A New Wind Turbine Drivetrain & Energy Storage Capabilities

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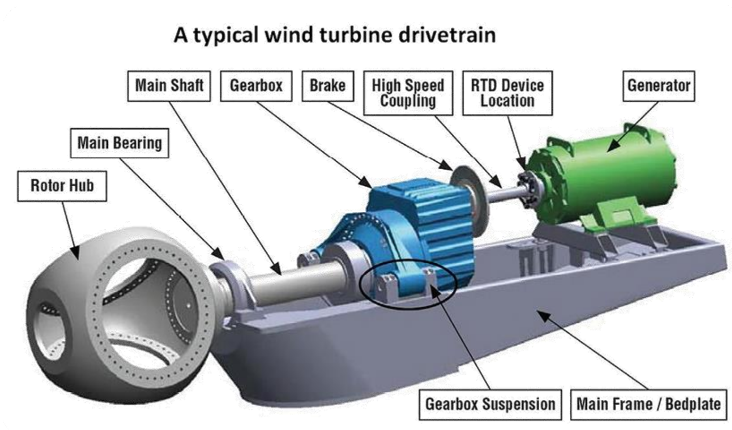
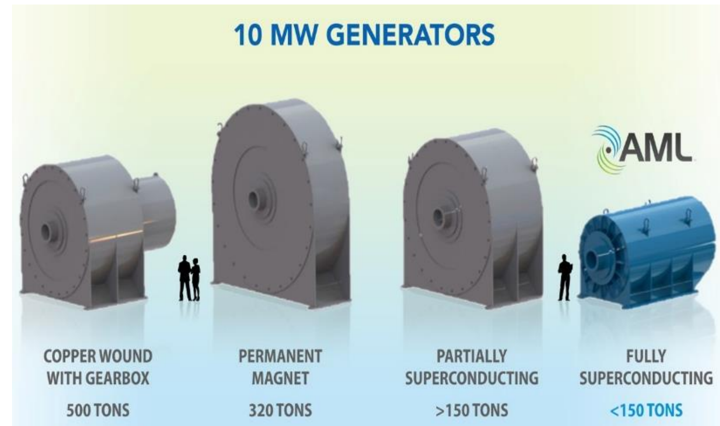
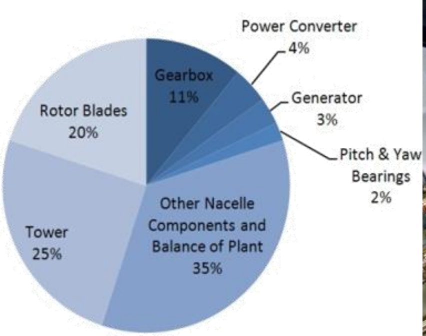
Wind Drivetrain Development

