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## IEA-DSM Task XXI: Standardisation of Energy Savings Calculations

Prioritised techniques

Madrid, 23<sup>rd</sup> December 2009



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This document shows the process and methodology developed in order to identify the items that should be prioritised to start our work in the task XXI, based on the initial list of 40 techniques

In addition, new techniques have been proposed, as well as some specific issues regarding demand side management

## Prioritised techniques

### Energy efficiency measures analysis

Our first step is the analysis of the initial Energy Efficiency Measures (EEM) proposed, complemented with other initiatives identified that should be included because of their interest for the aims of the task. On this initial analysis, each initiative has been categorized based on three criteria:

- 1. Useful potential:** qualitative measure of the current penetration of an initiative in the Spanish market, also taking into account the perspectives for the next years and other criteria as profitability, complexity, barriers, etc.
- 2. Savings potential:** qualitative measure of the savings reached by the implementation of this EEM, based on previous experiences and success cases
- 3. Demand Response potential:** qualitative measure of the impact of that EEM on the global energy demand curve, specially on those cases when the application of this measure can contribute to reduce energy demand on maximum peaks, and the contribution of this initiative to the control of demand side management

The choice of this three criteria and the valuation given to each one is based on practical experience, and also on the analysis of success cases on the implementation of these initiatives

## Prioritised techniques

### Additional considerations

Additionally to the qualitative criteria explained before, in the categorization and valuation of the initiatives some other criteria have been taken into account:

- **By sectors**, there are big differences in terms of quantity of energy used and savings potential:
  - **The household sector**, responsible of around 17% of total consumption, has a savings potential close to 10%<sup>(1)</sup>
  - **Commercial and industrial sectors**, both two represent more than 40% of total energy consumption in Spain; the savings potential can reach up to 18%<sup>(1)</sup> depending on the activity
- **By improvement areas**, heating systems, commercial lighting and industrial equipments are the areas with larger savings potential:
  - **Improvement of heating systems** has high savings potential on household sector, because more than 40%<sup>(3)</sup> of total energy consumption on a home is used on heating. The investments needed on this area have commonly a short payback, furthermore there are subventions to change heating systems
  - **On lighting systems savings potentials can reach up to 50%<sup>(2)</sup>**, especially in workspaces and commercial areas where lighting consumption has an important weight in total energy consumption
  - **On industrial equipment**, the extra cost of the reactive energy can be removed by the use of capacitor banks, variable speed drives can also help to reduce outstandingly the energy bill
- **In terms of network impact**, there are several initiatives that can contribute to reduce the peaks on consumption curve, either reducing global energy demand or moving the demand to valley zone

**All these considerations have been taking into account for the selection and prioritization of energy efficiency initiatives for this study**

<sup>(1)</sup> Source: Study "Indicadores de la Eficiencia Energética", Unión Fenosa, 2008

<sup>(2)</sup> Source: Energy Savers. US Department of Energy

<sup>(3)</sup> Source: IDAE, Guía Práctica de la Energía, 2nd Edition 2007

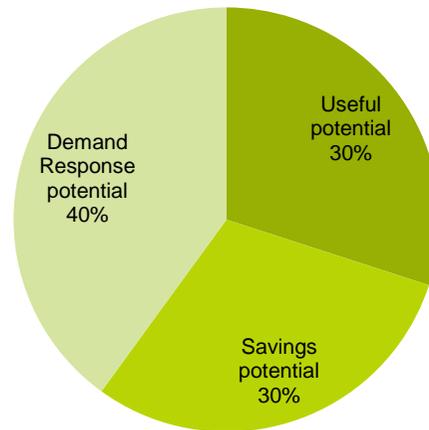
## Prioritised techniques

### Categorization of energy efficiency initiatives

In order to parameterize the initiatives, a quantitative valuation of every attribute (Useful potential, Savings potential and Demand Response potential) has been conducted<sup>(1)</sup>, putting different weights for every attribute:

○	Low
◐	Medium
◑	Medium – high
◒	High
●	Very high

To obtain a global valuation of each initiative, each one of the attributes has received a different relative weight, as follows:



