The Imperative for a New Urban Water and Resource Management Paradigm

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Turkish Cities of the Future Program Special Workshop No. 2:
Emerging Issues in Wastewater Treatment

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Let's Define the Problem(s) We are Trying to Solve

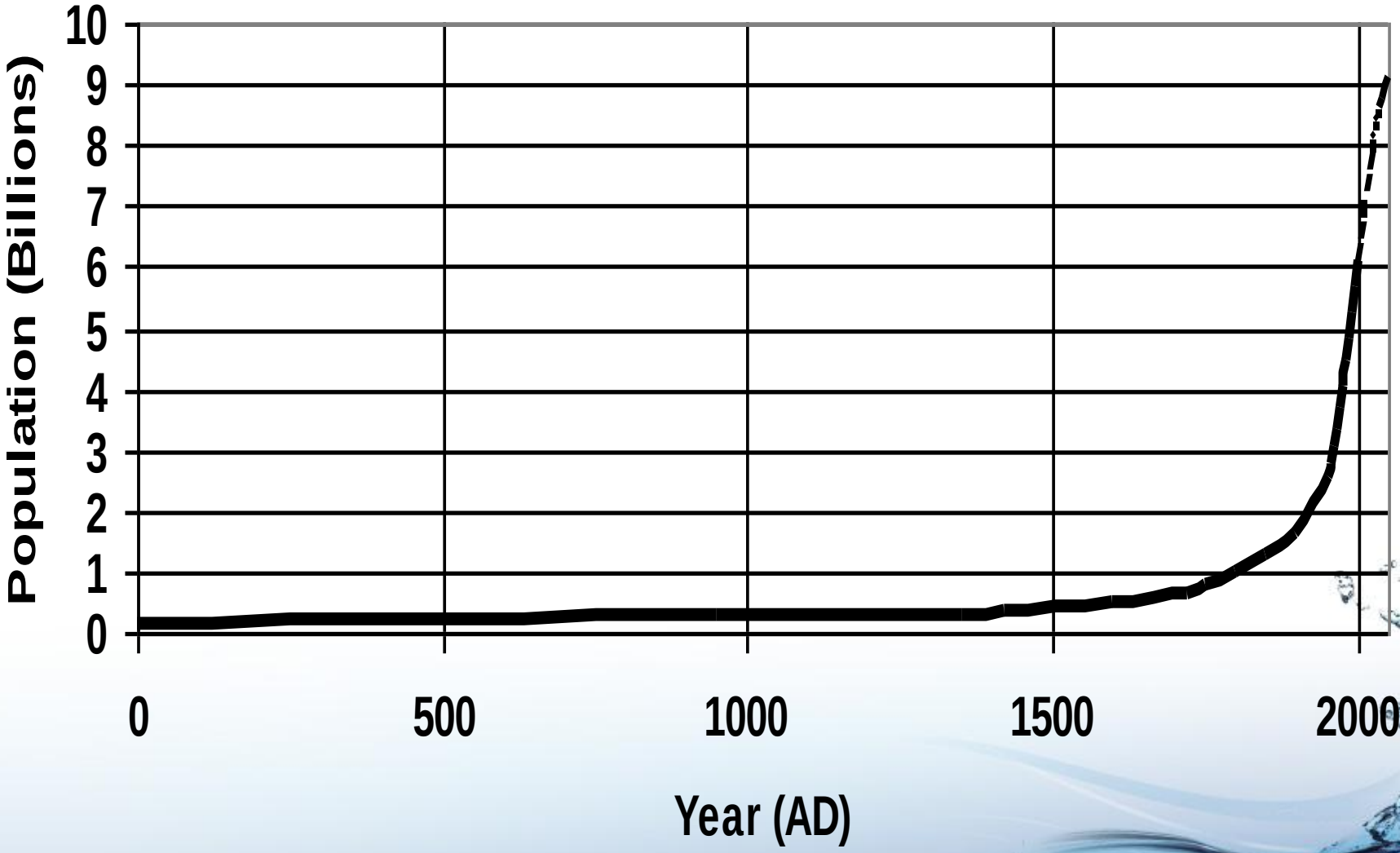
Population Growth + Consumption + Urbanization + "Linear System"

Integrated Water and Resource Management

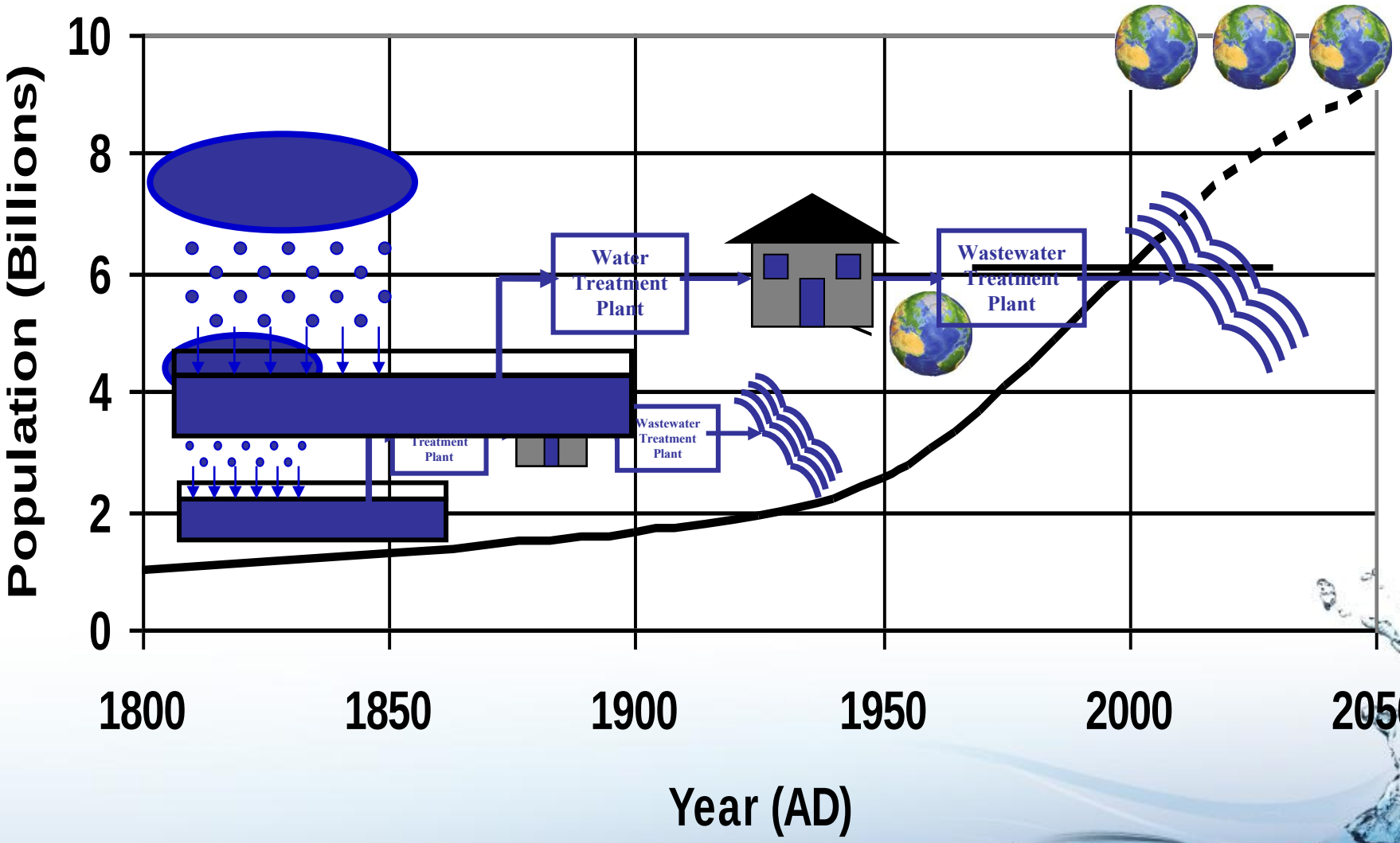
= Water Stress + Resource Consumption + Nutrient Dispersal

