SMPnet Response to Ofgem

Call for Input: The Future of Distributed Flexibility

May 2023

For the attention of Ofgem's Digitalisation and Decentralisation; Energy Systems Management and Security teams

SMPnet responds to Ofgem's Call for Input on The Future of Distributed Flexibility and welcomes its focus on distribution flexibility and accelerating the transition towards a flex-centred energy system.

Network operations are impacted by the deployment of renewable and zero-carbon technologies, which means utilities must depend on various tools in their control room for the enhanced coordination of different network nodes and across voltage levels. These smart grid enablers, which include flexibility services, monitoring systems, real-time optimisation platforms and digital substations, will form the backbone of a digitalised and decentralised energy system and must operate as an optimised, integrated, and interoperable network of tools.

We would welcome a further discussion of the positions set out in response to this Call for Input and would be happy to demonstrate our Omega technology to outline its role and benefits to distribution flexibility.

- **Distribution flexibility is critical:** for a resilient and cost-effective transition to net-zero.
- **There is a clear case for change:** a shift must happen to allow pockets of excellence to deploy at scale, at an accelerated pace and in a coordinated manner.
- **Network optimisation tools and flexibility markets must be integrated:** to capture the full value of distributed flexibility, a holistic approach must be set out that integrates flexibility markets with the full suite network optimisation tools and enablers, with digital substations at its core.
- **Existing technology can unlock distribution flexibility:** much of the technology needed for a flex-centred system exists and can be deployed now at scale and pace.

Introduction to SMPnet and Omega's Role in distribution flexibility

Founded by Dr Anastasios Rousis (PhD, MSc, MEng) and Dr Dimitrios Tzelepis (PhD, MSc, BSc), SMPnet has developed an energy tech platform that offers tangible solutions to imminent network issues. The Omega platform is an adaptive and real-time control technology, which, when installed at distribution network primary and secondary substations, unlocks several benefits to a flexible, resilient system:

1. The technology provides unprecedented close to real-time visibility and network activity monitoring at a granularity of <20ms. These measurements enable a shift away from predictions and forecasts to understanding the true nature of network activity, including constraints.
2. Omega can use this real-time monitoring capability to optimise and control primary and secondary substations dynamically and DER sites to ensure networks comply with capacity limits, exploit unutilised capacity, and remove the need to disconnect renewable generation.
3. Through a wide envelope of communications standards and protocols, including IEC61850 international standard, Modbus, DNP3, OpenADR, C37.118, IEC 60870-5-104 protocol, IEEE 2030.5, etc., Omega can connect and integrate across different systems and platforms, allowing data sharing, communication,

and signals to be exchanged, including with other substations, Active Network Management (ANM), Distributed Energy Resource Management Systems (DERMS), Advanced Distribution Management Systems (ADMS), Supervisory Control and Data Acquisition (SCADA) systems and flexibility marketplaces.

