

Institution: Cardiff University		
Unit of Assessment: Architecture, Built Environment and Planning (13)		
Title of case study: Reducing fuel poverty through targeted mapping of neighbourhoods		
Period when the underpinning research was undertaken: 2000 – 2020		
Details of staff conducting the underpinning research from the submitting unit:		
Name(s):	Role(s) (e.g. job title):	Period(s) employed by submitting HEI:
Phillip Jones Simon Lannon Joanne Patterson	Professor Senior Research Fellow Senior Research Fellow	01/09/1984 – 31/03/2020 22/08/1988 – present 06/01/1997 – present
Period when the claimed impact occurred: 2015 – 2020		
Is this case study continued from a case study submitted in 2014? No		
1. Summary of the impact (indicative maximum 100 words) Household fuel poverty and inadequate heating is linked to lower health and wellbeing. Identifying fuel-poor households for support is difficult, often requiring local knowledge and costly physical surveys. Cardiff research created a new tool able to identify neighbourhoods at high risk of fuel poverty by predicting household energy use through integrating census and housing datasets. The tool was applied across six local authorities in Wales and South West England and led to direct personalised assistance, including more targeted use of local authority funding to support poorer households, as well as ensuring minimum standards of energy efficiency in the private rental sector in Wales. This resulted in savings of £1.5M for over 2,000 households living in fuel poverty.		
2. Underpinning research (indicative maximum 500 words) In 2018, 12% of homes in Wales were identified as being in fuel poverty – when a household is unable to adequately heat its home due to low income, high energy costs, and poor energy efficiency. Colder and damper homes can cause cardiovascular disease and respiratory problems, especially affecting older people. To confront this challenge, Cardiff University's Welsh School of Architecture (WSA) team developed a mapping system to establish where the application of energy-saving measures, such as insulation retrofits, would deliver maximum reduction in waste energy usage, with particular focus on CO₂ emissions. 2.1 Modelling energy usage at an urban scale To assess the impact of improving the energy performance of existing housing stock, WSA developed an Energy and Environmental Prediction (EEP) tool [3.1] funded by EPSRC [G3.1]. This tool predicts and evaluates the energy performance of existing housing to target energy inefficiency and identify energy-saving measures. The tool is based upon a geographical information system (GIS) that contains information on all local authority housing. In 2001 EEP was deployed in Neath Port Talbot Council by combining Ordnance Survey maps with drive-by surveys to ascertain the physical factors of 55,000 dwellings. Historical OS maps were then used to gather the approximate age of dwellings [3.2]. While the tool was effective in identifying household characteristics en masse for Neath Port Talbot, the intensive data gathering required in surveying the building stock was a limiting factor in a wider roll out, prompting further innovations to enhance data collection. 2.2 Bringing in large datasets for efficiency Further research enhanced the mapping techniques by moving from a survey-based method to combining publicly available national records with the GIS data to create richer datasets [3.3]. In 2013 the team used Cardiff Local Authority area as a case study for the new approach, which included around 140,000 dwellings divided into 214 Census areas known as Lower Super Output Areas (LSOAs). Data from a variety of sources on the property age, dimensions,		

and typology (i.e., detached, semi-detached, terraced or flats) were used to build classifications.

The baseline energy demand for the identified classifications was calculated using the UK Government's recommended energy rating tool, Standard Assessment Procedure (SAP), and datasets were combined and aggregated to LSOA-level. In refining the SAP tool's sensitivity, and accounting for variables and assumptions in the SAP data, energy consumption of UK households can now be more accurately modelled to better determine areas of high fuel poverty. Results were then compared with reliable external sources for verification, such as the 2011 Census and Department of Energy and Climate Change data [3.4].

2.3 Achieving neighbourhood-level granularity

In 2014 the Cardiff team continued to refine its approach by using data from the Office for National Statistics. This generated a more fine-grained dataset that allowed results to be calculated for individual neighbourhoods containing around 120 households. The neighbourhood-level model overcame any 'aggregation limitations' of LSOA-level data which masked streets with vulnerable households adjacent to more affluent households, showing exactly where additional help is required.

This new level of granularity demonstrated that it is possible to build an accurate and efficient urban scale model to describe the domestic energy demand of large areas of existing housing stock, which can guide retrofit and other activities relating to building improvements. By assessing large areas, such as local authorities, as a whole system, the datasets could be used to evaluate correlations between housing and health data, further enhancing the capacity to identify regions experiencing fuel poverty [3.5].

Through the combination of large-scale housing and health data, energy usage modelling, and fine-grained regional datasets, the Cardiff tool was fundamental to enabling local authorities and private rental organisations projects. Using this tool, they have been able to identify specific neighbourhoods at increased risk of fuel poverty, and in turn enhance the measures they propose to provide support for households.

