GreenFoundry LIFE

Webinar April 22nd, 2022

Inorganic binder usage in iron & steel casting, implications for the BREF process

Dr.-Ing. Dirk Lehmhus
Fraunhofer IFAM

Fraunhofer IFAM

Green Foundry LIFE Webinar

Inorganic binder usage in iron & steel casting

LIFE17 ENV/FI/000173
Green Foundry
1/7/2018-30/6/2022

AGENDA

Time	TOP	Subject
09:00	1	**Overall Project Presentation** (Sara Tapola - Meehanite)
09:20	2	**Results of Test Casts** 09:20 Karhula / Valumehaanika Foundries (Hannu Pöntinen, Pekka Kemppainen – Meehanite) 09:40 Fonderie Assisi (Stefano Saetta – Università degli Studi di Perugia)
10:00	3	**Results of chamber test emission reductions with different inorganic and organic bínding systems** (Rafał Dańko - AGH University of Science and Technology)
10:20	4	**Tested surplus foundry sand recycling and reuse methods** 10:20 Thermal reclamation (Juhani Orkas – Association of the Finnish Foundry Industry) 10:40 Composting tests (Sara Tapola - Meehanite) 11:00 Washing tests (Patricia Caballero Oguiza – Tecnalia) 11:20 Mechanical, hydromechanical & ultrasonic treatment (Jean-Bernard Virolle – CTIF) 11:40 Leaching tests and identifying reuse options (Jean-Bernard Virolle – CTIF)
12:00	5	**Green Foundry LIFE BAT Report** (Dirk Lehmhus – Fraunhofer IFAM)
12:20	6	**Discussion, gathering of information & feedback** (Dirk Lehmhus – Fraunhofer IFAM)

Green Foundry LIFE Webinar
Organisational Issues

Rules for interaction during this webinar:

- **During presentations** we ask all participants to mute their microphone and switch off their camera.
- **During discussions** participants may either raise their hand or post their question using the chat function. We will monitor both and call up participants who raised their hand directly or communicate questions from the chat to presenters and audience.

  In the former case, we will ask you to switch on the camera and unmute the microphone.

Please note:

We have foreseen approximately five minutes of discussion following each technical presentation.

We have a final discussion session from 12:20 onwards until the scheduled end of the meeting at 13:00.

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GreenFoundry LIFE

Webinar April 22nd, 2022

Green Foundry LIFE BAT Report

Dr.-Ing. Dirk Lehmhus
Fraunhofer IFAM

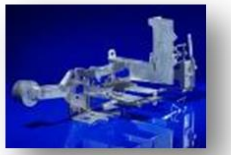
Fraunhofer IFAM

BAT Report

Presentation Overview

LIFE17 ENV/FI/000173
Green Foundry
1/7/2018-30/6/2022

- **Fraunhofer IFAM**
  Wiener Straße 12
  28357 Bremen
  Germany
- More than 600 researchers in Bremen, Dresden, Stade, Wolfsburg, Braunschweig – among the largest institutes of the Fraunhofer Society.
- Dept. of Casting Technology and Lightweight Construction




	High Pressure Die Casting (HPDC)	Low Pressure Die Casting (LPDC)	Investment Casting	Injection Molding
Materials / Alloys	**aluminium** **magnesium** **zinc**	**aluminium** **grey iron & steel** **salt** **copper**	**aluminium** **copper** **special alloys**	**plastics** **wax**
Machines	**cold-chamber** *BÜHLER SC N/66* **cold-chamber** *FRECH DAK 250*	**Low-pressure** *TEGISA I* *NDGA 110kW/51l* *TEGISA II* *NDGA 130kW/110l* *Kurtz-ERSA* *Al 16-12 SC*	**Investment casting** *Indutherm VC 3000D* *Indutherm VC 650* *BEGO Nautilus MC plus* **Mixing unit** *KWS Kächele EB10/16 S* **Wash out unit** *Karl Bauer WSK 1* **centrifugal casting** *BEGO Fornax G*	**Plastic-injection** *MCP KSA 100* **Wax-injection** *ModTech C 20* **3D-Printing** *3DSYSTEMS Spektrum Z510*
Special Features	real time control Fondarex®vacuum	quick-change system for crucible	Investment casting equipment with vacuum support (when needed)	ultra low pressure injection (1-5 bar)

