



CHAPNET Partners' Meeting
Brussels, 8 November 2004

CHAPNET
Progress in Work Package 9:
EDUCATION AND TRAINING

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WP9 Education and Training

Objective

To cluster medium to long term RTD
related to education and training on CHP.

Tasks:

- 9.1 Cluster Management
- 9.2 Data Gathering and Analysis
- 9.3 Input of Academia into Clusters
- 9.4 Assessment of Needs
- 9.5 Provision of Education Material
- 9.6 Cluster Workshops
- 9.7 Cluster Reporting and Feedback

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WP9 Education and Training

Summary of Progress and Findings

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T9.2 Data Gathering and Analysis - Action 1

1. Preparation of Questionnaire. **Completed**

Gathering information on teaching procedures and research activities on CHP at technological institutions of Europe.

Types of Questionnaires

- A: addressed to all types of educational institutions.
- B: addressed to national and municipal organizations and associations.
- C: addressed to industries.
- D: addressed to technical associations.

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T9.2 Data Gathering and Analysis - Action 2

2. Processing of the collected Information

- Classification of activities by
 - type, Completed
 - level, Completed
 - institution. Completed
- Evaluation of teaching procedures (*)
- Conclusions regarding actions required for improvement of education to meet the medium and long term RTD needs of CHP. (*)
(*) Close to completion

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T9.3 Input of Academia into Clusters

Aim

To bring together academic institutions with organizations and companies interested in bringing CHP technologies towards the market.

Status on 8 November 2004

Out of 319 questionnaires sent in European countries 91 have been filled and returned. Of these, active in education and training on CHP are:

- **33 Educational institutions,**
- **10 National and municipal institutions, associations, and organizations,**
- **9 Private companies.**

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T9.4 Assessment of Needs

Aim

Assessment of needs for education and training at the various levels of educational institutions in order to cover future needs of the European CHP industry.

Time horizon: 5-20 years.

Status on 8 November 2004

In progress.

Certain recommendations have been made during the two workshops on Education and Training on CHP (Task 9.6).

Additional recommendations are coming from those active in E&T, with whom a second correspondence is attempted, aiming at the provision and evaluation of the educational material (Task 9.5).

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T9.5 Provision of Educational Material

Aim

- Collection and classification of information on the available educational material
- Examination of the existing educational material from the point of view of technical excellence and completeness.
- Investigation of whether the needs revealed in Task 9.4 can be satisfied by the existing material.
- Recommendations for improvement of the existing and preparation of new material.

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T9.5 Provision of Educational Material

Status on 8 November 2004

In progress.

General information about the educational material has been collected with the questionnaire.

An effort to collect the provided educational material itself for a better evaluation has not been successful: only three responses have been received.

In order to correct this deficiency, a search through bibliographic data bases (such as amazon.com) has been performed. The results are satisfactory.

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T9.6 Cluster Workshops

Aim: Three Cluster Workshops

Scope of each Workshop: to discuss

- project results
- other activities
- needs for more research
- trends in the market and related implications.

Structure of each Workshop:

- Presentation of project results and activities
- Brainstorming and discussion on the needs and progress
- Recommendations for future activities and meetings.

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T9.6 Cluster Workshops

Status on 8 November 2004

All three workshops have taken place:

- 1st Workshop: Brussels, 18 November 2002
- 2nd Workshop: Brussels, 18 September 2003
- 3rd Workshop: Athens, 29 October 2004

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T9.7 Cluster Reporting and Feedback

Status on 8 November 2004

All the up to now required reports
have been submitted.

