SUSTENANCE

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Sustainable energy system for achieving novel carbon neutral energy communities

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The SUSTENANCE project is developing new solutions to establish a rapid green transition towards sustainable "energy islands" in different local communities across the EU and India

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The 3.5-year project involves 22 partners from 3 EU countries and India. Led by Aalborg University in Denmark it receives funding from the EC's Horizon 2020 programme and the Department for Science and Technology (DST) in India. It will benefit not only from different experiences across the EU but from perspectives from India as well.

The SUSTENANCE project is developing new solutions to establish a rapid green transition towards sustainable "energy islands" in different local communities across the EU and India

The project's goals include the decarbonisation of local energy systems via the optimal integration of locally available sources of renewable energy. The energy needs of the local communities, such as electricity, heat, water, waste, and transport will be integrated via technological solutions such as smart control, battery storage, energy balancing and application of active load control to ensure the highest energy flexibility among the different energy sectors. All these solutions will contribute to the green transition with higher shares of local renewable energy and more efficiently integrated energy solutions.

The project co-ordinator, professor Birgitte Bak-Jensen says that the green transition requires getting citizens involved and to learn how their behaviours can help to boost the identification of practical solutions for adapting the levels of energy consumption to ensure reliable energy supplies despite the increasing use of renewable sources of energy which can be unstable.

These solutions will be put to the test at demonstrator sites in Denmark, the Netherlands, Poland and India. Despite their economic, societal,

and political differences, these sites will deliver results showing that the same technical solutions can be applied in all cases and are thereby replicable on a global scale.

An important focus will be self-sufficiency from decarbonised and resilient energy systems which have the capacity to enhance the quality of life for local communities. The Indian dimension includes a focus on the eradication of energy poverty and the empowerment of women and children by uplifting the socio-economic status in rural areas. As Birgitte states, for two of the Indian cases the demonstration sites are in rural areas where local micro-grids will be established to ensure the power supply for water pumping, cooking and charging of e-rickshaws for transporting children to schools. These improvements will especially help women and children in their daily lives.

In addition, the SUSTENANCE project will analyse the existing market infrastructures, regulatory frameworks and system operations, which so far have limited levels of knowledge in understanding complex interdependencies between systems and components with multiple options. Guidelines for new energy management procedures will be invented and demonstrated with a focus on obtaining the active participation and increased awareness levels of the consumers, which can establish collective social acceptance, an essential element to develop and validate such integrated solutions into realistic business cases and products applicable to local communities.

As Birgitte explains, it is the project's holistic approach of looking at the green transition and the actual technical solutions required, by taking into account the human, market, regulatory, and environmental issues, that will ensure the realistic implementation of the solutions which SUSTENANCE will find. ■

STJÆR in Skanderborg will show the way from heating with natural gas to becoming a CO_2-neutral village

Author: Editorial Board
Photos: Helene Simoni Thorup

It is an old saying, but one that still holds true: "Think globally, act locally". The SUSTENANCE project team for the Danish demonstrator consists of the most important local actors in Skanderborg's energy arena. Let's find out who they are and how this "dream team" will, alongside Stjær citizens, improve the local transition to "green energy".

