IMPIreland
Integrated Modelling Project

epa
Environmental Protection Agency

Policy Decision Support in Ireland

Recent Work

EnvEcon
Decision Support

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Lisbon

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Structure of Presentation

Background

AADT Paper

ASHP Paper

Section 1 Background

EnvEcon and the IMP Project

- EnvEcon are a team of **economic researchers and advisers.**
- The team combine this base training with **specialist skills** in areas such as **GIS, Programming, Data Management, Integrated Modelling** etc.
- **Modelling is an important component** in our work but our **principal focus** is to provide **decision support for the analysis, design and implementation of practical and potent policies.**
- **Integrated policy** design for us, is all about finding **as many reasons as possible to act**. The goal is good **broad base policies which can be sold on multiple fronts** … not just a 'climate policy' or an 'air policy'.
- The two papers presented are **examples of some of our recent policy research**. They aim to **strengthen national capacities** and understanding of the topics, and also to **provide robust work** that can serve as the **foundation for actual policy initiatives** that deliver progress on air and climate targets (and offer other benefits) in Ireland.

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Air Climate Synergies … a quick mention

- As a quick aside … we recently completed a piece of work with another modelling team in Ireland who run the **TIMES energy model**.
- We worked to **adapt their basecase scenario**, and a non-ETS climate optimisation scenario **into the GAINS model**.
- Obvious **challenges** regarding technological detail and controls, but we adapted as best we could using our own control strategy work.
- Findings for their 2030 22% NETS **optimisation** : Their reductions delivered a **27% drop in NO_x and a 60% drop in SO_2** in 2030. But …
- They delivered a **15% increase in VOC and a 61% increase in $PM_{2.5}$**.
- The outcome is principally driven by **substantial increases in residential/commercial and industrial biomass** use.
- Another point is that it flags the **importance of adequate controls** where such recommendations are followed.
- Highlights **the issue of a narrow perspective** approach to solving one problem without due consideration of broader outcomes.

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Section 2 AADT Paper

AADT Annual Average Daily Traffic Research

- Transport research is **always welcome** in an environmental context…
- We felt that spatial referencing of transport **activity on all roads** could be helpful in a variety of ways…
- Could support **spatial impact assessments**, **targeted policy design, refinement of our prior MDV work to high-res scale** …
- And it could also support work to develop **bottom-up transport demand forecasts** for Ireland in a manner **distinct from top-down macro-economic/energy forecasting** approaches.
- Road counter data is available for big roads … but we wanted to estimate activity on **all the other roads too**…

