



“Future-proofing” Infrastructure for the Anthropocene

Hillary Brown, FAIA

April 5, 2016
Seattle, WA

UW Masters in Infrastructure, Planning and Management Program
Sustainable Path Foundation
Evergreen State College Center for Sustainable Infrastructure

FOREWORD BY DAVID W. ORR

NEXTGENERATION INFRASTRUCTURE

Principles for Post-Industrial Public Works

HILLARY BROWN

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Crisis creates opportunity

Level of investments needed:

- “D+” from the American Society of Civil Engineers, 2013
- 11% of our bridges (162,000 structures) deemed ‘structurally deficient’
- \$ 3.6 trillion over 6 years to get to ‘good repair’
- US: < 1% GDP
- Europe: 5% GDP
- India : 8% GDP
- China: 9% GDP



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Infrastructure renewal as national imperative



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Challenges to conventional infrastructure design?

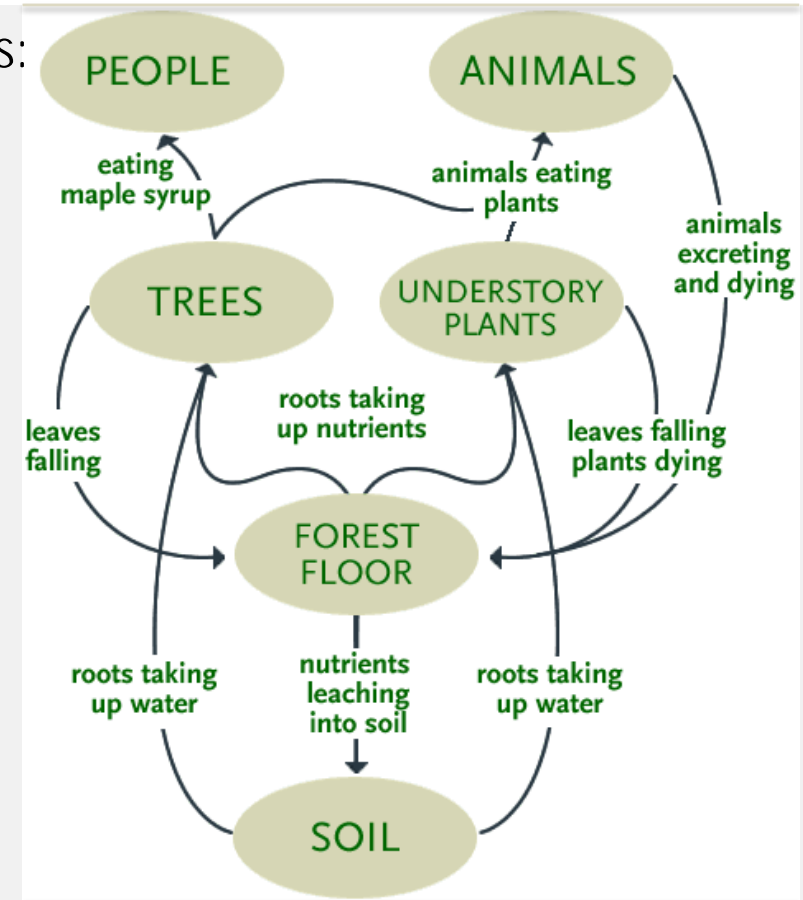
- environmental/low carbon imperatives
- NIMBYISM
- “distributed” vs. centralized systems
- design for resiliency

New habits of mind

- From “silo” separation (fragmentation) to integration
- Recognize vital interdependencies of energy, water, waste, IT and transport systems
- Capitalize on system synergies

“Infrastructural ecologies”

- Consider opportunistic relationships: technologies can be aligned and integrated synergistically
- Reflect the self-organized ‘ecosystems services’
 - water purification, waste digestion, biomass production, etc.
- Organized collectively and cooperatively, i.e. ecologically

