Economic analysis of energy efficiency programs in Italy

An investment analysis is performed on the two most important Italian energy efficiency initiatives, the 55% Tax Deduction (55%TD) and the White Certificates or Energy Efficiency Certificates (EEC) programs, estimating the investments made and the annual energy and economic savings resulting from the initiatives. Both multiyear programs stimulated significant energy savings, estimated at 56,000 GWh of secondary energy over the useful life of investments in the case of the 55%TD, and 97,000 GWh for the EEC. Total public and private costs of the two initiatives are 13 euro cents/kWh of saved energy for 55%TD, and 4 euro cents/kWh in the case of EEC. Although the EEC program is most effective, there are valid reasons for maintaining both. The greatest danger for the continuation of these successful programs, in the present Italian situation, is to rely too heavily on public financing. Even if the Energy Efficiency Certificates program is more difficult to manage with its requirement of long-term planning, it is the nearest to zero public cost, being financed through energy taxes

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Analisi economica dei programmi di efficienza energetica in Italia

Nell'articolo è riportata l'analisi degli investimenti sui due maggiori programmi italiani di efficienza energetica, la detrazione fiscale del 55% e i Titoli di Efficienza Energetica (TEE) o "Certificati Bianchi", concessi a fronte dei risparmi energetici ed economici conseguiti. Entrambi i programmi pluriennali hanno dato impulso a cospicui risparmi energetici: circa 56.000 GWh di energia secondaria per tutta la vita utile degli investimenti nel caso delle detrazioni fiscali del 55% e 97.000 GWh per i TEE. I costi pubblici e privati delle due iniziative ammontano a 0,013 euro/kWh di energia risparmiata per le detrazioni fiscali del 55% e 0,04 euro/kWh nel caso dei TEE. Sebbene questi ultimi siano più efficaci, esistono validi motivi perché possano coesistere entrambi anche se, nell'attuale situazione italiana, l'eccessiva tendenza a fare affidamento sul finanziamento pubblico rappresenta il pericolo maggiore per la prosecuzione di questi validi programmi. Pur essendo più difficili da gestire, richiedendo una pianificazione a lungo termine, i TEE sono più vicini all'azzeramento del costo pubblico, perché finanziati direttamente dalle imposte sull'energia

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This well-known program began in 2007 and has been extended through 2012. Published data exist for 2007, 2008 and 2009 and the report of the Ministry of Economic Development and ENEA [9,10] permits a comparison of the three years. The energy savings are calculated for the average investment for the different technologies represented by the subsections 344, 345, 346 and 347 of the law "Finanziaria" [8].

A methodological issue regards the conversion of the energy savings, which are reported in primary energy, to secondary energy and the cost to the home dweller. In the ENEA on line guide for technicians [6], the installers are given guidelines for the estimation of primary energy savings Qpr, given the savings in the thermal dispersion:

$$Qpr = \frac{\Delta Qa}{\eta g}$$

where ηg is the product of the single efficiencies.

The guidelines state to use a value between 0.65 and 0.80 for ηg. It is preferred to use the upper value of 0.8 to avoid any underestimation of the secondary energy savings. Natural gas, which was used in 74% of the cases, is taken as the main secondary source. The average price of natural gas of 7 cents €/kWh is used to calculate home dwellers savings according to data from the European Commission [7].

The net present value (NPV)[1] of the various types of investment is calculated taking the average cost of capital typical of long-term (10 year) Italian Treasury Bonds, for 2007, 2008, and 2009. These vary between 4.4% and 4.7%. Nominal energy prices are hypothesized to increase at an average rate of three-percent per year. More approximate measures of investment return, such as the payback time that do not have these complications are also calculated.

The results for the single average investments are shown in Table 1.

The net present value without the tax credit is negative for all except two investments, the integrated requalification of buildings in 2009 and solar thermal investments in 2008. These energy saving investments do not have the profitability that we would expect.

The payback times are also quite long in many cases exceeding the useful lifetime of the investments.

Instead, calculating the net present value of the private cost of the investment, which takes into consideration that the home dweller receives the tax deduction, one sees a mixed picture: eight have a slightly negative NPV and six are positive. Those with greatest negative NPV, with respect to the cost of investment, are concentrated in comma 345. Naturally, the point where the private NPV becomes positive is sensitive to the effective discount rate. For example, with the energy price growth rate to five percent per annum, without any increase in the cost of capital, only five categories remain with negative net present values. The conclusion is that in order for the investments to have positive returns for the private home dweller, the incentive is necessary. The investment without the 55% tax credit is anti-economic except in two out of fourteen cases.

