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Demi-journée de l'Environnement interne à l'ISE

Stock modelling for appliances – At the example of lighting.

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Outline

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    2. Average lifetime and standard deviation
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Introduction

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- ✓ Energy strategy 2050.
- ✓ Energy efficiency measures, highest potential to reduce energy consumption and CO2.
- ✓ Lighting, highest potential to reduce electricity consumption in residential sector.
- ✓ Emergence of LEDs, increasing performance, decreasing cost, change of market.
- ✓ Necessity to study the dynamic of stock.

Framework

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- ✓ **SCCER-CREST**
  - ✓ [Work Package 3: Energy Policy, Markets and Regulation]
    - ✓ **Task 3.2 Sectoral Effects of Energy Policy and Energy Market Regulation**
    - ✓ Analysis of Energy Savings and emission through EE measures.
    - ✓ Techno-economic bottom-up models tailored for Swiss energy market.

Lighting in households- Current state

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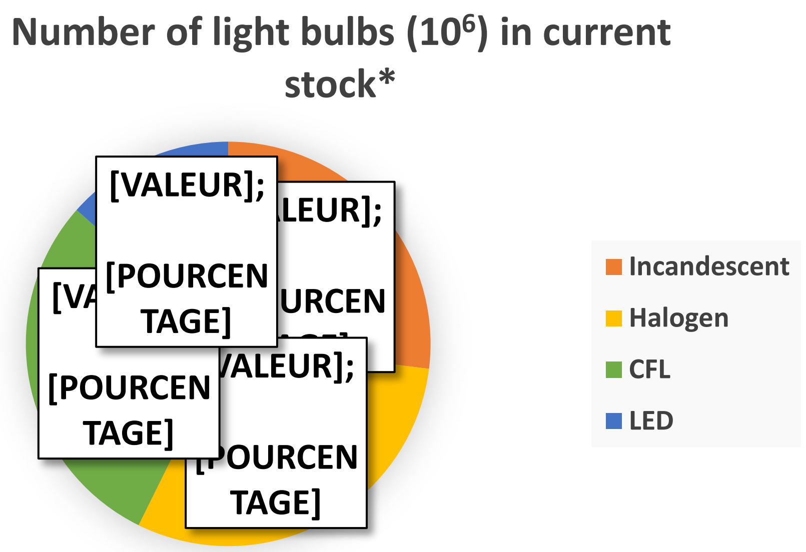
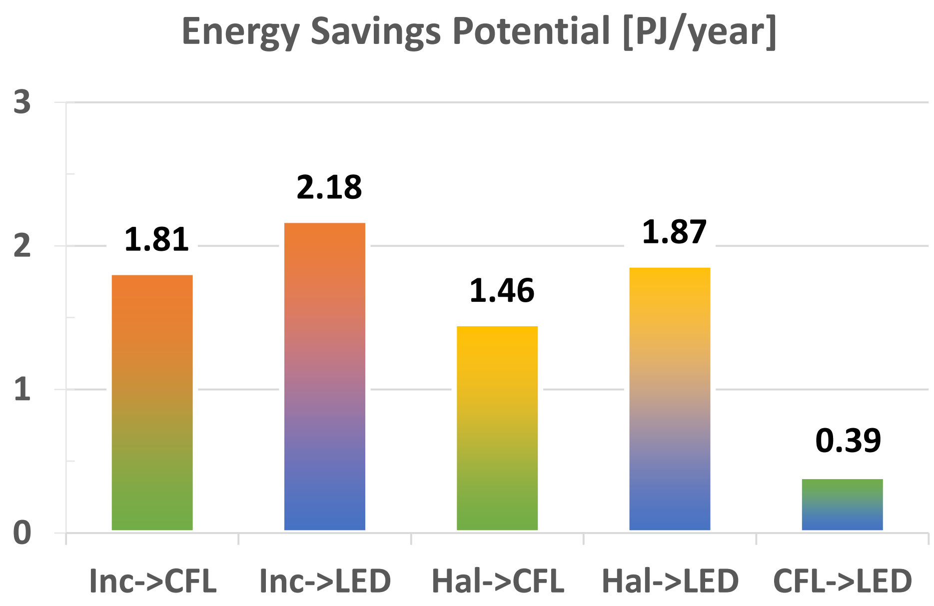


Annual potential energy savings for Lighting in Household in Switzerland is based on:

- Current **stock** per type of lighting technology
- **Energy savings potential** if all devices are replaced by highly energy efficient ones.



