



TAY CITIES
CLEAN GROWTH

The home of clean growth in Scotland's tay cities region

Web Launch event 19th April 2023



Scottish Government
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Be part of the
transformation



TAY CITIES
CLEAN GROWTH

Derek Watson

Quaestor & Factor – University of St Andrews

Co-chair of the Tay Cities Innovative, International Thematic Board

This project is supported by the Tay Cities Deal



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TAY CITIES
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Gillian Martin

Scottish Government – Minister for Energy

This project is supported by the Tay Cities Deal



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TAY CITIES
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Cllr. Grant Laing

Leader of Perth & Kinross Council

Chair of the Tay Cities Joint Committee

This project is supported by the Tay Cities Deal



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TAY CITIES
CLEAN GROWTH

Public launch of www.taycitiescleangrowth.scot

For collaboration, synergies, knowledge sharing,
commercial opportunities



The home of clean growth in Scotland's Tay Cities region

This is a platform for knowledge sharing, discussion, networking, ideas and project development for anyone involved or interested in clean economic growth connected to the Tay Cities Region.

Promote your project

Share details on projects past, present and future and have them included in the project library.

[Add a project](#)

Share knowledge

Contribute to the community by sharing ideas, initiatives, reports, websites, events, jobs etc.

[Start a discussion](#)

Reach out for help

Ask the community about a clean growth topic, or look for collaborators and partners.

[Request assistance](#)

Register today!

Be part of the transformation!



TAY CITIES
CLEAN GROWTH

An initiative to support the TCRD Clean Growth projects and provide wider benefits through the expansion of the projects base and a more effective, energised and collaborative Tay Region.

It builds on the TCRD components with the involvement of additional associated projects under 4 distinct regional USPs.



Regional context

Projects (Perth & Kinross):

International Barley Hub (James Hutton Institute) ^{TCRD}

Advanced Plant Growth Centre (James Hutton Institute) ^{TCRD}

Perth Innovation Highway ^{TCRD}

Low Carbon Transport & Active Travel Hub Perth ^{TCRD}

Perth-SEN (Smart Energy Network)

Perth Smart Energy City Programme

Perth Eco-Innovation Park

Binn Eco-Park, Perth

Project Beacon/Advanced Plastics Recycling ^{TCRD}

CG Themes:

Circular Economy

Green Agri-Tech

Sustainable Mobility

Clean Energy

Academia:

James Hutton Institute

UHI Perth College

Projects (Angus Fund ^{TCRD}):

Angus Centre for Agricultural Sustainability
Innovation

ZeroFour

Angus Rural Mobility Hub

Mercury Drone Port

Montrose 5g Project

Themes:

Green Agri-Tech

Sustainable Mobility

Data & Digital Solutions

Academia:

Dundee & Angus College

Projects (Dundee City):

Michelin Scotland Innovation Park

Themes:

Sustainable Mobility

Data & Digital Solutions

Academia:

University of Dundee

Abertay University

Projects (Northeast Fife):

Eden Campus ^{TCRD}

Stretch Dome Simulator ^{TCRD}

Themes:

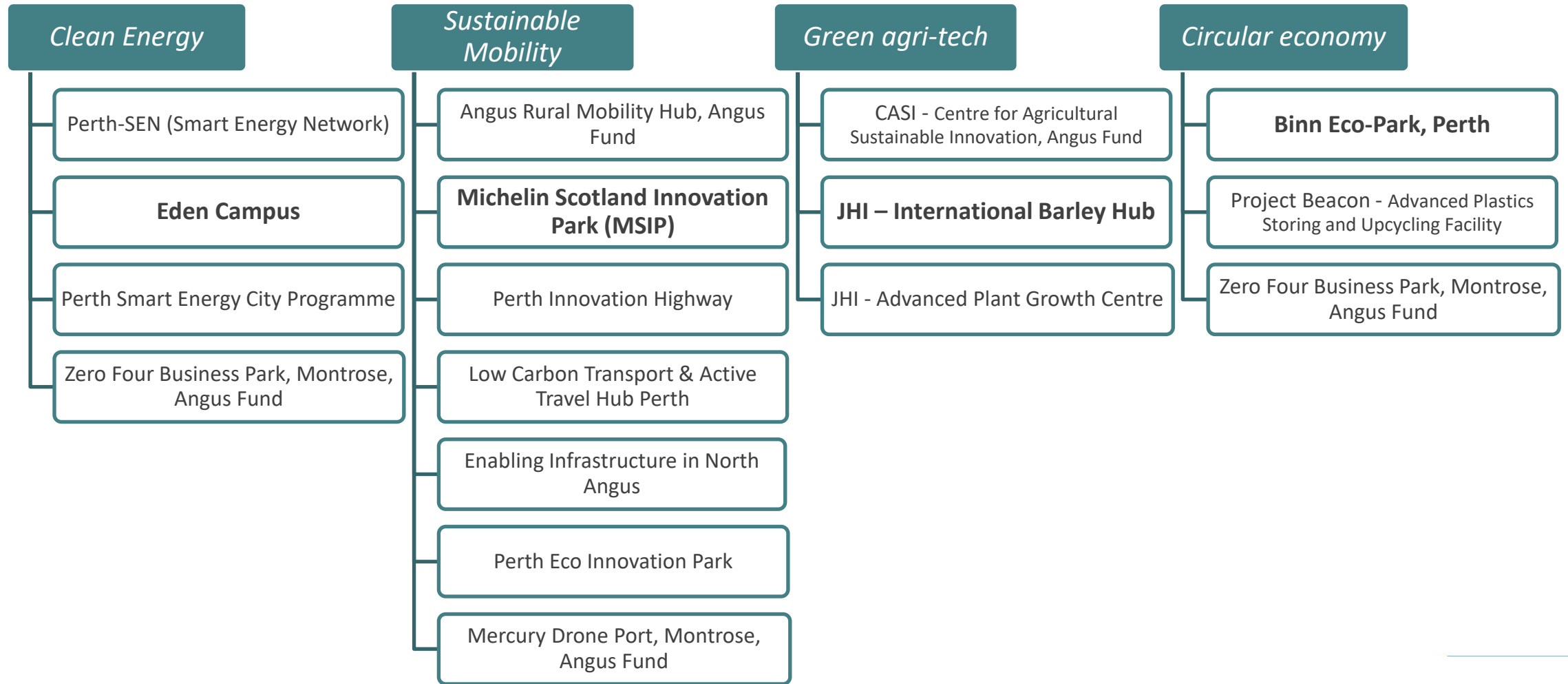
Clean Energy

Academia:

University of St Andrews

SRUC Elmwood

Tay Cities Clean Growth Projects by USPs



Data & Digital Solutions – Montrose 5G and other supporting projects / businesses across the region



TAY CITIES
CLEAN GROWTH

CGI & Website Ambitions

It is the aim of the CGI to significantly expand the wider group of associated projects enabling greater regional collaboration, knowledge sharing, adding to the region's clean growth portfolio and hence promotion as a joined-up proposition.



Register today!

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**Be part of the
transformation!**



**TAY CITIES
CLEAN GROWTH**



TAY CITIES
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John Ferguson

Head of Strategy at Binn Ecopark

Director of EcoideaM, Founder of Pi Polymer Recycling

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The Challenge



IPCC: Sixth Assessment Report - Synthesis Report - 20 March 2023

The warning

Pace and scale of climate action are insufficient to tackle climate change

The Challenge

**Adverse
impacts from
human-caused
change will
intensify**

Water scarcity and food production



Health and wellbeing



Cities, settlements and infrastructure

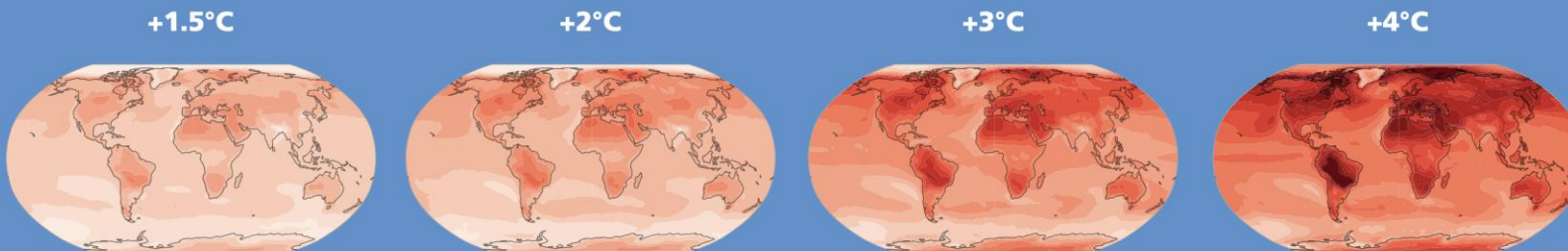


Ecosystem structure, species range shifts and changes in timing



The Challenge

Extremes become more widespread and pronounced with every increment **of** warming



The Challenge

The hope

Mainstreaming effective and equitable climate action now will reduce losses and damages **for nature and people.**

Climate action provides co-benefits.

