Old hat? Modelling the effect of age on electricity consumption practice

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Importance: Climate Change & Ageing Population

- Socio-economics and environmental impacts
  - Greater for **vulnerable** aged group
  - Physically, financially and emotionally less **resilient**

- Impact of rising energy prices

- Impact of ageing householders and their **choices** on energy targets (Hamza & Gilroy, 2010)

- Age of the population has substantial influence on:
  - transport carbon emissions
  - and residential electricity consumption
**Importance:** Energy Targets & Ageing Population

- What impact of ageing on escaping carbon lock-in (Rydin et al., 2010)
  - Different patterns for adoption of low carbon technologies
  - Role for a different type of social learning?

- Aging of population and studies on change/loss of economic activity in urban centers
  - link to “shrinking cities”, examples in Germany (schrumpfende Städte), Japan, United States, France, Eastern Europe, ….
Age Related Characteristics: examples

- Many
  - survive on low or fixed incomes
  - more dependent on reliable and continuous supplies of energy (health)
  - less active social life

- Many also
  - may be mortgage free (68% householders own home among 65+)
  - not have expenses related to upbringing of children

Energy usage (Liao & Chang, 2002, USA):
- Appliance selection less important
- Use more natural gas and fuel oil but less electricity for space heating except for 80+
- Spend more on space heating, less on water heating

Source: SEI, 2011 / The UK carbon footprint by age
UK Fuel Poverty

- Affects 1 in 5 household
- Between 2004 and 2009: rose by one million, or 22%, to 5.5 million (DECC)
UK Fuel Poverty: Age & Income

Source: DECC

Proportion of households in fuel poverty

Average annual income (£)

Percentage in fuel poverty

Average household income

Source: DECC
Complexity of System

Energy System:
• Multiple physical scales
• Multiple heterogeneous agents (/actors)
• Multiple temporal scales
• Multiple endogenous and exogenous factors (e.g. Including environmental and policy influences)
• …

Elderly population/agents:
• Multiple geographical/spatial scales
• Multiple economic scales
• Multiple age scales
• Multiple physical and health scales
• Multiple behavioural, learning scales
• Multiple network scales (e.g. influence of social network)
• Multiple scenarios (e.g. price change, income, retirement age, energy tax, …)
Agent-based Modelling Approach

- Individual-based, bottom up approach
- Heterogeneous agents
- Autonomous choice and decision making
- Autonomous interaction (social influence)
- Learning and adaptability
- Mobility (moving households)
- Emergence
- Visual feedback
- Policy informing tool potential
Partial Dynamic of System and its Relation to Objective

Households

Elec. Network (e.g. transformer)

Objective:
Climate Effect (e.g. Carbon reduction)

Elec. Market (Price/Tariff)
CASCADE Model Conceptualisation

Local aggregator agent (can be ESCO, retail supplier, virtual island)

Prosumer energy flows
Distribution costs and constraints

Prosumer response
Forward price broadcast

Prosumer agent (can be generator, load, or both)

Social interaction between prosumers

Agent environment (policy, weather, etc)

Grid & wholesale market agent

Local physical model
Agent based model
Concrete Scenario Example: DSM

- Context (‘future trend’): Smaller, more distributed, less reliable and dispatchable no-carbon generators

- Meso and macro effects of individual behaviour of elderly households’ electricity consumption and challenges in demand side response/management in the ‘future’ electricity system
UK Ageing Population

• Last 25 years (1985-2010):
  – 65+: 17% increase (1.7 million)
  – 16-: 3% decrease (from 21% to 19%)

• 2035 projection:
  – 65+: 23% total
  – 16-: 18% total

Source: GAD (2007)

• Households headed by retired person: 30% (currently)
Concrete Scenario Example: DSM

- Geographical/Spatial distribution of aged group population/households

- Aggregate (meso/macro) demand profiles are spatially (geographically) dependent (Constraint on distribution, DSM)
Summary

- Importance of ageing population (/householders) and climate change/ energy targets/ energy consumption

- Multidimensional and complex problem

- Multiple factors scenarios

- Challenges for Demand Side Management
  - in a more distributed, less reliable/ dispatchable environment
  - Differences in choices and behaviours (e.g. responses to price signals)

- A Complex Adaptive System, Agent-based Modelling framework approach (with GIS capabilities) for investigating various scenarios related to age and energy