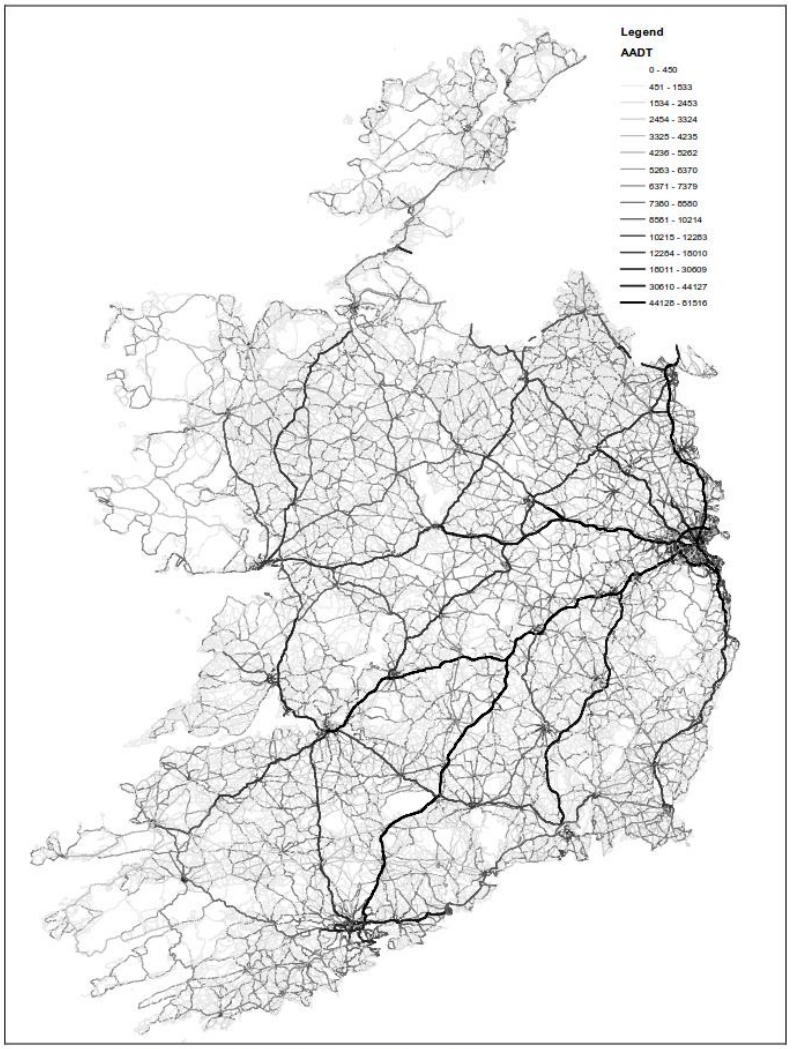

Figure 5 Estimated AADTs of roads in Ireland

AADT Annual Average Daily Traffic Research

- **Sorted roads into classes** Motorway, National ways and regional and local roads and tagged them all in a GIS system.
- Daily automated traffic counts for Motorways and National ways were sourced from the **NRA and mapped to our GIS**.
- For roads that have only occasional counts we used another method. For example … **DTO road user survey** data (a week of mornings in Dublin 7am to 10am). We took these data and **adjusted and extrapolated the counts using distributions** derived from the daily, weekly and yearly counts observed on **the M50 ring road around Dublin** which offers automated counter data.
- For residential roads we developed a GIS method to identify **'dangling roads'** – i.e. cul de sac/no throughs – low activity areas.
- Rural areas were challenging but we ultimately adjusted estimates using **urban-rural distribution data for AADTs in the UK**.
- **Overall Distributions from the empirical data all compare well** with literature and international data.

