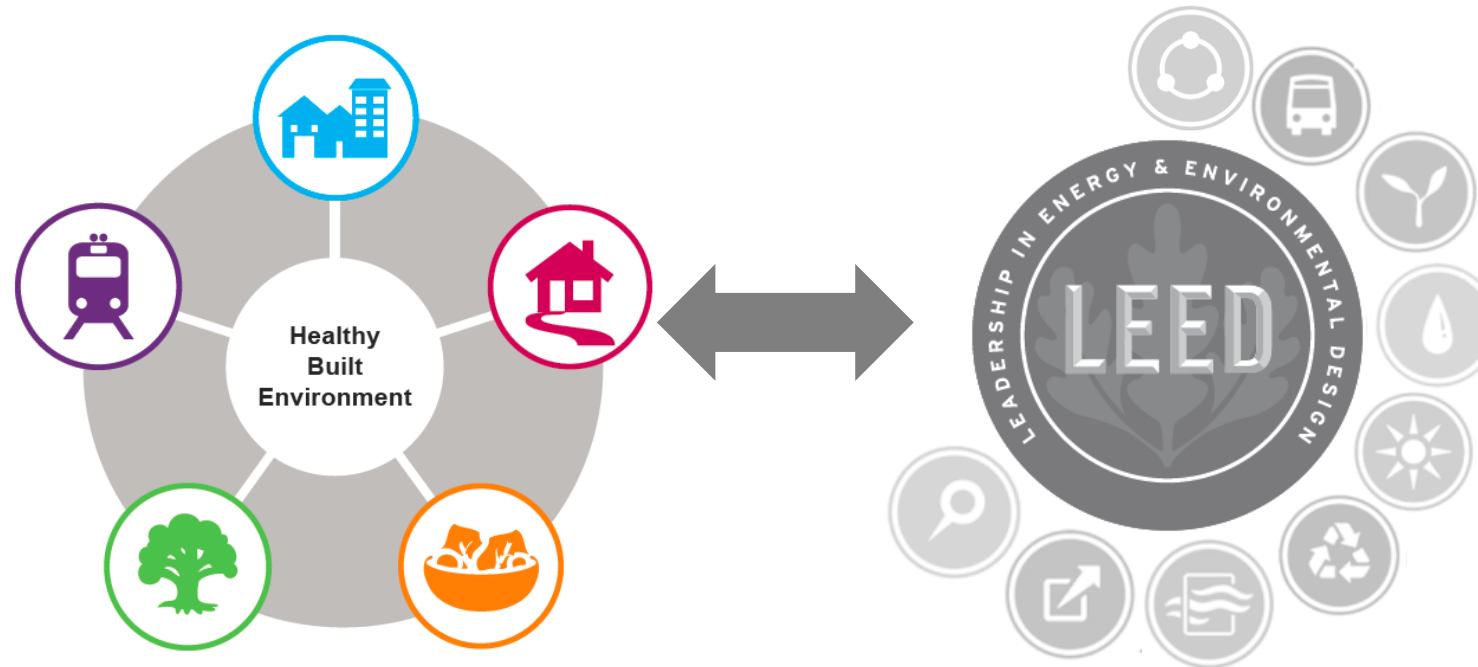


Exploring the connection between Healthy Built Environment (HBE v.2.0) Toolkit and Leadership in Energy and Environmental Design (LEED v.4.0 BD+C)



Prepared By:

Ghazal Ebrahimi, Sustainability Consultant – High Performance Buildings
Sonja Janousek, Sustainability Consultant
Alex Hutton, Energy Manager

An Initiative By:

Energy and Environmental Sustainability (EES) Team
Lower Mainland Facilities Management (LMFM)

1. Introduction

This document aims to explore the connection between the Healthy Built Environment (HBE) Linkages Toolkit and LEED (Leadership in Energy and Environmental Design) version 4.0 for Building Design and Construction (BD +C). This is an initiative by the Energy and Environmental Sustainability (EES) team within Lower Mainland Facilities Management (LMFM) department. EES¹ has taken a leadership role in advancing the environmental sustainability and resilience of LMFM assets; for example, through energy efficiency, water conservation, waste diversion, active and clean transportation, and climate preparedness.

In BC, the BC government is required to be carbon neutral in operation as of 2010, and all new public buildings must be certified LEED Gold. This requirement and its policy mandate are explicitly noted in [2008 BC Climate Action Plan](#) and [2008 Throne Speech](#).

LMFM requires projects to use USGBC's LEED v.4.0 BD+C : Healthcare for all healthcare related projects, unless already registered under a previous rating system. To ensure design teams pursue credits that reflect the priorities of the Lower Mainland Health Organizations, EES has provided guidance in its [Design Guidelines](#) and marked the LEED credits that are required or highly recommended to be achieved in each project.

Exploring the connection between HBE Linkages Toolkit and LEED v.4.0 BD+C identifies and

provides insight about the health-related outcomes of various LEED credits. The results of this exploration not only can inform the evolution of EES Design Guidelines, but also help project participants better understand the potential health-related outcomes of the LEED credits they select to pursue in each project. Moreover, due to the popularity of LEED in the design and construction industry, it is hoped that the identification of LEED credits associated with HBE planning principles will facilitate broader usage of the HBE Linkages Toolkit among industry professionals.

A brief description of the HBE Linkages Toolkit and LEED, and the methodology used for identifying the connection between the two are presented in the following sections. The potential users of this document are also introduced below.

1.1. HBE Linkages Toolkit

[HBE Linkages Toolkit](#) was developed under the leadership of BC's Healthy Built Environment Alliance (HBEA) to link community design, planning, and health outcomes. This toolkit, maintained by the Population and Public Health team at [BCCDC](#) (BC Centre for Disease Control), presents a number of planning principles around five features of a healthy built environment. These features include:

- Neighborhood Design
- Transportation Networks
- Natural Environments
- Food Systems
- Housing

The planning principles presented in the HBE Linkages Toolkit are those that are associated through research to health related outcomes. These outcomes and the strength of evidence available for each in the academic literature are described in the Toolkit.

1.2. LEED v.4.0 BD + C

[LEED](#) is a rating system that seeks to “optimize the use of natural resources, promote regenerative and restorative strategies, maximize the positive and minimize the negative environmental and human health consequences of the construction industry, and provide high-quality indoor environments for building occupants” (USGBC, 2013)². LEED contains a number of prerequisites and credits in the following nine categories:

- Integrative Process
- Location and Transportation
- Sustainable Sites
- Water Efficiency
- Energy and Atmosphere
- Materials and Resources
- Indoor Environmental Quality
- Innovation
- Regional Priority

LEED Prerequisites are required elements, or green building strategies that *must* be included in any LEED certified project. Credits are optional elements, or strategies that projects *can* elect to pursue to gain points toward LEED certification.

¹ For more information on EES scope and mandate, see Green Care's website at : <https://bcgreencare.ca/about-greencare>

² U.S Green Building Council, 2013, LEED Reference Guide for Building Design and Construction (Version 4.0).

2. How was this resource developed?

In order to identify whether there exists a connection between the HBE Linkages Toolkit and LEED v.4.0 BD+C, a content analysis of the Toolkit and the LEED Reference Guide was performed. First, the healthy built environment features and their planning principles were reviewed to gain a sense of the breadth and depth of the Linkages Toolkit. Reflective memos were written along the review process. After that, the Linkages Toolkit guide was reviewed for the second time. In this round, the characteristics of a healthy built environment and relevant planning solutions were captured and noted as codes. These codes were used in the process of content analysis to identify emergent themes.

In order to facilitate the coding process, the five features of a healthy built environment listed in the HBE Linkages Toolkit were labelled by alphabets (A to E), and the planning principles within each category were marked by numbers following the order presented in the HBE Linkages Toolkit guide. For example, “Create complete neighbourhoods through mixed land use” principle in “Neighbourhood Design” category was labelled as A1, and “Reduce urban air pollution by expanding natural elements across the landscape” planning principle in “Natural Environments” category was labelled as C3. After that, LEED Reference Guide was reviewed and the prerequisites and credits that had comparable intents and visions to the ones of the healthy built environment features and planning principles included in the HBE Linkages Toolkit were specified. These prerequisites and credits were

reviewed once more and were coded for correspondence with or exemplification of the categories and coding schemes that emerged from the content analysis of the HBE Linkages Toolkit guide. Coding was conducted using the constructed list of coding categories (i.e. A1, C3, etc.). Both documents were reviewed a final time to reassess and refine the identified correlations.

The results of the analyses are presented in a series of diagrams in the following sections. Each of these diagrams presents one of the five features of the HBE with its planning principles, and indicates LEED credit categories, prerequisites, and credits that were found to be associated with them. To add further context to the findings, the number of contributing LEED points for each HBE feature and planning principle was counted and the percentage of contribution to total possible LEED points (110) was calculated. This information is presented in the form of pie charts at the bottom of the diagrams in each page. These series of illustrations were developed to help the user in interpretation of the results.

It is important to note that all prerequisites and credits in various rating systems available for LEED v.4.0 BD+C (i.e. New Construction, Core and Shell, Schools, Retail, Data Centres, Warehouses and Distribution Centers, Hospitality, and Healthcare) were included in the content analysis process. Therefore, where any of these prerequisites and credits was found to be associated with HBE planning principles, it was coded and included in the diagrams presented in this document. However, only

the credits available for LEED v.4.0 BD+C: New Construction and Major Renovations (NC) were considered for calculating the contribution of HBE planning principles towards achieving LEED points. This rating system (LEED BD+C: NC) was selected to keep the results applicable more broadly to different types of projects.

Moreover, it is worth highlighting that the four credits included in the analysis for Regional Priority category are based on a situation that the hypothetical project is located in Vancouver, BC. As the list of the credits in this category can change depending on the location of the project, the analysis related to Regional Priority credits needs to be redone for different geographical locations.

The US Green Building Council (USGBC) claims that LEED works for rural communities¹ as well, and its use is not limited to urban areas. However, as shown in several studies, obtaining LEED credits and implementing their required strategies may be more challenging and costly in rural areas due to lack of certain infrastructure and resources². Testing the applicability and effectiveness of the HBE Linkages Toolkit and LEED for rural areas is beyond the scope of the present study. Doing such investigation and exploring the connection between the two resources with a “rural community” lens are examples of topics for future research.

¹ <https://www.usgbc.org/articles/rebuilding-and-resiliency-leed-greensburg-kansas>

² <https://www.cagbc.org/cagbcdocs/resources/CaGBC%20McGraw%20Hill%20Cdn%20Market%20Study.pdf>

The LEED credits included in the Innovation category were captured from the list of Open Pilot Credits that were available [in LEED Online Credit Library](#) in December 2018. All pilot credits that were found to be associated with HBE planning principles are listed in the diagrams presented in the following sections. Moreover, those base credits that had an exemplary performance point available for them were also identified and were included in calculation of the Innovation points. However, considering the allowable number of points for the Innovation category (6 in total: 5 for the innovation credits and 1 for inclusion of LEED APs in the project), a maximum of five points from this category was counted for calculating HBE planning principles' contribution to total possible LEED points. In addition, the Open Alternative Compliance Path (ACP) credits available in LEED Online Credit Library in December 2018 were also included in the analyses for this study.

And finally, it is worth noting that “Housing”, one of the five HBE features included in the Linkages Toolkit, can be considered separate to healthcare facilities (that are the focus of EES and LMFM). However, this HBE feature was still included in the analyses as some of its planning principles can be applicable to LMFM projects such as acute facilities (that may accommodate patients over long periods), residential care facilities, and staff housing facilities (e.g. Staff Housing Complex for R.W. Large Memorial Hospital in Bella Bella, BC). Moreover, the intention of this project was to explore the connection between HBE Linkages Toolkit and LEED BD+C as a whole; therefore, all LEED credit categories and HBE features were included in the analyses. This means that

the information in this document may not be applicable to all project types. Project participants will need to identify which HBE planning principles and LEED credits are relevant to their specific projects.

2.1. Who might use this resource and how?

This resource can be used by different groups of project participants. At the early stages of a project, this document can be used as a guide for developing Request for Proposals (RFPs) and Owner's Project Requirements (OPRs). In the planning phase, the project team can refer to this document when deciding which LEED credits to pursue considering their potential health related outcomes. This resource can also be used during the design stage guiding designers with principles that help achieving the desired LEED credits and their associated health related outcomes. Moreover, the results of this exploration can guide the development of the EES Design Guidelines helping teams with identifying project priorities.

2.2. Limitations

It is noteworthy that while LEED Reference Guide contains detailed information about each credit and prerequisite and how they can be employed and achieved in a project, HBE Linkages Toolkit does not intend to provide detailed information about how its planning principles can be put in practice. Therefore, finding the correlations between the two was challenging where the intents and visions of the HBE planning principles were broad and specific

planning solutions were not provided. This is acknowledged as a limitation for this study.

3. Results at a Glance

The following three figures summarize the findings of the analyses conducted to explore the connection between HBE and LEED. Fig.1. illustrates which LEED credit categories were found to be supported by each of the five HBE features presented in the Linkages Toolkit.



Note: The LEED credit categories that were found to be associated with HBE features are listed around the five icons representing "Neighbourhood Design", "Transportation Networks", "Natural Environments", "Food Systems", and "Housing". These credit categories are demonstrated with their indicative icons (in grey color) presented in LEED Reference Guide.

Fig.1. LEED credit categories found to be supported by HBE features

Fig.2. shows the potential contribution of HBE planning principles towards achieving LEED BD+C: NC points. The ring around each HBE feature icon illustrates what percentage of the total possible LEED points (110) was found to be associated with planning principles of that specific HBE feature. It can be seen that the number of potential contributing LEED points was found to be the highest for “Housing” (75 out of 110, representing 68.2% of the total possible points). In contrast, “Food Systems” was found as the HBE feature with the lowest number of potential contributing LEED points (15 out of 110, representing 13.6% of the total possible points). The number of potential contributing LEED points for the other three HBE features (“Natural Environments”, “Neighbourhood Design”, and “Transportation Networks”) were found to be between 45 and 19 out of 110 representing 40.9% to 17.3% of the total possible LEED points).

