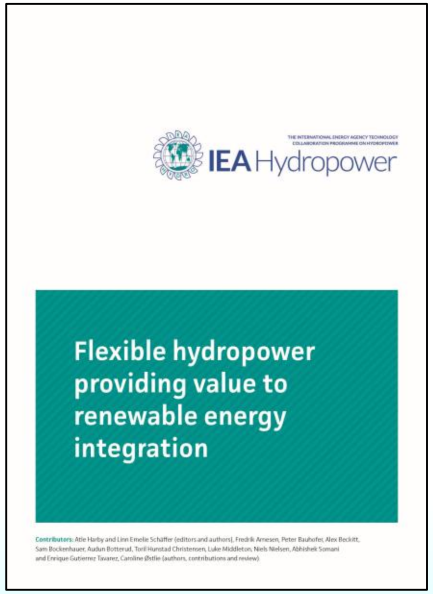
THE INTERNATIONAL ENERGY AGENCY TECHNOLOGY COLLABORATION PROGRAMME ON HYDROPOWER

IEA Hydropower

Presentation of White Paper no 1

Flexible hydropower providing value to renewable energy integration



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Flexible hydropower providing value to renewable energy integration

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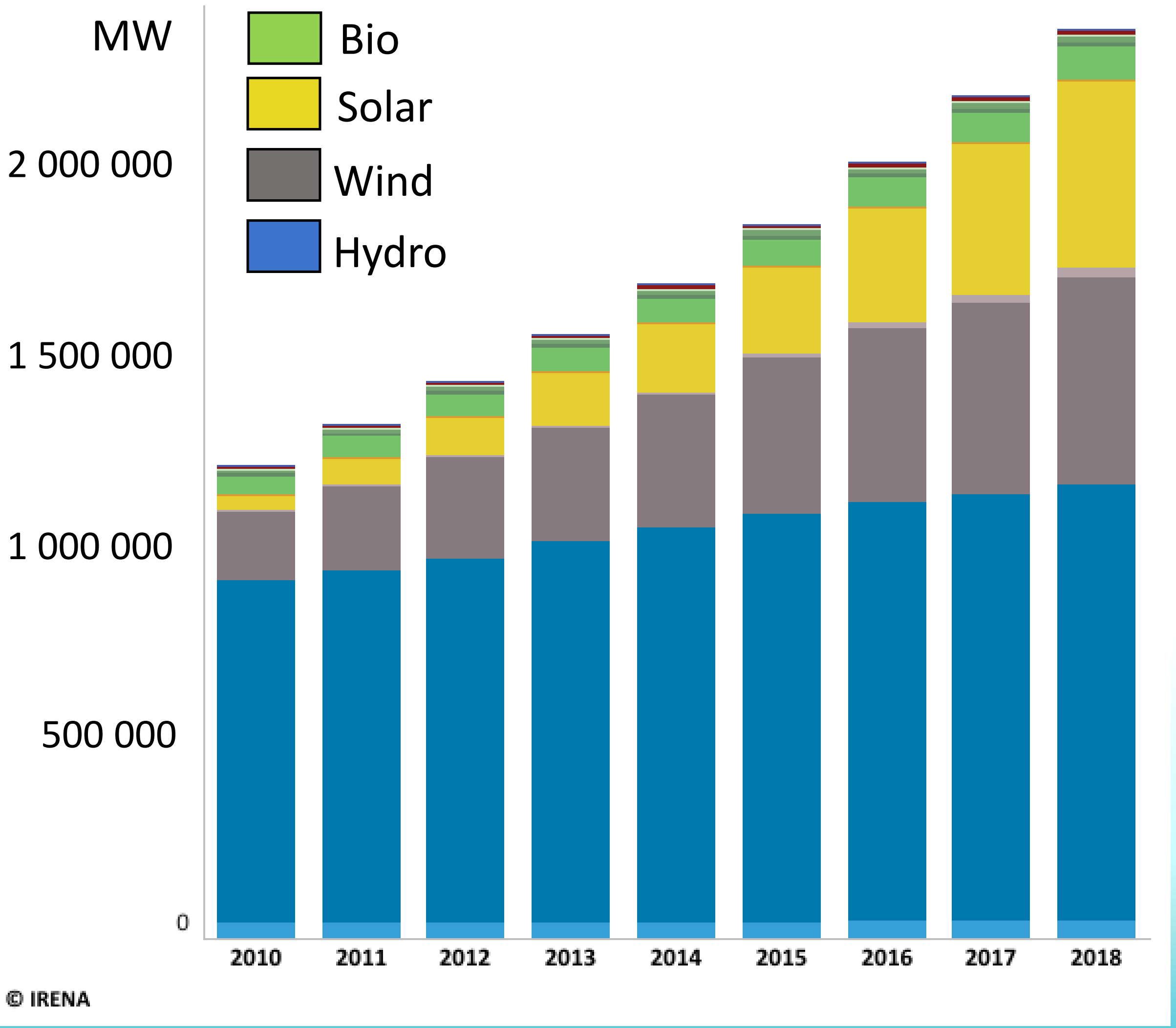
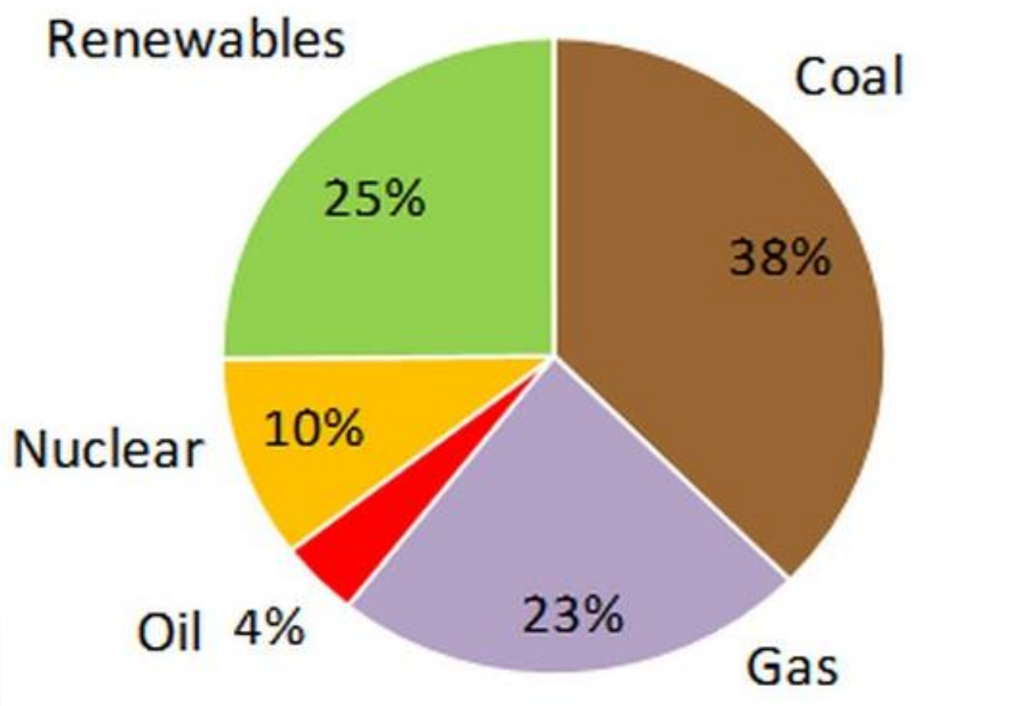
White Paper no 1 - October 2019

