Imperial College London

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Researching pathways to a low carbon future

What works?: A systematic review of heat policy options relevant to the UK context

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Structure of presentation

- UKERC Technology and Policy Assessments: remit and approach
- Research objectives, scope and method
- Evidence reviewed: heat pumps
- Evidence reviewed: district heating
- Conclusions and lessons for the UK

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The Costs and Impacts of Intermittency:

An assessment of the evidence on the costs and impacts of intermittent generation on the British electricity network

Global Oil Depletion

An assessment of the evidence for a near-term peak in global oil production

Energy from biomass: the size of the global resource

An assessment of the evidence that biomass can make a major contribution to future global energy supply

November 2011

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A report for UKERC by UKERC Technology & Policy Assessment Function

Low carbon jobs:

The evidence for net job creation from policy support for energy efficiency and renewable energy

Investment in electricity generation

the role of costs, incentives and risks

May 2007

The Rebound Effect:

an assessment of the evidence for economy-wide energy savings from improved energy efficiency

October 2007

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Presenting the Future

An assessment of future costs estimation methodologies in the electricity generation sector

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Energy Efficiency Evaluation:

The evidence for real energy savings from energy efficiency programmes in the household sector

What policies are effective at reducing carbon emissions from surface passenger transport?

A review of interventions to encourage behavioural and technological change

March 2009

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Great Expectations:

The cost of offshore wind in UK waters – understanding the past and projecting the future

September 2010

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Materials availability for low-carbon technologies: An assessment of the evidence

Overarching research question:

What policies/other factors have driven change/transformation in heat delivery technologies, fuels and infrastructure?

- What factors determine the success of the policy (barriers, other regulatory issues, market structure and historical factors)?
- What is the impact of external factors (fossil fuel prices, heat density, resources)?
- Who are the agents of change (local/national govt., utilities, consumers, others)?
- Would this policy (or aspects of the policy) work within the contemporary UK energy market context?
- What are the lessons for UK policy?

Rapid evidence review - method

Databases: Elsevier Science Direct and Google

Technology/infrastructure keywords were combined with policy, policy evaluation and market deployment keywords to identify evidence. These items were then assigned relevance ratings and information was extracted from the most relevant based on the following fields (drawn from research objectives):

- Country
- Technology or technologies targeted
- Customer segment targeted (residential/commercial/public sector)
- Policy intervention(s), aims and details
- Agents involved in policy delivery
- Study methodology
- Metrics to assess policy effectiveness
- Findings on policy effectiveness
- Factors influencing policy effectiveness (incl. contextual/external and historical factors)
- Any thoughts on transferability to UK context