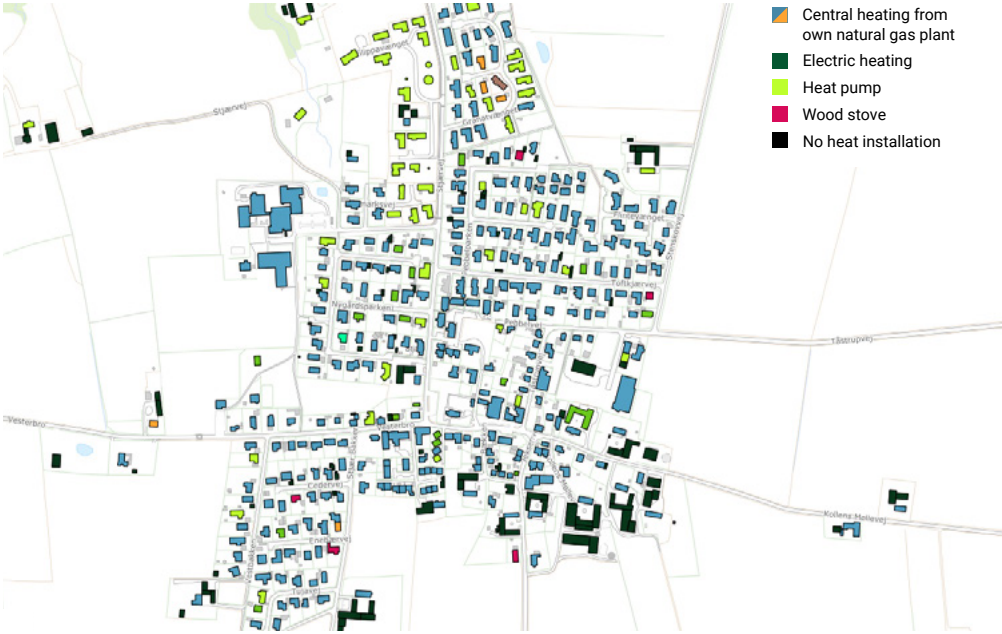
Stjær consists of app. 400 houses. Most of them are heated with individual natural gas boilers and the municipality's school and a kindergarten run on natural gas. Stjær has a very active community council that has been engaged in a sustainability project throughout 2021. The project has held 5 public meetings on: energy, resources, biodiversity, consumption and transportation. During these meetings, consisting of 50 volunteer families and an expert from The Energy Service, it was discussed what could be improved. Also, the actions that the families could take in terms of achieving a more sustainable lifestyle were identified. This has resulted in a big group of very interested and engaged citizens

in the village, who are very aware of their own CO_2-emmisions. In addition, Skanderborg municipality has a goal of being CO_2-neutral by 2025 and to cut down CO_2-emmissions by 70% for the whole municipality by 2030 compared to levels in 1990 (this includes emissions from citizens and businesses). In this transition, the replacement of oil and gas burners with district heating or heat pumps is essential. At the same time cars must change from burning fossil fuels to running on (mostly) electricity. Since Skanderborg's renewable sources are challenged by fluctuating production levels from the sun and wind, the use of smart control systems, which integrate the consumption of energy with energy storage will help improve the efficiency of the system and ensure that energy consumption is coordinated with energy production of renewables.

Having such goals and such wonderful residents, who are committed to taking action towards the green energy transition, the SUSTENANCE project will enable approximately 20 houses in Stjær to change from consuming natural gas to using heat pumps with smart control systems for their energy consumption – says Susanne Skårup, leader of the Danish demo in Sustenance.

This undertaking will be possible thanks to the well-matched team of local energy

Energy Fair in Stjær in September 2021



Map of heat sources in Stjær, 2021

players – admits Hans Bjerregaard, from Bjerregaard Consulting. The team consists of: Skanderborg Municipality, Stjær community council, Aura energy – the local electricity provider, The Energy Service – an impartial consultant on energy, Neogrid – a private provider of the smart control system, Suntherm – a private provider of heat pumps and salt-heating-storage and Bjerregaard consulting.

The project in Stjær will show how existing houses can become CO_2-neutral in their energy consumption including electricity, heat and transportation without challenging the overall electric system. The results will be used in the rest of the municipality. The project will also benefit from cooperation with the Energy Department from Aalborg University and the exchange of know-how with the other demonstration sites involved in Sustenance, located in the Netherlands, Poland and India. As such, this project will show how steps taken locally can lead to a wave of change and replicability on a global scale. ■

Rethinking the ways we integrate renewable energy into our daily lives in the Netherlands

Author & Photos: Gerwin Hoogsteen, PhD, University of Twente

With the paradigm shift from "supply follows demand", towards "demand follows (renewable) supply", we are at the brink of a transformation of our daily lives. At the Dutch demonstration sites within the SUSTENANCE project we will investigate how we, the citizens, have to deal with energy now and in the (near) future, especially if energy becomes scarce or more expensive.

