Policy instruments and social license for hydrogen uptake in Scotland.

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. Introduction

This conference paper proposes to critically explore several of the core features of Scotland's developing hydrogen policy framework. In doing so, this review focuses on policy instruments financing innovation, and designed to encourage hydrogen investments. This exploration touches on other policy programmes showing Scotland's ambition to deliver a multi-purpose, multi-target, hydrogen policy. In a second moment, this paper technically considers why progressing on social license, and social acceptance investigation, should enhance Scotland's hydrogen policy toolbox. It will argue for more policy initiatives focusing on the demand-side of hydrogen in Scotland, and connect this discussion to leading views on social license, insisting on researchers' recommendations to policymakers to investigate the social acceptance of hydrogen.

1. Internal instruments and external ambitions for hydrogen in Scotland

. Hydrogen policy context

In Scotland's policy roadmap to decarbonise the economy, the Scottish government committed in 2019 to reach net zero by 2045. This ambitious statutory target presses for effective decarbonisation strategies that include using large volumes of home-grown wind power as feedstock for Scotland's hydrogen and developing carbon capture, utilisation, and storage hubs. Producing, storing, consuming, and exporting, especially, green hydrogen derived from electrolysers is central to this strategy.
Scotland is also moving on hydrogen as a mature hydrocarbon province. The nation's economic development agencies face the challenge of having to transition Scotland's offshore industry by, notably, upskilling its workforce, and wedging on a reindustrialisation through notably building a hydrogen capacity. Supporting hydrogen for skills, to save and create jobs, is also part of the energy supply chain's strategy to deliver a fair and just energy transition in the North-East, and the rest of Scotland.

. Devolution limitations and Scotland not sovereign on energy policy support

Scotland's energy future is also progressing in a specific context. The UK constitutional arrangements make that Scotland does not have devolved powers on energy matters. Westminster and the Scottish government therefore face the additional challenges of having to balance and coordinate policy visions, when having to decide over policy actions for delivering the UK's energy and climate action. Scotland has to adjust to Westminster's policy priorities, and anticipated outcomes on energy, with a limited decision-making power on UK policy instruments designed to also address Scotland's energy transition.

. Aligning energy and decarbonisation strategies

In this context, Scotland's energy transition is largely influenced by energy priorities defined by the Westminster's Department for Business, Energy & Industrial Strategy (BEIS), Ofgem, the national regulator, and other energy bodies with UK-wide outreach. The Climate Change Committee also recognizes that Westminster's and Holyrood's policies on transition are increasingly aligned due to their decarbonisation priorities following similar pathways. Such chapters have been taking a renewed energy security dimension due to the global stress caused by Russia on energy markets. Growing green domestic fuels like hydrogen, boosting renewables, rethinking energy imports are all strategic chapters for a secure domestic decarbonisation on either side of the border.

. Scotland's early support to hydrogen against more limited UK initiatives

Until 2020, the Ten point Plan for a Green Industrial Revolution, and the Energy White Paper, Westminster's support for hydrogen pilot projects, research, and testing across Britain had been somewhat modest. BEIS's 2020 GBP 90-million package transformed this, and led to including support project in Scotland, with some of this money going to Aberdeen's hydrogen production plant. This package is also financing low carbon industrial hydrogen near Liverpool, and green hydrogen production tests using offshore wind near Grimsby. Since 2019, BEIS has also been acting with a GBP 100-million fund using competition to stimulate hydrogen supply, use, and hydrogen fuel-switching, in a variety of industrial sectors.

. Scotland relying on other devolved powers to support hydrogen

The UK's limited pre-2020 context encouraged Scotland to introduce local hydrogen policies by relying on its devolved powers on, e.g., research, environment, local economic development, planning, transport, or housing and heating. Scotland has been investing in these frameworks to help deliver its share of UK-wide policy outcomes on hydrogen. The Climate Change Committee's decarbonisation policy assessments also encourage Scotland to maintain its hydrogen momentum especially for heating, industry, and transport decarbonisation.

In terms of government technique, these policy outcomes help show how Scotland is following a multi-purpose, multi-target pathway for its policy frameworks supporting hydrogen. This approach is not unique among western economies, and quite typical of energy transition programmes. Scotland's policy outcomes also includes acquiring a leading status as an exporter of certified green hydrogen, resting on international partnerships, infrastructure, and a performing hydrogen market framework.

. A historical support to hydrogen through Scotland's funding for innovation

Historically, providing support to hydrogen as an innovation for decarbonisation formed the core of Scotland's policy approach. A timeline of official statements and policy documents sets out Scotland's strategy for hydrogen, and design pathways to deliver Scotland's climate 2030 and 2045 milestones. Legally, Scotland acts on hydrogen on the basis of its decarbonisation target legislated through the Climate Change (Scotland) Act 2009, as amended by the Climate Change (Emissions Reduction Targets) (Scotland) Act 2019.

The government's long-standing support for hydrogen has seen funding going to early research project on Orkney, such as the internationally-funded "BIG HIT" project. Government also supports industry groups, and the Scottish Hydrogen Fuel Cell Association, that notably help kick-start projects across Scotland's industries looking at solutions for hydrogen production, storage, or

distribution. In 2022, the Scottish government also granted project-specific funding to a North-East project, HOP2, looking at how to use offshore oil and gas assets for hydrogen production.

Scotland's financial support to hydrogen predates by many years its legal commitment to achieving net zero by 2045. This early-step funding reflects Scotland's interest for growing a competitive advantage by building a domestic hydrogen capacity using Scotland's technical heritage, and local wind power, that could give the nation a significant market advantage by producing certified green hydrogen.

Scotland's strategy has not, however, been restricted to supporting local research projects. Aberdeen's hydrogen bus fleet received GBP 7 million from the Scottish government between 2013 and 2017. Government further granted GBP 4.5 million to Aberdeen in 2020 through its Energy Transition Fund in order to add ten hydrogen buses to the city. On Orkney again, the government has been providing finance to Surf 'N' Turf, an energy conversion project. More recently in Fife, government allocated GBP 6.9 million to H100 Fife, where Scottish Gas Network is testing household hydrogen conversion. This project is centrally financed by the energy regulator, Ofgem, for GBP 18 million. Recently, Scotland pledged GBP 100 million for hydrogen, thus further signalling that Scotland believes that building a hydrogen supply chain could add billions of pounds to its economy.

Recent policy documents further confirmed Scotland's institutional strategy for hydrogen. The November 2021 Draft Hydrogen Action Plan (the Action Plan) lays out an action roadmap designed to deliver the Hydrogen Policy Statement released by government in December 2020. This Action Plan shows how Scotland understands it could act to maximise hydrogen production, its storage capacity for industry, transport, and heating. Its roadmap spells out how cross-sector synergies should be instrumental in helping Scotland grow an entirely new energy sector, and develop the skills required to adapt Scotland's energy workforce for a future hydrogen supply chain.

In this context, supporting hydrogen as an innovation remains central in Scotland's funding strategy. In May 2022, Scotland's First Minister speaking at a Glasgow hydrogen conference confirmed that the government would spend GBP 100 million on hydrogen up to 2026. This money derives from Scotland's GBP 180 million Emerging Energy Technologies Fund (EETF), and Scotland's Hydrogen Innovation Scheme opened in summer 2022, with a GBP 10-million first funding stream available to expressions of interest since June 2022.

. Impact of policy instruments and market signal

When looking at Scotland's support in real terms, however, innovation funding rapidly hits against reality checks. Expert voices, including the Royal Society of Edinburgh, indicate that Scotland's funding remains modest when compared against the amount of investments needed for electrolysers, grid connections, home or industrial retrofitting, and other hydrogen infrastructure. Consultancy firms, and OECD research, also show how infrastructure costs rapidly escalate in the billions of pounds for national grids and system conversions[1].

This funding also seeks, however, to send the right market signal to investors. It confirms how Scotland's socio-political trust is building around hydrogen[2]. In policy technique, this strategy shows Scotland's understanding that delivering energy and climate outcomes requires long-term policy consistency. This support to innovation also addresses local economic development, social, and

[1] IEA, 'Global Hydrogen Review 2022' IEA Publications (2022) <https://doi.org/10.1787/a15b8442-en> Accessed, 10 October 2022.
[2] Andrew MacGillivray and others, 'Innovation and cost reduction for marine renewable energy: A learning investment sensitivity analysis' (2014) 87 Technological Forecasting and Social Change 108.

industrial strategies. This multi-purpose, multi-target approach, demonstrates the government's policy approach, and how it seeks to impact as a core energy policy actor, even though energy is not a competence devolved to Scotland.

. Grant-based programmes, renewables, and innovation

International research investigating national programmes for funding R&D as a policy technique confirms that grant-based approaches lead to create value, and deliver innovation, new technology and development. Recent American research reviewing federal incentives supporting renewables shows how early-stage money, and grant-based approaches, effectively work as policy instruments leading to patentable technology and new investment[3].

Grant-based approaches nevertheless signal that market forces are still considered as not being capable of delivering competitive innovations. Researchers have criticised policies using government grants to address market failures. They have questioned these programmes' capacity to create additionality, or a swift deployment of technology. In practice, combining tax incentives and government grants would actually create a more impactful environment. This conclusion could partly explain Westminster's policy for deploying freeports across Britain, including one in Aberdeen as part of the city's future Energy Transition Zone.

