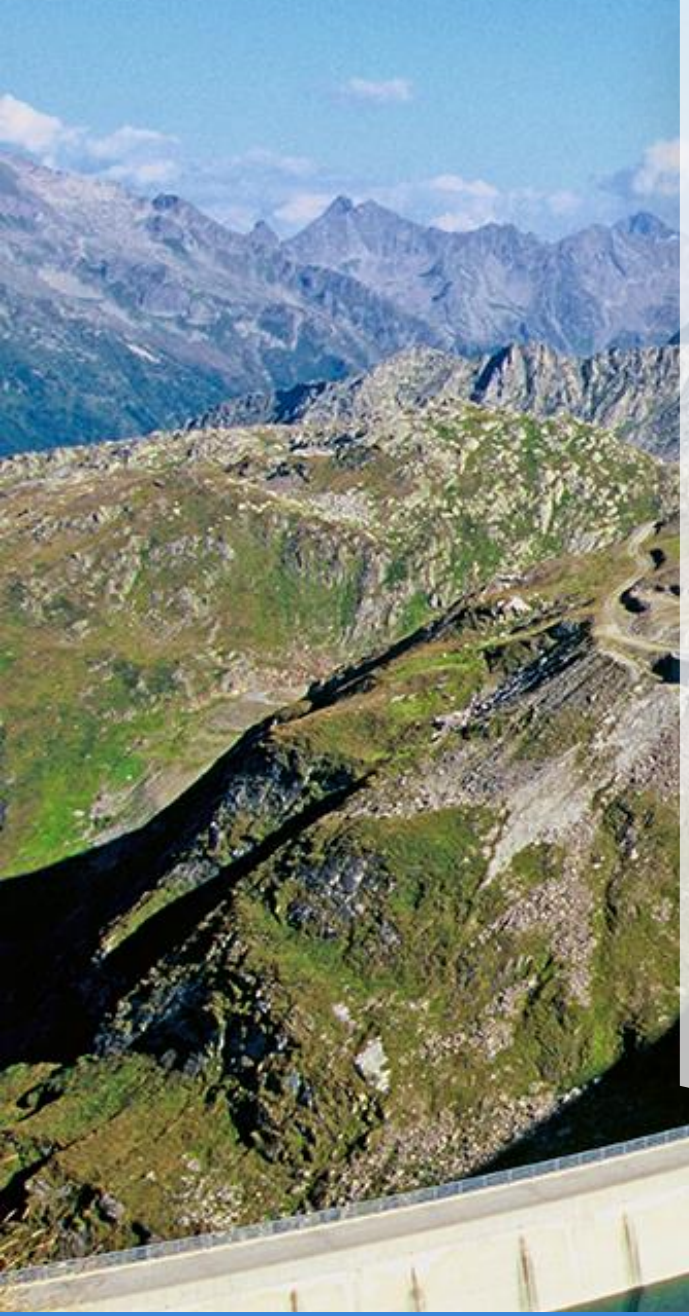


ETIP HYDROPOWER

OLE GUNNAR DAHLHAUG

NTNU, EERA JP HYDROPOWER

Ole Gunnar Dahlhaug is a Professor at Norwegian University of Science and Technology (NTNU), where he has been employed since 1999. He received his PhD from NTNU in 1997 and his professorship in 2005. He has been working with hydropower technology since 1992. In his previous career Ole Gunnar Dahlhaug was a project engineer at SN-Power Peru, Professor at Kathmandu University in Nepal and a research scientist at SINTEF in Trondheim, Norway. Today, he is the manager of EERA's joint program on Hydropower (eera-hydropower.eu), and he is heading ETIP Hydropower's Scientific Advisory Board.

Funded by
the European Union

NTNU | Norwegian University of Science and Technology

Large scale hybridization with offshore wind and storage hydropower in Norway

Ole Gunnar Dahlhaug

Department of Energy and Process Engineering

16th April 2024

Energy consumption in Norway, 2022

Type	Energy consumption	From renewables
Household	44,7 TWh	98,3 %
Industry	75,7 TWh	69,2 %
Oil- and gas-production	63,2 TWh	14,7 %
Transport	55,9 TWh	13 %
Service industries	34,6 TWh	84,6 %
Agriculture, forestry and fishing	7,3 TWh	31 %
SUM	281 TWh	51 %

Source: SSB

Production of electrical energy in Norway

Status per 31. Mars 2023

Technology	Number of powerplants	Installed power [MW]	Energy production [TWh]	Part of the energy production
Hydropower	1769	33 730	136,9	87 %
Wind	65	5 083	16,9	11 %
Thermal	30	642	3,1	2 %

