



HydroCen

NORWEGIAN RESEARCH CENTRE FOR HYDROPOWER TECHNOLOGY

Pumpe-turbines in existing powerplants

Hydropower Summit, Trondheim, 05.02.2020

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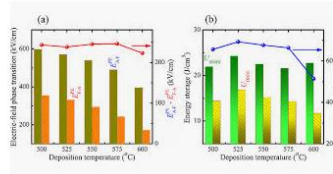
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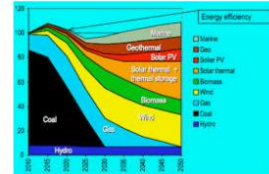
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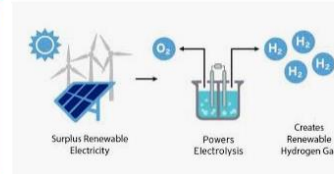
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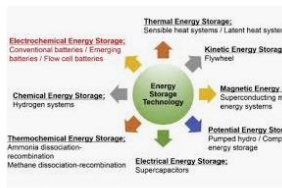
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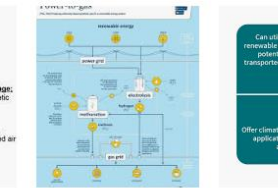
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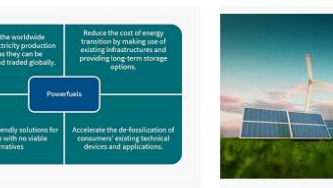
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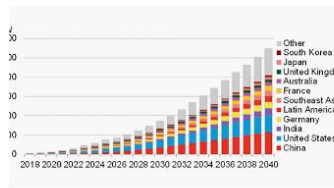
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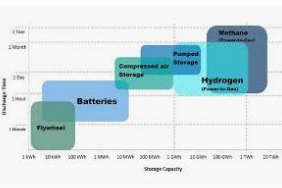
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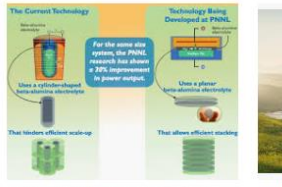
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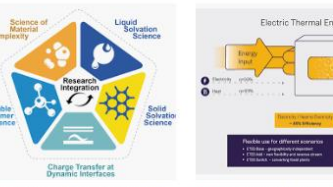
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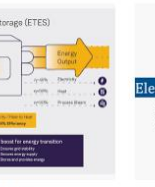
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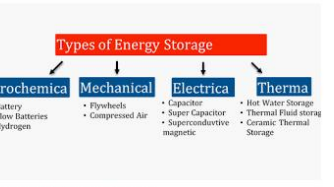
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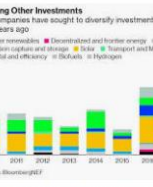
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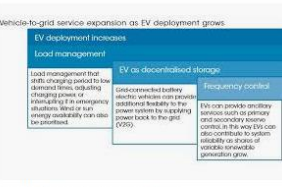


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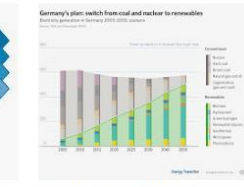


