The role of decentralised energy in delivering 'just sustainability' in Northern European cities - a review of theory and practice.

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Abstract

There are a number of justifications for approaching sustainable energy issues at the urban scale with the main rationale focussing on population density resulting in concentrations of carbon emissions and therefore their suitability for neighbourhood and city-wide distributed generation of sustainable energy. As well as the potential this gives for cutting carbon emissions through a transition to a decarbonised energy system, the benefits of such an approach could also positively impact on redressing issues of social and environmental justice through the concept of 'just sustainability'.

This paper therefore is concerned with the role of decentralised urban energy systems and achieving just sustainability objectives in the northern European context.. It argues that whilst existing approaches to planning for decentralised energy may be successful in achieving their ex-ante stated objectives (be it economic development, reducing carbon emissions or alleviating fuel poverty); they could achieve greater overall and long-term impact by developing objectives that deliver a broad just-sustainability agenda through the transition to decarbonised, decentralised energy systems. The approach taken focuses on a review of policy and practice relating to decentralised urban energy systems in a north European context, and develops a typology of initiatives relative to sustainability aims and objectives. This is further illustrated by case studies of two decentralised energy initiatives – one in north east Scotland and one in southern Sweden. The paper concludes that there is a significant gap in the research linking technological solutions to sustainable energy supplies with the delivery of a sustainable and just society, and that further research is required to develop theory and praxis to deliver trans-generational sustainability and resilience through a just transition to decarbonised, decentralised urban energy systems.

Key Words

'decentralised energy', 'just sustainability', 'environmental justice', 'social justice', 'Northern Europe'

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Energy and the city: towards a decentralised, decarbonised model of urbanisation

Cities currently use energy at a rate disproportionate to their ability to generate energy. Globally cities account for approximately 75% of global energy production (Droege, 2002). This pattern of intensive energy demand in cities is closely linked to economic growth and processes of urbanisation. "Cities …are creatures of their energy regimes" (Droege, 2006:2). Since the earliest urban settlements, cities "were the result of historically specific technological articulations of regional resource and energy frameworks" (op. cit.).

Energy use in buildings (space and water heating, cooling, lighting and appliances) accounts for approximately two-thirds of total energy demand (Worldwatch Institute, 2004). It can therefore be concluded that because cities are home to the greatest concentrations of people, housed and employed within the built environment, they are therefore the greatest users of energy. Unless that energy is derived from renewable energy resources, cities are the largest contributors to anthropomorphic climate change and thus offer substantial opportunities for the mitigation of carbon emissions from fossil fuel combustion. It makes sense therefore that if governments are serious about tackling climate change and ensuring environmental sustainability – they must focus efforts on energy use in cities. "You can't have a sustainable world without urban sustainability" (Girardet, 1999:17). The International Energy Agency suggests that 95% of the population growth in developing countries in the next 30 years will be urban, which further adds to the impetus to address energy generation and demand in cities.

Cities have the largest concentrations of households living in poverty and extreme polarisation of income and quality of life. This offers a meaningful opportunity to redress issues of social justice, particularly from a distributive perspective. It has been argued that tackling sustainable development at the urban scale offers increased potential for 'building resilience in the face of climate change' (Rydin, 2010:26). This suggests that in terms of infrastructure, such as that associated with energy generation and distribution - there are both economic and structural benefits from the urban scale, but also scope for increased human resilience through the creation of social capital that can be attributed to schemes that have high levels of community engagement and even governance and/or ownership.

This paper is concerned with the relationship between decentralised energy in a northern European urban context and its role in delivering trans-generational resilience by embedding a just sustainability agenda in sustainable energy policy making and praxis.

Decentralised Energy

In order to identify the scale of technologies to be deployed in an urban community context that can be classed as 'decentralised' the classification of socio-technical scales identified by Walker and Cass (2007) was used in conjunction with the definitions provided by the UK Government, and the definition of decentralised energy outlined used throughout the paper - i.e. the energy generated is predominantly used locally although the plant may be grid connected with an import-export arrangement to allow for demand/supply variations. Walker and Cass categorise the application of renewable energy technologies ('hardware', 2007:460) at four scales - macro, meso, micro and pico. They do not attribute a specific minimum/ maximum rated output of the different technologies to each of these scales preferring to cite possible applications such as a roof mounted wind turbine at the micro scale versus a wind farm at the macro scale (op cit). The UK Government in the Climate Change and Sustainable Energy Act, 2006 defines the micro scale through the use of the term 'microgeneration' as: the small-scale production of heat (less than 45 kilowatt thermal capacity) and/or electricity (less than 50kW electrical capacity) from zero or low carbon source technologies (2006:26:3). The large scale generation of energy from renewable energy sources

that cannot be deemed decentralised in that they form part of a national energy generating and supply infrastructure (macro) are those that in the UK qualify for Renewable Obligation Certificates (ROCs) with smaller generators of electricity qualifying for Feed in Tariffs (FiTs).