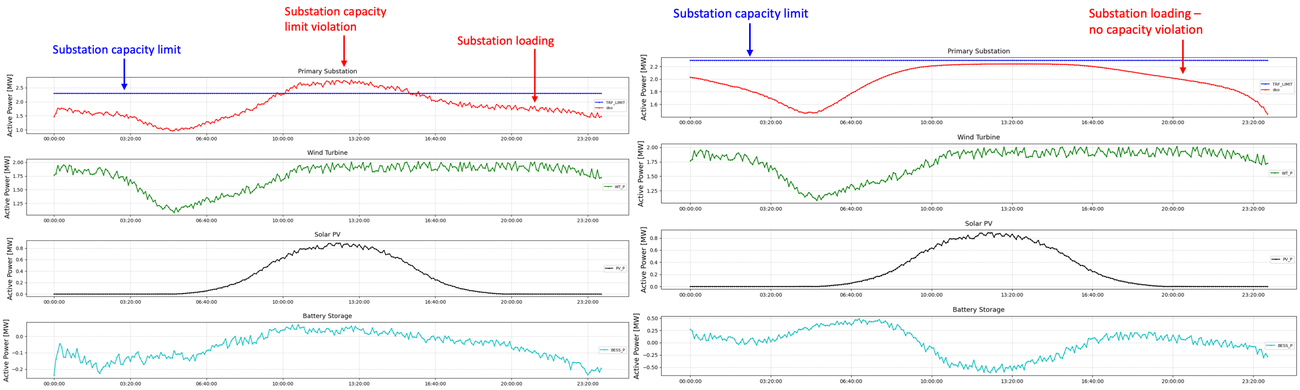

Figure 1. Operation of a network comprising primary substation and DER assets downstream; without Omega (left) and with Omega (right)

The platform acts as an important smart grid enabler by unlocking the close to real-time network visibility needed to understand network capacity limits and other constraints, optimise and control assets at a substation level to alleviate any identified conditions as well as share relevant data to systems (such as DERMS) capable of using the data to initiate flexibility service requirements and dispatch. It benefits the wider design and utilities by helping them to:

- **Operate their networks**: monitor, optimise and control multiple network assets in real-time, supporting increased resilience and security of supply.
- **Deliver value-based growth**: optimising networks to reduce OPEX, defer network reinforcements, increase revenues through flexibility and maximise renewable energy asset integration.
- **Digitise**: these digital tools enable multi-vendor interoperability and unlock data driven-based energy insights to inform planning schedules and operational regimes, creating a unified digitised platform for precise, optimised network management, much closer to real-time than currently achieved.

Response to questions

- **Question: What do you think distributed flexibility could contribute to the energy system?**

Distribution flexibility is critical for a resilient and cost-effective transition to net zero.

Climate change-related extreme weather conditions has already caused challenges for distribution grid operation. For instance, a 40-degree heat wave in 2022 led to mainstream media outlets reporting risks of network damage, demand outstripping generation, disconnections, and blackouts in the UK:

- ITV July 2022: [Heatwave: Power networks monitoring the situation as Met Office issues red weather warning]()
- iNews July 2022: 40°C heatwave pushed UK grid to the brink of blackouts with electricity demand close to outstripping supply

Renewable generation and zero-carbon technology deployment also mean that real-time monitoring and distribution flexibility is important in identifying and reducing network constraints and the need for network reinforcements.

The challenges facing network operation will increase as grids decarbonise, meaning network operation must use a coordinated, integrated, and optimised set of tools that unlock the value a smart, flexible energy system will drive. The transition to net-zero can only be done by optimising a flex-centred energy system with distribution flexibility at its core.

- **Question: Is there a 'case for change' and a need for a common vision for distributed flexibility?**

There is a clear case for change: a shift must happen to allow pockets of excellence to deploy at scale, at an accelerated pace and in a coordinated manner.

The role and value of distributed flexibility, as set out above, is clear, and as Ofgem outlines, there have been pockets of excellent progress made:

- Trials such as Constellation and Distributed ReStart have piloted network optimisation technologies.
- End-consumers have contributed to energy system security by participating in National Grid ESO's Demand Flexibility Service.
- Distribution flexibility markets have been established.
- Increased coordination across the transmission/distribution boundary is being explored.

We agree with Ofgem's case for change, which identifies that more is needed to move beyond these pockets of excellence and scale and integrate them into a coordinated system. We agree that moving towards this system would benefit from a common vision identifying the key enablers and the forward trajectory.

Specifically, the policy and regulatory framework must capture the benefits that proven technologies can deliver to a flex-centred energy system, enabling the shift beyond small-scale innovation trials to business-as-usual deployment. Examples where this kind of shift is necessary to include National Grid ESO's Distributed ReStart project and the UK Power Networks project on Constellation, which aims to create revolutionary smart substations that free up capacity for renewable energy. Both these projects have explored the potential for enabling technologies to accelerate and advance network decarbonisation or resilience. The networks must capture the benefits of these technologies and pilot projects moving forward.

