

# Urban Sustainability Assessment and Management Workshop

U.S. EPA Region 5

Chicago, IL • July 20-21, 2016

## **Final Report**



U.S. Environmental Protection Agency  
Office of Research and Development

**Final Report**

**EPA Urban Sustainability Assessment and Management Workshop**

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**Proceedings of the Urban Sustainability Assessment and Management  
Workshop**

**Final Report**

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## **Urban Sustainability Assessment and Management Workshop**

**U.S. EPA Region 5**  
**Ralph Metcalfe Federal Building**  
**77 West Jackson Boulevard**  
**Chicago, IL 60604-3590**  
**July 20 – 21, 2016**

### **EXECUTIVE SUMMARY**

The U.S. Environmental Protection Agency’s Office of Research and Development’s workshop entitled, “Urban Sustainability Assessment and Management Workshop,” occurred in Chicago, Illinois on July 20 and 21, 2016. The purpose of the workshop was to examine critical challenges faced by urban communities and to explore opportunities to use scientifically valid metrics and frameworks to help communities find long-term, sustainable solutions. The EPA’s Office of Research and Development (ORD) and EPA Region 5 hosted the workshop and actively engaged 30 experts from EPA, academic institutions, other federal agencies, and non-profit organizations.

The workshop produced a broad convergence of thought on the nature and magnitude of the scope and scale of unsustainable U.S. and worldwide resource consumption and management. It provided a broad overview of the state-of-practice, the state-of-science, and the emerging research methods in urban sustainability assessment and management. The workshop highlighted diverse perspectives and generated lively discussions regarding the nature of the challenges for urban sustainability assessment and management and priorities for overcoming these challenges. The participants generally agreed that a key challenge is the lack of public awareness and understanding of the implications of the unsustainable trajectory of U.S. and worldwide resource consumption and management, which creates challenges for incorporating sustainability as a priority among other critical urban needs.

The workshop resulted in thoughtful input regarding core research priorities for advancing the state-of-science and the state-of-practice in urban sustainability assessment and management. These include advancing methods that support evaluation of socio-economic co-benefits and equity considerations and align with local decision processes and authority; reframing the narrative and modes of delivery of information about urban sustainability; and advancing methods and uptake of participatory stakeholder engagement. Participants agreed that continued collaboration among government and non-government researchers and local decision-makers is critical to yield practical results, encourage uptake of scientifically valid methods, and help urban communities attain long-term sustainability. EPA and other participants expressed their interest in continued collaboration on this topic.

## **WORKSHOP SUMMARY**

### **Introduction and Overview**

The U.S. Environmental Protection Agency (EPA), including the Office of Research and Development (ORD) and Region 5, hosted a workshop on Urban Sustainability Assessment and Management in Chicago, Illinois on July 20 and 21, 2016. The workshop brought together leading experts to examine critical challenges faced by urban communities and to explore opportunities to use scientifically valid metrics and frameworks to help communities find long-term, sustainable solutions. The workshop actively engaged these experts in discussions of the state-of-practice, the state-of-science, and the innovations in urban sustainability assessment and management. EPA plans to use this information to inform further dialogue and research on this topic.

The workshop covered the following topics:

- EPA research on urban sustainability assessment and management
- Urban challenges and sustainability
- Integrated sustainability metrics
- State-of-practice in urban sustainability assessment and management
- New directions for urban sustainability assessment and management
- Practical considerations in urban sustainability assessment and management
- Systems of sustainability metrics
- Making sustainability relevant
- Core research needs

Thirty participants attended the workshop from EPA, academic institutions, other federal agencies, and non-profit organizations. CSRA provided contract support.

This report summarizes the scope of the workshop, presentations, and group discussions. Appendices A and B include the workshop agenda and list of workshop participants, respectively.

### **Summary of Workshop Discussions**

The following subsections present a high-level summary of workshop presentations, panel discussions, and group discussions. Appendix C includes abstracts describing presentations delivered during the workshop.

### **Welcome and Introductions**

Cheryl Newton, Acting Deputy Regional Administrator for EPA Region 5, welcomed the workshop participants and described EPA's efforts to engage with communities in Region 5 to achieve greater

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sustainability. Following these welcoming remarks, workshop participants introduced themselves, identifying their organizational affiliation and briefly describing their experience and research in urban sustainability assessment and management.

## **Urban Sustainability Assessment and Management**

Heriberto Cabezas (EPA's ORD) provided information to help frame the workshop, including a working definition of "sustainability," the goals of EPA's research on urban sustainability assessment and management, and the objectives of the workshop. The working definition of sustainability states that:

Sustainability, at its core, is an effort to create and maintain conditions on the Earth under which the human population and its necessary material and energy consumption can be supported indefinitely by the biological system of the Earth. Sustainability is not like a goal that you can reach, but like a corridor or a path through time that you must follow.

In addition, the presentation included a brief description of six existing metrics that could be used to assess and manage toward urban sustainability: Ecological Footprint, Emergy, Net Energy, and Energy Return on Investment, Green Net Regional Product (GNRP), Human Well-Being Index, and Fisher Information.

Following this initial presentation, workshop participants commented on other efforts underway to develop sustainability metrics that are scalable to the local level, the interface between metrics and stakeholders, and the use of multiple perspectives and indicators to support decision-making under uncertainty.

## **Urban Challenges and Sustainability**

Participants engaged in a facilitated large group discussion regarding the challenges facing urban communities and their relationship to urban sustainability, responding to the following questions:

- What are the most pressing challenges facing urban communities?
- How will the way communities approach these challenges affect urban sustainability (or unsustainability)?

Participants noted that current levels of resource use and waste are unsustainable and discussed the population and economic drivers behind the current and future projected state. They discussed the scale of the problem and the scope and scale of existing approaches to address urban sustainability. Participants noted that communities are typically focused on the pressing issues of jobs, crime, and education. They discussed the importance of developing a narrative that relates sustainability to these pressing issues, developing metrics to inform the narrative, and identifying opportunities to interject the narrative and metrics into community decision-making processes.

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## Integrated Sustainability Metrics

Arunprakash Karunanithi (University of Colorado Denver) delivered a presentation on research and applications of scientifically valid, integrated urban sustainability metrics. This was based on results from a project under a collaboration between EPA's ORD and Region 8, which is now concluding under an EPA research grant. The project was conducted in San Luis Valley, Colorado, the presentation examined the utility of multiple metrics to capture the different aspects of a system; stakeholder engagement in conceptualizing pathways for sustainable development; and approaches for translating conceptual pathways into quantitative scenario models and analytical tools.

