ReNU

Renewable Energy Northeast Universities

EPSRC Centre for Doctoral Training

Annual Report

1 April 2020 to 31 March 2021

Engineering and Physical Sciences Research Council

Contents

Foreword

I am pleased to introduce the second annual report for the EPSRC Centre for Doctoral Training (CDT) in Renewable Energy Northeast Universities (ReNU).The report covers the period 1st April 2020 to 31st March 2021 which, due to the global pandemic COVID-19, was unprecedented and presented both challenges and opportunities for everyone at ReNU.

As part of the UK national lockdown in March 2020, all ReNU doctoral candidates and academic staff made the transition to working from home. This caused significant disruption to doctoral candidates' projects, many of which were heavily reliant on laboratory access. With hindsight, I am pleased that one of the first steps we took was to understand doctoral candidates' individual circumstances and constraints via an online survey. As a result, the ReNU Management Committee (MC) ensured that every doctoral candidate had access to appropriate IT to be able to continue their project remotely. In addition, supervisory teams worked closely with doctoral candidates to adapt their projects where necessary and mitigate the impact of laboratory shutdowns.

More generally, despite the constraints imposed by COVID-19, we were still able to deliver ReNU's bespoke four-year training programme by adapting the schedule and moving significant parts to the online environment. This is described in detail in the report and while we all agree that there is no substitute for the richness of in-person interactions, we found positive (e.g. informal staff-student coffee catch-ups) and unexpected (e.g. increased diversity) characteristics of the many Zoom and Teams video calls, as well as regularly forgetting to "unmute".

Despite the pandemic, ReNU has had a successful year and central to that has been our doctoral candidates including the arrival of Cohort 2 in October. They have engaged wholeheartedly with ReNU's training programme which included a mini-MBA and a responsible research and innovation hackathon. In addition to the formal training, doctoral candidates have participated in regular interactions with their research groups and supervisors, actively seeking opportunities to adapt their individual research projects in view of the practical constraints.

In addition to our doctoral candidates, the ReNU academic team has worked to maintain a high standard of doctoral candidate experience as well as progressing their own research resulting in excellent contributions such as the 3rd Generation Photovoltaics in the Developing World Conference and the North East Centre for Energy Materials summer school on electron microscopy. In particular, I am grateful to the three Institution Directors, Dr. Vincent Barrioz (Northumbria University), Dr. Elizabeth Gibson (Newcastle University) and Prof. Chris Groves (Durham University) for their hard work and support over the past year. I would also like to acknowledge my predecessor, Prof. Glen McHale who took up a position at the University of Edinburgh in July. Glen's guidance and support was pivotal in establishing ReNU and we wish him all the best in his new role.

In summary, I am very proud of how our doctoral candidates and ReNU staff have responded to the challenges of the past year and am confident that the resilience and creativity they have developed will equip them for success whatever the future holds.

Professor Neil S. Beattie

Principal Investigator and Director of ReNU

1. Introduction

In 2018 the Engineering and Physical Sciences Research Council (EPSRC) launched a national Centre for Doctoral Training (CDT) exercise. The result of this exercise was an investment of £446m from UK Research and Innovation to create 75 new CDTs including the EPSRC Centre for Doctoral Training in Renewable Energy Northeast Universities (ReNU).

The EPSRC CDT in ReNU formally started in April 2019 and this document provides an overview of progress from the second year of the programme.

2. Aims and Objectives of ReNU

The overall aim of ReNU is to train and equip the next-generation of doctoral graduates with the skills required to drive UK innovation in renewable and sustainable distributed energy applications.

To achieve this aim, the objectives of ReNU are to:

1. create a pipeline of industry-ready doctoral graduates with outstanding problem-solving abilities to enable UK commercial development and exploitation of renewable energy (RE) and sustainable distributed energy (DE) technologies;
2. provide a comprehensive cohort training experience that leverages the unique co-location of the three Universities and is inherently multidisciplinary and international, extending well beyond an individual research project; and
3. add value to the UK economy by fostering a cohort of innovators in a geographical region which offers significant potential for increased productivity and growth.

3. Governance and Management

The organisation and structure of ReNU is shown in Figure 1. The Management Committee (MC), Strategic Advisory Board (SAB) and Delivery Groups (DGs) are all governed by a set of Terms of Reference that was developed during the first year of operation and approved by the MC.

