Methods, indicators and solutions for sustainable hydropower
…and some reflections

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Sustainability in Hydropower Conference, Trondheim, 13-15 June 2023

What is hydro-morphology?

Flow, riverbed, riparian zone

Velocity, depth, turbulence, substrate, physical habitat, river banks, floodplain

Directly impacted by hydropower

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Hydrology

Flow variation in time

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Geomorfologi

Two dilemmas about WFD

Hydro-morphology
= supporting element

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Hydro-morphology
= supporting element

= fundamental for the ecosystem

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Two dilemmas about WFD

Hydro-morphology = supporting element

= fundamental for the ecosystem

Water is flowing from source to sea

...difficult to split into units

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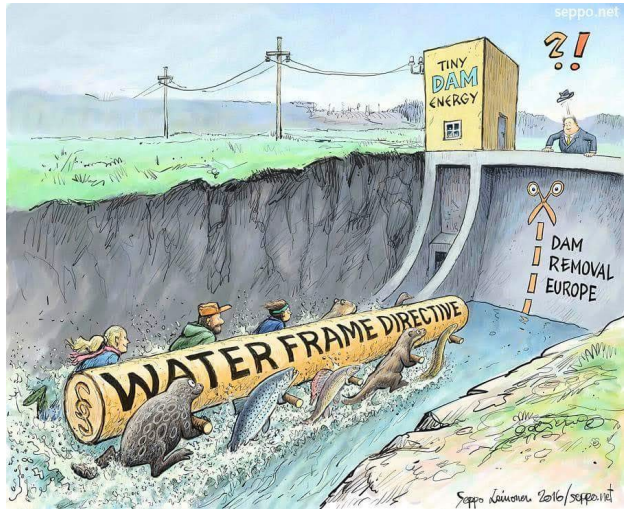
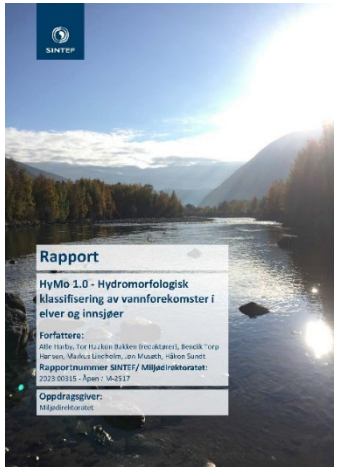
HyMo 1.0 report – final suggestion for Norwegian authorities

Field work and testing different methods

11 workshops

Reports and memos





HyMo 1.0 report

	Topic	Indicator for change	Class borders				
			Natural	Small changes	Moderate changes	Large changes	Very large changes
Along the river	Lateral connectivity	Running meters of river impacted [%]	<5%	5-20%	20-50%	50-80%	>80%
	Embankments	Running meters of river impacted [%]	<5%	5-20%	20-50%	50-80%	>80%
	Riparian vegetation	Running meters of river with higher vegetation [%]	<5%	5-20%	20-50%	50-80%	>80%
	Channelization	Changes in sinuosity [%]	<5%	5-20%	20-50%	50-80%	>80%
	Incision	Average incision of the river [m]	< 0,5m		0,5-1m	>1,5m	
Across the river	Barriers inside the water body	Number of barriers (absolute/partly) [#]	None/ none	None/ < 2	<2 / <3	<3 / <5	≥3 / ≥ 5
	Backwater effect inside the water body	Running meters of river impacted from backwater effect [%]	<10%	10-30%	30-50%	50-80%	>80%
	Barriers in upstream catchment/water bodies	Distance to upstream barrier [km]	None	> 50km	10-50km	2-10km	<2km