The speaker and participants noted that this research was an outgrowth of initial work by EPA ORD on four metrics: Ecological Footprint, Emergy, Green NRP, and Fisher Information. University of Colorado researchers, through a grant from EPA, extended the research to include Water Footprint and Carbon Footprint to address stakeholder needs. This research demonstrated the importance of stakeholder engagement to develop realistic pathways to sustainability and achieve local buy-in to implement solutions.

## State-of-Practice in Urban Sustainability Assessment and Management

After a break, guest speakers delivered the following presentations to address the questions of how urban communities define “sustainability” and measure sustainability for decision-making, management, and accountability:

- Gigatechnology: Developing Sustainable Urban Infrastructure to Solve Gigaton Problems, *John Crittenden, Georgia Institute of Technology*—The presentation defined “gigaton problems” as the most severe problems challenging humanity, which can often be measured at the “gigaton (billion tons)” scale, and used annual world energy consumption to illustrate the definition. The presentation described a new transformative science called “Infrastructure Ecology” with new engineering standards, protocols, tools, and workers to apply its laws and rules for building cities that are sustainable, resilient, equitable, and efficient.
- The Role of Resilience in Long-term Sustainability, *James Schwab, American Planning Association*—The presentation explored the functional relationships between the concepts of urban resilience and urban sustainability. The presentation addressed the questions of whether a community can be sustainable without incorporating resilient qualities and whether community resilience facilitates long-term sustainability.
- Urban Regions: A System of Systems, *Thomas Theis, University of Illinois at Chicago*—The presentation examined the urban “system of systems” that comprise urban regions and contribute to urban livability. The presentation used urban food systems and capital resources for infrastructure construction and renewal to explore the social and organizational factors to be integrated with the

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ecological landscape and infrastructure decisions to enhance community robustness in the face of change.

Following the presentations, the speakers participated in a facilitated panel discussion, addressing questions, and comments from workshop participants. The discussions addressed the prospects of infrastructure solutions designed to address “gigaton problems”; strategies for combining technology, resilience, and finance; engaging stakeholders in innovative infrastructure solutions; the importance of identifying co-benefits of sustainable infrastructure in terms that relate to quality of life; and relationships between the concepts of sustainability and resilience.

## New Directions for Urban Sustainability Assessment and Management

The next panel delivered the following presentations to describe emerging innovations in the science and practice of urban sustainability assessment and management:

- Open Data and Instrumented Cities, *Charlie Catlett, Argonne National Laboratory*—The presentation discussed the challenges associated with data scarcity and resolution needed to develop computational models to support planning for urban sustainability. The presentation described activities being conducted by Argonne National Laboratories to develop relatively inexpensive sensors to gather data in urban environments to address these challenges, including plans to deploy approximately 500 sensors in Chicago, Illinois to measure environmental conditions, traffic, and various other parameters.
- Web-based Dynamic-Sustainability Information Modeling (D-SIM) Data Analytics Platform for Urban Sustainability, *Ravi Srinivasan, University of Florida*—The presentation discussed the development of a Web-based platform that allows mapping and peer-to-peer energy and waste benchmarking across parcel, neighborhood, city, county, state, and country scales. The presentation described the goals of the platform—to support modeling, simulation, and visualization of linkages and the interplay of all elements of the urban fabric—and plans to integrate socio-economic data to support community decision-making.
- Engaging Stakeholders in Green Infrastructure Solutions to Urban Flooding, *Moirra Zellner, University of Illinois at Chicago*—The presentation described innovative community engagement protocols, including simulation models, interfaces, and facilitation guidelines, being used to help stakeholders collectively address sustainability problems. The presentation examined the use of these protocols to help a community examine green infrastructure (GI) alternatives and priority locations for neighborhood stormwater management.

Following the presentations, the speakers participated in a facilitated panel discussion, addressing questions, and comments from workshop participants. The discussions addressed the rationale for using participatory modeling and scenarios analysis techniques for engaging stakeholders in decision making around complex problems; the magnitude of the problem and long-term sustainability of urban systems;



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and the need for solutions that go beyond efficiency gains and involve policy at the regional scale in addition to local policy and action.

## **Practical Considerations in Urban Sustainability Assessment and Management**

During the afternoon of Day 1, participants split into two groups to discuss practical considerations in urban sustainability assessment and management, drawing on themes raised during the workshop to this point. Each group was provided with a series of topic areas, each with two framing questions to be considered. The topic areas, framing questions, and resulting discussions are summarized below.

### ***Topic 1: State-of-Practice in Urban Sustainability Assessment and Management***

#### **Question 1a:** What does “sustainability” mean to urban communities?

Participants in both groups noted that the way communities define “sustainability” is highly context sensitive. At a broader community level, the term is often conceived in terms of specific community goals. Therefore, its conception reflects community environmental, economic, and social contexts and priorities, where priorities often focus on jobs, crime, and education.

Participants in both groups commented that many urban communities do not have a clear conception of what “sustainability” means or looks like at a local level. Some communities have a systematic view of sustainability, encompassing environmental, economic, and social priorities and reflecting a broad conceptualization such as that developed by the Brundtland Commission.<sup>1</sup> Other communities define the term more narrowly and/or treat it as a separate priority in competition with others such as jobs, public safety, and education. Many communities avoid using the term “sustainability” altogether and use terms such as “quality of life” to address similar concepts. In some cases, the term “sustainability” has been co-opted as a funding rationale or for other purposes and has lost its fundamental meaning.

Participants in both groups noted that the way members of a community define “sustainability” is highly dependent on who you ask (i.e., on individual context). Cultural background, work history and profession, and role in the community can influence an individual’s conception of the meaning of the term ‘sustainability’. These factors affect the individual’s frame of reference, circumstances, and priorities, which, in turn, affect understanding and interest in “sustainability.”

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<sup>1</sup> Brundtland, G.H., and World Commission on Environment and Development. Our Common Future: Report of the World Commission on Environment and Development. Oxford University, 1987. Accessed December 1, 2016, at <http://www.un-documents.net/wced-ocf.htm>

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Participants agreed that communities and individuals do not share a common concept or definition of “sustainability.” It is critical to listen to organizations and individuals within communities to understand how they conceive and define the term.

