Innovations in Residential Rainwater Harvesting in the UK

A Preliminary Sustainability Assessment of Innovative Rainwater Harvesting for Residential Properties in the UK

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Sponsored by: Severn Trent Water Ltd and The EPSRC
Overview

• **Background**
  • UK water sector
  • Existing UK RWH market
  • Benefits of household RWH

• **Study Methodology**
  • Identify existing RWH technology
  • Horizon scan for innovations
  • Appraise traditional and innovative RWH approaches

• **Results**
  • Patents, roof-storage and low energy / low cost innovations

• **Initial Conclusions**
  • Are innovations more sustainable?
  • Future research
Background

- **UK Water Sector**
  - Water and the UK
    - Privatised water and sewerage network with a single water supplier / region & high coverage.
    - Annual rainfall in London, 600-800mm/year
    - Household water usage = 150 litres/person/day
    - Lack of resilience to drought and flooding?

“The South-East has less water per head of population than Sudan or Syria because it is much more densely populated” (Environment Agency Cited in Waterwise, 2009)
International Domestic Water Use

Litres per Person per Day
Background

• **UK Policy for RWH**

**Code for Sustainable Homes (water systems & fittings)**

**Building Regulations part G (water efficiency)**

**Building Regulations part H (drainage)**

**British Standards codes of practice**
- BS8515:2009 Rainwater Harvesting Systems
- BS8525-1:2010 Greywater Systems
- BS8595 (tbc) Selection of Water Reuse Systems
Background

- **Existing UK Residential RWH market**
  - **Traditional RWH**
    - 5,000 per annum
    - Traditional capture-store-pump-use systems
    - <50% of household water demand (WC and laundry)
    - Tank size: 1m$^3$ to 6m$^3$
  - Regulator suggests RWH supplies are:
    "generally more carbon intensive than mains/potable water"
    (Environment Agency, 2011)
Background

- **Perceived Benefits of RWH**
  For the PROPERTY OWNER

**ECONOMIC**
Reduced water and sewerage bills
£50-£300 / annum saved

**ENVIRONMENTAL / SOCIAL**
Water available during hosepipe bans

**SOCIAL**
Social feel-good factor (social)
Background

• “Future” Benefits of RWH
  For the WATER & SEWERAGE COMPANY
  • Reduce Carbon, Energy & Need for Capital Investment?

Abstraction / Reservoir
Treatment
Pumping
RWH reduces water demand by >25%
Sewers/CSOs
Pumping
Treatment
Background

• **Study Aim**
  Identify and undertake an initial appraisal of UK RWH systems against a conceptual model built upon the Three Pillars of Sustainability (Elkington, 2004)

An idealised RWH system can be identified having minimal economic cost, low social impact and positive environmental effects.
Methodology

- Identify traditional & innovative RWH technologies
  - Approach existing UK suppliers
  - Patent search
  - Develop simple Multi Criteria Analysis

<table>
<thead>
<tr>
<th>Economic</th>
<th>Installation Cost</th>
<th>Payback ability</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Annual financial benefit</td>
<td>Company able to install system within 4 weeks</td>
</tr>
<tr>
<td></td>
<td>Funding supporting the RWH company</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Social</th>
<th>Ease of new build installation</th>
<th>Ease of retrofit installation</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Risk of health issues minimised</td>
<td>Risks of structural issues minimised</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Environmental</th>
<th>All roof runoff collected by each system</th>
<th>Large storage achievable following development</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Zero Operational CO2</td>
<td>Low capital CO2</td>
</tr>
<tr>
<td></td>
<td>Provides flood management benefit</td>
<td>High Demand met / year</td>
</tr>
</tbody>
</table>
Results

• **Traditional RWH Appraisal**

  Four companies assessed
  • Specifications and costs provided for a small and large RWH system
  
  • Suppliers estimated on-site installation costs to be >1 times retail price assuming a retrofit scenario.
  
  • Onsite installation costs were therefore assumed at a cost of £1,300 for traditional systems with storage <2m$^3$:
  
  • Cheapest Traditional RWH System estimated at £2,653 with 1m$^3$ tank.

x10 for Yuan = 13,000 RMB
Results

- **Patents & Innovations**
  Aqua Harvest and Save, **gutter mounted** rainwater recovery

- 1m³ roof-space storage
- V low head pump (<0.5m)
- Very low energy requirements (50W pump)
- Easy to retrofit
- Patented load bearing tank system
Results

• Patents & Innovations
  Flushrain – Downpipe mounted rainwater recovery
  • 1m$^3$ roof-space storage
  • Low energy requirements
  • Easy to retrofit
Results

- **Capital Cost Assessment**
  1m³ roof-space storage systems found to be cheaper

- No external excavation
- Easy retrofit
- Lower manufacturing costs
Results

- **Simple Multi Criteria Analysis - Summary**

1m³ roof-space storage systems have higher “Sustainability Scores”:
- No external excavation
- Easy retrofit
- Low operational and capital carbon footprint

<table>
<thead>
<tr>
<th>Factor</th>
<th>Maximum Score (%)</th>
<th>Comment</th>
<th>Benchmark Traditional RWH</th>
<th>Innovative RWH Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic</td>
<td>35</td>
<td>Five economic factors have been weighted to derive this score: Installation Cost, Annual financial benefit, Payback-ability, Business-ready, Funding-ready.</td>
<td>22</td>
<td>23 25</td>
</tr>
<tr>
<td>Social</td>
<td>20</td>
<td>Four social factors have been weighted to derive this score: Ease of installation, Ease of retrofit installation, Health issues minimised, Risks of structural issues minimised.</td>
<td>13</td>
<td>14 15</td>
</tr>
<tr>
<td>Environmental</td>
<td>45</td>
<td>Six environmental factors have been weighted to derive this score: All roof runoff collected, Large storage achievable following optimised design, Low operational CO2, Low capital CO2, Flood management benefit, High demand met.</td>
<td>19</td>
<td>27 27</td>
</tr>
<tr>
<td>TOTAL SCORES</td>
<td>100</td>
<td></td>
<td>54</td>
<td>64 67</td>
</tr>
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Further Work

Conceptualising Further Research

House 1 – No RWH
- 220m³ potable water / annum
- Status quo

House 2 – With RWH
- 164m³ potable water / annum (25% reduction)
- Abstraction reduced, less flooding, cleaner watercourses, reduced energy used for pumping, water infrastructure assets have extended lifetime, lower CO₂, less chemical use
- Reduced water used = reduced income for water provider
- More sustainable? Cheaper whole life cost?
Further Work

Research Questions:
1) Is residential RWH a sustainable technology for the UK?
2) Does the evidence suggest that policy changes or subsidies are required?

Doctorate Project: “RWH in the Wild”
- Install pilot RWH systems in 12 properties
- Monitor water & energy use (>1 year) and compare to centralised “costs”
- Identify overall benefits to both customers and environment / water provider.
- Quantify and model broader benefits/negatives of wide scale RWH uptake
Looking Forwards

Initial Findings:
• Estimates project that RWH can be retrofitted in the UK for £2,653.
• Innovative roof-based RWH systems could be achieved for less than £1,000 (if a market develops)
• Roof-based RWH systems score more highly when appraised in a simple MCA sustainability appraisal.

Areas for Investigation:
• Realworld pilot installations will now be installed and appraised.
• Retrofitting risks (structural loading etc) most be considered
• Water quality risks need to be appraised

• Could these technologies be applied elsewhere?
Elkington, J. (2004) *Enter the Triple Bottom Line. The Triple Bottom Line: does it all add up.* Published; EarthScan: London UK.
