



Valuing Flexibility in Evolving Electricity Markets: Current Status and Future Outlook for Hydropower

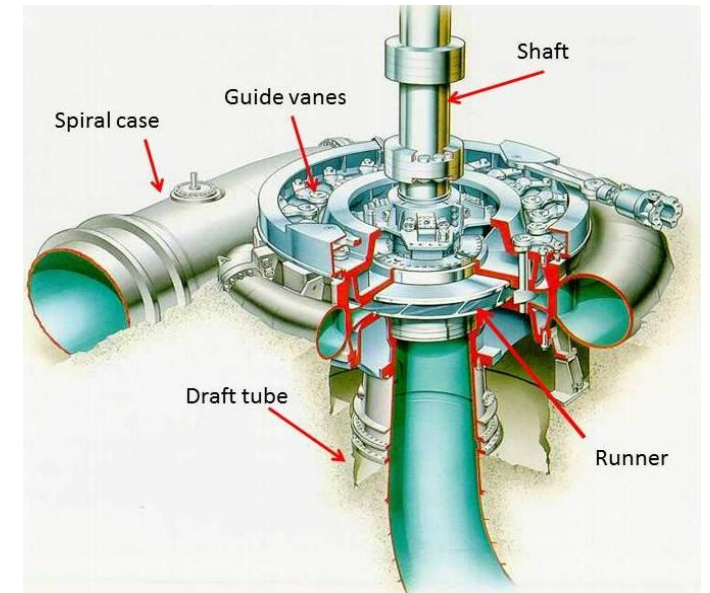


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Background

- Increasing penetration of variable renewable energy (VRE)
- Increasing need for flexibility in the power system
- Electricity markets are evolving to address these challenges
- A number of different flexibility solutions, including hydropower
- **How is flexibility procured in current electricity markets?**
- **What is the status and outlook for hydropower as a flexible resource?**





Power System Flexibility Across Different Timescales

Flexibility type	Short-term			Medium term	Long-term	
	Sub-seconds to seconds	Seconds to minutes	Minutes to hours	Hours to days	Days to months	Months to years
Issue	Ensure system stability	Short term frequency control	More fluctuations in the supply / demand balance	Determining operation schedule in hour- and day-ahead	Longer periods of VRE surplus or deficit	Seasonal and inter-annual availability of VRE
Relevance for system operation and planning	Dynamic stability: inertia response, voltage and frequency	Primary and secondary frequency response	Balancing real time market (power)	Day ahead and intraday balancing of supply and demand (energy)	Scheduling adequacy (energy over longer durations)	Hydro-thermal coordination, adequacy, power system planning (energy over very long durations)

