

# **HIAIba-IDEA**

## **Maximising Scotland's Well-Being by Bravely Innovating**

*The productivity puzzle and how to solve it needs new thinking.*

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*Dottles\**

### **Abstract**

### **Introduction**

### **The 3D era**

### **Beyond 3D?**

### **Productivity Gains by Transitioning to Export Powerhouse**

### **Proposed Papers**

- 1. Innovation in Building Social Capital to Maximise Well-Being***
- 2. Hydrogen Scotland: A Route to Export Powerhouse***
- 3. Investment in Demonstrations of Hydrogen Scotland Technologies***
- 4. Investment in the Deployment of Hydrogen Scotland Technologies and Advances***
- 5. Scoping the Extent of Eco-Industrialising the Highlands and Islands***
- 6. Crofting as a Catalyst for Hydrogen Scotland Development and Eco-Industrialisation***
- 7. Greenprint for a Lead Community on the Isle of Skye***
- 8. Evaluation of the National Socio-Economic and Environmental Impacts***
- 9. Appraisal of Manufacturing and Service Export Opportunities***
- 10. A Business Case for Operating an Implementation Capacity on the Isle of Skye***

### **Regional Contributions to Raising Productivity and Powering Export Performance**

### **Annex A: Distributed Ledger Technology Acceleration of Advances in Health Services and Genomics**

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## Abstract

This is an Overview of a series of papers that will report on proposed investigations to identify and evaluate latent<sup>1</sup> opportunities – existing, emerging, expecting – that if realised could contribute to maximising the well-being of not only Scotland’s citizens but the natural environment and resources which sustains them. We envisage such realisation depending on meshing “bravely innovating” processes of governments, enterprises and communities-of-interest to enhance Scottish strengths, particularly in export endeavour, in existing and emerging sectors and to shape the environment for “back-to-the-future” expectations of resurgent enlightenment.

We perceive the need for innovation in building social capital given its role as the preeminent driving force in achieving and mobilising the quality of human capital to maximise well-being, broadly defined. We consider social capital resources such as **trust**, **cultural norms**, and **networks of association**:

**Trust** – tolerance encouraging morals, habits and customs that harmoniously mesh economic life and social life, as richly perceived by Adam Smith and more recently formalised persuasively by leading thinkers such as Francis Fukuyama; effective informal contract mechanisms, encouraging innovators’ collaborations that spur innovation.

**Cultural Norms** – reciprocity encouraging bargaining, compromise, and pluralistic politics; belief in equality of citizens encouraging the formation of cross cutting groups.

**Networks of association** – [social cohesion](#) encouraging efforts to change the world for the better as characterised by Mead - “Never doubt that a small group of thoughtful, committed, citizens can change the world. Indeed, it is the only thing that ever has.”; *social coherence* characterised by the existence of stable and harmonious community-of-interest networks enabling social cohesion (clearly Mead’s groups command social cohesion); [super-diversity](#) (diversification of diversity) of cultures in groups of citizens and existing in networks of relationships nurturing social cohesion and coherence.

We concur with the view espoused in the [The Four Must Haves for Innovation](#) that “for innovation to fulfil its potential, there are four elements that must be aligned. Meshing **purpose**, **leadership**, **strategy** and **culture** is the way to new value creation.” – – –

Must Have # 1: **Purpose** clearly articulated – the case will be made in the papers for Scotland to take a “bravely innovative” lead role in “public purpose”, as exemplified by the [Institute for Innovation and Public Purpose](#): “rethinking how public value is created, nurtured and evaluated” and the insights

Must Have # 2: **Leadership** is every individual’s responsibility – we perceive that Scotland will enlighten once more and do so in highly productive ways if communities, innovators and enablers<sup>2</sup> populate each other’s minds on how to realise the opportunities arising from decarbonising economies, decentralising to optimise well-being in urban, rural and remote habitats, and digitalisation supporting such realisations; decarbonising mainly through a “game changing” opportunity for Scotland by generating renewable energy (a) to produce ammonia-hydrogen for exporting on a massive scale and (b) to produce highly innovative products and create enabling services using local and regional resources (including human and social capital) for local and national consumption and contributing to a massive scale export effort of services as well as products.

Must Have # 3: **Strategy** to shape the environment in your favour – perceive ways of delivering spectacular productivity gains to grow the economic pie and by sharing it more equitably accelerate that growth.

Must Have # 4: **Culture** is the force multiplier – from the role of modern crofting as a catalyst to “awakening the giant” of the Highlands and Islands potential to “populated-mind” teams focussed on realising latent global-scale, renewable energy distribution and consequent opportunities in manufacturing and services throughout Scotland, primarily supported by harnessing massive flows of FDI to build-own-operate the enabling renewable energy infrastructure.

We also proffer the view that innovation in tax reform is also critical to achieving an enlightened future, especially as this relates to the (re) formation and depreciation of ‘Social Capital’ by assessing:

- the contributions of various forms of polluter-pays taxation reforms, including carbon and other greenhouse gas taxes and attendant harvesting of significant flows of carbon credits;
- the contribution from wide-scale simplification of the taxation miasma through land tax reform;
- the means of affecting income distribution to ensure that the decline in poverty is commensurate with and enhances growth of the economic pie;
- the merit of meeting rising health and social welfare needs through reform in taxing property and inheritances of those well placed to consider doing so.

It is proposed to assess these and other possible forms of innovative taxation reform through the lenses of purpose, leadership, strategy and culture collectively focussed on delivering spectacular growth in productivity.

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<sup>1</sup> Latent in the sense of realising undeveloped opportunities of unreleased potential, analogous to Joseph Black’s release of “hidden” thermal energy leading to advances in thermodynamics and James Watt’s steam engine technology both at the University of Glasgow along with their firm friend Adam Smith, all fellow members of the Scottish Enlightenment.

<sup>2</sup> Local, regional and national forms of governance and corporates awake to the opportunities offered by renewable energy futures.

## Introduction

From Scotland the Brave to Scotland the Innovator. While in actuality, and as our historical journey indicates, our collective ethos is perhaps more enshrined by the latter, we are failing as a society to benefit sufficiently from this reality, preferring to revel in the former. Perhaps now is the time to forge a fusion? What would such a fusion look like?

A fusion focussed on policy changes to maximise (holistic – defined below) well-being creation rather than a sole focus on wealth creation as reasoned by the recently released study [The Origins of Happiness](#) which identifies the critical factors affecting a person's happiness are their relationships (social capital) and their mental and physical health (argued by some economists as key components of human capital together with educational attainment and financial independence) with "income inequality accounting for only two percent or less of the variance in happiness across the population" (based on a uniquely comprehensive range of evidence from longitudinal data on over one hundred thousand individuals in Britain, the United States, Australia, and Germany). And for an economist's take on happiness, we have this insight from Adam Smith: "*What can be added to the happiness of a man who is in health, out of debt, and has a clear conscience?*": perhaps viewing "health" as physical health, mental health related to a "clear conscience" and financial independence equating to "out of debt". So, we think of well-being in a holistic way rather than the narrower focus that has been used in recent policy debates.

