Circular economy through the ECOOM lens: patents, R&D and innovation indicators

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Background: ECOOM History & Mission

• Interuniversity consortium, participation of all Flemish universities (UA, VUB, UGent, UHasselt, KU Leuven)

• Originally established in 2002 as ‘Steunpunt O&O Statistieken’, transformed to permanent center of expertise (ECOOM) in 2009. Currently at the start of its third 5-year term.

• ECOOM’s mission:
  • Development of a consistent and coherent R&D indicator system,
  • for mapping and monitoring R&D efforts in Flanders and benchmark regions,
  • with the aim of providing support to the Flemish policy.
ECOOM Leuven – Activities & Structure

Structure reflects 3 main activities:

- Evaluation of research performance and quantitative science studies (Bibliometrics team)

- Evaluation of technological performance and quantitative technology studies (Technometrics team)

- Indicators of R&D and Innovation (Innovation team)
Technometric approach

• Patent-based indicators for mapping and monitoring technological development

• Based on ad hoc questions (mainly from the Flemish government), we performed several domain studies, relevant to green / circular / environmental technology:
  • LNE Vlaanderen (mapping of environmental technology, green growth)
  • Focus groups on biomaterials, food packaging, construction & textiles
  • ...

ecoom
EXPERTISECENTRUM O&O MONITORING
KU LEUVEN
Technometric approach

• Main challenge in domain studies: domain delineation

• By technological classification schemes
<table>
<thead>
<tr>
<th>1. ENVIRONMENTAL MANAGEMENT</th>
<th>IPC class</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1. AIR POLLUTION ABATEMENT</td>
<td>All classes from 1.1.1 to 1.1.3</td>
</tr>
<tr>
<td>1.1.1. Emissions abatement from stationary sources (e.g. SOx, NOx, PM emissions from combustion plants)</td>
<td></td>
</tr>
<tr>
<td>Post-combustion technologies</td>
<td></td>
</tr>
<tr>
<td>Chemical or biological purification of waste gases (e.g. engine exhaust gases, smoke, fumes, flue gases or aerosols, removing sulfur oxides, nitrogen oxides, etc.)</td>
<td>B01D53/34-72</td>
</tr>
<tr>
<td>Incinerators or other apparatus specially adapted for consuming waste gases or noxious gases</td>
<td>F23G7/06</td>
</tr>
<tr>
<td>Arrangements of devices for treating smoke or fumes of purifiers, e.g. for removing noxious material</td>
<td>F23J15</td>
</tr>
<tr>
<td>Shaft or like vertical or substantially vertical furnaces; Arrangements of dust collectors</td>
<td>F27B1/18</td>
</tr>
<tr>
<td>Integrated technologies</td>
<td></td>
</tr>
<tr>
<td>Blast furnaces; Dust arresters</td>
<td>C21B7/22</td>
</tr>
<tr>
<td>Manufacture of carbon steel, e.g. plain mild steel, medium carbon steel, or cast-steel; Removal of waste gases or dust</td>
<td>C21C5/38</td>
</tr>
<tr>
<td>Combustion apparatus characterised by means for returning flue gases to the combustion chamber or to the combustion zone</td>
<td>F23B80</td>
</tr>
<tr>
<td>Combustion apparatus characterised by arrangements for returning combustion products or flue gases to the combustion chamber</td>
<td>F23C9</td>
</tr>
<tr>
<td>Apparatus in which combustion takes place in a fluidised bed of fuel or other particles</td>
<td>F23C10</td>
</tr>
<tr>
<td>1.1.2. Emissions abatement from mobile sources (e.g. NOx, CO, HC, PM emissions from motor vehicles)</td>
<td></td>
</tr>
<tr>
<td>Post-combustion technologies</td>
<td></td>
</tr>
<tr>
<td>Processes, apparatus or devices specially adapted for purification of engine exhaust gases</td>
<td>B01D53/92</td>
</tr>
<tr>
<td>...by catalytic processes</td>
<td>B01D53/94</td>
</tr>
</tbody>
</table>

Source: OECD 2015 – Environmental technology classification
Technometric approach