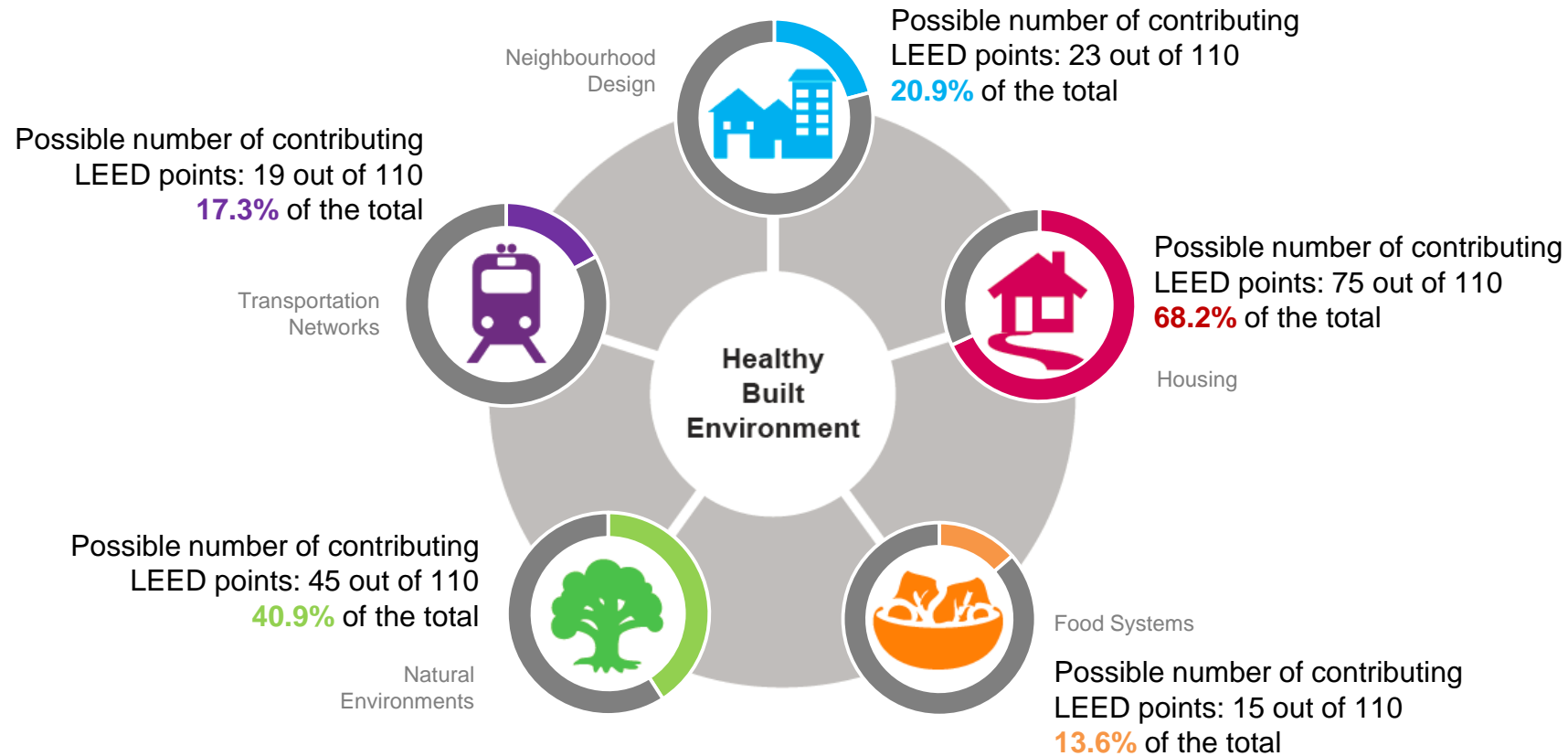


Fig.2. Potential contribution of HBE features towards achieving LEED BD+C:NC certification

Fig.3. shows eight LEED credit categories and the number of points possible to achieve for the credits within each that were found to be supported by the HBE planning principles. As noted earlier, the base and alternative compliance paths provided in LEED BD+C:NC Reference Guide were included in the analyses. Integrative Project Planning and Design, one of the categories in LEED Reference Guide, was excluded from the analyses as its' intent and requirements are beyond the scope of HBE Linkage Toolkit.

The number of points achievable by those LEED credits that were found to be associated with the HBE planning principles were added up, and the percentage of their contribution to total possible LEED points (110) was calculated. It can be seen in the pie chart that in total, 99 out of 110 points can be achieved by pursuing those LEED credits that were found to be correlated with the HBE planning principles. This represents 90% of the total possible LEED points for a project.

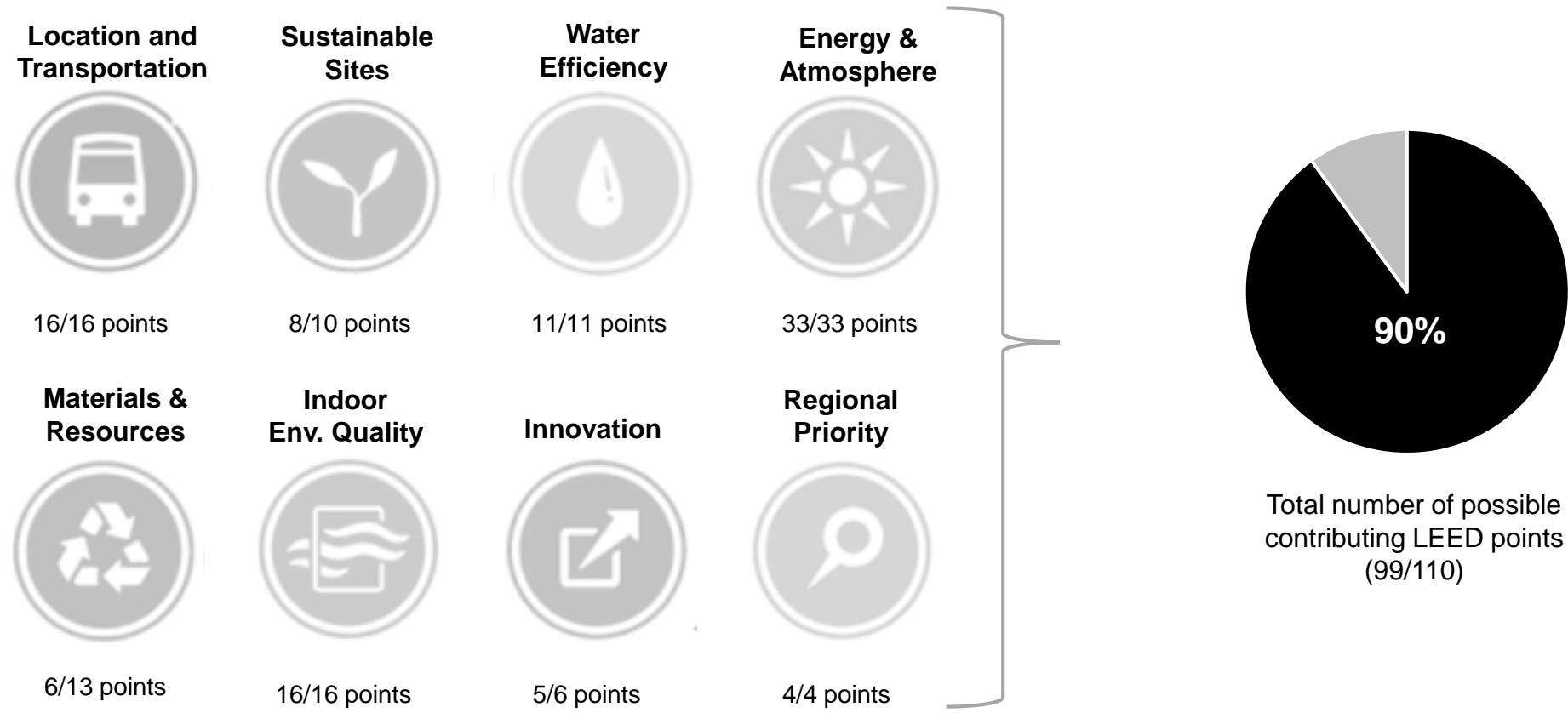


Fig.3. Number of LEED points within each credit category found to be associated with HBE planning principles

4. Detailed Description of the Results

The results are presented in the following sections as diagrams and organized by HBE features. Twenty-four diagrams were created in total. Five of these indicate the results for each HBE feature as a whole. These five diagrams show the LEED credit categories that were found to be supported by the planning principles within each of the HBE features. The remaining 19 diagrams are focused on each HBE planning principle separately. These diagrams present the LEED credit categories, and the list of those prerequisites and credits that were found to be correlated with each HBE planning principle. The diagrams have been designed with a parallel structure. One example of “HBE feature-focused” diagrams and one example of “HBE planning principle-focused” diagrams are presented below to show the user how to use this reference.

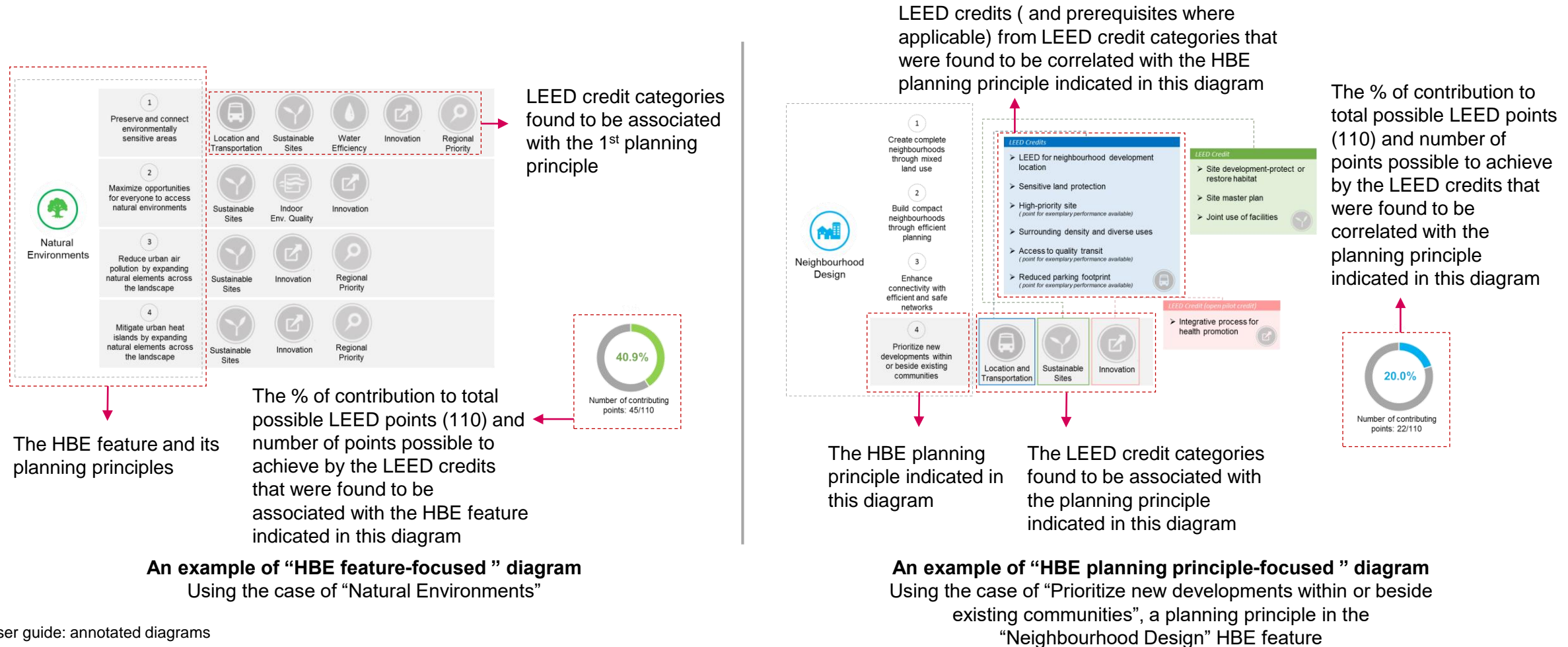
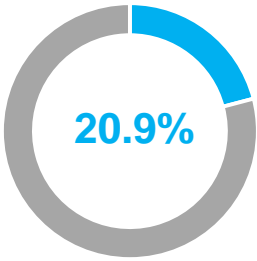
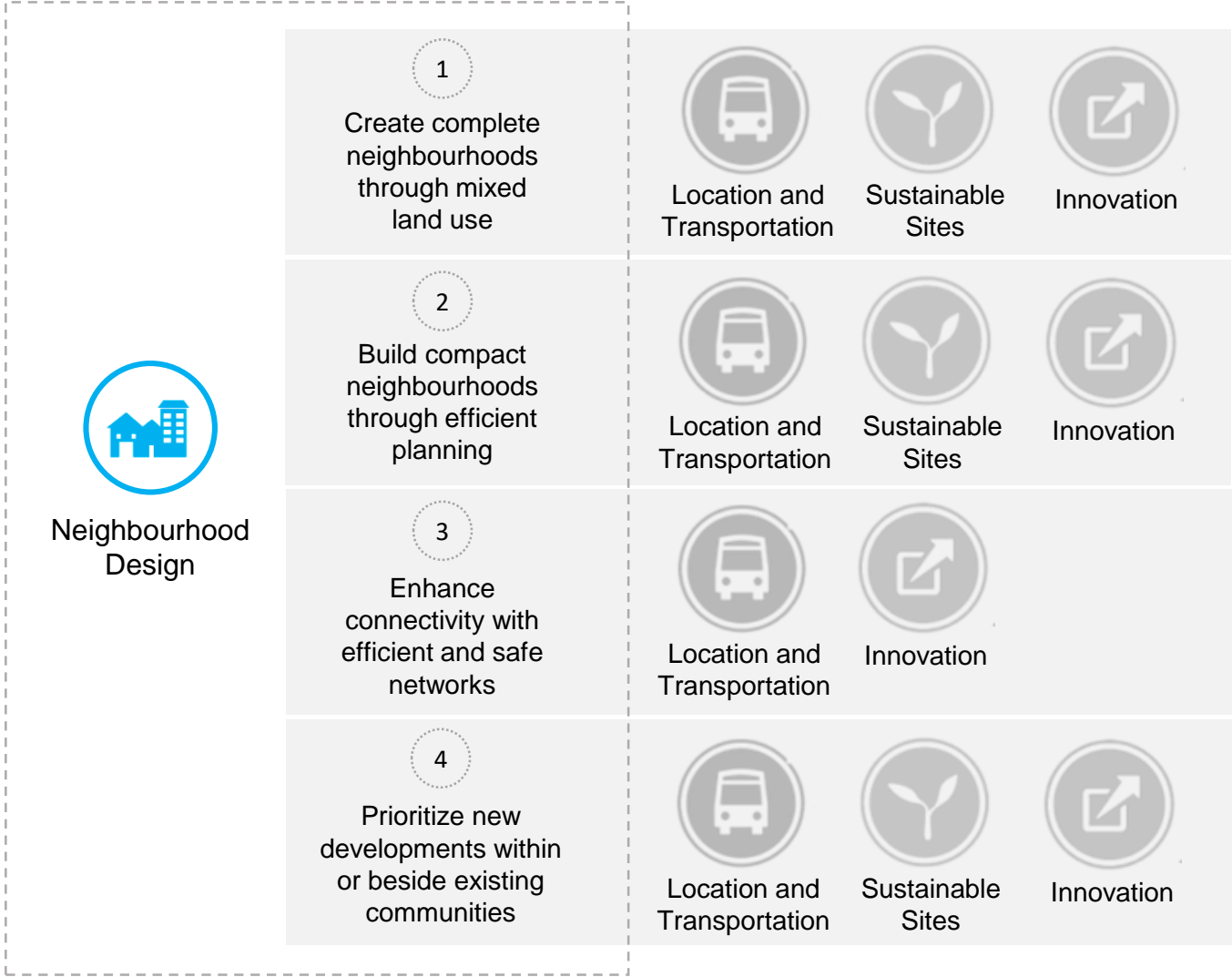


