Wallenberg Initiative Materials Science for Sustainability (WISE)

Materials science that enables a sustainable world

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CHALMERS UNIVERSITY OF TECHNOLOGY

KTH VETENSKAP OCH KONST

LINKÖPING UNIVERSITY

Knut och Alice Wallenbergs Stiftelse

LUND UNIVERSITY

Stockholm University

UPPSALA UNIVERSITET

Wallenberg Initiative Materials Science for Sustainability (WISE)

VISION Materials science that enables a sustainable world.

MISSION To perform basic and need-driven materials science at the international forefront, to empower sustainable techno-logies with positive impact on society, and to train future leaders in society, industry, and academia in Sweden.

Wallenberg Initiative Materials Science for Sustainability (WISE)

GOAL WISE will promote a transition towards a sustainable society, while pushing the scientific frontier in materials science to new vistas that establish Sweden as a leading nation in the field. WISE aims to explore and research advanced, functional materials targeting the thematic areas:

– Conversion, storage, and distribution of clean energy

– Circular materials replacing rare, energy-demanding, and hazardous materials

– Mitigation, cleaning, and protection of the atmosphere, soil, and water

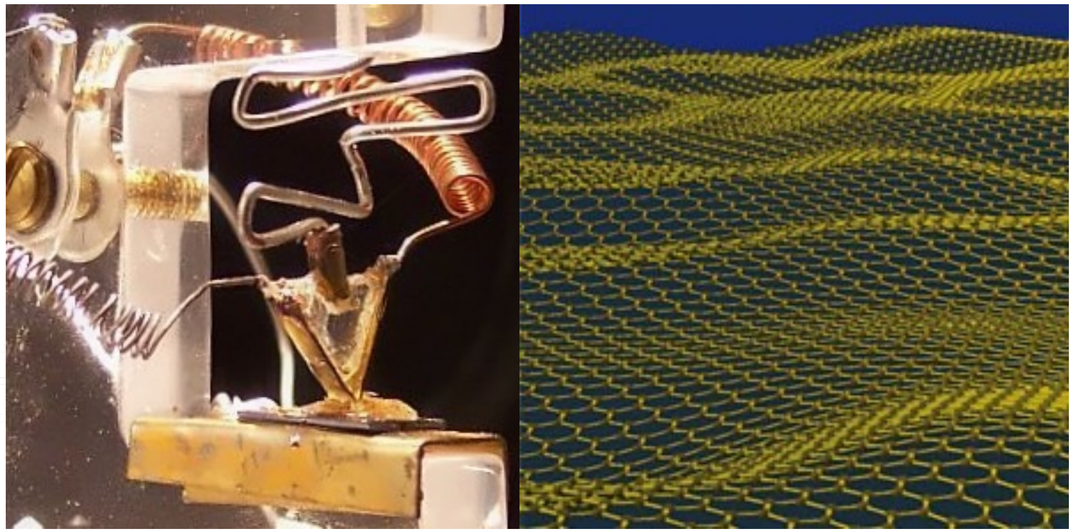
– Discovery of materials for novel sustainable technologies and applications

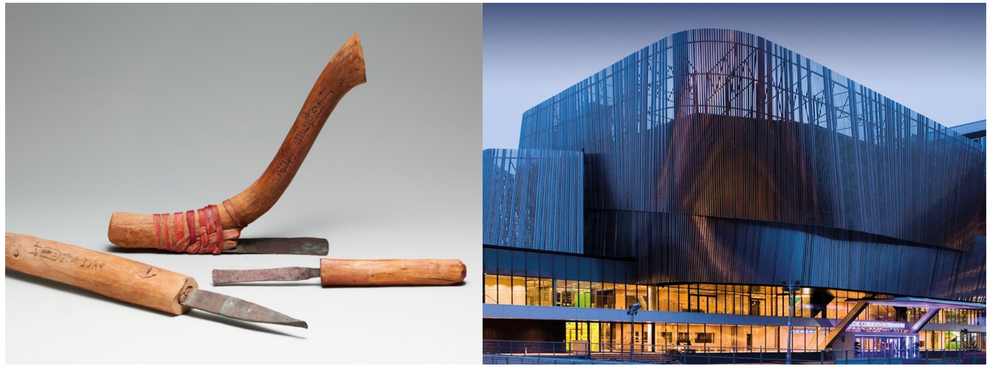
Materials make our world

Materials science and technology stems from metallurgy and from studies of minerals and ceramics