Source: *The Norwegian Water Resources and Energy Directorate (NVE)*

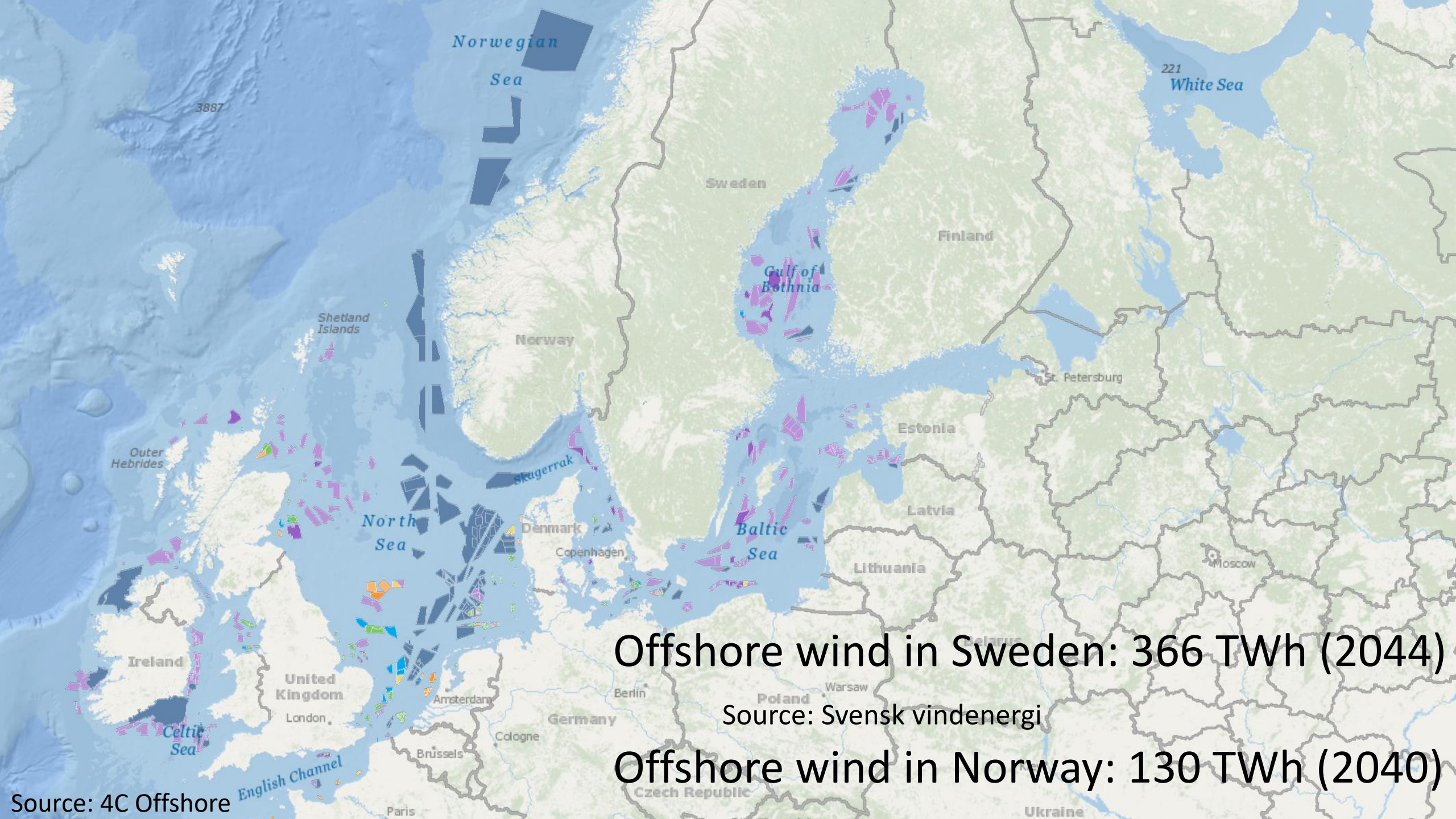
Norwegian Hydropower

- 1769 power plants
- Installed capacity: 33 730 MW
- Production: 137 TWh
- Storage capacity: ~87 TWh

Status per 31st March 2023	Size	Number	Total Power	Annual production
	[MW]	[-]	[MW]	[TWh/y]
Mini hydro	0 - 1	582	191	0,7
Small hydro	1 - 10	838	3 114	11,1
Large hydro	10 -100	265	10 021	43,6
Large hydro	> 100	84	20 404	81,8

