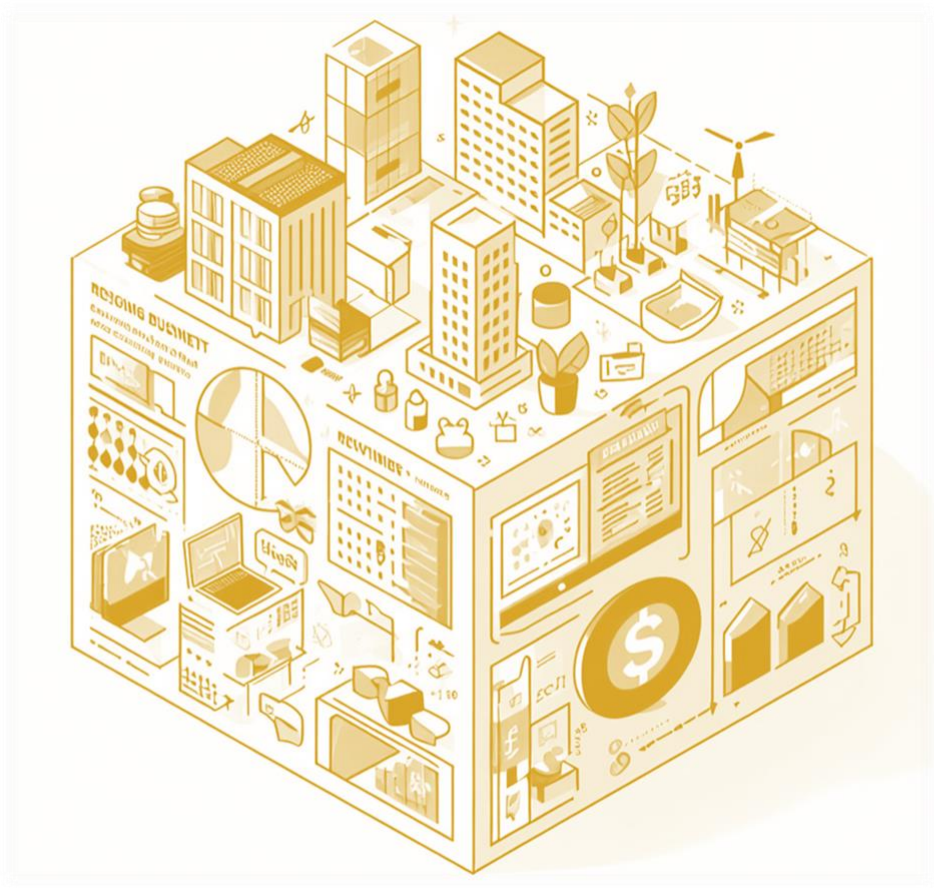
Energizing Investment

A Financial Analysis of Individual vs. Collective Sustainable Energy Technologies (SETs) in Housing



Master thesis | Management in the Built Environment
Jasper Koopman | 5739209
P5 | October 2024

Colophon

Personalia

Name:	Jasper Koopman
Student number:	5739209

Graduation details

University:	Delft University of Technology
Faculty:	Faculty of Architecture and the Built Environment
First mentor:	Paul Chan
Second mentor:	Michael Peeters
Third mentor:	Alex Fernández

Company details

Graduation company:	VIAC B.V.

Preface

Within the pages of this document lies the culmination of countless hours of research, analysis, and introspection. It is with great pleasure that I present my graduation thesis, "Energising Investment: A Financial Analysis of Individual vs. Collective Sustainable Energy Technologies (SETs) in Housing." This dissertation is the final step towards my master's degree in management in the Built Environment from the esteemed faculty of Architecture, Urbanism, and Building Sciences at Delft University of Technology.

This research focuses on retrofitting, sustainability, and finance. These topics have long captivated my curiosity. However, I noticed a lack of quantitative exploration in recent scholarly work. Therefore, this thesis aims to delve deeper into these areas, allowing me to combine theoretical concepts with empirical data. Through quantitative analysis, I aim to develop practical skills that will contribute to creating a resilient and sustainable built environment.

I am committed to promoting environmental sustainability and the responsible use of resources and believe that sustainable technologies will emerge as the pivotal point in our collective quest for a greener future. This research has provided valuable insights from real-world applications and explored emerging technologies. It has also deepened my understanding of real estate markets and the dynamics shaping urban landscapes. Reflecting on these experiences, I am excited to present my research on the financial analysis of Sustainable Energy Technologies in housing.

As you embark on the journey through these pages, I invite you to immerse yourself in the discourse, insights, and discoveries encapsulated herein. May this thesis serve as a catalyst for thought, dialogue, and action in advancing our collective vision for a sustainable future.

With warm regards,

Jasper Koopman

Enjoy reading

Abstract

Climate change requires an innovative approach to retrofitting current built environments. This study tackles the significant intersection among lasting technologies, and financial models in the context of sustainable retrofitting. The issue at hand pertains to the necessity for feasible plans to grab and exploit amplified value resulting from sustainable retrofitting procedures.

Using a mixed-methods approach, this research applies qualitative and quantitative methodologies. Qualitative techniques entail case studies and exploratory analyses, offering insights into success factors, and best practices. Quantitative methods, like the Total Cost of Ownership (TCO) financial modelling, assess the financial value of sustainable retrofit initiatives.

The primary objectives of this study are to comprehensively understand the intricate dynamics of individual and/ or collective Sustainable Energy Technologies (SETs) in retrofit practices at the neighbourhood level and will analyse whether implementing SETs on a building-by-building basis or at the neighbourhood level, or a combination of both, is preferable. The anticipated outcomes consist of a report consisting of literature review, case study, and comprehensive TCO model. These outputs aim to offer a robust framework for stakeholders include investors, policymakers, end-users, and others involved, facilitating informed decision-making and rule-setting regarding individual and/or collective SETs in retrofit projects.

Key findings from the TCO analysis show that collective systems become cost-effective beyond approximately 60 units due to economies of scale. In addition, the study highlights the critical role of accurate cost estimation, financial planning, and improved data transparency in SET implementation.

This research advances methodologies for assessing retrofits and lays the groundwork for sustainable building practices. By examining theoretical frameworks and practical applications, it paves the way for a more refined approach to sustainable retrofitting.

Keywords: sustainable retrofit, total cost of ownership, investor, built environment, sustainable energy technologies.

Glossary

BIM: Building Information Model
BIPV: Building-integrated photovoltaics
CBA: Cost-Benefit Analysis
CHP: Combined heat and power
CPI: Consumer Price Index
CSP: Concentrated Solar Power
GHP: Geothermal Heat Pump
EPC: Energy Performance Certificate
ESG Goals: Environmental, Social, and Governance Goals
HAWTs: Horizontal- axis wind turbines
HVAC: heating, ventilation, and air conditioning
IoT: Internet of Things
IRR: Internal Rate of Return
kWh: kilowatt per hour
LCA: Life Cycle Assessment
MPG: Environmental Performance of Buildings (Dutch: MilieuPrestatie Gebouwen)
NPV: Net Present Value
OCC: Opportunity Cost of Capital
OTEC: Ocean thermal energy conversion
PV: Photovoltaic
ROI: Return On Investment
RVO: Netherlands Enterprise Agency (Dutch: Rijksdienst voor Ondernemend)
SETs: Sustainable Energy Technologies
TBL: Triple bottom line
TCO: Total Cost of Ownership
VAT: Value Added Taxes
VAWTs: Vertical-axis Wind Turbines

Financial value:
The measurable benefits and returns generated by a monetary investment. It includes benefits such as reduced costs, increased property value and potential income from energy savings or generation.

Sustainable Energy Technologies (SETs):
SETs encompass a diverse range of innovative solutions and systems designed to generate, store, and utilize energy in environmentally friendly and renewable ways. These technologies aim to reduce dependence on traditional fossil fuels, mitigate climate change, and promote energy efficiency.

Retrofit:
The process of improving the performance and sustainability of an existing building by incorporating technologies, materials, and design strategies. It aligns solder structures with contemporary environmental and energy efficiency standards.

Executive summary

The thesis, entitled "Energizing Investment: A Financial Analysis of Individual vs. Collective Sustainable Energy Technologies (SETs) in Housing," presents a meticulous examination of SETs within the context of urban development. Through a thorough literature review, the study elucidates the multifaceted nature of SETs, encompassing a diverse array of sustainable energy sources and their associated technologies.

The primary goal of this thesis is to provide a comprehensive understanding of the different SETs that can be integrated in urban environments. In this context, SETs are classified into two categories: individual and collective technologies. Each category is characterised by specific attributes and applications. SETs are classified according to a number of factors, including the source of energy, the technology employed, the techniques used, and the energy carriers involved. Moreover, the study employs a detailed analysis and comparison to evaluate the financial value of different SETs.

Furthermore, the thesis delves into the complex interplay between SETs and the urban built environment. By examining factors related to the location of a building (like climate and proximity to resources), characteristics of the building itself (such as size and materials), the current facilities and systems in place (like roads and electricity), tangible attributes (including shape and layout), detailed descriptions of technical requirements (such as power output and efficiency), the effects on the environment (including emissions and energy use), and techniques used to assess performance, the study explains the complex relationships and considerations involved in integrating SETs within urban areas. These factors highlight the key considerations necessary for successful implementation. This holistic approach enables a nuanced understanding of the challenges and opportunities associated with SET implementation, considering factors ranging from land requirements and noise levels to financial costs and long-term benefits.

Moreover, the thesis contributes to the existing body of knowledge by proposing a Total Cost of Ownership (TCO) model tailored specifically to assess the financial value of SETs in retrofitting housing at a neighbourhood level. This model integrates various financial parameters, including initial investment, operational expenses, energy costs, to provide a comprehensive framework for decision-making.

The thesis emphasises the necessity of evaluating individual and collective SETs for building retrofits, considering technical, economic, environmental, social, and legal considerations. Individual SETs offer autonomy, customised solutions, and phased implementation, but face challenges such as space constraints, high initial costs, and maintenance responsibilities. Collective SETs benefit from economies of scale, enhance social cohesion, and optimise energy use. However, they require stakeholder coordination, regulatory compliance, and shared risks. A sensitivity analysis of ground source heat pumps (GHPs) indicates that individual GHPs are more resilient to energy price fluctuations and initially cheaper, while collective GHPs become more cost-effective beyond a certain number of units, especially when considering long-term investment and maintenance costs.

In conclusion, the thesis offers valuable insights into the intricate dynamics of SETs and their integration into retrofitting housing at a neighbourhood level. By illuminating the complexities and trade-offs involved, this study aims to inform investors, policymakers, and other decision makers in making informed decisions towards achieving sustainable and resilient urban environments.

Table of Content

Colophon 2

Preface 3

Abstract 4

Glossary 5

Executive summary 6

1 Introduction 9

1.1 Problem statement 10
1.2 Research aim 10
1.3 Research questions 11
1.4 Societal and scientific relevance 11
1.5 Research relevance 12
1.6 Structure 12

2 Theoretical underpinning 13

2.1 Financial value, economic principals and energy efficiency 14
2.2 Sustainable Energy Technologies (SETs) 19
2.3 Triple bottom line (TBL) 24
2.4 Conclusion and relevance to the study 25
2.5 Framework 25

3 Methodology 27

3.1 Research design 28
3.2 Case selection 29
3.3 Hypotheses 30
3.4 Data collection and type 31
3.5 Data analysis 32

4 Findings 35

4.1 The case: Campus UT Enschede 36
4.2 SQ1: Sustainable Energy Technologies (SETs) used in housing 38
4.3 SQ2: Factors influencing individual vs. collective Sustainable Energy Technologies (SETs) implementation 42
4.4 SQ3: Financial evaluation of Sustainable Energy Technologies (SETs) 51
4.5 SQ4: Comparison between individual and collective Sustainable Energy Technologies (SETs) 58
4.6 SQ5: Recommendation based on the Total Cost of Ownership (TCO) 68

5 Discussion, conclusion, and limitations 73

5.1 Discussion 74
5.2 Conclusion 75
5.3 Limitations 78
5.4 Closing statement 80

6 Reflection **81**
6.1 Reflection on the result and process 82
6.2 Reflection on the study 83
Acknowledgements **84**
References **86**
Appendixes **90**

1 Introduction

1.1 Problem statement

Climate change is no longer an upcoming threat. It's a common reality that affects every aspect of our lives. We witness its effects through harsh weather conditions, such as extreme heatwaves and deadly floods, are often aired on news channels. These occurrences are undeniable proof that we need to act. In this, the built environment is responsible for approximately 42% of annual global CO2 emissions (Architecture, 2020). Structures account for 40% of energy usage and 36% of greenhouse gas emissions in the European Union. These emissions primarily result from activities such as construction, operation, renovation, and demolition (Kerstens & Greco, 2023).

Figure 1: The consumer's dilemma. Source: https://marketoonist.com/2008/06/the-consumers-d.html

Figure 1, a comic by Tom Fishburne (2018), exemplifies the dilemma of the modern consumer, emphasizing the delicate balance between sustainability and cost. Consumers encounter a crossroads where their choices stem from their motivation to make environment-friendly decisions, while also considering economic constraints. This obstacle represents a wider challenge for both consumers and stakeholders in the domain of sustainable retrofit.

The challenge of balancing sustainability and cost permeates several facets of the retrofit process and presents a multifaceted problem that requires a comprehensive examination. Successful sustainable retrofit of existing buildings demands a balance of environmental practices and financial value. The interplay between environmental responsibility and economic viability significantly influences the decision-making of stakeholders.

There has been a recent surge of interest in integrating Sustainable Energy Technologies (SETs) into the built environment. Existing studies have primarily focused on the financial value of individual technologies in retrofitting of existing buildings. However, there is a significant gap in knowledge regarding the strategies that can be employed individually and/ or collectively to enhance the financial value of SETs in the retrofitting of existing buildings at a neighbourhood level.

It is within this dynamic context that the research finds its purpose. The research aims to address a critical issue in contemporary sustainable building retrofit. Specifically, it seeks to uncover the choose between individual or collective technologies at a neighbourhood level that efficiently utilize the increased value resulting from sustainable retrofit practices in existing built environments. This question is essential to the entire research and forms the basis for investigating the details and aspects of value capture in sustainable retrofit.

1.2 Research aim

This study aims to examine the financial value for implementing Sustainable Energy Technologies (SETs) at the neighbourhood level and will analyse the decision between implementing SETs on a building level innervations basis or at the neighbourhood level, or a combination of both. The study analyses whether it is more advantageous to implement SETs individually per building, collectively at the neighbourhood level, or a combination of both approaches. This presents challenges as each building is unique and may have diverse needs, states of maintenance, and owners. An individual approach may be more suitable for certain buildings, while a collective approach may be more appropriate for others. The objective is to make recommendations based on a Total Cost of Ownership evaluation (TCO).

1.3 Research questions

The research aims to address a critical issue in contemporary sustainable building retrofit. Specifically, it seeks to examine the optimal financial value for implementing Sustainable Energy Technologies (SETs) at the neighborhood level and will analyze whether implementing SETs on a building-by-building basis or at the neighborhood level, or a combination of both, is preferable. This question is essential to the entire research and forms the basis for investigating the details and aspects of value capture in sustainable retrofit.

The central question of this study is:

"How can investment in individual and/ or collective Sustainable Energy Technologies (SETs) generate financial value for the investors in retrofit of housing at a neighbourhood level?"

Sub-questions:

SQ1	What Sustainable Energy Technologies (SETs) can be used in the housing sector for individual and collective purposes?
SQ2	What factors determine whether individual or collective Sustainable Energy Technologies (SETs) should be implemented in housing?
SQ3	What method can be used to determine the financial value of individual and collective Sustainable Energy Technologies (SETs)?
SQ4	What are the specific advantages and disadvantages of individual compared to collective Sustainable Energy Technologies (SETs) in financial terms?
SQ5	What recommendations can be proposed based on the Total Cost of Ownership evaluation (TCO)?

This question focuses on the quantifiable aspects of value creation, aligned with the overarching goal of make recommendations based on a Total Cost of Ownership (TCO) evaluation.

1.4 Societal and scientific relevance

The study of sustainable retrofitting lies at the intersection of important current issues, including environmental sustainability, economic feasibility, and social well-being. In an era where climate change is a recognized fact, it is crucial to tackle the environmental impact of the built environment (Choi, 2009). Sustainable retrofitting provides a concrete avenue for decreasing greenhouse gas emissions, restraining energy consumption, and mitigating the ecological impact of current buildings.

Societally, this research's importance lies in its potential to revamp urban landscapes, making them more sustainable and liveable. By implementing advanced sustainable technologies to retrofit existing structures, we not only improve energy efficiency but also promote a healthier and more comfortable indoor environment for occupants (Jafari & Valentin, 2018). This has a direct impact on the well-being and quality of life of those residing or working within these retrofitted buildings.

Additionally, the economic benefits of sustainable retrofitting are significant. As governments and industries move towards more sustainable practices, the retrofitting sector offers a growing market with substantial economic potential (Shan et al., 2017). Additionally, technical terms must be explained when first used. Both investors and stakeholders can benefit from the financial returns of well-planned and executed retrofit projects. Objective and plain language is crucial in conveying this information. It is important to avoid subjective evaluations, use concise and necessary information, maintain a conventional structure, and adhere to grammatical correctness and clarity. Precise word choice and a formal register should be used to maintain balance and eliminate biases while ensuring the logical flow of information.

Scientifically, this research advances our comprehension of the intricate relationship between sustainable technologies and financial models in retrofit projects. By examining theoretical frameworks and practical applications, it establishes a groundwork for a more refined approach to sustainable retrofitting. This scientific breakthrough not only enhances the methodologies for retrofit assessment but also sets the stage for future retrofits in sustainable building practices.

1.5 Research relevance

This research is relevant to sustainable retrofitting, specifically in the context of housing. The discourse on sustainable retrofitting strategies often lacks a comprehensive exploration of the financial dimensions tied to Sustainable Energy Technologies (SETs) in specific housing case. This study investigates the relationship between individual and collective SETs and their financial value for the investor in retrofitting housing at a neighbourhood level. The research fills a gap in existing literature.

The practical implications of this research are substantial. The findings promise to offer tangible benefits for stakeholders involved in retrofit projects by deciphering the financial Total Cost of Ownership (TCO) in SETs for sustainable retrofitting. These stakeholders include investors, policymakers, and end-users. The study provides a clearer understanding of the financial value associated with various SETs. Furthermore, these insights could potentially influence policy formulation regarding incentives, regulations, and funding mechanisms aimed at promoting sustainable retrofitting initiatives.

From an industrial perspective, the outcomes of this research have the capacity to revolutionise the sustainable retrofitting industry. The study aims to guide industry practices towards more economically viable and environmentally sustainable retrofitting solutions by delineating the financial value generated by individual and collective SETs. This could lead to a wider adoption of sustainable.

1.6 Structure

This thesis presents a comprehensive investigation into the financial implications of Sustainable Energy Technologies (SETs) in the context of retrofitting buildings in the Netherlands. The document presents a logical progression through the research problem, methodology, analysis, and conclusions. The introduction provides a contextual framework, outlining the background, problem statement, objectives, and scope, emphasising the significance of SETs in financial value assessment within sustainable retrofitting.

The literature review collates current knowledge and theoretical frameworks on SETs in building retrofits, drawing upon academic databases, scientific journals, and industry reports in order to provide a comprehensive understanding of sustainable interventions. The methodology chapter outlines the research design, which integrates both quantitative and qualitative methods. These include an exploratory study, a literature review, case studies, financial analysis, hypothesis development, and data collection and analysis techniques.

The findings section categorises the implementation of SETs by energy source and discusses their varied economic, environmental, and social impacts, focusing on scales from individual buildings to neighbourhoods. The analysis also considers the financial implications of these interventions. The subsequent section of the discussion contextualises the findings, examining the implications for stakeholders such as investors, policymakers, and end-users. Furthermore, it offers insights into the total cost of ownership (TCO) of SETs for sustainable retrofitting.

The conclusion presents a summary of the key findings, outlines the contributions of the research to sustainable retrofitting, outlines the practical implications, and suggests directions for future research. References are listed in accordance with the APA 7th edition style, and supplementary materials, including detailed tables, are provided in the appendices to support the main text.

2 Theoretical underpinning

The domain of this research for sustainable retrofitting in the building environment requires a comprehensive understanding of two key pillars: Financial value and Sustainable Energy Technologies (SETs). The integration of these concepts is essential to achieving sustainable and economically viable retrofitting projects.

Financial value in sustainable retrofitting
Financial metrics are essential tools for evaluating the economic feasibility and success of retrofitting projects in the building industry. Assessing the economic viability and success of retrofitting projects in the building environment. These metrics are instrumental in evaluating the financial effectiveness and long-term economic benefits of implementing sustainable retrofitting measures (Ma et al., 2012).

The economic implications of sustainable retrofitting go beyond traditional cost-benefit analyses. The literature shows the positive correlation between green retrofitting practices and economic benefits (Copiello & Donati, 2021). These practices not only provide immediate financial returns but also contribute significantly to long-term value enhancement in existing buildings.

Sustainable Energy Technologies (SETs) in retrofitting
SETs include a variety of interventions and technologies aimed at reducing environmental impact and enhancing energy efficiency in building retrofitting (Gohardani & Björk, 2012; Jafari & Valentin, 2018). These interventions range from innovative energy-efficient systems to renewable energy integration, all aimed at reducing energy consumption and environmental footprint while ensuring financial viability.

The importance of SETs in increasing financial value in retrofitting projects cannot be overstated. Studies have shown the symbiotic relationship between SETs interventions and the creation of financial value (Gohardani & Björk, 2012; Jafari & Valentin, 2018).

2.1 Financial value, economic principals and energy efficiency

In the realm of real estate investment, the pursuit of financial value often entailing intricate analyses and strategic decision-making. Central to this pursuit is the evaluation of costs and benefits over the lifecycle of real estate assets. Traditionally, assessments of financial value have been primarily focused on initial investment outlays and projected returns. However, such narrow perspectives often fail to capture the comprehensive picture of ownership costs and long-term profitability.

The Total Cost of Ownership (TCO) model emerges as a holistic framework aimed at providing a more inclusive understanding of financial implications associated with real estate investments (Investopedia, 2023). Rooted in the principle of encompassing all costs incurred throughout the asset's lifecycle, TCO extends beyond mere acquisition costs to incorporate operational, maintenance, and energy cost. This model acknowledges the significance of not only upfront expenditures but also ongoing operational efficiencies and potential revenue streams.

The integration of TCO principles into real estate investment practice remains relatively underexplored, despite its theoretical validity and potential to provide nuanced financial insights. While conventional valuation methods offer initial estimates of financial viability, they often neglect the dynamic nature of costs and benefits over time. By contrast, TCO offers a comprehensive lens through which investors can evaluate the true economic impact of real estate assets, thereby enabling more informed decision-making and strategic resource allocation.

2.1.1 Economic principles in real estate

Real estate markets are shaped by economic principles that govern the behaviour of buyers, sellers, and investors within the market. It is imperative to comprehend these principles for thorough decisions and analysis within the real estate sector. The foundation of real estate economics lies in the interplay of supply and demand dynamics. The equilibrium price and rental rates are determined by the availability of properties (supply) and the demand of prospective buyers or renters. Ling and Archer (2017) highlight the crucial interrelationship between real estate markets and capital markets, emphasizing the impact of capital flows on property values.

Several multifaceted factors influence supply and demand, including economic growth, demographic trends, and government policies that play significant roles. Furthermore, the concept of demand elasticity, as explained by Van Gool et al. (2013), shows how changes in price levels affect the quantity of property demanded, providing valuable insights for market analysis.

Achieving market equilibrium, where supply aligns harmoniously with demand, is a vital objective in real estate. When demand is exceeded by supply, property values tend to decrease, whereas a surplus of demand over supply results in price escalation. The complex interplay between these forces shapes property values and informs investment decisions (McDonald & McMillen, 2010).

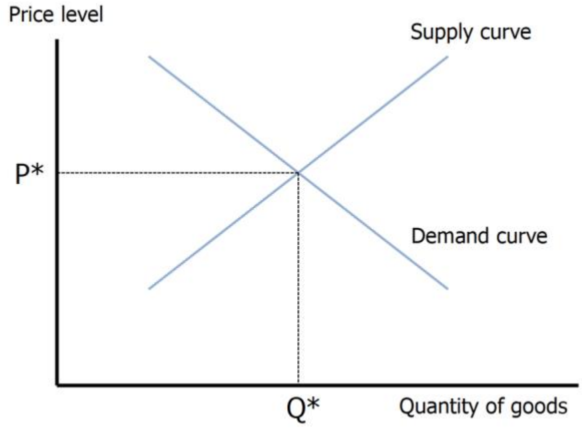


Figure 2: market equilibrium; perfect competition. Source: McDonald & McMillen, 2010

Ling and Archer (2017) explore the interconnections between the real estate and capital markets. They stress those changes to capital allocation caused by factors such as interest rates, investor sentiment, and macroeconomic policies can heavily impact property valuations. Ling and Archer (2017) explore the interconnections between the real estate and capital markets. It is crucial to deeply understand how capital flow influences real estate appraisals to develop informed investment strategies.

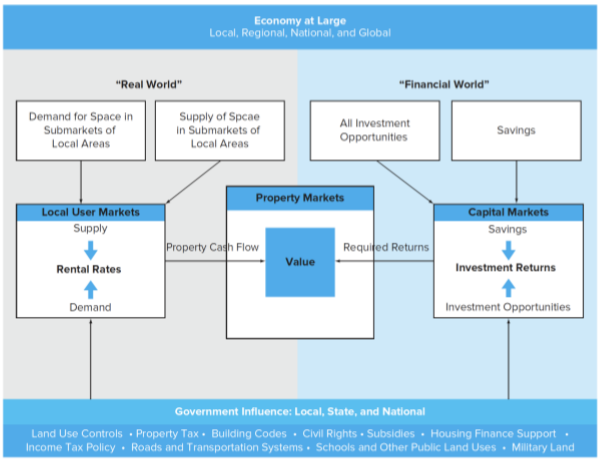


Figure 3: Interrelationship between Real Estate Markets and Capital Markets. adapted from: Ling & Archer, 2017

2.1.2 Economic viability of energy efficiency

The importance of energy efficiency in buildings has increased significantly in recent decades, driven by both environmental concerns and economic considerations (Copiello & Donati, 2021). In the context of the building sector, the housing sector has emerged as a key area of focus for policymakers and researchers, given its substantial contribution to energy consumption and greenhouse gas emissions (Copiello & Donati, 2021).

The economic literature on energy efficiency has undergone a number of shifts and reinterpretations over time. According to Giraudet & Missemer (2023), the earliest studies, dating back to the mid-19th century, concentrated primarily on the rebound effect, which describes the tendency of energy savings to result in increased energy consumption. From the 1970s onwards, the focus shifted to the concept of the energy efficiency gap, which highlights the discrepancy between the theoretical potential and the actual realisation of energy savings. More recently, since the early 21st century, there has been a growing interest in the energy performance cross-section, focusing on the role of behavioural factors, market failures and information asymmetries in explaining this gap (Giraudet & Missemer, 2023).

A significant factor influencing the economic viability of energy efficiency in the housing sector is the existence and magnitude of price premiums. A price premium can be defined as the additional amount that buyers are willing to pay for a property with superior energy efficiency in comparison to a similar property with lower energy efficiency.

A number of studies have demonstrated the existence of considerable price premiums for energy-efficient homes. To illustrate, a study by Copiello and Donati (2021) demonstrates that residential properties in Padua, Italy, bearing energy performance certificate (EPC) labels A and B can command a significantly higher price than those bearing an EPC label G. The price premiums for the A and B labels relative to the G label were 61.7% and 61.1%, respectively. The magnitude of the price premium is contingent upon a number of variables, including:

- ***Location:*** Price premiums for energy efficiency can be higher in areas with higher demand for energy-efficient housing, such as urban areas.
- ***Energy performance certificate (EPC):*** Different EPC labels can lead to different price premiums, with the highest premiums typically observed for the highest energy ratings.
- ***Characteristics of the house:*** Besides energy efficiency, other characteristics of the house, such as size, location and state of maintenance, can also influence the price.
- ***Market conditions:*** The size of the price premium can also be influenced by overall market conditions, such as mortgage rates and availability of credit.

It is important to note that while energy efficiency can be an important factor influencing the price of a property, it is not the sole determining factor. It is therefore essential to consider other housing characteristics and market factors when analysing price premiums.

Furthermore, a home's energy efficiency is often linked to other quality aspects, such as high-quality building materials, better insulation and advanced heating and cooling systems. These factors can also contribute to higher prices for energy-efficient homes, making it difficult to isolate the exact contribution of energy efficiency.

In addition to the price premiums associated with energy efficiency, it is essential to examine the cost premiums associated with the construction or renovation of energy-efficient houses. The economic viability of energy efficiency investments is contingent upon the relationship between the cost and price premiums (Copiello & Donati, 2021).

The marginal cost (MK), which quantifies the additional expense associated with enhancing energy efficiency by a single unit, tends to escalate in tandem with the advancement of energy performance. This indicates that the cost of attaining a higher energy label is rising (Copiello & Donati, 2021). Conversely, the marginal benefits (MB), represented by price premiums, may decline as the energy label improves. This suggests that the supplementary cost that buyers are prepared to bear for each incremental improvement in energy efficiency decreases with the attainment of higher energy labels.

From an economic standpoint, the optimal level of energy efficiency is attained when the marginal benefits and marginal costs are in equilibrium (MB = MK). Investments in energy efficiency are profitable only up to this point. Pursuing a higher energy label than this equilibrium point results in higher costs than benefits, thereby rendering the investment no longer economically justifiable.

It can be argued that public policy can play an important role in encouraging energy efficiency investments (Copiello & Donati, 2021). An illustrative example is the tax rebate for energy-saving measures in Italy, which serves to elevate the marginal benefit curve and augment its slope, thereby rendering investments in higher energy labels more profitable.

Nevertheless, the efficacy of incentives is contingent upon a number of factors, including the magnitude of the incentive, the duration of the programme and the ease with which homeowners can access information and financing. Furthermore, potential adverse effects, such as a rebound effect, whereby improved energy efficiency leads to higher energy consumption, thereby cancelling out expected energy savings, must be taken into account.

The term 'energy efficiency gap' is used to describe the discrepancy between the optimal level of energy efficiency, as determined by economic models, and the actual level of investment in energy efficiency (Giraudet & Missemer, 2023). This gap is a prominent feature of contemporary economic discourse on energy efficiency, indicating that there is considerable untapped potential for energy savings.

The existence of this gap is attributable to a number of factors. One significant factor is the existence of market impediments, including investor risk aversion and the diversity of consumer preferences (Giraudet & Missemer, 2023). These barriers, though intrinsic to market dynamics, can impede the uptake of energy-efficient technologies. Another significant factor is the presence of market failure. This occurs when the fundamental assumptions of perfectly functioning markets, such as those of perfect competition and symmetric information, are violated. For instance, information asymmetry may result in consumers underestimating the actual energy savings associated with an investment in energy efficiency (Giraudet & Missemer, 2023).

Furthermore, the energy efficiency gap is reflected in the energy performance gap, which represents the discrepancy between the predicted and actual energy savings. A significant gap has been demonstrated in this regard, particularly in the context of energy-efficient housing renovations (Giraudet & Missemer, 2023). One potential explanation for this phenomenon is the existence of moral hazard. This phenomenon occurs when, subsequent to investing in energy efficiency, consumers alter their behaviour in a manner that diminishes the anticipated energy savings.

2.1.3 Evolution of financial evaluation models

The evolution of financial evaluation models within the realm of real estate investments reflects a dynamic interplay between theoretical advancements, practical exigencies, and shifting market dynamics. Over time, scholars and practitioners alike have sought to develop frameworks that can effectively capture the complexities of financial value generation and assess the viability of real estate assets from a holistic perspective.

Historically, conventional valuation models in real estate have predominantly focused on assessing the initial investment outlay and projected returns, often overlooking the costs throughout the lifecycle. Methods such as the discounted cash flow (DCF) method, Return on Investment (ROI), Net Present Value (NPV) and Internal Rate of Return (IRR) have been widely utilised for estimating the present value of future cash flows and determining property values based on income streams. While these methods offer valuable insights into the potential profitability of real estate investments, they inherently neglect ongoing operational expenses, maintenance costs, the cost for end-user and other lifecycle expenditures.

The limitations of conventional valuation models have prompted interest in lifecycle costing approaches, which aim to capture the full spectrum of costs associated with real estate ownership and operation. Lifecycle costing models recognise that the true financial value of an asset extends beyond its acquisition cost and encompasses expenditures incurred over its entire lifespan. By accounting for operational efficiencies, maintenance requirements, and users' energy costs, lifecycle costing frameworks provide a more nuanced understanding of the economic implications of real estate investments.

The Total Cost of Ownership (TCO) model represents a synthesis of efforts to develop comprehensive financial evaluation frameworks tailored to the complexities of real estate investments. Primarily focused on the energy side of the building. Which becomes an important part of both end user and investor. Originating in the realm of business management and procurement, the TCO model has been adapted to the real estate context to address the need for a holistic approach to cost assessment. In contrast to traditional valuation methods, which focus solely on upfront expenses and income projections, the TCO model incorporates a broader array of cost components, including operational costs, maintenance expenses, disposal expenses and energy cost (Kulakov & Baronin, 2017).

2.1.4 Application of TCO in real estate investment

The application of the Total Cost of Ownership (TCO) model in real estate investment represents a pivotal advancement in financial analysis, offering practitioners a comprehensive framework to evaluate the long-term economic viability and sustainability of property assets (Kulakov & Baronin, 2017). This section will examine the practical application of the TCO model in the context of real estate investment, exploring its utilisation in decision-making, risk assessment, and value optimisation.

One of the principal applications of the TCO model in real estate investment is its capacity to inform decision-making and investment strategy formulation. By providing a comprehensive assessment of the total economic impact of asset ownership, including both direct and indirect costs, the TCO framework enables investors to make more informed decisions regarding property acquisition, development, and management. For instance, when comparing alternative investment options, such as different property types or locations, the TCO model allows investors to evaluate the full spectrum of costs and benefits associated with each option, thereby facilitating more rational and objective investment decisions.

Furthermore, the TCO model can be instrumental in guiding investment strategy formulation, particularly with respect to asset allocation, portfolio diversification, and risk management. The incorporation of lifecycle costing principles into investment analysis enables investors to identify opportunities to optimise returns, minimise risks, and enhance the overall performance of their real estate portfolios. Furthermore, the TCO framework enables investors to assess the financial implications of different management strategies, such as property refurbishment, renovation, or repurposing, thereby enabling more proactive and strategic asset management practices.

Another key application of the TCO model in real estate investment is its capacity to facilitate risk assessment and mitigation. By comprehensively analysing the total cost of ownership over the asset's lifecycle, the TCO framework enables investors to identify and quantify various sources of financial risk, including operational, maintenance, and market-related risks. Through sensitivity analysis and scenario planning, investors can assess the potential impact of different risk factors on investment performance and develop appropriate risk mitigation strategies to safeguard their financial interests.

Furthermore, the TCO model can be employed to assess the resilience and sustainability of real estate investments in the face of external shocks and disruptions, such as economic downturns, regulatory changes, or environmental risks. By integrating risk assessment methodologies into TCO analysis, investors can identify vulnerabilities and weaknesses in their investment portfolios and take proactive measures to mitigate potential threats and enhance long-term resilience.

Finally, the application of the TCO model in real estate investment extends to value optimisation and performance enhancement. By systematically analysing the total economic impact of asset ownership, including both costs and benefits, the TCO framework enables investors to identify opportunities for value creation and enhancement throughout the investment lifecycle. For instance, by identifying cost-saving opportunities, operational efficiencies, and revenue-generating initiatives, investors can optimise the financial performance of their real estate assets and maximise long-term returns.

Furthermore, the TCO model can facilitate the implementation of sustainable and socially responsible investment practices, such as energy efficiency upgrades, green building certifications, and community engagement initiatives. By quantifying the financial value of sustainability initiatives and social impact activities, investors can align their investment objectives with broader environmental, social, and governance (ESG) goals and enhance the overall resilience and sustainability of their real estate portfolios.

2.1.5 Summary of Financial value through Total Cost of Ownership (TCO)

The Total Cost of Ownership (TCO) model represents a paradigm shift in the evaluation of real estate investments, shifting the focus from short-term gains to a comprehensive, long-term view. While traditional financial evaluation methods are useful, they often fail to capture the true economic impact of real estate assets. Such models tend to prioritise initial costs and projected returns, with a consequent overlooking of the operational, maintenance, and energy expenses that accumulate over the asset’s lifecycle.

The integration of TCO into real estate investment analysis provides a more nuanced and realistic picture of financial performance. This comprehensive approach acknowledges that the true value of a property is not solely determined by its acquisition cost, but also encompasses its operational efficiency and long-term sustainability. To illustrate, a building with lower initial costs but high ongoing maintenance and energy expenses may be less financially viable over time than a more expensive, energy-efficient building.

The application of TCO in real estate is shaped by economic principles. The dynamics of supply and demand, capital flows, and market conditions exert a direct influence on the values of properties and the strategies employed in investment. The interrelationship between these factors highlights the necessity of integrating lifecycle costs into financial evaluations. The impact of capital markets on real estate values is mediated by interest rates and investor sentiment. Consequently, an understanding of these influences allows for more strategic investment decisions.

Furthermore, the evolution of financial evaluation models reflects an increasing recognition of lifecycle costing approaches. The limitations of methods such as discounted cash flow (DCF), return on investment (ROI), net present value (NPV), and internal rate of return (IRR) have prompted interest in more comprehensive frameworks, such as TCO. These models consider the full spectrum of costs associated with ownership and operation, thereby offering a more accurate assessment of long-term profitability.

The practical application of TCO in real estate investment is multifaceted. It enhances decision-making by providing detailed insights into the total economic impact of property ownership, guiding investment strategy formulation, risk assessment, and value optimization. By identifying cost-saving opportunities and operational efficiencies, the TCO model helps investors maximize returns and minimize risks. Additionally, it supports sustainable and socially responsible investment practices, aligning financial objectives with environmental, social, and governance (ESG) goals.

In conclusion, the TCO model is a crucial tool for real estate investors, offering a comprehensive framework that encompasses all costs associated with asset ownership over its lifecycle. By integrating TCO principles, investors can make more informed and strategic decisions, optimising their investment portfolios for long-term profitability and sustainability. The economic implications of sustainable retrofitting further highlight the model's relevance, demonstrating that investments in energy-efficient and environmentally responsible technologies can yield substantial financial and social returns.

The TCO model enables investors to gain a deeper understanding of the financial dynamics at play, allowing them to navigate the complexities of real estate investments with greater precision and foresight. This comprehensive approach not only enhances financial outcomes but also promotes sustainability and resilience in the real estate market, aligning economic goals with broader societal values.

2.2 Sustainable Energy Technologies (SETs)

This chapter undertakes a thorough investigation of critical Sustainable Energy Technologies (SETs), which are systematically classified into distinct categories based on existing literature: supply side, demand side and change of consumption (Bhuiyan et al., 2015; Huang et al., 2022; Ma et al., 2012). These technologies, evaluated at different scales from building-level interventions to covering entire urban areas. Furthermore, the financial implications and responsible stakeholders in implementing these technologies will be elucidated, offering insight into the practicalities of sustainable retrofit efforts.

This chapter serves a dual purpose: firstly, to provide a basic understanding of the diverse range of SETs, and secondly, to lay the groundwork for subsequent investigations into their financial value. Through a detailed examination of literature and empirical research in the sector, this chapter aims to offer a comprehensive overview of the key sustainable technologies.

2.2.1 Different sustainable technologies

The field of Sustainable Energy Technologies (SETs) is a nuanced landscape, encompassing a wide range of interventions designed to improve the environmental performance of existing urban structures. To navigate this complex domain, it is necessary to categorise these technologies according to their functional areas. Out of the literature the SETs can be categorised into three categories: Supply-side, demand-side and changing consumption. The ensuing classification provides a structured framework for comprehending the varied assortment of sustainable retrofit interventions.

Supply-side technologies
Supply-side technologies aim to enhance and optimize resources as inputs for the operation of buildings and urban systems. These interventions prioritise the generation, distribution and regulation of energy and water. An instance of which is the integration of renewable energy sources, like solar photovoltaic systems and wind turbines, to supplement or displace traditional energy grids. Furthermore, neighbourhood heating and cooling systems, in conjunction with advanced metering infrastructure, are essential interventions when striving for energy efficiency and resource conservation (Huang et al., 2022; Ma et al., 2012).

Demand-side technologies
Demand-side technologies, conversely, aim to perfect the consumption patterns of energy and water in urban environments (Ma et al., 2012). These technologies concentrate on enhancing usage, lessening waste, and overall efficacy. Examples of interventions targeting the reduction of energy demand in buildings include energy-efficient lighting systems, advanced insulation materials, and technology used for measuring occupancy (Ma et al., 2012).

Additionally, the integration of smart technology plays a crucial role in demand side. The deployment of Internet of Things (IoT) devices, furnished with sensors and intelligent algorithms, empowers occupants to oversee and refine their resource management in real time (Bhuiyan et al., 2015; Huang et al., 2022). Smart thermostats, occupancy sensors and water flow meters yield actionable insights, enabling informed decision-making to diminish energy consumption. Intelligent building management systems also offer automated adjustments, based on occupancy patterns and environmental factors. Such systems boost the efficacy of resource use.

Changing consumption
Conservation measures cover a range of approaches designed to alter the behaviour and consumption patterns of building and urban area occupants. These measures often go beyond physical solutions and concentrate on education, awareness, and incentive schemes. Behavioural nudges, resident engagement platforms, and community-led savings initiatives are all fundamental aspects of this category. Furthermore, educational campaigns and training programmes function as catalysts for promoting sustainable practices within urban populations.

Each of these categories represents a distinctive facet of Sustainable Energy Technologies (SETs), working together to transform existing urban environments into more resource-efficient, environmentally conscious entities (See figure 4).

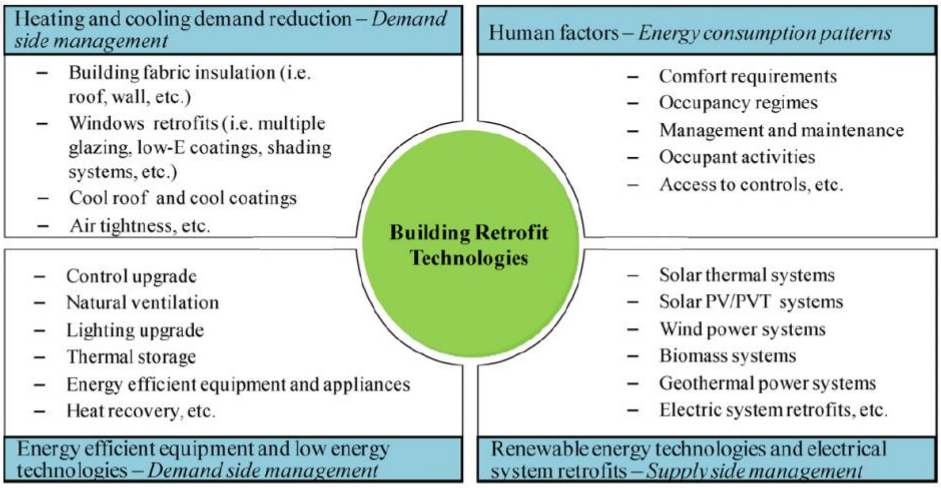


Figure 4: Main categories of building retrofit technologies. (Ma et al., 2012)

2.2.2 Scale of sustainable technologies

Sustainable Energy Technologies (SETs) cover various interventions that can be implemented within the built environment at different scales (Kerstens & Greco, 2023). This chapter explores the levels at which these technologies are applied, extending from individual buildings to wider urban areas.

Building level interventions

At the building level, SETs are customised to suit individual structures, with a main emphasis on enhancing energy efficiency, resource utilisation and overall environmental performance. At this level, adjustments and installations are confined specifically to a particular building. Some of the notable examples are highly effective insulation materials, energy-efficient lighting systems and advanced HVAC (heating, ventilation, and air conditioning) technologies.

Implementing sustainable technologies at the building level presents distinctive challenges and benefits. Careful planning and precise execution are required to coordinate with existing infrastructure and building constraints. Critical factors in decision-making include initial investment costs and compatibility with the building's existing systems. However, building-level interventions offer numerous benefits such as reduced energy consumption, lower operational costs, and a positive impact on the environment.

Neighbourhood level interventions

In addition to individual buildings, SETs can be applied at the street or block level. These interventions can cover a collection of buildings or a specific urban area. Neighbourhood level interventions include neighbourhood heating networks and share renewable energy systems.

Coordination and synergies between buildings should be considered. Neighbourhood level interventions offer opportunities for neighbouring buildings to create synergies. Integrated systems like neighbourhood heating facilitate efficient sharing of thermal energy resources, resulting in collective benefits such as lower energy costs and reduced emissions (Zhang et al., 2018). Nevertheless, Neighbourhood level technology requires successful coordination among stakeholders, including building proprietors, law-making bodies, and utilities, for effective deployment.

Urban areas interventions

At the highest scale, SETs are applied to entire urban areas or Urban areas. This approach involves a complete planning and implementation strategy that focuses on the wider environmental and social context. Interventions at the area-level might entail the creation of sustainable transportation systems, urban green spaces, and community-wide energy efficiency initiatives.

Integrated approaches and urban planning considerations are also considered. Holistic and integrated approaches are crucial for implementing area-level interventions in urban planning. Collaboration among various stakeholders, including urban planners, architects, engineers, and community representatives, is imperative. Considerations related to zoning, land use policies, and infrastructure development play a crucial role in successfully deploying sustainable technologies at this scale.

2.2.3 Individual and collective technologies

Sustainable Energy Technologies (SETs) can be approached from both individual and collective perspectives to understand their role, technical nuances, economic implications, and broader sustainability considerations.

Individual SETs

Individualised SETs are an essential aspect of sustainable retrofitting. They encompass a range of SETs that are tailored to specific building units. These bespoke solutions include solar photovoltaic systems, compact wind turbines, and micro hydropower installations. They are carefully calibrated to meet the unique energy demands of individual structures. These systems operate separately and play a crucial role in meeting local energy needs, significantly impacting energy generation, consumption patterns, and overall efficiency in retrofitting.

Individualised SETs are designed as compact-scale energy systems that are intricately engineered to meet specific energy requirements or facilitate consumption reduction within distinct building contexts. The main focus is to customize these solutions to align with the unique architectural attributes, energy consumption patterns, and specific user needs associated with individual buildings.

While these solutions are tailored to specific buildings, they may face limitations in scalability due to their focus on addressing local energy needs within discrete building settings. The design and deployment of the system are tailored to singular structures, which may limit their applicability across diverse architectural typologies or expansive urban contexts.

In the economic domain, individualized SETs typically involve initial investment costs primarily borne by individual building owners or stakeholders. The cost-benefit calculation mainly focuses on more immediate returns that are confined to the specific building where the system is installed. These benefits include generating energy locally, improving energy efficiency, and potentially saving costs for the property and its occupants.

Collective SETs

Collective systems provide a communal and holistic approach to promoting energy sustainability within communities. They operate on a urban area or neighbourhood scale and involve shared renewable energy initiatives, such as neighbourhood heating networks, communal photovoltaic arrays, and collective wind farms. Collective SETs are designed as shared energy architectures that serve as foundational energy infrastructures for multiple entities or buildings. They leverage economies of scale and facilitate synergistic energy management across a broader spectrum of users.

The infrastructure required for collective SETs is more expansive and interconnected, fostering the seamless distribution of energy among numerous users (Zhang et al., 2018). Efficient energy exchange and management across interconnected networks of users necessitates the establishment of robust frameworks such as heat networks, collective renewable energy installations, or smart grid integrations.

Collective SETs capitalize on economies of scale, showcasing extensive communal advantages that transcend individual boundaries. The potential for scalability enables the integration of these systems into larger neighbourhood contexts, fostering a more widespread and impactful implementation within the community.

In contrast to the individualized nature of singular systems, collective SETs operate on a collective investment model that potentially involves cost-sharing among multiple stakeholders or entities. This collaborative investment approach has broader societal benefits that go beyond individual property boundaries and contribute to the advancement of energy sustainability.

2.2.4 Cost allocation and Responsibility

The effective deployment of Sustainable Energy Technologies (SETs) is dependent not only on technological viability but also on financial considerations and cost allocation. This section delves into the complex web of financial responsibilities and models that are prevalent in the implementation of SETs within the Netherlands.

Cost Allocation for Different Sustainable Technologies

The cost allocation for SETs varies based on technology type and intended implementation scale. For example, supply side technologies like solar photovoltaic systems and wind turbines often incur higher initial capital costs but provide long-term energy generation benefits (Piacentino et al., 2019). The expenses are usually covered by the property proprietor or developer, with the possibility of receiving incentives or subsidies from governmental or industry schemes.

On the other hand, the demand side technologies include different energy-efficient techniques, such as insulation, lighting, and HVAC systems. The expenses linked with these technologies are typically divided between property owners and tenants, with the chance for adopting shared savings models in specific cases. In the context of behaviour modification programmes or waste reduction strategies, costs are typically included within wider sustainability initiatives and may require both public and private funding sources.

Stakeholders Responsible for Implementation

The implementation of SETs requires engagement of diverse stakeholders. Investors or developers are central figures at the building level, conducting decision-making and financing. In instances of neighbourhood-level technologies or area-wide initiatives, local authorities and urban planners play an increasingly significant role, coordinating actions and frequently offering economic backing through grants or tax incentives.

Funding Models and Financial Incentives in the Netherlands
Several funding models and financial incentives exist in the Netherlands to encourage the uptake of SETs. The government provides subsidies and grants for particular technologies, with the aim of encouraging investment in sustainable practices. Furthermore, property owners can benefit financially from tax incentives in the form of lowered VAT rates for labour-intensive renovation work. It serves as an added incentive to carry out these activities on their property.

In addition, creative funding approaches such as green bonds and energy performance contracts are now becoming popular tools for securing private investment in sustainable retrofitting undertakings. Often partnerships between public and private entities are involved, which can help reduce financial risks and further sustainable investments.

2.2.5 Role of SETs in financial value creation

The implementation of sustainable retrofitting interventions, encompassing energy-efficient systems and sustainable technologies, has the potential to markedly diminish operational costs throughout the lifespan of a building (Jagarajan et al., 2017). Such interventions result in decreased energy consumption, reduced maintenance costs and enhanced operational efficiency, which collectively enhance the economic performance of refurbished buildings (Ma et al., 2012). It is of the utmost importance to gain an understanding of these implications in order to define the economic value proposition of sustainable retrofit initiatives.

The incorporation of Sustainable Energy Technologies (SETs) in retrofit projects has been demonstrated to markedly enhance the asset value of existing buildings (Schneider-Marin et al., 2022). It is frequently observed that buildings equipped with energy-efficient systems and sustainable technologies often have a higher market value. This is because prospective purchasers and investors are increasingly inclined to favour properties with lower operating costs and a smaller environmental footprint, which serves to enhance market competitiveness and property value (Ma et al., 2012).

So, the investment in SETs has been demonstrated to yield significant long-term financial benefits (Schneider-Marin et al., 2022). Despite initial costs, implementation of SET technologies has the potential to result in significant savings through reduced operational expenses and increased asset valuations. The ROI of such initiatives is not only measurable, but also manifests itself in long-term economic benefits over the life cycle of the building.

The economic implications of sustainable retrofit projects are contingent upon their capacity to deliver tangible returns on investment (ROI) (Ma et al., 2012). It is essential to conduct a comprehensive evaluation that incorporates financial metrics in order to assess the financial viability and attractiveness of these initiatives for stakeholders. The evaluation in question exerts a significant influence on investment decisions and the financial valuation of projects.

Furthermore, sustainable retrofitting offers not only direct financial advantages but also broader socio-economic benefits. Such initiatives promote employment, stimulate local economies and meet the growing market demand for eco-friendly buildings (Jagarajan et al., 2017). This is consistent with the observed trend of tenants, investors and regulators prioritising sustainability, which has resulted in an increased demand for sustainable refurbished buildings (Ma et al., 2012).

2.2.6 Summary Sustainable Energy Technologies (SETs)

The sections have provided a thorough account of Sustainable Energy Technologies (SETs). These technologies have been categorized as supply-side, demand-side, and interventions that modify consumption. The chapter has also delved into the implementation scale of these technologies, ranging from individual buildings to entire urban areas. Furthermore, the report examined the allocation of costs and stakeholder responsibilities, revealing the complex financial considerations involved in introducing SETs in the Netherlands.

It was observed that these technologies are interconnected across different scales, highlighting the importance of a holistic approach. For example, implementing measures at the building level, like high-efficiency insulation and energy-efficient lighting, can act as the basis for wider interventions occurring at the street and area level. This interaction highlights the significance of taking a comprehensive approach to sustainable retrofitting, with simultaneous consideration of the benefits that can be attained by applying technologies across multiple scales.

In conclusion, the supply-side, demand-side, and consumption shift interventions classification provides a framework for comprehending the wide range of technologies accessible for retrofitting schemes. Additionally, the examination of scale underscores the adaptability of these technologies, empowering custom-made interventions at diverse levels of the built environment.

The observations presented in this chapter establish the foundation for subsequent explorations into the financial value of sustainable retrofitting schemes. By fully grasping the technologies, their implementation scales, and the related financial implications, stakeholders can make well-informed choices that promote resilient and eco-friendly urban settings.

2.3 Triple bottom line (TBL)

The Triple Bottom Line (TBL) framework serves as a fundamental framework for assessing the sustainability of retrofit initiatives, emphasizing a holistic approach that encompasses economic, environmental, and social dimensions. The past century has witnessed an ongoing debate regarding the feasibility of demolition as compared to the refurbishment of older housing and buildings (Gohardani & Bjork, 2012). Power (2008) argues that there are significant economic, social, and environmental benefits of refurbishment in comparison to demolition. These align with the Triple Bottom Line (TBL) framework, developed by John Elkington in 1994. This framework highlights economic, environmental, and social aspects, and each dimension holds significant importance in assessing the holistic impact of building retrofits on the ecosystem as a whole.

People (Social)
Preserving the social and cultural heritage ingrained in current structures is a crucial aspect of retrofitting (Liao et al., 2023). Although not universally applicable, planning regulations can help safeguard these elements. Additionally, retrofitting schemes have the potential to produce favourable impacts on society, such as heightened health and comfort for end-users, and improved security and resilience within communities (Jagarajan et al., 2017). However, stakeholders should ensure they are diligent in identifying projects that have the potential for significant social benefit.

Planet (Environmental)
Green retrofitting provides a sustainable option for conventional building practices by considerably reducing energy consumption, pollution, and resource usage during the construction phase (Jagarajan et al., 2017). This initiative is compatible with the overarching aim of conserving non-renewable fuel resources and mitigating carbon emissions. Retrofitted buildings minimize their ecological impact, contributing to a more balanced built environment.

Profit (Economic)
Economic retrofitting is a complex undertaking that involves financial considerations, cost-effectiveness, and overall economic feasibility. According to Gohardani and Bjork's (2012) study, retrofitting presents significant economic advantages over demolition. They demonstrate that retrofitting is frequently more cost-effective, as it reduces capital investments and financing costs associated with new build projects. Moreover, retrofitting buildings can significantly enhance property value (Jafari & Valentin, 2018). Nonetheless, it is vital to acknowledge that the profitability of building adaptation may differ depending on variables like building intricacy and statutory obligations.

The TBL framework provides a comprehensive evaluation approach that goes beyond financial considerations. It includes economic, environmental, and social dimensions, allowing for a holistic assessment of sustainable retrofitting initiatives to ensure that decisions align with overall sustainability goals.

2.4 Conclusion and relevance to the study

This chapter examines the theoretical foundations of Sustainable Energy Technologies (SETs) and financial value through the application in retrofitting initiatives within the built environment. By examining existing literature and empirical research, valuable have gained insights into the diverse range of technologies, their implementation scales, financial considerations, and implications for economic value creation. Nevertheless, several crucial observations and considerations emerge from our analysis.