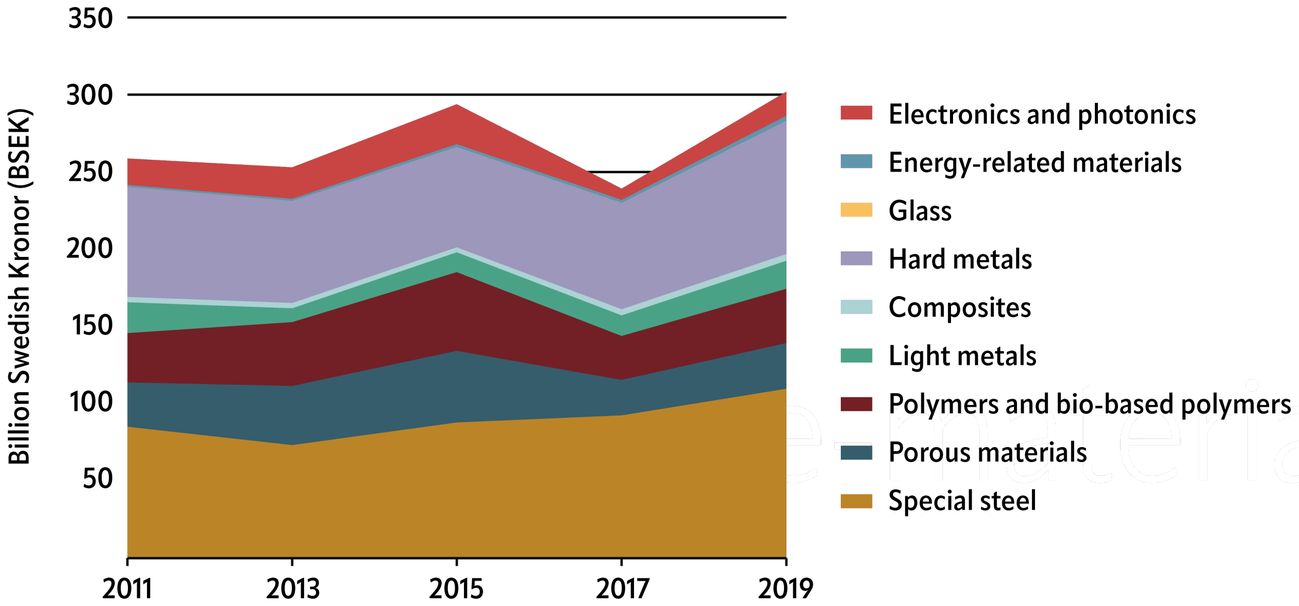
Materials make our world

More recently: semiconductors, functional materials, biomaterials, polymers, heterostructures, materials with reduced dimension, topological materials, and nanomaterials

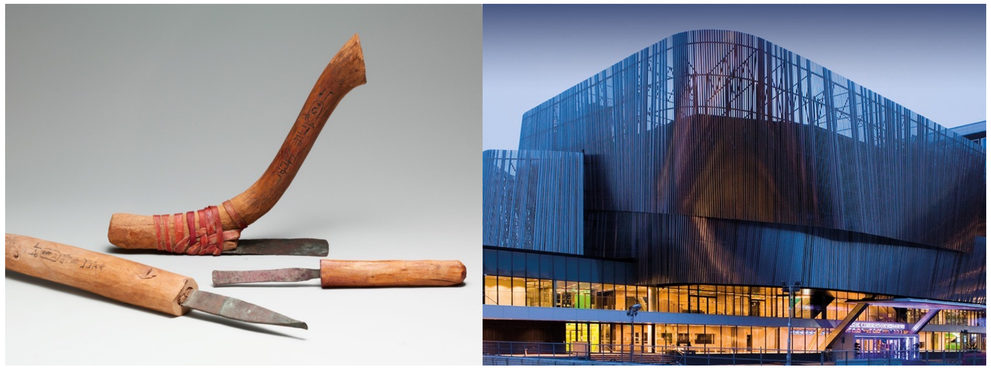


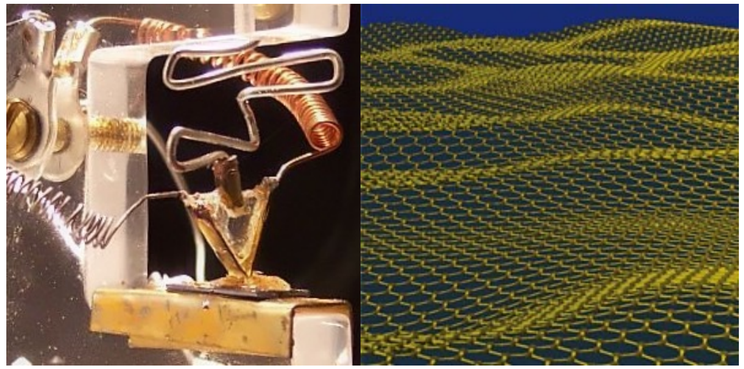


Materials make our world



In Sweden, “Materials” is a 300 BSEK industry





Materials in context

Global use of resources amounted to nearly 90 billion metric tons/year in 2017, forecasted to double by 2050

Primary production of materials accounts for 25% of all global greenhouse emissions

Prime production of metals alone exploits about 8% of the global energy production

Although the production and extraction of materials are connected to environmental strain, their use is paramount in transforming our world towards a sustainable society

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UN Sustainable Development Goals (SDGs) from a materials science perspective

Affordable materials able to be produced and recycled, enabling economic advancement

Materials for safe and increased productivity of food, at the same time reducing food waste