SOURCE: IEA

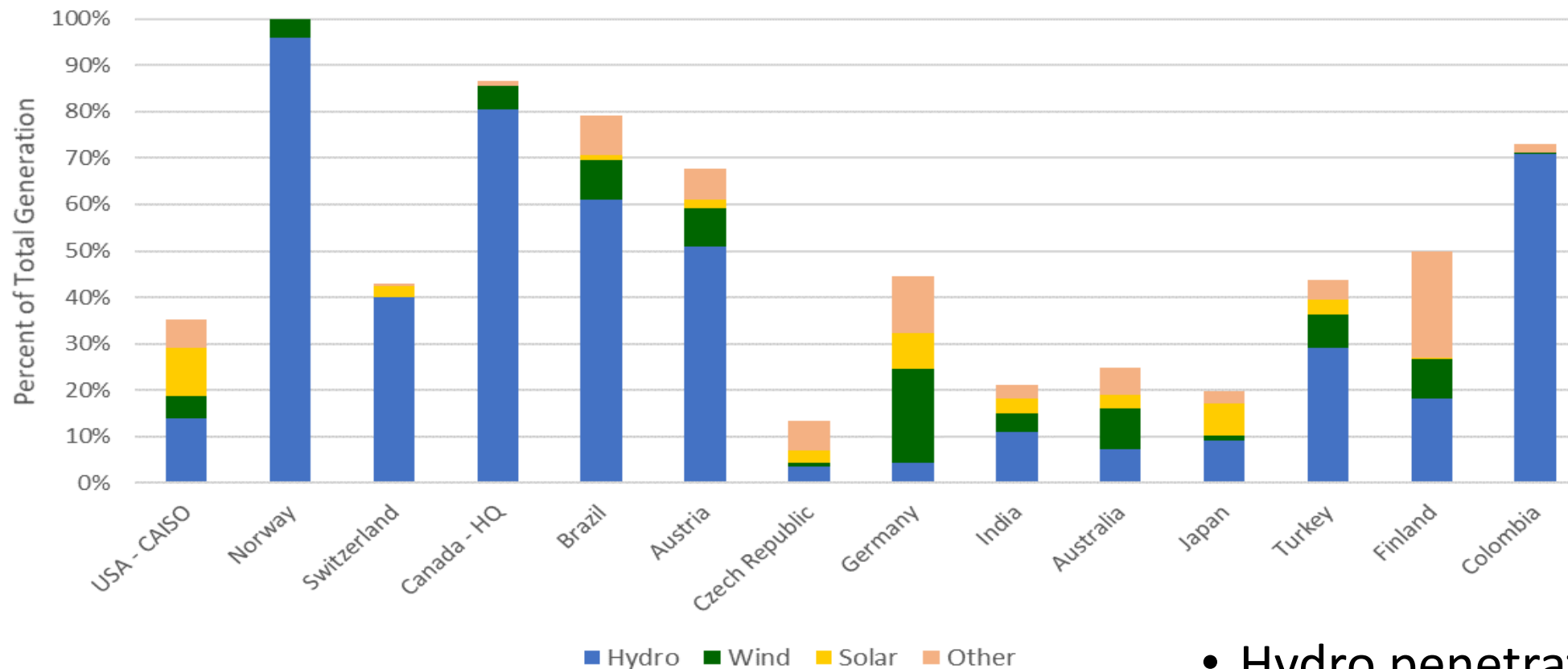


Survey of Electricity Markets and Flexibility

- Responses from 14 countries/regions and 5 continents
- Survey inputs
 - Flexibility products
 - Procurement mechanisms
 - Compensation
 - Hydropower contribution
 - Market size and quantity
 - Future developments

	Short-term			Medium term	Long-term	
	Sub-seconds to seconds	Seconds to minutes	Minutes to hours	Hours to days	Days to months	Months to years
Please provide a brief overview of relevant grid flexibility services and products						
How are these flexibility services currently procured?						
Are these services compensated?						
Does hydropower currently provide these services to the power grid?						
How much is normally procured of this service? Use the last year(s) average or similar						
List important current and future developments related to these flexibility services						

