Annex V
Education and Training

Survey of Current Education & Training Practice in Hydropower Planning

Report V/3-1

IEA Technical Report

IEA Hydropower Agreement

OVERVIEW OF THE IEA IMPLEMENTING AGREEMENT FOR HYDROPOWER TECHNOLOGIES AND PROGRAMMES

The Hydropower Implementing Agreement is a collaborative programme among nine countries: Canada, China, Finland, France, Japan, Norway, Spain, Sweden and the United Kingdom. These countries are represented by various organizations including electric utilities, government departments and regulatory organizations, electricity research organizations, and universities. The overall objective is to improve both technical and institutional aspects of the existing hydropower industry, and to increase the future deployment of hydropower in an environmentally and socially responsible manner.

HYDROPOWER

Hydropower is the only renewable energy technology which is presently commercially viable on a large scale. It has four major advantages: it is renewable, it produces negligible amounts of greenhouse gases, it is the least costly way of storing large amounts of electricity, and it can easily adjust the amount of electricity produced to the amount demanded by consumers. Hydropower accounts for about 17 % of global generating capacity, and about 20 % of the energy produced each year.

ACTIVITIES

Four tasks are operational, they are: 1. upgrading of hydropower installations, 2. small scale hydropower, 3. environmental and social impacts of hydropower, and 4. training in hydropower. Most tasks will take five years to complete, they started in March 1994 and the results are expected in 1999. To date, the work and publications of the Agreement have been aimed at professionals in the respective fields.

UPGRADING

The upgrading of existing hydropower installations is by far the lowest cost renewable energy available today. It can sometimes provide additional energy at less than one tenth the cost of a new project. One task force of the Agreement is studying certain technical issues related to upgrading projects.

SMALL SCALE HYDROPOWER

Advances in fully automated hydropower installations and reductions in manufacturing costs have made small scale hydropower increasingly attractive. The small scale hydropower task force will provide supporting information to facilitate the development of new projects.

ENVIRONMENTAL AND SOCIAL ISSUES

For some hydropower projects the environmental and social impacts have been the subject of vigorous debate. There is a need to communicate objective information to the public, so that countries can make good decisions with respect to hydropower projects. The environmental task force will provide such information on possible social and environmental impacts and on mitigation measures.

EDUCATION AND TRAINING

The availability of well-trained personnel is a key requirement in the hydropower sector. The education and training task force is concentrating on education and training in operations and maintenance, and planning of hydro power projects.

THE INTERNATIONAL ENERGY AGENCY – IMPLEMENTING AGREEMENT
FOR HYDROPOWER TECHNOLOGIES AND PROGRAMMES

SUBTASK V/3:
SURVEY OF CURRENT EDUCATION & TRAINING PRACTICE IN HYDROPOWER PLANNING"

Report V/3-1

Editor:
Subtask leader
Tom-Ivar Brate
Trondheim, Norway

November 1998

OTHER TECHNICAL REPORTS IN THIS SERIES

HYDRO POWER UPGRADING TASK FORCE (ANNEX 1)

Guidelines on Methodology for Hydroelectric Turbine Upgrading by Runner Replacement – RSW Inc. – 1998 (available to non-participants at a cost of US $ 1,500 per copy)

Guidelines on Methodology for the Upgrading of Hydroelectric Generators – to be completed in 1999.

SMALL SCALE HYDRO POWER TASK FORCE (ANNEX 2)

Small Scale Hydro Assessment Methodologies – E. Wilson, Wilson Energy Associates Ltd. – 1999 (available to non-participants on request)

Successful Low-Cost Technologies for Small Scale Hydro Projects – expected to be available in 2000.

Research and Development Priorities for Small Scale Hydro Projects – F. Armand, ADEME – 1999 (available to non-participants on request)

Financing Options for Small Scale Hydro Projects – T. Gjermundsen, Groner Trondheim AS – 1999 (available to non-participants on request)

ENVIRONMENT TASK FORCE (ANNEX 3)

Summary Report of Environmental and Social Impacts of Hydropower Projects, and the Effects of Mitigation Measures – Jens P. Taasen, Norwegian Water Resources and Energy Administration – 1999 (available to non-participants on request)

A Comparison of the Environmental Impacts of Hydropower with those of Other Generation Technologies – B. Svensson, Vattenfall Utveckling AB – 1999 (available to non-participants on request)

Legal Frameworks, Licensing Procedures, and Guidelines for Environmental Impact Assessments of Hydropower developments – C. Rivero, UNESA – 2000 (available to non-participants on request)

Guidelines for the Environmental Impact Assessment of Hydro Projects – J-E Klimpt, Hydro Quebec – 1999 (available to non-participants on request)

Guidelines for the Impact Management of Hydropower and Water Resources Projects – S. Trussart, Hydro Quebec – 1999 (available to non-participants on request)

EDUCATION AND TRAINING TASK FORCE (ANNEX 5)
(All of the following reports will also be available free of charge on the Internet at http://www.ich.civil.sintef.no/iea. Some reports may consist of more than one volume.)

