# Social Acceptance of Transmission Lines in Europe


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# The Renewable Future

image from Wikipedia "Little Chyne Court Wind farm" page

# Requires New Infrastructure

Including wind farms, solar arrays, and most notably **power lines** to connect these disparate generation sources.

A study funded by European Commission found that 28,400 kilometers (km) of overhead lines are necessary to accommodate the changing electricity landscape, 80% of which are directly due to the increase in renewable generation sources [1].

New infrastructure is also needed to ensure the security of future energy supply [1].

# Future of the European Electricity Grid (From [1])

# Local Opposition

- Across Europe local opposition to infrastructure projects causes delays and occasionally cancellation.
- Opposition is caused by the negative aspects of infrastructure construction (e.g. diminished viewsheds, increased noise, pollution or traffic, safety concerns and loss of property value).
- This has been characterized as a "not in my backyard" (NIMBY) response since the majority of Europeans generally favor infrastructural improvements [2].
- A vast and emerging literature investigates the causes and characterization of such opposition.


SAY NO
TO GIANT POWER LINES
PUBLIC HEARING
MAY 10th 5:00 pm
Bellville United Methodist Church
www.savecatspring.com

From [4]


STOP
THE
POWER

from [5]

# Our Project

The social acceptance of grid expansion and transmission lines in Europe.

# GOALS

I) To support grid developers with implementable strategies to 'bring locals to the table' and decrease local opposition to the point where locals consider a valid compromise.

II) To provide strategies that will lead to minimum cost and minimum delay in grid expansion and fair compensation for adversely affected local stakeholders.

# A Massive Survey Effort

- A 32 page survey was translated into 23 languages and administered in all EU-27 nations
- Over 13,000 interview hours and over 400,000 contact attempts
- Responses include household specific: demographic, lifestyle, and energy consumption information
- About 280 responses per nation with 7,659 responses in the sample

We asked the following ACCEPTANCE question which began by presenting one of four possible scenarios to each respondent.

# The Scenarios:

**Baseline** - During the next year a high-voltage power line with standard pylons would be built in your neighborhood. This power line (including pylons) would be up to 60 meters high and be built at a distance of 250 meters from your home.

**Economic Treatment (T1)** - This infrastructure will benefit your country's economy including, enhanced economic growth, especially in your region, resulting in the creation of new jobs.

**Environment Treatment (T2)** - This infrastructure will benefit the environment and complements your country's measures to fight climate change.

**Community Treatment (T3)** - The government and electricity company would compensate you and your community by providing budget for measures to improve the quality of life in your neighborhood.

# Possible Responses

I would...

1. DNA - *"definitely not accept without opposition"*
2. PNA - *"probably not accept without opposition"*
3. PYA - *"probably accept without opposition"*
4. DYA - *"definitely accept without opposition"*

