

THE DEV CARBON METHODOLOGY SCIENTIFIC, TECHNICAL, AND ENGINEERING FRAMEWORK

2024 EDITION

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TABLE OF CONTENTS

- 01** ABOUT THE FRAMEWORK
- 03** SYSTEMS ENGINEERING
- 05** OPEN DATA & DATA TRANSPARENCY
- 08** THE LIST OF DOCUMENTS



List of acronyms

DEV – Decentralized Environmental Verification.

RTD – Real Time Data.

NRTD – Near Real Time Data.

SE – Systems Engineering.

SI – Systems Integration.

SA – Systems Assurance.

MBSE – Model-Based Systems Engineering.

NIST – National Institute of Standards and Technology.

INCOSSE – International Council on Systems Engineering.

NASA – National Aeronautics and Space Administration.

IEEE – Institute of Electrical and Electronics Engineers.

KPI – Key Performance Indicator.

AI – Artificial Intelligence.

ML – Machine Learning.

MRV – Measurement, Reporting and Verification.

ESG – Environmental Social Governance.

SDGs – Sustainable Development Goals.

GHG – Greenhouse Gases.

UN – United Nations.

UNFCCC – United Nations Framework Conference on Climate Change.

IPCC – Intergovernmental Panel on Climate Change.

ABOUT THE FRAMEWORK



This document introduces the framework for the DEV open data carbon offsets. Open data carbon offsets are anchored by two main pillars: Systems Engineering and open data policies. In the urgent global endeavor to mitigate climate change, the need for rigorous methodologies and transparent data governance has reached an urgency level.

This framework is a direct response to this pressing need, furnishing the theoretical, methodological, technical, scientific, and engineering set of building blocks for the DEV Carbon Methodology. This framework achieves the integration of systems thinking, Systems Engineering, systems integration, data transparency principles, and carbon accounting & tracking methodologies.

Systems Engineering, characterized by its interdisciplinary approach and lifecycle perspective, furnishes a robust foundation for designing, analyzing, and managing the intricate systems inherent in carbon offset projects. By considering the interactions between various components and the broader environmental context, Systems Engineering ensures that carbon offset initiatives are conceptualized, executed, and monitored with efficacy, integrity, and accuracy. This approach is well beyond offset methodologies based on sets of rules and premises that inadvertently enable tautological and circular scientific reference models because of the lack of open, verifiable data behind their claims. This is the point where carbon markets transition from statistical inferences to engineering.

There is an urgent need for open data policies in carbon markets. Through the transparent dissemination of data pertaining to carbon offset projects, stakeholders will gain access to crucial information, enabling them to evaluate the veracity of claims and hold entities accountable for their true environmental impact, and not only what they report and one single audit states.

Open data policies will serve as a cornerstone for fostering trust and confidence in carbon markets, facilitating informed decision-making and propelling substantive progress towards global climate goals.

The integration of Systems Engineering and open data policies collectively presents a formidable opportunity for augmenting the accuracy, reliability, and credibility of carbon offsets and carbon markets as a whole.

In this document you will find a brief introductory note about Systems Engineering, a brief introductory note about open data, and the list of documents that constitute the framework for the DEV Carbon Methodology.

SYSTEMS ENGINEERING

Systems engineering is an interdisciplinary approach to designing, analyzing, and managing complex systems over their entire life cycles. It encompasses a holistic perspective that considers the interactions between various components and subsystems within a system, as well as the relationships between the system and its environment.

Systems engineering originated in the mid-20th century, primarily in response to the increasing complexity of engineering projects, such as those in aerospace, defense, and large-scale infrastructure. As technological advancements led to the development of more sophisticated systems with interconnected components, traditional engineering approaches proved inadequate for addressing the challenges posed by these complex systems.

Key aspects of systems engineering include integration, interdisciplinary collaboration, requirements management, design and optimization, risk management, lifecycle approach, and systems thinking.