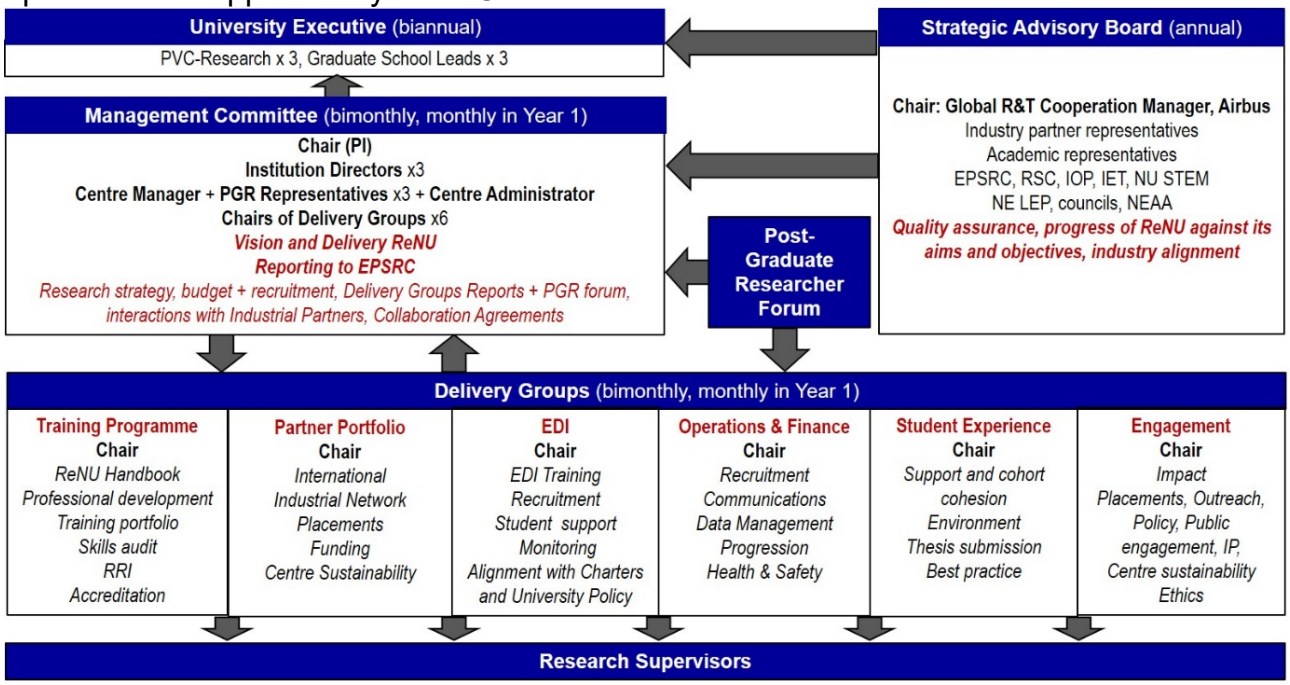


Figure 1: Governance structure of the CDT

3.1 Management Committee (MC)

The ReNU MC is composed of the named investigators, the Centre Manager, the Centre Administrator and doctoral candidate representatives. It has responsibility for the vision and operation of the CDT consistent with the project proposal. Note that the EPSRC Project Liaison Officer is formally a member and has access to all documents and the right to attend any meeting of the MC. During the first year of operation the MC met monthly and from March 2020, the MC has met every other month. The MC responsibilities are defined in a Terms of Reference according to: Strategy and Policy Development; Operations; Approval; Monitoring and Review; and Reporting Relationship with Other Bodies.

Following staffing changes at the partner universities, the ReNU MC membership was adjusted in 2020. This includes changes to the MC Chair, the Institution Director at Northumbria University and the Chairs of Training Programme and Partner Portfolio delivery groups. Table 1 summarises these changes which have all been confirmed with EPSRC. As a result of the changes, ReNU welcomed Dr Haimeng Wu (Northumbria University) and Dr Anh Phan (Newcastle University) as programme co-investigators.

Table 1: Summary of changes to ReNU Management Committee

Role	2019-20	2020-21
Director and MC Chair	Prof Glen McHale	Prof Neil Beattie
Northumbria Institution Director	Prof Neil Beattie	Dr Vincent Barrioz
Partner Portfolio DG Chair	Dr Vincent Barrioz	Dr Haimeng Wu
Training Programme DG Chair	Dr Eileen Yu	Dr Anh Phan

3.2 Strategic Advisory Board (SAB)

The ReNU SAB is chaired by a Global Research and Technology Coordination Manager from Airbus and is composed of the MC, industry representatives, the North East Local Enterprise Partnership, an EPSRC Project Liaison Officer, external academic advisors and non-profit organisations. The SAB met virtually in both April and November 2020.