Lack of Support for Urban Water Management Utilities

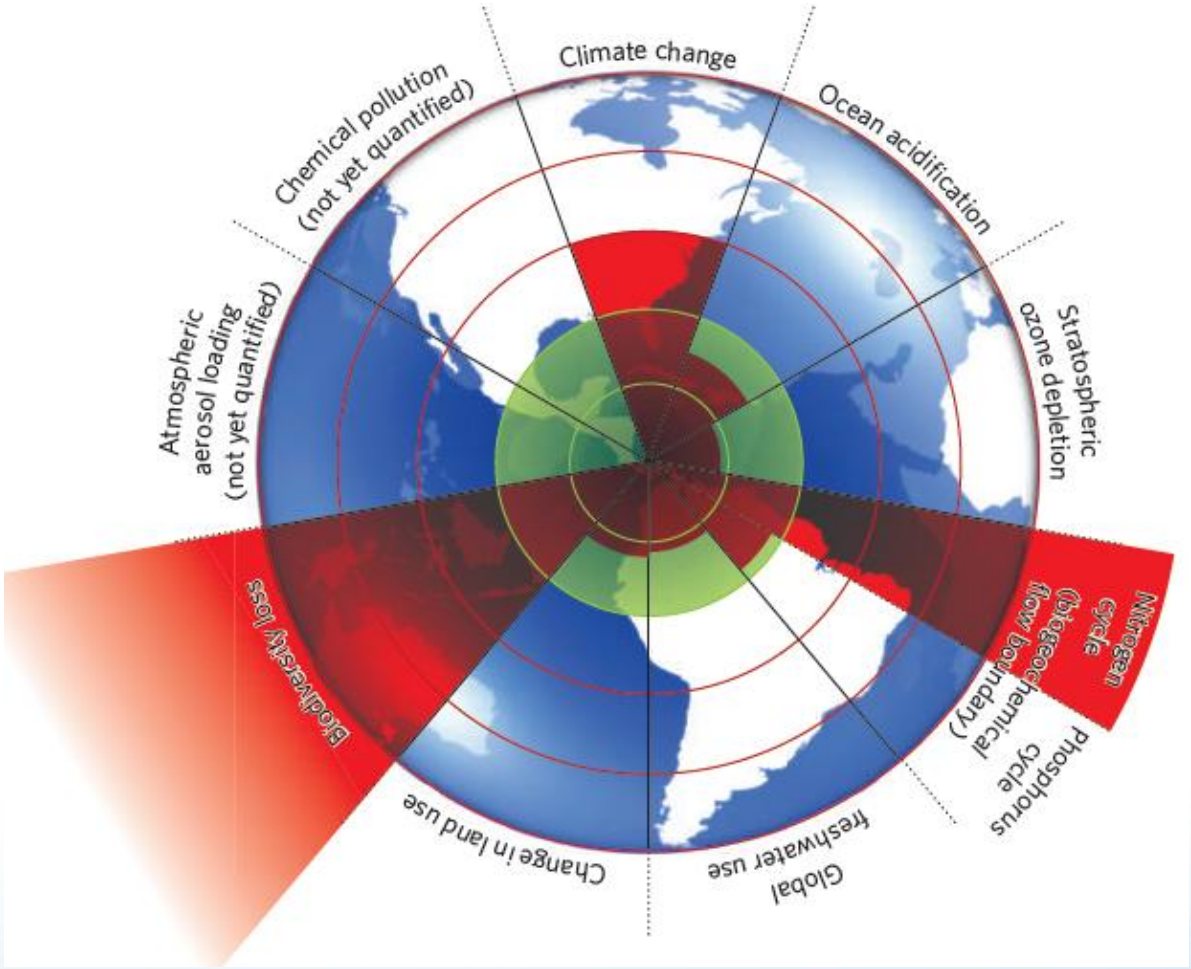
Population Growth in the 20th Century Has Been Astounding!



Population Growth is an Important But Not the Sole Driver



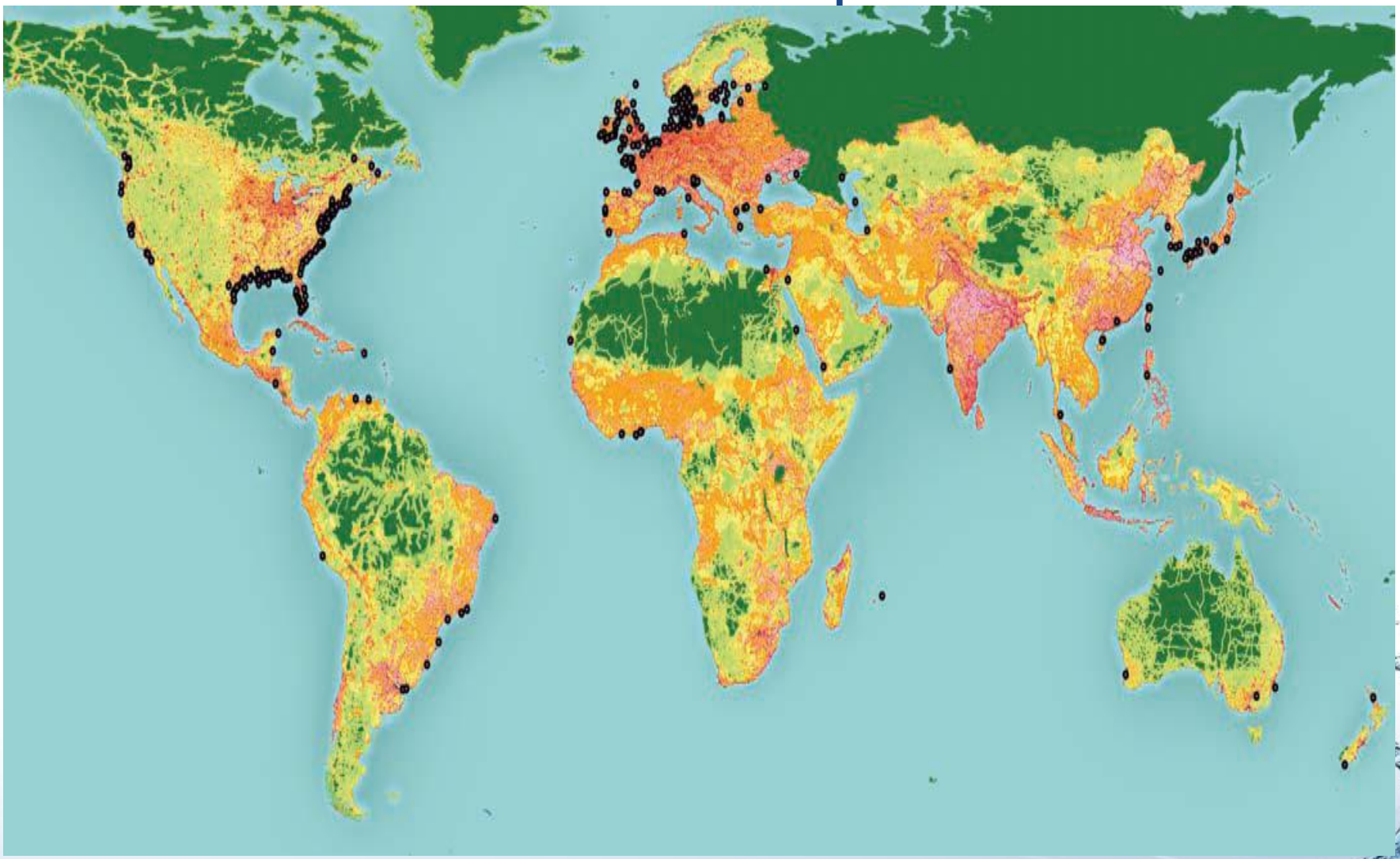
Scientists* Estimate That We Are Crossing Planetary Boundaries; New Technologies and Approaches Require to Return to Sustainabiltiy



