"White and Green":

Comparison of Market-Based Instruments to Promote Energy Efficiency in End-Uses

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SUSTAINABLE ENERGY STRATEGIES

All sustainable energy strategies are based upon three main points:

1. Improve the efficiency of energy utilisation
2. Develop and diffuse renewable energy sources of energy
3. Introduce new efficient and clean ways of using traditional sources (fossil and possibly nuclear)

Improve Energy Efficiency

- Improving energy efficiency is motivated by considerations of security of supply, of economics, of environmental and health protection and as a component of long-term stability of the global climate.
- The proposed EU Directive on Energy End-Use Efficiency and Energy Services is a concrete step in this direction. The proposal is aimed at saving 1% per year (cumulative) as a consequence of energy efficiency measures for final consumers in the domestic and tertiary sectors, industry (except energy-intensive industries included in the Emissions Trading Directive), and transport.
- Energy efficiency is also addressed by the directive on Energy Efficiency in buildings and the one on Combined Heat and Power Production.

Changes in the institutional environment

- Liberalisation of the energy markets
- Privatisation of state-owned energy companies
- Lack of money for incentives
- The general trend is a shift from “command and control” instruments to market mechanisms

BUT

Not all has been working as desired

Problems

- Short-term problems like black-outs in the UK, in Sweden, in Italy and in the US
- Energy prices did not always decrease as envisaged and expected; sometimes they even increased
- Long-term goals are not going to be met by market forces alone (security of supply, climate stability)

Hence…

There is a need to regulate the market by introducing corrections that take into account social needs and long-term goals

Categories of P&Ms

1.) RD&D

2.) Awareness

3.) Capital incentives and remuneration
Investment schemes, fiscal measures, feed-in

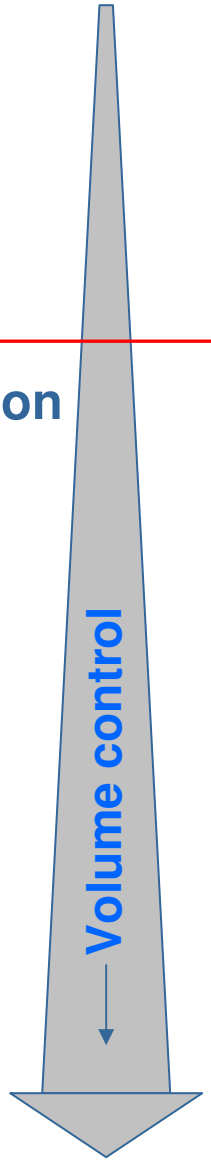
4.) Negotiated/voluntary agreements

5.) Labelling

6.) Standard setting

7.) Taxes

8.) Certificates



"Command & control":
Prescribed macrogoals

"Upfront measures"

Subsidies

Organisational measures

Per se: Awareness, but
usually in symbiosis

Prescriptive

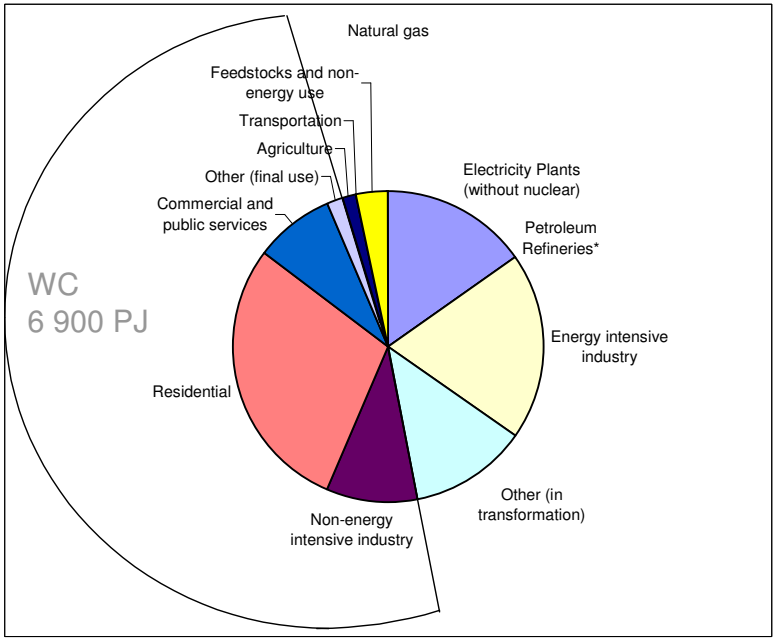
"Market-based"

White&Green

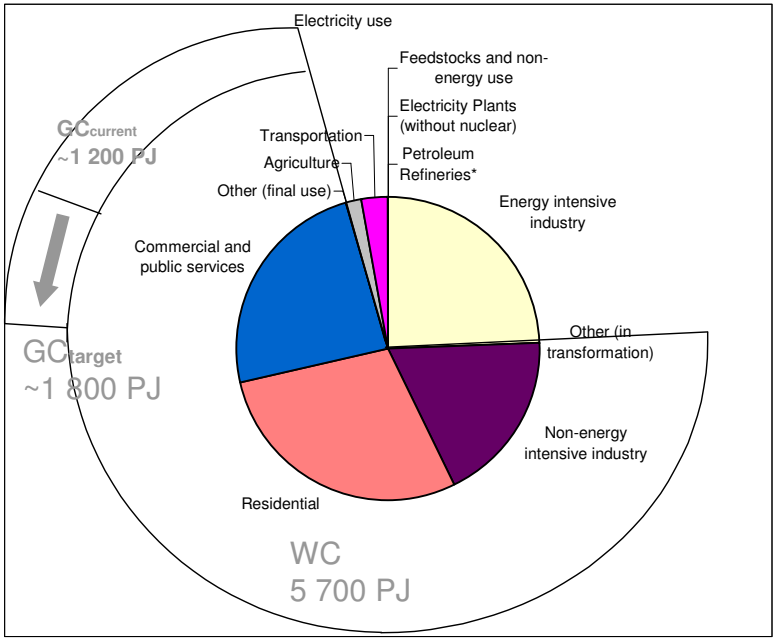
Measures selected for in-depth analysis

- White certificates
- Tradable Emission rights (or “black certificates”)
- Green Certificates
- Energy taxes
- (Smart standards)

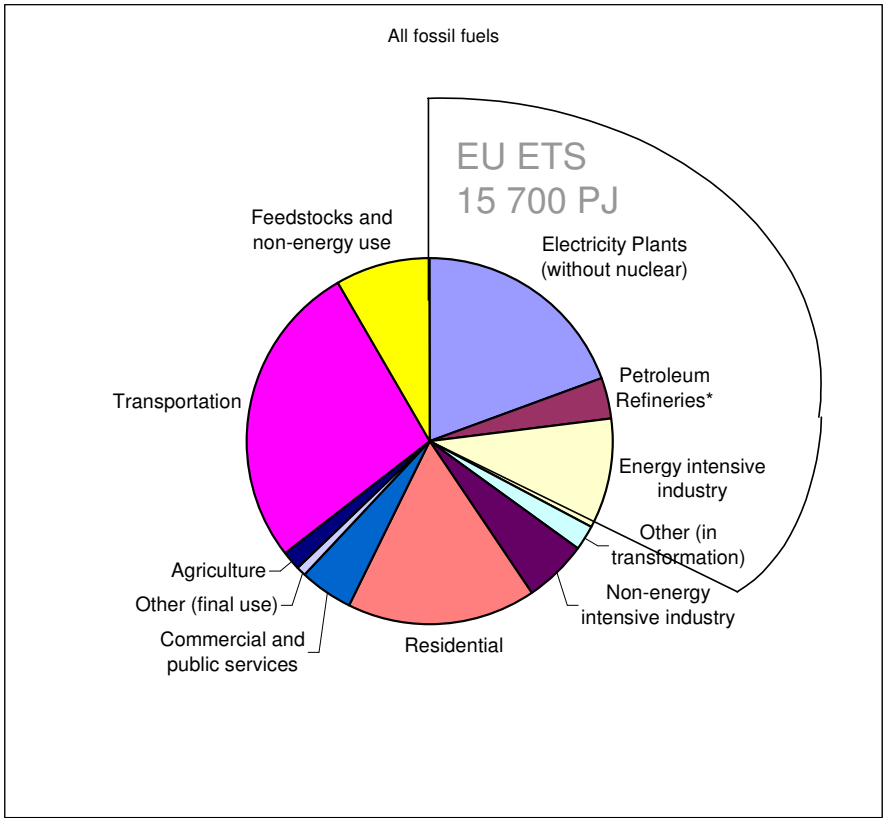
Natural gas



Electricity



All fossil fuels



Coverage of innovative policy measures in the European Union (EU-15) by the year 2000

	Fossil fuel PJ	Electricity PJ	Primary energy equivalents*) PJ	CO_2 emissions**) million tonnes CO_2
WC, Smart	6,900 (nat. gas)	5,700	21,150	940
GC	--	1,800 ***)	4,500	550
ET	15,700	---	15,700	1,230

*) Estimated adding up the fossil fuel use and the electricity demand in primary energy terms (assuming a conversion efficiency of 40% for the latter)

**) Estimated by assuming CO_2 emission factors for fossil fuels according to the IPCC Guidelines for National Greenhouse Gas Inventories, IPCC/OECD/IEA, Paris, 1997). For electricity, a value of 97 kg/GJel was estimated.