Multiple, feasible and effective options are available **to reduce GHG emissions and adapt to human-caused climate change.**

The Challenge

The challenge

- Cut emissions quickly, sharply to create a safer, sustainable world
- Scale up practices and infrastructure to enhance resilience
- Cut global GHG emissions by nearly half by 2030
- Action required along numerous dimensions

The Challenge

The path forward is clear

Tried and tested
options available now

Need to be designed
for diverse contexts

Need to be scaled up
and applied widely

Policy Context Scotland: Scotland's National Strategy for Economic Transformation – March 2022

Figure 1: Our Vision, Ambition and Programmes of Action for Scotland's Economy by 2032





TAY CITIES
CLEAN GROWTH

www.taycitiescleangrowth.scot

Website Functionality

www.taycitiescleangrowth.scot



Home page



www.taycitiescleangrowth.scot

Projects / Members / Organisations

ProjectsNewsForumFundingMembers

Projects

ListMap

All

Circular Economy3

Clean energy4

Data & digital solutions2

Green agritech3

Sustainable mobility5

Add new project

EV chargingFuture fuelsHydrogen

Low carbon transport infrastructureSustainable mobility

Angus Rural Mobility Hub

Clean energy

Perth Smart Energy Network

Battery storageBattery technologies

Circular EconomyClean energy

Energy efficient buildingsEnergy Storage

Advanced plant and crop solutions

Energy efficient agricultureGreen agritech

New high value cropsPest and disease management

ProjectsNewsForumFundingMembers

Members

Missing somebody? Invite them to join.

All Members43

Search Members...

Recently Active

Gardener

Nora Ferda-McKay

Joined Mar 2022 • Active now

Mark Richardson

Joined May 2022 • Active 8 hours ago

John Ferguson

Joined May 2022 • Active 9 hours ago

Aileen O'Hagan

Joined Apr 2023 • Active 2 days ago

Gardener

www.taycitiescleangrowth.scot

Funding / Forum / News

Projects News Forum **Funding** Members

Funding Opportunities

Funding Aggregators

Scottish Enterprise Grants & Funding Calls

Help with navigating the funding landscape in Scotland.

The funding information gateway

Support for Scottish businesses to find funding for innovation.

Business Gateway

Help and connections to funding & financing resources.

Find Business Support

Scotland's public sector grants, funding, advice, help, events and more.

UKRI Opportunities

UK Research and Innovation funding finder.

Energy Saving Trust

Grants and loans for energy and transport.

Open & Upcoming Funding

Open and upcoming funding Closed funding

[Add new funding](#)

All

[Circular Economy](#) [Clean energy](#) [Data & digital solutions](#) [Green agritech](#) [Sustainable mobility](#)

UKRI funding: ISCF SSPP collecting flexible plastic packaging waste at home

[Circular Economy](#)
01/03/2023 – 12/04/2023

Cyber security academic startup accelerator programme: phase one

[Data & digital solutions](#)
27/03/2023 – 19/04/2023

Pre-announcement: Centre of Excellence for Resilient Infrastructure Analysis on DAFNI

[Circular Economy](#) [Clean energy](#) [Data & digital solutions](#)
[Green agritech](#) [Sustainable mobility](#)
12/04/2023 – 31/05/2023

UKRI: Novel low-emission food production systems: investor partnership

[Green agritech](#)
03/05/2023 – 05/07/2023

Horizon Europe Call for Connected Regional Innovation Valleys

[Circular Economy](#) [Clean energy](#) [Data & digital solutions](#)
[Green agritech](#) [Sustainable mobility](#)

Dundee area: MICHELIN DEVELOPMENT BUSINESS LOAN SCHEME

[Circular Economy](#) [Clean energy](#) [Data & digital solutions](#)
[Green agritech](#) [Sustainable mobility](#)

Projects News **Forum** Funding Members

Forum

Ask for assistance

Ask about a clean growth topic, or look for collaborators and partners.

[Request assistance](#)

[View all requests](#)

Open positions

Share job opportunities, open positions and internships with the community.

[Share an open position](#)

[View all open positions](#)

All Discussions

[Subscribe](#)

[New discussion](#)



Bioeconomy and circular economy

[Assistance request](#) [ESG](#) [Eden Campus](#)

[Michel Lemagnen](#) replied 4 months ago 3 Members 3 Replies



Link doesn't work

[Funding: Horizon Europe: New Clean Energy Research And Innovation Funding For 2023](#)

[Nora Ferda-McKay](#) replied 4 months, 1 week ago 2 Members 1 Reply



Business Development Manager – Advanced Plant Growth Centre

[Open position](#)

[Derek Stewart](#) replied 6 months ago 2 Members 2 Replies



Innovate UK – Net zero living: Pioneer places

[Assistance request](#)

[Derek Stewart](#) replied 6 months ago 2 Members 2 Replies



Global Business Innovation Programme – Clean Growth

[Nora Ferda-McKay](#) replied 6 months ago 2 Members 1 Reply



Just transition fund

Projects **News** Forum Funding Members

News

Find out and keep up to date with what's going on in and around the Tay Cities clean growth ecosystem.

Share your news!

Our news are sourced from you, Tay Cities Clean Growth community members. Contact gardeners to share your news articles, tips or ideas.

[Contact gardeners and share news](#)

Button disabled for gardeners to prevent self-messaging.

04/04/2023

Tay Cities Clean Growth Website Launch

Do you want to be a part of a community in the Tay Cities Region which is passionate about clean growth and transforming our future...

[0 Comments](#)

03/04/2023

Addressing the Fertiliser Crisis in Europe

The global fertiliser crisis has reached a critical level in Europe, where farmers are facing unprecedented challenges due to record prices. The European Economic and...

[0 Comments](#)

29/03/2023

Innovate UK announces £100M for three high-potential innovation clusters

The Innovation Accelerators programme is investing £100 million in 26 projects to accelerate the growth of three high-potential innovation clusters. The £100 million Innovation Accelerators...

[0 Comments](#)

24/11/2022

Analysis: Fertiliser Crisis: Impact on food security

www.taycitiescleangrowth.scot

The Tay Cities Clean Growth Initiative – The Essence

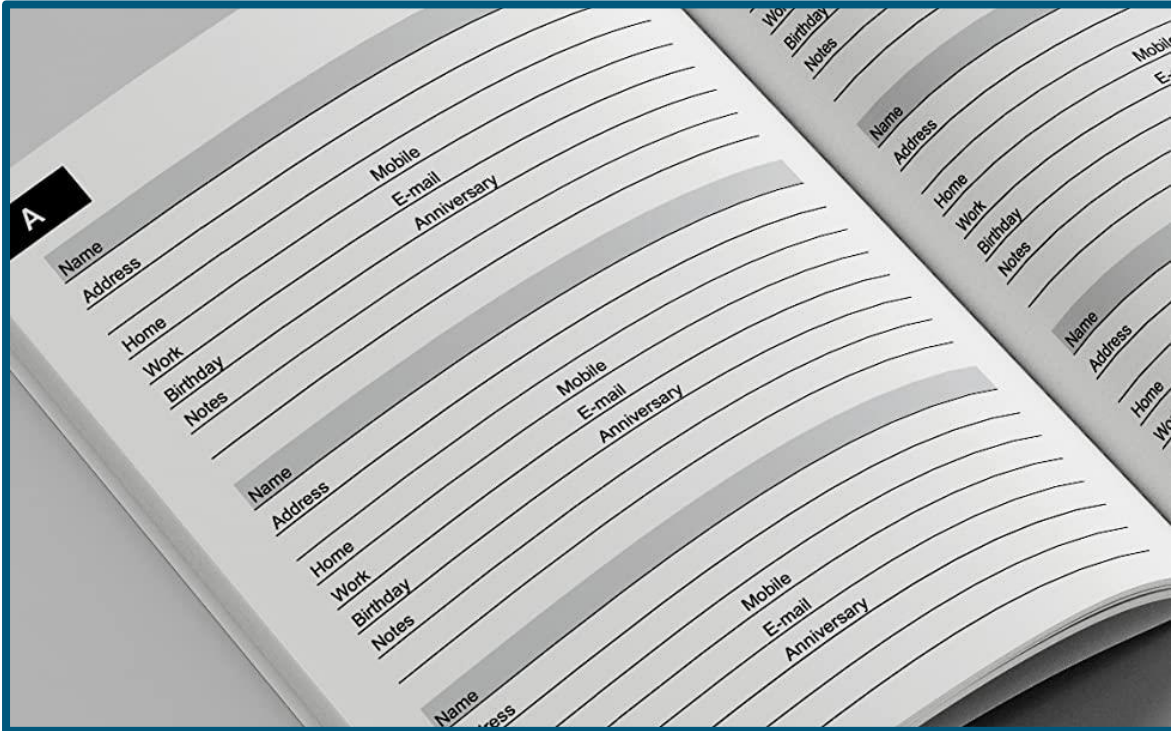
‘A platform for a benefit driven and coherent acceleration to a regenerative low carbon, resilient and just regional economy’.

Build strong regional economies from strong local economies and the national economy will transform.

This is our challenge to-day.