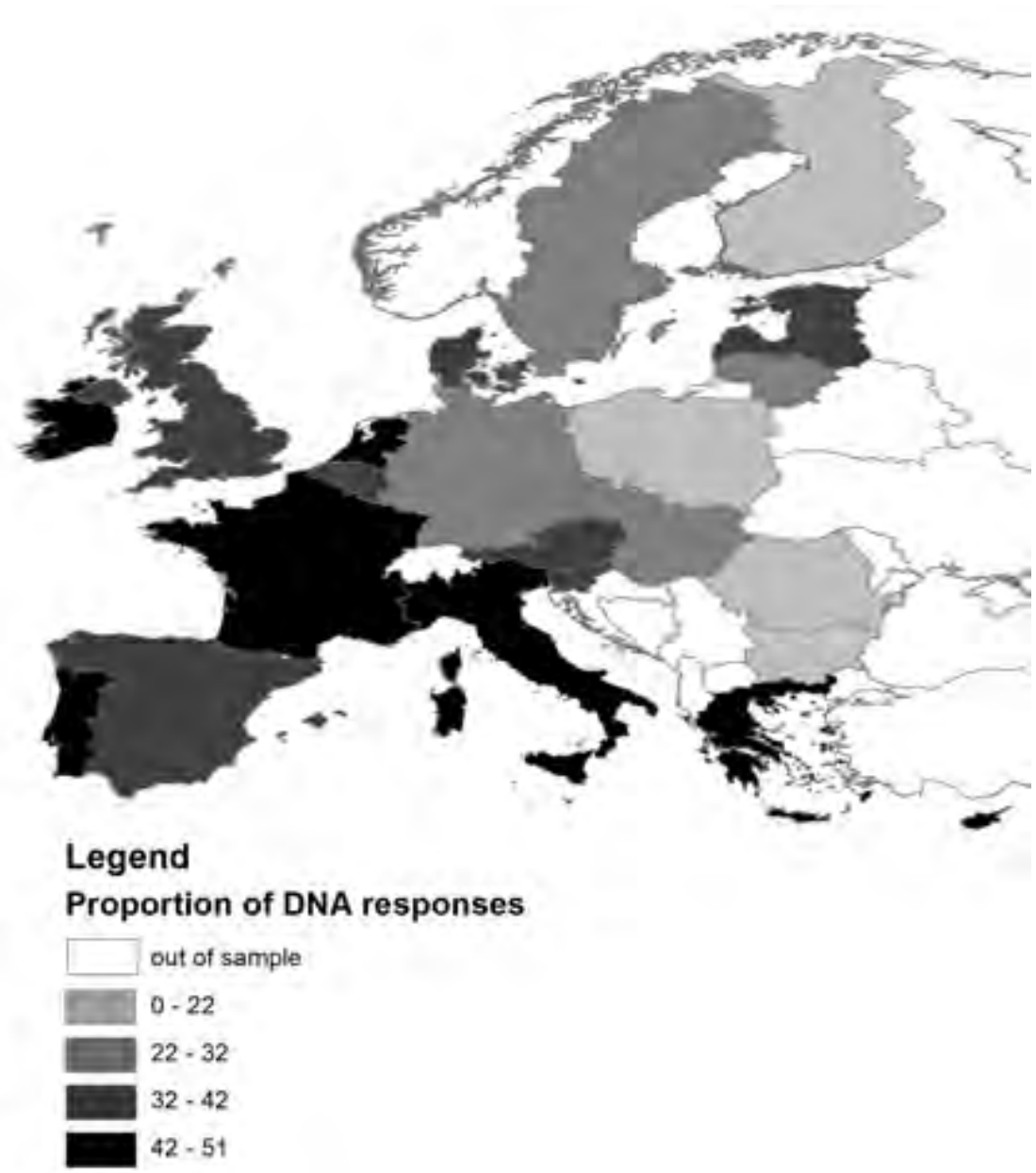
...the proposed infrastructure project

# We find:

**Table :** Survey responses to the acceptance question by country (%)

| | DNA | PNA | PYA | DYA | No. Obs. |
|---|---|---|---|---|---|
| **France** | 42.65 | 28.32 | 23.66 | 5.38 | 279 |
| **Germany** | 27.1 | 27.73 | 33.33 | 11.84 | 321 |
| **Italy** | 42.61 | 29.55 | 18.9 | 8.93 | 291 |
| **UK** | 38.41 | 26.16 | 27.15 | 8.28 | 302 |
| **Austria** | 39.51 | 25.87 | 28.32 | 6.29 | 286 |
| **Belgium** | 32.41 | 29.64 | 28.46 | 9.49 | 253 |
| **Denmark** | 38.72 | 24.81 | 27.07 | 9.4 | 266 |
| **Finland** | 15.44 | 27.02 | 47.02 | 10.53 | 285 |
| **Netherland** | 42.16 | 22.65 | 25.44 | 9.76 | 287 |
| **Spain** | 35.33 | 28.33 | 27.67 | 8.67 | 300 |
| **Sweden** | 26.71 | 30.14 | 32.88 | 10.27 | 292 |
| **Portugal** | 42.16 | 20.56 | 24.74 | 12.54 | 287 |
| **Ireland** | 44.48 | 22.07 | 24.48 | 8.97 | 290 |
| **Luxembourg** | 31.16 | 27.54 | 32.61 | 8.7 | 276 |
| **Bulgaria** | 20.43 | 23.66 | 32.97 | 22.94 | 279 |
| **Czech** | 28.47 | 24.07 | 32.88 | 14.58 | 295 |
| **Estonia** | 40.78 | 24.47 | 26.6 | 8.16 | 282 |
| **Hungary** | 23.59 | 25.91 | 39.2 | 11.3 | 301 |
| **Latvia** | 34.51 | 22.54 | 30.63 | 12.32 | 284 |
| **Lithuania** | 27.05 | 28.11 | 29.89 | 14.95 | 281 |
| **Poland** | 21.19 | 17.22 | 47.02 | 14.57 | 302 |
| **Romania** | 12.08 | 16.6 | 35.09 | 36.23 | 265 |
| **Slovakia** | 28.52 | 19.63 | 33.7 | 18.15 | 270 |
| **Greece** | 46.38 | 24.67 | 19.41 | 9.54 | 304 |
| **Cyprus** | 50.62 | 22.82 | 17.01 | 9.54 | 241 |
| **Slovenia** | 40.14 | 21.51 | 26.16 | 12.19 | 279 |
| **Malta** | 36.78 | 23.37 | 23.75 | 16.09 | 261 |
| **Average** | 33.68 | 24.63 | 29.48 | 12.21 | 284 |

