A Framework for Assessing Cumulative Environmental and Public Health Effects of Data Centers

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HEI

Air and Waste Management Association Conference

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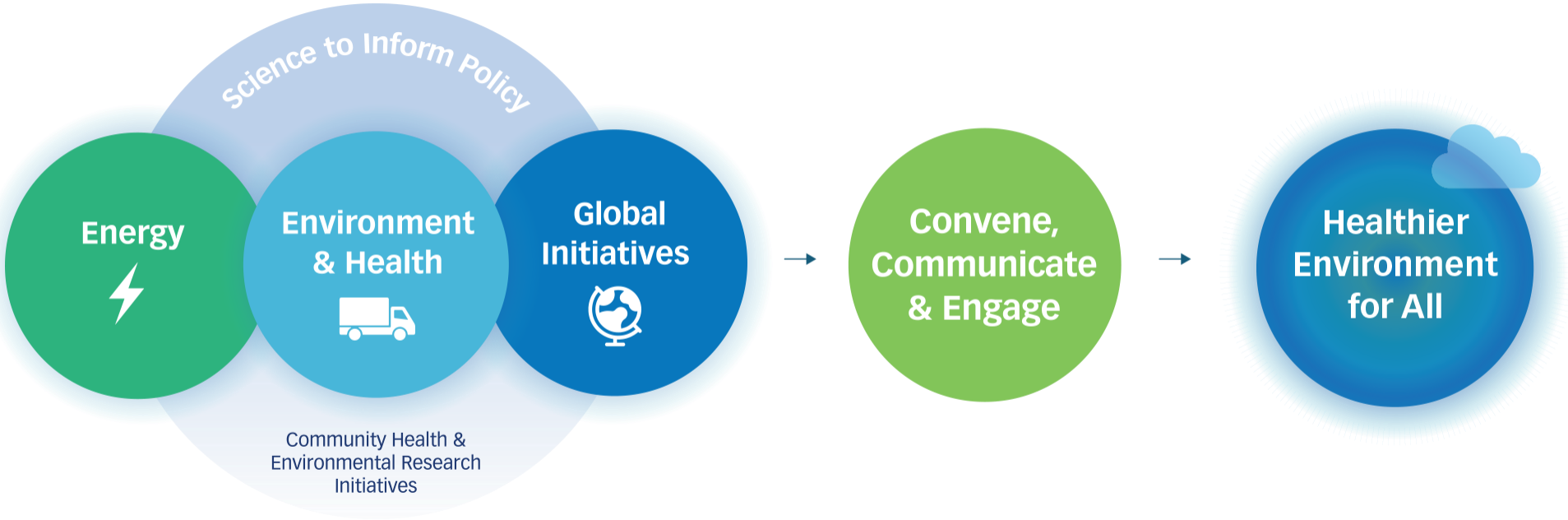
About HEI



Mission: Provide impartial science to inform decisions that foster a healthier environment for all.

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How We Achieve Our Mission

- Fund and support policy-relevant scientific research.
- Convene independent expert committees to select, oversee, and review the scientific research.
- Collaborate with and convene researchers, policymakers, industry experts, nongovernmental organizations, and broader society to identify research priorities.
- Synthesize, interpret, and communicate scientific evidence to various audiences around the world.
- Engage with our audiences to facilitate constructive planning and use of our science in decision-making.

HEI does not make policy recommendations.

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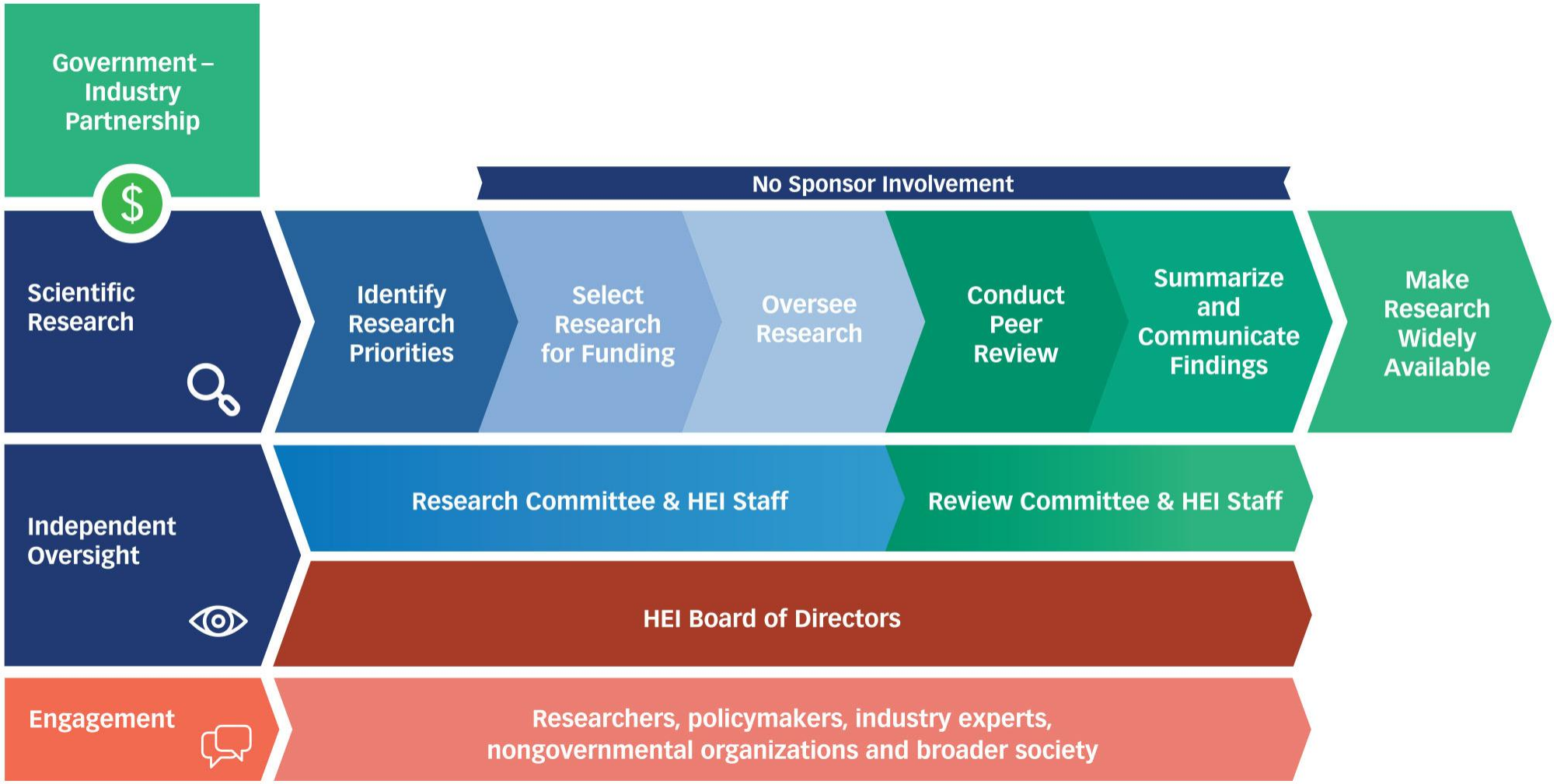
How HEI provides impartial science



