REDI PRESENTS

THE EVOLUTION OF ENERGY INFRASTUCTURE IN BUILDINGS

LESSONS LEARNED
AND THOUGHTS SHARED
STOCKHOLM, 2023

CONTENTS

01 SUMMARY

»In the global race to reach net zero, the importance of energy and power management in buildings have increased significantly.«

Buildings are becoming more complex as they are equipped with more sophisticated technology. The purpose is to build smart, integrated solutions that improve operations and increase tenant satisfaction, while simultaeneously reducing the overall environmental impact, e.g. security, heating, lighting, and a range of other building systems. Furthermore, the overall electrification of society will put even greater pressure on the real estate industry to develop new capabilities as the bearer of an emerging infrastructure for local energy production (solar), storage (batteries) and electric vehicle (EV) charging for the ever-growing number of electric vehicles.

So, not only do we require more power, there is also a risk that the existing infrastructure, e.g. the electrical grid is insufficient and incapable of managing the change. There is also the issue that many of the current energy solutions have a negative environmental impact.

But we believe that there are energy solutions possible today that can generate a positive business case.

Today, the energy-related ecosystem in real estate is not integrated to a satisfactory level. Solutions are often built, deployed and used in functional silos.

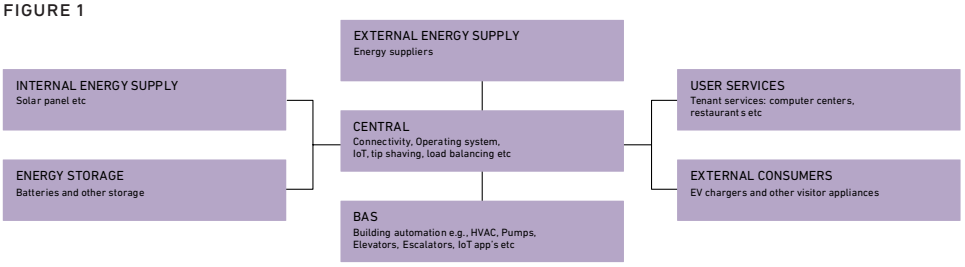
Although some stakeholders are starting to integrate the disparate systems, a significant amount of work remains to achieve the necessary levels of satisfaction and efficiency.

Property owners and managers need to understand what the energy ecosystem setup should look like in a modern building to secure safe, efficient operations without compromising tenant and visitor safety or the overall experience. It requires the setup to be smart (building and city), and able to connect to, utilize and/or manage assets in the building and portfolio, while being more energy efficient. In total, it should provide a positive (or less negative) impact on the environment compared to the existing solutions. Done properly, it should also have a positive impact on net operating income (NOI).

A "complete" ecosystem is built up of many assets. Most suppliers deliver their services in vertical silos, selling batteries, solar panels or EV chargers. Some of them may bundle two verticals, e.g. solar panels, batteries and a sell-to-grid solution.

A few stakeholders are starting to integrate different verticals. These stakeholders have one thing in common: they view the installation as an ecosystem where different building blocks act in a symbiotic relationship.

FIGURE 1



For the sake of clarity, property owners need to make sure that the solutions implemented are flexible and open, allowing for new business models and technical requirements.

Property owners have traditionally taken a single role, i.e. operating a building. In our White Paper, we explain how roles have changed over the last few years. Now, it is not uncommon for stakeholders to take multiple roles, up- and/or downstream.

As roles are not as clear cut as they once were, real estate owners need to rethink their traditional position.

Real estate owners' objectives are to take a holistic view and help stakeholders make the right decisions. The energy ecosystem should:

> Provide information and enable decision making
> Support the evolution of new use cases
> Support efficient usage and maintenance of assets, giving lower operational costs and improve net operating income
> Be environmentally sustainable and be compliant with regulations

To clarify: centralized capabilities, standardized open architecture and application programming interfaces (APIs), and an independent integration layer are all important. But it is not about physically putting all digital building assets into one location. Instead, it is about the benefits that come from having centralized access with the ability to aggregate data, monitor status, operate equipment, and support or make decisions. In this White Paper, we share some examples from REDI members and the participating companies.

It goes without saying that a smart and efficient energy setup will improve net operating income by:

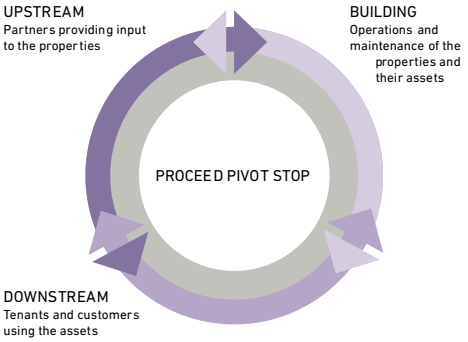
> Generating new revenue sources, e.g. customers selling energy-related services and selling excess energy back to the suppliers
> Increasing the attractiveness of your buildings, e.g. provide better, more flexible services and increase sustainability to keep rents attractive
> Lowering operating costs by managing peaks, optimizing loads, consuming less energy, and operating equipment more efficiently, all in symbiosis with tenants, visitors and other assets in the properties

This will increase the value of your property and produce a positive return. Other important values are resilience to malfunctions, compliance with (new) regulations, reporting, etc. A final major value created is the positive effect on the environment and society – all while ensuring a positive cash flow. We will include some examples in this White Paper.

To conclude: there are many initiatives that will have a positive financial and environmental impact and there is no reason to wait. However, we do not believe that "doing everything at once" is a good idea. This is a complex area that can be costly if not done properly. But if you look at some of the more advanced players rolling out a solution across several buildings in a portfolio, they have most likely done it because the business case is solid.

We hope you enjoy this White paper
The REDI team

FIGURE 2



02 THE OBJECTIVE OF THIS WHITE PAPER AND HOW TO READ IT

You may ask yourself who this report is written for? It's written for key stakeholders in the real estate industry. This includes real estate owners, property managers and business developers as well as partners and vendors to the above.

The main objective is to create a common ground and a common understanding of energy-related topics, so that the work to make buildings more attractive, sustainable and future-proof is more impactful.

Over the last decades, the importance of energy in buildings has increased significantly. In the 1950's, we heated our buildings with wood, oil, gas, or coal, while electricity was used for powering lights and some basic appliances.

Today, our buildings are connected. We are starting to build ecosystems with smart solutions and integrated systems such as security, heating, lighting, computers and a range of other building systems.

As in many other areas of real estate, the energy ecosystem is not integrated to a satisfactory level. The solutions are often built, delivered and used in functional silos. Although some stakeholders are starting to integrate the disparate systems, work remains to be done to achieve the necessary levels of satisfaction and efficiency.

There are a number of challenges that need to be taken into consideration:

> As we become more connected, we require more power
> New appliances and the electrification of, e.g. electric vehicles, "stress" the ecosystem and grid to a point where the existing infrastructure is insufficient
> Current infrastructure is not geared to manage the change
> Majority of current solutions have a negative impact on the environment
> Risk of high OpEx and CapEx if not managed properly

Allow us to take a brief deep dive into one problem area – EV charging in newly built housing. Sveriges Allmännytta (Public Housing Sweden) wrote a report based on a project called "Mobilitetsprojektet" (The Mobility Project), which analyzed the challenges associated with EV charging. A short summary of these challenges is that policymakers are setting high demands on parking and charging solutions for newly built housing. These demands result in high contributions from the housing-rent (70% of total cost) since income from parking fees/rent are significantly insufficient

However, given the expected growth of electric vehicles, the amount of charging stations/points and the size of the grid may be insufficient. Finally, the increasing number of electric vehicles means more cars sharing EV charging stations. This will increase pressure on the infrastructure and demand a change in behavior from EV owners.

We know that energy covers more than just electricity – heating and cooling are two adjacent areas. In this report we touch upon different energy types and usage but focus on energy transferable to electricity.

