SMART ENERGY TRANSITION

Smart Energy Transition (SET)-project

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Riikka Holopainen, Francesco Reda, Ari Laitinen & Sami Karjalainen

VTT Technical Research Centre of Finland Ltd.

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Smart Energy Transition project tackles the global disruption of energy markets by creating pathways for Finland to profit from the energy disruption.

How can Finland benefit from the decarbonization of the energy system?

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Project facts

- Consortium leader Aalto University School of Business
- Work packages led by Lappeenranta University of Technology (WP1), Aalto University School of Business (WP2), University of Sussex, Science Policy Research Unit SPRU (WP3), Consumer Society Research Centre, University of Helsinki (WP4), Finnish Environment Institute, Syke (WP5) and Aalto University School of Art and Design (WP6)
- Funded by the Academy of Finland's Strategic Research Council
- First phase 2015-2017, second phase 2018-2020

Experiences of solar PV owners in Finland

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Experiences of solar PV owners in Finland
- Introduction

- Households and companies are increasingly implementing renewable energy systems, such as solar PV systems.
- However, in Finland solar PV energy production is still under 0.05% of total production of electricity.
- The aim of this work is to provide an understanding of the experiences of early adopters of solar PV systems by means of semi-structured interviews.
- Understanding the barriers that these households have encountered and their experiences after implementation may be useful for speeding up future implementations.

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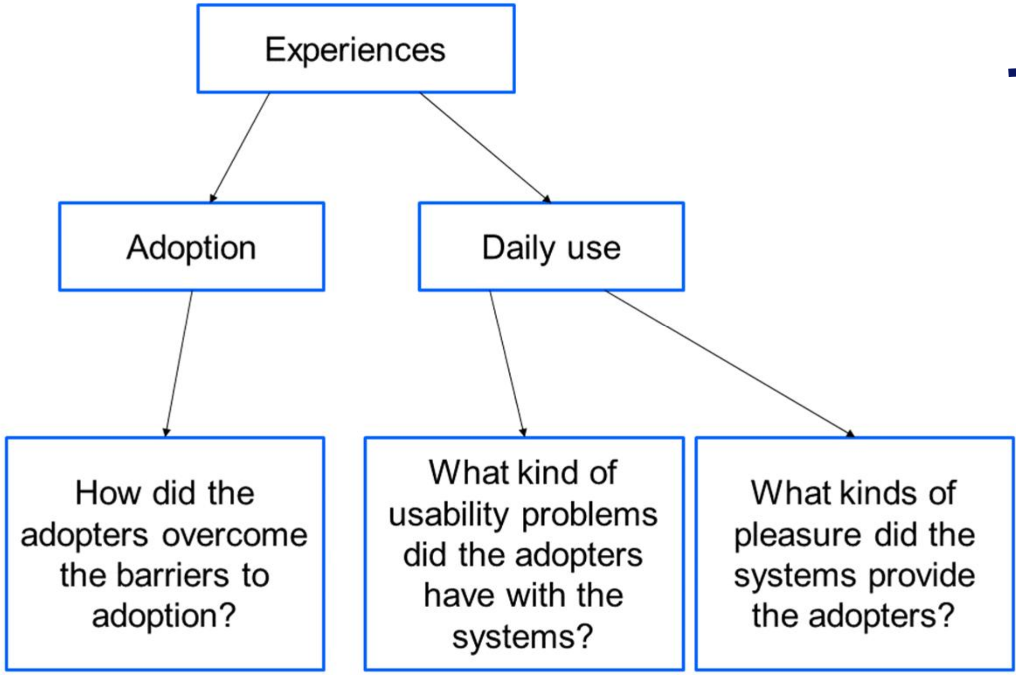
Experiences of solar PV owners in Finland

- Research questions



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Experiences of solar PV owners in Finland
- Method

- Semi-structured interviews were conducted to obtain an understanding of the experiences of Finnish pioneer households who have adopted a solar PV system.
- One person per household was interviewed. The person participating in the interview was also designated as the person responsible for acquisition of solar PV panels for the household.
- The interviewees were found from various sources: by direct inquiries to internet forums on Facebook in the field of microgeneration systems, inquiries sent to solar energy discussion lists (especially the Aurinkovirta newsletter) and with the help of a regional advisory organization of sustainable development (Valonia). In addition, a couple of interviewees were found by contact information given by other interviewees.
- A total of 28 interviews were performed, of which six were face-to-face interviews and 22 telephone interviews.
- The length of interviews was from 30 to 120 minutes. The study involved participants from different parts of Finland.
- Many of the telephone interviews involved material sent by interviewees to researchers, including photos of installations, screenshots of user interfaces and links to sites that show public information of their power plants.