On the basis of these parameters and definitions, decentralised energy technologies suitable for use in urban communities appropriate to this paper have been classed as at the 'meso' scale with a generating capacity in excess of 45kW for heat producing technologies and in excess of 50kW for electrical where the energy generated in predominantly used locally and not as part of a national energy generation and supply system. Appendix 1 shows the broad range of sustainable energy technologies, representative of projects across northern Europe, with a note as to the scale that they are considered most appropriate for deployment in urban communities based upon this definition, whilst Box 1 below provides a summary of the general characteristics relevant to decentralised energy projects under consideration in this paper. Natural gas combined heat and power (CHP) technologies have been included in this study because they can be considered as a 'transition technology'. Whilst natural gas is not sustainable in that it is a non-renewable hydrocarbon fuel, the use of CHP technology is widely recognised as a means of using input energy resources in an efficient way [1]

Box 1: Characteristics of Urban Decentralised Energy Initiatives

Initiative Form	**Scale**	**Technologies/Schemes**
Energy generation and supply Energy strategy/ policy/framework/ directive	Development site/ housing cluster Neighbourhood / urban centre City/city network	Renewable power Renewable heat networks Renewable combined heat and power Transitionary combined heat and power

In summary, this paper defines decentralised energy as energy generated at the scale of the building site through the neighbourhood and urban centre scale which is predominantly used locally although the plant may be grid connected with an import-export arrangement to allow for demand/supply variations. It refers predominantly to energy generation from renewable sources.

Just Sustainability

Agyeman, 2005 defines 'just sustainability' as "the need to ensure a better quality of life for all, now and into the future, in a just and equitable manner, whilst living within the limits of supporting ecosystems" (2003:5).

It could be seen as a marriage of environmentalism which focusses on ecological stewardship, with social justice which priortises issues of justice, equity and human rights. In many ways it is a *redistributive* approach to environmental goods, services and impacts, such as energy generation and supply, as is the focus of this paper.

The broadly accepted definition of that much contested phrase 'sustainable development' is set out in the Bruntland Report: 'development which meets the needs of the present without compromising the ability of future generations to meet their own needs' (1987) if taken literally (rather than interpreted to justify whatever approach suits the needs of the 'developer') is the definition of 'just sustainability'. It embraces environmental stewardship with issues of justice with an emphasis on trans-generational equity. The Bruntland definition it is frequently imagined in the popular and simplified Venn Diagram which separates and simultaneously co-joins the 'three pillars' of sustainable development - the economic, the environmental and the social. It is argued and indeed adopted here that if we are to consider development as sustainable in the sense that it delivers justice, then the social should underpin the environmental and the economic - it is the part that adds the human dimension, creates the contract between society and the environment including the goods and services derived from it (ecological capital). The social here represents justice and equity and it is the aspect of sustainable development that is most frequently ignored in the North and regarded by many as only overtly pertinent to the developing South (Jacobs, 1999). Hence the reason for focusing the analysis of decentralised energy initiatives in northern Europe - to what extent are justice and equity ignored or embraced in sustainable energy initiatives?

For the purposes of analysis a *justice framework* has been developed to set out the varying aspects of decentralised energy initiatives that determine the extent to which they contribute to a just sustainability discourse. The broad parameters for assessing whether or not decentralised energy initiatives deliver just sustainability are defined around two central concepts: *Socio-Environmental Justice:* Environmental impacts of decentralised energy developments will be distributed equally between communities, and *Socio-Economic Justice:* Economic impacts and benefits of decentralised energy developments will be distributed to address inequality between and within communities. These combined form the basis for just sustainability when taken into account with their temporal characteristics, model of governance and methods of setting and evaluating success as seen in Box 2 and it was on the basis of these criteria that the just sustainability typology was developed and against which initiatives were assessed.