Growing variable renewable energy (VRE) generation





IRENA International Renewable Energy Agency

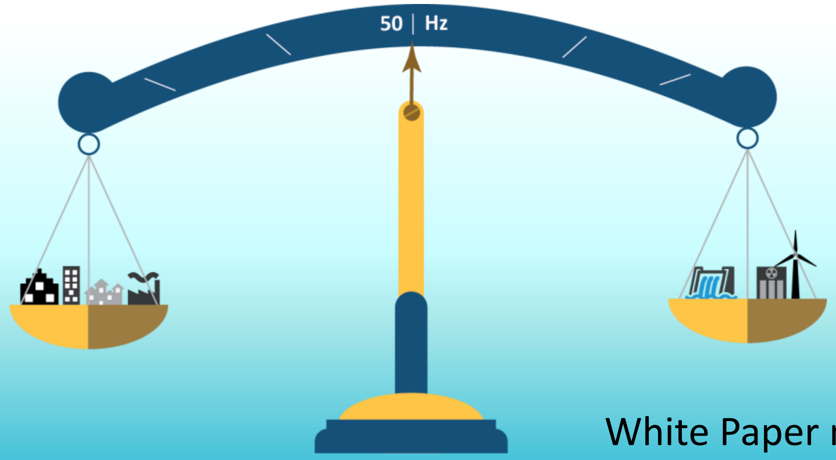
Balancing generation vs consumption

Energy storage

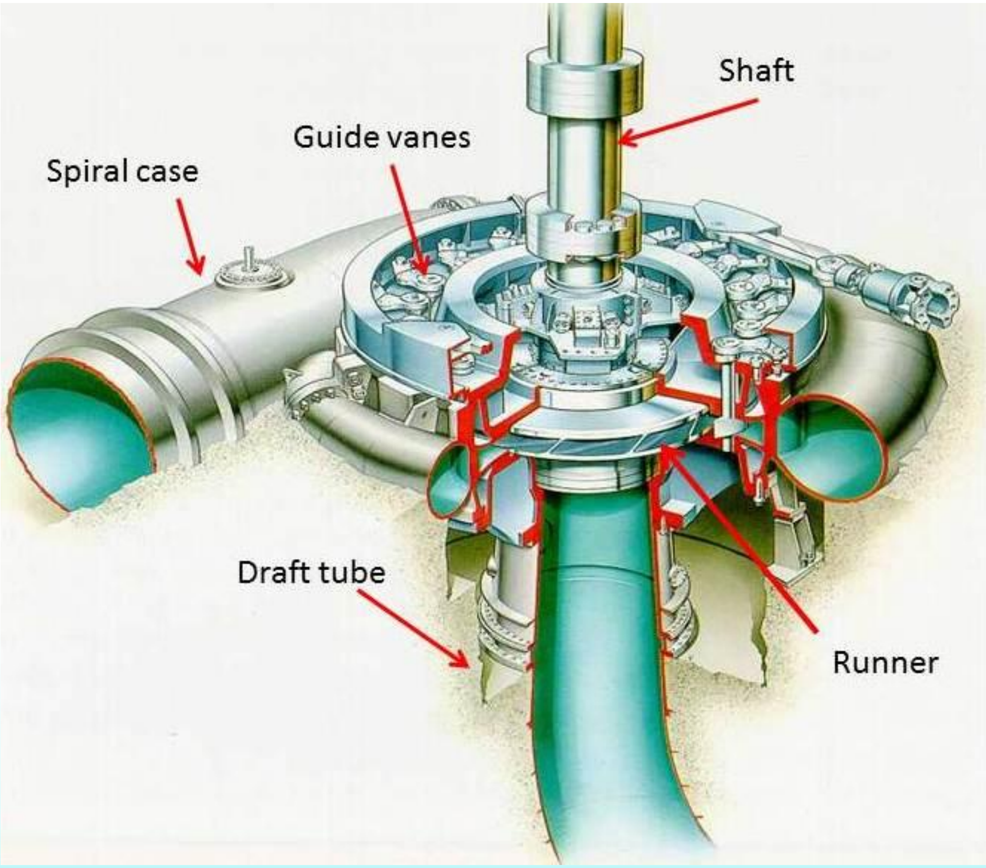
- Electrochemical
- Thermal storage
- Chemical storage
- Hydropower and PHS
- Flywheels
- Liquid and compressed air
- Superconductors
- Future technologies?