- Biodiversity Loss
- Nutrients
  - Nitrogen
  - Phosphorus
- Climate Change
- Chemical Pollution (Not Yet Quantified)

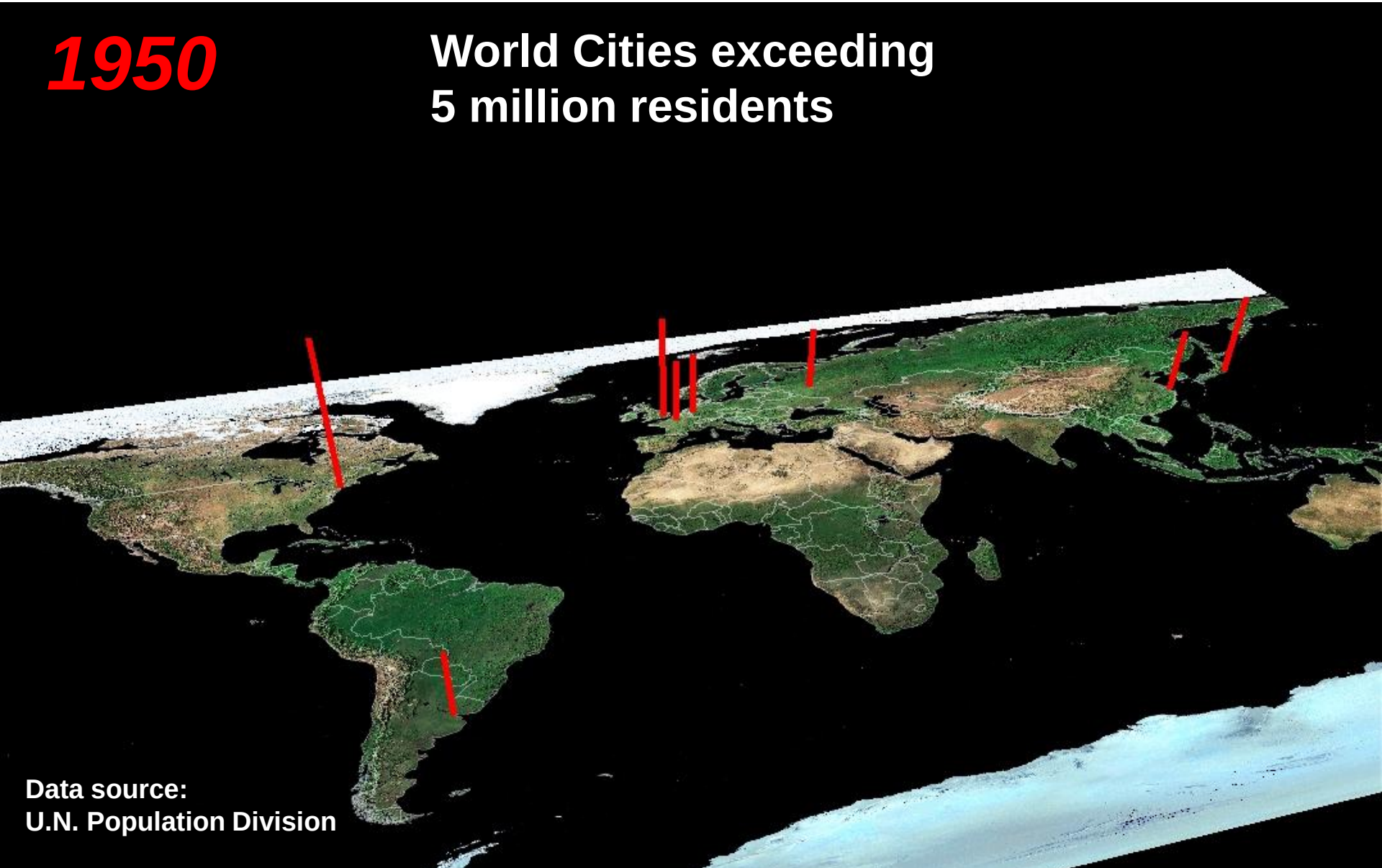
* Rockström, et al., *Nature*, **461|24**, September, 2009, 472-475.

Coastal Hypoxic Zone "Hot Spots" Correlate with Human Population



Diaz, R. J., *et al.*, "Spreading Dead Zones and Consequences for Marine Ecosystems," *Science*, **321**, 926-929, 2008.

