

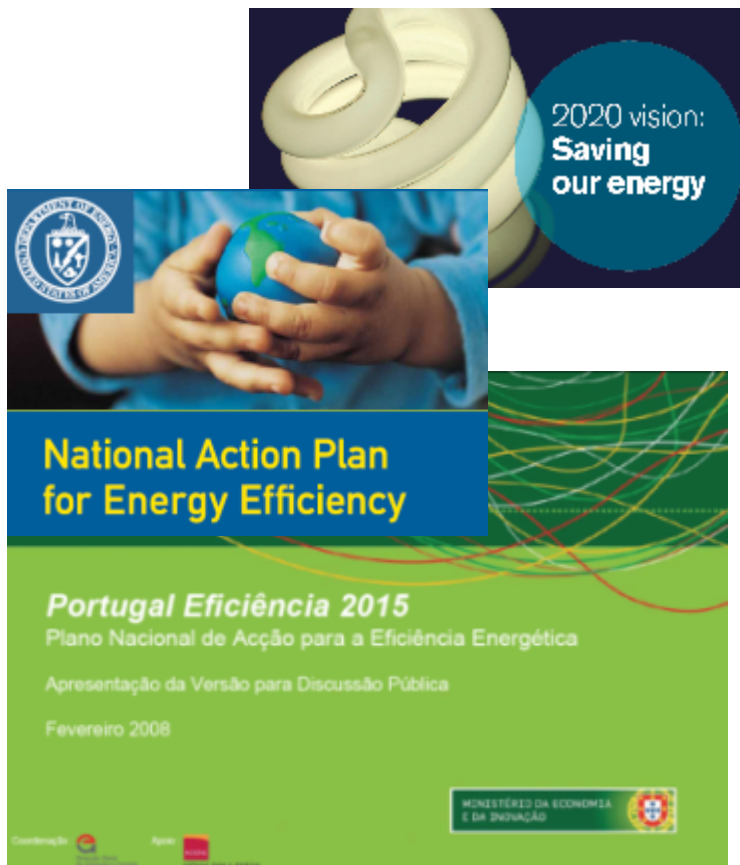
NEXT GENERATION ENERGY EFFICIENCY PROGRAM DESIGN

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Motivation

Several **countries and regions** are building **energy efficiency (EE) plans** in order to follow agreements to reach **sustainability targets**, decrease **energy dependence** and improve **efficiency of the economy**.



Evaluating several plans, it becomes clear that current planning practice is still missing :

- A transparent simulation method to **estimate** the **impacts** from **technology-oriented EE measures**;
- A methodology to **select** the most fitted sets of **measures**.

12 grandes Programas do Portugal Eficiência 2015

Com incidência em diferentes alavancas de eficiência energética

Tecnologias

Comportamentos

Transportes

1 Renove Carro

2 Mobilidade Urbana

3 Sistema Eficiência Transportes

Residencial e Serviços

4 Renove Casa & Escritório

5 Sistema Eficiência Edifícios

6 Renováveis na Hora e Programa Solar

Indústria

7 Sistema Eficiência Indústria

Estado

8 E3: Eficiência Energética Estado

Comportamentos

9 Programa Mais

10 Operação E

Fiscalidade

11 Fiscalidade Verde

Incentivos e Financiamento

12 Fundo de Eficiência Energética

Alavancas

- Adopção
- Acção
- Organização
- Valores

Transportes

1 Programa Renove Carro

2 Programa Mobilidade Urbana

3 Sistema de Eficiência Energética Transportes

- Reduzir em 20% o parque de veículos ligeiros com mais de 10 anos
- Reduzir em mais de 20% as emissões médias de CO₂ dos veículos novos vendidos anualmente (143g/km em 2005 para 110g/km).
- 20% do parque automóvel com equipamentos de monitorização (computador de bordo, GPS, *cruise control* ou verificação automática de pneus).
- Criação de plataforma inovadora de gestão de tráfego com rotas optimizadas por GPS
- Criação de planos de mobilidade urbana para capitais de distrito e centros empresariais com mais de 500 trabalhadores
- Transferência modal de 5% do transporte individual para colectivo.
- 20% do comércio internacional de mercadorias transferido do modo rodoviário para marítimo.