Fig.4. User guide: annotated diagrams



Neighbourhood Design



Number of possible contributing LEED points: 23/110

Fig.5. Neighbourhood Design: HBE planning principles and LEED credit categories



Neighbourhood Design

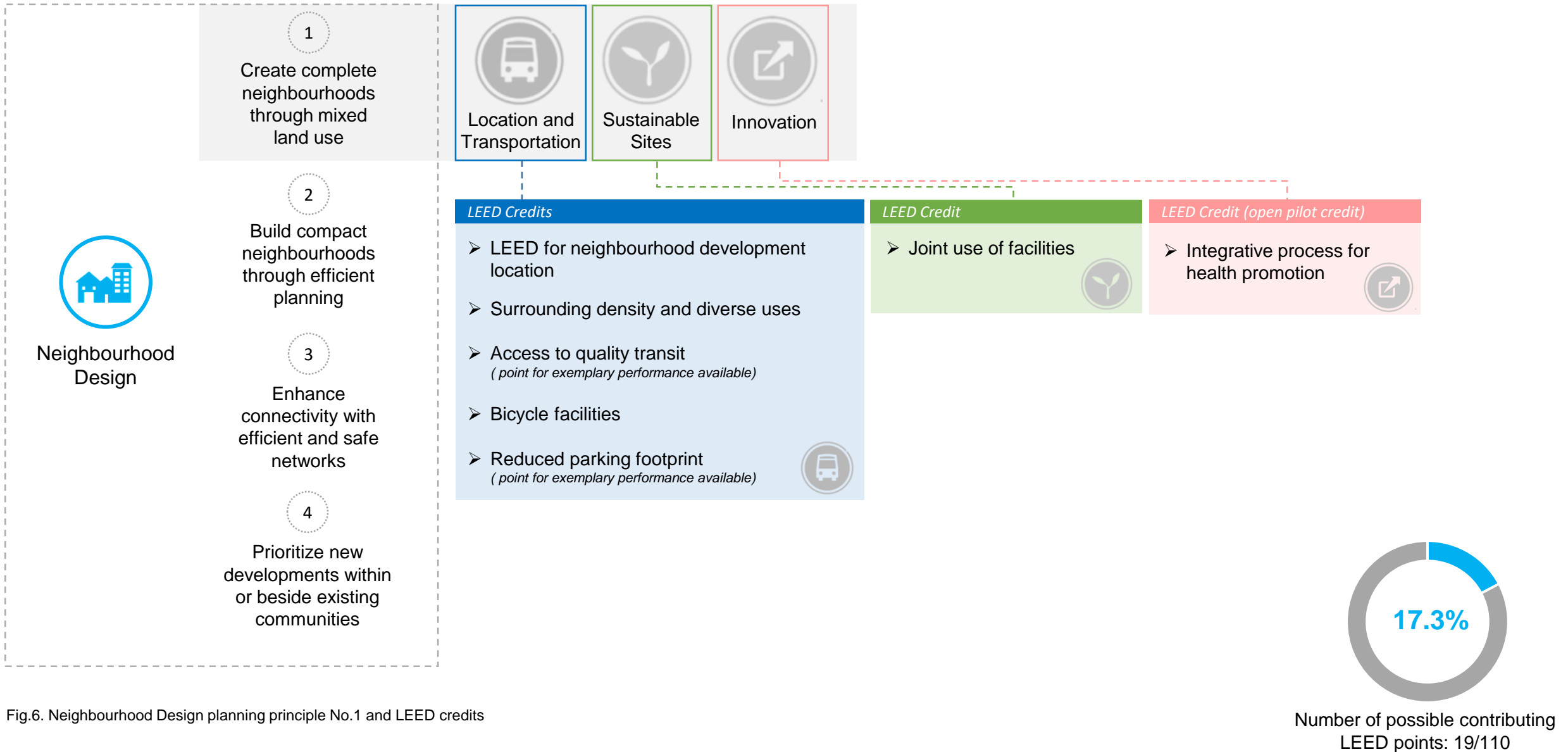


Fig.6. Neighbourhood Design planning principle No.1 and LEED credits

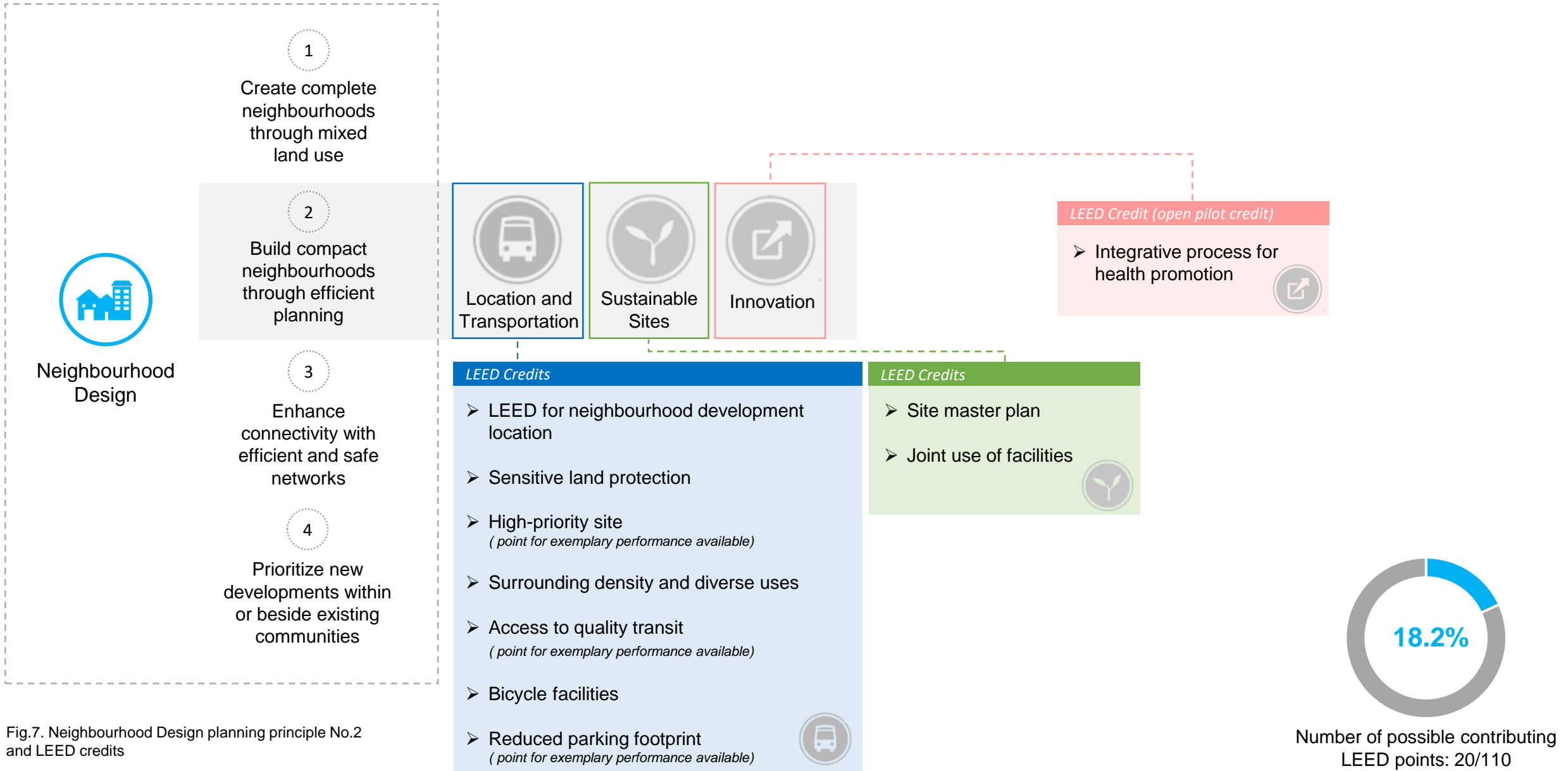
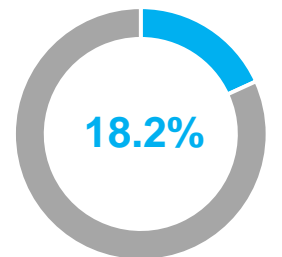
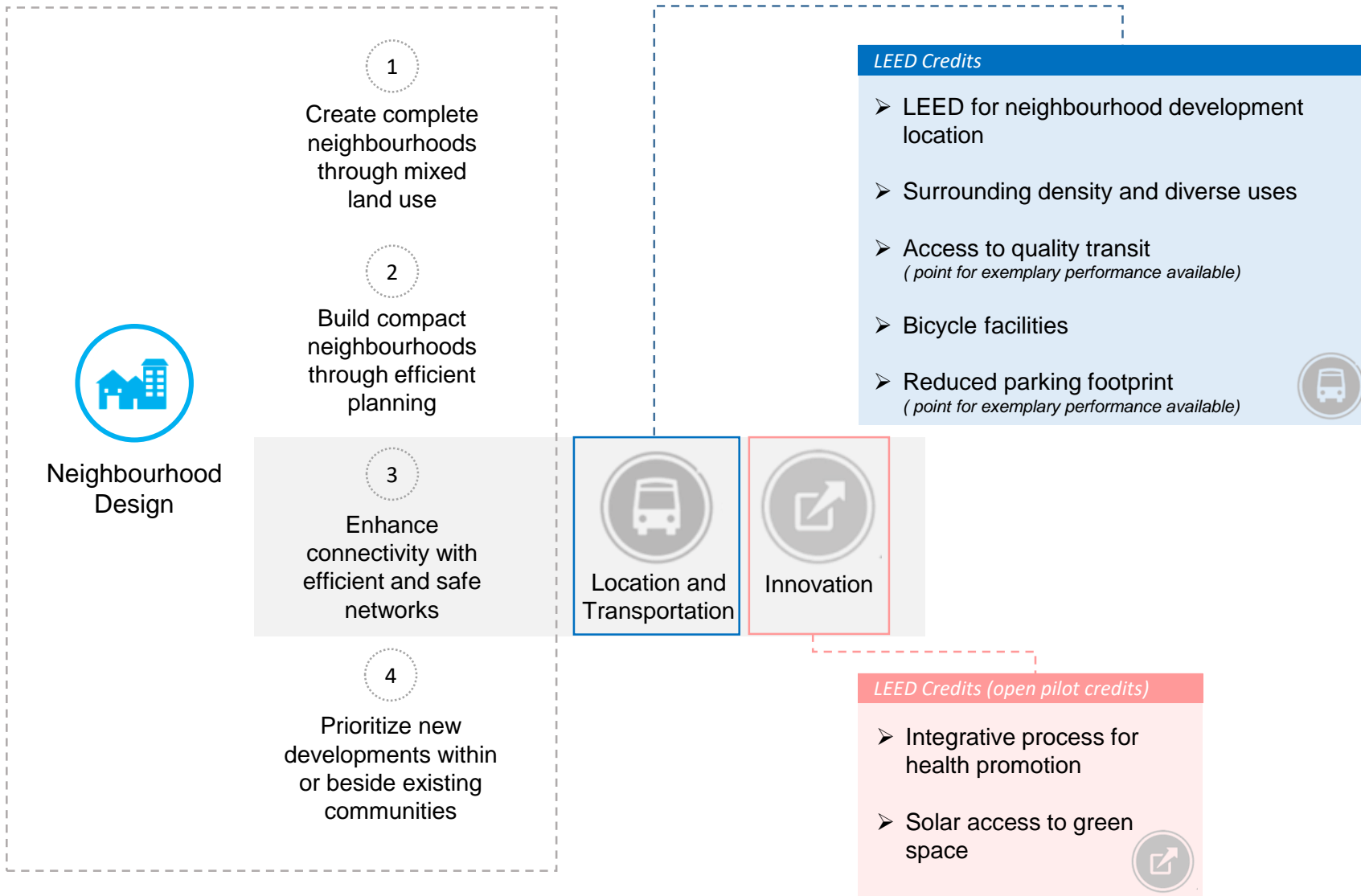