Dramatic Urbanization is Occurring



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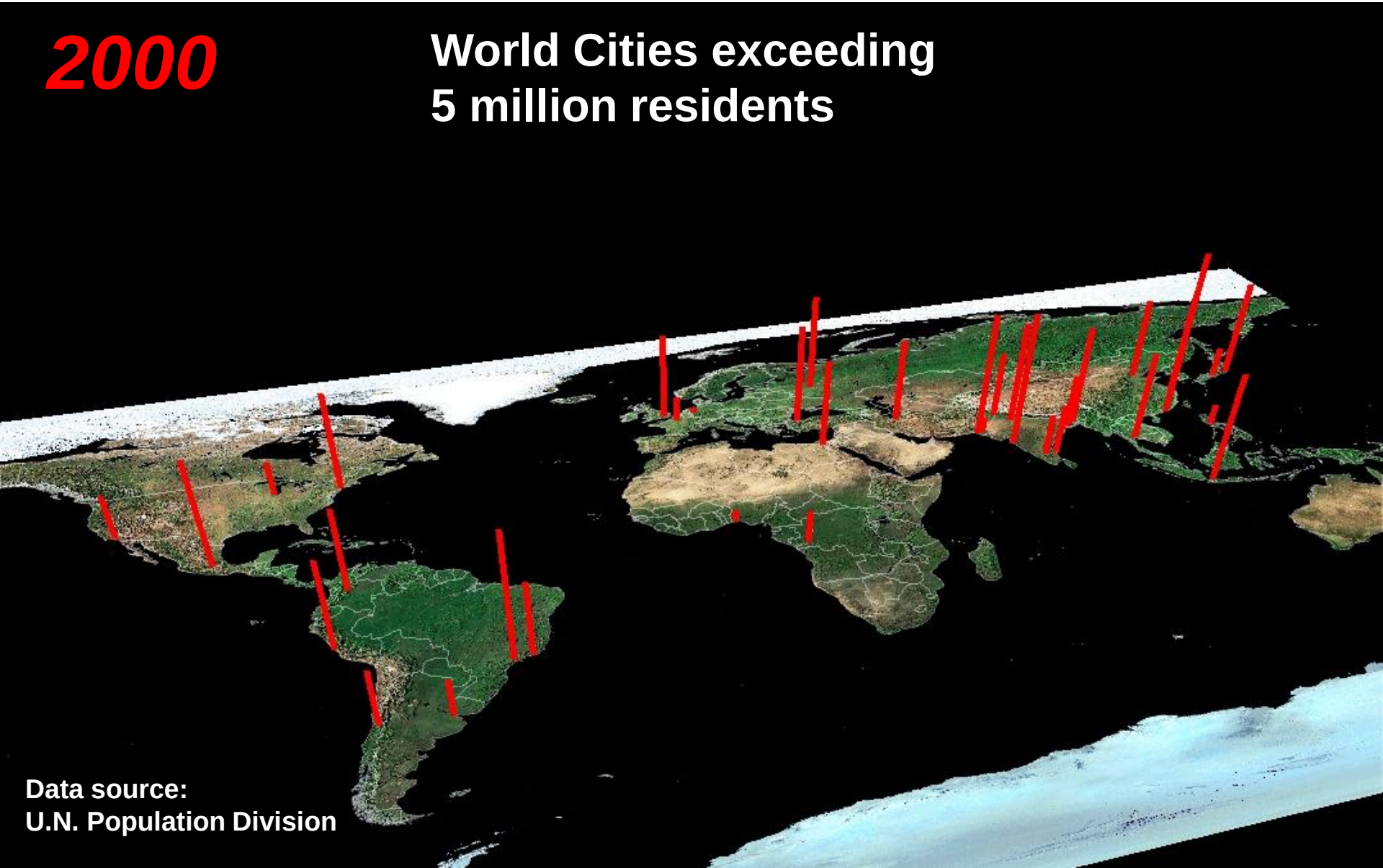
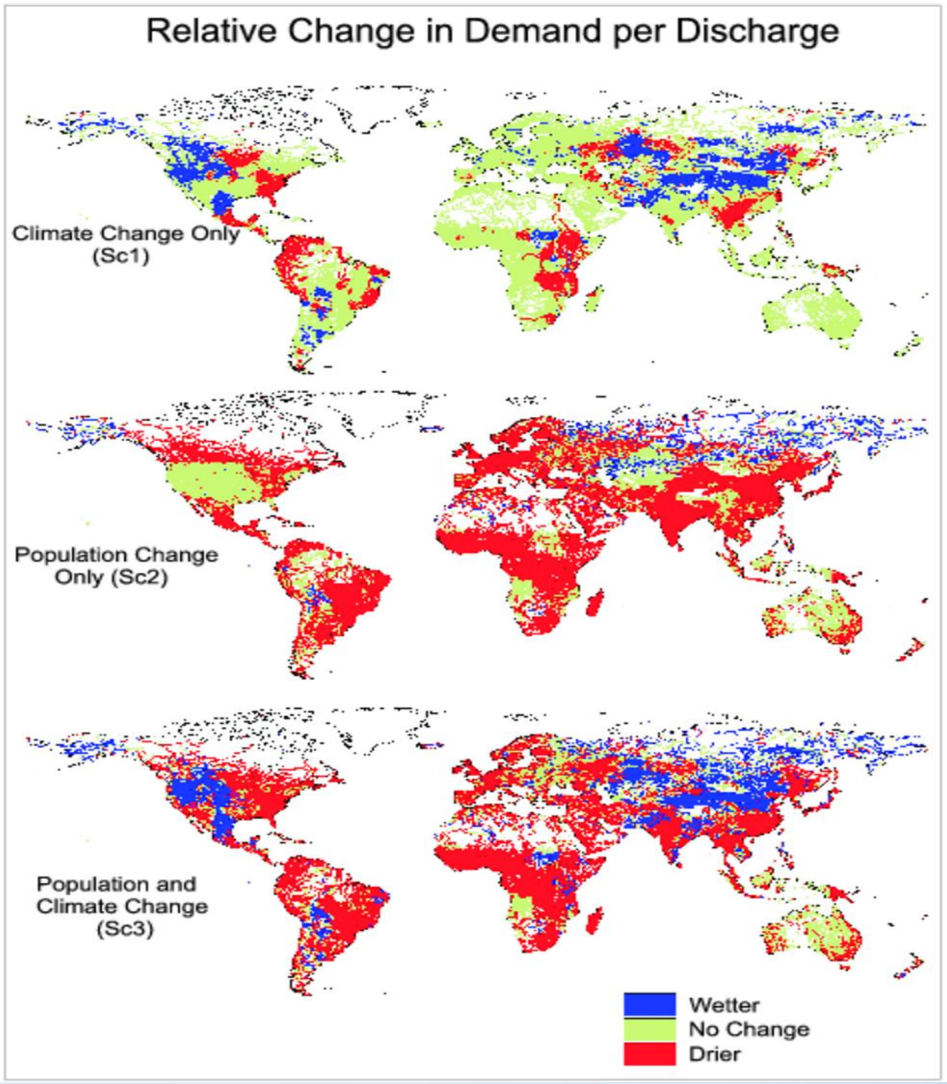


Dramatic Urbanization is Occurring

Global Water Crisis Caused by:



- Population Growth
- Increased Living Standard
- Climate Change
- Urbanization

Nearly Half of Human Population Will Experience Water Stress by 2025

Can a System That Evolved:

For Global Population < 2 Billion
Mostly Rural
Lacking Modern Technology

Be the Solution When:

Global Population ~ 10 Billion
Mostly Urban
Experiencing Greater Resource Constraints?

