MEMO

MEMO CONCERNING	LOCATION	
Travel report from mission to Turkey June, 2013	Ankara and Istanbul, Turkey	
AUTHOR	DATE	
Ånund Killingtveit & Tor Haakon Bakken	June 17th – 20th, 2013	
DISTRIBUTION		
Open		

1. Background and purpose of the visit

This memo summarizes the impressions from the seminar at the Middle East Technical University, Ankara (METU), meetings with authorities (regional DSI), Statkraft in Ankara and Istanbul and the field visit to Kizilirmak River. The visit was carried out as an activity within the research center CEDREN (www.cedren.no) and mostly related to the activities planned in the EcoManage-project.

The purpose of the visit was to:

- Establish contact and network with relevant partners and institutions in Turkey, including researchers at METU, authorities (DSI) and Statkraft representatives in Turkey
- Scope future research activities to be carried out in co-operation with the above-mentioned partners and institutions
- Visit relevant sites for future research

We would like to take the opportunity to thank everyone that has been involved in the field trip for generously sharing their expertise and time with us.

2. Workshop on sustainable hydropower development at METU

A seminar on sustainable hydropower development and operation was held at Middle Eat Technical University in Ankara, hosted by Prof. Ali Unal Sorman at Dept. of Civil Engineering, Water Resources Lab. Prior to the seminar the CEDREN researchers visited the Head of Department of Civil Engineering, and Director of Ocean Engineering Research Center, Prof. Dr. Ahmet Cevdet Yalçıner.

The following presentations were held by the Norwegian scientists:

- The Norwegian hydropower system – A brief introduction
- HydroBalance – A research project on the use of the Norwegian hydro reservoirs for large scale balancing of future wind power development in NE Europe
- Water consumption from hydropower plants – State-of-the-art and scope of work for further research
- Environmental impacts assessment in regulated rivers - Experiences from Norwegian and international studies

Abstracts of the presentations are given in the last section of the travel memo. Approximately 25 persons attended the seminar.

Figure 1. Prof. Ali Unal Sorman at Dept. of Civil Engineering, Water Resources Lab welcomes the audience and introduces the presentations.

Figure 2. Parts of the audience at the METU-seminar.

Figure 3. Prof. Ånund Killingtveit at Norwegian Technical University of Science and Technology (NTNU) and CEDREN explains the European Energy policy.

Table 1. Some of the attendees to the seminar on sustainable hydropower development at METU.

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3. Meetings with the authorities

