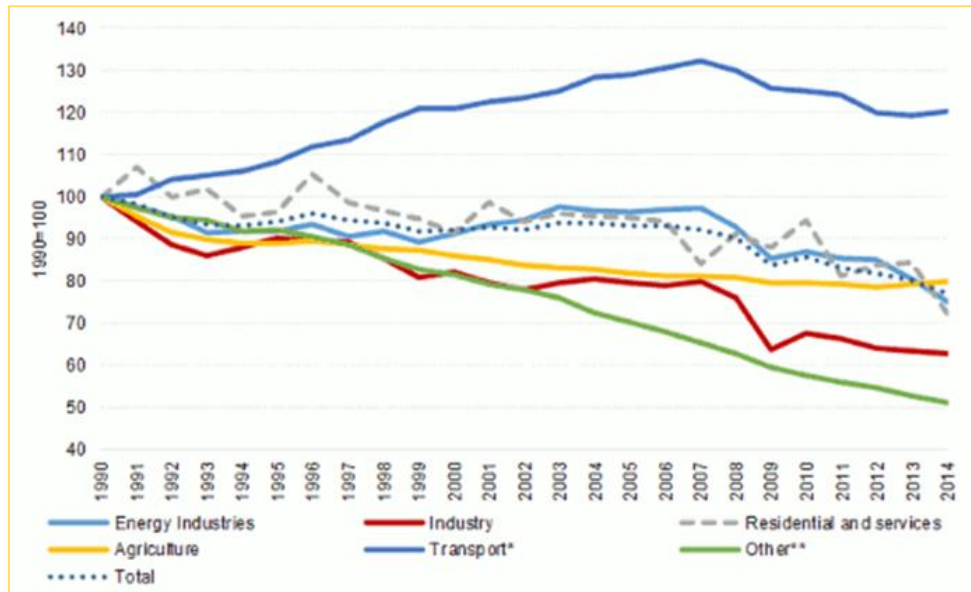


Attitudes to Renewable Energy Technologies: A Survey of Irish Households

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GHG emissions from transport are rising



Source: EEA

Transport accounts for about 25% of EU GHGs and is the major source of urban air pollution.

Unlike other sectors, emissions have not seen a definitive downward trend yet.

Road transport accounts for over 70% of the emissions from the transport sector.

Pros of electric vehicles (EVs) outweigh cons

Advantages	Disadvantages
<p>Environment - lowers carbon emissions and pollution levels drastically.</p> <p>Security - reduces reliance on imported oil by using domestically-generated electricity.</p> <p>Cost - has low maintenance and running costs, implying low total cost of ownership.</p> <p>Efficiency – can convert up to 90% of energy from batteries into motive energy vs 20-30% for conventional cars.</p>	<p>Cost - high upfront cost, especially of batteries.</p> <p>Battery re-use and recycling – uncertainties exist regarding battery disposal post vehicle life.</p> <p>Range – most electric cars don't travel as far on a full charge as conventional cars on a full tank.</p> <p>Availability – fewer model choices for consumers. Charge point infrastructure also not as developed as conventional filling stations.</p>

Early adopter studies have been growing

- Egbue & Long (2012) surveyed technology enthusiasts in the US.

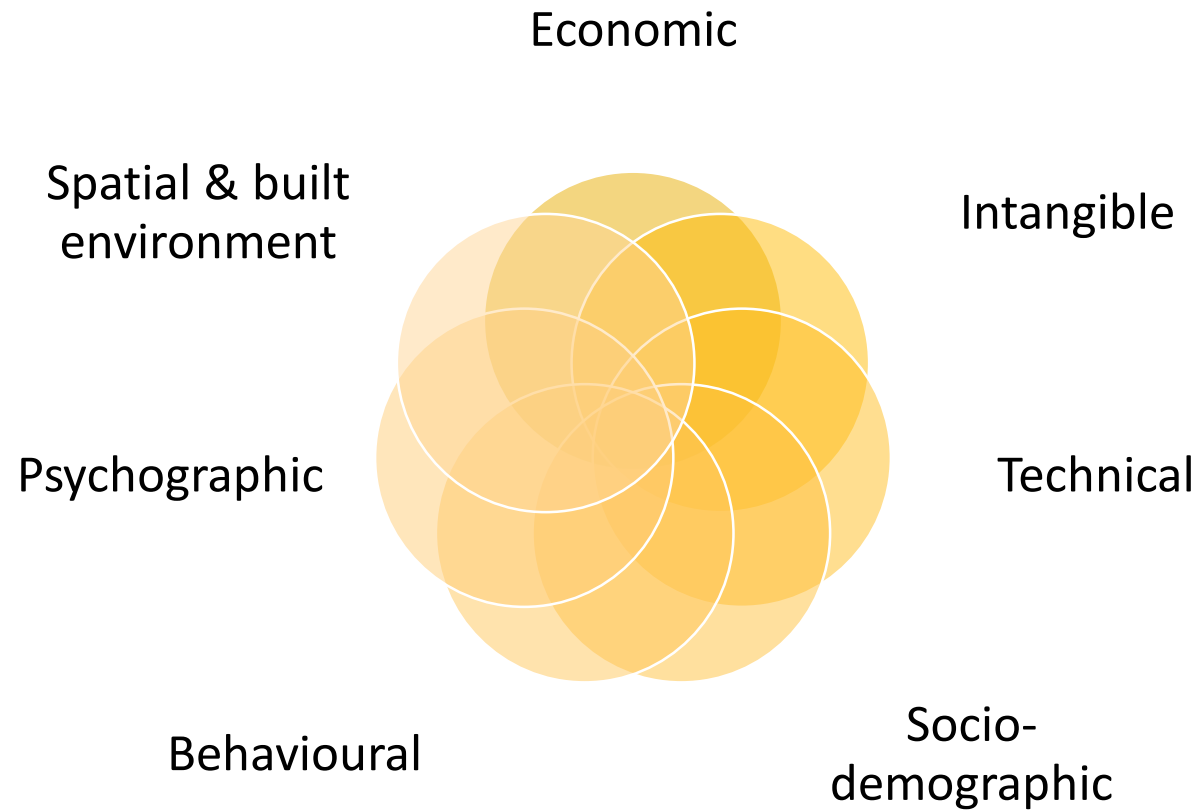
Concerns	Drivers
<ul style="list-style-type: none">❖ Battery range,❖ Cost,❖ Performance,❖ Infrastructure	<ul style="list-style-type: none">❖ Minimal maintenance requirements,❖ Eliminates use of petroleum,❖ Reduced GHGs.

- Plotz et al. (2014) sample early EV adopters & non-adopters who intend to adopt in Germany.
 - Adopters primarily
 - ❖ middle-aged,
 - ❖ male,
 - ❖ of high socio-economic status,
 - ❖ living in rural areas with several household members, often children,
 - ❖ interested in trying out technical innovations,
 - ❖ less concerned with comfort.

But characteristics are not well established

- Curtin et al. (2009) survey a representative U.S. sample.
 - ✓ Gender & location are not clear predictors.
- Sierzchula et al. (2014) conduct a multi-national study.
 - ✓ Charging infrastructure is the best predictor of a country's EV market share.
- Graziano & Gillingham (2015), Darshing (2017), Palm (2017) analyse secondary datasets spatially.
 - ✓ Peer effects affect regional PV uptake in the US, Germany & Sweden.

We identified seven determinants of uptake



Research question?