Lighting in households- Potential savings

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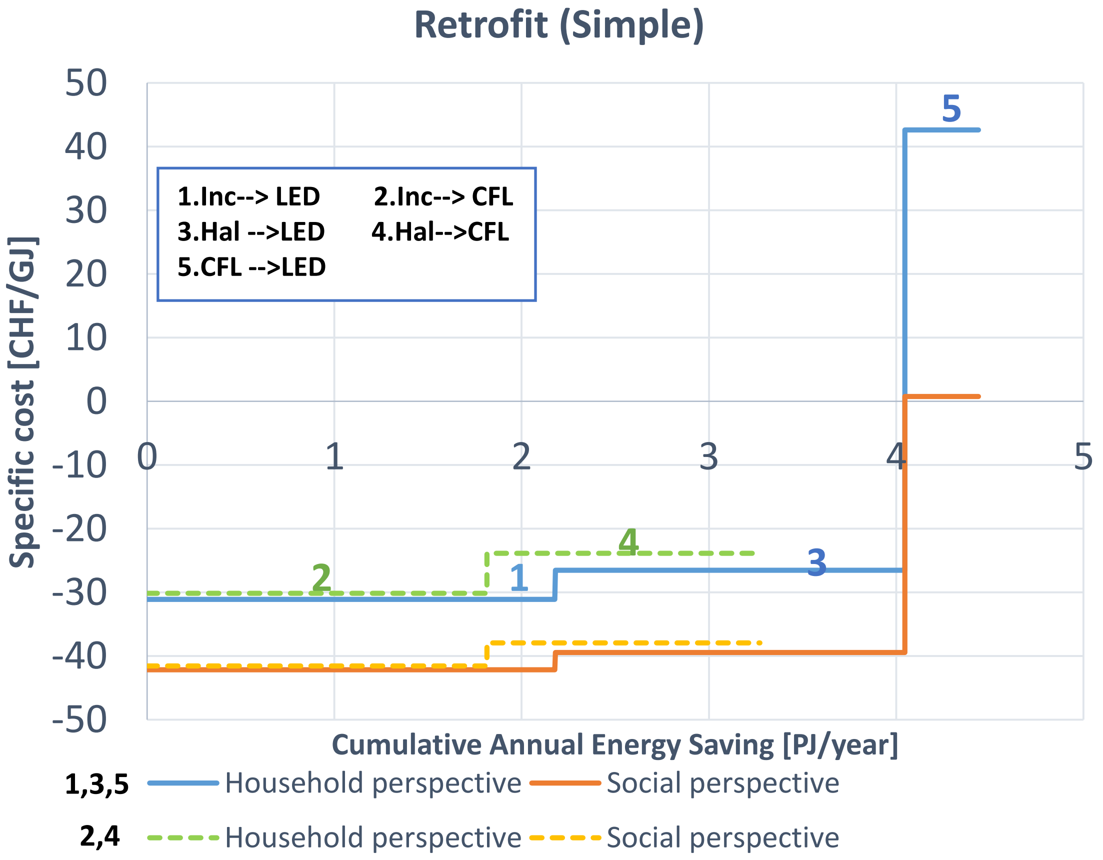
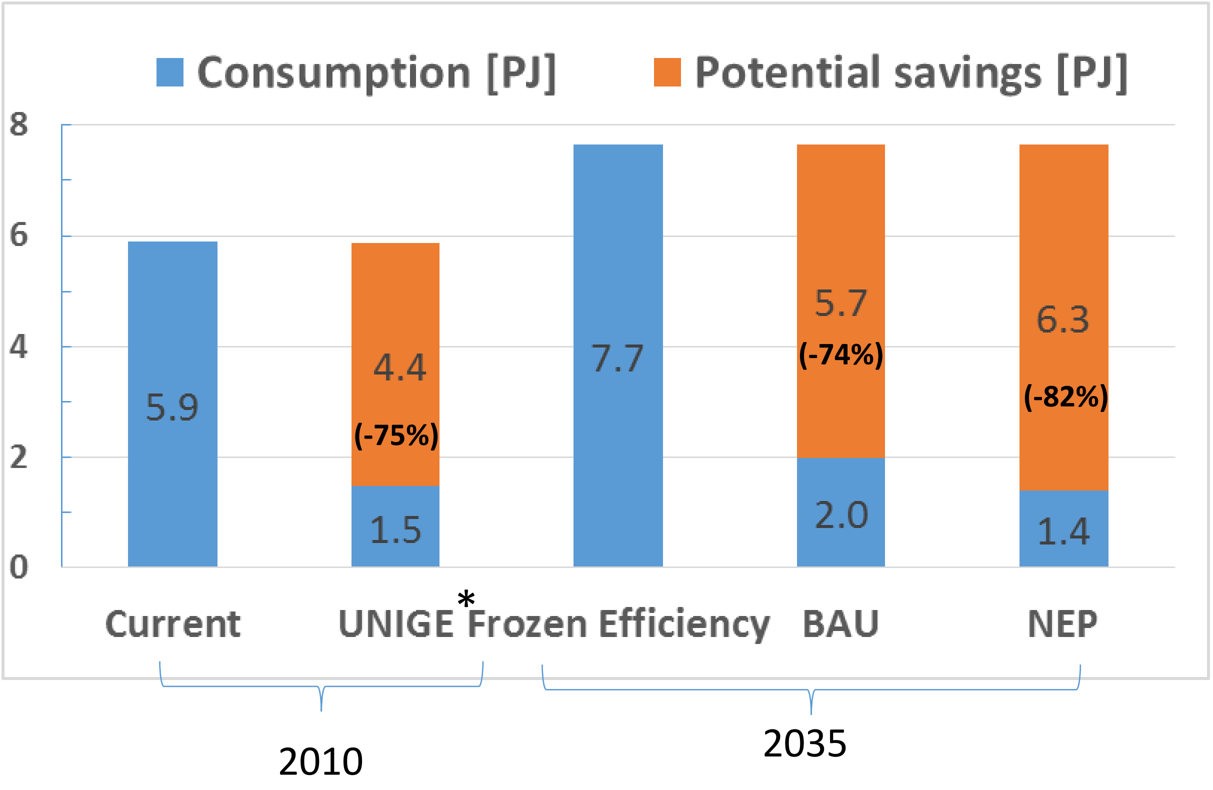
Comparing our Bottom-up model to Prognos :
4.4 PJ of potential saving vs 6.3 PJ difference between New Energy Policy scenario with a Frozen Efficiency.





