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Spatial-temporal dynamics of social value: Lessons learnt from two UK nuclear decommissioning case studies

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ABSTRACT

Recently, the concept of social value in construction has seen increasing policy, practice and research interest. In part, this interest stems from growing recognition that construction projects, and especially megaprojects, can create huge social impacts. Although many studies have focussed on defining and developing measures for quantifying social value, qualitative meanings and interpretations of these measures are relatively under-examined. In this paper, two instrumental case studies of infrastructure megaprojects in nuclear decommissioning are analysed to investigate the process of meaning-making of social value. Lessons are drawn from taking a more qualitative, dynamic and processual approach. The findings highlight the limitations of reductionism in existing quantitative measures and emphasise the importance of time and place in understanding the ever-changing idea (and ideals) of delivering social value. Social value is thus a condition of, and conditioned by, ongoing negotiations throughout the lifecycle. Adding to social value research that is dominated by quantitative studies, the nuances highlighted in the case studies show the need to move beyond static measures at a point in time to consider the ongoing and never-ceasing process of transforming social value in construction.

1. Introduction

In recent times, the concept of social value has gained increasing traction in policy, research and practice. From a policy perspective the UK government has, for instance, legislated in the Public Services (Social Value) Act of 2012 that those responsible for delivering public services should ensure the economic, environmental and social wellbeing of local communities in the production of goods and services in accordance with the Public Services Social Value Act, (2012). This addition of the 'social' serves to complete what has colloquially been known as the 'triple bottom line' of sustainable development, which has hitherto emphasised mainly environmental and economic aspects (Blom and Guthrie, 2017). Yet, incorporating the 'social' is not always straightforward, as the social value of sustainability is often well-intentioned but ill-defined (Sánchez, 2015; Nakamba et al., 2017).

In much early scholarship on social value, researchers have tended to focus on defining and measuring the concept. In project studies, for example, scholars have *inter alia* highlighted how social value equates to providing project teams with the 'social licence to operate' (Hall et al., 2015), produced frameworks for assessing social impacts in/of projects (Smyth and Vanclay, 2017), evaluated procurement options that consider social benefits (Hawkins and Wells, 2007) and examined social responsibility of mega infrastructure projects (Ma et al., 2016). Prevailing studies on social value have largely focussed on quantifying social value (see e.g. Watson and Whitley, 2017 for a critique), and there is a productive line of scholars attempting to produce frameworks that clarify what social value is or is not (see e.g. Cartigny and Lord, 2017; Daniel and Pasquire, 2017, 2019). In so doing, social value is often framed and reduced as a measure to facilitate performance reporting and comparisons of socio-economic impacts, often at a given point in time (Cartigny and Lord, 2017). Others have considered how social value can be delivered through mechanisms such as social procurement and enterprise in construction (Awuzie and McDermott, 2016; Loosemore, 2015; Renukappa et al., 2016).

Construction practitioners have also responded to the social value agenda by considering the socio-economic impacts of construction on employment (Mace Insights, 2017), and to provide projections of the impacts of the built environment at key moments

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Table 1
Examples of varied social value definitions in academic literature.

Definition	Source
"We define the social value of energy in terms of the total value derived by an individual or community from the use of energy, including economic and other forms of value, less any risks or burdens that accompany energy production, transmission, and consumption."	Miller et al. (2015): 67
"we define social value creation as an activity that leads to the realisation of any of the three core values of development, i.e. sustenance, self-esteem, and freedom from servitude"	(Sinkovics et al., 2014: 692)
"In reference to social value, this can be interpreted as envisaging how a community's social efficacy and an individual's networks and trust can be improved by the award of a construction contract."	(Cartigny and Lord, 2017: 109)
"… social values, defined here as nonmarket values perceived by ecosystem stakeholders (often corresponding to specific cultural ecosystem services such as aesthetic, recreational, and even spiritual services)"	(Sherrouse et al., 2014: 68)
"The term 'social values' has also been used in diverse ways. It can refer to the values of a particular community or the cultural values and norms of society at large, but can also be used to refer to the public interest, values for public goods, 'altruistic' values and feigned altruistic values, the values that people hold in social situations, contribution to welfare or well-being, the willingness-to-pay (WTP) of a group, the aggregated WTP of individuals, or values derived through a social process."	(Kenter et al., 2015: 88–89)
"social value can take many forms such as improved income, health and well-being and reduced crime, substance abuse and incarceration"	(Denny-Smith and Loosemore, 2017:653)
"Social value is concerned with how we contribute positively to the communities in which we work" (p, xvii)	Raidén et al., (2019)
"social value is simply the 'social impact' any construction organisation, project or programme makes to the lives of internal and external stakeholders affected by its activities" (p. 32)	

across the project life cycle (Supply Chain School, 2017). Many of these attempts still focus on developing frameworks or metrics for quantifying social value at a point in time, often referenced to present value (see e.g. HACT, 2016).[1]

Far less is known as to how social value evolves over time, especially in more complex megaprojects that take a long time to come to fruition (Goldthau, 2014; Flyvbjerg, 2014; Zhou and Mi, 2017). Existing research on social value in construction has also tended to focus on small-scale projects involving new-build (see e.g. Mulholland et al., 2019), resulting in the relative neglect of the context of end-of-life of the built environment in decommissioning (Invernizzi et al., 2017).

This paper addresses these two deficiencies in social value research by examining how the idea and ideals of social value are negotiated in two case studies in the UK nuclear decommissioning sector. The purpose of these case studies is to help answer two interrelated research questions, that is, what does social value mean for the community in and around decommissioning construction megaprojects, and how does this meaning-making vary over time? In so doing, the fundamental contribution of this article is to illustrate social value an ever-changing and evolving process.

2. Theorising social value: defining measures and delimiting boundaries

Table 1 below summarises some of the key definitions of social value found in the academic literature. From these definitions, it can be seen that scholarship on social value can be classified into two main groups: those concerned with defining how social value is measured as a consequence (output or outcome), and those identifying the conditions (inputs) that deliver social value. In this section, a salient review of these two streams of scholarship will be presented.

