Project coordinator:
ViaEuropa Competence Centre s.r.o.
Lazaretská 23, 811 09 Bratislava, Slovakia
+421 911 421 844 doktor@viaeuropa.sk

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Report on available platforms/frameworks

Authors: Mahendra Singh, Anne Kesselring (Fraunhofer Institute ISI)
Contributors: Aníbal T. de Almeida, Nuno Quaresma (ISR-University of Coimbra), Juan Urresti (Eni plenitude)

Building Up Next-Generation Smart Energy Services Offer and Market Up-take Valorising Energy Efficiency and Flexibility at Demand-Side.

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ViaEuropa Competence Centre s.r.o.
Lazaretská 23, 811 09 Bratislava, Slovakia
+421 911 421 844 doktor@viaeuropa.sk

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Nomenclature

AI	Artificial Intelligence
AaS	As-a-Service
B2B	Business-To-Business
ESP	Energy Service Providers
E-SLA	Energy Service Level Agreement
EU	European Union
EV	Electric Vehicle
ESCos	Energy Service Companies
HEMS	Home Energy Management System
IT	Information Technology
MENSA	Multi Energy Service Contracting Framework
OEMs	Original Equipment Manufacturers
QDA	Qualitative Data Analysis
SDM	Service Description Module
SLA	Service Level Agreement
SNM	Service Negotiation Module
SPM	Service Provisioning Module
SIM	Service Infrastructure Module
SAM	Service Adjustment Module
SMM	Service Monitoring Module
WP	Work Package
XaaS	X-as-a-Service / Anything-as-a-Service

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+421 911 421 844 doktor@viaeuropa.sk

(Image source: AI DAAL E3)

Executive Summary

Residential energy services meet the needs and demands of private households on many aspects of daily life: lighting, heating, cooling, charging of electric vehicles are only the most common examples. With the rise of prosumerism, the proliferation of energy storage, and the expansion of technology to manage all of these assets, modern buildings are full of connected energy services. The individual services are delivered to end-consumers under specific business models and value propositions, but the different services are "growing" closer together in the context of the smart home trend. The potential to combine, i.e., *bundle*, multiple energy services, is the subject of this report. In the context of the BungEES project that aims to advance next-generation energy services, one example is being explored. The offer, branded as **FlexiSmart Home**, is presented in Figure 1 to provide context. It explicitly combines different energy services and flexibility assets in residential buildings under the key value proposition of energy flexibility.

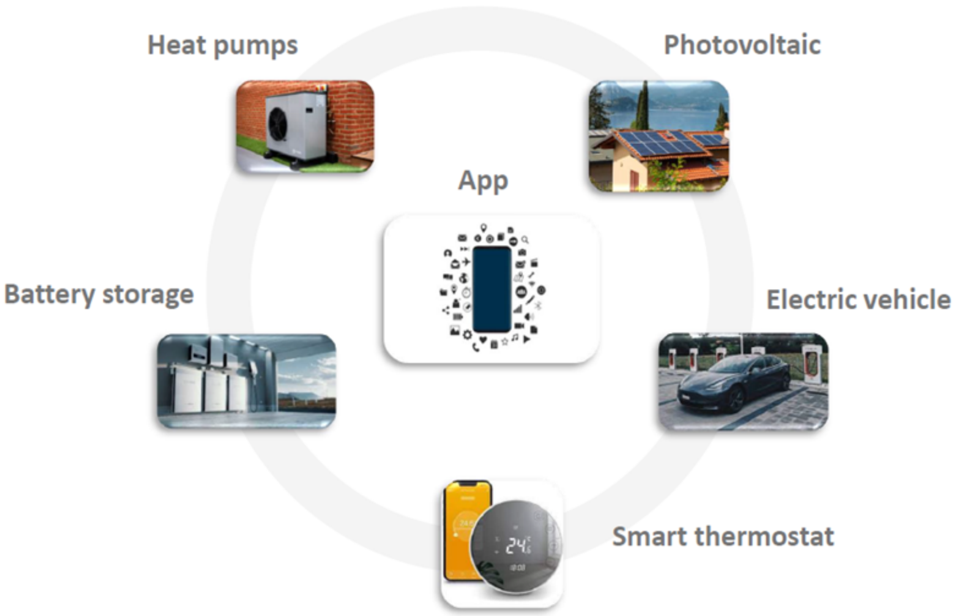

Figure 1: FlexiSmart Home: Energy flexibility service bundle

However, such product or service bundling brings different challenges in terms of service contracting and user adoption. To help pave the way for the development of service bundles and the accompanying contractual arrangements, the report first provides an overview on energy service bundling and multi-service contracting. The discussion reports various tools and use-cases concerning energy service bundles and contracting frameworks. From the consumer perspective, and with the help of a survey conducted among Spanish residential consumers, the study highlights the perception and attitude of consumers towards adopting energy service bundles and multi-service contracting. Building on this understanding, the report then makes two distinct contributions.

The first contribution is the introduction of a conceptual framework to design a multi-service energy contracting (MENSA) considering the energy service level agreement (E-SLA). This could facilitate energy service companies or providers to bundle their commercial offering. The framework distinguishes between a contracting unit and monitoring unit, for each of which it defines the sub-components as modules. In combination, the structure of units and modules lays out the essential elements of a multi-service energy offering and explains the functionalities to be covered in implementing it. This covers all steps from the setting up of the contract, through the delivery of the services, and the monitoring of compliance and quality. This framework also addresses the need for later adjustments of the contractual arrangements to allow for a dynamic approach to service provision.

The second contribution of the report is the analysis of empirical data to better understand consumer perceptions and service provider attitudes towards multi service offerings. On the demand side, we study the distinction between end consumers who are open to a multi-service contract and those who prefer separate contracts. The findings suggest that key drivers for the openness to a multi-service contract is the perceived fit of the service offering to the customer needs, and the willingness-to-adopt sector coupling technologies. By contrast, most socio-demographic characteristics do not create a meaningful distinction between these two groups. On the supply side, we survey service providers practicing innovative service-based business models. These insights reveal that there is currently the perception that the market is not ready for such an offer, yet there is a strong potential for multi-service contracts going forward. This comes despite concerns about added complexity and barriers from difficult data integration.

Taken together, the conceptual and empirical work in this report provide further information on an emerging topic in the context of energy servitization that has thus far received scarce attention due to the complex structures and was until recently blocked the lack of technology for implementation.

1. Introduction

About BungEES

BungEES aims to address opportunities and barriers to servitization in the European energy system along with the need for decarbonization of the European building stock. As market complexity increases and digitalization progresses, energy efficiency services are a key piece for coordination between energy efficiency measures and demand response for the future of the European Energy Market. The main objective of BungEES is to explore how energy efficiency services can evolve to deliver total energy solutions that combine services into integrated/one-stop-shop and end-to-end solutions. The project takes account of the interdependence between emerging technologies, new demands by active prosumers, and the changing energy market structure. Our vision is to conceptualize how energy efficiency and distributed generation, demand response, e-mobility, energy storage and the variety of energy uses in a building can be linked. Such integrated models could allow the market for energy efficiency services to develop fully and contribute to its full potential for achieving carbon neutrality by 2050. Within this context, the present study is dedicated to the bundling of multiple energy services in a single offer. It develops a conceptual framework and analyzes empirical data regarding perceptions on the provision and the uptake of multi-service offerings.

Work Package 3, Sub-Task 3.1.2

This study reports the work conducted in Subtask 3.1.2. This report is written within the framework of WP 3 (see Table 1), *Implementing and data acquisition for smart energy efficiency services (EES) validation, Sub-Task 3.1.2: Review on various tools and available frameworks to manage multiple energy services* along with a conceptual multiple service agreement management framework. The purpose of this subtask was to review various tools and available frameworks to manage multiple energy services. It lays the basis for the testing and implementation of a new multiple service agreement management framework during the project. Hence, the overarching objective of the proposed framework is to lay the foundation for the multiple energy service experience of end consumers and service providers, as well as the service portability and interoperability of services.

Research questions:

With this background and context in mind, the report has the following research objectives:

- How is the concept of energy service bundling currently emerging in the energy sector, for residential end-consumers?
- What is the state of play in multi-energy service contracting regarding tools and frameworks?
- How can multi-energy service contracts be defined and conceptualized?
- How can a new conceptual model for the multiple service agreement management framework be developed for the BungEES project?

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- What is the experience and willingness-to-adopt multi-energy service offers from the perspective of service providers?

To answer these questions, the report is structured as follows. Section 2 provides an overview on service bundling, which is already well established in other sectors such as telecommunication. Section 3 explains the BungEES team approach to building on these service concept to extend the existing knowledge towards the project work. This includes both the conceptual and the empirical methods. Section 4 presents the results from the literature review that forms the basis of the conceptial framework. Section 5 presents the empirical results that also feed into this. Section 6 then builds on all previous chapters to lay out the conceptual framework for multi energy service contracting (MENSA). Section 7 concludes thereafter.

Table 1: Overview of Work Package 3 within the BungEES project

Nr	Title	Objectives	Summary
1	**Study on emerging and market-proven service and X-as-a-Service business model in the building sector**	• **Task 3.1.1:** Study on emerging and market-proven service and X-as-a- Service (XaaS) business model in the building sector, value proposition, stakeholder mapping, and consumer • **Task 3.1.2:** This subtask reviews various tools and available frameworks to manage multiple energy services. A new framework for service level agreement and management is proposed to address interoperability challenges in building services.	Market study on XaaS energy services in energy sector. Incorporating multiple service management framework, tools and techniques improving services business models.
2	**User-centric appliances**	Installation of user-centric devices/appliances (e.g., smart thermostat, heating system with occupancy counter) at ongoing energy efficiency project site and impact monitoring.	Assessing potential impact of ICT enabled devices/appliances on ESPC operation and user behaviors.
3	**Automated measurement and verification tools**	Demonstration of proposed automated measurement and verification tools in different building type (Sub-task 3.2.3).	Assessing energy saving opportunities and new business models for energy efficiency service providers by deploying, automated measurement and verification techniques.

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4	**Energy and non-energy visualization tools**	Use of effective energy and non-energy benefits visualization tools (Subtask 3.2.2) in different sites.	Improving user participation via communicating over advanced visualization tools.
5	**Demand Response Platform demonstration**	Use of effective energy and non-energy benefits visualization tools (Subtask 3.2.2) in different sites.	Improving user participation via communicating over advanced visualization tools.

2. Service bundling

2.1 Definition and Benefits

The practice of service bundling is well-established in industries such as telecommunications, software, and manufacturing, where companies offer combined services and products to enhance profitability or fulfill customer needs (Mikkonen et al. 2015). It can be defined as:

"selling goods in packages or marketing two or more products/services in a single package" (Stremersch and Tellis 2002).

Usually, the following types of product or service bundles are identified in the literature (Beverungen et al. 2011):

- ***Pure bundles***: can be described as products that are not available separately;
- ***Mixed bundles***: refer to products and services that can also be bought separately;
- ***Price bundles***: combines two or more service or products in a discount package.

The motivation behind service/product bundling encompasses several strategic benefits for both consumers and service providers (Herrmann et al. 1999). For consumers, bundling services often results in higher savings, as bundled offers are typically lower in price than the total cost of purchasing each service separately. For service providers, bundling can lead to higher revenue streams. This is achieved by increasing the perceived value of the offer, encouraging consumers to purchase more services in a single contract. Additionally, service bundling often includes value-added elements that improve the overall service package, making it more attractive compared to standalone offerings. Moreover, bundling can include non-price related benefits and incentives, such as improved customer service, exclusive features, or rewards, further enticing customers and fostering loyalty (Wang et al. 2015).