N=7659


Legend
Proportion of DNA responses
out of sample
0 - 22
22 - 32
32 - 42
42 - 51

# Other information obtained from respondents

| Variable | Description | Mean | Std. Dev. |
|---|---|---|---|
| *T1* | 1 if respondent heard economic benefits script | 0.2026374 | 0.4019908 |
| *T2* | 1 if respondent heard environmental benefits script | 0.2006789 | 0.4005345 |
| *T3* | 1 if respondent heard community compensation script | 0.2043348 | 0.403241 |
| *income* | annual income in Euros | 17699.52 | 13770.3 |
| *male* | 1 if respondent is male | 0.4934064 | 0.4999892 |
| *age35t45* | 1 if repsondent is age 35-45 | 0.2372372 | 0.4254167 |
| *age46t60* | 1 if repsondent is age 46-60 | 0.3063063 | 0.4609886 |
| *over60* | 1 if repsondent is older than 60 | 0.250816 | 0.4335111 |
| *college* | 1 if respondent completed college | 0.4054054 | 0.4910024 |
| *posutil* | 1 if respondent has a positive view of their energy provider | 0.4653349 | 0.4988294 |
| *negutil* | 1 if respondent has a negative view of their energy provider | 0.0584933 | 0.2346892 |
| *satisfied* | 1 if repondent is satisfied with their level of supply security | 0.9040345 | 0.2945632 |
| *urban* | 1 if respondent considers their neighborhood urban | 0.3121817 | 0.4634138 |
| *yearsinarea* | number of years repondent has lived at current address | 18.52553 | 15.16288 |
| *needgrids* | 1 if respondent thinks grid expansion is necessary | 0.5571223 | 0.4967588 |

N=7,659

# Key fact:

Only 56% of our sample awsered ‘yes’ to the question, “new power grids (including pylons and grid lines) are necessary in order to ensure your country’s energy supply in the future.”

# Hypotheses

## Global Hypothesis

Auxiliary positive information regarding the proposed development project will have a positive impact on acceptance.

## Testable Hypothesis

The application of treatment scripts will increase the level of acceptance exhibited by survey participants.

# Ordered Probit Model

$$
\begin{aligned}
y_i^* &= \mathbf{X}_i\beta + \epsilon_i \quad \epsilon \sim N(0,1) \\
y_i &= 1(\text{DNA}) \quad \textit{iff} \quad y_i^* \leq v_1 \\
y_i &= 2(\text{PNA}) \quad \textit{iff} \quad v_1 < y_i^* \leq v_2 \\
y_i &= 3(\text{PYA}) \quad \textit{iff} \quad v_2 < y_i^* \leq v_3 \\
y_i &= 4(\text{DYA}) \quad \textit{iff} \quad y_i^* \geq v_3,
\end{aligned}
$$

Where:

- $y_i^*$ is the latent continuous variabe for individual $i$, say a change in utility
- $y_i = \{1, 2, 3, 4\}$ is the observed response to the acceptance question
- $\beta$ is a vector of slope coefficients
- $\mathbf{X}$ is a matrix of explanatory variables
- $v_1$, $v_2$ and $v_3$ are threshold values that are estimated along with $\beta$

We want to know how the probability of a DNA *"definitely not accept without opposition"* response changes with explanatory variables, and the application of our three treatment scripts.