New technology adoption is in early stages

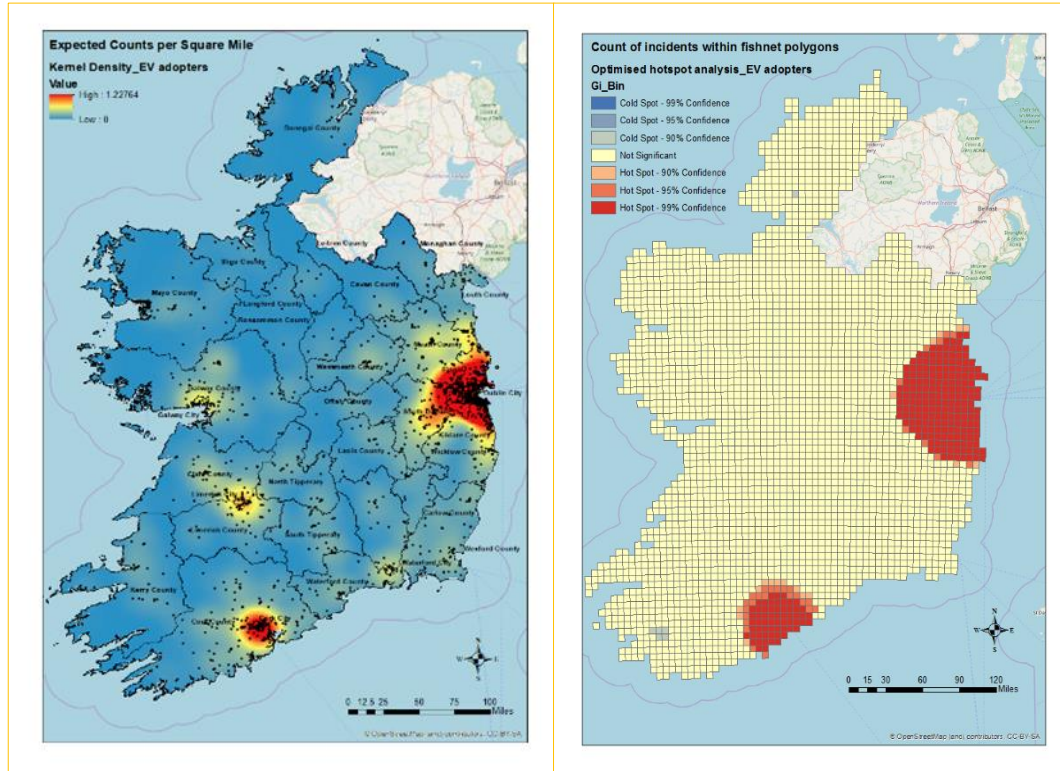
Only 23 EVs in 2010 → cumulative uptake of 1,759 by 2016.

- 1,179 of these adopted in 2015 and 2016 alone.

Count of adopters	No. of Small Areas
0	16892
1	1520
2	183
3	34
4	9
5	2
15	1

Source: ESB ecars data.

Heat maps show geographic clusters



Adopters mainly cluster around major urban centres - Dublin and Cork.

We combine CSO census data & ESB ecars to create our dataset.

Source: Author's illustrations using ESB ecars data.

Summary statistics

Variable (N = 18,641)	Mean	SD	Min	Max
Count of adopters	.11	.38	0	15
Average distance to nearest charge point (km)	.07	.73	0	23.21
Large households (≥ 4 rooms)	.78	.19	0	1
Middle-aged (35-54 years)	.28	.05	0	.53
Elderly (55-74 years)	.19	.09	0	.77
Highly educated (university degree)	.28	.16	0	1
Long commuters (≥ 1 hour/day)	.08	.05	0	.34
Count of dealers	.01	.12	0	5

NB. Socio-demographic variables are normalised by population in each small area.

Econometric analyses add to evidence base

Poisson & negative binomial models appropriate for non-normal count data.

Significant variables in order of importance:

1. Long commuters.
2. Large households.
3. Dealer count.
4. Elderly population.
5. Average distance to nearest charge point.

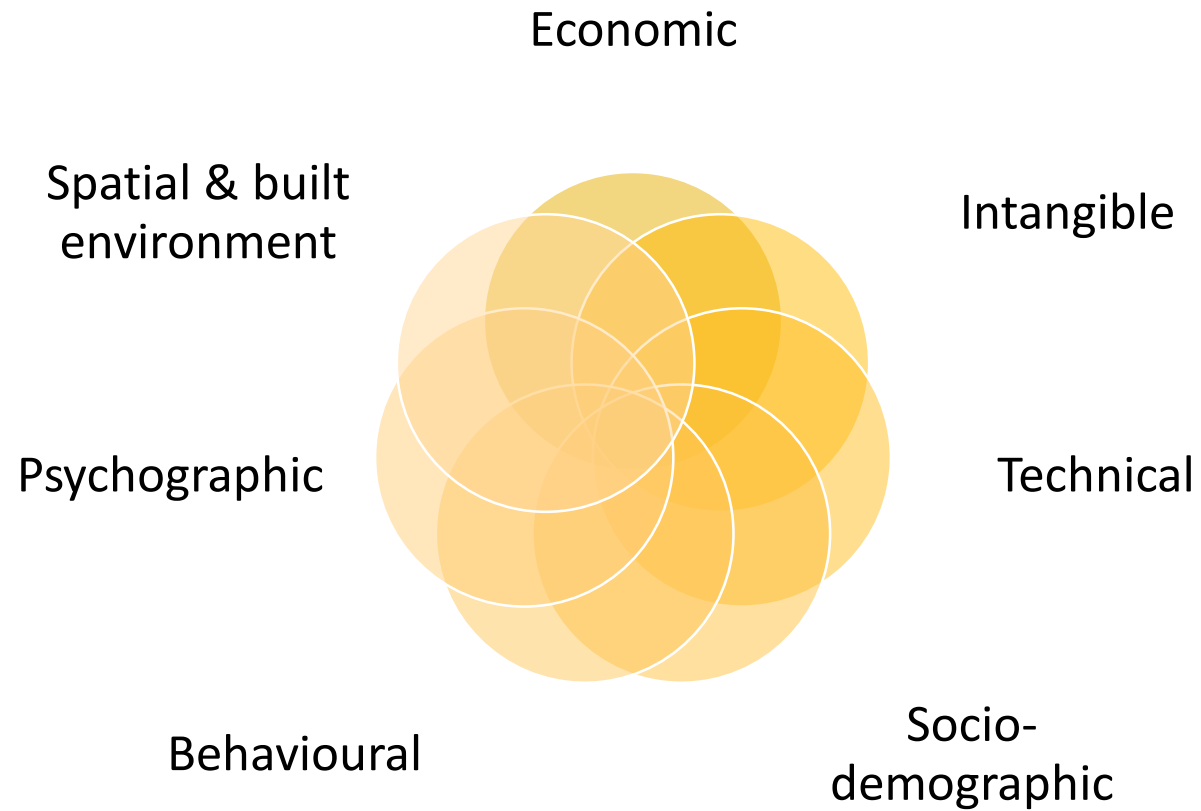


EV owners cluster around populous urban centres.