Materials enabling good health and protection against hazardous compounds

Affordable low-tech and high-tech materials for life-long learning and education

Materials enabling affordable security technology empowering women

Materials to capture, clean, transport, pressurize, filter, purify, store, and detoxify water

Green materials for efficient technology and infrastructure to harvest, transport, store, and convert energy

Resource-efficient use of materials for processes enabling an increased value of (raw) materials

Construct and operate infrastructure from sustainable functional materials

Improved extraction and ennobling methods for rare raw materials and developing replacement materials

Settlements built up from materials that are safe, resilient, and sustainable

Efficient (re)use/recycling of (natural) materials for sustainable production/consumption with lower chem release into soil, air and water

Materials to protect and develop oceans, targeting marine eco-systems and food production

Materials promoting reforestation, enrichment of soil, and restoration/ maintenance of biodiversity

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Thematic areas: (i) harvesting-to-distribution

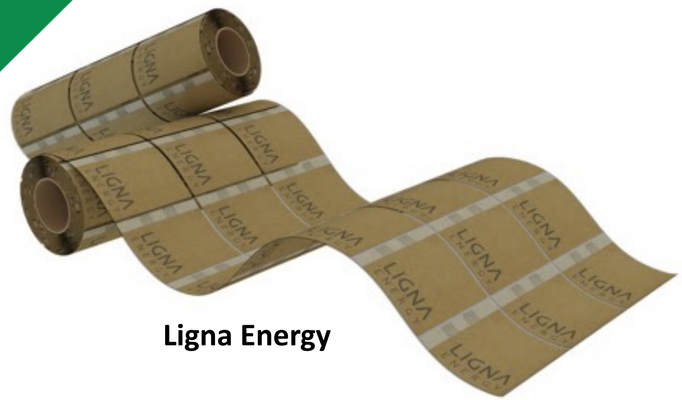
solar
wind
biomass
water

energy
harvesting/
conversion

fuels
electricity
heat

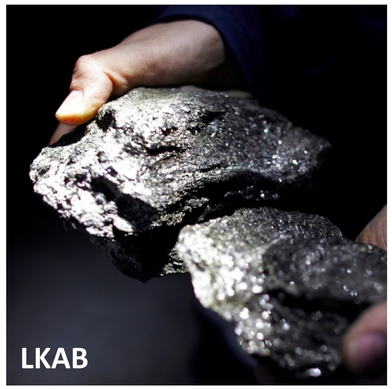
energy
storage

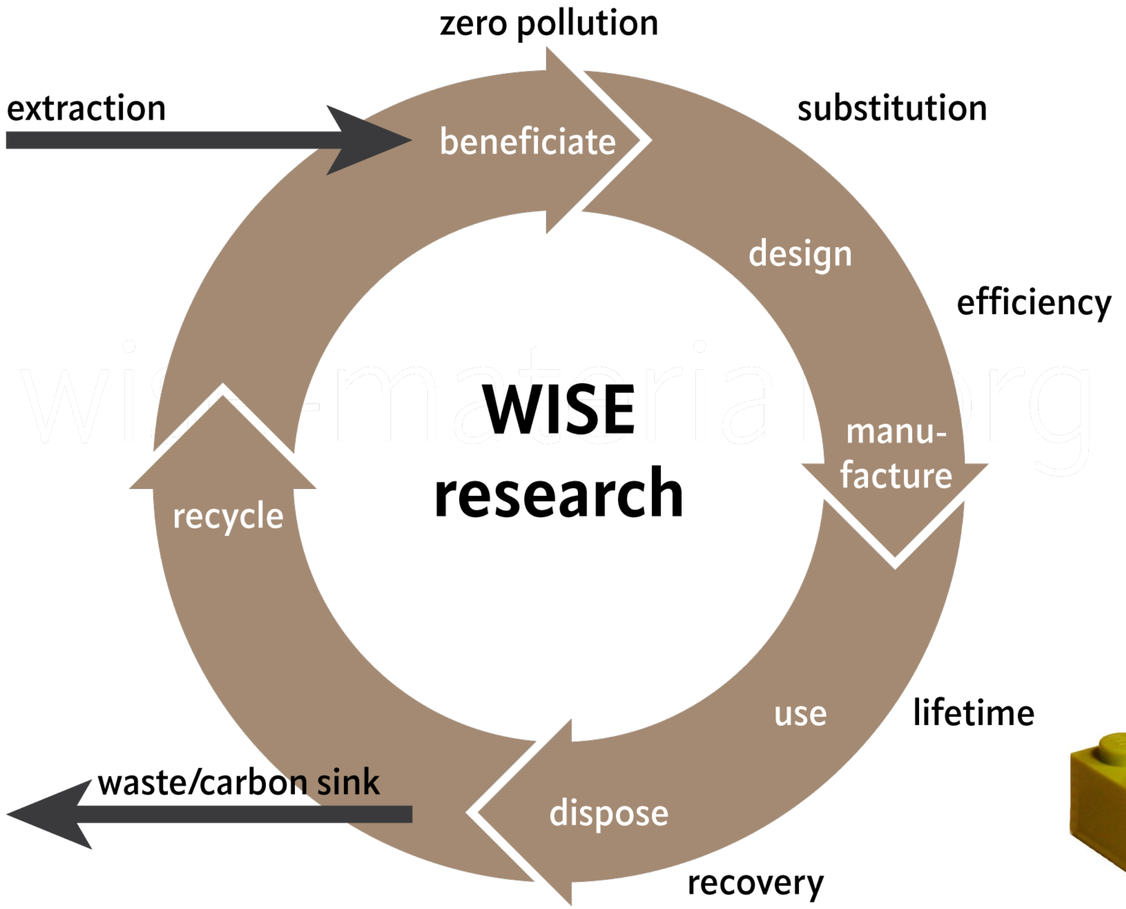
energy
distribution

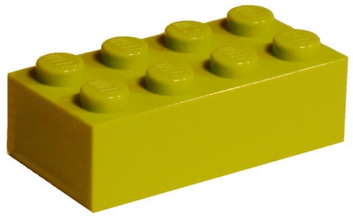


Ligna Energy

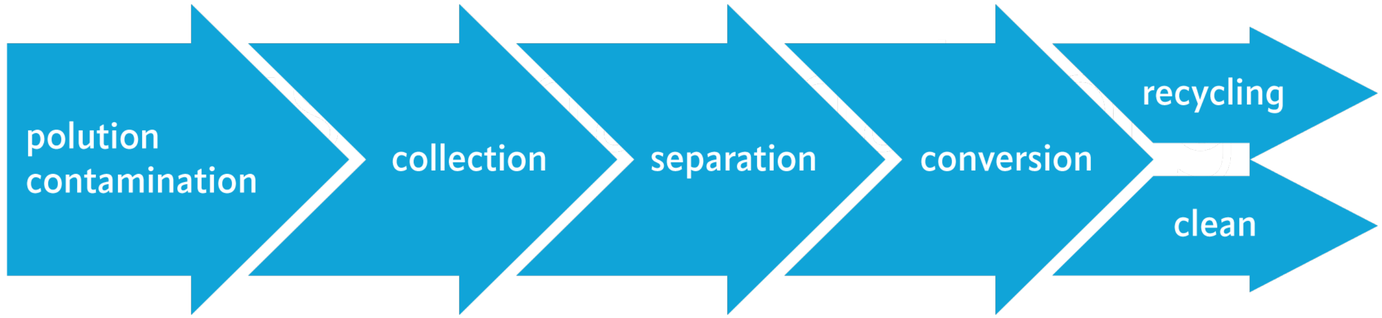
Thematic areas: (ii) extraction-to-recycling loop





