Advantages of green building design

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WHAT IS SUSTAINABILITY?

United Nations Brundtland Commission (1987):

- Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

International Union for Conservation of Nature (1997)

- Improving the quality of human life while living within the carrying capacity of the Earth's supporting eco-systems.

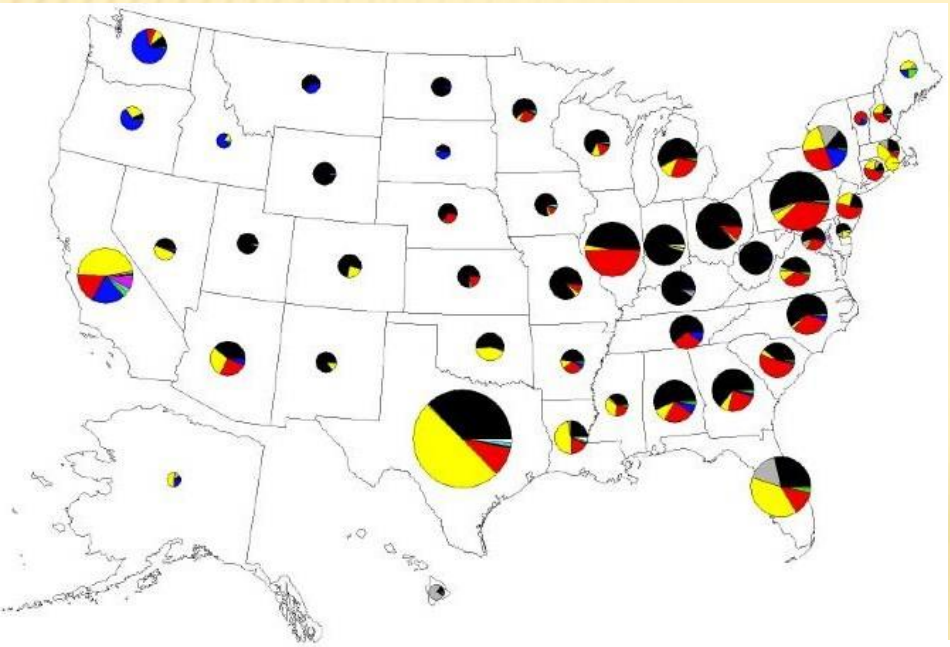
US Environmental Protection Agency (EPA):

- Simple principle: Everything that we need for our survival and well-being depends, either directly or indirectly, on our natural environment.
- Creates and maintains the conditions under which humans and nature can exist in productive harmony, that permit fulfilling the social, economic and other requirements of present and future generations.

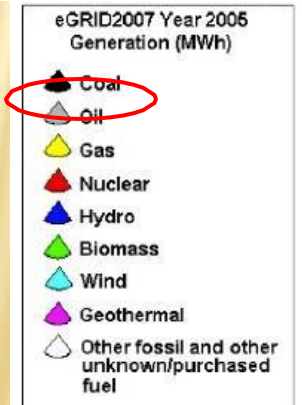
ENERGY: US SUPPLY BY REGION

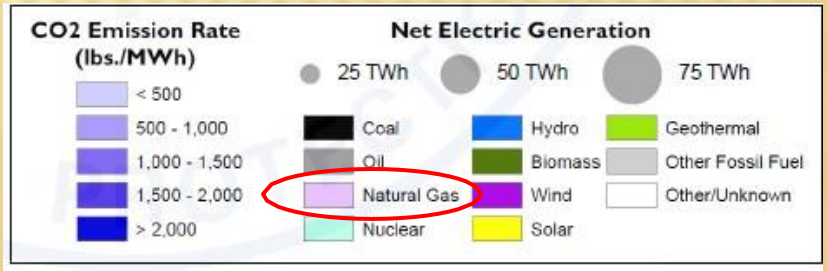
Electricity Generation by Fuel Type & CO2 Emission Rates: 2005 vs. 2010

