INTEGRATED OPTIMIZATION OF ENERGY RESOURCES IN A RESIDENTIAL SETTING

DEVELOPMENT OF AN ENERGY MANAGEMENT SYSTEM

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Energy for Sustainability Initiative

Agenda

1. Introduction
2. Optimized use of energy resources in a residential setting
3. Simulation results
4. Conclusion

1. Introduction

EU Energy Flow 2012 (Mtoe)

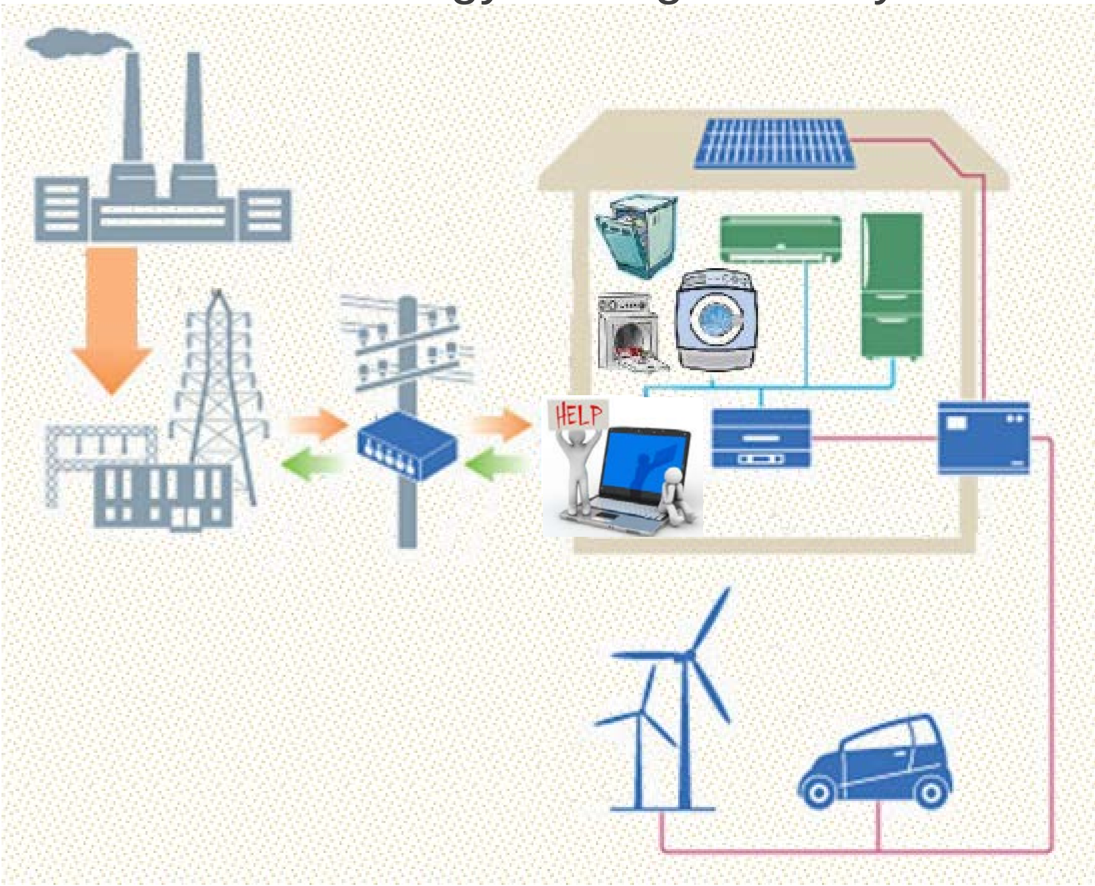
Source: Energy Statistical Pocketbook 2014 (European Commission) (https://ec.europa.eu/energy/sites/ener/files/documents/2014_pocketbook.pdf)

