AFRY
ÅF PÖYRY

AFRY Insights

Management Consulting

Interview

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Insights

Arrival of the LNG bubble
Africa

Imprint

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THANKS TO
Engie, Energie Steiermark,
The RES4Africa Foundation

SOURCES
Photography:
AFRY, Engie,
Energie Steiermark,
Tesvolt, iStock,
Adobe Stock, Gettyimages

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WANT MORE?

Editorial

Dear readers,

It is with great pleasure that I welcome you, after the launch of our new brand AFRY [eɪˈfjuː], in November 2019, to this inaugural edition of our new client magazine “AFRY Insights”.

With the merging of ÅF and Pöyry, AFRY has become an international engineering, design and advisory company, driving sustainability in the energy, infrastructure and industrial sectors all over the world. Bringing our combined expertise to the major challenges facing the world today is at the heart of our work. It is at the core of AFRY.

“Our company has great staff, that are driven by our curiosity to always grow and learn more. With the merger of ÅF and Pöyry, we have brought together experts from key areas that enable us as AFRY to offer truly sustainable solutions to the pressing issues of our time. Solutions that are sustainable because they result from a holistic perspective.” In the first interview of AFRY Insights (p.6) Roland Lorenz, Head of Management Consulting, gives more insight on the brand, its strategy and AFRY’s offer to the client.

For years, Fortune magazine has ranked Isabelle Kocher, CEO of Engie among the world’s Top Ten most powerful women. We are proud to have her as an interview partner (p.18) in this inaugural issue. She sets out Engie’s plan to become a world leader in the zero carbon transition and describes the huge transformation process she has been guiding her company through since she became CEO in 2016.

As a consequence of the increased range of services within AFRY, I am glad that right from the birth of this new magazine we can offer you insights along AFRY’s entire value-creation chain. Helena Paulsson’s article on the “future city” discussion (p.17) is one example: She gives us seven principles to deal with the challenges of the “future city”. One of them, “Dare to act today – don’t wait for the next big thing”, makes me think of two things: Seneca’s quote “It is not because things are difficult that we do not dare, it is because we do not dare that they are difficult.” And the second one is AFRY’s claim of “Making Future”. Because we decided that “We don’t care about making history. We care about making future.”

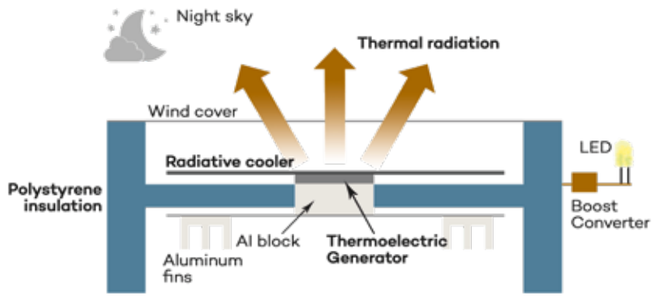
Enjoy reading!

Matt Brown
Vice President

The 1st

Plastic Patrol staged first mass clean-up of its kind

On 21 September 2019 Plastic Patrol, a global movement to eradicate single use plastic, coordinated a series of clean ups across Europe, Brazil, Thailand, Mexico and the USA to mark World Clean Up Day. The goal was simple, but crucial: to run the first mass activity based clean up of its kind and collectively remove and record a whopping 250,000 pieces of rubbish from nature in just 24 hours.
Uniting individuals worldwide to pick litter and log findings in an app enables Plastic Patrol to gather real-time, scientifically robust data to drive long-lasting change and reinforces the positive impact of a single person in tackling the crisis. All data collected was shared with partner scientists at the University of Nottingham to analyse, alongside the existing 210,000 examples of pollution uploaded from 66 countries globally to date.



0.5 WATTS PER M²

THIS "ANTI-SOLAR PANEL" COULD GENERATE POWER FROM DARKNESS

Scientists from UCLA and Stanford University have developed a device similar to a solar panel that starts generating electricity after the sun goes down. The temperature difference between the top side of the panel (cooling off quickly) and underside pushes electrons through from one side of the electrically conductive material to the other, creating an electrical current. The "darkness" panel created far less electricity than a solar panel at only 0.5 W/m² (compared to 200 W/m² for solar panels), but it could be useful for low-wattage nighttime applications, when solar isn't available.

2 TONS OF HYDROGEN

Hamburg plans world's largest hydrogen electrolysis plant with a capacity of 100 MW. Hydrogen from green electricity could become a central component in making the economy climate-neutral. Hamburg now wants to bring a globally unique plant into the port. A 100-MW electrolysis for the production of hydrogen would be a new technical dimension. The largest plants to date only have a capacity of 10 MW, usually less. According to Siemens, a plant manufacturer, such an electrolysis would produce about 2 t/hour of hydrogen. With this hourly production, a car could travel 200,000 km, a truck 25,000 km.

4.4 MEGAWATT HOURS

New megawatt container storage facility

Tesvolt, the manufacturer of electricity storage systems for trade and industry, presented its TPS 2 MW container storage system for the first time at this year's Electrical Energy Storage EES in Munich. With a capacity of up to 4.4 MWh, the container is suitable for any application and can be installed anywhere in the world because it can withstand temperatures between minus 40 and 55 °C. The TPS 2.0 is capable of black starting, AI ready and can be serviced remotely. The battery modules are made by Samsung SDI. A newly developed dynamic balancing of the battery modules and innovative thermal management make the MW storage system particularly powerful.

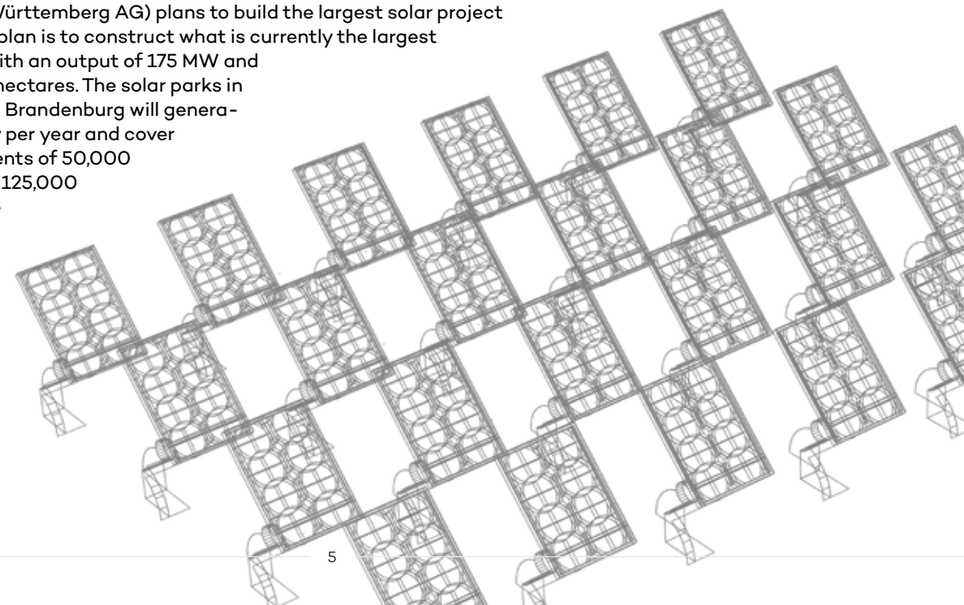
700,000 m²

PONTEVEDRA: THE SPANISH CITY THAT BANNED CARS

In Pontevedra pedestrians have priority. The city has been almost completely car-free for more than 10 years. At the beginning of the 2000s, Mayor Miguel Ángel Lores transformed the old town into a 700,000 m² pedestrian zone. The main idea was to reconquer the public space for the inhabitants and bring the city back to life. The successful concept will now be applied throughout the province.

175 megawatts

EnBW (Energie Baden-Württemberg AG) plans to build the largest solar project in Germany to date. The plan is to construct what is currently the largest solar park in Germany, with an output of 175 MW and covering an area of 164 hectares. The solar parks in Weesow-Willmersdorf in Brandenburg will generate 175 GWh of electricity per year and cover the aggregate requirements of 50,000 households while saving 125,000 tonnes of carbon dioxide (CO_2).



A new future

INTERVIEWS
More Interviews at afry.com

“We launched our new brand AFRY to make a difference and provide leading solutions for generations to come.”

As an international engineering, design and advisory company, AFRY is committed to offering leading solutions for future generations. Roland Lorenz, member of the AFRY executive team and new Head of Division Management Consulting, brings with him a wealth of consulting experience, especially regarding the transition of the energy sector. He shares his thoughts with AFRY Insights about the new company, its strategy and culture - and what all these changes mean for clients.

Roland, since the last edition of our client magazine, there have been a number of exciting developments. Let us start with the release of the new brand, AFRY. Can you share a bit about your thoughts regarding AFRY?

Roland Lorenz: The birth of AFRY and the launch of the brand is certainly one of the most exciting chapters of my career and I feel honored to help shape the future of this company together with my colleagues. With AFRY we start to make a difference, to provide leading solutions for the generations to come as our company tagline indicates “We don’t care much about making history. We care about making future.”

Our organization can look back on a long history. ÅF was founded in 1895 and Pöyry in 1958. The AFRY brand will unite almost 17,000 colleagues behind a strong philosophy and culture. We have now become the biggest company in our sector in the Nordic region, and a global player with offices in 50 countries, projects in 100 countries and an annual revenue of approximately EUR 2billion.

AFRY is a new start for everyone in our organization and a great source of strength. As we are now one company, we can join up our areas of expertise to provide our clients with a truly unique proposition; we are indeed greater than the sum of our parts.

How has AFRY positioned itself?

Roland Lorenz: We have identified relevant macro themes that every one of our 17,000 experts will contribute to and drive forward, hand in hand with our partners, stakeholders and clients. These themes – Changing Energy Markets, Industrial Digitalisation, Smart Cities & Infrastructure, Future Mobility and Transition to Bioeconomy – are relevant to all our experts and clients, as well as society overall.