2.1. Energy service bundling

In the context of residential building services bundles represents

"Service bundles integrate different products and services in a single contract, comprising, e.g. electricity, gas, telecommunications and public transportation, offered by a single provider (Hackbarth et al. 2022)."

However, within the scope of the current work, energy service bundles refer to integrated packages of energy-related services, products, and technologies offered by energy providers, utility companies, or third-party service providers. These bundles may include a mix of energy efficiency solutions, renewable energy installations, smart home devices, energy management systems and demand response technologies. Energy service bundles comprise a range of services offered by Energy Service Providers (ESP) to consumers.

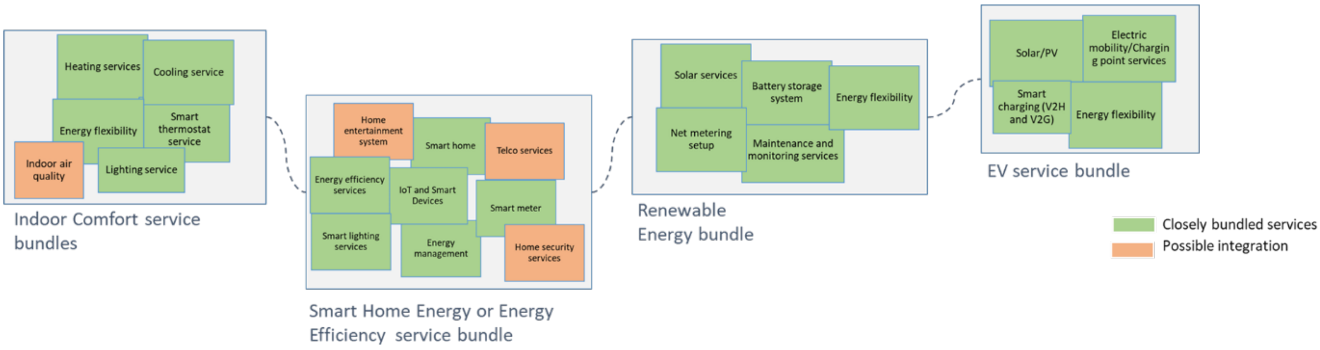

Figure 2: Energy service bundles illustrative examples (Source: own representation).

Figure 2 exemplify the integration of various services into different energy service bundles. These bundles are grouped into four main categories:

- Indoor comfort service bundle
- Smart Home or energy efficiency service bundle
- Renewable energy bundles
- EV Service bundle

The closely bundled services represent those that are typically offered together, while the possible integrations suggest additional services that can be combined to enhance the overall service offering. For example, telecommunications or home security systems could potentially be combined with smart home energy service bundles. Similarly, indoor air quality monitoring or health monitoring services like biosensors have future opportunities to be combined with indoor comfort service bundles (Morita et al. 2023).

State-of-the-art: Energy service bundles

Recently, a number of innovative business models have been implemented to test the different energy service bundles. These bundles often include renewable, smart home, energy management, indoor comfort and EV charging etc.
Table 2 below highlights a few examples from industry, academia, and projects where the concept of energy service bundling is taken into account.

Table 2: Energy service bundling practice identified in literature (Own illustration)

Energy service bundles examples	Reference, Use cases
Hypothesis testing to solar panels and electric vehicles as a bundle	(Delmas et al. 2017)
Solar panel combined with battery storage in a bundle with an electric vehicle	(Rai et al. 2016), (Stauch 2021), (Priessner and Hampl 2020),
Energy storage, smart thermostats, connected home energy management systems and high-speed internet	(Daziano 2020), (Duman et al. 2021)

Bundling of smart metering and smart-home energy services	(Daziano 2020)
Data-driven recommendation tool for sustainable utility service bundles (e.g., real time tariff in combination with an electric vehicle, real time tariff in combination with an electric vehicle and heat pump)	(Scheidt and Staudt 2024)
Preferences for residential service bundles	(Hackbarth et al. 2022)
Electric vehicle and charging services	(Plananska and Gamma 2022)
Multi-service package toolkit for service providers (combination of both ESCO and Aggregator services)	EU funded (frESCO project 2024)
Energy bundle - Smart energy management from the cloud (energy optimization bundle)	(Energy Bundle | Energiemanagement nach ISO 50 001 | aedifion 2024) (https://www.aedifion.com/loesungen/energy-bundle)

For example, (Delmas et al. 2017) investigated a recent trend using hypothesis testing that reveals suburban households will be increasingly likely to purchase both solar panels and electric vehicles as a combined product or service package. They used data from household in California. In other studies, (Rai et al. 2016), and (Stauch 2021) identified the possibilities and challenges of combining solar PV with energy storage, EVs, energy efficiency, and other energy-related residential services.

Furthermore, in a recent study by (Scheidt and Staudt 2024) from Germany, the authors developed a machine learning-based recommendation system for energy service bundles tailored for energy utility companies (see Figure 3). They identified different bundle combinations of technology and services with Real-Time Pricing (RTP). According to this study, energy service bundles benefit consumers by offering tailored recommendations based on individual household data, leading to higher cost reductions and enabling more reliable recommendations than a naive benchmark. For providers, energy service bundles present opportunities for diversifying their service portfolio and tapping into future business opportunities, as well as enabling local utilities to market sustainable energy technologies to households.

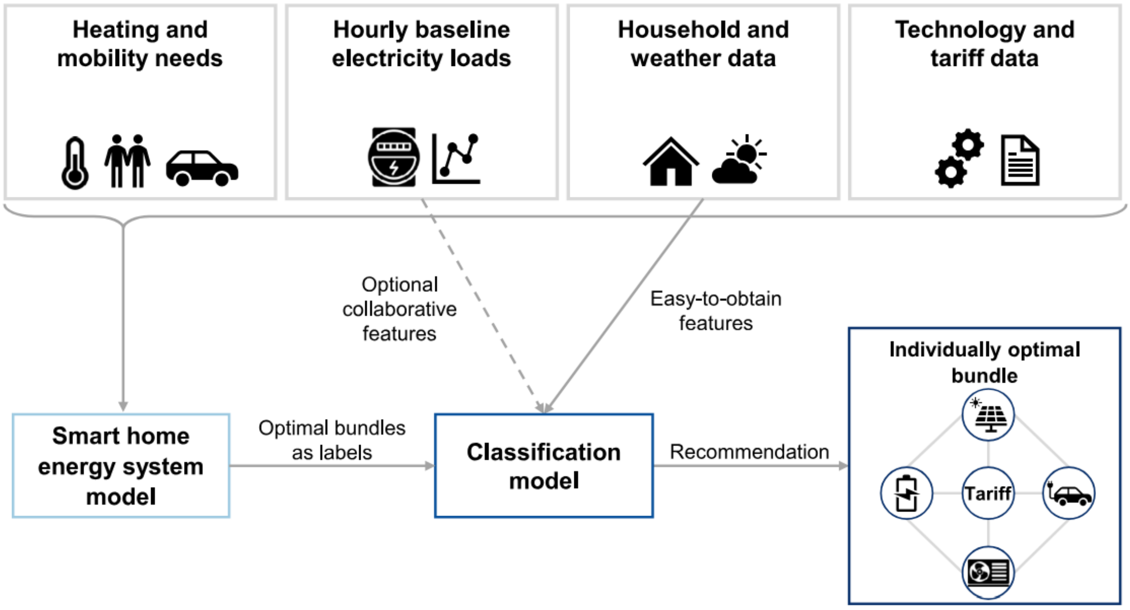

Figure 3: Utility service bundle recommender (source: Scheidt and Staudt 2024)

Beyond these, a multi-service package toolkit (see Figure 4) for service providers, aggregators, was developed within the EU-funded frESCO project. The proposed solution offers a comprehensive suite of services designed to enhance the operational capabilities of energy companies. This toolkit includes sensoring and smart equipment retrofitting (RT), aimed at modernizing and improving system responsiveness. It also provides energy efficiency and self-consumption optimization services (EE), which help reduce energy waste and maximize self-generated energy use. Additionally, the toolkit offers Flexibility Services (FL) that allow more adaptable energy management solutions. Lastly, it includes Non-energy services (NE) that complement the primary offerings, providing additional value to customers beyond traditional energy services. All of them help to increase the Smart Readiness Indicator (SRI) of buildings, as they empower users when it comes to managing and getting informed about their energy usage.

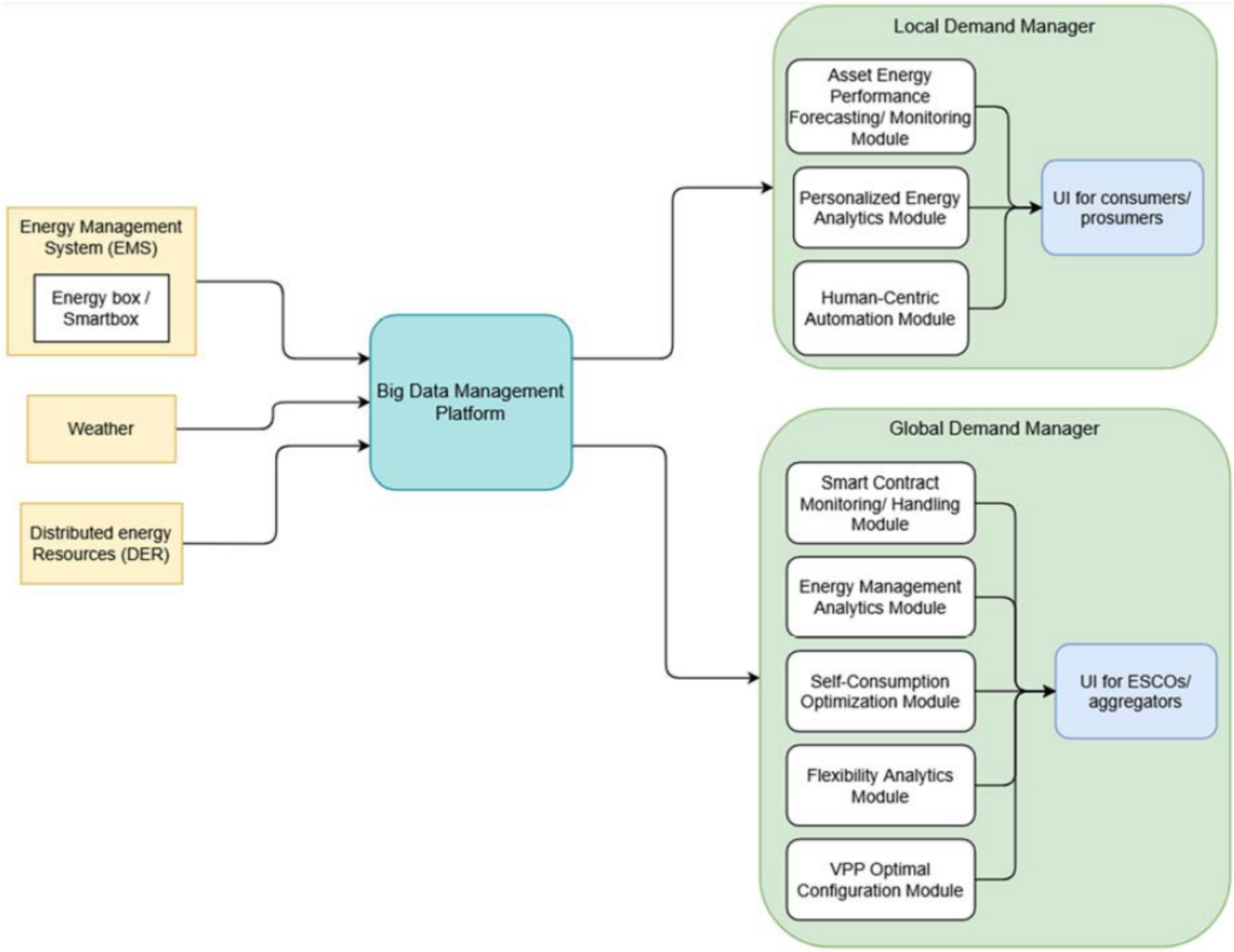

Figure 4: frESCO architecture, Multi-service package toolkit (source: D2.5. Report on the frESCO conceptual architecture)

One commercial use case of energy service bundling from aedifion[1] is an additional application beyond the academic studies that is highly relevant here. The solution offers a comprehensive solution for smart energy management through a cloud-based platform, designed to save energy. This toolset supports the implementation of energy management systems in compliance with ISO 50001[2] standards. As an energy management software, it encompasses all critical phases including data collection, integration of smart metering, AI-based data analysis, and monitoring of energy consumption. With these capabilities, aedifion's Energy Bundle provides users with everything needed to optimize energy usage efficiently and effectively.

