Liite 1 esitykseen maisterikoulutusohjelmien perustamiseksi Kemian tekniikan korkeakouluun

CHEM Master’s programme portfolio renewal

Aalto University
School of Chemical
Engineering

June 2023

CHEM Master´s programmes and majors in 2021

Master´s Programme in Chemical, Biochemical and Materials Engineering

Biomass Refining
Fibre and Polymer Engineering
Biotechnology
Chemistry
Functional Materials
Sustainable Metals Processing
Chemical and Process Engineering

Aalto Master´s

Life Science Technologies
Biosystems and Biomaterials Engineering

Advanced Energy Solutions
Industrial Energy Processes and Sustainability

International Design Business Management

Creative Sustainability (First admission 2020)

Master´s in international co-operation

European Mining, Minerals and Environmental Programme – EMMEP -> EMC

Energy Storage, EIT InnoEnergy Master School program

European Master in Biological and Chemical Engineering for Sustainable Bioeconomy – BIOCEB

Advanced Materials for Innovation and Sustainability (EIT Raw Materials) (AMIS)

Nordic Master in Polymer Technology (discontinuing)

Environomical Pathways for Sustainable Energy Systems – SELECT (discontinuing)

Framework for development founded on CHEM research focus areas (agreed in June 2022)

Biomass refining and advanced lignocellulosic materials

- Biomass refining
- Fiber and Polymer Engineering
- N5P in Polymer Technology (discontinuing)
- Biological and Chemical Engineering for a Sustainable Bioeconomy (Bioceb)

Molecular bioscience and Industrial biotechnology

- Biotechnology
- Biosystems and Biomaterials engineering

Chemical engineering and circular processes

- Chemical and Process Engineering
- Sustainable Metals Processing
- Industrial Energy Processes (Advanced Energy solutions)
- European Mining, Minerals and Environmental Programme (EMMEP)

Chemistry for renewable energy and functional materials

- Chemistry
- Functional Materials
- Advanced Materials for Innovation and Sustainability (AMIS)
- Master's Programme in Energy Storage

MSc study offerings:
CHEM own offerings
AALTO Joint offerings
International offerings

- International Design Business Management (IDBM) -> (includes compulsory CHEM minor)
- Creative Sustainability CHEM (connects to research focus area 1 & 3)
- Environomical Pathways for Sustainable Energy Systems (SELECT) -> selected courses from all study fields (discontinuing)

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Renewal background and aims

Why?

- **Increasing size of student cohorts affects the master programmes and majors in 2024. The resourcing (personell and space) must be well planned by that.**
- **Clearer portfolio and programme profiles and differentiation within the portfolio (conclusion from TEE 2020 evaluation)**
- **Need to use teaching resources more efficiently and scale up when possible the number of participants in courses. Teacher workload uneven.**
- **Role of minors in portfolio is unclear**

Renewal aims

- Ensuring that we have enough teaching resources and quality can be maintained when numbers of Master's students are increasing
- Making sure that teaching equips students for the working life of the (near) future even better
- Enabling smoother progression through studies by making study paths easier to follow
- Making it easier for applicants to distinguish between different programmes offered in the School

Master’s portfolio renewal goals

Applicants

Clear and attractive view for applicants to studies and future work opportunities

