Akshay Chaudhari, Ph.D.
Analyst

TODAY'S WEBINAR WILL BEGIN SHORTLY

The Lux Sustainable Manufacturing Radar

QUESTIONS?
Use the questions box on your screen

AUDIO ISSUES?
Use the global dial-in number in your confirmation email

Lux Research | The Deciding Factor

THE LUX SUSTAINABLE MANUFACTURING RADAR

Akshay Chaudhari, Ph.D.
Analyst

Lux Research | The Deciding Factor

Agenda

1 | Tackling sustainable manufacturing

2 | Using the sustainable manufacturing radar to set a strategy

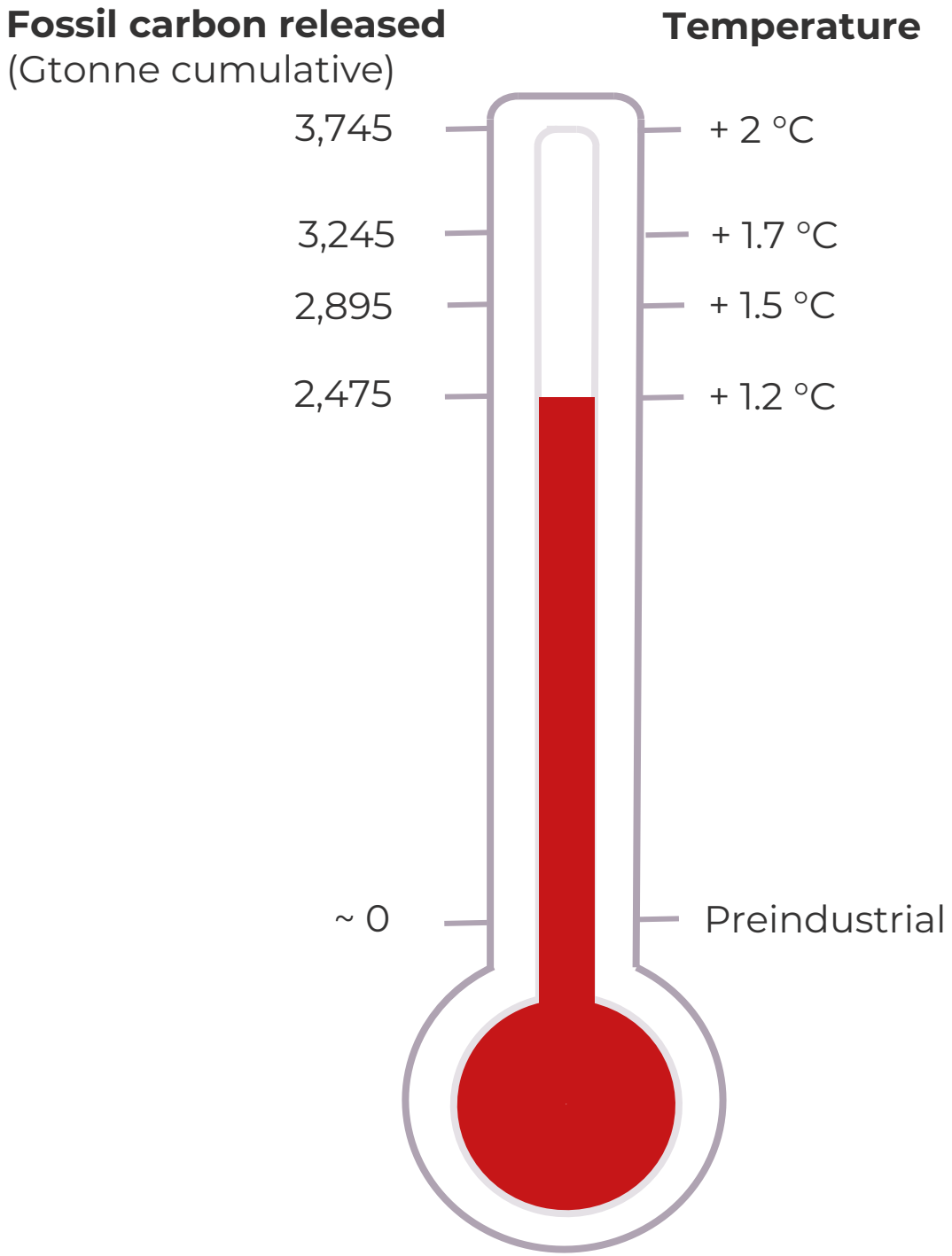
3 | Outlook and recommendations

Near the limit

To limit global warming to 1.5 ˚C, no more than 2,895 Gtonne of CO_2 can be released from fossil sources.