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DETAILS OF PROGRESS AND FINDINGS

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WP9 Education and Training

Information from completed Questionnaires and Other Sources

(1 January 2002 - 8 November 2004)

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Geographical Coverage

Country	Questionnaires										Active in E&T on CHP				
	Sent					Received					A	B	C	D	Tot
	A	B	C	D	Tot	A	B	C	D	Tot					
Austria	2	2	3		7	1	0	3		4	1	0	3		4
Belgium	2	2	4		8	2	2	0		4	2	1			3
Bulgaria	5	2		1	8	2	0			2	1				1
Croatia	1		2		3			0		0					0
Cyprus	1				1	1				1	0				0
Czech Republic	7	1	2		10	2	1	1		4	2	0	1		3
Denmark	5	11	23	1	40	2	1	5		8	2	1	2		5
Estonia	1	1			2	0	0			0					0
Finland	2	1	3		6	1	1			2	0	1			1
France	4	2	7	1	14	1	0	1		2	1		0		1
Germany	7	4	4		15	2	0	2		4	2		1		3
Greece	10	1		2	13	6	1		0	7	4	0			4

(continued)

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Geographical Coverage

Country	Questionnaires										Active in E&T on CHP				
	Sent					Received					A	B	C	D	Tot
	A	B	C	D	Tot	A	B	C	D	Tot					
Hungary	2	3			5	0	3			3		0			0
Iceland		1			1		0			0					0
Ireland	4	1	2		7	0	1	1		2		1	0		1
Italy	9	3	5		17	4	0	2		6	2		1		3
Latvia	1			1	2	0			1	1				0	0
Lithuania	2				2	0				0					0
Luxembourg			1		1			1		1			0		0
Malta	2	1			3					0					0
Netherlands	2	3	19		24	1	2	3		6	0	2	0		2
Norway	1			2	3	0				0					0
Poland	21	5	5		31	5	2	1		8	5	1	0		6
Portugal	2	2	1		5	2	1			3	1	1			2

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Geographical Coverage

Country	Questionnaires										Active in E&T on CHP				
	Sent					Received					A	B	C	D	Tot
	A	B	C	D	Tot	A	B	C	D	Tot					
Romania	5	1	2		8	1	1	0		2	1	1			2
Russia	6				6					0					0
Slovakia	3	1			4	0	1			1		0			0
Slovenia	3	1			4	2	0			2	2				2
Spain	4	4	4		12	1	2	0		3	1	2			3
Sweden	12	1	1	1	15	2	0	0		2	2				2
Switzerland	1	1	4		6	0		1		1			0		0
Turkey	5	1	3		9	0	0	0		0					0
UK	39	5	21	1	66	7	0	5		12	4		0		4
Total	171	61	116	10	358	45	19	26	1	91	33	11	8	0	52
Tunisia	1				1	0				0					0
USA		1	5		6		0	2		2			2		2

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Analysis of Data

Questionnaires
and other sources

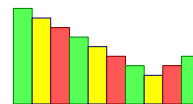


Electronic Database



Environment: **MS Access**

Data Analysis



per type,
per country

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Educational Institutions Active in Education and Training on CHP (A)

1. Austria Vienna Institute of Technology
2. Belgium Universite Catholique de Louvain
3. Belgium Universite de Liege, LASSC
4. Bulgaria Technical University of Sofia
5. Czech Republic Brno University of Technology
6. Czech Republic VSB-Technical University of Ostrava
7. Denmark Aalborg University
8. Denmark Technical University of Denmark
9. France Ecole de Mines de Douai
10. Germany Rheinisch-Westfälische Technische Hochschule
11. Germany Technical University of Berlin
12. Greece Higher Technical Educational Institute of Athens
13. Greece National Technical University of Athens
Dept. of Mechanical Engineering (two entries)
14. Greece National Technical University of Athens
Dept. of Naval Architecture and Engineering

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Educational Institutions Active in Education and Training on CHP (A)

15. Italy Università deli Studi di Napoli Federico II - DETEC
16. Italy University of Padova, Dept. Of Mechanical Engineering
17. Poland Cracow University of Technology
18. Poland Technical University of Lodz
19. Poland Technical University of Silesia (two entries)
20. Poland Technical University of Szczecin
21. Portugal University of Porto
22. Romania Technical University of Iassy
23. Slovenia University of Ljubljana
24. Slovenia University of Maribor
25. Spain CREVER - Universitat Rovira I Virgili
26. Sweden Royal Institute of Technology
27. Sweden Swedish University of Agricultural Sciences

