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Article

Why District Energy is the **solution of the future**

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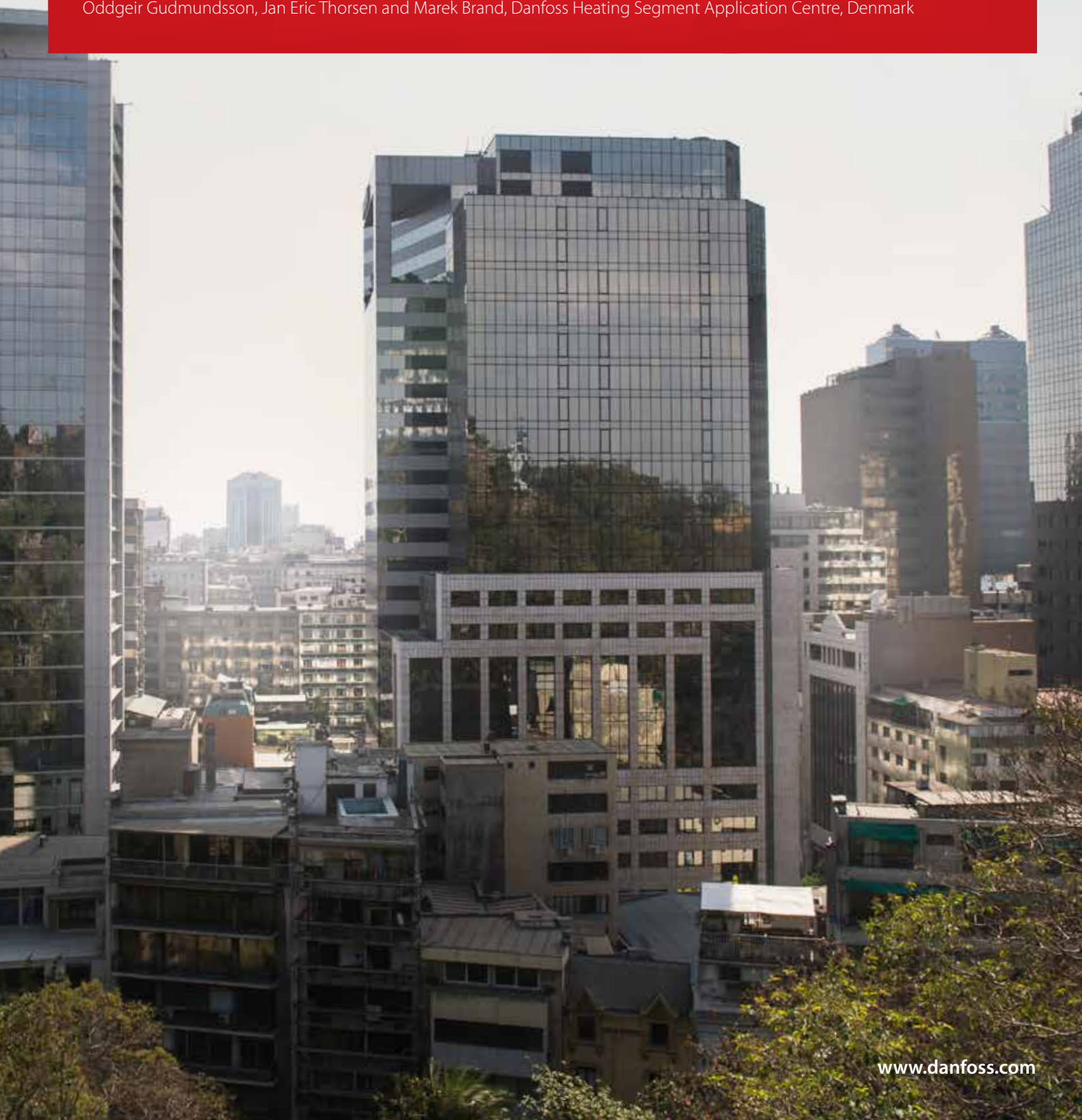

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Why District Energy is the solution of the future

In the recent COP21 meeting in Paris a global agreement was signed with a goal of limiting the global warming to less than 2°C compared to pre-industrial levels. Further, the parties will pursue efforts to limit the temperature increase to 1.5°C. This is a monumental agreement and the census is that to achieve this goal greenhouse gas emission must become net zero in the period of 2030 and 2050. This is very ambitious goal and will require significant changes in the world energy structure.