Additionally, SMPnet's technology has been trialled in the UK and Spain as part of commercial and innovation projects, respectively. The project in the UK concerns a small-scale microgrid network which has been a safe testbed to test data platforms and, most importantly, optimisation and control algorithms of Omega. More importantly, in collaboration with Iberdrola in Spain, the project has utilised Omega's capabilities to control converter-fed assets within one electric cycle (i.e. 20 milliseconds) to re-synchronise a power island back to the main distribution grid. Whilst the latter is not in the UK, the regulatory environment must be adapted to ensure innovation trials like this can deploy business-as-usual and at scale.

Case study: i-DE Redes Electricas Inteligentes (Iberdrola Group) Power Island resynchronisation for distribution grids

As renewable generation reaches higher penetration in distribution networks, parts of the grid may be subject to planned and unplanned islanding with associated costs for reconnection. In the UK, an islanded operation is currently prohibited; however, in Spain, where this project was implemented, it is permitted if the distributor controls it. Current trends show that wider legislation may change as technological advancements and commercial merits of islanded operations are realised. I-DE launched this project to search for innovative solutions to promote synchronisation systems in remote locations adapted to the needs of the distribution grid.

A typical response to managing power island reconnection is to shut down the power island, close the circuit breaker(s) and gradually restore power within the power island. This process comes with two main drawbacks:

1) It often involves diesel generators as they exhibit enhanced controllability features.
2) It requires the shutdown of the power island (i.e., demand disconnection).

This project showed how Omega helps network operators avoid a shutdown of the islanded grid during reconnection with associated benefits:

- Remote operation (no need for dispatching personnel to manage shutdown/ resynchronisation).
- Millisecond control of battery storage systems (replacing the need for diesel generators)
- Clean operation (no dependence on fossil fuel generators).
- Compatible and coordinated resynchronisation of equipment from different manufacturers.
- No shutdown impact on network users and customers.

i-DE: *"The team at SMPnet have shown that the coordinated voltage, frequency and stability capabilities offered by Omega could radically improve how networks are operated with increased penetration of carbon-free distributed resources and without any compromise in the security of supply and network resilience. We are excited about what this technology offers global networks and look forward to extending this collaboration using Omega to resolve various challenges across our business units".*

In addition to business-as-usual deployment, smart grid-enabling technologies must all be coordinated and integrated for system optimisation. Currently, much of the progress (such as the developments outlined above), the different flexibility markets, the distribution/transmission boundary, and the flexibility service/network optimisation boundary of DERMS, ADMS, DMS, ANM and SCADA systems all are being trialled, developed, and operated separately to one another with minimal visibility or coordination.

In the UK, it remains difficult to adopt innovation projects as business-as-usual with too few examples of success. Where success has happened, such as with the example of the adoption of the Piclo Flex marketplace for DSO flexibility services, the UK has become a renowned leader and shaped the development of that area of expertise.

A shift in the mindset of utilities must occur, which unlocks their willingness and ability to move beyond pockets of excellence in the form of projects and trials and deploy the technologies in a coordinated, business-as-usual way. This shift will help implement smart grid enablers in distribution control rooms, which deliver the associated benefits of network visibility, control and optimisation needed to secure the best value for end consumers.

A common vision would help set the trajectory towards achieving integrated and optimised systems and is important to unlock distribution flexibility.

- **Question: What is your vision for accelerating the delivery of accessible, coordinated and trusted markets for distributed flexibility?**

Network optimisation tools and flexibility markets must be integrated: to capture the full value of distributed flexibility, a holistic approach must be set out that integrates flexibility markets with the full suite of network optimisation tools and enablers, with digital substations at its core.

Networks must transform to be fit for purpose in a net-zero system. The conventional, hardware-based set-up of substations with minimal visibility, reliance on predictions of network activity and lack of communication or coordination with other substations and procedures need to be revised for the new challenges and required close-to-real-time activity as the networks decarbonise. Similar transformations have already occurred in other industries, such as with the examples of broadband and the internet. So the learnings and principles in these cases can be applied to unlocking distribution flexibility.