Experiences of solar PV owners in Finland

- Characteristics of solar PV system adopters interviewed

- The solar PV system adopters interviewed in this study were between 30 and 73 years old (on average 57 years).
- Two of the 28 interviewees were women, the others were men.
- The education level of the interviewees was higher than in the Finnish population on average. Of the interviewees 17 had an academic background, although the study also involved participants with a low level of education. Fourteen of the interviewees had an educational background in technology.
- The solar PV systems owned by the participants were installed between 2013 and 2017. The households own all of the solar PV systems. All except two of the households in the study are able to sell their surplus solar energy to the grid. Those who do not sell energy to the grid have batteries for energy storage.
- The average knowledge of energy technology is much higher among the adopters of solar PV systems than in the population on average.

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Experiences of solar PV owners in Finland

- Classification into four groups of solar PV owners

1. Environmentally concerned (who want to produce clean energy and reduce their emissions),
2. Economically concerned (who want to reduce their living costs by installing solar PV panels),
3. Innovator/developer/experimenter (who typically have good DIY skills and have implemented their own energy or home automation solutions) and
4. Energy specialist (who have professional background in energy technology or maintain a recreational interest in the field).

Experiences of solar PV owners in Finland

- Overcoming the barriers to adoption

- The results highlight the importance of expert advice and co-operation in overcoming barriers.
- Twenty-two of the interviewees participated in joint orders of solar PV systems (e.g. panels, inverters and installation equipment). In addition to the joint orders, modes of co-operation included arranging and attending briefing events on solar energy, visiting each other's solar energy plants, discussions on social media, newsletters and personal contacts with each other.
- Many of the respondents stated the importance of one particular individual. This person acted as project coordinator and organized the joint orders of the solar PV systems, and his experience and knowledge were instrumental in the adopters' choice of products and plant size. He also provided instructions for installing the panels as well as realistic information on the energy production of solar PV systems.

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Experiences of solar PV owners in Finland

- Overcoming the barriers to adoption

Barriers to adopting solar PV systems (as reviewed by Karakaya and Sriwannawit (2015), see Section 2.2)		**Strategies of adopters to overcome the barriers (according to the interviews)**
Sociotechnical barriers	Quality standards for PV systems are low in some countries	The products were ordered jointly and those products known to be of good quality were chosen based on expert advice.
	Lack of knowledge	Expert advice, including volunteer activism. Cooperation between adopters.
	Lack of knowledge on the supply side (e.g. among architects and planners)	Self-sufficient operation.
	Complexity of interaction between people and PV systems	Shared knowledge between adopters. Choosing products with high usability based on expert advice.
	Perceived complexity of solar PV technology	Sharing realistic information.
	Some attributes of PV systems, e.g. low battery storage and low power capability, are perceived negatively	Sharing realistic information.
	Inadequate installation space	Roof space normally available for installation (one respondent installed some the panels at ground level).
Management barriers	Unsuitable business strategies available, especially for rural contexts in low-income countries	(Not a relevant barrier for a high-income country.)
	Weak after-sales services	Co-operation between adopters.
	Ineffective marketing and education campaigns	Expert advice, including volunteer activism. Sharing realistic information.

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Experiences of solar PV owners in Finland

- Economic aspects

- Each study respondent invested from EUR 5,000 to 30,000 in a solar PV system (average EUR 12,000). The size of plant was between 3.2 and 21 kWp (average 7 kWp).
- Most interviewees (22) reduced costs by installing the panels as far as possible themselves.
- Most respondents reported the payback time to be between 15 and 25 years and noted that it cannot be calculated accurately because the future price of electricity is not known. Some older respondents commented that they will not get their investment back during their lifetime.
- The adopters did not consider payback time to be a relevant way to evaluate the investment. They compared the investment in a solar PV system to investment in a new car or kitchen renovation: ‘what is the payback time of these?’ The solar PV system investment is seen to create monetary savings every year after installation (‘the return is higher than from a bank account’).