Other sources of flexibility

- Demand response
- Generation flexibility
- Flexible transmission
- Curtailment



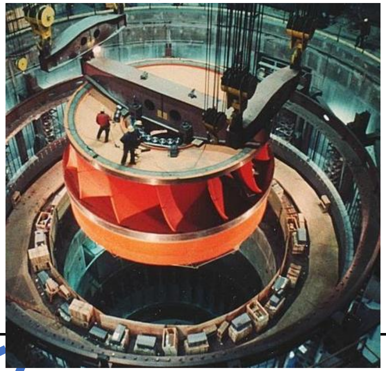
Flexible hydropower



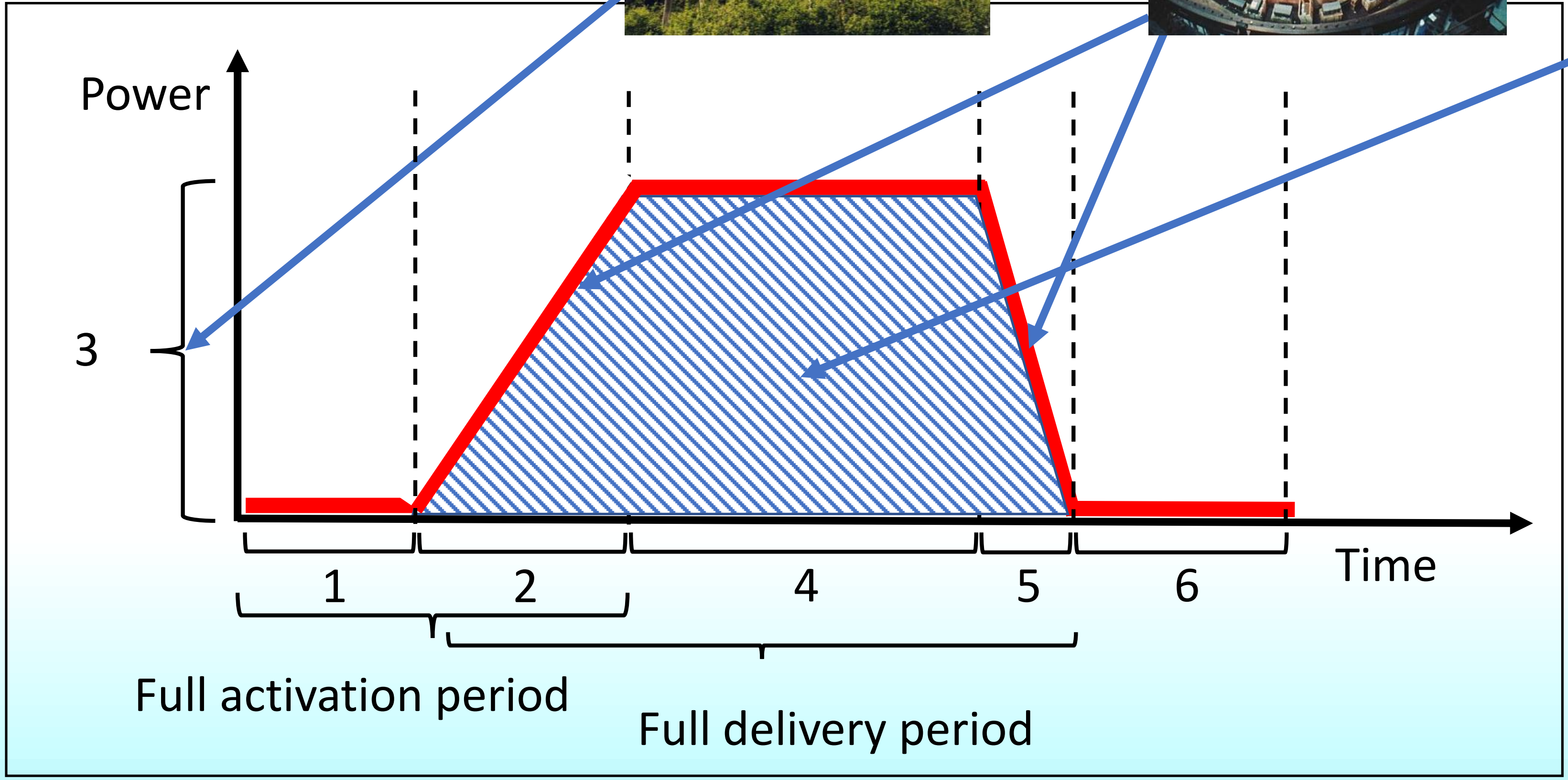
Capability

Power

Ramp rate



Energy



1. Preparation period
2. Ramping period
3. Min and max quantity
4. Min and max delivery period
5. Deactivation period
6. Min duration before next activation

What kinds of flexibility are needed?

- Power system size
- Power plant flexibility
- Demand-side flexibility and storage
- Correlation of VRE and demand
- Geographical distribution
- Interconnection and bottlenecks