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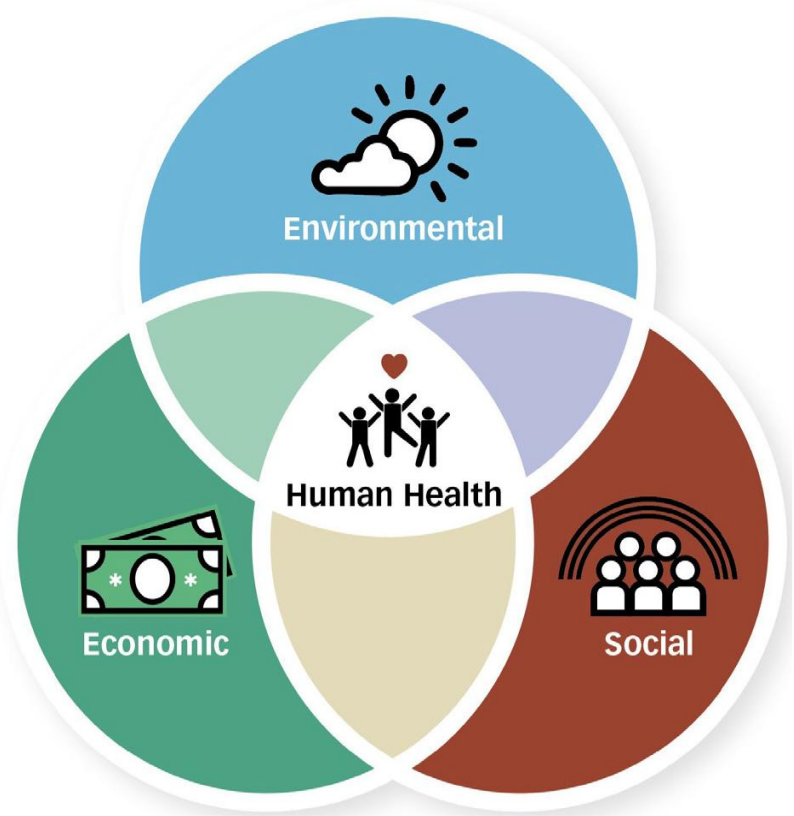
Roadmap for Evaluating Adverse and Beneficial Environmental, Social, and Economic Factors that Affect Human Health: Objective

Objective: To contribute to previous and ongoing efforts[1] by providing a flexible set of considerations that may inform a cumulative impacts assessment (CIA) process.

Value of CIA Roadmap:

1. Find solutions and paths forward towards mitigating important adverse impacts while capitalizing on opportunities.
2. Enhance transparency in decision-making process.
3. Involve and gather perspectives from multi-sector stakeholders.
4. Flexible use-cases: can be adapted to educational, research, regulatory and other contexts.