Firstly, while the classification of SETs into supply-side, demand-side, and consumption shift interventions offers a structured framework for understanding these technologies, it also highlights the inherent complexity and interconnectedness of sustainable retrofitting efforts. The challenge lies in navigating this complexity and identifying synergistic opportunities for integrated interventions across different scales of the built environment.

Secondly, the discussion on the relative merits of individual versus collective SETs highlights the trade-offs between the localized benefits and broader societal impacts. Individualised systems offer tailored solutions for specific buildings, whereas collective systems leverage economies of scale and foster communal advantages. Nevertheless, the successful implementation of collective SETs necessitates the establishment of robust frameworks and collaboration among multiple stakeholders, which presents challenges in terms of coordination and cost-sharing.

Additionally, the examination of the economic implications of sustainable retrofitting highlighted the significant impact on building values and financial effectiveness (Jafari & Valentin, 2018; Liao et al., 2023). The integration of sustainable practices is crucial for enhancing economic viability and efficiency in retrofit projects, as highlighted by the synthesis of financial models and analyses like the Total Cost of Ownership (TCO). Moreover, the role of SETs in financial value creation highlights the potential for long-term economic benefits through energy cost savings, asset valuation enhancement, and market competitiveness.

A comprehensive exploration of SETs within the context of building retrofitting provides valuable insights for stakeholders involved in urban development and sustainability initiatives. By acknowledging the interconnectedness of economic, environmental, and social dimensions within the Triple Bottom Line (TBL) framework, decision-makers can strive for more holistic and sustainable retrofitting strategies that align with broader sustainability goals.

In conclusion, while the theoretical foundations presented in this chapter offer valuable insights into the complexities and opportunities surrounding SETs in retrofitting initiatives, several challenges and considerations warrant further investigation. Future research efforts should focus on addressing these challenges, exploring innovative financing mechanisms, and developing holistic approaches to sustainable retrofitting that integrate economic, environmental, and social dimensions.

2.5 Framework

The theoretical underpinning presented in this chapter has provided further insight into the research concepts. The research framework was formed with the intention of evaluating the financial value of integrating SETs through retrofitting initiatives. The framework prioritises a methodological approach centred on real-world projects, thereby enabling a comprehensive exploration of the financial value associated with SETs based on the literature review.

The framework as seen in figure 5 establishes a link between SETs and the generation of financial value within retrofit efforts. It describes how different technologies within the SETs spectrum have different impacts on the resulting financial value. Each technology presents a unique set of advantages and disadvantages that have a direct impact on the financial outcome of retrofit projects. The case study detailed in the report serves as a central illustration that underpins the entire study. It underlines how several factors such as location, size, functional use, and others significantly shape the viable SETs applications (Copiello & Donati, 2021). Moreover, these factors have a complex impact on the financial value delivered by these SETs interventions. In addition, it is important to recognize that assessing financial value is a multifaceted process, subject to different valuation methodologies (Copiello & Donati, 2021). The different approaches to assessing financial value play a significant role in determining the perceived economic benefits of SETs interventions. These methodologies are key to identifying and quantifying the financial value of implementing SETs in retrofit projects.

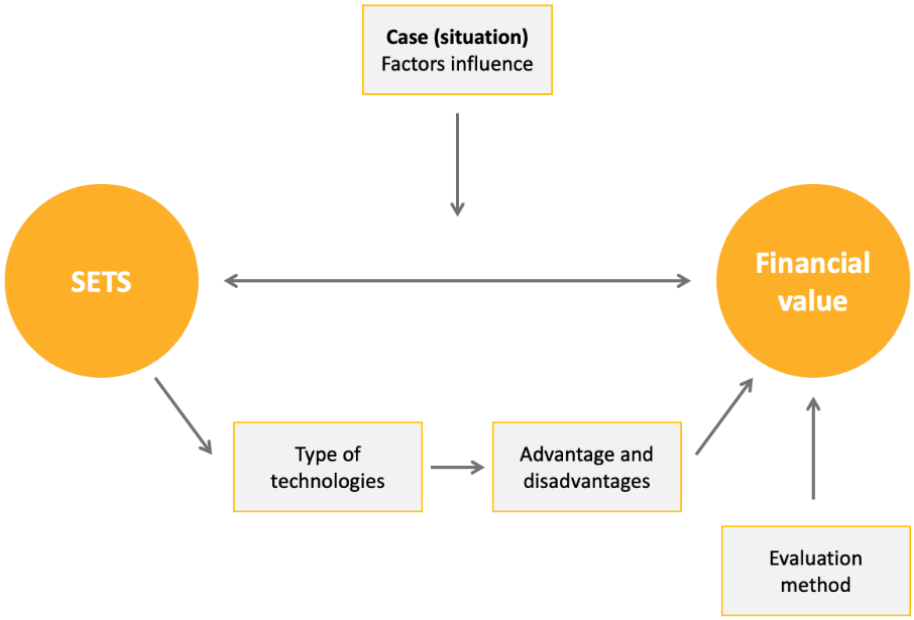


Figure 5: Research framework. Source: Own illustration

3 Methodology

3.1 Research design

The aim of this research is to investigate the financial value of incorporating Sustainable Energy Technologies (SETs) in retrofit initiatives within the context of housing. This chapter will briefly explain the different research methods that can be applied to study the following sub-questions:

1. What Sustainable Energy Technologies (SETs) can be used in the housing sector for individual and collective purposes?
   Literature research
2. What factors determine whether individual or collective Sustainable Energy Technologies (SETs) should be implemented in housing?
   Literature research, Case study
3. What method can be used to determine the financial value of individual and collective Sustainable Energy Technologies (SETs)?
   Literature research, Case study, financial analysis
4. What are the specific advantages and disadvantages of individual compared to collective Sustainable Energy Technologies (SETs) in financial terms?
   Literature research, Case study, financial analysis
5. What recommendations can be proposed based on the Total Cost of Ownership (TCO) evaluation?
   Literature research, Case study, financial analysis

The research methodology involves a systematic exploration see figure 7, beginning with a sequential analysis and an in-depth examination of case studies to identify feasible approaches. The selection of SETs depends on several factors, such as location and the characteristics of the building(s) under consideration. Following the assessment, the SETs are systematically listed and compared based on their financial values within their specific parameters.

It is important to note the dynamic nature of this analytical process, which requires regular review and reassessment. This cyclical review allows for a nuanced understanding of the interplay between SETs and their financial implications. This cyclical review ensures that the research remains aligned with emerging insights and adapts to the evolving landscape of sustainable retrofitting. The cumulative findings from this iterative process ultimately inform the formulation of well-considered recommendations.

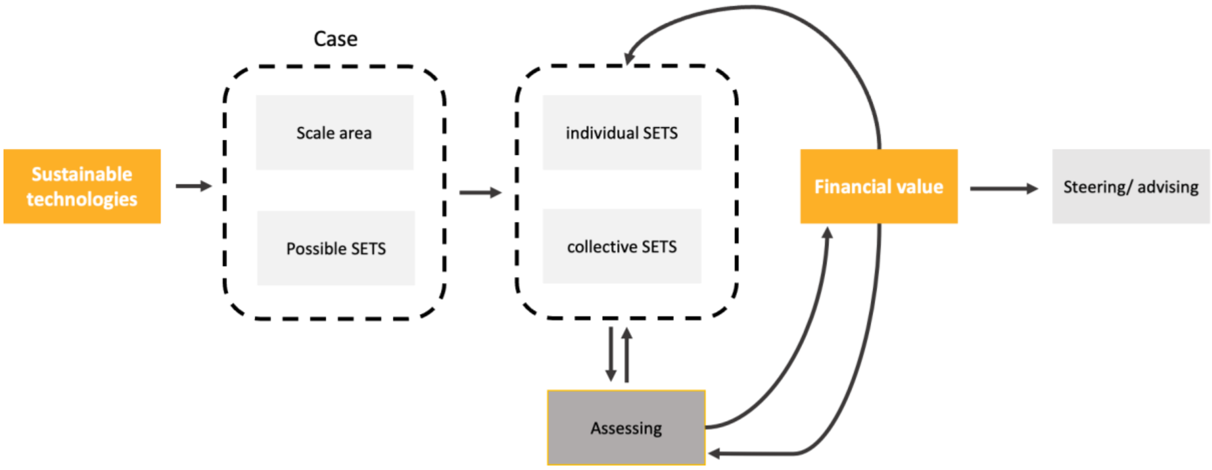


Figure 7: Research sequence. Source: Own illustration

3.1.1 Methods and techniques

The study's research design aims to investigate the financial value of Sustainable Energy Technologies (SETs) in retrofitting housing at a neighbourhood level. To achieve this, a mixed-methods approach has been chosen, integrating both quantitative and qualitative methodologies. This approach enables a comprehensive exploration of the multifaceted aspects associated with SETs and their financial impact.

Exploratory study
This research will utilize an exploratory study to comprehensively understand the impact of sustainable retrofit practices on the value of existing buildings. The study aims to maintain a reasonable level of objectivity and precision in language while following conventional academic structure and formatting. It will avoid biased and emotional language, ornamental vocabulary, biased evaluations, and ambiguous terminology. Additionally, we will prioritize grammatical correctness, precise word choice, and logical structure with causal connections between statements. Selecting a varied assortment of sustainable retrofit projects, this methodology endeavours to encompass a wide array of practices, stakeholder dynamics, and contextual factors that impact value creation.

Literature review
An extensive literature review will be conducted to gather existing knowledge, empirical studies, and theoretical frameworks related to SETs in retrofitting housing. Academic databases, scholarly journals, industry reports, and reputable publications will serve as primary sources to synthesize information on various SETs, financial models, and successful retrofitting case studies.

Case studies
Case studies are a primary methodological tool used in this research to conduct a comprehensive analysis of sustainable retrofit projects. The case study follows a structured protocol that includes qualitative data collection methods such as interviews and document analysis. The case study was chosen based on the criterion in chapter 03.03 Case selection. This methodology was chosen to gather useful insights and best practices for the retrofit of housing.

Financial analysis
The financial analysis employs quantitative methods to evaluate the value generated by sustainable retrofit practices, in line with the research objective of achieving financially rewarding outcomes. The financial analysis employs quantitative methods to evaluate the value generated by sustainable retrofit practices, in line with the research objective of achieving financially rewarding outcomes. Clear causal connections between statements ensure a logical flow of information. To quantify the economic impact of sustainable retrofit initiatives, financial modelling technique Total Cost of Ownership (TCO) will be utilized. The language and vocabulary are precise, objective, and adhering to the conventional structure of academic writing. This assessment will provide quantifiable metrics for evaluating the financial feasibility and efficiency of value capture strategies.

3.2 Case selection

Selecting appropriate case studies is crucial to ensure a comprehensive understanding of sustainable retrofit practices in housing. The criteria for case study selection must align with the research objectives, facilitating the exploration of diverse SETs and their financial implications.

- ***Diversity in sustainable technologies:*** The selected cases should cover a variety of SETs, such as solar panels, energy-efficient HVAC systems, insulation methods, and water management solutions.
- ***Representing individual and collective purposes:*** The case must demonstrate both individual and collective purposes, highlighting implementations that serve specific buildings as well as those that serve broader housing communities.
- ***Regional dynamics within the Netherlands**:* The case concerns a neighbourhoods or regions within the Netherlands, the settings that may vary in terms of infrastructure, building types, and community dynamics.
- ***Duration of implementation:*** It is important to include cases covering a spectrum of implementation durations, from short-term projects to long-term sustainable initiatives, to provide insights into the temporal aspects of financial impact.
- ***Accessibility and collaboration:*** It also emphasizes the importance of collaboration with institutions, property managers, or stakeholders involved in the case studies to ensure data accessibility and facilitate an in-depth understanding of the retrofit initiatives.

3.2.1 Campus UT Enschede

The selected case study for this is: the Campus UT Enschede is an urban area development on the outskirts of Enschede. This initiative encompasses student housing provided by the housing corporation Vechtdal Wonen. The project entails the creation of 445 residential units across two distinct sub-areas: Calslaan Oud and Campuslaan Hoog. These areas comprise a total of 10 buildings characterized by various energy labels and architectural styles. In 2023, the decision was made to retrofit the buildings within this area to meet current comfort standards.

Figure 8: Situation Campus UT Enschede. Source: https://d7n00qtpfqqtn.cloudfront.net/PDF-bestanden/Vraagspecificatie_Aanbestedingsleidraad_ROC-Enschede_v2.0.pdf

3.3 Hypotheses

The development of hypotheses is a key component of creating a structured framework for empirical research. Hypotheses guide the research efforts by methodically examining the relationships between independent and dependent variables. This study presents a set of hypotheses aimed at clarifying the financial consequences of incorporating renewable technologies into building refurbishment initiatives.

Hypothesis 1: posits that the integration of sustainable technologies will have a financial impact.
The initial hypothesis proposes that the inclusion of sustainable technologies in renovation schemes results in considerable financial gains. More specifically, it anticipates a favourable connection between integrating sustainable technologies, like solar panels and energy-efficient HVAC systems, and the overall monetary benefit of the renovation initiative. This hypothesis aligns with prior research that emphasises the economic advantages of investing in sustainable technologies (Choi, 2009; Shan, Hwang, & Zhu, 2017).

H0 (null hypothesis): There is no significant relationship between the incorporation of sustainable technologies and financial value in retrofit projects.

H1 (Alternative Hypothesis): Incorporation of sustainable technologies in retrofit projects is positively associated with higher financial value.

Hypothesis 2: Financial value differences between individual building level innervations Sustainable Energy Technologies (SETs) and collective SETs at the neighbourhood level.
The second hypothesis aims to investigate potential differences in financial outcomes between individual building level innervations SETs and collective SETs implemented at the neighbourhood level. It is hypothesized that the mode of deployment, whether individual or collective, may result in varying financial returns and overall value in building retrofit projects. This hypothesis is based on the idea that various deployment strategies can impact the economic viability and performance of Sustainable Energy Technologies in retrofit initiatives.

H0 (null hypothesis): There is no significant difference in financial value between the deployment of individual building level innervations SETs and collective SETs at the neighbourhood level in retrofit projects.

H1 (Alternative Hypothesis): The deployment of collective SETs at the neighbourhood level yields higher financial returns and value compared to individual building level innervations SETs in retrofit projects.

3.4 Data collection and type

The exploratory phase of this study entails a comprehensive search of academic literature, industry reports, and relevant publications. This involves systematically searching electronic databases like Google Scholar, Scopus, and academic journals related to sustainable retrofit and value addition of existing buildings. The search strategy uses keywords such as "sustainable retrofit," "building value enhancement," and "best practices" to ensure a thorough investigation. Additionally, this research will analyse grey literature and industry reports to comprehensively understand the current knowledge in this field.

Case studies play a crucial role in the data collection process. The criteria for selecting case studies entail a successful record of sustainable retrofit, variation in project types and locations, and the presence of pertinent documentation. Data is collected through analysis of project reports and design plans, on-site observations, and financial statement review, all aimed at obtaining a comprehensive grasp of the process of sustainable retrofit.

As part of the financial analysis component, data will be gathered from collaborating organizations/ internship. This report will gather financial statements, investment expenses, operational costs, and revenues generated by sustainable retrofit projects. Additionally, quantitative data on the financial performance of these projects pre retrofit will be collected. This data will be essential for applying financial metrics and modelling techniques to evaluate the value generated by sustainable retrofit practices. This is specified in the following table:

SQ1 What Sustainable Energy Technologies (SETs) can be used in the housing sector for individual and collective purposes?
Data Source: - Academic literature, industry reports, and relevant publications in SETs - Government publications on renewable energy in housing
Data Type: - Quantitative data on the efficiency and performance of specific technologies

SQ2 What factors determine whether individual or collective Sustainable Energy Technologies (SETs) should be implemented in housing?
Data Source: - Academic literature, industry reports, and relevant publications research on decision-making in sustainable energy implementation - Government publications on SETs capabilities and limits in the area
Data Type: - Qualitative data on decision-making criteria and considerations

SQ3 What method can be used to determine the financial value of individual and collective Sustainable Energy Technologies (SETs)?
Data Source: - Financial reports of housing projects with individual and collective SETs - Research papers on financial evaluation methods for sustainable energy - Expert opinions on best practices in financial evaluation
Data Type: - Quantitative financial data on costs, returns, and benefits - Comparative data on different financial evaluation methodologies

SQ4 What are the specific advantages and disadvantages of individual compared to collective Sustainable Energy Technologies (SETs) in financial terms?
Data Source: - Comparative financial analyses of projects with individual and collective SETs - Research papers highlighting economic pros and cons of different SETs approaches - Industry reports/financial models on Cost-Benefit analyses of sustainable energy implementations
Data Type: - Quantitative financial data showcasing specific advantages and disadvantages - Expert opinions and qualitative insights on the economic impacts - Comparative data on the Total Cost of Ownership (TCO) and benefits of different SETs approaches

SQ5 What recommendations can be proposed based on the Total Cost of Ownership (TCO) evaluation?
Data Source: - Best practice guidelines in sustainable energy implementation - Expert consultations on financial optimization in sustainable energy
Data Type: - Quantitative data on the financial outcomes of recommended approaches - Comparative data on the economic efficiency of different optimization strategies

3.5 Data analysis

The qualitative data analysis phase shall utilize the thematic analysis approach, enabling the recognition of recurrent themes, patterns, and categories within the qualitative data obtained from the exploratory study and case studies. The analysis process comprises various stages which include acquainting oneself with the information, creating initial codes, exploring themes, assessing themes, naming, and defining the themes, and then composing the final report. This thorough approach seeks to acquire a detailed and subtle comprehension of the qualitative data, providing significant findings on sustainable retrofit practices and stakeholder dynamics.

As for the quantitative data acquired through financial analysis, descriptive statistics and inferential techniques will be utilized. This involves using means, standard deviations, and correlation coefficients to provide a comprehensive overview of the financial performance of the chosen sustainable retrofit projects. Regression analysis can also be performed to investigate the correlations between different financial variables and the overall value increase resulting from sustainable retrofit. The objective quantitative analysis of data will provide a comprehensive and reliable evaluation of the financial mechanisms that impact the creation of value. Technical abbreviations will be defined upon first use, and a logical flow of information will be maintained throughout the document. Consistent citation and formatting features will be adhered to. The language used will be clear, objective, and value-neutral, avoiding figurative or ornamental language. The document will be written in a formal register, avoiding contractions, colloquialisms, informal expressions, and unnecessary jargon. The tone will be passive and impersonal, avoiding first-person perspectives unless deemed necessary. The structure of the document will be clear and coherent, with causal connections between statements, and in adherence to conventional academic standards. Biased language will be avoided, and precise word choices will be employed where specific vocabulary conveys meaning more accurately.

The financial metrics Total Cost of Ownership (TCO) will be utilized in the assessment for key financial indicators. Furthermore, a sensitivity analysis will evaluate the influence of different financial variables on results, enhancing comprehension of the economic feasibility of various value capture methods.

3.5.1 Total Cost of ownership (TCO) model

The Total Cost of Ownership (TCO) model used in this research provides a comprehensive framework for evaluating the overall costs associated with implementing Sustainable Energy Technologies (SETs) in buildings. The model considers various factors that contribute to the total cost over the lifecycle of the technology deployment.

The model is structured as follows (see Figure 9): First, the heat energy demand is determined to establish the appropriate technology size. This serves as the foundation of the model. Additionally, the initial investment costs are included, encompassing labour, material, and equipment costs, as well as general execution costs, expenses, and profit and risk margins. Also included here are the operational expenses for maintenance, repairs, and replacement costs, as well as the opportunity cost in the form of energy costs for the users.

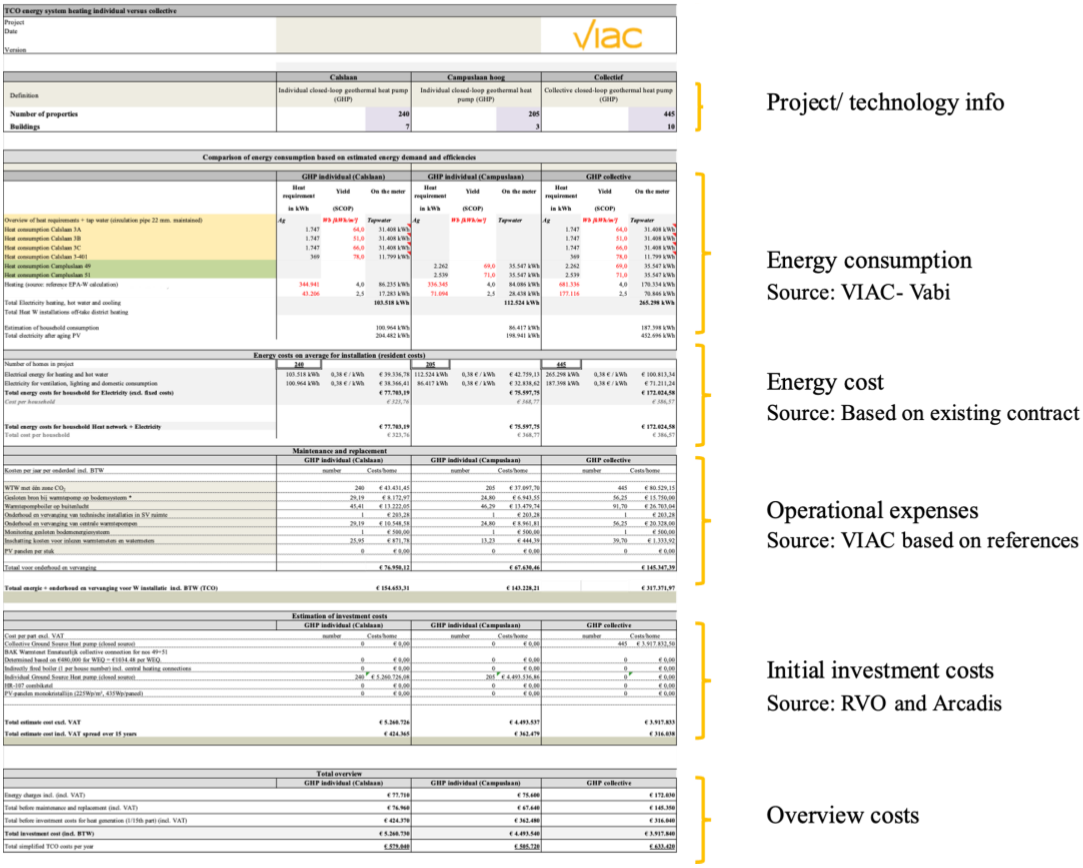


Figure 9: TCO Model. Source: Own illustration

The Total Cost of Ownership (TCO) is calculated using the following formula:

$$TCO = \frac{initial\ investmen\ cost}{15} + Operational\ cost + energy\ cost$$

Figure 10 illustrates the data sources utilized in this formula.

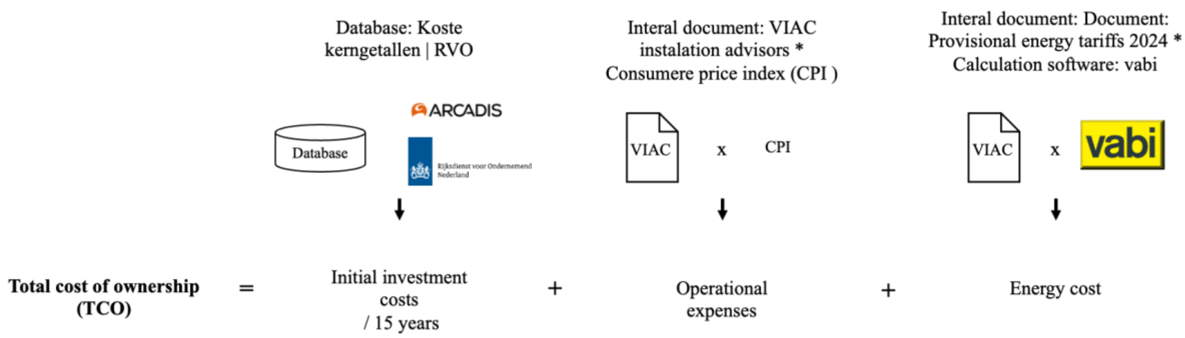


Figure 10: Formula and data imput TCO. Source: Own illustration

The energy demand analysis is based on data provided by VIAC to evaluate the heating and energy requirements of each building, considering the current gas and electricity consumption and the specific number of units. To address potential heat loss through underground piping networks, a 10% heat loss factor is incorporated into the collective variant, as advised by experts from VIAC.

Secondly, energy expenses are accounted for through a fixed contract established with UT Enschede for energy procurement. This is only the purchase tariffs. The final cost for the user still has to deal with: subsidies, Network costs, Energy taxes, VAT and Meter rent. It is important to acknowledge that these expenses are subject to variability over time, potentially impacting the overall financial analysis.

Thirdly, maintenance and replacement costs are estimated based on data provided by VIAC, which is derived from previous projects and adjusted for inflation using the Consumer Price Index (CPI). Expert guidance is used to supplement this data to ensure accuracy and reliability.

The investment costs are determined using data sourced from the RVO (Netherlands Enterprise Agency) and Arcadis database. This collaborative effort provides comprehensive cost estimates for sustainability measures in buildings, considering various factors such as labour costs, material costs, equipment costs, general execution costs, general expenses, and profit and risk margins. Regular consultations and feedback mechanisms help to maintain the relevance and accuracy of these cost estimates. Additionally, for the collective option, a form factor of 5% less is applied per 50 houses due to economies of scale, which can lead to cost savings.

The model's output provides key values, including energy expenses (including VAT), total costs for maintenance and replacement (including VAT), total investment costs for heat generation (1/15th part) (including VAT), total investment costs (including VAT), and simplified annual TCO costs. These values offer insights into the financial implications of implementing SETs in buildings and facilitate informed decision-making processes regarding investments.

3.5.2 Monte Carlo Simulation

In addition to the Total Cost of Ownership (TCO) calculation, a Monte Carlo simulation was conducted to account for the inherent uncertainties associated with the cost parameters. The TCO calculation provides a static view of costs; however, in practice, these costs can vary due to various factors. Monte Carlo simulation is an effective tool for modelling these variations and providing a probabilistic estimate of potential outcomes, thereby offering a more robust basis for decision-making.

To gain a representative picture of the possible variations in costs, the Monte Carlo simulation was conducted with 1,000 trials. The simulation included the three main cost components: energy costs, operational costs, and investment costs. Different distribution models were employed for each of these components to model uncertainties.

- ***Energy costs:*** Energy costs are based on a digital model and a fixed contract. Although the variation is limited, a normally (Gaussian) distributed assumption set with a standard deviation of 10% is used to accurately reflect the possible fluctuations.
- ***Operational Costs:*** Based on expert estimates, operational costs may vary due to maintenance, service contracts and unforeseen problems. A triangular distribution is applied to model these uncertainties, with a minimum, maximum and most likely value.
- ***Investment costs:*** Investment costs can fluctuate due to material costs and contractual factors. These costs are modelled with a normally (Gaussian) distributed assumption set and a standard deviation of 10%, based on data from the RFO and Arcadis databases.

The Monte Carlo simulation generates a distribution of potential TCO outcomes, thereby providing insight into the probability of different cost estimates. The probabilistic model provides not only an average expected value, but also a representation of the potential realistic outcomes.

4 Findings

4.1 The case: Campus UT Enschede

This study focuses on a retrofit project located in Enschede, specifically the Campus UT Enschede. The project is currently in the conceptual stage, with various retrofit approaches being considered. The initiative is overseen by the housing corporation Vechtdal Wonen and targets student housing. The project includes two distinct sub-areas: Calslaan Oud, and Campuslaan Hoog. Energy assessments were conducted for Calslaan Oud and Campuslaan Hoog, providing foundational data for the analysis. Additionally, the current energy labels for all three sub-areas were ascertained, aiding in the evaluation of potential retrofit strategies.

4.1.1 Context

The Campus UT Enschede is located on the northwest of Enschede see figure 11. The land is part of the University of Twente but owned by the housing corporation Vechtdal Wonen. The buildings in the area variance from quality and each have their own pros and cons. But all of them need retrofitting.

Figure 11: Situation Campus UT Enschede. Source: https://d7n00qtpfqqtn.cloudfront.net/PDF-bestanden/Vraagspecificatie_Aanbestedingsleidraad_ROC-Enschede_v2.0.pdf

The plans include three types of buildings comprising a total of 24 complexes, namely:

1. **Complex 801 to 807: Calslaan Oud** - Calslaan 1 to 13; 7 buildings with a total of 240 rooms.

Figure 12: Complex 801 to 807: Calslaan Oud. Source: Vechtdal Wonen (n.d.)

2. **Complex 812 to 814: Campus Avenue High** - Campus Avenue 21-21, 45-51, 59-65; 3 buildings with a total of 205 rooms.

Figure 13: Complex 812 to 814: Campus Avenue High. Source: Vechtdal Wonen (n.d.)

The decision to retrofit these buildings has been made by Vechtdal Wonen, with various stakeholders involved in the process. The objective is to prepare the student accommodations at UT programmatically, structurally, and energetically for future needs. In addition to preservation, the renovation work will include upgrading all bathrooms and kitchens, improving fire safety provisions, enhancing ventilation, addressing comfort in the complexes, updating the appearance of the common areas, and upgrading the electrical installation to meet current standards. Calslaan Old and Campuslaan High are currently heated with gas-fired boilers, but they should be fitted with a gasless installation.

The design process aims to achieve an optimal design through integrated collaboration between the architect, energy consultant, and builder. The value of each building type is recognized, and measures are determined per building type to preserve or enhance this value, considering aesthetic features, layout, and location. These values serve as input for upgrading the building energetically, balancing the preservation of the original design with opportunities for modernization. The text explores different scenarios, including the use of renewable energy sources like solar panels, heat pumps, and wind turbines. It also considers comfort and user experience, considering factors such as noise pollution, ease of operation, and maintenance (Vechtdal Wonen, n.d.).

Additionally, the design process prioritises circularity, with a focus on value retention, creating a healthy living environment, nature inclusivity, material reuse, and building layer separation. Various measures have been implemented to reduce environmental impact, including the use of an Environmental Performance of Buildings (MPG) calculation and circular performance measurements (Vechtdal Wonen, n.d.).

4.1.2 Current state

The University of Twente is located on the outskirts of Enschede, Netherlands. The climate in this area is hot and temperate, with significant precipitation even during the driest month. According to the Köppen-Geiger climate classification, this weather pattern falls under category Cfb. The average temperature in Enschede is 10.5°C. About 858 mm of precipitation falls annually. in this area annually, which is located in the northern hemisphere (climate-data.org, n.d.).

VIAC has conducted research on the current state of the plan and assessed its needs and current status. In collaboration with Vechtdal Wonen, they have identified areas for improvement in terms of energy consumption and have proposed measures to enhance the current complexes. This includes exploring energy solutions and the possibility of implementing them.

Name	**Gaslaan Oud**
Number	7 buildings (total 240 rooms)
Addresses	Calslaan 1t/m 13 (3 groups per building +1 penthouse)
Surface	23 square metres
Heat demand	45-90 kWh/m2
Total	248400 - 496800 kWh

Table 1: Complex 801 to 807: Calslaan Oud details. Adopted from: Vechtdal Wonen (n.d.)

Name	**Campuslaan hoog**
Number	3 buildings (total 205 rooms)
Addresses	Campus Avenue 21-21, 45-51, 59-65
Surface	22 square metres
Heat demand	45 kWh/m2
Total	202950 kWh

Table 2: Complex 812 to 814: Campus Avenue High details. Adopted from: Vechtdal Wonen (n.d.)

4.2 SQ1: Sustainable Energy Technologies (SETs) used in housing

This section presents an analysis of Sustainable Energy Technologies (SETs) that are applicable to the retrofit housing projects. The selection of appropriate SETs is crucial for achieving energy efficiency and sustainability goals in building retrofits. The analysis aims to identify potential SETs that can be utilized in the retrofitting process and assess their financial value and suitability within the context of the project.

4.2.1 Analysis of available SETs

This section presents a detailed analysis of the Sustainable Energy Technologies (SETs) available for retrofit housing projects. The analysis aims to identify and evaluate SETs options suitable for implementation in the building retrofit, considering their feasibility, effectiveness, and compatibility with the project objectives. The literature divided five distinct categories of are among the most popular technologies: geothermal energy, solar energy, wind energy, hydropower energy and biomass (Beccali et al, 1998; Krukanont & Tezuka, 2007; Dicorato et al, 2008; Tsoutsos et al, 2009).

1. **Geothermal energy** derived from the Earth's heat reservoirs and is manifested through natural phenomena such as fumaroles, geysers, volcanoes, and hot springs. Its potential lies in the vast reserves stored beneath the Earth's surface, accessible within the upper 10 km of the crust, which is characterized by a mean temperature gradient of 20 to 30°C/km depth (Kruger, 2006).
2. **Solar energy** is originating from the sun, which functions as a continuous fusion reactor, emitting energy across the solar system. Kruger (2006) identifies several exploitable variants of solar energy, including direct beam (thermal) radiation, diffuse (thermal) radiation scattered by clouds, and secondary forms converted to biomass, wind energy, and hydropower.
3. **Wind energy** is a significant contributor to global energy production. The growth of wind energy can be attributed to advancements in offshore wind farm projects and investors' perception of wind energy as a relatively mature, low-risk sector within the green energy landscape (San Cristobal, 2011).
4. **Hydropower** is the most prominent source of renewable energy, accounting for 94% of renewable energy production and meeting 20% of global energy needs (Ansel & Robyns, 2006). Large-scale hydroelectric installations, which have been operational for a century, are facing challenges related to site availability and environmental considerations.
5. **Biomass,** derived from forestry, agriculture, and municipal residues, as well as dedicated energy crops, is available in solid, liquid, and gaseous forms, and constitutes a significant share of global primary energy production.

In addition to these five categories from the theory, there may be other technologies that do not fit within them. Therefore, I have added another category for these technologies. Examples of such technologies include those that use air to extract heat.

6. **Others** like air heating systems harness the inherent warmth of surrounding air to deliver heating. These systems commonly circulate air through ducts or pipes, where it undergoes heating before dispersing throughout a structure. Another example is neighbourhood heating (Dutch: stadverwarming), where sustainability hinges greatly on the heat source's nature.

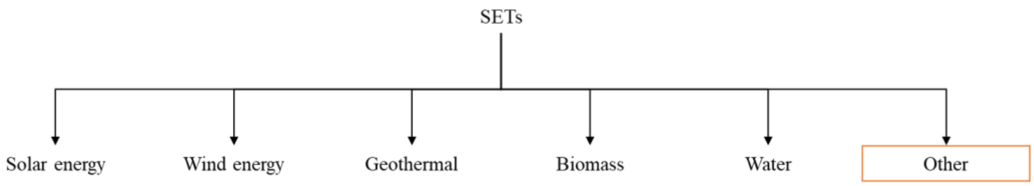


Figure 14: Sustainable Energy Technologies (SETs) sources. Adapted from: Beccali et al, 1998; Krukanont & Tezuka, 2007; Dicorato et al, 2008; Tsoutsos et al, 2009

The energy sources each have their own individual and collective technologies, each with their own techniques. This creates a complex and extensive landscape. When examining the common Sustainable Energy Technologies (SETs) within those categories that are suitable for the case, the following table is observed (see appendix 1 for complete table):

Individual Sustainable Energy Technologies (SETS)

Energy source	Technology	Techniques
Solar energy	Photovoltaics (PV)	• Monocrystalline solar panels: Use single-crystal silicon for high efficiency. • Polycrystalline solar panels: Made from multiple silicon crystals, are less efficient but cheaper. • Thin-film solar panels: Use layers of semiconductor materials applied to a substrate, offering a flexible solution with varying efficiencies. • Building-integrated photovoltaics (BIPV): Incorporate PV materials into building structures, like windows or facades.
	Solar water heating systems	• Flat-plate collectors: Insulated, weatherproofed boxes containing a dark absorber plate under one or more transparent or translucent covers. • Evacuated tube collectors: Use transparent tubes that encase absorber plates, providing insulation and higher efficiencies. • Thermosiphon systems: Utilize the tendency of water to circulate as it is heated, without the need for pumps.
Wind energy	Wind turbines (small-scale) / Horizontal-axis wind turbines (HAWTs)	• Pitch control: Adjusting the angle of the blades to control the rotor speed. • Yaw control: Rotating the turbine around a vertical axis to align with the wind direction. • Active stall control: Adjusting the blade pitch to reduce the aerodynamic force on the blade.
	Vertical-axis wind turbines (VAWTs)	
Geothermal	Open-loop geothermal heat pump (GHP) systems	• Direct use systems: Use the geothermal water directly for heating without a heat pump. • Ground source heat pumps: Use the stable ground temperature to heat in winter and cool in summer.
	Closed-loop geothermal heat pump (GHP) systems	
Biomass	Biomass boilers	• Combustion: Burning biomass to heat water and create steam for turbines or heating. • Gasification: Converting biomass into a combustible gas mixture for more efficient energy recovery. • Anaerobic digestion: Breaking down biomass in the absence of oxygen to produce biogas.
Water	Micro-hydro power systems	• Impulse turbines: Use the velocity of water to move the turbine and are used in high head, low flow situations. • Reaction turbines: Use the pressure of water to generate energy and are typically used in low head, high flow settings.
Other	Air-to-Air heat pump	• Air-Source Heat Pumps: extract heat from the outdoor air using a refrigerant cycle and transfer it indoors to provide space heating. They can also be reversed to provide cooling during warmer seasons.
	Air-to-Water heat pump	• Air-source heat pumps: Extract heat from the outdoor air and transfer it indoors for space heating. • Water heating: Utilize heat from the outdoor air to heat water for domestic use. • Defrosting mechanisms: Implement systems to prevent frost buildup on outdoor coils during cold weather.

Collective Sustainable Energy Technologies (SETS)

Energy source	Technology	Techniques
Solar energy	Concentrated Solar Power (CSP)	• Parabolic troughs: Use parabolic mirrors to focus sunlight on a receiver tube. • Solar power towers: Use a field of mirrors that track the sun and focus light on a central receiver. • Dish Stirling systems: Use parabolic dish mirrors to focus light on a Stirling engine for power generation.
	Community solar projects/ Photovoltaics (PV)	• Net metering: Allows community members to feed excess energy into the grid and receive credit. • Virtual net metering: Participants receive bill credits for their share of the power produced.
Wind energy	Community wind farms/ Horizontal-axis wind turbines (HAWTs)	• Pitch control: Adjusting the angle of the blades to control the rotor speed. • Yaw control: Rotating the turbine around a vertical axis to align with the wind direction. • Active stall control: Adjusting the blade pitch to reduce the aerodynamic force on the blade.
	Community wind farms/ Vertical-axis wind turbines (VAWTs)	
Geothermal	Geothermal power plants	• Dry steam plants: Directly use steam from geothermal reservoirs to turn turbines. • Flash steam plants: Lower the pressure of hot water to create steam for turbines. • Binary cycle power plants: Use the heat from geothermal water to vaporize a secondary fluid with a lower boiling point to turn turbines.
	Open-loop geothermal heat pump (GHP) systems	• Direct use systems: Use the geothermal water directly for heating without a heat pump. • Ground source heat pumps: Use the stable ground temperature to heat in winter and cool in summer.
	Closed-loop geothermal heat pump (GHP) systems	
Biomass	Biomass power plants	• Pyrolysis: Heating biomass in the absence of oxygen to produce bio-oil for energy.
Water	Conventional hydropower	• Kaplan turbines: Adjustable blades for variable flow conditions, often used in run-of-river installations. • Francis turbines: Used in a wide range of head and flow conditions, common in conventional hydropower.
	Run-of-river hydropower	
	Wave energy	• Oscillating water columns: Use air displacement by wave-driven water in a column to drive turbines. • Point absorbers: Float on the surface and absorb energy from all directions.
	Ocean thermal energy conversion (OTEC)	• Closed-cycle OTEC: Uses warm surface water to vaporize a working fluid, which drives a turbine to generate electricity. • Open-cycle OTEC: Vaporizes seawater itself to drive the turbine. • Hybrid systems: Combine both closed and open cycles for increased efficiency.
	Tidal power	• Barrage systems: Use dams to capture the potential energy from the rise and fall of tides. • Tidal stream generators: Underwater turbines that capture kinetic energy from tidal currents.
Other	Neighbourhood heating *(dutch: stadverwarming) (Sustainability depends on the source of heat)*	• Combined heat and power (CHP): Simultaneous production of electricity and useful heat, improving overall efficiency. • Heat networks: Distribute heat generated from various sources to multiple buildings.

Table 3: individual and collective SETs. Source: Own illustration

4.2.2 Discussion and Conclusion

The analysis of Sustainable Energy Technologies (SETs) in the housing sector has identified key technologies for sustainable energy provision. The sub question, "What Sustainable Energy Technologies (SETs) can be used in the housing sector for individual and collective purposes?" guides the exploration into the diverse array of SETs available for retrofit housing projects.

The key energy sources include geothermal energy, solar energy, wind energy, biomass, water-based systems, and others, offering diverse opportunities for energy generation and utilization at both individual and collective levels. Geothermal energy utilises the Earth's heat reservoirs through innovative systems, including open-loop and closed-loop water source heat pumps. This presents a reliable and efficient option for heating and cooling residential spaces. Similarly, solar energy solutions, such as photovoltaics and solar water heating systems, offer versatile alternatives for electricity and heat generation tailored to household needs. Wind energy, facilitated by horizontal-axis and vertical-axis wind turbines, is a prominent source of renewable electricity generation. It complements other SETs in a holistic energy strategy. Biomass and water-based systems also enrich the sustainable energy landscape, providing avenues for diverse energy production methods, including combustion, gasification, anaerobic digestion, and hydropower generation.

SETs can be designed with a variety of configurations, either relying solely on one energy source or integrating multiple sources. In a single-source system, only one type of power generation, is utilized along with appropriate energy storage and electrical components. A hybrid energy system combines energy storage and electrical devices with two or more power generation options, which may include both renewable and non-renewable sources, such as diesel generators or small gas turbines (Farghali et al., 2023).

Various configurations, such as photovoltaic–wind–diesel, hydro–wind–photovoltaic, biomass–wind–photovoltaic, wind–photovoltaic, and photovoltaic–wind–hydrogen/fuel cell systems, can be employed in a hybrid energy system to produce electricity. Hybrid systems offer several benefits compared to single-source approaches, such as enhanced reliability, reduced dependency on energy storage, and increased efficiency. However, it is important to note that improper sizing or design of a hybrid system can lead to higher installation costs. Therefore, it is crucial to conduct comprehensive technical and financial analyses when planning and implementing a hybrid energy system to effectively harness renewable energy sources. Due to their complexity, the systems require careful evaluation (Farghali et al., 2023).

The identified SETs are established and widely utilized in the housing sector. However, it is important to acknowledge the dynamic nature of the sustainable energy landscape. Emerging and exotic technologies, not captured within the confines of this study, continually enrich the spectrum of available options. Novel technologies, including advanced materials, energy storage solutions, and innovative energy conversion techniques, have the potential to revolutionise the way we generate, distribute, and consume energy in residential settings. The integration of different SETs can enhance performance, resilience, and sustainability. The housing sector can address pressing environmental challenges and create resilient communities for future generations by embracing innovation and fostering collaboration across disciplines to harness the full potential of Sustainable Energy Technologies.

In conclusion, the housing sector can benefit from a diverse range of SETs that cater to both individual and collective energy needs. By embracing innovation, fostering collaboration, and conducting thorough analyses, stakeholders can effectively harness the full potential of SETs to promote sustainability and resilience in retrofit housing projects.

4.3 SQ2: Factors influencing individual vs. collective Sustainable Energy Technologies (SETs) implementation

The implementation of Sustainable Energy Technologies (SETs) in housing projects requires a comprehensive evaluation of various factors to determine the most appropriate approach, whether individual or collective. This section explores the complex landscape of decision-making factors that influence the selection of individual or collective SETs implementation strategies, specifically within the context of the retrofit project at Campus UT Enschede.

4.3.1 Evaluation of SETs

To identify potential SETs for the retrofit project, a comprehensive review of literature and case studies was conducted. Various sources, including academic journals, industry reports, and technical documents, were consulted to gather information on available SETs suitable for residential buildings. Insights from experts in the field of sustainable energy and building retrofitting were sought to ensure a thorough understanding of the latest advancements and best practices in SETs implementation.

Many factors are involved in the decision-making process. As the complexity of decisions increases, it becomes more difficult to determine an alternative that will meet or maximise needs. Energy assessments must deal with attributes that are difficult to define and components that may involve both quantitative and qualitative factors and it goes beyond mere economics. The evaluation should cover technical, economic, or environmental issues that may not be easily identifiable, as well as socio-economic factors that affect the needs of different interest groups or stakeholders. In view of these difficulties, Demirtas (2013) and San Cristóbal (2011) identifies four dimensions associated with sustainable energy planning indicators as collected from the literature: technical, economic, environmental, and social aspects (see table 4). These align with the Triple Bottom Line (TBL) framework. This framework highlights economic, environmental, and social aspects, and in which each dimension holds significant importance in assessing the holistic impact of building retrofits on the ecosystem as a whole. And enriches it with the technical aspects of the technology with the factors involved.

Indicator	Criteria
Technical	Energy Production Capacity
	Technological Maturity
	Reliability
	Safety
Economical	Investment Cost
	Operation and Maintenance Cost
	Service Life
	Payback Period
Environmental	Impact on Ecosystem
	CO_2 Emission
Social	Social Benefits
	Social Acceptability
Legal & regulations	

Table 4: List of evaluation criteria for sustainable energy planning. Adapted from: Demirtas (2013)

The assessment of the institutional framework that supports the effectiveness and efficiency of energy systems involves the use of technical indicators. These metrics are used to measure the availability and adequacy of the institutional infrastructure in facilitating the optimal functioning of energy systems. The economic indicators appraise the influence of energy utilization and production patterns, as well as the quality of energy services, on economic development progression (Demirtas, 2013). Additionally, they ascertain the extent to which advancements in the energy sector and its corresponding trends contribute to fostering sustainable economic development pathways.

Environmental indicators are important for evaluating the environmental impact of energy systems. They quantify both positive and negative trends in land, freshwater and marine ecosystems, and air quality. This provides insights into the overall impact of energy systems on the environment (Demirtas, 2013).

Furthermore, the availability of energy services has a multifaceted impact on various dimensions of human well-being, including poverty levels, employment opportunities, educational attainment, community development, cultural preservation, demographic transitions, indoor pollution levels, and overall public health. Therefore, social indicators are used to evaluate the broader impact of energy systems on human welfare and societal development trajectories (Demirtas, 2013).

In the evaluation criteria outlined by Demirtas (2013), a notable absence is the consideration of regulation and legal factors. While the dimensions identified by Demirtas provide a comprehensive framework for evaluating sustainable energy planning, the oversight of regulatory and legal aspects is a significant gap.

Regulation and legal factors play a crucial role in shaping the feasibility and implementation of SETs. Government policies, regulations, and legal frameworks directly impact the adoption and deployment of SETs in residential buildings. These factors influence incentives, subsidies, permitting processes, building codes, and compliance requirements, all of which affect the economic viability and scalability of SETs. Without proper consideration of regulation and legal factors, the evaluation of SETs lacks a critical dimension necessary for assessing their real-world applicability and potential barriers to adoption.

By failing to consider the role of regulation and legal factors, the evaluation criteria may provide an incomplete picture of the challenges and opportunities associated with sustainable energy planning. Incorporating this dimension into the evaluation criteria would enhance the comprehensiveness and accuracy of assessments, enabling stakeholders to make more informed decisions regarding the selection and implementation of SETs.

This study primarily examines the economic indicators of SETs. However, it is important to acknowledge that a comprehensive assessment must also consider other essential aspects. Therefore, this study also incorporates considerations of various dimensions beyond purely economic factors.

4.3.2 Limitations and considerations

When evaluating and selecting Sustainable Energy Technologies (SETs) for retrofit housing, it is important to consider various limitations and factors that may affect their implementation and effectiveness. Based on the evaluation of Demirtas (2013) there are also limitations include technical, economic, environmental, social, and Regulation and legal aspects, all of which are crucial in determining the suitability and feasibility of SETs in specific contexts.

Technical limitations

The integration of SETs into existing buildings depends on their technical feasibility and compatibility with the infrastructure and systems already in place (Ellabban et al., 2014). It is important to assess whether the building's design, layout, and condition can effectively accommodate the installation and operation of SETs. However, the diverse nature of building structures poses challenges as certain SETs may require specific conditions or modifications to existing infrastructure for optimal performance.

For example, the installation of solar photovoltaic (PV) systems can be hindered by several factors, despite offering a promising avenue for renewable energy generation. Shading from nearby structures or greenery can significantly reduce the energy output of PV panels (Piacentino et al., 2019). Therefore, careful site analysis is necessary to maximize exposure to sunlight. Additionally, variations in roof orientation and angle can impact the efficiency of solar panels. This requires customized design solutions to optimize energy capture based on the building's specific characteristics.

Likewise, the installation of heat pumps, a commonly used option for heating and cooling in sustainable buildings, may face difficulties in buildings with limited space or complex layouts. Heat pumps need sufficient space for installation, ventilation, and efficient heat exchange processes. Upgrading older buildings with space constraints to accommodate heat pump systems may require structural modifications and meticulous planning to ensure proper functionality and performance.

Another important consideration is the structural integrity of the building to support the installation of SETs. For example, the addition of rooftop solar panels or wind turbines necessitates a sturdy framework capable of bearing the additional weight and wind loads imposed by these systems. To ensure the safe and reliable operation of SETs without compromising the building's stability, it is essential to assess the building's load-bearing capacity and conduct structural reinforcements if necessary.

Additionally, integrating SETs with existing building systems, such as electrical grids, HVAC systems, and controls, requires careful coordination and compatibility assessments. Ensuring seamless communication and interoperability between SETs and building automation systems is vital to optimize energy performance and achieve synergies in energy management (Ellabban et al., 2014).

Economic considerations

Regarding the economic considerations of implementing SETs, the financial landscape plays a crucial role in shaping the decision-making process for investors. Although the long-term benefits of energy savings and environmental impact reduction are appealing, the upfront costs often act as a deterrent to the widespread adoption of SETs in retrofit projects (Ellabban et al., 2014). Short-term financial gains often take precedence over long-term sustainability goals, creating a challenging dynamic that needs to be carefully navigated.

The substantial initial investment requirements associated with SETs can pose significant challenges for investors, particularly in the context of competing priorities and constrained budgets. Allocating resources towards implementing SETs can lead to difficult decisions (Ellabban et al., 2014). Stakeholders must weigh the potential benefits against the immediate financial implications. To achieve this balance, a comprehensive financial analysis is necessary. This analysis should consider not only the projected energy savings and environmental benefits but also the opportunity costs and risks associated with investing in SETs.

Furthermore, the financial feasibility of SETs is complicated by uncertainties related to future energy prices and regulatory incentives. Variations in energy costs and evolving government policies can add complexity to the financial planning process, necessitating a proactive approach to risk assessment and scenario analysis. Building owners and developers must carefully evaluate the potential impacts of these external factors on the cost-benefit equation of SETs implementation, ensuring that the investment remains viable and sustainable in the long run. It is even possible for a product to retain residual value over time.

Considering these challenges, it is essential for stakeholders involved in retrofit projects to adopt a proactive and strategic approach to addressing the economic considerations associated with SETs. This involves performing comprehensive cost-benefit analyses, investigating financing options and incentives, and collaborating with financial experts to create inventive funding models. By utilizing financial tools and strategies customized to the specific requirements of SETs projects, investors can overcome obstacles, unlock opportunities for sustainable investment, and pave the way for a more durable and energy-efficient built environment.

Environmental implications

SETs provide potential solutions for reducing carbon emissions and enhancing environmental sustainability in the built environment. However, the deployment and lifecycle of these technologies also raise significant environmental considerations that must be carefully addressed to ensure overall sustainability. It is important to note that the production of SETs can have environmental impacts that need to be considered.

The production processes of components used in renewable energy systems, such as solar panels, wind turbines, and energy storage systems, can have significant environmental implications. This is due to the carbon emissions and resource depletion resulting from the extraction of raw materials, manufacturing processes, and supply chain logistics involved in producing these technologies (Turkenburg et al., 2000). For example, the manufacture of solar panels often involves the use of rare earth metals and toxic chemicals, which can have negative environmental impacts if not handled responsibly. Furthermore, if the manufacturing processes for SETs are not powered by renewable sources, they can contribute to greenhouse gas emissions due to their energy-intensive nature. It is important to note that transportation poses additional challenges.

Transporting SET components from manufacturing facilities to installation sites is a critical consideration. Long-distance transportation by trucks, ships, or planes can result in additional carbon emissions and energy consumption, offsetting some of the environmental benefits that these technologies aim to provide (Turkenburg et al., 2000). Strategies to optimise logistics, reduce transportation distances, and prioritise sustainable modes of transport can help minimise the environmental footprint associated with the transportation phase of SET deployment.

Land use considerations are important in biomass energy production. Biomass energy is derived from organic material such as wood, agricultural waste, and dedicated energy crops. It offers renewable energy solutions with the potential to reduce carbon emissions and promote environmental sustainability. However, the production and use of biomass for energy generation raises important land-use considerations that require attention in the context of environmental impacts associated with SETs (Turkenburg et al., 2000).

Proper disposal and end-of-life management of SET components are essential to prevent environmental harm and maximise resource recovery. Many SET technologies have long lifespans, but eventually they will need to be decommissioned. It is crucial to recycle or dispose of these components in an environmentally responsible manner to minimize waste generation and pollution. Additionally, the development of recycling technologies for materials used in SETs, such as lithium-ion batteries in energy storage systems, can help mitigate resource depletion and reduce the environmental impact of their disposal.

Social and cultural factors

Exploring the impact of social acceptance and cultural factors on the adoption and success of SETs within communities requires an examination of the complex dynamics that shape how these technologies are perceived, embraced, and integrated into society.

One common obstacle that can hinder the implementation of SETs in communities is resistance to change (Ellabban et al., 2014). People may resist adopting new technologies due to a fear of the unknown, concerns about disruptions to their daily routines, or scepticism about the effectiveness of the proposed solutions. To address this resistance, targeted efforts are required to educate, inform, and engage community members in dialogues that foster understanding, trust, and a shared vision for a sustainable future powered by SETs.

It is important to raise awareness of the benefits of SETs and their potential to contribute to a sustainable future. Limited awareness of the benefits, functionalities, and potential of SETs can impede their adoption and utilization in communities. Individuals may not fully comprehend the significance of transitioning to sustainable energy solutions or may be unaware of the available options that can help reduce carbon footprints and energy consumption.

Considerations related to aesthetics, noise, and perceived risks: public perception and acceptance of SETs installations can be influenced by aesthetic concerns, noise considerations, and perceived risks (Ellabban et al., 2014). Community members may express reservations about the visual impact of solar panels or wind turbines, the noise generated by certain energy systems, or safety risks associated with innovative technologies. Achieving a balance between sustainability and community preferences and concerns requires a nuanced approach that considers local aesthetics, noise regulations, and risk mitigation strategies. This ensures that SETs installations blend in with their surroundings, minimize disruptions, and gain trust and acceptance from end-users.

Regulation and legal factors

The implementation of SETs in retrofit projects is significantly influenced by regulatory and legal factors. The approval process for SET installation is governed by permitting and zoning regulations. Distinctions between individual and collective requirements may introduce complexities in navigating regulatory frameworks (Demirtas, 2013). Grid interconnection agreements govern the conditions for energy exchange between SET owners and grid operators. Individual net metering regulations encourage individual ownership, while collective agreements promote aggregated energy resources (Wang et al., 2009).

Clear and comprehensive contractual agreements are crucial for shared ownership, operation, and maintenance of SET systems in collective approaches. These agreements should address rights, responsibilities, and liabilities to ensure equitable distribution of costs and benefits (Wang et al., 2009).