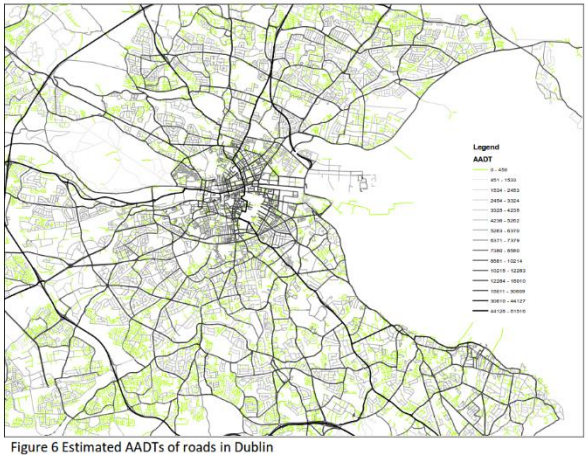

Figure 6 Estimated AADTs of roads in Dublin

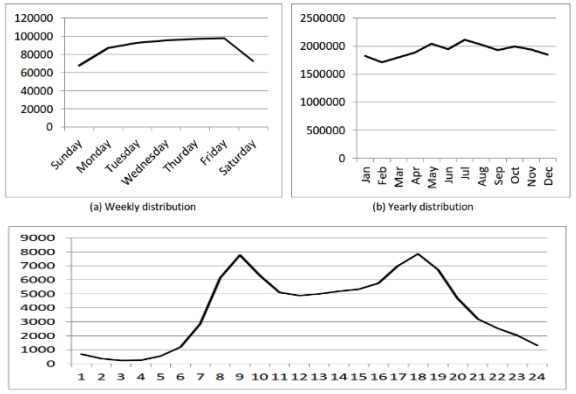

Figure 2 Daily distribution of two way traffic in urban areas

Hours of the Day, Days of the Week, Months of Year

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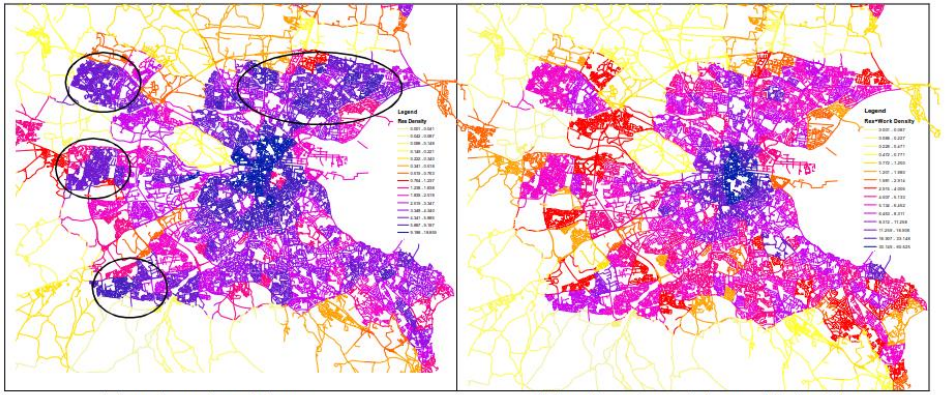
AADT Annual Average Daily Traffic Research

- These initial AADT estimates were then **refined for each road segment using SAPS level POWSCAR** data (e.g. residential and work densities, car ownership densities, travel modes)

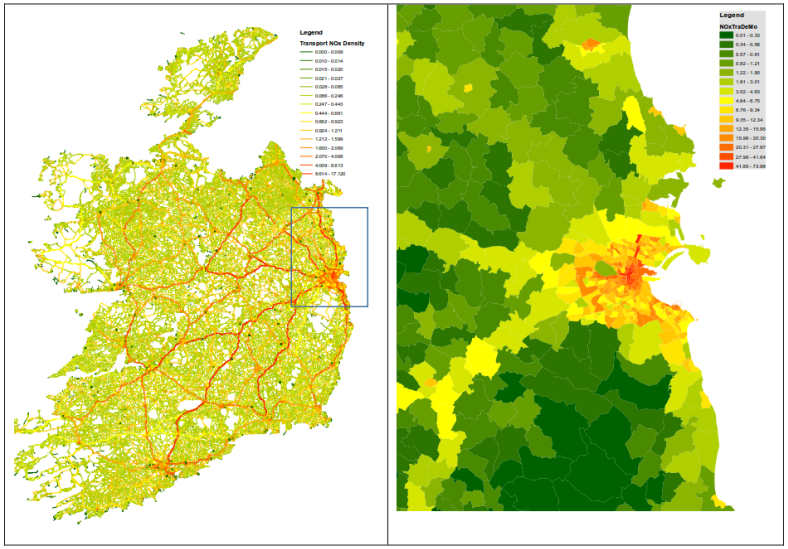
- Developed an **equation to adjust representative AADTs for any given road segment** using these factors. Compared with main traditional and modern methods (OLS, Log Linear, Neural Network). Method offers better MAPE to LL and OLS, and improves on irregularities in Neural network for some routes.

- AADTs were then **apportioned to different vehicle types in the fleet** on the basis of the Road User Monitoring Report. Except for HGVs on Motorway/Nationals where data are taken from available ratios in the NRA data.

- **Tried estimating VKMs and then emissions by dividing VKM estimations** into fleet data for vehicles and technologies **using TREMOVE**, speeds from **URBIS and COPERT** emission factors. Needs work. For now we just use the **ratios to inform spatial allocation of inventory**.