More EV adopters in neighbourhoods of

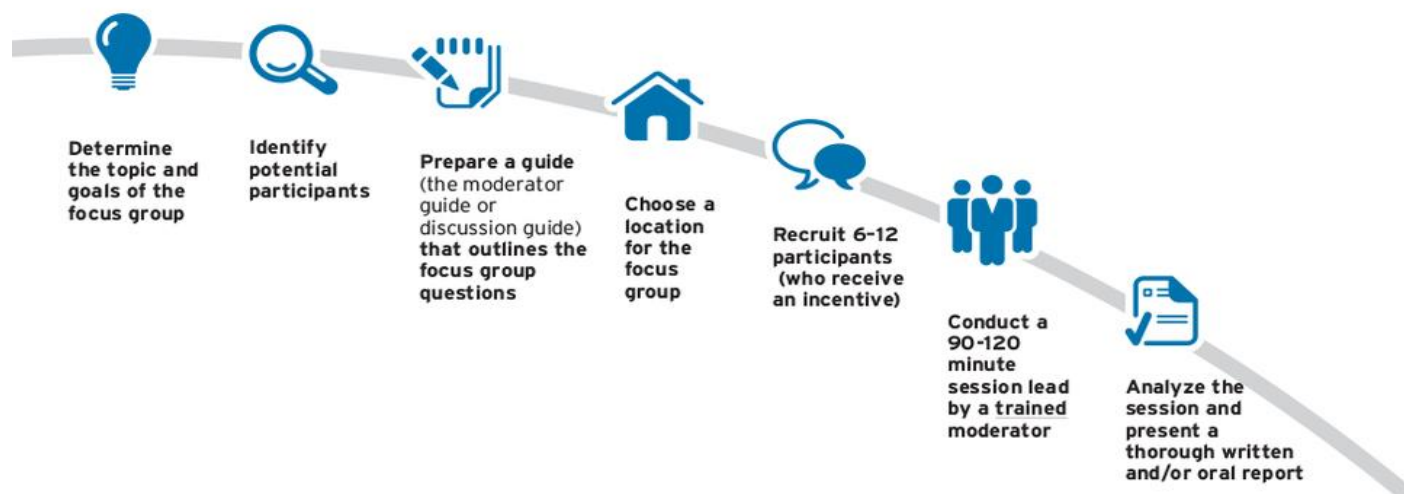
- high socio-economic status,
- perhaps in suburbs with long commute time,
- large houses,
- relatively younger population,
- presence of dealers, and
- longer distances to public charge points.

Revisit slide 6



Focus Groups

HOW A FOCUS GROUP WORKS



Group	Gender	Location	Age	Profile
1 Focus Group	Mixed	Dublin	Mixed	Owners of electric vehicles
2 Focus Group	Mixed	Dublin	Mixed	Have had solar PV's installed
3 Focus Group	Mixed	Dublin	Mixed	Not adopters of renewable technologies
4 Four in-depth interviews	Mixed	Tipperary, Westmeath	Mixed	Owners of heat pumps

Online survey complements real-world data

We collect granular preference data using nationally-representative sample.

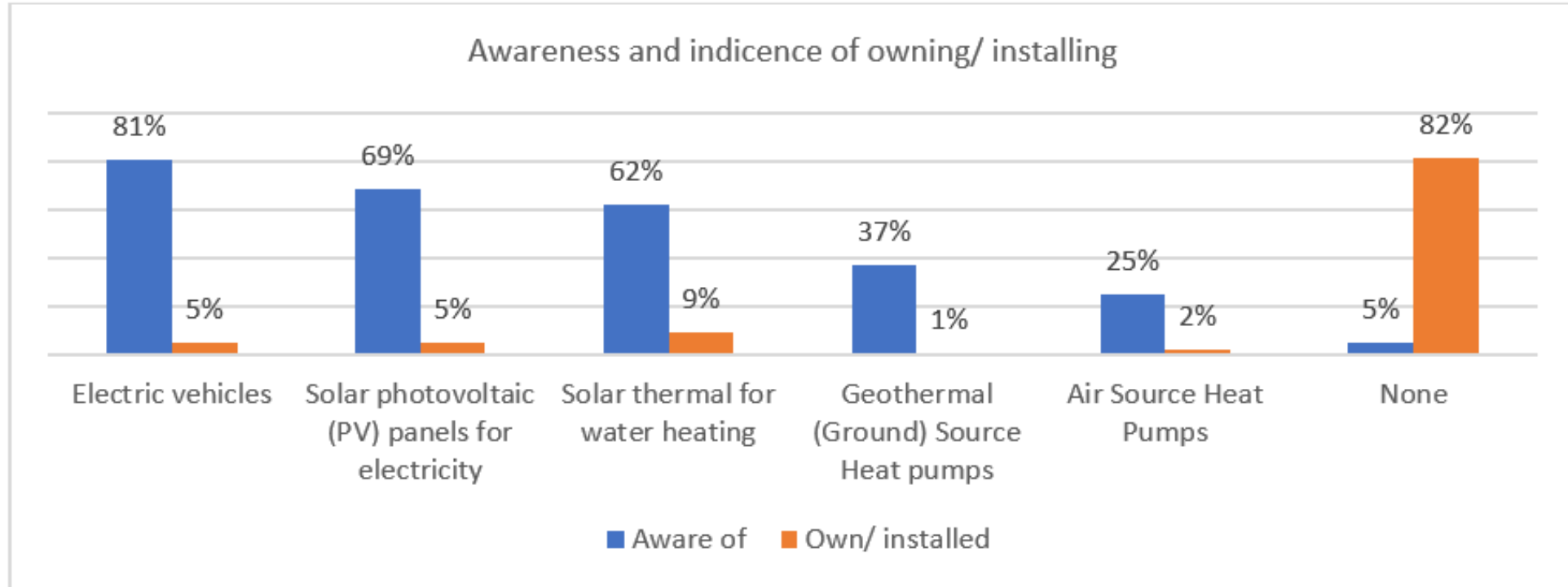
- 3 groups of 400 adult participants, for solar panels, heat pumps and EVs.
- Random sample from market research panel stratified on age, gender, region and social class.
- Socio-demographic data, risk and time preferences, attitudinal variables e.g. towards new technology & the environment.
- Discrete choice experiment (DCE) to identify key criteria in the renewable energy technology (RET) adoption process.