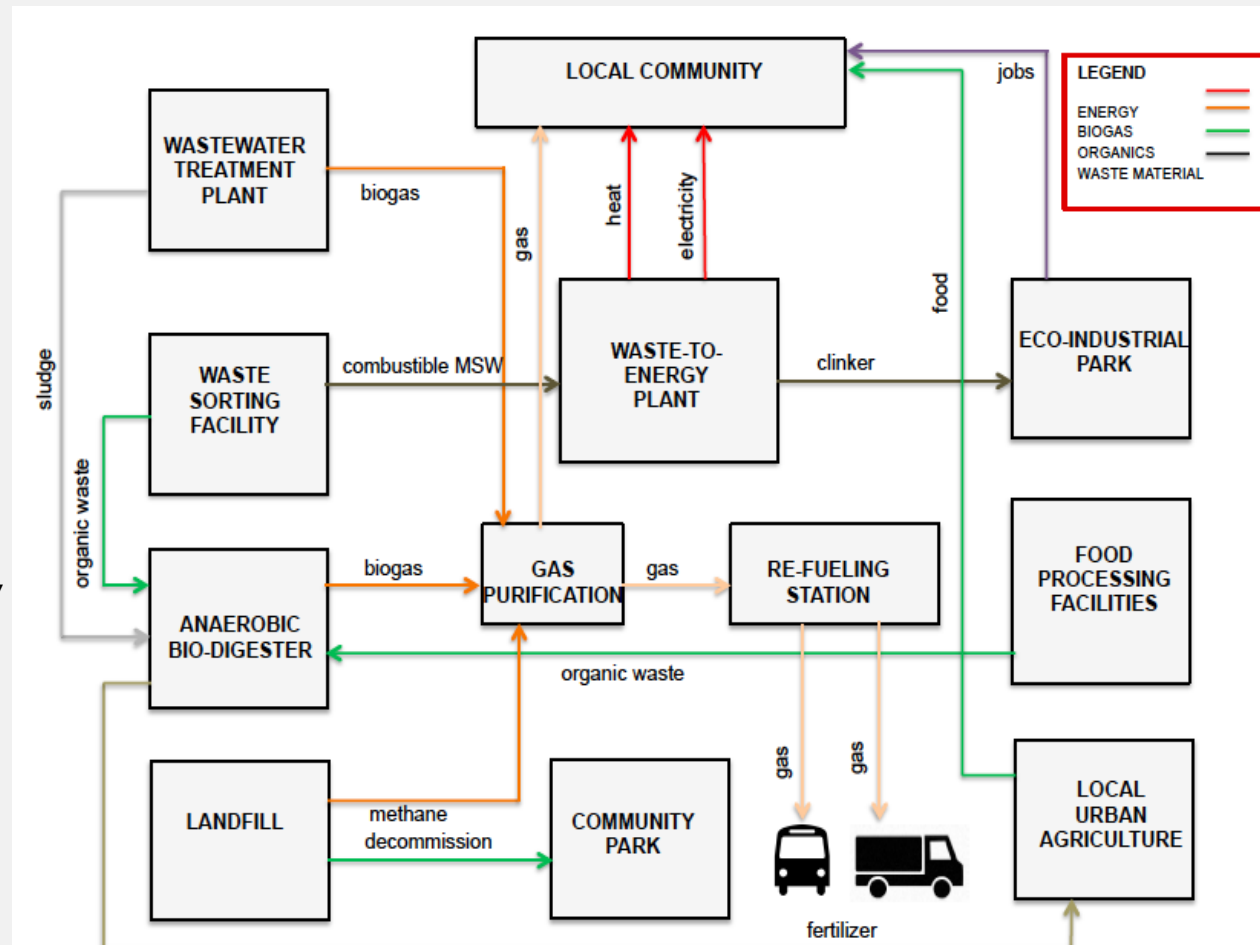


Forest eco-system

"Infrastructural ecologies"

A holistic system of beneficial exchanges across multiple sectors to reduce collective system costs, improve performance and reduce environmental and social impacts.

Fosters system synergies by proactive colocation in order to capitalize on adjacent or local land-uses, natural systems or resources



Public works and utilities that are ...

- **MULTIFACETED:** multipurpose, interconnected and synergistic
- **LOW CARBON:** reduce global warming
- ***SOFT PATH:*** work with passive, natural processes
- **COMMUNITY-FRIENDLY:** improve social contexts and serve local constituencies
- **ADAPTED:** resilient and responsive to dynamic conditions of a changing world

Justification for infrastructure ecology

Benefits/Cost savings

- Optimized land use \$
- Economies of scale \$
- Eliminated redundancies in maintenance and operations \$
- Synergistic cascading of energy and/or resources \$
- Reduced environmental impact/resource conservation
- Reduced construction disruption
- Community benefits
- Job creation and new tax revenue
- Increase resiliency

METRICS

- SO** Site optimization
- ES** Economies of scale
- OS** Operational savings
- RC** Resource Conservation
- RE** Reduced environmental impact
- RD** Reduced disruption
- PA** Public amenity /community benefit
- EB** Job creation/new revenue
- RE** Resiliency

$$\Sigma = \text{SO} + \text{ES} + \text{OS} + \text{RC} + \text{RE} + \text{RD} + \text{PA} + \text{EB} + \text{RE}$$