Question 1b: How do urban communities measure sustainability for decision-making, management, and accountability?

The two groups discussed existing sustainability assessment and management approaches in use by communities; processes by which communities identify sustainability metrics; factors affecting the quality of sustainability metrics; and challenges to the development, adoption, and use of more robust approaches.

Participants identified several existing formal frameworks that have been developed and/or are being used by urban communities for urban sustainability assessment and management. These included the Human Well-Being Index, Boston City Score, Human Development Index, State of Maryland Sustainability Indicators, and SustainLane.

Participants observed that many of these and other sustainability metrics and frameworks are built around the “politics of happiness,” emphasizing characteristics of a community that foster human well-being in general. In some communities (e.g., where the term “sustainability” is avoided), well-being is the primary focus of sustainability-related assessment and management. A relatively common, related, and often less formal approach used by urban communities is to measure sustainability in terms of the extent to which younger residents choose to stay and new families and individuals chose to move into a community.

In both groups, the discussion of existing approaches led to broader discussions of the qualities of effective urban sustainability metrics and frameworks. Some participants noted that sustainability and happiness/well-being are not necessarily the same. Decisions focused solely on achieving near-term happiness and well-being can often be unsustainable. Effective urban sustainability assessment and management considers the long-term consequences of current decisions, biophysical constraints, and intra- and intergenerational equity.

Participants commented that the effectiveness of urban sustainability assessment and management is often a result of the manner in which communities develop and apply sustainability metrics and frameworks. They discussed common challenges for communities’ attempts to implement sustainability assessment and management programs, including borrowed assessment methods; emergent versus explicit nature of sustainability efforts; conceptual challenges; and resource availability.

Participants commented that communities often borrow approaches from other communities that have developed successful programs without tailoring the approach to their own context, priorities, and/or scope and scale of influence. This can result in sustainability metrics that are misaligned with community needs, priorities, and decision processes and do not resonate with community leaders and the public.

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Participants noted that unlike the structured decision-making processes posited in academic research, decisions regarding sustainability often occur organically or as outgrowths of projects tackling other key priorities. Assessment is often an afterthought, which can result in a lack of data and metrics for use in evaluating initial efforts and a lack of support for continued investment in sustainability programs.

Participants commented that even in cases where communities establish sustainability programs explicitly (e.g., as opposed to an outgrowth of other programs), they often lack a robust assessment and management framework due to conceptual and resource issues. Many programs lack clear metrics for measuring sustainability or for understanding the often complex relationships between policies, actions, and sustainability outcomes. The need and/or desire to tackle multiple issues at the same time often exacerbate the latter issue. Policies and actions in one area can result in co-benefits in another. Inability to account for these inter-relationships and competition for public resources makes it difficult to make efficient funding choices.

Participants commented that even in communities that are committed to and have a strong conception of sustainability, the ability to assess and manage to sustainability outcomes can be limited by lack of resources and/or expertise. Resources and expertise are required to analyze sustainability challenges and develop strategies; establish metrics and processes for assessment and management; and collect, analyze, and interpret data. Participants noted that when resources are tight, data gathering activities are often the first cut from the budget. In some communities, funding constraints inhibit the ability to measure sustainability at all.

#### ***Topic 2: Available and Emerging Approaches, including Metrics, for Sustainability Assessment and Management***

**Question 2a:** How could available and emerging approaches to urban sustainability assessment and management be applied to address pressing issues in urban communities like Chicago?

Participants commented that experience with available and emerging approaches suggests it is most important to create a cohesive set of metrics that combines community priorities with metrics linking policies, actions, and outcomes across scales. The first step is to work to identify key community priorities and goals (e.g., health, economic, environmental) and to define sustainability objectives in terms of these goals. Key priorities can warrant multiple and inter-related policies and activities, each with different sets of relevant metrics and available data sources. A common framework linking disparate policies, actions, and metrics to overall community goals can help organize analytical efforts, monitor progress, and inform decision-making, management, and accountability.

Participants suggested that when developing a systems-based approach to sustainability assessment and management, it is important to consider scale and consider relationships between micro- and macro-level outcomes. It is important to define priorities, goals, and associated metrics across different scales of community organization, including, for example, neighborhood, city, and greater metropolitan area. It is also important to analyze sustainability at the micro level, where specific actions result in closely related

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and attributable outcomes, and the macro level, where the combined effect of multiple actions results in outcomes associated with broader goals and associated metrics.

Participants noted that ORD has undertaken research regarding ways to categorize different types of community issues (e.g., health, economic, environmental) and methods for integrating metrics across categories. This research could help cities such as Chicago develop appropriate metrics aligned with key priorities and goals and systematically organize and relate these metrics into a cohesive framework.

Participants commented that in order to elicit community input to develop a systems-based approach that responds to community needs, it is important to listen, engage, and follow through. These processes should seek to optimize community/stakeholder engagement in design, decisions, and action, where optimization should consider not only progress and efficiency but also diversity. It is important that a range of voices be heard, including, for example, younger voices, to ensure intra- and inter-generational equity. Follow-through, including action, continued engagement, and reporting, is important to build a system that supports continuity (not inflexibility) over time.

One group discussed the example of creating green space in Chicago by demolishing older abandoned buildings. This could have multiple co-benefits, including benefits to health, well-being, air quality, lowered flood risk, and increased biological diversity. Mostly low-income areas would be affected. Participants noted that this idea is complicated by questions of when it is more appropriate to retrofit versus demolish and build and how this decision is made. Systematically identifying co-benefits, engaging stakeholders in decisions, and using a cohesive set of measures to track progress and follow through are keys to a successful approach that responds to community priorities. The second group discussed a similar scenario focused on developing and implementing a tree canopy program.

Participants commented that given the complexity of establishing systematic approaches responsive to community context and interests, it is important to engage experts to help elicit community input, establish community-relevant metrics, and support processes that establish sustainability assessment and management.

Question 2b: What if anything is missing from these available and emerging approaches to urban sustainability assessment and management?

Participants commented that the greatest challenge to this type of approach—and the major missing piece—is a rigorous technical approach for interconnecting metrics across policies, actions, and outcomes in a complex system such as a city. Similarly, more needs to be done to develop and demonstrate processes for collaborating across organizations and stakeholders with disparate knowledge, interests, and priorities to establish a common foundation for sustainability.