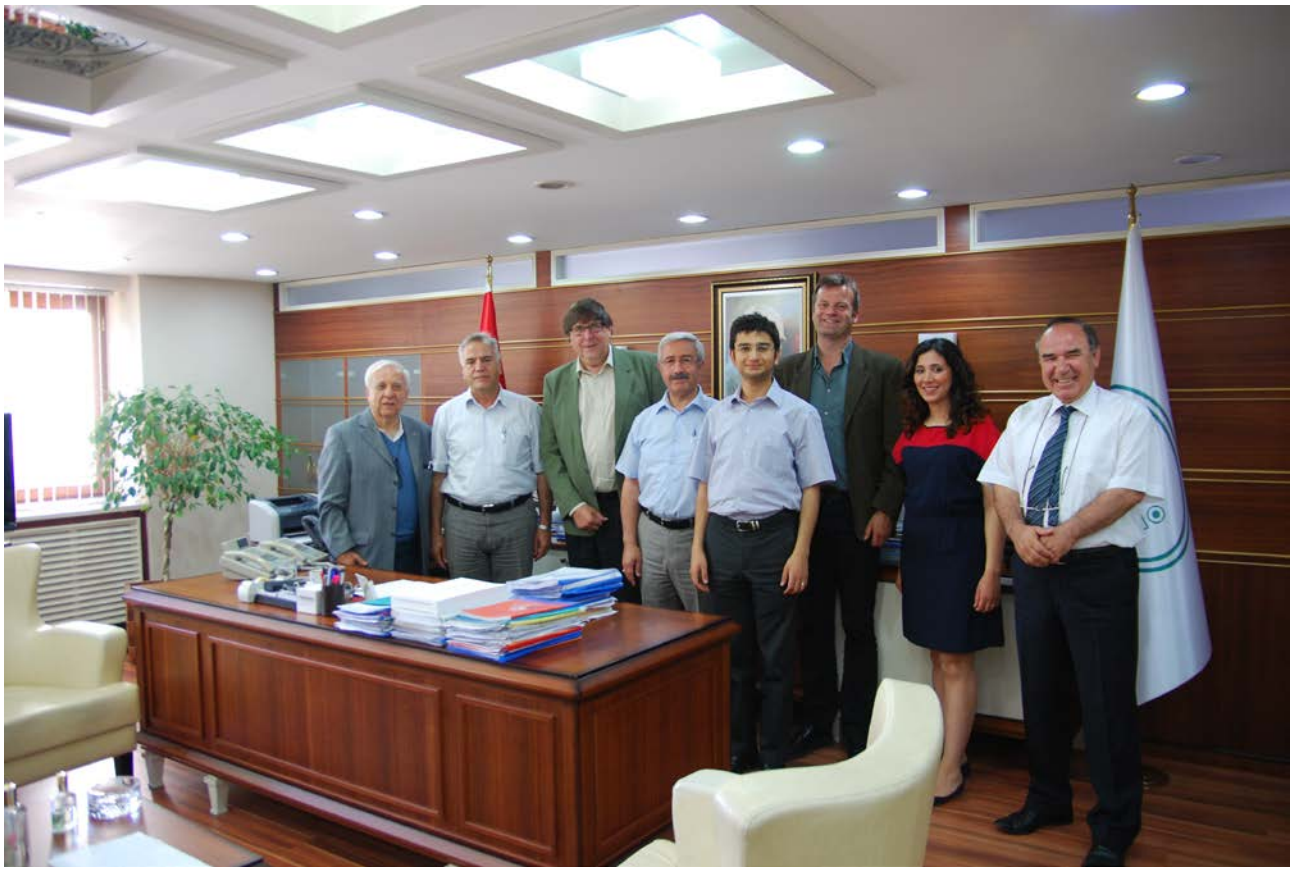

Figure 4. The following persons could be seen from left to right: Prof. Dr. Ali Ünal Şorman (METU), Hacı Haksal (Director of V. Region of DSI), Prof. Ånund Killingtveit (NTNU/CEDREN), representative from DSI, Student from Eskişehir Anadolu University, Tor Haakon Bakken (NTNU/CEDREN), Derya Soylu (Statkraft) and Fuat Karaaslan (DSI V. Region).

A very informative and useful meeting with the regional DSI was made during the morning June 19th. The scientists from CEDREN and METU informed about the background and plans for research on hydropower and water resources in Turkey and personnel from DSI explained the responsibilities of DSI with respect to energy production (hydropower) and water resources management, as well the situation regarding data and access to data.

The visited staff in DSI (State Hydraulic Works) V. Regional Directorate

- Hacı Haksal (Director of V. Region of DSI)
- Şener Elgül (Planning Branch Director)
- İnci İnal (Hydrology Chief Engineer in Planning Department)
- Şerafettin CANAZ (Chief Engineer in Dams & HEPP Department)
- Nihat Oğuz (Planning Department)
- Fuat Karaaslan

4. Meetings with Statkraft Ankara and Istanbul

Statkraft Ankara acted as a host to the researchers from CEDREN during our visit to Ankara and assisted very professionally in all practicalities with respect to transportation and accommodation. Both in Ankara and especially in Istanbul the CEDREN/NTNU researchers were informed about the status of the three Statkraft-owned hydropower projects that are either in operation or under construction. We were also informed about the status for further expansion in Turkey.

The CEDREN/NTNU researchers informed Statkraft about the background for our interest in doing research in Turkey, which is due to requests from Statkraft Norway, and our current and more specific plans for work.

The following persons from Statkraft were involved during our visits to Ankara and Istanbul:

Person	**Position**	**Contact information**
Steinar Bjørnbet	Managing Director (Istanbul)	Steinar.Bjornbet@statkraft.com
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Gamze Gündogan	Team assistant (Ankara)	gamze.gundogan@statkraft.com

5. Field visit to Kizilirmak River

A half-day field trip was carried out June 19th with departure from Ankara and Kizilirmak Town as the destination where one of the larger irrigation projects on Kizilirmak River is located.