Multipurpose

multimodal + utilities transport

Enneüs Heerma Bridge IJberg, Amsterdam

civic plaza + sewage treatment plant

Forum/Besos Wastewater Treatment Plant, Barcelona, Spain



Multipurpose, interconnected

Multimodal transit + public park + mixed-use development

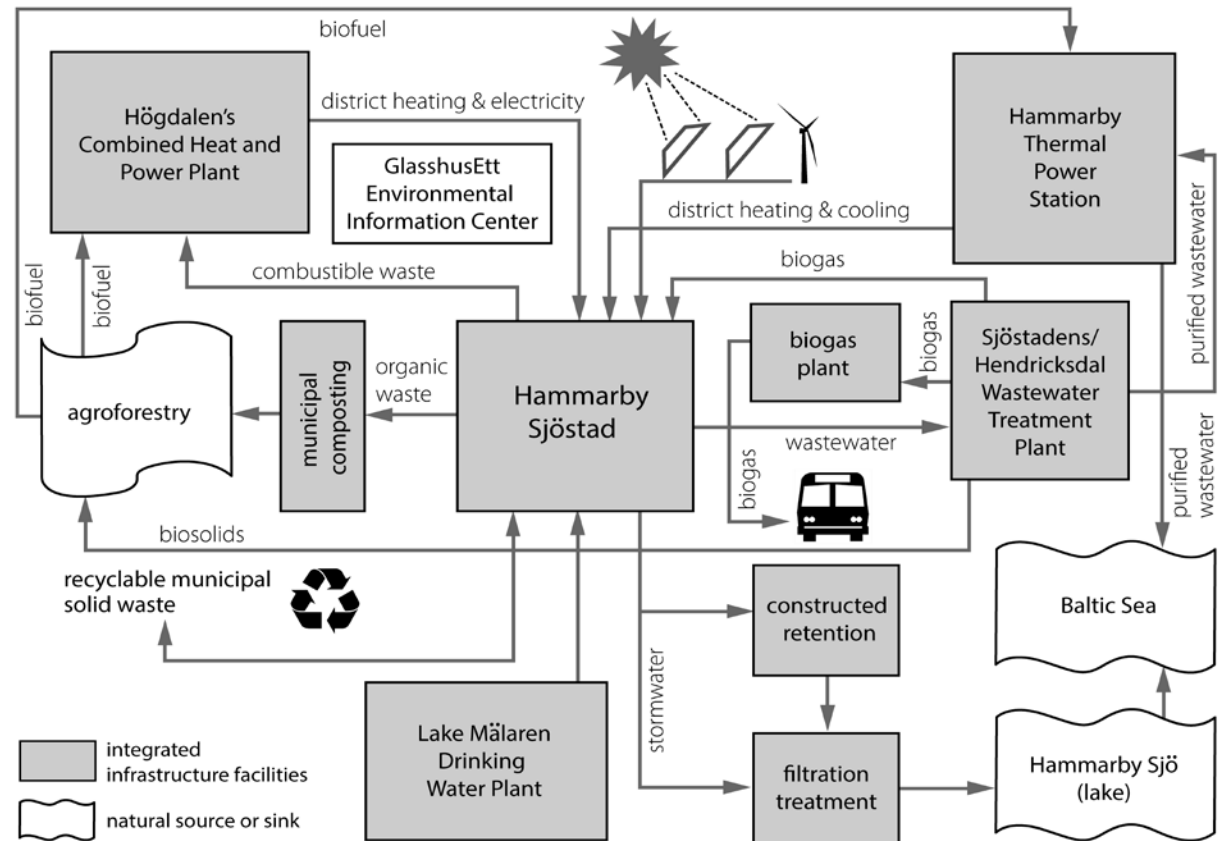
Transbay Transit Center San Francisco, CA



