



# EUROPEAN HEAT PUMP NEWS

## The Newsletter of the European Heat Pump Concerted Action

Issue 3, November 1999.

### EDITORIAL

This is the third Newsletter within the project: 'Concerted Actions for the Promotion of Heat Pumps in Europe', partially funded by the European Commission as a THERMIE B activity and co-ordinated by FIZ Karlsruhe, Germany. Other participants in the project include SINTEF (Norway), NOVEM (The Netherlands), ADPM (France), Leitungsgemeinschaft Wärmepumpe (Austria) and David Reay & Associates, assisted by BG Technology, (UK).

As detailed in the 1<sup>st</sup> Issue, there are four main objectives of the Concerted Action:

- To implement the promotion of heat pumping technologies on a Europe-wide basis
- To improve the awareness concerning heat pumps of a number of specific groups who are crucial to increased heat pump market penetration
- To make recommendations for a European training programme, for example for installers
- To support the application of environmentally sound working fluids.

In this issue, we are concentrating upon the outcome of the two workshops held in early November, in association with the *Interclima* Exhibition in Paris. Additionally, a contribution by Dr. Zogg of the Swiss Federal Office of Energy, examines some future trends in heat pump developments in his country.

It is interesting also to consider, as we approach the new Millennium, where we are going with regard to heat pumps, be it in industrial applications or in the built environment. Certainly, as illustrated by the first article in this issue of *European Heat Pump News*, there are encouraging signs that concerted attempts are being made to bring together all the major European players to promote the heat pump as a product – the acknowledged principal role of such associations. The phrase 'encourage the proper deployment of...' is perhaps the most significant in this respect, for although many of us are probably sick of hearing about earlier 'bad experiences' with heat pumps, the European Heat Pump Association is right to emphasis

their proper or correct application, and all that goes with it. The participation of the EC in the Workshop on Natural Working Fluids, and the positive contribution made there by Per Rosenqvist of DG11, is of great help. Also is the point made by Hermann Halozan in the Workshop on Training, concerning a recognised pan-European basic training programme, which would significantly help the open market.

An aspect of energy policy which affects heat pumps, and will continue to do so in the next Millennium, is the price we pay for energy. In my 'guest editorial' for the December issue of the *IEA Heat Pump Newsletter*, I refer to the UK Climate Change Levy and criticism from major energy users – one saying that energy should be as cheap as possible. The mixed messages put out by governments, and the too-distant prospect of a united pan-European front on strong policies to counter increased fossil fuel consumption make it even more important that at the 'grass roots' of conservation policy, activities such as the EHPA, the IEA HPC and our own networking efforts are given encouragement and, even more important, financial support.

David Reay,  
November 1999.

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## SETTING UP OF EUROPEAN HEAT PUMP ASSOCIATION

*The following text is based upon a press release to be issued shortly:*

“At a meeting in Brussels on October 22, 1999, hosted by the Directorate General for Energy, representatives from 15 European countries agreed to proceed with the formation of the European Heat Pump Association (EHPA). All interests were represented at this meeting, ranging from manufacturers, installers and utilities to national heat pump associations, the IEA Heat Pump Centre, and the European Heat Pump Network (our Concerted Action – Editor).

The primary aim of the new Association will be to promote awareness and to encourage the proper deployment of this technology in the marketplace for residential, industrial and commercial applications. Heat pump technology has the possibility in the European residential housing sector alone of saving 100 TWh of electricity by 2020 through the use of renewable ambient energy.

It was agreed that the new Association would be constituted as a European Economic Interest Group (EEIG), and that its constitution would be ratified at a further meeting to be held in Brussels on February 18, 2000.

Membership will be open to all legally-constituted organisations and links would be set up with other bodies with common interests in the fields of heating, cooling and energy recovery. The work of the Association would be undertaken by a number of committees and this would provide a co-ordinating framework for many of the existing initiatives.

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## HEAT PUMP WORKSHOPS AT INTERCLIMA – REPORTS

Two Workshops were held in conjunction with Interclima in Paris on 8 & 9 November 1999. These covered, respectively, heat pump training programmes and natural working fluids.

