

Universidad Politécnica de Cartagena
Department of Electrical Engineering



Doctoral Course on “Industrial Technologies”.

Subprogram “Neurotech, Control, Robotics and Energy
Management”

**Analysis of Distributed Energy Resources:
an Introduction to Demand Response**

Cartagena, 2011

- **Example: lesson 4**

- Potential for energy efficiency in the residential sector
- Policy: replacement of GLS by CFL lamps

- **Review:**

- Lesson 4: Energy Efficiency
- Lighting technologies (efficient lighting)
- <http://www.demandresponse.eu>

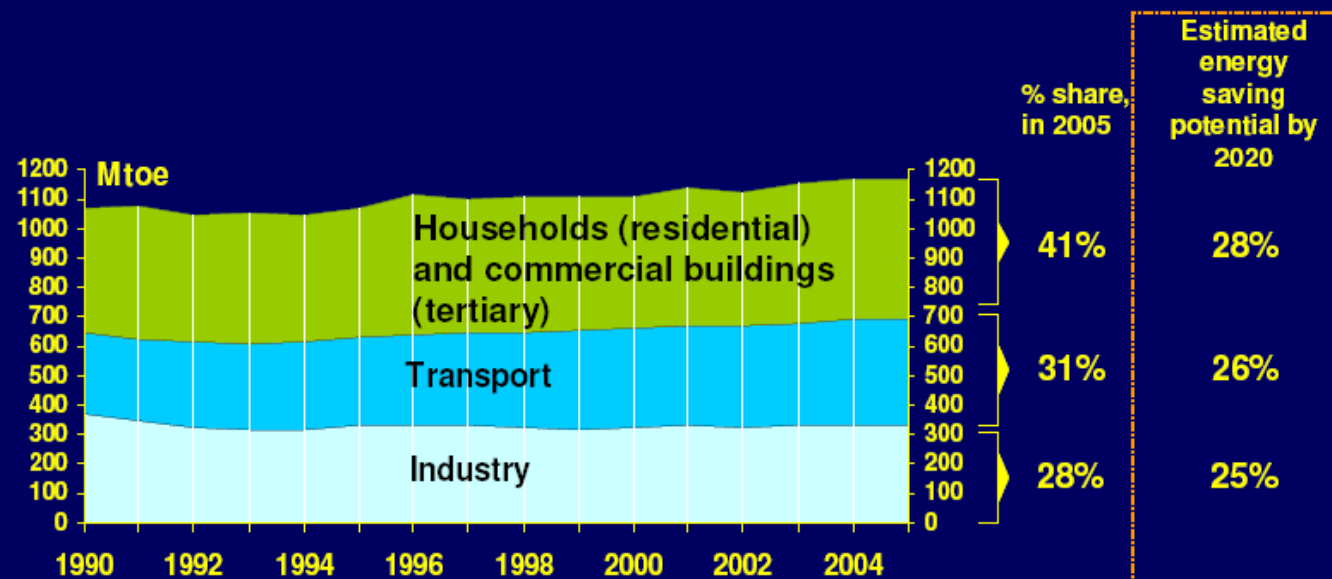
- **Objective: To present basic procedures and methodologies to evaluate the potential of an energy efficiency policy.**



● Savings potential in the EU (see lesson 4)

- Notice: The EU stands at a 28% the savings potential in 2020 (residential segment).
- Another forecast (source: European Commission): 11.5 billion kWh / year savings in the EU-25 (lighting)
 - Figure source: JRC (Inst. Energy), EU. 2006/2009 reports

Important energy saving potentials to be realised by 2020 through energy efficiency measures



Information Sources (I)

- Enerdata: Consumption data and indices of energy efficiency. Limited access.
 - www.enerdata.net
- ODYSSEE database (EU). Energy Efficiency Indicators in Europe (very simplified data, reports). Free access.
 - <http://www.odyssee-indicators.org/>
- Eurostat (statistical database of the EU): Energy and demographic data
 - <http://epp.eurostat.ec.europa.eu>
- Utility reports: INDEL Project (REE, Spain 1997)
 - http://www.ree.es/sistema_electrico/pdf/indel/Atlas_INDEL_REE.pdf
 - Old database (1997) but It contains interesting information on consumption patterns in different segments.
- US Department of Energy
 - <http://www.energy.gov/energyefficiency/index.htm>