1. Introduction

Source: http://solutions.3m.com/wps/portal/3M/pt_PT/PT-Smart-Grid/Smart-Grid/

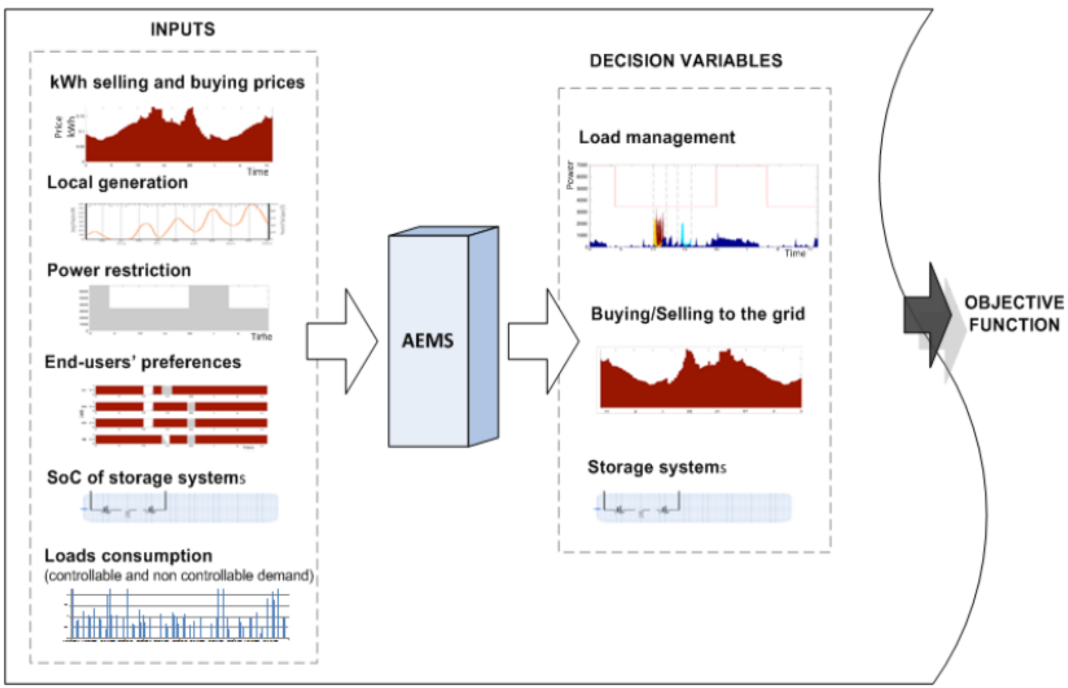
1. Introduction

Residential energy management system



Source: http://www.hd-plc.org/images/feature/090619_1_en.jpg

1. Introduction

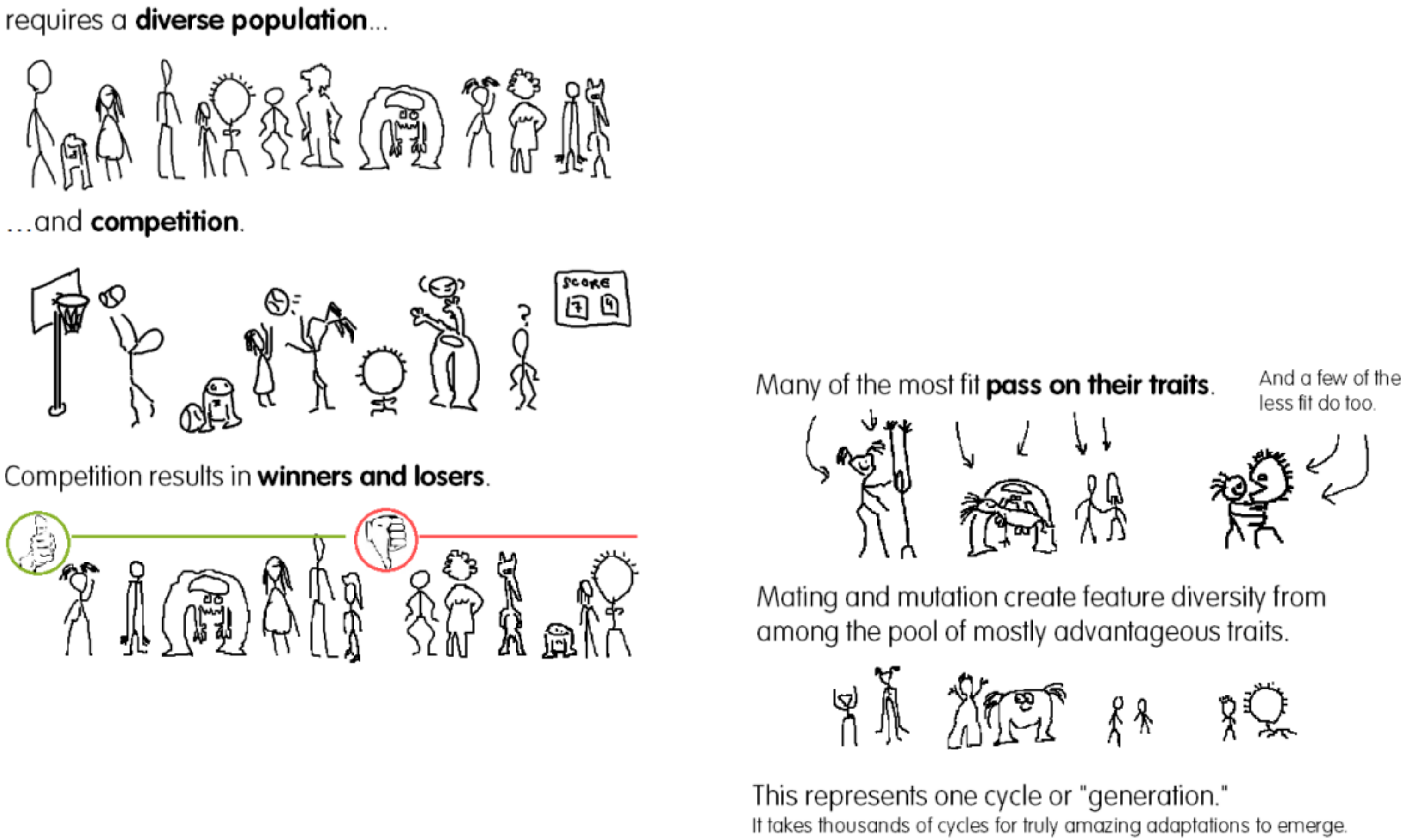


Source: Soares, Lopes, et al., 2012

Multi-objective model considering explicitly **cost** and user's **preferences evaluation aspects** in order to assess their trade-offs and identifying a good compromise solution to the user.