It will matter to track how fast the Scottish government's on-going grant-based programmes lead to patentable hydrogen technology. American or Chinese research recently confirmed that state-subsidised programmes for innovation and renewables tend to deliver good local performance. This research has also, however, confirmed that delivering patentable innovations still takes a lot of time[4]. This is a classic finding of research investigating the efficiency of government schemes for innovation. This reality certainly confirms that building a competitive advantage by progressing on local hydrogen is also a race against the clock, when other major energy producers, and especially the USA, are now introducing hydrogen tax credits that may completely reshuffle the world's hydrogen economics[5].

. Other forms of supply-side support

Additional Scottish supply-side policies include government support to industry working groups and hydrogen stakeholders. The Energy Task Force, Scottish Enterprise, or the Grangemouth Future Industry Board, all have working programmes to deliver advice on Scotland's future hydrogen supply chain[6]. Scotland also circulates business intelligence by publishing business plans and opportunity assessments. Industry stakeholders get opportunities to meet at hydrogen trade fairs organised in Scotland to discuss the costs, risks, and commercial prospects associated with the H2 industry.

[3]Taekyoung Lim, Tang Tian and William M. Bowen, 'The Impact of Intergovernmental Grants on Innovation in Clean Energy and Energy Conservation: Evidence from the American Recovery and Reinvestment Act' (2021) 148 Energy Policy 111923.

[4] Su, Yi and Dan Li, 'Interaction effects of government subsidies, R&D input and innovation performance of Chinese energy industry: a panel vector autoregressive (PVAR) analysis' (2021) Technology analysis & strategic management 1.

[5] Recharge, 'US tax credits 'could make green-hydrogen-fired power cheaper than gas by 2030': consultancy' <https://www.rechargenews.com/energy-transition/us-tax-credits-could-make-green-hydrogen-fired-power-cheaper-than-gas-by-2030-consultancy/2-1-1303340> accessed on 21 September 2022.

[6] The Energy Task Force, Scottish Enterprise, https://www.scottish-enterprise.com/ ; Grangemouth Future Industry Board, https://www.gov.scot/groups/grangemouth-future-industry-board/

. External dimension

Building a strong domestic profile appears consistent with Scotland's other big priority aiming at identifying early possible alliances to become a frontrunner on hydrogen exports. The Scottish government has thought to move rapidly on export prospects and, in spring 2022, Scotland was already talking to overseas partners to investigate future possible commercial routes. Leading in these talks are a number of German Länder looking at importing growing volumes of hydrogen by 2030 to swiftly disconnect their industries from Russian gas. By 2050, Germany could import up to 70% of its hydrogen supplies.

. Ownership, "Just Transition", and populations

Scotland's support to private investment, its export strategy, and the government's policy for innovation, largely leave this nation's hydrogen future to private investors and actors. So far, government is not signalling that it would invest tax-payers' money, or secure ownership interests, in hydrogen ventures. Such steps are, however, not unusual, when investing public money is used as policy instrument to help de-risk early technology ventures or renewable projects[7].

In addition, Scotland's policy includes gathering the right skills and workforce, including from the transitioning hydrocarbon industry. Educating and upskilling for Scotland's renewables is an essential policy chapter of Scotland's Just Transition programme. For that purpose, the government is again relying on funds and budgetary instruments, such as the GBP 75 million Energy Transition Fund, the GBP 100 million Green Jobs Fund, or its more sizeable GBP 500 million Just Transition Fund.

Yet, building a world-class hydrogen industry should invite the Scottish government to demonstrate how this nation is effectively moving on hydrogen with a strong case from its population. This investigation would open a policy chapter focusing on the demand-side of the market. This is where government should seek to connect communities with stakeholders, and see how to structure the necessary social license and acceptance for hydrogen. This effort would put government in its role to investigate the Scottish communities' values, proximity, and understanding for hydrogen in order to build a fuller domestic case around this new technology, and its future Scottish market. This investigation is also encouraged by published UK and European research showing how a low level of public awareness, knowledge, and understanding keeps behind pervasive amongst populations and could constitute the real hurdle to hydrogen deployment and its applications[8].

2. Social license and acceptance for hydrogen in Scotland

The first part has discussed how Scotland has been developing a far-reaching ambition, and spending policy, to progress on its energy transformation. This strategy delivers on programmes detailed in policy documents confirming Scotland's positive stance on hydrogen. Yet, very little information, if any, is available, to discuss the populations' understanding, or social acceptance, of hydrogen.

[7] Matteo Deleidi, Mariana Mazzucato and Gregor Semieniuk, 'Neither crowding in nor out: Public direct investment mobilising private investment into renewable electricity projects' (2020) 140 Energy Policy 111195.
[8] Sabrina Glanz and Anna-Lena Schönauer, 'Towards a low-carbon society via hydrogen and carbon capture and storage: Social acceptance from a stakeholder perspective' (2021) 9(1) Journal of Sustainable Development of Energy, Water and Environment Systems 1.

. A limited investigation of public acceptance justified by Scotland's energy background?

An extensive corpus of social licence research, spanning across decades, discusses the meaning and purpose of securing a social license to operate (SLO)[9]. Research in the extractive and energy sectors exploring SLO in mining, large renewable projects, or biofuels, show how these industries' impact on their communities, infrastructure, safety, landscapes, and how energy system transformation can disrupt consumption and economic patterns[10]. This social science research aims to show governments and industrialists, how underestimating community values, the populations' understanding, fears, hopes, assumptions around local projects can seriously delay, including, the most desirable energy projects[11]. Recent public perception investigations around carbon capture, utilisation, and storage projects (CCUS), confirm how public acceptance data help reveal meaningful variations in the understanding of, e.g., safety issues, and how such findings should be understood as critical markers when contemplating energy projects.[12] Engagement with local communities, their more remote, non-professional, stakeholders also appears central in social science research, in order to achieve an effective democratic outreach, and bringing local contributions within the development strategy of decarbonisation projects.[13]

Project developers have decades of experience testing the strategic value of building a strong SLO. Energy projects, innovations, end-up being well received because of an understanding of their environmental, economic, local, political, socio-technical, and consumption variables. These are classic markers in SLO investigations. Such data show energy stakeholders how constructing an SLO requires much more than meeting regulatory compliance. Research around fuels, and biofuel projects, also show how public acceptance data form a critical chapter when interpreting an SLO profile[14].

Hydrogen promoters in Scotland may presume that a broad public acceptance for energy projects exists, considering this nation's North Sea history, or its world-leading wind power capacity. This heritage may encourage simplistic conclusions whereby introducing hydrogen would logically succeed in Scotland, considering that this industry will create jobs and promote environmentally-friendly solutions.

Sociotechnical research, however, confirms that if general public acceptance is an important variable, it is yet just one dimension of the wider concept of social acceptance[15]. Profiling social acceptance for hydrogen in Scotland requires investigating community and stakeholders' values, the perceptions around this fuel, and how they are likely to impact on populations' trust in Scotland's

[9] Nnaemeka Vincent Emodi and others, 'A systematic literature review of societal acceptance and stakeholders' perception of hydrogen technologies' (2021) 46(60) Int J Hydrogen Energy 30669.
[10] Chin Hon-Choong and others, 'Issues of social acceptance on biofuel development' (2014) 71 J Clean Prod 30.
[11] Okkonen, Lasse and Lehtonen, 'Socio-economic impacts of community wind power projects in Northern Scotland' (2016) 85 Renewable Energy 826.
[12] Alina Ilinova, Alexey Cherepovitsyn and Olga Evseeva, 'Stakeholder Management: An Approach in CCS Projects' (2018) 7(4) Resources (Basel) 83.
[13] Farah Mulyasari, and others, 'Potentials of the public engagement strategy for public acceptance and social license to operate: Case study of Carbon Capture, Utilisation, and Storage Gundih Pilot Project in Indonesia' (2021) 108 International Journal of Greenhouse Gas Control 103325.; Daniel Fiorino, 'Citizen Participation and Environmental Risk: A Survey of Institutional Mechanisms' (1990) 15(2) Science, Technology, & Human Values 226.
[14] Federica Dessi, and others, 'Sustainable technology acceptability: Mapping technological, contextual, and social-psychological determinants of EU stakeholders' biofuel acceptance' (2022) 158 Renewable and Sustainable Energy Reviews 112114.
[15] Diego Peñaloza and others, 'Social and market acceptance of photovoltaic panels and heat pumps in Europe: A literature review and survey' (2022) 155 Renewable and Sustainable Energy Reviews 111867.

evolving energy system[16]. Such an inquiry should lead to draw a fuller market acceptance profile, exposing views not just from the supply-side, but also communities and consumers. A scientific triangular model for social acceptance is available starting with, for instance, Rolf Wüstenhagen's collective investigation of wind turbines' acceptance[17]. Renewable fuels are, however, more than wind turbines. Green fuels are also commodities, and their social acceptance criteria inevitably differ from those applying to wind farms. Contextualisation certainly matters in public acceptance studies, and explains why understanding social license and social acceptance requires dedicated funding streams for sociotechnical investigations.

. Scotland's hydrogen policy offers a case for social acceptance investigation

The published research informing this paper consistently shows how integrating SLO data as part of energy projects' planning and delivery comes out as a condition to their success and delivery. Articles from Australia or Indonesia have confirmed how a lack of public acceptance, or community resistance, could lead to the demise of, including, vital renewable energy projects[18].

