PhD Thesis Proposal Call

Organization proposing the subject:

I-Identification of the thesis project

1. Thesis title and fields:

- **Thesis title in English:** Development of a Comprehensive Database and Optimal Flexibility Indicator for Smart Retrofitted Buildings.
- **Disciplinary field(s):** building energy, building physics, building science, energy engineering.
- **Specialties:** building energy retrofit, demand response, building energy flexibility, database development, data analytics.
- **Keywords:** smart retrofit, database, energy efficiency, flexibility, Key Performance Indicators, grid interaction.

2. Structure(s) and/or host laboratory(ies) where the doctoral student will be located:

- Main location: LTDS team GCD, ENTPE.
- Name and address: LTDS/ENTPE: 3 rue Maurice Audin 69120 Vaulx-en-velin
- As part of the thesis, the PhD candidate will plan with the co-superviser at BUILDERS École d'ingénieurs, Lab in Caen some visits according to the needs of the thesis.

3. Supervision

- Thesis supervisors:
  - Mohamed El Mankibi, Research Director (DR1), ENTPE, 3 rue Maurice Audin 69120 Vaulx-en-velin, mohamed.elmankibi@entpe.fr , +33 (0) 6 42 45 64 75.
  - Nassim Sebaibi, Head of research Unit at Builders Lab, BUILDERS École d'ingénieurs, Builders Lab, 1 Rue Pierre et Marie Curie 14610 Epron, nassim.sebaibi@builders-ingenieurs.fr.
- Thesis co-supervisors:
  - Joud Aldakheel, Postdoctoral researcher. ENTPE, 3 rue Maurice Audin 69120 Vaulx-en-velin, joud.aljumaaaldakheel@entpe.fr , +33 (0) 6 40 79 58 38.
  - Rime Chehade, Temporary Teaching Researcher, Builders École d'Ingenieurs, 3 rue Maurice Audin 69120 Vaulx-en-velin, rime.chehade@builders-ingenieurs.fr.

II-Summary of the thesis project

1. Context and aim

As buildings are responsible for 40% of global energy consumption and 33% of greenhouse gas emissions, retrofitting existing buildings with smart technologies has emerged as a crucial strategy to enhance energy efficiency, reduce environmental impact, and optimize building performance. RE-SKIN (Renewable and Environmental-Sustainable Kit for building Integration) is an EU project that this thesis will be a part of and aims to enhance total energy and environmental efficiency in the building sector, intensively applying at the same time the life cycle sustainability and circular economy principles. The project is expected to develop and demonstrate an integrated, multi-technology and low-impact renovation package for energy retrofit and smart upgrade of residential, public, and commercial buildings. It emphasizes the importance of considering the entire life cycle of buildings and leveraging ICT technologies to optimize design, performance, and management.

However, despite the advancements in smart retrofitting, there are notable gaps in the availability of data on smart retrofitted buildings and the assessment of their performance. Quantitative analysis and validation of crucial aspects such as flexibility, demand-side management, advanced control systems, grid interaction, and renewable energy integration require access to real monitored data from smart retrofitting projects. The lack of a comprehensive and easily accessible database hampers research and validation efforts in the field, hindering the optimization and wider adoption of smart retrofitting practices. Furthermore, while flexibility indicators play a pivotal role in assessing the adaptive capabilities of smart retrofitted buildings, the lack of consensus and standardized calculation methodologies for flexibility indicators poses a challenge. Existing indicators often focus on a limited set of parameters and fail to capture the holistic nature of flexibility, which depends on factors such as energy storage systems, control systems, user behavior, and climate conditions. A comprehensive and optimal flexibility indicator is needed to accurately evaluate the ability of smart retrofitted buildings to adjust energy consumption and production dynamically.

To this end, the proposed PhD thesis aims to refine and develop an optimal flexibility indicator that encompasses the three properties of time, energy, and costs, providing a holistic assessment of the building's adaptability. Additionally, it aims at developing a comprehensive database that consolidates data on smart retrofitted buildings, facilitating data-driven research and validation efforts. The database will provide hourly data on building energy demands, consumption patterns, retrofitting interventions, renewable energy integration, storage performance, and grid interaction.

2. Innovative character of the thesis:

This research aims to enhance the understanding of smart retrofitting practices, optimize system performance, and contribute to the advancement of sustainable building practices.

The PhD thesis will provide valuable insights into data management, database development, flexibility assessment methodologies, and their practical applications within the RE-SKIN project and the broader field of smart retrofitting.
Specifically in this PhD thesis the candidate will undertake the following tasks:

1. Literature Review: Conduct an extensive review of literature on smart retrofitting, data availability, database development, and flexibility indicators. Then identify research current gaps and opportunities.
2. Database Design and Implementation: Design and develop the framework for the comprehensive database.
3. Data Collection and Analysis: collaborate with ongoing research projects and initiatives to collect data from smart retrofitted buildings.
4. Flexibility Framework Integration: Enhance the existing definition of Flexibility. Develop an approach that integrates the three properties of flexibility: time, energy, and costs.
5. Flexibility Indicator development: Refine the definition and calculation methodology of the flexibility indicator, considering smart retrofitted buildings.
6. Collaboration and Documentation: assist with the database developments in RE-SKIN project.

3. Specific qualifications and skills for the PhD candidate include:

The PhD candidate for this research project should have a strong background in the field of sustainable buildings, energy efficiency, or a related discipline. The candidate should possess a solid understanding of smart retrofitting concepts, database development, and flexibility assessment methodologies. Additionally, the candidate should have knowledge and experience in data management, data analysis, and programming skills.

- **Academic Background:** the candidate should hold a master's degree (or equivalent) in a relevant field such as civil engineering, building engineering, energy engineering, or a related discipline.
- **Research Experience:** previous research experience in the areas of sustainable buildings, energy efficiency, or database development. Experience with research project and collaboration with multidisciplinary teams is desirable.
- **Technical Skills:** knowledge in database design and management, knowledge of Python, MATLAB and TRNSYS is required.