# Marginal Effects

The difference in predicted probabilities for a specified change in $\mathbf{X}$ is denoted the **marginal effect**.

$$\frac{\Delta prob(y = m|\mathbf{X})}{\Delta \mathbf{X}_k} = prob(y = m|\mathbf{X}, \mathbf{X}_k = \mathbf{X}_e) - prob(y = m|\mathbf{X}, \mathbf{X}_k = \mathbf{X}_s)$$

Where:

- $m$ is the ordinal response category, $m = \{1, 2, 3, 4\}$
- $\mathbf{X}_k$ are the dimensions of X which change from,
- starting values $\mathbf{X}_s$
- to ending values $\mathbf{X}_e$

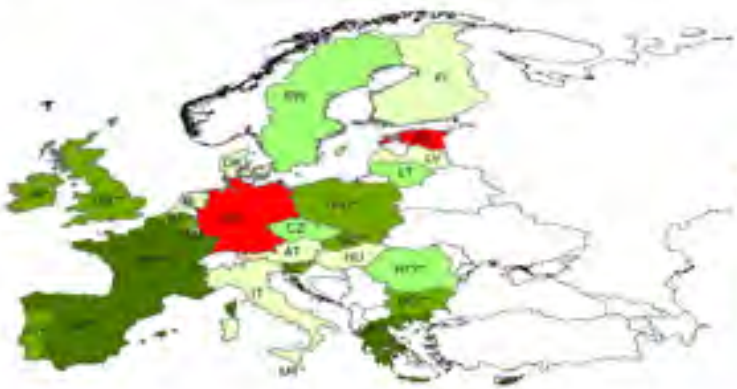
**Table :** Household-level variable marginal effects on probability of **not** giving a "definitely not accept" (DNA) response

| Variable | Marg. Eff. Estimate | Marg. Eff. Std. Dev | |
|---|---|---|---|
| *income* | -.00186 | .000491 | ** |
| *male* | 0.078 | 0.009 | ** |
| *age35t45* | -0.046 | 0.013 | ** |
| *age46t60* | -0.067 | 0.013 | ** |
| *over60* | -0.058 | 0.015 | ** |
| *college* | -0.020 | 0.009 | ** |
| *posutil* | 0.023 | 0.009 | ** |
| *negutil* | -0.066 | 0.019 | ** |
| *satisfied* | 0.025 | 0.016 | |
| *urban* | 0.018 | 0.010 | * |
| *yearsinhome* | -0.001 | 0.000 | * |
| *needgrids* | 0.089 | 0.009 | ** |

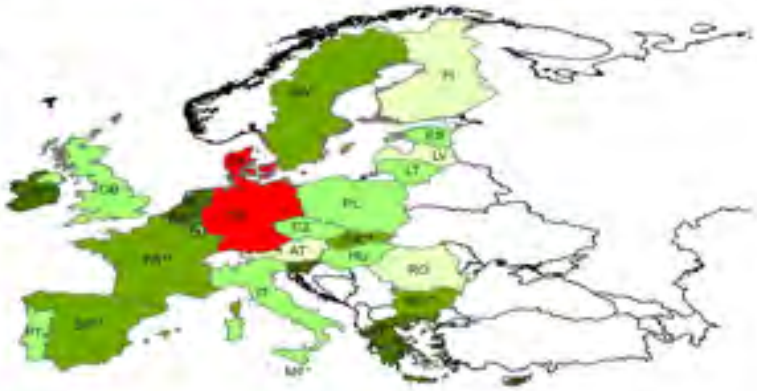
*estimate is significant at 10% level; **estimate is significant at 5% level

# Treatment Effects

Economic Benefits Treatment (1)



Environmental Benefits Treatment (2)