2005 Data



2010 Data

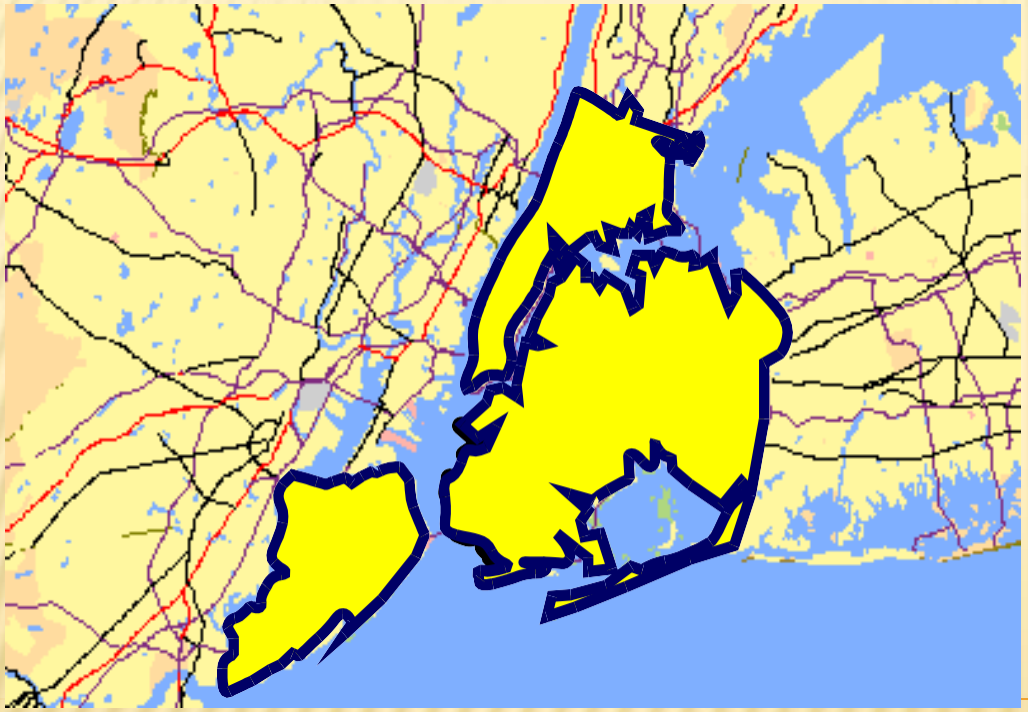




Energy: Solar

if we cover all of NYC with Solar Panels…

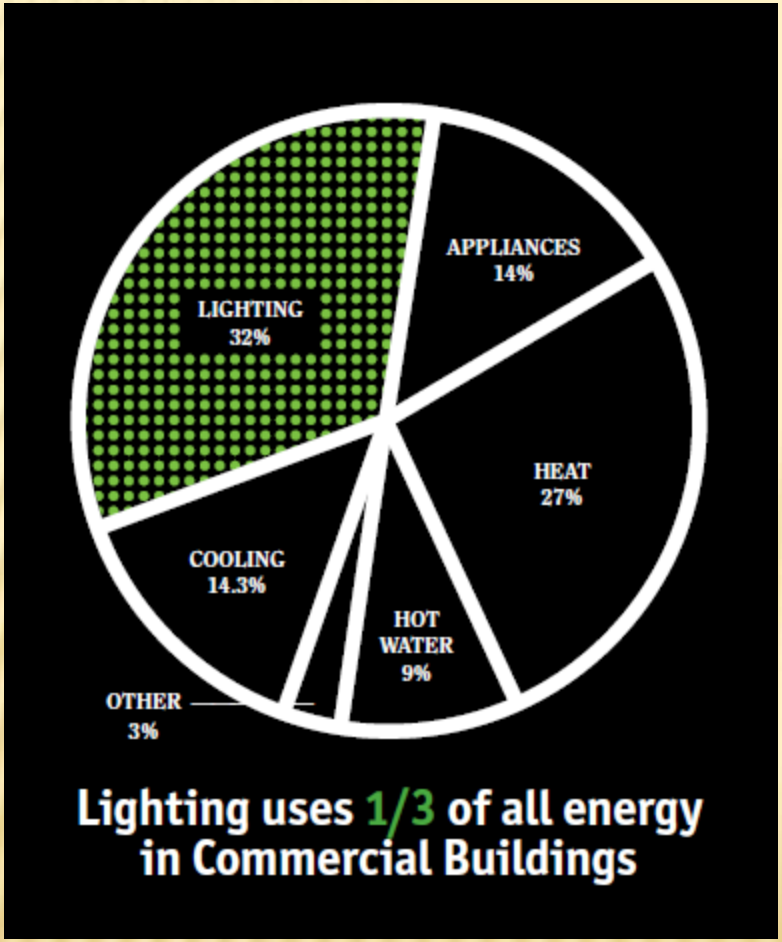
125 billion kWh per year

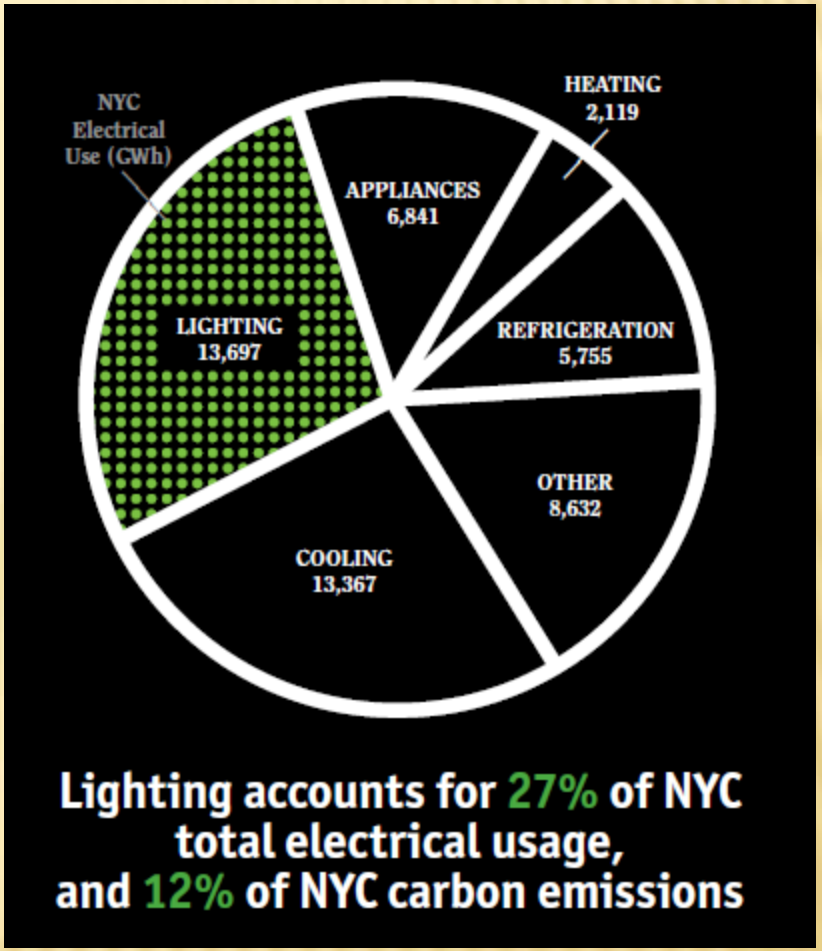


Perez et al., ASRC

2.5 CONED total generation

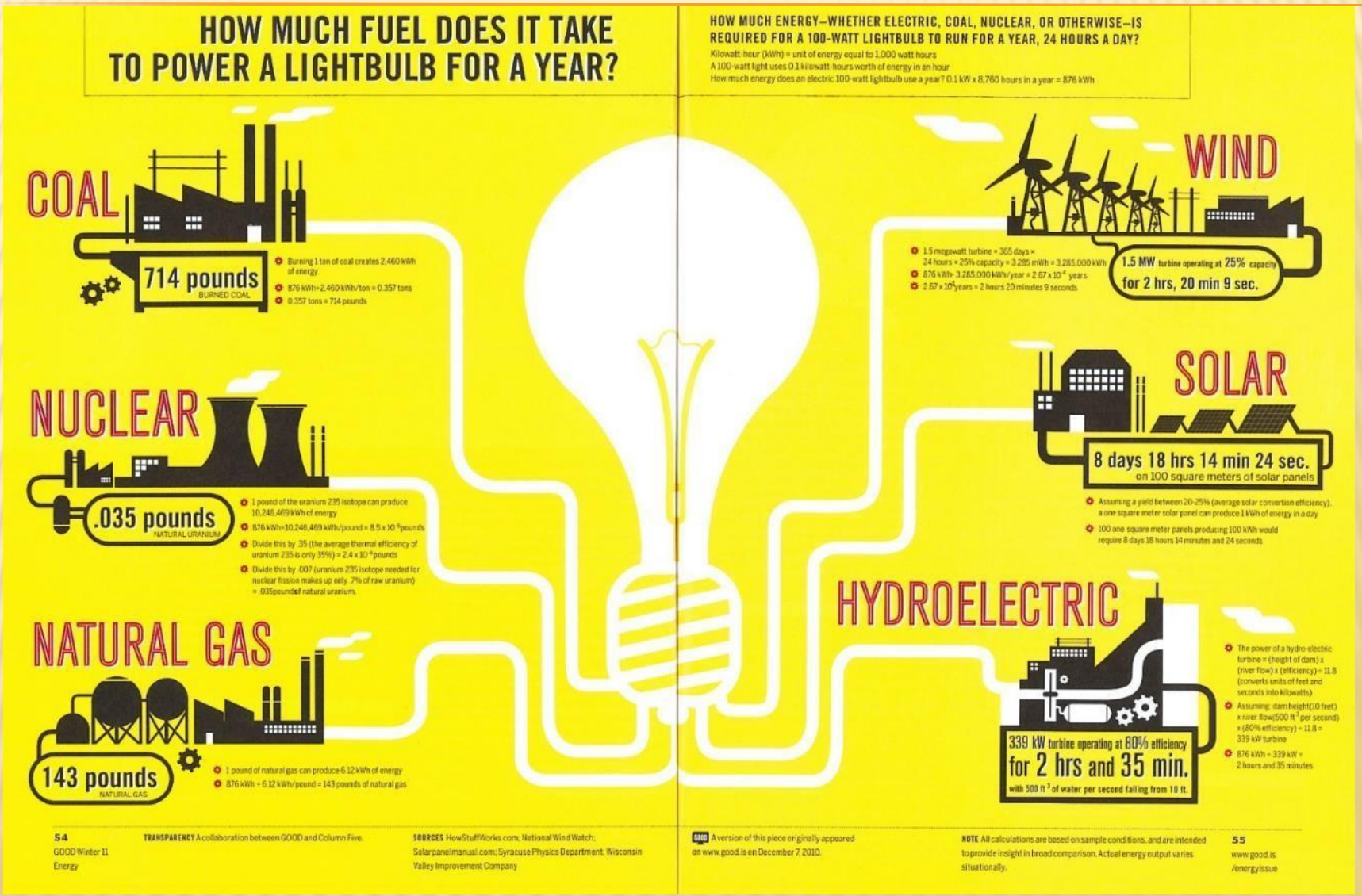
ENERGY:LIGHTING IN NEW YORK CITY





slide credit: Green Light New York, 2012

ENERGY: ELECTRICITY



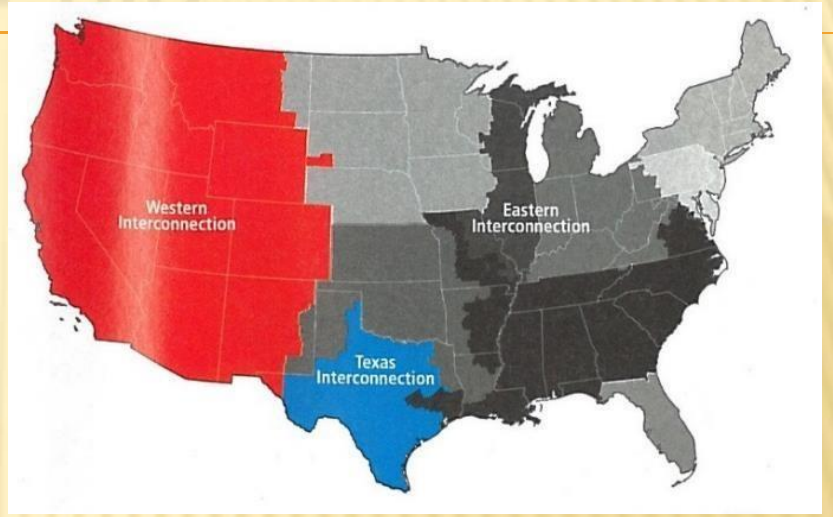
Good Magazine, Winter 2011

ENERGY: ELECTRICITY GRID

Scientific American 6/16/09

What is the Power Grid?

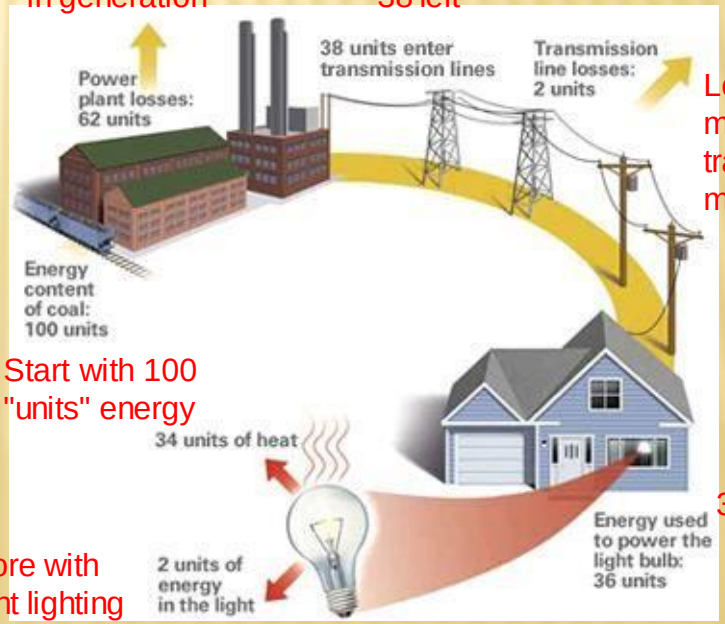
- US: 3 major interconnected regional grids
  - Western
  - Texas
  - Eastern (comprised of smaller grids)
- The grid is comprised of:
  - Power generation plants (coal, natural gas, nuclear, renewables, etc.)
  - Power distribution network (substations, transmission lines, feeders, etc)



- System losses (inefficiencies):
  - Transmission losses during distribution of electricity over long distances by cables.
  - End result: Only around 1/3 of the original fuel burned is actually converted into electricity.