Fig.7. Neighbourhood Design planning principle No.2 and LEED credits



Number of possible contributing
LEED points: 20/110

Fig.8. Neighbourhood Design planning principle No.3 and LEED credits

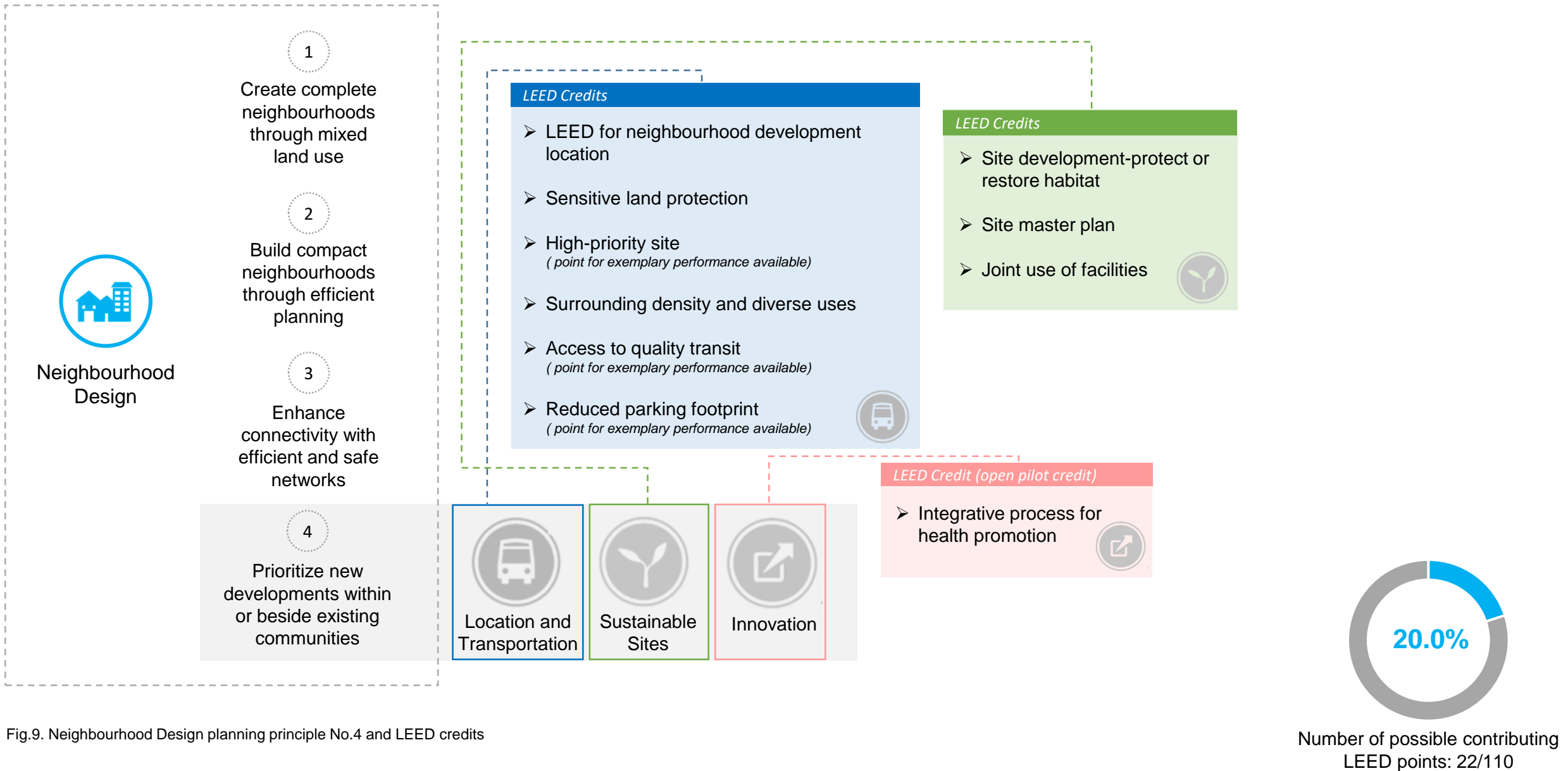


Fig.9. Neighbourhood Design planning principle No.4 and LEED credits



Transportation Networks

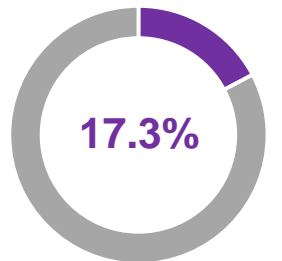
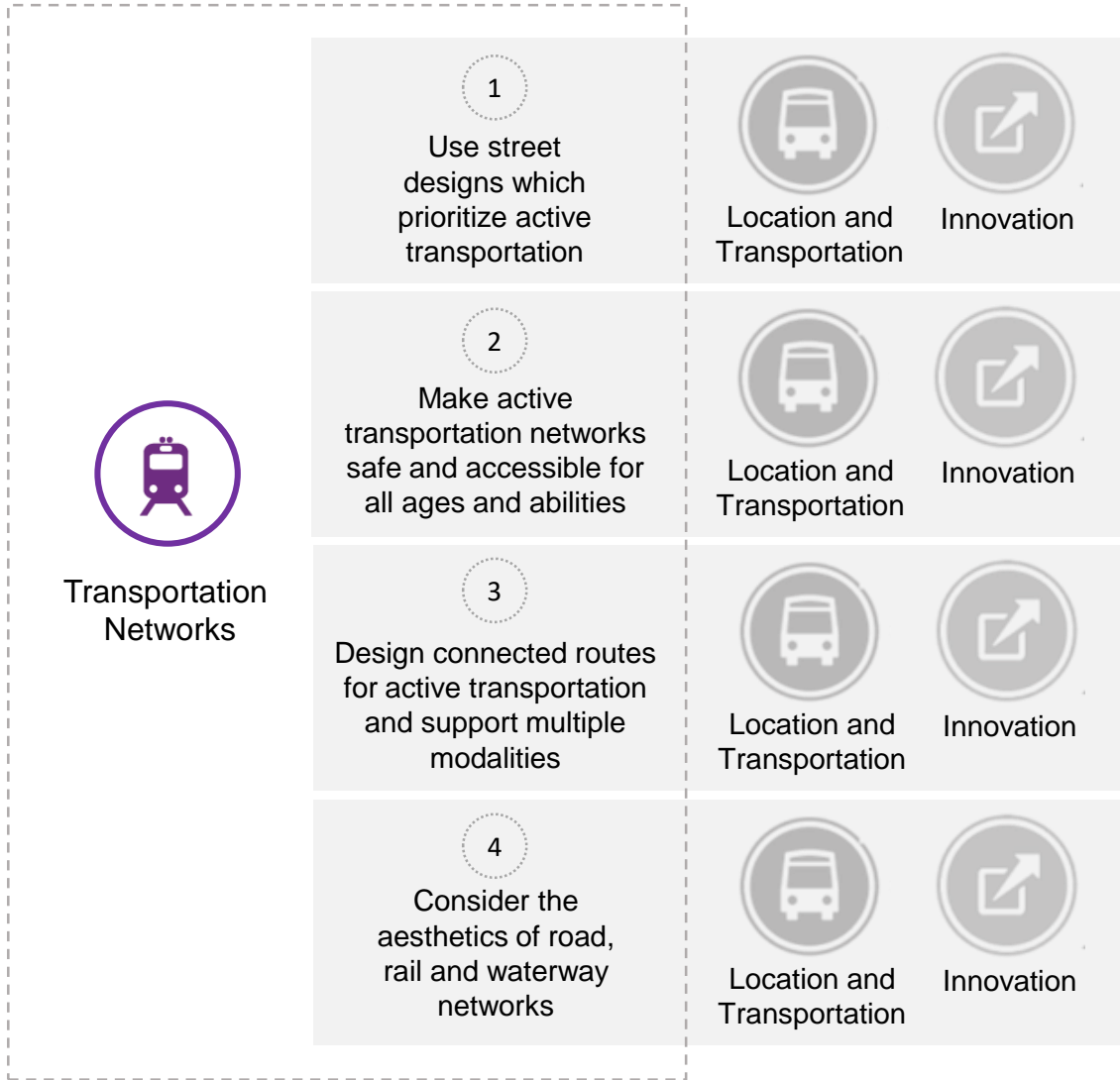


Fig.10. Transportation Networks: HBE planning principles and LEED credit categories

Number of possible contributing
LEED points: 19/110



Transportation Networks

14

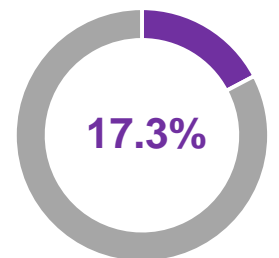
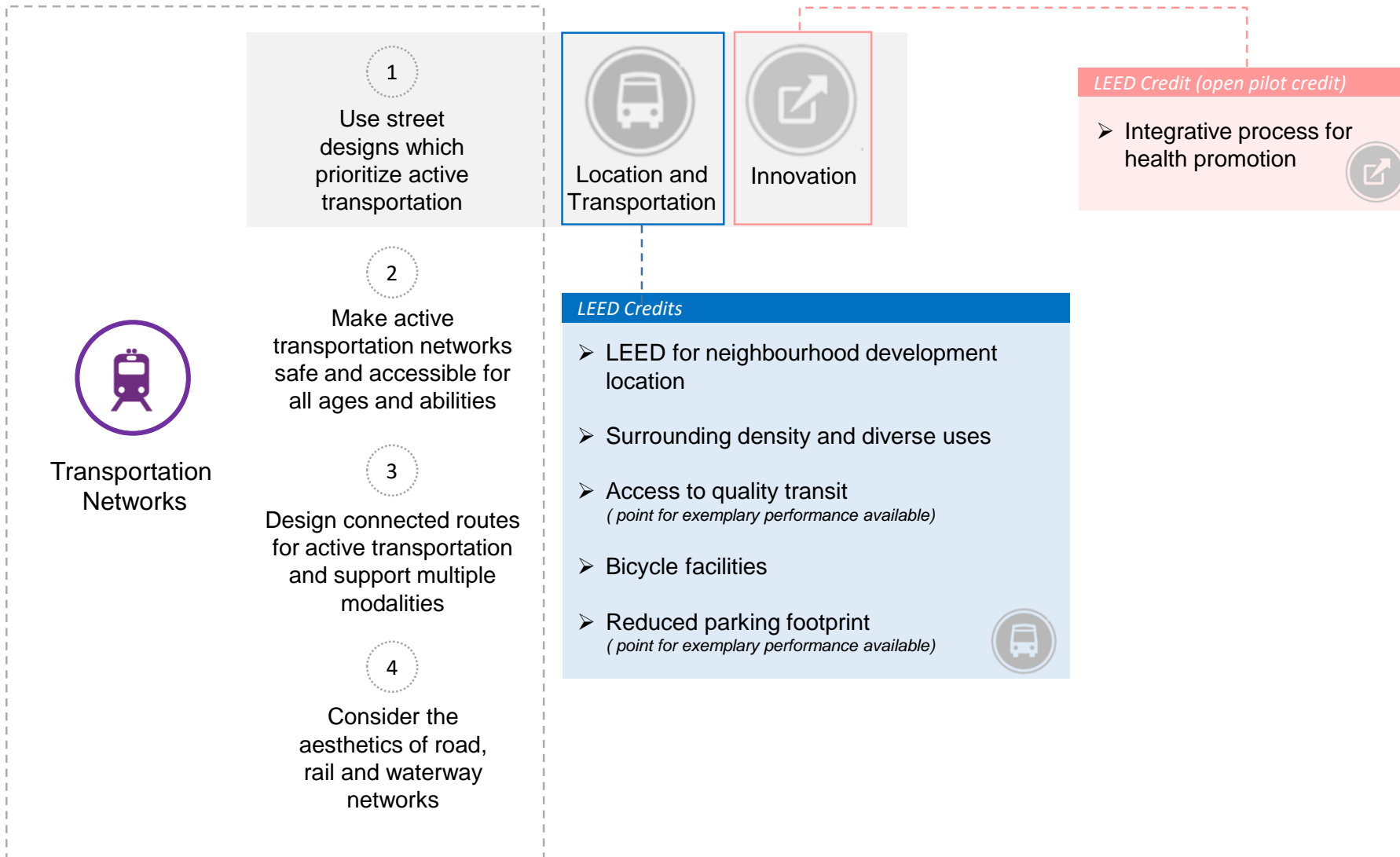


Fig.11. Transportation Networks planning principle No.1 and LEED credits

Number of possible contributing
LEED points: 19/110



Transportation Networks

15

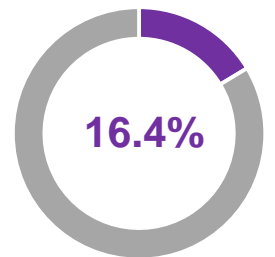
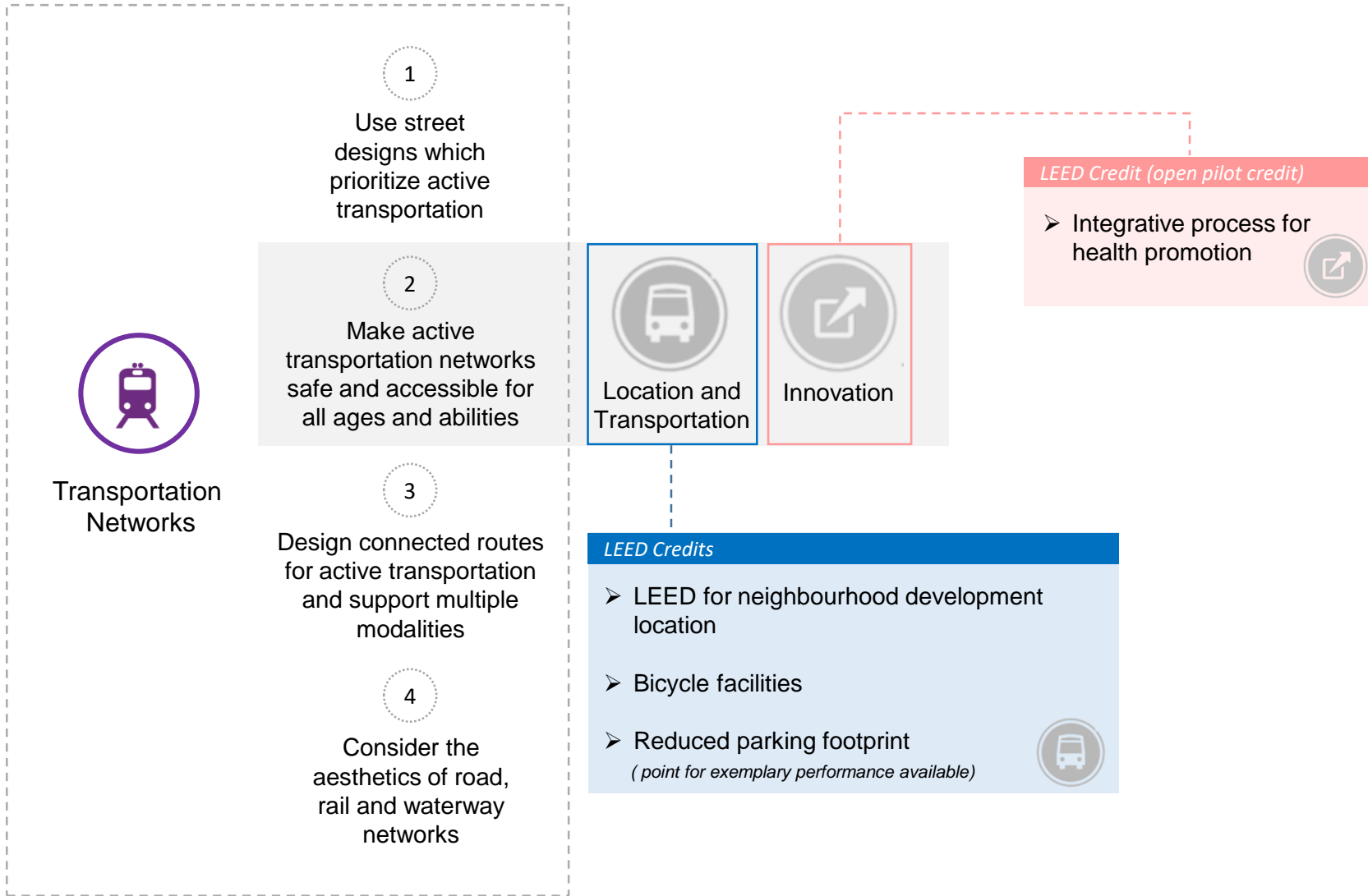


Fig.12. Transportation Networks planning principle No.2 and LEED credits

Number of possible contributing
LEED points: 18/110



Transportation Networks

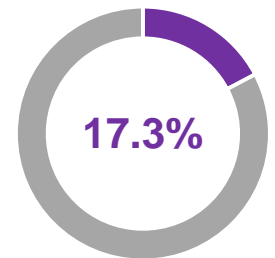
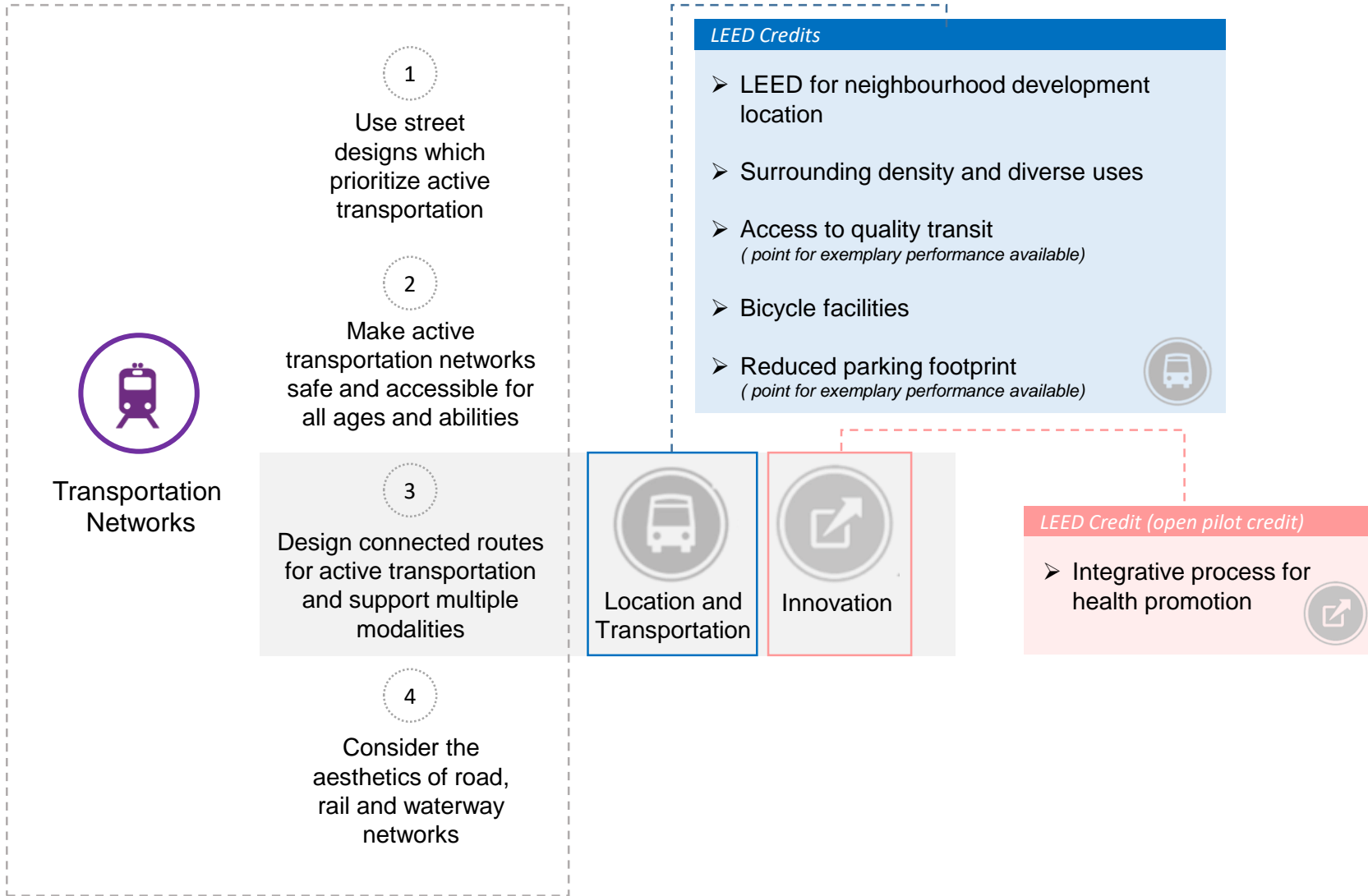