(a) With residential density (b) With residential plus work/school density



(a) Line emission (b) Area average emission

Unit : Tonne/km per annum for line emission, and Tonne/km^2 per annum for areal average

Figure 7 Street-level NOx pollution from road transport and its area averages, 2010

AADT Annual Average Daily Traffic Research

- Higher resolution approach allows us now to **drill down to all segments of road across the entire country** to see the estimate of AADT.
- Refinements in the method consider **not only residential density, but also work/school density** to estimate AADT and these are sensible adjustments.
- This research is part of our **plan to develop specific capacities** that can be **linked-up** to enhance research and decision-support in this context.
- Specifically values could be used to **stimulate further development of VKM** estimates and forecasts in Ireland.
- Refinements can come from new counts and new data in time.
- Current method is focused on estimating **spatial trip distributions.**
- Development for **VKM and independent emissions** will take **time**.

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Section 3 ASHP Paper

ASHP Air Source Heat Pump Residential Research

- Policy paper that **linked with industry (Glen Dimplex)** and which makes **use of developing national data (Detailed Building Energy Ratings)** in the area.

- **ASHP Technology has progressed** somewhat and no longer necessarily requires major heat distribution upgrades (e.g. special radiators or underfloor system). Viable for **retrofit.**

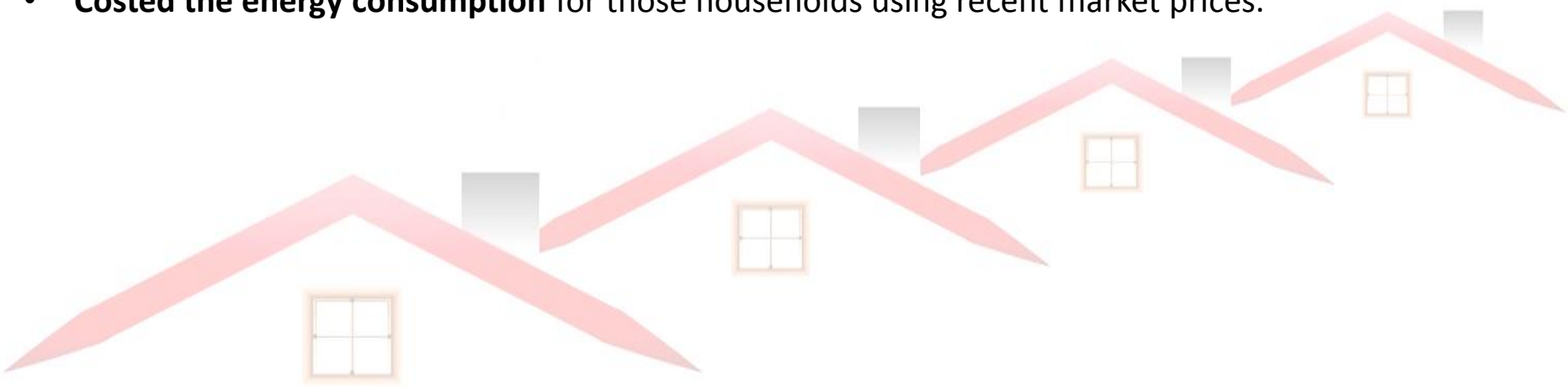
- Clear **potential for this technology in the retrofit market** and wanted to explore if a strong case can be made for action from the **household, societal and political** perspectives.

- Is it **a policy that could be sold on multiple angles?**

ASHP Air Source Heat Pump Residential Research

Stage 1 - What are the houses currently using and how much energy do they need?

- **Filtered BER data** to homes (no apartments), and excluded existing heat pump homes and nulls.
- 400,000 records analysed for **energy consumption** of main and secondary space & water heating.
- Set standard **target indoor temperatures** and allowed for local external temperature. This may still overstate actual energy demand – **No behavioural factor adjustments.**
- Estimated energy consumption based on these values and the **efficiency of those existing systems**.
- **Costed the energy consumption** for those households using recent market prices.



ASHP Air Source Heat Pump Residential Research

Stage 2 – What heat pump could replace the existing system and how much would it cost?