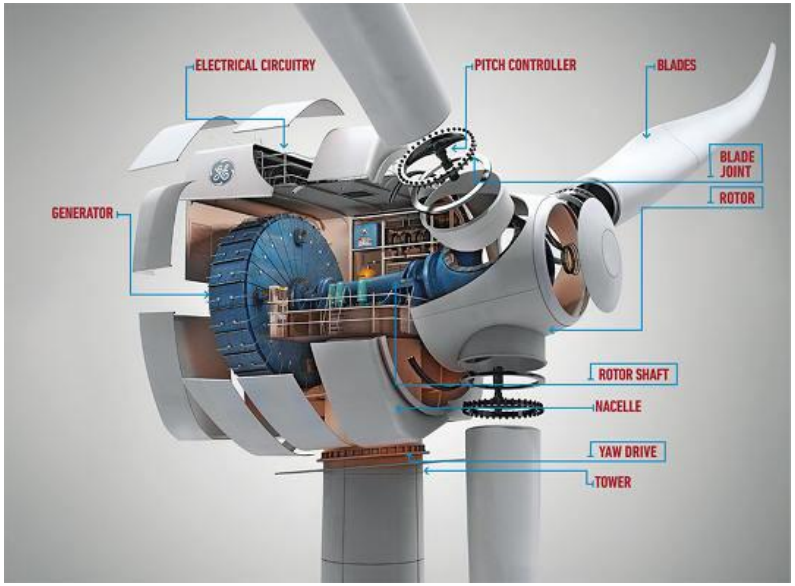




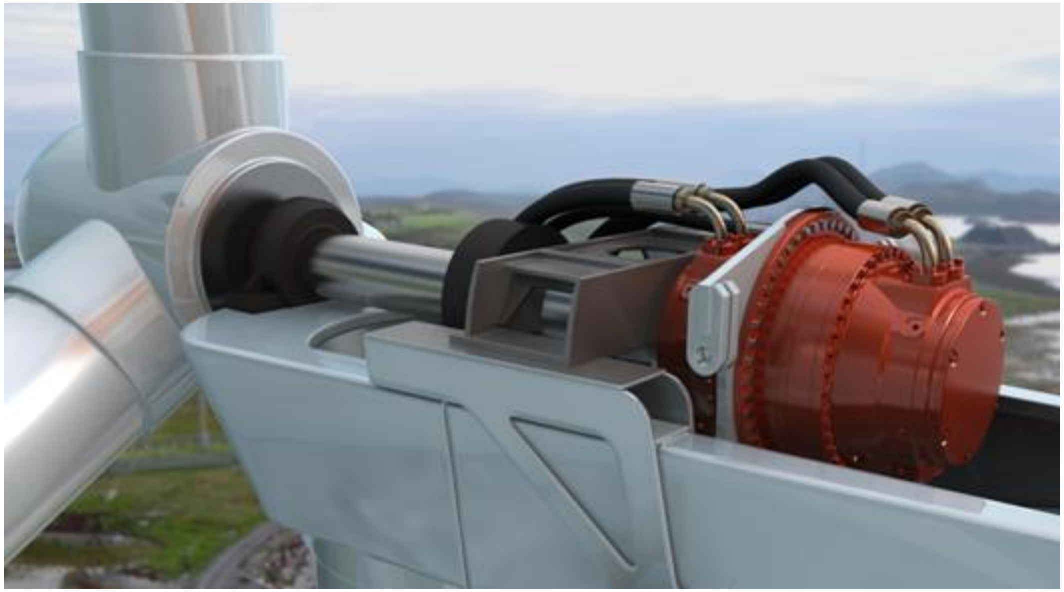


Alternative Options

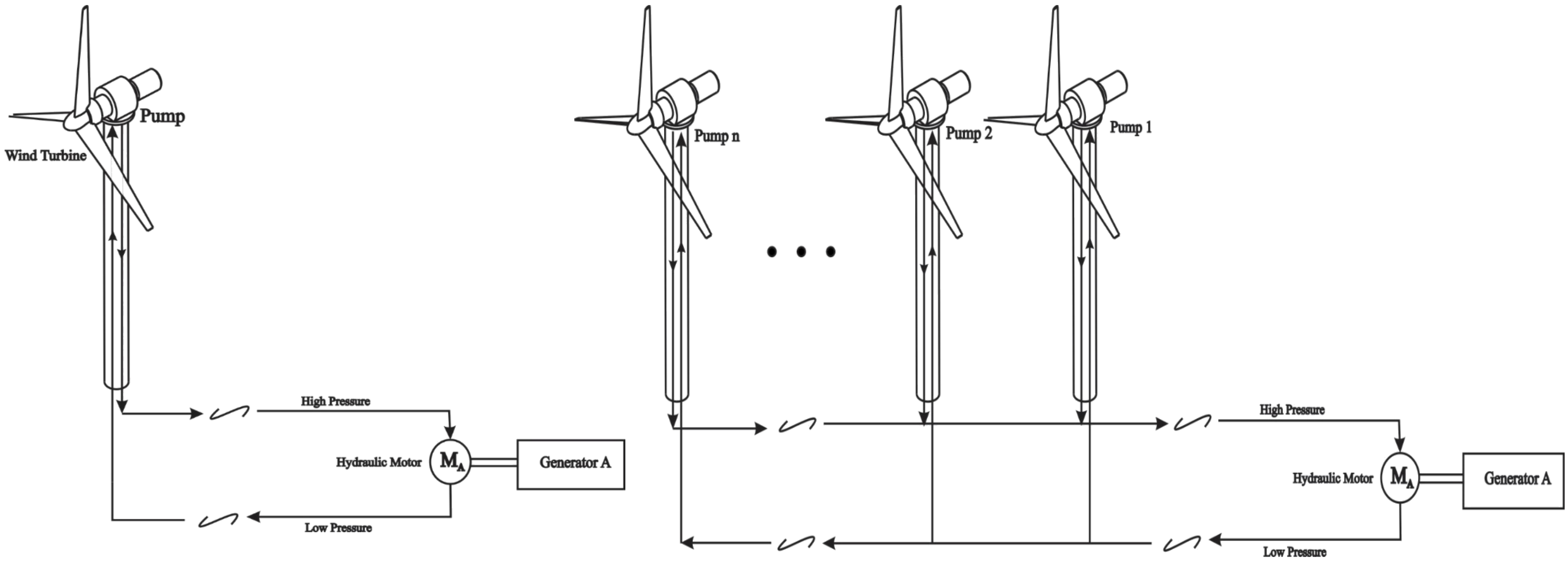
Direct Drive



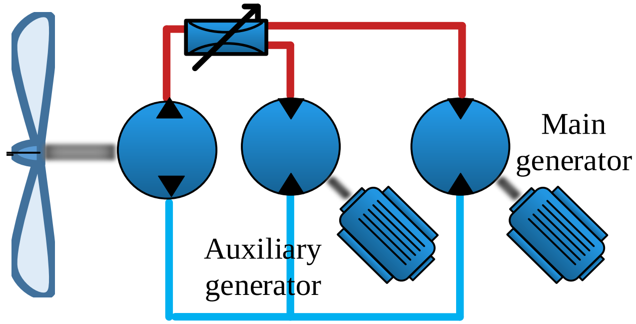
Hydraulic Systems



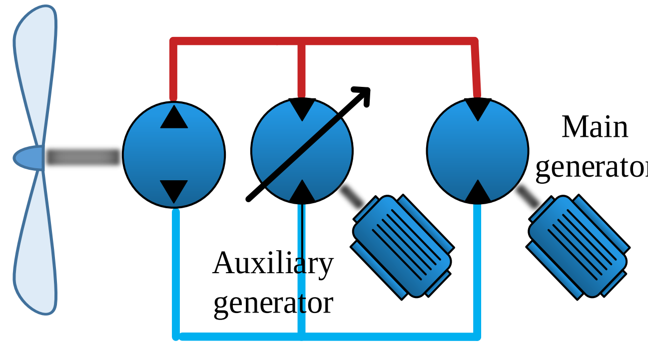
System Operation Expansion



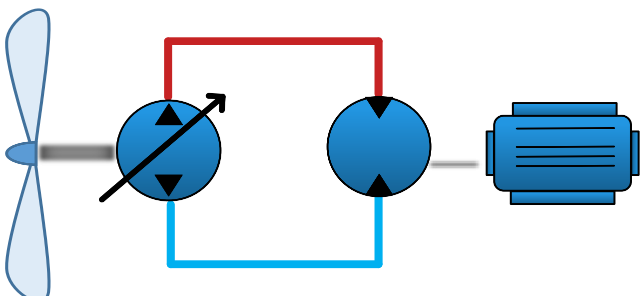
New Drivetrain Configurations



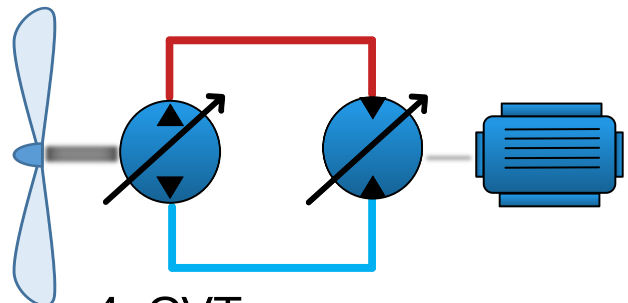
1. Flow Control Valve



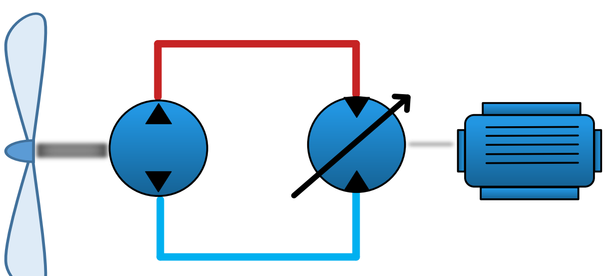