Box 2 : Criteria to determine extent to which Decentralised Energy projects deliver justice objectives.

Are the aims and objectives of the initiative primarily concerned with:
• Environmental stewardship/ reducing greenhouse gas emissions? • Developing the local or regional economy on the basis of private enterprise? • Distributing the environmental costs (e.g. pollution) and benefits (e.g. reduced emissions) so as not to impact disproportionately on the quality of life of disadvantaged communities? • Distributing the benefits of deploying decentralised energy technologies to address issues of socio-economic inequality (e.g. fuel poverty)? • Distributing the environmental costs/benefits and socio-economic benefits to address inequalities between and within communities?
Other factors to consider:
• How are projects to be delivered? Temporal frameworks, ownership, governance and measurement. • Are the outcomes/legacy limited to a set period of time (e.g. by 2020 the city will have reduced its carbon emissions by 30%). • Are the outcomes/legacy based upon delivering trans-generational resilience and sustainability. • Will the initiatives be under the ownership and governance of the private sector, the municipality, the community or a combination of these? • Will the initiative be measured using participatory methods for setting and reporting upon indicators of success?

Review of Practice

The North Sea Sustainable Energy Planning project (North Sea SEP)[2] is an EU Interreg funded initiative that is primarily concerned with learning from current experience of energy planning and seeking to develop 'best practice' model approaches. Decentralised energy approaches are at the heart of sustainable energy planning. the project engages partners from Belgium, Denmark, Germany, the Netherlands, Scotland (UK) and Sweden. The partner organisations are representative of a proactive knowledge community where a robust understanding of sustainable development is assumed. A 'snapshot' analysis of participating projects sought to identify the extent to which just sustainability was addressed by the North Sea SEP projects and as a further anchorage in contemporary practice, a range of related initiatives identified through an internet search of other EU funded projects. It was therefore able to deduce within obvious limitations the extent to which such thinking is prevalent amongst actors in the 'community-scale' renewable energy sector in the North and it emerges that whilst objectives other than reducing carbon emissions are often stated, the references to economic issues focusses on job creation and private sector investment, and there is little or no elaboration on the term 'socio-economic' benefit. This suggest that either the information readily available about these initiatives is inadequate and when probed further there would be increased clarity, or that there is a lack of understanding about the social and the economic impacts of decentralised energy initiatives and that the language used is rhetorical or simply the use of 'buzz-words' to ensure the right box is ticked. This requires further investigation.

In order to probe that bit deeper, two projects were considered in more detail as case studies - Aberdeen City Council - Aberdeen Heat and Power (Scotland, UK), and the Municipality of - Energi AB (Sweden). The lead author conducted an interview with the key actors in the Aberdeen initiative and visited the site of the Swedish project as part of a study tour in December 2010, but did not have opportunity for a follow up interview. These two projects were assessed against a typology developed by the author on the basis of the literature review and practice in sustainable development and environmental and social justice. Box 3 below outlines the five types of project where the first two are at the lower end of the just sustainability spectrum and five clearly demonstrates a commitment to addressing issues of equity and justice through the project.

Box 3: Typology of North European decentralised energy projects and their 'sustainability' focus.

Environmental	Economic	Socio-Economic	Socio-Environmental	Just
Ecological stewardship.	Private enterprise/ private profit.	Redistribution of economic resources/ benefits towards disadvantaged communities.	Equitable distribution of environmental costs and benefits.	Redistribution of social, economic and environmental costs and benefits to deliver trans-generational sustainability.

The case study initiatives were categorised by project type, scale, technologies deployed and then assessed against criteria to determine the engagement of justice issues in project planning, development and implementation - either overtly (clearly states justice issues as integral to the project aims), covertly (where justice issues are implied by actions but not necessarily stated) or if missing completely at all stages. The existence of measurement criteria and forms of evaluative practice also helped determine a justice agenda, for example was the evaluation method and indicators participatory or even designed by the 'community' at the heart of the projects or is a less robust box ticking method to evaluation to be deployed? The decision about which characteristics could be attributed to a justice-led approach was based upon the justice framework outlined earlier. The information gathered through these activities form the basis of the case studies as follows:

Aberdeen City Council - Aberdeen Heat and Power Ltd.