We’re less than 420 Gtonne away from that limit.

Industrials are responsible for 22% carbon emissions.



Near the limit

To limit global warming to 1.5 ˚C, no more than 2,895 Gtonne of CO_2 can be released from fossil sources.

We're less than 420 Gtonne away from that limit.

Industrials are responsible for 22% carbon emissions.

230 km³/a

water use in industrials

Gtonne/a

material extraction

Gtonne/a

hazardous and nonhazardous waste generation

Manufacturing today faces new imperatives

POLICIES AND REGULATIONS

Net-zero emissions pledges and goals to limit the impact of production will drive stronger government action

CONSUMER AND EMPLOYEE EXPECTATIONS

Consumers expect sustainable products, and employees want to work for firms aligned with their values

INVESTMENT

Investors want to back companies with high environmental, social, and governance ratings

DIGITAL TRANSFORMATION

Digital technologies enable tracking and optimization processes; the digitalization trend will drive sustainability efforts

Agenda

1 | **Tackling sustainable manufacturing**

2 | Using the sustainable manufacturing radar to set a strategy

3 | Outlook and recommendations

Sustainable manufacturing is defined as the creation of manufactured products through economically sound processes that minimize negative environmental impacts while conserving energy and natural resources. Sustainable manufacturing also enhances employee, community, and product safety.