Additionally, **for each initiative the IPMVP measurement scheme** applicable has been analyzed, because of its importance as one of the most used nowadays

<sup>(1)</sup> Source: everis and exeleria analysis

## Prioritised techniques

### Categorization of energy efficiency initiatives

For every group of initiatives, some additional premises have been considered before giving a quantitative evaluation of each attribute:

- **Insulation building envelope:** Due to legislative restrictions (Spanish Technical Building Code) there is reduced potential in new constructions. In legacy housing exists some potential, where glazing is the most critical aspect especially in office buildings
- **Hot water heating equipment:** Domestic Hot Water (DHW) is one of the main consumptions in the residential sector. There is great potential to reduce energy consumption at a reduced cost, however DHW demand is generally lower in office and public buildings
- **Heating:** Heating is one of the main energy consumption in the Spanish residential sector. There are synergies with DHW production. For commercial uses usually heating is lower than cooling demand, nonetheless, there is enough potential to warrant attention
- **Cooling:** Not as important in energy volume as heating, but it has big effect in the electrical system. Cooling is a critical aspect of energy consumption in commercial sector, with big savings potential
- **Ventilation:** Due to current regulatory issues there is not a big potential in most cases
- **Electrical appliances:** The energy savings potential in household sector is reduced. For commercial uses, except in CPD installations, there is not a big field of application as an energy efficiency product
- **Lighting:** One of the most easily applied and measured energy efficiency products, with better payback periods and with great potential to be integrated in Demand Response Control schemes
- **Power Generation:** strategic group, with the potential to greatly increase the overall efficiency of energy usage, combined with mature technology. On industrial environment, these measures are highly effective
- **Energy Management:** Energy Management systems are critical in the implementation of energy efficiency measures, as well as a measure to save energy in itself, with great profitability
- **Energy efficient industrial equipment:** Depending on the specifics of the industrial process involved, a mix of these measures delivers maximum efficiency
- **Steam:** Steam production and usage is a key aspect of energy efficiency in the industrial sector
- **Public lighting:** Is the main energy consumption in municipalities, easy to integrate in demand response control systems

# Prioritised techniques

## Categorization of energy efficiency initiatives

As a result, the quantitative valuation for each categorization and the global result is showed in the next table, where also the IPMVP scheme applicable is listed for the initiatives on the household sector....

Household sector	Useful potential	Savings potential	Demand Response potential	Global Valuation	IPMVP Scheme
<b>1. Insulation building envelope</b>					
1.1 Wall insulation	●	○	○	●	D
1.2 Roof insulation	●	○	○	●	D
1.3 Windows / glazing	●	○	○	●	D
1.4 Floor	●	○	○	●	D
1.5 Draught proofing, increase the air-tightness of buildings	●	○	○	●	D
<b>2. Hot water heating equipment</b>					
2.1.1 Boiler	●	●	○	●	A/B
2.1.2 Solar thermal collectors	●	●	○	●	B
2.2 Hot water storage tank	●	●	○	●	D
2.3 Insulation hot water pipes	●	○	○	●	D
<b>3. Heating</b>					
3.1.1 Boiler	●	●	○	●	A/B
3.1.2 Heat pump	●	●	●	●	B
<b>3.1.3 District heating</b>	●	●	●	●	B
3.2.1 Timing devices	●	●	○	●	B
3.2.2 Thermostats and radiator valve thermostatic controls	●	○	○	●	A
3.3 Reflecting radiator panels	○	○	○	○	B/D
<b>4. Cooling</b>					
4.1 Energy efficient cooler or room air-conditioner	●	●	●	●	B/C
4.2 Integral airconditioning system	●	●	●	●	B/C
<b>5. Electrical appliances</b>					
5.1.1 Refrigerators	●	●	○	●	A/C
5.1.2 Freezers	●	●	○	●	A/C
5.2.1 Dish washers	●	○	○	●	A
5.2.2 Washing machines	●	○	○	●	A
5.2.3 Tumble dryers	●	○	○	●	A
5.3.1 DVD player	○	○	○	○	A
5.3.2 TV	○	○	○	○	A
5.3.3 Settop box, decoder	○	○	○	○	A
5.3.4 Home computer	○	○	○	○	A
5.3.5 Printer	○	○	○	○	A
<b>6. Lighting</b>					
6.1 Energy efficient compact fluorescent light bulbs	●	●	●	●	A/C
6.2 LED's	●	●	●	●	A/C
<b>7. Power Generation</b>					
7.1 Micro-CHP	●	●	●	●	B
7.2 Photovoltaic solar panels	○	○	●	●	B