**TRAINING PROGRAMMES – The Way to Certification:** Over 30 attended this meeting, and heard six talks on a variety of aspects of training and

certification from around Europe, under the chairmanship of Bertrand Rivain of UCF, France. The proceedings began with Manfred Petz of TWK in Germany

describing the activities of his organisation in training installers of heat pumps. A comprehensive course, lasting up to 45 hours and including 9 modules, ranging from the basics of refrigeration/heat pump facilities to operation of units, is provided. Of particular importance is the content of the course in the context of the draft Standard prEN 13313, which is a standard for competence of all involved in refrigeration systems with regard to health, safety, energy and environmental considerations. The lowest level of competence required is the ability to maintain the system without breaking in to the working fluid circuit.

In an active discussion, there was argument as to whether a course lasting 7-10 days (as does this one) or a number of short (1-2 day) sessions, (the view of COSTIC, France) was best. The causes of heat pump failures were highlighted by Prof. Halozan, citing evidence from a study by Prof. Steimle that 94% of failures were due to poor system integration, rather than the heat pump itself.

COSTIC themselves (Francoise Hacque & Jean-Jacques Lenotte) detailed the route to certification by training in France. A strong case was made for certifying of training centres, giving them credibility and also giving customers the insurance that training will be competently performed and able to meet the needs of the market. An emphasis on practical sessions and the use of case studies in technical training were brought out as important features of the 2-4 day courses run. It was believed that shorter, intensive, courses were attractive to companies because personnel were not away from their job for too long. In particular, SMEs cannot afford staff absence for longer periods.

Hermann Halozan from Graz University, Austria, asked at the start of his talk – ‘Why heat pump training programmes?’ The answer is related to success, or otherwise, in the marketplace of heat pump technology. Training and the competence of installers has, of course, a major role to play in this. D-A-CH (see *European Heat Pump News Issue 1*), has supported a quality label for heat pumps, and a training course leading to a recognised qualification, (Geprüfte Qualität), which is given for three years, the course for which resembles that of TWK. The study period is 84 hours plus 2 days practical experience, (now being examined with respect to modularisation), and the person, not the company, obtains the certification. Interestingly, and a point which should reassure potential heat pump purchasers, one criterion to be met is the ability to repair a system up to 10 years after it has been installed, necessitating access to spares, for example, over this period.

Hermann Halozan made a very important point in the discussion of his paper – he prefers one basic training programme (which should be mandatory) for the whole of Europe. This will also have the effect of opening up the market. The same argument for pan-European certification also exists. (Of all the messages to come out of this Workshop, this was the most important, in my opinion, and is a message which should be strongly conveyed to Brussels – Editor).

René Auguy, a member of the ‘Heat Pump Board’ of the Association Française du Froid, talked on the training of air conditioning engineers, literally translated as climatic engineers, in France. This subsector of the building industry is large, almost 11,000 companies employing 61,000 staff, with 40% being involved in maintenance and 30% on installation of ventilation & a/c units. With an intake of over 4000 new staff of all grades per year, and increasing technological complexity of systems, adequate training is becoming more important. M. Auguy pointed out that one could instruct in climatic engineering without having any practical experience, and the position in France was, with the exception of e.g. COSTIC, IUT (Rouen) and EdF, poor.

If there is a rapid market penetration of heat pumps in France, the installation engineers will need to have many qualities, covering training in electrical wiring, handling working fluids, mechanical assembly, etc. Where fluids such as ammonia are used, specific training will be necessary, and such training must be fully certified/approved by professional bodies – an example cited by the speaker relating to the acceptance by insurers of a piece of paper (a certificate) without question. Real qualifications are what is needed.