Number 1 choice in Chemical Engineering

Educational offering is understood nationally and internationally

Students

Clear and understandable study paths

Clear view and support on the employment opportunities

Flow of studies

Teachers

Workload

Synergy

Managing growing student numbers

More clear and transparent processes

Stakeholder

Future workers

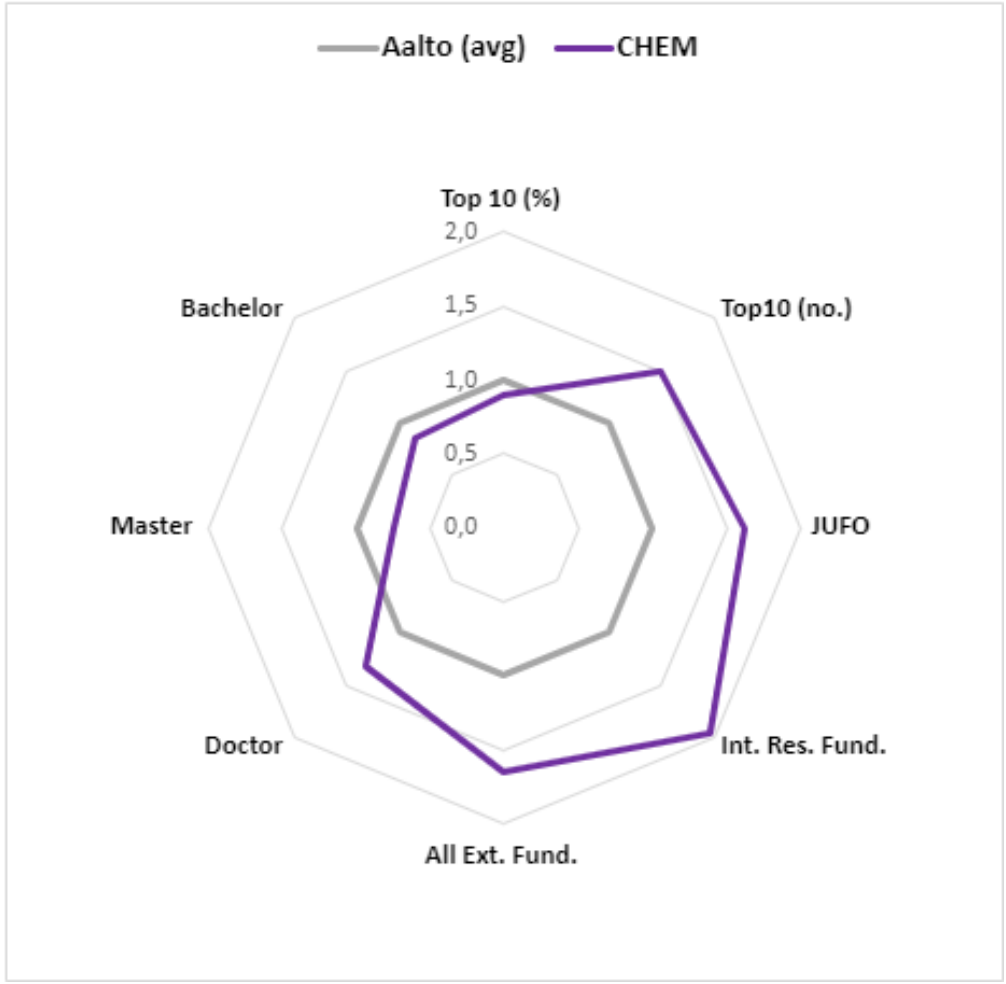
Necessary skills, knowledge and competences

Educational offering is understood nationally and internationally

How?

- **Research based approach and focus areas as background**
- **Incorporation & visibility of cross-cutting themes in education**
- **Evaluation of data on programme and major level (e.g. applicant numbers, student numbers, degrees, different feedback materials, credit points, number of courses, student-teacher-ratios, resourcing)**
- **Collaborations, discussions and workshops with teachers, students and stakeholders (employers and high schools)**

Motivation for portfolio renewal
Funding model



Framework for discussion – students and resources

	MSc thesis / field	Professors	Lecturers	Students starting 2022
Biomass refining and advanced lignocellulosic materials	134	15	5	54
Molecular bioscience and Industrial biotechnology	92	7	2	56
Chemical engineering and circular processes	180	13	10	78
Chemistry for renewable energy and functional materials	75	12	7	69