Renewable Penetration in Participating Countries/Regions



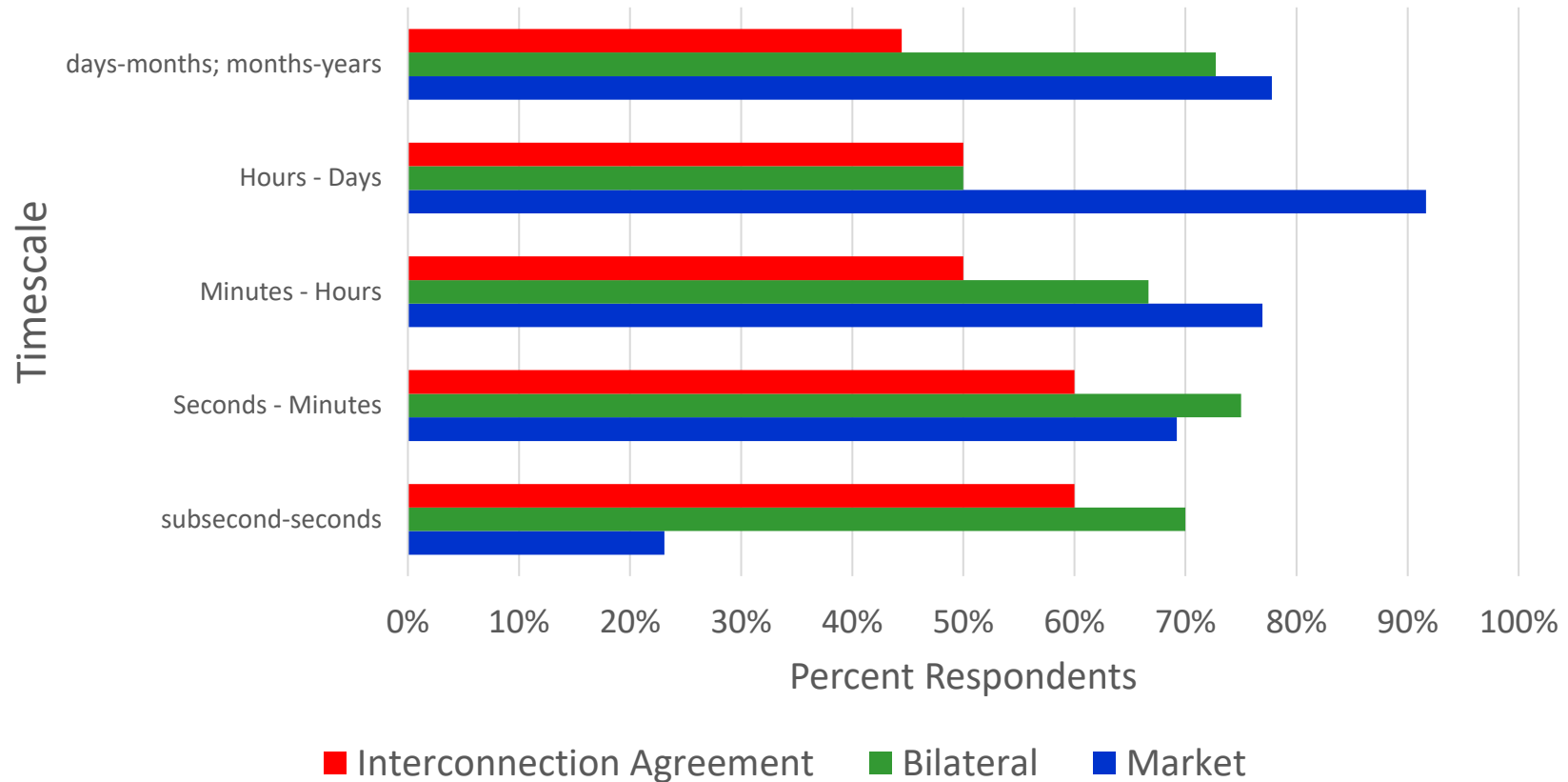
- Hydro penetration (4-96%)
- VRE penetration (0-28%)



Survey Results – Flexibility Products

Timescale	Services	
Subsecond-seconds	1) Inertia 2) Reactive power 3) Voltage control	4) Frequency support 5) Spinning reserve 6) Special protection systems
Seconds - minutes	1) Frequency support	2) Last minute dispatch
Minutes - hours	1) Energy 2) Frequency support	3) Black start 4) Power unit dispatch
Hours - days	1) Energy 2) Ancillary services	3) Long term reserves 4) Demand response
Days-months; Months-years	1) Resource adequacy	