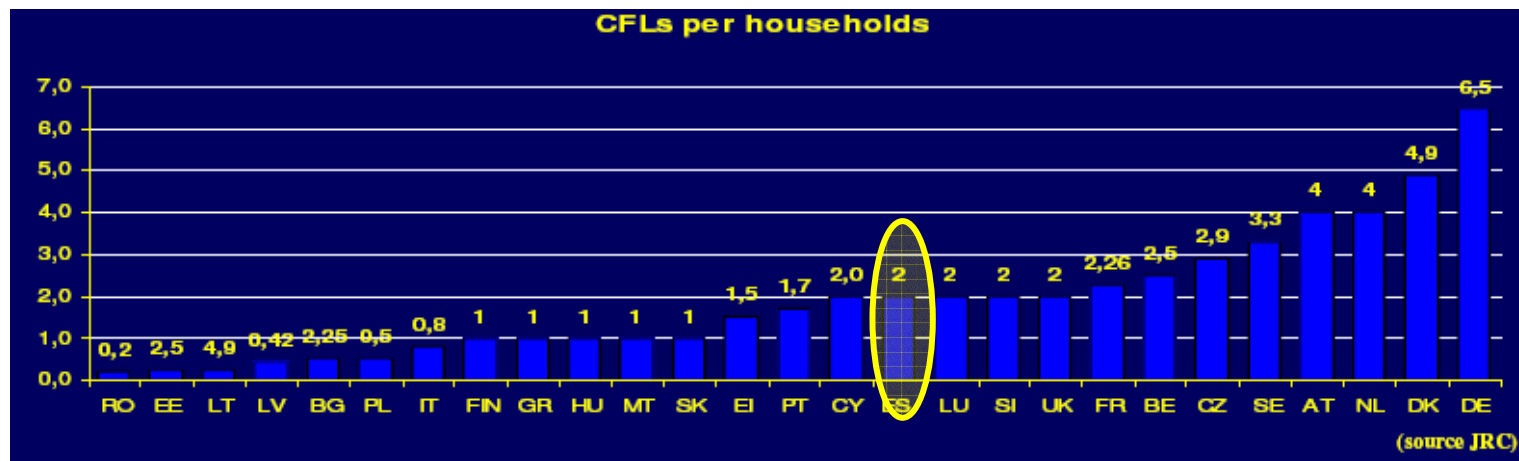


● Information Sources (II)

- Manufacturers: Information about power consumption, technologies, prices,...
- Research Labs (only two examples): technologies, standards, pilot projects, ... ► Evaluate existing programs
 - Lawrence Berkeley Nat. Lab (LBNL, USA): DR Center
 - <http://drrc.lbl.gov/>
 - Joint Research Centre (EU): Institute for Energy
 - <http://ie.jrc.ec.europa.eu/>
 - Other web sites: Please, visit www.demandresponse.eu
- Energy Star: efficiency standards for electronic equipment and other appliances, losses in standby, etc
 - <http://www.energystar.gov/>



- Application: Spain ... and EU
- How many lamps are there in each household?
 - In Spain, there are two compact fluorescent lamps (CFL) / housing (source: IE-JRC, UE)