Summary:

- Initiative type - energy generation and supply
- Scale - development site/housing cluster and neighbourhood
- Technology - transitionary combined heat and power
- Dominant Just Sustainability Project type 3 - socio-economic

Aberdeen is a city with a population of approximately 250,000 citizens located on the north east coast of Scotland. Its principal industries are oil and gas and the local authority and her partners hold claim to the city's title of ' Oil Capital of Europe'. In spite of the city's relative wealth there is an issue of low income, indeed the polarisation between rich and poor is significant. In response to a Government requirement for Scottish Local Authorities to reduce carbon emissions from the domestic sector and to address 'fuel poverty' (fuel poverty is defined in the Scottish Government Fuel Poverty Statement (2002) as when a household spends more than 10 percent of their income on domestic fuel), officers within Aberdeen City Council investigated the possibility of using natural gas combined heat and power (CHP) technologies to reduce the energy bills of tenants in the public housing stock. In 2002 they established Aberdeen Heat and Power Limited - a non-profit distributing arms length company - to take forward plans for gas CHP projects across the city, with a focus on high-rise apartment blocks. At the time of writing gas CHP systems have been installed in three communities serving 850 households. The affordability of space and water heating for tenants has been the main driver for the projects and it is reported that weekly energy costs per household have reduced from 25 GBP (when using electric heating) to around 8 GBP with the district heating. This figure can be reported accurately because tenants pay a set amount each week, set by the municipality as landlord, as a component of their rent. It is difficult to gauge if this is an actual amount relative to consumption because heat meters are not installed in the individual properties and it is possible that the amount is subsidised by the landlord to ensure that affordability objectives are delivered. This will require further investigation and is outwith the scope of this paper.

The founding document of Aberdeen Heat and Power Limited states: *The Company is established for the benefit of citizens of The City of Aberdeen*. The benefits to the city's citizens are described in terms of affordability of heating for tenants, security of energy supplies and reduced carbon emissions through the use of an energy efficient technology (interview with Directors of Aberdeen Heat and Power, 2010). The organisation is managed by a voluntary Board of Directors and the municipality as the founding member is entitled to one place on the Board. There is also an allowance for a tenant representative to be a Director but this has not yet been taken up. Regarding environmental justice issues - the siting of the energy centres has been necessarily close to the apartments they serve (to ensure maximum energy efficiency) and as such concerns over air quality issues (from flue gas emissions), visual amenity and noise were addressed through consultation with both residents and the planning officials in the municipality. The design of the building considered the coastal 'links' environment hence the low profile, undulating turf roof - a sharp contrast to the residential buildings it serves. This building also serves as changing and showering facilities for users of the adjacent football pitches.

The fuel source used in all of Aberdeen Heat and Power's CHP installations to date has been natural gas. The Directors are investigating the possibility of developing a biomass CHP project however are reticent about the reliability of the technology due to some high profile projects in Scotland that have 'gone wrong'. There are also issues about the supply of biomass fuels and some concerns about particulate emissions. These issues indicate the immaturity of biomass as a fuel source in the UK as compared to Scandinavia (as will be seen in the case study) and as such the use of gas for CHP installations is considered in this paper as at least a step in the right direction, given the efficiency benefits of district heating and decentralised energy generation. As such it is deemed rather pragmatically by the authors to be a transition-technology - not ideal from a true environmental stewardship perspective, but to get from A (inefficient use of fossil fuels) to C (100% renewable energy) we have to transition through B.

Växjö Municipality - Fossil Fuel Free Vaxjo/Vaxjo Energi AB

Summary:

- Initiative type - strategy and energy generation and supply
- Scale - city network
- Technology - renewable combined heat and power
- Dominant Just Sustainability Project type 1 - environmental stewardship

The municipality of Växjö is located right in southern Sweden, being the capital of the county Kronoberg, placed in the province of Småland. The municipality of has on the region of 82,000 inhabitants, of whom approximately 52,000 live in the city of Växjö. The main industries are glass-making, furniture, bio-energy and education. The municipality has an initiative known as Sustainable Växjö which has the following listed indicators: climate impact, sustainable growth, income equality between genders, levels of education, state of public health, segregation, levels of employment/unemployment, waste, water quality, risk of poverty and creativity. They state that they integrate economic, social and ecological sustainability with a holistic, long-term view. They have a range of initiatives relating to specific indicators (e.g. around air quality and health) - of particular interest is Fossil Fuel Free Växjö - which aims to have no climate change emissions from energy use, including transportation. It is this energy specific initiative that is under consideration in this case study.

