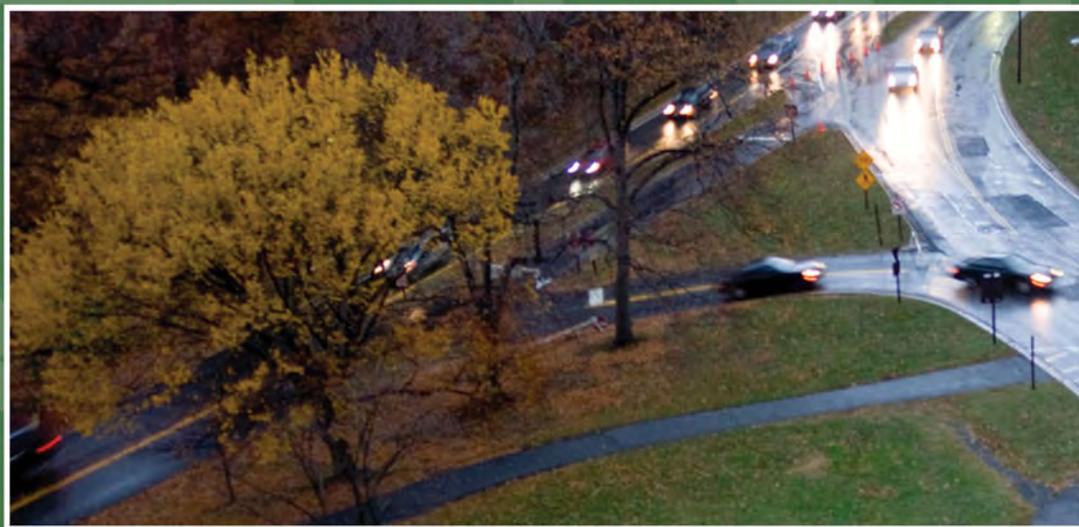


Multi-Sector Sustainability Browser (MSSB) User Manual: A Decision Support Tool (DST) for Supporting Sustainability Efforts in Four Areas - Land Use, Transportation, Buildings and Infrastructure, and Materials Management - Technical Report



Author: Eric S. Hall (EPA/ORD)

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Author: Eric S. Hall (EPA/ORD)

Disclaimer

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Acronyms/Abbreviations (in MSSB)

3D+R	Destinations, Distance, Density, and Route	GHG	Greenhouse Gas
ACE	Air, Climate and Energy Research Program	GI	Green Infrastructure
BC	Black Carbon (soot)	GIS	Geographic Information System
BMI	Body Mass Index	GIWiz	Green Infrastructure Wizard
BMP	Best Municipal Practices	GPI	Genuine Progress Indicator
CAFO	Concentrated Animal Feeding Operation	H₂	Hydrogen Gas
CCAT	Community Cumulative Assessment Tool	H₂O	Water
CEHII	Cumulative Environmental Hazard Inequality Index	H₂S	Hydrogen Sulfide
C-FERST	Community-Focused Exposure and Risk Screening Tool	Hg	Mercury
CFR	Code of Federal Regulations	HIA	Health Impact Assessment
CH₄	Methane	HOT	High-Occupancy Toll Lanes
Cl₂	Chlorine	HUD	Housing and Urban Development
CO	Carbon Monoxide	HWBI	Human Well-Being Index
CO₂	Carbon Dioxide	IBI	Indices of Biotic Integrity
CSO	Combined Sewer Overflow	ICLEI	International Council for Local Environmental Initiatives
CSS	Chemical Safety and Sustainability Research Program	ICLUS	Integrated Climate and Land Use Scenarios
DASEES	Decision Analysis for a Sustainable Environment, Economy, and Society	IPM	Integrated Planning Model
DOSII	Database of Sustainability Indicators and Indices	km	Kilometer
DOT	Department of Transportation	KWh	Kilowatt Hour
DSS	Decision Support System	LIDAR	Light Detection and Ranging
DST	Decision Support Tool	m	Meter
EGS	Ecosystem Goods and Services	MSSB	Multi-Sector Sustainability Browser
EPA	U.S. Environmental Protection Agency	MSW	Municipal Solid Waste
EQI	Environmental Quality Index	NAAQS	National Ambient Air Quality Standard
FECS-CS	Final Ecosystem Goods and Services Classification System	NASA	National Aeronautics and Space Administration
FR	Federal Register	NCORE	National Core Air Pollution Monitoring Network
GAR	Green Area Ratio	NERL	National Exposure Research Laboratory
GDP	Gross Domestic Product	NLCD	National Land Cover Database
		NNIP	National Neighborhood Indicators Partnership
		nm	Nanometer

NO	Nitric Oxide	SHC	Sustainable and Healthy Communities Research Program
NO₂	Nitrogen Dioxide	SO₂	Sulfur Dioxide
NOx	Oxides of Nitrogen	SoVI	Social Vulnerability Index
NPDES	National Pollutant Discharge System	SSO	Sanitary Sewer Overflow
NSF	National Science Foundation	SSW	Safe and Sustainable Waters Research Program
NVI	Neighborhood Vitality Index	SVI	Social Vulnerability Index
O₂	Oxygen	SWMM	Storm Water Management Model
O₃	Ozone	T-FERST	Tribal-Focused Exposure and Risk Screening Tool
OD	Outer Diameter	TOD	Transit-Oriented Development
ORD	Office of Research and Development	UEQ	(indices of) Urban Environmental Quality
OTAQ	Office of Transportation Air Quality	USDA	United States Department of Agriculture
PAH	Polycyclic Aromatic Hydrocarbons	V	Volts
Pb	Lead	VMT	Vehicle Miles Travelled
PM	Particulate Matter	VOC	Volatile Organic Compounds
POTW	Publically Owned Treatment Works	WEPP	USDA Water Erosion Prediction Project Add-On Tool
ppm	Parts Per Million	WWTP	Waste Water Treatment Plant
ppb	Part Per Billion		
R²	Coefficient of Determination		
RH	Relative Humidity		
ROE	Report On the Environment		
RTI	Research Triangle Institute		
RTP	Research Triangle Park		

1.0

Introduction

EPA's Sustainable and Healthy Communities (SHC) Research Program is developing methodologies, resources, and tools to assist community members and local decision makers in implementing policy choices that facilitate sustainable approaches in managing their resources affecting the built environment, natural environment, and human health. In order to assist communities and decision makers in implementing sustainable practices, EPA is developing computer-based systems including models, databases, web tools, and web browsers to help communities decide upon approaches that support their desired outcomes. Communities need access to resources that will allow them to achieve their sustainability objectives through intelligent decisions in four key sustainability areas:

- Land Use
- Buildings and Infrastructure
- Transportation
- Materials Management (i.e., Municipal Solid Waste [MSW] processing and disposal)

The Multi-Sector Sustainability Browser (MSSB) is designed to support sustainable decision-making for communities, local and regional planners, and policy and decision makers.

