as rebound.
4. ***Regulator/Governance/Policy:*** Where potential for rebound effects has been identified, the system should actively prevent these to manifest. This is not possible for an individual solution provider to achieve but requires sector-wide action, that should be accompanied by information campaigns that result in shifting norms. Policy should also fund more research to investigate how rebound can be prevented without overly compromising individual liberty.

The tracking of rebound effects should involve a collaborative effort among solution developers/providers, buyers, occupants/users. Such a cross-sectorial collaboration needs to be supported by the policy. By establishing clear responsibilities and promoting cooperation, it becomes possible to effectively monitor and mitigate rebound effects associated with the deployment of ICT solutions in the Buildings and Construction sector.

Funded by
the European Union

Avoidance or Mitigation of Rebound Effects:
Rebound effects can be avoided or mitigated through a combination of approaches involving solution design, awareness, and prevention. By incorporating preventive measures through solution design, promoting awareness among users and buyers, and encouraging energy-efficient behaviours, rebound effects can be avoided or mitigated.
Each stakeholder group can contribute to avoiding or mitigating rebound effects in the following ways:

5. **Solution developers/providers:**
    a. Solution design: Developers can incorporate features that automate processes and limit human intervention, reducing the potential for energy-intensive behaviours. For example, implementing AI optimise energy usage or utilising occupancy sensors to control lighting and HVAC systems efficiently.
    b. Supporting users by increasing user awareness and providing training: Users should receive appropriate training and education to understand the potential rebound effects associated with ICT solutions. This can include information on energy consumption hotspots and behaviours to promote energy efficiency (in ways that does not contribute to rebound) and avoid unintended but anticipated rebound effects. Developers and providers should report identification of unanticipated rebound effects. For this sector-wide learning, tracking, reporting and knowledge exchange of rebound effects is necessary.
6. **Solution buyers** (including deployers such as public bodies, cities, and companies):
    a. Assessing risks and increasing user awareness: Solution buyers should consider the possible ways in which rebound effects may materialise and assess the risks in each of the users/uses for which they are purchasing a solution. Buyers should establish regular high-level reviews of the identified rebounds, to assess materialisation, and performance monitoring of the deployed solutions to track impact and assess any rebound effects. Like solution developers and providers, solution buyers should engage with users to raise user awareness to the risks of rebound effects, and provide appropriate training and incentives to avoid or mitigate the potential rebound effects.
    b. Collaboration with developers: Buyers should also bring to the attention of solution developers/providers any identified rebound effects, to raise awareness and seek their expertise in mitigating potential impacts. This collaboration can lead to the development of tailored solutions and continuous improvement.
7. **Solution users:**
    a. Behaviour modification: Users should actively adopt energy-efficient practices and being mindful of their consumption behaviours. Regular reminders and feedback mechanisms can help users track and modify their behaviours to mitigate rebound effects.

b. Continuous monitoring and feedback: Users should engage in regular monitoring of energy consumption and provide feedback on the performance of the solutions and savings to solution buyers, who can feed this back to the solution developers/providers, sector-wide representation, and policy.

8. **Policy/Regulator**:
   a. In order to effectively manage rebounds, wide-ranging general data on the scale of rebound effects as well as detailed information on the context and manifestation of individual rebound behaviour needs to be collected and analysed. This includes unintended as well as unanticipated rebound effects.

4 Measuring net carbon impacts

Metrics are essential to support the solution's value proposition and to assess benefits and impacts. This section will provide guidance on which metrics to use and/or how to select them and can also address pitfalls to avoid in the process of selecting and communicating metrics.

4.1 Selecting the most relevant metrics

Different stakeholders care about different metrics. For example, solution developers might focus primarily on energy/fuel savings, whereas customers might focus more on reduced input costs. Focusing communication on metrics that matter to solution developers but don't matter as much to their clients or financial backers may lead to limited adoption. To optimise the deployment of a solution, understanding what metrics matter most to solution users and other stakeholders is key.

