



THE INTERNATIONAL ENERGY AGENCY TECHNOLOGY  
COLLABORATION PROGRAMME ON HYDROPOWER

# IEA Hydropower

**ANNEX IX Workshop**  
**3 June 2020, online GoToMeeting platform, 2pm – 4.30pm CET**

## **Flexibility in Evolving Electricity Markets**

### **Final Agenda**

<b>Time (CET)</b>	<b>Wednesday 3<sup>rd</sup> June 2020</b>	<b>Presented by</b>
14:00	Opening and welcome	Atle Harby, SINTEF
14:10	Brief overview of the idea of White Paper II "Valuing Hydropower Flexibility in Evolving Electricity Markets"	Audun Botterud, Argonne
14:20	Grid and Flexibility Services: An Overview of the Swiss scenario	Elena Vagnoni, EPFL
14:30	Flexibility Services: An overview of the Australian NEM	Donald Vaughan, ENTURA
14:40	Flexibility Services in the Power Grid: Indian case	SS Barpanda, POSOCO
14:50	Potential for flexibility revenues on different time horizons in the spot market	Fredrik Arnesen, NVE
15:00	Q&A and discussions	
15:15	Break	
15:25	Flexibility Services in the Power Grid: Brazil case	Albert de Melo, CEPEL
15:35	Flexibility Services in the Power Grid: Quebec case	Guillaume Tarel, Hydro Quebec
15:45	Flexibility Services in the Power Grid: California case	Abishek Somani, PNNL
15:55	Q&A and discussions	
16:15	Content and contributions to White Paper II	Audun Botterud, Argonne
16:25	Any other business	
16:30	End of meeting	



# IEA Hydropower

Registered participants	
Audun Botterud	Abhishek Somani
Atle Harby	Pravin Karki
Niels Nielsen	Bente Taraldsten Brunes
Linn Emelie Schäffer	Schleiss Anton
Aniruddha Kumar	Jean-Jacques FRY
Alain Tremblay	Michael Belsnes
David Samuel	Gregory Brinkman
Rita Berthelsen Johnsen	Goncalo Correia
Jan Steinkohl	Magnus Korpås
Maria Elvira Pineiro Maceira	Matteo De-Felice
Fredrik Arnesen	S.S. Barpanda
Matt Felix	Cesar Zani
Morten Ramberg	Yasmina Abdelilah
Virgílio Mendes	Óli Grétar Blöndal Sveinsson
Guillaume Jean Tarel	Alberto Lamadrid
Dominique Bain	Martin Burdett
Samuel Law	Arun Kumar
Greg Stark	Audun Fidje
Aydın Çitlak	K.V.S. Baba
Ota Koichi	Richard Taylor
Peter Bauhofer	S.C. Saxena
Toril Christensen	
Vladimir Koritarov	
Nathalie Voisin	
Ånund Killingtveit	
Carolyn Maxwell	
Albert de Melo	
Alex Beckitt	
Jorge Machado Damazio	
Donald Vaughan	
Luke Middleton	
Emanuele Quaranta	
Elena Vagnoni	
Klaus Jorde	
Chris O'Reilley	
	Tentative participants
	Heymi Bahar
	Emil Schwabe-Hansen
	Siri Stokseth
	Cécile Münch-Alligné
	Orkan Akpınar

*(the list above is not complete according to who actually participated, but includes those who used Outlook to respond to meeting invitation)*



## Questions, comments and answers

(copy of chat-log, slightly edited)

**Magnus Korpås:** 14:49: How much of the 80 GW ACG (by FY21) will be hydro?

**Arun Kumar:** 14:50: 80 GW is only solar and wind. Hydro though is renewable by pososco and cea it is still considered separately

**Botterud, Audun:** 15:28: Donald Vaughan: I think you used the term deep storage. Could you elaborate on the meaning?

**Alex Beckitt:** 15:35: To Audun, re your question to Donald, FYI we have released a whole paper on 'deep storage' simplistic it means longer duration than seconds, minutes, few hours... the paper can be found at: <https://arena.gov.au/assets/2020/04/the-case-for-deep-storage-why-the-nem-needs-battery-of-the-nation.pdf>

**Emanuele Quaranta:** 15:00: Fredrik, 40 euro/MWh is for any installed power capacity?

**Fredrik Arnesen:** 15:10: Emanuele Quaranta: 40 Euro/MWh was the average price for all the power production in 2018. Hydro power production achieved 40,4 Euro/MWh

**Botterud, Audun:** 15:18: Fredrik Arnesen: Interesting price analysis from Norway. Can one conclude from your analysis that the current market does a good job in compensating hydro power for providing storage and flexibility to the system?