Lose 62 in generation

38 left



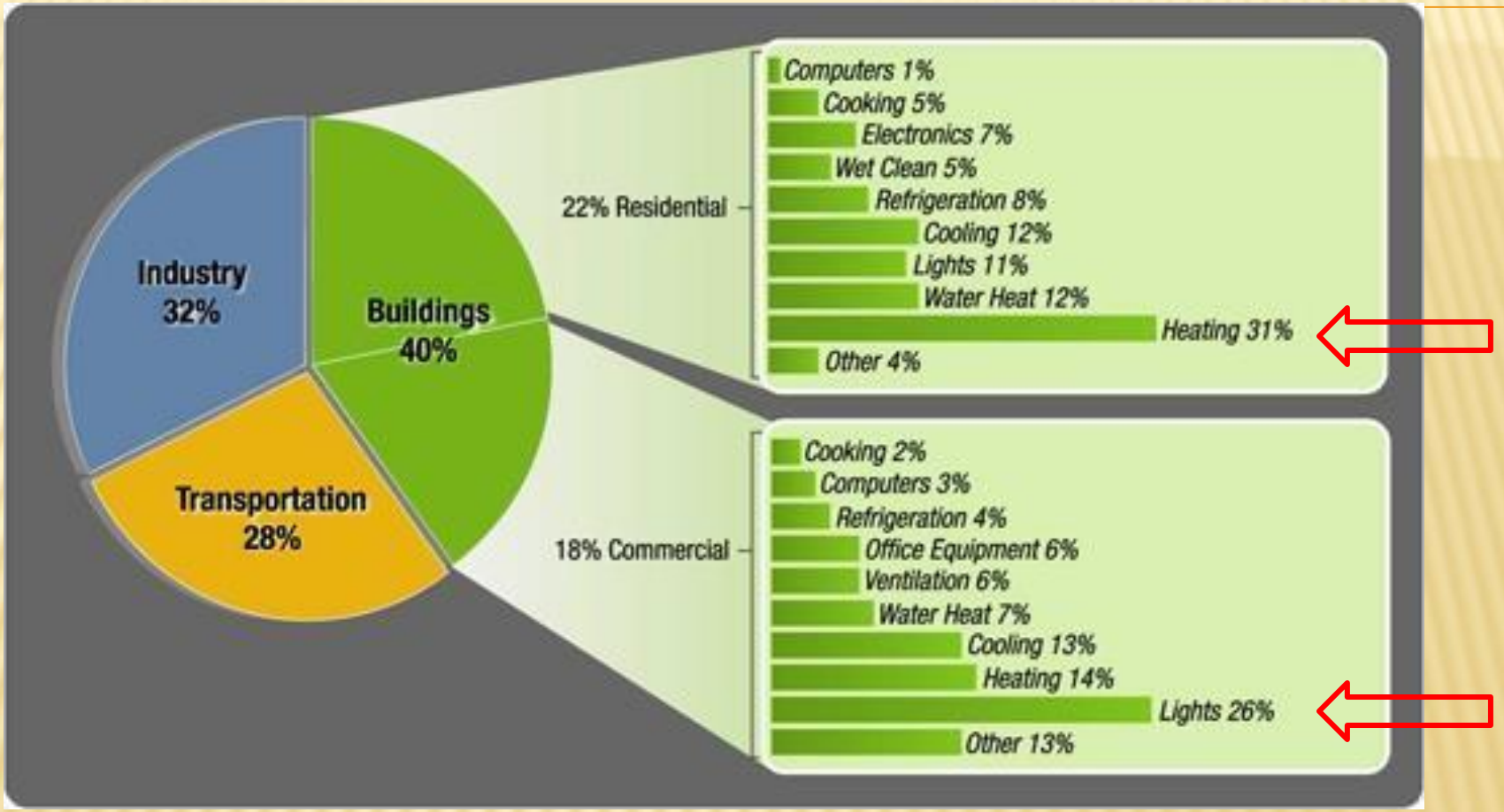
Lose 2 more in trans-mission

Start with 100 "units" energy

36 left

Lose more with inefficient lighting

ENERGY: HOW IS IT USED IN BUILDINGS?

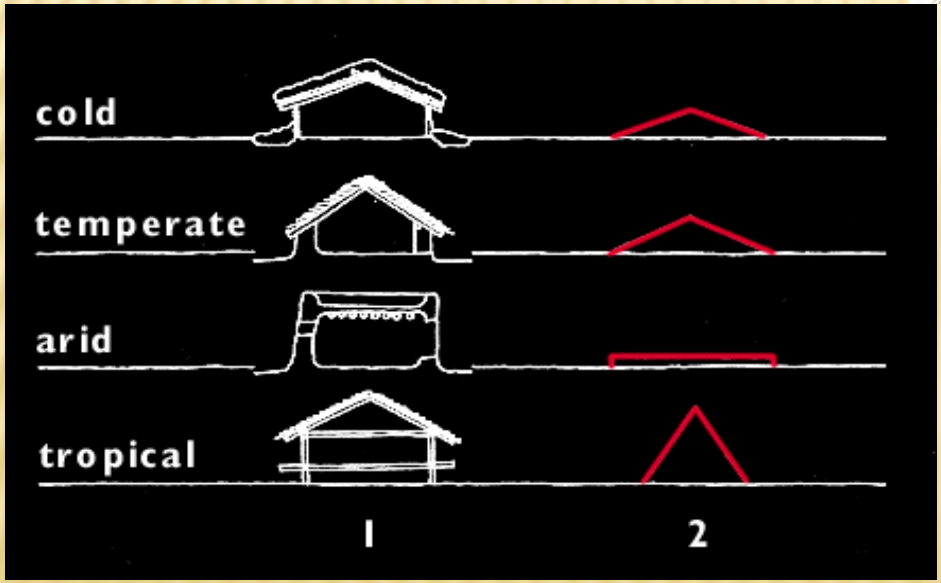


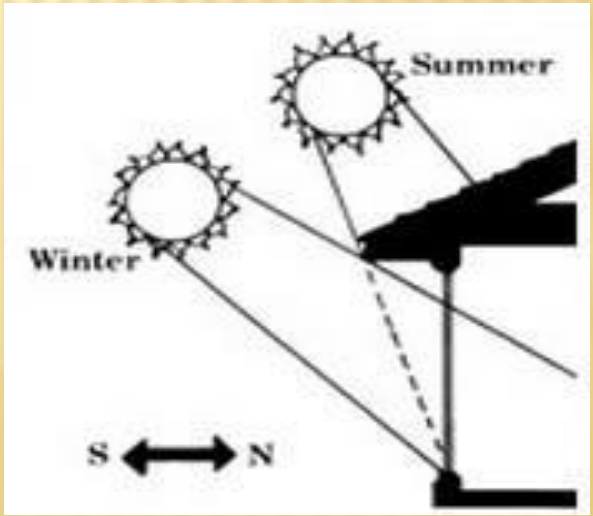
Building sector consumes 40% of the energy resources in the US.

GREEN BUILDING DESIGN:

How do we define “Green”?

- High performance
- LEED certified
- Net zero
- Healthy building





ENERGY: IMPORTANT METRICS (ENERGY STAR SCORE)

How Do We Compare Buildings?