Social studies investigating technology uptake and hydrogen acceptance in Germany, Australia, or the UK, equally confirm how exploring social acceptance provides the adequate expert framework, and toolbox, to understand the values, arguments, and assumptions underlying successful uptakes of hydrogen technology[19]. As indicated, scientific SLO and acceptance frameworks are available to assist governments in working out policy programmes more in line with their communities, and informed by supply-side and demand-side actors. Research on project acceptance also emphasizes the role of SLO for renewable energy deployment, considering the greater proximity of communities with energy infrastructure coming with decentralised energy models, and a need for community benefits[20].

Socio-technical research around biofuels has, for instance, revealed how such policies' underperformances significantly connects to a lack of understanding of populations' values and their consumption patterns. Research across two large biodiesel producers such as Indonesia and Brazil, shows how under-exploring the demand-side drivers for biodiesel has contributed to low biofuel intake, lasting government subsidies, and costly policies artificially supporting this industry. Similar findings may have informed the evidence submitted to the House of Commons' Scottish Affairs Committee in March 2022, highlighting the risks associated with a lack of demand-side understanding, and secure demand, for hydrogen in Scotland (see also below)[21] .

[16] Mitchell D. Scovell 'Explaining hydrogen energy technology acceptance: A critical review' (2022) 47(19) Int J Hydrogen Energy 10441.
[17] Rolf Wüstenhagen, Maarten Wolsink, and Mary Jean Bürer, 'Social acceptance of renewable energy innovation: An introduction to the concept' (2007) 35(5) ENERG POLICY 2683.
[18] Carmel Anderson, Jacki Schirmer, and Norman Abjorensen "Exploring CCS community acceptance and public participation from a human and social capital perspective" (2012) 17 (6) Mitig. Adapt. Strateg. Glob. Change, 687; Farah Mulyasari,and others 'Potentials of the public engagement strategy for public acceptance and social license to operate: Case study of Carbon Capture, Utilisation, and Storage Gundih Pilot Project in Indonesia' (n 13).
[19] Anna-Lena Schönauer, Sabrina Glanz, S. 'Hydrogen in future energy systems: Social acceptance of the technology and its large-scale infrastructure' (2022) 47(24) Int J Hydrogen Energy 12251.; Joel A. Gordon, Nazmiye Balta-Ozkan and Seyed Ali Nabavi, 'Homes of the future: Unpacking public perceptions to power the domestic hydrogen transition' (2022) 164 Renewable & sustainable energy reviews 112481.
[20] Hogan, Jessica L. and others, 'What makes local energy projects acceptable? Probing the connection between ownership structures and community acceptance' (2022) 171 Energy Policy 113259.
[21] Scottish Affairs Committee, 'Written evidence submitted by Shell (HCC0043)' (UK Parliament 2022) <https://committees.parliament.uk/writtenevidence/107123/html/> accessed 09 August 2022.

There is also growing research from Australia and Germany focusing on social acceptance of hydrogen solutions and infrastructure. These investigations confirm how new fuels disrupt customer perceptions and attitudes. They emphasize the need to technically investigate the drivers commanding public trust in green fuels, their technology, and uptake by populations. This expertise reflects decades of research inviting industry stakeholders, and policymakers, to have regard for public perception data before firming up policy decisions on, including, green fuels.

Australia's 2019 National Hydrogen Strategy contains an entire chapter on community engagement, emphasizing how securing public trust, addressing local concerns, and educating the populations around hydrogen have become federal priorities[22]. This approach should inspire other jurisdictions, and government in Scotland, to play a central role in investigating the nation's social acceptance and readiness for hydrogen. This socio-technical exploration would not only better connect Scotland's hydrogen future with communities, but it would better inform public and private stakeholders, and supplement Scotland's current hydrogen framework that, so far, hardly touches on aspects of social license and acceptance of hydrogen.

. Approaching Scottish communities on hydrogen

The above findings also support the views presented in April 2022 by the Royal Society of Edinburgh to the House of Commons' Scottish Affairs Committee. These findings equally connect to the recommendations published in 2021 by the Scottish Government's Just Transition Commission.

The developing frameworks for a domestic and international hydrogen market should encourage Scottish authorities and councils to use their proximity with local communities to explore their understanding, acceptance, and readiness for hydrogen. For homes, UK-published research emphasizes the need to better understand local end-users, and household acceptance, of hydrogen[23]. This effort would put government in greater consistency with its market-oriented approach, by also considering demand-side data, that would gradually help work out the area-based acceptance of hydrogen in Scotland.

Government is also in an ethical position to show that its policies financing innovation do not essentially reflect views primarily informed by supply-side data. Mapping the social acceptance of Scotland's hydrogen industry calls for an independent investigation, also considering that the government is promoting hydrogen against a background of public interest for decarbonising Scotland's energy, heat, transport, and industry.

. Conclusion

Scotland's developing policy framework for hydrogen should help draw a fuller market profile for this fuel. A wider investigation of hydrogen social acceptance across Scotland would help shape the nation's SLO for hydrogen, with greater emphasis on the demand-side that would help identify the communities' understanding and values around their future with hydrogen. Councils, local authorities, Holyrood, and communities have a central role to play in revealing Scotland's readiness and understanding of what means operating with growing volumes of hydrogen for, including, heat and transport. This investigation would better inform public action for decarbonisation, and

[22] COAG Energy Council, 'Australia's National Hydrogen Strategy' (Commonwealth of Australia 2019) < https://apo.org.au/organisation/66620 > accessed August 2022.
[23] Joel A. Gordon, Nazmiye Balta-Ozkan and Seyed Ali Nabavi, 'Homes of the future: Unpacking public perceptions to power the domestic hydrogen transition' (2022) 164 Renewable & sustainable energy reviews 112482.

supplement the existing research around other decarbonisation solutions such as CCUS in Scottish industrial hubs[24]. Investigating community values, their understanding of future hydrogen uptake and impact, also connects to larger renewable projects, and government guidance, encouraging carrying out impact assessments before moving forward with decisions on large energy and resource projects.

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[24] Juan Alcalde and others, 'Acorn: Developing full-chain industrial carbon capture and storage in a resource- and infrastructure-rich hydrocarbon province' (2019) 233 J Clean Prod 963.

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Energy Law and Policy

Policy Instruments and Social License for Hydrogen Uptake in Scotland

~ Scotland's hydrogen policy approach and key policy instruments.

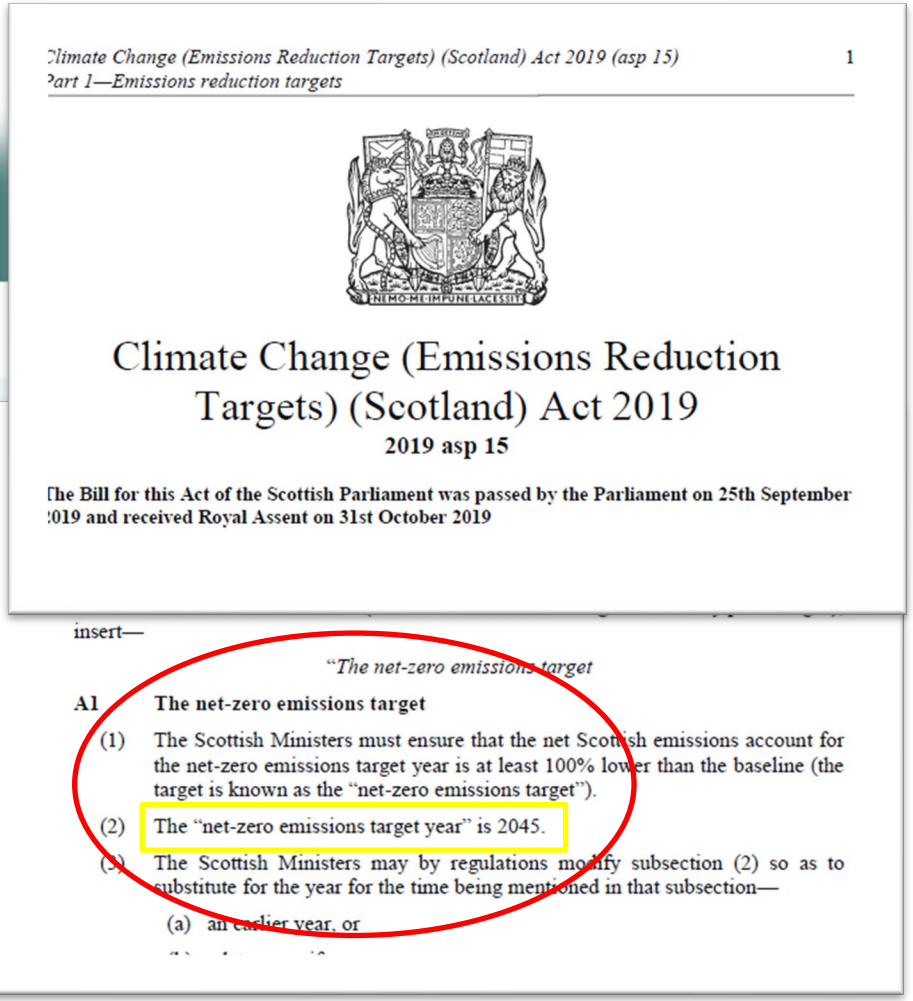
~ Understanding the role of social license and social acceptance for a successful hydrogen uptake in Scotland.

