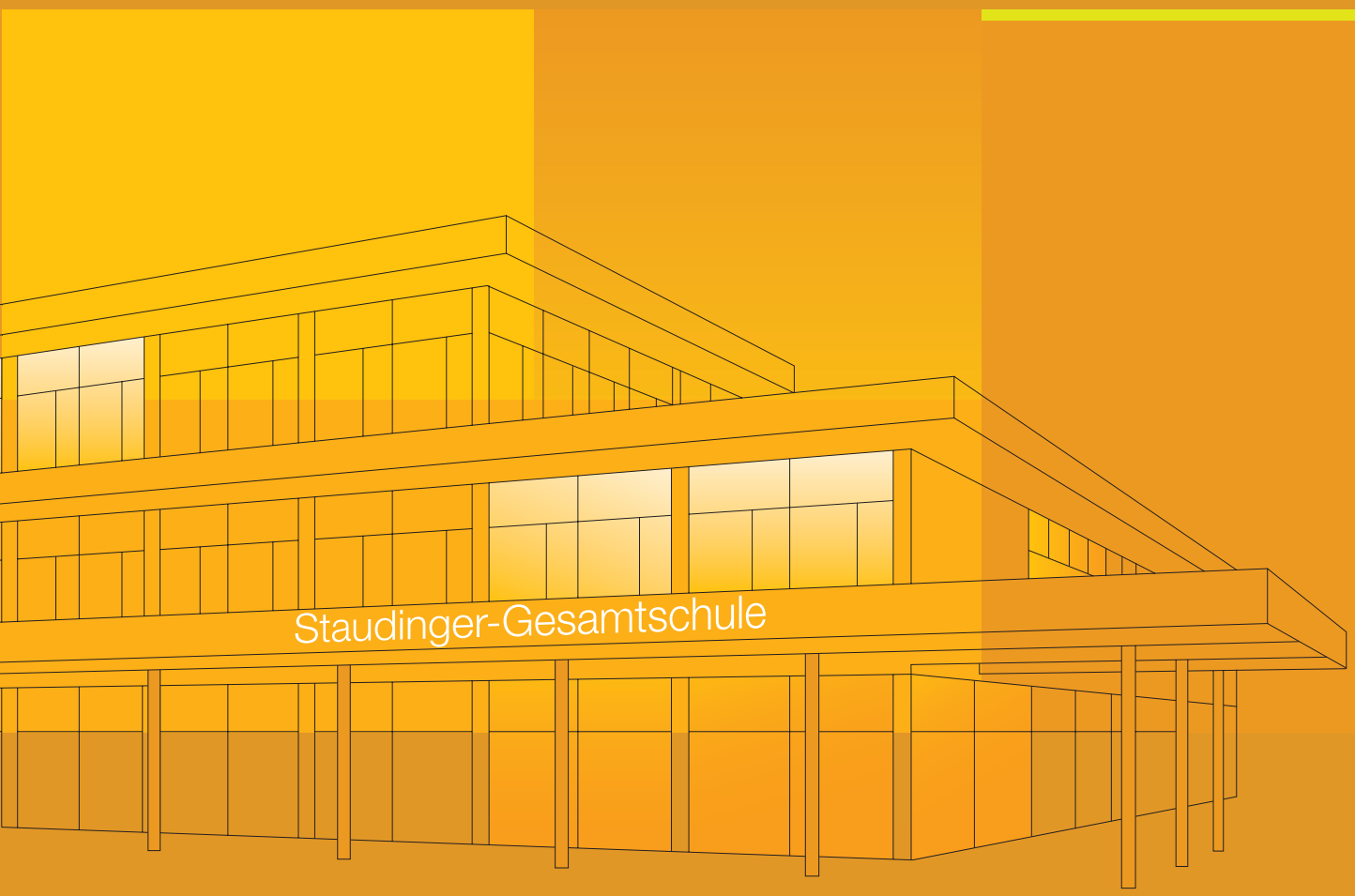
Making Climate Change Mitigation Pay

ECO-Watt: The Community-Financed Negawatt Power Plant



ECO Watt

Tell me and
I will forget.
Show me and
I will remember.
Involve me and
I will understand.

[Confucius]

Contents

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Prof. Dr. Peter Hennicke
President, Wuppertal Institute for
Climate, Environment and Energy

Foreword

The ECO-Watt project is an extraordinary success story. It provides insights and lessons that extend far beyond its Freiburg home. One is that being climate-friendly pays its own way if efficiency and renewables are combined. The astonishing economy gains and financial pay-back from this nationally pioneering community contracting project defuse the myth still being put about by many climate protection doubters that what is right for the climate means financial sacrifices and high costs. When investing in appliances, vehicles and buildings that have to be renewed in any case, it is often forgotten that the (sometimes) higher up-front cost of climate-friendly alternatives is soon recouped in major energy savings.

ECO-Watt also shows how school pupils and teachers can be brought on board and complex ideas integrated into the physics, geography and social studies curriculum. Pupils take this knowledge home with them, spreading the energy economy message among family and friends.

Another important lesson taught by the ECO-Watt project is that innovations in energy efficiency are not self-propagating - not even if they pay for themselves. Instead, they still have to overcome a mixture of complacency, lack of information, prejudice and energy industry interests. Even reputable experts simply overlook these everyday hurdles and continue to preach that whatever fails to sell on its own merits in the free market cannot be economic in the first place. This ignorance regrettably goes all the way up to the highest ministerial and official levels, with the result that vast potential for 'intrinsically economic' energy savings goes untapped the world over.

The ECO-Watt project shows what it takes on the ground to turn this potential into a highly profitable investment: It takes innovative ideas, precise analysis of the obstacles to be over-come and sound expert knowledge; and it takes high-calibre players and experts on the demand side of the energy market. Until the state provides for a new operating framework, better incentives and pools of expertise - for example by setting up an energy efficiency fund to coordinate, fund and evaluate energy efficiency projects - until that happens, pioneers will continue to have a hard time of it. The ECO-Watt project and the leading role of its enter-prising mastermind provide an outstanding example in this regard.

The complex market for environmentally and economically appropriate energy services needs pioneers like this so that the new energy market – the market for 'negawatts' – can grow and enter the mainstream. And as the Freiburg example shows, it takes a network of many creative minds, dedicated teachers, forward-thinking local politicians and inquisitive school pupils to give such a pioneering project the backing it needs. In ECO-Watt, this alliance has led to a highly innovative project that has since prompted successors in the German state of North Rhine-Westphalia, in the Hegau area on the shores of Lake Constance and elsewhere – and to a veritable wave of community-financed projects.

As this all shows, a good idea resolutely implemented can become an energy success story. There are thousands of schools where the next story in this chapter is waiting to be written.

Dieter Seifried (Dipl.-Ing., Dipl.-Volksw.)
Managing Director, ECO-Watt GmbH;
Owner, Büro Ö-quadrat

Freiburg, October 2007

In October 2006, Sir Nicholas Stern issued a wake-up call to the public at large. In his report – the Stern Review – the former World Bank chief economist urged the countries of the world to invest without delay in mitigating climate change. Making good the damage caused by climate change would be far more costly, he said, than investing to avert that damage now.

For many policymakers, this was a new message: Promoting climate change mitigation not just with the environment in mind, but first and foremost on economic grounds.

In the same year that Stern jolted awake the global public, a project in the southern German city of Freiburg entered its closing phase - a project that for eight years had delivered real, tangible proof of Stern's proposition that climate change mitigation pays: The ECO-Watt Negawatt Power Plant at a state secondary school, Staudinger-Gesamtschule.

Investors, parents, teachers and all involved saw year for year with their own eyes that major energy savings could be made with conventional technology and without any loss in comfort or convenience. They learned that public buildings harbour huge potential efficiency gains that are only waiting to be mobilised. And that mobilising these savings is technically feasible and can generate large profits.

This publication portrays the ECO-Watt model project from a number of different perspectives. It describes both the project's history and the specific technologies used to secure efficiency gains, and also goes into the main economic details. But it also presents personal experiences and events arising in the run up to the project and over its duration.

With this publication, we hope to inform and motivate you, the reader, to make use of our experience and launch more 'ECO-Watts' of your own. Whether you are involved in a citizen's initiative, local government or an industrial enterprise, potential for energy savings can be found and mobilised everywhere.

Our experience shows it can be done. It just needs someone to actually do it.

ECO-Watt: A success story

In the beginning was the idea

Our story actually goes back to the mid-1990s. We* worked at Öko-Institut, an institute for applied ecology in Freiburg, where we had shown in countless reports, studies and energy plans that energy-efficient practices generally paid for themselves. Back then, this was not generally considered obvious. On the contrary, we often enough heard people claim that while energy efficiency might be good for the climate, it was unfortunately uneconomic in practice. The numbers told the opposite story, but abstract calculations proved no match for ingrained prejudice.

After all the theoretical study, we judged the time had come to prove our proposition that what is good environmentally is good economically in a real, tangible project. This is how we came to the idea of launching a profitable energy-efficiency project. An investment initiative seemed the most suitable approach, since we thought if a lot of people take stakes in an energy efficiency project and stand to profit from its economic success, this would be the most elegant possible proof of our idea.

The idea and the thought behind the ECO-Watt project was that of making climate change mitigation pay.

There were already various community-financed projects in Freiburg at the time, mostly for solar power and later some for wind power. Shares in these installations were successfully marketed by a recently launched fundraising organisation, Förderverein Energie- und Solaragentur Regio Freiburg (Fesa). Seven large solar power installations with a total output of 250 kW came into being in this way. This was a breathtaking accomplishment by the standards of the time – before changes to the German regulatory framework that heralded today's high feed-in tariffs for renewables-generated electricity sold to the national grid. Anyone who in-ves-ted in solar power back then did so out of idealism with no prospect of sound returns, the aim being merely to help the environment or set an example.

Despite the lack of a probable return on investment, Fesa found 260 people who were prepared to buy shares in the solar installations. This encouraging outcome set us thinking that if residents were prepared, under the conditions of the time, to take shares in economically unviable solar systems, they would certainly be happy to invest in an economically viable 'negawatt power plant', as we called it. The climate mitigation effect was at least as powerful and we could demonstrate real returns.

As a result, we were confident of being able to find enough residents to take shares in the energy-efficiency project.

Energy-saving as hard work: An image still propagated by the electricity industry as late as the mid-1990s

* Jürgen Leuchtner, Rainer Schüle, Dieter Seifried

What is a negawatt power plant?

Amory Lovins of the Rocky Mountain Institute in the USA was the first to publicise the idea of a negawatt power plant. Eco-efficiency guru Lovins used a simple example to explain the basic idea:

"We should accustom ourselves to the idea that by buying an electricity-saving appliance we do the same as if we were to build a tiny negawatt power plant in our own house or factory.
If I install a new light bulb that consumes 15 watts but delivers just as much light as a conventional 75-watt bulb, then I have in fact built such a tiny power plant. This plant is producing 60 NEGAwatts, or unused watts.