2. Methodology

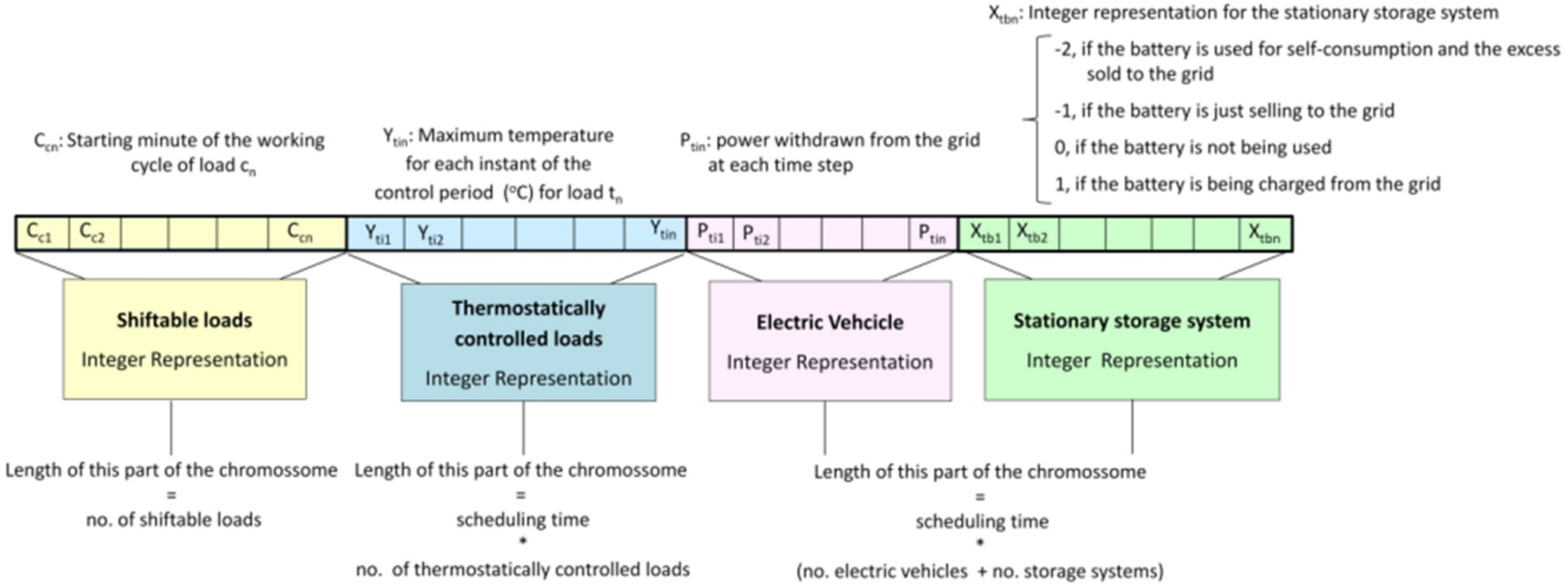
Evolutionary algorithm



Source: https://chewychunks.files.wordpress.com/2013/08/evolution-explained-cartoon-natural-selection-infographic.png?w=600&h=1066