2. Less Resistive Path



3. Demand Flow

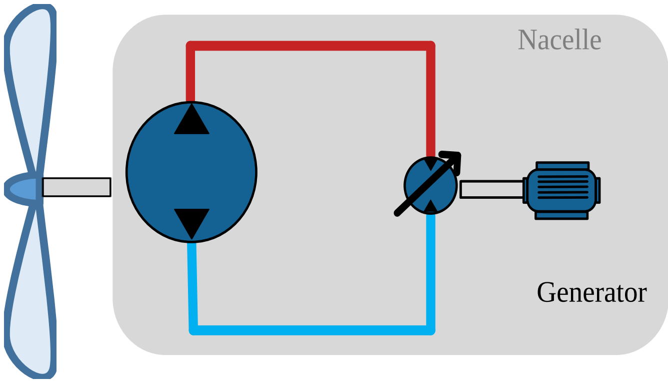


4. CVT

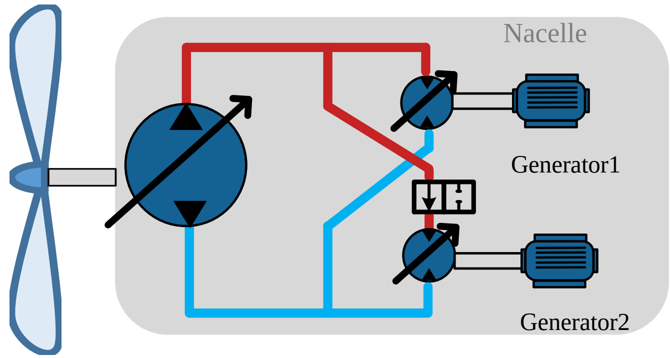


5. Constant Flow

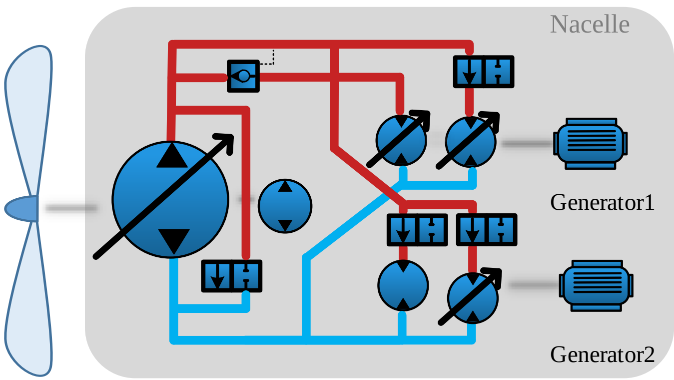
Existing Industry Examples



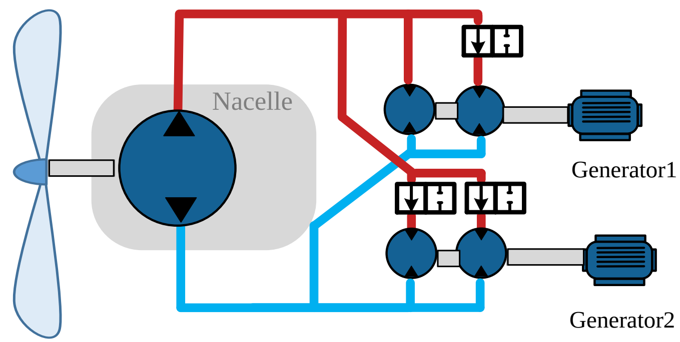
1. ChapDrive Drivetrain



2. Artemis Drivetrain



3. IFAS Concept
(Institute for Fluid Power Drives and Controls)



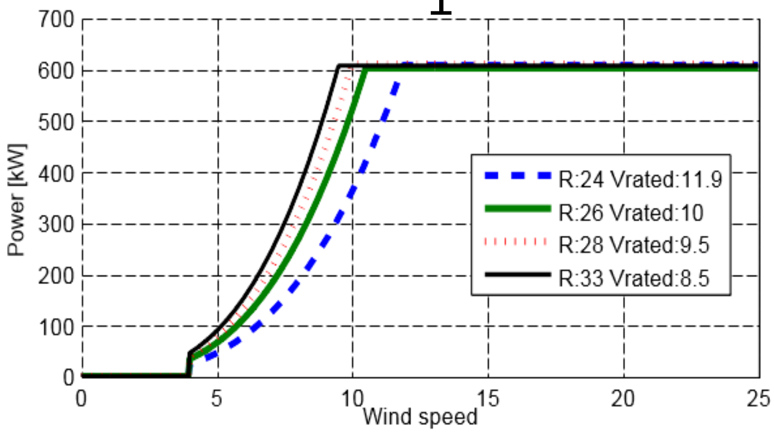
4. Statoil Drivetrain

Hydraulic Drivetrain

- Hydraulic drivetrain
  - Elimination of power converters
  - Weight reduction from the nacelle
  - Low cost generator technology
    - Fixed speed synchronous
  - Simultaneously achieve of MPPT at fixed speed operation of generator
  - Increased AEP
  - Collect energy of multiple wind turbines to one central generation unit
  - Increase the capacity factor of the plant.
  - Reduce capital cost
  - Reduce operation cost
  - Reduce maintenance cost