- Determined **appropriate sized heat pump** for each home based on extended BER data.
- **8kw – 12kw – 16kw** on the basis of the estimated energy needed for the individual home.
- Calculated **Seasonal Performance Factor** with Dimplex **for each of the ASHPs**.
- Flow temperature is important and **most should work at 55C. Results presented are for this flow.**
- An **additional run planned at 65C** which will give a **reduced performance and a range** for results.
- **Retrofit install costs** were provided from Dimplex and contractors.

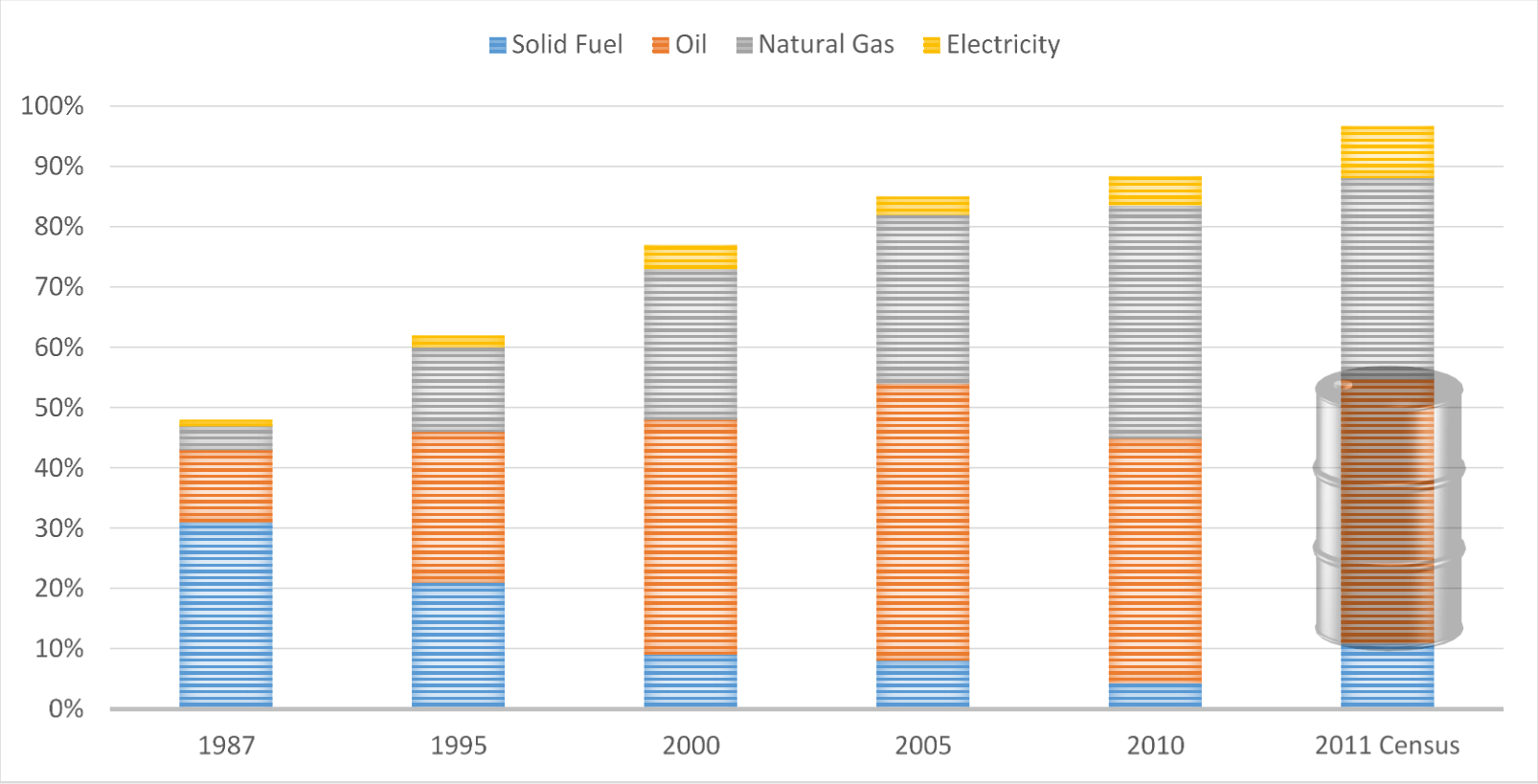
ASHP Air Source Heat Pump Residential Research