Experiences of solar PV owners in Finland

- Human interaction and usability

- The PV system adopters are satisfied with the operation of the solar PV systems.
- The systems have worked properly and have needed no attention apart from cleaning snow from the panels during winter.
- The study did not reveal significant problems in usability (only minor problems).
- The solar PV systems operate fully automatically but users can easily get information on how much energy their solar PV system has produced (kWh) and currently produces (kW).
- The users were very active in monitoring system performance. The majority reported that they monitor their system's production daily (even up to ten times a day), at least during the productive solar energy season.
- They monitor their energy production and consumption through web portals via personal computer or mobile phone. Many receive daily email reports on the previous day's production. The users can also monitor their production via the small display on inverter panel.
- The web applications typically also provide information on CO2 reduction (kg), but these values were not noted at all or were found to be less interesting than those related to energy (kWh/kW). Respondents had problems understanding the magnitude of the CO2 values: 'I've no idea whether this is high or low'.

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Experiences of solar PV owners in Finland

- Pleasure derived from owning a solar PV system

- The adopters derive pleasure from their household solar PV system in a number of ways:
  - The capability to produce own clean energy and reduce emissions
  - The capability to deliver information about clean energy production to other people through own installations
  - Cooperation with other producers of solar energy creates a feeling of belonging to a social group.
  - The good usability of solar PV systems and their user interfaces and effortless energy production
  - The household’s self-sufficiency in energy production and reduced dependency on energy companies provide pleasure, as do the self-made installations carried out.
  - The savings gained by producing own energy and selling the surplus energy to the grid creates a sense of achievement.

Experiences of solar PV owners in Finland

- Effect on energy behaviour

- The solar PV system owners are aware that it is economically more beneficial to use the solar energy that they produce themselves rather than to sell to the grid.
- It is common practice for the majority of the families to put the washing machine and dishwasher on during periods their own solar energy is available. One interviewee had even developed their own term for this practice: ‘solar laundry’ (‘aurinkopyykki’ in Finnish).
- Some respondents turn their electric water heater on when the sun is shining (this function is typically not supported by domestic automation and needs to be done manually).
- One respondent said that he uses a welding machine and circular saw when the amount of solar energy produced is at its highest.

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Experiences of solar PV owners in Finland

- Possible consequences of adopting PV system

- You learn better to understand your energy use and may change energy consumption habits
- You want more solar panels (“as much as the roof allows”)
- You want to upgrade your domestic energy system with improved home automation (and water boiler)
- You want an electric car (”want to drive using own clean energy”)
- You may want more electric appliances (such as electric grill)
- You may get interested in energy politics

Experiences of solar PV owners in Finland

- Conclusions

- The adopters are very satisfied with and proud of their PV plants even though the economic profitability of the systems remains low.
- Own production of solar energy produces various kinds of pleasures for the adopters. The adopters find pleasure in producing pollution-free energy effortlessly and being able to offer information about clean energy production to others through their own installations.
- The adopters actively monitor their energy production and have become highly engaged in domestic energy matters. Many have enlarged their solar PV system or plan to do so, or are highly interested in upgrading their energy system with an electric car or advanced home automation.
- The adopters overcame the barriers to adoption primarily through access to expert advice and co-operation, which provided them with realistic information about the solar PV systems, their installation, costs and the amount of energy that they can potentially produce.

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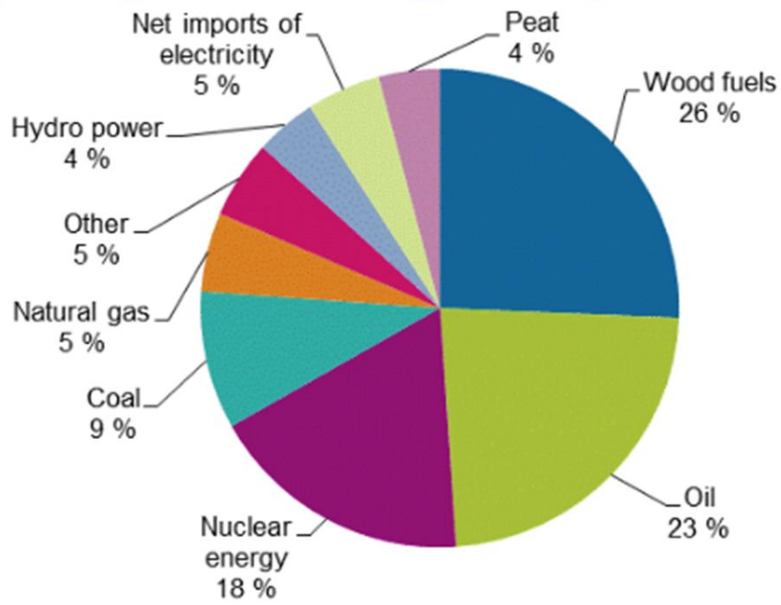
Challenge:
How to get rid of the fossil fuels in the district heating sector?