Delivering a just transition

Key message one: Pursue an orderly, managed transition to net-zero that creates benefits and opportunities for people across Scotland

1. To move us from strategy development to delivery at pace, the Scottish Government must ensure sufficiently developed roadmaps exist for the net-zero transition in Scotland, including for key technology options.

Source: Scottish Government, Just Transition Commission report; HMSO.



Climate Change (Emissions Reduction Targets) (Scotland) Act 2019 (asp 15) 1
Part 1—Emissions reduction targets

Climate Change (Emissions Reduction Targets) (Scotland) Act 2019

2019 asp 15

The Bill for this Act of the Scottish Parliament was passed by the Parliament on 25th September 2019 and received Royal Assent on 31st October 2019

insert—

"The net-zero emissions target

A1 The net-zero emissions target

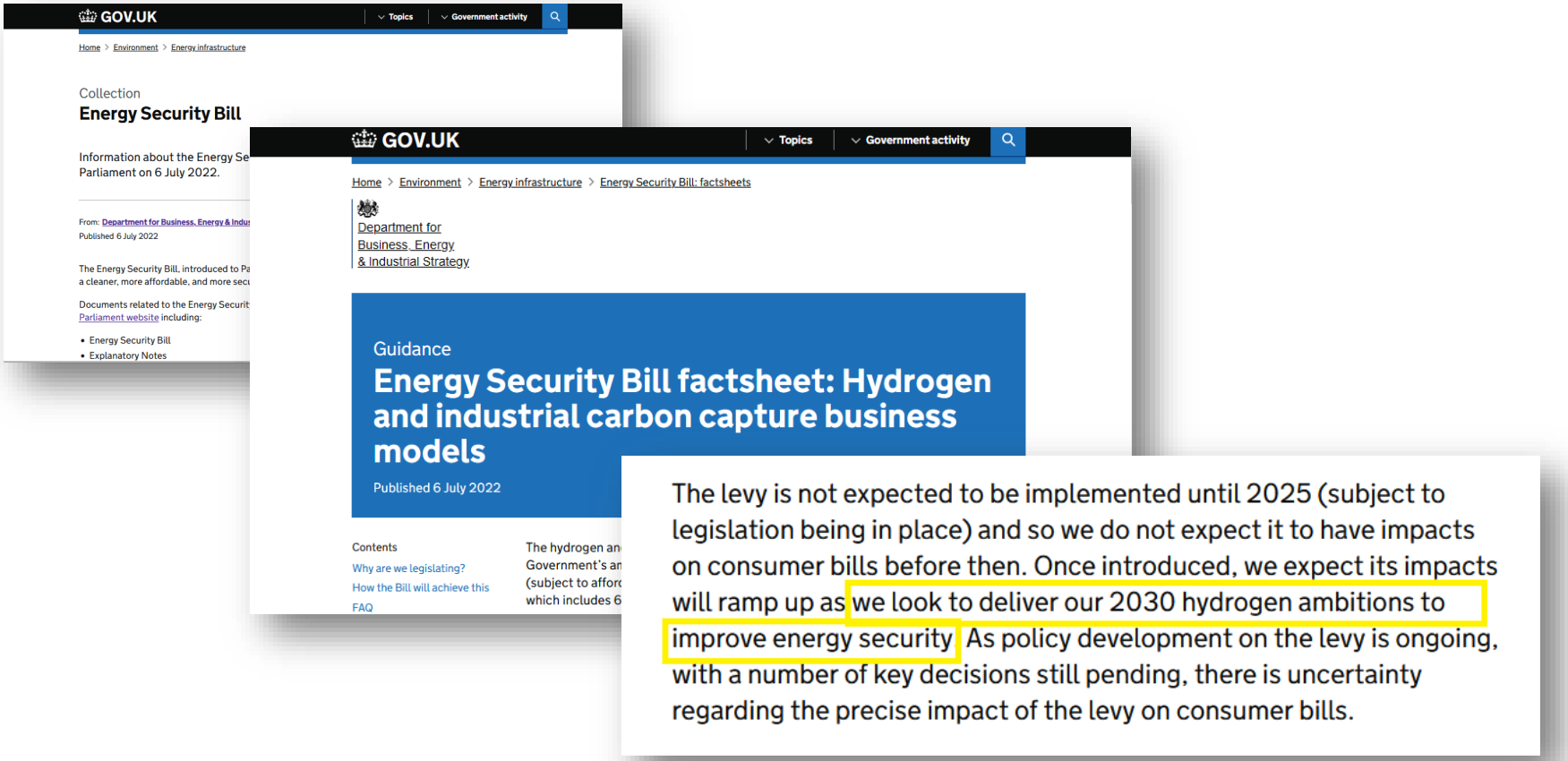
(1) The Scottish Ministers must ensure that the net Scottish emissions account for the net-zero emissions target year is at least 100% lower than the baseline (the target is known as the "net-zero emissions target").

(2) The "net-zero emissions target year" is 2045.

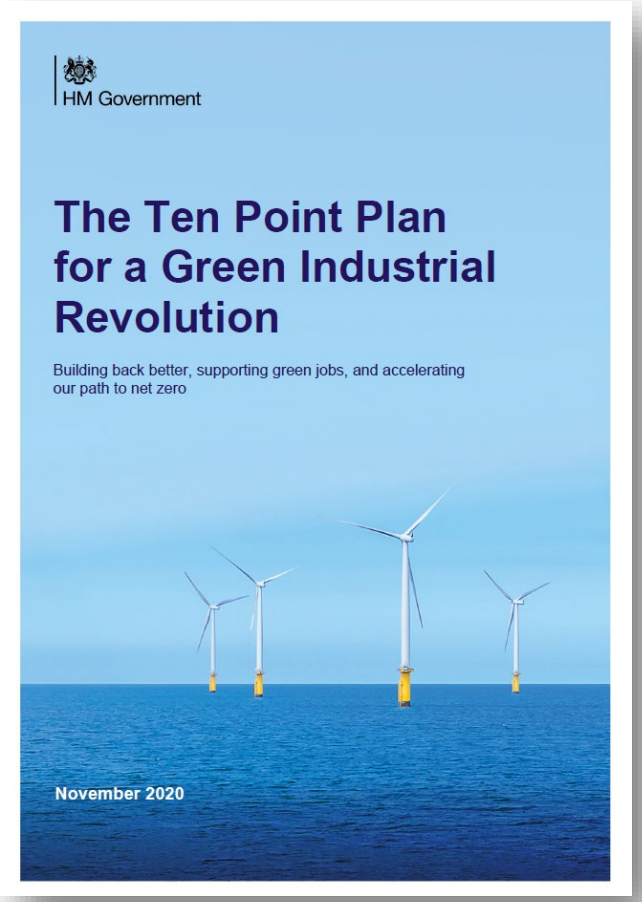
(3) The Scottish Ministers may by regulations modify subsection (2) so as to substitute for the year for the time being mentioned in that subsection—

(a) an earlier year, or

UK - Energy White Paper 2020



Source: Government Digital Service, GOV.UK platform.



GOV.UK Topics Government activity

Home > Environment > Energy infrastructure > Low carbon technologies

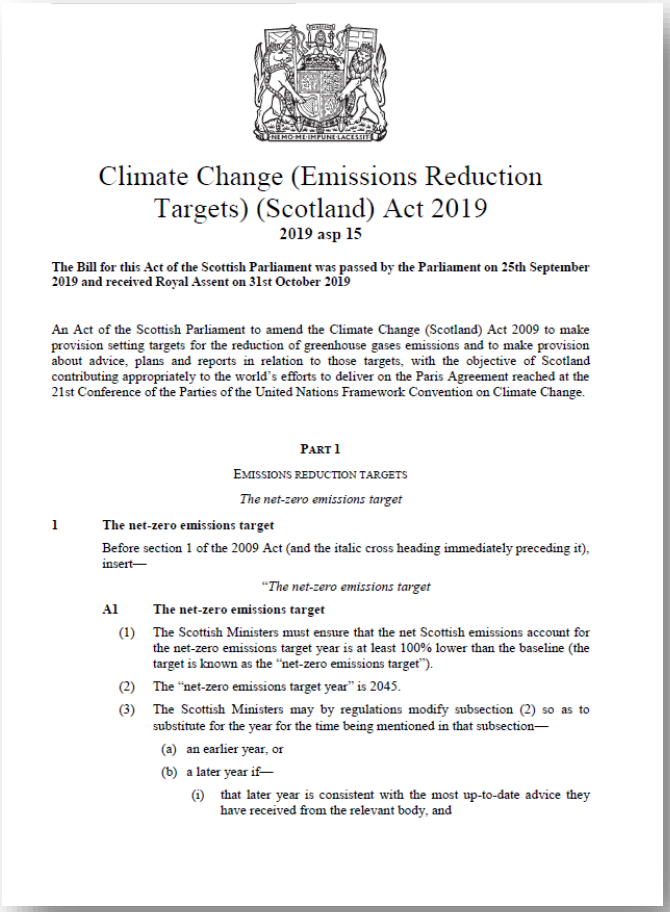
£90 million UK drive to reduce carbon emissions

Households and businesses will benefit from £90 million to cut carbon emissions in industry and homes.