It is our contention that the slow productivity growth that has been on the radar in both the UK and Scotland of late is not just attributable to the depreciation and quality of physical and human capital but also the depreciation of social capital, a much under researched source in the recent literature. Social capital has been linked to a number of positive outcomes, including, for example, mental health. However, few studies have examined the role of [social capital and mental health and wellbeing](#) concurrently. In this respect, depression is ranked by WHO as the single largest contributor to global disability (7.5% of all years lived with disability in 2015); anxiety disorders are ranked 6th (3.4%). Depression is also the major contributor to suicide deaths, which number close to 800 000 per year. The influential book [Lost Connections - uncovering the real causes of depressions - and the unexpected solutions](#) (January 2018) seeks redressment. Also relevant is the thinking underpinning the 2001 OECD report [The Well-being of Nations—the role of human and social capital](#) which in considering the relationship between human well-being, economic well-being and GDP concludes that economic well-being is broader than measures such as GDP "...and political, institutional and legal arrangements are extremely important complements to human and social capital."

However, although a fusion that completely transcends Krugman's perspective in his study [The Age of Diminished Expectations](#) (that "Productivity isn't everything, but, in the long run, it is almost everything. A country's ability to improve its standard of living over time depends almost entirely on its ability to raise its output per worker.") appears attractive, the reality would seem to be that productivity improvements are still essential to delivering the wider wellbeing of Scottish and UK citizens. This in part relates to the recent relatively poor productivity performances in the UK and in Scotland and the knock-on effects this has for GDP growth and the consequent generation of tax revenue for the provision of public services. This theme would seem to resonate especially strongly in the current Scottish context given that the majority of the Scottish Government's budget is now raised by a combination of devolved income tax and assigned VAT, along with a group of minor taxes.

How would we know this fusion is succeeding? One approach would be to assess the performance over time of Scotland as a separate country in the global [Ranking of Happiness](#) report. In the recently released report, all five Nordic countries (Finland, Norway, Denmark, Iceland and Sweden) are in the top 10 along with Switzerland, the Netherlands, Canada, New Zealand and Australia. The USA and UK (including Scotland) take 18th and 19th places. Should Scotland alone strive to join the Nordics? The ranking criteria encompass "GDP per capita, Social support, Healthy life expectancy at birth, Freedom to make life choices, Generosity, Perceptions of corruption". So, while maximising national wealth (as inferred by GDP per capita) through innovatively fostering the creation of increasingly productivity enterprises, policy responses focussed on the other criteria are more likely to be maximising the well-being rather than the wealth of a nation's citizens, with Scotland joining the Nordics?

## The 3D era

Permeating our thinking as well as [social capital building imperatives](#) and *The Four Haves of Innovation* is a growing awareness of what we refer to as the emerging 3D era and the enhanced expectations that it engenders. Not 3D in a dimensional sense, such as the potential of 3D printing, but 3D characterising the major societal change processes of Decarbonisation, Decentralisation, Digitalisation...

The case is being made in the papers for the Highlands and Islands of Scotland (an area the size of Wales and vitally important to the Scottish economy), and more widely for the whole of Scotland, to take a “bravely innovative” approach to conceiving and delivering innovation and public purpose<sup>3</sup> in capturing the opportunities afforded by the **3D era**. Opportunities which are accelerating the processes of:

- **Decarbonisation** of electrification and transportation (through a “game changing” use of renewable energy to produce ammonia as a store and carrier of hydrogen), driven by very rapid reductions in the cost of renewable energy and a dramatic breakthrough in reducing the cost of producing hydrogen from ammonia which we believe could have revolutionary implications for the Scottish economy.
- **Decentralisation** with its attendant manifold societal benefits that could be realised by rapidly decreasing costs of generating and using off-the-grid renewable energy at the local level for residential living and sustainable production of export goods from local and regional natural resources, supported by [blockchain](#) and Decentralised Ledger Technologies (DLTs) that facilitate participating communities to maximise their returns from inputs to the national grid. And a future where drones support the delivery of medicines and [defibrillators](#) by operating as [full-sized drone ambulances](#) with CT scanning facilities and [5G telemedicine](#) is commonplace.
- **Digitalisation**<sup>4</sup> expanding applications of information and communications technologies into every relevant facet of human behaviour and endeavour through advances in:
  - a) Autonomous electrical vehicles and the security and controllability of transportation systems.
  - b) AI and machine learning (e.g. delivering medical diagnosis and robotised treatments globally).
  - c) Additive and increasingly robotised manufacturing.
  - d) Security and controllability of ubiquitous Internet-of-Things (IoT) devices.
  - e) DLTs<sup>5</sup>, including variants of blockchain technology eventually delivering stable (i.e., declining bubble latency) advances in crypto currencies underpinning sustainable financial systems (i.e., less characterised by Central Bank money creation and the global dictates of the “[exorbitantly privileged](#)” US dollar), and the formulation and management of all manner of contractual agreements.
  - f) DLT acceleration of advances in health services and genomics (see Attachment A).

In embracing **decarbonisation**, Scotland is clearly already a world leader in the transition to renewable energy-based electrification. This has afforded vanguard opportunities in the development and installation of innovative renewable energy technologies. And with this the enhancement of the prospects for increasing the productivity of the manufacturing and transportation systems they enable. Notable advancements in Scotland include siting of the [world’s first floating wind farm](#). Add to this the world’s first commercial applications in harnessing [wave and tidal energy](#) and [kite-generated electricity](#). Further add, various forays into enhancing the prospects for the contributions of hydrogen to fuelling pollution-free and increasingly productive transportation systems and of course the large number of wind farms that are now sighted all over the Scottish landscape, some of which are controversial.

Accelerating the processes of decarbonisation is a willingness to enact systems of taxation that produce this outcome. A useful assessment starting point is the 2015 OECD report [Aligning Policies for the Transition to a Low-Carbon Economy](#) and its consideration of taxation reforms looking at energy and beyond by assessing: (a) the taxing issue of low-carbon economies; (b) how energy subsidies and taxes undermine climate change action; (c) beyond energy taxes - tax signals hindering low-carbon choices; (d) where next for tax revenues and budgets in the context of lower fossil energy use?

We make the case that worldwide efforts seeking to boost national productivity through **decentralisation** would be ideally suited to Scotland’s noble crofting heritage and culture, holding the potential to catalyse the creation of productive communities maximising wellbeing creation in contradistinction to a sole focus on

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<sup>3</sup> As exemplified by the [Institute for Innovation and Public Purpose](#): rethinking how public value is created, nurtured and evaluated.

<sup>4</sup> Cf. [digitisation](#) to increase the efficiency of processes.

<sup>5</sup> [Distributed Ledger Technology: beyond block chain](#), UK Government Office for Science, Jan 2016 and the [Video](#).

maximising wealth creation. We see this development as crucial, for example, in stopping the process of splitting up crofts for development that has become so prevalent in parts of the Highlands such as Skye. We will seek answers to whether this has the potential to reverse the breakdown of that culture through the drift to incomers buying the crofts for pepper corn prices, de-crofting and selling on the land as developments.

For many the era of crofting seems long past and this seems very evident to one of the authors based on Skye where de-crofting and the use of crofting land for effectively property speculation seems to have become the norm. Markedly increasing land values for new townships and in this case the adjoining crofting community(ies) could be internalised along line of this Economist article "[Why Henry George had a point: Ideal in theory, elusive in practice: the case making landowners pay for the benefits which location gives them.](#)" No free loaders, no developers making a killing, scaling landowner tax from the lowest for crofters, then productive residents to virtually prohibitive land taxes for the absentee landowners/landlords/lairds. The Lincoln Institute's report, [Assessing the Theory and Practice of Land Value Taxation](#), provides real world experience on land value tax implementations. Also, of possible relevance would be an assessment of the small and medium size enterprises unique to Germany, and the backbone of its strong economy as reported in "[Prosperity through cooperation – Germany's economic miracle – case studies](#): an investigation of their underlying concepts, characteristics, and how they thrive in competitive markets while being socially responsible".