Existing Opportunities in Hydropower Education and Training – National Reports from Participating Countries. Editor: T. S. Jørgensen, International Centre for Hydropower, Trondheim, Norway, April 1997 (available to non-participants on request)

Summary of Results of the Survey of Current Education and Training Practices in Operation and Maintenance. T. S. Jørgensen, International Centre for Hydropower, Trondheim, Norway, October 1998 (available to non-participants on request)

Development of Recommendations and Methods for Education and Training in Hydropower Operation and Maintenance. S. Eklund, Jokkmokk Training Centre, Jokkmokk, Sweden, 2000 (available to non-participants on request)

Survey of Current Education and Training Practice in Hydropower Planning. T.-I. Brate, the Norwegian University of Science and Technology (NTNU), Trondheim, Norway, 1999 (available to non-participants on request)

Structuring of Education and Training Programmes in Hydropower Planning, and Recommendations on Teaching Material and Reference Literature. D. K. Lysne, the Norwegian University of Science and Technology (NTNU), Trondheim, Norway, 2000 (available to non-participants on request)

Tentative title: Implementation of Information Technology; Test case on Distance Learning in the Hydropower Sector. T.-I. Brate, the Norwegian University of Science and Technology (NTNU), Trondheim, Norway, 2000 (available to non-participants on request)

PREFACE

This report is the result of the work of subtask 3 – "Survey of Current Education & Training Practices in Hydropower Planning" of the Task Force on *Annex V: Education and Training*, which is one of four task forces of the IEA Implementing Agreement for Hydropower Technologies and Programmes. The subtask started its work in mid-1996 and has drawn on the resources and expertise of the three participating countries in the task force.

The intention of the survey is to establish an overview of international E&T practices in this sector as a basis for the work of subtask 4 of Annex V, in which recommendations for future E&T in hydropower planning will be developed.

The survey is partly conducted in close cooperation with the parallel work in subtask 1, which is focussing on the current E&T situation in hydropower operation and maintenance.

We would like to acknowledge all our colleagues in the international hydropower community who have responded on our questionnaires and requests for information, and hence made this survey possible.

Dagfinn. K. Lysne
Operating Agent
Annex V

The views presented in this report do not necessarily represent the views of the International Energy Agency, nor the governments represented therein.

SUMMARY

This report contains a compilation of results of a survey of current education and training practices in hydropower planning. The report is divided into three major sections.

The first section describes the survey methodology that was utilized. It was decided to make use of questionnaires as the basic tool for gathering information. A two-step strategy was selected, with a simple, two-page questionnaire forming the first stage. The questionnaire was sent to 120 addresses with the intention of establishing a network of contacts throughout the hydropower industry. A more detailed phase 2 questionnaire was produced as a follow-up, and aimed at those who had responded to the first one.

In the second section the results are compiled and evaluated by regions; Africa, America, Asia, Australia and Europe. A total of 31 phase 1 questionnaires from 18 countries were completed and returned. Most of the information has been collected through direct contact as very few responded to the phase 2 questionnaires. Including all information we have received, the survey counts 29 countries.

The final section, the Appendixes, include detailed information sent to us from our contacts at institutions where hydropower education exists.

We have received information about existing hydropower planning activities in 15 countries. Many of the offers we have identified refer to hydropower planning as a subject given as a part of programmes in water resource management and hydraulics. This seems to be the most frequent way of including hydropower planning into university programmes.

TABLE OF CONTENTS

1. INTRODUCTION

The objective of subtask V/3: *"Survey of Current Education and Training Practice in Hydropower Planning"* is to establish an overview of available Education and Training (E&T) Practices in the world. This will be valuable information for the task of presenting recommendations for E&T within Hydropower Planning which will be covered by subtask V/4: *"Structuring of Education and Training Programmes in Hydropower Planning, and Recommendations on Teaching Material and Reference Literature"*.

It is regarded as being beyond the scope and resources of the project to attempt to produce a complete mapping of all existing offers in Hydropower Planning E&T in the world-wide hydropower sector.
The challenge has therefore been to identify universities or other institutions that offer E&T in Hydropower Planning in order to provide a representative picture of current offers and the contents and syllabuses of these programmes.

In order to achieve this, a combination of questionnaire surveys, task force member networking and interviews was employed. Nevertheless there is reason to believe that relevant E&T activities of interest to this investigation have not yet been identified. This report should therefore be regarded as preliminary, and it is subject to revision at a later stage in the project on the basis of anticipated input from the hydropower sector.

The report has been compiled by the International Centre for Hydropower (ICH), which acts as secretariat for the IEA Annex V.

2. SURVEY METHODOLOGY

It was decided at an early stage to make simple questionnaires in order to establish a network of contacts among universities and other institutions that deal with E&T in hydropower planning. Questionnaires were sent to a mailing list containing 120 addresses which was compiled from existing lists owned by the three Annex V participating countries. The questionnaire has also been available on ANNEX V's Internet page, in order to enable people to fill in their answers and send them by E-mail. The questionnaire and cover letter were distributed by the secretariat early in 1997, with the following regional coverage:

Africa:	25 countries
Asia:	15 countries
America:	11 countries
Europe:	6 countries
Australia/NZ:	2 countries
Total:	59 countries

2.1. The questionnaires

The phase 1 questionnaire contained questions whose main goal was to identify contact persons in the countries. A simple questionnaire was sent to a mailing list produced by the participants. The contact persons were asked to provide information about training in hydropower planning in their own countries without any details.