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BAT Report
Presentation Overview

- BREF Preparation Overview
  - *BREF, BAT, ET: What is it?*
  - *Creating a BREF: How is it done?*
  - *Smitheries and Foundries BREF: Previous Document, Status & Timeline of Updates*
- Green Foundry LIFE BAT Report
  - *Current Status*
  - *BAT suggestions by Green Foundry LIFE*
  - *ET suggestions by Green Foundry LIFE*
- Next Steps
  - *Next Steps*
  - *Gathering your Input*

BREF Preparation Overview

BREF, BAT, ET: What is it?

- **BREF: Best Available Techniques Reference Document**
- **Purpose:** Defining and fixing what is state of the art e.g. for an industrial sector in terms of the best technologies available in it for minimizing the respective sector's effects on the environment. BAT conclusions provide the reference e. g. for setting boundary conditions for permission of industrial installations covered by the Industrial Emissions Directive throughout the European Union.
- **Responsibility:** The process of creating or updating a BREF is organized by the European Integrated Pollution Prevention and Control (IPPC) Bureau (EIPPCB) linked to the Institute for Prospective Technological Studies located in Sevilla as part of the European Commission's Joint Research Centre.
- **Relation to Green Foundry LIFE:**
  - *Directive 2008/98/EC on waste (Waste Framework Directive)*
  - *Directive 2010/75/EU on industrial emissions (integr. pollution prevention & control)*
  - *2018 Circular Economy Package (Report on Critical Raw Materials and the Circular Economy)*

Overview existing and planned BREFs:
https://eippcb.jrc.ec.europa.eu/reference

BREF Preparation Overview

BREF and BAT/ET details: What is it?

The BREF process distinguishes between techniques based on technology readiness and availability (note the term „available“ in BAT):

- **Best Available Technique (BAT):** In order for a technology to be included in a BREF document and even more so in BAT conclusions, potential users must necessarily have access to it – thus to be a BAT, the technology has to be commercially available for all affected companies in all member states subject to the BREF document.
- **Emerging Technology (ET):** Given the long term between initially drawing up a BREF and preparing an update, it makes sense to already include techniques which have not yet reached the BAT level of maturity. These ETs can then be reevaluated as soon as a BREF update is underway. They are thus included in the BREF document, but do not enter into the BAT conclusions. Their thus not binding in the same way as BATs.

BREF Preparation Overview

Creating a BREF: How is it done?

- **The Sevilla Process:** Multi-stage process meant to involve all stakeholders and member states in the setting-up of new environmental standards.
  - *Initiation of preparation/update process for a sectoral or a cross-cutting/horizontal BREF through EIPPCB.*
  - *(Re-)Establishment of a **Technical Working Group (TWG)**, collection of first ideas on content, scope.*
  - *KickOff-Meeting: Freezing of scope, environmental issues to be addressed, procedure.*
  - *Gathering of information regarding current state of emissions and techniques (TWG, EIPPCB).*
  - *First draft provided by EIPPCB and presented to TWG for comments.*
  - *If needed, revision of the first and preparation of a second draft integrating TWG comments (EIPPCB). Second round of consultations with TWG.*
  - *Final meeting with TWG including assessment of comments received, discussion and consensus on **BAT conclusions** (EIPPCB, TWG).*
  - *Preparation of pre-final draft; last opportunity for comments by the TWG. Update made available to the **forum** established by the Industrial Emissions Directive (Article 13) and comprising member state representatives, industries concerned, environmental NGOs.*
  - *Opinion of the forum to be considered by the **Commission** w.r.t. the adoption of the BAT conclusions.*

BREF Preparation Overview

Creating a BREF: How is it done?