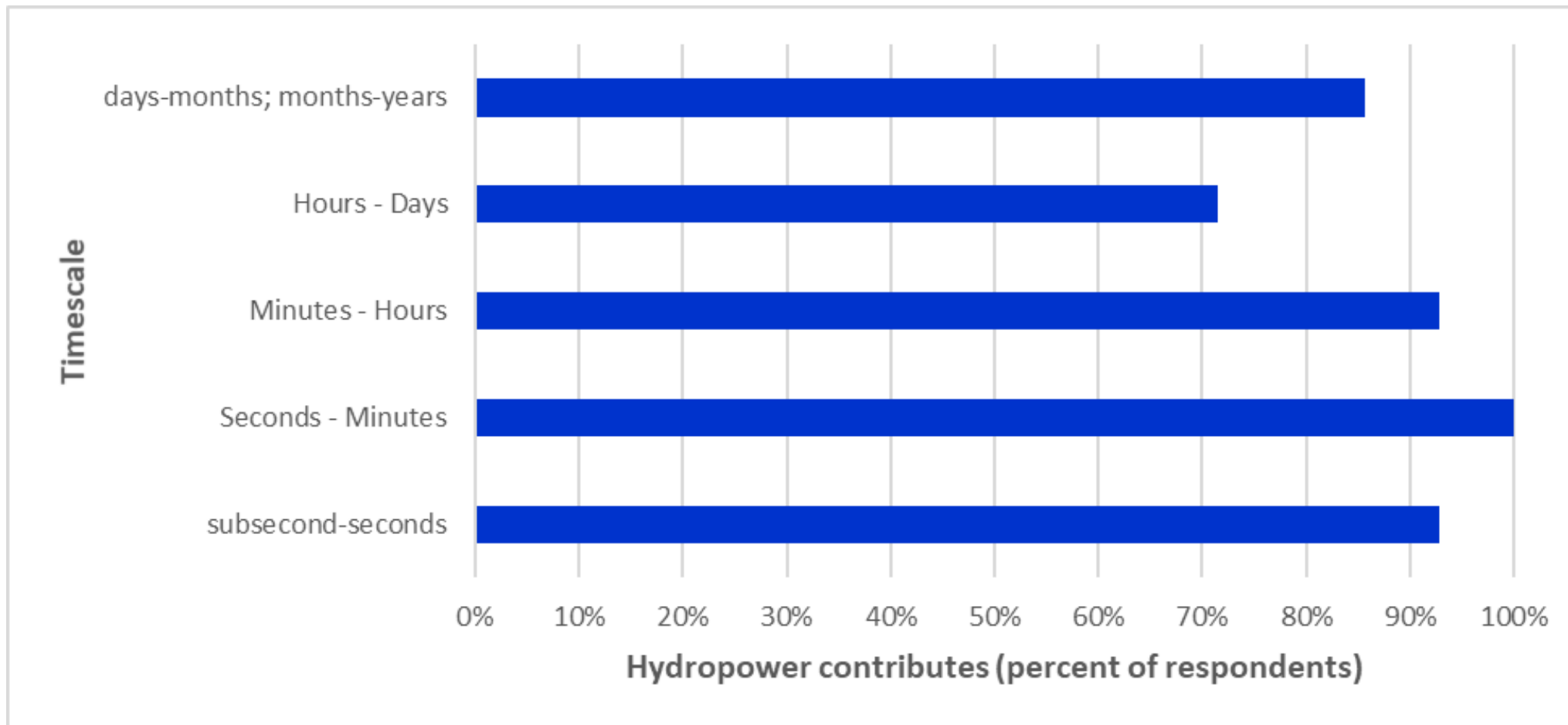
Survey Results – Procurement of Flexibility Services



Most respondents state that some (or all) services are compensated, although less at the shortest timescale