THE OBJECTIVE OF THIS WHITE PAPER AND HOW TO READ IT

THE OBJECTIVE OF THIS WHITE PAPER HAS BEEN:

> To understand how the electrical set-up should look in modern buildings to ensure safe, efficient operations without compromising tenant and visitor safety and the overall experience
> To find solutions that:
    - Are smart (building and city)
    - Can connect to and utilize and/or manage assets in the building and the portfolio
    - Take other stakeholders needs into consideration
    - Have a positive (or less negative) impact on the environment compared with existing solutions
    - Are more energy efficient, or support a more energy efficient use of assets
> To clarify which role the real estate owner should take in this solution
> To understand if it makes sense to build local energy ecosystems and if there are viable business models

Although we cover all of the above, we have not exhausted the topics and may not have reached final conclusions. This is mainly because each vertical has vast amounts of data and some of the initiatives and solutions in the market have not reached a point of maturity where final conclusions can be drawn.

The White Paper is based on the work and experiences of REDI.city's members and is complemented by 18 companies with diverse backgrounds such as energy, grid, building management systems, EV charging, solar, battery, IoT, sensors and data management.

We do not claim to have identified the ultimate solutions and have not produced manuals or "templates". However, we believe that we have found some common denominators for a solid structure that we would like to share with interested stakeholders in the market. This White Paper is intended to be inspirational and provide guidelines that can be used in discussions between different stakeholders.

We are targeting a wide audience – from executives and professionals to specialists. We have tried to keep it relevant while balancing key messages with the right level of detail. We have also tried to keep it to a reasonable length, so it is easy to digest.

We hope you will find the information in this White Paper interesting, relevant and enjoyable.

03 THE STAKEHOLDERS AND DIFFERENT BUILDING BLOCKS

When we began our work, we took the EV charging value chain as a starting point. Interestingly, we realized that most stakeholders described the value chain in a similar way with energy suppliers, EV charger manufacturers, installation & maintenance, charge point operators, e-mobility service providers and, last but not least, EV owners. This perspective, excluding property owners, could be found in other verticals as well.

Almost no one mentioned real estate owners. They were seen as someone who provides a parking lot or a roof. This is understandable from the outside, but what is forgotten is that the operators need to connect to the building's electrical infrastructure that has not been prepared for this type of load. This means the costs for providing this type of service can be quite high as the electrical infrastructure often needs to be upscaled. Also, in some parts of the city, the grid's capacity is insufficient and needs to be upscaled, which may not always be possible in the short term.

Therefore, we have decided to look at the value chain from the perspective of property owners. Not because we believe we are the center of the universe, but simply because the main audience for this White Paper is property owners and related stakeholders.

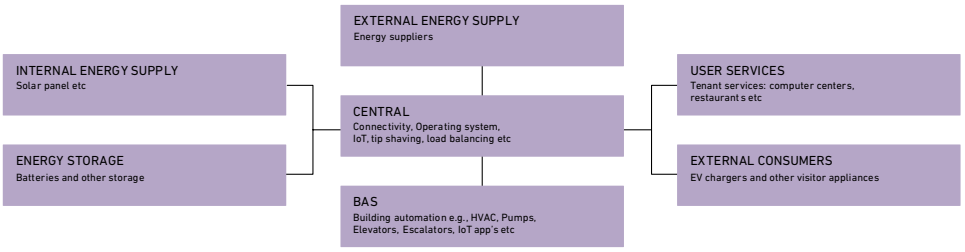
To do this, we first need to understand what the different "building blocks" are, and then look at the stakeholders operating or using them.

Please note that we understand that the complexities of micro- and macrogrids go beyond the scope of this document. Our focus is on how the building's "internal grid" should look. Not because we think the broader perspective is unimportant, but simply to limit the scope of this White Paper to buildings.

If you are interested, we explore these building blocks in 'Appendix 1: The building blocks'.

Most suppliers deliver their services in vertical silos, selling batteries, solar panels or EV chargers. Some of them may bundle two verticals, e.g. solar panels, batteries and a sell-to-grid solution.

FIGURE 3



THE STAKEHOLDERS AND DIFFERENT BUILDING BLOCKS

The three stakeholder groups can be seen as:

UPSTREAM
> Suppliers of both Energy and BAS solutions, providing the solutions (e.g. providing open API's and possibility to steer assets remotely)

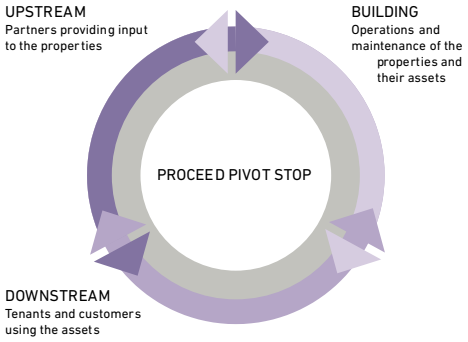
BUILDING
> Stakeholders such as facility managers and equipment operators, operating the building (e.g. aligning and coordinating assets to operate efficiently)
> Asset/property owners, making offering and investment decisions (e.g. deciding how the building should evolve, applying data driven decisions)

DOWNSTREAM
> Tenants renting the space, having comfort, sustainability and efficiency type of demands (e.g. demanding energy used in the building is renewable, or EV charging stations)
> Visitors coming to the facilities ...

A few stakeholders are starting to see the benefits of looking at a holistic solution, starting to look at how the different verticals can interact. They have one thing in common, looking at the installation as an ecosystem where the different building blocks act in a symbiotic relationship. It is quite common that they originate with one product or service and add third party products to their offering to build a complete solution.

Also yesterday's consumers become producers (e.g. when property owners, private and commercial, start producing energy) and yesterday's producers become buyers and consumers become sellers (e.g. energy companies buying energy from prosumers).

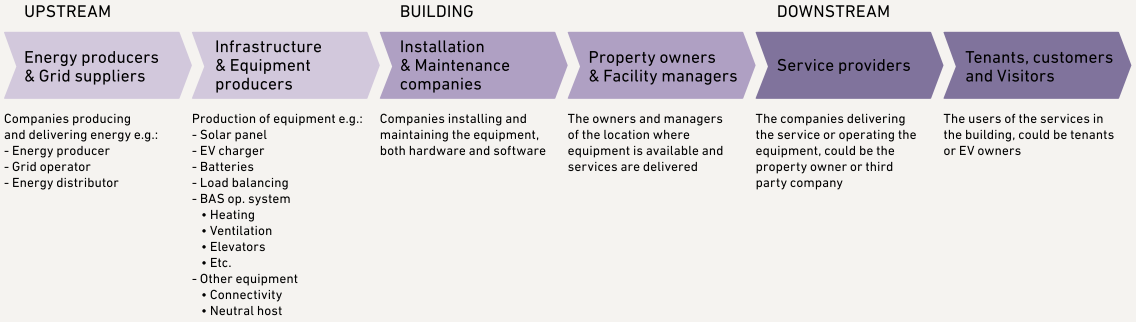
FIGURE 5



Another important consideration is that this is not a static situation. Evolution of the value chain is going very fast, with new products, services and stakeholders. The value chain is evolving and as a property owner you need to look at it as a circular flow, where you need to look at how the stakeholders interact and be ready to evolve with the change.

That means that the roles are not as clear cut as they used to be, and the real estate owners need to rethink their traditional position. For the sake of clarity, the property owners need to make sure that the solutions that are implemented are flexible and open, thus allowing for new business models and technical requirements.

FIGURE 4



04 A POSSIBLE HIGH-LEVEL STRUCTURE

Before a structure can be set, the objectives need to be understood. The objectives must take a holistic view and need to help stakeholders make the right decisions. REDI has identified the following objectives:

> The structure must allow for increased understanding (data) and enable decision making
> It needs to support the evolution of new use cases, e.g. the fast growth of electric vehicles
> It must support the efficient usage and maintenance of assets, delivering lower operational costs and improving net operating income, e.g. load shifting, peak shaving, managing, storing, buying, selling electricity at the right time
> It needs to be environmentally sustainable and comply with necessary regulations

The difficulty with these objectives is that the final solution may vary depending on the type of property that is being addressed. Therefore, the structure (fig. 6) should be viewed as a framework and not a template.

One of the biggest questions to come out of our work is how far should property owners go?

