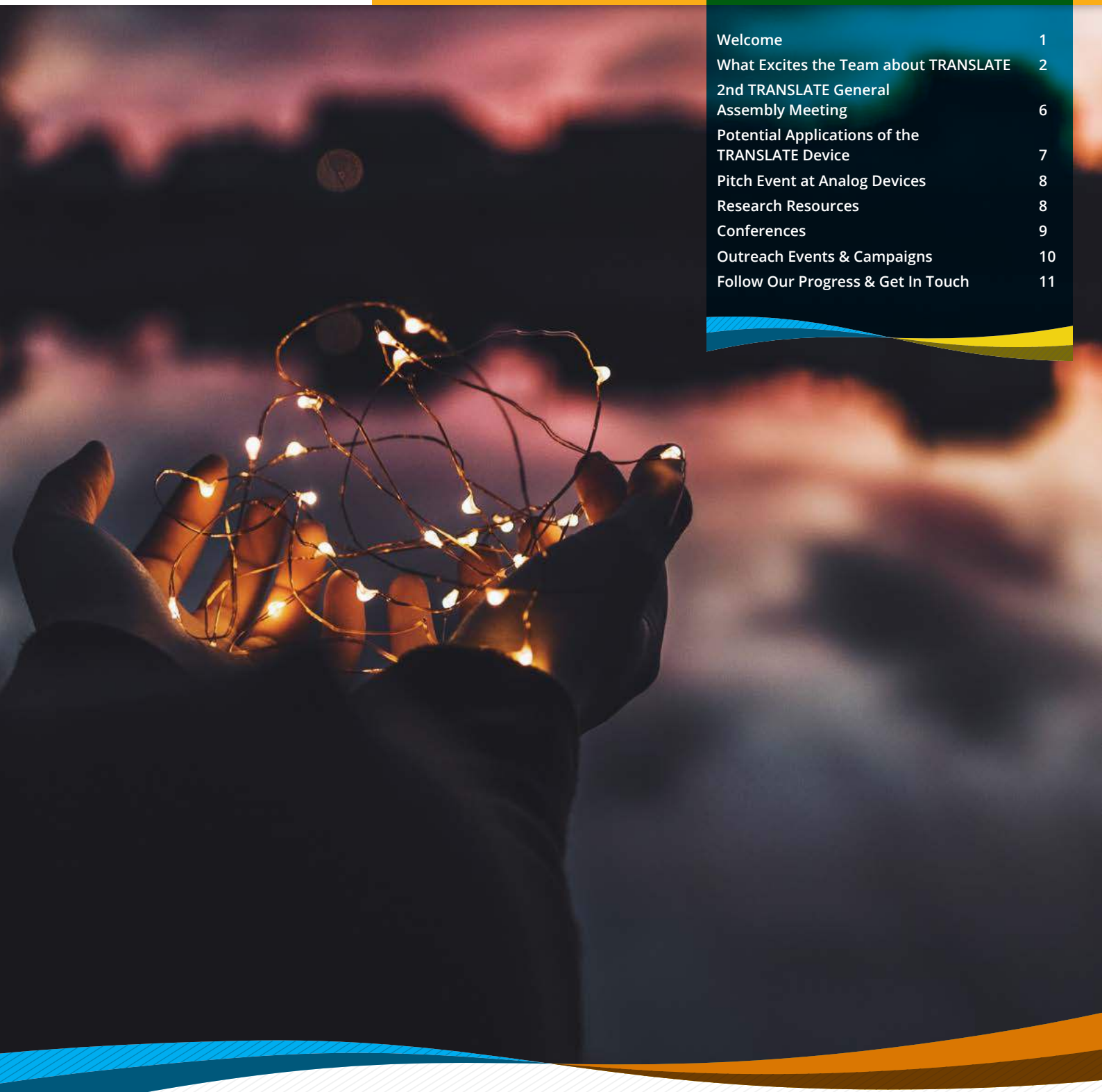
translate

waste heat to electricity

newsletter

ISSUE 2 – JUNE 2023



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement number 964251.

Welcome – Professor Justin Holmes

Professor Justin Holmes

Welcome to the second issue of the TRANSLATE project newsletter! We are excited to share with you the progress and achievements of our team as we continue our journey towards developing a sustainable solution for converting waste heat into electricity using porous membranes.

Over the past year, our team has been hard at work, building on our previous successes since our **previous newsletter ↗**.