Feeding information into the BREF process: **BAT/ET template structure I**

- **Title:** Title/summary containing the type and purpose of the technique (or combination of techniques).
- **Description:** A brief description of the technique with a view to being used in the BAT conclusions.
- **Technical Description:** A more detailed and yet concise technical description using, as appropriate, chemical or other equations, pictures, diagrams and flow charts.
- **Achieved Environmental Benefits:** The main potential environmental benefits to be gained through implementing the technique.
- **Environmental Performance and Operational Data:** Actual and plant-specific performance data (including emission levels, consumption levels – of raw materials, water, energy – and amounts of residues/wastes generated) from well-performing installations/plants (with respect to the environment taken as a whole) applying the technique accompanied by the relevant contextual information.
- **Cross-Media Effects:** Relevant negative environmental effects due to implementing the technique (for assessing the impact on the environment as a whole).

BREF Preparation Overview

Creating a BREF: How is it done?

Feeding information into the BREF process: **BAT/ET template structure II**

- **Technical Considerations Relevant to Applicability:** Indication if the technique can be applied throughout the sector (i.e. indication of the type of plants or processes within the sector to which the technique can not be applied) and information on the main general technical restrictions on the use/implementation of the technique. Indicate which local conditions (e.g. lack of water) may influence the implementation.
- **Economics:** Information on costs and possible savings, including details on how these costs have been calculated. If a project included other parts of an industrial installation, estimate the costs related only to the foundry installation.
- **Driving Force for Implementation:** Rationale behind the choice of technique, i.e. local conditions or requirements, non-environmental triggers or savings which stimulated the implementation of the project.
- **Reference Literature:** Literature or other reference material that was used in writing the section and that contains more detailed information.

BREF Preparation Overview

Creating a BREF: How is it done?

Feeding information into the BREF process: **BAT/ET template structure III**

- **Date of Implementation:** Date of implementation of the technique.
- **Example Plants:** Reference to plant(s) where the technique has been implemented and from which information has been collected.
- **Comments:** Other contextual information, e.g. techniques which have been considered, discarded due to certain constraints (technical or economic, limited environmental benefit).

BREF Preparation Overview

Creating a BREF: How is it done?

Feeding information into the BREF process: **BAT/ET template structure III**

- **Date of Implementation:** Date of implementation of the technique.
- **Example Plants:** Reference to plant(s) where the technique has been implemented and from which information has been collected.
- **Comments:** Other contextual information, e.g. techniques which have been considered, discarded due to certain constraints (technical or economic, limited environmental benefit).

Structure is reflected in the Green Foundry LIFE BAT Report draft #1 of which was distributed to webinar participants.

BREF Preparation Overview

Smitheries and Foundries BREF Update: Status & Timeline

- **Present Document:** Current version of Smitheries & Foundries BREF dates from 05/2005.
- **KickOff-Meeting for Update:** Sevilla, September 17th-20th, 2019.
- **TWG establishment:** Up and running, including thematic subgroups.
- **Members:** Representation of the European foundry industry among others by the industry association CAEF, and here in person by Elke Radtke (BDG/CAEF). Representation of Green Foundry LIFE via Juhani Orkas.
- **Duration:** Typically expected 3-4 years, delay likely due to Covid-19.
- **Status:** First draft recently published (02/2022), link below.

Juhani Orkas

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First Draft Smitheries & Foundries BREF:
https://eippcb.jrc.ec.europa.eu/sites/default/files/2022-02/SF_BREF_D1_web.pdf

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BREF Preparation Overview

Smitheries and Foundries BREF: Present Document

- **Present Document:** Current version of Smitheries & Foundries BREF dates from 05/2005.
- **Relations to Green Foundry LIFE topics** – general sections:
  - 2. Applied Processes and Techniques in Foundries
    - 2.5 Mould and Core Production
      - 2.5.1 Raw materials
        - 2.5.1.2 Binders and other chemicals
      - 2.5.6 Moulding and core-making with chemically-bonded sand
  - 3. Current Emission and Consumption Levels in Foundries
    - 3.9 Mould and Core Production
      - 3.9.4 Moulding and core-making with chemically-bonded sand
    - 3.10 Casting
      - 3.10.1 Casting, cooling and shake-out using lost moulds
        - 3.10.1.4 Used foundry sand