The executive team has put sustainable solutions in focus and sustainability is one of the pillars of our new company culture. There are several reasons for this. One is that the need

Our growth drivers

Smart cities and infrastructure

Future mobility

Industrial digitalisation

Changing energy markets

Transition to bioecenomy

to take a stand and work towards a sustainable future is greater than ever in these times of increased globalisation, urbanisation, digitalisation and climate change. Another reason is that more than 30% of our employees belong to future generations, meaning they are under 30 years old and therefore naturally have an even greater concern for the future. As you might know, AFRY in the Nordics is one of the most attractive employers among young professionals ahead of Google. As a consequence "Making Future" is not just a motto for us; it is in our DNA.

AFRY gives us a clear vision of the potential to drive the transformation, and together with our clients, influence many parts of society through solutions that reduce our impact on our planet.

What potential do you see for your team of Management Consultants within AFRY?

Roland Lorenz: The real unique selling point we developed over the years came from combining deep sector expertise, strong management consulting skills and access to engineering capabilities within the group. I see the same three assets at play today for the Management Consulting Division in AFRY, except now we are in an even better position since we are covering additional sectors and we have strong capabilities in digitalisation.

The whole team of Management Consulting is inspired by the potential we have to collaborate with the other AFRY Divisions. The digitalisation expertise that we now have as a combined company is just one of many opportunities that we are keen to explore. Projects are already underway with our Infrastructure Division in the areas of Future Mobility and Smart Cities, and we see exciting joint initiatives with our Telecom and Digital experts. Especially in digitalisation we can now cover a wide spectrum of services, for example from design thinking and the UX design of any type of digital solution, to the development and implementation of complex IT solutions, including artificial intelligence, cyber security and IoT platforms.

What is your plan for the future of Management Consulting?

Roland Lorenz: Over recent years the Management Consulting Division has made very good progress in developing our market position as a truly global, sector-focused consultancy. In the energy sector we are able to provide strong expertise in all relevant parts of the traditional and new energy world, from upstream to downstream.

We are now focusing on growth and look forward to selective expansion into adjacent sectors. In many countries, we are widely recognised as the advisor of choice. As a sector-focused consultancy we are able to cover a broad spectrum of services, from forward-looking market analysis to strategic advice, and from operational excellence to M&A and transaction services.

In AFRY Management Consulting our real asset is our people. We have very skilled and experienced people and as management consultants we have to be keen on developing ourselves, because only then can we fully support our customers and stay ahead of the market. Although we do not know the future and all the answers to its challenges, our consultants have to aim for the forefront.

The AFRY values are to be "Brave", "Devoted", "Team Players". What do these values mean to you?

Roland Lorenz: If we want to further develop our offering and provide our clients with the full benefit of the expertise we now have, all our experts have to aim high. Bravery in this context means to me, breaking new grounds and helping customer to deal with tough challenges but also to find new paths into an unknown but successful future. We bring together exceptional people with the passion to transform industries and to create value – for clients and society.

Being devoted?! Let me answer with Albert Einstein's words: "There is no greater satisfaction for a just and well-meaning person than the knowledge that he has devoted his best energies to the service of the good cause." All our consultants have passion for our chosen industries, the ongoing transitions and for AFRY. Our company has great people, that are driven by our curiosity to always grow and learn more. With the merger of ÅF and Pöyry, we have brought together experts from key areas that enable us to offer truly sustainable solutions to the pressing issues of our time.

James Cox
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Plotting an AFRY pathway to 2050

With the rate of change of the energy industry accelerating to meet decarbonisation goals, AFRY has extended its view of future electricity markets in Europe to 2060. The scale of the transformation needed to occur is extraordinary, and even then, the likelihood is the net zero 2050 ambitions will not be met.

MOVING POLICY GOALPOSTS

In Europe, although there has been much discussion around a 2050 net zero ambition, current policy remains a long way short of this. Firm European targets really only extend to 2030, with the EU Emissions Trading Scheme (EU ETS) having a 2030 target of a 42% reduction on 2005 levels. Other agreements, such as the 2016 Paris Agreement, are much more woolly with a commitment to keep global climate change "well below" 2°C. Despite the European Union President Ursula von der Leyen confirming support for a 2050 net zero economy-wide target, there remains substantial opposition against these policies, particularly from eastern European countries that rely heavily on coal generation.

Against this backdrop, the AFRY Central view anticipates a rapid decline in European emissions but falling well short of the net zero ambition for 2050. Our analysis suggests an economy-wide decarbonisation of 70% against 1990s levels, with the power sector bearing a greater load than industry, transport or heating.

RED SHIFT, BLUE SHIFT, GREEN SHIFT?

To achieve the AFRY Central view, European capacity will have to shift rapidly from a coal and gas dominated system, to renewables dominated. As shown in Figure 1, Europe is likely to build over 500GW of solar by 2050, rising to 630GW by 2060. This represents an investment of over €300bn in total in solar farms alone. Of course, it makes sense that this solar gets largely built in the sunny parts of Europe and in our modelling we ensure that all capacity gets an economic return on capital. Consequently France, Italy and Spain will each have over 100GW of solar by 2060, with Germany close behind. Even with improvements in efficiency of solar panels, with technologies such as trackers and bifacial panels, the typical capacity factor of PV in southern Europe is only 20%, which means that the impressive 600GW of capacity only generates about 17% of total electricity demand.

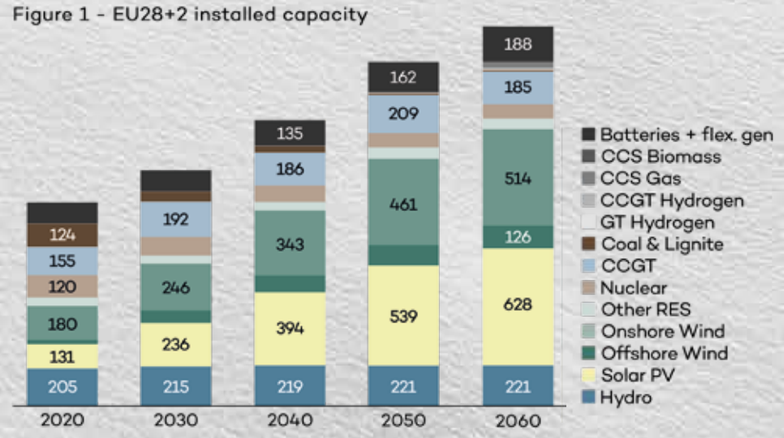
With falling costs of solar and rising carbon prices, we see a shift from government supported build to merchant build (where the developer takes the full market risk) during the 2020s, and with pure merchant projects becoming the biggest driver in the 2030s. Since government subsidies have driven almost all renewables development so far, developing this volume of solar without them will require far-reaching changes in financing and risk management.

For wind, an equally ambitious transformation occurs, with the 500GW mark being reached by 2050. This is mostly onshore wind, due to lower costs of deployment and the greater range of sites across Europe where it can be built, but there is an important and substantial development of offshore wind in and around the North Sea where favourable wind conditions combine with reasonable water depths. Although much of the early development of wind is driven by government incentives or support (whether to underwrite a floor price or through 'hidden' subsidies such as paying the connection costs), development from 2030 onwards is again driven by subsidy free deployment helped by rising carbon prices and rapidly falling technology costs. The 650GW of wind covers 40% of demand by 2060.

Although we foresee a continuation of CO_2 emitting technologies, the worst offending coal and lignite plant will be wholly decommissioned by 2050, leaving a residual of high efficiency gas plant. However, the emissions from these are relatively small as they run at low load factors of typically 30%. Without the development of currently unforeseen storage technologies, a backup of thermal plant operating at low load factors appears to be the most economically viable option in this low (but not zero) carbon world.

All in all, we foresee €1000bn needs to be spent over the time period in generation technology alone; based on economic investment patterns

Figure 1 - EU28+2 installed capacity



that would lead to a split roughly 30% solar, 50% onshore wind and 20% offshore wind. This does not account for the even greater amounts needed in transmission, distribution and other infrastructure to bring about the change.

SYMBIOSIS OF SOLAR AND STORAGE

In terms of 'new' technologies, the rising volumes of variable renewables creates a strong demand for batteries and storage: even just based off wholesale market arbitrage there is a need for over 100GW of batteries by 2060. These are Li-ion with a split between 2, 4 and 6-hour storage. If other battery technologies are economically developed whose costs scale better with hours of storage – such as flow batteries – there will be an enormous demand for them.

The 'symbiosis of solar and storage' means that most battery build occurs in the southern European markets where solar is being built, although there is a demand across all of Europe.

By 2050, we foresee small developments in hydrogen-fuelled CCGTs and GTs, which by 2060 will have grown into 30GW of new build. Some of these will be associated with electrolysis – particular in southern Europe where low prices persist for much of the year. However, we also foresee a steady production of hydrogen via Steam Methane Reformation (SMR) and associated technologies, as hydrogen will be required in the heavy transport sector and other sectors such as high temperature process heat.

MORE TREES PLEASE?

Given the difficulty of decarbonising much of the wider economy, such as aviation or very high temperature processes, that strongly suggests that negative emissions technologies will be needed in the power sector to leave 'room' for CO_2 emissions in these difficult-to-decarbonise sectors. This leads to 20GW of CCS biomass by 2060 in the power sector, taking CO_2 out of the air by growing biomass and storing it underground.

As a result of the scale of the renewable deployment, the capacity of electricity interconnectors across Europe roughly doubles. This helps make best use of weather patterns that sweep across Europe, as well as stopping renewable energy being 'trapped' in any one country. Without this increase in interconnection, there would be large differentials in prices between countries and significant curtailment of renewables.