Perhaps Norway can teach us all a lesson in this regard – Frode Nebell of SINTEF gave a comprehensive review of the variety and depth of courses available in his country, and the opportunities available in the near future for certification. Courses vary in length from one to ten days, the longer courses having examinations at the end. Qualifications for entry vary, with some needing a good level of technical education as a prerequisite, up to a MSc. Courses aimed at ‘continuing education’ in heat pump technology are offered, one held recently attracting 14 participants. Such ‘refreshers’ are very important in view of rapid changes in technology, legislation, and perceptions of equipment purchasers/users.

In discussing these courses, it was emphasised by Hermann Halozan that if SMEs on a pan-European are to be given full access to such data, courses need to be translated into national languages. In a point echoed by Axel Lehmann of FIZ, who stressed that the existing EU network could be the basis of dissemination of

such courses, it was also suggested by Prof. Halozan that national (and possibly the European) Heat Pump Associations could play a role here.

The Norwegian certification scheme under preparation is targeted at suppliers of heating systems with heat pumps of <25 kW, and those supplying subsystems

associated with these. While participation is currently voluntary, it is put together by the Norwegian Heat Pump Association and funded by NVE, the Norwegian Water Resources and Energy Directorate.

Returning to France, we heard from Jacques Bernier and Thierry Delavallee on the contents of certified training courses for heat pump personnel, together with three courses for installers and/or designers. Technical guides for installers are already available (in French – including two on ground source heat pumps) with others for specific h.p. systems in preparation. With regard to the certification of training centres, two important points were made – the centres have to be selected by the national heat pump organisation (i.e. it is not a governmental role), and the courses have to be firstly checked and then certified by the national body. Only then can certification be offered by these centres.

Axel Lehmann of FIZ included within the draft proceedings of the Workshop the draft Summary Report of the survey of heat pump training programmes, which will be published as one of the outputs of the Concerted Action. This will be published towards the end of the project, but will be a compendium of National reports on training/certification activities which will provide a most useful base for what we hope will be a concerted activity to produce a Europe-wide agreed approach to these important topics.

In summarising the Workshop, Michel Guittard of ADPM said that there was still a lack of objective and comprehensive training material, and in all countries (of the EU) there was a need for certification. The proposed European Heat Pump Association, currently scheduled for launching in early 2000, could well play a significant role in addressing some of the issues raised at the meeting, leading to pan-EU standards and accepted qualifications. The point made about such actions helping to create an open market is a particularly strong one, and may well help the European Commission to take a role as a ‘facilitator’ in the co-ordination.

***NATURAL WORKING FLUIDS – A Challenge for the Future.*** The EU Concerted Action was joined by the IEA Heat Pump Centre, (who will publish the Proceedings) for this Workshop, which was chaired by Jos Bouma of the HPC. Held in the same venue on 9 November, it was interesting, if somewhat frustrating, to note that training and certification featured strongly in the discussion here also –

but with different speakers and audience to those participating on 8 November! It is of course quite understandable that these aspects will feature in a discussion on natural working fluids, as health and safety aspects, as well as different system engineering criteria, have to be at the forefront in discussion of 'alternatives'. We were also fortunate in having Per Rosenqvist of DG11 of the EC addressing us on EU policy on substances that affect the ozone layer and global warming – but more of this later.

Jos Bouma saw the topic as a challenge for today, as well as for the future. We already have over 15 million refrigerators operating on hydrocarbons (HC), with a good safety record. Ammonia is starting to be used in heat pumps, and CO<sub>2</sub> appears to be very promising for space & water heating & space cooling. The reality, Jos stated, was that HFCs dominate the residential scene, with planned fluid production increases of 25%. The demand for cars alone was substantial, with 50% of new cars in the EU having air conditioning. (This means cooling, of course, and hope we do not see this percentage reflected, ever, in the EU residential market unless it displaces heating!)

Miep Verwoerd of TNO reviewed the many cycles which could provide heating and cooling, ranging from vapour compression cycle and absorption to even more 'natural' cooling such as evaporative systems. The scoping study mirrored one I did earlier this year for the UK DETR, *via* the Building Research Establishment, and of course the conclusions of both are open to argument – something I may enjoy at a later date!