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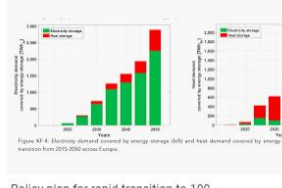
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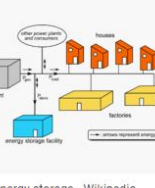
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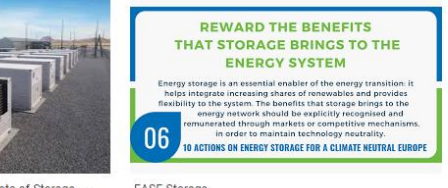
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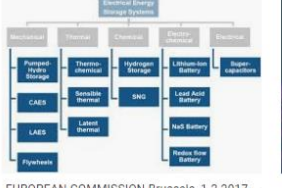
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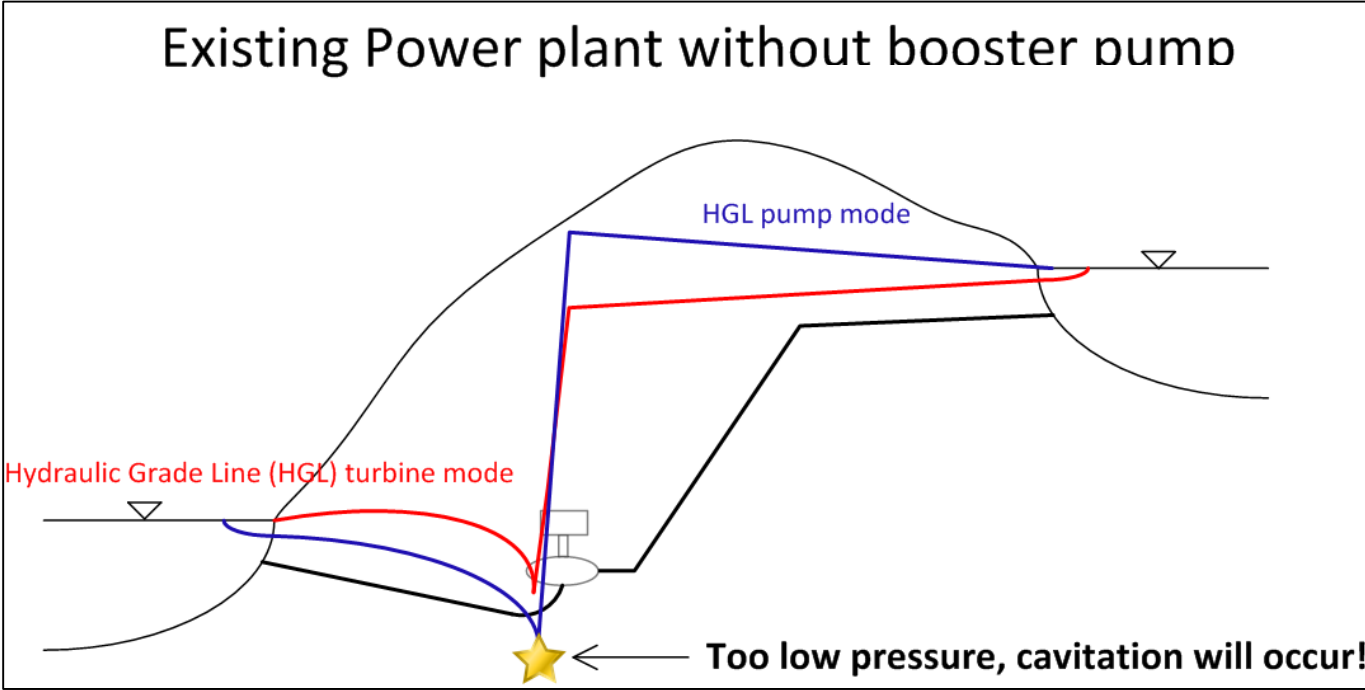
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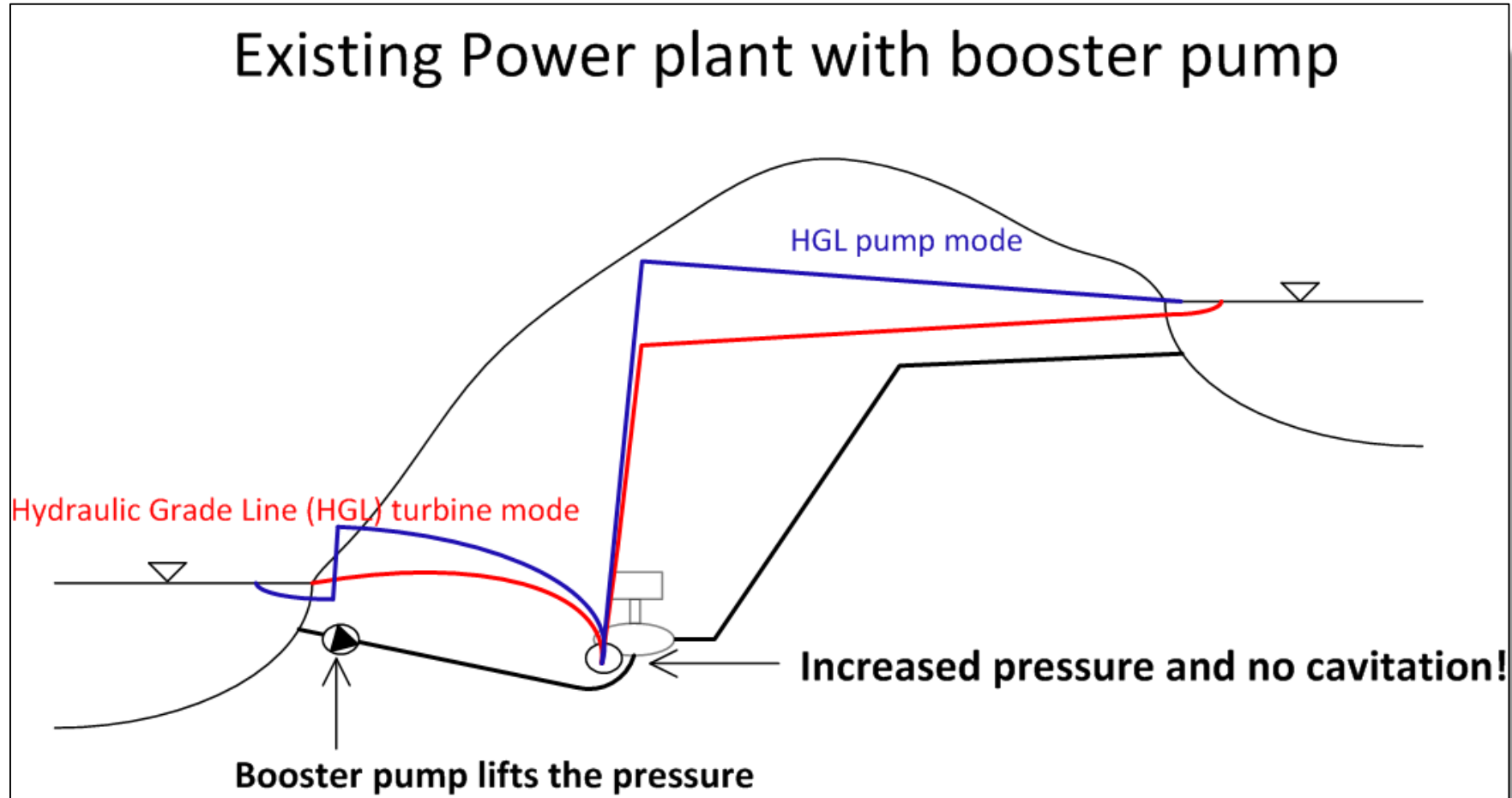
Storage Hydropower can provide dispatchable electrical energy, but some locations are suited for Pumped Storage Hydropower

