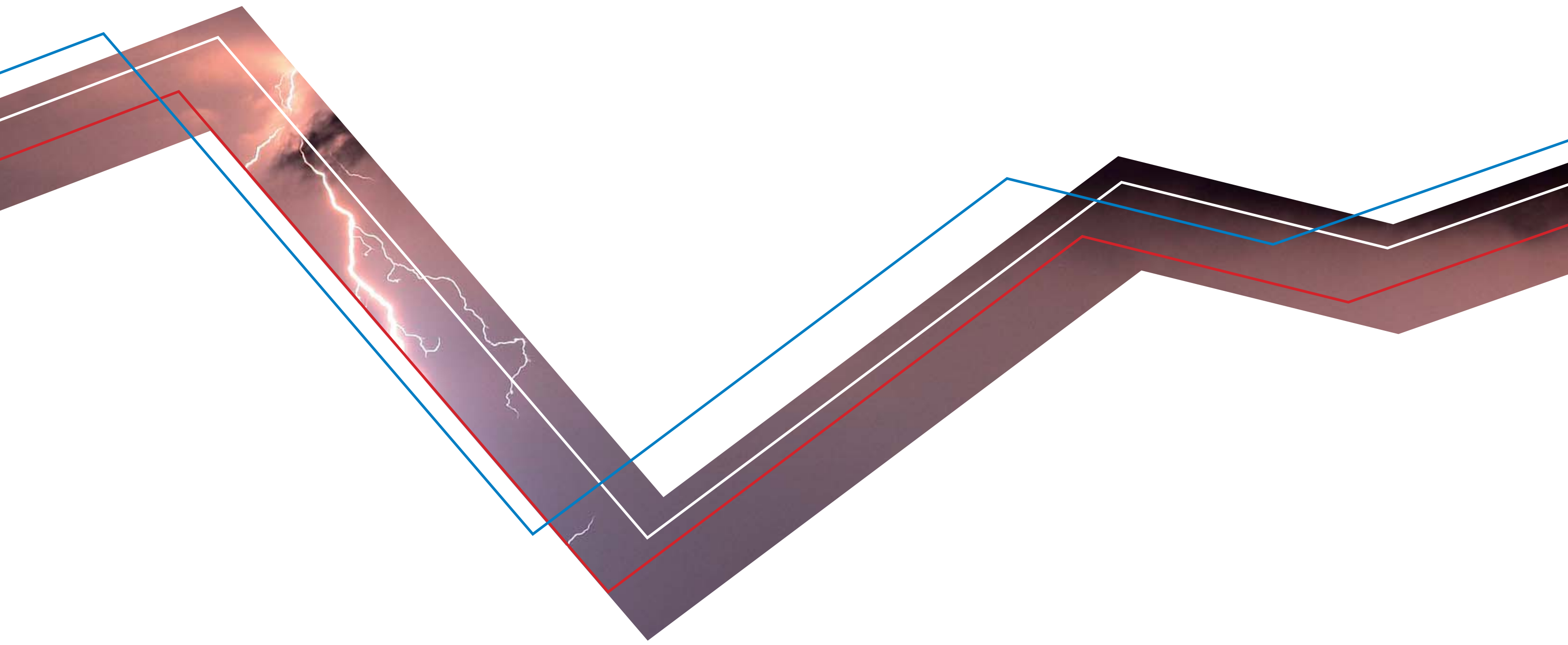
COMPACT NO 01/2009

ENERGY IN CLIMATE CHANGE

A BACKGROUND REPORT OF CIPRA



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cc.alps in a nutshell

The Project "cc.alps – climate change: thinking one step further!" is organised by CIPRA, the International Commission for the Protection of the Alps, and financed by MAVA Foundation for Nature. Through the Project, CIPRA is helping to ensure that climate response measures in the Alpine region are in harmony with the principle of sustainable development.

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1 FOREWORD

Through the project "cc.alps – Climate Change: Thinking one Step Further!" – CIPRA (Commission Internationale pour la Protection des Alpes) investigates climate measures in the Alps. CIPRA brings together climate protection and climate adaptation activities in the Alps (hereinafter these activities are defined as Climate measures) and analyses what effects these climate measures have on the environment, economy and society. CIPRA's aim is to make available to a wider audience those climate measures which are in line with the principles of sustainable development and to warn against those climate measures which have negative consequences not only on nature and the environment but also on the social structure and the economy.

The "CIPRA compact" collection features various theme books that deal critically with climate measures in the Alps. The collection comprises the field of activity "energy" besides others like: building and renovating, energy self-sufficient regions, spatial planning, traffic, tourism, nature hazards, nature protection, agriculture, forestry and water.

The CIPRA compact "Energy" provides an overview on energy use and energy production in the Alps and describes national and regional strategies for climate protection and climate adaptation. Here CIPRA gives its central statement on this issue: if we want to stem earth warming, increasing efficiency is important but not sufficient: we must reduce our consumption of energy services. Renewable energies must be imposed – with respect to this we must proceed carefully since even renewable energy sources hide significant potential for ecological conflicts. Particularly problematical sources are biomass, wind energy and the further exploitation of water energy in the Alps. If we want to change energy use we need a decentralised energy economy and macroeconomic measures. CIPRA's demand in this field is to put together an "Energy Vision for the Alps".

The third chapter focuses attention on the production of energy in the Alps and analyses various energy sources with respect to their sustainability: what potentials do energy sources have for an energy supply which is neutral towards the climate, and which sustainability issues can arise due to their increased use? The fourth chapter provides model examples: the sustainable energy supply in Achental, Bayern, the district heating station in Toblach, South Tyrol and the Energy School in Upper Bavaria show how this can be achieved and encourage its imitation. In chapter five the authors summarise their most significant notions and conclusions.

RENEWABLE, DECENTRALISED, HIGHLY EFFECTIVE

CC.ALPS: CIPRA DEMANDS ON ENERGY

In order to limit global warming, first of all it is important that we use energy more efficiently. Yet this will not be enough for operating in a way that climate can sustain. We must radically change our energy consumption and our consumption of energy-intensive goods and services. Experience shows that consumption only goes down when clear political signals are sent — which include legislative initiatives, rewarding energy saving and punishing waste.

The switch from fossil to renewable energies must be forced — but not to the detriment of nature. Biomass production, the installation of wind power turbines and new hydroelectric power stations in the Alps hide many potential conflicts. The environmental, social and economic consequences of climate projects must be carefully assessed and compared.

CIPRA requests:

AN ENERGY VISION FOR THE ALPS

In the post-oil age there will be an increasing decentralisation of energy generation. This energy change must be supported by social and environmental tax reforms, an infrastructure and spatial planning policy to reduce traffic, as well as by a technology policy which enables further rises in efficiency. In order to bundle these strategies, Cipra requests an "Energy vision for the Alps", which must be defined together with all stakeholders from the economy, civil society and local institutions. It can be drafted within two years, and then enforced by the Alpine Convention and the EU strategy for the Alpine space, and be rapidly implemented thereafter. It must foster and regulate energy saving and efficiency increases, the construction mode of new plants for the production of renewable energy (wind, water, sun, biomass, ...), so that they do not damage nature and landscape.