— U.S. Environmental Protection Agency

Thinking about sustainable manufacturing needs to evolve

Sustainable manufacturing today

Reducing emissions by energy efficiency

Substituting renewable energy

Treating/reusing wastewater

Sourcing greener inputs

Thinking about sustainable manufacturing needs to evolve

Sustainable manufacturing today

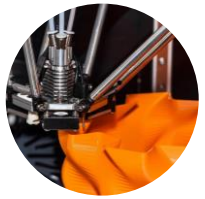
Reducing emissions by energy efficiency

Substituting renewable energy

Treating/reusing wastewater

Sourcing greener inputs

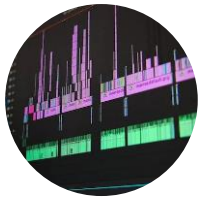
Sustainable manufacturing potential



Novel production processes

Product (re)design for circularity

Waste valorization and upcycling



Alternative business models

Images: Pexels and Delta Sacs

Agenda

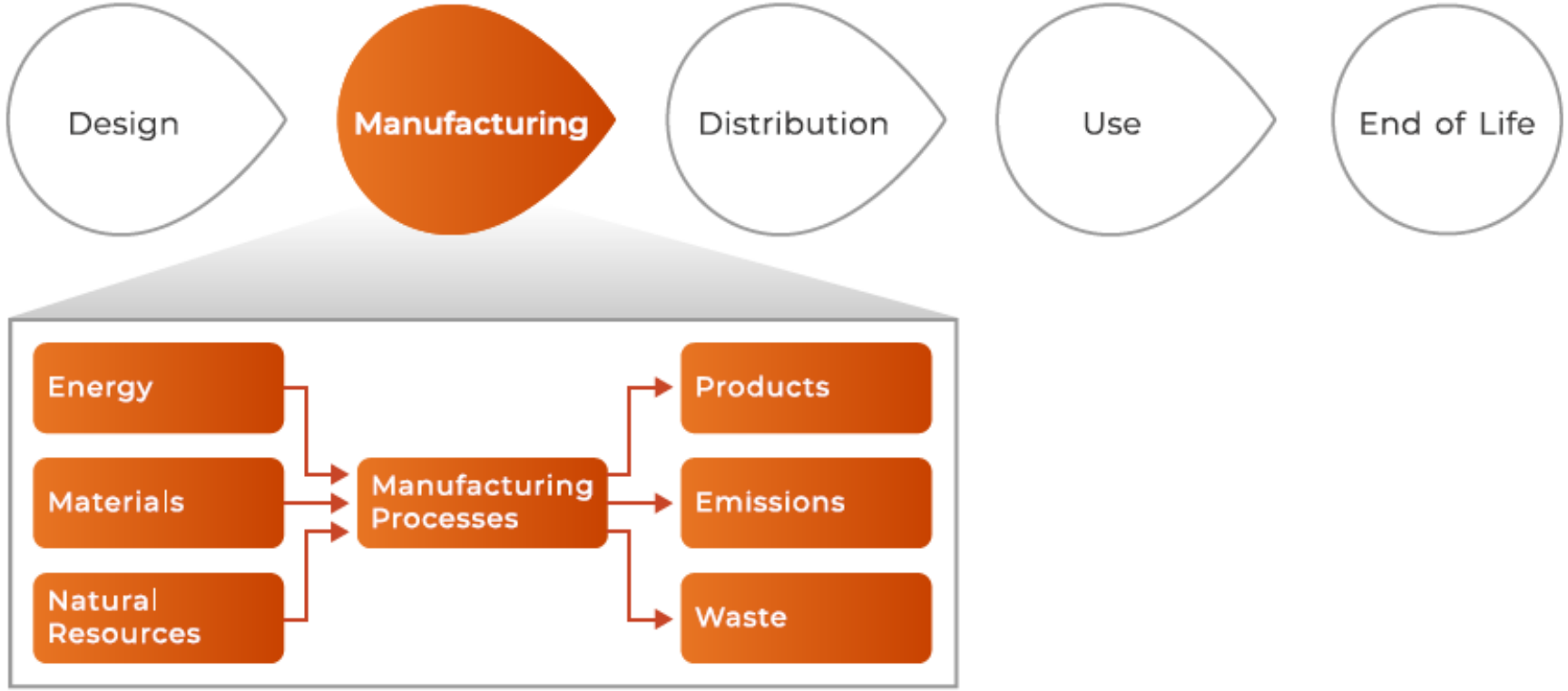
1 | Tackling sustainable manufacturing

2 | **Using the sustainable manufacturing radar to set a strategy**

3 | Outlook and recommendations

Our approach: Life cycle thinking

To take a comprehensive view, we followed a life-cycle-thinking approach, examining not only how to improve current manufacturing operations but also how changes to the whole product life cycle — in design, distribution, and end of life (EoL) — can enable more sustainable manufacturing.



Three steps to prepare a sustainable manufacturing roadmap

Step 1

Select indicators

Four key indicators are tracked for sustainable manufacturing

GHG EMISSION INTENSITY: All companies will need to reduce greenhouse gas (GHG) emissions, though the importance of Scope 1, 2, and 3 emissions (for direct, indirect, and value chain emissions, respectively) will vary by industry.

WATER INTENSITY: The purpose and amount of water usage vary across industries. Besides the environmental impact, water use has a direct impact on social wellbeing in the vicinity of the manufacturing facility.

MATERIAL INTENSITY: Materials can have significant upstream environmental and social impacts. Minimizing material usage by reducing waste along value chains and finding alternative sources are critical for reducing material intensity.

WASTE INTENSITY: For sustainable manufacturing, minimizing waste generation is a major objective and can be particularly critical if waste products are harmful — or can be valorized for other uses.

METHODOLOGY

Three steps to prepare a sustainable manufacturing roadmap

Step 1

Select indicators

Step 2

Choose approaches

Three categories of approaches to achieve sustainable manufacturing

IMPROVE OPERATIONS

Innovations where changes to the underlying processes remain minimal. Many of these technologies are well established and have a clear value proposition beyond sustainability.

Example approaches

- Reduce waste
- Energy efficiency
- Alternative energy

ENABLE CIRCULARITY

Recycling, reuse, and repair technologies reduce impact, but may need additional EoL infrastructure — and challenge firms to move beyond their existing supply chains.

Example approaches

- EoL recycling
- Design for circularity
- Remanufacturing

TRANSFORM MANUFACTURING

Innovations that transform current operations through significant changes to product, processes, and business models.

