President's Working Group on Sustainability and the Environment
Friday, January 24, 2019
1:00 p.m. - 3:00 p.m.
Facilities Operations, Conf Rm B
25 Ledoyt Road

<u>ATTACHMENT</u>

1. Working Group Charge [5 min.]   1

2. Planning [10 min.]
   a. Draft Schedule of Topics   2
   b. Terminology   3

3. Climate Action at UConn ~ Presentation [15 min.]   4

4. Carbon Emissions and Reductions at UConn ~   5
   Presentation [15 min.]

5. Discussion [60 min.]

6. Next Steps [10 min.]

7. Close

CHARGE

President's Working Group on Sustainability and the Environment

Examine UConn's current carbon emissions reduction goals and our progress to achieving them; assess whether or not accelerating those goals is feasible within the context of our budget and available technology. Recommend actions UConn can take based on facts, data, sound strategies and the best estimates we are able to make.

President's Working Group on Sustainability & the Environment			
Date	Time	Location	Proposed Discussion Topics
01/24/20	1:00-3:00pm	Fac.Ops - Conference Room B, 25 Ledoyt Road	Baseline: Committee Charge, Planning and Schedule, Climate Action Taken, Carbon Emissions and Reductions
02/05/20	9:00-11:00am	Fac.Ops - Conference Room B, 25 Ledoyt Road	Energy use and generation (Storrs and UCH)
02/27/20	3:00-5:00pm	Fac.Ops - Conference Room B, 25 Ledoyt Road	Energy use and generation (Storrs and UCH)
03/10/20	9:00-11:00am	Fac.Ops - Conference Room B, 25 Ledoyt Road	Transportation and Behavior (Vehicles Parking, Landscape, Behavior)
03/25/20	1:00-3:00pm	Fac.Ops - Conference Room B, 25 Ledoyt Road	Transportation and Behavior (Vehicles Parking, Landscape, Behavior)
04/09/20	2:00-4:00pm	Fac.Ops - Conference Room B, 25 Ledoyt Road	Report First Draft
04/30/20	2:00-4:00pm	Fac.Ops - Conference Room B, 25 Ledoyt Road	Report Final Draft

Review of sustainability terms and their definitions

2 authors:

Peter Glavič
University of Maribor
127 PUBLICATIONS   **2,476** CITATIONS

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Rebeka Kovačič Lukman
29 PUBLICATIONS   **1,658** CITATIONS

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Some of the authors of this publication are also working on these related projects:

University Educators for Sustainable Development, UE4SD View project

RECDEV | Innovative solutions for WEEE Recycling Industry View project

ELSEVIER

Review of sustainability terms and their definitions

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Abstract

Terminology in the field of sustainable development is becoming increasingly important because the number of terms continues to increase along with the rapid increase in awareness of the importance of sustainability. Various definitions of terms are used by different authors and organizations, for example, green chemistry, cleaner production, pollution prevention, etc. The importance of this topic has stimulated research into the problems of clarifying ambiguity and classifying terms used in the sustainability field. This paper provides results of the literature survey and summarizes the definitions of the terms, focusing on the environmental engineering field. In some cases, it proposes an improved definition. A hierarchical classification of the terms and their relationships has been based on a layer format that is presented graphically.
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Keywords: Sustainability; Cleaner production; Terminology; Definitions; Classification

1. Introduction

The recent research and growth of knowledge about sustainable development have increased interest in sustainable development terminology, which has gained prominence over the past decade. It embraces terms such as cleaner production, pollution prevention, pollution control, and minimization of resource usage, eco-design and others. These terms are in common use in scientific papers, monographs, textbooks, annual reports of companies, governmental policy usage, and the media. Application of terms depends on their designation and recognition, rather than on domain concept. Yet, some of the terms are specific, permitting differentiation from the others. Also, differences amongst term usages, based upon geographical area, exist that often lead to imprecise definitions of the terms and their usage.

The availability of various information sources increases the spread of sustainability terms and their definitions, as employed by different authors and organizations. As

a consequence, numerous new terms are emerging, or the existing ones are being extended in the sustainability field, but not enough critical attention has been given to the definitions and their semantic meanings. The multitude of definitions causes much confusion about their usage, since the meaning of some terms is either sloppy or similar, or is only slightly different from one another.

Another important issue is that most of the terms are multiword units and, therefore, the definitions are unavailable in dictionaries. To our knowledge, this topic has not been analysed, yet. Semantics and content analysis enable the researcher to better describe and understand sustainable development concepts. Consequently, communications within the scientific community, organizations, agencies and stakeholders can be improved. A hierarchical classification and relationship of the terms needs to be developed in order to achieve better and easier understanding.

Much of this research was devoted to a survey of literature and Internet sources, comprising the terms and definitions associated with the sustainable development field. Therefore, the terminology is based upon usage within the United Nations Environment Programme (UNEP), the U.S. Environmental Protection Agency (EPA), the European Environmental

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Agency (EEA), the Organization for Economic Co-operation and Development (OECD), the Journal of Cleaner Production, and others.

The survey revealed that definitions used to describe a concept might be non-specific and the terms could be understood ambiguously.

Therefore, this research was designed to develop a framework for improved, coherent, and sustainable terminology, providing enough freedom to make clear distinctions to spur research in this field for developing the basic terms, thus allowing the terminology to be further advanced. An important reason for this research was that sustainable development should be supported by a common, unambiguous terminology, applicable to real-world problems.

2. Terminology

Terminology represents an integrated framework for all related terms and serves as a basis for communication within a particular scientific field. In addition, in sustainable development, various terms are used to describe different strategies, actions, effects, phenomena, etc. Movement from usage of inappropriate terms and unambiguous definitions can help us to make more rapid progress in sustainable development science and engineering. In this research, special attention has been given to terms connected with the environmental engineering field. Fifty-one selected terms were investigated: a semantic analysis of these terms and their definitions were performed. First, the terms were identified, and the content of their definitions was analysed. Then, improved definitions have been proposed in some cases.

Our classification framework uses a '*system's approach*'. The systems consist of simple elements (principles): *Environmental/Ecological, Economic, and Societal Principles*. These elements are followed by *Environmental Approaches (Tactics)* and *Environmental Sub-systems (Strategies)*. The broader term embracing principles, approaches and sub-systems is labelled as *Sustainable System*. Therefore, the system is treated as a hierarchical structure of principles, approaches and sub-systems. The term *tool*, used to further realization of principles, approaches, sub-systems, systems and policy, is not included into systems.

3. Definitions of principles: an overview

As used in this text, *principles* are fundamental concepts that serve as a basis for actions, and as an essential framework for the establishment of a more complex system. Semantically, principles are narrow and refer only to one activity or method. They provide guidance for further work and, therefore, occupy the lowest position in the hierarchy. We have positioned the principles within environmental and ecological, economic, and societal dimensions (Fig. 1).

There are only a few one-dimensional principles, situated at the vertices of the base. Principles having two dimensions of sustainable development are placed along a side of the triangle. Principles situated in the plane, directly or indirectly,

include all the three dimensions. Three-dimensional principles can serve as a basis for building a more complex system — *Sustainable system*.

3.1. Environmental principles

Environmental principles denominate those terms that describe environmental performance, in order to minimize the use of hazardous or toxic substances, resources and energy. These terms are: *renewable resources, resource minimization, source reduction (dematerialization), recycling, reuse, repair, regeneration, recovery, remanufacturing, purification, end-of-pipe, degradation*, and are arranged from preventive to control principles.

3.1.1. Renewable resources

Renewable resources *are available in a continually renewing manner, supplying materials and energy in more or less continuous ways. In other words, renewable resources do not rely on fossil fuels of which there are finite stocks* [1]. The term emerged as a response to increased carbon dioxide emissions. It is fostered by the rise of the sustainability paradigm and includes energy resources such as solar, wind, tidal, wood, biomass, and hydroelectric. Of course food and feed are renewable resources as well.

3.1.2. Minimization of resource usage

The fact that natural resources will not last forever is leading to widespread concerns about energy, raw materials and water supply. Therefore, a resource minimization principle has been developed. The definition of the term has not been proposed, yet.

Minimization of resource usage is understood as *conservation of natural resources*. It is an activity that can be applied to any reduction of usage of resources. Therefore, the term encompasses not only raw materials, water, and energy, but also applies to natural resources such as forestry, watersheds, other habitats, hunting, fishing, etc. All these resources and processes which enable ecosystems to survive and are essential for helping societies to make progress toward sustainability must be addressed. Thus, resources can be conserved, their availability improved and maintained. Reduction in the usage of materials and energy can result in dramatic cost savings.

