

Pumped Hydro Storage Plants

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ALSTOM
Shaping the future

Three main activities in four sectors

Equipment & services for power generation



Alstom Thermal Power

Equipment & services for power transmission



Alstom Grid

Equipment & services for rail transport



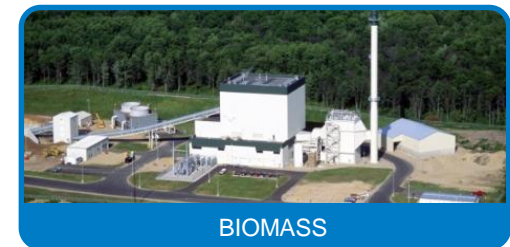
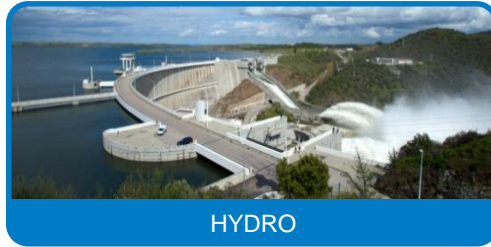
Alstom Renewable Power



Alstom Transport

Alstom Renewable Power

Technologies adapted to all renewable energy sources



...for new plants and the installed base

Alstom, the leading supplier in hydropower for over 100 years

A global leader

- from water to wire
- for new plants & the installed base
- for service & retrofit



Alstom accounts for over 25% of world's hydro power plants

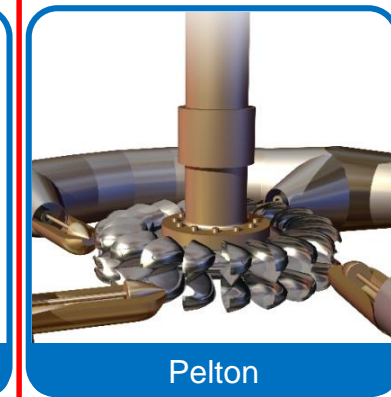
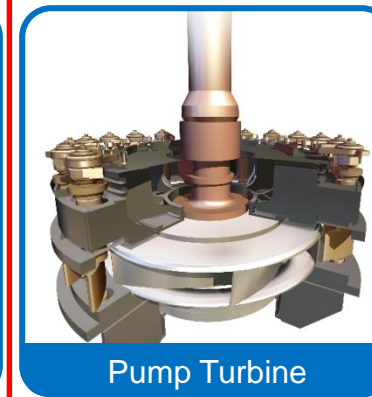
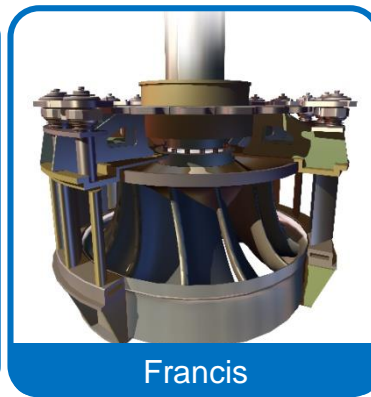
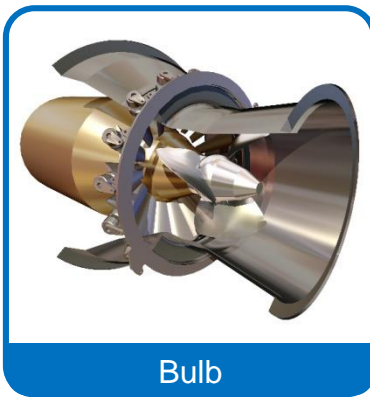
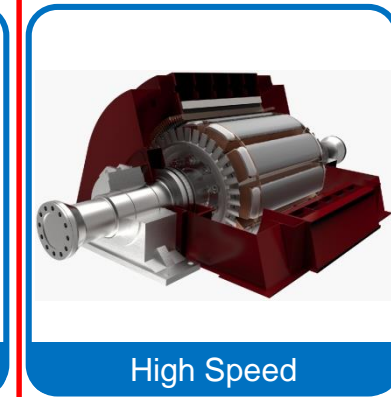
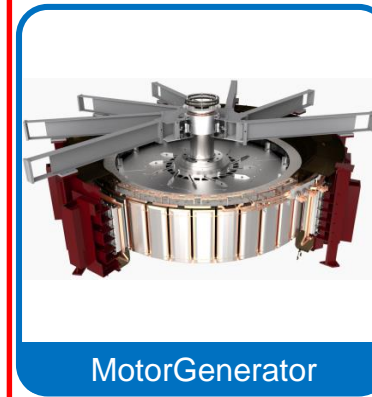
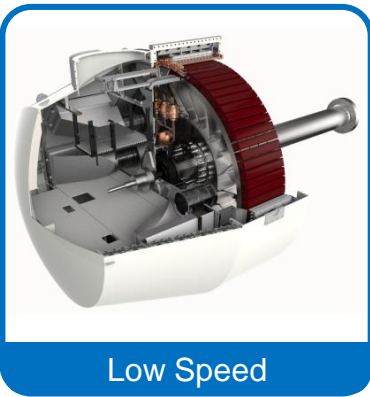
The broadest hydropower portfolio