SAVE ENERGY

If we want to limit global warning in future years to a tolerable extent of around two degrees, we must reduce the emission of greenhouse gases by approximately 80 percent. We can only succeed if we sharply reduce our energy consumption. Legislation for this purpose is necessary, and energy prices must include the environmental and social costs of energy production. Waste must not be rewarded and supported by governments.

MORE EFFICIENT HYDROELECTRIC POWER STATIONS INSTEAD OF NEW ONES

The expansion or modernisation of hydroelectric power stations can enormously increase their efficiency level in the short term: there are examples where modernisation has led to tripling power generation, whereby the environmental situation was even improved thanks to accompanying measures. Such improvements have priority over constructing new hydroelectric power stations, with their negative impacts on nature and landscape. The environmental friendliness must be checked and ensured in all revamping projects, or — when interferences are inevitable — these must be compensated according to the water framework directive of the EU and national laws. The contracting parties to the Alpine Convention are requested to overhaul their respective legal requirements for the promotion of environmentally friendly electricity. Regulations must be changed so that efficiency increases and the optimisation of existing hydroelectric power plants are more strongly supported and no new environmentally damaging plants are promoted.

A SUSTAINABLE USE OF ENERGY

Countries, regions and municipalities in the Alpine arch are invited to draft exhaustive and, where possible, concrete programmes, which speed up the switch to renewable energies. Such models include the Swiss project "Energiestadt/ Energy city" or the "e5" Austrian city programme. The allocation of funds in the energy sector must be made dependent on the fact that municipal applicants are obliged to state their participation in such programmes.

NUCLEAR POWER PLANTS ARE NOT A FUTURE OPTION

Nuclear power must no longer figure in the future power supply of the Alps. Greenhouse gas emissions are released by the construction, maintenance and demolition of these power plants. The nuclear combustion cycle swallows significant quantities of fossil energy. Uranium is a finite raw material — based on current demand, its extraction might become unprofitable by 2030. Only 30% of the energy released by nuclear fission can be utilised and large quantities of waste heat are produced, leading to environmental impacts such as heating of rivers caused by discharge waters. The risk of catastrophic events is indissolubly linked with nuclear power. In addition, radioactive material is produced, which represents a significant risk for the safety of current and future generations.

3 CLIMATE CHANGE AND ENERGY

3.1 ENERGY USE IN THE ALPS

The combustion of fossil energy sources such as oil, natural gas or coal to generate energy is one of the main causes of the climate change brought about by mankind. CO_2, which reaches the atmosphere through the combustion of fossil energy sources, is the greenhouse gas which, especially in the long term, turns out to be the highest contributor to climate change. In most of the world, CO_2 emissions come from the use of fossil energy. Additionally, the use of coal and natural gas generates methane emissions, which also have an effect on climate. Alpine countries, with their energy consumption and energy mix, are also contributors to climate change since they are industrial countries. Figure 1 shows the use of primary energy in the various Alpine countries in the years between 1970 and 2004: overall, energy use in the Alps almost doubled between 1970 and 2004 (see Table 1). With more than 2000 Petajoule (PJ) the energy use in the Alps accounts for almost 3 % of the total energy use of the European OECD countries – and per capita energy consumption in the Alps is approximately 10 % more than the European average.

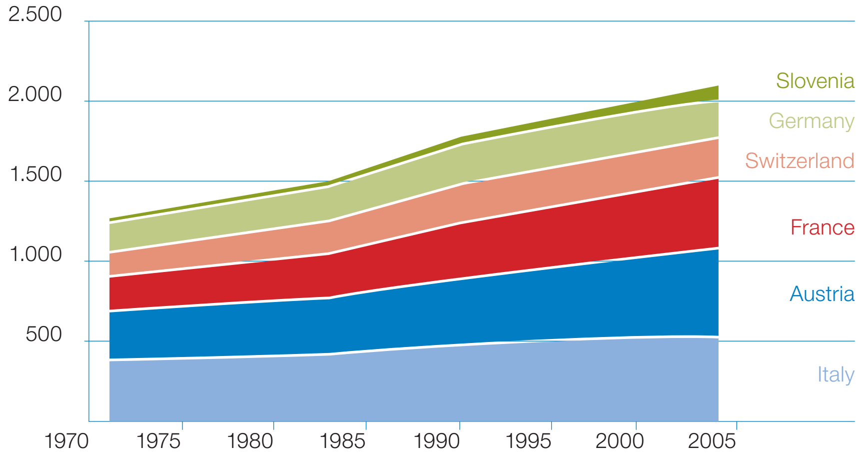
As in the past, the energy mix in the Alpine area is dominated by traditional fossil energy sources: coal, natural gas and oil products contribute together to more than 70% of the final energy use (Haberl et al. 2001). Coal consumption, which generates the highest CO_2 emission per energy unit produced, has decreased in the last decades by around 50 %. The use of oil, which in 1971 accounted for two thirds of the final energy use, grew only slightly by the end of the 20th century. The increase in energy use was accounted for above all by natural gas, electricity (in the Alps, largely coming from hydroelectric power) and other energy sources (biomass and district heating). This has led to a "relative decoupling" between energy consumption and CO_2 output: today less CO_2 is released per unit of energy utilised than in the 1970s. However, this increase in efficiency has been clearly more than offset by the increase in energy consumption.

Industry, households and traffic each consume approximately 30 % of the final energy. Other sectors such as agriculture, trade, service companies and the public sector need on the whole only around 15 %. While in the last decades energy use in the industry has stagnated, the consumption of traffic and households has doubled since the 1970s. Also, the percentage of the other sectors of the use of final energy has grown.

Energy scenarios in the Alpine countries start from the assumption that energy requirements over the next decades will grow only slowly or maybe even stagnate thanks to increases in efficiency (especially in residential heating) and in prices (Kratena & Wüger 2005, OcCC & ProClim 2007); however, no decrease in energy requirements can be foreseen – unless drastic political action is taken.

Figure 1:

Primary energy use in the Alpine countries 1971-2004, in Petajoule (PJ).



Source: Haberl et al. 2001, Pastorelli 2007, IEA 2007a, IEA 2007b

Table 1:

Energy use in the Alpine area in 2004, in tonnes of oil equivalents (TRÖE).