Suggested indicators

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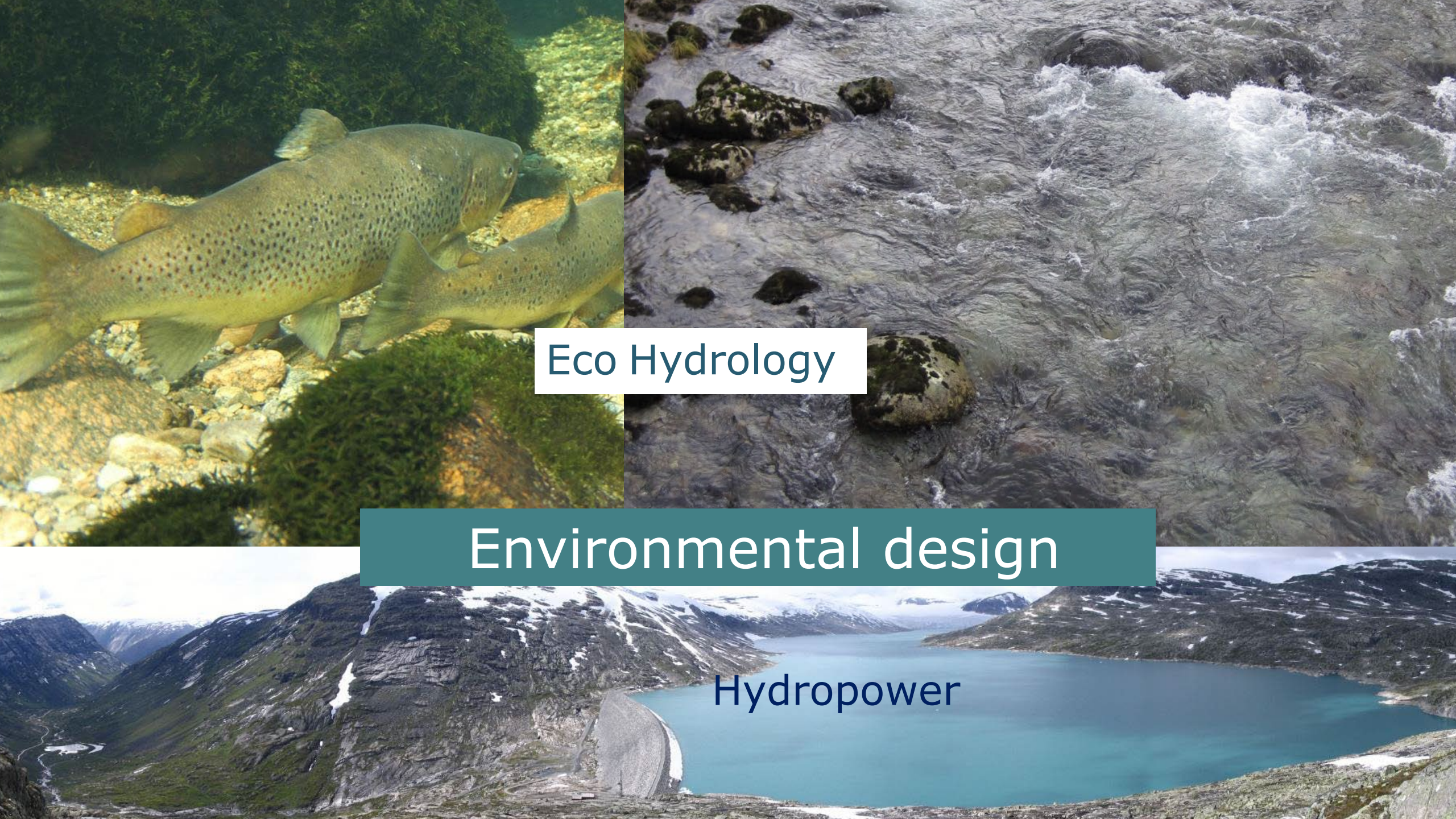
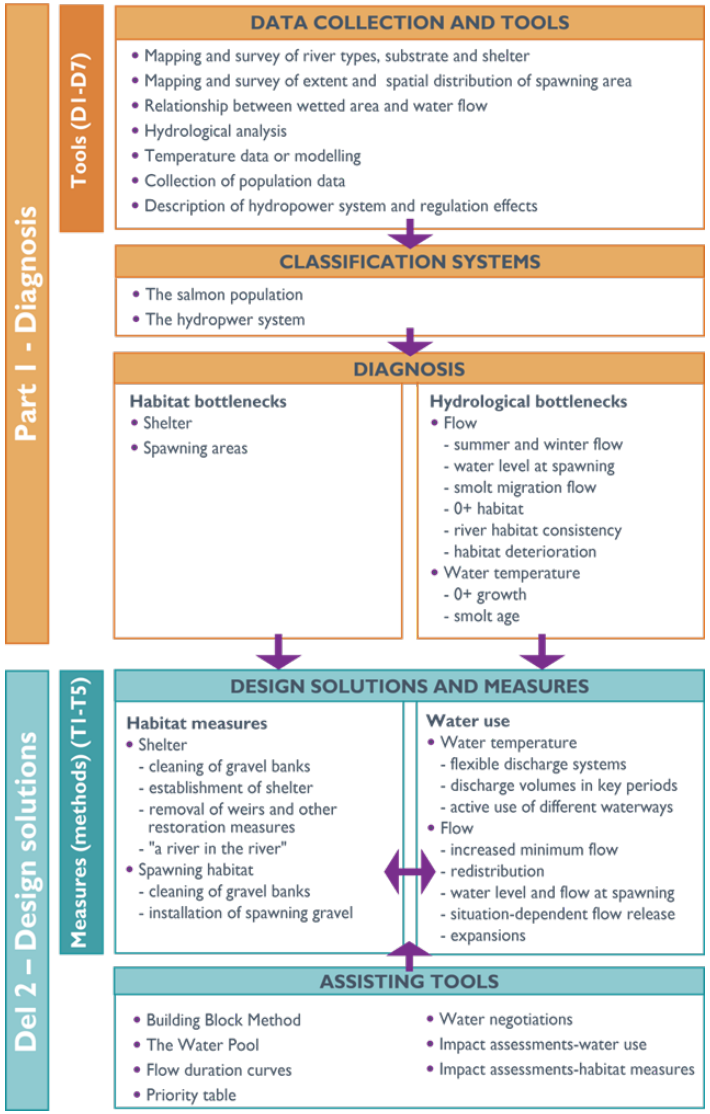

Eco Hydrology
Environmental design
Hydropower

Environmental design – what is it?

- A **method** to consider power production, societal needs and the environment
- A **systematic approach** combining recognized and new knowledge
- **Handbook**, course and a set of tables and graphs for hydropower and salmon
- Under further **development** to include other species, biodiversity, recreation and other services

