**Project Concept Note**

**Calls:** Collaborative Project to Meet Societal and Industry-related Challenges (Energy & Transport)
Researcher Project for Early Career Scientists (FRIPRO)

**Destination:** District heating, building control, smart cities

**Potential Title:** CityGrid: Coordinating suppliers and consumers of district heating via distributed optimal control

**The Challenge:** The heating and cooling of buildings is responsible for 10% of global greenhouse gas emissions, and a large part of the electricity consumption in most European nations. This consumption can be reduced by up to 30% by using centralized optimal control tools. On the supplier side, stochastic production and demand of electricity and thermal energy in district heating grids leads to substantial losses of energy, and therefore additional operational cost. The cooperative coordination of energy supply and consumption can therefore lead to substantial savings in both greenhouse gas emissions from the consumer side, and operational costs on the supplier side.

**Objective:** The objective of this proposal is to use smart integration and control strategies to reduce the energy consumption of end-users of district heating grids, and to reduce costs to the supplier. The primary goal of CityGrid is to increase the TRLs of novel control & optimization methods for district heating & cooling from TRL5 to TRL7 via pilot demonstrators in Norway and Switzerland on end-use systems in the built environment on both the supplier and consumer side. This will involve data collection and exploitation, including the creation of a digital twin of the Lillestrøm municipal buildings. We expect to demonstrate a 30% drop in energy consumption on a city-wide demonstration, based on our TRL5 preliminary pilot projects, paving the way for adoption by the city of Lillestrøm and its district heating supplier in 2030.

**Funding:** 12 Million NOK over 4 years (FRIPRO: 8 Million NOK over 4 years)

**Expected Timeline:**

Deadline for submission: **March 13, 2024** (FRIPRO: April 1, 2024)

Expected evaluation results: **June 2024**

Expected project launch: **(tentative) October 1, 2024**

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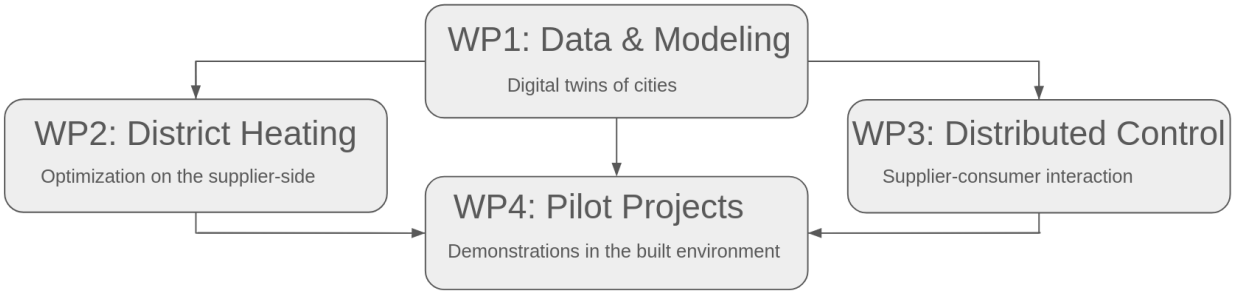
## Initial Methodology:




**WP1: Digital twins of buildings and district heating grids:** WP1 will focus on how to use data (including time series data such as energy consumption, temperatures in buildings and the DHG, and weather forecasts; as well as static data such as architectural plans) for modeling in control algorithms, digital twins, and the interaction thereof. The main objective of this WP is to design the standard for safe data practices through creating a digital twin of a city, which will be used in subsequent WPs. To achieve this goal, there are a few challenges that need to be addressed, such as handling large datasets and their quality, resolution, utility, and informativity, as well as handling uncertainties (eg., forecasting of weather and consumption, noisy/incomplete/erroneous data, and controller misactuation). Additionally, a major challenge is the automation of the digital twin construction process - how can we use a live stream of data to update the digital twin of the city in real time?

**WP2: Optimization of district heating:** WP2 focuses on optimizing the energy consumption of buildings for heating and cooling, with an emphasis on minimizing energy consumption while meeting end-users' comfort and operational constraints. WP2 addresses several key challenges, including the online tuning of parameters for MPC, handling uncertainty from models, privacy preservation, and the integration of different heat sources in terms of their carbon footprints.

Enabling the renewable energy transition requires that renewable energy be prioritized in heterogenous energy systems. We will develop climate neutral MPC as a strategy that will prioritize heating & cooling demand when green energy dominates the heating power, and tested on the district heating grid in Lillestrøm in cooperation with Akershus Energi with municipal buildings as the end-users. This will be delivered in conjunction with methods for demand response, peak shaving, and thermal reserves as part of WP3.

**WP3: Distributed control of suppliers and consumers:** One of the main tasks of WP3 will be to develop a method for using swimming pools as reserves and thermal balancing. Another goal will be to develop the "buildings-as-batteries" prosumerism concept from distributed MPC by creating a virtual market that enables the DHG to engage with end-users by encouraging demand response mechanisms. This will empower end-users to use their building as a short-term thermal reserve, creating value for the supplier. WP3 will also study the resiliency of the DHG network in Lillestrøm, taking a network science perspective, to understand the physical interaction between sources, temperature, and distribution.

**WP4: Pilot demonstrations in the built environment:** WP4 focuses on demonstrating and piloting the developed control methods and strategies to address the challenges of scalability, defining standards of operation, and handling uncertainty in district heating systems. The primary objective of WP4 is to test and validate the various methods developed in the previous work packages on the Lillestrøm case study, using the software API developed as part of the Municipality of Lillestrøm's digitization initiative.