Energy consumption	Alpine countries (Mio. TRÖE)	in the Alpine area (Mio. TRÖE)	Per capita (TRÖE)	Population in the Alpine area (Mio.)	Total population (Mio.)	Surface area (1000 km²)	Surface area in the Alpine area (1000 km²)
Austria	33.7	13.5	4.1	3.3	8.3	8.39	5.49
France	262.6	10.8	4.3	2.5	61.7	54.40	3.98
Germany	328.5	5.6	4.0	1.4	82.3	35.70	1.09
Italy	202.5	14.7	3.5	4.2	57.9	30.13	5.24
Slovenia	6.0	1.8	3.0	0.6	2	2.03	0.78
Switzerland	29.0	6.6	3.9	1.7	7.5	4.13	2.68
total	862.3	53.0	3.8	13.7	219.7	134.77	19.25

Source: Pastorelli 2007

In the Kyoto Protocol, the Alpine countries (with the exception of Monaco) have undertaken to reduce, by 2012, the emissions of greenhouse gases (including CO_2) to 92 % of the reference year 1990. The EU is now planning to reduce its greenhouse gas emissions by 2020 to 70% of the 1990 value. In December 2008 the EU Parliament issued the "Climate and Energy Package", a regulatory text with legislative measures which is based on two main strategies:

a Increase in energy efficiency: with respect to the energy utilized per unit, the quality of the "energy service" must be increased. Efficiency increases must give the opportunity in the future to heat more living spaces with the same energy quantity or to cover longer distances. The EU aims at an efficiency increase of minimum 20 % by 2020 compared to a development without the relevant interventions. It is particularly oriented to room heating, where today efficiency increases can already be analysed (see CIPRA compact Building and Renovating). One mechanism that should contribute to the increase in energy efficiency is the "Trade of Greenhouse Gas Emissions": Around 12.000 of the large emitters currently registered, such as factories or power stations. have the opportunity to sell the emissions they save on the European marketplace. In this way, an economic incentive is generated to reduce emissions. This measure is a politically appropriate way to increase efficiency, however it does not contribute (yet) to an absolute reduction in the emissions, because of the (too) high emission quantities that can be traded.

b A greater use of renewable energies: the share of renewable energies of the total energy mix must be increased from current 9 % to 20 % in 2020. In this way, the CO_2 output per unit of energy utilised will be further reduced. This is an ambitious goal – but from an ecologic viewpoint with an energy system which is 80 % based on fossil energy sources, we are still far from a sustainable and climate neutral energy supply.

Figure 2:
Energy efficiency in buildings plays a very significant role in energy saving. For detailed information, see CIPRA compact "Constructing and refurbishing"

The Alpine Convention's Declaration on climate change calls for the "improvement in energy efficiency and the use of existing energy saving potential" as well as the "increased use of renewable energies in the Alpine area". Climate protection programmes of the Alpine countries and of some regions in the Alps make very similar requests.

The increase in energy efficiency and a switch to renewable energies can counter a further increase in the emission of greenhouse gases – but are they sufficient? The so-called "rebound effect" is taken into too little consideration in the climate protection measures which are currently implemented: it describes the fact that an increase in efficiency accompanied by simultaneous economic growth may lead to an increase in the demand for efficiently manufactured products. This applies also to energy services. This way, the ecological benefit of efficiency increase is reduced or even turned into its opposite. In the Alpine area similar effects contributed to the fact that energy consumption continued to grow despite constant efficiency increases. Even the significant reduction in CO_2 emissions per quantity of final energy utilised was more than offset by the growth in energy consumption, so that CO_2 emissions on the whole have increased (see www.cipra.org/de/alpmedia/publikationen/3222).

Climate protection therefore cannot be considered only at a “micro-level”, that is, at the level of factories, products and consumers. Climate change is more a social issue. An opportunity to act in this sense is the eco-tax, which reduces taxes on labour while increasing taxes on energy consumption. These ideas have been implemented in Germany in the ecological tax reforms since 1999. However, the extent of the changes in the tax system was far too small to bring about the necessary trend changes for a successful climate protection policy.

Energy use not only causes climate change: through climate change also energy itself needs change as well as the time in which the energy is required. This particularly affects the energy needs of households. In warm winters less heating is utilised, however in an increasing number of buildings air conditioning systems are installed for cooling air in the summer. Some scenarios show in Switzerland that the cooling requirement in 2050 versus 1984-2004 may increase by 150 %, while heating energy needs in winter will decrease by only15 % (Aebischer & Catenazzi 2007). While Alpine countries mainly use fossil fuels such as oil and natural gas for heating, traditional air conditioning systems are mainly supplied by electric power. It is estimated that the increase in power requirements generated by this cannot be covered through climate neutral energy sources such as hydroelectric power, and that by 2050, owing to the expected climate changes, power production from water may shrink by up to 10 % (UVEK 2007, Akademien der Wissenschaften Schweiz (Hg.) 2007).

3.2 ENERGY SUPPLY IN THE ALPS

Energy supply in the Alps is markedly different from regional energy consumption: with their storage power stations, the Alps act as the “batteries of Europe”, since they produce peak current in cases of high demand. At the same time, the Alpine area imports electricity generated by nuclear power plants and large quantities of crude oil and natural gas, which are not produced at all in the Alpine countries. Table 2 summarises the most significant energy sources in the Alps, arranged in fossil energy sources (coal, crude oil, gas), “traditional” renewable energy sources (water power and biomass for heat generation), “new renewable” energy sources (biofuels, wind energy, solar power and waste heat) as well as nuclear energy.

Table 2:

Overview of various energy sources and their relationship with climate change, see also ProClim (2007).

	Energy source	Use	Effect on climate	Impact of climate change	Contribution to energy consumption in the Alpine countries	Potential, conflicting goals
Fossil Energy Sources	Coal	Heat, electricity	Highly detrimental to climate	Medium (cooling water)	Medium	Greater use would be counterproductive in terms of climate and environmental policy
	Crude oil	Heat, electricity, fuels	Detrimental to climate	Medium (cooling water)	Very high	Greater use would be counterproductive in terms of climate policy
	Natural gas	Heat, electricity, stationary engines	Detrimental to climate	Medium (cooling water)	High	Greater use would be counterproductive in terms of climate policy
Traditional renewable energy sources	Water power	Electricity	Low impact on climate	high (changes in water flow)	Relatively high	Potential exhausted in a considerable part, conflicts with nature protection
	Traditional biomass (firewood)	Heat	Low impact on climate	Medium (changes in growth through climate change)	Relatively high	Still relatively high potential; potential conflicts with nature protectionz
New renewable energy sources	"Modern" biomass (Biofuels, Pellets etc.)	Electricity, heating, fuels	Depends on production method	Medium (changes in growth through climate change)	Minimum, growing	High potential estimated, probably overvalued. Conflicts with nature protection and food production
	Wind energy	Electricity	Low impact on climate	Medium (danger through storms)	Still minimum, rapidly growing	Medium potential in the Alps
	Solar power	Heat, electricity	Low impact on climate	Minimum (changes in sunshine hours)	Still minimum, rapidly growing	High potential, in particular in heat production
	Terrestrial heat, industrial waste heat, combustion heat from waste	Heat	Low impact on climate	Minimum	Minimum	Relatively high potential for spatial heating.
Nuclear power	Nuclear fission	Electricity	Risky. Final storage issue not solved.	Regionally different, based on water availability (cooling water)	Relatively high	Due to ecologic and social risks and long-term consequences linked to high acceptance problems

Source: ProClim 2007

3.2.1 FOSSIL ENERGY SOURCES (CRUDE OIL, NATURAL GAS, COAL)

Fossil energy sources (in particular crude oil) account for the majority of energy use in the Alps. However, these resources are hardly available in the Alps and almost all the fossil energy used there is imported. For electricity production in the Alps, fossil energy plays a relatively small role: in 2000 there were eleven thermal power stations in the Austrian Alps with a total capacity of 844 Megawatt (MW), three in Switzerland (331 MW) and one in Slovenia (662 MW), that generate electricity by burning fossil fuels. In particular, the large thermal power stations mainly burn local brown coal (Haberl et al. 2001). During the combustion of this type of coal, particularly high CO_2 is generated per unit of energy produced (Table 3). In Switzerland, currently, the activation of a natural gas combined-cycle power station is planned in Chavalon (Wallis).