Source: *The Norwegian Water Resources and Energy Directorate (NVE)*

Hydropower in Norway

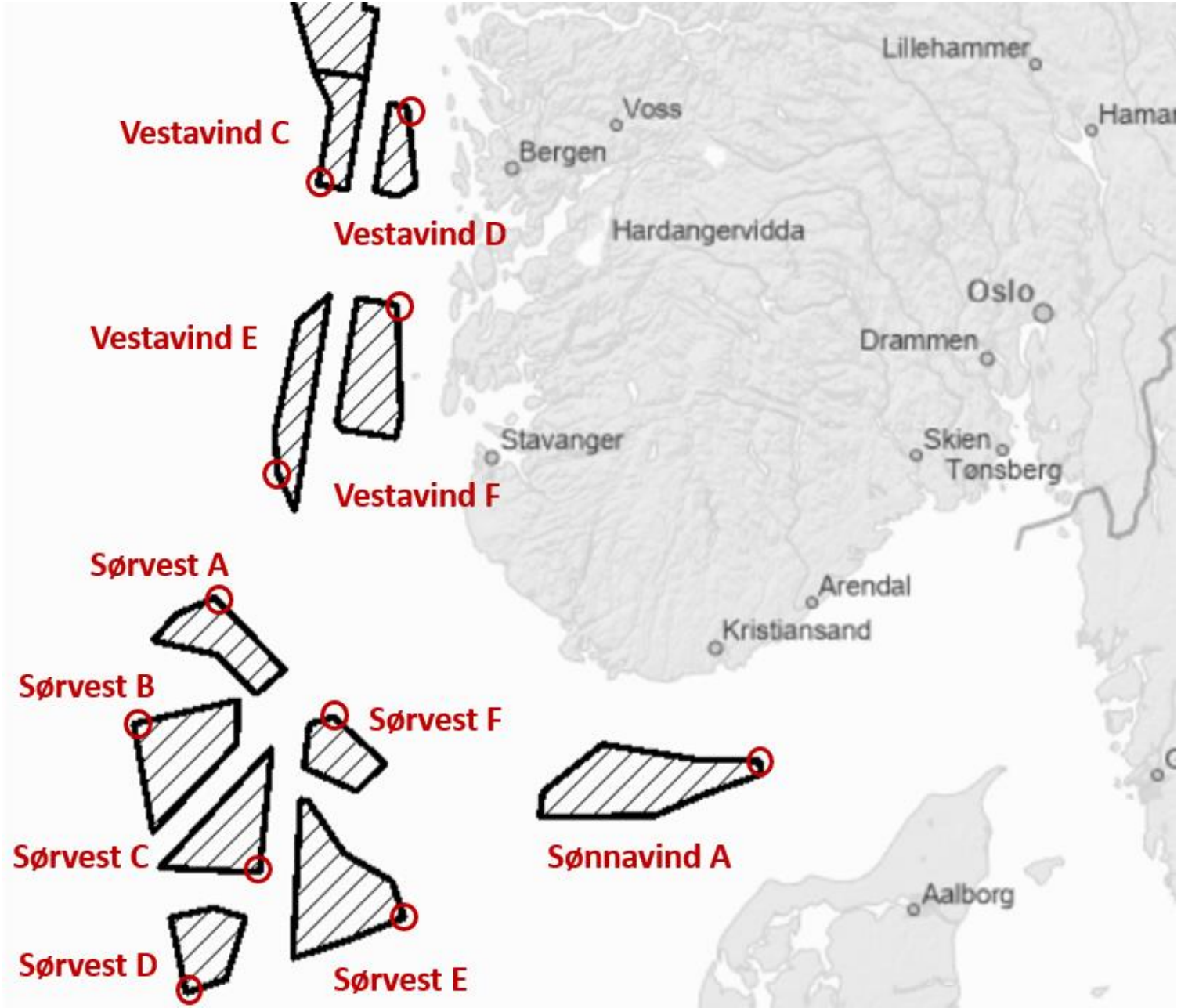


Offshore wind in Sweden: 366 TWh (2044)

Source: Svensk vindenergi

Offshore wind in Norway: 130 TWh (2040)