Valuation	
○	low
●	medium
●	medium - high
●	high
●	very high

IPMVP Scheme	
A	Partially Measured Retrofit Isolation
B	Retrofit Isolation
C	Whole Facility
D	Calibrated Simulation

Demand Response Impact
Those initiatives highlighted with <b>bold green text</b> are the ones with most impact on demand response management

# Prioritised techniques

## Categorization of energy efficiency initiatives

.....for commercial and public spaces sector.....

Commercial, industrial and public buildings		Useful potential	Savings potential	Demand Response potential	Global Valuation	IPMVP Scheme
8.	Insulation building envelope					
8.1	Wall insulation	◐	○	○	◐	D
8.2	Roof insulation	◐	○	○	◐	D
8.3	Windows / glazing	◑	◐	○	◐	D
8.4	Floor	◐	◐	○	◐	D
8.5	Draught proofing, increase the air-tightness of buildings	◐	○	○	◐	D
9.	Ventilation					
9.1	Efficient ventilation system (mechanically controlled)	◐	◐	○	◐	A/B
10.	Hot water					
10.1	boiler	○	○	○	○	A/B
11.	Heating					
11.1.1	Boiler	◐	◐	○	◐	A/B
11.1.2	Heat pump	◑	◑	◐	◑	B
11.1.3	<b>District heating</b>	◑	◑	●	◑	B
12.	Cooling					
12.1	Energy efficient cooler or room air-conditioner	◐	○	○	◐	B/C
12.2	Integral airconditioning system	◐	◐	◐	◐	B/C
12.3	Passive cooling (blinds, etc.)	◐	○	○	◐	B/C
13.	Appliances					
13.1	Office equipment	◐	○	○	◐	A
13.1.1	Computers	◐	○	○	◐	A
13.1.2	Printers	◐	○	○	◐	A
13.1.3	Copiers	◐	○	○	◐	A
13.1.4	Fax machines	◐	○	○	◐	A
14.	Lighting					
14.1	<b>High efficiency lighting systems</b>	◑	◑	◑	◑	A/C
14.2	Motion detection lightswitches	◐	◐	◐	◐	B/C
15.	Energy Management					
15.1	<b>Consumption management</b>	◐	◑	◑	◑	B/C
<b>Public sector</b>						
20.	Public lighting					
20.1	<b>Energy efficient lighting systems for public spaces (e.g. roads)</b>	◑	●	◑	●	B/C

Valuation	
○	low
◐	medium
◑	medium - high
◒	high
●	very high

IPMVP Scheme	
A	Partially Measured Retrofit Isolation
B	Retrofit Isolation
C	Whole Facility
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Demand Response Impact
Those initiatives highlighted with <b>bold green text</b> are the ones with most impact on demand response management

# Prioritised techniques

## Categorization of energy efficiency initiatives

.... and for the industrial and production sector. On this last table the **new initiatives proposed** are also listed:

Industrial sector		Useful potential	Savings potential	Demand Response potential	Global Valuation
16.	Power Generation				
16.1	<b>CHP</b>	●	●	●	●
16.2	Windmills	○	○	●	●
16.3	Efficient generators	○	○	●	●
17.	Energy Management System				
17.1	Monitoring	●	●	●	●
17.2	Waste heat recovery system and recirculation of heat	●	●	●	●
18.	Energy efficient industrial equipment				
18.1	Electric motors	●	●	●	●
18.2	<b>Variable speed drive</b>	●	●	●	●
18.3	Compressed air system	●	●	●	●
18.4	<b>Pumping systems in industrial processes</b>	●	●	●	●
19.	Steam				
19.1.1	Boiler monitoring system	●	●	○	●
19.1.2	Boiler load management	●	●	○	●
19.1.3	Boiler condensate return	●	●	○	●
19.3	Distribution system	●	○	○	●
Public sector		Useful potential	Savings potential	Demand Response potential	Global Valuation
20.	Public lighting				
20.1	<b>Energy efficient lighting systems for public spaces (e.g. roads)</b>	●	●	●	●
Additional measures		Useful potential	Savings potential	Demand Response potential	Global Valuation
21.1	<b>Individual monitoring and control system for public lighting</b>	●	●	●	●
21.2	High performance UPS in Data Centers	●	●	●	●
21.3	<b>Capacitor bank</b>	●	●	●	●
21.4	Free cooling in Data Center	●	●	●	●