Rendering: Pelli, Clarke, Pelli Architects. Courtesy Transbay Joint Powers

Networked utilities: closed loop cycling of energy and matter

Hammarby Sjöstad, Stockholm, Sweden



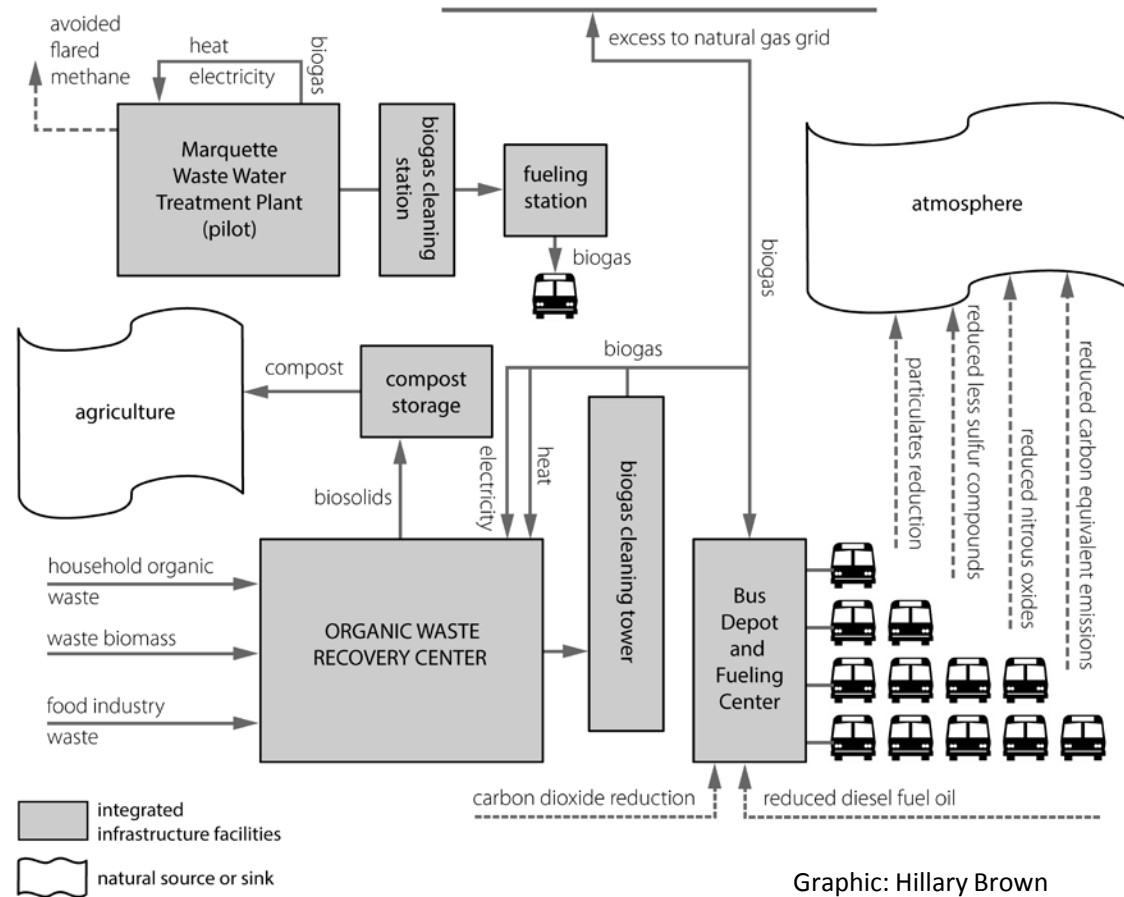
Graphic: Hillary Brown

Biogas recovered from organic waste and wastewater

Lille Métropole Organic Waste Recovery Center and Transfer Center, Lille, France



Courtesy ADEME & Vous

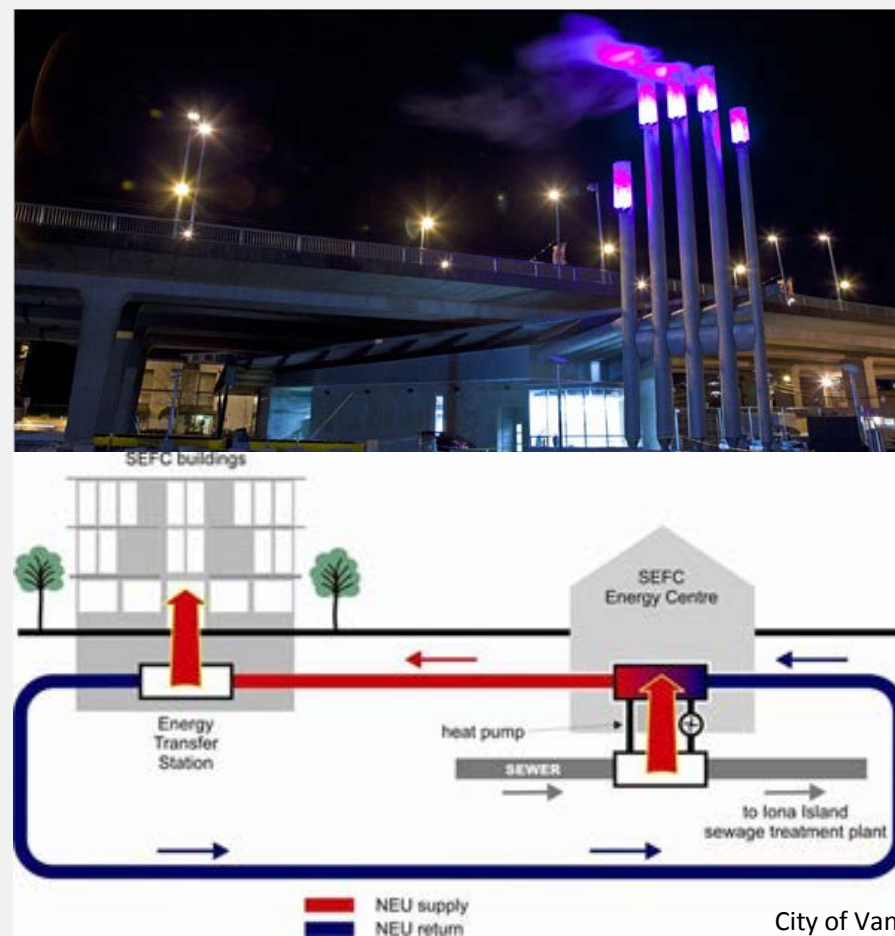


Graphic: Hillary Brown

Southeast False Creek Neighborhood Energy Utility