> "Islanding": full capability to manage and operate the energy in the building even if the grid connection is down or not supplying electricity
> "Prosumer": a mix between producing and using electricity from the grid, but not being self-sufficient
> "User": fully dependent on energy from the grid

Regardless of which option is chosen from the above, it is necessary to build a structure that is:

> Efficient in usage and has predictive capabilities regarding consumption of assets
> "Future-proof" by having smart architecture that is prepared for either: a "command center," integration layer with standardized APIs, a cloud solution that is not dependent and distributed across multiple vendors or solutions. For further clarification, see the remainder of this White Paper and our IoT report at redi.city.

ORGANIZATION OF PEOPLE, ASSETS AND COMPETENCE

This means that there is a strong advantage in having centralized operations with the ability to aggregate data, monitor status, operate equipment, and support or make decisions.

Later in this White Paper, we will provide a few examples of how this is beneficial.

To be explicit, it is not enough to have a centralized systems, but the knowledge, data, and processes need to be aligned with a (small) group of people having portfolio view over the assets.

This group needs to have:

> Standardized and centralized data structure and management
> Standardized processes (where reasonable)
> Mandates to create and execute portfolio wide solutions (in close cooperation with the local organization)
> Centralized monitoring and operations, where we see different breakdowns in execution of activities where some
    - execute and implement the required updates, fixes and solutions are locally and other
    - have central support for execution and implementation

We don't have a strong view of which of islanding, prosuming or using is the right way, but the key is to make sure that the right competence is available in the execution team and, very important, make sure that the implementation and execution is aligned with centralized standards and mandates.

For the sake of clarity, when we talk about centralized and standardized we talk about the benefit of standardized open API's and an independent integration layer so that assets can be managed remotely, potentially from a single point (either through automatic tools and algorithms or manual adjustments). It is not necessarily about physically putting all digital building assets in one location.

This set-up balances the centralized capabilities of optimizing and benchmarking with local operations, management and servicing of the underlying assets in the buildings.

It may be difficult to do all the above in one go. If you want to take it step by step the order above is, in most cases, a sound order to plan your evolution.

To explain the above from a different angle:

> Developing central capabilities first,
> Then roll those out in your entire portfolio to get economies of scale,
> Follow on by connecting each vertical by financial benefits (e.g. HVAC) or by strategic choice of capability (e.g. EV chargers)

FIGURE 6
Source: Stronghold/Newsec

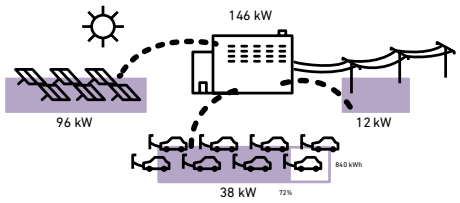
INTEROPERABILITY

Without a centralized infrastructure, it becomes impossible to manage the different assets efficiently. For load shifting and peak shaving to function fully, it is essential to have all assets connected to a "central command" that can determine when to:

1. Source the energy and from where
2. Store or sell energy from producing units
3. Start, limit or stop certain assets

When this type of infrastructure is in place, real benefits can be achieved – as illustrated in the example in fig. 7. Figure 8 shows connected EV charging stations connected to a central monitoring and control system.

FIGURE 7
Source: Wallbox



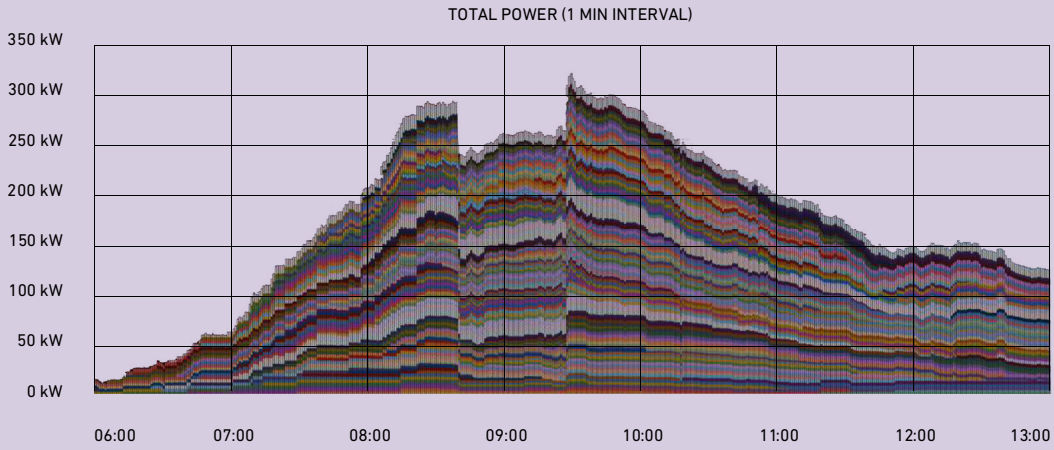
This allows for intelligent sourcing and asset usage to achieve smart load shifting in buildings.

In this case, the system monitors the EV charging stations and sets the power in relation to other assets in the building. Around 9 o'clock, the office is filling up with people and the system recognizes that other systems, e.g. heating, ventilation and air conditioning (HVAC) and other equipment in the building require energy, so it sends a signal to the EV stations to limit the EV charging power. Once other assets require less power, the power for EV charging can be increased again.

To benefit fully from a set-up such as this one, it is important to have a structure that follows standards such as Real Estate Core, Brick Schema, Haystack, etc. It is also important to follow a service-oriented architecture with an independent data layer in the middle.

For more details, please read our IoT and Digitalization Report on www.redi.city

FIGURE 8
Source: Vasakronan



A good technical architecture allows real estate owners to achieve four crucial capabilities that are required to operate real estate efficiently:

1. Data: Aggregate, own/manage and centralize
2. Monitor: Know what is happening where and when
3. Analyze: Understand, predict, and make smart decisions based on what is happening in your buildings
4. Control/manage: Steer and optimize your assets
5. Predict: Allow for either centralized (manual ML and AI) or edge (ML, AI) based decisions and predictions

Figure 9 illustrates how three asset classes are integrated:

> With an integration layer applying standardized APIs
> Working in a centralized cloud environment
> With an operating system, e.g. Proptech OS by Idun or RoadRunner by Cavill or another platform that uses standards such as Real Estate Core or Brick Schema
  - gathers data
  - monitors equipment
  - analyses data
  - controls assets
  - predicts behavior
> Connects to the grid and energy producers through an energy "marketplace"

One possible way of illustrating this from a stakeholder and asset point of view can be seen in the figure 10.

FIGURE 9

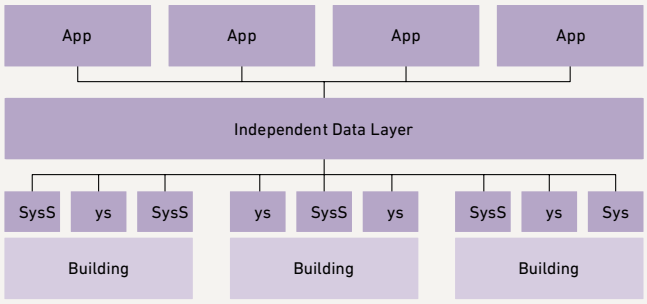
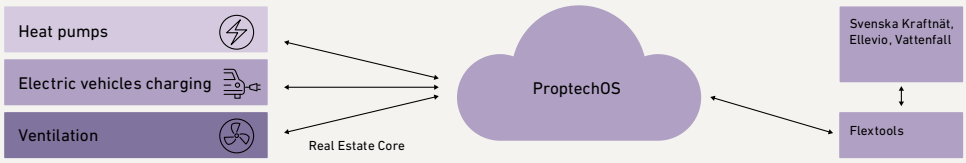