Example approaches

- Product redesign
- Alternate manufacturing processes

METHODOLOGY

Three steps to prepare a sustainable manufacturing roadmap

Step 1

Select indicators

Step 2

Choose approaches

Step 3

Prioritize technologies

Maturity and potential impact are key criteria for prioritizing technologies within each approach

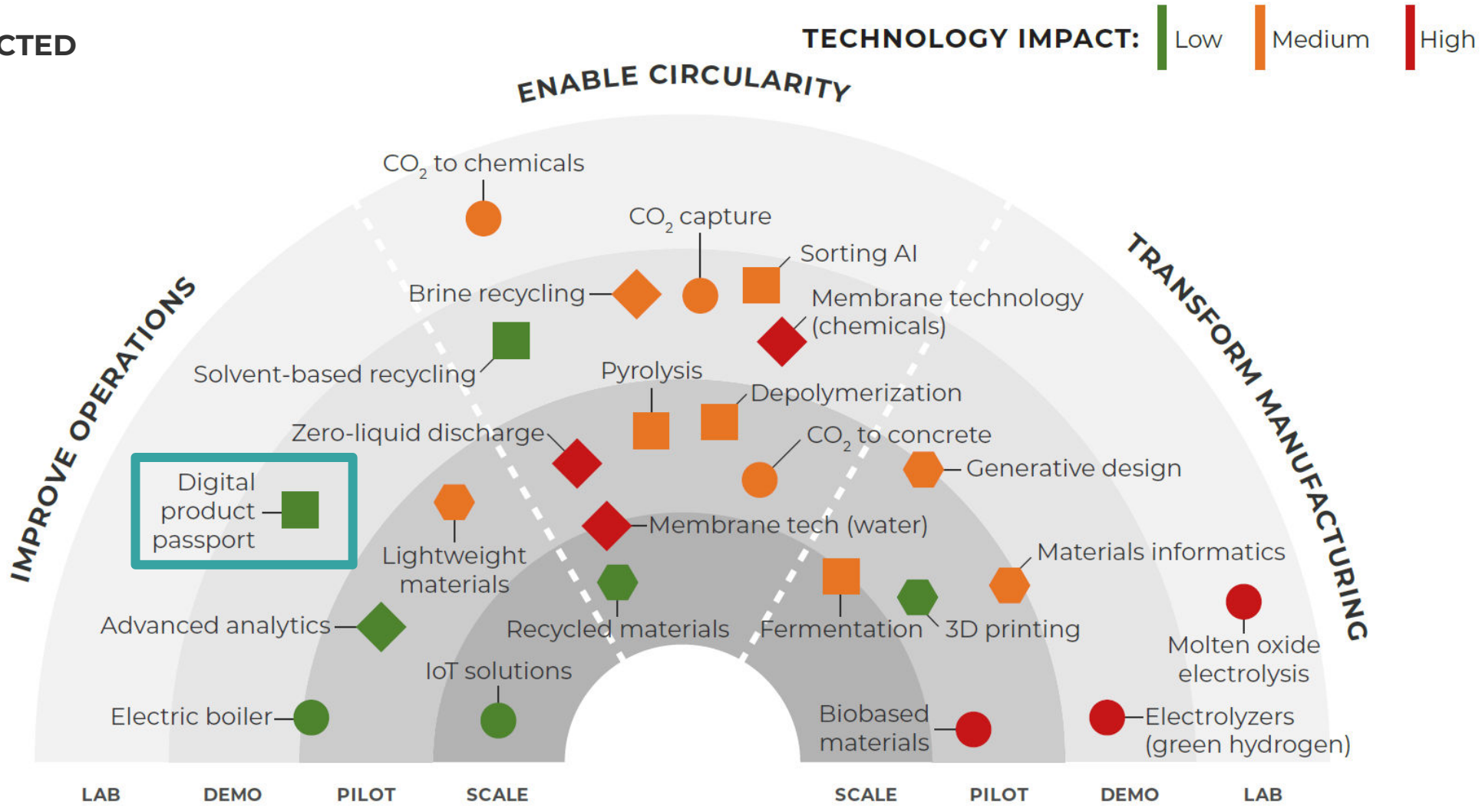
To help build a roadmap, we assess technologies within each approach according to their maturity and potential impact, as well as identifying which indicator they primarily address.