To all responders with knew of existing offers in hydropower planning E&T, a phase 2 questionnaire was mailed as a follow up. In the phase 2 questionnaire we asked for detailed information about topics relevant for hydropower planning.

2.2. Use of personal network

In addition to the questionnaires, and because the response rate was low, it was decided to follow up the survey with personal letters to contacts known to be interested in Hydropower Education. Faxes and letters have been sent to contacts at universities and organisations in order to gather more information.

2.3. Workshops

A workshop related to the needs for education and training in hydropower planning was held at the Kafue Gorge Regional Training Centre in Zambia, in October 1997. Our experience from this meeting is that workshops are a convenient means of gathering information, and it has been decided to arrange two more workshops, one on the American continent, and one in Asia. Selected representatives from countries in the

two regions will be invited to form a forum for input to the needs and recommendations for future E&T (Subtask V/2 and V/4).

3. RESULTS OF QUESTIONNAIRES

31 questionnaire replies were received from 18 countries. Including the information received by letters, this report cover 29 countries where we have received information about existing E&T activities in 15 countries.

From the phase 1 questionnaires, we have received information related to education and training in hydropower planning in the following universities:

Brazil:	University of São Paulo / University of Campinas.
China	Hohai University; North China Institute of Water Resource and Hydropower; Graduate School of North China Institute of W.R.P.H.
Philippines	The University of Philippines.
Sweden:	Kungliga tekniska Høgskolan.
Thailand:	Asian Institute of Technology (AIT) and the Kasetsart University, Bangkok.
Zambia:	University of Zambia, School of Engineering, Lusaka.

In addition, we have received information about training in hydropower planning from the following organisations:

Spain:	Several hydropower enterprises.
Thailand:	Electricity Generating Authority of Thailand.
Taiwan	Taiwan Power Company, the Training Centre of Taipower

A phase 2 questionnaire was sent to all responders who had indicated that they were aware education in hydropower planning. The phase 2 questionnaire is more detailed and emphasises knowledge of topics needed by hydropower project managers or planners. So far, this follow up questionnaire has not produced any results, but it will be followed up as a task sharing activity carried out by the Annex V task force members in accordance with the following agreement:

Japan:	Asia excluding Russia
Sweden:	Europe and America
Norway:	Africa and Russia

The result from this follow up will be appended to the report for subtask V/4 “Structuring of Education and Training Programmes in Hydropower Planning, and Recommendations on Teaching Material and Reference Literature”.

3.1. Responses from Africa

Question	No	yes
Is education within hydropower planning available in your country?	11	1
Is there any kind of organised training within hydropower planning in your country?	12	0

The only country that reported activities in hydropower planning education was Zambia at the "University of Zambia, School of Engineering, Lusaka". So far, we have not received any detailed information from there.

No existing E&T are reported from Ghana, Lesotho, Mauritius, Mozambique, Tanzania (NB! Education in Hydropower Planning started in Dar Es Salaam the autumn 1998) and Zimbabwe.

Other Information

Zambia:

In October 1997 an Annex V contact meeting was held at the Kafue Gorge Regional Training Centre in Zambia. The meeting included a workshop to obtain information about the status of hydropower planning activities in the SADC region. The contact meeting included 12 participants from Zambia, Mozambique, Swaziland and the Democratic Republic of Congo in addition to the Annex V participants from Norway and Sweden.

The workshop stated that there are generally very few engineers in the SADC region who deal with hydropower planning, because the field is more or less fully covered by external consultants. These local hydropower engineers are educated in other parts of the world, and they gain their experience as local counterparts or project workers in co-operation with external consultants.

Tanzania:

In autumn 1998 the University of Dar es Salaam will start a sector-oriented hydropower MSc programme in Hydropower Planning. This MSc programme was conceived as a result of a regional survey which showed that there is a great need for education, training and resource in hydropower generation technology in the SADC region. The region is endowed with many large rivers and has a severe deficit in electrical energy. The programme will train local experts from the region, in order to build up their capacity to exploit the untapped hydropower resources in the region. No institutions in the region currently offer this type of training.

The main objective of the post-graduate hydropower programme in Dar es Salaam will be to develop the regional and national expertise needed for the implementation of the national water and energy policy as well as the Principles of the Rio Declaration on Environment and Development. The programme is expected to be a centre of excellence for hydropower planning and development for the African region south of the Sahara.

3.2. Responses from America

Question	No	yes
Is education within hydropower planning available in your country?	3	1
Is there any kind of organised training within hydropower planning in your country?	3	1

Brazil and the University of Säo Paulo / University of Campinas have been named as universities with E&T in hydropower. So far, we have not received any detailed information from these universities.

No existing E&T are reported from El Salvador, Guatemala, Nicaragua.

Other Information

Ecuador:

At the Latin American Energy Organisation (OLADE) in Ecuador a MSc programme has been developed in Energy and the Environment in co-operation with the University of Calgary. The programme is particularly for students from Latin America and the Caribbean. The program is aimed at high level technical and managerial professionals from the government and energy enterprises. The program is thus not a specialised hydropower program, but touches on a number of areas and topics, both energy and environmental, and tries to establish connections between the two spheres. The program lasts for 14 months and the topics covered include non-renewable and renewable sources, energy economics and planning, energy environmental risk assessment, environmental management tools and risk management.