The key highlights of our research over the past year include:

- **The first optimal design of the nanochannels that will form part of the overall TRANSLATE device, based on simulation results from TUD.**
- **The selection of two different materials for the fabrication of the nanofluidic membranes: anodised aluminium oxide (AAO) and cellulose.**
- **The functionalisation of the nanochannels – both negative and positive charges were introduced onto the inner walls of cellulose nanochannels.**
- **The selection of an optimised electrode and electrolyte for the battery-like thermoelectric cell of the TRANSLATE device.**

The excellent project management and communications support provided by UCC Academy has been vital to the project's success. We are grateful for their dedication and expertise in ensuring smooth coordination among our partners and facilitating effective communication within our team.

Furthermore, in the last 12 months, the TRANSLATE team met for the first time in person at our 2nd General Assembly, participated in 4 outreach events, presented project results at 7 international conferences and much more.

We invite you to stay connected with us through our **Twitter ↗** and **LinkedIn ↗** pages for regular updates on our project. If you have any questions or would like to know more about TRANSLATE, please feel free to reach out to us at translate@ucc.ie.

Thank you for your continued support, and we hope you enjoy reading the second issue of the TRANSLATE project newsletter!

What Excites the Team about TRANSLATE

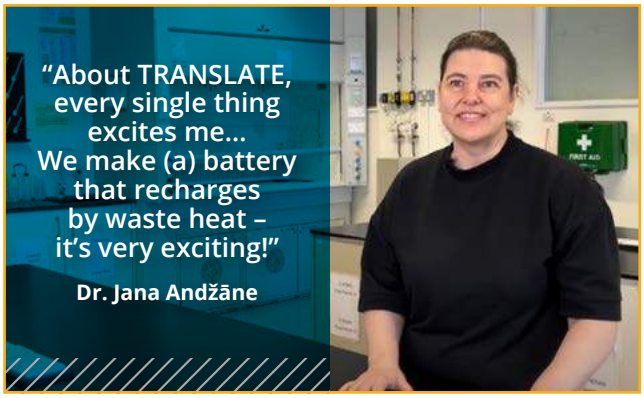
In TRANSLATE, we are conducting ground-breaking research in the field of thermoelectric energy conversion. We asked our teammates what excites them most about the project from their perspective. We received some fascinating responses, which have been captured in a video series ↗. This series provides valuable insights into the passion and excitement that drives our team's work in TRANSLATE.

We extend a special thank you to the individuals who organised and created these videos, bringing the perspectives of our teammates to life.

Dr. Jana Andžāne is a seasoned researcher with a passion for nanotechnology and environmental science. With over 15 years of experience at the University of Latvia (UL), Institute of Chemical Physics (ICP), Dr. Andžāne has progressed from a research assistant to a senior researcher, participating in numerous EU-funded projects and serving as an evaluator for Horizon 2020 and ERANET projects.

Her expertise is in the synthesis of 1D and 2D nanostructures, especially thermoelectric and topologic insulator materials – designing and conducting research in the laboratory, focusing on the measurements of TE properties and scientific interpretation of experimental data. For TRANSLATE, her role involves developing a battery that can recharge using waste heat.

Dr. Andžāne is excited about TRANSLATE as it matches her experience and enthusiasm for working in the field of nano-thermoelectrics and it aligns perfectly with her recent passion for alternative energy sources and environmental science, and she is thrilled to be contributing her expertise to such an innovative and impactful endeavour.



Watch the video: **https://youtu.be/PRgzIwbRTC0**

Dr. Raimonds Meija is an accomplished researcher in the field of material science and energy harvesting. With a PhD in Physics from the University of Latvia (UL) in 2019, Dr. Meija currently serves as a senior researcher at the UL Institute of Chemical Physics (ICP), as well as an Assistant Professor at the Department of Physics, Faculty of Medicine of the Riga Stradins University.

Dr. Meija's expertise lies in the measurement of physical properties of nanostructures and their applications for electronic components, sensors, and energy storage. In his current postdoctoral research, Dr. Meija is focused on energy harvesting and battery cell electrodes. His main tasks in TRANSLATE involve designing and developing electrodes for energy harvesting within the cell, and selecting the best electrode materials based on experimental data and scientific interpretation.

