Synergies between space and energy

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Synergies Between Space and Energy: Space as a Tool to Support European Energy Goals

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ABSTRACT

The space and energy sector have similar sustainable ambitions and face similar technological difficulties, providing numerous occasions for learning, collaborating and creating economic and societal value. Adopting space technology and applications within the energy sector offers many high-potential opportunities worth exploring. Space can serve as an enabler for revolutionizing the energy sector by providing information on renewable energy sources and energy efficiency to facilitate the energy transition and support decision and policy-makers in developing, implementing, and monitoring various energy policy areas such as energy resource management and energy transport. Political interest in this topic is rising, and multiple high-level discussions took place in Europe in 2018 to gain a deeper understanding of the opportunities and enablers for space as a tool to support European energy policy. This article draws on the insights from two dedicated events to highlight the most prominent opportunities and enablers. The outcomes of these events provide a source of inspiration for policy development, investment decisions, and R&D proposals to further stimulate space as an enabler for sustainable economic growth in the energy sector.

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1. Introduction

The space and energy sector have similar sustainable ambitions and similar technological challenges, providing numerous occasions for learning, collaborating, and creating economic value. By leveraging such synergies, innovation and growth can be stimulated, ultimately creating sustainable returns for society. The energy sector faces challenging times, as governments and industry actors need to ensure stable, competitive energy supplies in the face of global pressure to reduce the production and emission of greenhouse gases. Such challenges require industry actors and policy-makers to focus on sustainable innovation and technology development beyond what is available today. Investing in innovation is a top priority for policy-makers since it is a means to stimulate sustainable economic growth [1]. This is a challenging process, and governmental agencies are still searching for new ways to effectively manage and facilitate sustainable innovation [2,3]. An important way to address these challenges and increase the number of innovations that are successfully brought to the market is by exploring and exploiting synergies with other sectors and investing in the development of effective partnerships outside the energy sector. Space technology (i.e. navigation, telecommunication, earth observation, and combinations) and applications have the potential to revolutionize the energy sector in various ways. For example by providing information on aspects such as energy grids, cybersecurity, or construction efficiency, by facilitating the energy transition, and by supporting policy-makers in developing, implementing, and monitoring various energy policy areas such as energy resource management and energy transport. Moreover, space technology and applications can be employed to estimate renewable energy production, monitor emissions and heat loss, assess the environmental impact of energy production, facilitate maintenance of energy infrastructure in remote areas, increase safety and efficiency of energy systems, etc. The article of Vasko et al. [4] presents a more detailed overview of European energy policy priorities with examples of how space can contribute in their realization and monitoring.

With energy and sustainability being a top priority for European national and international policy-makers, many European policies and programmes have been established to stimulate innovation in the energy sector. While the space sector and the energy sector have a long history of synergetic alignment, starting with the technological developments of the solar panels around 60 years ago, both sectors have evolved differently over time and have established strong independent communities with limited overlap. Moreover, both sectors are typically risk averse and invested in their own knowledge domain, limiting opportunities for collaboration. Furthermore, both sectors have a different degree of governmental interaction, as the energy market is more privatized. As such, it is quite challenging to bring both sectors together. The existing policies and programmes are therefore not always connected, inhibiting the potential impact space technology could have on energy (and vice versa).

In view of the aforementioned opportunities and challenges, political interest in space and energy synergies is on the rise and, as a result, multiple high-level discussions took place in Europe in 2018 to gain a deeper understanding of the opportunities and enablers for space as a tool to support European energy policy. This article discusses the outcome of two high-level events in line with these questions. The first event, “*Energy debate: Energy and Space Synergies*”, took place in April 2018 at the European Parliament [5]. This joint conference of the European Space Agency (ESA) and the Kangaroo Group invited European politicians, government officials, and industry actors to share their vision on how the energy and space sector can mutually benefit and how synergies can be leveraged to stimulate innovation, entrepreneurship and growth. The second

event, “*Space as an enabler for sustainable energy management—local and regional perspectives*”, took place in the European Union (EU) Sustainable Energy Week at the European Committee of the Regions [6]. This event, jointly organized by the European Committee of the Regions, ESA, and Eurisy, aimed to foster synergies among experts and policy-makers from the energy, IT, and space sectors to analyze the needs of the energy sector, assess the possible contributions of space assets to respond to such needs, and discuss best practices to make space-based data and services available to potential users operating in the energy sector. The outcomes of these events, as reported below, provide a source of inspiration for policy development and R&D proposals to further stimulate space as an enabler for sustainable economic growth in the energy sector.