2.0

Multi-Sector Sustainability Browser (MSSB) Description

The MSSB is an interactive decision support tool (DST) containing information from the scientific literature and technical reports that must be considered when making decisions to support sustainability objectives in the key sustainability areas (Land Use, Buildings and Infrastructure, Transportation, and Materials Management). The MSSB is designed to assist communities in understanding the impacts that sustainable decision alternatives and actions made in the key sustainability areas can have on human health, the economy and the environment (ecosystem services). The MSSB has the following capabilities:

- Generates and displays appropriate linkages between major concepts in four key sustainability decision areas and subordinate concepts related to these areas;
- Displays literature references that provide information about each major concept, the associated subordinate concepts, and weblinks as applicable;
- Displays quantitative data and system parameters related to each major concept and the associated subordinate concepts.

The MSSB can be found on EPA's EnviroAtlas Platform on the following website: (<https://www.epa.gov/enviroatlas>). The MSSB behaves in a similar manner to EPA's Eco-Health Relationship Browser (<https://www.epa.gov/enviroatlas/enviroatlas-eco-health-relationship-browser>). The Eco-Health Relationship Browser is documented in the literature (Jackson, L. E., Daniel, J., McCorkle, B., Sears, A., Bush, K. F., "Linking ecosystem services and human health: the Eco-Health Relationship Browser", October 2013, International Journal of Public Health, Volume 58, Issue, 5, pp 747 – 755: DOI 10.1007/s00038-013-0482-1). This browser is also located on the EPA's EnviroAtlas website (<https://www.epa.gov/enviroatlas>). The MSSB provides a new capability integrated into EPA's EnviroAtlas platform, and can be thought of as a 'visual database' of sustainability knowledge in the four key sustainability areas.

3.0

Use of Multi-Sector Sustainability Browser (MSSB) – Disclaimer

The MSSB is not a full Decision Support System (DSS), which would provide a range of alternative decision choices or pathways based on the nature of the input data. Instead, this tool is designed for the user to investigate one or more of the four key sustainability areas, explore the available scientific literature references, and from the information, assess the potential impact of planned sustainability initiatives on desired decision objectives. Note, the references presented in the MSSB represent an extensive, but not comprehensive, bibliography of sustainability science, engineering, and policy. The MSSB reduces the amount of time and effort that a user interested in understanding the current scientific knowledge in sustainability science and engineering, as applied in the context of Land Use, Buildings and Infrastructure, Transportation, and Materials Management, is required to spend collecting the initial information to determine the important considerations required for decision-making. The MSSB should be used for the following activities:

- Exploring the linkages between the four key sustainability areas;
- Obtaining information on a specific sub-discipline/question area in one or more of the four key sustainability areas;
- Assessing the number of relevant references that should be read by subject-matter experts in one or more of the four key sustainability areas;
- Determining if there are important system parameters or variables (including their values and/or ranges) that can influence a decision in one or more of the four key sustainability areas;
- Learning about the influence of sustainability, practices, activities and/or metrics on human health, the natural environment, and the economy;
- Developing a plan for a scientific literature review in one or more of the four key sustainability areas;
- Creating a framework for an approach to develop a structured approach to decision-making in the context of one or more of the four key sustainability areas;
- Examining the importance of Land Use in all sustainability-related activities and decisions;
- Building a database of available resources in the scientific literature related to sustainability;
- Investigating the tools, databases, models, libraries, and browsers that are available for providing information and data for planned sustainability initiatives and decisions;
- Initiating a literature review in one or more of the four key sustainability areas.

The quality assurance approach used in developing the MSSB software is documented in the SED Software Development QA Guidance Document. The design of the MSSB is documented in the Workplan/Design and Software Development Quality Assurance Project Plan, QAPP-1J16-010.R1. Any questions or comments on the operation of the MSSB should be directed to Eric S. Hall, hall.eric@epa.gov.

4.0

Summary

The MSSB is not a full Decision Support System (DSS), but this tool is designed for the user to investigate one or more of the four key sustainability areas, explore the available scientific literature references, and assess the potential impact of planned sustainability initiatives on desired decision objectives. The MSSB reduces the amount of time and effort required to find information on sustainability science and engineering in the context of Land Use, Buildings and Infrastructure, Transportation, and Materials Management.

5.0

References:

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Appendix:

Operation of the Multi-Sector Sustainability Browser (MSSB)

The MSSB displays can be viewed on a desktop computer using a computer mouse, page up and page down keys, and arrow keys on the computer keyboard. The MSSB was designed to be accessible by laptop computers, tablets, and smartphones. No special software is required to use the MSSB, and any standard browser can be used with the MSSB. When using a desktop computer, displays can be selected either by use of the drop-down list menu or through direct selection of the displays using a mouse (as indicated in Figure 1). Figure 1 illustrates the default display screen that is shown when the MSSB is initially selected.

The MSSB has multiple levels of displays, with top-level displays representing primary sustainability concepts, and

subordinate displays representing supporting concepts, questions, or relationships between different concepts. The displays are outlined either in green or in gray. Green outlines indicate that selecting the display will reveal additional lower levels of displays (and related concepts). Gray outlines indicate that there are no lower level displays under the selected display, although additional information is provided. This is illustrated in Figure 2. Each display that is selected has a text box with information explaining or defining the major concept in the selected display. Important resources, such as technical reports, scientific journal articles, and websites containing tools, models, databases, and calculators, can be accessed in the MSSB through the weblinks that are provided in the applicable display text boxes.