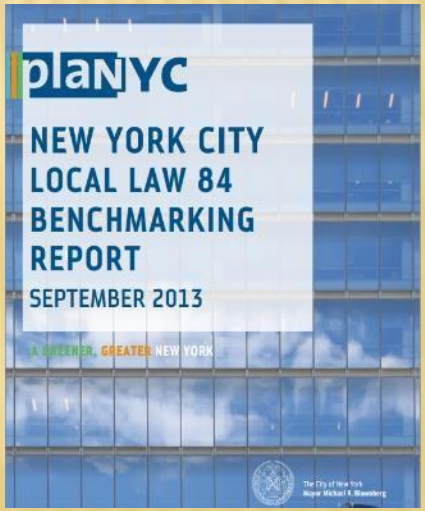
Image: EPA Energy Star

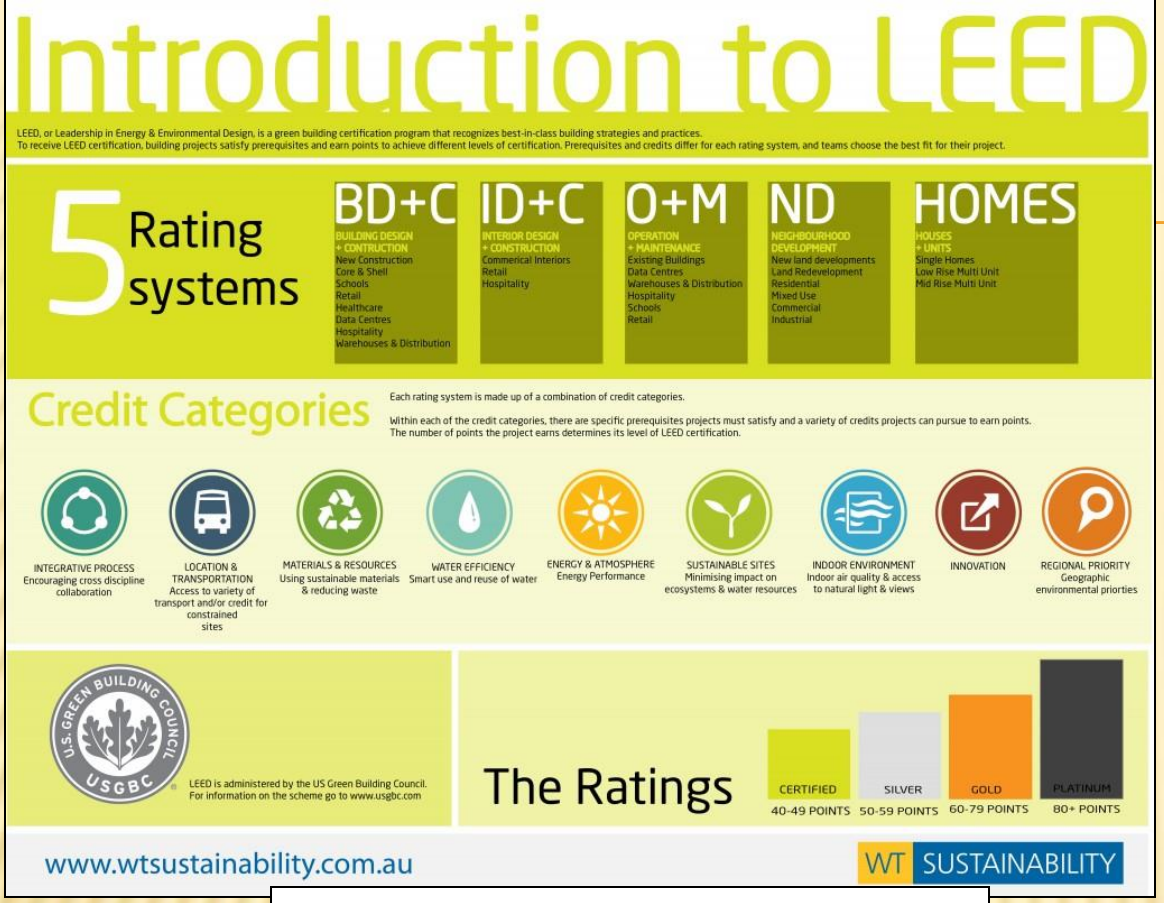
Energy Star score

- Compares your building to national average for that particular building type
- 1 – 100 ENERGY STAR score
- Score 50 is median (average)
- Score 75 (75th percentile):
  - Means your building is better than 75% of similar buildings nationwide
  - Your building can be Energy Star certified
- 25 different building types
- "Benchmarking": compare your building's performance against similar buildings

New York City

- NYC Local Law 84
- Benchmarking data is public (city, large commercial, and large apt. buildings)





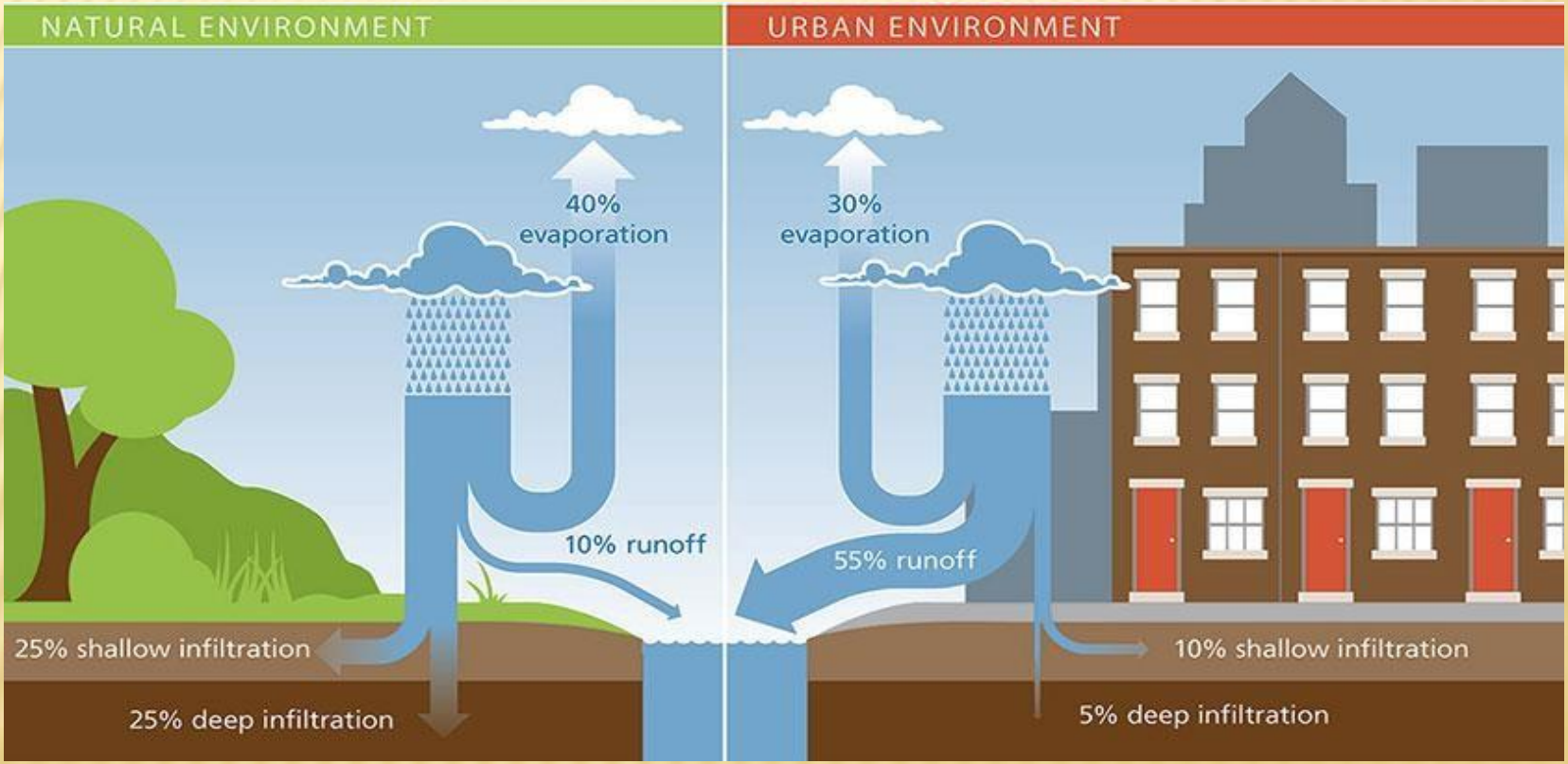
LEED is one of the best known green building rating program, and is used internationally, “certifying 1.5 million square feet of building space each day in 135 countries” with more than 54,000 projects currently participating.

The comprehensive green building certification program includes five separate rating “families”, each of which are further broken down into project types.

The LEED v4 system – released November 2013 – addresses 26 different types of construction situations.

The Hydrologic Cycle

- In "natural," undeveloped conditions, most rainfall either infiltrates or evaporates back into the air.
- Land development (buildings, roads, driveways, parking lots) alters the Hydrologic Cycle.
  - Less infiltration due to more impervious surfaces
  - Less evaporation due to less vegetation.
  - More runoff directly into water bodies (rivers, streams), carrying pollutants with it.

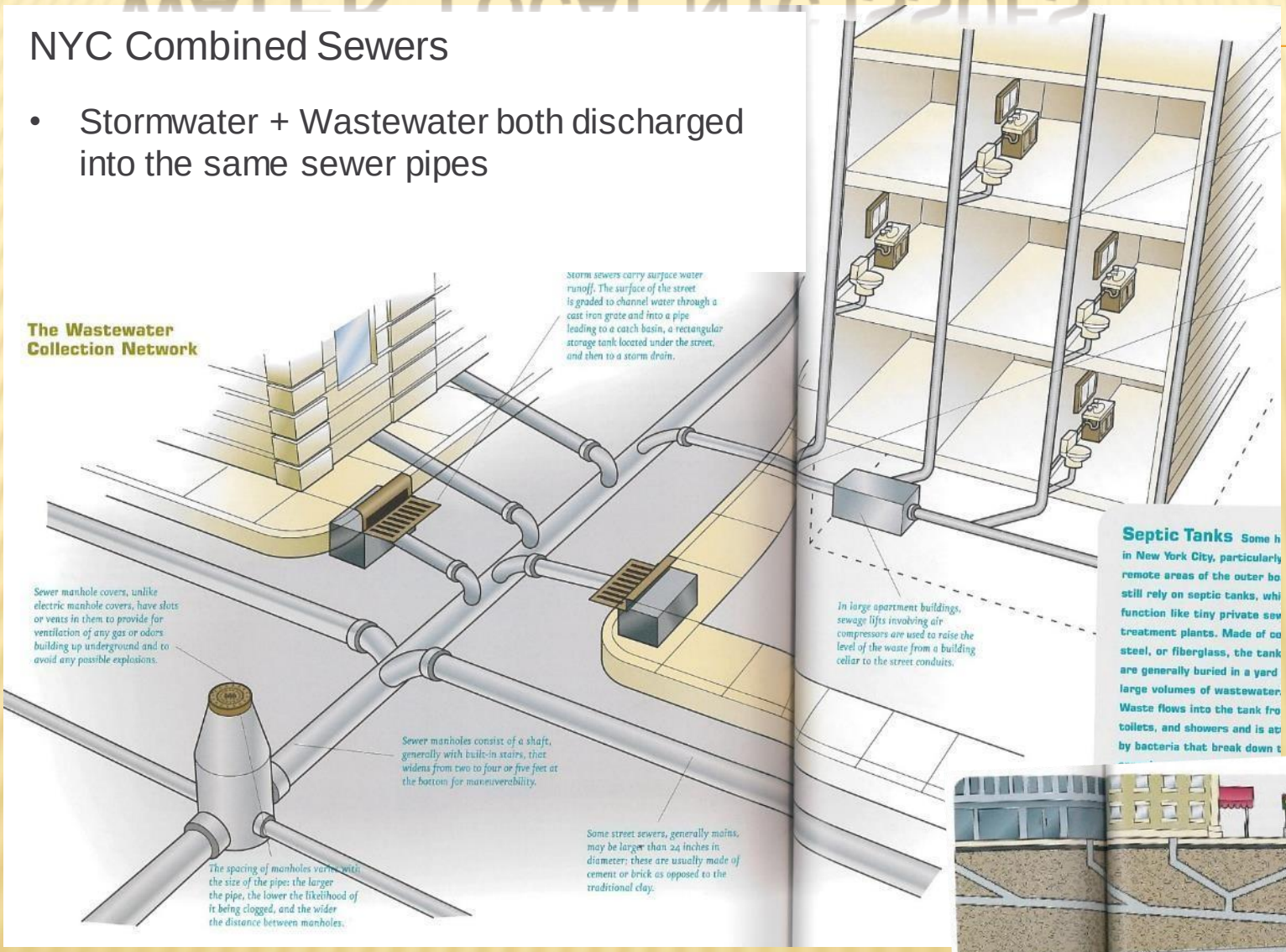


Effects of Urbanization on the Hydrologic Cycle
Image: Philadelphia Water Dept (PWD)
https://www.pwdplanreview.org/manual/introduction