Maturity	Potential impact*
• **Scale:** Expect to mature in the near term and are scalable • **Pilot:** Expect to mature in the near to midterm, but scaling can be costly • **Demo:** Need more than five years to mature, and scalability still under investigation • **Lab:** Technologies still at early stages of development, and scalability still questionable; clients should monitor	Impact on the GHG intensity, material intensity, water intensity, or waste intensity: • **High** reduction in indicator intensity • **Medium** reduction in indicator intensity • **Low** reduction in indicator intensity ***Qualitative indicator

Sustainable Manufacturing Radar

KEY INDICATOR IMPACTED

- GHG intensity
- Water intensity
- Materials intensity
- Waste intensity



Note that this chart is not a comprehensive list of technologies. The technology impact may vary across industries case by case, influenced by ability to scale and implementation cost. In addition, some of the technologies could impact more than one indicator, but for simplicity, we marked each with the indicator where it has relatively more impact.

CASE STUDY: IMPROVE OPERATIONS

Improving circularity through a digital product passport (DPP)

- VTT plans to develop a minimum viable DPP and evaluate challenges in DPP implementation.
- VTT's framework targets sustainable and circular manufacturing.
- A DPP will improve the quality of assessments and save costs associated with collection and transportation.

LUX TAKE

Scaling DPP projects and industrywide DPP adoption are still long-term goals given the technology's hurdles and uncertain ROI. Although at an early stage, companies should take note of the changing regulatory landscape and prioritize enabling technologies.