Residencial e Serviços

4 Programa Renove Casa & Escritório

5 Sistema de Eficiência Energética nos Edifícios

6 Renováveis na Hora e Programa Solar

- Programa de incentivo à reabilitação urbana sustentável, com o objectivo de ter 1 em cada 15 lares com classe energética optimizada (superior ou igual a B-).
- Programa de renovação de 1 milhão de grandes electrodomésticos
- Substituição de 5 milhões de lâmpadas por CFL
- Benefícios no licenciamento à construção eficiente (majoração da área de construção)
- 75 mil lares electroprodutores (165MW potência instalada).
- 1 em cada 15 edifícios com Água Quente Solar.

Indústria

7 Sistema de Eficiência Energética na Indústria

- Acordo com a indústria transformadora para a redução de 8% do consumo energético.
- Criação do *Sistema de Gestão de Consumos Intensivos de Energia* com alargamento às médias empresas (> 500 tep) e incentivos à implementação das medidas identificadas

Estado

8

Programa E3: Eficiência Energética no Estado

- Certificação energética de todos os edifícios do Estado
- 20% dos edifícios do Estado com classe igual ou superior a B-
- 20% da frota de veículos do Estado com emissões de CO₂ inferiores a 110 g/km
- *Phase-out* da iluminação pública ineficiente
- 20% da semaforização de trânsito com iluminação eficiente (*LED*)

Comportamentos

9

Programa Mais

10

Operação E

- Lançamento do "Prémio Mais Eficiência" para premiar a excelência ao nível das várias vertentes (ex. empresas, edifícios, escolas, entre outros).
- Conceito "*Mais* Eficiência Energética": "selo"/credenciação para identificar boas práticas em cinco vertentes: Casa, Autarquia, Empresa, Escola e Equipamentos.
- Aumento da consciencialização para a eficiência energética e mudança de comportamentos através de campanhas de comunicação e sensibilização (até 2 milhões de euros/ano)

Fiscalidade

11

Fiscalidade Verde

- Novo regime de tributação automóvel e fiscalidade sobre os combustíveis industriais
- Regime de amortizações aceleradas para equipamentos e viaturas eficientes
- Incentivos fiscais à micro-produção e alinhamento progressivo da fiscalidade com o Sistema de Certificação Energética dos Edifícios (ex. benefício em IRS a habitações classe A/A+)

Incentivos e financiamento

12

Fundo de Eficiência Energética

- Incentivo à eficiência no consumo eléctrico - incentivo aos clientes de maior consumo por contrapartida de prémio aos de menor consumo e do Fundo de Eficiência Energética
- Cheque eficiência: Prémio equivalente a 10% ou 20% dos gastos em electricidade durante 2 anos em caso de redução verificada de 10% ou 20% do consumo de electricidade
- Crédito bonificado: €250M/ano para investimentos em eficiência (enfoque reabilitação urbana)
- Dinamização de Empresas de Serviços de Energia através de incentivos à sua criação (QREN), concursos para auditorias no Estado e regulamentação do "Contrato Eficiência"

Efficiency planning as a choice problem



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Thermal insulation of roofs

Solar thermal

Photovoltaic

Cogeneration

Bus pricing

LED Street lighting

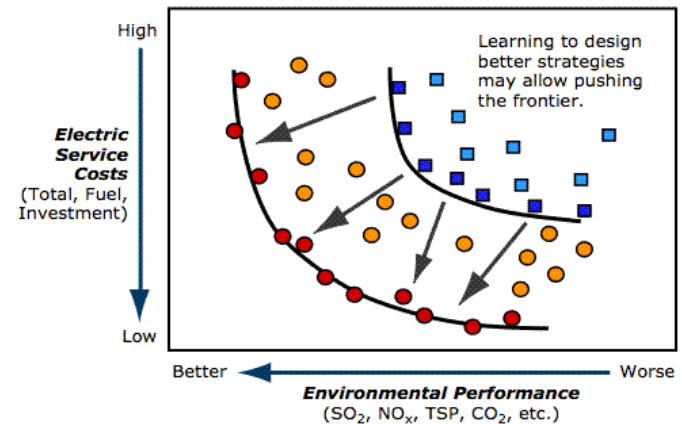
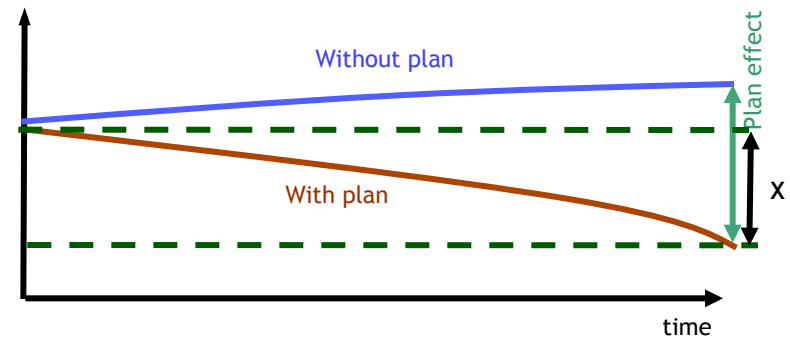
Pathways for bicycles