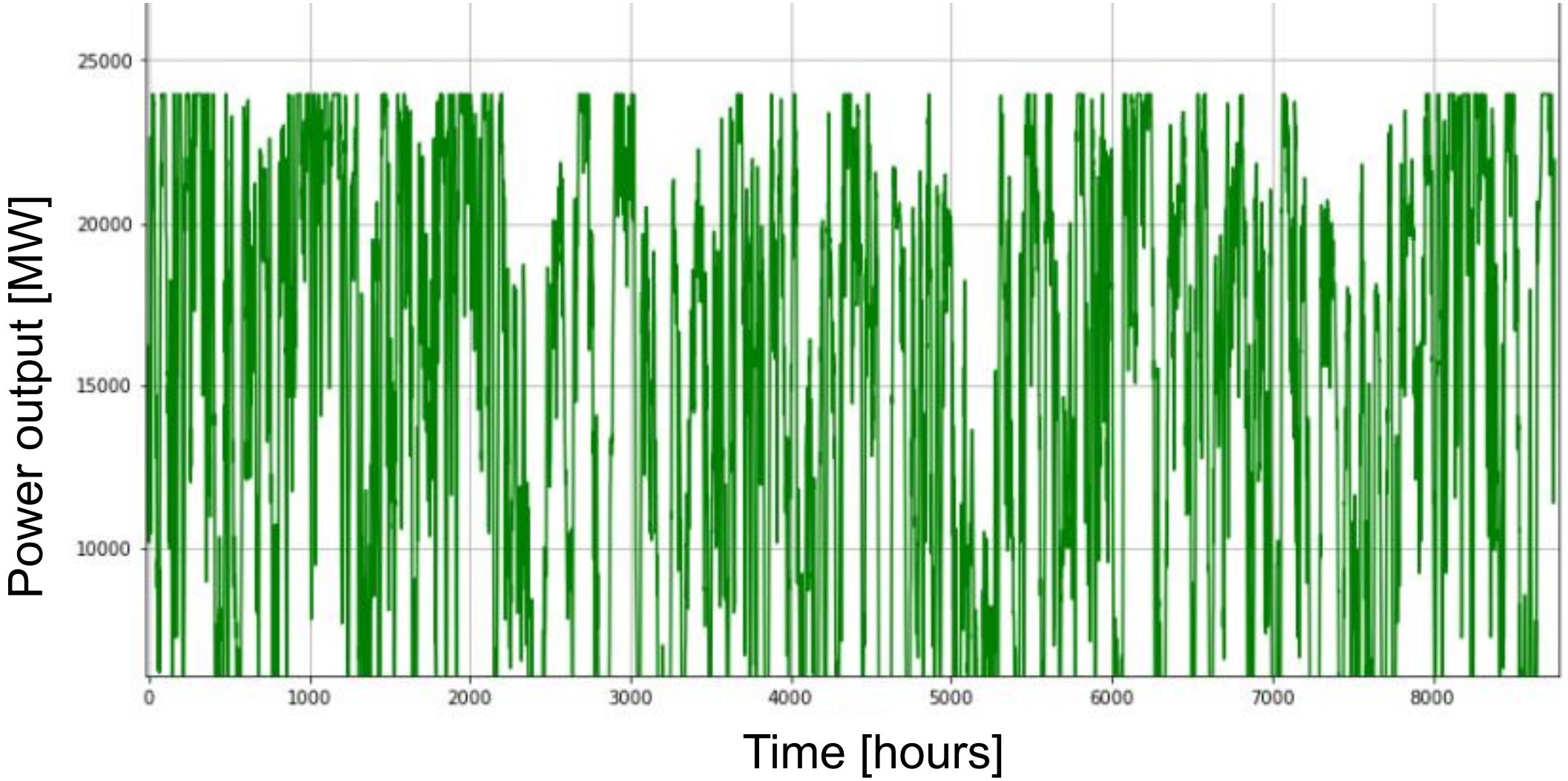
Source: 4C Offshore



NTNU | Norwegian University of Science and Technology

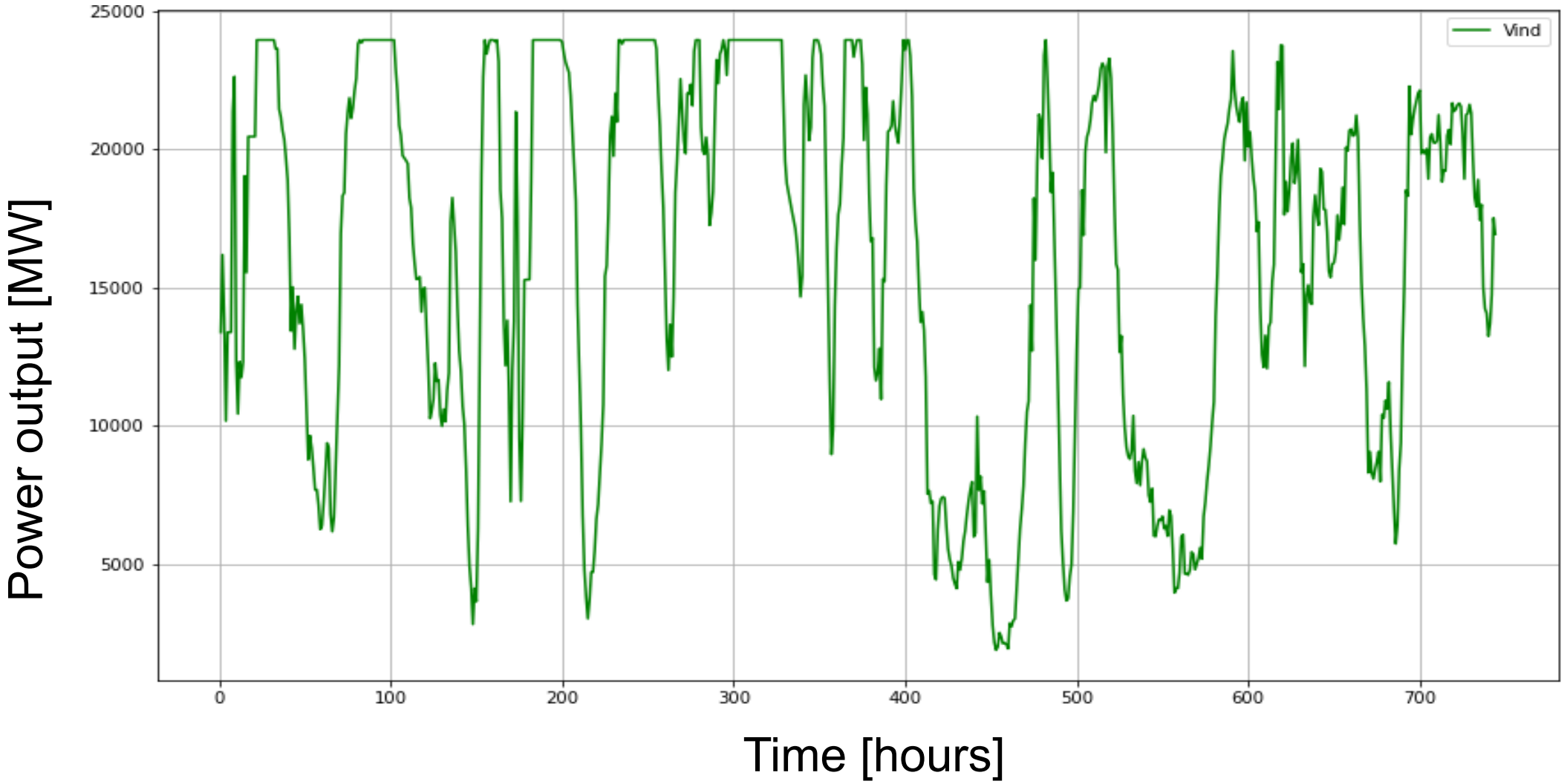