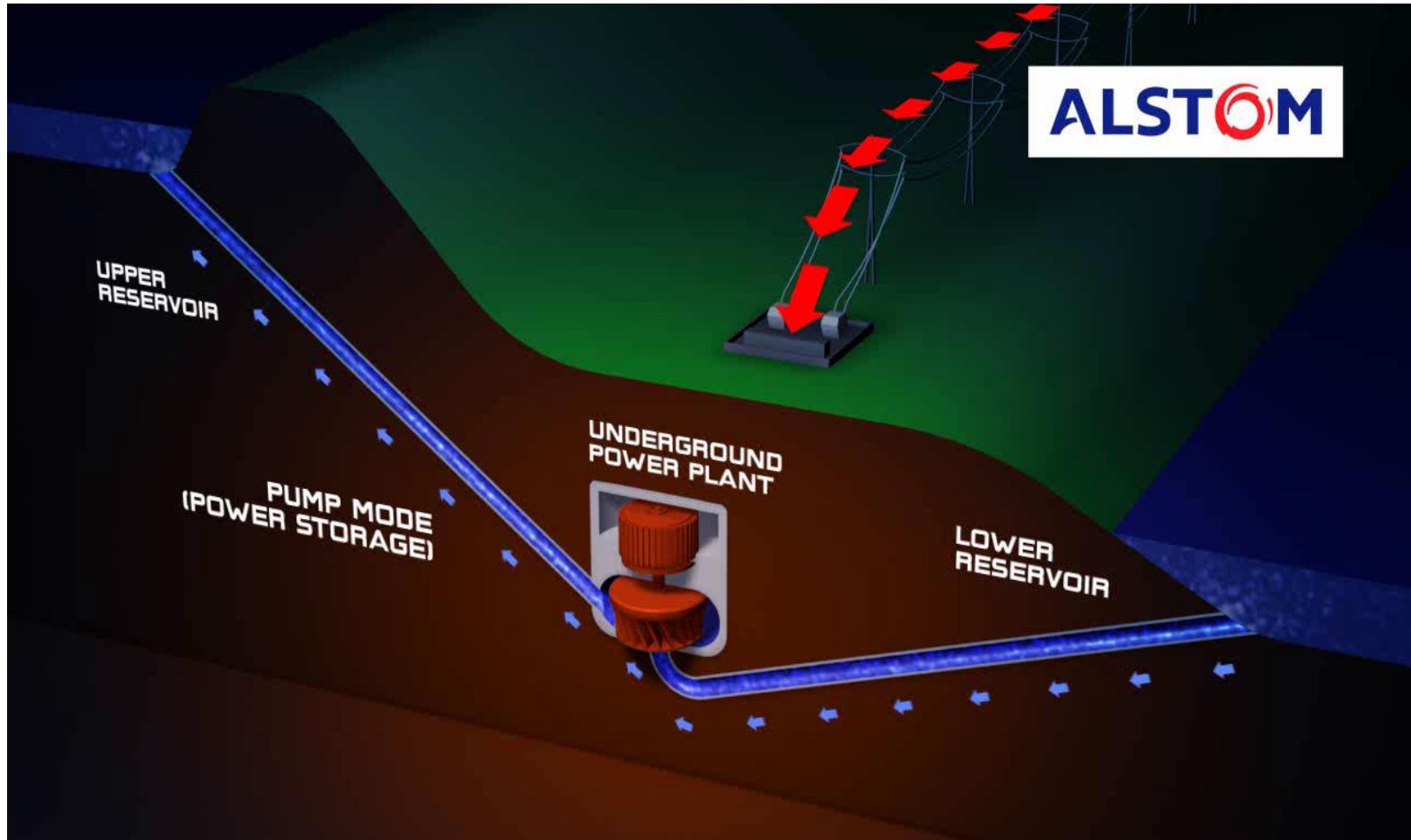
Turnkey plant or individual products

Product Portfolio Hydro Business

Turbines and Generators



A reliable large-scale storage solution: Pumped Hydro Storage Plants (PSPs)

