Sustainable Water Use in Buildings

Role of Energy and Water Resource Efficiency in Buildings

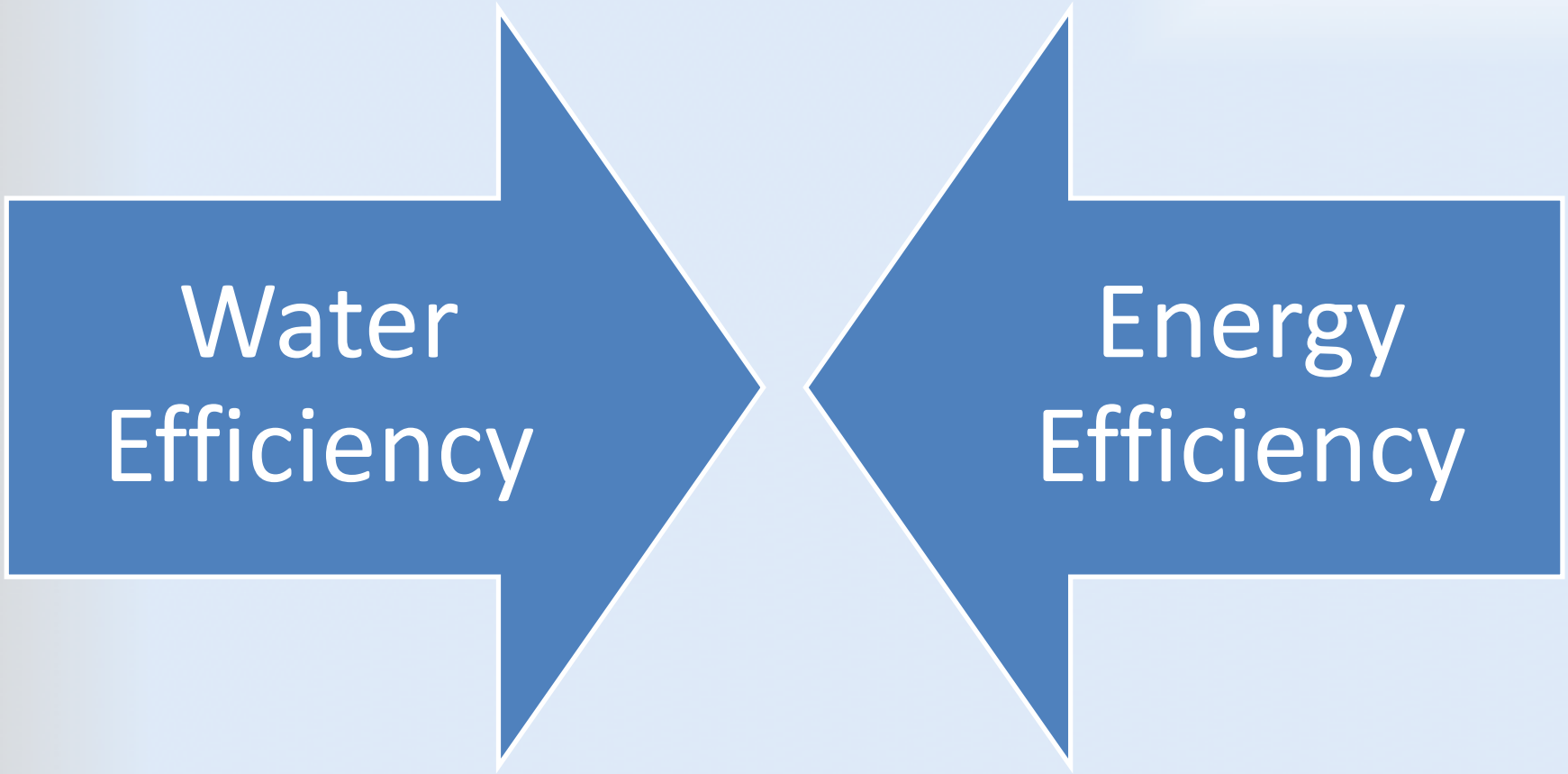
Prof. (Dr.) Virendra Kumar Paul

Department of Building Engineering & Management,

School of Planning and Architecture, New Delhi

Blue is the New Green!!