LED semaphores

Parking taxes

...

- Measure the effect of a plan by comparing with “the future without a plan”, not with the present;
- It is not enough to develop A plan that achieves the targets: It is important to develop Many alternatives and to choose the “best” one;
- The targets themselves can be subjected to cost-benefit analysis instead of being chosen still before knowing what they require;



The original PhD thesis contributions



- **Development of Method & Tool where decision makers can find the most fitted sets of measures in relation to their specified chosen criteria.**
- A method to structure and quantify the breakdown per energy end-use in the sectors of the economy, considering the different end-uses and energy carriers.
- A method to project a base-line scenario and compare results (EE scenarios and base-line) in the future.
- A methodology to compare and evaluate EE measures using a Multi-criteria approach.

The approach to the problem

1. Characterize the **end-uses**, their **technologies** and the respective **energy carriers**, from the main sectors in order to **model an energy system** (regional or national level).
2. Develop **physically-based** method to project **future demand**.
3. Systematic **identification** and **quantification** of **technology-oriented EE measures** inside each sector.
4. Identify criteria to evaluate EE measures.
5. Develop Method to compute impacts of sets of measures on future demand;
6. Develop MCDM evaluation platform;
7. Test in a case using Portugal



End-use breakdown model



12 End-uses
47 Technologies



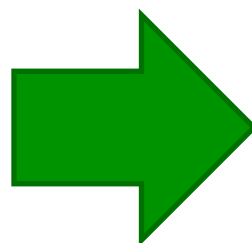
10 End-uses
55 Technologies



10 End-uses
28 Technologies



10 End-uses
37 Technologies



42 End-uses
177 Technologies

From end-use model to energy efficiency measures

Around **200*** quantifiable technology-oriented energy efficiency measures

End-use	Measures
Domestic Hot Water	Substitution of domestic hot water systems for most efficient natural gas storage water heaters
	Substitution of domestic hot water systems for most efficient electric heat pump water heaters
	Substitution of domestic hot water systems for most efficient solar water heaters + electric storage water heater
	Replacement of ambient heating systems for most efficient centralized natural gas heating
Ambient Heating	Replacement of ambient heating systems for most efficient centralized electric heat pump systems
	Replacement of ambient heating systems for heat distribution systems
Motors	Replacement of motor with output range between 0 and 0.75 kW for most efficient ones (EFF3)
	Replacement of motor with output range between 10 and 30 kW for most efficient ones (EFF3)
	Replacement of motor with output range between 130 and 500 kW for most efficient ones (EFF3)
Lighting	Substitution of lamps for most efficient compact fluorescent lamps
	Substitution of lamps for most efficient high intensity discharge lamps
	Introducing sensors and control systems
Process Heating	Increase the use of waste heating
Individual Transport by Road	Substitution of individual transports for most efficient hybrid gasoline cars
	Substitution of individual transports for most efficient CNG cars
	Substitution of individual transports for most efficient PHEV
Mass Transport by Rail	Substitution of trains for most efficient diesel trains
	Substitution of trains for most efficient electric trains
	Modal shift from bus to trains
Freight Transport by Road	Substitution of trucks for most efficient diesel trucks
	Substitution of trucks for most efficient CNG trucks