3.1.3. Source reduction (dematerialization)

Source reduction is *the practice that reduces the quantity of materials entering a waste stream from a specific source by redesigning products or patterns of production and consumption* [2]. Besides materials, this definition also encompasses energy. According to the EPA **dematerialization** refers to *quantitative reduction in the volume of material and energy used to meet user's demand, while maintaining a uniform quality of services* [3] and as introduced by Wernick et al., it *refers to the absolute or relative reduction in the quantity of materials required to serve economic functions and matters for the environment* [4]. This definition of materialization
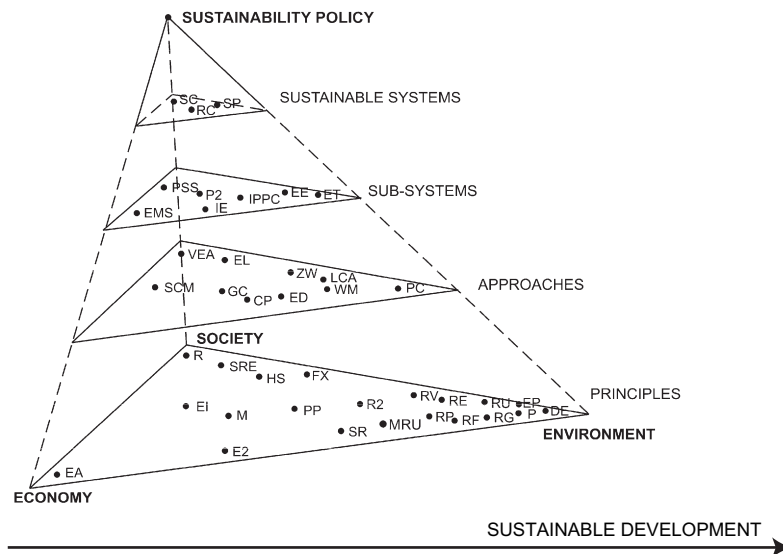
CP, cleaner production; DE, degradation; EA, environmental accounting; ED, eco-design; EE, environmental engineering; EI, ethical investment; EL, environmental legalisation; EMS, environmental management strategy; ET, environmental technology; E2, eco-efficiency; F*X*, factor *X*; GC, green chemistry; HS, health and safety; IE, industrial ecology; IPPC, integrated pollution prevention and control; LCA, life cycle assessment; M, mutualism; MRU, minimization of resource usage; P, purification; PC, pollution control; PO, policy; PP, "polluter pays" principle; PSS, product service system; P2, pollution prevention; RC, responsible care; R, reporting to the stakeholders; RE, recycling; RF, remanufacturing; RG, regeneration; RP, repair; RU, reuse; RV, recovery; R2, renewable resources; SC, sustainable consumption; SCM, supply chain management; SD, sustainable development; SP, sustainable production; SR, source reduction; SRE, social responsibility; VEA, voluntary environmental agreement; WM, waste minimization; and ZW, zero waste.

Fig. 1. Classification of sustainability oriented terms.

is more appropriate, because dematerialization is semantically not applicable to energy.

Source reduction contributes to a lowering of disposal and handling costs, because it avoids the costs of recycling, municipal composting, landfilling, and combustion. Source reduction also conserves resources and reduces pollution, including greenhouse gases that contribute to global warming [2].

3.1.4. Recycling, reuse, repair

The **recycling** is defined as *a resource recovery method involving the collection and treatment of waste products for use as raw material in the manufacture of the same or a similar product* [1]. The EU waste strategy distinguishes between reuse and recycling. The **reuse** *means using waste as a raw material in a different process without any structural changes* and **recycling** *refers to structural changes in materials within the same process* [1]. **Repair** *means an improvement or complement of a product, in order to increase quality and usefulness before reuse*; it decreases consumption, because the product's life is extended.

3.1.5. Regeneration, recovery, remanufacturing

Regeneration is *an activity of material renewal to return it in its primary form for usage in the same or a different process*. This activity enables an internal restoration and, therefore,

decreases the environmental impacts. **Recovery** is an *activity applicable to materials, energy and waste. It is a process of restoring materials found in the waste stream to a beneficial use which may be for purposes other than the original use* [1], e.g. resource recovery in which the organic part of the waste is converted into some form of usable energy. Recovery may be achieved by combustion of a waste material in order to produce steam and electricity, or by a pyrolysis of refuse to produce oil or gas, or by anaerobic digestion of organic wastes to produce methane gas and a fermentate that can be used as a soil-conditioner [1]. **Remanufacturing** is defined as *substantial rebuilding or refurbishment of machines, mechanical devices, or other objects to bring them to a reusable or almost new state*. This prevents many reusable objects from becoming waste. The remanufacturing process usually involves disassembly, and frequently involves cleaning and rebuilding or replacing components. Remanufactured objects are sometimes referred to as rebuilt objects [5].

3.1.6. Purification and end-of-pipe

Purification is *the removal of unwanted mechanical particles, organic compounds and other impurities*. The process of removal could be mechanical, chemical or biological in order to improve the environment and quality of life. **End-of-pipe** is defined as *a practice of treating polluting substances at the end*

of the production process when all products and waste products have been made and the waste products are being released (through a pipe, smokestack or other release point) [3]. This approach is designed to reduce the direct release of pollutants so as to achieve compliance with environmental regulations; sometimes it results in transmitting pollutants from one medium to another. Therefore, it can result in only a temporary delay of causing environmental problems.

3.1.7. Degradation

Term **degradation** could be understood as *a biological, chemical or physical process, which results in the loss of productive potential* [1]. From the biological point of view, degradation can lead to the elimination and extinction of living organisms. It can also refer to biological degradation of plant and animal residues, thereby making their elemental components available for future generations of plants and animals.

3.2. Ecological principles

Industrial and all other human systems have their origin in natural systems that must obey natural laws. The most important feature of natural systems is their interconnection. **Ecological principles** have to be considered in order to understand the relationships between natural ecosystems. These principles are essential for the interaction of various systems. Every sub-system in nature is linked with every other sub-system through indirect or direct interconnections. In the natural ecosystem, many relationships exist between species, each with different consequences. Among the possible interrelationships, the following are the most common:

- *competition*: influences the species in a negative way and none of the species benefits; the main objective is the elimination of other species from an ecological niche;
- *predatory*: one species "eats" the prey; the predator has the benefit;
- *amensalism*: one species is impaired and the other is neither positively nor negatively affected;
- *parasitism*: one species benefits and the other is impaired;
- *neutralism*: a hypothetical category where one species does not harm or benefit the other species;
- *commensalism*: one species receives benefits and the other is not impaired;
- *protocooperation*: both interrelated species receive conditional benefits, but they can survive separately; and
- *mutualism*: both species receive benefit.

The last three relationships are understood as symbiosis, because systems are either not impaired or receive benefits due to the interactions.

In the industrial environment, similar relationships are being documented and developed. Industrial symbiosis seems to be the most common of all the existing relationships, but a more appropriate term may be 'industrial mutualism', where the involved subjects (enterprises, employees, and community) live together and all of them enjoy benefits. Such relationships present an obligation for all the subjects involved, allowing better utilization of resources and energy; thus resulting in increased probability of survival. The key issues of industrial symbiosis are collaboration and the synergistic possibilities offered by geographic proximity [6].

3.3. Economic principles

Economic principles embrace terms like *Environmental Accounting*, *Eco-efficiency (Factor X, Factor 4, and Factor 10)*, and *Ethical Investments*.

3.3.1. Environmental accounting

Environmental accounting *is designed to bring environmental costs to the attention of the corporate stakeholders who may be able and motivated to identify ways of reducing or avoiding those costs while at the same time improving environmental quality and profitability of the organization* [2]. Environmental accounting can be applied at the national, regional and corporate levels. National accounting refers to physical and monetary accounts for environmental assets and the costs of their depletion and degradation. Corporate environmental accounting refers to environmental auditing, but may also include the costing of environmental impacts caused by the corporation [1].

3.3.2. Eco-efficiency

The term Eco-efficiency was perceived within numerous definitions of cleaner production. [7]. **Eco-efficiency** is *the delivery of competitively priced goods and services that satisfy human needs and bring quality of life, while progressively reducing ecological impacts and resource intensity throughout the life cycle, to a level at least in line with the earth's estimated carrying capacity* [3,15]. It is based on the concept of "doing more with less" [8] representing the ratio between economy and environment, with the environment in the denominator [7]. It is about more efficient use of materials and energy in order to provide profitability and the creation of added value. In the triangle, it could be located at the side between the economic and environmental dimensions. According to the usual usage, eco-efficiency specifically emphasizes production processes and services.

3.3.3. Factor X, Factor 4, and Factor 10

Robert et al. [9] defined **Factor X** as *a direct way of utilizing metrics in various activities that can reduce the throughput of resources and energy in a given process*.

The Factor X concept is a very useful and flexible approach for monitoring activities aimed at reducing the materials and energy usage of diverse industrial and societal processes [9]. The overall aim of Factor X is to enable society to achieve the same or even better quality of life improving human welfare, while using significantly less resource inputs and causing less ecosystem destruction. The Factor X concept proposes X times more efficient use of energy, water and materials in the future as compared to the usage today. In other words, **Factor 4** refers to *a fourfold increase in resource productivity*;

Factor 10 refers to *a tenfold increase in productivity* [10,11]. These approaches are societally and environmentally oriented, and are therefore, located at the side between these two dimensions.