3.3. Responses from Asia

Question	No	yes
Is education within hydropower planning available in your country?	7	5
Is there any kind of organised training within hydropower planning in your country?	10	2

Of the five responders who were aware of E&T offers in Asia, three were from Thailand, one from China and one from Taiwan where training is given by the Taiwan Power Company, at the Training Centre of Taipower. In Thailand the Kasetsart University and the Asian Institute of technology were cited as institutions that offer E & T, but the Electricity Generating Authority of Thailand (EGAT) also offers internal training programmes.

No existing E&T are reported from Cambodia, Laos, Malaysia and Sri Lanka,

Further investigation revealed that AIT in Thailand offers Water Resource Planning, but this does not include hydropower.

In the Philippines some training in hydropower is included in the Water Resource Programme at the University of Philippines.

In China we were informed about E&T in Hohai University, the North China Institute of Water Resource and Hydropower and the Graduate School of North China Institute of Water Resources and Hydropower.

Other Information

India:

Since 1982, the University of Roorkee has offered courses on promoting the development of small hydro in hills as well as the planning and development of de-centralised integrated energy systems in conjunction with renewable energy sources such as biomass, solar etc. The main objective of the centre is to design and develop various non-conventional energy technologies and to impart training to field engineers in the field of renewable energy in India. The MSc course "Alternate Hydro Energy Systems" is the first course in India, which specialises in renewable energies with special emphasis on small hydropower development. The personnel trained are expected to contribute significantly to the development of non-conventional energy sources for which trained manpower is extremely scare. The course is planned to last three semesters, and is most suitable for personnel working in organisations/institutions involved in implementation, planning and execution of non-conventional energy sources. There are 15 seats pr. academic session and the course is open to both national and international students.

China:

The "Graduate School of North China Institute of Water Resources and Hydropower" offers Graduate Student Education (MSc), distance education (BSc) and also continuing education (training). The strategy for the E&T is to engage in "the cultivating of qualified personnel with skills both in hydraulics and hydropower technology and management."

Nepal :

At the moment there are plans to start a MSc programme in Hydropower Development at the Tribhuvan University in Kathmandu. Discussions are under way between the Tribhuvan University and the Norwegian University of Science and Technology, where there is a similar programme. The course is still at the planning stage, but will soon be available for Asian students.

3.4. Responses from Australia / New Zealand

Question	No	yes
Is education within hydropower planning available in your country?	0	0
Is there any kind of organised training within hydropower planning in your country?	0	0

So far, we have not received any information on E&T activities in New Zealand or Australia.

3.5. Responses from Europe

Question	No	yes
Is education within hydropower planning available in your country?	1	2
Is there any kind of organised training within hydropower planning in your country?	1	2

The two countries that provide information on hydropower activities were Spain and Sweden. Further investigation has revealed that the answer from Spain (Polytechnic University of Catalonia) is related to coastal engineering and not hydropower.

Finland responded that no education is available.

Other Information

Greece:

The National Technical University, Faculty of Civil Engineering, Dept. of Water Resources in Greece, provided information about hydropower related education. Since 1960 a course has been taught in the 8th semester of the Hydraulic Engineering Cycle (Civil Engineering is a 5-years degree) as a compulsory course.

The Netherlands

In the International Institute for Infrastructural, Hydraulic and Environmental Engineering (IHE) in Delft, The Netherlands, a core activity is the provision of postgraduate educational programmes leading to MSc and PhD –degrees. A large majority of the student body consists of engineers and other professionals from developing countries, while a few come from Eastern/Central/West European countries, Australasia and North America. A total of some 320 students/year take the 12 month MEng or MSc programme. Specialisation is provided in:

- River Engineering and River Basin Development
- Coastal Engineering and Port Development
- Land and Water Development
- Hydrology
- Water and Environmental Resources Management
- Sanitary Engineering
- Environmental Sciences and Technology
- Transportation Engineering.

Hydropower is included as a part of the specialisation in River Engineering. Yearly, some 15 students follow the specialisation in River Engineering. MSc and MEng research topics cover Hydraulic Structures – Hydraulic and Morphological Phenomena in Rivers – Dams and Dikes – Environmental Impact Assessment/Mitigation Measures etc.

In The Netherlands, the largest centre of civil engineering education is the Technical University of Delft, which offers courses related to Hydraulic Construction, but as a secondary option one course is offered on dams and hydropower.

Sweden
In the Royal Institute of Technology (KTH) in Stockholm, Sweden, Division for Hydraulic Engineering teaches hydropower related topics such as Ecology, Geology, River Engineering, Applied Hydrology, Development of Water Resources and Environmental Impact Assessment. The KTH also has ongoing research in Dam Safety.

Norway:
Since 1993, the Norwegian University of Science and Technology has offered an international MSc programme in Hydropower Development. This MSc study is a follow up of the 10 month diploma course which has been taught since 1976. The programme is sponsored by the Norwegian Agency for International Cooperation (NORAD), and the target group is engineers from developing countries.

