The primary scope of my graduation project has been to understand what role architecture can play in urbanisations' everchanging infrastructures, namely the energy transition in response to climate change. Beyond this, it seeks to establish how architecture can enable electrical infrastructures to be more culturally responsive, landscape responsive and resilient to shifting climatic stresses, while also ameliorating our landscapes with aesthetic quality.

This has been achieved through an overarching 'research by design' methodology, a framework established by the Transitional Territories studio. The research approaches I employed throughout my MSc3 sought to establish a toolset that would lead to a spatial symbiosis between infrastructure, habitable architectural space and the receiving landscape. This was carried out using two main methodological frameworks: scenario building and mapping techniques. Both of these techniques were buttressed with extensive literature reviews.

Why

Scenario building established the 'why' of the research – the former being research tool in itself. Though the North Sea region's energy transition has begun, the prospect of how it will happen and what it will look like though is still shrouded in uncertainty. What is clear is that the sheer quantity of renewable energy technologies (RETs) we must integrate into our energy infrastructures in order to meet the EU 2050 renewable energy targets will transform our landscapes and seascapes as we know them. Moreover, it brings the pressing issues of intermittency and the requirement for electrical storage to the fore. This therefore begs the question: what spatial implications will the energy transition have through the production of energy landscapes? As Dirk Sijmon's (2014) highlights, "*all through history there has been a close and shifting relation between energy use and land use. The relationship is reciprocal. The exploitation of any energy source comes with a set of land use demands and consequences.*" In short, energy and space change each other, and the coming transition to renewables exemplifies this. It is therefore not an overstatement to suggest that, in this century, our civilisations will witness the emergence of a new spatial energy order; as Sijmons (2014) highlights in his book *Landscape and Energy: Designing Transition*, up until recently energy generation and supply has been kept discreetly separate from our everyday lives. In the current landscape, electrical and heat generation only becomes visible as a tiny fire or plume of smoke on a horizon when a plant is fired up. Even further from our awareness are the mines and wells that produce the fossil-fuels these plants run off. Indeed, "*our energy supply is embedded in a global system in which we do not have to know the origin of the oil or coal that drives our way of life, or the effects that mining has on the scenic qualities of those faraway places. Thanks to this concealment, our landscape is largely an illusory one*" (Sijmons, 2014, p.17). In the past few decades, the illusion of being able to generate energy for our consumption demands without touching our landscapes has slowly been broken. The energy transition brings energy production, in its true scale and quantity, into full view. It is breaking down the disconnect between energy consumption and production, because renewable energy technologies (RETs) are 'in our back yards'. With this in mind, what is the role of the designer? It is not in quantitative engineering; I believe that it is in extensive planning and qualitive transcalar design that responds to site specificity and leads to energy landscape amelioration.

The project is set up to have a spatio-temporal response to flooding and draught treats in the future of the Highlands. During the making of the studio Atlas, research suggested that the north of Scotland is likely to experience increased rainfall and flooding in winter, while suffering more droughts in summer. Indeed, increasing rainfall and changes in rainfall patterns mean that the country's rivers are likely to flood more often. Since 1961, the north of Scotland has seen a 67-69 percent rise in precipitation. The increasingly severity of the Scottish climate may also impact power distribution, as seen in the damage caused by extreme weather events such as floods and flash storms in the past decade. This is has resulted in an increasing trend of 'undergrounding' - relocating overhead electricity transmission and distribution lines underground. Summer water shortages caused by the dying up of local streams, on the other hand, are a threat to one of Scotland's agricultural practices and one of its most lucrative industries - whisky production.

The product of this process and planning has been to explore if multi-functionality can be successfully introduced into the electrical infrastructure in the form of pumped hydro storage. Hitting to birds with one stone, the issue of renewables' intermittency is dealt with in the infrastructure through the introduction of a man-made, high-level reservoir. Simultaneously, storm-water capture occurs in the reservoir, easing the severity of winter flooding and

acting as a water store during the drought months for a number of industrial sites in Loch Brora's rural peripheries and for the town of Brora itself. As such, the project has focused on the schematic design of a electro-hydraulic infrastructure in Brora. The resolved architectural and landscape design of the thesis illustrates a delivery field, which feeds water and electricity from the infrastructure's viaduct to Clynelish. This small rural area mainly consists of a farm, the Clynelish Distillery and the famous Brora Distillery, with a scattering of a few farm houses. The distilleries became particularly significant in the research process, because they use water from the naturally occurring Clyne Burn in their whisky production. Brora distillery is set to open next year and will be the main grafting focus of the delivery, due to this and its cult status within the industry – enhancing the cultural significance. The design includes: the design of the viaduct itself; a low voltage sub-station; a cistern that will be sized to provide enough water storage for the whole of Clynelish for a month; a water purifying reed field; and a new water tanks that attach onto the existing distillery. When the distillery is short of natural water supply in the summer, the stored water will be heated using a heat exchanger (using residual heat from the distillation cooling process) that will be designed into the distillery, seeking to create a closed heating loop in the whiskey making process. The heated water can then be used in the in the mashing and aging stages of the whiskey production. This project's programme illustrates an example of a how the grafting of an infrastructure onto a building can influence it's typological arrangement for the better (energy-efficiency wise) and how an infrastructure can be multi-functional by: responding to site-specific geographical conditions; and, in turn, being able to support a threatened existing local industry or practice.

