# CERMA

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## Definition of a Home Automation System for Energy Management and Efficiency

Dr. Sergio Romero Hernández
Departamento de Ingeniería Industrial y Operaciones (IIO)
Instituto Tecnológico Autónomo de México (ITAM)
sromero@itam.mx

MTIA Paulina Clares García
Maestría en Tecnologías de Información y Administración
Instituto Tecnológico Autónomo de México (ITAM)
paulina.clares@gmail.com

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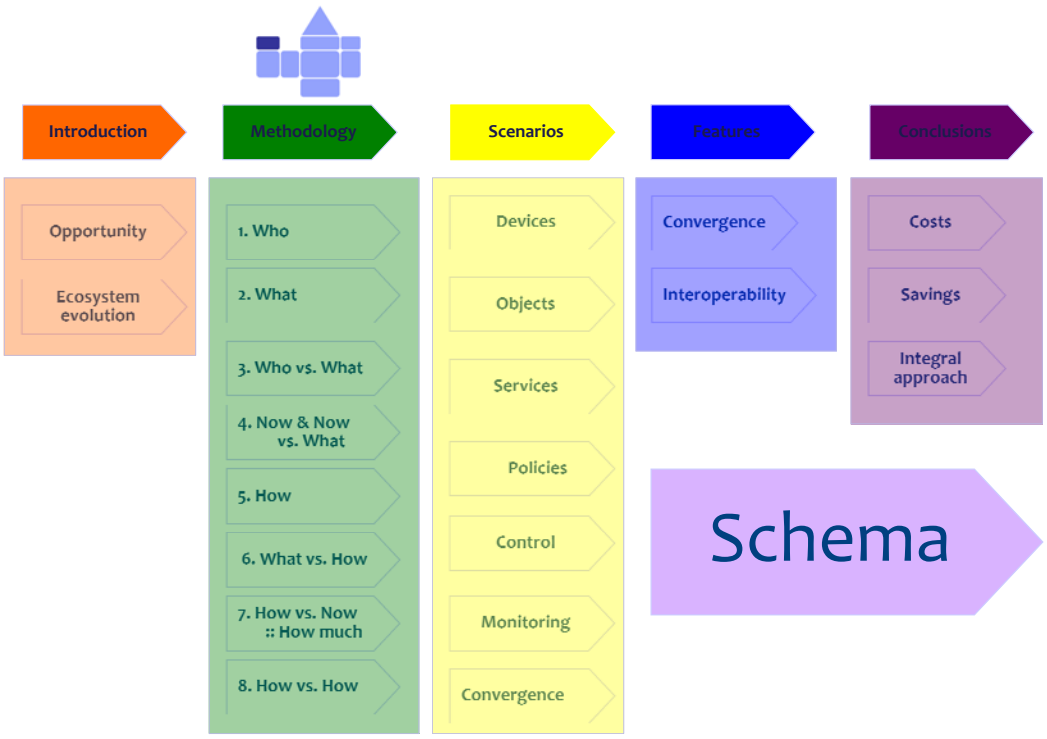


- Expansion of Electricity Structure in Mexico could lead **new business models within «energy ecosystems»**

  - Mexican homes/resident sector
  - Producers
  - Distributors
  - Consumption

- Understand **energy consumption**, to improve how energy is *planned*, *built* and *operated*.
- **Knowledge of consumption** management at home; *consciousness and culture*.





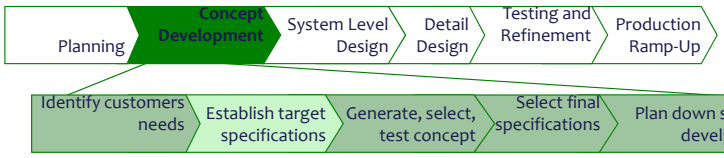
| | Equipment | Operation | Manteinance | Management | Cost |
|---|---|---|---|---|---|
| Ecosystem efficient fuction through evolution | | | | | |
| → HVAC (Heating systems) | | | | | |
| Security (Motion detector) | | | | | |
| Fire (Smoke detector) | | | | | |
| Access (Door / Wireless key) | | | | | |
| → Lighting (Occupancy sensors) | | | | | |
| Electrical distribution | | | | | |
| IT & Telecom | | | | | |
| Garden (Irrigation System) | | | | | |
| Inventory (Tracking of users and objects at home) | | | | | |
| → Integral control home automated (The connected sustainable home) | | | | | |


