DESIGN GUIDE I

• ECOLOGICAL DESIGN MODEL

Ecological design as the biointegration of 5 sets of ecoinfrastructures to create constructed ecosystems.

Ecological design as the seamless biointegration of our built environment with nature, hydrology, energy and human society

General System (key design factors):

hydrology

NZW (Net Zero Water)

- water management
- water conservation
- water reuse & recycling
- ground water
- rainfall
- waterways
- seas
- snow
- dew
- lakes

nature

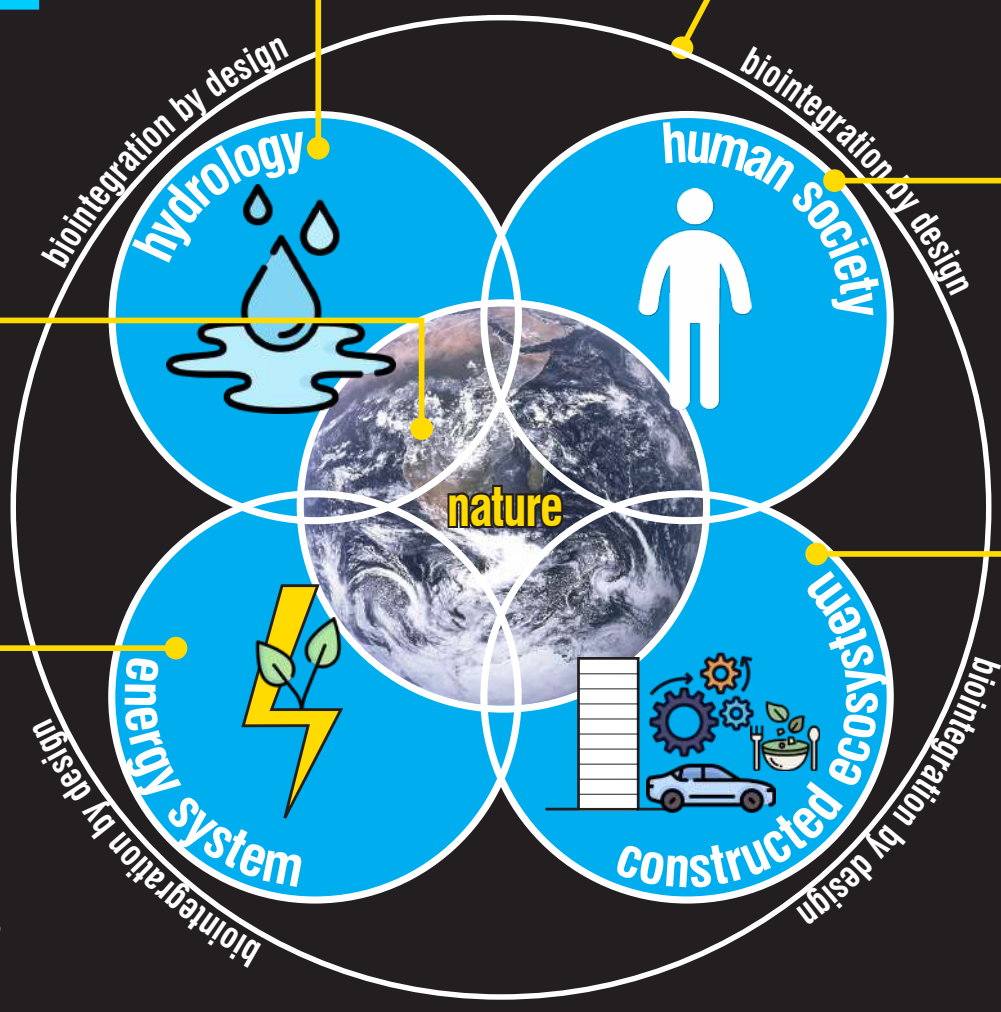
NPEI (Net Positive Ecological Impact)

- biosphere
- biogeochemical cycles
- abiotic constituents
- biotic constituents
- ecosystems
- habitats
- species
- biodiversity
- biomes

energy systems

NZE/C (Net Zero Energy / Carbon)

- renewable
- ambient
- electronic systems
- advance biofuels
- geothermal energy
- thermal storage
- battery
- hydrogen
- passive mode systems
- mixed-mode systems
- smart full mode systems
- productive mode systems



human society

NWS (Net Well-being & Happy Society)

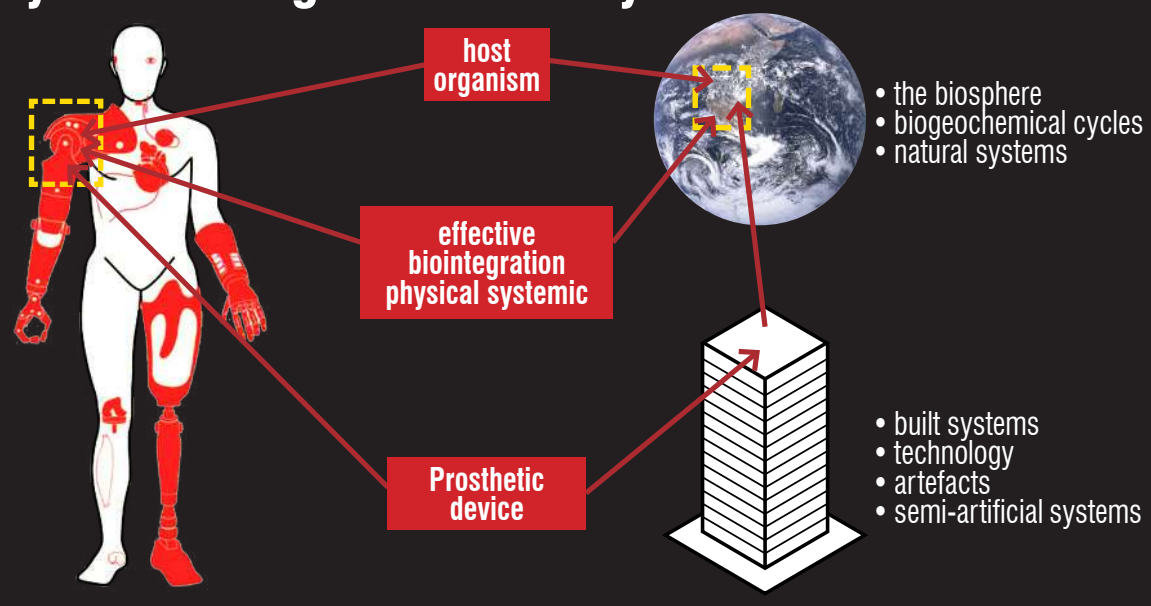
- social
- economic
- political
- institutional
- culture
- ecologically responsible behavior
- ecological responsible diet
- human health well-being & happiness

constructed ecosystems

NZW/E (Net Zero Waste / Emissions)

- technological systems
- built environment systems
- artefacts
- recycling
- reuse
- carbon capture
- hydrogen production without emitting carbon
- low embodied energy
- large scale electricity storage
- zero carbon steel
- zero carbon cement
- zero carbon fertilizer
- zero carbon plastic
- smart systems

systemic integration of ecosystem attributes



- the biosphere
- biogeochemical cycles
- natural systems

- built systems
- technology
- artefacts
- semi-artificial systems

Ecosystem Attributes:

- biological structure
- biodiversity connectivity
- provision of ecosystem services
- ecosystems biointegration
- responsiveness to climate
- use and cycling of materials
- hydrology
- symbiosis
- homeostasis
- food production
- succession

*** to be emulate, replicate and augmented constructed ecosystems**

Green design is the biointegration of the following 5 constituents as ecoinfrastructure:

Nature
(as the ground zero context for all human being)

Human society
(Social, economic, political, institutional and cultural systems)

Hydrology
(to close the water cycle and bring water back to recharge the ground water and to discharge of rainfall to water waste, natural water in the climate)

Energy systems
Provide energy systems for human society existence and to conserve use of non-renewable energy. Designing for Net Zero Energy is to reduce non-renewable resource as the outcome of use of energy systems. The stages starts from optimising low embodied energy, passive mode to optimising mixed-mode and reduction of embodied energy in active system. With eventual objective to make use of renewable energy as much as possible to achieve near net zero dependency on non-renewable energy resources and reduction of carbon content.

Constructed ecosystems
Built environment is essentially that human society makes of use and dispose. These includes building infrastructures, artefacts, foods and products. The key objective is to reduce wastage and contaminating emissions to natural environment. Designing to allow for reuse and recycling (within built environment) with Net Zero Energy (where possible) and impact on the natural environment.

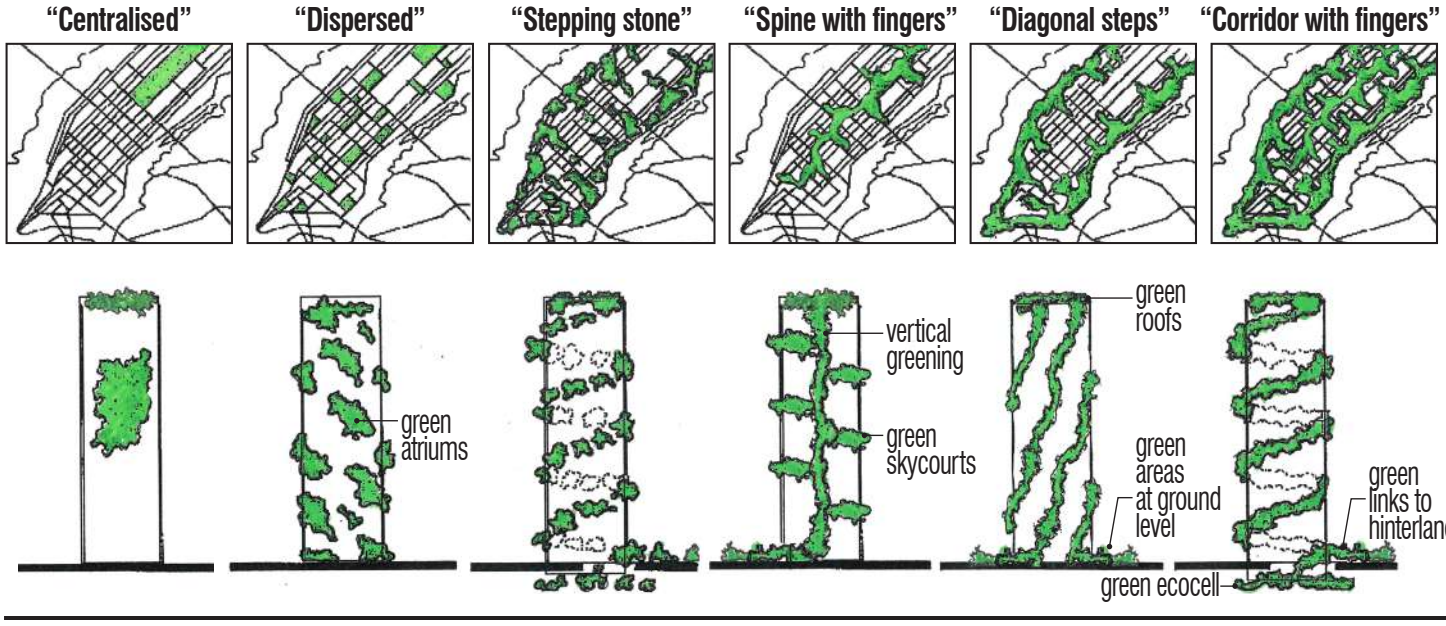
Achieving an effective, seamless and benign biointegration is a challenge for ecological design.

DESIGN GUIDE II

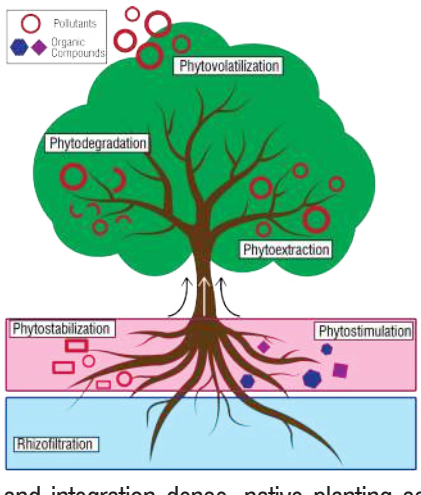
- **NATURE** (biointegration with other ecoinfrastructure)

Design for Net Positive Ecological Impact (NPEI)

greening patterns (habitats creation)



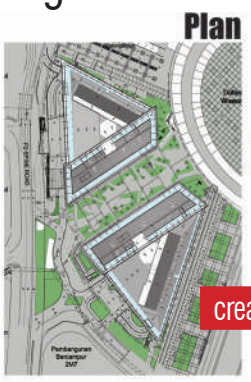
phytoremediation



Planting and integration dense, native planting as urban forests in buildings and cities is scientifically proven to be one off the best ways that we can mitigate climate crisis. With our client, we have planted native urban forest in our building and planning projects.

Biodiversity Targets Matrix (identify species and habitats)

design of habitats within development to enhance local biodiversity



Habitats

Level 1 Promenade	Level 1 External Planters	Level 1 Trees	Level 2 Trees & Shrubs	Level 3 Shrubs	Level 6-13 Shrubs
Shrubs/Groundcovers • *Zephyranthes candida* • *Tristellateia australasiae* • *Acalypha siamensis* • *Ficus pumila* • *Phyllanthus myrtifolius* • *Spathiphyllum cannifolium* • *Costus speciosus 'Marginatus'* • *Orthosiphon aristatus* • *Brunfelsia calycina* • *Canna indica* • *Vernonia elliptica* • *Loropetalum* • *Justicia gendarusa* • *Zoysia matrella* • *Axonopus compressus*		• *Caesalpinia ferrea* • *Ficus nitida* • *Eucalyptus deglupta* • *Plumeria obtusa*	Trees • *Cyathea cooperi* Shrubs • *Pisonia alba* • *Brunfelsia calycina*	• *Angelonia salicarifolia* • *Belamcanda chinensis* • *Osmoxylon lineare yellow*	• *Belamcanda chinensis* • *Osmoxylon lineare yellow* • *Pisonia alba* • *Vernonia elliptica* • *Allamanda nerifolia* • *Costus speciosus 'Marginatus'*