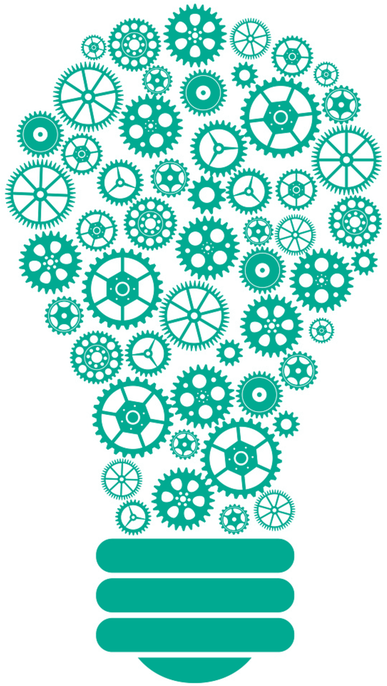


Thematic areas: (iii) mitigation, cleaning, protection



Thematic areas: (iv) discovery

Solar cells



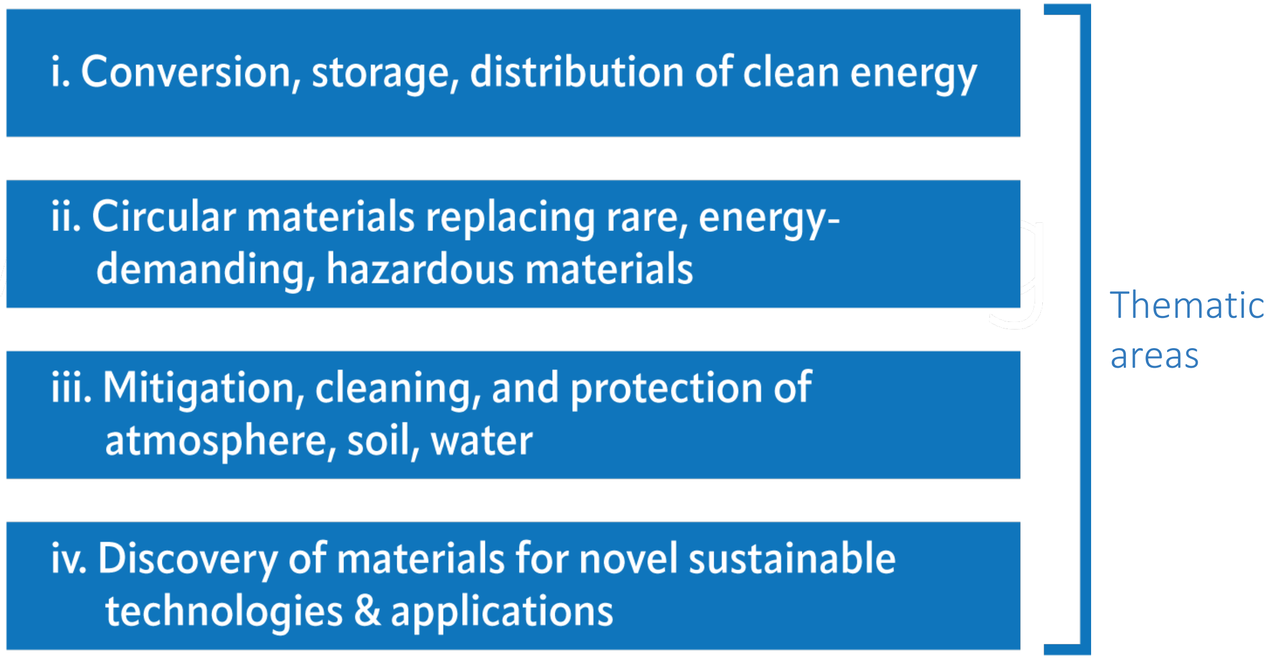
Room temp super-conducivity

