Unlocking the Potential:
Physical Loss Reduction
and
Carbon Credits

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Preface

This book presents concepts like carbon credits, leakage reduction associated with CO_2 mitigation, and Nationally Determined Contributions (NDCs) would serve as an indispensable resource in tackling the complexities of climate change mitigation. Carbon credits are pivotal in incentivizing emission reductions by providing a market-based mechanism for companies to offset their carbon footprint. Understanding the nuances of carbon credits, such as how they are traded and verified, equips stakeholders with the knowledge to engage effectively in carbon markets, thereby fostering sustainable practices.

Moreover, the book's coverage of leakage reduction linked to CO_2 reduction is crucial in addressing the potential unintended consequences of climate policies. Leakage occurs when emissions are displaced from regulated to unregulated sectors or regions, undermining the effectiveness of emission reduction efforts. By delving into strategies to minimize leakage, such as border carbon adjustments and robust monitoring mechanisms, the book empowers policymakers and practitioners to design more resilient climate policies that account for interconnected global markets.

Furthermore, elucidating the intricacies of Nationally Determined Contributions (NDCs) enhances the transparency and ambition of climate action on a global scale. NDCs outline each country's commitments to mitigate greenhouse gas emissions and adapt to climate change, forming the cornerstone of the Paris Agreement. A comprehensive understanding of NDCs enables stakeholders to evaluate the adequacy of national climate targets, track progress, and identify opportunities for collaboration and support, ultimately facilitating collective efforts towards a low-carbon future.

About the Authors

Stuart Hamilton

Stuart currently holds the position of Vice President at the Caribbean Water and Wastewater Association (CWWA), chairs the International Water Association (IWA) Water Loss Specialist Group, and leads the CWWA Caribbean Water Loss Specialist Group.

He is an accomplished author, having written numerous papers and co-authored four books for the IWA and one for the AWWA. His latest book, "Improving Water Supply Networks – Fit for Purpose Strategies and Technologies," was released in 2021, following an updated version of "Leakage Detection" in 2020.

Stuart, a qualified Civil Engineer, Chartered Environmentalist (CEnv), Chartered Manager (CMgr), and Fellow of the Chartered Institute of Water and Environmental Managers (FCIWEM), pursued his studies at Northampton and Huntingdon universities in the UK.

Passionate about mitigating climate change, Stuart focuses on innovative solutions for environmental sustainability. He is dedicated to fostering harmony between human intervention and nature, striving for impactful global change through awareness and institutional transformation across all water sectors.

His unwavering commitment to raising awareness and instigating meaningful global change is apparent in both his thoughts and tangible initiatives.

Stuart boasts over 40 years of experience in the water sector, having conducted extensive work in over 30 countries with a focus on distribution management and training. He is widely acknowledged as one of the leading global experts in water loss control.

Bambos Charalambous

A Chartered Civil Engineer, a Chartered Environmentalist, a Member of the Institution of Civil Engineers (UK), a Fellow of the Chartered Institution of Water and Environmental Management (UK) and a Fellow of the International Water Association (IWA).

With over 40 years of expertise in urban water distribution network management, including specialization in non-revenue water (NRW) and intermittent water supply (IWS), has developed a robust skill set applicable to water utility efficiency programs, water audits, and NRW reduction strategies. Moreover, his extensive experience extends to the implementation of Performance-Based Contracts (PBC) tailored for NRW reduction, as well as comprehensive utility governance and capacity-building training.

Having 20 years as Technical Manager of a Water Board and the last 15 years working internationally as a consultant / advisor, with assignments spanning five continents in ιover 25 countries, Bambos brings a global perspective to his work. In addition to technical and operational efficiency improvement in water utilities, his expertise now encompasses areas such as leakage carbon emission reduction, Nationally Determined Contributions (NDCs), carbon credits, and advocacy for climate-resilient water management practices.

Bambos is well experienced in developing holistic approaches to address technical and operational challenges, setting clear and achievable goals including the adept use of participatory methods to foster awareness, creativity, and engagement among utility staff, facilitating the attainment of higher levels of operational performance and efficiency while simultaneously advocating for climate-conscious water management strategies on a global scale.

Bambos published numerous papers and books on issues relating to NRW, water losses, urban water supplies. He is Past Chair of the IWA’s Water Loss Specialist Group and Intermittent Water Supply Specialist Groups, member of the IWA Strategic Council and Past President of the Cyprus Water Association.

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1 CONTENTS

1. INTRODUCTION

Climate change has necessitated global action to reduce greenhouse gas emissions. A pivotal tool in this fight is the concept of carbon credits, which come in various forms and are integral to both regulatory and voluntary markets. This document looks at types of Carbon Credits but concentrates on the process where the Carbon Credits can be issued back to the country where the carbon reduction program took place and where the credits can be claimed back against their NDC's.

The carbon credits landscape is richly varied and intricately woven, aiming to connect the realms of compliance and voluntary actions. As the world continues to combat climate change, understanding the nuances of carbon credits is paramount for governments, businesses, and consumers alike. These credits not only represent a commitment to a greener future but also embody the collaborative spirit needed to address the global challenge of climate change.