***) Estimated by multiplying total electricity use in the EU in 2000 with the EU-15 target by 2010 (22.4%; see also Johansson and Turkenburg, 2004)

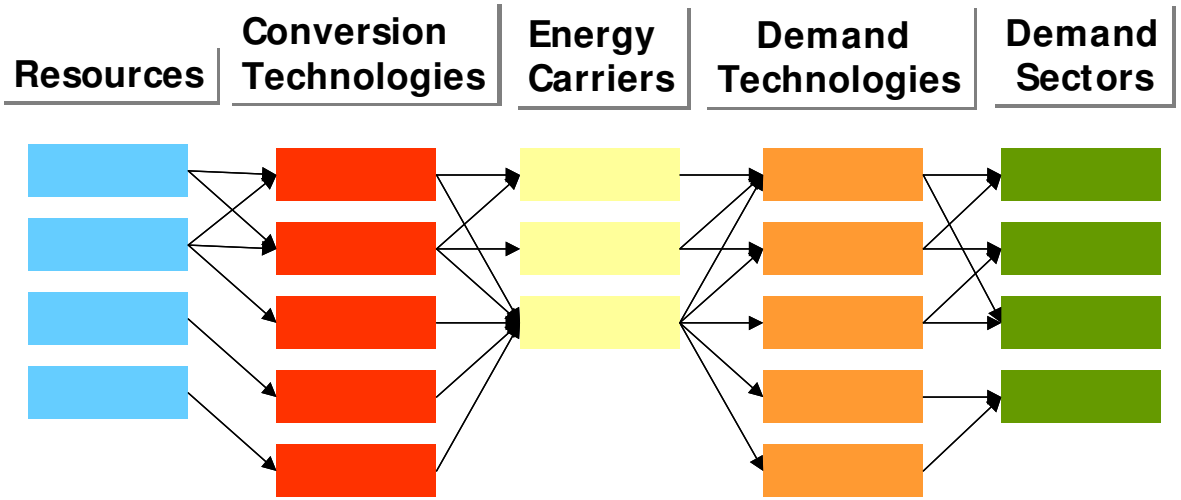
Methodology of the modelling work

- The impact of the policies has been evaluated by means of different models built with ETSAP tools, the MARKAL methodology.
- MARKAL is a generator of economic equilibrium programming models of energy systems and their time development. Supply/demand curves of commodities are specified by stepwise linearised functions. Each step refers to a different technology providing/consuming the commodity. The minimum and maximum length of each step (quantity) is imposed by the market potential of each input/output technology and fuel. The height of each step (cost) depends on the costs (investment, fixed operation and maintenance, or fixed and variable O&M) of each input/output technology and fuel.

The MARKAL model generator

- MARKAL (MARKet ALlocation) has been developed by the Implementing Agreement of the International Energy Agency for a Programme of Energy Technology Systems Analysis (IEA/ETSAP).
- Two international teams based at Brookhaven National Laboratory (USA) and Kernforschungsanlage Juelich (Germany) implemented jointly the first version in the late seventies.
- The "*Second Assessment Report*" of IPCC (IPCC, 1995) suggests using MARKAL models to evaluate possible impacts of mitigation policies.
- The source code is open, regularly maintained and documented.
- The most recent versions of the tool are considerably more powerful and rich of options; they are documented together with the users' interfaces at www.etsap.org and in several related web sites.

Scheme of MARKAL model



Drivers for demand of energy services

Driver	No	2000	2005	2010	2015	2020	2025
GDP (1997 Billions US$)	1	9312	10,378	11,694	13,125	14,724	16,395
Population (Millions)	2	389	391	391	389	387	385
GDP/Population	3	24	27	30	34	38	43
Housing Stock Total (Millions)	4	148	152	155	158	161	164

S

Commercial Sector	2000	2010	2020	2030	Driver	Elasticity
Cooling	1217	1368	1540	1628	1	-0.15 ~ -0.05
Cooking	124	133	141	143	3	-0.05 ~ 0
Space heat	1380	1478	1560	1586	1	-0.1 ~ 0
Hot water	573	614	648	659	1	-0.1 ~ 0
Lighting	4078	4585	5162	5454	1	-0.15 ~ 0
Office equipment	398	613	949	1154	1	-0.05 ~ 0
Other	131	134	137	139	1	-0.15
Refrigeration	187	200	212	216	3	0

Advantages of MARKAL

- The same MARKAL toolkit is used to create models of systems
- o with few or thousands of energy commodities, materials, emissions and technologies,
- o including all energy sectors from primary reserves expressed in PJ to energy services, expressed in specific units, such as passenger.km or in tons of steel,
- o extended to many regions interlinked together in multi-regional models with endogenous trade,
- o limited to the energy supply sector and/or selected sectors of final energy demand (partial equilibrium) or extended to the full economy (general equilibrium, MARKAL-MACRO versions),
- o at increasing level of equilibrium: from nearly simulation modes, to intra-temporal equilibria and myopic view, to inter-temporal perfect foresight allocation of capital investments and decisions, to endogenous learning.

Limitations of MARKAL

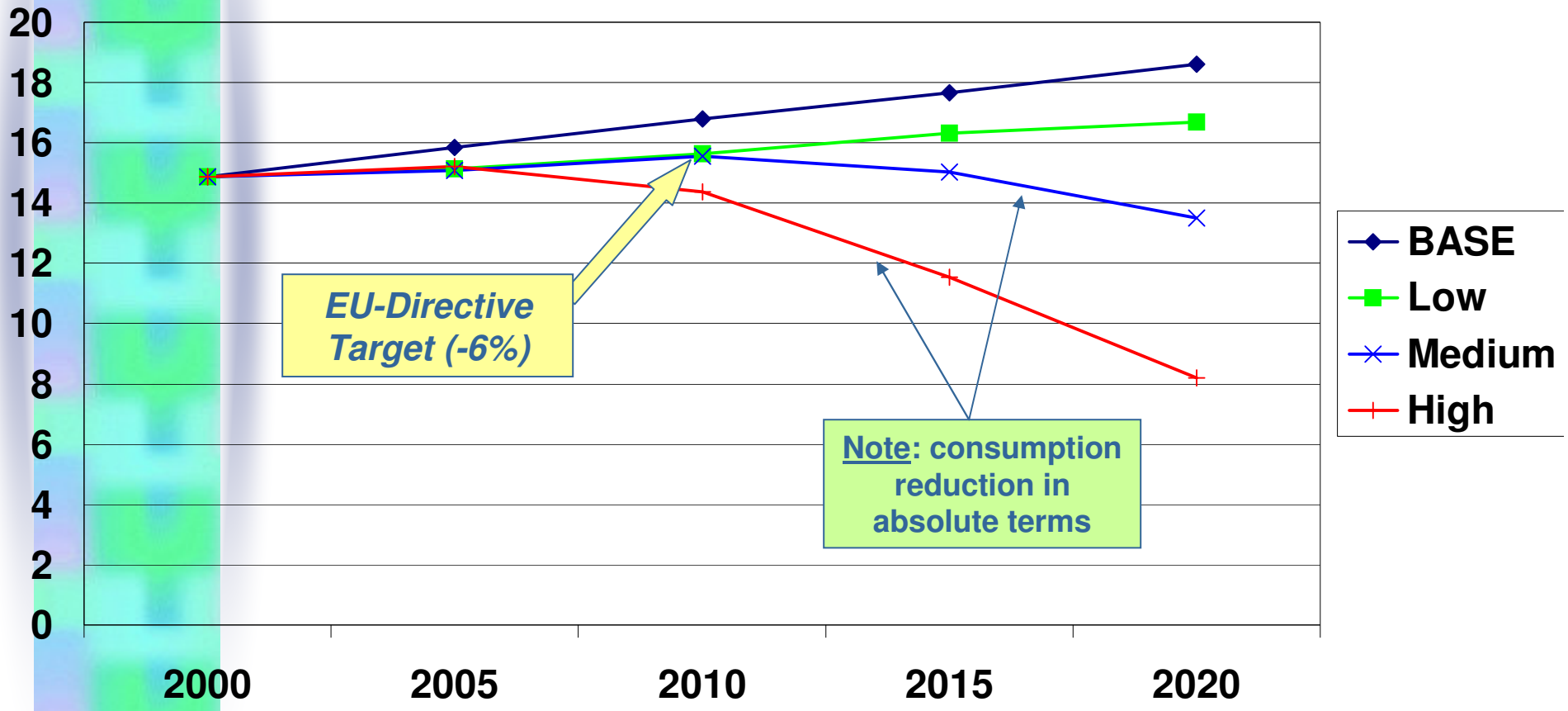
MARKAL has limited capabilities to estimate the following economic issues:

- Effects of market imperfections
- Number of participants (buyers and sellers)
- Price speculations
- Participants' savings (difference between the marginal cost of domestic actions vs. the market price of the certificate or permit)
- Traders and risk takers

Furthermore, the specific MARKAL-generated models used in this study do not include:

- Transaction costs and
- Volume of certificates banked

WEU Markal model - White Certificates Scenarios
Residential and Commercial Sector
Final Energy Consumption (EJ)



White Certificates scenario selected indicators for different targets

		Residential&Commercial Sector Final Energy Consumption						
		annual average reduction	cumulated reduction	annual average reduction	cumulated reduction	Average Energy System Cost	CO2 Emission Reduction (Mt CO2)	CO2 Emission Reduction (% of b.a.u.)
		'04-'10	*2010*	'10-'20	*2020*	2000-2020	2010÷2015	2010÷2015
TARGETS	Low	-1%	*-7%*	-0.35%	*-10%*	-4%	-160	-5%
	Medium	-1%	*-7%*	-2%	*-27%*	+4%	-230	-7%
	High	-2%	*-14%*	-4%	*-56%*	+16%	-340	-11%

Some results: saving energy may save money…

- For the EU-15+ market there is a financial potential of increasing energy efficiency by 15% until 2020 ("zero-cost target"); in other words, the average unit cost of the energy system, following the application of a WCS for a reduction of 15% (-3 EJ) of the overall energy consumption of residential and service sectors with respect to BAU, is equal to the average unit cost of the energy system in the BAU case; in other words, the increase of the energy efficiency is free of cost;

For less ambitious targets, and in particular for the 1% per annum for 6 years target defined by the EU directive proposal, the cost of the energy savings is negative and, by freeing resources, it involves a positive impact on GDP growth

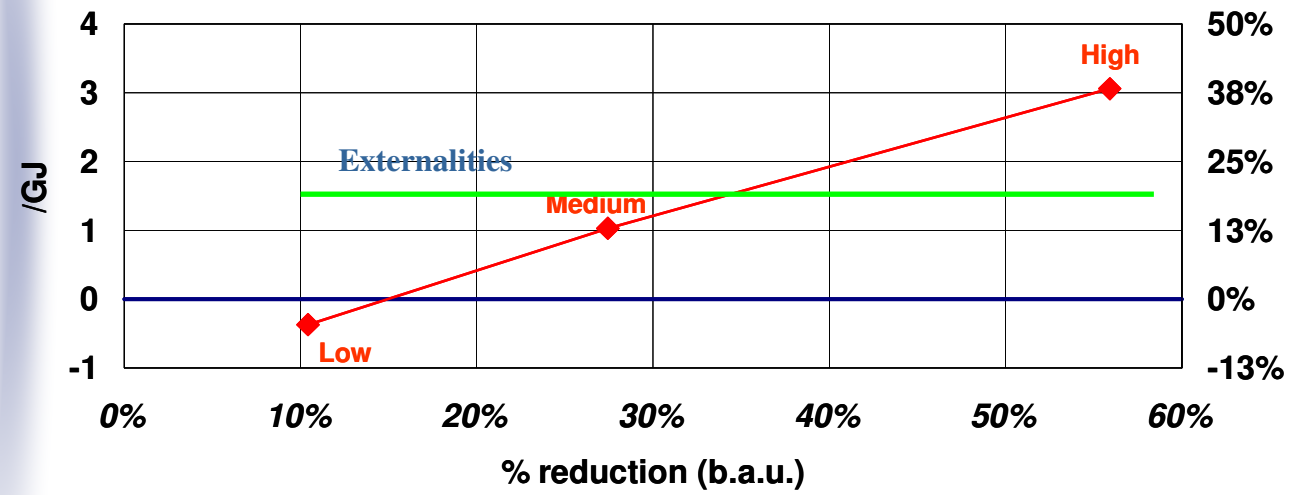
If the target of energy saving in the residential and service sectors is greater than 1% per annum (cumulative) until 2020, the cost of the energy savings may become positive; for instance, a target of 1% until 2010, then of 2% from 2010 to 2020 ("medium target") implies for the year 2020 a reduction of consumption by 5 EJ (-27% of BAU) and an increase of the average unit cost of the energy system of 1 €/GJ (+13%)

…but one should also include externalities!

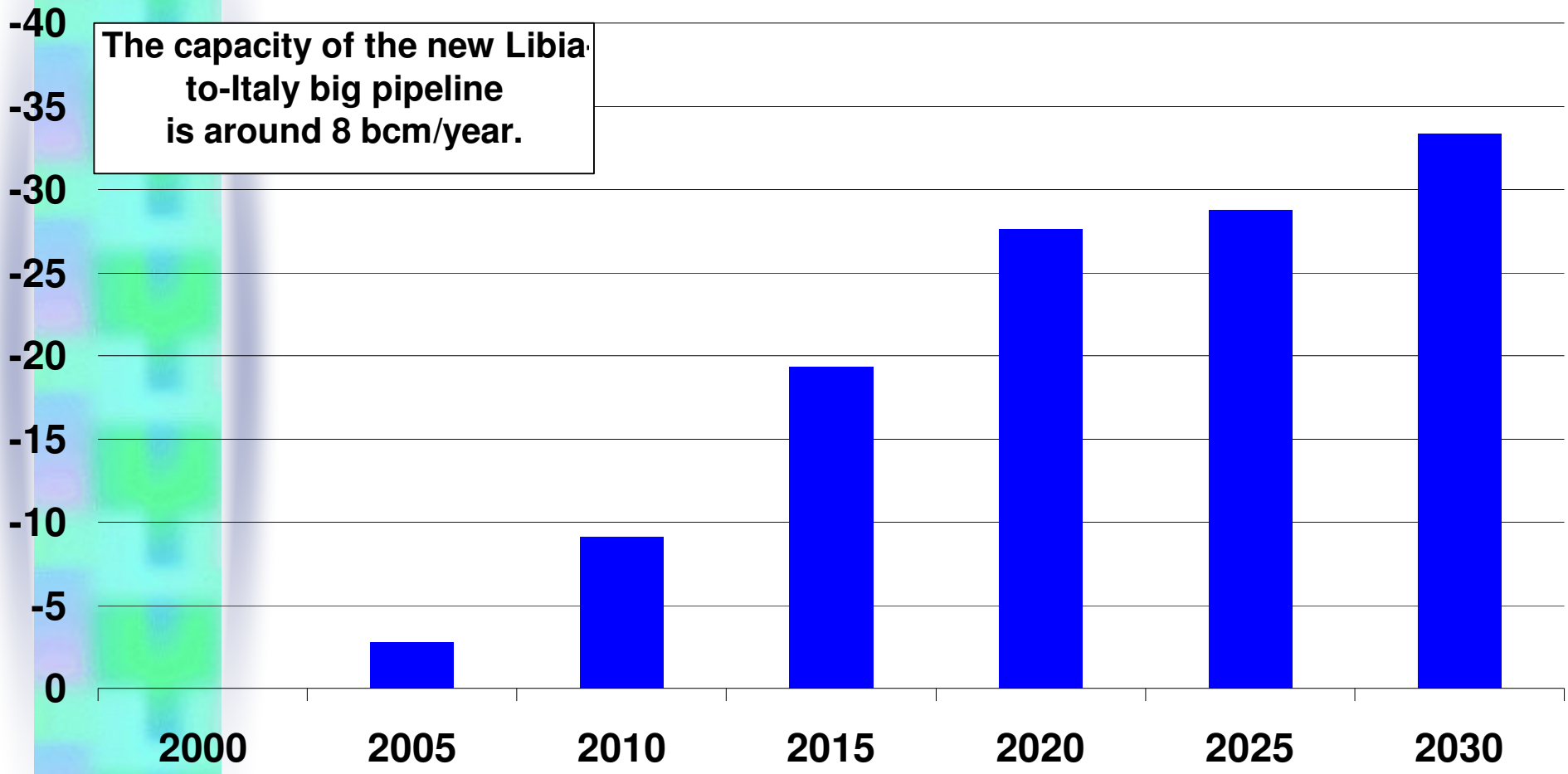
- Very ambitious targets have relatively high costs, but are technically possible; for instance, a target of 2% per annum until 2010 and of 4% per annum between 2010 and 2020 ("high target") brings to more than halving the energy consumption of the residential and service sectors with respect to BAU (-56%), with an increase of the average system unit cost of 38% (or 3 €/GJ).