Additional measures proposed by everis and exeleria

Valuation	
○	low
◐	medium
◑	medium - high
◒	high
●	very high

IPMVP Scheme	
A	Partially Measured Retrofit Isolation
B	Retrofit Isolation
C	Whole Facility
D	Calibrated Simulation

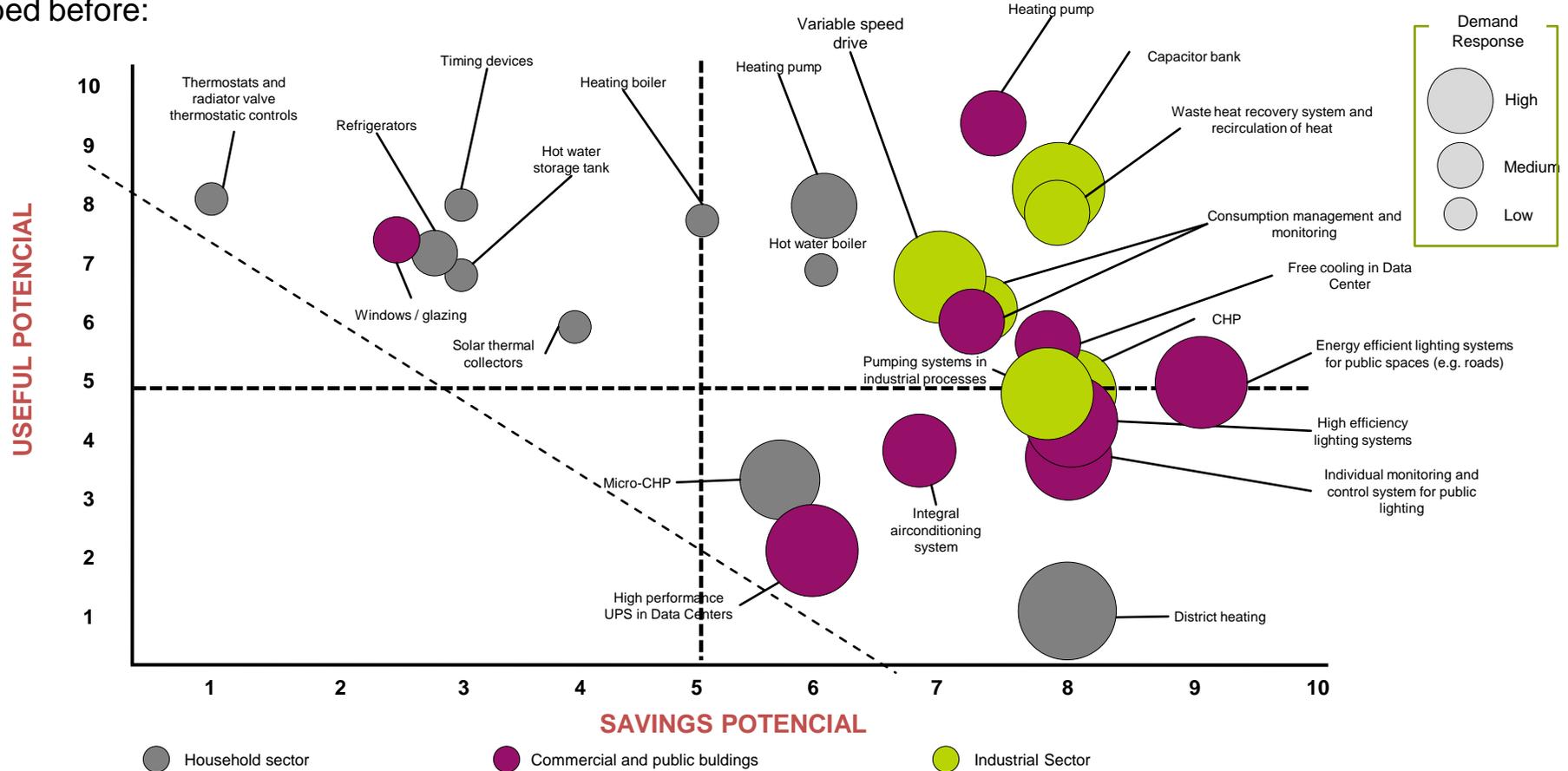
Demand Response Impact	
Those initiatives highlighted with <b>bold green text</b> are the ones with most impact on demand response management	