One of the oft heard criticisms of the way crofting has developed in the Highlands is that the breakdown of the traditional crofting communities amounts to a breakdown, or perhaps more correctly the depreciation, of social capital and the profound implications this can have not only for the culture but the broader economic environment. But we believe such depreciation has a wider resonance across modern day Scotland and indeed beyond.

The concept of [Social Capital](#) was first introduced by [L. J. Hanifan](#) in 1916 and described "as those tangible assets [that] count for most in the daily lives of people: namely goodwill, fellowship, sympathy and social intercourse among individuals and families who make up a social unit". As Robert Putnam's analysis of social capital in the USA demonstrates, in his best-selling book [Bowling Alone](#), the importance of understanding changes in social capital has important implications for a nations overall Wellbeing, including its productivity capacity and consequently economic growth. Putnam argues that although Americans have become wealthier in aggregate in the last century their sense of community has declined and depreciated. 'Cities and traditional suburbs have given way to 'edge cities' and 'exurbs' – vast anonymous places where people sleep and work and do little else' (see, for example, [OECD Insights: Human Capital – What is Social Capital?](#)). Putnam uses the example of bowling to argue that the decline of the community networks that once led Americans to bowl together represents a loss of social capital.

James Coleman in his article *Social Capital in the Creation of Human Capital* has argued that Social Capital is an important component of human capital and therefore a key determinant in the productivity/economic growth nexus. Francis Fukuyama in *The Social Virtues and the Creation of Prosperity* pushes this further by noting that the ability for people to associate and create social capital is a function of Trust which can be demonstrated to have measurable economic value. The decline of trust and sociability in many advanced countries has led to the breakdown of social capital in terms of the family and a wide range of intermediate structures. The concept of social capital and particularly its implications for inequality has been highlighted more recently (2012) by Charles Murray in his book [Coming Apart](#). Possible the most powerful insights into eradicating poverty are posed by economist Daron Acemoglu and political economist James Robinson in [Why Nations Fail](#) depends on whether the institutions of a state are "inclusive" or "extractive", where the former accords its citizens a say in decision-making and the latter privilege the voice of the few allowing them to exploit and rule. Just as the threat of the authoritarian state oppresses so also does market fundamentalism exacerbate disparity and deprivation. To avoid the tyranny of both democratic politics is key to reinforcing the role of society in fostering the forms of civic engagement essential for participation and accountability in public and political life.

In sum, the key point here is that the social capital represented by related networks and understandings engenders trust thereby enabling people to work together and that inevitably has consequences for productivity and growth. One particular concern is that there is bound to be a further depreciation of social capital in Scotland as the kind of digitalisation processes referred to above develop. Accordingly, we reason it is crucially important in moving forward to recognise the role of social capital as part of the big picture to improve Scotland's productivity.

In **digitalisation** the case is made throughout the proposed papers that AI and machine learning can extend the global reach of Scottish medical services (from cities and regional centres) and be a major player in the industrial scale development of attendant advances in enabling software. Also, as DLTs begin to underpin - (a) secure and increasingly productive peer to peer transactions, (b) secure financial transactions and (c) secure contractual needs - Scotland by embracing decarbonisation and decentralisation opportunities will naturally create and export attendant advances in DLTs software at an industrial scale of endeavour.

While there is an understandable step back from 'digital revolutions' among many, we reason that having missed out on the massive commercial (and not always admirable) gains made by the Internet giants, Scotland could be in the vanguard of the development of software enabling AI, machine learning and DLT applications on a commensurate scale by actively embracing the opportunities of the 3D era. But in doing so, we envisage that this generation of software development offers routes to being vastly more productive, secure and well-being enhancing than that arising from current social media offerings and the increasingly anticompetitive behaviour of online search and social networking services (transitioning from a nascent generosity of spirit in a "do no evil" reach to the blind-eye commercial expedient of a "see no evil" grasp).

With major investors and foundation developers of Facebook withdrawing support and [growing](#) concerns about threats imposed by the [behaviour modification empires](#), Facebook and Google, there are increasing efforts to conceptualise the creation of [sustainable information ecosystems](#) free of ever more insidious incursions into human privacy driven by advertising technology and "big-data, deep-learning applications" that threaten the future of democracy. Beyond conceptualisation comes [BAT](#) offering a blockchain-based digital advertising technology cryptocurrency exchanges between publishers, advertisers and users where users control their peer-to-peer networking data and are paid for its uses in ways they deem appropriate. And [Hold](#) a smart-phone app seeking to reverse the growing productivity sapping trend in smart-phone addiction by providing rewards (cinema tickets, coffee, drinks, etc) for set periods of abstinence. Also, the youth-inspired, despair reducing initiative, [Reperceived](#), that is "bringing together young people from around the world to explore a range of current issues. From politics, social issues, education and human rights to religion, the environment, economics and modern technology."

Of course, one of the key challenges in the digitalisation agenda is that it will undoubtedly lead to, perhaps spectacular, productivity gains but it may also lead to challenges of employability along the lines of the issues discussed at the [Scotland's Inclusive Growth Conference](#). Many recent assessments, including a recent Asian Development Bank report, reason that automation and other changes will ultimately lead to the creation of more jobs in the coming decades than are displaced through rising demand spurred by improved efficiency or productivity. Serial entrepreneur Nathan Myhrvold writing in Scientific America (April 2018) provides a well-reasoned anti-luddite perspective in his article: ["What the History of Math Can Teach Us about the Future of AI: Domsayers say it will put us all out of work, but experience suggests otherwise."](#) However, of greater concern is the type of jobs and the degree of financial security they will secure. While it's more than likely that the economic pie will grow larger with ever more to share around, how do we do this much more equitably than has occurred in the past 50 years?

Many assessments are coming to the fore concerning the provision of incentive-based basic incomes. Two recent Ted Talks traversing the issues ["How we'll earn money in the future without jobs."](#) and ["Poverty isn't a lack of character; it's a lack of cash."](#) exhibit advances in thinking since the Thatcher pronouncement, "Poverty is a personality defect." As [Ontario](#) gears up for a major basic income trial and [Finland](#) is already trialling, but seemingly not seriously enough, there is a burgeoning conversation online – e.g., [The Top 10 Best Blogs on Universal Basic Income](#) and the [Basic Income Earth Network](#) – "Overview of Current Basic Income Related Experiments" (October 2017), including an account of proposed Scottish initiatives based on the highly regarded British think tank report on the potential for a basic income in the UK, ["Creative Citizen, Creative State"](#). Useful insights are peppered through the comments on The Economist article [Automation and anxiety - Will smarter machines cause mass unemployment?](#)

In short, we perceive that Scotland, by dealing effectively with the challenges of employability, will enlighten once more and do so in a highly productive way if communities, innovators and enablers populate each other's minds to the opportunities of the 3D era, increasingly using AI, machine learning and DLT to facilitate outcomes. By enablers we mean local, regional and national forms of governance and corporates awake to the opportunities offered by renewable energy futures.

## Beyond 3D?

But why limit our aspirations to 3D. Why not add to the 'D list' further dimensions? Specifically, **D** for **Disruption** caused by rapid advances in innovation and technology? Mainly because the accelerating pace of innovation and technology change permeates all facets of decarbonising economies, decentralising populations, and digitalising societies and more. This is apparent in the papers the authors are preparing on ways in which the Highlands and Islands can maximise their own wellbeing while massively and sustainably boosting the export effort of Scotland.