Figure 5. Turkey and the river basins. Kizilirmak River Basin is located in the center (in green color) of Turkey and draining into the Black Sea. Kizilirmak River is the longest river in Turkey.

Figure 6. Kizilirmak River Basin is located in the center of Turkey and drains into the Black Sea. Kizilirmak River is the longest river in Turkey. The Statkraft-owned Kargi hydropower project, which is under construction, is located in the lower part of the river (red ring) and will short-cut a bend of the river. Kizilirmak Town and the visited irrigation project are upstream of Kargi.

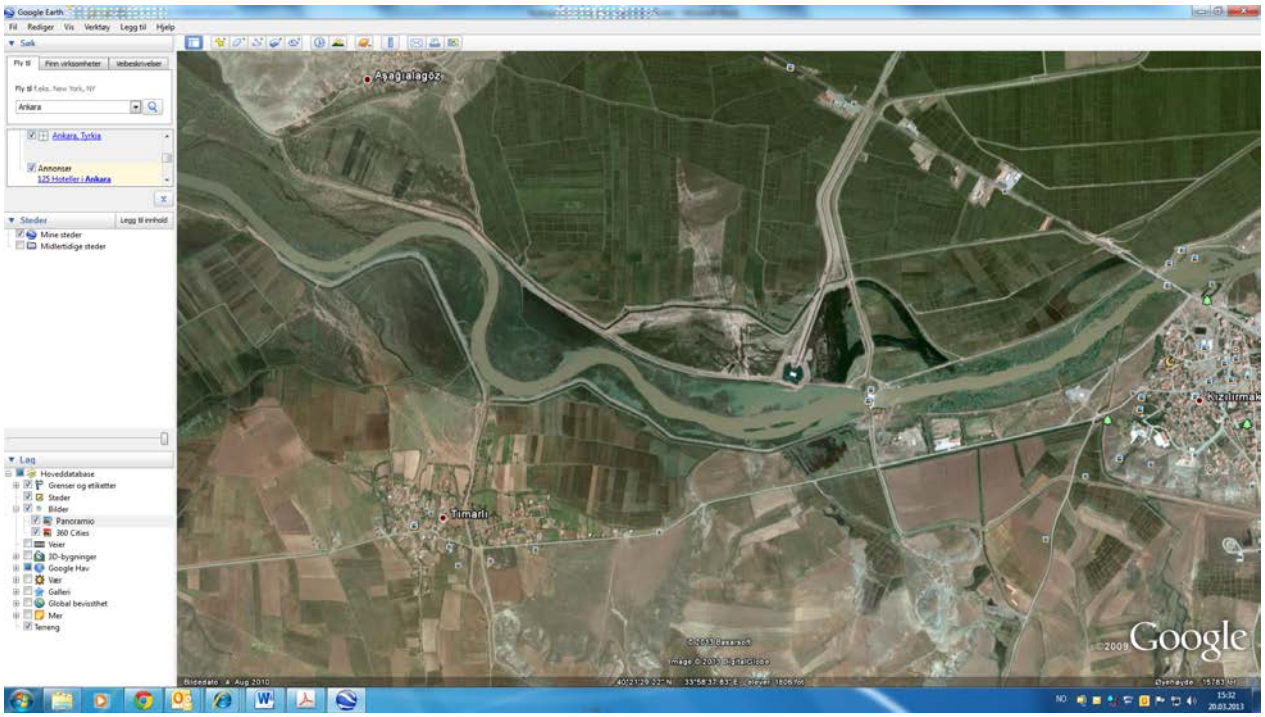

Figure 7. Google Earth view of Kizilmak river and dam at Kizilmak town. Road bridge (1) and barrage with water diversion (2). Picture in Figure 8 is taken at the barrage (2).

Figure 8. Photo taken at barrage dam close to Kizilirmak Town where a barrage (diversion dam) is established and 10 m^3/sec of water is withdrawn in the most intensive irrigation period. The following persons could be seen from left to right, starting with number two from left: Prof. Dr. Ali Ünal Şorman (METU), Prof. Ånund Killingtveit (NTNU/CEDREN), Fuat Karaaslan (DSI V. Region). The names and affiliations of the persons to the very left and right are unknown.