From the above example, it emerges that the concept of energy service bundling and the related business model are emerging and gaining attention from multiple actors in the energy service value chain.

[1] https://www.aedifion.com/loesungen/energy-bundle
[2] https://www.iso.org/iso-50001-energy-management.html

3. Methodology

The methodology employed in this study utilizes both conceptual and data-driven approaches. In the conceptual part, the BungEES team examined the current landscape of energy service bundles and contracting. This involved analyzing relevant publications, projects, commercially available tools and use cases highlighting energy service bundling and energy contracting.
To complement the conceptual work developed through desk research, the team also collect and analyze empirical data. The purpose of this approach is to gain an understanding of consumer's openness to multi-energy service contracting. This is important because there is very little empirical insights available on consumer attitudes towards those novel offers, and we are not aware of any study on such bundling for the case of energy services in particular.

To fill this gap, the BungEES team draw on two data sources. First, data collected through a survey among **household consumers made** by the project partner Plenitude. This survey provided quantitative data, which was analyzed using regression techniques. Second, the team looked at the supply-side of the market, i.e., the **perspective of companies** regarding the provision of multi-energy service contracts. This data was collected through a combination of survey and semi-structured interviews from a sample of innovative companies practicing service-based business models (for more information on this survey, please see Deliverable 3.1). This data provides insights on the opportunities and barriers that companies face in offering bundled products. The details of the data collection and the analysis steps for the collected data, are presented in Section 5.
However, before delving into the data-driven analysis, the underlying definitions and use cases of multi-energy service contracting are discussed in the following section.

Finally, the results of the conceptual pre-study and the empirical inputs are combined to develop the final conceptual framework (see Section 6).

4. Multi Energy Service Contracting

This section of the report provides details on the various aspects of Energy Service Level Agreement (E-SLA). Later in Section 6, a conceptual framework for the Multi Energy Service Contracting Framework (MENSA) is discussed. It takes into account comprehensive energy service level agreements.

Energy service level agreement (E-SLA):

A Service Level Agreement (SLA) is a vital component of any service business involving the delivery of services. The term '***Service Level Agreement (SLA)***' is commonly used in the Information Technology (IT) and software service sector, where service providers guarantee the availability, reliability, and performance of their IT assets and services. Recently, SLAs have become highly significant and a critical parameter for IT cloud services due to their heavy reliance on the underlying infrastructure and the availability of cloud-based services.

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In recent years, similar to the IT sector, the delivery of energy has also become service oriented. Many energy suppliers provide energy-as-a-service to end consumers. These service providers are also responsible for equipment installation, maintenance, monitoring, and control. Along the same vein, different bill-to-service models such as pay-for-performance/outcome have also emerged in this realm. Moreover, the digitalization of energy is changing the landscape of energy service delivery. A number of energy services are being offered via digital platforms, smart home, energy clouds, mobile applications, etc. Therefore, smart energy services have a strong link with digital hardware and software infrastructure such as smart meters and sensing, data clouds, Application Programming Interfaces (APIs), and communication protocols.

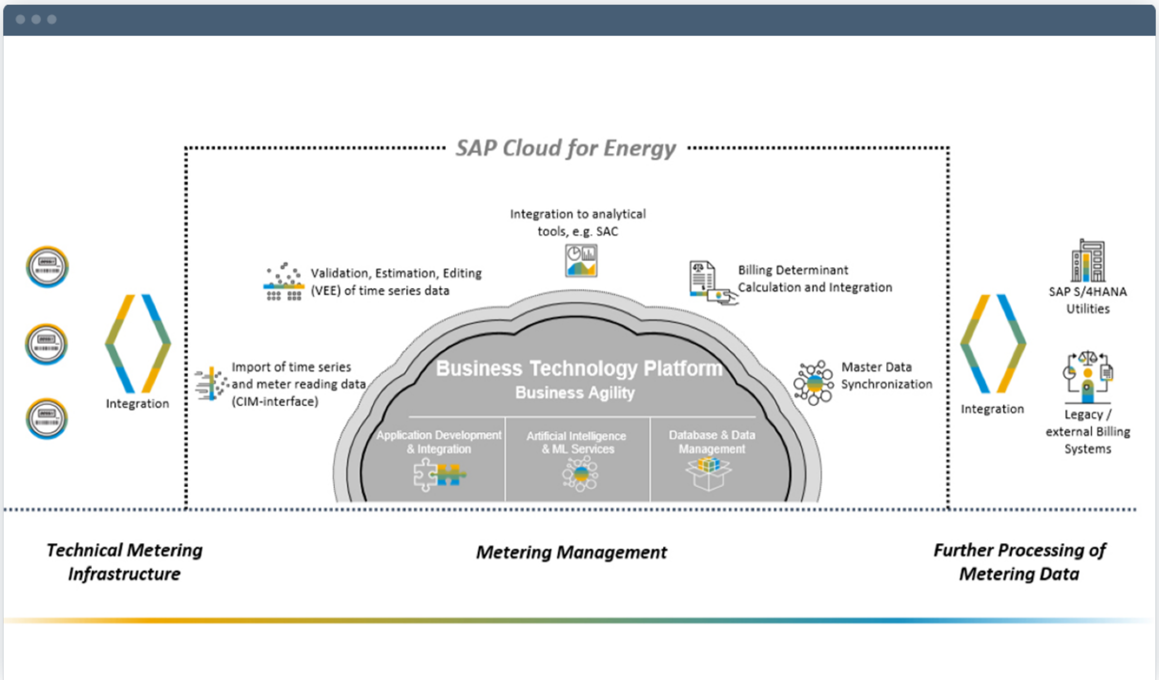

Figure 5: SAP Energy cloud (Source: SAP)

Figure 5 above shows the SAP Cloud[3] for Energy, designed to support energy data management for utility companies. It is a part of SAP's industry cloud portfolio and is tailored to meet the specific needs of the energy sector. It helps utility companies manage and analyze large volumes of data related to energy distribution and consumption, enabling them to optimize their operations, improve customer service, and support sustainability initiatives.
In line with the arguments presented above, the concept of an Energy Service Level Agreement (E-SLA) has become an important aspect of service delivery. Moreover, In the context of energy sector an Energy service level agreement (E-SLA) is defined below:

[3] https://www.sap.com/products/scm/cloud-for-energy.html

'An Energy Service Agreement is a contractual arrangement between an energy service provider (e.g., energy efficiency/management or renewable energy solutions service provider) and an end-customer. The E-SLA outlines the terms, conditions, and service performance expectations related to energy services provided by the vendor'.

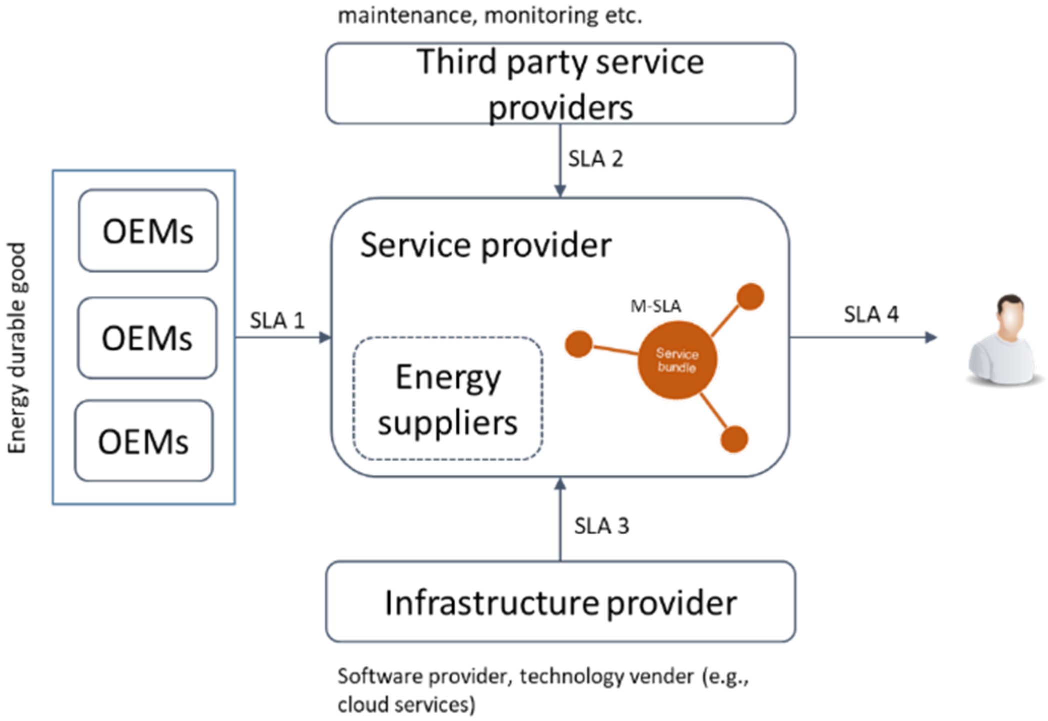

Figure 6: Illustration of different service level agreement in an energy service eco-system

The following section explains how the service level agreement applies to the project context. The E-SLA ensures that both energy providers and clients have a clear agreement regarding the services to be provided and the manner of their delivery. The E-SLA outlines performance targets, response times, reporting periods, penalties, and the responsibilities of both the energy provider and the client. The primary goal of the E-SLA is to ensure customer satisfaction by delivering consistent and reliable energy services. This agreement also acts as a foundation for resolving conflicts between the energy provider and the client. The arrangement helps industry progress by fostering trust and confidence, as well as promoting accountability and transparency.

Furthermore, energy services involve not only the energy service providers but also includes various actors who build a service eco-system to delivery energy services to end consumers. An example of such service ecosystem is illustrated in Figure 7 It visualizes the system architecture of service providers, encompassing various sub-service providers and OEMs, each handled by distinct SLAs.

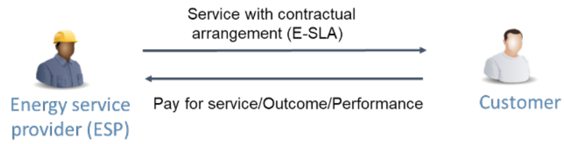

Figure 7: E-SLA between service provider and end-consumer

In fact, there are different versions of E-SLAs are available. For example, Figure 7 illustrates the performance-based E-SLA between an energy service provider and the end-consumer in a pay-for-service-driven environment.