Community Benefits Treatment (3)

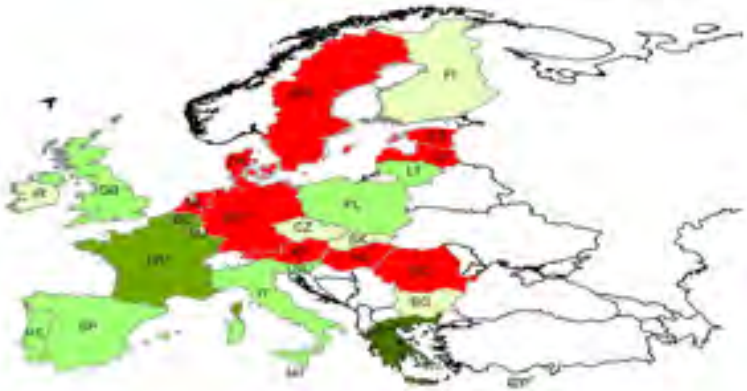


**Table :** Treatment effects on probability of **not** giving a "definitely not accept" (DNA) response

| | T1 | | T2 | | T3 | |
|---|---|---|---|---|---|---|
| **France** | 30.66% | ** | 15.38% | ** | 12.68% | * |
| **Germany** | 0.00% | | -0.60% | | -12.89% | ** |
| **Italy** | 3.55% | | 8.00% | | 7.75% | |
| **UK** | 13.57% | ** | 9.24% | | 9.08% | |
| **Austria** | 0.06% | | 4.08% | | -11.31% | |
| **Belgium** | 12.13% | * | 21.88% | ** | 10.71% | |
| **Denmark** | 0.11% | | -0.92% | | -6.67% | |
| **Finland** | 4.44% | | 2.31% | | 2.66% | |
| **Netherlands** | 1.27% | | 22.28% | ** | -1.29% | |
| **Spain** | 20.85% | ** | 14.85% | ** | 9.17% | |
| **Sweden** | 5.69% | | 10.58% | * | -0.96% | |
| **Portugal** | 12.52% | * | 8.16% | | 9.08% | |
| **Ireland** | 12.13% | * | 20.12% | ** | 0.74% | |
| **Luxembourg** | 9.90% | | 5.36% | | 0.26% | |
| **Bulgaria** | 14.37% | ** | 13.94% | ** | 4.73% | |
| **Czech** | 8.21% | | 5.83% | | 0.58% | |
| **Estonia** | -4.30% | | 9.90% | | -0.61% | |
| **Hungary** | 2.99% | | 5.37% | | -2.22% | |
| **Latvia** | 1.58% | | 2.98% | | -2.04% | |
| **Lithuania** | 7.56% | | 8.58% | | 7.41% | |
| **Poland** | 14.42% | ** | 7.57% | | 7.65% | |
| **Romania** | 6.71% | ** | 2.46% | | -0.80% | |
| **Slovakia** | 12.18% | ** | 11.64% | ** | 0.89% | |
| **Greece** | 28.25% | ** | 23.07% | ** | 26.96% | ** |
| **Cyprus** | 23.44% | ** | 25.67% | ** | 9.83% | |
| **Slovenia** | 18.81% | ** | 25.75% | ** | 6.10% | |
| **Malta** | 11.76% | * | 12.19% | * | 9.93% | |
| **Average** | 10.11% | ** | 10.95% | ** | 3.61% | ** |

*estimate is significant at 10% level; **estimate is significant at 5% level
All treatment effect results flow from reduced model.

Treatment scripts have a positive effect on acceptance

$\Rightarrow$

Ancillary positive information about a new grid development project can be used to improve local acceptance

# Other Conclusions

1. Strong heterogeneity between nations in how citizens will respond to a project and auxiliary information.
2. Environmental treatment had, on average, the strongest desirable effect, with community benefits having the least positive effect.
3. However, 'best' treatment can be chosen in a country/project specific context.

# THANK YOU!

# References

[1] ENTSO-E. Ten year network development plan 2012. Technical report, European Network of Transmission System Operators for Electricity, 2012.