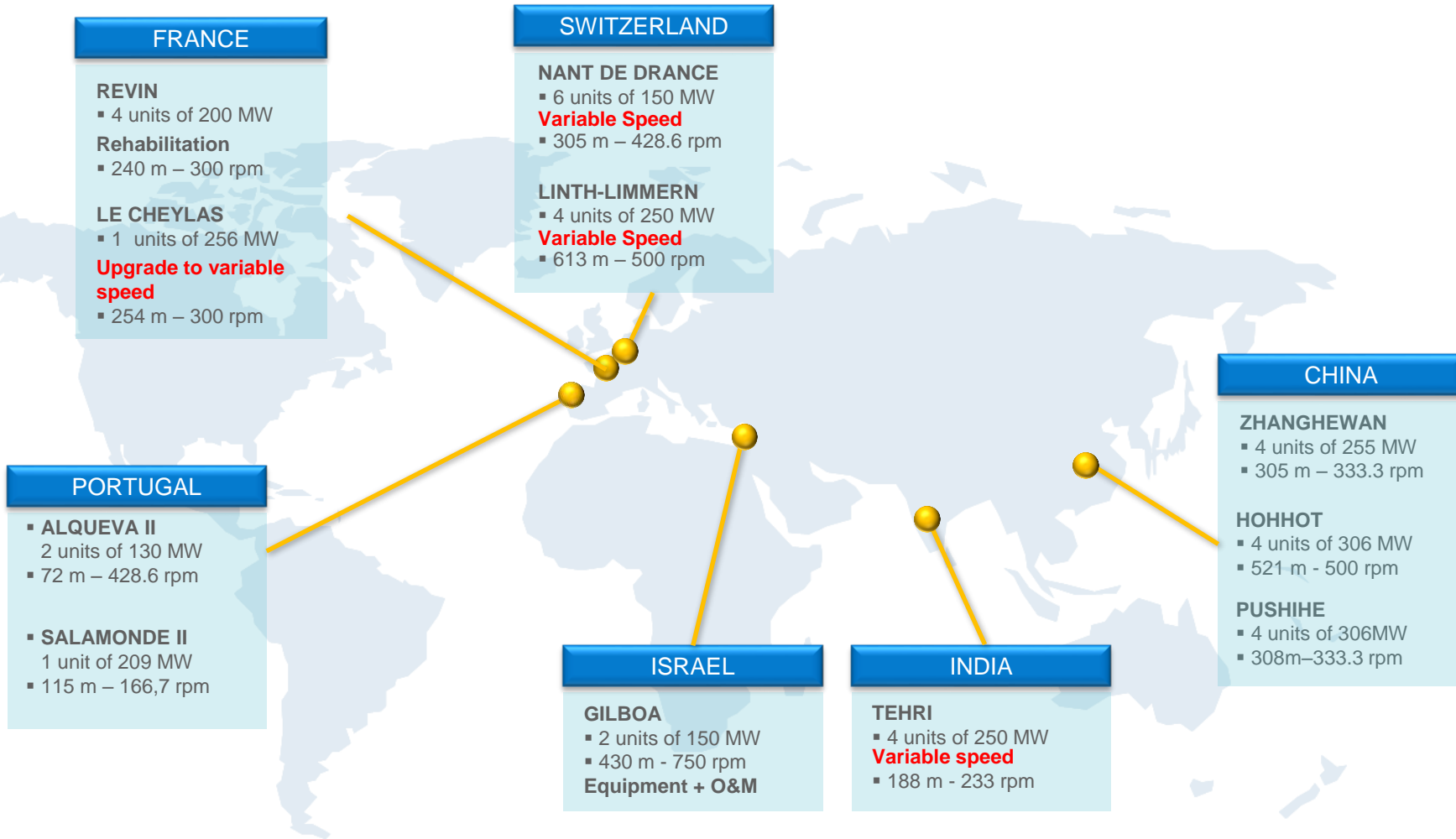


PSP in Europe



199 plants,
48,8 GW turbine capacity
537 machines with
a pumping mode (representing
a turbine capacity of 46,6 GW)