Link to published Roadmap and Checklist

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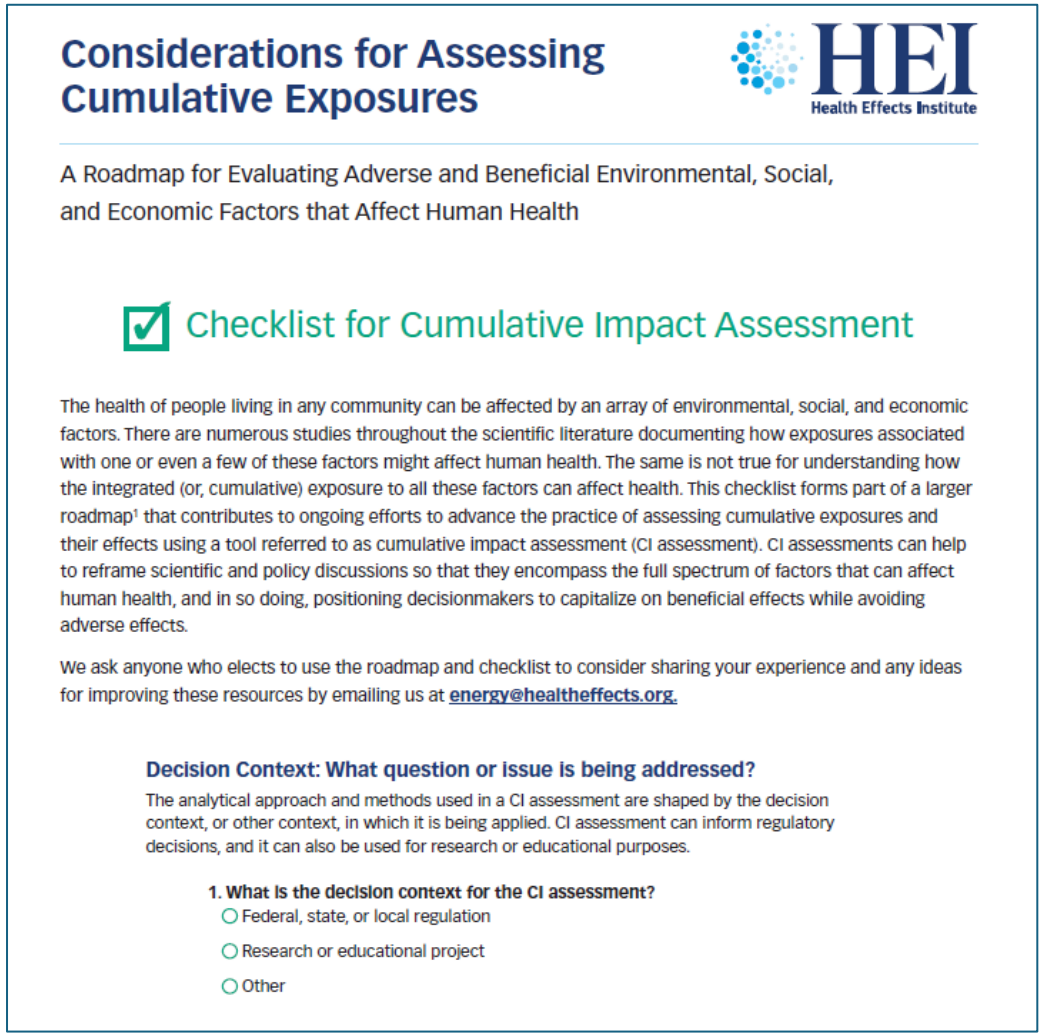
[1] National Academies of Science, Engineering and Medicine; ToxStrategies; US EPA

Roadmap for Evaluating Adverse and Beneficial Environmental, Social, and Economic Factors that Affect Human Health: Structure

Each section of the roadmap includes

- An overview of the CIA phases
- Guiding questions
- Potential resources
- Example contexts drawn from HEI Energy-funded research in oil and gas regions



Considerations for Assessing Cumulative Exposures

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A Roadmap for Evaluating Adverse and Beneficial Environmental, Social, and Economic Factors that Affect Human Health

☑ Checklist for Cumulative Impact Assessment

The health of people living in any community can be affected by an array of environmental, social, and economic factors. There are numerous studies throughout the scientific literature documenting how exposures associated with one or even a few of these factors might affect human health. The same is not true for understanding how the integrated (or, cumulative) exposure to all these factors can affect health. This checklist forms part of a larger roadmap[1] that contributes to ongoing efforts to advance the practice of assessing cumulative exposures and their effects using a tool referred to as cumulative impact assessment (CI assessment). CI assessments can help to reframe scientific and policy discussions so that they encompass the full spectrum of factors that can affect human health, and in so doing, positioning decisionmakers to capitalize on beneficial effects while avoiding adverse effects.

We ask anyone who elects to use the roadmap and checklist to consider sharing your experience and any ideas for improving these resources by emailing us at energy@healtheffects.org.

Decision Context: What question or issue is being addressed?

The analytical approach and methods used in a CI assessment are shaped by the decision context, or other context, in which it is being applied. CI assessment can inform regulatory decisions, and it can also be used for research or educational purposes.

1. What is the decision context for the CI assessment?

- ○ Federal, state, or local regulation
- ○ Research or educational project
- ○ Other