How

Mapping provided the 'how' for the fulfilment of the project's multiscalar scope. Clynelish lies in the shadow of 600m high hills. Using the 200mm line as a new ground zero, this altitude is sufficient to introduce a high-level reservoir that connects to the existing Loch Brora; a suitable site for the introduction of pumped electrical storage into the infrastructure was chosen. There is a natural dip between two high points in the topography that is a well-suited location of a reservoir. Moreover, it was through mapping that I located the distilleries in the first place, situated along the high voltage transmission lines, sandwiched between existing and planned onshore and offshore windfarms.

It was through cartography and the use of historical precedents that the architectural connections, housing and delivery points of the infrastructure began to materialise in my mind. This project design has sought to explore the scope of architecture's agency in advancing and aiding the aforementioned symbiosis between landscape, infrastructure and cultural needs, by becoming a qualitative bridge between an infrastructure's multi-functionality and a locality's cultural needs. Architecture can afford the development and improvement of a system that already exists.

Simultaneously, each scale of mappings was fed by information derived from different heuristic techniques within themselves, however GIS stands out as being a highly useful tool in generating the all-important topographical information for this project. Further theoretical, infrastructural and site information was gathered through literary research. Technical journals and case-study information were read to understand how electrical infrastructures work, what physical components they are composed of and how decentralisation affects network performance. A literature review of books, essays and articles have been highly important in developing an architectural position within the project's theme - the energy transition and energy landscapes. This is because they provided a thorough understanding of the background forces the project is situated within, be they political, economical, cultural, ecological or architectural. Therefore, this information informed what to look for and what to express in the maps created.

Looking Back

Infrastructural Scale Design

The emergence of a new energy infrastructure will, in fact, be the emergence of a new landscape infrastructure; the boundaries between settlements and their hinterlands – between 'urban' and 'nature' – will begin to blur. This project has aimed to investigate the potentials of this new spatial order, where: urban morphology is landscape

morphology; and where infrastructural success is dependent on site-specific solutions that take advantage local ecological, climatic and topographical potentials. As Walter Benjamin (1978) said, "*technology is not the mastery of nature but of the relation between nature and man*".

In order to do this, the design scope of the project has been very much transcalar from the get go. On the larger infrastructural/landscape scale, it has sought to deal with three main topics or objectives:

1. *Decentralisation & Evolutionary Resilience*
   Through the mechanism of decentralisation, RETs and fresh water cisterns can become a tool for introducing evolutionary resilience into the electro-hydraulic l infrastructure. By using a myriad of semi-autonomous and contextually-responsive RETs in the network, the system can be managed in smaller pockets. It therefore becomes more adaptable to temporal changes and external stresses, within the fluctuating context of complex ecosystems. I believe that this objective has driven the spatial manifestation of my project, however has not been proven by it. Rather, it has taken literature reviews as a foundation for the next two objectives.
2. *Landscape Infrastructure*
   By connecting decentralised RETs within a mutli-functional grid (electrical and hydraulic in the case of the Highlands), a new spatial order will arise: one of productive landscapes. This required a dialectic relationship between the RETs, their supporting infrastructure and the receiving landscape: the landscape becomes part of the infrastructure, particularly for gravitational purposes. I found that this approach helped to improve efficiency and reduce the need for pumping in the design of the hydraulic infrastructure.
3. *Landscape Morphology as Urban Morphology*
   During the design of the project, Classical references have been used to evoke imagery of infrastructural beauty, and learn about more passive infrastructural design. Roman aqueducts and cisterns have been a key inspiration of architectural prowess and functionality, which actually have an additive aesthetic value in landscapes. With this in mind, I have relearnt about the importance of learning from the past, from masters who understood the connection between infrastructure, landscape and beauty. I found tutor feedback concerning materiality and structural integrity of the design the most iterative and challenging part of the design, pertaining that the aqueduct use materials that are of the land itself. Through this, I have hoped to challenge the perceptive cultural divide between 'urban' and 'landscape' in my design; landscapes cease being an unseen resource highway and backdrop to urban life, a cultural view of 'nature' that developed in the Romantic period and perpetuated under neo-extractivism. Rather it is seen as part of urbanisation, one which is more ecologically and temporally sensitive.

Architectural Scale Design

Shifting to the architectural scale of the project and the potential symbiosis between the infrastructure's delivery, the rural urban fabric's needs and the landscape's morphology, both technical and architectural precedents were highly important in the design process. In order to achieve successful, site-specific hybridisation, local and historical building vernaculars were studied, namely Scottish brochs and blackhouses. By understanding the natural topography of the site, the reed bed design succeeded in being pump-free until its delivery to Brora distillery. By researching and understanding the water-needs and functionality of the distillery, water storage volumes were sized and then architecturally integrated with the existing volume. I believe that the logistical research done throughout the design process was highly successful in its influence on the design proposal. The landscaping levels, the vessel volumes and the minimalist attitude towards the design are all a direct response to the research. By understanding all of these elements, the infrastructural design becomes the connective tissue at all the scales: territorial, infrastructural, site and architectural. The architectural design is the improvement of the habitable spaces that are being connected. By composing these spatial elements and designing their topology in response to site-specific conditions, the marriage results in a more resilience urban fabric.

