PLEA
STGO
2022

November 22 - 25, 2022

WILL CITIES SURVIVE?

The future of sustainable buildings and urbanism in the age of emergency.

BOOK OF PROCEEDINGS VOL 1 ONLINE SESSIONS

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PLEA STGO 2022: WILL CITIES SURVIVE?

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Passive and Low Energy Architecture (PLEA)
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PLEA STGO 2022: WILL CITIES SURVIVE?

ABOUT

PLEA Association is an organization engaged in a worldwide discourse on sustainable architecture and urban design through annual international conferences, workshops and publications. It has created a community of several thousand professionals, academics and students from over 40 countries. Participation in PLEA activities is open to all whose work deals with architecture and the built environment, who share our objectives and who attend PLEA events.

PLEA stands for “Passive and Low Energy Architecture”, a commitment to the development, documentation and diffusion of the principles of bioclimatic design and the application of natural and innovative techniques for sustainable architecture and urban design.

PLEA serves as an open, international, interdisciplinary forum to promote high quality research, practice and education in environmentally sustainable design.

PLEA is an autonomous, non-profit association of individuals sharing the art, science, planning and design of the built environment.

PLEA pursues its objectives through international conferences and workshops; expert group meetings and consultancies; scientific and technical publications; and architectural competitions and exhibitions.

Since 1982 PLEA has been organizing highly ranked conferences that attract both academia and practicing architects. Past Conferences have taken place in the United States, Europe, South America, Asia, Africa and Australia.

After almost a decade the PLEA conference is coming back to South America, Santiago (Chile), to be organized by the Pontifical Catholic University of Chile (PUC). Inevitably, the theme of PLEA 2022 is inspired by the current pandemic which has put the whole world on alert and makes us rethink our built environment in terms of health and safety. Whereas due to its current social unrest and significant social divide Santiago and South America in general provides a great ground to talk about inequalities and revisit social movements, that spanned around the globe from Lebanon, France to Chile and other countries just before the pandemic hit.

The aim of the PLEA 2022 is to question the whole idea of a city, the way we inhabit and use them generating the definitive inflection point that a sustainable city requires.

GOAL AND THEME

For decades, the climate crisis has been demanding our action and commitment. Numerous efforts to reach an international consensus via climate summits, such as COP25, and Paris Agreement have not had any expected results yet. However, even though the COVID-19 pandemic has intensified the sense of urgency, many talks about climate change were put on hold during 2020, when the new virus put the world on alert.

In no time it has become a global issue and provoked various reactions from political leaders around the world—from absolute denial to the harshest restrictions—adjusting and learning in the process by trial and error.

This process has not been easy as COVID-19 highlighted critical deficiencies in our built environment and urban design. Even though infections battered affluent areas too, the pandemic hit the hardest when the virus reached sectors with high rates of poverty. Dense neighborhoods and overcrowded buildings could facilitate the rapid spread of infections due to the difficulty of generating social distancing and the application of extensive quarantines.

Yet, various changes have been adopted rapidly. Hygiene protocols, wearing masks, social distancing and other strategies has become part of our ordinary life. On top of that, the use of public spaces, streets, parks, homes and all buildings had to be adjusted to control the spread of the virus transforming our habits and conception of them. Numerous studies showed great variations in the use of transportation during the pandemic too. But the questions are: are those changes here to stay? What does the future hold for our built environments?

Some even go as far as to question: Will cities survive? While many intellectuals and academics call for the end of cities (at least as we know them), some stakeholders urge to return to normality, or so-called status quo.

Is this the last opportunity to effectively build a healthy, livable and equitable city? It is clear that cities can no longer be conceived as before and it is time to question the way we inhabit and use them. What are the standards, mechanisms and criteria to define a sustainable city and building? Do they respond to the problems and deficiencies in the age of emergency? History shows us how cities reacted to and changed after health crises similar to COVID-19; this is the time to question everything around us and strive for environmentally sustainable and socially just cities.

The aim of PLEA 2022 is to be a relevant part of the discussion and bring about proposals to the developing and developed world. It is a great chance to talk about the changes that affected cities around the globe since the start of the pandemic and bring the scientific knowledge generated in this short time to the discussion.

