Scotland's Future Energy Visions: 100% Renewable by 2030

Backcasting: Planning from the Future

Report on the Backcasting Event on the 12th March 2014

(DRAFT)

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Backcasting: Planning from the Future

1.0 Introduction

The introduction covers the rationale for the Scotland 2030 backcasting process, an overview of what is involved in backcasting and a short background to the visions that were introduced, elaborated and discussed at the workshop on 12th of March.

1.1 Rationale behind the Scotland 2030 Backcasting events: Introduction to the Challenge of Planning for a Safer Future

The Climate Exchange (CxC) in Edinburgh was established to provide independent advice, research and analysis to support the Scottish Government as it develops and implements policies on adapting to the changing climate and the transition to a low carbon society. The Adaptation in the Built Environment team is based at Heriot Watt University and had previously been working for a decade on looking at climate change impacts on buildings and the challenge of measuring progress in adapting buildings and communities to the changing climate, exploring strategies and policies to 'future-proof' building, cities and citizens against changing climate trends and extreme climate events[1].

The discussions on adaptation have moved this decade into efforts to understand the means and drivers to building social, economic and environmental resilience into the physical planning of our Scottish systems. There are many definitions of resilience, adopted by disciplines as wide ranging as metallurgy to ecology[2]. In ecosystems resilience was defined by Berkes et. Al. (2008)[3] as 'potential to sustain development by responding to, and shaping, change in a manner that does not lead to the loss of future options. Resilient systems also provide capacity for renewal and innovation in the face of rapid transformation and crisis'. Wilson (2012)[4] defined it as 'the capacity of a system to absorb disturbance and reorganize while undergoing change to still retain essentially the same function,

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[1] See the early and influential book first published in 2005: Roaf, S., D. Crichton and F. Nicol (2009). *Adapting Buildings and Cities for Climate Change*, 2nd Edition, Taylor and Francis, London.

[2] Roaf, S. (2014). Transitioning to Eco-Cities: Reducing Carbon Emissions while Improving Urban Welfare, Chapter 7 in Secure & Green Energy Economies edited by Young-Doo Wang and John Byrne, *Energy and Environmental Policy*, Volume 10, Transaction Publishers, Washington.

[3] Berkes, F., J. Colding, and C. Folke (2008). *Navigating social-ecological systems: Building resilience for complexity and change.* Cambridge University Press, Cambridge, UK.

[4] Wilson, Geoff, A. (2012). *Community Resilience and Environmental Transitions*, Routledge, London.

structure and identity, and feedbacks… resilience is measured by the size of the displacement the system can tolerate and yet return to a state where a given function can be maintained.' That encompasses the idea of being able to 'bounce back' or as some prefer today to 'bounce forwards' to a safer place.

Holling (1978)[5] noted that 'Placing a system in a straightjacket of constancy can cause fragility to evolve' and all too often in recent years this fragility, or brittleness, of the fabric of the built environment has proved lethal in terms of the thousands of lives and buildings lost to flood, heat, cold or winds as well as proving catastrophic for the livelihoods and communities involved. Many authors point to the confounding nature of the high level of complexity of the systems in play and their feedback loops, and the problems associated with our reliance on such *trend extrapolating models* in forecasting and predicting the performance of systems.

Ayres (1999)[6] specifically points out that to forecast 'turning points' it is necessary to get away from trend based models as were used in extrapolation but goes on to point out the weakness of trying to characterise too many complex non-linear interactions with limited differential equations such used since the early year of Ecological modelling and in the original Limits to Growth model by Meadows et al. (1972)[7]. Ayres claimed that simple quantifiable models will not be adequate to identify timings and other attributes of Turning Points but that '*naive intelligence and intuition may be the best tool for coping with a very complex and non-deterministic future'*.

Our current society and its patterns of consumption and production are highly energy dependant, whether related to buildings, mobility or production systems. Energy is key to the way in which the built environment currently provides comfort and shelter. However a major impact of the warming climate trend and increasingly extreme weather events that characterise the developing global climate is the failure of the essential energy systems.

The increasing cost of fossil fuel energy, the way it is understood and used, and its availability in buildings are all critical features of the ability of populations to survive in a rapidly changing environment.

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[5] Holling, C.S. (ed.)(1978). *Adaptive Environmental Assessment and Management*, John Wiley and Sons Inc., Chichester, p. 105

[6] Ayres, R. U. (1999). *Turning point: the end of the growth paradigm*, Earthscan, London. First published 1998.

[7] Meadows, D.H., D. L. Meadows, J. Randers, and W. Behrens. (1972) *The Limits to Growth; A Report for the Club of Rome's Project on the Predicament of Mankind***.** London, St Martin's Press. See also: Meadows, D. (2009). *Thinking in systems*, Earthscan, London