And what about a fifth **D** for **Diaspora**? While Scotland's diaspora has always stood ready to contribute to the advancement of Scotland in all spheres of endeavour, magnifying these contributions in the 3D era could abound, as encapsulated by this testimonial on the potential of [GlobalScot](#): "The GlobalScot network is undoubtedly one of Scotland's biggest assets. Entrepreneurs and businesses need to exploit this resource to the fullest and work with GlobalScots to realize their full potential." Consequently, the papers being prepared will consider prospective diasporic contributions systematically, notably in facilitating FDI.

## Productivity Gains by Transitioning to Export Powerhouse

Central to achieving ever increasing productivity outcomes is extending the capacity for Scotland to increase massively its production of high value-added products for export by maximising gains from 3D opportunities. Yester years saw Scotland excel in the export of advanced engineering services, shipbuilding and heavy industry manufactures and medicine. For a much longer period, the Highlands and Islands complemented this with the export of essentially low-value, polluting products from the harvesting and processing of seaweed (e.g., soda ash and potash and the attendant release of carbon dioxide and methane from the burning process).

Today it is primarily whisky and tourism. It's not that Scotland is asleep to the opportunities of adding significant value to its natural resources. Initiatives include world-leading research in seaweed cultivation by the Oban-based Scottish Association for Marine Science, the production of high value products from seaweeds, producing advanced materials from [root vegetable "waste"](#), boosting an already significant [biomethane production](#) capacity as well as leading in the development and deployment of renewable energy technologies.

These and many other prospects for new high value-added products are considered for expansion to industrial and significant export scales through a proposed process of "eco-industrialising" the Highlands and Islands, a form of *industrial symbiosis* operating as a closed loop production cycle continuously improving environmental and economic outcomes. Of topical interest, as the UK Prime Minister heralds a 25-year plan to reduce plastic waste<sup>6</sup>, is the exciting prospect of producing a replacement for plastic packaging from seaweed, either biodegradable or edible<sup>7</sup>: packaging for a myriad for high-value products transforming local natural resources for export, all benefiting from the marketing glow of this form of packaging.

Scotland wide prospects include reviving the steel industry through an ambitious programme of producing decarbonised steel, a significant programme of building niche ships associated with harvesting and attending seaweed farms and larger scale vessels to rid the oceans and seas of ubiquitous plastic waste, and the large-scale export of machinery manufactures, initially required to produce an envisaged wide range of products for local and national consumption and export.

## Regional Contributions

The report [Scotland's economic performance - comparative research](#) provides comparisons of Scotland's productivity with OECD countries and comparisons of four Scottish regions (North Eastern Scotland (NES) - Eastern Scotland (ES) - South Western Scotland (SWS) - Highlands and Islands (HI)) with EU regions.

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<sup>6</sup> Theresa May proposes [plastic-free supermarket aisles](#) in green strategy.

<sup>7</sup> [Kelp packaging](#), [Edible seaweed packaging](#), [Plastic-from-seaweed](#).

## Proposed Papers

The working titles of the papers on proposed investigations, which represent an ambitious but nonetheless entirely achievable working programme, are as follows:

1. *Innovation in Building Social Capital to Maximise Well-Being*
2. *Hydrogen Scotland: A Route to Export Powerhouse*
3. *Investment in Demonstrations of Hydrogen Scotland Technologies*
4. *Investment in the Deployment of Hydrogen Scotland Technologies and Advances*
5. *Scoping the Extent of Eco-Industrialising the Highlands and Islands*
6. *Crafting as a Catalyst for the Hydrogen Scotland Development and Eco-Industrialisation*
7. *Greenprint for a Lead Community on the Isle of Skye*
8. *Evaluation of the National Socio-Economic and Environmental Impacts*
9. *Appraisal of Manufacturing and Service Export Opportunities*
10. *A Business Case for Operating an Implementation Capacity on the Isle of Skye*

### **1. Innovation in Building Social Capital to Maximise Well-Being**

This paper focuses on the 'macro' backdrop to our work in terms of the well-known fall off in productivity, and its consequences for economic growth, in the UK and Scotland since the financial crisis, and the more secular productivity lag in Scotland vis a vis the rest of the UK and other European Countries. Many and various explanations for the slowdown in productivity have been given, from the quality of the supply of labour to the quantity and quality of capital investment, and these are discussed in detail in this paper. Some have concluded that the financial crisis signals the end of the market-based economic model and have offered radical alternatives; for example Reed, [Rip it up and Start again: the case for a new economics](#):

"In some ways this moves us away from neoclassical economics and back towards the classical economics of Smith, Ricardo and Marx—although, of course, with much better data, and infinitely more computational power to crunch it."

"Finally, economics needs to be pluralistic. For the last half-century neoclassical economics has been gradually colonising other social science disciplines such as sociology and political science. It is high time this process reversed itself so that there was two-way traffic and a mutually beneficial learning exchange between disciplines. It is possible—and probably desirable—that the “deconomics” of the future looks more like psychology, sociology or anthropology than it does today’s arid economics."

Others focus on maximising the well-being of humans crucially depends on maximising the well-being of the natural environment and resources which sustains them. This is persuasively expounded by so called “renegade” economist Kate Raworth in [Doughnut Economics: How to Think Like a 21<sup>st</sup> Century Economist](#) which in recognising “economics as the mother tongue of public policy” underscores “the need for a new generation of economists who are ready to manage our planetary home”. As such she argues for a new model citing Buckminster Fuller:

“You never change things by fighting the existing reality. To change something, build a new model that makes the existing model obsolete.”

With respect to this new model the “computational power to crunch” the deep learning algorithmic analysis of relevant “big data” sets will have to await the arrival of quantum computing<sup>8</sup>, encompassing not only the requirements of market-based structures and the types of techno-economic opportunities identified here but also the techno-sociological, the techno-ecological and the techno-psychological pathways to build the forms of social capital and social media maximising well-being. The reader of this Overview will probably note the

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<sup>8</sup> [Australian of the Year, 2018, Michelle Simmons](#) and her research team are leading in the race to build a quantum computer capable of solving problems in minutes, which would otherwise take thousands of years. Such a discovery has the potential to revolutionise drug design, weather forecasting, self-driving vehicles and artificial intelligence.

wide diversity and plurality of academic and information sources we have drawn on essentially recognises that the market-based model continues to thrive within and beyond the Anglo-Saxon world, suggesting that Reed's radical alternative to overcome the malaise may have to be assessed by a feasible new model, at least until the lead is in the hands of the computationally empowered new "generation of economists".

Indeed, in his influential book the *End of History*, Francis Fukuyama argues that the convergence of modern day economies into market-based economies and their integration into the global economy suggests that the Marxist-Hegelian sense of history as a 'broad evolution of human societies advancing toward a final goal' has arrived. However, there is no doubt that in Anglo Saxon countries there is a questioning of the neoclassical economic paradigm that underpins much of the theoretical justification for the model. The underpinning assumption of purely rational self-interested behaviour, which is also reflected in the finance and macroeconomics literature in terms of the assumption of rational expectations hypothesis, have been questioned by many with various alternatives being proposed.

