



# Empirically grounded agent-based policy evaluation of the adoption of sustainable lighting under the European Ecodesign Directive

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## Overview

- › Background
- › The model
- › Results and conclusions

## Lighting Market 2012

Environment > Energy efficiency

### Light goes out for incandescent bulbs

Phased ban on the sale of incandescent lightbulbs is completed following EU directive to reduce energy use of lighting



Incandescent lightbulbs have been phased out in Europe from September 2009 and September 2012. Photograph: Ina Fassbender/Reuters

<http://www.theguardian.com/environment/2012/aug/31/lightbulbs-incandescent-europe>



**How many dead polar bears  
 does it take  
 to change a light bulb?**



**If you haven't replaced all your  
 incandescent bulbs with Compact  
 Fluorescents, you're contributing to  
 Global Warming and driving Polar  
 Bears toward extinction. Ban the Bulb!**





## EU Regulation

- › Goal: Getting consumers to choose “green”
- › Reality: Incandescent bulbs remain popular
- › Research questions:
  - Why do incandescent bulbs remain popular?
  - How can we promote energy-efficient lamps?



# Agent-based models

- > “Economic man” turned out to be not quite true
- > We want to account for culture, social behaviour, the effort of acquiring knowledge



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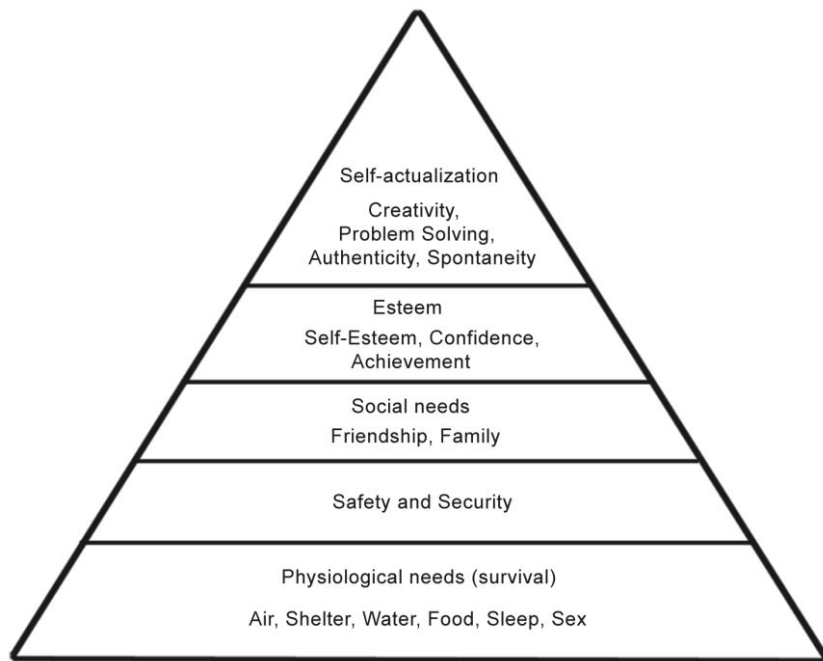
# Consumat agent model

- › Consumat: artificial consumer
- › Based on driving forces of human behaviour
- › Inherently social





# Psychological-based model



> Needs & values

> Opportunities & abilities

> Uncertainty



## Social & functional axes

	Automated	Reasoned
Individually determined	<b>Repetition</b> (1) <ul style="list-style-type: none"><li>- Classical conditioning theory</li><li>- Operant conditioning theory</li></ul>	<b>Deliberation</b> (2) <ul style="list-style-type: none"><li>- Decision and choice theory</li><li>- Theory of reasoned/planned behaviour (attitude and perceived control)</li></ul>
Social determined	<b>Imitation</b> (3) <ul style="list-style-type: none"><li>- Social learning theory</li><li>- Theory of normative conduct</li></ul>	<b>Social comparison</b> (4) <ul style="list-style-type: none"><li>- Social comparison theory</li><li>- Relative deprivation theory</li><li>- Theory of reasoned/planned behaviour (social norm)</li></ul>

## What do people look for in a bulb?

- › Initial price
- › Ramp-up time
- › Colour discrepancy
- › Energy usage



- › Agents based on archetypes from this survey

## What will the market do?

- › 2012 “ban on bulbs” had some limits
  - . *Industrial* bulbs still allowed
- › Currently incandescent bulbs easily available



Merkloos

**Kogellamp Gloeilamp - 40 Watt Helder E27 400 lumen - (10 stuks)**

Kogellamp met grote fitting.

Gloeilamp | E27 | Wattage: 40

★★★★☆ (13)

De kogellamp/gloeilamp van 40 Watt met een E27 aansluiting (grote fitting) is een ouderwetse kogellamp/gloeilamp... [Meer](#)

EOL geen nieuw label beschikbaar

**15<sup>95</sup>**

[Op voorraad](#)

Voor 20:00 uur besteld, morgen in huis



Verkoop door [Gloeilicht.nl](#)

Wat je kan verwachten



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Merkloos

**Gloeilamp 60W E27 Helder 710 lumen - 10 stuks**

Bollen Lampen Verlichting Grote Fitting

Gloeilamp | E27 | Wattage: 60

★★★★☆ (10)

De gloeilamp van 60 Watt met een E27 aansluiting (grote fitting) is een ouderwetse gloeilamp met helder... [Meer](#)

**15<sup>95</sup>**

Of bespaar 19% als je er 24 koopt

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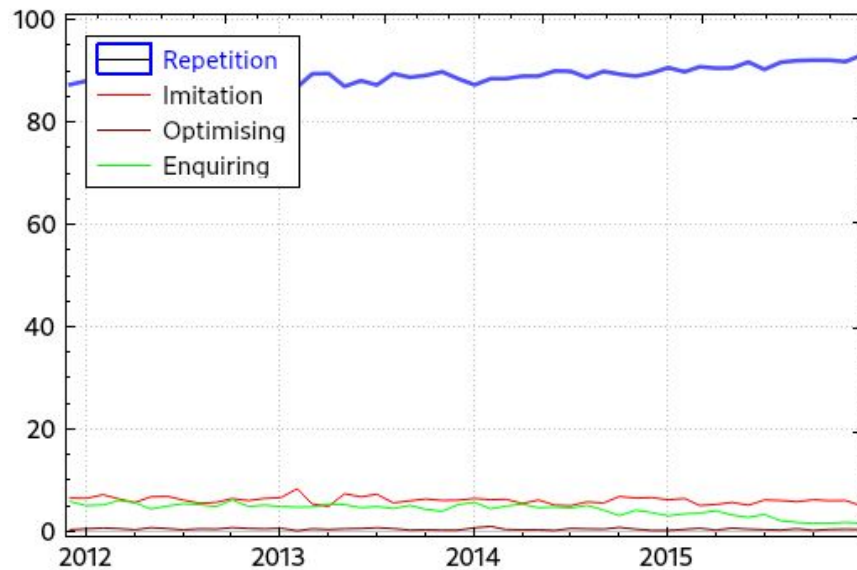
## Results from scenarios

- › No regulation: no LED adoption
- › Regulation of incandescent bulbs
  - . If prices increase: slow adoption
  - . If unavailable: switch to LED over CFL
- › Social campaigns: medium adoption



## Explainability

- > If prices increase: slow adoption





## Model behaviour

- › “Repetition” rate very high
- › Social influence helps to reach Consumats
- › Agents are quickly satisfied and require outside influence to change behaviour





## Final conclusions

- › Habitual behaviour due to low involvement explains slow “green” adoption
- › Interrupting habitual behaviour is key