3.3 Delivery Groups (DGs)

There are six delivery groups overseeing operational aspects of ReNU and these are shown in Figure 1. These involve a named investigator as Chair as well as academic supervisors and doctoral candidate representatives. The DGs meeting on average every two months and are governed by a Terms of Reference ratified by the MC.

3.4 ReNU Manager and Academic Support Coordinator

ReNU has a Centre Manager and Academic Support Coordinator. The Centre Manager position is a 1.0 FTE permanent academic position in the Department of Mathematics, Physics and Electrical Engineering at Northumbria University. This post has an 0.5 FTE secondment to the CDT for its duration that is funded by EPSRC. The administrator position is a 0.5 FTE post funded entirely by EPSRC.

3.5 Risk Management and Mitigation

A project Risk Register detailing project risks, controls, risk rating, mitigation actions, timescales and owners is reviewed at quarterly MC meetings (standing item). In addition, the ReNU Director holds quarterly update meetings with the Faculty Pro-Vice Chancellor at Northumbria University and annual update meetings with Senior Management at Newcastle and Durham universities.

3.6 Systems and Tools

A ReNU Microsoft SharePoint site hosted at Northumbria University is available to all ReNU investigators, Professional Support Staff and Graduate Schools across the three institutions. This site includes terms of reference for the delivery groups and minutes of the MC meetings. This site is also linked to a ReNU Microsoft Teams site which is accessible to doctoral candidates and provides a single virtual location for all training materials used in the training programme.

4. Doctoral Candidate Recruitment: Cohort 2

4.1 Principles

In recruiting doctoral candidates, we applied several strategic principles including: quality; industry involvement in projects; balance across the partner universities; gender balance; balance across technical themes; and alignment with UKRI rules on international eligibility. Following a review of the proposed projects by the SAB in November, advertisements were placed in December 2019 with interviews in March 2020. Further rounds of interviews were conducted in May and July resulting in a cohort of 11 doctoral candidates enrolling in October 2020.

4.2 Marketing

The ReNU recruitment process for Cohort 2 prioritised attracting high-quality applicants and direct industry cash contributions to projects. Marketing activities were supported by the following actions:

- distribution of marketing materials to key UK academics working in renewable energy including consideration of recipient gender balance;
- advertisement of PhD positions and dissemination of marketing materials via ReNU website, FindAPhD.com and Twitter (@CDT_ReNU);
- dissemination of PhD positions via academic networks including EPSRC SuperSolar UK Solar Fuels Network and EPSRC NECEM UK conference; and
- inclusion of marketing materials in partner-specific recruitment activities such as Enrichment Week at Newcastle University

4.3 Project allocation and selections

ReNU projects are allocated according to an annual target of 5 at Northumbria, 4 at Newcastle and 4 at Durham. The allocation process seeks to balance strategically shaping the portfolio across ReNU topics and investigators whilst ensuring the appointment of quality doctoral candidates and industry involvement. The process also seeks to devolve management to the three individual IDs on behalf of their universities and working as a group for consistency, whilst including the MC step for oversight.

The process is described in the following steps but it is important to note that the offer of an individual studentship is devolved to each ID where the doctoral candidate will be enrolled as a student and registered for a PhD.

1. Three IDs agree a consistent approach to applications, interviews and offers consistent with the three University processes.
2. All proposals checked for linguistic gender bias using software http://gender-decoder.katmatfield.com.
3. IDs and co-investigators within an institution meet to review and rank project proposals using quality and fit to scope as the main criteria. The top 8 project proposals are taken forward to the MC.

4. The ReNU MC meets to review 24 project proposals (8 from each institution) and selects 18 for advertisement after consideration of the principles listed in section 4.1
5. Following an advertisement period of 4-6 weeks, interviews are held at each institution with the host ID attending all interviews.
6. Offers are made to the best candidate for each project. If no offer is made, a project is re-advertised.

4.4 Outcome and review

In 2020-21 ReNU recruited 11 students to Cohort 2 who enrolled at one of the three partner institutions on October 1st 2020. Anonymised data was collected for all applications (including ineligible candidates), for statistical analysis including gender, age, ethnicity and disability against EPSRC statistics. These data are shown in Table 2.