T, P, Efficiency Improvements Compared with Existing System

1



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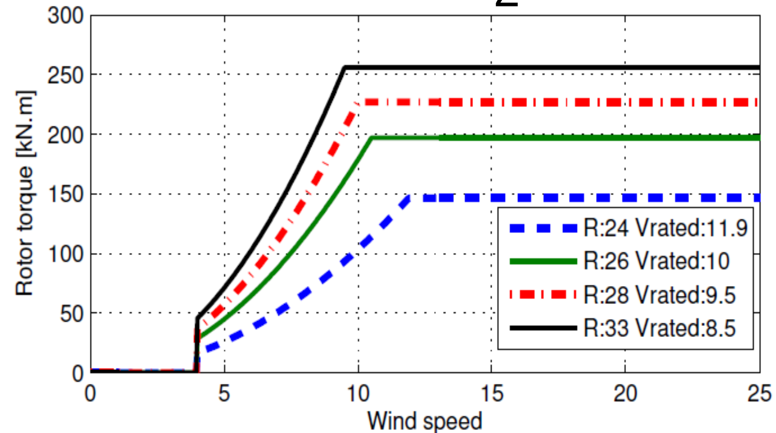

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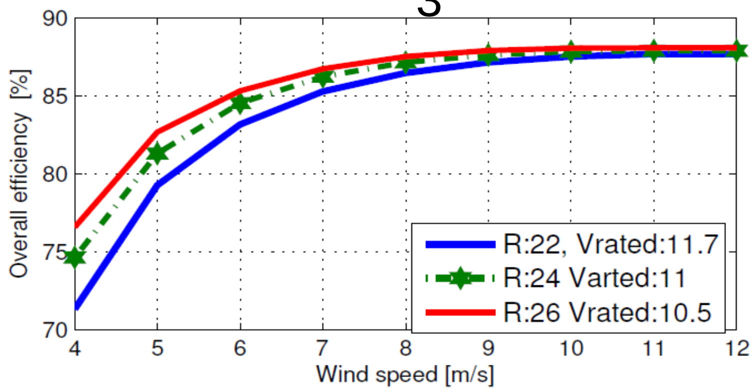