Daniel Colbourne of Calor Gas – many will recognise as a supplier of working fluids – gave an illuminating talk about Standards relating to natural working fluids. Daniel sits on the CEN TC 182 Working Group (5), and gave us hard facts about the up and coming Standards affecting the use of these fluids – and of course we ignore them at our peril. In particular, it was observed that HCs would be the subject of a new EU Standard, but some ambiguity still exists, particularly with regard to direct air conditioning. Few problems were foreseen for CO<sub>2</sub>, subject to system/component pressure testing to 3.5 times operating pressure.

It is always helpful at meetings like this to have an EC representative present, as it can avoid misdirection and misconceptions gaining ground! Per Rosenqvist commenced by summarising the status of the new EU bill on phasing out ozone-depleting substances, which should be adopted early in 2000. Implications for CFCs are a ban on sale & use, and new recovery / destruction requirements. HCFC phase-out is to be accelerated, with this occurring for new refrigeration, air cond. & heat pump equipment in 2001. With regard to using HCFCs as retrofit fluids, virgin fluids will be

banned after 2005-2007, while banning of recycled HCFCs is being studied to take place by 2007.

Reference was made to HFCs, and other greenhouse gases such as SF<sub>6</sub>. Emissions in the EU from these gases are likely to exceed 100 million tonnes CO<sub>2</sub> equivalent by 2010. The EC is looking at measures to reduce these, be they legislative, voluntary, or a combination of the two. Per Rosenqvist stressed, however, that any measures taken must be practical, effective, and not delay the implementation of measures leading to ozone layer recovery.

A broader approach to greenhouse gas reduction is being formulated by the EC, and it is inviting industry to form voluntary agreements in this regard. A policy workshop is planned in Luxembourg in February 2000, to be followed by construction of a framework for legislation.

It was at this point that the implications for training of installers etc. became as great a part of this workshop as on the previous day! Martin Wolfer talked about risk assessment and legal responsibilities when using flammable refrigerants, based on Swiss experience. He suggested that a propane heat pump was safer than a gas-fired heating system, but did highlight a greater risk in the case of a technician working on an ammonia-filled system, although the risk did not extend to the home owner of this system.

Morten Arnvig & Norman Mitchell of AREA (representing installers), covered several aspects concerning the effect of using natural working fluids. In Denmark, where HFCs will be phased out within the next 5 years, courses for ammonia (on safety) lasting 2 days are run. Contractors need retraining to use steel/ammonia rather than copper/HFC in systems. While hydrocarbons were 'easy to install', it was believed that manufacturers were working down to a price, using thinner pipework etc. which was not compatible with vibrations and higher pressures.

HCs in Sweden were discussed by Holger Svensson. Domestic ventilation heat recovery heat pumps traditionally had used R22, until 1 January 1998, and 100,000 units had been sold. Propane-filled units are now being used, the 350-450 g inventory being within the 500 g limit in Sweden. The lack of regulations and the access to export markets (which would be helped by EU-wide Standards) are hurdles to be overcome. Component suppliers have been reluctant to guarantee some parts, and second sources of components need to be found.

A number of manufacturers, including York and Stiebel Eltron, gave useful comments on progress on ammonia and HC systems, highlighting some quite significant benefits, as well as additional hurdles to be overcome.

During the discussion, apart from the usual arguments as to whether HCs were natural refrigerants, there was considerable constructive comment on barriers to natural working fluids. Per Rosenqvist of the EC said that the EC

stipulated types of training programmes to alleviate the ozone depletion problem, (i.e. CFC removal, disposal etc.), and suggested that a message should be sent to the Commission saying that such training was important for hydrocarbons also.

Who will now take the initiative?

(Article written by David Reay, based upon notes made at the two Workshops, and draft papers given out).

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### Swiss Research Projects on Heat Pumps

Every third new residential dwelling in Switzerland is already being heated with heat pumps. Today heat pumps combined with efficient co-generation-units or modern combined cycle power plants are already saving up to 45% in fuel and CO<sub>2</sub> emissions. Focal points for research and development of the Swiss Federal Office of Energy for the years 2000 to 2003 concern the development of new heat pumps for the retrofit sector and the improvement of the overall System consisting of the heat source, the heat pump, the heat distribution system and the building.