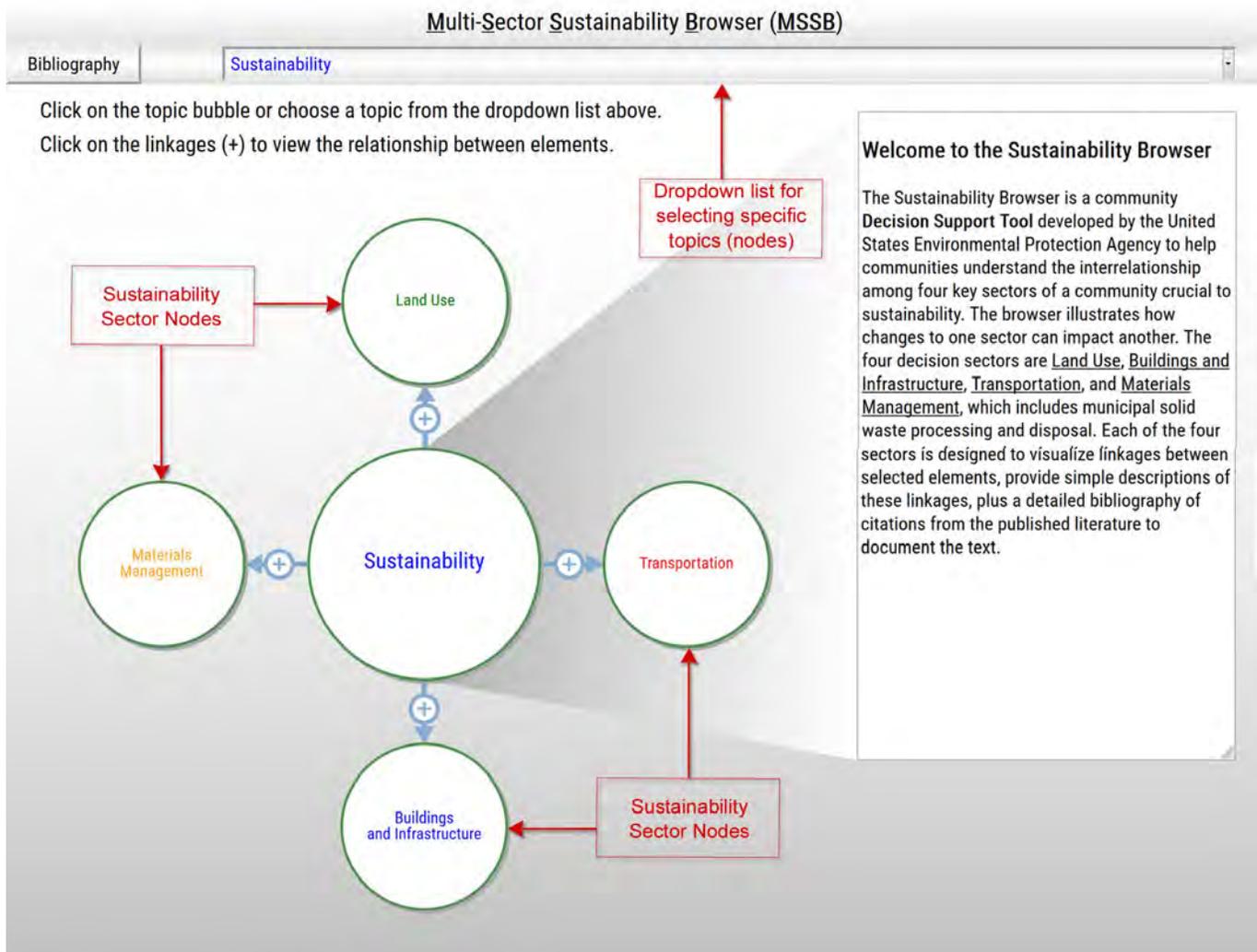
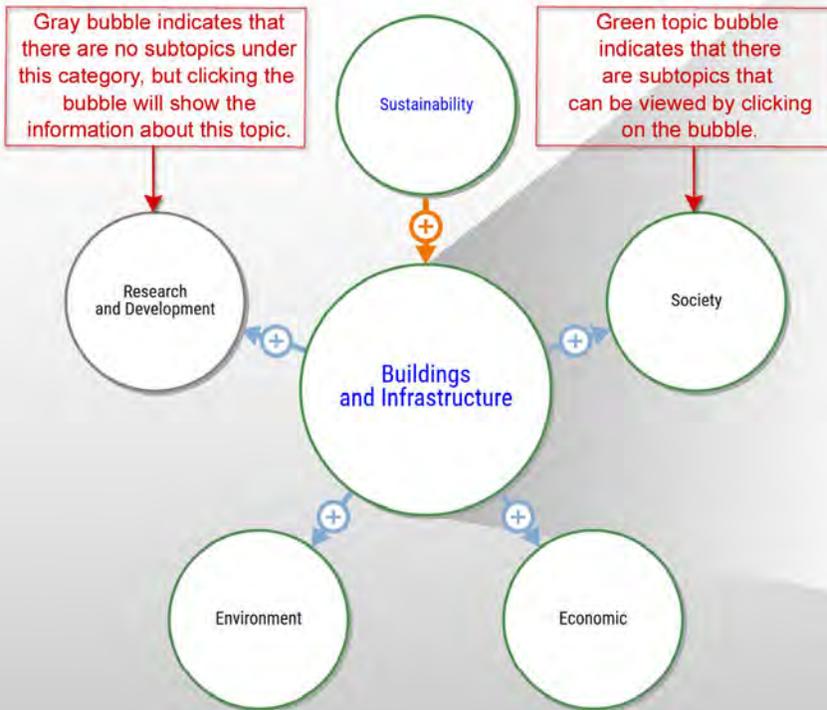


Figure 1. The MSSB Main Screen (Sustainability) shown with text labels pointing to the topics in the graphical display elements and the drop-down menu selection list.

Click on the topic bubble or choose a topic from the dropdown list above.
 Click on the linkages (+) to view the relationship between elements.



The text and data shown are distillations of the document: Zimmer, A. and Ha H. *Buildings and Infrastructure from a Sustainability Perspective* US Environmental Protection Agency, National Risk Management Research Laboratory. EPA/600/X-14/369, 2014.

Which can be accessed here: [Buildings & Infrastructure Synthesis Document \(PDF\)](#) (30 pp, 1.58MB) [About PDF](#)

Buildings and Infrastructure

Buildings and Infrastructure include all of the man-made, built environment components that are essential to a functioning society, including residential homes, commercial buildings, roads, bridges and railways, wastewater treatment facilities, power generating stations and power transmission lines, and storm drainage and sewer systems. In the United States, **Buildings and Infrastructure** are responsible for 37% of greenhouse gas (GHG) emissions, and 41% of energy consumption. It is apparent that proper planning and management of **Buildings and Infrastructure** can have a significant positive impact on sustainability activities.

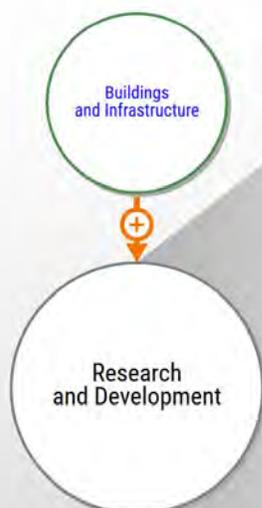
Your previous >>> current displays:
 Sustainability >>> Buildings and Infrastructure

Figure 2. The Buildings and Infrastructure Main Screen with text labels identifying a green outline on a topic ‘bubble’ and a gray outline on a topic ‘bubble’.

Figure 3 illustrates what is shown when the gray outlined topic in Figure 2 is selected. The Research and Development topic area appears with information on the research and development being conducted on Buildings and Infrastructure..

Click on the topic bubble or choose a topic from the dropdown list above.

Click on the linkages (+) to view the relationship between elements.



Research and Development

Research and development on buildings only constitutes 0.2% of all federally funded research in the United States. One area where more research funding could be directed includes building materials. The literature on the health impact of building materials is slowly increasing, but the legacy of the use of materials such as asbestos for fire suppression and lead for paints and pigments reminds us of the importance of research in this area. The fact that only 1% of the building stock in the United States can be labelled as 'green' buildings, suggests that we need to understand the impact that having more green buildings will have on energy consumption patterns and human health. Another area requiring more research is the state of development of decision support tools capable of presenting the range of options and decisions, which should be considered by communities when developing sustainable buildings and infrastructure.

Sources & Related Reading

[USGBC, \(2006\)](#) Exit

[Alter, L., \(2011\)](#) Exit

[Herrera, T., \(2012\)](#) Exit

[Marcacci, S., \(2012\)](#) Exit

Your previous >>> current displays:

Buildings and Infrastructure >>> Research and Development

Figure 3. Buildings and Infrastructure: Research and Development sub-topic gray 'bubble'.