*Potential saving Estimated by UNIGE

Methodology of stock model

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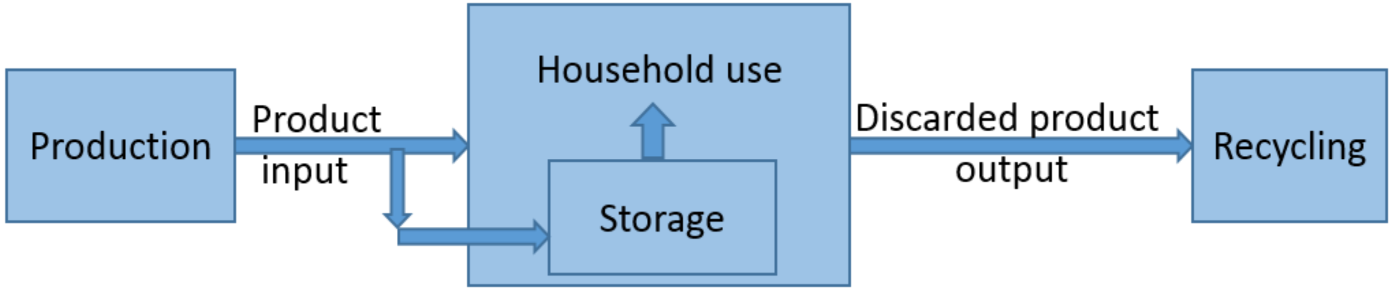
Stock model follows the methodology of material flow analysis (MFA).

$$F_{in}(t) = \mathrm{S(t)} - S_0 + F_{out}(t)$$

$$F_{out}(t) = \sum_{k=1}^{L} F_{in}(t-k) * d(k)$$



$F_{in}(t)$ and $F_{in}(t-k)$ are the product inflows (per unit) entering society in year t and year $t-k$;
$F_{out}(t)$ is the outflow of obsolete product in year t;
$\mathrm{S(t)}$ is the in-use stocks of product (per unit) in year t;
S_0 is the initial stock of product;
L is the maximum lifetime (years) of the product;
$d(k)$ is the lifetime distribution density value;