Flora Species

create habitats

select native fauna species to be brought back to locality: for feeding, breeding, refugee from prey (based on ecological survey of site and surrounding)

Target Fauna Species

Cynopterus brachyotis Lesser Short-Nosed Fruit Bat	CP			R	F	F
Streptopelia chinensis Spotted Dove	IA	F		R	B	
Geopelia Striata Zebra Dove	IA	F		R	B	B	
Caprimulgus macrurus Large-tailed Nightjar	IA					F
Apus affinis House Swift	US IA					F
Megalaima haemacephala Coppersmith Barbet	IA			B	F	F
Aegithina tiphia Common Iora	IA			F B		
Lanius schach Long-tailed Shrike	IA					B
Pynonotus goiavier Yellow-vented Bulbul	IA	F	F	F B	F B	F B	F B
Oriolus chinensis Black-naped Oriole	IA	F	F	F B	F	F	F
Copsychus saularis Oriental Magpie-robin	IA			F B	F	F	F
Gerygone sulphurea Golden-bellied Gerygone	IA			F B			

establish interactions between flora, fauna and habitats

Target Species

1. Priority species for nature conservation
2. Flagship species that could symbolise scheme success
3. Indicator of good populations of small mammals
4. Indicator of good population of small birds
5. Indicator of good populations of fish/amphibians
6. Indicator of good populations of invertebrates
7. Indicator of good water quality
8. Species with special aesthethis qualities or interest to man. eg. conspicuous beauty, song or tendency to use artificia refuges.

Keys

R Roost · WQ Water Quality · F Feeding · DPS Dominant Plant Species · H Host · B Breeding

Species with Social/Amenity/Cultural/Educational Values:

FS 'Flagship' – species that champion the biodiversity of the wider landscape in which they are found, often because of their conspicuousness, appealing appearance/behaviour or cultural iconography

IA 'Innate Appeal' – Species of above-average value to people in terms of its aesthetic value or curiosity value: for example, a species of bird with particularly melodious song or perhaps a plant with particularly appealing perfume; or species contributing to a valued whole ecosystem aesthetic such as 'lushness' or 'multicoloured beauty' to which society responds positively

EW 'Early Warning' – … early warning of th… rather like a Canary in a coal mine. Classic examples include the Peregrine Falcon and DDT, lichen assemblages and sulphur dioxide and invertebrate populations in rivers and water pollution

Species with 'Innate' and 'Ecosystem Support' Values:

CP 'Conservation Priority'– spe… biodiversity value which ma… for example, on the basis of … as a particularly high-quality … kind.

KS 'Keystone' – species having a … ate effect in the functioning … vironment.

habitats. They are species wh… ise the presence of an overall … tat at good conservation statu…

select non-invasive flora species to attract fauna

Flora Species

Caesalpinia ferrea	Leopard Tree	
Ficus nitida	Indian Laurel Fig	
Eucalyptus deglupta	Rainbow eucalyptus	
Plumeria obtusa	Frangipani	
Zephyranthes candida	Fairy lily	
Tristellateia australasiae	New Caledonia	
Acalypha siamensis	Tea leaf	
Ficus pumila	Creeping fig	
Phyllanthus myrtifolius	Mousetail plant	
Spathiphyllum cannifolium	Peace Lily	
Costus speciosus 'Marginatus'	Spiral ginger Var.	
Orthosiphon aristatus	Cat's Whiskers	
Brunfelsia calycina	Ystrd-Today-Tmrw	
Canna indica	Bunga Tasbih	
Vernonia elliptica	Curtain Creeper	
Loropetalum	Purple Diamond	
Justicia gendarusa	Daun Rusa	
… matrella	Carpet Grass	
… compressus	Cow Grass	
Cyathea cooperi	Lacy Fern Tree	
Pisonia alba	Moonlight Tree	
Allamanda nerifolia	Bunga Loceng	

create landscape conditions for habitats to survive at all season

emulate, replicate & augment ecosystem attribute to create hybrid ecosystem

the biosphere
- biogeochemical processes
- energy and material resources
- ecosystems

ecosystem

humans + constructed ecosystems

- community of plants & animals
  - plant community
    - Green Plants → Primary producers
    - Herbivores → Primary consumers
  - animal community
    - Carnivores → Secondary consumers; Tertiary consumers; Quaternary consumers
  - community of plant & animal microbes
    - Bacteria and fungi → Decomposers

biotic biological constituents

- physical environment
  - site characterised by given climate features
  - site characterised by given edaphic