However, these evaluations do not include externalities. If the environmental and other externalities were taken into account, one would evaluate an economic potential of energy saving much higher than the 15% indicated above, which is "zero cost" only in strictly financial terms

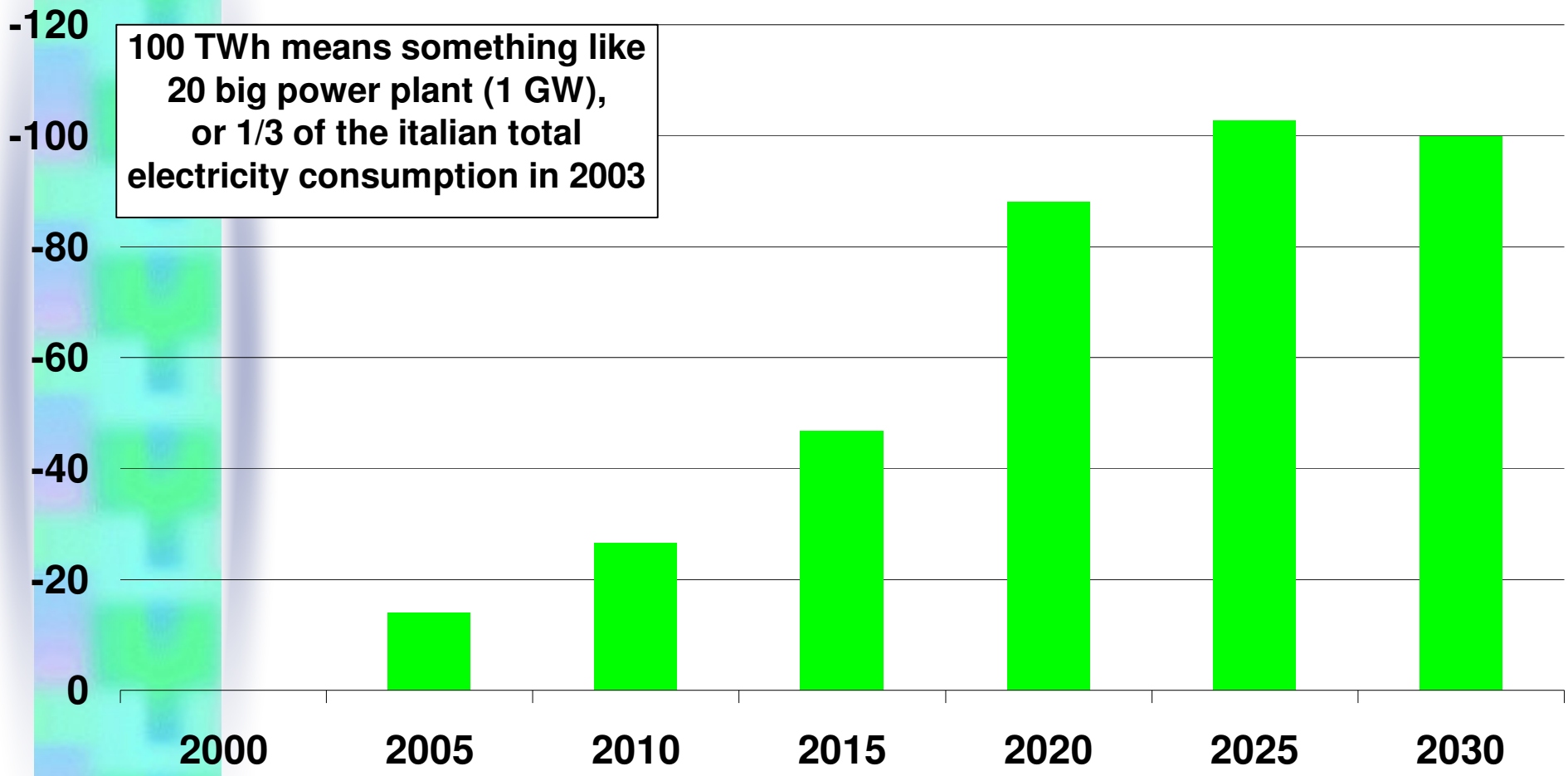
WEU Markal model - White Certificates Scenarios
Residential and Commercial Sector
Trade-off curve:
total (R&C) final energy saved in 2020 (% of b.a.u. scenario) vs.
average energy system cost increase (/GJ and %) in 2020



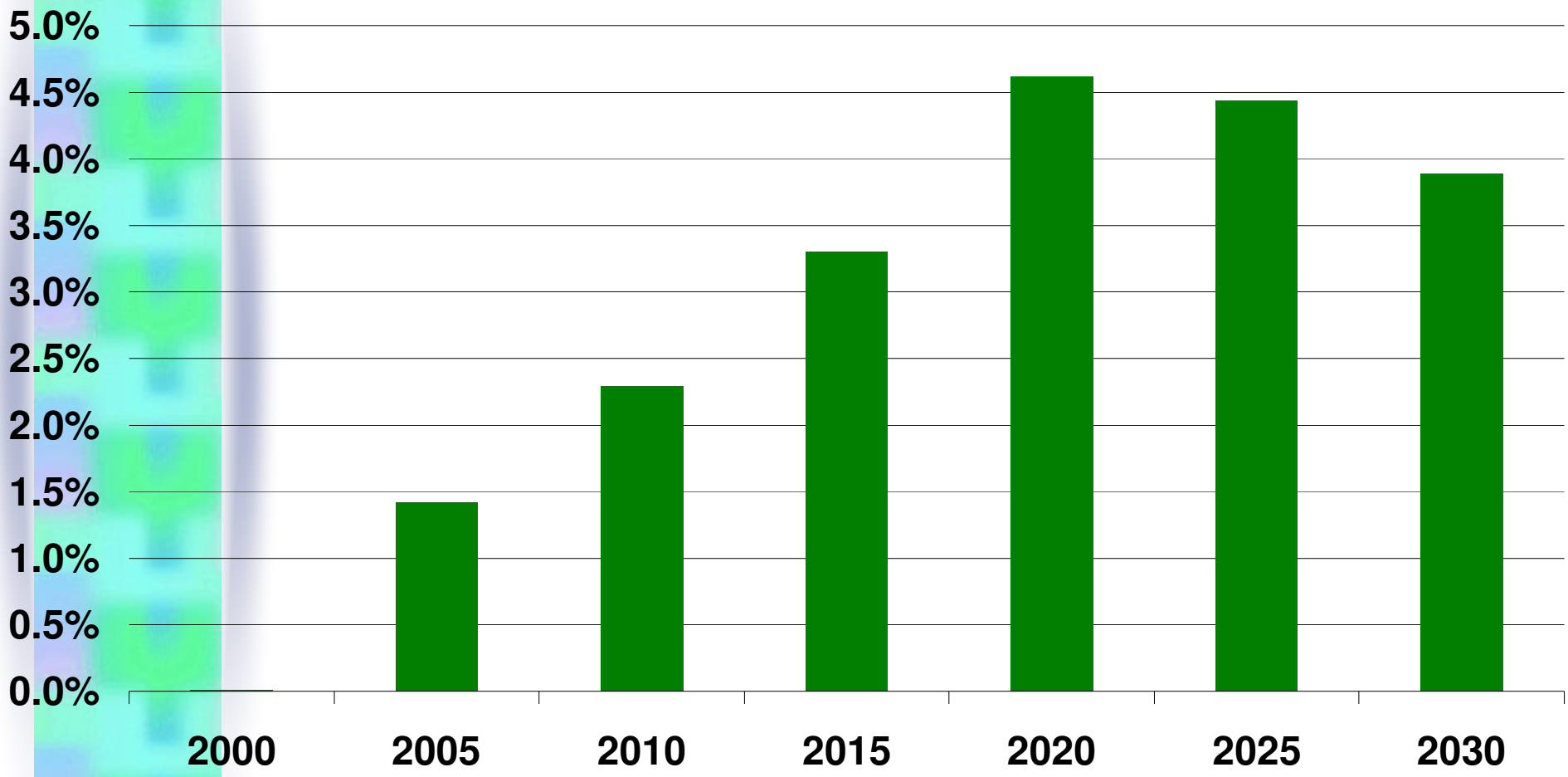
Total natural gas savings in residential and commercial sectors (bcm/year)