Although we do not advocate a dramatic move away from this paradigm we do believe that the literature on social capital, discussed above, suggests that a return to some form of the more traditional themes of political economy, a specialism still very much alive in Scottish Universities until comparatively recently, would pay dividends. For example, Adam Smith's writings are peppered with discussions of the fact that economic life very much meshes with social life and that the former cannot be understood without an understanding of morals habits and customs. His thoughts have been formalised more recently by writers such as Fukuyama who has argued that although the standard neo-classical model gets human behaviour right about 80 per cent of the time, the remaining 20 per cent can only be understood by understanding culturally related factors and central to this is the concept of social capital, cultural norms and the concept of trust.

The concept of social capital seems to have been entirely missed in the current UK and Scottish debate about boosting productivity and economic growth and so the main theme of this paper is to reintroduce a discussion of the concept and related concepts and how they may improve wellbeing in the broadly defined usage here.

## **2. *Hydrogen Scotland: A Route to Export Powerhouse***

This paper, the starting point of our discussions on economic development, focuses on a "game-changing" opportunity for Scotland in general and the Highlands and Islands in particular arising from a recent breakthrough in markedly reducing the cost of producing hydrogen from renewable energy generated ammonia. This results from technological advances accelerating reductions in the costs of renewable energy for the production of ammonia. Game changing in the sense that the opportunity holds the potential for Scotland to exceed the maximum annual levels of energy extracted from North Sea oil & gas in perpetuity. And to do so in cost-effective, sustainable, and ecologically enhancing ways as innovative efforts are made to extend the life of existing oil & gas fields while simultaneously realising commercial returns from decommissioning these fields.

Perhaps in emulating Germany as an export powerhouse, Scotland could better the UK performance of 2.8 primary care doctors per 1,000 people compared with Germany's 4.1 and 2.7 hospital beds per 1,000 compared with Germany's 8.2, with the latter expending 11% of GDP compared with the UK's 9% as reported by the OECD. The rural numbers in Scotland are of course much worse with the newly defined health care area in Highland region of Skye, Lochalsh and South West Ross only having a figure of 1.6, very much in the developing country league. And converting to opportunities the threats recently reported in The Times:

- a) [Diluting teacher training standards](#)
- b) [Rise of robots puts 230,000 Scottish jobs under threat](#)
- c) [Lack of well-paid jobs leading to brain drain, tycoon Jim McColl warns](#)

References are also made to the need for many communities across the Highlands and Islands to be involved actively in the build, own and operate activities of the massive wind power installations proposed, whether onshore, offshore or floating. In as far as existing wind farms can be extended, it is also proposed that these communities will benefit from the availability of the ever-lowering cost of renewable energy to enrich existing and establish new settlements with the capacities to produce high-value products from local natural resources for local consumption and large-scale export outcomes.

Consideration could be given to doing this in adjoining industrial parks that optimise an association between two or more industrial facilities or companies in which the wastes or by-products of one become the raw materials for another. This form of industrial symbiosis, or eco-industrialisation, seeks to emulate the processes of ecosystems in nature in what are commonly referred to as eco-industrial parks (EIPs). In reviewing locations for these communities and EIPs the suitability of extending existing wind farms would be assessed.

### **3. Investment in Demonstrations of Hydrogen Scotland Technologies**

This paper will investigate the feasibility of attracting investment in prototype demonstrations of existing, emerging and future technologies to produce ammonia from renewable energy sources at many sites throughout the Highlands and Islands. It is envisaged that this will involve extensive consultations with communities, technologists and enabling corporates. A detailed assessment of a prospective testing site on the Isle of Skye will be provided as the starting point of this project.

### **4. Investment in the Deployment of Hydrogen Scotland Technologies and Advances**

The feasibility of attracting the massive investment to build, own and operate the renewable energy capacity to produce and export ammonia on a game-changing scale at multiple sites throughout the Highlands and Islands and beyond. This will involve consultations with communities, technologists and enabling corporates at many sites throughout Scotland and the Highlands & Islands. Initially, indicative assessments of, say, 25 prospective sites for the Highlands & Islands will be provided. By game changing we mean onshore wind energy farm developments delivering in the order of 500MW at each location and resulting in the production of a significant export capacity in the form of hydrogen stored in the production of ammonia. Some 25 such developments would more than double Scotland's existing wind energy capacity. Offshore wind farms delivering a great many times this capacity could rank Scotland as a major global exporter of stored renewable hydrogen.

### **5. Scoping the Extent of Eco-Industrialising the Highlands and Islands**

The paper will provide the results of a study into producing high-value existing and new products from the sustainable use of local natural resources throughout the Highlands and Islands for local and regional consumption and for large-scale exporting. Low and increasingly lower costs of renewable energy from the "Hydrogen Scotland" developments will be a key driver of increasingly effective and efficient symbiotic operations within and between enterprises focussed on the production of high value-added goods that can compete in national and global markets.

In addition to clean air and water and cheap renewable energy for ammonia production, preliminary consideration is being given to the use of natural resources such as seaweed, peat and bog iron. The return to these resources after so many decades may seem rather out of place in today's digital era, however, as noted above this crucially keys into initiatives such as producing packaging from kelp and the myriad of kelp-based products noted below, all relying on digital technologies to be delivered with high productivity.

Worldwide there are concerted efforts to harvest seaweed sustainably and to achieve environmentally enhancing outcomes such as the foray into manufacturing substitutes for plastic packaging noted above. This recent [ABC Catalyst video](#) "investigates how seaweed is helping to save the world - from growing the foods of the future, helping save the reef and even combating climate change". This FAO report provides an [Introduction to Commercial Seaweeds](#). High value products from seaweed include:

- a) A myriad of food products such as [kelp caviar](#) and from Scotland a widely exported award-winning range of [vegan "cheese"](#) (sheese) using kelp extracted agar agar.
- b) AlbaVegan? – Quite frankly, clean-green Scotland is well placed to export a burgeoning range of vegan food products (mainly using local natural resources, including nutritious seaweed oil) of higher quality than nearly all of the suspect-oil<sup>9</sup>-based vegan products being pushed in global markets. Do it right and sky's the proverbial limit, especially as it costs no more. The US vegan products' market alone is now \$22B with statistics on China's demand growing at over 17% pa for the last 5 years. The 2015 [World Health](#)

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<sup>9</sup> [Effect of canola oil consumption on memory, synapse and neuropathology in the triple transgenic mouse model of Alzheimer's disease](#), Nature, Scientific Reports, volume 7, Article number: 17134(2017)

[Organisation report](#) on the carcinogenic risks of eating red and processed meats is leading to major vegan-oriented revisions of national food guidelines, but this does not include the NHS which only recommends a 25% reduction in consumption of red and processed meats. Import replacing the avalanche of processed and junk foods would provide the basis for rapid growth of Scotland-based global corporates in this space.

- c) Craft beer – [kelpie seaweed ale](#) - “My favourite beer. Ever. It’s rarely seen in my part of the States, but when I find it, I buy up all I can.”
- d) [Healthcare](#) - Already a staple in many Asian cuisines, kelp is a natural source of essential vitamins, minerals, and antioxidants.
- e) [Cosmetics](#) – e.g. La Mer, Estée Lauder Companies and body balms from the [Isle of Skye Seaweed Co.](#)
- f) High quality leather produced from [kelp](#) (with traditional leather manufacturers having to compete with more eco-friendly and humane alternative materials) and [jellyfish](#).
- g) [Biofuels](#) – obviating severe adverse economic, environmental and social impacts of using food crops to produce biofuels driving up global prices in a world where a billion people are already hungry.
- h) [Advanced materials](#) - carbonization of kelp in an ammonia atmosphere to produce enriched 3D porous carbon for supercapacitors of high volumetric capacity.
- i) [Nanotechnology](#) – kelp extracts to produce low cost solar cells.
- j) [Revolutionary feedstock for cattle to reduce to near zero their methane excretions.](#)

In relation to seaweed harvesting, consideration is given in the Hydrogen Scotland paper to the prospect of operating large-scale seaweed harvesting operations in conjunction with disused oil rigs and associated offshore wind farms established for offshore ammonia production. This would build on and extend the current [revival in Scotland of wild seaweed harvesting](#)<sup>10</sup>.