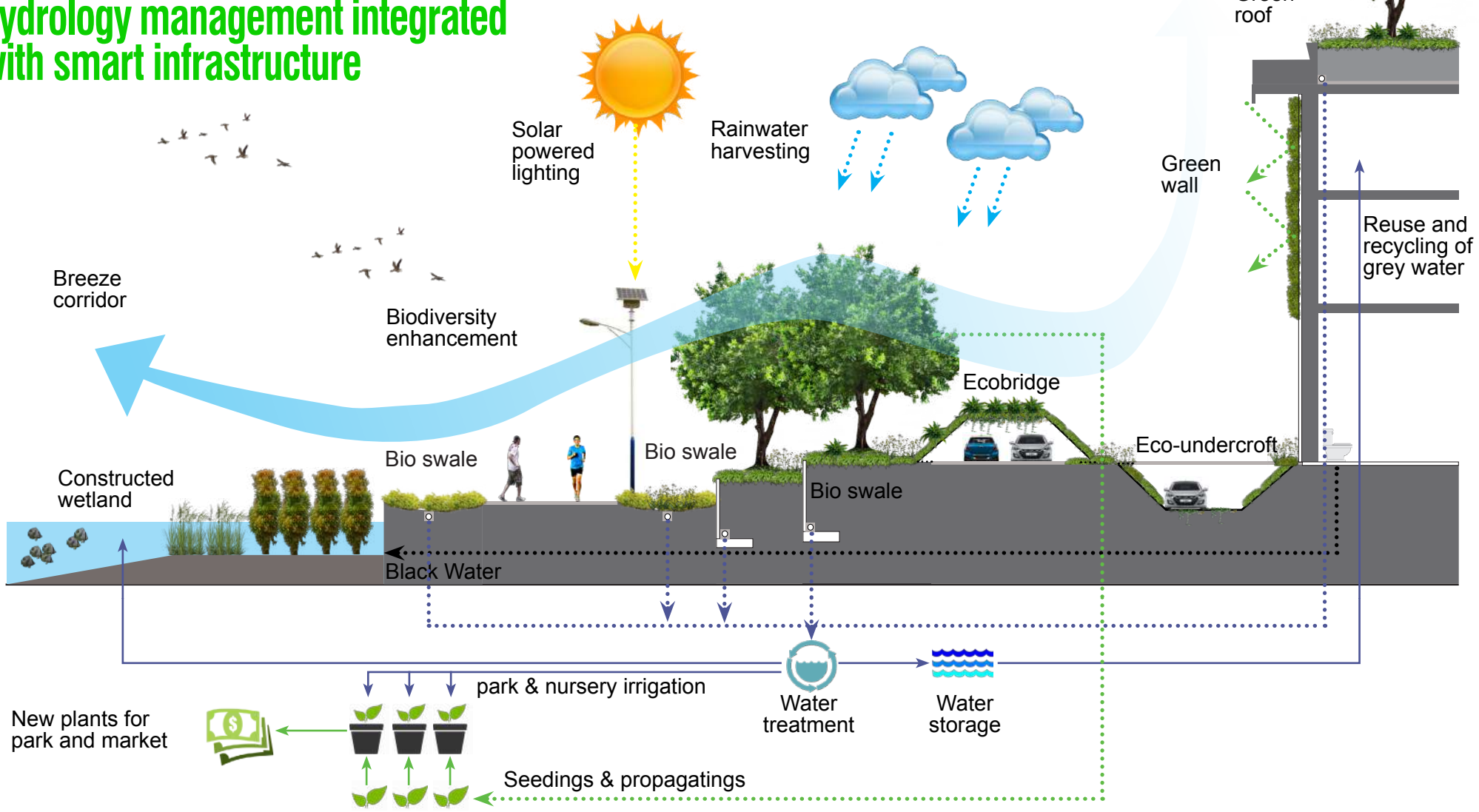
abiotic physical constituents

DESIGN GUIDE III

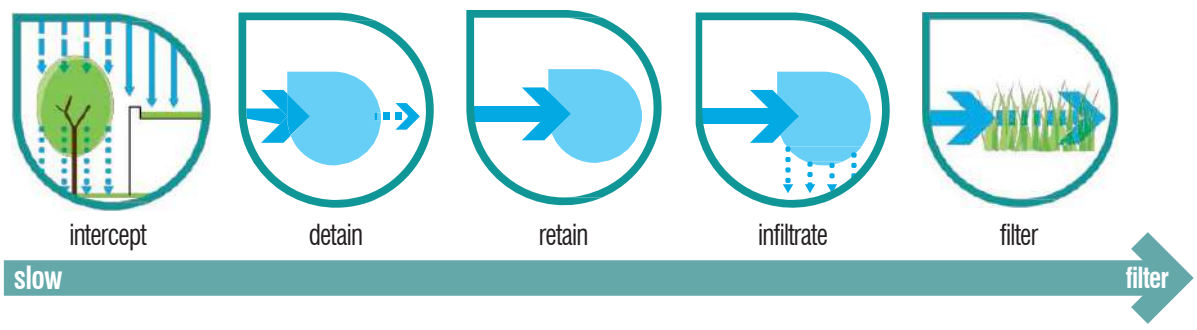
• HYDROLOGY (biointegration with other ecoinfrastructure)

Design for Net Zero Water (NZW)

hydrology management integrated with smart infrastructure

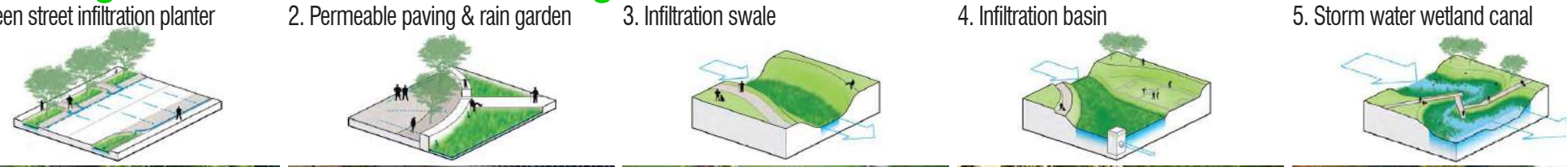


methods to reduce runoff and improve water quality

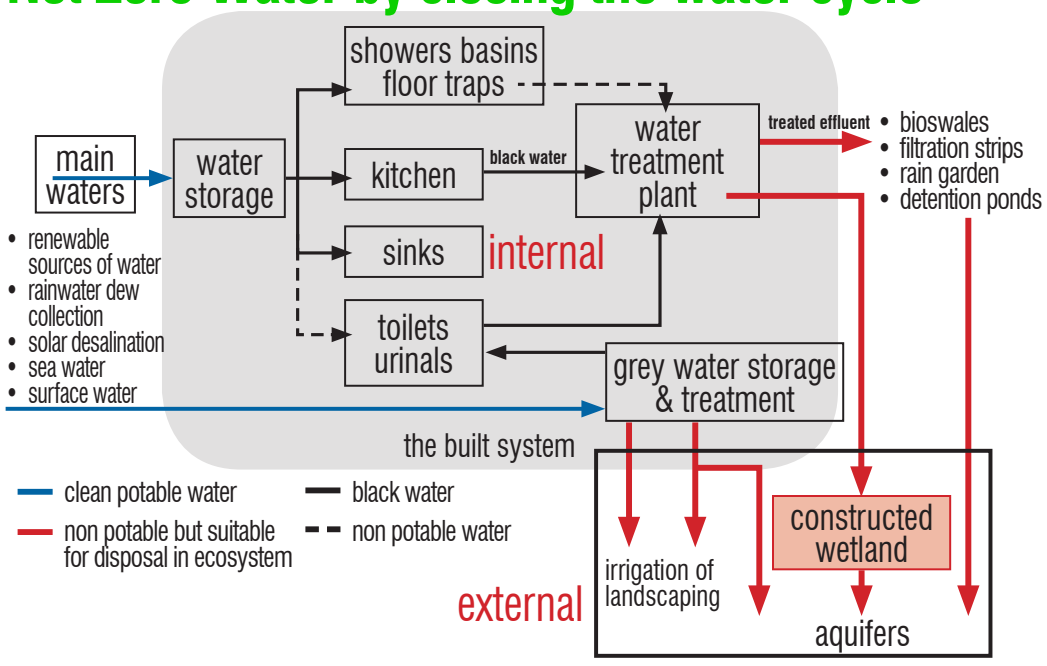


returning storm water back into the ground

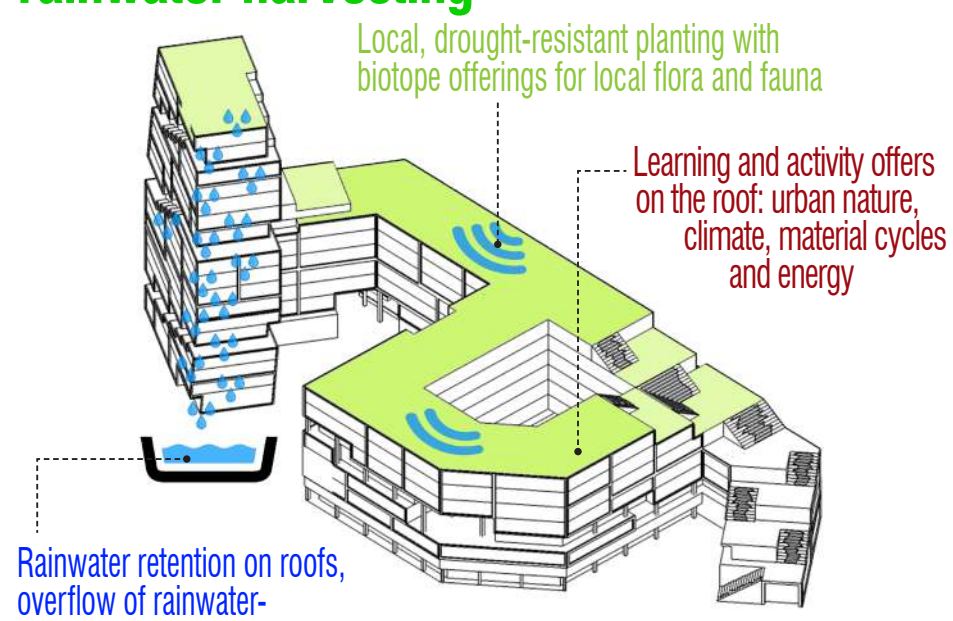
1. Green street infiltration planter
2. Permeable paving & rain garden
3. Infiltration swale
4. Infiltration basin
5. Storm water wetland canal