The energy statistics from the European Union (EU-28) shows that households are responsible for around 39% of the final energy consumption, excluding transport. Of the household energy consumption a major share is used for heating and cooling purposes. Here it becomes very interesting as the energy quality needed for space heating and cooling is very low. In fact the required energy quality is so low that there is abundance of suitable energy sources around us. Despite the fact that there is an abundance of suitable energy sources available for fulfilling space heating and cooling demand the demand is today primarily being met by high quality energy in the form of either gas or electricity. The reason for the mismatch between needed energy quality and delivered energy quality is from historical, logistical and financial reasons. Historically due to the formerly wide acceptance of using fossil fuels and logistically as transportation of gas and electricity is simple per energy unit. Financial reasons have played both direct and indirect role, directly as accessing the renewable energy sources can be investment expensive and hence not practical on building level and indirectly as the "energy product" is characterized by low temperatures, which makes it impractical to transport the energy over vast distances, which limits the market potential.

However, today we have the knowhow, the experience and the technology to tap into the abundantly available renewable energy sources and supply the energy in an efficient manner to the building mass through water based distribution networks, known as district energy systems.

Currently district heating has an average only 9% market share in the heat market in the EU. This is well below the feasible market share, which has been estimated to be between 60-80% of the heat market in various countries [1]. A certain proof of that statement can be found in Denmark, Sweden and Finland where the market shares were approximately 65%, 50% and 50% respectively in 2011. In the eastern European countries Lithuania and Latvia the market shares were 67% and 64% respectively in 2011.

When it comes to decarburization of the space heating and cooling sector a special case can be seen in Sweden were the heat delivered by district heating was decarburized by 80% between 1980 and 2006. In reality this is a very simple once district heating systems have been established as it just a matter about connecting environmentally friendly heat sources to the distribution grid.

As for district cooling it is a relatively newly applied solution but built on the vast experience acquired in the district heating field. A quick survey of existing district cooling schemes gives a clear indication on how promising the technology is. As a proof of how good district cooling is the installed schemes typically grow extremely fast until the cooling market in the area has been saturated. Examples of successful district cooling systems in Europe can be found in Sweden, France and Finland.

In Denmark, the country with among the highest share of renewable energy in the energy system and very ambitious goals of almost 100% renewable energy system in the near future, district energy is considered as the backbone of the future fully renewable energy system. This is based on the fact that heat storages in combination with district heating provide the most efficient energy storage that can be achieved for compensating the fluctuating nature of renewable energy sources such as wind and solar.

What makes district energy the enabler of renewables

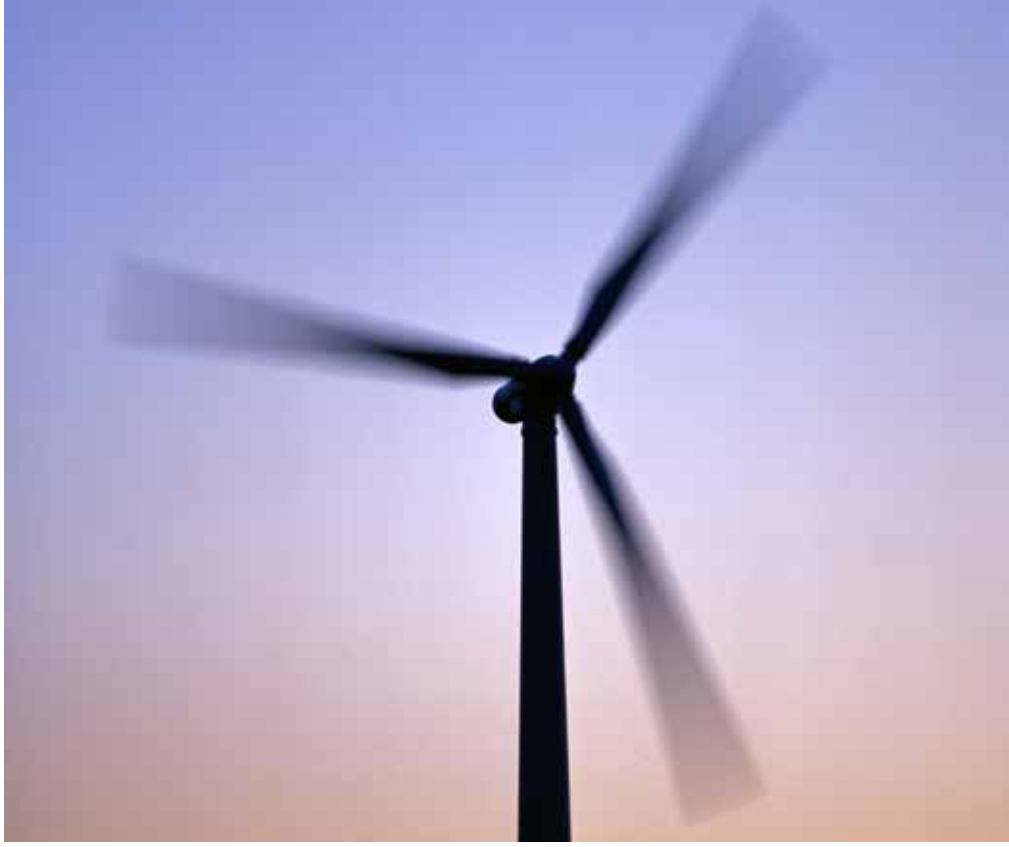
Common forms of renewables are:

- Solar
- Wind
- Geothermal
- Biomass
- Surplus heat from the industry
- Free cooling

Typical challenges with renewable energy are:

- It is intermittent
- It is of low temperature nature
- It is found at remote locations
- It is expensive to develop
- It is valuable resource for many processes

If the challenges when utilizing renewable energy sources are analyzed in combination with energy intensive locations, urban areas, interesting points can be derived.



Solar power and heat

The challenges with harnessing solar energy are:

- Solar panels need space with certain incline and facing in the direction. In urban areas this would generally mean rooftops of buildings. If solar heat is applied the roof may need structural enhancements.
- Solar energy is intermittent, both during the day and seasonal.
- During winter the solar yield is low.

The best utilization of solar energy can be utilized if the harnessed energy is fed in to a either power or heat grids. The main issue with solar energy is that it is only accessible when the sun is shining. This implies that it cannot fulfill the whole power or heating demand throughout the year. However if the solar energy used to substituted alternative energy sources it provides the cleanest energy that can be achieved.

Wind energy

The challenges with harnessing wind energy are:

- The wind is intermittent.
- Large power fluctuations can be experienced within short period of time.
- It is not applicable in urban areas.

The best utilization of wind energy is through connection to a power grid. In countries like Denmark where high wind power concentration has been achieved there can be periods of strong winds were the power generation can become higher than the demand. In case of excess wind, and hence power generation, either some wind mills need to be stopped or the excess power needs to be used. The best way to use the excess generated power would be to heat or cool water using heat pumps and feed the hot/cold water to a district energy system. In case of low heating/cooling demand the heat or cold can be stored in large water storages for later usage.

Geothermal energy

In general geothermal energy is a stable and secure renewable energy source. The challenges with utilizing geothermal energy are:

- Initial investment is high.
- Suitable locations can be remote.
- In most locations the geothermal energy is of low temperature nature.

Almost independently on locations geothermal energy can be found with sufficiently high temperature for fulfilling space heating demands, a great case can be found in Paris where a total capacity installed is 270 MWth. In case of low temperature sources heat pumps can be used to lift the temperature to suitable levels, as is done in Sønderborg, Denmark. However, the above mention challenges have resulted in that utilizing geothermal energy on a grand scale is not main stream, even though geothermal energy could achieve tremendous reduction in fossil fuels usage.

The way forward for grand geothermal utilization can only be achieved in combination with district heating networks. By applying district heating networks the plant capacity utilization can be maintained very high throughout the year, which results in low investment costs per energy unit. In combination with solar and wind energy the geothermal energy can cover the base load demand. The geothermal energy can also be used to fulfill peak load demand to some extent, if the well is rested in periods of high availability of energy from heat and wind.

Biomass

Biomass is without doubt one of the key energy sources in the future energy mix. However, many processes rely on fossil fuel based materials and once fossil fuels have been faced out these processes will look towards substitutes and most likely the substituting materials will be found in the biomass. Additionally it is expected that the transportation industry will look heavily towards biomass for alternatives to fossil fuels.

The challenges with biomass are:

- Origin of biomass is in rural areas, potentially far from the energy demand.
- Transportation of biomass in grand scale is challenging.
- It is valuable resource for various processes.

It is expected that many current power plants will be changed from fossil fuels to biomass plants. During power generation and fuel conversion processes heat will always be a by-product. It would only be natural to utilize the heat for heating purposes through district heating networks.

Surplus heat from the industry

By looking into studies made on the availability of surplus heat from industry it can be seen that surplus heat is available throughout Europe [2]. By utilizing the industry surplus heat, which is seldom used today, huge amount of fossil fuels can be replaced. The main issues with utilizing surplus heat from industry is that it can be of low temperature, which would require lifting the temperature using heat pumps.

Free cooling

Commercial buildings have cooling demand more or less throughout the year. For long periods of time this cooling could be achieved by utilizing free cooling from the sea, lakes or rivers. The district cooling network is then used to transport the cold from the cooling source to the buildings. This can significantly reduce the power consumption for cooling purposes. Once the district cooling network has be established it can be used in combination with electrical chillers and thermal storages during the summer months to decouple the cooling generation and cooling demand and hence reduce the strain on the power grid during peak load periods.