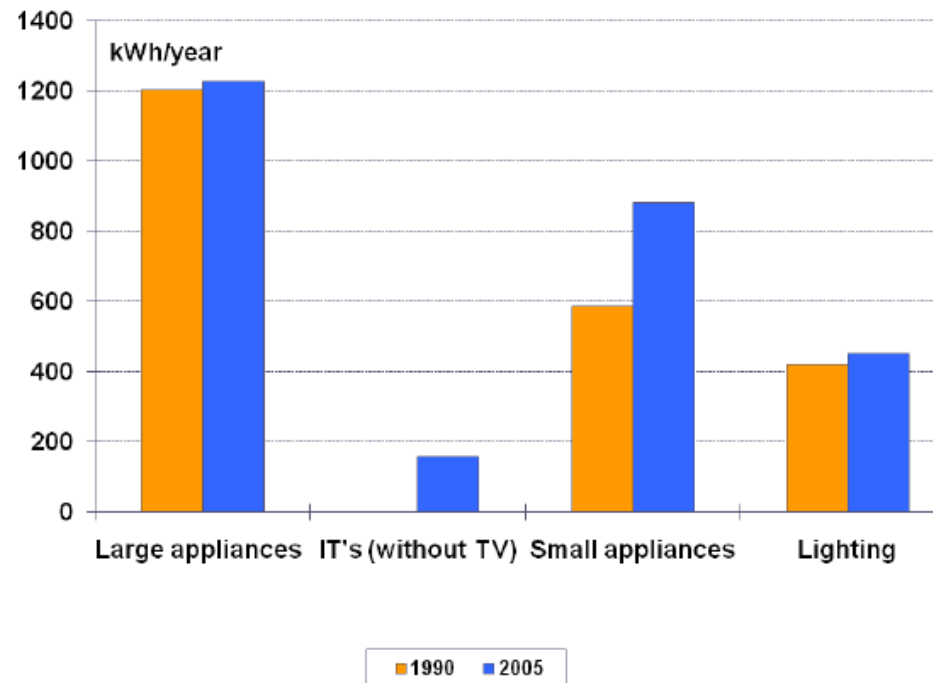
- According to data available in project INDEL (REE, Spain)
 - Each household in Spain has an average of 20.6 lamps
 - The illumination is about 23% of residential electricity consumption
 - Total lighting demand (1996): 6180 GWh/year
 - Demand growth rates, between 0.6 and 2.5% per year (necessary to evaluate the actual demand)
- I.e. about 18 lamps/house are not efficient lamps (GLS)



Block 4

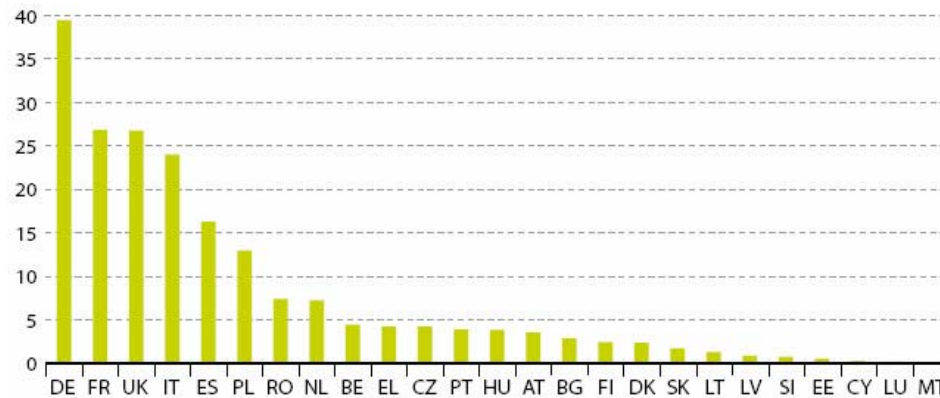
- Alternative source to establish the base case: demand per household in EU-15 and trends for 1990-2005 (source: Enerdata)

- Approx. lighting consumption: 450 kWh / year and home
- 17 Million households in Spain (2008) (source: Eurostat)
- It serves as an alternative to the INDEL data (Spain)
- Essentially the data are the same: 6200GWh/17M households = 363kWh (base case for demand in 1997)



● **More information (II): Population and housing**

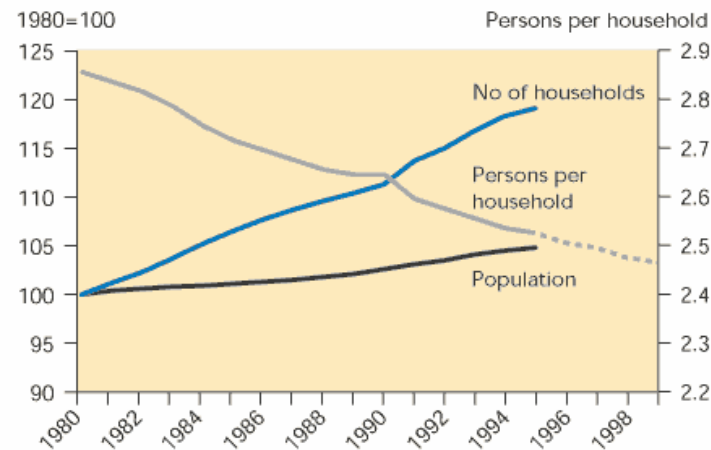
- Number of homes for EU countries (in millions). Source: Eurostat
- Possible use? To extrapolate the potential for the EU-15, EU-27,...