Net Zero Water by closing the water cycle



rainwater harvesting

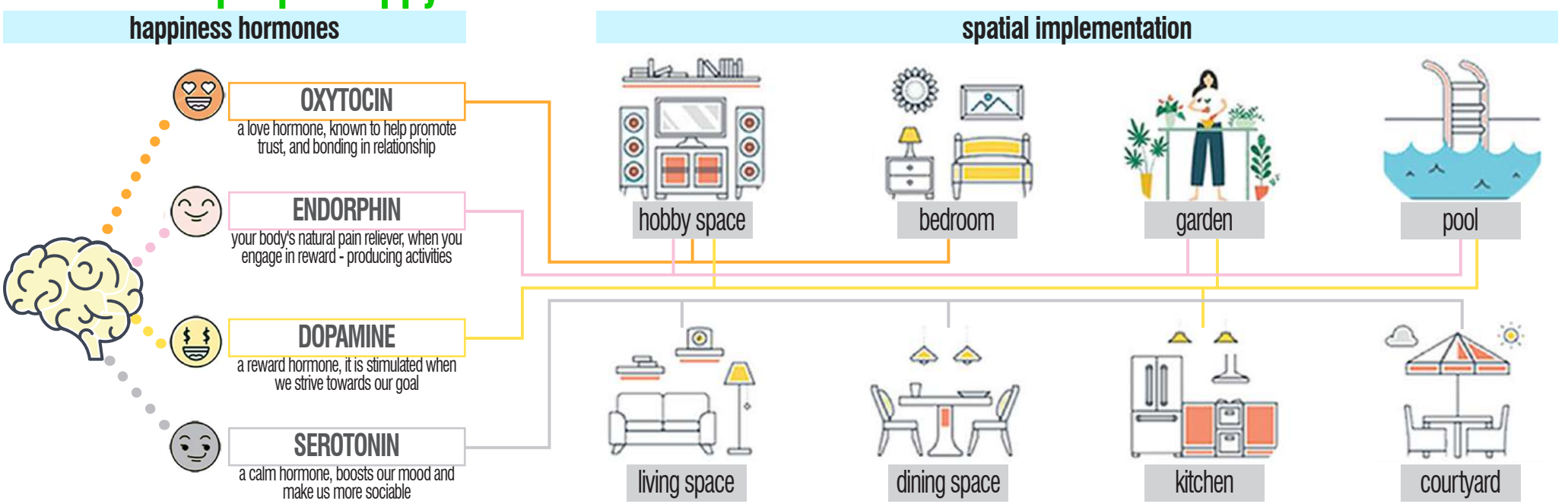


DESIGN GUIDE IV

• HUMAN SOCIETY (biointegration with other ecoinfrastructure)

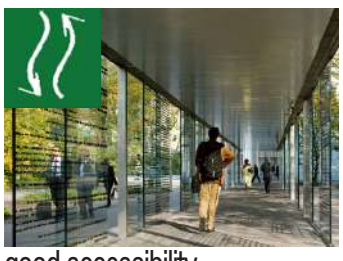
Design for Net Well-being & Happy Society (NW&S)

what makes people happy?



