Decarbonising heating and fuel poverty in the UK: causes, policy implications, and the next steps.

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Decarbonising Heating and Fuel Poverty in the UK: Causes, Policy Implications, and Next Steps

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Introduction

- Fuel poverty occurs when a household cannot afford to adequately heat their home or meet basic energy requirements.
- National Energy Action's figures for April 2024, show 6 million UK households are in fuel poverty.
- Fuel poverty problem needs to be addressed along with decarbonisation of heating and achieving the net zero target.

Aim & Objectives of the Research

This study aims to identify the main causes of fuel poverty and critically analyse the impact of policy measures taken by the UK government, with a view to provide alternative green approaches to combat the crisis. The objective of the research is to:

(i) Evaluate the main causes and impact of fuel poverty within the UK by drawing parameters from various definitions.

(ii) Analyse the impact of government policy on the fuel poverty.

(iii) Identify the renewable energy options.

(iv) Recommend policy measures.

Fuel Poverty Definitions

- Inability to afford adequate warmth at home (Bradshaw and Hutton 1983)
- Energy expenditure exceeding 10% of the household income (Boardman 1991) Northern Island and Wales
- Fuel poverty in the England is now measured using the Low Income Low Energy Efficiency (LILEE) indicator. Under this indicator, a household is considered to be fuel poor if:
  - they are living in a property with a fuel poverty energy efficiency rating of band D or below

    and
  - when they spend the required amount to heat their home, they are left with a residual income below the official poverty line.

Existing Studies on Fuel Poverty

- Fuel poverty and energy poverty have been used interchangeably. (Deller Turner & Price 2021; Li et at 2014)
- Several studies have been conducted to analyse the **definition** of fuel poverty (Thomson & Snell 2012, Hill 2012).
- **Drivers of fuel poverty** analysed in the literature (Thomson & Snell 2012, Fillipidou et al 2018, Bouzarouski et al 2018).
- **Impact of fuel poverty** on the health and wellbeing of individuals especially vulnerable groups studied (Awaworyi & Smyth, 2020; Llorca et al. 2020; Wang et al 2022).
- The **government policy and interventions** have been critically analysed (Matiolli et al 2018).
- In addition to managing the fuel poverty issues, **decarbonising heating** is also an additio challenge that the UK policy makers. Several studies have evaluated the renewable ener options available (Chaudry et al., 2015; Risinggård et al., 2023)

Gap in the Literature and Contribution

- Most of the existing literature focuses on the association of fuel poverty with a limited number of parameters and lacks a robust multi variable analysis.
- Causes of fuel poverty and its impacts are linked to each other such that if a variable A impacts a variable B (A->B) and B affects C (B->C), it is possible that A may have an influence on C (A->C) or vice versa. It is therefore important to study the causes and effects in a single model.
- While most studies have used cross-sectional data for analysis this research is based on representative panel data for 13 years, focusing on the objective and quantifiable subjective measures of fuel poverty, using Structured Equation Model.
- The findings from SEM analysis are then evaluated to consider the option resolving the fuel poverty issues along with reducing GHG emissions.
- Most recent definition of Fuel Poverty has been used.

Research Methodology

Philosophy	Approach	Methodology	Data	Time Horizon	Analysis
Positivism	Deductive	Quantitative	Published (Secondary Sources)	Panel Data 2011-2020	Systematic Equation Modelling And Regression Analysis

Methodology

Partial Least Squares (PLS) Structural Equation Modelling (SEM) used for building the theory.