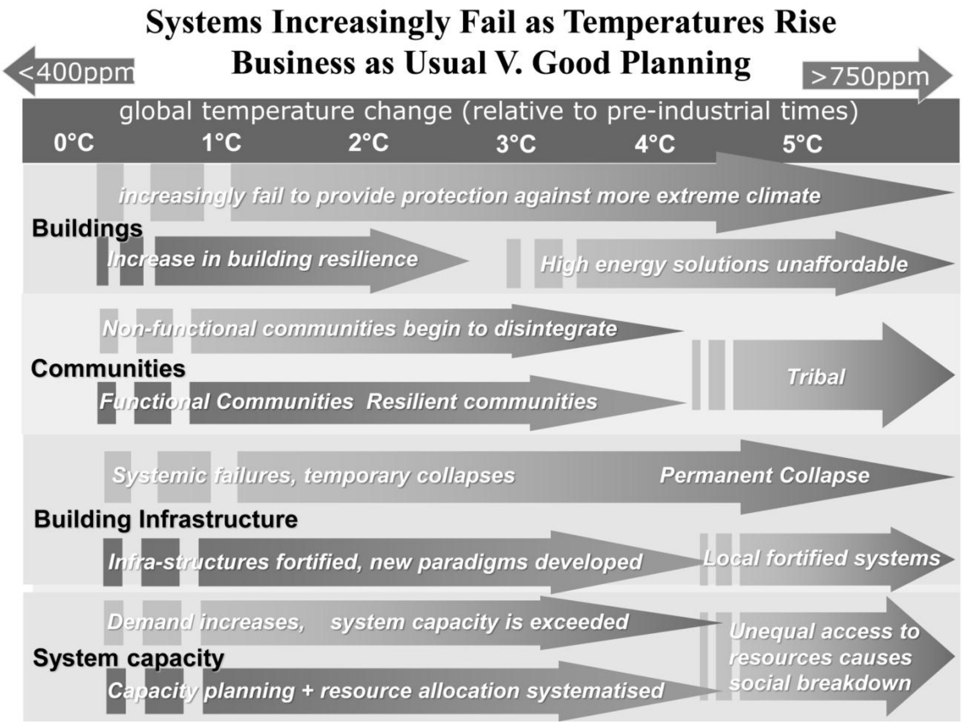

Figure 1. The warming of the climate will exacerbate the nature and rate of collapse of the whole gamut of our social and physical systems within the built environment (Roaf et al. 2009).

It is against this background that we started the process of backcasting to provide a new tool for planning for a non-linear, and better energy future for Scotland in which the continuation of many existing building types, technologies, infra-structures and social, environmental and economic systems will be called into question in a rapidly warming world.

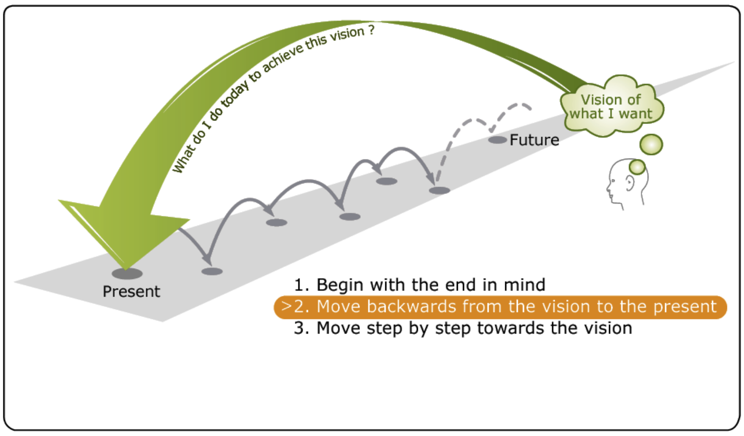

Figure 2. Diagram of the Backcasting process (http://www.naturalstep.org/backcasting)

We chose to experiment with the idea of backcasting in Scotland because this Visioning process can be central to a strategic approach to planning for non-linear, sustainable development and providing real innovation. A successful backcasting outcome is an imagined Vision of how the system works in the future, then the question is asked: "what do we need to do today to reach that vision of success"?

Backcasting is often more effective in answering such questions than forecasting, which tends to produce a more limited range of options, hence stifling creativity. More importantly, forecasting relies on what is known today - but that knowledge is always imperfect and things change over time. Such was the rationale behind our foray into the backcasting process and on the 11th November 2013, we organised a small backcasting event at Heriot Watt University to better understand the core issues involved in:

- Generating a credible / desirable energy future for Scotland
- Scoping out the impacts of that future on the types of building energy technologies and the way they may be powered and applied in a different future.

One outcome of this event was that it became clear that to backcast successfully needed some expert management and that none of the decisions involved can be effectively understood or planned for outwith the context of the larger social, economic, environmental and economic infra-structures involved.

The future of individual building level technologies like heat pumps are inextricably linked to the condition of future grids systems, and the cost and availability of energy vectors. Assumptions and agendas were noticeably influenced by where individual participating stakeholders were 'coming from' and predominant solutions molded and shaped as such.

A wide range of core concerns were usefully scoped out from all sides on issues such as planning constraints; transmission limitations; energy storage opportunities and potentials such as;

- Problems in intelligently planning for time and space in the emerging systems;
- Inadequacies of current problem anticipation and solving processes;
- Limitations on current related research on technology optimisation;
- The need for new thinking, price tariff rethinking;
- Issue of whether there is a genuine citizen focus in planning – qui bono?;
- Maintenance costs and issues.

This preliminary event made us understand the need for a more rigorous and professional approach to the whole backcasting process which is when we turned to Jaco Quist who with support from the Energy Technology Partnership of Scotland was able to help us plan, run and report on the Scotland 2030 Energy backcasting events in 2014.

1.2 Introduction to Backcasting

After early ground-breaking work on energy backcasting and soft energy paths in the late 1970s and early 1980s especially in the USA (by Amory Lovins)[8], Canada (by John Robinson)[9] and Sweden, backcasting has undergone a major and still ongoing revival since the early 1990s. This is especially due to a shift towards broader stakeholder participation and applying it to a wider range of sustainability issues. It now has been widely shown that participatory backcasting is an excellent approach to explore system innovations towards sustainability and to define and initiate follow-up and spin-off.