Since 1997 the International Centre for Hydropower (ICH) in Norway has offered three-week intensive courses with hydropower topics. The course ”Hydropower Resources Development and Management” was held in September, 1997, and the course ”Hydropower and the Environment” was held in June, 1998 and repeated in September. These courses are planned to be offered regularly, and new courses are in planning. The target group is hydropower professionals on a middle-management level, primarily from developing countries. This activity is financially supported by NORAD (The Norwegian Agency for Development Cooperation).

Russia:
Hydrotechnical construction is one of the basic courses taught by the Faculty of Technology-Economics and Management, Department of Hydrotechnical Construction at the Sankt Petersburg State Technical University, for the production of Professional Specialist Hydrotechnique, code No. 290400. The academic plan in this course is oriented towards the training of Civil Engineer (Hydropower) who are equally capable of working in a wide range of fields, such as Energy, Industrial, Urban Planning, Highway, Operation and Maintenance of Hydropower.

4. Conclusions

Total response on phase 1 questionnaire

Question	No	yes
Is education within hydropower planning available in your country?	22	9
Is there any kind of organised training within hydropower planning in your country?	26	5

The term Hydropower Planning refers in this report to reconnaissance, prefeasibility or feasibility studies. These studies requires integration of technical, economic and environmental topics as well as management issues.

From our questionnaires distributed to 59 countries, we received 31 replies. It was expected that the response rate was low on the questionnaires. In any case the survey has succeeded in identifying activities for E&T in Hydropower Planning. It has given us valuable contacts for the further work with recommendations for hydropower planning E&T.

In the Annex V subtask V/3 survey, our goal has been to identify programmes whose main focus is on hydropower planning. So far we have received information about existing hydropower planning activities in 15 countries. One MSc programmes will start in the near future at the Tribhuvan University in Kathmandu, Nepal, and one MSc programme started in the autumn 1998 at the University of Dar es Salaam, Tanzania.

Many of the offers we have identified refer to hydropower planning as a subject given as a part of programmes in water resource management and hydraulics. This seems to be the most frequent way of including hydropower planning into university programmes.

An important grand conclusion is, however, that very few countries are offering any education and training in hydropower planning. This may very well be the case for most of the countries that have not responded to the questionnaire.

5. References

/1/ "Existing Opportunities in Hydropower Education and Training. National Reports from Participating Countries" IEA Annex V Report, April 1997.

6. Appendix A: The Questionnaires

***IEA** – INTERNATIONAL ENERGY AGENCY*

IMPLEMENTING AGREEMENT FOR HYDROPOWER TECHNOLOGIES AND PROGRAMMES

Annex V Education and Training

Phase I Questionnaire Planning

Company/Organisation : ……

Address : ……
……
……

Telephone : …… **Telefax** : ……

Number of employees : ……

Activity profile of company/organisation:

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……
……
……
……

Contact Person : …… …… **Title** : ……

Sex : …… **E-mail address** : ……

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Is education within hydropower planning available in your country? **Yes [ ]** **No [ ]**

If yes: please write name of university/school of training centre: ……

Is there any kind of organised training within hydropower planning in your country? **Yes [ ]** **No [ ]**

If yes: which organisation(s) is offering such training? ……

THANK YOU FOR YOUR HELP

Please return the form by airmail or fax to:

Tom-Ivar Brate
International Centre for Hydropower
S.P. Andersens vei 5
N-7034 Trondheim
tel: +47 73 59 47 44 fax: +47 73 59 12 98

you may also return your answers by e-mail to:

tom-i.brate @civil.sintef.no
(please send by airmail or fax if you do not receive any confirmation from us within one week)

IEA *– INTERNATIONAL ENERGY AGENCY*

IMPLEMENTING AGREEMENT FOR
HYDROPOWER TECHNOLOGIES AND PROGRAMMES

Annex V Education and Training

Phase II Questionnaire Planning

University/Company/Organisation : ……

Address : ……
……
……

Telephone : …… Telefax : ……

Number of employees : …… Company E-mail : .....

Activity profile of company/organisation:

……
……
……
……
……

Contact Person : …… …… Title : ……

Sex : …… Personal E-mail : ……

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EDUCATIONAL PROGRAMMES

Do you offer a series of courses on B. Sc or M. Sc level which allows students to specialize in Hydropower Planning? Yes [ ] No [ ]

Continuing educating courses:

- **Do you offer courses to practising Engineers?**
  Yes [ ] No [ ]
- **Duration of course (s)?**
  [_____]
- **Main contents of this /these course(s).**

……
……
……
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……

Do you know about future strategies for E&T related to Hydropower Planning in your country?