Ecosystem efficient function through evolution

fit all the pieces together and create a sustainable home

# Methodologies

## I.

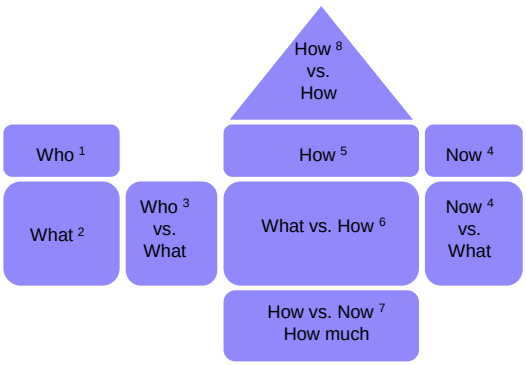



Generic product development process

## II.

HOQ

QFD diagram







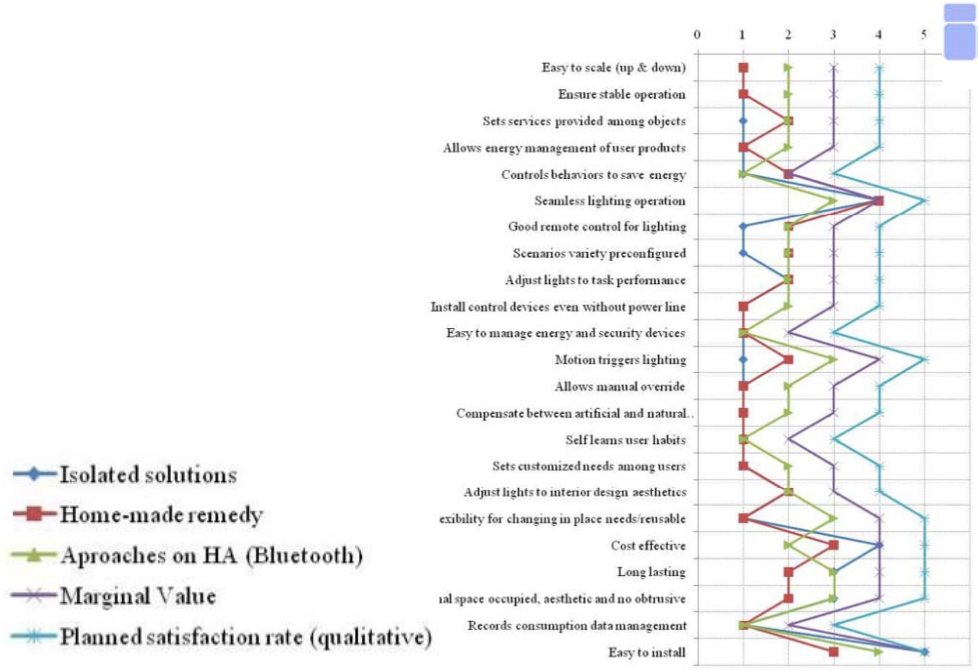

| Mission statement: | Integrated lighting control system for luminaries at home |
|---|---|
| Key Business Goals | • Encourage Energy Management & Efficiency at Mexican homes within Home Automation applications, so a resilient, secure and reliable energy system could emerge.<br>• Reduce energy consumption in 30% on lighting at home through efficient applications.<br>• Applications that are adaptable to the functional characteristics of existing infrastructures. |
| Primary Market | • Home and their inhabitants |
| Secondary Markets | • Installer personnel<br>• Sales staff or Organizations for improvements in sustainability solutions at homes |
| Assumptions and Constrains | • Innovation available for the National Electricity System<br>• Interoperability among services: demand response and load control<br>• Home Automation within PLC and ZigBee |
| Stakeholders | • Users<br>• NGOs<br>• Mexican Government<br>• Educational Institutions<br>• Citizens |