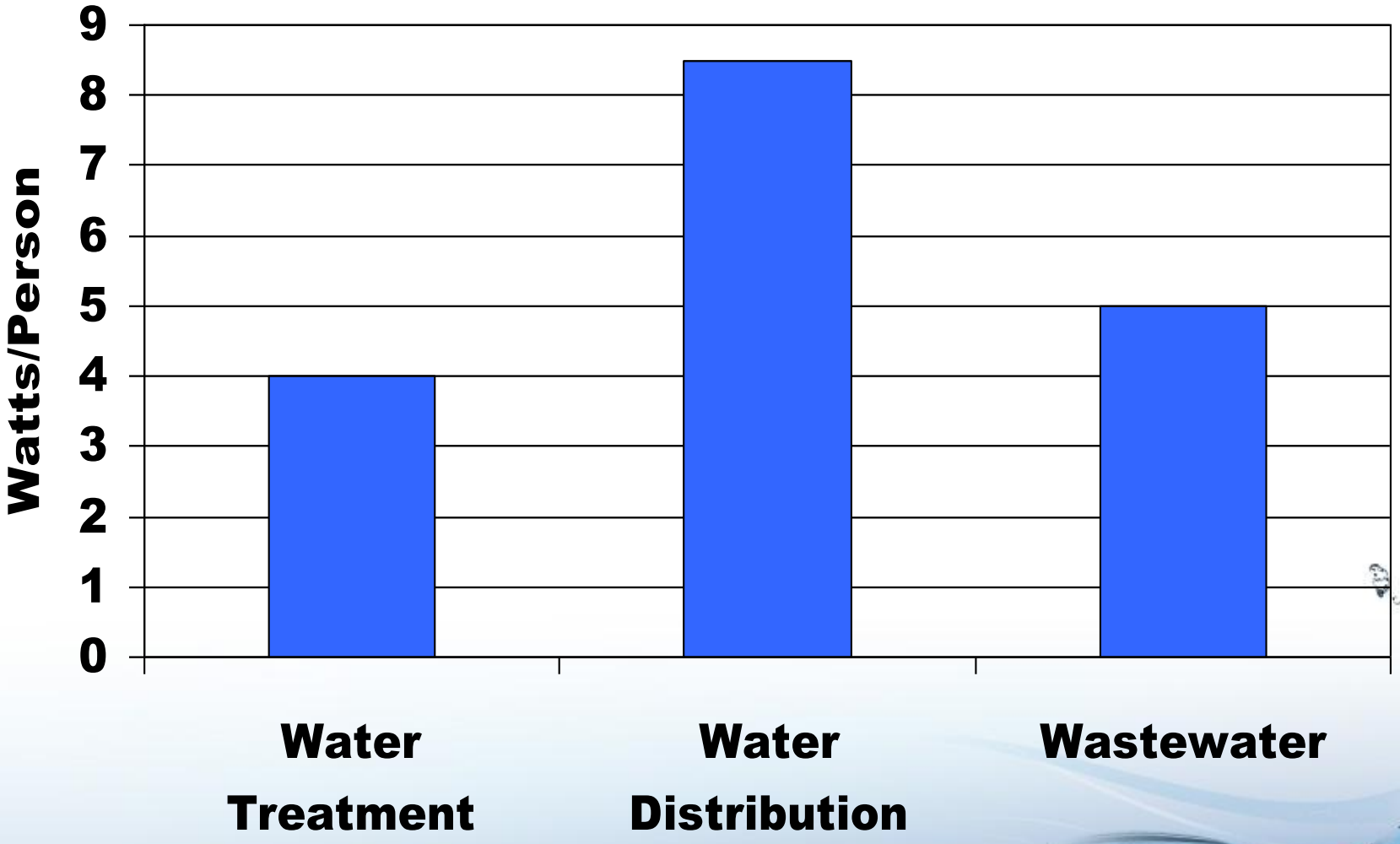
Strategies and Practices Evolve, Not Principles

Principles	• Science Based • Protect Public Health • Protect and Restore the Environment • Innovation	
Strategies	**Historical**	**Evolving**
Water Supply	Remote	Local
Optimizes	Infrastructure	Water use, energy consumption
Functions	Single purpose	Multiple purposes
Configuration	Centralized	Hybrid (centralized and decentralized components)
Practices	Current Design Manuals	Water Sensitive Urban Design, SUDS

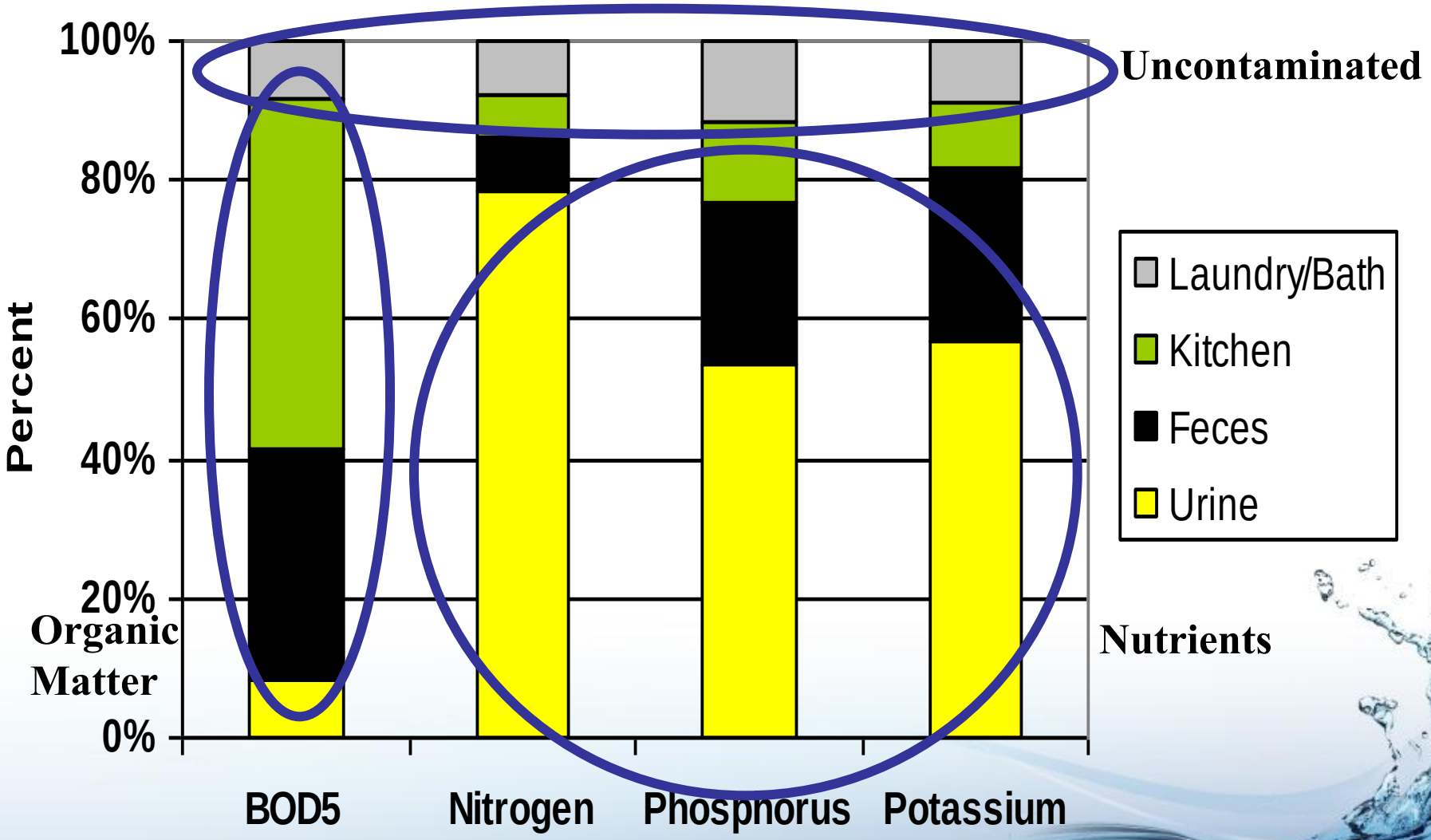
Components of Integrated Urban Water and Resource Management System Include:

- Water Conservation
- Distributed Stormwater Management
  - Low Impact Development
  - Rainwater Harvesting
- Distributed Water Treatment
- Water Reclamation and Recycling
- Heat Recovery
- Organic Management for Energy Production
- Nutrient Recovery
- Source Separation

About Half of Water/Wastewater Energy Used for Water Distribution



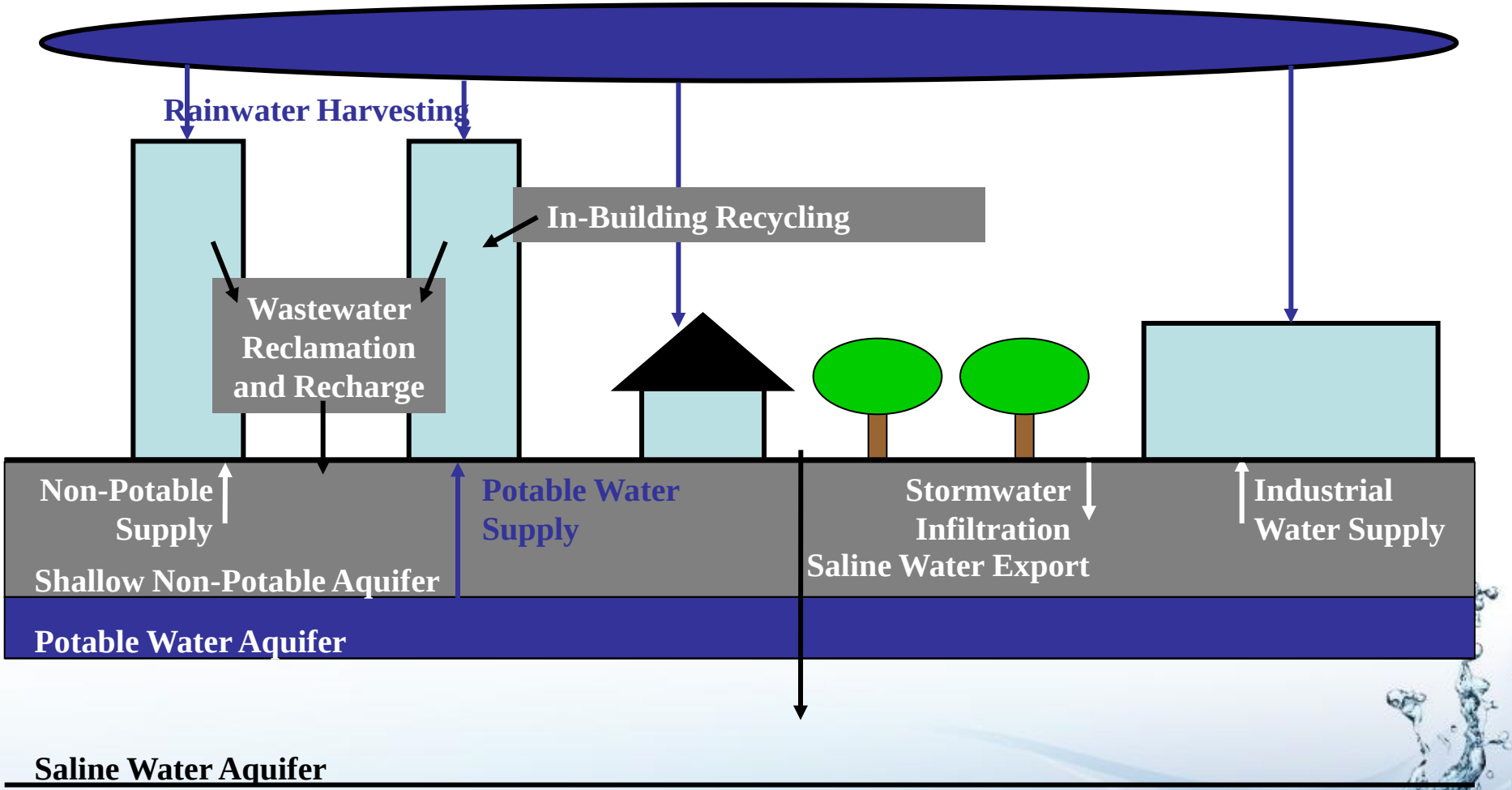
Wastewater Separation Creates Energy and Nutrient Recovery Options



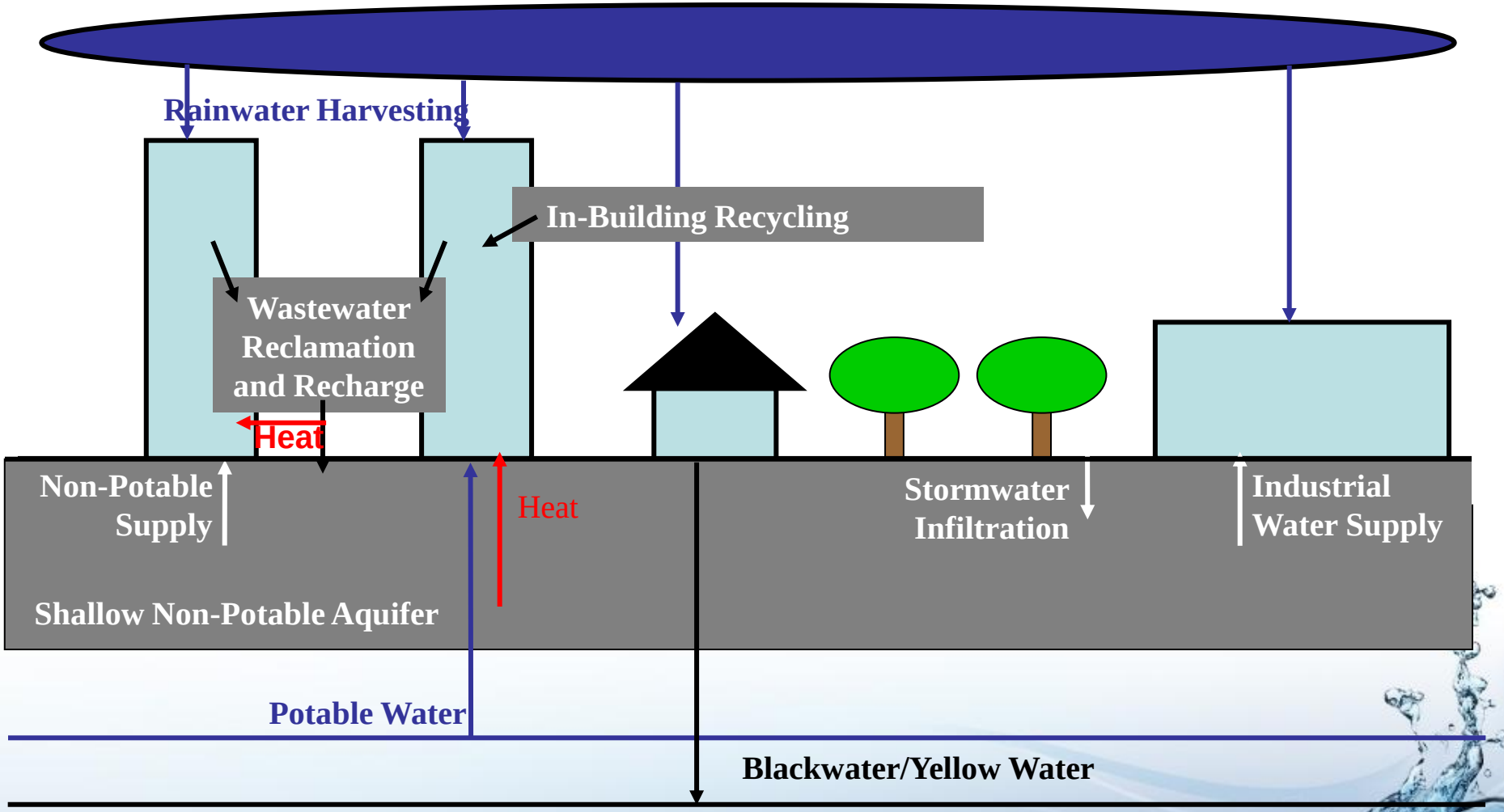
Toolkit Components Apply to Centralized and Decentralized (Hybrid) Systems