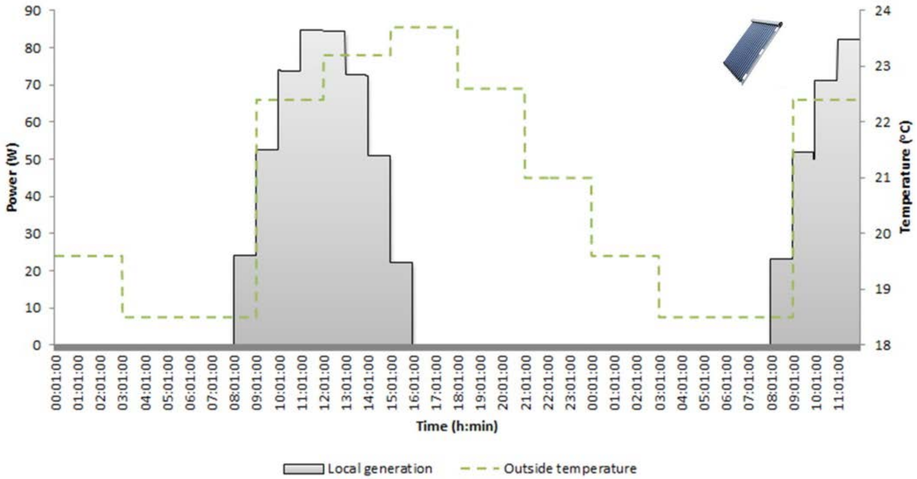
2. Methodology

Solution representation

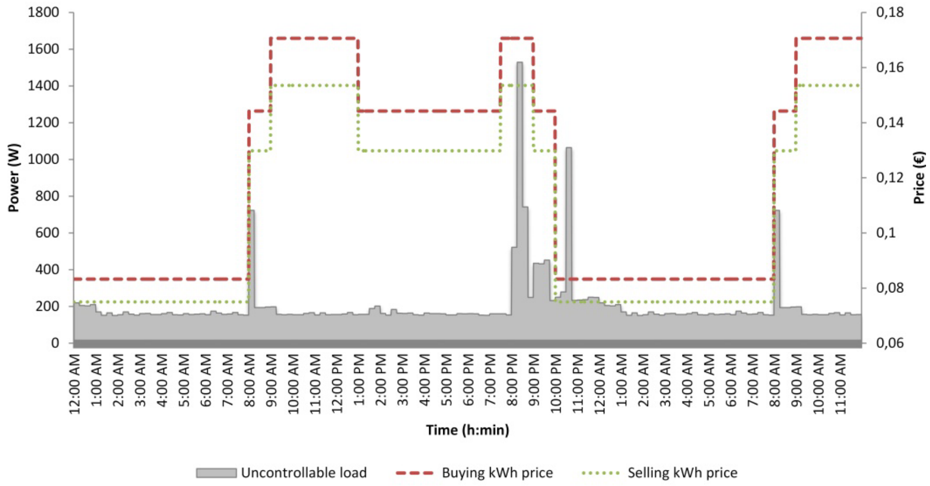


3. Simulation Results

Input parameters – temperature, local generation, kWh prices, uncontrollable demand



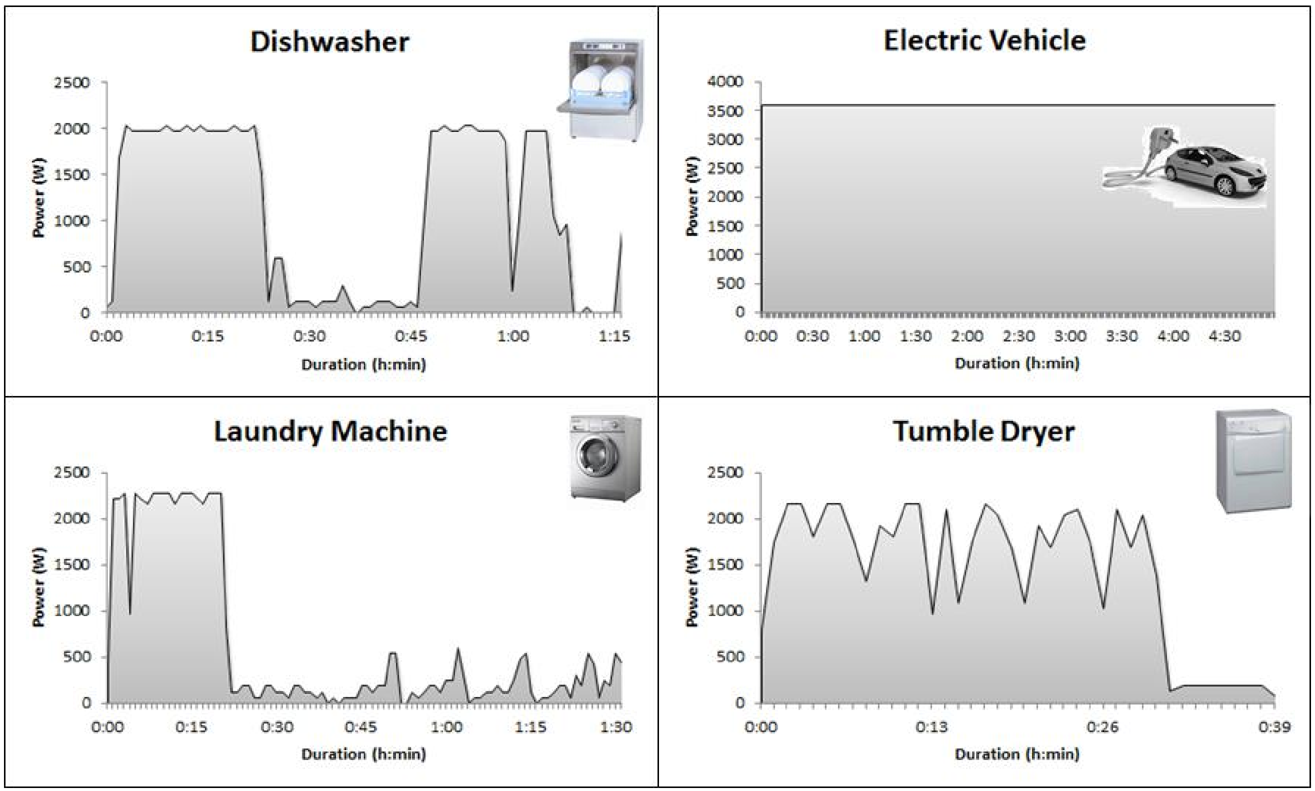
Temperature and local generation (photovoltaics) forecast.



Input information - kWh prices and uncontrollable load profile.