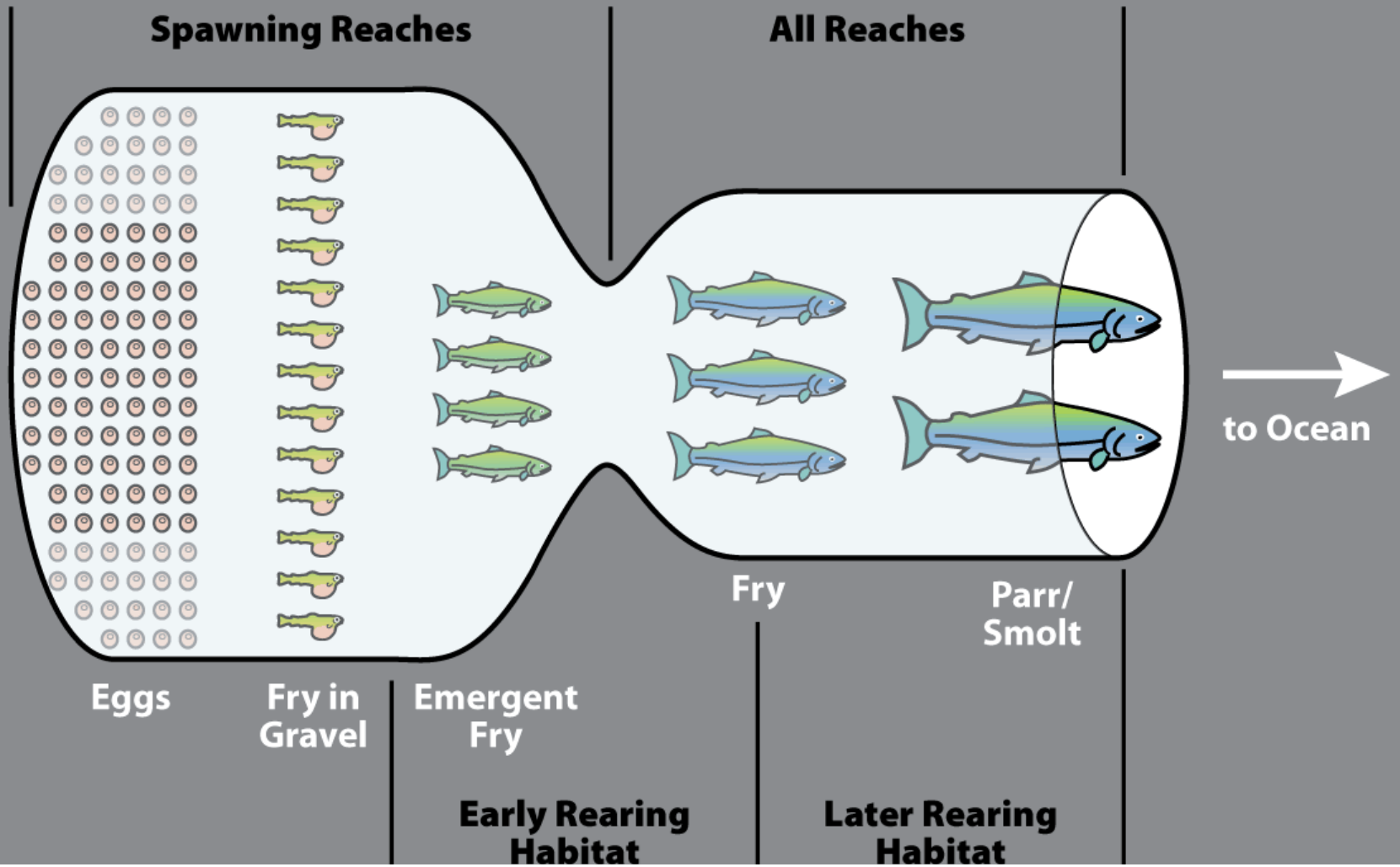


- Methods for Atlantic salmon
- These methods also applicable for other species and services
- Printed and pdf available in English, Norwegian and Chinese