FIGURE 10
Source: Vasakronan



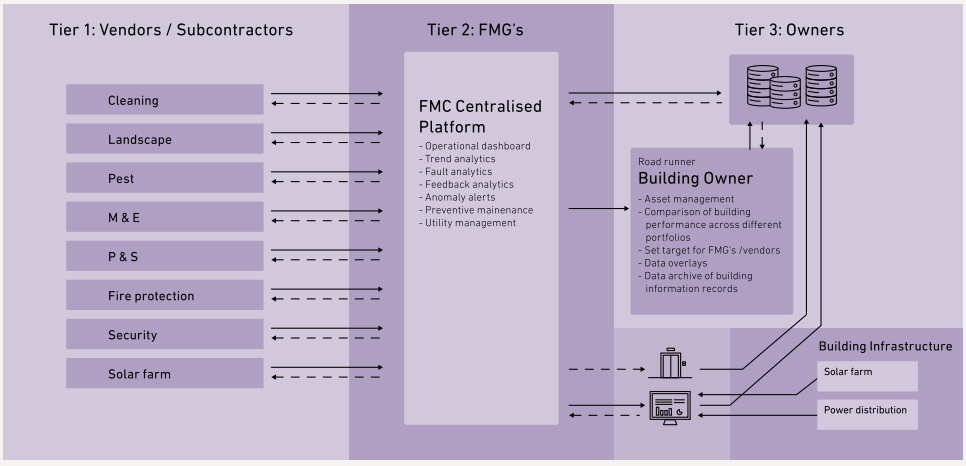
The key to the image in figure 11 is how the "signal" flows throughout the ecosystem. The signal can be seen as, e.g. data and energy – or maybe even heating, cooling, water, lighting, etc. It is not unusual for the signal to take an inefficient path as equipment, e.g. the heating system, solar panels, EV chargers has been installed as vertical "stand-alone" solutions. When different systems and assets are connected to a central command and operating system, the flow of data may take "crooked roads" to "fit" the assets' own operating system.

We have shared a lot of pointers in this chapter. So, let's summarize:

1. Understand your objectives
2. Determine your level of ambition
3. Think future capabilities, don't just focus on the present
4. Understand how you will interact with the outside world
5. Set portfolio-wide architecture
6. Start with central capabilities for the entire portfolio
7. Work with standards and open APIs
8. Add verticals across the portfolio by financial benefit or strategic importance for scale
9. Take control of your data and add capabilities – analyze, control, predict
10. Follow the signal and make it as straight as possible. Don't just add "things" and create a patchwork

As you can see, it is important to define a good system architecture and work with open APIs that connect through a consistent integration layer, allowing for an intelligent (central) data structure. You can read more about this in our Digitalization and IoT report at redi.city.

FIGURE 11
Source: Cavill



05 SOME THOUGHTS AROUND THE BUSINESS MODEL

It is no secret that buildings have gone from being places we live and work in, to one of the world's largest financial asset classes. Whether you like it or not, it has led to two obvious drivers that both have a major impact on how properties are developed:

> Can an investment improve the net operating income and generate more cash flow?
> How will I get a good return on my investment, and will the asset value increase?

Historically, initiatives have mainly focused on decreasing energy demand and need, and less on what power is actually needed for and when.

Energy and related use cases have a direct impact on the drivers mentioned above. Below, we break them down into tangible components:

NET OPERATING INCOME

> Revenue:
    - From new services provided for tenants and visitors, such as EV charging where it is possible to differentiate service levels and charge different fees
    - From integrating (new) assets with an internal and external ecosystem (and markets), e.g. becoming a prosumer that sells excess power back to suppliers and supports the grid operators with maintaining frequency
> Costs:
    - Lowering the power need and energy consumption by, e.g. optimizing assets and planning when they operate
    - Peak shaving and load shifting, identify anomalies and achieve better tariffs as assets are deliberately managed and coordinated to stay within acceptable consumption levels
    - Monitoring, optimizing and steering assets to pick the most efficient source/asset when it makes sense from a financial perspective

VALUE

> Increase asset value through:
    - Higher net operating income due to efficient operations and lower costs
    - Increased attractiveness to tenants and visitors
> Longevity of assets, smart management of assets leads to a longer lifespan
> Resilience to malfunctions, enables continuous operations and allows for premium rents
> Compliance with (new) regulations, have an infrastructure in place that provides insight and control, allows for efficient reporting and avoids potential penalties

There are also other values that allow us to contribute to society and protect the environment. We can achieve this by becoming more sustainable through consuming less energy, and supporting our energy infrastructure and grid by working with stakeholders to lower volatility and imbalances in our electrical grid.

Here are a few examples of how some of us have addressed the topics mentioned above:

(DE-)ACTIVATE ASSETS BASED ON OPERATIONAL AND FINANCIAL PARAMETERS TO OPTIMIZE ASSETS AND LOWER OPERATING COSTS

In a number of Fabege's facilities, a function has been developed and implemented to reduce the electrical power in the building when electricity prices are high.
The override function uses an API from Nord Pool with Day Ahead electricity prices to set in motion a number of regulatory sequences in the building. As of now, it's main focus is to gear down and turn off heat pumps in the facility when the electricity price is higher than using the alternative, e.g. district heating. Different buildings have different technical conditions. This means that different electricity price limits are set at different times in each building.

The settings are related to, e.g. the heat pump's coefficient of performance (COP) and the setup of the district heating taxes. The motivation behind this function is to help stabilize the electrical grid in times of high demand as well as increase the building revenue over time.

MONITOR AND OPTIMIZE ASSETS TO LOWER OPERATING COSTS

One of the most basic ways to save energy and money is to connect and monitor the assets. A good granular tool can measure when an asset is used and, as in this case, clearly show that it could be re-programmed to save energy and money.

Once the property manager has a good understanding of the systems, the data can be combined, e.g. visitor, HVAC and "inertia" data to optimize when HVAC equipment is to be switched on and off during the day, leading to additional energy savings.

FIGURE 12
Source: Fabegé

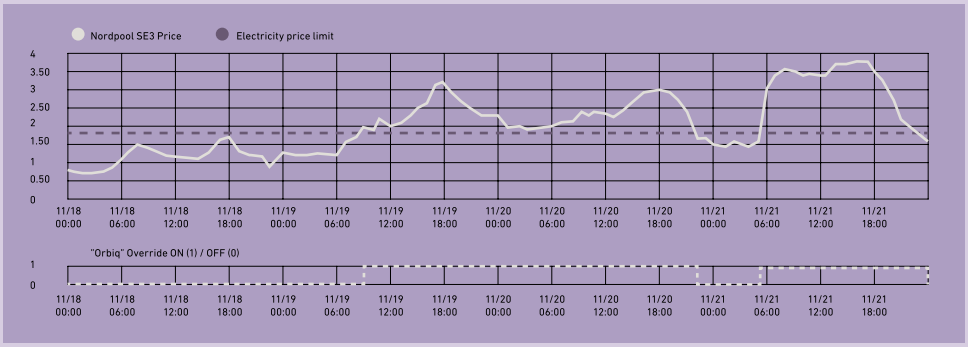
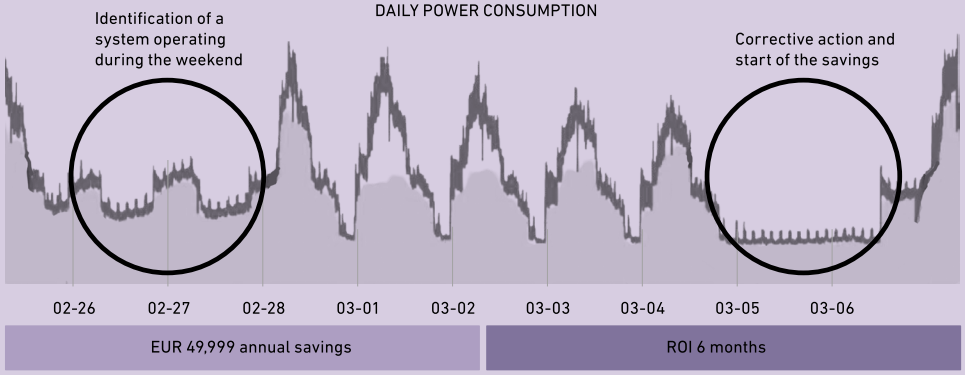


FIGURE 13
Source: Infogrid



INCREASE ATTRACTIVENESS TO TENANTS WITH SUSTAINABILITY DEMANDS

Given that energy suppliers feed data to the system, it is possible to not only choose the right source at the right time, but to also get a good breakdown of sources that can be used, e.g. for sustainability reporting. Some tenants demand green energy, which is increasing the attractiveness of property on the market. However, the actual premium on rents is very limited.