Retrofit projects can overcome regulatory hurdles and unlock opportunities for sustainable energy transformation by proactively addressing regulatory requirements and engaging relevant stakeholders.

To address these limitations and considerations, it is crucial to take a holistic and interdisciplinary approach that integrates technical expertise with economic analysis, environmental assessment, and stakeholder engagement. By carefully evaluating and mitigating potential challenges, retrofit projects can maximize the benefits of implementing SETs while minimizing risks and ensuring sustainable outcomes.

4.3.3 Factors affecting individual SETs implementation

When selecting SETs for building retrofits, it is important to consider whether individual or collective systems should be implemented. Individual SETs are installed on a building level innervations basis, while collective SETs serve multiple buildings or an entire community. This section provides an overview of the distinction between individual and collective SETs, highlighting their respective benefits, challenges, and considerations in the context of building retrofits.

Individual SETs are typically installed within the confines of a single building and serve the energy needs of that specific structure. Examples of individual SETs from table 2 include rooftop solar panels, ground source heat pumps for heating and cooling, and biomass boilers for localised energy production. These technologies provide building-level energy solutions and give occupants greater control over their energy consumption and production.

Benefits of individual SETs

- ***Customisation:*** Individual SETs can be tailored to the specific needs and energy requirements of each building, enabling customised solutions that optimise energy efficiency and performance (Vink, personal communication, March 1, 2024).
- ***Independence:*** By installing individual SETs, buildings can achieve greater energy independence and resilience, reducing reliance on centralised energy grids and mitigating the risk of supply disruption (Vink, personal communication, March 1, 2024).
- ***Flexibility and scalability:*** Individual SETs offer flexibility and scalability in deployment, allowing for incremental investments and phased implementation strategies tailored to the unique needs and priorities of each building. The investment cost can be split up in different phases. And this way, problems can also be solved individually which can reduce costs.

Challenges of individual SETs

- ***Space limitations:*** The installation of individual SETs may be constrained by available space on rooftops or within building footprints, limiting the capacity for energy generation or storage (Vink, personal communication, March 1, 2024).
- ***Maintenance responsibility:*** Building owners are responsible for the maintenance and upkeep of individual SETs, including regular inspections, repairs, and replacement of components, which can add costs and administrative burdens. It is crucial to identify the owners of the building or dwellings.

4.3.4 Factors affecting collective SETs implementation

In contrast, collective SETs serve multiple buildings or an entire community, providing centralised energy solutions that distribute thermal or electrical energy to multiple users. Examples of collective SETs include neighbourhood heating and cooling systems, community solar projects and microgrid networks. These technologies offer scalability and efficiency benefits by aggregating energy resources and optimising their use over a wider area.

Benefits of collective SETs

- ***Economies of scale****:* Collective SETs benefit from economies of scale by leveraging shared infrastructure and resources to achieve cost efficiencies in energy production, distribution, and maintenance (Oliveira et al., 2023; Vink, personal communication, March 1, 2024).

- ***Resource optimisation:*** By aggregating energy demand and supply across multiple buildings, Collective SETs can optimise the use of renewable energy resources, maximise energy efficiency and minimise waste (Oliveira et al., 2023).
- ***Community benefits:*** Collective SETs promote community engagement and collaboration, fostering a sense of ownership and shared responsibility for energy sustainability goals. They can also promote social cohesion and equity by providing equitable access to renewable energy resources and benefits (Oliveira et al., 2023).

Challenges of collective SETs

- ***Complexity:*** Implementing collective SETs requires coordination and collaboration between multiple stakeholders, including building owners, utilities, local authorities, and community members, which can create complexity and logistical challenges (Oliveira et al., 2023).
- ***Regulatory hurdles:*** Regulatory frameworks and legal considerations can be barriers to implementing collective SETs, requiring careful navigation of permitting, zoning, and interconnection requirements (Vink, personal communication, March 1, 2024).
- ***Risk sharing:*** Collective SETs entail shared risks and liabilities among participating stakeholders, requiring clear agreements and governance structures to manage responsibilities and mitigate potential conflicts (Vink, personal communication, March 1, 2024).

4.3.5 Variables affecting individual vs. collective Sustainable Energy Technologies (SETs) implementation

This chapter applies the conceptual framework from Chapter 3.2 to practice, identifying variables that influence the implementation of individual and collective Sustainable Energy Technologies (SETs). The variables in question have been derived from an extensive literature review and empirical findings, as described in Chapters 2 and 4. These factors have the potential to impact the financial value of SETs in a variety of ways. In one way or another.

The case study highlights the pivotal role of location and building characteristics in the successful implementation of SETs. Geographical positioning, climatic conditions, building orientation, and available space exert a significant influence over the feasibility and efficacy of both individual and collective SETs, ultimately impacting their financial viability. Furthermore, the physical attributes of the building, including aspects such as roof type, size, and structure, exert a significant influence on the selection and financial valuation of SETs. Furthermore, the presence of pre-existing infrastructure, such as electricity grids, heat networks, and water pipes, can either facilitate or impede the implementation of SETs. Ensuring compatibility and seamless integration with existing systems emerges as a critical consideration for both individual and collective applications, significantly impacting their financial worth.

The spectrum of SETs encompasses diverse technical and physical specifications, including power, efficiency, lifespan, and maintenance requisites, all of which dictate their suitability and performance across varying environments. A profound comprehension of these specifications is indispensable for selecting and designing optimal SET solutions. Furthermore, the environmental ramifications of SETs, encompassing factors such as CO2 emissions, energy consumption, and resource utilisation, emerge as pivotal considerations in implementation decisions. Comparative assessment of the environmental footprint between individual and collective SETs yields valuable insights into their sustainability benefits and constraints.

The financial value of SETs is contingent upon a number of factors. Financial costs, which include initial investment outlay, operational expenditures, and payback duration, serve as pivotal metrics in evaluating SET implementation. Comparative cost analysis between individual and collective SETs provides nuanced perspectives on their economic viability and return on investment. Furthermore, the long-term financial benefits of SETs, such as energy savings, cost mitigation, and enhancement of building value, are of significant importance to both investors and building owners. A systematic analysis of these benefits can be used to justify SET implementation and to optimise financial outcomes. Finally, market dynamics, which include factors such as supply, demand, competition, and regulatory frameworks, exert a profound influence on the adoption and proliferation of SETs in the market. A nuanced understanding of these dynamics is therefore essential for the identification of opportunities and the overcoming of challenges associated with both individual and collective SET implementations.

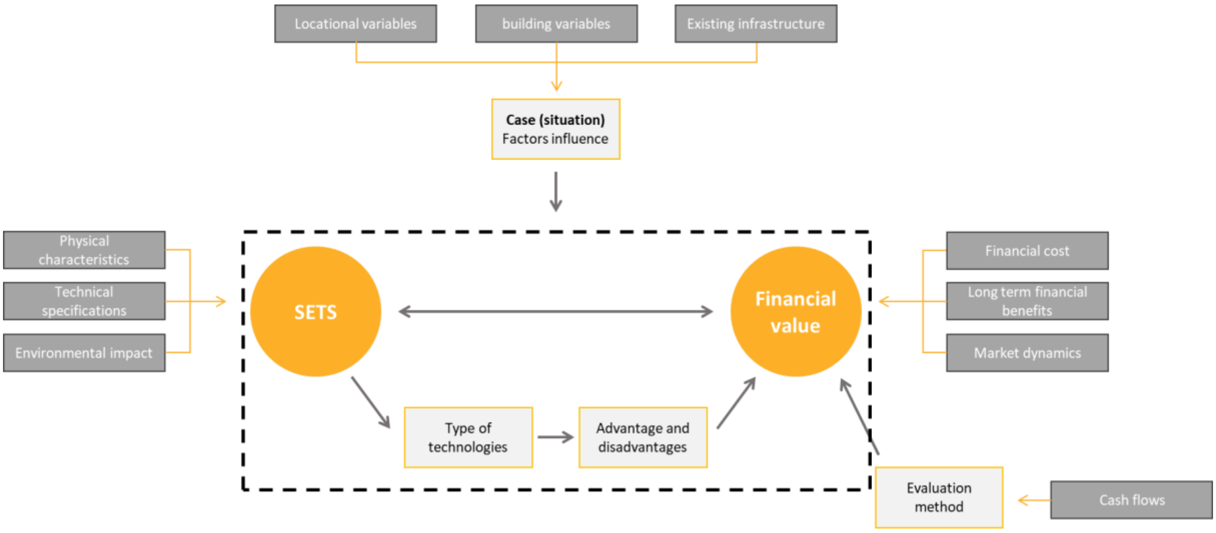


Figure 15: Research framework with variables. Source: Own illustration

Each of these variables has been carefully selected and defined based on their pertinence to the SET implementation and their ability to be empirically measured. These variables have been integrated into the research framework, which is shown in Figure 15, with the aim of facilitating a comprehensive and holistic understanding of the factors influencing the implementation of SETs. By quantifying and analysing these variables, an in-depth understanding of the advantages and disadvantages of both individual and collective SET applications in different contexts can be gained. The variables are divided into units to make them measurable, as shown in Table 5 (see appendix 2 for complete table).

Case study	Variable (Imput)	Unit
Locational variables		
	Transportation acces	Meters
	Neighborhood Index	Index Value
	Proximity to urban center	Meters
	Average price	€
	Availability of (Energy) source(s)	Categorical: Geothermal, solar, wind, hydropower and/ or biomass
	Biodiversity Index	Index value
	Regulatory compliance	Categorical: Compliance Status
Building variables		
	Population occupation	Working professionals, students, retirees, unemployed individuals
	Architectrual style	Non, national, provincial, and municipal monuments
	Age and condition	Years
	Energy Performance	kWh/m²/year
	Construction quality	Scale (good- bad)
	Building size	m2
Existing infrastructure		
	Transportation network	Quality and capacity scale
	Water systems	Capacity (liters per day), Quality (scale)
	Electrical grids	kW capacity
	Compatibility	Compatibility scale (good-bad)
	Future expansion	Expansion potential scale (low-high)
	Existing capacity	kW capacity, physical space
	Hydrogen and/ or green gas infrastructure	Categorical: hydrogen, green gas, or none

SETS	Variable (Impute)	Unit
Physical characteristics		
	Land requirement	m2/kW
	Room configuration	m2
	Noise	dB
	Vibration	Peak Particle Velocity (PPV)
Technical specifications		
	Capacity	kW
	Ownership	Categorical: private, public, cooperative
	Scalability	Scalability scale (low-high)
	Lifetime	Years
	Compatility with existing grid	Compatibility scale (good-bad)
Environmental impact		
	Environmental impact	LCA score

Evaluation method	Variable (Imput)	Unit
Cash flows		
	IRR, NPV	%, €
	Inflation Rate	%

Financial value	Variable (Imput)	Unit
Financial cost		
	Inital investment	€
	Operational expenses	€/ year
	Opportunity cost	€
Long term financial benefit		
	Savings streams	€/ year
	Revenue streams	€/ year
	Replacement and disposal Costs	€
Market dynamics		
	Demand	Volume (units/year)
	Supply	Volume (units/year)

Table 5: Variable and units influencing decision making of SETs. Source: Own illustration

4.3.6 The interrelationships between the different factors

Understanding the interrelationships between various factors that influence the implementation of Sustainable Energy Technologies (SETs) is crucial for devising effective strategies and achieving sustainable outcomes. This section examines the interplay between technical, economic, environmental, and social in the context of SET projects.

Technical considerations:

Technical factors, including building characteristics, energy performance, and infrastructure compatibility, determine the feasibility and effectiveness of SET integration (Wang et al., 2009). Building age and condition may require retrofitting measures to accommodate SETs, while energy performance metrics inform the sizing and optimization of energy systems. Additionally, compatibility with existing infrastructure, such as electrical grids and water systems, is essential for seamless integration and optimal performance of SETs.

Economic impact:
Economic factors, such as average property prices, regulatory compliance costs, and financial incentives, also have a direct impact on the feasibility and attractiveness of SET projects. Higher property prices in urban areas may incentivise investments in energy-efficient technologies. However, regulatory barriers could pose challenges to projects. Additionally, the availability of funding mechanisms and financial models, such as energy performance contracting, influences the affordability and accessibility of SETs for different stakeholders.

Market factors, such as demand-supply dynamics, consumer preferences, and regulatory frameworks, shape the market acceptance and penetration of SETs. Understanding market demand drivers, including energy efficiency goals and carbon reduction targets, is crucial for identifying market opportunities and addressing barriers to adoption. Moreover, technological advancements and innovations in SETs influence market competitiveness and differentiation strategies among industry players.

Environmental impact:
The sustainability of SET projects is affected by various factors, including the availability of renewable energy sources, biodiversity conservation goals, and compatibility with existing infrastructure. The use of local renewable energy resources, such as solar and wind, can help to reduce greenhouse gas emissions and decrease reliance on fossil fuels. However, it is important to carefully assess the environmental impact of SET deployment through life-cycle assessments to identify potential trade-offs and minimize adverse effects on ecosystems and biodiversity.

Social impact:
Social factors, such as transportation access, neighbourhood characteristics, and population demographics, significantly influence the acceptance and adoption of SETs. Improved transportation infrastructure enhances accessibility and convenience, positively impacting community cohesion and well-being. Furthermore, energy consumption patterns and preferences for SET solutions are significantly influenced by community demographics such as occupation and age distribution.

Regulation and legal impact:
The regulation and legal impact on SETs is hindered by inflexible frameworks that struggle to keep pace with technological advancements, leading to fragmented and contradictory regulations. This lack of harmonisation across jurisdictions exacerbates complexity and undermines scalability. Moreover, social equity considerations often remain overlooked, contributing to resistance and opposition. Addressing these deficiencies requires fostering greater regulatory agility, coherence, and inclusivity to enable technically feasible and socially just energy transitions.

These factors interact not only between social, economic, environmental, technical, and regulation and legal but also with each other. Figure 16 illustrates how these variables influence each other and what depends on what.

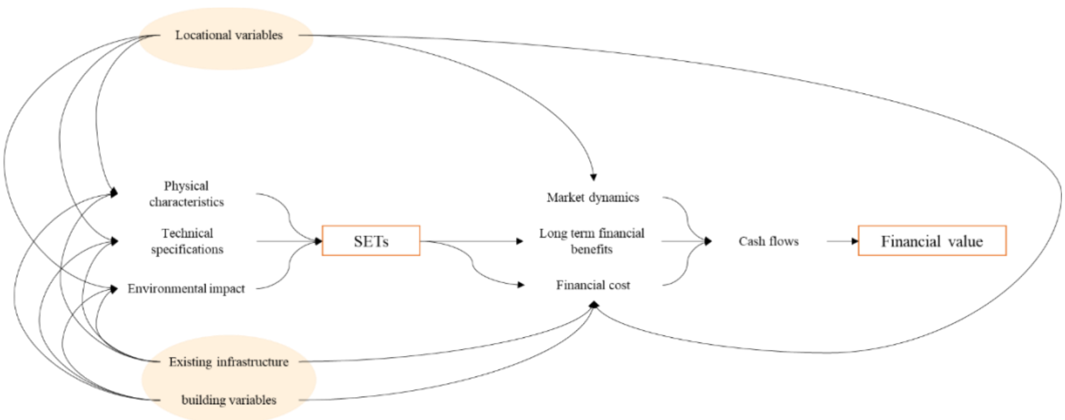


Figure 16: Interrelationships between variables. Source: Own illustration

4.3.7 Discussion and Conclusion

The evaluation of factors influencing the choice between individual and collective Sustainable Energy Technologies (SETs) implementation in housing projects reveals a multifaceted landscape that requires careful consideration. This discussion synthesises the findings and addresses the sub question, "What Sustainable Energy Technologies (SETs) can be used in the housing sector for individual and collective purposes?"

The decision to implement individual or collective SETs in housing projects is influenced by various factors, including technical feasibility, regulatory compliance, financial viability, community engagement, and long-term flexibility. The variable discussed in Figure 14 and expanded in Table 5 initially serve to identify which SETs are possible and in which way they affect the financial value. Figure 16 illustrates that these factors are interconnected. This illustrates that a complex network of interrelated factors is involved. When one factor is altered, all other factors are concomitantly affected. This renders the equation highly complex. This makes the equation complex.

Individual SETs provide customization and direct benefits to building occupants, while collective SETs offer opportunities for cost efficiencies, resource optimization, and community collaboration. To align implementation strategies with overarching sustainability goals, stakeholders must balance the trade-offs between autonomy and shared benefits.

Community engagement is a critical success factor for SETs projects, with stakeholder preferences, social equity considerations, and transparent communication shaping acceptance and adoption. Targeted efforts to educate, inform, and engage community members are essential for fostering understanding, trust, and a shared vision for sustainable energy solutions. It is paramount to address aesthetic concerns, noise considerations, and perceived risks to gain public acceptance and support for SET installations.

The decision-making process is heavily influenced by financial considerations, with investment decisions guided by funding availability, risk sharing, and return on investment (ROI) analysis. Although individual projects may encounter upfront investment barriers, collective approaches provide opportunities for risk sharing and economies of scale. To evaluate the long-term financial implications of SET implementation and overcome investment hurdles, stakeholders must conduct comprehensive cost-benefit analyses and explore innovative funding models.

The regulatory landscape has a significant impact on the implementation of SETs. Permitting and zoning regulations, grid interconnection agreements, and contractual arrangements all influence decision-making. Clear and comprehensive contracts are essential for navigating shared ownership, operation, and maintenance responsibilities in collective approaches. Throughout the project lifecycle, stakeholders must ensure compliance with evolving regulatory frameworks to mitigate legal risks.

A forward-thinking approach is imperative to ensure the long-term sustainability and resilience of SETs projects. It is important to develop adaptive strategies that can evolve with changing needs and regulations. To future-proof SETs implementations and maximize their long-term impact, stakeholders must consider future scalability, technological advancements, and compatibility with existing infrastructure. To achieve this, stakeholders must anticipate future challenges and opportunities.

In conclusion, the decision between implementing individual or collective SETs requires a holistic assessment of technical, economic, environmental, social, and regulatory factors. By navigating regulatory complexities, optimizing financial strategies, fostering community engagement, and embracing long-term flexibility, stakeholders can unlock the full potential of SETs to drive sustainable transformation in the built environment.

4.4 SQ3: Financial evaluation of Sustainable Energy Technologies (SETs)

The financial evaluation of Sustainable Energy Technologies (SETs) is essential to assess their financial viability and determine their potential contribution to building retrofits. This section presents a comprehensive analysis of the financial aspects associated with the implementation of SETs at the UT Enschede campus, including initial investment costs, operating costs, and opportunity cost.

4.4.1 The assessing of financial value

The evaluation of Sustainable Energy Technologies (SETs) involves assessing their financial value and determining their potential contribution to building retrofits. The evaluation process focuses on costs, including initial investment and operational costs, as well as opportunity cost.

Initial investment costs

The initial investment costs associated with the implementation of Sustainable Energy Technologies (SETs) play a pivotal role in determining the feasibility and economic viability of retrofit projects. These costs encompass various expenditures incurred during the acquisition, installation, and commissioning phases of SETs, including equipment procurement, labour, materials, permits, and engineering fees.

Accurate estimation of initial investment costs is imperative for effective budget planning and project feasibility assessment. Factors such as system size, technology specifications, and installation intricacies are carefully considered to develop comprehensive cost estimates.

Additionally, the initial investment costs may vary depending on the specific characteristics and requirements of individual SETs. For example, the installation of solar photovoltaic (PV) systems may entail higher upfront costs due to the procurement and installation of PV panels, inverters, mounting structures, and associated electrical components. Conversely, the deployment of heat pumps may involve different cost considerations, including equipment selection, site preparation, and integration with existing building systems.

Furthermore, it is essential to account for additional costs such as permitting fees, regulatory compliance, and potential contingencies when estimating initial investment costs. These ancillary costs contribute to the overall financial outlay and should be factored into the project budget to ensure comprehensive cost coverage and risk mitigation (Ding, 2008).

Operational expenses

Operational expenses are a significant part of the Total Cost of Ownership (TCO) for Sustainable Energy Technologies (SETs). These expenses include ongoing costs for operating, maintaining, and managing SETs throughout their lifespan. Accurately estimating operational expenses is crucial for evaluating the financial sustainability and performance of SETs in building retrofit projects.

Maintenance and repair costs represent a substantial portion of operational expenses for SETs. Regular maintenance activities, including system inspections, component replacements, and troubleshooting, are essential to ensure the continued functionality and efficiency of SETs. These activities can prevent system failures, optimize performance, and extend the operational lifespan of SETs. Unforeseen repairs may arise due to equipment malfunction, wear and tear, or environmental factors, necessitating timely interventions to mitigate downtime and minimize operational disruptions.

Energy consumption is also a significant operational expense associated with SETs, particularly for systems that require electricity to operate. Heat pumps, ventilation systems, etc consume energy during operation to provide heating, cooling, ventilation, and etc (Piacentino et al., 2019). Optimising energy consumption through energy-efficient design, system controls, and occupant behaviour management can help mitigate operational costs and enhance the financial performance of these systems.

Operational expenses are incurred through system monitoring and management activities, which involve data collection, analysis, and optimization of SET performance. Continuous monitoring of SETs enables stakeholders to identify inefficiencies, deviations, and performance deviations, allowing for proactive maintenance and optimization strategies (Ellabban et al., 2014). In addition, the efficient management of SETs involves coordinating maintenance schedules, responding to alarms and alerts, and implementing corrective actions to ensure optimal system operation and energy performance (Demirtas, 2013).

Accurate estimation of operational expenses requires a comprehensive understanding of SETs maintenance requirements, energy consumption patterns, and management protocols. To effectively forecast expenditure patterns, historical data analysis, industry benchmarks, and expert insights are utilised. In addition, optimizing operational efficiency and minimizing overall operational expenses are considered through warranty coverage, service contracts, and potential cost-saving measures.

Opportunity cost
When evaluating Sustainable Energy Technologies (SETs) for building retrofits, decision-making and financial analysis are influenced by the concept of opportunity cost. Opportunity cost refers to the potential benefit that is lost when choosing one SET over another or allocating resources towards a particular investment option (Boardman et al., 2018). Understanding and quantifying opportunity costs is crucial for making informed decisions about selecting SETs, optimizing financial outcomes, and maximizing the overall value proposition of retrofit projects.

Opportunity cost analysis involves assessing the potential savings that SETs can offer to end-users or building occupants. Building owners can reduce energy consumption, lower utility bills, and enhance operational efficiency by implementing energy-efficient technologies and renewable energy systems. The opportunity cost arises from the difference between the actual energy costs incurred with SETs and the hypothetical costs that would have been paid without their implementation. The potential for cost savings represents a valuable economic benefit that contributes to the financial attractiveness of SETs investments.

In addition to potential SETs may also generate revenue streams for building owners through various mechanisms. For instance, onsite renewable energy generation systems, such as solar photovoltaic (PV) arrays or wind turbines, can produce surplus energy that can be sold back to the grid under net metering or feed-in tariff programs. Revenue can also be generated through participation in demand response programs. Building owners receive payments for curtailing energy consumption during peak demand periods. Incentive schemes such as carbon credits or renewable energy certificates offer financial rewards for reducing carbon emissions and promoting environmental sustainability. By capitalising on these revenue sources, building owners can offset initial investment costs, enhance project economics, and improve the overall financial performance of SETs installations.

Additionally, evaluating the efficiency measures associated with SETs is another dimension of opportunity cost analysis. The efficiency of energy conversion in SETs, whether it be for electricity, heat, or other forms of energy, directly affects their operational costs and financial. Higher efficiency usually results in lower operating costs and greater financial returns over the technology's lifetime. Therefore, assessing the efficiency measures of SETs is essential for optimising their financial value and ensuring economic sustainability in building retrofit projects.

It is important to consider that funds allocated for an expensive initial investment in SETs cannot be used elsewhere. Choosing to invest in SETs means forgoing alternative investment opportunities that could potentially yield different returns or benefits. This represents an opportunity cost associated with the allocation of financial resources towards SETs projects. Stakeholders can make more informed decisions regarding resource allocation and project prioritization by recognizing and quantifying the opportunity cost involved in SETs investments.

4.4.2 TCO findings
This study initially examines a smaller sample of Sustainable Energy Technologies (SETs). The total cost of ownership (TCO) model was employed to evaluate ground source heat pump (GHP) closed-loop systems individual and collective (See figure 17) and briefly touches on an option using photovoltaic (PV) panels. The financial implications of implementing closed-loop GHP systems were assessed through a case study conducted at the University of Twente (UT) in Enschede, the Netherlands.

The UT Enschede case study encompasses ten buildings, comprising approximately 445 units of around 23 square metres each. Seven of these buildings are located on Calslaan, while the remaining three are situated on Campuslaan. This investigation yielded key insights, which are detailed in section 4.4.1 on assessing financial value. This assessment encompasses initial investment, operational costs, and opportunity costs in the form of energy charges. Furthermore, an alternative scenario was considered, involving the integration of PV panels with the GHP systems.

In this study, the term 'individual' represent the provision of separate closed-loop GHP systems for each building, while 'collective' represents the interconnection of all buildings to a single closed-loop GHP system.

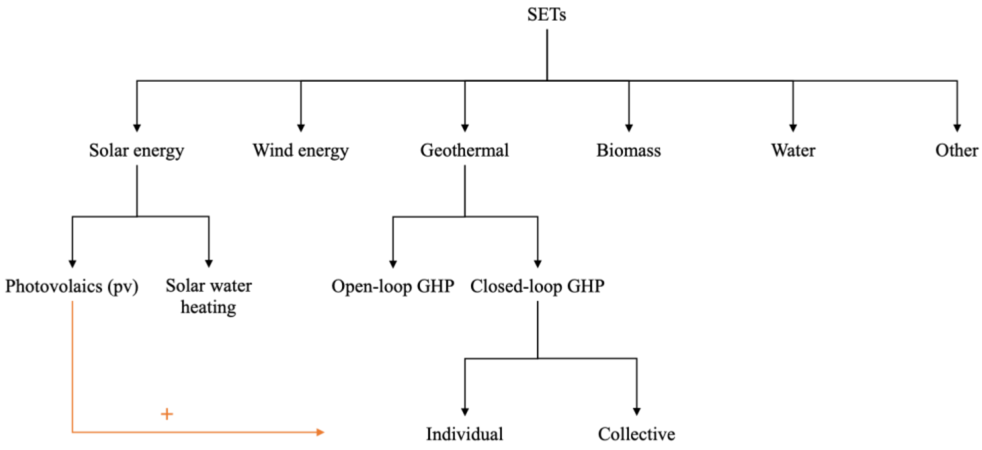


Figure 17: Comparison GHP. Source: Own illustration

TCO outcome of UT Enschede campus area case

	GHP individual (Calslaan)	GHP individual + PV (Calslaan)	GHP individual (Campuslaan)	GHP individual + PV (Campuslaan)	GPD individual combined	GPD individual + PV combined	GHP collective	GHP collective + PV
Energy charges incl. (incl. VAT)	€ 77.710	€ 17.010	€ 75.600	€ 23.760	€ 153.310	€ 40.770	€ 172.020	€ 59.470
Total maintenance and replacement (incl. VAT)	€ 76.960	€ 77.170	€ 67.640	€ 70.860	€ 144.600	€ 148.030	€ 145.350	€ 152.350
Total investment costs (1/15th part) (incl. VAT)	€ 424.370	€ 470.790	€ 362.480	€ 402.130	€ 786.850	€ 872.920	€ 316.040	€ 420.650
Total investment cost (incl. BTW)	€ 5.260.730	€ 5.836.130	€ 4.493.540	€ 4.985.030	€ 9.754.270	€ 10.821.160	€ 3.917.840	€ 5.214.610
Total TCO costs per year	**€ 579.040**	**€ 564.970**	**€. 505.720**	**€ 496.750**	**€ 1.084.760**	**€ 1.061.720**	**€ 633.420**	**€ 632.490**

Table 6: Outcome TCO model. Source: Own illustration

Table 6 depicting the TCO model outcome, synthesizes these findings, highlighting the economic viability of adding individual or collective GHP systems to the UT campus area, with and without the inclusion of PV panels. examination of TCO between collective and individual GHP systems underscores the advantage of the collective approach. While individual systems may incur lower energy costs, the collective system presents a lower overall TCO due to reduced initial investment expenses. Despite higher operational costs associated with collective systems, the lower upfront investment offers attractive financing opportunities. Nonetheless, questions arise regarding the distribution of these costs among stakeholders and their ultimate impact on end-users.

Further Comparing scenarios with and without PV panels demonstrates a notable reduction in TCO over a 15-year period, primarily attributed to decreased energy charges. However, initial investment and maintenance costs are higher, necessitating careful consideration of the investor's role in cost distribution. Depending on whether energy costs are passed on to users or self-utilized, the implications on maintenance investment and subsequent cost savings vary significantly.

	GHP		GHP + PV	
	GPD individual combined	**GHP collective**	**GPD ind + PV** combined	**GHP collective +** PV
Energy charges incl. (incl. VAT)	€ 153.310	€ 172.020	€ 40.770	€ 59.470
Total maintenance and replacement (incl. VAT)	€ 144.600	€ 145.350	€ 148.030	€ 152.350
Total investment costs (1/15th part) (incl. VAT)	€ 786.850	€ 316.040	€ 872.920	€ 420.650
Total investment cost (incl. BTW)	€ 9.754.270	€ 3.917.840	€ 10.821.160	€ 4.987.890
Total TCO costs per year	**€ 1.084.760**	**€ 633.420**	**€ 1.061.720**	**€ 632.490**

Table 7: GHP with or without PV. Source: Own illustration

Incorporating PV panels into GHP systems, as depicted in Table 7, further accentuates the trade-off between long-term cost savings and upfront investment expenditure. While PV integration leads to advantageous TCO reductions over the system's lifecycle, the initial capital investment presents a significant barrier. Addressing this challenge requires innovative financial mechanisms to facilitate broader stakeholder adoption and realize economic benefits associated with reduced TCO.

Moreover, within collective systems, disparities in energy needs among individual buildings pose complexities in cost allocation and financial feasibility. The equitable distribution of costs necessitates transparent mechanisms that account for divergent energy consumption patterns, ensuring fair cost-sharing among stakeholders.

	GHP per unit		GHP + PV per unit	
	GPD individual combined	**GHP collective**	**GPD ind + PV** combined	**GHP collective +** PV
Energy charges incl. (incl. VAT)	€ 345	€ 387	€ 92	€ 134
Total maintenance and replacement (incl. VAT)	€ 325	€ 327	€ 333	€ 342
Total investment costs (1/15th part) (incl. VAT)	€ 1.768	€ 710	€ 1.962	€ 945
Total investment cost (incl. BTW)	€ 21.920	€ 8.804	€ 24.317	€ 11.718
Total TCO costs per year	**€ 2.438**	**€ 1.423**	**€ 2.386**	**€ 1.421**

Table 8: GHP with or without PV per unit. Source: Own illustration

In addition to the broader TCO analysis, it is essential to examine the costs at the unit level in order to gain a more detailed understanding of the financial implications for individual users. Table 8 presents a breakdown of the costs associated with GHP systems at the level of individual houses or units. This analysis provides insight into the economic feasibility from the perspective of individual stakeholders, who are directly affected by the operational and investment costs of the system.

The data presented in Table 8 clearly demonstrates the considerable discrepancy in investment costs per unit between individual and collective systems. To illustrate, the investment cost per house for an individual GHP system without PV is €21,920, whereas the collective GHP system without PV reduces this to €8,804 per house. This notable discrepancy reflects the financial advantage of collective systems, wherein economies of scale result in a substantial reduction in the initial investment burden on individual users. The incorporation of PV panels, while augmenting the initial investment costs (for instance, from €1,768 to €1,962 per house for the individual system), culminates in a discernible reduction in energy charges. In particular, the energy charges are reduced from €345 per house for the individual GHP system without PV to €92 with PV, thereby further enhancing the long-term cost savings potential.

Furthermore, the maintenance and replacement costs are relatively similar across both individual and collective systems, with only marginal differences. By way of illustration, the maintenance costs for the collective GHP system without PV are €327 per house, compared to €325 for the individual system. This indicates that while there are notable differences in initial investment costs, the ongoing operational costs remain relatively consistent, regardless of the system scale.

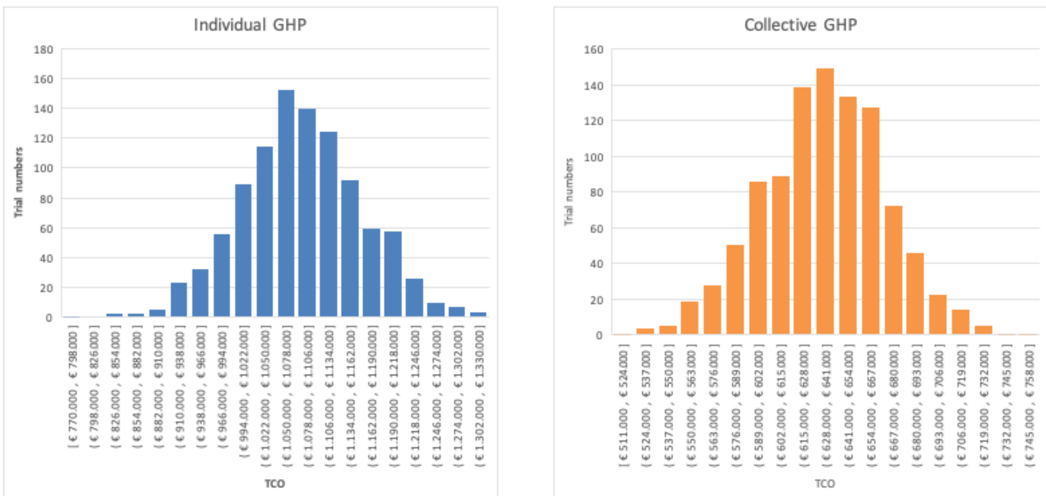
TCO per year, which combines energy, maintenance, and investment costs, provides further evidence in support of the economic benefits of collective systems. The TCO for the collective GHP system without PV is €1,423 per house, in comparison to €2,438 for the individual system. Furthermore, the integration of photovoltaic (PV) panels serves to accentuate this discrepancy, reducing the total cost of ownership (TCO) for the collective system with PV to €1,421 per house, in comparison to €2,386 for the individual system with PV. These findings indicate the potential for collective systems, particularly when combined with PV technology, to provide long-term financial benefits by reducing the per-unit costs for end users.

In conclusion, the TCO analysis of GHP systems, both individually and collectively, highlights the significance of considering not only the initial investment and operational costs but also the distribution of financial burdens and potential long-term savings associated with sustainable energy solutions.

Combining TCO with Monte Carlo simulation

Nevertheless, the TCO calculation provides a static representation of costs, which may not align with the actual financial implications in a dynamic environment. To gain a more comprehensive understanding, a Monte Carlo simulation was employed to facilitate a more robust estimation. A Monte Carlo simulation was conducted with 1,000 trials (can been found in the appendix). The simulation encompassed the three principal cost categories: energy costs, operational costs and investment costs. In order to model the uncertainties, different distribution models were employed for each of the aforementioned components.

The energy costs were based on a digital model and a fixed contract. Although the variation is limited, a normally distributed assumption set with a standard deviation of 10% is used to accurately reflect the possible fluctuations, given that this is a Gaussian distribution. In light of expert estimates, it is possible that operational costs may fluctuate due to maintenance, service contracts and unforeseen issues. A triangular distribution is employed to model these uncertainties, with a minimum, maximum, and most probable value. It is possible that investment costs may fluctuate due to changes in material costs and contractual factors. The aforementioned costs are modelled with a normally distributed assumption set and a standard deviation of 10%, based on data from the RVO and Arcadis databases.



Individual GHP		
Average TCO	€	1.084.873
Minimum TCO	€	770.165
Maximum TCO	€	1.312.709
Standard deviation	€	79.187

Collective GHP		
Average TCO	€	634.162
Minimum TCO	€	510.852
Maximum TCO	€	752.779
Standard deviation	€	35.882

Figure 18: Comparison GHP – Monte Carlo simulation. Source: Own illustration

The results of the Monte Carlo simulation are presented in figure 18. The simulation yielded an average TCO of €1.084.873 for the individual GHP systems, with a minimum of €770.165 and a maximum of €1.312.709. The standard deviation of €79,187 indicates a moderate level of variability in the cost outcomes.

In contrast, the collective GHP systems demonstrate a lower average TCO of €634.162, with a minimum of €510.852 and a maximum of €752.779. The standard deviation is €35.882, indicating a lower level of variability and a narrower range of potential outcomes in comparison to the individual systems.

These findings reinforce the conclusion that the collective GHP system offers a more cost-effective solution, even when accounting for the uncertainties in cost components. The lower average TCO and reduced variability in the collective system suggest greater financial predictability and stability, making it a preferable option for large-scale implementation in the context of sustainable retrofitting.

4.4.3 TCO findings and stakeholders

A further analysis of the data in table 7 , calculated on a per-unit basis as in table 9, allows us to identify the stakeholders generally responsible for these costs. In most cases, the energy cost and maintenance cost is the responsibility of the tenant, as the investment costs fall on the investor.

The data in the table 9 illustrate a discrepancy between the preferences of tenants and investors when selecting between individual and collective ground source heat pump (GHP). Tenants tend to favour individual systems due to the reduced maintenance costs and lower energy costs that they entail (see Table 9). In contrast, investors tend to favour collective systems due to the reduced initial investment costs. Nevertheless, an examination of the overall total cost of ownership (TCO) reveals that collective GHP systems exhibit the lowest total cost. Therefore, it can be concluded that a collective solution is the optimal choice, which aligns with the investor's preference. However, this is not the case for the tenant.

A similar pattern emerges when GHP is combined with solar photovoltaics (PV) panels. Tenants express a preference for an individual GHP with PV panels due to the lower energy costs, despite the slightly higher maintenance costs. Investors continue to express a preference for a collective GHP due to the lower initial investment costs. Nevertheless, the TCO model again demonstrates that a collective GHP with PV provides the lowest total cost. While this solution is objectively the most cost-effective, it does not align with the tenant's preference. However, it does align with that of the investor.

This dilemma highlights that although collective systems are objectively better from a financial point of view, tenants' preferences do not always align with the optimal financial choice.

	GHP per unit		GHP + PV per unit	
	GPD individual combined	GHP collective	GPD ind + PV combined	GHP collective + PV
Energy charges incl. (incl. VAT)	€ 345	€ 387	€ 92	€ 134
Total maintenance and replacement (incl. VAT)	€ 325	€ 327	€ 333	€ 342
Total investment costs (1/15th part) (incl. VAT)	€ 1.768	€ 710	€ 1.962	€ 945
Total investment cost (incl. BTW)	€ 21.920	€ 8.804	€ 24.317	€ 11.718
Total TCO costs per year	**€ 2.438**	**€ 1.423**	**€ 2.386**	**€ 1.421**

Renter: Prefer individual GHP + PV lower energy prices and just bid higher maintain cost

Investor: Prefer collective GHP lower investment cost

Overall: Prefer collective GHP + PV lower total cost of ownership

Table 9: GHP with or without PV per unit. Source: Own illustration

4.4.4 Discussion and Conclusion

The evaluation of the financial viability of Sustainable Energy Technologies (SETs) is crucial in determining their feasibility and potential contribution to building retrofits. This study presents a comprehensive analysis of the financial aspects associated with the implementation of SETs at the UT Enschede campus. This discussion synthesises the findings and addresses the sub question, “What method can be used to determine the financial value of individual and collective Sustainable Energy Technologies (SETs)?"

One notable finding is the critical role of accurate cost estimation in project planning and feasibility assessment. The economic viability of SETs installations is heavily influenced by the initial investment costs. The examination of the total cost of ownership (TCO) reveals that the initial investment cost for individual ground-source heat pump (GHP) installations represents more than 70% of the TCO, whereas for collective GHP installations, it accounts for approximately 50% of the TCO. This discrepancy is particularly evident in the case of GHP + PV systems, where the initial investment cost is higher, but the energy charges are significantly lower. Accurate estimation of these costs requires meticulous analysis, taking into account factors such as equipment procurement, labour, materials, permits, and engineering fees. Additionally, additional costs such as permitting fees and regulatory compliance must be accounted for to ensure comprehensive cost coverage and risk mitigation.

Operational expenses are a significant component of the total cost of ownership for SETs. These expenses comprise maintenance, repair, and energy consumption costs incurred throughout the lifespan of the systems. The process involves analysing historical data, industry benchmarks, and expert insights to understand maintenance requirements, energy consumption patterns, and management protocols.

Another essential aspect of the financial evaluation process is opportunity cost analysis. By assessing potential savings and revenue streams generated by SETs, stakeholders can make informed investment decisions. Evaluating the efficiency of energy conversion in SETs is crucial for optimizing financial value and ensuring economic sustainability. The integration of PV panels, for instance, results in substantial energy charge reductions, from €172.020 for GHP collective to €59.470 for GHP collective + PV, highlighting the long-term cost-saving potential.

The TCO model evaluate all of the initial investment costs, operational expenses, and energy costs. The analysis indicates that the TCO for individual GHP systems is € 1.084.760 and €633.420 for collective approach. This suggests that a collective approach at UT Enschede could be financially beneficial. Furthermore, when considering GHP + PV systems, the total cost of ownership (TCO) for collective GHP + PV is €632.490, which is a bit lower than the €633.420 for collective GHP alone. This evidence demonstrates that the combination of collective GHP and PV represents the most advantageous scenario in terms of total costs.

However, it is important to acknowledge the limitations of the existing data landscape. Although the initial investment costs are well-documented, there is a lack of data on the specific operational expenses associated with SETs. This makes it difficult to conduct a comprehensive comparison of total costs between different SET installations. In addition, it is worth noting that some sources provide costs for full installation systems, which include both equipment and installation services. This makes it even more challenging to isolate and analyse specific operational costs.

In conclusion, this study emphasises the significance of rigorous financial evaluation in implementing SETs. It also highlights the necessity for enhanced data availability and transparency. Addressing these challenges will not only improve the accuracy of financial assessments but also foster greater confidence and uptake of Sustainable Energy Technologies in building retrofit projects.

4.5 SQ4: Comparison between individual and collective Sustainable Energy Technologies (SETs)

The choice between individual and collective Sustainable Energy Technologies (SETs) for building retrofits requires careful consideration of several factors, including technical feasibility, economic viability, environmental impact, social acceptance, and legal permission, as discussed in Chapter 4.3. This section presents a comparative analysis of individual and collective SETs, highlighting their respective advantages, challenges, and suitability within the context of building retrofits.

4.5.1 Analysis of individual SETs

As discussed in chapter 4.3.3, individual Sustainable Energy Technologies (SETs) have several advantages that make them an attractive option for building retrofits. They provide building occupants with greater autonomy and control over their energy consumption and production, allowing for customized solutions tailored to specific building requirements and preferences. SETs can be installed incrementally, allowing for phased implementation and flexibility in adapting to changing energy needs and technological advancements. SETs promote energy independence and resilience by reducing reliance on centralized energy grids and mitigating the risk of supply disruptions.

While individual SETs do offer certain advantages, it is important to consider their suitability for building retrofits in light of certain challenges, as previously highlighted in chapter 4.3.3. One such challenge is the limitation of available space, as the installation of individual SETs, such as solar panels or heat pumps, may be constrained by the available rooftop or building space. Moreover, the initial expenses associated with individual SETs, such as equipment acquisition and installation, require a significant capital investment, which may discourage certain building owners or developers. Furthermore, the regular maintenance and upkeep of individual SETs entails additional expenses and administrative responsibilities for building owners.

4.5.2 Analysis of collective SETs

As outlined in chapter 4.3.4, collective Sustainable Energy Technologies (SETs) offer unique advantages due to their centralized and shared nature. By aggregating energy demand and supply across multiple buildings or an entire community, collective SETs benefit from economies of scale, resulting in cost efficiencies in energy production, and maintenance. Collective SETs promote social cohesion and community engagement by fostering a sense of ownership and shared responsibility for energy sustainability goals (Oliveira et al., 2023). Additionally, collective SETs optimize renewable energy resources by leveraging shared infrastructure and resources to maximize energy efficiency and minimize waste (Oliveira et al., 2023).

However, collective SETs face challenges related to their implementation and operation, as discussed in chapter 4.3.4. The deployment of collective SETs involves coordination and collaboration among multiple stakeholders, including building owners, utilities, local authorities, and community members. However, these challenges can be overcome through effective communication and collaboration among. The implementation of collective SETs may face regulatory and legal barriers, requiring careful navigation of permitting, zoning, and interconnection requirements. Participating stakeholders in collective SETs share risks and liabilities, necessitating clear agreements and governance structures to manage responsibilities and mitigate potential conflicts.

4.5.3 Sensitivity analysis

Based on the findings of the total cost of ownership (TCO) model, a sensitivity analysis was carried out. Chapter 4.4.2 shows that the financial implications of implementing closed ground source heat pump (GHP) systems are investigated in the case study of UT Enschede. The analysis focuses on individual GHP systems or collective GHP systems. Based on the TCO model of individual and collective closed GHP systems, a sensitivity analysis was carried out.

The impact of energy prices on energy charges

The discussion of energy prices in the context of housing projects is relevant as it directly impacts the financial viability and sustainability of the project. Energy prices play a crucial role in determining the total cost to the end-user, particularly for social housing associations that have limited ability to charge for energy consumption. Additionally, this factor is highly variable depending on location, project, and current trends. Table 10 illustrates sensitivity analysis of individual ground source heat pump (GHP) versus collective GHP and the relationship between the price kilowatt per hour (kWh) and the energy cost in euros per year, with the price of energy per kWh on the x-axis and the energy cost on the y-axis. The collective solution requires more energy, resulting in higher energy costs. This is only the purchase tariffs. The final cost for the user still has to deal with things like subsidies. Figure 19 illustrates that as energy prices rise, the collective solution becomes relatively more expensive than the individual solution. The reason for this is that the pipelines are spread out over a large area (Vink, personal communication, April 14, 2024). In the case of collective GHP, a 10% allowance for train loss is utilised.

This sensitivity analysis of individual versus collective changes over time and their impact on the project. This suggests that higher energy prices lead to relatively higher costs for the user.

→ So, the individual GHP is more resilient for change in energy price than a collective GHP.

Impact of energy price on energy charges

		0,10 € / kWh	0,15 € / kWh	0,20 € / kWh	0,25 € / kWh	0,30 € / kWh	0,35 € / kWh	0,40 € / kWh	0,45 € / kWh	0,50 € / kWh
GHP individual (Calslaan)	#	€ 20.450	€ 30.680	€ 40.900	€ 51.130	€ 61.350	€ 71.570	€ 81.800	€ 92.020	€ 102.250
GHP individual (Campuslaan)	#	€ 19.900	€ 29.850	€ 39.790	€ 49.740	€ 59.690	€ 69.630	€ 79.580	€ 89.530	€ 99.480
GHP collective	#	€ 45.270	€ 67.900	€ 90.540	€ 113.170	€ 135.800	€ 158.440	€ 181.070	€ 203.700	€ 226.340
Individual total	#	€ 40.350	€ 60.530	€ 80.690	€ 100.870	€ 121.040	€ 141.200	€ 161.380	€ 181.550	€ 201.730
Collective vs individual GHP	#	€ 4.920	€ 7.370	€ 9.850	€ 12.300	€ 14.760	€ 17.240	€ 19.690	€ 22.150	€ 24.610

Table 10: Effect of energy charges per kWh on energy cost. Source: Own illustration

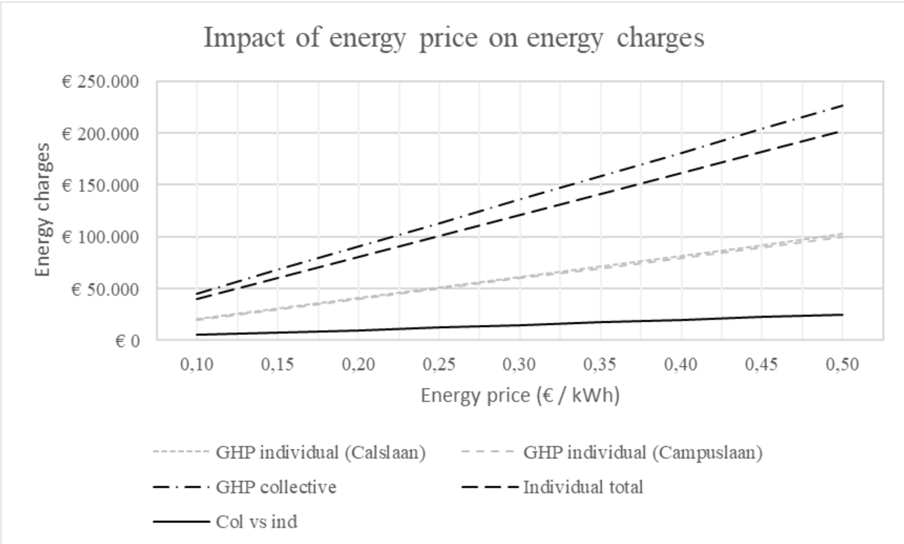


Figure 19: Impact of energy price on energy charges. Source: Own illustration

Impact of housing units on the Total Cost of Ownership (TCO)

A sensitivity analysis was conducted to compare individual and collective closed loop GHP comparing to the number of housing units. This analysis is based on data from UT Enschede. Figure 20 presents a graph of the relationship between cost and number of dwellings. The graph illustrates how costs change in relation to the number of housing units. The comparison was based on the TCO, energy costs, maintenance, and investment costs over a 15-year period.

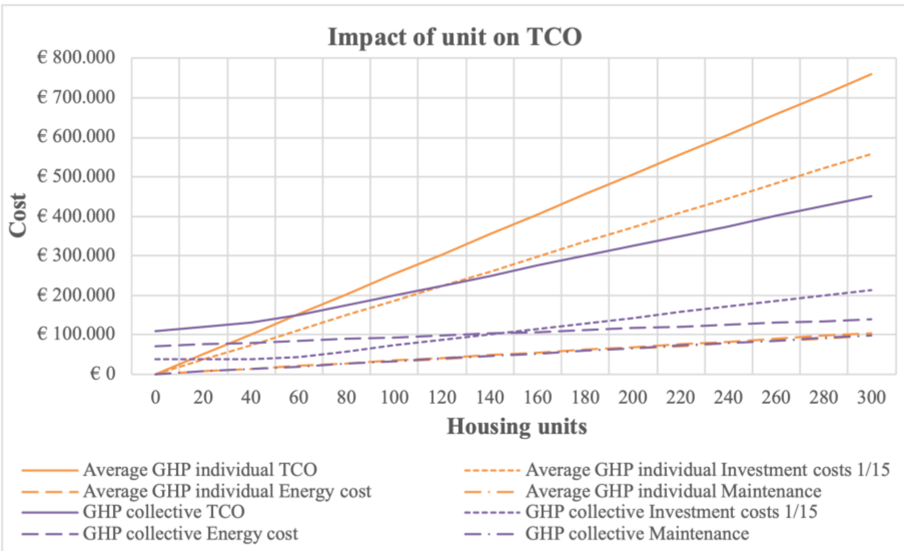


Figure 20: Impact of unit on TCO. Source: Own illustration

Impact of unit on TCO – investment

The graph in Figure 21 has been adjusted to exclude investment costs, providing a clearer depiction of the relationship between individual and collective GHP systems. For individual GHP systems, the graph illustrates a consistent upward trajectory, indicating the need for new equipment purchases with fixed costs each time. This results in a stable line of increasing costs over time. In contrast, the collective GHP curve initially remains relatively flat, reflecting the absence of additional costs until a certain threshold of homes is reached. Once this threshold is surpassed, the demand for a larger pump necessitates additional expenses, albeit at a slower rate compared to individual systems. This is because the existing infrastructure can accommodate additional homes without significant augmentation.

→ The graph shows that there exists a tipping point in investment cost, around 20 housing units, where the collective GHP system becomes more economically advantageous compared to individual systems. So based on investment costs, collective solutions would be chosen in the UT Enschede case study.

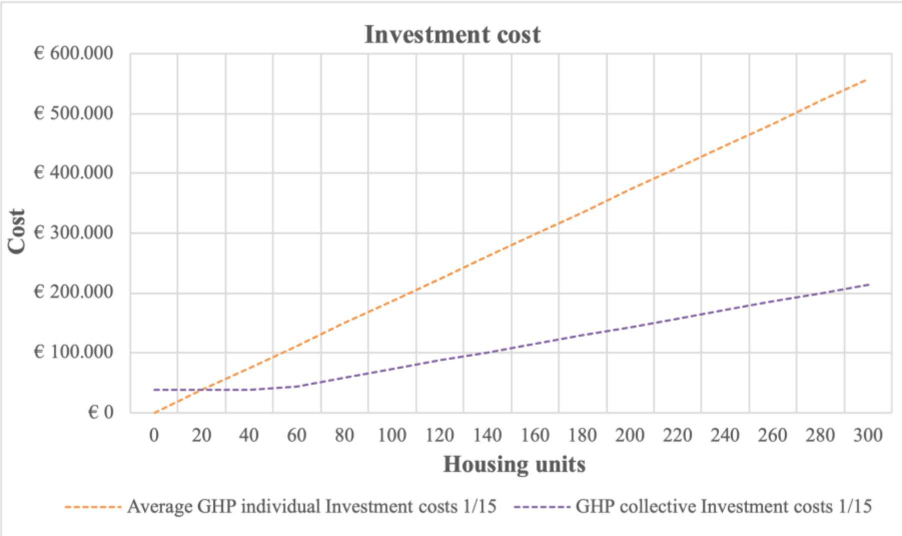


Figure 21: Impact of unit on TCO – Investment cost. Source: Own illustration

Figure 22 provides a more detailed view of the investment costs per unit for individual and collective GHP systems. In contrast to Figure 21, which is concerned with total costs, this figure emphasises per-unit costs, thereby providing a more detailed perspective for decision-making at the individual housing level.

In the case of individual GHP systems, a consistent increase in cost per unit is observed as the number of homes increases. This demonstrates that the cost per unit remains stable at a relatively high level regardless of the number of connected units, indicating limited economies of scale. In contrast, collective GHP systems demonstrate a reduction in investment costs per unit as the number of units increases. This pattern clearly illustrates the economies of scale associated with collective systems, where investment costs per unit decline as the system expands.

Figure 22 highlights that while the total investment cost may initially be similar for individual and collective systems (as shown in Figure 21), the cost per unit for collective solutions becomes much more favourable with a larger number of units. This makes the use of collective GHP systems more attractive in projects with a scale of more than 20 dwellings, as seen in the UT Enschede case study.

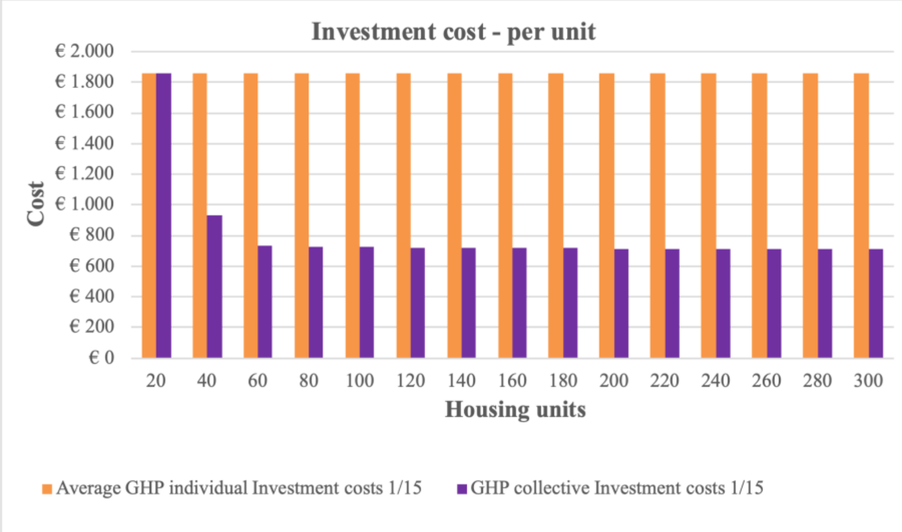


Figure 22: Impact of unit on TCO – Investment cost per unit. Source: Own illustration

The investment costs presented in Figures 21 and 22 are based on data from the Rijksdienst voor Ondernemend Nederland (RVO) and Arcadis, as detailed on the website kostenkentallen.rvo.nl. For the purposes of this analysis, the costs of individual and collective heat pumps have been compared, with the collective variants based on a scenario involving 50 residential units.