Component	Centralized	Decentralized/Hybrid
Stormwater	–	Permeable Pavements, Green Roofs, Rain Gardens, etc.
Water Conservation	Wide Variety of Technologies, Along with Behavior Changes	
Treatment	Treatment for Potable Use and Reuse (Direct and In-Direct)	Treatment for Potable Use and Non-Potable Reuse
Energy Management	Anaerobic Digestion, Thermal, Microbial Fuel Cells	Capture Heat Energy, Microbial Fuel Cells
Nutrient Recovery	Land Application of Biosolids, Struvite Precipitation	–
Source Separation	Treatment of Kitchen, Black and Yellow Water	Supply Potable and Non-Potable; Treatment of Kitchen, Black, and Yellow Water

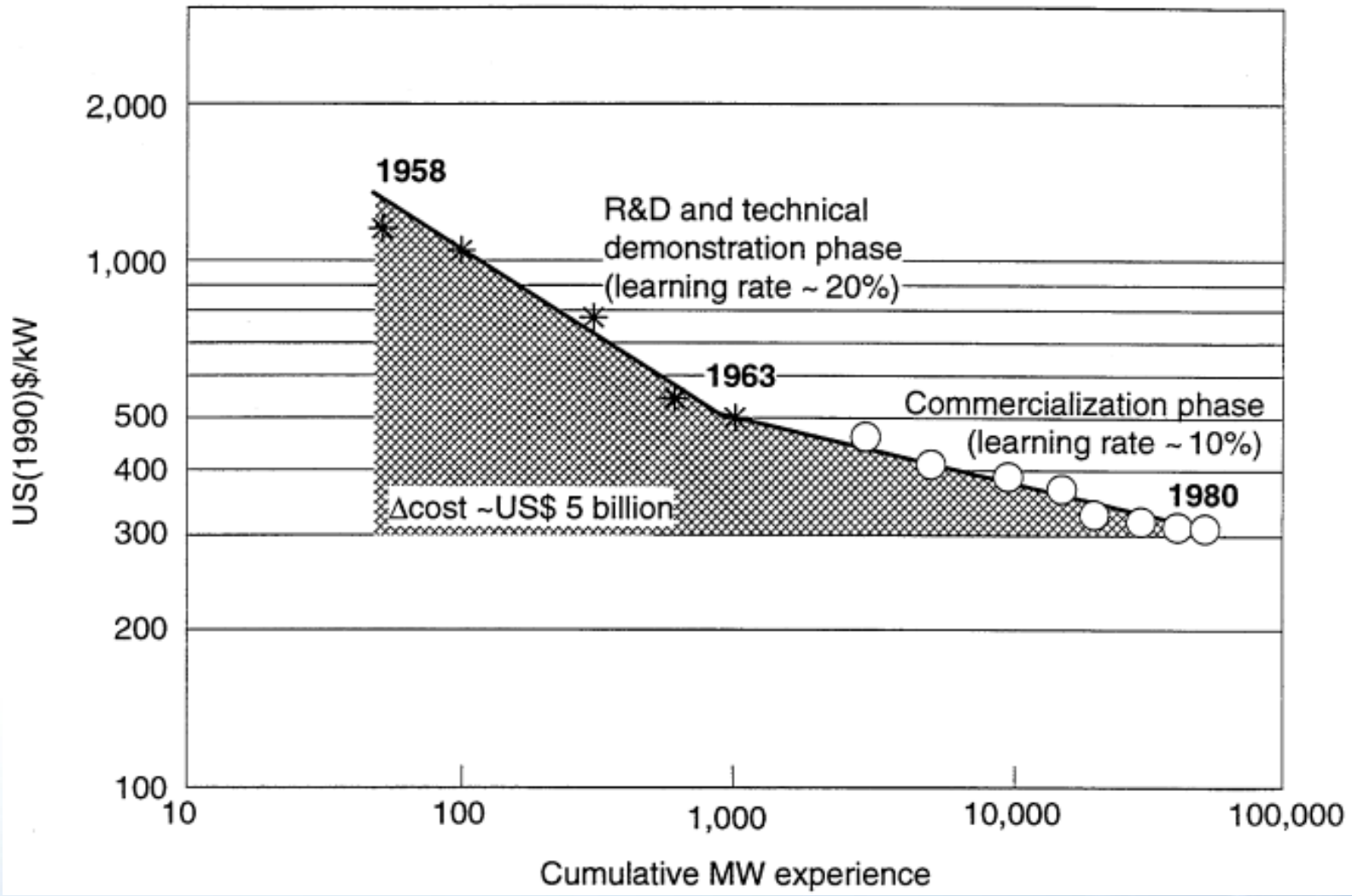
Let's Look at an Example That Uses Only Local Water Resources