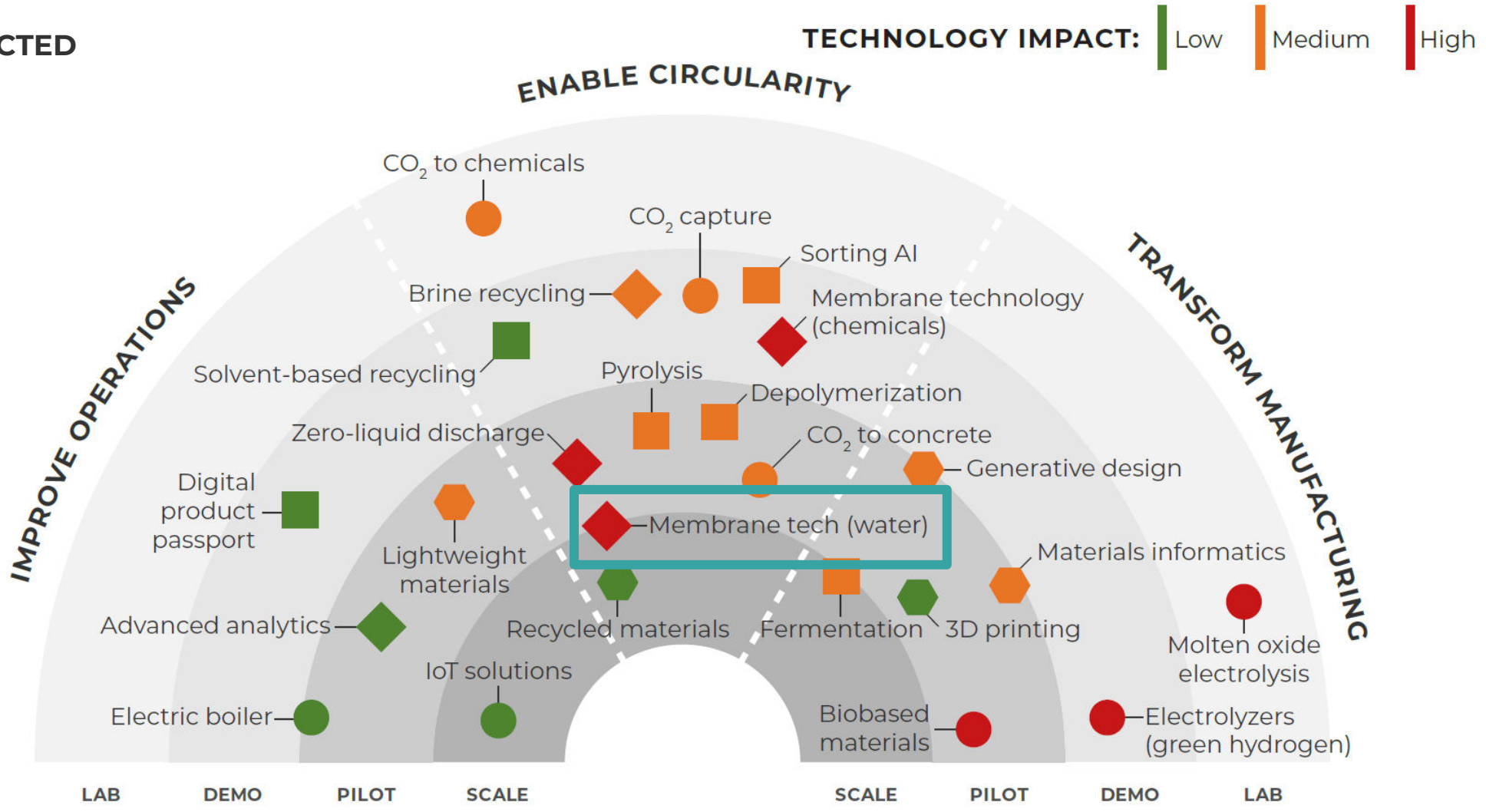
VTT

Image source: https://www.axfoundation.se/

Sustainable Manufacturing Radar

KEY INDICATOR IMPACTED

- GHG intensity
- Water intensity
- Materials intensity
- Waste intensity



Note that this chart is not a comprehensive list of technologies. The technology impact may vary across industries case by case, influenced by ability to scale and implementation cost. In addition, some of the technologies could impact more than one indicator, but for simplicity, we marked each with the indicator where it has relatively more impact.

CASE STUDY: ENABLE CIRCULARITY

Via Separations reduces energy use with advanced membranes

- Via Separations' graphene oxide-coated membranes filter the waste byproduct of pulp and paper mills called "black liquor."
- The use of graphene oxide greatly reduces organic fouling.
- Membrane-filtering modules reduce energy use by up to 50% and increase factory throughput 3%–10%.

LUX TAKE

Despite its high potential, membrane technology remains underutilized in process intensification for production of chemicals and materials. Consider similar technology solutions in efforts to decarbonize heavy manufacturing industries.