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www.taycitiescleangrowth.scot

Carlene Simpson
Carlene.Simpson@fife.gov.uk

Nora Ferda-McKay
nora.ferda-mckay@sotent.co.uk

Karen Primrose
kp59@st-andrews.ac.uk

www.taycitiescleangrowth.scot



TAY CITIES
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Professor John Irvine

University of St Andrews

School of Chemistry, JTSI Group – Energy and Materials

This project is supported by the Tay Cities Deal



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Transitioning to a new energy future

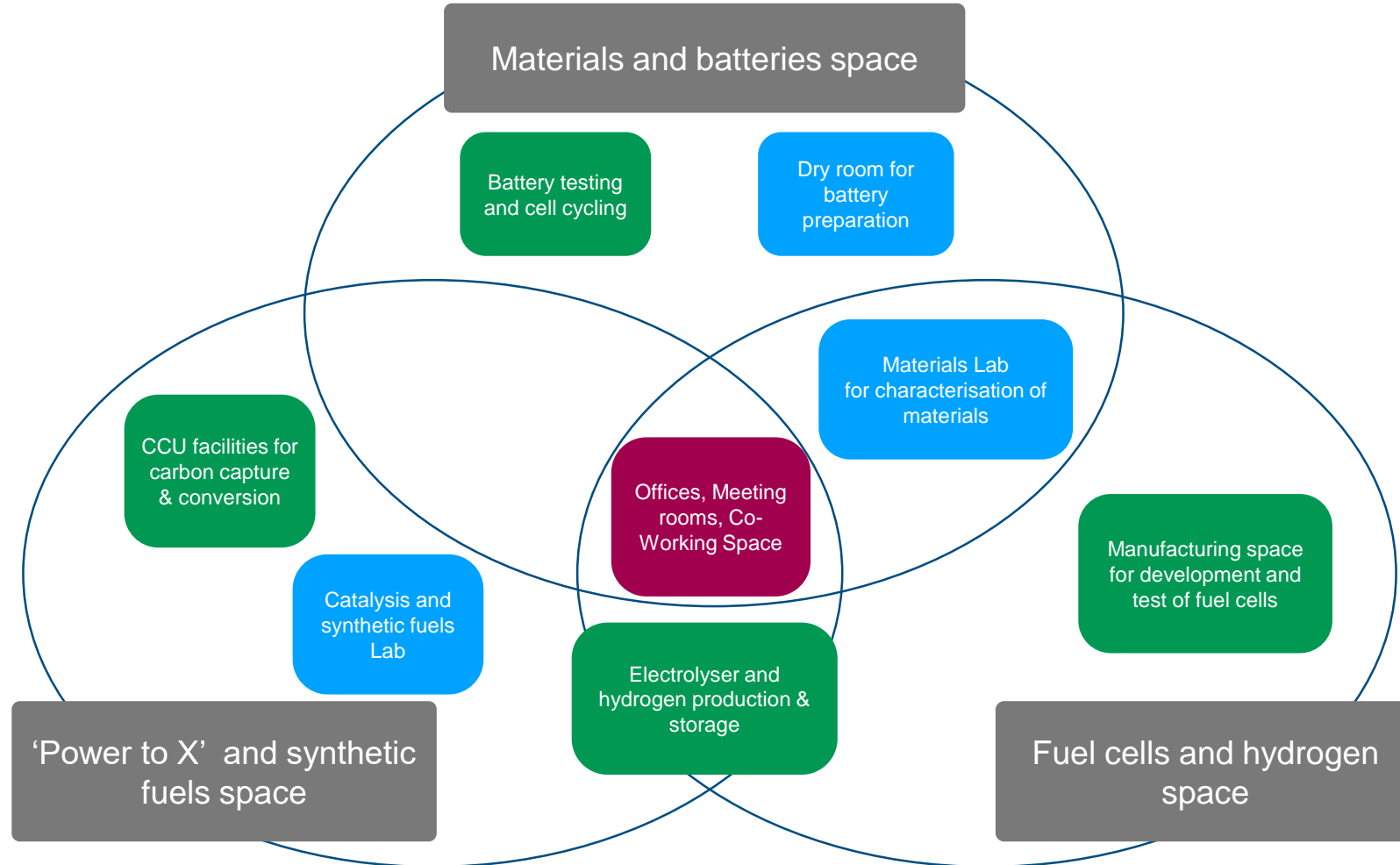
- Clean Energy
- Battery Scale up
- Sodium Ion batteries
- Ammonia
- Solid Oxide Electrolysis

This project is supported by the Tay Cities Deal



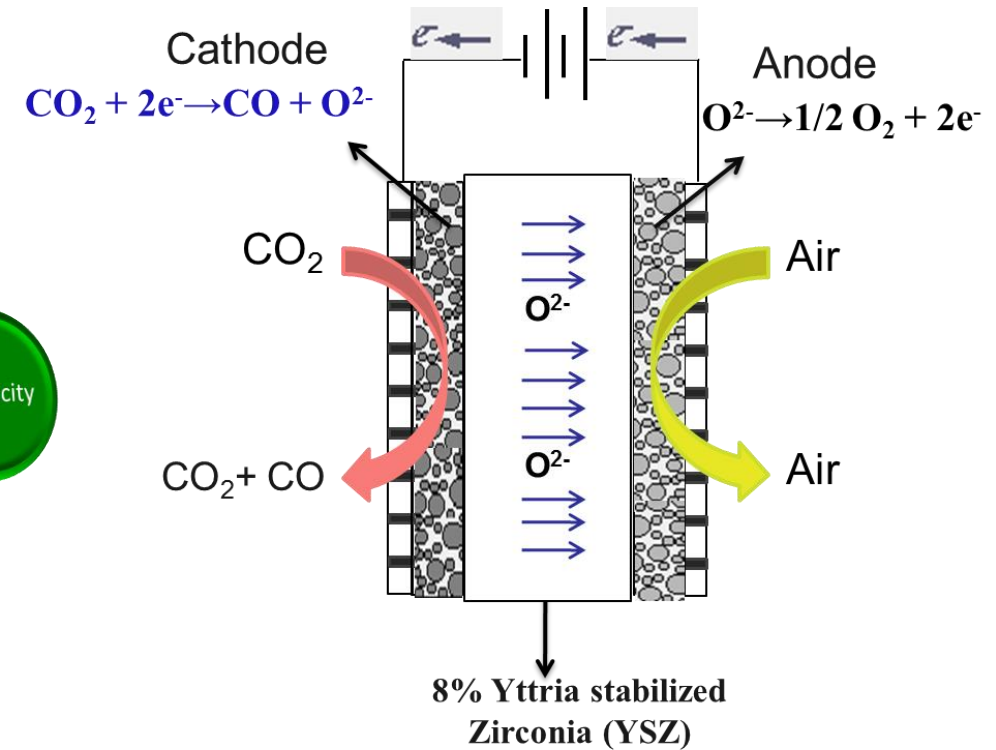
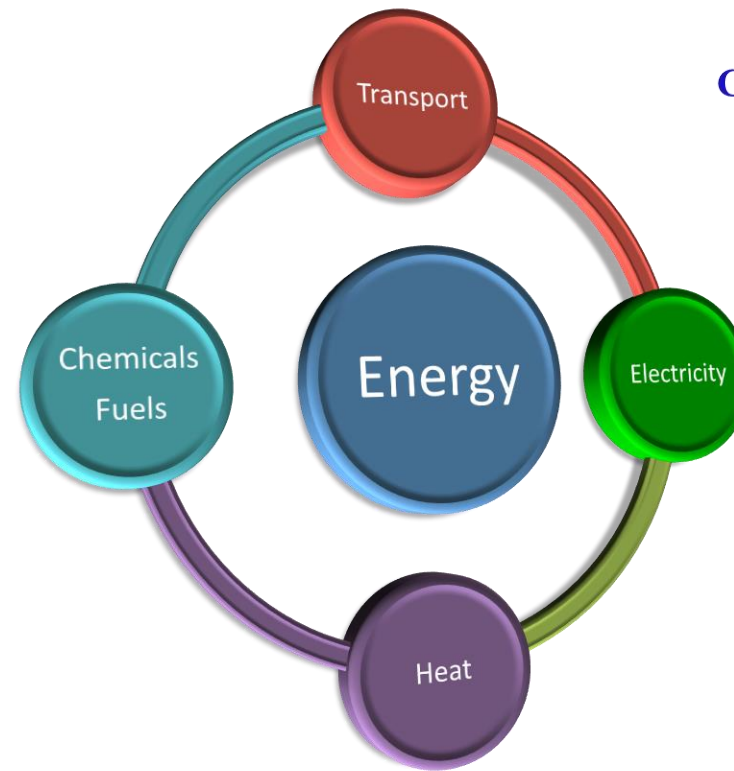
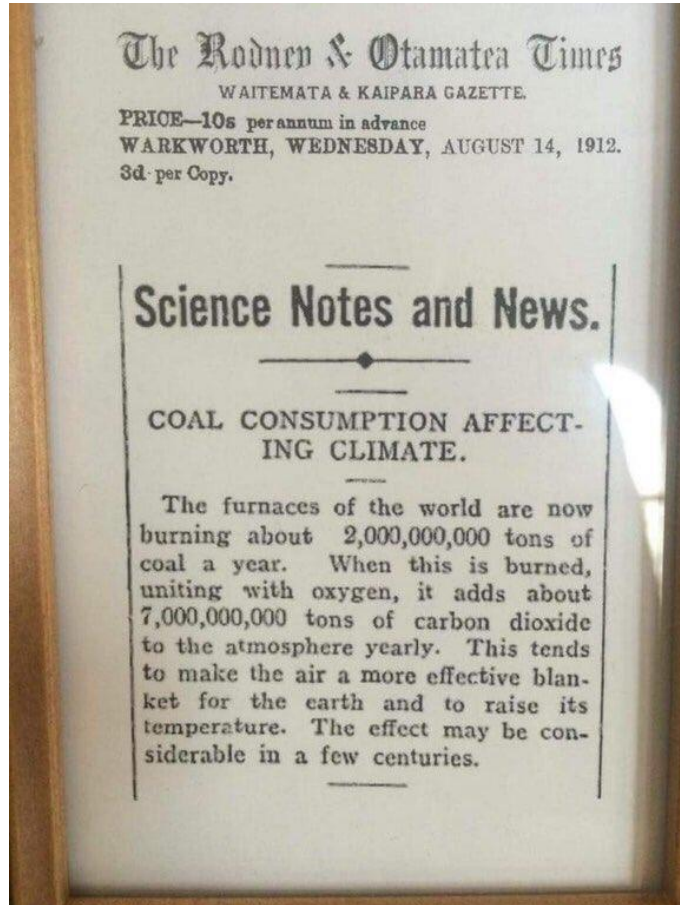
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University of St Andrews contribution to net zero: *Technologies and Themes*