designing for health, happiness & well-being

designing public space and create pleasureable public realms


good accessibility

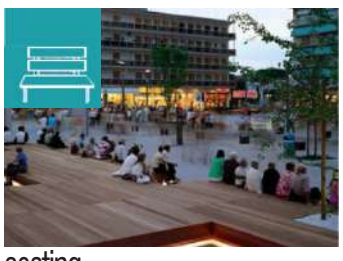

active edges


food & beverage


all ages spaces


water


human scale

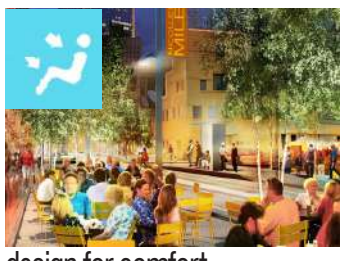

seating


art & culture


shade


public spaces management


24 / 7 spaces


design for comfort

designing to enhance well-being & happiness

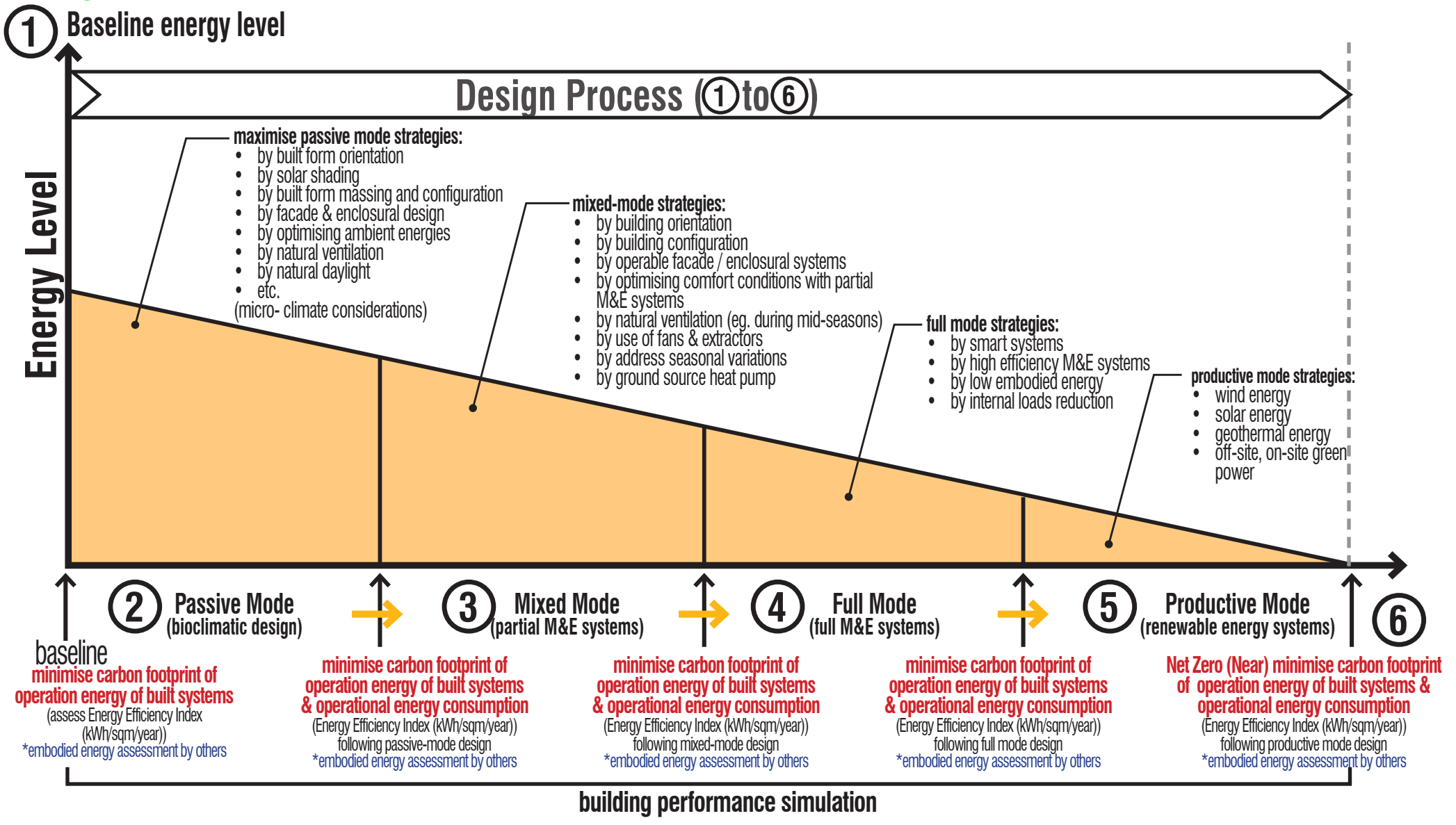
rooftop aerial jogging track

DESIGN GUIDE V

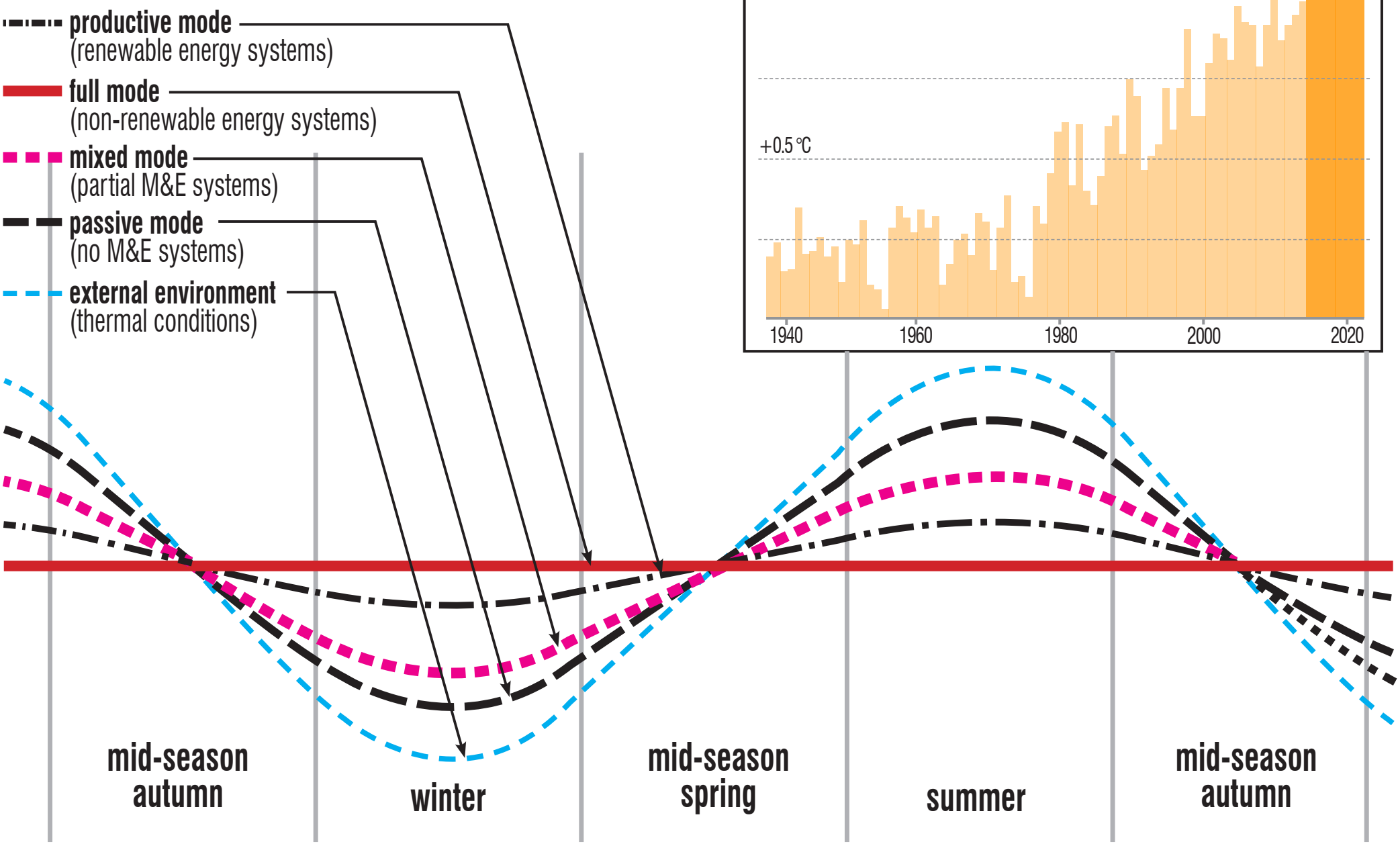
• ENERGY SYSTEMS (biointegration with other ecoinfrastructure)

Design for Net Zero Energy / Carbon Neutral Design (NZE/CND) (reduce use of fossil fuels)