Participants commented that sustainability needs to be more clearly linked to economic value and metrics and methods need to be established to support markets for sustainability “services” (e.g., incentive breaks for green infrastructure). Because our models for economic development are built on growth, if we do not

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have a way to pay for consuming less, it will not happen. While metrics and methods would provide a necessary start, this type of shift would require new institutional and policy infrastructure.

Participants noted that there is a general lack of metrics and tools for assessing the impact of purchasing choices by local cities and local governments. Models and metrics that communicate the life cycle impacts of these decisions would be useful. Because cities are relatively large consumers, use of such metrics and methods to inform purchasing decisions could have a significant sustainability impact.

#### ***Topic 3: Practical Challenges for Urban Sustainability Assessment and Management***

Question 3a: What are the technical challenges to implementing approaches to urban sustainability assessment and management?

Participants commented that the most significant challenges associated with urban sustainability assessment and management are “people challenges” versus technical challenges, although the technical challenges are not insignificant. People challenges occur because it is difficult to break established patterns of behavior, e.g. driving automobiles versus using mass transit. Technical challenges associated with sustainability metrics and data include the lack of consistent data across spatial and temporal scales; the use of short-term data to inform long-term solutions; research and data for connecting scientifically valid sustainability metrics to larger socioeconomic contexts; and over-reliance on disconnected single dimensional versus systems of inter-related metrics. Earlier workshop discussions explored these technical issues.

Participants noted that processes for transferring lessons learned from one community to another represents a technical challenge for disseminating research and best practices in urban sustainability assessment and management. The challenge is identifying generalizable findings and leveraging these findings to inform community-tailored approaches. Participants commented that, short of a more comprehensive approach, communities could learn valuable lessons from each other by sharing processes (versus actual metrics) that work (e.g., engaging stakeholders, identifying relevant metrics, repurposing existing data). The City of Chicago Climate Action Plan is a good example of a successful, sustainability-oriented effort.

Question 3b: What are the conceptual and/or organizational challenges to implementing approaches to urban sustainability assessment and management?

Participants commented that at its highest level, the greatest conceptual and organizational challenge for urban sustainability assessment and management is the complexity of the problem itself. Unsustainable resource consumption and management is a cross-sector, multi-level problem that can seem overwhelming on the surface. This is often a barrier for action because it is difficult to know where to begin. Narrowing down key objectives and identifying the unique role that the community can play in achieving these objectives is good place to start.

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Participants noted that another key challenge for urban sustainability assessment and management is overcoming social barriers, including resistance to change and a tendency to focus on the present. These barriers represent a challenge and an opportunity. Depending on how it is done, sustainability assessment and management can help people see beyond familiar paradigms and support behavior change and can bring into focus the implications of today's actions on the future.

To take advantage of this opportunity, it is important to frame solutions in a way that is tangible, builds buy-in, and creates a sense of familiarity with the issues. This includes linking sustainability to the larger socio-economic context, as discussed throughout the day. It includes framing sustainability as a “journey,” not a “destination.” Working towards sustainable urban environments requires flexibility; and sustainability assessment and management approaches must be capable of accommodating this flexibility and supporting iterative, adaptive management. It is important to recognize that a fundamental shift in the way people interact with information has occurred, from a traditional, authority-based approach to more experiential means. Approaches such as participatory modeling engage in ways that align with this shift.

Participants commented that government bureaucracy represents a significant barrier to implementing successful sustainability assessment and management programs. Local government decisions are often made on short-term cycles; and decisions are made through established administrative procedures. There often exists a culture of working in silos, which can create barriers to collaboration within and across local government agencies and across levels of government. All of these factors work against effective sustainability assessment and management, which usually require long-term horizons, systems thinking, inter-agency collaboration, and applying the right science at the right time in decision processes.

Participants noted that another challenge for urban sustainability assessment and management includes a lack of openness to data sharing. They suggested that in order to overcome this barriers, it is necessary to make the case that the benefits of data sharing—to the community overall and the data owner—often outweigh the costs.

Participants also noted that different research organizations have access to different resources and are affected by different constraints. They stressed the importance of collaboration across governmental and non-governmental organizations to advance the research on urban sustainability assessment and management.

Finally, participants reiterated that the lack of local government funding for sustainability-related programming is a serious challenge for urban sustainability assessment and management. Subsequent discussions emphasized the importance of leveraging research and expertise in the field to help communities overcome this challenge.

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## A System of Sustainability Metrics

Day 2 of the workshop began with a recap of Day 1. Following the recap, a panel delivered the following presentations addressing the topic of opportunities and challenges for developing integrated metrics and systems of metrics to provide practical guidance for solutions to urban sustainability issues:

- Toward the “Eco-City”: Essential Metrics for Urban Sustainability, *William Rees, University of British Columbia*—The presentation discussed the use of bottom-up ecological footprint analysis to assess ecosystem degradation and address the problem of “overshoot” using data routinely collected by cities on energy use, material flows, and waste. The presentation noted that applying this method shows that modern cities should plan to reduce their ecological footprints (material and energy throughput) by 50–80 percent if the world is to achieve global sustainability, assuming greater material equity and a common goal of “one-planet living.” The presentation concluded that such reductions are technically possible with policies to address food systems/diet, transportation, building construction/maintenance, and consumer life-styles.
- Ecology, Empathy, & Relationships: An Entrepreneurial Approach to Creating Sustainable Value in Cities, *David Tilley, University of Maryland*—The presentation summarized the case that new metrics of sustainability are needed to reflect the “New Normal” of the personally empowered citizen, so public and private institutions can adapt to help cities become more sustainable. The presentation described experience using new tools of innovation and entrepreneurship, such as Lean Startup, to affect the relationship citizens have with their environment and then contrasted this with emergy analysis, a classic biophysical metric. It concluded that Ecological Entrepreneurship offers promise for society to evolve sustainable habits.

Following the presentations, the speakers participated in a facilitated panel discussion, addressing questions, and comments from workshop participants. The discussions addressed how to develop a narrative that will be meaningful to individuals; avoiding approaches that instill fear and inaction; the use of metaphors and analogies (e.g., footprint, metabolism, accounting system) and visualization; and challenges of raising consciousness to break historical cultural cycles.