3.3.4. Ethical investments

Ethical investments or **socially responsible investments** are *financial instruments (mortgages, bank accounts, investments, utilities, and pensions), favouring environmentally responsible corporate practices and those, supporting workforce diversity as well as increasing product safety and quality* [12,13].

3.4. Societal principles

Societal principles are composed of terms such as *Social Responsibility, Health and Safety, ''Polluter pays'' principle (Taxation)*, and *Reporting to the stakeholders*.

Social responsibility refers to *safe, respectful, liberal, equitable and equal human development, contributing to humanity and the environment*. Furthermore, the term **health and safety** usually refers to *the working environment and includes responsibilities and standards*.

The **Polluter pays principle** was defined by the EEA [1] as *a principle that those causing pollution should pay the costs it causes*. Thus, the polluter pays for environmental damage in the form of a clean-up or taxation but usually, in practice, this principle is overlooked.

Reporting to the stakeholders is about *sharing the progress, results and planning with the general public*. The leading role has been taken by Global Reporting Initiative, presenting global effort to create a framework for reporting on economic, environmental and social performance by all organizations [14].

4. Definitions of approaches

Approaches (tactics) contain a group or cluster of principles related to the same topic, building a more complex system. Approaches are semantically broader than principles and they are organized within environmental, economic and societal dimensions. Strictly one-dimensional approaches do not exist, as in the case of principles. They are connected to all other dimensions of sustainable development.

4.1. Environmental approach

The term environmental approach is a concept-oriented term that encompasses pollution control, cleaner production, green chemistry, eco-design, life cycle assessment, waste minimization, and zero waste. It involves more or less economic and societal content at a higher level of hierarchy as shown in Fig. 1. All the terms incorporate the elementary principles and activities, showing how to apply specific practices in order to contribute to improved industrial performance.

4.1.1. Pollution control

A 'pollution control' definition was not found in the literature examined. The term relates to the past, when pollutants were simply 'managed.' The so-called *end-of-pipe pollution control technologies* utilize pollution control for the management of most problems of waste and emissions of pollutants from industrial sources.

Pollution control can be defined as ''*an approach that is designed to reduce the impacts of pollutants that are produced, before they are released into the environment; this is accomplished by some type of treatment*.'' The pollution control approach focuses upon capturing and treating, rather than reducing the *production of pollutants at their sources* and thus, is a ''react and treat'' approach [15]. It includes end-of-pipe pollution control technologies, emission abatement, purification, and monitoring activities. Consequently the pollutants are often merely transferred from one medium to another and cause additional costs. Since pollution control does not lead to prevention of the production of pollutants at their sources, it is not in accordance with the sustainable development vision.

4.1.2. Cleaner production

The definition of cleaner production has raised a lot of interest during the past decade. This definition was developed by UNEP in Paris in 1989. Since then the definition has been expanded and a sustainable development orientation has been added. For example, a broader vision was established in the year 2004. The direct involvement of the economic dimension ''…by using better management strategies, methods and tools…'' [16,17].

It includes both a condition for achieving environmental improvements in process and product development, and a contribution to a more sustainable world.

Cleaner production management strategies endeavour to:

- increase the productivity of materials;
- improve energy efficiency;
- improve material flow management;
- apply preventive environmental protection approaches;
- strive for sustainable use of natural capital; and
- achieve accordance with legal compliance [17].

These expansions of the cleaner production definition have led to confusion. Therefore, we propose an improved **cleaner production** definition, in order to reduce or prevent ambiguity: *cleaner production is a systematically organized approach to production activities, which has positive effects on the environment. These activities encompass resource use minimization, improved eco-efficiency and source reduction, in order to improve the environmental protection and to reduce risks to living organisms*. It can be applied to processes used in any industrial sector and to products themselves (cleaner products). Although cleaner production, as practiced and taught and underscored by UNEP and UNIDO, includes services, this definition excludes them, because production is understood as output, such as units made in a factory, oil from an

oil well, chemicals from a processing plant [18] or the process of growing or making goods or materials [19,20]. On the other hand, service is understood as the performance of maintenance, supply, repair, installation, distribution, and so on, for or upon an instrument, installation, vehicle, or territory [18], or as a system that provides something that the public needs, a business whose work involves doing something for consumers, but not producing goods [19,20]. Therefore, a new term *Cleaner services* should be used.

4.1.3. Eco-design

Terms used for the description and characterization of product and service design are adjusted under the multi-word terms **eco-design** and **design for environment**. Both terms are understood as *a product development process that takes into account the complete life cycle of a product and considers environmental aspects at all stages of a process, striving for products, which make the lowest possible environmental impact throughout the product's life cycle* [3,15]. The inclusion of environmental dimensions in product design and services contributes to product innovations. This term encompasses eco-efficiency, health and safety, remanufacturing, recycling, source reduction, waste minimization and it is linked with life cycle assessment.

4.1.4. Green chemistry

Despite the numerous green chemistry definitions, similarity among them is clearly visible from the semantic point of view. **Green chemistry**, also known as sustainable chemistry, introduces an umbrella concept that has grown substantially since it emerged a decade ago [21]. *Green chemistry is the design of chemical products and processes that eliminate or reduce the use and generation of hazardous substances* [22]. Moreover, green chemistry relies on a set of 12 rules that contain five principles: waste minimization, renewable resources, eco-efficiency, degradation, and health and safety. Therefore, chemical reactions should be designed or modified to be clean and sustainable, while maintaining the current standard of living. Under the green chemistry approach, the reduction of hazardous materials through the selection of feedstocks, reagents, and reaction pathways as well as the use of alternative solvents is emphasized. Green chemistry also includes the use of catalysts to yield desired products by achieving higher selectivity than may have been achieved by previously used catalysts [22].

4.1.5. Life cycle assessment

The term **life cycle** addresses *all stages and the life time of products, their environmental impacts as well as services, manufacturing processes, and decision-making*. It is realized through the life cycle assessment (LCA). Life cycle presents a basis for achieving improved life cycle performance and it is an essential approach for the implementation of sustainable development into product design.

The most precise definition of **life cycle assessment (LCA)** was provided by EPA [2] and EEA [1] as *the method/process for evaluating the effects that a product has on the environment over the entire period of its life, thereby increasing resource-use efficiency and decreasing liabilities*. It can be used to study the environmental impact of either a product or a function the product is designed to perform. LCA is commonly referred to as a ''cradle-to-grave'' analysis. Its key elements are the following: (1) identify and quantify the environmental loads involved, e.g. the energy and raw materials consumed, the emissions and wastes generated; (2) evaluate the potential environmental impacts of these loads [1]; and (3) assess the options available for avoiding or reducing these environmental impacts.

A more detailed expansion in the second part of the definition may explain that LCA introduces input/output accounting and can be applied to production processes, to products and services or even to strategic planning. A basic step in LCA is an inventory analysis that provides qualitative and quantitative information regarding consumption of material and energy resources (at the beginning of the cycle) as well as releases into the anthroposphere, hydrosphere, geosphere, and atmosphere (during its use or at the end of its life cycle). It is based upon various material cycles and budgets; it quantifies the materials and energy required as inputs, and the benefits and liabilities posed by the products. The related area of impact analysis provides information about the kinds and degrees of environmental impacts resulting from the complete life cycle of the product or activity. After the environmental and resource impacts have been evaluated, it is possible to perform an improvement analysis in order to determine measures that can be taken to reduce impacts on the environment or to reduce resource or energy usage [23]. Thus, LCA includes the life cycle principle and it refers to the supply chain management approach.

4.1.6. Waste minimization

Following EPA, **waste minimization** is defined as *measures or techniques that reduce the amount of wastes generated during industrial production processes* [2]. It is including source reduction or recycling activity undertaken by the generator that results in either (1) a reduction in the total volume of waste, or (2) a reduction in the toxicity of the waste, or (3) both, so long as the reduction is consistent with the goal of minimizing present, and reducing future threats to human health and the environment. It is about minimizing waste at source, recycling, and purifying during the production process. According to the definition, this term is environmentally oriented, and refers to industrial performance. But, the term indirectly refers to the human health and safety dimensions. Due to toxicity and waste minimization, it is also linked to cost and risk reduction.

4.1.7. Zero waste

The definition of **zero waste** was not found among the UNEP, EPA or EEA glossaries, but is defined by the Grass Roots Recycling Network [24] as *a design principle for the 21st century. It includes 'recycling' but goes beyond recycling by taking a holistic approach to the vast flow of resources and waste through human society*. Zero waste maximizes recycling, minimizes waste towards zero, reduces consumption

and ensures that products are planned to be reused, regenerated, repaired, and recycled internally or back into nature or the marketplace. Zero waste makes recycling a powerful entry point into the critique of excessive consumption, waste, corporate responsibility, and the fundamental causes of environmental destruction [24]. Furthermore, zero waste does not take into consideration waste as a material that must be disposed off or incinerated, but treats waste as a resource that can be used again and so takes full advantage of the waste potential.