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Educational Institutions Active in Education and Training on CHP (A)

- | | |
|--------|---|
| 28. UK | University of Manchester
Institute of Science and Technology (UMIST) |
| 29. UK | University of Sheffield |
| 30. UK | University of Strathclyde |
| 31. UK | University of Ulster |

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Institutions, Organizations and Associations Active in Education and Training on CHP (B)

- | | |
|----------------|---|
| 1. Belgium | BELCOGEN |
| 2. Denmark | Danish Gas Technology Centre |
| 3. Finland | Finish District Heating Association |
| 4. Netherlands | COGEN Nederland |
| 5. Netherlands | Energy Research Centre of the Netherlands |
| 6. Poland | Baltic Energy Conservation Agency |
| 7. Poland | National Energy Conservation Agency |
| 8. Portugal | COGEN Portugal |
| 9. Romania | Institute of Power Studies and Design |
| 10. Spain | IDAE |
| 11. Spain | Institut Catala d'Energia |

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Companies Active in Education and Training on CHP (C)

1. Austria Jenbacher AG
2. Austria Österreichischer Energiekonsumenten Verband (OEKV)
3. Austria PRIMAGAZ Austria
4. Czech Republic TEDOM
5. Denmark Burmeister & Wain Scandinavian Contractor A/S
6. Denmark Energi- og Miljødata (EMD)
7. Germany B+V Industrietechnik GmbH
8. Italy CESI

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Universities or Research Institutions (Type A)

**Active in education and training: 33
with CHP courses**

embedded: 25

independent: 8

Type of Course:		Independent	Embedded
Courses in Level:	Undergraduate	4	21
	Graduate	5	18
	PHD	0	4
Educational Material:	Books	6	21
	Notes	6	31
	Software	3	22
	Journals	1	1
	On the Web	0	3
	Video	0	1
	Unspecified	0	3
Experimental CHP unit used in courses:		3	8

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Seminars and training offered by National and Municipal Institutions, Organizations and Associations (Type B)

Active in education and training: 11
with CHP seminars embedded: 3 independent: 8

Type of Seminars:	Independent:	13	Level of Participants:	University grad.:	8
	Embedded:	3		Technologists:	11
Duration:	2 – 5 hours:	5	Frequency:	Technicians:	6
	6 – 10 hours:	5		Unspecified:	2
	11 – 15 hours:	1		Once:	5
	1 – 3 days:	4		Twice:	1
	Over 3 days:	1		Once a year:	3
Educational Material:	Books:	6	Mode:	On demand:	1
	Notes:	12		Seldom:	1
	Software:	4		Unspecified:	5
	Unspecified:	2		Theory only:	6
Funding:	Internal:	12	In addition:	Practice only:	1
	National:	2		Theory & Practice:	6
	European Union:	6		Unspecified:	3
	Private Sector:	3		Seminars with experimental CHP unit:	3
				Future plans for seminar introduction:	1
				Training activities:	3

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Seminars and training offered by Companies (Type C)

Active in education and training: 8
Offer CHP seminars: 7
Offer CHP training: 4

Type of Seminars:	Independent:	6	Level of Participants:	University grad.:	5
	Embedded:	2		Technologists:	8
Duration:	2 – 3 hours:	2	Frequency:	Technicians:	5
	6 – 10 hours:	1		Once a year:	2
	11 – 16 hours:	2		Twice a year:	2
	1 – 3 days:	2		4 – 5 times a year:	1
	Unspecified:	1		On demand:	2
Educational Material:	Books:	3	Mode:	Unspecified:	1
	Notes:	6		Theory only:	3
	Software:	5		Practice only:	0
	Brochures:	1		Theory & Practice:	5
Funding:	Internal:	6	Type of Commercial Activity:	Field Trips:	1
	National:	0		Manufacturer:	6
	European Union:	1		Consulting:	2
	Unspecified:	1		Software Developer:	1
				Gas Supplier:	1