The individual technique analysed is listed as WB182: The collective technique is listed as WB191: Heat pump bottom collective (closed source) instead of heat supply, mgw-tus-pro-min.

Table 11 provides a detailed breakdown of each cost item down to the pipes, including time taken for work, material costs and hourly wages. This comprehensive overview provides a complete understanding of the total investment cost, accurately including both labour and material costs.

It is important to stress that these figures represent average values, and that the complexity of renovation projects can vary considerably. As a result, significant deviations can occur in both individual and collective solutions, depending on the specific circumstances of a project. In some cases, an individual system may be more complex and expensive than a collective system, and vice versa.

As a non-technical expert, I lack the requisite knowledge to accurately compare different devices. This leaves a grey area in interpreting the costs and technical feasibility of the systems.

Bodemwarmtepomp - gesloten bron (gbes)																		
WB182 | Warmtepomp bodem combi (gesloten bron) i.p.v. warmtelevering, mgw-tus-pro-min.				€ 23073,36 / won														
NL SfB	**Code**	**Omschrijving**	**Specificatie**	**Hoeveelheid**	**Eenheid**	**Uurnorm**	**Uren**	**Uurloon**	**Totaal Arbeid**	**Materiaal**	**Opslag Materiaal**	**Totaal Materiaal**	**Materieel**	**Totaal Materieel**	**Eenheidsprijs directe kosten**	**Totaal directe kosten**	**Totaal bouwkosten**	**Bouwkosten per Eenheid**
51.20		Warmtepomp bodem combi (gesloten bron) i.p.v. warmtelevering, mgw-tus-pro-		1	won	104,32	104,32		6.153,84	16.919,53		16.919,53			23.073,36	23.073,36	28.057,21	28.057,21
51.20	60	Verwarmingsinstallaties	Aansluiten VWA incl. breekwerk	1	won	2,00	2,00	58,99	117,98						117,98	117,98		
51.20	60	Verwarmingsinstallaties	Afvoeren stadsverwarming	1	st	0,50	0,50	58,99	29,50	15,91		15,91			45,41	45,41		
51.20	60	Verwarmingsinstallaties	Appendages en hulpmaterialen	1	st	2,00	2,00	58,99	117,98	256,25		256,25			374,23	374,23		
51.20	60	Verwarmingsinstallaties	Appendages en hulpmaterialen	1	won			58,99		75,00		75,00			75,00	75,00		
51.20	52	Waterinstallaties	Appendages en hulpmaterialen	1	won			58,99		50,00		50,00			50,00	50,00		
51.20	60	Verwarmingsinstallaties	Bodemwisselaars incl. boringen	3	st	8,00	24,00	58,99	1.415,76	1.862,26		5.586,78			2.334,18	7.002,54		
51.20	60	Verwarmingsinstallaties	CV. buis 22mm	2	m	0,50	1,00	58,99	58,99	26,69		53,38			56,19	112,37		
51.20	60	Verwarmingsinstallaties	CV. buis 28mm	10	m	0,70	7,00	58,99	412,93	36,90		369,00			78,19	781,93		
51.20	60	Verwarmingsinstallaties	Demontage en afvoeren HR-ketel	1	st	1,20	1,20	58,99	70,79						70,79	70,79		
51.20	60	Verwarmingsinstallaties	Elektrische voeding 400V	1	st	8,00	8,00	58,99	471,92	419,67		419,67			891,59	891,59		
51.20	60	Verwarmingsinstallaties	Engineering	1	won	12,00	12,00	58,99	707,88						707,88	707,88		
51.20	60	Verwarmingsinstallaties	Expansievat 12 liter	1	st	2,00	2,00	58,99	117,98	47,57		47,57			165,55	165,55		
51.20	5	Bouwplaatsvoorzieningen	Extra bouwkundige voorzieningen	1	won			52,14		302,94		302,94			302,94	302,94		
51.20	60	Verwarmingsinstallaties	Gaten dichten in de gevel	1	st	1,00	1,00	58,99	58,99	31,18		31,18			90,17	90,17		
51.20	60	Verwarmingsinstallaties	Hor. leidingwerk 50mm HDPE tot op	30	m	0,35	10,50	58,99	619,40	5,63		168,90			26,28	788,30		
51.20	60	Verwarmingsinstallaties	Hulpmateriaal 200%	1	won			58,99		20,95		20,95			20,95	20,95		
51.20	52	Waterinstallaties	Inlaatcombinatie	1	st	0,40	0,40	58,99	23,60	13,50		13,50			37,10	37,10		
51.20	52	Waterinstallaties	Isolatie 15mm	7,5	m	0,10	0,75	58,99	44,24	0,85		6,38			6,75	50,62		
51.20	60	Verwarmingsinstallaties	Kleinmateriaal	1	st	4,00	4,00	58,99	235,96	142,84		142,84			378,80	378,80		
51.20	52	Waterinstallaties	Omschakelklep	1	st	0,40	0,40	58,99	23,60	139,05		139,05			162,65	162,65		
51.20	60	Verwarmingsinstallaties	P.V.C. leiding 40mm	4	m	0,30	1,20	58,99	70,79	3,34		13,36			21,04	84,15		
51.20	60	Verwarmingsinstallaties	Ruimtethermostaat RBE	1	st	0,25	0,25	58,99	14,75	56,61		56,61			71,36	71,36		
51.20	60	Verwarmingsinstallaties	Sifon 40mm	1	st	0,12	0,12	58,99	7,08	7,42		7,42			14,50	14,50		
51.20	52	Waterinstallaties	Voorraadboiler 200L	1	st	4,00	4,00	58,99	235,96	1.766,66		1.766,66			2.002,62	2.002,62		
51.20	60	Verwarmingsinstallaties	Vullen en aftappen van de installatie	1	won	2,00	2,00	58,99	117,98						117,98	117,98		
51.20	60	Verwarmingsinstallaties	Warmtepomp 3,5kW incl. 200L. Voorraadboiler	1	st	16,00	16,00	58,99	943,84	7.217,78		7.217,78			8.161,62	8.161,62		
51.20	60	Verwarmingsinstallaties	Warmtepomp 5,5kW incl. 200L. Voorraadboiler		st	16,00		58,99		7.217,78								
51.20	60	Verwarmingsinstallaties	Warmtepomp 7,5kW incl. 200L. Voorraadboiler		st	16,00		58,99		7.617,38								
51.20	52	Waterinstallaties	Warm- en koudwaterleiding RK 15mm	10	m	0,40	4,00	58,99	235,96	15,84		158,40			39,44	394,36		
Historie	**Maatregel opgesteld: 03-08-2023**																	
Datum	**Wijziging**																	
03-04-2024	Er zijn nog geen wijzigingen doorgevoerd aan deze maatregel.																	

Table 11: Investment cost. Source: https://kostenkentallen.rvo.nl/

Impact of unit on TCO – energy cost

Upon examination of energy costs in Figure 23, it becomes evident that collective GHP systems incur higher energy costs at least up to 300 housing units. This disparity arises due to the supplementary heat generation necessary in the collective variant. As the pipes traverse an area, heat loss occurs, necessitating additional heat generation to compensate, thereby increasing energy consumption.

However, a notable trend emerges while the energy costs for individual GHP systems escalate more rapidly than those for collective GHP systems, eventually reaching a tipping point. At this juncture, the energy costs for individual systems surpass those of collective GHP systems.

→ In figure 19, it can be seen that individual GHP is more resilient for change in energy price than a collective GHP. Although a tipping point can be seen in Figure 23 at 300 units, this can be predicted to be the case. So up to 300 units in UT Enschede's situation, the energy costs of individual GHP are lower than those of collective.

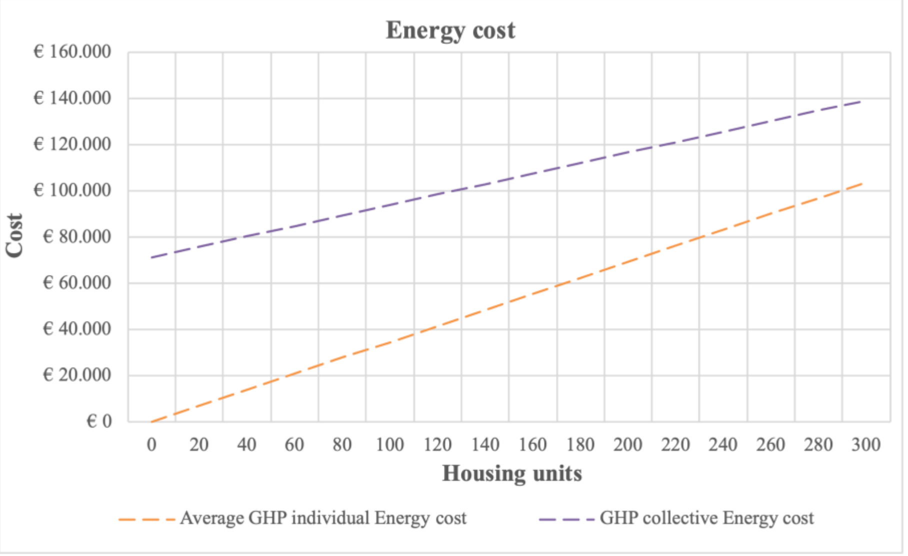


Figure 23: Impact of unit on TCO – Energy cost. Source: Own illustration

Figure 24 illustrates the energy costs per unit for individual and collective GHP systems. The figure demonstrates how energy costs vary in accordance with the number of connected housing units.

In the initial stages, collective GHP systems demonstrate higher energy costs per unit in comparison to individual systems, primarily due to the occurrence of heat loss within the distribution network. However, as the number of units increases, the energy costs for individual systems rise at a faster rate, leading to a point of inflection where collective systems become more cost-efficient.

Figure 24 highlights that, while individual systems may be more cost-effective at smaller scales, collective systems offer evident advantages as the project size increases. In large-scale applications, such as the UT Enschede case study, collective GHP systems ultimately result in a reduction in energy costs per unit.

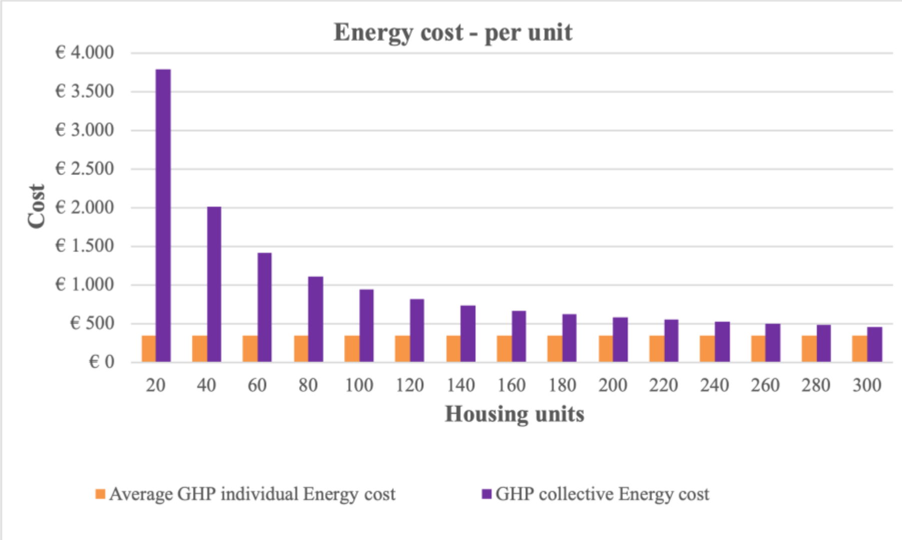


Figure 24: Impact of unit on TCO – Energy cost per unit. Source: Own illustration

The energy costs presented in Figures 23 and 24 are based on energy demand (as shown in Table 12), which was subjected to a simulation using the Vabi software. Furthermore, the collective SET variant incorporates a 10% transmission loss surcharge, as communicated by Vink (personal communication, 14 April 2024).

Furthermore, it should be noted that the cost of energy may vary depending on the specific energy contract in question. These variations are documented in an internal document entitled 'Provisional energy tariffs 2024' (1 February 2024).

When comparing energy costs, there are several factors that make it difficult to reach unambiguous conclusions. Firstly, it should be noted that energy prices can fluctuate significantly depending on the time of conclusion and the terms of the contract. Secondly, the costs are based on simulations conducted with the Vabi software, but the actual usage data may vary due to the behaviour of the occupants, the weather conditions, and the performance of the building. Additionally, the 10% transmission loss associated in collective systems is contingent upon the efficiency of the system and the installation conditions. Moreover, energy costs typically do not encompass maintenance and repair expenses, which may unexpectedly increase. It is possible that future technological innovations may result in a reduction in the costs associated with energy usage, which may not be reflected in the current estimates. Finally, regional variations in total energy costs may be influenced by local regulations and subsidies.

Comparison of energy consumption based on estimated energy demand and efficiencies									
	GHP individual (Calslaan)			GHP individual (Campuslaan)			GHP collective		
	Heat requirement in kWh	Yield (SCOP)	On the meter	Heat requirement in kWh	Yield (SCOP)	On the meter	Heat requirement in kWh	Yield (SCOP)	On the meter
Overview of heat requirements + tap water (circulation pipe 22 mm. maintained)	*Ag*	*Wb [kWh/m²]*	*Tapwater*	*Ag*	*Wb [kWh/m²]*	*Tapwater*	*Ag*	*Wb [kWh/m²]*	*Tapwater*
Heat consumption Calslaan 3A	1.747	64,0	31.408 kWh				1.747	64,0	31.408 kWh
Heat consumption Calslaan 3B	1.747	51,0	31.408 kWh				1.747	51,0	31.408 kWh
Heat consumption Calslaan 3C	1.747	66,0	31.408 kWh				1.747	66,0	31.408 kWh
Heat consumption Calslaan 3-401	369	78,0	11.799 kWh				369	78,0	11.799 kWh
Heat consumption Campluslaan 49				2.262	69,0	35.547 kWh	2.262	69,0	35.547 kWh
Heat consumption Campluslaan 51				2.539	71,0	35.547 kWh	2.539	71,0	35.547 kWh
Heating (source: reference EPA-W calculation)	344.941	4,0	86.235 kWh	336.345	4,0	84.086 kWh	681.336	4,0	170.334 kWh
	43.206	2,5	17.283 kWh	71.094	2,5	28.438 kWh	177.116	2,5	70.846 kWh
Total Electricity heating, hot water and cooling			**103.518 kWh**			**112.524 kWh**			**265.298 kWh**
Total Heat W installations off-take district heating									
Estimation of household consumption			100.964 kWh			86.417 kWh			187.398 kWh
Yield PV for own use (N/A)			kWh			kWh			kWh
Total electricity consumption			204.482 kWh			198.941 kWh			452.696 kWh
Correction for aging PV panels	10%		kWh	10%		kWh	10%		kWh
Total electricity after aging PV			204.482 kWh			198.941 kWh			452.696 kWh
Energy costs on average for installation (resident costs)									
Number of homes in project	**240**			**205**			**445**		
Electrical energy for heating and hot water	103.518 kWh	0,38 € / kWh	€ 39.336,78	112.524 kWh	0,38 € / kWh	€ 42.759,13	265.298 kWh	0,38 € / kWh	€ 100.813,34
Electricity for ventilation, lighting and domestic consumption	100.964 kWh	0,38 € / kWh	€ 38.366,41	86.417 kWh	0,38 € / kWh	€ 32.838,62	187.398 kWh	0,38 € / kWh	€ 71.211,24
Total energy costs for household for Electricity (excl. fixed costs)			**€ 77.703,19**			**€ 75.597,75**			**€ 172.024,58**
Cost per household			*€ 323,76*			*€ 368,77*			*€ 386,57*

Table 12: Energy cost. Source: Own illustration

Impact of unit on TCO – maintenance cost

Upon examination of Figure 25, it becomes evident that the maintenance costs are relatively consistent. In contrast, the process of maintaining an individual GHP is more intricate, necessitating the monitoring of numerous appliances. Furthermore, the balancing of groundwater arrows and the correction of imbalances in heat and cold represent additional complexities inherent to collective systems. It is also assumed here that the maintenance of GHPs is conducted by external parties due to the complexity of the system itself.

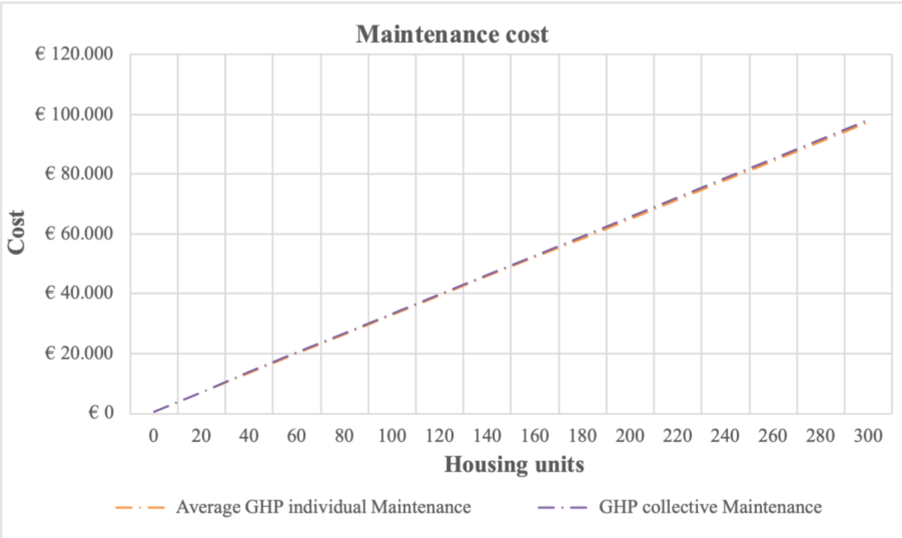


Figure 25: Impact of unit on TCO – maintenance cost. Source: Own illustration

Figure 26 illustrates the maintenance costs per unit for both individual and collective ground source heat pump (GHP) systems. While the maintenance costs for individual systems increase gradually with each additional unit, due to the inherent complexity of managing multiple devices, the difference in maintenance costs between individual and collective systems is relatively minor.

Nevertheless, collective GHP systems continue to benefit from economies of scale, resulting in a general reduction in per-unit costs as the number of connected homes increases. While the cost advantage of collective systems in terms of maintenance is not substantial, it does contribute to their overall efficiency when scaled up.

This indicates that, although maintenance costs do not vary significantly between individual and collective GHP systems, collective solutions continue to offer incremental savings as project size increases, thereby enhancing their appeal for larger projects, such as the UT Enschede case study.

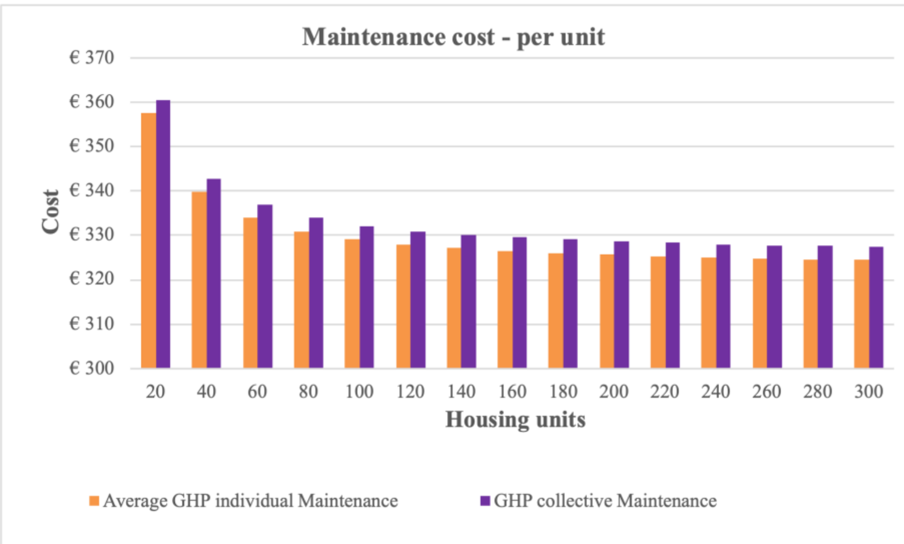


Figure 26: Impact of unit on TCO – maintenance cost. Source: Own illustration

The maintenance costs presented in Figures 25 and 26 are based on calculations of source values from 2021/2022 provided by VIAC. The costs processed can be seen in Table 13. Furthermore, the costs have been disaggregated into the various operational elements of the system. A 12% form factor based on the Consumer Price Index (CPI) has been applied to update the costs. The maintenance costs are additionally based on the capacity of the devices, as communicated by Vink (personal communication, 14 April 2024).

Kosten per jaar per onderdeel incl. BTW	
WTW met één zone CO_2	180,96
Gesloten bron bij warmtepomp op bodemsysteem *	280,00
Warmtepompboiler op buitenlucht	291,20
Onderhoud en vervanging van technische installaties in SV ruimte	203,28
Onderhoud en vervanging van centrale warmtepompen	361,39
Monitoring gesloten bodemenergiesysteem	500,00
Inschatting kosten voor inlezen warmtemeters en watermeters	33,60
PV panelen per stuk	€ 7,87
Totaal voor onderhoud en vervanging	

* Maintenance costs are based on device power (Vink, personal communication, April 14, 2024)

Table 13: Maintenance cost. Source: Own illustration

Impact of unit on TCO – TCO

A synthesis of all previous costs yields an overall picture of the total cost of ownership (TCO). Upon extracting the TCO from graph Figure 27, it becomes evident that a clear turning point emerges between the individual and collective systems at a TCO of around 60 units. At this point, the individual TCO surpasses the collective TCO.

Upon conclusion of the analysis, it becomes evident that investment costs play a significant role in the consideration of energy costs, maintenance, and investment costs over a 15-year period. These costs are typically higher for individual solutions compared to collective solutions.

→ So looking at the total cost in Figure 26. It is preferable to choose for the collective TCO after 60 units in the situation of the UT Enschede.

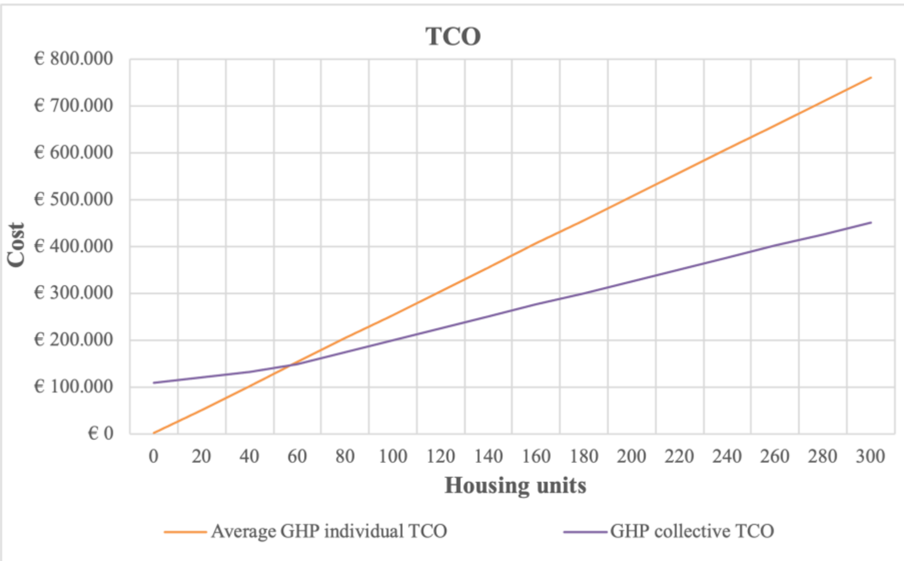


Figure 27: Impact of unit on TCO - TCO. Source: Own illustration

Figure 28 illustrates the TCO per unit for both individual and collective GHP systems. The figure illustrates a definitive tippping point: while individual systems exhibit a lower TCO per unit initially, collective systems become increasingly cost-effective as the number of units increases.

At approximately 60 housing units, the TCO of collective systems declines below that of individual systems, due to economies of scale in both investment and energy costs. Subsequently, collective systems continue to demonstrate a lower per-unit TCO, thereby rendering them the optimal selection for larger-scale projects.

This figure emphasises that collective GHP systems become significantly more cost-efficient beyond a certain threshold, rendering them ideal for large-scale applications, such as that observed in the UT Enschede case study.

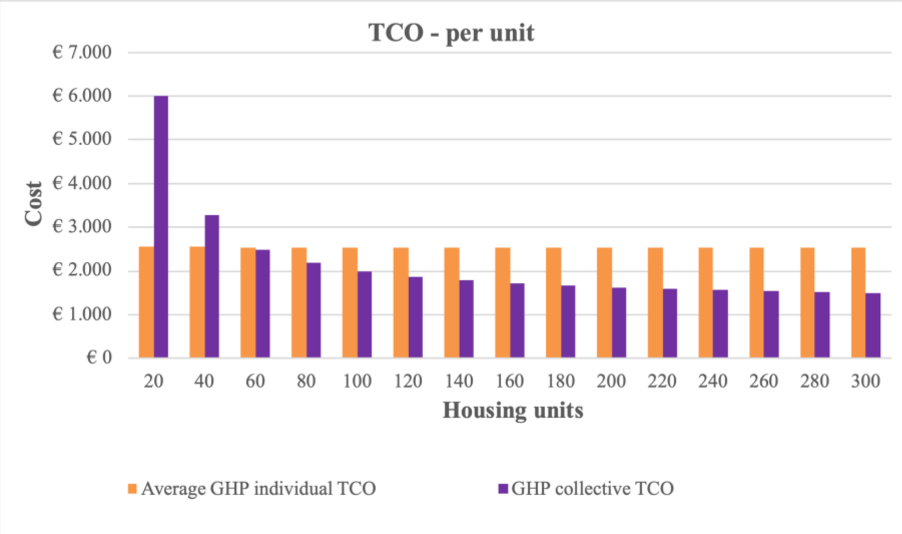


Figure 28: Impact of unit on TCO – TCO per unit. Source: Own illustration

4.5.4 Discussion and Conclusion

The findings of this study provide insight into the complex landscape of Sustainable Energy Technologies (SETs) implementation in building retrofits, particularly within the context of the UT Enschede campus. The comparative analysis between individual and collective SETs reveals multifaceted considerations that warrant careful examination and critical evaluation. The sub question, "What are the specific advantages and disadvantages of individual compared to collective Sustainable Energy Technologies (SETs) in financial terms?" guides the analysis between individual and collective SETs for retrofit housing projects.

One notable finding is the critical role of accurate cost estimation in project planning and feasibility assessment. The economic viability of SETs installations is heavily influenced by the initial investment costs, as also stated in chapter 4.4.3. Accurate estimation of these costs requires meticulous analysis, taking into account factors such as equipment procurement, labour, materials, permits, and engineering fees. Additionally, ancillary costs such as permitting fees and regulatory compliance must be accounted for to ensure comprehensive cost coverage and risk mitigation.

Operational expenses are a significant component of the total cost of ownership for SETs. These expenses comprise maintenance, repair, and energy consumption costs incurred throughout the lifespan of the systems. Accurately estimating operational expenses is crucial for evaluating the financial sustainability and performance of SETs. The process involves analysing historical data, industry benchmarks, and expert insights to understand maintenance requirements, energy consumption patterns, and management protocols.

Another essential aspect of the financial evaluation process is opportunity cost analysis. By assessing potential savings and revenue streams generated by SETs, stakeholders can make informed investment decisions. Evaluating the efficiency of energy conversion in SETs is crucial for optimizing financial value and ensuring economic sustainability.

The first sensitivity analysis of energy price compared to energy charges indicates that individual GHP systems are more resilient to changes in energy prices compared to collective systems. As energy prices rise, the relative cost of collective GHP systems increases more significantly due to the higher energy consumption associated with heat loss in the distribution network.

The second sensitivity analysis of cost compared to housing units indicate that investment costs for individual systems exhibit a consistent upward trajectory, while collective systems initially show a flatter cost curve that eventually rises at a slower rate. This indicates that collective systems become more cost-effective as the number of units increases, particularly beyond the 20-unit threshold identified in the case study.

The energy costs for collective GHP systems are initially higher than those for individual systems up to 300 housing units, primarily due to additional heat generation required to compensate for heat loss in the collective variant. However, as the number of units increases, individual GHP systems' energy costs eventually surpass those of collective systems, indicating a tipping point.

While maintenance costs for individual GHP systems increase in direct proportion to the number of units due to the necessity of monitoring multiple appliances, collective systems benefit from the economies of scale that result from centralised maintenance, which becomes more efficient as the system scales.

The comprehensive analysis of the overall TCO over a 15-year period indicates that collective systems become more favourable beyond approximately 60 units. This is due to the cumulative effect of lower per-unit investment, energy, and maintenance costs in larger collective systems.

In conclusion, this study emphasises the significance of rigorous financial evaluation in implementing SETs. It also highlights the necessity for enhanced data availability and transparency. Addressing these challenges will not only improve the accuracy of financial assessments but also foster greater confidence and uptake of SETs in building retrofit projects.

4.6 SQ5: Recommendation based on the Total Cost of Ownership (TCO)

As previously stated in the introduction, there has been a growing recognition in recent years of the necessity for a sustainable energy transition. This is driven by concerns about climate change, energy security and resource depletion. Within the context of the built environment, the adoption of Sustainable Energy Technologies (SETs) has the potential to mitigate environmental impact, enhance energy efficiency and promote long-term sustainability. Nevertheless, the successful implementation of SETs is contingent upon comprehensive evaluation methodologies that go beyond initial investment considerations to encompass the full spectrum of costs and benefits over the project lifecycle. A key element of this evaluation framework is the concept of total cost of ownership (TCO), which encompasses not only initial investment costs but also operational expenses and energy costs. This chapter sets out to elucidate the findings of TCO analysis conducted in the context of sustainable energy solutions for building retrofits, and to provide actionable recommendations for investors, end-users, and policymakers involved in SETs implementation. This chapter aims to synthesise key insights from the TCO evaluation and offer strategic guidance for technical, economic, environmental, social, and regulatory dimensions. The intention is to contribute to informed decision-making and sustainable development practices in the built environment. In order to provide an answer to the sub-question: “What recommendations can be proposed based on the Total Cost of Ownership (TCO) evaluation?”

4.6.1 Recommendation for investors, end-users, and policymakers

In light of the findings presented in the preceding chapter, it is possible to set specific sections that address the implications for various stakeholders, including investors, end-users, and policymakers.

Investors

It can be argued that investors represent a key stakeholder group in the process of driving the adoption of Sustainable Energy Technologies (SETs) in building retrofits. Their decisions exert a profound influence on the distribution of financial resources, and thus determine the ultimate success or failure of SETs projects. It is of the utmost importance for investors to be fully aware of the financial implications of investing in SETs. This enables them to make informed decisions and to achieve the greatest possible returns, while also contributing to environmental sustainability. This section presents a critical examination of the findings from the Total Cost of Ownership (TCO) analysis and offers insights and recommendations tailored to investors in the retrofit sector.

Key findings and recommendations:

1. ***Opportunity for long-term value:*** The TCO analysis reveals a potential for long-term value creation through investments in SETs. Despite higher initial investment costs, SETs demonstrate significant cost savings and potential revenue streams over their lifecycle. While SETs often require a higher initial investment, they ultimately result in cost savings due to reduced energy consumption. It is necessary to develop a financial model that can be used to calculate these costs.
2. ***Leveraging financial mechanisms:*** Innovative financial mechanisms, such as green bonds, tax incentives, and energy performance contracts, present opportunities for investors to enhance the financial viability of SETs projects. However, it is essential for investors to critically assess the effectiveness and suitability of these financial instruments in the context of their investment objectives, risk tolerance, and market dynamics.

Investing in SETs presents a significant opportunity for investors to generate attractive returns while contributing to environmental sustainability. By embracing sustainable investment strategies, leveraging financial mechanisms, and fostering collaboration, investors can play a pivotal role in driving sustainable transformation in the built environment.

End-users

The adoption and utilization of SETs in building retrofits is contingent upon the actions of end-users. As the ultimate beneficiaries of these technologies, end-users' decisions and behaviors have a profound impact on the energy performance, comfort, and sustainability outcomes of buildings. This section presents a critical examination of the findings from the TCO analysis, accompanied by insights and recommendations tailored to end-users.

Key findings and recommendations:

1. ***Cost-benefit analysis:*** The TCO analysis indicates that investments in SETs can result in significant cost savings and financial benefits for end-users over the lifecycle of building retrofits. By reducing energy consumption, lowering utility bills, and potentially generating revenue through mechanisms such as feed-in tariffs or demand response programs, SETs offer the potential for long-term economic gains.
2. ***Maintenance and operational considerations:*** While SETs installations offer cost savings in terms of energy consumption, they also entail ongoing maintenance and operational expenses. End-users should be aware of these additional costs, including maintenance, repair, and replacement of SETs components, to ensure the continued performance and reliability of the systems. Moreover, end-users should consider the energy efficiency and reliability of SETs technologies when selecting systems for building retrofits to minimize operational costs and maximize savings over time.
3. ***Behavioral impacts:*** The successful implementation and utilization of SETs in building retrofits also depend on end-users' behaviors and attitudes towards energy consumption and conservation. Behavioral factors, such as occupant behavior, user engagement, and awareness, influence energy usage patterns and system performance. End-users should be actively involved in SETs projects from the planning and design stages to foster a culture of energy efficiency and sustainability in buildings
4. ***Behavior changes interventions:*** Behavioral interventions, such as energy conservation campaigns, feedback mechanisms, and incentive programs, can encourage positive energy-saving behaviors among end-users. By promoting energy-efficient practices and behaviors, end-users can contribute to the overall energy performance and sustainability of buildings equipped with SETs technologies.

The role of end-users in the successful adoption and utilization of SETs in building retrofits is of importance. By grasping the financial implications, operational considerations, and behavioral impacts of SETs installations, end-users can make well-informed decisions and actively contribute to energy efficiency and sustainability goals. Education, engagement, and behavior change interventions are essential strategies for empowering end-users to embrace SETs technologies and realize their full potential in the built environment.

Policymakers

Policymakers occupy a pivotal position in the formation of the regulatory framework and incentives that regulate the adoption and implementation of SETs in building retrofits. This section evaluates the implications of the TCO analysis for policymakers and provides recommendations to facilitate the integration of SETs into policy agendas and initiatives.

Key findings and recommendations:

1. ***Economic viability:*** The TCO analysis highlights the economic viability of SETs in building retrofits, showing potential cost savings and financial benefits over their lifecycle. Policymakers should incentivize SETs adoption through financial mechanisms such as grants, subsidies, tax incentives, and low-interest loans. Innovative financing models like energy performance contracting (EPC) and green bonds can attract private capital, reduce investment risks, and secure new funding for sustainable projects. Despite high initial costs, the long-term operational savings are substantial. Decision-makers need to create financial incentives that offer immediate benefits to investors, bridging the gap between upfront costs and long-term savings.
2. ***Regulatory support:*** Regulatory frameworks are crucial for deploying and integrating SETs in building retrofits. Policymakers should implement policies that mandate or incentivize SETs in building codes, standards, and certification programs. Collective solutions, which often intersect public and private spaces, face complex regulatory challenges according to Vink (personal communication, 2023), particularly around ownership and cost allocation. To address these challenges, decision-makers must streamline permitting processes, reduce administrative burdens, and harmonize zoning regulations. Establishing transparent guidelines, standardized procedures, and online permitting platforms tailored to collective SET projects will enhance transparency, efficiency, and accessibility, facilitating quicker project approvals and reducing compliance costs.
3. ***Market transformation:*** Policymakers have the opportunity to drive market transformation and foster the uptake of SETs by creating a conducive environment for investment, innovation, and collaboration. By fostering partnerships between government, industry, academia, and other stakeholders, policymakers can facilitate knowledge exchange, capacity building, and technology transfer in the SETs sector. Moreover, policymakers should prioritize research and development funding for SETs innovations and pilot projects to demonstrate the feasibility and effectiveness of emerging technologies in real-world applications. By supporting demonstration projects and pilot initiatives, policymakers can de-risk investments, build confidence among investors and end-users, and catalyze market uptake of SETs solutions.
4. ***Monitoring and evaluation:*** Policymakers should establish robust monitoring and evaluation mechanisms to track the progress, performance, and impact of SETs policies and initiatives. By collecting data, conducting surveys, and analyzing key performance indicators, policymakers can assess the effectiveness, efficiency, and equity of policy interventions and identify areas for improvement and optimization. Moreover, policymakers should promote transparency, accountability, and stakeholder engagement in the monitoring and evaluation process to ensure the credibility and legitimacy of policy outcomes.
5. ***Promoting interconnection and grid integration:*** The integration of grid interconnection is of paramount importance for the optimization of the value and reliability of SETs installations, as well as for ensuring their meaningful contribution to the broader energy system. It is essential that decision-makers collaborate with utilities, grid operators, and regulatory agencies to establish clear interconnection standards, technical requirements, and grid integration protocols for the deployment of SETs. Furthermore, the implementation of demand response programs, dynamic pricing mechanisms, and grid flexibility measures can enhance the resilience, efficiency, and stability of the electricity grid, enabling the seamless integration of variable renewable energy sources, such as solar and wind power.

It is evident that policymakers play a pivotal role in facilitating the transition to sustainable and energy-efficient buildings through the integration of SETs in building retrofits. By acknowledging the economic, environmental, and social advantages of SETs and implementing supportive policies and regulations, policymakers can create an environment conducive to investment, innovation, and market transformation. By aligning policy objectives, building capacity, and monitoring progress, policymakers can facilitate the accelerated adoption and implementation of SETs, thereby contributing to the achievement of energy efficiency, carbon reduction, and sustainable development goals.

4.6.2 Technical considerations

This section addresses the technical considerations essential for the successful implementation of Sustainable Energy Technologies (SETs) in building retrofits. It draws upon the findings of the total cost of ownership (TCO) evaluation and existing literature to examine the key technical factors that influence the performance, efficiency, and reliability of SETs solutions in the built environment.

Technology selection and integration:

The selection and integration of appropriate SETs technologies are critical determinants of project success and long-term sustainability. Decision-makers must therefore carefully evaluate available technologies based on their compatibility with existing building infrastructure, site-specific conditions, energy demand profiles, and project objectives. Additionally, the integration of complementary technologies, such as solar photovoltaic (PV) systems, energy storage solutions, and building energy management systems (BEMS), can enhance system efficiency, resilience, and flexibility. Nevertheless, the integration process presents technical challenges related to system interoperability, control strategies, and performance optimization. These challenges necessitate interdisciplinary collaboration and expertise.

Energy efficiency and performance optimization:

The primary objective of SETs projects is to achieve the greatest possible energy efficiency and to optimise system performance. This is achieved by minimising energy consumption, reducing operational costs, and enhancing environmental sustainability. The achievement of these objectives necessitates the implementation of a strategic approach that integrates energy-efficient design principles and technologies.

Those responsible for decision-making should give priority to the adoption of energy-efficient design principles, such as passive solar design, strategic building orientation, robust thermal insulation, and high-performance HVAC systems. The incorporation of these principles into project planning and design allows for the minimisation of energy demand and the optimisation of building performance, resulting in significant energy savings over the project's lifecycle.

Moreover, the integration of advanced control algorithms, predictive analytics, and real-time monitoring technologies is crucial for the continuous optimisation of SETs systems. These technologies facilitate proactive management of energy usage by enabling adaptive responses to fluctuating environmental conditions, occupant behaviour, and energy demand patterns. The utilisation of these innovative tools enables SETs projects to achieve heightened levels of efficiency, resilience, and sustainability, thereby paving the way for a greener and more resource-efficient built environment.

Lifecycle Assessment (LCA) and environmental impact:

It is of paramount importance to conduct comprehensive lifecycle assessments (LCAs) in order to evaluate the environmental impact of the deployment of SETs and to ensure that they align with sustainability goals. LCAs assess the environmental footprint of SETs solutions across their entire lifecycle, from the extraction and manufacturing of raw materials to the installation, operation, and end-of-life disposal. Those responsible for decision-making should consider key environmental indicators, such as greenhouse gas emissions, resource depletion, water consumption, and ecosystem impacts, in order to identify potential trade-offs and minimise adverse environmental effects. Furthermore, the integration of circular economy principles, such as material reuse, recycling, and resource recovery, can enhance the environmental sustainability of SETs projects and contribute to a more circular and regenerative built environment.

Resilience and adaptability:

The Dutch news has recently reported that new construction projects are no longer being permitted to proceed due to the inability to connect them to the grid. This is due to the fact that the grid is already overcrowded. It is therefore evident that resilience and adaptability play a significant role in this context. But also to mitigate the risks posed by climate change, technological advancements, and unforeseen disruptions. It is imperative that decision-makers prioritise the design of SETs solutions that are equipped with built-in redundancy, modularity, and flexibility in order to withstand and recover from potential disruptions such as extreme weather events, equipment failures and cybersecurity threats.

The incorporation of redundancy, which encompasses backup systems and fail-safe mechanisms, enables SETs systems to continue functioning even in the event of the failure of individual components. Modularity facilitates straightforward scalability and replacement of components, thereby ensuring expedient recovery from disruptions without compromising the overall integrity of the system. Furthermore, the flexibility of design and operation allows SETs systems to adapt to changing conditions and emerging challenges, thereby ensuring long-term effectiveness and sustainability.

Moreover, the deployment of distributed energy systems, microgrids, and decentralised control architectures enhances system resilience by reducing reliance on centralised infrastructure. These technologies serve to minimise the occurrence of single points of failure, enhance the robustness of the system, and enable autonomous operation during grid outages or emergencies. The decentralisation of control and diversification of energy sources enable SETs systems to maintain functionality and provide essential services to communities even in the face of adverse circumstances.

In conclusion, it is of the utmost importance to address technical considerations in order to ensure the successful implementation of SETs in building retrofits. By selecting and integrating appropriate technologies, maximizing energy efficiency, conducting lifecycle assessments, enhancing resilience and adaptability, and implementing effective maintenance and lifecycle management practices, decision-makers can optimize the performance, reliability, and sustainability of SETs solutions in the built environment.

4.6.3 Summary of findings

In conclusion, this study has undertaken a comprehensive examination of the Total Cost of Ownership (TCO) evaluation for Sustainable Energy Technologies (SETs) in building retrofits. Through a systematic analysis of financial, technical, regulatory, and policy considerations, key insights and recommendations have been identified to guide for investors, end-users, and policymakers in the effective implementation of SETs projects.

A review of the TCO findings has revealed the complex interplay between initial investment costs, operational expenses, and energy savings associated with the deployment of SETs. While individual SETs offer advantages in terms of autonomy and flexibility, collective SETs present opportunities for cost efficiencies and community engagement. However, challenges related to space limitations, upfront investment, maintenance, and regulatory barriers must be addressed to realise the full potential of SETs in building retrofits.

The recommendations for decision-makers encompass a range of policy interventions aimed at streamlining permitting processes, incentivising investment, reassess building codes, promoting grid integration, and fostering stakeholder engagement. By addressing these critical areas, decision-makers can create an enabling policy environment conducive to the widespread adoption and successful implementation of SETs projects.

Furthermore, the financial strategies outlined in this study emphasise the importance of innovative financing mechanisms, such as grants, subsidies, tax credits, and green bonds, in mobilising private capital and de-risking investments in sustainable energy solutions. Additionally, technical considerations highlight the significance of grid interconnection, energy efficiency, and performance monitoring in optimising the performance and reliability of SETs installations.

Moreover, regulatory and policy recommendations emphasise the necessity for transparent and coherent regulatory frameworks, streamlined permitting processes, and effective stakeholder engagement strategies to overcome obstacles and facilitate collaboration among diverse stakeholders. By aligning regulatory incentives with sustainability goals and promoting market-driven solutions, decision-makers can accelerate the transition to a low-carbon built environment.

5 Discussion, conclusion, and limitations

5.1 Discussion

The purpose of this discussion is to undertake a critical analysis of the findings of this study in the context of existing literature and to evaluate the validity of the stated hypotheses. Furthermore, this section seeks to examine the implications of these findings, particularly in relation to the integration of Sustainable Energy Technologies (SETs) and their potential impact on Scope 3 emissions.

The first hypothesis posits that the integration of sustainable technologies will have a financial impact. Previous research has consistently demonstrated that the integration of SETs into building renovation projects can result in both immediate and long-term financial benefits (Choi, 2009; Shan et al., 2017). The findings of these studies posit that the installation of technologies such as PV panels and energy-efficient HVAC systems not only serves to reduce operational costs but also serves to enhance property values. However, these studies frequently concentrate on theoretical projections, thereby leaving scope for empirical data to provide further substantiation of these claims.

The findings of this study are in accordance with the general consensus regarding the long-term financial benefits of SETs. The case study analyzed demonstrate that retrofitted buildings with solar panels and closed ground source heat pump (GHP) systems exhibited considerable reductions in energy costs over a 15-year period, in accordance with the savings proposed by Choi (2009). However, in contrast to the findings of previous studies, this research highlights the considerable initial investment costs, which were higher than anticipated and constituted a significant obstacle to immediate financial gain.

This divergence from earlier research highlights a crucial point that has been somewhat overlooked in prior studies: while the long-term financial benefits are substantial, the short-term financial barriers present a significant challenge. Despite the assertion by Shan et al. (2017) that SETs yield considerable returns, the potential burden of upfront capital costs is not sufficiently addressed, particularly in the context of smaller projects or investors with limited access to financing. The results of my study indicate that, while total cost of ownership (TCO) modelling confirms financial benefits over time, the initial cost barrier cannot be overlooked and necessitates careful financial planning.

In this regard, my study contributes to the existing body of knowledge by suggesting that financial incentives and subsidies are critical to offsetting these initial costs. As observed in the case study, without such incentives, the adoption of SETs could be delayed or limited to larger-scale projects with significant financial backing. This builds on earlier insights by providing concrete evidence that targeted policy interventions are necessary to facilitate wider adoption of SETs in retrofitting initiatives.

The second hypothesis concentrates on the financial consequences of individual versus collective deployments of SET. The existing literature on the subject predominantly discusses individual implementations of SETs, whereby each building or project operates autonomously. Empirical evidence supports financial viability and opportunities through SETs integration in the TCO. However, the study shows that the switch to collective systems occurs quite early, particularly in smaller apartment complexes. From approximately 60 housing units, collective systems appear to become more appealing due to economies of scale. This aligns with expectations, but it is noteworthy that this threshold is reached at an even earlier stage in smaller housing units than anticipated.

A key finding of this study is the discrepancy between the preferences of tenants and investors when selecting between individual and collective closed-loop GHP. Tenants tend to favor individual systems due to the reduced maintenance costs and lower energy expenditure that they entail. Conversely, investors favor collective systems due to the reduced initial investment costs. Nevertheless, an analysis of the TCO reveals that collective GHP systems offer the most cost-effective solution. Therefore, it can be concluded that a collective solution represents the optimal choice, a view that is also held by investors, although this is not the preference of tenants.

A similar pattern emerges when geothermal heat pumps are considered in conjunction with PV panels. Tenants tend to favor an individual GHP with PV panels due to the reduced energy costs, despite the slightly elevated maintenance expenses. Investors continue to express a preference for a collective GHP system, citing the lower initial investment costs as a key factor. Nevertheless, the TCO model once more demonstrates that a collective GHP with PV provides the lowest total cost. Although this solution is objectively the most cost-effective, it does not align with the tenant's preferences. However, it does align with those of the investor. This illustrates that while collective systems are objectively superior from a financial perspective, tenant preferences do not always align with the optimal financial choice. This demonstrates the importance of considering end-users' needs and preferences in addition to financial models when implementing sustainable energy solutions.

While Scope 3 emissions were not explicitly addressed in the referenced literature, they are becoming increasingly relevant in the context of sustainable retrofitting. The integration of SETs can result in a notable reduction of Scope 3 emissions, which encompass indirect emissions from an organization’s value chain. The reduction of operational energy consumption through the utilization of technologies such as PV panels systems and GHP systems directly contributes to the reduction of these indirect emissions.

The case study analyzed in this research demonstrate that buildings equipped with SETs experience a notable reduction in energy consumption, which in turn leads to a reduction in operational and embodied emissions. This is consistent with the overarching goals of sustainable development and illustrates the capacity of SETs to contribute to the reduction of Scope 3 emissions. The extent of emissions reduction is contingent upon the technology employed and the scale of implementation. However, the findings underscore the imperative of integrating a lifecycle perspective into retrofit projects to ensure optimal environmental benefit.

This observation offers further insight into the environmental impacts of SETs, particularly when deployed on a large scale. Reducing Scope 3 emissions through collective SET projects, for instance, presents a more significant opportunity for impact than smaller, individual implementations due to the broader reach and resource-sharing benefits.

The findings of this study have several key implications for both policy and practice. For policymakers, there is a clear need to address the initial cost barriers that hinder the adoption of SETs. Financial incentives, subsidies, and supportive regulatory frameworks will be crucial in promoting wider adoption, particularly for collective neighborhood-level projects where coordination and setup costs are higher. My findings suggest that long-term financial planning, coupled with targeted support mechanisms, will be necessary to ensure the financial viability of SET-driven retrofit projects.

For industry practitioners, the results emphasize the importance of long-term planning and the necessity of considering the total lifecycle costs when implementing SETs. The TCO model employed in this research offers a practical framework for assessing these costs and can serve as a valuable tool for stakeholders looking to invest in sustainable technologies.

In conclusion, this study offers valuable insights into the financial impacts of integrating SETs in retrofitting projects. While the long-term financial benefits are evident, significant initial cost obstacles persist, particularly for collective initiatives that necessitate collaboration across multiple stakeholders. Moreover, the potential for reducing Scope 3 emissions through the integration of SETs highlights the environmental value of these technologies when considered from a lifecycle perspective. These findings emphasize the necessity of comprehensive policy frameworks and financial planning to facilitate the widespread adoption of SETs and enhance the sustainability of the built environment.

5.2 Conclusion

Writing a conclusion serves a dual purpose: not only does it highlight the findings and benefits of the study, but it also invites further questions and reflection. For example, while cost has been a central factor in determining the value of Sustainable Energy Technologies (SETs), is it really the only consideration? What happens if the energy consumption patterns of buildings differ significantly, with one requiring significantly more energy than the other? This raises potential conflicts over ownership and financial responsibility: who should bear the greater part of the installation costs?

There are also ethical considerations. In the Netherlands, for example, investors cannot sell energy, but they can sell heat. This creates a moral dilemma: if buildings are poorly insulated, they will consume more energy, potentially leading to higher profits for investors at the expense of greater energy inefficiency. These complexities highlight the need for a nuanced and multi-faceted approach to the implementation of SETs, considering not only the financial but also the ethical and practical dimensions.

5.2.1 Summary of findings

The findings of this study indicate that the financial viability of sustainable energy technologies (SETs) in building retrofits is contingent upon a number of contextual factors, including the scale of deployment and the specific energy requirements of the housing projects in question. While cost remains a primary determinant, the findings reveal that several other factors, including energy consumption patterns, building insulation quality, and regulatory frameworks, play a significant role in the successful implementation of these technologies. These findings underscore the necessity of a multi-dimensional approach to decision-making in the deployment of SETs.

The following key conclusions can be drawn from the study:

1. ***Financial viability of collective SETs:*** Collective systems become economically advantageous when scaled beyond 60 units, owing to economies of scale. This makes them particularly suitable for larger housing developments or densely populated neighbourhoods.
2. ***Individual sets for smaller projects:*** While individual systems offer customization and resilience to energy price fluctuations, they are less cost-effective at larger scales. These systems are best suited for smaller or bespoke housing projects where autonomy is prioritized.
3. ***Sensitivity to energy prices:*** Individual GHPs demonstrated a stronger capacity to withstand energy price volatility, compared to collective systems, which face higher potential heat loss during energy distribution.
4. ***Policy implications:*** The study calls for more robust policy interventions to support the adoption of SETs. Streamlining permitting processes, offering financial incentives, and updating building codes can facilitate the transition toward sustainable energy solutions in the built environment.

5.2.2 Contributions to knowledge

This study makes a significant contribution to the existing body of knowledge on Sustainable Energy Technologies (SETs) in building retrofits, particularly in the context of the UT Enschede campus. By providing a detailed comparative analysis of individual versus collective SETs, the research highlights the financial, technical, and operational complexities associated with each approach. This nuanced understanding helps stakeholders to make informed decisions about the adoption and implementation of SETs in retrofit housing projects.

A major contribution of this research is the development of a comprehensive Total Cost of Ownership (TCO) framework tailored to the evaluation of SETs. This framework incorporates initial investment costs, operating costs, and opportunity costs to provide a holistic view of the financial implications over the life cycle of the system. The inclusion of sensitivity analyses further enhances this framework by demonstrating the impact of varying energy prices and unit sizes on the economic viability of SETs. These findings are critical for policy makers, investors and practitioners seeking to optimise the financial sustainability of SET installations.

The study also sheds light on the benefits and limitations of individual and collective SETs. It highlights that while individual systems offer autonomy and flexibility, collective systems benefit from economies of scale, particularly beyond a certain threshold of housing units. This understanding is central to strategic planning in urban development and energy management, guiding stakeholders in selecting the most cost-effective and efficient SET configurations for large-scale projects.

In addition, the study highlights the critical need for improved data availability and transparency in the evaluation of SETs. By advocating for better data collection and sharing practices, the research paves the way for more reliable and credible financial assessments, fostering greater confidence and uptake of SETs in building retrofit projects. This call for improved data practices is a crucial step towards a more sustainable and resilient built environment.

Overall, this research enriches the academic discourse on SETs by providing practical insights and methodological advances that can be applied across contexts and scales. The findings and recommendations presented in this study serve as a valuable resource for advancing the successful implementation of SETs, ultimately contributing to the broader goal of sustainable urban development and energy transition.

5.2.3 Practical implications

The findings of this research have several practical implications for several stakeholders involved in the design and implementation of sustainable urban development initiatives and Sustainable Energy Technologies (SETs).

Firstly, the comprehensive analysis of locational variables, building characteristics, and existing infrastructure highlights the importance of considering site-specific factors in the planning and deployment of SETs. It is recommended that decision-makers prioritise areas with favourable conditions, such as proximity to renewable energy sources, sufficient building space, and compatible infrastructure, in order to maximise the effectiveness and efficiency of SET projects.

Furthermore, accurate cost estimation and financial planning are crucial. The comprehensive Total Cost of Ownership (TCO) framework provided by this study allows stakeholders to assess economic feasibility effectively, covering initial investment, operational expenses, and opportunity costs. This thorough financial analysis ensures precise budgeting and risk management.

Moreover, the study highlights the cost advantages of collective SETs for larger projects in the context of UT Enschede. In this context projects with more than 60 units, collective systems become increasingly cost-effective by looking at the TCO. Urban planners and developers can leverage these findings to achieve cost savings or new business models.

Lastly, strategic policy interventions are necessary to support SET adoption. Streamlining permitting processes, incentivizing investments, and updating building codes can create a supportive environment for SET implementation. Additionally, innovative financing mechanisms like grants, subsidies, tax credits, and green bonds can attract private capital and reduce investment risks in sustainable energy solutions.

5.2.4 Future research directions

This study provides valuable insights into the integration of Sustainable Energy Technologies (SETs) into urban development. However, several avenues for future research remain unexplored. Addressing these research gaps can further advance our understanding of the challenges and opportunities associated with sustainable urban development and SET deployment.