# Prioritised techniques

## Selection of energy efficiency initiatives

After this prioritization, it is possible to determine which of the initiatives will be selected based on the criteria described before:



For the selection of these 25 initiatives, as well as the criteria of useful and savings potential, has been taken into account the sector and the IPMVP scheme applicable in order to have a varied sample of measures

# Prioritised techniques

## Selected energy efficiency initiatives (1/2)

For these 25 initiatives, the next two tables indicate the valuation of each parameter, IPMVP scheme applicable and a brief comment regarding its selection. On the first table, the initiatives on household and commercial sector.....

Id.	Household sector	Useful potential	Savings potential	Demand Response potential	Global Valuation	IPMVP Scheme	Comments
2.	Hot water heating equipment						
2.1.1	Boiler	●	●	○	●	A/B	High efficiency boilers, combined with small thermal energy accumulation vessels
2.1.2	Solar thermal collectors	●	●	○	●	B	Solar energy for Domestic Hot Water (DHW)
2.2	Hot water storage tank	●	●	○	●	D	Hot water accumulation, improves the performance of production system
3.	Heating						
3.1.1	Boiler	●	●	○	●	A/B	Condensation and low-temperature boilers
3.1.2	Heat pump	●	●	●	●	B	Depending on the climate zone, the heat pump represents a significant energy save over boilers, specially where DHW consumption is minimal or null
3.1.3	<b>District heating</b>	●	●	●	●	B	<b>Centralized hot water production: reduces the unitary costs and improves efficiency, as well as reduce the net impact caused by electric heating devices on peaks</b>
3.2.1	Timing devices Thermostats and radiator valve	●	●	○	●	B	Control devices that allow for optimal strategies in boiler and terminal units operation
3.2.2	thermostatic controls	●	○	○	●	A	Control 2-way valves in terminal units, thus reducing electrical and fuel consumption
5.	Electrical appliances						
5.1.1	Refrigerators	●	●	○	●	A/C	High energy efficiency class refrigerator
7.	Power Generation						
7.1	Micro-CHP	●	●	●	●	B	Local Combined Heat and Power production, in the lower electrical power band
<b>Commercial, industrial and public buildings</b>		Useful potential	Savings potential	Demand Response potential	Global Valuation	IPMVP Scheme	
8.	Insulation building envelope						
8.3	Windows / glazing	●	●	○	●	D	Thin film to reduce solar loads, complete overhaul of glazing systems, including low-E and high reflection layers
11.	Heating						
11.1.2	Heat pump	●	●	●	●	B	Depending on the climate zone, the heat pump represents a significant energy save over boilers, specially where DHW consumption in minimal or null
12.	Cooling						
12.2	Integral airconditioning system	●	●	●	●	B/C	Centralized system has lower cost and better efficiency
14.	Lighting						
14.1	<b>High efficiency lighting systems</b>	●	●	●	●	A/C	<b>Low consumption lightings, TL5 fluorescent, high pressure sodium, LED, motion detection lightswitches, etc.</b>
15.	Energy Management						
15.1	<b>Consumption management</b>	●	●	●	●	B/C	<b>Real-time energy consumption measurement, recording and control, and load control on the energy distribution system</b>

# Prioritised techniques

## Selected energy efficiency initiatives (2/2)

... and on the second table, the initiatives for public spaces, industrial sector and the new initiatives proposed:

Industrial sector		Useful potential	Savings potential	Demand Response potential	Global Valuation	IPMVP Scheme	
16.	Power Generation						
16.1	CHP	🟢	🟢	🟢	🟢	B	Combined Heat and Power production in industrial scale, helps to manage de demand response (distributed generation)
17.	Energy Management System						
17.1	Monitoring	🟡	🟡	🟡	🟡	B/C	Real-time energy consumption measurement, recording and control, and load control on the energy distribution system
17.2	Waste heat recovery system and recirculation of heat	🟢	🟢	🟡	🟢	B/C	Recovery of residual thermal energy and usage in pre-heat systems
18.	Energy efficient industrial equipment						
18.2	Variable speed drive	🟢	🟢	🟢	🟢	B/C	Decrease the speed drive (and so the energy consumption) based on the current needs
18.4	Pumping systems in industrial processes	🟢	🟢	🟢	🟢	B	Variable flow hot water pumping systems
Public sector		Useful potential	Savings potential	Demand Response potential	Global Valuation	IPMVP Scheme	
20.	Public lighting						
20.1	Energy efficient lighting systems for public spaces (e.g. roads)	🟢	🟢	🟢	🟢	B/C	High efficiency lamps, LED streetlights, automatic intensity regulation, etc.
Additional measures		Useful potential	Savings potential	Demand Response potential	Global Valuation	IPMVP Scheme	
21.1	Individual monitoring and control system for public lighting	🟢	🟢	🟢	🟢	B	Remote control of public lighting: data bus connection or wireless networks with integrated "intelligent" systems
21.2	High performance UPS in Data Centers	🟡	🟡	🟡	🟡	B/C	Static bypass on UPS, load transfers systems, delta topology, etc.
21.3	Capacitor bank	🟢	🟢	🟢	🟢	B/C	Real time or static control of the Power Factor in the electrical loads, helps to reduce electric load
21.4	Free Cooling on Data Centers	🟡	🟡	🟡	🟡	B/C	Rejection of heat generated by the CPD to the ambient without usage of compressors, when low external temperatures allow to

These 25 initiatives selected are composed by 10 initiatives for household sector, 5 for commercial sector, 5 for industrial processes, 1 for public sector and 4 new additional measures

# Prioritised techniques

## Description of energy efficiency initiatives

For every initiative, an index card will be developed, describing the following characteristics:

Contents description for the index cards

High efficiency lighting systems		
<b>Sector</b>	Sector where this initiatives applies on	
<b>Code</b>	Code of the measure	
<b>Description</b>	Brief explanation of the measure	
<b>Useful potential</b>	○ ◐ ◑ ◒ ●	Evaluation of the potential implementation of the measure
<b>Savings potential</b>	○ ◐ ◑ ◒ ●	Evaluation of the savings potential that implies the application of the initiative
<b>Demand Response Potential</b>	○ ◐ ◑ ◒ ●	Description of how this measure can contribute to demand response management
<b>Global valuation</b>	○ ◐ ◑ ◒ ●	Global valuation of the measure applying the weighted average of the criteria described before
<b>IPMVP scheme</b>	A/B/C/D	Indicating which one of the IPMVP measurement schemes applies for the measurement of this initiative
<b>Related initiatives</b>	Listing other related initiatives	
<b>Comments</b>	Other relevant aspects, barriers, etc.	

Illustrative

# Prioritised techniques

## Description of energy efficiency initiatives

As an example, two index cards are shown describing two energy efficiency initiatives:

Example of an index card for an initiative in commerce sector

High efficiency lighting systems		
<b>Sector</b>	Commerce, offices and workplaces	
<b>Code</b>	14.1	
<b>Description</b>	Low consumption lightings, control systems, presence detectors, etc.	
<b>Useful potential</b>	☐	High useful potential in short terms
<b>Savings potential</b>	●	Lighting consumption can be up to 20-40% of total electric consumption in an office. With low investments, savings can be up to 40% of the lighting bill
<b>Demand Response Potential</b>	●	In some cases can reduce the peak demand
<b>Global valuation</b>	●	High potential, easy implementation
<b>IPMVP scheme</b>	A/C	
<b>Related initiatives</b>	Motion detection light switches	
<b>Comments</b>	Common initiative in Spain, IDAE has guides explaining how to save money improving the lighting systems on offices, workplaces and public buildings	