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Experimental Facilities in Educational Institutions

(Type A)

Country	Institution	Type of System	Electric Capacity (kW _e)	Thermal Capacity (kW _{th})
Belgium	Universite de Liege - LASSC	Fuel cell	220	240
Czech Rep.	Brno University of Technology	Gas engine	83	134
Czech Rep.	VSB-Technical University of Ostrava (2 units in industry)	Diesel engine	4500	4000
France	Ecole des Mines de Douai	Steam	13	(650)
Greece	National Technical University of Athens	Gas engine	1527	1573
Italy	Universita degli Studi di Napoli Federico II – DETEC	Gas engine	3	5
Poland	Cracow University of Technology (unit in the city)	Gas engine (landfill gas)	250	?
Poland	Technical University of Lodz (units in the city and industry)	Steam	500000	2000000
		Steam	6000	20000
Romania	Technical University of Iassy	Steam (4)	80000	93040
		Steam (3)	25000	40700
Slovenia	University of Ljubljana	Steam	20	85
UK	University of Strathclyde	Diesel engine	5.4	20

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Experimental Facilities in Institutions, Organizations and Associations (Type B)

Country	Institution	Type of System	Electric Capacity (kW _e)	Thermal Capacity (kW _{th})
Denmark	Danish Gas Technology Centre	Gas engine	5	?
		Gas engine	40	?

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Experimental Facilities in Companies

(Type C)

Country	Institution	Type of System	Electric Capacity (kW _e)	Thermal Capacity (kW _{th})
Germany	B+V Industrietechnik GmbH	Dual fuel engine	7700	8265
Italy	AMG ENERGIA s.p.a.	Gas engine (*)	15	25
Italy	CESI	Gas turbine (*)	100	160
		Gas turbine (**)	60	?
		MCFC (**)	125	?

(*) Used for research.

(**) The gas turbine is integrated with the molten carbonate fuel cell (MCFC) unit. They are used for research.

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Conclusions from the Analysis of the Data

- Cogeneration as an independent course is rather seldom in educational institutions: 21%.
- Most of the seminars, held by organizations and companies, are focused on CHP as an independent subject.
- Educational material usually is in the form of notes rather than books.
- Software is often included in the educational material of CHP courses or seminars.
- Experimental activities are not very frequent in educational programs or seminars: 21%.
- Most of the seminars have duration less than 16 hours and they are given with an average frequency of once a year.
- Seminars are usually funded by the organizers and/or the European Union.

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Workshop Details

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Information about the Workshops

Workshop Nr.	Location	Number of	
		Presentations	Participants
1	Brussels	9	15
2	Brussels	10	15
3	Athens	11	17

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Conclusions and Recommendations from the 3rd Workshop on Education and Training on CHP

A. On the assessment of the current and future needs

- ◆ The evolution from cogeneration to polygeneration (including production of chemicals) will require new knowledge and skills of the persons involved. Therefore there will be need to develop appropriate programs of studies.
- ◆ The complex and interdisciplinary issues involved in cogeneration projects cannot be covered in the classical courses alone such as thermodynamics, heat transfer, etc. Special courses dedicated to cogeneration have to be introduced. The integration of the CHP system with the plant or the district heating network it serves is of particular importance. Knowledge of how to perform an economic analysis is a must.
- ◆ The complete knowledge can only be acquired by a variety of options, well integrated: classroom teaching, use of computers, building and testing of models, hands-on experience, etc. The teachers themselves need to have a good multi-disciplinary background.