4.2. Economic and societal approaches

In order to understand and make progress toward a sustainable system, economic and societal approaches are also needed. These approaches are of fundamental importance and they embrace the terms: *environmental legalisation*, *voluntary environmental agreements*, and *supply chain management*.

Environmental legalisation *is a set of legal principles, acts, regulations, directives, and laws, influencing both the environment and the inhabitants of each country or union*. The aim of such a system is to improve the environmental protection, and the quality of life.

According to Long and Arnold [25] **voluntary environmental agreements** are defined as *agreements among the corporate, government and/or non-profit sectors, not required by legislation. They present contracts between the public administration and the industry in which the firm agrees to achieve a certain environmental objective and receives a subsidy to change its technology through research, development, and innovation* [1]. The agreement is bilateral, between one party and the administration, and requires a voluntary element on both sides [1]. The aim is to improve the environmental quality and the utilization of natural resources. Voluntary Environmental Agreements could have important influences in our common future as long as they are fostered by local communities, non-governmental organization, and industrial sectors rather than by government.

Supply chain management is defined as *a process of planning, implementing, and controlling the operations of the supply chain with the purpose of satisfying consumer requirements*. Moreover, it spans all transportation and storage of raw materials, work-in-process inventory, and finished goods from point-of-origin to point-of-consumption [26].

5. Definitions of sub-systems: strategies

Sub-systems present parts of a more complex system. Each consists of approaches, connected together; they introduce strategies that are to be met in order to achieve integral conservation of the environment, and contribute to short- and long-term human welfare.

5.1. Environmental sub-systems

The consciousness about human activities and their impacts on the global environment has fostered the implementation of various strategies to prevent environmental degradation. These activities are embraced under the term *Environmental Subsystems* and are practiced through *Environmental/green technology and engineering*, *Integrated pollution prevention and control*, *Industrial ecology*, and *Pollution prevention*. These strategies are mostly environmentally oriented, but they also include societal and economic dimensions.

5.1.1. Environmental engineering and environmental technology

Particular emphasis should be given to the terms **engineering** and **technology**. While **engineering** encompasses *activities of design and construction, operation and use of techniques*, **technology** deals with *processes and methods of production*.

Environmental (green) engineering can be defined as *the design, construction, operation, and use of techniques, which are feasible and economical while minimizing the generation of pollution at the source and the risk to human health and the environment* [2], and, therefore, includes eco-design, LCA, and green chemistry. Environmental engineering focuses on achieving sustainability through the application of science and technology [22]. On the other hand, **environmental (green) technology** is *the systematic knowledge of, and its application to production processes, making efficient use of natural resources while reducing/recycling wastes, to control/minimize the risks of chemical substances, and to reduce pollution* [18,27]. It includes cleaner production, supply chain management, waste minimization and zero waste.

5.1.2. Integrated pollution prevention and control

The EEA has defined **Integrated Pollution Prevention and Pollution Control (IPPC)** as *a legal process, by which large industrial processes are licensed and regulated*, referring specifically to the requirements of the European Commission's directive [1,28]. The main objective of the IPPC is to prevent or minimize emissions to all media as well as waste from industrial and agricultural edifications and their activities, whether new or existing, in order to achieve environmental protection. These obligations cover a list of measures following discharges into water, air and soil, and following waste, wastage of water and energy, and environmental accidents [29].

5.1.3. Industrial ecology

There are several different definitions of **industrial ecology**. The best one has been proposed by UNEP: *Systems-oriented study of the physical, chemical, and biological interactions and interrelationships both within industrial systems and between industrial and natural ecological systems* [15]. The definition includes the system's theory, well-known in ecology.

Industrial ecology is closely related to industrial ecosystems. In ecology, an ecosystem consists of various complex environs and sub-systems. The most important issues are the interrelationships, because they present a basis for

interconnections between environs. Therefore, the **industrial ecosystem** represents *a group of enterprises that utilize each other's materials and by-products such that waste materials are reduced to an absolute minimum* [23]. The consumption of energy, raw materials, water and other resources is optimized in an industrial ecosystem, and waste from one process serves as a raw material for another.

Industrial ecology has influenced the development of **eco-industrial parks**. It is *a community of businesses, manufacturing and services, located together in a common property, seeking enhanced environmental, economic, and societal performance through collaboration in managing environmental and resource issues including information, energy, water, materials, infrastructure, and natural habitats* [15,23]. The benefit of such a community is greater than the sum of individual benefits [6]. This community benefits from the relationships and interconnectedness between environs and their environment.

Cradle to cradle is a paradigm, based on principles in which materials are viewed as 'nutrients' circulating in closed loops [30]. The term can be related to industrial ecology, because both terms are designed to mimic nature, where everything is used and nothing becomes a waste. This maximizes the material value without damaging ecosystems. On the other hand, cradle-to-grave assessment considers impacts at each stage of products' life cycle from the time when natural resources are extracted from the ground to their final disposal [1].

5.1.4. Pollution prevention

Although several definitions of pollution prevention are available, a similarity between them remains. Despite the EPA's definition of pollution prevention emphasizing the essential concept, new definitions are still emerging. The most common explanation discussing indirect semantic relationships and representing a consistent and reasonable definition was introduced by the Centre for Environmental Training and International Consulting (CENTRIC) [17]. This definition has its roots in the U.S. EPA's definition, **pollution prevention** being *a multi-media environmental management approach which emphasizes the elimination and/or reduction of waste at the source of generation*. In our opinion, the more appropriate term is 'strategy' instead of 'approach', because the term encompasses numerous principles and approaches.

The need to investigate all types of waste in order to protect the environment and conserve natural resources has spurred implementation of the pollution prevention strategy. The objective of the strategy is to stop the production of pollutants before they are generated and to achieve sustainable improvements, involving not only conservation of natural resources and materials, but also preventing accidental spills and releases, and avoiding exposure to toxic and dangerous materials.

An ambiguity was recognized between the terms 'cleaner production' and 'pollution prevention'. Cleaner production has a definition similar to pollution prevention; the term 'pollution prevention' is more frequently used in North America, and 'cleaner production' is used throughout the world.

Firstly, a lot of similarities have been recognized. Both definitions emphasize the pollution prevention principles, efficiency improvements through source reduction and beneficial use of resources and energy. Unlike the past when pollutants were simply controlled and treated, pollution prevention and cleaner production are both designed to prevent, reduce or eliminate pollutant production and transfer to all media in efficient and sustainable ways [17]. Both terms also involve cost reduction as their activities. Importantly, hazards to society and environment should be decreased at their sources. Moreover, cleaner production can be included in pollution prevention performance since it directs prevention-oriented activities within the industrial sector [24].

Nevertheless, differences between these two terms exist. Pollution prevention is established as a strategy. Semantically, a 'strategy' is obviously a broader term than an 'approach' (tactics), as introduced in the cleaner production definition. Moreover, pollution prevention differs from cleaner production in the fact that it comprises services and, therefore, encourages continuous performance of all activities, i.e. environmental management. Therefore, pollution prevention is an approach that is not only manufacturing oriented but can be applied to other sectors and services in general, from households to the tourism. In practice, cleaner production is applied also to services, from household, corporate and financial sector to tourism and others, but from a semantic point of view it is incorrect. Therefore, we have proposed a new definition for cleaner production.

5.2. Economic and societal strategies

Societal and economic dimensions are introduced through Economic and Societal sub-systems: *Environmental Management System* (*ISO 14000, Eco-management and Audit Scheme (EMAS)*), and *Product Service System*. Such strategies provide better quality of life and harmony with the surrounding ecosystem. Although, in some of the terms, the word 'system' appears, they are a sub-system in our classification.

5.2.1. Environmental management strategies

Environmental Management Strategy (EMS) presents a sub-system created to manage the environmental performance of organizations. **EMS** is *a set of management tools and principles designed to guide the allocation of resources, assignment of responsibilities and ongoing evaluation of practices, procedures and processes, and environmental concerns that industries, companies, or government agencies need to integrate into their daily business or management practices* [31]. EMS ensures that environmental issues are systematically identified, controlled, and monitored. It provides a mechanism for responding to changing environmental conditions and requirements, reporting on environmental performance, and reinforcing continual improvement [32]. EMS also embraces Supply Chain Management.

The **ISO 14000** series is *a family of environmental management standards developed by the International Organization for Standardisation (ISO)*. The ISO 14000 standards are

designed to provide an internationally recognized framework for environmental management, measurement, evaluation and auditing. They do not prescribe environmental performance targets, but instead provide organizations with the tools to assess and control the environmental impact of their activities, products or services. The standards address the following principles: environmental auditing, environmental labelling and declarations, environmental performance evaluation, as well as approaches: environmental management and life cycle assessment [1].