Figure 4 illustrates what is shown when a green outlined topic in Figure 2 is selected. Links to the Society topic area appear along with links to the Health and Demographics sub-topic areas that provide information on the interplay between populations, health, and buildings.

Click on the topic bubble or choose a topic from the dropdown list above.
Click on the linkages (+) to view the relationship between elements.

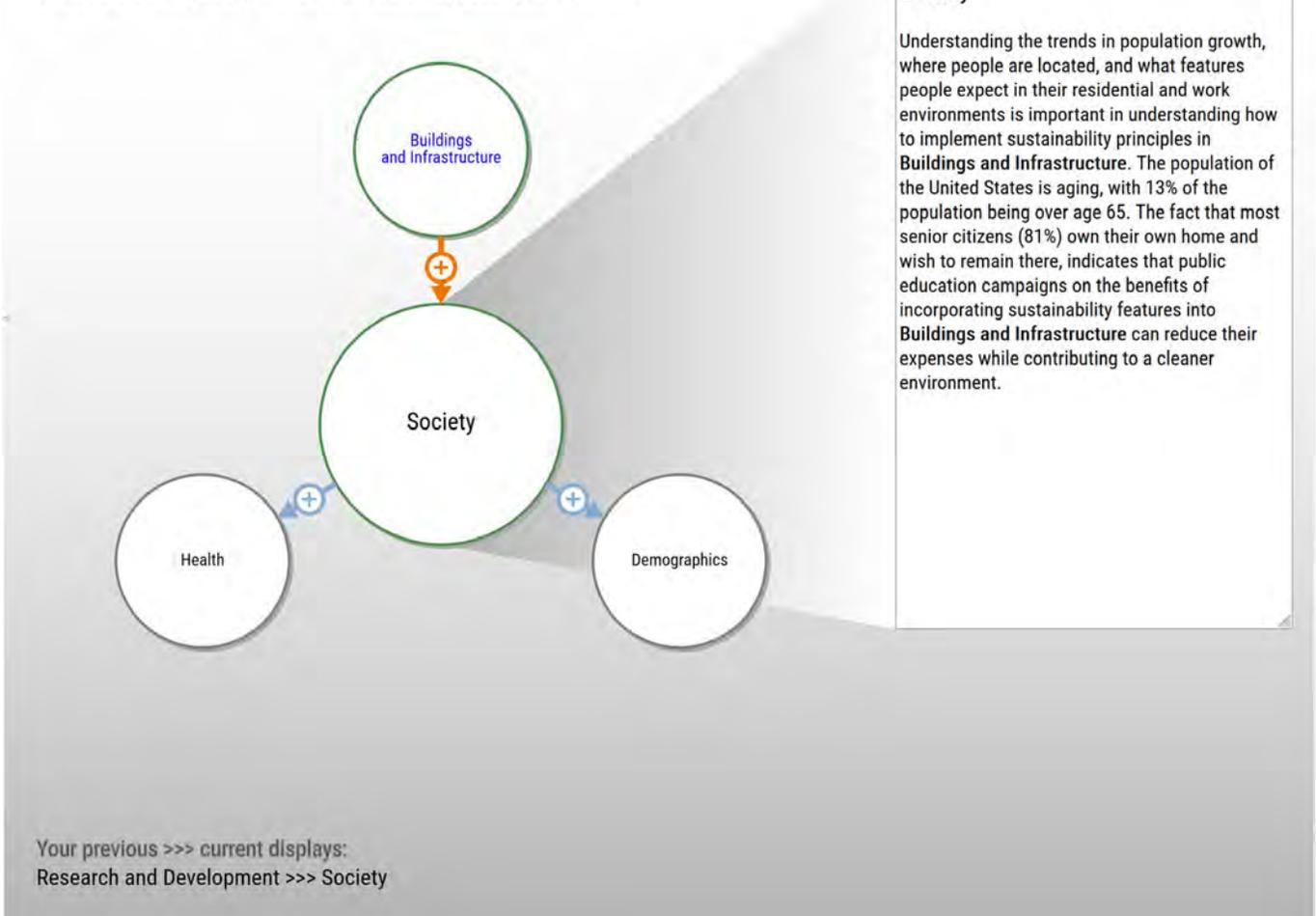


Figure 4. Buildings and Infrastructure: Health and Demographics sub-topics linked to the Society topic green 'bubble'.

The bibliography button reveals references for each of the four sustainability areas, Land Use, Transportation, Buildings and Infrastructure, and Materials Management. The references in the bibliography are arranged in the order in which they were cited in each of the technical reports associated with the four key sustainability areas (Land Use, Transportation, Buildings and Infrastructure, and Materials Management) which were used to develop the MSSB. Selecting the 'Bibliography' button, located in the upper left-hand corner of the MSSB will display the bibliography webpage.