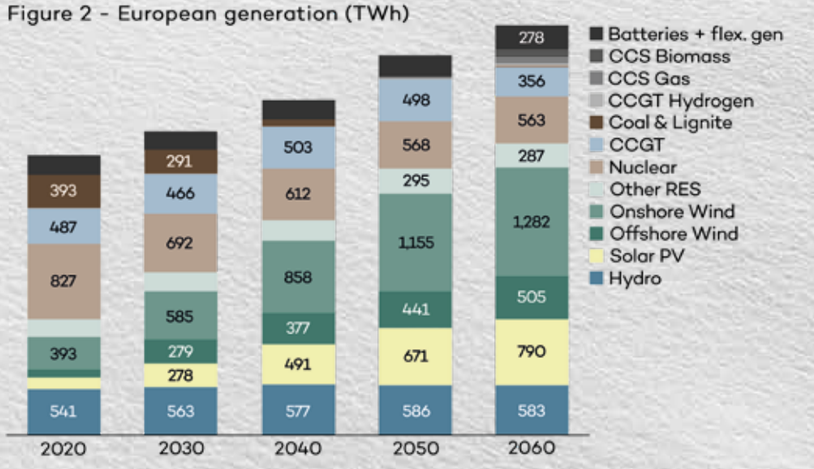
Whilst the scale of the change in the power sector we foresee is substantial, in other sectors it is equal or greater. In the transport sector, we see a steady conversion from internal combustion engines to electric vehicles, with over 200million battery EVs on the road after 2050. In the heavy transport sector, Li-ion batteries have a long way to go before delivering the necessary energy density required for heavy good vehicles. As a result, our scenarios see long-distance trucks dominated by hydrogen technologies due to the higher energy density.

Of course, the greatest challenge remains the heat sector. Road vehicle are replaced every 10 years, power stations are replaced every 30 years or so, but many houses and buildings have lives measured in hundreds of years. Progress of zero carbon technologies therefore is not inevitable given the high costs of retrofit and the low rate of new build. Some of the low-hanging fruit is adopted quickly – in particular replacing electric (resistive) heating systems with air-source heat pumps with their much greater gain in performance. However, heating remains dominated by natural gas or hydrogen until post-2050.

"THE EYES OF ALL FUTURE GENERATIONS ARE UPON YOU. ... "
Greta Thunberg

Although this remains our central outlook, we are continually updating our views based on latest policy, market and technology assessments. Although these may undergo seismic shifts over the next few years, equally progress could go backwards particularly if the prevailing economic and political climate favours the short-term over the long-term vehicles every 10 years or economic conditions becoming more challenging. We'll keep you posted.

Figure 2 - European generation (TWh)



AFRY

PAGE

Pricing Atlas for Green Electricity

Are you looking for a precise and neutral assessment of the market value difference for a specific wind park?

AFRY's PAGE provides you with an accurate overview of the market performance of a particular wind park under review.

This allows you to answer the fundamental question of whether your wind park captures prices above the reference market price.

PAGE calculates the site-specific Market Value Difference of individual wind parks and offers marketers an accurate estimation of future competitiveness.

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Arrival of the LNG bubble

Record amounts of LNG have been arriving in Europe in 2019. After a period of low utilisation of Europe's LNG terminals, imports grew steadily in 2018 and have surged in the last 15 months.

The additional supplies, after a mild winter, meant gas prices collapsed from around €24/MWh ($8/mmbtu) in September 2018 to €11/MWh ($3.6/mmbtu) in September 2019. This phenomenon is not just seen in Europe, as Asian spot LNG prices have also collapsed with plentiful supplies and a drop in the LNG demand growth rate outside of Europe.

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WHY IS IT HAPPENING NOW?

This LNG bubble has been sign posted for a few years, as 140 bcm of new LNG production has been planned and constructed to come onstream between 2018 and 2021, mostly in Australia, USA and Russia. A significant amount of this new capacity has been constructed without a fixed destination in the contracts, so it is being shipped to markets that are willing to pay the highest price.

Until Q3 2018, Asian LNG demand growth had kept pace with supply growth, and Asian prices remained at a premium to Europe. New LNG capacity did not, therefore, significantly affect suppliers to Europe. However, in the six months from October 2018, LNG prices in Asia fell by over 60% and by April 2019 were at parity with those in Europe, even though European prices had also fallen by 50%. Europe is now the natural place for spot cargoes from the new US terminals in particular, as the cost of delivery is significantly less than to Asia.

WHAT IS HAPPENING TO OTHER SUPPLIES?

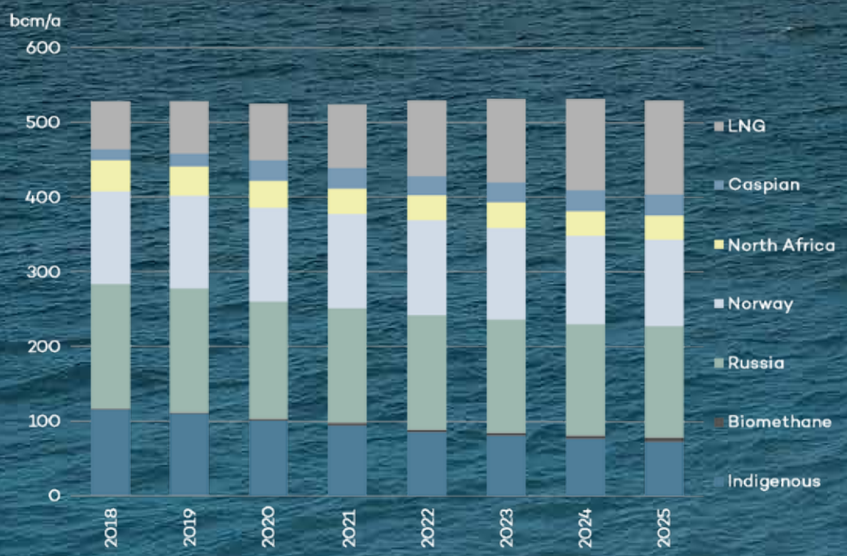
Given this increase in LNG supplies to Europe, has another supplier lost out? Probably not, as the reduction in prices has had a positive impact on demand. As European gas prices have fallen, gas-fired power plants have become more competitive relative to coal plants, boosting power sector gas demand.

Indigenous production across Europe has continued to decline, particularly in the Netherlands thanks to the forced reductions to the Groningen field, as well as supplies from Algeria where a lack of investment and increased demand within the country has led to lower export volumes. Consequently, the increased supply of LNG has had a relatively minor impact on supplies from other countries.

A NEW POLITICAL DIMENSION

New LNG suppliers to Europe have emerged leading to an increased political dimension to global LNG supply. At the time of writing, the US is the third largest supplier of LNG to Europe (behind Qatar and Nigeria) and this is likely to increase in the coming months as more LNG production and export facilities are commissioned.

The US has been strongly opposed to the Nord Stream 2 pipeline, the venture between Russia's Gazprom and five European companies that is expected to deliver Russian gas to Europe from 2020. According to the Kremlin, the US is seeking to force Russia out of the European energy market in order to sell more LNG to Europe. However, Washington claims that the new Russian gas pipeline will increase Europe's dependence on Moscow. However, Gazprom has shown no inclination to pull back on European flow volumes in the face of the recent wave of LNG. Analysts at the Oxford Institute of Energy Studies suggest the Russian political landscape may continue to push Gazprom towards high export volumes. However this will depend, in part, on a successful renegotiation of the transit contract through Ukraine which is due to expire at the end of 2019.



Interestingly, at the same time as the European Commission follows through on its commitment to reduce the dependency of a number of EU countries on Russian pipeline gas, Russia has also significantly increased its LNG deliveries into Europe. During the first half of 2019, some of the LNG from Russia's Yamal LNG plant which was intended to be trans-shipped in Europe and ultimately exported to Asian markets, was actually regasified in Europe. In fact, in February 2019 Russia was the biggest LNG supplier to Europe.

In the short term, Gazprom could be viewed as foregoing short-term revenue by contributing to a TTF slump towards €11/MWh ($4/mmbtu). But it is possible that Russia is pursuing a longer term more strategic objective in continuing to push gas into a well-supplied European market. By allowing TTF (and by arbitrage Asian LNG spot prices) to fall well below the break-even price required for new LNG projects ($7-8/mmbtu), it is making it difficult for new liquefaction projects to take FIDs.

HOW MUCH LONGER WILL IT CONTINUE?

The European Commission has often stated that LNG is essential to diversify sources of energy supply to its member states. One of the Commission's key objectives is to ensure that all of the member states have direct or indirect access to LNG.

Europe's import requirement is expected to increase by 10% (or about 40 bcm/y) in the next five years, as indigenous gas production enters a phase of rapid decline and domestic consumption remains relatively flat. There is, therefore, room for both Russian supplies and more imported LNG during the period.

A big factor affecting the amount of LNG reaching Europe is the demand for LNG in the rest of the world, and Asia in particular. China has been behind most of the global growth in LNG demand in recent years, but this may start to decline in coming years as they start to develop their own resources and Russia starts to supply gas to China through the new Power of Siberia pipeline, which has started this winter. There is a significant uncertainty over the growth in demand from China, South Asia (India, Pakistan and Bangladesh) and the Middle East in particular, as they try to clean up their energy sectors and meet increasing domestic requirements. The demand for LNG from these countries will affect the global LNG supply-demand balance and will impact available supplies to Europe as well as global gas prices.

By 2025, global LNG supplies could increase by over 50 bcm/y compared to 2018. With an extra 25 bcm/y coming to Europe from new pipeline supplies from Azerbaijan via Turkey, then it is possible that Russian supplies to Europe may decline by about 10% (or about 16 bcm/y) and North African supplies may reduce by a further 7 bcm/y. During this period, Gazprom will be building up its pipeline supplies to China, and with more Russian LNG facilities to be completed it is likely to continue to increase its sales globally.

On the back of this strong supply to Europe, gas prices are likely to remain depressed until at least 2022 before the global supply/demand balance starts to tighten.

However, from the middle of the next decade, a new wave of LNG supply is starting to take shape. A combination of restarts and committed projects that have recently taken FID are anticipated to increase supply by around 67 bcm/y by the mid-2020s. There is another 43 bcm/y of Qatari gas that will almost certainly come to market by the middle of the next decade, but with some uncertainty around timing. In addition, a further 117 bcm of LNG liquefaction capacity has credible FID potential across the next 2-3 years. That's a massive 227 bcm of both committed and credible new capacity.

As mentioned earlier, the current slump in global spot prices is making it difficult to achieve FID on new LNG facilities, even if it looks like there could be a supply gap in the mid-2020s. Delays or cancellations would support faster price recovery in the early- to mid-2020s and also help Russia recover its market share of the European gas market.

The big question is when this next wave will arrive and whether it will prevent a tight LNG market in the 2023-25 horizon? That will depend largely on the strength of Asian LNG demand growth and the volume of new FIDs taken over the next 12 months – it is a difficult equation to balance, but AFRY has the tools and knowledge to help.