Social inequality should also be a part of the debate as both health and climate emergencies may further increase the injustice and, at the same time, the inequality may make such crises worse. Latin America, as the most unequal region, and Chilean case might serve as a great example of such issues and could become a source of inspiration to find the definitive inflection point that a truly sustainable city requires.

WELCOME TO SANTIAGO DE CHILE

Dynamic and cosmopolitan Santiago is a vital and versatile city. Home to many events showcasing the very best of Chilean culture, it also hosts superb international festivals of sound, flavor and color. The Chilean capital breathes new life into all its visitors!

The city's diversity shines through in its many contrasting neighborhoods. Set out to explore the city streets and you'll discover beautiful and original art galleries, design shops and handicraft markets, as well as a great selection of restaurants, bars and cafes. Night owls can enjoy a taste of lively Latino nightlife in hip Bellavista!

Visit downtown Santiago to get a real feel for the city. Learn more about the country in its many fine museums, or wander around the famous Central Market – a gourmet's delight.

Fans of the great outdoors can head for the hills that surround the city and marvel at panoramic views of Santiago with the magnificent Andes as a backdrop. Take the opportunity to grab a picnic and visit one of the city´s many parks.

In Chile there are places that have not seen a drop of rain in decades, while there are others where the rain brings out the green in the millenial forests.

This diversity captivates and surprises its visitors. Because, as a consequence of its geography, Chile has all the climates of the planet and the four seasons are well differentiated. The warmest season is between October and April and the coldest, from May to September.
The temperature in Chile drops down as you travel south. In the north, the heat of the day remains during the day while the nights are quite cold. The central area has more of a Mediterranean climate and the south has lower temperatures and recurring rainfall throughout the year.

The conference will be held at the Centro de Extensión de la Pontificia Universidad Católica de Chile, located at Avenida Libertador Bernardo O'Higgins 390, Santiago, Metropolitan Region. Universidad Católica subway station, Line 1

The Center is located in the center of the city of Santiago, with excellent connectivity to the rest of the city and the most characteristic neighborhoods of the capital, either through the Metro network (Line 1) or other means of public transport such as Transantiago (Santiago's public bus network).

To make your hotel reservations, we recommend looking in the Providencia or Las Condes districts, close to Metro Line 1. We also have some suggestions for accommodation close to the conference venue.

WILL CITIES SURVIVE?: TRACKS

1. Sustainable Urban Development
– Regenerative Design for Healthy and Resilient Cities
– Sustainable Communities, Culture and Society
– Low Carbon Neutral Neighbourhoods, Districts and Cities
– Urban Climate and Outdoor Comfort
– Green Infrastructure
– Urban Design and Adaptation to Climate Change

2. Sustainable Architectural Design
– Resources and Passive Strategies
– Regenerative Design
– Energy Efficient Buildings
– Net-zero Energy and Carbon-neutrality in New and Existing Buildings
– Vernacular and Heritage Retrofit
– Building Design and Adaptation to Climate Change

3. Architecture for Health and Well-being
– Comfort, IAQ & Delight
– Thermal Comfort in Extreme Climates
– IAQ and Health in Times of Covid-19
– Comfort in Public Spaces

4. Sustainable Buildings and Technology
– Renewable Energy Technologies
– Energy Efficient Heating and Cooling Systems
– Low Embodied Carbon Materials
– Circular Economy
– Nature-based Material Solutions
– Water Resource Management and Efficiency

5. Analysis and Methods
– Simulation and Design Tools
– Building Performance Evaluation
– Surveying and Monitoring Methods
– User-building Interaction and Post-occupancy Evaluation

6. Education and Training
– Architectural Training for Sustainability & Research
– Professional Development
– Sustainable Initiatives and Environmental Activism
– Methods and Educational Practices
– Strategies and Tools

7. Challenges for Developing countries
– Energy poverty
– The Informal City
– Climate Change Adaptation
– Affordable Construction and Architecture Strategies
– Urban Planning and Urban Design Policies for Sustainable Development
– Housing and urban Vulnerability

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PLEA SANTIAGO 2022
Will Cities Survive?

