

# Smart Cities and Communities Oralign Halmstad University

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### Smart Cities and Communities

- A city that:
  - Strives towards sustainability
  - Make use of technology when there is a benfit from doing it
  - Make the most of local conditions
  - Is small or medium sized
- Measured against Agenda 2030 (for now)
- Focus (for now):
  - Smart mobility Enabling Technologies for Dependable Cooperative Autonomous Driving targeting Traffic Safety and Efficiency
  - Smart Energy Utilizing local conditions/opportunities in enabled by smart technology



#### Predictive maintenance

**Outlier Detection:** 

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- **Backround:** •
  - Big Data & Al
    - a lot of data is being collected
    - often without a clear idea of how and why
    - later re-used for solving different problems
- Predicitive Maintenance: •
  - Plannable repairs
    - avoid high consequential costs for failures
  - Shorter time to fix
    - better planning and diagnostics
    - reduce number of incorrect repairs ٠
  - Optimization of maintenance intervals
    - based on the needs of individual substation
  - Increase knowledge about the network and its usage
    - how it actually operates and what conditions really affec
- Areas of research interest: .
  - How to construct self-monitoring systems that use joint-human machine learning to adapt to specific domains, by taking advantage of groups of peers, and ubiquitous streams of data?
  - Understanding operation of complex systems it's difficult to grasp how all the relevant aspects connect especially taking into account environment & usage
  - Normal operation is difficult to characterise and faults are unknown or hard to describe precisely
  - Relevant information is not directly measured relationships in the data are unknown and hard to quantify
  - Several different (but related) tasks are of interest diagnostics, failure prediction, RUL estimation, operation optimisation, ...





#### Predictive maintenance

- Initial Findings:
  - Knowledge-based features for heat pumps and district heating
  - Functions for data exploration on our server
  - Preliminary deviation detection method for district heating
  - Ranking of deviating substation



- Preliminary method for detection of faulty switch valve and maintenance heating for heat pumps
- Proposed and demonstrated a way to present machine learning concepts, hands-on, to professionals (district heating engineers) with no prior knowledge of AI
- Mirroring of a company's data stream to the University in real-time, allowing us to monitor and evaluate quality of our algorithms in comparison to existing methods
- Creating a tool that is used in daily operation and significantly improved productivity & efficiency
- Future contribution:
  - Better service
  - Allow convenient scheduling of corrective *maintenance*, and to prevent unexpected equipment failures
  - Energy savingsl



## District heating and cooling

#### • Areas of research interest

- Holistic market analysis
- Improved infrastructure technology
- Digitalisation
- Operational risk management & business models
- Projects and contributions
  - Published research have supported the introduction of an EU heating and cooling strategy proposed by the European Commission
  - Spatial mapping of heat sources and demands through The Pan-European Thermal Atlas and the Heat Roadmap Europe projects (four sequential projects)



- Instigators of development towards **low temperature district heating** (4GDH)
- Currently active in four different Horizon 2020 projects, one of which is coordinated by member of the HU district heating research group
  - ReUseHeat (<u>https://www.reuseheat.eu/</u>)
  - Heat Roadmap Europe (<u>http://www.heatroadmap.eu/</u>)
  - TEMPO (<u>https://www.tempo-dhc.eu/</u>)
  - sEEnergies (<u>https://www.seenergies.eu/</u>)





### District heating and cooling

- Some examples:
  - Heat synergy regions
    - Identifying NUTS3 regions with high levels of available excess heat and high heat demands
  - Distribution capital cost model
    - Specific investment cost for district heating
    - Spatial assessment by hectares for all EU28 Member States
  - 4<sup>th</sup> generation low-temperature district heat distribution technology
    - Three-pipe solution to facilitate low return temperatures
- Continuous work to assess and map the possibilities for higher energy and resource efficiency in Europe
  - District heating is a city solution
    - Our research contributes directly in the area of Climate Neutral and Smart Cities till 2030 by investigating possibilities and conditions for the urban scale circular economy
    - "By using energy twice through heat recycling, you cut the energy demand by half." (Quote Prof. Sven Werner)





Source: Persson U, Wiechers E, Möller B, Werner S. Heat Roadmap Europe: Heat distribution costs. Energy. 2019;176:604-22.



# Our expectations on the Mission on Climate Neutral and Smart Cities

- Taking local conditions into account
- Targeting small and medium sized cities
- Human centred approaches
- Comprehensive take on sustainability