BREF Preparation Overview

Smitheries and Foundries BREF: Present Document

LIFE17 ENV/FI/000173
Green Foundry
1/7/2018-30/6/2022

- **Present Document:** Current version of Smitheries & Foundries BREF dates from 05/2005.
- **Relations to Green Foundry LIFE topics** – specific sections:
  - 4. Techniques to Consider in the Determination of BAT for Foundries
    - 4.3 Mould- and Core-making, including Sand Preparation
      - 4.3.3 Moulding and core-making with chemically-bonded sand
    - 4.8 Sand: Regeneration, Recycling, Re-Use and Disposal
      - 4.8.7 Thermal regeneration
      - 4.8.8 Combined regeneration
      - 4.8.13 External re-use of sand and the undersize from the sand circuit and regeneration processes
  - 5. Best Available Techniques for Foundries
    - 5.4 Lost Mould Casting
  - 6. Emerging Techniques for Foundries
    - 6.5 Inorganic Binder Material for Core-making

BREF Preparation Overview

Smitheries and Foundries BREF: Present Document

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  - 5. Best Available Techniques for Foundries
    - 5.4 Lost Mould Casting
  - 6. Emerging Techniques for Foundries
    - 6.5 Inorganic Binder Material for Core-making

BREF Preparation Overview

Smitheries and Foundries BREF: Present Document

- **Present Document:** Current version of Smitheries & Foundries BREF dates from 05/2005.
- 5. Best Available Techniques for Foundries: 5.4 Lost Mould Casting
  General aim: Minimising the amount of sand going to disposal,
  Measures directly or indirectly related to Green Foundry LIFE:
  - silicate monosand is regenerated using heating and pneumatic treatment. A regeneration ratio of 45 – 85 % (as yearly average) may be achieved (Section 4.8.10). The use of slow reacting esters should be minimized
  - cold-box, SO2, hot-box and Croning monosands and mixed organic sands are regenerated using one of the following techniques: cold mechanical regeneration (e.g. grinding, impact drum, pneumatic chafing) or thermal regeneration (Sections 4.8.4, 4.8.5, 4.8.6, 4.8.7). The overall regeneration ratio depends on the amount of cores used. For core-making 40-100 % of regenerated sand can be used; in mould making 90 – 100 % of regenerated sand can be used
  - mixed green and organic sand are regenerated using mechanical-thermal-mechanical regeneration (Section 4.8.8), grinding (Section 4.8.4) or pneumatic chafing (Section 4.8.6). For core-making 40 – 100 % of regenerated sand can be used; in mould making 90 – 100 % of regenerated sand can be used

Green Foundry LIFE BAT Report

Inorganic Binder Usage: Rationale

There are several reasons to believe that (a) inorganic binder technology and (b) the introduction of new waste foundry sand reclamation and reuse techniques will be adopted by the industry:

- Increasing costs, decreasing possibilities of landfill disposal, with pressure increased by tighter regulations shifting waste foundry sands into „less inert“ waste classification categories.
- Natural resources – sand is already becoming a critical raw material for some industries.
- Environmental awareness of consumers reflected in customers‘ decisions: Increased focus on carbon footprint inhouse and along supply chains as e.g. seen for automotive OEMs can turn environmental concern on foundries‘ side into a competitive advantage.
- Human resources: Inorganic binders and the resulting reduction of emissions and improvement indoor air quality may make foundries more attractive to workers – moving away from the „3D industry“ image.
- Market penetration of inorganic binders is already huge in the European light alloy casting industry – spreading the news that they are an option for iron and steel casting should meet with great interest.