Spatial mapping approach to target the local deployment of distributed energy resources in the UK

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ABSTRACT: Energy systems in most countries distribute electricity over centralized networks using primarily carbon intensive fossil fuels. For energy system to become decarbonised and decentralised to meet climate targets, large-scale application of distributed energy resources (DERs) that provide low carbon heating and electricity will be necessary. This paper uses a domestic energy mapping approach to baseline energy use and target appropriate dwellings for the application of DERs (heat pumps, rooftop solar, batteries) in five existing neighbourhoods (each comprising 200-450 dwellings) located in five council districts in Oxfordshire (UK). The dwellings are assessed using a bottom-up energy model called DECoRuM combined with a GIS-based approach to spatially map results. The results show that rooftop solar installation potential ranges widely depending on neighbourhood; between 1%-9% of dwellings can take up installations of 4kWp size and above, with an average size of 2.1 kWp, resulting in average energy reductions ranging from 69%-77%. The proposed approach can enable local authorities, community energy project developers and district network operators to extract local spatial intelligence rapidly and accurately for large-scale deployment of distributed energy resources. This can avoid expensive reinforcement of the local electricity networks.

KEYWORDS: Geographic Information System, Mapping, Distributed Energy Resources, Renewables, Community energy

1. INTRODUCTION

The conventional power systems in most countries primarily use diesel, coal, and natural gas–based generation units for producing electricity for distribution over their centralised networks. These conventional generation sources emit significant greenhouse gas (GHG) emissions, contributing to climate change [1]. However, several countries are successfully progressing in their effort to reduce GHGs from the energy supply network. This is an important first step as increasing capacity of conventional power systems on a centralized grid cannot sufficiently meet increasing global energy demand nor reduce GHG emissions [1].

To meet the UK government's net zero GHG emissions target by 2050 [2], the national energy supply network has been improved significantly. In 2020 the UK supplied more electricity via renewable energy sources (RESs) than fossil fuels [3]. Despite this type of progress there is concern that the centralized energy system structure has constantly proven to be vulnerable to the impacts of a changing climate and extreme weather events in many places. Examples include the 2017 hurricane Maria in Puerto Rico [4], annual heatwaves in Los Angeles causing blackouts [5], and the winter 2021 snow storm Uri in Texas [6].

In the UK the domestic sector has been lagging all other sectors in reducing emissions [2]. Furthermore, there has been an increase in the number of people working from home. This number has nearly quadrupled in the last 20 years [7]. Notably, this statistic was printed before the COVID-19 lockdown and the resulting cultural shift that is expected to occur as a result of employees and employers becoming accustomed to staff working from home [8].

During the pandemic in 2020, total global electricity and gas demand levels were lower; however, residential electricity consumption increased in many countries. Where the USA saw an almost 30% increase in residential electricity consumption, the UK reported an increase of 2% in total residential energy consumption, despite a warmer than average year [9]. According to the UK Office for National Statistics (ONS) [10] 24% of businesses in the UK intend to use increased homeworking going forward. This means that more energy is expected to be used during the day at home instead of in the office. One positive outcome from this would be a higher rate of self-consumption (SC) in domestic scale renewable energy, e.g., photovoltaics, especially if coupled with a heat pump.

From a technological standpoint, in order to meet the net zero target in the residential sector, the Committee on Climate Change [7] recommends that from 2025 no new homes should be connected to the gas grid. Instead, these homes should use low-carbon systems like heat pumps or be connected to community heat networks. As the recommendations for meeting the low carbon targets include a significant shift from gas to electrification of heat and transport, several future scenarios forecast an increase in peak demand.

To help offset this demand there will need to be a large increase in low carbon generation which tends to be variable and intermittent, Balancing the system, especially in the summer will also be a challenge, wherein a projected 30 GW of solar connected to the distribution network would mean the difference of almost 20 GW transmission demand depending on whether it is a cloudy or sunny day.