Integration involves combining different elements, such as hardware, software, personnel, processes, and facilities, to create a functioning system that meets defined requirements and objectives. Interdisciplinary collaboration is essential, as systems engineering requires input from various disciplines, including engineering (mechanical, electrical, software), mathematics, physics, and social sciences.

Requirements management is a critical aspect of systems engineering, involving the elicitation, analysis, and management of requirements throughout the system's life cycle. This ensures that the final system meets stakeholder needs and technical specifications. Design and optimization focus on designing the architecture, structure, and behavior of complex systems to achieve desired performance, reliability, and efficiency. Risk management involves identifying and managing risks associated with system development, implementation, and operation.

The lifecycle approach considers the entire lifecycle of a system, from concept development and design to manufacturing, deployment, operation, maintenance, and disposal. This ensures that the system is designed for sustainability, reliability, and ease of maintenance.

Finally, systems thinking emphasizes a holistic perspective that considers the interactions and interdependencies between different parts of a system and its broader context. This approach helps identify emergent properties, unintended consequences, and system-level behaviors that may not be apparent when focusing on individual components.

The NASA Systems Engineering Competency Model (SECM) serves as a comprehensive framework developed by NASA to delineate the requisite knowledge, skills, abilities, and behaviors necessary for proficient performance within the realm of systems engineering at the agency. It offers a detailed guide for recruiting, training, nurturing, and appraising systems engineers across the diverse array of projects and programs within NASA.

One fundamental aspect of the NASA SECM is its division of systems engineering competencies into distinct domains or categories, which encapsulate various facets of systems engineering practice. These domains typically encompass Technical proficiency, Project Management acumen, Leadership qualities, Communication skills, Collaboration capabilities, and Professionalism standards.

Within each domain, the SECM delineates specific competency elements that further elaborate on the knowledge, skills, abilities, and behaviors essential for effective systems engineering. These elements span a broad spectrum, including but not limited to Requirements Management, System Architecture, Risk Management, Integration and Testing, Decision Making, Stakeholder Engagement, Team Leadership, Conflict Resolution, Written and Oral Communication, Ethics, and Continuous Learning.

Moreover, the SECM establishes proficiency levels for each competency element, ranging from rudimentary to advanced levels of proficiency. These proficiency levels serve as a structured framework for evaluating and enhancing systems engineering competencies across different stages of an engineer's career trajectory.

To facilitate competency assessment and development endeavors within NASA, the SECM incorporates behavioral indicators for each competency element and proficiency level. These indicators delineate observable actions or behaviors that correlate with successful performance, thereby providing clarity on expectations and offering guidance for both individuals and managers in assessing competency levels and pinpointing areas for improvement.

In essence, the NASA SECM plays a pivotal role in supporting competency assessment and development initiatives at NASA by furnishing a standardized framework for gauging systems engineering capabilities. It informs various aspects of talent management, including recruitment processes, performance evaluations, training and development initiatives, career planning endeavors, and succession management strategies.

OPEN DATA & DATA TRANSPARENCY



Enhancing Stakeholder Confidence is currently of utmost importance, particularly in light of numerous instances of greenwashing that have tarnished the reputation of carbon solutions overall. Implementing transparent carbon principles will instill trust among stakeholders, including governments, businesses (buyers of carbon offsets/credits), investors, and the public. Through the establishment of clear rules, procedures, and oversight mechanisms, transparency promotes credibility and reduces uncertainty, thereby encouraging increased participation and investment in carbon markets as effective tools for climate mitigation.

Establishing transparent principles and guidelines for carbon markets is essential for bolstering accountability, ensuring environmental integrity, and fostering trust in climate change mitigation efforts. Transparency must permeate all facets of carbon markets, encompassing project development, emissions accounting, carbon trading, and the utilization of carbon credits or offsets.

Transparent guidelines are imperative to verify that carbon projects financed through market mechanisms deliver genuine and additional emissions reductions or removals. Without transparent regulations governing project development, monitoring, and reporting, there exists a risk that carbon credits or offsets may be issued for activities that fail to yield authentic emissions reductions, thereby compromising the environmental integrity of carbon markets.