1. ***Focus on expanding the scope:*** The analysis should encompass a wider range of SETs and urban contexts. This study primarily examines the financial value of ground source heat pumps (GHP) and solar photovoltaic (PV) systems. However, there is a need to investigate other emerging SETs, such as tidal power, wind energy and ocean thermal energy conversion (OTEC), and their applicability in diverse urban environments. Additionally, considering the heterogeneity of urban landscapes, future studies should explore the spatial variability of SET potential and identify optimal deployment strategies for different urban typologies.
2. ***Comprehensive Cost-Benefit Analysis (CBA):*** Conducting robust CBAs that consider both economic and non-economic factors is essential for informed decision-making in SET projects. This includes assessing long-term revenue potentials, and intangible benefits such as environmental impact and social equity. Adapting CBAs to specific urban contexts and SET types ensures relevance and accuracy in strategic planning.
3. ***Evaluate socio-economic and environmental impacts:*** Beyond financial considerations, further research should delve into the social acceptance and equity implications of SET deployment. Assessing how SET projects affect different socio-economic groups and vulnerable communities is critical for designing inclusive urban development strategies. This includes examining distributional effects and identifying mechanisms to enhance social equity through SET initiatives.
4. ***Investment in data collection, monitoring, and analysis:*** Investing in advanced data collection and analytical capabilities is fundamental for conducting robust Total Cost of Ownership (TCO) assessments of SETs in urban environments. Improved data infrastructure enables accurate

forecasting of lifecycle costs and performance metrics, providing empirical insights into the long-term efficacy of SET implementations.

5. ***Role of policy and governance:*** Evaluating the effectiveness of existing policy instruments, such as feed-in tariffs and renewable energy mandates, in promoting SET deployment is crucial. Identifying barriers to policy implementation and enforcement and conducting comparative studies across different jurisdictions can provide valuable insights for policymakers. This knowledge can aid in replicating successful policy interventions and overcoming challenges in advancing sustainable urban development.
6. ***Exploration Innovative Funding Models:*** Overcoming financial barriers associated with SET projects necessitates exploring innovative funding mechanisms. Public-private partnerships, green bonds, and incentive programs can align investor interests with long-term societal benefits. These models not only facilitate capital mobilization but also promote equitable distribution of benefits, fostering sustainable urban development.

5.3 Limitations

This study offers valuable insights into the financial implications and challenges of implementing Sustainable Energy Technologies (SETs) in housing retrofit projects. However, several limitations must be acknowledged to contextualize the findings and guide future research. These limitations span data issues, stakeholder dynamics, methodological constraints, and broader contextual factors.

5.3.1 Data and Methodological Constraints

A significant limitation is the data employed in the Total Cost of Ownership (TCO) model, which is essential for evaluating the integration of SETs. The key data inputs include estimates of energy consumption, costs associated with energy use, operational costs, and investment costs. Each of these data points has inherent limitations.

- ***Energy consumption estimates:*** The study relies on projections from VIAC and computer models like Vabi. However, these estimates may not accurately reflect future energy needs, particularly for retrofit projects where historical data might not align with new efficiency standards or improved insulation. The assumptions and algorithms in these models may also diverge from real-world conditions, impacting the reliability of energy consumption forecasts.
- ***Energy costs:*** The study uses fixed contract rates for energy costs, but these can fluctuate based on geographical location, market dynamics, and temporal factors. The volatility in energy prices may limit the applicability of the findings to different contexts. Future research should incorporate sensitivity analyses to account for these fluctuations.
- ***Operational costs:*** Derived from reference projects and adjusted for inflation, operational cost estimates may not fully capture variations due to vendor selection, maintenance practices, or geographic differences. This variability necessitates a critical evaluation of the generalizability of these estimates.
- ***Investment costs:*** Sourced from external databases, such as the RVO website, investment cost estimates may not reflect the specific requirements of individual projects. Comparing various technology options adds complexity to cost assessments. Detailed cost breakdowns and sensitivity analyses are recommended for future research.

Methodologically, the study's reliance on secondary data and predefined models introduces the potential for bias and limitations. The utilisation of secondary data sources for variables such as building characteristics and energy consumption may not fully encompass the diversity of urban contexts. The collection of primary data, for instance through surveys and field measurements, could serve to enhance the accuracy and representativeness of future studies. Furthermore, the modelling techniques utilised may exclude certain environmental impacts and externalities, indicating the necessity for sensitivity analyses and uncertainty quantification.

5.3.2 Stakeholders and financial responsibility

The apportionment of financial responsibility in SETs projects is a highly intricate process. The initial investment costs are typically borne by the investors, which may include private entities, government agencies, or social housing companies. The challenge lies in achieving a balance between lower energy costs for end-users and viable returns for investors. Higher initial investments may result in higher operational costs, which in turn may complicate the financial dynamics for end-users.

The potential transfer of investment responsibility to end-users, as evidenced by the growing prevalence of residential solar panel installations, illustrates the evolving financial landscape. For instance, homeowners who invest in solar PV systems may assume the financial burden that would otherwise be borne by investors. This aligns with the concept of distributed energy generation. Nevertheless, in order to develop equitable financing mechanisms, it is essential to consider the motivations of the various investors involved, which may include financial, environmental, or social considerations.

5.3.3 Broader contextual limitations

The generalisability and applicability of the study's findings are contingent upon a number of broader factors.

- ***Sensitivity to price fluctuations:*** The Total Cost of Ownership (TCO) evaluations are particularly sensitive to fluctuations in electricity and gas prices, which can significantly influence the financial value of Sustainable Energy Technologies (SETs). It is imperative for future research to delve into robust methodologies that can effectively account for price volatility. Additionally, resilient financing strategies must be developed to mitigate the risks associated with energy price fluctuations.
- ***Material scarcity and scalability (International Energy Agency, 2021):*** The future scalability of SETs could encounter obstacles due to material scarcity, presenting a challenge to their widespread adoption. The limited availability of critical components may result in increased installation costs and hinder the progress towards sustainable energy transitions.
- ***Environmental impacts of production processes (Farghali et al., 2023):*** Despite the environmental advantages they offer, certain SETs raise concerns about the sustainability of their production processes. Evaluating the life cycle impacts of manufacturing and deploying SETs is crucial to ensure that their environmental benefits outweigh potential drawbacks.
- ***Technological obsolescence and disruptive innovations (International Energy Agency, 2021):*** The rapid pace of technological advancements may render current SETs obsolete, introducing disruptive innovations that offer superior performance and cost-effectiveness . It is essential to anticipate and adapt to such technological disruptions to maintain the competitiveness and relevance of sustainable energy projects. Researchers should continuously monitor emerging technologies and evaluate their potential implications for existing infrastructure and investment decisions.
- ***Adaptation to changing environmental and social conditions:*** The need for adjustments to the design and operation of SETs may arise from climate change and evolving energy demands. Changes in energy usage patterns, such as increased demand for cooling due to rising temperatures, could affect the efficacy of existing SETs and necessitate additional investments in complementary technologies.

The study's focus on particular SETs, such as ground source heat pumps and solar PV systems, and its geographical and temporal boundaries restrict the extrapolation of findings. The dynamics of urban areas vary significantly from one region to another. In light of the rapid pace of technological and socio-economic change, it is essential to maintain an ongoing programme of monitoring and adaptation.

In conclusion, although this study offers valuable insights into the financial dynamics of SETs, it is essential to address the identified limitations to advance research and achieve sustainability goals. By acknowledging and addressing these constraints, future research can enhance the robustness and applicability of TCO analyses and contribute to the development of more effective sustainable energy solutions.

5.4 Closing statement

In conclusion, it is imperative to emphasise that the selection of appropriate Sustainable energy Technologies (SETs) in retrofitting housing and the determination of their financial value are contingent upon the specific location, function, and situation. It is of the utmost importance to conduct a comprehensive Cost-Benefit Analysis (CBA), encompassing not only financial aspects but also social and sustainability considerations aligning with the Triple Bottom Line (TBL). A Total Cost of Ownership (TCO) model may be perceived as being a significant departure from CBA, TCO provides a comprehensive overview of the costs and benefits associated with a project over its entire lifespan, which is of significant importance to a range of stakeholders. A business model that is aligned with these considerations should be developed in order to ensure a sustainable and successful outcome.

6 Reflection

6.1 Reflection on the result and process

The research and design in the graduation phase presented both successes and challenges. The methodological approach chosen was a fundamental part of the study plan, aimed at addressing the research questions effectively. Where I know from myself that I am more of the numbers I have therefore opted for a quantitative study. However, the complexity of the factors involved in the research process posed significant challenges.

The start of my research journey and design can be compared to the development of a river delta. In the beginning, my research flows like a narrow, steady stream of ideas and information. With the choice between should I choose individually or collectively Sustainable Energy Systems (SETs) based on the finance. However, as I was delving deeper, this stream branches out in various directions, much like the river divides into different arms that flow into the sea. With first looking at all the technology, each of which has its own techniques. Which can then be combined again. But again, the unloading aspects whether this technology is possible. And depending on even more variable what the financial value is then. Each branch of the delta represents a different aspect or component of my research, with each topic forming a tributary that ultimately converges back into the larger whole.

As I delved deeper into a specific branch, I discover that various topics intersect, much like the currents and tributaries that meet and merge in the delta. In this way, the river delta symbolizes the growth and complexity of my research, with the mainstream branching out and converging again, while different subjects and perspectives intersect and connect in interesting ways. Whereas I thought I had chosen a manageable topic, this was nevertheless a complex problem. And a much more technical subject than I initially thought. Whereas at first, I was more focused on finance, a much more technical aspect came into play.

One of the main challenges encountered was the scarcity and ambiguity of financial data, which hindered the analysis and comparison of key figures. Furthermore, predictive aspects, such as opportunity cost, proved to be particularly complex due to their speculative nature.

The initial expectation of a straightforward decision model yielding definitive answers was replaced by the realization that project outcomes are contingent upon numerous factors, each exerting influence on the results. In addition, the complexity of the research endeavour is highlighted by the uniqueness of each project, which is characterised by heterogeneous objects, environments, and contextual factors.

Upon reflection of the 'how and why', it became clear that the iterative process of engaging with mentors' feedback was instrumental in refining the research approach. During the research, the feedback was open-ended, which allowed for exploration of diverse perspectives and avenues. However, this also led to a sense of ambiguity and complexity at times. As the research progressed, collaborative efforts were made to address concerns regarding the complexity and workload. This included delineating the scope and enhancing concreteness.

The feedback was continuously translated into the work, which influenced the evolution of the research trajectory. At the outset, the feedback prompted an extensive examination of several sub-questions, leading to a scattered focus. However, as the research progressed and stress levels increased, a decision was made to prioritize a specific comparison, enabling a more targeted analysis in line with the feedback received.

Furthermore, learning from the process underscored the realization of the massiveness of the subject matter and the necessity for deeper technical expertise, particularly in the realm of installations. Data data data… The acquisition and interpretation of data emerged as a formidable challenge, highlighting the importance of data literacy and discernment in research endeavours.

In conclusion, the research journey presented challenges and complexities, but also facilitated learning and growth. This emphasizes the iterative nature of academic inquiry and the significance of adaptability and resilience in navigating multifaceted research landscapes.

6.2 Reflection on the study

As I near the end of my graduation period, it is important to reflect on my journey so far and plan for the final stages of the thesis. The following sections cover important aspects related to the graduation project topic, its alignment with my master track, the relationship between research and recommendations, the assessment of my approach and methodology, and the academic and societal implications of the project.

The relation between my graduation project topic and my master track in Management in the Building Environment is close. My graduation project topic focuses on Sustainable Energy Technologies (SETs) in urban development, which aligns with the core themes of my master track. I have developed a comprehensive understanding of urban development dynamics, stakeholder management, and sustainable building practices through courses and seminars. This forms the foundation for my research on integrating SETs into urban development.

The research findings have directly influenced the formulation of recommendations aimed at promoting the adoption of SETs in urban development projects. Conversely, the research has been shaped by the identification of practical recommendations, which have highlighted areas requiring deeper investigation. This iterative process has fostered a symbiotic relationship between research and recommendations, ensuring that the proposed strategies are grounded in empirical evidence and responsive to real-world challenges.

The strength of my approach and methodology lies in their adaptability and rigour in addressing complex interdisciplinary issues. I employ a quantitative method that combines analyses to gain holistic insights into the multifaceted nature of sustainable urban development. Although there have been difficulties encountered along the way, the process itself has proved to be beneficial in terms of enhancing the robustness and comprehensiveness of the research outcomes.

The graduation project has significant academic value as it contributes to the existing body of knowledge on sustainable urban development and energy management. The project elucidates the potential benefits and challenges of integrating SETs into urban infrastructure, informing academic discourse and policy debates on sustainable urbanization. Furthermore, the project has implications for promoting environmental stewardship, enhancing energy security, and providing access to clean energy technologies, from a societal perspective. Ethical considerations, such as the equitable distribution of benefits and the minimization of environmental harm, have been integrated throughout the research process to ensure responsible and ethical conduct.

Based on the research there are also self-reflection questions:

1. How can the findings of the research be effectively communicated to diverse stakeholders, including policymakers, investors, and community members, to facilitate informed decision-making?
2. In what ways can future research endeavours build upon the insights generated in this project to advance the field of sustainable urban development and energy management further?

In the final stages of the graduation period, the focus will be on synthesising research findings, refining recommendations, and connecting the dots together. Efforts will also be made to reflect on the project's journey, identify lessons learned, identifying the limitations and implications, reflected on the whole process and delineate avenues for future research and professional development. Through dedication and collaboration, I am committed to contributing to the advancement of sustainable urban development practices and fostering positive societal impact.

Acknowledgements

This journey would not have been possible without the support and guidance of several individuals and organizations.

First, I would like to express my deepest gratitude to my supervisors, Paul Chan, Michael Peeters, and Alex Fernández, for their continuous guidance, insightful feedback, and encouragement throughout this research process. Their expertise and dedication have been invaluable to the completion of this thesis.

I would also like to thank VIAC, particularly Paul Vink and Gertjan van den Brink, for providing access to crucial data and for facilitating the practical aspects of this research. Their collaboration has significantly enhanced the scope and impact of my study.

I owe a debt of gratitude to all those who have contributed, either directly or indirectly, to the completion of this thesis. Your assistance and confidence in my work have been pivotal in the realisation of this project.

Finally, I wish to express my gratitude to my family, friends and my partner. Their unwavering encouragement, patience, and belief in me have provided a constant source of strength, particularly during periods of significant challenge.

A final statement should be said about artificial intelligence (AI) used writing my thesis.

During the writing of this thesis, I observed the rapid rise of AI technologies, which sparked my interest in exploring their potential for academic purposes. The image for the cover page and the background image for the reflection section were created using Bing AI. Moreover, as someone with dyslexia, AI has been an invaluable tool in helping me articulate my ideas more clearly. I used the ChatGPT-3 language model to refine my quick or disorganized thoughts into structured, coherent text. Through prompts such as, *"Acting as a PhD student at the technical university. Based on the outline above, help me translate my thoughts into a structured academic text. It is about the [introduction] of the report. Here are my thoughts: [xxx],"* It also allowed me to efficiently scan academic papers, determine their relevance, and delve deeper into complex topics. I am convinced that these tools have elevated my research capabilities to a new level.

References

Ansel, A., & Robyns, B. (2006). Modelling and simulation of an autonomous variable speed micro hydropower station. *Mathematics and Computers in Simulation*, *71*(4-6), 320–332. https://doi.org/10.1016/j.matcom.2006.02.011

Architecture. (2020). *Why The Built Environment – Architecture 2030*. Architecture2030.org. https://www.architecture2030.org/why-the-built-environment/#:~:text=The%20built%20environment%20is%20responsible,of%20annual%20global%20CO2%20emissions.

Beccali, M., Cellura, M., & Ardente, D. (1998). Decision making in energy planning: the ELECTRE multicriteria analysis approach compared to a FUZZY-SETS methodology. *Energy Conversion and Management*, *39*(16-18), 1869–1881. https://doi.org/10.1016/s0196-8904(98)00053-3

Bhuiyan, S. I., Jones, & Wanigarathna, N. (2015). *An approach to sustainable refurbishment of existing building* (pp. 1093–1102). https://www.arcom.ac.uk/-docs/proceedings/2bdf2ceb7a32e4b6e197c75ce335bd3c.pdf

Boardman, A. E., Greenberg, D. H., Vining, A. R., & Weimer, D. L. (2018). *Cost-benefit analysis : concepts and practice*. Cambridge University Press.

Choi, C. (2009). Removing Market Barriers to Green Development: Principles and Action Projects to Promote Widespread Adoption of Green Development Practices. *Journal of Sustainable Real Estate*, *1*(1), 107–138. https://doi.org/10.1080/10835547.2009.12091785

climate-data.org. (n.d.). *Klimaat Enschede: Klimatogram, Temperatuur grafiek en Klimaat tabel voor Enschede*. Nl.climate-Data.org. Retrieved March 20, 2024, from https://nl.climate-data.org/europa/koninkrijk-der-nederlanden/overijssel/enschede-924/

Copiello, S., & Donati, E. (2021). Is investing in energy efficiency worth it? Evidence for substantial price premiums but limited profitability in the housing sector. Energy and Buildings, 251, 111371. https://doi.org/10.1016/j.enbuild.2021.111371

Demirtas, O. (2013). Evaluating the Best Renewable Energy Technology For Sustainable Energy Planning. *DOAJ (DOAJ: Directory of Open Access Journals)*, *Vol. 3, pp.23-33*(Special Issue).

Dicorato, M., Forte, G., & Trovato, M. (2008). Environmental-constrained energy planning using energy-efficiency and distributed-generation facilities. *Renewable Energy*, *33*(6), 1297–1313. https://ideas.repec.org/a/eee/renene/v33y2008i6p1297-1313.html

Ding, G. K. C. (2008). Sustainable construction—The role of environmental assessment tools. *Journal of Environmental Management*, *86*(3), 451–464. https://doi.org/10.1016/j.jenvman.2006.12.025

Ellabban, O., Abu-Rub, H., & Blaabjerg, F. (2014). Renewable energy resources: Current status, future prospects and their enabling technology. *Renewable and Sustainable Energy Reviews*, *39*(39), 748–764. https://doi.org/10.1016/j.rser.2014.07.113

Farghali, M., Osman, A. I., Chen, Z., Abdelhaleem, A., Ihara, I., Mohamed, I. M. A., Yap, P.-S., & Rooney, D. W. (2023). Social, environmental, and economic consequences of integrating renewable energies in the electricity sector: a review. *Environmental Chemistry Letters*, *21*(3), 1381–1418. https://doi.org/10.1007/s10311-023-01587-1

Giraudet, L.-G., & Missemer, A. (2023). The history of energy efficiency in economics: Breakpoints and regularities. Energy Research & Social Science, 97, 102973. https://doi.org/10.1016/j.erss.2023.102973

Gohardani, N., & Björk, F. (2012). Sustainable refurbishment in building technology. *Smart and Sustainable Built Environment*, *1*(3), 241–252. https://doi.org/10.1108/20466091211287128

Gool, P. van. (2013, January 9). *Onroerend goed als belegging*. Noordhoff.

Hayles, C., & Kooloos, T. (2008, February). *(PDF) The challenges and opportunities for sustainable building practices*. ResearchGate. https://www.researchgate.net/publication/228350441_The_challenges_and_opportunities_for_sustainable_building_practices

Huang, H., Wang, H., Hu, Y.-J., Li, C., & Wang, X. (2022). The development trends of existing building energy conservation and emission reduction—A comprehensive review. *Energy Reports*, *8*, 13170–13188. https://doi.org/10.1016/j.egyr.2022.10.023

Jafari, A., & Valentin, V. (2018). Selection of optimization objectives for decision-making in building energy retrofits. *Building and Environment*, *130*, 94–103. https://doi.org/10.1016/j.buildenv.2017.12.027

Jagarajan, R., Abdullah Mohd Asmoni, M. N., Mohammed, A. H., Jaafar, M. N., Lee Yim Mei, J., & Baba, M. (2017). Green retrofitting – A review of current status, implementations and challenges. *Renewable and Sustainable Energy Reviews*, *67*, 1360–1368. https://doi.org/10.1016/j.rser.2016.09.091

Jansen, S., Mohammadi, S., & Bokel, R. (2020). Developing a locally balanced energy system for an existing neighbourhood, using the “Smart Urban Isle” approach. *Sustainable Cities and Society*, 102496. https://doi.org/10.1016/j.scs.2020.102496

Ji, L., Wu, Y., Xie, Y., Sun, L., & Huang, G. (2022). An integrated framework for feasibility analysis and optimal management of a neighborhood-scale energy system with rooftop PV and waste-to-energy technologies. *Energy for Sustainable Development*, *70*, 78–92. https://doi.org/10.1016/j.esd.2022.07.012

Kerstens, A., & Greco, A. (2023). From Buildings to Communities: Exploring the Role of Financial Schemes for Sustainable Plus Energy Neighborhoods. *Energies*, *16*(14), 5453–5453. https://doi.org/10.3390/en16145453

Kruger, P. (2006). *Alternative Energy Resources*. John Wiley & Sons.

Krukanont, P., & Tezuka, T. (2007). Implications of capacity expansion under uncertainty and value of information: The near-term energy planning of Japan. *Energy*, *32*(10), 1809–1824. https://doi.org/10.1016/j.energy.2007.02.003

Kulakov, K., & Baronin, S. (2017). Methods of modeling TCO residential real estate in the life cycles of buildings as a promising energy efficiency management tool. *MATEC Web of Conferences*, *106*, 06022. https://doi.org/10.1051/matecconf/201710606022

Liao, H., Ren, R., & Li, L. (2023). Existing Building Renovation: A Review of Barriers to Economic and Environmental Benefits. *International Journal of Environmental Research and Public Health*, *20*(5), 4058. https://doi.org/10.3390/ijerph20054058

Ling, D. C., & Archer, W. R. (2017). *Real estate principles : a value approach* (5th edition). Mcgraw-Hill Education.

Ma, Z., Cooper, P., Daly, D., & Ledo, L. (2012). Existing building retrofits: Methodology and state-of-the-art. *Energy and Buildings*, *55*, 889–902. https://doi.org/10.1016/j.enbuild.2012.08.018

Mcdonald, J. F., & Mcmillen, D. P. (2010). *Urban economics and real estate : theory and policy*. Wiley.

Oliveira, S., Chatzimichali, A., Atkins, E., Badarnah, L., & Faezeh Bagheri Moghaddam. (2023). From individuals to collectives in energy systems — A social practice, identity and rhythm inspired lens. *Energy Research & Social Science*, *105*, 103279–103279. https://doi.org/10.1016/j.erss.2023.103279

Piacentino, A., Duić, N., Markovska, N., Vad Mathiesen, B., Guzović, Z., Eveloy, V., & Lund, H. (2019). Sustainable and cost-efficient energy supply and utilisation through innovative concepts and technologies at regional, urban and single-user scales. *Energy*, *182*, 254–268. https://doi.org/10.1016/j.energy.2019.06.015

Power, A. (2008). Does demolition or refurbishment of old and inefficient homes help to increase our environmental, social and economic viability? *Energy Policy*, *36*(12), 4487–4501. https://doi.org/10.1016/j.enpol.2008.09.022

San Cristóbal, J. R. (2011). Multi-criteria decision-making in the selection of a renewable energy project in spain: The Vikor method. *Renewable Energy*, *36*(2), 498–502. https://doi.org/10.1016/j.renene.2010.07.031

Schneider-Marin, P., Winkelkotte, A., & Lang, W. (2022). Integrating Environmental and Economic Perspectives in Building Design. *Sustainability*, *14*(8), 4637. https://doi.org/10.3390/su14084637

Shan, M., Hwang, B.-G., & Zhu, L. (2017). A Global Review of Sustainable Construction Project Financing: Policies, Practices, and Research Efforts. *Sustainability*, *9*(12), 2347. https://doi.org/10.3390/su9122347

Tsoutsos, T., Drandaki, M., Frantzeskaki, N., Iosifidis, E., & Kiosses, I. (2009). Sustainable energy planning by using multi-criteria analysis application in the island of Crete. *Energy Policy*, *37*(5), 1587–1600. https://doi.org/10.1016/j.enpol.2008.12.011

Turkenburg, W. C., & Faaij, A. (2000). *Renewable energy technologies* (pp. 219-72). UNDP/UNDESA/WEC: Energy and the Challenge of Sustainability. World Energy Assessment. New York: UNDP, 219-272.ISO 690

Turkenburg, W. C., Beurskens, J., Faaij, A., Fraenkel, P., Fridleifsson, I., Lysen, E., Mills, D., Moreira, J. R., Nilsson, L. J., Schaap, A., & Sinke, W. C. (2000). Renewable Energy Technologies. In *lup.lub.lu.se*. United Nations Development Programme. https://lup.lub.lu.se/search/publication/ff951bff-d2d8-4375-ac1e-ceb18078140e

Wang, J.-J., Jing, Y.-Y., Zhang, C.-F., & Zhao, J.-H. (2009). Review on multi-criteria decision analysis aid in sustainable energy decision-making. *Renewable and Sustainable Energy Reviews*, *13*(9), 2263–2278. https://doi.org/10.1016/j.rser.2009.06.021

Zhang, X., Lovati, M., Vigna, I., Widén, J., Han, M., Gal, C., & Feng, T. (2018). A review of urban energy systems at building cluster level incorporating renewable-energy-source (RES) envelope solutions. *Applied Energy*, *230*, 1034–1056. https://doi.org/10.1016/j.apenergy.2018.09.041

Appendixes

Appendix 1 – Table common SETs

Appendix 2 – Table of variables

Appendix 3 – TCO model

Appendix 4 – Monte Carlo Simulation

Appendix 1 – Table common SETs

Individual Sustainable Energy Technologies (SETS)			
Energy source	**Technology**	**Techniques**	**Energy carrier**
Solar energy	Photovoltaics (PV)	• Monocrystalline solar panels: Use single-crystal silicon for high efficiency. • Polycrystalline solar panels: Made from multiple silicon crystals, are less efficient but cheaper. • Thin-film solar panels: Use layers of semiconductor materials applied to a substrate, offering a flexible solution with varying efficiencies. • Building-integrated photovoltaics (BIPV): Incorporate PV materials into building structures, like windows or facades.	Electricity
	Solar water heating systems	• Flat-plate collectors: Insulated, weatherproofed boxes containing a dark absorber plate under one or more transparent or translucent covers. • Evacuated tube collectors: Use transparent tubes that encase absorber plates, providing insulation and higher efficiencies. • Thermosiphon systems: Utilize the tendency of water to circulate as it is heated, without the need for pumps.	Heat
Wind energy	Wind turbines (small-scale) / Horizontal-axis wind turbines (HAWTs)	• Pitch control: Adjusting the angle of the blades to control the rotor speed. • Yaw control: Rotating the turbine around a vertical axis to align with the wind direction. • Active stall control: Adjusting the blade pitch to reduce the aerodynamic force on the blade.	Electricity
	Vertical-axis wind turbines (VAWTs)		Electricity
Geothermal	Open-loop geothermal heat pump (GHP) systems	• Direct use systems: Use the geothermal water directly for heating without a heat pump. • Ground source heat pumps: Use the stable ground temperature to heat in winter and cool in summer.	Heat
	Closed-loop geothermal heat pump (GHP) systems		Heat
Biomass	Biomass boilers	• Combustion: Burning biomass to heat water and create steam for turbines or heating. • Gasification: Converting biomass into a combustible gas mixture for more efficient energy recovery. • Anaerobic digestion: Breaking down biomass in the absence of oxygen to produce biogas.	Electricity

Water	Micro-hydro power systems	• Impulse turbines: Use the velocity of water to move the turbine and are used in high head, low flow situations. • Reaction turbines: Use the pressure of water to generate energy and are typically used in low head, high flow settings.	Electricity
Other	Air-to-Air heat pump	• Air-Source Heat Pumps: extract heat from the outdoor air using a refrigerant cycle and transfer it indoors to provide space heating. They can also be reversed to provide cooling during warmer seasons.	Heat
	Air-to-Water heat pump	• Air-source heat pumps: Extract heat from the outdoor air and transfer it indoors for space heating. • Water heating: Utilize heat from the outdoor air to heat water for domestic use. • Defrosting mechanisms: Implement systems to prevent frost buildup on outdoor coils during cold weather.	Heat

Collective Sustainable Energy Technologies (SETS)

Energy source	Technology	Techniques	Energy carrier
Solar energy	Concentrated Solar Power (CSP)	• Parabolic troughs: Use parabolic mirrors to focus sunlight on a receiver tube. • Solar power towers: Use a field of mirrors that track the sun and focus light on a central receiver. • Dish Stirling systems: Use parabolic dish mirrors to focus light on a Stirling engine for power generation.	Electricity
	Community solar projects/ Photovoltaics (PV)	• Net metering: Allows community members to feed excess energy into the grid and receive credit. • Virtual net metering: Participants receive bill credits for their share of the power produced.	Electricity
Wind energy	Community wind farms/ Horizontal-axis wind turbines (HAWTs)	• Pitch control: Adjusting the angle of the blades to control the rotor speed. • Yaw control: Rotating the turbine around a vertical axis to align with the wind direction. • Active stall control: Adjusting the blade pitch to reduce the aerodynamic force on the blade.	Electricity
	Community wind farms/ Vertical-axis wind turbines (VAWTs)		Electricity

Geothermal	Geothermal power plants	• Dry steam plants: Directly use steam from geothermal reservoirs to turn turbines. • Flash steam plants: Lower the pressure of hot water to create steam for turbines. • Binary cycle power plants: Use the heat from geothermal water to vaporize a secondary fluid with a lower boiling point to turn turbines.	Electricity
	Open-loop geothermal heat pump (GHP) systems	• Direct use systems: Use the geothermal water directly for heating without a heat pump.	Heat
	Closed-loop geothermal heat pump (GHP) systems	• Ground source heat pumps: Use the stable ground temperature to heat in winter and cool in summer.	Heat
Biomass	Biomass power plants	• Pyrolysis: Heating biomass in the absence of oxygen to produce bio-oil for energy.	Electricity
Water	Conventional hydropower	• Kaplan turbines: Adjustable blades for variable flow conditions, often used in run-of-river installations.	Electricity
	Run-of-river hydropower	• Francis turbines: Used in a wide range of head and flow conditions, common in conventional hydropower.	Electricity
	Wave energy	• Oscillating water columns: Use air displacement by wave-driven water in a column to drive turbines. • Point absorbers: Float on the surface and absorb energy from all directions.	Electricity
	Ocean thermal energy conversion (OTEC)	• Closed-cycle OTEC: Uses warm surface water to vaporize a working fluid, which drives a turbine to generate electricity. • Open-cycle OTEC: Vaporizes seawater itself to drive the turbine. • Hybrid systems: Combine both closed and open cycles for increased efficiency.	Electricity
	Tidal power	• Barrage systems: Use dams to capture the potential energy from the rise and fall of tides. • Tidal stream generators: Underwater turbines that capture kinetic energy from tidal currents.	Electricity

Other	Neighbourhood heating (dutch: stadverwarming) *(Sustainability depends on the source of heat)*	• Combined heat and power (CHP): Simultaneous production of electricity and useful heat, improving overall efficiency. • Heat networks: Distribute heat generated from various sources to multiple buildings.	Heat

Appendix 2 – Table common SETs

Case study	Variable (Imput)	Unit	Data source	Use for output	Area of impact	Source
Locational variables						
	Transportation acces	Meters	GIS Data	Assess accessibility and convenience for end-users and commuters to determine the financial value.	Social, Economical	
	Neighborhood Index	Index Value	National statistics office, Local surveys	Utilize a multifactorial index to evaluate neighborhood quality.	Social, Economical	
	Proximity to urban center	Meters	GIS Data	Determine the urbanization level and accessibility to amenities to determine the financial value.	Social, Economical	
	Average price	€	Real estate market reports	Understand the affordability and property value of the area to determine the financial value.	Economical	
	Availability of (Energy) source(s)	Categorical: Geothermal, solar, wind, hydropower and/ or biomass	Geothermal energy maps, energy providers, location accesment	Identify local sustainable energy resources available for exploitation.	Environmental, Economical	
	Biodiversity Index	Index value	Environmental report, biodiversity studies	Use standardized biodiversity measures to assess ecological impacts	Environmental	(Demirtas, 2013; Wang et al., 2009; Ding, 2008)
	Regulatory compliance	Categorical: Compliance Status	Government regulatory bodies, legal documents	Use detailed regulatory criteria for precise compliance assessment.	Environmental, Legal	(Wang et al., 2009)
Building variables						
	Population occupation	Working professionals, students, retirees, unemployed individuals	Local surveys	Characterize the demographic profile to tailor SET solutions to community needs and behaviors.	Social, Economical	(Ding, 2008)
	Architectrural style	Non, national, provincial, and	Heritage conservation authorities	Identify architectural characteristics and design trends to determine SET compatibility.	Social, Economical, Technical	

		municipal monuments				
	Age and condition	Years	Building inspection reports, historical records	Assess the structural integrity and maintenance requirements to evaluate SET retrofitting potential.	Social, Economical, Technical	
	Energy Performance	kWh/m²/year	Energy audits, utility bills	Evaluate current energy consumption to size SETs appropriately.	Economical, Technical	(Wang et al., 2009)
	Construction quality	Scale (good- bad)	Structural assessment reports	Determine the durability and safety of the structure with respect to SET installation.	Economical, Technical	
	Building size	m2	Property records/ historical records, architectural plans	Understand the scale and capacity of the building for energy generation and retrofit possibilities.	Economical, Technical	
Existing infrastructure						
	Transportation network	Quality and capacity scale	Transportation studies, municipal reports	Evaluate the impact of SETs on local transportation and potential improvements.	Economical, Social	
	Water systems	Capacity (liters per day), Quality (scale)	Water utility reports, environmental assessments	Assess the impact of SETs on water supply and quality for sustainable usage and hydro SET potential.	Technical, Environmental, Social	
	Electrical grids	kW capacity	Power grid studies, energy department reports	Determine the current infrastructure and potential integration with SETs	Technical, Economical	(Jansen et al., 2020)
	Compatibility	Compatibility scale (good-bad)	Technical assessments	Identify constraints and opportunities for SETs integration	Technical	(Jansen et al., 2020)
	Future expansion	Expansion potential scale (low-high)	Urban development plans, long-term city plans/ goverment reports	Plan for future growth and technological advancements	Economical, Technical	
	Existing capacity	kW capacity, physical space	Infrastructure capacity analysis	Determine available capacity for SETs integration and optimization with respect to energy and space.	Economical, Technical	(Jansen et al., 2020)

	Hydrogen and/ or green gas infrastructure	Categorical: hydrogen, green gas, or none	Infrastructure maps, energy infrastructure analyses	Evaluate the availability of hydrogen and green gas infrastructure for potential integration with Sustainable Energy Technologies.	Economical, Technical	
SETS	**Variable (Impute)**	**Unit**	**Data source**	**Use for output**		
Physical characteristics						
	Land requirement	m2/kW	Land use planning documents, zoning regulations	Determine space availability for SETs installation relative to power output.	Technical	(Wang et al., 2009)
	Room configuration	m2	Building layout plans	Identify suitable locations within individual units for SETs placement and integration.	Technical	
	Noise	dB	Environmental standards, noise assessment studies	Provide a range or maximum acceptable noise level (in dB) according to local regulations for residential and mixed-use areas.	Environmental, Technical	(Wang et al., 2009)
	Vibration	Peak Particle Velocity (PPV)	Environmental standards, vibration analysis reports	Indicate the PPV threshold that must not be exceeded during SET operation to avoid structural damage and to adhere to local comfort standards.	Environmental, Technical	
Technical specifications						
	Capacity	kW	Demand analysis studies, energy consumption records	Determine the capacity needed from the SETs to meet individual energy demands.	Technical	(Demirtas, 2013; Jansen et al., 2020)
	Ownership	Categorical: private, public, cooperative	Legal ownership documents	Understand ownership structure to navigate decision-making and financial responsibilities.	Economical, Legal	
	Scalability	Scalability scale (low-high)	Technology vendor specifications, market analysis	Assess the ability to increase or decrease SET capacity over time to meet changing demands.	Economical, Technical	
	Lifetime	Years	Manufacturer warranties, longevity studies	Estimate the expected operational lifespan of the SETs to calculate return on investment and replacement schedules.	Economical, Technical	(Demirtas, 2013; Ding, 2008)

	Compatility with existing grid	Compatibility scale (good-bad)	Electrical system analysis, grid compatibility studies	Evaluate the need for adjustments or upgrades to the existing electrical grid for SET integration.	Economical, Technical	
Environmental impact						
	Environmental impact	LCA score	Life-Cycle assessment reports, environmental impact studies	Expand to a comprehensive LCA for environmental impact evaluation.	Environmental	(Demirtas, 2013, Jansen et al., 2020)

Evaluation method	**Variable (Imput)**	**Unit**	**Data source**	**Use for output**		
Cash flows						
	IRR, NPV	%, €	Financial models, Economical analysis	Calculate the internal rate of return (IRR) and net present value (NPV) to assess investment profitability and value over time.	Economical	(Wang et al., 2009; Ma et al., 2012)
	Inflation Rate	%	Central bank reports, Economical forecasts	Over time, the value of cash flows can be affected by inflation, which should be considered in long-term projects.	Economical	

Financial value	**Variable (Imput)**	**Unit**	**Data source**	**Use for output**		
Financial cost						
	Inital investment	€	Cost estimates, vendor quotes	Determine upfront investment required for SET implementation, including equipment and installation costs.	Economical	(Demirtas, 2013; Wang et al., 2009)
	Operational expenses	€/ year	Operating cost records, maintenance schedules	Assess the long-term financial implications of SETs, including maintenance, repairs, and energy costs.	Economical	(Demirtas, 2013; Wang et al., 2009)
	Opportunity cost	€	Market analysis, investment reports	Evaluate the financial trade-offs and potential missed opportunities by choosing SET implementation over other investments.	Economical	(Demirtas, 2013; Wang et al., 2009)
Long term financial benefit						

	Savings streams	€/ year	Utility bills, energy efficiency reports	Quantify the annual savings from reduced energy costs and maintenance to inform ROI and long-term financial planning.	Economical	(Wang et al., 2009)
	Revenue streams	€/ year	Power purchase agreements	Identify potential income generated from energy production, incentives, or by selling excess power back to the grid.	Economical	(Ding, 2008)
	Replacement and disposal Costs	€	Equipment lifecycle analysis	At the end of their lifetime, SETs may incur costs for replacement or proper disposal.	Economical	
Market dynamics						
	Demand	Volume (units/year)	Market research studies	Evaluate the availability, diversity, and competitiveness of real estate demand to identify market gaps and potential for market entry.	Economical	(McDonald & McMillen, 2010)
	Supply	Volume (units/year)	Market research studies	Evaluate the availability, diversity, and competitiveness of real estate supply to identify market gaps and potential for market entry.	Economical	(McDonald & McMillen, 2010)

Appendix 3 – TCO model

Impact of energy price on energy charges

		0,10 € / kWh	0,15 € / kWh	0,20 € / kWh	0,25 € / kWh	0,30 € / kWh	0,35 € / kWh	0,40 € / kWh	0,45 € / kWh	0,50 € / kWh
Connected to network	#	€ 20.450	€ 30.680	€ 40.900	€ 51.130	€ 61.350	€ 71.570	€ 81.800	€ 92.020	€ 102.250
GHP individual (Campuslaan)	#	€ 19.900	€ 29.850	€ 39.790	€ 49.740	€ 59.690	€ 69.630	€ 79.580	€ 89.530	€ 99.480
GHP collective	#	€ 45.270	€ 67.910	€ 90.540	€ 113.180	€ 135.810	€ 158.450	€ 181.080	€ 203.720	€ 226.350
Individual total	#	€ 40.350	€ 60.530	€ 80.690	€ 100.870	€ 121.040	€ 141.200	€ 161.380	€ 181.550	€ 201.730
Collective vs individual GHP	#	€ 4.920	€ 7.380	€ 9.850	€ 12.310	€ 14.770	€ 17.250	€ 19.700	€ 22.170	€ 24.620

Effect of energy charges on TC0

		0,10	0,15	0,20	0,25	0,30	0,35	0,40	0,45	0,50
Connected to network	#	€ 544.120	€ 554.350	€ 564.570	€ 574.800	€ 585.020	€ 595.240	€ 605.470	€ 615.690	€ 625.920
GHP individual (Campuslaan)	#	€ 469.100	€ 479.050	€ 488.990	€ 498.940	€ 508.890	€ 518.830	€ 528.780	€ 538.730	€ 548.680
GHP collective	#	€ 506.660	€ 529.300	€ 551.930	€ 574.570	€ 597.200	€ 619.840	€ 642.470	€ 665.110	€ 687.740
Individual total	#	€ 1.013.220	€ 1.033.400	€ 1.053.560	€ 1.073.740	€ 1.093.910	€ 1.114.070	€ 1.134.250	€ 1.154.420	€ 1.174.600
Collective vs individual GHP	#	€ -506.560	€ -504.100	€ -501.630	€ -499.170	€ -496.710	€ -494.230	€ -491.780	€ -489.310	€ -486.860

TCO vs units

Units (Appartments)

		0	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300
GHP individual (Calslaan)	TCO #	€ 710	€ 50.770	€ 100.840	€ 150.880	€ 200.940	€ 250.990	€ 301.050	€ 351.100	€ 401.160	€ 451.200	€ 501.270	€ 551.310	€ 601.380	€ 651.420	€ 701.480	€ 751.530
	Energy cost #	€ 0	€ 6.480	€ 12.960	€ 19.430	€ 25.910	€ 32.380	€ 38.860	€ 45.330	€ 51.810	€ 58.280	€ 64.760	€ 71.230	€ 77.710	€ 84.180	€ 90.660	€ 97.130
	Maintenance #	€ 710	€ 7.060	€ 13.420	€ 19.770	€ 26.120	€ 32.480	€ 38.830	€ 45.190	€ 51.540	€ 57.890	€ 64.250	€ 70.600	€ 76.960	€ 83.310	€ 89.660	€ 96.020
	Investment costs 1/15 #	€ 0	€ 37.230	€ 74.460	€ 111.680	€ 148.910	€ 186.130	€ 223.360	€ 260.580	€ 297.810	€ 335.030	€ 372.260	€ 409.480	€ 446.710	€ 483.930	€ 521.160	€ 558.380
		0	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300
GHP individual (Campuslaan)	TCO #	€ 710	€ 51.850	€ 102.990	€ 154.110	€ 205.250	€ 256.370	€ 307.510	€ 358.620	€ 409.760	€ 460.880	€ 512.020	€ 563.140	€ 614.280	€ 665.410	€ 716.540	€ 767.670
	Energy cost #	€ 0	€ 7.380	€ 14.760	€ 22.130	€ 29.510	€ 36.880	€ 44.260	€ 51.630	€ 59.010	€ 66.380	€ 73.760	€ 81.130	€ 88.510	€ 95.890	€ 103.260	€ 110.640
	Maintenance #	€ 710	€ 7.240	€ 13.770	€ 20.300	€ 26.830	€ 33.360	€ 39.890	€ 46.410	€ 52.940	€ 59.470	€ 66.000	€ 72.530	€ 79.060	€ 85.590	€ 92.120	€ 98.650
	Investment costs 1/15 #	€ 0	€ 37.230	€ 74.460	€ 111.680	€ 148.910	€ 186.130	€ 223.360	€ 260.580	€ 297.810	€ 335.030	€ 372.260	€ 409.480	€ 446.710	€ 483.930	€ 521.160	€ 558.380
Average GHP individual	TCO	€ 710	€ 51.310	€ 101.915	€ 152.495	€ 203.095	€ 253.680	€ 304.280	€ 354.860	€ 405.460	€ 456.040	€ 506.645	€ 557.225	€ 607.830	€ 658.415	€ 709.010	€ 759.600
	Energy cost	€ 0	€ 6.930	€ 13.860	€ 20.780	€ 27.710	€ 34.630	€ 41.560	€ 48.480	€ 55.410	€ 62.330	€ 69.260	€ 76.180	€ 83.110	€ 90.035	€ 96.960	€ 103.885
	Maintenance	€ 710	€ 7.150	€ 13.595	€ 20.035	€ 26.475	€ 32.920	€ 39.360	€ 45.800	€ 52.240	€ 58.680	€ 65.125	€ 71.565	€ 78.010	€ 84.450	€ 90.890	€ 97.335
	Investment costs 1/15	€ 0	€ 37.230	€ 74.460	€ 111.680	€ 148.910	€ 186.130	€ 223.360	€ 260.580	€ 297.810	€ 335.030	€ 372.260	€ 409.480	€ 446.710	€ 483.930	€ 521.160	€ 558.380
		0	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300
GHP collective	TCO #	€ 109.090	€ 120.120	€ 131.150	€ 149.240	€ 174.390	€ 199.550	€ 224.700	€ 249.850	€ 275.010	€ 300.160	€ 325.320	€ 350.470	€ 375.620	€ 400.770	€ 425.920	€ 451.070
	Energy cost #	€ 71.220	€ 75.750	€ 80.280	€ 84.810	€ 89.340	€ 93.870	€ 98.400	€ 102.930	€ 107.460	€ 111.990	€ 116.530	€ 121.060	€ 125.590	€ 130.120	€ 134.650	€ 139.180
	Maintenance #	€ 710	€ 7.210	€ 13.710	€ 20.210	€ 26.710	€ 33.210	€ 39.710	€ 46.210	€ 52.720	€ 59.220	€ 65.720	€ 72.220	€ 78.720	€ 85.220	€ 91.720	€ 98.220
	Investment costs 1/15 #	€ 37.160	€ 37.160	€ 37.160	€ 44.220	€ 58.340	€ 72.470	€ 86.590	€ 100.710	€ 114.830	€ 128.950	€ 143.070	€ 157.190	€ 171.310	€ 185.430	€ 199.550	€ 213.670
			0%	16%	24%	19%	16%	14%	12%	11%	10%	9%	8%	8%	7%	7%	
		0	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300
Connected to network	TCO #	€ 36.450	€ 40.420	€ 45.320	€ 51.160	€ 57.950	€ 65.690	€ 74.390	€ 84.020	€ 94.600	€ 106.120	€ 118.600	€ 132.030	€ 146.400	€ 161.710	€ 177.980	€ 195.190
	Energy cost #	€ 36.450	€ 39.890	€ 43.800	€ 48.180	€ 53.030	€ 58.350	€ 64.150	€ 70.420	€ 77.150	€ 84.360	€ 92.050	€ 100.200	€ 108.830	€ 117.920	€ 127.490	€ 137.530
	Maintenance #	€ 0	€ 320	€ 960	€ 1.920	€ 3.210	€ 4.830	€ 6.770	€ 9.030	€ 11.630	€ 14.540	€ 17.780	€ 21.350	€ 25.240	€ 29.460	€ 34.010	€ 38.870
	Investment costs 1/15 #	€ 0	€ 210	€ 560	€ 1.060	€ 1.710	€ 2.510	€ 3.470	€ 4.570	€ 5.820	€ 7.220	€ 8.770	€ 10.480	€ 12.330	€ 14.330	€ 16.480	€ 18.790

TCO energy system heating individual versus collective	
Project	
Date	
Version	

viac

	Calslaan		Calslaan (GHP) + PV		Campuslaan hoog		Campuslaan hoog (GHP) + PV		Collectief		Collectief (GHP) + PV	
Definition	Individual closed-loop geothermal heat pump (GHP)		Individual closed-loop geothermal heat pump (GHP) + PV		Individual closed-loop geothermal heat pump (GHP)		Individual closed-loop geothermal heat pump (GHP) + PV		Collective closed-loop geothermal heat pump (GHP)		Collective closed-loop geothermal heat pump (GHP) + PV	
Number of properties		240		240		205		205		445		445
Buildings		7		7		3		3		10		10

** Heat requirements have only been calculated from few buildings. This is why a multiplication has been made to include all buildings.*

Comparison of energy consumption based on estimated energy demand and efficiencies

	GHP individual (Calslaan)			GHP individual + PV (Calslaan)			GHP individual (Campuslaan)			GHP individual + PV (Campuslaan)			GHP collective			GHP collective + PV		
	Heat requirement in kWh	Yield (SCOP)	On the meter	Heat requirement in kWh	Yield (SCOP)	On the meter	Heat requirement in kWh	Yield (SCOP)	On the meter	Heat requirement in kWh	Yield (SCOP)	On the meter	Heat requirement in kWh	Yield (SCOP)	On the meter	Heat requirement in kWh	Yield (SCOP)	On the meter
Overview of heat requirements + tap water (circulation pipe 22 mm. maintained)	*Ag*	*Wb [kWh/m²]*	*Tapwater*	*Ag*	*Wb [kWh/m²]*	*Tapwater*	*Ag*	*Wb [kWh/m²]*	*Tapwater*	*Ag*	*Wb [kWh/m²]*	*Tapwater*	*Ag*	*Wb [kWh/m²]*	*Tapwater*	*Ag*	*Wb [kWh/m²]*	*Tapwater*
Heat consumption Calslaan 3A	1.747	64,0	31.408 kWh	1.747	64,0	31.408 kWh							1.747	64,0	31.408 kWh	1.747	64,0	31.408 kWh
Heat consumption Calslaan 3B	1.747	51,0	31.408 kWh	1.747	51,0	31.408 kWh							1.747	51,0	31.408 kWh	1.747	51,0	31.408 kWh
Heat consumption Calslaan 3C	1.747	66,0	31.408 kWh	1.747	66,0	31.408 kWh							1.747	66,0	31.408 kWh	1.747	66,0	31.408 kWh
Heat consumption Calslaan 3-401	369	78,0	11.799 kWh	369	78,0	11.799 kWh							369	78,0	11.799 kWh	369	78,0	11.799 kWh
Heat consumption Campluslaan 49							2.262	69,0	35.547 kWh	2.262	69,0	35.547 kWh	2.262	69,0	35.547 kWh	2.262	69,0	35.547 kWh
Heat consumption Campluslaan 51							2.539	71,0	35.547 kWh	2.539	71,0	35.547 kWh	2.539	71,0	35.547 kWh	2.539	71,0	35.547 kWh
Heating (source: reference EPA-W calculation)	344.941	4,0	86.235 kWh	344.941	4,0	86.235 kWh	336.345	4,0	84.086 kWh	336.345	4,0	84.086 kWh	681.336	4,0	170.334 kWh	681.336	4,0	170.334 kWh
	43.206	2,5	17.283 kWh	43.206	2,5	17.283 kWh	71.094	2,5	28.438 kWh	71.094	2,5	28.438 kWh	177.116	2,5	70.846 kWh	177.116	2,5	70.846 kWh
Total Electricity heating, hot water and cooling			**103.518 kWh**			**103.518 kWh**			**112.524 kWh**			**112.524 kWh**			**265.298 kWh**			**265.298 kWh**
Total Heat W installations off-take district heating																		
Estimation of household consumption			100.964 kWh			100.964 kWh			86.417 kWh			86.417 kWh			187.398 kWh			187.398 kWh
Yield PV for own use (N/A)			kWh	480	2,0 PV/home	-177.480 kWh			kWh	410	2,0 PV/home	-151.598 kWh			kWh	890	2,0 PV/home	-329.078 kWh
Total electricity consumption			204.482 kWh			27.002 kWh			198.941 kWh			47.344 kWh			452.696 kWh			123.619 kWh
Correction for aging PV panels	10%		kWh	10%		17.748 kWh	10%		kWh	10%		15.160 kWh	10%		kWh	10%		32.908 kWh
Total electricity after aging PV			204.482 kWh			44.750 kWh			198.941 kWh			62.504 kWh			452.696 kWh			156.527 kWh

** Calculation based on a simulation software Vabi*
** Including 10% train loss surcharge with collective*
(Vink, personal communication, April 14, 2024)

Energy costs on average for installation (resident costs)

	GHP individual (Calslaan)			GHP individual + PV (Calslaan)			GHP individual (Campuslaan)			GHP individual + PV (Campuslaan)			GHP collective			GHP collective + PV		
Number of homes in project	240			240			205			205			445			445		
Electrical energy for heating and hot water	103.518 kWh	0,38 € / kWh	€ 39.336,78	103.518 kWh	0,38 € / kWh	€ 39.336,78	112.524 kWh	0,38 € / kWh	€ 42.759,13	112.524 kWh	0,38 € / kWh	€ 42.759,13	265.298 kWh	0,38 € / kWh	€ 100.813,34	265.298 kWh	0,38 € / kWh	€ 100.813,34
Electricity for ventilation, lighting and domestic consumption	100.964 kWh	0,38 € / kWh	€ 38.366,41	-58.768 kWh	0,38 € / kWh	-€ 22.331,75	86.417 kWh	0,38 € / kWh	€ 32.838,62	-50.020 kWh	0,38 € / kWh	-€ 19.007,73	187.398 kWh	0,38 € / kWh	€ 71.211,24	-108.772 kWh	0,38 € / kWh	-€ 41.333,27
Total energy costs for household for Electricity (excl. fixed costs)			**€ 77.703,19**			**€ 17.005,03**			**€ 75.597,75**			**€ 23.751,40**			**€ 172.024,58**			**€ 59.480,08**
Cost per household			*€ 323,76*			*€ 70,85*			*€ 368,77*			*€ 115,86*			*€ 386,57*			*€ 133,66*
Total energy costs for household Heat network + Electricity			**€ 77.703,19**			**€ 17.005,03**			**€ 75.597,75**			**€ 23.751,40**			**€ 172.024,58**			**€ 59.480,08**
Total cost per household			€ 323,76			€ 70,85			€ 368,77			€ 115,86			€ 386,57			€ 133,66

** Energy cost difference depending on contract*
(internal document: Provisional energy tariffs 2024, February 1, 2024)

Maintenance and replacement

	GHP individual (Calslaan)		GHP individual + PV (Calslaan)		GHP individual (Campuslaan)		GHP individual + PV (Campuslaan)		GHP collective		GHP collective + PV	
Kosten per jaar per onderdeel incl. BTW	number	Costs/home	number	Costs/home	number	Costs/home	number	Costs/home	number	Costs/home	number	Costs/home
WTW met één zone CO_2	240	€ 43.431,45	240	€ 43.431,45	205	€ 37.097,70	205	€ 37.097,70	445	€ 80.529,15	445	€ 80.529,15
Gesloten bron bij warmtepomp op bodemsysteem *	29,19	€ 8.172,97	24,32	€ 6.810,81	24,80	€ 6.943,55	24,80	€ 6.943,55	56,25	€ 15.750,00	56,25	€ 15.750,00
Warmtepompboiler op buitenlucht	45,41	€ 13.222,05	45,41	€ 13.222,05	46,29	€ 13.479,74	46,29	€ 13.479,74	91,70	€ 26.703,04	91,70	€ 26.703,04
Onderhoud en vervanging van technische installaties in SV ruimte	1	€ 203,28	1	€ 203,28	1	€ 203,28	1	€ 203,28	1	€ 203,28	1	€ 203,28
Onderhoud en vervanging van centrale warmtepompen	29,19	€ 10.548,58	24,32	€ 8.790,49	24,80	€ 8.961,81	24,80	€ 8.961,81	56,25	€ 20.328,00	56,25	€ 20.328,00
Monitoring gesloten bodemenergiesysteem	1	€ 500,00	1	€ 500,00	1	€ 500,00	1	€ 500,00	1	€ 500,00	1	€ 500,00
Inschatting kosten voor inlezen warmtemeters en watermeters	25,95	€ 871,78	12,97	€ 435,89	13,23	€ 444,39	13,23	€ 444,39	39,70	€ 1.333,92	39,70	€ 1.333,92
PV panelen per stuk	0	€ 0,00	480	€ 3.775,20	0	€ 0,00	410	€ 3.224,65	0	€ 0,00	890	€ 6.999,85
Totaal voor onderhoud en vervanging		**€ 76.950,12**		**€ 77.169,17**		**€ 67.630,46**		**€ 70.855,11**		**€ 145.347,39**		**€ 152.347,24**
Totaal energie + onderhoud en vervanging voor W installatie incl. BTW (TCO)		**€ 154.653,31**		**€ 94.174,20**		**€ 143.228,21**		**€ 94.606,51**		**€ 317.371,97**		**€ 211.827,31**