Eco-management and auditing scheme (EMAS) is *the European Union's (EU) voluntary instrument that acknowledges organizations, which improve their environmental performance on a continuous basis* [33]. EMAS was originally designed for enterprises within industrial/manufacturing sectors. In 2001 the Regulation of the European Parliament, proposed EMAS for all the organizations, having environmental impacts, including public ones [34]. Therefore, EMAS introduced the tool for all organizations (i.e. enterprises, institutions, public and private organizations) in the EU area, to better manage their environmental impacts and to contribute to a more sustainable future. The objective of the scheme is to promote continuous improvements in the environmental performance of industrial activities by: (a) the establishment and implementation of environmental policies, programmes and management systems by companies, in relation to their sites; (b) the systematic, objective and periodic evaluation of the performance of such elements; (c) the provision of environmental performance information to the public [1]. Therefore, EMAS fosters organizations to estimate and improve the environmental efficiency, and publish their environmental achievements. On the other hand, EMAS presents a management strategy for companies and other organizations, evaluating, reporting, and improving their environmental performance.

5.2.2. Product service systems strategy

The term **product service systems (PSSs)** have been defined as *a marketable set of products and services capable of jointly fulfilling a user's need. The product/service ratio in this set can vary, either in terms of function fulfilment or economic value* [35]. Thus, more traditional, material-intensive ways of product utilization are replaced by the possibility of fulfilling consumers' needs through the provision of more dematerialized services, which are often also associated with changes in ownership structure [36]. The importance of product service systems ought to be in satisfying equity and the requirements of people with low budgets.

6. Sustainable systems

A system is a group of interdependent and interrelated sub-systems comprising a coherent entity. Sub-systems function together as a whole to accomplish sustainable development.

Sustainable systems present the highest level of activities required in order to make progress towards sustainable development. The achievement of such objectives demands a change in thinking patterns, and lifestyles. The term 'sustainable systems' incorporates *Responsible care*, *Sustainable consumption*, and *Sustainable production*.

6.1. Responsible care

Responsible care is *the chemical industry's global voluntary performance guidance system, which shares a common commitment to advancing the safe and secure management of chemical products and processes*. 'Responsible care' practices may vary between countries and each country's law does not determine them. Therefore, 'Responsible care' enables companies to go above and beyond government requirements and the companies must openly communicate their results to the public. It encompasses employees, transportation and process safety, releases into the environment, distribution incidents, eco-efficiency, etc. [37]. The term includes environmental management systems as well as product service systems.

Practices of making health, safety and environmental improvements an integral part of sustainable systems can importantly contribute to more sustainable societies.

6.2. Sustainable production

Sustainable production is *creating goods by using processes and systems that are non-polluting, that conserve energy and natural resources in economically viable, safe and healthy ways for employees, communities, and consumers and which are socially and creatively rewarding for all stakeholders for the short- and long-term future* [38]. The term encompasses pollution prevention, IPPC, environmental engineering and technology.

6.3. Sustainable consumption

Sustainable consumption is *about finding workable solutions to social and environmental imbalances through more responsible behaviour by everyone*. In particular, sustainable consumption is linked to production and distribution, use and disposal of products and services, and provides the means to rethink personal life cycles. The aim is to ensure that the basic needs of the entire global community are met, excess consumption of materials and energy is reduced and environmental damage is avoided or reduced [39]. The term embraces industrial ecology and product service systems.

7. Sustainability policy

Sustainability policy is *a set of ideas or a plan of what to do in particular situations that has been agreed officially by a group of people, a business organization, a government or a political party* [20]*, about environmental, economic and social issues*. Sustainable policy is important on institutional, corporate, as well as on regional, state, and alliance

level. Therefore, we added sustainability policy as a fourth dimension. Policy can be locally, nationally or internationally oriented and can address issues such as sustainable development, climate change, air, water, waste, health, etc. For example, the European Commission proposed Declaration on Guiding Principles for Sustainable Development [46]. The term policy is closely related to environmental legislation.

There exist many international documents, frameworks and declarations, designed to foster sustainable development at all levels and to help society to make progress toward sustainable development. The Agenda 21 and the Rio Declaration on Environment and Development were adopted by more than 178 Governments at the United Nations Conference on Environment and Development (UNCED) held in Rio de Janerio in 1992. Agenda 21 is a comprehensive plan of action to be taken globally, nationally and locally by organizations of the United Nations System, governments, and major groups in every area in which humans have impact upon the environment [40], while The *Melbourne Principles* present a vision of sustainable cities, and have been developed to assist cities to achieve sustainable development. The *Melbourne Principles* provide a simple set of statements on how a sustainable city should function [41].

Some globally oriented documents include: *The Earth Charter*, *The Natural Step Principles*, and *UN Millennium Development Goals (MDGs)*. The Earth Charter is a declaration of fundamental principles for building a just, sustainable, and peaceful global society for the 21st century [42]. *The Natural Step Principles* are four principles, necessary for survival of the ecosystems, and refer to the society and its environmental impact [43]. *The Earth Charter* and *The Natural Step Principles* present a bottom up approach, fostering global policy, while the MDGs, including environmental sustainability, where the target is also to integrate the principles of sustainable development into country policies and programmes that include a top-down approach [44].

8. Sustainable development

Sustainable development could be introduced as a *process or evolution*. Numerous definitions of sustainable development are attainable but, in principle, they remain similar to the one from 1987. In that year the World Commission on Environment and Development (i.e. Brundtland's Commission) defined sustainable development as *"…development that meets the needs of the present without compromising the ability of future generations to meet their own needs"* [45].

Sustainable development emphasizes the evolution of human society from the responsible economic point of view, in accordance with environmental and natural processes. Therefore, the political dimensions are central elements. Furthermore, in a sustainable development paradigm the limitations of economic, societal and environmental resources are considered in order to contribute to present and future generations' welfare and can be applied on local, regional, national and international levels, based on political will.

9. Classification and relationships of terms

Classification means allocation of a term in comparison with other terms, according to their essential characteristics. The most important characteristics are the semantic meaning, and the size of the term. These features build a basis for the determination of relationships among terms. We propose a hierarchical and interdependent concept, made of definition nodes. The conceptual graph allows better understanding of the terms (see Fig. 1).

The terms are organized according to their characteristics, introduced by principles that present the basic elements for building more complex (sub)systems. These categorizations are presented through triangular planes and the positions of the terms within the triangle depend on their orientation (economic, ecological, and societal). Another dimension, which has been added, is political, presenting a top of the pyramid. In our paper, causal relationships between the terms have been pointed out. For example, the *eco-design* approach is including *eco-efficiency, health and safety, reuse, remanufacturing, and recycling*. On the other hand, eco-design presents a component of more complex sub-systems; therefore, it was included in the definitions of *environmental technology*, *environmental engineering*, and *pollution prevention*. Similarly, pollution prevention, and environmental technology/engineering are parts of *Sustainable Production* as a sustainable system. Policy is the fourth dimension, presenting political will of countries besides the environmental, economic and societal issues. *Sustainable development* is a timeline, where principles, approaches, strategies and policies may help us to develop and implement our future vision of a sustainable society that will require different thinking patterns and changes in lifestyles to achieve. System's approaches can help us to manage our societies in a more thoughtful and preventively oriented manner that can result in improved and hopefully more humane societies.

10. Conclusions

Sustainability terms, their definitions and interconnections are crucial for understanding and for better communication in the process of moving our societies toward sustainable development. To help to achieve this, the authors of this paper sought to clarify the meanings and applications of 51 terms and their definitions. Particular emphasis has been given to the environmental engineering field. Some improved definitions are proposed and argued. Furthermore, the relationships among terms, based on semantic similarities and differences, have been established. Each term has its own definition and semantic features, but it is difficult to isolate it from the other terms. All the terms form an interconnected system. Also, sustainable systems introduce interconnections between environmental protection, economic performance and societal welfare, guided by a political will, and ethical and ecological imperatives. Therefore, it is of utmost importance to understand the relationships among the terms, and their semantic meanings.

The authors hope that the discussions in this paper will assist the scientific community, policy makers and other stakeholders to better understand sustainable development issues and to avoid imprecise usage of the terms. Clearly, additional studies are needed to enhance further development and to establish a database for sustainability terms and their relationships that can further help societies to make progress toward more sustainable patterns.