• Main challenge in domain studies: domain delineation
  • By technological classification schemes
  • By keyword searches in patent documents
(…) (select appln_id from APPLN_TITLE where upper(appln_title) like '%BIOPOL%'
or upper(appln_title) like '%BIO-POL%' or upper(appln_title) like '%BIOPLAS%' or upper(appln_title) like '%BIOPLAS%' or upper(appln_title) like '%BIORESIN%' or upper(appln_title) like '%BIO-RESIN%' or upper(appln_title) like '%BIOFOAM%' or upper(appln_title) like '%BIO-FOAM%' or upper(appln_title) like '%BIO-BASED%' or upper(appln_title) like '%BICOMPOSITE%' or upper(appln_title) like '%BIO-COMPOSITE%' or upper(appln_title) like '%POLY(LAC%' or upper(appln_title) like '%LACTID%' or upper(appln_title) like '%POLYHYDROXYAL%' or upper(appln_title) like '%POLY(HYDROXYAL%' or upper(appln_title) like '%SUCCIN%' or upper(appln_title) like '%BIOABSORB%' or upper(appln_title) like '%BIO-ABSORB%' or upper(appln_title) like '%BIO-RESORB%' or upper(appln_title) like '%BIORESORB%' or upper(appln_title) like '%BIOMASS%' or upper(appln_title) like '%POLYM%' or upper(appln_title) like '%POLY(LAC%' or upper(appln_title) like '%LACTID%' or upper(appln_title) like '%POLYHYDROXYAL%' or upper(appln_title) 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Technometric approach

- Main challenge in domain studies: **domain delineation**
  - By technological classification schemes
  - By keyword searches in patent documents
  - By patent portfolios of relevant organisations
<table>
<thead>
<tr>
<th>building material</th>
<th>product</th>
<th>biobased origin</th>
<th>organisation</th>
<th>country</th>
<th>type of organisation</th>
</tr>
</thead>
<tbody>
<tr>
<td>bricks</td>
<td>coral making micro-organisms</td>
<td>Biomason</td>
<td>USA</td>
<td>start-up</td>
<td></td>
</tr>
<tr>
<td>compositessteen</td>
<td>biobindlidel + natuurlijke anorganische afvalstoffen</td>
<td>Holonite</td>
<td>NL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>binnentegels</td>
<td>egg shells + cork</td>
<td>NihonMtecs</td>
<td>Japan</td>
<td></td>
<td></td>
</tr>
<tr>
<td>facade bekleding</td>
<td>bioplastic</td>
<td>DUS / Henkel</td>
<td>NL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>bouwplaat</td>
<td>waste from paper/noxious weeds, industrial hennep en waste wood</td>
<td>University of Colorado</td>
<td>USA</td>
<td>project (start-up?)</td>
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<tr>
<td>bouwplaat</td>
<td>geperste vlasscheven</td>
<td>Linex</td>
<td>NL</td>
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<tr>
<td>honeycombs core sandwich panels</td>
<td>ThermHex production technology</td>
<td>PLA</td>
<td>EconCore</td>
<td>BE</td>
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<tr>
<td>WPC</td>
<td>wood polymer granules</td>
<td>Beologic</td>
<td>BE</td>
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<tr>
<td>WPC</td>
<td>composieten kunststof houtvezels</td>
<td>Dumaplast</td>
<td>BE</td>
<td></td>
<td></td>
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<tr>
<td>lijm voor acoustische panelen</td>
<td>Acous-Tec Adhesive</td>
<td>soya</td>
<td>W.F. Taylor</td>
<td>USA</td>
<td></td>
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<tr>
<td>asphalt</td>
<td>bio-asfalt</td>
<td>lignin</td>
<td>Wageningen &amp; Dutch Asphalt Knowledge Center</td>
<td>NL</td>
<td>project</td>
</tr>
<tr>
<td>asphalt mix</td>
<td>CECABASE</td>
<td>50%biobased additives for warm asphalt mix</td>
<td>CECA (ex SEPPIC Belgium)</td>
<td>BE</td>
<td></td>
</tr>
<tr>
<td>bitumen/ waterdichtingsmembraan</td>
<td>Orineo/ DERBiPURE</td>
<td>BIOTOMEN: Bio-based dakmembraan op bases van geraffineerde pyrolyse olie</td>
<td>Derbigum/ IMPERBEL NV</td>
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<tr>
<td>piping (regenwater)</td>
<td>DYKA Bioplastic</td>
<td>PLA (Corbion)</td>
<td>DYKA (dochter Tessenderlo</td>
<td>NL/ BE</td>
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<td>isolatieschuim</td>
<td>Ucore+ (isolate plastic window frames)</td>
<td>soya</td>
<td>WFI Global</td>
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<td>isolatieschuim</td>
<td>Heatlox XT</td>
<td>soya</td>
<td>Demilec, Inc</td>
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<td>isolatiekorrels</td>
<td>BiofoamPearls</td>
<td>PLA</td>
<td>SYNBRA Technology BV</td>
<td>NL</td>
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<td>styrofoam vervanger</td>
<td>cellufoam</td>
<td>wood cellulose as replacement for styrofoam</td>
<td>Cellutech</td>
<td>Sweden</td>
<td>start-up</td>
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<tr>
<td>insulation panels</td>
<td>bioplastic insulation panels</td>
<td>bioplastic matrix + Flax, jute &amp; cork</td>
<td>OSIRYS project</td>
<td></td>
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<tr>
<td>gronddoek/ geotextiles</td>
<td>Ökolys</td>
<td>PLA</td>
<td>Beaulieu Technical Textiles</td>
<td>BE</td>
<td></td>
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<tr>
<td>gronddoek/ geotextiles</td>
<td>Duracover geweven grondbedekker</td>
<td>PLA</td>
<td>Bonar Technical Fabrics</td>
<td>BE</td>
<td></td>
</tr>
<tr>
<td>gronddoek/ geotextiles</td>
<td>PLA</td>
<td>DS Textiles</td>
<td>BE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>flexible foams</td>
<td>BLOOM</td>
<td>algae derived</td>
<td>Meridian</td>
<td>USA</td>
<td></td>
</tr>
<tr>
<td>flexible foams</td>
<td>Biofoams from Cargill’s soy-based BiOH™ polyols.</td>
<td>Recticel</td>
<td>BE</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