What excites Dr. Meija the most about the project is the opportunity to collaborate with outstanding scientists. The collaborative nature of the project and the prospect of developing cutting-edge technologies for energy harvesting is a driving force for Dr. Meija, in addition to the scientific advancements being made. The interdisciplinary nature of the project and the potential for practical applications in the field of alternative energy sources further ignite Dr. Meija's enthusiasm for the project.

Watch the video: **https://youtu.be/Z3mCMAAhfPI**

What Excites the Team about TRANSLATE

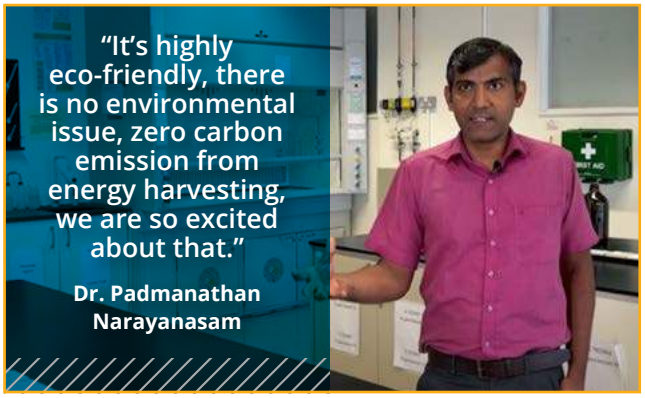
Dr. Padmanathan Narayanasamy is a post-doctoral researcher in the AEMG (Advanced Energy Materials Group) since 2014, with a primary focus on advanced materials development for energy storage and conversion applications.

Dr. Narayanasamy's expertise lies in the synthesis of new functional materials and their fabrication for low-grade thermoelectric energy conversion and devices, which are the targeted outcome of the TRANSLATE project.

In the TRANSLATE project, Dr. Narayanasamy's main role is in the development of energy storage materials, specifically for supercapacitors and thermoelectric devices. He focuses on thermoelectric measurements, evaluating thermal conductivity, power output, and energy conversion to assess the performance of the materials.

The aim of the project is to exploit new concepts for converting low-grade heat energy into electricity in an eco-friendly manner, with zero carbon emissions.

Dr. Narayanasamy is excited about the potential of this technology to pave the way for next-generation energy storage and conversion devices, and to contribute to the commercialisation of this breakthrough technology.



Watch the video: **https://youtu.be/RpqkqAqVul4**

Professor Paul Hurley is a renowned expert in the field of nanoelectronics and semiconductor materials. He received his Ph.D. (1990) and B.Eng. (1985) in Electronic Engineering from the University of Liverpool and currently serves as Head of the Nanoelectronic Materials and Devices Group at the Tyndall National Institute, as well as a Research Professor in the Department of Chemistry at University College Cork.

With a background in semiconductor materials and devices, Professor Hurley has been extensively involved in researching alternative materials and device structures aimed at improving energy efficiency in various applications, including nanoelectronics, flexible electronics, mobile communications, and low power sensor technologies.

He leads a research team focused on III-V and 2D (e.g., MoS2, WSe2) semiconductors and their interfaces with metals and oxides, which are critical components of next-generation logic devices. His expertise lies in the development of energy-efficient and miniaturized devices that are used in integrated circuits, such as microprocessors and memory.

In the TRANSLATE project, Professor Hurley is involved in exploring how low-grade heat energy can be converted into electricity using advanced semiconductor materials and device structures. His research focuses on capturing and utilising the heat generated by information communication technologies, such as mobile phones and computers, which currently account for a significant portion of global electrical energy consumption. He is actively involved in developing new materials and technologies that can transform this waste heat into usable energy, with a particular emphasis on metal-oxide-semiconductor (MOS) systems for solar fuel generation through water splitting reactions.

Professor Hurley is passionate about utilizing his expertise in semiconductor materials and devices to address the pressing environmental issues associated with energy consumption and waste heat generation.

He is excited about the potential of the TRANSLATE project to harness the very technology that generates heat to capture and transform it into usable energy, thus contributing to sustainable energy solutions. He sees the project as a unique opportunity to play a role in safeguarding the environment and the atmosphere, and is inspired by the brilliant minds involved in the project who are committed to finding innovative ways to utilise waste heat for energy conversion.

Watch the video: **https://youtu.be/2dHjX7DDrzA**

What Excites the Team about TRANSLATE

Anjali Ashokan is currently pursuing her doctoral research in the Materials Chemistry and Analysis Group (MCAG) under the guidance of Prof. Justin Holmes at UCC.