6. Water and energy management in Turkey

Country data

Figure 9. Map of Turkey (Source: www.cia.gov).

The Republic of Turkey has an area of 780 580 km^2. It is situated in Southwestern Asia but also with a portion in Southeastern Europe. Turkey has borders with the EU (Greece and Bulgaria) in the West, the Caucasus (Georgia, Armenia, Azerbaijan) and Iran in the East, and Iraq and Syria in the South-East, see Figure 9.

Turkey's capital is Ankara, with a population of 4.5 million, but the largest city is Istanbul with a population of 13 million. The total population of Turkey is 72 million. The country is divided into 81 administrative provinces.

Energy profile of Turkey

Energy balance statistics for Turkey can be found up to 2009, with data supplied from IEA. It shows that Turkey's main energy sources are coal, oil, natural gas, hydropower, geothermal, solar, wind and waste. In 2009, primary energy consumption reached 97.6 million tons of oil equivalents (Mtoe). Fossil fuels provided about 90% of the total primary energy consumption, from about equal shares of oil (29.8%), coal (30.4%) and natural gas (29.5%). About 75% of energy consumption is based on imports, especially for oil and natural gas. The coal sector, which includes hard coal as well as lignite, accounts for more than half of the country's total primary energy production, with lignite being the main domestic energy source. The renewables collectively provided nearly 10% of the primary energy, mostly in the form of biofuels and waste (about 5%), hydropower (about 3%) and other renewable sources such as geothermal and solar (about 2.0%). (Source: https://www.iea.org/stats/balancetable.asp?COUNTRY_CODE=TR).

Electricity infrastructure

For electricity production more recent data from 2011 and 2012 can be found from Eurostat. In 2012 total electricity generation was 228 TWh and in 2012 257 TWh. The largest share (73-75%) was thermal generation, but 23-24% (and the main share of the renewables) came from hydropower, see Tables below. Source: Eurostat.

	Share of Electricity generation in Turkey (GWh)				
	Thermal	Hydro	Wind	Geothermal	**Sum**
2011	170 939	52 102	4 750	665	**228456**
2012	188 078	61 643	6 178	911	**256810**

	Share of Electricity generation in Turkey (%)				
	Thermal	Hydro	Wind	Geothermal	**Sum**
2011	74,8	22,8	2,1	0,3	**100**
2012	73,2	24,0	2,4	0,4	**100**

Hydropower potential

The theoretical potential has been estimated to 433 TWh, the technical potential to 216 TWh and the economically usable to 140 TWh (all per year). Presently, about 40% of the economically potential has been developed. According to stated state policy the remaining economical potential will be developed before 2023, with a planned capacity of 45 000 MW and annual generation of 140 TWh. If this is achieved, it will bring Turkey up in the front in Europe, together with Norway.

The largest potential and the largest developed projects are found in the far eastern rivers, in Euphrates and Tigris, which together have 28% of the water resources in Turkey. The large project called Southeastern Anatolian Project (GAP in Turkish) have been developed for hydropower and irrigation purposes, and combines the use of water in both these rivers.

Water and Energy Management

The organization of water management in Turkey is quite complex, with a high number of Ministries and Directorates with responsibility for different parts of the water management. Currently, at least seven different ministries can be listed as “water-related”:

- Ministry of Forestry and Water Affairs
- Ministry of Food, Agriculture and Livestock
- Ministry of Energy and Natural Resources
- Ministry of Environment and Urbanization
- Ministry of Internal Affairs
- Ministry of Health
- Ministry of Culture and Tourism
- Ministry of Foreign Affairs (Trans-boundary water issues)

Each ministry usually has one or more General Directorates (GD) for managing special topics under the responsibility of the ministry, for example GD of Environmental Management, GD of

Environmental Impact Assessment and Planning and GD of Disaster Affairs under Ministry of Environment and Urbanizations.