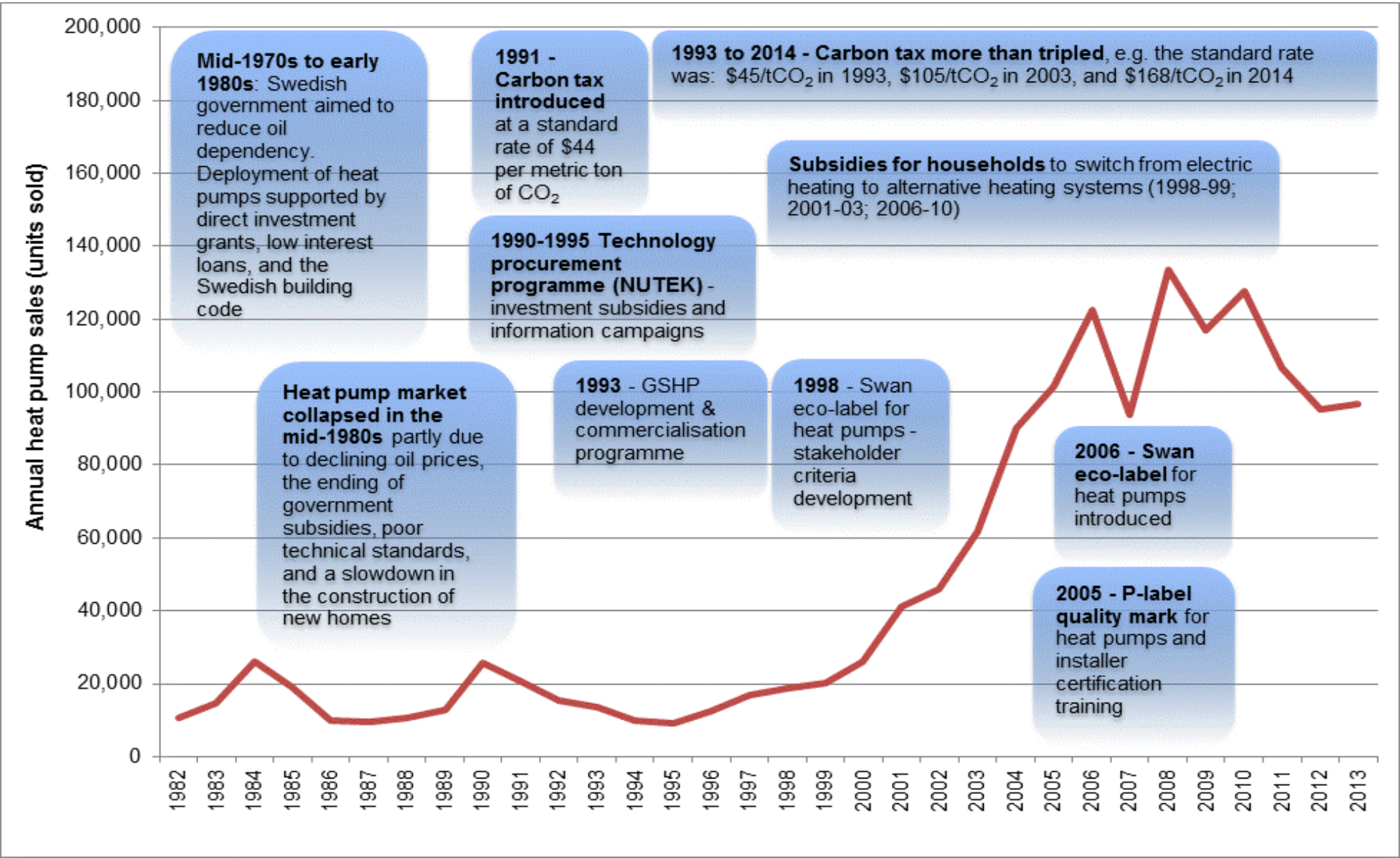
Findings on heat pumps

Heat pump findings – contextual factors

Country	European climate zone (s)	Indigenous production of natural gas, 2013 (TWh, gross calorific value)	Natural gas customers, 2013 (1000s)	Private households, 2013 (1000s)	Average annual heat pump sales, 2010-2013 (Absolute numbers)	Average annual heat pump sales, 2010-2013, per 1000 households
Finland	Colder	0.0	34	2,571	64,885	25.2
Sweden	Colder	0.0	40	4,632	106,502	23.0
Estonia	Colder	0.0	52	556	12,607	22.7
Denmark	Average	56.0	420	2,339	27,364	11.7
France	Warmer / average / colder	3.7	11,301	27,804	136,831	4.9
Italy	Warmer / average / colder	81.9	22, 941	25,518	119,658	4.7
Austria	Colder	14.5	1,351	3,722	17,405	4.7
Spain	Warmer / average	0.5	7,473	18,212	62,014	3.4
Portugal	Warmer / average	0.0	1,354	4,007	12,805	3.2
Switzerland	Average / colder	0.0	423	7,970	21,248	2.7
Germany	Average / colder	115.8	21,179	39,411	67,755	1.7
Netherlands	Average	796.4	7,152	7,549	8,616	1.1
United Kingdom	Average / warmer	424.2	23,003	27,611	18,185	0.7
Lithuania	Colder	0.0	559	1,310	620	0.5
Slovakia	Colder	1.0	1,503	1,811	738	0.4
Hungary	Colder	19.2	3,468	4,106	813	0.2
Column data source(s)	EC (2013); Zimny et al. (2015)	Eurogas (2014)	Eurogas (2014)	Eurostat (2016)	EHPA (2014)	EHPA (2014); Eurostat (2016)