Demographic profile vs. national statistics

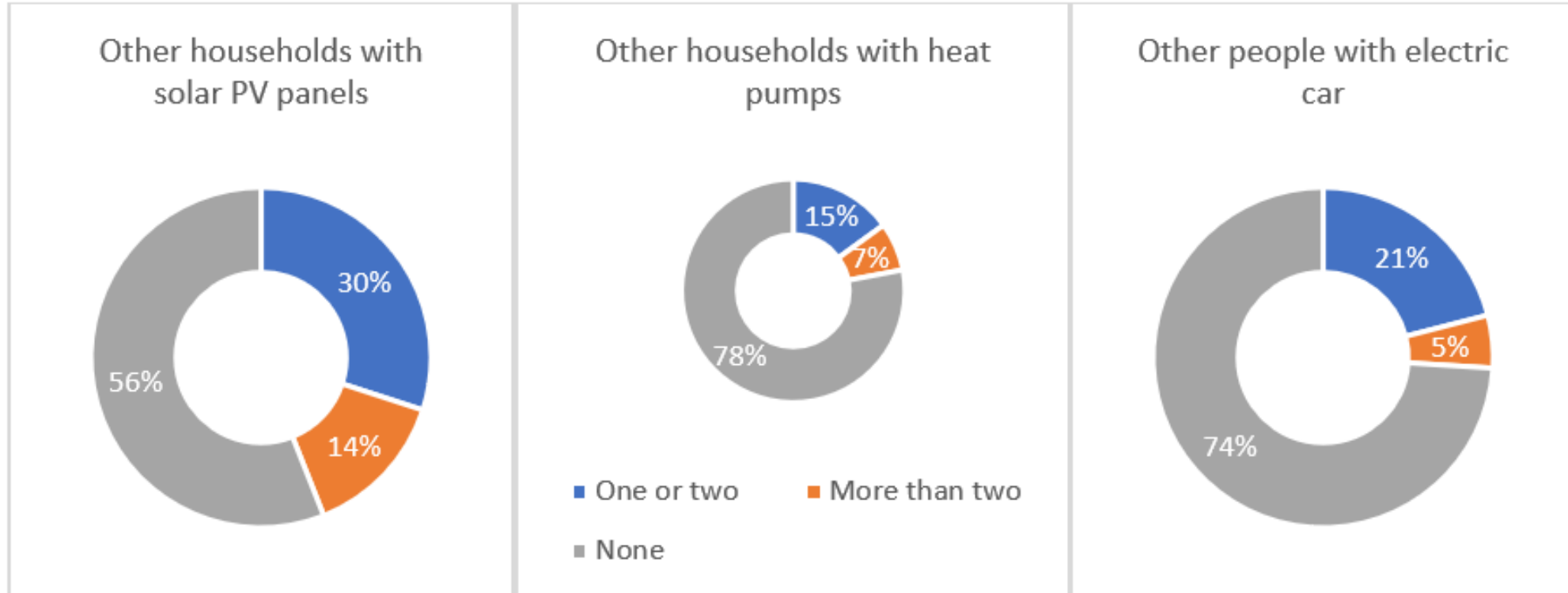
Sample attributes	% in survey	% in Ireland
Age		
18-24	11	11
25-34	18	18
35-44	21	21
45-54	17	17
55+	32	32
Gender		
Male	49	49
Female	51	51
Socio-economic status		
ABC1F50+	47	46
C2DEF50-	53	54
Working status		
Full-time employed/self-employed	43	56
Part-time employed/self-employed	18	56
Retired	13	15
Home-keeper	10	9
Student	6	7
Unemployed	7	8
Others	2	5
Region		
Dublin	29	28
Leinster	26	27
Munster	27	27
Connulster	18	18

National statistics are largely aligned with sample characteristics.

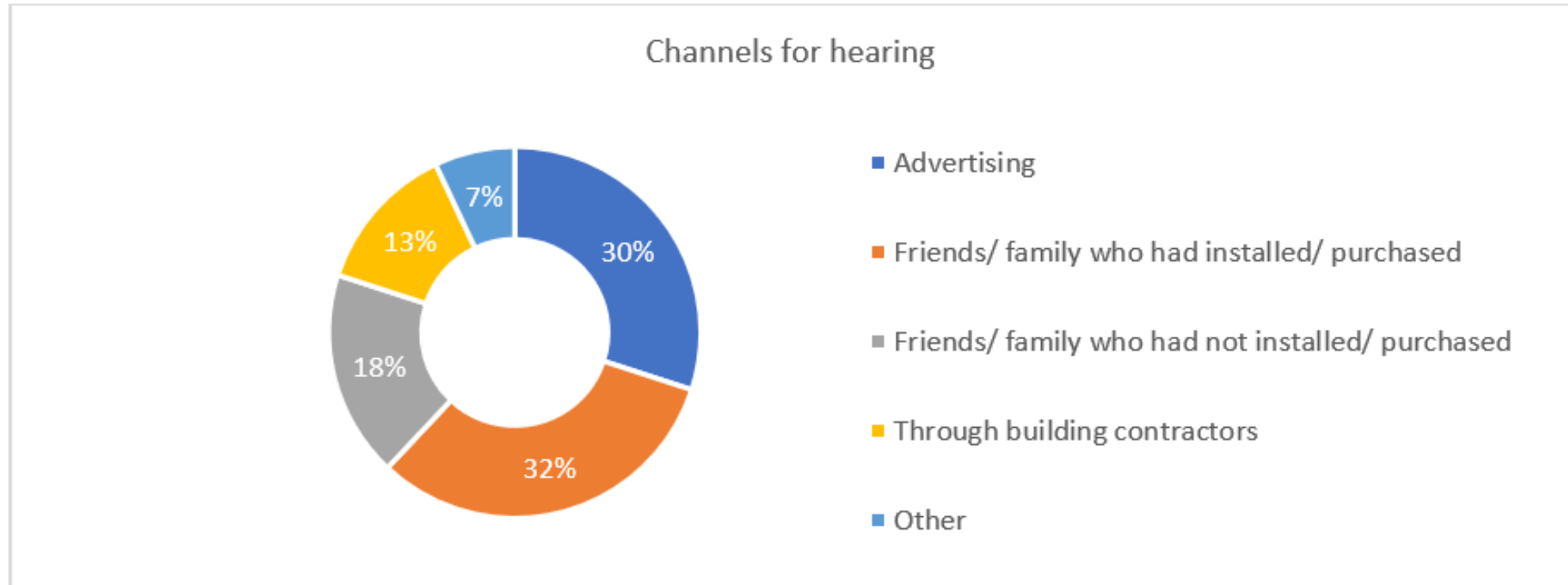
Awareness of RETs is quite high



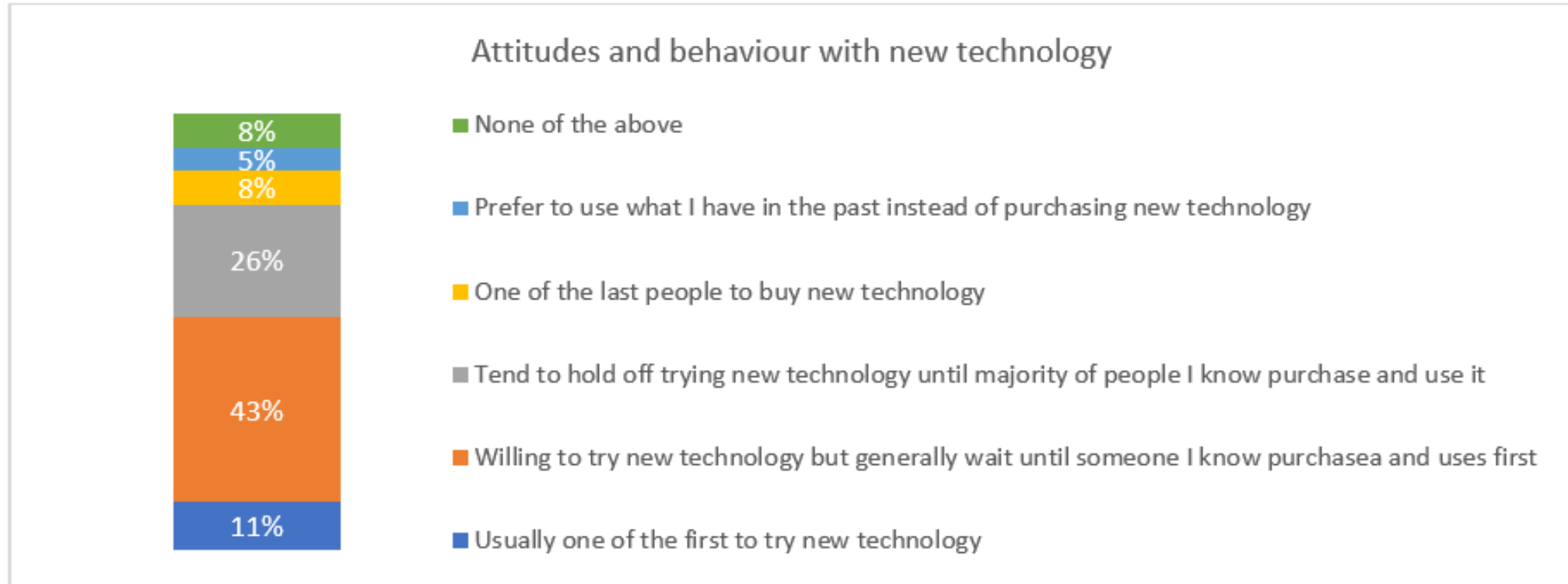
Awareness of other owners is relatively poor