With their **high potential for reducing CO<sub>2</sub> emissions and fossil fuel consumption** realisable in the short-term, heat pump technology and the combination of co-generation-units (CGU) with heat pumps (HP) are extremely topical themes. Through the combination of efficient co-generation-units with electrical heat pumps savings of **30% to 45% in fuels and hence CO<sub>2</sub> emissions** are already possible today, compared to standard oil and gas fired boilers. *Figure 1* highlights this with an example of a larger co-generation-unit with (generally several small) heat pumps in the local electrical distribution sector. A comparable to higher fuel utilisation is yielded also for electrical heat pumps operated with electrical current from modern combined cycle power plants: *Figure 2*.

Great efforts are still necessary in order to **increase the reliability and efficiency** of such heat pump systems, **to lower their price** and where possible also to replace the alternative hydrofluorocarbons by **natural working media**. Described in brief below are the planned papers in connection with the research programme

*Ambient and Waste Heat, Combined Heat and Power Generation* for the years 2000/2003. The concept for this research programme is detailed in [2].

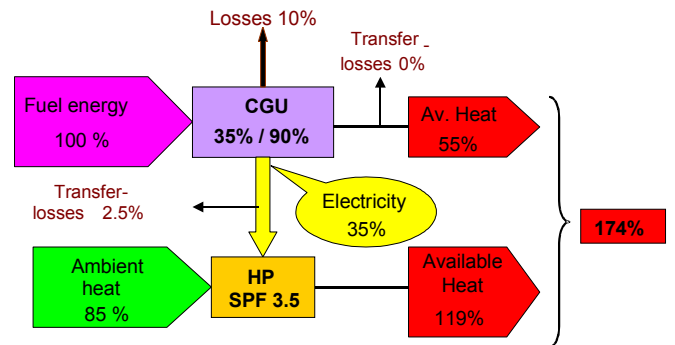


Fig. 1. Example showing production of 174% heat from 100% fuel energy, using a co-generation unit (CGU) with heat pumps (HP), the latter using all the CGU power output. (Ref. 1).

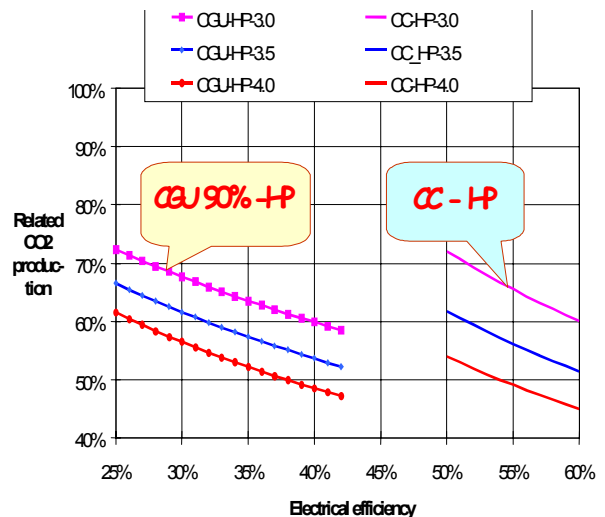


Fig. 2. Ratio of the CO<sub>2</sub> production of the co-generation heat pump unit (CGU-HP) to that of a boiler with a utilisation factor of 100% (LCV). The RHS shows a combined-cycle power plant with heat pumps, (CC-HP). The seasonal performance factors of the heat pumps are in the table at the top of the figure, (see ref. 1).