2.1. Defining output measures, developing measurement frameworks and reporting tools

As a nascent field of inquiry, there has been much scholarship that characterises what social value is. These can be broadly grouped into three main strands, namely defining indicators, developing measurement frameworks, and reporting tools for communicating the measures.

In the first strand the dimensions of social value tend to focus on tangible (e.g. employment and number of trained personnel) and intangible (e.g. culture and a sense of place) outcomes mainly for people living in the communities that are affected by the project. As can be seen in Table 2, the social is often intertwined with economic and environmental indicators (see also Sánchez, 2015; Nakamba et al., 2017).

In the second strand the focus moves from identifying measure to developing methods for measurement. For instance, methods of measuring and reporting social value relevant to construction include: contingent-valuation method, cost-benefit analysis, social accounting, Social Return on Investment (SROI), and basic efficiency resource analysis (see Cartigny and Lord, 2017). These measurement frameworks attempt to combine cost-benefit analysis with assessments of social impacts, often producing financial values that have not traditionally been reported (see e.g. Kroeger and Weber, 2014; Watson and Whitley, 2017).

In the third strand scholars have developed tools for reporting on social value measures. For example, geographical information systems have been used to map social value for a given geographic area or ecosystem (Sherrouse et al., 2014; van Riper et al., 2017). Others have attempted to connect social and natural sciences to communicate ecological, economic and socio-cultural value (see Burdon et al., 2015; Kenter et al., 2015). While these representations may show what social value means for a particular locality, such reporting tools still privilege numerical (and typically financial) values at a point in time over qualitative understandings and how these change over time.

2.2. Conceptualising social value as a basis for developing strategic outlook for projects

Another less-examined area is to view social value as a fundamental basis for developing a strategic outlook for how projects are approached. One of the earliest writings on this can be found in Rhine (1964) who challenged engineers to think beyond technology as he argued for the need for engineers to develop greater political awareness and social consciousness. While scholarship on social value has largely focussed on output-based measures (see preceding sub-section), a number of contemporary studies have shown how valuing the 'social' can serve as a fundamental basis for developing a strategic outlook for projects.

For instance, McDonald and Young (2012), through an in-depth

[1] This quantification is now beginning to be questioned. See the headline article of the RICS Construction Journal, by the Chair of Constructing Excellence's Social Value theme group, Rob Wolfe (2019).

Table 2
Academic defined dimensions of social value.

Aspect of Social Value	Dimensions	Key references
Social	▪ Engaging local community ▪ Access, mobility and infrastructure ▪ Education ▪ History and cultural significance: sense of place ▪ Recreational and therapeutic experience ▪ Healthy living and wellbeing ▪ Human health and safety	Cole et al. (2015); Patala et al. (2015); Sherrouse et al. (2014); van Riper et al. (2017); De Vreese et al. (2016); Daniel and Pasquire (2019).
Economic	▪ Inclusive employment and training ▪ Quality work and cost security ▪ Real estate and land management ▪ Local/social procurement and responsible sourcing	
Environmental	▪ Resource management ▪ Ecosystems pollution and biodiversity	

case study of a mining company, demonstrated how a proactive approach to value the social has enabled a collaborative approach to be developed with local communities to improve the reputation of the mining firm. Kemp and Owen (2013) also argued, from their study of the mining sector in West Africa, that viewing community relations as a core competence does not equate to treating engagement with the community as a core business. Thus, how valuing the social is framed can result in different and divergent strategies.

The issue of framing also featured in Jiang and Wong (2016) who surveyed construction companies in China to show how despite growing awareness of the importance of the 'social', social value is still a secondary concern in corporate social responsibility initiatives that tend to be framed more closely to environmental concerns. More recently, Cherrier et al. (2018) also studied the power of framing to show how technology can be put to more productive use when the 'social' is valued.

To delineate the complexity of social value literature with myriad of approaches, it has been presented in Fig. 1 as falling into 2 social value frames. The iterative process of evaluating social value, can in turn shape the outlook on a project as the outputs are reflected on (see e.g. Cherrier et al., 2018). This can create opportunities for improvements in social value. The iterations between the two approaches raises questions around how social value can be a dynamic process, with a back-and-forth negotiation.

3. Methods

In the preceding section, the argument was made to examine the meaning-making process of social value to go beyond social value as a performance indicator or a measure of returns on inputs to considering how social value evolves over time. A corollary of this argument is the need to broaden the context of investigation beyond projects of constructing new-build to analyse the meaning-making of social value at the end-of-life of buildings. Analysis of how stories of two different energy infrastructure decommissioning projects have developed over time addresses these arguments, taking into consideration the external environment and multiple perspectives.

To capture how meaning-making of social value happens from multiple perspectives, instrumental case study research was chosen as an appropriate research strategy, since this allowed us to study a "complex entity operating within […] a concatenation of domains" (Stake, 2003: 141) using various data sources (Piekkari et al., 2009). Case studies have been commonly used to examine the complexities of project-based sectors such as the construction and management of the built environment, and provide opportunities for engagement between academia and practice (Flyvbjerg, 2006). As the purpose of this study is to examine the dynamics and ever-changing character of 'social value', the use of instrumental case study research is also an opportunity for providing

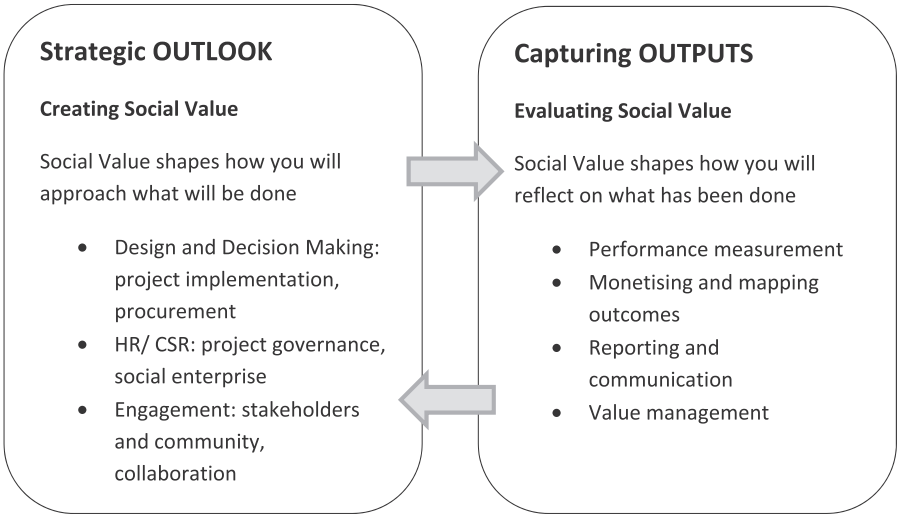

Fig. 1. The dyadic framing of social value.