Table 2: Recruitment data for ReNU Cohort 2 (2020-21)

Institution	Female Candidates			Minority Candidates			Total No. of Candidates		
	Applied	Shortlisted	Appointed	Applied	Shortlisted	Appointed	Applied	Shortlisted	Appointed
UNN	19	10	2	32	13	1	54	28	5
DU	3	2	2	11	NA	1	22	3	2
NU	7	3	0	11	2	0	24	14	4
Total	**29**	**14**	**4**	**54**	**15**	**2**	**100**	**45**	**11**

ReNU has an aspiration to recruit 33% of any single gender[1] and has achieved this as a proportion of Cohort 2 in which 4/11 doctoral candidates are female. This is consistent with Cohort 1 however, in comparison with Cohort 1, ReNU has increased doctoral candidate appointments from minorities to 18% of Cohort 2 which is above the EPSRC average[2]. Note that the relatively large number of applications from minority candidates is partly driven by UKRI recruitment rules which, for this Cohort, permitted 10% international recruitment per institution across all EPSRC training awards. Overall, Cohort 2 received more applications than for Cohort 1 and in addition to international recruitment, this is attributable to advertising project positions at an earlier stage.

In summer 2020, the ReNU Institution Directors met to review the Cohort 2 recruitment process and it was agreed that given the challenge balancing different recruitment drivers, it is advantageous to advertise for future cohorts as early as possible. It was further agreed that existing cohorts could be engaged to help recruit future cohorts and in February 2021, we created a Q&A video discussion between the ReNU Director and ReNU Cohort 1 doctoral candidates via Zoom. This was promoted on Twitter and is

[1] Data from the Higher Education Statistics Agency (HESA) indicates that in 2019/20 41% of undergraduate students studying Physical Sciences were female compared with 18% studying Engineering and Technology. This difference narrows when considering postgraduate research students only where 36% of female students study Physical Sciences abd 26% study Engineering and Technology. Aggregating across STEM subjects, this indicates that ReNU's aspiration to recruit doctoral candidates with a minimum of 33% of any single gender is challenging but reasonable.

[2] Available at: https://public.tableau.com/profile/uk.research.and.innovation.ukri.#!/vizhome/EDIfundingdata2021/Awardrate

publicly available on the ReNU website. The Institution Directors also confirmed that ReNU would place half-page advertisement in the hard and soft-copy of Physics World magazine and Physics World Career Guide supplement published by the Institute of Physics. The impact of these actions and more will be reviewed in the recruitment of Cohort 3.

5. Equality, Diversity and Inclusivity

ReNU takes seriously its responsibility to offer equality of opportunity to all staff and doctoral candidates and is keenly aware of the challenges facing STEM subjects in increasing diversity. The three Universities in ReNU all hold Athena SWAN awards at Institutional Level. Newcastle University holds a Silver Award, and Durham and Northumbria hold Bronze Awards.

In addition to ensuring recruitment of doctoral candidates follows EDI guidelines, with a particular focus on improving female representation, the EDI Delivery Group has responsibility for raising awareness in this area amongst staff and students. Mental health and unconscious bias training are mandatory for all ReNU doctoral candidates and academic supervisors, and is respectively coordinated with the Durham University Counselling Service Team and Northumbria University's NUSTEM, which is a flagship outreach programme that encourages girls and pupils from diverse backgrounds in the North East to study and pursue STEM careers.

ReNU students also voluntarily participate in NUSTEM outreach activities, such as the Physics Experience week, which involves supervision of Year 12 students in a scientific project over 2 days, leading up to a poster presentation. The Delivery Group has also connected ReNU academics and researchers to the EPSRC Northern Power Inclusion Matters programme, which aims to support early career researchers in under-represented groups by providing mentoring and network building opportunities. Furthermore, the Delivery Group is also in discussion with National Energy Action to deliver training on the impacts of Energy poverty on social equality and mobility. We expect to deliver this training to all cohorts in CDT week 2021/22.

6. Training Programme

The ethos of the ReNU training programme is to provide our doctoral candidates with both the deep knowledge of materials science for energy as well as the broader business and innovation skills to allow our graduates to succeed and lead in industry. A schematic diagram of ReNU's training programme can be found in Figure 2. Our approach is to distribute the training over the four years of the PhD to enable us to maximise the benefits of inter-and intra-cohort interactions in addition to giving flexibility to respond to the developing needs of our students. The programme comprises 10 compulsory core (C) modules, which begin with essential knowledge to kick-start their research career, namely Scientific and Technical Training and Researcher Skills, before moving on to broader contextual topics such as the Mini MBA programme. Additional to these modules are the optional (O) training modules which are delivered on a regular basis to address specific needs as they arise. The training is delivered through a mix of lectures from technical experts from the three universities and group working activities with an industry (e.g. C7, C9) or energy (e.g. C4) focus.