Hydropower Contributions to Flexibility Services



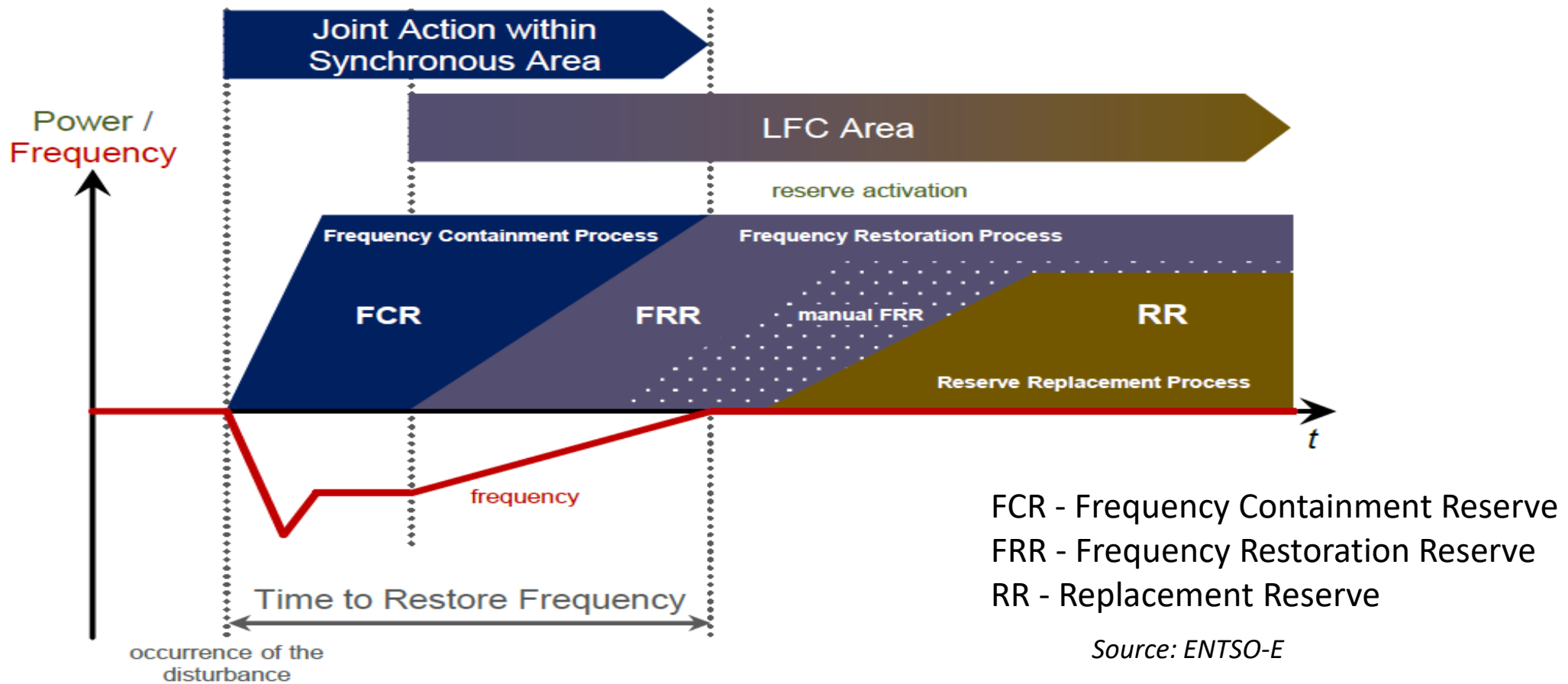
Hydropower contributes to flexibility across the timescales