Let's Look at an Example That Maximizes Nutrient and Energy Recovery

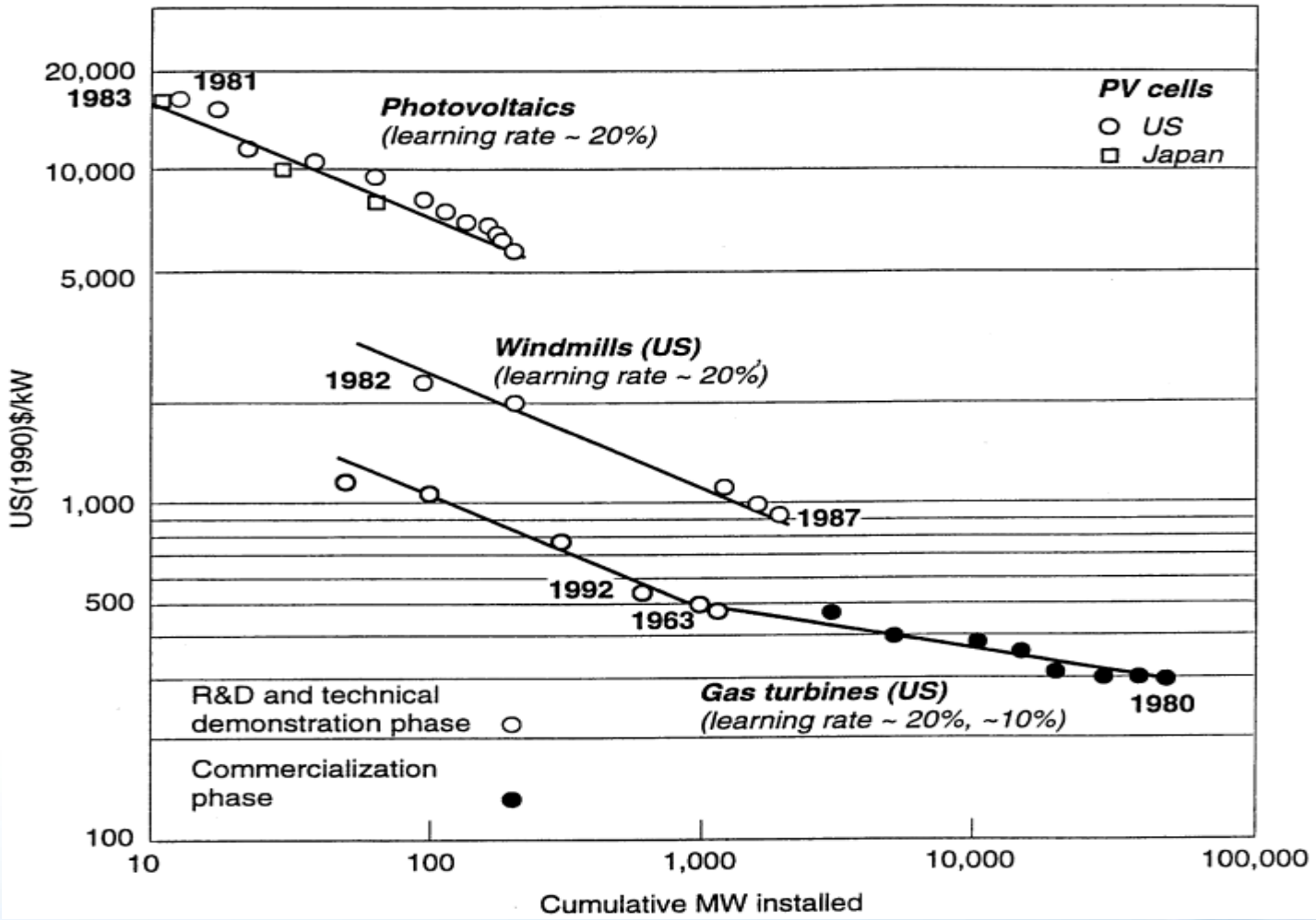


Technology “Learning Curves” Drive Cost/Performance: Gas Turbines*



*From Grübler, *et al.*

Technologies Compete While They Evolve in the Marketplace*



*From Grübler, *et al.*

Changes are Necessary to Fully Implement Integrated Urban Water and Resource Management

Item	Approach	
	Historical	**Evolving**
Institutions	Single purpose	Integrated
Management		
Conveyance	Distributed	Distributed
Treatment	Centralized	Distributed
Financing	Volume-based	Service-based
Planning	Independent, followed city planning	Integrated with city planning

Transition to Sustainable Integrated Water and Resource Management Accelerated by:

- Communicating Water Benefits to Community Served
- Institutional Structures That Plan, Implement, and Manage Centralized and Decentralized Infrastructure
- Performance-Based Regulatory Structures, Compared to Traditional Practice-Based Regulatory Structures
- Revised Quality Standards:
  - "Fit-for-Purpose" Water Quality Standards for Each Use
  - Eliminate Water Source Considerations
- Global and Local "Forcing Functions":
  - Decreased Water Supply
  - Increased Energy Prices
  - "Carbon Tax"
  - Resource Constraints (i.e. Phosphorus)
  - Environmental Damage (i.e. Eutrophication)

“Legacy Systems” Must be Dealt With In Existing Urban Areas

- Centralized Systems Serve Existing Development
- Distributed Elements Aggressively Incorporated Into New Developments and Redevelopment
  - Allows System to be Converted Over Time
- Existing Water Distribution and Wastewater Collection System Provides Necessary Capacity as Urban Density Increases
  - Avoids Need for System Expansion
  - May be “Downsized” Over Time and “Re-Purposed”
- Centralized Plant Transitions From “Wastewater” to “Organic Matter” Processing Facility

What Will These Systems Achieve (Why Would We Do This)?

- Improved Public Health Protection
  - Greater Isolation and Potential for Treatment of Potable Water
- Less Net Water Abstraction From Environment
- Significantly Reduced Environmental Discharges
  - Volume (Stormwater, Wastewater)
  - Constituents (Organics, Nutrients, Compounds of Concern)
- Reduced Resource Consumption (Energy, Chemicals)
- Easier System Upgrade and Expansion
- Increased System Resiliency
- Enhanced Urban Environment

What Actions Can We Take to Accelerate Transition to the Cities & Villages of the Future?

- Recognize That We are Dealing with Complex Systems
  - Counter-Intuitive Behavior
  - Results Driven by Few Key Factors
- Focus on Results Rather Than Specific Practices
- Recognize the Need for Learning:
  - Fashion a “Learning by Doing” Process
  - Adapt Learning Into Practice
- Remember That Systematic Results Occur Because of the System
  - Not Because of Bad People
- Drive Forward with “Patient Impatience”

Leadership is a Learned Skill*

- Model the Way
  - Clarify Values
    - Find Your Voice
    - Affirm Shared Values
  - Set the Example
    - Personify the Shared Values
    - Teach Others to Model the Values
- Inspire a Shared Vision
  - Envision the Future
    - Imagine the Possibilities
    - Find a Common Purpose
  - Enlist Others
    - Appeal to Common Ideals
    - Animate the Vision
- Challenge the Process
  - Search for Opportunities
    - Seize the initiative
    - Exercise Outsight
  - Experiment and Take Risks
    - Generate Small Wins
    - Learn from Experience
- Enable Others to Act
  - Foster Collaboration
    - Create a Climate of Trust
    - Facilitate Relationships
  - Strengthen Others
    - Enhance Self-Determination
    - Develop Competence and Confidence
- Encourage the Heart
  - Recognize Contributions
    - Expect the Best
    - Personalize Recognition
  - Celebrate the Values and Victories
    - Create a Spirit of Community
    - Be Personally Involved
- Be Credible
  - Honest
  - Forward-Looking
  - Inspiring
  - Competent

* Kouzes & Posner, The Leadership Challenge, 4th Edition, Jossey-Bass, San Francisco

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