We might say this saved electricity is sent back to the energy supplier. It can then be sold to another customer without first having to be generated all over again."

Wolfgang Kolb, head of the Staudinger-Gesamtschule secondary school in Freiburg

Wanted: A suitable building

It was soon clear that not every building would be suited to the project. We did not just aim to offer an investment opportunity – we had a mission: We wanted to reach as many people as possible with our 'climate change mitigation pays' message. To do this, we needed and wanted to properly document the results of the planned project. It also had to be a building where many people would see the energy-efficient technologies being installed and be able to pass on the experience.

That made the best choice a public building – a school. A school is not only frequented by pupils and teachers, but by parents and relatives as well, providing a large number of people to spread the word. At the same time, we thought a school would present a chance to raise awareness about energy and the climate, leading to further energy savings beyond those obtained by purely technical means.

Found: The Staudinger-Gesamtschule secondary school

Our quest led us to Staudinger-Gesamtschule, a secondary school in Freiburg.
This looked to be the perfect choice. With over 1,000 pupils, an attached youth centre and a local library, it seemed big enough for our model project. It was (and still is) known for its committed, enthusiastic teaching staff – all in all an excellent starting point for our project.

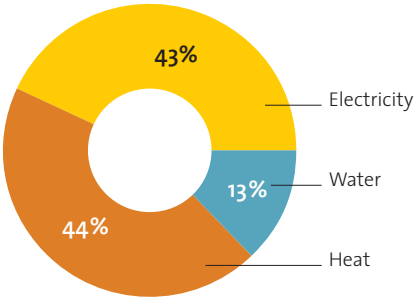
We contacted the school's head, Wolfgang Kolb, who showed instant interest in the project. The school needed a large amount of modernisation work, not least on the heating system. Kolb was pleased to be shown an idea based on outside funding that also promised new impetus for everyday school life and teaching.

Initial analysis shows feasibility

As an initial step, we drew up a feasibility study, at that stage still using Öko-Institut funds. We analysed the energy and water consumption and used the results to develop specific economy measures. A first glance at the consumption figures surpassed our expectations: The school's energy and water bills ran to €260,000 a year. That suggested ample scope for savings.

We also made use of outside advice during the analysis phase. A Freiburg engineering consultancy, SGEU, helped in pinpointing savings on the sanitation and electricity side. The Fraunhofer Institute for Solar Energy Systems analysed the available efficiency gains as regarded heating.
Back at Öko-Institut, we finally compiled all the detailed analyses into an overall plan. The result was a comprehensive and in our view highly sound plan of action.

Return-on-investment calculations showed it was feasible to implement the project on an energy performance contracting basis.
The capital outlay came to roughly €280,000. On a conservative estimate, energy and water costs would decrease as a result by at least €60,000 a year - enough to pay a return on the necessary capital and repay the principal amount in a reasonable timeframe.



Percentage shares of utility costs (around € 260,000) in the 1995-1997 reference period

Parents and teachers give the go-ahead

We involved teachers and the parents' association in the project right from the technical planning stage. This was a key step - after all, we wanted to awaken the interest of pupils and teachers in energy efficiency and climate change mitigation issues. Once again we found we were pushing at an open door: Both the teaching staff and the parents' association gave the idea their unqualified approval and offered us their support in carrying out the ECO-Watt project.

ECO-Watt goes corporate

Three Öko-Institut members and two others brought in from outside set up a limited company, ECO-Watt GmbH. A closed-end investment fund, ECO-Watt GmbH & Co. KG, was then launched for the Staudinger-Gesamtschule ECO-Watt project. 'GmbH & Co. KG' indicates a German-law limited partnership (KG) whose one general (unlimited-liability) partner is a limited company (GmbH). ECO-Watt GmbH was the general partner and was therefore liable up the full amount of its €26,000 share capital. The remaining capital was to be raised by attracting limited partners - investors whose liability was restricted to the amount they each paid in.

Raising the capital

We began raising the capital in June 1998, setting the minimum investment for parents and teachers at 1,000 deutschmarks (€511). This was so as many local residents as possible could afford to participate financially in the project.

The minimum investment for outsiders was 5,000 deutschmarks (€2,556) to hold administrative overhead at a minimum. The job of recruiting investors was given to Fesa and ECO-Watt GmbH. The aim was to generate at least €200,000 from investors and meet the remainder with a loan from Ökobank, a German alternative cooperative bank of the time.

We approached the public with a six-page prospectus and held three information events to present the project to parents and teachers at the school. Articles placed with a number of newspapers covering the wider region made for extra publicity.
That appeared to suffice: Fesa, which acted as trustee, was able to cease accepting new investors as early as November 1998.
The necessary capital was raised – in fact, the total had reached €250,000.

Staudinger-Gesamtschule, a secondary school with 1,100 pupils in Freiburg, southern Germany.

Snares and pitfalls

The project did not seem very popular within the city authorities. The first sign of this was a refusal by the building office to provide us with the school's power and heat consumption data – even after we had made them an offer to analyse the power and heat consumption free of charge. Only after we involved the city council did the authorities make the data available.

Because the contract still had to be signed in the name of the city (as the authority in charge of the school), all investment agreements between ECO-Watt GmbH & Co. KG and the limited partners had to be made conditional on the contract between ECO-Watt GmbH & Co. KG and the city of Freiburg coming into being by the end of the year. Getting that decision from the city council proved difficult: The authorities did not have a mandate from the council to draw up a dossier on the project. The authorities did not want to act without a mandate from the council and the council could not decide anything without a dossier from the authorities.

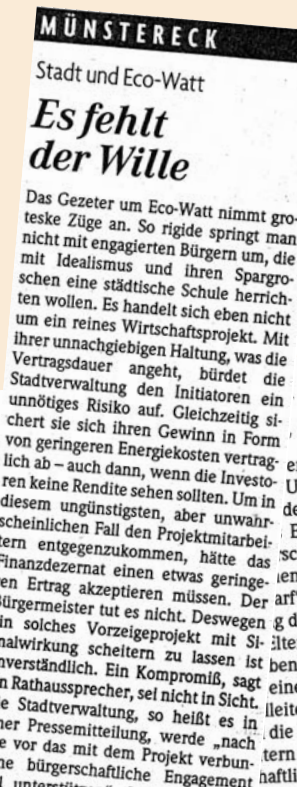
The circle was only broken through intensive talks with councillors and the authorities.

Contract negotiations between the city authorities and ECO-Watt GmbH were finally held in the summer months of 1998. This was not a straightforward affair as both sides were breaking new ground and no-one had negotiated a similar contract before. After several rounds the two sides reached mutually acceptable terms. The project seemed home and dry.

Then came what for us was an inexplicable turn of events: In a municipal memo of 2 October 1998, the city authorities tabled an alternative version of the draft contract without consulting ECO-Watt. The council approved the project on the basis of this alternative version – in other words, on terms different to those we had negotiated with the city authorities and set out in the prospectus.

We of course brought it to the city authorities' notice that the rules of play had been unilaterally changed in our disfavour. In response, the authorities published a statement claiming that ECO-Watt GmbH & Co. KG had doubts about the project's success and had asked the city to "underwrite the venture financially". That we doubted the project's success was simply untrue. ECO-Watt wanted the project - it just wanted it on the original negotiated terms.

Freiburg and Eco-Watt
Lacking the will



MÜNSTERECK

Stadt und Eco-Watt

Es fehlt der Wille

Das Gezeter um Eco-Watt nimmt groteske Züge an. So rigide springt man nicht mit engagierten Bürgern um, die mit Idealismus und ihren Spargroschen eine städtische Schule herrichten wollen. Es handelt sich eben nicht um ein reines Wirtschaftsprojekt. Mit ihrer unnachgiebigen Haltung, was die Vertragsdauer angeht, bürdet die Stadtverwaltung den Initiatoren ein unnötiges Risiko auf. Gleichzeitig sichert sie sich ihren Gewinn in Form von geringeren Energiekosten vertraglich ab – auch dann, wenn die Investoren keine Rendite sehen sollten. Um in diesem ungünstigsten, aber unwahrscheinlichen Fall den Projektmitarbeitern entgegenzukommen, hätte das Finanzdezernat einen etwas geringeren Ertrag akzeptieren müssen. Der Bürgermeister tut es nicht. Deswegen ein solches Vorzeigeprojekt mit Signalwirkung scheitern zu lassen ist unverständlich. Ein Kompromiß, sagt ein Rathaussprecher, sei nicht in Sicht. Die Stadtverwaltung, so heißt es in einer Pressemitteilung, werde „nach wie vor das mit dem Projekt verbundene bürgerschaftliche Engagement

Eco-Watt: Pressure builds
on Freiburg

Eco-Watt: Der Druck auf die Stadt wächst

SPD, Grüne und Linke Liste haben be
tragt, das Thema Eco-Watt im Umw
ausschuß am Montag zu behandeln
ßerdem soll ein Vertreter des En
sparprojekts an der Staudingersch
Wort kommen. Die Fraktionen
„erheblichen Diskussionsbedarf"
dem das Vorhaben am Vertrag
zu scheitern droht. Der Elt
zeigt sich in seinem Schreib
Stadträte „erschüttert". In e
nen Brief kritisieren Schul
Öko-Institut, Öko-Bank und
Solaragentur, ein Schei

Thanks to the support and intervention of the school parents' association, the school teaching staff, the press and a cross-party motion from the greens, social democrats and socialist/women's parties in the council – all of whom came out in the project's favour – we finally reached a compromise. The contract between ECO-Watt GmbH & Co. KG and the city of Freiburg was signed in December 1998. The legal hassle was at an end and we could dedicate all our energies to the task at hand.

Takeover averted

In a hand-out circulated at a council meeting on 20 October 1998, the management of what was then still the Freiburg electricity and water corporation, FEW, proposed that ECO-Watt's plans for an energy-efficiency project at the Staudinger-Gesamtschule secondary school should be implemented by FEW alone. One condition was that FEW be provided with the paperwork that had been placed at the disposal of the city authorities (ECO-Watt GmbH & Co. KG's consumption analysis and action plan). But that was not all: FEW wanted to include the capital raised from residents so far. Quote: "Interest shall be payable on the loan capital furnished by parents, teachers and residents at one percent above the Bundesbank discount rate."

The city council decided in favour of the ECO-Watt project.

Project threatens to fail
Eco-Watt and Freiburg in dispute on energy efficiency contract for school

Projekt droht zu scheitern

Eco-Watt und Stadt streiten über den Vertrag zum Energiesparen an der Staudingerschule

Das Energiesparprojekt an der Staudingerschule steht kurz vor dem Scheitern. Die Firma Eco-Watt hält den vorgelegten Vertrag der Stadt für inakzeptabel. Das Finanzdezernat beharrt auf seiner Position, daß jegliches Risiko von den Investoren zu tragen sei.