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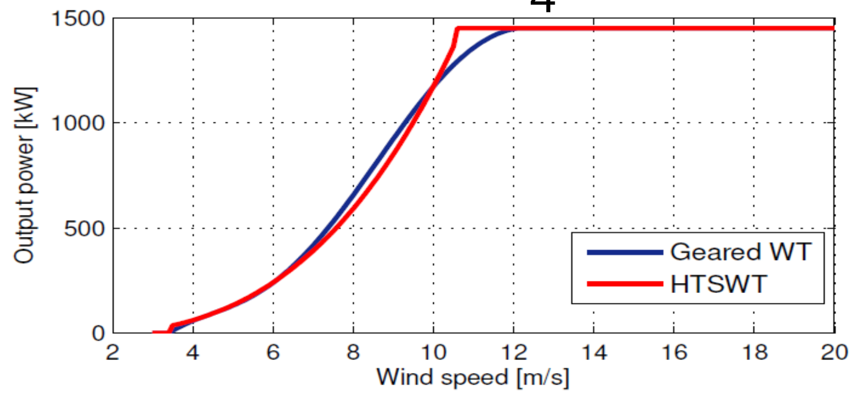
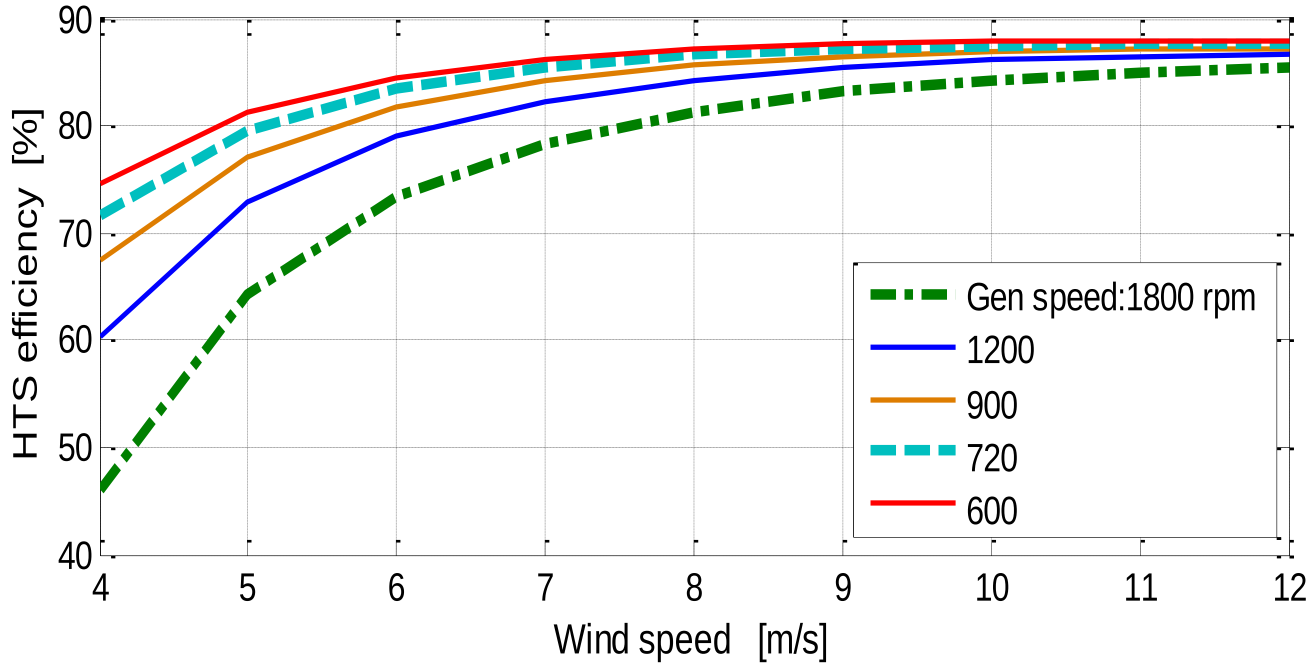
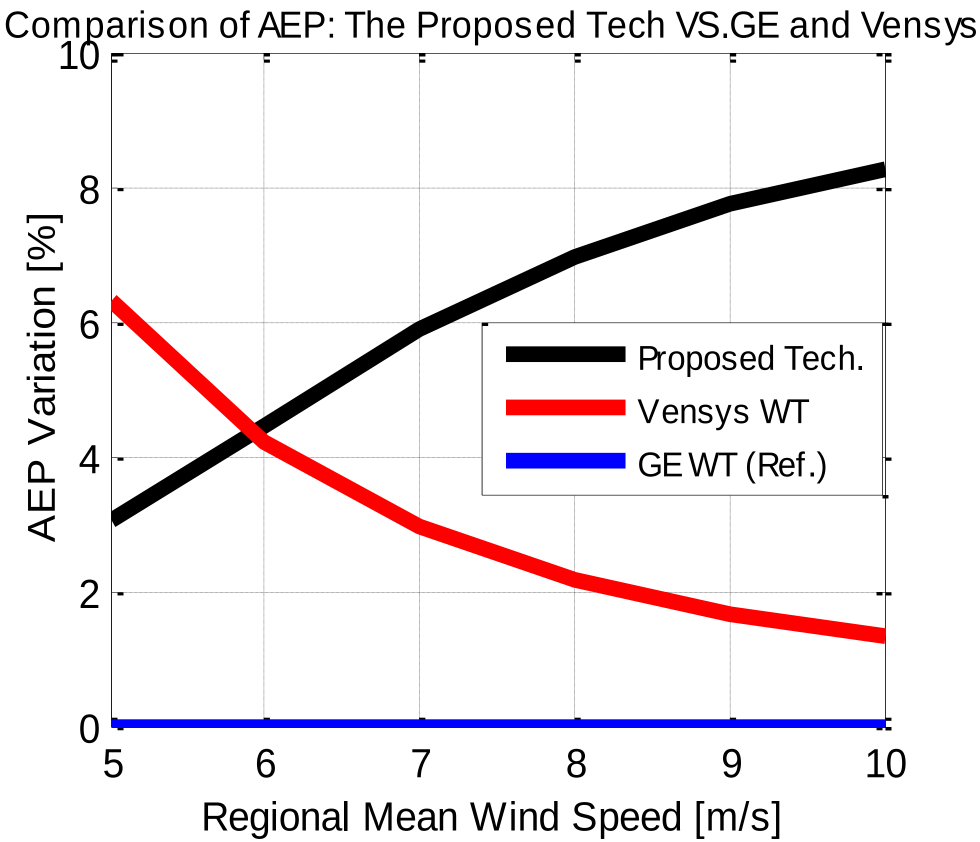