Alstom ongoing PSP Projects Worldwide



What PSP Does



Provide flexibility to ***balance base load generation***

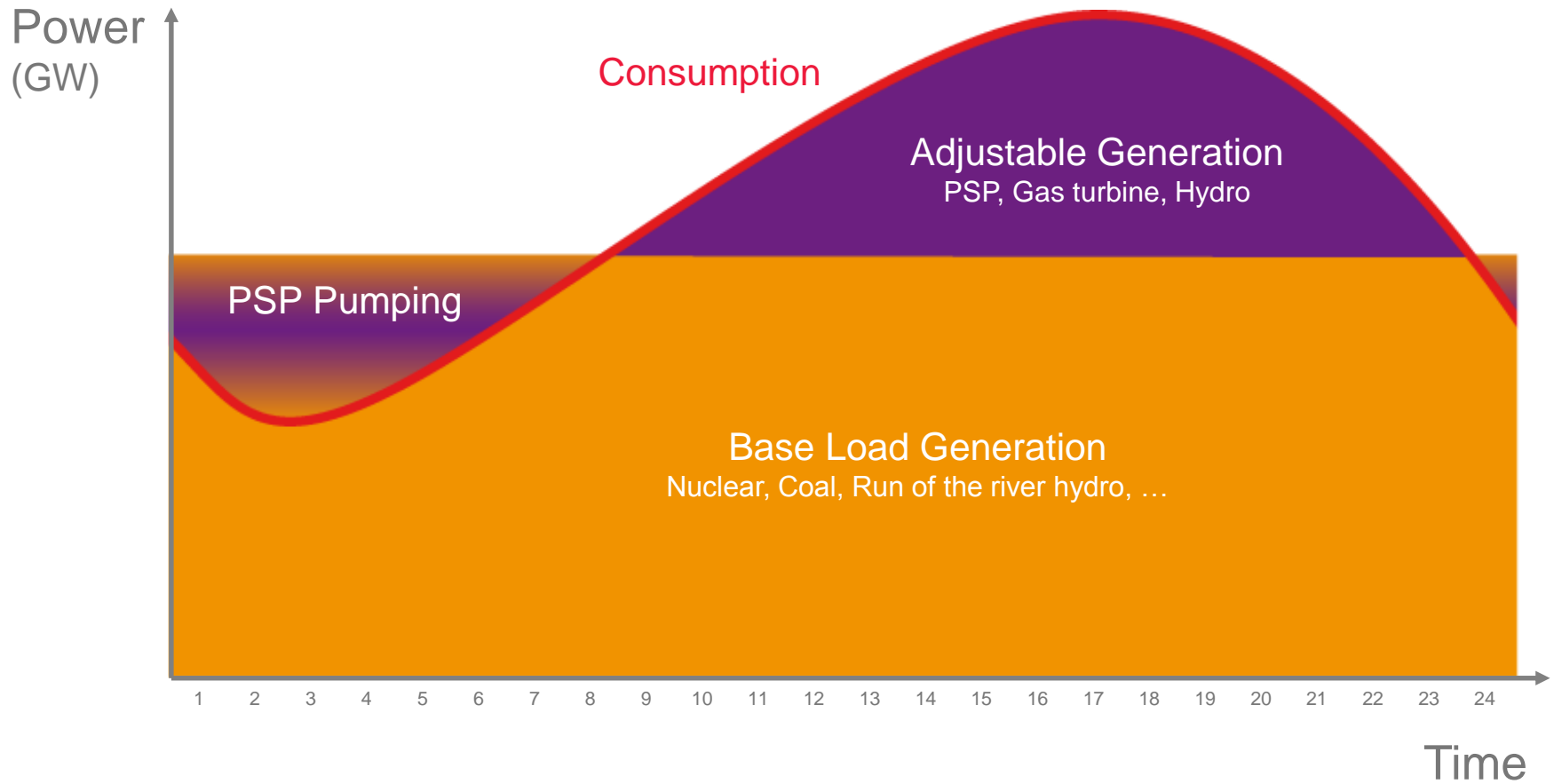


Complement ***intermittent renewable energies***