Currently, most people use energy without giving it a second thought. However, the recent bankruptcy of energy suppliers and rapidly rising gas prices started a debate in the Netherlands about energy. One main, but also philosophical, question regarding our energy use is: *What is the ´new´ normal?* I talked with Professor Johann Hurink of the University of Twente about these issues and asked for his view on what should or will be the normal energy use in the future when we aim to operate a fully sustainable energy system.

Johann Hurink shares his vision: *In the near future the new normal will be one where we are more aware of the relationship between the best time to consume energy and when this energy is produced. For some, this will be a result of owning PV panels and experiencing the financial advantages that come from directly consuming this energy in their own houses. For others, it will need to be learned by time-varying prices, meaning that in the evening, consuming energy may be more expensive.*

These abstract means can be translated into concrete examples that will change our daily lives. For instance, you could adapt the time when you start the washing machine, dryer, or when you charge your electric vehicle (EV). Or it could be that you buy a battery to bridge the gap between the generation of energy from your PV panels and the demand from your energy hungry appliances. However, Johann expects that in the long term, the required actions will get more and more automated by local energy management systems, so that users will only have to specify their preferences and side-constraints.

This is exactly what we would like to test at the University of Twente's campus, where we have installed a solar PV roof on a parking space together with 9 EV chargers and a battery. By using novel decentralized energy management technologies and the development of intuitive user interfaces we aim to change the charging behaviour of EV owners by making them more conscious about the effect of their choices. The options we offer to the driver, via an App, might be for instance to only charge using surplus renewable energy, or to accept that the EV will charge less then requested at times when energy is scare, but still guaranteeing that enough energy is in the car to make it back home. In this context it is important to find the best balance where users stay engaged by keeping this interaction with the system as effortless as possible, just like we are used to nowadays.

Prof Johann Hurink charging his EV

On the technical side, we aim to develop and test new concepts to ensure a stable supply of energy during periods of scarcity from renewable energy sources and potential grid overloading from high demand. In this case, the energy management system receives information about such an abnormal status, which we call an "energy modus", and has to ensure that executed actions are done "in collaboration" with the user. The latter may be seen as a loss of comfort compared

to our current energy usage. To get a different view on this aspect, I asked our PhD student, Aditya Pappu, who grew up in India and experienced outages, what we, Europeans, can learn from his experiences. Aditya passionately responds: *Energy plays a critical role in the daily hustle of a middle-class family. A power outage can effectively bring the entire schedule of a working-class family to a standstill. Given the critical role energy played in our daily lives, my sister and I were taught small but important lessons to be mindful of our energy usage.* Aditya give three concrete examples from his youth: They could only switch on the AC for one hour, they could only use the washing machine in the morning of every second Sunday and since they couldn't use both ACs at the same time, they had to choose one room and everyone would sit in there. Aditya jokingly calls these the "energy lessons from an Indian mother". However, he adds that *the importance of these energy-aware actions on the user's side for energy resilience is evident, now more than ever*.

The test sites at the University of Twente and also those at Saxion, provide the solid ground to develop and test new ideas in a controlled environment. Starting from these initial experiences with "tech loving" users, we aim to transfer the knowledge to other user groups . We will focus especially on the potential test sites in Olst and the inhabitants of "Vriendenerf" ("Friends' Garden"), where solar PV and EVs are already available. The inhabitants in these sites have well insulated houses with heat pumps, giving room to utilize untapped flexibility. As these citizens are more senior, the group will be largely different from the tech-savvy users at the University of Twente, which brings additional challenges, including, how to make the systems even more intuitive, comfortable, and less intrusive to the end users. Nevertheless, these citizens are all also very aware that we need to change behaviours to keep our planet habitable for the coming generations and are therefore ready to cooperate with us! ■

Solar carport test-site
at the University of Twente

The Mickiewicza Housing Association in Sopot City takes its first steps towards a sustainable energy system and the creation of a local energy community

Author: Editorial Board
Photos: Sebastian Bykuć, IMP PAN & KEZO Research Centre

Since its inception in the 1970s, the Mickiewicza Housing Association (WSM) cooperative, has been ahead of its time. It took a pioneering approach to the construction of the apartments, which saw members contributing 50% of the value and then paying the rest in instalments over the next 25 years. Whilst this is a common practice today, it was unheard of in communist Poland. Now, this cooperative is taking the next pioneering step to become a sustainable "energy island".