Where consumers pay for the service or outcome rather than for the kWh. On the other hand, standard E-SLAs mainly deal with maintenance schedule, availability, response times and customer support services. Although the E-SLA offers a comprehensive overview of energy service contracting, it faces certain challenges when implemented for energy service bundles or multiple energy service packages. Considering the emerging business model of energy service bundling, several challenges in implementing SLAs for multiple energy service bundles were identifies as presented below:

- There is a lack of transparency from the service provider, particularly regarding the responsibilities of sub-actors in the service ecosystem, which are not clearly communicated to end-consumers. This often leads to delays in service implementation and conflict resolution;
- Furthermore, there is no insight into how individual SLA violations can be transferred to different actors in the service ecosystem and reported to end-consumers is ill-implemented;
- Each energy service requires certain resources to implement and resilience in the event of critical failures. However, existing approaches result in inefficient resource allocation.

The majority of available energy SLAs are only compatible with specific service types and cannot be tailored to meet consumers' demands for energy service bundles.

M-SLA: Multi-service SLA (Service Level Agreement) for energy service bundles

The underlying definition of Multi-service SLA for energy service in given below:

'A multi-service SLA (Service Level Agreement) for energy services is a comprehensive contract that outlines the performance expectations, responsibilities, and metrics for ***multiple energy-related services provided to a customer****. This type of SLA is particularly relevant for* ***integrated energy solutions*** *where different services, such as electricity supply, energy efficiency, renewable energy integration, maintenance, and demand response are bundled together.'*

Moreover, multi-energy service contracting in as-a-service (AaS) environments may help to ensure uniformity in the quality and reliability of services across all areas covered by the agreement, leading to a better overall customer experience, provided the complexity of the contractual arrangement can be implemented successfully. Consumers could then tailor the agreement to include only the services they need, allowing for more personalized energy solutions.

One example of such contracting is developed in the Effect4Building[4] projects funded by the Interreg Europe[5]. It is a multi-phase toolbox (see Figure 8) and focuses not only on energy efficiency but adds value to planning and contracting by including additional parameters (e.g., indoor climate, maintenance, and operation management). It also ensures that energy renovation aligns with overall building performance and occupant comfort.

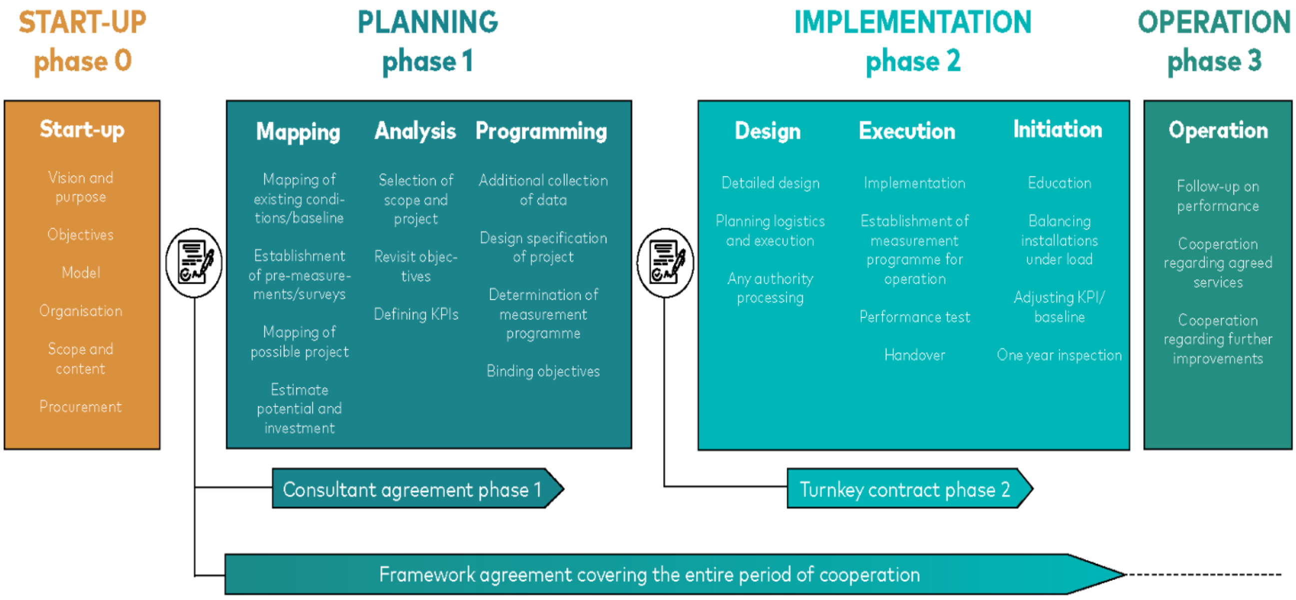

Figure 8: Multi-service contracting (MSC) guide and toolbox for building renovation (source: Effect4Building project)

5. Collection and Analysis of Data

5.1 Empirical data analysis on end consumers

The basis for the empirical analysis is a consumer survey conducted by Plenitude among their existing customers. The target group were private households (end consumers) residing in Spain. The survey was executed by TP Knowledge Services in the form of 10-minute short interviews and resulted in 626 responses. It was conducted from 18th December 2023 to 7th January 2024. The survey had the core purpose to test consumer interest and attitudes towards energy efficiency solutions. This was presented as a combined product: the FlexiSmart Home solution for connected energy services that is developed and validated by Plenitude through the BungEES project (Work Package 4). In addition, there were also

[4] https://www.effect4buildings.se/toolbox/multi-service-contracting/#:~:text=Multi%20service%20contracts%20is%20a,being%20issues%20in%20the%20investments.
[5] https://www.interregeurope.eu/

questions about the bundling of multiple energy services in a single contract. This is what we analyze in the present study (anchored in Work Package 3).

The consumers were asked questions organized by topics:

- Socio-demographics, e.g., sex, education, profession;
- Household conditions, e.g., household size, location and neighborhood, renting/owning, energy-saving behaviors in daily life;
- Knowledge and interest regarding smart energy concepts, e.g., prosumerism, flexibility.;
- Feedback on FlexiSmart Home offering, regarding both the understanding and the attitudes/perceptions towards the offering;
- Energy-specific information, e.g., electricity bill, equipment, current adoption of sector coupling technologies and basic infrastructure for potential adoption;
- Bundling of multiple energy services under a single contract (see details below).

This last item is the core interest for the analysis. More specifically, the survey contained a question about the perception of a single contract for multiple energy services:

"In the past few years, have you signed a single contract for multiple energy-related services, such as purchasing a self-consumption installation, heat pumps, charging points, etc.?"

There were four answer choices (percentages of answers in brackets):
A) No, I prefer to have specific contracts for each service (46%)
B) No, but I would like to have a contract for multiple energy services (20%)
C) Yes, I have a contract for multiple energy services (12%)
D) *I don't know (22%)*

Based on this data foundation, the empirical analysis has two research questions:

- What is the target group for the bundled contract offer? I.e., which consumer characteristics separate the groups (A) "*No, I prefer separate*" from (B) "*No, but I would like to*"?
- What does this mean for the potential market uptake of bundled connected energy services from a policy perspective?

5.1.2 Analytical Strategy

To answer the above research question, we use a multi-nominal logit regression to explore which household-specific characteristics explain what consumers choose in the above question. In simple terms, this method compares the four options and tests explanatory variables that explain which consumers choose a certain answer on the multi-service question. We are especially focused on the distinction between the two "No"-variants: what distinguishes those who prefer separate contracts from those who are open to a single contract for the bundled solution?

The outcome variable is the perception of the single contract (see the four options above), and the explanatory variables are grouped in three categories selected from the available data in the survey: (a) socio-demographics, (b) attitudes and perceptions, (c) household equipment. Due to potential issues with multi-collinearity, these three categories are reported separately in the results.

In simple terms, the output from the regression can be interpreted in terms of probabilities: How does a household characteristic (i.e., a factor) change the probability that the consumer says "No, but I would like to" instead of saying, "No, I prefer separate ". For binary variables (YES/NO Statements), this means: If a factor is TRUE, the probability increases/decreases by **x**% . For continuous variables, where a range of values is possible, this means: If the variable increases by 1 unit, the probability increases/decreases by **x**% .

In econometric terms, the coefficient on **x** is the estimated average marginal effect of the variable in question, which represents the discrete change from base levels for binary variables. These values are calculated from the estimated coefficients and reported graphically in Figure 9 and 11- 13.[6]

The tested variables are on the x-axis, the impact on the probability is on the y-axis. The height of the blue rectangular bars indicates the estimated coefficient, i.e., the impact that a variable has on the probability of being open to the multi-service contract. The 95% confidence intervals are represented as thin capped bars for each coefficient. If the capped bar crosses zero, the effect is not statistically significantly different from zero. To ease access to the results to readers without a statistical background, we also provide a non-technical summary of the output tables at the end of the results in Section 5.2.4.

5.2 Findings from the Household Survey

5.2.1 Panel A: Socio-Demographic Factors

The analysis considers five socio-economic characteristics:

- 1: Urban = 1 if living in city, 0 if rural, suburbs or other
- 2: HigherEdu = 1 if university or postgraduate degree, 0 if high school or lower
- 3: SingleBuilding = 1 if free-standing or semi-detached house, 0 for multi-apartment buildings
- 4: Renting = 1 if house is not owned
- 5: Age (18-94 is the range)

Before running the regression, we look at the group averages. This is presented in Table 3. The distribution across groups shows that there are no large apparent distinctions at first glance. The average age is very similar around 50 for all groups. The fraction of urban households and higher education hovers around 50% in all groups, although the data indicate that those who

[6] Figure 9 is different, as it shows the distribution of the raw data, not the statistical result.

answer "No, but I would like to" tend to be more highly educated (59% have a university degree or higher). Regarding the building characteristics, only about 1/3 of households live in single buildings. Among those who already have a multi-service contract, the fraction is close to 50%. About 1 in 4 households are renters, meaning the majority owns their home, but there are no large differences across groups.

Table 3: Summary of socio-demographic factors

	Age	**Urban**	**HighEdu**	**SingleB**	**Renting**
Unit	Years	Fraction	Fraction	Fraction	Fraction
No, I prefer separate	49.18	0.51	0.48	0.30	0.25
No, but I would like to	49.37	0.54	0.59	0.32	0.25
Yes, I already have	50.48	0.45	0.52	0.47	0.28
I don't know	49.11	0.50	0.46	0.27	0.19
Total	**49.35**	**0.51**	**0.50**	**0.32**	**0.24**

Figure 9 shows the regression results based on the same data and variables, comparing the rejecting group ("No, I prefer separate") and the interested group ("No, but I would like to") group. The bar height shows the effect size in probability terms, and the overlaid capped bar indicates the respective confidence interval. Age is scaled to 10-year increments for easier interpretation. The important factor emerges to be higher education: having a higher education degree increases the probability of being interested in the single contract by 6.83%. All other household variables have very small effects (<2%) and the results are not statistically significant. Hence, these socio-demographic characteristics do not allow a distinction of the interested group from the rejected group.