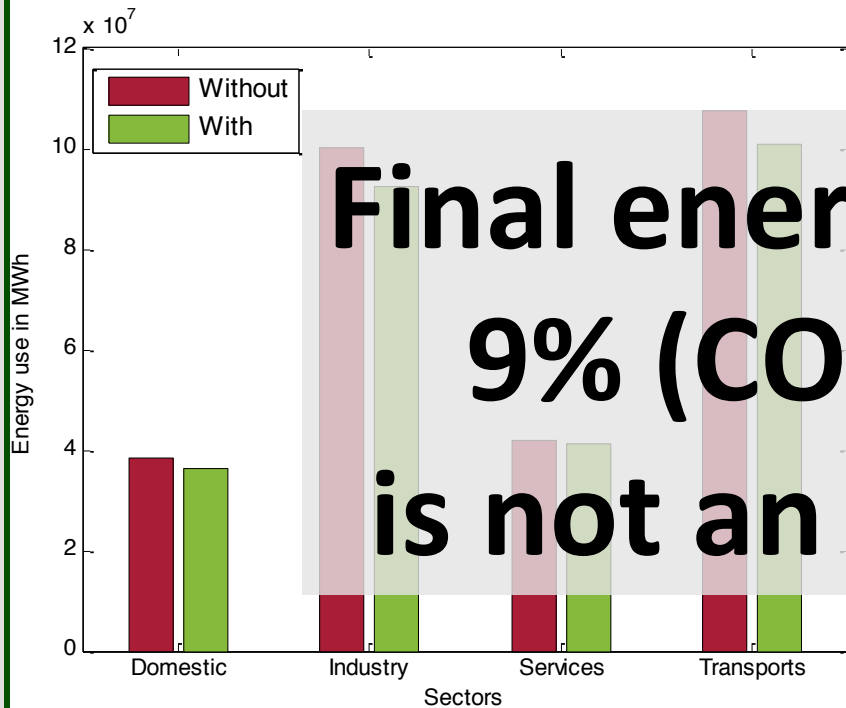
*1600 when considering specific technology and energy carrier substitution

Scenario assessment – test case 0

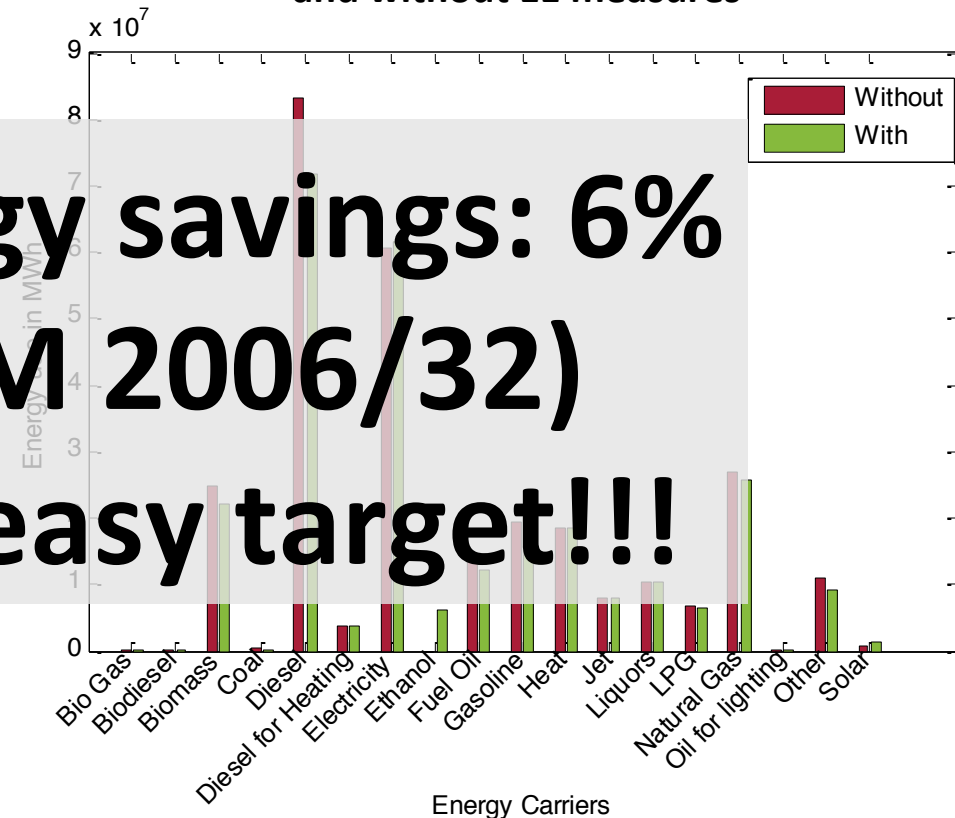
EE Scenario: Change of 10% of the stock relevant to each measure

Measures: Insulation of houses, changing windows, substitution of cold appliances, replacing electric motors, introducing electric and ethanol cars, solar hot water.