insight and facilitating understanding of how the meaning of 'social value' is constructed by those involved (Stake, 2003; Ridder, 2017). The focus here is not on developing generalisations, but to provide contextualised and in-depth, specific examples of the meaning-making of social value (Stake, 2003; Remenyi et al., 2002; Flyvbjerg, 2006).

3.1. Case selection and overview

The Nuclear Decommissioning Authority (NDA) is a non-departmental government body sponsored by the Department for Business, Energy and Industrial Strategy, with a 120-year programme costing £121 Billion across 17 sites in the UK with the purpose of managing the nuclear legacy challenges and complexities sustainably (Nuclear Decommissioning Authority, 2016). After reviewing 50 industry documents to delineate the characteristics of these 17 sites, two instrumental case studies were purposefully chosen (Ridder, 2017), one in which the immediate site end-state is being planned for delivery by mid 2020s (i.e. the site is further along the process of being decommissioned), and one where strategies for decommissioning are still being deliberated with the maintenance of the site projected to last until at least 2083.

The UK was one of the pioneers of nuclear energy, with the launch of the first fast-reactor technology in 1959 (Lehtonen and Lieu, 2011). In the rush to pursue low-cost, clean energy through what was a 'first-of-a-kind' technology in the 1950s, the deconstruction of the facilities housing these reactors at their end-of-life was not considered at that time, thus leaving the complex technical challenges of decommissioning currently faced. The UK has most of the world's gas-cooled reactors (Nuclear Energy Agency, 2012), which have been shown to incur the greatest costs, and involve the longest timelines of decommissioning. With not many other places to look for lessons learnt on the specific engineering solutions needed to decommission the fast-reactors, the choice of the two case studies represent some of the most complex, engineering megaprojects to examine.

The multiple contexts influencing these complex engineering megaprojects meant that there are huge degrees of technical uncertainties, and changes in technical decisions would have a subsequent impact on social value. Consideration of social value by the NDA pre-dates the Public Services (Social Value) Act of 2012. Since the creation of the NDA from the Energy Act, 2004, which requires the NDA to consider the socio-economic impacts of its work, Site Stakeholder Groups have been implemented. The purpose of these Site Stakeholder Groups is to engage with local communities to explain the financial, economic and technical value of the decommissioning and site remediation work, as well as to involve stakeholders in discussions on the socio-economic impacts of such work (NDA, 2008).

3.2. Data collection

Research on social value in construction projects has tended to focus mainly on the context of new-build ignoring the end-of-life of buildings. Therefore, in capturing the stories of social value in nuclear decommissioning and site remediation, the fieldwork was designed to analyse how social value is conceptualised, talked about and put to work across the project life cycle, from the historical inception of the two nuclear energy plants to the current state of decommissioning and remediation. The focus was also not just about what the Nuclear Decommissioning Authority and the sites thought and did, but also the involvement of and impacts on the local communities.

The two case studies were informed by a number of sources, including interviews (with site employees and those who are only community members), observations and documentary analysis (Piekkari et al., 2009). Creswell et al. (2007) offer projects as a suitable unit of analysis for qualitative case studies, using interviews, observations and documents as corroborating evidence to build the case. Table 3 outlines the data collected for ease case, with a brief explanation of each below.

The point of departure for each case study was the interview participants (n = 9, 5), being audio-recorded and later transcribed for in-depth analysis. Participants were found through an opportunistic, strategic sampling process (Patton, 1990) using industry contacts to purposefully choose local community members with professional or personal experience with decommissioning. Industry contacts were initially used as a gate-keeper to the case study participants, giving the research credibility in a somewhat conservative industry. As in in-depth research approach was used

Table 3
Data collected from each case study.

	Interview participants	Observations	Site visits	Documents	Supporting
Dounreay Caithness, Scotland	9 Work on site D01 Environmental specialist D02 Sustainability advisor D03 Heritage D04 Site manager D05 Stakeholder engagement D06 Previous union rep Community member D07 Museum volunteer D08 Archive staff D09 Clergy community leader	2 OBS Site Stakeholder Group sub-committee meetings (socio-economics, and site-end-state)	5 DSV1 Decommissioning site DSV2 Archives DSV3 nuclear museum DSV4 heritage museum DSV5 tourist trail	~50 DOC Local newspapers; site published grey literature; relevant policy documents; local flyers for community groups sites of interests etc.	6 D10 Conservation volunteer D11 Nuclear graduate D13 Hotel staff member D14 Shop owner D15Museum employee D16 Stakeholder rep Questions focused on their perception of nuclear
Trawsfynydd Snowdonia National Park, Gwynedd, Wales	5 **Work on site** T01 Stakeholder engagement T02 Site end-state manager T03 Engineering consultant **Community member** T04 Enterprise Zone steering member T05 Local council member	1 OBS Public Site Stakeholder Group meeting	4 TSV1 Decommissioning site TSV2 Trawsfynydd Lake visitor centre TSV3 Slate museum TSV4 Blaenau Ffestiniog	~50 DOC newspapers; site published grey literature; relevant policy documents; local flyers for community groups sites of interests etc.	2 T06Hotel staff member T07 Site Engineer *Questions focused on their perception of nuclear*

to build rich case studies from a myriad of sources, the number of interviews depended on reaching a point of no significantly new evidence emerging for the over-arching themes (Baker and Edwards, 2012).