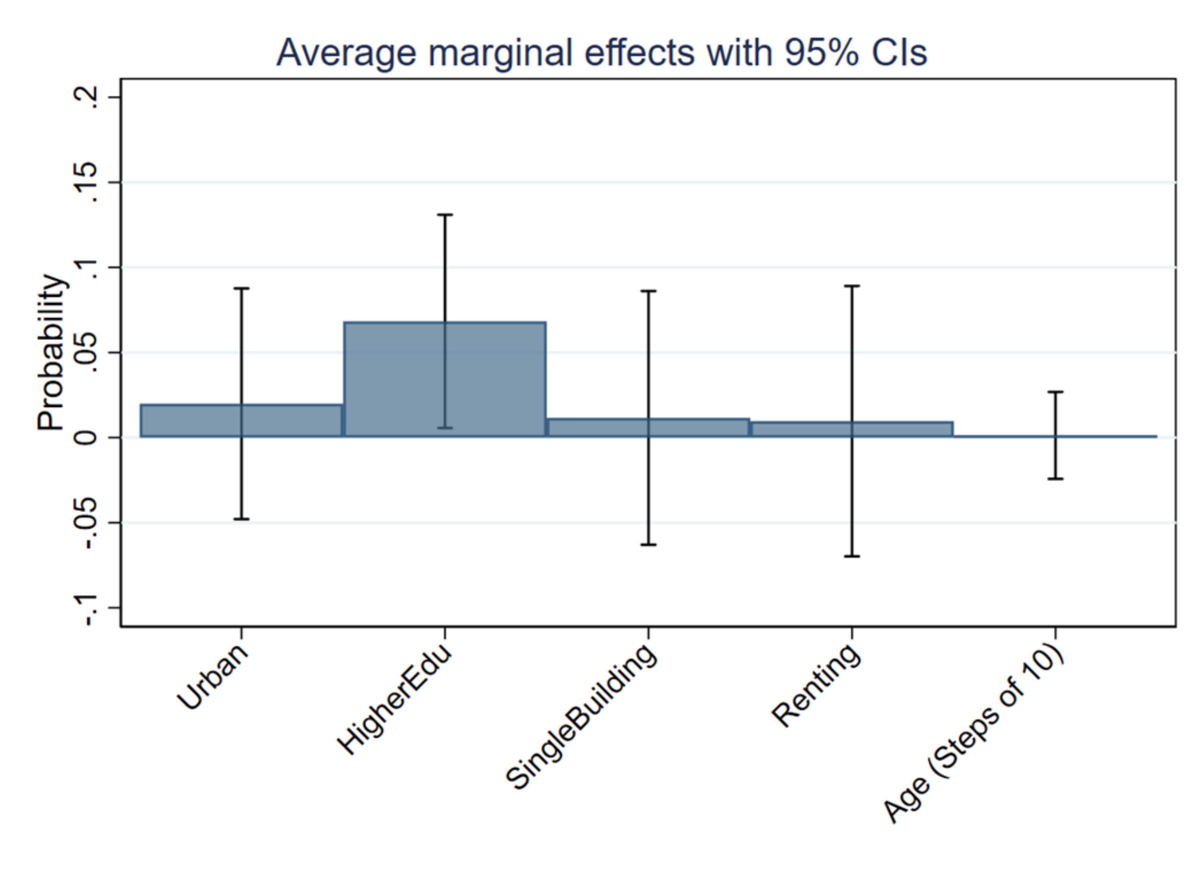

Figure 9: Statistical results for socio-demographic characteristics

5.2.2 Panel B: Perceptions and Attitudes

The analysis considers which advantage of the FlexiSmart Home solution is most relevant for participants. The question was framed as a ranking and had five answer choices:

- 1: Convenience and efficiency
- 2: Cost savings
- 3: Integrated solutions
- 4: Long-term partnerships
- 5: Service customization

We again start with the descriptive analysis, plotting the top ranked advantage by group. This is shown in Figure 10. The numbers on the y-axis correspond to the answer choices numbered as above.

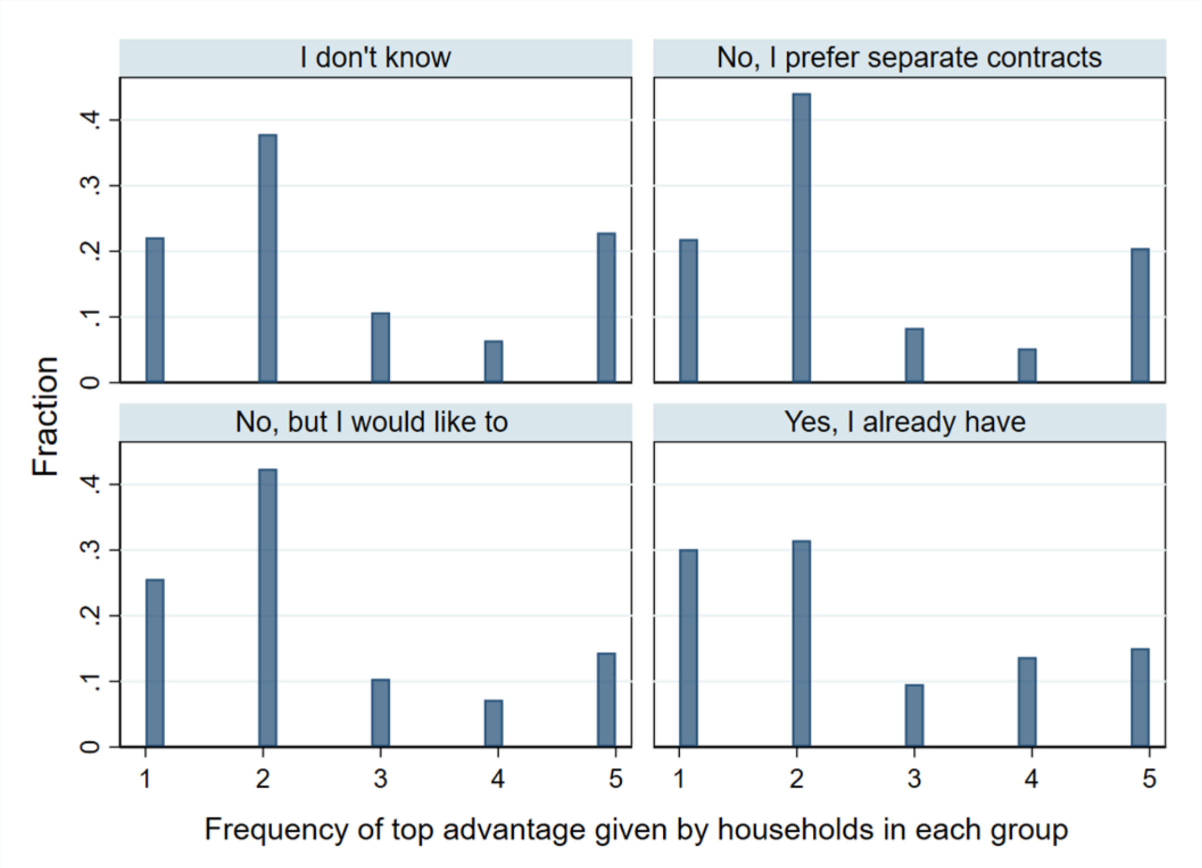

Figure 10: Statistical results for perceptions and attitudes

The results show that cost savings (option 2) are the top ranked advantage across all groups, but that households differ substantially in their perception.

The distribution is highly consistent across groups, despite a slightly lower cost focus in the adopter group ("Yes, I already have"). There is however no clear distinction across groups, which indicates that the perception of a single contract is not driven by the perception of the solution (FlexiSmart Home) itself.

In the regression, we add three additional factors that also capture perceptions/attitudes.

Additional Factors (all on 1-5 scale):

- How well does the solution align with your needs?
- How well do you understand this solution?
- How would you rate the comfort of your current home?

These regression results are presented in Figure 11.

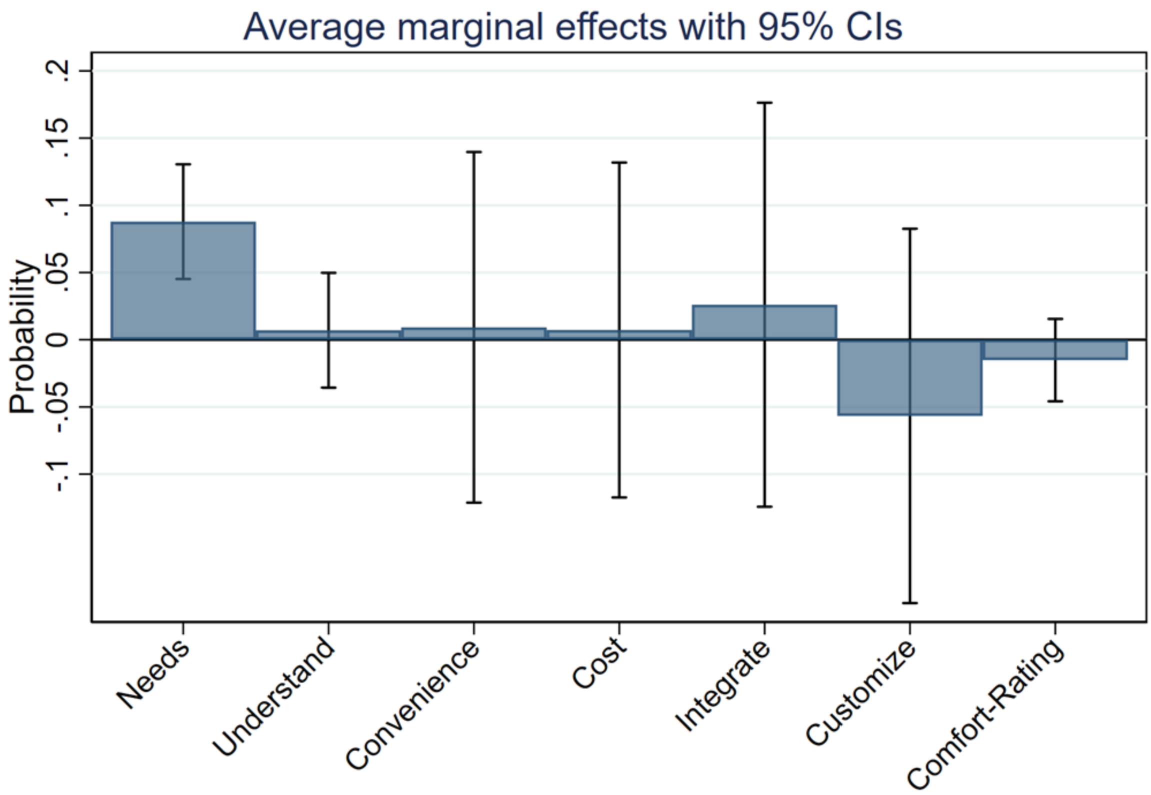

Figure 11: Statistical results for additional attitude-related variables

The alignment of the solution with the consumer's self-perceived needs is clearly influential. For each 1-step increase on the 1-5 scale, the probability of being in the interested group increases by 8.77%. By contrast, the understanding does not have an influence.

Moreover, the results for the top ranked advantage are all insignificant as well. Interestingly, the effect direction for the customize option is negative, which would indicate that those who value customization are *less* likely to be the interested group. This is intuitive as a trade-off between bundling and loss of customization, but the result is not statistically significant, so this statement is only suggestive. In summary, there is no strong evidence that the chosen top advantage separates the interested group from the rejecting group. This fits with the descriptive results above and confirms that the perception of the contract is not driven by the subjective ranking of advantages. The comfort rating is also not a significant predictor.