WATER: LOCAL NYC ISSUES

NYC Combined Sewers

- Stormwater + Wastewater both discharged into the same sewer pipes

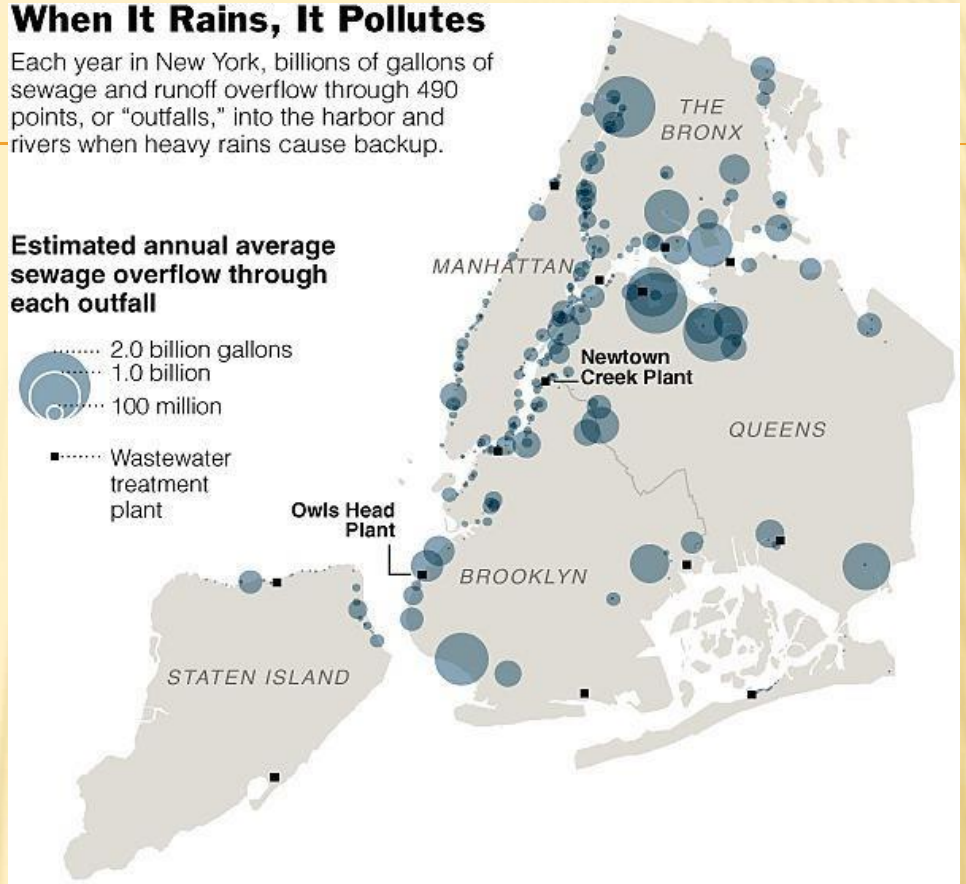


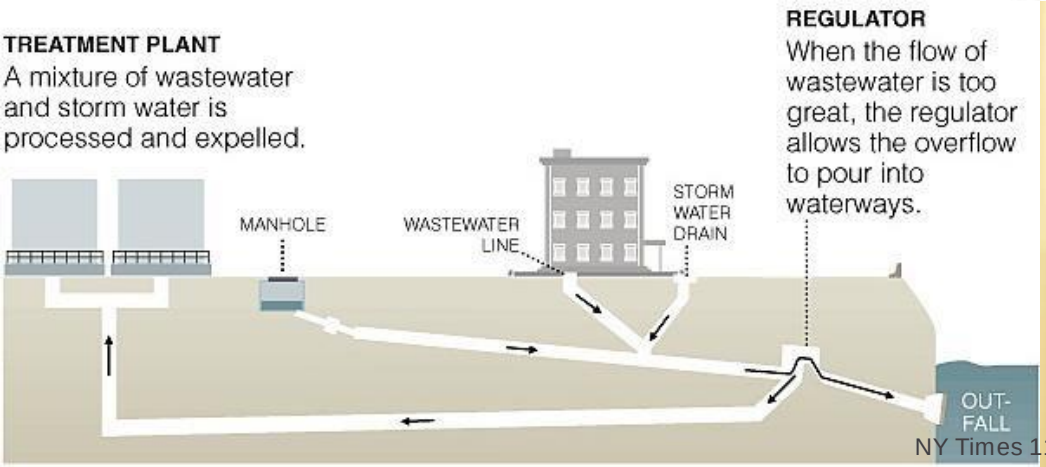
The Works by Kate Ascher

WATER: LOCAL NYC ISSUES

NYC Combined Sewers: CSOs

- During heavy rain and snow storms, combined sewers receive higher than normal flows.
- Treatment plants are unable to handle flows that are more than 2x design capacity
- When this occurs, a mix of excess stormwater + untreated wastewater discharges directly into the City's waterways at certain outfalls.
- CSO's are a concern due to their effect on water quality and recreational uses



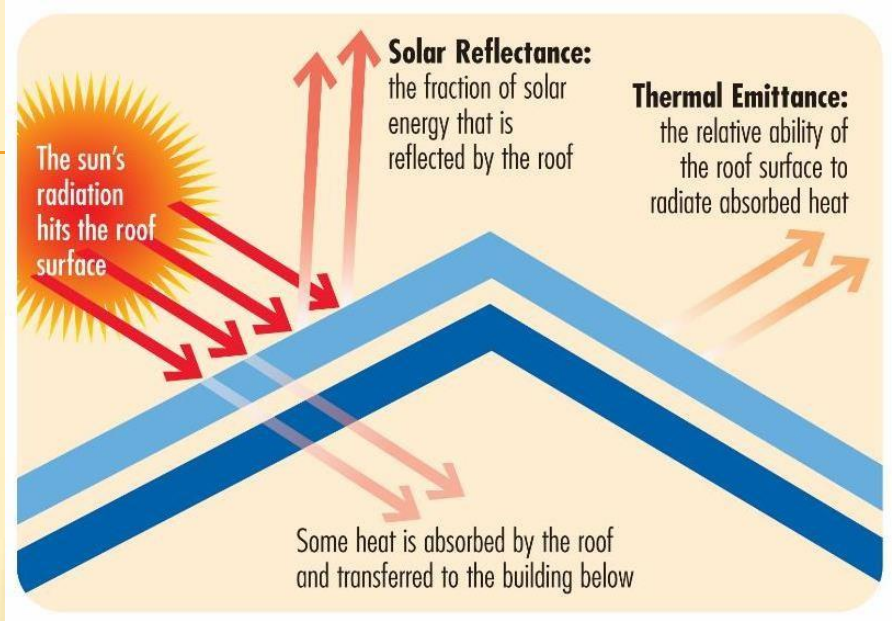


NY Times 11/22/2009

ROOFS

Solar Radiation on the Roof

- Reflected
- Absorbed
- Emitted



Urban Heat Island Effect

- Phenomenon in which cities and urban areas are several degrees hotter than surrounding areas
- Due to lack of vegetation and many dark colored surfaces (roofs, pavement) that absorb, hold, and slowly re-radiate heat

Boston, MA surface temps, 2009
http://www.urbanheatislands.com/

GREEN ROOFS

Green Roofs

Extensive Type

- Shallow soil (4" to 6")
- Typically low growing plants like sedums, which have shallow roots and do not require deep soil
- Can be built up in layers (membrane, protection layers, etc)
- OR, installed in modular, pre-planted containers or trays (easy installation and removal)

Intensive Type

- Deep soil (6" to 24" or more)
- Can accommodate trees, shrubs, larger plants, more variety
- Typically built up in layers (membranes, protection layers, etc)

Built-up, layered system

Modular, container system

Yale Univ Smilow Cancer Hospital, New Haven, CT (greenroofs.com)

Chicago City Hall

GREEN ROOFS

Green Roofs

- Benefits
  - Stormwater retention
  - Extends roof membrane life: protects against freeze/thaw, UV exposure
  - Reduces "Urban Heat Island Effect"
  - Creates habitat (birds, butterflies, bees)
  - Potential food production
  - Aesthetics, well being (e.g., hospital healing gardens)
  - Some insulating value
- Costs
  - Additional materials, labor
  - May need to reinforce building structure due to extra weight (load)
  - Maintenance
  - Irrigation (water the plants)