3. References to the research (indicative maximum of six references)

[3.1] Jones, P. J., Lannon, S. C. and Patterson, J. L. 2000. Planning for a sustainable City: An Energy and Environmental Prediction Model. *Environmental Planning and Management*, 43(6), pp.855-872 (18). DOI: 10.1080/09640560020001728

[3.2] Jones, P. J., Patterson, J. L., & Lannon, S. 2007. Modelling the built environment at an urban scale – Energy and health impacts in relation to housing. *Landscape and Urban Planning*, 83, 39–49. DOI: 10.1016/j.landurbplan.2007.05.015

[3.3] Jones, P. J., Lannon, S. C. and Patterson, J. L. 2013. Retrofitting existing housing: how far, how much? *Building Research and Information* 41(5), pp.532-550. DOI: 10.1080/09613218.2013.807064

[3.4] Iorwerth, H., Lannon, S., Waldron, D., Bassett, T. and Jones, P. 2013. A SAP sensitivity tool and GIS-based urban scale domestic energy use model. Presented at: Building Simulation 2013 (BS2013): 13th International Conference of the International Building Performance Simulation Association, Chambéry, France, 25-28 August 2013. Proceedings of BS2013: 13th Conference of the International Building Performance Simulation Association. International Building Performance Simulation Association (IBPSA), pp.3441-3448.

[3.5] Lannon, S., Iorwerth, H., Eames, M. and H., Miriam 2018. Regional modelling of domestic energy consumption using stakeholder generated visions as scenarios. Presented at: uSIM 2018 - Urban Energy Simulation, Glasgow, UK, 30 November 2018. Available from HEI on request.

Selected grant:

[G3.1] "Development and completion of the EEP model." EPSRC Grant GR/L81536/01, January 1998 to May 2001, total award £345,334.

4. Details of the impact (indicative maximum 750 words)

Cardiff University's Welsh School of Architecture (WSA) created data-enriched maps that identified homes at risk of fuel poverty, enabling better-directed support for these households and ultimately reducing fuel poverty. These impacts were achieved through two collaborations: **1) Warm Wales (Cymru Gynnes)** and **2) Rent Smart Wales**.

4.1 Warm Wales (Cymru Gynnes) – FRESH vulnerability mapping

Warm Wales (Cymru Gynnes) is a Community Interest Company that delivers energy efficiency measures to vulnerable communities and operates across Wales and (as Warm West) in the South West of England. Cardiff University helped Warm Wales develop FRESH, a new mapping system for identifying homes at risk of fuel poverty, using the high granularity and efficient data collection methods made possible by Cardiff's research. Jonathan Cosson, Director of Warm Wales, confirmed: *"In 2014, Warm Wales began using the Foundation Data for Robust Energy Strategies for Housing (FRESH) software, based on research undertaken at the Welsh School of Architecture"* [5.1].

FRESH is a suite of maps that show vulnerability levels by cross-matching data from agencies such as the Department for Work and Pensions' housing benefits data and GP Health Cluster data resulting from Cardiff's extensive data collection. FRESH offers a 'spotlight' on the communities most likely to be suffering from fuel poverty and cold-related ill-health, enabling prioritisation of resources and reliable quantitative information on effectiveness of these interventions. FRESH helped Warm Wales improve its targeted energy assistance through the *Healthy Homes Healthy People* project for households across Wales and in Cornwall. FRESH introduces strategic changes for councils (as expanded below).

a. Enabling the "Healthy Homes Healthy People" project

The effectiveness of direct surveying for targeted assistance projects is generally limited by high resource cost and unpredictable return. A 2014 pilot demonstrated that FRESH can highlight groups at high risk of fuel poverty not previously identified by existing methods [5.1] and could therefore help local authorities and third sector organisations make the best use of funding available. As a result, in 2015 Wales & West Utilities invested £90,000 over two years to enable Warm Wales to generate FRESH maps for six local authorities: Cardiff, Ceredigion, Cornwall, Flintshire, Neath Port Talbot, and Rhondda Cynon Taff [5.1].

The FRESH maps were used to guide the *Healthy Homes Healthy People* (HHHP) project across Wales and the South West of England, identifying vulnerable households and supporting energy retrofits to homes, benefit entitlement, and fuel debt advice. Warm Wales stated: *"Without being able to target our visits to those most in need of our assistance through FRESH, the Healthy Homes Healthy People project would be untenable"* [5.1].

Warm Wales noted that Cardiff's data-driven approach revealed unknown households in need of intervention to each local authority: *"These individuals would not have been identified if we had not had access to the research developed at the Welsh School of Architecture"* [5.1]. This was further recognised within Cardiff Council; Ramesh Patel, then-Cabinet Member for Transport, Planning and Sustainability, stated: *"This powerful mapping tool is highlighting areas where poor health is made worse by high levels of damp cold-hazard homes and enables us to identify and then help those most in need"* [5.3].

By identifying those most in need of assistance, Warm Wales achieved an average direct saving of £668 per annum for each household supported. This was noted by Warm Wales as *"a significant saving, particularly for the most vulnerable in our society"* [5.1]. As of March 2020, FRESH has been used to target and assist 2,283 vulnerable households across North Wales, Cardiff, Rhondda Cynon Taff, and Cornwall, and has saved £1.5M for people previously having difficulty meeting energy bills [5.1].