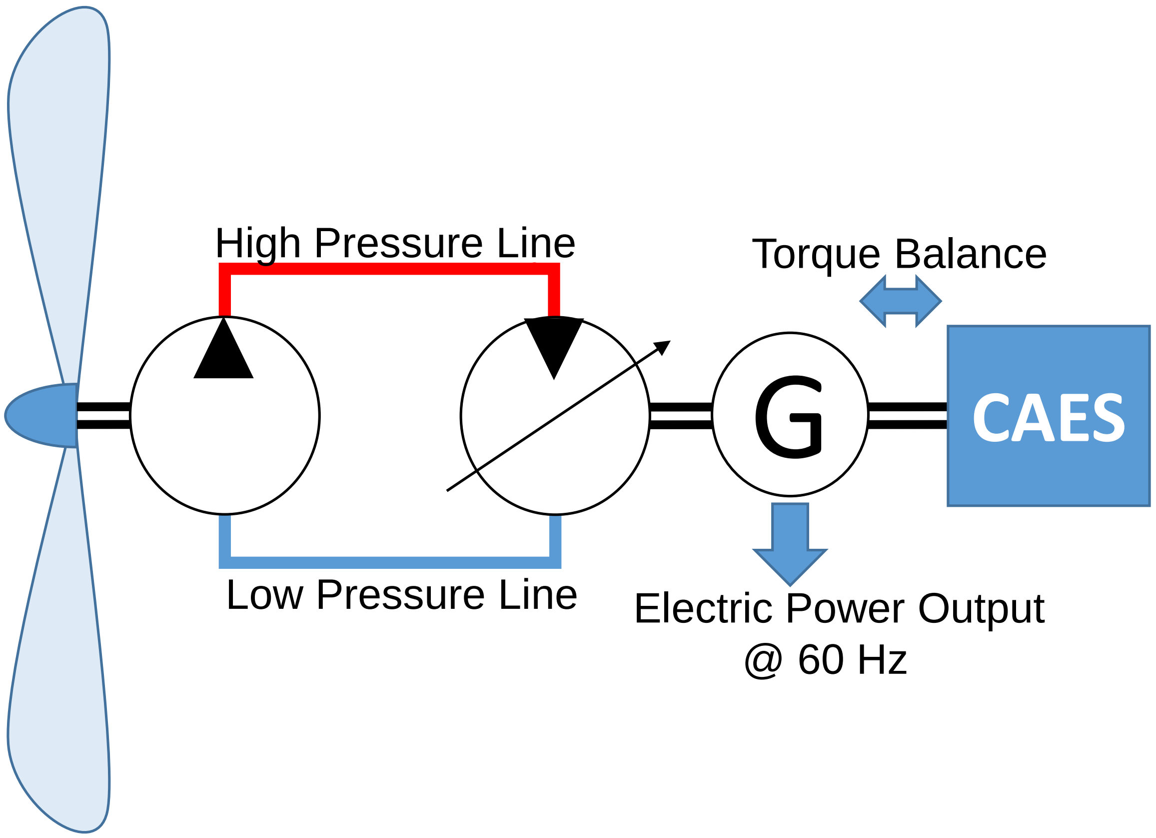
Effect of Hydraulic Motor/Generator Speed on HTS Efficiency