Illustrative

Example of an index card for an initiative in household sector

Solar thermal collectors		
<b>Sector</b>	Household, public buildings	
<b>Code</b>	2.1.2	
<b>Description</b>	Use of solar energy to heat water on buildings	
<b>Useful potential</b>	●	High useful potential in short terms, commonly nowadays, short payback
<b>Savings potential</b>	●	Solar energy is free, reduce considerably the energy bill
<b>Demand Response Potential</b>	○	Not related with electricity demand
<b>Global valuation</b>	●	High potential, easy implementation
<b>IPMVP scheme</b>	A/C	
<b>Related initiatives</b>	Photovoltaic solar panels, Hot water storage tank	
<b>Comments</b>	Deep penetration in Spain, high dependence with the weather	

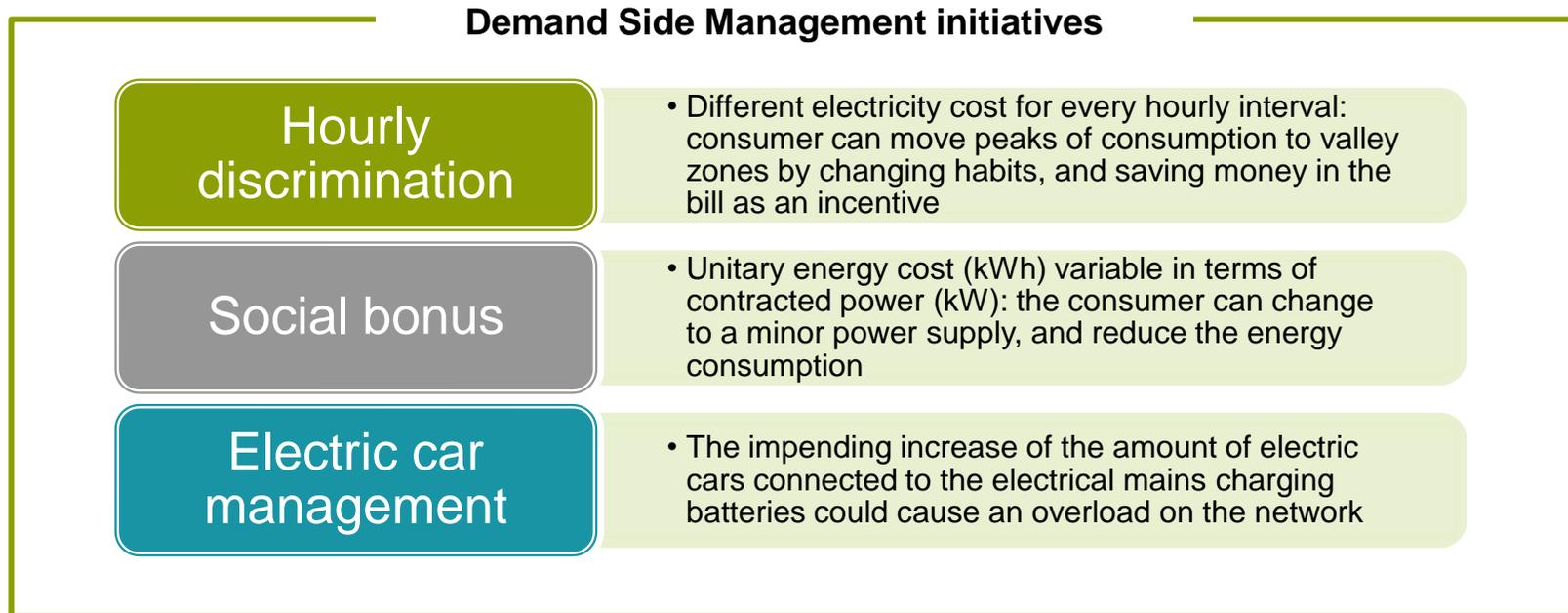
Illustrative

## Prioritised techniques

### Demand Side Management Proposals

Additionally to the initial proposed measures, there are other mechanisms and initiatives related that can contribute to manage the energy demand, know as Demand Side Management