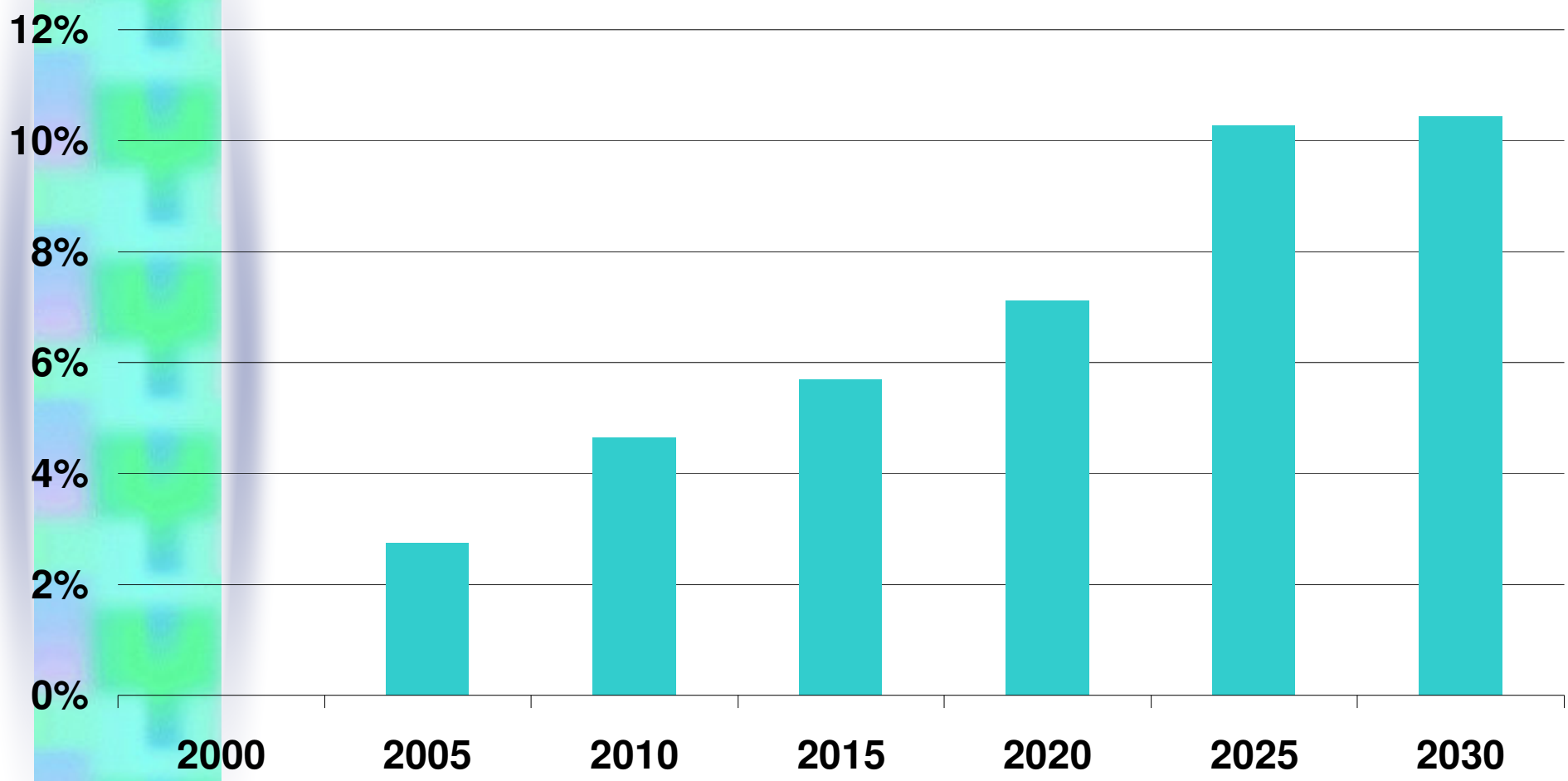
Total electricity savings in residential and commercial sector (TWh/year)



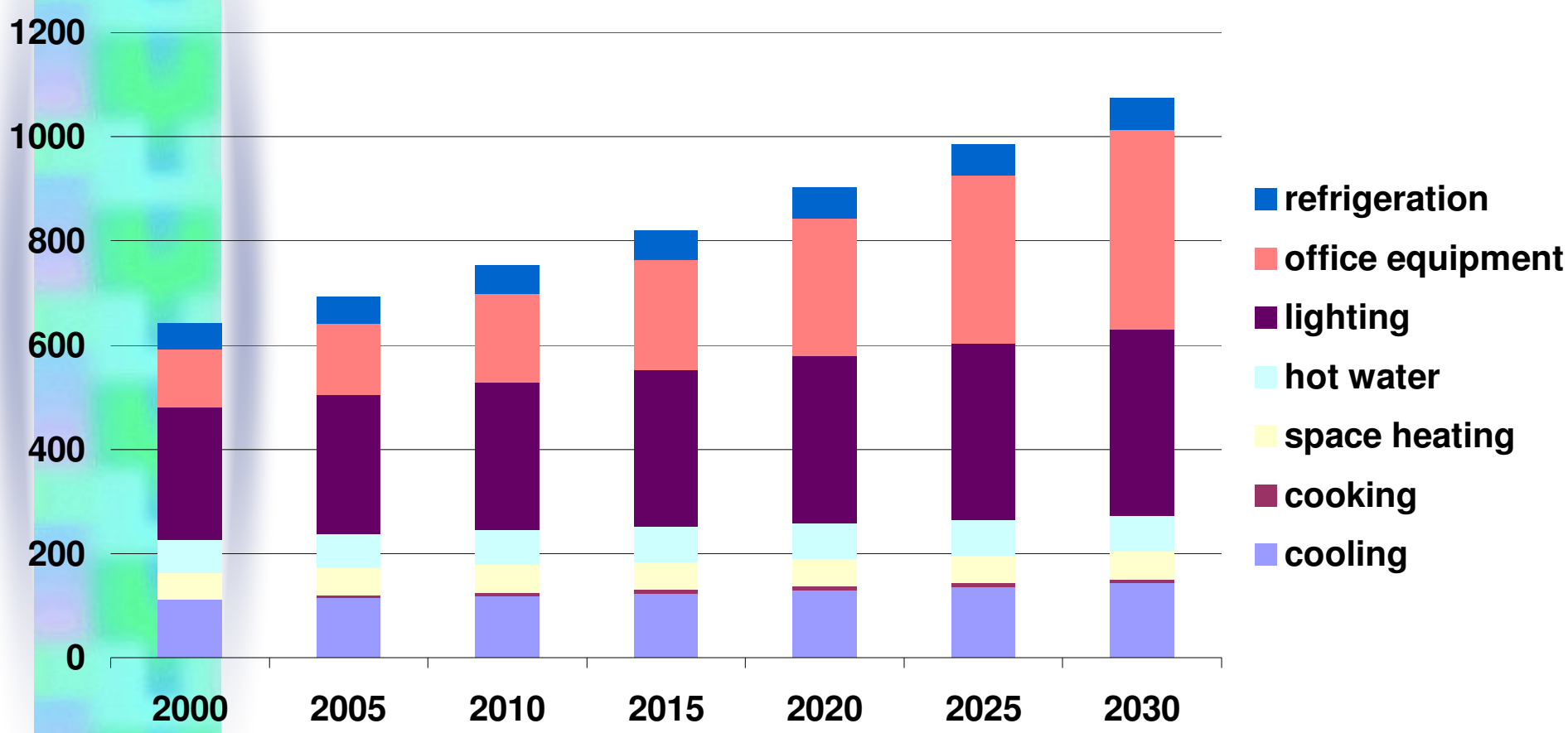
Undiscounted total energy system cost growth in White Certificates scenario (%/year)