Free download at:
www.cedren.no

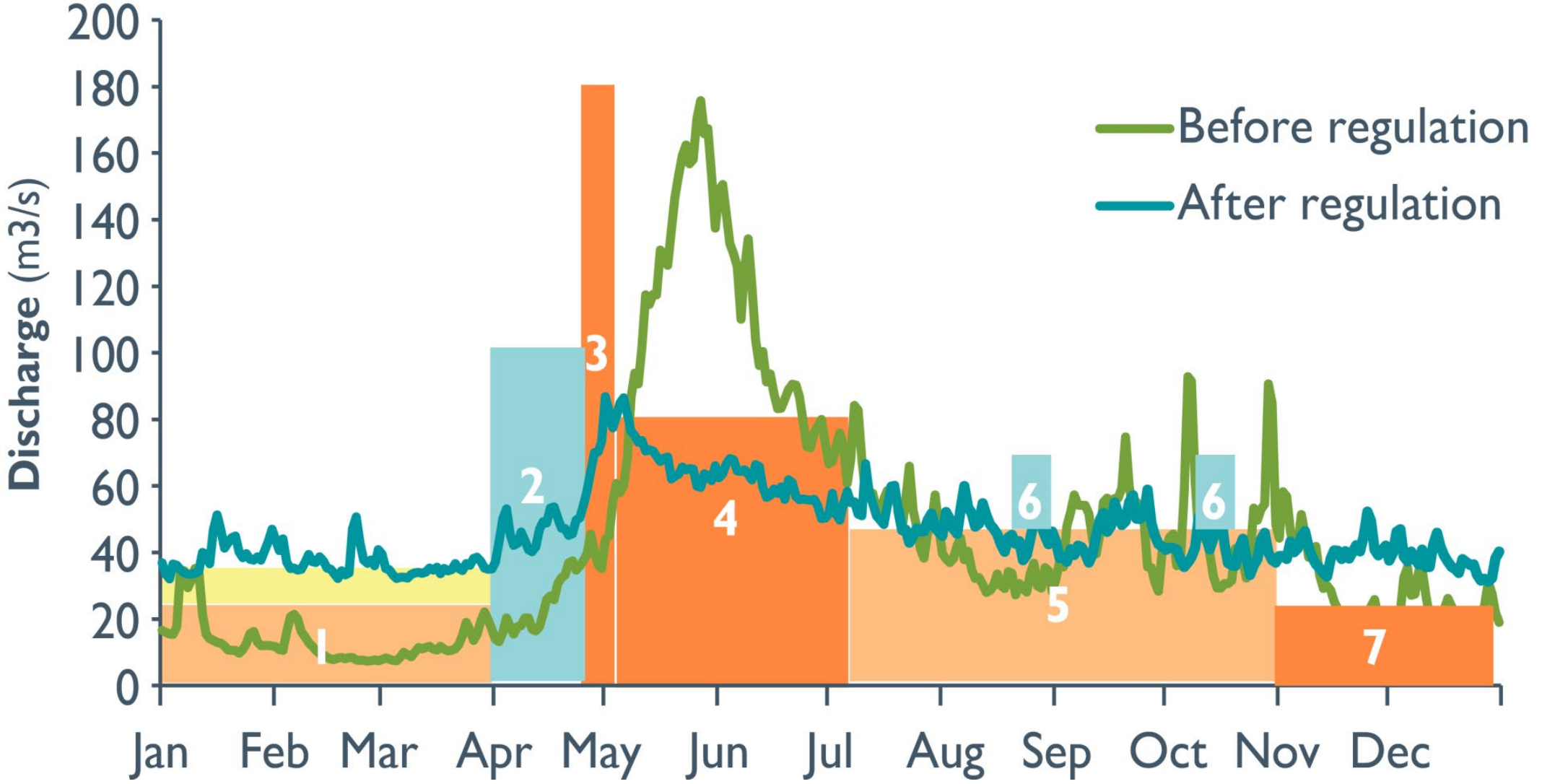
SINTEF CEDREN HydroCen

HABITAT BOTTLENECK



Fish dies only once!

Design solutions – how to use water?



Mitigation measures – design solutions

Environmental flow release

Stable temperature and ice cover

Introduce "a river in the river" when water is withdrawn

Two-way migration solutions

Improving habitats

"Water bank"

Species, activities and services

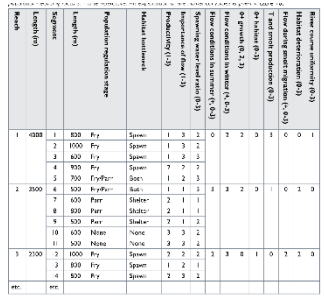
Other species and habitats

Flood protection

Energy services

Recreation and tourism

		Extent of spawning habitat as a percentage of river area.		
		Small (<1%)	**Moderate (1-10%)**	**Large (>10%)**
Distance between spawning habitats (across all segments)	Large (>500 m)	Small	Small	Moderate
	Medium (200-500 m)	Small	Moderate	Large
	Small (<200 m)	Moderate	Large	Large



Guidance, methods and tools

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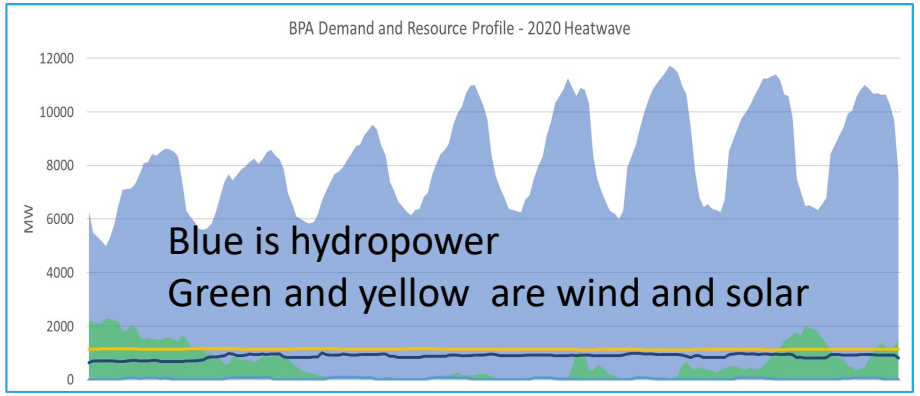
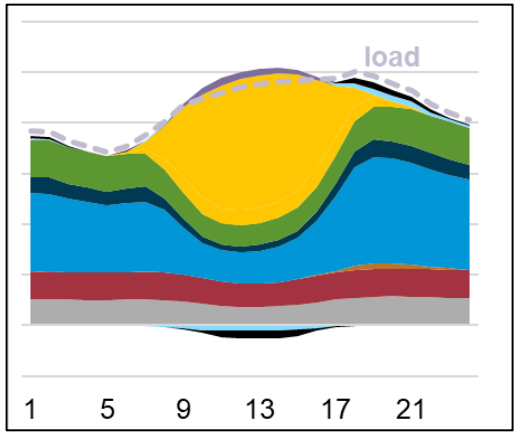
Dunkelflaute

- periods with hardly no wind, nor solar power





Surplus periods

- how to use excess energy and avoid curtailing generation?