| # | Major types of customers' requirements | Requirements |
|---|---|---|
| 1 | Allows an integral solution | Easy to install |
| 2 | | Flexibility for changing in place needs/reusable |
| 3 | | Install control devices even without power line |
| 4 | | Scenarios variety preconfigured |
| 5 | | Self learns user habits |
| 6 | | Sets customized needs among users |
| 7 | | Sets services provided among objects |
| 8 | Offers lighting application in action | Adjusts lights to interior design aesthetics |
| 9 | | Adjusts lights to task performance |
| 10 | | Compensates between artificial and natural illumination |
| 11 | | Good remote control for lighting |
| 12 | | Minimal space occupied, aesthetic and non obtrusive |
| 13 | | Motion triggers lighting |
| 14 | | Seamless lighting operation |
| 15 | Provides energy conservation and optimizing energy consumption | Allows energy management of user products |
| 16 | | Allows manual override |
| 17 | | Controls behaviours to save energy |
| 18 | | Easy to manage energy and security devices |
| 19 | | Records consumption data management |
| 20 | Is simple to maintain | Cost effective |
| 21 | | Easy to scale (up & down) |
| 22 | | Ensures stable operation |
| 23 | | Long lasting |

| | Priority per user | | | |
|---|---|---|---|---|
| | Relevance for each user / Percentage | 40% | 35% | 25% | 100% |
| | | User 1 | User 2 | User 3 | |
| | Customer requirements | Home and their habitants | Installer personnel | Sales staff or Organizations for improvements in sustainability solutions at homes | Importance level for the need |
| 1 | Adjust lights to interior design aesthetics | 3 | 1 | 2 | 2.05 |
| 2 | Adjust lights to task performance | 3 | 2 | 3 | 2.65 |
| 3 | Allows energy management of user products | 4 | 3 | 5 | 3.9 |
| 4 | Allows manual override | 4 | 1 | 2 | 2.45 |
| 5 | Compensate between artificial and natural illumination | 3 | 1 | 3 | 2.3 |
| 6 | Controls behaviors to save energy | 4 | 2 | 5 | 3.55 |
| 7 | Cost effective | 3 | 1 | 2 | 2.05 |
| 8 | Easy to install | 1 | 2 | 1 | 1.35 |
| 9 | Easy to manage energy and security devices | 3 | 1 | 4 | 2.55 |
| 10 | Easy to scale (up & down) | 4 | 5 | 5 | 4.6 |
| 11 | Ensure stable operation | 5 | 4 | 4 | 4.4 |
| 12 | Flexibility for changing in place needs/reusable | 3 | 1 | 2 | 2.05 |
| 13 | Good remote control for lighting | 4 | 2 | 2 | 2.8 |
| 14 | Install control devices even without power line | 1 | 4 | 3 | 2.55 |
| 15 | Long lasting | 2 | 1 | 3 | 1.9 |
| 16 | Minimal space occupied, aesthetic and no obtrusive | 3 | 1 | 1 | 1.8 |
| 17 | Motion triggers lighting | 3 | 1 | 4 | 2.55 |
| 18 | Records consumption data management | 1 | 1 | 3 | 1.5 |
| 19 | Scenarios variety preconfigured | 4 | 1 | 3 | 2.7 |
| 20 | Seamless lighting operation | 4 | 2 | 3 | 3.05 |
| 21 | Self learns user habits | 4 | 1 | 1 | 2.2 |
| 22 | Sets customized needs among users | 2 | 3 | 1 | 2.1 |
| 23 | Sets services provided among objects | 4 | 5 | 4 | 4.35 |

| Customer requirements | Isolated solutions | Home-made remedy | Approaches on HA (Bluetooth) | Marginal value | Planned satisfaction rate (qualitative) | Sales power |
|---|---|---|---|---|---|---|
| Adjust lights to interior design aesthetics | 2 | 2 | 2 | 3 | 4 | 1.45 |
| Adjust lights to task performance | 2 | 2 | 2 | 3 | 4 | 1.45 |
| Allows energy management of user products | 1 | 1 | 2 | 3 | 4 | 1.45 |
| Allows manual override | 1 | 1 | 2 | 3 | 4 | 1.35 |
| Compensate between artificial and natural illumination | 1 | 1 | 2 | 3 | 4 | 1.45 |
| Controls behaviors to save energy | 1 | 2 | 1 | 2 | 3 | 1.45 |
| Cost effective | 4 | 3 | 2 | 4 | 5 | 1.4 |
| Easy to install | 5 | 3 | 4 | 5 | 5 | 1.3 |
| Easy to manage energy and security devices | 1 | 1 | 1 | 2 | 3 | 1.4 |
| Easy to scale (up & down) | 1 | 1 | 2 | 3 | 4 | 1.35 |
| Ensure stable operation | 1 | 1 | 2 | 3 | 4 | 1.4 |
| Flexibility for changing in place needs/reusable | 1 | 1 | 3 | 4 | 5 | 1.3 |
| Good remote control for lighting | 1 | 2 | 2 | 3 | 4 | 1.35 |
| Install control devices even without power line | 1 | 1 | 2 | 3 | 4 | 1.4 |
| Long lasting | 3 | 2 | 4 | 4 | 5 | 1.3 |
| Minimal space occupied, aesthetic and no obtrusive | 3 | 2 | 4 | 4 | 5 | 1.2 |
| Motion triggers lighting | 1 | 2 | 3 | 4 | 5 | 1.35 |
| Records consumption data management | 1 | 1 | 1 | 2 | 3 | 1.4 |
| Scenarios variety preconfigured | 1 | 2 | 2 | 3 | 4 | 1.5 |
| Seamless lighting operation | 4 | 4 | 3 | 4 | 5 | 1.5 |
| Self learns user habits | 1 | 1 | 1 | 2 | 3 | 1.4 |
| Sets customized needs among users | 1 | 1 | 2 | 3 | 4 | 1.5 |
| Sets services provided among objects | 1 | 2 | 2 | 3 | 4 | 1.45 |