## Making Sustainability Relevant

The next panel delivered the following presentations to address the question of how to make the connection between urban sustainability and pressing urban social needs:

- A Metabolic View of Urban Sustainability: A Case Study of Neighborhood-Based Food Waste Management, *Ning Ai, University of Illinois at Chicago*—This presentation discussed the connection between community needs and sustainability goals in an urban metabolism (UM) framework, which is an analogy to the metabolic process in ecological systems. The presentation used a neighborhood-based food system planning case to illustrate the use of UM to connect inputs, outputs, and stocks in

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an urban system and identify opportunities to reduce waste generation, address other impacts, and achieve urban sustainability goals.

- Partnership Work in Gary, Indiana, *James Van der Kloot, EPA Region 5*—The presentation discussed EPA’s work with the city of Gary, Indiana, to help the community adapt to the impacts of demographic and economic changes and improve the quality of life of its residents. The presentation emphasized the importance of stakeholder engagement and development of a geographically defined vision and strategy to build confidence, strengthen non-profit capacity, and encourage public and private investment in the community.
- Multiple Benefits of a Sustainable City and the Sustainable Chicago Action Agenda, *Karen Weigert, Chicago Council on Global Affairs*—The presentation described strategies used and lessons learned from the presenter’s experience as the former Chief Sustainability Officer for the City of Chicago, Illinois. The presentation described a number of the City’s sustainability-related projects and explained how each project involved developing a story, backed up with data, around the resonant and reinforcing themes of livability, competitiveness, and sustainability. Examples included creation of Greencorps Chicago; energy benchmarking and disclosure; and transit, bike share, and rail-to-park conversion programs and projects.

Following the presentations, the speakers participated in a facilitated panel discussion, addressing questions, and comments from workshop participants. The discussions addressed challenges and approaches for using vacant lands in shrinking cities for stormwater mitigation and urban agriculture; research and initiatives associated with food waste; and opportunities for creating sustainable funding for communities that provide services (e.g., green infrastructure to mitigate stormwater impacts).

## Core Research Needs

The workshop concluded with a facilitated large group discussion regarding research priorities for advancing the state-of-science and the state-of-practice in urban sustainability assessment and management, responding to the following questions:

- What are the most critical gaps and associated research needs identified during the workshop?
- What are the key priorities for advancing the state-of-science and the state-of-practice in urban sustainability assessment and management?

Participants suggested that it is critical that researchers develop better approaches for communicating information from existing and future metrics in ways that resonate with people’s values, encourage action, and compete effectively with the other types of information that people use to make decisions.

Participants suggested that in order to tell a complete story, including problems and potential solutions, scientists will need to work with policy-makers to identify the range of policies and actions that are



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politically acceptable and will make a significant enough impact to address the current, unsustainable trajectory. The absence of this could result in fear, denial, and inaction.

Participants discussed the utility of using multiple sustainability metrics/indicators, each telling different parts of the story, and combining to form a whole. Participants suggested that efforts to develop or refine urban sustainability metrics focus on robustness; align with the complexity of the problem; focus on areas where communities tend to use mistaken assumptions; and support analysis of consequences of community decisions.

Participants reiterated earlier discussions of the importance of collaboration across governmental and non-governmental organizations to advance the research on urban sustainability assessment and management. Participants noted that different organizations have access to different resources and are affected by different constraints and that collaboration strengthens networks, lowers the barriers to information dissemination, and helps build alliances. Participants emphasized that funding for further research on urban sustainability assessment and management will depend on communicating the magnitude and immediacy of the problem and providing the rationale and potential benefits of the research.

## **Workshop Conclusion**

EPA ORD thanked the participants for their active and substantive engagement in the workshop. EPA and other participants expressed their interest in continued collaboration on this topic, including finding opportunities to apply the research to support community decision making, well-being, and sustainability.

## **Synthesis of Workshop Findings**

Following the conclusion of the workshop, EPA ORD reviewed the presentations and discussions and developed the following synthesis of workshop findings for use in informing further dialogue and research on the topic of urban sustainability assessment and management.

1. Problem/framing summary:
  - a. U.S. and worldwide resource consumption and waste management are on an unsustainable trajectory.
  - b. The scope and scale of existing sustainability solutions are not well aligned with the scope and scale of the problem.
  - c. The greatest impact on resource consumption and waste generation are the urban communities and they will play a critical role in changing the trajectory.
  - d. Existing sustainability metrics illustrate the problem, but have not had a significant enough influence on public consciousness and decision making to move toward a sustainable trajectory.
2. State-of-science and practice:

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- a. No one metric assesses “urban sustainability”; a combination of indicators offering different perspectives is necessary to assess urban sustainability.
  - b. Existing metrics/frameworks for assessing urban sustainability include Ecological Footprint, Energy, Net Energy, and Energy Return on Investment, Green Net Regional Product, Human Well-Being Index, Fisher Information, Water Footprint, Carbon Footprint, Urban Metabolism Framework, Human Development Index, Gross Domestic Happiness, and Boston City Score.
  - c. Effective metrics/frameworks use readily available information that can be collected at adequate resolution; are scalable to the level of decision-making authority; and draw on analogies that facilitate broad stakeholder understanding. They have a strong basis in science and an established record in the scientific literature.
  - d. Recent technical advances in urban sustainability assessment include the use of new monitoring technology to improve data resolution and development of systems models that evaluate lifecycle impacts, connect micro and macro scales, and incorporate socio-economic factors.
  - e. Recent advances in processes for incorporating sustainability indicators in local decision making include engaging stakeholders in defining relevant indicators, participatory modeling, and development of sustainability programs that emphasize co-benefits aligned with community priorities.
3. Key challenges:
- a. There is limited public awareness and understanding of the implications of the unsustainable trajectory of U.S. and worldwide resource consumption and waste, which creates challenges for incorporating sustainability as a priority among other critical urban needs.
  - b. Relationships between existing urban sustainability indicators/ frameworks and the immediate concerns of urban communities (e.g., jobs, crime, and education) are not always clear or clearly communicated.
  - c. Urban sustainability indicators/frameworks are often limited by scarcity of data at the necessary resolution to support methods, models, and/or indicators that align with the scope and scale of local decision-making.
  - d. A significant challenge for urban sustainability assessment and management is the complexity of the problem itself, which can be a barrier for action because it is difficult to know where to begin.
  - e. Social paradigms and bureaucratic processes that are resistance to change and tend to focus on the present or short-term represent key challenges to urban sustainability assessment and management.
  - f. The complexity of urban jurisdictional authority and decision processes create challenges for effectively incorporating sustainability indicators/frameworks into decision processes.
4. Research priorities:

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- a. Key challenges for urban assessment and management revolve more around raising awareness and integrating existing metrics/frameworks into local decision processes and less around developing new or refining existing metrics/frameworks.
- b. Research that advances data collection and integration methods will be most effective if it improves the quality and practical application of metrics/frameworks, including robustness across scales; systems/lifecycle capabilities; capacity to evaluate and communicate co-benefits and equity considerations; and alignment with decision processes and authority.
- c. Research focused on reframing the narrative and modes of delivery of information about urban sustainability is a priority and will be most effective if it builds on a solid understanding of stakeholders' (e.g., urban decision-makers, leaders, and the public) evolving needs, trusted information sources, and preferred modes of receiving information.
- d. Research that advances participatory stakeholder engagement (e.g., in selecting sustainability metrics and evaluating sustainable options) is a priority and will be most effective if it builds on a solid understanding of the timing and structure of local decision processes and opportunities to address knowledge and information gaps and build stakeholder confidence in the process.
- e. Collaboration among governmental researchers, non-governmental researchers, and local decision makers will be critical to advance research that yields practical results, encourages uptake of scientifically valid indicators and frameworks, and helps urban communities attain long-term sustainability.

#### **Disclaimer**

The views expressed in this report are those of the authors and do not necessarily represent the views or policies of the US Environmental Protection Agency.

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**Agenda, Day 1 – Wednesday, July 20, 2016**

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- 9:30 am**      **Welcome and Introduction**
- 10:00 am**      **Urban Sustainability Assessment and Management**  
*Presentation: overview of urban sustainability assessment and management challenges, opportunities, and innovations*  
Speaker:    Heriberto Cabezas, EPA Office of Research and Development
- 10:30 am**      **Break**
- 11:00 am**      **Urban Challenges and Sustainability**  
*Large group discussion: challenges facing urban communities and their relationship to urban sustainability*  
Framing questions:
- What are the most pressing challenges facing urban communities?
  - How will the way communities approach these challenges affect urban sustainability (or unsustainability)?
- 11:30 pm**      **Integrated Sustainability Metrics**  
*Presentation: scientifically valid, integrated metrics and their practical uses*  
Speaker:    Arunprakash Karunanithi, University of Colorado Denver
- 12:00 pm**      **Lunch Break**
- 1:00 pm**      **State-of-Practice in Urban Sustainability Assessment and Management**  
*Panel presentations and interactive discussion: how urban communities define “sustainability” and how urban communities measure urban sustainability for decision making, management, and accountability*  
Speakers:   John Crittenden, Georgia Institute of Technology; James Schwab, American Planning Association; Thomas Theis, University of Illinois at Chicago
- 2:00 pm**      **New Directions for Urban Sustainability Assessment and Management**  
*Panel presentations and interactive discussion: emerging innovations in the science and practice of urban sustainability assessment and management*  
Speakers:   Charlie Catlett, Argonne National Laboratory; Ravi Srinivasan, University of Florida; Moira Zellner, University of Illinois at Chicago

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**Agenda, Day 1 (continued)**

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- 3:00 pm**      **Break**
- 3:30 pm**      **Practical Considerations in Urban Sustainability Assessment and Management**  
*Small group discussions and large group report-out: practical considerations in urban sustainability assessment and management*
- 3:30–4:00    State-of-Practice
- What does “sustainability” mean to urban communities?
  - How is sustainability measured for decision making, management, and accountability?
- 4:00–4:30    Available and Emerging Approaches, including Metrics, for Sustainability Assessment and Management
- How could these be applied to address pressing issues in Chicago?
  - What if anything is missing?
- 4:30–5:00    Practical Challenges
- What are the technical challenges to implementing these approaches, including metrics?
  - What are the conceptual and/or organizational challenges?
- 5:00 pm**      **Wrap-up**
- 5:30 pm**      **Adjourn**

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**Agenda, Day 2 – Thursday, July 21, 2016**

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**9:00 am**      **Recap of Day 1**

**9:20 am**      **A System of Sustainability Metrics**

*Panel presentations and interactive discussion: opportunities and challenges for developing integrated metrics and systems of metrics to provide practical guidance for solutions to urban sustainability issues*

Speakers: William Rees, University of British Columbia; David Tilley, University of Maryland

**10:30 am**      **Break**

**11:00 am**      **Making Sustainability Relevant**

*Panel presentations and interactive discussion: how to make the connection between urban sustainability and pressing urban social needs*

Speakers: Ning Ai, University of Illinois at Chicago; James Van der Kloot, EPA Region 5; Karen Weigert, The Chicago Council on Global Affairs

**12:00 pm**      **Lunch Break**

**1:00 pm**      **Core Research Needs**

*Group discussion on research priorities for advancing the state-of-science and state-of-practice in urban sustainability assessment and management*

Framing questions:

- What are the most critical gaps and associated research needs identified during the workshop?
- What are the key priorities for advancing the state-of-science and state-of-practice in urban sustainability assessment and management?

**1:30 pm**      **Wrap-up and Next Steps**

**2:00 pm**      **Adjourn**

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#### List of Workshop Participants

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\*Presenter



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#### **Integrated Sustainability Metrics**

Scientifically valid, integrated metrics and their practical uses. *Arunprakash Karunanithi, University of Colorado Denver*

This presentation will focus on the development of a metrics based framework for integrated sustainability assessment of regions. Utilizing results from a four-year project conducted in San Luis Valley Colorado, we will examine the utility of multiple metrics, all capturing different aspects of a system, in understanding the long-term sustainability of regions. Further, we will also elaborate on how in depth engagement with local stakeholders can assist in conceptualizing realistic, feasible, and attainable pathways for sustainable development. Technical aspects related to translating the conceptual pathways into quantitative scenario models and analysis tools will also be presented. The usefulness of the metrics based framework in assessing these scenarios, and more importantly, its role in credible and easy communication of the findings to stakeholders and policy actors leading to securing community buy-in for intervention will be addressed. Particular emphasis will be placed on a discussion around advantages and best practices related to formal and continuous engagement with the community in co-developing the metrics and scenarios.