City of Vancouver, British Columbia CA

- Thermal energy recovery from sewage supplies 3.2 MW of district heating and hot water to Southeast False Creek neighborhood
- 60% GHG reductions

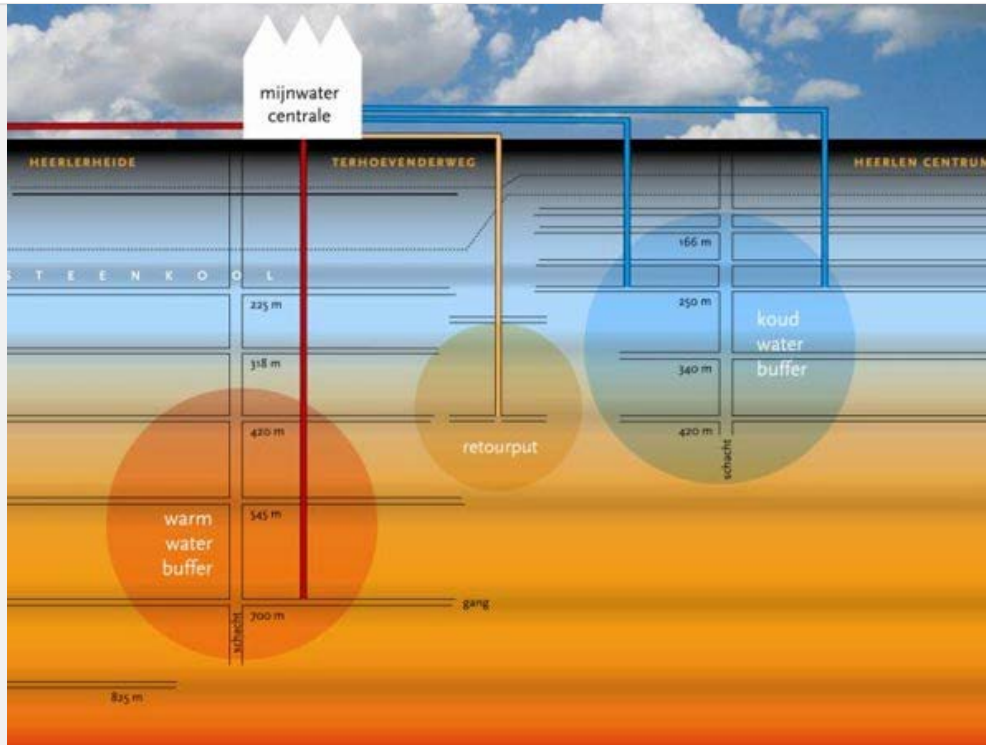


City of Vancouver.

Carbon-reducing (green heat and power)

District heating + cooling from town's abandoned coal mine

The Minewater project, Heerlen, The Netherlands



"Soft-path" solution

Multiuse public waterfront park+ wastewater treatment plant *Sherbourne Common, Toronto Waterfront, Toronto Canada*