8. Hydrogen projects awarded funding:

Project	Leading body	Funding received
Dolphyn Project	Environmental Resources Management Ltd	£3.12 million
HyNet	Progressive Energy Limited, in collaboration with Johnson Matthey, SNC Lavalin and Essar Oil	£7.48 million
Gigastack	ITM Power Trading Ltd, in collaboration with Orsted, Phillips 66 and Element Energy	£7.5 million
Acorn	Project Pale Blue Dot Energy	£2.7 million
HyPER	Cranfield University, in collaboration with Gas Technology Institute and Doosan	£7.44 million

Source: Government Digital Service, GOV.UK platform.



Climate Change (Emissions Reduction Targets) (Scotland) Act 2019

2019 asp 15

The Bill for this Act of the Scottish Parliament was passed by the Parliament on 25th September 2019 and received Royal Assent on 31st October 2019

An Act of the Scottish Parliament to amend the Climate Change (Scotland) Act 2009 to make provision setting targets for the reduction of greenhouse gases emissions and to make provision about advice, plans and reports in relation to those targets, with the objective of Scotland contributing appropriately to the world's efforts to deliver on the Paris Agreement reached at the 21st Conference of the Parties of the United Nations Framework Convention on Climate Change.

PART 1

EMISSIONS REDUCTION TARGETS

The net-zero emissions target

1 The net-zero emissions target

Before section 1 of the 2009 Act (and the italic cross heading immediately preceding it), insert—

"*The net-zero emissions target*

A1 The net-zero emissions target

(1) The Scottish Ministers must ensure that the net Scottish emissions account for the net-zero emissions target year is at least 100% lower than the baseline (the target is known as the "net-zero emissions target").

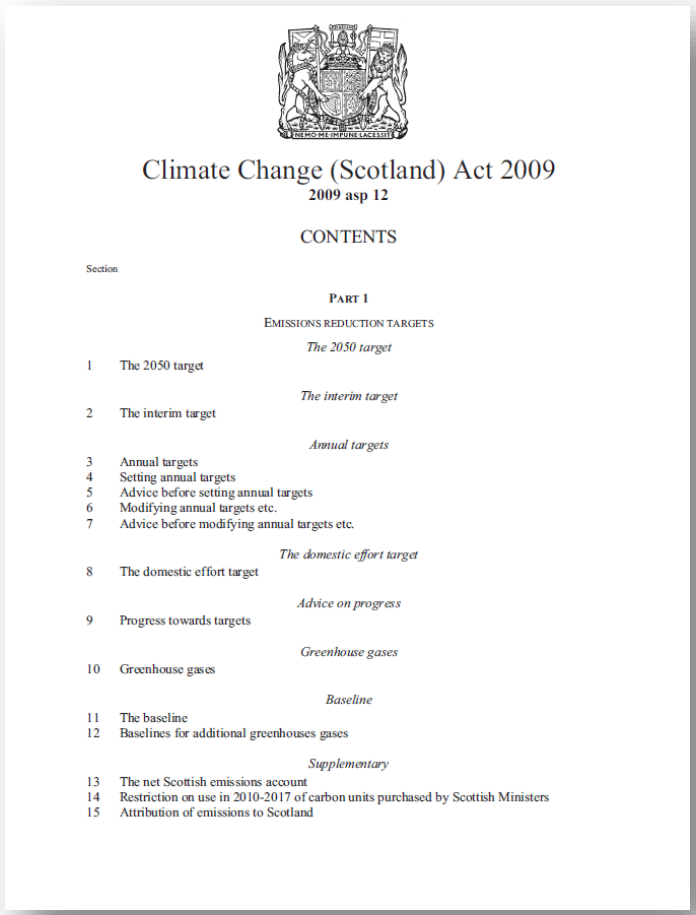
(2) The "net-zero emissions target year" is 2045.

(3) The Scottish Ministers may by regulations modify subsection (2) so as to substitute for the year for the time being mentioned in that subsection—

(a) an earlier year, or

(b) a later year if—

(i) that later year is consistent with the most up-to-date advice they have received from the relevant body, and



Climate Change (Scotland) Act 2009

2009 asp 12

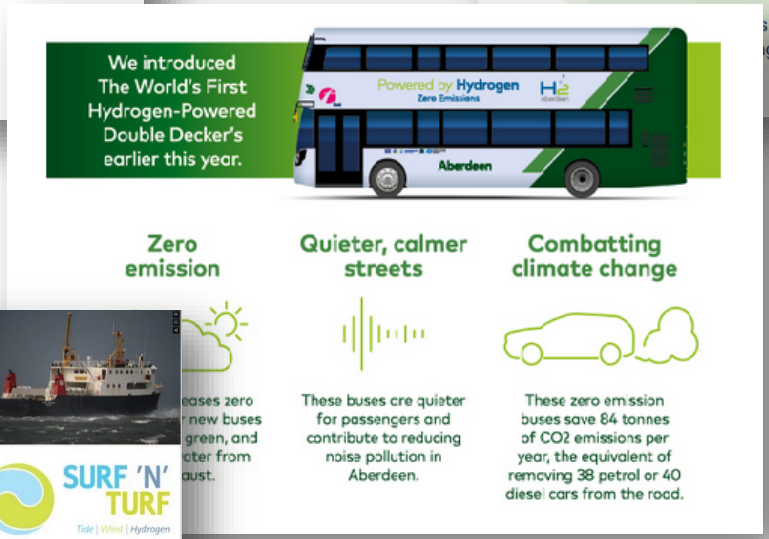
CONTENTS

Section

Source: HMSO.

Source: BIG HIT Project, BIG HIT webpage.

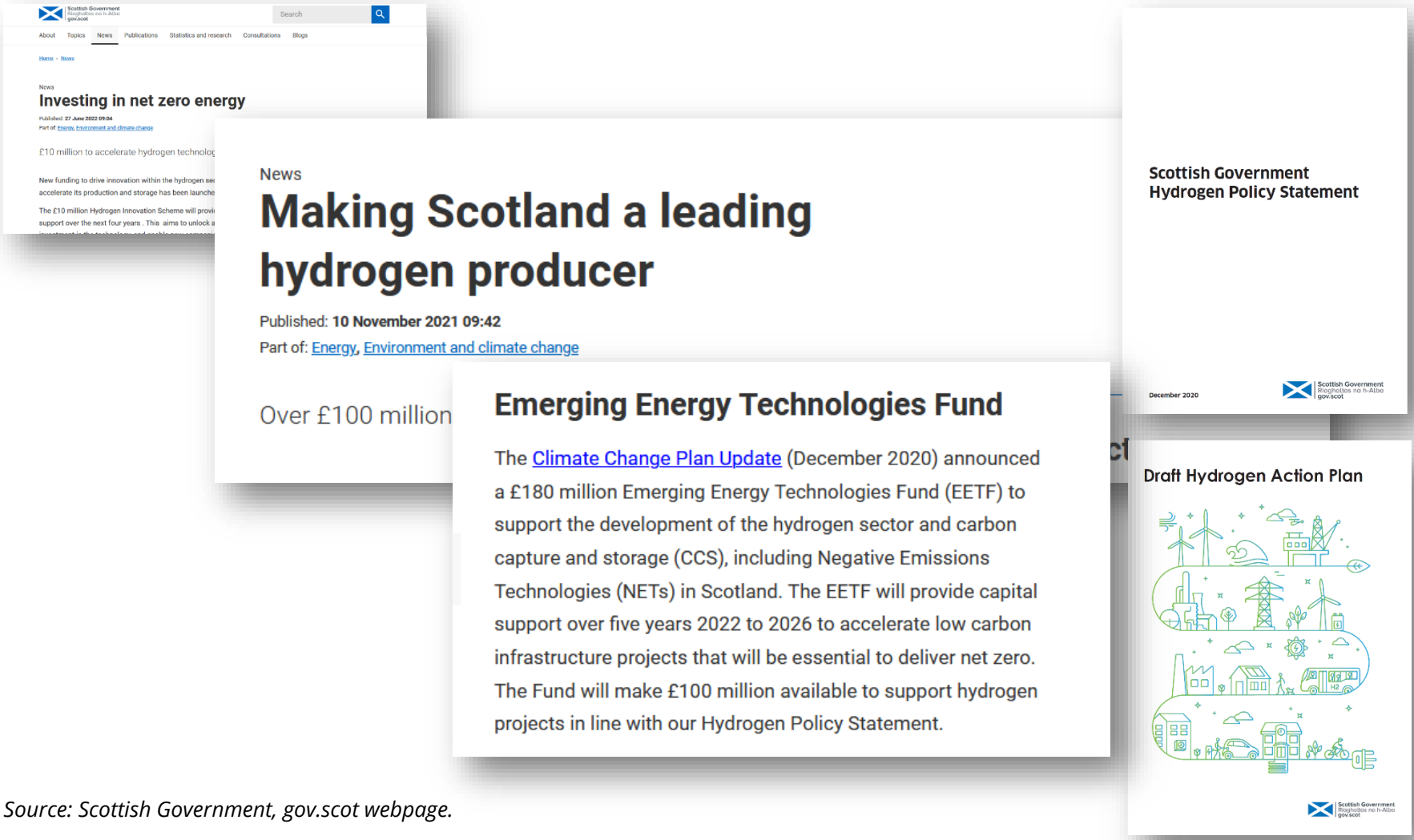
Policy Instruments and Social License for Hydrogen Uptake in Scotland