Fig.13. Transportation Networks planning principle No.3 and LEED credits

Number of possible contributing
LEED points: 19/110



Transportation Networks

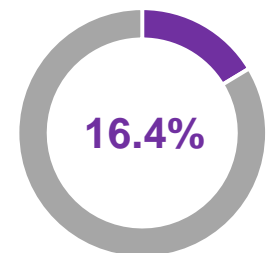
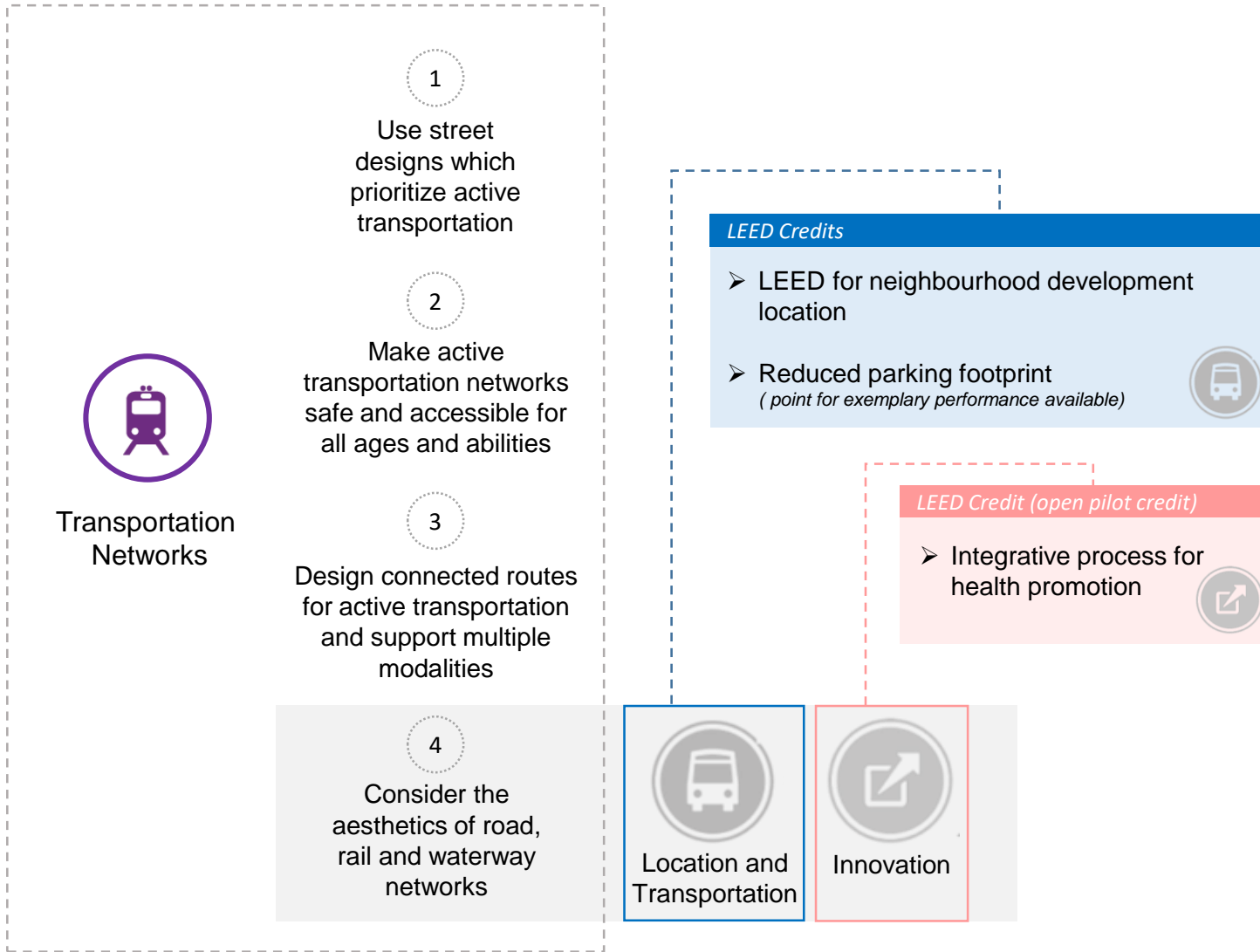
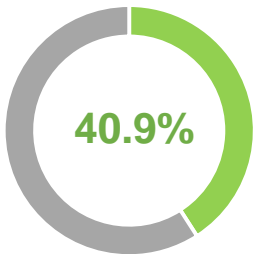
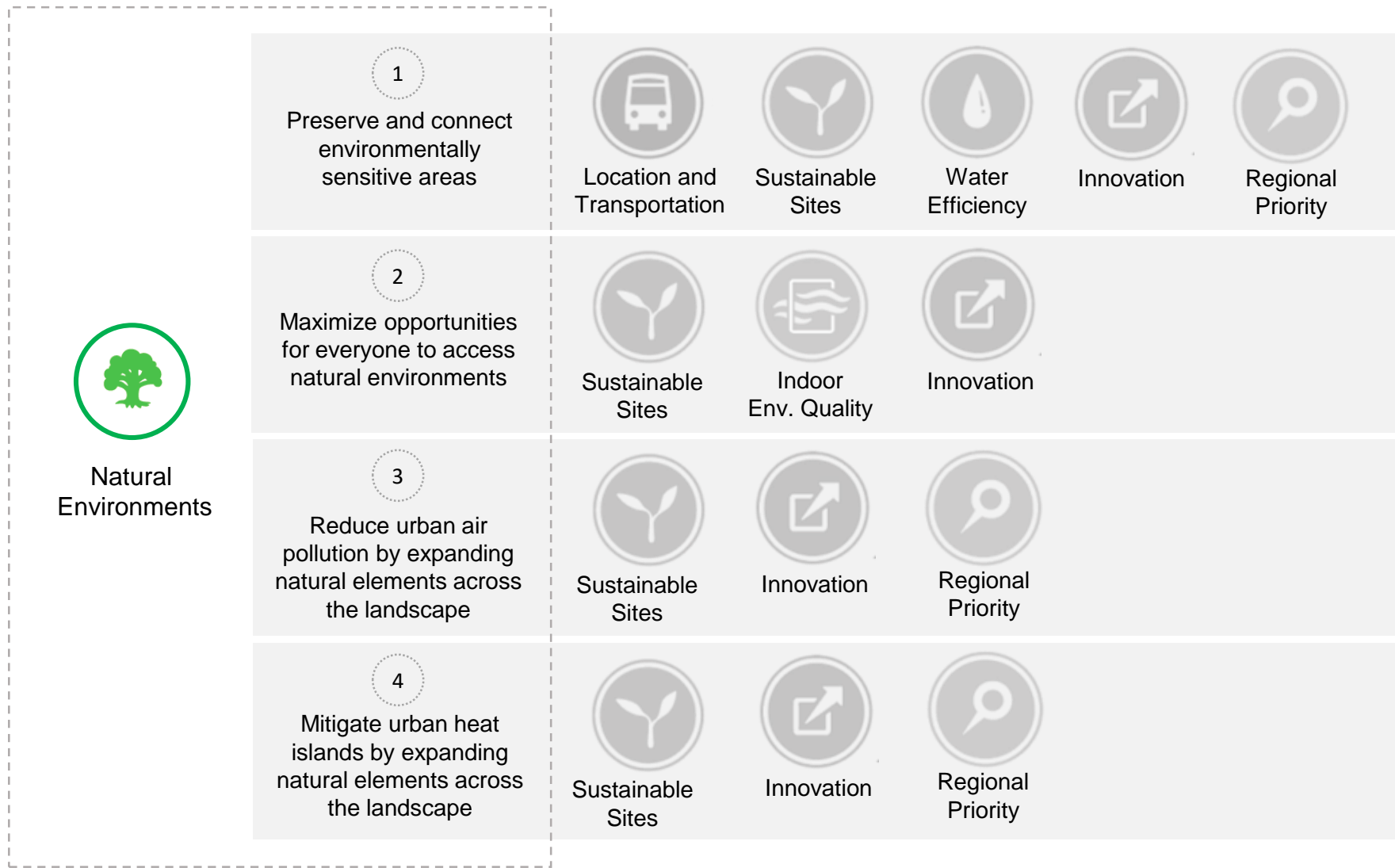