**The costs are based on old cost of source values 2021/2022 from VIAC.*
A form factor of 12% based on CPI has been applied to.
** Maintenance costs are based on device power*
(Vink, personal communication, April 14, 2024)

Estimation of investment costs

	GHP individual (Calslaan)		GHP individual + PV (Calslaan)		GHP individual (Campuslaan)		GHP individual + PV (Campuslaan)		GHP collective		GHP collective + PV	
Cost per part excl. VAT	number	Costs/home	number	Costs/home	number	Costs/home	number	Costs/home	number	Costs/home	number	Costs/home
Collective Ground Source Heat pump (closed source)	0	€ 0,00	0	€ 0,00	0	€ 0,00	0	€ 0,00	445	€ 3.917.832,50	445	€ 3.917.832,50
BAK Warmtenet Ennatuurlijk collective connection for nos 49+51 Determined based on €480,000 for WEQ = €1034.48 per WEQ.	0	€ 0,00	0	€ 0,00	0	€ 0,00	0	€ 0,00	0	€ 0,00	0	€ 51.724,00
Indirectly fired boiler (1 per house number) incl. central heating connections	0	€ 0,00	0	€ 0,00	0	€ 0,00	0	€ 0,00	0	€ 0,00	0	€ 175.000,00
Individual Ground Source Heat pump (closed source)	240	€ 5.537.606,40	240	€ 5.260.726,08	205	€ 4.730.038,80	205	€ 4.493.536,86	0	€ 0,00	0	€ 0,00
HR-107 combiketel	0	€ 0,00	0	€ 0,00	0	€ 0,00	0	€ 0,00	0	€ 0,00	0	€ 0,00
PV-panelen monokristallijn (225Wp/m², 435Wp/paneel)	0	€ 0,00	480	€ 575.403,60	0	€ 0,00	410	€ 491.490,58	0	€ 0,00	890	€ 1.070.048,80
Total estimate cost excl. VAT		**€ 5.537.606**		**€ 5.836.130**		**€ 4.730.039**		**€ 4.985.027**		**€ 3.917.833**		**€ 5.214.605**
Total estimate cost incl. VAT spread over 15 years		**€ 446.700**		**€ 470.781**		**€ 381.556**		**€ 402.126**		**€ 316.038**		**€ 420.645**

** Source of cost: (https://kostenkentallen.rvo.nl/)*
** The collective variance is based on 50 units.*
** Due to the econmy of scale, a shape factor of 5% is implemented every 50 houses.*
** Based on 4 PV panels and an inverter*

Total overview

	GHP individual (Calslaan)	GHP individual + PV (Calslaan)	GHP individual (Campuslaan)	GHP individual + PV (Campuslaan)	GHP collective	GHP collective + PV
Energy charges incl. (incl. VAT)	**€ 77.710**	**€ 17.010**	**€ 75.600**	**€ 23.760**	**€ 172.030**	**€ 59.490**
Total before maintenance and replacement (incl. VAT)	**€ 76.960**	**€ 77.170**	**€ 67.640**	**€ 70.860**	**€ 145.350**	**€ 152.350**
Total before investment costs for heat generation (1/15th part) (incl. VAT)	**€ 446.710**	**€ 470.790**	**€ 381.560**	**€ 402.130**	**€ 316.040**	**€ 420.650**
Total investment cost (incl. BTW)	**€ 5.537.610**	**€ 5.836.130**	**€ 4.730.040**	**€ 4.985.030**	**€ 3.917.840**	**€ 5.214.610**
Total simplified TCO costs per year	**€ 601.380**	**€ 564.970**	**€ 524.800**	**€ 496.750**	**€ 633.420**	**€ 632.490**
Total simplified TCO costs per year excl. Investment	€ 154.670	€ 94.180	€ 143.240	€ 94.620	€ 317.380	€ 211.840
TCO in 30 years	€ 18.041.107,49	€ 16.948.833,83	€ 15.743.893,90	€ 14.902.366,39	€ 19.002.554,66	€ 18.974.544,83

Individual total	Collective vs individual GHP	
€ 153.310	€ 18.720	112%
€ 144.600	€ 750	101%
€ 828.270	€ -512.230	38%
€ 10.267.650	€ -6.349.810	38%
€ 1.126.180	€ -492.760	56%

Underpinning rates TCO based on projects 2020-182 (Old Harbour) and 2020-165 (Performance Factory)
Underpinning operator costs electricity o.b.v. The Steel (2019-113)
Beng reference 6D 4800 beech average garden and corner house

Appendix 4 – Monte Carlo Simulation

Monte Carlo-simulatie

Invidueel GHP

Trial number	Total energy cost	Total investment cost	Total operational cost	TCO	Rounded
1	€ 153.598	€ 373.300	€ 142.603	**€ 669.501**	€ 670.000
2	€ 152.554	€ 443.012	€ 151.303	**€ 746.869**	€ 747.000
3	€ 170.715	€ 379.080	€ 147.434	**€ 697.229**	€ 697.000
4	€ 157.216	€ 417.532	€ 148.654	**€ 723.402**	€ 723.000
5	€ 142.163	€ 427.322	€ 139.090	**€ 708.576**	€ 709.000
6	€ 116.926	€ 340.796	€ 138.480	**€ 596.202**	€ 596.000
7	€ 149.003	€ 440.042	€ 149.108	**€ 738.152**	€ 738.000
8	€ 150.643	€ 377.803	€ 139.365	**€ 667.811**	€ 668.000
9	€ 151.702	€ 467.412	€ 148.095	**€ 767.209**	€ 767.000
10	€ 149.507	€ 324.139	€ 148.840	**€ 622.487**	€ 622.000
11	€ 154.360	€ 407.421	€ 130.414	**€ 692.194**	€ 692.000
12	€ 145.781	€ 395.629	€ 138.654	**€ 680.065**	€ 680.000
13	€ 148.199	€ 324.124	€ 137.311	**€ 609.634**	€ 610.000
14	€ 153.976	€ 408.007	€ 146.475	**€ 708.458**	€ 708.000
15	€ 164.257	€ 438.622	€ 136.918	**€ 739.797**	€ 740.000
16	€ 150.662	€ 388.146	€ 144.772	**€ 683.579**	€ 684.000
17	€ 151.307	€ 446.913	€ 145.323	**€ 743.543**	€ 744.000
18	€ 155.619	€ 395.291	€ 128.698	**€ 679.608**	€ 680.000
19	€ 134.577	€ 290.701	€ 142.012	**€ 567.290**	€ 567.000
20	€ 141.180	€ 409.600	€ 151.328	**€ 702.108**	€ 702.000
21	€ 146.155	€ 459.444	€ 149.614	**€ 755.213**	€ 755.000
22	€ 139.607	€ 365.290	€ 130.562	**€ 635.459**	€ 635.000
23	€ 134.356	€ 363.825	€ 133.990	**€ 632.171**	€ 632.000
24	€ 127.345	€ 366.351	€ 142.193	**€ 635.889**	€ 636.000
25	€ 144.351	€ 398.873	€ 129.967	**€ 673.191**	€ 673.000
26	€ 153.568	€ 350.546	€ 140.503	**€ 644.618**	€ 645.000
27	€ 160.880	€ 377.000	€ 142.759	**€ 680.639**	€ 681.000
28	€ 152.528	€ 477.893	€ 144.453	**€ 774.873**	€ 775.000
29	€ 155.198	€ 378.419	€ 153.902	**€ 687.519**	€ 688.000
30	€ 156.597	€ 432.967	€ 145.440	**€ 735.005**	€ 735.000
31	€ 148.968	€ 360.581	€ 146.763	**€ 656.312**	€ 656.000
32	€ 118.695	€ 371.724	€ 137.325	**€ 627.744**	€ 628.000
33	€ 145.634	€ 486.432	€ 148.661	**€ 780.727**	€ 781.000
34	€ 148.194	€ 324.684	€ 146.661	**€ 619.538**	€ 620.000
35	€ 149.641	€ 421.716	€ 139.291	**€ 710.647**	€ 711.000
36	€ 147.829	€ 382.118	€ 138.162	**€ 668.109**	€ 668.000
37	€ 159.411	€ 388.736	€ 143.151	**€ 691.298**	€ 691.000
38	€ 143.621	€ 436.030	€ 150.433	**€ 730.085**	€ 730.000
39	€ 136.565	€ 425.916	€ 148.052	**€ 710.533**	€ 711.000
40	€ 157.718	€ 393.698	€ 142.608	**€ 694.024**	€ 694.000
41	€ 159.501	€ 281.631	€ 149.420	**€ 590.552**	€ 591.000
42	€ 123.824	€ 370.192	€ 147.058	**€ 641.073**	€ 641.000
43	€ 181.416	€ 307.578	€ 137.720	**€ 626.713**	€ 627.000
44	€ 172.640	€ 377.157	€ 130.458	**€ 680.254**	€ 680.000
45	€ 174.640	€ 418.833	€ 128.346	**€ 721.818**	€ 722.000
46	€ 181.617	€ 376.477	€ 148.814	**€ 706.908**	€ 707.000
47	€ 191.417	€ 398.585	€ 134.365	**€ 724.367**	€ 724.000
48	€ 177.924	€ 431.369	€ 151.964	**€ 761.256**	€ 761.000
49	€ 133.140	€ 351.676	€ 137.974	**€ 622.790**	€ 623.000
50	€ 142.546	€ 293.552	€ 150.176	**€ 586.274**	€ 586.000
51	€ 142.233	€ 350.214	€ 128.741	**€ 621.188**	€ 621.000
52	€ 142.349	€ 414.619	€ 135.423	**€ 692.392**	€ 692.000
53	€ 158.488	€ 440.758	€ 141.829	**€ 741.075**	€ 741.000
54	€ 138.143	€ 438.951	€ 142.007	**€ 719.101**	€ 719.000
55	€ 147.638	€ 428.583	€ 138.319	**€ 714.541**	€ 715.000
56	€ 132.450	€ 400.875	€ 146.347	**€ 679.671**	€ 680.000
57	€ 146.692	€ 331.206	€ 143.473	**€ 621.372**	€ 621.000
58	€ 155.513	€ 422.445	€ 140.937	**€ 718.895**	€ 719.000
59	€ 136.072	€ 345.630	€ 132.027	**€ 613.729**	€ 614.000
60	€ 165.258	€ 506.214	€ 144.842	**€ 816.313**	€ 816.000
61	€ 174.441	€ 422.357	€ 141.240	**€ 738.037**	€ 738.000
62	€ 149.398	€ 353.375	€ 143.515	**€ 646.288**	€ 646.000
63	€ 144.814	€ 361.424	€ 145.147	**€ 651.385**	€ 651.000
64	€ 130.755	€ 395.591	€ 145.906	**€ 672.252**	€ 672.000
65	€ 149.243	€ 349.770	€ 141.030	**€ 640.043**	€ 640.000
66	€ 151.937	€ 457.677	€ 135.953	**€ 745.566**	€ 746.000
67	€ 137.576	€ 400.322	€ 145.915	**€ 683.812**	€ 684.000
68	€ 150.399	€ 426.358	€ 145.200	**€ 721.956**	€ 722.000
69	€ 146.767	€ 356.709	€ 141.134	**€ 644.610**	€ 645.000
70	€ 143.829	€ 367.135	€ 135.124	**€ 646.088**	€ 646.000
71	€ 158.810	€ 354.400	€ 124.544	**€ 637.755**	€ 638.000
72	€ 151.326	€ 411.002	€ 151.066	**€ 713.394**	€ 713.000
73	€ 160.393	€ 394.666	€ 138.723	**€ 693.782**	€ 694.000
74	€ 143.960	€ 338.740	€ 146.832	**€ 629.532**	€ 630.000

Collective GHP

Trial number	Total energy cost	Total investment cost	Total operational cost	TCO	Rounded
1	€ 156.397	€ 167.901	€ 147.850	**€ 472.148**	€ 472.000
2	€ 190.409	€ 125.728	€ 142.110	**€ 458.246**	€ 458.000
3	€ 141.442	€ 191.588	€ 148.769	**€ 481.799**	€ 482.000
4	€ 159.350	€ 161.096	€ 141.482	**€ 461.928**	€ 462.000
5	€ 161.323	€ 150.022	€ 153.443	**€ 464.788**	€ 465.000
6	€ 158.913	€ 133.515	€ 143.003	**€ 435.431**	€ 435.000
7	€ 184.419	€ 162.287	€ 139.267	**€ 485.973**	€ 486.000
8	€ 176.561	€ 156.707	€ 151.184	**€ 484.451**	€ 484.000
9	€ 205.378	€ 147.529	€ 150.647	**€ 503.554**	€ 504.000
10	€ 165.622	€ 163.372	€ 143.028	**€ 472.022**	€ 472.000
11	€ 186.249	€ 147.743	€ 149.393	**€ 483.385**	€ 483.000
12	€ 174.110	€ 134.544	€ 146.491	**€ 455.145**	€ 455.000
13	€ 178.228	€ 166.555	€ 150.409	**€ 495.192**	€ 495.000
14	€ 192.779	€ 177.251	€ 134.479	**€ 504.509**	€ 505.000
15	€ 145.900	€ 152.499	€ 135.480	**€ 433.878**	€ 434.000
16	€ 178.113	€ 145.235	€ 149.320	**€ 472.668**	€ 473.000
17	€ 159.095	€ 154.042	€ 141.198	**€ 454.335**	€ 454.000
18	€ 169.066	€ 113.943	€ 139.302	**€ 422.312**	€ 422.000
19	€ 165.499	€ 129.916	€ 148.875	**€ 444.291**	€ 444.000
20	€ 146.124	€ 158.100	€ 150.452	**€ 454.675**	€ 455.000
21	€ 173.079	€ 145.404	€ 150.266	**€ 468.749**	€ 469.000
22	€ 212.113	€ 155.361	€ 139.889	**€ 507.363**	€ 507.000
23	€ 156.693	€ 139.270	€ 139.753	**€ 435.715**	€ 436.000
24	€ 148.291	€ 148.701	€ 141.680	**€ 438.672**	€ 439.000
25	€ 183.118	€ 186.816	€ 146.339	**€ 516.273**	€ 516.000
26	€ 155.344	€ 165.210	€ 143.386	**€ 463.940**	€ 464.000
27	€ 174.804	€ 148.502	€ 139.232	**€ 462.538**	€ 463.000
28	€ 181.847	€ 151.881	€ 146.957	**€ 480.685**	€ 481.000
29	€ 151.902	€ 146.962	€ 152.339	**€ 451.203**	€ 451.000
30	€ 181.328	€ 156.889	€ 132.284	**€ 470.501**	€ 471.000
31	€ 190.703	€ 149.015	€ 133.347	**€ 473.065**	€ 473.000
32	€ 196.051	€ 173.366	€ 141.298	**€ 510.715**	€ 511.000
33	€ 162.777	€ 141.821	€ 148.504	**€ 453.102**	€ 453.000
34	€ 163.007	€ 194.402	€ 150.006	**€ 507.415**	€ 507.000
35	€ 158.281	€ 168.777	€ 142.500	**€ 469.558**	€ 470.000
36	€ 188.011	€ 188.502	€ 139.862	**€ 516.374**	€ 516.000
37	€ 204.027	€ 165.167	€ 143.273	**€ 512.467**	€ 512.000
38	€ 190.232	€ 152.705	€ 151.380	**€ 494.317**	€ 494.000
39	€ 143.434	€ 161.678	€ 142.644	**€ 447.756**	€ 448.000
40	€ 165.508	€ 149.617	€ 141.539	**€ 456.663**	€ 457.000
41	€ 174.595	€ 155.308	€ 139.455	**€ 469.359**	€ 469.000
42	€ 216.266	€ 131.978	€ 147.241	**€ 495.485**	€ 495.000
43	€ 186.236	€ 148.858	€ 150.335	**€ 485.429**	€ 485.000
44	€ 158.509	€ 154.118	€ 144.411	**€ 457.039**	€ 457.000
45	€ 163.806	€ 148.203	€ 138.512	**€ 450.521**	€ 451.000
46	€ 185.199	€ 132.850	€ 150.514	**€ 468.563**	€ 469.000
47	€ 189.357	€ 173.538	€ 150.559	**€ 513.455**	€ 513.000
48	€ 173.286	€ 152.032	€ 139.544	**€ 464.862**	€ 465.000
49	€ 175.770	€ 165.936	€ 139.222	**€ 480.927**	€ 481.000
50	€ 158.024	€ 155.271	€ 141.001	**€ 454.296**	€ 454.000
51	€ 200.076	€ 182.167	€ 143.979	**€ 526.222**	€ 526.000
52	€ 177.016	€ 153.879	€ 147.922	**€ 478.817**	€ 479.000
53	€ 178.322	€ 159.458	€ 150.466	**€ 488.246**	€ 488.000
54	€ 183.172	€ 159.595	€ 138.617	**€ 481.384**	€ 481.000
55	€ 156.354	€ 146.371	€ 147.646	**€ 450.371**	€ 450.000
56	€ 165.828	€ 147.366	€ 139.113	**€ 452.306**	€ 452.000
57	€ 155.217	€ 168.731	€ 141.549	**€ 465.496**	€ 465.000
58	€ 201.201	€ 158.170	€ 139.130	**€ 498.500**	€ 499.000
59	€ 179.054	€ 154.180	€ 145.589	**€ 478.823**	€ 479.000
60	€ 168.591	€ 162.157	€ 142.289	**€ 473.037**	€ 473.000
61	€ 188.475	€ 158.821	€ 139.555	**€ 486.852**	€ 487.000
62	€ 193.611	€ 159.963	€ 152.861	**€ 506.435**	€ 506.000
63	€ 195.636	€ 153.063	€ 145.449	**€ 494.148**	€ 494.000
64	€ 194.862	€ 170.436	€ 149.799	**€ 515.097**	€ 515.000
65	€ 185.982	€ 141.203	€ 142.386	**€ 469.571**	€ 470.000
66	€ 164.019	€ 146.150	€ 145.154	**€ 455.323**	€ 455.000
67	€ 194.017	€ 142.454	€ 136.400	**€ 472.871**	€ 473.000
68	€ 178.110	€ 147.122	€ 146.192	**€ 471.424**	€ 471.000
69	€ 184.934	€ 152.537	€ 137.543	**€ 475.014**	€ 475.000
70	€ 171.127	€ 170.457	€ 144.040	**€ 485.623**	€ 486.000
71	€ 194.190	€ 141.062	€ 153.403	**€ 488.655**	€ 489.000
72	€ 154.312	€ 179.309	€ 146.250	**€ 479.871**	€ 480.000
73	€ 201.159	€ 155.752	€ 137.218	**€ 494.129**	€ 494.000
74	€ 173.661	€ 160.803	€ 145.435	**€ 479.899**	€ 480.000

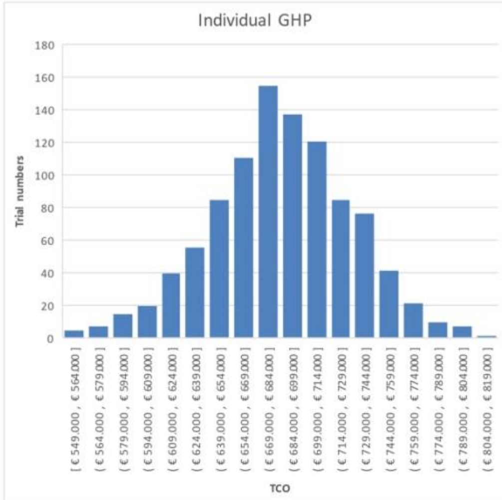
Info
Trial numbers: 1000

Energy cost: The energy costs are based on a digital model and a fixed contract, which suggests that the variation is limited. However, there may still be some uncertainty. In order to reflect these costs with greater accuracy, the assumptions have been adjusted using a normal (Gaussian) distribution, allowing for fluctuations around the mean. This approach is based on the internal document Provisional energy tariffs 2024, which presents the calculation of a computer software programme: vabi. This allows for a standard deviation of 10% in the simulation.

Operatrional cost: The figures presented for operating costs are based on expert estimates. However, it is possible that these figures may be affected by a number of factors, including maintenance costs, service contracts and unforeseen operational problems. It is acknowledged that there may be some uncertainty. Given the possibility of asymmetry, with a minimum, maximum, and most likely value, a triangular distribution has been employed.

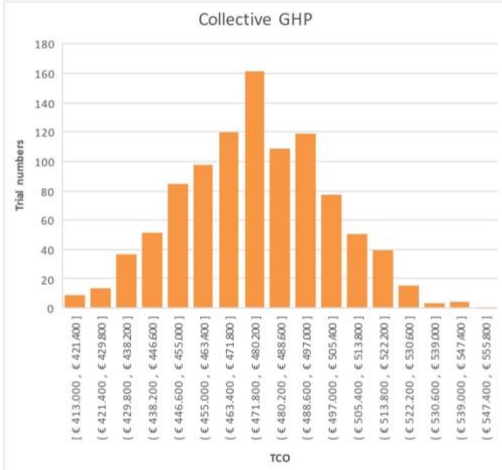
Investment cost: The investment costs are subject to fluctuations due to a number of factors, including changes in material prices, contractual obligations, and the potential for unforeseen expenses. In order to provide a more accurate representation of these costs, the assumptions have been adjusted with a normally (Gaussian) distributed to fluctuate around the average, with the data sourced from the RVO (Netherlands Enterprise Agency) and Arcadis databases. This approach allows for a standard deviation of 10% in the simulation.

Individual GHP	
Average TCO	€ 685.144
Minimum TCO	€ 548.721
Maximum TCO	€ 816.313
Standard deviation	€ 44.136



75	€ 162.546	€ 366.786	€ 132.444	**€ 661.776**	€ 662.000	€ 170.377	€ 177.868	€ 147.885	**€ 496.130**	€ 496.000
76	€ 145.936	€ 420.010	€ 135.475	**€ 701.421**	€ 701.000	€ 146.236	€ 178.614	€ 147.970	**€ 472.821**	€ 473.000
77	€ 157.439	€ 425.237	€ 146.407	**€ 729.083**	€ 729.000	€ 180.233	€ 151.575	€ 135.096	**€ 466.905**	€ 467.000
78	€ 155.390	€ 435.091	€ 135.858	**€ 726.339**	€ 726.000	€ 178.463	€ 189.994	€ 152.606	**€ 521.063**	€ 521.000
79	€ 142.636	€ 341.612	€ 143.289	**€ 627.537**	€ 628.000	€ 168.667	€ 146.418	€ 147.805	**€ 462.889**	€ 463.000
80	€ 126.060	€ 414.170	€ 140.075	**€ 680.305**	€ 680.000	€ 202.154	€ 171.078	€ 141.980	**€ 515.213**	€ 515.000
81	€ 180.355	€ 383.110	€ 147.654	**€ 711.119**	€ 711.000	€ 171.954	€ 144.405	€ 145.193	**€ 461.551**	€ 462.000
82	€ 174.168	€ 397.598	€ 143.836	**€ 715.601**	€ 716.000	€ 188.889	€ 134.621	€ 148.842	**€ 472.352**	€ 472.000
83	€ 155.236	€ 361.586	€ 155.449	**€ 672.271**	€ 672.000	€ 178.781	€ 180.201	€ 145.165	**€ 504.146**	€ 504.000
84	€ 140.206	€ 398.597	€ 143.746	**€ 682.549**	€ 683.000	€ 173.136	€ 156.312	€ 145.102	**€ 474.551**	€ 475.000
85	€ 153.237	€ 473.849	€ 141.469	**€ 768.555**	€ 769.000	€ 169.594	€ 147.655	€ 146.900	**€ 464.149**	€ 464.000
86	€ 178.299	€ 399.330	€ 137.967	**€ 715.597**	€ 716.000	€ 163.003	€ 175.938	€ 139.002	**€ 477.944**	€ 478.000
87	€ 166.471	€ 370.107	€ 149.616	**€ 686.195**	€ 686.000	€ 177.700	€ 146.593	€ 154.394	**€ 478.687**	€ 479.000
88	€ 166.290	€ 391.375	€ 135.222	**€ 692.887**	€ 693.000	€ 216.555	€ 154.156	€ 151.267	**€ 521.978**	€ 522.000
89	€ 124.412	€ 335.057	€ 135.494	**€ 594.962**	€ 595.000	€ 177.611	€ 170.553	€ 155.638	**€ 503.802**	€ 504.000
90	€ 140.241	€ 440.716	€ 138.980	**€ 719.938**	€ 720.000	€ 171.513	€ 158.738	€ 149.363	**€ 479.613**	€ 480.000
91	€ 178.027	€ 433.184	€ 143.942	**€ 755.153**	€ 755.000	€ 184.468	€ 187.028	€ 136.823	**€ 508.319**	€ 508.000
92	€ 159.368	€ 483.526	€ 147.313	**€ 790.208**	€ 790.000	€ 144.100	€ 155.032	€ 139.464	**€ 438.596**	€ 439.000
93	€ 150.797	€ 384.908	€ 151.539	**€ 687.244**	€ 687.000	€ 185.915	€ 154.754	€ 149.139	**€ 489.809**	€ 490.000
94	€ 158.791	€ 434.755	€ 146.718	**€ 740.265**	€ 740.000	€ 145.593	€ 150.396	€ 142.584	**€ 438.573**	€ 439.000
95	€ 157.506	€ 427.179	€ 132.748	**€ 717.433**	€ 717.000	€ 179.708	€ 141.136	€ 149.687	**€ 470.531**	€ 471.000
96	€ 151.529	€ 398.246	€ 126.610	**€ 676.386**	€ 676.000	€ 152.418	€ 153.464	€ 145.557	**€ 451.439**	€ 451.000
97	€ 146.054	€ 385.872	€ 148.161	**€ 680.087**	€ 680.000	€ 148.964	€ 168.794	€ 152.201	**€ 469.959**	€ 470.000
98	€ 178.692	€ 407.321	€ 147.520	**€ 733.534**	€ 734.000	€ 186.101	€ 148.396	€ 144.003	**€ 478.500**	€ 479.000
99	€ 153.391	€ 370.476	€ 135.313	**€ 659.180**	€ 659.000	€ 161.236	€ 156.705	€ 135.950	**€ 453.891**	€ 454.000
100	€ 145.892	€ 317.535	€ 127.752	**€ 591.180**	€ 591.000	€ 176.958	€ 153.716	€ 139.533	**€ 470.207**	€ 470.000
101	€ 153.508	€ 404.785	€ 145.936	**€ 704.229**	€ 704.000	€ 148.468	€ 152.103	€ 141.022	**€ 441.593**	€ 442.000
102	€ 165.179	€ 416.255	€ 149.685	**€ 731.118**	€ 731.000	€ 163.101	€ 147.011	€ 149.814	**€ 459.926**	€ 460.000
103	€ 154.978	€ 451.370	€ 148.343	**€ 754.692**	€ 755.000	€ 146.130	€ 156.004	€ 141.886	**€ 444.020**	€ 444.000
104	€ 140.143	€ 400.912	€ 143.876	**€ 684.932**	€ 685.000	€ 156.482	€ 175.342	€ 145.574	**€ 477.399**	€ 477.000
105	€ 162.600	€ 377.887	€ 155.685	**€ 696.172**	€ 696.000	€ 171.444	€ 170.385	€ 152.094	**€ 493.923**	€ 494.000
106	€ 157.935	€ 392.448	€ 141.204	**€ 691.587**	€ 692.000	€ 196.621	€ 156.742	€ 141.513	**€ 494.875**	€ 495.000
107	€ 178.653	€ 328.719	€ 129.914	**€ 637.286**	€ 637.000	€ 182.430	€ 168.466	€ 146.408	**€ 497.304**	€ 497.000
108	€ 149.895	€ 379.844	€ 149.311	**€ 679.050**	€ 679.000	€ 180.616	€ 146.862	€ 142.846	**€ 470.324**	€ 470.000
109	€ 122.310	€ 394.012	€ 134.416	**€ 650.738**	€ 651.000	€ 164.365	€ 185.158	€ 151.426	**€ 500.949**	€ 501.000
110	€ 160.046	€ 382.450	€ 138.373	**€ 680.869**	€ 681.000	€ 167.638	€ 145.843	€ 141.209	**€ 454.690**	€ 455.000
111	€ 156.756	€ 400.890	€ 145.595	**€ 703.241**	€ 703.000	€ 186.378	€ 169.098	€ 145.760	**€ 501.236**	€ 501.000
112	€ 152.765	€ 396.485	€ 136.527	**€ 685.777**	€ 686.000	€ 174.271	€ 141.872	€ 141.971	**€ 458.113**	€ 458.000
113	€ 162.524	€ 374.706	€ 128.283	**€ 665.513**	€ 666.000	€ 191.556	€ 170.658	€ 144.737	**€ 506.952**	€ 507.000
114	€ 156.771	€ 361.839	€ 158.584	**€ 677.194**	€ 677.000	€ 187.030	€ 190.286	€ 139.156	**€ 516.473**	€ 516.000
115	€ 134.140	€ 475.406	€ 139.346	**€ 748.892**	€ 749.000	€ 159.433	€ 169.115	€ 144.454	**€ 473.002**	€ 473.000
116	€ 121.763	€ 410.889	€ 140.640	**€ 673.292**	€ 673.000	€ 177.675	€ 194.151	€ 149.035	**€ 520.860**	€ 521.000
117	€ 160.208	€ 383.047	€ 135.328	**€ 678.583**	€ 679.000	€ 208.593	€ 155.675	€ 147.865	**€ 512.134**	€ 512.000
118	€ 170.374	€ 330.329	€ 144.953	**€ 645.656**	€ 646.000	€ 170.422	€ 161.239	€ 148.342	**€ 480.003**	€ 480.000
119	€ 160.582	€ 391.342	€ 138.137	**€ 690.061**	€ 690.000	€ 163.412	€ 143.280	€ 146.783	**€ 453.475**	€ 453.000
120	€ 158.235	€ 405.654	€ 126.583	**€ 690.473**	€ 690.000	€ 186.353	€ 192.587	€ 154.687	**€ 533.627**	€ 534.000
121	€ 152.972	€ 396.178	€ 149.513	**€ 698.663**	€ 699.000	€ 164.331	€ 176.899	€ 148.535	**€ 489.765**	€ 490.000
122	€ 158.785	€ 412.708	€ 148.546	**€ 720.040**	€ 720.000	€ 156.305	€ 166.912	€ 149.668	**€ 472.885**	€ 473.000
123	€ 157.410	€ 297.011	€ 133.209	**€ 587.630**	€ 588.000	€ 176.002	€ 158.600	€ 158.136	**€ 492.738**	€ 493.000
124	€ 187.386	€ 395.189	€ 146.115	**€ 728.690**	€ 729.000	€ 172.897	€ 182.539	€ 141.418	**€ 496.854**	€ 497.000
125	€ 161.776	€ 425.233	€ 139.099	**€ 726.108**	€ 726.000	€ 157.189	€ 165.945	€ 147.957	**€ 471.091**	€ 471.000
126	€ 149.549	€ 392.295	€ 138.666	**€ 680.510**	€ 681.000	€ 130.023	€ 157.148	€ 156.086	**€ 443.257**	€ 443.000
127	€ 161.543	€ 382.485	€ 146.021	**€ 690.049**	€ 690.000	€ 186.030	€ 152.509	€ 149.227	**€ 487.767**	€ 488.000
128	€ 170.639	€ 328.375	€ 150.061	**€ 649.074**	€ 649.000	€ 175.173	€ 153.878	€ 134.374	**€ 463.425**	€ 463.000
129	€ 175.004	€ 441.706	€ 139.582	**€ 756.292**	€ 756.000	€ 150.023	€ 140.844	€ 145.398	**€ 436.265**	€ 436.000
130	€ 147.673	€ 356.356	€ 135.541	**€ 639.570**	€ 640.000	€ 211.578	€ 151.236	€ 149.822	**€ 512.636**	€ 513.000
131	€ 171.385	€ 346.626	€ 128.971	**€ 646.982**	€ 647.000	€ 188.850	€ 166.901	€ 145.348	**€ 501.098**	€ 501.000
132	€ 128.240	€ 342.552	€ 145.206	**€ 615.998**	€ 616.000	€ 157.742	€ 142.821	€ 142.613	**€ 443.176**	€ 443.000
133	€ 140.652	€ 411.910	€ 127.706	**€ 680.267**	€ 680.000	€ 161.663	€ 147.959	€ 151.255	**€ 460.876**	€ 461.000
134	€ 160.790	€ 416.521	€ 145.816	**€ 723.127**	€ 723.000	€ 215.821	€ 156.266	€ 143.677	**€ 515.764**	€ 516.000
135	€ 144.086	€ 354.385	€ 125.478	**€ 623.949**	€ 624.000	€ 177.774	€ 172.071	€ 142.908	**€ 492.752**	€ 493.000
136	€ 161.576	€ 455.054	€ 144.300	**€ 760.930**	€ 761.000	€ 139.578	€ 171.573	€ 141.652	**€ 452.803**	€ 453.000
137	€ 183.999	€ 406.711	€ 148.114	**€ 738.824**	€ 739.000	€ 158.598	€ 172.537	€ 150.559	**€ 481.693**	€ 482.000
138	€ 156.474	€ 387.319	€ 142.372	**€ 686.166**	€ 686.000	€ 144.402	€ 148.135	€ 148.989	**€ 441.526**	€ 442.000
139	€ 160.153	€ 423.116	€ 149.682	**€ 732.951**	€ 733.000	€ 186.296	€ 123.772	€ 148.907	**€ 458.975**	€ 459.000
140	€ 161.362	€ 373.564	€ 140.235	**€ 675.162**	€ 675.000	€ 162.521	€ 160.103	€ 148.027	**€ 470.652**	€ 471.000
141	€ 141.140	€ 461.108	€ 135.520	**€ 737.769**	€ 738.000	€ 176.504	€ 156.259	€ 146.493	**€ 479.256**	€ 479.000
142	€ 122.637	€ 389.076	€ 141.856	**€ 653.569**	€ 654.000	€ 204.548	€ 148.743	€ 134.332	**€ 487.623**	€ 488.000
143	€ 159.353	€ 382.029	€ 136.054	**€ 677.436**	€ 677.000	€ 162.841	€ 149.917	€ 151.090	**€ 463.848**	€ 464.000
144	€ 151.152	€ 326.720	€ 143.493	**€ 621.365**	€ 621.000	€ 150.297	€ 173.485	€ 150.489	**€ 474.270**	€ 474.000
145	€ 153.621	€ 410.153	€ 135.324	**€ 699.098**	€ 699.000	€ 191.428	€ 177.261	€ 155.463	**€ 524.152**	€ 524.000
146	€ 143.590	€ 430.971	€ 144.104	**€ 718.665**	€ 719.000	€ 187.519	€ 174.466	€ 140.415	**€ 502.401**	€ 502.000
147	€ 161.773	€ 399.758	€ 121.247	**€ 682.778**	€ 683.000	€ 186.805	€ 146.440	€ 148.142	**€ 481.388**	€ 481.000
148	€ 185.625	€ 465.861	€ 145.819	**€ 797.306**	€ 797.000	€ 165.838	€ 175.558	€ 143.320	**€ 484.716**	€ 485.000
149	€ 138.074	€ 388.144	€ 155.079	**€ 681.297**	€ 681.000	€ 182.868	€ 158.348	€ 139.547	**€ 480.763**	€ 481.000
150	€ 148.467	€ 414.494	€ 148.755	**€ 711.716**	€ 712.000	€ 174.061	€ 146.901	€ 138.672	**€ 459.634**	€ 460.000
151	€ 161.020	€ 401.453	€ 155.932	**€ 718.404**	€ 718.000	€ 178.642	€ 166.259	€ 156.203	**€ 501.104**	€ 501.000
152	€ 158.526	€ 407.390	€ 133.157	**€ 699.073**	€ 699.000	€ 160.709	€ 151.840	€ 151.387	**€ 463.935**	€ 464.000

Collective GHP	
Average TCO	€ 476.707
Minimum TCO	€ 412.680
Maximum TCO	€ 553.091
Standard deviation	€ 24.102



153	€ 154.512	€ 388.962	€ 134.437	**€ 677.911**	€ 678.000	€ 182.930	€ 156.389	€ 149.954	**€ 489.274**	€ 489.000
154	€ 153.753	€ 361.492	€ 156.538	**€ 671.783**	€ 672.000	€ 163.424	€ 159.151	€ 147.173	**€ 469.747**	€ 470.000
155	€ 133.076	€ 312.347	€ 149.502	**€ 594.925**	€ 595.000	€ 138.738	€ 131.785	€ 148.767	**€ 419.290**	€ 419.000
156	€ 146.070	€ 362.510	€ 148.435	**€ 657.015**	€ 657.000	€ 175.581	€ 147.607	€ 147.859	**€ 471.047**	€ 471.000
157	€ 142.897	€ 341.606	€ 136.108	**€ 620.611**	€ 621.000	€ 188.069	€ 136.328	€ 138.844	**€ 463.241**	€ 463.000
158	€ 125.579	€ 387.960	€ 141.784	**€ 655.324**	€ 655.000	€ 192.226	€ 154.646	€ 146.862	**€ 493.734**	€ 494.000
159	€ 134.459	€ 379.963	€ 125.526	**€ 639.949**	€ 640.000	€ 171.404	€ 167.067	€ 148.801	**€ 487.272**	€ 487.000
160	€ 132.566	€ 372.339	€ 134.557	**€ 639.463**	€ 639.000	€ 185.099	€ 148.553	€ 138.039	**€ 471.691**	€ 472.000
161	€ 170.848	€ 389.063	€ 126.919	**€ 686.830**	€ 687.000	€ 175.712	€ 170.916	€ 141.665	**€ 488.293**	€ 488.000
162	€ 172.593	€ 405.276	€ 127.624	**€ 705.493**	€ 705.000	€ 166.827	€ 162.168	€ 145.500	**€ 474.495**	€ 474.000
163	€ 146.331	€ 325.388	€ 139.275	**€ 610.994**	€ 611.000	€ 162.877	€ 186.137	€ 150.951	**€ 499.965**	€ 500.000
164	€ 153.167	€ 403.367	€ 143.108	**€ 699.642**	€ 700.000	€ 227.992	€ 131.617	€ 149.196	**€ 508.805**	€ 509.000
165	€ 149.009	€ 372.916	€ 145.159	**€ 667.084**	€ 667.000	€ 158.306	€ 151.363	€ 150.871	**€ 460.541**	€ 461.000
166	€ 149.838	€ 378.869	€ 133.220	**€ 661.927**	€ 662.000	€ 162.217	€ 160.281	€ 144.185	**€ 466.684**	€ 467.000
167	€ 142.723	€ 442.622	€ 149.577	**€ 734.921**	€ 735.000	€ 172.618	€ 156.294	€ 145.360	**€ 474.273**	€ 474.000
168	€ 166.709	€ 350.167	€ 123.353	**€ 640.229**	€ 640.000	€ 168.173	€ 133.457	€ 139.911	**€ 441.541**	€ 442.000
169	€ 176.901	€ 404.342	€ 126.102	**€ 707.345**	€ 707.000	€ 122.450	€ 185.525	€ 142.600	**€ 450.575**	€ 451.000
170	€ 185.303	€ 368.002	€ 139.126	**€ 692.430**	€ 692.000	€ 168.375	€ 150.719	€ 150.390	**€ 469.484**	€ 469.000
171	€ 185.009	€ 416.544	€ 137.105	**€ 738.658**	€ 739.000	€ 196.318	€ 141.182	€ 143.431	**€ 480.931**	€ 481.000
172	€ 162.810	€ 378.255	€ 142.475	**€ 683.540**	€ 684.000	€ 165.440	€ 168.588	€ 150.404	**€ 484.432**	€ 484.000
173	€ 145.622	€ 419.127	€ 143.528	**€ 708.278**	€ 708.000	€ 205.793	€ 149.723	€ 154.241	**€ 509.757**	€ 510.000
174	€ 161.702	€ 420.772	€ 152.522	**€ 734.997**	€ 735.000	€ 151.825	€ 148.245	€ 144.625	**€ 444.695**	€ 445.000
175	€ 164.768	€ 403.933	€ 142.996	**€ 711.697**	€ 712.000	€ 162.038	€ 148.785	€ 144.243	**€ 455.066**	€ 455.000
176	€ 164.565	€ 377.005	€ 140.191	**€ 681.761**	€ 682.000	€ 197.437	€ 138.366	€ 142.912	**€ 478.715**	€ 479.000
177	€ 148.187	€ 407.420	€ 141.978	**€ 697.585**	€ 698.000	€ 155.247	€ 165.387	€ 148.329	**€ 468.962**	€ 469.000
178	€ 118.003	€ 301.990	€ 150.807	**€ 570.800**	€ 571.000	€ 170.752	€ 182.089	€ 143.131	**€ 495.971**	€ 496.000
179	€ 169.271	€ 350.924	€ 140.050	**€ 660.245**	€ 660.000	€ 162.211	€ 150.353	€ 140.758	**€ 453.321**	€ 453.000
180	€ 159.298	€ 339.082	€ 132.147	**€ 630.527**	€ 631.000	€ 182.569	€ 174.235	€ 151.218	**€ 508.022**	€ 508.000
181	€ 154.500	€ 366.972	€ 146.928	**€ 668.400**	€ 668.000	€ 174.151	€ 167.372	€ 147.680	**€ 489.203**	€ 489.000
182	€ 134.996	€ 342.082	€ 133.133	**€ 610.211**	€ 610.000	€ 179.071	€ 146.141	€ 141.699	**€ 466.912**	€ 467.000
183	€ 176.945	€ 414.139	€ 145.643	**€ 736.726**	€ 737.000	€ 170.425	€ 165.403	€ 135.300	**€ 471.128**	€ 471.000
184	€ 150.144	€ 390.097	€ 148.383	**€ 688.623**	€ 689.000	€ 145.772	€ 171.129	€ 144.767	**€ 461.667**	€ 462.000
185	€ 137.800	€ 414.324	€ 144.632	**€ 696.756**	€ 697.000	€ 148.212	€ 151.316	€ 139.697	**€ 439.226**	€ 439.000
186	€ 163.645	€ 427.169	€ 131.775	**€ 722.589**	€ 723.000	€ 179.838	€ 178.037	€ 140.375	**€ 498.250**	€ 498.000
187	€ 150.414	€ 365.108	€ 141.120	**€ 656.641**	€ 657.000	€ 163.347	€ 169.136	€ 148.519	**€ 481.002**	€ 481.000
188	€ 124.222	€ 340.406	€ 141.145	**€ 605.773**	€ 606.000	€ 149.387	€ 189.324	€ 142.246	**€ 480.957**	€ 481.000
189	€ 140.939	€ 374.809	€ 140.343	**€ 656.090**	€ 656.000	€ 191.796	€ 186.379	€ 152.305	**€ 530.481**	€ 530.000
190	€ 152.787	€ 511.542	€ 148.050	**€ 812.379**	€ 812.000	€ 178.936	€ 166.074	€ 147.366	**€ 492.376**	€ 492.000
191	€ 141.975	€ 396.326	€ 149.332	**€ 687.633**	€ 688.000	€ 166.375	€ 164.438	€ 149.347	**€ 480.160**	€ 480.000
192	€ 164.006	€ 358.466	€ 150.580	**€ 673.052**	€ 673.000	€ 178.091	€ 151.989	€ 156.187	**€ 486.267**	€ 486.000
193	€ 172.317	€ 405.445	€ 145.406	**€ 723.168**	€ 723.000	€ 136.543	€ 135.329	€ 157.479	**€ 429.351**	€ 429.000
194	€ 120.859	€ 291.069	€ 137.630	**€ 549.558**	€ 550.000	€ 204.390	€ 182.148	€ 143.335	**€ 529.873**	€ 530.000
195	€ 113.124	€ 383.987	€ 152.770	**€ 649.881**	€ 650.000	€ 177.415	€ 176.818	€ 149.204	**€ 503.436**	€ 503.000
196	€ 160.000	€ 392.087	€ 151.170	**€ 703.257**	€ 703.000	€ 164.421	€ 124.065	€ 147.917	**€ 436.403**	€ 436.000
197	€ 148.781	€ 432.530	€ 148.980	**€ 730.291**	€ 730.000	€ 175.825	€ 173.977	€ 149.600	**€ 499.402**	€ 499.000
198	€ 125.318	€ 417.745	€ 132.162	**€ 675.226**	€ 675.000	€ 152.121	€ 168.676	€ 140.926	**€ 461.723**	€ 462.000
199	€ 156.810	€ 411.847	€ 148.686	**€ 717.343**	€ 717.000	€ 147.163	€ 150.969	€ 140.365	**€ 438.496**	€ 438.000
200	€ 137.097	€ 359.633	€ 136.748	**€ 633.478**	€ 633.000	€ 172.863	€ 154.323	€ 140.581	**€ 467.767**	€ 468.000
201	€ 166.448	€ 401.557	€ 140.318	**€ 708.322**	€ 708.000	€ 162.407	€ 167.516	€ 145.861	**€ 475.783**	€ 476.000
202	€ 140.361	€ 332.731	€ 138.873	**€ 611.965**	€ 612.000	€ 179.893	€ 170.643	€ 139.045	**€ 489.581**	€ 490.000
203	€ 153.475	€ 363.229	€ 148.410	**€ 665.113**	€ 665.000	€ 123.727	€ 178.683	€ 139.999	**€ 442.409**	€ 442.000
204	€ 121.563	€ 324.443	€ 142.021	**€ 588.028**	€ 588.000	€ 167.855	€ 156.974	€ 147.489	**€ 472.318**	€ 472.000
205	€ 165.788	€ 416.670	€ 138.327	**€ 720.784**	€ 721.000	€ 131.544	€ 140.373	€ 147.563	**€ 419.480**	€ 419.000
206	€ 141.485	€ 374.022	€ 150.366	**€ 665.872**	€ 666.000	€ 199.422	€ 175.299	€ 147.318	**€ 522.040**	€ 522.000
207	€ 135.871	€ 348.179	€ 135.736	**€ 619.786**	€ 620.000	€ 162.011	€ 155.800	€ 147.717	**€ 465.528**	€ 466.000
208	€ 155.758	€ 454.764	€ 149.476	**€ 759.997**	€ 760.000	€ 159.639	€ 164.129	€ 140.673	**€ 464.442**	€ 464.000
209	€ 166.209	€ 372.286	€ 150.837	**€ 689.332**	€ 689.000	€ 173.315	€ 164.843	€ 138.700	**€ 476.858**	€ 477.000
210	€ 169.944	€ 407.426	€ 142.151	**€ 719.521**	€ 720.000	€ 193.442	€ 138.013	€ 146.637	**€ 478.091**	€ 478.000
211	€ 172.099	€ 423.703	€ 142.648	**€ 738.451**	€ 738.000	€ 141.409	€ 159.054	€ 145.245	**€ 445.708**	€ 446.000
212	€ 152.963	€ 371.930	€ 145.829	**€ 670.722**	€ 671.000	€ 181.626	€ 165.151	€ 155.038	**€ 501.815**	€ 502.000
213	€ 155.875	€ 438.239	€ 138.534	**€ 732.647**	€ 733.000	€ 176.265	€ 157.331	€ 143.023	**€ 476.620**	€ 477.000
214	€ 164.119	€ 383.094	€ 149.589	**€ 696.802**	€ 697.000	€ 183.548	€ 146.324	€ 146.026	**€ 475.899**	€ 476.000
215	€ 168.359	€ 362.058	€ 136.908	**€ 667.326**	€ 667.000	€ 156.603	€ 159.214	€ 148.365	**€ 464.181**	€ 464.000
216	€ 135.773	€ 464.438	€ 134.946	**€ 735.157**	€ 735.000	€ 186.699	€ 163.465	€ 149.615	**€ 499.780**	€ 500.000
217	€ 170.060	€ 437.669	€ 150.263	**€ 757.992**	€ 758.000	€ 176.504	€ 170.998	€ 142.794	**€ 490.296**	€ 490.000
218	€ 150.391	€ 408.802	€ 140.388	**€ 699.581**	€ 700.000	€ 173.540	€ 131.260	€ 149.603	**€ 454.403**	€ 454.000
219	€ 154.042	€ 477.602	€ 148.923	**€ 780.567**	€ 781.000	€ 192.518	€ 169.969	€ 144.322	**€ 506.810**	€ 507.000
220	€ 162.371	€ 356.487	€ 147.572	**€ 666.431**	€ 666.000	€ 204.986	€ 153.892	€ 150.394	**€ 509.272**	€ 509.000
221	€ 152.429	€ 455.520	€ 124.818	**€ 732.767**	€ 733.000	€ 171.780	€ 141.091	€ 140.348	**€ 453.220**	€ 453.000
222	€ 183.787	€ 396.870	€ 135.417	**€ 716.074**	€ 716.000	€ 164.724	€ 161.182	€ 146.819	**€ 472.724**	€ 473.000
223	€ 159.092	€ 395.012	€ 156.175	**€ 710.278**	€ 710.000	€ 178.820	€ 170.093	€ 151.294	**€ 500.207**	€ 500.000
224	€ 182.561	€ 408.192	€ 140.792	**€ 731.545**	€ 732.000	€ 188.369	€ 166.257	€ 143.013	**€ 497.639**	€ 498.000
225	€ 148.154	€ 409.113	€ 150.671	**€ 707.938**	€ 708.000	€ 202.792	€ 147.666	€ 148.070	**€ 498.528**	€ 499.000
226	€ 137.189	€ 360.553	€ 145.370	**€ 643.112**	€ 643.000	€ 195.795	€ 134.375	€ 144.401	**€ 474.570**	€ 475.000
227	€ 154.145	€ 332.932	€ 147.367	**€ 634.445**	€ 634.000	€ 185.743	€ 169.330	€ 144.832	**€ 499.904**	€ 500.000
228	€ 147.047	€ 394.658	€ 143.603	**€ 685.307**	€ 685.000	€ 175.850	€ 161.635	€ 147.128	**€ 484.612**	€ 485.000
229	€ 178.894	€ 359.511	€ 139.062	**€ 677.467**	€ 677.000	€ 164.205	€ 147.257	€ 151.291	**€ 462.753**	€ 463.000
230	€ 163.218	€ 358.414	€ 153.434	**€ 675.066**	€ 675.000	€ 162.913	€ 141.871	€ 142.449	**€ 447.234**	€ 447.000