Helena Paulsson
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Friction –
driver or barrier in future cities

The smart city or future city discussion is often centred around technical solutions and its infrastructure, big data and efficiency. As an advisory company within design and engineering, AFRY believes in technology as one key to sustainable development, but how do we create future cities where people really want to live? We have seen for some time now that citizens are reclaiming the public space again occupied by the car for decades. However, when we talk about future cities we still tend to want our cities and daily lives to become smoother, smarter and more optimised. Is this really the right way?

Let's approach the issue from a slightly different angle. We focus on the people and the interactions in the city, and how people can drive urban development through frictions in everyday life. We can look at three different aspects or hierarchies of this:

- **The democratic planning process;**
- **The everyday urban life; and**
- **Our cities' soundscapes.**

To live in cities is to compromise. People with different goals and priorities have to co-exist in a limited space. **Friction is unavoidable**. To plan cities is also to compromise. Many different aspects need to be taken into account and we often have to prioritise. This makes planning a political issue – not always on a left-right scale – but in the sense that we need to decide which interests to give preference. It is therefore essential that urban planning is a democratic process.

In the everyday urban life we need to bump into each other and let our eyes meet. We need smaller blocks and more crossings, and with them more meetings and interactions. Urban places where people meet in this sense are often also perceived as safer. Hearing is a sense that cannot be switched off. We are constantly affected by sound. However, after overexposure of unwanted sound impressions, people have learned to ignore their acoustic environment. A human-centric approach to soundscaping would discuss what sounds should be preserved, highlighted or multiplied in built environments.

To compromise is not to meet in the middle. It's bigger than that. It is about emphasising the great resources in society and collaborating to reach our visions. All such cooperation requires compromises – that is the essence of democracy and friction that drives our cities forward. Today we are facing a reality in which we have to face the challenge of looking into the future, in one way or another, on a daily basis. As a way of dealing with this, we have formed seven principles for how to predict the unpredictable:

Seven principles for future cities:

1. **Plan cities according to goals rather than prognoses.**
2. **Include citizens in the development – use their needs as a starting point.**
3. **Make sure that the city of the future is inclusive, safe and enables a sustainable way of life.**
4. **Let nature and buildings interact in the urban environment.**
5. **Ensure the flexibility of the urban realm.**
6. **Use the technological development to make our vision a reality.**
7. **Dare to act today – don't wait for the next big thing.**

AFRY recently launched the book Predicting the Unpredictable – a Nordic Approach to Shaping Future Cities, written by Jonas Gustavsson, President and CEO and Helena Paulsson, Head of Urban Development.

More information is available at afry.com/en/insights/future-cities

“My conviction is that unsustainable business models are sustainable neither from an environmental point of view nor from a business one.”

Isabelle Kocher
CEO of Engie

The winner takes it all

For years, Fortune magazine has ranked Isabelle Kocher, CEO of Engie among the world’s Top Ten most powerful women. We are proud to have her as an interview partner in this inaugural issue of AFRY Insights. In this interview she sets out Engie’s plan to become a world leader in the zero carbon transition and describes the huge transformation process she has been guiding her company through since she became CEO in 2016.

Engie is committed to becoming the world leader of the zero-carbon transition. Many people still see a contradiction between a sustainable corporate strategy and value creation for a company with a strong hydrocarbon position. Can you explain why this is not the case for you?

Isabelle Kocher: My conviction is that unsustainable business models are sustainable neither from an environmental point of view nor from a business one. We consume at least 2 planets a year, even more for people living in a developed country. We know that we’ll have to find models that consume fewer natural resources, especially fossil fuels. We know that the future belongs to these new models, regarding performance, public image, license to operate, costs and resilience to climate change.

You are right: being a hydrocarbon company is not compatible with a zero-carbon economy. That’s why we decided in 2016 to disinvest from all activities that were not convertible to zero-carbon. We sold our gas exploration and production activities. All of our remaining gas assets can be converted to biogas and hydrogen. One thing is sure: consistency and authenticity are key. To get all your stakeholders on board, you need to align your HR policies, your strategy, your public discourse and your business practices.

Talking of zero-carbon activities, together with EDP you have founded a joint venture. What are your goals?

Isabelle Kocher: EDP and Engie have been partners in offshore wind farms for many years now. Offshore wind farms are key to a successful transition thanks to their strong and steady production capabilities. Our joint venture intends seizing development opportunities worldwide and improving our competitivity in a fast-maturing technology.

In connection with the change process you started in 2016 and in which the group still finds itself, you speak of the transformation of a whale into a shoal of fish. How do you intend to promote this agility?

Isabelle Kocher: Agility was an existential issue for Engie in 2016. We used to be a very successful company with assets

“We cut our carbon emissions by half, we are growing and we are profitable again. Now agility is like a mother tongue for Engie teams.”

all over the world, innovative and socially minded. Nevertheless, we were shrinking and losing money. We needed to move on. We changed our business model. We used to produce energy and be paid for it. Now we are a company that helps its clients to consume less and greener energy with more comfort and we are paid for it. And it worked! We cut our carbon emissions by half, we are growing and we are profitable again. Now agility is like a mother tongue for Engie teams. They all understand how it helped us being relevant again.

How do your clients react to the transformation of the group?

Isabelle Kocher: Very quickly and very positively. When we announced our transformation plan in 2016, we started to increase our client base almost immediately. Wherever we look, in industry, in services, in government, in civil society, the issue of energy is everywhere. There is not a country in the world, whatever the policy of the national government, where my contacts do not care about the security of their energy supply, its sustainability, the reduction of its carbon footprint. But reaching net-zero carbon emissions is so demanding, requires us to be so efficient, to optimize so many energy uses, that a company whose core business is not energy, cannot manage all of it in a proper and affordable manner. Moreover, we have more than 100 000 employees on the sites of our clients, it is a very powerful force to understand our clients’ needs and seamlessly integrate our solutions in their activities.

To offer sustainable energy as a service is a model you promote as a mantra and that you have decided to implement in France with ENGIE Solutions. Can you explain the revolutionary approach and why leading consumers to energy savings is so important?

Isabelle Kocher: All scenarios for the transition require two ingredients: energy savings and renewables. Both are indispensable and they cannot be treated separately for one simple economic reason: there is no room for higher energy bills, neither for families nor for companies. The only way to finance renewable production assets is by offsetting them with massive energy savings. We developed our “as-a-service” model because it is an accelerator of value creation. By managing our clients‘ energy assets under long-term contracts, by investing ourselves, we unlock the desire to improve their facilities and guarantee state of the art technologies at all times, in cooling, heating, lighting and mobility, with a strong digital input. We can install renewables on their site or dedicate off-site renewables capabilities under Corporate PPA (Power Purchase Agreement). “As a service” also means that each company is different from the next and needs its very own roadmap, specific to its assets, its uses, its geographic position, its surroundings. Our comprehensive approach to our clients energy uses, from end to end, is the fastest and most efficient way to reach zero-carbon.

Isabelle Kocher has been CEO of Engie since May 2016

In 2002, she joined Suez Group, which became GDF - SUEZ in 2008 and ENGIE in 2015. From 2002 to 2005, she worked in the strategy and development department, and then from 2005 to 2007, she was head of performance and organization. From 2007 to 2011, Isabelle Kocher was deputy-CEO and then CEO of Lyonnaise des Eaux, a water subsidiary of the company. From 2011 to 2014, she was deputy-CEO and CFO of the GDF-SUEZ group. In 2014, she became member of the board, deputy-CEO and COO.

Before joining the group, Isabelle Kocher was a civil servant in the French Ministry of Economy where she was in charge of telecommunications and defence budgets. From 1997 to 2002, she was industrial affairs advisor in the Office of the French Prime Minister Lionel Jospin.

Isabelle Kocher graduated from Ecole Normale Supérieure (rue d’Ulm) and from Mines-ParisTech as a civil servant “Ingénieure du corps des Mines”. She holds a MSc in quantum optics and a postgraduate teaching certificate in physics (agrégation).

She is a Knight of the Legion of Honor (chevalier de la Légion d’Honneur) and a Knight of the Order of Merit (chevalier de l’Ordre du Mérite).

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From copper plate to wires

In the “good old days”, Power Transmission System Operators (TSOs) were always well informed about actual and potential power flows in transmission and distribution systems, but this is changing rapidly and getting it wrong can have major consequences for us all.

First and foremost, it is TSOs‘ business to ensure stable, reliable and efficient operation by managing the power flow and aligning generation with market demand. For this purpose, they have had routines in place to come up with the appropriate measures at the right time for customers to get reliable electricity delivery.

That has worked well in a rather simple structure. However, the entire TSO business is now being shaken up by the increasing use of renewable energy, decentralized generation, an increasing number of E-vehicles and modern IT-driven industrial electrification from the likes of Amazon, Google, Facebook, Tesla, Northvolt etc.

The good old days are over and we are on the verge of an entirely new paradigm. Not only do we require increased transport of power over long distances, (e.g. from off-shore wind farms in the North Sea to demand centers hundreds of kilometers away) but also extreme flexibility in handling and balancing the weather dependent intermittencies in larger and more differentiated energy markets at the same time.

Several new challenges are indeed appearing and a situation that cannot be mastered by mere changes in generation dispatch and TSOs’ system control.

- **Physical power flows, following Kirchhoff´s law, as a function of grid impedance becomes much more complex due to**
  1) new and more market players with different profiles on both sides,
  2) stronger weather dependencies and
  3) increasing demand for international energy exchange capacity hindered by local and political constraints for grid extension.
- **The market asks for larger increase in power exchange capacity between markets, than is currently provided, when calculating and planning load flows with traditional methods. This worked well in the old stable environment, but induces problems in the new volatile one. Flow based market coupling, allows larger capacities for exchange but is more complex to forecast, model and manage.**

The result is an unbalanced disruptive handling of market forces on the one hand and management of physical flows - which increases the complexity of TSOs‘ tasks as well as internal costs - on the other hand. Even extensive grid investments – TSOs in Europe planned to invest €150 bn in 200 projects in the next 10 years would not solve the issue, but rather the opposite: higher uncertainties have emerged which counteract measures already taken.