1.1 What is an NDC?

A Nationally Determined Contribution (NDC) stands as a strategic climate action blueprint designed to reduce emissions and adapt to climate change impacts. At the Paris Agreement, each participating nation committed to formulating an NDC and revising it every five years. These contributions provide frameworks for countries to set targets for reducing greenhouse gas emissions and detail strategies for addressing climate-related challenges and delineate the pathways to achieve these objectives and outline mechanisms for monitoring and ensuring progress.

Given the pivotal role of climate finance in implementation, NDCs ideally incorporate detailed financing strategies. While the Paris Agreement mandates NDC updates every five years, the Glasgow Climate Pact of November 2021 urged countries to reassess and strengthen their targets in 2022 due to the disparity between current emission reduction plans and those necessary to limit global warming to 1.5°C. Each successive update cycle is anticipated to spur greater ambition, fostering deeper emissions cuts and broader adaptation efforts.

As NDCs evolve, they play a critical role in shaping a sustainable future for all inhabitants of the planet. The most effective NDCs set ambitious goals and are underpinned by thorough analysis and data, facilitating a transformative shift towards greener and more sustainable development. They drive necessary changes across various sectors of the economy and provide opportunities for reimagining production and consumption patterns. Additionally, they can promote social inclusivity by offering specific benefits to women, youth, and indigenous communities. Some countries have begun aligning NDCs with national development plans, including those aimed at achieving Sustainable Development Goals.

1.2 How do NDCs Work?

Addressing climate change necessitates a comprehensive overhaul of our economies and societies. Every facet of our existence – from energy and industry to agriculture, transportation, institutions, and individual behaviors – must undergo transformation to mitigate emissions and adapt to the already unfolding climate impacts.

While this task may seem daunting, it is not insurmountable. Developing actionable plans enables countries to comprehend and coordinate the diverse array of measures required to reduce emissions and transition to more sustainable practices, thereby safeguarding lives and livelihoods. Urgent and ambitious measures are essential to prevent the global temperature from exceeding the critical threshold of 1.5 degrees Celsius, beyond which climate impacts would exacerbate significantly.

Nationally Determined Contributions (NDCs) acknowledge the imperative to balance emissions reductions with other pressing priorities such as poverty eradication. Moreover, major emitters must undertake the most significant and rapid emission cuts.

Nevertheless, every action and improvement matters, necessitating collective efforts from all countries. Some of the most ambitious initiatives have emerged from small island developing states, driven by the urgency of climate action as they grapple with rising sea levels that threaten their very existence.

1.3 Where does NDC come from?

Since a NDC is a government obligation under the Paris Agreement, one or more national ministries will generally lead its development. For NDCs to work, they need to be widely understood and used by businesses, civil society, academia, and ordinary citizens. Each entity has its own role to play, which is why many governments invite different stakeholders to take part in defining and developing their NDC priorities.

1.4 Carbon Credit:

Carbon credits serve as a standardized unit of measurement that quantifies the reduction in carbon emissions, avoidance, or removal of one tonne of carbon dioxide (CO_2) or its equivalent in other greenhouse gases. The underlying principle behind carbon credits is the acknowledgment that each emission reduction generates a positive environmental impact and plays a role in advancing toward carbon neutrality.

Different Types of Carbon Credits may include but are not limited to:

- Compliance Carbon Credits.
- Certified Emission Reductions.
- Emission Reduction Units.
- Verified Emission Reductions.

1.5 Compliance Carbon Credits

Compliance carbon credits, also known as regulatory or mandatory carbon credits, constitute essential elements of governmental and international efforts to mitigate emissions. These credits are produced within frameworks of government-mandated carbon and renewable programs and protocols, where certain industries' obligated parties must adhere to regulations. These parties fulfill their compliance obligations by implementing specific practices or investing in carbon avoidance technologies, thereby generating certificates that signify the implemented changes.

1.6 Certified Emission Reductions

CERs, or Certified Emission Reductions, constitute a category of compliance carbon credits generated through the Clean Development Mechanism (CDM) under the auspices of the United Nations Framework Convention on Climate Change (UNFCCC). Projects under the CDM, predominantly implemented in developing countries, seek to promote sustainable development alongside emission reductions. Given the implementation of the Paris Accord, the CDM is undergoing substantial restructuring.

1.7 Emission Reduction Units (ERUs)

ERUs, or Emission Reduction Units, originate from Joint Implementation initiatives that encompass emission reduction endeavors in developed nations. These initiatives enable countries with emission reduction obligations to participate in comparable projects in other developed countries, fostering a collaborative approach to emission reduction efforts.

1.8 Verified Emission Reductions (VERs)

Voluntary Emission Reductions (VERs), commonly referred to as Voluntary Carbon Credits, are the outcomes of projects that have undergone rigorous third-party verification procedures. Unlike compliance carbon credits, VERs are not bound by mandatory regulatory frameworks or international agreements. They encompass a wide range of activities, including renewable energy projects, reforestation efforts, energy efficiency initiatives, and more. These credits are issued by various carbon registries such as Verra, Gold Standard, Universal Carbon Registry, and Global Carbon Council.

2 How Carbon Savings are Measured in the Water Industry

The utility water balance refers to the apportionment of the water input to the utility's system to the constituent water balance components. This balance is crucial for several reasons, and utility managers employ water balance assessments to ensure efficient and sustainable water management practices. Here are some key reasons for conducting a utility water balance:

2.1 Resource Management:

Optimizing Water Use: A water balance helps utilities understand how much water is being withdrawn, treated, distributed, and consumed. This information is vital for optimizing water use and minimizing losses, ensuring that water resources are used efficiently.