Fig.14. Transportation Networks planning principle No.4 and LEED credits

Number of possible contributing
LEED points: 18/110



Natural Environments



Number of possible contributing LEED points: 45/110

Fig.15. Natural Environments: HBE planning principles and LEED credit categories



Natural Environments

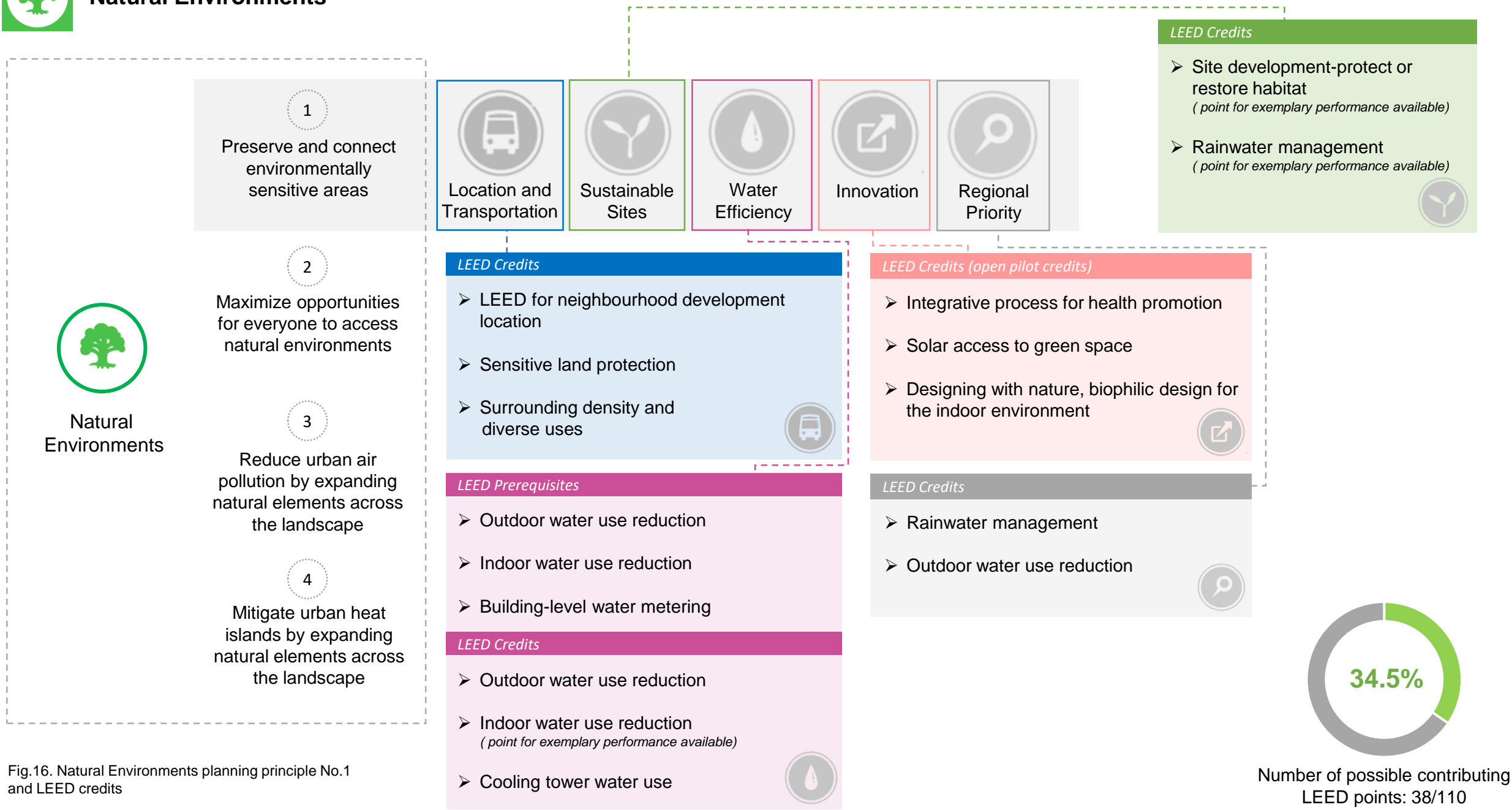


Fig.16. Natural Environments planning principle No.1 and LEED credits



Natural Environments

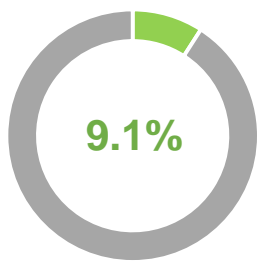
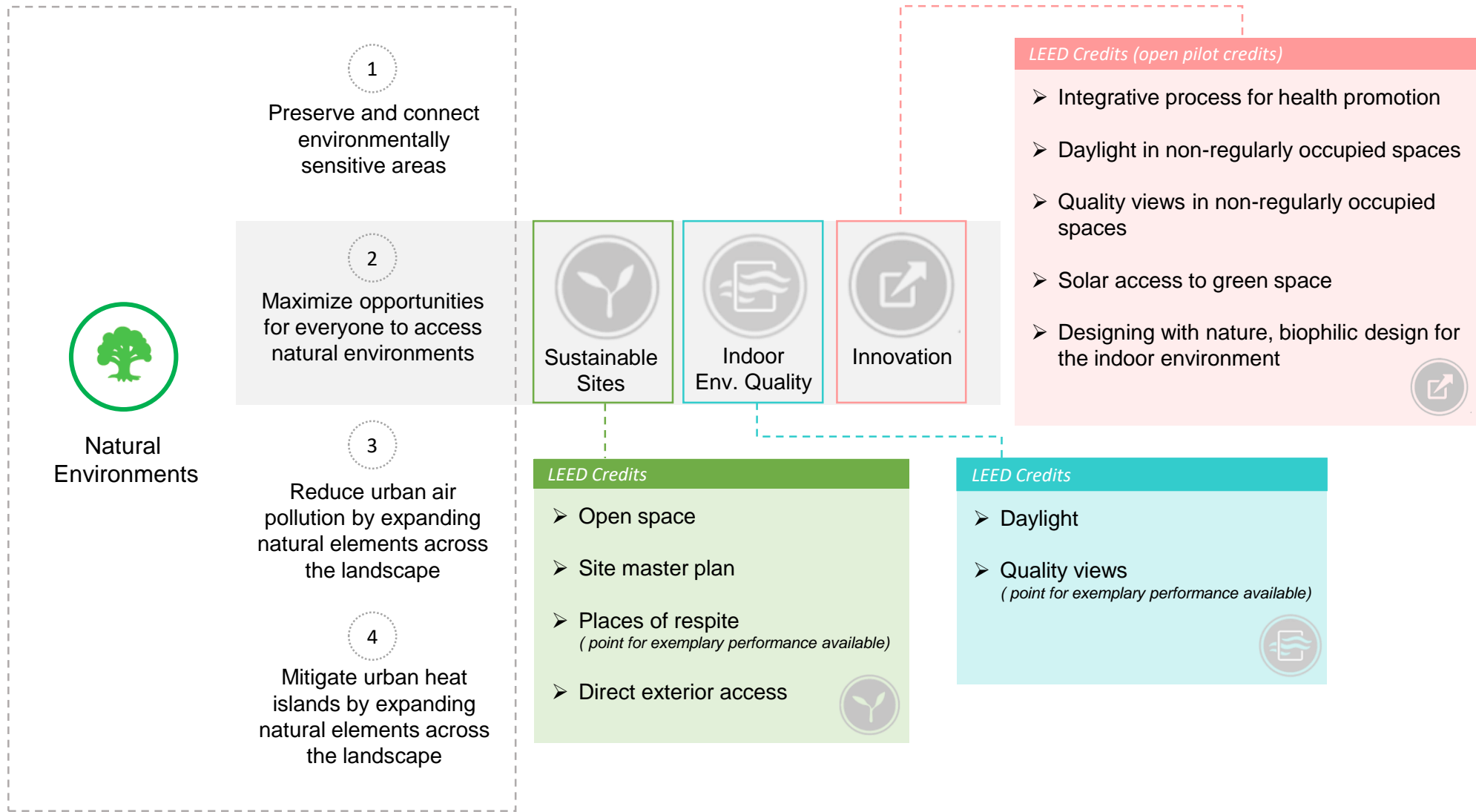


Fig.17. Natural Environments planning principle No.2 and LEED credits

Number of possible contributing LEED points: 10/110



Natural Environments

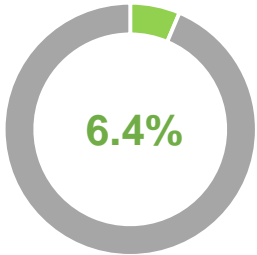
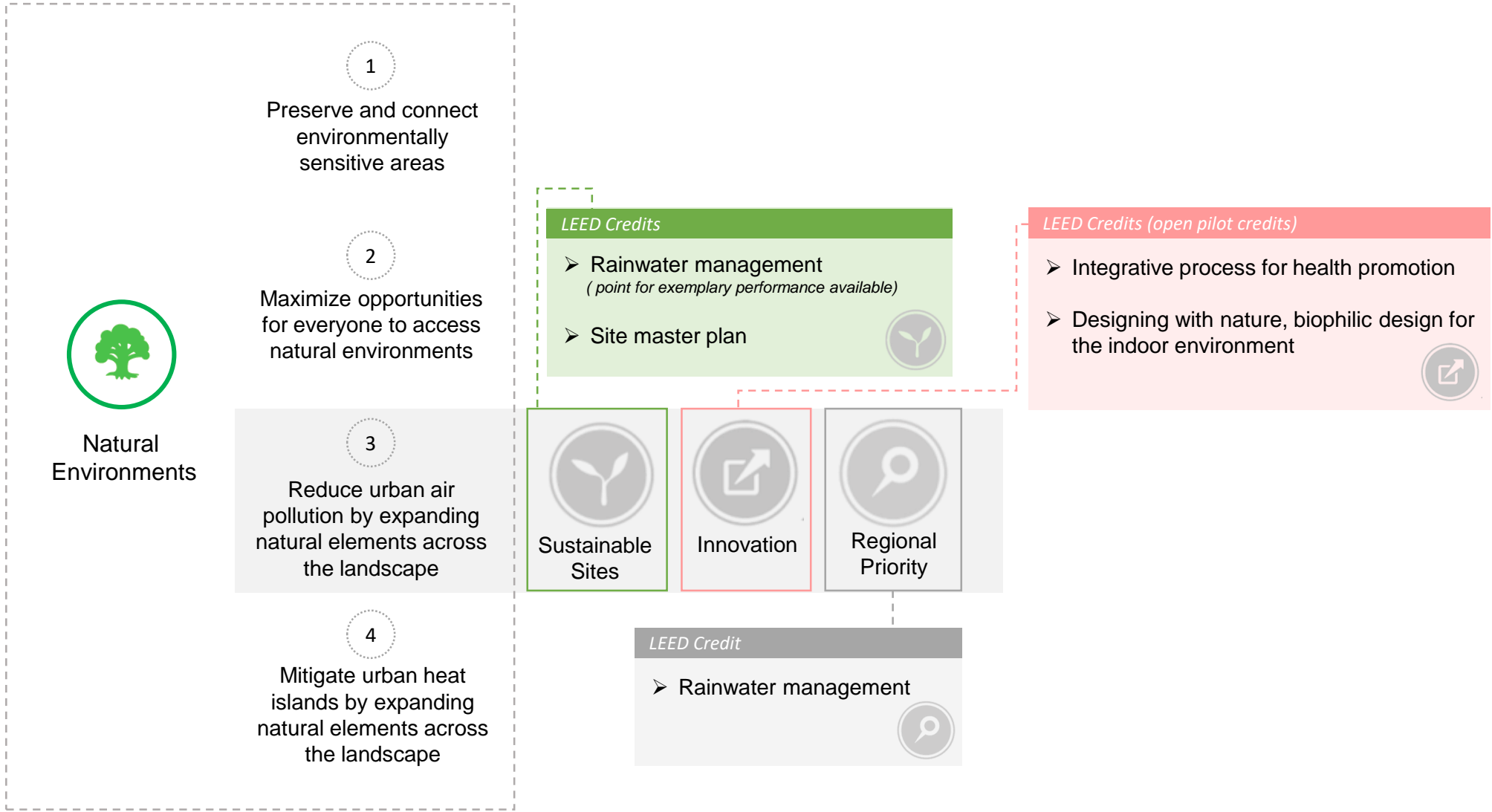
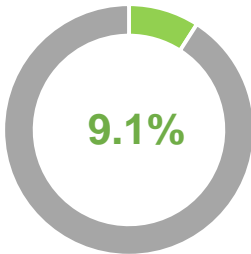
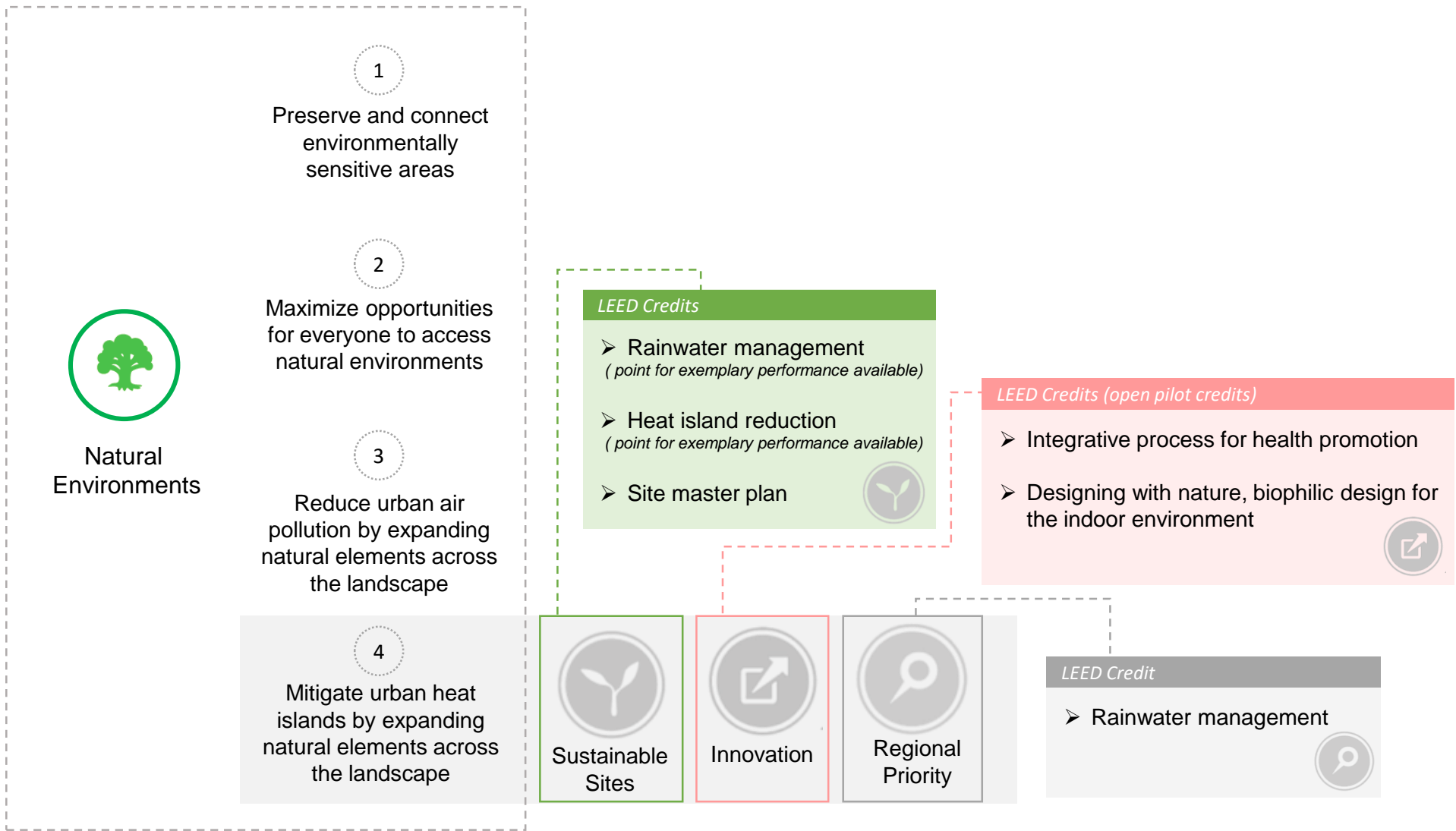


Fig.18. Natural Environments planning principle No.3 and LEED credits

Number of possible contributing LEED points: 7/110



Natural Environments



Number of possible contributing LEED points: 10/110

Fig.19. Natural Environments planning principle No.4 and LEED credits



Food Systems

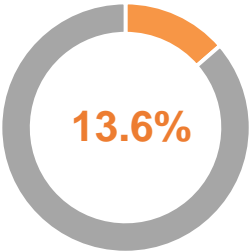
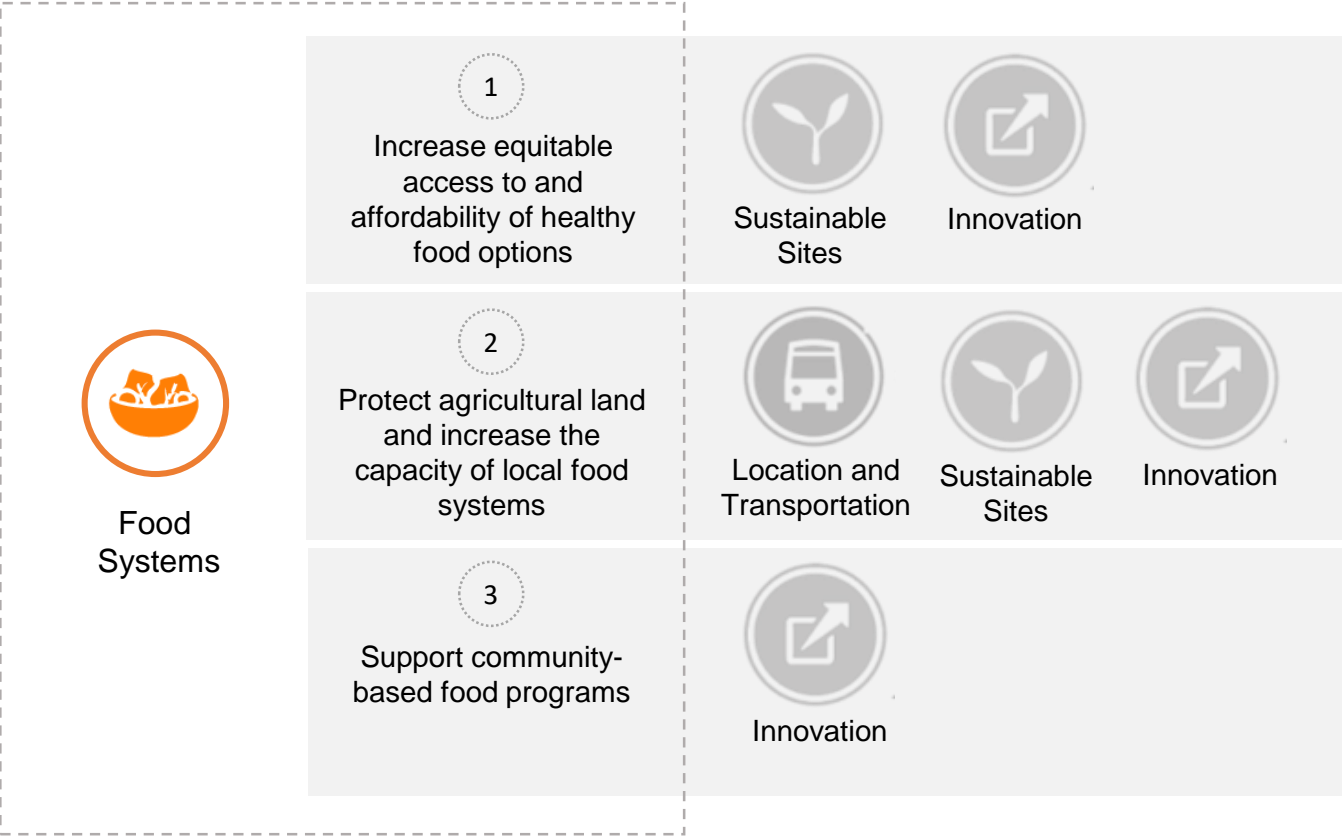