These interviews were anchor points for the researcher to build the case study around and triangulate with the multiple sources of data for a richer account. The interviews followed a question protocol (Spradley, 1979), with the core questions:

- Tell me about your background (professionally and personally)
- What are your views on nuclear decommissioning, remediation and regeneration?
- Have you heard of 'social value'? If not, what do you think it means?
- How does social value link in the work you do in decommissioning or regeneration?
- What do you think is the future of nuclear energy [and decommissioning] in your community?

Observations were agreed prior to the meetings. At Dounreay the 2 sub-committee meetings were held in a closed room with invited members. The socio-economics meeting covered a range of topics from the community being fed back to Dounreay. The site-end state meeting was the experts presenting information. At Trawsfynydd it was the 6-monthly open forum, with experts presenting updated reports for interested stakeholders. The field researcher took handwritten field notes following a prepared protocol (Spradley, 1980).

Site visits were planned in advance, taking photographs and notes on the physical surroundings to give a context to place, enriching the case study context (Creswell et al., 2007). These differed from the observations as no organised events were taking place, instead it was an opportunity for the researcher to explore the area and learn more about the context external to the site.

Informal interviews were captured in these places with participants who had not given prior consent, but the researcher reflected on in the field notes. The unplanned addition of capturing informal conversations offered the opportunity of gathering data that had not been found within the planned work proved to be very useful (as highlighted by early Eisenhardt, 1989) for the researcher to ask probing questions to gauge the emotional response to social value.

Documentary analysis provided a wealth of data that triangulated with the other sources whilst providing detailed information that was otherwise missed. Collecting site publications and community flyers provided a talking point with the research participants or proved as a memento of the site observations. The desk study also resulted in numerous archived materials such as dissertations, working papers and historical accounts. It was the documentary analysis which provided the clear markers within the longitudinal case study view of the wider stakeholder perspective.

3.3. Data analysis

An inductive approach was used for analysis, interpreting the data for emerging themes, using thematic analysis to build theory from the case. Thematic analysis allows for rich, detailed, complex account of the data within and across case studies (Vaismoradi et al., 2013) which aligns with the case study design (Ridder, 2017).

The coding began with the three strands identified in the theoretical orientation: with social value dimensions, inputs and outputs, and outlining boundaries. Reiterative coding layers between the data sources was used to inductively draw out the higher themes, and the emerging triggers and consequences of social value evolution were marked on the site timelines. By using probing questions for the participants to elaborate on their experience with decommissioning and how it may have changed over time, the changing meaning of social value was compared against significant events on-site to unpack why the change in social value may have occurred at this time.

The results have been presented firstly as a narrative of the over-arching social value evolution and context for each case with timelines marking the significant events which impacted the meaning-making of social value; and then the cases have been broken down into examples as per the social value typology template with the spatial and temporal aspects explored with thick descriptions (Ridder, 2017).

4. Case study background

The background context for the case studies is summarised below, to give the wider general story before focusing on exemplary social value vignettes for each.

4.1. Dounreay: pioneering nuclear science on the north coast of scotland

Dounreay is the location of the pioneering Fast Breeder reactor nuclear energy research, commissioned by the UK Government in 1955, and the key social value phases of Dounreay since conception have been explored in Fig. 2, demonstrating changing emphasis over time.

In 2012 it was estimated that Dounreay employed around 14% of the working population of Caithness and North Sutherland region and that 70% of the £90 million spent on goods and services by Dounreay annually is spent with companies in Caithness and Sutherland. At its height Dounreay employed around 12,000

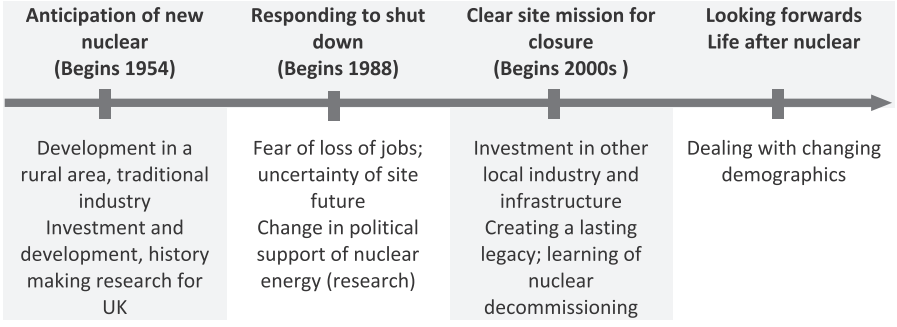

Fig. 2. Social value timeline of Dounreay.

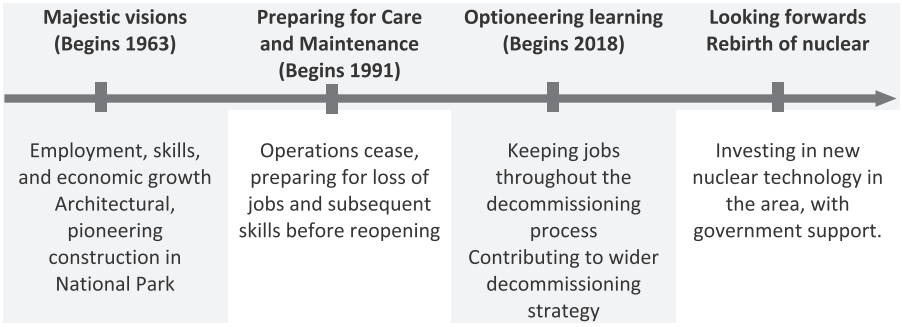

Fig. 3. Social value timeline of Trawsfynydd.

people. The area is now again facing issues of declining skills and employment with staff lay-offs (Grangeston, 2012).

Decommissioning was originally planned to take 60 years at a cost of £4.3 billion; this timeframe changed several times, and in 2018 it is still set to complete in the mid-2020's at a cost of £2.9 billion after significant management restructuring in response to safety incidents. These decreasing cost and time parameters of such a huge project have put extra pressure on an uncertain programme of work. After the final site end-state is reached there will be 12 a low-level waste repository left to be maintained for up to 300 years (Dounreay Site Restoration Ltd, 2014).