Anjali's expertise and experience lie in the field of synthetic chemistry, specifically in bio-inorganic chemistry, organic electronics, nanomembrane synthesis and functionalization, electrochemical energy storage and conversion, and thermoelectric cells.

She holds an Integrated Master's degree in Chemistry from the Central University of Tamil Nadu, and has been involved in prestigious research projects during her academic career, including the IASc, NASI, INSA summer research fellowship at IISc Bangalore under Prof. G. Mugesh, and her Master's thesis on organic electronics under Prof. S. Nagarajan at CUTN. She has also conducted research on the synthesis and characterisation of symmetrical diarylcarbazole for aggregation and nitroaromatic studies.

In the TRANSLATE project, Anjali's main focus is on the fabrication, functionalisation, and optimisation of the ionic nanofluidic harvester. She is working on the functionalisation and characterisation of nano channels, with the aim of effectively converting low-grade waste heat into usable electricity. Her work involves designing efficient heat to electrical energy conversion systems, specifically using nanofluidic platforms.

What excites Anjali most about the TRANSLATE project is the novel idea and potential it holds for converting waste heat into electricity, which could be a sustainable solution for future energy crises.

She is motivated by the opportunity to contribute to innovative research that addresses global energy challenges, and she finds the concept of utilising nanofluidic platforms for efficient energy conversion to be particularly fascinating. Anjali's background in synthetic chemistry and her previous research work on organic field effect transistors and aggregation studies further fuel her enthusiasm for the project.

Watch the video: **https://youtu.be/TVoK9C2dtw0**

Dr. Kamil Rahme is an accomplished researcher with a strong background in interdisciplinary research at the interface of chemistry, physical chemistry, and biology.

He received his PhD in Supra and macromolecular chemistry from the University of Toulouse, France, in 2008. He then joined the material and supercritical fluid group led by Prof. Justin Holmes at the Department of Chemistry in UCC as a Post-Doctoral Research Associate for nearly 2 years.

In 2010, Dr. Rahme was appointed as an Assistant Professor of Chemistry at Notre Dame University-Louaize (NDU) in Lebanon, where he was later promoted to Associate Professor in 2016. He has published numerous papers in international journals and conferences and serves as a peer reviewer for several publishers, as well as an editorial member/reviewer for Polymers MDPI Journal. Currently, he is a Research Topic Editor for Frontiers in Drug Delivery Journal.

Dr. Rahme's research interests are focused on the fields of nanoscience and bionanotechnology. His expertise lies in the functionalisation of nano channels for the development of sustainable low-grade heat energy harvesters.

With his extensive experience and expertise, Dr. Rahme brings a wealth of knowledge and innovation to the TRANSLATE project, where he joined as a Research Fellow in September 2021. The project excites him due to its novel approach and open collaboration with diverse research groups.

Dr. Rahme is enthusiastic about the opportunity to work with experts from different disciplines, learn from their expertise, and contribute towards the creation of clean energy and electricity without pollution, which would benefit the environment and the community.

Watch the video: **https://youtu.be/d-n6qn4waNU**

What Excites the Team about TRANSLATE

Rupa Ranjani P is currently pursuing her doctoral research in the Materials Chemistry and Analysis Group (MCAG) under the guidance of Prof. Justin Holmes at UCC. Her research is focused on the TRANSLATE project, which involves designing an efficient heat-to-electrical energy conversion system.

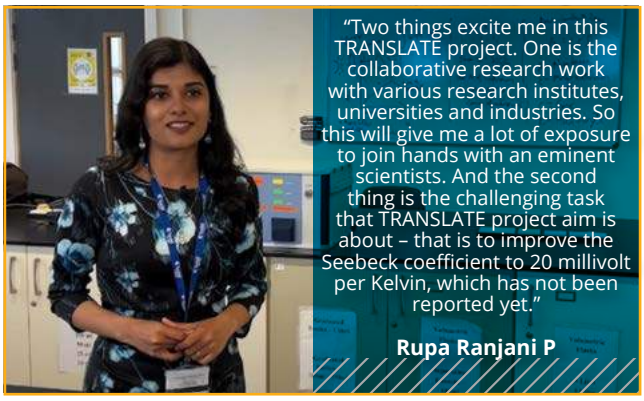
Rupa's research interests lie in nanomaterials synthesis, electrochemical energy storage and conversion, thermoelectric cells, and nanofluidic systems. Her ultimate goal is to develop new materials, enhance and modify the morphology and chemical functionalities of materials, and bring about necessary changes to improve the performance of energy-based applications, ultimately contributing to the sustainable advancement of human communities through material science.