As the 55%TD legislation specifies no limit to profitability, or the lack thereof, of the investment; it is not known if the investment data is accurate or if additional work has been performed within the home to raise the total cost and amount of deduction. For example, after these intrusive investments, it will often be nec-

Type of Investment and year	Payback without tax credit (years)	Net Present Value without tax credit (euro)	Net Present Value with tax credit (euro)
Integ. Requalif. (Art. 344)			
2007	40	-26,652	-2,668
2008	19	-3,910	8,266
2009	11	7,416	12,784
All Types (Art. 345)			
2007	46	-8,085	-1,874
2008	50	-8,593	-3,723
2009	50	-7,466	-3,151
Solar Therm. (Art. 346)			
2007	27	-2,447	1,037
2008	16	374	3,124
2009	18	-126	2,604
Winter Clim. (Art. 347)			
2007	18	-4,008	1,041
2008	20	-5,560	-847
2009	24	-6,681	-1,796
Others			
2007	43	-15,592	-2,363
2008	40	-16,429	-5,313

Source: elaboration by authors of data ENEA

TABLE 1 Analysis of Average Single Investments of 55% TD Program

Year	Number of Investments	Annual energy savings, end of 2009, primary energy (Mtoe/yr)	Lifetime energy savings, secondary energy (GWh)
2007	106,000	0.15	10,578
2008	245,000	0.37	26,654
2009	236,723	0.29	18,994
Sum	587,723	0.79	56,227

Source: elaboration by authors of data ENEA

TABLE 2 Analysis of Total Investments of 55% TD Program

essary to repaint large areas. Re-flooring or re-roofing may also be appropriate. Obviously, the new legislation for 2012, which lowers the present value of the deduction by extending them to ten years, goes in the direction of more economically acceptable deductions.

The data for the average individual investments are multiplied times the total number of investments made each year to give the total investments. This in turn permits the calculation of the annual savings and lifetime savings, as shown in Table 2.

The annual totals the sum over the three years are impressive: in only three years 587 thousand investments have been made and 0.79 Mtoe of annual savings of primary energy have been realized by the end of 2009. During 2010, another 0.3 Mtoe/year may be added, bringing the total annual saving to 1.1 Mtoe/year by the year 2010. From 2007 through 2010 about 2.5 Mtoe have been saved. The state may have been overly generous in its incentives for energy efficiency in this program, assuming that the energy investment costs have been somewhat overstated, however it acted as a stimulus to employment in a labor-intensive sector in a time of global economic crisis. The total energy savings, in secondary energy, over the lifetime of the investments for years 2007 through 2009 is estimated at 56,000 GWh.

Economic Analysis of the Energy Efficiency Certificates (EEC) Program

For this analysis we include all the operational actors of Energy Efficiency Certificates within the subsystem boundary of EE activities: energy producers, energy distributors, ESCOs, the household and industrial energy savers and the 'Gestore dei mercati energetici' (GME – the energy market managing authority). The Authority for Electricity and Gas (AEEG) and the 'Cassa Conguaglio' (Compensation Fund) acting on its behalf, which makes compensation payments to the producers/distributors of energy for the energy saving activities, are considered outside the subsystem of EE activities.

There are three important inputs and outputs to the subsystem as defined: the payment for the purchase of the EE products (investments), the annual flow of energy and economic savings that result from the use of these products, and finally the annual compensation that is given by the AEEG and 'Cassa Conguaglio' for the services necessary to run the system.

With regard to the cost of investment, the most important 'standard' and 'analytic' products (CFL, slow-flow regulators, RA, household appliances) are usually self-installed with little or no appreciable installation costs. Retail prices are used. These certainly are more than the prices that are available for large initiatives managed by 'ESCOs' and others; however, using the retail price is a way of including the cost of delivery to the final user. It is hypothesized that the discounted price for large orders plus the cost of the ESCO for delivering the product to the user is approximately equal to the retail price. For one specific measure, solar collectors, the installation costs are estimated separately. For investments evaluated after completion, a different approach is taken.