The SMPnet vision for accelerating accessible, coordinated, and trusted markets for distributed flexibility is that they can only be delivered through their integration with the wider system of digital substations and network optimisation tools. Digital substations are core to delivering and providing the visibility, monitoring, control, and communication across DERMS, ANM, ADMS and SCADA at the granular level required for a flex-centred net-zero energy system. These transformed substations will allow the real-time nature of network activity, even at a low voltage, to be understood and make it possible to identify capacity constraints or operational issues. Digital substations using common communications to align with DERMS, ANM, and ADMS can determine where and when control of assets can be used to alleviate these issues and where and when flexibility services must be procured and dispatched to support, reducing the spend on network reinforcements and upgrades, such as new substations.

A net-zero system will see significant periods where total substation loading exceeds the capacity limits of integrated networks. Hence, visibility, monitoring and management across integrated networks and in communication with the system of tools, markets and services are essential. Without this functionality, flexibility markets will continue to operate separately from other network systems, and their activity will be based on suboptimal data. The deployment and integration of digital substations with wider systems form the basis for accelerating the delivery of accessible, coordinated, and trusted markets.

- **Question: What should a common energy digital infrastructure look like, and why? Please consider the archetypes or develop your proposition.**

Energy systems are already shifting to a regime where many environments (including marketplaces, digital substations, and data platforms) will start exchanging data and collaborating in real-time. A common data infrastructure would make the such exchange more efficient, in contrast to 'ad-hoc' digital energy infrastructures, which introduce several techno-economical risks.

In addition, the continuous technological development and evolution across the energy system, in areas such as digital substations, powerful cloud computing systems and CIM modelling of energy systems, means that an evolving common digital infrastructure must be in place to support these relevant developments.

As set out by Ofgem's archetypes, multiple ways exist to develop a common energy digital infrastructure. However, its design must ensure it is scalable, flexible, and interoperable. These are all core to providing the digital infrastructure can develop necessary functionalities or provisions such as:

1. The ability to accommodate new technologies and applications as they become available (e.g., integrating new software applications to existing DERMS or digital substation environments) and must be able to work with different types of energy sources, data, platforms, and devices.
2. The provision of real-time data exchanges in various timeframes allows for optimisation and control strategies to be applied.
3. A secure and reliable infrastructure ensures that data is protected from unauthorised access or manipulation. Data classifications for different purposes should also be utilised, including open data for transparency. This is especially important given the sensitive nature of energy data and the potential impact of cyber-attacks on critical energy infrastructure.
4. Information and data flows must be available across all scales, as the realisation of flexibility and other services will require many participants to interact with the energy system on and offline.

A common energy digital infrastructure with the above features requires the introduction of global standards and protocols for all the functions and services of the energy system. Currently, organisations design and implement software on models and services that cannot easily be integrated into other environments and act as a barrier to a common digital infrastructure. For example, it could be agreed that optimisation services should run only using the CIM, or flexibility market signals should be exchanged by a certain number of protocols without allowing alterations and customisations.