231	€ 165.574	€ 338.568	€ 138.146	**€ 642.288**	€ 642.000	€ 148.535	€ 151.193	€ 150.114	**€ 449.842**	€ 450.000
232	€ 154.813	€ 403.972	€ 141.247	**€ 700.032**	€ 700.000	€ 144.477	€ 171.520	€ 143.361	**€ 459.359**	€ 459.000
233	€ 132.285	€ 447.645	€ 150.679	**€ 730.609**	€ 731.000	€ 153.232	€ 179.856	€ 142.064	**€ 475.152**	€ 475.000
234	€ 163.060	€ 398.084	€ 137.134	**€ 698.278**	€ 698.000	€ 170.290	€ 178.283	€ 149.614	**€ 498.186**	€ 498.000
235	€ 161.064	€ 384.233	€ 142.509	**€ 687.807**	€ 688.000	€ 163.063	€ 176.454	€ 133.613	**€ 473.130**	€ 473.000
236	€ 129.194	€ 421.591	€ 154.768	**€ 705.553**	€ 706.000	€ 144.010	€ 172.597	€ 139.470	**€ 456.077**	€ 456.000
237	€ 157.676	€ 340.500	€ 131.444	**€ 629.621**	€ 630.000	€ 158.407	€ 172.332	€ 141.580	**€ 472.319**	€ 472.000
238	€ 175.082	€ 410.436	€ 141.945	**€ 727.463**	€ 727.000	€ 170.170	€ 156.546	€ 141.220	**€ 467.936**	€ 468.000
239	€ 180.144	€ 361.743	€ 131.733	**€ 673.621**	€ 674.000	€ 151.810	€ 146.857	€ 144.698	**€ 443.365**	€ 443.000
240	€ 117.568	€ 386.103	€ 132.987	**€ 636.659**	€ 637.000	€ 184.959	€ 167.545	€ 139.572	**€ 492.076**	€ 492.000
241	€ 143.753	€ 367.807	€ 142.170	**€ 653.729**	€ 654.000	€ 182.865	€ 150.263	€ 141.414	**€ 474.543**	€ 475.000
242	€ 150.485	€ 354.626	€ 146.145	**€ 651.256**	€ 651.000	€ 169.650	€ 139.986	€ 147.612	**€ 457.248**	€ 457.000
243	€ 134.503	€ 410.691	€ 148.310	**€ 693.504**	€ 694.000	€ 147.945	€ 176.169	€ 139.677	**€ 463.791**	€ 464.000
244	€ 160.580	€ 394.882	€ 149.623	**€ 705.084**	€ 705.000	€ 191.332	€ 154.696	€ 149.423	**€ 495.451**	€ 495.000
245	€ 154.560	€ 390.450	€ 148.639	**€ 693.648**	€ 694.000	€ 188.049	€ 198.726	€ 146.291	**€ 533.066**	€ 533.000
246	€ 160.788	€ 393.091	€ 134.725	**€ 688.603**	€ 689.000	€ 167.124	€ 191.963	€ 136.842	**€ 495.929**	€ 496.000
247	€ 163.631	€ 413.714	€ 140.043	**€ 717.387**	€ 717.000	€ 176.008	€ 150.265	€ 146.125	**€ 472.398**	€ 472.000
248	€ 178.469	€ 378.867	€ 145.640	**€ 702.976**	€ 703.000	€ 199.895	€ 195.351	€ 144.786	**€ 540.032**	€ 540.000
249	€ 171.289	€ 355.383	€ 148.128	**€ 674.800**	€ 675.000	€ 189.343	€ 191.901	€ 144.424	**€ 525.668**	€ 526.000
250	€ 142.158	€ 319.816	€ 136.885	**€ 598.859**	€ 599.000	€ 155.690	€ 157.580	€ 148.992	**€ 462.262**	€ 462.000
251	€ 149.010	€ 356.256	€ 144.428	**€ 649.695**	€ 650.000	€ 179.710	€ 158.045	€ 152.450	**€ 490.205**	€ 490.000
252	€ 167.127	€ 365.857	€ 126.537	**€ 659.521**	€ 660.000	€ 187.624	€ 166.290	€ 147.009	**€ 500.923**	€ 501.000
253	€ 152.798	€ 377.003	€ 137.804	**€ 667.606**	€ 668.000	€ 178.883	€ 151.319	€ 142.149	**€ 472.351**	€ 472.000
254	€ 165.117	€ 392.570	€ 138.819	**€ 696.506**	€ 697.000	€ 189.986	€ 151.897	€ 140.019	**€ 481.901**	€ 482.000
255	€ 165.881	€ 384.800	€ 149.155	**€ 699.836**	€ 700.000	€ 201.766	€ 157.299	€ 142.518	**€ 501.583**	€ 502.000
256	€ 149.509	€ 374.949	€ 129.917	**€ 654.376**	€ 654.000	€ 163.600	€ 126.883	€ 149.861	**€ 440.344**	€ 440.000
257	€ 159.436	€ 416.080	€ 146.944	**€ 722.460**	€ 722.000	€ 165.734	€ 159.659	€ 141.408	**€ 466.801**	€ 467.000
258	€ 151.463	€ 382.010	€ 150.761	**€ 684.235**	€ 684.000	€ 188.067	€ 151.112	€ 143.147	**€ 482.326**	€ 482.000
259	€ 125.193	€ 415.651	€ 150.854	**€ 691.697**	€ 692.000	€ 220.112	€ 165.895	€ 142.688	**€ 528.694**	€ 529.000
260	€ 164.978	€ 375.523	€ 148.555	**€ 689.055**	€ 689.000	€ 163.786	€ 177.891	€ 145.449	**€ 487.126**	€ 487.000
261	€ 188.365	€ 454.098	€ 150.190	**€ 792.653**	€ 793.000	€ 157.453	€ 152.321	€ 149.354	**€ 459.129**	€ 459.000
262	€ 163.061	€ 419.741	€ 137.961	**€ 720.763**	€ 721.000	€ 146.278	€ 177.522	€ 142.363	**€ 466.163**	€ 466.000
263	€ 135.867	€ 385.946	€ 151.234	**€ 673.047**	€ 673.000	€ 166.547	€ 151.205	€ 147.004	**€ 464.755**	€ 465.000
264	€ 154.333	€ 412.571	€ 142.340	**€ 709.244**	€ 709.000	€ 171.923	€ 166.350	€ 149.719	**€ 487.991**	€ 488.000
265	€ 170.416	€ 345.990	€ 140.256	**€ 656.662**	€ 657.000	€ 170.650	€ 147.585	€ 148.971	**€ 467.205**	€ 467.000
266	€ 166.539	€ 390.173	€ 139.265	**€ 695.978**	€ 696.000	€ 166.654	€ 177.306	€ 147.165	**€ 491.125**	€ 491.000
267	€ 142.795	€ 375.563	€ 140.177	**€ 658.535**	€ 659.000	€ 168.312	€ 146.033	€ 142.462	**€ 456.808**	€ 457.000
268	€ 138.585	€ 328.637	€ 151.793	**€ 619.016**	€ 619.000	€ 161.474	€ 165.535	€ 145.995	**€ 473.004**	€ 473.000
269	€ 144.287	€ 383.040	€ 135.791	**€ 663.118**	€ 663.000	€ 186.680	€ 141.457	€ 144.299	**€ 472.437**	€ 472.000
270	€ 168.318	€ 370.332	€ 140.763	**€ 679.413**	€ 679.000	€ 173.830	€ 156.071	€ 147.700	**€ 477.601**	€ 478.000
271	€ 159.479	€ 372.710	€ 150.136	**€ 682.325**	€ 682.000	€ 192.602	€ 153.472	€ 140.294	**€ 486.368**	€ 486.000
272	€ 145.932	€ 402.183	€ 143.450	**€ 691.565**	€ 692.000	€ 171.947	€ 159.881	€ 146.128	**€ 477.956**	€ 478.000
273	€ 160.582	€ 250.975	€ 137.164	**€ 548.721**	€ 549.000	€ 167.213	€ 155.747	€ 140.204	**€ 463.164**	€ 463.000
274	€ 158.766	€ 411.643	€ 148.264	**€ 718.673**	€ 719.000	€ 170.030	€ 136.710	€ 138.898	**€ 445.639**	€ 446.000
275	€ 156.027	€ 379.688	€ 150.317	**€ 686.032**	€ 686.000	€ 145.861	€ 174.893	€ 147.368	**€ 468.122**	€ 468.000
276	€ 150.635	€ 367.733	€ 138.013	**€ 656.382**	€ 656.000	€ 159.575	€ 136.929	€ 153.940	**€ 450.443**	€ 450.000
277	€ 168.286	€ 338.530	€ 145.029	**€ 651.845**	€ 652.000	€ 203.930	€ 174.384	€ 141.913	**€ 520.228**	€ 520.000
278	€ 173.141	€ 388.533	€ 142.630	**€ 704.305**	€ 704.000	€ 168.869	€ 155.112	€ 140.757	**€ 464.738**	€ 465.000
279	€ 143.363	€ 316.188	€ 139.588	**€ 599.139**	€ 599.000	€ 171.376	€ 124.758	€ 144.095	**€ 440.229**	€ 440.000
280	€ 128.988	€ 415.581	€ 143.900	**€ 688.469**	€ 688.000	€ 193.298	€ 166.507	€ 148.246	**€ 508.052**	€ 508.000
281	€ 153.502	€ 423.174	€ 148.414	**€ 725.090**	€ 725.000	€ 138.930	€ 172.677	€ 148.568	**€ 460.176**	€ 460.000
282	€ 142.197	€ 402.259	€ 139.913	**€ 684.370**	€ 684.000	€ 171.566	€ 138.624	€ 147.974	**€ 458.164**	€ 458.000
283	€ 158.582	€ 408.505	€ 146.810	**€ 713.897**	€ 714.000	€ 192.728	€ 167.623	€ 141.645	**€ 501.996**	€ 502.000
284	€ 196.590	€ 402.465	€ 151.634	**€ 750.688**	€ 751.000	€ 157.697	€ 183.392	€ 143.937	**€ 485.026**	€ 485.000
285	€ 154.795	€ 411.902	€ 145.114	**€ 711.811**	€ 712.000	€ 159.773	€ 161.995	€ 139.794	**€ 461.563**	€ 462.000
286	€ 158.572	€ 407.345	€ 132.019	**€ 697.937**	€ 698.000	€ 138.810	€ 168.608	€ 150.663	**€ 458.080**	€ 458.000
287	€ 166.921	€ 356.482	€ 146.493	**€ 669.895**	€ 670.000	€ 162.927	€ 162.486	€ 139.390	**€ 464.803**	€ 465.000
288	€ 149.339	€ 416.892	€ 139.677	**€ 705.908**	€ 706.000	€ 146.692	€ 138.723	€ 141.693	**€ 427.107**	€ 427.000
289	€ 151.355	€ 443.213	€ 147.733	**€ 742.301**	€ 742.000	€ 152.418	€ 174.314	€ 140.235	**€ 466.968**	€ 467.000
290	€ 159.274	€ 354.805	€ 146.648	**€ 660.727**	€ 661.000	€ 168.964	€ 180.872	€ 147.476	**€ 497.311**	€ 497.000
291	€ 117.060	€ 371.142	€ 135.949	**€ 624.150**	€ 624.000	€ 155.939	€ 155.703	€ 141.841	**€ 453.483**	€ 453.000
292	€ 159.463	€ 403.162	€ 146.322	**€ 708.948**	€ 709.000	€ 161.495	€ 160.779	€ 138.249	**€ 460.523**	€ 461.000
293	€ 150.584	€ 368.057	€ 127.475	**€ 646.116**	€ 646.000	€ 174.760	€ 161.175	€ 154.818	**€ 490.753**	€ 491.000
294	€ 148.779	€ 417.081	€ 121.910	**€ 687.770**	€ 688.000	€ 172.463	€ 168.421	€ 150.795	**€ 491.678**	€ 492.000
295	€ 131.500	€ 356.582	€ 147.495	**€ 635.577**	€ 636.000	€ 173.186	€ 147.643	€ 147.086	**€ 467.916**	€ 468.000
296	€ 126.633	€ 423.243	€ 148.153	**€ 698.028**	€ 698.000	€ 169.248	€ 162.332	€ 144.519	**€ 476.099**	€ 476.000
297	€ 148.716	€ 365.417	€ 139.540	**€ 653.672**	€ 654.000	€ 193.950	€ 167.936	€ 149.855	**€ 511.741**	€ 512.000
298	€ 159.265	€ 461.414	€ 136.533	**€ 757.212**	€ 757.000	€ 199.658	€ 145.719	€ 149.925	**€ 495.302**	€ 495.000
299	€ 122.950	€ 416.375	€ 133.128	**€ 672.453**	€ 672.000	€ 188.419	€ 164.736	€ 150.401	**€ 503.555**	€ 504.000
300	€ 127.672	€ 431.501	€ 147.451	**€ 706.623**	€ 707.000	€ 207.817	€ 160.497	€ 150.340	**€ 518.655**	€ 519.000
301	€ 162.665	€ 364.422	€ 144.835	**€ 671.922**	€ 672.000	€ 170.502	€ 159.567	€ 146.530	**€ 476.600**	€ 477.000
302	€ 164.256	€ 432.605	€ 142.496	**€ 739.357**	€ 739.000	€ 180.901	€ 149.244	€ 153.957	**€ 484.102**	€ 484.000
303	€ 150.853	€ 463.222	€ 146.467	**€ 760.542**	€ 761.000	€ 168.825	€ 175.020	€ 146.372	**€ 490.217**	€ 490.000
304	€ 164.270	€ 392.594	€ 140.930	**€ 697.795**	€ 698.000	€ 173.990	€ 171.604	€ 143.790	**€ 489.384**	€ 489.000
305	€ 176.583	€ 379.168	€ 150.867	**€ 706.618**	€ 707.000	€ 167.118	€ 128.631	€ 145.535	**€ 441.284**	€ 441.000
306	€ 173.695	€ 414.774	€ 145.142	**€ 733.611**	€ 734.000	€ 179.031	€ 159.510	€ 144.830	**€ 483.370**	€ 483.000
307	€ 136.727	€ 397.698	€ 126.985	**€ 661.409**	€ 661.000	€ 185.655	€ 122.744	€ 146.111	**€ 454.510**	€ 455.000
308	€ 109.595	€ 339.142	€ 137.967	**€ 586.705**	€ 587.000	€ 154.084	€ 164.663	€ 139.320	**€ 458.067**	€ 458.000

309	€ 166.666	€ 441.776	€ 138.017	**€ 746.460**	€ 746.000	€ 144.523	€ 146.488	€ 142.164	**€ 433.175**	€ 433.000
310	€ 129.062	€ 327.566	€ 144.568	**€ 601.196**	€ 601.000	€ 167.113	€ 128.704	€ 150.468	**€ 446.285**	€ 446.000
311	€ 155.698	€ 363.815	€ 155.349	**€ 674.862**	€ 675.000	€ 174.415	€ 180.434	€ 149.872	**€ 504.720**	€ 505.000
312	€ 151.540	€ 350.533	€ 141.939	**€ 644.012**	€ 644.000	€ 173.129	€ 169.790	€ 151.480	**€ 494.399**	€ 494.000
313	€ 146.346	€ 373.780	€ 148.868	**€ 668.994**	€ 669.000	€ 170.046	€ 184.790	€ 149.898	**€ 504.733**	€ 505.000
314	€ 162.267	€ 411.143	€ 151.717	**€ 725.127**	€ 725.000	€ 167.738	€ 150.512	€ 137.782	**€ 456.032**	€ 456.000
315	€ 165.980	€ 371.582	€ 138.873	**€ 676.435**	€ 676.000	€ 207.107	€ 146.961	€ 142.885	**€ 496.953**	€ 497.000
316	€ 152.288	€ 339.947	€ 141.369	**€ 633.604**	€ 634.000	€ 183.256	€ 164.226	€ 149.294	**€ 496.777**	€ 497.000
317	€ 145.705	€ 377.793	€ 146.577	**€ 670.075**	€ 670.000	€ 175.531	€ 123.961	€ 141.486	**€ 440.978**	€ 441.000
318	€ 159.363	€ 395.942	€ 149.544	**€ 704.849**	€ 705.000	€ 172.193	€ 154.038	€ 146.094	**€ 472.325**	€ 472.000
319	€ 150.692	€ 413.637	€ 140.808	**€ 705.137**	€ 705.000	€ 176.746	€ 144.419	€ 139.679	**€ 460.844**	€ 461.000
320	€ 154.673	€ 462.961	€ 151.282	**€ 768.917**	€ 769.000	€ 181.743	€ 193.567	€ 151.193	**€ 526.502**	€ 527.000
321	€ 142.078	€ 427.206	€ 139.283	**€ 708.567**	€ 709.000	€ 189.132	€ 152.660	€ 154.223	**€ 496.015**	€ 496.000
322	€ 119.753	€ 387.586	€ 147.633	**€ 654.971**	€ 655.000	€ 190.245	€ 182.576	€ 149.690	**€ 522.510**	€ 523.000
323	€ 160.488	€ 368.745	€ 147.124	**€ 676.357**	€ 676.000	€ 165.175	€ 159.199	€ 138.704	**€ 463.078**	€ 463.000
324	€ 137.110	€ 393.236	€ 151.284	**€ 681.629**	€ 682.000	€ 178.141	€ 141.202	€ 155.214	**€ 474.557**	€ 475.000
325	€ 151.660	€ 418.069	€ 138.890	**€ 708.619**	€ 709.000	€ 154.189	€ 154.867	€ 142.125	**€ 451.181**	€ 451.000
326	€ 139.402	€ 369.209	€ 149.400	**€ 658.011**	€ 658.000	€ 152.638	€ 137.865	€ 150.835	**€ 441.338**	€ 441.000
327	€ 119.545	€ 367.893	€ 150.575	**€ 638.013**	€ 638.000	€ 171.234	€ 157.192	€ 149.564	**€ 477.990**	€ 478.000
328	€ 132.587	€ 403.877	€ 137.767	**€ 674.232**	€ 674.000	€ 170.513	€ 161.372	€ 143.324	**€ 475.209**	€ 475.000
329	€ 141.368	€ 412.694	€ 149.078	**€ 703.140**	€ 703.000	€ 164.198	€ 166.986	€ 150.845	**€ 482.028**	€ 482.000
330	€ 142.440	€ 385.351	€ 146.216	**€ 674.007**	€ 674.000	€ 192.886	€ 160.211	€ 151.195	**€ 504.293**	€ 504.000
331	€ 148.598	€ 441.309	€ 137.144	**€ 727.050**	€ 727.000	€ 218.214	€ 149.094	€ 141.816	**€ 509.124**	€ 509.000
332	€ 165.007	€ 359.644	€ 136.138	**€ 660.789**	€ 661.000	€ 171.134	€ 168.208	€ 140.463	**€ 479.804**	€ 480.000
333	€ 172.411	€ 433.072	€ 145.203	**€ 750.686**	€ 751.000	€ 161.783	€ 175.805	€ 134.226	**€ 471.814**	€ 472.000
334	€ 157.555	€ 365.957	€ 142.209	**€ 665.721**	€ 666.000	€ 155.164	€ 156.436	€ 139.770	**€ 451.371**	€ 451.000
335	€ 144.036	€ 407.245	€ 141.461	**€ 692.742**	€ 693.000	€ 174.039	€ 181.825	€ 150.380	**€ 506.244**	€ 506.000
336	€ 126.537	€ 426.620	€ 151.768	**€ 704.925**	€ 705.000	€ 176.822	€ 178.328	€ 134.701	**€ 489.851**	€ 490.000
337	€ 149.078	€ 359.540	€ 138.890	**€ 647.507**	€ 648.000	€ 158.422	€ 152.371	€ 139.611	**€ 450.403**	€ 450.000
338	€ 155.028	€ 432.904	€ 143.365	**€ 731.297**	€ 731.000	€ 158.682	€ 176.941	€ 146.642	**€ 482.265**	€ 482.000
339	€ 141.168	€ 355.033	€ 137.123	**€ 633.324**	€ 633.000	€ 188.388	€ 139.376	€ 145.390	**€ 473.154**	€ 473.000
340	€ 160.230	€ 374.505	€ 150.913	**€ 685.648**	€ 686.000	€ 174.373	€ 168.088	€ 156.183	**€ 498.644**	€ 499.000
341	€ 154.094	€ 394.451	€ 141.457	**€ 690.003**	€ 690.000	€ 172.679	€ 165.846	€ 141.742	**€ 480.267**	€ 480.000
342	€ 153.030	€ 415.373	€ 137.122	**€ 705.524**	€ 706.000	€ 170.925	€ 165.880	€ 132.346	**€ 469.151**	€ 469.000
343	€ 175.561	€ 363.427	€ 137.929	**€ 676.917**	€ 677.000	€ 191.259	€ 153.912	€ 145.192	**€ 490.363**	€ 490.000
344	€ 151.984	€ 471.796	€ 135.375	**€ 759.155**	€ 759.000	€ 151.038	€ 179.568	€ 140.573	**€ 471.179**	€ 471.000
345	€ 165.508	€ 364.086	€ 147.198	**€ 676.791**	€ 677.000	€ 183.890	€ 174.592	€ 139.954	**€ 498.436**	€ 498.000
346	€ 161.878	€ 374.977	€ 140.288	**€ 677.143**	€ 677.000	€ 192.024	€ 172.150	€ 139.379	**€ 503.554**	€ 504.000
347	€ 155.597	€ 383.260	€ 135.755	**€ 674.612**	€ 675.000	€ 159.018	€ 136.050	€ 144.793	**€ 439.862**	€ 440.000
348	€ 134.965	€ 389.144	€ 149.820	**€ 673.929**	€ 674.000	€ 175.340	€ 153.702	€ 144.072	**€ 473.113**	€ 473.000
349	€ 174.691	€ 388.890	€ 145.476	**€ 709.057**	€ 709.000	€ 180.614	€ 176.469	€ 143.742	**€ 500.826**	€ 501.000
350	€ 164.648	€ 385.143	€ 145.029	**€ 694.820**	€ 695.000	€ 152.677	€ 170.693	€ 147.945	**€ 471.315**	€ 471.000
351	€ 147.076	€ 451.333	€ 144.233	**€ 742.642**	€ 743.000	€ 171.271	€ 151.819	€ 153.046	**€ 476.135**	€ 476.000
352	€ 142.473	€ 449.130	€ 141.019	**€ 732.622**	€ 733.000	€ 183.879	€ 166.426	€ 146.737	**€ 497.041**	€ 497.000
353	€ 169.524	€ 475.503	€ 134.898	**€ 779.925**	€ 780.000	€ 159.299	€ 155.501	€ 153.906	**€ 468.705**	€ 469.000
354	€ 139.862	€ 424.910	€ 147.471	**€ 712.243**	€ 712.000	€ 166.921	€ 131.441	€ 141.342	**€ 439.704**	€ 440.000
355	€ 143.092	€ 389.778	€ 137.270	**€ 670.140**	€ 670.000	€ 184.413	€ 134.319	€ 149.900	**€ 468.632**	€ 469.000
356	€ 143.997	€ 363.205	€ 134.691	**€ 641.894**	€ 642.000	€ 185.914	€ 175.279	€ 142.510	**€ 503.703**	€ 504.000
357	€ 155.889	€ 400.192	€ 136.534	**€ 692.615**	€ 693.000	€ 149.052	€ 152.965	€ 143.286	**€ 445.303**	€ 445.000
358	€ 170.160	€ 412.826	€ 140.246	**€ 723.232**	€ 723.000	€ 192.216	€ 191.470	€ 143.658	**€ 527.344**	€ 527.000
359	€ 154.808	€ 380.940	€ 138.155	**€ 673.903**	€ 674.000	€ 182.483	€ 152.491	€ 139.276	**€ 474.250**	€ 474.000
360	€ 162.644	€ 363.557	€ 149.054	**€ 675.255**	€ 675.000	€ 169.454	€ 149.873	€ 149.441	**€ 468.768**	€ 469.000
361	€ 164.596	€ 391.722	€ 142.927	**€ 699.245**	€ 699.000	€ 206.749	€ 158.625	€ 152.522	**€ 517.896**	€ 518.000
362	€ 141.244	€ 348.675	€ 145.709	**€ 635.627**	€ 636.000	€ 169.780	€ 113.839	€ 144.661	**€ 428.279**	€ 428.000
363	€ 177.720	€ 321.393	€ 142.370	**€ 641.483**	€ 641.000	€ 169.647	€ 149.382	€ 139.166	**€ 458.196**	€ 458.000
364	€ 150.205	€ 406.274	€ 140.115	**€ 696.594**	€ 697.000	€ 172.208	€ 172.236	€ 138.214	**€ 482.659**	€ 483.000
365	€ 156.426	€ 417.011	€ 139.962	**€ 713.400**	€ 713.000	€ 187.292	€ 157.689	€ 147.719	**€ 492.699**	€ 493.000
366	€ 163.392	€ 358.654	€ 146.223	**€ 668.270**	€ 668.000	€ 144.217	€ 137.117	€ 149.882	**€ 431.216**	€ 431.000
367	€ 163.926	€ 494.146	€ 145.751	**€ 803.823**	€ 804.000	€ 182.715	€ 156.046	€ 140.580	**€ 479.341**	€ 479.000
368	€ 164.251	€ 443.246	€ 144.095	**€ 751.592**	€ 752.000	€ 170.856	€ 125.199	€ 140.372	**€ 436.427**	€ 436.000
369	€ 149.593	€ 377.780	€ 144.236	**€ 671.609**	€ 672.000	€ 174.187	€ 146.171	€ 151.321	**€ 471.680**	€ 472.000
370	€ 137.914	€ 406.154	€ 128.284	**€ 672.352**	€ 672.000	€ 160.653	€ 156.015	€ 145.575	**€ 462.244**	€ 462.000
371	€ 141.665	€ 423.446	€ 147.149	**€ 712.260**	€ 712.000	€ 189.834	€ 178.735	€ 147.654	**€ 516.223**	€ 516.000
372	€ 138.734	€ 454.959	€ 132.967	**€ 726.659**	€ 727.000	€ 202.350	€ 163.148	€ 143.303	**€ 508.800**	€ 509.000
373	€ 154.934	€ 411.715	€ 127.085	**€ 693.734**	€ 694.000	€ 186.300	€ 153.154	€ 139.550	**€ 479.004**	€ 479.000
374	€ 149.354	€ 410.396	€ 144.880	**€ 704.630**	€ 705.000	€ 170.232	€ 165.396	€ 141.271	**€ 476.899**	€ 477.000
375	€ 159.658	€ 439.133	€ 145.204	**€ 743.996**	€ 744.000	€ 191.658	€ 126.592	€ 139.899	**€ 458.150**	€ 458.000
376	€ 159.535	€ 429.132	€ 140.427	**€ 729.094**	€ 729.000	€ 172.830	€ 121.968	€ 149.606	**€ 444.404**	€ 444.000
377	€ 163.617	€ 384.427	€ 123.896	**€ 671.940**	€ 672.000	€ 172.103	€ 152.077	€ 146.609	**€ 470.789**	€ 471.000
378	€ 150.989	€ 356.257	€ 141.573	**€ 648.818**	€ 649.000	€ 178.679	€ 165.797	€ 145.078	**€ 489.554**	€ 490.000
379	€ 141.960	€ 462.623	€ 138.494	**€ 743.077**	€ 743.000	€ 154.548	€ 134.033	€ 143.410	**€ 431.991**	€ 432.000
380	€ 145.688	€ 405.240	€ 132.679	**€ 683.607**	€ 684.000	€ 132.863	€ 154.142	€ 147.812	**€ 434.816**	€ 435.000
381	€ 140.710	€ 339.484	€ 149.648	**€ 629.842**	€ 630.000	€ 132.575	€ 156.850	€ 139.808	**€ 429.233**	€ 429.000
382	€ 160.330	€ 420.824	€ 125.750	**€ 706.904**	€ 707.000	€ 140.250	€ 147.031	€ 148.944	**€ 436.224**	€ 436.000
383	€ 147.368	€ 453.874	€ 125.330	**€ 726.572**	€ 727.000	€ 161.675	€ 151.624	€ 148.670	**€ 461.969**	€ 462.000
384	€ 145.208	€ 388.404	€ 149.394	**€ 683.007**	€ 683.000	€ 153.837	€ 144.362	€ 142.763	**€ 440.962**	€ 441.000
385	€ 145.890	€ 383.599	€ 150.322	**€ 679.812**	€ 680.000	€ 163.213	€ 152.463	€ 154.149	**€ 469.825**	€ 470.000
386	€ 164.526	€ 398.789	€ 138.860	**€ 702.175**	€ 702.000	€ 181.670	€ 174.052	€ 140.692	**€ 496.414**	€ 496.000

387	€ 175.623	€ 366.859	€ 134.350	**€ 676.832**	€ 677.000	€ 200.933	€ 185.592	€ 133.612	**€ 520.137**	€ 520.000
388	€ 169.801	€ 455.726	€ 144.856	**€ 770.384**	€ 770.000	€ 194.979	€ 138.306	€ 139.198	**€ 472.484**	€ 472.000
389	€ 129.294	€ 450.485	€ 132.578	**€ 712.356**	€ 712.000	€ 170.815	€ 174.522	€ 142.296	**€ 487.633**	€ 488.000
390	€ 173.245	€ 400.766	€ 138.175	**€ 712.186**	€ 712.000	€ 199.748	€ 161.636	€ 149.517	**€ 510.901**	€ 511.000
391	€ 146.042	€ 371.582	€ 138.125	**€ 655.749**	€ 656.000	€ 203.066	€ 165.487	€ 144.254	**€ 512.807**	€ 513.000
392	€ 169.663	€ 378.363	€ 149.541	**€ 697.567**	€ 698.000	€ 158.535	€ 154.664	€ 140.293	**€ 453.493**	€ 453.000
393	€ 148.705	€ 505.105	€ 148.537	**€ 802.347**	€ 802.000	€ 179.273	€ 169.411	€ 149.112	**€ 497.796**	€ 498.000
394	€ 166.190	€ 346.013	€ 148.543	**€ 660.746**	€ 661.000	€ 159.860	€ 171.425	€ 141.182	**€ 472.467**	€ 472.000
395	€ 140.433	€ 499.012	€ 151.261	**€ 790.705**	€ 791.000	€ 154.766	€ 156.439	€ 147.696	**€ 458.900**	€ 459.000
396	€ 121.621	€ 357.174	€ 149.169	**€ 627.965**	€ 628.000	€ 169.350	€ 154.984	€ 150.073	**€ 474.406**	€ 474.000
397	€ 153.204	€ 411.452	€ 124.503	**€ 689.159**	€ 689.000	€ 189.841	€ 170.772	€ 142.492	**€ 503.105**	€ 503.000
398	€ 155.760	€ 405.378	€ 141.467	**€ 702.605**	€ 703.000	€ 168.319	€ 157.277	€ 149.764	**€ 475.361**	€ 475.000
399	€ 172.322	€ 397.642	€ 147.499	**€ 717.463**	€ 717.000	€ 172.836	€ 137.688	€ 144.561	**€ 455.085**	€ 455.000
400	€ 151.359	€ 376.688	€ 150.492	**€ 678.539**	€ 679.000	€ 190.940	€ 178.052	€ 146.826	**€ 515.819**	€ 516.000
401	€ 145.618	€ 421.147	€ 147.039	**€ 713.804**	€ 714.000	€ 190.999	€ 166.389	€ 146.284	**€ 503.672**	€ 504.000
402	€ 138.424	€ 343.801	€ 145.874	**€ 628.098**	€ 628.000	€ 154.901	€ 158.028	€ 146.805	**€ 459.735**	€ 460.000
403	€ 156.134	€ 372.669	€ 136.123	**€ 664.926**	€ 665.000	€ 167.186	€ 148.680	€ 146.924	**€ 462.790**	€ 463.000
404	€ 138.627	€ 426.638	€ 140.696	**€ 705.961**	€ 706.000	€ 150.276	€ 169.085	€ 149.183	**€ 468.543**	€ 469.000
405	€ 136.537	€ 371.217	€ 142.016	**€ 649.769**	€ 650.000	€ 184.592	€ 171.327	€ 150.897	**€ 506.816**	€ 507.000
406	€ 138.697	€ 451.473	€ 145.292	**€ 735.462**	€ 735.000	€ 190.434	€ 133.853	€ 150.638	**€ 474.926**	€ 475.000
407	€ 148.007	€ 452.790	€ 144.616	**€ 745.413**	€ 745.000	€ 170.068	€ 137.092	€ 151.050	**€ 458.211**	€ 458.000
408	€ 139.732	€ 369.425	€ 147.575	**€ 656.731**	€ 657.000	€ 164.525	€ 154.481	€ 147.109	**€ 466.115**	€ 466.000
409	€ 151.353	€ 385.144	€ 129.057	**€ 665.554**	€ 666.000	€ 187.435	€ 159.147	€ 145.474	**€ 492.057**	€ 492.000
410	€ 180.464	€ 323.310	€ 137.772	**€ 641.546**	€ 642.000	€ 179.957	€ 166.686	€ 140.183	**€ 486.826**	€ 487.000
411	€ 153.023	€ 365.183	€ 149.705	**€ 667.911**	€ 668.000	€ 155.566	€ 168.939	€ 148.440	**€ 472.945**	€ 473.000
412	€ 132.766	€ 382.009	€ 142.420	**€ 657.195**	€ 657.000	€ 176.260	€ 158.196	€ 150.401	**€ 484.858**	€ 485.000
413	€ 145.030	€ 380.496	€ 143.675	**€ 669.201**	€ 669.000	€ 171.499	€ 171.746	€ 141.851	**€ 485.096**	€ 485.000
414	€ 161.000	€ 452.536	€ 150.582	**€ 764.118**	€ 764.000	€ 177.648	€ 173.706	€ 142.173	**€ 493.526**	€ 494.000
415	€ 135.481	€ 431.923	€ 148.010	**€ 715.414**	€ 715.000	€ 160.763	€ 139.125	€ 147.616	**€ 447.504**	€ 448.000
416	€ 155.307	€ 363.841	€ 138.243	**€ 657.390**	€ 657.000	€ 149.609	€ 178.208	€ 151.257	**€ 479.073**	€ 479.000
417	€ 171.780	€ 437.811	€ 145.799	**€ 755.391**	€ 755.000	€ 175.346	€ 168.885	€ 155.781	**€ 500.012**	€ 500.000
418	€ 152.843	€ 354.277	€ 139.292	**€ 646.412**	€ 646.000	€ 175.625	€ 148.457	€ 136.720	**€ 460.803**	€ 461.000
419	€ 152.642	€ 304.318	€ 130.935	**€ 587.895**	€ 588.000	€ 168.346	€ 164.884	€ 146.675	**€ 479.905**	€ 480.000
420	€ 166.564	€ 442.920	€ 140.277	**€ 749.762**	€ 750.000	€ 170.884	€ 169.090	€ 150.530	**€ 490.503**	€ 491.000
421	€ 167.488	€ 437.060	€ 150.515	**€ 755.063**	€ 755.000	€ 182.990	€ 129.496	€ 147.005	**€ 459.491**	€ 459.000
422	€ 163.001	€ 378.665	€ 127.876	**€ 669.542**	€ 670.000	€ 154.655	€ 142.853	€ 153.443	**€ 450.950**	€ 451.000
423	€ 132.474	€ 380.338	€ 149.519	**€ 662.331**	€ 662.000	€ 184.569	€ 185.318	€ 151.369	**€ 521.256**	€ 521.000
424	€ 177.917	€ 349.740	€ 138.930	**€ 666.588**	€ 667.000	€ 170.647	€ 172.022	€ 145.173	**€ 487.842**	€ 488.000
425	€ 158.499	€ 353.396	€ 145.880	**€ 657.775**	€ 658.000	€ 186.681	€ 164.218	€ 142.363	**€ 493.261**	€ 493.000
426	€ 142.811	€ 353.237	€ 132.685	**€ 628.734**	€ 629.000	€ 154.945	€ 143.244	€ 149.354	**€ 447.544**	€ 448.000
427	€ 129.725	€ 354.160	€ 151.172	**€ 635.057**	€ 635.000	€ 159.727	€ 166.478	€ 142.778	**€ 468.983**	€ 469.000
428	€ 161.451	€ 467.274	€ 129.547	**€ 758.273**	€ 758.000	€ 114.552	€ 164.619	€ 141.580	**€ 420.751**	€ 421.000
429	€ 140.438	€ 317.881	€ 148.915	**€ 607.234**	€ 607.000	€ 202.562	€ 153.788	€ 150.744	**€ 507.094**	€ 507.000
430	€ 175.827	€ 349.707	€ 140.748	**€ 666.283**	€ 666.000	€ 186.184	€ 135.216	€ 147.021	**€ 468.421**	€ 468.000
431	€ 151.616	€ 352.486	€ 144.576	**€ 648.677**	€ 649.000	€ 138.974	€ 138.500	€ 146.570	**€ 424.044**	€ 424.000
432	€ 145.281	€ 375.393	€ 139.646	**€ 660.319**	€ 660.000	€ 192.773	€ 155.465	€ 142.852	**€ 491.090**	€ 491.000
433	€ 125.121	€ 419.962	€ 131.578	**€ 676.661**	€ 677.000	€ 172.940	€ 156.689	€ 144.930	**€ 474.559**	€ 475.000
434	€ 146.951	€ 399.779	€ 148.030	**€ 694.761**	€ 695.000	€ 155.143	€ 118.361	€ 156.992	**€ 430.495**	€ 430.000
435	€ 166.666	€ 445.402	€ 134.888	**€ 746.956**	€ 747.000	€ 168.709	€ 135.909	€ 151.000	**€ 455.619**	€ 456.000
436	€ 146.728	€ 392.213	€ 148.444	**€ 687.385**	€ 687.000	€ 186.889	€ 150.362	€ 140.117	**€ 477.369**	€ 477.000
437	€ 153.165	€ 475.254	€ 140.115	**€ 768.534**	€ 769.000	€ 177.380	€ 178.024	€ 149.957	**€ 505.361**	€ 505.000
438	€ 143.107	€ 392.769	€ 141.053	**€ 676.929**	€ 677.000	€ 170.379	€ 164.957	€ 137.207	**€ 472.543**	€ 473.000
439	€ 169.132	€ 364.371	€ 137.325	**€ 670.828**	€ 671.000	€ 183.978	€ 138.834	€ 151.995	**€ 474.807**	€ 475.000
440	€ 125.497	€ 327.445	€ 130.722	**€ 583.665**	€ 584.000	€ 160.342	€ 130.281	€ 136.667	**€ 427.290**	€ 427.000
441	€ 139.967	€ 384.558	€ 144.070	**€ 668.595**	€ 669.000	€ 142.970	€ 142.384	€ 144.372	**€ 429.726**	€ 430.000
442	€ 148.599	€ 361.641	€ 147.268	**€ 657.507**	€ 658.000	€ 190.125	€ 182.056	€ 149.501	**€ 521.681**	€ 522.000
443	€ 178.546	€ 364.642	€ 122.902	**€ 666.090**	€ 666.000	€ 176.214	€ 164.849	€ 146.394	**€ 487.456**	€ 487.000
444	€ 153.732	€ 462.835	€ 149.226	**€ 765.794**	€ 766.000	€ 157.153	€ 185.828	€ 142.965	**€ 485.947**	€ 486.000
445	€ 171.370	€ 384.211	€ 143.554	**€ 699.134**	€ 699.000	€ 176.523	€ 130.467	€ 150.133	**€ 457.123**	€ 457.000
446	€ 165.791	€ 400.738	€ 136.250	**€ 702.779**	€ 703.000	€ 179.046	€ 153.818	€ 147.219	**€ 480.083**	€ 480.000
447	€ 157.340	€ 421.356	€ 148.583	**€ 727.279**	€ 727.000	€ 207.261	€ 158.146	€ 141.733	**€ 507.140**	€ 507.000
448	€ 128.682	€ 390.180	€ 147.899	**€ 666.761**	€ 667.000	€ 173.967	€ 147.981	€ 140.127	**€ 462.075**	€ 462.000
449	€ 176.683	€ 453.679	€ 143.324	**€ 773.686**	€ 774.000	€ 127.334	€ 178.890	€ 146.239	**€ 452.463**	€ 452.000
450	€ 145.263	€ 421.267	€ 148.480	**€ 715.009**	€ 715.000	€ 183.627	€ 163.915	€ 146.417	**€ 493.959**	€ 494.000
451	€ 128.972	€ 365.426	€ 142.435	**€ 636.833**	€ 637.000	€ 175.657	€ 148.297	€ 150.679	**€ 474.633**	€ 475.000
452	€ 154.883	€ 378.134	€ 140.019	**€ 673.036**	€ 673.000	€ 167.819	€ 171.064	€ 149.086	**€ 487.968**	€ 488.000
453	€ 153.669	€ 389.955	€ 143.793	**€ 687.416**	€ 687.000	€ 165.898	€ 149.931	€ 149.478	**€ 465.306**	€ 465.000
454	€ 159.423	€ 390.292	€ 154.940	**€ 704.655**	€ 705.000	€ 167.602	€ 169.657	€ 142.455	**€ 479.714**	€ 480.000
455	€ 167.837	€ 428.583	€ 144.298	**€ 740.718**	€ 741.000	€ 197.903	€ 155.228	€ 149.057	**€ 502.188**	€ 502.000
456	€ 173.424	€ 395.731	€ 140.525	**€ 709.680**	€ 710.000	€ 158.850	€ 177.561	€ 144.957	**€ 481.369**	€ 481.000
457	€ 174.494	€ 389.697	€ 132.888	**€ 697.080**	€ 697.000	€ 164.582	€ 133.811	€ 140.712	**€ 439.106**	€ 439.000
458	€ 142.174	€ 387.536	€ 138.442	**€ 668.153**	€ 668.000	€ 173.577	€ 155.160	€ 141.014	**€ 469.752**	€ 470.000
459	€ 139.857	€ 330.212	€ 135.551	**€ 605.619**	€ 606.000	€ 162.953	€ 163.348	€ 147.341	**€ 473.642**	€ 474.000
460	€ 141.387	€ 378.914	€ 148.418	**€ 668.719**	€ 669.000	€ 147.711	€ 154.912	€ 139.448	**€ 442.071**	€ 442.000
461	€ 153.221	€ 387.048	€ 146.583	**€ 686.852**	€ 687.000	€ 155.908	€ 143.870	€ 152.105	**€ 451.882**	€ 452.000
462	€ 161.341	€ 374.163	€ 135.500	**€ 671.004**	€ 671.000	€ 155.495	€ 154.962	€ 150.372	**€ 460.829**	€ 461.000
463	€ 156.141	€ 437.659	€ 145.083	**€ 738.884**	€ 739.000	€ 165.357	€ 180.897	€ 137.809	**€ 484.063**	€ 484.000
464	€ 141.497	€ 356.378	€ 135.819	**€ 633.694**	€ 634.000	€ 172.870	€ 161.685	€ 141.690	**€ 476.245**	€ 476.000

465	€	112.980	€	390.197	€	151.202	**€ 654.379**	€	654.000	€	144.591	€	171.520	€	142.801	**€ 458.912**	€	459.000
466	€	155.074	€	433.225	€	149.070	**€ 737.370**	€	737.000	€	156.511	€	154.355	€	150.636	**€ 461.502**	€	462.000
467	€	141.333	€	398.712	€	129.053	**€ 669.098**	€	669.000	€	162.971	€	157.280	€	134.185	**€ 454.436**	€	454.000
468	€	162.743	€	362.471	€	128.061	**€ 653.274**	€	653.000	€	135.148	€	151.984	€	149.687	**€ 436.819**	€	437.000
469	€	160.858	€	391.694	€	130.597	**€ 683.149**	€	683.000	€	178.253	€	167.401	€	146.650	**€ 492.305**	€	492.000
470	€	179.771	€	367.352	€	150.839	**€ 697.962**	€	698.000	€	192.568	€	154.880	€	142.517	**€ 489.965**	€	490.000
471	€	142.670	€	417.416	€	129.545	**€ 689.631**	€	690.000	€	169.779	€	173.843	€	144.080	**€ 487.701**	€	488.000
472	€	148.976	€	413.072	€	147.954	**€ 710.002**	€	710.000	€	191.428	€	176.502	€	140.809	**€ 508.739**	€	509.000
473	€	140.989	€	436.525	€	149.578	**€ 727.092**	€	727.000	€	157.297	€	144.023	€	134.831	**€ 436.152**	€	436.000
474	€	139.770	€	464.157	€	137.489	**€ 741.416**	€	741.000	€	189.716	€	153.191	€	141.395	**€ 484.302**	€	484.000
475	€	152.725	€	404.055	€	145.244	**€ 702.024**	€	702.000	€	162.455	€	146.175	€	144.390	**€ 453.020**	€	453.000
476	€	154.557	€	396.698	€	146.109	**€ 697.364**	€	697.000	€	165.282	€	173.579	€	137.650	**€ 476.512**	€	477.000
477	€	148.549	€	345.889	€	150.169	**€ 644.607**	€	645.000	€	176.904	€	155.079	€	140.687	**€ 472.671**	€	473.000
478	€	164.853	€	389.185	€	136.941	**€ 690.979**	€	691.000	€	199.580	€	164.817	€	146.991	**€ 511.388**	€	511.000
479	€	168.117	€	370.445	€	141.530	**€ 680.091**	€	680.000	€	172.867	€	156.685	€	148.628	**€ 478.180**	€	478.000
480	€	159.763	€	363.005	€	132.274	**€ 655.042**	€	655.000	€	161.935	€	153.269	€	151.681	**€ 466.885**	€	467.000
481	€	155.478	€	424.048	€	140.539	**€ 720.065**	€	720.000	€	151.293	€	158.769	€	143.152	**€ 453.214**	€	453.000
482	€	162.657	€	398.803	€	145.455	**€ 706.914**	€	707.000	€	182.928	€	175.257	€	147.168	**€ 505.353**	€	505.000
483	€	125.420	€	405.842	€	136.277	**€ 667.540**	€	668.000	€	174.816	€	181.891	€	146.252	**€ 502.959**	€	503.000
484	€	161.924	€	358.954	€	149.281	**€ 670.159**	€	670.000	€	131.976	€	146.365	€	146.463	**€ 424.804**	€	425.000
485	€	167.835	€	429.328	€	146.944	**€ 744.107**	€	744.000	€	157.985	€	150.955	€	146.722	**€ 455.662**	€	456.000
486	€	159.134	€	424.439	€	146.995	**€ 730.568**	€	731.000	€	165.716	€	182.301	€	139.518	**€ 487.534**	€	488.000
487	€	164.710	€	433.104	€	157.389	**€ 755.204**	€	755.000	€	192.072	€	172.383	€	150.047	**€ 514.501**	€	515.000
488	€	158.387	€	428.502	€	138.079	**€ 724.968**	€	725.000	€	150.388	€	172.693	€	148.081	**€ 471.162**	€	471.000
489	€	141.940	€	375.864	€	124.734	**€ 642.537**	€	643.000	€	193.105	€	119.005	€	142.720	**€ 454.830**	€	455.000
490	€	151.703	€	374.066	€	136.539	**€ 662.308**	€	662.000	€	170.180	€	156.617	€	135.467	**€ 462.264**	€	462.000
491	€	156.012	€	394.190	€	141.333	**€ 691.536**	€	692.000	€	157.062	€	164.542	€	147.509	**€ 469.113**	€	469.000
492	€	158.360	€	420.143	€	143.028	**€ 721.532**	€	722.000	€	181.737	€	163.636	€	149.712	**€ 495.086**	€	495.000
493	€	133.181	€	413.288	€	143.638	**€ 690.107**	€	690.000	€	173.261	€	176.656	€	150.700	**€ 500.617**	€	501.000
494	€	169.819	€	423.262	€	134.424	**€ 727.505**	€	728.000	€	159.224	€	186.199	€	141.553	**€ 486.976**	€	487.000
495	€	169.372	€	471.194	€	139.689	**€ 780.255**	€	780.000	€	163.404	€	151.984	€	134.205	**€ 449.593**	€	450.000
496	€	145.907	€	350.155	€	136.127	**€ 632.188**	€	632.000	€	178.134	€	130.981	€	150.476	**€ 459.591**	€	460.000
497	€	177.310	€	374.873	€	150.259	**€ 702.442**	€	702.000	€	218.514	€	181.871	€	145.625	**€ 546.010**	€	546.000
498	€	154.256	€	335.617	€	121.753	**€ 611.625**	€	612.000	€	201.010	€	180.768	€	147.759	**€ 529.537**	€	530.000
499	€	175.184	€	371.391	€	146.612	**€ 693.187**	€	693.000	€	164.886	€	137.123	€	144.101	**€ 446.110**	€	446.000
500	€	154.918	€	363.902	€	151.083	**€ 669.903**	€	670.000	€	173.246	€	154.840	€	147.667	**€ 475.752**	€	476.000
501	€	171.919	€	395.696	€	141.806	**€ 709.420**	€	709.000	€	168.948	€	166.405	€	141.349	**€ 476.702**	€	477.000
502	€	149.723	€	366.773	€	144.203	**€ 660.698**	€	661.000	€	206.342	€	178.731	€	151.457	**€ 536.531**	€	537.000
503	€	158.544	€	373.886	€	149.546	**€ 681.976**	€	682.000	€	156.511	€	153.618	€	142.057	**€ 452.186**	€	452.000
504	€	135.390	€	292.294	€	140.952	**€ 568.636**	€	569.000	€	161.989	€	170.246	€	142.801	**€ 475.036**	€	475.000
505	€	167.604	€	399.956	€	148.082	**€ 715.642**	€	716.000	€	189.577	€	154.752	€	146.079	**€ 490.407**	€	490.000
506	€	173.220	€	341.493	€	136.299	**€ 651.012**	€	651.000	€	154.353	€	138.869	€	144.789	**€ 438.011**	€	438.000
507	€	157.654	€	371.934	€	154.385	**€ 683.973**	€	684.000	€	190.400	€	149.151	€	145.377	**€ 484.928**	€	485.000
508	€	155.527	€	430.544	€	136.999	**€ 723.069**	€	723.000	€	206.838	€	148.175	€	152.451	**€ 507.464**	€	507.000
509	€	128.302	€	341.851	€	149.755	**€ 619.908**	€	620.000	€	151.296	€	154.080	€	136.274	**€ 441.651**	€	442.000
510	€	160.594	€	416.200	€	137.615	**€ 714.408**	€	714.000	€	166.771	€	162.837	€	137.912	**€ 467.520**	€	468.000
511	€	152.415	€	411.082	€	142.311	**€ 705.807**	€	706.000	€	165.255	€	171.813	€	144.089	**€ 481.157**	€	481.000
512	€	157.946	€	402.315	€	141.190	**€ 701.451**	€	701.000	€	154.104	€	157.322	€	140.423	**€ 451.850**	€	452.000
513	€	149.816	€	462.796	€	138.179	**€ 750.791**	€	751.000	€	162.709	€	173.811	€	141.540	**€ 478.060**	€	478.000
514	€	163.986	€	378.385	€	143.536	**€ 685.908**	€	686.000	€	181.254	€	165.374	€	142.427	**€ 489.055**	€	489.000
515	€	160.751	€	403.188	€	145.973	**€ 709.911**	€	710.000	€	169.554	€	148.565	€	144.361	**€ 462.480**	€	462.000
516	€	156.142	€	409.894	€	129.088	**€ 695.123**	€	695.000	€	171.530	€	142.653	€	140.443	**€ 454.626**	€	455.000
517	€	126.856	€	397.469	€	148.960	**€ 673.285**	€	673.000	€	169.860	€	147.628	€	157.975	**€ 475.463**	€	475.000
518	€	166.293	€	354.083	€	147.510	**€ 667.885**	€	668.000	€	150.340	€	176.037	€	149.945	**€ 476.323**	€	476.000
519	€	154.146	€	376.697	€	136.058	**€ 666.901**	€	667.000	€	183.917	€	159.782	€	145.125	**€ 488.824**	€	489.000
520	€	153.613	€	426.429	€	139.775	**€ 719.817**	€	720.000	€	166.323	€	164.613	€	142.231	**€ 473.167**	€	473.000
521	€	171.147	€	390.861	€	138.426	**€ 700.434**	€	700.000	€	159.579	€	158.798	€	144.164	**€ 462.541**	€	463.000
522	€	135.180	€	338.614	€	143.656	**€ 617.450**	€	617.000	€	145.098	€	155.547	€	144.120	**€ 444.765**	€	445.000
523	€	148.311	€	330.589	€	142.487	**€ 621.388**	€	621.000	€	192.810	€	164.539	€	147.546	**€ 504.894**	€	505.000
524	€	154.023	€	401.088	€	151.477	**€ 706.588**	€	707.000	€	181.947	€	152.937	€	149.269	**€ 484.153**	€	484.000
525	€	147.944	€	439.772	€	143.561	**€ 731.277**	€	731.000	€	143.161	€	151.833	€	151.078	**€ 446.072**	€	446.000
526	€	129.562	€	416.529	€	143.913	**€ 690.004**	€	690.000	€	188.695	€	141.930	€	139.407	**€ 470.032**	€	470.000
527	€	167.313	€	395.701	€	147.171	**€ 710.185**	€	710.000	€	199.202	€	175.919	€	146.950	**€ 522.071**	€	522.000
528	€	142.411	€	375.729	€	143.058	**€ 661.199**	€	661.000	€	199.167	€	145.730	€	139.590	**€ 484.487**	€	484.000
529	€	171.002	€	394.502	€	149.085	**€ 714.589**	€	715.000	€	160.392	€	171.944	€	152.109	**€ 484.445**	€	484.000
530	€	174.532	€	399.050	€	135.544	**€ 709.126**	€	709.000	€	162.386	€	171.386	€	139.857	**€ 473.628**	€	474.000
531	€	148.517	€	391.059	€	138.142	**€ 677.719**	€	678.000	€	152.938	€	121.581	€	151.295	**€ 425.814**	€	426.000
532	€	124.278	€	422.411	€	147.282	**€ 693.971**	€	694.000	€	203.442	€	156.060	€	139.144	**€ 498.647**	€	499.000
533	€	140.040	€	392.197	€	126.899	**€ 659.136**	€	659.000	€	153.553	€	157.973	€	146.953	**€ 458.480**	€	458.000
534	€	111.079	€	311.845	€	144.342	**€ 567.266**	€	567.000	€	181.035	€	163.547	€	148.124	**€ 492.706**	€	493.000
535	€	146.133	€	421.116	€	126.893	**€ 694.142**	€	694.000	€	169.170	€	127.473	€	141.934	**€ 438.577**	€	439.000
536	€	189.754	€	392.846	€	150.907	**€ 733.507**	€	734.000	€	165.566	€	157.502	€	144.732	**€ 467.801**	€	468.000
537	€	133.063	€	409.226	€	137.964	**€ 680.253**	€	680.000	€	158.795	€	178.690	€	144.848	**€ 482.334**	€	482.000
538	€	167.707	€	377.833	€	149.035	**€ 694.574**	€	695.000	€	128.839	€	140.822	€	157.405	**€ 427.067**	€	427.000
539	€	165.522	€	403.703	€	147.593	**€ 716.817**	€	717.000	€	160.878	€	118.087	€	150.687	**€ 429.652**	€	430.000
540	€	142.802	€	404.391	€	145.403	**€ 692.596**	€	693.000	€	186.522	€	164.246	€	145.030	**€ 495.798**	€	496.000
541	€	153.256	€	456.242	€	152.533	**€ 762.031**	€	762.000	€	200.915	€	146.736	€	153.374	**€ 501.025**	€	501.000
542	€	158.007	€	386.172	€	141.273	**€ 685.452**	€	685.000	€	164.703	€	177.945	€	152.852	**€ 495.500**	€	496.000