Ability to steer EV charging to manage peaks and loads (on the cost side) and differentiate pricing and predetermined parameters (revenue management)

To fully benefit from an integrated monitoring and controlling solution, it is important to connect the services, e.g. EV charging stations to external assets such as power producers, grid and payment systems.

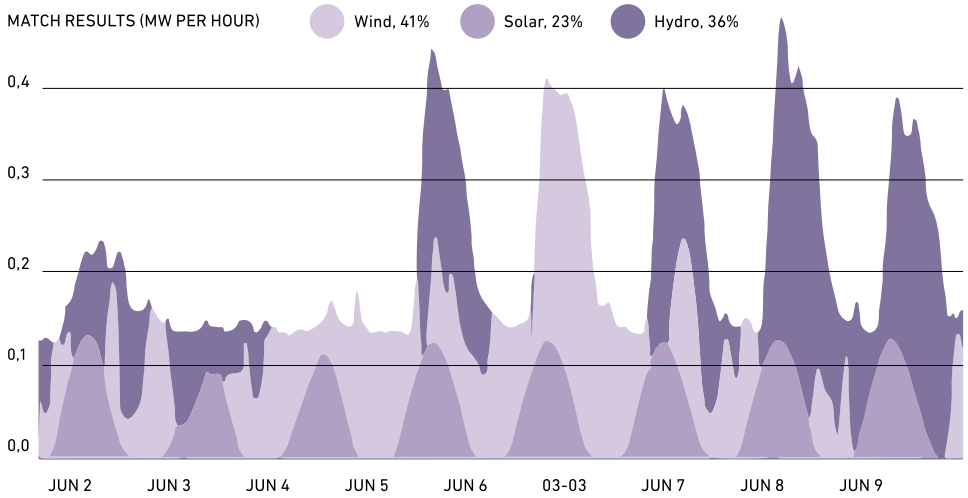
The example in figure 14 shows one business model where customers using EV chargers can be billed. There are different business models for managing revenue. It is a commercial agreement between the property owner and service provider where space can be rented (by service provider or tenant) and a service provided to increase attractiveness, e.g. at a shopping mall. A revenue share model is applied. Taking an active role in buying and selling electricity as well as supporting the frequency in the grid

The wider picture goes beyond the scope of what you can do in your own building. It requires multiple stakeholders in the value chain coming together and building a solution where the stakeholders work together to increase efficiency in the ecosystem.

The challenge for the energy system is that electricity needs to be produced as it is consumed. This means the frequency needs to be balanced simultaneously, and the energy system needs frequency regulation services to maintain the capability to deliver power. This allows property owners to take part in the energy market, generate new revenue and lower operating costs (see Stockholm Flex figure 15 and 16).

Becoming active in the energy market may seem like a large, complex and costly step. But when energy prices are as high as they were in late 2022 and early 2023, several stakeholders indicated payback periods of under 3 years.

FIGURE 14
Source: AMF Fastigheter



SO, HOW CAN YOU MAKE MONEY BY PARTICIPATING IN THE ELECTRICAL MARKETS?

> Spot prices and grid tariffs
- Plan for and use assets when electricity is cheap on the spot market
- By peak shaving and load shifting you can avoid consumption levels that put you on a higher tariff or exceed agreed levels
- Add battery/storage capacity to store electricity when it's cheap, and use or sell it back to the grid when it's more expensive

> Frequency regulation
- Frequency regulation services – over the next five years, frequency regulation will be more valuable than spot price optimization to property owners that can regulate their power consumption. A modern and fast energy infrastructure allows the property owner to support the frequency in the grid so that the 50Hz can be maintained in the grid. See Table 1.

> Local flexmarkets
- Local flexmarkets – the local grid operator connects to a multitude of assets or buildings, e.g. property owners that can aggregate different properties in the portfolio to support the local or regional grid. This generates additional opportunities to leverage real estate owners' flexibility and generate new revenue, while resolving grid capacity issues. The local flex markets are still in the early stages and more volumes need to be introduced into the system to generate value.

TABLE 1
Source: Castellum, Effektstrategi

Service	FFR Fast Frequency Reserve	FCR-N Frequency Containment Reserve, Normal	FCR-D Frequency Containment Reserve, Disturbance	aFRR automatic Frequency Restoration Reserve	mFRR manual Frequency Restoration Reserve
Purpose	Managing fast and deep frequency changes Battery	Stabilizes the frequency when small changes occur based on usage or production	Stabilizes the frequency when disturbances occur Battery and equipment	Resources the frequency to 50 Hz NA	Manual intervention service that restores the frequency when the automatic services are insufficient NA

SOME THOUGHTS AROUND THE BUSINESS MODEL

FIGURE 15
Source: Epspot

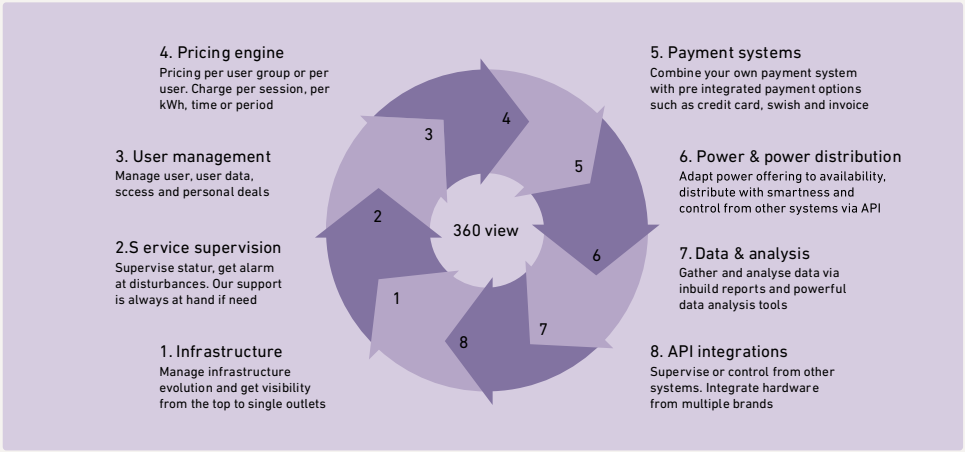


FIGURE 16
Source: Vattenfall

Value stacking

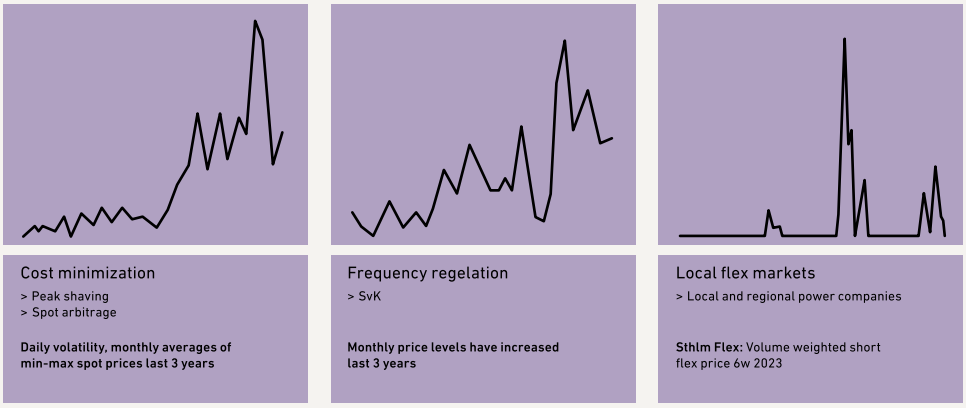
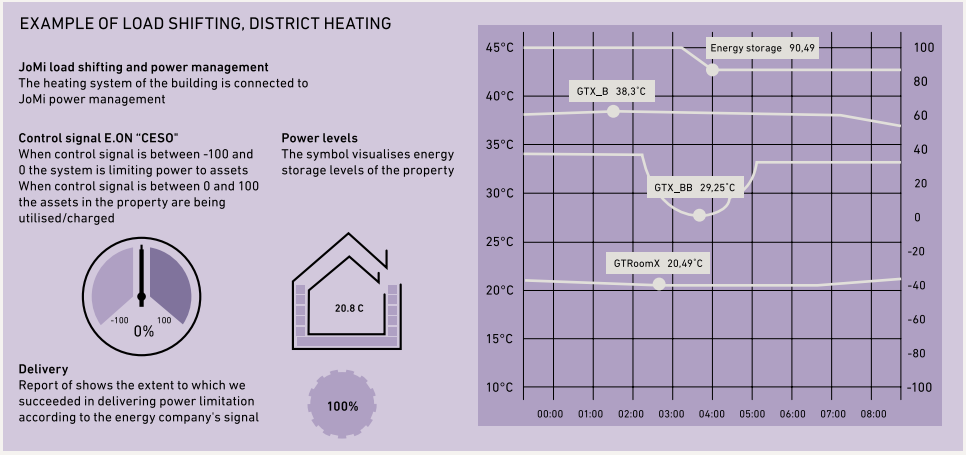