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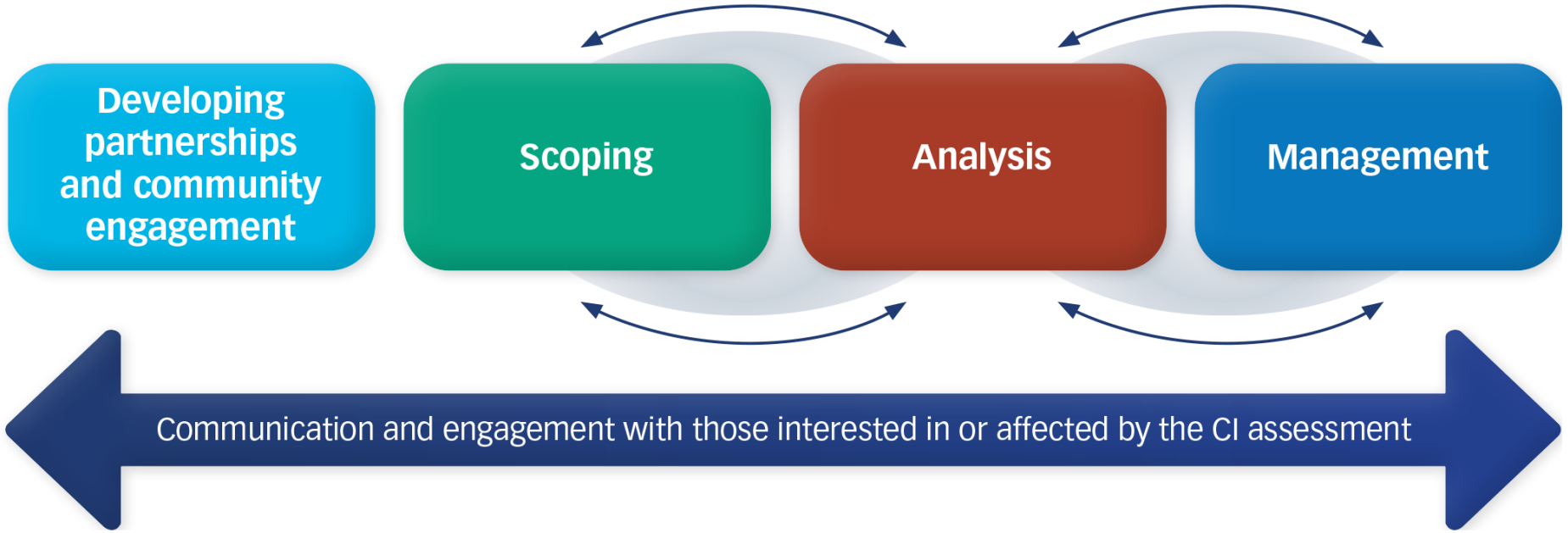
Roadmap for Evaluating Adverse and Beneficial Environmental, Social, and Economic Factors that Affect Human Health: Assessment Phases

Decision Context for CI Assessment



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Why Apply the Roadmap to Data Centers?

- Misinformation and lack of information of potential benefits and drawbacks.
- The data center sector is still evolving in its methods to engage communities, in governance practices, choice of technologies and energy sources.
- The roadmap can support decision-making across stakeholders to help achieve a common understanding of potential tradeoffs.

Credit: iStock/Gerville

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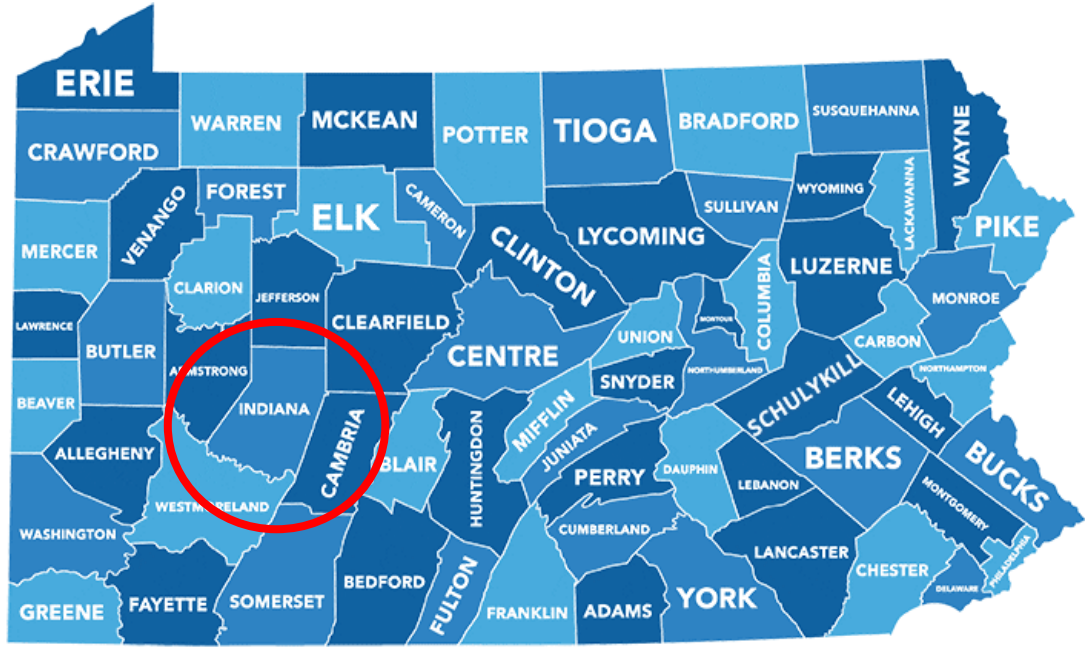
Illustrating Application of the Roadmap: Homer, PA



https://www.indianacountypa.gov/

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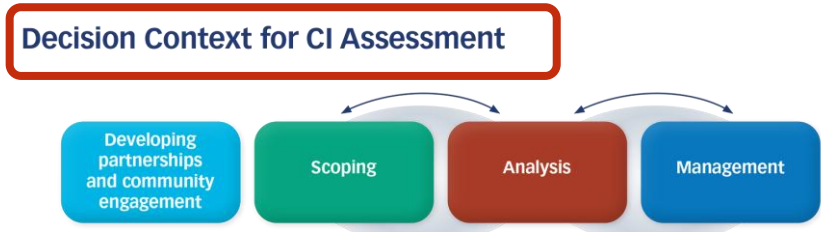
Decision Context