Methodology | 1. Who | 2. What | 3. Who vs. What | **4. Now & Now vs. What** | 5. How | 6. What vs. How | 7. How vs. Now :: How much | 8. How vs. How

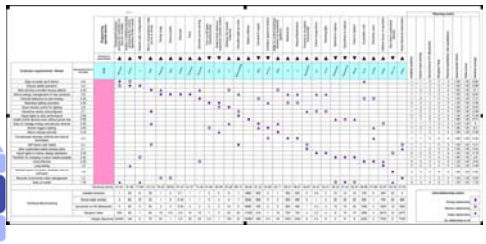


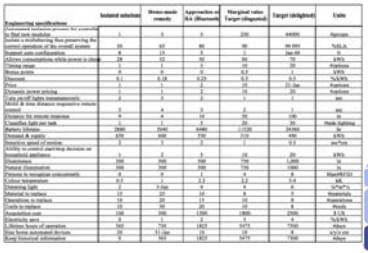



Methodology | 1. Who | 2. What | 3. Who vs. What | 4. Now & Now vs. What | **5. How** | 6. What vs. How | 7. How vs. Now :: How much | 8. How vs. How

| # | Basic Dimensions of Quality | Engineering specification |
|---|---|---|
| 1 | Performance | Ability to control start/stop decision on household appliance |
| 2 | | Colour temperature |
| 3 | | Dimming light |
| 4 | | Distance for remote response |
| 5 | | Illuminance |
| 6 | | Mobil & time distance responsive remote control |
| 7 | | Natural illumination |
| 8 | | Sensitive speed of motion |
| 9 | Features | Allows consumptions while power is cheap |
| 10 | | Bonus points |
| 11 | | Demand & supply |
| 12 | | Discount |
| 13 | | Dynamic power pricing |
| 14 | | Keep historical information |
| 15 | | Persons to recognize concurrently |
| 16 | | Price |
| 17 | | Timing range |
| 18 | Reliability | Automated inclusion process for controllers to find new modules |
| 19 | | Isolate a misbehaving thus preserving the correct operation of the overall system |
| 20 | | Support auto-configuration |
| 21 | Durability | Battery lifetime |
| 22 | | Lifetime hours of operation |
| 23 | Serviceability | Material to replace |
| 24 | | Operations to replace |
| 25 | | Tools to replace |
| 26 | Confirmance | Acquisition cost |
| 27 | | Electricity save |
| 28 | Aesthetics | Size home automated devices |
| 29 | Perceived-quality | Classifies light per task |
| 30 | | Turn on/off lights instantaneously |