Shai Gil, Courtesy Teeple Architects

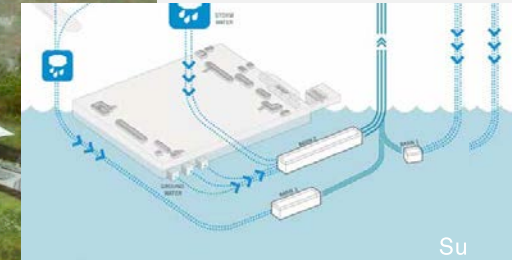
"Soft-path" solution

Driving range/public facilities/ water filtration treatment plant

Croton Water Filtration Plant Bronx, New York



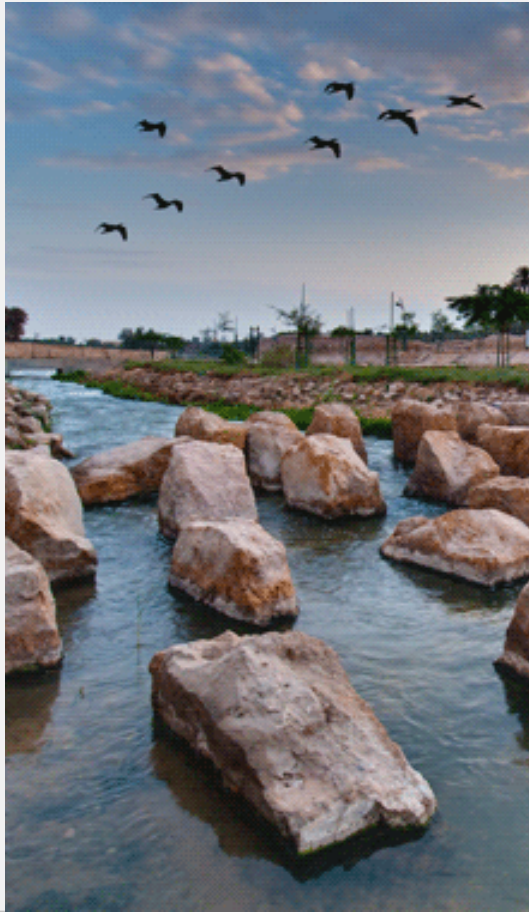
Courtesy Grimshaw



“Soft-path” solution

Urban river water bioremediation for reuse + public park

Wadi Hanifah Bioremediation Facility Riyadh, Saudi Arabia



Courtesy Arriyadh Development Authority | Moriyama & Teshima | Buro Happold

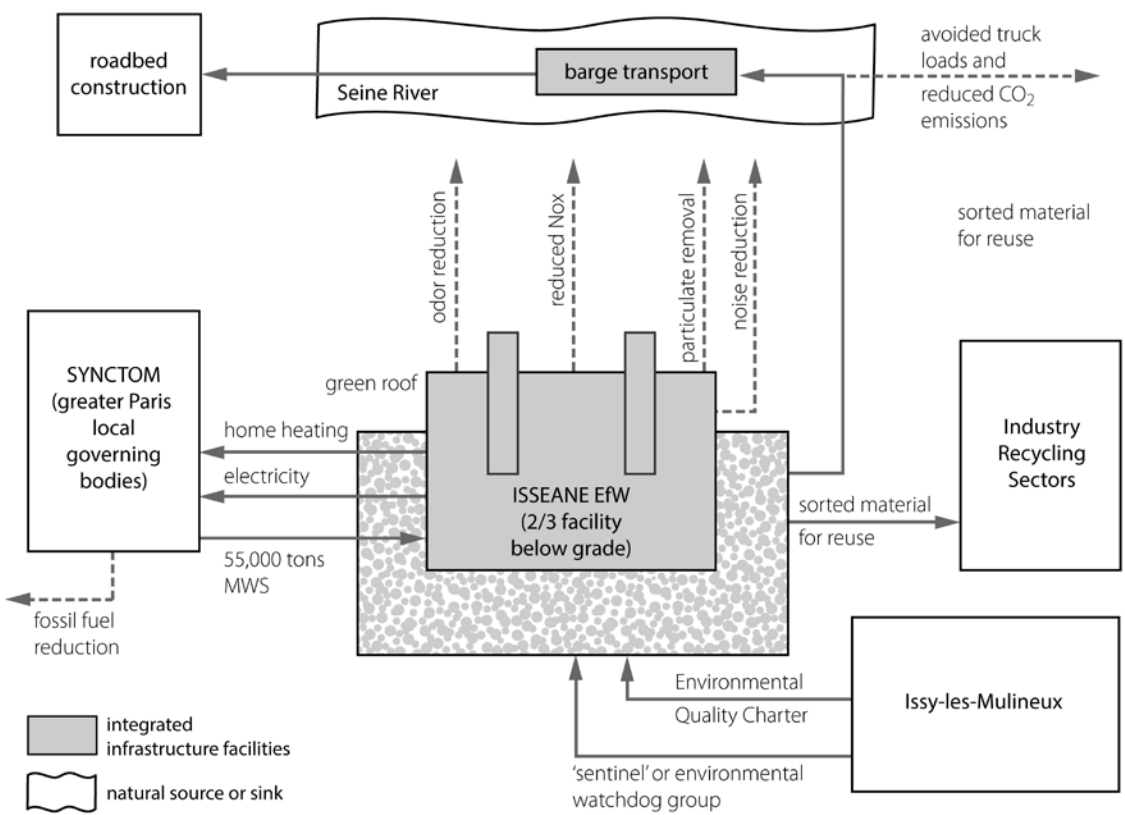
Ecorium ("museum of garbage")+ CHP + waste heat reuse