Rupa holds a Bachelor's degree in Physics and a Master's degree in Nanoscience and Technology from Bharathiar University, India. Her master's research project focused on the preparation of ternary chalcogenides with abundant chemical functionalities to enhance the energy storage performance of supercapacitors. Her research experience includes the preparation of cost-effective and efficient electrode materials, physiochemical characterisation techniques, and performing electrochemical analysis techniques.

Rupa is currently involved in the development and optimisation of basic components in thermoelectric devices, including membranes, electrodes, and electrolytes. Her competence also includes the preparation of aluminium oxide membranes with interesting channels that can be used as membranes in thermoelectric devices to improve efficiency.

She is particularly excited about the opportunity for collaborative research work with various research institutes, universities and industry as part of the TRANSLATE project, which will provide her with the opportunity to work alongside eminent scientists. Additionally, Rupa is motivated by the challenging task of improving the Sabre coefficient to 20 millivolts per Kelvin, a goal that has not been reported before.

Despite acknowledging that it is a challenging and difficult task, Rupa believes it is not impossible and is determined to contribute to the success of the TRANSLATE project.



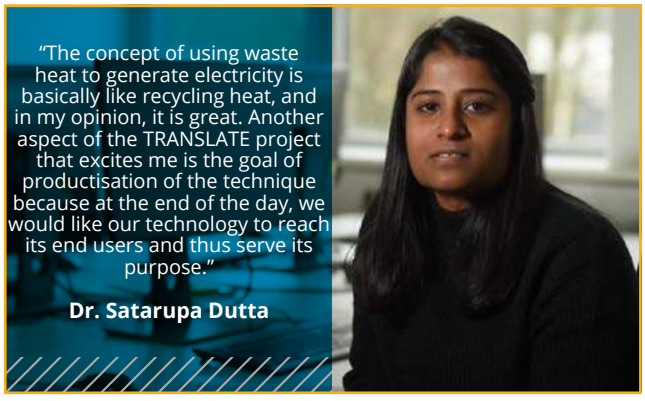
Watch the video: **https://youtu.be/vFl_q2iAMxE**

Dr. Satarupa Dutta is a postdoctoral researcher with a background in chemical engineering and expertise in micro and nano fluidics. She obtained her Bachelor of Engineering Degree in Chemical Engineering from Assam Engineering College in 2013, followed by a M.Tech. degree in Chemical Engineering from the Indian Institute of Technology Guwahati in 2015, where she worked on biosensors for clinical diagnostics. In 2021, she completed her Ph.D. in Chemical Engineering from IIT Guwahati, focusing on external field-driven microfluidic phenomena for future applications.

Dr. Dutta's research interests are in fundamental and application-based fluid mechanical studies, with a specific focus on electro hydrodynamics and electric field-induced effects on micro flows, particle interactions, and droplet migrations.

She has always been driven by research that is practically relevant and provides solutions to pressing issues, particularly in the field of energy generation from unconventional sources. Upon learning about the TRANSLATE project, Dr. Dutta was immediately drawn to its concept of recycling waste heat to generate electricity.

She is excited about the opportunity to optimize the operating parameters of thermoelectric energy harvesters and work towards maximum energy efficiency through analytical models and numerical simulations. Additionally, the goal of productisation of the technique, with the aim of bringing the technology to end users and serving its purpose, is an aspect of the project that excites Dr. Dutta. With her passion for practical and impactful research, Dr. Dutta is enthusiastic about contributing to the success of the TRANSLATE project.



Watch the video: **https://youtu.be/Fyi8cwlerJs**

2nd TRANSLATE General Assembly Meeting

Since the start of the TRANSLATE project in June 2021, almost all our interactions had been virtual, until June 2022 when TRANSLATE had its first in-person General Assembly meeting at University College Cork, Ireland.

Our team met over three days between 8th-10th June, with 22 researchers, project managers and advisors from across 4 European countries gathering in Cork, Ireland.

Some of the highlights from the meeting included:

- Work Package meetings looking back on what has been achieved and the challenges faced over the past year, along with many spontaneous scientific conversations about the project.
- A tour of University College Cork's campus that is steeped in history.
- Filming with TRANSLATE's communications partner, UCC Academy.
- A tour of Tyndall National Institute's state-of-the-art facilities, led by project team members Professor Paul Hurley and Dr Kafil M. Razeeb.