Built-up, layered system

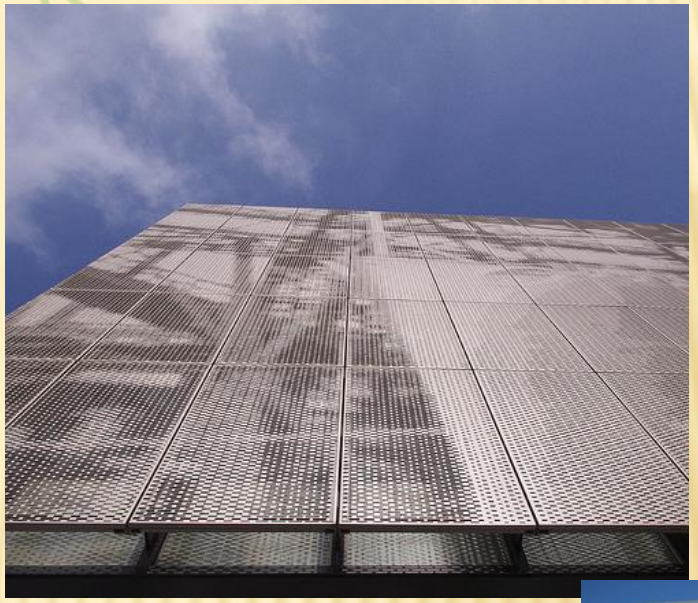
Modular, container system

Yale Univ Smilow Cancer Hospital, New Haven, CT (greenroofs.com)

Chicago City Hall

BROOKLYN NAVY YARD, BLDG 92

Brooklyn Navy Yard, Building 92



Brooklyn Navy Yard, Bldg 92

LEED Scorecard

0010424382, Brooklyn, NY

Brooklyn Navy Yard Center at Building 92

LEED BD+C: Core and Shell (v2.0) — **PLATINUM, AWARDED APR 2013**

SUSTAINABLE SITES		AWARDED: 13 / 15
SSc1	Site selection	1 / 1
SSc2	Development density and community connectivity	1 / 1
SSc3	Brownfield redevelopment	1 / 1
SSc4.1	Alternative transportation - public transportation access	1 / 1
SSc4.2	Alternative transportation - bicycle storage and changing rooms	1 / 1
SSc4.3	Alternative transportation - low emitting and fuel efficient vehicles	1 / 1
SSc4.4	Alternative transportation - parking capacity	1 / 1
SSc5.1	Site development - protect or restore habitat	1 / 1
SSc5.2	Site development - maximize open space	1 / 1
SSc6.1	Stormwater design - quantity control	1 / 1
SSc6.2	Stormwater design - quality control	0 / 1
SSc7.1	Heat island effect - non-roof	1 / 1
SSc7.2	Heat island effect - roof	1 / 1
SSc8	Light pollution reduction	0 / 1
SSc9	Tenant design and construction guidelines	1 / 1

WATER EFFICIENCY		AWARDED: 5 / 5
WEc1.1	Water efficient landscaping - reduce by 50%	1 / 1
WEc1.2	Water efficient landscaping - no potable water use or no irrigation	1 / 1
WEc2	Innovative wastewater technologies	1 / 1
WEc3.1	Water use reduction - 20% reduction	1 / 1
WEc3.2	Water use reduction - 30% reduction	1 / 1

ENERGY & ATMOSPHERE		AWARDED: 13 / 14
EAc1	Optimize energy performance	8 / 8
EAc2	On-site renewable energy	0 / 1
EAc3	Enhanced commissioning	1 / 1
EAc4	Enhanced refrigerant Mgmt	1 / 1
EAc5.1	Measurement and verification - base building	2 / 1
EAc5.2	Measurement and verification - tenant submetering	0 / 1
EAc6	Green power	1 / 1

MATERIAL & RESOURCES		AWARDED: 10 / 11
MRc1.1	Building reuse - maintain 25% of existing walls, floors and roof	1 / 1
MRc1.2	Building reuse - maintain 50% of existing walls, floors and roof	1 / 1
MRc1.3	Building reuse - maintain 75% of existing walls, floors and roof	1 / 1

MATERIAL & RESOURCES		CONTINUED
MRc2.1	Construction waste Mgmt - divert 50% from disposal	1 / 1
MRc2.2	Construction waste Mgmt - divert 75% from disposal	1 / 1
MRc3	Materials reuse - 1%	1 / 1
MRc4.1	Recycled content - 10% (post-consumer + 1/2 pre-consumer)	1 / 1
MRc4.2	Recycled content - 20% (post-consumer + 1/2 pre-consumer)	1 / 1
MRc5.1	Regional materials - 10% extracted, processed and manufactured regionally	1 / 1
MRc5.2	Regional materials - 20% extracted, processed and manufactured regionally	1 / 1
MRc6	Certified wood	0 / 1

INDOOR ENVIRONMENTAL QUALITY		AWARDED: 7 / 12
EQc1	Outdoor air delivery monitoring	1 / 1
EQc2	Increased ventilation	1 / 1
EQc3	Construction IAQ Mgmt plan - during construction	1 / 1
EQc4.1	Low-emitting materials - adhesives and sealants	3 / 1
EQc4.2	Low-emitting materials - paints and coatings	0 / 1
EQc4.3	Low-emitting materials - carpet systems	0 / 1
EQc4.4	Low-emitting materials - composite wood and agrifiber products	0 / 1
EQc5	Indoor chemical and pollutant source control	1 / 1
EQc6	Controllability of systems - thermal comfort	0 / 1
EQc7	Thermal comfort - design	0 / 1
EQc8.1	Daylight and views - daylight 75% of spaces	0 / 1
EQc8.2	Daylight and views - views for 90% of spaces	0 / 1

INNOVATION		AWARDED: 4 / 5
IDc1	Innovation in design	3 / 4
IDc2	LEED Accredited Professional	1 / 1

TOTAL	52 / 62

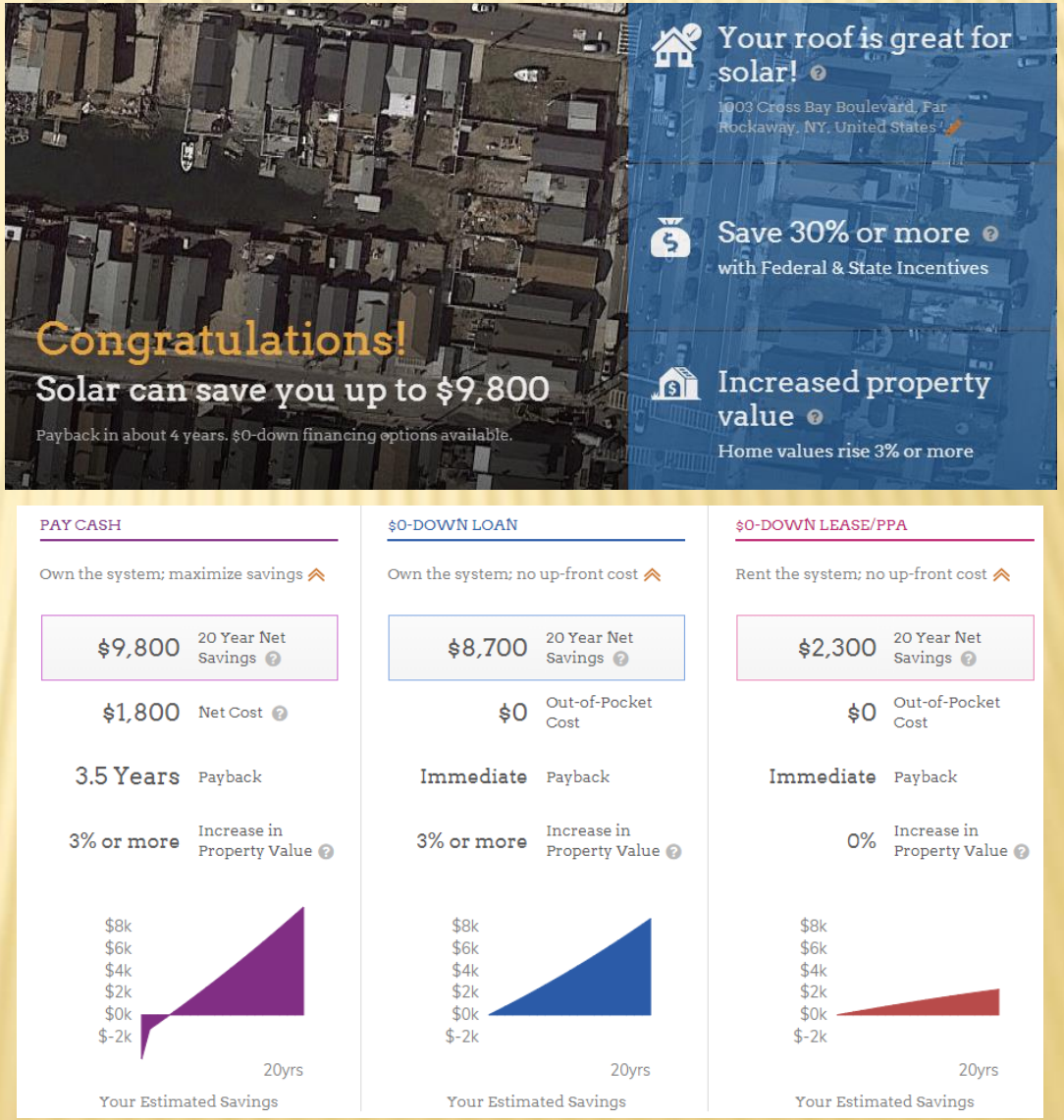
SUSTAINABLE MATERIALS: WHAT IS THE TRUE COST?