Large computing systems (e.g., at LiU)

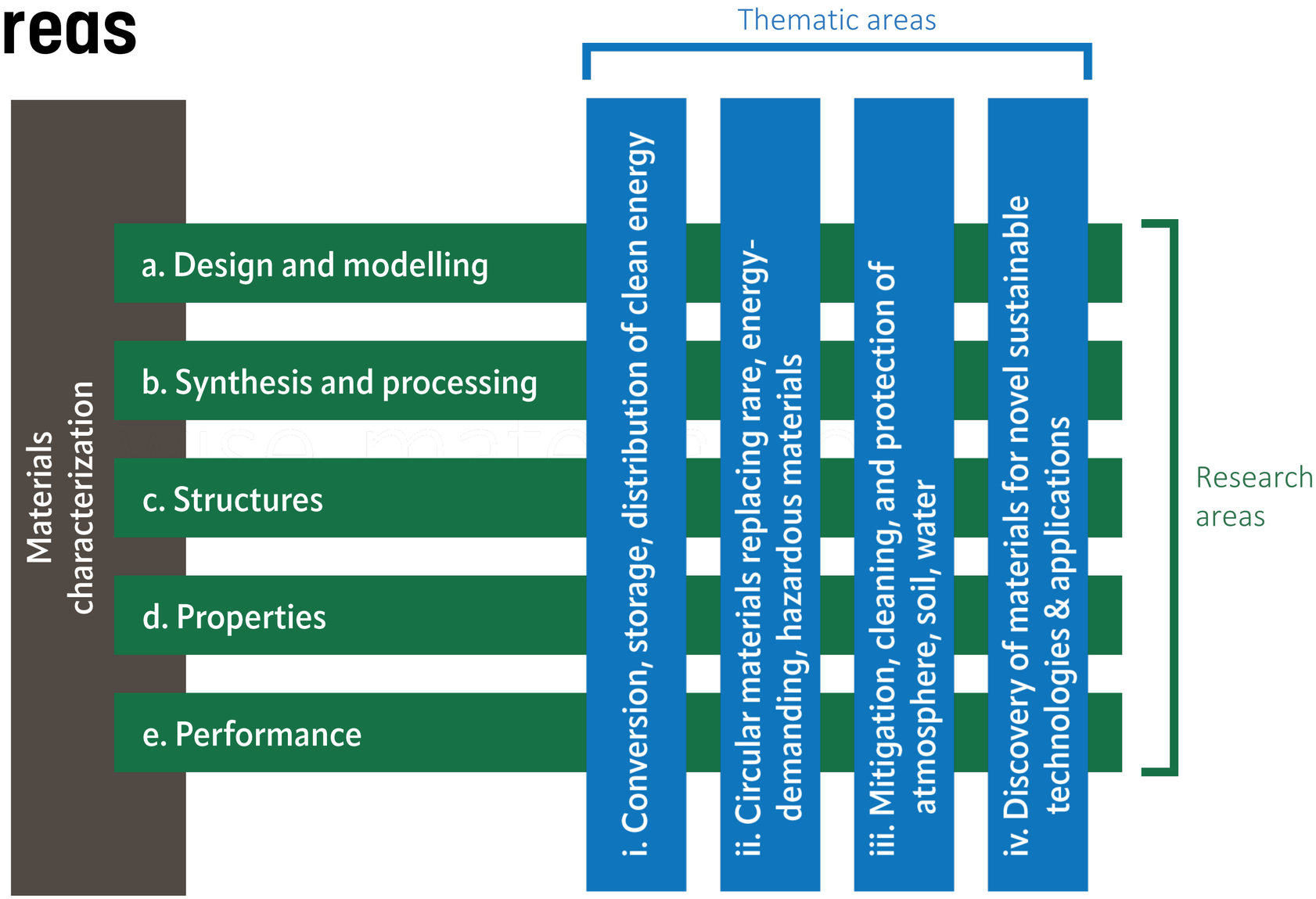
Advanced metallurgical modeling

Efficient, affordable, upscalable, recyclable, …., materials for sustainability technologies