AEP Comparison with Existing Technologies

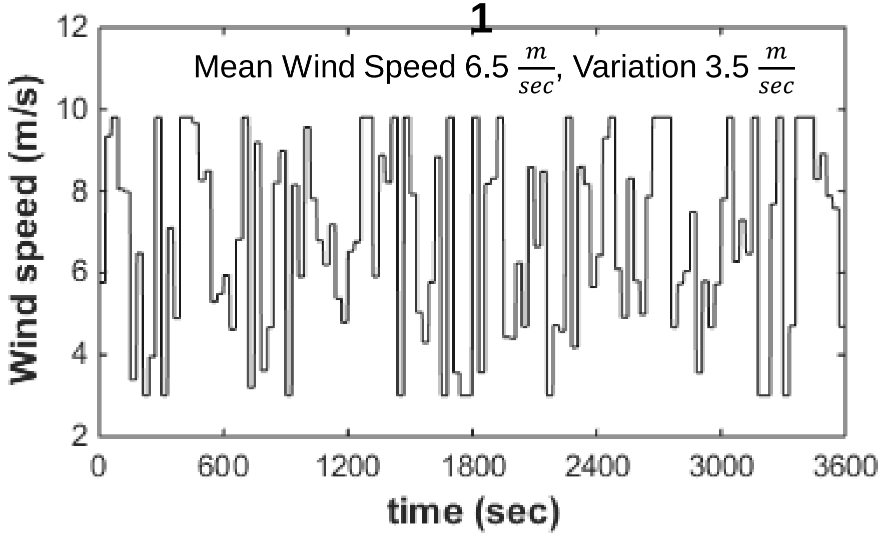


Energy Storage Integration



Effect on Power Quality (A case Study)

1



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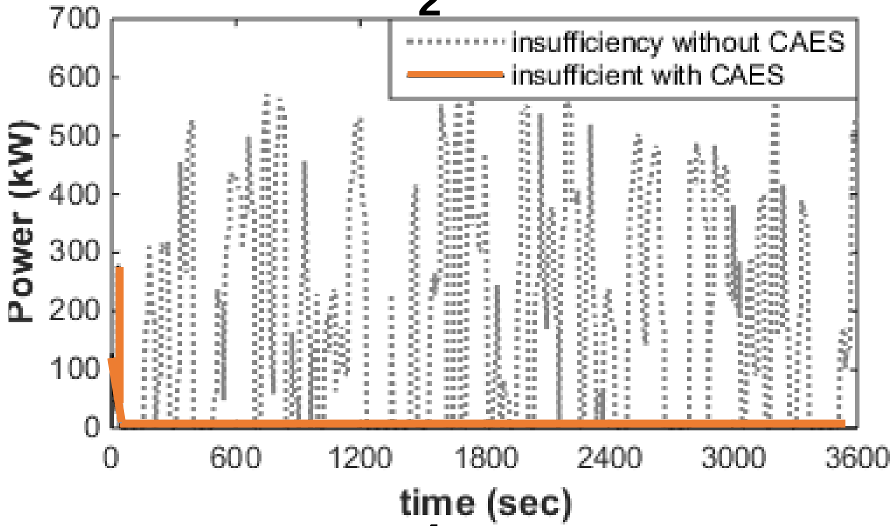

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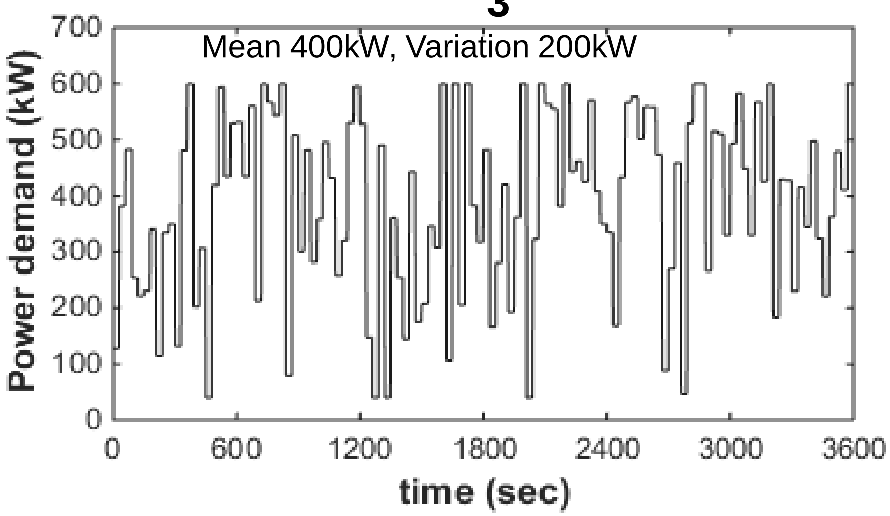

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