Source: Ingrid Hals, NTNU

Power output from offshore wind



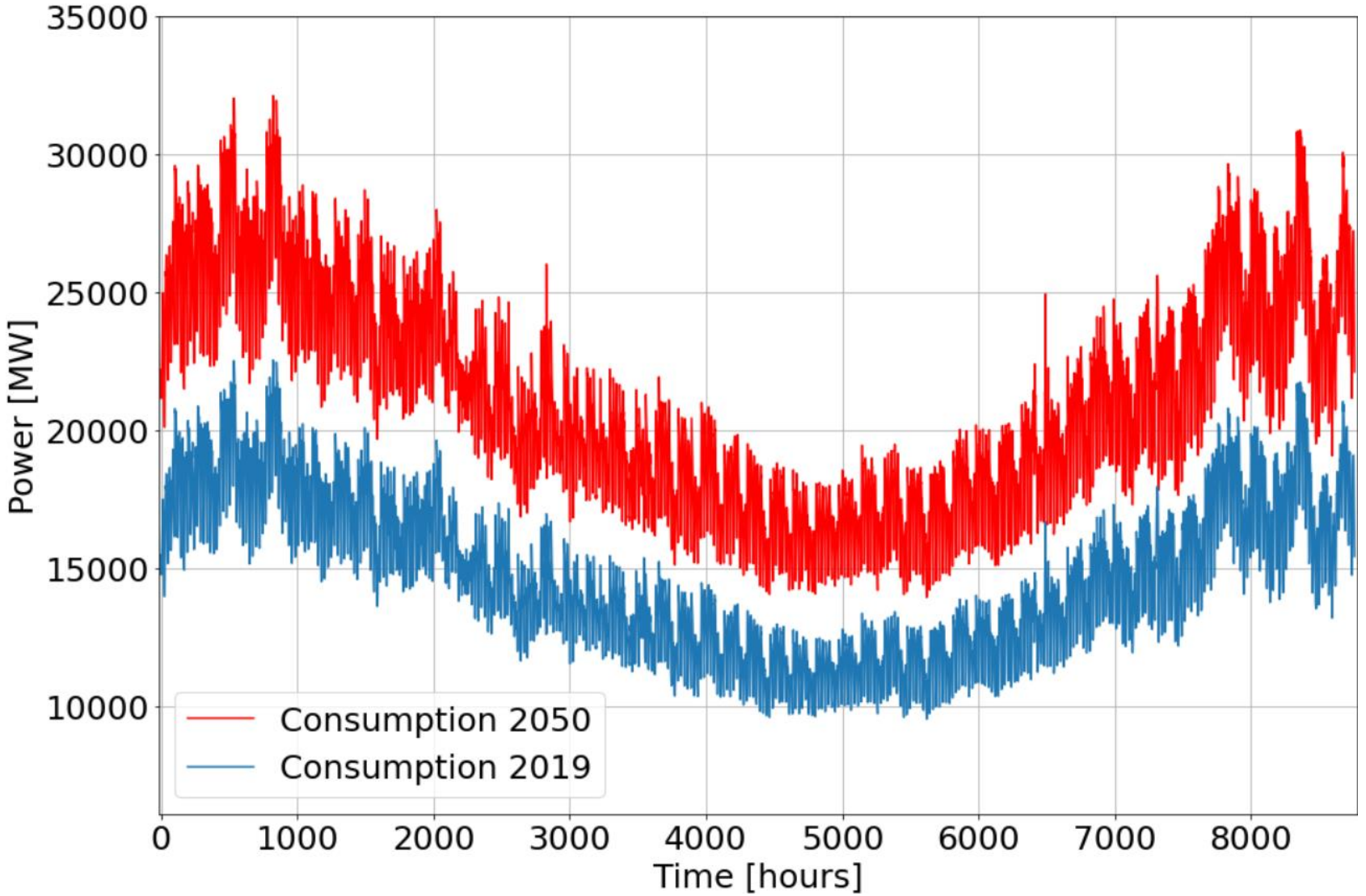
Source: Ingrid Hals, NTNU

Power output from offshore wind (January)