### Swiss Retrofit Heat Pump

Whilst heat pump heating in Switzerland with new building is making pleasing progress with a market share of around 33% (1998), *Fig. 3*. The far greater market potential of retrofitting heating systems is practically stagnating for heat pumps with a quota of under 3%. Therefore, the development of an efficient, low cost heat pump for retrofit applications, the so-called **Swiss Retrofit Heat Pump (SRHP)**, is the most important target for the

years 2000 to 2003. Compared to the present day heat pumps, the objective for the *SRHP* is to

- achieve a **higher** seasonal performance factor with a smaller **storage volume**,
- permit efficient operation with ambient air as a heat source and **feed temperatures up to 60 °C**,
- where possible **use natural working media** and
- by means of a modular construction, **reduce the costs** of joint development and serial production.

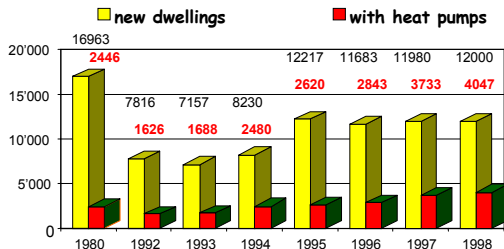


Fig. 3. Proportion of new single family houses in Switzerland with heat pumps (thermal outputs <20kW). Note: A total of 3578 heat pumps were sold in Germany for room heating in 1997; in Switzerland the figure was 5225.

The detailed requirements list for the *Swiss Retrofit Heat Pump*, including the envisaged mode of realisation is described in [3]. Following experiments on the test rig of two to three bench systems and through measurements in the field we are hoping for support from the KTI (Swiss Commission for Technology and Innovation) in the further development up to readiness for series production.

Work has already started on several projects on elaborating the fundamentals for a *Swiss Retrofit Heat Pump*. Here, the objectives are as follows:

- Development and testing of **new cycles** for high efficiency and thermal output at the high temperature lifts customary in the retrofit market. *Figure 4* shows one of the investigated cycle variants.
- Research on components with **low liquid hold-up**, which are also suitable for natural refrigerants.
- Development of new, **intelligent control concepts** with system diagnosis for high efficiency with low storage volume.
- Development of safety systems for **natural working media**.

Envisaged as further activities for the development of the *Swiss Retrofit Heat Pump* are the construction and measuring of bench systems as well as tests on simplification measures for cost reduction.

**System optimising:** The high energy savings potential from heat pump heating systems is only utilised when these achieve a high seasonal performance. A precondition for this is not only an efficient heat pump

but an optimal whole comprising heat source, heat pump, heat distribution system and building.

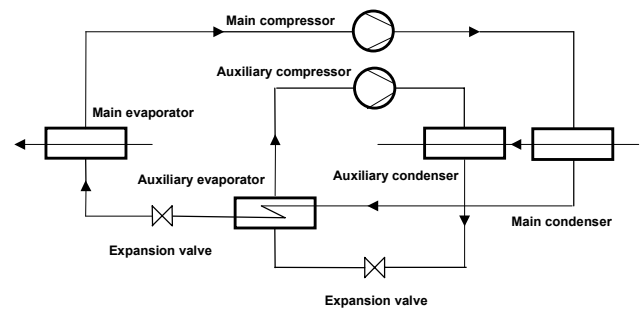


Fig. 4. Heat pump for the retrofit market, with a separate loop for condensate supercooling, (ref. 4).

Frequently however considerable shortcomings occur in the interaction between the individual components of heat pump heating systems. The Swiss Federal Office of Energy is implementing its research work for the years 2000/2003 with the following focal points:

- The development of methods for the **continuous monitoring and diagnosis** of heat pumps and complete heat pump heating systems by a short-test method. This is aimed at assisting operational optimisation and further reducing the maintenance costs. Parameters for a new heat pump controller generation are also to be supplied.
- More cost-effective and more energy-efficient heat pump operation through **new control concepts**, which make optimal use of the information obtained by the short-test method. The aim is to replace the conventional outside temperature/return temperature control by a model-based pulse-duration modulation. With this the controlling variables are not the feed or return temperatures, as with conventional heat pump controllers, but the quantity of heat required for a longer time span. This is calculated on the basis of a physical model of the heat pump, heat distribution system and building, and then optimally supplied by the longest possible, uninterrupted heat pump operating phases.
- Design of low cost **heat pump heating systems for low energy dwellings** with hot water supply: *Figure 5*.
- Elaboration of fundamentals and PC tools for improving the **design of complete** systems. To be included in this framework is the development of a **dynamic heat pump test**, which can measure the start-up and run-down losses of a heat pump in a generalisable way. The knowledge and experience gained in the various projects is also to be implemented into the design programs WP-Calc and WKK-Calc developed on behalf of the Swiss Federal Office of Energy.