On the other hand, tracking the right metrics to be able to quantify the net carbon impact and understand the positive environmental potential of a solution is crucial to aid the path to sectoral decarbonisation. Some suggestions for relevant metrics for pre and post implementation are discussed below.

4.2 Pre-implementation metrics

What needs to be measured before implementation to establish a baseline from which to measure the solution's benefits?

To understand the benefits enabled by ICT solutions, key metrics must be defined and tracked. It is key to start tracking the relevant metrics before the implementation of the solution to allow for a reliable comparison between the before and after scenario. Without this, establishing a baseline and evidencing the positive impact of an ICT solution may be difficult and will likely need to rely on high-level assumptions. It is the combined responsibility of solution developers/providers, buyers, and users to work in collaboration to track the current scenario before the implementation of the solution.

Procedures should be put in place to normalise this practice. For solution buyers and users, tracking the current conditions and impact allows them to better understand their own current environmental impact and identify key hotspots for emission reduction. Without understanding the current conditions, it is harder to know what needs to be reduced, and by how much. On the other hand, solution developers/providers should encourage this practice and request this information pre-sale or at sale. Not only will this data help them better deploy the solution for the buyers and users but will also help them better understand and quantify the impact. Policy should introduce requirements to track relevant metrics for businesses and any other organisation operating energy-consuming infrastructure; as per scope 1 and 2 accounting rules.

Building and Construction Sector

To quantify the solution's impact, it is important to measure datapoints as accurately as possible before its implementation. The specific metrics to track depend on the solution type, but common metrics to track for the sector include:

- Energy sources
- Annual/monthly energy/fuel consumption; and/or resource use
- Areas of high energy/fuel consumption; and or/ resource use
- Fluctuations in consumption and why they happen

4.3 Metrics to track during and after implementation

To quantify and evidence the net carbon impact of an ICT solution, please see below suggested metrics to track during and after implementation. These metrics should align to those measured pre-implementation and should ideally also be metrics of interest for solution developers, buyers, users, and financial backers so that this data can be used to inform tracking beyond emissions reductions.

Building and Construction Sector

Buildings:

1. Energy consumption (before and after implementation): Measure the total energy consumption of the building, including electricity, heating, cooling, and other energy use sources. This metric helps assess the energy efficiency of the building and the effectiveness of the ICT solution in optimising energy usage. Alternatively, measure and calculate energy performance indicators such as energy use intensity (EUI) or energy consumption per unit area (kWh/m²). These indicators help compare the energy efficiency of the building before and after the implementation of the ICT solution and provide a benchmark for tracking improvements.

Other considerations:

2. Waste management (before and after implementation): Measure the amount of waste generated by the building, including solid waste and recyclables. Tracking waste management helps evaluate the effectiveness of the ICT solution in promoting waste reduction and recycling practices.
3. Renewable energy integration (before and after): Evaluate the integration of renewable energy sources in the building, such as solar panels. Monitoring the share of renewable energy used in the building pre-implementation of the ICT solution helps assess its effectiveness.

Construction:

1. Construction waste (before and after implementation): Measure the amount of construction waste generated, such as debris, packaging materials, and unused materials. Tracking waste reduction indicates the efficiency of the ICT solution in optimising material usage and promoting waste minimisation.
2. Material efficiency: Monitor the quantity of construction materials used per unit of construction output or area.
3. Energy consumption construction: Measure the energy consumption during the construction phase, including electricity and fuel used for construction equipment, lighting, and temporary facilities.

Note: with all these metrics it is also important to track any other changes that may be affecting these changes, to be able to separate variabilities from savings caused by the implementation of the ICT solution.

