# MSc Thesis Proposal Abroad

**(In collaboration with the Reliability and Risk Management Lab of Tsinghua University, China)**

## ❖ Title of the research

Deep Transfer Learning Methods for Prognostics and Health Management (PHM) of Batteries

## ❖ Objectives of the research

Batteries are highly nonlinear energy storage devices and their performance is very sensitive to the operating conditions (e.g., temperature, voltage, current, state-of-charge, etc.). Moreover, the performance of batteries degrades over time. Consequently, to avoid costly downtime periods, the estimation of battery states (e.g., state-of-charge, state-of-health, etc.) and remaining useful lifetime (RUL) prediction are mandatory.

Without the complex modeling and priori knowledge, the data-driven methods have become the effective techniques for battery state estimation and RUL prediction. The recent advances of deep transfer learning have been widely investigated in the conditions of the rarity of labeled data and data shift across different tasks. The goal of this thesis project is to extend the deep transfer learning approaches to develop effective estimation algorithms of battery states under complex operating conditions. This thesis project involves the following main steps:

- Study the state-of-the-art on deep learning and transfer learning methods applied to battery PHM. The references may include, but are not limited to [1-4].
- Develop the deep transfer learning methods for state estimation and RUL prediction under a range of operational and environmental conditions.
- Implementation of the developed algorithms in a proper platform in Matlab and/or Python, and conduct method validation with the existing battery data.

**References:**

[1] H. Meng, Y.F. Li. 2019. A review on prognostics and health management (PHM) methods of lithium-ion batteries. Renewable and Sustainable Energy Reviews. 116, 109405.

[2] Y Zhang, Q Tang, Y Zhang, et al. 2020. Identifying degradation patterns of lithium ion batteries from impedance spectroscopy using machine learning. Nature communications. 11(1): 1-6.

[3] S Shen, M. Sadoughi, M. Li, et al. 2020. Deep convolutional neural networks with ensemble learning and transfer learning for capacity estimation of lithium-ion batteries. Applied Energy. 260: 114296.

[4] J Ma, P Shang, X Zou, et al. 2021. A hybrid transfer learning scheme for remaining useful life prediction and cycle life test optimization of different formulation Li-ion power batteries. Applied Energy. 282, Part A, 116167.

For further information, please contact Prof. Enrico Zio enrico.zio@polimi.it, Prof. Yanfu Li, liyanfu@tsinghua.edu.cn or Dr. Te Han, hant15@tsinghua.org.cn