4.2. Trawsfynydd: bringing nuclear power to inland wales

Developed as part of the Magnox fleet of reactors, Trawsfynydd is one of 12 nuclear energy decommissioning sites managed by Magnox Ltd (Energy Solutions, 2013). Opening in 1965, the site produced energy for almost 30 years before it closed in 1993. In 2015/16 the Trawsfynydd site was planned to reach final end-state by 2083 at a cost of £1.9 billion, but in 2018 this has been revised to £2.7 billion as work is underway to bring the final site handover forward several decades. This changing focus on site and subsequent social value is demonstrated in Fig. 3.

As a chosen learning site for the NDA they are demonstrating how stepping away from care and maintenance plans (a period of site closure to allow for radiological particles to decay before decommissioning) could prove a smoother transition to final end-state. The NDA is optioneering different management paths which provide the most overall value, most significantly exploring entering directly into decommissioning work without the several quiescent decades after care and maintenance.

Enterprise Zone status was granted to the Snowdonia area to mitigate for future needed skills being lost (Economy Infrastructure and Skills Committee, 2018), as part of the Government Industrial Strategy in 2012. It has been influential is shaping the management and decisions of technical issues and considering alternative land-use at the site.

5. Social value in decommissioning megaprojects

Social value strategy and measures are found within both cases as socio-economic reports, particularly since the conception of NDA in 2005 with the remit of socio-economic impact stipulated in the Energy Act (2004). These were uncovered in the initial desk study. In building the cases social value was found in different guises throughout the site life.

Tables 4 and 5 present the results of analysis of the two case studies, offering examples of what social value means to the community involved in and around nuclear decommissioning work. Applying the social value typology template as developed from the literature review the social value outcomes have been categorised accordingly.

In Tables 4 and 5 the social value examples appear to be 1 dimensional. Even as qualitative evidence is provided, there is not much understanding of the meaning-making process. The following contextualised expanded case stories weave together the different social value dimensions bringing deeper meaning of wider value in the storytelling process.

5.1. Changing and merging local identities of dounreay

Dounreay was experimental site, pioneering nuclear technology for energy use after WWII. It was not about energy production, but developing an unknown technology. The rural location was chosen as part of risk mitigation in case something went wrong.

> "[…] *that's what they did with Dounreay. They built it here because it was remote and nobody lived here. You know, it was the furthest place as far away from London as possible."* (D06 Previous union rep)

With fears of nuclear technology widespread in the public many communities were wary of hosting the new industry. Caithness was chosen because they were a struggling community in decline, with a falling population and traditional industries being lost.

> *"There was fishing and farming, and of course those were heading towards decline. So, this was a big industry to bring to the area. And it was a big exciting vision for the future. It was cutting edge research, and in some ways, it still is today."* (D04 Site manager)

Local people were hired to be educated and trained with the necessary skills, but the leaders moved in from elsewhere. These scientists and engineers became known as "The Atomics". They were regarded somewhat suspiciously as outsiders, coming from different socio-economic demographics, and with the local town Thurso tripling in size they soon outnumbered the "locals".

As the Atomics moved in, Dounreay helped build necessary infrastructure and it was instrumental in encouraging the growth of services in the area. In the early days of nuclear energy development in the UK there was a lot of investment into social infrastructure and benefits to support workers newly arrived in the area. Over the decades the role of the nuclear sector in supporting such social benefits was pulled back, particularly in the 1980's as the rest of the UK also saw decreased public spending. In line with decreased government funding there were increased questions around the impact of spending and 'value for money'.

Table 4
Meaning of social value in the Dounreay community.

Dimension of Social Value		Example	How the social value changes [source]
Social	Engaging local community	Site Stakeholder Group (SSG) to facilitate speaking to community	*"we've got to get the next generation involved otherwise the stakeholder group just becomes the management talking to themselves."* (D09 Clergy community leader)
	Healthy living and wellbeing	Onsite hairdressers, dentist, gym, bank etc. for convenience in early days	Imbalance between those who work in nuclear and those who don't SSG OBS
	Human health and safety	High levels of awareness of safety culture on site and in community	Participants' response to smashed glass in interview, risk aversion on site much higher now (DSV1 Decommissioning site)
	History and cultural significance: sense of place	Nucleus archive and Dounreay 'sphere' unofficially listed on North West 500 tourist driving route	"*people are no longer having to rely on Dounreay so they have to do something but there's no doubt that the North Coast 500 it's forcing that as well because people are seeing opportunity*" (D07 Museum volunteer)
	Recreational and therapeutic experience	The community project programme has helped fund a local harbour project, encouraging hobby sailing	Museum exhibition highlighting the development project (DSV3 Nuclear museum)
	Education	People trained up and went to other industries; pioneering technology; onsite education programmes promoted	"*people have now realized that it's not only one employer here, you know there has to be diversity*" (D07 Museum volunteer)
	Access, mobility and infrastructure	Roads, hospitals, schools, houses, public transport actively built by Dounreay and as an effect of development	these are no longer seen as NDA remit or responsibility (SSG OBS)
Economic	Real estate and land management	Reclaimed a WWII aircraft field; turned brownfield into industrial site; plans to return to greenfield	Planning consultations have varied hugely since closing, with stakeholders being involved at different levels DOC
	Quality work and cost security	Changing timelines and costs causing confusion	"*there was new business directorates set up, a whole new management regime. And that really was a turnaround for the site.*" (D04 Site manager)
	Local/social procurement and responsible sourcing	Many spin-off organisations in the area prompted by Dounreay; spending £63 million in the local economy	Industry actively encouraged enterprise for a brief period (D04 Site manager)
	Inclusive employment and training	Nuclear opportunities replaced the declining traditional industries of agriculture and fishing	SSG OBS Representative for the Chamber of Commerce pushing for NDA involvement in Scottish Government local economy strategy
Environmental	Resource management	Low level waste repository planned for 300 years management	"*that's what they did with Dounreay. They built it here because it was remote, and nobody lived here*" (D06 Previous union rep)
	Ecosystems pollution and biodiversity	Birds of prey used to discourage aggressive gulls on site	Birds seen on visit (DSV1 Decommissioning site)

It was after the Atomics became embedded in the area that these huge budget changes created new shifts in employment; most severely with the announcement of closing the site in 1988. The shift in government views of nuclear technology development meant fears of disrupted employment, which has been felt for several decades. Even with new employees being hired for decommissioning work, the lay-offs in 2017 re-ignited the concerns of the Caithness communities as the population is again in decline with less opportunities for work.