2.2 Infrastructure Maintenance:

Leak Detection and Repair: Water losses due to leaks in the distribution system can be a significant problem for utilities. Conducting a water balance aids in identifying and addressing leaks promptly, reducing physical losses in the distribution network and conserving water.

2.3 Financial Efficiency:

Cost Reduction: By minimizing water losses, utilities can reduce the costs associated with treating and distributing water. Efficient water management contributes to financial sustainability, allowing utilities to allocate resources effectively and potentially reduce the need for costly infrastructure investments.

2.4 Compliance with Regulations:

Meeting Regulatory Requirements: Water utilities often need to comply with regulations regarding water quality, distribution, and conservation. Understanding the water balance helps utilities meet regulatory requirements by ensuring that water quality standards are maintained and that distribution systems operate efficiently.

2.5 Sustainability and Environmental Impact:

Conservation Efforts: Managing water resources responsibly is essential for long-term sustainability. A water balance allows utilities to implement conservation measures, promoting responsible water use and minimizing the environmental impact associated with water extraction and treatment.

2.6 Demand Forecasting:

Planning for Growth: By understanding current water usage patterns, utilities can better forecast future demand. This information is critical for planning infrastructure improvements and ensuring that the utility can meet the water needs of a growing population or changing demographics.

2.7 Customer Service:

Reliable Service: A balanced water system contributes to the reliability of water supply services. This is crucial for customer satisfaction and maintaining trust in the utility's ability to deliver a consistent and high-quality water supply.

2.8 Risk Management:

Contingency Planning: By understanding the water balance, utilities can develop effective contingency plans for addressing emergencies, such as droughts, supply interruptions, or infrastructure failures. This proactive approach enhances the utility's resilience to various challenges.

3 THE WATER BALANCE

The utility water balance is essential for managing water resources effectively, maintaining infrastructure, ensuring financial efficiency, complying with regulations, promoting sustainability, and providing reliable services to customers. By regularly assessing and optimizing the water balance, water utilities can contribute to the overall resilience and sustainability of their water supply systems.

Building a utility water balance involves gathering data on various components of the water system and analysing the inputs and outputs to ensure that water resources are managed efficiently. Here's a step-by-step guide on how to build a utility water balance:

3.1 Define Objectives and Scope:

Clearly outline the goals of the water balance study. Determine the scope, including the specific utility service area, time frame, and level of detail required.

3.2 Identify Water Balance Components:

Break down the water balance into key components. These typically include:

- Water Sources: Identify all water sources supplying the utility, such as rivers, lakes, groundwater, or reservoirs.
- Treatment: Quantify the volume of water treated for distribution.
- Distribution: Measure the amount of water distributed through the network.
- Consumption: Assess the water consumed by different user groups (residential, commercial, industrial).

- Losses: Evaluate non-revenue water, which includes physical losses (leaks) and apparent losses (meter inaccuracies, unauthorised consumption).

3.3 Data Collection:

Gather relevant data for each component. This may involve:

- Utility Audit Boundary: The physical boundary of the water utility where input and usage can be clearly identified for analysis.
- Water Source Data: Obtain data on water extraction, quality, and availability.
- Treatment Plant Data: Collect information on treatment processes, capacity, and efficiency.
- Distribution System Data: Measure water flow rates, pressure, and identify leaks.
- Customer Data: Analyse consumption patterns and trends.

3.4 Conduct Water Audits:

Perform water audits to measure and assess water losses in the distribution system. This may involve flow measurements, pressure testing, and leak detection surveys.

3.5 Develop a Water Balance:

Create water balance equations for each stage of the water system. The general equation is:

- System Input Volume – Authorised Uses = Losses

Break down each component further to understand the sources and destinations of water within the system.

3.6 Components of the Water Balance

The International Water Association (IWA) and the American Water Works Association (AWWA) Water Loss Balance is a framework designed to assess and manage water losses in a water distribution system. Water losses can occur through physical leaks, unauthorised consumption, and other inefficiencies within the distribution network. The Water Balance provides a structured approach to quantify and analyse these losses.

3.7 System Input Volume:

The total volume of water entering the distribution system from various sources, including treated water from treatment plants, imported water, and any other inflows.

3.8 Authorised Consumption:

The portion of the input volume that is legally and legitimately consumed by customers. This includes water used for domestic, industrial, commercial, and public service purposes.

3.9 Unbilled Authorised Consumption:

Legitimate water consumption that is not metered or billed, often found in certain public services, fire-fighting activities, or other authorised uses.

3.10 Apparent (Commercial) Losses:

Apparent (Commercial) Losses involve systematic data handling errors (in the customer billing process), all types of customer metering inaccuracies, and unauthorised consumption. Apparent losses can be due to meter inaccuracies, data errors, and billing issues.

3.11 Real (Physical) Losses:

Real (Physical) Losses of water within the distribution system, primarily caused by leaks in pipes, joints, and other infrastructure. Real losses are a significant focus of water loss management efforts.