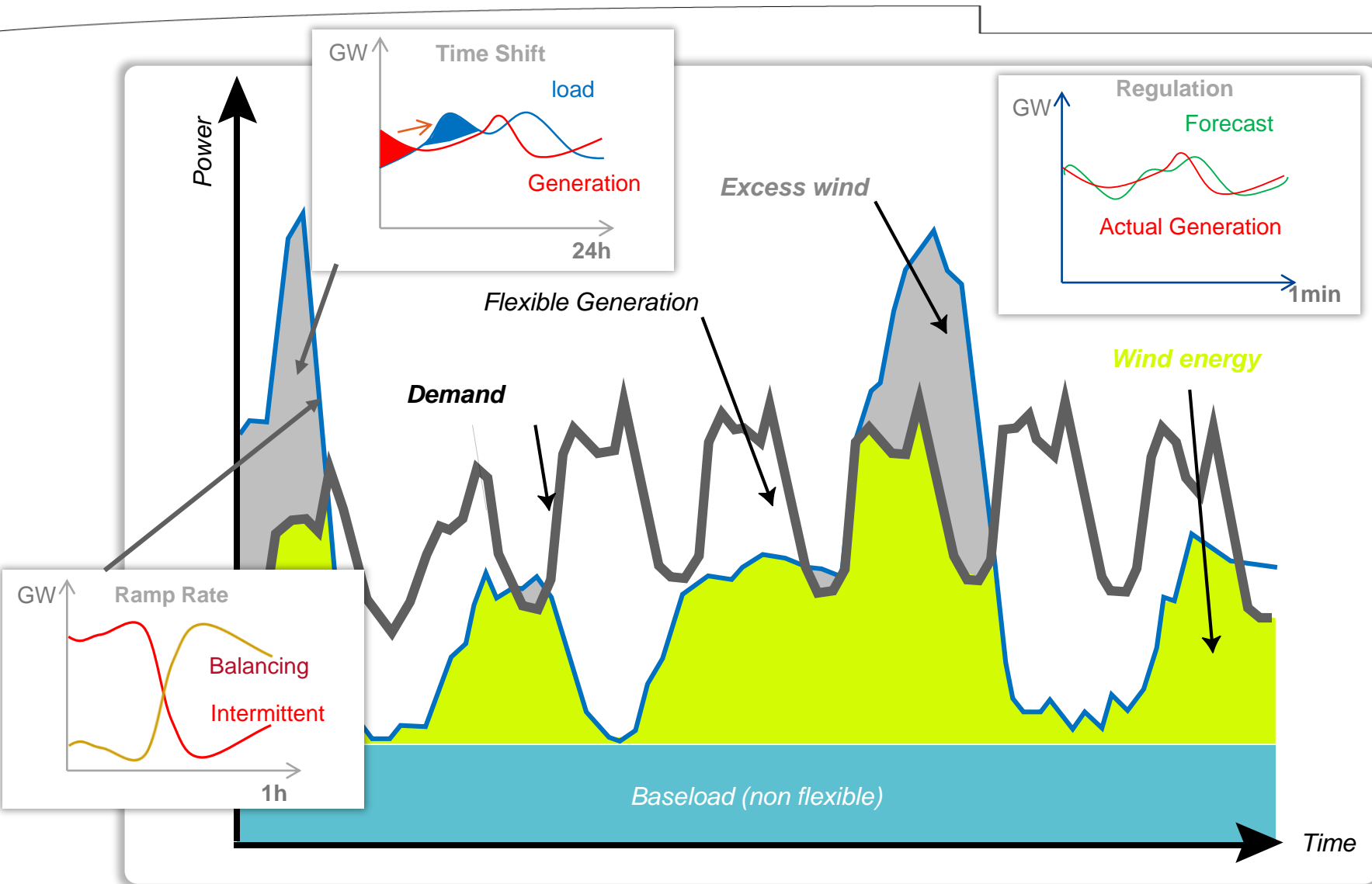


Optimise ***electrical grids***

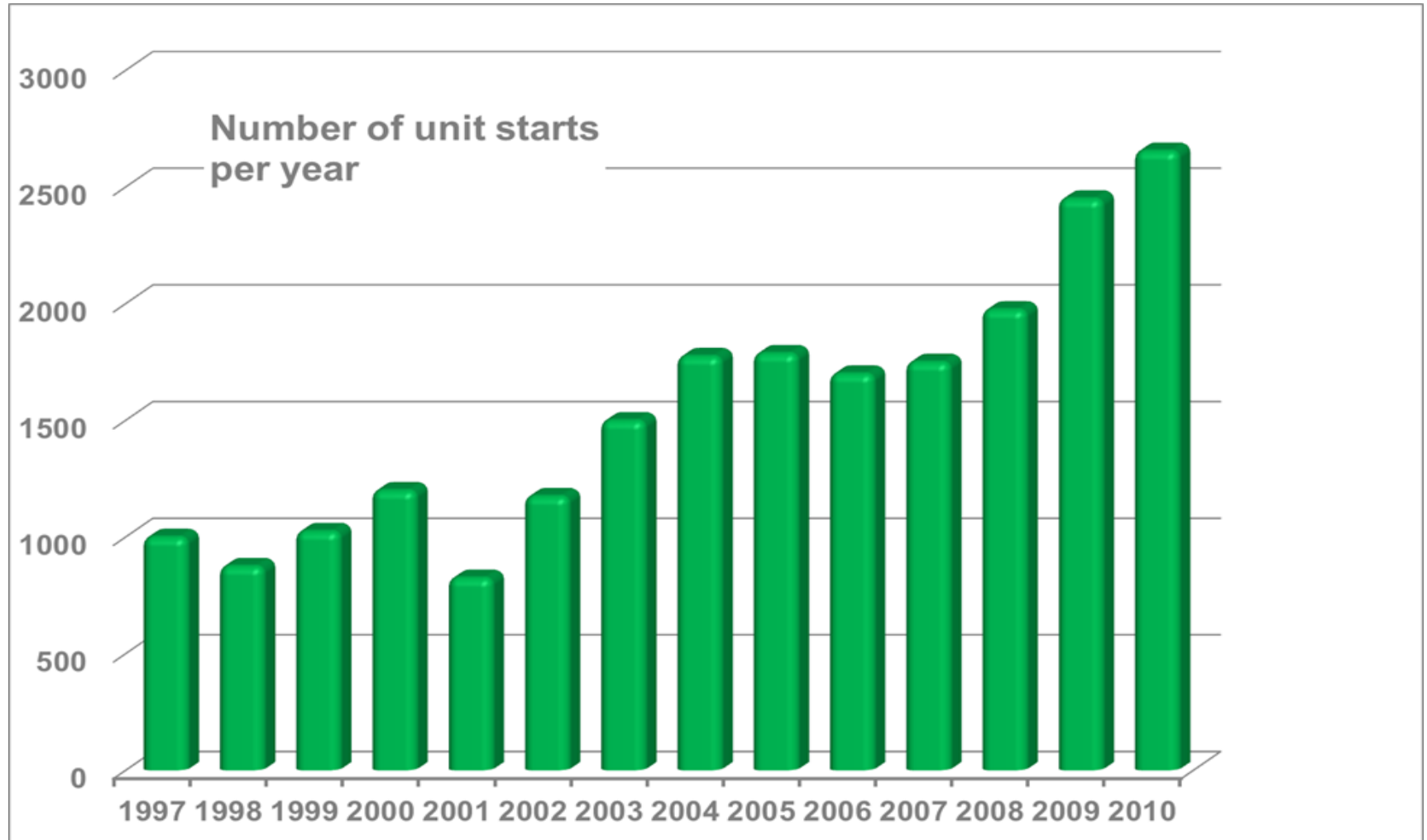
Thermal & Nuclear plants optimisation



New need for flexibility



Increase of unit cycling