By now both participatory and non-participatory backcasting are increasingly applied across the globe, and several other vision-based foresighting approaches can be identified as well. Both backcasting and related vision-based approaches share the focus on developing normative desirable futures and visions. In addition, a considerable variety can be found among current backcasting practices (Quist 2007)[10]. Differences can be found in the degree and way of stakeholder involvement, in the tools and methodologies that are applied and in the extent to what follow-up and spin-off occur. For an introductory exposition of backcasting and scenario development see Jaco Quist's and Per Lundqvist's introductory powerpoints on the ICARB website.

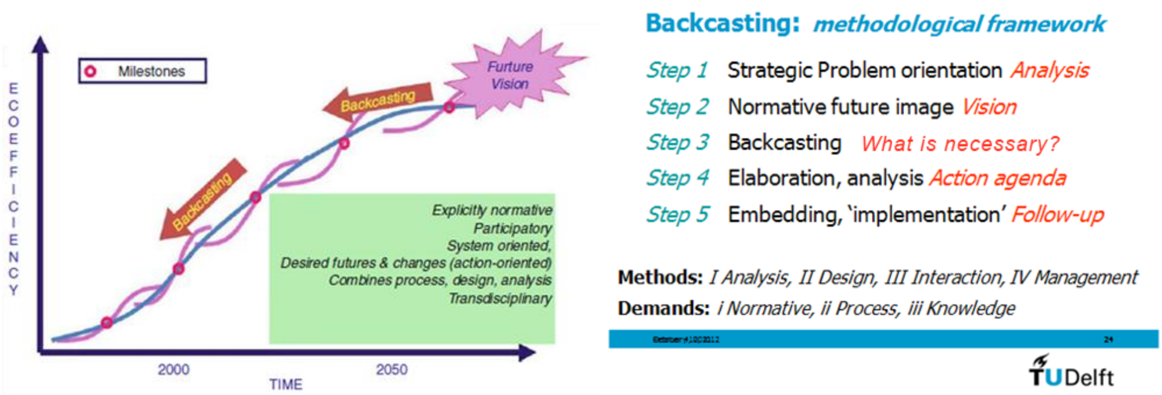

Figure 3. (a) Backcasting: key concept and characteristics & (b) methodological framework with steps, types of methods & demands.

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[8] Lovins, Amory (1979). *The Energy Controversy: Soft Path Questions and Answers* ISBN 978-0-913890-22-6
[9] Robinson, John. 1990. "Futures Under Glass: A Recipe for People Who Hate to Predict," *Futures* .

[10] Quist J (2007) Backcasting for a sustainable future: the impact after ten years, Eburon Publishers, Delft NL, ISBN 978-90-5972-175-3. Download at repository.tudelft.nl or http://www.library.tudelft.nl/ws/search/publications/search/metadata/index.htm?docname=372819 or hard copies at EBURON through www.eburon.nlhttp://www.eburon.nl/backcasting_for_a_sustainable_future?language_code=en

Key to participatory backcasting are (i) involvement of stakeholders who (ii) contribute to developing, discussing and assessing visions of more sustainable futures, and (iii) learn about the opportunities and dilemmas related to these future visions and the pathways towards these visions. Learning only results in increased awareness of and support for these future visions, but also lead to formulating follow-up agendas and implementation plans. Stakeholders seizing opportunities in the future vision then can initiate activities or start collaboration to initiate joint actions and activities, which can be research, business-related activities, policy development, user pilots, or others.

1.3 The Scotland 2030 Energy Visioning Backcasting Exercise[11]

On the 12th of March 2014 a broad group of interested parties ranging from local and central government, to SMEs, universities, community, cities and energy companies gathered at the ECCI building to explore three very different visions of how Scotland might become powered by 100% renewable energy in a Backcasting workshop. This one day event was generously funded by the Energy Technology Partnership and the Climate Exchange and expertly managed by Jaco Quist of Delft University assisted by two facilitators, Tony Craig and Gary Polhill, both of the James Hutton Institute. The three Visions explored were heroically led by Iain Staffell of Imperial College London, Stuart Hazeldine of Edinburgh University and Andrew Peacock of Heriot Watt University and their contributions are outlined below.

To set the scene we had introductory talks from two influential Scandinavian 'Visionaries'. Harald Rostvik of Norway showed how the dreams of electric vehicles in 1989 were gradually realised over 25 years until in 2013 11% of all cars sold in Norway were electric. Per Lundqvist explained how Sweden had gone about developing and exploring their own energy scenario planning and the methods used and results achieved. Thomas Novak, the Director of the European Heat Pump Association then briefly touched on future scenarios for this growing technology and Alex Hill of the Scottish Meteorological Office put the Visions into the context of 2030 climate predictions and their implications for resource availability and management. The full range of their presentations can be viewed on the ICARB website. The three Vision leads then set out their ideas stalls to attract attendees to their own workshops and the afternoon was spent exploring and interrogating the proposals. At the end of the afternoon the highlights of their deliberations were then brought back to be shared with the whole group in a final plenary session and the discussions extended into a final networking reception. Rapporteurs including Philip Scott helped the Vision leads and facilitators to draw the ideas forward into this report on the event that was edited by William Brownlie and the ICARB team.

[11] http://icarb.org/2014/02/14/100-renewables-in-scotland-by-2030-an-energy-visioning-backcasting-exercise/

Over 120 people registered for the day which proved to be challenging, mould-breaking and saw people leaving with views they would never have dreamed of when they entered eight hours earlier. This event is followed up by the Backcasting at the ECCI on the 17th June 2014 from 1.30 pm to 6.30 pm to which all interested parties will be invited.