FIGURE 17
Source: Castellum



ROBUSTNESS AND RESILIENCE

In addition to new revenue and cost reduction, there are some additional values such as robustness of operations and not being dependent on grid uptime. Naturally, in many areas this is rare and not a serious problem. In other areas, however, it can have a real commercial impact, providing uninterrupted power supply to, e.g. commercial centers, schools, hospitals, computer centers. Being able to provide specific services, such as remote access services that provide access to buildings, can be of great value when the fire department, police or medical staff need to enter premises fast.

DISTRICT HEATING AND ELECTRICITY

For simplicity we have focused on electricity in buildings in this White Paper. But it is a much broader topic and below (fig. 17) we expand into heating.

The image in figure 17 shows how district heating and a building's batteries and heat pumps work together to optimize heating, lower costs and generate savings in heating costs.

STOCKHOLMFLEX

Stockholm flex is an initiative that intends to aggregate multiple assets and property owners to manage capacity constraints in the local energy grid.

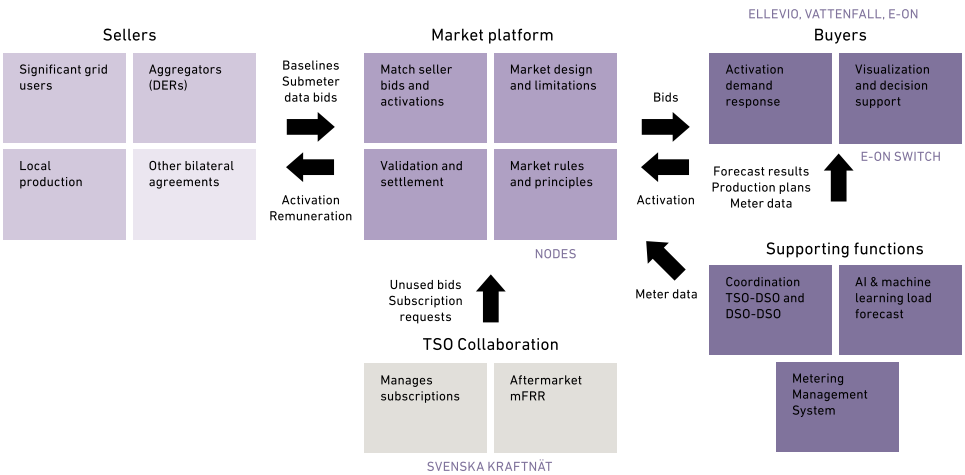
Stockholm Flex and related stakeholders have recently launched a pilot. From a business point of view, it has taken its first steps, and the set-up is being worked on to achieve the desired benefits.

The technical ability and benefits to our society of local flexibility markets are provided and supported by the authors of this report. However, by early 2023, it has too few participants and too low volumes, so it requires more participants to generate the desired results. To achieve the desired results, the technology must come down in price. The solution also needs to be reviewed and made more attractive for smaller property owners and the financial incentives improved, e.g. grants and pricing model. Only then will the volumes be sufficient, and the initiative will reach its desired goals.

To summarize: this setup's business objective is to relieve (energy) congestion in the Stockholm region by unlocking capacity within the distribution grid, securing the availability and reliability of energy.

FIGURE 18
Source: Ellevio

ECOSYSTEM OF PARTNERS AND STHLMFLEX SOLUTION OVERVIEW



06 WHERE TO BEGIN

»Execution is difficult. The solution is not a "given" and the approach will depend on several factors.«

WE HAVE GATHERED SOME OF THESE FACTORS BELOW:

> Most buildings have a legacy of previously installed assets and equipment. In most cases, it does not make financial sense to "tear everything out" and replace it with new assets.

> The needs and solution may vary depending on the type of building – commercial, residential, industrial, etc. – as well as the assets, tenants, location, technical maturity, age of building and building portfolio.

> The property owner's technical maturity, financial strength, willingness to invest and take risk in the property impacts the type of solution. Although an energy efficient building saves money in most cases, it requires investment to reach that level of efficiency. Poor decisions may lead to a significant investment with a longer payback period.

> A building's technical maturity when entering refurbishment projects. If you do not "plan for the future" when entering a refurbishment project, your costs are likely to increase over time.

All REDI members have piloted or implemented different parts of the energy value chain discussed in this White Paper. Some have come further in one area; others have made more progress in another. Three members – Sveriges Allmännytta, Fastighetsägarna and Newsec – advise their members and customers on how to approach the challenge. The other members have all designed their strategies and approach for "electrifying" their properties.

In 'Appendix 2: A Possible Approach' we have attempted to consolidate parts of the experience and knowledge from REDI members. Since there is no "one way," we have chosen to share a path on how to approach the challenge, rather than a stringent project plan and detailed architecture.

It is crucial to understand that the energy architecture is more than connected equipment and processes. Success requires an energy strategy, a supporting organization, domain competence and expertise. A possible approach can be to follow some of the larger property owners. If they roll out a solution or technology across their portfolio, it often has a solid business case behind the initiative.

07 CONCLUSIONS

THE CONCLUSIONS ARE QUITE STRAIGHTFORWARD:

1. The customer demands and behavior, e.g. around EV chargers or sustainability require you to act if you wish to be attractive as a landlord.

2. There is no point in waiting as the business benefits of energy management are obvious and significant. Don't wait, future-proof your buildings now.

3. There is plenty to do, but don't do everything at once. Do not pursue "bleeding edge" technologies. Look at which solutions are widely rolled out by some of the larger property owners.

4. Energy management and solutions are an integral part of a successful property owner's portfolio of services. It requires a competent organization with a clear mandate and integrated technical assets with standardized APIs connected via an integration layer giving portfolio-wide control.

5. It is no longer sufficient to act solely on a building level to achieve full synergy. You need new competencies, where energy is viewed as an asset you can buy, sell, store, produce, consume – and where your role can vary depending on the situation and time of day. It's not a "static state", but a continuous evolution where you need to be active, expand in the value chain and take greater responsibility as a property owner.

6. There is a clear benefit to society from improving your own energy efficiency, and from improving how we interact with energy operators and the grid, e.g. through local flexibility markets.

7. Your net operating income will benefit significantly from a modern and efficient energy set-up – the opposite will punish your asset value.

This is not a simple journey. From beginning to end, you have to set a strategy that defines the endgame. This "space" is moving fast, so you must be careful not to limit yourself and think and act in narrow verticals.

Regulators and politicians see this space as one of great importance for our welfare, but also one with the potential to pollute our environment if ignored. Therefore, it is quite likely that new regulations will be introduced. This means adopting a "wait and see" approach could leave you far behind and catching up could be expensive. This doesn't mean you must do everything at once, you can implement sound, established practices step-by-step that save money and the environment.

This is a complex matter – especially to new property owners. Make sure to do your research or get good advice so you understand the bigger picture. If you get it right, not only will you make money, you will also help society and the environment.

So, take your first step today and good luck!