4.4 How to track effectively

Effective tracking of the deployment of ICT solutions requires careful consideration. To track their implementation, several key factors should be taken into account. Please find below the recommended checklist to follow:

Buildings and Construction Sector
Checklist:

- Clearly defined metrics: Define the specific metrics and indicators that will be tracked to assess the performance and impact of the ICT solution. Ensure that these metrics align with the goals and objectives of the solution and are measurable and quantifiable.
- Baseline assessment: Establish a baseline assessment of the building or system's performance before the deployment of the ICT solution. This provides a reference point for comparison and enables the measurement of the solution's effectiveness in achieving improvements. To align with best practice, the baseline should represent market average. Please refer to the Methodology (how to quantify net carbon impact) for specifics.
- Data collection and monitoring systems: Implement robust data collection and monitoring systems to gather accurate and reliable data on energy consumption, emissions, operational performance, occupant feedback, and other relevant parameters. Automated systems or sensors can help streamline data collection processes.
- Timely and continuous tracking: Initiate tracking efforts from the very beginning, ideally during the pre-deployment phase, to capture the baseline data. Continuously track and monitor the performance and impact of the ICT solution over time to assess its long-term effectiveness.
- Long-term measurement: The impacts of the ICT solution may evolve and change over time. It is important to monitor and measure the effects of the solution beyond the initial deployment phase to understand its sustained performance and identify any potential deviations or trends.
- Avoiding tracking pitfalls: Be cautious of common pitfalls in tracking, such as relying solely on self-reported data, inadequate data validation and verification processes, or inconsistent data collection methodologies. Implement rigorous quality control measures and ensure data accuracy and reliability.

Funded by
the European Union

- ❖ <u>Stakeholder engagement</u>: Clearly define roles and responsibilities for tracking among different stakeholders involved, including solution developers/providers, building owners, facility managers, and occupants. Collaborate closely with stakeholders to ensure effective data collection, monitoring, and reporting.
- ❖ <u>Continuous improvement</u>: Utilise the tracking results to identify areas for improvement, optimise the performance of the ICT solution, and inform future decision-making processes. Regularly review and update the tracking methodologies and metrics to align with changing goals and emerging best practices.
- ❖ <u>Policy</u>: Implement efficient rules to establish baseline data.

5 Going further: designing the solution to broaden its reach

While it is important to focus the deployment and implementation of each ICT solution on maximising of carbon benefits, it is important not to forget the impact of scalability. The more instances of deployed and scenarios of use, the greater the overall carbon benefits. Solutions are often designed with a specific use case in mind – however, sometimes making small design or development changes can make the solution usable in more scenarios and circumstances.

5.1 Relevance across potential use cases

When deploying ICT solutions to maximise their impact in decarbonisation efforts, it is important to consider their relevance and potential use cases. ICT solutions should not be limited to specific sectors or large-scale applications but should aim to be versatile and adaptable to various use cases. This approach ensures that the benefits of digitalisation reach a broader spectrum of industries and applications, including use by small and medium-sized enterprises (SMEs).

By designing ICT solutions with scalability and flexibility in mind, solution developers/providers enable their relevance across diverse sectors and empower small players, like SMEs, to embrace sustainable practices. This might involve developing user-friendly interfaces, providing customisable features, and offering affordable implementation options. By making ICT solutions relevant to as many use cases as possible, their potential can be unlocked across the entire economy, accelerating decarbonisation efforts at scale, and fostering a more inclusive and sustainable future.

Building and Construction Sector

Example

A high-performance building management system designed primarily to optimise energy consumption in office buildings, can be modified and approach to rollout adapted to other types of buildings with sub-partitions, such as hospitals, hotels, and educational buildings.

Below is a list of questions for solution developers to consider during the design phase of an ICT solution, to broaden the scope and use of solutions.

This section of the Deployment Guidelines aims to stay high-level, and it should be noted that these questions are only meant as a thought starter.

