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## Synergy with non-academic sector:

AECo – Advancing electrochemical processes for water safety and circularity

# Cross-border Living Lab between Norway, USA and Canada

Zakhar Maletskyi
Norwegian University of Life Sciences (NMBU)

Inter-project coaching, 23. September 2020

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University of Nis

www.swarm.ni.ac.rs

Strengthening of master curricula in water resources management for the Western Balkans HEIs and stakeholders

Project number: 597888-EPP-1-2018-1-RS-EPPKA2-CBHE-JP

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# Why?

- Increase **relevance** of water-related education to the real world issues
- Promote **research-based** education
- Support **collaboration** between academia and industry, facilitate knowledge transfer

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# How can we work together?

**Norwegian University of Life Sciences**

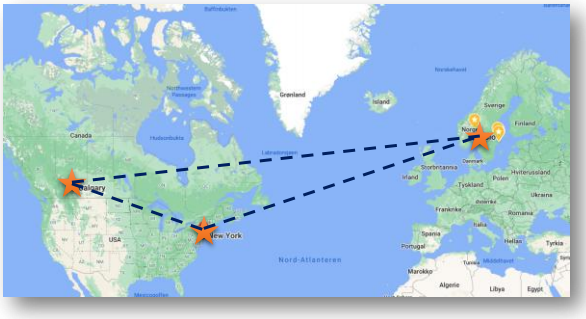
One of eight universities in Norway and the leading producer of Master level graduates in Water and Wastewater technologies. NMBU has long traditions in international project collaborations including Horizon 2020, EU FP7, Erasmus+ and other European programs

**University of Calgary**

The University of Calgary is a public research university. This university consistently ranks among the top ten in Canada based on a variety of criteria and is consistently ranked top 200 in the world by various international ranking tables

**Columbia University**

Columbia University is one of the world's most important centers of research and at the same time a distinctive and distinguished learning environment for undergraduates and graduate students in many scholarly and professional fields



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# Project Methodology – **Living Lab**

**Living Labs** refer to **user-centred**, **open innovation** ecosystems based on a systematic user co-creation approach integrating research and innovation processes **in real life communities and settings**


*The Living Lab Methodology Handbook*

1. **Practice-driven**
2. Facilitate and foster **open, collaborative innovation**
3. **Real-life environments**, where both open innovation and user innovation processes, can be studied and subject to experiments

User + Open Innovation + Real Environment

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# Living Lab Principles

Living labs are designed to **generate concrete, tangible innovations based on user and community contributions**, and at the same time to advance (academic) understanding of open and user innovation principles and processes

## Living Lab Key Principles

In Living Lab activities there are five Key Principles that should permeate all operations:

**VALUE**
**INFLUENCE**
**SUSTAINABILITY**
**OPENNESS**
**REALISM**

*The Living Lab Methodology Handbook*



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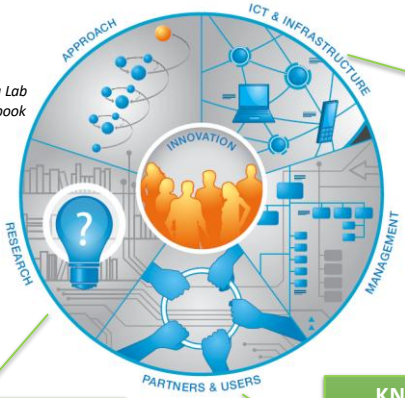
# Living Lab Key Components