Price and efficiency modeling of light bulbs per technology

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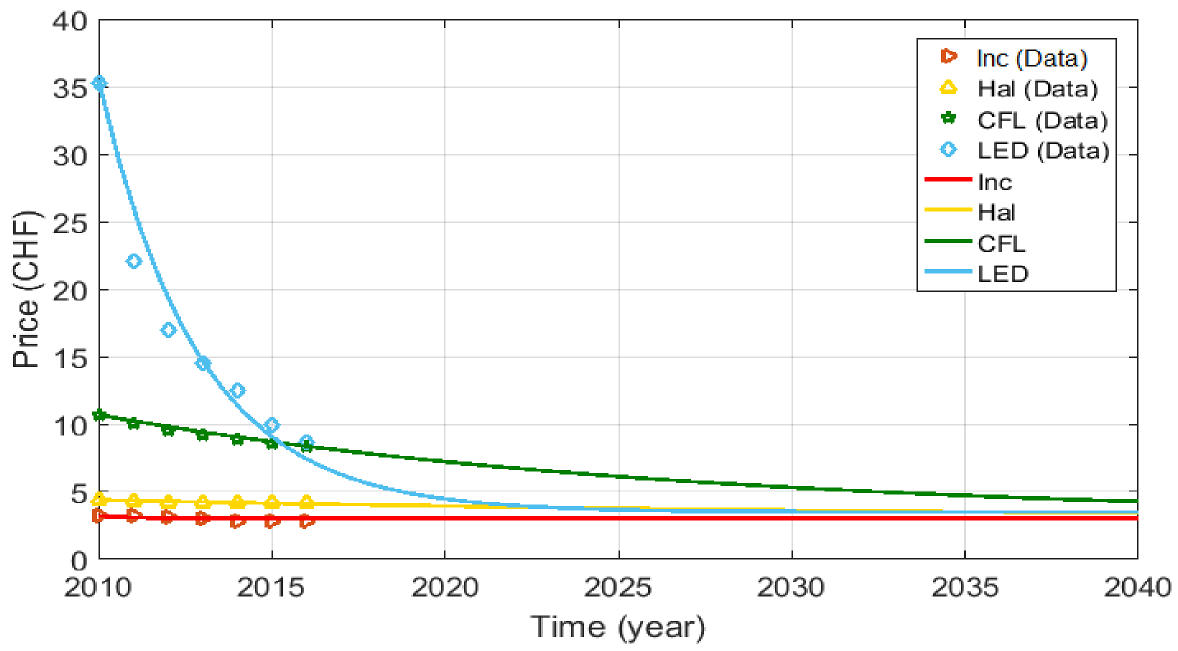
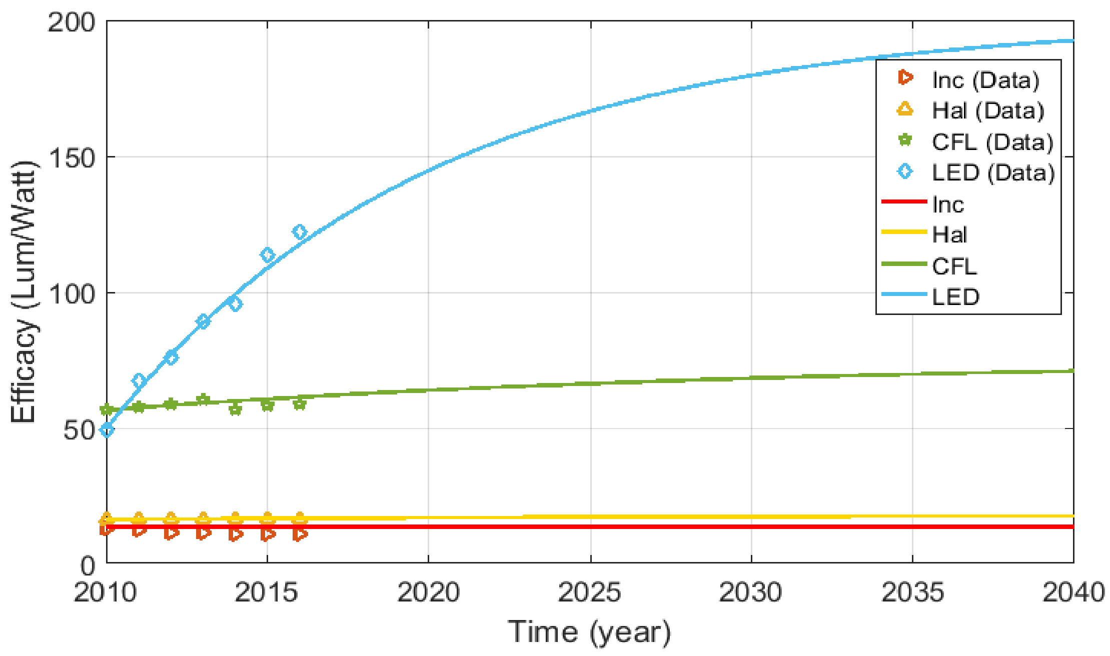
exponential function used for projection of future parameters

$$P(t) = (P_0 - P_f).e^{-rt} + P_f$$

Price history and projection for future



Efficacy history and projection for future.