[2] Energy technologies: knowledge-perceptions-measures, eur22396. *ec.europa.eu/research/energy/pdf/energy_tech_eurobarometer_en.pdf*, 2006. Accessed: 14.6.2013.

[3] Soini, Katriina et al (2011). Local residents' perceptions of energy landscape: the case of transmission lines. *Land Use Policy*, 28, pgs. 294-305.

[4] Crossley, David. Austin County up in arms about power lines. houstontomorrow.org. Acessed February 5th, 2014. http://www.houstontomorrow.org/livability/story/austin-county-up-in-arms-about-power-lines

[5] Protest against power lines in Washington County. WPXI. Acessed February 5th, 2014. http://www.wpxi.com/news/news/protest-against-power-lines-in-washington-county/nGbsB

# We ask:

**Q9a-i** How do you think YOU would react to the announcement of this power infrastructure program? Please tell me for each of the following alternatives whether you would "*Definitely*", "*Probably*", "*Probably Not*", or "*Definitely Not*" react in this way. Let's take the first one....

INTERVIEWER: READ REACTION (I) AND RECAP RESPONSES, BEFORE COLLECTING SINGLE RESPONSE.

PROGRAMMER: ROTATE ORDER OF POTENTIAL ANSWERS/PRESENTATION (keep first option fixed)

| Potential Reactions | Definitely accept without opposition | Probably accept without opposition | Probably not accept without opposition | Definitely not accept without opposition |
|---|---|---|---|---|
| PROGRAMMER: Q9a-i (SCREEN 2) | 1 □ | 2 □ | 3 □ | 4 □ |
| You would accept without opposition | IF Definitely ACCEPT, Skip Q9a-ii and proceed to Q9b | IF Probably ACCEPT, Skip Q9a-ii and proceed to Q9b | IF Probably NOT, PROCEED TO Q9a-ii | IF DEFINITELY NOT, PROCEED TO Q9a-ii |

# The Scenarios:

Baseline - "Long term reliability of the electricity system can only be ensured by a bundle of measures, such as - but not exclusively - the construction of new power lines and pylons. Please imagine that your local government announced a large program of local infrastructure investments, contributing to the enhancement of the power grid in the whole of your country. As part of this program, during the next year a high-voltage power line with standard pylons would be built in your neighborhood. This power line (including pylons) would be up to 60 meters high and be built at a distance of 250 meters from your home."

Economic Treatment (T1) - This infrastructure program has significant benefits for your country's economy including, enhanced economic growth, especially in your region, resulting in the creation of new jobs and in greater independence from foreign energy supplies.

Environment Treatment (T2) - This infrastructure program has significant benefits for the environment and complements your country's measures to fight climate change - the strengthening of the national electric infrastructure being necessary for increased use of renewable energy sources, such as wind power.

Community Treatment (T3) - The government and electricity company would compensate you and your community by providing budget for measures to improve the quality of life in your neighborhood. Possible improvements could include the construction of recreational areas and parks, or equipment for local schools. All people living in the community would have the chance to determine how this extra budget should be used by popular vote.