GENEration Storage Innovation and Sustainability

GENESIS



St Andrews

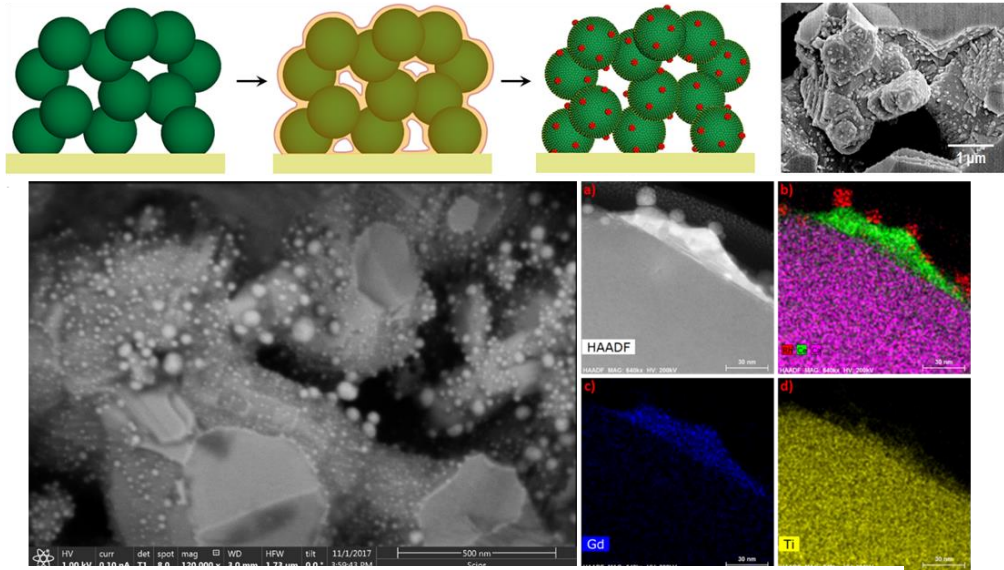


2020 constraint payments to onshore wind in Scotland 3,460 GWh (at a cost of £243M), 2021 1,783 GWh (£107M)

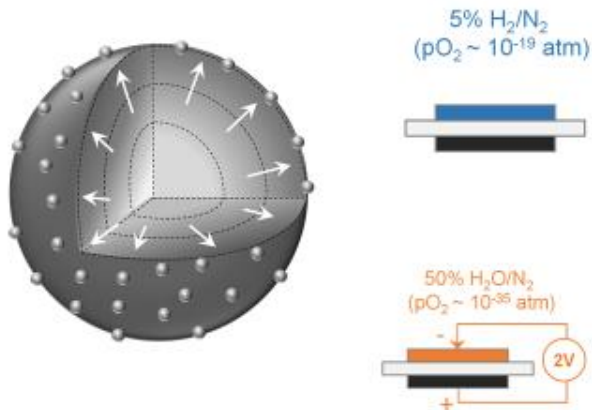
CO₂

Enabling Science

Nano-engineering of solid oxide cells *Adv. Energy Mater.* 2021



Switching on electrocatalytic activity in solid oxide cells



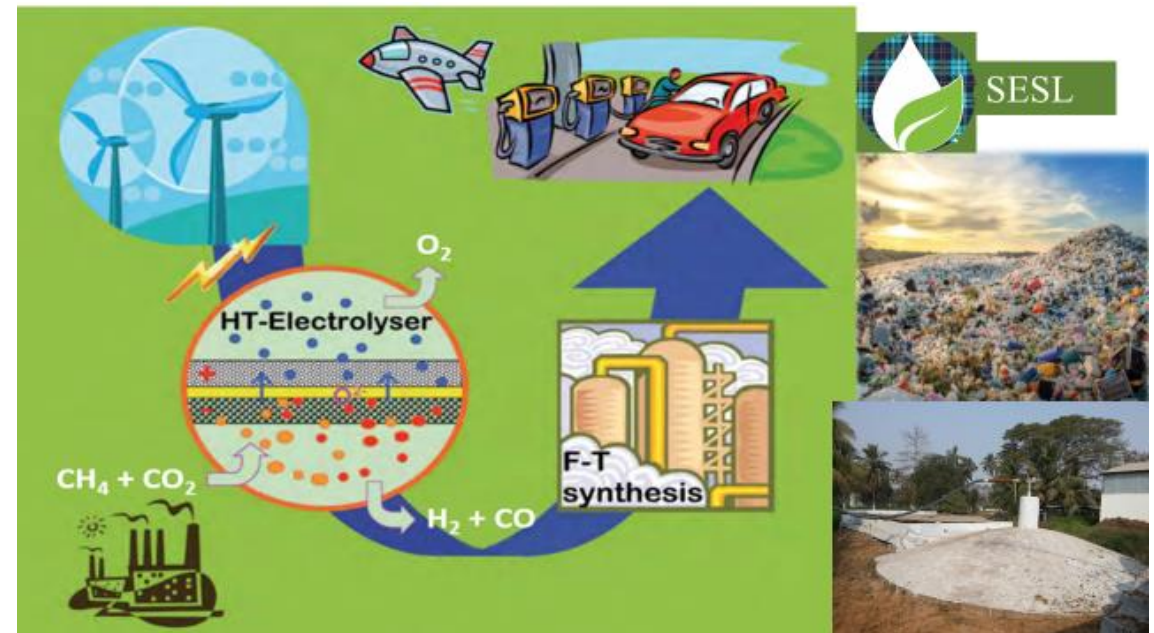
J.H. Myung, D. Neagu, D.N. Miller & J.T.S. Irvine
Nature, 2016. 537, 528-531



Platinum Incorporation into Titanate Perovskites via a Trojan Horse Route to Deliver Emergent Active and Stable Platinum Nanoparticles

Nat. Chem. 2021, 13, 677-682

Maadhav Kothari^{1,†}, Yukwon Jeon^{1,2,†}, David N. Miller¹, Andrea Eva Pascui³, John Kilmartin³, David Wails³, Silvia Ramos⁴, Alan Chadwick⁴ and John T.S. Irvine^{1*}



St Andrews Pouch Cell Facility



European Union



gov.scot

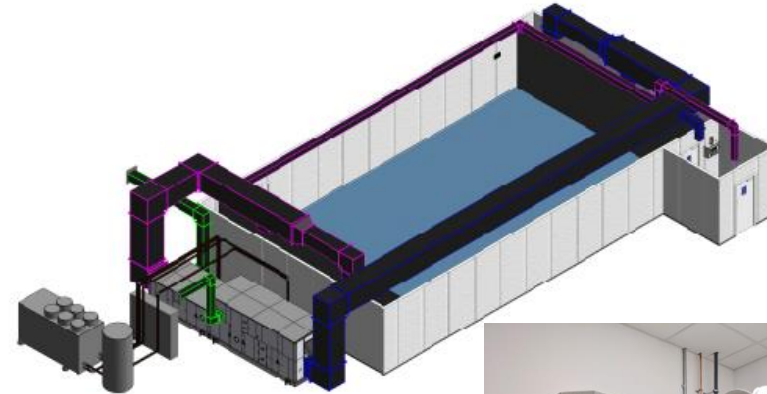


EUROPE & SCOTLAND
European Regional Development Fund
Investing in a Smart, Sustainable and Inclusive Future

- Battery scale-up facility, NOW OPEN!
- Tay cities deal (c. £5.5m, buildings), Scottish Enterprise (ERDF; c. £1.1m, core equipment) and the Faraday Institution (c. £200k, additional equipment).
- Complement businesses with a pouch cell production line.
- Supporting NEXGENNA WP3 scale-up research

Scale-up and Processing of Materials

- Three person dry-room (8 x 14 m) with dew point of $< -50^{\circ}\text{C}$.
- Processing equipment:
 - Roll-to-roll coater (blanketed with dry air).
 - Mixers (1L and 20L); temperature controlled; inert atmospheres/vacuum.
 - Reel-to-reel calender
 - Z-fold stacker
 - Electrolyte filling, degassing, and sealing.
 - Test chambers, cycling and formation.
- Hundreds 10 Ahr cells per annum.