3. Simulation Results

Input parameters – shiftable loads



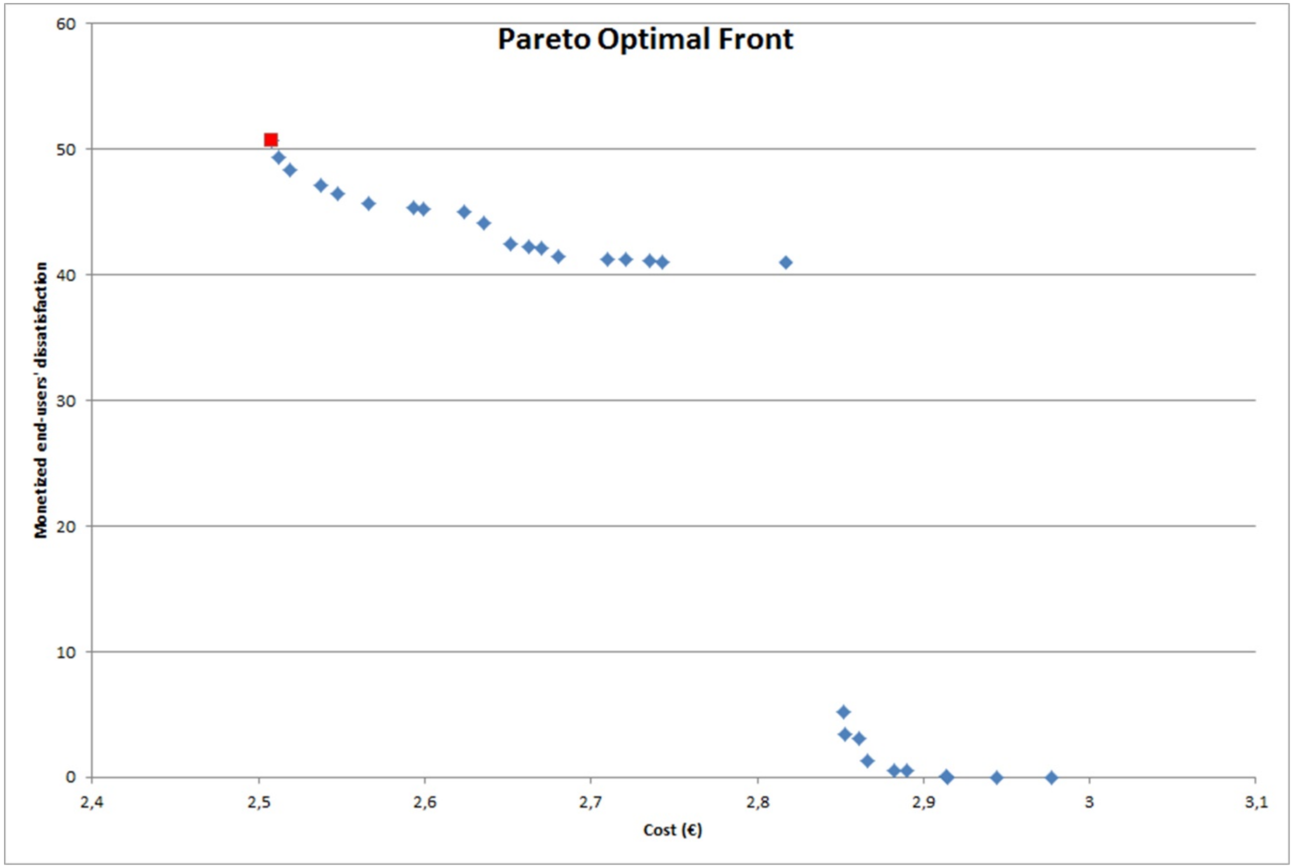
Shiftable loads operation cycle.

3. Simulation Results

Input parameters – time slots

Representation of the end-user's preferences for the operation of shiftable loads.