Die kleine Gesellschaft, hinter der das Öko-Institut steht, will mit Sparmaßnahmen den Energie- und Wasserverbrauch der Schule senken. Die eingesparten Kosten sollen die Investition refinanzieren und den Geldgebern eine Rendite ermöglichen. Das Investitionskapital von 450 000 Mark stammt von der Öko-Bank und 100 interessierten Bürgern.

Als Knackpunkt entdeckte Finanzchef Otto Neideck die Strompreise. Die Liberalisierung des Markts läßt sinkende Preise erwarten, und diesen Vorteil die vorgesehenen acht Jahre laufen, um Investitionen und Rendite erwirtschaften zu können. Der Gemeinderat beschloß daraufhin „eine flexible Vertragsdauer", falls die Preise variieren.

Zwei Wochen später wollten Vertreter von Eco-Watt und Rathaus den Vertrag formulieren – und bissen sich fest: Die Stadt versteht unter Flexibilität, daß bei steigenden Strompreisen (etwa durch die künftige Ökosteuer) und damit höheren Einspareffekten auch die Vertragszeit verkürzt wird. Das lehnt Eco-Watt strikt ab. Diesen Punkt habe die Verwaltung ohne Abstimmung geändert. Von höheren Einsparungen sollen die Geldgeber profitieren – mit einer Verzinsung von maximal sechs Prozent. Was drüber geht, fließt ins Projekt.

Doch die Initiatoren fürchten vor allem jenen Fall, der die Anleger um ihre Zinsen bringen könnte: Wenn die Energie-Einsparung deutlich unter der Prognose liegt und damit den Vertrag verkürzen. „Das ist für uns gegenüber den engagierten Bürgern nicht verantwortbar", heißt es in einem Brief von Eco-Watt an OB Böhme. Die Stadt zeigt sich davon unbeeindruckt und fordert, die Eco-Watt GmbH müsse sich nun entscheiden, ob „sie das unternehmerische Risiko weiterhin tragen will". Der Bauausschuß wurde darüber in nichtöffentlicher Sitzung informiert.

Grünen-Stadtrat Eckart Friebis ist entsetzt. Er wirft der Verwaltung vor, dem Bauausschuß den Sachverhalt falsch dargestellt zu haben. Er vermutet, daß die Stadt das ganze Projekt „der FEW zuschustern will". Gleichzeitig hofft Friebis noch auf einen Kompromiß in letzter Minute. Denn am 16. Dezember zahlt Eco-Watt den Anlegern ihr Geld zurück, wenn der Vertrag platzt. „Den Kompromiß", sagt Rathaussprecher Jessen, „sehe ich nicht."

Uwe Mauch
Münstereck

Trouble at the town hall
Departments block each other on Eco-Watt

Zoff im Rathaus

In Sachen Eco-Watt blockieren sich Dezernate gegenseitig

Hinter den Rathaustüren knirscht es ganz gewaltig. Das Verfahren um den Antrag der Firma Eco-Watt hat gezeigt, daß sich einige Dezernate gegenseitig blockieren. „So geht es nicht weiter", [illegible]berbürgermeister Rolf [illegible]e Verwaltung und kün[illegible]e Energieorganisation in [illegible]e zu überprüfen.

[illegible]t will mit Eltern, Lehrern [illegible]en den Energieverbrauch [illegible]chule senken. Dazu sind [illegible]n mehr als einer halben [illegible]ötig. Sie sollen innerhalb [illegible]refinanziert werden über [illegible]Energiekosten, die zudem [illegible]gebern noch eine Verzin[illegible]. Für das Projekt wurde [illegible]co-Watt gegründet.

[illegible]e Energiesparmaßnahme [illegible]soviel Energie gekostet", [illegible]nent Otto Neideck. Be[illegible]veltdezernat, Hochbau[illegible]. Monatelang dauerten [illegible]. Jetzt verabschiedete [illegible]ne Variante, die der OB [illegible]t muß mit den tatsäch[illegible]kalkulieren und nicht [illegible]ekten üblich - mit den [illegible]der vergangenen drei [illegible]baldige Marktliberali[illegible]eis drückt, um so ge[illegible]lle Spareffekt an der [illegible]diesem Fall wird der [illegible]rlängert, bis sich die [illegible]en amortisiert ha[illegible]

eine gepfefferte Stellungnahme der FEW. Sie wirft der Stadt vor, die Entscheidung „bewußt ohne Beteiligung der FEW herbeigeführt" zu haben. Mehr noch: Der Energieversorger hatte bereits im April 1997 schriftliche Angebote für ähnliche Projekte in städtischen Einrichtungen eingereicht, darunter auch in Schulen. Erst ein Jahr später erhielt die FEW die Bitte, diese Vorhaben zu modifizieren, was sie schon am 7. April dieses Jahres erledigte. „Trotz mehrfacher Aufforderung ist seitdem nichts gelaufen", teilt FEW-Sprecher Erich Möck auf Anfrage mit. Daß Eco-Watt nun - allerdings nach langem Hin und Her - zum Zuge kommt, hat die FEW verstimmt. Die Vorstandsmitglieder Häge und Juling fordern deshalb, die Energiesparmaßnahmen für die Staudingerschule öffentlich auszuschreiben. Bei der FEW wachsen Frust und Ärger, bislang nur hinter verschlossenen Türen. Dort macht man Kompetenzgerangel zwischen Umwelt- und Baudezernat dafür verantwortlich. Wenn dann auch noch der Kämmerer urplötzlich seine Bedenken anmeldet, ist die Blockade perfekt.

Eckart Friebis von den Grünen las der Verwaltung die Leviten – und bekam vom OB recht. Ungewöhnlich scharf rügte Böhme seine Verwaltung, sie sei schlecht vorbereitet gewesen. Warum die FEW nicht gefragt wurde und ihre Angebote liegen geblieben sind, „möchte ich auch gern wissen." Jetzt will der OB die Zuständigkeiten für die Energiepolitik neu ordnen. Denkbar, so Rathaussprecher Walter Preker, sei ein neuer Zuschnitt der Dezernate

The negawatt power plant is born

After all the ups and downs, we were at last able to sign the energy efficiency contract with the city of Freiburg, just before the 1998 year-end deadline.

Core terms of the contract:
Over a period of eight years, ECO-Watt would be paid an amount equal to the energy and water costs saved compared with baseline consumption figures from preceding years. This allowed ECO-Watt to pay out a return on the invested capital and refund the principal amount to investors at the end of the eight years. The installed technical systems and fittings were then made over to the city, which could profit from the reduced energy costs from then on - at a conservative estimate, to the tune of €800,000 over the 20-year service life of the energy-efficient technology.

With the contract signed, the way was now free to set up the negawatt power plant. The necessary work was soon put out to tender, in February 1999, and contracts were awarded to local traders in early March. This meant the Easter holidays could be used to replace the lighting throughout much of the building. The final capital investment work was completed during the summer holidays. The negawatt power plant was ready for service.

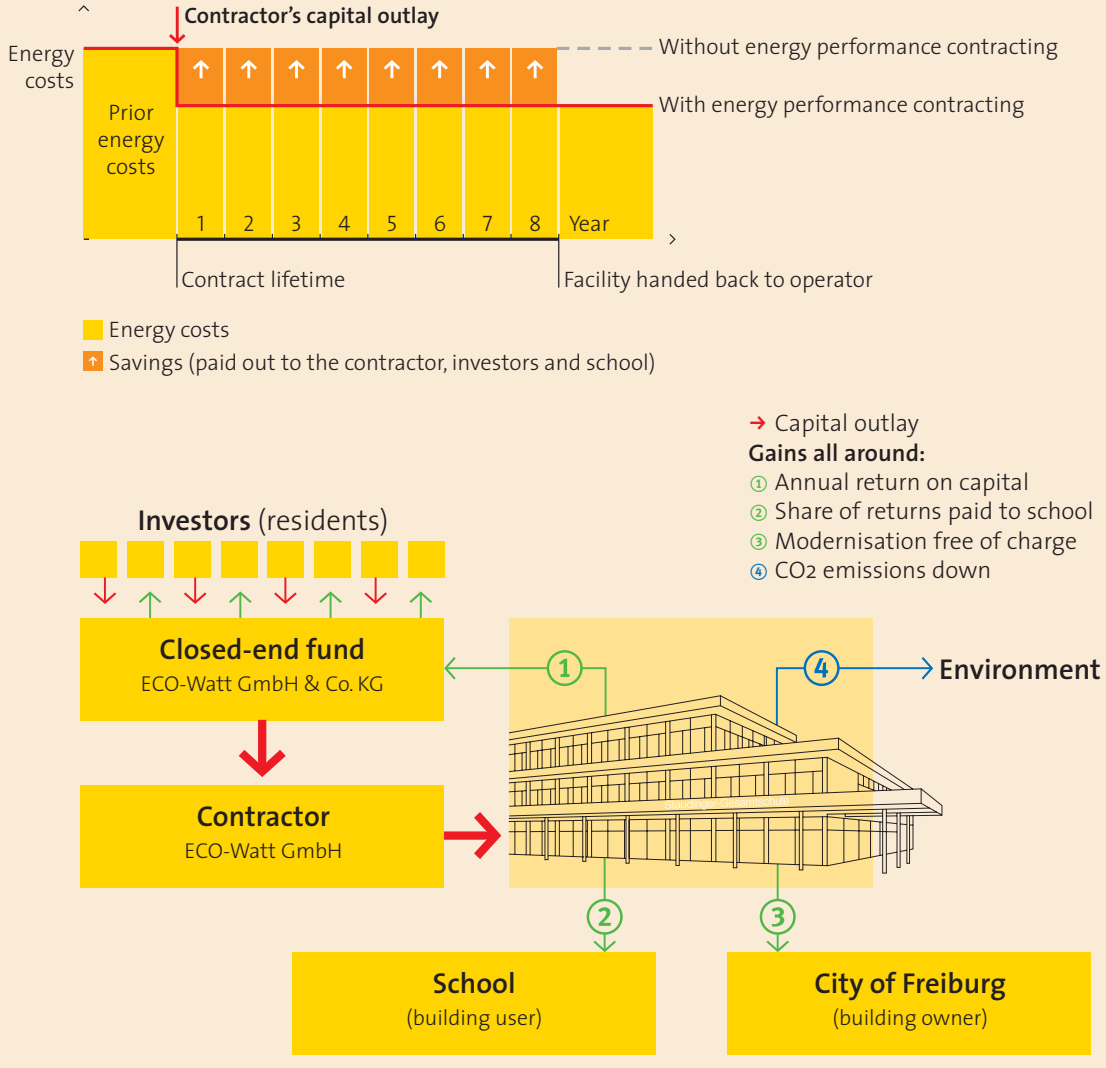
From October 1999, the negawatt power plant operated to the benefit of both investors and the school. The contract provided for the school to receive between €2,560 and g10,260 to spend as it pleased, the actual amount depending on the success of the energy-efficiency project.