#### **State-of-Practice in Urban Sustainability Assessment and Management**

Gigatechnology: Developing Sustainable Urban Infrastructure to Solve Gigaton Problems. *John Crittenden, Georgia Institute of Technology*

Gigaton problems refer to those most severe problems challenging humanity, which can often be measured at the “gigaton” (billion tons) scale. For example, the annual world energy consumption is around 12 billion tons of oil equivalent (Gtoe), 80% of that from nonrenewable fossil fuels. The combustion of these fossil fuels emits approximately 29 billion tons (Gton) of CO<sub>2</sub>. In addition, the world uses more than 79 Gton of materials each year, only about 29% of which are renewable. These gigaton problems call for solutions which can meet the gigaton scale, or gigaton solutions. Urban centers are the largest complex, adaptive gigatechnology systems that humans create and within which humans manipulate mass and energy. Accordingly, properly designed urban system can solve the gigaton problems. A new transformative science for gigatechnologies has been established called, “Infrastructure Ecology,” with new engineering standards, protocols, tools, and workers to apply its laws and rules for building cities that are sustainable, resilient, equitable, and efficient. Analogous to natural ecology, the urban system of systems are combined to produce larger functional wholes, and new properties emerge (e.g., quality of life, air quality, traffic congestion) that were not present or evident at the next level below. By examining the complex interactions among social decision making, economic drivers, (re)development, sustainability metrics, Infrastructure Ecology is being developed to allow stakeholders to design and choose infrastructure solutions that consume fewer resources and generate less waste.

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#### The Role of Resilience in Long-term Sustainability. *James Schwab, American Planning Association*

In recent years, the concept of resilience has gained nearly as much traction as that of sustainability, which has been in circulation somewhat longer. What has not generally been explored in great depth, however, is the functional relationship between these two ideas. The larger question is whether the two ideas can be complementary in an urban setting. Resilience is central to the notion of recovery.

Resilience, by emphasizing the ability to rebound from a disaster, involves a relatively short-term capability based on more long-term traits that enable that capability. The foresight embodied in planning for long-term recovery prior to a disaster cultivates a culture of preparedness that cannot be generated on short notice. Sustainability seeks to preserve opportunities for future generations by trying to rely more on renewable resources and not depleting resources for current use. A quintessential example of resilience leading to sustainability has been the vision of Greensburg, Kansas, to embrace a renewable energy future in the wake of a devastating 2007 tornado. This leads to a straightforward but complex question: Can a community be truly sustainable over the long term without incorporating resilient qualities that help it recover from major short-term setbacks? How does resilience facilitate true long-term sustainability?

#### Urban Regions: A System of Systems. *Thomas Theis, University of Illinois at Chicago*

Urban systems are formed by a diversity of actors and activities, and consist of complex interactions involving financial, information, energy, health, ecological, and material stocks and flows that operate on different spatial and temporal scales. The urban systems that emerge from these interactions are continually in flux as they are constructed, replaced, and regenerated. While scholars of all disciplines agree that urban systems form and grow from the economic surplus that they capture, less transparent are the manner in which social and organizational factors should be integrated with the ecological landscape and infrastructure decisions and designs to enhance robustness in the face of change. This presentation will examine the urban “system of systems” that compose urban regions and contribute to urban livability with emphasis on two in particular: urban food systems and capital resources for infrastructure construction and renewal.

### **New Directions for Urban Sustainability Assessment and Management**

#### Open Data and Instrumented Cities. *Charlie Catlett, Argonne National Laboratory*

Urbanization is one of the great challenges and opportunities of this century, inextricably tied to global challenges ranging from climate change to sustainable use of energy and natural resources, and from personal health and safety to accelerating innovation and education. There is a growing science community—spanning nearly every discipline—pursuing research related to these challenges. The availability of urban data has increased over the past few years, in particular through open data initiatives, creating new opportunities for collaboration between academia and local government in areas ranging from scalable data infrastructure to tools for data analytics, along with challenges such as replicability of solutions between cities, integrating and validating data for scientific investigation, and protecting privacy.

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For many urban questions, however, new data sources will be required with greater spatial and/or temporal resolution, driving innovation in the use of sensors in mobile devices as well as embedding intelligent sensing infrastructure in the built environment. Collectively, these data sources also hold promise to begin to integrate computational models associated with individual urban sectors such as transportation, building energy use, or climate. Catlett provided an overview of the work that Argonne National Laboratory and the University of Chicago are doing in partnership with the City of Chicago and other cities through the Urban Center for Computation and Data, focusing in particular on new opportunities related to the National Science Foundation-funded Array of Things project, which will install a network of 500 sensor nodes in Chicago, with embedded processing power to support machine learning and in-situ data analytics, by 2018.

#### Web-based Dynamic-Sustainability Information Modeling (D-SIM) Data Analytics Platform for Urban Sustainability. *Ravi Srinivasan, University of Florida*

As economies develop and living standards improve worldwide, the demand for energy is increasing at unprecedented rates. The largest consumers of energy, globally and domestically, are buildings. As a result of this large scale consumption, buildings generate large amounts of carbon dioxide, sulfur dioxide, and nitrogen oxide emissions. This traditional building sector model, based upon high levels of consumption and waste, is unsustainable and must be changed in order to avoid energy shortages and reduce hazardous impact to its environment. What we need is a robust, Web-based, and interactive tool to track and draw meaningful comparisons of energy and non-energy qualifiers across multiple scales.

This presentation will discuss the development of a Web-based D-SIM platform that allows mapping and meaningful peer-to-peer benchmarking process covering a swath of scales, namely parcels, neighborhoods, cities, counties, states, and countries. While the main focus of D-SIM has been in the context of buildings, the true beauty of this platform is that it will be applicable at many different scales with available tools varying along with the scope of analysis. This ability to cut across a broad swath of scales is what allows the platform to achieve its ultimate goal: to model, simulate, and visualize the linkages and the interplay of all elements of the urban fabric, regardless of scale. Work is in progress to expand D-SIM data analytics to identify fine-resolution community-specific action priorities using AI techniques and through integration of socio-economic databases in the analyses. Additionally, this presentation will discuss the recently developed web-based Build-Em tool that assesses building's environmental impacts on the surroundings such as ecological toxicity, biodiversity, human health, and ecosystem services.