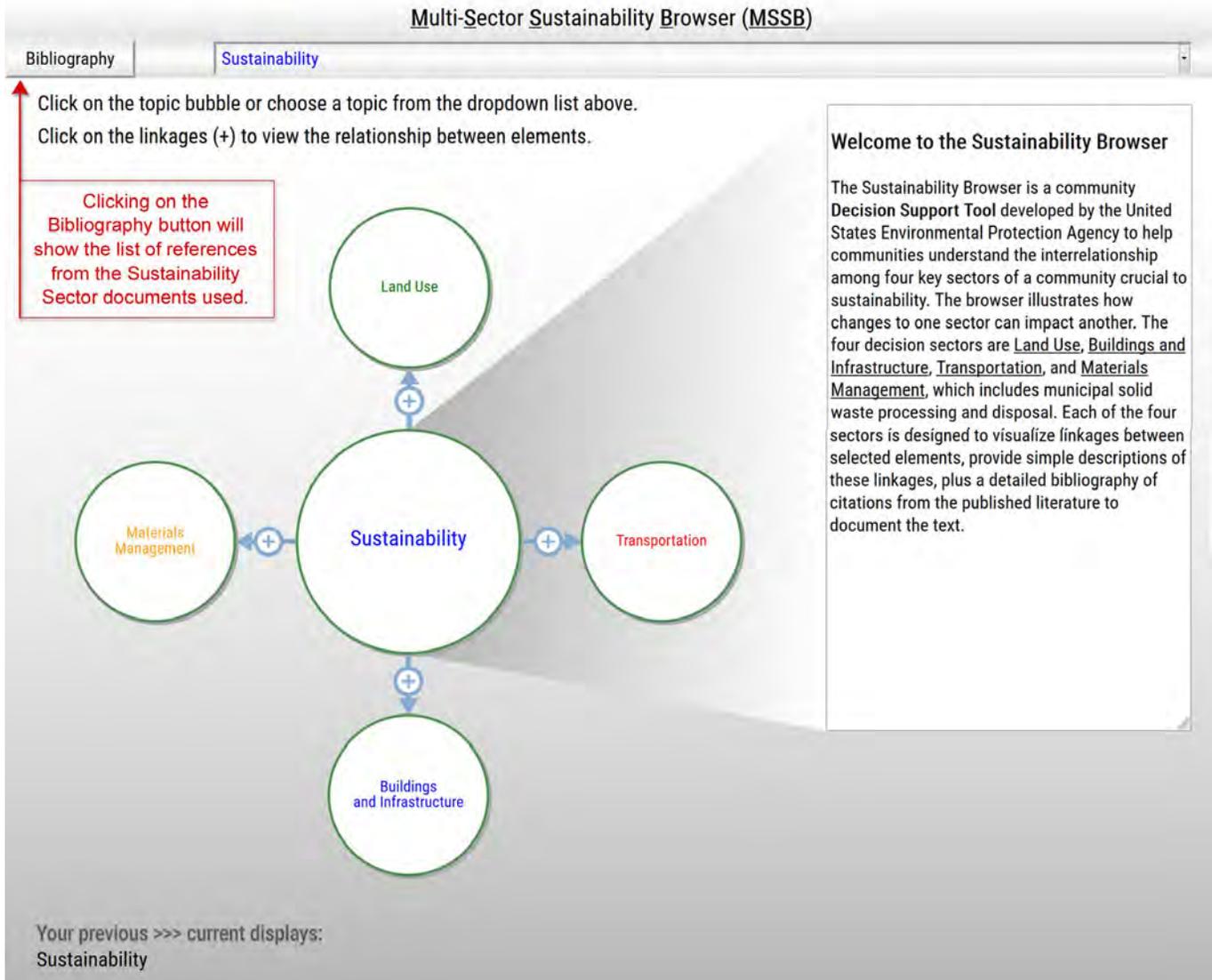


Figure 5. The MSSB main screen with a text label pointing to the Bibliography Button.

When the 'Bibliography' button is selected, the bibliography webpage is displayed in Figure 6. This webpage contains the citation information for the references, and provides weblinks to the references for those users who wish to learn more information and possibly download the reference(s), as applicable. Note that some of the references may be obtained at no cost, while others may have a cost associated with them based on the individual journal. EPA is not responsible for the potential cost of the references linked to in the MSSB.

Citations and Further Reading

Land Use

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Figure 6. Result of selecting the Bibliography Button.

The MSSB uses a display element that is shown as a ‘plus sign’ surrounded by a circle to indicate some type of relationship, linkage, or connection between the topics that are connected by them. When the ‘plus sign’ is selected, a text box is displayed that provides information on the relationship between the two connected topics. Figure 7 illustrates the text box that provides information on the relationship between residential land use and residential segregation.

Click on the topic bubble or choose a topic from the dropdown list above.

Click on the linkages (+) to view the relationship between elements.



Residential

Residential land use is specifically developed to provide housing for people to live in. Housing consumes land, energy, water, and produces greenhouse gas (GHG) emissions. Housing is also an important contributor to human well-being by providing shelter and protection from the weather and other experiences that can negatively impact human health. The location of a person's residence determines their personal accessibility to a host of services, amenities, education, jobs, entertainment, etc.

Sources & Related Reading

[VandeWeghe, J.R., et al., \(2007\)](#) [Exit](#)

[Kenway, S.J., et al., \(2011\)](#) [Exit](#)

[Holden, E., et al., \(2005\)](#) [Exit](#)

[Sahely, H.R., et al., \(2003\)](#) [Exit](#)

Your previous >>> current displays:
Society >>> Residential

Figure 7. Expanded Text Box with Information on the Relationship between Residential (Land Use) and Residential Segregation when the “+” sign is selected.

The most extensive component of the MSSB is the Land Use component. This is the most extensive component because the other three sustainability components (Transportation, Buildings and Infrastructure, and Materials Management) are dependent on how land is used in implementing them. Each of the key Land Use topics shown in the main screen have lower levels of topics with additional information, as shown in Figure 8.

Bibliography | **Land Use**

Click on the topic bubble or choose a topic from the dropdown list above.
Click on the linkages (+) to view the relationship between elements.

The text and data shown are distillations of the document:

L. Cox, V. Hansen, J. Andrews, J. Thomas, I. Heilke, N. Flanders, C. Waters, S.A. Jacobs, Y. Yuan, A. Zimmer, J. Weaver, R. Daniels, T. Moor, T. Yuen, D.C. Payne-Sturges, M.W. McCullough, B. Rashleigh, M. TenBrink and B.T. Walton. **Land Use: A Powerful Determinant of Sustainable & Healthy Communities.** US Environmental Protection Agency, Internal Technical Report. 2013. which can be accessed here: [Land Use Synthesis Document \(PDF\)](#)(225 pp, 4.11MB)[About PDF](#)

Land Use

Land Use is a critical factor in achieving community sustainability goals. Land is critically important as the source of natural capital that supplies materials (biomass, fuels, food, and water) to the agricultural, industrial, commercial, and residential sectors. Land conservation and land preservation represented the first systematic federal strategy to protect the environment for future generations. This 19th century approach was manifested in the

Your previous >>> current displays:
Sustainability >>> Land Use

Figure 8. The Land Use Main Screen displaying the Land Use primary topics.

When one of the Land Use topics is selected, it displays its subordinate (lower-level) topics containing additional information. Weblinks to the applicable references are displayed in the lower portion of the text box area. An example is shown in Figure 9

Click on the topic bubble or choose a topic from the dropdown list above.

Click on the linkages (+) to view the relationship between elements.



How Do Different Land Use Types Impact Sustainability

Land Use approaches and methodologies, linked in an integrated framework to manage the natural capital that provides materials (biomass, fuels, food, and water), locations for residences, employment, education, retail, entertainment, along with associated transportation infrastructure, agricultural development, building infrastructure, and solid waste and wastewater management to the economy and for the general population, is a critical factor in achieving community sustainability goals. Land must be available for residential, commercial, industrial, agricultural, parks and open space, and roads. These land use types are required to maintain society while meeting its needs. Communities face difficult decisions when the demand for available land conflicts with the need to sustain ecosystem services, maintain the beauty of natural landscapes, and provide healthy living conditions. Communities making land use decisions need to understand that land use changes are long lasting and cumulative, and

Sources & Related Reading

[VandeWeghe, J.R., et al., \(2007\)](#)^{Exit}

[Kenway, S.J., et al., \(2011\)](#)^{Exit}

[Holden, E., et al., \(2005\)](#)^{Exit}

[Sahely, H.R., et al., \(2003\)](#)^{Exit}

Your previous >>> current displays:

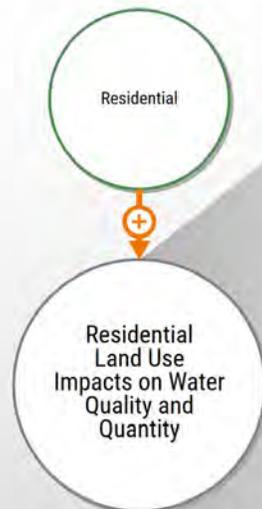
Land Use >>> How Do Different Land Use Types Impact Sustainability?

Figure 9. The lower-level topics shown when the ‘How do Different land Use Types Impact Sustainability’ topic is selected.

When one of the ‘How do Different Land Use Types Impact Sustainability’ topics is selected, it shows a lower-level topic containing additional information. Figure 10 shows the result when the lower-level ‘Residential’ topic is selected. Weblinks to the applicable references are displayed in the lower portion of the text box area.