International Case Studies

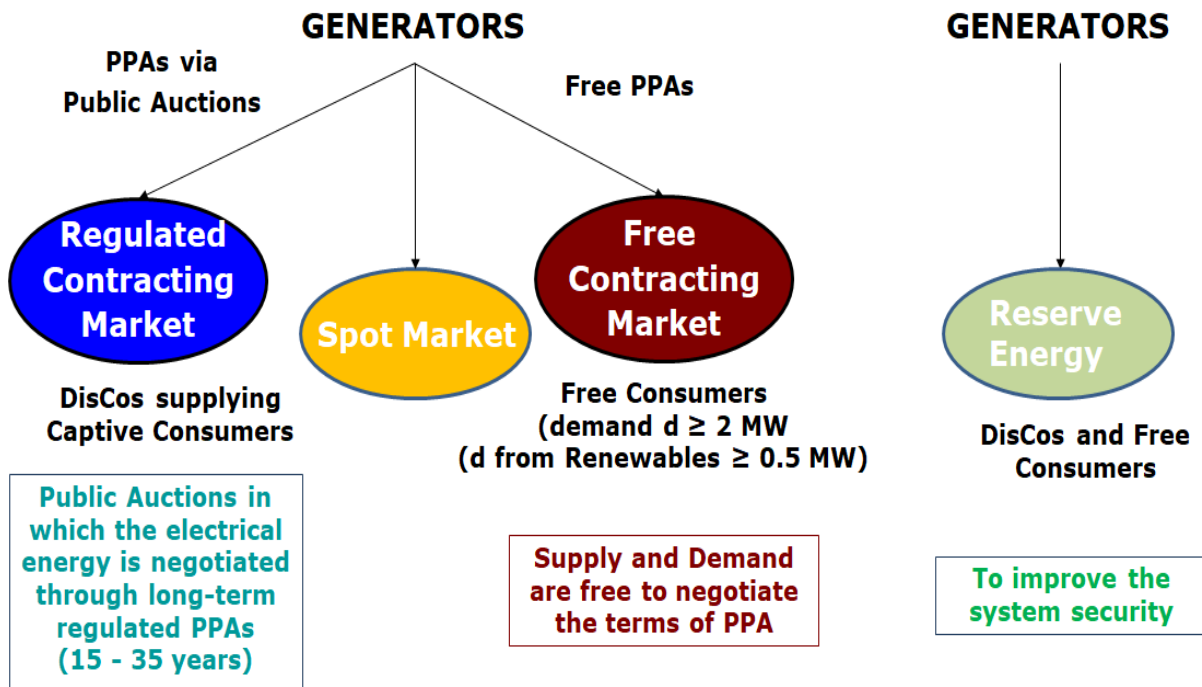
- Switzerland: Coordination of flexibility services with Continental Europe
- Norway: Large-scale hydropower for balancing wind and solar power in Northern Europe
- Canada: Flexibility requirements and services in Hydro Québec
- USA: Flexibility requirements and new market initiatives in California ISO
- Brazil: Maintaining long-term resource adequacy through public auctions
- Australia: The impending need for deep storage but no path to get there (yet)
- Japan: VRE integration and the role of pumped storage hydropower

Joint Definitions of Flexibility Services (Europe)

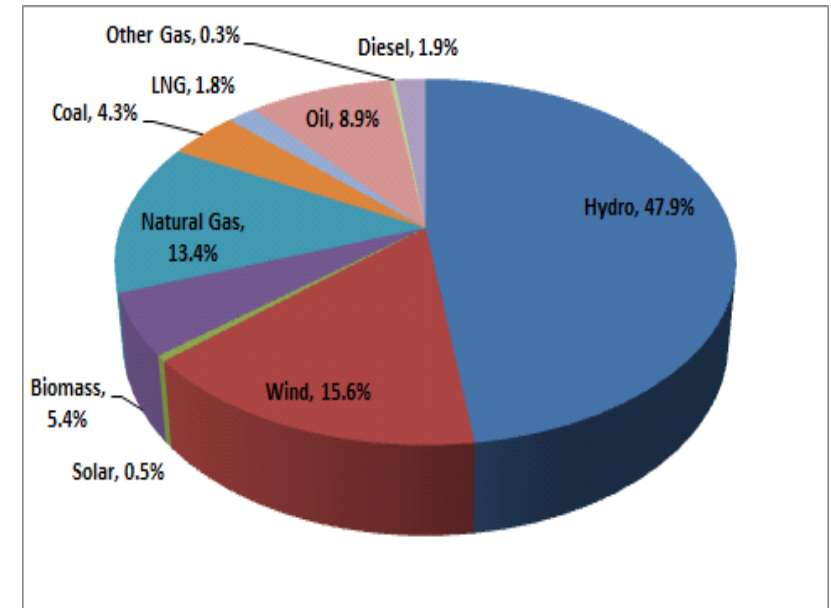


Joint definitions and common trading platforms enable coordination and exchange of flexibility services across regions/countries

Public Auctions for Long-term Procurement (Brazil)



Contract environment for electricity in Brazil.



Results of public auctions in Brazil: 2008-2015. Total investment 65 GW.