MORE COMPLEXITY IN FORECASTING

These multiple drivers lead to soaring complexity in power flow forecasting for TSO networks. Modelling and simulation of future scenarios in TSO grids is time consuming and still uncertain because multiple parameters and their interdependencies have to be considered and quantified. First steps have been taken and TSOs are including flexible generation units, demand side management and storage, but no broad-based solution for appropriate low uncertainty forecasting has surfaced so far.

So how can TSOs go about these risky tasks and find a way to make the best of physical and market flows, work more effectively to minimize uncertainties and achieve higher efficiency and reliability as a result?

COMBINED ANALYTICS

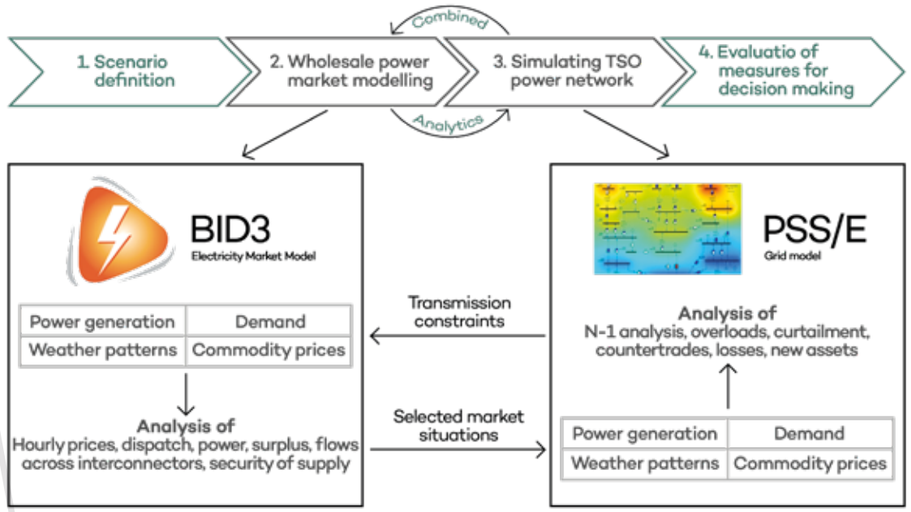
The solution to this multi-faceted issue can only be a multi-faceted, holistic approach. Therefore, we combine our advanced fundamental market model BID3 with a proven grid system simulation methodology, PSS/E from Siemens. The intelligent combination couples the market flows and physical flows in a holistic approach and provides convergent results respecting both commercial and technical constraints. AFRY labels it Combined Analytics and it consists of a modular four step program:

Module 1: Scenario definition based on AFRY standard scenarios
Module 2: Wholesale power market modelling using BID3
Module 3: Power network system simulation using PSS/E
Module 4: Evaluation of measures for decision making

The Combined Analytics approach includes iteration loops between power market modeling and network system simulation. This process then supports TSO decision making by turning the “theoretical copper plate” (market perspective) into “lines and wires” with physical electrical behavior, it also enables forecasting of power flows through TSO networks depending on the future generation and consumption structure and identify bottlenecks in the grid.

The information compiled from two different angles sets the basis for further assessment of short-term operational measures such as re-dispatch or remedial actions as well as long-term network investments.

THE FOUR STEPS TO COMBINED ANALYTICS



The AFRY two-perspective methodology provides several advantages as compared to standard approaches, such as:

- **The interaction of market model and system simulation on a unified platform provides consistent overall projections;**
- **Consideration of grid bottlenecks and congestion leads to an improved security of supply analysis (e.g. 'winter statement');**
- **Joint analysis of new market interconnectors and national grid reinforcement improves the quality of results and saves time;**
- **Consideration of grid and wires means there is no 'blind spot' in future implementation of flow-based market coupling;**
- **Identifying risk-mitigating solutions and remedial actions beyond generation re-dispatch by stress-testing of challenging or critical operational system situations (e.g. high RES infeed and low inertia operation conditions)**
- **Introduction of an early plausible market and physical outcome to base dynamic network simulation on. – I.e. testing of loss of largest infeed etc. A valuable tool to minimise operational risk and increase reliability.**

The iteration of market model and system simulation ends, when the simulation provides a consistent stable scenario with a generation cost minimum without grid congestion. Usually this is the case after three iteration loops.

When the market model cannot solve constraints in the grid model, the grid operator identifies and implements measures to avoid loss of energy, system overload or failure. For short-term solutions (one or two days ahead) remedial actions are identified (e.g. phase shifter set points, HVDC control etc.). In the long run, the network planners can – by AFRY Combined Analysis – identify certain particularly beneficial grid extensions, like new lines or topological changes.

Since investments in infrastructure assets are impeded by slow processes, about 8 to 10 years lead time, and expensive (CAPEX for HV overhead lines €0,75-0,9 m/km and HV underground cable 8-12 times that cost), the AFRY combined approach supports grid decisions with a fully-fledged Cost Benefit Analysis according to the ENTSO-E development.

With this step, all results are allocated and put on a "T- account sheet" for evaluation. In this step, CAPEX and OPEX are considered on the cost side and criteria like socio-economic welfare, CO2 reduction, adequacy, flexibility, system stability on the benefit side are scrutinized as well. In addition, the residual environmental and social impact is included.

BENEFITS

The Combined Analytics approach allows market and system operators to:

- **Better predict grid capacity,**
- **Identify congestion,**
- **Stress test operational situations for the grid infrastructure and power supply, and**
- **Identify short- and long-term solutions to avoid critical situations and provide for reliable operation**
- **Improve power system planning,**
- **Better adapt power exchange capacity to be offered to the market, and**
- **Prepare for the upcoming Europe-wide flow-based market coupling mechanism.**

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Grid capacity challenges in Sweden

Sweden is growing and things are moving fast. The traditional industry is being renewed, and growth in robotisation, cloud services, artificial intelligence (AI) and other digitalisation phenomena are leading to a strong increase in the demand for power. At the same time, utilisation of the once well-dimensioned electricity grids is reaching unprecedented levels and providing grid access for new users and connections is no longer straightforward. Adding to the challenges, several large grid development projects have lingered in complex concession processes for up to as much as 15 years.

A study conducted by AFRY in 2018 shows dramatic implications of grid capacity restraints; If the situation is not improved, as much as 16 GW of new connections representing an annual socio-economic value of 150 billion SEK may be lost by 2030. Already today, the estimated socio-economic cost of insufficient grid capacity is as high as 80 billion SEK per year, not counting indirect effects. By comparison, the value of the full, Swedish electricity network is 170 billion SEK.

The lack of capacity hurts economic development, especially in southern and mid Sweden, by limiting electrification of transport, establishment of new companies, development of new urban areas, business and residential buildings. In particular, lack of grid capacity limits regional development in the larger urban areas like Stockholm, Gothenburg and Malmö.

There is no shortage of power generation, the issue is transmission and grid capacity. Growing demand is balanced by increased generation, especially from wind power plants. However, the majority of added wind power capacity is in the north, while the ageing nuclear plants in the south are phased out one block at the time. The large power lines from the north to the south will not fully absorb the change and the transfer capacity (NTC) between Northern and southern Sweden will be a bottleneck to a larger extent than it is today. It currently maxes out at 7000 MW NTC. Relatively little wind generation is coming online in the south and it is not enough to compensate for the strong demand growth foreseeable. In low wind operational hours, southern Sweden relies on the net import of energy from neighbouring countries.

The increased pressure on the backbone in the 400 kV- grid means that operational margins will diminish, the system will be more exposed to faults during high transmission hours being more challenging to mitigate.

To deal with the lack of capacity, multiple measures and actions are required. While building more grid capacity is a high priority action and the ultimate solution, a different set of tools can help to manage the crisis:

- **Changes to the operational rules for use of right of way and existing grid to improve the utilisation.**
- **Demand side flexibility, where the key issue is how to adjust demand with minimised socioeconomic cost, and how to create efficient marketplaces to ensure this is happening.**

Along with better market design for flexibility and simpler and targeted investments in alternatives to grid, like grid-size battery storage, these two families of measures could mitigate at least some of the capacity constraints.

There is an obvious need to weigh socioeconomic costs of chosen reliability levels with socio economic costs of severe grid capacity constraints.

SPEEDING UP GRID CONCESSION AND CONSTRUCTION

Democratic processes take time. While a fundamental and highly valued part of Sweden's democracy, streamlining concession and investment processes will be necessary to catch up with the current backlog in grid capacity. This is especially true for transmission grids, where lead time for construction regularly exceed ten years. At the same time, insufficient communication and coordination between stakeholders aggravate the challenges and the time spent on decision processes. Enhanced planning and coordination processes should be introduced to ensure that all important elements in understanding the future need for capacity is properly dealt with. Economic incentives and financing are other important elements. Many of the larger grid owners will be required to lower their tariffs and thus their income in the forthcoming regulatory period. Lower tariffs are justified with consumer protection; however, lowered tariffs are also likely to result in reduced grid investments.

Finally, both the organisation and the capacity in public bodies could be strengthened and improved. Instead of sequential proceedings, parallel processes across different public bodies should be developed when possible. Staffing in the relevant bodies and offices should be increased as to avoid unnecessary delays in public proceedings.

DEMAND SIDE MANAGEMENT

DSM can be defined as the array of activities to alter utilities' load shape and/or energy consumption patterns. It can be utilised to shift part of the electricity demand from peak demand hours or unfavourable electricity generation hours, to valley hours or favourable electricity generation hours.

The incorporation of DSM into the electricity market has been made possible through technological advancement in communication and the rollout of smart meters. Its implementation can be facilitated, amongst other strategies, by load-based time varying grid tariffs, targeted at resolving acute congestion and capacity constraints. However, our studies on end user behaviour and preferences clearly show that end users are unlikely to accept and react to complicated, dynamic pricing models unless combined with automated load and energy management systems. In consequence, third party players like energy service companies (ESCOs) are crucial in order to help end users utilise their available flexibility.

New business models require a financial basis: This could be realised either directly through the price signal in the grid tariff, while it could also be organised as regional and local flexibility marketplaces, where DSOs or the TSO pay aggregators like ESCOs to provide flexibility in specific locations when needed.