2. Policy developments

Space technologies and applications are an indispensable part of the daily lives of European citizens, and space is integrated in all sectors of society. Political developments also show a rising interest in cross-sectoral innovation between space and various other sectors. Society is at the frontend of Space 4.0 in which “*Space activities are further expanding in the direction of commercialization, public and private activities, spin-off and spin-in, and more direct interaction with society*” [7]. This shift calls for new governance structures and transcends the traditional market mechanisms, opening up new opportunities for job creation, economic growth, and society.

The European Commission stated in the “*Space Strategy for Europe*” that “*The European member states must work together to promote its position as a leader in space, increase its share on the world space markets, and seize the benefits and opportunities offered by space*” [8]. Rapporteur Jaadla from the European Committee of the Regions reflected his vision in line with the “*Space strategy for Europe*” and said: “*Local and regional authorities have the competence and the will to be involved in the implementation of EU's space policy. While many regions have joined the Network of European Regions Using Space Technologies (NEREUS), pointing to the growing importance of space for regional economies, these actions need to be highlighted more and foster integrative partnerships between civil society, business, public institutions, and the science community.*” [9].

The shared vision and goals for the future of Europe in space were consolidated in a joint statement with the shared vision of the EU and ESA. This statement was signed on the 26th October 2016 by Elżbieta Bieńkowska, Commissioner for Internal Market, Entrepreneurship and SMEs and Jan Wörner, Director General of ESA. One of the three identified goals envisioned by the EU and ESA is to maximize the integration of space technologies and applications into the European society and economy to support public policies and to provide effective solutions to the huge European and global challenges. The statement highlights space as an important and strategic sector with the ability to contribute to various sectorial policies (e.g. energy, transport, digital agenda, including telecommunications, environment, climate change, agriculture, migration, security, and defence) [10].

Although cross-sectoral synergies are not yet fully explored, many people are convinced of their potential. A special Eurobarometer survey from 2014 on “*Europeans' attitudes to space activities*” [11] pointed to the energy sector as the sector where people considered space could contribute the most and best to public fulfillment and societal progress.

Space also offers crucial support to the United Nations sustainable development goals [12]. For example, space technology and applications support the sustainable development goal “*Ensure access to affordable, reliable, sustainable, and modern energy for all*” [13] by offering decision-makers a cost-effective way of collecting

information on trends and needs to support sustainable development policies.

Synergies between space and energy can serve as an enabler for responding to societal challenges and contributing to the competitiveness of the European economy, smart growth, and the creation of highly qualified jobs. The “Energy Debate” in the European Parliament in April 2018 brought experts together to explain the current state of play and to exchange and discuss future possibilities on how the two sectors can mutually benefit from each other and improve the welfare of the European citizen [14].

During the workshop on “Space as an enabler for sustainable energy management—local and regional perspectives” at the European Committee of the Regions in June 2018, Daiva Matonienė, (LT/ECR), Member of the Šiauliai City Council, former Vice Minister of Environment of Lithuania and rapporteur on “Renewable energy and the internal energy market in electricity”, said: “Space technologies can play a great role in reaching the EU’s energy and climate objectives, but its potential must be maximized through innovative mechanisms that attract private investments. Space policy needs to be solidly based on a long-term strategy. Success will be ours if public authorities of all levels closely cooperate with businesses to further develop space industry public-private partnerships.” [15].

The importance of space for energy was again highlighted in the June 2018 UNISPACE+50 conference, where the international community celebrated the 50th anniversary of the first United Nations Conference on the Exploration and Peaceful Uses of Outer Space [16].

3. Opportunities to support European energy goals

The overarching goals for European energy can be summarized in three main focal areas: (1) energy efficiency first, (2) European global leadership in renewable energy, and (3) providing a fair deal for consumers [8]. Focus on energy efficiency and boosting the energy renewables industry lowers the European dependence on fossil fuels, makes energy production more sustainable, and drives technological innovation in Europe. Data provided by satellite constellations and the derived accurate and up-to-date information give European policy-makers input to make informed decisions in areas of various energy policies, such as energy efficiency, renewable energy site locations, and infrastructural monitoring. Moreover, the data from space has the ability to predict the influence of space weather on the energy infrastructure. The following sections outline the most prominent opportunities for space technology and applications for supporting European energy goals.