> *"The demands going to reduce such that someone might turn around and say not enough people come to the hospital, we're going to close the hospital."* (D06 Previous union rep)

The case data strongly reflected concerns in the north of Scotland as it faces strategic issues for services such as hospitals, internet, postal delivery and road access, due to decreasing population and further Government spending cuts.

This investment in social infrastructure demonstrates that the social value of a project is not just about the site, but also the ancillary services that the site attracts and creates. Trying to establish this multiplier effect is not always straightforward, especially as the social value was not included strategically. It was only in later reflecting on the social value outcomes that these practical decisions are appreciated for their wider value.

In considering the wider social value the variations can be seen across relatively small geographic areas. With new arrivals still referred to as 'incomers' the "*cosmopolitan*" Thurso community has strongly adopted its nuclear identity and shifted the relationship of ownership. Caithness Horizon's Museum has been housed on the main street of Thurso, as an effort to mark the nuclear legacy as a significant part of the town's history. A wider Heritage Strategy has been developed to preserve the cultural legacy of the industrial construction.

> *"Having a big employer in such a remote area has quite a significant impact…but I suppose the impact is in the immediate area."* (D06 Previous union rep)

Half an hour away the nearby town of Wick, on the North East coast, was a European centre of herring fishing in the 19th and 20th Century. This was already in decline when nuclear energy arrived, but the town was worried about the impact it would have on the struggling industry. As most people working at Dounreay lived in Thurso, being that bit further away meant Wick felt less direct effect on their local economy. The internationally leading Nucleus nuclear and local history archive was purposely put in Wick as the social value was viewed as most beneficial there. Located adjacent to the small airport where nuclear materials used to be flown from on the outskirts of town, they have been working since opening in 2016 to become an active part of the community.

The Scrabster Harbour redevelopment project to the west of Dounreay was a strategic decision as part of a technical process to upgrade an old fishing harbour for large vessel nuclear waste transportation. This has had a ripple effect by encouraging marine activity to return, both as recreational and large-scale tourism with cruise ship docking. But there are doubts of local traders of the impact they have felt from day visitors from the ships who don't spend much on shore. Those tourists driving through on the North West 500 route, staying and sleeping locally, have more of an impact. Nucleus archive have worked to get themselves put on the official route map, and there are calls from local stakeholders to save the iconic Dounreay 'sphere', seen in Fig. 4, as a landmark of the industrial heritage.

Table 5
Meaning of social value in the Trawsfynydd community.

Dimension of Social Value		Example	How the social value changes [source]
Social	Engaging local community	Public involvement contributed to decommissioning decision-making	"*it's just trying to streamline our SSG meetings to dovetail with those dates if we can, so that the stakeholders have the best opportunity to have their say and get involved*" (T01 Stakeholder engagement)
	Healthy living and wellbeing	Support of community building schemes	"*apply for up to £1000, it's called our Good Neighbour Fund. So that's things like your football strips, community events, kind of grassroots type of stuff. Support for schools, primary schools in particular*" (T01 Stakeholder engagement)
	Human health and safety	Never been a major environmental incident on site	*"When we walk away from this site … we'll make sure that the asbestos landfill site has been capped off and restored. But of course, what happens in the next 100, 200, 300 years?*" (T02 Site end-state manager)
	History and cultural significance: sense of place	Tate Britain art project in 2013 celebrated the architecture on site by the famous Sir Basil Spence	(TSV1) walking around outside the site the structure was visually striking. This was reaffirmed with an Tate exhibited film and sound installation DOC
	Recreational and therapeutic experience	Fishing on the adjacent Trawsfynydd lake has been supported by nuclear money from Magnox	(TSV2) Trawsfynydd Lake visitor centre encouraging recreational activities, was modern and well-equipped for angling club
	Education	Supporting the securing of funding for Snowdonia Aerospace Centre	The second key strategic site for the Snowdonia Enterprise Zone DOC
	Access, mobility and infrastructure	Limited road access to site through the national park, and railway has now closed	(TTSV4) nearby Blaenau Ffestiniog, outside the national park, feels isolated as the railway line is no longer used
Economic	Real estate and land management	Active council involvement has shaped the future of Trawsfynydd site	"*they've [NDA] certainly widened their* remit *around non-commercial land utilisation*" (T03 Engineering consultant)
	Quality work and cost security	Magnox are reviewing the original decommissioning plan, considering not entering a period of no-work for several decades	workers moving between Magnox sites; skills retention factor in full decommissioning before closure DOC
	Local/social procurement and responsible sourcing	Working with other near nuclear facilities to share skills; many workers aren't from the area	*"it's not that there aren't jobs in Gwynedd, but there are very few high-level jobs … high value for us here means more than £26500*" (T05 Local council member)
	Inclusive employment and training	Provided best opportunity of jobs in the area	"there's a specific problem, really, with regards to Trawsfynydd in that wages are, for the area, disproportionately high there" (T05 Local council member)
Environmental	Resource management	Intermediary Level Waste storage facility onsite	*"there's an awful lot of non-nuclear stuff, you know, conventional waste, non-radioactive discharges to sea, etc ….we actually have a closed asbestos landfill on this site.*" (T02 Site end-state)
	Ecosystems pollution and biodiversity	There has been resistance to the inland location next to the lake	SSG OBS Update on environmental monitoring; A flow chart was displayed, detailing what was monitored; including flora and fauna both on land and aquatic.