Table 3:
CO_2 emissions of various fossil energy sources per energy unit (Terajoule, TJ) in Austria.

	CO_2-emissions [tCO_2/TJ]
Coal	95
Brown coal	110
Heavy fuel oil	80
Natural gas	50

Source: BMWA (ed.) 2004

In climate protection, the issue currently focuses too little on a substantial withdrawal from fossil energy, which would be necessary for a climate-neutral energy supply. Instead, the debate is focused on the efficiency increase of thermal power stations through the use of cogeneration systems. This type of power station generates thermal energy as a by-product of its electricity generation, which can be utilised for example as district heating. This way the level of efficiency of energy use can be increased from 35-50 % in power stations without heat cogeneration, to up to 85 % with cogeneration. Nonetheless, even with such an efficient use of fossil energy sources, the contribution of CO_2 output to climate change remains a very big problem.

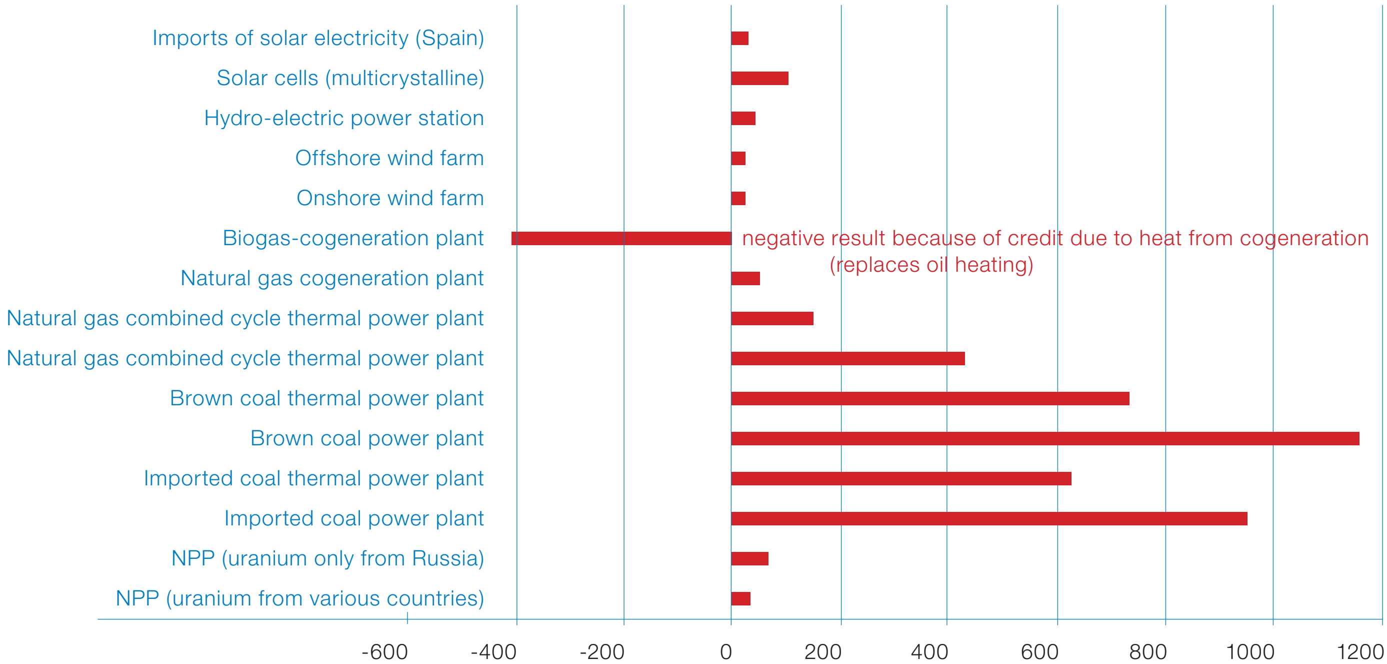
Thermal power stations are affected by climate change because, in the event of a change in temperature and rain levels in summer, there may be too little cooling water, or it may overheat. Fossil energy activated power stations are also central energy suppliers, which require large electricity distribution networks. In case of an increase of extreme weather events (storms, snowfall) the impact on these electricity networks is particularly heavy.

3.2.2

RENEWABLE ENERGY SOURCES

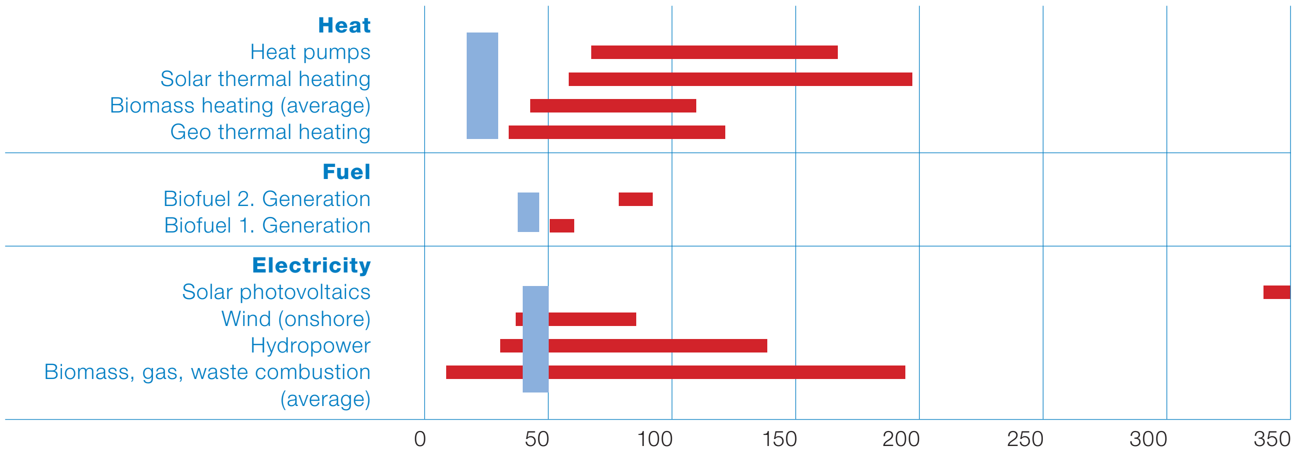
Within renewable energy sources there is a distinction between traditional renewable (water power and wood for heating purposes) and new renewable energy sources (biofuels, wind energy, photovoltaics, geothermal energy). Renewable energy sources are considered as "climate neutral" since, in energy production, they cause either no greenhouse gas emissions (water power, wind energy, solar energy, geothermal energy) or release only so much carbon dioxide as they have absorbed previously from the atmosphere (biomass). When building and maintaining the necessary infrastructure as well as during energy production, high greenhouse gas emissions occur at different levels.

