**Research Topic for the ParisTech/CSC PhD Program**

## *Field: Energy, Processes*
## *Subfield*: Applied Physics

# *Title*: Efficiency enhancement of the compressed air energy storage (CAES) process

***ParisTech School:*** Arts et Métiers Sciences et Technologies

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***Lab location***: *151 Boulevard de l'hôpital 75013 PARIS*
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***Short description of possible research topics for a PhD***:

The intermittent nature of renewable energy has pushed in recent years the need for efficient, reliable, low-cost and scalable energy storage technologies. Given its relatively high efficiency and its low environment impact, electro-mechanical storage appears as a good candidate. CAES (Compressed Air Energy Storage), which belongs to this family, is a promising technology but requires high compression ratio to be competitive.

This PhD research aims at analysing the CAES process and at designing versatile and innovative technologies in order to improve its overall efficiency. CAES systems involve specific mechanical devices (pumping system, compression/expansion chamber, turbines, etc) and a strong coupling between different fields of applied physics, such as thermal management, turbomachinery, multiphase flow, material science, etc. A global and systemic approach is thus necessary to carry out this research project.

The thesis will be mainly experimental, but will also involve numerical modelling. An experimental rig capable of achieving high-pressure ratio has already been set up in the LIFSE laboratory. The student will therefore be prompted to carry out tests.

***Required background of the student***:
Physics / Fluid Dynamics / Thermodynimics

***A list of 5 (max.) representative publications of the group:***

1. Specklin, M., Deligant, M., Porcheron, S., Wagner, M., Bakir, F., (2019) Experimental study and modelling of a high-pressure ratio liquid piston compressor, *14th International Conference on Heat Transfer, Fluid Mechanics and Thermodynamics* Wicklow, Ireland
2. M.A. AitChikh, I.Belaidi, S.Khelladi, J.Paris, M.Deligant}, and F.Bakir.
Efficiency of bio- and socio-inspired optimization algorithms for axial turbomachinery design.
3. Smoothed particle hydrodynamics: A consistent model for interfacial multiphase fluid flow simulations.
Journal of Computational Physics}, 358:53—87, 2018.
4. Deligant, M., Sauret, E., Danel, Q., & Bakir, F. (2020). Performance assessment of a standard radial turbine as turbo expander for an adapted solar concentration ORC. *Renewable Energy*, *147*, 2833-2841.
5. Deligant, M., Danlos, A., Podevin, P., Clenci, A., & Guilain, S. (2017, October). Surge detection on an automotive turbocharger during transient phases. In *IOP Conf. Ser. Mat. Sci. Eng.* (No. 12082).