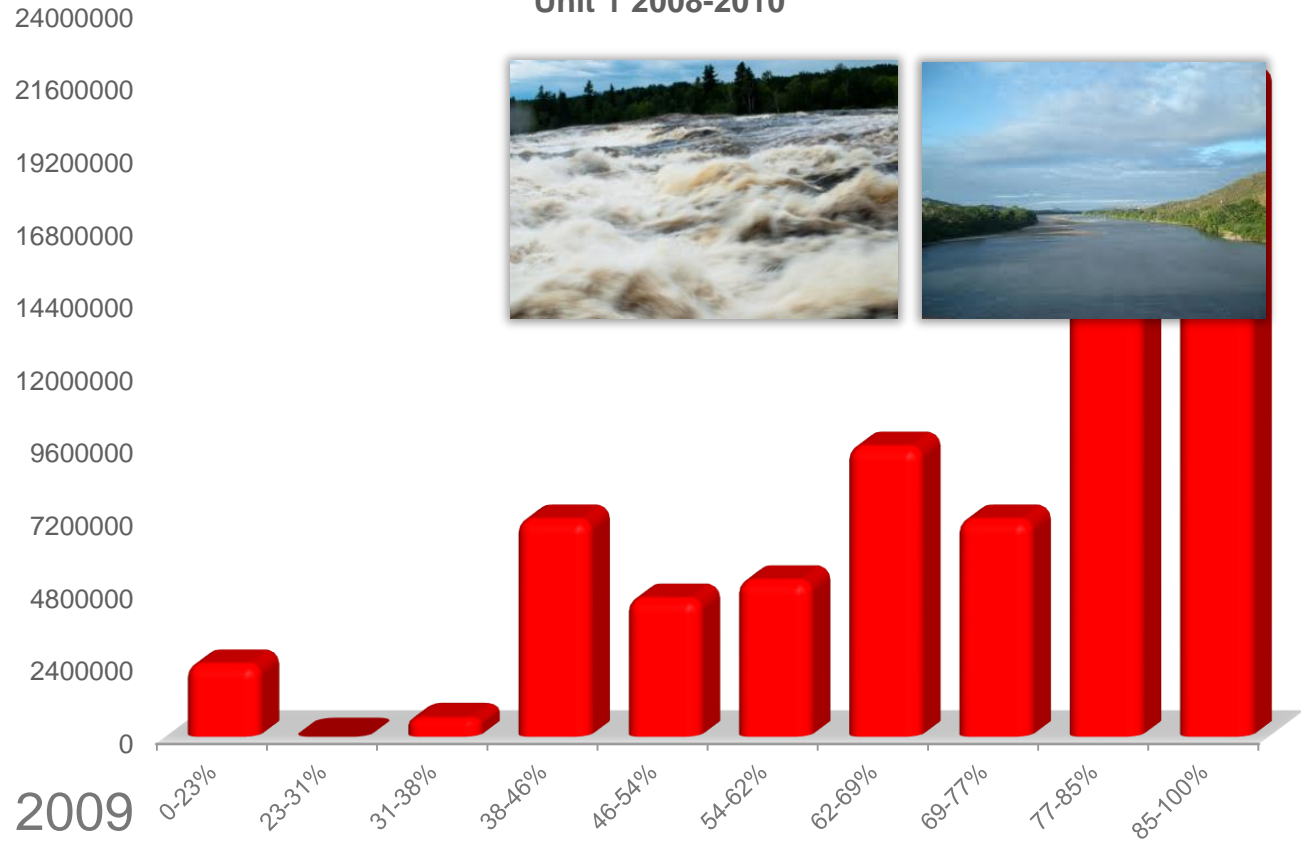


Increased partial load operation

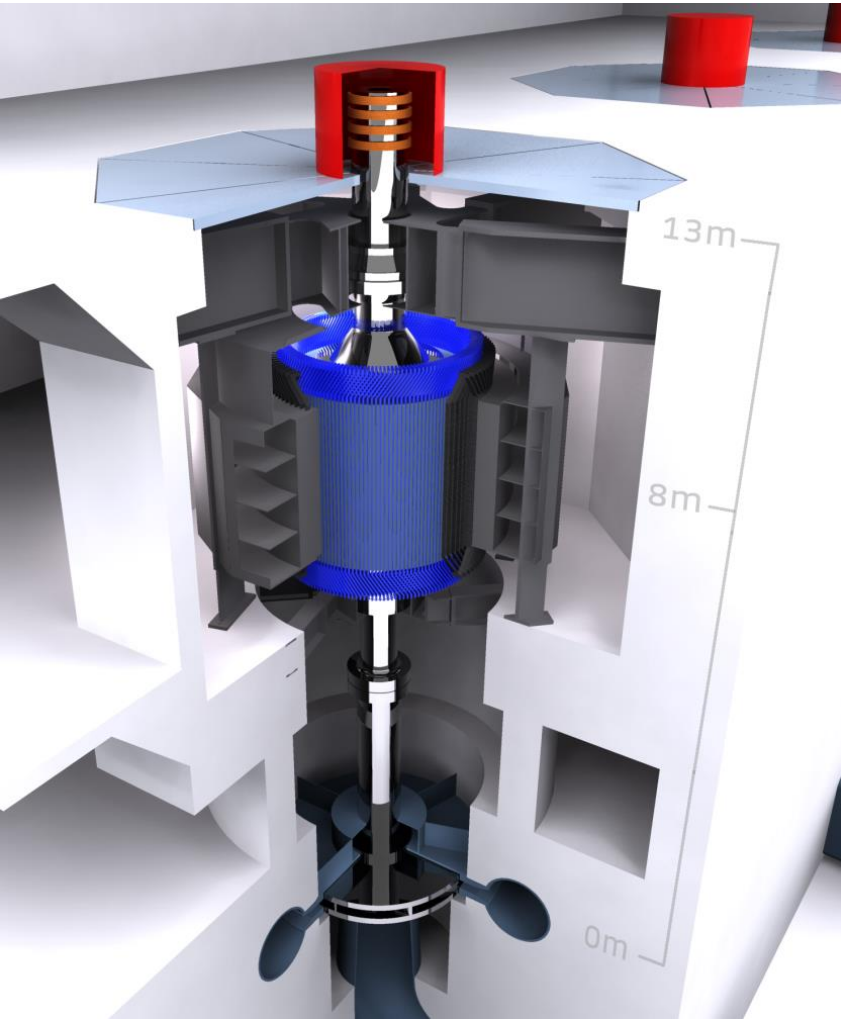
Unit 1 2005-2007



Unit 1 2008-2010



PSP Development Trends



Performance improvement

- Efficiency: 70 to 80% in 40 y.
- Availability, Reliability, Cycling

Overcoming topological limitation

- Very High or Very Low Head
- Head range increase
- Underground reservoir
- Sea water operation