Figure 3:
Emissions of CO_2 Equivalents (CO_2 and other greenhouse gases) per Kilowatt hour (kWh) generated electricity from renewable and non-renewable energy sources, taking into account the process chain of the various plants in Germany.



Net balance including upstream processes in terms of greenhouse gases [CO_2-Eq./kWhel] Source: Fritsche et al. 2007

Figure 4:
The average costs, which arise per unit of energy generated from the various energy sources, are represented in EUR/MWh)



Costs of the various renewable energy sources in Europe for heating, transport and electricity compared to the costs of fossil energy sources

Source: Commission of the European Communities 2007

Unlike fossil energy sources, renewable energy sources can be produced in the Alpine area. This has two crucial advantages: first, the value created remains in the region and thus generates positive effects on employment; second, its higher use reduces dependence on imports thus increasing supply security and reducing political risks (see the natural gas conflict between Russia and Ukraine) for the energy systems. With the exception of water power which can be generated in large power stations, renewable energies are characterized by the fact that they are decentralized with relatively minimum energy density. The structure of their supply is thus more decentralised . To a large extent, their efficient use requires a massive conversion of the energy systems. With respect to climate protection this is positive, since decentralised energy structure and use of renewable energies integrate nicely.

• TRADITIONAL RENEWABLE ENERGY SOURCES

WATER POWER

Water power is the traditional form of renewable energy used in the Alpine area. More than 90% of electricity production in the Alpine area is generated by water power (Haberl et al. 2001). Also, the share of national electricity requirements, which is covered by water power, is comparably high in the alpine countries (table 4).

Table 4: Share of water power in national electricity supply in the Alpine countries.

PERCENTAGE OF NATIONAL ELECTRICITY REQUIREMENTS COVERED BY HYDROELECTRIC POWER

Land	%	Quelle
Switzerland	62	Umwelt-Werkstatt e.V., Deutschland: www.bs-net.de
Austria	76	
Germany	4	Bundesamt für Wasser und Geologie, Schweiz: www.bwg.admin.ch
Italy	20	
France	15	
Liechtenstein	45	Liechteinsteinische Kraftwerke
Slovenia	29	Zdruzenja za energetiko, Slowenien: www.gzs.si/si_nov/druzenia/z26
UE	14	Verband der Elektrizitätswirtschaft VDEW e.V., Deutschland: www.strom.de
Norway	99	Umwelt-Werkstatt e.V., Deutschland: www.bs-net.de

Source: Haubner 2002. Warning: since the publication of this table, some percentages have fallen (e.g. Austria: 60 %): not because electricity production from water power has diminished, but because electricity consumption has substantially increased.

Various strategies to reduce the emissions of greenhouse gases in the Alpine countries are based on an increase in the production of electricity from water power (see CIPRA compact Water):

- Construction of new large water power stations: Slovenia plans the construction of five large water power stations, in Italy the target is to add to current production another three Terawatt hours (Clini 2004), and also in Austria, the Tiroler Wasserkraft AG TIWAG company intends to provide two new large power stations and to expand two existing pump storage stations. This expansion is connected with significant environmental issues, since it would mean the loss of the last natural Alpine rivers (Tödter 1998).
- Extension of small power stations: in Austria, Switzerland, Germany and France, where water power potential has already been largely tapped, there are initiatives to promote small water power stations, such as the “small water power stations programme” (CH). The same applies here: without ecological requirements, the expansion of water power threatens the biodiversity of Alpine rivers. Labels such as “naturemade” or “greenhydro” in Switzerland characterise environmentally-friendly electricity generated from water.
- Efficiency increases: in regions which have relied on water power for centuries (Austria, Switzerland, Germany and France), there is great potential to increase the efficiency of existing stations. The Kemmelbach power station in Lower Austria for example, by converting, may more than triple its electricity production from 4 Gigawatt hours (GWh) to 15 GWh. The ecological situation was improved thanks to complementary measures like a fish ladder of 463 m length.

Figure 5:
Expansion or revamping of hydroelectric power stations can quickly increase their efficiency level.

Pumped storage hydro power stations differ from other techniques to generate renewable energies since they not only deliver a relatively high amount of energy but also “improve” energy: they deliver expensive peak power at times when demand is particularly high and utilize cheap night power, which often comes from nuclear power stations, to pump water back into storage for the next peak demand. An expansion of pumped storage hydro power stations would thus lead to an increased night energy demand. Pumped storage hydro power stations can however also be useful for storing the energy which comes irregularly from renewable energy sources such as wind or solar energy and for making it available in case of need – in a sustainable energy system, based on renewable energy sources, they would thus play a key role in the Alps (Erlacher 2005). However, the same applies also to pumped storage hydro power stations: the construction of new stations threatens biodiversity (see CIPRA compact Nature protection).

Power production from water power is very strongly impacted by climate changes, since the hydrologic balance of Alpine rivers will change, because of climate change due to glacier shrinkage and a shift of rainfalls in cold seasons (Federal Ministry for the Environment 2008, see also CIPRA compact Water). More rainfall in winter can increase the capacities of pumped storage hydro power stations also without expansion, however demand for electricity increases even more rapidly. Already at the moment electricity production from water power is no longer sufficient to meet demand for electricity in some Alpine countries. It can therefore be expected that rising power requirements over the next decades in the Alps will not be covered by water power (UVEK 2007, Academy of Sciences Switzerland (Hg.) 2007)

- TRADITIONAL BIOMASS (FIREWOOD)

Wood combustion is the oldest method of heating. Even today, most of the barely 10 % of final energy production in the Alps accounted for by biomass consists of using wood and wood pellets. The use of wood to generate thermal energy must be considered as sustainable, since

- in the long term wood will no longer be used, or in a much lesser than the wood that grows (in the Alps a regionally problematic forestation can currently be identified).
- wood production is environment-friendly (natural forestry).
- cut wood is completely utilized (including the use of wood chips from the wood working industry).
- local air pollution is avoided as much as possible through filters.

Wood and wood chips are increasingly utilized also in biomass power stations for district heating and electricity production (see CIPRA compact Forestry).


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Figure 6:
The switch from fossil to renewable energies must be impelled – but not to the detriment of nature. Biomass production, the installation of wind power stations and new hydroelectric power stations in the Alps hide many potential conflicts.