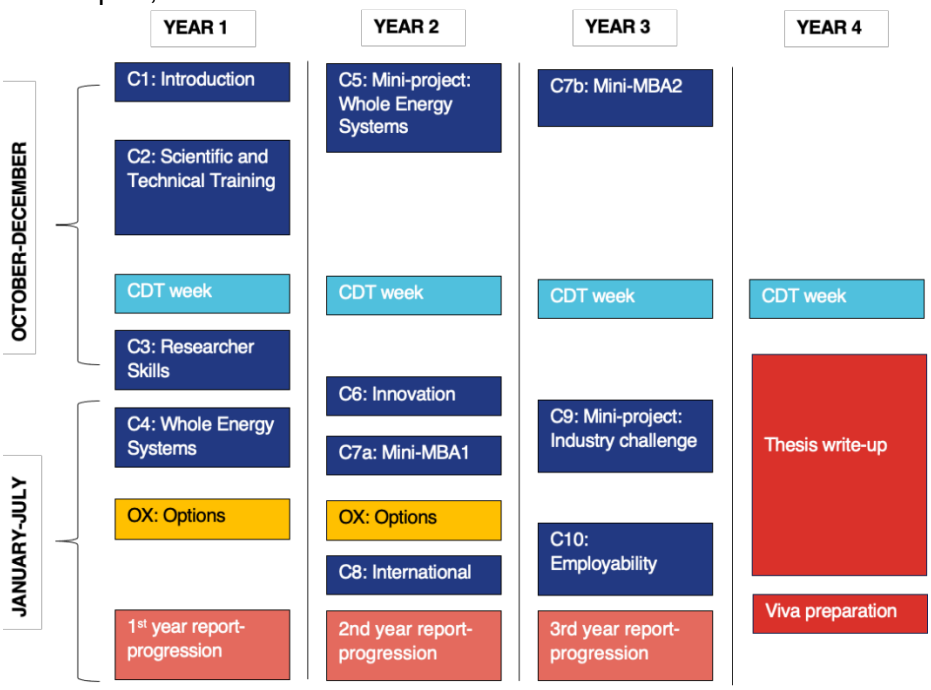


Figure 2: ReNU training programme schematic

6.1 Cohort integration

A key element of ReNU is the way in which the training programme has been designed to maximise cohort integration. The following subsections describe both intra- and inter-cohort interactions together with a selection of doctoral candidates' feedback.

Intra-cohort interactions

The ReNU training programme began with a collaborative group project (C1 in Figure 2) in which the students worked together to programme an Arduino microcontroller to make solar cell measurements. This activity was undertaken by Cohort 2 as part of their induction and although the pandemic made an in-person event impossible, we facilitated an on-line event that was well-received by students. 100% agreed that C1 was well planned and organised. Similarly, 100% agreed that they had ample opportunity to interact with other students.

"I enjoyed the social and getting to know other people a bit better even if it wasn't in person. The Arduino exercise was very interesting and new as none of us had used Arduino before so learning how to use them and then using them to acquire data was good."

"The Arduino task - it was great fun getting to figure out the system and get to know other cohort members."

"The social activity by Chris was a very good way to meet everyone and get to know each other in an informal environment. The Arduino activity was also very good to try a new task as a team with people you didn't know that well."

Additionally, Cohort 1 students took part this year in a Whole Energy Systems project (C5) in which they worked together as a group to take a broader view of energy in society outside the scope of their individual programme of research. This year the students considered topics as diverse as enabling an affordable transition to low carbon heating, decarbonisation of transport in Washington State, and solar farm design in Fiji. The students' feedback was largely positive (see below) and we also shared the outputs with

Sunderland City Council with a view to informing collaboration opportunities for the Future Living Expo in 2023.

"C5 Group Project training was very enjoyable and provided an opportunity to work with others, learn different perspectives, consider different outlooks, and contribute to a group presentation."

"It was really interesting, helped me visualise my project from different perspectives."