5.2.3 Panel C: Household Equipment

In the final block, the households' equipment is tested. For this, we look at four technologies: e-Mobility, Photovoltaic, Heatpumps, and Smart Thermostats. The last item is a binary factor: the variable equals 1 if the household has a smart thermostat. For the other three, (e-Mobility, Photovoltaic and Heatpumps), the variable is presented as readiness index of 0-3:

- 0: Does not have the basic preconditions

- 1: Is able to adopt the technology
- 2: Is willing to adopt the technology
- 3: Already has the technology

Hence, the effect sizes in the regression refer to the effect of being 1 level higher on this scale. These results are shown in Figure 12. E-Mobility does not have a significant effect, but for both Photovoltaic and Heatpump, the effects are positive and statistically significant. This means that those that score higher on the readiness index for these technologies are more likely to be interested in the single contract. The effect sizes are ca. 5% for Photovoltaics and ca. 3% for Heatpumps. Regarding the final item, the presence of a smart thermostat is not significant, the negative effect is also small and not economically relevant.

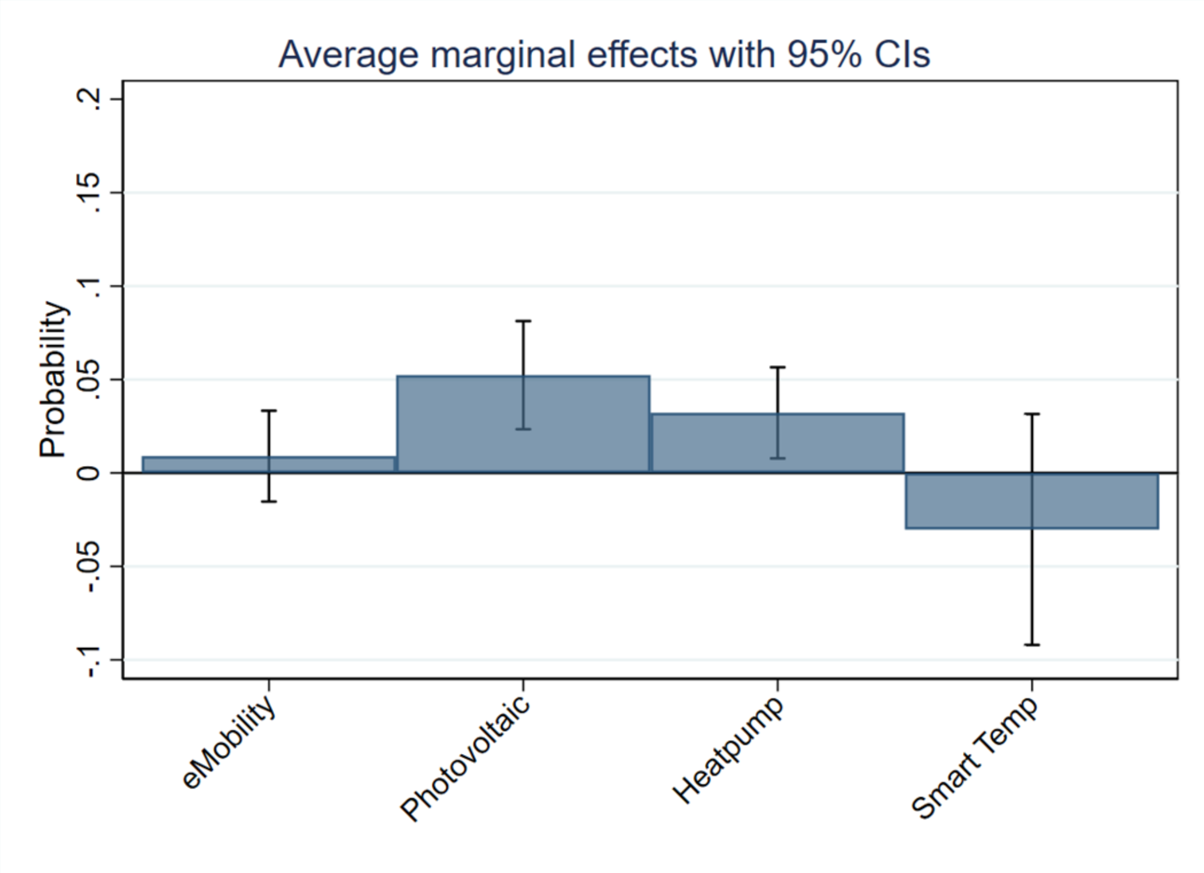

Figure 12: Statistical results for household equipment

Finally, we take a deeper look at the technologies and separate the different levels of the readiness index into binary variables. This allows more insights whether there are differences between the levels of readiness that are not visible in the average effect represented above. These results are presented in Figure 13. For each technology, the different levels are labelled as ”Able”, ”Willing” and ”Adopted” in accordance with the description of the statements for levels 0 to 3 above. The base level is 0, hence all effects are relative to this base level. For e-Mobility, an additional category was added for having a garage to separate the preconditions for the electric and the basic infrastructure. The results show a common finding across the technologies: the main factor is the willingness-to-adopt. Those who are willing to adopt are

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Lazaretská 23, 811 09 Bratislava, Slovakia
+421 911 421 844 doktor@viaeuropa.sk

significantly more likely to be interested in a single contract. Importantly, it appears more important whether consumers are *willing* to adopt a technology than whether they actually adopt it. Hence, interest in new technology and interest in a single contract are strongly positively associated.

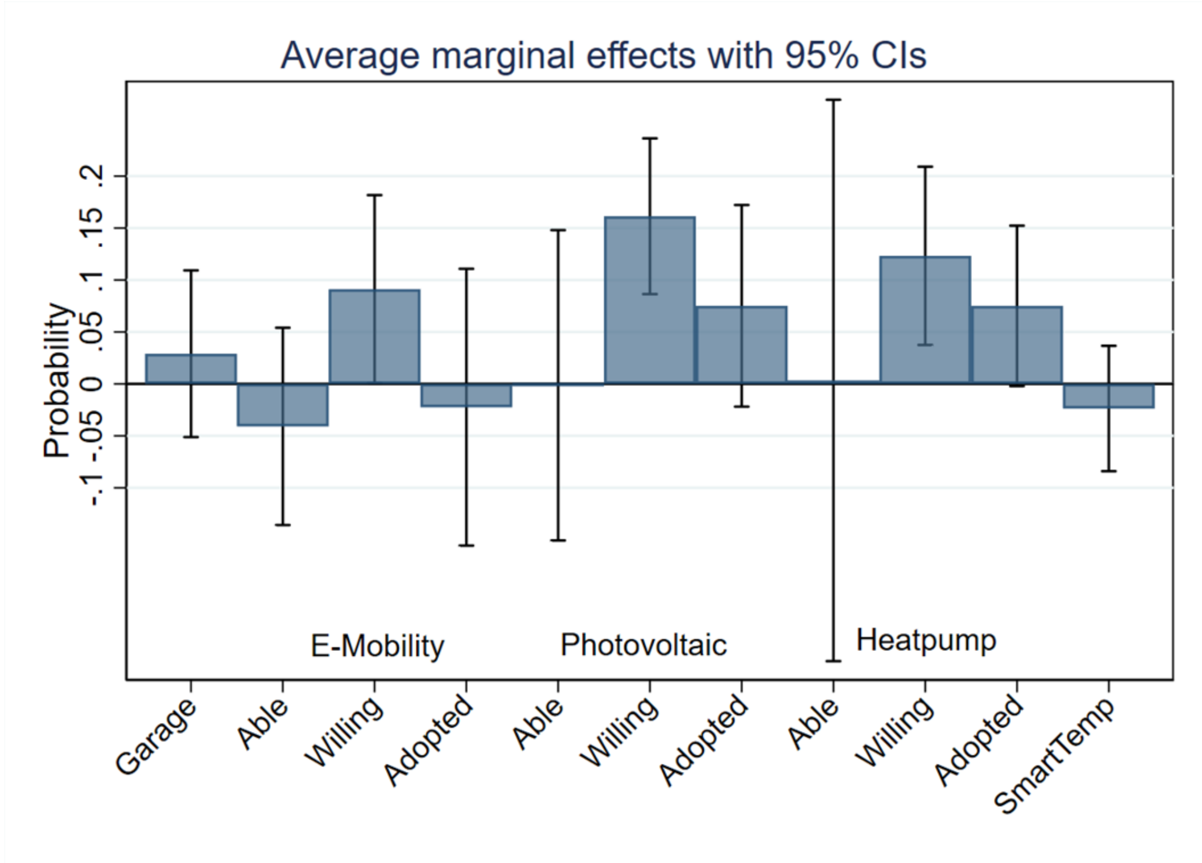

Figure 13: Statistical results for household equipment separated into levels: ability to adopt, willingness to adopt, completed adoption

5.2.4 Non-Technical Summary of Results

The findings for the three groups of characteristics are summarized in Figure 14.

Socio-Demographics

- Higher education a factor that predicts interest in bundling contract
- No differences by age, house ownership or building type in the data
- Potential adopters among a broad population

Attitudes and Perceptions

- Alignment of FlexiPro with current needs predicts interest in bundling contract
- Top ranked advantage does not make a difference → it's not only for a certain „persona"

Household Equipment

- Higher readiness for solar and heatpumps predicts interest in bundling contract
- Willingness-to-adopt is a much stronger predictor than actually being an adopter → those who *think* about these technologies

Figure 14: High level summary of results across three groups of variables

We find that advanced equipment, the need alignment and education matter for the perception of single contracts, but overall, there are no strong dividing lines for a narrow or specific ''target group ". While this is a challenge for the marketing of the solution from a private company perspective, it can be seen as positive from a distributional perspective. Bundling contracts is not found to be a sophisticated add-on for a certain sub-segment of the population. Instead, the willingness-to-adopt a single contract is spread throughout the population. Finally, the interest in the single contract is linked to the interest in and the needs for the technologies in the solution. Building an acceptance of technologies and the energy-services they offer goes hand in hand with interest in an integrated contract framework.

Besides this high-level summary, the graphical summary in Table 4 also provides a non-technical summary of the individual factors, and the main implications from the analysis. For simplicity, the answer *A) No, I prefer to have specific contracts for each service* is abbreviated as "prefer separate", while answer B*) No, but I would like to have a contract for multiple energy services* is abbreviated as *"like combo".* The findings are again structured into the three groups of variables. Factors that were found to be influential are marked with green check marks, those where we find no significant impact are marked with red cross marks. Black marks mean that there is a positive effect (check) or negative effect (cross), but it is not statistically significant, indicating that future research is needed to better understand these results.