MSc thesis / field:
2016-2021

Master’s admissions context to Portfolio Renewal 2022

Statistics

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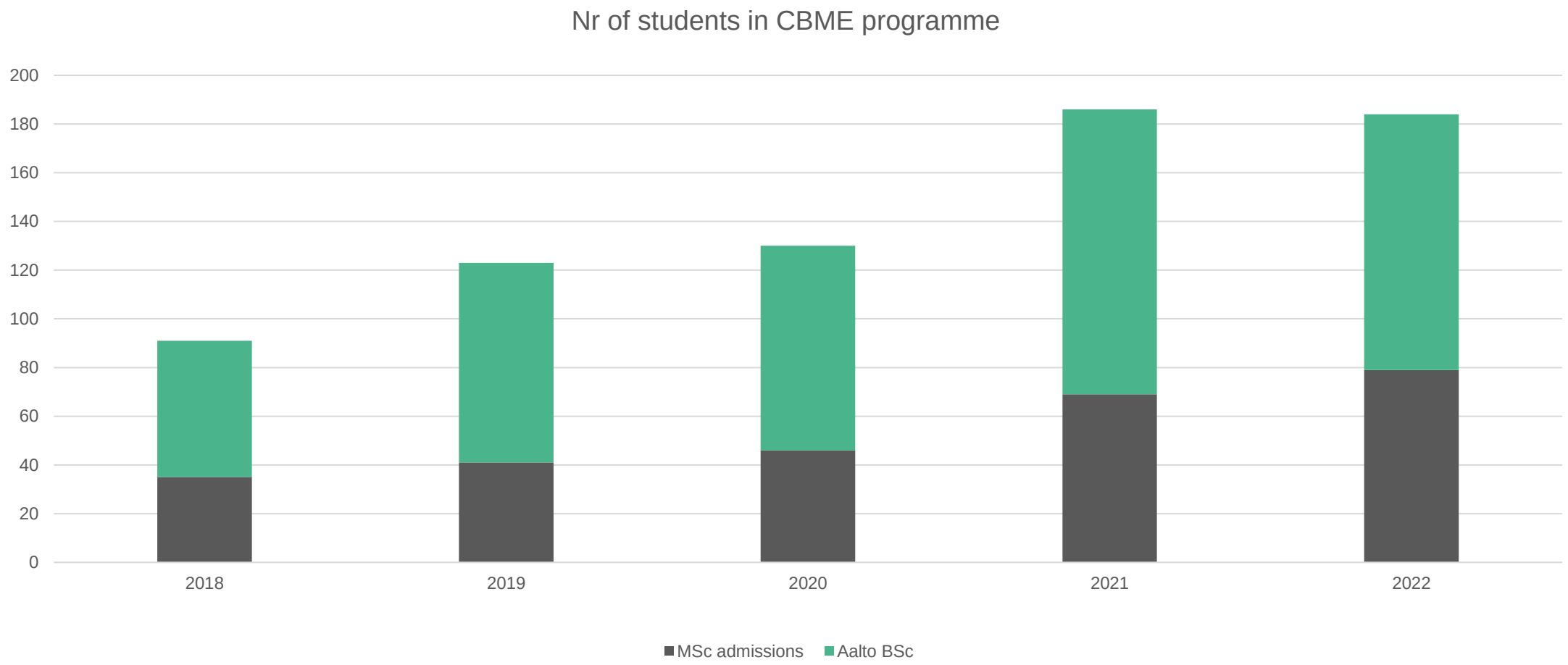
Master’s Programme in Chemical, Biochemical and Materials Engineering