Whereas the focus of the meeting on March 11th was on developing and discussing future visions for renewable energy in Scotland in 2030, the focus of the workshop on June 17th will be on assessing these, on developing pathways and defining elements for an implementation plan (http://icarb.org/2014/06/02/backcasting-summit/).

1.4 Scotland's Future Energy Visions: 100% Renewable by 2030

In 2009 the Scottish Climate Change Bill was signed into law and in it the country pledged to reduce carbon emission by 2050 by at least 80% from 1990 levels. To do this requires a major transformation of the energy sector and in the Bill Scotland pledged to create a largely:

- De-carbonised electricity generation sector by 2030 (The Scottish Government, 2011)
- De-carbonised heat sector by 2050 with significant progress by 2030

But are these targets ambitious enough in light of accelerating climate change impacts? Germany has produced a report exploring three energy Scenarios with which, by 2050 they may have achieved 100% renewable electricity supply (Klaus et al., 2010)[12]. Sweden has pledged to be 'Oil Free' by 2030[13] .

There are a number of UK wide projections (HM Government, 2011[14]; Parsons Brinckerhoff, 2009[15]) but Scotland is already renewable-energy autonomous in the South West and North of the Great Glen and perhaps could be 100% renewable by 2030? The potential does exist with Scotland's huge natural renewable resources[16]. Existing studies employ traditional energy industry accounting approaches that may not result in truly Sustainable or Successful development and that often ignore extraordinary renewable energy developments at building, community, city and regional scales.

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12 http://www.umweltbundesamt.de/sites/default/files/medien/publikation/add/3997-0.pdf

13 http://en.wikipedia.org/wiki/Making_Sweden_an_Oil-Free_Society

14 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48253/3884-planning-electric-future-technical-update.pdf

15 http://www.pbworld.com/pdfs/powering_the_future/pb_ptf_full_report.pdf

16 http://www.scotland.gov.uk/Topics/Business-Industry/Energy/Energy-sources/19185

Backcasting is done to arrive at credible and implementable Visions of desirable futures as opposed to Scenarios and other Future Studies aimed at producing likely, possible or normative future projections. We started with the desirable Vision of being 100% renewable by 2030. The backcasting methodology of this event was as follows:

1) Interrogate three Visions of energy supply for Scotland for 2030.
2) Involve participation from a wide range stakeholders, including a core of academic, community, city, government and SME participants, to not only inform the development of the vision, but to act as a dating event to put clients, theorists and industry together to potentially help build the envisioned futures.
3) Scope out a structured programme of follow-up activities for interested stakeholders to turned visions into technological and economic realities help Scotland lead in such markets.

The Proposed Scotland Future 2030 100% Renewable Energy Visions chosen (based on the German experience) were the:

UK Centric scenario: Electricity production and storage is based on large scale technology and mega-grid projects in the UK and its vicinity. Electricity is distributed via an upgraded transmission grid. Electricity production is optimised by distributing fluctuating feed-in from renewable energy most efficiently throughout the UK.

Standalone Scottish Network scenario: All regions (Highlands and Islands (North), Central, South West and South East) in Scotland make extensive use of their regional renewables potential. Electricity is exchanged throughout the country. Pumped storage potentials are exploited, Electricity imports are marginal but exporting energy encouraged.

Local Energy Autarky scenario: In this scenario, small-scale decentralised energy systems, at building, campus or estate, community, city and other scales, largely using locally available renewable energy sources, maximally efficient technologies and storage to satisfy their own power demand without electricity imports.

1.5 Report Structure

The following report outlines, in very draft form, some of the issues and deliberations raised for each of the three visions of the future. Reader is referred to the website where the full power points for each vision are available on the ICARB website. The benefits, challenges and realities of reaching each future vision within an imagined timeframe are discussed. Expert opinions voiced within the discussions of those attending the backcasting event on the 12th March 2014 are summarised. Each Vision section is formatted as follows:

- The Vision – as proposed by the Vision leads
- How do we get there? Vision workshop discussion outlines
- Conclusion: Summary of the Vision highlights

2.0 The UK-Centric Vision: Better Together?

Iain Staffell, Imperial College London

2.1 The Vision

Electricity production and storage is based on large scale technology and mega-grid projects in the UK and its vicinity. Electricity is distributed via an upgraded transmission grid. Electricity production is optimised by distributing fluctuating feed-in from renewable energy most efficiently throughout the UK.

2.2 How do we get there?

An energy sustainable future for Scotland requires transformation of the Scottish energy system to one that is completely renewable, with a shift from about 15% to 100% renewable within 15 years. This would begin with the decarbonisation of electricity, followed by heating and finally transport. Energy must be provided at low cost, from supplies that are stable, secure and robust both in terms of price as well as system resilience; this is of increasing importance in respect to predicted global change scenarios (i.e. climate change, weather extremes, population growth and economic instability).

The EU as an interconnected society

Until wind turbines can be placed in the mid-Atlantic, Scotland is among the best places on Earth for them. Whereas renewable such as hydro-renewable energy may be best put in the Norwegian mountains and solar systems most successful in Spain and those countries that have sunny climates. But as weather systems can be the size of continents, and as extreme weather conditions are set to increase, we must work together to ensure smooth provision of energy when renewable energy sources can be harnessed. To do this we must work and share with our neighbouring countries. First there must be highly diverse system of renewable energy technologies that takes all opportunities available to produce clean energy.