Naka Waste-to-Energy Plant Hiroshima, Japan



Low profile organic waste sorting center + energy from waste facility

Isséane: Issy-les-Moulineaux, France



Graphic: Hillary Brown

Waste to Heat + Energy as Ski Slope

Amager Bakke plant Copenhagen, Denmark



Courtesy Bjarke Ingels Group



Sea and Flooding Protection - Plus

Various locations, The Netherlands



Sunken polder reserved for emergency water storage

Storm Surge and Flooding Protection +

Dak Park, Rotterdam, The Netherlands



Images © Michael Singer Studio, photo: David Stansbury

Hard Solutions: Water Squares (multi-use)

Rotterdam, The Netherlands



Hard Solutions: Water Squares (multi-use)

Rotterdam, The Netherlands



Images © Michael Singer Studio, photo: David Stansbury

Hard Solutions: Garage & Stormwater Storage

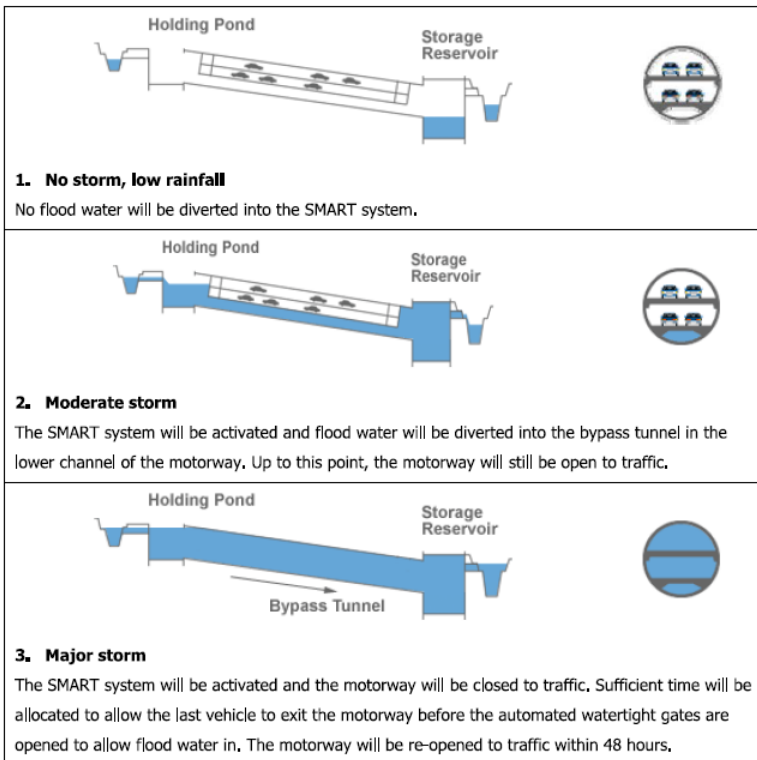
Rotterdam, The Netherlands



Images © Michael Singer Studio, photo: David Stansbury

Hard Solutions: Tunnel & Stormwater Storage

Kuala Lumpur, Malaysia



Images © Michael Singer Studio, photo: David Stansbury

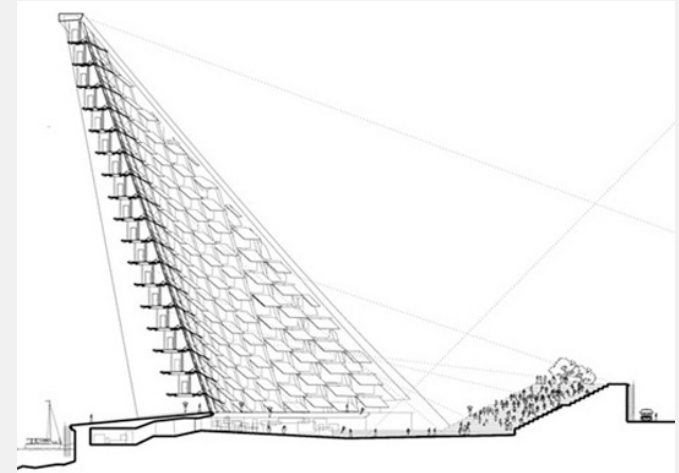
Eastern Scheldt Storm Surge Barrier/ Tidal Energy/ Parkland

Eastern Scheldt , *The Netherlands*



Solar desalination plant + civic amphitheater

"Teatro del Agua" – Tenerife, Canary Islands, Spain



“Think systematically; experiment locally”

- Oklahoma City sales tax : \$ 750 M for parks , bike trails, streetcar system and transit hub
- The Chicago Infrastructure Trust- private investment for cross-sector urban projects
- California I-Bank
- West Coast Infrastructure Exchange (WCX) regional energy, water and transport