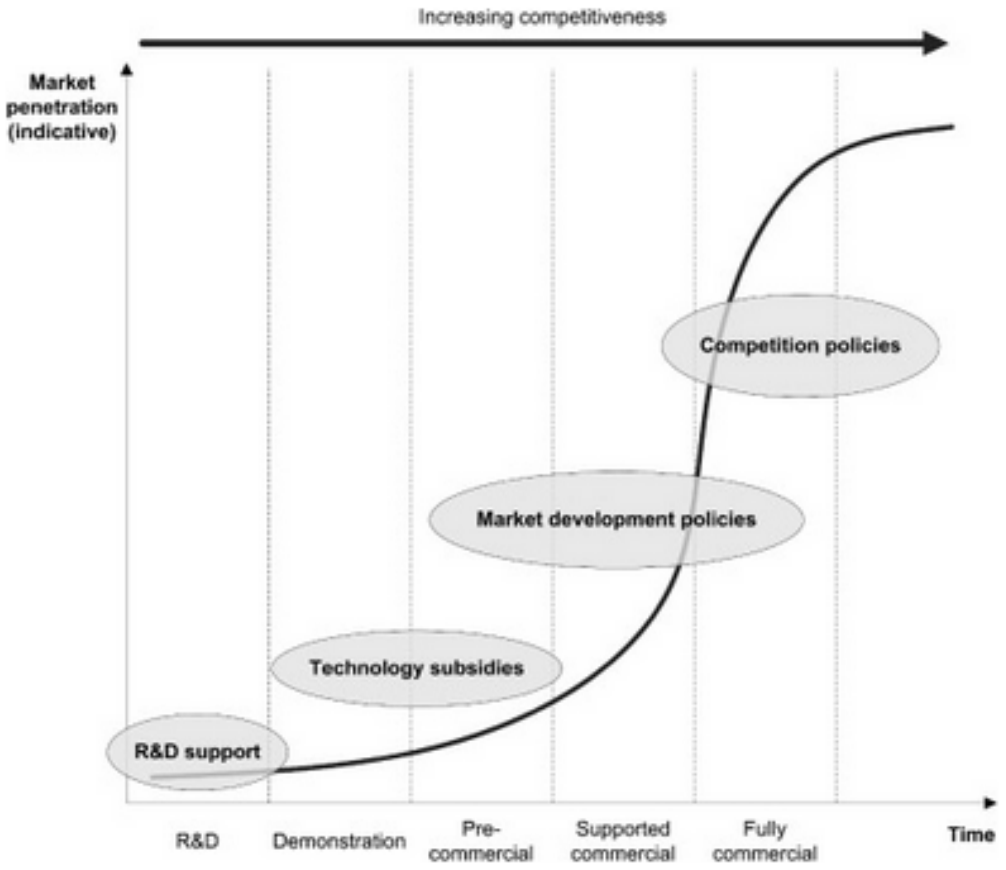
- The Aberdeen Hydrogen Hub presents the opportunity to use green hydrogen in the transport sector.

Source: Scottish Government, gov.scot; Scottish Gas Network, H100 Fife; FirstGroup plc; Community Energy Scotland, Surf 'N' Turf, webpages.

Policy Instruments and Social License for Hydrogen Uptake in Scotland



Source: Scottish Government, gov.scot webpage.



Source: S.R. Allen et al. / Applied Energy 85 (2008) 532.

Policy Instruments and Social License for Hydrogen Uptake in Scotland

INTERNATIONAL JOURNAL OF HYDROGEN ENERGY 47 (2022) 10441–10459

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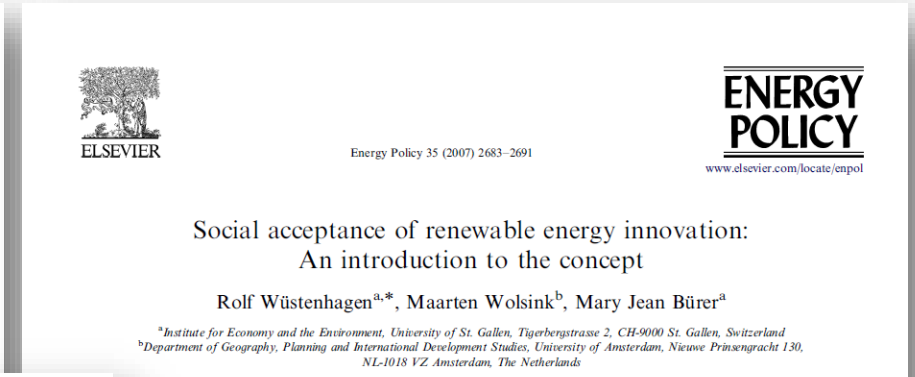
ELSEVIER

Review Article

Explaining hydrogen energy technology acceptance: A critical review

Mitchell D. Scovell



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Energy Policy 35 (2007) 2683–2691

ENERGY POLICY

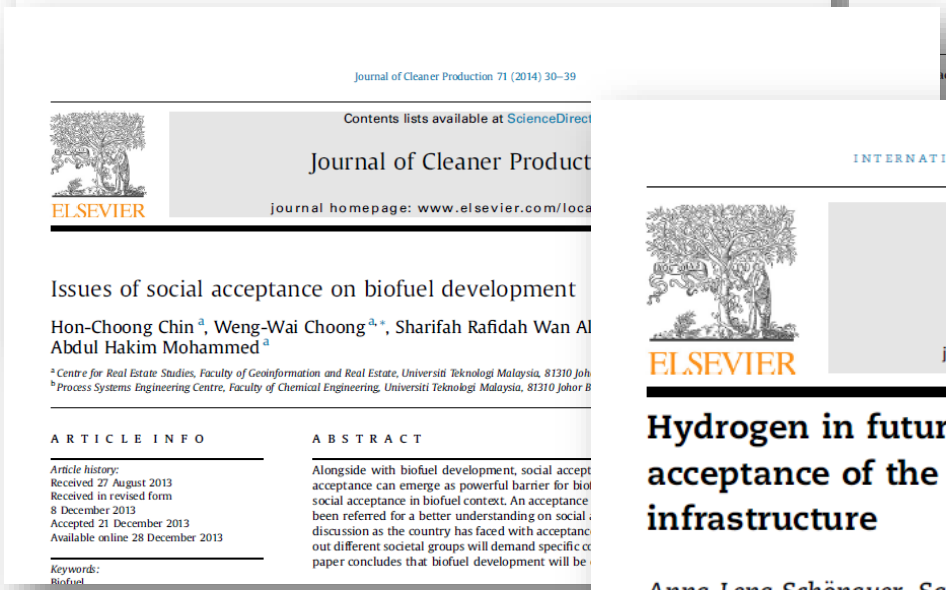
www.elsevier.com/locate/enpol

Social acceptance of renewable energy innovation: An introduction to the concept

Rolf Wüstenhagen[a,*], Maarten Wolsink[b], Mary Jean Bürer[a]

[a]Institute for Economy and the Environment, University of St. Gallen, Tigerbergstrasse 2, CH-9000 St. Gallen, Switzerland
[b]Department of Geography, Planning and International Development Studies, University of Amsterdam, Nieuwe Prinsengracht 130, NL-1018 VZ Amsterdam, The Netherlands

Available online 26 February 2007



Journal of Cleaner Production 71 (2014) 30–39

Contents lists available at ScienceDirect

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Issues of social acceptance on biofuel development

Hon-Choong Chin[a], Weng-Wai Choong[a,*], Sharifah Rafidah Wan Al
Abdul Hakim Mohammed[a]

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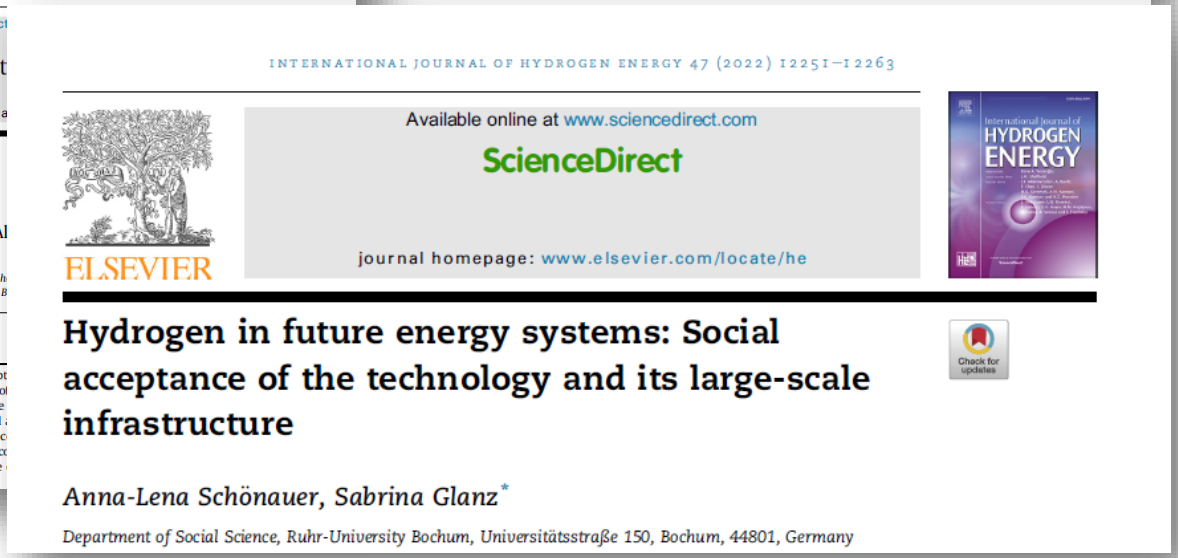
ABSTRACT

Alongside with biofuel development, social accept
acceptance can emerge as powerful barrier for bio
social acceptance in biofuel context. An acceptance
been referred for a better understanding on social
discussion as the country has faced with acceptanc
out different societal groups will demand specific c
paper concludes that biofuel development will be



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Hydrogen in future energy systems: Social acceptance of the technology and its large-scale infrastructure

*Anna-Lena Schönauer, Sabrina Glanz**

Department of Social Science, Ruhr-University Bochum, Universitätsstraße 150, Bochum, 44801, Germany

Source: See references.