VIA SEPARATIONS

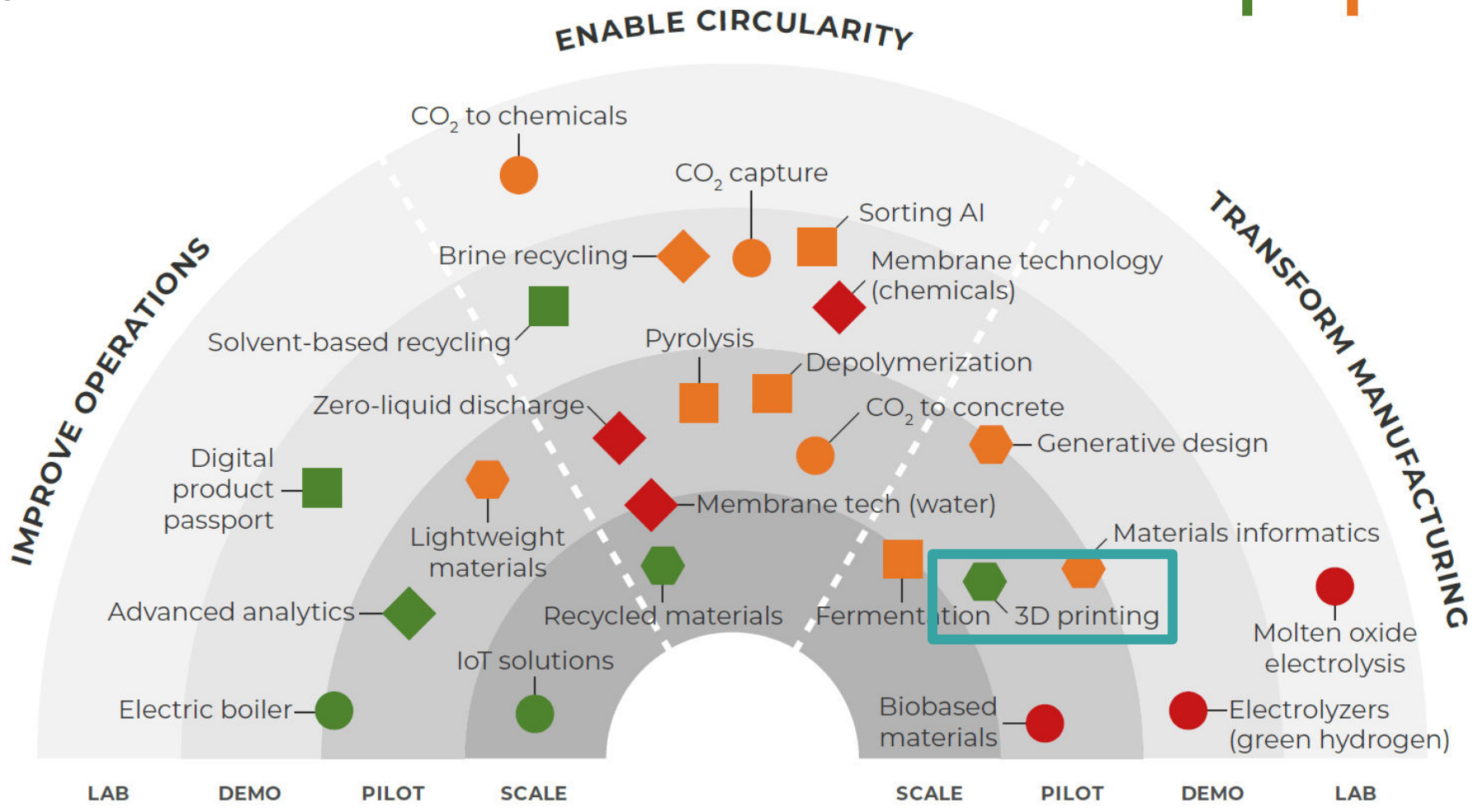
Image source: Greentown Labs

Sustainable Manufacturing Radar

KEY INDICATOR IMPACTED

- GHG intensity
- Water intensity
- Materials intensity
- Waste intensity

TECHNOLOGY IMPACT: Low | Medium | High



Note that this chart is not a comprehensive list of technologies. The technology impact may vary across industries case by case, influenced by ability to scale and implementation cost. In addition, some of the technologies could impact more than one indicator, but for simplicity, we marked each with the indicator where it has relatively more impact.

3D printing reduces weight by 40%

- The energy intensity of 3D printing remains higher than that of conventional manufacturing counterparts.
- Overall energy saving over the life cycle can be positive.
- RUAG used finite element analysis to redesign an antenna bracket, reducing the weight of the brackets from 1.4 kg to 0.95 kg (40% decrease).

LUX TAKE

To scale and increase adoption of 3D printing, innovative tools like generative design and materials informatics are necessary. While 3D printing uses will grow, its overall impact on sustainability will be low, despite some promising niche use-cases.

RUAG

Aerospace Defence Technology

Agenda

1 | Tackling sustainable manufacturing

2 | Using the sustainable manufacturing radar to set a strategy

3 | **Outlook and recommendations**

Link your digital transformation efforts to sustainability KPIs

- Most digital transformation projects target improved operations.
- Automation can improve productivity and worker safety.
- Look for new business models.
- Digital transformation should enable sustainable manufacturing.