Acknowledgements

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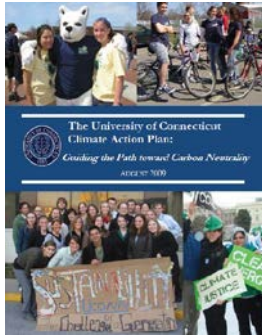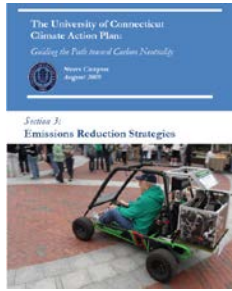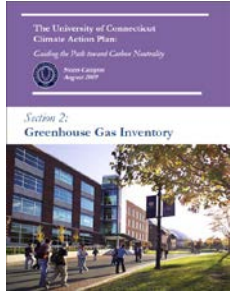
Climate Action at UConn

Office of Sustainability, Institute of the Environment
Rich Miller

January 24, 2020

UCONN

UConn's Climate Action Commitment
Adopted 2008 – Reaffirmed 2012

March 26, 2012 - President Herbst Reaffirms UConn's Climate Commitment

2010: UConn's 1st Climate Action Plan (Updated in 2012 and 2015)

June 2017: UConn Joins WASI Coalition Upholding Paris Agreement

**March 2008: President Hogan signs ACUPCC while DEP Commissioner Gina McCarthy looks on**

2019 Climate Strike & President's Response

- UConn has made "great progress" but not enough to meet our goals
- Climate Change:
  - "More than an emergency"
  - "Global crisis worsening by the day"
- Accelerate emissions reductions - 45% by 2030
- Dedicate Board TAFS Committee to CC
- Form Sustainability Workgroup
  - Analysis, Policy, Strategic Planning ➜ 2020 Report
  - Update Sustainability Framework to 2015 Campus Master Plan

3

Carbon Reductions Under Climate Action Plan

- Steam System Pipe and Infrastructure Replacement
- LED/Lighting Retrofits
- eCO2 Credits
  - Ag Composting
  - UConn Forest (Sequestration)
- Energy Efficiency
  - Occupancy Sensor HVAC
  - Heat Recovery
  - Insulation
  - Retro-Commissioning
  - LEED Gold Construction Policy

4
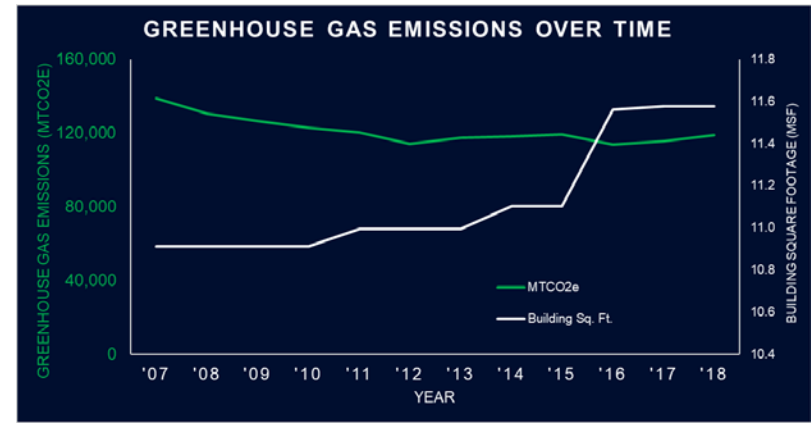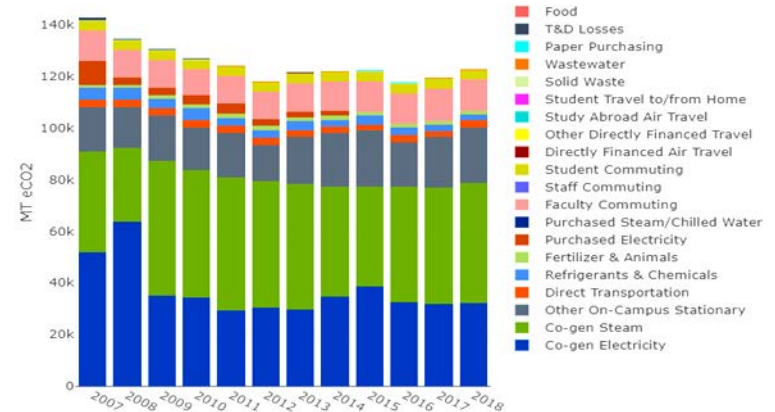
Accelerating Carbon Reductions: Renewable Energy & Clean Transportation

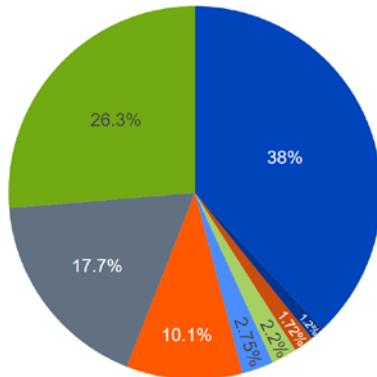Increased % of electric and hybrid vehicles in UConn's bus and light duty fleet

Bicycle/Active Transportation Subcommittee Working for a More Bike-Friendly Campus

Since 2015, all UConn purchased power is 100% renewable (offset by RECs)

EVERSOURCE

Direct Energy.

500 kW Solar Array Proposed for Science 1 Building ➔ 2022

2018 GHG Emissions by Source

- Co-gen Steam
- Co-gen Electricity
- Other On-Campus Stationary
- Faculty & Staff Commuting
- Student Commuting
- Direct Transportation
- Refrigerants & Chemicals
- Fertilizer & Animals

38%
26.3%
17.7%
10.1%
2.75%
2.2%
1.72%
1.2%
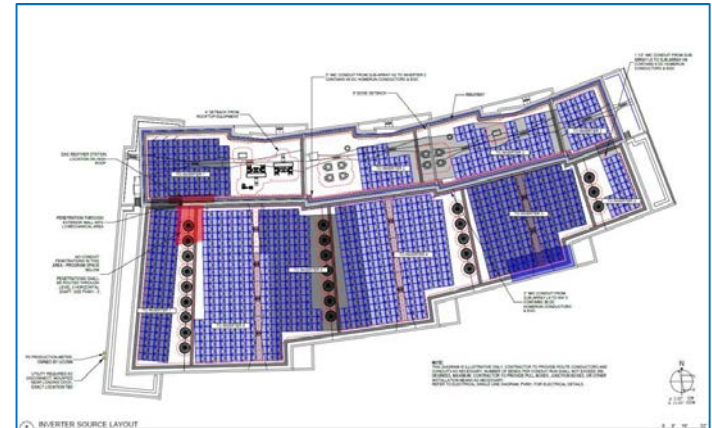
EcoMadness – Student Engagement

EcoMadness Water Reduction

2015: -1.8%
2016: -0.4%
2017: -3.2%
2018: -6.8%
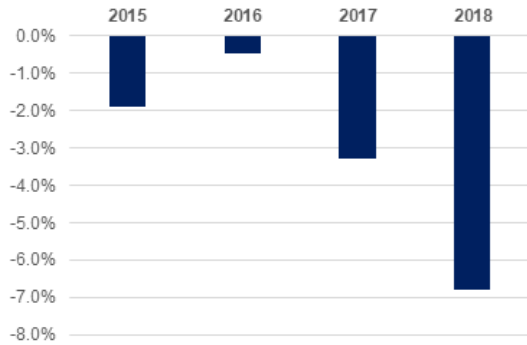
EcoMadness Electricity Reduction

2015: -9.6%
2016: -13.0%
2017: -2.6%
2018: -12.6%

6

ECO UCONN MAD-NESS
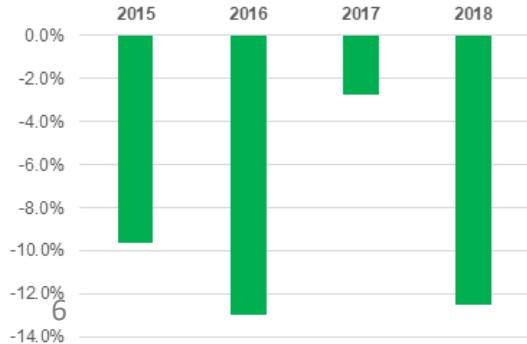
Congratulations to our Winners!

Energy	Water	Recycling
-22% REDUCTION	-39% REDUCTION	90% COMPLIANCE
GOODYEAR	BUCKLEY	HICKS

Green Offices – Faculty & Staff Engagement

- **93** Certified Green Offices
  - 2020 goal: 100 certified offices
  - 26 possible energy conservation points, including:
    - No screen savers
    - Sleep mode for electronics
    - Centralized coffee & tea makers, fridge, microwave for multiple users
    - Smart power strips for "phantom load"
    - Minimal use of space heaters
    - Lights off in empty rooms and maximum use of natural daylight
    - LED task lighting
    - No blocking radiators & HVAC vents
    - Blinds closed at night

GREEN OFFICE CERTIFICATION PROGRAM

Become Green Office Certified Today! Click to Take the Survey

GREEN OFFICE CERTIFICATE

Carbon Emissions and Reductions at UConn

Facilities Operations
Mike Jednak

January 24, 2020

UCONN

Climate Change Drivers
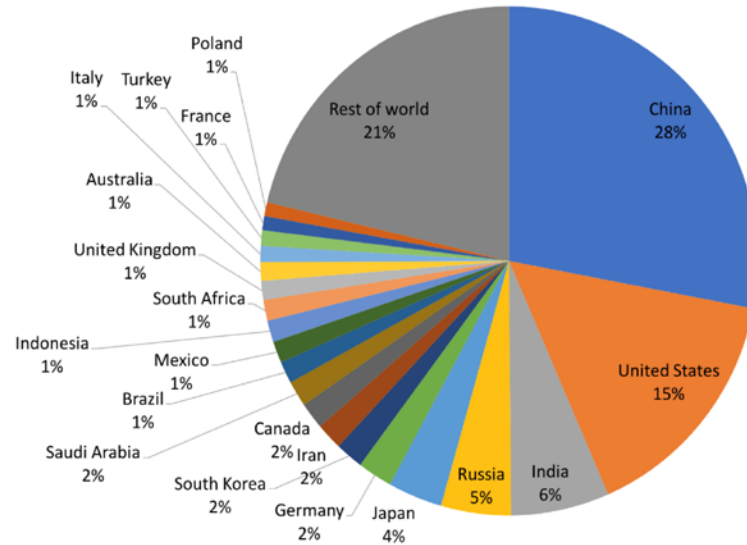
Six (6) Primary Greenhouse Gases