Inter-cohort interactions

ReNU's annual CDT week (9-13 November 2020) is a major event in the training calendar involving doctoral candidates, academic staff, industry partners and external trainers. It enables our doctoral candidates not only to make connections between the cohorts by learning about one another's work (e.g. project "elevator pitches" and Whole Energy Systems group mini-project presentations), but also with industry via our varied seminars and discussion sessions (detailed agenda can be seen in Appendix 2). The main components of this week were:

Monday: Scientific presentations (Cohort 2) of projects to a broad audience of ReNU academics, external advisors and industrialists. Cohort 1 group presentations describing their Whole Energy Systems project.
Tuesday: 7th North East Energy Materials (NEEM) meeting involving a programme of industry talks, break-out and elevator pitch sessions promoting interaction between doctoral candidates and industrialists.
Wednesday: ReNU Strategic Advisory Board and Management Committee meeting. Outreach training for doctoral candidates provided by NUSTEM team.
Thursday: Unconscious bias training for Cohort 1 students and innovation training for doctoral candidates delivered by an external industry partner.
Friday: Guest talk on nuclear energy and a virtual site visit to three photovoltaic installations on campus at Northumbria University via video.

Feedback from CDT week indicated that doctoral candidates particularly enjoyed interactions with industry and would welcome more interactions with partners. This type of activity has proved challenging in the virtual environment and the ReNU team will continue to seek ways to progress this. Further feedback from CDT week included:

"Really good to hear from other students in the cohort about what they are doing."

"It was interesting to interact with industry partners, however it was understood that due to the ongoing pandemic, the capacity at which this would be possible was limited."

"Enjoyed the talks taking part during the week."

As part of our broader response to the impact of COVID-19 on the training programme, ReNU introduced a weekly student-led journal club. This session provided a forum for discussing ideas and wider topics in renewable energy. Both the journal club and regular informal coffee-mornings with ReNU staff proved to be very popular with doctoral candidates. Another very successful training activity was the first of two parts of a mini-MBA at Durham University. This involved doctoral candidates participating in a Design Sprint to develop a business idea over a two-week period, supported by experts, with the aim this year of 'Enabling a sustainable, green recovery from COVID in the North East'.

6.2 Professional Accreditation and Career Development

A distinctive aspect of ReNU's training programme is that we are seeking professional accreditation from the Royal Society of Chemistry and the Institute of Physics for doctoral candidates to obtained Registered Scientist status. The documentation for this application is nearing completion and doctoral candidates now keep an online reflective record of their training as evidence towards this qualification. This can also be used as part of an application for Chartered status should doctoral candidates wish to pursue this at a later stage in their careers.

6.3 ReNU Training for Supervisors

ReNU continues with its aim to not only train the students but also the supervisors of ReNU projects. As with last year, all supervisory teams have undertaken Responsible Research and Innovation training (see below) as well as mental health awareness training. Additional development for supervisors comes in the form of ReNU's Supervisor Forum which allows for sharing best practice (e.g. mental health awareness and planning around COVID impacts)

6.4 Responsible Research and Innovation (RRI)

ReNU's approach to RRI is to train academic supervisors and this is a condition of becoming a ReNU doctoral candidate supervisor. Following this, ReNU now has 23 academic supervisors that formally hold Registered Practitioner status.

Our approach to Responsible Research and Innovation was highlighted by the professional consultancy ORBIT as good practice and in September 2020, ReNU's Director was invited to share ReNU's approach to RRI with all UK CDT Directors and EPSRC in a virtual meeting.

In addition to training academic supervisors, ReNU is committed to training doctoral candidates in RRI and in September 2020, ORBIT provided a Foundation-level course for doctoral candidates. This was augmented by a bespoke 2-day RRI "hackathon" in October in which doctoral candidates took part in a design exercise in agri-photovotlaics.

7. COVID-19

Following the UK national lockdown in March 2020, the ReNU MC established a COVID-19 Response Group composed of the Director, the three Institution Directors, the Centre Manager and the Chair of the Student Experience Delivery Group. This group met fortnightly from April through August and monthly thereafter. ReNU's general approach was to move the training programme to the online environment either as 'live' content or asynchronous with accompanying 'live' discussion sessions. In addition, the COVID-19 Response Group agreed the following actions:

1. An initial online student survey to understand the impacts of COVID-19 and ensure every doctoral candidate had access to an appropriate working environment including IT equipment.
2. Communication to all principal supervisors confirming the importance of regular online individual supervision meetings, interaction with wider research groups and doctoral candidate participation in wider online training activities.
3. A one-to-one meeting between every doctoral candidate and the ReNU Director to understand individual circumstances and provide more bespoke support.
4. Establishment of a Supervisors' Forum to support ReNU supervisors and share good practice.
5. Monthly MC email updates to doctoral candidates highlighting ReNU-specific information as well as COVID protocols at the partner institutions.

6. Virtual meetings of the ReNU Student Forum facilitated by the Chair of the Student Experience Delivery Group.
7. Creation of weekly online student-led ReNU journal club and fortnightly virtual coffee sessions led by the ReNU Director.