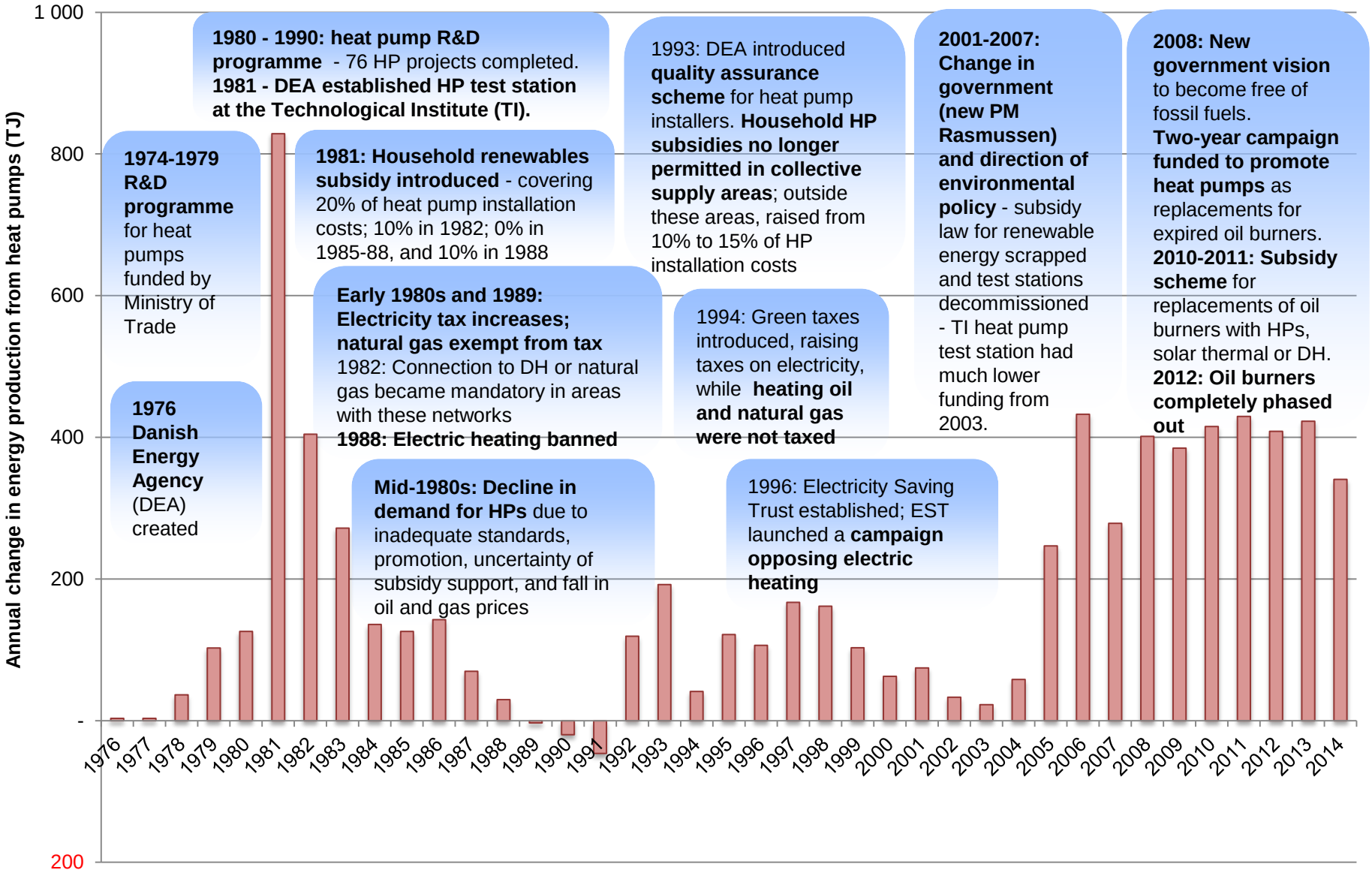
Heat pump case study: Sweden 1982-2013:

Oil prices, building codes, technology procurement, subsidies, information campaigns, carbon tax, technical standards and quality assurance



Policy developments and change in heat pump production in Denmark, 1976-2014

R&D, HP test station, household subsidies, electricity taxes, low policy prioritisation, shifting policy support, disincentivisation of / phasing out of heating oil



Heat pumps - findings summary

- In market leading European countries, policies to promote heat pumps, implement information campaigns and increase technical standards have been successfully deployed in combination with subsidies.