Total coal and peat usage in Finland

- Coal and peat consumption was 183 200 TJ in 2016
  - 13% from the Finnish total energy consumption 1 361 600 TJ
  - mainly used by the industry (p.ej. metals, forestry)
  - 33% or 59 855 TJ used in the district heating

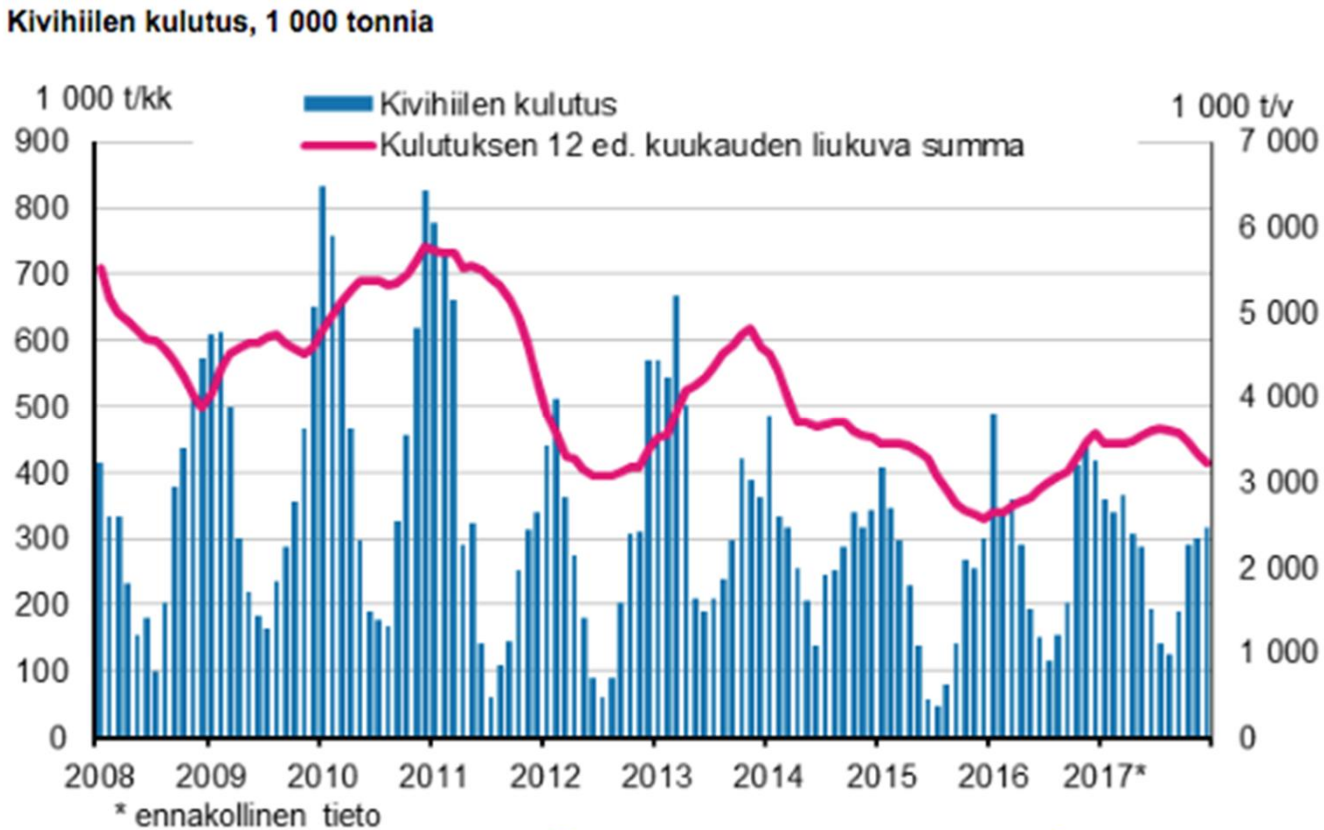
Appendix figure 1. Total energy consumption 2016



Source: Energy supply and consumption, Statistics Finland

Trend: coal consumption is decreasing

- in the district heating coal is mostly used in combined power and heat (CHP) production



How to achieve the coal phase out?