Distribution of lifetimes

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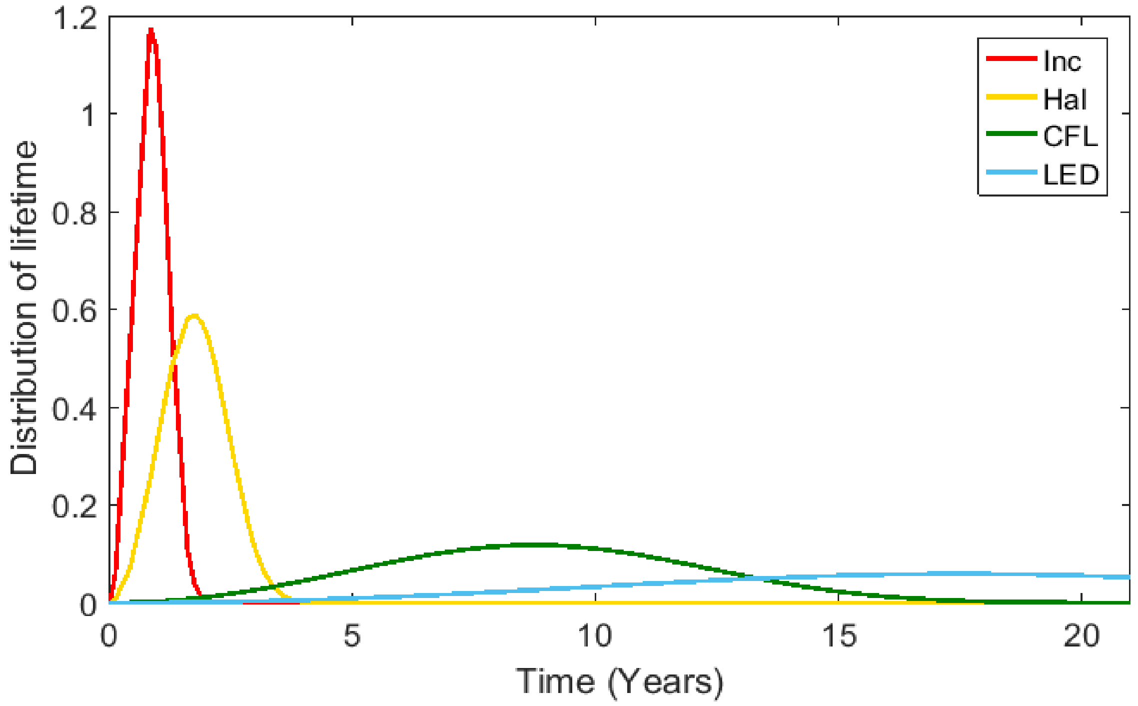
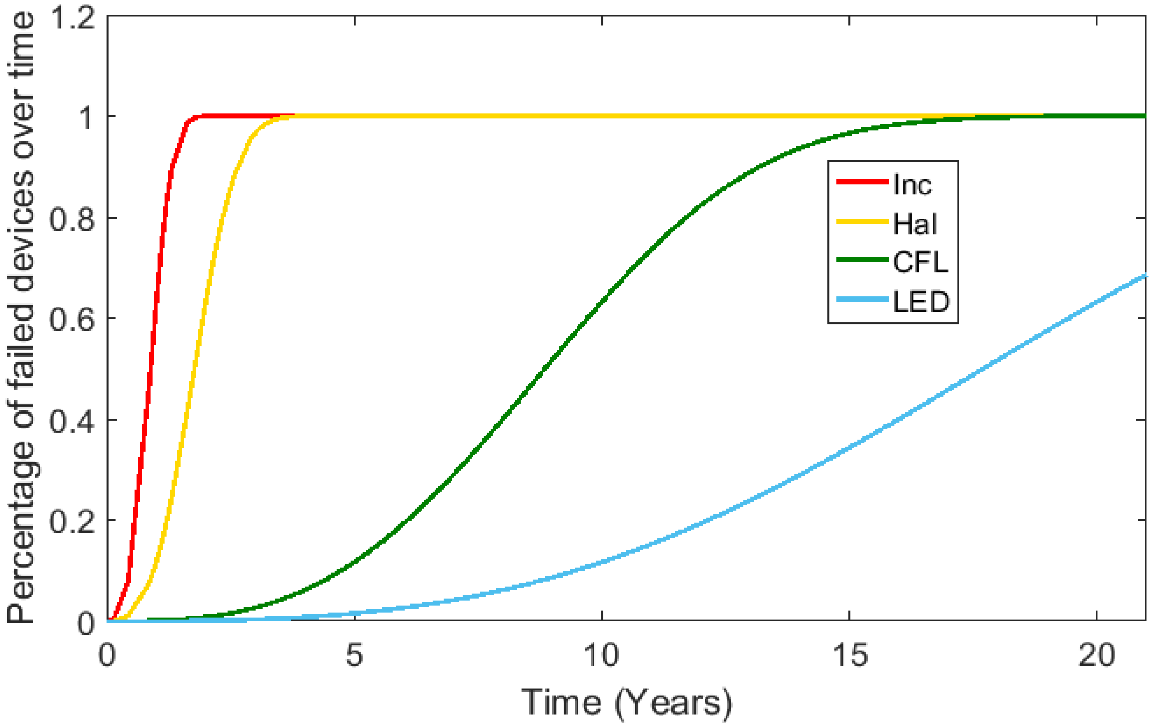
Lifetime modeling (Weibull distribution):