Social networks & adverts are key communication channels

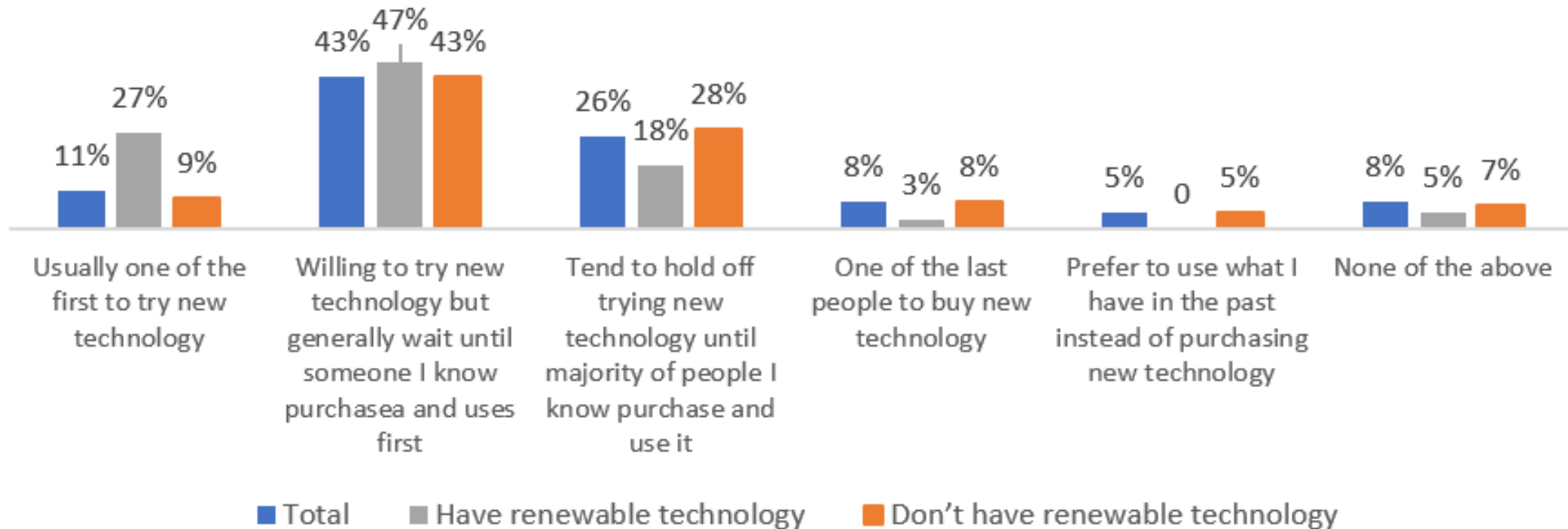


Most people adopt a wait-and-see approach

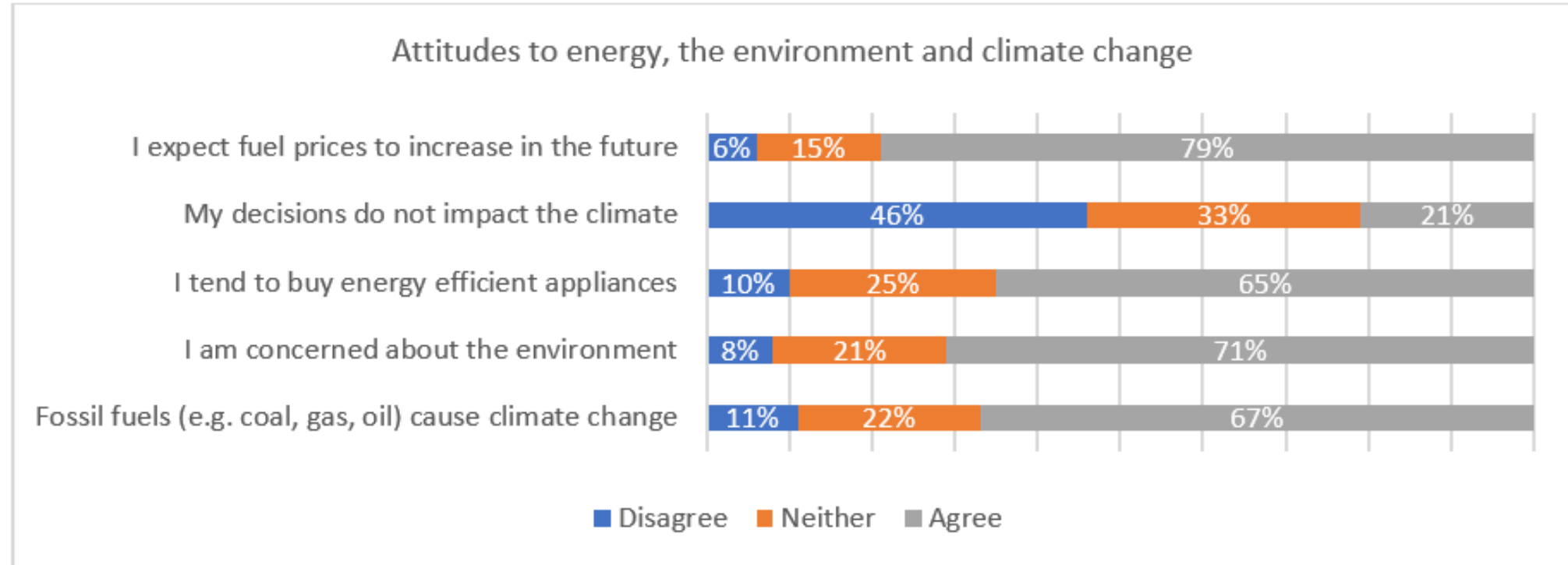


Current adopters tend to be innovators