Technology and Infrastructure – Questions:

- How dependent is the solution on the availability and reliability of other technologies and infrastructure (e.g. mobile telecom grid, broadband network, electricity grid, roads, etc.)?
- Is the required infrastructure widely available in the markets where the solution could be deployed?
- Can the solution still work in areas where that technology/infrastructure is not as available/reliable?
- If not, would it be feasible and/or relevant to make the solution more adaptable to cases where those technologies and infrastructure are not available or reliable?

People – Questions:

- Does the solution require local labour skills for optimal implementation and after-sales/maintenance? (This is especially relevant if improper implementation and/or maintenance can lead to reduced carbon benefits.)
- If a lack of available skilled labour could lead to reduced carbon benefits, is there a way to prevent or mitigate this through solution design?

Physical environment – Questions:

- Is the solution limited to certain geographical and climatic conditions?
- Can the solution be adapted to work in a wider variety of geographic and climatic conditions?

Financial, business and policy environment – Questions:

- In the markets where the solution is intended to deploy, are there any financial, business and/or policy barriers (e.g. mobile data tariffs, regulatory barriers such

as tariffs for importing technology and parts, licensing…) that would significantly hamper deployment?
- If so, would it be feasible and relevant to design out some of these barriers (e.g. using materials subject to lower tariffs)?

6 Beyond greenhouse gas emissions: wider sustainability impacts

This section aims to take stock of the solutions' impacts beyond its effects on the climate, and to provide general guidance on how to mitigate negative impacts. As the focus of these guidelines is climate benefits, this 'wider impacts' section is intended to be high-level rather than specific guidelines. Its purpose is to highlight potential positive impacts beyond emissions savings that can be enabled by ICT solutions, while also helping stakeholders identify a range of potential negative impacts so that these can be prevented or mitigated before they arise. Where possible, solutions should adhere to the 'Do No Harm' principle[4].

Possible areas to consider when assessing wider impacts of the solution:

Environmental impacts beyond carbon	Economic and Social impacts	Health and Safety Impacts

6.1 Environmental impacts beyond carbon benefits

Beyond carbon, ICT solutions have the potential to have both positive and negative environmental impacts. Through the enabled monitoring, optimising, and automating, ICT solutions can help identify and improve environmental impacts, particularly around waste and water. However, the ICT sector can sometimes be overly tech-optimistic, assuming that digital innovations will inherently lead to positive outcomes and this optimism can overshadow critical issues such as the short lifetime of digital devices, the generating of electronic waste, and posing safety concerns. Below are a few examples to

[4] Please refer to the EGDC Net Carbon Impact Methodology for the definition and discussion of the Do No Harm Principle.

help prompt and guide stakeholders (developers, buyers, and users of ICT solutions) to explore the non-carbon sustainability impacts of ICT solutions.

Waste

Positive

ICT solutions can provide opportunities for training on waste reduction practices in the building and construction sector. By enhancing knowledge and awareness, these solutions empower professionals to adopt more sustainable practices, leading to reduced waste generation.

Negative

While designing an ICT solution to reduce carbon emissions, developers might overlook choices that do not directly affect the carbon impact but may still have a negative effect on the environment. For instance, the use of certain plastics as a material component can have a lower emissions footprint than many metallic components. However, given many plastics are hard to recycle, they tend to end up at landfill or in the natural environment, with considerable consequences for nature and local biodiversity. Capturing the wider environmental consequences of an ICT solution is challenging, but completing the appropriate lifecycle analysis will help solution developers and users to more accurately assess the end-to-end carbon impact of a solution.

On the other hand, electronic waste has also become a pressing environmental issue, as the proliferation of digital technologies leads to an increase surplus of discarded electronic devices. This increase is in part a result of a lack of ICT solutions being upgradable or repairable. Therefore, it is important that ICT solutions incorporate this into their deployment, to allow them to evolve with the changing requirements and advancements in technology and better align with the lifespan of buildings.