3.12 Infrastructure Input Volume (Unbilled Authorised Use):

The volume of water supplied to the distribution system, including but not limited to the water used for system flushing, firefighting, and other operational needs.

3.13 Infrastructure Output Volume (Authorised Consumption – both billed and unbilled, metered, and unmetered):

The volume of water leaving the distribution system through customer connections, service connections, and any other authorised outlets.

3.14 Non-Revenue Water (NRW):

The sum of Water Losses (Apparent and Real Losses) plus Infrastructure Input Volume (Unbilled Authorised Consumption), representing the total volume of water that is being within the distribution system but did not yield revenue.

3.15 Performance Indicators:

Monitoring and assessing various performance indicators related to water losses, such as Infrastructure Leakage Index (ILI) and the ratio of Night Flow to Total Flow.

3.16 Confidence Limits:

Validate the water balance by reviewing and evaluating source data for water balance inputs and assigning confidence limits (error margins) to the values used.

3.17 The IWA Water Balance

<table>
<tr><th colspan="5">Water Balance in m3/year</th></tr>
<tr><td rowspan="7">System Input Volume
410,088,097 m3/year
Error Margin [+/-]:
5.0%</td><td rowspan="4">Authorized Consumption
237,225,393 m3/year
Error Margin [+/-]:
0.7%</td><td rowspan="2">Billed Authorized Consumption
233,944,688 m3/year</td><td>Billed Metered Consumption
73,991,035 m3/year</td><td rowspan="2">Revenue Water
233,944,688 m3/year</td></tr>
<tr><td>Billed Unmetered Consumption
159,953,653 m3/year</td></tr>
<tr><td rowspan="2">Unbilled Authorized Consumption
3,280,705 m3/year
Error Margin [+/-]:
50.0%</td><td>Unbilled Metered Consumption
0 m3/year</td><td rowspan="5">Non-Revenue Water
176,143,409 m3/year
Error Margin [+/-]:
11.6%</td></tr>
<tr><td>Unbilled Unmetered Consumption
3,280,705 m3/year
Error Margin [+/-]: 50.0%</td></tr>
<tr><td rowspan="3">Water Losses
172,862,704 m3/year
Error Margin [+/-]:
11.9%</td><td rowspan="2">Commercial Losses
40,323,244 m3/year
Error Margin [+/-]:
34.1%</td><td>Unauthorized Consumption
3,272,955 m3/year
Error Margin [+/-]: 44.7%</td></tr>
<tr><td>Customer Meter Inaccuracies and Data Handling Errors
37,050,289 m3/year
Error Margin [+/-]: 36.9%</td></tr>
<tr><td colspan="2">Physical Losses
132,539,460 m3/year
Error Margin [+/-]: 18.7%</td></tr>
</table>

4 REDUCTION OF REAL (PHYSICAL) LOSSES

4.1 The Four Pillars of Real Losses

The management of real losses in water distribution systems typically revolves around four key pillars, often referred to as the "Four Pillars of Real Losses." These pillars represent the primary areas of focus for water utilities and authorities seeking to minimize and control physical losses within their distribution networks:

These Four Pillars of Real Losses provide a comprehensive framework for water utilities to systematically address and manage the physical losses in their distribution systems. By focusing on pressure management, leak detection and repair, active leakage control, and infrastructure management, utilities can work towards achieving more efficient and sustainable water distribution practices.

4.2 Pressure Management:

Maintaining optimal pressure levels within the distribution system is crucial for minimizing real losses. Excessive pressure can lead to more leaks and bursts, increasing the volume of water lost.

Objective: Achieving and maintaining an appropriate balance of pressure to reduce the likelihood of leaks and pipe failures.

Strategies: Implementing pressure regulation devices, conducting regular pressure monitoring, and optimizing system pressure to minimize stress on the infrastructure.

4.3 Leak Detection and Repair:

Description: Identifying and addressing leaks in the distribution system is essential for reducing real losses.

Timely detection and repair of leaks help prevent water from escaping the system.

Objective: Minimizing the volume of water lost due to physical leaks in pipes and other infrastructure.

Strategies: Using advanced leak detection technologies, conducting regular system inspections, and promptly repairing identified leaks with quality materials and workmanship.

4.4 Active Leakage Control (ALC):

Description: ALC involves the systematic management of leakage through continuous monitoring, assessment, and control measures. It goes beyond event based or sporadic leak detection canvassing leak detection and repair to include ongoing efforts to control and reduce leakage.

Objective: Implementing proactive measures to control and reduce real losses on an ongoing basis.

Strategies: Implementing district metered area (DMA) management, zoning, and pressure-dependent analysis to target specific areas and times with high leakage rates.

4.5 Infrastructure Management and Renewal:

Description: Ensuring the integrity and reliability of the distribution system infrastructure is crucial for minimizing real losses in the long term. This pillar involves maintaining, rehabilitating, and, when necessary, replacing aging or deteriorating infrastructure.

Objective: Ensuring the long-term sustainability of the distribution system by managing and renewing infrastructure components.

Strategies: Implementing a proactive infrastructure maintenance program, prioritizing rehabilitation, and replacement projects, and integrating infrastructure management into long-term planning.

4.6 Metering and Data Management:

Ensuring accurate metering and effective data management to reduce errors in billing and improve the accountability of water use.