Energy performance contracting: Gains all round

Energy performance contracting is based on a simple idea: A contractor steps in to carry out capital spending that a facility owner is unable to do for financial or other reasons.

The contractor's capital outlay is paid back out of energy costs saved over the lifetime of the contract. In ECO-Watt's case, part of the return thus generated was paid out to investors (a maximum of six percent on their investment) and part to the school (a maximum of €10,240 a year).

At the end of the contract, the investors get back what they paid in and the facility owners (here the city of Freiburg) have a building with modernised energy systems that they can run cost-effectively from now on.



Beyond all expectations

In its very first year of operation, and in every year after that, the ECO-Watt project exceeded our projected returns. That was good news for investors, who were paid out not the minimum return each year, but the maximum six percent. The school received €10,260 each year - again the maximum amount set in the contract.

This enabled numerous projects to be started at the school. Part of the money went on enlarging its solar power array, allowing it to earn the statutory feed-in tariffs for renewables-generated electricity.

The ECO-Watt project proved its worth in other ways as well. The pupils and teachers in the ECO-Watt project group at the school launched a wide range of activities that shaped pupils' and teachers' environmental awareness and improved their knowledge regarding sustainable use of energy.
More on this later.

Striking the right balance, or how much energy efficiency is enough?

A thorny but interesting issue when carrying out energy-efficiency projects is that of sharing out the 'gains' between the environment and investors. If only the least-cost energy-efficiency measures are implemented, the financial gains are large but the amount of energy saved is small. If financially less viable or uneconomic measures are included, the energy savings rise but return on capital falls.

So how much energy efficiency is enough? The following was decided for the ECO-Watt project: A minimum financial return was promised of three percent a year (over eight years). If more energy was saved than planned, the extra savings would be divided between the schools and the investors up to a return to the latter of six percent.
Any energy cost savings in excess of this level would be used for further energy-efficiency measures and for projects in the school.

The ECO-Watt energy-efficiency package

The ECO-Watt energy-efficiency package

- New lighting
- Modernisation of the heating and ventilation control system
- Improve load management to avoid power consumption peaks
- Water-economy measures
- Solar hot water system

Lighting

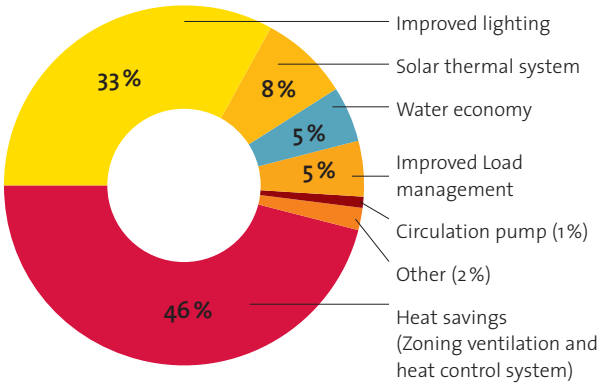
Investment in new lighting and in control of the existing lighting was the largest single capital spending item, amounting to some €80,000 in total. Measures ranged from replacing ceiling and wall lights (of which there were about 500) to setting up daylight-controlled lighting in the gym and some corridors. There was huge variation in cost-efficiency between the different measures.

The previous twin-tube prismatic diffuser strip lights with conventional ballast and no reflector were replaced by single-tube lamps with an electronic ballast, three-band fluorescent tube and reflector. This cut power consumption by about 60 percent. The new three-band fluorescent tubes also provide a pleasant light and have a high light output to power ratio. Lights were replaced in this way in all classrooms in one entire building. In Year 5 and 6 classrooms, more rugged prismatic diffusers were used in place of louvred mirror lights.

In the staffrooms and the library, single-tube louvred mirror lights were installed with a T5 fluorescent tube and electronic ballast.

The peak load effect of the changes was included in the cost/benefit calculation (see table). The economics of energy savings heavily depend on whether the savings reduce peak power consumption or leave it
unchanged.

The calculations are based on a six percent annual return on capital. The initial capital outlay was depreciated over eight years (the lifetime of the contract). Planning and design expenses are not included in the calculations.

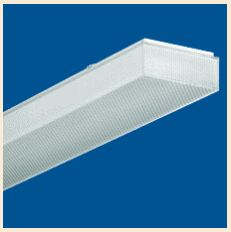


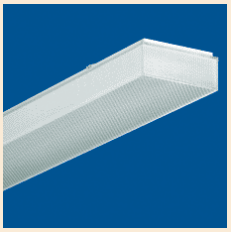
Initial capital outlay on the ECO-Watt project: Upgrading the lighting and measures to save on heating account for the largest share (79%).

Measures with a cost-benefit ratio greater than one must be cross-subsidised by other measures in the project. For example, the new classroom lighting did not pay for itself within the eight-year lifetime of the contract due to the relatively little use made of it (650 hours a year). In contrast, the new lights in the library paid for themselves in only four years.

If we look instead at the cost-benefit ratios over the 15 to 20-year service life of each technology - a standard, meaningful form of analysis - all envisaged lighting modernisation measures are economic.

Lighting options





	Previous lighting	**Option 1**	**Option 2**
Type	Prismatic diffuser	Prismatic diffuser	Louvred reflector
Lamp power	2 x 58 Watt	1 x 58 Watt	1 x 35 Watt
Tubes	T8, conventional	T8, three-band	T5
Reflector	No	Yes	–
Ballast	Conventional ballast with 2 x 13 W ballast loss	Electronic ballast with 5 W ballast loss	Electronic ballast
Circuit Power	142 W	55 W	35 W
Luminous efficiency	56%	65%	78%
Luminous flux	4,100 lm	5,000 lm	3,650 lm
Installed power in Room 2221 (70 m²)	Three strips of five lamps total 2,130 W	Three strips of five lamps total 825 W	Three strips of five lamps total 525 W
Power saving	–	61%	75%

Power savings from new ceiling lights:
This was particularly lucrative in the district library attached to the school.

One point of technical interest is the lighting control system in the gym. This controls the use of artificial light according to the incident daylight but is also programmed in other ways: For example, only a third of the lights can be switched on in the morning for cleaning, and 300 lux or two-thirds are made available for school sports. Full-strength lighting is only made available for competitions and certain sports.

An important point regarding all changes made to the lighting is that the energy savings are reaped without any loss of comfort or convenience. On the contrary, pupils and teachers at the school find the lighting far better. Installing electronic ballasts has made flickering fluorescent tubes a thing of the past. The same goes for the buzzing noise from defective conventional ballasts.
The learning environment for pupils has improved considerably and replacing the lighting would have made sense even without the power savings.

Selection of changes made to lighting

Unit	Measures	Power consumption before kW	Power consumption after kW	Hours used before h/a	Hours used after h/a	Total electricity cost saving Euro/a	Capital cost (ex VAT) Euro	Capital cost annualised Euro/a	Cost/benefit ratio
Building 2: All classrooms	Swap twin-tube for single-tube prismatic diffusers with electronic ballast and three-band tubes	33.23	12.87	650	650	3,069	24,600	3,961	1.29
Staffrooms	Swap twin-tube prismatic diffusers for single-tube louvre reflector lamps with electronic ballast and three-band T5 tubes	9.37	2.31	800	800	1,140	7,108	1,145	1.00
Social facilities (pool rooms youth club)	Presence-controlled lighting	1.85	1.85	1,500	500	131	359	58	0.44
Toilets	Swap lamps and add control system in 13 sets of toilets	4.54	1.76	2,400	200	1,115	5,779	931	0.84
Basement corridor	Presence control in corridor	0.50	0.50	2,400	100	114	231	37	0.33
Library (Building 3)	Swap filament spot for fluorescents	1.80	0.27	500	500	154	415	67	0,43
Library (Building 3)	Swap twin-tube prismatic diffusers for single-tube louvre reflector lamps with electronic ballast and three-band tubes	12.50	3.08	1,200	1,200	1,788	9,477	1,526	0.85
Large gym	Presence and daylight-controlled lighting; training/competition light levels	21.00	21.00	2,500	1,700	2,110	8,205	1,321	0.63
Interior lighting total	**Selected measures**	**84.8**	**43.6**			**9,621**	**56,174**	**9,046**	**0.94**

Return on capital 6 %
No planning/design costs
Eight-year contract
1998 electricity prices
Amounts in euros ex VAT

Heating and ventilation

When it came to the heating system, ECO-Watt had to make allowances for the arrangements already in place. The city of Freiburg had put the then still municipally owned Freiburg energy and water corporation (FEW) in charge of the school's heating some years before the ECO-Watt project started. The local utility provided heat from old gas boilers from the 1970s and a combined heat and power (CHP) plant at a nearby public swimming baths. As a result, ECO-Watt's hands were tied as regards modernising the heating system. We were restricted to 'behind the meter' measures.

Insulation not an option

Adding thermal insulation always makes sense when the outer skin of a building is up for renewal. Insulation added at such an opportunity will pay for itself over its lifetime. At the project school, no such renewal of the building's outer skin was planned due to the poor financial situation in the city of Freiburg. If outer wall insulation had been included in the package of energy-efficiency measures anyway, the energy savings would not have been large enough over the eight years to pay for the investment. Heat insulation was therefore not an option for the ECO-Watt project.

Smart heating control

There was still plenty of scope to save on heat, however. In a badly insulated building it is all the more important to ensure that rooms are only heated when necessary. Because there is no school in the evening, at weekends and in the holidays, school classrooms are used less than 20 percent of the year. But the heating is often on far longer. A suitably programmed smart heating control system can make sure rooms are only heated when in use and so minimise heat loss in heating and ventilation.

The supply of heat can be optimally controlled with a modern direct digital control (DDC) system. CO_2 sensors can be used to ensure that the room ventilation only comes on when the air quality deteriorates. Generally this means rooms are only ventilated when actually in use.

Fitting a DDC system is among the most cost-effective energy-efficiency measures that can be applied to an ageing building. But energy savings can often still be achieved in buildings that are already equipped with advanced instrumentation and control technology: Open-loop control systems are rarely programmed for maximum energy efficiency.

Optimising the heating and ventilation control system was a very cost-effective part of the ECO-Watt project

Improvements to the heating control system

Various changes were made to ensure that the various parts of the school were not heated more than necessary:

- Thermostatic valves on classroom radiators were replaced where defective and installed where previously lacking.
- More rugged public building-style thermostatic radiator valves were installed in zones where damage was a problem. A total of 180 thermostatic valves and nine zone valves with room thermostats were installed.
- Special room temperature regulators (zone valves) were fitted in corridors and toilets and approximate temperatures there lowered from previously 23 °C to 18 °C.
- Some radiators were moved as there were more than necessary in some zones and the required room temperature was not being reached in others.
- A DCC system was installed in the main school hall.
- Improvements were made to the existing night, weekend and holiday shutdown schedule, with the supply pipe temperature and 'on' times for the various heating circuits now regulated by a computer according to the outdoor temperature. Heating is switched off at night, in school holidays and at weekends when the outdoor temperature is above 2 °C and otherwise run in freeze-prevention mode with substantially lower supply and return pipe temperatures.
- On-school areas such as the basement club room, youth club room and attached workshops were put on a separate heating circuit so other parts of the building do not have to be heated with them during school holidays.