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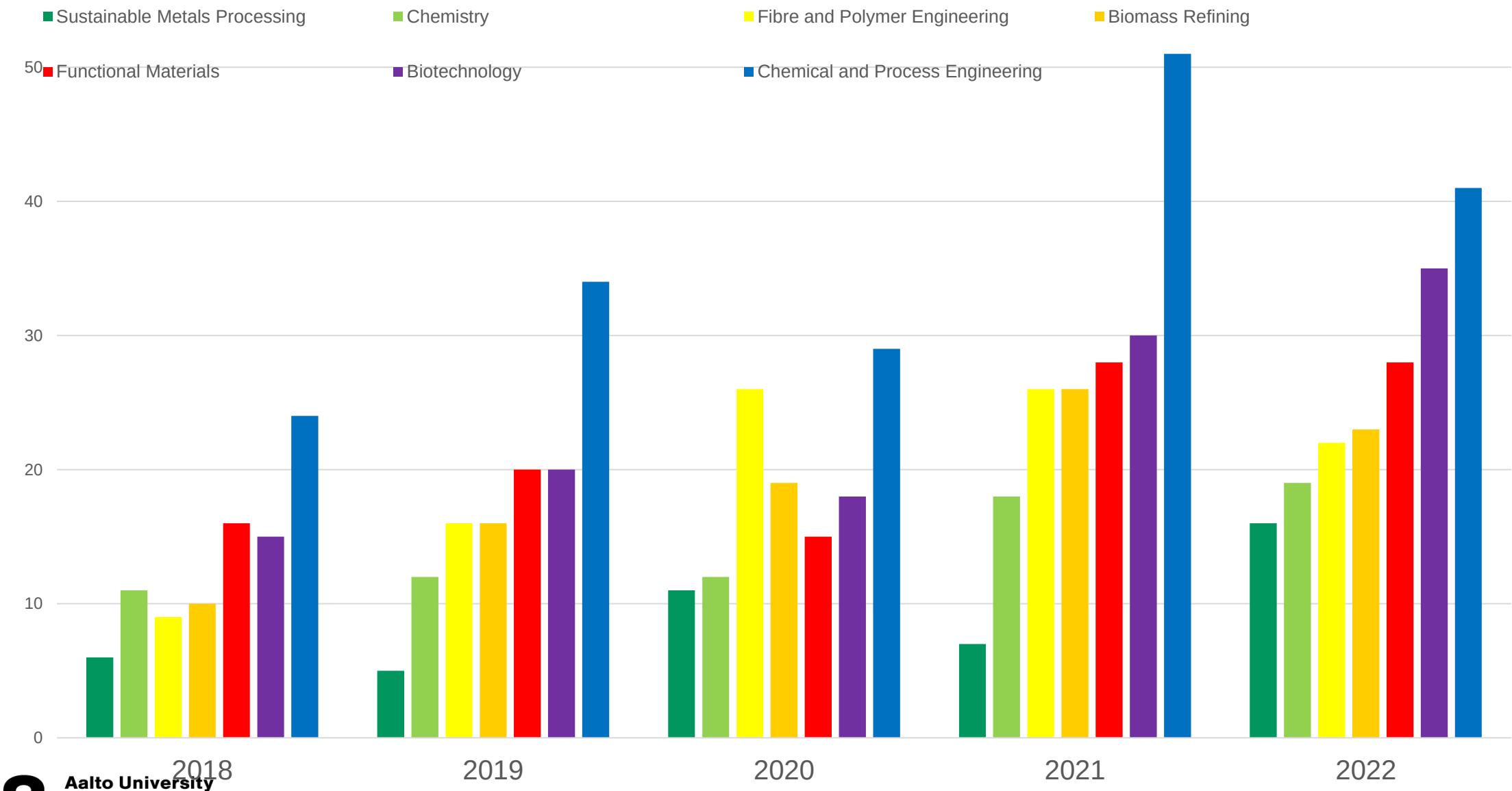
CBME majors: Total number of students