Batteries help balance grid consumption. In a recent previous project [11], a high electricity consuming gas-heated household utilised the battery to charge after hours in a time-of-use-tariff (TOU) arrangement. The household displaced 25% of their total electricity use by doing this. This contributed to a reduction in peak demand and saved the household an estimated £105 in one year. If the dwelling used a heat pump for heating, the savings are estimated to have been higher.

A solution to these problems is decentralisation of energy using renewables, energy storage, demand side response (DSR), smart networks, and increased interconnection [12]. A decentralised system relies on distributed generation or distributed energy resources (DERs), energy storage and demand response.

- The primary component to energy decentralization is distributed generation.
- Second, energy storage allows for more efficient use of generated energy and is important for flattening the curve of RES intermittency.
- Third, demand response, through smart grid technology helps facilitate grid management.

As an example, in Australia, where 16% of all RES generation is from rooftop solar installations, a Decentralised Energy Exchange (deX) has been set up. The deX signals to households when there is a power demand surge giving them the ability to auction excess self-generated or battery-stored power back to the grid at market-determined prices [13].

The technology has yet to reach the point of allowing intelligent autonomous user control over the buying and selling of their energy on a decentralised network [14] and avoiding cybersecurity risks whilst opening multiple multi-directional pathways for energy exchange [15]. However, for the grid to be decarbonised and decentralised, there is a need for large-scale area-based deployment of DERs.

Geospatial energy mapping is emerging as a useful approach for targeting suitable areas for application of energy saving measures, given their ability to provide rapid and accurate spatial intelligence. This paper uses a domestic energy mapping approach (DECoRuM - Domestic Energy, Carbon counting and carbon Reduction Model) to baseline energy use and rapidly target appropriate homes for the application of DERs (e.g., heat pumps, rooftop solar, batteries) in five existing neighbourhoods in Oxfordshire, England.

2. CASE STUDY AND METHODS

The case study neighbourhoods are in five district councils in Oxfordshire England. These district councils are Oxford, Bicester, Didcot, Abingdon, and Charlbury. The neighbourhoods comprise between 200 to 450 dwellings and were assessed using a bottom-up energy model called DECoRuM (Domestic Energy, Carbon counting and carbon Reduction Model) combined with a GIS-based approach to spatially map and visualise the results.

2.1 Identification of focal neighbourhoods

The first step was to identify areas of interest in the five council districts of Oxfordshire. The selection of each area was a combined effort between local interest and data-driven nudging from the authors (researchers) on the project.

The data-driven suggestions for area selection were informed by a research interest in choosing areas with:

- high fuel poverty (as this is a high priority for retrofit in the UK),
- high energy consumption,
- other socio-economic factors like vulnerable householders, and
- an attempt to cover a wide variety of dwelling types.

The process involved assessing publicly-available datasets including the UK Government's sub-national energy [16] and fuel poverty [17] data at lower layer super output area (LSOA) (areas of approximately 400-800 dwellings). As an example, Table 1 shows key characteristics of the selected neighbourhoods.

The local engagement involved providing maps of recommended areas of study to local low carbon community groups. The community groups in turn, approved or made requests for other areas to be evaluated.

Table 1:
Characteristics of dwellings [16, 18, 19].

	Dwellings	Mean Area	Dominate type	Mean EPC
ABINGDON	349	84 m^2	1950-65 Semi-detached	61 (D)
BICESTER	440	83 m^2	1950-65 Terraced	65 (D)
CHARLBURY	211	101 m^2	1960-76 Semi-detached	61 (D)
DIDCOT	320	67 m^2	1950-65 Semi-detached	53 (D)
ROSEHILL	431	97 m^2	1930-49 Terraced	63 (D)

2.2 Creation of the baseline and the retrofit model

A full description of the development, assumptions and limitations of the model (DECoRuM) are detailed in [20, 21]. Data for calculations include actual dwelling characteristics (e.g., floor area, built age, area of glazing, area of exposed fabric, etc.) gathered from historic (Digimap) and current maps (OS MasterMap and Google street view). Fabric, system and energy related data were gathered from EPCs [19] and literature describing home characteristics based on age and typology (e.g. Tabula/Episcope [22]).