Fig.20. Food Systems: HBE planning principles and LEED credit categories

Number of possible contributing
LEED points: 15/110

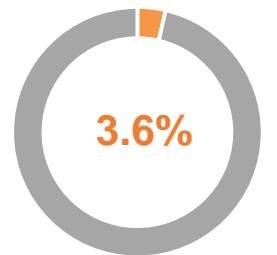
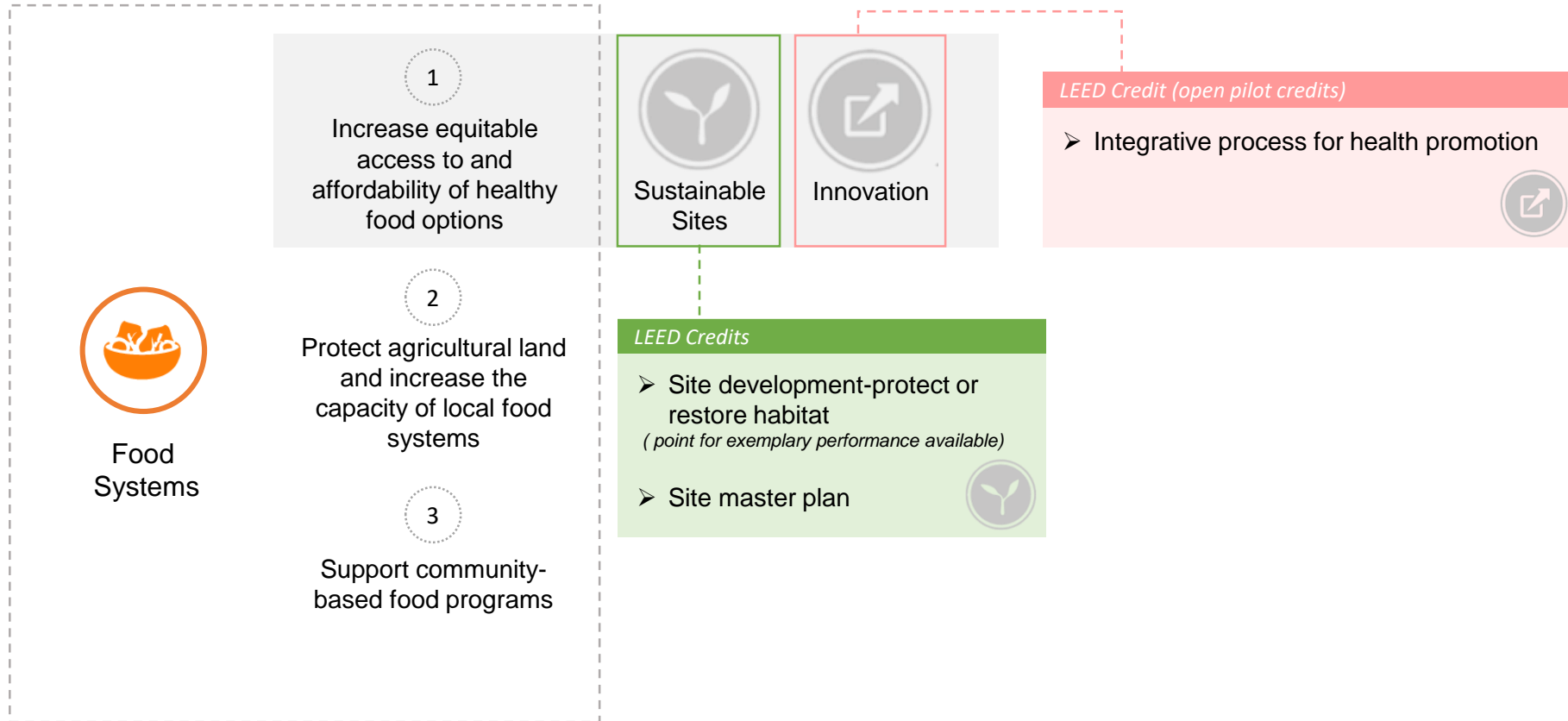
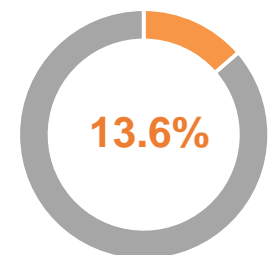
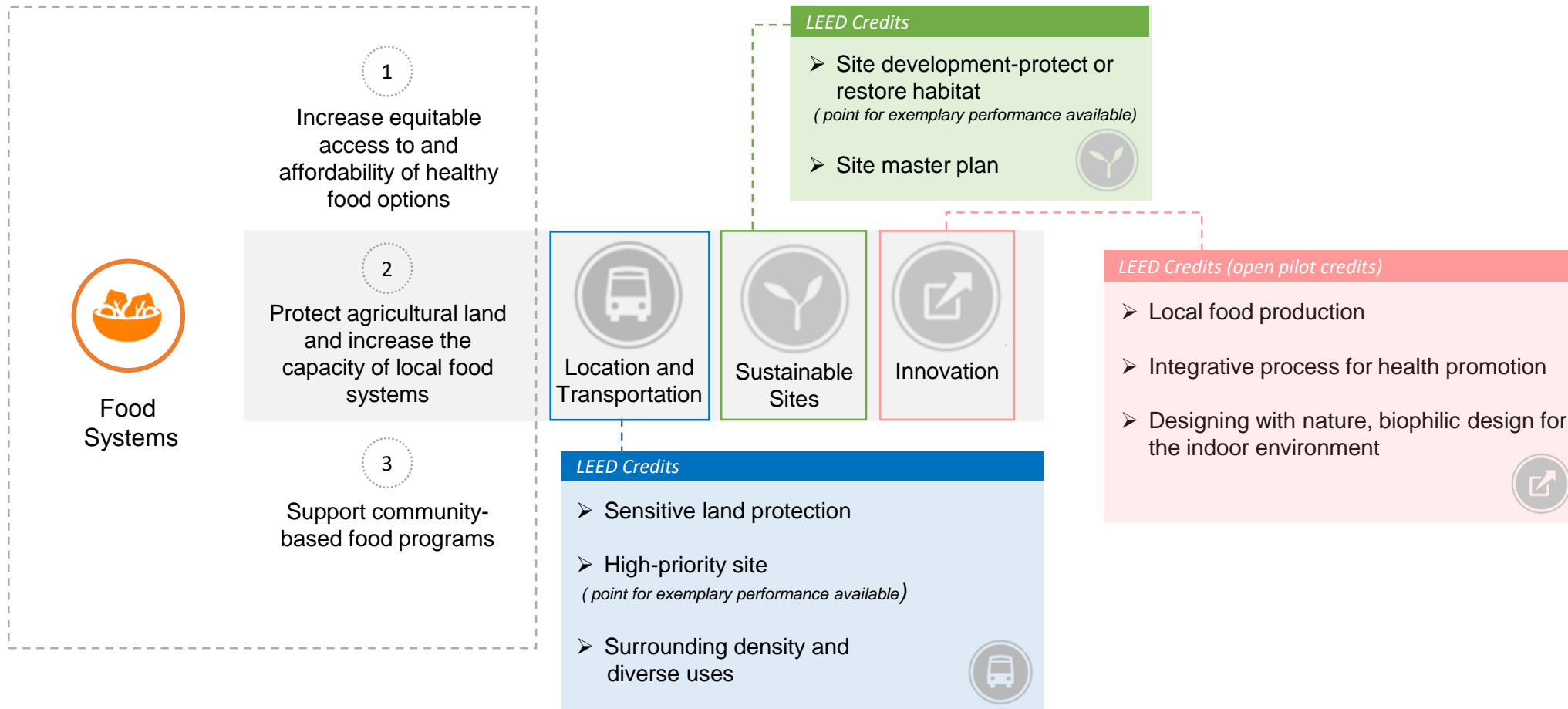


Fig.21. Food Systems planning principle No.1 and LEED credits

Number of possible contributing
LEED points: 4/110



Number of possible contributing
LEED points: 15/110

Fig.22. Food Systems planning principle No.2 and LEED credits

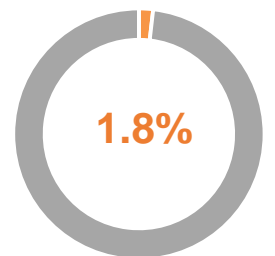
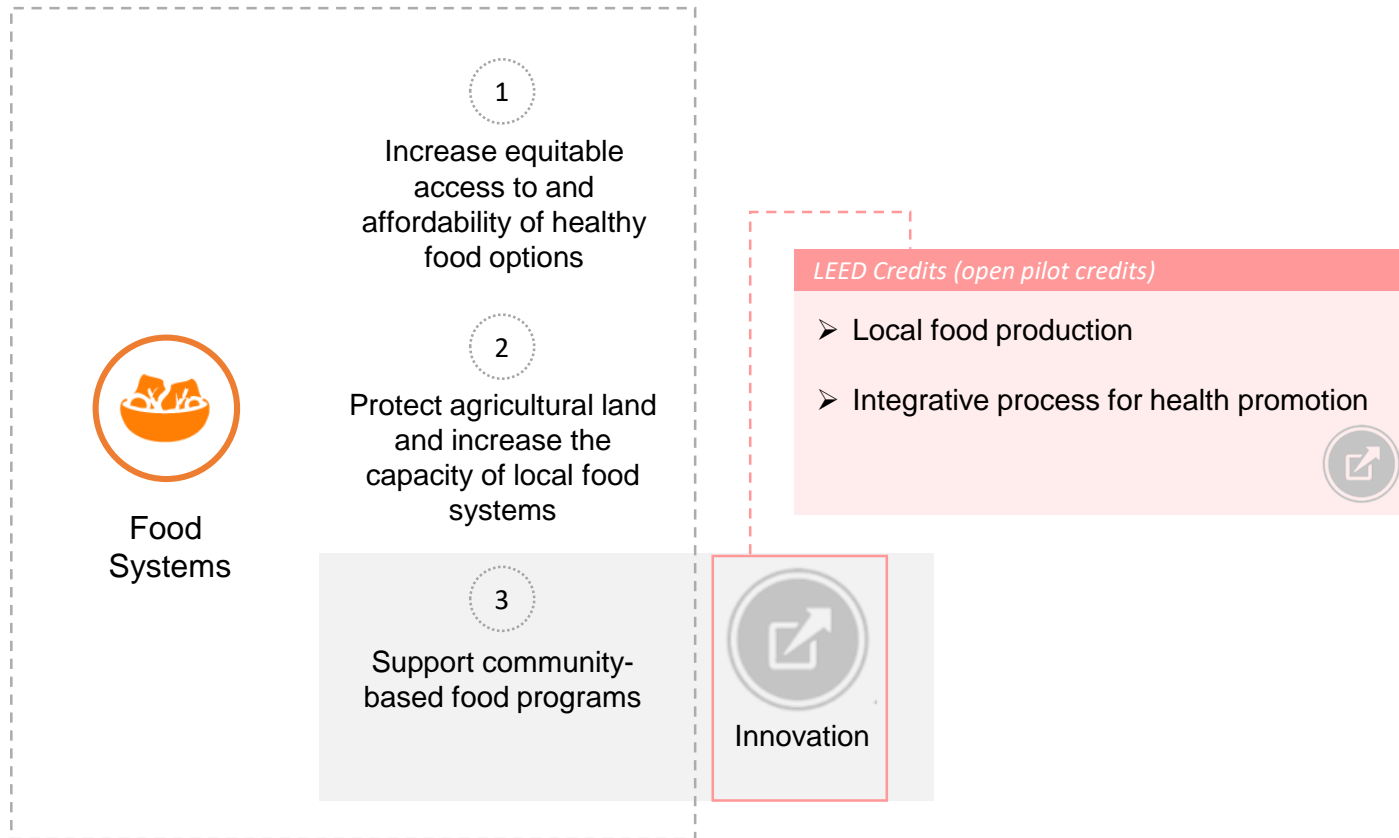


Fig.23. Food Systems planning principle No.3 and LEED credits


















Number of possible contributing
LEED points: 2/110



Housing



Housing

1 Prioritize affordable housing options through diverse housing forms and tenure types	 Water Efficiency	 Energy & Atmosphere	 Materials & Resources	 Indoor Env. Quality	 Innovation	 Regional Priority
2 Ensure adequate housing quality for everyone	 Water Efficiency	 Energy & Atmosphere	 Materials & Resources	 Indoor Env. Quality	 Innovation	 Regional Priority
3 Provide specialized housing options to support the needs of marginalized populations	 Innovation					
4 Site and zone housing developments to minimize exposure to environmental hazards	 Energy & Atmosphere	 Materials & Resources	 Indoor Env. Quality	 Innovation		