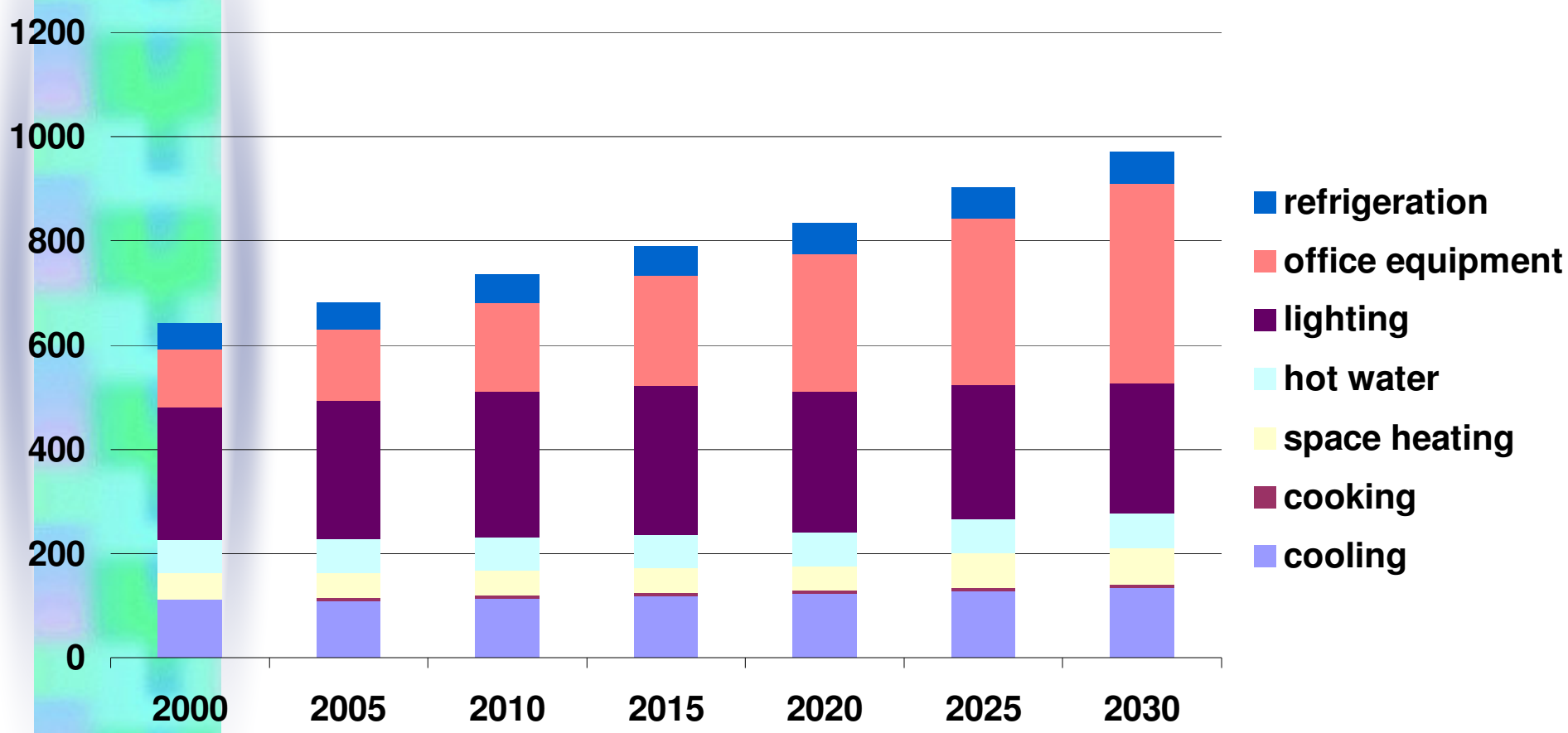
Undiscounted total investments in demand technologies
White Certificates scenario vs Base Case (%/year)