The second flow is the annual energy and economic savings to the users, which is generated by the use of the product/investment. This is available from the certificates of the energy efficiency declared by producers/distributors and ESCOs.

Finally, there is an overall cost to the State for compensating all the services performed. This amount is calculated in the form of a compensation between 89 e 100 euro /TEE (certificate of energy efficiency for one toe). It includes compensation for all the services performed by the producers/distributors and ESCOs, including: marketing costs, cost of identifying potential users, cost of reaching the users, cost of delivering the products, administrative costs and so on. It is not known if this compensation covers all the real costs or not. One does not know the profits/losses of the individual players such as ESCOs or producers. These are inside the subsystem. Each year the Authority for

Electricity and Gas authorizes a payment to the obliged producers/distributors. For years 2005 through 2009 the public contribution was 531 million euros, AEEG [1].

The data for investments and cumulative savings from the beginning of the program to December 31, 2010, for each type of investment is taken from the latest statistical report AEEG, [2], as illustrated in Table 3. The cost of investments comprised in the first seven of the technical data modules are estimated using retail prices as discussed, except for solar panels where installation costs per square meter are utilized. These seven types of investments produced 97% of the savings from the entire of the technical data group. The cumulative savings value was converted to average annual savings for each type of investment by taking the difference of the cumulative savings of 2010 and that of 2009. This difference is the annual savings of year 2010, which comprises the sum of the annual savings of all the investments made in the previous years.[2] This annual savings in terms of primary energy was converted to secondary energy, where appropriate, distinguishing between gas and electricity savings. For example, according to the latest estimates of the stock of devices for heating sanitary water: 24% use electricity, 73% gas/gasoil and 3% solar. These proportions are used for allocating the type of secondary energy saved. Using the price of electricity or gas per kWh of secondary energy, the annual economic savings for the final users is calculated.

The same logic is applied to the inputs for investments evaluated after completion. However, to estimate the cost of these rather complex investments, where no financial investment data are provided to the public officials (they are provided with detailed technical and energy savings data); reasonable payback times according to the type of investment and sector are hypothesized. Given the annual savings data, an elaborated input, investment costs are estimated by calculating the annual savings multiplied by the payback. The hypothesized payback times are shown and an analysis of sensitivity is performed subsequently.

Category of Investment	Investment costs (million euro)	Certified energy savings thru 2010 (ktoe, primary energy)	Certified energy savings thru 2010 (GWh, secondary energy)	Annual energy savings (million euro/yr)	Pay back (years)	Lifetime energy savings (GWh, secondary energy)
01 Compact F. Lamps	386	4,366	23,349	1,236	0.3	37,451
13a Low-flow Reg.	128	1,073	7,779	201	0.6	11,572
13c 2nd Group Low-F. R.	14	107	776	42	0.3	2,409
14 R.A.	281	364	2,637	77	3.7	4,420
18 Other Lighting	14	181	966	24	0.6	729
08 Thermal Solar Coll.	106	138	1,000	24	4.5	2,172
12 Home Appliances	1623	70	373	17	9.8	506
Other Tech. Modules	315	215	1,147	39	8.0	2,685
Total Tech. Modules	1,408	6,513	38,027	1,659	0.8	61,944
Invest. E. A. C.: GEN-IND	246	587	3,410	62	4	11,827
Invest. E. A. C.: T-IND	733	451	4,197	183	4	17,623
Invest. E. A. C.: E-IND	531	271	1,448	133	4	4,146
Invest. E. A. C.: T-CIV	183	105	857	23	8	1,637
Invest. E. A. C.: GEN-CIV	-38	30	203	-5	8	-409
Invest. E. A. C.: E-CIV	59	30	161	7	8	224
Invest. E. A. C.: IP	2	30	161	1	2	31
Total Invest. E. A. C.	1,716	1,504	10,436	404	4.2	35,080
Total	3,124	8,017	48,464	2,063	1.5	97,023