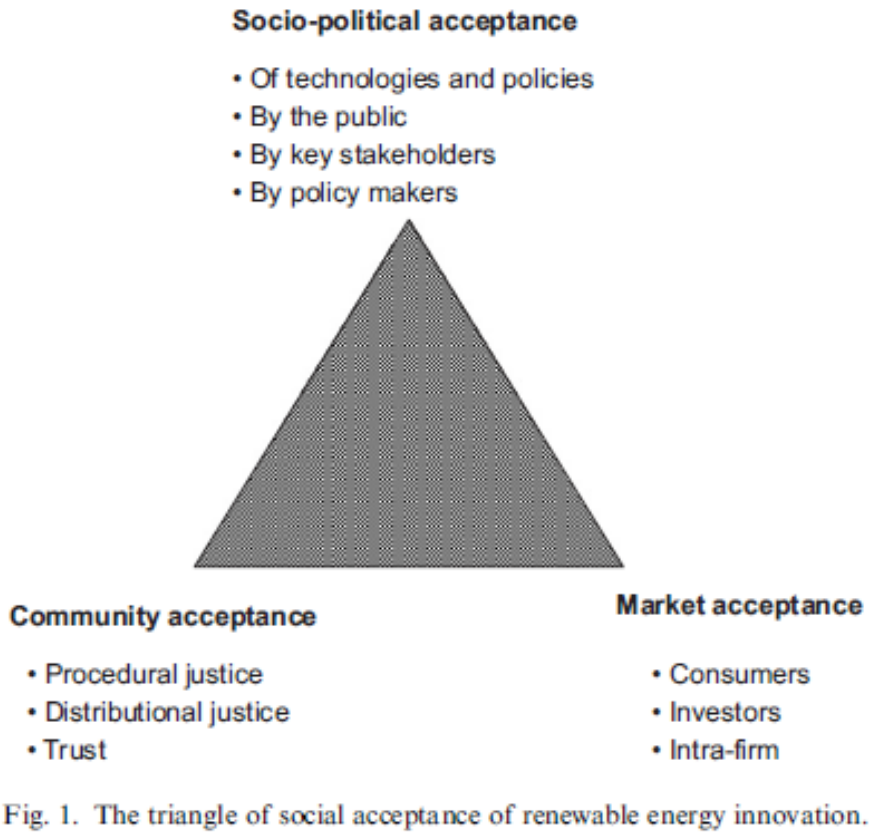


Fig. 1. The triangle of social acceptance of renewable energy innovation.

Source: R. Wüstenhagen et al. / Energy Policy 35 (2007) 2684.

Building community knowledge about hydrogen

Enhanced understanding of hydrogen is another key to increasing public confidence in a hydrogen industry. A University of Queensland study suggests the more Australians know about hydrogen, the more likely they are to support developing a hydrogen industry.

While acceptance of hydrogen is likely to grow of its own accord as people get used to its everyday use, public education will help accelerate the process. The University of Queensland study suggests Australians want governments and trusted research institutions, such as the CSIRO and universities to provide them with accessible, easy to understand information about the emerging hydrogen industry.[1] Community consultations to inform the Strategy suggest the same.

To begin building community knowledge, Australia will develop a community education program to provide clear and accessible information about hydrogen's risks, benefits and safe use. The program will communicate the particular benefits hydrogen development can bring to regions as well as more general benefits such as economic growth, lower carbon emissions and reduced air pollution.

Source: Commonwealth of Australia.

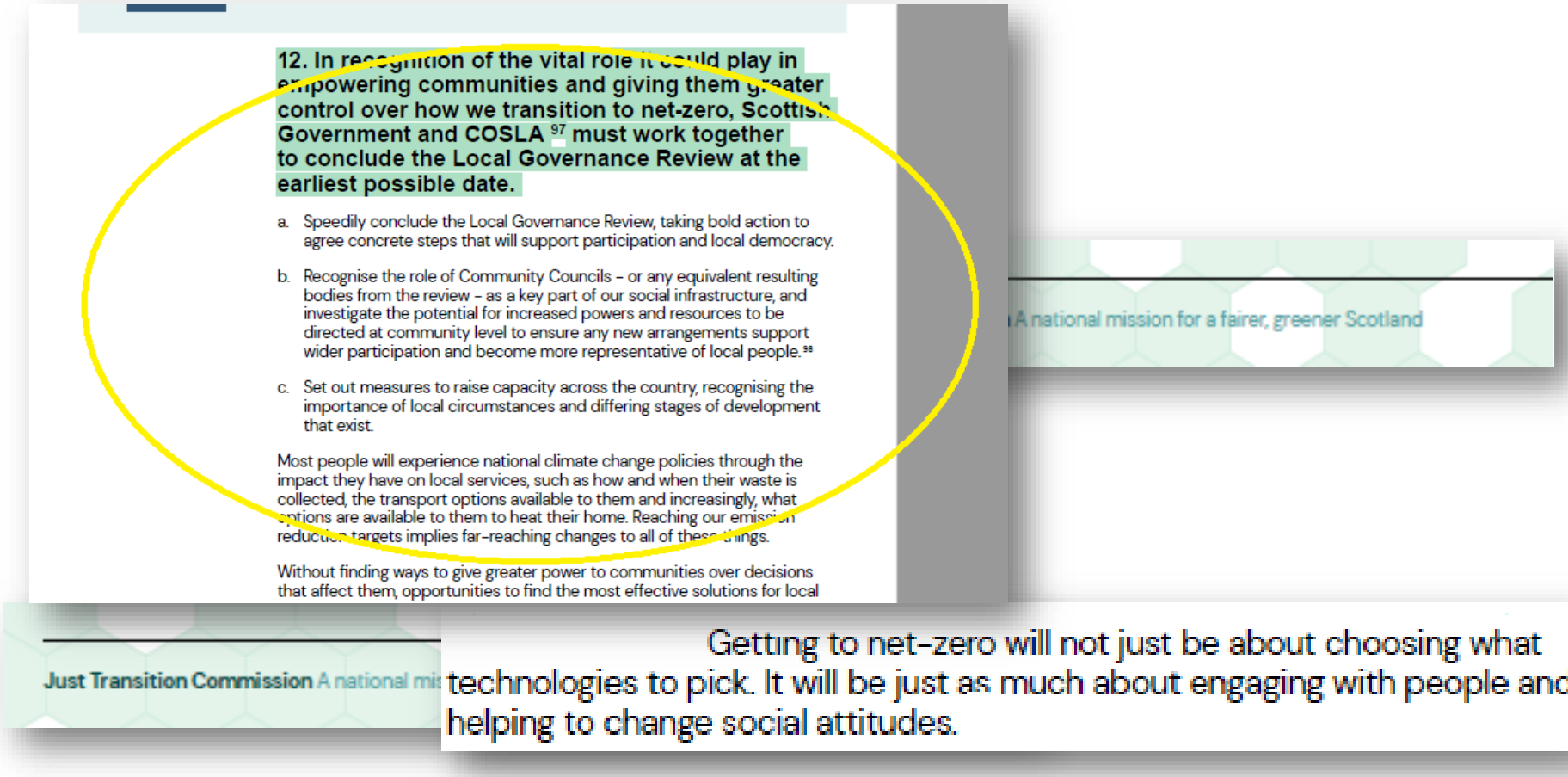
Written evidence submitted by the Royal Society of Edinburgh (HCC0044)

Scottish Affairs Committee inquiry into hydrogen and carbon capture: a response by the Royal Society of Edinburgh

Research priorities

16 Social scientists will be critical to achieving public acceptance of hydrogen. Although hydrogen is a proven technology, the public's awareness of its applications and benefits is variable. Social scientists can identify the barriers that undermine widespread behavioural change and work with individuals and communities to co-design interventions suited to the local context. This is particularly important from a just transition perspective as decarbonisation is already having an impact on skills needs and workers must be empowered to retrain and adapt to these changing

Source: UK Parliament, Scottish Affairs Committee webpage.



12. In recognition of the vital role it could play in empowering communities and giving them greater control over how we transition to net-zero, Scottish Government and COSLA [97] must work together to conclude the Local Governance Review at the earliest possible date.

a. Speedily conclude the Local Governance Review, taking bold action to agree concrete steps that will support participation and local democracy.

b. Recognise the role of Community Councils – or any equivalent resulting bodies from the review – as a key part of our social infrastructure, and investigate the potential for increased powers and resources to be directed at community level to ensure any new arrangements support wider participation and become more representative of local people.[98]

c. Set out measures to raise capacity across the country, recognising the importance of local circumstances and differing stages of development that exist.