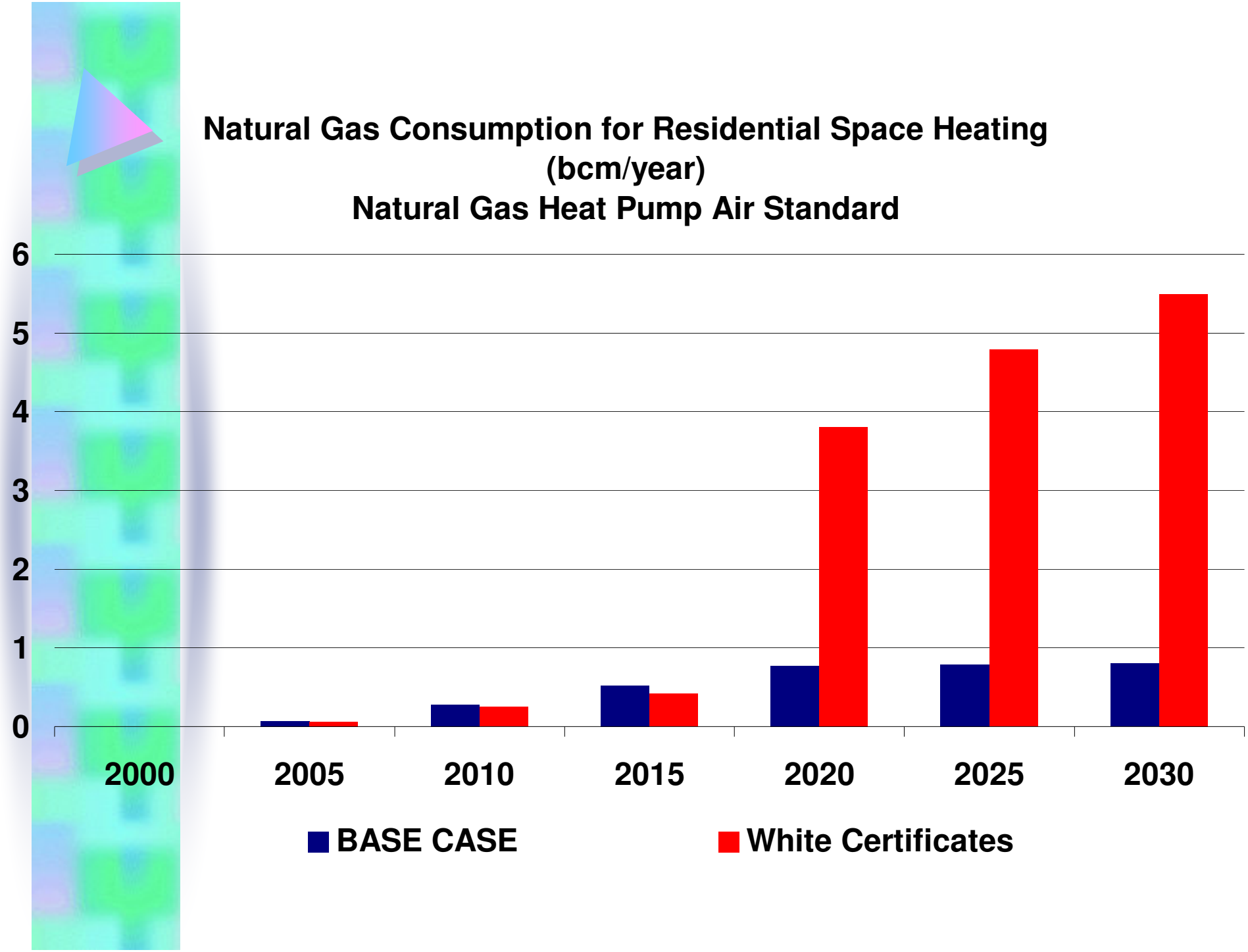


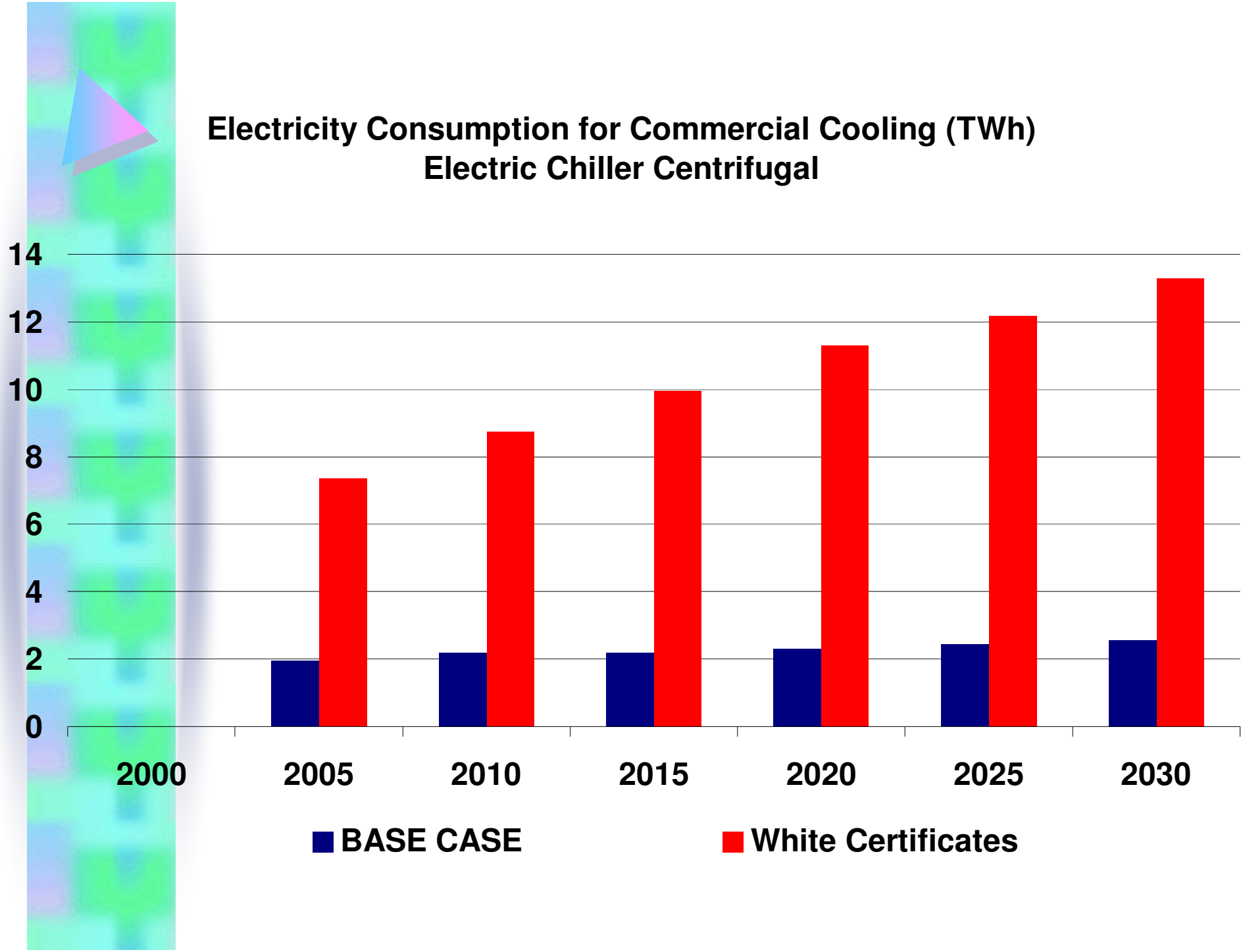
BASE CASE
Total electricity consumption in commercial sector by energy service demand (TWh/year)



WhC SCENARIO
Total electricity consumption in commercial sector by energy service demand (TWh/year)




Natural Gas Consumption for Residential Space Heating
(bcm/year)
Natural Gas Heat Pump Air Standard
6
5
4
3
2
1
0
2000
2005
2010
2015
2020
2025
2030
BASE CASE
White Certificates


Electricity Consumption for Commercial Cooling (TWh)
Electric Chiller Centrifugal
14
12
10
8
6
4
2
0
2000
2005
2010
2015
2020
2025
2030
BASE CASE
White Certificates

To take into account market imperfections…

The definition of a base proved in itself to be at the same time difficult and enlightening. The MARKAL approach is an equilibrium approach seeking an economic optimisation, and assuming that market forces will automatically bring to this (dynamic) equilibrium. The actual situation is different, and does not correspond to an optimal solution, insofar as economically (and financially) convenient technological solutions do not diffuse as much as the optimisation would require. This points to the fact that there are imperfections in the market, especially when one considers the level of single households. This brought to an approach that takes into account the market imperfections and financial aspects (difficulties of access to credit, scarcity of capital available for investments etc.) not through constraint equations, but by introducing an apparent discount rate applied to the investments in new energy technologies in the residential and service sectors.

…an “apparent” discount rate is introduced

By comparing the results of the simulation with reality, we found that a discount rate of **about 30% per year** has to be assumed in order to explain the limited diffusion of “convenient” energy saving technologies.
Such apparent discount rate (much higher than the system's "social" discount rate), has proved to simulate well the displacement of the system from the economic optimum in the business-as-usual scenarios. The application of the White Certificate system, coupled to well-targeted and diffused information campaigns, and to simplified and publicly guaranteed access to credit, should cause the apparent discount rate decrease, tending to the value of the social discount rate. This approach can be considered as one of the relevant accomplishments of the project.

Opportunities and barriers for White Certificates

There is a nearly unlimited range of opportunities to increase energy efficiency. Many of these opportunities are highly cost-effective, with payback times of one or two years (e.g. most of the thermal insulation projects, compact fluorescent lamps, avoidance of stand-by losses) and are profitable in their own rights. The fact they do not diffuse rapidly points to important market imperfections. The most important is lack of information: most people and organisations do not know what options they have for saving energy, or get incomplete or distorted information. With the exception of energy-intensive industry, energy costs are not high enough for actors to bother about saving energy. Another important barrier is organisational and financial: it is much more difficult and more costly to find funding for a high number of small interventions than for one large intervention of the same total amount. The sharing of costs and benefits between owners and renters is also a problem. Further, in many cases it may be difficult to find a reliable operator to contact in order to make this intervention. Finally, there may be other kind of barriers such as inadequate building codes, obsolete norms etc.

Need for accompanying measures

As a consequence, policy action is required. The WC system cannot be implemented in isolation: it must be accompanied:

- by information campaigns and other means to promote opportunities of energy saving;
- by facilitating the setting up of subjects that are able, qualified and certified to implement certain types of intervention, typically the Energy Service Companies, or ESCOs, which may also aggregate a large number of similar interventions both to make use of economies of scale and to present the aggregation as a lump for financing;
- finally, efforts must be made to remove non-technical, non-financial barriers that impede the diffusion of economically sound solutions.

Implementation of White Certificate systems: in the UK….

- One of the main difficulties for the WC scheme is its high transaction costs for evaluation, monitoring and certification.
- It may be expensive and not always easy to estimate & verify the energy saved by a project with respect to a baseline (which evolves with time).
- In the UK this difficulty is overcome by admitting only a finite set of interventions, with standardised energy savings, and baselines calculated and agreed beforehand
- This approach drastically reduces the complication of the system and the transaction costs,
- But it has the disadvantage of reducing the range of possible interventions and efficiency technologies admissible.

…and in Italy

In Italy the WC system is intended to be more flexible and more extended, but it pays for this with higher transaction costs and with technical and political difficulties, such as:

- Establishing rules for valuation of “open” (not pre-defined) projects
- Uncertain roles of regional governments vs. central gvt.
- Sceptical attitude of electricity and gas distributors (the “obliged parties”), which prefer selling commodities rather than services
- Unresolved question whether distributors should be allowed to perform post-meter interventions (antitrust)
- Evaluation of the results of information campaigns.

Rebound effects

- The result of a WC system may be lower than expected because of the "**rebound effect.**"

More energy efficiency

⧖

Less cost for service

⧖

More demand for services

⧖

Less energy saved

Rebound effects (2)

- Actually, the rebound effect may come from 2 sources:

1. Direct: since the cost of the service is lower, there is more demand for the same service (elasticity)
2. Indirect: spending less, frees some money which is spent for something else, which will have some energy content.