Source: elaboration by authors of data ENEA & AEEG

TABLE 3 Analysis EEC Program from 2005 to 2010

As illustrated for the simpler investments presented through technical modules, the cost of investment is 1,400 million euros, the annual savings about 1,660 million euros and thus there is a very rapid payback of 0.8 years. Instead the investments evaluated after completion cost 1,700 million euro with annual savings on the order of 400 million euro per year, and an average estimated payback of 4.2 years. These more complex types of investments, concentrated in industry, contributed to about 36% of the total savings. For the program of Energy Efficiency Certificates, from the beginning of year 2005 through the end of year 2010, a total of 8 Mtoe of primary energy has been saved and 48 TWh of secondary energy. This has been brought about by an estimated 3.1 billion euros of private investment with an annual economic savings of 2.1 billion euros for a payback of less than two years. This low payback time is due to the effective, low cost investments made in the initial years of the program. The lifetime savings are estimated at 97 TWh. In Table 4 the public and private costs of the White Certificates or EEC Program are illustrated.

As shown, the total public contribution for years 2005 through 2009 is 531 million euros. Combined with that for year 2010, AEEG [5], results in a total public contribution for the EEC program of 857 million euros for the entire period.

Public Contributions years 2005-9 (million euros)	531		
Public Contributions year 2010 (million euros)	326		
Public Contributions years 2005-10 (million euros)	857		
Energy Savings years 2005-2010, secondary energy (TWh)	48	Sensitivity Analysis:	
Public Contributions years 2005-10/Energy Savings years 2005-2010, secondary energy (euro cents/kWh)	1.77	Minimum	Maximum
Estimate of Private Investments (2005-2010) (million euros)	3,124	2,476	3,790
Private Investments years 2005-10/Energy Savings years 2005-2010, secondary energy (euro cents/kWh)	6.45	5.11	7.82
Payback Tech. Modules (years)	0.85	0.72	1.01
Payback All Investments	1.5	1.2	1.8

Source: elaboration by authors of data ENEA & AEEG

TABLE 4 Public Contributions and Private Investments in the EEC Program

Taking the ratio of the total public contribution to the secondary energy saved during the same period, it results in a value of 1.77 euro cents/kWh of secondary energy savings. This is very near the 1.70 euro cents/kWh estimated for the first five years of the program, calculated by AEEG [3]. Given the inexpensive investments at the beginning of the EEC initiative, one would expect the ratio to increase. It is instructive to compare the public contribution[3] to the estimate of the private investment, 3.1 billion euros. Every euro of public contribution stimulated an estimated 2.5 euros of private investment in years 2005 to 2010. In relation to secondary savings, private investments cost 6.5 euro cents/kWh of secondary energy savings for the same period.

Taking into consideration the approximation in the estimates of the investment costs, we have estimated a high and low range as shown. Private investments are estimated from 2.5 to 3.8 billion euros. Again, the public contribution of the EEC program activated from two to three times the same amount in private investment.

Comparison of the two energy efficiency programs

The most important economic characteristics, the public contribution, the private investment and the resulting energy savings are compared for the 55%TD and EEC programs using the data developed in the previous tables. The lifelong energy savings have been used for comparison, multiplying the annual savings times the useful life of the investment. In order to simplify white certificates, the AEEG has standardized the allowable useful life for different classes certainly less than those used for our evaluation of the program 55%TD. No adjustment has been made and the results[4] are shown below.

The lifelong energy savings are distinct: 97 TWh for the EEC and 56 TWh for 55%TD program. This also reflects the longer existence of the EEC initiative. However, it may not have been expected given the large public contribution of the 55%TD program.

The two programs have different objectives: the white certificate initiative focuses upon energy savings, which set the amount of public incentive; and the 55%

	55%TD (2007-2009)	EEC (2005-2010)	Sensitivity Analysis EEC	
Private investments (million euros)	3,352	3,124	2,476	3,790
Public Contribution (million euros)	4,097	857		
Lifelong Energy Savings (GWh secondary energy)	56,227	97,023		
Private Investments/ Lifelong Energy Savings (euro cents/kWh)	6.0	3.2	2.6	3.9
Public Contribution/ Lifelong Energy Savings (euro cents/kWh)	7.3	0.9	0.9	0.9
Private & Public Costs/ Lifelong Energy Savings (euro cents/kWh)	13.2	4.1	3.4	4.8