#### Engaging Stakeholders in Green Infrastructure Solutions to Urban Flooding. *Moirra Zellner, University of Illinois at Chicago*

Moirra Zellner and her research team at University of Illinois at Chicago have developed process-based models to examine the effectiveness of green infrastructure (GI) for neighborhood stormwater management, and to derive landscape GI design principles that can help determine thresholds and priority

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locations within a study area. In addition, they have developed innovative community engagement protocols that include simulation models, mobile and paper interfaces, and facilitation guidelines to help stakeholders collectively make sense of the flooding problem, design solutions, and discuss these solutions.

### **A System of Sustainability Metrics**

Toward the “Eco-City”: Essential Metrics for Urban Sustainability. *William Rees, University of British Columbia*

The world is in “overshoot”—the human enterprise is depleting and polluting ecosystems faster than the latter can regenerate resources and assimilate wastes. (Even climate change is a waste management problem.) Ecosystems degradation can be attributed largely to consumption in cities, yet most urban sustainability efforts remain ill-conceived and ineffective. Conceptual problems include little appreciation of cities as heterotrophic ecosystems, the failure of analysts to frame their efforts in global context; inadequate measuring/monitoring; and a lack of biophysically meaningful targets. Bottom-up ecological footprint analysis addresses these problems in the context of global biocapacity using data on energy use, material flows, and waste generation commonly collected by cities. We show that typical high-income cities functionally “occupy,” and are dependent upon, a productive extra-urban ecosystem area hundreds of times larger than the cities’ political or geographical areas. Assuming greater material equity and a common goal of “one-planet living,” the method shows that modern cities should plan to reduce their ecological footprints (material and energy throughput) by 50–80% if the world is to achieve global sustainability. Such reductions are technically possible with policies to address food systems/diet, transportation, building construction/maintenance and consumer life-styles.

Ecology, Empathy, & Relationships: an entrepreneurial approach to creating sustainable value in cities. *David Tilley, University of Maryland*

Social media technology has empowered people in democratic societies far beyond their historic levels. Information is readily available; mass communication is easy, spreads quickly, and empowers individuals to form effective clusters of thought and action. Authority in the classic sense of a few elected officials and enabled bureaucracies is weakened as a driver of change. Entrepreneurship and the innovation that accompanies free-enterprise can transform the empowering force of social media to advance social learning and self-actualization to promote sustainable behaviors. New metrics of sustainability are needed to reflect this “New Normal” of the personally empowered citizen, so public and private institutions can adapt to help cities become more sustainable. The authors will present their experience using new tools of innovation and entrepreneurship, such as Lean Startup, to affect the relationship citizens have with their environment and contrast it with emergy analysis, a classic biophysical metric. Ecological Entrepreneurship offers some promise for society to evolve sustainable habits.

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#### **Making Sustainability Relevant**

A Metabolic View of Urban Sustainability: A Case Study of Neighborhood-Based Food Waste Management. *Ning Ai, University of Illinois at Chicago*

This presentation will discuss the connection between community needs and sustainability goals in an urban metabolism (UM) framework, which is an analogy to the metabolic process in ecological systems. UM connects inputs with outputs as well as stocks of elements of urban systems, and thus facilitates the identification of inefficiencies in operation for long-term planning processes. In particular, this presentation will focus on data-driven research and policy-making about sustainable management of system outputs, or waste residuals. The current waste management practice, which focuses on short-term impacts and end-of-pipe solutions, is reactive in nature and inadequate to promote sustainability within urban systems, across jurisdictions, and across generations. Through material flows in and out of urban systems, many potential opportunities exist to reduce waste generation and to minimize the negative impacts on the environment, the economy, and the society. Case illustrations are provided for neighborhood-based food system planning, with a focus on bottom-up approaches to achieving urban sustainability goals. Numerical data analysis demonstrates the need of community- and material-specific policy design.

Partnership Work in Gary, Indiana. *James VanderKloot, U.S. EPA Region 5*

Federal Partnerships have been applying Sustainable Development principles and practice on the ground in Gary, Indiana, over the last 4 years, in partnership with the City of Gary, the Legacy Foundation, and many local leaders. Based upon the results of successful sustainable redevelopment projects in cities such as Milwaukee, Kenosha, and Moline, the work began with the definition of a clearly defined corridor for reinvestment. The Mayor selected a corridor centered on the City's two main train stations, which had been slated for closure, to be replaced by a park-and-ride which would mainly serve out-of-town commuters. EPA funds were utilized to bring in consultants SRA/Vita Nuova and John Antaramian, the former Mayor of Kenosha, who helped walk the city through a process of planning for future reuse. The result was a plan for the Gary Northside Redevelopment Project, which has been successful in attracting significant investment. Key investments have included demolition of the ruins of residential homes using Treasury's Hardest Hit Funds, Installation of over \$2 Million in Green Infrastructure, the Demolition and reuse of the former Sheraton Hotel, and several Foundation-funded Arts Projects

([www.arthousegary.com](http://www.arthousegary.com))

Multiple Benefits of a Sustainable City and the Sustainable Chicago Action Agenda. *Karen Weigert, Chicago Council on Global Affairs*

The City of Chicago serves as an example to other cities that economic growth and care for the environment are not mutually exclusive pursuits. The City of Chicago's Sustainable Chicago Action Agenda proves that many co-benefits can be realized from building a strong and sustainable city. The Sustainable Chicago Action Plan aims to make the City more livable, competitive and sustainable in tandem with one another.

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The plan, which launched in 2012, outlines 7 themes, 24 goals and 100 actions that are mutually reinforcing and offer co-benefits for one another. Success in any one of these areas supports other related actions across the City. The 7 themes outlined in the plan are (1) Economic Development and Job Creation; (2) Energy Efficiency and Clean Energy; (3) Transportation Options; (4) Water and Wastewater; (5) Parks, Open Space and Healthy Food; (6) Waste and Recycling; and (7) Climate Change.

According to Chicago Mayor Emanuel, the City of Chicago defines a sustainable city as one that spends less on energy use with each passing year, creates good-paying jobs in up-and-coming industries, responsibly maintains and upgrades its infrastructure, and ensures every Chicagoan has the opportunity to live a healthy and active lifestyle. More information about the Sustainable Chicago Action Agenda can be found at [https://www.cityofchicago.org/city/en/progs/env/sustainable\\_chicago2015.html](https://www.cityofchicago.org/city/en/progs/env/sustainable_chicago2015.html).