Long-term contracts have enabled substantial hydropower investments



Flexibility and Electricity Markets: Key Observations

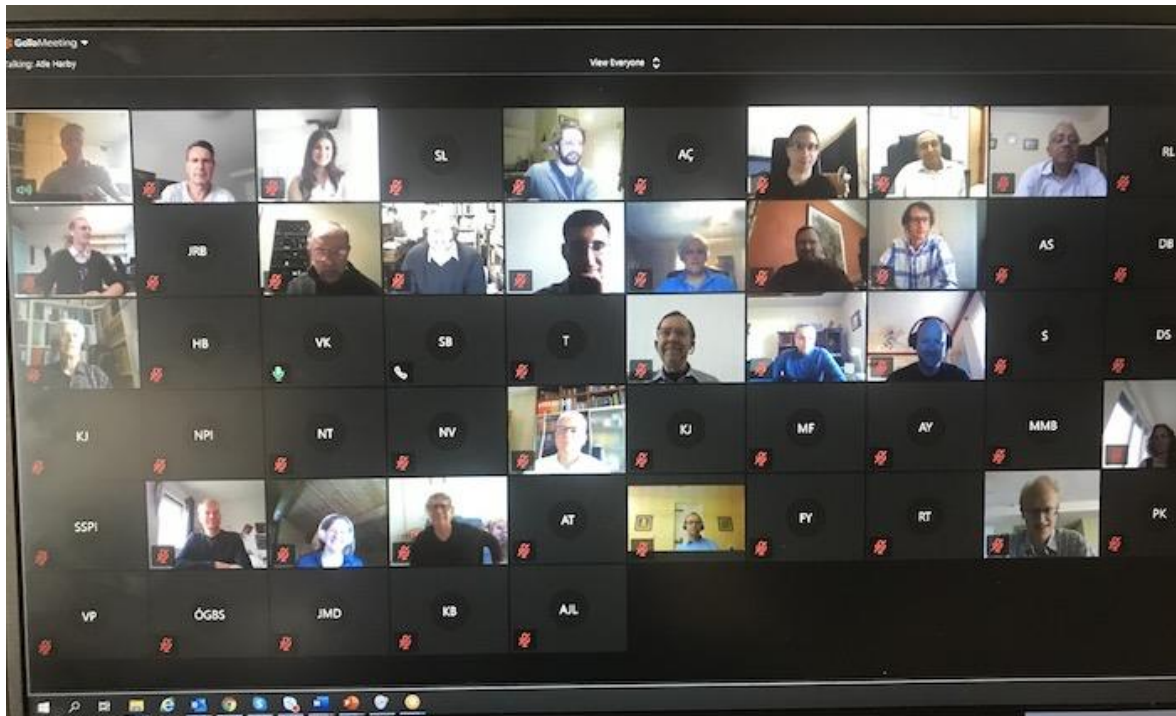
- A number of ongoing revisions in market products due to changing system conditions (e.g. fast frequency response and flexi-ramp products)
- Market-based procurement dominates in mid time-scale (seconds to days)
- Importance of standardized product definitions for flexibility services to enable trading across countries/regions
- Importance of transmission for hydropower to access areas with flexibility needs
- In many cases, a lack of consistent and commensurate long-term signals for investments in flexible hydro and long-duration storage through PSH
- Long-term contracts provide consistency and low risk for investors, but possibly limited visibility to the cost and value of flexibility



Conclusions and Hydropower Outlook

- A wide range of solutions to address flexibility challenges in evolving power systems with higher VRE levels
- Hydropower plays an important role providing flexibility services across all timescales
- Hydropower's value to grid flexibility will increase with more VRE and as non-renewable generation is retired
 - Could also lead to more stress on hydropower plants
- Important to overcome common challenges
 - Shortest time-scale: compensation lacking for some services
 - Longest time-scale: investment incentives for reliability and flexibility
- Importance of international collaboration and cooperation
 - Similar challenges, different solutions
 - Lessons to be learned between countries and regions
- Look for upcoming IEA Hydro Annex IX report: <https://www.ieahydro.org/annex-ix-hydropower-services>

Thank You!



Annex IX: Hydropower Services Online Workshop 3 June 2020

<https://www.ieahydro.org/annex-ix-hydropower-services/workshops/flexibility-in-evolving-hydropower-markets>

IEA Hydro Annex IX



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