Dry-room

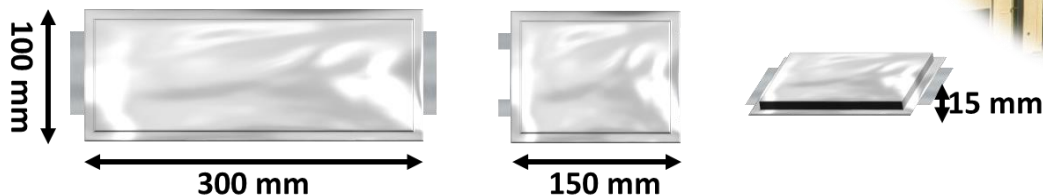


Roll-to-roll coater



Mixer

Calender Press



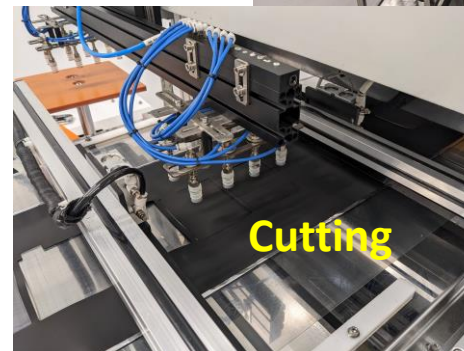
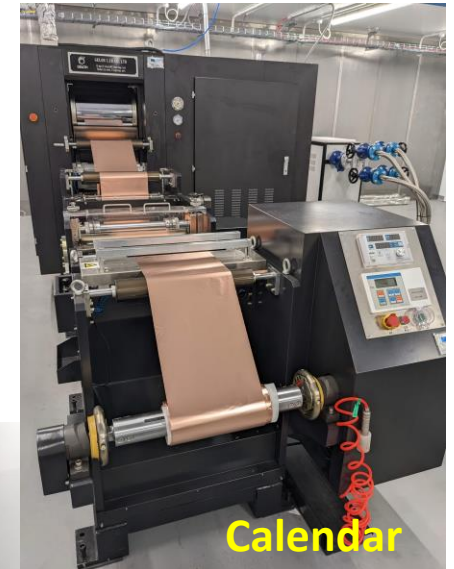
St Andrews Pouch Cell Facility

- **Staffing:** 2 dedicated technicians and 2 affiliated to NEXGENNA
- **Model:** Work **WITH** users.
- Favorable rates for early users (and Scottish SMEs).
- All the equipment have been tested in isolation.
- We've produced a dummy cell.
- Had our first couple of commercial users for stages in the process.
- Held discussion with AMTE and Faradion about potential projects.
- Tasks-in-hand:
 - Establishing and documenting procedures.
 - Designing and commissioning jigs for welding, foil transfer, formation etc.
 - Best practice in powder handling.
- Working toward opening events.

ulabequipment.com/facility/nexgenna/nexgenna.org/



EUROPE & SCOTLAND
European Regional Development Fund
Investing in a Smart, Sustainable and Inclusive Future





Nissan Leaf

Sodium-ion batteries;
safe, sustainable,
scalable.

John T.S. Irvine

University of St Andrews

Rob Armstrong, Nuria Tapia-Ruiz, Scott Lilley

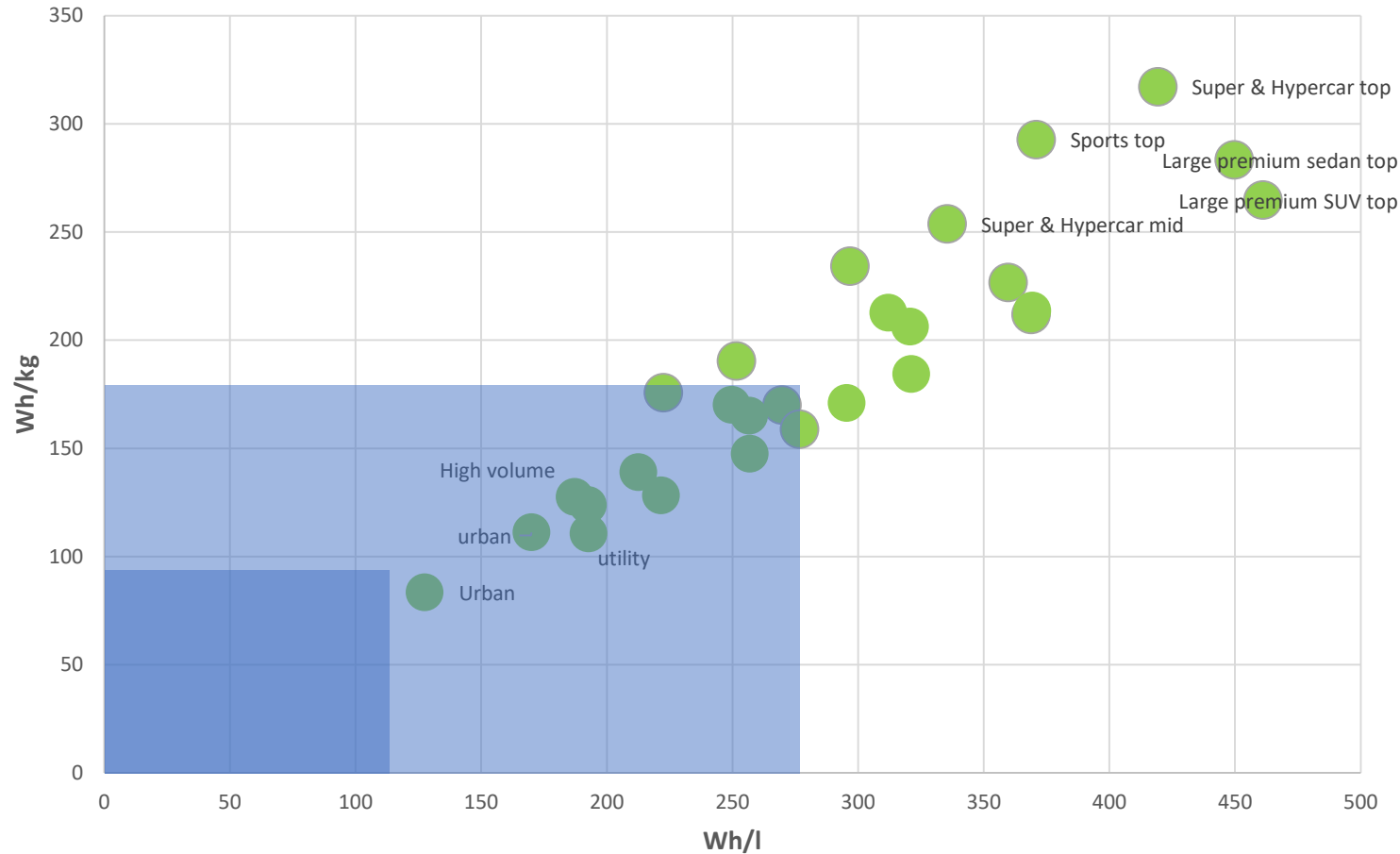
 THE FARADAY
INSTITUTION

NEXGENNA

NEXT GENERATION SODIUM-ION BATTERIES

NIB - Sodium Ion: Possible range of capability relative to UK BEV production

UK battery requirements 2030



Cell Chemistry	Wh/l	Wh/kg
	Nominal	Nominal
Na ion today AMTE	280	140
Na Ion futured 2030	420	200

NIB Cell to Pack Ratio best case assumptions	65%	85%
NIB Cell to Pack ratio worst case assumptions	40%	65%

Pack Calculated	Wh/l	Wh/kg
NIB 2030 best case assumptions	273	170
NIB 2030 worst case assumptions	112	112

BEV	2020	2025	2030	2035
High Volume	23478	25000	255000	480000
Small-Mid Premium	20403	100432	376000	514000
Large Premium		47654	62600	234600
Luxury / Supercar		11318	16500	21713
Utility <3.5T		7002	10000	55000
Urban		10000	50000	80000
Total	43881	201406	770100	1385313

SODIUM-ION BATTERIES



Sodium-ion batteries are an emerging rechargeable battery technology

Inexpensive



- Secure supply and a predictable price
- No copper current collector
- No cobalt
- BoM 70% of LFP / NMC

Safe



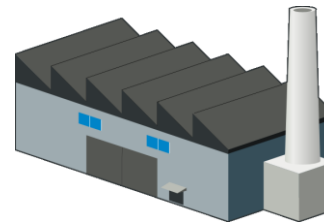
- Can be transported or stored in their low energy state at 0V
- Excellent safety testing results



Sustainable

- Sodium is abundant and ubiquitous
- No Lithium
- No copper current collector
- No cobalt related ethical or environmental issues
- No toxic lead

Scalable



- Same operation principle and format as lithium-ion batteries
- Diverse chemistries are possible
- Are manufactured using existing plants