Common Goal and Objective



Water Efficiency = Energy Efficiency

Water + Energy = **WatErnergy**

- California Energy Commission: *19 percent of the state's electricity and 30 percent of the state's natural gas support the state's water and sewer systems.*

- Water and energy efficiency efforts in Indian municipalities are reported to be efficient

Water Demand Reduction

Water-need assessment (during use)		
Domestic water Requirement (Typical		Reduction by improved technology
WC	30 l	25 l
Washing and clothes	20 l	15 L
Bathing	55 l Using 12-14 L/Min option	36 L Using 8-9 L/Min option
Drinking	5 L	5 L
Cooking	5 L	5 L
Washing utensils	10 L	10 L
Washing house	10 l	**Using gray, recycled water**
Total consumption	**135 L/ P/D**	**96 L/ P/D**

Water Requirement Reduction Causing Energy Saving

REDUCED WATER REQUIREMTN REFLECT THE REDUCED COST AND LESS CONSUMPTION OF ENERGY	
✓Total consumption 135l/p/d ✓Nos of users 4 x135 = 540l For one month = 16200 l ✓Energy consumption for pumping 1hr into 6 Rs per unit per 10min , one hr 6 units = 6x6 = 36 For one month = 1080	✓Total consumption after effective reduction 96 l/p/d ✓Nos of users 4 x96 =384l For one month = 11520 l ✓Energy consumption for pumping 40min into 6 Rs per unit per 10 min , 40 min ,4 units = 4x6 = 24 For one month = 720

Energy Saving = 33% Water saving = 28%

Impact of Recycling

- Energy cost increases as the levels of treatment increases
- For residential occupancy, surplus treated water may be produced
- Thus, Recycling may be effective in a only in a system involving multi-occupancy buildings at neighborhood level
- Possible uses for recycled water: Landscaping, horticulture, HVAC, DG sets, service industry

Water Audit

- Building information
- Weather / climate, ground
- Occupant information *(planned, current, anticipated)*
- Mapping water cycle (supply, treatment, distribution, consumer / utility points, recycle data)and system component details

A water audit is an on-site survey and assessment of water-using hardware, fixtures, equipment, landscaping, and management practices to determine the efficiency of water use and to develop recommendations for improving water-use efficiency

Water Specific Energy Audit

- Determine connected electrical load (supply, recycling, pumping),
- Collect energy consumption data through energy sub-metering (kWhr)
- Collect equipment data, maintenance
- Identify and document water consumption of all equipment and services using water, such as cooling towers, boilers etc.
- Determine data for water consumption, water cost for HVAC and other engineering systems.

Water efficiency labeling of plumbing products

- American Water Works Association (AWWA) estimates possible reduction up to 35% of per capita household water use by way of installation of water efficient plumbing fixtures and plugging leaks in the systems.

- Home Water Use
  - Toilets28% • Clothes Washers21%
  - Showers17% • Faucets15% • Leaks14%
  - Other5%

Water Efficient Initiatives - Europe	Type
Water supply (water fittings) Regulations : WC Suite Performance Specifications **(UK); 1999**	Mandatory
BMA Water Efficiency Labeling Scheme **(UK); 2007**	Voluntary
Waterwise Marque **(UK); 2006**	Voluntary
Enhanced Capital Allowance Scheme **(UK); 2003**	Tax rebate
Ordenanza de Gestion y Uso Efficiente del Agua en la Ciudad de Madrid **(Spain); 2006;** Local coverage in Madrid	Mandatory regulations
Decreto 202/1998 **(Spain); 1998;** Local coverage in Catalonia	Mandatory regulations
Distintivo de Grantia de Calidad Ambiental Catalan **(Spain); 1994 ;** Local coverage in Catalonia	Voluntary label
Ambientale al Regolamento dell Citta di Avigliana – Allegato Energetico **(Italy); 2007** Local coverage in Avigliana	Voluntary label
Variente all' Art.8 delle Norme Techniche di Attuazione del P.R.G. **(Italy); 1997** Local coverage in Urbino	Regulation
Regolamento Energetico Ambientale **(Italy); 2008** Local coverage in Sassari	Regulation
Regulamento gerls dos sistemas publicos e predias de distibuicao de aguae de drenagem de aguas residuals **(Portugal); 1998**	Regulation
Certificacao de Efficnenncia Hidrica de Produtos **(Portugal); 2008**	Voluntary (E to A++ rating system)
Building Regulations **(Ireland); 2008**	Mandatory regulation
The Blue Angel **(Germany); 1978**	Voluntary label
The Nordic Eco-label **(Nordic countries); 1989**	Voluntary
The European Eco-label **(Europe); 1993**	Voluntary label

UK

Spain

Italy

Portugal

Water Efficient Products– India (WEP-I)
A Rating System

Objectives

- Provide credible information on water-efficient products and practices
- Raise awareness about the importance of water efficiency, recommend water-efficient products
- Aid consumers make an informed choice of products that conserve water.

WEP-I Rating

Water closets

- European water closet with cistern or flush valve using not more than 6 litres per flush. ★
- European water closet with dual flush cistern or flush valve using 6 litres for full flush and 3 litres for half flush. ★★
- High-efficiency European water closet using 5 litres single flush. ★★
- High-efficiency European water closet using less than 5 litres per flush. ★★★
- Combination or Asian / Indian pan using 6 litres per flush; cistern or flush valve. ★
- Combination or Asian / Indian pan using 6 litres per full flush and 3 litres for half flush; cistern or flush valve. ★★

WEP-I Rating

Urinals

- With flushing device using 4 liters per flush. 
- With flushing device using 3 liters per flush. 
- With flushing device using 2 liters per flush. 