design method



thermal comfort conditions in relation to design mode



season: tempered & cold climate

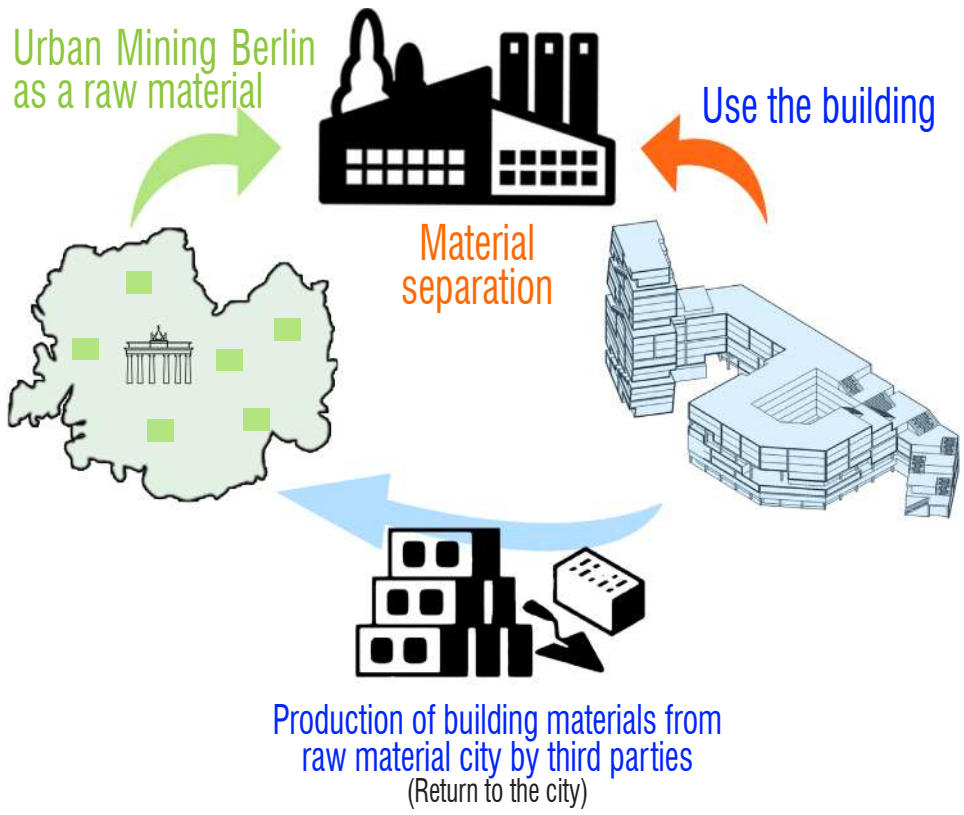
global average temperature compared to a preindustrial baseline

DESIGN GUIDE VI

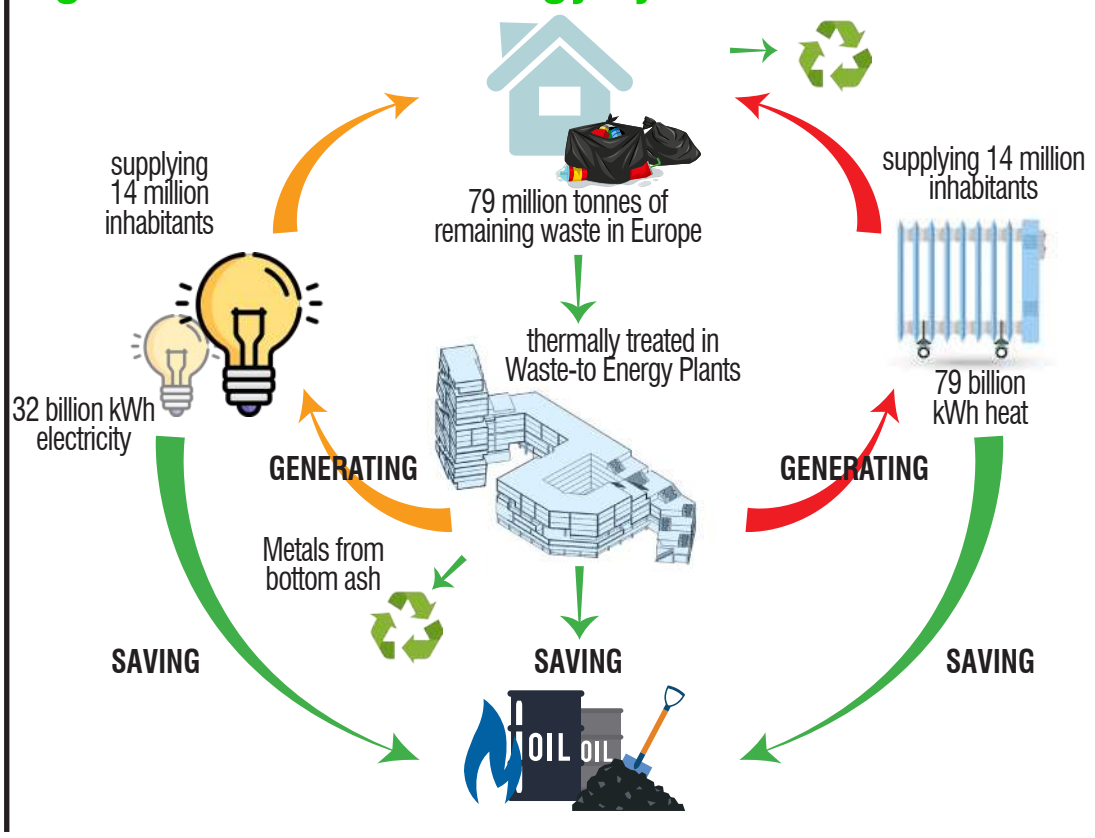
• CONSTRUCTED ECOSYSTEMS (biointegration with other ecoinfrastructure)

Design for Net Zero Waste / Emissions (NZW/E)