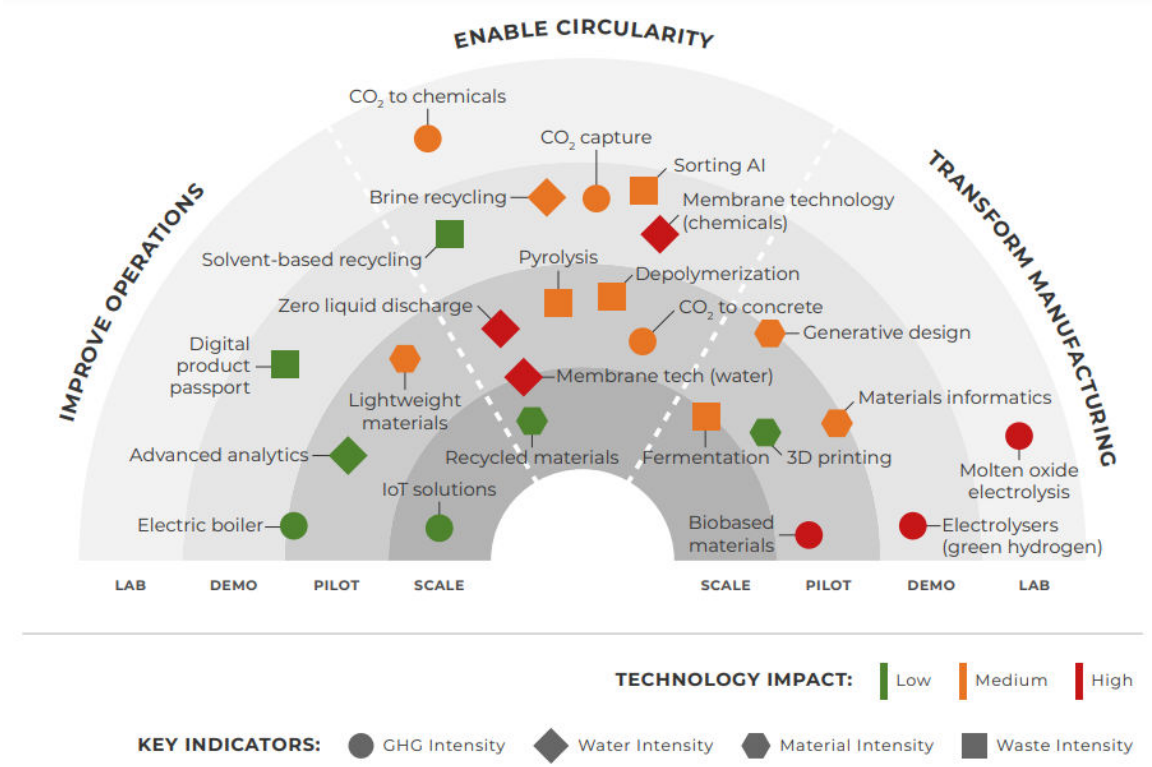
RECOMMENDATIONS

Changing organizational culture is critical for achieving sustainability

- It’s not just about the technology.
- Alignment across strategy, execution, and technology is important.
- We need a clear vision and communication for sustainable manufacturing.
- We also need suitable training, incentives, and clear objectives.

Customize the radar according to your needs

- Several factors affect sustainable manufacturing.
- A comprehensive product life cycle assessment is a good starting point.
- Geography will have a significant impact.
- Use the custom sustainable manufacturing radar to take a *portfolio* approach.



SUMMARY

Outlook

1 **As system transitions progress, be proactive to stay ahead of the curve**

Ensuring circular and transformational technologies enables companies to develop internal expertise and competitive advantages in the long term.

2 **Integration and collaboration are necessary for success and scalability**

Sustainable manufacturing should be integrated into product and business planning from the beginning, while partnerships across industries will be essential enablers.

3 **Sustainable manufacturing needs new business models**

The volume-based revenue model needs to be changed to solve this conflict.

Thank You

A link to the webinar recording will be emailed within 24–48 hours.

KEEP IN TOUCH

Email: questions@luxresearchinc.com

Visit: www.luxresearchinc.com

Read: http://www.luxresearchinc.com/blog/

@LuxResearch

LuxResearch

UPCOMING WEBINARS

November 22nd

Product Innovation: Balancing Sustainability, Risk, and Returns

December 20th

The Top Technologies Enabling the Net-Zero Grid of the Future

January 24th

Market Opportunities in Emerging Consumer Health and Wellness Ecosystems

February 21st

Sustainability Driving New Business Models in Manufacturing