5.2. Cultural connections to the land at trawsfynydd

Trawsfynydd is a peculiar place, as the only inland nuclear power facility in the UK, built within Snowdonia National Park, on the edge of the man-made reservoir lake used as a cooling source but which is also popular with anglers. As part of the early roll-out of the Magnox fleet, a new technology that was not yet standardised, a large focus was put on the architectural design. Basil Spence, the famous British architect, created the 2 reactor buildings to resemble looing cathedrals in the middle of the Welsh hills, as seen in Fig. 5. Today the views from Lake Trawsfynydd Visitor Centre are serene, looking across the site of what is considered by many as a dangerous technology.

There are many, within the industry, local community and visiting, who agree the structures have played an important role in shaping the identity of the area. A Tate-led exhibition of the buildings wanted to explore "*what is art when it's lost its function?*". But equally, the brutalist architecture is often viewed as a blight on the natural landscape with the shifting appreciation of the style over decades.

The Intermediary Level Waste (ILW) repository which will be maintained for 150 years, has been clad in local Welsh slate when built in 2009. This aesthetic touch, due to the constraints within the National Park, seem paradoxical compared to the Governments new push (2018) for Small Modular Reactor pioneering technology set to take place on the old Magnox site.

Fig. 4. View of entrance to Dounreay site with the iconic 'Sphere' housing the decommissioned reactor, (Source: researcher's own, July 2017).

Fig. 5. View of Trawsfynydd 'cathedral like' reactor buildings from viewing platform next to site (Source: researcher's own, December 2017).

> *"The kind of small reactor which could be sited in Trawsfynydd is set to usher in an era of cost-effective power."* — Greg Clark, Business and Energy Secretary, 27 June 2018 (Clark, 2018) (Documentary analysis)

This new Small-Modular Reactor technology (cheaper, faster to build, replicable) is being celebrated as the future for sustainable energy within scientific communities, and some local stakeholders have seen their opportunity to push forwards at Trawsfynydd. As may be expected, the enthusiasm may not be shared or even known by others locally as they have other priorities.

The Snowdonia Economic Enterprise Zone is instrumental in creating job opportunities in the area. This can contribute to the "*Corridor of opportunity*" (Engineering consultant, Trawsfynydd) from the closest Magnox decommissioning site at Wylfa to Trawsfynydd. But this may be controversial to those not directly connected to or benefitting from the "corridor".

Blaenau Ffestiniog is the closest town to the Trawsfynydd Magnox site, and used to be local stop on the railway that ran from Trawsfynydd to Bala. At one point known as "the town that roofed the world" it is surrounded by the remaining slate tips from the quarrying industry, appearing as a barren, moonlike environment. These quarry caves were big enough to hold national art treasures during WWII.

Falling outside of the National Park zone, the town relies mostly on tourism brought in by the heritage railway line. With much of the high street closed up and many holiday homes the 'nuclear community' is not obvious here. This may be due to the Trawsfynydd site having close relations with the Wylfa site on Anglesey to the North West, with many employees now moving between sites.

NDA, 2008 socio-economic plan for North Wales is aligned with Welsh National Assembly Spatial Plans and partnerships, with the vision:

> "*A high-quality natural and physical environment supporting a cultural and knowledge-based economy that will help the area to maintain and enhance its distinctive character, retain and attract back young people and sustain the Welsh language*" NDA Socio-Economic Anglesey and Meirionnydd Priority Area Plan, June 2009 (Documentary Analysis)

The NDA and Magnox were involved as partners in the Blaenau Ffestiniog regeneration plan. The deprivation of the town and surrounding area was highlighted in the 2007–2013 plan, with the loss of jobs at Trawsfynydd on the local economy a major concern. The plan was commended by RTPI (Royal Town Planning Institute) Awards 2013.

The Welsh language scheme annual report in 2008–09 identified the significance of Welsh language initiatives in supporting the Strategic Regeneration Plans in Wales, specifically the economic impact for Blaenau Ffestiniog. The Chubut Region of Argentinian Patagonia was identified as the most significant opportunity for promoting and sustaining Welsh on an international platform. Pioneers from the nearby Bala agreed with the Argentinian government to come to Patagonia in 19th Century, as a place for the Welsh culture to be saved and to create outposts for Argentinian territories. These settlers moved to an area of the new Americas where they felt they could preserve their culture in their own space.

Blaenau Ffestiniog became twinned with Rawson in 2015, the capital of Chubut where most of the Welsh immigrants settled where Patagonian Welsh is spoken (there is a Welsh-Spanish bilingual school in the region). Ffestiniog Council offers annual scholarships for young people 16–30 to visit Patagonia region since 2015, and descendants visited Blaenau Ffestiniog in 2016.

Capturing this wider value of Trawsfynydd's socio-economic work is difficult. The Magnox fund continues to donate money into community benefitting organisations, but most relevant is support of the local Eisteddfod group, continuing the tradition of a Welsh language celebration of literature and art. A direct support of this international Welsh cultural connection.

6. Discussion

The case studies found that the evolving social value of infrastructure can be examined from a dynamic perspective, exploring changes across larger timescales and comparing the effects of spatial boundaries. Stakeholders affected by nuclear decommissioning are found spread nationally, and possibly internationally, as such is the scale of megaprojects. The NDA, and subsequently Trawsfynydd and Dounreay, are publicly funded so answer to and communicate with national stakeholders such as with contract enquiries (House of Commons Committee of Public Accounts, 2018).

Both perspectives of social value as an output measure and as a fundamental basis for a strategic outlook featured in both case studies. The industry created much social value in the early days as a consequence of practical and technical decisions. In hindsight these outputs were acknowledged as central parts of the social value of nuclear energy, and in attempting to measure the future decommissioning strategies are subsequently being shaped.