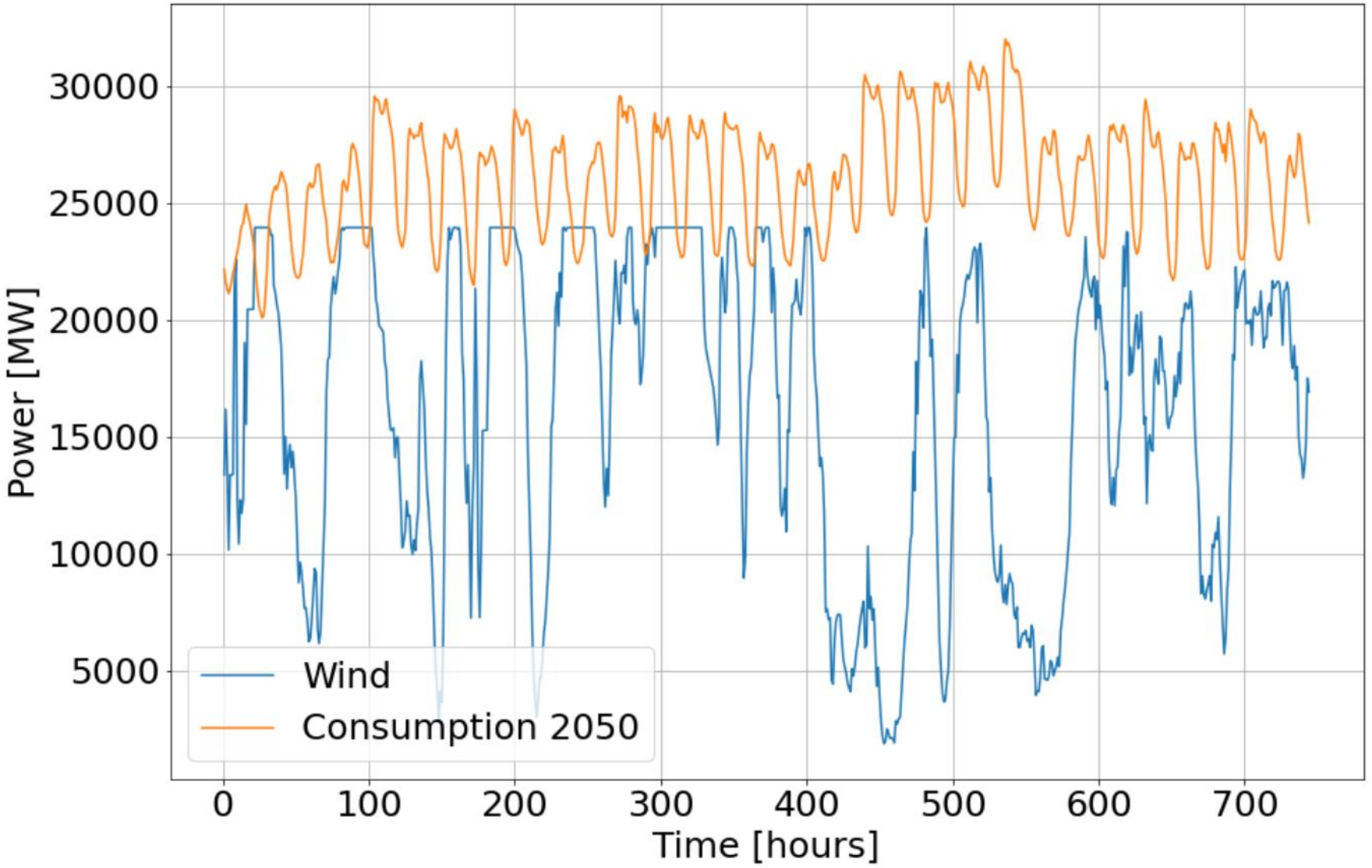
Source: Ingrid Hals, NTNU

Power Consumption



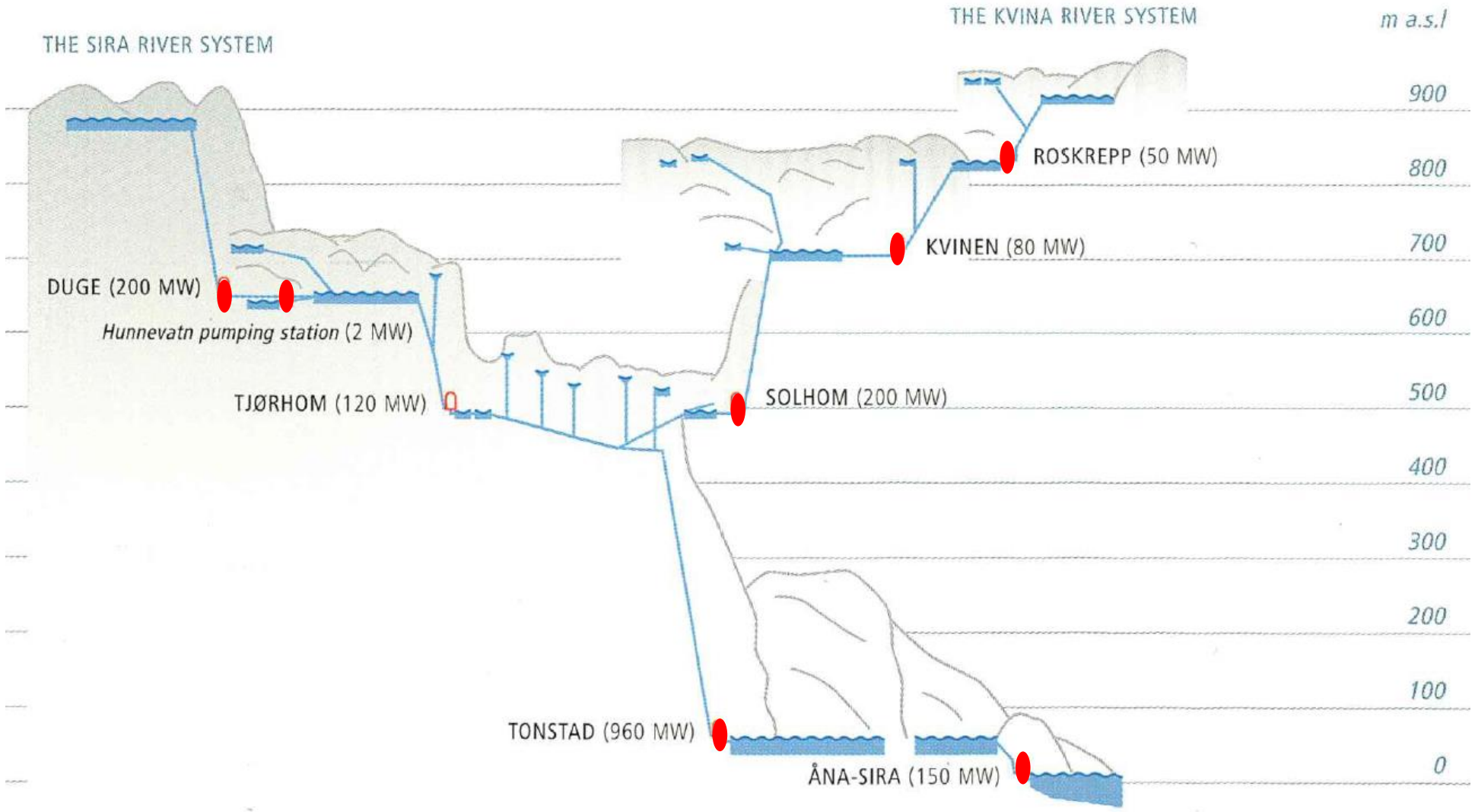
Source: Ingrid Hals, NTNU

Power Generation versus Consumption