- Regional correlation of VRE generation

Timescales of power system flexibility

Flexibility type	Short-term			Medium term	Long-term	
Time scale	**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	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, voltage, frequency	Primary and secondary frequency response	Balancing real time market (power)	Day ahead and intraday balancing (energy)	Scheduling adequacy (longer durations)	Hydro-thermal coordination, adequacy, power system planning (energy over very long durations)

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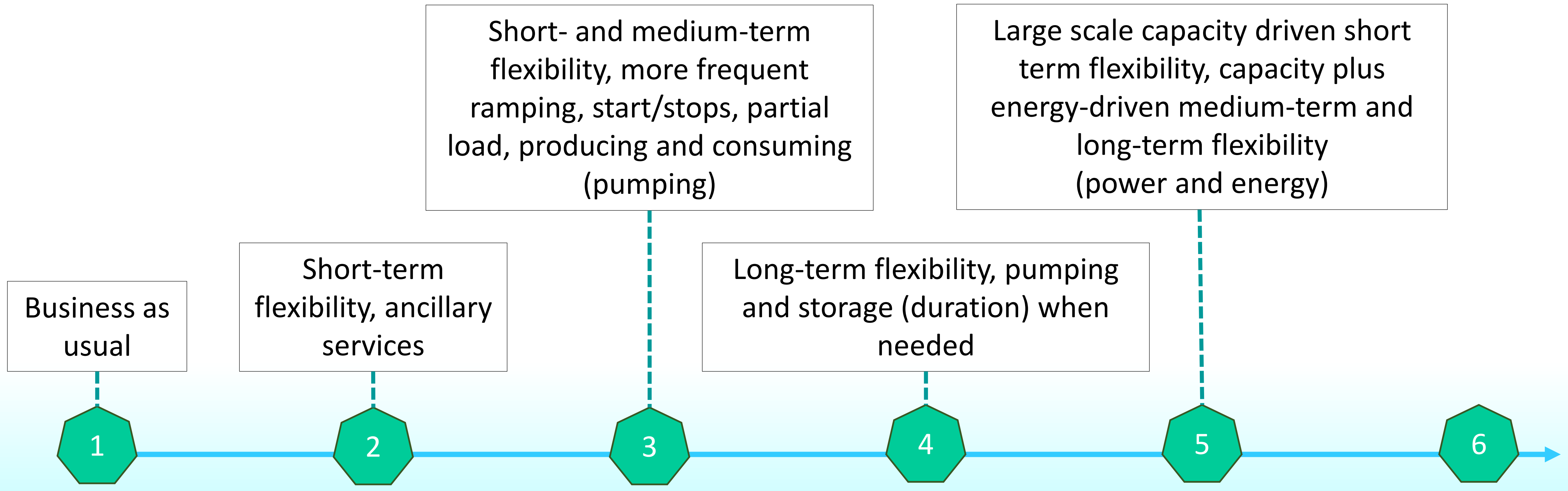
Phases of VRE integration [IEA 2017]