## Table : Country comparison of household-level variable means

| | *income (EUR)* | *male* | *age* | *college* | *posutil* | *negutil* | *satisfied* | *urban* | *yearsinhome* | *needgrids* |
|---|---|---|---|---|---|---|---|---|---|---|
| **France** | 26,378.14 | 0.43 | 46.26 | 0.44 | 0.52 | 0.05 | 0.95 | 0.31 | 13.39 | 0.28 |
| **Germany** | 25,098.13 | 0.55 | 47.22 | 0.40 | 0.60 | 0.05 | 0.98 | 0.25 | 16.79 | 0.67 |
| **Italy** | 20,871.99 | 0.49 | 47.49 | 0.30 | 0.49 | 0.07 | 0.93 | 0.34 | 19.88 | 0.46 |
| **UK** | 22,804.79 | 0.49 | 47.97 | 0.36 | 0.53 | 0.05 | 0.99 | 0.14 | 15.54 | 0.62 |
| **Austria** | 25,750.87 | 0.52 | 47.70 | 0.26 | 0.52 | 0.02 | 0.99 | 0.23 | 20.80 | 0.41 |
| **Belgium** | 25,470.36 | 0.51 | 47.94 | 0.48 | 0.47 | 0.09 | 0.94 | 0.37 | 15.30 | 0.32 |
| **Denmark** | 30,949.48 | 0.59 | 49.11 | 0.38 | 0.46 | 0.04 | 0.99 | 0.29 | 13.50 | 0.36 |
| **Finland** | 25,662.28 | 0.50 | 50.42 | 0.42 | 0.50 | 0.02 | 0.96 | 0.20 | 12.82 | 0.75 |
| **Netherlands** | 23,741.29 | 0.49 | 48.48 | 0.32 | 0.57 | 0.02 | 0.98 | 0.25 | 14.86 | 0.42 |
| **Spain** | 17,985.00 | 0.51 | 46.89 | 0.41 | 0.39 | 0.16 | 0.78 | 0.54 | 15.95 | 0.52 |
| **Sweden** | 23,445.57 | 0.54 | 47.27 | 0.40 | 0.48 | 0.02 | 0.97 | 0.25 | 11.53 | 0.60 |
| **Portugal** | 12,888.50 | 0.50 | 46.75 | 0.38 | 0.46 | 0.08 | 0.92 | 0.38 | 15.98 | 0.54 |
| **Ireland** | 28,462.07 | 0.53 | 47.93 | 0.35 | 0.56 | 0.04 | 0.98 | 0.14 | 16.03 | 0.58 |
| **Luxembourg** | 45,884.96 | 0.53 | 48.49 | 0.36 | 0.50 | 0.02 | 0.98 | 0.19 | 16.50 | 0.36 |
| **Bulgaria** | 4,144.83 | 0.45 | 47.02 | 0.62 | 0.30 | 0.16 | 0.75 | 0.63 | 24.39 | 0.65 |
| **Czech** | 9,104.07 | 0.47 | 48.67 | 0.32 | 0.45 | 0.04 | 0.96 | 0.29 | 21.97 | 0.53 |
| **Estonia** | 8,584.40 | 0.42 | 48.30 | 0.45 | 0.39 | 0.04 | 0.82 | 0.25 | 17.97 | 0.58 |
| **Hungary** | 5,090.22 | 0.49 | 48.95 | 0.29 | 0.51 | 0.07 | 0.94 | 0.20 | 23.36 | 0.62 |
| **Latvia** | 6,165.74 | 0.37 | 48.05 | 0.48 | 0.55 | 0.04 | 0.85 | 0.32 | 20.18 | 0.58 |
| **Lithuania** | 6,084.60 | 0.48 | 48.21 | 0.64 | 0.41 | 0.02 | 0.91 | 0.31 | 20.44 | 0.56 |
| **Poland** | 6,034.05 | 0.48 | 46.47 | 0.36 | 0.44 | 0.03 | 0.88 | 0.39 | 22.09 | 0.64 |
| **Romania** | 2,794.26 | 0.46 | 48.89 | 0.50 | 0.48 | 0.07 | 0.79 | 0.58 | 23.73 | 0.77 |
| **Slovakia** | 7,468.52 | 0.45 | 48.30 | 0.37 | 0.54 | 0.03 | 0.98 | 0.34 | 24.09 | 0.51 |
| **Greece** | 15,706.41 | 0.49 | 42.94 | 0.58 | 0.26 | 0.11 | 0.74 | 0.41 | 18.30 | 0.76 |
| **Cyprus** | 23,255.19 | 0.54 | 50.28 | 0.45 | 0.28 | 0.10 | 0.67 | 0.28 | 17.85 | 0.69 |
| **Slovenia** | 14,508.06 | 0.48 | 49.24 | 0.34 | 0.47 | 0.03 | 0.96 | 0.28 | 25.19 | 0.42 |
| **Malta** | 14,919.54 | 0.56 | 50.91 | 0.31 | 0.36 | 0.11 | 0.77 | 0.29 | 22.21 | 0.80 |
| **Average** | 17,750.12 | 0.49 | 48.00 | 0.41 | 0.46 | 0.06 | 0.90 | 0.31 | 18.54 | 0.56 |