The demand side flexibility reserve is already substantial, and with the rise of e-mobility it is growing. In the building sector, electric space- and water-heating, ventilation and cooling are all to some extent flexible loads that can be shifted at least between hours. EV charging, especially at home, is highly flexible and can easily be shifted from day-time to night-time.

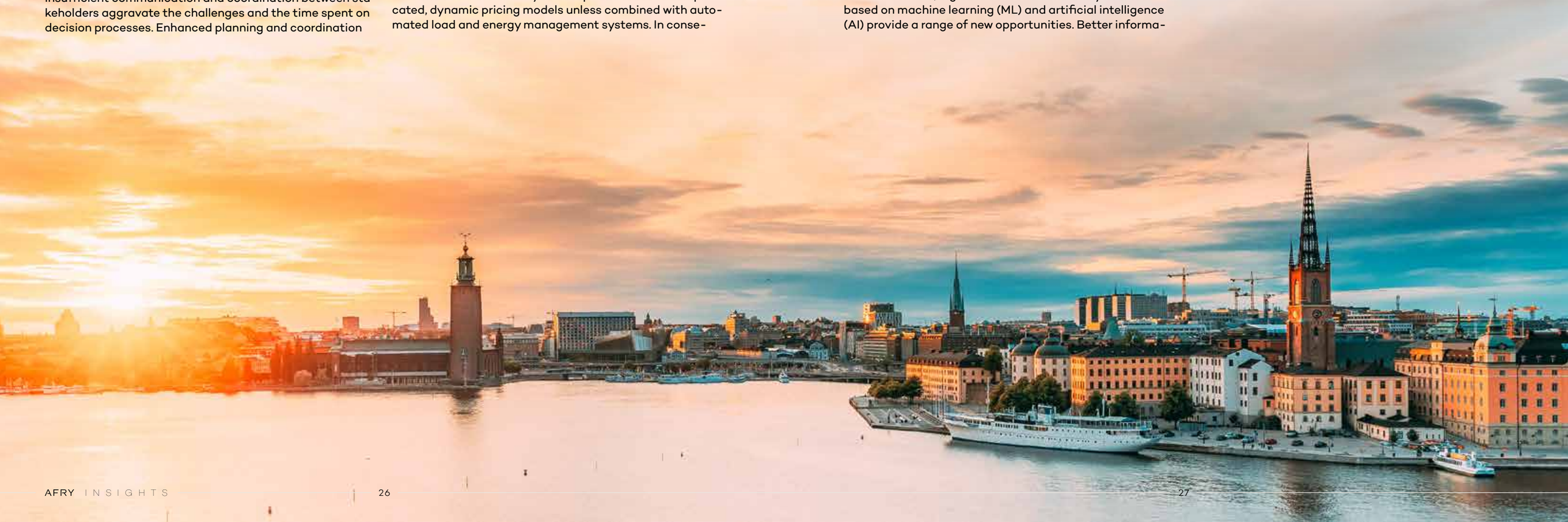
Introduction of behavioural incentives, like neighbourhood competitions, could be equally important to actually mobilise the flexible demand resources in the system. In this regard, new, customer-focused players like energy service companies will play a central role.

ENHANCE THE USE OF THE EXISTING GRID

New technology and digitalisation not only enable end users to play a much more active role by providing flexibility and load control, giving grid companies entirely new knowledge and tools to use the existing grid capacity better. New sensors, big data collection and analytical tools based on machine learning (ML) and artificial intelligence (AI) provide a range of new opportunities. Better information and control system enable operators to adjust risk assessments and rules for maintaining the desired level of safety and security of supply. Predictive analysis and targeted fault prevention will contribute to reduce down-time and revision periods. Real-time ambient- and grid-temperature data enable optimal use of the grid through dynamic line rating (DLR) – where the available capacity actually increases during cold periods, at the same time as the typical Nordic demand is peaking due to heater load.

A part of the capacity challenge is related to short-term situations, like unexpected outages and system faults, or demand peaks of short duration. There are alternatives to building grids to handle such situations. Grid-sized batteries can help stabilise the grid, avoid outages and reduce system costs. Under current EU legislation, however, battery ownership and operation is outside of the regulated network business, and new business models and access to markets for relevant flexibility services must therefore be put in place first.

Functionality, value and usage will most likely span the range from grid capacity constraint alleviation to advanced real time power system control. These are very different values brought to the system and the overall investment case will most likely be dependent on several different revenue streams that need to be co-optimised. In this context, operation of high renewable power systems is very relevant and also the topic of an upcoming AFRY Point of View.



Expanding and growing

Martin Graf
Member of the Board of Directors of Energie Steiermark

While Austria has a high share of hydropower plants, almost none have been built in recent years. In addition to financing, which is becoming an ever smaller hurdle due to rising electricity prices and the need for green certificates, it is above all a question of acceptance. Your company is an exception, you even managed to initiate a hydropower plant in Graz, capital of the state of Styria. What were the factors that made this success possible?

Martin Graf: At Energie Steiermark, there is a clear commitment to implementing renewable-energy projects and thereby making an important contribution to achieving the climate-protection goals outlined in the Paris Agreement. At present, the share of renewable energy in Styria is at around 30%. Over the next few years, Energie Steiermark intends to invest around EUR 500 million in the expansion of renewable-energy projects so as to help Styria achieve its energy and climate goals.

An essential factor in the success of major projects such as the hydroelectric-power plants in Graz is a matter-of-fact communication with all stakeholders and above all the willingness to engage in a dialogue with them. Right from the approval phase of the project, there have been comprehensive and proactive reports through diverse channels – both analogue and digital media – on ecological measures and the construction progress and there is an ombudsman available in person for talks. The sensitive and transparent handling of concerns and questions as well as giving interested people the opportunity to get a picture of the construction measures and the ecological compensatory measures on site at any time, have helped to reduce the resistance.

What makes the Austrian energy market so special, apart from its location right in the heart of Europe?

Martin Graf: In the heart of Europe, the Austrian electricity and gas market plays a central role among the sometimes very different energy regions in the North, South, East and West of Europe. As a result of this positioning as an energy hub, the Austrian energy market has a very high degree of integration in the networks of the adjacent countries. In the electricity sector, this is reflected by the number of interconnectors, in the gas sector by the high number of transport pipelines and by the large volume of gas-storage capacities. Especially in the winter months, Austria ensures the supply of many neighbouring European countries with its gas-storage facilities and transport pipelines to Russia.

With its renewable-energy share of approximately 78%, Austria is also one of the leaders among European power producers and is considered a pioneer in the CO_2-free and sustainable generation of electricity, especially with the help of hydropower. Another characteristic of the Austrian electricity and gas market is the complete liberalization already achieved in 2001 and 2002, the high degree of supply security and the choice of Vienna as the capital of five internationally renowned energy organizations, the IAEA, OPEC, OSCE, UNIDO and the Energy Community.

Do innovations play a major role at your company?

Martin Graf: The challenges posed by climate change, digitization but also the liberalization of the energy market, create an environment in which innovation becomes indispensable. It is important that we keep pace with the times. We demand and promote innovation in every field. The NEXT-Incubator scouts international and national start-ups for Energie Steiermark and always looks for new, innovative solutions. The key partner in this process is the world's largest start-up generator, "Plug and Play", based in Silicon Valley. At present, numerous innovative projects are running in parallel at the corporation and some have already assumed operations.

As a founding partner of the Green Energy Lab, we are also actively involved in the biggest innovation laboratory in Austria focusing on a sustainable-energy future and closely cooperate with partners from research, economy and industry. "Smart Cities" are also among our central topics – and the cities are our project partners. The megatrend of urbanization is clearly visible. Asking ourselves the question of "How do we live and work in the city of the future?" is a major help for us to be a sustainable energy-service provider. The transition towards more green energy will mainly take place in the cities; this is why interconnected "Smart Cities" are the recipe for success in the future.

Do you see a need for closer cooperation with the industry as Austria has a high degree of industrialisation compared to other European countries (29%)?

Martin Graf: Austrian industry is an important driver of and impulse for innovation, progress and employment in our country. This is especially true for an industrialized Austrian federal state like Styria, where approximately 37% of the regional added-value is generated by enterprises from the producing sector, which accounts for about half of all employees. The high degree of industrialization compared to other European countries is therefore very positive. Energie Steiermark has been maintaining long-standing relationships with many, especially energy-intensive, industrial companies. In many projects and joint initiatives, various starting points and opportunities for cooperation arise:

These can range from the use of heat generated by the burning of industrial waste for the local heat supply of cities, to the commissioning of Styrian industrial companies for the joint realization of major projects. For example, at the recently commissioned hydropower plant in Graz, 90% of the contracts were awarded to companies from the region.

Are you taking first steps towards internationalisation?

Martin Graf: At Energie Steiermark, we are constantly striving to grow sustainably and profitably, both in Austria and abroad. We are currently also represented with our own subsidiaries in the corresponding markets of Germany, Slovenia, Czechia and Slovakia. Our commitment ranges from supplying low-carbon heat, via assuming utility assignments, up to offering innovation topics and services. A few months ago, we started a joint venture together with the German company Codeatelier in Berlin.

The focus of this young company is the smart-home solution "Homee" – realizing the intelligent home of tomorrow, which in principle takes over some of the thinking for its inhabitants. On Amazon, this product – which is already in use in more than 10,000 households worldwide – got the best ratings of all comparable products. In that field, we are planning a Europe-wide sales offensive and see enormous potential. By expanding and growing our activities, we pursue both an organic and M&A-based approach towards higher growth.

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How to capture the Spanish sun

Support schemes have been vital in developing wind and solar to now, but what is the best way of delivering growth without support?

Power systems across the globe will incorporate increasing shares of Renewable Energy Sources (RES) in the decades to come.

The spectacular cost decrease of wind power and especially solar PV have turned these technologies into cheap, sustainable local energy sources. Grid parity' has been reached in some countries and will allow subsidy-free developments. Even in countries in which it hasn't yet been reached, the cost of support schemes has reduced enormously. The environmental concerns of the 'climate crisis' have pushed Governments to commit to even more ambitious environmental targets, with a long-term goal to almost fully decarbonise the economy by 2050. Going green now actually brings votes.