Phase	Description	Examples
1	At initial stage of VRE deployment with no relevant effects in system operation	Still many countries
2	Additional flexibility needs can be met by minor adjustments in existing operations	Brazil, China, India, Sweden, Texas
3	VRE generation determines system operations in order to maintain stability	Italy, Germany, Portugal, Spain, UK, California
4	Additional investments in flexibility resources are needed to balance the system	Ireland, Denmark, South Australia
5	Structural surpluses of VRE generation from weeks to months may lead to curtailment	
6	Structural over- or under-supply over seasons to years validates the need for sector coupling	

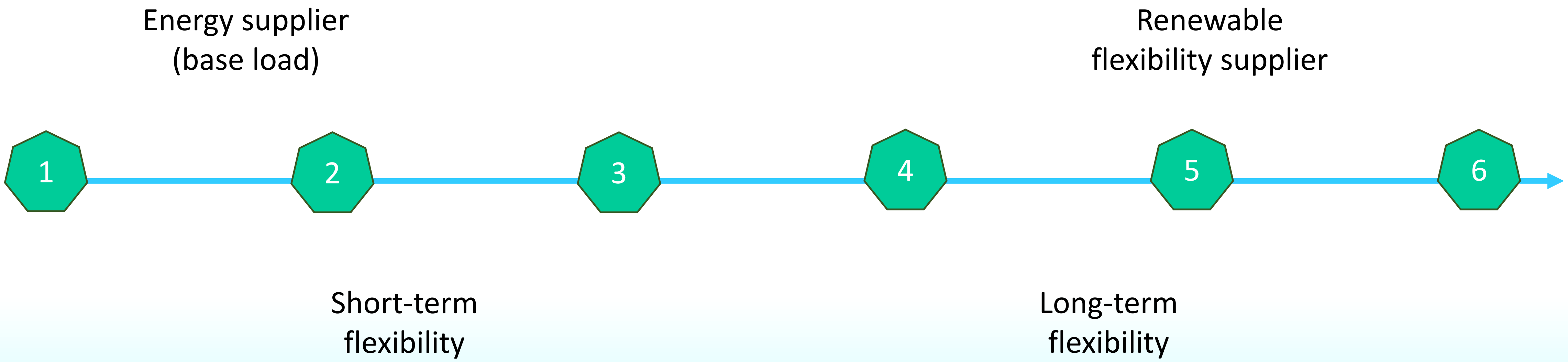
from IEA 2017

How can hydropower contribute?



Phases of VRE

How can hydropower contribute?



Phases of VRE

What is the value of flexibility?