Improving the ventilation control system

The ventilation control system was improved and adjusted to match actual needs. Before the project started, the system was set to provide about 90 m^3/h per person. The hygienically necessary rate is only 30 m^3/h. As there was no heat recovery system, this meant about two-thirds of the air intake was heated superfluously and pumped back outside as hot air unused. Adding a heat ex-changer would have been uneconomic because of the building layout.

In the course of the upgrading work, some rooms were fitted with air quality transducers (sensors). The ventilation in the school canteen afterwards supplied only as much fresh air as was actually needed. The fan running time was also shortened.

Air quality transducers were also installed in the main hall. Extractors in shower rooms were connected to air humidity sensors. In other words, the shower facilities are only ventilated as long as the sensors detect humidity in the air.

The ventilation was also connected to the existing load management system.
This identifies power consumption peaks and switches the fans off for a few minutes at times when electricity is most expensive.

The school heating system, outdated and in need of renewal. As it was operated by the local energy utility, the system could not be upgraded in the ECO-Watt project.

Solar thermal system supplies hot water for sports facilities

The south-facing side of the main hall was fitted with 42 square metres of solar thermal panels to supply hot water. These were connected to the existing hot water tanks. Hot water management was optimised at the same time. Previously, 6,000 litres of water were kept at 60 °C all day. The new system only keeps 1,500 litres of water up to temperature, reducing heat loss.

Saving water

Various water efficiency measures were implemented as part of the modernisation work:

- All urinals were fitted with push-button flushes. Previously, all urinals had been on a timer and flushed every 45 minutes.
- All wash basins in pupils' toilets were fitted with self-closing taps and all taps in pupils' toilets fitted with pressure-reducing valves.
- Economy shower heads were fitted in the main sports hall shower block. This was not possible in the shower block belonging to the school's smaller second gym due to layout. Self-closing shower taps already fitted in sports hall and gym showers and still capable of adjustment were set to a uniform, shorter duration.

In all, some €12,000 was spent on water economy. This saved over nine million litres of water a year and cut water utility costs (supply and wastewater) by over €20,000. Viewed overall, the water efficiency measures paid for themselves in less than a year!

42 m² of solar collectors heat water for the sports hall showers

A glance at the water meter shows huge scope for savings

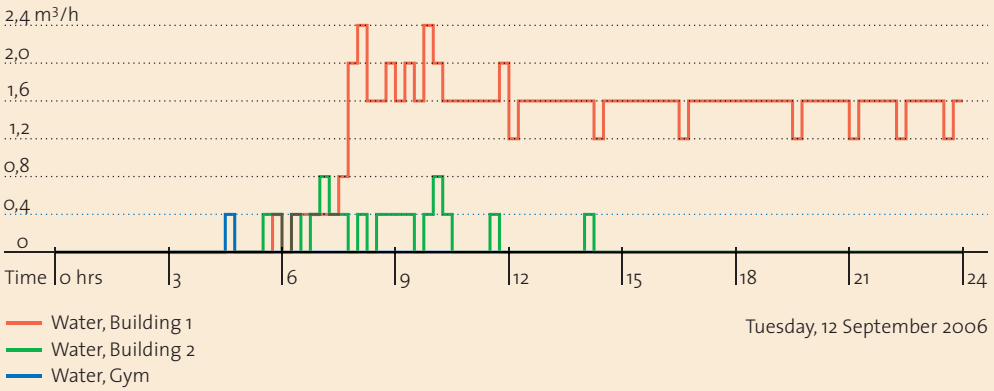
Energy monitoring and system operation

Technical efficiency measures doubtless offer the greatest scope for cutting a building's energy use. Still more kilowatt-hours can be saved without compromising on comfort and convenience by ensuring that building systems are properly run. In public buildings, energy monitoring is a facility management task, but in many cases the technical means for it to work are lacking. The consumption data were queried remotely at the beginning of the ECO-Watt project.

This was made possible by connecting electricity, heat and water meters to the load management system. Regular monitoring of consumption data shows if the heating is wrongly adjusted or if there are any faults on the sanitation side. For example, it becomes easy to see if a toilet flush has stuck and is constantly running.

Great value was attached from the outset of the ECO-Watt project to developing a good working relationship with the relevant caretaking personnel. We responded to their wishes and suggested improvements as soon as possible, and they watched that systems were not left running longer than necessary.

Rigorous energy monitoring can yield major energy and water savings: Caretakers Rainer Barth and Daniel Baier



Water consumption over the course of a day: High night-time consumption due to a faulty valve (red line) detected by checking consumption data

Combining energy-efficiency and renewables: False economy or real gain?

The first priority with a sustainable energy system is to exhaust the available scope for rational energy use. Any remaining energy needs are then met as far as possible from renewable sources.

Energy-saving measures – however efficient – are only one chapter of the climate change mitigation story. Energy needs must also be actively met by promoting the use of renewable energy. This lesson was underscored in the Staudinger-Gesamtschule ECO-Watt project by installing a solar thermal system with 42 square metres of collectors, providing most of the hot water needed for the school's two sports halls. A 2 kW solar array was also built, partly using grant and sponsorship funds.

As the photovoltaic and solar thermal installations did not pay for themselves over the eight-year lifetime of the contract but were still to be included for the reasons already mentioned, they had to be paid for out of the energy cost savings obtained from the remaining installed efficiency technologies.

Though the school is not at all in a high-wind location, the pupils and teachers in the ECO-Watt project group built a small 1 kW wind turbine next to the arts and crafts building for demonstration and teaching purposes.

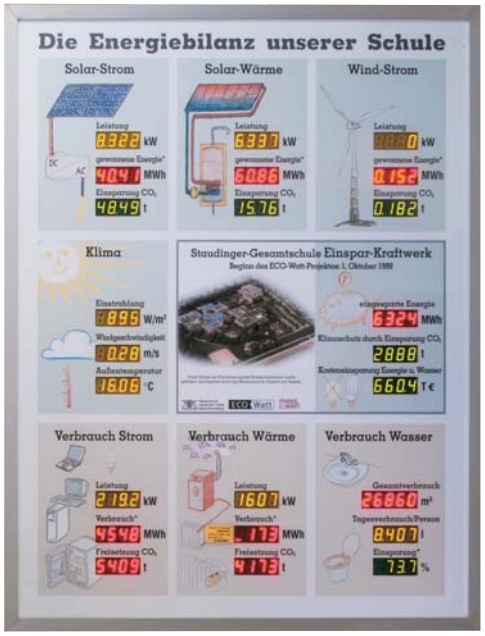
Aside from considerations regarding the ideal solar energy set-up, the wind power and solar installations installed at the school have a symbolic role, making the energy-saving efforts of pupils and teachers clearly visible to the outside world and standing in for the invisible, intangible efficiency technology inside the building.

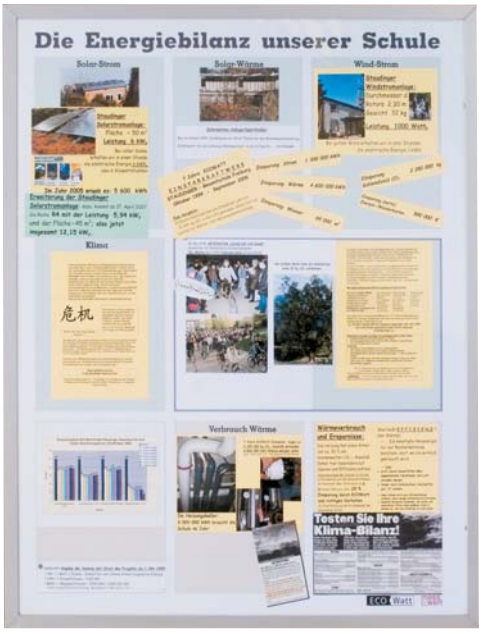
Hands-on energy-saving:
ECO-Watt captures the
imagination of many
pupils at the school

School activities on energy efficiency

A negawatt power plant has one major downside over renewable energy sources: You can't see it. To the layperson, a newly fitted efficient luminaire looks just like the one that was there before. And the money-saving modern heating controls are hidden somewhere in the basement or some other room closed to unauthorised access.

So people could actually see the energy-efficiency measures in the ECO-Watt project at work, a one-of-a-kind electronic display panel was developed in cooperation with a German instrumentation company, Messwert GmbH.





The electronic display panel is part of an information system that displays the current energy figures. An additional information panel provides further information and explanations.

The information panel in the school foyer allows teachers, pupils and visitors to see the current state of the school's energy supply:

- How much are the solar arrays contributing to the power and heat supply?
- What is the current power and heat consumption?
- How much water, electricity, heat and carbon dioxide has the project saved so far?
- What is the temperature outside, how strong is the incident sunlight and what is the wind speed?

The display panel aims to spark the interest of pupils and teachers regarding the complex issues of energy supply and climate change, beginning close to home with the energy and water consumption of their own school. It also makes energy efficiency visible, presenting the 'output' from the negawatt power plant in the form of saved kilowatt-hours, cubic metres of CO_2 and euros' worth of energy.

Educational benefit

Of course, the numbers on the display did not mean much to anyone at first. When the display panel was first introduced, it became an important part of the school curriculum for every class to spend lessons in one subject or another describing and explaining the figures and activities involved in saving energy and water at the school.

To take just one example, the ECO-Watt project saves 9,000 cubic metres of water a year. How many ten-litre buckets make up a cubic metre? Pupils learned just how much water is in a cubic metre by building a wall of 100 buckets. If the amount of water involved was carried on 40-ton trucks, pupils calculated, it would result in a line of lorries 3 km long.

Experience has shown the display panel to meet with great interest. It not only supplies a constant flow of data – it really sets people thinking.

Germany's junior road cycling champion demonstrates her power output on a bike compared with that of incident sunlight. While the athlete has to work very hard to generate 200 watts, the sun beats down at a steady ten million on the school roof on a fine sunny afternoon.

Energy savings lead to more solar power

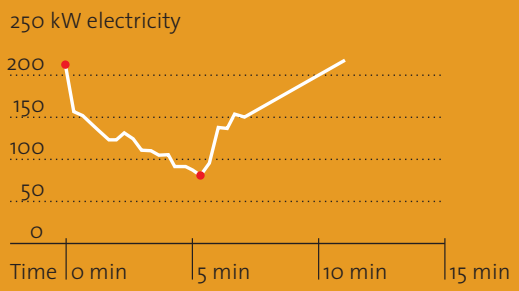
The first photovoltaic array was fitted on the school arts and crafts building in early 2000. The same year, the school fundraising association expanded the array to double its original size. The savings from the ECO-Watt project had allowed the school to have additional solar modules installed on the roof. The final output of the school solar power array is 12 kWp. It generates about 12,000 kWh of solar electricity a year.