NEW RENEWABLE ENERGY SOURCES

- «MODERN» BIOMASS

IIn recent decades biomass has become increasingly significant as an energy source for more valuable forms of energy such as fuels or electricity. In all Alpine countries strategies to expand the use of biomass represent a significant component in the efforts towards climate protection. In France, through the tender “Appel d‘offre biomasse”, the objective is to generate an additional output of 300 Megawatts (MW) by 2009 using biomass. The Italian programme “PROBIO” (Programma Nazionale Biocombustibili) has been supporting the production of biofuels in Italy since 2003. In Switzerland biofuels have been tax exempt since 2008, if their production complies with minimum environmental requirements – though expectations are modest: 5-10 % of the overall fuel consumption by 2035 (UVEK 2007). The Austrian government programme of 2007 plans to cover 10 % of fuel requirements in 2010 through “alternative fuels” – among them also biogas (BMLFUW - Federal Ministry for Agriculture and Fore-

Figure 7:
Land areas used for growing energy crops are no longer available for food production.

stry 2007). These targets clearly show that the production potential of biofuels is not sufficient to supply the current system of mobility (see CIPRA compact Transport). The likely contribution of biomass to electricity production is estimated in Switzerland at approximately 5 % and is similarly relatively modest.

The use of biomass for these energy forms is in addition to that which is only theoretically neutral to climate. Unlike the use of extensively produced wood or of agricultural waste, in the intensive agricultural production of oil plants for the production of biodiesel there are relatively high CO_2 emissions: in Europe, in biodiesel production from rape, only 1.7 units of renewable energy are generated per fossil energy unit utilized (Escobar et al. 2009). A worldwide conversion to biodiesel would not reduce greenhouse gas emissions at all, and might even increase them because, by cutting down woods and with the nitrous oxide emissions due to the use of nitrogen fertilisers, the same amount of greenhouse gas emissions are produced as in the use of fossil fuels (Crutzen et al. 2007).

Furthermore, in the production of biofuels there are conflicts of interest in the field of land use: those areas which are utilised to grow plants for energy are no longer available for other functions such as food production or nature protection. With respect to land efficiency, photovoltaic systems should, for instance, be very much preferred to biofuels: from the same area, solar cells can generate approximately 100 times more energy.

The combustion of agricultural and forestry waste to obtain energy can instead be considered as having a genuinely low impact on climate. In addition, the above-mentioned conflicts of aims on land use are not involved. A useful strategy in this context is the “cascade use”: this way the whole utilisation chain of biomass from production to end use is optimised. An opportunity to do so is the use of by-products such as

- biogas production from farm animal manure, humid crop by-products (e.g. corn straw, turnip leaves), organic home waste or residues from food production or
- energy recycling of straw or wood waste.

This way the productivity of agricultural and forestry areas can be utilised much more efficiently, on the one hand increasing the potential for energy biomass and, on the other, defusing conflicts of aims.

In the use of biomass the issue is the type of production – nature-near agriculture and forestry minimizes negative ecological effects and can even contribute to the maintenance of biodiversity; whereas intensive monocultivations have negative effects on the soil, ground water and the variety of species. Attention must therefore be particularly devoted to compliance with rigid sustainability standards in the production of bioenergy (see CIPRA compacts Agriculture and Nature protection).

- WIND ENERGY

There are high expectations from wind energy in the Alpine countries, first and foremost outside the Alpine area. Wind turbines for electricity production are currently highly appreciated since their construction and maintenance is cost-effective (Table 4). The number of wind turbines has significantly increased in the Alpine countries. In Austria the installed power of wind turbines has increased from less than 1 Megawatt (MW) in 1995 to almost 1,000 MW (Proidl 2006), and in 2007 more than 2 Terawatt hours (TWh) electricity were produced. France plans to install 5,000 Megawatts (MW) through wind turbines by 2010, and in Italy there are more than 2,000 Megawatts (Clini 2004). In Germany, where the installation of wind energy is encouraged by the Law on renewable energies and climate conditions in the North Sea areas are particularly favourable, power production from wind energy increased from 1.8 TWh in 1995 to almost 40 TWh in 2007 (Federal Office of Statistics 2008). Despite this, wind energy in the Alpine countries remains relatively insignificant. Even in Germany, the largest power producer from wind energy among the Alpine countries, wind energy accounts for just 6% of power production, and a large part of the wind power stations is located outside the Alpine area.

Figure 8:
CIPRA has published further information about wind power in the CIPRA Dossier "Wind Power in the Alps". http://www.cipra.org/de/alpmedia/dossiers/3

Furthermore, so far very few studies on the impact of climate change on wind energy have been conducted. In principle it should be considered that more frequent extreme weather events such as storms will increase the stability requirements of wind power plants. More wind however can also increase power production by wind turbines.

The potential of wind energy and possible environmental impacts of wind turbines give a less positive outlook to wind energy (see www.cipra.org/de/alpmedia/dossiers/3). Due to the wind situation, the Alps are not particularly suited as a site for wind turbines: the sites where the wind speed is highest are mainly on mountain tops. Building wind turbines in these sites would thus have an impact on landscape and require high infrastructure investments, such as the construction of special roads. In addition to that, it is worth noting that wind energy is very irregular. For a general conversion to wind power (also outside the Alps) it is necessary to build more pumped storage hydropower stations (Erlacher 2005).

- SOLAR POWER AND PHOTOVOLTAICS

The energy of the sun can be directly utilised in two ways: either as heat for spaces and for hot water or through photovoltaic systems for the production of electricity. The use of solar energy has little impact on climate and is comparably little endangered by climate change.

The use of solar energy for space heating is encouraged in the Alpine countries. A consequence of this is that the use of other energy sources for heating, such as oil, gas, wood or district heating, might stagnate or even diminish. It is worth exploiting this potential saving of greenhouse gas emission through efficiency increases and through a more widespread use of solar power (see CIPRA compact Building and Refurbishing).

Similarly to wind turbines, photovoltaic systems have not been very widespread up to now but are expanding rapidly. For instance, the Italian programme "10,000 photovoltaic roofs" should lead to savings of 0.12 Megatons (Mt) CO_2 per year, while in Germany people a "100,000 photovoltaic roofs" programme is under way. Even Austria and Liechtenstein encourage the construction of new photovoltaic systems.

Power production through photovoltaic is comparably expensive, at more than 300 EUR/Megawatthour (MWh) (see table 4) and, compared to other renewable energies such as wind or water power, the manufacture of solar cells generates a relatively high CO_2 output (see table 3). Despite this, because of its great potential, photovoltaics is an advanced technology. In Germany, the solar industry recorded growth rates of 30-40 % from 2000 to 2003 thanks to the support provided from the Law on renewable energies. The installation of solar cells on house roofs is ecologically negligible and can produce significant quantities of power – with regard to Germany, various studies calculate a power production of up to one third of the current demand through the installation of photovoltaic systems on roofs, façades and free areas such as waysides. Solar power can be utilized in a decentralized manner from power production and thus contribute to supply security. Similarly to wind energy however, also solar power is irregular and raises the same questions regarding storage or improvement.

Figure 9:

Solar cells on house roofs are ecologically harmless, therefore they should be installed on every roof in the Alps.

