Circular-economy market formation in the Danish construction industry

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The circular economy
**Constr/demo waste recycling**

**Denmark, 2015**

- "Recycling"
- "Re-use"
- "Disposal"

<table>
<thead>
<tr>
<th>Fraction</th>
<th>Generation (1,000 t)</th>
<th>&quot;Recycling&quot; (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete wastes</td>
<td>1.061</td>
<td>90 %</td>
</tr>
<tr>
<td>Wood wastes</td>
<td>107</td>
<td>87 %</td>
</tr>
<tr>
<td>Tiles and ceramic wastes</td>
<td>77</td>
<td>87 %</td>
</tr>
<tr>
<td><strong>C&amp;D waste total</strong></td>
<td><strong>4.162</strong></td>
<td><strong>87 %</strong></td>
</tr>
</tbody>
</table>
(Construction) waste market characteristics

- Waste as a “high-entropy” product (messy)
- Quality and consistency
- Misalignment of ownership and capabilities
- Market learning
- Scale and scope economies
- Geography and natural monopolies
- Timing and management attention
Market dynamics
Material mix over the years
Demand: product attractiveness

\[ A = W \left( \frac{P}{P_A} \right) ^\pi \left( \frac{Q}{Q_A} \right) ^\theta \left( \frac{K}{K_A} \right) ^\rho , \]

WtC Price Quality Scope
Supply

- Constrained by capacity (production, distribution, marketing, administration, etc.)
- Sales (demand) constrained by stocks available (except concrete RA sector)
- Quantity signals: recent sales (and needs for stock replenishments) → desired capacity → investments in capacity
- Price signals: Shortages → margins → investments in capacity
- Potential shortage of virgin material could drive up price, supporting recycle market
Tipping point dynamics from market awareness

Recycled material attractive (PV = 2)

WtC=10% Figure 3

WtC=20% Figure 4
Market learning as a barrier to scarcity signal

Scarcity of virgin material activated (rho=1)

Figure 5

Ideal market (initial WtC=100%)  

Figure 6

Market learning (initial WtC=10%)
Scope economy as barrier

Ideal market (initial WtC=100%)  
Figure 5

Scope economy barrier (initial beta=0,25)  
Figure 7
Scale economy as barrier

Ideal market (initial WtC=100%)
Figure 5

Scale economy barrier (initial alpha=1)
Figure 8
Implementing policy initiatives

<table>
<thead>
<tr>
<th>Parameter</th>
<th>#1: Certification</th>
<th>#2: Trading platform</th>
<th>#3: Value demonstration</th>
<th>#4: GPP</th>
</tr>
</thead>
<tbody>
<tr>
<td>(h): marketing effect on WtC</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>(\kappa): strength of word-of-mouth</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
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<tr>
<td>(Q): quality</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>(\nu): required inventory coverage</td>
<td></td>
<td>-</td>
<td></td>
<td></td>
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<tr>
<td>Reference unit cost</td>
<td></td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reference scope capacity</td>
<td></td>
<td>-</td>
<td></td>
<td></td>
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<tr>
<td>Autonomous demand component</td>
<td></td>
<td></td>
<td></td>
<td>+</td>
</tr>
</tbody>
</table>
Policy 1: Certification, seems to work...

Figure 3

Figure 9
... but not if, e.g., scope effects are active
Policy 2: Trading platform (reduces scope barrier)
Policy 4: GPP
(drives transition)

Figure 10

Figure 13
Policy conclusions

- All four policies can have positive effects, but they are likely to all have to be used in combination to effect transition.
- Initiatives operate on different leverage points in the system
- Demo projects, certification and trading all improve information to buyers and thus mitigate risks.
- In case of concrete RA market, this is enough to effect transition, but may not be in the other markets
- Market matching improves scope economies and quality which can accelerate development, but results are sensitive to assumptions
- GPP is a robust and effective way of boosting transition
- TRANSITION TAKES TIME!!! Due to inertial factors in the system