Energy efficiency in action: The 'lights out' experiment

Thursday, 23 January 2003, 8.38-8.45 a.m.

At 8.38 a.m., pupils from Form 11b spoke an announcement into the school tannoy. "We are doing an experiment. Please switch off all lights for five minutes so we can watch what happens to the power consumption. Thank you."

Shortly beforehand, representatives from forms throughout the school had gathered in front of the energy display panel. A stopwatch running, they watched with excitement as the school's wattage decreased – from 210 kW to 81 kW in only five minutes! With all the corridor lighting switched off and only the display lamps lit in red, amber and green, the display panel was an impressive sight.



Impressive drop in the school's electricity consumption during the 'lights out' experiment

From calculations based on the observed figures, the school's pupils showed that lighting accounted for about 60 percent of all electric power used on a winter morning. A practical lesson in energy saving: Only switch lights on when needed.

Activities by pupils and teachers in the ECO-Watt project group

Throughout the duration of the ECO-Watt project, a project group comprising pupils and teachers set itself the task of supporting the technical side of the project with educational activities. The result was a huge range of activities, projects and teaching units on topics relating to climate change and the environment. By way of example, the following is a list of activities in one school year:

- Information panels put together showing and explaining tips on how to save energy
- 'Cold dark school' day: The school heating and lights were left switched off on a cold autumn day. The pupils soon discovered what a difference energy made to their lives. There followed form projects on saving energy in the school.
- Information sheet on the school's CO_2 emissions and climate impact compiled and distributed to parents via the pupils.
- 'Energy watches' set up in all forms to monitor ventilation, heating, lighting and waste separation.
- Wall thermometer provided in each classroom, light switches labelled to show which sets of lights they control, and radiator valves checked.
- Pupils take part in the 'CO_2 challenge' issued by Friends of the Earth Germany. Poster competition on energy saving.
- A project group went on the hunt for small appliances around the school. These were switched off where possible (e.g. hot water boilers) or put on a timer (e.g. the staffroom coffee machine).
- In a six-week competition, the most energy-conscious forms were identified by older pupils conducting regular spot checks. The winners were awarded a prize.

Besides these activities, climate change and the environment were incorporated in various ways into the curriculum:

- All Year 11 pupils wrote an interdisciplinary essay titled 'Protecting the Earth's Atmosphere'.
- The school's annual project days were held under the title of Spaceship Earth.
- Pupils built electronic heat and light meters that gave out a signal when a set (adjustable) threshold value was exceeded.
- A number of German lessons were given over to writing environmental poetry.

Energy at school
The ECO-Watt project sparked a series of activities and campaigns by pupils at the school. Awareness was raised to energy issues and some very practical answers were found.
Habits changed regarding energy use and energy consumption dropped further.

A sharp eye for energy savings: The Energy Hawks

In cooperation with the managing director of ECO-Watt GmbH, a project group made up of pupils and teachers launched a wide range of activities to educate pupils, teachers and parents.

There were project days and project weeks on energy-related topics, and climate change became an increasingly frequent subject in the classroom. It has now become a modern tradition at the school for Year 8-10 pupils to introduce new arrivals coming up from junior school to the ECO-Watt project and explain how they can help save energy by proper ventilation and by only switching on lights when they are needed.

All forms are invited to take part in energy-saving competitions to help promote energy efficiency throughout the school.

Once the negawatt power plant was successfully up and running, it was time to start training 'Energy Hawks'. With the help of a teacher, Year 6 pupils were shown how to find and take advantage of opportunities to save energy at home themselves.

Almost all Energy Hawks spied out ways of saving energy in their own homes. They spotted hidden power hogs among televisions, printers, video players and halogen lights. They learned how to prevent standby wastage by switching off at the socket. And they learned to swap conventional lightbulbs for power-saving ones.

The high point of the campaign was a visit to the Solar-Fabrik solar panel factory in Freiburg. A tour of the production facility sparked pupils' enthusiasm and interest. School can be fun and teach something useful after all!

High point of the project: A tour of the Solar-Fabrik AG solar panel production facility in Freiburg

“…when the dog leaves the patio door open…” - life as mother to an 'Energy Hawk'

Dear Teachers,

Life in our four-person household has changed a lot since last year. The reason: Our son's training as an Energy Hawk last year in Year 6 with the help of his teachers Mrs. Gierz and Mrs. Straub and Dieter Seifried from ECO-Watt.

As environmentally aware parents, we have long followed with interest the ECO-Watt project at your school and the rapid successes that have been achieved. We supported the two teachers' initiative of training the then Form 6d as 'Energy Hawks' by signing a Save Energy contract with our son: Half the heating, water and electricity money we saved was to go onto his savings account. In return, he promised to keep a watchful eye on us when it came to saving energy and to make sure that we used energy economically at home.

Things no longer found in our household: The television on standby, an electric toothbrush still plugged in, a window open in a room where the radiator is on … Maximilian saw to everything like an attentive shadow … even the dog got a reproachful look for leaving the patio door open after coming in from the garden. Best of all, we three others simply became caught up in it all and began to do many things as a matter of course for fear of a telling-off.

To think how I used to complain about stereos left on in bedrooms while we ate downstairs, about the front door having been left standing open, about the 'illuminations' on the landing… But going through all the electrical items in the kitchen cupboard together soon showed I was a fine one to talk … some electrical appliances we realised we could really do without.

There were happy faces all round when the electricity bill finally came: Our monthly payments drop to 35 deutschmarks next year and Maximilian has a nice nest-egg on his savings account. Maybe I can animate him to save for an electric scooter… they really get up speed, make no noise and can even run on solar power.

My compliments and thanks to two teachers who have managed to open at least one young man's eyes, spark his enthusiasm and teach us something as well. If this carries on, our children will certainly be able to do without nuclear power.

Yours faithfully,

Astrid Späth, mother to an 'Energy Hawk'

Members of the ECO-Watt teachers' project group (left to right): Heinz Epping, Almut Witzel, Dieter Seifried, Val Kobler, Christoph Heine and Malu Gattermann

Questions to the ECO-Watt teachers' project group

What has the ECO-Watt project achieved at the school?

Almut Witzel (physics): The environment was already an issue at the school - for example we were already building model solar arrays in the 1980s. The impetus given by ECO-Watt made climate change a core topic. Today, protecting the environment is enshrined in the school's official profile.

How have pupils responded?

Heinz Epping (physics): When the project and the activities that went with it were first presented it had my elective students fired up straight away. The idea of Year 10 pupils passing on their knowledge to Years 5 and 6 met with a very good response on all sides.

Erich Hosenseidel (chemistry): The project did not only meet with approval. There were also the occasional sighs and some teachers showed signs of flagging when talk came back round to the project because it went on for such a long period of time.

What has the project meant for you as teachers?

Malu Gattermann (sport): It's something close to my heart, so I am happy to get involved – even if some of the staff show mild annoyance when the topic comes up on the agenda at meetings year after year. But then you have to bear in mind that it has to compete with a lot of other issues that are important in their own right.

Johannes Kenkel (art): It's a fun topic to work with pupils on. I also find interesting all the contacts we had through the project – professors of education, teachers in Japan, student teachers and environmental groups.

Has the project changed how people go about things and what you teach?

Marlies Braun (domestic science): The washing line has seen more use at the school since the project started, and the dryer is only switched on nowadays for teaching purposes. Washing the dishes under running water is out, and using recycled paper is practically a requirement.

Val Kobler (English and German): We used funds from the ECO-Watt project to pay for a project day in cooperation with the Ökostation environmental education centre, where 200 girls from the school learned how to avoid and separate waste. They're bound to have taken that back home with them as well.

The final analysis: Positive on all counts

With the project now at an end, the final appraisal is very satisfactory indeed:
The negawatt power plant works and will continue to deliver the city of Freiburg large monetary savings beyond the end of the contract lifetime. The project is a complete success for the environment, investors, the school and not least for the city of Freiburg.

Heat savings

Overall, between 20 and 30 percent of the original heat consumption was saved at the school in the years 1999 to 2007. Energy consumption for heating and hot water was reduced by no less than 5.4 million kilowatt hours. That is equivalent to half a million litres of oil - and it only represents a fraction of the total available heat savings: Exploiting the potential for thermal efficiency gains at the school by installing insulation, efficient windows and condenser boilers would yield savings of between 70 and 80 percent of the original heat consumption.

Huge power savings

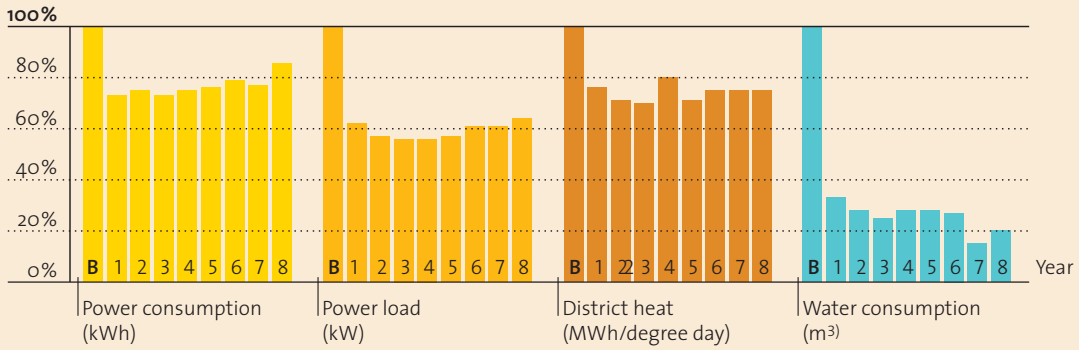
Over the eight-year contract, the ECO-Watt project cut the school's electricity consumption by 1.48 million kilowatt hours. That's the amount of electricity 60 average households would use in the same period.

Benefits to the environment and the climate

About 2,650 tonnes of CO2 were avoided over the contract term. This means someone who invested €5,000 in the project saved 53 tonnes of CO_2 over the eight years. This roughly equals the average CO2 emissions accounted for by a German citizen over a five-year period.
There are other positive environmental impacts as well. The efficient fluorescent tubes in the new lighting contain 90 percent less mercury than their predecessors. Also, the same level of illumination is now provided by a smaller number of lights that use longer-lived tubes, reducing the number of tubes that have to be replaced each year by over 75 percent - a major improvement for the school caretakers.

Major reductions in water consumption

Improved water efficiency saved a huge amount of money - far more than originally projected. Some 77,000 m³ (77 million litres) of water were saved over the eight-year contract period. To hold that much water, a 20 x 50 m swimming pool would have to be 77 m deep.



The energy and water consumption figures for the ECO-Watt project clearly show the major savings made from the very first year. The baseline consumption (B) before commencement of the project is taken as 100 percent.