For these reasons, plus the additional benefits of becoming a world leader in renewable nergy and reducing the high energy dependency, the EU has recently made the binding commitment to increase the share of RES in final energy to 32% by 2030. Considering the lower contribution of the Transport sector (currently around 6% in most markets through the use of biofuels) and the Heating & Cooling sector (generally still below 20% through biomass or other biofuels), the highest pressure for decarbonising the economy in most countries will be on the power sector and the deployment of renewable capacity in power systems will grow at a faster pace than ever before.

UTILITY-SCALE OR DISTRIBUTED PV

Whilst wind technologies will keep playing a relevant role - multiplying its generation by over two times by 2040 - solar PV will be the fastest growing technology quadrupling its current production mostly in the south of Europe.

A big question to many stakeholders and to the design of the power system is whether Solar PV will be deployed in utility scale plants to export to the grid, or in distributed plants for self-consumption (typically on rooftops).

Countries like Germany, Italy and even the UK recently, have large shares of their total PV capacity on rooftops, as a consequence of various incentive schemes. Conversely Spain, with the highest radiation factors in Europe, has disincentivised the development of rooftop solar through the so-called 'solar tax' - finally removed in 2018 - and almost all installed capacity is in utility-scale plants. The new context of low-cost solar modules, and energy users' rising concern about bills, has brought several changes that have driven uncertain attitudes towards a further growth of distributed PV. In one extreme, some suggest that very cheap panels will drive huge penetrations of distributed PV and foresee the end of utilities as we know them today. At the other extreme, others suggest that the gradual end of incentives will stop distributed PV in favour of larger plants with high economies of scale.

AFRY has developed its methodology to create scenario projections of distributed PV deployment in Spain based on a range of key parameters, with somewhat counterintuitive results and insights.
Distributed PV production can be split into two groups:

- **A: Self-consumption (coloured in blue in the chart), when instantaneous production is lower than the instantaneous demand; and**
- **B: Export of surpluses (coloured in yellow), when instantaneous production is higher than demand.**

Effectively, self-consumption implies a reduction of electricity consumption requested from the grid and as such, it is not metered by the distribution company nor billed by the supplier. This saves both the acquisition of kWh at the wholesale price and the variable component of the grid charge for the transiting of said kWh. However, all surplus which is poured into the grid does not save the variable component of the grid charge and may be remunerated at a maximum price equal to the prevailing wholesale market price. It is therefore only profitable to design a rooftop PV system that exports surpluses if the regulatory framework and proper metering arrangements allow for compensation at a higher value than the Levelised Cost of Energy (LCOE) of the solar PV system.

Yet in the long run, we can expect that future wholesale prices at times of solar production will decrease in line with the LCOE of utility scale PV, as prices sustainably above this level would trigger merchant investments. Finally, because the LCOE of utility scale PV is expected to probably remain significantly lower than rooftop PV (lower capex, lower opex, lower installation cost, and higher load factor for utility scale PV), we can conclude that the surplus from roof-top PV is not expected to be economically profitable. In other words, the optimal panel size for self-consumption that minimises total annuitised end-user bill should be small enough such that it minimises unnecessary surpluses. In fact, self-consumption is only profitable where the saving in the variable grid charge more than offsets the lower economy of scale of distributed PV; which happens to be the case in Spain.

AFRY's analyses on several standard customer types for Spain suggest that it is not economically profitable to try and exceed an annual self-consumption above 20% for average domestic consumers and up to 30% for some larger customer categories . Even with batteries attached the case is not changed significantly, as the wholesale peak vs off-peak price differentials, the value of the fixed component of the grid charges, the potential reduction of contracted capacity, the 'degree of smartness' of the storage system and competition from utility-scale projects all impact the economic viability of distributed batteries.

OPTIMAL PANEL SIZING

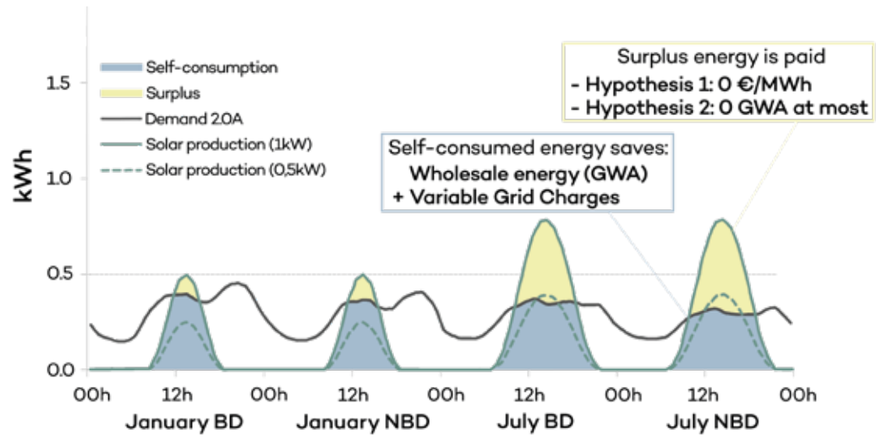
An additional finding is on the total economic saving that can be reached by an 'optimal panel sizing'. Considering that distributed PV has the additional savings of the variable component of grid charges, but on the other hand its installation and maintenance costs are higher, the total saving on the annual end-user bill is projected to be in the range of 2% to 7% depending on the customer type, already including a rental or depreciation component of the panel (for instance assuming the cost of a leasing business model). For example, a Spanish domestic consumer with an average electricity bill of 50 euros (including taxes) can expect monthly savings of around €2-3/month, or €6-8/month, with a payback period above 10 years with a full upfront payment of the PV system.

This analysis for Spain suggests that counterintuitively rather low savings, or high payback periods, driven by the high weight of the fixed component of grid charges and the cheap 'solar wholesale prices', are likely to prevent a massive adoption of distributed roof-top PV if the social driver remains purely economic. Our central expectation would lead to a national penetration of distributed PV in the range of just 4% of national annual demand, with a total of 3 to 5 GW installed by 2030 and beyond, or 300-500MW/year. Which supports the idea that the high installation of solar PV capacity in the Spanish mainland system, currently projected at a combined total of 30 to 36 GW by 2030, will come mostly from more efficient utility-scale plants rather than from distributed rooftop small plants.

Note that several factors could modify the conclusions of AFRY's analysis for the Spanish market, such as:

- **A redesign of grid charges, with a higher weight on the variable component to the detriment of the fixed component (although recent changes have actually gone in the opposite direction of increasing the fixed component of grid charges to pay for regulated costs which are mostly fixed);**
- **The development of economic incentives for distributed PV such as the German, Italian or British cases (although these are not expected in Spain);**
- **Society's massive adoption at some point of distributed PV as a trendy way to address the climate crisis, regardless of the economics and the theoretical 'optimal panel sizing'. After all, we also buy larger phones and TVs than the 'economic optimal size'.**

It would be interesting to know, as an electricity consumer, what is your take towards installing a PV system on your roof?



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Infrastructure investments

Large scale investments are needed urgently, as infrastructure is aging rapidly and needs to be renewed, plus new infrastructure needs to be built to meet increasing demand. However, with rapid technological developments and more volatile customer needs, how do investors avoid ending up with stranded assets when the world has moved on?

This lack of certainty coupled with changing business models is holding some investment decisions back – which in turn is making the case for new infrastructure investment even more pressing. So in today's world of dramatically changing markets and increased uncertainty, new approaches are needed to evaluate long-term infrastructure investments.

Rising to this challenge, AFRY executed a project in the summer of 2019 with one of Europe's largest infrastructure operators. We decided that a novel approach was required. Together with the client, our teams from management consulting, engineering and operations set about coupling the long-term perspective of a corporate foresight analysis with the more concrete and conservative approach of strategic decision making.

Our approach consisted of four steps:

1. **Foresight analysis: Examining all relevant trends and drivers for infrastructure in order to develop coherent scenarios for the future for infrastructure**

2. **Future infrastructure: Developing a clear understanding for future characteristics of infrastructure in the foresight scenarios**

3. **Opportunities and Threats: Identifying opportunities and threats emerging from the evolution of infrastructure towards their future shape**

4. **Strategic advice: Developing strategic options and first strategic recommendations to optimally respond to the identified opportunities and threats**

The client was very pleased with the resulting analysis and advice. The approach, summarised in the case study below, is applicable to all types of infrastructure and AFRY is very happy to help if you are facing similar dilemmas.

Case study: Strategic foresight for one of Europe's largest infrastructure operators.

1. Execution of the foresight analysis

Corporate foresight is a set of methods and practices that aims to understand and evaluate possible scenarios of what the future could look like. This is accomplished by understanding the key trends that shape the future of society, technology, ecology, economy and politics (STEEP) throughout the next decades. Within the foresight analysis, STEEP trends are derived from several sources. One is a compilation of general large-scale (mega-) trends such as the increasing climate change awareness among the general public. Another source is a list of concrete signals-of-change already visible today, such as the growing technical capabilities of autonomous vehicles. Finally, a further source is a collection of concrete expert-based projections of future developments.

In the context of this project, the entirety of these STEEP trends was assembled and evaluated to derive several consistent scenarios of how the future world may look in 2030 and 2050. One such scenario was a "progressively digitalised world", in which digital AI assistants manage all aspects of people's lives. In this scenario, people are willing to let algorithms schedule their utilisation of infrastructure leading to more predictable utilisation patterns. Another scenario addressed a "fully sustainable world", in which all efforts for climate protection are supported by the general public. In this scenario, a fully circular resource economy is established and all of the infrastructure's operation is geared towards a more sustainable resource consumption.

2. Deriving the future characteristics of infrastructure

From the future scenarios, major changes to existing infrastructure's operation and utilisation were deduced. Further, the potential role of newly emerging infrastructure was investigated. The analysis was focused on a multitude of distinct aspects concerning infrastructure: Operational topics such as changed utilisation patterns and novel technologies, commercial topics such as new financing structures, revenue models and changed risk profiles, as well as legal topics such as new regulations were considered. For example, in the "progressively digitalised world", the general utilisation of infrastructure is not changed dramatically, but digitalisation enables the provision of entirely new services with existing infrastructure. Whereas in the "fully sustainable world", the perceived urgency to protect the environment leads to aggressive global taxation of CO_2 emissions, which enables novel renewable technologies to establish a foothold in the energy sector. The relevance of similar developments was evaluated across all future scenarios to assemble a coherent and robust outlook of what infrastructure operators' future businesses may look like.