Click on the topic bubble or choose a topic from the dropdown list above.

Click on the linkages (+) to view the relationship between elements.



Residential Land Use Impacts on Water Quality and Quantity

Residential uses also consume a large portion of the nation's land, increasing impervious (non-porous) surface cover. Residential land use significantly contributes to urban heat island formation and surface water pollution and runoff. Surprisingly, low-density, single-family style housing, despite providing more lawns and trees, results in more impervious (non-porous) surface cover for the same occupancy capacity than higher density housing. Lawns exact a price in water quantity and quality. Lawns require irrigation, which increases water usage, increases runoff, and reduces the community's capacity to manage flooding. Researchers estimate that the projected rate of urbanization in the US Corn Belt cities is causing an expansion of turf grass in residential areas that leads to an increase in runoff of 15% - 48%. In addition, greenhouse gas (GHG) emissions produced are significantly lower in residential areas in the city center than in suburban areas. When accounting for per-person transportation emissions and

Sources & Related Reading

[Schneider, A., et al., \(2012\)](#) Exit

[VandeWeghe, J.R., et al., \(2007\)](#) Exit

[Colford, J.M., Jr., et al., \(2012\)](#) Exit

[Heaney, C.D., et al., \(2012\)](#) Exit

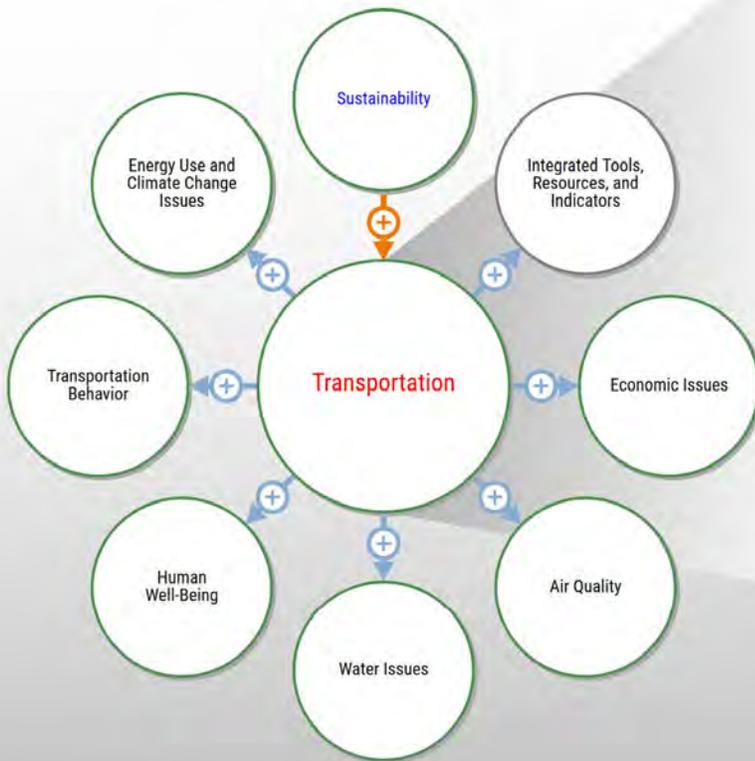
Your previous >>> current displays:

How Do Different Land Use Types Impact Sustainability? >>> Residential Land Use Impacts on Water Quality and Quantity

Figure 10. The display shown when the 'Residential' sub-topic under How do Different Land Use Types Impact Sustainability is selected.

The Transportation main display screen is shown in Figure 11. Each of the key Transportation displays shown in the main screen, with the exception of the 'Integrated Tools, Resources, and Indicators' display, have lower levels of displays with additional information, as shown in Figure 11.

Click on the topic bubble or choose a topic from the dropdown list above.
Click on the linkages (+) to view the relationship between elements.



The text and data shown are distillations of the document:

Flanders, N., J. Yang, R. Dodder, G. Furie, Rich Baldauf, L. Bachle, A. Bostrom, L. Berry, C. Walters, J. Bare, T. Barzyk, Randy Bruins, E. Cooter, F. DiCosmo, T. Eason, Tom Fontaine, L. Jackson, N. Schumaker, and J. Weaver. **Synthesis Paper on Sustainable Transportation**. US Environmental Protection Agency, Cincinnati, OH, EPA/600/R-14/278, 2015.

Which can be accessed here: [Transportation Synthesis Document \(PDF\)](#) (130 pp, 1.62MB) [About PDF](#)

Transportation

Transportation can be defined as the use of vehicles, conveyances, and modes to move goods, animals, information, and people from one physical/spatial location to another physical/spatial location. The main modes of **transportation** include land-based (trail, road, railroad, pipeline, cable), water-based (marine navigation [ship, boat, hovercraft, submarine],

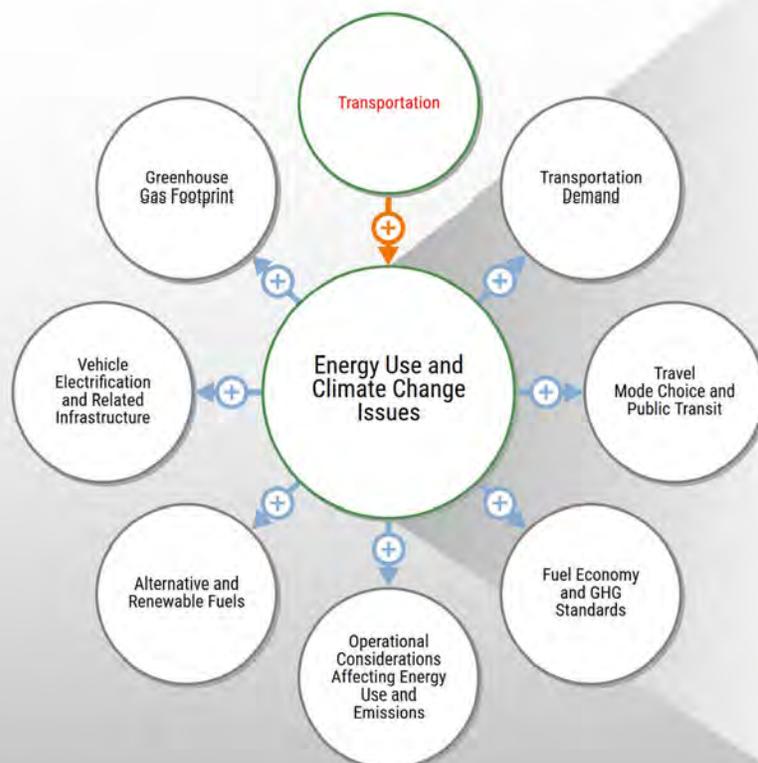
Your previous >>> current displays:
Residential Land Use Impacts on Water Quality and Quantity >>> Transportation

Figure 11. The Transportation Main Screen illustrating the primary Transportation topics.

When one of the Transportation topics is selected, it displays its subordinate (lower-level) topics containing additional information. When the ‘Energy Use and Climate Change Issues’ topic is selected, the result is shown in Figure 12. Weblinks to the applicable references are displayed in the lower portion of the text box area.