Statistics on retrofit progress in England [23] was also applied to the model baseline. This included:

- 68% of cavity wall dwellings were estimated to have cavity wall insulation by 2013,
- 80% of all dwellings and 91% of housing association homes were estimated to have more than half of windows double-glazed by 2013, and
- 56% of dwellings had 150mm or more of loft insulation by 2013.

In the energy models of the dwellings, three carbon reduction measures were applied to create the electrification retrofit package. These were heat pumps, rooftop photovoltaic, and batteries. No additional fabric or passive reduction improvements were added to the retrofit package.

Dwellings were modelled with heat pumps as the UK Government is planning to install 600,000 heat pumps per year by 2028 to move from the gas network to electricity. The dwellings were modelled with air source heat pump (ASHP): coefficient of performance (COP) = 2.6. In addition, all dwellings were assessed for rooftop solar suitability. The model considers roof area, orientation of the roof and obstacles on the roof identified via aerial imagery. Based on the empirical data from two studies [24, 25] (one located in a neighbourhood next to Rosehill and another in York, England) by the authors, the average self-consumption (SC) of PV in 78 dwellings was found to be 50%. This SC was applied to the model.

Finally, the impact of batteries was calculated using findings from the same empirical research. From these, an additional SC of 34% was gained by using a 13.5 kWh Tesla Powerwall II battery in each dwelling.

3. RESULTS

3.1 Baseline consumption results

Rosehill and Charlbury had the highest mean consumption. The lowest mean and smallest range in consumption results were in Didcot. Throughout all neighbourhoods most dwellings were in the 2,000 – 4,000 kgCO$_2$ range for the baseline. Didcot had the most dwellings below this range and Rosehill had the most above this range. Table 2 shows the mean results for the baseline model in the five neighborhoods: a total of 1751 dwellings.

Table 2:
Modelled baseline energy and emissions results

	Mean energy consumption	Mean CO$_2$ emissions
ABINGDON	16,331	3,234
BICESTER	15,781	3,373
CHARLBURY	17,857	3,598
DIDCOT	14,354	2,868
ROSEHILL	17,919	3,643

Currently there are only a total of 35 dwellings with PV installed in all mapped areas (2%); Bicester with the most (n=14, 3%). This indicates a significant potential for distributed renewable energy.

3.2 Retrofit results

Following the full electrification retrofit package modelling of the entire selection of 1751 dwellings, the mean total annual energy reduction potential was found to be 74%. Table 3 shows the mean results for the individual neighborhoods.

Table 3:
Modelled retrofit energy and emissions results

	Mean energy consumption	Reduction %	Mean CO$_2$ emissions
ABINGDON	3,864	75%	863
BICESTER	4,279	69%	964
CHARLBURY	3,865	77%	919
DIDCOT	3,491	74%	780
ROSEHILL	4,099	76%	942

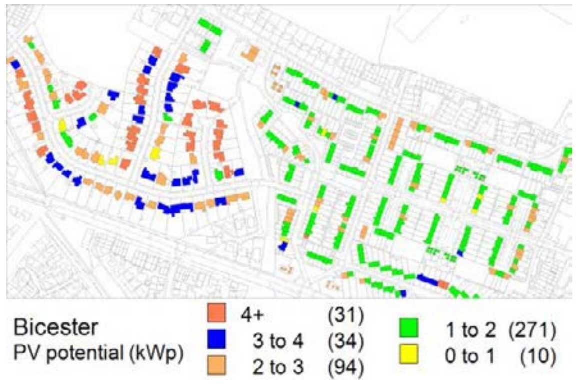
Overall photovoltaic installation modelling results across all dwellings showed the potential to install a mean of 2.1 kWp with a max. of 14.1 kWp. Table 4 distributes the results between the most common dwelling type and age for each neighbourhood. Potential PV installations were the largest in Charlbury and smallest in Didcot which respectively had the largest (101 m^2) and smallest (67 m^2) mean dwelling areas.

Table 4:
PV potential and mean reduction results for the dominate dwelling types in each neighbourhood. D = detached, SD = semi-detached, Ter = terraced.