## European Heat Pump News

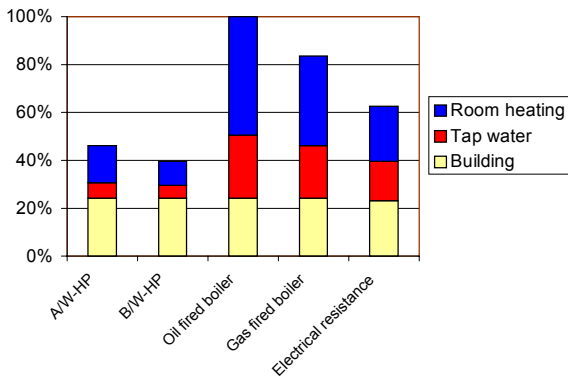


Fig. 5. Ecological advantage of HP heating in low energy houses: Comparison of the greenhouse effect of heating, hot water production and building ('grey energy') for different hot water heating systems. For full explanation see (5). A/W = air-water; B/W = brine-water heat pump.

Themes	Institutions
Research and development	Universities, technical universities
Pilot and demonstration systems	Federation and cantons
Flanking measures:	
- Basic and further training	Federal, cantonal, professional associations, Swiss Association for the Promotion of Heat Pumps (FWS)
- Creating planning tools	Universities, technical universities, professional associations
- Quality assurance	Federation, heat pump testing centre (WPZ), Swiss Association for the Promotion of Heat Pumps (FWS)
- Marketing, monitoring of success, dealing with tariff questions	Swiss Association for the Promotion of Heat Pumps (FWS)
- Information for building promoters	Federation (Novaenergie), cantons, utilities
- Air hygiene aspects	BUWAL, cantons

Table 1: Sectors and public actors for the promotion of heat pump technology in Switzerland.

### International co-operation

To date various projects could be carried out in the framework of the International Energy Agency IEA without undue administrative expenditure through international work sharing. Our Swiss activities have also benefited from the lively international exchange

of knowledge and experience. This collaboration is therefore to be continued in the years to come. It is also aimed to extend the already intensive bilateral **collaboration** with Germany, Austria and France by increased participation in the **research programme of the EU**.

### Implementing the results of research

The heat pump is an important link in the promotion of renewable energy sources by the public sector. In principle this promotion comprises the themes and institutions listed in Table 1. The deployment of research results is being facilitated by close collaboration with these institutions.

An important pillar for implementation is the direct participation of **private companies** in most research projects. The intentions of the programme management and the results of projects necessitate critical dialogue between those taking part. For this reason **workshops** and technical seminars are held for the individual research projects. Also held annually are review **conferences**<sup>1</sup>. **Summaries** of the results of the research works are continuously published in the relevant technical publications and in [www.waermepumpe.ch/fe](http://www.waermepumpe.ch/fe).