*The Living Lab Methodology Handbook*




**FACILITATE**
new ways of cooperating and co-creating new innovations

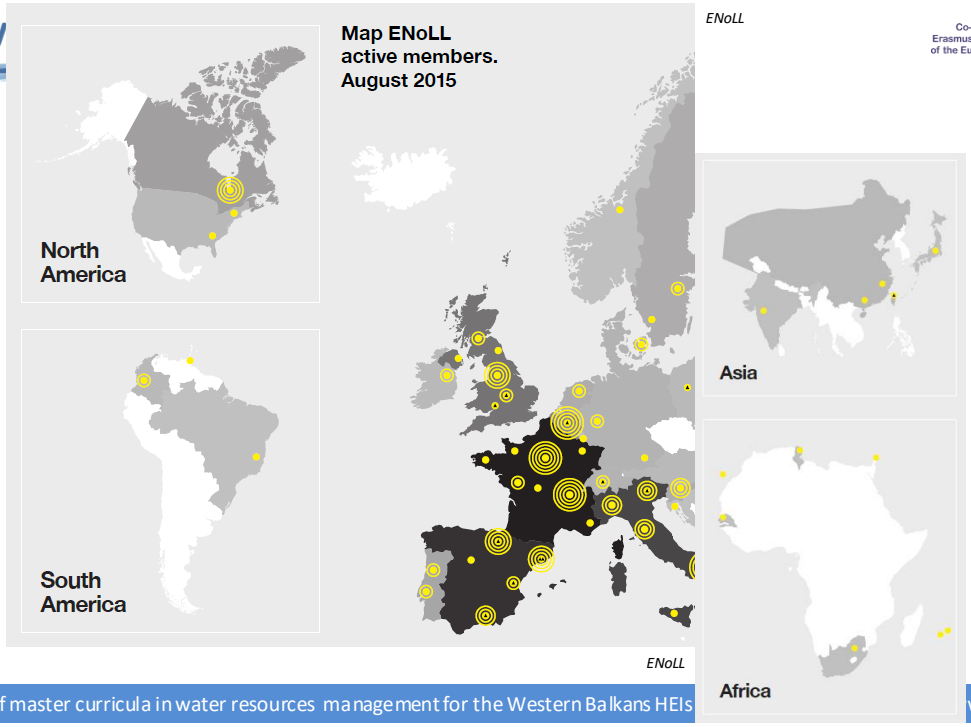
**KNOWLEDGE & EXPERTISE**
to the collective, helping to achieve boundary spanning knowledge transfer

**COLLECTIVE LEARNING & REFLECTION**
result in contributions to both theory and practice

# Living Lab Experience


ENoLL has recognised nearly **400 living labs** from around the world maintained by municipalities, universities, regions and companies acting also as the development and piloting partners





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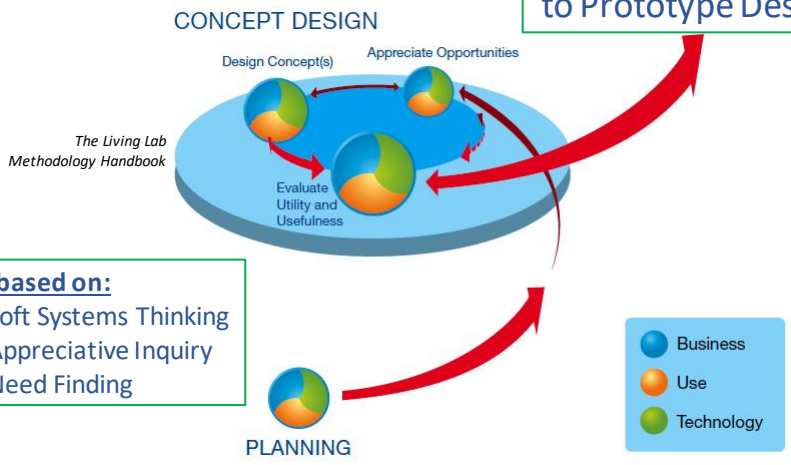
Planning | Concept design | Prototype design | Pre-launch | Launch…