- Low consumer awareness and confidence form a barrier to the uptake of heat pumps; enhancing industry reputation through standards and regulations have been key in overcoming this barrier in countries with high levels of uptake.

- Heat pump deployment in Denmark affected by varying political support for the environmental agenda, opposition to electric heating and heat pumps.

- In several countries (e.g. Sweden and Denmark) there is evidence that presence of carbon taxes on domestic fuels contributed strongly to heat pump adoption, particularly where this combined with use of higher carbon oil-fired heating systems (in Denmark, recent subsidies and regulation have encouraged and mandated phase out of oil burners).

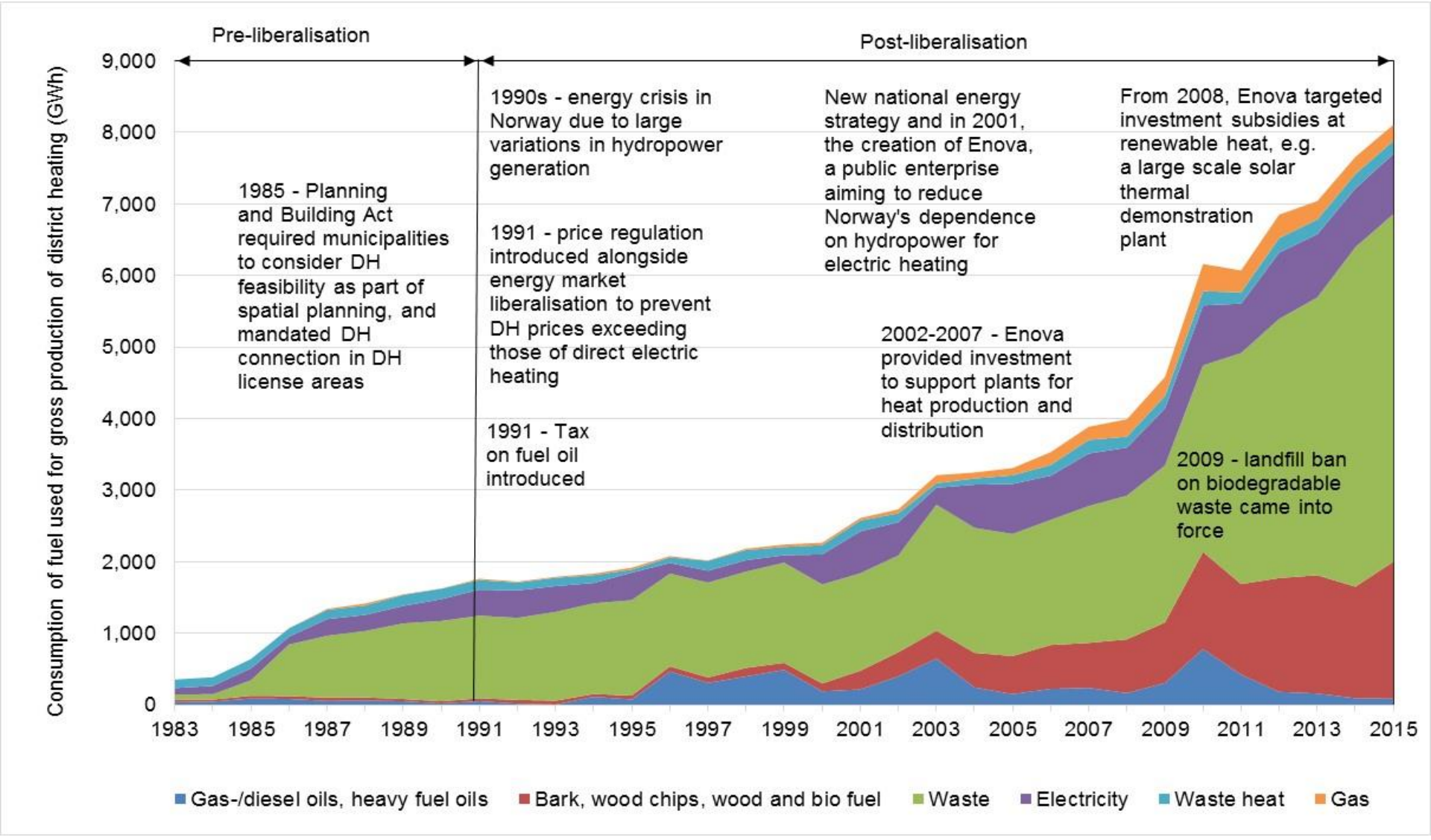
- Similarity between the UK and Denmark - in both countries subsidy programmes supporting renewable heat technologies have been delayed or terminated, adversely impacting on market confidence.