Source: elaboration by authors of data ENEA & AEEG

TABLE 5 Comparison of Programs

tax deduction is based on the cost of investment, which determines the amount deduction. As a result, the former will emphasize the most energy savings with the least amount of investment and the latter will concentrate on those higher cost investments with acceptable savings. The data confirm this:
public contribution is much higher in the 55%TD program: 7.3 c€/kWh compared to 0.9 c€/kWh for EEC;
private investment is also higher for the 55%TD: 6.0 c€/kWh versus 2.6 to 3.9 c€/kWh; and
total costs per unit of saved energy are also higher: 13,2 c€/kWh versus 3.4 to 4.8 c€/kWh.
It is noteworthy that the 55%TD program presupposes available capital or credit for the home dweller, whereas with the EEC initiative the investment costs maybe shared with ESCOs and distributors, and even financed through the sales of the energy saving certificates.

Conclusions

One can reasonably surmise that the 55%TD program has been about three times more expensive per kWh saved compared to EEC. Is the 55%TD still worth it? First, it must be recalled that the latest legislation has extended the application of the 55% deduction to ten years instead of five. At a five percent discount rate, the difference in the present value of the two is 10 percent; that is the state saves 10% of the cost of the deduction with longer period. Second, the payback times of investments will be going toward a midrange for both programs: getting longer for the EEC, since the quick fixes are gone; and getting shorter for the 55%TD since otherwise the lower public contribution will not be sufficient. So performance figures should also move to a middle ground for both. We would expect that EEC would remain the most effective, but the differences would be less.
Clearly the EEC program has been a very successful initiative, permitting long-term programming with limited public costs as shown. However, it relies on a renewal of the objectives for the long period that has not been forth coming for 2013 and beyond. 2012 is currently the last year of the program, unless these objectives are renewed, AEEG [4]. The Government should renew its most effective and least cost program without delay.
Given the importance of energy savings in Italy, characterized by costly energy imports, and given the necessity of reducing the deficit in the balance of payments; it is better to maintain the two programs, gradually shifting resources to the most effective one, rather than risk that one or the other be shut down. In any case, there are opportunities to improve both programs:

- for the 55%TD, limits should be introduced regarding proposed investments with excessive payback times;
- both initiatives should focus on their particular characteristics, the 55%TD with the credit worthiness of its users could concentrate on the larger initiatives such as integrated investments in buildings; whereas EEC could operate more in industry and smaller investments in the residential sector. Energy efficiency in public buildings and transportation needs to be better addressed;
- for EEC, procedures could be simplified and the useful life of investments could become more realistic, given the present low costs;
- there is a general need to have more complete economic data from the programs: energy savings

in terms of secondary energy in the 55%TD program and the payback times on investments, anonymously collected, for the EEC initiative. It is necessary to track the economic evolution of the various types of investment in time and space to better calibrate the programs. A national database of all investments with public contribution would be ideal. ENEA has already accomplished this for the 55%TD program. Regional initiatives and other programs could be integrated into this database;

- only with such a database can we begin to accurately estimate EE potentials and begin to answer the question of the optimum rate of implementation of the programs.

The greatest threat to both programs is that public financing could be interrupted or stopped. In particular the 55%TD is the most exposed. In the intermediate term, it would be prudent to develop an alternative program based on private financing of EE. In fact, in contrast to alternative energy sources most EE investments have a positive net present value, Vattenfall and McKinsey [12], thus in theory – overcoming other obstacles, UNEP [11] – they could be appropriate for private financing.

Instead the EEC program, pending renewal for the necessary long-term planning, has the advantage that most of its costs are covered by the energy taxes and thus it is practically 'zero cost' to the State, an important feature in the present context.

Notes

[1] NPV=Discounted annual energy savings-cost of investment=(å from year i = 1 to n, (annual energy savings) x (1+annual increase in nominal energy price)^{i} /(1+cost of capital)^{i})-cost of investment.

[2] There are two inaccuracies in this method, specifically and only regarding the groups GEN-CIV and IP of investments evaluated after completion. The energy data available had been rounded to one significant digit and thus the difference in these numbers of energy between year 2010 and year 2009 is very approximate. In any case, the amount of investment in these two categories represents only 0.4% of the total.

[3] The EEC Program is supported by a public contribution to the obliged energy distributors for their services in obtaining certified savings. This contribution is funded by a tax on energy consumption (UC7 and RET) of the final users of electricity and natural gas.

[4] Lifelong energy savings are the annual energy savings multiplied by the useful life.

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