As well as the formal actions, the ReNU team have understood the added importance of regular informal interactions with doctoral candidates during the pandemic. We will continue these while at the same time prioritising access to key facilities for doctoral candidates to complete their projects to a high standard. We have also prepared doctoral candidates and supervisors for potential future lockdowns by encouraging a strong theoretical component of projects and arranging externally facilitated Plan B workshops. A key aim is to allow doctoral candidates to develop creativity and resilience skills which will not only help them in their projects but also their future career directions. Furthermore, in October, ReNU responded to a request from EPSRC and provided details of COVID-related mitigations with the aim of sharing best practice across all UK CDTs.

8. Partners

ReNU began with external 35 partners, including 27 companies (of which 12 are small and medium-sized enterprises) and 8 non-profit organisations previously. Over the last year, we have established a wider connection with new partners (e.g. Northumbrian Water, Nissan and Orsted) via the introduction of a formal registration procedure. The North East Energy Materials (NEEM) series of meetings have been a key mechanism by which to engage with industry partners and NEEM 7 took place in November as part of ReNU's annual CDT week. The full programme for this week can be found in Appendix 2 and included the following keynote talks:

- *Materials challenges in decarbonisation* (BP)
- *Power delivery challenges posed by the move to electric vehicles* (Zero Carbon Futures)
- *Putting the environment at the heart of prosperity and social inclusion* (University of Stirling)
- *Local climate and energy (*Department for Business, Energy and Industrial Strategy*)*

The business environment has been significantly disrupted by COVID-19 and in particular, restrictions on physical meetings has reduced opportunities for doctoral candidates to interact with industry partners at networking-type events. On the other hand, the online environment has afforded new opportunities and ReNU has facilitated virtual training events such as innovation training from Shell and several guest speakers e.g. *Boilers on the brink*, Narec Distributed Energy.

ReNU continues to receive in-kind support from regional, national and international industry partners and Cohort 2 includes an industry-sponsored project in offshore floating wind with the Offshore Renewable Energy Catapult in Blyth, Northumberland.

9. Internationalisation

2020-21 has presented several challenges for the entire ReNU team. Not least of these were the restrictions on both national and international travel. This meant of course, that doctoral candidates were not able to participate in a planned short-placement to ReNU partner, the Institute for Clean and Renewable Energy at Huazhong University of Science and Technology. Similarly, doctoral candidates were not able to physically attend key conferences in energy materials and systems but were able to attend many of those (e.g.

the IEEE Photovoltaics Specialists Conference) that converted to an online format. As an alternative international experience for doctoral candidates, ReNU worked directly with international partner, the University of Calgary, to jointly host a UK-Canada CO_2 Conversion Research Workshop in March 2021. This was a collaboration between ReNU and the National Sciences and Engineering Research Council (Canada) Collaborative Research and Training Experience (CREATE) in Materials for Electrochemical Energy Solutions (MEE). The workshop flyer may be found in Appendix 3. The format involved short talks by both ReNU and CREATE MEE staff and doctoral candidates and was attended by over 50 participants on Zoom.

ReNU has a growing international relationship with academic partners in Canada as a result of a joint virtual workshop on CO_2 reduction and the award of our first UKRI UK-Canada Globalink doctoral exchange scheme scholarship to a ReNU doctoral candidate.

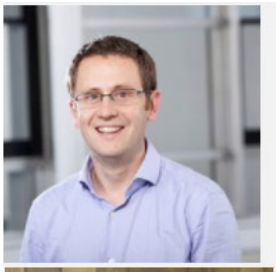
10. Looking Ahead

Despite the unprecedented challenges of 2020-21, the ReNU team has shown resilience, creativity and support for one another throughout. From January 2021, many doctoral candidates with laboratory-based projects have been able to return to campuses at the partner institutions albeit with restricted access and subject to the local COVID-19 protocols. For Cohort 1, this has helped tremendously with motivation and developing a sense of progress. We hope that the current UK Government policies including a mass vaccination programme, will allow this to continue throughout 2021 and further, allow Cohort 2 to settle more fully into both their individual research project but also the cohort-based learning which is at the heart of the ReNU training programme. In October 2021, ReNU will also welcome Cohort 3 whom we hope to be able to meet in person depending on any restrictions.