By August 2019, Wales and West Utilities had invested £433,867 in the HHHP project [5.4]. Calculating the return-on-investment, Wales and West Utilities found that fuel-poor households saved £2.65 for every £1 spent on HHHP [5.4]. In addition, Wales and West Utilities commissioned the cost-benefit analysis for wider society, based on the HMRC Green

Book principles and independently verified by Sia Partners. This analysis found that the HHPP project represented a social return on investment of 9:1, achieved largely through health benefits to residents including *“reduced ambulance calls, non-elective inpatient stays (short and long stays), cost of GP consultation and reduced fatal injury within the home”* [5.2]. The analysis calculated the work saved health services an average of £258 per annum for each household assisted, for at least five years [5.2].

In 2017 Warm Wales received the Award for Energy Consultancy of the Year at the Energy Efficiency and Healthy Homes Awards for their work utilising FRESH [5.1]. Testimonials from people who have used the scheme show how it has benefitted individuals, for example:

- *“I am very pleased Warm Wales saved me £118 a year, it means a lot on a pension”* [5.4].
- *“The water bill savings and benefit advice have left me over £3,000 better off, you are unsung heroes”* [5.4].
- *“[HHPP] looked at everything and discovered that my heating system was over 30 years old and ineffective... the difference in the warmth is amazing, my house is now lovely and warm and it has inspired me to do things I have been wanting to do for years”* [5.4].

With the success of FRESH, Wales and West Utilities confirmed they will invest £1.2M between 2021 and 2026 to continue the project, forecasting £5.76M in financial benefits and £4.86M in social benefits [5.5].

b. Strategic change for councils

Warm Wales and FRESH have brought changes to how local authority partners administer fuel poverty support at a broader level. Cardiff Councillor Ramesh Patel confirmed: *“We are working to change our focus from reactive services to proactive targeting of the most needy households, using the latest data mapping technique, FRESH”* [5.3]. Flintshire County Council Cabinet Member for the Environment, Councillor Bernie Attridge, commented that, *“Joining forces under the Healthy Homes Healthy People initiative allows us to share best practise, creating more effective action plans”* [5.3].

Flintshire and Cardiff Councils have instigated Fuel Poverty Reduction Hubs that share FRESH data to inform a working toolkit, improving knowledge sharing and resource deployment across health, housing, and social service agencies within the authority and between areas [5.6]. For instance, Warm Wales uses FRESH data to help local authorities assess their work against the criteria in the NICE Guidelines for reducing Excess Winter Deaths [5.1].

4.2 Private rented stock improvements – Rent Smart Wales

In January 2019, the Cardiff team developed maps of private rental properties across all of Wales for Rent Smart Wales, which is tasked with improving property conditions and standards of management of the private rental sector. Under the Minimum Energy Efficiency Standards (MEES), all private landlords must hold an Energy Certificate Register grade of E or above to ensure the health and wellbeing of Welsh private renters, but enforcement was nearly impossible without targeted identification. The ability of the maps to target action accurately was presented to Cardiff Council in their capacity as the single licensing authority of Welsh Government for this work, who awarded £40,000 to Rent Smart Wales to develop the strategy further [5.7].

Rent Smart Wales is now using the maps generated from Cardiff research to identify all properties in Wales which do not meet the MEES. Landlords suspected of not meeting the standard are contacted with the requirements and are provided options for improving the quality of properties. Rent Smart Wales stated: *“Due to the robustness and detail of the data provided from the Cardiff University maps, a case was made to the Warm Homes Funds provided by National Grid that Rent Smart Wales could accurately identify the poorest performing properties and target assistance measures”* [5.7].

This case has supported a successful bid from the Warm Homes Fund to undertake 275 central heating installations in the properties across Wales identified from the mapping as

those most hazardous to tenants. Warm Homes funding, landlord contributions and Energy Company Obligation (ECO) funding have generated a total project budget of over £1M for this work [5.7]. As part of this project, all Welsh local authorities have now been provided the mapping data to support greater targeting of assistance resources such as social care and housing assistance.

4.3 Summary

The Cardiff-developed mapping approach helped a community interest company (Warm Wales) and local authorities identify and address regions at high risk of fuel poverty, enabling a project which has helped 2,283 vulnerable households across Wales and Cornwall save £1.5M on their heating bills. It also changed heating assistance provision strategies for local authorities in Cardiff and Flintshire, enabling greater long-term support for households. The Cardiff-based modelling provided to Rent Smart Wales additionally informed improvements to 275 private rented properties across Wales, and targeted areas of improvement across all private rental properties in the country by ensuring landlords are complying with the MEES.

5. Sources to corroborate the impact (indicative maximum of 10 references)

[5.1] Testimonial from Jonathan Cosson, Director, Warm Wales (Cymru Gynnes).

[5.2] Testimonial from Nigel Winnan, Customer and Social Obligations Manager, Wales & West Utilities.

[5.3] Fuel Poverty Reduction Hubs and the use of FRESH.

[5.4] Testimonials from Warm Wales (Cymru Gynnes) by recipients of assistance identified via FRESH.

[5.5] Appendix 7e of the Wales and West Utilities “Our business plan for 2021-26”, October 2019.

[5.6] Citizen’s Advice Toolkit.

[5.7] Testimonial from Bethan Jones, Operational Manager, Rent Smart Wales.