Sopot city, often called by Poles the "Pearl of the Baltic Sea", is a small tourist destination in Northern Poland. The buildings owned by WSM consist of 5 multi-family blocks of flats (each approx. 3400m2), with 10 floors and 77 apartments in each block. Some residents are apartment owners, but a large proportion are tenants. The WSM Board aims to eliminate the use of natural gas from the energy system and replace it with electricity from renewable sources for domestic hot water (DHW) preparation. The whole residential area is supplied by a low voltage network, which is of poor quality and suffers from frequent power outages that can last up to 2 hours. Despite these inconveniences, there is some resistance towards change among a number of the residents. Inhabitants are thus divided into those who wish to remove the old gas pipelines from the buildings and seek safe and "green" alternatives and those who are against such changes. Furthermore, previous attempts to introduce new technologies have been rejected, such as the use of ground source heat pumps due to the high level of social resistance. This lack of trust for new technologies stems from an uncertainty about new cost levels and benefits, plus a lack of reliable information or examples of good practice.

Therefore, knowing about such experiences, Sebastian Bykuć, Head of the KEZO Research Centre & Distributed Energy Department at IMP PAN1, and a co-leader of the Polish Demo in SUSTENANCE, underlines that *the WSM community must be actively involved in the development of the SUSTENANCE activities from the very beginning to be able to co-plan investments, participate in trainings and awareness programs on the benefits of becoming a local energy community and possible "energy island" in the future.* The Board of WSM is very open-minded and seeking external support and guidance for technical improvements, modernizations and financing possibilities to establish a self-sufficient energy community. SUSTENANCE is a project, which will bring them closer to that goal.

What is actually planned to be realised within SUSTENANCE for this local community? *The dedicated, integrated energy system combining*

View from the roof of one of the blocks of flats at the Mickiewicza Housing Estate in Sopot

renewable electricity generation and storage, domestic hot water from heat pumps and EV transportation with V2G technology at the site, is what is going to be designed and tested in chosen apartment buildings with the engagement of community residents – explains Patryk Chaja, from IMP PAN and a co-leader for the Polish PhD Case. Further, he adds that the demo activities in Poland comprise of the following: the installation of measurement systems for data gathering of electrical grid and DHW; development of the local "energy island" concept, including engagement from community member; installation, demonstration and testing of technologies for local electricity and heat production (solar photovoltaic, heat pump), energy storage unit, EV (electric vehicles) and a local energy management system; increase of visibility and flexibility of the power grid; development of business models for the proposed technological and organizational solutions.

All Polish members of the SUSTENANCE team are strong actors in the local energy market and will actively participate in demo activities and support the WSM Board in this project. IMP PAN acts as the coordinator, ENERGA-OPERATOR S.A. is the local energy distributor, who will modernise the local transformer station and install smart meters, STAY-ON ENERGY MANAGEMENT will pioneer the design and management of energy storage systems, and KEZO

View on one of the blocks of flats in the Mickiewicza Housing Association in Sopot

Foundation will support the analysis of the business models. As in every demonstrator of this H2020 project, the overall goal is to provide guidance that will enable the technical and business solutions from Sopot to be replicable not just in other Polish cities, but in other countries in Europe and the rest of the world. ■

[1]) WSM - Własnościowa Spółdzielnia Mieszkaniowa im. Adama Mickiewicza

[2]) The Szewalski Institute of Fluid-Flow Machinery Polish Academy of Sciences/InstytutMaszyn Przepływowych im. R.Szewalskiego Polskiej Akademii Nauk (IMP PAN)

How three different demonstrations in India aim to establish carbon neutral communities & become role models

Author: Editorial Board
Photos: IIT Bombay

Different backgrounds, different challenges, but above all – a common goal for a transition to green energy and sustainable, carbon neutral energy communities, is what makes Indian demonstrators in SUSTENANCE so important, promising and interesting. In a developing country like India, the communities in remote and rural areas require access to very basic and reliable energy systems . Such systems experience significant participation from the local citizens and communities, which started from the very beginning of the project .