Findings on district heating

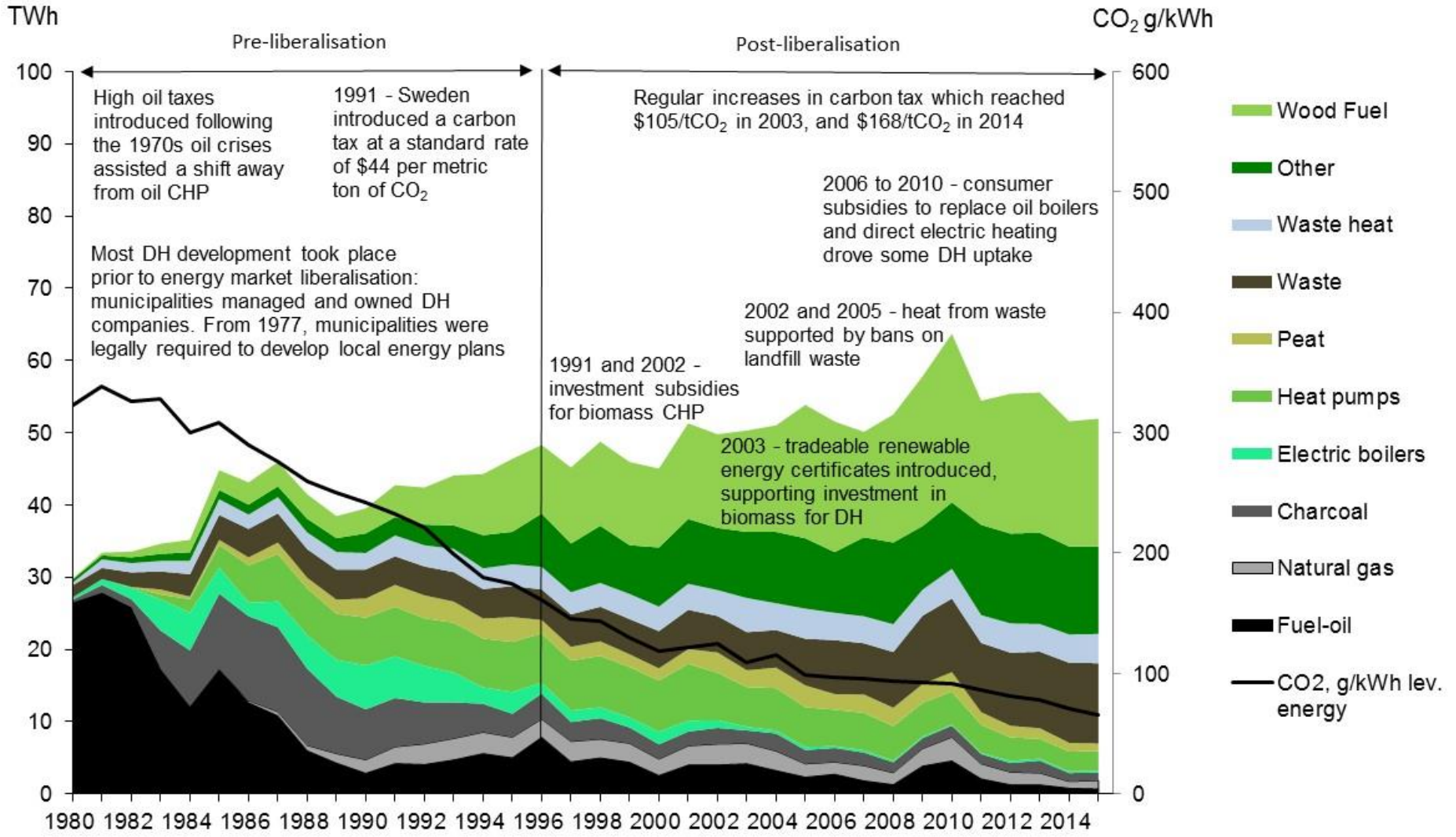
District heating findings – contextual factors