- Ongoing trend: coal is replaced by biomass, peat and gas
  - Risk: technology lock-in
- What is needed to achieve Paris Climate Agreement?
  - The whole energy system needs to be renovated
  - Stop the burning

Ministeri Tiilikainen: Kivihiilen käyttö energiatuotannossa kielletään lailla vuonna 2029

Asunto-, energia- ja ympäristöministeri Kimmo Tiilikainen poistuu pääministerin virka-asunnolta Kesärannasta Helsingissä 10. huhtikuuta 2018. *(KUVA: Martti Kainulainen / Lehtikuva)*

Julkaistu: 10.4. 17:52

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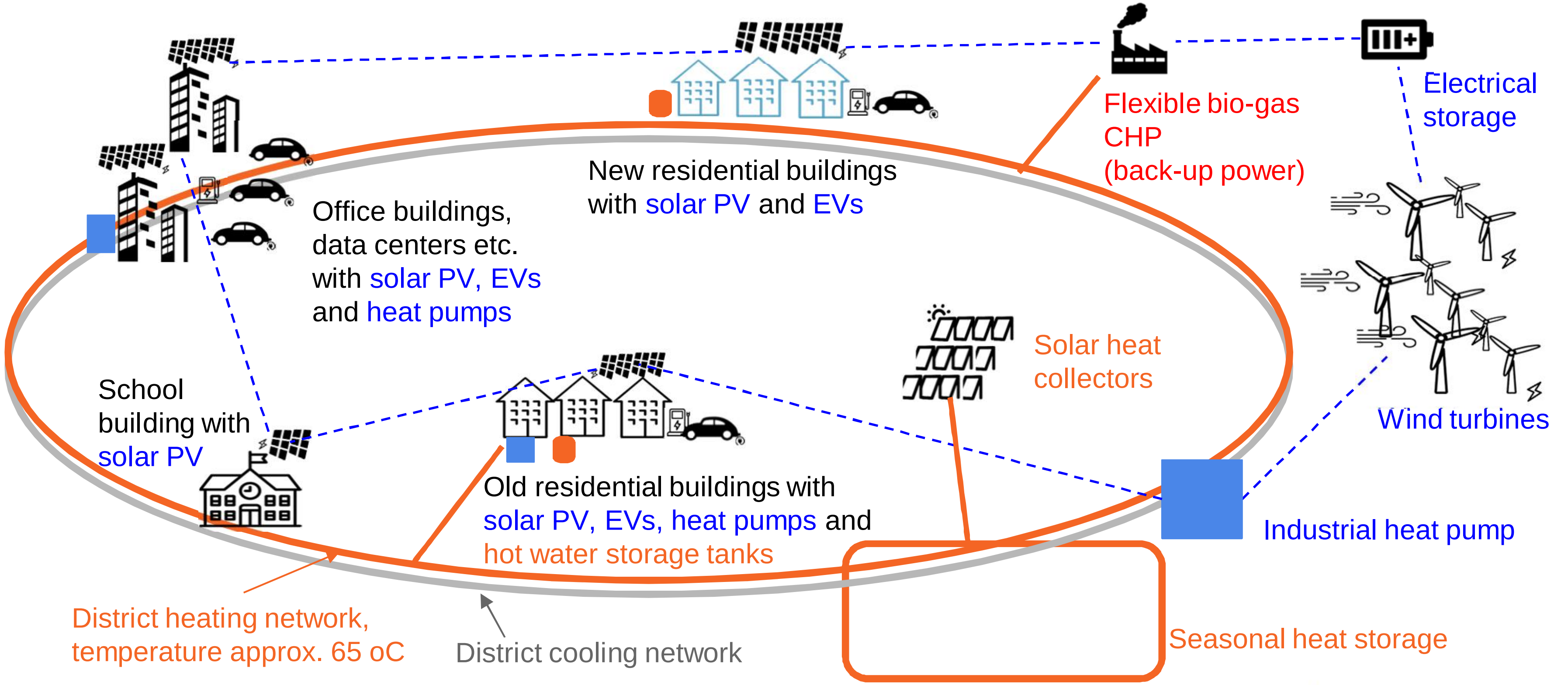
Clean district heating & cooling network concept