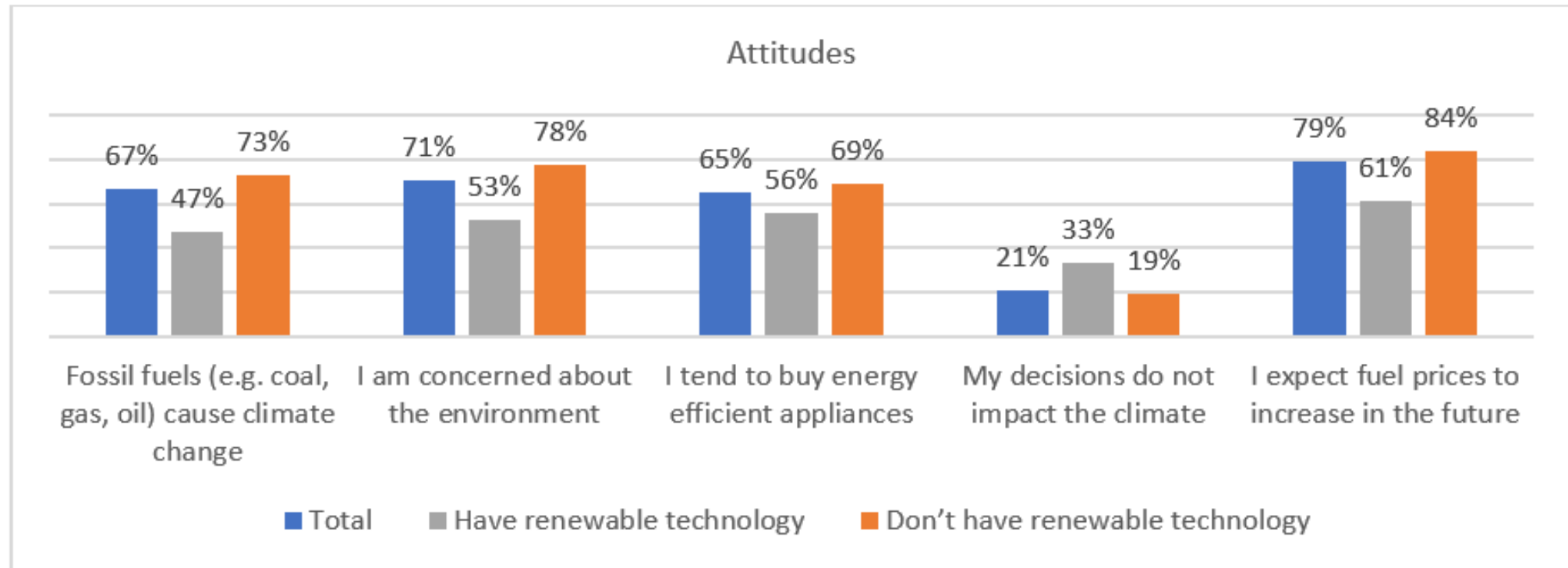
Attitudes and behaviours towards new technology



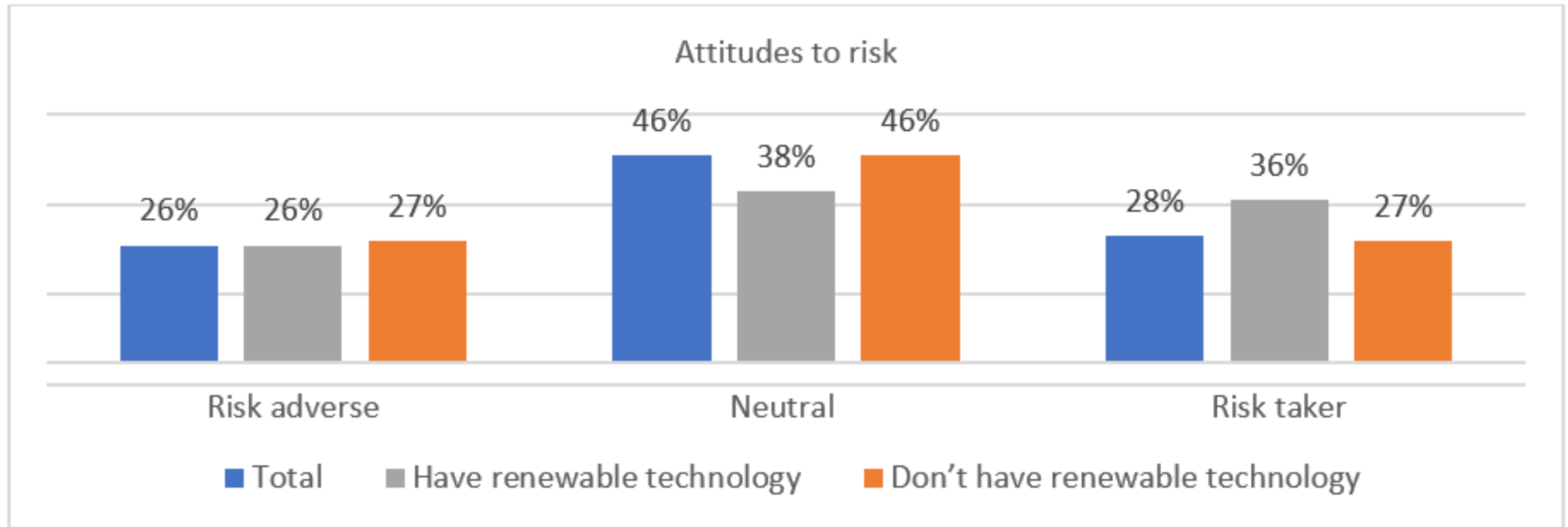
Most people care about the environment



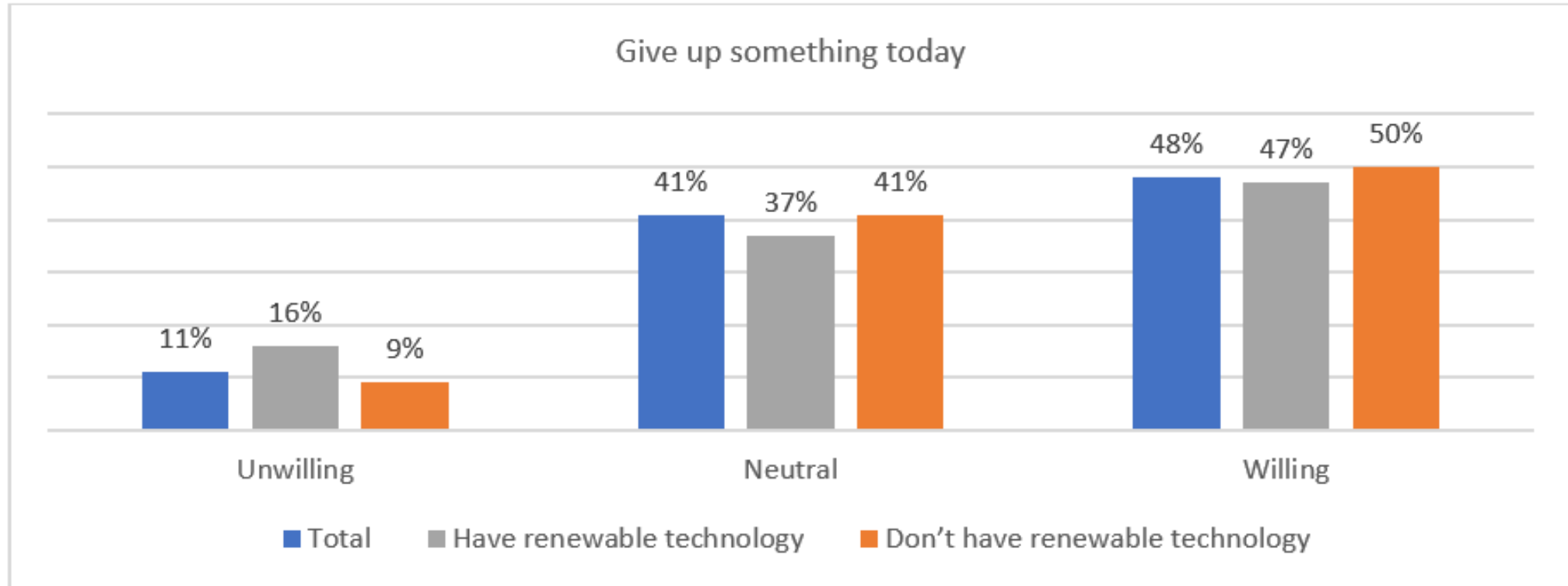
Non-adopters tend to care even more!