Looking Forward

Transitional Territories is a research studio with an over-arching heuristic methodological framework: 'research by design' through scenario building. A form of 'theory-led' research, Ray Lucas (2016, 14) explains that it is "critique, analysis [and] dialectically oriented." According to Sijmons (2014, p.19), "this type of research has evolved in recent

decades as a useful tool for research into the future, because it has turned out to be capable of bringing together the worlds of science (facts, forecasts) and politics (involvement, choices) by means of design and imaginations." As previously discussed, this research method has been fully employed in this project's development thus far. To ensure agency within the ever-changing complex systems of today's cities, the studio's transcalar methodological framework has also been utilised and has become highly important in the project's development and narrative. As such, this architectural project has been architectural research in itself.

The research methods I will employ in MSc4 will fully shift from knowledge collection to knowledge production methods. Building upon the main heuristic methods that I have been using in the research phase (scenario building and mapping), I shall fulfil the project through architectural visualisation, that is orthographic and perspective drawings. The illustration of object 'types' that are inherent for network functionality and delivery, in relation to particular design criteria that depend on the site's topography, are being expressed in the form of a design syntax. Through this, I aim to develop a system of knowledge that, while being site-specific, is an adaptable 'methodology-led' research approach that can be reapplied to different contexts. The idea behind this strategy is not to exert a heterogeneous or a 'one size fits all' plan in the landscape, resulting in the sprawl of generic and identity-less landscapes. Rather, designers should look to the site-specific conditions of a place, it's natural and cultural 'talents', and unlock those potentials. Moreover, site-specificity does not only encompass ecological or topographical factors; the successful integration of energy landscapes into communities also requires analysis of the socio-cultural milieu, economic factors and historical remnants. Indeed, the complex processes that are required to make our built environments function can be aided through architecture's agency; how infrastructures interact and interdepend in space and time may be the nidus of a new architectural ontology.

With this in mind, the relevance of this project lies in highlighting what knowledge systems architects can employ to contribute to the energy transition. It seeks to explore how we can advance our discipline, by acknowledging its inherent potentials and limitations, to ensure it bears agency in this mammoth challenge. In this regard, the project subscribes to *Transitional Territories*' ontological understanding of architecture as an agent for larger, and ever-fluctuating, urbanisation and infrastructural processes. This stems from the studio's recognition of cities and urban landscapes as complex systems that are rooted in a temporal dimension. Rather than seeing architecture as the building of object-space entities, it is being interpreted as an enabler within the electrical infrastructure: a space-time discipline. This is buttressed by David Harvey, who insists that the primary challenge for designers has transcended spatial determinism. Architectural practice should involve itself with the unlocking, enabling and remoulding of urbanisation forces and interactions, which depend on the physical constructions that house them, in time and space: "*Ideas about spatiality are moving away from physical objects and forms towards the variety of territorial, political and psychological social processes that flow through space. The interrelationships amongst things in space, as well as the effects that are produced through such dynamic interactions, are becoming of greater significance for intervening in urban landscapes than the solely compositional arrangement of objects and surfaces*" (Corner, 1999, p. 227). If the efficacy of our discipline is to evolve in response to the transition, then so must its academic episteme and supporting heuristic techniques. As such, it is essential to undertake the right kind of research in response to clear hypotheses, questions or concerns that contribute to existing bodies of knowledge. Architectural practice should involve itself with the unlocking, enabling and remoulding of urbanisation forces and interactions, which depend on the physical constructions that house them, in time and space. Once we value architectural design as 'a cognitive process', the malleability of 'design as thinking' becomes a tool that eases interaction with such complex topics as the energy transition. This is especially true when the project has not been tackled using a multidisciplinary approach. When dealing with extensive issues that exists within complex systems and ecologies, knowledge production benefits from multidisciplinary input because it encourages dialectical thinking. I believe that this is the way forward for all disciplines that can contribute to the energy transition. With this in mind, I relish the opportunity to integrate building science, landscape, urbanism and scientific academia into my design process.

In Summary

A new spatial order will arise: one of energy landscapes. The energy transition presents societies with a unique opportunity to make our electrical and hydraulic infrastructures more resilient to temporal stresses and break down the cultural divide between 'urban' and 'landscape'. This project aims to investigate this infrastructural and morphological transition through transcalar design, re-establishing the role of architecture as an infrastructural enabler. This thesis' agency culminates in achieving symbiosis between infrastructural design, landscape and an existing habitable space that needed for the perpetuation, if not improvement, of social/cultural life. This is only achieved in the project through site-specificity and delivery.

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