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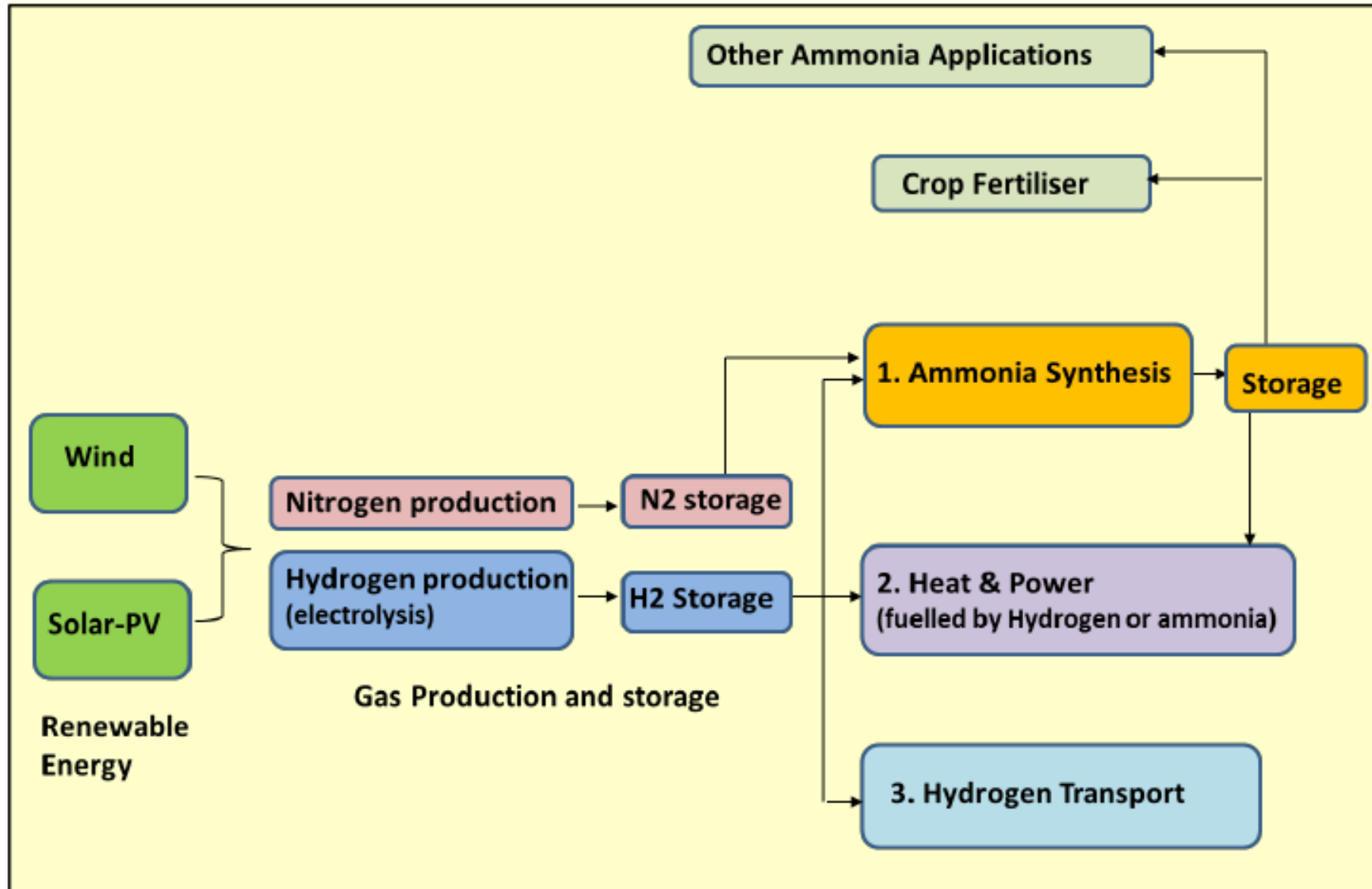
Green Ammonia a Vector for future Marine and Beyond

This project is supported by the Tay Cities Deal

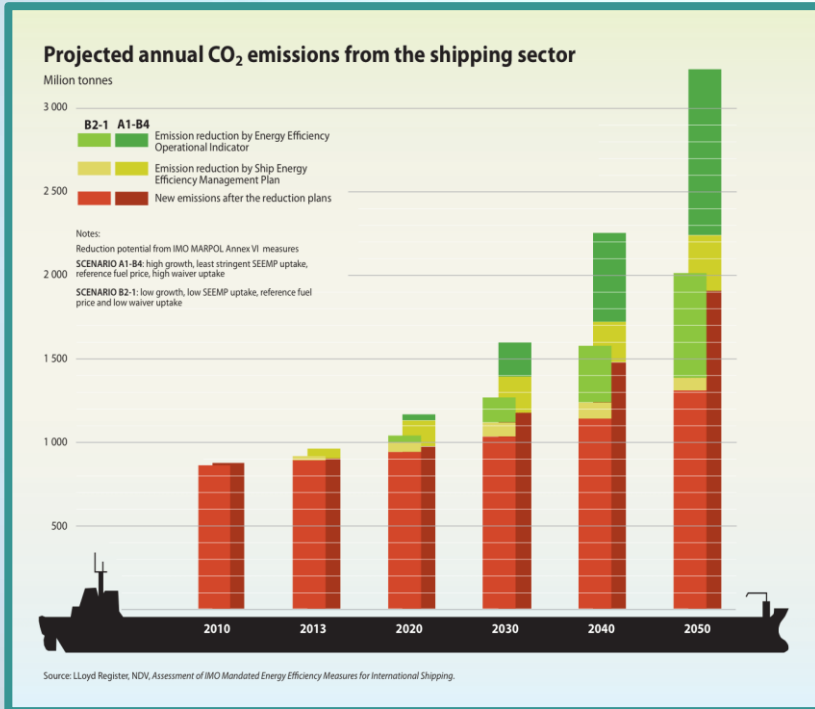


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Renewable Ammonia System

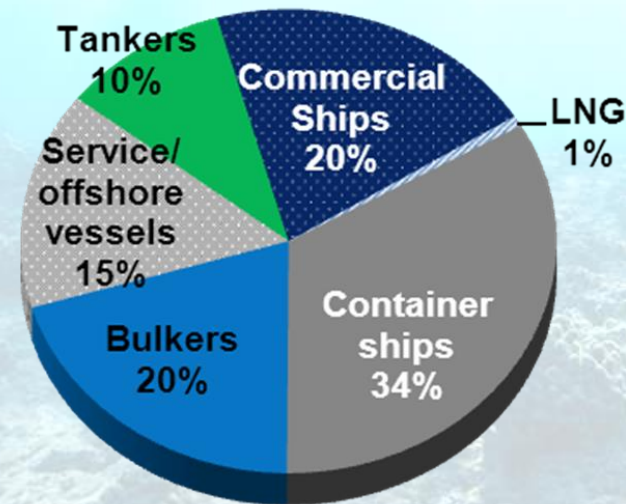


Background



Responsible for

- 3% of carbon emissions and
- SO_x and NO_x air pollution



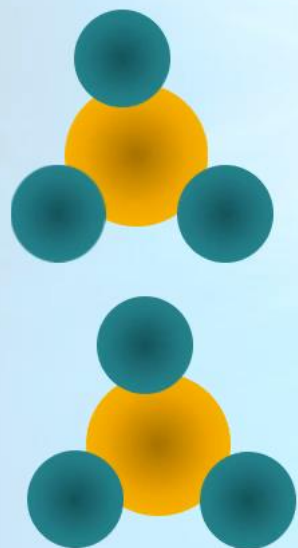
Total Market Volume: 50,000
Total Market Value: >£30bn



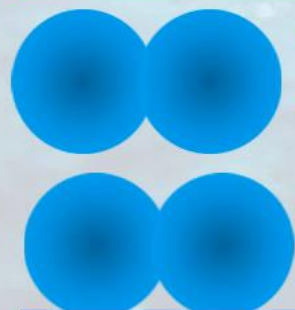
A new way fuelling the marine industry

Hydrogen is an ideal low carbon carrier, but its effective energy density is too low for marine applications

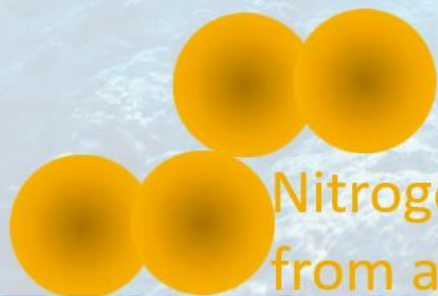
Ammonia is a perfect carrier



Ammonia



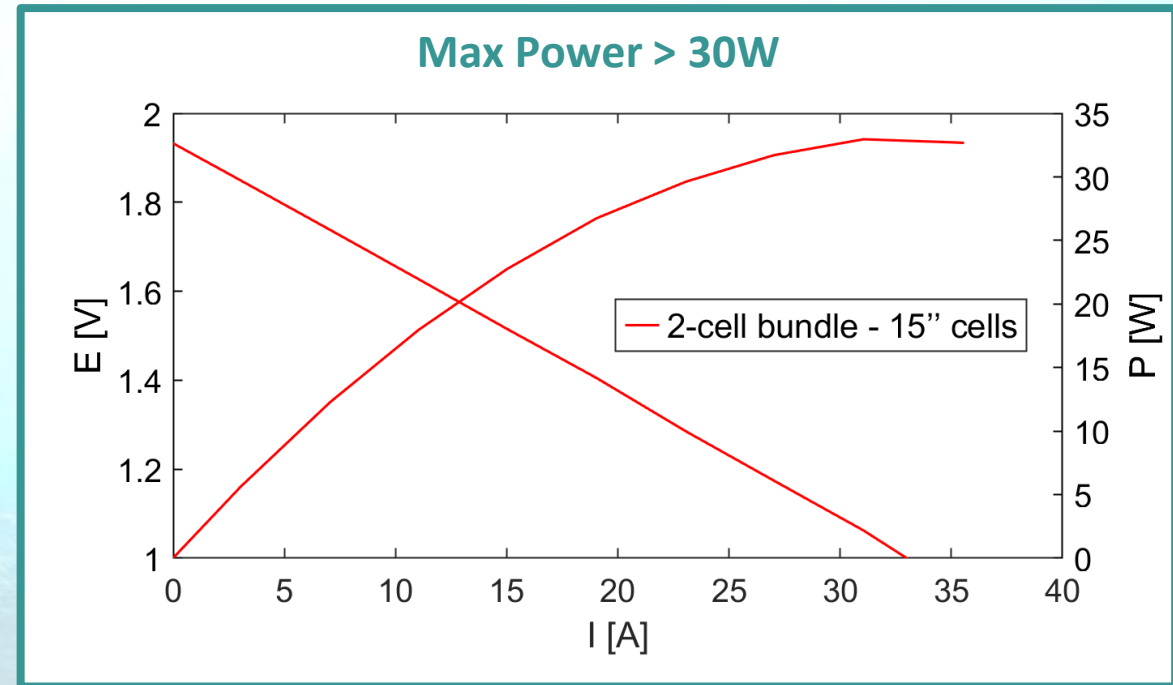
Oxygen
from air



Nitrogen
from air



Technology Stage



Target Markets

Auxiliary Power Applications

Early Demonstrations:

- Maritime auxiliary power unit on board
- Lighting, heating, and instrumentation



Stationary Power Generation Applications

Early Demonstrations:

- Cold ironing-portside battery charging applications



Mobility Applications

Short-term local opportunities:

- Diving boats
- Fishing boats

Long-term opportunities shipping





University of
St Andrews

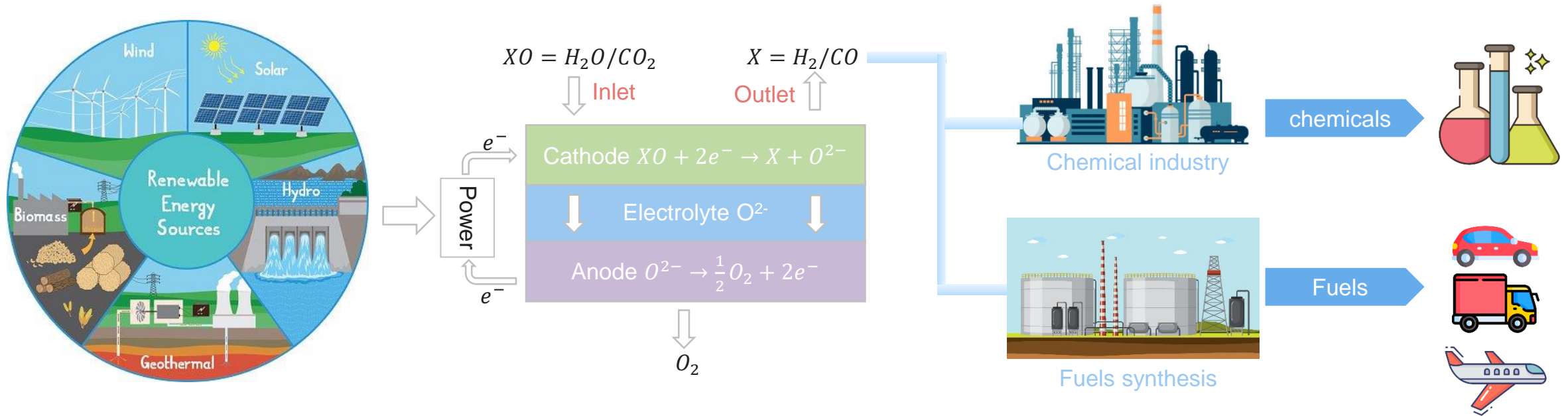
Solid Oxide Electrolysis for CO₂ Utilisation

Dr Nuoxi Zhang

nz29@st-andrews.ac.uk

www.st-andrews.ac.uk

Introduction



- Solid oxide electrolysis cells (SOECs) can convert electrical energy from renewable sources into chemical energy for storage.
- They can directly electrolyze steam and carbon dioxide into syngas, which can be used as a versatile feedstock for the production of synthetic fuels, chemicals, and materials.
- SOECs can contribute to a low-carbon energy system by enabling the use of renewable and low-carbon fuels, reducing greenhouse gas emissions, and improving energy security.

Potential usage of H₂ and syngas

Green hydrogen $H_2O + 2e^- \rightarrow H_2 + O^{2-}$

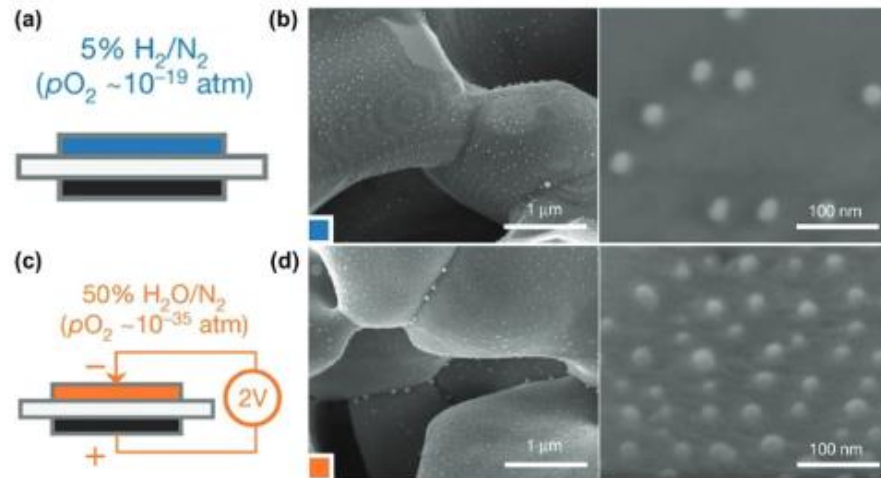
- **Transportation:** hydrogen fuel cell vehicles produce zero emissions and have a longer range than battery electric vehicles.
- **Energy storage:** hydrogen can be stored for long periods of time and can be used to generate electricity via solid oxide fuel cells when demand exceeds supply.
- **Industry:** hydrogen can be used as a feedstock for the production of chemicals and materials such as ammonia and steel.

Syngas $H_2O + CO_2 + 4e^- \rightarrow CO + H_2 + 2O^{2-}$

- **Chemical production:** syngas can be used as a feedstock for the production of various chemicals, such as methanol, ammonia, and synthetic natural gas.
- **Fuel production:** syngas can be converted into liquid fuels, such as diesel and gasoline, using Fischer-Tropsch synthesis.
- **Power generation:** syngas can be burned to generate electricity in gas turbines or used in fuel cells.

Material development of fuel electrode

2. In-situ exsolution (current research)

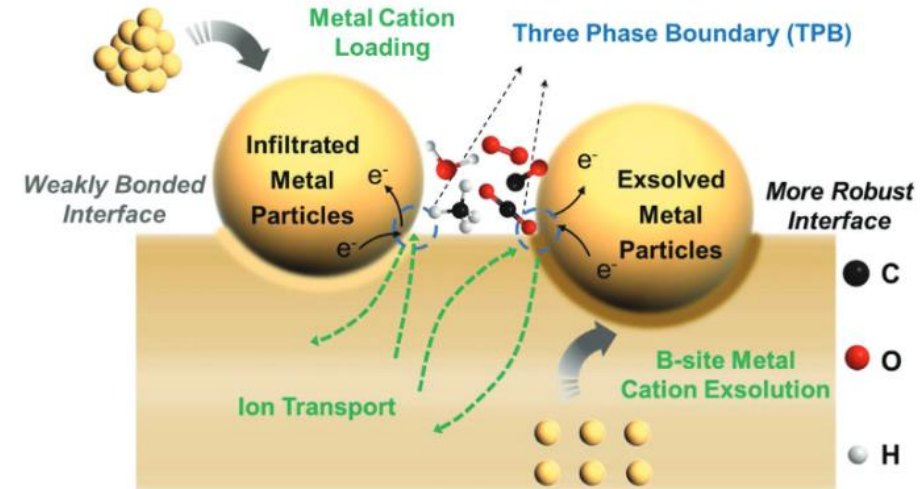


Schematics show the exsolution introduced by reduction in a) 5% H₂/N₂ and by c) electrochemical switching with a 2 V bias across the cell.^[3]

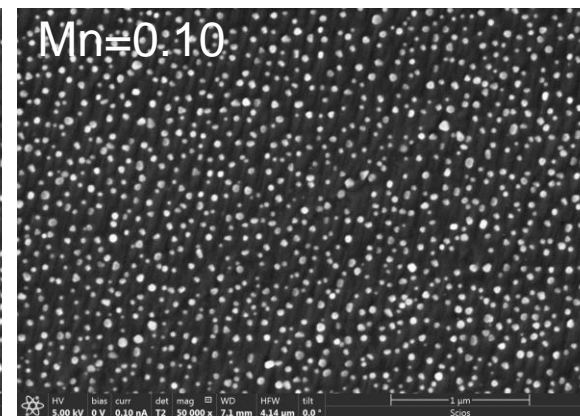
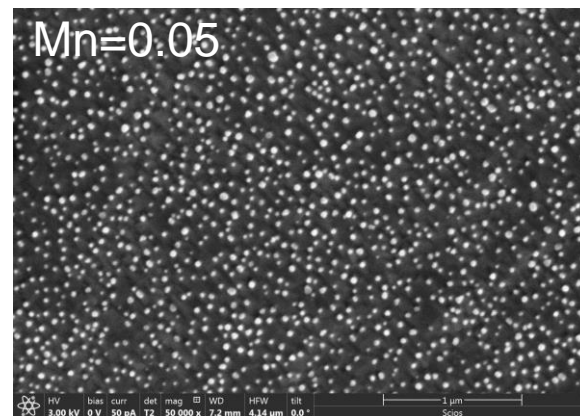
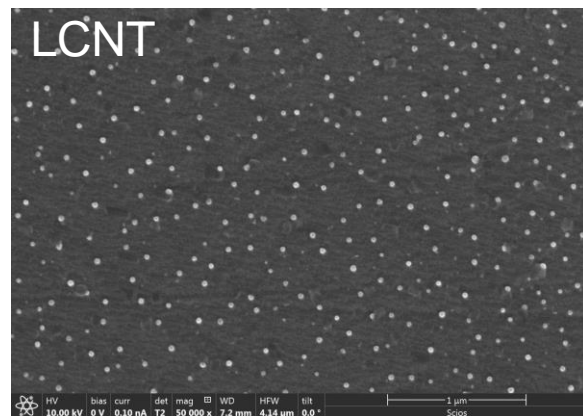
Advantages:

- Exsolved nanoparticles display finer and more uniform distribution on the porous perovskite electrode surface
- Excellent catalytic activity due to the larger specific surface area
- Strong interaction between nanoparticles and the matrix, resulting in a low propensity for agglomeration and coking

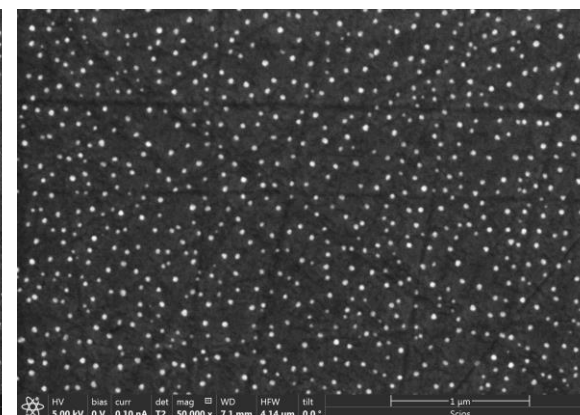
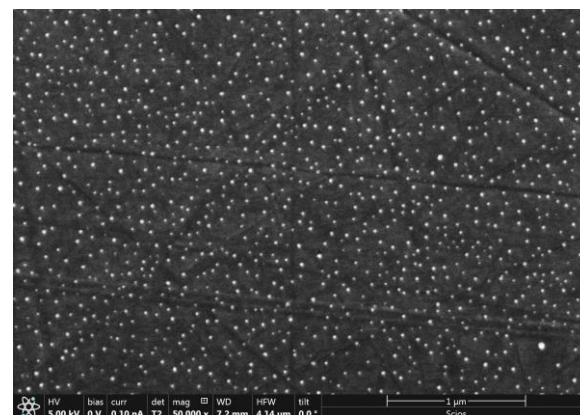
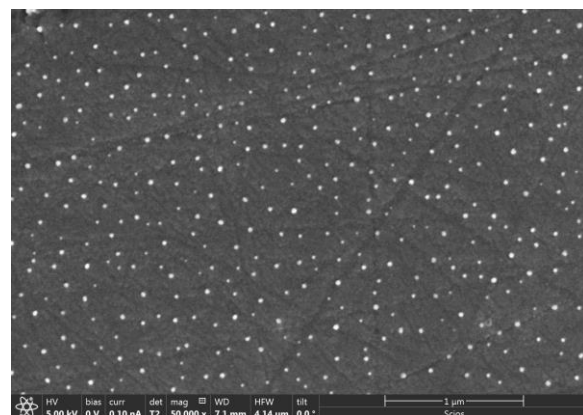
3. Infiltration vs. in-situ exsolution



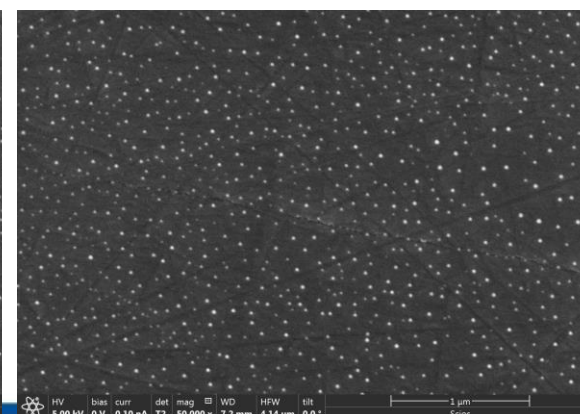
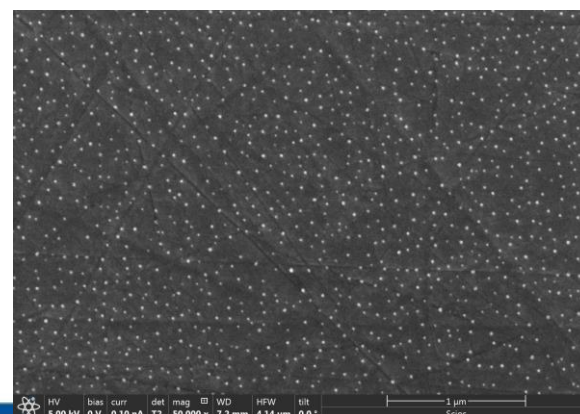
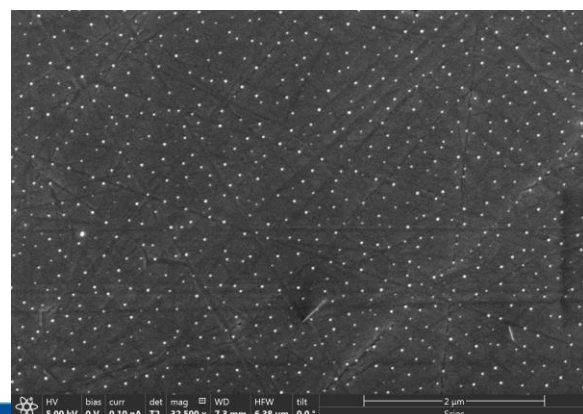
Comparison of oxide-supported metal particle catalysts prepared by loading and in situ exsolution.^[4]



900 °C

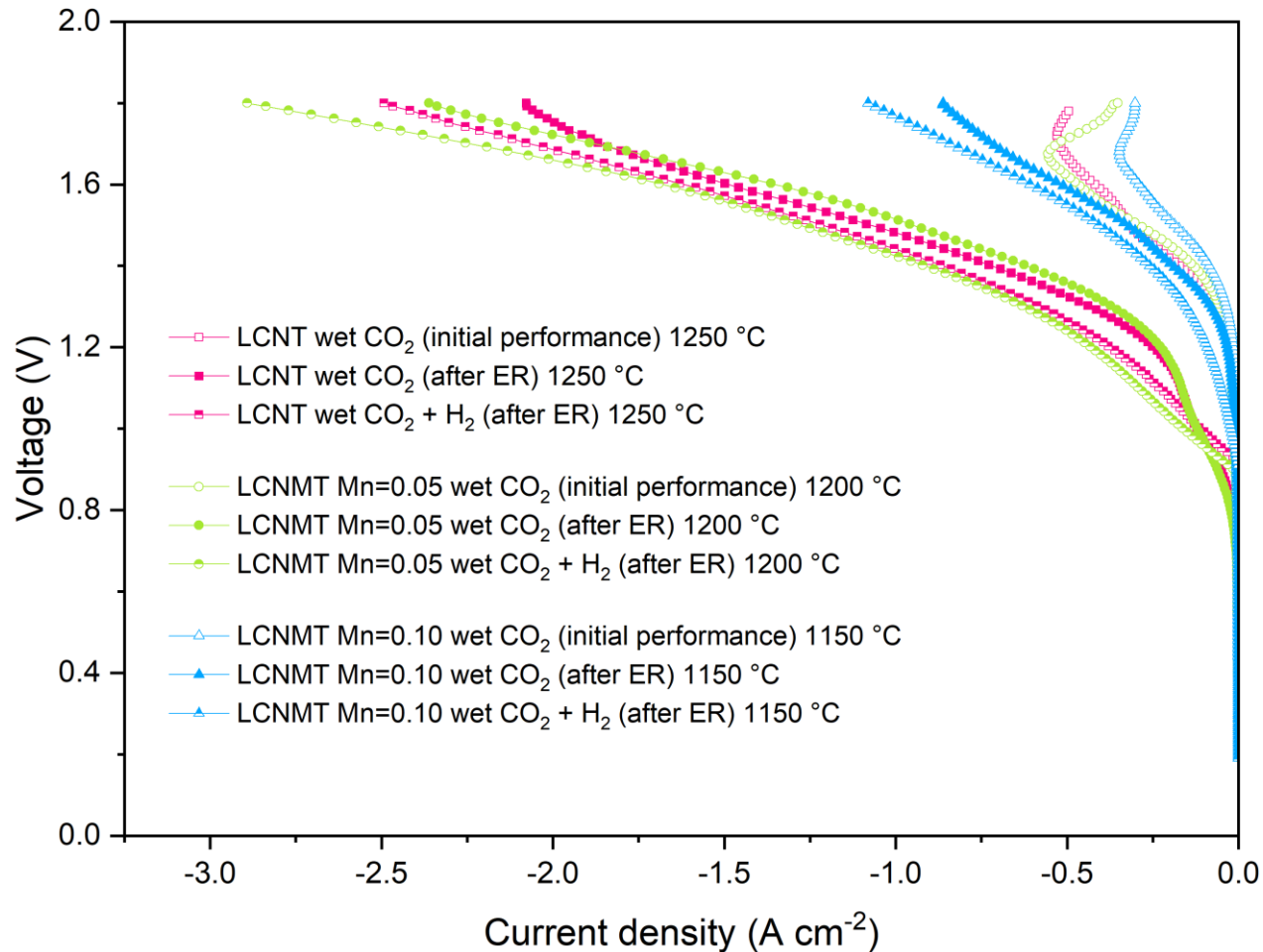


800 °C



700 °C

Research results



In terms of comparative cell performance, the LCNMT Mn=0.05 cell demonstrated superior results compared to the LCNT and LCNMT Mn=0.10 cells. Despite exhibiting initial current limitations for all the cells, this limitation was notably alleviated upon electrochemical reduction. Furthermore, introducing an additional 20% H₂ into CO₂ enhanced cell performance for all materials.

Thank you for listening!