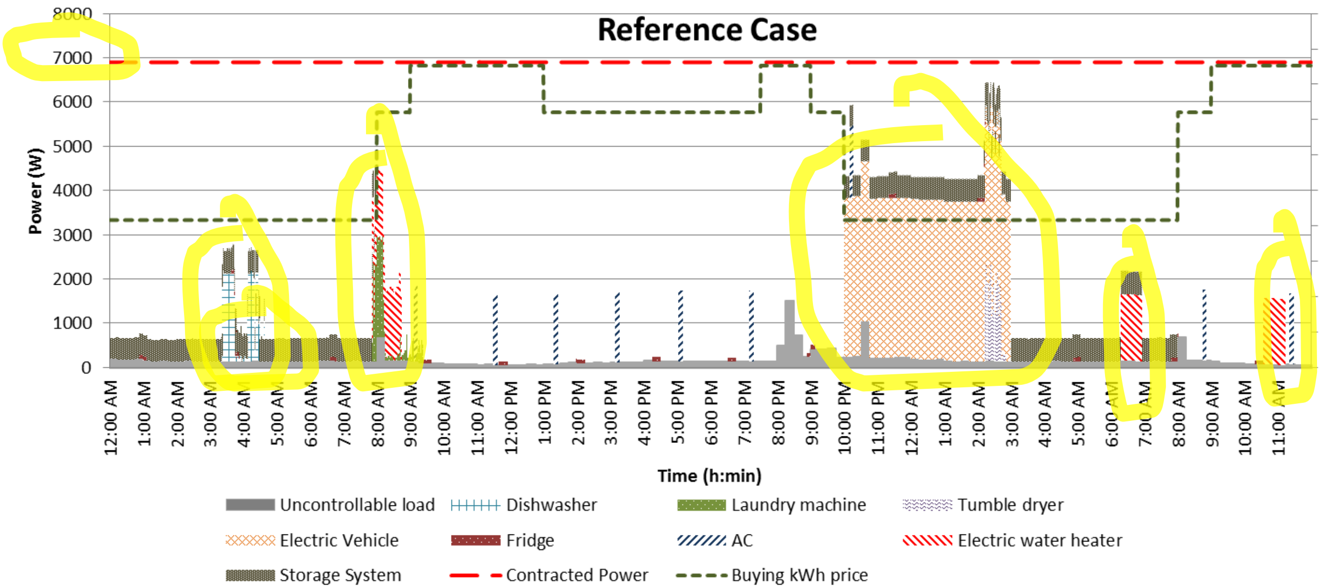
3. Simulation Results



Pareto optimal front signaling the selected solution.

The region where no solutions were found is mainly due to the penalty associated with managing thermostatically controlled loads to decrease electricity bill. Any ADR action over those loads would simultaneously mean a decrease in the electricity bill and an increase in end-users' dissatisfaction.