4.7 Risk Assessment:

Identifying and assessing risks associated with water losses, including factors like aging infrastructure, geological conditions, and climate change.

4.8 Water Loss Reduction Strategies:

Developing and implementing strategies to reduce water losses, including infrastructure rehabilitation, pressure management, and public awareness campaigns.

4.9 Benchmarking:

Compare the results of the water balance with industry benchmarks or standards to assess the utility's performance relative to best practices.

4.10 Identify Anomalies and Opportunities:

Analyse the water balance results to identify anomalies, such as unexpected water losses or inefficient processes. Look for opportunities to improve efficiency, reduce losses, and enhance overall water management.

4.11 Identify Opportunities for Improvement:

Analyse the water balance results to identify areas for improvement. This may involve reducing losses, optimizing treatment processes, or implementing water conservation measures.

4.12 Develop Action Plans:

Based on the findings, develop action plans to address inefficiencies, reduce losses, and improve overall water management. Include short-term and long-term strategies.

4.13 Monitor and Update:

Regularly monitor the utility water balance and update the calculations as new data becomes available. This ensures that the water balance remains accurate and relevant over time.

4.14 Stakeholder Engagement:

Involve key stakeholders, including utility staff, regulatory bodies, and customers, in the process. Their input can provide valuable insights and support for implementing changes.

Building and maintaining a utility water balance is an ongoing process that requires collaboration, data accuracy, and a commitment to continuous improvement. Regular reviews and updates are essential to ensure the effectiveness of water management practices.

5 AUDIT A WATER BALANCE

Auditing a water balance involves systematically reviewing and assessing the components of a water system to identify and quantify water inputs, outputs, and losses. Here's a step-by-step guide on how to audit a water balance. The auditor role is to review the gathered and presented inputs from the Utility. The auditor also confirms accurate balance quantity entries, uncover obvious errors, and assign and or comment on the specific water balance input data reliability.

5.1 Define the Scope and Objectives:

Clearly define the scope of the water balance audit. Identify the objectives, including understanding water sources, assessing distribution efficiency, and identifying opportunities for improvement.

5.2 Collect Data:

Gather comprehensive data on various components of the water system. This may include:

- Water Sources: Information on extraction rates, availability, and quality.
- Treatment Plants: Data on treatment processes, capacity, and efficiency.
- Distribution System: Flow rates, pressure measurements, and leak detection data.
- Customer Consumption: Analyse customer usage patterns and trends.

5.3 Identify Measurement Points:

Determine specific measurement points in the water system where data can be collected. This includes intake points, treatment plants, distribution network nodes, and customer meters.

5.4 Water Loss Assessment:

Conduct a water loss assessment to identify and quantify physical and apparent losses in the distribution system. Key steps include:

- Flow Measurements: Use flow meters to measure water flow rates at various points in the distribution network.
- Pressure Testing: Assess the pressure in the system to identify potential leaks.
- Leak Detection: Conduct leak detection surveys to identify and locate leaks.

5.5 Develop Action Plans:

Based on the findings, develop action plans to address identified issues and capitalize on opportunities for improvement. Prioritize actions based on their potential impact and feasibility.

5.6 Monitor and Review:

Implement changes and regularly monitor the water balance to assess the effectiveness of improvements. Conduct periodic reviews and updates to ensure ongoing optimization.

5.7 Engage Stakeholders:

Involve key stakeholders, including utility staff, regulatory bodies, and customers, in the audit process. Their insights and collaboration are crucial for implementing changes and ensuring long-term success.

Conducting a water balance audit is an iterative process that requires ongoing attention and a commitment to continuous improvement. Regular audits contribute to the efficient and sustainable management of water resources within a utility system.

6 CARBON INITIATIVES

A carbon initiative (also known as a carbon reduction or carbon offset initiative) is a program or project designed to mitigate or offset the greenhouse gas emissions associated with human activities. The primary focus is on reducing the net carbon footprint to combat climate change and promote sustainability. These initiatives aim to balance the emission of greenhouse gases with activities that either capture, reduce, or sequester an equivalent amount of carbon dioxide (CO_2) or other greenhouse gases.

Key elements of a carbon initiative typically include:

6.1 Carbon Footprint Assessment:

The first step in a carbon initiative involves calculating or assessing the carbon footprint of an individual, organization, event, or product. This involves quantifying the amount of greenhouse gas emissions produced, usually measured in terms of carbon dioxide equivalents (CO_2e).

6.2 Emission Reduction Strategies:

Implementing strategies to reduce emissions at the source is a fundamental component of carbon initiatives. This may include adopting energy-efficient technologies, transitioning to renewable energy sources, improving energy conservation practices, and optimizing industrial processes.

6.3 Carbon Offsetting:

Carbon offsetting is a practice where organizations or individuals invest in projects that reduce or remove greenhouse gas emissions from the atmosphere. These projects may include reforestation efforts, renewable energy projects, methane capture initiatives, or technologies that remove carbon dioxide directly from the air.

6.4 Renewable Energy Investments:

Many carbon initiatives involve supporting the development and use of renewable energy sources such as solar, wind, hydro, and geothermal energy. By investing in these technologies, initiatives aim to displace the use of fossil fuels and reduce emissions.