OTHER ENERGY USES TO PRODUCE HEAT

There is a series of other energy sources that can be utilized for the production of heat (or for heating external air inputting air conditioning systems). Among these are

- geothermal energy
- industrial waste heat
- heat from the combustion of domestic waste, industry waste and sludge

In principle, the use of geothermal energy and waste heat to heat spaces makes sense, since energy is utilised which otherwise would remain unused or – in the case of industrial waste heat – can have negative ecological impacts. The use of district heating from the combustion of domestic and industrial waste or sludge gives the opportunity to use energy which would otherwise remain idle – even though in this process climate damaging greenhouse gases are generated. Nonetheless, in the sense of a cascading use of resources, these strategies of energy use, such as for example the Bavarian programme "climate protection in waste industry", can be judged positively. The goal here can however only be an increase in efficiency – there are no big growth potentials.

Geothermal energy is an exception: geothermal power plants, that utilise heat from water reservoirs that lie a few thousand metres deep underground, generate power, which comes whatever the season (unlike most climate neutral energy sources).

3.2.3 NUCLEAR POWER

There are no nuclear power stations in the Alps, whereas there are in some Alpine countries (Germany, France, Switzerland and Slovenia), and all Alpine regions take electricity generated from nuclear power plants from nearby regions. Unlike the combustion of fossil energy sources, nuclear fission does not directly release CO_2. In recent years, however, nuclear power has resurfaced in public debate. Greenhouse emissions are involved during the construction, maintenance and destruction of nuclear power stations. In addition to this, the nuclear combustion cycle devours considerable quantities of fossil energy. The use of nuclear power is not sustainable also for other reasons: uranium is a finite raw material – the extraction may laready become unprofitable by 2030 at current demand levels. With nuclear fission, only 30% of the energy released can be utilized, thus large quantities of waste heat are also generated, which have environmental consequences (such as the heating of rivers caused by discharge waters).

In the climate strategies of Alpine countries, nuclear power has a double-edged role. Even though no Alpine country plans the expansion of nuclear power (Germany even plans to opt out), in France and Bavaria, for instance, nuclear power is also responsible for the comparably low CO_2 emissions, which are boasted everywhere.

Indissolubly linked with nuclear power is the risk of disastrous accidents, when radioactive material might be released and cause major and long-lasting environmental and health damage. The use of nuclear power generates radioactive material that must be kept far from the environment for millennia and therefore represents a significant safety risk for current and future generations. With respect to climate issues, other – sustainable – options of energy supply are therefore to be preferred. This is also confirmed by the fact that nuclear power as a centralised technology with large power stations can only have a tenuous connection with any decentralised energy plan.

4 CONCLUSIONS

Climate change represents one of the most significant challenges for the energy system of the Alps. This regards both adaptation to current and future climate changes as well as the need for a radical conversion to an energy system that is neutral towards climate.

The reduction of energy use in the Alpine area is a first step in the achievement of the dramatic saving of greenhouse gases (more than the amount that would be necessary to limit earth warming to a tolerable extent (around 2°C). The greatest challenge is the "Rebound" effect, which is the cancelling out (or worse) of the efficiency advantages by an increased consumption of energy services. Realising the technical potential for a more efficient energy use – though this is also very important – cannot be sufficient.

A reduction of the aggregate energy used is only conceivable through a strategy which not only creates stimulus for the use of more efficient technologies but is also effective in macro-economic terms. A bundle of measures would be necessary which only in combination might lead to the objective: implementation of socio-ecological tax reforms, infrastructure and spatial planning policies as well as technological policy supporting efficiency. This is the only way to offset the fact that, although there has been a rapid rise in the use of "new renewable energy sources", greenhouse gas emissions continue to increase.

Alongside increased efficiency in energy use, a conversion to renewable energies is necessary. Since renewable energies are usually decentralised, this change is connected with a fundamental restructuring of energy supply. This requires a reorganising of the energy industry whose size is still often underestimated. It is clear that there are great interactions in the necessary changes mentioned in the infrastructural policy and in the energy production and supply. The necessary paradigm change is however still insufficiently understood.

Therefore significantly greater efforts in the field of research and development are also necessary. It is important not only to consider the field of technical research and development, but also to develop an improved integrated understanding of the social, economic and space dimensions of the energy issue.

5 EXAMPLES OF GOOD PRACTICES

ACHENTAL SELF SUPPLY PROJECT

People living in Achental have recently been going to energy classes in addition to health classes. Around 100 home owners per year utilise this offer of the Achental e.V eco-model, a union of seven towns south of Chiemsee under the direction of Fritz Irlacher. There, householders learn everything about the possibilities of renewable energies. This is just one of many measures which have been planned or have already been implemented in Achental, Bavaria.

People in Achental have set ambitious objectives: the entire energy requirements for heating and power must be produced by 2020 from the combination of various measures involving renewable regional energy sources. It has now been long recognised that sustainable energy supply is not a purely technical issue. It is much more a challenge that requires intense regional collaboration: maintaining nature and the cultural landscape, protection of agricultural farms and encouragement and development of tourism and industry compatible with nature – these are the three pillars of the eco-model. The seven towns have together been carrying forward

Figure 10:
Biomass facility in Achental

sustainable regional development since 1999, partly in close collaboration with two Austrian neighbouring towns.

A further measure is the Biomassehof Achental GmbH, a subsidiary of the Achental e.V. eco-model that deals with the field of energy supply. Under the slogan "100 % from the Region for the Region", wastes of biological or organic origin are turned into energy. Regional circles and value creation chains are established. Bioenergy resources available are provided, processed and consumed in a model concatenation. In a future building section, Biomassehof builds a district heating supply based on woodchips for the Grassau market which, with 7000 inhabitants, is the largest town in Achental.

These measures not only help save CO_2, they also stabilize energy costs. Not least, local agricultural and forestry farms gain from the possibility of selling biogenous waste.

Yet this is not enough: a "Bio-Energy Forum" is also planned for joining the relevant actors in the region into a network, as well as further training for specific target groups such as constructors of heating systems, owners of delicatessen stores or school classes. In the longer term, the successes achieved must have an impact also beyond Achental: classes, guided tours and public relations in neighbouring regions and in Europe must initiate a series of similar projects.

www.cipra.org/competition-cc.alps/wolfgangwimmer (de)

RENEWABLE ENERGY IN THE MOUNTAINS – TOBLACH ENERGY PROJECT

Toblach (Dobbiaco) is a cold place. At 1,200 meters above sea level, this place has an annual average temperature of five degrees Celsius and is one of the coldest towns in Italy. So it is not just the 3000 Toblach inhabitants but also the many tourists who need a lot of heating energy.

Already in the 1990s the town inhabitants took the first steps towards the conversion to renewable heating energy and established the "Fernheizwerk Toblach Genossenschaft mit beschränkter Haftung". After preliminary agreements had been signed with 220 future customers, the Technical firm of per. ind. Alfred Jud began construction of the district heating power station in 1995. By November 1995 it was possible to deliver the first district heating to the inhabitants of Toblach. Today the station delivers 50 million Kilowatthours heat to more than 1,000 households in Toblach and to the neighbouring town of Innichen. The cooperative has more than 500 members.