"Seed Project"

to Prototype Design




**All based on:**
1. Soft Systems Thinking
2. Appreciative Inquiry
3. Need Finding



# Project Consortium

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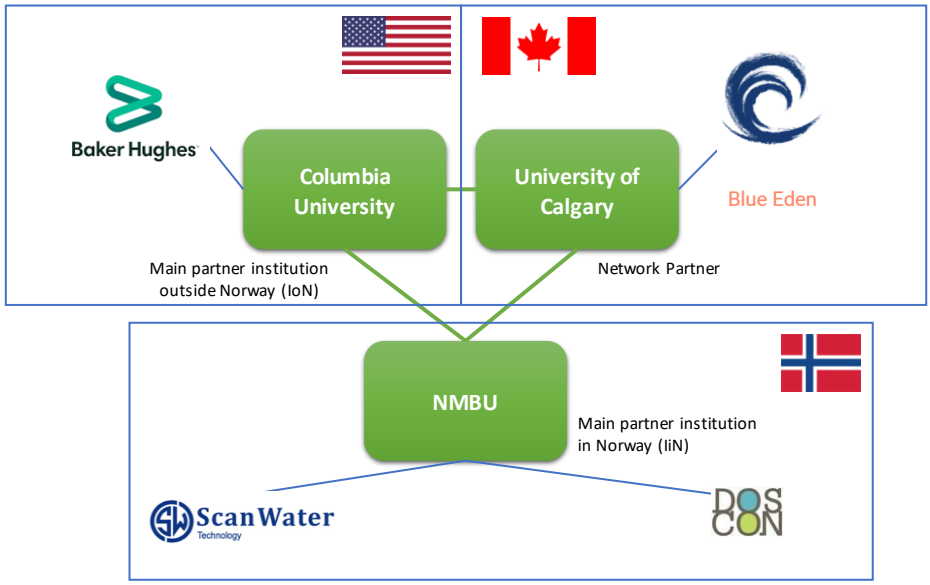


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# Research & Knowledge Pillars

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| Columbia University (CU) | University of Calgary (UoC) | Norwegian University of Life Sciences (NMBU) |
|---|---|---|
| • **Combined processes: EC-electroflotation and EC-electroflotation-AOP** for removal of dispersed oil/bitumen, colorants, and heavy metals<br>• **Enhancement of EC sludge dewatering** through rheometry studies | • **Kinetics of the process and mathematical modeling** considering synergism of coagulation, flotation and electrochemistry<br>• **Cell design and novel electrode** | • **Process control and optimization** considering:<br>• Treatment efficiency<br>• Dewaterability of EC sludge<br>• **Plants availability of Phosphorus in EC sludge**<br>• **Potential for disinfection and organic matter removal** |



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# How to operationalise?

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# Face-to-face workshops with the industry

- Focusing on real issues that matter

Oslo

New York - Boston

Calgary



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# Send students with “special missions”

- MSc thesis "Effects of electrochemical treatment of mixed liquor in submerged ceramic membrane bioreactor", 2019
- MSc thesis "Electrocoagulation in wastewater treatment", May 2020


Team landing in Norway

Training in Calgary

Hands-on in New York

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# Present own research to each other and to the public

- Finding joint interests and cross-cutting issues

Presentations at the 256 American Chemical Society National Meeting & Exposition, Boston, MA, USA, 2018

Prof. Harsha Ratnaweera, NMBU: "Competition between the hydrolysis-phosphate precipitation reactions in wastewater coagulation"
Dr. Zakhar Maletskyi, NMBU: "Fouling behaviour of chemically modified mixed liquor from submerged ceramic biofilm-membrane bioreactor"
Dr. Sathish Ponnurangam, UoC: "Novel conducting composites for enhanced separation of salt from brackish water"
Dr. Irina Chernyshova, CU: "The origin of the elusive first intermediate of CO2 electroreduction"




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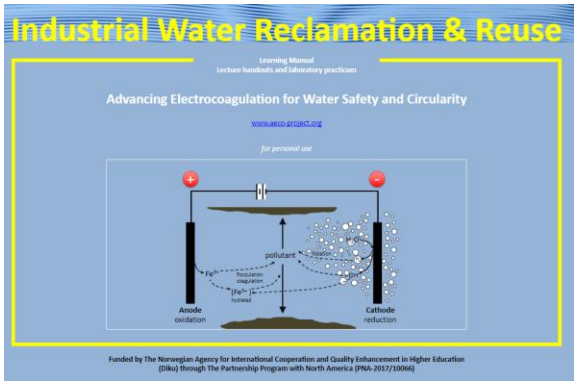
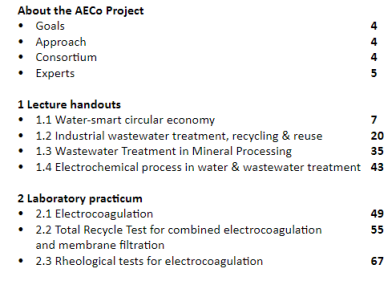
# Compile a course from joint materials