Probability density function(p.d.f.)



Cumulative Distribution Function (CDF)



Results of stock model

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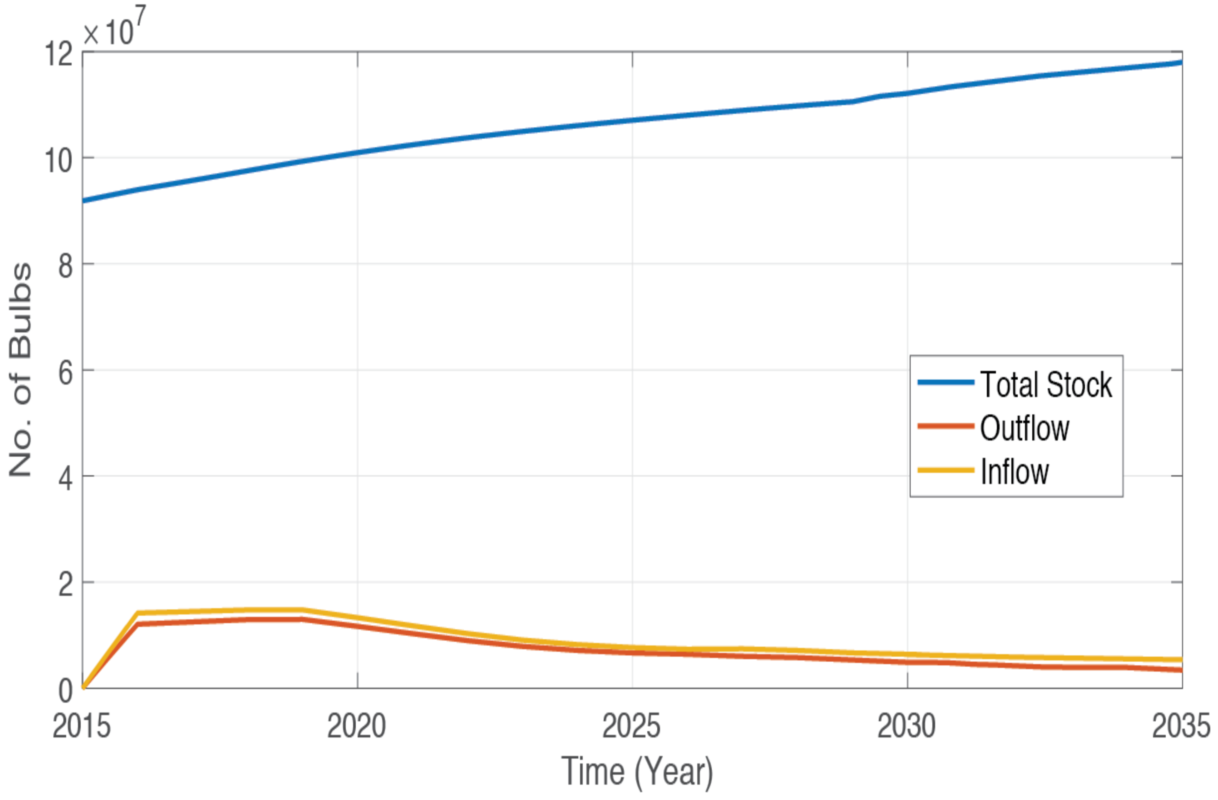
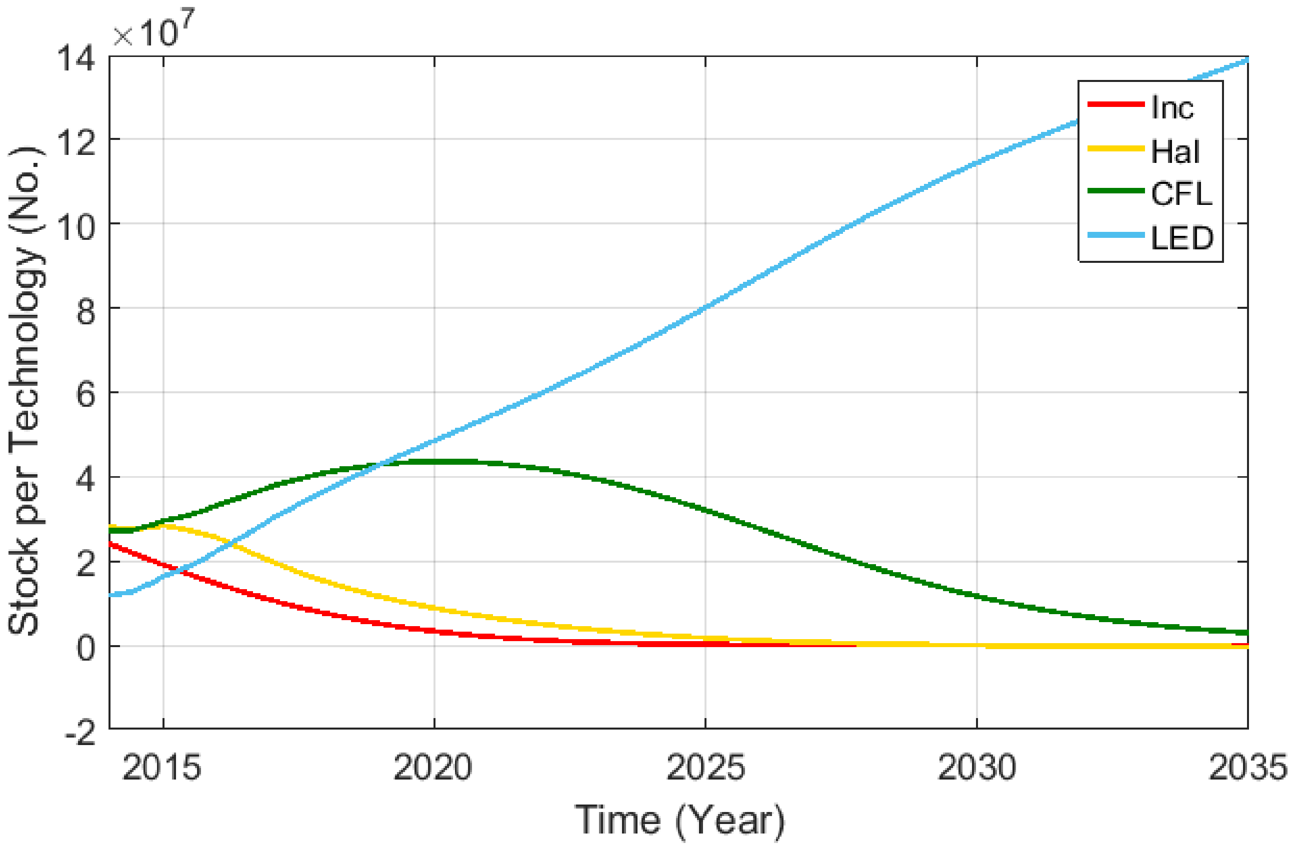
- Change in the stock relative to the previous year is equal to the input minus the output :