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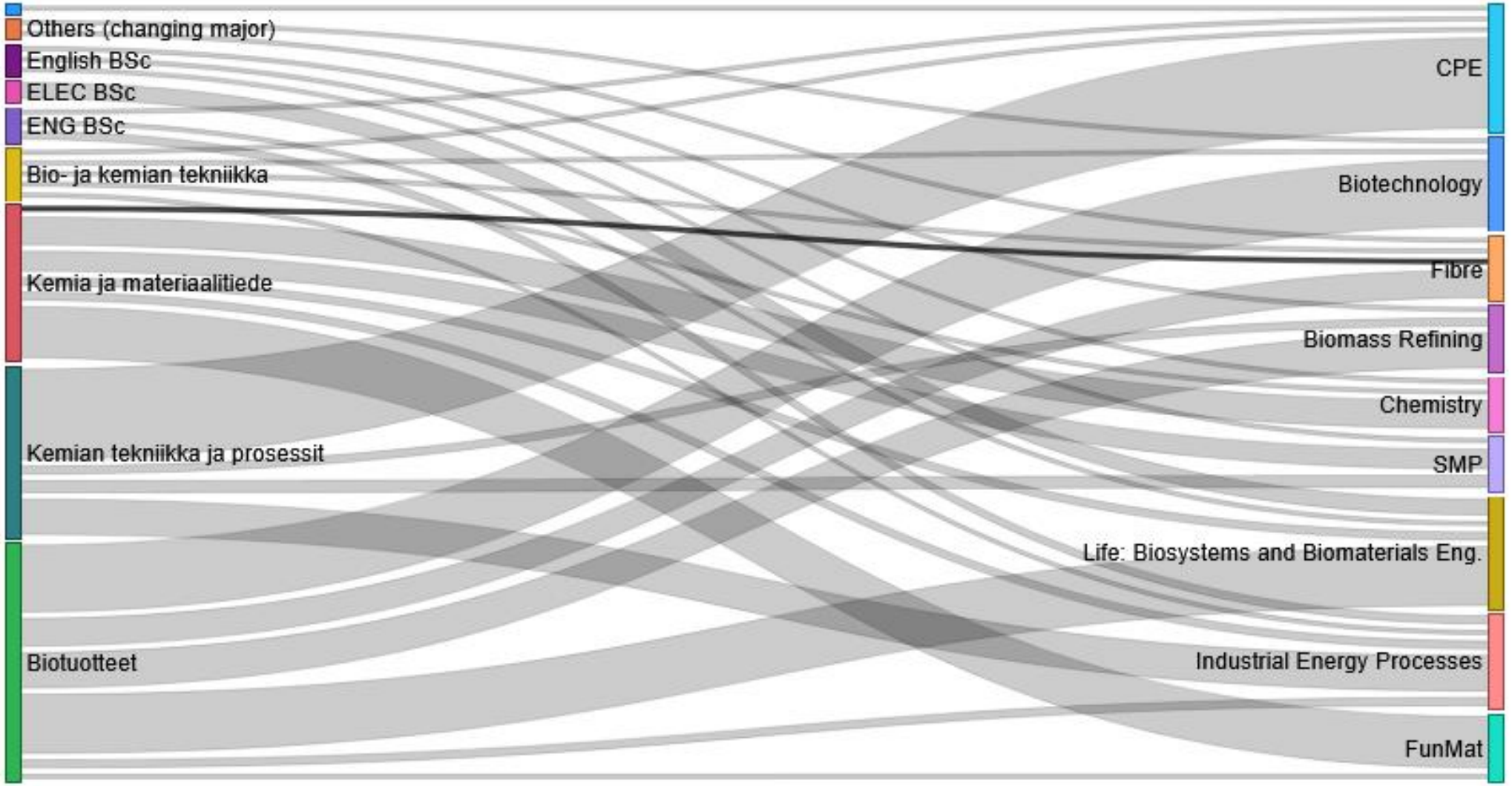
Student flow from bachelor to master 2022:



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Data based on Jan 2022 applications, small changes since
More details: https://app.powerbi.com/links/pCB4gZxF7a?ctid=ae1a7724-4041-4462-a6dc-538cb199707e&pbi_source=linkShare

Project organisation and communication

Development of portfolio in four clusters

Cluster leads nominated by the departments

Bioproducts engineering
~~Biomass refining and advanced lignocellulosic materials~~
Cluster lead:
Eero Kontturi

- Biomass refining
- Fiber and Polymer Engineering
- N5P in Polymer Technology (discontinuing)
- Biological and Chemical Engineering for a Sustainable Bioeconomy (Bioceb)

Biotechnology
~~Molecular bioscience and Industrial biotechnology~~
Cluster lead:
Alexander Frey

- Biotechnology
- Biosystems and Biomaterials engineering

Chemical and metallurgical engineering
~~Chemical engineering and circular processes~~
Cluster lead:
Marjatta Louhi-Kultanen

- Chemical and Process Engineering
- Sustainable Metals Processing
- Industrial Energy Processes (Advanced Energy solutions)
- European Mining, Minerals and Environmental Programme (EMMEP)

Chemistry and materials science
~~Chemistry for renewable energy and functional materials~~
Cluster lead:
Kari Laasonen

- Chemistry
- Functional Materials
- Advanced Materials for Innovation and Sustainability (AMIS)
- Master's Programme in Energy Storage

Cluster leads will lead the discussion and development work in the cluster. Responsibility to take forward development actions and participate in portfolio renewal steering group work.