08 US, THE PARTICIPANTS AND CONTRIBUTING COMPANIES

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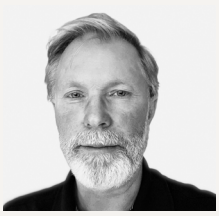

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Keba
Northvolt
PoppyTec
Position Green
Soltech Energy
Stella Interactive
Terraloop
Vattenfall
Wallbox

APPENDIX 1, THE BUILDING BLOCKS

In this appendix, we will touch upon several technologies within one building block. Often, we focus on 1-3 of these when describing the block. This is not because we recommend one technology over another, but because they are more prevalent in the property sector.

In saying that, technology in this space is evolving very fast. And what is strong today, can be surpassed by another technology tomorrow.

Another word of caution. Depending on your need, one technology can be more attractive than another, e.g. do you want to store electricity or heat?

1. EXTERNAL ENERGY SUPPLY

External energy sources are exactly what they sound like. We refer to large and small energy companies such as Vattenfall, Fortum, Entellios, Ellevio, Örebro Energi, etc. as well as grid operators like Svenska Kraftnät, Ellevio and Vattenfall.

Some key considerations when engaging with these companies relate to:

> Flexibility around services and support when moving your building towards future energy solutions
> Ability to provide a solution that allows you to buy and sell back energy
> In this, you should also secure data to be able to optimize your assets, especially with regard to spot prices, frequency, price optimization, etc.
> What type of power supply do you need, both now and in the future?
> Are there any uses, equipment or appliances that need dedicated circuits/power supply?

All of the above are important in order to work efficiently. They are also important if you are to really benefit from load shifting, peak shaving and optimizing the potential storage solution beyond your own assets in the building.

2. INTERNAL ENERGY SUPPLY

Internal energy supply looks at things such as solar panels, small wind turbines, solar water heaters, etc. In other words, assets that can generate electricity or heat. In most cases in Sweden, solar panels are used and tested when it comes to local building solutions.

We won't go into which equipment is best. Instead, we will describe the importance of managing energy production.

APPENDIX 1,
THE BUILDING BLOCKS

Below, you will find some key considerations when connecting energy generators – for the sake of simplicity, we talk primarily about solar panels:

> Is the equipment producing energy compatible with the needs and formats of your energy partner, grid, and your equipment? In most cases, this is a minor problem if you use an established company in Sweden.
> It goes without saying that any regulatory constraints and potential permits need to be in place.
> Does your chosen solution have open and standardized APIs that can communicate with other equipment installed in – or that communicates with – the building?
> Can the installation generate the right data to communicate with other systems and ensure that load shifting, peak shaving and net metering (including integrating with data on when to consume, store e.g. local batteries or sell energy back to the grid) can be managed efficiently?
> Ensure that the division of roles and responsibilities is clear in terms of safety, support, maintenance, etc.

3. ENERGY STORAGE

The most obvious and common form of energy storage in buildings is batteries. But there are other options. For example: flywheels that store kinetic energy and convert it into electricity, salt thermal storage solutions that "give back" heat/energy, and hydrogen production that can be converted back into energy.

All of these solutions lose energy in the process of storing and converting energy. Sometimes this can be as much as 70%, but very rarely less than 10% – these figures are correct at the time of writing this report, but it's a fast-moving area.

The most mature energy storage solutions for buildings are batteries and flywheels. We will use these below for the key considerations of storing energy:

> The cost of energy storage (batteries and flywheels) is fairly high. Understand the key drivers of choosing a storage solution. This will impact whether the business case is sensible or not.

- Do you want to?
    - Secure operations when the grid is down for mission critical operations or service levels
    - Increase frequency optimization, load shifting and peak shaving, to e.g. lower (OpEx) costs in operating equipment and decrease (CapEx) e.g. need for high-power connections to the grid
    - Increase capability of optimizing, selling and buying back electricity to generate new revenue or keep costs down when electricity prices are volatile and high

> Consider how to build your "energy ecosystem" to lower the "wear and tear" of your battery, e.g.

    - with the help of a flywheel that takes out peaks and makes the battery work more "smoothly" and extends its lifetime
    - by optimizing other equipment (HVAC, EV chargers, etc.) to decrease power before allowing the battery to "kick-in"

> Batteries are becoming safer and safer, but they are still made of chemicals that can be dangerous, e.g. in case of fire, batteries reach very high temperatures and the fire department may choose not to extinguish the fire for safety reasons. This means you need to consider additional fire safety in your building where the battery is stored.

> Is the equipment producing energy compatible with the needs and formats of your energy partner, grid, and your equipment? In most cases, this is a minor problem if you use an established company in Sweden.
> Does your chosen solution have open and standardized APIs that can communicate with other equipment installed in – or that communicates with – the building?
> It is important that the installation can generate the right data to communicate with other systems and ensure that load shifting, peak shaving and net metering (including integrating with data on when to consume, store e.g. local batteries or sell energy back to the grid) can be managed efficiently.
> In addition, there are some technical choices to consider such as battery type, capacity needed, charge controller, inverters to manage "types" of energy, etc. in your building.

4. BAS (BUILDING AUTOMATION SYSTEMS)

We define BAS as BMS (Building Management), Automation and IoT systems in a building. Some of these systems are real energy consumers, such as heating and cooling, elevators and escalators, water heating, lighting (less and less thanks to energy efficient lighting), major appliances, etc. Some equipment needs energy when it needs energy – we will obviously not stop an elevator full of people to save energy – but other equipment can be managed efficiently or even turned off for short periods, e.g. turning off heating for one hour at known peak times.

Please look at our IoT report for some more in-depth thinking around this building block and how you need to think about it from a digitization perspective.

Below, you'll find a few things to consider regarding this building block:

> Assess and understand which assets consume large amounts of energy
> Assess and understand which assets are volatile in their consumption over time and look for patterns you can work with, e.g. pausing heating for one hour at peak times
> Make sure the equipment has open and standardized APIs
> Not all equipment can be turned off and on "just like that," so understand which equipment can and cannot. When you need to upgrade or replace your equipment make sure this topic is part of your procurement process.

5. EXTERNAL CONSUMERS AND CUSTOMERS

Many properties, especially commercial properties, have a large number of external visitors. For these visitors, there are often services ranging from toilets to EV charging stations.

Some of these services have a very small impact on your energy ecosystem, while others have a much larger impact. For the purpose of this White Paper, we will focus on one example that uses large amounts of energy – EV chargers.

Below, we list several aspects that are important to consider regarding EV charging:

> Consider how much you are willing to invest and understand the business case before engaging
> The offer
    - Understand the need – what type of users will you have and how many? Will they stay for the entire day or just pop in and out while shopping?
    - What type of service do you want to provide? Is it free or does it cost? Is it fast charge or fully charged at the at the end of day (charging speed), etc.?
    - etc...

> The set up
  - Understand what power capacity you have available or are willing to upscale to. This can determine how many EV chargers you will offer.
  - Choose which type of chargers you will install.
  - It is very important to make sure you connect the chargers to your ecosystem with standardized open APIs. This allows you to monitor, analyze and steer how much power you provide and when.
  - Understand the needs and prepare for different billing models, even if you choose not to charge in the beginning.
  - Whether you demand or offer vehicle-to-grid or not, e.g. for load shifting, always prepare for the capability.

> Selecting your partner
  - management and maintenance – pick someone who can meet your demands and expectations in terms of different services, e.g. authentication, billing, and remote monitoring
  - Compare and contrast prices

Several of the considerations listed above also apply to other types of high energy consuming assets.

6. USER SERVICES

The challenge with tenant and user services is that you may not be in control over their usage – compared with external users of your assets where you can steer and control consumption to a larger degree. It will most likely be detrimental to your customer relationship if you do not have sufficient capacity to support, e.g. the cooling of a server room for a financial institution or kitchen equipment at a restaurant during lunch hours.

So here, you need to have ways of:

> Understanding how much power they can consume
> Measuring their outtake to identify patterns of consumption
> Working with assets in your building to balance the total outtake of your assets

7. CENTRAL COMMAND

The key to building an energy ecosystem, instead of installing vertical solutions in your building, is to have a central "command" station.