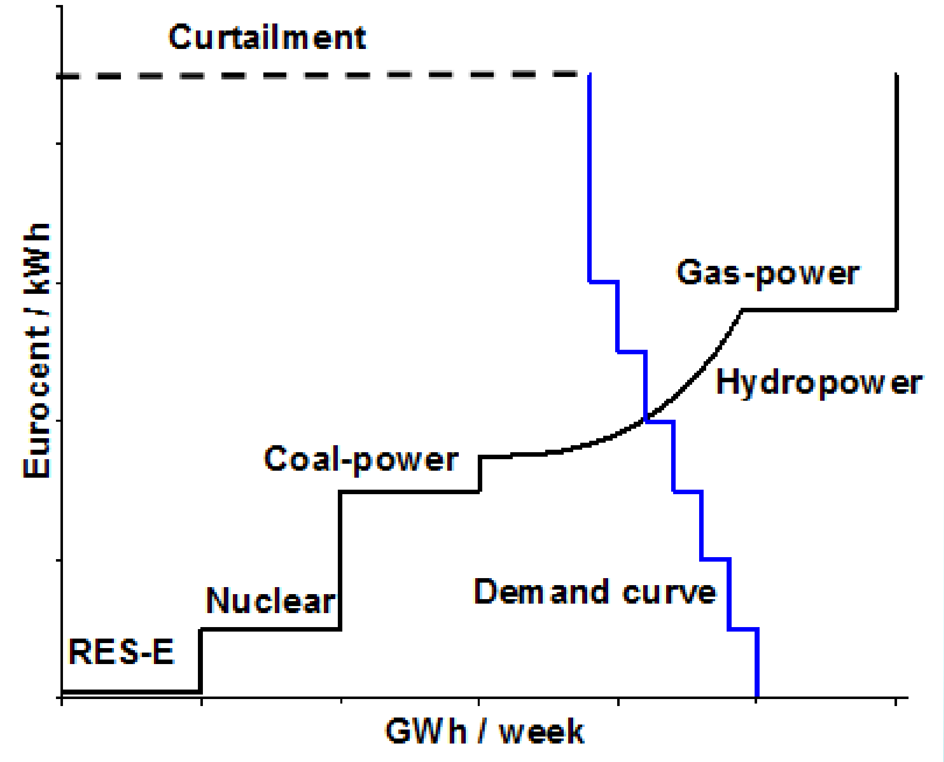
- Providing ancillary services, power and energy
- Highest value when the system is at the extremes
- Avoid deficit and limit surplus
- The value depends on available solutions
- Plant characteristics are important

The value of providing flexibility in market-based systems

- Price impact of changing systems
  - Lower average power price
  - Increase variations in price
  - Higher price peaks?

- Increasing importance?
  - Magnitude and frequency of extremes
  - Trading in several markets
  - New markets? What about long-term flexibility?

Marginal cost of the last unit sets the price



Conclusions

→ Increasing shares of VRE + decommissioning of fossil-based plants = increasing needs for flexibility at all time scales

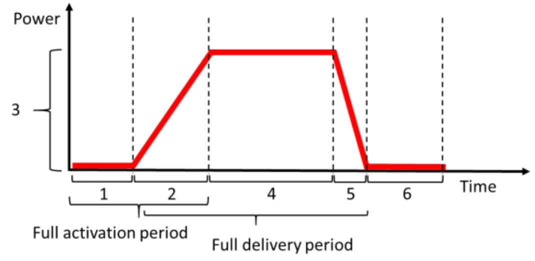
→ Hydropower offers a unique range of possible flexibility capabilities

→ The market value of flexibility-related products should reflect the value these products provide to the electricity system and to the society

Recommendations

Authorities should design markets that trigger investments in system infrastructure so that all the services required to ensure a secure, reliable and affordable supply of energy are delivered

Existing and new hydropower plant owners should analyse the capability and possible investments after deciding which type(s) of flexibility are best suited for their assets



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Joint Annex IX and XII task:

Flood control and drought management provided by hydropower

- The value of the services that hydropower can provide in minimizing and mitigating the risks of floods and management of droughts in a changing climate
- The value of avoiding and reducing floods
  - Reduced damage by protection
  - Providing possibilities of land use
- The value of providing water management services
  - Water for irrigation, domestic and industrial use
  - Water for the environment
- How can different needs for water and energy security be met today and in the future?
- Kick-off workshop organized in Rio in December 2019
- Collection of case studies and examples of flood control and drought management

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Further work

- Assessment of technological, market, policy and regulatory requirements to ensure appropriate investments

- Optimizing market mechanisms to ensure sufficient flexibility at the right scale and the right time
- Understanding the frequency and magnitude of extremes and the impact on power prices

- The investment dilemma – effective price signals to ensure sufficient system capacity – avoiding price shocks for consumers in the long run
- Workshop to discuss 2nd white paper in Washington DC March/April