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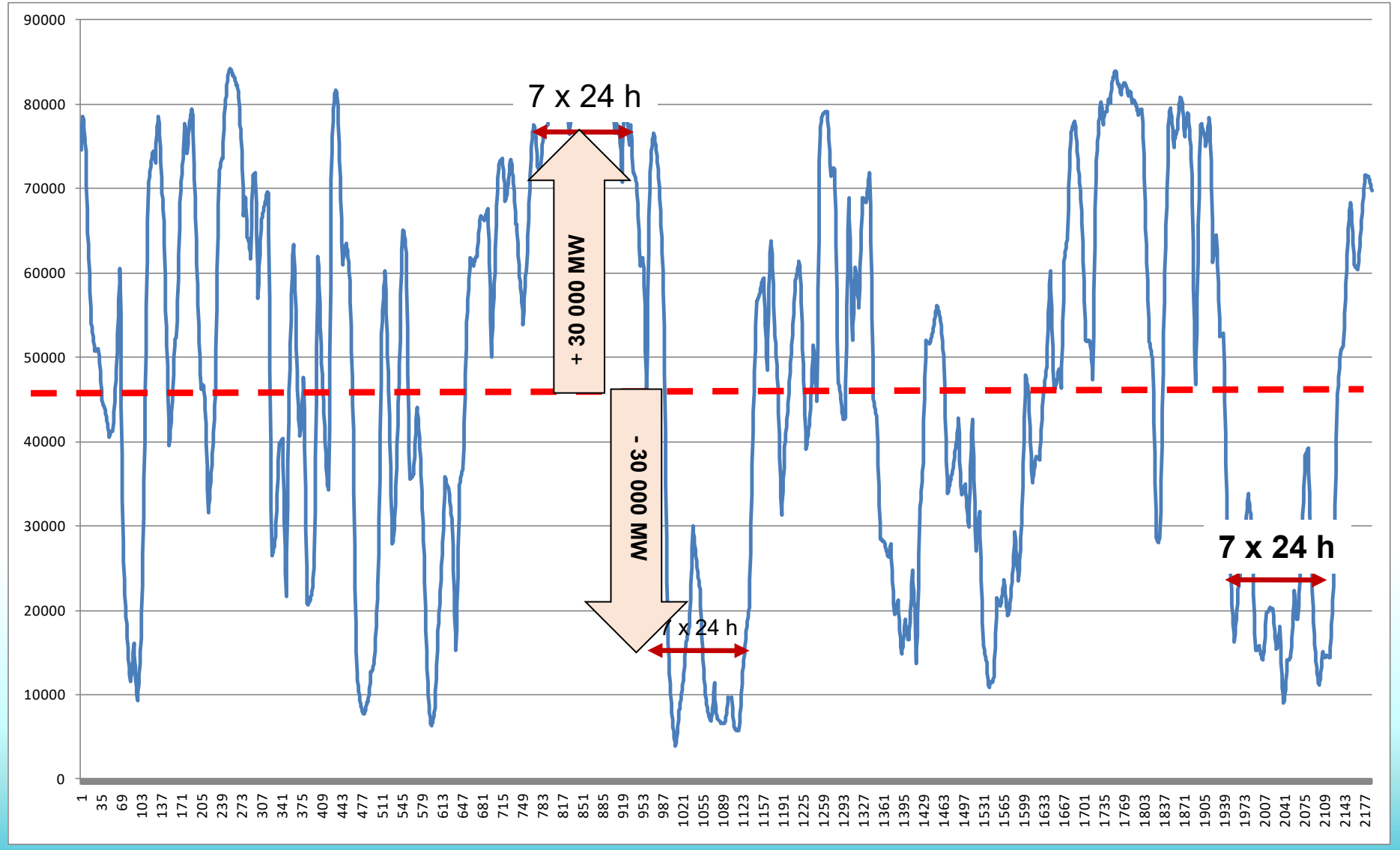
THE INTERNATIONAL ENERGY AGENCY TECHNOLOGY COLLABORATION PROGRAMME ON HYDROPOWER

IEA Hydropower

Simulated wind production in the North Sea area in 2030



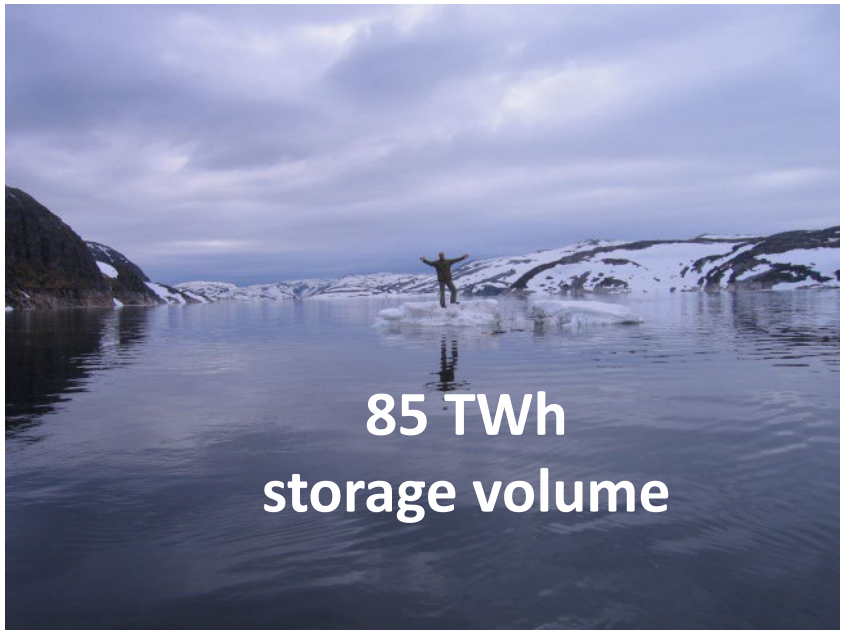
One week balancing
= 30 000 MW in 168h
= 5 000 GWh energy