Other less obvious natural resources for transformation to high value export products include peat, bog iron and limestone for cement:

- a) There are claims for products from peat that are 100 times more valuable and less invasive than horticultural uses – see, for example, [Peat could be northern Minnesota's newest cash crop.](#)
- b) From way left-field, bog iron is considered in a preliminary version of the Hydrogen Scotland paper for renewable energy electrification of pollution-free steelmaking as a possible input to local manufacturing of low-cost, larger and more efficient windmill blades and as a catalyst in a new technology to convert onshore natural gas into hydrogen and graphite
- c) 3D printing of houses for less than \$10K using locally produced concrete: [video](#) -- [article](#). Then consider making these houses autonomous with a larger flat roof surface serving as a water tank to catch rainwater and providing additional outdoor living space. Add to this [3D printed ultra-low cost, high efficiency solar panels](#) on the flat roof and the external walls clad with sheets of [3D printed solar cells, using seaweed extracts](#). The 3D printed versions of these [roof mounted wind turbines](#) (perhaps adapting this [3D printing process](#) for large blades) would then generate more than sufficient supplies of energy regardless of the weather, especially if the cost of battery storage continues to plummet, possibly with this [seaweed-based advance](#). Provide a 5G service and the occupants can interact at ever more advancing levels of communication/data-sharing/computation with any groups anywhere and elder citizen occupants can be supported by an ever-increasing efficacy of telehealth monitoring and supporting drone services.

Consideration will also be given to the work and projects of the United Nations University sponsored [Zero Emissions Research & Initiatives \(ZERI\)](#) as espoused in their philosophy of action:

- a) Where the best for health and the environment is cheapest and the necessities for life are free thanks to a local system of production and consumption that works with what you have.

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<sup>10</sup> [Wild Seaweed Harvesting: Strategic Environmental Assessment - Environmental Report](#), November 2016

- b) "Innovative business models" are capable of bringing competitive products and services to the market responding to basic needs while building social capital and enhance mindful living in harmony with nature's evolutionary path.
- c) "Competitiveness" is harnessing and optimizing the innate virtues and values connecting untapped local potential - like a natural system, where the seeds lie fallow only to sprout with amazing vigour at the first rain unleashing joy and happiness as the conditions for mindful living are met in balance and in harmony.

Also worthy of active consideration in this context is the 1973 and 1999 versions of Schumacher's *Small Is Beautiful: A Study of Economics as If People Mattered*, ranked by *The Times Literary Supplement* as among the 100 most influential books published since World War II. Schumacher espouses a philosophy that grew out of his study of village-based economics, casting education as the greatest resource and refutes platitudes about Capitalism as a social order concluding with advice to socialists:

"Socialists should insist on using the nationalised industries not simply to out-capitalise the capitalists -- an attempt in which they may or may not succeed -- but to evolve a more democratic and dignified system of industrial administration, a more humane employment of machinery, and a more intelligent utilization of the fruits of human ingenuity and effort. If they can do this, they have the future in their hands. If they cannot, they have nothing to offer that is worthy of the sweat of free-born men."

And recently, this from [McKinsey](#) in assessing the competitiveness of small-to-medium metal and mining projects: small doesn't mean unprofitable; unlocking new value from small-to-medium metal and mining projects; managing smaller projects with increased rigor and a through-cycle mentality can help companies to capture significant untapped value.

## **6. Crofting as a Catalyst for Hydrogen Scotland Development and Eco-Industrialisation**

The feasibility of creating a system of *innovation and public purpose* governance, as referred to above, based on crofting and existing crofting settlements performing a key catalysing role at various scales of effort:

- a) Individual crofts and clusters of crofts producing cash crops for processing in eco-industrial parks (EIPs) into value-adding export products as noted above and, in some cases, doing so through the use of *drones and robotised farming practices*<sup>11</sup>, leading-edge *permaculture*<sup>12</sup> and *afforest*<sup>13</sup> activities and hosting training programs for developing country farmers<sup>14</sup>;
- b) Crofting communities operating as major players in the establishment, delivery, and operation of the proposed massive renewable energy and ammonia-hydrogen production projects and providing inputs to as well as the operations of the envisaged EIPs;
- c) Networking between crofting communities and businesses (benefiting from ever increasing levels of information and communications technologies including distributed ledger technologies to determine and foster synergistic interplays between EIPs.

Meet the new generation of young crofters in this [video](#) and if in any doubt about this catalytic force, note the wisdom of the young crofter at 12:38: "Crofting is always evolving and it always has done and that's something that history shows us that crofting has always changed, always adapted and we shouldn't be afraid to do that."

Consideration could be given to 3D printing of houses (as considered above) on crofts to house: (a) young family members; (b) working visitors; (c) developing country students/farmers receiving an education & training in farming/crofting/permaculture/afforest, perhaps obtaining the University of the Highlands and Islands (UHI) [certificate in crofting](#); (d) small communities of elderly citizens moving from acute hospital beds to community care and the therapy of participating in permaculture and afforest activities. Another prospect could be UHI based research on 3D to produce designs for 3D house printing machinery (for central belt manufacturing) and software drivers and leverage this into a significant R&D 3D printing program.

<sup>11</sup> [Drones and Robots: Revolutionizing Farms of the Future](#) and from [Compute Scotland](#): robotic and drone technologies are playing increasing roles in raising the productivity of agriculture in Scotland.

<sup>12</sup> [Skye Permaculture](#) recently morphed into [Earth Ways](#) - building a permaculture community with a significant training capacity.

<sup>13</sup> [Afforestt](#) creating dense crop bearing native woodlands for local consumption and value-added EIP products.

<sup>14</sup> McKinsey articles on agricultural transformations in developing countries -- (a) and (b) -- justify the case for such training programmes.

In assessing innovation in taxation reform, we envisage that crofting communities could provide an ideal test bed for well-designed, community-driven programs. In addition to possible 3D era innovations in tax reform earlier identified, there emerges this message from the Intergenerational Commission, Tax and Welfare, March 2018: “[Baby boomers are going to have to pay more tax on their wealth to fund health and social care,](#)” stemming from the Prime Minister’s concern of “a growing divide between a more prosperous older generation and a struggling younger generation.”

In traversing an impressive range of prospects for “what can be done?” in [The Crofting Problem](#) (1953), Collier refers to the need for enabling social capital. We will review these prospects in relation to envisaged proposals to be appraised in the “Eco-Industrialising” paper. The article [Why crofting is so important to owners of professional services firms](#) refers to the establishment of Inksters, a law firm acting with successful differentiation by providing legal, including crofting law, services throughout the Highlands and Islands. This augurs well for all manner of services that can be delivered at home and abroad, collectively on an industrial scale across the Highlands and Islands, increasingly through advances in information and communications technology, including AI, machine learning and DLT. Similarly, for the manufacture of goods as considered above through advances in these technologies as well as robotics, drones and 3D printing.