Table 4: Non-technical summary of statistical results across groups of variables

Panel A: Socio-demographic characteristics

Statistical Result

		Prefer separate	Like combo
✔	**Higher Education** (university degree or higher)	48 %	**59 %**
✘	**Age** (18-94 is the range)	49.2	49.4
✘	**Urban** (living in city)	51%	54 %
✘	**Single Building** (free-standing / semi-detached)	30 %	32%
✘	**Renting** (house is not owned)	25%	25%

Raw Data

Preliminary View:

- Surprisingly stable, no big differences

Statistical Analysis:

- Consumers with higher education more likely to prefer the combo

Implication:

- Building knowledge could be more helpfu than focusing on young/urban consumers

Panel B: Attitudes and Perceptions

	Perceptions about FlexiSmart Pro:
✓	How well does the solution fit your <u>needs</u>?
✗	How well do you understand the solution?
	Ranking of Advantages:
✗	1: Cost savings
✗	2: Convenience and efficiency
✓	3: Service customization
✗	4: Integrated solutions
✗	5: Long-term partnerships

Preliminary View:

- Similar rankings for both the „prefer separate“ and the „like combo“ consumer

Statistical Analysis:

- Top ranking has no effect on whether consumers like the combo
- Consumers who see the solution aligned with their needs are more likely to prefer combo

Implication:

- Understanding of consumer needs more important than focus on a particular product attribute

Panel C: Household Equipment

	Technology	Willing to adopt	Already adopted
✓	**E-Mobility**	✓	✗
✓	**Photovoltaic**	✓	✓
✓	**Heatpump**	✓	✓
✗	**Smart thermostat**	✗	✗

Preliminary View:

- Distinction between basic pre-conditions (e.g. garage), and the ability, willingness and actual adoption as a sequence

Statistical Analysis:

- Consumers with more technology openne are more likely to prefer the combo
- Willingness-to-adopt is the critical step, no much extra effect from already-adopted

Implication:

- Readiness for new technologies and readiness for a combined offer go hand-in hand

5.3 Empirical insights from service providers

5.3.1 Data collection and analysis

The data come from a survey that was conducted among companies practicing energy service business models in Europe in 2023. The survey was comprised of an online questionnaire and semi-structured interviews, leading to a combination of quantitative and qualitative data. The interviewers guide the participant through the survey, and prompt them to elaborate on points raised by the interviewee him/herself throughout the process, whereas the online questionnaire can be filled out flexibly time-wise by the company. More details on the full contents of the survey, along with the complete list of questions is provided in the BungEES Deliverable 3.1 (Singh et al. 2024).

Particular to the present study, the analysis focuses on the third block of the survey. Block 3 builds on the prior questions, now adding a focus on the bundling of multiple services. The objective is to understand the perceived viability and current practices toward the one-stop-shop packages envisioned in the BungEES project. This contains two items on current business opportunities (sliding scale) and multi-service contracts (single selection). These are:

1**. How do you rate business opportunities in bundling (or connecting) multiple energy services?**
Hint: Bundling of multiple energy services refers to the practice of combining two or more energy-related products or services into a single offering or package to provide enhanced value or convenience to customers. This can include offering multiple energy services, such as heating, cooling, energy management solutions, energy efficiency upgrades, or flexibility services, as a bundled package to customers.

The answer choices were: Low, Medium, High and: I don't see any immediate or future opportunities.

2. In recent years has your organization implemented any multi-service contracts for more than one energy service (e.g., energy flexibility and heating services, EV charging and solar energy contracts, etc.)**?**

The answer choices were:
- No: It is too complicated to combine multiple services in one single contract;
- We are looking forward to implementing but no details are available for now;
- Yes [please enter the name of services].

If participants chose the final answer, they were guided to an open text box with a prompt to elaborate on the specifics. The data was analyzed using computer-assisted qualitative data analysis (QDA). The methodology is implemented using the software program MAXQDA. The survey answers are collected for analysis in the program, the semi-structured interviews are first transcribed. Structuring QDA with software allows the balance between quantitatively comparable results and the textual data to broaden and deepen the analysis given the small sample: there are 11 online respondents and 7 interviews.

5.3.2 Findings on the provision of multi-service contracts

For the first question on business opportunities in bundling multiple energy services, the quantitative evaluation of the survey reveals that practitioner are split between high potential and lack of opportunity. More specifically, 7 out of 11 participants (64%) rate the business opportunities as ‘’High “, whereas 3 out of 11 (27%) see no immediate or future opportunity (see Figure 15). By contrast, there were no answers in the low-medium range among the participants. This dichotomy between High and None is at first not intuitive, but the interviews allow for a better understanding of participant’s perceptions (see below).

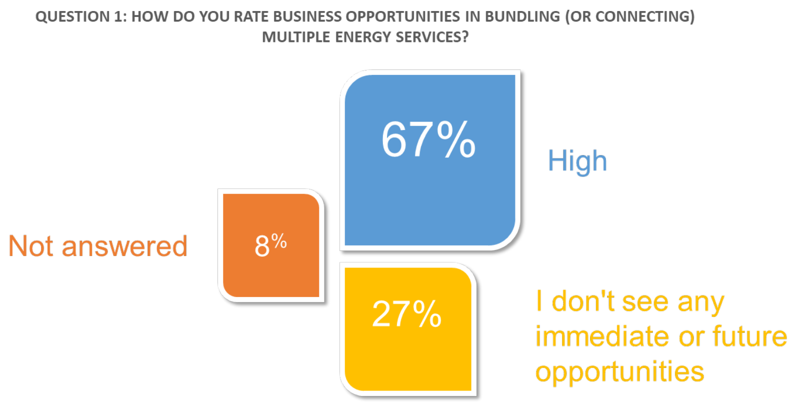

Figure 15: Future business opportunity in bundling multiple energy services

For the second question on actual implementation in recent years, the distribution is much wider than for the first question. Around 18% (2 out of 11) answered that bundling is too complicated, 27% (3 out of 11) answered that their organization is looking forward to bundling, and 45% answered that they were already implementing bundled contracts (see Figure 16).

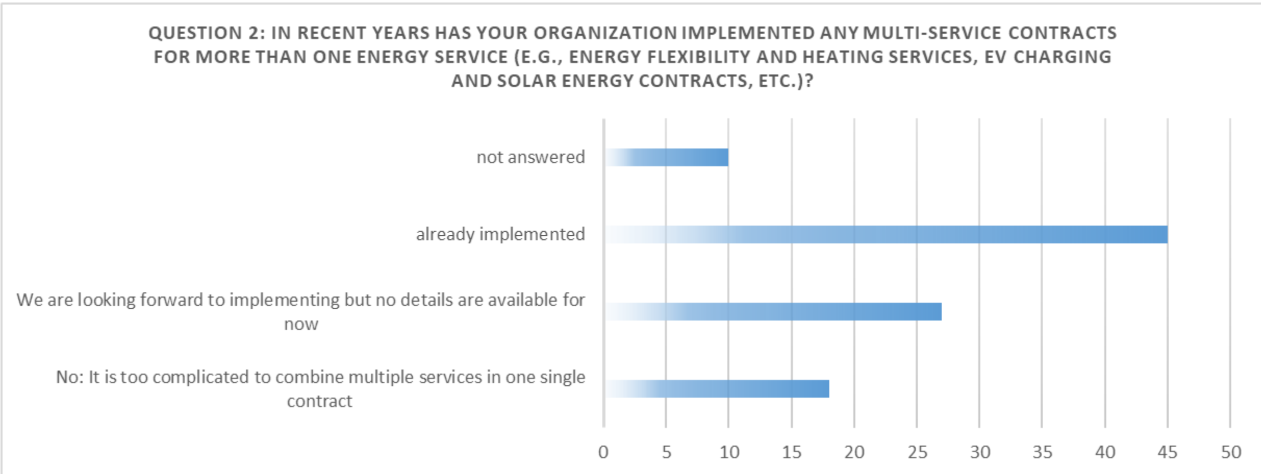

Figure 16: implementation of multi energy services (participants response)

In the latter group, the answers varied widely on which services are being bundled, as revealed by the free text question. To preserve anonymity, these answers are summarized in aggregated form in the following. For example, electricity and cooling are being coupled in building management. In more complex arrangements, there are bundles for prosumers that include energy management, solar and electromobility. Flexibility services, as well as the combination of mobility and battery were noted as a future opportunity for further inclusion into different household level bundles (currently at pilot stage). Finally, it was also reported that the bundling of individual assets of households is being integrated with contracts at the level collective consumption, for example in the context of an energy community.

From the interviews, a blend between hesitation about bundling and the apparent opportunities became apparent. Companies indeed perceive that there is potential, but the majority indicated that current market maturity was not ready for more complex bundling solutions. This general summary was referred to through several different lenses. One interviewee noted that bundling is difficult in operation due to the need to also connect the underlying data. Artificial intelligence was referred to as the technology set to change this in the coming years. This potential was especially emphasized for platform-based solutions, where artificial intelligence can help to connect data from different systems and bring it all onto a common platform.

For services targeting end consumers, the emergence of dynamic tariffs was mentioned as a factor promoting a shift to bundling services. With dynamic tariffs and energy communities, the business model for a combined contract that optimizes energy flows starts to gain promise for future offers. By contrast, there was also hesitation regarding the added complexity that comes with multi-service contract. One interviewee highlighted that B2B contracts are already highly complex objects, and that adding more services increases this „exponentially“. A noted exception are ESCO-type business models where cross-selling is explicitly part of the business model. However, this is confined to larger B2B-contracts and may not be applicable to the same extent for end consumer services.

Finally, it was also noted that a strict definition of bundling services might not capture the full range of options. Instead, one interviewee explained that working in close co-operation with partners allows for a wider service portfolio as perceived by the client, even if those services come from several partners within the organization's network.

6. Multi Energy Service Contracting Framework (MENSA): Conceptual Framework

This Section presents a conceptual framework of multi energy service contracting (MENSA), composed of two primary units - the ***contracting*** and the ***monitoring*** unit. Each of these units encompasses several sub-building blocks, which are listed in the following Table 5. All components are subsequently elaborated on in the text.

Table 5: Building blocks of MENSA

Contracting unit	Monitoring unit
• Service description module (SDM) • E-contracting module • Service negotiation module (SNM) • Service provisioning module (SPM) • Service infrastructure module (SIM)	• Service adjustment module (SAM) • Service monitoring module (SMM)

6.1. Multi Energy Service Framework: Contracting unit

In the first step, the consumer queries for individual energy services or service bundles. As a result, the SDM sends the service description along with the pricing model. Afterward, the consumer can decide to accept or reject the offer. The service provision process involves several interconnected modules. It starts with the Service Description Module (SDM), which gathers and outputs service descriptions and customer queries. This information feeds into the E-contracting Module, where agreed policies and service details are used to create contract templates.

The Service Negotiation Module then adapts these templates to specific service requirements, checks resource availability, and prepares the necessary actions. Finally, the Service Provisioning Module (SPM) ensures resources are ready and available, completing the service delivery process efficiently.

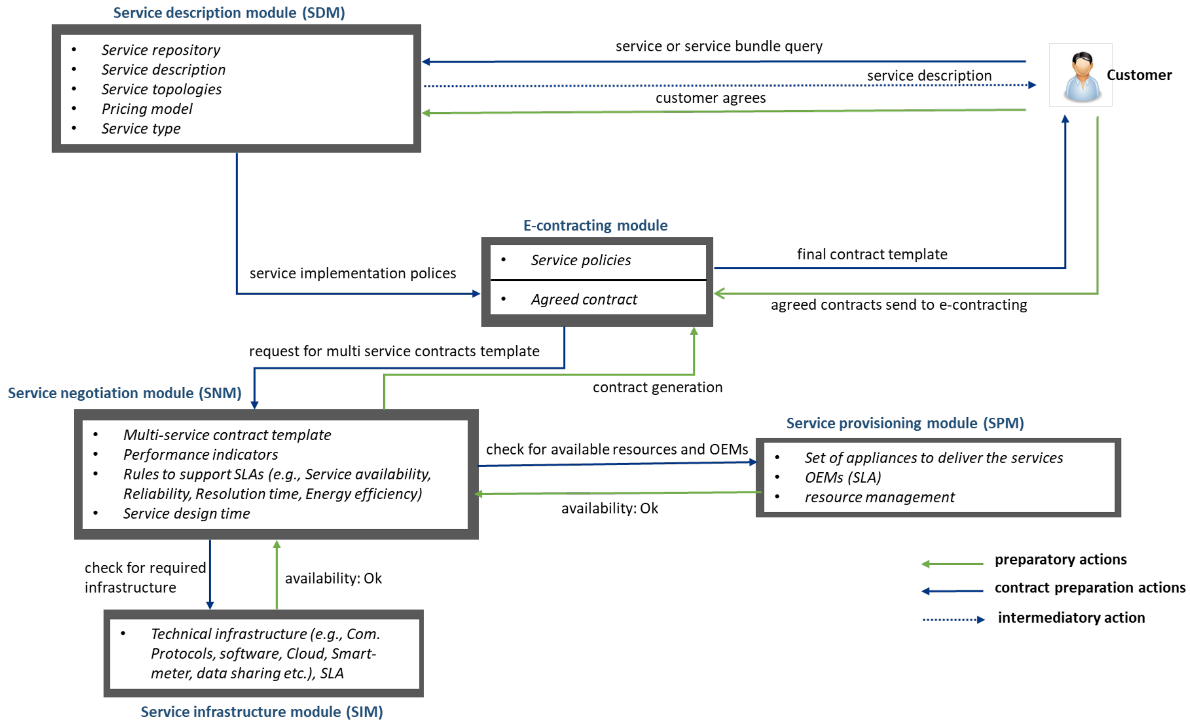

Figure 17: Service contracting unit (Source: own representation)

Figure 17 above illustrates a streamlined approach to managing and delivering services across multiple stakeholders.