Context	Example Contexts for Application of the Roadmap
Educational	• Raising awareness • Educating community members and policymakers • Enhance transparency and find mutually agreed upon directions
Research	• Community-driven and other types of scientific research • Theoretical framework formulation
State Regulation	• State-level environmental assessment mandates • Permitting (e.g., facility siting; approval of air permits; approval or changes to operations) • Technical documentation associated with cumulative impacts policies
Local Regulation	• Permitting decisions (e.g., construction or modification of stationary sources) • Land use and zoning decisions

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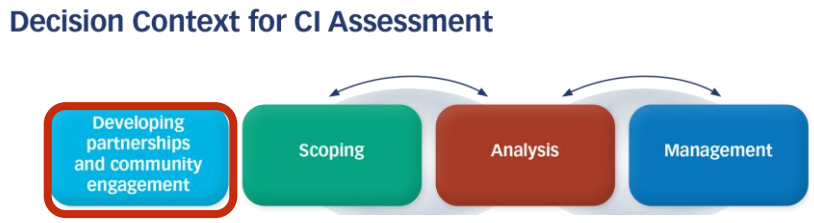
Developing Partnerships and Community Engagement



- ✓ **Who will lead and who will be involved in the assessment process?**
- ✓ **How will participants be involved in the assessment process?**
- ✓ **How will information be communicated throughout and after assessment?**
- ✓ **How will broader engagement occur?**

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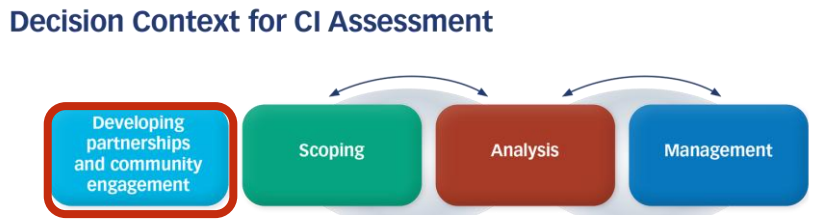
Developing Partnerships and Community Engagement



Example Homer Stakeholders	Assessment Involvement	Engagement Frequency
Local Community Residents	• Resident emails • Early recruitment • Informational meetings • Opportunities for public comment	Regularly
Non-Profit and Advocacy Organizations	• Meetings throughout	Occasionally
State-level Regulatory Agencies	• Scoping phase meetings • Final report-out presentation	Occasionally
Local Government Agencies (e.g., planning boards, zoning commissions)	• Meetings throughout	Regularly
Data Center Construction Employees	• Scoping phase meetings • Final report-out presentation	Occasionally
Data Center Developer	• Scoping and management phase meetings • Final report-out presentation	Regularly
Energy Grid Operators	• Scoping and management phase meetings • Final report-out presentation	Occasionally
Potential Tenants	• Scoping phase meetings • Final report-out presentation	Occasionally
Financial Manager	• Written communication • Final report-out presentation	Occasionally
Power and Equipment Suppliers	• Scoping phase meetings • Final report-out presentation	Occasionally

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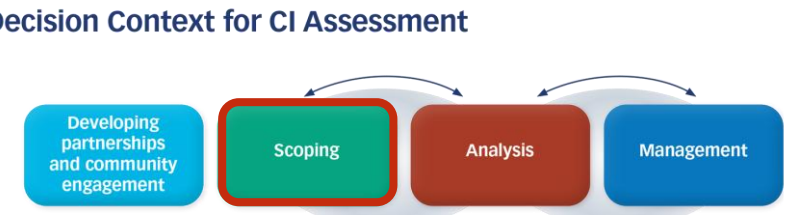
Scoping



- ✓ **Identify potential impacts**
  - Categories included in regulatory context
  - Literature reviews, surveys, focus groups, community meetings
- ✓ **Prioritize potential exposures or factors**
  - Relationships and interactions among factors
  - Available data and information gaps
  - Final set based on greatest potential impact, time, labor and resources
- ✓ **Determine geographic and temporal boundaries**
  - Spatial extent and scale
  - Timeframe for baseline and impact assessment
- ✓ **Identify other related factors**
  - Other industries, sources or activities within geographic scope
  - Atmospheric and topographic conditions

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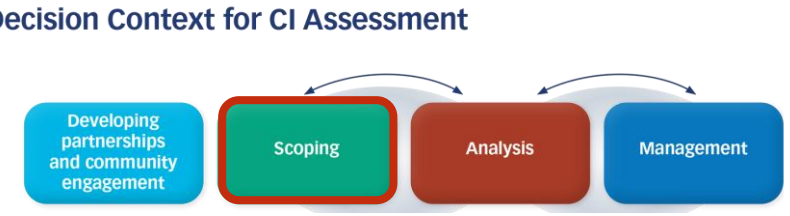
Scoping: Illustrative Approach to Identifying & Prioritizing Factors and Exposures



Impact: well-being

Spatial and Temporal Boundaries:

- Spatial extent - Homer City
- Temporal boundaries – one year before and after

Sources of Factors or Exposures

- **Stakeholders:**
  - Public hearings
  - Reputable news sources
  - Permit applications, granted permits, and appeals
  - Maps and reports detailing other local sources
- **Literature review:**
  - Search term in Web of Science
  - Reference lists
  - Grey literature in PA