Replacing existing Francis units with Reversible Pump Turbines (RPTs) should enable reuse of existing infrastructure and provide a cost-effective retrofit of pumping capabilities?

«Cavitation» is the phenomena which makes this retrofit difficult; the RPT should ideally be positioned much lower than the existing turbine location to avoid cavitation.



Suggested solution: boost the pressure



Added benefit of the booster pump presence:

- Relieving the RPT of some of the effort; not necessary with the same increase in centripetal acceleration to get pumping action as without the booster pump
 - Not requiring as much increase in rotational speed and/or pump outlet diameter adding to the potential of reusing as much infrastructure as possible
- Lifting height of the RPT in pumping mode more similar to net head in generating mode
 - The penalty in generating mode on turbine efficiency should be less, and new design will possibly make stability issues less prominent

Many possible configurations

Limitations for the work are necessary, our choices:

- Rotational speed up to one synchronous speed higher than the original one (we don't believe that the booster pump alone can cover the lifting height deficit)
 - Modification of existing synchronous generator or adding variable speed capabilities?
- Pump outlet diameter within limitations on the existing unit (Roskrepp HPP)
 - Makes reusing existing spiralcasing possible

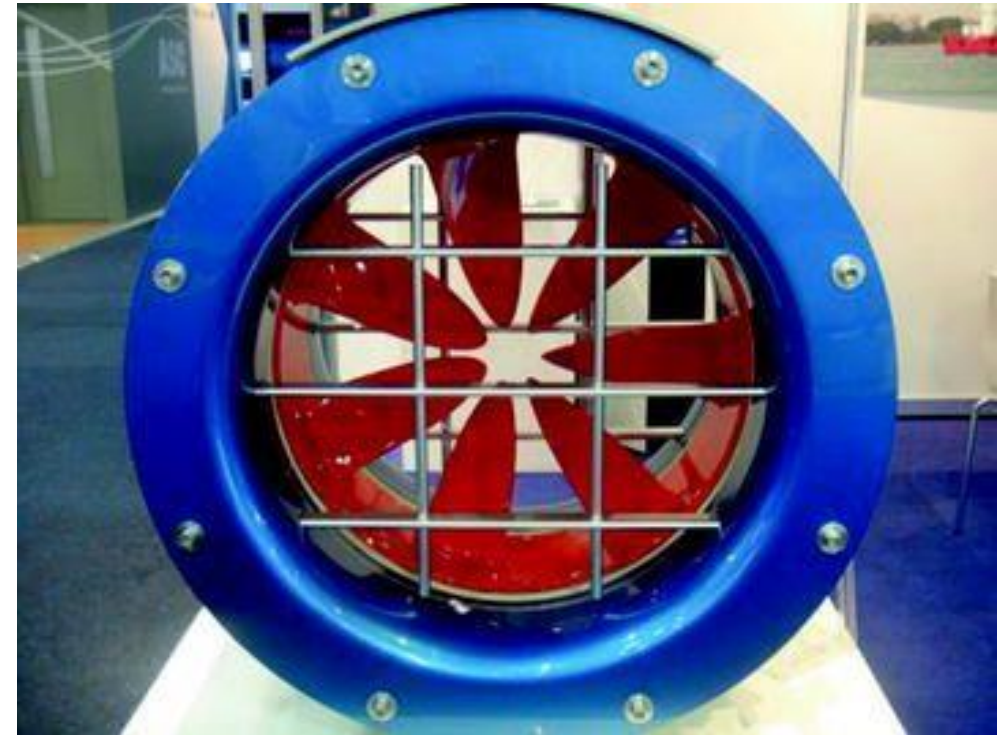
- Booster pump developed based on two stage counter rotating rim driven axial machine (retractable versions exist in marine industry, can such booster pump be removed from the flow in generating mode?)

→ Two of these in series configuration, in huge size?

Overlapping work with ALPHEUS project (H2020)

The project is delayed due to happy circumstances (Maternity leave)

PhD within electrical engineering has been difficult to recruit



Three master theses on different aspects of the topic:

- Stable operation is likely to be achieved
- Semiaxial pump gives a low efficiency for the proposed application
- Having a small swirl in the flow leaving the pump will increase the lifting height of the RPT

Thank you for your attention!