The technique of the district heating plant is very simple: woodchips, bark and sawdust are burnt in a boiler. The heat generated heats water which is delivered to the customers connected. Since 2003 the plant has also been generating electricity. The ORC-Module – "Organic Rankine Cycles" utilised for this, is one of the biggest in Europe with a capacity of 15 Megawatts. The plant is very environmentally friendly since it utilises as raw materials only waste products of the local wood working industry. An electric filter and a system for the condensation of flue gases minimise the output of polluents through exhaust air.

With their conversion to district heating, the inhabitants of Toblach not only protect the environment, but also save money. Compared to traditional heating with crude oil, they pay 40 % less during winter. The heating plant also creates new jobs. The Mayor of Toblach, Bernhard Mair, is rightly proud that the energy concept of his town was presented as a positive example at the CIPRA meeting "Kühler Kopf im Treibhaus! – Bewusst handeln im Klimawandel" in Bolzano, Italy.

www.cipra.org/ccalpsresearch/centrale-di-cogenerazione-di-dobbiaco (en)

• LET THE SUN IN. UPPER BAVARIA ENERGY SCHOOL

Children in Upper Bavaria utilise solar power to cook sausages. They put a pan in the centre of a large silver dish and wait until the collected energy of incoming sun rays makes the water boil. Through the "Solar Cooking" programme and other similarly creative activities, the Upper Bavaria Energy School shows students of primary school age just how much they can do with solar energy.

Three partners work in the Upper Bavaria Energy School: "ZIEL 21 e.V.", "Bürgerstiftung Energiewende Oberland" and "Green City e.V." on innovative training projects on energy use and energy production. Responsible energy use and production are considered as a contribution to sustainable development. Each of the three partners runs an "Energy Station", which conduct projects in one of three regions in Upper Bavaria.

Figure 11:
Upper Bavaria Energy School – Children get to know the sun as a source of energy

In the “Sun – full of energy” project, the Upper Bavaria Energy School works with children in primary schools. The Energy School staff instructs students, but also their teachers, to deal intensively with the themes of sustainable energy use and solar power during the project week. The Upper Bavaria Energy School makes teaching materials available, and offers proposals for excursions and works connected to the project. The energy day is always the conclusion of the project week: students present their artistic and craft works, experts teach the most recent knowledge on the issues of renewable energy and energy saving, and exhibitors offer the opportunity to speak directly with them. The energy day is therefore a platform for the most diverse target groups.

Alongside the active care of training projects, the Upper Bavaria Energy School also makes available educational material for classes of different levels on their website free of charge.

www.cipra.org/competition-cc.alps/EWO (de)

• HEAT FROM THE LAKE – THE LAKE OF ST. MORITZ AS A “HEATING “

Guests in Hotel Badrutt’s Palace in St. Moritz/CH and students in the Grevas school have never frozen. This is because of the oil boilers which, until 2005, generated enough heating power and warm water. But since December 2006, guests and students have had even more pleasant warmth, while winter storms outside sweep the lake of St. Moritz. A heat pump draws warmth from the lake and takes it to the aristocratic hotel and neighbouring school building.

When in Hotel Badrutt’s Palace the fossil-activated heating systems were being renovated in 2005, there came a proposal from the department of energy services (Energy Contracting) of the electricity plant of the city of Zürich (ewz) to heat by drawing heat from the lake of St. Moritz exactly at the right time: instead of adapting the old fashioned technology, the management of the Hotel asked ewz to draft a system for energy supply, to plan and fund the system and finally to make the project. Grevas School, whose heating system also needed renovating, joined the project.

10 metres below the surface of the lake and 50 metres from the bank there is a water suction pillar. It pumps 4000 litres of water per minute to the bank and below Kantonstrasse up to the heat pump plant. There, energy is taken from the lake water, four degrees cold. With the help of heat pumps, the water is heated to 70 degrees and led to a separate heating circle.

This heating circle supplies Hotel and school directly with heating power. Lake water cooled to one degree is taken back to the lake through a second line. Hydrological examinations confirm that cooled-down water has no impact on the ecological balance of the lake.

The heat pump plant delivers around 4,700 Megawatt hours per year. 4,000 Megawatt hours are used by the Hotel, the rest by the school building. The system covers some 80% of the whole energy demand of the Hotel and more than 70% of the school's. For peak demand times in both buildings there are conventional modern oil boilers available, whose use however is only rarely necessary. Through the installation of a new heat pump system around 475,000 litres of heating oil are saved every year and therefore 1,200 tonnes of CO_2.

Alongside the savings of heating oil, relevant for the climate, the system has further positive effects for St. Moritz. The construction and operation of the plant create jobs and the creation of value remains mostly on site. For a tourist resort such as St. Moritz this system is also a good sign to exhibit, showing that the town is environmentally aware. And through the use of the system in the school, also youth in St. Moritz can be made aware and inspired by innovative and environmentally friendly alternatives to conventional heating systems.

www.cipra.org/competition-cc.alps/ewzedl (de)

Figure 12:
In St. Moritz a school and a hotel are supplied with energy from the lake, in order to heat these buildings in a way which is environmentally friendly..

PHOTOVOLTAIC SYSTEMS FOR ALL THE INHABITANTS OF LAAKIRCHEN

How many years will it take for me to recoup the costs of my car? Nobody asks this question when deciding to buy a car, but all when deciding to install a photovoltaic system. Many householders don't even think about it, because often 10 years look to them like eternity. The municipality of Laakirchen in Law Austria don't accept this position and by means of an information campaign and generous city subsidies, the city is aiming to motivate inhabitants to install photovoltaic systems.

This town, with 9400 inhabitants, had already 2003, very successfully, encouraged its population to build solar systems for water heating purposes on their roofs. After solar systems had been bought by the municipality, many citizens followed this example, so that in a few months more than 200 solar systems had been installed on private houses. In 2007 the municipality was ready to take a further step and to move on to generating solar electricity from photovoltaic systems.

On 16 May 2008, called the Day of the Sun, the campaign was presented to the population of Laakirchen. The Mayor explained to 220 interested householders the idea behind the campaign and the various types of incentives that the municipality would grant for photovoltaic systems (600

Figure 13:
The town of Laakirchen, Austria, seeks to motivate its whole population to install photovoltaic systems on their roofs.

Euro), solar systems, heat pumps, installing double glazing and wall insulation. The Laakirchen firms that deal with renewable energy and energy-saving interventions were directly invited to participate in the event and to prepare favourable offer packages for citizens. They were also asked to show their products and to exchange views with the citizens.

The outcome was great success: in a few days the municipality received almost 150 applications to take part in the campaign. In 2008 another 30 photovoltaic systems were built, and yet another 30 in 2009.

Crowning their commitment in the field of energy efficiency, the municipality of Laakirchen received the Energy Globe Austria on 1 October 2008 for the «Photovoltaic systems for all Laakirchen inhabitants» campaign. On 4 October this was followed also by the Solar Award from Eurosolar Austria.

www.cipra.org/competition-cc.alps/laakirchen (de)

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FURTHER INFORMATION

- **A current listing of links, further examples, and compacts on other topics available on www.cipra.org/cc.alps (de/en/fr/it/sl)**

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