- [1] Zogg, M; Maximale Primärenergienutzung und CO<sub>2</sub>-Reduktion mit Wärmepumpen heizsystemen, Bundesamt für Energie 1998; *or in French: Utilisation maximale de l'énergie primaire et réduction des rejets de CO<sub>2</sub> avec les systèmes de chauffage à pompe à chaleur*, Office fédéral de l'énergie 1999; *both available for downloading in [www.waermepumpe.ch/fe](http://www.waermepumpe.ch/fe)*.
- [2] Zogg, M., Rognon, F.: Konzept 2000/2003: Forschungsziele und Prioritäten; *available for downloading in [www.waermepumpe.ch/fe](http://www.waermepumpe.ch/fe) heading "Ausschreibung"*.
- [3] Public tender: Swiss Retrofit Heat Pump of the Swiss Federal Office of Energy; *available for downloading in [www.waermepumpe.ch/fe](http://www.waermepumpe.ch/fe) heading "Ausschreibung"*.
- [4] G.Reiner, M.Zehnder, D.Favrat, C.Brugnoli: Wärmepumpe mit Hilfskreislauf zur Kondensatunterkühlung, Phase 1, Schlussbericht, Bundesamt für Energie, 1998; *summary in [www.waermepumpe.ch/fe](http://www.waermepumpe.ch/fe)*.
- [5] Th.Afjei, *et al*: Kostengünstige Niedrigtemperaturheizung mit Wärmepumpe, Phase 2: Ökologischer und ökonomischer Vergleich, Systemoptimierung, intelligente Regelung, Versuche, Bundesamt für Energie 1997; *summary in [www.waermepumpe.ch/fe](http://www.waermepumpe.ch/fe)*.

<sup>1</sup> The next conference with the theme "More efficient heat pump heating through optimisation of the system as a whole" is being held in Burgdorf/Switzerland on 9.May 2000. Information via [www.waermepumpe.ch/fe](http://www.waermepumpe.ch/fe).

*Contributed by: Dr. Martin Zogg, Head of the research programme on Ambient and waste heat, combined heat and power generation of the Swiss Federal Office of Energy.*

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*Second announcement and call for papers:*

**4<sup>TH</sup> MINSK INTERNATIONAL SEMINAR ON HEAT PIPES, HEAT PUMPS, REFRIGERATORS**

Minsk, Belarus, 4.-7. September 2000

The key issue of these seminars are heat pipes - one of the remarkable achievements of heat transfer engineering in 20th century. Heat pipes are unique in their capability to transfer heat over large distance without considerable losses of energy, because their thermal resistance is negligibly small and mostly independent of their dimensions and shape. The second issue, which is important for the Seminar, is heat transfer enhancement in non-ozone depleting heat pumps, refrigerators, thermal and gas stores (solid sorption, liquid sorption, vapor-compression). In many cases heat pipes can be advantageously employed in such devices.

**The main subjects of the seminar are:**

- Fundamental research and basic processes connected with physical phenomena in heat pipes, heat pumps and refrigerators;
- Theoretical and experimental studies of heat pipes, capillary loops and thermosyphons, solid and liquid sorption machines;
- Modelling of heat pipes (miniature/micro, CPL, LHP, pulsating, rotating) and solid sorption devices transient performance;
- Scientific and industrial applications of heat pipes, heat pumps and refrigerators;
- Material problems in heat pipes, heat pumps and refrigerators;
- State-of-the-art surveys of heat pipe and sorption machines (in different countries and different fields).

**CALL FOR PAPERS**

Papers will be assessed for presentation at the symposium on the basis of 600 word (2-3 pages including figures) extended abstracts. They should not have been previously published.

**Technical exhibition**

A technical exhibition of new equipment, models, and services will be held in parallel with the seminar. Companies interested in taking part in the exhibition are invited.

**DATES TO REMEMBER**

- Deadline for submission of extended abstracts 31 December 1999
- Acceptance and classification of extended abstracts 15 February 2000
- Deadline for registration at standard fee 31 March 2000
- Deadline for submission of manuscript 31 March 2000
- Final date for submission of the camera-ready papers 15 June 2000

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**IN THE NEXT ISSUE OF 'EUROPEAN HEAT PUMP NEWS':**

- A full Report on the outcome of the European Heat Pump Concerted Action activity, how you can access the results of the studies that have taken place during the project, and our follow-up plans, including the European Heat Pump Association.
- Summaries of projects in the area of heat pumps funded by the EU as a result of the 1999 call for proposals within FP5.
- 'Snapshots' of the views of the participants in the Concerted Action as to the future of heat pumps, and the best way to ensure sustained progress.

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