Secondly there must be a European transmission network that is big enough to share energy across UK and Europe. This highly interconnected grid throughout the whole EU must have inter-seasonal energy storage that can meet change in seasonal energy requirements and production. Removing constraints for offshore and onshore grid infrastructure will support this aim, and Smart grid technologies will be essential to manage infrastructure. Cultural acceptance that hydrocarbons will inevitably become more expensive and that adaptation to renewable technologies will aid support of this new world vision. The logic of this scenario (rightly or wrongly) is that the economics drive us towards a bigger interconnected society. A Pan-European price for energy – so that PV in Greece competes with wind in Scotland which competes with the hydro in Norway.

Investment

Scotland will need huge investment to convert the power sector to renewable sources. To beat global competition for funding, investors will need to be assured that investing in Scotland's renewable sector will result in a profitable return on their investment, and that their investment are safely backed by a reliable government. Whether those investing are visionary people with great ideas about sustainability they need to be assured that there is a return on their investment.

Reducing Societies need for Energy

To support this vision, the energy consumption of the growing population must be reduced, and the development of a 'prosumer' culture adopted. Education will be a driving force in changing societal behaviours, although will only be effective if pro-environmental behavioural alternatives are accessible to the public, and are easy to use and of low cost.

There needs to be a focus on reducing heat demand in buildings, with policy to ensure public and private building insulation is optimised, both in new builds and retrofit schemes. Societal reductions in the consumption of products and foods that have a large energy footprints associated with their production and delivery are necessary. Transport must be electric or fuelled by bio-fuel, although bio-fuel growth requirements may pose a challenge both in terms of room and net energy requirements of crop production. Incremental increases in incentives for EV & hybrid cars working alongside the introduction of disincentives for high energy cars. Improved user control (i.e. housing smart control) and self-awareness of energy consumption both directly (i.e. electricity usage) and indirectly (i.e. carbon footprint of consumer products) will support this. Energy schemes at a community level should be led by appointed champions and local community leaders. Demand Side Response (DSR) tariffs, new and better Green Deals and a tax on energy inefficient housing design and schemes that are specifically designed to reflect the differing needs of both urban and rural communities should be common place. Finally, industry from both the private and public sector must be make further and leading commitments to reduce energy use, to encourage its employees to do the same and take an educational responsibility in this role. Incentives for industry not only to reduce their energy use, but to be producers of energy will help achieve the aims of a greater energy sustainable society.

Government and Stakeholder change

The government must be lead equitable policies and incentive schemes for low carbon and energy efficiency. But first there is a real need for a united political consensus on Scotland's future; is Scotland to stay with in the UK? Is UK to stay as part of Europe? Without political stability change will be delayed and agreements on local, regional and national targets difficult to set. In terms of the energy sector, national targets may only be possible under nationalisation of the electricity and gas system. Stable incentives regime both for research and development, and deployment stage of technological innovation must be supported by government. Furthermore a market structure that works to support innovation and entrepreneurship is vital.

2.3 Conclusion: Summary of highlights

- Need a frame work for international electricity distribution (physical and economic) covering all EU areas involved
- Insulation and energy efficiency measures for homes with 100% subsidy by 2030.
- Aim for 30% electric vehicles on the market by 2030.
- Aim for 80% of homes having full smart control by 2030.
- Improved Smart technology – to allow energy demand management
- Incentivise industry energy efficiency along the whole supply-chain.
- Multi-national energy interconnectors
- Current economics model for energy does not work - need a new model
- Equity of energy prices

3.0 The Standalone Scottish Network scenarios: Going it alone

Stuart Hazeldine; University of Edinburgh

3.1 The Vision

All regions (Highlands and Islands (North), Central, South West and South East) in Scotland make extensive use of their regional renewables potential. Electricity is exchanged throughout the country. Pumped storage potentials are exploited, Electricity imports are marginal but exporting energy encouraged.

The Context Professor Hazeldine chose to aim for was 42% carbon reductions against a 1990 reference base, 60% by 2020 and 90% carbon reductions by 2050. But as he pointed out, if we are to contain climate change over the longer term TOTAL emissions of fossil carbon have to be contained, not just the rate of emission. For this to happen he argued by Carbon Capture and Storage (CCS) from conventional coal and gas plants is necessary as well as a new generation of Renewable Energy Systems. Energy Efficiency can buy the atmosphere some time but to maintain the working infrastructural services and manufacturing capabilities that Society requires to function normally Industry needs CCS. That means that ultimately we will have to account for not just ELECTRICITY use in Scotland but also our contribution to emissions from energy EXTRACTED and EXPORTED in and from Scotland. This will be a huge challenge and has significant implications for the Scottish Economy over time. In Scotland in 2006 the total energy use, including electricity, heat, transport and industry was 166 TWHr for the year. In 2009 demand had reduced to 143 TWhr /yr but Hazeldine posits that even with stringent efficiency and demand reduction programmes demand 2030 may rise to 150 – 200 TW hr/yr.

In this scenario energy demand is reduced across the board and while power both renewables and energy efficiency are employed, industry must rely largely on carbon Capture and Storage, transport on new gas and electric technologies and heat will be supplied from a range of sources. The current bedrock of the Scottish Economy is fossil fuels in both extraction and in the powering of its manufacturing base. 2,000 – 4,000 direct jobs exist in such Scottish industry and there are some 250,000 jobs in offshore oil and gas and some 10,000 Scottish jobs already existing in its renewables industries. But Industrial process emissions cannot currently be displaced and must be captured.