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Energy production

- Heating and cooling produced mostly by industrial and large buildings’ heat pumps
  - Heating & cooling pumps use 20-35% electricity, that can be produced by clean energy sources like wind, solar, hydro and nuclear power
  - Heat pumps can collect the rest of the energy from the underground, lake, sea, air and different waste heat sources such as wastewater, data centers, industrial processes etc.
- Assisting heat energy source: solar heat collectors
- Backup generation for the cold winter periods: flexible biogas-CHP ~ Syngas from municipal waste

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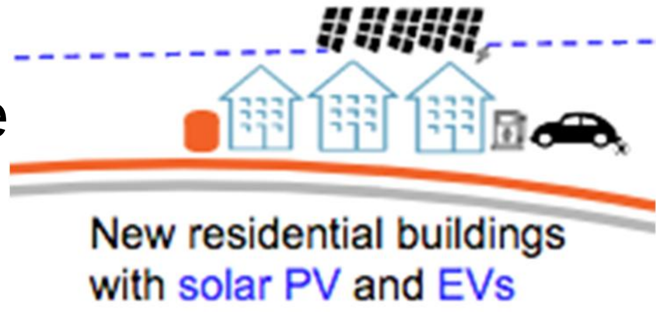
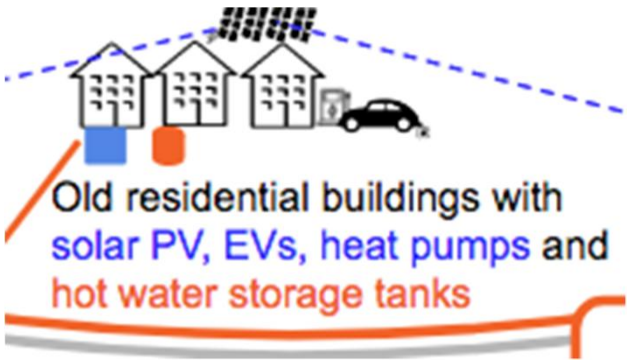
Role of new energy efficient buildings

- Connected to heating and cooling networks
- Low heating consumption during the cold period
- Cooling necessary during summer season -> extra heat can be sold and stored in centralized seasonal heat storage
- Water > 65 ^{o}C can be heated with extra electricity



Role of old buildings

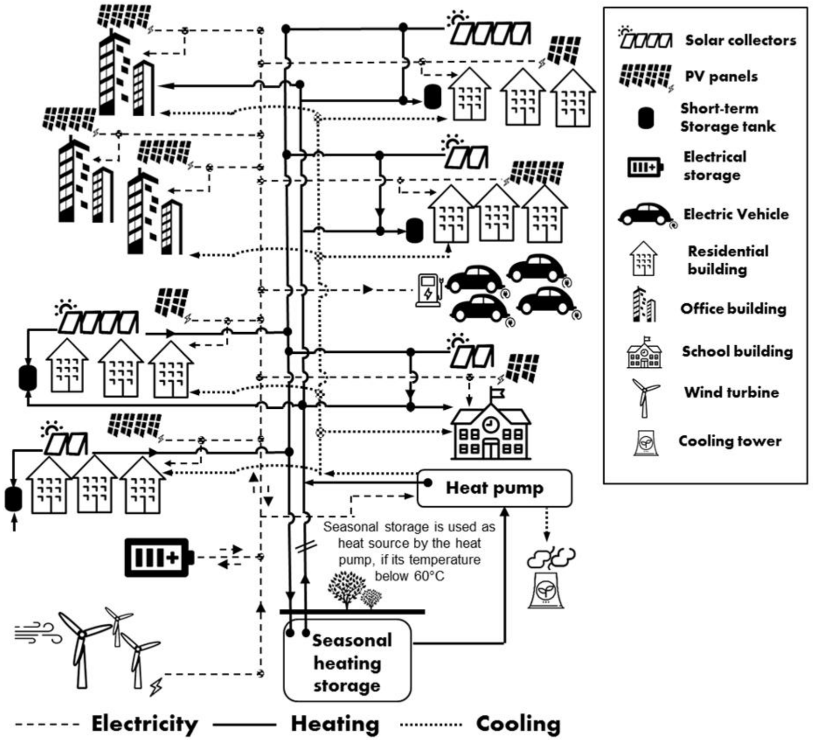
- Connected to heating and cooling networks
- Heating and hot water > 65 oC can be produced with heat pump
- Energy efficiency improvements & smart energy solutions reduce peak heat and electricity demand!
    - New windows, better insulation
    - Enhanced heat circulation
    - Demand response solutions
    - Local hot water storage tanks