Flooring Comparison (assume 50 yr. building): First Cost vs. Life Cycle Cost

Characteristic	VCT (vinyl composition tile)	Linoleum flooring
Composition	Binders, filler, pigments (some pigments contain heavy metals). Vinyl content 30% max.	Linseed oil, wood flour, pine rosin on jute backing, man-made. Environmentally friendly pigments
Disposal	Non-biodegradable	Biodegradable
Hygienic Properties	No antimicrobial properties	Inherently antimicrobial. Inhibits the growth of many micro-organisms
VOC Emissions	VOC's come from maintenance procedures	No harmful agents.
Availability	Produced in US Stocked in US	Produced in Europe. Shipped and stocked in US (Lower energy requirements in manufacturing offset shipping energy.)
Maintenance	Traditional waxing with periodic stripping and resealing	Wet method or dry method (preferred)
Initial Cost (Installed)	$1.50 per sf (avg.)	$3.50 per sf (avg.)
Maintenance Cost (per yr)	$1.45/sf	$.50/sf
Maintenance Cost (over 20 yrs)	$29,000	$10,000
System Service Life (yrs)	15 years	30 years
Number of replacement systems (in 50 yrs)	3 replacements	1 replacement

SOLAR

- One of the main advantages is that can either drastically reduce or totally eliminate your electric bills. This benefit of solar panels is pretty straightforward – when you install solar power for your home, you generate your own electricity, become less reliant on your electric utility and reduce your monthly electric bill.
- A solar panel system typically has a 25-30 year lifespan, which means that you can cut your electricity costs for decades to come by going solar. In addition it improves the value of your home.
- Solar panels are useful, especially at this location. Broad channel is prone to regular flooding which in turn causes blackouts form time to time. With the solar panels this will reduce the owners dependency of the grid and will keep the owner with electricity for some time while the respective authorities restore the electric service.



PASSIVE HOUSE/ GREEN DESIGN

- In theory can work with any building type not only houses, but most projects to date have been:
  - Residential (single family, multi family)
  - Schools
  - Some commercial
- Very popular in Europe
- Many projects in NYC, especially Brooklyn
- Like LEED, you can take a certification exam
  - Certified PH Designer or Consultant
  - Certified PH House Tradesperson (contractors)

Tighthouse, Brooklyn
Fabrica 718
completed 2013

174 Grand St, Brooklyn
Loadingdock5
completed 2011

Urban Green Council

INSULATION

Generally we want...

- Nice, thick layer of insulation
- Continuous insulation
- Avoid intermittent, interrupted insulation (e.g., in between metal stud framing)

Thermal images below:

- Yellow, orange, and red colors represent heat loss out through the envelope (i.e., the building is "leaking" heat and wasting energy and money).
- Purple and blue colors are cooler temperatures (i.e., heat is not escaping the building). This shows us where the insulation is located.

Insulation in between framing

Continuous insulation

Images from: Dryvit Systems, Inc. and The Dow Chemical Company

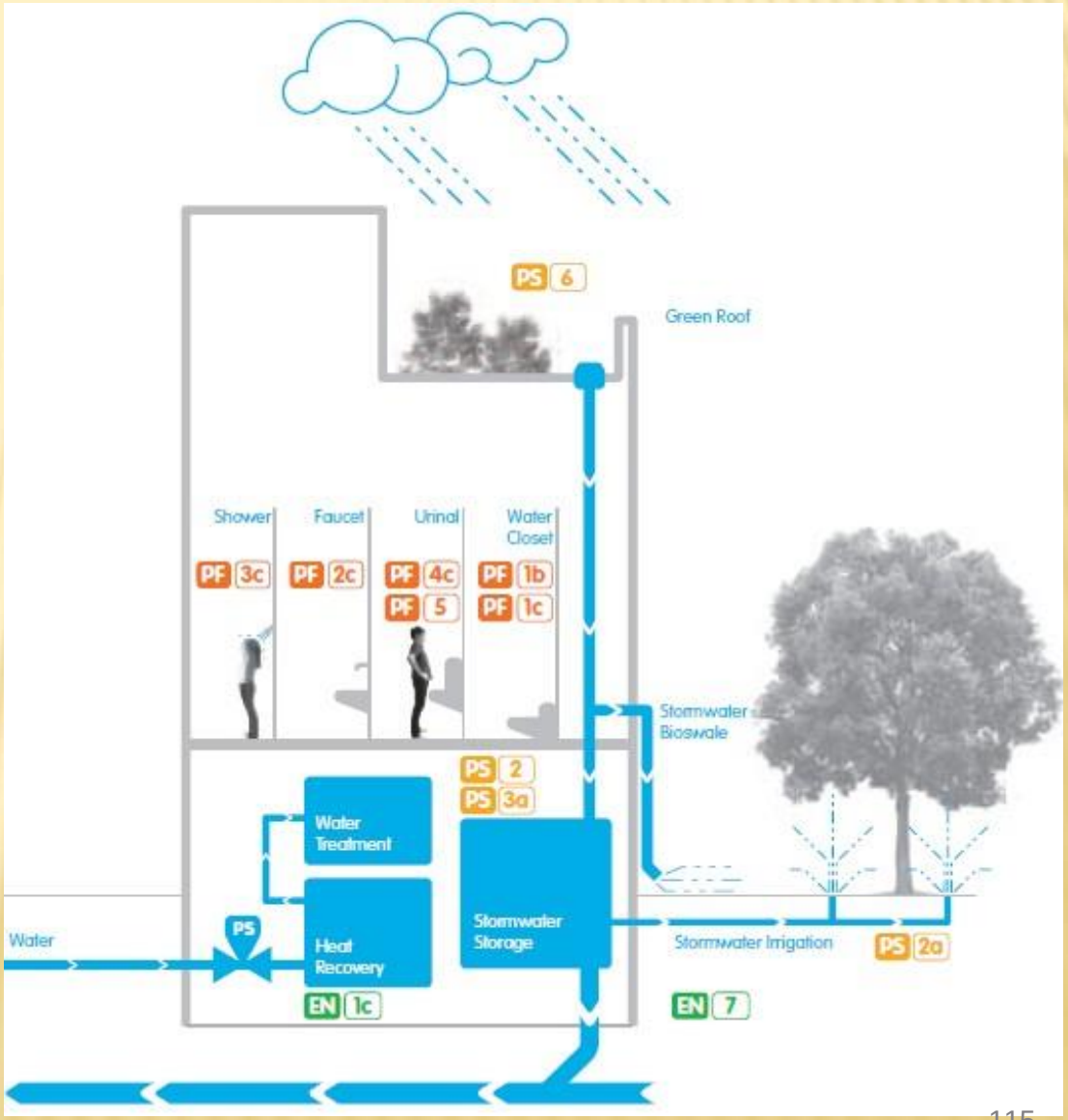
WATER: BUILDING SYSTEM STRATEGIES/DESIGN

Water Harvesting & Reuse

NYC Dept. of Design & Construction: Water Matters, June 2010

- Potential water collection ("harvesting") from:
  - Stormwater
  - Greywater
  - Blackwater
  - HVAC cooling condensate

- Potential water reuse for:
  - Irrigation
  - Mechanical system (cooling towers)
  - Flushing fixtures (toilets, urinals)

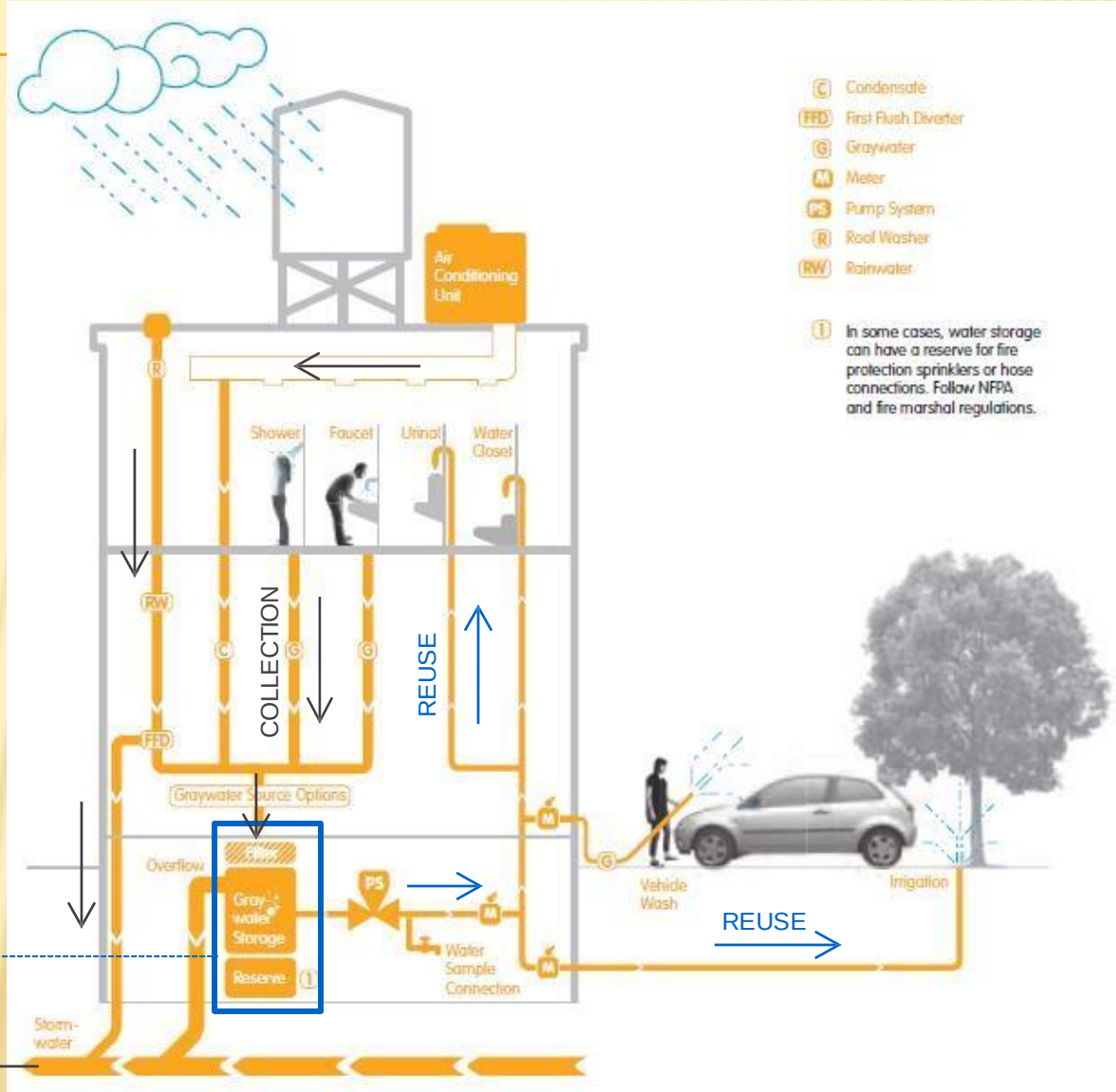


WATER: BUILDING SYSTEM STRATEGIES

Storm & Greywater Harvesting

In this example scenario...