Program areas



Program areas



WISE universities, complementing scientific strengths

Batteries, thermoelectrics, graphene, MC2 nano-laboratory, electron microscopy

Polymers, theoretical modelling, energy materials, electronic materials, metallurgy

Ceramics, organic energy materials, transmission electron microscopy, additive manufacturing

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Nanoscience, sustainable information technologies, green chemistry, fuel cell materials , MAX IV

Organic synthesis, catalysis, environmental chemistry, materials recycling, green chemistry

Solar cells, theoretical modelling, batteries, nano-materials, electrochemistry, Ångström Laboratory

Across the 6 universities, and within the areas of materials, 12 scientists have been awarded as Wallenberg Scholars, 30 scientists have been awarded a Wallenberg Academy Fellowship, and 76 scientists have been awarded an ERC starting, consolidator, advanced, or synergy grant.

WISE universities, complementing scientific strengths

SHANGHAI RANKING

2021 Global Ranking of Academic Subjects

→ Materials Science & Engineering

World Rank	Institution	Sweden	Total Score	TOP
101-150	Linkoping University			40.3
151-200	Chalmers University of Technology			28.2
151-200	KTH Royal Institute of Technology			23.8
151-200	Uppsala University			17.4
201-300	Stockholm University			12.3
301-400	Lund University			12.3

WISE universities, complementing scientific strengths

SHANGHAI RANKING

2021 Global Ranking of Academic Subjects

→ Nanoscience & Nanotechnology

World Rank	Institution	Sweden	Total Score	TOP
101-150	KTH Royal Institute of Technology			33.8
101-150	Linkoping University			36.1
151-200	Chalmers University of Technology			35.4
151-200	Lund University			38.2
151-200	Uppsala University			26.1
301-400	Stockholm University			13.9

Program components

25 (+1) strategic recruitment packages
(Asst/Assoc Prof, 2 PhD students and 2 postdocs each)

130 PhD students (of which 40 industry students) and
130 postdocs (of which 40 industry postdocs)

Guest professors

Science and technology platforms

Research arenas with industry (WIRAs)

Operational costs: management, graduate school and collaborations

Strategic initiatives

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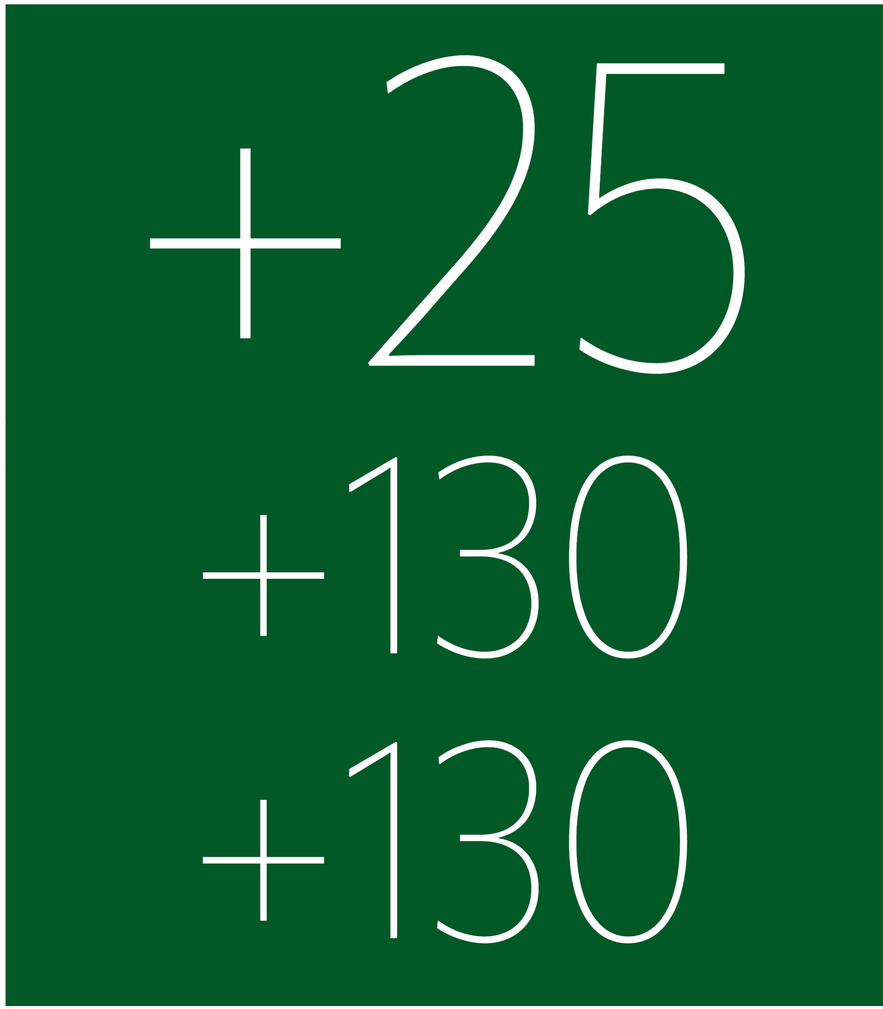