6.5 Sustainable Practices and Certification:

Encouraging and adopting sustainable practices in various industries is a common aspect of carbon initiatives. This may involve obtaining certifications for environmentally friendly products, implementing sustainable agriculture practices, or promoting circular economy principles.

6.6 Education and Awareness:

Raising awareness about the impact of carbon emissions and promoting sustainable behaviour is a crucial part of many carbon initiatives. Education efforts may target individuals, businesses, and communities to encourage responsible environmental practices.

6.7 Carbon Trading and Markets:

Some carbon initiatives participate in carbon markets where credits representing emissions reduction and avoidance are bought and sold. Companies or organizations with lower emissions can sell their excess carbon credits to those with higher emissions, creating a financial incentive for emissions reduction.

6.8 Regulatory Compliance:

Compliance with local and international regulations related to greenhouse gas emissions is often a motivation for organizations to engage in carbon initiatives. Governments may establish emission reduction targets and require businesses to participate in carbon reduction efforts.

Carbon initiatives play a significant role in the global effort to combat climate change by addressing the root causes of greenhouse gas emissions and promoting sustainable practices. These initiatives contribute to a broader transition towards a low-carbon and resilient future.

7 CARBON CALCULATIONS

Calculating carbon savings involves assessing the reduction in greenhouse gas emissions achieved through specific actions, projects, or initiatives. Here's a general guide on how to calculate carbon savings:

7.1 Define the Baseline:

Establish a baseline to determine the initial level of greenhouse gas emissions associated with a particular activity, process, or system. This baseline represents the emissions that would occur in the absence of any intervention or improvement.

7.2 Collect Data:

Gather relevant data to quantify the greenhouse gas emissions associated with the baseline scenario. This data may include energy consumption, fuel use, production outputs, transportation activities, or other relevant metrics.

7.3 Identify Emission Reduction Measures:

Identify and implement emission reduction measures or interventions. These measures could include energy efficiency improvements, renewable energy adoption, changes in transportation practices, waste reduction, or any other action that leads to lower emissions.

7.4 Calculate Emission Reductions:

Quantify the emission reductions achieved by comparing the baseline emissions with the emissions under the new scenario, considering the implemented measures. The formula for calculating emission reductions is:

Emission Reductions = Baseline Emissions − Emissions with Intervention

7.5 Convert to Carbon Dioxide Equivalent (CO_2e):

Express the emission reductions in terms of carbon dioxide equivalent (CO2e). This is a common practice to standardize and compare the impact of different greenhouse gases. Various gases have different global warming potentials and expressing them in CO_2e provides a common metric.

7.6 Apply Conversion Factors:

Use conversion factors specific to each greenhouse gas to convert the emissions of gases other than carbon dioxide into CO_2e. Conversion factors are typically provided by environmental agencies or international standards.

7.7 Verification:

For more accurate and reliable results, consider engaging in a third-party verification process. This may involve an independent assessment to validate the accuracy and completeness of the data and calculations.

Example Calculation using Water Balance:

Baseline Emissions: Calculate the emissions associated with the previous system by way of water balance.

Emissions with Intervention: Calculate the emissions associated with the new water balance after interventions have been completed.

Emission Reductions: Subtract the emissions with intervention from the baseline emissions.

Convert to CO_2e: If necessary, convert the emissions reductions to CO_2e using conversion factors.

7.8 Reporting:

Clearly communicate the calculated carbon savings, the methodology used, and any assumptions made. This is important for transparency and for reporting to stakeholders, regulatory authorities, or for participating in carbon markets.

Keep in mind that the accuracy of the calculation depends on the quality and precision of the data collected and the appropriateness of the chosen methodology. When in doubt, seek guidance from experts or consider involving a sustainability consultant or verifier in the process.

8 How the Project Will Work

8.1 Typical Project Outline

To reduce non-revenue water, implement projects to improve water supply infrastructure and enhance efficiency of the water supply.

8.2 Applicability

- To reduce non-revenue water, implement measures to improve water supply infrastructure, such as water supply pipes and distribution pipes.
- To reduce non-revenue water, implement measures to improve the operation of the water supply system.

8.3 Methodology of Emission Reduction Calculation

The emission reduction from the project activity is determined as the differences between the GHG emissions of baseline scenario (without the project) and project scenario (with the project). GHG emissions are associated with electricity consumption in the water supply processes, and by reducing water leakage through measures to reduce non-revenue water, GHG emissions associated with the supply of excess water at the baseline will be reduced.

In addition to conducting measures on reducing non-revenue water, consider if the NRW Reduction Project involves measures on energy efficiency through improvement of the water supply infrastructure.

In the following calculation, it is assumed that the NRW level would be reduced from the initial level after project implementation. However, the Carbon Emissions calculation relates to the corresponding reduction of Physical Losses.

8.4 Calculation of Baseline Emission Prior to Project Start

The baseline emission in tonnes of carbon prior to project start is calculated by multiplying following parameters:

- Volume of Physical Losses prior to project start calculated using the IWA or AWWA Water Balance

  multiplied by the

- CO_2 emissions associated with the supplied electricity consumption per 1m^3 of the water distributed.

8.5 Calculation of Carbon Emission after Project Completion or Annually if Ongoing

The emissions in tonnes of carbon after project completion or annually if ongoing is calculated by multiplying following parameters:

- Volume of Physical Losses after project completion or annually if ongoing using the IWA or AWWA Water Balance

  multiplied by the

- CO_2 emissions associated with the supplied electricity consumption per $1m^3$ of the water distributed.