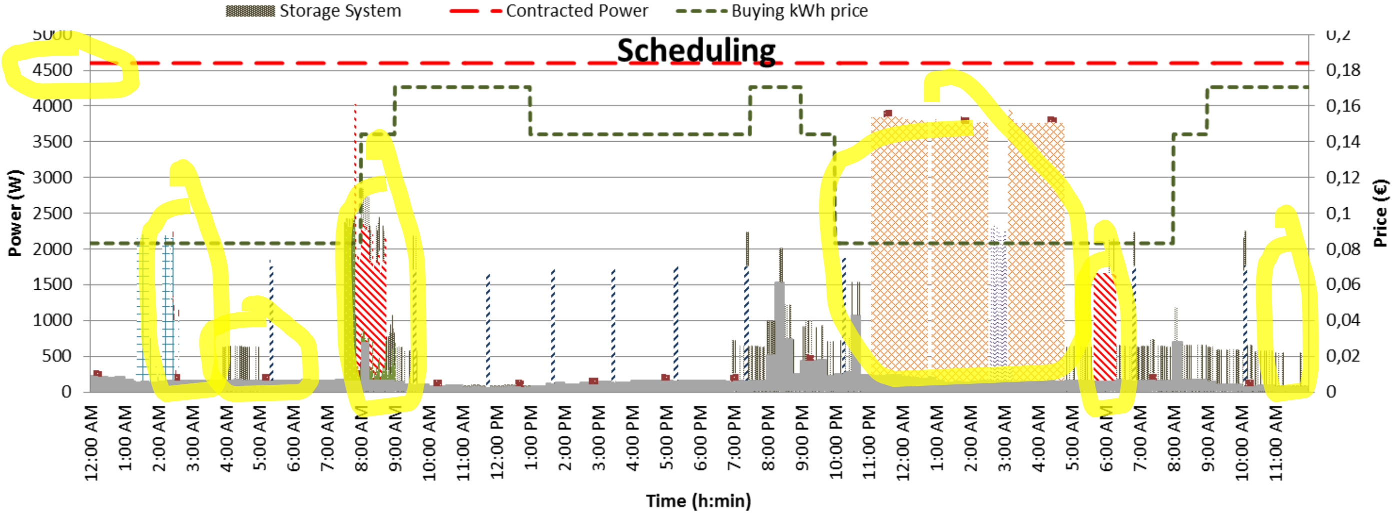
3. Simulation Results



Electricity bill: 3.17 €

Energy acquisition cost: 4.08 €

Profit from injecting energy into the grid: 0.91 €

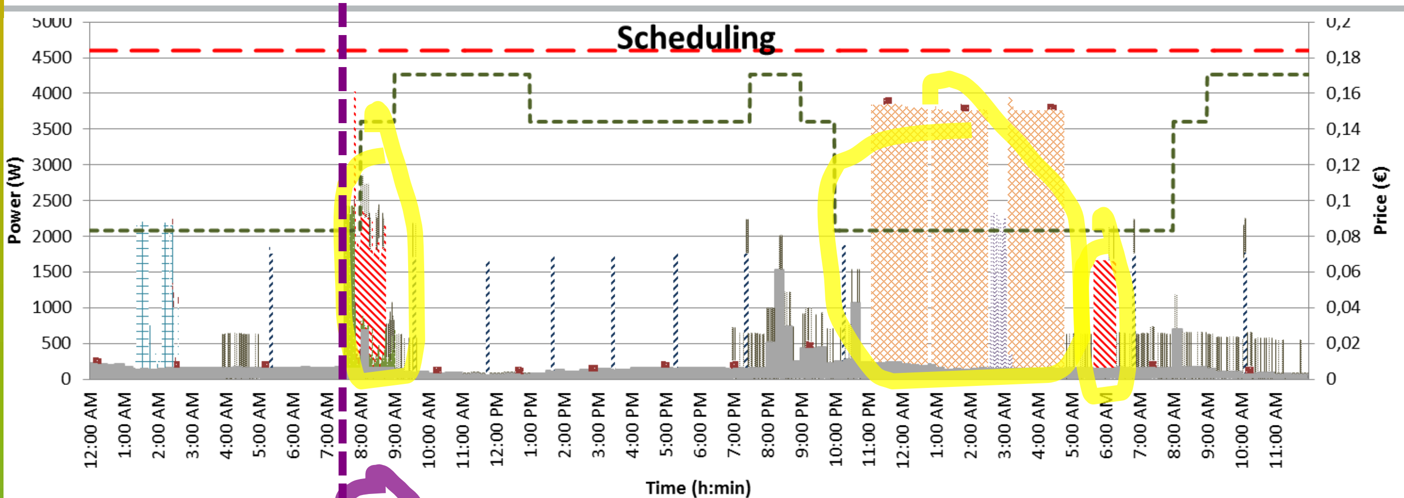


Electricity bill: 2.50 €

Energy acquisition cost: 3.30 €

Profit from injecting energy into the grid: 0.80€

3. Simulation Results



Electricity bill: 2.50 €

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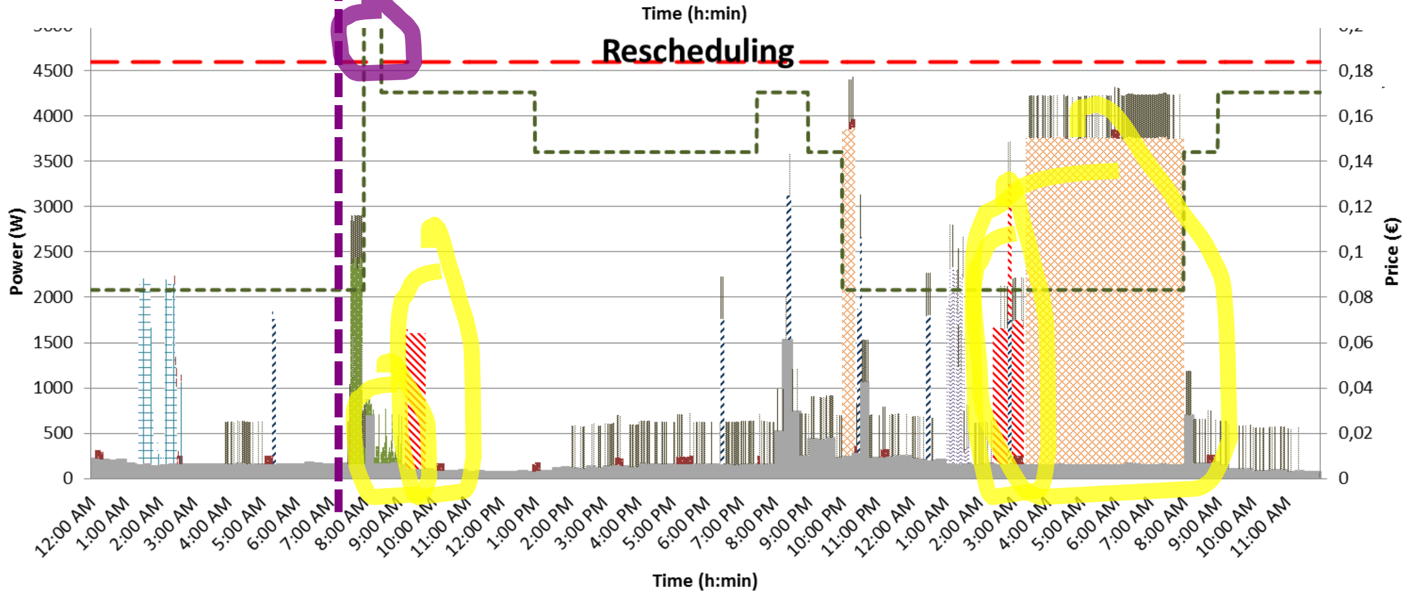
Profit from injecting energy into the grid: 0.80€