**Magnus Korpås:** 15:22: Audun, Fredrik: Also, interconnectors make it possible to utilize more of the flexibility potential of hydro. BTW: The spot price is 3 EUR/MWh today due to very large amounts of stored water combined with relatively low demand

**Fredrik Arnesen:** 15:49: Audun Botterud: Thank you. On these time scales, I believe so. Just in very special cases shortages could occur. In such cases, the government can impose rationing.

**Pravin Karki:** 15:04: Question to everyone. How should future dams/intakes, head race tunnels, powerhouse, tailrace be designed to be more flexible. How should the turbines and governors be designed differently?

**Roy Liu:** 15:16: To Pravin: To have better flexibility, future dam should be designed with larger live storage capacity, head race tunnels should be fast response. Turbine should be designed to be able to operate stably in any load condition.

**Furkan YARDIMCI:** 15:16: to Pravin Karki: I think, the turbine runners should design to cope with working under part loads without cavitation damage... I mean the turbine operation range can be larger.

**Arun Kumar:** 15:19: To Roy Liu- More storage means more submergence and more resistance

**Roy Liu:** 15:21: To Arun, Yes. I mean under the same inundation, we can design the dam to have more live capacity, which means less dead capacity.

**Arun Kumar:** 15:22: to Furkan YARDIMCI- A good suggestion - requires further high degree of nematical and model studies

**Arun Kumar:** 15:23: To Roy Liu- yes dead storage may be removed by having frequent sediment flushing and better sediment management

**Furkan YARDIMCI:** 15:27: to Arun Kumar: Yes, and we need to improve our CFD knowledge....



# IEA Hydropower

**Niels Nielsen:** 16:01: For Pravin Karki, reference your original question. The structures and equipment need to be robust enough to manage the increases in flow and pressure variability. This needs an understanding of the value of flexibility and the increased costs of the structures and equipment. In addition to design, economics and risk need to be taken into account. Niels Nielsen

**Magnus Korpås:** 15:38: Albert Melo: Is the Brazilian power price determined by the optimization model or set by other means?

**Albert de Melo (to Magnus):** In spot market, the price is determined by optimization models, developed by CEPEL. The RM the generators must participate of public auctions to be able to sign power purchase agreements (PPAs) with the regulated (captive) consumers supplied by the distribution companies (discos). Each winner in auctions is that one which offers the lowest price per kWh also limited to ceiling prices; in exchange, all discos have an obligation to enter into PPAs (15 to 35-year duration) with each auction winner in proportion to their declared load forecasts. (RM = Regulated market, i.e., those consumers supplied by distribution companies.)

**Michael Martin Belsnes:** 16:05: Large change from 2017-2018 is seen in California. Is the growth in contribution from batteries expected to continue?

**Vladimir Koritarov:** 16:06: Michael Belsnes: Yes, battery growth in CA is expected to continue.

**Arun Kumar:** 16:08: Battery growth is manufacturers big push compared to hydro storage which low due to longer gestation time

**Michael Martin Belsnes:** 16:09: Is the batteries in California mainly grid sized installations or home size installations?

**Michael Martin Belsnes:** 16:12: Thanks for your comment Arun, then hydro should do something about gestation time:-)

**Vladimir Koritarov:** 15:59: Everyone: In your power system, what percentage (approximately) of secondary frequency control and operating reserves (e.g., spinning, non-spinning) are provided by hydropower vs. other generating technologies? Also, it would be helpful to indicate the share of hydropower in total generation mix.

**Furkan YARDIMCI:** 16:05: to Vladimir Koritarov: first 5 months of 2020, hydropower generation share is 35 % in Turkey

**Guillaume, Hydro Québec:** 16:13: Its almost 100% for us; we have a 400 MW oil-fired peaker which is used from time to time

**Magnus Korpås:** 16:15: Norwegian hydro power also provides balancing power to neighbouring countries through power lines (Nordic area) and HVDC cables (to continental Europe)

**Donald Vaughan:** 16:16: Vladimir: Hydropower is around 12 % of installed capacity in Australia. The level of regulation would be higher since wind and solar do not contribute at this time. We'll try and firm up though.

**Guillaume, Hydro Québec:** 16:18: In Quebec: 4 000 MW wind, 36 000MW hydro. Then hydropower provides most of system services, including wind integration.

**Roy Liu:** 16:25: Vladimir: Hydropower is about 16 % both of installed capacity (313GW) and output in China. Hydro contributes about 30% of the flexibility.



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# IEA Hydropower

**Michael Martin Belsnes:** 16:17: Does anyone consider circularity when comparing hydro with other flexible power sources?

**Signed up in chat to contribute to white paper:**

**Donald Vaughan:** 16:25: Happy to volunteer to contribute

**Elena Vagnoni:** 16:27: Happy to help too

**Óli Grétar Blöndal Sveinsson:** 16:28: Iceland can also contribute. Especially on flow impacts due to climate change.