Ecology and economics

Investors were paid a return of 6 percent a year over the entire duration of the project. The negawatt power plant thus generated a return on investment as well as recouping the €246,000 collected from investors at the outset. A total of €78,250 was released for the school to use at its own discretion. This made it possible for numerous interesting projects to be carried out at the school.

Climate efficiency creates jobs

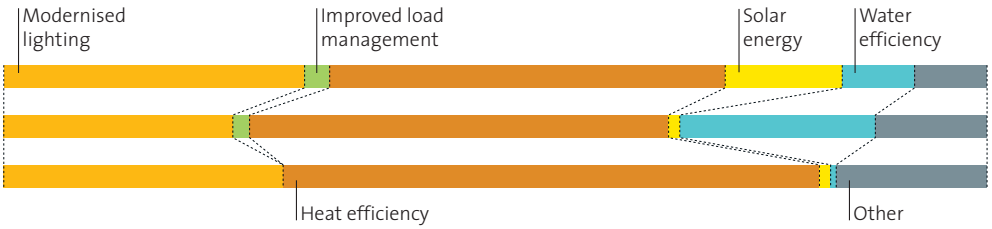
About half of the capital investment in the ECO-Watt project was accounted for by labour to install the energy-efficient fixtures and systems and the other half by purchasing the hardware to be installed. As none of the relevant branches of industry are located in Freiburg (except solar panel manufacture), roughly half of the resulting demand stimulus was concentrated in the Freiburg region and the remainder distributed across Germany.

Projects such as ECO-Watt are also important for craft trades. Firms gain practical experience with modern energy efficiency and control technologies. This can lead them to change the selection of products, works and services they recommend and provide. All in all, the various direct and indirect effects result in electricity and oil imports from other regions and countries being replaced by innovative technologies and labour. This creates additional jobs and boosts both purchasing power and the regional economy.

CO_2 avoidance cost

Different figures are given in the literature for the cost of avoiding a given quantity of CO_2 emissions. What is the cost of one tonne of CO_2 avoided in the ECO-Watt project?

The total cost of the project (capital cost plus servicing, maintenance, insurance, accountancy and management) came to €469,000 over the eight years. The total benefit came to €674,000. In other words, benefit exceeded cost by €206,000. At the same time, 2,650 tonnes of CO_2 were saved in the eight-year period. That is, the project generated a net benefit (cost-benefit) of €78 per tonne of avoided CO_2. Put differently, the project's CO_2 avoidance cost was actually negative.



Proportion of capital cost, cost savings and CO_2 savings accounted for by each set of measures

The awards roll in

The outstanding savings and the dedicated efforts of all involved were not long in attracting due recognition. A coveted award came in the very first year of the ECO-Watt project: the Energy 2000 Innovation Prize (second place) put out by Germany's leading seminar and congress hoster IIR Deutschland GmbH together with the highly regarded energy industry periodical Energiewirtschaftliche Tagesfragen and supported by global business consultants Arthur D. Little.

The project also came an excellent third place in the Wuppertal Energy and Environment Prize awarded by the Wuppertal Institute for Climate, Environment and Energy.

Award: Dieter Seifried accepts the coveted 'e-norm' prize on behalf of everyone involved in ECO-Watt.

ECO-Watt starts a trend in Freiburg...

After the initial success with the ECO-Watt project, Freiburg's city council urged for energy contracting arrangements to cover other buildings in the city. Buildings were grouped into 'pools', where the annual energy cost of each pool was at least €250,000. The projects were put out to EU tender. Two pools of six school buildings each had been implemented by 2006. A third and a fourth pool were at the preparation stage.

... and elsewhere

ECO-Watt also bore fruit in the north-western German state of North Rhine-Westphalia. The Wuppertal Institute there took the idea a stage further with a 100,000 Watt Solar Initiative. The targets of this initiative were to install 50 watts' worth of solar panels and additionally to save 50 watts of lighting power for each pupil (for a total saving in conventional energy of 100 watts per pupil) at selected schools in the state. This enabled a school with, say, 1,000 pupils to create a 100,000 watt solar-based negawatt power plant.

Community-financed energy contracting projects along ECO-Watt lines but with a far larger solar capital investment followed at four schools in North Rhine-Westphalia. These projects also included combined heat and power plants (www.solarundspar.de).

The more comprehensive approach taken in these later projects was a result of policy changes relating to the energy industry. Germany's Renewable Energy Sources Act significantly increased the feed-in tariffs for solar power and a Combined Heat and Power Modernisation Act introduced attractive feed-in bonuses for power from CHP plants with up to 50 kW electrical output (at least 5.1 cents per kWh plus what the grid operator would normally have paid for the electricity on the open market). An ecotax reform led to higher electricity prices and CHP plant operators were exempted from paying tax on natural gas, which also improved the economics of combined heat and power.

Another major difference in the later projects in North Rhine-Westphalia was the length of the contract - in three cases twenty years and in one case fourteen. This allowed for a larger capital outlay, making it possible to exploit potential savings from the installed technology almost to the full.

The project organisers also sought and secured the cooperation of the applicable local and regional energy suppliers. In the systems upgrade at the Aggertal grammar school, for example, modernisation of the lighting, a 43 kW solar array, hydraulic balancing of the heating circuits and pump replacement were financed through a community contracting arrangement. The Aggertal local electricity utility additionally financed a CHP plant with an electrical output of 50 kilowatts and supplies the school with heat from it at a price comparable with that of natural gas. The overall outcome is that significantly more power is produced at the school than is needed. The energy-efficiency measures slashed the school's electricity consumption from some 120,000 kWh to roughly 65,000 kWh a year. The solar array generates about 35,000 kWh each year and the CHP plant produces 230,000 kWh of electricity.

“As a result, the school now feeds around 200,000 kWh into the national grid and produces about 70 percent less CO_2 than before upgrading”, says Dr. Kurt Berlo CEO solar and efficiency projects.

A second project, at the Willibrord grammar school in Emmerich am Rhein, even achieved CO_2 savings of 85 percent. In recognition of their exemplary nature, this and the Aggertal project were selected in summer 2003 as lead projects for a North Rhine-Westphalia state energy innovation initiative. The investors (largely teachers and parents of pupils at the schools) had the prospect of six per cent returns every year for 20 years.

The solar energy and economy projects also emphasise another factor that is indisputably just as important as high levels of returns and CO_2 savings: Environmental education and awareness of climate change issues through active involvement in the project.

Solar arrays at the Aggertal grammar school, Engelskirchen and the Willbrord grammar school, Emmerich am Rhein.

New boiler and CHP plant in the solar energy and economy project, Europa school, Cologne

For all emulators: What you can expect

■ The ECO-Watt project is structured as an energy performance contracting project with a special financing arrangement - community finance with teachers, parents and other local residents providing the capital. You can expect to meet considerable resistance in local authorities and among local politicians. In the private sector, outsourcing specific production operations or services is standard practice. But in the public sector, people have problems with 'letting others do the saving'. You may encounter reservations and lines of argument that make energy performance contracting look unattractive or even impossible to implement. Don't let this put you off.

■ Energy performance contracting does not suit every school. You may also come up against the view that energy economies can generally be put into practice more easily and sometimes more cost-efficiently if the local authorities take things into their own hands. This is basically true, because it cuts out what are known as transaction costs – drafting contracts, billing, communication, etc. – between the authorities and the contractor, and it removes the need for separate costing of the energy savings associated with the building's change of use. In reality, however, this usually results in neither the local authorities nor the contractor going into action. The alternative to a second-best solution then becomes no solution at all.

■ Local building authorities often lack financial incentives and electoral control. Energy efficiency projects also mean more work for the authorities without any prospective reward for success or for achieved savings. The drop in energy costs 'goes under' in the general budget.

■ Changing an existing, functioning heating system can result in problems and extra work for those involved. With this in mind, it is not surprising that people hesitate to implement energy economies or block them altogether. Openly addressing the issues involved before starting can help avoid later discord.

■ With 'outside' contractors, the response is often akin to repelling an unwanted meddler. This is only human, and it is also understandable from a local authority standpoint: If the project succeeds, the people in charge will be asked why they didn't do it on their own. If it fails, they will be held responsible. In times of climate change, there is a need for proactive approaches and arrangements that remove authorities' fear of decisions and responsibility. Systematic effort is needed to reap the potential economies locked up in public buildings. As a rule of thumb, if local authorities cannot make necessary investment in a space of five years using their own financial and human resources, they should turn to outside help in the form of energy performance contracting – with or without community finance.

■ Community finance projects depend on good and intensive communication at all stages. It is especially important for project outcomes to be actively communicated to the outside world. After all, the aim is to show that climate change mitigation is not something that involves huge cost and sacrifice, but an investment that generates good monetary returns.

Summing up

The ECO-Watt project shows very clearly that an energy efficiency project in the form of a 'negawatt' power plant can be highly viable economically and have a wide range of ancillary benefits besides helping to mitigate climate change. But the experience has also shown that economic viability alone is not enough for a negawatt power plant like the ECO-Watt project to become reality. Too many ingrained structures and ways of thinking get in the way – even today, in 2007. Overcoming these obstacles in a community financed project takes a lot of energy, perseverance and even doggedness.

We would not want to have missed out on the experience of ECO-Watt. Not only because the project ended successfully, but because we got to know so many people along the way who wanted to join us on our energy efficiency journey and gave us their dedicated backing. And it gave us a chance to help hundreds of schoolchildren become more aware of how they use energy - something that gives us a certain pride.

Following on from Sir Nicholas Stern, who brought attention to the low cost of climate change mitigation compared with the high cost of climate change with such urgency in his recently published review: In the case of the ECO-Watt project, we were actually able to prove that avoiding CO_2 generates a financial benefit that is greater than the cost - meaning that CO_2 avoidance costs can even be negative. So it can be done: Environmental and economic benefit can go hand in hand. It just takes someone to make a start.

Acknowledgements

Our grateful thanks go to the many people whose advice, hard work and monetary contribution helped carry out the project - first and foremost ERTOMIS Stiftung for its financial support at the important preparatory stage. A big thank you, too, to the pupils, teachers and the caretakers of the Staudinger-Gesamtschule secondary school in Freiburg, whose commitment helped the project succeed. Last but not least, we thank the investors who showed courage with their stake in the project to venture out with us onto new ground.

Freiburg, October 2007
Dieter Seifried

Negawatt power plants – a global view

That negawatt power plants are by no means restricted to schools or Germany is well illustrated by the ensuing examples of energy efficiency projects I have appraised in the context of feasibility studies. They show that in principle, potential energy savings can be exploited on the basis of community-financed energy performance contracting anywhere in the world.

The potential is huge, the economics usually very sound indeed - and implementation mostly turns out to be extraordinarily difficult. The most frequent obstacle is local government. Local authorities everywhere tend not to be very cost-conscious. Even highly lucrative proposals are turned away.