……
……
……
……
……

CONTENTS OF EDUCATIONAL PROGRAMME IN HYDROPOWER PLANNING

A project manager / hydropower planner does need knowledge in most of the topics listed below. Could you please indicate which topics you are offering on B.Sc or M. Sc. level

	Offered	No. of Hours	Compulsory	Elective
Geo Subjects				
- Engineering geology				
- Rock blasting and tunnelling				
- Soil mechanics				
- Embankments dams				
- Concrete dams / structures				
- Properties of concrete				

	Offered	No. of Hours	Compulsory	Elective
Hydro Subjects				
- Basic and applied hydrology				
- Hydraulics/Hydraulic design				
- Scour and sediment transport				
- Turbines and hydraulic equipment				
- Electro-mechanical equipment				
- Power house design				

	Offered	No. of Hours	Compulsory	Elective
Planning and management subjects				
- Project management				
- Feasibility studies				
- Implementation of hydropower / water resources projects				
- Construction management				
- Operation and maintenance				

	Offered	No. of Hours	Compulsory	Elective
Environmental and economic subjects				
- Basic economics				
- Investment analysis				
- Socio-economic analysis				
- Environmental impact studies				

THANK YOU FOR YOUR HELP

Please return the form by airmail or fax to:

Tom-Ivar Brate
International Centre for Hydropower
S.P. Andersens vei 5
N-7034 Trondheim
tel: +47 73 59 47 44 fax: +47 73 59 12 98

you may also return your answers by e-mail to:

tom.i.brate @bygg.ntnu.no
(please send by airmail or fax if you do not receive any confirmation from us within one week)

7. Appendix B: List of Responders

Africa

Ghana	Architectural & Engr, Svcs. Ltd Water division P.O.Box 3969 Accra-Ghana
Lesotho	SADC (Southern African Dev. Community) Water Section Coordination Unit Private Bag A440 Maseru – 100, Lesohto
	Lesotho Highland Development Authority P.O.Box 7332, Maseru 100, Lesotho
Mauritius	Central Electricity Board Royal Road Curepipe
Mozambique	Electicicidade de Mocambique – EDM Av. Agostino Netd No. 70 P.O.Box 2447 – Maputo
Tanzania	Tanzania Electricity Supply Company Ltd (TANESCO). Samora Avenue P.O.Box 9024 Dar-es Salaam
	University of Dar es Salaam Department of Civil Engineering P.B.Box 35131 Dar es Salaam Tanzania
Zambia	Zambia Electricity Supply Corp. LTD (ZESCO) Stand 6949, Great East Rd Lusaka
	Kariba North bank Power Station P.O.Box 92 Siavonsa
Zimbabwe	Z.E.S.A P.O.Box 377 Harare

America

Brazil	Comphania Energetica de São Paulo Av. Angelica, 2565 - 8 Andar Concolacio CEP: 01227-908 - São Paulo
Ecuador	OLADE/University of Calgary Quito
El Salvador	Comision Ejecutiva Hidroelectrica del Rio lempo CEL Carretera al Puerto de la Libertad, Km 11 1/2, Colonia San José del Pino, Nueva San Salvador, La Libertad
Guatemala	Institutio Nacional de Electrificacion - INDE - km. 14.5 Carretera al Pacificio San Jose Villa Nueva, Villa Nueva
Nicaragua	Empresa Nicaraguense de Electricidad Planificcación P.O.Box 55 Managua

Asia

Cambodia	Energy Department Ministry of Industry, Mines and Energy 47 Preah Norodom Blvd. Phnom Penh
China	Graduate School of North China Institute of Water Resources and Hydropower Huayuancun 100044, Beijin China
India	Alternate Hydro Energy Centre University of Roorkee Roorkee-247 667 India
Laos	Electricité du Laos Yeset Hydropower Plant
Malaysia	Sarawak Electricity Supply Coorp. Wisma Sesco Petra Jaya P.O.Box 149, 93700 Kuching Sarawak
Nepal	Institute of Engineering Pulchowk Campus Tribhuvan University P.O.Box 1175 Katmandu

Philippines	National Power Corporation Agham Road Corner Quezon Ave. Diliman Quezon City
Phillipines	Mini-Hydro Division Department of Energy energy Resource Development Bureau, Energy Centre, Meritt Road Fort Bonifacio, Metro Manila,
Sri Lanka	Ceylon Electricity Board Samanalawewa Hydropower Station Kapaguala, Handagiriya Balangoda
Taiwan	Taiwan Power Company No. 242, 11F. Rooesevelt Rd. 3 Sec. 3 Taipei
Thailand	Electricity Gererating Atuhority of Thailand (EGAT) Charansanitwong RD. Bankraui, Nonthaburi, 11130

Europe

Finland	Kemijoki Oy, P.O.Box 8131 FI-96101 Rovaniemi
Greece	National technical University, Faculty of Civil Engineering Dept. of Water Resources, Hydraulics and maritime Engineering 42 Patission Str. Athens 106 82
Spain	ETS Ingenieros de Caminos Canales y Puertos c(Gran Capitan D1/Sn 08034 Barcelona
Sweden	Stochholm Energi Vattenfall AB 115 77 Stochholm Royal Institute of Technology SE-151 45 Södertälje
The Netherlands	IHE Delft Westvest 7 2601 DA Delft

8. Appendix C: Ecuador, Olade

OLADE/The University of Calgary
Casilla 17-11-6413
Quito, ECUADOR
Fax: +(5932) 539 684

The University of Calgary, with the support of the Canadian International Development Agency (CIDA) and the Latin American Energy Organisation (OLADE), has developed an MSc. degree in Energy and the Environment for students from Latin America and the Caribbean in Quito, Ecuador. Professors from the University of Calgary, and from leading universities in Latin America and the Caribbean region, deliver courses at the OLADE headquarters.

Who could apply?
The program is for high-potential technical and managerial professors from government and energy enterprises. Participants will acquire knowledge and develop skills that are needed to manage energy projects and operations effectively in accordance with sustainable development principles.