Green Foundry LIFE BAT Report

Inorganic Binder Usage: Rationale

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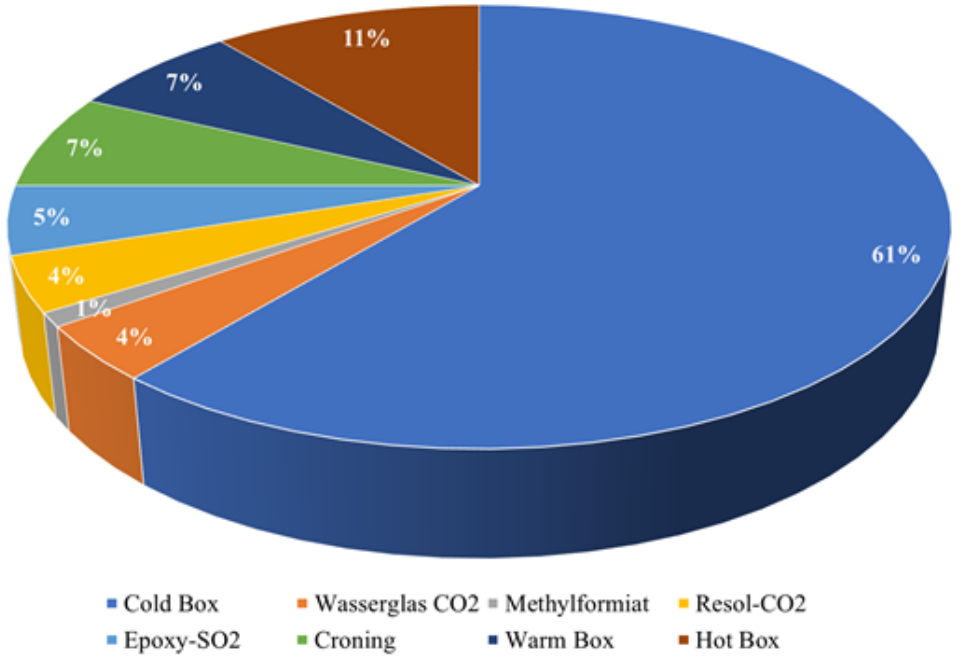
- Market penetration of inorganic binders is already huge in the European light alloy casting industry – spreading the news that they are an option for iron and steel casting should meet with great interest.

Core production methods
Germany, 2020
(Source: ASK Chemicals)



Data is across all casting alloys. Of the hot box processes, 50-60% are inorganic, which means that altogether, approx.10-11% of cores are inorganically bonded today.

In light alloy casting, all European OEMs and Tier 1 suppliers are now using inorganic binders based on hot box processes. In many cases, this applies to 100% of cores produced.

There is room for more.

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Next Steps

Sustainability & Transferability of Project Results

LIFE17 ENV/FI/000173
Green Foundry
1/7/2018-30/6/2022

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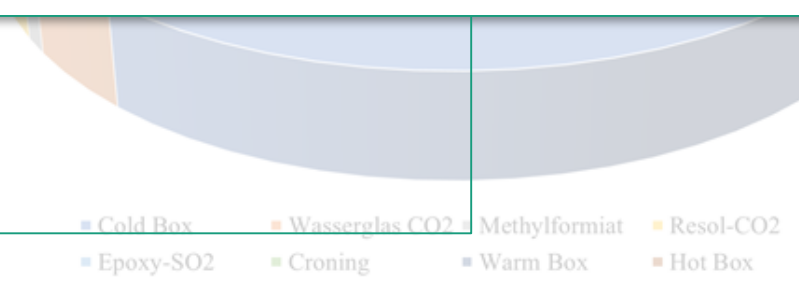

Follow-up Activities:

Support to informing and training European iron and steel foundries on inorganic binder use e.g. via workshops, demonstration activities:

Leveraging the results of Green Foundry LIFE by actively transferring them into the industry.

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Green Foundry LIFE BAT Report

Current Status

A third draft of the Green Foundry LIFE BAT report has recently been circulated internally to project partners for comments and additions. The current draft has also been distributed to you.

It will be further refined in discussions with

- project partners,
- TWG members and
- external stakeholder (→ **public webinar today**)

When finished, altogether 7 techniques will be submitted, using the BAT template, to the Sevilla process for inclusion in the upcoming new BREF for the smitheries & foundries industries.

Green Foundry LIFE BAT Report

Best Available Techniques (BAT) Suggestions by Green Foundry LIFE

The following techniques are deemed sufficiently mature by the consortium to be considered as BAT:

- Use of inorganic binders for moulds in iron and steel casting (← today's presentations by Hannu Pöntinen, Pekka Kemppainen, Rafał Dańko):
  As shown within Green Foundry LIFE, suitable binder systems are commercially available.
- Use of inorganic binders for cores in iron and steel casting (← today's presentations by Hannu Pöntinen, Pekka Kemppainen, Rafał Dańko):
  As shown within Green Foundry LIFE, suitable binder systems are commercially available.
- Thermal reclamation of foundry sands (← today's presentation by Juhani Orkas)
  Primarily for organic binder WFS, unnecessary for inorganic binders, of interest for hybrid systems and mixed waste foundry sand, e.g. organic moulds/inorganic cores. Commercially available both as a service and for in-house installation in foundries.
- Composting of waste foundry sands (← today's presentation by Sara Tapola)
  Mostly not required for purely inorganic systems. Commercial availability through regular composting plants.