Most people will experience national climate change policies through the impact they have on local services, such as how and when their waste is collected, the transport options available to them and increasingly, what options are available to them to heat their home. Reaching our emission reduction targets implies far-reaching changes to all of these things.

Without finding ways to give greater power to communities over decisions that affect them, opportunities to find the most effective solutions for local

A national mission for a fairer, greener Scotland

Just Transition Commission A national mis

Getting to net-zero will not just be about choosing what technologies to pick. It will be just as much about engaging with people and helping to change social attitudes.

Source: Scottish Government, Just Transition Commission report.

Policy Instruments and Social License for Hydrogen Uptake in Scotland

INTERNATIONAL JOURNAL OF HYDROGEN ENERGY 47 (2022) 10441–10459

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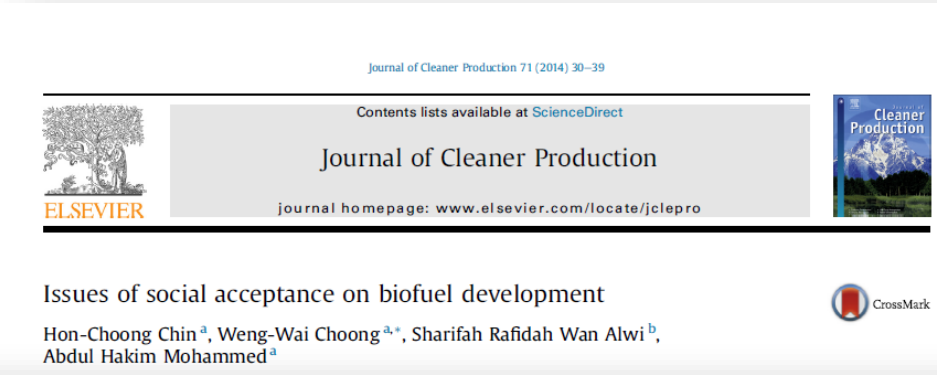
Commonwealth Scientific and Industrial Research Organisation (CSIRO), Dutton Park, QLD, 4102, Australia



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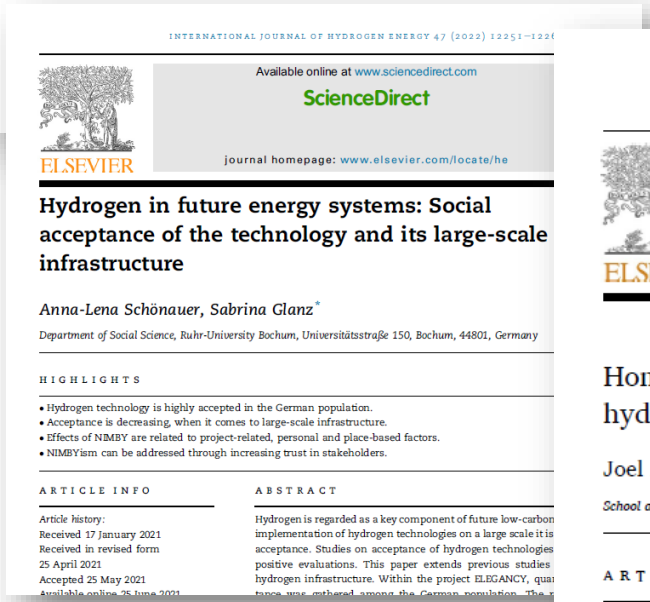

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Hydrogen in future energy systems: Social acceptance of the technology and its large-scale infrastructure

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Department of Social Science, Ruhr-University Bochum, Universitätsstraße 150, Bochum, 44801, Germany

HIGHLIGHTS

- Hydrogen technology is highly accepted in the German population.
- Acceptance is decreasing, when it comes to large-scale infrastructure.
- Effects of NIMBY are related to project-related, personal and place-based factors.
- NIMBYism can be addressed through increasing trust in stakeholders.

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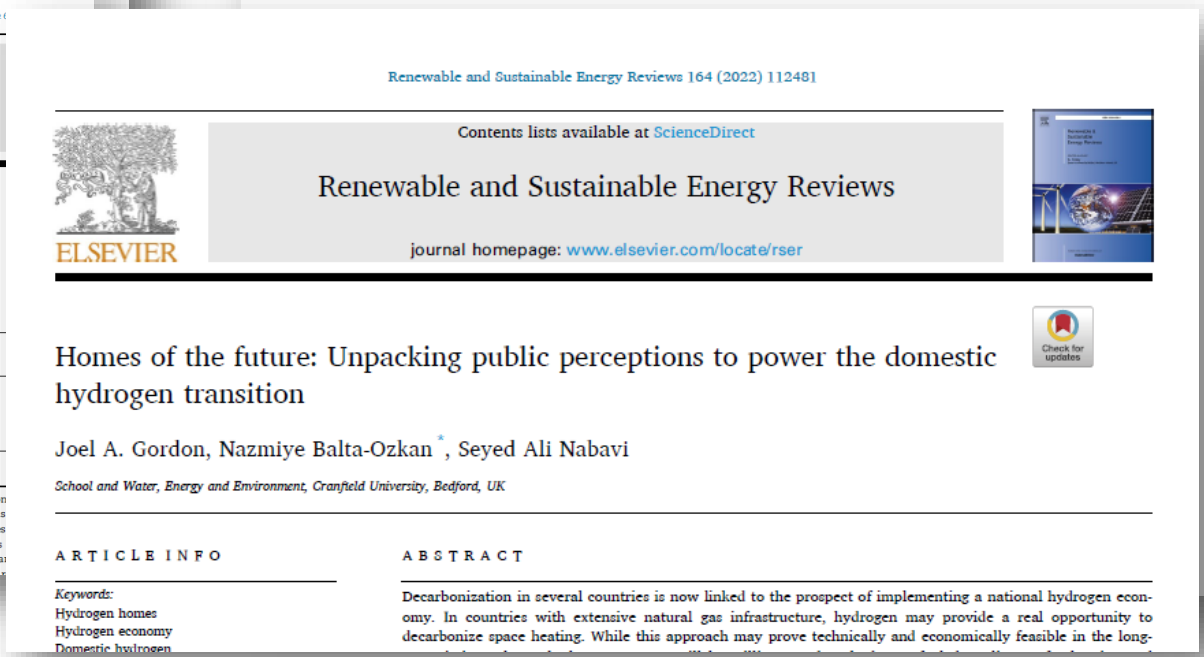
ABSTRACT

Hydrogen is regarded as a key component of future low-carbon
implementation of hydrogen technologies on a large scale it is
acceptance. Studies on acceptance of hydrogen technologies
positive evaluations. This paper extends previous studies
hydrogen infrastructure. Within the project ELEGANCY, qua



Renewable and Sustainable Energy Reviews 164 (2022) 112481

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Renewable and Sustainable Energy Reviews

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Homes of the future: Unpacking public perceptions to power the domestic hydrogen transition

Joel A. Gordon, Nazmiye Balta-Ozkan *, Seyed Ali Nabavi

School and Water, Energy and Environment, Cranfield University, Bedford, UK

ARTICLE INFO

Keywords:
Hydrogen homes
Hydrogen economy
Domestic hydrogen

ABSTRACT

Decarbonization in several countries is now linked to the prospect of implementing a national hydrogen economy. In countries with extensive natural gas infrastructure, hydrogen may provide a real opportunity to decarbonize space heating. While this approach may prove technically and economically feasible in the long-

Source: See references.

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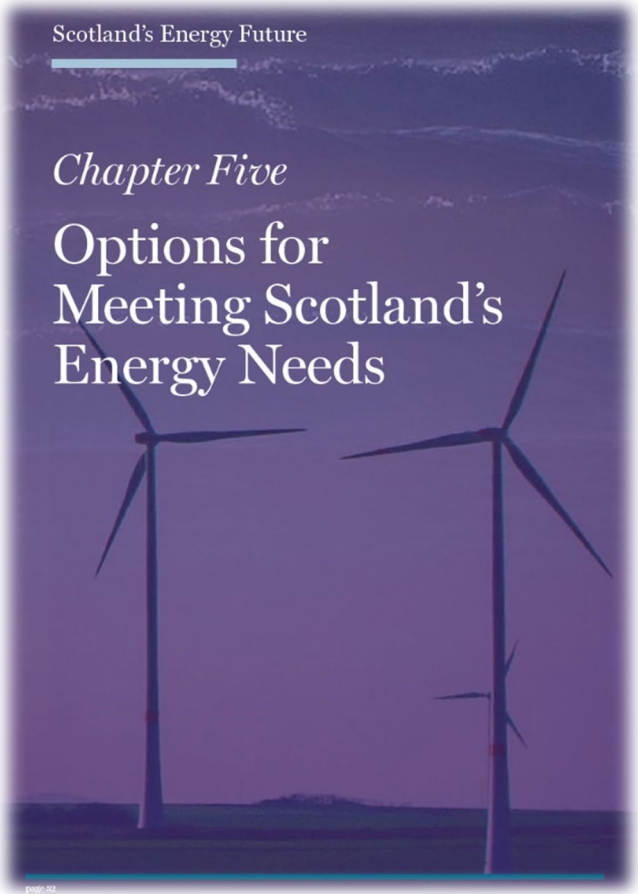

Thank you for your attention ~

Source: The Royal Society of Edinburgh, Scotland's Energy Future report.