Click on the topic bubble or choose a topic from the dropdown list above.

Click on the linkages (+) to view the relationship between elements.



Your previous >>> current displays:

Transportation >>> Energy Use and Climate Change Issues

Energy Use and Climate Change Issues

Energy use in the transportation system, including both passenger and freight transportation, is of key interest at the global, national, state, and local levels. At the national level, approximately 28% of total energy consumption in the U.S. is for transportation, including light and heavy duty vehicles, airplanes, buses, trains, barges, and ships. Personal transportation in light-duty vehicles (including cars, minivans, light-duty trucks, SUVs, motorcycles, etc.) accounted for the majority (59%) of total transportation energy use (highway and non-highway) and 72% of highway transportation energy use in 2010. Energy use is also closely coupled to a number of other environmental outcomes, particularly air quality and climate change. Economic factors also play an important role in assessing transportation energy production and use.

Climate change is closely interrelated with transportation energy use due to the combustion of petroleum-based fuels. As a major consumer of fossil fuels, the U.S.

Sources & Related Reading

[Pacala, S., et al., \(2004\)](#)^{Exit}

[Balbus, J.M., et al., \(2014\)](#)^{Exit}

[Samaras, C., et al., \(2008\)](#)^{Exit}

[Majeau-Bettez, G., et al., \(2011\)](#)^{Exit}

Figure 12. The display shown when the 'Energy Use and Climate Change Issues' sub-topic under Transportation is selected.

When the 'Integrated Tools, Resources, and Indicators' topic is selected from the Transportation main display screen, the result is shown below in Figure 13. Weblinks to the applicable references are displayed in the lower portion of the text box area.

Multi-Sector Sustainability Browser (MSSB)

Bibliography | **Integrated Tools, Resources, and Indicators**

Click on the topic bubble or choose a topic from the dropdown list above.
Click on the linkages (+) to view the relationship between elements.

Integrated Tools, Resources, and Indicators

The three major interrelated elements of sustainability are the environment, the economy, and society (human well-being). These elements include a variety of additional relevant factors including natural and human ecology, political concerns, technological limitations, regulatory frameworks, resource conservation, human health, and demographic, socioeconomic, geographic, and intergenerational equity. In assessing how well a given community's transportation decisions are in supporting the various elements of sustainability, a hierarchy of goals, objectives, subobjectives, and performance measures should be established. Major categories of decisions that performance measures can be utilized to support include future system capacity, predicting future levels of demand, selecting construction materials and methods, amounts of land to use, and what future upgrades and rehabilitations require investment. Sustainability assessment tools should be incorporated into existing planning

Sources & Related Reading

[Koo, D.-H., et al., \(2009\) Exit](#)

[Wallbaum, H., et al., \(2011\) Exit](#)

[Black, J.A., et al., \(2002\) Exit](#)

[Sinha, K.C., \(2003\) Exit](#)

Your previous >>> current displays:
Energy Use and Climate Change Issues >>> Integrated Tools, Resources, and Indicators

Figure 13. The display shown when the ‘Integrated Tools, Resources, and Indicators’ sub-topic under Transportation is selected.

The Materials Management main display screen is shown in Figure 14. Each of the key Materials Management topics shown in the main screen has lower levels of topics with additional information, as shown in Figure 14.

Click on the topic bubble or choose a topic from the dropdown list above.

Click on the linkages (+) to view the relationship between elements.



The text and data shown are distillations of the document: Industrial Economics Inc. 2015. A Systems Approach to Sustainable Materials Management Prepared for: U.S. Environmental Protection Agency, Office of Research and Development, Sustainable and Healthy Communities Research Program

This document can be accessed here: [Materials Management Synthesis Document \(PDF\)](#) (66 pp, 2.35MB) [About PDF](#)

Materials Management

The Materials Management system is composed of a number of processes which are used to address the disposal of Municipal Solid Waste (MSW). Waste generation is a continual process in communities, and sustainable approaches to managing this issue include reuse, recovery, and recycling of waste materials. Each of the Materials Management processes provides a path for either reuse, recovery, or recycling of the output products.

Your previous >>> current displays:

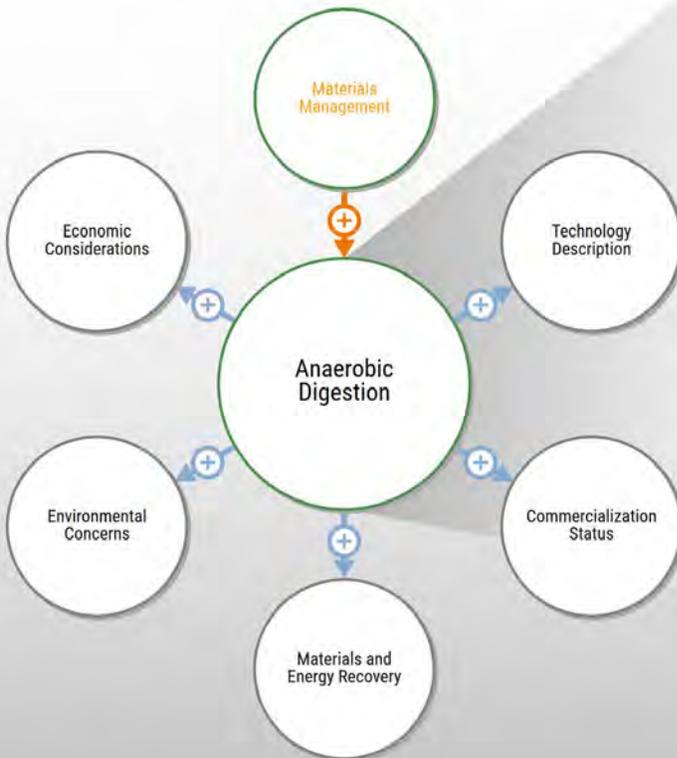
Integrated Tools, Resources, and Indicators >>> Materials Management

Figure 14. The Materials Management Main Screen primary topics.

When one of the Materials Management topics is selected, it displays its subordinate (lower-level) topics containing additional information. When the 'Anaerobic Digestion' topic is selected, the result is shown in Figure 15.

Click on the topic bubble or choose a topic from the dropdown list above.

Click on the linkages (+) to view the relationship between elements.



Anaerobic Digestion

Anaerobic digestion is a process where organic matter (e.g., food waste) is biodegraded by microorganisms in the absence of oxygen, to produce methane (CH₄) and a biosolid that can be used to enrich soil used to grow food crops and plants. Most commercial anaerobic digesters use sludge from wastewater treatment plants and livestock waste products as the starting organic matter for the process. The organic waste in municipal solid waste (MSW) is another source of organic matter for anaerobic digesters. Nearly 3500 wastewater treatment facilities and 190 commercial livestock farms use anaerobic digesters to generate methane and biosolids.