3.1. Space technology and applications for energy efficiency

The “energy efficiency first” principle seeks to make energy demand and supply more efficient in all energy planning, investment decisions, and policy development [17]. The energy system is extremely capital-intensive and has a slow development cycle, offering various opportunities for efficiency measures. Major short-term impact can be realized in the long-term change process from hydrocarbons to renewables by increasing energy efficiency. One of the focal areas in European energy policy is the decrease of energy needs and avoidance of excessive consumption of resources. The EU energy efficiency target has recently been revised, and the new regulatory framework sets the target at 32.5% for 2030 in comparison to the envisioned energy consumption, with an upwards revision by 2023 [18]. Space technology development and applications are a key enabler in reaching this target, as the fleet of earth observation satellites and forthcoming services provide crucial information to monitor the earth surface and give insight for

proper energy management. Data from earth observation satellites can provide information about the energy loss from buildings and industrial sites, the optimal working of solar and wind farms, management of hydroelectric farms, etc. Additionally, navigation satellites support optimum transport to enhance energy efficiency.

3.2. Space technology and applications for renewable energy sources

Space technology and applications can support the European position of global leadership in renewables. The adjusted targets set a high ambition for 2030 to have 32% of all energy from renewable sources [19]. With the information from earth observation data, the optimum location of renewable energy plants can be determined, such as solar plants, wind farms, biomass farms, and hydroelectric plants. This information leads to an optimized design of renewable power systems and has the ability to estimate yield forecast production based on near real-time weather and forecasting.

3.3. Space technology and applications for infrastructural monitoring

The added value of space data applications offer the opportunity to monitor energy infrastructure and enhance safety. Information on the integrity of oil and gas transmission pipelines is available, as well as information on the optimal working conditions of renewable energy plants.

3.4. Space weather monitoring

Space weather involves the environmental influence of the sun on the magnetosphere, ionosphere, and thermosphere of the earth [20]. This phenomenon could cause disturbances in various sectors in the global economy by interfering with weather services, telecommunication, navigation, power distribution, etc. The potential effects can have major impact on the energy sector, as it could distort the energy distribution system, causing power blackouts and corrosion in oil and gas pipelines. Initiatives such as the ESA space situational awareness programme [21] provide insight in space weather forecasting. The prediction of space weather conditions allows preparation for the potential major impacts on the global energy system and society in general.

4. Enablers for further integration of space technology and applications in the energy sector

Space technology and applications have been embedded in all areas of society and are gradually expanding their presence in various sectors. However, further diffusion and adoption of these applications may encounter resistance in the energy sector. It therefore requires the important, yet challenging, alignment between governmental incentives and industry activities to overcome such challenges and may involve breaking well-established routines in the energy sector to enable the implementation of technological developments from outside the energy domain [22].

To reach the full potential, high-level fora for discussion, such as the workshop at the European Parliament in April 2018 and the workshop at the European Committee of the Regions in June 2018, provide insights in the most prominent enablers, as followed below, to secure further integration and maximize the potential of synergies in space and energy. Via enablers such as these, an agenda is set for policy-makers, industrial actors, researchers, and other stakeholders to capitalize on the energy sector.

4.1. Promotion and communication

A conducive environment for public awareness and galvanizing good ideas should not only include experts from the space or energy sector. The needs of the energy sector and opportunities from the space sector have to be made more generally accessible to better match user needs with technological possibilities. There is a need to enable the important dialogue between the space and energy sector and initiate more (diverse) debates to bring both communities closer together and enable the development of sustainable technology and applications.

4.2. Global, national, and regional cooperation

The global challenges of decarbonizing our economy require a global approach. By matching the energy needs of a certain region with the potential production capacity of another region, both regions can mutually benefit from sustainable energy development and economic growth. Space technology can facilitate such initiatives.

4.3. Connection of European programmes and initiatives

Various European policies and programmatic measures are already in place to support development of space technology and applications for societal needs and economic growth in the energy sector. However, these are mostly unconnected, and efforts to link them are necessary to facilitate further integration of space technology and applications in the energy sector to maximize the potential opportunities. Moreover, successful implementation of European energy policies is dependent on the ability to interconnect EU internal markets, manage energy infrastructures across national borders, and learn from European regional developments. Transfer and integration of successful business cases from one region to another offers high-level opportunities to leverage each other's knowledge and resources and maximize sustainable economic growth.