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Conclusions and Recommendations from the 3rd Workshop on Education and Training on CHP

A. On the assessment of the current and future needs (continued)

- ◆ For a better education and training, experimental facilities are required. Currently, there are very few experimental units (most of them are located in universities).
- ◆ Manufacturers strive continuously for increased efficiency, reduced emissions, increased reliability, reduced cost of their products (CHP units). Therefore, the educational programs should focus on areas of strategic importance such as cost reduction, improved reliability, availability and maintainability, materials, high-temperature thermal barrier coatings, life duration, fuels, emissions control, etc.
- ◆ There is need to educate not only engineers, but also policy makers and legislators both at a national and a European Union level, as well as personnel in ministries involved with issuing permissions for building and operating cogeneration systems.
- ◆ Students at the primary and secondary education level should have a first acquaintance with cogeneration.
- ◆ There is still room for improvement of the methodology for evaluation of cogeneration projects in order to quantify the various effects and take those into consideration in a multi-criteria approach.

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Conclusions and Recommendations from the 3rd Workshop on Education and Training on CHP

B. On the assessment of the available educational material and recommendations for improvement

- ◆ There are many books and reports on cogeneration written in English, which, however, cannot cover subjects specific in a particular area or country (legislature, financial opportunities, environmental regulations, tariff structure, etc.). Therefore, there is need to develop educational packages on cogeneration pertinent to each country and written in the language of the country.
- ◆ Appropriate educational material for students at the primary and secondary education level has to be developed.
- ◆ The associations for the promotion of cogeneration (such as COGEN Europe as well as national associations for cogeneration) can help with the development of educational material.
- ◆ It is useful to prepare and publish leaflets addressed to particular groups of non-engineers, e.g. "Cogeneration for policy makers," "Cogeneration for Administrators," etc.
- ◆ Publication of articles in newspapers and magazines addressed to the general public is important.

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Conclusions and Recommendations from the 3rd Workshop on Education and Training on CHP

C. On modern means of education and training on CHP

- ◆ The available computer and communication technology makes distant learning a viable option. Appropriate educational packages and procedures for cogeneration have to be developed.
- ◆ The Royal Institute of Technology has started and continues developing a platform that can be used for both teaching and learning about heat and power technology. This platform can be supplemented with "books" on cogeneration.

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Conclusions and Recommendations from the 3rd Workshop on Education and Training on CHP

D. On the means for increasing cooperation between educational institutions and interested companies

- ◆ Companies may endow chairs or other university units (in universities that do not have chairs) active in education on cogeneration.
- ◆ Adjunct professors (i.e. experienced persons from the industry, who have teaching duties in universities as a part time job) is a possibility also. On a smaller scale, invited lecturers from the industry may contribute in parts of courses offered in universities.
- ◆ Faculty members may ask for the opinion and suggestions of companies on the contents of courses on cogeneration.
- ◆ A contact should be established between educational institutions and the training department of companies.
- ◆ The associations for the promotion of cogeneration can help in various ways. For example, they can accept university students as members free of charge for a certain period of time.

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Conclusions and Recommendations from the 3rd Workshop on Education and Training on CHP

E. On a proposed European strategy for proper education and training on CHP with a vision of 20 years

A few focal points:

- ◆ The education on cogeneration should start at the primary school and continue at the secondary school.
- ◆ Cogeneration is a mature technology but there are always important improvements of existing equipment and development of new systems (e.g. fuel cells), while there is a trend to extend the concept to polygeneration. On the other hand, the implementation of efficient and viable cogeneration projects requires an interdisciplinary education of the persons involved. To cover these needs, proper education is required. National and European support in developing appropriate programs of studies is necessary.

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Conclusions and Recommendations from the 3rd Workshop on Education and Training on CHP

E. On a proposed European strategy for proper education and training on CHP with a vision of 20 years (continued)

- ◆ Policy makers and legislators of individual nations and of the European Union should have a fair knowledge of cogeneration. This can be acquired through special publications, seminars and workshops. Incentives and support by the individual nations and by the European Union is necessary.
- ◆ Cogeneration is equally (if not more) important as renewable energy for energy savings, protection of the environment and economic progress. Therefore, the favorable policy towards renewable energy should be extended to cogeneration.

Thank you for your attention