} 13 peer-reviewed publications

Category	Homer City Example Potential Concerns and Interests
Data Center Developer	• Data center approval (permits) • Financial metrics
Local Community Residents	• Cost of living • Cost of electric bills • Environmental effects (e.g., water, noise, air quality) • Jobs • Tax benefits
Non-Profit and Advocacy Organizations	• Environmental (e.g., air and water pollution) • Electricity costs
State-level Regulatory Agencies	• Environmental protections and monitoring (aquifer depletion, thermal discharge, air pollution) • Regulatory compliance
Local Government Agencies (e.g., planning & zoning boards)	• Tax benefits • Jobs • New infrastructure
Energy Grid Operators	• Power grid supply and capability
Potential Tenants	• Power for AI and computing • Financial metrics • New infrastructure & jobs
Financial Manager	• Data center approval • Financial metrics
Power and Equipment Suppliers	• Supplying necessary equipment and energy • Financial metrics

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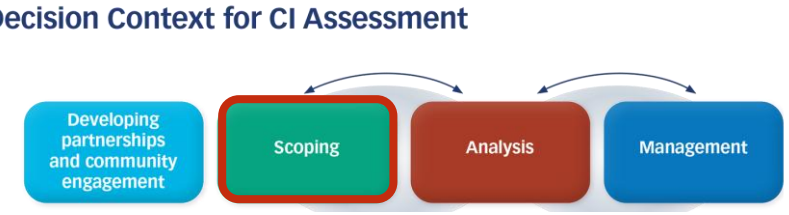
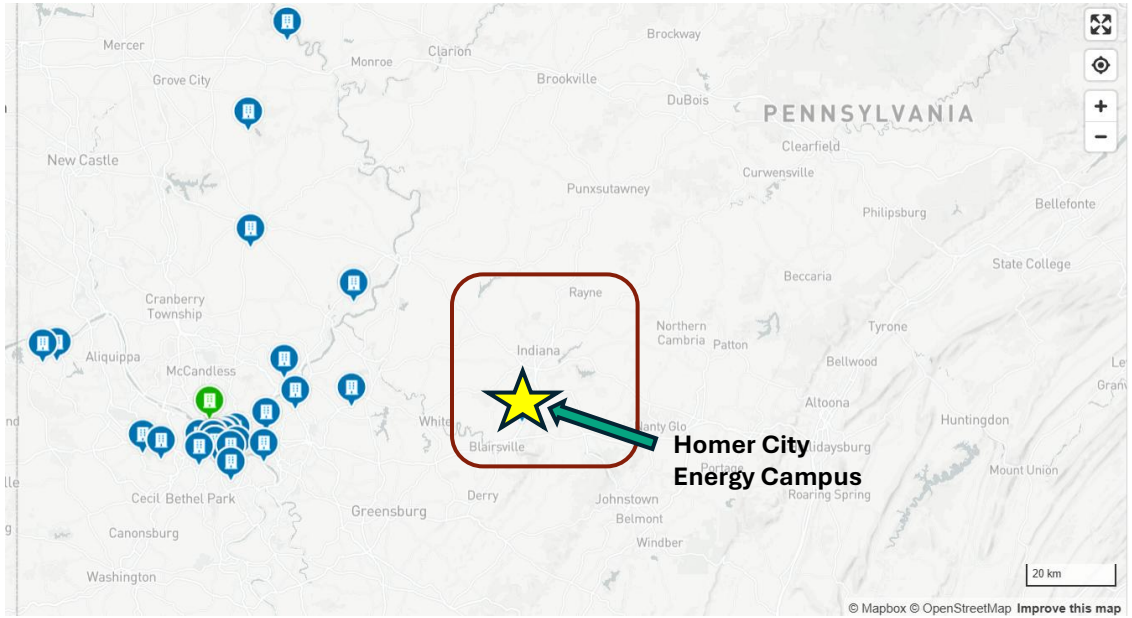
Scoping: Other Sources