We also had our 6-monthly Executive Board meeting, where we welcomed TRANSLATE's external advisor, Dr Colm Glynn (Analog Devices Inc), who guided the discussion on commercialisation and innovation.

The meetings were very productive, and an excellent preparation for TRANSLATE's then-upcoming review meeting with the European Commission and our 1st periodic report.

A big thanks to the project management team who organised the meetings: Professor Justin Holmes (University College Cork), Dr Tamela Maciel and John Buckley (UCC Academy).

Potential Applications of the TRANSLATE Device

Heat engines that use fossil fuel combustion as a heat source generate approximately 90% of the world's power. These engines typically operate at 30–40% efficiency, such that roughly 15 terawatts of heat is lost to the environment.

Every day, we use many rechargeable and battery-operated devices, including domestic appliances and portable/wearable electronics, most of which generate heat energy that is not used or recycled.

By Dr. Kafil Razeeb Mahmood, Tyndall National Institute, UCC

The device we are trying to develop at TRANSLATE will harvest heat energy from the environment (e.g. from skin of the human body) and convert it into electricity, and then into chemical energy or directly into chemically stored energy.

The investigations in TRANSLATE over the next 2.5 years, if successful, will allow us to develop micro-devices that have a small form factor. This can be integrated into any portable device from mobile phone to smartwatch, a range of wearable medical devices such as a Holter and sleep apnea monitor system that can measure blood pressure and ECG, different types of patches that can monitor blood sugar level, respiration and oxygen saturation in the blood, and other types of biomedical sensor systems which are under development.

In particular, wearable devices is an emerging application area.

The global wearable technology market size is projected to grow from USD 116.2 billion in 2021 to USD 265.4 billion by 2026 with an expected growth at a CAGR of 18.0% from 2021 to 2026. Sectors ranging from different body-wear (wrist-wear, headwear, and footwear), fashion & jewellery to smart textile and non-textile segments are driving this growth. However, the main obstacle is the limited battery life. The present generation Li-ion battery can only be recharged around 1,000 times and their energy and power are limited.

The battery is also the heaviest component in any portable system. Therefore, the main applications of the TRANSLATE device could be in the consumer electronics and healthcare, as well as in enterprise automation and industrial productions (Industry 4.0).

Beyond biomedical and wearable systems, the TRANSLATE energy harvesting and storage device can be applied for a wider implementation of wireless sensor nodes and to power the Internet of Things in smart buildings, next generation industry automation, and even in automobile and transport systems.

Pitch Event at Analog Devices

Analog Devices Inc ↗. is a renowned global semiconductor company with over 50 years of history, specialising in innovative analog and mixed-signal integrated circuits for various industries.

ANALOG DEVICES

AHEAD OF WHAT'S POSSIBLE™

TRANSLATE Principal Investigator Justin Holmes and Project Manager Rebecca Buckley were invited by Dr Colm Glynn, Senior Process Sustaining Engineer at Analog Devices and External Advisor of TRANSLATE, to provide a pitch and overview of the project to various business units at Analog Devices in Limerick, Ireland.

The visit included a tour of Analog FAB facilities showcasing their advanced manufacturing capabilities. Discussions also revolved around potential future collaborations and opportunities for researcher placements, highlighting the strong synergies between TRANSLATE and Analog Devices.

Professor Justin Holmes & Rebecca Buckley

Research Resources

TRANSLATE is committed to Open Access research and is taking part in a European Commission pilot on Open Access to Research Data. All publications from the TRANSLATE project are freely accessible and published as open access articles at either gold or green standard.

Our research publications and data are stored in an **open-access data repository on Zenodo ↗** to enable future researchers to access, exploit, reproduce and disseminate our data. This repository is validated as Open Access by OpenAIRE, with an associated **OpenAIRE project page ↗**.