	Percent of total	Mean PV (kWp)	Mean reduction
ABINGDON			
1950 - 1965 SD	58%	2.0	75%
1950 - 1965 Ter.	39%	2.1	72%
1950-1965 D	3%	2.2	76%
BICESTER			
1950-65 Ter.	57%	1.7	67%
1950-65 SD	12%	2.1	66%
1950-65 D	10%	3.5	70%
CHARLBURY			
1966 - 1976 SD	55%	2.8	79%
1967 - 1976 D	29%	2.9	75%
1968 - 1976 Ter.	16%	2.6	72%
DIDCOT			
1950 - 1965 SD	94%	1.6	74%
1950-1965 D	3%	2.3	79%
1950 - 1965 Ter.	3%	1.1	75%
ROSEHILL			
1930 - 1949 Ter.	48%	1.8	73%
1930 - 1949 SD	26%	1.9	74%
1950-1965 SD	13%	2.9	74%

Bicester had the largest range in PV potential. This can be seen in figure 1 where the left side of the map shows a section of predominate detached dwellings and their larger PV potential.

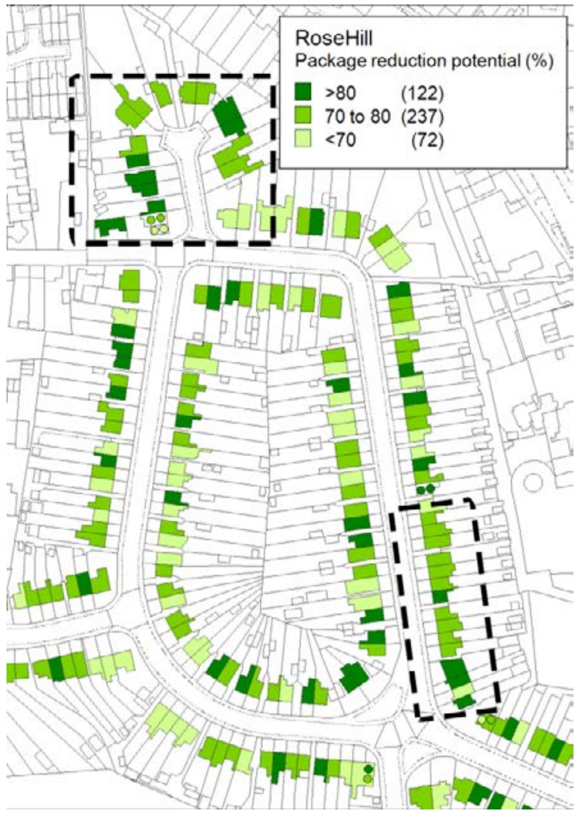
Figure 1:
Rooftop PV potential in Bicester; Map© Crown Copyright and Database Right 2018. Ordnance Survey (Digimap Licence).



The right side of the map shows the predominance of terraced dwellings with the majority smaller array size in PV potential.

Rosehill had a fairly well integrated distribution of reduction potential throughout the neighbourhood. The boundary boxes in figure 2 show potential areas to begin retrofit where energy consumption reduction is forecasted to be higher.

Figure 2:
Energy consumption reduction potential in select area of Rosehill; Map© Crown Copyright and Database Right 2018. Ordnance Survey (Digimap Licence).



4. DISCUSSION

The mapping process and spatial maps presented in this paper make energy use visible by highlighting groups of dwellings by their PV array size or energy consumption reduction potential. Benefits include use as a communication tool for planning and where to allocate funding, and a visual source for tracking retrofit progress and change.

From the analysis, there was a 74% reduction in total energy consumption. As can be expected, this approach will not bring the residential retrofit sector to net zero; however, the reductions are noteworthy. Where contribution to the net zero target is the goal, these measures would ideally be combined with deep / whole-house retrofits (e.g. inclusive of insulation, air tightness) to achieve greater reductions. In addition, local community buildings like schools and/or dedicated energy centres may be required to provide more renewable and storage solutions to create a localised DER micro-grid.