More adopters report being risk-takers



Most seem forward looking but adopters less so and present bias exists



Evidence from pairwise t-tests closely resembles our econometric results

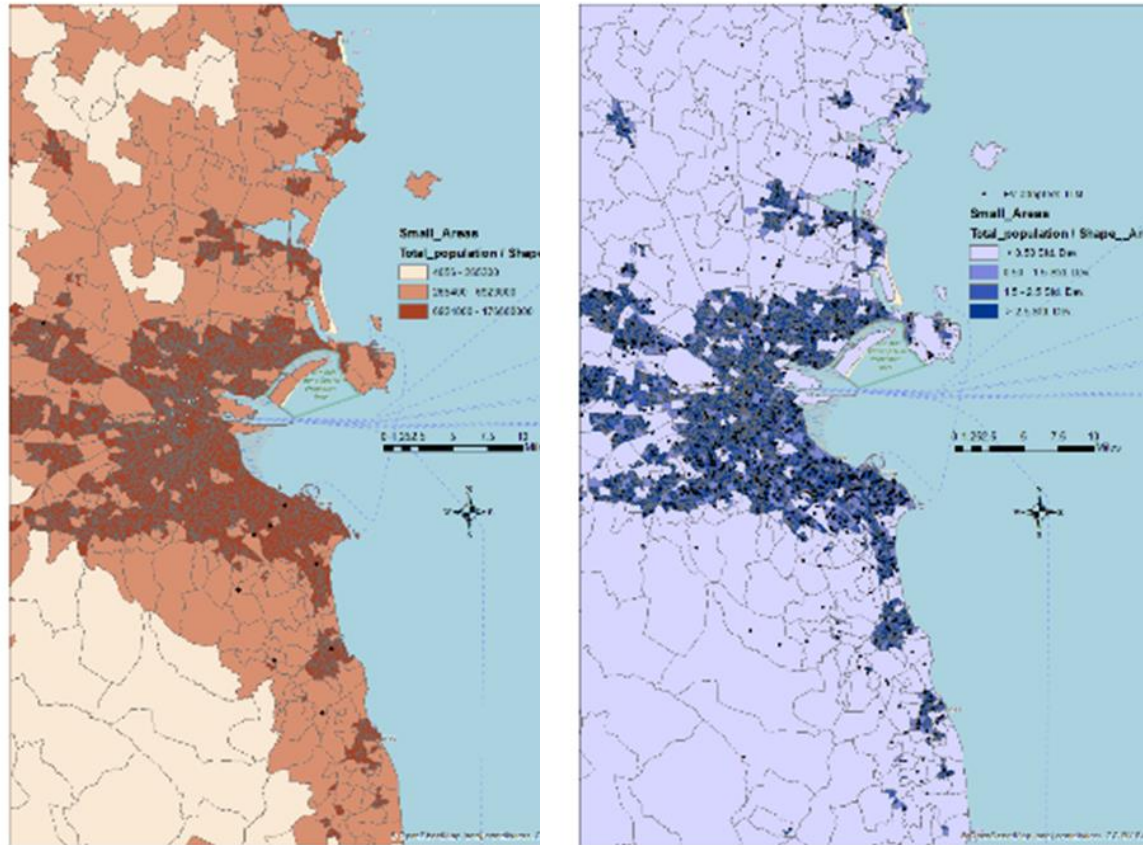
- Adopters (n=203) & non-adopters (n=1005).
- Adopters are
 1. Younger
 2. Male
 3. Employed full time
 4. Higher socio-economic status
 5. Live in newer residences, large size/families
 6. Have higher energy use
 7. Larger social networks
 8. More aware of RET, willing to take risks, present biased, take personal responsibility.
- Policy implications.
- Can create typology of households to predict near future geographic uptake.

Sample attribute	Comment
Age	Younger
Gender	Male
Socio-economic status	Higher
Income	Higher
Education	Ambiguous
Employment status	Full-time employed
Occupation	High managerial, professional
Marital status	Single
Children under 17	More
Children over 17	Fewer
Location	Dublin
Property type	Flat/apartment
Property size	More number of rooms
Building era	2006-18
Residence period	Lower, by 67 months
BER awareness, rating	Higher, therefore more across most bands
Perceived household energy usage	Higher
Perceived heating costs	Cheap
Perceived future heating costs	Will remain similar
Primary heating system	Electric, renewable (solar thermal, ashp, gshp)
Will change heating system	Yes
Bi-monthly heating bill	Higher, by €461
Bi-monthly electricity bill	Higher, by €502
Satisfaction with home heating system	Higher
Satisfaction with heating last winter	Higher
Awareness of RETs	Higher overall, but lower for EVs, PVs, solar thermal, small wind turbine
Social network	Larger, by 6 members
Willingness to try new technology	One of the first people to try (i.e. innovators)
Willingness to trade current gains for future benefit	Lower
Willingness to take risks	Higher
Environmental attitudes	Less likely to believe fossil fuels impact climate change or fuel prices will rise in the future, less concerned about environment, & buys fewer energy efficient appliances. However, more likely to believe own decisions impact climate change.
Happiness levels	Very happy vs. quite happy

A few policy implications...

- Monetary incentives are most important, especially in the short term.
- Attitudes towards sustainability not sufficient predictors of uptake → policies must help translate attitudes into pro-environment behaviour.
- Better understanding of specific technology will help diffuse uncertainty & inertia.
- Inclusive non-monetary benefits help ensure benefits pertain to the long term → e.g. public charging network for EVs.

High adoption areas appear to be close together in current policy scenario



EV adoption in Dublin moved from south to centre-north between 2011 & 2017.

Introduction of €5,000 purchase grant, lower road tax of €120, zero rate of Vehicle Registration Tax (VRT) relief of up to €5,000.

Source: Author's illustrations using ESB ecars data.

Questions?

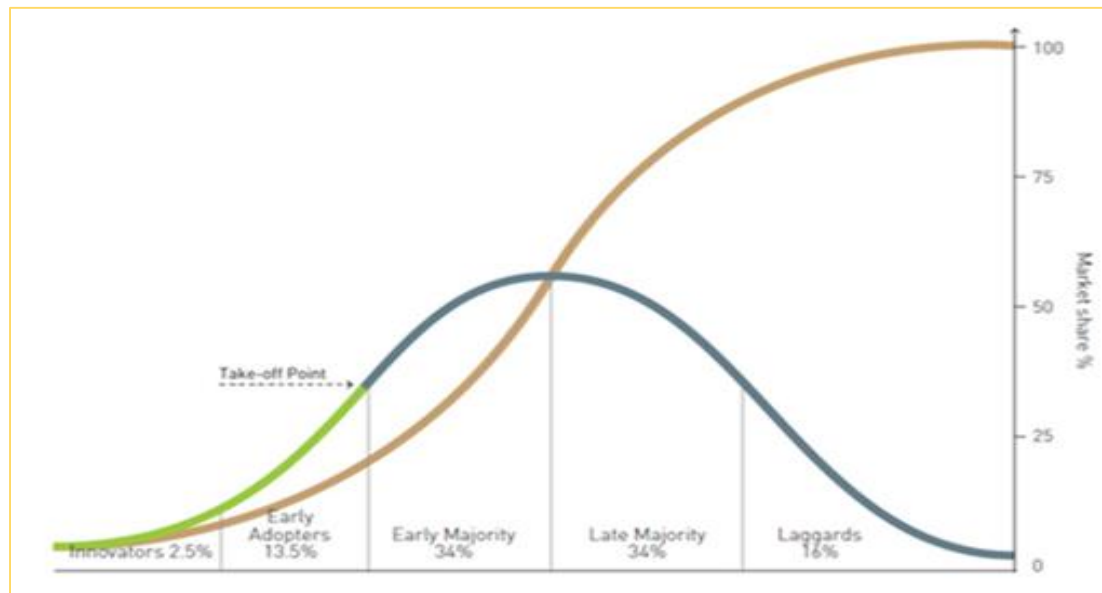
Thanks for your attention!