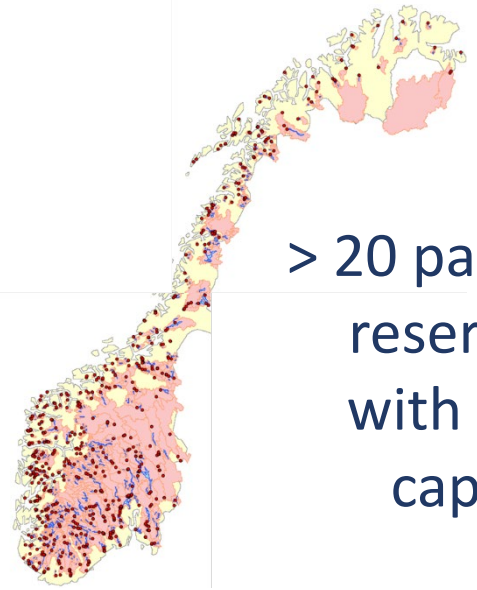
= 1 000 typical PSH

= 38 700 Hornsdale Power Reserve (Elon Musk battery project in Australia)

from IEA TCP Hydropower

Upgrading capacity in Norwegian hydro





> 20 pairs of reservoirs with large capacity

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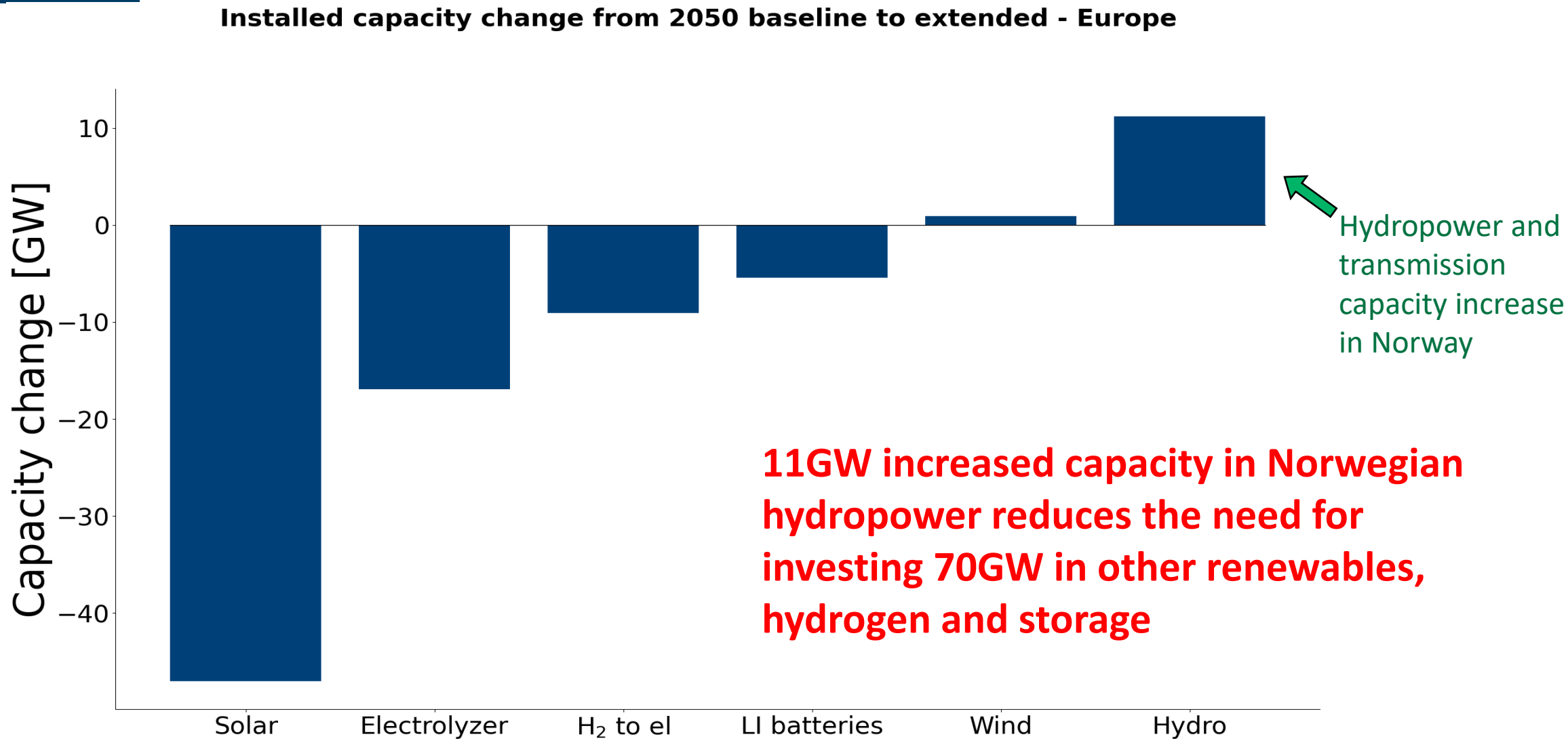
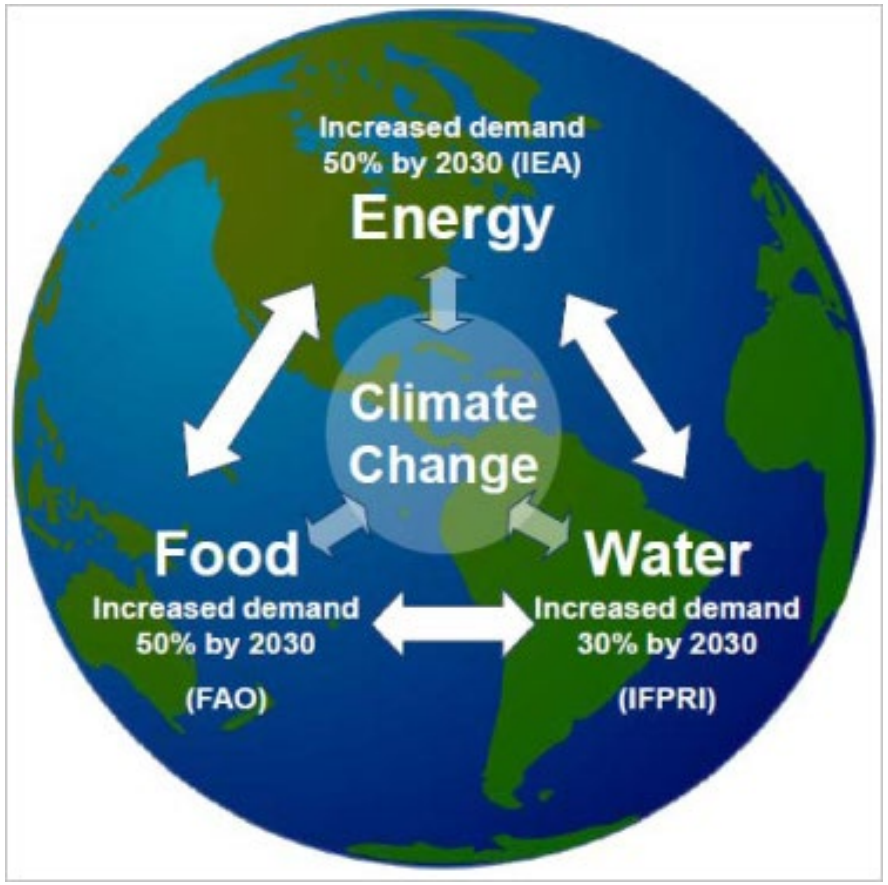
The amount of solar PV, hydrogen and batteries needed in Europe reduced substantially