### **7. Greenprint for a Lead Community on the Isle of Skye**

Imagine a new town of up to 10,000 residents integrated with a crofting community actively involved in the local and regional delivery of “Hydrogen Scotland” and eco-industrial developments. Wind power is generated on croft lands or offshore to meet town and surrounding community needs and as the base for a major export facility to produce ammonia from air and water. This power also provides a low-cost input to competitive production of high-value products from local and regional natural resources at a centrally located eco-industrial park (EIP): goods that are produced for local and regional consumption and to meet growing export demands as envisaged in the “eco-industrialising” and “crofting as a catalyst” papers.

This paper will envision such a development at a location to be determined on the Isle of Skye as an important example for the Skye community but also one that can be replicated beyond to other Highland and Scottish communities. It will be drafted in close consultation with all communities of interest. One of the authors has extensive experience in consulting on the design and assessing the social benefit-costs of such developments as noted in this [bio](#). This includes reference to a proposed “eco-technopolis” development for 75,000 residents near Port Macquarie in Australia, referred to as the Hastings 2000 Project, documented in the submission [Urban Living in a Natural Environment](#) to the New South Wales Government. Among other things, this report describes a process of internalising increasing land values for the benefit of all residents. This along with the results of assessing innovative taxation reforms from the *Crofting as a Catalyst* paper will be rigorously appraised by prospective Skye communities.

### **8. Evaluation of the National Socio-Economic and Environmental Impacts**

Drawing on a comprehensive social-benefit cost analysis and assessments of the increased productivity flowing from the effective urban design of the proposed new town development on the Isle of Skye, an assessment can be made of the national benefits of replicating this at multiple sites throughout the Highlands and Islands, say, 10, 25, 50 times. This has been done using a computable general equilibrium model (CGEM) for a 25-fold replication of the proposed Hastings 2000 Project and reported in [Assessing the National Economic Impacts and Benefits of Decentralised Development Through Hastings 2000 Projects](#).

In addition to the assessing the national impacts of multiple Highlands and Islands communities, the proposed CGEM application could include assessing the increased productivity flowing from the wide range of manufacturing and service export activities noted below.

### **9. Appraisal of Manufacturing and Service Export Opportunities**

There are a wide range of other opportunities involving decarbonised steelmaking, boosting ship building, large-scale manufacturing and exporting of advanced machinery, and the export of IT-based network services that would arise from the implementation of the prospects reviewed in the Hydrogen Scotland paper.

These include:

- a) Central Belt decarbonised steelmaking, ship building and manufacturing of advanced machinery:

- i) Manufacturing revolutionary new machinery for low cost extraction of hydrogen from ammonia-to hydrogen;
  - ii) Manufacturing Solid-State Ammonia Synthesis (SSAS) machinery for renewable-ammonia production (not only for numerous Highland & Islands wind farms but also for a prospective worldwide boom in renewable-ammonia-hydrogen production) possibly using additive manufacturing (3D printing) and thereby putting Scotland in the vanguard of large-scale manufacturing and exporting of 3D printing machinery and enabling software;
  - iii) In situ carbon-neutral production of hydrogen and graphite from onshore natural gas reserves using a revolutionary new technology referred to as the [Hazer Process](#), currently being commercialised;
  - iv) Carbon-negative production of hydrogen and graphite by biomethane collocating the Hazer Process with many biomethane production operations throughout Scotland;
  - v) Manufacturing Hazer machinery for European and African markets;
  - vi) Manufacturing machinery for new technology to convert [Hazer graphite to graphene](#) and the subsequent transformation of graphene into high temperature superconductors<sup>15</sup> for use, among other things, in reducing the dissipation of electrical energy transmission to near zero;
  - vii) Decarbonised steel production (i.e., renewable hydrogen to electricity to power electric arc furnace) in an ambitious revival of Scotland's once formidable steel industry – see [proposed CGF in operation to melt scrap steel in Scotland](#);
  - viii) Building ships to harvest and tend large-scale seaweed farming operations on a scale dwarfing the workload of the Scottish fishing fleet;
  - ix) Building ships to collect sea-borne plastics, initially from the seaweed farms and subsequently from UK and European waters;
  - x) Building very large autonomous, ocean-going vessels to not only collect sea borne plastics such as exist in the massive patches (3 time the size of France) swirling and growing in the Pacific Ocean but to convert the plastics to minimal pollution biofuels on board and thereby power the vessels indefinitely.
- b) DLT-based establishment and operation of renewable energy networks for not only renewable-ammonia-hydrogen production and distribution but also for grid-based distribution - by bedding this down for the mega ambitious Highlands & Islands renewable energy development programme, say from administrative bases in Inverness and Aberdeen, there is every prospect that this could be delivered globally as well – that is Scotland wide propagation of Software as a Service (SaaS) on a massive scale.

The forthcoming Hydrogen Scotland paper identifies and briefly considers several other prospects to boost the export of high value-added goods and services from Scotland which will be reviewed and evaluated in detail in this appraisal.

### **10. A Business Case for Operating an Implementation Capacity on the Isle of Skye**

The authors recently produced a discussion paper on improving the tourism infrastructure of the Isle of Skye which outlined a case for a multipurpose building referred to as [Skye IDEA](#) (page 34), featuring among other things: a world-class climbing wall; capacities for attracting entrepreneurs and innovative enterprises; a business incubation centre to producing designs for 3D printing machinery (for central belt manufacturing) and software drivers; research activities supporting EIP initiatives, in particular processes for reaching agreement on the governance arrangements for the proposed new towns throughout the Highlands & Islands drawing on sources such as the Highland Council, the Crofting Commission, the Scottish Crofters' Federation and the Institute for Innovation and Public Purpose.

The business case for this centre would draw on the investigations and the results of consultations pertaining to the foregoing papers. An outline is provided in the preliminary version of the "Hydrogen Scotland" paper.

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<sup>15</sup> [Surprise graphene discovery could unlock secrets of superconductivity](#), Nature, March 2018

## Regional Contributions to Raising Productivity and Powering Export Performance

The report [Scotland's economic performance - comparative research](#) provides comparisons of Scotland's productivity with OECD countries and comparisons of four Scottish regions (North Eastern Scotland (NES) - Eastern Scotland (ES) - South Western Scotland (SWS) - Highlands and Islands (HI)) with EU regions.

This Overview outlines development scenarios indicating how the productivity of these four regions could be raised to the level of Norway:

- NES (70% increase in productivity to equal Norway) - offshore wind farms and for renewable ammonia-hydrogen production and exporting together with associated major seaweed harvesting zone developments could enhance the relatively high performance of NES as offshore oil & gas exploitation declines.
- ES (144% increase) - based on realising a plethora of manufacturing opportunities identified above, with possible onshore exploitation of natural gas (map of [central shale belt](#)), as per: (a) [Scotland pressed to exploit onshore oil and gas reserves](#) and (b) [Significant economic benefit for Scotland can flow from lifting unconventional oil and gas exploration moratorium](#) if and only if this can be done *in situ* with carbon-neutral electric-arc-furnace steelmaking using e.g. Hazer technology and/or renewable ammonia-hydrogen production (using SSAS ammonia technology) and ceasing huge subsidies to the coal and natural gas industries hoping that they will eventually deliver Carbon Capture & Storage (CCS) solutions; highly innovative proposals for niche but large scale ship building to clear seas and oceans of plastic and related wastes.
- SWS (144%) - This region but could be developed as for HI re Eco-Industrialisation and Eco-newtowns with electricity generated from hydrogen that has been extracted from ammonia shipped to the region from HI ports obviating the need for wind power farms and visually polluting transmission pylons striding the landscape (as convincingly opposed [here](#)). This could be supplemented by a considerable tidal power plant at the Solway Firth producing ammonia-hydrogen for Kircudbright, Castle Douglas, Dumfries and Lockerbie and smaller scale tidal power stations serving the coastal towns from Ardrossan to Stranraer with the possibility of Kilmarnock and Lanark becoming major centres for the manufacturing of tidal energy plant and equipment and tidal plant development services with a view to putting Scotland at the forefront of harnessing tidal power - (see 2017 article on [The wave and tidal resource of Scotland](#)).
- HI (159%) - Renewable Ammonia-Hydrogen exporting; Eco-Industrialisation and Eco-newtowns with Crofting (interaction within and between crofts, crofting communities, crofting communities' regional cooperatives, inter-regional cooperation) as a creative commons catalyst.