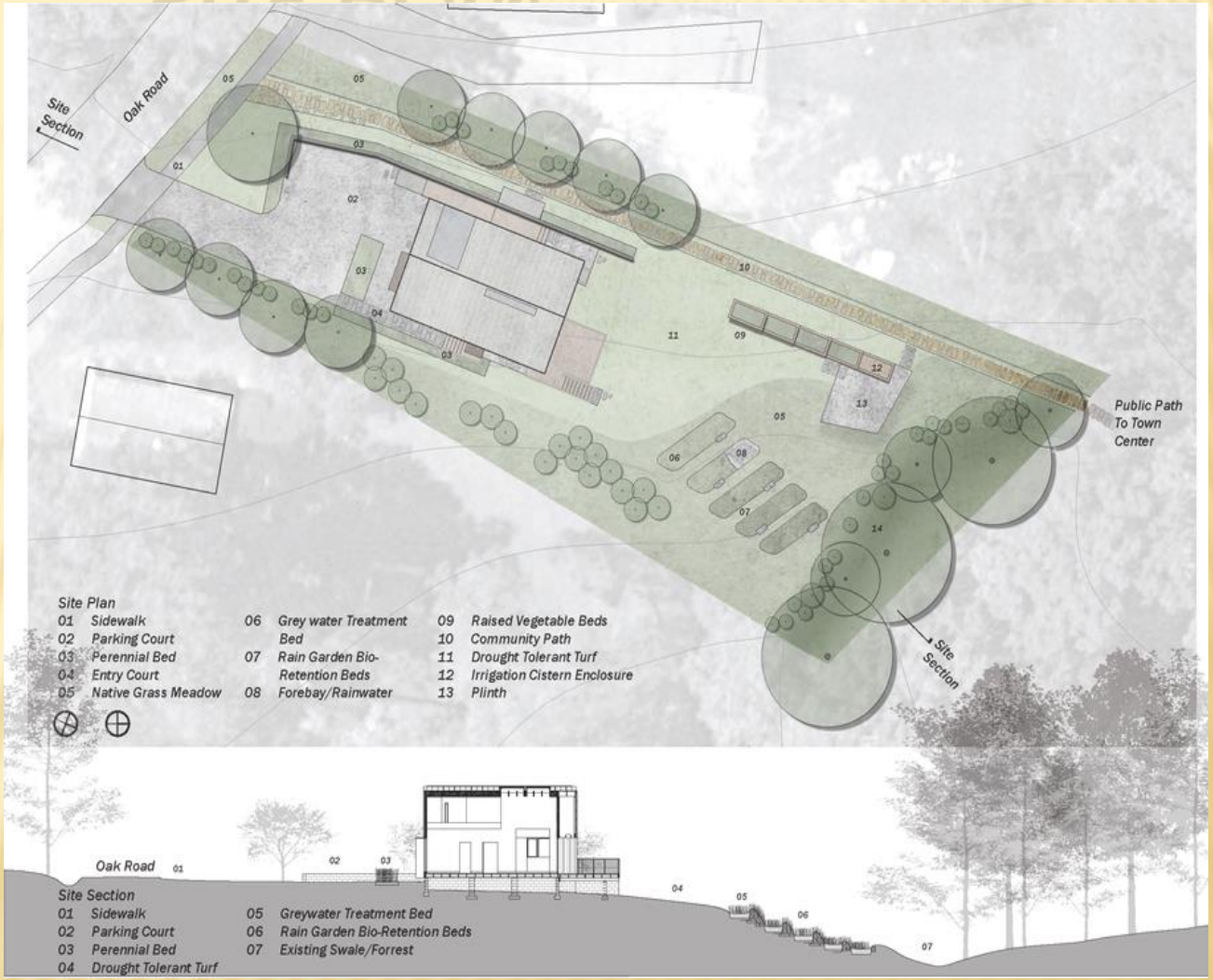
1. Collection from faucets, showers, roof rainwater, and air conditioning condensate
2. Initial "first flush" of each rainfall (which has most of the dirt and pollutants) is diverted to the sewer. The rest of rainwater goes to storage tank
3. Harvested water is filtered, treated, and stored in a tank
4. Treated non-potable water is reused for toilet and urinal flushing, irrigation, and vehicle washing



NYC Dept. of Design & Construction: Water Matters, June 2010

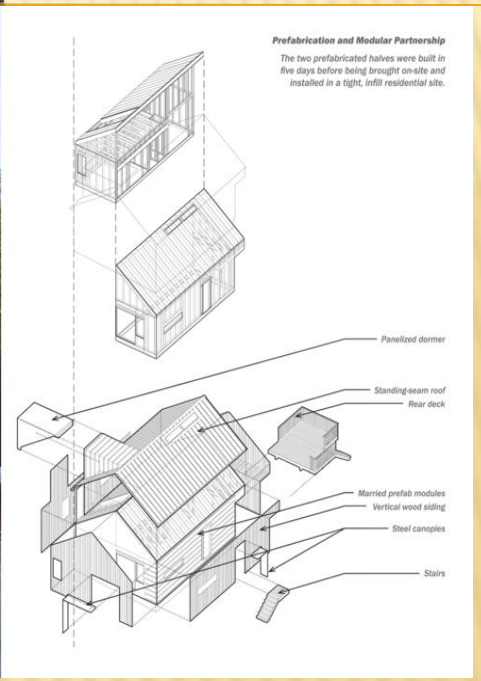
SITE PLAN

- The house is located on a previously developed lot in a previously developed community, minimizing the environmental impacts.
- The historic plan supports lifestyles that emphasize walking and cycling a half-mile to 14 basic amenities.
- Estimated percent of occupants using public transit, cycling or walking: 100%



BUILDING OVERVIEW

At 1008 sf, A New Norris House is less than half the size of the median house, and it is sited on a 0.3 acre lot. “Right-sizing” reduced material and operational loads and costs, and shifted funds to quality design and construction, passive strategies and high-efficiency systems.



- The compact house was designed for off-site manufacture.
- Advanced framing techniques resulted in a 17.5% reduction in lumber, increased insulation, and decreased thermal bridging.
- 70% diversion of construction waste.
- Low- and no-VOC glues, paints and finishes were carefully controlled, critical to air quality given the tight envelope and immediate occupancy inherent in manufactured housing.

GREEN DESIGN FEATURES

- LEED for Homes Rating Date:2012. Platinum (26 points over Platinum threshold)
- One year of post-occupancy evaluation has revealed that the home is able to collect and treat rainwater that is safe for human contact by EPA. In the first year of study, 39,388 gallons of water has been passively returned to the landscape through greywater and rainwater overflow systems.
- Over 73% of waste water has been reused on-site.

REFERENCES

- Zhang, Fangzhu, and Philip Cooke. “Green Buildings and Energy Efficiency.” Green Buildings and Energy Efficiency, Centre for Advanced Studies, Cardiff University, UK, 2010, www.dimeeu.org/files/active/0/Cooke-2010-Fang-Green-building-review.pdf.
- Stutz, Bruce. “Green Roofs Are Starting To Sprout in American Cities.” Yale E360, 2 Dec. 2010, e360.yale.edu/features/green roofs are starting to sprout in American cities.
- Foroudastan, Saeed D, and Olivia Dees. “Solar Power and Sustainability in Developing Countries.” Engineering Technology and Industrial Studies College of Basic and Applied Sciences Middle Tennessee State University, 2006, pp. 1–13., www.udc.edu/docs/cere/Solar Power and Sustainability in Developing Countries.pdf.
- Biswas, Tajin, and Ramesh Krishnamurti. “FRAMEWORK FOR SUSTAINABLE BUILDING DESIGN.” FRAMEWORK FOR SUSTAINABLE BUILDING DESIGN, Carnegie Mellon University, 1 Jan. 2009, repository.cmu.edu/cgi/viewcontent.cgi?article=1046&context=architecture
- Circo, Carl J. “Using Mandates and Incentives to Promote Sustainable Construction and Green Building Projects in the Private Sector: A Call for More State Land Use Policy Initiatives.” Using Mandates and Incentives to Promote Sustainable Construction and Green Building Projects in the Private Sector, Http://Www.pennstatelawreview.org, 16 Apr. 2008, 11:33AM, www.pennstatelawreview.org/articles/112 Penn St. L. Rev. 731.pdf.
- ARCH 3551: Sustainability History & Practice, Spring 2018 class
- AIA COTE (Committee on the Environment) Top Ten Projects, http://www.aiatopten.org/node/280