Seasonal heat storages roles in the energy infrastructure

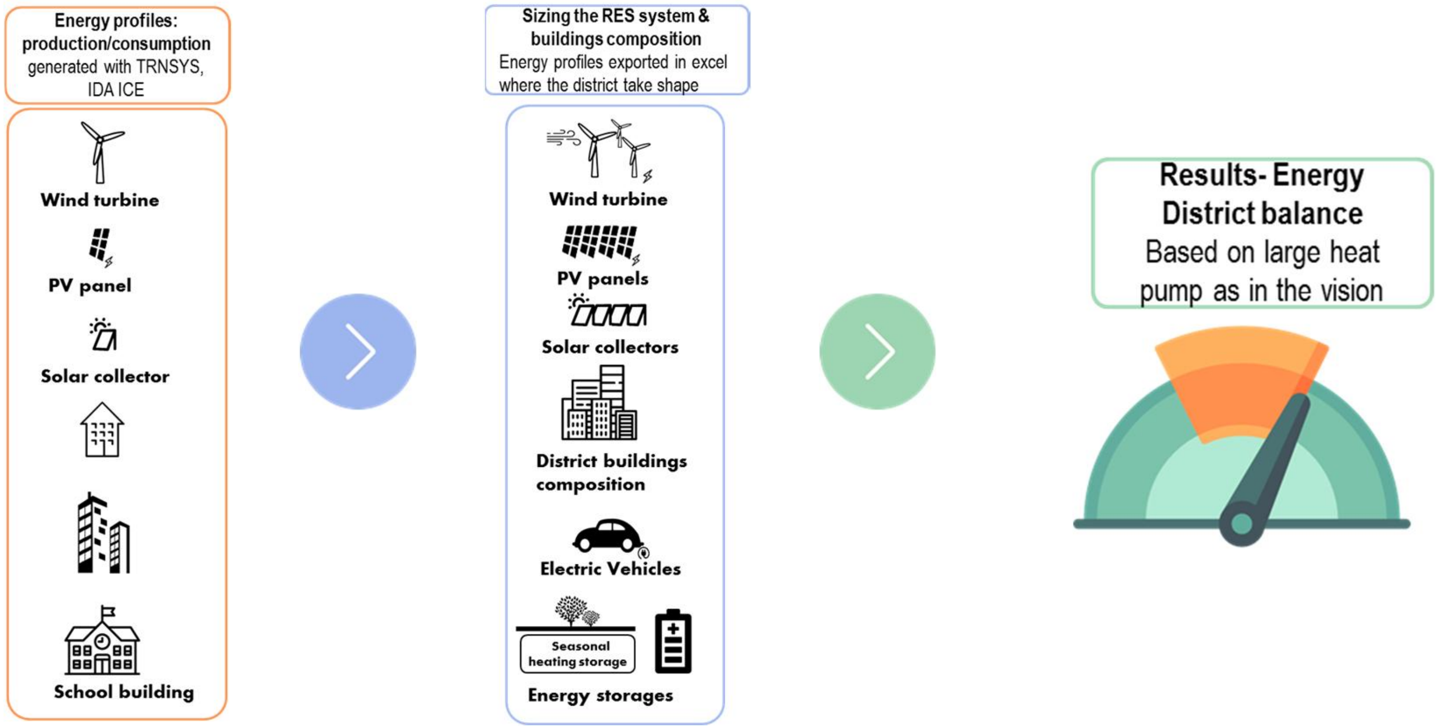
- Solving the seasonal renewable energy mismatch
- Balancing the low or negative electricity market prices during peak wind power production times
  - Seasonal heat storages are significantly cheaper than electric storages
- Levelizing district heating operation by peak shaving
  - Mean annual efficiency of the CHP plant about 1.5% due to a longer use at nominal output power
  - Long payback time of a dedicated heat storage use if used only for peak shaving and only connected to conventional heating generation sources without renewable energy sources

SET-vision of a low-energy community



- **Various load (Residential, civil, office, Electric Vehicle)**
- **Scenarios: 50% - 75% and 100% Renewable**
- **Distributed Renewable energy generation systems (Solar collectors, PV and Wind turbines**-especially for responding to the lack of solar irradiation in winter**)**
- **Community energy storages**: battery and Water-gravel pit storage
- **Dual source heat pump:** water and air

Excel simulation platform



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