- Knowledge and practices exchange between the labs

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## Build a team



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## The seed project

**SIU funding**
**300 000 NOK**

**Strengthen partnership**

**Increased**

- academic cooperation
- connections between research and education
- collaboration with enterprises
- student mobility

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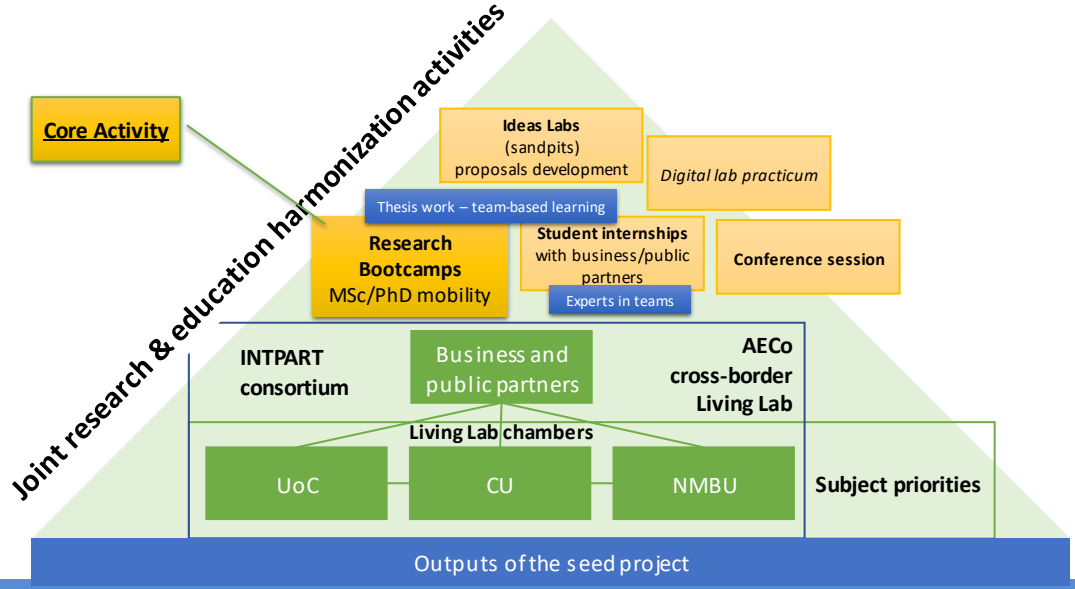
# Focus areas: Methods, applications & advantages

| Applications | Electrochemical methods | | | | PI |
|---|---|---|---|---|---|
| | Electrocoagulation | Electroadsorption | Electrooxidation | Electroflotation | |
| Removal of organic matter (natural organic matter and chemical oxygen demand in wastewater) | Consolidation of organic matter<br>Disinfection, log red | High rate, kinetics, and regeneration of ads | High rate, hard degradable matter<br>Electro-Fenton | - | NMBU |
| Removal of Contaminants of Emerging Concern | - | Heavy metals | Contaminants of Emerging Concern, micropollutants | Microplastics | CU |
| Oil-water separation | High separation efficiency, electric field induced coalescence | - | - | Higher rate, microemulsions with membranes | UoC |
| **Group advantage** | Stabilized pH<br>Less sludge | Recyclable adsorbents | Persistent Organic Pollutants<br>In-situ H2O2 & reactive oxygen species | No need air supply | |
| **Class advantage** | Chemical-free, energy efficient, flexibility | | | | |
| | Easy to combine and synergy with traditional technologies | | | | |