When solutions do reach their end-of-life, if they are disposal is not properly managed the negative consequences can be very high. Improper disposal of e-waste poses significant environmental and health risks, as most electronic devices contain hazardous materials. Many regions lack proper recycling infrastructure, and as a result, a considerable portion of e-waste ends up in landfills or is informally processed, often in developing countries with more limited environmental regulations. There is a critical need for comprehensive and sustainable e-waste management strategies, which includes promoting the extension of product lifespans, encouraging responsible recycling practices, and designing electronics with eco-friendliness and ease of recycling in mind. Users should also be educated about the importance of recycling e-waste, to raise awareness of and promote the proper handling and recycling of electronic devices.

Water

Positive

Like with waste, ICT solutions can help manage areas of resource consumption in buildings and construction, such as water management. Specific ICT solutions have also been developed to help identify and reduce water leakage.

Negative

ICT solutions in the Building and Construction sector should be weary of any negative direct effects on the neighbouring environment, including solutions that may negatively impact biodiversity, soil health, waterways, or the use of natural resources. For instance, a solution that provides on-site water extraction and use from nearby water sources for construction, should take into consideration how its implementation affects fish and other aquatic life. Similarly, the installation of physical equipment should not hinder natural pass-throughs preventing wildlife from crossing habitats.

6.2 Economic and Social Impacts

Beyond climate and environment, ICT solutions should do no significant harm in any other ESG areas, including in economic or social matters. ICT solutions should consider how they affect the composition of the labour market and should be weary of not impacting any demographic unfairly.

Positive

Decarbonising the building and construction sectors also generates **economic opportunities.** Transitioning to a low-carbon economy requires a skilled workforce capable of implementing energy-efficient retrofits, constructing sustainable buildings, and developing renewable energy infrastructure. Solution developers, users and buyers should consider ways of mitigating these job displacements, e.g., by engaging with local government and companies to offer upskilling training.

Affordability of energy in homes: ICT solutions in buildings, such as energy management systems, can lead lower utility costs and resource consumption for tenants.

Inclusive Smart Solutions: These technologies can be designed with inclusivity in mind, catering to the needs of diverse users, including those with disabilities or special requirements. For example, smart home technologies can be adapted to provide aids to the aging population.

Negative

Not taking into account social or demographic context can lead solutions developed for green purpose to fall short. For example, digital enable solar powered cooking stoves can address the issue high emissions from cooking, where the primary energy source is fossil fuel based. However, there are limitations to these stoves, as they often take much longer to heat up and will not work at night. If a well-rounded assessment of the context of use of stoves is not done, these stoves may be rolled out and soon after be discarded as they might not be fit for purpose for some circumstances / social contexts.

Human Rights Violations: Electronic waste is not the only concern when it comes to the impact of hardware, the extraction of raw materials and the manufacturing of components of an ICT solution can also be linked to human rights violations throughout the supply chain.

6.3 Health and safety impacts

Finally, developers should consider how their solution may affect health and safety.

During construction, ICT solutions can help improve safety on construction sites by providing real-time monitoring, enhanced communication, and predictive capabilities. For example:

- Drones equipped with cameras and sensors can perform aerial inspections of construction sites, identifying safety issues like unstable structures or unsafe working conditions in hard-to-reach areas.
- Other types of real-time monitoring of construction activities, such as IoT enabled sensors and wearable devices with integrated automated alerts, can warn relevant personnel if unsafe conditions are detected, facilitating quick responses to mitigate risks.
- ICT solutions can also be used to provide safety training and e-learning courses, and AR and VR technologies can be used for safety training and simulation

exercises, allowing workers to be trained virtually to handle hazardous situations safely, enhancing their knowledge and preparedness before encountering such scenarios in the field.

Once buildings have been developed and occupied, ICT solutions can enhance the health and wellbeing of building occupants. For example, IoT devices can monitor indoor air quality, temperature, and lighting, creating healthier living spaces. Additionally, digital platforms can promote community health initiatives, encourage physical activity, and connect residents with healthcare services.

Funded by
the European Union