Heat storages

Heat storages are simple mean to decouple supply and demand. By applying heat storages the energy can be generated at the most

The benefits of heat storages are:

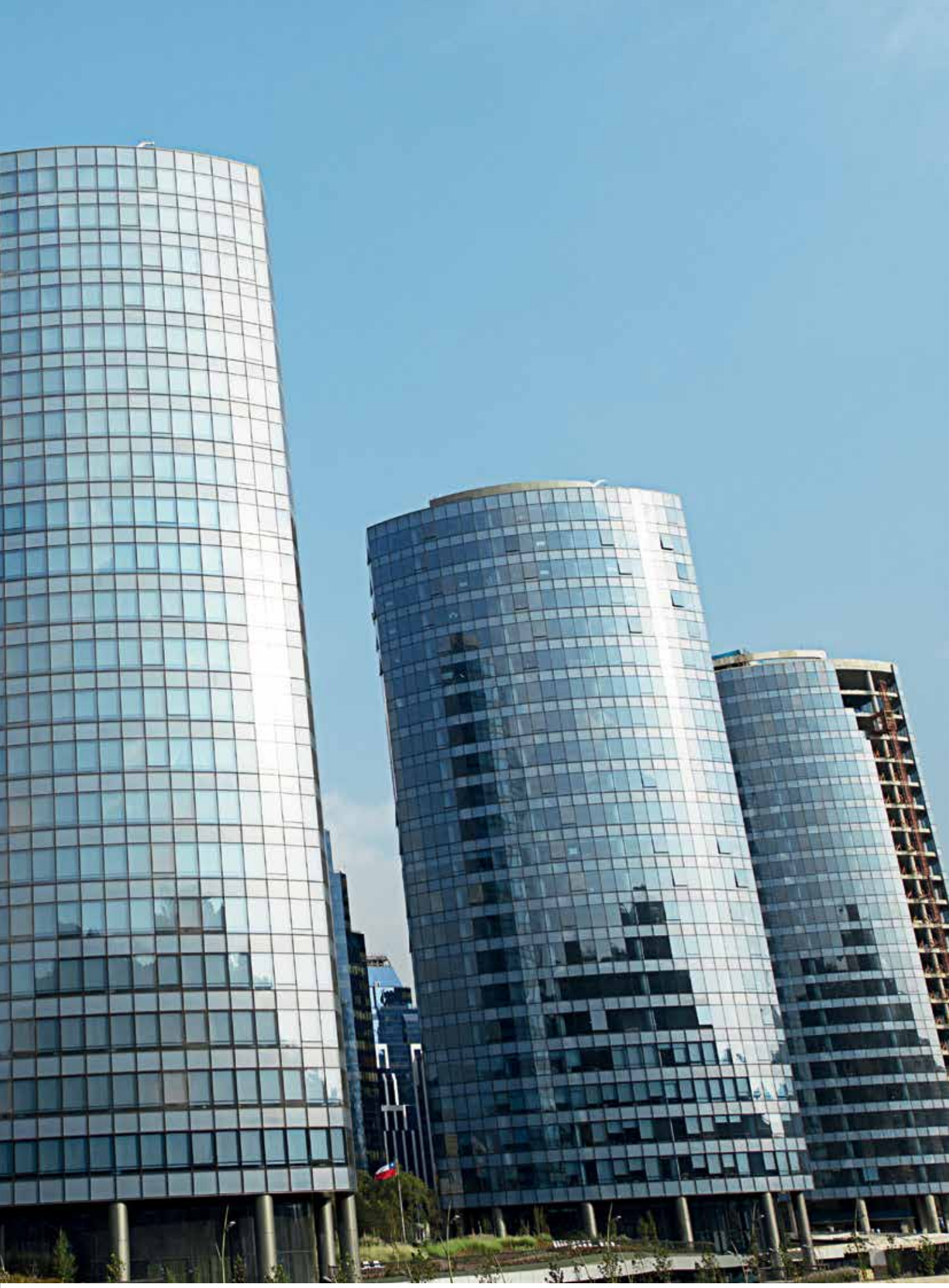
- Enables use of seasonal renewable heat sources.
- Reducing peak heating / cooling demand on the district energy networks.
- Enable large scale heat pumps and electric boilers to produce heat in periods with low electricity prices.
- Allows utilization of heat from intermittent industry processes.

Heat storages come in various sizes, from big tanks at power plants 30.000 m3 to large pit storages of 200.000 m^3.

Remarks

Concluding remarks are:

- District energy is the perfect technology to achieve quick and permanent wins in the fight against climate change.
- District energy is the only technology which allows grand utilization of renewable energy sources at feasible cost levels.
- In combination with heat storages it opens up for larger penetration of fluctuating renewable power sources such as wind and solar.
- District energy increases the flexibility and the efficiency of the entire energy infrastructure.



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