Technometric approach

• Main challenge in domain studies: domain delineation
  • By technological classification schemes
  • By keyword searches in patent documents
  • By patent portfolios of relevant organisations

• Combining approaches: allows for cross-validation
• In either approach: importance of expert validation!
Example results – patent studies:

[Graphs showing trends in patent studies.
Legend:
- EPO België
- EPO Vlaanderen
- PCT België
- PCT Vlaanderen

Graphs compare trends across different categories of environmental technology.

Graph 1: ENV-TECH TOTAAL
- General Environmental Management
- Water-related adaptation technologies
- Climate change mitigation technologies related to ENERGY generation, transmission of distribution
- Capture, storage, sequestration or disposal of greenhouse gases
- Climate change mitigation technologies related to TRANSPORTATION
- Climate change mitigation technologies related to buildings]
Measuring R&D and Innovation in the Business Enterprise Sector (Innovation team)

- R&D surveys (even years)
  - R&D expenditure, R&D personnel, funding, types of costs

- Innovation surveys (uneven years)
  - Product innovation, business process innovation, innovation expenditure, cooperation, funding, ...

- Mandated by European Commission
- In line with international guidelines
Module on Eco Innovation in 2009 Innovation Survey

• Part of harmonized survey form within EU

• Innovations with environmental benefits
  • During production
  • During after sales use

• Reasons for innovations with environmental benefits
% Enterprises with eco innovation (2006-2008)

- Chemicals & plastics
- ICT & electronics
- Machinery, equipment & vehicles
- Textiles, clothing & leather
- Other manufacturing
- Food, beverages & tobacco
- Metal & metal products
- Wholesale
- Paper & wood
- Information services
- Transport, financial & printing...
% Enterprises with eco innovation (2006-2008)

- **Large**
- **Medium**
- **Small**

![Bar chart showing percentage of enterprises with eco innovation from 2006 to 2008 by size category.](/images/bar_chart.png)
Innovations w/ environmental benefits (2006-2008)

- Reduced soil, water, noise, air pollution
- Recycled waste, water or materials
- Reduced energy use
- Less polluting/hazardous materials used
- Reduced CO2 footprint
- Reduced material use
- During after sales use
- Improved recycling after use
- Reduced energy use
- Reduced soil, water, noise, air pollution

0% 20% 40% 60% 80% 100%
Innovations w/ environmental benefits (2006-2008)

- Recycled waste, water or materials (f)
- Reduced soil, water, noise, air pollution (f)
- Reduced energy use (f)
- Less polluting/hazardous materials used (f)
- Reduced CO2 footprint (f)
- Reduced material use (f)
- Reduced energy use (u)
- Improved recycling after use (u)
- Reduced soil, water, noise, air pollution (u)

DE  FR  BE  NL

0%  10%  20%  30%  40%  50%
Reasons for eco innovation (2006-2008)

- Voluntary sector codes or agreements
- Existing eco regulations or taxes
- Expected eco regulations or taxes
- Current or expected market demand
- Eco grants, subsidies or financial incentives

Bar chart showing percentages of large, medium, and small entities for each reason:

- Large
- Medium
- Small

0% 10% 20% 30% 40% 50% 60%
Reasons for eco innovation (2006-2008)

- Voluntary sector codes or agreements
- Existing eco regulations or taxes
- Expected eco regulations or taxes
- Current or expected market demand
- Eco grants, subsidies or financial incentives

BE  FR  DE  NL
Eco Innovation Module Conclusions

• 37% of Flemish firms introduced an eco innovation in 2006-2008

• 92% of those indicated environmental benefits during production, vs. 62% environmental benefits during after sales use

• Voluntary sector codes, existing and expected regulations were more important than grants or financial incentives for introducing eco innovations
More information

• [www.vlaamsindicatorenboek.be/vorige-edities](http://www.vlaamsindicatorenboek.be/vorige-edities)

• Select the 2011 edition, chapter 9
Contact:

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(technometrics) julie.callaert@kuleuven.be