9 SCENARIO APPLICATION

9.1 Applicability

This is applicable to project activities that:

> "Seek to reduce GHG emissions by explicitly reducing the amount of water through leakage reduction activities."

9.2 Project Boundary

The project developer will need to clearly define the boundary on the system in question. This could be the boundary of an entire municipal water system or just the water supply system. Defining the boundaries of the system in question allows the project implementers to develop an adequate metering and monitoring system to determine water entering the boundaries of the system, water being delivered out of the system and the energy used to move it from start to finish. It also allows the project developer to ensure that the project boundaries do not change significantly over the course of the project. In situations where multiple schemes are being upgraded, the project developer must monitor each scheme separately and calculate the emissions reductions for each separately.

The project boundary will extend from the point of water intake to the system in question, including all pumping stations (major pumping station if the project boundary is the last one) to the delivery point from the system in question. Supplemental pumps, booster stations and other sources of power consumption are included. It is to be noted that pumps not metered or covered by the water utility, as in bulk supplier, will be included in the project boundary only if they are (1) subject to the project implementation and (2) exclusive to the defined water system.

Project boundary in terms of gases and sources is CO_2 from electricity generation.

To determine the project boundaries, the project developers will have to provide the auditor with a map of the system covered by the project. This should include all inflows and outflows to the system that must be metered.

For electricity, the grid is the system boundary.

9.3 Baseline

A typical carbon emissions baseline is established by multiplying the pre-project total volume of Physical Losses and the carbon emission factor.

Baseline Emissions (E_B)= PL_B * CEF_B

In which:

Baseline Emissions (E_B)= CO_2 Emissions in the baseline year (kg CO_2)
PL_B= Total pre-project water Volume of Physical Losses in Baseline Year (m^3)
CEF_B= Carbon Emission Factor for electricity production in Baseline Year (kg CO_2/m^3)

The Carbon Emission Factor for the carbon intensity of electricity CEF_B could be calculated using source data from https://ourworldindata.org/grapher/carbon-intensity-electricity in case of specific data related to the project is not available.

9.4 Project Savings Calculations

Project period Emissions for Year Y (E_Y)= PL_Y * CEF_Y

In which:

Project period Emissions in Year Y (E_Y)= CO_2 emissions in the Year Y (kg CO_2)
PL_Y= Water Volume of Physical Losses in year Y (m^3)
CEF_Y= Carbon Emission Factor for electricity production in year Y (kg CO_2/m^3)

9.5 Emission Reductions

Annual or Total Emissions Reduction arising from the project activity (ER_Y) for the period under consideration is calculated as:

ER_Y= Baseline emissions – Project period emissions

$ER_Y = (PL_B * CEF_B) - (PL_Y * CEF_Y)$

The standard baseline period is one year (typically last year available), but in situations where the project had its base line developed up to 10 years ago then this base line can be used for the annual calculation.

10 CONCLUSION

This document provides an exploration of NDCs (Nationally Determined Contributions), Physical Losses, and Water Balance concepts, alongside outlining the operational framework of a project designed to quantify water savings through physical losses reduction in cubic meters (m^3) and convert these into kg CO_2/m^3. This conversion process facilitates the calculation of volumetric savings from the project's initiation, which are subsequently translated into annual tonnes of carbon saved.

These carbon savings are regarded as a tradable commodity and are subject to potential market engagement. However, the primary focus of this document is on utilizing these tonnes of carbon to offset NDC commitments. The rationale for this approach stems from the public ownership of the utility responsible for reducing physical losses and consequent carbon emissions. Consequently, these tonnes of carbon are considered the ownership of the public entity or country, available for offsetting against country NDC targets.

Further investigation is necessary to ascertain whether offsetting these carbon tonnes against the country's NDC targets can lead to the transfer of financial credits within the government, supplementing the physical loss project from the climate change division. These credits would be equivalent to the investments allocated by the country for reducing its NDC targets through alternative means.

While the primary focus of this concept document is to emphasize the feasibility and streamlined process of using the savings to reduce the country's NDC targets or achieve the utility's carbon-neutral goals, it is important to note that these tonnes of carbon savings can still be sold on the open carbon market.

Various approaches can be considered, although this document does not delve into this aspect extensively. One potential consideration is for the utility to engage in private negotiations and enter into agreements with large energy users to sell them their tonnes of carbon under long-term contracts. The financial returns from such agreements can then be reinvested to further reduce physical losses within the utility.

Efforts should be made to engage with International Financial Institutions (IFIs) to explore if they can fund projects aimed at reducing Physical Losses through their climate change budgets. This presents a novel idea that is gaining traction among members of these institutions. Historically, projects based solely on the merits of volumes of water saved have been challenging to fund. However, approaching these initiatives through the climate change framework and converting volumes of water saved to tonnes of carbon saved introduces a different dimension to funding options.

For projects to qualify for the offsetting of tonnes of carbon against NDC targets, a measurable baseline must be established, alongside quantifiable annual savings. These calculations must undergo auditing and approval processes. The savings period may begin from the project's inception and represent an accumulative sum. While the specific duration is yet to be confirmed, a rolling 5-year average is proposed as a fair benchmark by the authors.