This paper adds to the growing interest in the social implications of mega infrastructure (Flyvbjerg, 2014), examining the dynamic features of social responsibility (Zhou and Mi, 2017). The uncertainties and tensions that can arise from such cultural changes

necessary for significant site mission changes through phases of the project lifecycle (van Marrewijk, 2007) have been seen clearly in the UK nuclear decommissioning programme, with both Dounreay and Trawsfynydd struggling to make definitive decommissioning plans. Dealing with the death of an organisation, as mission changes, as sites close, and eventually the facility is deconstructed (Bell and Taylor, 2011) is a difficult transition. While definitions and boundaries matter in shaping what is valued in terms of sustainability and resilience of megaprojects, the findings show that these definitions are far from stable. Instead, taking a processual view (see Chan, 2016), definitions, boundaries and decisions are often a result of replying to situations that arise in this difficult transition rather than to reproduce off-the-shelf solutions.

6.1. Transformations and transitions: history matters

The overarching aim of the NDA is "*How we manage communities so they're better off once we're not there*", Director of Communications and Stakeholder Engagement, NDA, (recorded at the NDA Stakeholder Summit, 2017) but defining 'better' is difficult. NDA has recognised the complex nature of value, and have included socio-economics, health and safety, security, finance and environment within their Value Framework (NDA, 2016).

When telling the social value story, the past and future blend in the 'present'. The snapshot in time when capturing a quantitative social value measure forgets all which has come before, and what is to come. If looking at development of social value over time the quantitative measures offer clear points that assume transition has occurred between, but with no clear qualitative explanation of how this has happened (Child and Breyer, 2017) or which actors have taken a role in shaping it (Wittmayer et al., 2017)?

The future of these energy infrastructures and landscapes is a societal challenge as energy transitions take place internationally (Miller et al., 2013). Changes in energy systems will have significant human impacts, and people are closely bound up with energy when living with, in and around the systems on which they heavily depend.

6.2. Social implications of megaprojects: place matters

Perceptions of nuclear energy and subsequent decommissioning have been shown to vary depending on the stakeholder proximity to site (Jenkins-Smith et al., 2011; Kim et al., 2013). Devine-Wright et al. (2017) have called for more research into public acceptance of changes to energy infrastructure. This study has shown that social value is perceived differently if the stakeholder engages with the project differently. Stakeholders affected by nuclear decommissioning are found to spread regionally, nationally and internationally, as such is the scale and effects of megaprojects. The NDA in general, and Trawsfynydd and Dounreay in particular, are publicly-funded so it is important that these megaproject answer to the needs of and communicate with stakeholders across different spatial scales , and this accountability can be seen in a number of public inquiries (e.g. House of Commons Committee of Public Accounts, 2018).

Decommissioning is a process of figuring out what to do with the physical space, but can often forget the changing identity of the place as in the case study findings. The importance of place in sustainable energy infrastructure decisions has been previously recognised (Whitton et al., 2015) and partially addressed with geographical information mapping (Sherrouse et al., 2014; van Riper et al., 2017). However, the cases presented demonstrate social value can help to identify the significance of established versus emergent identities across spatial boundaries which cannot be captured with GIS mapping at a point in time.

6.3. Research implications

This paper adds to the growing interest in the social implications of mega infrastructure (Flyvbjerg, 2014), contributing to identified fragmented gaps in the knowledge of megaproject social responsibility, particularly by examining the dynamical features of social responsibility (Zhou and Mi, 2017). As the Cabinet Office, (2015) social value review demonstrated a lack of understanding in how to apply social value in practice, critiquing current methods and approaches offers a wider description to engage with organisations developing their social value approach.

This paper continues research into social value, an area with growing interest within academia and practice. This study examines the meaning of social value in more complex contexts, which was previously acknowledged as a barrier to social value practice (Erzurumlu and Erzurumlu, 2015; Fitton et al., 2014), developing on the UK construction social value discussion (Cartigny and Lord, 2017; Daniel and Pasquire, 2019) with empirical examples.

This approach to social value highlights the meaning-making process behind social value by telling the story of time and place, contributing to developing new theory in the field (Ridder, 2017). Social value measures alone do not tell the full picture as emphases change over time. The dynamics of this change needs to be accounted for through more processual studies. Ongoing meaning-making is also a constant, informal, intuitive and interactional conversation that replies to the changing contexts (see also Chan, 2016).

7. Conclusion and closing remarks

The purpose of this paper was to review the evolution of the meaning of social value throughout the whole life of infrastructure, until reaching the current end-of-life stage to answer the two interrelated research questions: what does social value mean for the community in and around decommissioning construction megaprojects, and how does this meaning-making vary?

Using two instrumental case studies this paper has demonstrated the evolution of social value with regards to temporal and spatial boundaries with three-fold contributions. The primary contribution is addressing social value as a dynamic and changing 'over time' as opposed to 'a point in time' evaluation with changing spatial and temporal factors. The second contribution is the questioning of defining stakeholder boundaries for social value— service deliverers are also part of the community, and the non-humans like the sphere in Dounreay are more than just symbolic; they have agency too in terms of conceptualising and enacting social value. And finally, querying the focus on social value measurement frameworks as the most significant barrier to successful implementation, instead demonstrating the iterative negotiation process.

This study critiques the quantifying of social value but does not argue for it to be abandoned. Instead, qualitative approaches should be used to sense check the meaning-making process. This has implications for research, policy and practice to develop more systematic methods for capturing stories, especially in megaproject contexts.

7.1. Limitations

The limitations of this study lie partly in the fact that research on social value is an emerging field. As theory building work, the outcomes rely on further investigation for elaboration and generalisation. In the study design, along with limitations listed within the methods, again it is reiterated that social value needs to be researched and applied within broader contexts and across larger

samples to replicate the theories offered. A longitudinal study may be appropriate for such cases.

To create clear boundaries for the case studies the 'community' had to be restricted to those living within a geographical region usually considered by the NDA in their socio-economic work (the county the site is in). Future research could broaden the geographic boundaries to capture stories and meanings of social value that matter to a wider constituency, and how this broadening can influence the ways social value is created and communicated.

Declaration of interest

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Submission declaration

All authors have approved the manuscript and agree with its submission to Journal of Cleaner Production.

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Appendix A. Supplementary data

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