WEP-I Rating
Showerheads

- With flow-rates of 9.5lpm. ★
- With flow-rates of 7.5 lpm. ★★
- Flow-rates less than 7.5 lpm. ★★★

WEP-I Rating

Faucets

- Non-metered faucets or faucets with aerators with flow-rates of 8lpm. ★
- Non-metered faucets or faucets with aerators with flow-rates of 5.7 lpm. ★★
- Non-metered faucets or faucets with aerators with flow-rates less than 5.7 lpm. ★★★
- **Public use faucets:**
- Metered faucets with or without aerators with flow-rates of 1 litre per cycle or non-metered faucets with flow-rate of 2 lpm. ★★
- Metered faucets with electronic actuator with flow-rates of 1 litre per cycle. ★★

WEP-I Rating

Kitchen sinks

- Kitchen sink faucets or faucets with aerators with flow-rates of 8 lpm.
- Kitchen sink faucets or faucets with aerators with flow-rates of less than 8 lpm.

WEP-I Rating
Hand-held Bidet Spray

- With flow-rates of 8 lpm. 
- With flow-rates of less than 8 lpm. 

WEP-I Rating

Dish Washer

- With a Water Factor of 22 liters. 
- With a Water Factor less than 22 liters. 

Water factor: the quantity of water used in liters per full machine wash and rinse cycle

WEP-I Rating

Clothes washer

- With a Water Factor of 5 liters for private use and 8 liters for public use.
- With a Water Factor of less than 5 liters for private and less than 8 liters for public use.

Water factor: quantity of water in liters used to wash each cubic meter volume of machine drum capacity

Water and Energy Studies

- Water consumed/ built up area (Kl/m2)
- Overall Energy Consumption (KW/kl) in water system
- Water Supply & distribution energy Consumption (KW/kl)
- Waste Treatment Plant Energy Consumption (KW/kl)
- Recycling (STP) Energy Consumption (KW/kl)

Case Examples of Water and Energy Consumption

- Office Building nearing completion (based on design data calculations
- Residential Colony (operational data)
- Compilation of design stage (17 design stage analysis)

OFFICE BUILDING

INPUT
Design Data

OUTPUT
Analysis Data

Parameters	Value	Unit
Total Water Consumption	37	KL
Total Sewage Generation	30	KL
Total Population	900	Persons
Energy consumption in supplying fresh water	45	KWHr
Energy consumption in STP	134	KWHr
Energy Factor (Domestic Water supply)	**1.22**	**WHr/L**
Energy Factor (Recycled Water)	**4.47**	**WHr/L**
LPCD Water Consumption	**41.11**	**LPCD**
LPCD Sewage Generation	**33.33**	**LPCD**

Residential Colony

INPUT
Operation Data

OUTPUT
Analysis Data

Parameters	Value	Unit
Water consumption	804.14	KL
Sewage Generation	542	KL
Population	2430	Persons
Energy consumption in supplying fresh water	271.43	KWHr
Energy consumption in STP	653.66	KWHr
Actual water recycled	488.57	KL
Percentage Water Recycled	**60.76**	**%**
Energy Factor (Domestic Water supply)	**0.34**	**WHr/L**
Energy Factor (Recycled Water supply)	**1.34**	**WHr/L**
Actual Avg. LPCD Water Consumption	**330.92**	**LPCD**
Actual Avg. Sewage Generation	**223.05**	**LPCD**

17 Design Stage Analysis

Projects	LPCD Fresh Water Consumption	Overall Energy Consumption (KWHR/kl)	Energy Factor for Water Supply (KWHR/kl)	Energy Factor for Recycling (KWHR/kl)
Total Average of 11 Residential Projects	171.92	5.12	1.20	3.51
Total Average of 3 Hotel Projects	226.36	6.74	1.64	3.19
Total Average of 3 Office Projects	86.19	11.18	8.07	0.95

Conclusions

- Residential Colony :
  - In spite of emphasis of water efficiency, no demand side reduction
  - 40% water is unaccounted as only 60% goes for recycle
  - Rampant use of fresh water for car washing
  - Dwelling level irrigation using fresh water
  - 480KL recycled water used daily for irrigation *alongwith 147 KL water drawn from bore wells!*
  - Although a new project, no attempt made for use of gray water for flushing although treatment met the required standards!!

Conclusions

- Office Building
  - No demand reduction due to recycling although an office building
  - Although a new project, no attempt made for use of gray water for flushing although treatment met the required standards!!

Conclusions

- Other Case analysis:
  - Energy consumption for recycling is almost three times the normal fresh water supply
  - No proper plans for:
    - Achieving demand side reduction
    - No concrete plan for re-cycled water use
    - No attempt made for making water supply and recycle system energy efficiency
    - Irrigation is only use envisaged but no strategy to reduce ware needs in selecting low water need landscape options!
    - High Energy Embedded water is wasted

Thank You !!