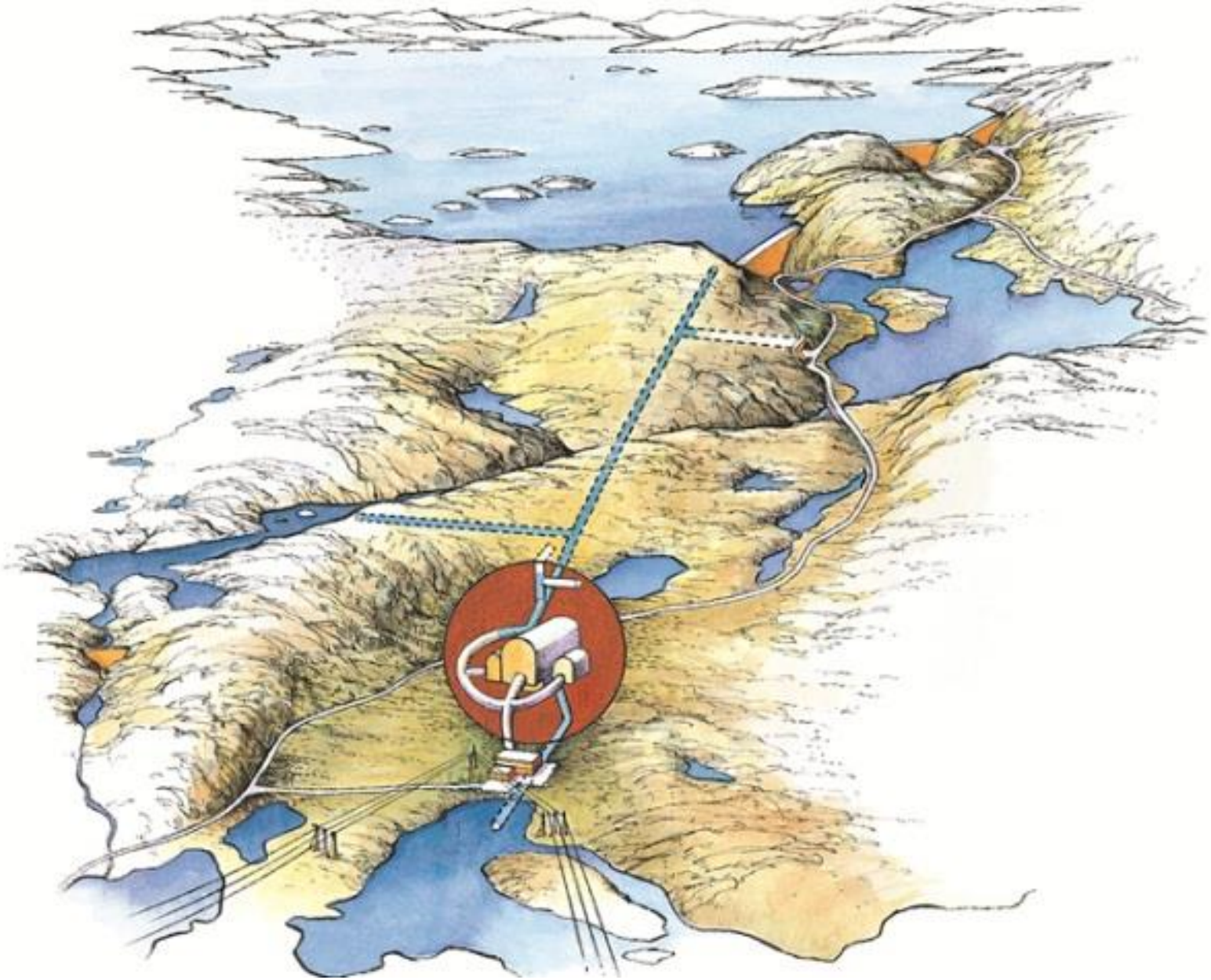
Source: Ingrid Hals, NTNU

Sira-Kvina hydropower system



Source: Sira-Kvina Kraftselskap

Roskrepp Power Plant

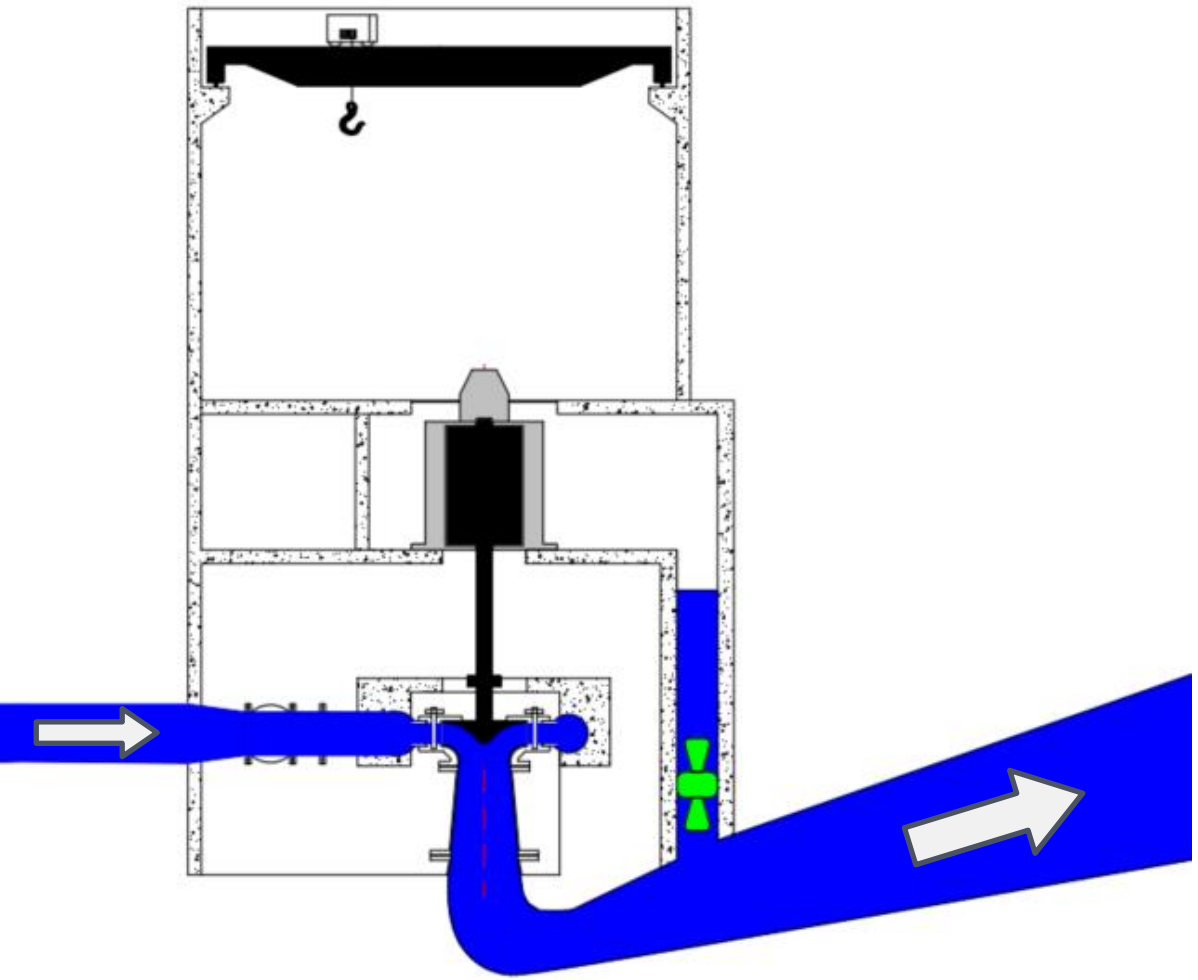


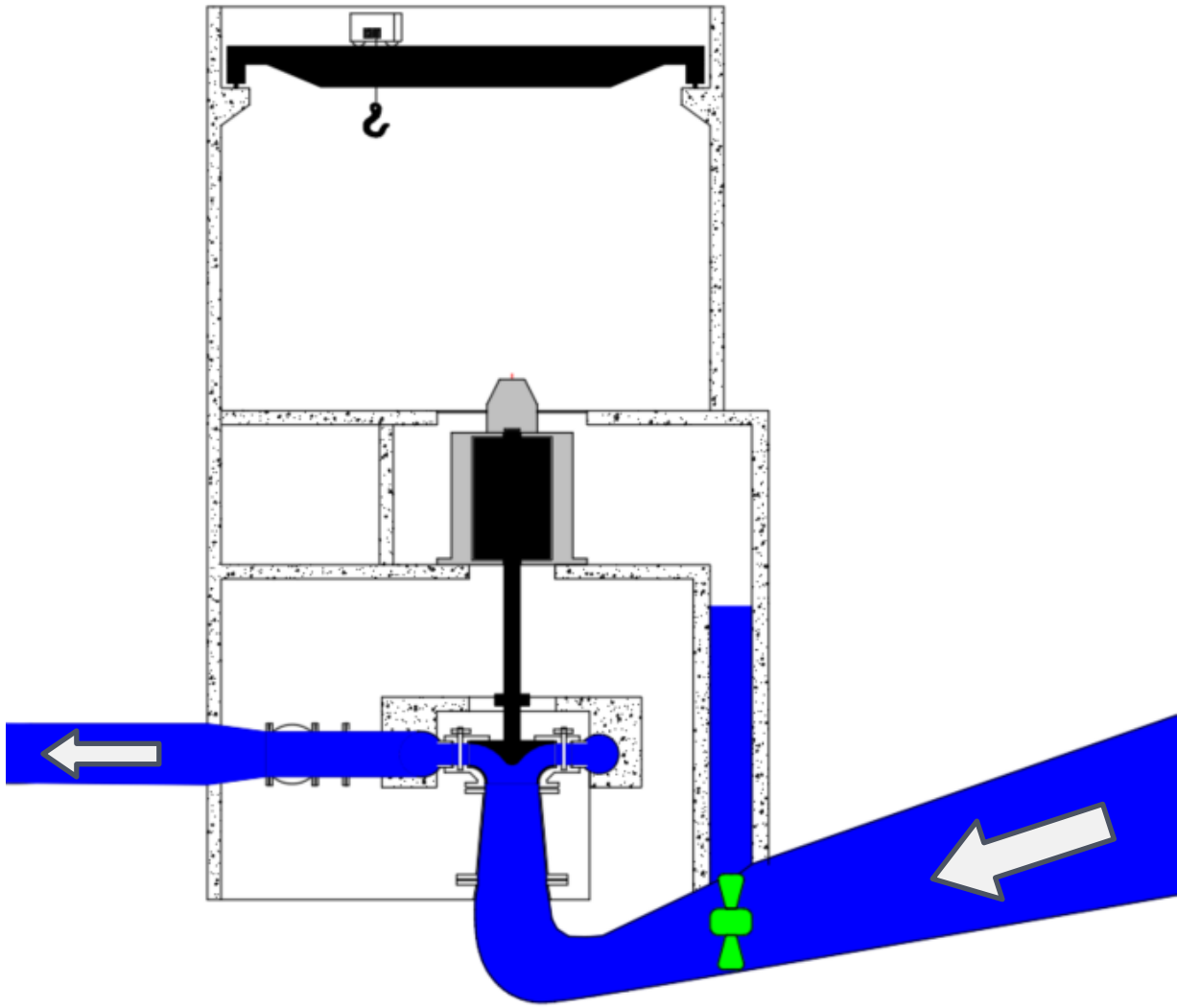
Roskrepp Power Plant:

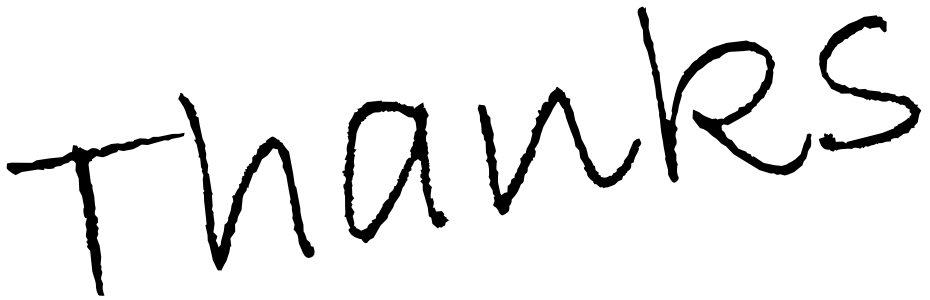
- Power: 50 MW
- Head: 83 m.
- Flow rate: 70 m^3/s

Source: Sira-Kvina Kraftselskap

Reversible Pump Turbine and Booster pump






thanks