3. Assessment of opportunities and threats emerging from the foresight implications

In the third step, a longlist of opportunities and threats was derived from the most relevant changes to infrastructure operations. Opportunities could emerge from changed customer preferences or new technologies for example. Threats could emerge from reduced usage of an infrastructure due to demographics, substitution by a different infrastructure, tightened regulations or new competitors entering the market, etc. In the scenario of a "fully sustainable world", an exemplary threat for an infrastructure operator could be the reduced utilisation of natural gas networks due to the taxation of CO_2. A corresponding opportunity in this scenario could be the provision of green or blue hydrogen to replace natural gas as energy carrier in the industrial, heating and transportation sectors.

The longlist of opportunities and threats was evaluated by internal and external market experts in order to derive a shortlist of the most relevant opportunities and threats for the client's business. The basis for the deduction of the shortlist was an in-depth analysis of each opportunity and threat. This in-depth analysis was composed of qualitative elements (e.g. opportunity description, competitive environment, time relevance, value chain, etc.) and quantitative elements (e.g. value pools, possible market shares, attainable margins, etc.). Moreover, the in-depth analysis investigated the strategic fit to the client's existing business.

4. Development of strategic options and derivation of first strategic recommendations

The foundation for the last step of the work was the identification of the client's strengths and weaknesses. Taking these into account, the shortlisted opportunities and threats (including their interrelation) were analysed with regard to possible strategic options. An example of a strategic option in the "fully sustainable world" could be to partner with OEMs of large-scale electrolysers to build and operate hydrogen fuel stations and to supply them with renewable electricity. This would position the client as provider of a carbon-free energy carrier for district heating networks and industrial processes, which would further enable the supply of a future-proof material energy carrier for the transportation sector.

A list of first strategic recommendations for short-term actions were derived from the SWOT-analysis and the strategic options. On the one hand, the recommendations focused on utilising the client's strengths to capture new and relevant business opportunities. On the other, the recommendations sought to help the client cope with the most relevant threats to its existing business. As a result, the client received strategic guidance to enable a solid positioning for the future world of 2030 and beyond.

Expertise from AFRY engineers crucial for the project

The high applicability and value of the overall project results were substantially driven by the systematic long-term view from foresight in combination with AFRY's ability to thoroughly validate and evaluate the trends and future developments. In this regard, it was crucial for the project success to combine two aspects: First, the broad spectrum of expertise provided by AFRY (management consulting, engineering, operational experience) and the client; Second, the clear focus on translating AFRY's technical expertise into tangible advice for the client's decision-making process.

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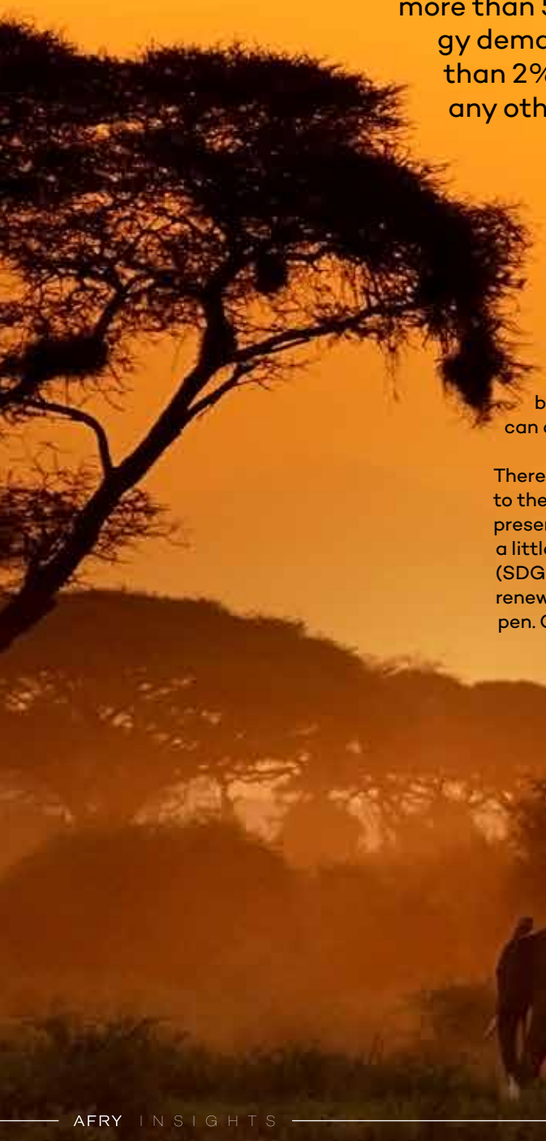
Africa

In recent years many African countries, especially those located in the Sub-Saharan part of the continent, have experienced growth trends that match or even surpass average global growth rates. Africa's economic growth is projected to accelerate to more than 4% per annum in the next few years, and it is expected to host 25% of the world's population by 2050, with a rapid urbanization trend leading to more than 50% of Africa's population living in cities. Energy demand is therefore expected to increase at more than 2% per annum in the coming years, faster than in any other part of the world.



However, the current levels of access to electricity are insufficient to address these upcoming structural challenges, and the energy-related regulatory framework is still far too uncertain to encourage stable investment flows from developed countries. Support programs have been developed by many international stakeholders, but a lot still needs to be done. It has been estimated that $1.5 trillion will be needed by 2040 just to install more than 120GW of renewable generation and sustain socio-economic growth, which in large part will require a substantial contribution from the private sector. Renewables are expected to play a significant role, as a catalyst to allow African countries to leapfrog towards a more sustainable development model.

There is no doubt that renewable energy technologies in particular, due to their vast resources, cost-effectiveness, modularity, and scalability, present an effective strategy to drive Africa's clean energy transition. With a little more than 10 years to reach the Sustainable Development Goals (SDGs) by 2030, achieving this in Africa has never been more urgent, while renewable energy solutions have never been better suited to make it happen. Grand challenges require grand strategies. Reaching universal access to energy in Africa requires a scale-up and mobilisation of investment, which cannot be achieved without private sector involvement and financing. Given the scale of the challenge, universal electrification in Africa must rely on a combination of multiple and diverse technological solutions to deliver competitive and reliable energy to communities who need it the most in both urban and rural areas. It will need significant investments in large scale generation, decentralised off-grid applications, enhanced transmission and distribution solutions, as well as grid expansion.

Energy access can achieve more than you may think. Along with water and food, energy is one of the building blocks of development, and access to these resources is essential for human wellbeing, poverty reduction and sustainable economic growth. Energy is deeply interwoven with these other sectors that are fundamental to Africa's human and industrial development. **The RES4Africa Foundation** has coined the phrase Water-Energy-Food (WEF) Nexus to represent the complex interrelations between resource and supply systems.

The sectoral interdependencies are particularly challenging in Africa where widespread resource infrastructure is still lacking, hampering agricultural productivity, industrial development, and poverty alleviation. Indeed, Africa's future counts on ensuring access to energy, water, and food resources, with a strong role therein for renewables.

This offers an innovative perspective on the wider impacts of approaching the energy access challenge in Africa by considering how energy can both enable development and solve resource challenges. If powered by renewable energy technologies, the approach can inspire investment cases and business models that account for ways in which energy can mitigate resource needs and enable sustainable, productive uses of energy in high-potential economic sectors in African markets, such as water and agri-business. If taken to scale, the WEF Nexus approach has the transformative potential to build new energy access markets and to enable virtuous cycles for development impact that is needed to meet the SDGs by 2030. RES4Africa explored the added value of a renewables-based WEF Nexus projects in a preliminary study with a cost-benefit modelling exercise of an integrated business model in rural Tanzania. Results indicate that over a long-term lifespan, renewables-based integrated multi-service projects have more than twice as much economic impact on a local community than the provision of energy alone. Moreover, the integrated approach enables a multiplier effect that increases local purchasing power, translating into improvements in other socio-economic areas. Specifically, the biggest benefits were increased access to better education, improved agricultural productivity, and time saved from having water and energy access on site. These results help make the case to support the expansion of such projects in order to bring their benefits to scale.

Private energy actors need to consider the WEF Nexus in their central role to solving Africa's energy access challenge. Private players should consider WEF Nexus strategies in order to overcome barriers they face in energy access markets and to create new spheres of economic impact. The Nexus represents an opportunity for companies to create value by solving social needs – the true calling of business-led impact in the 21st century. Companies can do well by doing good, and economic growth benefits business development in a reciprocal manner.

Today's challenges can no longer be understood through the siloed prisms of the past, and Africa's energy access challenge is no exception. The paradigm shift lies in the idea that energy enables development and is interlinked with other key sectors, which creates opportunities for market and business growth as well as for virtuous sustainable development cycles.

AFRY has matured a long-standing presence in and deep understanding of the African continent. We have been involved in a broad range of projects, including regulatory assessments and policy advice, power market modelling (through the BID Africa modelling tool), ssLNG and power market analysis and due diligences.
We cover an increasing number of countries such as Egypt, Morocco, Tunisia, Kenya, South Africa, Benin, Algeria, Mozambique, Uganda and others.

AFRY, through its office in Milan, is now one of the most respected and active members of **the RES4Africa Foundation** (www.res4africa.org). Through the participation to the Foundation, it has taken part and led several projects in the energy sector, including

- **Contribution to the last RES4Africa Foundation flagship publication, "Africa Future Counts";**
- **Leadership in the development of a fully fledged study, "What does it take to accelerate RES investments in Africa: priorities and recommendations", which will be advanced through a partnership with the United Nations Economic Commission for Africa (UNECA) to apply the methodology on a broader set of Northern and Sub-Saharan countries; and**
- **Active participation in renewAfrica, a recently born Initiative which aims to create a new European multi-stakeholder backed initiative to accelerate Africa's sustainable energy transition, through the creation of comprehensive programmes to boost RES development in the continent.**

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