Here is a list of recent TRANSLATE resources and publications with the link they can be accessed at:

- Innovation Radar: Improved energy harvester with capacitor capabilities based on advanced nano-structures, whilst utilising Earth-abundant materials **Click here ↗**
- Transport through nanochannels driven by electric fields and temperature gradients | **Zenodo ↗**
- Overview of TRANSLATE and Results to Date at the 80th International Scientific Conference of the University of Latvia | **Zenodo ↗**
- Converting waste heat into electricity using cellulose membranes | **Zenodo ↗**
- Characteristics of ionic transport in highly ordered nanoporous aluminum oxide membranes. | **Zenodo ↗**
- Functionalisation of nanochannels for the development of a sustainable and efficient low-grade waste heat harvester | **Zenodo ↗**
- Ionic thermoelectric effect in nanofluidic membranes for efficient conversion of waste heat into electrical energy | **Zenodo ↗**
- European Researcher's Night at the University of Latvia | **Zenodo ↗**
- Converting waste heat into electrical energy in ionic nanofluidic membranes | **Zenodo ↗**
- A fully automated measurement system for the characterization of micro thermoelectric devices near room temperature | **Zenodo ↗**
- Nanowood: Fully renewable, biodegradable, environmentally friendly, natural material for the next generation thermoelectrics | **Zenodo ↗**

Conferences

Environ 2022 - 32nd Irish Environmental Researchers Colloquium (20th – 22nd June 2022)

TRANSLATE researcher Dr Ievgen Nedrygailov, University College Cork presented a poster at the Environ 2022 conference in Belfast, Northern Ireland entitled **'Converting waste heat into electricity using cellulose membranes'** ↗

NIBS Conference 2022 (4th – 6th July 2022)

TRANSLATE researcher Dr Gints Kučinskis, University of Latvia delivered a presentation entitled ***'Preparation and characterization of electrodes for Na-ion batteries: Na2FeP2O7 and NA0.67MNO2'*** at the Functional Materials and Nanotechnologies (FM&NT) and Nanotechnology and Innovation in the Baltic Sea region (NIBS)) conference which took place in Riga, Latvia.

TRANSLATE researcher Dr Valerii Malyshev, University of Latvia, also delivered a presentation entitled ***'Infiltration control of highly ordered nanoporous aluminum oxide membranes with aqueous electrolytes' at the same conference.***

European Materials Research Society Fall Meeting (19th – 22nd September 2022)

TRANSLATE researcher Dr Ievgen Nedrygailov, University College Cork attended the 2022 E-MRS Fall Meeting at the University of Technology in Warsaw, Poland with two presentations entitled **'Ionic thermoelectric effect in nanofluidic membranes for efficient conversion of waste heat into electrical energy'** ↗ and **'Functionalisation of nanochannels for the development of a sustainable and efficient low-grade waste heat harvester'** ↗ (poster presentation).

American Physical Society (APS) 2022 (20th – 22nd November 2022)

TRANSLATE team members Professor Steffen Hardt and Dr Rajkumar Sarma, Technische Universität Darmstadt delivered a presentation entitled ***'Thermoelectric energy conversion in nanochannels filled with ionic liquids'*** at the 75th Annual Meeting of the APS Division of Fluid Dynamics in Indiana, USA.

IEEE Apscon 2023 (23rd – 25th January 2023)

TRANSLATE team member Dr Kafil M. Razeeb was an invited speaker at the first IEEE Applied Sensing Conference (APSCON) in Bengaluru, India, which was the first major event of the 25th year of the constitution of the IEEE Sensors Council. Dr Kafil M. Razeeb and Amit Tanwar (PhD student) from Tyndall National Institute, University College Cork presented on the ***'Development of Micro-Thermoelectric Generator as an Alternative Energy Source for Wearable Bio-Medical Devices'***.

Environ 2023 (3rd – 5th April 2023)

TRANSLATE researcher Dr Ievgen Nedrygailov, University College Cork attended the 2023 ESAI Environ Conference (33rd Irish Environmental Researchers Colloquium) in Co. Donegal, Ireland and gave a presentation entitled **'Nanowood: Fully renewable, biodegradable, environmentally friendly, natural material for the next generation thermoelectrics'** ↗.

7th Green and Sustainable Chemistry Conference (22nd – 24th May 2023)

TRANSLATE researcher Anjali Ashokan (PhD student) presented a poster entitled ***'Optimization of nanoporous membranes for ionic thermoelectric energy harvester'*** at the 7th Green and Sustainable Chemistry Conference in Dresden, Germany.

Outreach Events & Campaigns

European Researchers' Night at the University of Latvia (30th September 2022)

TRANSLATE took part in University of Latvia's Researchers' Night where TRANSLATE researchers Raimonds Meija, Valerii Malyshev and Irina Oliševeca welcomed visitors to the lab and shared their work on nano- and thermoelectric materials.