Stage 3 Comparing costs and emissions

- Running costs compared based on **fuel prices, efficiency** and individual household energy needs.
- Capital cost for ASHP based on **capital asset pricing model** for rated **20 years** lifecycle.
- Estimated **emissions from Guidebook 2013 (Tier 1 only)** and using Power sector data (SEMO). Recognition that these **may overstate emissions** in the absence of greater detail.
- Developed and ran a number of **economic scenarios** relating to running cost of a new heating system, capital cost and running cost, provision of an ASHP grant, and alternative oil prices.
- 400k houses **scaled up to national stock** to give national scale emission outcomes for the paper.
- Provisional estimates of pollutant **impact values from marginal damage value guidebook (2015).**
- **Results should be considered upper range** due to **a) flow temp. b) heating use estimate c) Tier 1.**
- **Lower Range is being developed** for review.

ASHP Air Source Heat Pump Residential Research

- Market is **dominated by oil and gas fired central heating** systems at circa **41% and 39%.**
- **Solid Fuel accounts for approximately 10%** of the market central heating systems.
- The **key results** therefore **relate to oil systems** and to a lesser extent, solid fuel systems.



Source: SEAI (2013) and CSO data

ASHP Air Source Heat Pump Residential Research

Table 1 Proportion of households that would derive net positive savings from an ASHP

Scenarios	*R only*	*RC*	*G+RC*	*H+RC*	*G+H+RC*
Coal	99.53%	41.91%	57.10%	42.57%	57.78%
Peat	100.00%	81.59%	90.66%	81.76%	90.84%
Oil	99.85%	59.47%	76.56%	83.97%	93.18%
LPG	95.31%	47.32%	60.05%	71.12%	80.87%
Gas	99.49%	36.61%	53.34%	38.44%	54.83%
Wood	93.75%	53.38%	64.63%	53.75%	65.51%
Electricity	98.59%	88.83%	91.87%	88.93%	91.94%

Notes : *R* means only comparing running cost between heap pumps and existing heating systems (capital cost of heat pumps is ignored). *RC* means considering running cost and capital cost of heat pumps. *G* includes a grant of €2422 and *H* indicates a high oil price scenario.

- 60% of all homes **currently using oil** would derive net positive savings under 'RC' ASHP switch.
- This is an **upper band estimate** – but is a strong result against one of the dominant market fuels.
- **Grants, High Oil Prices** and a combination of both understandably further influence the share.

ASHP Air Source Heat Pump Residential Research

Table 2 Average savings for those households that derive savings from an ASHP replacement

Scenarios	*R only*	*RC*		*G+RC*		*H+RC*		*G+H+RC*	
Average Saving	S running	S all	S running	S all	S running	S all	S running	S all	S running
Coal	1004	1092	1834	956	1497	1095	1837	962	1502
Peat	1532	1019	1767	1102	1652	1037	1785	1119	1668
Oil	995	604	1352	642	1192	844	1587	946	1491
LPG	1024	948	1693	921	1467	1147	1885	1190	1730
Gas	691	487	1222	497	1034	500	1235	515	1051
Wood	1198	1088	1837	1074	1625	1093	1841	1071	1622
Electricity	1751	1184	1901	1336	1859	1194	1912	1346	1869

Notes : S running means savings from the replacement when only considering running costs, i.e., capital cost of heap pump is ignored. S all means saving from the replacement when considering running cost and capital cost of heat pump.