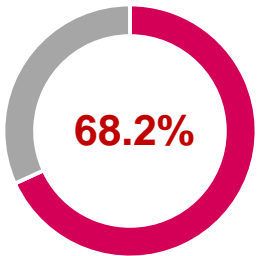


Fig.24. Housing: HBE planning principles and LEED credit categories

Number of possible contributing LEED points: 75/110



Housing

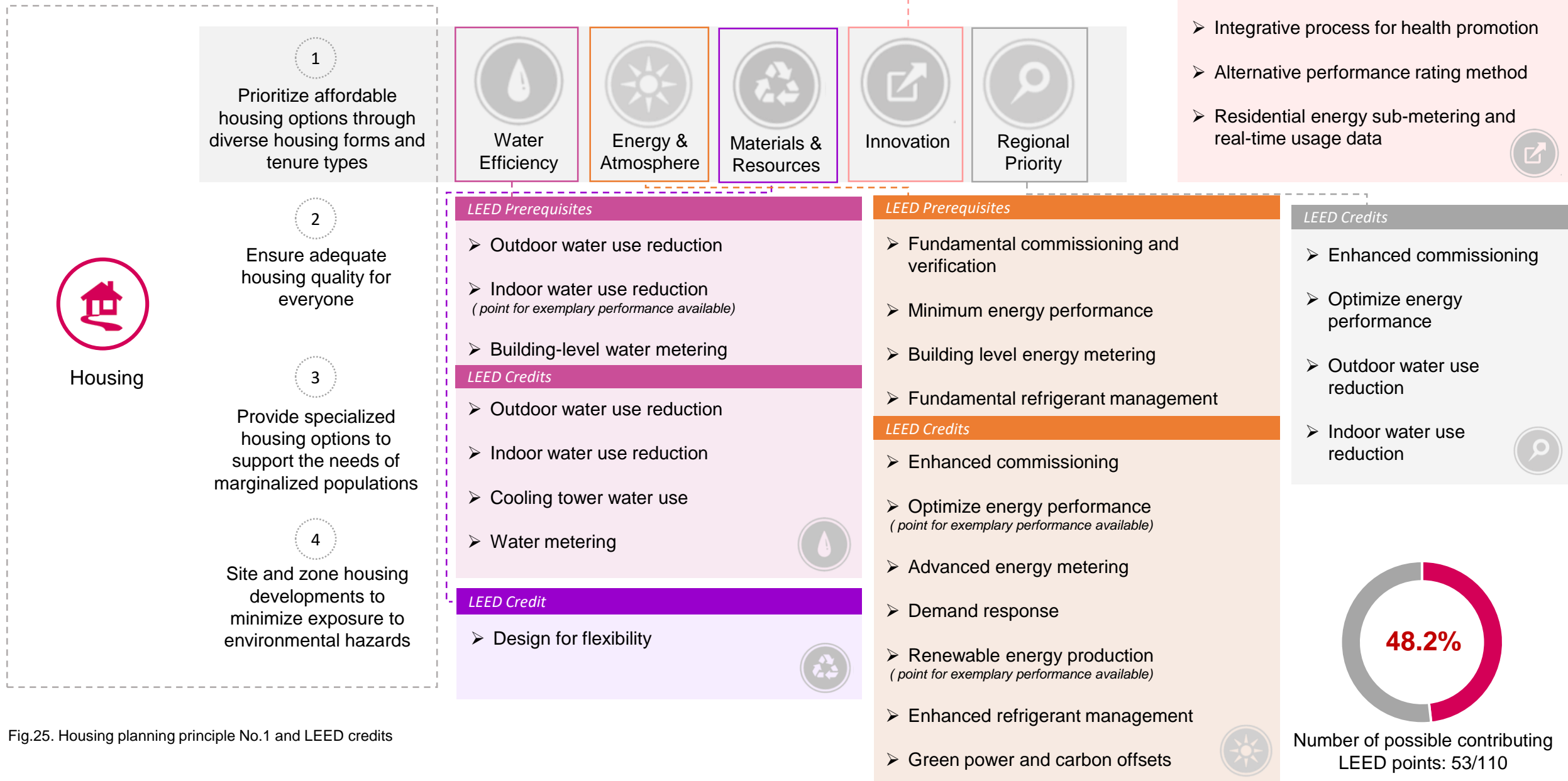


Fig.25. Housing planning principle No.1 and LEED credits



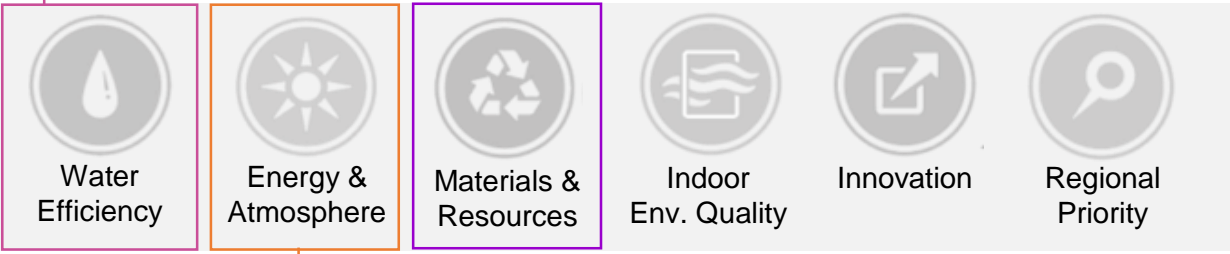
Housing



Housing

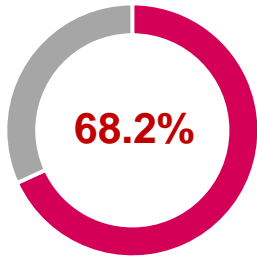


LEED Prerequisites	LEED Credits
<ul style="list-style-type: none">➤ Outdoor water use reduction➤ Indoor water use reduction (point for exemplary performance available)➤ Building-level water metering	<ul style="list-style-type: none">➤ Outdoor water use reduction➤ Indoor water use reduction➤ Cooling tower water use➤ Water metering



LEED Prerequisites	LEED Credits
<ul style="list-style-type: none">➤ Fundamental commissioning and verification➤ Minimum energy performance➤ Building level energy metering➤ Fundamental refrigerant management	<ul style="list-style-type: none">➤ Enhanced commissioning➤ Optimize energy performance (point for exemplary performance available)➤ Advanced energy metering➤ Demand response➤ Renewable energy production (point for exemplary performance available)➤ Enhanced refrigerant management➤ Green power and carbon offsets

LEED Prerequisites
<ul style="list-style-type: none">➤ PBT¹ source reduction – mercury
LEED Credits
<ul style="list-style-type: none">➤ Building product disclosure and optimization – environmental product declarations (point for exemplary performance available)➤ Building product disclosure and optimization – sourcing of raw materials (point for exemplary performance available)➤ Building product disclosure and optimization – material ingredients (point for exemplary performance available)➤ PBT source reduction – mercury➤ PBT source reduction – lead, cadmium, and copper➤ Furniture and medical furnishings (point for exemplary performance available)



Number of possible contributing LEED points: 75/110

Fig.26. Housing planning principle No.2 and LEED credits

¹ PBT: Persistent, Bioaccumulative and Toxic



Housing



Housing

1

Prioritize affordable housing options through diverse housing forms and tenure types

2

Ensure adequate housing quality for everyone

3

Provide specialized housing options to support the needs of marginalized populations

4

Site and zone housing developments to minimize exposure to environmental hazards

LEED Prerequisites

- Minimum indoor air quality performance
- Environmental tobacco smoke control
- Minimum acoustic performance

LEED Credits

- Enhanced indoor air quality strategies
- Low-emitting materials
- Construction indoor air quality management plan
- Indoor air quality assessment
- Thermal comfort
- Interior lighting
- Daylight
- Quality views
(point for exemplary performance available)
- Acoustic performance



Water Efficiency



Energy & Atmosphere



Materials & Resources



Indoor Env. Quality



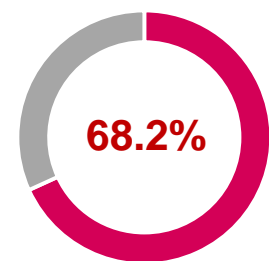
Innovation



Regional Priority

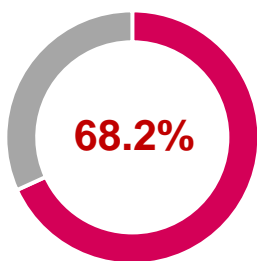
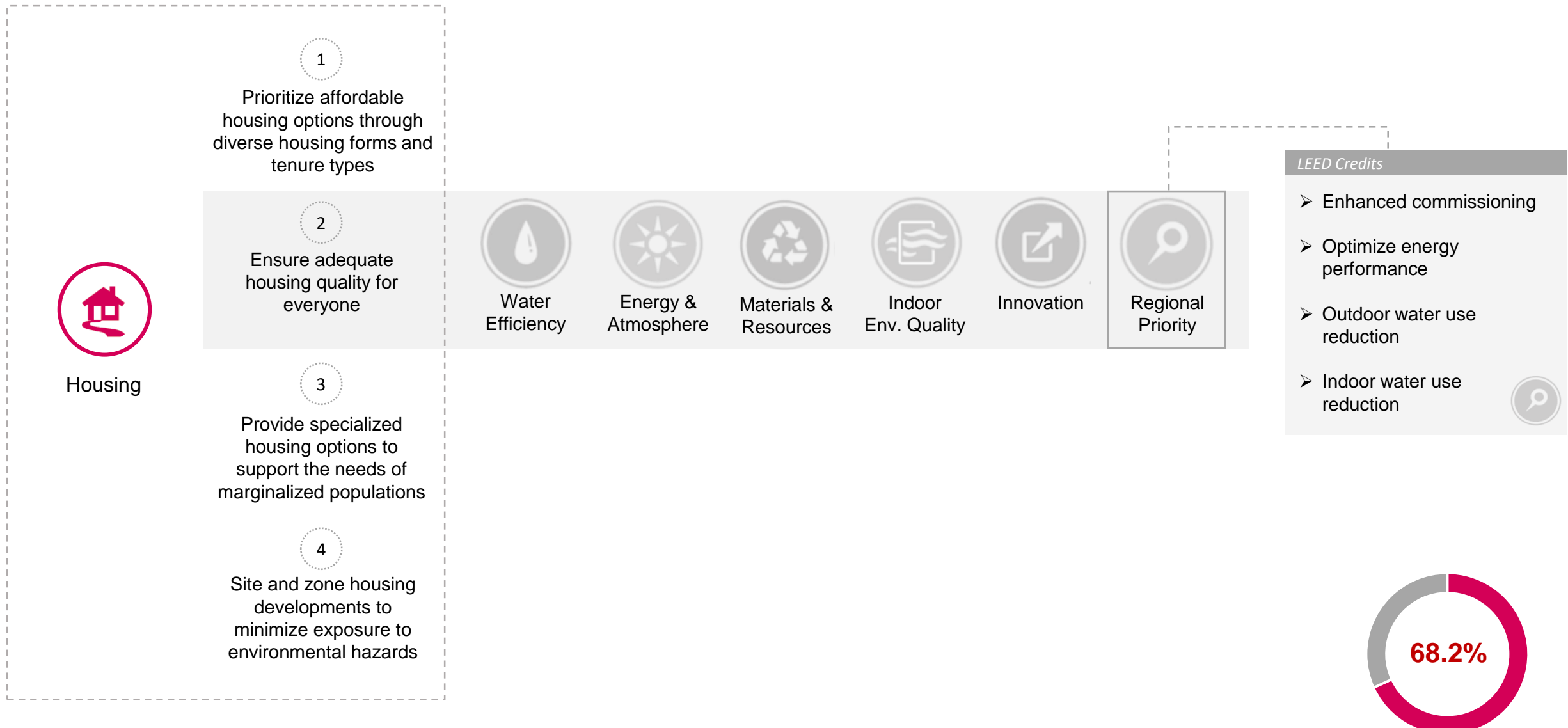
LEED Credits (open pilot credits)

- Enhanced acoustical performance – exterior noise control
- Community contaminant prevention – airborne releases
- Clean construction
- Assessment and planning for resilience
- Design for enhanced resilience
- Passive survivability and back-up power during disruptions
- Integrative analysis of building materials
- Lead risk reduction
- Integrative process for health promotion
- Building material human hazard and exposure assessment
- Alternative performance rating method
- Daylight in non-regularly occupied spaces
- Quality views in non-regularly occupied spaces
- Residential energy sub-metering and real-time usage
- Performance-based indoor air quality design and assessment



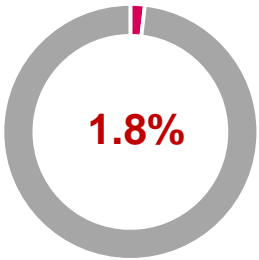
Number of possible contributing LEED points: 75/110

Fig.27. Housing planning principle No.2 and LEED credits



Number of possible contributing LEED points: 75/110

Fig.28. Housing planning principle No.2 and LEED credits



Number of possible contributing
LEED points: 2/110

Fig.29. Housing planning principle No.3 and LEED credits



Housing



Housing

1

Prioritize affordable housing options through diverse housing forms and tenure types

2

Ensure adequate housing quality for everyone

3

Provide specialized housing options to support the needs of marginalized populations

4

Site and zone housing developments to minimize exposure to environmental hazards

LEED Prerequisites

- Fundamental refrigerant management

LEED Credits

- Enhanced refrigerant management



LEED Prerequisites

- Minimum indoor air quality performance
- Environmental tobacco smoke control

LEED Credits

- Enhanced indoor air quality strategies
- Low-emitting materials
- Construction indoor air quality management plan
- Indoor air quality assessment
- Thermal comfort



Energy & Atmosphere



Materials & Resources



Indoor Env. Quality



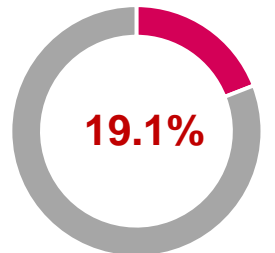
Innovation

LEED Prerequisites

- PBT source reduction – mercury

LEED Credits

- Building product disclosure and optimization – environmental product declarations
(point for exemplary performance available)
- Building product disclosure and optimization – sourcing of raw materials
(point for exemplary performance available)
- Building product disclosure and optimization – material ingredients
(point for exemplary performance available)
- PBT source reduction – mercury
- PBT source reduction – lead, cadmium, and copper
- Furniture and medical furnishings
(point for exemplary performance available)



Number of possible contributing LEED points: 21/110

Fig.30. Housing planning principle No.4 and LEED credits



Housing



Housing

1

Prioritize affordable housing options through diverse housing forms and tenure types

2

Ensure adequate housing quality for everyone

3

Provide specialized housing options to support the needs of marginalized populations

4

Site and zone housing developments to minimize exposure to environmental hazards

LEED Credits (open pilot credits)

- Community contaminant prevention – airborne releases
- Clean construction
- Assessment and planning for resilience
- Design for enhanced resilience
- Passive survivability and back-up power during disruptions
- Integrative analysis of building materials
- Lead risk reduction
- Integrative process for health promotion
- Building material human hazard and exposure assessment
- Solar access to green space
- Performance-based indoor air quality design and assessment



Energy & Atmosphere



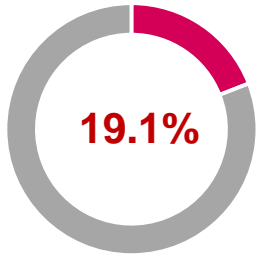
Materials & Resources



Indoor Env. Quality



Innovation



Number of possible contributing LEED points: 21/110

Fig.31. Housing planning principle No.4 and LEED credits

5. Recommendations and Next Steps

Teams and organizations can adapt this resource to their context. For example, School Districts and Post-Secondary Institutions can use the approach and methodology presented in this document for developing a version of this resource focused on educational facilities. Similarly, Crown Corporations (e.g. BC Housing) as well as private sector entities can develop a version that matches their specific needs and context (e.g. residential sector). Municipalities (e.g. City of Vancouver, City of Richmond), and the Province of British Columbia that employ LEED in their facilities can also take a similar approach.

Canada Green Building Council (CaGBC) can also use the methodology presented in this document to specify the health related outcomes and co-benefits of various LEED rating systems (e.g. LEED for Homes, LEED for Neighbourhood Development).

6. Acknowledgements

The authors would like to thank the following individuals for taking the time to review earlier versions of this document and share their valuable insights and feedback:

- Mark Holland (President - Holland Planning Innovations)
- Sammie Hwang (Environmental Health Officer - Vancouver Coastal Health)
- Florrie Levine (Project Manager - Lower Mainland Facilities Management)
- Sabrina Sandhu (Environmental Health Officer- Vancouver Coastal Health)

As next steps, EES team plans to develop a healthcare specific version of this document using LEED v.4.0 BD+C: Healthcare. This rating system was designed for healthcare facilities that provide inpatient medical treatment, including acute and long-term care.

EES team will also develop a “flipped version” of the present document. The “flipped version” will be similar to the present document in terms of content; however, it will have a different look. It will use LEED credit categories instead of HBE features as the basis of the diagrams and graphics. This will be done to enhance the readability of this resource for design and construction professionals that are familiar with LEED. In the present document, the results are described in five groups following five HBE features (Neighbourhood Design, Transportation Networks, Natural Environments, Food Systems, and Housing). This makes is easy for those familiar with HBE Linkages Toolkit to follow the diagrams and graphics. In the “flipped version”, the results will be presented in eight groups, following eight LEED credit categories (Location and Transportation, Location and Transportation, Sustainable Sites, Water Efficiency, Energy and Atmosphere, Materials and Resources, Indoor Environmental Quality, Innovation, and Regional Priority). This will make it easy for those familiar with LEED to follow the diagrams and graphics.

If you have any comments, feedback, or question, please direct them to Ghazal Ebrahimi at ghazal.ebrahimi@fraserhealth.ca