Science and technology platforms

WISE aims to fill the gap between individual instruments and large-scale national or international facilities. An inventory of existing platforms of relevance to sustainable materials is shown to the right. Few labs of instrumentation, aiming at the synthesis or characterization of materials for sustainability, presently qualify in the scope of WISE and thus such resources will be reinforced by both the universities and WISE in concert. Even in the first year of the program, the universities will to define their needs for sustainable materials with the ambition to serve a significant and well-defined researcher community at local, regional, and national level.

	Existing platforms	Proposed platforms
CHALMERS UNIVERSITY OF TECHNOLOGY	– Mass-spectrometry – Materials Analysis Laboratory – Nano Fabrication Laboratory – SEEL-batteries and fuel cells	– [T.B.D.]
KTH VETENSKAP OCH KONST	– Albanova Nanolab – Hultgren Lab (metals) – Odqvist Lab (engineering)	– [T.B.D.]
LINKÖPING UNIVERSITY	– Additive processing – Soft functional materials – Advanced functional ceramics – Electron microscopy	– Scanning probe for soft functional materials – *In situ* and *operando* electron microscopy

Open/bookable to all WISE

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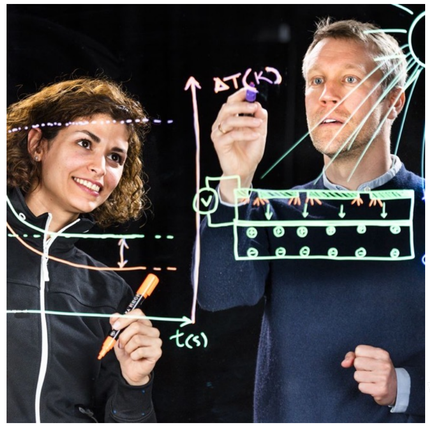
	Existing platforms	Proposed platforms
LUND UNIVERSITY	– In-situ electron microscopy – Semiconductor nanofabrication – *Operando* scanning, electrical, and optical probes	– Nanolab Science Village: equipment enabling synthesis, structuring, and characterization of sustainable materials
Stockholm University	– Green chemistry – Electron microscopy – Lab on porous materials – Heterogenous catalysis for the synthesis of fine chemicals	– *In situ* and *operando* liquid phase electron microscopy and cryo-EM for soft matter – [T.B.D.]
UPPSALA UNIVERSITET	– Solar Cell Laboratory – Tandem Lab – SuperADAM (ILL)	– Compact X-ray source – Sustainable synthesis

Open/bookable to all WISE

WISE Research Arenas (WIRAs)



WISE-ABB WIRA (example)