Energy use in Portugal in 2020 by sector with and without EE measures



Energy use in Portugal in 2020 by carrier with and without EE measures



**Final energy savings: 6%
9% (COM 2006/32)
is not an easy target!!!**

Methodology to collect objectives and attributes

This work follows alternative-focused supporting value-focused thinking¹ to identify desirable decision criteria or attributes to evaluate alternatives.

Alternatives: Energy efficiency measures or groups of energy efficiency measures constrained by target(s).

Three decision makers were interviewed:

- Prof. Oliveira Fernandes, representing AdEPorto
- Eng. Paulo Calau, representing ADENE - PT
- Eng. Raymundo Aragão, representing Brazilian EPE

Main sources from bibliographic review:

- Directive 2006/32/EC of the European
- L.M.P. Neves, Avaliação multicritério de iniciativas de eficiência energética, Universidade de Coimbra, 2004.
- E. Brown, G. Mosey, Analytic Framework for Evaluation of State Energy Efficiency and Renewable Energy Policies with Reference to Stakeholder Drivers, NREL, 2008.

1: R.L. Keeney, Value-focused thinking: Identifying decision opportunities and creating alternatives, European Journal of Operational Research. 92 (1996) 537-549.

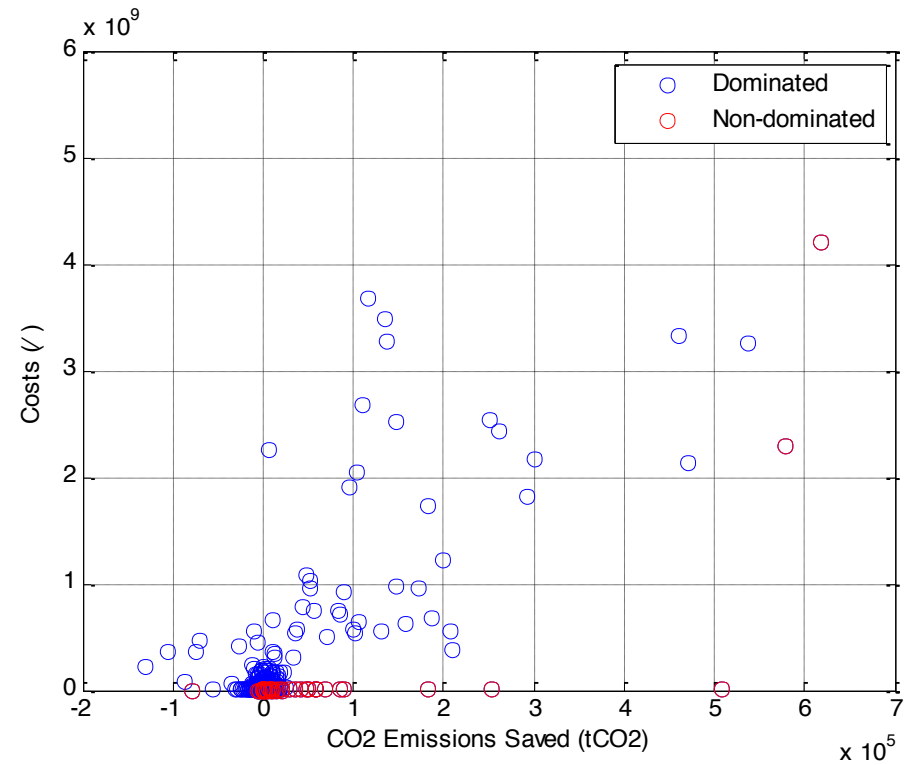
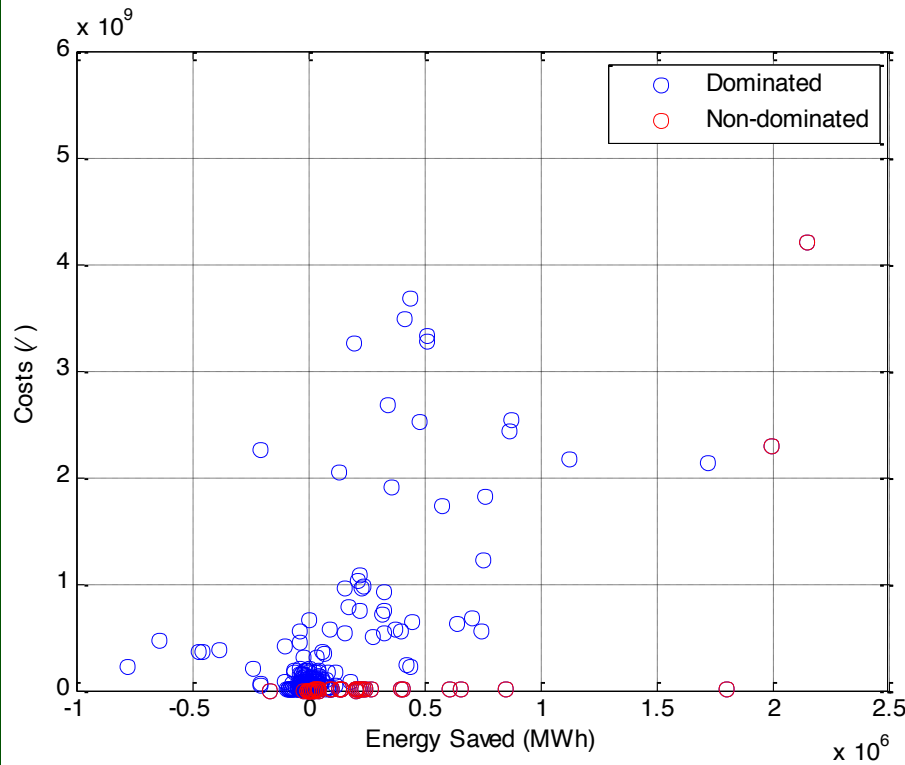
Objectives and attributes