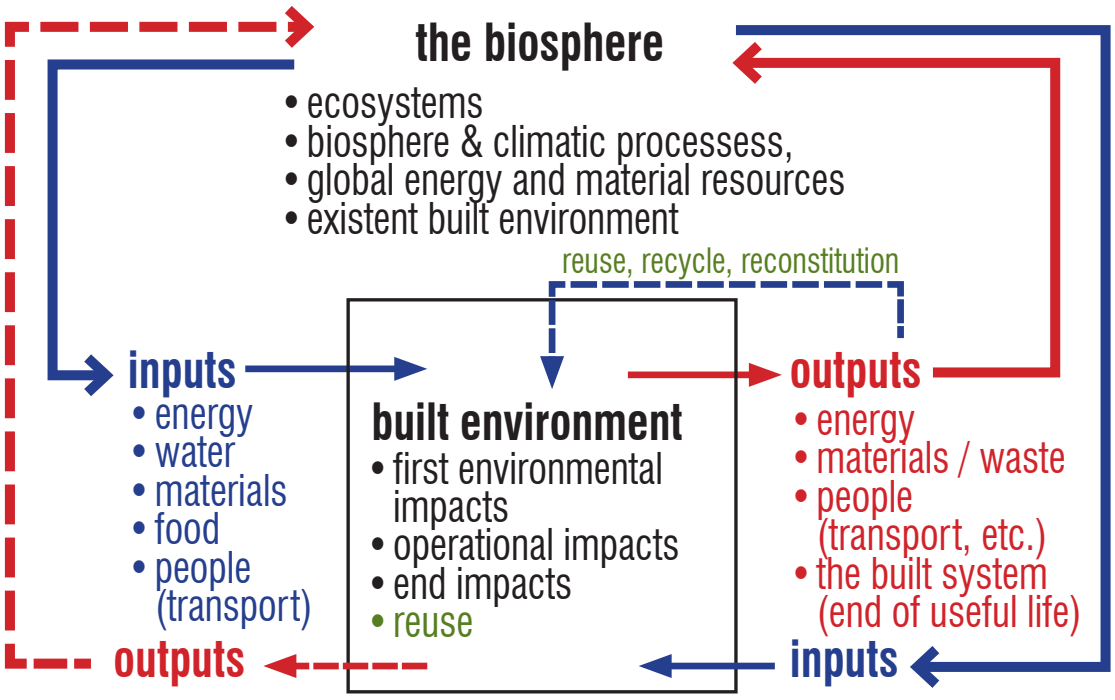
the circular economy



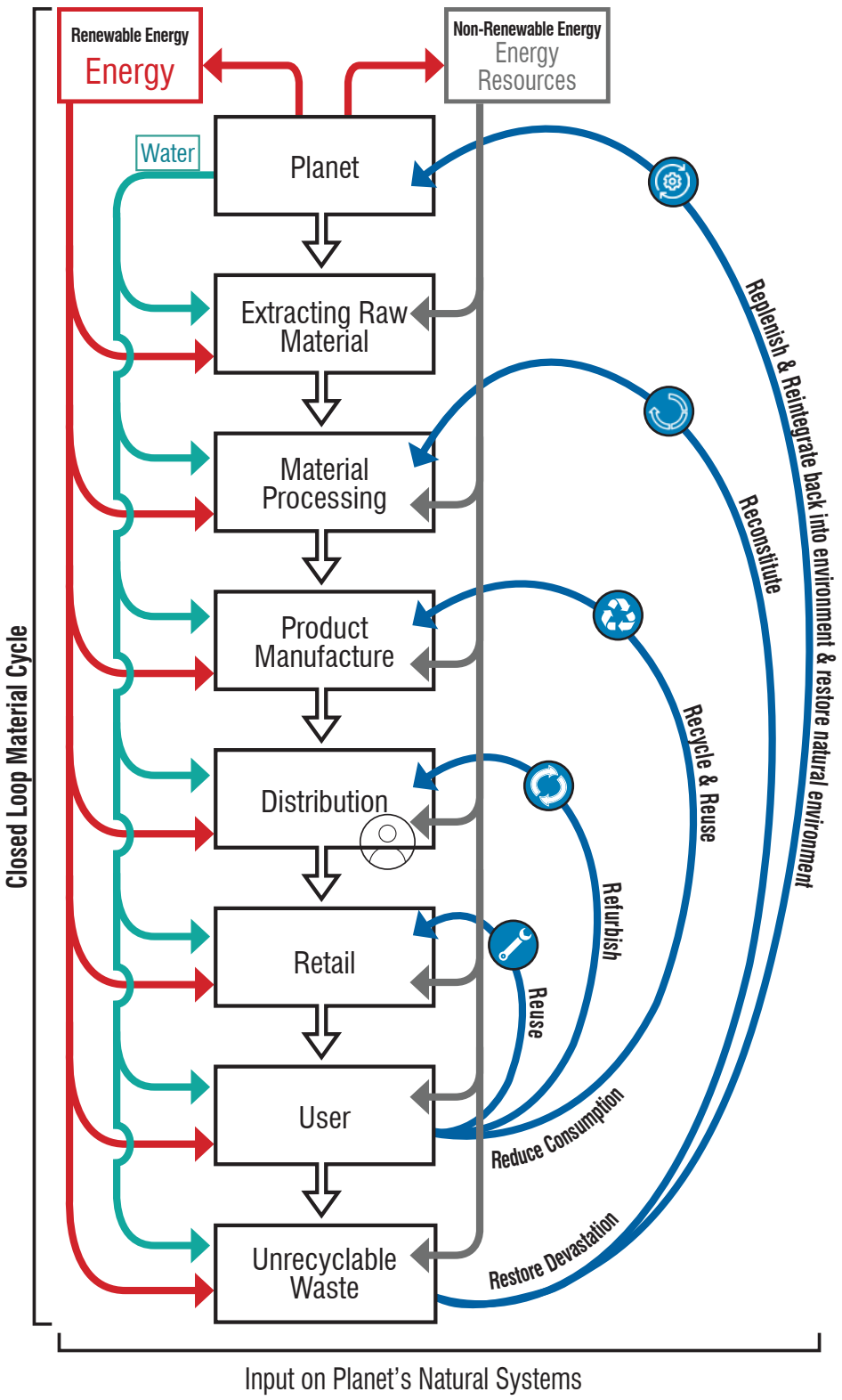
general waste-to-energy cycle



the constructed ecosystem emulates and replicates ecosystem recycling

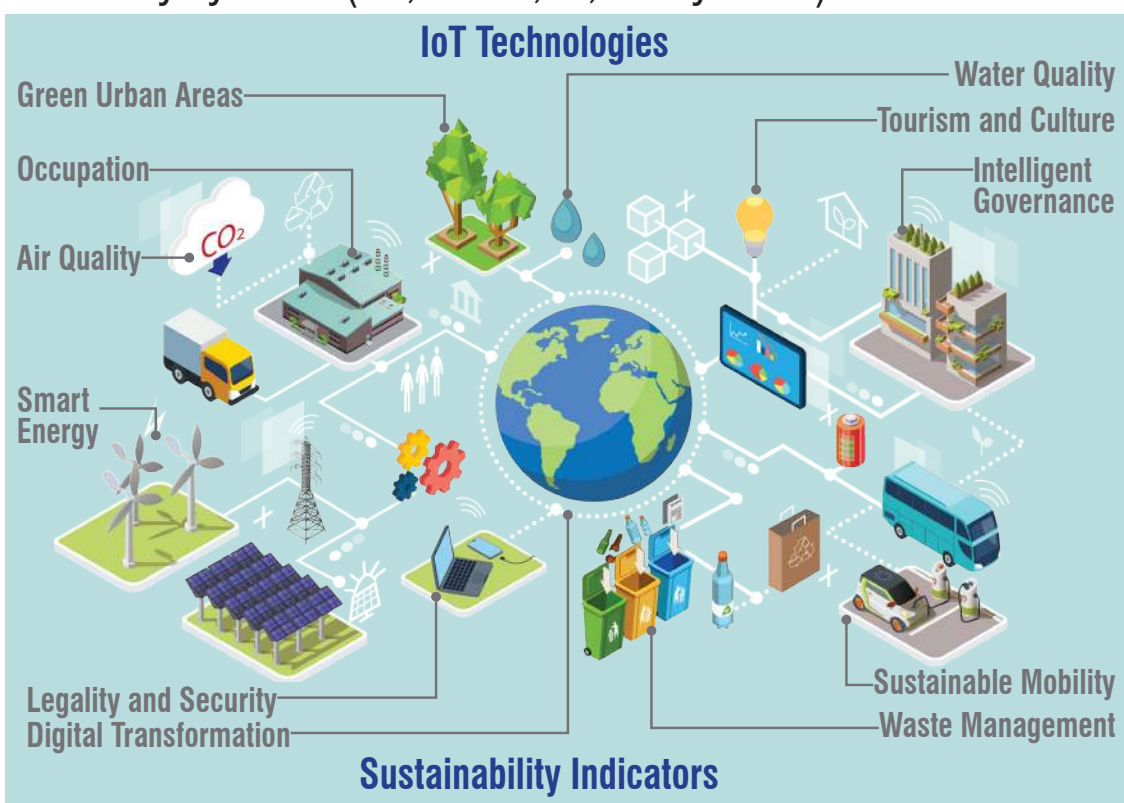


closed loop material cycle



designing for smart sustainable cities

smart city systems (5G, WiFi 6, AI, IoT systems)



Note:
- Design for reusability remanufacturability separability disassembly recyclability disposability
- Minimize maintenance and service waste Optimuze energy use Extend product life
- Self product function Assure product safety Design for upgradability.