Country	Indigenous production of natural gas, 2013 (TWh, gross calorific value)	Percentage of natural gas customers per private household, 2013 (%)	Total heat demand for domestic space heating (TJ)	Number of District Heating systems	Total installed District Heating capacity (MWth)	Percentage of citizens served by District Heating (%)
Denmark	56	18.0	131,187	394	N/A	63%
Estonia	0	9.4	N/A	230	5,406	62%
Lithuania	0	42.7	25,500	357	9,920	57%
Poland	49.4	49.9	431,853	317	56,521	53%
Sweden	0	0.9	289,080	N/A	N/A	52%
Finland	0	1.3	198,500	400	23,270	50%
Czech Rep.	1.6	62.4	172,070	666	22,958	38%
Slovakia	1	83.0	N/A	2,350	15,793	35%
Austria	14.5	36.3	205,030	N/A	10,300	24%
Hungary	19.2	84.5	N/A	214	8,377	15%
Germany	115.8	53.7	1,664,400 (2012)	3372 (plants)	49,691	12%
France	3.7	40.6	1,050,000	501	21,230	7%
Italy	81.9	89.9	741,763	200	8,056	6%
Netherlands	796.4	94.7	270,000	400	5,850	4%
Switzerland	0	5.3	182,400	153	2,466	4%
United Kingdom	424.2	83.3	N/A	2,000	335	2%
Column data source(s)	**Eurogas (2014)**	**Eurogas (2014), Eurostat (2016)**	**Euroheat & Power (2015)**	**Euroheat & Power (2015)**	**Euroheat & Power (2015)**	**Euroheat & Power (2015)**

Norway: key policy developments and changes in the production of district heating by energy source, 1983 - 2015



Sweden: policy developments and energy sources used for the production of district heating, 1980 - 2015



District heating - findings summary

- Investment subsidies likely to be necessary to support district heating deployment in liberalised markets. In Denmark and Sweden, investment subsidies not involved in extensive DH development which took place before energy market liberalization.

- Pre-liberalization examples: DH companies owned and/or controlled by municipalities, risk reduced through planning and regulation of heat supply. Granting monopoly powers to DH companies led to ability to access capital at very low rates, and willingness to invest for relatively low rates of return.

- DH schemes may need to access a high proportion of the heat market in the area they supply to operate economically. In UK, securing and growing a customer base is perceived as uncertain, discouraging investment.

- Policy stability is a key success factor: in Iceland and Denmark, perceived policy stability means banks compete to loan to district heating projects
  - UK: short-term abruptly changing policies relating to DH development have created uncertainty and perceived risks for local government and commercial sector.

- Carbon and energy taxes on alternative heating sources can also play an important role, e.g. heating oil taxed from start of DH development in Denmark in 1970s, and this tax was raised after oil prices fell in 1980s, allowing CHP systems to be run profitably.

Conclusions

- **Heat provision can be transformed -** Denmark, Sweden and Finland: 50-60% of buildings supplied by DH. France, Italy and Sweden: over 1 million heat pumps sold from 2005 to 2013.
- **Policy stability, continuity and support is a key success factor for both technologies.** Heat system change can be catalyzed by disruptive events, e.g. oil crisis, hydropower crisis in Norway.
- **Technical standards, quality of installation are key to heat pump progress – boom, bust and recovery…** subsidies, information, tax breaks won't work if the consumer experience is poor.
- **Investment grants appear to be particularly important for heat networks where energy markets have been liberalized.**
- **Fossil fuel or carbon taxation has been successful in building stable low-carbon heat markets in Sweden and Denmark.** Subsidies for replacing oil and electric heating can also be effective in stimulating demand both for heat pumps and heat networks.
- **Strong planning policy is a feature of most large-scale heat network development.** Planning and regulatory frameworks needed to give heat network developers confidence.
- **A group of 'middle ground' countries possess a more mixed portfolio of gas heating, heat pumps and heat networks.** Recent policy in Germany has explicit focus on replacing gas grids with heat networks.
- **Successful approach in UK likely to combine subsidies, carbon taxes, planning policy, regulation and strong support for certification, skills and product standards.**