As is defined by the International Energy Agency, **Demand Side Management** deals with a variety of strategies to reduce and manage energy demand, including policies, technologies, applications and other resources that facilitate energy system operations or needed market transformations



For each one of these initiatives there is an index card with the main characteristics

# Prioritised techniques

## Description of Demand Side Management proposals

Hourly discrimination

Social bonus

Electric car management

Hourly discrimination		
<b>Sector</b>	General	
<b>Code</b>	-	
<b>Description</b>	Electric energy contracts where the variable term of energy is more expensive on peaks hours rather than on valley hours. This fact makes customers to move main electric consumption load to periods of time where energy is cheaper (and the mains are not congested)	
<b>Useful potential</b>	●	Nowadays there are different options of this product on the Spanish market, with good results
<b>Savings potential</b>	◐	This measure is not aimed to save energy, but to redistribute the load on the mains. For the client, when it is possible to change habits, it produces economic savings.
<b>Demand Response Potential</b>	○	Nowadays, the few number of clients with this service makes the global impact not much considerable on the mains.
<b>Global valuation</b>	◐	It is one of the most effective measures to control the hourly load of the electric mains.
<b>IPMVP scheme</b>	-	
<b>Related initiatives</b>		
<b>Comments</b>	It is a simple initiative to manage the demand response, especially on household sector because of its load flexibility	

**Future evolution of measures like this is conditioned to government subventions and distributors information campaigns. Clients need to be aware of the economic savings that these measures represent**

# Prioritised techniques

## Description of Demand Side Management proposals

Hourly discrimination

Social bonus

Electric car management

Social bonus		
Sector	Household	
Code	-	
Description	From 1 <sup>st</sup> July 2009, with the last resource tariff there is a grant that freeze energy prices up to 2012. One of the cases for adopt this tariff is having a contracted power less than 3 kW.	
Useful potential	●	To subscribe to this tariff, the only condition is that the client has to have power under 3 kW.
Savings potential	●	Reducing contracted power implies reducing total consumption (more efficient electrical equipment, new habits, tc.)
Demand Response Potential	●	There are few consumers with this tariff, so the global impact on the network is not significant. Similar initiatives, based on subvention to low power contracts could have more impact for the next years
Global valuation	●	Easy implantation of this initiative, good results in short terms
IPMVP scheme	-	
Related initiatives		
Comments	This is a practical example of how a price reduction policy can make the customer to change the contracted power, and so, the energy consumption	

This kind of initiatives offers a clear incentive to energy savings. A reduction in power contracted creates a reduction of energy consumption, and so, less investments in generation, transport and distribution

# Prioritised techniques

## Description of Demand Side Management proposals

Hourly discrimination

Social bonus

Electric car management

Electrical car battery charging management		
<b>Sector</b>	Household and services	
<b>Code</b>	-	
<b>Description</b>	Although nowadays electric cars have only testimonial representation, it is planned a huge raise of the amount of these cars on the Spanish roads. Experiments to know the impact of the charging process of these cars on the electrical mains are being conducted now.	
<b>Useful potential</b>	<input type="radio"/>	It is a problem that currently does not exist, but that is going to be necessary to face down, and so, it is necessary to design the most optimal solution
<b>Savings potential</b>	<input type="radio"/>	This measure is not aimed to generate savings, but to manage the impact on the electric mains that can suppose
<b>Demand Response Potential</b>	<input checked="" type="radio"/>	The uncontrolled charging of these batteries could cause huge overloads on the electric mains
<b>Global valuation</b>	<input checked="" type="radio"/>	High potential for the next years
<b>IPMVP scheme</b>	-	
<b>Related initiatives</b>	Hourly discrimination	
<b>Comments</b>	Proper management of these charges can minimize the impact on the net, avoiding consumption on peaks. Free use of the net to recharge electrical car batteries could imply the need of huge investments on new networks and reinforcement of the existing ones.	

The consumption of the daily charge of an electrical car battery is almost the consumption of a full household installation. The management of this process is an issue for the next years



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