Overall, across all dwellings there were higher reductions in detached dwellings. This is generally because they are larger dwellings in which space heating is reduced and on which there is larger roof space for PV installation. In fact, area to reduction correlation through all dwellings is positive though the correlation coefficient is moderately weak (r=0.4).

As would be expected, smaller PV arrays provided greater SC ratios. This was also seen empirically in the ERIC (Energy Resources for Integrated Communities) project [24] where dwellings with 1.5 kWp, 2.25 kWp and 2.5 kWp resulted in total electricity consumption correlation to SC of r = 0.61, r = 0.47 and r = 0.31 respectively. Therefore, though it is tempting to question the value of the impact of such small PV systems, smaller PV arrays were more efficiently used in these dwellings. In addition, batteries help use more of the generated electricity, further increasing the cost efficiency of the PV.

Morrissey *et al.* [26] demonstrated through a survey in northwest England that the willingness to pay (WTP) for uninterrupted power was high. WTP was high to avoid outages during peak times, higher to avoid outages on weekends and holidays, and highest to avoid interruption in heating in winter. Furthermore, households with only electric heating had the highest WTP. The authors suggest increasing efficiency of the electricity system through targeting power quality to customers based on their household characteristics and willingness to pay. This, however, could lead to inequity and deepening fuel poverty. Alternatively, avoiding outages through decentralisation would be a better way to utilise WTP.

The pandemic has expanded fuel poverty as work changes and lockdowns have increased time at home driving up energy consumption and energy costs [27]. Energy generation and storage can reduce the pressure assuming the upfront costs are appropriately subsidised or affordable. With batteries, fuel poor dwellings can benefit from Economy 7 tariff or a dynamic pricing tariff. As mentioned in the introduction, one live dwelling saved an estimated £105 by charging overnight. Even without PV, TOU tariffs would be effective money saving and peak load shifting option.

DSR via appliance timing is perhaps also needed. This is shifting the times when electricity is consumed to take further peak demand pressure off the grid. This can be done in response to a signal [12], perhaps through in-home energy monitoring devices or as the technology has progressed, through smart phone application linked to smart metering. Obvious examples include timing laundry or dishwasher activation during peak PV generation times or overnight by setting timers on the appliances. If DSR through shifting energy consumption to overnight is recommended, Economy 7 tariffs – referring to seven hours overnight where electricity is offered at a cheaper rate, is a potential incentive.

With the Covid-19 lockdown and its potential impact on a larger shift to home working, local energy generation and storage arrangements would be beneficial. This is particularly true of PV, as there would be more energy consumption throughout the middle of the day particularly in the winter. Furthermore, as there is a recommendation to shift to electrified heating, PV and batteries would be even more relevant. Working from home contributing to greater instantaneous SC of PV generation would provide a greater return on investment. This is important now more than ever as there is no longer FiT for new PV installations. However, incentives are an effective policy tool.

Energy storage will benefit the overall system and therefore, should be rewarded for its impact [28]. Like the previous FiT for solar renewable technology, there should be a *peak demand shift tariff* that would incentivise PV (again), batteries or even well managed DSR. This would pay householders a tiered tariff rate based on the proportion of electricity reduced during peak demand hours. The progress could be judged based on a baseline year for the household and paid monthly. This example; however, would only work for retrofits. For new build, the baseline would likely need to be a local, perhaps, post-code level average from which to base improved performance.

5. CONCLUSION

With a changing climate, changing economy, and changing work-life structure, it is clear that the way energy is used, generated and managed will need to change also. In response to this, the paper demonstrated the application of a spatial mapping approach that brings together energy calculations and GIS mapping to *baseline* energy use and *target* local deployment of DERs on a house-by-house level and aggregated to a neighbourhood scale. The approach is useful for local authorities, community energy project developers and district network operators to extract local spatial intelligence rapidly and accurately for large-scale deployment of distributed energy resources.

Generally, all existing dwellings on their own are unable to achieve self-sufficiency or net zero; however local sharing of energy generation using smart batteries can help homes without rooftop solar to access solar electricity and become net zero. This can also avoid expensive reinforcement of the local electricity networks.

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