MSc study offerings:
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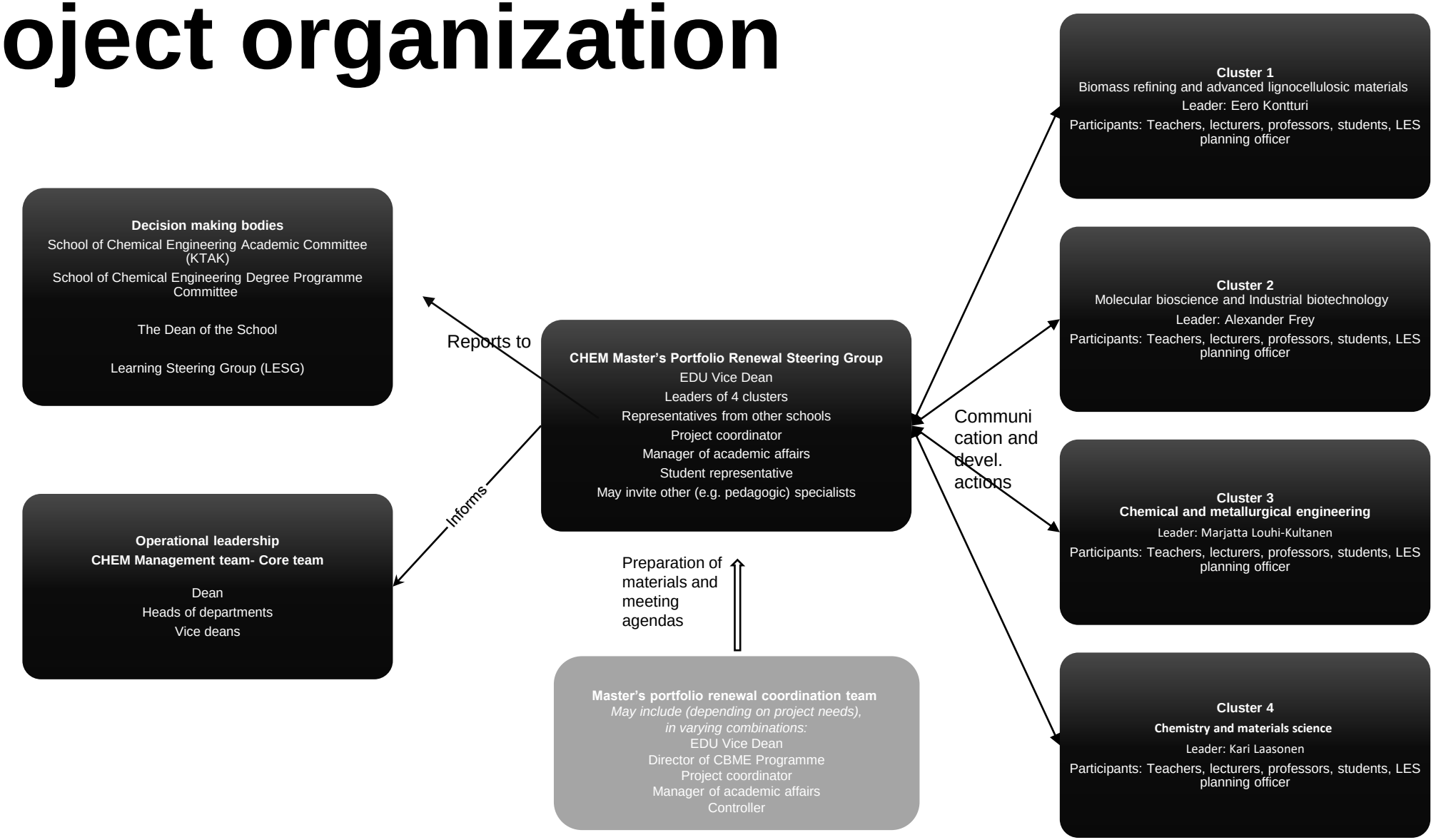
Project organization



Portfolio Renewal website

- Focal point of information about project and guidelines
- Also document repository

www.aalto.fi/school-of-chemical-engineering/masters-portfolio-renewal

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School of Chemical Engineering

Project achievements by spring 2023

Progress made in 2022

- Mapping requirements of future working life: meetings held with stakeholders
- Developing new programmes in ‘clusters’; work led by cluster leaders
- Identifying ‘purpose’ for each programme
- Mapping programme-level ILOs for each programme
- Decision: Programme (and not major) = application target
- Decision: School-level programme structure
- Communicating about renewal: website & Teams site

Internal Stakeholder Events

Programme Review held 18.8.2022 with teaching staff, learning services and student representatives

- Purpose of this meeting was to identify:
  - Foreseen changes impacting field of chemical engineering by 2035
  - Purpose, objectives and societal relevance (e.g. employability/ addressing societal challenges etc.) of each programme.
  - How does the programme distinct itself from other educational offering within Aalto and domestically/internationally?
- Internal workshops held with teaching staff, learning services and student representatives continuously since, to work on curriculum development or other matters at hand