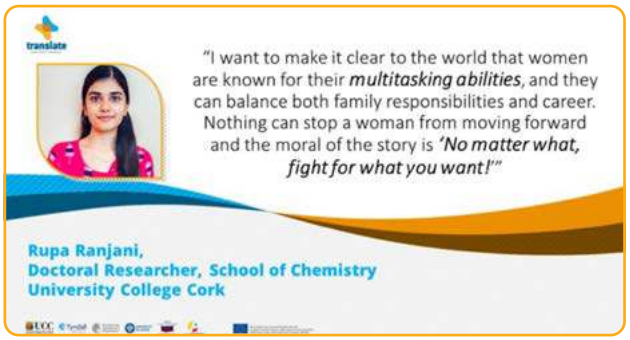
School Outreach Programme, University of Latvia (21st October 2022)

TRANSLATE researcher Irina Oliseveca from the University of Latvia participated in a school outreach programme in Latvia by giving a presentation about her profession as a Researcher of Chemistry and an overview of the TRANSLATE project.

'Celebrate Science', Cork Science Festival 2022 (13th November 2022)

TRANSLATE took part in the 'Celebrate Science' family day in Western Gateway Building, UCC as part of Cork Science Festival 2022. It was a busy and exciting day full of interactive science activities for all ages. TRANSLATE activities included 'Thermovision', 'Under the microscope' and a thermoelectric demo, as well as interactive games showcasing the importance of clean energy, waste heat capture, and materials science. This event was a joint effort with fellow Horizon 2020 FET-Open project RADICAL. Volunteers from the project included PI Justin Holmes, Ievgen Nedrygailov, Tamela Maciel, Rupa Ranjani Palanisamy, Anjali Ashokan and Amit Tanwar.

International Women in Science Day Campaign (11th February – 17th February 2023)



TRANSLATE honoured women in STEM by conducting a week-long social media campaign on Twitter and LinkedIn. During the campaign, female scientists from the TRANSLATE team shared their perspectives on being women in science.

They highlighted challenges they have faced and shared messages of inspiration for girls and women interested in pursuing careers in science.

Partnering for Engaged Research: Environment and Climate Action (29th March 2023)

Access Europe, in collaboration with University College Cork, organised an in-person networking event in Cork City which was attended by TRANSLATE team member Abhisweta Bhattacharjee. The event brought together civil society representatives and researchers working in the environment and climate space to foster networking opportunities and facilitate discussions on accessing funding for engaged research projects.

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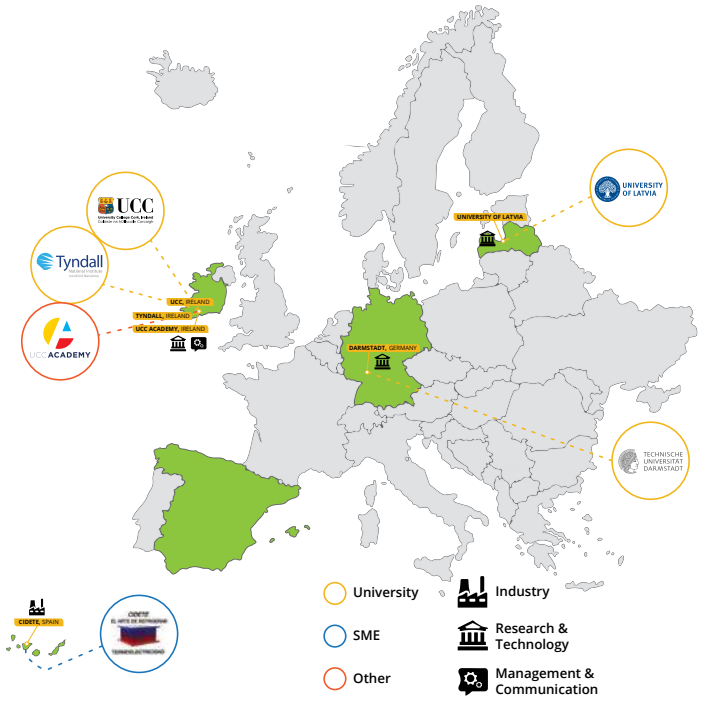
TRANSLATE is a multidisciplinary collaboration between partners across Europe including University College Cork (Ireland), Technische Universität Darmstadt (Germany), University of Latvia (Latvia), Cidete Ingenieros Sociedad limitada (Tenerife, Spain) and UCC Academy (Ireland).



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