A "Water Management Coordination Committee" was established in 2012, under the leadership of Ministry for Forestry and Water Affairs, and with representatives from all other water-related ministries and GD's. The mandate of this committee is to determine necessary measures to conserve the water resources, provide inter-sectoral coordination and collaboration, all within the framework of integrated river basin management.

General Directorate of State Hydraulic Works (DSI)

The General Directorate of State Hydraulic Works (DSI) is the primary agency responsible for planning, management, development, and operation of the Turkey's water resources. (Ref http://www2.dsi.gov.tr/english/)

DSI works under the aegis of the Ministry of Forestry and Water Affairs. It takes the responsibility for achieving four major tasks:

- Irrigated agriculture enhancement
- Hydroelectric energy generation
- Domestic water supply for all settlements
- Flood prevention measures.

In order to reach these objectives, DSI primarily develops dam projects which are at the center of the four objectives. Therefore, DSI is mainly known as a public agency developing dam projects.

DSI has a three-tiered organization. Its top management level is the General Directorate office in Ankara. The Secondary management level is also the Department offices of General Directorate in Ankara. The Tertiary management level consists of the Field or Regional Directorate offices. At present, there are 26 Regional Directorates dispersed throughout Turkey.

The 26 Regional Directorates are comprised of Central Regional Offices, Field Division Offices and Field Section Offices. Major functions of these offices are firstly collect data in the field of mapping, hydrometric measurements, agricultural economy, land classification, drainage, groundwater and geology, and secondly to evaluate them for the planning, construction and operation of water structures. The Regional Directorates are based on the river basin boundaries and dispersed throughout Turkey. They execute their work on behalf of the DSI according to annual and 5-year development plans as well as investment programs.

The names and numbers of the 26 Regional Directorates are as follows: I-Bursa, II-Izmir, III-Eskisehir, IV-Konya, V-Ankara, VI-Adana, VII-Samsun, VIII-Erzurum, IX-Elazığ, X-Diyarbakır, XI-Edirne, XII-Kayseri, XIII-Antalya, XIV-Istanbul, XV-Sanlıurfa, XVI- Ilısu Project, XVII-Van, XVIII-Isparta, XIX-Sivas, XX-Kahramanmaras, XXI-Aydın, XXII-Trabzon, XXIII-Kastamonu, XXIV-Kars, XXV-Balıkesir, and XXVI-Artvin (Çoruh Projects).

As of 2008, approximately 25 650 staff are employed in this water agency. The organizational structure of DSI resembles the United State of Bureau Reclamation (USBR). Since 54 years from its establishment, DSI has constructed 592 dams, irrigation networks for 3 million ha area, domestic

water for 70 million people and hydropower plants with 13 500 MW installed capacity accounting for 43.5 TWh of annual generation.

The operation of hydropower plants has now been transferred to Turkish Electricity Generation Agency (EUAS), operation of irrigation networks to Water User Organizations (WUOs) and Water Treatments Plants and their main conveyance lines to Municipalities.

General Directorate for Electric Power Resources Survey and Development Administration (EIE).

EIE works under the aegis of the Ministry of Energy and Natural Resources. It takes the responsibility for several tasks (http://www.managenergy.net/actors/904)

- to research the water sources and other energy sources to determine if they are suitable for producing electrical energy
- to make hydrological studies and Geotechnical research
- to execute engineering services and design studies for dams and HEPPs
- to make research and studies for new and renewable energy resources (windpower, solar energy, etc.)
- to make surveys and application studies for the rational use of energy resources
- to make studies of education, to research and to make people conscious of energy conservation at the sector of industry, residence, transportation
- to execute nationalizing process, control of plant of HEPP realized based on Built-Operate-Transfer (BOT) project and
- to make investigation and research at the special fields for association and establishment against payment

The Turkish Electricity Sector

The Turkish Electricity Authority (TEK3) was founded in 1970. In 1993 it was divided into two independent companies owned by the Turkish state:

TEAS - (Turkish Electricity Company), responsible for generation and transmission and

TEDAS - responsible for distribution and retail

In 2001 TEAS was again divided into three separate companies, as a consequence of the implementation of Electricity Market Law:

- Electricity Generation (EUAS)
- Transmission of electricity (TEIAS)
- Wholesale of electricity (TETAS)