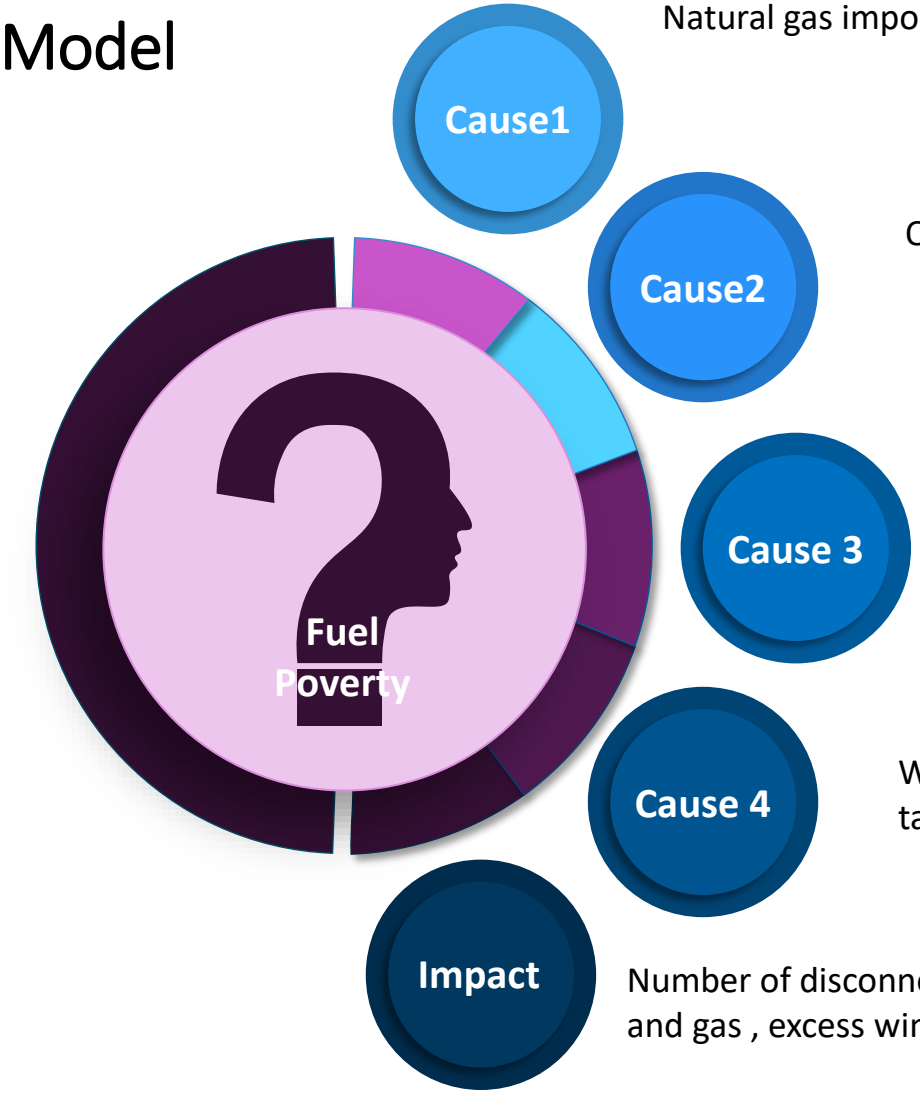
Secondary data from various sources have been analysed.

Data set for 13 years (2010-2022) used for analysis to accommodate comparable renewable energy data.

SEM helps in modelling causal networks of effects simultaneously—rather than in a piecemeal manner.

SEM can model multiple independent variables (IV) and multiple dependent variables (DV), chains of causal effects and indirect effects, and the latent constructs that variables are meant to measure.

The Theoretical Model



Natural gas imports , Inflation

Oil price, Gas price

Household expenditure

Winter fuel payments, Environmental taxation

Number of disconnections for nonpayment electricity and gas , excess winter deaths

Theoretical model Proposed

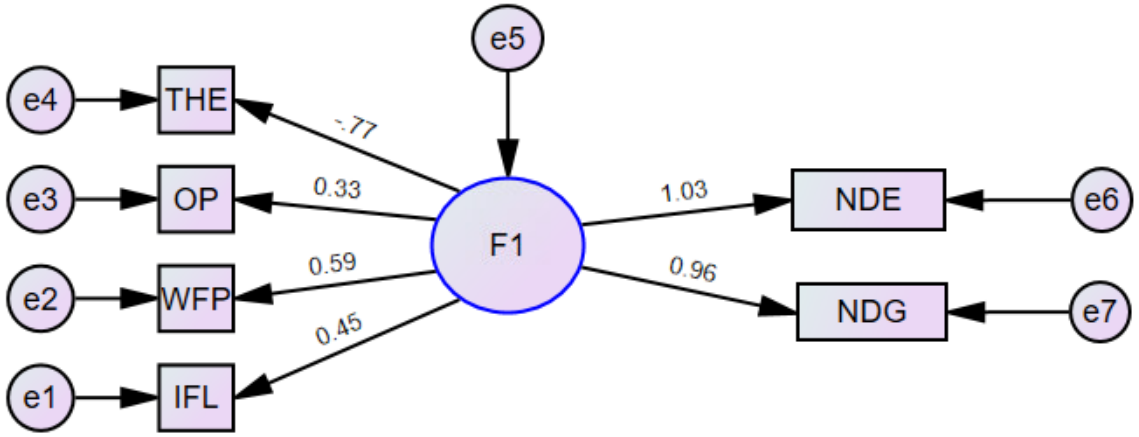
$$M1 - NFP = f(x_1, x_2, x_3, x_4, x_5, x_6, x_7)$$
$$M2 - NFP \cdots (z_1, \dot{z}_2, z_3)$$