Additional material

Technology uptake follows S-shaped curve

Adoption is the individual uptake of an innovation whereas diffusion is the spread of an innovation within a group, community or country.

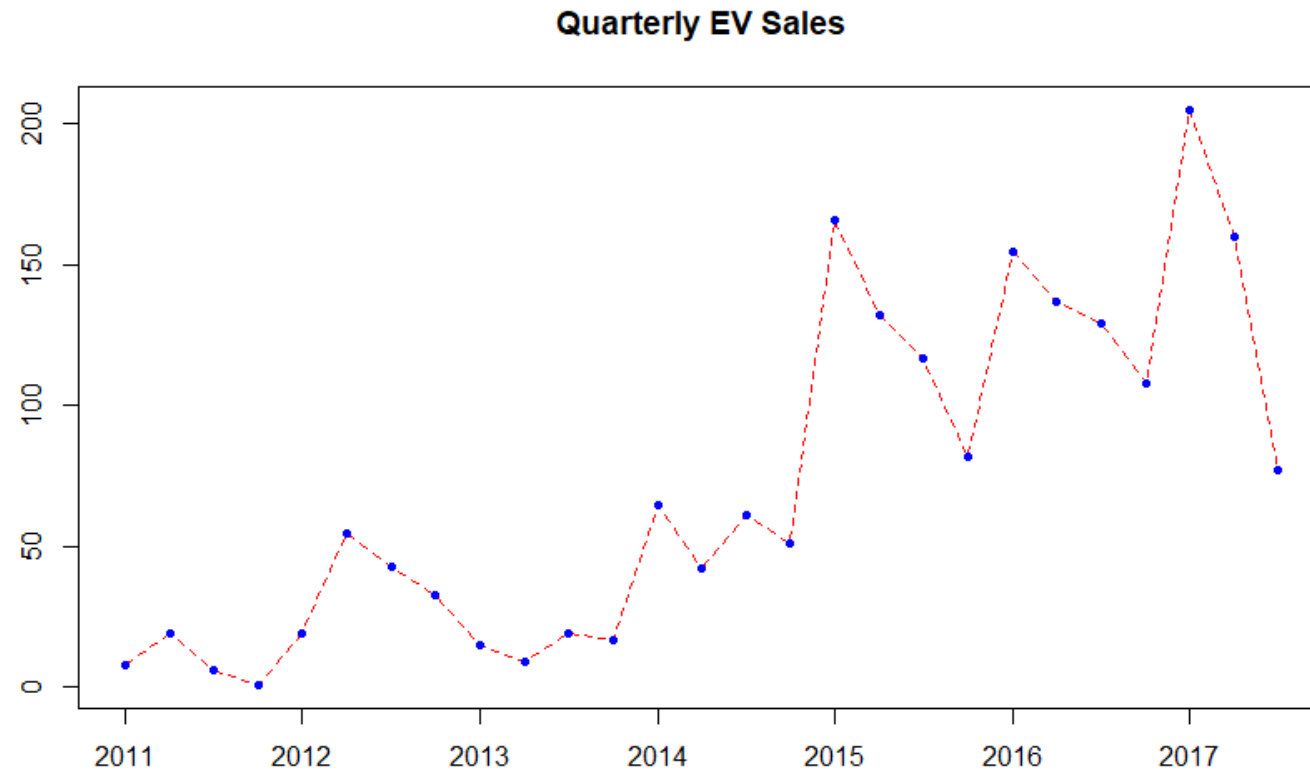


Source: Everett Rogers, Diffusion of Innovations, 1995

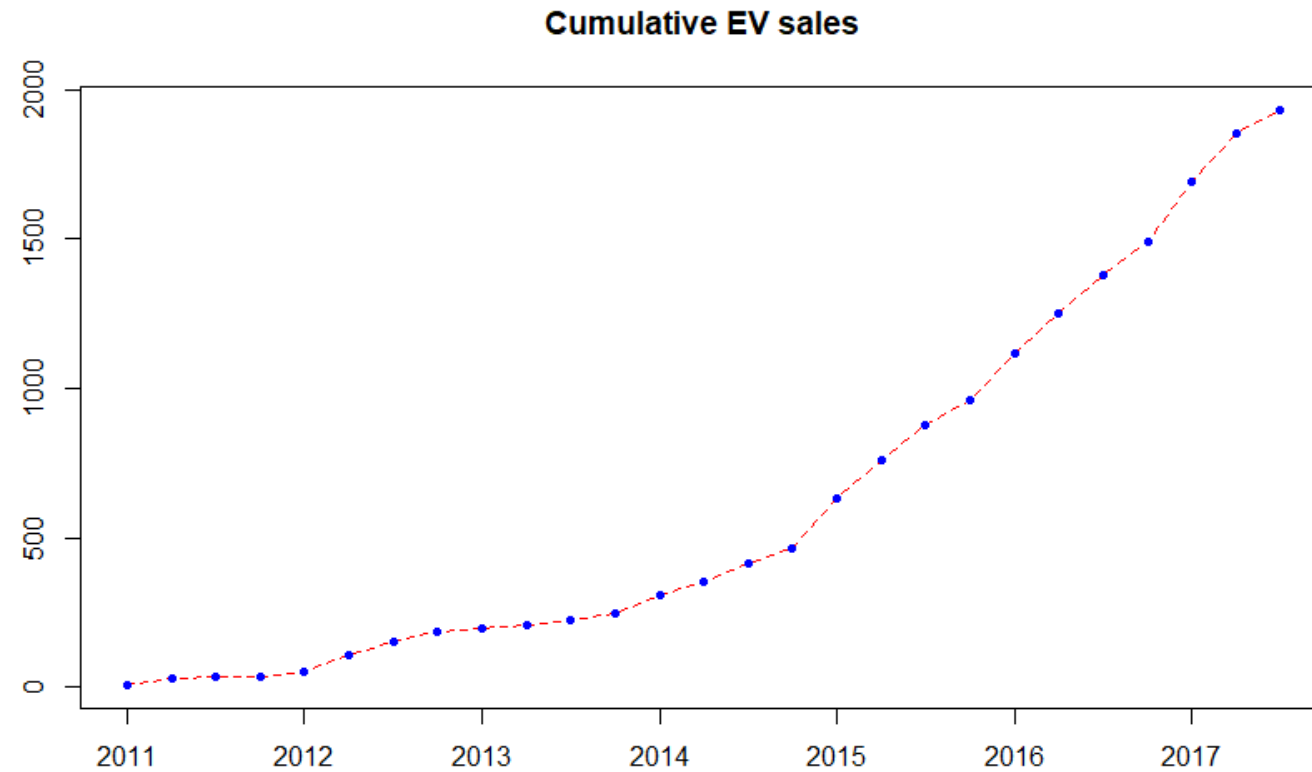
Rogers (1995) partitioned a bell-shaped curve into five distinct categories of adopters:

- (1) innovators (the first 2.5% to adopt),
- (2) early adopters (the next 13.5% of adopters),
- (3) early majority (34%),
- (4) late majority (34%),
- (5) laggards (the last 16% to adopt).

Quarterly EV sales in Ireland rising overall



Cumulative Irish sales shows upward trend



Several technology adoption models exist

Bass model of innovation diffusion

→ forecast future adoption of a new technology based on observed sales.

Key parameters:

- coefficient of innovation (p) – influence of mass media.
- coefficient of imitation (q) – influence of word-of-mouth.

A product is successful only when $q > p > 0$.

Bass model applied to Irish EV sales data