4.4. Long-term sustainable funding schemes

The utilization and development of space applications in the energy sector is a long-term process, for which long-term investment plans are necessary to secure optimal integration. Cross-sectoral synergies require innovative funds to stimulate developments that offer mutual benefits both to the energy and the space sector. Involvement of the IT sector is crucial in this matter. Innovative developments and future market uptake could be further enhanced by user involvement already at the start of these projects. This positive tendency in R&D development for space and energy is a part of programmes such as the ESA-Integrated Applications Promotion (IAP) Programme [23]. Additionally, smaller grants for initial market exploration and the development of products and service based on specific user group need further validation. For example, the Netherlands has set out Small Business Innovation Research (SBIR) projects for the deployment of satellite data in the energy sector [24]. The advantage of such smaller funding projects is the low threshold for small companies to contribute to funded technology development and relatively short development and life cycles. Moreover, governmental agencies can act as a lead customer for newly developed products and services, boosting market creation and development for innovative products and services.

4.5. Private sector engagement

There is a pressing need to engage the private sector in the investment of developing space technology and applications for the

energy sector. A stricter regulatory framework and numerical targets for renewables and efficiency are a crucial starting point. Lucrative incentives are necessary to enhance the involvement of investors.

4.6. Raising awareness and user involvement

An important step in mainstreaming space within the energy sector is actively involving European citizens and creating awareness of the possibilities of space technology and applications among the various user groups within the energy sector. Inspiration of users in the energy sector proves to be challenging. Users are often not aware of how space technology and applications could benefit their daily activities and are therefore hampered in addressing their specific needs in view of the possibilities that the space sector has to offer. Raising awareness of space-enabled assets, and making them more accessible and understandable for the general public, is a first step in the right direction. The creation and promotion of concrete application results and innovative business cases are a source of inspiration. Initiatives such as the ESA catalogue of "Activities supporting the Sustainable Development Goals" [25] are valuable starting points for discussion.

4.7. Uncovering the chain of innovation

The adoption of space technology and applications in the energy sector requires the collaboration of various actors in both the space and energy sector. The success of enabling space technology applications to benefit the energy sector is dependent on mutual understanding of both sectors and how well the space sector understands the daily work processes of the energy sector and actually manages to add value to these processes. This value-adding chain is long and diffuse, for example, and the satellite data component is only a small part in the offered service to the end-user. Intermediary organizations, such as research institutions and national space agencies, can play a crucial role in connecting the various actors in the value chain and aligning industry activities and governmental incentives.

5. Research needs to enhance space as a tool to support energy goals

Several areas for research can enhance the beneficial support of space in reaching European energy goals. The following technological areas are the most pressing necessities for future research to seamlessly integrate space technology and applications in the energy sector:

- The refinement of spatial and temporal resolution of earth observation data for near real-time monitoring
- Big data processing
- The integration of satellite data in existing products and services and combination with other data sources, such as in-situ data
- The improvement of weather forecasting to optimize climate simulation models and improve forecasting of renewable energy production
- Seamless data synchronization
- The impact of energy management on the planet and the climate
- The availability of limited satellite frequency bands
- The certification and standardization of satellite data
- The availability of an integrated platform for various data sources and related open data standards

6. Conclusion

Space technology and applications offer many high potential opportunities to assist in achieving Europe's energy goals. This study offers a summarized overview of the most prominent enablers for further development of space technology and applications for the energy sector. Together with the short overview of the technological research needs, this article serves as a starting point for further development and discussion in order to reach the maximum potential of space technology and applications to support European energy policy.