The purpose of central command is to aggregate data, monitor assets, analyze data, steer the assets and, last but not least, predict patterns and asset behavior.

We suggest you read our IoT and Digitization report on our webpage. In this report, we elaborate on how you connect different assets through an integration layer. We also suggest how you can group different assets to create a digital ecosystem.

APPENDIX 2,
A POSSIBLE APPROACH

If you have a portfolio of assets that needs to be digitized, modernized and upscaled, it takes more than installing the necessary building blocks – especially if you have a portfolio of buildings.

There are three major areas to be addressed when moving your assets into the present and preparing them for the future. These areas are not sequential but need to be addressed in parallel and scaled.

1. Organization: To make buildings smart, you need the right competencies and organization. It is not about replacing, but adding and rebalancing competencies. Compared to traditional competencies you will need digital (strategy, architecture, delivery, operations, etc.), sustainability, new technologies (energy, sensors, connectivity, etc.) and, finally, implementation and change management.

2. Central Capabilities: Today, many buildings have technology installed. Going forward, it is necessary to integrate and coordinate the solutions both from a building and portfolio point of view. Over time, external services and the city will have to be added. To succeed, certain capabilities will benefit from a centralized organization and approach. These areas include:
> maintenance and operations capabilities
> supervision and monitoring
> data-driven decision making

3. Strategy and Roadmap: Having a clever view on how the portfolio will be digitized and modernized is extremely beneficial. This is not about going into great detail, but about understanding the objectives, challenges and solutions. Finally, the strategy needs to have a clear transformation or change plan, and a roadmap that outlines how to go about the transformation.

There is an abundance of methods, tools and approaches on managing change. Some buzzwords you have probably heard include, issue trees, OKRs, lean - MVPs, pilots, lean canvas, waterfall, and scrum - agile. These terms are a little bit like apples and pears. They are applied at different stages during the change, and all have their own strengths and weaknesses.

The key is to find an approach that the organization accepts, and which provides structure and direction. Below, you will find one of many options to guide you through your transition. We have used a healthy blend of Lean, innovative thinking, Sveriges Allmännyttas report and the participants' own experiences and thoughts.

APPENDIX 2, A POSSIBLE APPROACH

1. BEGIN BY ASSESSING AND UNDERSTANDING YOUR CURRENT ASSETS

Your current assets will simultaeneously give you a head start and limit you in the transition to a connected, energy efficient building. Assess your assets from a predetermined set of criteria. For example:

> Key functionality and its efficiency – the ability to deliver a desired service
> Open and standardized APIs, e.g. REC or Brick Schema
> Level of integration to central infrastructure and the capability to monitor, analyze and control assets
> Costs to operate and maintain – depreciations and potential revenue may be added
> Category of system. In section 4. The stakeholders and different building blocks' we described a set of building blocks. Where do your assets fit in?

Please note: the idea is not to analyze this data ad absurdum. The purpose is to carry out a diagnostic test to see where you are today and what can be reused.

2. DEFINE YOUR STRATEGY AND ROADMAP

The key to success is understanding what you are trying to achieve, i.e. what are your objectives for the transition – cost, attractiveness to tenants and visitors, future-proofing, resilience, simplicity to maintain, safety, etc.? Of course, you have to detail your objectives as your objectives will determine your investments and choices. Keep in mind that you need to have some view on where the evolution of buildings is going to ensure that your objectives are relevant for the future.

> Set clear and measurable objectives. There is nothing wrong with 5-year plans, but make sure you convert your strategies into shorter targets, e.g. 3 months, 6 months and 12 months.
> Quantify your goals and objectives into measurable results. Be careful with "vague and fluffy" goals like "the best solution in the world". Instead, set clear, unambiguous goals like "installing 30 EV charging stations by 2023 in the property" or "install load shifting capability for EV charging, solar panel and HVAC system in the Gothenburg portfolio". Don't make the goals too easy, though. Think of them as tough but realistic key results.
> Since the goals are tough, you should be supportive as a manager.
> Follow up on these objectives periodically. See '5. Measure and asses' below.

Understand your business case and choose the path of digitization. Set a high-level architecture and see if you can identify standards and key assets that will facilitate future expansion. Standards are important as they allow you to be "modular" and plug in and change assets without "redoing everything". Document the above in a policy document that can be shared with key stakeholders and set a structure for the change.

Determine which of your assets can connect and work in accordance with your objectives and architecture. Make a plan where you identify which asset class to start with and scale it to reach economies of scale in your investment. Add a new asset (class) and scale.

This sounds simple in theory, but you will encounter situations that will force you to diverge from your plan. For example: If you decide to connect all your high energy consuming HVAC assets in a system that allows you to manage your temperature and balance loads in the premises across all your buildings. You may have to refocus your assets if some assets break and need to be changed. Or if you construct a new building or completely renovate an existing one where all the building blocks need to be implemented and connected. This is why the strategy and roadmap are important from the very beginning and why you need to have a high-level plan to reach the endgame.

APPENDIX 2,
A POSSIBLE APPROACH

3.ALIGN AND COMMUNICATE WITH YOUR ORGANIZATION

The difference between a vision and a hallucination is that in a vision you have a following, while in a hallucination you stand alone. This means that you need to involve and engage your key stakeholders early. Coming with a "final, ultimate solution" that is not accepted or understood can set you back months, if not years.

To execute the vision and implement the solution, it is crucial to establish and secure the buy-in of key stakeholders in your organization – this includes those at the very top and those responsible for implementing and operating the solution. In the beginning, it may feel like your "losing" time, but the investment made in involving and explaining will pay off over time – especially if management and owners become sponsors instead of hurdles.

There are numerous approaches to communication. As we are not attempting to provide a comprehensive manual, we will not go into how to build an entire messaging platform. But we do want to highlight a few key points to ensure that you reach different stakeholders with different levels of communication:

> Make sure you have a simple version of the strategy where you share why this is important for the company and properties
> Illustrate some type of high-level endgame, e.g. "What does good look like?" and a roadmap to clarify how you will "get there"
> Prepare a policy document that provides clear guidelines around key aspects of your solution
> Make sure to report both good and bad progress to stakeholders – and always together with a plan for the next step or a change to the plan
> Whatever channels and formats you choose to share this data, make sure you have executive sponsorship.

4. IMPLEMENT STEPWISE

We now come to one of the most difficult decisions: How to digitize and connect your building. There is no "one way" to do this, so we will share a few parameters and paths to transform and "future-proof" your building portfolio.

In most cases, "all in" is not a good strategy. Instead, a stepwise approach is preferred. Also, make sure there is a base IT infrastructure/architecture to which you can connect the energy, BMS and IoT assets – preferably applying a standard. See our IoT Digitalization Report.

After that, there are several parameters that will determine the best path. We will mention a few.

5. MEASURE AND ASSESS

Follow up against your key results periodically. See '2. Strategy and Roadmap' above. It is very important not to fool yourself by making your goals too easy or letting them "slide". The purpose of the assessment is to make sure that you are on the right track. It is not a tool for "punishing", but for helping the team progress. So the manager, steering committee or executive team should view themselves as engaged supporters and not controllers.

After the set assessment period, you have three main options in your work:

> Proceed: This means you are on the right track and close to your key results, so you can proceed with your work
> Pivot: You are not meeting your expected key results. Don't immediately change your goals or give up, but don't simply proceed as if everything is OK and will solve itself. Figure out why it is not working and decide whether you need to:
    • change your plan
    • change your solution
    • change your business model
> Stop: Sometimes an idea just isn't working and you should stop

APPENDIX 3, GLOSSARY

AFM	Administration & Facility Management
BIM	Building Information Model
BAS	Building Automation System
BMS	Building Management System
EV	Electric Vehicles
FM	Facility Management
API	Application Programming Interface
AI	Artificial Intelligence
ML	Machine Learning

REDI PRESENTS

THE EVOLUTION OF ENERGY INFRASTUCTURE IN BUILDINGS

LESSONS LEARNED
AND THOUGHTS SHARED
STOCKHOLM, 2023