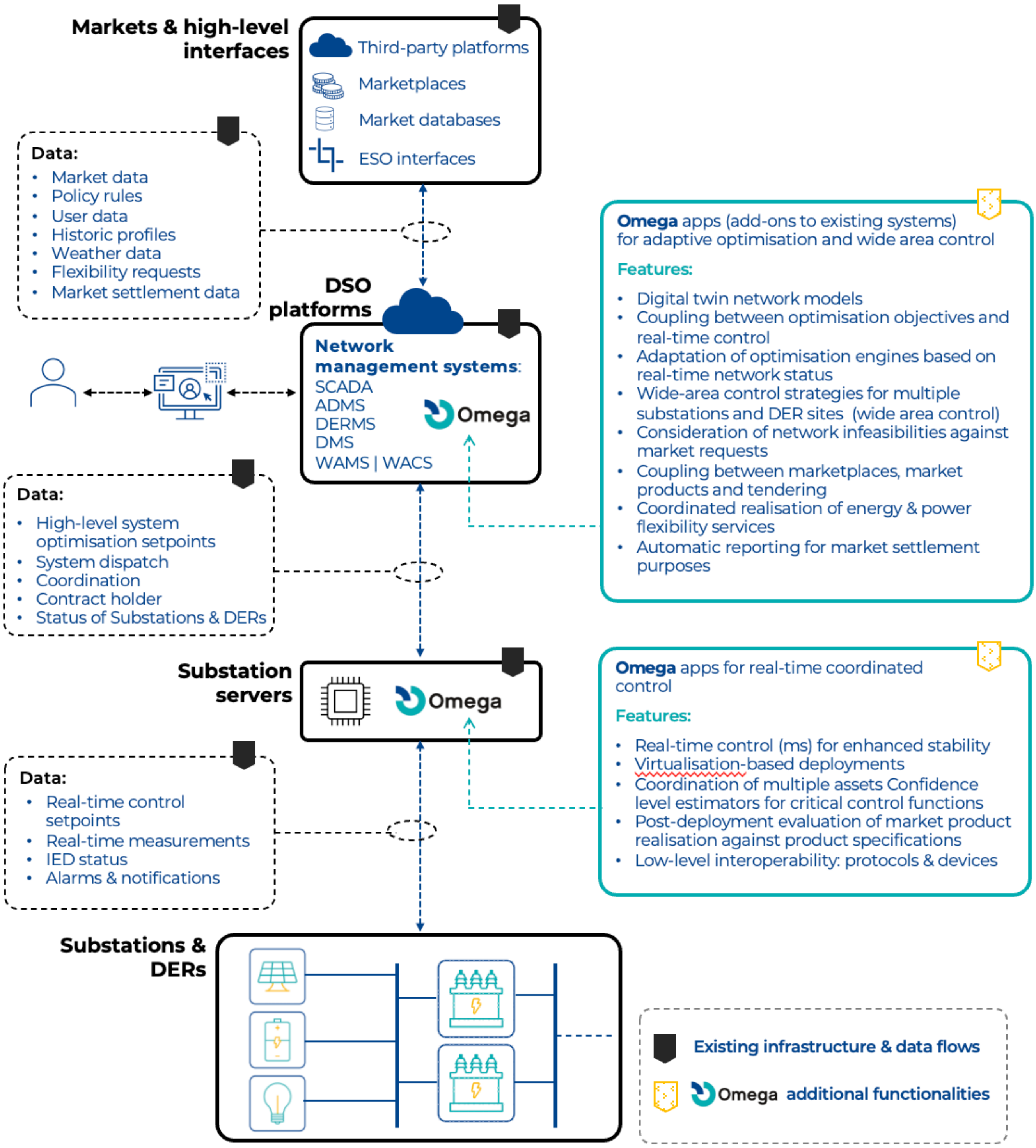

Figure 2. Outline of integrated and coordinated digital architecture at a distribution level.

At a high-level, Figure 2 sets out one possible digital architecture that demonstrates the integration of digital substations with wider systems such as flexibility markets. This architecture is based on scalability, flexibility and interoperability principles and can deliver the required features identified above. We see this architecture as in alignment with elements of the BAU, thin and medium archetypes Ofgem has outlined.

For the next steps of developing a common energy digital infrastructure, Ofgem should ensure that the coordination and integration of network optimisation tools and the standards and protocols behind the infrastructure are set out. SMPnet would be happy to contribute to these discussions.

- **Question: Will certainty of an end vision help accelerate enabling work and make it cohesive?**

Yes, a clear vision will help accelerate the enablers and make it cohesive. It would help shift the mindset of utilities to one that approaches the development of a cohesive suite of network optimisation tools and technologies needed for a smart, resilient, and flex-centred energy system. A clear vision will also help set the trajectory and can contribute to what and how proven technologies can be scaled and deployed at a pace.

Although a common vision is useful, it must be able to react and adapt to new changes, challenges and developments that emerge. The pace of change in technological developments is fast, and the vision must be flexible and open to new solutions being developed.