The counter argument is that hydro carbons should be left in the ground? But this is very unlikely to happen with current EU / UK oil and gas prices. Scotland still has lots of oil, coal, shale oil and shale gas that most probably will be exploited if the alternative is that the lights go out. So we have to see our Scottish energy future as including CCS but this will require good, high level planning to create the necessary synergies - to build the necessary pipes and storage – to make this happen in time, at an affordable cost and with minimal social or economic impacts over time.

Scotland is in the throes of an heroic and world leading move into renewables but this will never be enough. It is necessary to understand that electricity is but a small part of our energy requirement. We must realistically include HEAT and INDUSTRY in our calculations and this means pioneering CCS in Scotland. The cost of doing so is always mooted but is carbon, or money more important? It is time to start long term planning to lay the foundations for a long term future that does not stop at 2030 or 2050 but goes on to 3,100 and beyond. Key to achieving this is the need for the Long Term Security of energy supplies. For Scotland this means renewables PLUS storage, or INFILL.

Inevitably our approach to the charging of transmitting energy is also key and we can also generate income with a Scotland-centric energy Charging policy. But we have enormous potentials for a world beating Mix of generation incorporating windpower on best sites, balancing carbon extraction to the planting of trees for fuel and establishing a stable baseload flexible generation with CCS when and where necessary.

With an intelligent ‘joined-up’ policy Scotland can not only lead the world in low carbon energy supply but also build a long term successful economy based on it.

3.2 How do we get there?

The following Table 4 provides an insight into the general types of discussions on the day at one of the 5 tables in this Vision group:

TABLE 1. Smaller teams of 4-5 worked on the following questions for the entire Vision or part of it.

WHAT (change elements)	**HOW (activities)**	**WHO (stakeholders)**
Technological Changes **1) STORAGE** **2) HEATING EFFICIENCY** **3) SMART GRID** **4) BUILDING REFURBS** 5) **OFF-SHORE WIND**	1) Large scale pumped storage sites – and more R + D into on-site domestic storage 2) Force District heating into New Stock – communal buying and generation to reduce per capital costs 3) Install cheap effective Smart Meters	1) Government commissioned surveys of private commissioned eco-housing developments. 2) Local Councils fund retrofitting 3) Legislation for new builds. 4) Community initiatives – council owners + coops (with Utility companies ?) 5) Govt incentives – Utilities and households cooperate
Cultural-Behaviour Changes	1) Black-outs – energy problems 2) Acceptance of RE and associated intermittencies 3) Increase knowledge of damage caused by Power Companies	1) General Public who will grasp the issues and implement solutions as problems occur. 2) Educate children in issues from early age.
Structural-Institutional Changes **BUILDING REGS** **REVERSE PRICING AND DEMAND REGULATIONS**	1) Legislation for new Buildings + Strategic Design of Retrofits 2) Government intervention in Utility companies to create equality as solutions are implemented	1) National and Local Government

The discussions were wide-ranging and well summarised in the final presentation summaries below.

3.3 Conclusion: Summary of highlights

a) Technologies for 2030:

- Storage (localised and centralised, thermal/electric)
- Heat pumps and district heating (via biomass /geothermal/waste)
- Realisable new home carbon target; ditto for refurb
- Smart meters integral
- Offshore wind + creation of exportable surplus (inc. gas +CCS); Develop pump storage system; Upgrade transmission system – high voltage export lines

b) Cultural / Behavoural changes for 2030:

- Greater tolerance of interruption of supply (but not service) and acceptance of demand response via smart grid
- Allow centralised control of energy demand for balancing
- Low carbon transport becomes the norm (see activities)
- Widespread communication; Public awareness and education; Monitoring; smart grid/DSM
- Customer expectations (comfort and convenience) must be managed / understood better.

c) Cultural / Institutional changes for 2030:

- Increase public sector borrowing; Go back to permitting public investment (as opposed to PPP/PFI); Nationwide regulatory body; Subsidy schemes
- Governance – (multiple levels – from EU down..); Strong legislation and standards (fixed)
- Reversal of pricing structure to remove disincentive (higher price at higher level of consumption)

d) Technological Issues for 2030:

Power:

- Large increase in large-scale renewables
- Storage in new pumped storage (LT) and local-domestic (short term)
- Smart grids

Heat: District heating, heat pumps, biomass, heat storage (inc PCM)

Transport:

- Smart mobility
- Decarbonisation - Fuel switching (e.g. Evs and biofuel)

Cross cutting issues: Efficiency of buildings

e) Cultural / Behavioural Issues for 2030:

Power: Pricing and taxation issues all resolved (e.g. low carbon vs low cost?)

Heat: Community driven renewable/low carbon heating incentives

Transport:

- Psychological meaning of car-driving will change (encourage)
- Incentives for low-carbon transport modes
- National debate about public transport – subsidy (e.g free buses?)

