1. Energy saving calculations in Spain

Household lighting

The goal of this program is to save energy through the reduction in the installed and consumed power in the lighting systems of the domestic sector. This is one of the main measures included in the E4 Strategy and aims to impact in a 21% of the existing buildings, although the plan does not elaborate on how to measure the savings or the impact of the program.

Technology:

The measure for energy saving involves the **substitution of old existent lamps for more efficient, new lamp** types in the domestic sector. The **lighting levels** are assumed to be **unchanged**, as is the **location** of lamps within the house **and the hours** of usage.

The main types of lamps that can be used are:

- CFL: Compact Fluorescent.
- Metal halide lamps.
- LED (Light Emitting Diode

Formula for calculation of Annual Net Energy Savings

The **annual savings for a single house are**:

$$Savings(kWh) = N * (Po - P)$$

N is the **annual number of hours** of lighting usage, **around 700 in Spain**, possibly higher in countries like Germany, France, etc.
Po is the installed power before the measure, it can be determined as:

$$Po = \sum ni * Pi$$

With ni the number of lamps of one specific kind and Pi the power (in kilowatt) per lamp of that specific type.
P is the installed power (in kilowatt) after the retrofit, is determined as Po, using the new lamp characteristics.

The baseline is the energy consumed before the application of the measure and **is considered to be static**; there are no factors of influence. This is acceptable in a system as domestic lighting.

There are **no significant interactions** to be considered. There is no need for normalization as there are no influence variables.

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Input data and calculations

The **number of hours of usage is estimated** upon a normal usage of two hours per day of the lighting system. Its accurate measurement would involve the usage of energy meters or other form of recording.

The **installed power** can be determined in one of two ways:

- Using the datasheet of lamps
- Measuring the power before and after with a wattmeter

Assuming a house with 5 lamps of 40 Watts, substituted by LED with 4 Watt consumption, annual savings are:

$$Savings(kWh) = 700 * 5 * (0,4 - 0,04) = 126\ kWh/year$$

Efficient lamps often have a much longer lifetime than incandescence lamps. The useful life of a LED lamp, for example is around 50.000 hours, thus, the lifetime of the measures would be beyond 70 years.

$$Savings(kWh) = 126\frac{kWh}{year} * 71,4\ year = 9.000\ kWh$$

Example: Typical house, 90 sqm. Substitution of incandescent lamps with CFL. Power consumption reduced by 50%.
Peak power of the whole house reduced by 6%, energy consumption reduced by 5% in a typical day.
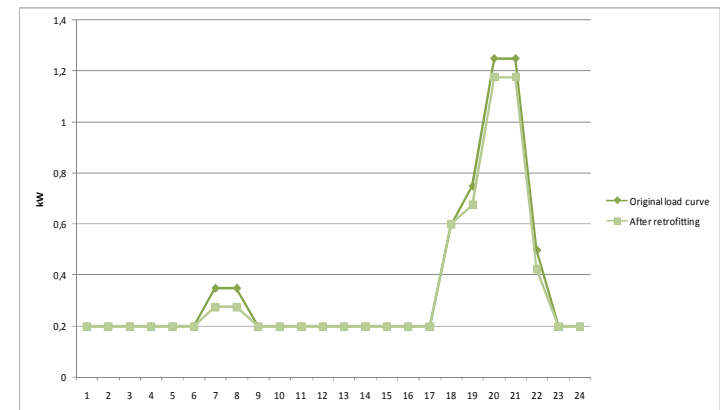
GHG Savings

The GHG savings are determined using the medium emission factor for the national electrical system. **For Spain the value is 0,360** (using as reference data from REE, and evaluated in accordance to the European Commission Directive 2007/589/CE) kg of CO2 per kWh of electrical consumption.

Thus, the annual savings of CO2 are:

$$GHG\ savings\ (kg\ CO2) = 0,360 * N * (Po - P)$$

There are no other GHG affected significantly by this measure other than CO2.

There is no standard methodology in Spain to measure savings in efficient lighting programs. The method presented can comply with IPMVP given that actual measurements of power are used and that reporting and sampling guidelines are followed