We do not envisage significant if any, international travel in the coming year, and to that end, the ReNU team will continue to seek out online opportunities which benefit either all or a subset of our cohorts. There is little doubt that some element of online remote interactions will remain for much of 2021-22 and we will be able to draw on the learnings of the last year to maximise the opportunities that these bring. For example, we have recently piloted a new virtual industry seminar series designed to give doctoral candidates broader context of renewable energy, which in 2020 saw the biggest year-on-year increase in capacity since 1999[3]. The combination of such a context and the enthusiasm and commitment of ReNU's doctoral candidates provides the whole ReNU team with the inspiration and confidence needed to tackle the uncertainties which lie ahead.

[3] International Energy Agency at https://www.iea.org/reports/renewable-energy-market-update-2021/renewable-electricity

Appendix 1 – ReNU team



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ReNU topics: Photovoltaics, earth abundant materials

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ReNU topics: Smart grid and systems, photovoltaics

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ReNU topics: Solar fuels, photovoltaics

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ReNU topics: Power electronics and control, wireless power transmission

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ReNU topics: Conversion technologies, green hydrogen, biofuels

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ReNU topics: Earth abundant materials, photovoltaics, transparent electrodes

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ReNU topics: Earth abundant materials, photovoltaics

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ReNU topics: Earth abundant materials, photovoltaics

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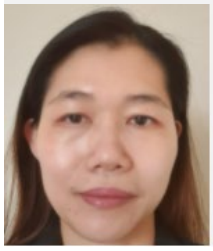
ReNU topics: Molecular and solid state chemistry and metal complexes



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Appendix 2 – CDT week agenda

DAY (9-13 Nov)	A.M.	P.M.
Monday	09:30-12:30 (Teams) **Cohort 2 - Project introductions (10mins + 5mins Q&A each)**	14:00-16:30 (Zoom) **Cohort 1: Whole Energy Systems group project presentations**
Tuesday NEEM 7	10:00-10:30 (Zoom) **The BP-ICAM: Materials Challenges in Low Carbon (BP)** 10:30-11:00 **Power delivery challenge posed by the move to EV (Zero Carbon Futures)** 11:00-11:30 **The Stirling Protocol (University of Stirling)** 11.30-12:00 **Local Climate and Energy (BEIS)**	13:30-14:00 (Zoom) **Work with us (ReNU Business Development Manager)** 14:00-15:00 **Cohort 1: Elevator Pitches (3 mins)** 15:00-16:30 **Break out session: presentation of whole energy systems projects** 16:30-17:00 **Closing remarks (ReNU Director)**
Wednesday	09:30-11:30 (Teams) **Strategic Advisory Board meeting** 12:00-13:30 (Teams) **Management Committee meeting** 11:00 (Teams) **Unconscious bias training (Cohort 2)**	15:00 (Teams) **Outreach training (Cohorts 1 + 2)**
Thursday		14:00-15:30 (Teams) **Innovation Training (Shell)**
Friday	**Photovoltaics on campus at Northumbria** (Virtual site visit)	

Appendix 3 – ReNU-CREATE joint workshop programme

Renewable Energy Northeast Universities (ReNU)
&
Materials for Electrochemical Energy Solutions NSERC CREATE ME²

UK - Canada CO_2 Conversion Research Webinar

March 24, 2021
09:00 – 11:00 MST
15:00 – 17:20 GMT

We are pleased to invite you to the first joint event between Canada's CREATE ME² and the UK's Renewable Energy Northeast Universities (ReNU). ReNU is a doctoral training centre in Renewable Energy Northeast Universities established in 2019 and funded by the Engineering and Physical Sciences Research Council (EPSRC). ReNU is a collaboration between three major UK universities which are uniquely co-located in the Northeast of England: Newcastle University, Durham University and Northumbria University. CREATE ME2 is a training program for researchers working on electrochemical energy solutions, funded by the Natural Sciences and Engineering Council of Canada (NSERC). CREATE ME2 is led by the University of Calgary in partnership with the University of Alberta and the University of Waterloo.

The common objective between ReNU and CREATE ME² programs is to create a pipeline of highly qualified personnel (HQP) who will drive innovation in renewable and sustainable distributed energy. This collaboration aims to provide technical training combined with economic and environmental perspectives. The joint training aims to share ideas, opportunities for collaboration, to accelerate the research towards solutions that are suitable for commercialization and beneficial to the environment. Both programs aim to provide HQP with skills that will be of great value to a wide range of industries. Our long-term objective is to extend develop a UK-Canadian hub in the area of clean energy conversion and storage and provide networking opportunities.

In the first joint workshop, we will present our latest research in the area of CO_2 conversion from both ReNU and CREATE ME² research groups. The planned program for the webinar is provided below. Click here to register.

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