Furthermore, comprehensive transparent principles will aid in combatting greenwashing by verifying that carbon credits or offsets indeed represent legitimate emissions reductions or removals surpassing business-as-usual scenarios. Well-defined guidelines for assessing additionality and quantifying emission reductions help differentiate genuine climate action from misleading or deceptive claims, thus nurturing trust and credibility in carbon markets.

Open data and data transparency policies in the context of international cooperation for sustainability and data governance refer to the principles and practices aimed at making data openly accessible, understandable, and usable by all stakeholders. These policies prioritize the sharing of data related to sustainability, environmental protection, and global development to facilitate informed decision-making, foster collaboration, and drive positive societal and environmental outcomes.

A complete definition of open data and data transparency policies in this context would encompass the following elements:

- **Accessibility:** Open data policies ensure that data related to sustainability and environmental issues are readily available to the public, policymakers, researchers, businesses, and other stakeholders. This accessibility is typically facilitated through online platforms, data portals, and repositories that provide easy and free access to datasets.
- **Interoperability:** Data transparency policies promote interoperability by standardizing data formats, metadata, and protocols to facilitate the exchange and integration of data across different systems, organizations, and geographic regions. This interoperability enhances the usability and utility of data for analysis, modeling, and decision-making.
- **Quality and Reliability:** Open data policies emphasize the importance of data quality and reliability to ensure that information used for sustainability purposes is accurate, up-to-date, and trustworthy. This may involve establishing data quality standards, conducting quality assurance checks, and providing metadata to help users assess the reliability of the data.
- **Transparency and Accountability:** Data transparency policies promote transparency and accountability by disclosing information about the sources, methods, and limitations of the data. This transparency enables stakeholders to understand how data is collected, processed, and used, and to hold data providers accountable for the integrity and accuracy of the information.
- **Privacy and Security:** Open data policies address privacy and security concerns by safeguarding sensitive information and personal data through appropriate anonymization, encryption, and access controls. These policies ensure that data sharing respects individual privacy rights and complies with relevant data protection regulations.
- **Collaboration and Engagement:** Open data initiatives encourage collaboration and engagement among diverse stakeholders, including governments, NGOs, academia, businesses, and local communities. By fostering an open and inclusive data ecosystem, these policies enable collective problem-solving, knowledge sharing, and innovation for sustainable development.

- **Capacity Building and Empowerment:** Open data policies support capacity building and empowerment efforts to enhance data literacy, analytical skills, and technical capabilities among stakeholders. This may involve providing training, education, and technical assistance to enable users to effectively access, analyze, and utilize data for decision-making and action.
- **Continuous Improvement:** Open data and data transparency policies promote continuous improvement through feedback mechanisms, data-driven evaluation, and stakeholder engagement. By soliciting input from users and incorporating lessons learned, these policies ensure that data initiatives evolve to meet the changing needs and priorities of the sustainability community.

Open data plays a crucial role in sustainability efforts, particularly in addressing climate change, for several reasons:

- **Enhanced Transparency and Accountability:** Open data enables greater transparency and accountability in climate change mitigation and adaptation efforts. By making data related to greenhouse gas emissions, climate impacts, and environmental policies freely available to the public, governments, businesses, and civil society organizations can be held accountable for their actions and progress towards climate goals.
- **Informed Decision-Making:** Open data provides decision-makers with access to a wealth of information and evidence-based insights that can inform climate action strategies, policies, and investments. Decision-makers can use open data to identify trends, assess risks, evaluate the effectiveness of interventions, and prioritize resources where they are most needed to achieve sustainability goals.
- **Facilitated Collaboration and Innovation:** Open data fosters collaboration and innovation by enabling diverse stakeholders, including researchers, policymakers, businesses, and communities, to access and share data, knowledge, and expertise. This collaboration can lead to the development of innovative solutions, technologies, and approaches to address climate change challenges more effectively.
- **Empowered Communities and Citizen Engagement:** Open data empowers communities and individuals to participate in climate change efforts by providing them with access to information and tools to understand and address local climate impacts. Citizen scientists can contribute valuable data and insights to climate monitoring and research efforts, while community-based organizations can use open data to advocate for climate-resilient infrastructure and policies.
- **Improved Planning and Resource Allocation:** Open data supports better planning and resource allocation for climate change adaptation and mitigation initiatives. Governments and organizations can use open data to identify vulnerable regions, assess climate risks, and allocate resources for infrastructure development, disaster preparedness, and ecosystem restoration in areas most susceptible to climate impacts.
- **Monitoring and Evaluation of Progress:** Open data enables the monitoring and evaluation of progress towards climate goals by providing transparent and standardized metrics for tracking emissions reductions, renewable energy deployment, forest conservation, and other sustainability indicators. This data-driven approach allows stakeholders to assess the effectiveness of climate policies and interventions and adjust strategies as needed to achieve desired outcomes.