The Degree
Graduates of the program will receive an interdisciplinary university degree, a MSc in Energy and the Environment from the Faculty of Graduate Studies, The University of Calgary.

The Final Project
Towards the end of the fourteen-month program, students are asked to complete two special projects, one to be completed by each individual and one to be completed by a group. The individual projects focus on issues of importance to agency, institutions or company sponsoring the student. The group project enables students to work in multicultural and interdisciplinary teams.

Program Structure
The program has been organised in the form of compulsory courses and seminars, optional seminars, individual work and group work. The courses will be presented in three week-modules over a 14-month period.

First Quarter
Energy systems I : Nonrenewable Energy
Energy systems II: Renewable Energy
Air pollution and its Impact in Energy Development

Second quarter

Ecology and Environmental Chemistry
Water Pollution in Energy Development
Land Pollution and Waste Control

Third quarter
Energy systems: Energy economics
Environmental Impacts Assessment and Risk Management
Human Resource Management Principles in Energy Projects

Fourth quarter
Environmental Management Tools in Energy Project Development
Environmental Law in the Energy Sector
Strategic Environmental Planning for Energy Organisations

Fifth Quarter
Interdisciplinary team project
Major project

9. Appendix D: Norway, NTNU

NTNU
Norwegian University of
Science and Technology

Faculty of Civil and
Environmental Engineering
Department of Hydraulic
and Environmental Engineering

Place	Norwegian University of Science and Technology, Department of Hydraulic and Environmental Engineering
Programme and duration	The studies comprises lectures, exercises, group and individual project assignments, excursions and M Sc thesis. Two academic years.
Admission and requirements:	Candidates should have a B Sc degree or equivalent in civil engineering and 2-5 years experience from planning, design, and/or construction of hydraulic works. All lectures are given in English. A good working knowledge of English is therefore essential. The candidate has to undergo a TOEFL or ELTS test with good results.
Course management:	Dagfinn K. Lysne, Professor in charge Hilbjørg Sandvik, Course Co-ordinator
Steering committee:	Einar Broch, Professor Ånund Killingtveit, Professor Erik Lund, Faculty Director

MASTER OF SCIENCE IN HYDROPOWER DEVELOPMENT

Course Outline

Hydropower development is a typical interdisciplinary task. Most often, the person responsible for organizing the activities and coordinating the work of the specialists involved is a civil engineer. Consequently he/she needs to have a working knowledge of a wide range of fields but is not a specialist in all of them him-/herself. The Hydropower Development Programme has been organized to meet the training needs of persons who are, or in the future will be, in such key positions.

With this objective in mind a wide range of engineering, economic and environmental subjects are covered in the programme. Both fundamental and applied subjects are included, with main emphasis on the latter. The programme is suitable for young professional engineers engaged in planning and implementation of hydropower and/or other water resources projects.

The different subjects are presented by university staff and/or professional engineers, all with international experience.

FIRST YEAR

Geo subjects
- Engineering geology
- Rock blasting and tunnelling
- Soil mechanics
- Embankment dams
- Concrete dams/structures
- Properties of concrete

Hydro subjects
- Basic and applied hydrology
- Hydraulics/Hydraulic design
- Scour and sediment transport
- Turbines and hydraulic equipment
- Electro-mechanical equipment
- Power house design

Planning and management subjects
- Project management
- Feasibility studies
- Implementation of hydropower/ water resources projects
- Construction management
- Operation and maintenance

Environmental and economic subjects
- Basic economics
- Economic design criteria
- Investment analysis
- Socio-economic analysis
- Environmental impact studies
- Choice of energy source for electricity production

EXCURSIONS
In September in first year of the studies the students visit some Norwegian hydropower plants.
If it is possible there is also arranged one excursion to construction sites.

EXAMINATIONS
Examinations are arranged in accordance with the regulations of NTNU.There are two written examinations - in December and February, and one oral in the beginning of May. The students have to pass these examinations to continue to second year of studies.

SECOND YEAR

A	S	O	N	D	J	F	M	A	M	J

*** Rock Engineering, A.C.**

*** River System Analysis, A.C.**

*** Withdrawel of water from sediment carrying rivers, A.C.**

EXAMINATIO

M SC THESIS

CLOSING

10. Appendix E: India, University of Roorkee

Alternate Hydro Energy Centre

Address:
Alternate Hydro Energy Centre / University of Roorkee
Roorkee – 247667
INDIA

MSc Degree in "Alternative Hydro Energy Systems"

Autumn Semester

1. Small Hydro Power System Planning and Management
2. Design of Small Hydropower Structures
3. Numerical Methods
4. Renewable Energy Resources Development Technology
5. Environmental Planning and management
6. Fluid Mechanics
7. Computer Programming (Non Credit Course)

Spring Semester

8. Small Hydro Generator, Protection & Control System Equipment
9. Energy System Economics, Policies and Laws
10. Hydro Mechanical Equipment

Elective I

11. Construction Planning & Management
12. Biomass Production and Bio Conversion
13. Operation and Maintenance of Small Hydropower Plants
14. Solar and Photo-voltaic Design and Applications