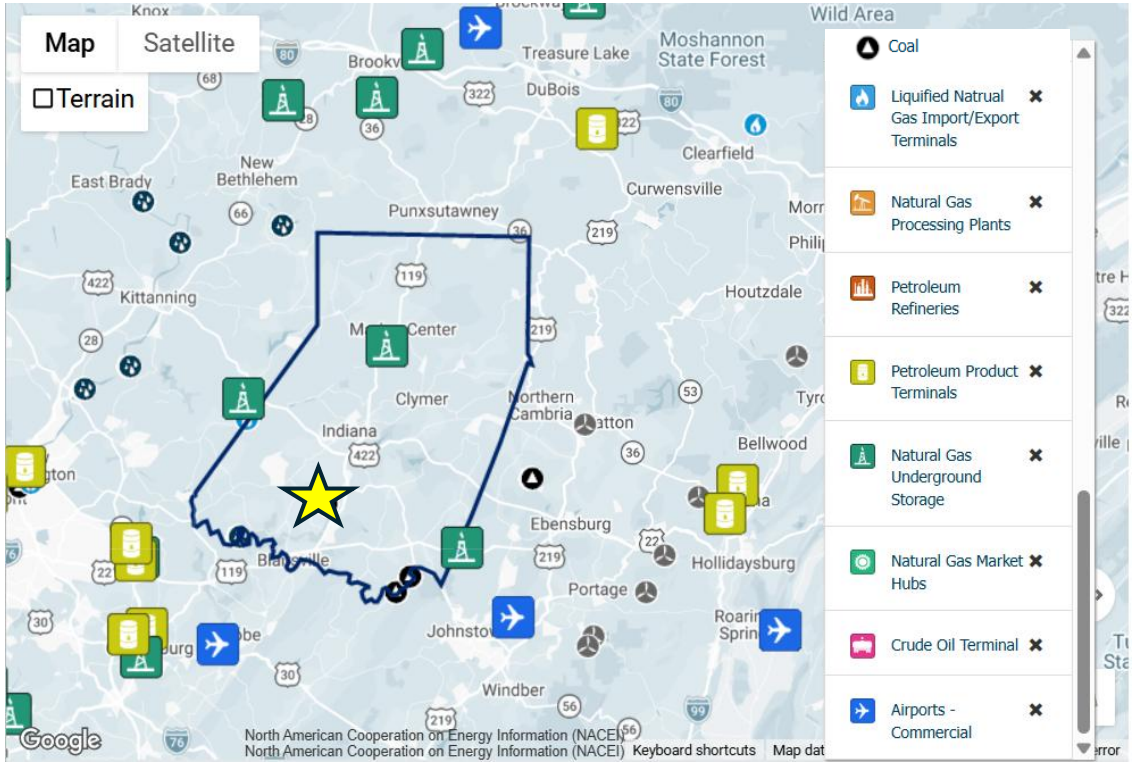


Data Centers



https://www.datacentermap.com/usa/pennsylvania/pittsburgh/

Other Industry



https://indianacountyceo.com/data-center/mapping-gis-data/

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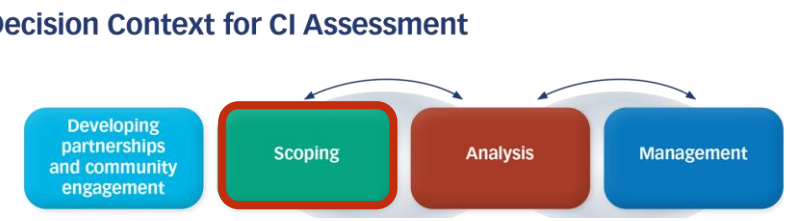
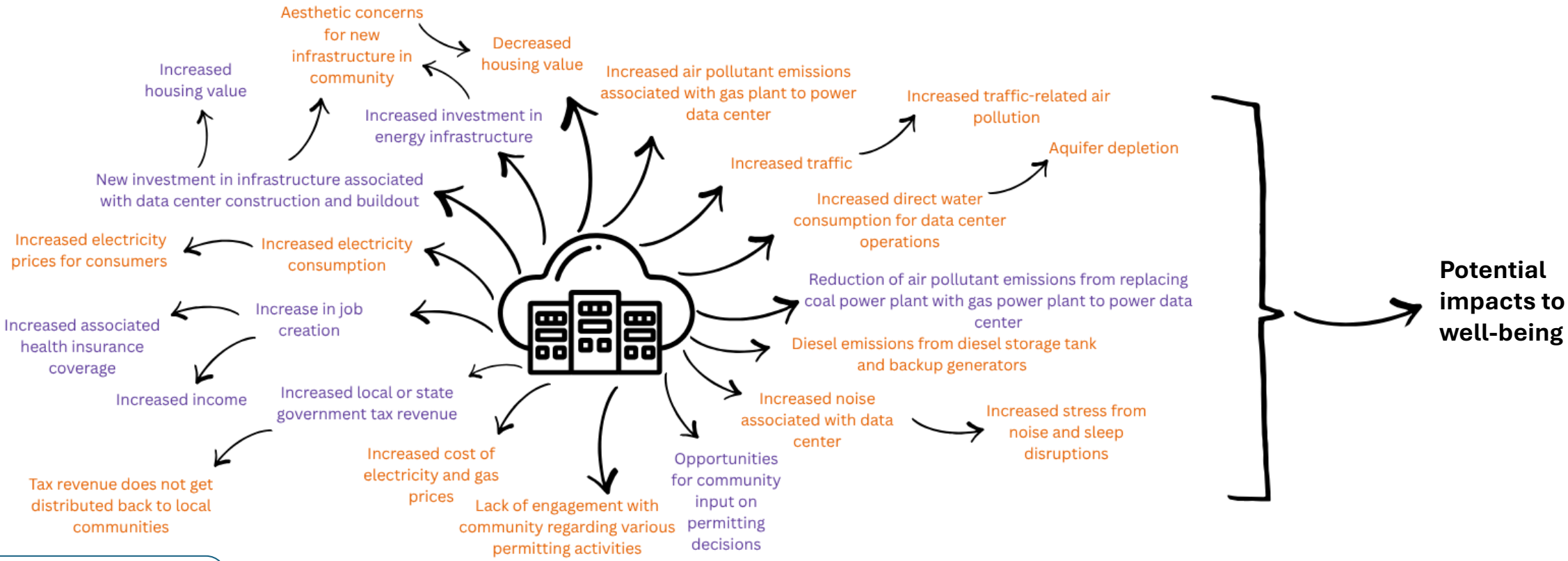
Scoping Example: Prioritized Potential Beneficial and Adverse Factors Related to Well-Being

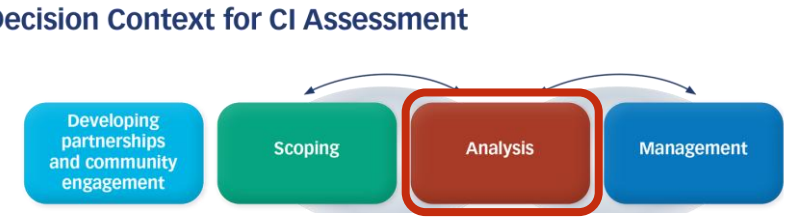


Factors and exposures reported in news sources, public fora, and scientific literature.