- The direct effect may reduce the expected savings by a maximum of 40%, but many services are rather inelastic (e.g. “white goods”, or home appliances). 20% seems a reasonable assumption on the average
- The indirect effect is more difficult to evaluate, but it is unlikely to be higher than 10%
- A MARKAL calculation for Italy has shown a 27% rebound effect for a specific case

The Emission Trading System

- The ET is very clearly defined in the EC directive, and the implementation may be very effective, in the sense that it sets a cap (decreasing with time) to emissions (in the sectors concerned) and by imposing adequate penalties ensures that the policy goal is met.
- However, the initial phase of implementation is the allocation of emission permits to each plant involved, which has proved to be a non-trivial endeavour.
- Transaction costs should be relatively low. However, the financial cost of this instrument may be high, and in particular it becomes very high if the emission cap is lowered significantly, as apparent in the simulation results.
- The reason for that is that energy-intensive industries, which make up the bulk of the obligated parties, have been aware for a long time of the burden of the energy cost on their total costs, so they have generally already introduced those energy efficiency measures that appeared to be cost-effective

Opportunities for ETS

- Opportunities for adopting new technologies and processes with higher energy efficiency do exist in some energy-intensive activities (such as steel production) but this "leapfrogging" is generally justified only when new plants are being built, which is quite uncommon in the EU for such industrial sectors.
- In the medium to longer term, however, this situation is likely to change, with an expected increase in the number of replacement investments in energy-intensive industries as present plants approach the end of their useful life, or major overhauls are needed, and as highly efficient new technologies are increasingly available on the market at lower costs.
- Kyoto's flexible mechanisms (JI and CDM) offer other opportunities in countries that have only recently introduced market economy, and where little attention was given to energy efficiency in the past even for energy-intensive industry.

Green Certificates

- Green Certificates were introduced in this study not so much for themselves, but for the indications they may give for W.C.
- For instance, the experience with GC is that only a small fraction of the GC is actually traded on the market
- The mechanism of GC is very different in the various countries; a EU market of GC is difficult to reach
- One of the problems encountered is that other energy sources (as for instance combined heat and power production) are “assimilated” to RES, lowering the value of the GC and making the incentive they provide completely inadequate to support their diffusion
- The GC systems are presently under scrutiny and criticism, but the problems are more in their implementation than in the system itself.

White Certificates vs. Emission Trading

White Certificates

- Goal: Energy saving
- Policy obj.: Energy security, environment, economics
- Includes fuel substitution only if it saves primary energy; does not include CO_2 seq.
- Sectors involved: residential, commercial, possibly medium-low E-intensive industry
- Does not include energy industry
- Saves energy, reduces pollution and often also GHG emissions

Emission Trading

- Goal: Reduce CO_2 emissions
- Policy obj.: Global climate
- Includes: fuel substitution, CO_2 sequestration
- Sectors involved: High energy-intensive industry
- Includes energy industry
- Reduces GHG emissions and may save energy

omparison of (fossil) energy saving vs. CO_2 emission reductions

or different policy instruments - year 2020, EU-15+, intermediate scenarios

	otal CO_2 mission *(Mt CO_2)* eduction	otal fossil nergy *(Mtoe)* aved	CO_2 saved er toe *t CO_2/toe* aved
lack certificates	245	57	.3
reen certificates	188	67	.8
hite certificates	216	91	.4


and, to conclude…
SOME
RECOMMENDATIONS!

Energy-climate co-ordination

- 1. There is ample space for increasing energy efficiency in all sectors of final energy utilisation as well as in energy production and transformation, so as to contribute to all energy and environmental goals while promoting rather than hindering economic development. USE THIS SPACE!!
- 2. Environmental, climate and energy policy should be more strictly co-ordinated than in the past; all impacts of an energy-related policy on climate, economy, environment, health, security of supply, competitiveness, employment etc. should be considered at the same time with appropriate weights, which are the result of general political decisions.
- 3. In particular, action in the domain of energy should be carried out jointly by Ministries responsible for Energy and those responsible for Environment at all levels (Member states, Commission, Regional and local governments).

EU coordination – and aim higher!

4. Guidelines on the design and implementation of energy efficiency measures, and in particular of the White Certificate systems, should be issued at the EU level, and the performance of the different systems at country and regional level monitored and benchmarked, so as to help in their further development and diffusion. If this system is going to diffuse in the EU Member states, it would be important to ensure that they develop in a compatible manner, allowing for a EU market, and avoiding the difficulties inherent in the GC situations where many non-compatible schemes have been adopted.

5. The quantification of energy-saving objectives should be quite more ambitious than has been the case so far both at the EU and at the Member-state levels and related to the overriding objectives of energy security, health and environment, and climate change mitigation.

Many different instruments are required

6. An energy efficiency policy (and more generally a sustainable energy policy) requires a number of different policy instruments and not just one. Norms, regulations and incentives are necessary and have their role; however, market-based instruments, properly designed and implemented, should be used as widely as possible.
7. Specific instruments should be employed for heat and power generation (in particular district heating), for biofuels and for energy valorisation of wastes
8. While the ET system appears adequate to cover the energy-intensive industrial sectors, the White Certificate system now considered for the residential and commercial buildings seems more adequate for reaching new sectors, in particular the industrial sectors with medium and low energy intensity; it is suggested that this system should progressively be extended from the domestic and the service sectors to industry.

The transport sector lags behind

9. The transport sector is still waiting for market-oriented mechanisms to improve energy efficiency; although great progress has been obtained in terms of the energy efficiency of single vehicles, this has been more than compensated by the increase in the demand for private transport, larger average size of cars and in many cases worse traffic congestions, and little or nothing has been achieved in terms of transport systems and modal shifts. Inventive thought is required in this direction; new ideas and experimentation should be encouraged; an eventual extension of a WC-like system to transport should be evaluated.

Implementation of White Certificate systems

10. The evaluation of projects should be standardised as much as possible and be based on simple and agreed criteria to calculate the base-line, as done in the UK and proposed for most technologies in Italy so as to simplify procedures and reduce transaction costs. Due to the importance of transaction costs for the success of WC schemes, R&D in this direction is recommended. Progressive implementation of the WC scheme, gradually introducing new technologies and new sectors, may be considered.

11. In order to have an effective implementation of a White Certificate system, a parallel or preliminary action is needed to eliminate or at least reduce market imperfections: this is a task for national and regional governments. The first step should be through effective and objective information campaigns, starting from the residential sector, where the largest potentialities are present.

ESCOs and financing

12. There is generally a lack of effective and objective structures to carry out the field work required for demand side management. Such Energy Service Companies (or ESCO) should be the backbone of a WC system, which creates a market for their services. However, this market has been slow in stimulating the birth of such companies, or the expansion of those which are already present. Public support in the start-up and in the first phases of ESCOs is recommended, as is a system of qualification of ESCOs that can guarantee the client of their competence and ability to deliver. Investing in ESCOs also brings benefits in terms of job creation.

13. Financial barriers have been recognised as one of the main obstacles to the introduction of energy saving measures, even when they are cost-effective. Provisions to facilitate financing of such measures by bundling similar projects, or by guarantees through a rotating fund should be introduced by the banking system with public back-up.

14. Legislative and normative constraints slowing down the penetration of effective energy-saving measures should be identified and removed whenever possible; such barriers may be present for instance in (outdated) building codes, in unnecessary safety regulations or in competition-protecting rules.

15. Energy efficiency can not only be the right solution for the long-term energy system (e.g. by reducing import dependence and hence increasing security of supply) but also provide the quickest and most effective response to unbalance between energy supply and demand (e. g. in order to avoid blackouts). Schemes to remunerate energy efficiency as a “power credit” should be explored.

R&D on energy efficiency is needed!

16. **Technological development** is a pre-condition for a sustained improvement in the efficiency of energy use. Long-term energy scenarios as those considered in the present work show that the gradual improvement of the technologies available or being studied today will not be sufficient to feed the efficiency improvements needed beyond 2015 or 2020. **Fundamental research on many aspects of energy utilisation** and innovative approaches are needed and should be supported.

THE WHITE & GREEN PARTNERSHIP THANKS YOU FOR YOUR ATTENTION!