THE LIST OF DOCUMENTS THAT CONSTITUTE THE FRAMEWORK

- INCOSE's Systems Engineering Vision 2035, Engineering Solutions for a Better World.
- INCOSE's Systems Engineering & System Definitions.
- INCOSE's Systems Engineering Competency Framework.
- Survey of Model-Based Systems Engineering (MBSE) Methodologies (INCOSE MBSE Initiative).
- The NASA Systems Engineering Handbook.
- The Expanded Guidance for NASA Systems Engineering.
- The Future Model-Based Systems Engineering Vision and Strategy Bridge for NASA.
- The Model-Based Mission Assurance in a Model-Based Systems Engineering (MBSE) Framework (NASA).
- NASA's Systems Engineering Processes and Requirements.
- The NASA Earth Science Reference Handbook.
- The Sandia National Laboratories report on MBSE, "Systematic Literature Review: How is Model-Based Systems Engineering Justified?".
- NIST's Framework for Cyber-Physical Systems.
- NIST's "Developing Cyber-Resilient Systems: A Systems Security Engineering Approach".
- NIST's "Engineering Trustworthy Secure Systems".
- NIST's Big Data Interoperability Framework.
- NIST's "Environmental Scan 2023: Societal and Technology Landscape to Inform Science and Technology Research".
- The Open Data Charter.
- The world's first standard on AI ethics: UNESCO's Recommendation on the Ethics of Artificial Intelligence.
- UNESCO's Ethical Impact Assessment: A Tool of the Recommendation on the Ethics of Artificial Intelligence.
- The Core Carbon Principles (CCPs), proposed by The Integrity Council for the Voluntary Carbon Market.
- AERTH's Planetary Data Integrity Principles.
- The Systems Engineering and Systems Integration Methodology for the Validation and Verification of Carbon Capture & Avoidance Data (by The Association of Engineers for Carbon Facts).

- The Methodology to Avoid Double Counting in Carbon Markets (also referred to as the “NO double counting Principles”) of the Data Transparency Research Group organized by The Global Nature Data Engineering Network.
- The Carbon Offset & Carbon Credit Transparency Principles proposed by The Council for Fair Green Finance.
- The Carbon Data Transparency, Traceability & Visibility Standard (by The Scientific Alliance for Carbon Offset Transparency).
- The Technical Industrial Standard for Open Data Carbon Offsets (Estándar Técnico Industrial para Offsets de Carbono de Datos Abiertos). NORMEX.
- The 2023 OECD Open, Useful and Re-usable Data INDEX.
- The UN A/RES/70/1 – Transforming our world: the 2030 Agenda for Sustainable Development.
- The UN Global Compact Management Model: Framework for Implementation.
- The UN Global Compact Guide to Corporate Sustainability.
- CDM – (1) Accreditation Standard. (2) Project standard for project activities. (3) Determining coverage of data and validity of standardized baselines. (4) Large-scale Consolidated Methodology. Afforestation and reforestation of lands except wetlands. (5) CDM – Large-scale Methodology. Afforestation and reforestation of degraded mangrove habitats.
- The IUCN Global Ecosystem Typology
- The IUCN Red Listed Ecosystems platform.

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