Unit : Euro per annum

- Of those 60% of oil homes – the **average saving would be €600** per annum under 'RC'.
- Again an upper band estimate but **an encouraging result.**

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ASHP Air Source Heat Pump Residential Research

Table 10 Net estimated changes in annual health and environmental impacts versus the base case scenario

Difference in Impact Costs versus BC (€2010)	*S1*	*S2*	*S3*
NO_X Power Sector	88,800	(109,150)	(152,625)
NO_X Residential Sector	3,496,625	4,721,750	5,284,125
$PM_{2.5}$ Power Sector	33,000	(33,000)	(46,200)
$PM_{2.5}$ Residential Sector	72,446,000	95,918,800	118,814,400
Sum Total	76,064,425	100,498,400	123,899,700

- Estimated emission impacts are encouraging where ASHPs replace oil and solid fuel heating.
- Even the S1 (RC ex. Gas) scenario can halve CO_2 and NO_X from the sector, and more than halve $PM_{2.5}$.
- Power sector emissions are easily compensated and cleaner power tech will enhance results.

"…Under a combined high oil-price and grant scenario, **CO_2 emissions** could be reduced by approximately **4 million tonnes per annum** and **residential $PM_{2.5}$ and NO_X emissions from oil, LPG and solid fuels could be reduced close to zero** with **corresponding health and environmental benefits of approximately €100m per annum…**"

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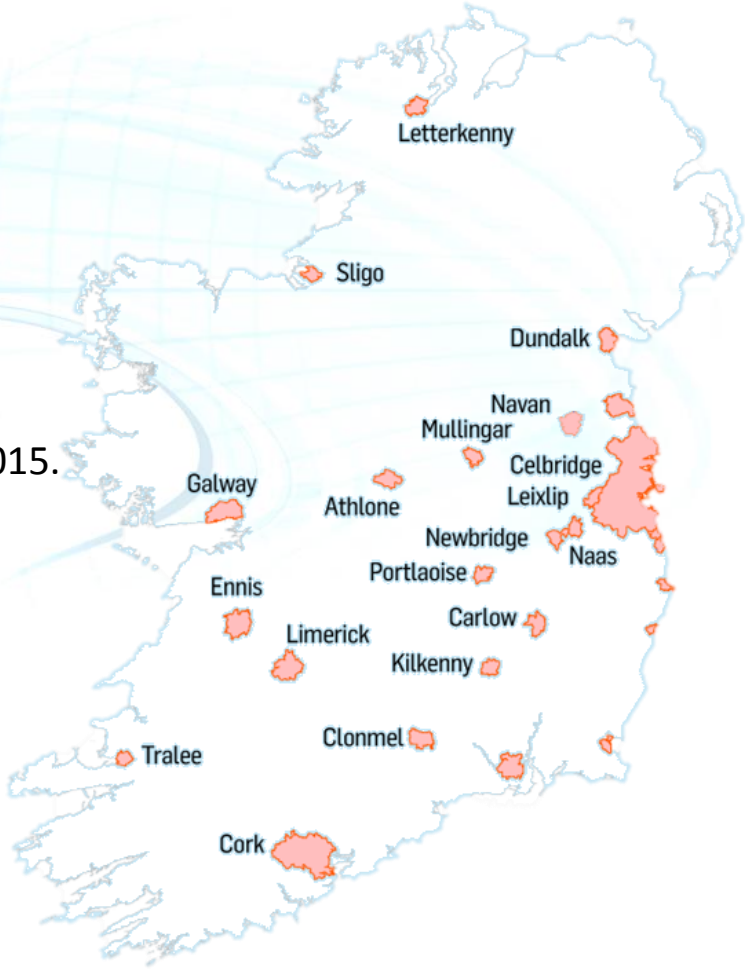
Final Note on Related Irish Policy

- History of **pioneering policy initiatives** related to health and ambient air quality.
- Such as the **smoky coal ban** and the **smoking ban**.
- **Clean Air Strategy** is under development.
- **Solid fuel regulation** is an area of particular interest.
- Research and policy modelling work is **influencing** change.
- **Nationwide smoky coal ban** was announced at event in 2015.
- **North-South** aspects are an important factor.
- **Competition issues** are also a challenge to address.



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