| Engineering specifications | Units | Improvement direction |
|---|---|---|
| Ability to control start/stop decision on household appliance | kWh | ▲ |
| Acquisition cost | $ US | ▲ |
| Allows consumptions while power is cheap | kWh | ▲ |
| Automated inclusion process for controllers to find new modules | #Logical groups | ▲ |
| Battery lifetime | hr | ▲ |
| Bonus points | kWh | ▲ |
| Classifies light per task | #task-lighting | ▲ |
| Colour temperature | kK | ▲ |
| Demand & supply | kWh | ▼ |
| Dimming light | lx*m²/ | ▲ |
| Discount | %/kWh | ▲ |
| Distance for remote response | m | ▲ |
| Dynamic power pricing | #options | ▲ |
| Electricity save | %/kWh | ▲ |
| Illuminance | lx | ▲ |
| Isolate a misbehaving thus preserving the correct operation of the overall system | %SLA | ▲ |
| Keep historical information | #days | ▲ |
| Lifetime hours of operation | #days | ▲ |
| Material to replace | #materials | ▼ |
| Mobil & time distance responsive remote control | sec | ▼ |
| Natural illumination | lx | ▲ |
| Operations to replace | #operations | ▼ |
| Persons to recognize concurrently | Max#RFID | ▲ |
| Price | #options | ▲ |
| Sensitive speed of motion | sec*cm | ▼ |
| Size home automated devices | x/y/z cm | ▼ |
| Support auto-configuration | 0 | ▼ |
| Timing range | #options | ▲ |
| Tools to replace | #tools | ▼ |
| Turn on/off lights instantaneously | sec | ▼ |

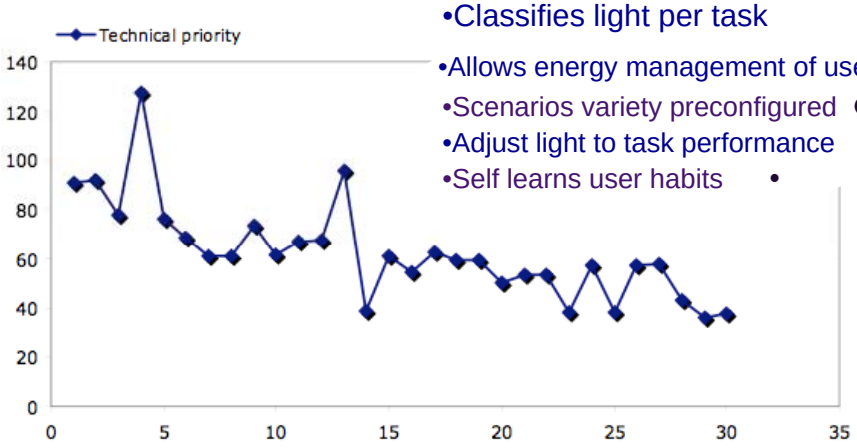




- Allows consumption while power is cheap
- Sets services provided among objects •
- Scenarios variety preconfigured •
- Easy to manage energy and security devices ▲
- Self learns user habits O

Strong relationship •
Medium relationship O
Weak relationship ▲
Not relationship

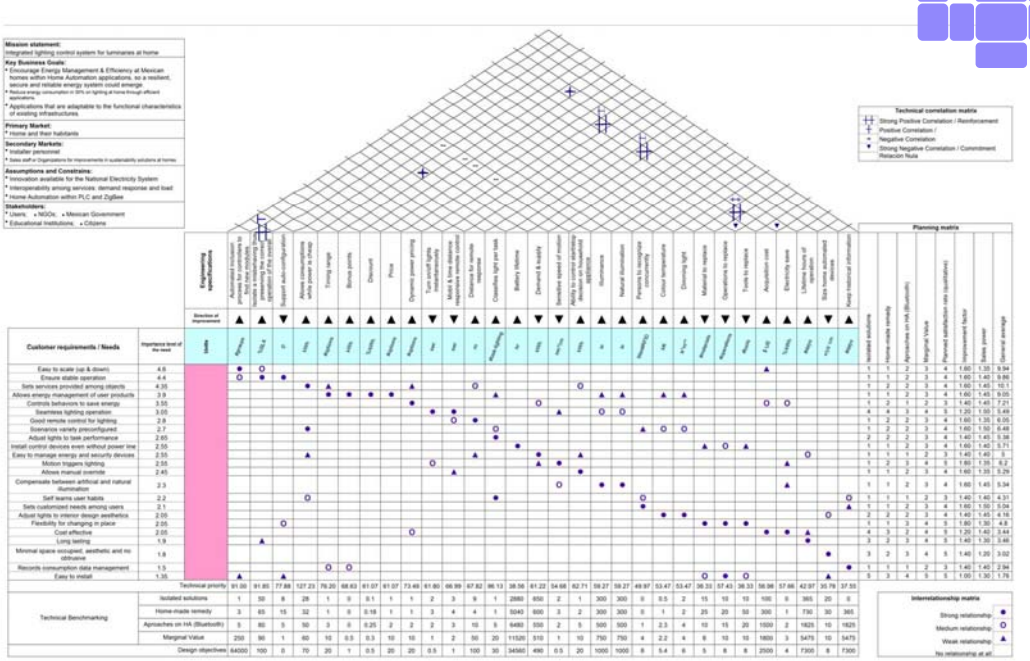
Planned - Marginal
Improvement factor
Sales power
Importance level of the need
→ General average