Objectives	Attributes	DM
Minimize CO2 emissions or maximize emissions saved	A natural attribute is emissions saved in tons of CO2	1,2,4
Minimize payback time	The Payback period	2
Maximize the security of supply / secure of economy	A natural attribute is imported energy saved or imported energy not used. If harmonization is needed this can be measured in savings per cost.	1,2,3,4
Maximize the duration of measures (lifetime)	This is measured by the expected lifetime of a measure (lifetime of the technology)	1,3,4
Minimize implementation costs	This can be measured in total costs of a measure or costs in relation to energy not used	3,4
Maximize local air quality / Minimize health problems	A natural attribute is the particulates (PM10 or PM2.5) from energy use.	4
The minimize peak load / avoid building new power plants	A proxy attribute can be electricity saved, since the methodology followed to build the energy system accounts energy use by total energy used per energy carrier per year and not in an hourly basis.	4

Prof. Oliveira Fernandes (1) from AdEPorto, Eng. Paulo Calau (2) representing ADENE, Eng. Raymundo Aragão (3) from EPE and 4 refers to bibliographic review.

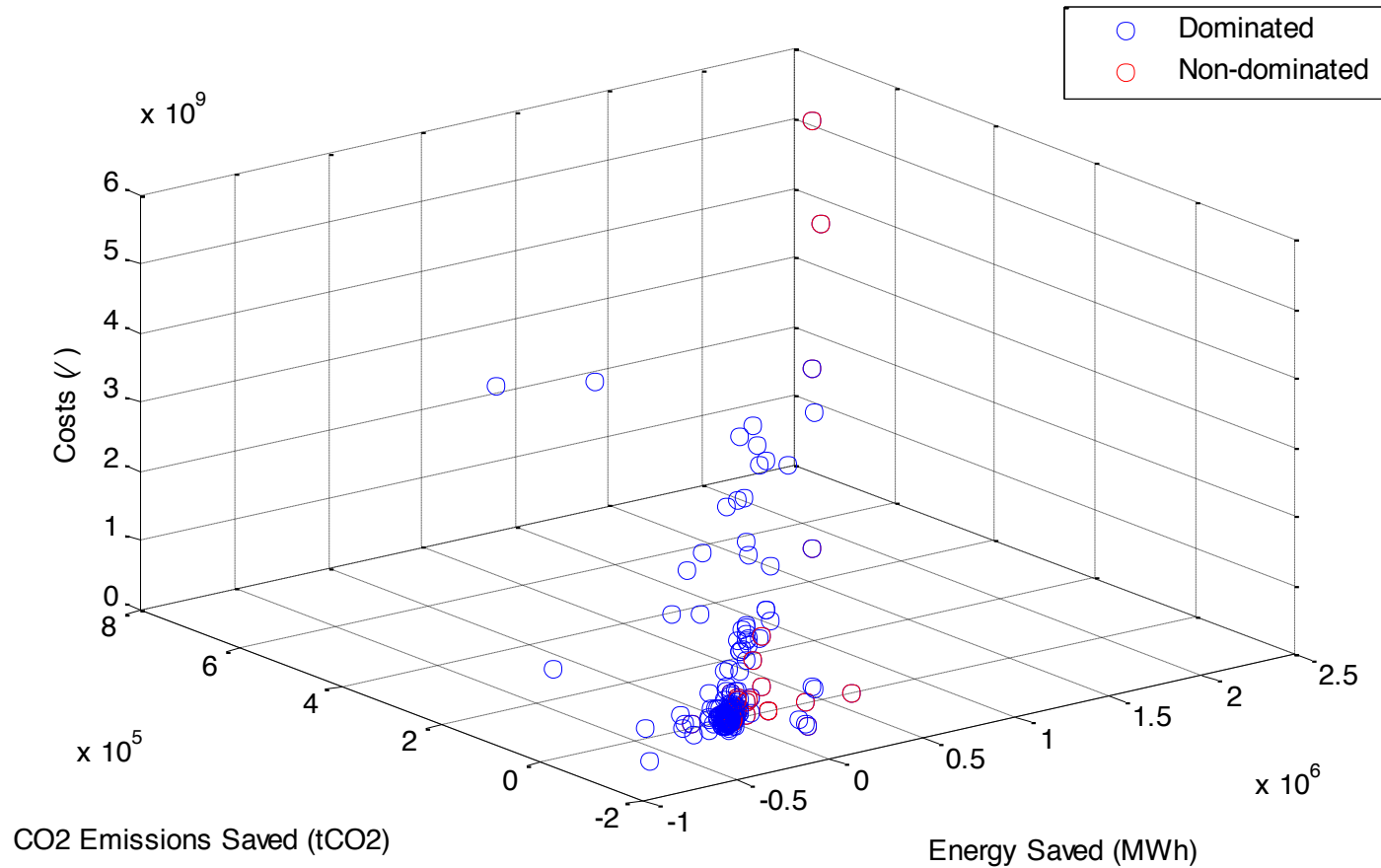
Some Results – non dominated measures

1600 measures evaluated for all 4 sectors



Some Results – non dominated measures

1600 measures evaluated for all 4 sectors



Ongoing work

- Upgrading tool to estimate the impact of EE measures in all 7 criteria
- Performing a multi-criteria “screening” process to select the most-fitted measures to form EE plan sets
- Multi-criteria evaluation of EE sets to choose the most relevant



Possible integration with GIP



Model Based on:

- Identifying the main end-uses
- Identifying the end-uses drivers
- Identifying technologies to satisfy the end-uses
- Finding methods to translate drivers into energy use

Possible identification of most fitted technology-oriented EE measures to apply to GI to fulfill desired targets

Drivers	Proxy values (Portugal - 2006)	Examples of data sources
Needs of hot water per day per household	111 l	Surveys, studies
Temperature difference between the cold water and desired hot water	45°C	Statistics, studies
Ownership of the technology or the end-use by energy carrier	%	Surveys, studies, statistics
Number of households	3,829,464	Statistics
Number hours of use per light point per household per year	236	Surveys, studies
Number of light points of each technology	5 (Halogen) 4 (CFL) 3 (Fluorescent Tube) 13 (Incandescent)	Surveys, studies
...
household size	107 m ²	Statics, surveys, studies

Thanks