External stakeholder events

- Events held 23.9. and 30.9.2022 with external industry representatives and internal key academic staff
- Purpose of these meetings was to identify:
  - Future developments of chemical engineering industries
  - Future skillsets and core competencies needed in chemical
- Major future developments identified:
  - Circular economy and energy-related questions
  - Digitalisation will evolve further
- Ideal future graduate has strong core engineering, leadership and comms skills
- Problem-solving and openness to life-wide learning will help graduates tackle new challenges

CHEM academic committee (KTAK) decisions Nov 2022 – Apr 2023

1. **Programme = Study option (application target)**
2. **Programme structure of new programmes**
   - Studies towards the major: 60-65 credits
   - Thesis, including a maturity essay: 30 credits
   - Elective studies: 25-30 credits
3. **Number and names of new programmes**
4. **Intended learning outcomes for new programmes**
5. **Majors of new programmes**

Specialisation tracks in new programmes – discussions ongoing

Programme	*Major(s)*	*Specialisation tracks*
Master's programme in Bioproducts Engineering	**Bioproducts Engineering**	*Discussion ongoing on whether to establish tracks*
Master's programme in Biotechnology	**Biotechnology**	• *Industrial Biotechology* • *Bioscience*
Master's programme in Chemical and Metallurgical Engineering	**Chemical and Process Engineering** **Sustainable Metallurgical Engineering**	
Master's programme in Chemistry and Materials Science	**Chemistry and Materials Science**	• *Chemistry* • *Materials Science*

Intended learning outcomes for new programmes

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5 Päätösasia/Decision item: Maisteriohjelmien portfoliouudistustyö: neljän maisterikoulutusohjelman ohjelmatason osaamistavoitteet / Master's programme portfolio renewal: programme level intended learning outcomes for four master programmes (Pauliina Ketola)

Perustelut/Justification
Portfoliouudistustyön seurauksena ehdotetaan, että neljän maisterikoulutusohjelman ohjelmantason osaamistavoitteet hyväksytään liitteen 2 mukaisesti.

It is proposed that as a result of the portfolio renewal programme level intended learning outcomes for four master programmes will be confirmed according to the attachment 2.

Liitteet/Appendices
Liite/attachment 2 Portfolio renewal: intended learning outcomes

Päätösesitys/Decision proposal
Vahvistetaan neljän maisterikoulutusohjelman ohjelmatason osaamistavoitteet Koulutusneuvoston esityksen (liite 2) mukaisesti.

Programme level intended learning outcomes for four master programmes will be confirmed according to the proposal by the Degree Programme Committee (attachment 2).

Kokouskäsittely/Handling of the matter
Esille nostettiin ohjelmatason osaamistavoitteiden yhdenmukainen esitystapa. Osaamistavoitteet on listattu liitteessä 2, huomiota kiinnitettiin erityisesti kahden ohjelman osaamistavoitteeseen "Knowledge on sustainability-related challenges and their systemic nature. Ability to contribute with one's field specific expertise for sustainable future solutions" jonka muotoilu poikkeaa muista osaamistavoitteista. Todettiin, että ohjelmat voivat muokata kyseisen kohdan sanamuotoja yhdenmukaiseksi muiden osaamistavoitteiden kanssa. Osaamistavoitteen täytyy pysyä kuitenkin sisällöllisesti samana.

Unified way of presenting intended learning outcomes was discussed. Intended learning outcomes are listed in the attachment 2, attention was paid especially on the intended learning outcome shared with two programmes "Knowledge on sustainability-related challenges and their systemic nature. Ability to contribute

with one's field specific expertise for sustainable future solutions" because the formulation of the text differs from the other intended learning outcomes. It was noted that the programmes can modify the wording of the intended learning outcome in question so that it matches with the others. However, the content of the intended learning outcome must stay the same.