Cross cutting issues:

- Increase information to consumers – inc. Pricing and benefits (via smart meters)
- Attitude change via education and experience
- Community buy-in + generation important
- Acceptance of limits on consumption

f) Structural / Institutional Issues for 2030:

Power: Restructuring of domestic and non-domestic tariffs

Heat: Upholding "meaningful" targets - legislation for new build

Transport:

- Improve electric vehicle charging infrastructure (chicken and egg…)
- Taxation certainty around low carbon fuels

Cross cutting issues: Dropping the emissions trading schemes

Stakeholders: Government; Institutions; Individuals; Investors

4.0 Autarky: Local energy Autarky scenario

Definitions:

"*We define a region to be energy autarkic when it relies on its own energy resources for generating the useful energy required to sustain the society within that region"*
Muller et al., Energy Policy 39 (2011) 5800-5810

"… a situation in which a region does not import substantial amounts of energy resources"
Schmidt et al., Energy Policy 47 (2012) 211-221

"… a framework for local action towards the development of a region's viability, based on the transformation of the energy subsystem"
Muller et al., Energy Policy 39 (2011) 5800-5810

4.1 The Vision

This scenario considers the extent to which a building, campus or estate, community, city or region can satisfy their energy demand via small-scale decentralised energy systems that largely utilise locally available renewable energy sources. The vision was stated as follows:

- *Each region in Scotland will practice energy autarky with goal for a minimum 70% self-sufficiency by 2030*
- *Dealing with space conditioning and electricity vectors – to include transport*
- *Heterogeneous, co-operating communities through a transition to community awareness and empowerment*

4.2 How do we get there?

There are a rising set of global circumstances and trends that are challenging the hegemony of incumbent, top down, predict and provide models of energy provision. Prominent among these factors are energy security, climate change and increasingly a loss of faith in the capacity for centralised institutions to provide democratised provision. Allied to these factors is rapid technological change in the fields of energy generation and communications that is creating economic opportunities for different visions of provision at a radically different scale[17] [18] [19]. The principal disruptive influence is likely to be cultural in dimension through the creation of new entrants into the energy space (e.g. local utilities, Consumer Co-op', Housing Associations trading in energy). These new entrants will seek to exploit technology and communications advances to create change in energy provision to support a desire for more local/regional solutions.

One emergent framework that has the potential to encapsulate this socio-technical shift is *Energy*

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[17] Lovins A, Rocky Mountain Institute, 2007;

[18] Awerbuch S., Tyndall Centre, 2004,

[19] Verbong & Geels, Tech Fore & Soc Chng, 77 (2010) 1214-1221

Autarky. This can be presented as a conceptual framework for implementing sustainable regional development based on the transformation of the energy subsystem[20] [21]. It would be realised by the formation of an organising entity(s) whose role is to characterise energy demand for the local economy and services and to subsequently source this requirement from energy services derived from predominately locally renewable energy resources (see Figure below).

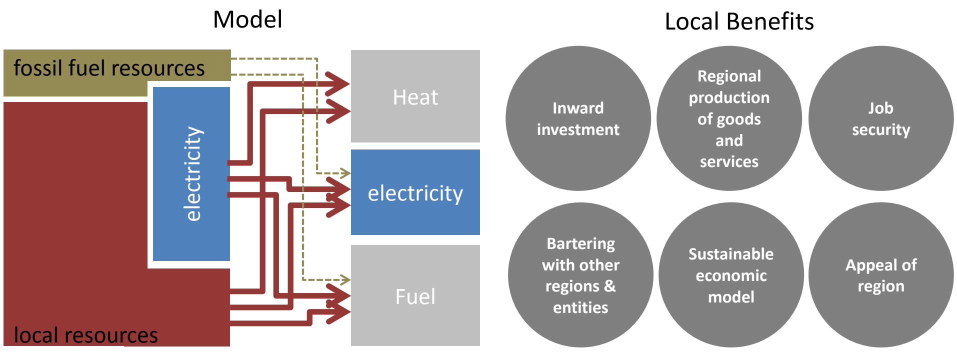

Figure 3. Energy services derived from predominately locally renewable energy resources

A number of issues abound with the definition and management of Energy autarky. For instance; how are boundaries defined, should embodied energy to be included, neo-classical trade theory would predict a reduction in trade resulting in higher commodity and transaction costs, security and resilience of energy supply may be impaired and there is significant jeopardy of some regions experiencing transitional lock-out associated with a lack of universality of application.

There were concerns raised that most discussions centred in rural locations and implementing the autarkic vision in urban setting where 80% of the population live would present greater challenges. A number of economic issues would have to be addressed, namely issues about who would pay for grid connectivity, localised energy generation may actually increase costs, attracting start-up capital and how autarkic approaches might have an impact on the wider economy and country wide GDP.A range of technical possibilities were discussed; energy efficiency and retrofitting was key, development of system integration knowledge was critical, potential for DC grids, heat and power system should be championed, twinning urban areas with rural to allow renewable energy technologies to be correctly situated but allow urban areas to benefit economically. Case Studies in rural Scotland were provided by Community Energy Scotland and additional European case studies were provided, the most prominent being in Güssing, Austria. The key messages that emanated from analysis of these case studies were that this transition will take time and that to see this vision become a reality will require profound societal change, updated values, new economic models/values and perhaps most importantly local champions and leaders.

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[20] Muller et al., Energy Policy 39 (2011) 5800-5810

[21] Schmidt et al., Energy Policy 47 (2012) 211-221

Major required changes as identified in the workshop
Technical Changes Energy efficiency first – reduce demand Greater availability of and use of energy data Highly integrated proven supply technologies coupled in to heat, power and comms networks Enhanced communication between technologies and with people (interfaces) Benchmarking, case studies Greatly increased demand side management
Main Cultural-behavioural changes Greater environmental awareness and sense of urgency Awareness of community power Mentoring and cooperation Encouraging and building community leadership Stimulating sharing, trust and transparency
Main Structural-institutional changes Easy access to expert knowledge (technical, financial, environmental, local) Twinning of urban and rural (e.g. rural can support urban networks) New financial paradigm valuing social, environmental, and wider economic benefits instead of only financial benefits

Suggested activities till 2020 include:

- Field trial work and that this should be urban in nature, ideally situated in a traditional city centre tenement
- Issues around energy efficiency and retrofitting would have to play a more prominent role
- New financial models would have to be developed that overcome the benefits of incumbency
- Impact of planning and regulation would have to be explored and changed
- There should be a strong focus on people, behaviour and change
- Remove barriers (e.g. some planning) and support for wider social benefits of community energy
- Allow for a flexible, longer term investment horizon, and secure financial models
- Stimulate new investment models, building on crowd funding and community ownership
- Dissemination of best practice, access to expertise, pilot study exemplars (e.g. retrofit tenement block, Eigg), proof of concept
- Start a shift of power away from Utilities to communities

4.3 Key Outcomes from the Autarky Vision discussions

The Autarkic vision represented a very positive, empowering vision for global → local energy transition. The initiative is very firmly placed in the hands of the people creating more dynamic activity, local job creation and long term sustainability for communities. It was also felt that the vision would provide substantial societal benefits, reducing sense of isolation and lack of connectivity and helping to bind communities through heightened social interaction.

The discussion did recognise, however that the drive for the vision would have to be cultural, reflected by some of these key comments:

- Collective responsibility needs to be established – openness between people and a shared responsibility
- Participants must be active in the system to make it work
- Huge change in the average person's thinking with regards to the importance of sustainability – can't just be an afterthought

In summary, the workshop emphasised that any drive toward autarky would be predominantly social and application in an urban setting would be required to create understanding of boundary definition and ultimately the limitations that would be placed on the vision.

5.0 Conclusion

Climate change, air quality and energy security will change how energy is used and provided in the future. Population increase and economic growth increase the pressure to make such changes. Provision of clean and secure energy will not be possible without major innovation coupled with large scale investment.

Several clean energies are already available, and emerging new technologies show great potential to widen our ability to produce future requirements for clean energy. Whilst societal adoption of new energy technologies is often restricted by cost, costs will reduce as technologies improve and as the competitive clean energy sector evolves.

Although great challenges lie ahead, there are visible paths which lead to a future of clean and secure energy for all. To get there requires clean energy widely commercially available, commercialisation and delivery of new technologies at the advanced research, development and demonstration stage, with continuation of research into new technologies.

Scotland's future economic development may well be influenced by the decisions taken on its own energy future. There is no reason why Scotland, should not play a leading role globally in the development of new energy paradigms and in so doing build a sound future for its own economy and citizens. This backcasting event has shown that to achieve the necessary step changes new ways of scoping out, and planning for, a better future are required and backcasting appears to be a powerful tool for doing just that.

6.0 Backcasting– Suggested Further Background Reading

Dreborg KH (1996) Essence of backcasting, Futures 28 (9): 813-828.

Green K, Vergragt P (2002) Towards sustainable households: a methodology for developing sustainable technological and social innovations, Futures 34: 381-400.

Höjer M, A. Gullberg, R. Pettersson(2011), Backcastingimages of the future city-Time and space for sustainable development in Stockholm." Technological Forecasting and Social Change 78(5): 819f.

Holmberg, J. and K. H. Robèrt (2000). "Backcasting: a framework for for strategic planning." International Journal of Sustainable Development and World Ecology 7(4): 291-308.

Holmberg J (1998) Backcasting: a natural step in operationalising sustainable development, Greener Management International 23: 30-51.

Quist J, Thissen W, Vergragt P (2011) The impact and spin-off of participatory backcastingafter 10 years: from Vision to Niche, Technological Forecasting and Social Change 78(5): 883-897.

Quist J, Knot M, Young W, Green K, Vergragt P (2001) Strategies towards sustainable households using stakeholder workshops and scenarios, Int J of Sustainable Development (IJSD) 4(1): 75-89.

Quist J, Vergragt P (2006) Past and future of backcasting: the shift to stakeholder participation and a proposal for a methodological framework, Futures, in press, 19 pp.

Robinson J (2003) Future subjunctive: backcastingas social learning, Futures 35: 839-856.

Rotmans J, Kemp R, van Asselt M (2001) More evolution than revolution: transition management in public policy, *Foresight* 3 (1): 15-31.

Wangel, J., (2011) Exploring social structures and agency in backcastingstudies for sustainable development. Technological Forecasting and Social Change. 78(5): p. 872-882.

Appendix A:

Programme Scottish 2030 Vision Development & Elaboration, March 12th, 2014

09.00 Arrival and Registration

09.30 Event Opening & Purpose, Susan Roaf of ICARB and Donald Booth of the Energy Technology Partnership, the event sponsors.

09.40 Presentation of the Swedish Future Energy Scenarios by Per Lundqvist (see below)

10.00 Getting Demand and Supply partnerships right: Electric Cars in Norway by Harald Rostvik

10.15 Brief introduction to Backcasting and the programme by Jaco Quist

10.30 Draft ideas for RE futures Scotland outlining the 3 possible 2030 Visions – starting with the major confounding factor – climate change brief introduction by Alex Hill then outline presentations on each of the three possible futures By Iain Staffell (UK Centric), Stewart Hazeldine (Scotland Alone) and Andrew Peacock (Local Autarky)

11.00 COFFEE BREAK for informal networking

11.30 Subgroup elaborations of presentations on 3 Visions for Scotland

13.00 LUNCH BREAK

14.00 Scenario elaboration in three groups

15.30 TEA BREAK

16.00 Plenary Vision Reporting back to the whole group & Discussions

17.00 RECEPTION and informal Networking and Discussions

18.00 End