Nonetheless, energy efficiency is and always will be a highly profitable investment. But unlike in other walks of economic life, mobilising the available potential will always take political pressure and persuasion. With this in mind you, the reader, are encouraged to identify potential energy efficiency projects in your own area and to lend your voice and commitment to seeing them become reality.

Please get in touch if you need support.

Freiburg, February 2008
Dieter Seifried

Energy Efficiency Example 1*
Lighting refurbishment in the Mexico City Metro

Outline

- 160,000 outdated and inefficient lights illuminate Mexico City's Metro stations day and night.
- Potential monetary savings well over 50 percent.
- Potential annual electricity savings around 70 million kWh.
- Capital outlay needed about US$14 million.
- Payback period less than four years (including capital outlay).
- Cut in CO_2 emissions: 50,000 tonnes/year

* Dieter Seifried, Feasibility Study for Lighting Refurbishment of the Pedestrian Underpass at Alexanderplatz in Berlin, Germany and for the Subway System in Mexico City. Freiburg, Germany, July 2006, on behalf of the WISIONS foundation.

Description

Building of the Mexico City Metro began in 1967. From the mid-1990s, the Metro had 11 lines totalling 201.7 km of track and 175 stations (including some above ground). The Mexico City Metro serves some 4 million people a day. The price of a journey is two Mexican pesos (about €0.15) regardless of destination.

The Metro is a very safe and extraordinarily environment-friendly form of transportation. There has only ever been a single accident, and that was back in the 1970s. The average electricity consumption per person per trip is 0.64 kWh.
The majority of stations still have the original lighting, meaning most lighting fixtures are between 20 and 35 years old. Over 90 percent of lights use outdated T12 technology with a conventional ballast and about twice the power consumption per unit luminous flux than more efficient T8 or T5 technology.

The great majority of lights are single or twin-tube inset or surface-mounted fixtures without a cover. In some exceptional cases (e.g. some stations on Line 3), lights have been retrofitted with a mirror reflector. The standard type, however, is a low-reflectivity box fitting or bare tubes.

Lights on in a day-lit Metro station

Inefficient T12-tubes with magnetic ballast

Subway station with daylight and additional artificial lighting

Inefficient lights in Metro entries and exits

A feasibility study on improvement of the Metro lighting brought me to an astonishing conclusion: It was possible to improve and renew all the lighting for high financial returns using an energy performance contract. After the four-year contract lifetime, this would save the Metro - or the Mexican state which covers its deficits - around US$7 million a year. Over the lifetime of the new fittings, the savings in electricity and maintenance would add up to no less than US$120 million, without the Metro directorate having to invest a single dollar - a goldmine, in other words.

So why is there so little change? Firstly, the Metro directorate has no financial interest in reducing its deficits, which after all are met by the Mexican state. Secondly, there are powers that be who fear for their positions and aim to guard perks inherent in the existing procurement system.
It would be wrong to think problems like these are restricted to third-world, emerging economies. There are comparable cases, for example, in Germany. Take Freiburg University, recently dubbed a 'University of Excellence'. Things there are less excellent behind the scenes. Lights are inefficient and

Energy wastage is not only a third-world problem: Even in the industrialised world, like here at Freiburg University, Germany, inefficient lighting is left on the whole day while sunshine streams in from outside.

stay on in the daytime despite ample daylight streaming in. Power consumption is enormously high as a result, and everyone knows what that means for climate change. As early as 1999, we and Eco-Watt GmbH submitted a proposal to upgrade the lighting in a community-financed project, regrettably to no avail. It is a shame that such wastage of public money and resources should continue in times of climate change.

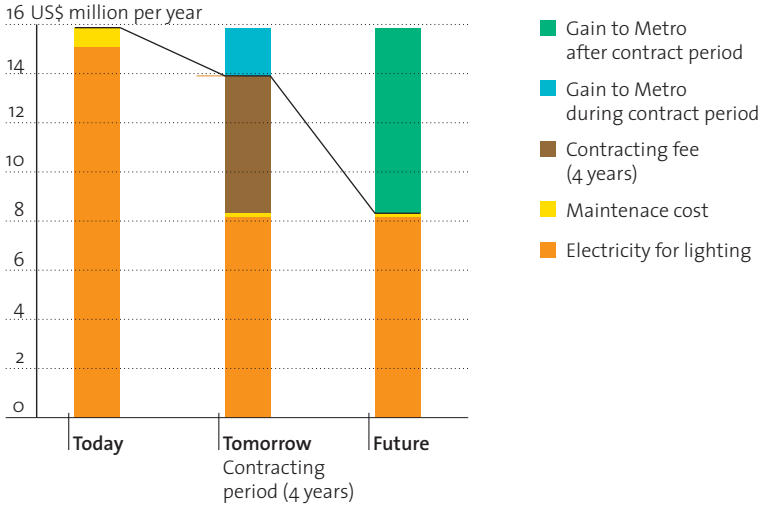


Chart: Cost-benefit situation for the Metro with and without a performance contracting project covering a four-year contract period.

Efficient refrigerators for the Caribbean
Energy Efficiency Example 2*

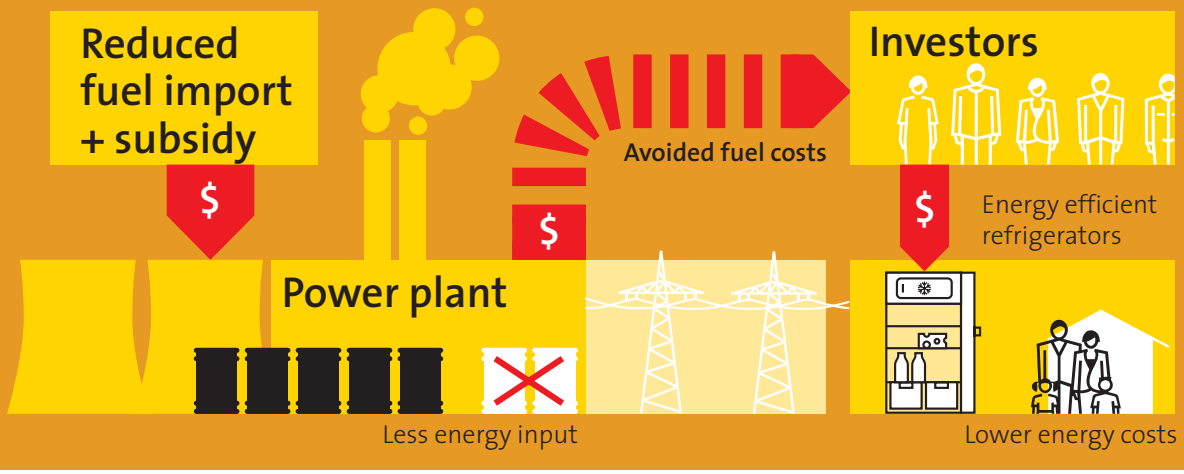
* Dieter Seifried, Büro Ö-quadrat, Machbarkeitsstudie für ein Kühlschrank-Direktinstallationsprogramm auf Kuba [Feasibility Study for a Refrigerator Direct Installation Programme in Cuba], Freiburg, July 2005, on behalf of Deutsche Energieagentur and the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

Outline

- The average household refrigerator in Cuba uses four times as much energy as an efficient modern appliance.
- The potential energy savings are roughly 700 kWh per refrigerator per year.
- Cuban households cannot afford to buy efficient appliances.
- The price of electricity for Cuban households is so low that it would not be worth them buying an efficient refrigerator in any case.
- Power generation is heavily subsidised by the state.
- A proposal is made to replace the old appliances with new ultra-efficient ones. The cost of replacement would be met by a company which would receive part of the cost savings in electricity generation.

The refrigerator is by far the most important household appliance in Cuba by a wide margin. Nearly every household has one. With homes otherwise sparsely equipped, refrigerators account for well over half of household electricity consumption. The great majority of Cuban household refrigerators are old, inefficient units from the USA and the former USSR. Their average power consumption in the hot Cuban climate is some 900 kilowatt-hours per year. In a commissioned feasibility study, I weighed up the economic and environmental pros and cons of replacing these appliances. The outcome: Replacing them using private investment would produce a win-win situation for all concerned.

The cost of replacing the outdated electricity guzzlers with ultra-efficient modern refrigerators would be recouped from fuel savings in power generation alone. Cuban power generation is largely based on expensive crude oil and diesel. An approximately 75 percent cut in refrigerator power consumption (compared with the old appliances) would reduce CO_2 emissions in electricity generation together with sulphur dioxide and nitrous oxide pollution. Proper disposal of the old refrigerators would also prevent the atmospheric release of chlorofluorocarbons, which are highly damaging to the stratospheric ozone layer.



Financing model for energy-efficient refrigerators

Under the conditions prevailing in 2004, neither Cuban households nor the state energy utility were able to replace the refrigerators. In view of this, the proposal provided for private-sector finance of the capital expense, with the investors to be paid back out of the real reduction in electricity generation and transmission costs. As the price of electricity in Cuba is heavily subsidised and the energy utility incurs uncovered costs for every kilowatt-hour saved, this model would also offer huge advantages for the state electricity supplier.

Assuming a crude oil price of US$20 per barrel, the payback period for the private-sector investment capital was calculated at eight years. At an oil price of some US$95 a barrel (January 2008), the payback period would be correspondingly shorter.
In total, about 1.7 million Cuban refrigerators need replacing with new ones. Replacing all of them would take a capital outlay of roughly US$ 400 million.

About the author

Dieter Seifried (Dipl.-Ing., Dipl.-Volkswirt) studied Energy and Power Generation Technology at the Technical University of Stuttgart and the Technical University of Munich and Economics at the University of Freiburg.

From 1983 to 1999 he was Project Officer, Coordinator and Project Manager at Öko-Institut in Freiburg. His main focus was on climate-friendly strategies for the energy sector, least-cost planning, energy performance contracting and green electricity.

Dieter Seifried is a lecturer at Basel Engineering School, where he teaches Economics and Ecology for postgraduates in the Energy programme.

Since 1998, Dieter Seifried has been Managing Director of ECO-Watt GmbH, which focuses on third-party financing projects, including with community finance.

Since December 1999, he has run his own consultancy, Büro Ö-quadrat.

Further information in German at www.oe2.de

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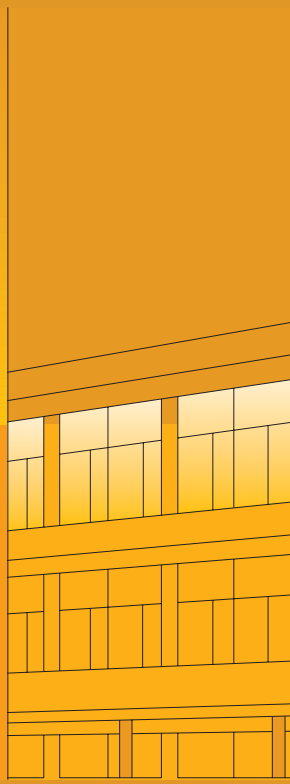

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