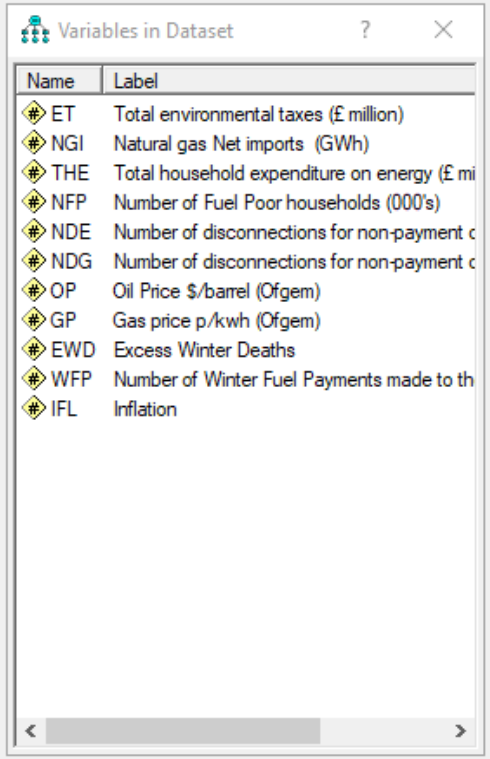
Therefore

$$(x_1, x_2, x_3, x_4, x_5, x_6, x_7) \cdots (z_1, z_2, z_3)$$

x_1	Total Environmental tax (ET)
x_2	Net Gas Imports (NGI)
x_3	Total Household Expenditure (THE)
x_4	Oil Price (OP)
x_5	Gas Price (GP)
x_6	Winter fuel payments (WFP)
x_7	Inflation (IFL)
z_1	Electricity disconnections (NDE)
z_2	Gas disconnections (NDG)
z_3	Excess winter deaths (EWD)

Structural Equation Model for Fuel Poverty





Results

- Total household expenditure of energy has strong & significant relationship with FP and regression weight of -0.8
- FP is strongly influenced by total environmental tax with regression weight of 0.5, result is statistically significant
- Winter Fuel Payment also has a strong and significant impact on FP
- FP has a direct bearing on electricity and gas disconnections due to non-payment.
- Though FP impact Extra Winter Deaths results are not statistically significant

Interpretation of Results

Household Expenditure

IMPACT

Winter Fuel Payments

IMPACT

Oil Prices

IMPACT

Inflation

IMPACT

Disconnection of Gas and Electricity

IMPACT

Env Tax

Gas Price

Excess Winter Deaths

Solving Fuel Poverty in a Green Way

- There is a drive to move to low carbon energy vectors like electricity, hydrogen and district heating that does not generate CO2 at the source.
- In order to meet the target of reducing GHG emissions from buildings to near zero by 2050 there is a need for wholistic strategy.
- The policy needs to address the issues of the cost of energy heating technologies and incentives for use of renewable energy
- A post hoc regression analysis conducted to evaluate the impact of use of green energy on Fuel Poverty in the UK.

Regression Analysis

- $NFP = f(FC\ , GHGE, ESOLAR, REHEAT)$
- FC= Final consumption of renewable energy in the UK (in 1,000 metric tons of oil equivalent)
- GHGE= Estimated territorial greenhouse gas emissions , by million tonnes carbon dioxide equivalent (MtCO2e)
- ESOLAR = Energy used for heat generation from active solar heating (in 1,000 metric tons of oil equivalent)
- REHEATING = Renewable energy used for heating and cooling (in 1,000 metric tons of oil equivalent)

Regression Results

		NFP	FC	GHGE	ESOLAR	REHEATING
Pearson Correlation	NFP	1	-0.97	0.735	-0.871	-0.882
	FC	-0.97	1	-0.691	0.778	0.869
	GHGE	0.735	-0.691	1	-0.843	-0.552
	ESOLAR	-0.871	0.778	-0.843	1	0.717
	REHEATING	-0.882	0.869	-0.552	0.717	1

Significance (Model Summary)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
	.989a	0.979	0.965	103.722	0.979	68.928	4	6	<.001
a Predictors: (Constant), REHEATING, GHGE, ESOLAR, FC									

Model Summary

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	7315.354	1239.647		5.901	0.001
FC	-0.085	0.018	-0.673	-4.775	**0.003**
GHGE	-4.842	9.264	-0.061	-0.523	0.62
ESOLAR	-55.697	22.476	-0.334	-2.478	**0.048**
REHEATING	-0.085	0.119	-0.091	-0.711	0.504

Post Hoc Regression Results

Use of Renewable energy for heating has a positive impact.

Use of Solar Energy for heating has significant impact.

Use of Renewable energy has an impact on GHG.

Consumption of renewable energy has a significant impact.

Result as compared to policy

- The UK government is aiming to combat the fuel poverty crisis by improving **household incomes**. As per this study, that is a step in the right direction.
- The government also seeks to improve the energy efficiency by improving the efficient housing stock. This has not come out as a significant variable.
- Government is also implementing programmes such as the Winter Fuel Payment to help vulnerable customers. This study demonstrates that Winter fuel payment is counterproductive as some of existing studies have also concluded.
- UK Government's Energy Company Obligations including environmental taxation which does not have a significant impact on fuel poverty.
- **The government needs to control inflation which has a significant bearing on the fuel poverty. Oil prices affect fuel poverty but are driven by international market. Government needs to focus on alternative energy sources to reduce the dependence on oil because of the lack of control on the oil price.**

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