The public institutes, product and project developers, NGOs and other energy stakeholders participate actively and work closely with the community for the successful implementation and operation of the local "energy islands". Such local energy systems are well integrated into communities and contribute immensely to the quality of life of the villagers, social integration and sustainable development.

Demo from India

How three different demonstrations in India aim to establish carbon neutral communities & become role models.

The three Indian demonstration sites under SUSTENANCE are: **Barubeda Village, Jharkhand** - focusing on off grid local energy systems, **Borakhai Village, Assam** – with a weak and unreliable grid connection, and **IIT Bombay campus, Mumbai** - a grid connected, integrated smart building system. In Barubeda Village, the core income source of villagers is agriculture. There is limited access to water in general, and clean water in particular. The inhabitants (primarily women) have to fetch water manually for its use in the community, as there is no water pumping system, primarily due to lack of electricity. Firewood is primarily used for cooking, and kerosene based lamps for lighting. The village does not have access to any public transportation, and the inhabitants generally walk over 3 kms to reach the nearest road. For several months in a year, the men migrate to the city for work. Since the village is in dire need for energy supply, the inhabitants are keen to have a local sustainable energy system established.

Borakhai Village is in a relatively comfortable situation as compared to Barubeda, since it is partly and temporarily electrified. For some houses, it means a connected load of less than 200 W, limited to only few hours a day. Whereas for others it is a maximum power of 0.5 kW, however the residents are getting electricity for only one third of a day. The villagers do not have access to a clean and reliable domestic water

Case 1: BARUBEDA VILLAGE, which aims at becoming a carbon neutral "islanded" energy community

supply. Moreover, while some families have LPG connection, firewood is primarily used for cooking purposes. Kerosene -based lamps are used for lighting. The residents have a very limited access to an unreliable transport system.

In the two rural sites (Barubeda and Borakhai), the overall goal is to develop a community-based integrated renewable energy system (RES) enabling smart energy solutions for supplying 24x7 reliable, low-carbon, efficient and quality energy supply for meeting the basic daily needs of the community. Around 50 households in the Barubeda village, and 40 households of Borakhai village are involved for implementing the local energy system. The IIT Bombay campus demonstration is significantly different from the other two sites as the campus is having 24x7 power supply from the main grid as well as rooftop solar PV systems of around 1 MW installed capacity in the campus. For IIT Bombay, the aim is to set up a smart energy system consisting of a smart electric building coupled with EV charging infrastructure.

Having described briefly the status quo and the planned sustainable energy system for the demonstration sites, the question how the SUSTENANCE project will achieve such changes arises? SUSTENANCE aims at mutual learning and cooperation to show how the same technical concepts (such as coupling of different energy vectors, storage

Case 2: BORAKHAI VILLAGE, which aims at delivering smart clusters based on local energy systems powered by renewables

solutions, demand response, intelligent control schemes and digitalization) can be applied to all the demonstration cases despite the significant variation in local conditions including geographical, climatic and cultural differences among the sites. For Barubeda Village, the aim is to deliver a sustainable clean local energy system for the remote off-grid village; to improve the living standards of the villagers by providing reliable electricity access, e-rickshaw based green transportation, reliable water supply – all this improving their socio-economic status. In case of Borakhai Village, objectives are to deliver a sustainable and reliable local energy system and, in general, to improve the living standard of the inhabitants by actual provision of electricity access, e-rickshaw mobility, reliable water supply, waste treatment plant, and thus providing a scope for improving their socio-economic status. In both rural sites the added value is to also improve the healthcare and education system thereby empowering women and children. Finally, at the IIT Bombay campus in Mumbai, the expectation from SUSTENANCE is that it will develop an intelligent electric vehicle charging infrastructure, utilizing local renewables, which will be coupled with a smart electric building system. Last but not least, in all three demonstrators in India, (as is the case in all the EU demonstrators), the overarching intention is to establish technical and business solutions, which will stimulate further replication in other villages and urban communities respectively. ■

Case 3: Solar powered building in IIT BOMBAY CAMPUS IN MUMBAI (left) and a campus map with planned EV-chargers localization (right)

How three different demonstrations in India aim to establish carbon neutral communities & become role models.

Editorial Team

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