The Electricity Market Law in 2001 also led to the establishment of an Energy Market Regulatory Authority (EMRA). The main task of EMRA is to monitor the whole energy sector, including the electric power, natural gas and petroleum markets. The Ministry of Energy and Natural Resources is responsible for overall policy in the sector. For more info about these companies we provide URL's tested in early July 2013:

State Owned Electricity Generation Company (EUAS) (www.euas.gov.tr)

Electricity Transmission Company (TEIAS) (www.teias.gov.tr)

Turkish Electricity Distribution Company (TEDAS) (www.tedas.gov.tr)

State Owned Electricity Wholesale Company (TETAS) (www.tetas.gov.tr)

Energy Market Regulatory Authority (EMRA) (www.epdk.gov.tr)

7. List of contacts

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Hacı Haksal	Regional DSI	Director of V. Region of DSI	
Şener Elgül	Regional DSI	Planning Branch Director	
İnci İnal	Regional DSI	Hydrology Chief Engineer in Planning Department)	
Şerafettin CANAZ	Regional DSI	Chief Engineer in Dams & HEPP Department	
Nihat Oğuz	Regional DSI	Planning Department	
Fuat Karaaslan	Regional DSI		
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	Technology (NTNU) and CEDREN		
Tor Haakon Bakken	Norwegian University of Science and Technology (NTNU) and CEDREN	PhD-student and researcher	Tor.haakon.bakken@sintef.no

Contact info for some important institutions

Institution	Address	URL	Comments
Turkish Electricity Trading and Contracting Company (TETAS)	İnönü Bulvarı No:27 KLMN Blok 06100 Bahçelievler/ANKARA	www.tetas.gov.tr	
Turkish Electricity Transmission Company (TEIAS)	İnönü Bulvarı No:27 Bahçelievler/ANKARA 06490	www.teias.gov.tr	
Turkish Electricity Distribution Company (TEDAS)	İnönü Bulvarı NO:27 Bahçelievler / ANKARA	www.tedas.gov.tr	
Ministry of Energy and Natural Resources (MENR)	İnönü Bulvarı No:27 06100 BAHÇELİEVLER/ ANKARA	www.enerji.gov.tr	
Turkish General Directorate of State Hydraulic Works (DSI)	Devlet Mahallesi Inonu Bulvari No: 16 Çankaya / Ankara	www.dsi.gov.tr	
Energy Market Regulatory Authority (EMRA)	Muhsin Yazıcıoğlu Caddesi No:51/C 06530 Yüzüncüyıl-ANKARA	www.epdk.gov.tr	
Electricity Generation Company (EUAS)	İnönü Bulvarı, No:27, B-9, Bahçelievler, 06490 Ankara	www.euas.gov.tr	

8. Abstracts from the seminar on sustainable hydropower

The following abstracts were prepared from the Norwegian side:

1. The Norwegian hydropower system – A brief introduction
2. HydroBalance – A research project on the use of the Norwegian hydro reservoirs for large scale balancing of future wind power development in NE Europe
3. Water consumption from hydropower plants – State-of-the-art and scope of work for further research
4. Environmental impacts assessment in regulated rivers - Experiences from Norwegian and international studies

Seminar on sustainable hydropower development – Ankara, Turkey, 18th – 19th of June, 2013

The Norwegian hydropower system – A brief introduction

Aanund Killingtveit[1]

Hydropower development in Norway has a long tradition, from the first plant built in 1885 up to the present system with an installed capacity of over 30 000 MW and an annual generation capacity of 130 TWh/yr. Norway in nr 6 in the world regarding hydropower generation, and largest in Europa, about the same as the two next, Sweden and France, combined. The technical potential is ca 214 TWh, about the same as Turkey. The lecture will cover some of the main technological steps in the development, with special focus on underground power plants, where Norway has pioneered the development and still have active research and development, for example by setting a new world record for unlined pressurized tunnels at the Tyin complex, with more than 1000 m head in an unlined shaft. The operation of hydropower plants using hydrological modeling and optimization tools will also be briefly described, and also the integration in the European power system.