Service description module (SDM)

- *Service repository*
- *Service description*
- *Service topologies*
- *Pricing model*
- *Service type*

The Service description module (SDM) is a comprehensive framework designed to encapsulate various aspects of service contracting management. It includes a service repository that serves as an energy service database (ESD) for all service-related information. Further, the service description provides detailed documentation and description of each energy service's features and functionalities. Service topologies outline the structural and operational aspects of how services are interconnected and deployed. The pricing model defines the cost structure associated with each service, including any pay-for-service or outcome-based pricing strategies, as well as interdependencies in the pricing of the combined service package. Lastly, the service type categorizes the services based on their functionalities and usage scenarios, enabling better organization and management.

E-contracting module

- *Service policies*
- *Agreed contract*

The E-contracting Module is an integral component that facilitates the digital management of service agreements. It encompasses the enforcement of service policies, ensuring that all terms and conditions are adhered to by both parties. The module also manages the drafting and finalization of agreed contracts, streamlining the process through automated workflows. This not only enhances process efficiency, but also ensures the accuracy and compliance of contractual agreements.

Service negotiation module (SNM)

- *Multi-service contract template*
- *Performance indicators*
- *Rules to support SLAs (e.g., Service availability, Reliability, Resolution time, Energy efficiency)*
- *Service design time*

The Service negotiation module (SNM) performs several key functions. It provides a standardized structure for creating contracts that cover multiple services through a multi-service contract template. Also, defines and monitors key metrics to evaluate service performance with performance indicators. Additionally, it establishes and enforces rules to ensure compliance with Service Level Agreements (SLAs), including service availability, reliability, resolution time, and energy efficiency. The module also optimizes and manages the time required to design and deploy new services. These functions enable effective and efficient service management, ensuring agreed standards are met and performance is optimized.

Service provisioning module (SPM)

- *Set of appliances to deliver the services*
- *OEMs (SLA)*
- *resource management*

The Service provisioning module (SPM) is crucial for the efficient delivery of requested energy services. It manages a set of appliances that facilitate the provision of these services. Additionally, the SPM coordinates with Original Equipment Manufacturers (OEMs) to ensure compliance with Service Level Agreements (SLAs). It also includes resource management functionalities, optimizing the allocation and utilization of resources to ensure optimal performance and high availability of energy services.

Service infrastructure module (SIM)

- *Technical infrastructure (e.g., Com. Protocols, software, Cloud, Smart-meter, data sharing etc.), SLA*

The Service infrastructure module (SIM) is set up to maintain the technical foundation required for energy service delivery. This module includes elements such as communication protocols, software, cloud infrastructure, smart meters, and data sharing mechanisms. The SIM ensures that these technical components are seamlessly integrated and function efficiently. Additionally, it plays a key role in complying with Service Level Agreements (SLAs), guaranteeing that the technical infrastructure meets the required standards and performance metrics.

6.2. Multi Energy Service Framework: Monitoring unit

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The Figure below shows the architecture of service monitoring unit and its building blocks.

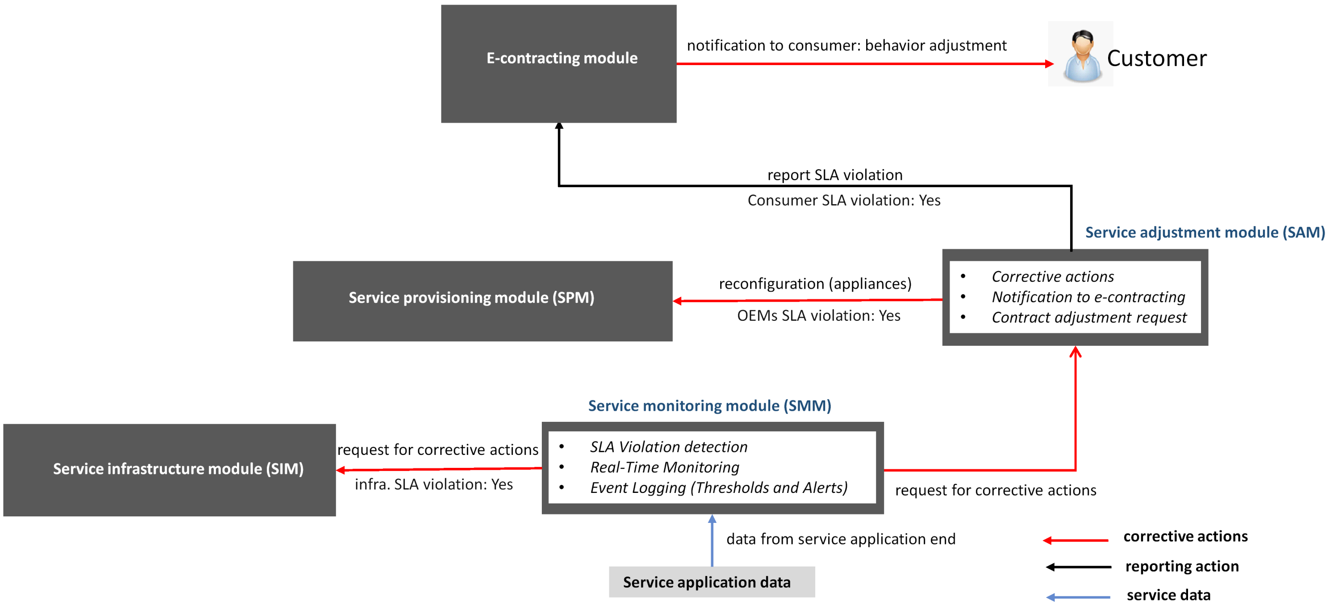

Figure 18: Service monitoring unit.

Service adjustment module (SAM)

- *SLA Violation detection*
- *Real-Time Monitoring*
- *Event Logging (Thresholds and Alerts)*

The Service adjustment module (SAM) is designed to manage and implement necessary adjustments to services. It is responsible for taking corrective actions to address any issues that arise during service delivery. The SAM also notifies the e-contracting module about these adjustments and handles contract adjustment requests. This ensures that all changes are documented and that the contractual terms are updated accordingly, maintaining alignment between service delivery and contractual obligations.

Service monitoring module (SMM)

- *Corrective actions*
- *Notification to e-contracting*
- *Contract adjustment request*

The Service monitoring module (SMM) is essential for overseeing and ensuring the quality-of-service delivery. It detects any violations in Service Level Agreements (SLAs) promptly, enabling quick responses to potential issues. The SMM provides real-time monitoring capabilities, ensuring continuous oversight of system performance. Additionally, it includes event logging features, such as thresholds and alerts, to keep track of significant events and notify relevant stakeholders when predefined conditions are met. This comprehensive monitoring helps maintain service reliability and performance.

The aforementioned framework is adapted from multi-service contracting commonly used by IT and cloud service providers[7]. However, this adapted version is better suited for energy services and/or energy service bundles. The practical implementation of this proposed framework can be further explored through industry collaboration, particularly with energy service companies and companies expertise in energy software development services.

[7] SCC UK; MULTI-SERVICE FRAMEWORK AGREEMENT, https://www.scc.com/wp-content/uploads/2023/05/Multi-Service-Framework-Agreement-AV14.pdf

7. Conclusions

The future development of energy service bundles is expected to be driven by rapid advances in information technology (IT), with a focus on managing energy services through systematic deployment of IT-based mechanisms for processing, delivering, and consuming energy. Furthermore, the future trends in energy service bundles are likely to involve the emergence of innovative services linked to sustainable and circular energy systems, with a growing focus on consumer-centric service models offering simple and convenient no-frill services, customized and personalized solutions, or more fully integrated services , (Theilmann et al. 2008), and (Comuzzi et al. 2010) . In conclusion, energy service bundles encompass a wide range of services that benefit both consumers and providers, but their implementation is not without challenges.

Against this background, this report explores the significance of service level agreements (SLA) in the energy sector. The developing trend of bundling energy services calls for a multi-energy service level agreement (M-SLA). Consequently, the report offers an energy-specific analysis concerning M-SLA. Moreover, it proposes a conceptual framework for multi-energy service contracting (MENSA) to demonstrate how service monitoring and control can be managed among various stakeholders, each with distinct SLAs and value propositions. The proposed concept could bring additional value to energy service providers and end-consumers.

To complement the conceptual work, this study has also provided empirical insights on the perspectives of both end consumers and service providers regarding multi-service contracts. We find that 1 in 5 consumers (20%) is interested in such a contractual model, although very few consumers have experience with it. By contrast, almost half of the surveyed consumers actually prefer separate contracts. Studying the distinction between those who are open to a multi-service contract and those who prefer separate contracts, the report presents several findings.

In brief, the BungEES find that socio-demographic characteristics do not create a meaningful distinction between customers who are interested in multi-service contracts and those who prefer separate contracts. Considering that education level is the only significant result in these groups, the results suggest that building knowledge about energy services could be more beneficial to obtain consumer acceptance than a narrow focus on a specific demographic group. However, this result hinges on the assumption that overall higher education is linked to higher energy literacy.

The openness to a multi-service contract is also driven by the perceived fit of the service offering to the customer needs. Hence, understanding consumer needs towards the provision of a tailored offering may be more influential than a business focus on a particular product attribute. The openness to the contract for an offer comes with the need alignment to the offer itself. The final insight is that household equipment matters, but the critical step explaining openness to a multi-service contract is the willingness-to-adopt sector coupling

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technologies, not the actual adoption. This suggests that readiness for new technologies and readiness for a new contract model go hand-in-hand.

Current prosumers are thus not the only potential target group. Rather, there may be untapped potential by building up the segment of potential adopters to serve within the multi-energy framework. The end consumer survey thus suggests a substantial potential market size that is currently confined to early adopters. Growing this market also requires more offers from the supply side, which we study as well.

Overall, the main takeaway from the service provider perspective is that the market is not ready to offer such products at a large scale, but that there is a perception of opportunity going forward. This opportunity is expected to grow with the diffusion of technology (e.g., artificial intelligence and machine learning algorithms) and the expansion pricing options in the energy sector (e.g., variable tariffs). However, there are concerns about added complexity from bundling, as well as the need for data integration to match the contractual model.

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Project coordinator:
ViaEuropa Competence Centre s.r.o.
Lazaretská 23, 811 09 Bratislava, Slovakia
+421 911 421 844 doktor@viaeuropa.sk

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