An "imagination creates reality"<sup>16</sup> challenge then could be how to grow Glasgow-Edinburgh (47 miles apart) into a conurbation on the scale of Greater London (45 miles across) and increasing productivity by 500% to match it - simultaneously climbing 45 places to match Switzerland at the top of the [European Innovation rankings](#). Possibilities for the development of export industries include:

- Rapid growth in renewable electric steelmaking and "ocean clean-up" shipbuilding and other niche shipbuilding opportunities as indicated above – in Leith (?) as well as Glasgow shipyards.
- Becoming a world leader in [hyperloop](#) technology by using it to emulate the London Underground and export leveraging accordingly - and linking with the proposed [Virgin venture](#) of London to Edinburgh in 45 minutes.
- Pipelining renewable ammonia from North Sea operations to produce hydrogen for fuel-cell to electricity for transportation throughout the conurbation, including trucking, bus and train networks, and the hyperloop network and exporting the production of enabling machinery and services as outlined in the Hydrogen Scotland paper.
- Growing Scotland's financial services sector of 85,000 people and information technology related industries of 100,000 people into, among other things, a world leading fintech industry by developing a

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<sup>16</sup> Richard Wagner: "Imagination creates reality."

major global presence in DLT-based services, initially by supporting the applications identified in the foregoing as well as banking, insurance and funds management, and subsequently leveraging of this into exporting services approaching the scale of [London's financial services sector](#) and the 750,000 people it employs, perhaps growing at a rate in excess of the 15,000 new fintech roles in Scotland in the next 10 years predicted by the [Centre for Financial Regulation and Innovation](#).

- As outlined in the Hydrogen Scotland paper, embracing vertical farming throughout the conurbation (initially exploring the claims from [AeroFarm](#) that it has achieved plant growth that is 390 times more productive per square foot than a commercial field and from [VertiCrop](#) using a hydroponic technology in vertical farms with the claim of 20 times more yield than open field agriculture) to feed a burgeoning population and leverage the acquired knowledge into exporting enabling machinery manufactures and services.
- Imagine a conurbation with high productivity in high-value manufacturing as well as globally demanded high-value services that largely feeds itself – and consistently rates as the world's most liveable city.

The CGEM analysis proposed in Paper 8 above could also be applied to assessing the socio-economic and environmental impacts of the four regions and the conurbation.

As foreshadowed in the outline for Paper 1 we may have to await the advent of quantum computing to determine how to maximise the creation of well-being (in particular, policies to decrease inequality) of Scotland's people and the resources and environment that sustains them subject to attaining levels of productivity and economic growth in its four sub-regions comparable with that of, say, Norway. Conceivably this will facilitate transcendence from *ad hoc* policy incrementalism to conceiving, evaluating and implementing bravely innovative reforms driven by the policy agenda in decarbonisation, decentralisation, digitalisation, and socially equitable taxation reform and building the enabling social capital and human capital.

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### All in All

So, do we persist with the status quo grasping babel of disjointed incrementalism or do we “reach for the stars” of widespread agreements on enlightening futures. Or more succinctly from Robert Browning:

“Ah, but a man's reach should exceed his grasp, Or else what's a heaven for?”

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## Attachment A

### Distributed Ledger Technology Acceleration of Advances in Health Services and Genomics

Distributed Ledger Technology (DLT) is providing opportunities to revolutionise health services by “de-siloising” operations for increased system efficiency and effectiveness while fulfilling the dream of enabling patients to access securely their own health records. This is being explored and tested by the UK National Health Service – [Can Blockchain save the NHS?](#) - largely based on progressive tech savvy doctors and the recommendations of the 2016 report of the UK Government Office for Science: [Distributed Ledger Technology: beyond block chain](#). In contradistinction the National Health Service of Scotland (NHSS) do not appear to be conducting similar assessments, if this 2018 IT-based assessment is valid: [Old IT and staff reluctance stop Scottish NHS from adopting new tech](#). At the leading edge of delivering core capacities stands MIT’s research project [MedRec](#) trailing a records system to manage the complexities (including secure patient access) of multi-institutional, lifetime medical records.

Epidemiological campaigns at national and international scales and attendant drug design, production and timely delivery also stand to benefit from advances in DLT: [Global Public Health: Blockchain for Contagious Disease Relief](#).

Central to the de-siloising advances in the worlds of medical research is 'Permissioned Blockchains' configured to control participant transactions, define their roles to access and contribute and to maintain their identity. Of even greater relevance is the capacity for participants to allow databases they control on a prescribed DLT operating in the public domain to be used for calculation and scenario simulation purposes whilst keeping the data private even in public networks, once again through an MIT-led advance - [SNARKs for C: Verifying Program Executions Succinctly and in Zero Knowledge](#). Given the availability of this capacity and more particularly DLT enabled authentic IP ownership and hyper-secure protocols available in the early 2000s, it is likely that CRISPR as the leading advance in molecular cell engineering would be several years ahead of where it is today: in fact, by the time a panel of judges at the US Patent and Trademark Office gets around to deciding on patent ownership, CRISPR may have lost its preeminent title as the most precise tool for genetic engineering.

The SNARK enabled Blockchain as a Service (BaaS), specifically a scenario simulation service has already been commercialised by the NASDAQ listed company [SimulationsPlus](#) with a market capital of \$367m. Now imagine that such a DLT-BaaS could be delivered by a company like Skye-based Sitekit<sup>17</sup> (building on its strong alliance with MIT) in revitalising the IT support of NHSS as a forerunner to customising the end result for health services worldwide.

Further imagine the HIAIba-IDEA think tank working in conjunction with Sitekit (sporting a growing number of world-class DLT blockchain-engineers and an alliance with the Skye-based offshoot of DHI<sup>18</sup>) and the University of Glasgow’s Centre for Cell Engineering<sup>19</sup> collaborating in the establishment of first-to-market Scottish start-up companies resulting from DLT-accelerated advances in genomics, including breakthroughs in stem cell therapies.

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<sup>17</sup> Sitekit goal: for every person in the world to have secure access to innovative digital services that provide them with the right information, at the right time, using technology that’s familiar and easy-to-use.

<sup>18</sup> Digital Health Institute: Our vision is that innovation in digital health and care will help the Scottish population to live longer and healthier lives, while creating new jobs for the economy.

<sup>19</sup> The Centre for Cell Engineering (CCE) is a multidisciplinary, collaborative group of international standing working in tissue engineering. The group consists of biologists, bioengineers, clinicians, chemists and physicists.