- **Carbon Dioxide (CO_2):** Burning of fossil fuels and deforestation;
- **Methane (CH_4):** Livestock enteric fermentation (i.e. cows) and manure management
- **Hydrofluorocarbons (HFCs):** Refrigeration, air conditioning, foam blowing, aerosols, fire protection suppressants, solvents
- **Perfluorocarbons (PFCs):** Refrigeration, electrical equipment, solvents
- **Nitrous Oxide (N_2O):** Anesthetic, analgesic, oxidizer in rocketry and in motor racing to increase the power output of engines
- **Sulfur Hexafluoride (SF_6):** High-voltage (35 kV and above) circuit breakers, switchgear, other electrical equipment

Commonly expressed as Carbon Dioxide Equivalent (CO_{2e}) corrected by the Global Warming Potential (GWP) Factor

United States GHG Policy

- Energy Policy Act of 2005
- Executive Order 13834 (5/17/2018)
- Goals
  - Increase efficiency
  - Optimize performance
  - Eliminate unnecessary use of resources
  - Protect the environment

Share of global carbon dioxide emissions from fuel combustion (2015)

China 28%
United States 15%
India 6%
Russia 5%
Japan 4%
Germany 2%
South Korea 2%
Iran 2%
Canada 2%
Saudi Arabia 2%
Brazil 1%
Mexico 1%
Indonesia 1%
South Africa 1%
United Kingdom 1%
Australia 1%
France 1%
Turkey 1%
Italy 1%
Poland 1%
Rest of world 21%

Data: IEA
Image: Union of Concerned Scientists

Connecticut GHG Policy

- Comprehensive Energy Strategy 2018

- 2018 Act Concerning Climate Change Planning and Resiliency

- Conn. Gen. Stat. § 22a-200a reduce to 80% below 2001 levels by 2050

- Governor Lamont's Executive Order 1
  - 45% Reduction from 2001 Baseline by 2030
  - 34% Reduction from 2014 Baseline by 2030
  - 70% Reduction from 2016 Baseline by 2040
  - Net Zero GHG Emissions by 2050

- Governor Lamont's Executive Order 3
  - 100% Zero Carbon Electric Sector by 2040

Connecticut CES Strategies

- **Strategy 1:** Ensure sustainable and equitable funding for efficiency

- **Strategy 2:** Advance market transformation of the energy efficiency industry

- **Strategy 3:** Grow and sustain renewable and zero-carbon generation in the state and region

- **Strategy 4:** Expand deployment of all cost-effective distributed generation ("behind the meter") programs in a sustainable manner

Connecticut CES Strategies

- **Strategy 5:** Continue to improve grid reliability and resiliency through state and regional efforts

- **Strategy 6:** Reduce transportation greenhouse gas emissions by accelerating adoption of low- and zero-emission vehicles and strengthening alternative-fueling infrastructure

- **Strategy 7:** Increase mobility, connectivity, and accessibility by advancing smart-growth, mixed-use transit-oriented development, and innovative transportation partnerships

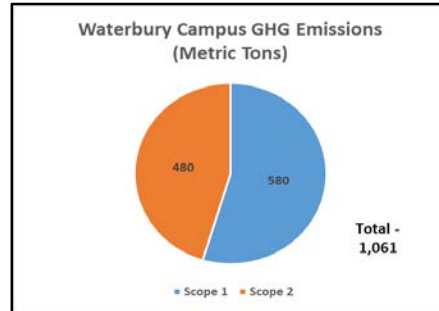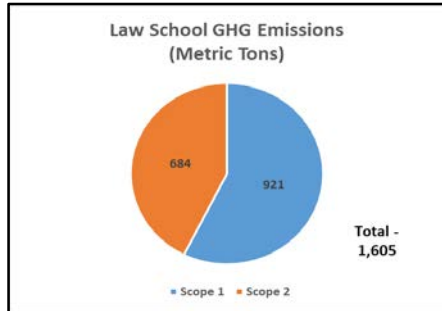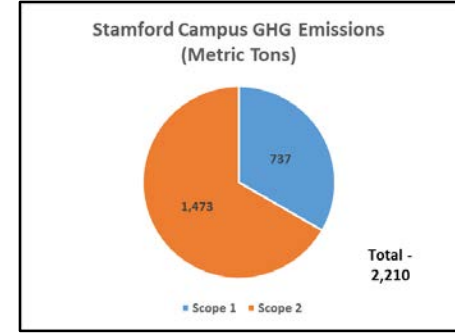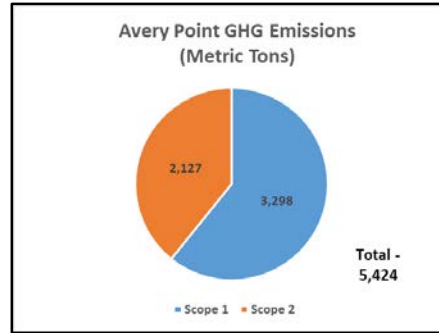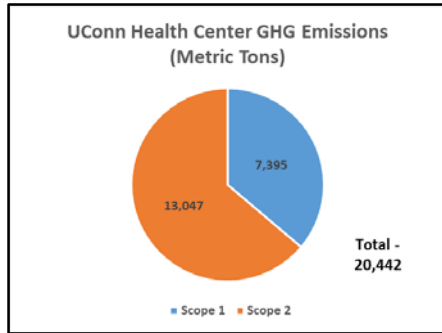- **Strategy 8:** Modernize the grid

6

Common Sources at UConn

- **SCOPE 1** – GHG emissions from sources that are owned or controlled (FY-21 75%)
- **SCOPE 2** – GHG emissions resulting from the generation of electricity, cooling, or heating purchased (FY-21 14%)
- **SCOPE 3** – GHG emissions from sources not owned or directly controlled but related to our activities (FY-21 11%)

UConn FY-21 GHG Emissions

Scope 3, 11%

Scope 2, 14%

Scope 1, 75%
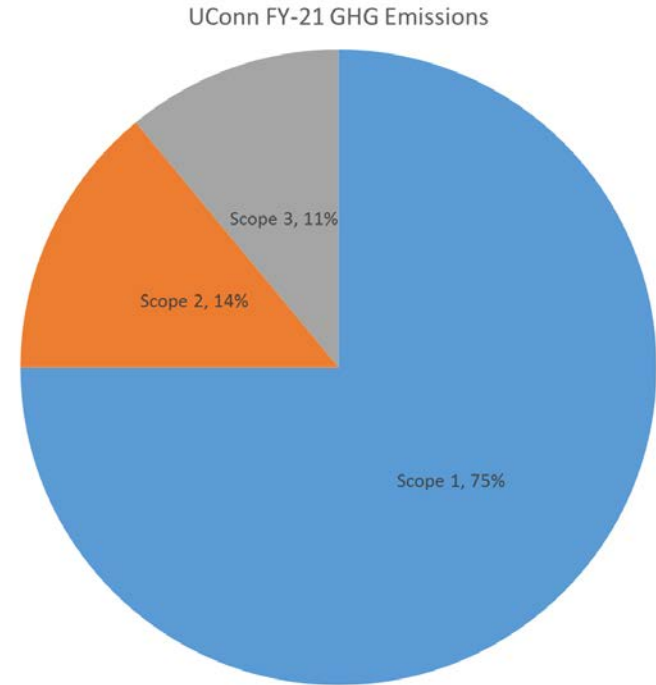
Greenhouse Gas Emissions

Regional Campuses GHG Emissions (CY 2018)*

UConn Health Center GHG Emissions (Metric Tons)
7,395 — Scope 1
13,047 — Scope 2
Total - 20,442

Avery Point GHG Emissions (Metric Tons)
3,298 — Scope 1
2,127 — Scope 2
Total - 5,424

Stamford Campus GHG Emissions (Metric Tons)
737 — Scope 1
1,473 — Scope 2
Total - 2,210

Law School GHG Emissions (Metric Tons)
921 — Scope 1
684 — Scope 2
Total - 1,605

Waterbury Campus GHG Emissions (Metric Tons)
580 — Scope 1
480 — Scope 2
Total - 1,061

Downtown Hartford GHG Emissions (Metric Tons)
683 — Scope 1
136 — Scope 2
Total - 819

*Scope 2 emissions are offset by the purchase of Renewable Energy Certificates generated from 100% renewable zero carbon sources