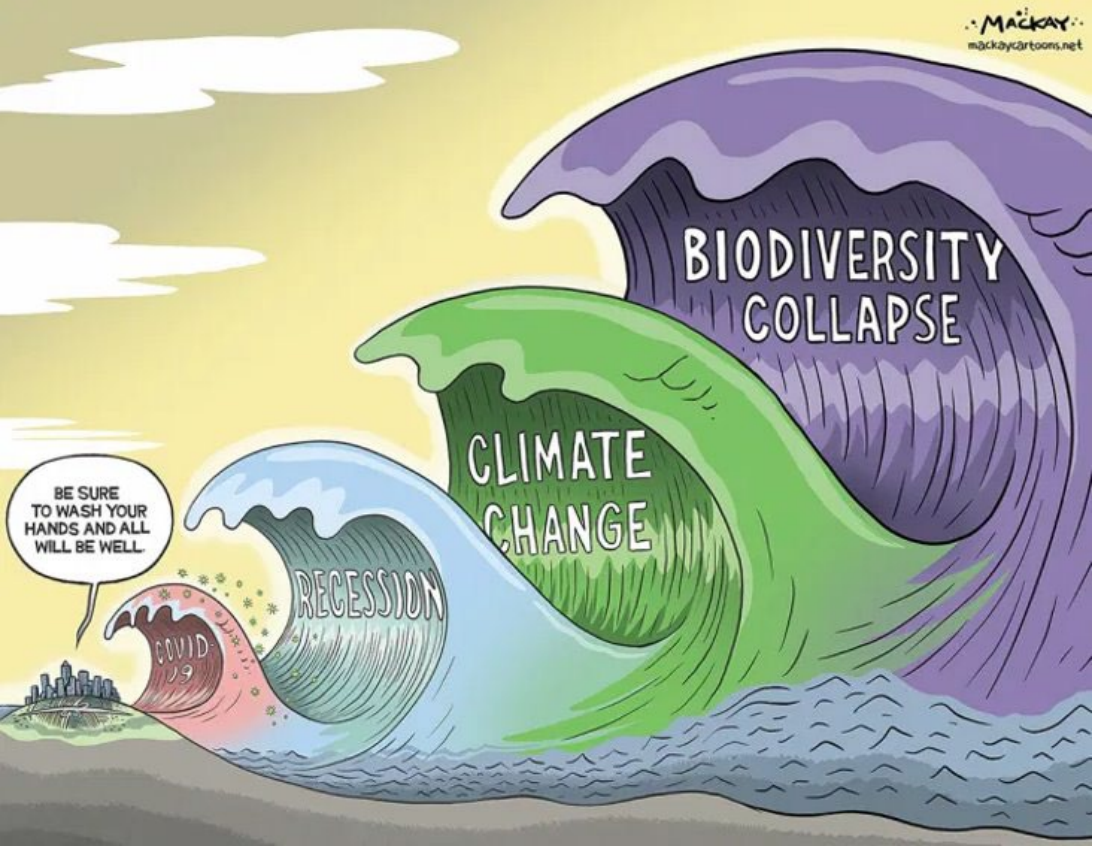
11GW increased capacity in Norwegian hydropower reduces the need for investing 70GW in other renewables, hydrogen and storage

