13th IWA Specialized Conference on Small Water and Wastewater Systems, 5th IWA Specialized Conference on Resources-Oriented Sanitation, Athens, 14-16th September, 2016

Multi-purpose rainwater harvesting

Professor David Butler Director, Centre for Water Systems University of Exeter, UK



Summary

- RW costs and benefits
- Low energy systems
- Zero energy systems
- Dual purpose systems
- Potable supply systems
- Conclusions





RWH costs & benefits



Increasing whole life cost



Melville-Shreeve, P., Ward, S. and Butler, D. (2015). Rainwater Harvesting Typologies for UK Houses: A Comprehensive Comparison of System Configurations. *Water*, doi:10.3390/w70x000x

RWH costs & benefits

Costs

- Storage tank
- Pumping: energy/GHGs
- Treatment
- Installation (retrofitability)

Benefits

- Water resource: corporate
- Water saving: individual (potable/non-potable)
- Stormwater: flood control
- Stormwater: pollution control
- Resilience/emergency





RWH for UK houses



Costs

- Storage tank
- Pumping: energy/GHGs
- Treatment
- Installation (retrofitability)

Benefits

- Water resource: corporate
- Water saving: individual (potable/non-potable)
- Stormwater: flood control
- Stormwater: pollution control
- Resilience/emergency



RWH water saving efficiency



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An explosion of new system configurations





Storage tanks & configurations







Storage tanks & configurations







Low energy RWH



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Costs

- Storage tank
- Pumping: energy/GHGs
- Treatment
- Installation (retrofitability) ٠

Benefits



- Water resource: corporate
- Water saving: individual (potable/non-potable)
- Stormwater: flood control
- Stormwater: pollution control
- Resilience/emergency •

Low energy RWH



A) Chamber connected to downpipe



B) Illustration of chamber discharging to downpipe

C) Illustration of chamber being pumped empty







Low energy RWH – lab testing







Water supply power consumption

System	Consumption (kWh/m ³)	Ref
This study	0.12 - 0.18	
Commercial RWH	0.54	1
Market Leader RWH	0.68	1
Municipal supply	0.60	1
Median of 10 RWH studies	1.40	2
Global desalination	3.60	2



 Ward S., Butler D. & Memon F.A. (2012), Benchmarking energy consumption and CO2 emissions from rainwater-harvesting systems: an improved method by proxy. *Water and Environment Journal*, 26: 184 – 190. [2] Vieira et al.(2014). Energy intensity of rainwater harvesting systems. Renewable and Sustainable Energy Reviews 34, 225 –242.

Low energy RWH – lab testing







System components











Safe&SuRe Water management

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Low energy RWH – field trials



10-20m³/annum

Safe&SuRe

Water management



Zero energy RWH – lab testing







Zero energy RWH – product









www.atlaswaterharvesting.co.uk

Dual purpose systems: water supply & stormwater



• Resilience/emergency



Dual system: passive control









Dual system: passive control



2.5m³ RWH tank supplying 30-60m³/annum. <u>PLUS</u> >2.5m³ of stormwater attenuation (source control)



www.rainwaterharvesting.co.uk



Dual systems: active control



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RWH: direct potable supply



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RWH: direct potable









RWH: direct potable

		Inlet (no/ml)			Tank (no/ml)			Outlet (no/ml)		
	PCV	Range	Mean	SD	Range	Mean	SD	Range	Mean	SD
Coliforms	0	0-510	185	203	N/A	0	N/A	N/A	0	N/A
E. coli	0	0-210	57	75	N/A	0	N/A	N/A	0	N/A
Entero- cocci	0	0-900	229	309	N/A	0	N/A	N/A	0	N/A
TVC22	100	1- 25600	3581	6256	0-157	16	40	0-300	73	126
TVC37	10	0- 1350	381	377	0-56	8 Base	16 d on 26 wee	0-300 ekly samples	55 s taken duri	114 ng 2015





RWH Costs & benefits





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Conclusions

- RWH can come in many configurations
- Lower cost: smaller, retrofitable tanks (€1,500/house, ~3x cheaper than existing systems).
- Lower GHG emissions: high-level systems (comparable or lower than central delivery)
- Lower stormwater discharges: larger tanks, dual configuration (active improves over passive).





Conclusions

- All systems deliver water saving benefits AND stormwater benefits to varying degrees
- Where **demand is low**, tanks are likely to be emptied less frequently so **yield is higher**
- Where demand is high, tanks are likely to be emptied more frequently so yield is lower, but this provides greater stormwater control.
- Multi-purpose RWH systems tailored
 solutions for droughts & floods!
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 Safe&SuRe Water management

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Thanks to Pete Melville-Shreeve and Dr Sarah Ward for their significant contributions to this presentation.