Päätös/Decision
Päätettiin esityksen mukaisesti huomioiden osaamistavoitteiden yhdenmukainen esittämistapa. / *The motion was passed as proposed, taking into account the unified way of presenting the intended learning outcomes.*

Maisteriohjelmien portfoliouudistustyö: neljän maisterikoulutusohjelman ohjelmatason osaamistavoitteet

Master's programme portfolio renewal: programme level intended learning outcomes for four master programmes

Master's programme in Bioproducts engineering

A graduate is able to:

- Describe value chains in a circular bioeconomy: from raw materials to end products and further to recycling/biodegradation
- Identify and analyse the principles for transitioning to a circular bioeconomy
- Apply sustainable development tools in the engineering of bioeconomy value chain products and processes
- Master the hierarchical structure of plant cells and understand its relevance in bio-based raw material processing and application
- Select and apply analytical techniques for characterizing biomass, fibres, polymers and other relevant raw materials and end products
- Apply models on processes relevant to the forest products and broader bio-based industries
- Design, execute, and report on a scientific or research and development project to address academic, industrial, and societal problems.
- Identify challenges, ideate, experiment and implement feasible solutions, and has capability and perseverance for acting in an environment of risks and uncertainty.
- Engage in scientific discussions in fields of science, engineering and technology and communicate the findings in oral and written form
- Follow development of one's field and acquire and process new scientific, technological, and societal information
- Act and communicate as an expert in multidisciplinary teams on multi-dimensional problems, and being able to reflect, present and justify decision making in such teams
- Assess sustainability-related challenges and contribute with one's field specific expertise for sustainable future solutions.

Master's programme in Biotechnology

A graduate is able to:

- Evaluate and explain the impact and potential of biotechnology for society and industry
- Describe the molecular basis of living systems in the context of biotechnology
- Apply experimental and computational methods to analyze problems in a systematic manner and ideate and implement biotechnology-based solutions that support sustainable development
- Devise genetic engineering strategies to modify proteins, metabolic pathways and cellular functions leading to improved productivity or to novel or improved products
- Describe the bioreactor environment and explain how it influences cells or enzymes and thereby the bioprocess outcome
- Differentiate the suitability of different raw materials and recommend the most suitable bioprocessing approach
- Apply mechanistic and data-driven modelling approaches to predict biological and biophysical phenomena
- Design, execute, and report on a scientific or research and development project to address academic, industrial, and societal problems.
- Have capability and perseverance for acting in an environment of risks and uncertainty.
- Engage in scientific discussions in fields of science, engineering and technology and communicate the findings in oral and written form
- Follow development of one's field and acquire and process new scientific, technological, and societal information
- Act and communicate as an expert in multidisciplinary teams on multi-dimensional problems, and being able to reflect, present and justify decision making in such teams

Master's programme in Chemical and Metallurgical Engineering

A graduate is able to:

- Apply engineering, natural sciences, and mathematics to solve complex problems in a chemical engineering or metallurgical engineering context
- Design sustainable industrial-scale processes
- Select and design unit operations and unit processes for industrial applications
- Aid the transition towards use and production of renewable and recyclable resources
- Make decisions based on raw materials' criticality and availability
- Demonstrate critical thinking skills in multidisciplinary groups to design economically feasible, safe, and ecological industrial processes
- Use computer-aided tools for process modelling, simulation, and control
- Follow development of field, acquire and process new scientific, technological, and societal information
- Devise and communicate strategic outcomes that meet academic, industrial, and societal requirements

Master's programme in Chemistry and Materials Science

A graduate is able to:

- Design, synthesize, characterize, and apply molecules and materials
- Describe structure and properties of molecules and materials using fundamental principles across different length-scales: from atoms to molecules; from molecules to nano; from nano to surface and bulk
- Work independently in research and development laboratories
- Model molecules and materials with computational methods
- Identify and address sustainability needs when creating molecules and materials
- Apply one's knowledge of materials and molecules in academia, industry, and society
- Design, execute, and report on a scientific or research and development project to address academic, industrial, and societal problems.
- Identify challenges, ideate, experiment and implement feasible solutions, and has capability and perseverance for acting in an environment of risks and uncertainty.
- Engage in scientific discussions in fields of science, engineering and technology and communicate the findings in oral and written form
- Follow development of one's field and acquire and process new scientific, technological, and societal information
- Act and communicate as an expert in multidisciplinary teams on multi-dimensional problems, and being able to reflect, present and justify decision making in such teams
- Assess sustainability-related challenges and contribute with one's field specific expertise for sustainable future solutions.