Elective II

15. Wind Energy Application Technology
16. Design and Testing of Hydro-Mechanical Equipment
17. Instrumentation
18. Rural Electrical Energy System Planning & Design
19. Sediment Transport and River Engineering
20. Solar Energy Thermal Processes
21. Welding Technology
22. Remote Sensing and GIS for SHP Planning
23. Electrical Design in SHP Stations

11. Appendix F: Greece, National Technical University

Faculty of Civil Engineering

Address:
National Technical University
Faculty of Civil Engineering
Dept. of Water Resources, Hydraulics and Maritime Engineering
42 Patission Str.
Athens 106 82
Greece

The compulsory Hydropower Education in the 8th semester of the Hydraulic Engineering Cycle

Lecturer: E. Kalkani
tel: +30 1 772 3446
fax: +30 1 772 3447

Introduction. Hydraulic Energy. Flow in turbine runner and pump impeller. Cavitation. Water hammer. Surge tanks. Impulse turbines (Pelton). Reaction turbines (Francis, Kaplan). Pumps. Pump-turbines. Turbines for small hydro powerplants. Layout of small hydro powerplants. Layout of conventional hydro powerplants. Layout of pumped storage hydro powerplants. Special cases of layout. Stages and preliminary design, final design, construction and operation of powerplants. Exploratory works (surveying, geology, geotechniques, hydrology, climate, electric loads). River diversion. Reservoirs and safety structures (intake, headrace tunnels and penstocks, powerplants). Financial aspects of hydropower development. Bill of quantities, budgeting, investment, debt payments, project management, cash flow. Powerplant operation. Power generation. Hydrothermal cooperation.

12. Appendix G: Tanzania, The University of Dar es Salaam (UDSM)

Address:
University of Dar es Salaam
Department of Civil Engineering
P.O.Box 35131
Dar es Salaam, Tanzania

Objectives of the MSc (Hydropower Planning) Programme

- To equip MSc (Hydropower Planning) graduates with up-to-date knowledge in the design and planning of hydropower plants for which Africa and Tanzania have a good potential.
- To provide a curriculum which covers the environmental aspects and impact of this multidisciplinary undertaking.
- To equip engineers with modern aspects of design and equipment selection.

Main features of the curriculum

The full MSc (Hydropower Planning) programme offers a total of 540 hours of lectures, of which a student is required to select at least 480 hours composed of 360 compulsory and 120 hours from electives. Five units of 40 hours each are taken from the existing Water Resources Engineering programme. The first 12 months will be devoted to coursework. The courses will be offered on a unit basis. One unit is equivalent to 40 hours of lectures, tutorials and demonstrations. The minimum number of units required for the MSc (Hydropower Planning) is 12.

The six months of the second year are devoted to an individual research project which involves about 800 hours of work and concludes with a dissertation. Normal course length will therefore be 18 months full time. One month may be extended to allow candidates to make corrections and submit A final version of the dissertation after examination.

Entrance Requirements

The minimum qualification for admission to the programme is a lower second BSc (Eng) in Civil Engineering or its equivalent from the University of Dar es Salaam or any other recognised university.

Candidates are required to have basic knowledge of computers, and the minimum number of students in any one intake is five, as per Faculty of Engineering recommendations.

MSc (Hydropower Planning) Curriculum

Compulsory courses: Engineering
Mathematical Analysis
Statistics for Engineers
Applied Engineering Hydrology
Hydraulics of Open Channels

Environmental Management
Hydrosystem Simulation Models
Applied Rock Engineering
Design of Hydraulic Structures
Hydropower Plant Layout
Project

Electives:
Embankment Dams
Concrete Dams
Hydropower Planning and Management
Hydropower Electro-mechanical Equipment
Hydrometry
Computation in Water Resources Engineering

13. Appendix H: Russia

Ministry of General and Professional Education of the Russian Federation
SANKT PETERSBURG STATE TECHNICAL UNIVERSITY
Faculty of Technology-Economics and Management
Department of Hydrotechical Construction

Introduction
The course plan provide for the study a wide range of topics in hydrotechnical construction, common and special destination. In addition to all the common subjects (physics, higher mathematics and theoretical mechanics) the Hydrotechnical Construction course is substantially based on special subjects: Survey, Architecture, Hydraulics, Applied Mechanics, Soil Mechanics, Process Technology, Economics and Management.

The aim and tasks of the course follow from its role and position in the training of civil engineers, and is oriented towards enabling future specialists to comprehend the diversity of hydrotechnical structures, their special features, design, construction and operation.

The study system includes series of lectures, practical classes, semester assignment projects, and a course project for the basic subjects that are included in this programme.

14.

Name of Degree: *MSc in Civil Engineering"Hydrotechnique"*
Code No: 290400
Duration of study. 5 years 10 months
There are a total of 11 semesters (The duration of one semester is six months)

The courses are organised under four major headings:

1.0 Socio-Economics & Social Science Subjects and Sports.
238 hr. lectures and 272 hr. practical classes.

2.0 Basic Engineering and Sciences Subjects
340 hr. lectures, 238 hr. practical classes and 68 hr. lab classes.

3.0 General Engineering Subjects
442 hr, lectures, 374 hr. practical classes and 153 hr. lab classes.

4.0 Special Profession Engineering Subjects
442 hr. lectures, 238 hr. practical classes and 119 hr. lab classes.