Maximising flexibility

- Variable Speed offering
- Power range increase
- Reaction time reduction

Variable speed PSP

Double Fed Asynchronous Motor Generator

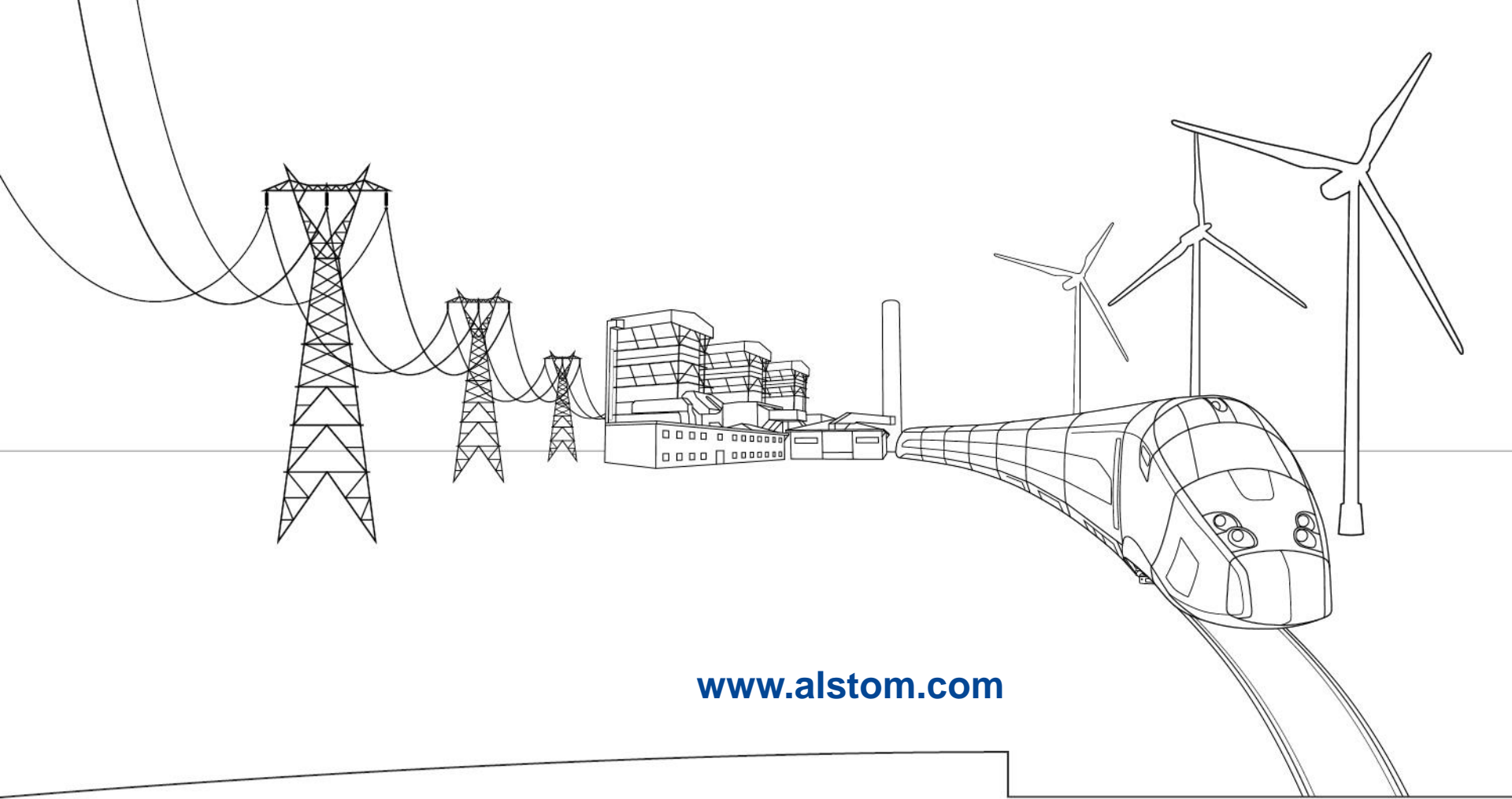
-
- Adjustable pumping power
 - Compatible with larger head variation
 - Faster power adjustment
 - Pump Turbine global efficiency (+ ~ 1%)
-



PSP allows Renewable to remain Renewable

Customised solutions for each application

Economical feasibility highly depends on
regulatory framework



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