# Project activities



# Core activity

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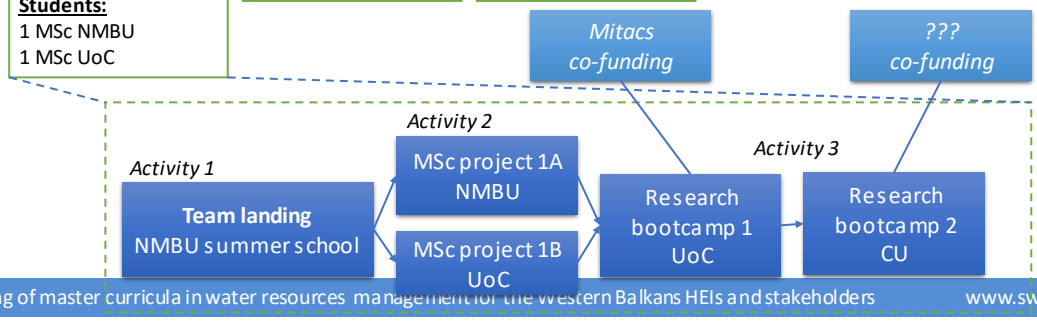
- Team-based learning – MSc projects

**Electrochemical methods for:**

| Removal of organic pollutants: NOM in DWT and COD in WWT | Removal of micropollutants | Oil-water separations |
|---|---|---|
| **PI:** NMBU<br>**Co-PI on EC:** UoC<br>**Co-Pi on micropollutants:** CU | **PI:** CU<br>**Co-PI on EC:** UoC<br>**Co-Pi on DW&WWT systems:** NMBU | **PI:** UoC<br>**Co-PI on micropollutants:** CU<br>**Co-Pi on DW&WWT systems:** NMBU |
| **Students:**<br>1 MSc NMBU<br>1 MSc UoC | | |



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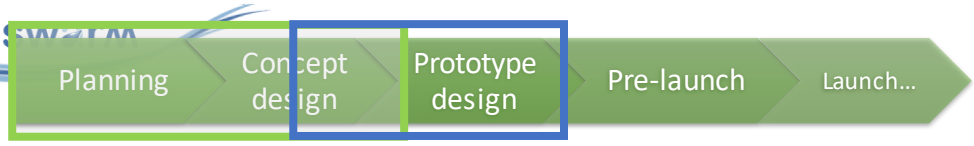
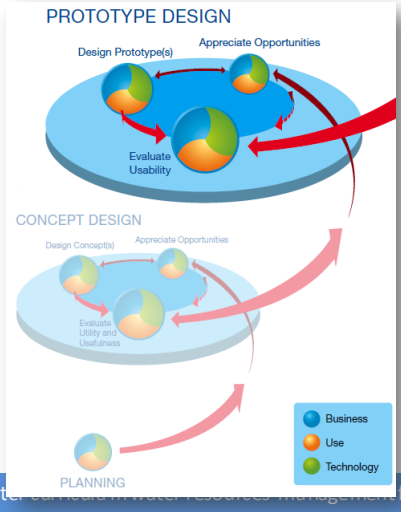



**"Seed Project"** **INTPART project**




**Cycle 2, phase 1**
APPRECIATING OPPORTUNITIES

The focus here is to find what needs users have. We want to find the basis for the design of the systems interface, and its functionality. The overall purpose is to collect sufficient, relevant, and proper data so that stable requirements can be produced. You already have a picture of the requirements, but they need to be expanded, clarified and confirmed.

**Cycle 2, phase 2**
PROTOTYPE DESIGN

The aim is to move from concepts (or low-fidelity prototypes) to high-fidelity prototypes with a focus on users identified needs throughout the whole process. The main objective is to **look beyond** the immediate vision that comes to mind and to do that with the **users expressions** in focus. Aim to come up with different design solutions.

**Cycle 2, phase 3**
USABILITY EVALUATION

The focus is to encourage users to express their thoughts and attitudes towards the innovation being developed.

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# Continuation

- INTPART – Programme for International Partnerships for Excellent Education, Research and Innovation
- **Advancing EleCtrochemical processes for water safety and circularity (AECo)**
- Another 3 years: 2020-2024