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References

- [1] European Commission, EUROPE 2020 - A Strategy for Smart, Sustainable and Inclusive Growth, 2010. <http://ec.europa.eu/eu2020/pdf/COMPLET%20EN%20BARROSO%20%20%20007%20-%20Europe%202020%20-%20EN%20version.pdf>. (Accessed 27 September 2016).
- [2] K.R. Fabrizio, S. Pocztar, B.A. Zelter, Does innovation policy attract international competition? Evidence from energy storage, Res. Pol. 46 (2017) 1106–1117.
- [3] K. Flanagan, E. Uyarra, M. Laranja, Reconceptualising the 'policy mix' for innovation, Res. Pol. 40 (2011) 702–713.
- [4] C.A. Vasko, M. Adriaensen, A. Bretel, I. Duvaux-Bechon, C.G. Giannopapa, Space assets, technology and services in support of energy policy, Acta Astronaut. 138 (2017) 295–300.
- [5] The Kangaroo Group, Energy Debate, Energy and Space Synergies, 2018. <https://www.kangarogroup.de/events/energy-debate/>. (Accessed 12 September 2018).
- [6] Eurisy, Space as an Enabler for Sustainable Energy Management, 2018. <https://www.eurisy.org/event-space-technology-for-sustainable-energy-management/objectives-and-background>. (Accessed 12 September 2018).
- [7] European Space Agency, What is space 4.0?, (n.d.). https://www.esa.int/About_Us/Ministerial_Council_2016/What_is_space_4.0 (accessed September 13, 2018).
- [8] European Commission, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions - Space Strategy for Europe, 2016. <http://ec.europa.eu/DocsRoom/documents/19442/attachments/2/translations/en/renditions/native>. (Accessed 9 January 2017).
- [9] European Committee of the Regions, Regions Bring Space Down to Earth, 2017. <https://cor.europa.eu/en/news/Pages/regions-bring-space-down-to-earth.aspx>. (Accessed 13 September 2018).
- [10] Joint Statement on Shared Vision and Goals for the Future of Europe in Space by the European Union and the European Space Agency, 2016. <http://ec.europa.eu/DocsRoom/documents/19562/>. (Accessed 8 November 2018).
- [11] European Commission, Special Eurobarometer 403- Europeans' Attitudes to Space Activities, 2014.
- [12] UNITED NATIONS Office for Outer Space Affairs, Benefits of space: Sustainable Development, (n.d.). <http://www.unoosa.org/oosa/en/benefits-of-space/sustainable-development.html> (accessed September 13, 2018).
- [13] United Nations, Sustainable Development Goal 7: Ensure Access to Affordable, Reliable, Sustainable and Modern Energy for All, 2017. <https://sustainabledevelopment.un.org/sdg7>. (Accessed 13 September 2018).
- [14] N. Kerstens, J. von Metternich, C. Giannopapa, ENERGY DEBATE: "ENERGY and SPACE SYNERGIES" - Conference Proceedings of the Joint Conference of the European Space Agency and the Kangaroo Group that took place at the European Parliament in Brussels on the 24th of April 2018, (forthcoming).
- [15] How Space Technologies Improve Sustainable Energy Management, 2018. <https://cor.europa.eu/443/lt/news/Pages/how-space-technologies-improve-sustainable-energy-management.aspx>. (Accessed 12 November 2018).
- [16] UNITED NATIONS Office for Outer Space Affairs, The United Nations Conference on the Exploration and Peaceful Uses of Outer Space (1968 - 2018), UNISPACE+50, 2018. <http://www.unoosa.org/oosa/en/ourwork/unispaceplus50/index.html>. (Accessed 13 September 2018).
- [17] European Parliament, Energy: New Target of 32% from Renewables by 2030 Agreed by MEPs and Ministers, 2018. <http://www.europarl.europa.eu/news/en/press-room/20180614IPR05810/energy-new-target-of-32-from-renewables-by-2030-agreed-by-meps-and-ministers>. (Accessed 12 September 2018).
- [18] European Commission, Energy Efficiency First: Commission Welcomes Agreement on Energy Efficiency, 2018. http://europa.eu/rapid/press-release_STATEMENT-18-3997_en.htm. (Accessed 8 September 2018).
- [19] European Commission, Europe Leads the Global Clean Energy Transition: Commission Welcomes Ambitious Agreement on Further Renewable Energy Development in the EU, 2018. http://europa.eu/rapid/press-release_STATEMENT-18-4155_en.htm. (Accessed 12 September 2018).
- [20] European Space Agency, Space Situational Awareness Space Weather - What is Space Weather, (n.d.). <http://swe.ssa.esa.int/what-is-space-weather> (accessed September 12, 2018).
- [21] European Space Agency, Space Situational Awareness Space Weather - SSA Space Weather Activities, (n.d.). <http://swe.ssa.esa.int/ssa-space-weather-activities> (accessed September 12, 2018).
- [22] N. Kerstens, C. Giannopapa, S. Dolmans, I. Reymen, Down to earth: popularisation of geo-information services in The Netherlands, Space Pol. 41 (2017) 12–19. <https://doi.org/10.1016/j.spacepol.2017.04.001>.
- [23] European Space Agency, Integrated Applications Promotion (IAP), (n.d.). http://www.esa.int/Our_Activities/Telecommunications/Integrated_Applications/Promotion_IAP (accessed January 18, 2018).
- [24] Rijksdienst voor Ondernemend Nederland, SBIR: Satellietdiensten voor de energiesector | RVO.nl, (n.d.). <https://www.rvo.nl/subsidies-regelingen/sbir/overzicht-sbir-oproepen/satellietdiensten-voor-energiesector> (accessed September 13, 2018).
- [25] European Space Agency, ESA Activities Supporting Sustainable Development - Catalogue 2016, 2016. http://esamultimedia.esa.int/docs/spaceforearth/SD_Catalogue_COMPLETE_161128.pdf.