- **Question: When should a common digital energy infrastructure be in place? And therefore, when should development begin?**

A common digital energy infrastructure should be in place as soon as possible, as it can enable greater efficiency, security, scalability, interoperability, and resilience in energy systems. A factor that could affect the 'when' question goes hand-by-hand with the climate targets of each country and market openness expectations. For example, since the UK has a net-zero electricity system target by 2035, the infrastructure should be in place at least a decade in advance to reach the maturity levels required. The same timelines should be targeted if a country aims to create decentralised markets with elevated participation (e.g., local energy markets, low-voltage DSR, etc.).

Development in many areas has already started (such as digital substations, powerful cloud computing systems and CIM modelling of energy systems). Energy systems are continuously evolving; therefore, there should be an evolving common digital infrastructure to support the relevant developments.

- **Question: Should a common digital energy infrastructure be new-build, or should it build- out from existing infrastructure?**

Existing technology can unlock distribution flexibility: much of the technology needed for a flex-centred system exists and can be deployed now at scale and pace.

A common digital energy infrastructure can be built-out from the existing infrastructure with appropriate additions. This is because a significant amount of established infrastructure is in operation, which requires time, expertise, and capital resources to develop. For example, a smart meter and digital substation infrastructure are used to realise flexibility and system stability services. Such infrastructure should be included in the future common digital energy infrastructure. Still, it should be integrated with relevant amendments when required (for example, enhancing their cyber-security) without compromising security, reliability, or efficiency.

The use of existing infrastructure should therefore be strongly considered wherever possible, providing they can be interoperable and integrated. This capitalises on innovation money already spent, increases efficiency through not requiring existing functionality to be scoped out and improves the sector's approach to collaboration and coordination. In turn, a common digital energy infrastructure can be developed quickly through adaptable solutions deployed at a pace, and the maximum value is delivered to consumers.

About the Founders:

- Dr Dimitrios Tzelepis is a reputable engineer with core expertise in power systems control and protection. He is a co-founder of SMPnet and currently serves as its CTO. His work has involved the implementation of intelligent algorithms for control and fault management applications, including machine learning methods and advanced and intelligent signal processing techniques. Before co-founding SMPnet, Dimitrios led research projects sponsored by National Grid, ENA, SONI and NIE Networks, which have had a huge impact on UK networks through authoring and contributing to 'Engineering Recommendations' for the connection of renewable energy sources and establishing new protection and control settings for distribution systems, including EREC G59/3. He has also co-designed HVDC protection systems for General Electric, patented and commercialised later. He has also played a leading role in the execution of national flagship projects in the UK, including Constellation, PHOENIX and EFCC, Distributed ReStart and VSM. Additionally, he has developed MVPs for other start-ups in the energy sector and has led relevant FAT activities. Dimitrios is currently occupying strategic roles in several technical committees to decarbonise the energy sector, including CIGRE, Global Smart Grids Innovation Hub of Iberdrola, and R&D Committees to draft and advance Grid Codes in Asia and Saudi Arabia. He has authored or co-authored over 50 research papers and patents.
- Dr Anastasios Rousis is a highly accomplished engineer-turned-entrepreneur who serves as the CEO and co-founder of SMPnet. His work at SMPnet is focused on breaking down the barriers to a sustainable energy transition, promoting digitalisation and decarbonisation in the process. With his vast experience working alongside C-level executives and thought leaders in the energy sector, Anastasios brings a unique perspective to the industry. Dr Rousis also serves as an advisor to the Greek government as a member of the Greek Sectoral Council for Environment, Energy, and Sustainability Mobility, which falls under the Ministry of Development & Investments. He is also a member of technical committees (including CIGRE and Global Smart Grids Innovation Hub of Iberdrola) challenging the status quo to realise a successful and cost-effective energy transition. Anastasios' academic credentials include two Master's degrees and a PhD from Imperial College London. He has had a leading role in significant research projects of the UK and European Commission, including the Power Potential (NG ESO) and EU SysFlex projects. He has authored or co-authored more than 25 peer-reviewed research papers and patents, laying the foundations for the work he has been conducting more recently to revolutionise the energy world.

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