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Sources By Campus at UConn FY-21

			UConn Greenhouse Gas Emissions (CO2e Metric Tons)						

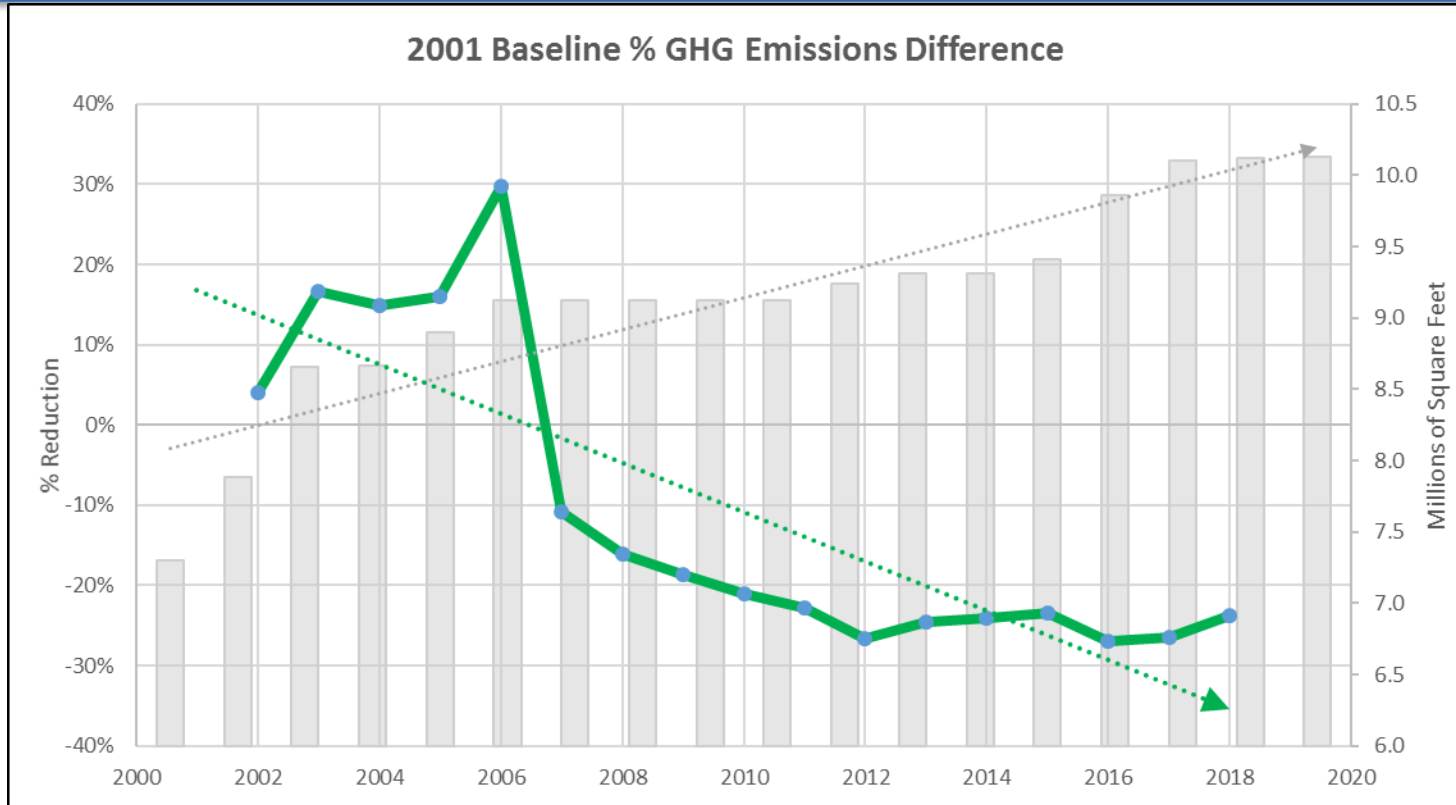| Type	Avery Point	Downtown HTFD	Health Center	Law School	Stamford	Storrs and Depot	Waterbury	Total	Percentage
Scope 1	3,298	683	7,395	921	737	100,885	580	114,498	75%
Scope 2	2,127	136	13,047	684	1,473	3,730	480	21,678	14%
Scope 3	?	?	?	?	?	15,592	?	15,592	10%
Total	5,424	819	20,442	1,605	2,210	120,207	1,061	151,768	100%
Contribution	4%	1%	13%	1%	1%	79%	1%	100%	

UConn GHG Emissions

GHG Emissions (CO2e Metric Tons)

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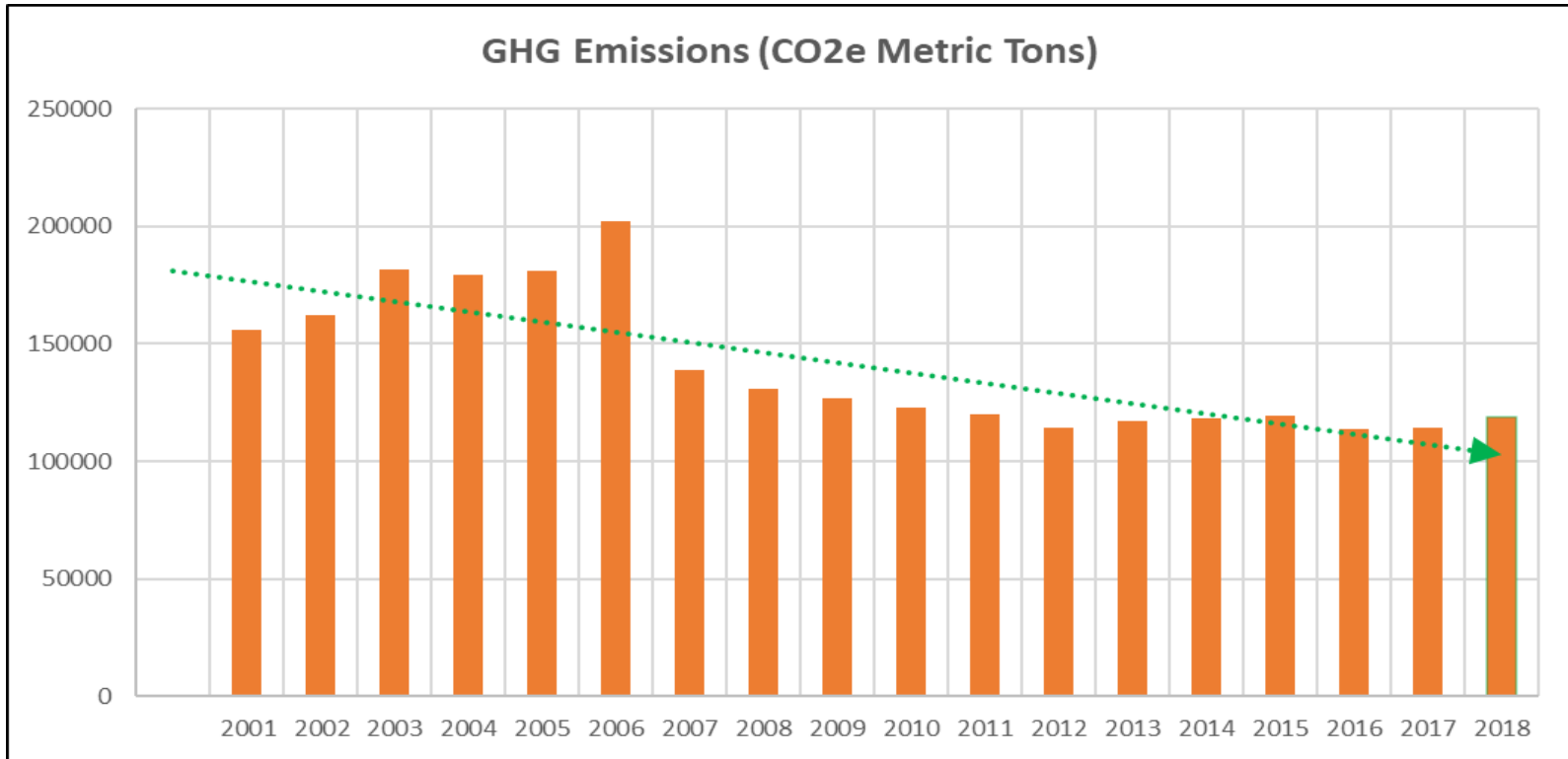
UConn Reductions to Date

Storrs and Depot Campus GHG Emissions (CO2e Metric Tons)

Type	2001	2007	2014	2021
Scope 1	67,532	116,562	104,736	100,885
Scope 2	71,577	9,432	2,592	3,730
Scope 3	20,460	16,721	15,581	15,592
Total	159,569	142,715	122,909	120,207
Reductions from Baseline Year	2001:	10.56%	24.44%	26.64%
	2007:		13.88%	16.08%
	2014:			2.20%

UConn Reductions to Date

2001 Baseline % GHG Emissions Difference

UConn Reductions to Date

2007 Baseline % GHG Emissions Difference