A major component of the municipality's efforts to transition to a renewable energy based system is the arms length company Vaxjo Energi AB (VEAB) and specifically the Sandvik plant. The Sandvik plant is a 104 megawatt (MW) city-scale combined heat and power station that supplies the city with electricity, heating and increasingly cooling through a city grid and district heating network via a process known as co-generation. Of all the energy produced one third is electricity and two thirds are heat. Since 1980 the operators of the plant have been increasing the amount of biofuels used to generate the energy and in 2007 that reached 98.7% of energy from biofuels., the balance from oil. The district heating network serves over 7,000

customers and over 29,000 electricity customers in the city of Vaxjo. Smaller biomass district heating schemes serve neighbouring towns.

The Sandvik plant employs 161 people and states job creation as a key advantage of the plant's existence (as opposed to a centralised energy system remote form the city). It is not stated anywhere publicly that affordability of energy is an objective of the initiative however the author was informed by the manager of the plant that district heating customers make savings of some 40% on their heating bills over the alternatives of oil or electric heating. The average domestic heating cost is 1500 Euros per year. The plan is to include the whole city in the district heating network through further expansion of the plant.

Conclusion

The literature examining and connecting the relationship between decentralised energy and aspects of just sustainability in a northern context is limited. EU policy and legislation surrounding the deployment of renewable energy technologies at the decentralised scale, particularly the Cogeneration (CHP) Directive 2004/8/EC puts the emphasis very much on increasing energy efficiency (to cut carbon emissions) and improving security of energy supplies (to ensure resource supplies can be prolonged). There is little overt recognition of the redistribute justice potential of such technological developments and research and policy about social justice issues like fuel poverty are at the emergent stage in an EU context. Whilst decentralised energy initiatives can lay claim to improving socio-economic conditions as well as cutting climate change emissions, there is little elaboration on what this means and it is not set in the holistic ' eco-socio-technical' frame necessary to enable just sustainability. To this end, claims made can only be taken at face value and may be interpreted as rhetoric.

The paper concludes that there is a significant gap in the research linking technological solutions to sustainable energy supplies with the delivery of a sustainable and just society, and that further research is required to develop theory and praxis to deliver trans-generational sustainability and resilience through a just transition to decarbonised, decentralised urban energy systems. Put simply, there is an urgent need to rethink how we think about energy, society and the ecological resources available to meet our needs (not wants) without compromising the needs of future generations. "*Here is a pattern for the new urban constellation*" Mumford, 1961:566).

End Notes

[1] Elliott describes the efficiency merits of gas CHP technology on the basis that it makes use of the waste heat from electricity production in a way that conventional, centralised energy systems do not, with waste heat being used in district heating schemes. CHP plants can also be deployed at a smaller scale than conventional power stations to generate both electricity and heat for local use, as is included here. He states that the general shift from coal to natural gas for electricity production in the UK has been beneficial from a carbon reduction perspective (gas combined cycle turbine plants produce in the region of 40% less carbon per kWh than coal - Elliot, 1997:52).

[2] See www.northseasep.eu for further information.

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Appendix 1 - Overview of types of decentralised energy technologies deployed in Northern Europe.

Decentralised Energy (DE) Technology	Energy Output (Electrical and/or Thermal)	DE Applications	Meso Application - Scale	Minimum Energy Output for Urban DE
Biofuel Combined Heat and Power	Electrical and Thermal	Renewable combined heat and power	Neighbourhood / urban centre.	> 50kW electrical and >45kW thermal
Biofuel District Heating	Thermal	Renewable heat networks	Development site/ housing cluster. Neighbourhood / urban centre.	> 45kW thermal
Geothermal Heat Pumps	Thermal	Renewable heat networks	Development site/ housing cluster. Neighbourhood / urban centre.	> 45kW thermal
Natural Gas inc. Tri-Generation Combined Heat and Power	Electrical and Thermal	Transitionary combined heat and power	Neighbourhood / urban centre.	> 50kW electrical and >45kW thermal
Solar Photovoltaic (PV) Arrays	Electrical	Renewable power	Development site/housing cluster.	> 50kW electrical
Solar Thermal / Water Heating Panels	Thermal	Renewable heat networks	Development site/housing cluster. Neighbourhood / urban centre.	> 45 kW thermal
Wind Turbines - onshore and offshore (harbour/ estuary)	Electrical	Renewable power	Development site/housing cluster. Neighbourhood / urban centre.	> 50kW electrical