ABB facility

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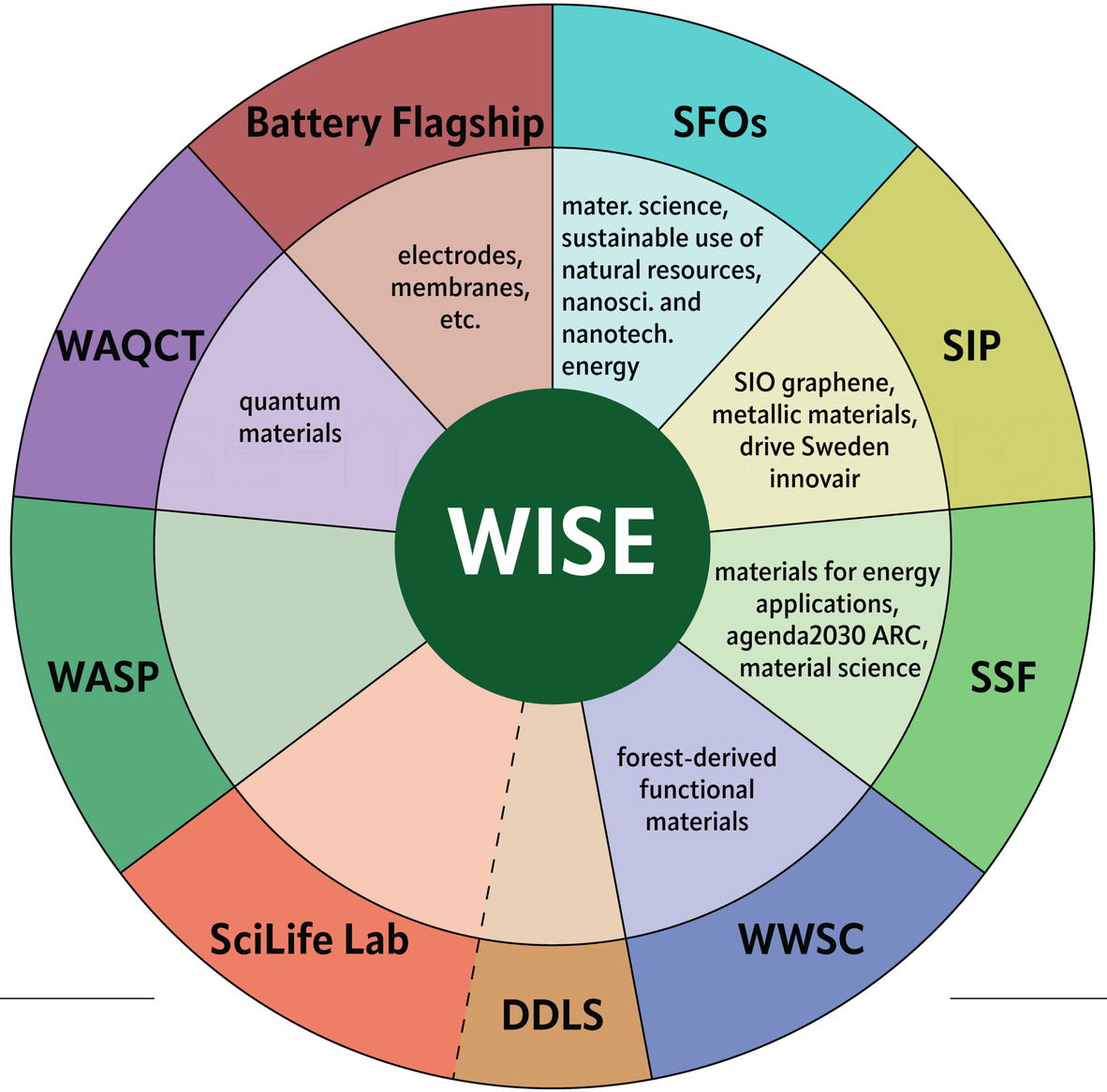
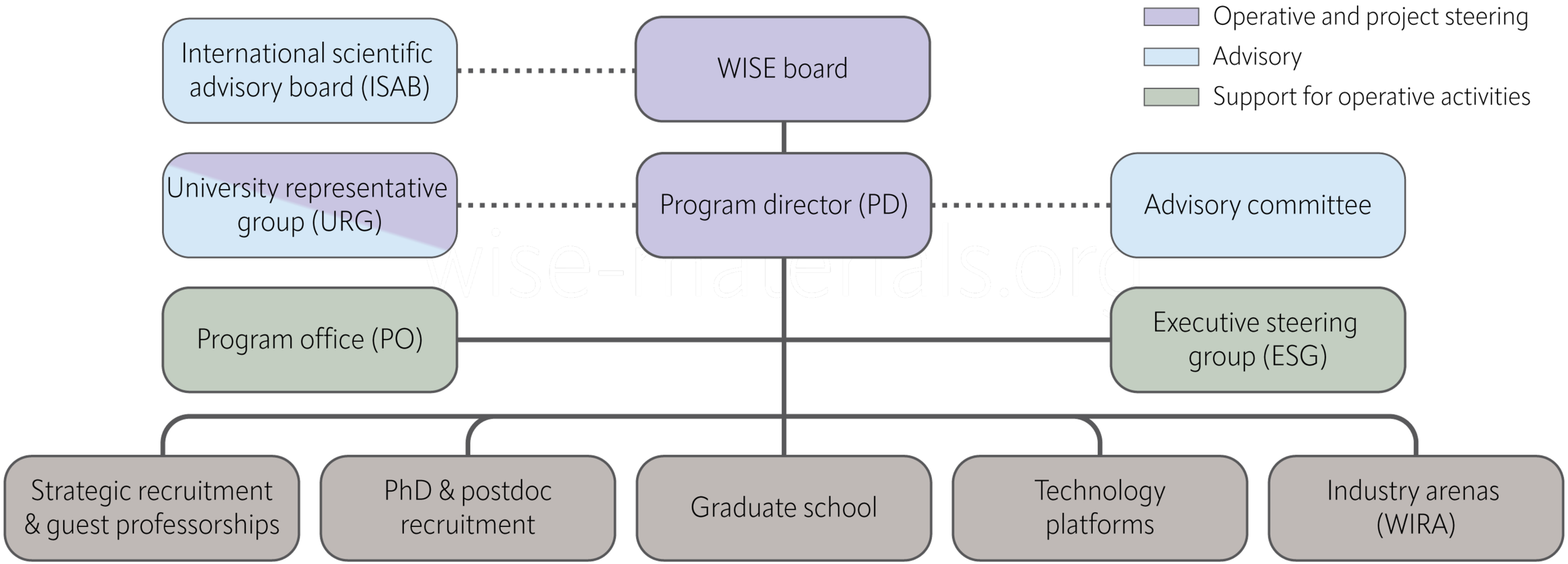
WIRAs are defined as research or development settings (production and design may also apply) established in industry or in any other organization outside academia.

WIRAs will serve as a laboratory or development resource where research results can be explored, evaluated, and positioned in the context of industrial applications and societal needs.

WISE in relation to national research ecosystem



Organization



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Or visit wise-materials.org

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