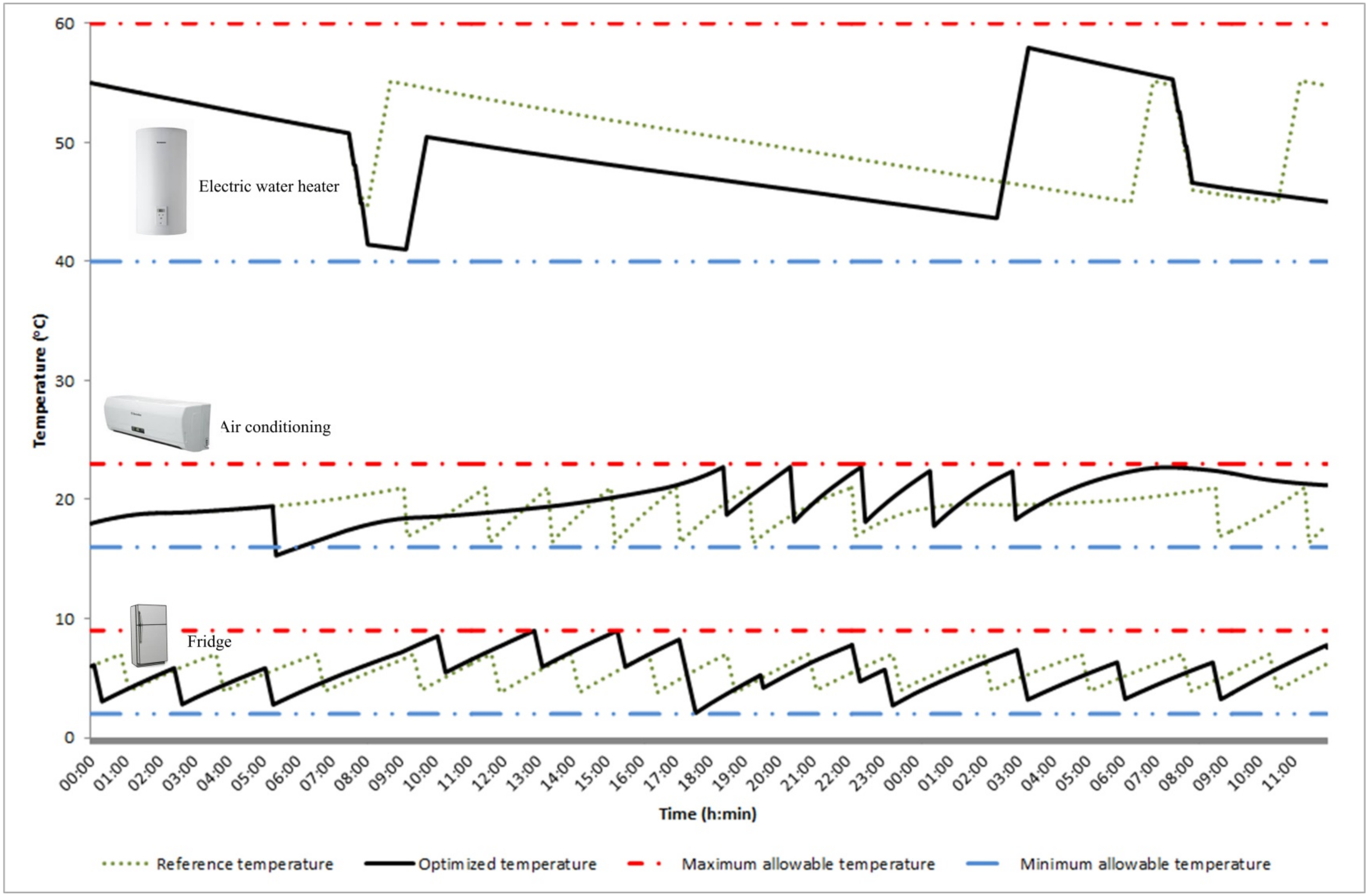


Electricity bill: 2.97 €

Energy acquisition cost: 3.48 €

Profit from injecting energy into the grid: 0.50€

3. Simulation Results



Temperature variation of thermostatically controlled loads for the final solution caused by the implementation of ADR actions.

4. Conclusion

Energy Management System

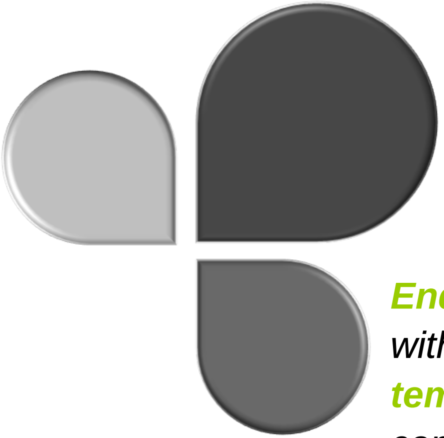
Control algorithms: manage loads, generation, storage and selling / buying electricity

- Minimize the electricity bill;
- Minimize end-user's dissatisfaction due to the automated control;
  … without jeopardizing the quality of the end-use energy services provided.

The **methodology** developed is expected to **help consumers optimizing** the **usage** of **energy services** to **reduce** the **electricity bill** while **guaranteeing** the desirable levels of **comfort** and **quality** of the energy services provided.

4. Conclusion

Choice of the final solution → strongly linked to the end-user's profile and the trade-offs associated with the two evaluation axes (dissatisfaction vs. cost of energy acquisition).



End-users preferring *solutions in which the scheduling of the* ***shiftable loads*** *is done as* ***soon as possible*** *according to their time preferences may see this request translated into an ↑ in the* ***electricity bill*** *.*

End-users more willing *to accept* ***≠*** *types of* ***ADR*** *actions may achieve ↑* ***savings*** *in the electricity bill.*

End-users *who are* ***not comfortable*** *with* ***allowing*** *the system to* ***change temperatures*** *in thermostatically controlled loads may see the* ***potential*** *of* ***reducing*** *the* ***electricity bill*** *↓ .*

More information…

Soares, Ana; Gomes, Alvaro; Antunes, Carlos H. 2015. Integrated Management of Energy Resources in the Residential Sector Using Evolutionary Computation:. In Soft Computing Applications for Renewable Energy and Energy Efficiency, ed. Maria del Socorro García Cascales, Juan Miguel Sánchez Lozano, Antonio David Masegosa Arredondo, Carlos Cruz Corona, 320 - 347. ISBN: 9781466666313. IGI Global. doi: 10.4018/978-1-4666-6631-3.ch013

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