Keywords: Hydropower, hydrology, optimization

[1] Norwegian University of Science and Technology

Seminar on sustainable hydropower development – Ankara, Turkey, 18th – 19th of June, 2013

HydroBalance – A research project on the use of the Norwegian hydro reservoirs for large scale balancing of future wind power development in NE Europe

Aanund Killingtveit[2]

According to preliminary studies, future installed wind power development may reach a capacity of 100 000 MW or more in and around the North Sea within the next 20 years. Analysis based on measured and modeled wind data indicates that the output from the combined wind power system will be highly variable, and may be as low as 10 % of the capacity or less over periods lasting several days and up to a week or two.

The research centre CEDREN (Centre for Environmental Design of Renewable Energy) in Norway was established to conduct long-term research for tomorrow's energy system, focusing on technical, environmental and social sciences for hydropower and environmental impacts of wind power and transmission lines. A new project within CEDREN (HydroBalance) is focusing on opportunities and challenges for using existing Norwegian hydro reservoirs to balance intermittent energy sources in the Nordic and European grid, with special focus on wind power.

Results from the first phase of HydroBalance shows draft technical solutions for developing 20 000 MW of new pumped storage hydropower capacity only using only existing reservoirs. Environmental impacts considering water level variations, erosion, ice conditions, water temperature and current velocities will also be studied, as well as potential impacts on fish, ecosystems and biodiversity. Preliminary results regarding market design, business development, grid integration, policy and regulatory frameworks and local and social acceptance will also be presented.

The presentation will contain an overview of the total potential for development in Norway, and a few detailed case studies with a detailed analysis of technical solutions, economic parameters and environmental consequences.

Keywords: Hydropower, reservoir balancing, wind-hydro integration

[2] Norwegian University of Science and Technology

Seminar on sustainable hydropower development – Ankara, Turkey, 18th – 19th of June, 2013

Water consumption from hydropower plants – State-of-the-art and scope of work for further research

Tor Haakon Bakken[3] and Ånund Killingtveit[4]

Climate change asks for the development of new renewable energy. The IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation (2012) is a benchmark in the assessment of to which extent and to which costs, in a wide sense, renewable energy sources can replace fossil based fuels. The IPCC-report also assessed the water needed to produce a certain volume of electricity from various renewable technologies, and the study uncovered a great need to perform more research within this topic. The talk at the seminar on sustainable hydropower development, hosted by METU (Turkey), will present the first findings from a newly launched research project on water consumption from hydropower plants and reservoirs. A review to be published this Summer documents that more studies on the topic are now available than when the IPCC-report was finalized, that the published estimates show a large variation with maximum values far beyond the published values by IPCC, and that the methodological basis for assessing the water consumption from hydropower projects is weak. The talk will further on present ideas for new research activities with a close cooperation with Turkish partners.

Keywords: Hydropower, water consumption, methodological basis, review

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[4] Norwegian University of Science and Technology & CEDREN (anund.killingtveit@ntnu.no)

Seminar on sustainable hydropower development – Ankara, Turkey, 18th – 19th of June, 2013

Environmental impacts assessment in regulated rivers - Experiences from Norwegian and international studies

Tor Haakon Bakken[5]

Norway is blessed with high precipitation rates and a topography which is ideal for hydropower development and it is now more than 100 years since the first hydropower plant was set in operation. Until the early 1990's the main purpose has been to secure reliable supply of electricity to households and power-intensive industry. From the 1970's an increased concern about the environmental impacts due to river regulations raised in the general public, and more comprehensive environmental studies were carried out and the stricter environmental requirements/legislation were put in place. As we have a long history in of carrying out environmental studies in regulated rivers, and a traditional of performing assessment across traditionally separated disciplines, i.e. by performing studies were hydrologists, hydraulic experts, biologists and even social scientists are working in a team, Norway is today among the leading countries on carrying out integrated environmental studies. The talk at the seminar on sustainable hydropower development, hosted by METU (Turkey), will focus on three specifics topics – assessment environmental flows in bypass sections, environmental impacts from hydro-peaking (intermittent flow regulation) downstream outlet of hydropower plants and emissions of green-house gases from hydropower reservoirs.

Keywords: Hydropower, environmental impacts, hydro-peaking, green-house gas emissions (GHG)

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