NB: DK: data from 2006.

● **Number of users / home.**

● Copyright holder: European Environment Agency



Block 4

- **Optimistic assumption: Maximum Technical Potential (MTP)**

- Demand trends: 2% annual demand growth
- Replace all CFL lamps for Energy Class A lamp (20% of the demand of conventional incandescent GLS)

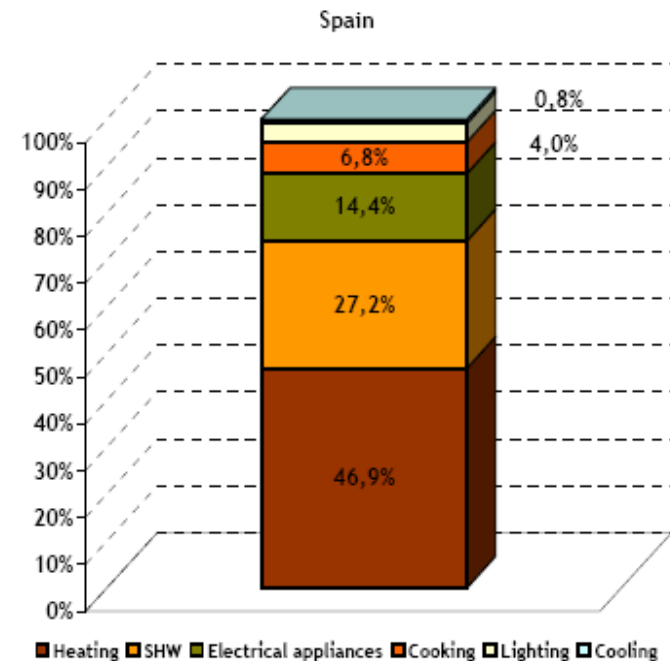
- **Save up approximately 80%, i.e. +5000 GWh / year**

- Spain 8.7% households in the EU

- **Reference: total consumption per household Spanish: 1 toe / year (~ 11.6 MWh / year)**

- Lighting 4% ~ 0.46 MWh / year
- Number of households: 17million
- (↓ 0.3 MWh / year and home)

Figure source: IDAE reports, Spain



- **Instantaneous MTP is not a realistic prospect because**
 - It is not possible to replace 100% of the lamps.
 - Customer acceptance (capital costs, design of lamps,...)
 - Is the replacement cost-effective ? Not for all the lamps
 - Eg. Lamps with low use periods (corridors, galleries)

- **A more realistic assumption is necessary:**
 - Change 1 or 2 lamps in the next four years (the European average is 3-4 per household CFL, i.e. we need 2 lamps to reach EU avg)
 - 2008-2012 Action Plan (Spanish Government): This plan implies the change of 34 million lamps in the residential sector.

- **Total cash savings per household:**
 - The user would replace the most commonly used lamps
 - 2 lamps: (20% consumption) * (80% savings) = 0.16
 - $0.16 * 6000 \text{ GWh} = 960 \text{ GWh / year from 2012}$
 - Household savings: 56kWh/year
 - I.e. we save: $56\text{kWh/year} * 0.16 \text{ c€/ kWh} = 9 \text{ € per year}$ (the measure is cost-effective in 2-3 years)



● CFL savings forecast in the EU source (1) JRC, EU, 2009

- Do they match our assumptions (2)?
 - (2) With 34 million bulbs in Spain ► 960GWh
 - (1) With 155.85 million lamps in EU-15 ► 9600GWh
 - (1) With 441 million lamps in EU-15 ► 13300 GWh
- We are within the ranges and EU scenarios (Scenario 2)!!!!

	scenario 1		scenario 2	
	no. of additional CFL's [millions]	savings [TWh]	no. of additional CFL's [millions]	savings [TWh]
EU-15	155,85	9,6	441	13,30
NMS12	35	3,2	100	5,35
EU-27	190,85	12,8	541	18,85

(source JRC)

From our study, in the residential sector a total replacement of incandescent lamps with CFLs can save in whole EU-27 some 44TWh!