- Classifies light per task
- Allows energy management of user products ▲
- Scenarios variety preconfigured O
- Adjust light to task performance •
- Self learns user habits •



Methodology



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## **Scenario** :: strategic design for Energy Management & Efficiency within home automation

- Interactions
  - Commodities
  - Users
  - Objects
  - Services
  - Devices
- Robustness
  - Periodicity
  - Service coverage
- Demand response
  - «Smart energy usage»
- Load control
  - Manipulation of loads profiles

Thin daily scenario includes
Lighting
HVAC
heating water

All converge within:

Policies Monitoring Control Service discovery

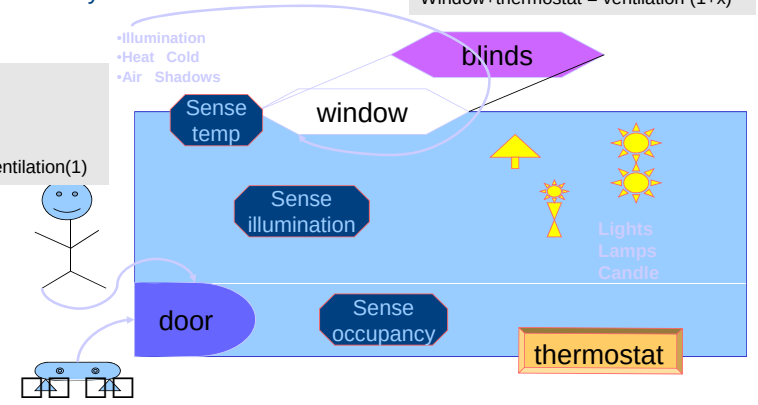




Monitoring :: temp; occupancy; illumination
Control ::--> then blinds; window+thermostat
Police :: If someone in --> converge* to deliver service
else --> converge* to safe energy
*converge :: service discovery

Temp=warm
Occupancy=1
illumination=%natural light
→ then
Blinds=%open
Window+thermostat = ventilation (1+x)

Temp=warm
Occupancy=0
→ then
Blinds=close
Window+thermostat = ventilation(1)



## Convergence: working together

- Devices and Communications
  - Require *strategies for working collaboratively* and through diverse teams
  - Working in a team requires *smart behavior* from devices
  - They are interoperating among getting to know each other for their services (service discovery). Service discovery protocols
  - Applications (convergence - routing): scalability, convergence time, manageability and efficiency
  - ++ rooms or spaces at home; ++ scenarios; ++ devices in one same room; ++ communications; ++ providers; ++ technologies.
  - Reestablish; Reusability
- Devices
  - Sense; Control; Applications among teams
- Networking (Ad - hoc networks)





| 2007 | Electricity consumption of the residential sector | |
|---|---|---|
| | 25.4% | 45,835 GWh |

| 2017 | Electricity consumption of the residential sector | | Combined cycle capability | Average Combined cycle plant capability |
|---|---|---|---|---|
| | 25.4% | 80,932 GWh | 7,500 GW | 600 GW :: 12.5 plants |

| 2017 | Energy savings on lighting at home | Energy savings on electricity consumption residential sector | Proportion not used | # plants not used for savings |
|---|---|---|---|---|
| + | 30% | 24,280 GWh | 40% | 5 |
| +/- | 20% | 16,186 GWh | 24% | 3 |

- Energy management working collaboratively indoors & outdoors, among operators commodities.
- Business models, production, transmission, consumption improve energy efficiency, through metering and demand response programs.
  - For an instance think in a smart grid, where the end-user at home has guarantee on the services, and the possibilities to consume own energy, or creative combinations among his operators and distributors.
- Convergence/Interoperability for energy management and efficiency at home automation.
  - Monitor, control, service discovery; localization & identification; policies; energy provisions, in-house generation; energy delivery.
- Methodologies integration allows innovation, even to improve/stimulate efficient use of energy.
  - Generic product development process
  - House of quality (HOQ), also known as the Quality Function Development (QFD) diagram



# Questions…?