Key:
-beneficial factors
-adverse factors

Analysis:
Example Data Collection



Category	Factor	Data Source	Metric
Natural Environment	Air pollution	PA DEP air quality monitoring sites	Monthly concentration of air pollutant
	Water	PA DEP water use reports	Total gallons used per month in the county and/or total gallons used for thermoelectric power (cooling)/other sector per month in county
	Noise	-	Average a-weighted decibel (dBA) and dBA levels
Built Environment	Energy	-US EIA -NREL State and Local Planning for Energy Tool	Pricing: average price of electricity to customer by end-use sector Generation: net electricity generation by energy source Consumption: total energy consumption by end-use sector
	Traffic Related Air Pollution	Indiana County Traffic Volume Map	Traffic count
	Infrastructure	Environmental Justice Index (EJI) from ATSDR	Points of interest (clinics, hospitals, schools); number of each or proportion of the country within a certain buffer distance to each
Socioeconomic	Employment	American Community Survey	Total annual employment for the county, total employment percent change, or total percent of population age 16+ in the civilian labor force (2020-2024)
	Income	American Community Survey	Median household income 2020-2024 at the county level
	Public revenue and local government services	PA Department of Revenue	Monthly tax revenue at the county level
	Cost of living	American Community Survey	Median selected monthly owner costs at the county level (2020-2024), includes utility costs
	Housing Value	American Community Survey	Median value of owner-occupied housing units (2020-2024)
Baseline Health	General	PA County Health Profiles	Age-adjusted incidence rates of selected cancers (2017-2021); percent fair or poor general health at the county level (2020-2022)
	Asthma	PA County Health Profiles	Percent that currently has asthma at the county level (2020-2022); Hospitalizations for respiratory or heart diseases (2023)
Well-Being	Quality of Life	PA DEP Public Comments	Qualitative coding involving psychosocial concerns (qualitative analysis)

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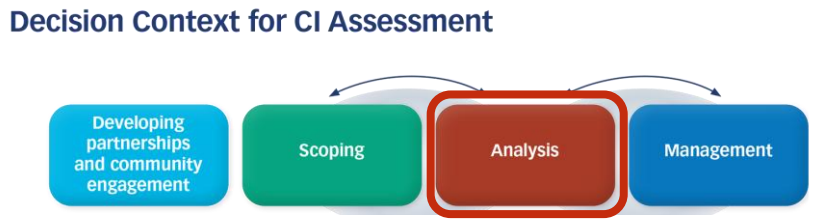
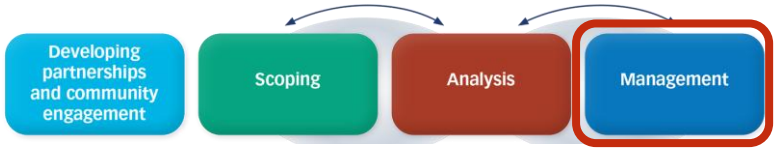
Analysis



- ✓ **Assess Cumulative Impacts**
  - Consider ranking of location based on state developed indices (e.g., PennEnviroScreen)
  - Rankings or thresholds to quantify and compare impacts before and during operation.
  - Evaluate factors separately and compare each to point of comparison (matrix).
  - Statistical: traditional, machine learning.
  - Mixed methods.

- ✓ **Determine Significance of Cumulative Impact(s)**
  - Do impacts meet or exceed pre-determine regulatory thresholds?
  - Normative and subjective determination based on participant and expert consultation, literature review, or review of other impact assessments.

Management



- ✓ **Identify strategies for preventing or mitigating potential adverse impacts and achieving potential benefits:**
  - Policy
  - Regulatory
  - Technological
  - Other (e.g., Community Benefit Plans)

- ✓ **Determine how strategies will be monitored and evaluated:**
  - Working groups
  - Multisector collaborations

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Why Apply the Roadmap to Your Work

1. Enhance transparency for local communities, researchers, municipalities, and society at-large.

2. Involve and gather perspectives from multi-sector stakeholders.

3. Provide data-driven approaches to decision-making.

4. Find mutually agreed upon solutions and paths forward towards mitigating important adverse impacts while capitalizing on opportunities.

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HEI Annual Conference 2026

Session titles:

1. Stories of Policy Success: Real Examples of Inspiring Science-based Air Quality Action
2. Global Progress Towards Air Quality Action And Its Impacts
3. Smog to Synapse: Unraveling the Web of Neurodegenerative Risk and Resilience
4. Particles in Motion: Tackling Brake, Tire, and Road Dust Emissions
5. Everything You Wanted to Know About Bias in Environmental Health Research (But Were Afraid to Quantify)
6. From Space to Place: Advancing Environmental Health with Remote Earth Observations
7. Driving Change: Intermodal Freight's Air Quality and Health Challenges and Opportunities

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