State-developed alternative investment vehicles

- State revolving funds (SRFs)
- State Infrastructure banks (SIBs)
- “Green” banks

Financing entities adopt outcome-oriented, threshold, or supplementary criteria along lines of 5 principles

Award formulas aligned with 5 principles

prioritize projects that:

Support Mixed Land Use:

- Mixed-use by two or more sectors of under-utilized, degraded or brownfield property
- Shared use of roads, operation, and maintenance facilities and utilities

Mitigate CO₂ Production

- operational energy efficiency coupled with on-site production of, or purchase of green power
- Interlinked facilities that reduce energy demand and environmental impacts through the recovery and exchange of waste, wastewater, or waste heat or other useful matter.

Award formulas aligned with 5 principles

prioritize projects that:

Incorporate green infrastructure

- Systems planned in accordance with integrated water-resource management programs
- On-site water harvesting, retention, and/or treatment for non-potable reuse or for direct infiltration, and to eliminate stormwater runoff

Integrate social and/or economic benefits

- Improved quality of life, and economic competitiveness for the community through inclusion of community amenities

Include climate adaptation measures

- place-based measures to achieve resilience against extreme weather events, or sited in climate-sensitive areas, with priority given to soft infrastructure
- Inclusion of safeguards (e.g., redundancy) to reduce cross-sectoral cascading failures.

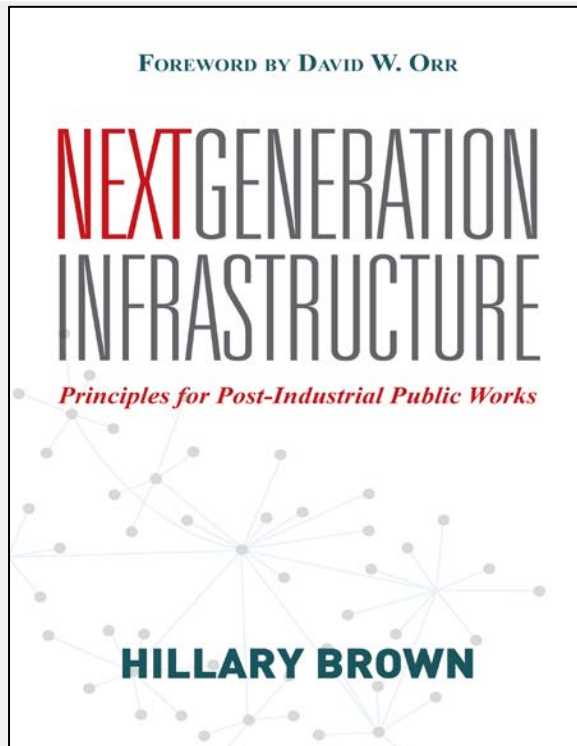
Commission Roles and Responsibilities

Advocate for cross-sector infrastructural improvements

- Promote integrated infrastructure development through advocacy, outreach and advisory technical support
- Broker between state and local authorities, service providers, and other stakeholders as well as private investors and equity owners
- Encourage blending of state (or city) funds from across multiple capital programs

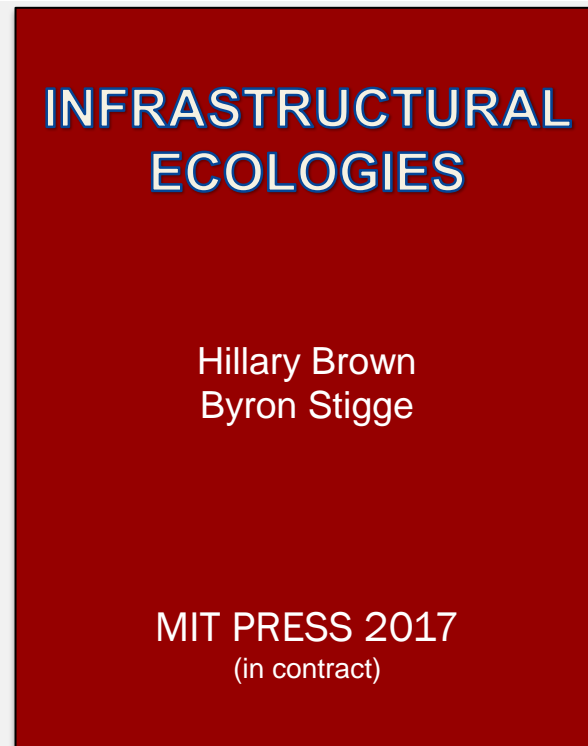
Thanks for your attention

QUESTIONS AND COMMENTS!



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