Your previous >>> current displays:

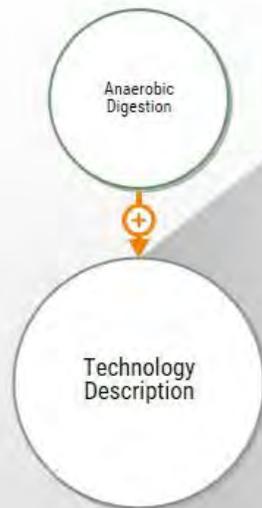
Materials Management >>> Anaerobic Digestion

Figure 15. The lower-level topics shown when the ‘Anaerobic Digestion’ topic is selected.

When the ‘Technology Description’ topic is selected from the Anaerobic Digestion display screen, the result is shown below in Figure 16. Weblinks to the applicable references are displayed in the lower portion of the text box area.

Click on the topic bubble or choose a topic from the dropdown list above.

Click on the linkages (+) to view the relationship between elements.



Technology Description

The anaerobic digestion process for converting organic matter to methane (biogas) can be divided into four distinct and sequential phases: conversion of complex molecules and compounds into simple sugars; conversion of the simple sugars into acetic acid, CO₂, and hydrogen (H₂) gas via fermentation; generation of additional acetic acid, CO₂, and hydrogen (H₂) gas; production of methane (CH₄) using the acetic acid or CO₂ and H₂ gas produced from previous phases. The amount of methane and biosolids generated in anaerobic digestion is dependent on the starting organic matter, its moisture content, temperature, acidity, and availability of the appropriate microorganisms. There are a number of anaerobic digestion systems, and the majority of them are manufactured in Europe. Heat is required from an external source to begin the process, but once that occurs, anaerobic digestion proceeds without further assistance.

Sources & Related Reading

[Heo et al. \(2004\)](#) Ex

[Gerardi \(2003\)](#) Ex

[Li et al. \(2011\)](#) Ex

[Gavala et al. \(2003\)](#) Ex

Your previous >>> current displays:

Anaerobic Digestion >>> Technology Description

Figure 16. The display shown when the ‘Technology Description’ sub-topic under Anaerobic Digestion is selected.

The Buildings and Infrastructure main display screen is illustrated below. Each of the key Buildings and Infrastructure topics shown in the main screen, with the exception of the ‘Research and Development’ topic, has lower levels of displays with additional information, as shown in Figure 17.

Click on the topic bubble or choose a topic from the dropdown list above.

Click on the linkages (+) to view the relationship between elements.



The text and data shown are distillations of the document: Zimmer, A. and Ha H. **Buildings and Infrastructure from a Sustainability Perspective** US Environmental Protection Agency, National Risk Management Research Laboratory. EPA/600/X-14/369, 2014.

Which can be accessed here: [Buildings & Infrastructure Synthesis Document \(PDF\)](#) (30 pp, 1.58MB) [About PDF](#)

Buildings and Infrastructure

Buildings and Infrastructure include all of the man-made, built environment components that are essential to a functioning society, including residential homes, commercial buildings, roads, bridges and railways, wastewater treatment facilities, power generating stations and power transmission lines, and storm drainage and sewer systems. In the United States, **Buildings and Infrastructure** are responsible for 37% of greenhouse gas (GHG) emissions, and 41% of energy consumption. It is apparent that proper planning and management of **Buildings and Infrastructure** can have a significant positive impact on sustainability activities.

Your previous >>> current displays:

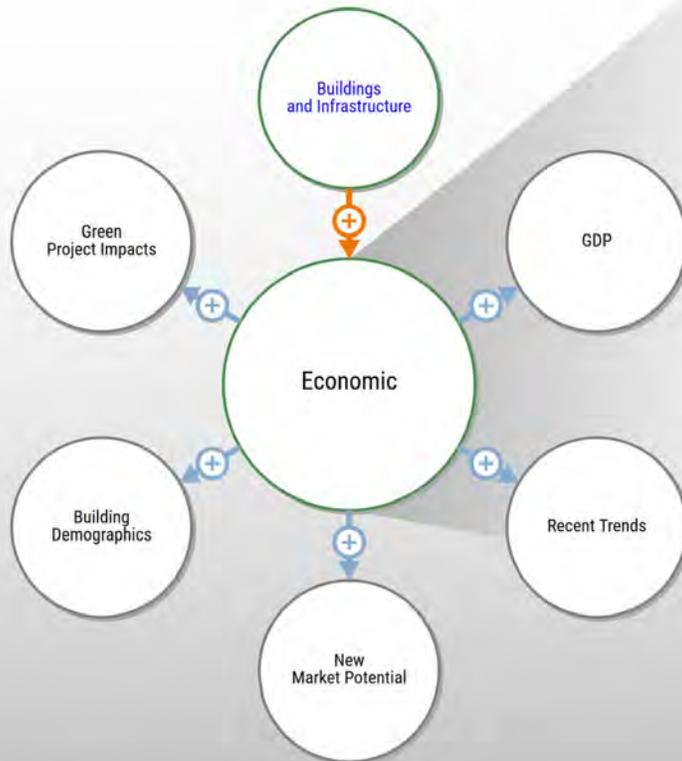
Building Demographics >>> Buildings and Infrastructure

Figure 17. The Buildings and Infrastructure primary topics.

When one of the Buildings and Infrastructure topics is selected, it displays its subordinate (lower-level) topics containing additional information. When the 'Economic' topic is selected, the result is shown in Figure 18.

Click on the topic bubble or choose a topic from the dropdown list above.

Click on the linkages (+) to view the relationship between elements.



Economic

The construction industry is used as an economic indicator in assessing the health of the economy. As of 2007, there were approximately 730,000 construction-related companies in the United States, which employed more than 7 million employees. The utility industry, including power generation and wastewater treatment, had more than 16,600 companies employing over 635,000 employees by 2007. Sustainability efforts in these two areas can have a huge impact on reduced energy consumption and greenhouse gas emissions.

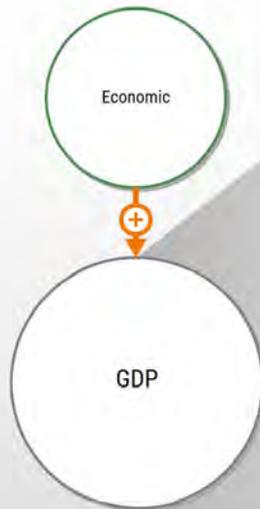
Your previous >>> current displays:

Buildings and Infrastructure >>> Economic

Figure 18. When the ‘Economic’ topic is selected from the Buildings and Infrastructure display, the result is shown in Figure 18.

When the ‘GDP’ topic is selected from the Economic sub-topic under the Buildings and Infrastructure display, the result is shown in Figure 19.

Click on the topic bubble or choose a topic from the dropdown list above.
Click on the linkages (+) to view the relationship between elements.



GDP

In the United States, **Buildings and Infrastructure** represent approximately 16% of the nation's gross domestic product (GDP). The total impact of **Buildings and Infrastructure** on the economy of the United States represents more than \$2.3 billion in economic value, which is 1/6th of the total gross domestic product (GDP).

Your previous >>> current displays:
New Market Potential >>> GDP

Figure 19. The display shown when the 'GDP' sub-topic under Economic is selected.



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