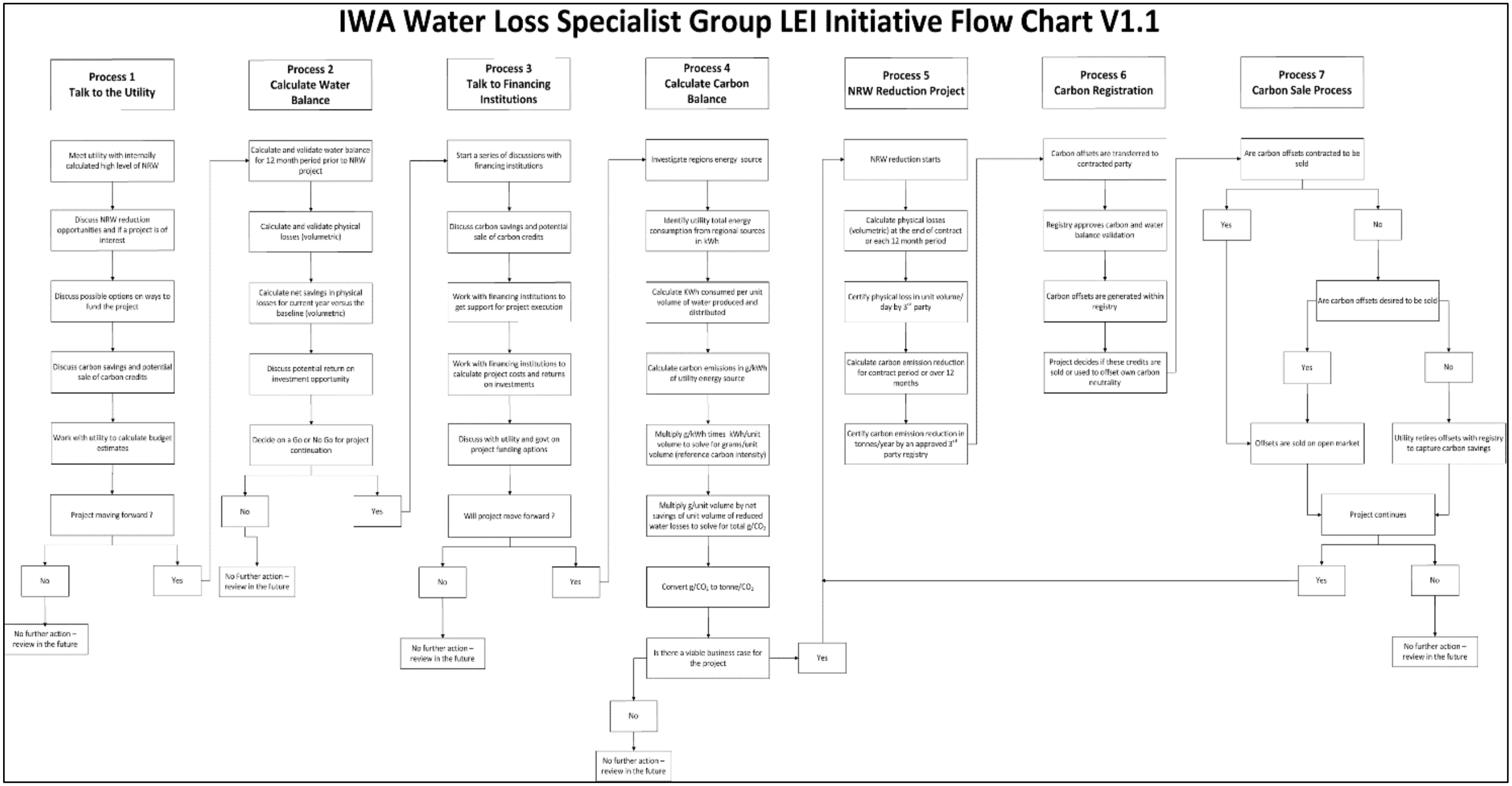
This document predominantly emphasizes savings derived from reduction of Physical Losses. Without the implementation of such projects, any additional consumption within the distribution system would inevitably exacerbate the existing physical losses.

11 The Leakage Emissions Initiative

The Leakage Emissions Initiative (LEI) comprises members of the Water Loss Specialist Group of the International Water Association and was established in July 2022 after the Water Loss 2022 conference in Prague. The Initiative's goal is to link carbon emissions to a utility's operational activity by creating a carbon balance which calculates the carbon emissions associated with each step of the water balance. Through the carbon balance, we can then show the calculable carbon emissions that can be avoided by managing and reducing non-revenue water. By approaching non-revenue water projects as both a carbon initiative and a water-based utility improvement project, the Leakage Emissions Initiative sets the framework to allow for utilities to access funding more easily via carbon reduction investment for items such as infrastructure improvements, technical assistance, and employee training.

The Process Flow Chart, Figure 1, depicts the lifecycle of an active LEI project. This framework is intended to educate the international water loss community on the operational implementation of a project that will involve both physical losses reduction coupled with the corresponding carbon emissions reduction. This flow chart may be subject to further updates as the LEI continues to develop and expand the methodology.

Figure 1: Process Flow Chart



12 Relevant Literature for Further Reading

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