Green Foundry LIFE BAT Report

Emerging Techniques (ET) Suggestions by Green Foundry LIFE

The following techniques have been proven on lab scale within Green Foundry LIFE, but are either not yet commercially available, or are currently not available on in this scale.

- Washing of waste foundry sand (← today's presentation by Patrizia Caballero Oguiza):
  Temporarily available on commercial level in Spain, provider currently out of business.
- Ultrasonic treatment of waste foundry sand (← today's presentation by Jean-Bernard Virolle):
  Proven on lab scale in the course of Green Foundry LIFE, scale-up pending.
- Hydromechanical treatment of waste foundry sand (← today's presentation by Jean-Bernard Virolle):
  Proven on lab scale in the course of Green Foundry LIFE, scale-up pending.

Green Foundry LIFE BAT Report

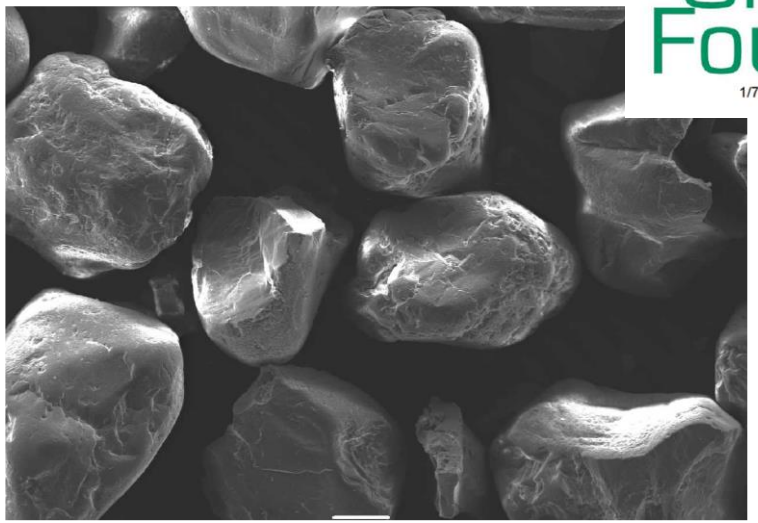
Next Steps

- Distribution of BAT report draft to public webinar participants prior to the workshop.
- **Today's public webinar:**
  Gathering of feedback from stakeholders, update of BAT report until beginning of May.
- Update of BAT report based on webinar input until beginning of May.
- Forwarding of BAT report to BAT TWG through Juhani Orkas, request for comments beginning of May.
- Project-internal workshop, discussion of current state of BAT report middle of May.
- Final version of BAT report prepared in June 2022 as project deliverable.
- Derivation submission of BAT/ET templates and submission to the BREF process.
- National seminars for distribution of project results to be held in conjunction with stakeholder meetings, typically in the second half of the year (e.g. BDG-FA „Eisenguss", „Stahlguss").

Thank you very much …

… for your kind attention -
and now for a lively discussion!

“The publication reflects only the Author´s view and the Agency/Commission is not responsible for any use that may be made of the information contained.”



„To see a World in a Grain of Sand
and a Heaven in a Wild Flower.
Hold Infinity in the Palm of your Hand
and Eternity in an Hour.“

William Blake, Auguries of Innocence (1803)

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Green Foundry LIFE

Discussion

- What are your foundries biggest environmental problems and challenges?
- Whether the customers and/or authorities are putting pressure on your foundry to solve these problems?
- Whether the customers choose their suppliers based on the environmental impact?
- Are your customers willing to “pay extra” if your foundry changes to greener production processes?
- Does your foundry have experiences with inorganic binder systems? If so, what kind of experiences (pros and cons)?