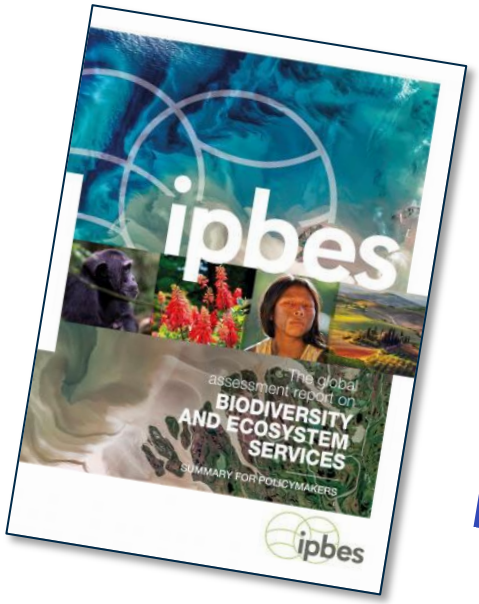
Source: The HydroConnect project

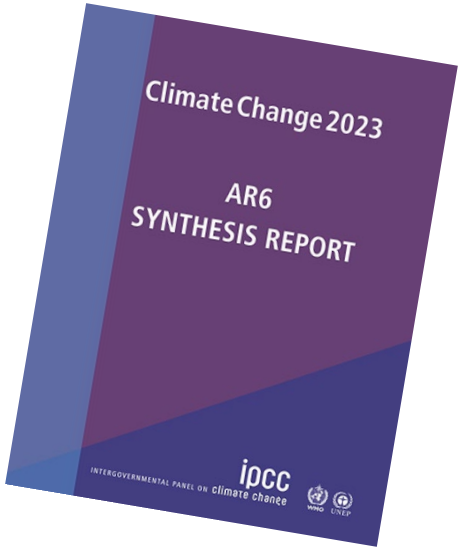
Ensure access to affordable, reliable, sustainable and modern energy for all



The role of hydropower?







Requires hydropower companies to declare their impact and dependency on nature and climate,

Environmental and social impacts

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Need to keep some undisturbed nature

Perfect for hydropower

Pristine areas in dark green

from Lars Haltbrekken

What is sustainable hydropower?

- Sustainable hydropower leads to:
  - Energy for all
  - Clean water and sanitation
  - Zero hunger
  - Economic growth
  - Sustainable communities
  - Life on land (including freshwater)

- What is sustainable hydropower?

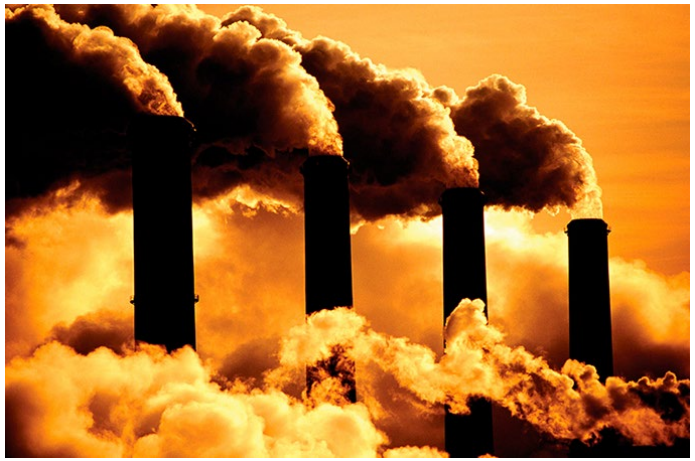
  It's the wrong question to ask!

- Sustainable hydropower must not be seen isolated from the society
- Good practice hydropower
  - Adapted to local challenges and needs
  - Meeting global requirements

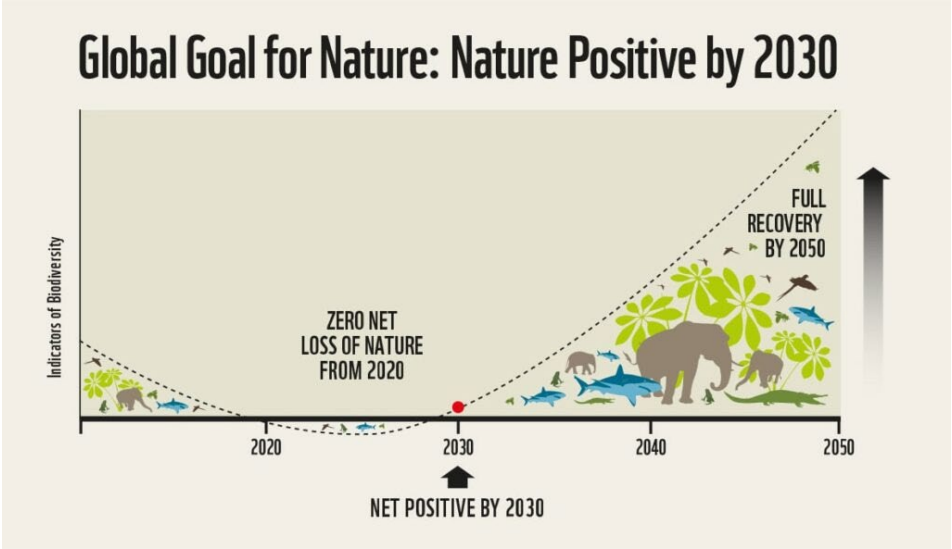
Hydropower that provides energy, water management for all users and interests and contributes to welfare

What is a sustainable energy system?

- What is the alternative to hydropower?
  - ~~More efficient energy generation~~
  - More efficient energy use
  - Less energy use …but more electricity
  - ~~Fossil fuels~~



- We must have a holistic view
  - Maximise reduction in CO_2 emissions
  - Maximise benefit for society
  - Include effects of alternatives
    (also the zero-alternative = doing nothing)
  - Minimise impact on nature
    → becoming nature positive



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