- Stock per technology:



Results of stock model

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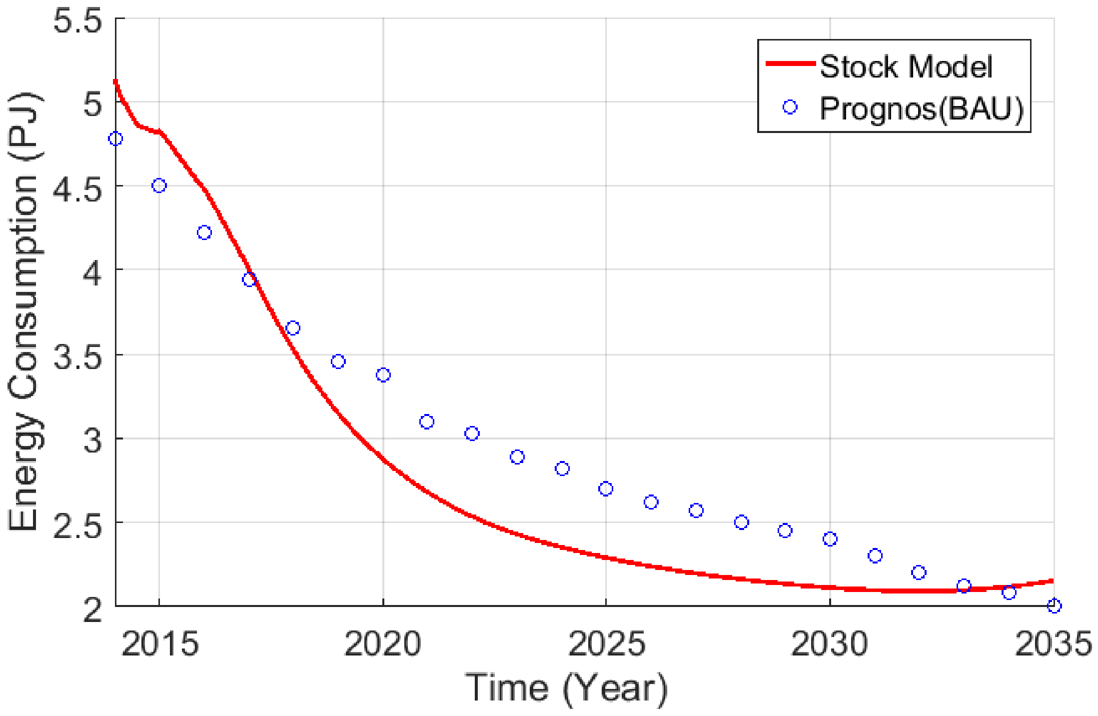
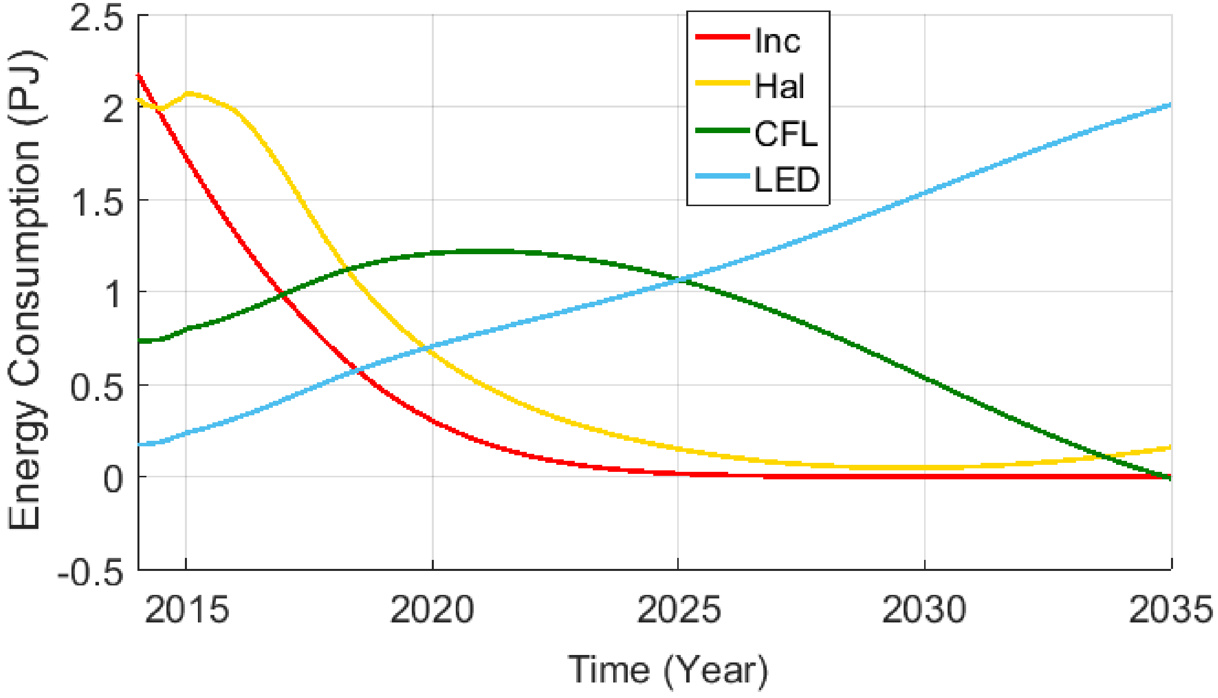
Total Energy Consumption Evolution:



Energy Consumption per Technology



Discussion and conclusions

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- The annual potential energy savings for lighting in households in Switzerland is 4.4 PJ. This estimation is very close to Prognos scenario with a Forzen Efficiency minus New Energy Policy (NEP).
- **For household lighting**, almost all the measures are highly cost effective thanks to the emergence and cost decrease of LED lighting.