543	€ 176.492	€ 356.239	€ 157.486	**€ 690.216**	€ 690.000	€ 170.955	€ 181.279	€ 144.445	**€ 496.679**	€ 497.000
544	€ 174.477	€ 357.298	€ 138.688	**€ 670.463**	€ 670.000	€ 203.610	€ 154.427	€ 150.344	**€ 508.381**	€ 508.000
545	€ 128.688	€ 425.717	€ 123.036	**€ 677.440**	€ 677.000	€ 137.777	€ 167.029	€ 142.161	**€ 446.967**	€ 447.000
546	€ 138.507	€ 402.710	€ 122.752	**€ 663.970**	€ 664.000	€ 175.864	€ 144.336	€ 135.649	**€ 455.850**	€ 456.000
547	€ 155.991	€ 427.711	€ 143.640	**€ 727.342**	€ 727.000	€ 153.949	€ 161.408	€ 149.540	**€ 464.897**	€ 465.000
548	€ 173.559	€ 435.798	€ 125.783	**€ 735.140**	€ 735.000	€ 187.350	€ 179.296	€ 150.740	**€ 517.385**	€ 517.000
549	€ 156.996	€ 453.252	€ 145.944	**€ 756.192**	€ 756.000	€ 162.343	€ 176.598	€ 141.143	**€ 480.083**	€ 480.000
550	€ 122.665	€ 401.774	€ 128.731	**€ 653.169**	€ 653.000	€ 170.672	€ 145.828	€ 150.912	**€ 467.412**	€ 467.000
551	€ 163.175	€ 336.522	€ 133.224	**€ 632.921**	€ 633.000	€ 195.052	€ 157.046	€ 147.374	**€ 499.472**	€ 499.000
552	€ 137.751	€ 317.150	€ 131.292	**€ 586.192**	€ 586.000	€ 183.682	€ 167.210	€ 136.874	**€ 487.767**	€ 488.000
553	€ 152.188	€ 379.341	€ 146.066	**€ 677.595**	€ 678.000	€ 160.436	€ 149.831	€ 142.490	**€ 452.758**	€ 453.000
554	€ 155.693	€ 427.009	€ 136.327	**€ 719.030**	€ 719.000	€ 127.490	€ 141.468	€ 157.785	**€ 426.743**	€ 427.000
555	€ 152.197	€ 479.923	€ 140.922	**€ 773.043**	€ 773.000	€ 168.856	€ 152.568	€ 139.556	**€ 460.980**	€ 461.000
556	€ 163.396	€ 401.384	€ 143.695	**€ 708.475**	€ 708.000	€ 196.957	€ 168.960	€ 147.899	**€ 513.816**	€ 514.000
557	€ 148.430	€ 381.101	€ 138.658	**€ 668.189**	€ 668.000	€ 188.699	€ 174.388	€ 150.852	**€ 513.939**	€ 514.000
558	€ 155.544	€ 359.752	€ 138.216	**€ 653.513**	€ 654.000	€ 149.201	€ 160.569	€ 147.574	**€ 457.344**	€ 457.000
559	€ 140.570	€ 453.303	€ 131.828	**€ 725.701**	€ 726.000	€ 185.687	€ 162.754	€ 151.154	**€ 499.595**	€ 500.000
560	€ 162.339	€ 389.263	€ 146.243	**€ 697.845**	€ 698.000	€ 169.599	€ 158.089	€ 150.444	**€ 478.132**	€ 478.000
561	€ 141.182	€ 389.228	€ 146.473	**€ 676.884**	€ 677.000	€ 163.471	€ 162.732	€ 143.044	**€ 469.247**	€ 469.000
562	€ 129.612	€ 396.518	€ 150.939	**€ 677.069**	€ 677.000	€ 182.466	€ 165.283	€ 147.107	**€ 494.856**	€ 495.000
563	€ 138.412	€ 401.184	€ 145.893	**€ 685.489**	€ 685.000	€ 174.267	€ 183.382	€ 143.828	**€ 501.476**	€ 501.000
564	€ 151.825	€ 383.743	€ 150.831	**€ 686.399**	€ 686.000	€ 116.577	€ 153.842	€ 142.999	**€ 413.417**	€ 413.000
565	€ 131.928	€ 362.780	€ 135.256	**€ 629.963**	€ 630.000	€ 174.776	€ 135.354	€ 139.863	**€ 449.994**	€ 450.000
566	€ 143.160	€ 431.745	€ 149.730	**€ 724.635**	€ 725.000	€ 168.320	€ 135.483	€ 146.472	**€ 450.274**	€ 450.000
567	€ 142.572	€ 393.394	€ 135.421	**€ 671.387**	€ 671.000	€ 148.075	€ 144.396	€ 144.350	**€ 436.820**	€ 437.000
568	€ 153.964	€ 354.516	€ 129.598	**€ 638.078**	€ 638.000	€ 153.617	€ 144.931	€ 151.298	**€ 449.845**	€ 450.000
569	€ 126.327	€ 384.923	€ 147.732	**€ 658.982**	€ 659.000	€ 186.093	€ 177.549	€ 146.770	**€ 510.412**	€ 510.000
570	€ 176.624	€ 390.040	€ 138.929	**€ 705.592**	€ 706.000	€ 194.242	€ 168.423	€ 139.372	**€ 502.037**	€ 502.000
571	€ 133.805	€ 370.908	€ 149.490	**€ 654.203**	€ 654.000	€ 155.837	€ 144.828	€ 153.517	**€ 454.182**	€ 454.000
572	€ 141.721	€ 365.839	€ 139.259	**€ 646.819**	€ 647.000	€ 190.615	€ 172.823	€ 143.175	**€ 506.614**	€ 507.000
573	€ 130.363	€ 413.202	€ 143.249	**€ 686.814**	€ 687.000	€ 163.480	€ 153.283	€ 143.262	**€ 460.025**	€ 460.000
574	€ 165.679	€ 445.675	€ 138.559	**€ 749.913**	€ 750.000	€ 171.713	€ 176.369	€ 140.058	**€ 488.141**	€ 488.000
575	€ 155.475	€ 344.868	€ 140.393	**€ 640.736**	€ 641.000	€ 155.797	€ 160.778	€ 146.697	**€ 463.272**	€ 463.000
576	€ 149.995	€ 360.125	€ 128.365	**€ 638.484**	€ 638.000	€ 179.200	€ 167.055	€ 155.234	**€ 501.490**	€ 501.000
577	€ 149.470	€ 409.168	€ 140.754	**€ 699.392**	€ 699.000	€ 166.425	€ 160.200	€ 141.683	**€ 468.308**	€ 468.000
578	€ 152.465	€ 473.730	€ 129.449	**€ 755.644**	€ 756.000	€ 169.850	€ 175.778	€ 147.811	**€ 493.438**	€ 493.000
579	€ 143.545	€ 419.049	€ 146.753	**€ 709.348**	€ 709.000	€ 180.687	€ 173.606	€ 141.731	**€ 496.024**	€ 496.000
580	€ 138.078	€ 411.521	€ 127.366	**€ 676.965**	€ 677.000	€ 179.412	€ 158.620	€ 146.203	**€ 484.236**	€ 484.000
581	€ 135.075	€ 384.628	€ 150.093	**€ 669.796**	€ 670.000	€ 164.764	€ 136.359	€ 142.236	**€ 443.359**	€ 443.000
582	€ 167.881	€ 381.293	€ 123.359	**€ 672.533**	€ 673.000	€ 170.284	€ 147.595	€ 150.649	**€ 468.529**	€ 469.000
583	€ 143.098	€ 418.600	€ 137.703	**€ 699.400**	€ 699.000	€ 144.054	€ 147.364	€ 149.931	**€ 441.349**	€ 441.000
584	€ 160.598	€ 340.310	€ 146.683	**€ 647.591**	€ 648.000	€ 185.764	€ 159.593	€ 140.310	**€ 485.666**	€ 486.000
585	€ 150.394	€ 401.791	€ 136.842	**€ 689.027**	€ 689.000	€ 160.937	€ 155.523	€ 138.985	**€ 455.445**	€ 455.000
586	€ 148.949	€ 440.536	€ 142.932	**€ 732.417**	€ 732.000	€ 156.975	€ 162.842	€ 148.930	**€ 468.747**	€ 469.000
587	€ 169.127	€ 371.299	€ 149.775	**€ 690.202**	€ 690.000	€ 153.235	€ 128.776	€ 148.017	**€ 430.028**	€ 430.000
588	€ 153.368	€ 414.841	€ 142.254	**€ 710.463**	€ 710.000	€ 177.862	€ 175.813	€ 143.285	**€ 496.960**	€ 497.000
589	€ 161.289	€ 366.080	€ 144.244	**€ 671.613**	€ 672.000	€ 175.988	€ 149.018	€ 143.472	**€ 468.478**	€ 468.000
590	€ 153.224	€ 395.832	€ 150.276	**€ 699.332**	€ 699.000	€ 182.026	€ 145.197	€ 146.201	**€ 473.424**	€ 473.000
591	€ 147.689	€ 368.650	€ 150.243	**€ 666.582**	€ 667.000	€ 172.090	€ 152.836	€ 144.886	**€ 469.812**	€ 470.000
592	€ 139.737	€ 350.723	€ 144.199	**€ 634.660**	€ 635.000	€ 215.837	€ 146.035	€ 147.254	**€ 509.125**	€ 509.000
593	€ 150.599	€ 438.273	€ 141.853	**€ 730.725**	€ 731.000	€ 179.063	€ 184.221	€ 155.416	**€ 518.700**	€ 519.000
594	€ 206.041	€ 348.756	€ 145.674	**€ 700.471**	€ 700.000	€ 136.497	€ 132.217	€ 143.966	**€ 412.680**	€ 413.000
595	€ 144.148	€ 367.939	€ 143.635	**€ 655.722**	€ 656.000	€ 182.397	€ 149.088	€ 146.223	**€ 477.708**	€ 478.000
596	€ 155.683	€ 400.704	€ 139.040	**€ 695.427**	€ 695.000	€ 165.664	€ 171.237	€ 146.439	**€ 483.340**	€ 483.000
597	€ 157.567	€ 460.982	€ 127.741	**€ 746.290**	€ 746.000	€ 193.625	€ 157.466	€ 144.827	**€ 495.919**	€ 496.000
598	€ 144.724	€ 394.854	€ 143.937	**€ 683.515**	€ 684.000	€ 168.446	€ 161.508	€ 148.688	**€ 478.641**	€ 479.000
599	€ 135.646	€ 353.620	€ 135.208	**€ 624.474**	€ 624.000	€ 202.084	€ 186.649	€ 141.231	**€ 529.963**	€ 530.000
600	€ 132.328	€ 396.682	€ 136.314	**€ 665.324**	€ 665.000	€ 190.242	€ 166.121	€ 148.305	**€ 504.668**	€ 505.000
601	€ 162.236	€ 358.969	€ 132.753	**€ 653.958**	€ 654.000	€ 185.384	€ 195.069	€ 149.778	**€ 530.230**	€ 530.000
602	€ 156.535	€ 422.699	€ 145.236	**€ 724.470**	€ 724.000	€ 144.835	€ 164.375	€ 142.977	**€ 452.187**	€ 452.000
603	€ 136.282	€ 381.857	€ 144.301	**€ 662.440**	€ 662.000	€ 218.495	€ 123.416	€ 147.065	**€ 488.976**	€ 489.000
604	€ 135.418	€ 328.147	€ 147.133	**€ 610.698**	€ 611.000	€ 183.476	€ 156.220	€ 141.954	**€ 481.650**	€ 482.000
605	€ 174.405	€ 399.101	€ 136.203	**€ 709.708**	€ 710.000	€ 192.103	€ 177.674	€ 150.571	**€ 520.348**	€ 520.000
606	€ 146.627	€ 463.376	€ 153.787	**€ 763.789**	€ 764.000	€ 175.872	€ 191.871	€ 149.817	**€ 517.560**	€ 518.000
607	€ 143.773	€ 375.403	€ 151.688	**€ 670.864**	€ 671.000	€ 163.090	€ 172.149	€ 148.702	**€ 483.940**	€ 484.000
608	€ 157.837	€ 382.466	€ 142.800	**€ 683.103**	€ 683.000	€ 168.345	€ 189.013	€ 142.024	**€ 499.382**	€ 499.000
609	€ 144.401	€ 370.932	€ 156.134	**€ 671.467**	€ 671.000	€ 180.200	€ 175.299	€ 149.871	**€ 505.369**	€ 505.000
610	€ 172.558	€ 268.316	€ 137.113	**€ 577.986**	€ 578.000	€ 150.355	€ 145.924	€ 139.796	**€ 436.075**	€ 436.000
611	€ 144.969	€ 421.147	€ 123.311	**€ 689.427**	€ 689.000	€ 163.475	€ 184.064	€ 148.956	**€ 496.495**	€ 496.000
612	€ 151.857	€ 338.730	€ 141.851	**€ 632.438**	€ 632.000	€ 173.692	€ 153.623	€ 142.715	**€ 470.030**	€ 470.000
613	€ 172.456	€ 501.766	€ 130.017	**€ 804.239**	€ 804.000	€ 161.209	€ 176.026	€ 149.083	**€ 486.318**	€ 486.000
614	€ 134.090	€ 388.455	€ 139.291	**€ 661.836**	€ 662.000	€ 162.086	€ 176.877	€ 148.172	**€ 487.135**	€ 487.000
615	€ 157.433	€ 366.382	€ 138.881	**€ 662.696**	€ 663.000	€ 175.418	€ 136.417	€ 145.542	**€ 457.377**	€ 457.000
616	€ 166.000	€ 329.337	€ 141.081	**€ 636.419**	€ 636.000	€ 170.714	€ 159.358	€ 143.947	**€ 474.018**	€ 474.000
617	€ 137.970	€ 395.382	€ 148.681	**€ 682.033**	€ 682.000	€ 198.085	€ 156.781	€ 140.782	**€ 495.648**	€ 496.000
618	€ 142.522	€ 445.560	€ 131.032	**€ 719.115**	€ 719.000	€ 167.280	€ 143.908	€ 152.727	**€ 463.915**	€ 464.000
619	€ 161.101	€ 344.749	€ 136.241	**€ 642.090**	€ 642.000	€ 160.936	€ 168.342	€ 145.302	**€ 474.580**	€ 475.000
620	€ 161.381	€ 399.037	€ 137.047	**€ 697.466**	€ 697.000	€ 187.853	€ 146.653	€ 140.684	**€ 475.190**	€ 475.000

621	€ 152.420	€ 396.588	€ 141.439	**€ 690.447**	€ 690.000	€ 174.816	€ 190.930	€ 139.313	**€ 505.059**	€ 505.000
622	€ 150.384	€ 430.376	€ 154.231	**€ 734.991**	€ 735.000	€ 186.522	€ 137.830	€ 138.419	**€ 462.771**	€ 463.000
623	€ 161.567	€ 463.972	€ 149.168	**€ 774.706**	€ 775.000	€ 178.066	€ 175.724	€ 148.512	**€ 502.301**	€ 502.000
624	€ 154.693	€ 439.700	€ 150.441	**€ 744.835**	€ 745.000	€ 152.915	€ 164.577	€ 148.757	**€ 466.249**	€ 466.000
625	€ 147.166	€ 429.571	€ 132.793	**€ 709.531**	€ 710.000	€ 151.795	€ 150.023	€ 148.194	**€ 450.012**	€ 450.000
626	€ 153.882	€ 361.191	€ 138.866	**€ 653.939**	€ 654.000	€ 183.802	€ 180.238	€ 149.838	**€ 513.877**	€ 514.000
627	€ 151.675	€ 309.365	€ 140.808	**€ 601.847**	€ 602.000	€ 191.098	€ 176.813	€ 139.094	**€ 507.004**	€ 507.000
628	€ 175.434	€ 380.949	€ 149.259	**€ 705.642**	€ 706.000	€ 194.452	€ 120.758	€ 137.502	**€ 452.711**	€ 453.000
629	€ 178.945	€ 436.427	€ 137.503	**€ 752.875**	€ 753.000	€ 141.267	€ 179.119	€ 145.206	**€ 465.592**	€ 466.000
630	€ 141.509	€ 393.546	€ 154.608	**€ 689.662**	€ 690.000	€ 169.746	€ 159.233	€ 136.717	**€ 465.695**	€ 466.000
631	€ 171.211	€ 347.346	€ 138.894	**€ 657.451**	€ 657.000	€ 162.435	€ 116.580	€ 139.961	**€ 418.976**	€ 419.000
632	€ 136.356	€ 398.441	€ 144.054	**€ 678.851**	€ 679.000	€ 176.391	€ 153.797	€ 147.352	**€ 477.541**	€ 478.000
633	€ 139.086	€ 362.640	€ 122.258	**€ 623.984**	€ 624.000	€ 177.941	€ 180.163	€ 138.981	**€ 497.084**	€ 497.000
634	€ 190.324	€ 360.287	€ 139.746	**€ 690.357**	€ 690.000	€ 168.364	€ 182.044	€ 145.726	**€ 496.133**	€ 496.000
635	€ 143.391	€ 407.151	€ 138.238	**€ 688.781**	€ 689.000	€ 151.090	€ 165.279	€ 141.614	**€ 457.982**	€ 458.000
636	€ 182.414	€ 426.682	€ 154.688	**€ 763.784**	€ 764.000	€ 177.728	€ 180.026	€ 150.395	**€ 508.148**	€ 508.000
637	€ 151.738	€ 380.892	€ 138.558	**€ 671.189**	€ 671.000	€ 165.121	€ 165.131	€ 143.394	**€ 473.646**	€ 474.000
638	€ 134.359	€ 460.650	€ 135.643	**€ 730.652**	€ 731.000	€ 177.491	€ 165.385	€ 149.353	**€ 492.229**	€ 492.000
639	€ 146.165	€ 421.384	€ 144.175	**€ 711.724**	€ 712.000	€ 165.121	€ 197.547	€ 158.412	**€ 521.080**	€ 521.000
640	€ 173.732	€ 383.814	€ 147.755	**€ 705.301**	€ 705.000	€ 145.214	€ 157.350	€ 141.663	**€ 444.227**	€ 444.000
641	€ 160.788	€ 433.688	€ 148.484	**€ 742.960**	€ 743.000	€ 184.977	€ 171.043	€ 149.715	**€ 505.735**	€ 506.000
642	€ 163.124	€ 433.885	€ 153.210	**€ 750.218**	€ 750.000	€ 149.333	€ 177.847	€ 150.505	**€ 477.685**	€ 478.000
643	€ 165.791	€ 345.751	€ 144.522	**€ 656.064**	€ 656.000	€ 168.774	€ 157.755	€ 140.259	**€ 466.787**	€ 467.000
644	€ 156.928	€ 399.211	€ 139.879	**€ 696.018**	€ 696.000	€ 190.227	€ 175.816	€ 154.136	**€ 520.180**	€ 520.000
645	€ 155.326	€ 362.171	€ 137.722	**€ 655.219**	€ 655.000	€ 171.502	€ 157.972	€ 145.140	**€ 474.614**	€ 475.000
646	€ 142.303	€ 409.927	€ 148.437	**€ 700.667**	€ 701.000	€ 191.224	€ 158.897	€ 148.574	**€ 498.695**	€ 499.000
647	€ 156.093	€ 452.761	€ 133.602	**€ 742.456**	€ 742.000	€ 173.994	€ 172.024	€ 156.708	**€ 502.725**	€ 503.000
648	€ 143.930	€ 382.841	€ 153.432	**€ 680.203**	€ 680.000	€ 187.870	€ 174.175	€ 152.999	**€ 515.044**	€ 515.000
649	€ 162.817	€ 438.923	€ 151.251	**€ 752.991**	€ 753.000	€ 162.492	€ 161.644	€ 150.513	**€ 474.648**	€ 475.000
650	€ 146.959	€ 451.006	€ 141.326	**€ 739.291**	€ 739.000	€ 172.562	€ 164.149	€ 145.020	**€ 481.731**	€ 482.000
651	€ 142.522	€ 342.246	€ 149.182	**€ 633.950**	€ 634.000	€ 179.707	€ 137.607	€ 137.423	**€ 454.737**	€ 455.000
652	€ 153.002	€ 404.611	€ 140.895	**€ 698.507**	€ 699.000	€ 191.750	€ 158.014	€ 143.987	**€ 493.751**	€ 494.000
653	€ 147.908	€ 385.359	€ 141.185	**€ 674.452**	€ 674.000	€ 180.214	€ 137.041	€ 145.211	**€ 462.466**	€ 462.000
654	€ 178.744	€ 390.460	€ 127.856	**€ 697.060**	€ 697.000	€ 180.643	€ 168.193	€ 142.353	**€ 491.189**	€ 491.000
655	€ 155.961	€ 431.643	€ 137.371	**€ 724.975**	€ 725.000	€ 150.304	€ 158.827	€ 141.113	**€ 450.244**	€ 450.000
656	€ 190.298	€ 328.650	€ 141.332	**€ 660.280**	€ 660.000	€ 178.641	€ 165.973	€ 144.676	**€ 489.289**	€ 489.000
657	€ 143.785	€ 381.582	€ 139.677	**€ 665.044**	€ 665.000	€ 156.371	€ 152.817	€ 139.649	**€ 448.837**	€ 449.000
658	€ 136.934	€ 367.465	€ 147.034	**€ 651.434**	€ 651.000	€ 169.454	€ 183.325	€ 139.200	**€ 491.980**	€ 492.000
659	€ 142.122	€ 343.795	€ 128.634	**€ 614.551**	€ 615.000	€ 130.376	€ 142.532	€ 143.670	**€ 416.578**	€ 417.000
660	€ 152.053	€ 414.633	€ 138.976	**€ 705.662**	€ 706.000	€ 147.112	€ 183.432	€ 143.423	**€ 473.967**	€ 474.000
661	€ 145.997	€ 332.060	€ 136.762	**€ 614.820**	€ 615.000	€ 155.435	€ 152.095	€ 150.983	**€ 458.514**	€ 459.000
662	€ 160.557	€ 461.226	€ 140.960	**€ 762.742**	€ 763.000	€ 183.257	€ 143.641	€ 151.512	**€ 478.410**	€ 478.000
663	€ 158.942	€ 387.080	€ 142.517	**€ 688.539**	€ 689.000	€ 166.515	€ 138.958	€ 144.580	**€ 450.053**	€ 450.000
664	€ 154.890	€ 377.770	€ 158.151	**€ 690.810**	€ 691.000	€ 156.607	€ 145.094	€ 141.804	**€ 443.506**	€ 444.000
665	€ 151.538	€ 342.652	€ 130.589	**€ 624.779**	€ 625.000	€ 182.646	€ 177.005	€ 151.974	**€ 511.626**	€ 512.000
666	€ 151.236	€ 354.783	€ 150.717	**€ 656.735**	€ 657.000	€ 167.617	€ 151.389	€ 145.996	**€ 465.002**	€ 465.000
667	€ 139.209	€ 410.843	€ 157.645	**€ 707.698**	€ 708.000	€ 179.994	€ 178.697	€ 146.063	**€ 504.755**	€ 505.000
668	€ 159.770	€ 369.275	€ 150.040	**€ 679.085**	€ 679.000	€ 168.315	€ 149.759	€ 147.617	**€ 465.691**	€ 466.000
669	€ 136.503	€ 407.144	€ 128.392	**€ 672.038**	€ 672.000	€ 154.940	€ 149.752	€ 145.382	**€ 450.073**	€ 450.000
670	€ 157.878	€ 477.200	€ 147.908	**€ 782.985**	€ 783.000	€ 174.211	€ 146.708	€ 140.775	**€ 461.694**	€ 462.000
671	€ 197.060	€ 371.899	€ 147.059	**€ 716.018**	€ 716.000	€ 169.336	€ 174.271	€ 149.250	**€ 492.857**	€ 493.000
672	€ 150.306	€ 428.855	€ 148.709	**€ 727.871**	€ 728.000	€ 191.480	€ 167.414	€ 142.258	**€ 501.153**	€ 501.000
673	€ 140.189	€ 416.826	€ 143.154	**€ 700.169**	€ 700.000	€ 190.637	€ 139.397	€ 140.531	**€ 470.565**	€ 471.000
674	€ 161.674	€ 405.236	€ 130.593	**€ 697.504**	€ 698.000	€ 179.647	€ 153.811	€ 146.679	**€ 480.138**	€ 480.000
675	€ 148.753	€ 382.496	€ 140.367	**€ 671.617**	€ 672.000	€ 170.934	€ 159.498	€ 150.643	**€ 481.076**	€ 481.000
676	€ 174.755	€ 365.224	€ 137.690	**€ 677.669**	€ 678.000	€ 180.821	€ 174.795	€ 139.519	**€ 495.135**	€ 495.000
677	€ 150.508	€ 374.565	€ 130.020	**€ 655.093**	€ 655.000	€ 188.767	€ 156.627	€ 141.735	**€ 487.128**	€ 487.000
678	€ 145.374	€ 414.523	€ 144.579	**€ 704.476**	€ 704.000	€ 182.381	€ 152.378	€ 131.606	**€ 466.365**	€ 466.000
679	€ 141.159	€ 413.035	€ 150.825	**€ 705.020**	€ 705.000	€ 152.912	€ 148.728	€ 151.453	**€ 453.094**	€ 453.000
680	€ 129.609	€ 334.297	€ 139.801	**€ 603.707**	€ 604.000	€ 168.078	€ 170.150	€ 147.330	**€ 485.558**	€ 486.000
681	€ 148.419	€ 368.663	€ 135.260	**€ 652.341**	€ 652.000	€ 198.078	€ 155.011	€ 146.282	**€ 499.370**	€ 499.000
682	€ 145.558	€ 368.746	€ 137.434	**€ 651.738**	€ 652.000	€ 178.008	€ 185.842	€ 154.265	**€ 518.114**	€ 518.000
683	€ 150.220	€ 438.313	€ 150.613	**€ 739.146**	€ 739.000	€ 153.616	€ 150.299	€ 149.218	**€ 453.134**	€ 453.000
684	€ 129.896	€ 408.405	€ 149.869	**€ 688.170**	€ 688.000	€ 180.010	€ 163.058	€ 145.381	**€ 488.449**	€ 488.000
685	€ 115.608	€ 450.788	€ 139.884	**€ 706.280**	€ 706.000	€ 170.004	€ 120.764	€ 150.673	**€ 441.441**	€ 441.000
686	€ 143.910	€ 368.325	€ 138.806	**€ 651.041**	€ 651.000	€ 185.176	€ 163.799	€ 139.204	**€ 488.179**	€ 488.000
687	€ 148.862	€ 389.448	€ 147.099	**€ 685.409**	€ 685.000	€ 185.714	€ 145.253	€ 151.449	**€ 482.416**	€ 482.000
688	€ 147.510	€ 407.879	€ 131.960	**€ 687.349**	€ 687.000	€ 182.508	€ 137.669	€ 144.335	**€ 464.512**	€ 465.000
689	€ 149.616	€ 371.425	€ 127.199	**€ 648.240**	€ 648.000	€ 164.795	€ 162.103	€ 143.261	**€ 470.160**	€ 470.000
690	€ 145.230	€ 382.164	€ 146.997	**€ 674.392**	€ 674.000	€ 145.248	€ 140.900	€ 142.652	**€ 428.800**	€ 429.000
691	€ 154.787	€ 334.693	€ 137.215	**€ 626.694**	€ 627.000	€ 197.369	€ 141.807	€ 151.359	**€ 490.536**	€ 491.000
692	€ 172.506	€ 405.304	€ 133.863	**€ 711.673**	€ 712.000	€ 202.967	€ 181.907	€ 142.017	**€ 526.891**	€ 527.000
693	€ 173.050	€ 412.343	€ 137.753	**€ 723.146**	€ 723.000	€ 162.017	€ 195.340	€ 138.092	**€ 495.449**	€ 495.000
694	€ 157.255	€ 445.151	€ 135.906	**€ 738.312**	€ 738.000	€ 171.169	€ 151.163	€ 152.509	**€ 474.842**	€ 475.000
695	€ 158.416	€ 389.461	€ 149.908	**€ 697.785**	€ 698.000	€ 193.825	€ 154.903	€ 142.597	**€ 491.325**	€ 491.000
696	€ 165.755	€ 352.377	€ 144.950	**€ 663.082**	€ 663.000	€ 140.071	€ 152.469	€ 142.742	**€ 435.283**	€ 435.000
697	€ 155.599	€ 421.180	€ 137.316	**€ 714.094**	€ 714.000	€ 190.777	€ 173.324	€ 150.495	**€ 514.596**	€ 515.000
698	€ 131.935	€ 459.718	€ 147.496	**€ 739.150**	€ 739.000	€ 191.587	€ 208.211	€ 142.915	**€ 542.712**	€ 543.000

699	€ 153.156	€ 375.171	€ 139.257	**€ 667.583**	€ 668.000	€ 186.060	€ 159.328	€ 143.639	**€ 489.027**	€ 489.000
700	€ 136.089	€ 445.899	€ 137.266	**€ 719.254**	€ 719.000	€ 175.675	€ 164.932	€ 148.799	**€ 489.407**	€ 489.000
701	€ 163.876	€ 346.882	€ 142.777	**€ 653.535**	€ 654.000	€ 170.337	€ 130.996	€ 140.062	**€ 441.395**	€ 441.000
702	€ 162.112	€ 379.359	€ 123.446	**€ 664.917**	€ 665.000	€ 165.399	€ 180.173	€ 142.176	**€ 487.748**	€ 488.000
703	€ 151.766	€ 385.311	€ 140.025	**€ 677.102**	€ 677.000	€ 169.330	€ 147.462	€ 135.601	**€ 452.393**	€ 452.000
704	€ 126.317	€ 356.298	€ 136.814	**€ 619.429**	€ 619.000	€ 147.555	€ 127.755	€ 144.807	**€ 420.117**	€ 420.000
705	€ 163.375	€ 422.246	€ 146.749	**€ 732.371**	€ 732.000	€ 180.259	€ 151.215	€ 142.077	**€ 473.551**	€ 474.000
706	€ 162.386	€ 418.104	€ 129.076	**€ 709.567**	€ 710.000	€ 154.687	€ 163.058	€ 139.719	**€ 457.463**	€ 457.000
707	€ 174.737	€ 367.593	€ 136.445	**€ 678.776**	€ 679.000	€ 173.964	€ 152.229	€ 142.483	**€ 468.676**	€ 469.000
708	€ 151.521	€ 374.210	€ 121.318	**€ 647.049**	€ 647.000	€ 157.023	€ 154.103	€ 142.355	**€ 453.482**	€ 453.000
709	€ 180.750	€ 442.653	€ 142.062	**€ 765.465**	€ 765.000	€ 186.652	€ 181.634	€ 150.090	**€ 518.377**	€ 518.000
710	€ 151.064	€ 410.717	€ 146.786	**€ 708.567**	€ 709.000	€ 154.786	€ 163.514	€ 142.866	**€ 461.165**	€ 461.000
711	€ 141.930	€ 426.517	€ 148.876	**€ 717.323**	€ 717.000	€ 156.648	€ 162.116	€ 134.374	**€ 453.138**	€ 453.000
712	€ 120.156	€ 381.812	€ 131.218	**€ 633.186**	€ 633.000	€ 178.421	€ 145.415	€ 153.041	**€ 476.877**	€ 477.000
713	€ 162.107	€ 383.134	€ 141.865	**€ 687.106**	€ 687.000	€ 195.524	€ 164.991	€ 145.326	**€ 505.842**	€ 506.000
714	€ 167.838	€ 497.720	€ 135.456	**€ 801.015**	€ 801.000	€ 179.585	€ 150.774	€ 157.399	**€ 487.758**	€ 488.000
715	€ 142.764	€ 407.372	€ 154.585	**€ 704.721**	€ 705.000	€ 198.186	€ 165.202	€ 148.974	**€ 512.362**	€ 512.000
716	€ 143.665	€ 362.119	€ 138.853	**€ 644.636**	€ 645.000	€ 156.065	€ 159.401	€ 142.917	**€ 458.384**	€ 458.000
717	€ 151.174	€ 412.539	€ 136.091	**€ 699.803**	€ 700.000	€ 168.907	€ 151.497	€ 141.885	**€ 462.288**	€ 462.000
718	€ 180.889	€ 361.268	€ 145.698	**€ 687.856**	€ 688.000	€ 161.467	€ 137.621	€ 144.885	**€ 443.973**	€ 444.000
719	€ 141.777	€ 380.850	€ 147.691	**€ 670.317**	€ 670.000	€ 161.959	€ 169.121	€ 150.434	**€ 481.514**	€ 482.000
720	€ 138.587	€ 359.056	€ 151.086	**€ 648.730**	€ 649.000	€ 154.599	€ 121.422	€ 144.324	**€ 420.345**	€ 420.000
721	€ 154.199	€ 349.027	€ 123.835	**€ 627.060**	€ 627.000	€ 181.080	€ 137.226	€ 145.544	**€ 463.850**	€ 464.000
722	€ 152.682	€ 380.489	€ 143.417	**€ 676.589**	€ 677.000	€ 177.550	€ 155.104	€ 142.193	**€ 474.847**	€ 475.000
723	€ 168.117	€ 334.576	€ 139.762	**€ 642.454**	€ 642.000	€ 162.930	€ 171.807	€ 144.181	**€ 478.918**	€ 479.000
724	€ 159.917	€ 351.303	€ 136.370	**€ 647.590**	€ 648.000	€ 186.739	€ 152.724	€ 141.253	**€ 480.717**	€ 481.000
725	€ 141.599	€ 407.756	€ 140.451	**€ 689.806**	€ 690.000	€ 162.341	€ 172.617	€ 144.003	**€ 478.960**	€ 479.000
726	€ 158.987	€ 354.164	€ 149.254	**€ 662.404**	€ 662.000	€ 182.576	€ 176.249	€ 150.216	**€ 509.041**	€ 509.000
727	€ 158.037	€ 400.861	€ 146.778	**€ 705.676**	€ 706.000	€ 157.759	€ 177.781	€ 141.068	**€ 476.608**	€ 477.000
728	€ 120.944	€ 435.868	€ 136.155	**€ 692.967**	€ 693.000	€ 153.500	€ 183.182	€ 143.333	**€ 480.014**	€ 480.000
729	€ 145.170	€ 360.620	€ 142.325	**€ 648.114**	€ 648.000	€ 165.634	€ 181.143	€ 151.440	**€ 498.217**	€ 498.000
730	€ 148.793	€ 376.121	€ 143.722	**€ 668.636**	€ 669.000	€ 180.010	€ 169.236	€ 139.674	**€ 488.920**	€ 489.000
731	€ 177.060	€ 324.117	€ 142.308	**€ 643.485**	€ 643.000	€ 163.196	€ 124.127	€ 154.908	**€ 442.231**	€ 442.000
732	€ 147.779	€ 424.192	€ 135.018	**€ 706.988**	€ 707.000	€ 189.657	€ 139.930	€ 142.816	**€ 472.402**	€ 472.000
733	€ 150.851	€ 331.236	€ 128.223	**€ 610.310**	€ 610.000	€ 181.919	€ 152.560	€ 142.859	**€ 477.337**	€ 477.000
734	€ 143.375	€ 340.359	€ 132.878	**€ 616.612**	€ 617.000	€ 170.422	€ 158.118	€ 140.281	**€ 468.820**	€ 469.000
735	€ 146.070	€ 307.179	€ 144.226	**€ 597.475**	€ 597.000	€ 169.153	€ 129.084	€ 148.955	**€ 447.192**	€ 447.000
736	€ 156.326	€ 380.984	€ 149.105	**€ 686.415**	€ 686.000	€ 141.341	€ 144.032	€ 146.207	**€ 431.580**	€ 432.000
737	€ 150.379	€ 403.345	€ 140.826	**€ 694.550**	€ 695.000	€ 150.750	€ 181.089	€ 152.399	**€ 484.238**	€ 484.000
738	€ 168.082	€ 374.600	€ 147.824	**€ 690.506**	€ 691.000	€ 191.738	€ 161.741	€ 141.860	**€ 495.338**	€ 495.000
739	€ 169.225	€ 330.200	€ 144.761	**€ 644.186**	€ 644.000	€ 153.983	€ 161.525	€ 150.590	**€ 466.098**	€ 466.000
740	€ 160.907	€ 366.520	€ 126.081	**€ 653.507**	€ 654.000	€ 188.019	€ 164.819	€ 138.216	**€ 491.055**	€ 491.000
741	€ 159.856	€ 374.724	€ 148.914	**€ 683.495**	€ 683.000	€ 170.910	€ 134.118	€ 150.225	**€ 455.252**	€ 455.000
742	€ 165.738	€ 449.510	€ 147.482	**€ 762.731**	€ 763.000	€ 194.856	€ 157.949	€ 143.863	**€ 496.669**	€ 497.000
743	€ 141.119	€ 284.708	€ 144.437	**€ 570.264**	€ 570.000	€ 175.506	€ 193.161	€ 132.893	**€ 501.560**	€ 502.000
744	€ 135.515	€ 423.385	€ 148.738	**€ 707.639**	€ 708.000	€ 155.815	€ 160.367	€ 139.120	**€ 455.301**	€ 455.000
745	€ 148.844	€ 412.612	€ 142.312	**€ 703.768**	€ 704.000	€ 178.832	€ 153.884	€ 150.629	**€ 483.345**	€ 483.000
746	€ 141.666	€ 390.236	€ 137.586	**€ 669.488**	€ 669.000	€ 187.084	€ 180.971	€ 140.656	**€ 508.711**	€ 509.000
747	€ 152.233	€ 262.355	€ 147.897	**€ 562.486**	€ 562.000	€ 210.556	€ 158.833	€ 146.696	**€ 516.085**	€ 516.000
748	€ 148.343	€ 391.588	€ 137.051	**€ 676.983**	€ 677.000	€ 185.282	€ 177.054	€ 142.418	**€ 504.754**	€ 505.000
749	€ 152.369	€ 419.135	€ 136.294	**€ 707.798**	€ 708.000	€ 189.636	€ 164.778	€ 150.189	**€ 504.603**	€ 505.000
750	€ 156.027	€ 384.640	€ 150.245	**€ 690.911**	€ 691.000	€ 191.735	€ 143.724	€ 146.404	**€ 481.863**	€ 482.000
751	€ 158.199	€ 355.964	€ 149.531	**€ 663.694**	€ 664.000	€ 154.975	€ 173.116	€ 152.697	**€ 480.788**	€ 481.000
752	€ 174.579	€ 372.755	€ 150.506	**€ 697.840**	€ 698.000	€ 169.359	€ 179.857	€ 151.371	**€ 500.586**	€ 501.000
753	€ 160.487	€ 359.094	€ 143.268	**€ 662.848**	€ 663.000	€ 206.794	€ 138.101	€ 132.200	**€ 477.094**	€ 477.000
754	€ 171.246	€ 406.827	€ 127.642	**€ 705.714**	€ 706.000	€ 161.900	€ 147.552	€ 145.527	**€ 454.979**	€ 455.000
755	€ 161.695	€ 373.497	€ 144.929	**€ 680.121**	€ 680.000	€ 178.736	€ 157.435	€ 143.553	**€ 479.724**	€ 480.000
756	€ 157.181	€ 339.637	€ 146.649	**€ 643.467**	€ 643.000	€ 170.676	€ 168.909	€ 151.671	**€ 491.255**	€ 491.000
757	€ 166.873	€ 378.117	€ 133.913	**€ 678.903**	€ 679.000	€ 199.756	€ 140.750	€ 140.084	**€ 480.590**	€ 481.000
758	€ 151.015	€ 395.787	€ 140.105	**€ 686.907**	€ 687.000	€ 168.613	€ 173.651	€ 145.110	**€ 487.374**	€ 487.000
759	€ 140.677	€ 392.382	€ 148.414	**€ 681.474**	€ 681.000	€ 202.870	€ 121.110	€ 140.109	**€ 464.089**	€ 464.000
760	€ 158.522	€ 465.535	€ 137.896	**€ 761.953**	€ 762.000	€ 186.715	€ 155.663	€ 142.718	**€ 485.096**	€ 485.000
761	€ 166.211	€ 381.692	€ 130.015	**€ 677.919**	€ 678.000	€ 151.623	€ 175.539	€ 145.729	**€ 472.891**	€ 473.000
762	€ 170.055	€ 399.424	€ 145.854	**€ 715.333**	€ 715.000	€ 190.883	€ 166.157	€ 138.789	**€ 495.829**	€ 496.000
763	€ 176.426	€ 378.934	€ 132.586	**€ 687.946**	€ 688.000	€ 161.346	€ 148.892	€ 151.103	**€ 461.341**	€ 461.000
764	€ 161.834	€ 458.033	€ 128.799	**€ 748.666**	€ 749.000	€ 197.548	€ 184.894	€ 144.722	**€ 527.165**	€ 527.000
765	€ 147.947	€ 408.902	€ 133.496	**€ 690.344**	€ 690.000	€ 177.983	€ 134.341	€ 142.035	**€ 454.359**	€ 454.000
766	€ 171.262	€ 364.268	€ 134.877	**€ 670.408**	€ 670.000	€ 170.516	€ 169.662	€ 149.561	**€ 489.739**	€ 490.000
767	€ 155.127	€ 390.435	€ 137.934	**€ 683.496**	€ 683.000	€ 142.371	€ 140.845	€ 139.410	**€ 422.625**	€ 423.000
768	€ 143.613	€ 411.754	€ 150.701	**€ 706.069**	€ 706.000	€ 156.917	€ 181.110	€ 150.315	**€ 488.341**	€ 488.000
769	€ 149.742	€ 386.710	€ 133.850	**€ 670.302**	€ 670.000	€ 173.045	€ 162.904	€ 151.002	**€ 486.951**	€ 487.000
770	€ 139.079	€ 435.030	€ 142.721	**€ 716.830**	€ 717.000	€ 184.772	€ 130.630	€ 143.835	**€ 459.236**	€ 459.000
771	€ 158.029	€ 369.024	€ 152.891	**€ 679.944**	€ 680.000	€ 204.370	€ 133.303	€ 142.488	**€ 480.161**	€ 480.000
772	€ 139.070	€ 389.194	€ 146.317	**€ 674.581**	€ 675.000	€ 194.152	€ 159.869	€ 156.118	**€ 510.139**	€ 510.000
773	€ 148.437	€ 338.890	€ 138.265	**€ 625.592**	€ 626.000	€ 164.798	€ 141.879	€ 143.229	**€ 449.905**	€ 450.000
774	€ 155.740	€ 436.014	€ 144.958	**€ 736.712**	€ 737.000	€ 198.322	€ 160.259	€ 144.108	**€ 502.689**	€ 503.000
775	€ 126.061	€ 332.663	€ 125.009	**€ 583.732**	€ 584.000	€ 197.971	€ 155.985	€ 151.164	**€ 505.121**	€ 505.000
776	€ 140.581	€ 402.618	€ 147.242	**€ 690.441**	€ 690.000	€ 204.883	€ 163.231	€ 146.526	**€ 514.640**	€ 515.000

777	€ 152.400	€ 397.075	€ 140.023	**€ 689.498**	€ 689.000	€ 156.524	€ 134.493	€ 145.656	**€ 436.672**	€ 437.000
778	€ 175.818	€ 368.520	€ 144.969	**€ 689.307**	€ 689.000	€ 146.567	€ 147.737	€ 142.078	**€ 436.382**	€ 436.000
779	€ 145.980	€ 351.689	€ 131.943	**€ 629.612**	€ 630.000	€ 155.940	€ 144.250	€ 146.811	**€ 447.001**	€ 447.000
780	€ 146.012	€ 432.408	€ 138.758	**€ 717.178**	€ 717.000	€ 157.318	€ 160.292	€ 141.049	**€ 458.659**	€ 459.000
781	€ 175.168	€ 429.854	€ 143.908	**€ 748.930**	€ 749.000	€ 162.258	€ 161.395	€ 142.451	**€ 466.103**	€ 466.000
782	€ 123.987	€ 398.456	€ 145.875	**€ 668.317**	€ 668.000	€ 172.040	€ 151.910	€ 146.934	**€ 470.884**	€ 471.000
783	€ 153.797	€ 405.558	€ 133.315	**€ 692.671**	€ 693.000	€ 198.725	€ 148.416	€ 138.906	**€ 486.046**	€ 486.000
784	€ 175.210	€ 366.164	€ 139.826	**€ 681.199**	€ 681.000	€ 171.977	€ 166.937	€ 133.934	**€ 472.849**	€ 473.000
785	€ 123.072	€ 400.785	€ 148.523	**€ 672.380**	€ 672.000	€ 197.361	€ 137.992	€ 150.238	**€ 485.591**	€ 486.000
786	€ 154.453	€ 390.361	€ 146.091	**€ 690.905**	€ 691.000	€ 184.028	€ 149.698	€ 151.835	**€ 485.560**	€ 486.000
787	€ 139.409	€ 383.931	€ 135.771	**€ 659.111**	€ 659.000	€ 190.847	€ 168.890	€ 144.411	**€ 504.148**	€ 504.000
788	€ 191.019	€ 378.996	€ 151.694	**€ 721.709**	€ 722.000	€ 183.731	€ 161.914	€ 145.349	**€ 490.993**	€ 491.000
789	€ 107.188	€ 387.673	€ 140.011	**€ 634.873**	€ 635.000	€ 181.748	€ 145.484	€ 140.346	**€ 467.578**	€ 468.000
790	€ 169.661	€ 451.577	€ 139.813	**€ 761.052**	€ 761.000	€ 156.503	€ 155.006	€ 138.330	**€ 449.839**	€ 450.000
791	€ 162.094	€ 405.056	€ 141.911	**€ 709.061**	€ 709.000	€ 173.262	€ 138.151	€ 144.352	**€ 455.765**	€ 456.000
792	€ 174.155	€ 430.074	€ 143.939	**€ 748.168**	€ 748.000	€ 193.442	€ 148.440	€ 149.576	**€ 491.459**	€ 491.000
793	€ 149.977	€ 355.677	€ 148.793	**€ 654.448**	€ 654.000	€ 170.129	€ 128.724	€ 144.374	**€ 443.227**	€ 443.000
794	€ 169.164	€ 314.796	€ 135.882	**€ 619.842**	€ 620.000	€ 122.814	€ 159.063	€ 154.448	**€ 436.325**	€ 436.000
795	€ 124.100	€ 331.642	€ 146.633	**€ 602.376**	€ 602.000	€ 188.984	€ 154.527	€ 144.667	**€ 488.177**	€ 488.000
796	€ 138.974	€ 367.271	€ 139.137	**€ 645.382**	€ 645.000	€ 174.647	€ 163.738	€ 146.259	**€ 484.643**	€ 485.000
797	€ 118.882	€ 338.763	€ 149.176	**€ 606.821**	€ 607.000	€ 156.398	€ 170.217	€ 151.881	**€ 478.496**	€ 478.000
798	€ 158.846	€ 389.681	€ 135.014	**€ 683.541**	€ 684.000	€ 165.323	€ 135.547	€ 139.581	**€ 440.451**	€ 440.000
799	€ 142.626	€ 400.190	€ 135.338	**€ 678.154**	€ 678.000	€ 149.223	€ 162.366	€ 147.922	**€ 459.511**	€ 460.000
800	€ 159.255	€ 331.999	€ 148.247	**€ 639.501**	€ 640.000	€ 152.954	€ 155.195	€ 148.601	**€ 456.749**	€ 457.000
801	€ 178.579	€ 409.381	€ 151.540	**€ 739.500**	€ 740.000	€ 181.808	€ 149.523	€ 146.439	**€ 477.770**	€ 478.000
802	€ 141.757	€ 381.099	€ 143.421	**€ 666.277**	€ 666.000	€ 173.105	€ 153.571	€ 140.615	**€ 467.290**	€ 467.000
803	€ 164.672	€ 344.648	€ 151.236	**€ 660.556**	€ 661.000	€ 167.854	€ 167.390	€ 143.152	**€ 478.396**	€ 478.000
804	€ 125.916	€ 299.400	€ 137.299	**€ 562.615**	€ 563.000	€ 194.520	€ 152.402	€ 144.577	**€ 491.499**	€ 491.000
805	€ 138.802	€ 429.377	€ 143.284	**€ 711.463**	€ 711.000	€ 145.670	€ 181.546	€ 146.850	**€ 474.065**	€ 474.000
806	€ 174.787	€ 402.624	€ 148.044	**€ 725.454**	€ 725.000	€ 184.049	€ 164.136	€ 146.139	**€ 494.324**	€ 494.000
807	€ 133.470	€ 368.439	€ 143.382	**€ 645.290**	€ 645.000	€ 164.467	€ 165.420	€ 144.245	**€ 474.132**	€ 474.000
808	€ 174.114	€ 413.761	€ 142.174	**€ 730.048**	€ 730.000	€ 195.605	€ 192.474	€ 147.025	**€ 535.104**	€ 535.000
809	€ 143.728	€ 463.845	€ 130.399	**€ 737.972**	€ 738.000	€ 173.116	€ 187.678	€ 147.526	**€ 508.319**	€ 508.000
810	€ 164.662	€ 373.120	€ 144.228	**€ 682.010**	€ 682.000	€ 162.364	€ 169.721	€ 144.044	**€ 476.129**	€ 476.000
811	€ 165.668	€ 406.868	€ 151.139	**€ 723.675**	€ 724.000	€ 175.825	€ 171.060	€ 144.048	**€ 490.933**	€ 491.000
812	€ 139.686	€ 290.637	€ 142.262	**€ 572.585**	€ 573.000	€ 193.615	€ 165.926	€ 143.687	**€ 503.227**	€ 503.000
813	€ 145.710	€ 308.464	€ 142.254	**€ 596.428**	€ 596.000	€ 150.344	€ 184.010	€ 142.330	**€ 476.684**	€ 477.000
814	€ 167.588	€ 420.443	€ 138.850	**€ 726.881**	€ 727.000	€ 141.610	€ 149.778	€ 141.672	**€ 433.059**	€ 433.000
815	€ 164.722	€ 291.520	€ 137.597	**€ 593.839**	€ 594.000	€ 166.705	€ 148.806	€ 143.960	**€ 459.470**	€ 459.000
816	€ 147.580	€ 489.072	€ 147.919	**€ 784.571**	€ 785.000	€ 163.440	€ 164.907	€ 139.449	**€ 467.796**	€ 468.000
817	€ 162.659	€ 407.972	€ 139.955	**€ 710.586**	€ 711.000	€ 152.390	€ 145.493	€ 144.378	**€ 442.261**	€ 442.000
818	€ 112.324	€ 447.512	€ 150.959	**€ 710.795**	€ 711.000	€ 198.632	€ 163.391	€ 140.021	**€ 502.044**	€ 502.000
819	€ 169.562	€ 366.442	€ 146.035	**€ 682.039**	€ 682.000	€ 162.078	€ 166.888	€ 144.600	**€ 473.566**	€ 474.000
820	€ 137.817	€ 343.487	€ 137.360	**€ 618.664**	€ 619.000	€ 162.799	€ 162.686	€ 147.850	**€ 473.335**	€ 473.000
821	€ 142.400	€ 327.860	€ 144.193	**€ 614.454**	€ 614.000	€ 169.562	€ 173.805	€ 147.950	**€ 491.317**	€ 491.000
822	€ 137.450	€ 319.772	€ 147.308	**€ 604.530**	€ 605.000	€ 175.309	€ 174.723	€ 145.051	**€ 495.083**	€ 495.000
823	€ 146.808	€ 377.406	€ 138.916	**€ 663.131**	€ 663.000	€ 172.498	€ 131.121	€ 139.511	**€ 443.130**	€ 443.000
824	€ 150.713	€ 434.184	€ 137.846	**€ 722.743**	€ 723.000	€ 159.221	€ 154.229	€ 141.436	**€ 454.886**	€ 455.000
825	€ 135.282	€ 363.286	€ 122.785	**€ 621.352**	€ 621.000	€ 146.923	€ 177.363	€ 155.869	**€ 480.155**	€ 480.000
826	€ 162.118	€ 266.266	€ 148.629	**€ 577.013**	€ 577.000	€ 150.018	€ 155.999	€ 148.451	**€ 454.467**	€ 454.000
827	€ 127.036	€ 337.802	€ 150.579	**€ 615.417**	€ 615.000	€ 137.236	€ 172.205	€ 133.168	**€ 442.608**	€ 443.000
828	€ 157.284	€ 374.417	€ 148.049	**€ 679.750**	€ 680.000	€ 191.272	€ 148.719	€ 148.212	**€ 488.203**	€ 488.000
829	€ 136.190	€ 389.614	€ 124.917	**€ 650.721**	€ 651.000	€ 229.500	€ 141.593	€ 139.182	**€ 510.275**	€ 510.000
830	€ 141.963	€ 397.567	€ 144.316	**€ 683.846**	€ 684.000	€ 167.670	€ 148.132	€ 139.873	**€ 455.675**	€ 456.000
831	€ 148.544	€ 333.677	€ 139.717	**€ 621.937**	€ 622.000	€ 174.184	€ 179.550	€ 150.496	**€ 504.229**	€ 504.000
832	€ 156.536	€ 416.949	€ 125.669	**€ 699.153**	€ 699.000	€ 139.103	€ 150.307	€ 142.313	**€ 431.722**	€ 432.000
833	€ 144.749	€ 382.012	€ 145.668	**€ 672.428**	€ 672.000	€ 173.486	€ 156.196	€ 139.292	**€ 468.975**	€ 469.000
834	€ 125.850	€ 395.271	€ 137.737	**€ 658.858**	€ 659.000	€ 165.943	€ 148.923	€ 155.736	**€ 470.602**	€ 471.000
835	€ 136.168	€ 405.491	€ 141.741	**€ 683.400**	€ 683.000	€ 164.685	€ 153.801	€ 140.647	**€ 459.133**	€ 459.000
836	€ 152.061	€ 339.741	€ 140.162	**€ 631.964**	€ 632.000	€ 196.733	€ 151.622	€ 146.554	**€ 494.909**	€ 495.000
837	€ 155.972	€ 353.655	€ 150.174	**€ 659.801**	€ 660.000	€ 206.397	€ 194.866	€ 151.828	**€ 553.091**	€ 553.000
838	€ 159.214	€ 396.045	€ 148.917	**€ 704.176**	€ 704.000	€ 162.575	€ 141.356	€ 157.796	**€ 461.727**	€ 462.000
839	€ 133.544	€ 394.631	€ 148.531	**€ 676.706**	€ 677.000	€ 155.698	€ 163.027	€ 145.165	**€ 463.889**	€ 464.000
840	€ 152.540	€ 356.490	€ 145.351	**€ 654.381**	€ 654.000	€ 195.511	€ 182.512	€ 141.967	**€ 519.989**	€ 520.000
841	€ 134.573	€ 390.688	€ 135.136	**€ 660.397**	€ 660.000	€ 186.494	€ 163.533	€ 140.898	**€ 490.925**	€ 491.000
842	€ 163.371	€ 427.490	€ 150.814	**€ 741.675**	€ 742.000	€ 176.849	€ 155.403	€ 140.190	**€ 472.442**	€ 472.000
843	€ 170.809	€ 427.753	€ 137.732	**€ 736.294**	€ 736.000	€ 162.602	€ 161.672	€ 152.166	**€ 476.440**	€ 476.000
844	€ 154.684	€ 338.278	€ 125.841	**€ 618.804**	€ 619.000	€ 181.706	€ 129.127	€ 144.648	**€ 455.481**	€ 455.000
845	€ 149.472	€ 423.051	€ 149.631	**€ 722.153**	€ 722.000	€ 173.430	€ 158.715	€ 152.466	**€ 484.611**	€ 485.000
846	€ 163.180	€ 384.595	€ 146.699	**€ 694.474**	€ 694.000	€ 176.258	€ 143.920	€ 156.174	**€ 476.352**	€ 476.000
847	€ 155.639	€ 413.969	€ 139.309	**€ 708.918**	€ 709.000	€ 166.264	€ 140.672	€ 156.249	**€ 463.184**	€ 463.000
848	€ 154.800	€ 421.498	€ 143.914	**€ 720.212**	€ 720.000	€ 170.375	€ 147.875	€ 144.619	**€ 462.869**	€ 463.000
849	€ 138.757	€ 310.637	€ 141.417	**€ 590.811**	€ 591.000	€ 170.066	€ 143.301	€ 143.345	**€ 456.712**	€ 457.000
850	€ 143.788	€ 326.662	€ 127.699	**€ 598.149**	€ 598.000	€ 157.309	€ 203.594	€ 134.971	**€ 495.873**	€ 496.000
851	€ 166.147	€ 416.723	€ 139.956	**€ 722.826**	€ 723.000	€ 199.285	€ 148.516	€ 142.955	**€ 490.756**	€ 491.000
852	€ 176.074	€ 421.287	€ 143.024	**€ 740.385**	€ 740.000	€ 152.271	€ 159.728	€ 145.943	**€ 457.942**	€ 458.000
853	€ 135.215	€ 461.729	€ 140.149	**€ 737.093**	€ 737.000	€ 170.798	€ 155.128	€ 147.100	**€ 473.026**	€ 473.000
854	€ 159.273	€ 408.624	€ 142.058	**€ 709.955**	€ 710.000	€ 176.595	€ 161.737	€ 150.309	**€ 488.640**	€ 489.000

855	€ 141.133	€ 397.261	€ 140.551	**€ 678.945**	€ 679.000	€ 160.810	€ 176.861	€ 142.171	**€ 479.842**	€ 480.000
856	€ 171.769	€ 368.084	€ 152.591	**€ 692.443**	€ 692.000	€ 152.648	€ 136.612	€ 149.408	**€ 438.668**	€ 439.000
857	€ 141.937	€ 338.004	€ 150.415	**€ 630.357**	€ 630.000	€ 189.485	€ 188.683	€ 143.919	**€ 522.087**	€ 522.000
858	€ 142.237	€ 388.115	€ 149.181	**€ 679.533**	€ 680.000	€ 180.781	€ 183.426	€ 142.836	**€ 507.043**	€ 507.000
859	€ 160.528	€ 328.652	€ 137.344	**€ 626.525**	€ 627.000	€ 169.337	€ 176.907	€ 145.417	**€ 491.661**	€ 492.000
860	€ 149.000	€ 401.099	€ 147.959	**€ 698.058**	€ 698.000	€ 176.325	€ 154.506	€ 141.033	**€ 471.863**	€ 472.000
861	€ 143.261	€ 355.079	€ 144.646	**€ 642.986**	€ 643.000	€ 184.765	€ 164.303	€ 145.944	**€ 495.012**	€ 495.000
862	€ 163.443	€ 430.183	€ 148.936	**€ 742.562**	€ 743.000	€ 141.022	€ 140.642	€ 152.446	**€ 434.111**	€ 434.000
863	€ 144.496	€ 330.733	€ 141.764	**€ 616.992**	€ 617.000	€ 176.667	€ 153.175	€ 157.630	**€ 487.472**	€ 487.000
864	€ 145.204	€ 440.353	€ 146.085	**€ 731.642**	€ 732.000	€ 144.604	€ 180.687	€ 148.369	**€ 473.661**	€ 474.000
865	€ 135.624	€ 356.058	€ 151.205	**€ 642.887**	€ 643.000	€ 173.335	€ 136.732	€ 141.783	**€ 451.850**	€ 452.000
866	€ 155.707	€ 427.343	€ 149.272	**€ 732.321**	€ 732.000	€ 175.560	€ 154.585	€ 143.078	**€ 473.223**	€ 473.000
867	€ 148.208	€ 388.260	€ 147.059	**€ 683.527**	€ 684.000	€ 186.486	€ 150.856	€ 145.519	**€ 482.860**	€ 483.000
868	€ 152.337	€ 409.836	€ 143.745	**€ 705.918**	€ 706.000	€ 159.578	€ 169.623	€ 148.828	**€ 478.029**	€ 478.000
869	€ 126.191	€ 320.962	€ 136.358	**€ 583.512**	€ 584.000	€ 164.606	€ 169.461	€ 140.852	**€ 474.919**	€ 475.000
870	€ 149.505	€ 407.883	€ 141.968	**€ 699.356**	€ 699.000	€ 188.807	€ 142.312	€ 142.953	**€ 474.072**	€ 474.000
871	€ 161.155	€ 312.940	€ 142.082	**€ 616.177**	€ 616.000	€ 163.698	€ 146.917	€ 144.377	**€ 454.993**	€ 455.000
872	€ 162.225	€ 341.249	€ 135.353	**€ 638.827**	€ 639.000	€ 177.499	€ 130.208	€ 151.446	**€ 459.153**	€ 459.000
873	€ 176.459	€ 401.643	€ 127.781	**€ 705.883**	€ 706.000	€ 170.221	€ 158.546	€ 144.366	**€ 473.133**	€ 473.000
874	€ 145.345	€ 381.524	€ 150.565	**€ 677.434**	€ 677.000	€ 159.144	€ 156.191	€ 142.702	**€ 458.037**	€ 458.000
875	€ 160.138	€ 422.534	€ 151.153	**€ 733.825**	€ 734.000	€ 180.391	€ 129.164	€ 144.643	**€ 454.199**	€ 454.000
876	€ 149.823	€ 427.850	€ 145.233	**€ 722.905**	€ 723.000	€ 179.073	€ 138.940	€ 142.656	**€ 460.669**	€ 461.000
877	€ 141.780	€ 428.864	€ 141.013	**€ 711.657**	€ 712.000	€ 190.705	€ 155.155	€ 139.758	**€ 485.617**	€ 486.000
878	€ 167.379	€ 458.179	€ 129.287	**€ 754.845**	€ 755.000	€ 176.589	€ 167.506	€ 148.304	**€ 492.399**	€ 492.000
879	€ 120.837	€ 393.576	€ 151.012	**€ 665.425**	€ 665.000	€ 177.508	€ 161.958	€ 148.567	**€ 488.034**	€ 488.000
880	€ 127.468	€ 413.875	€ 137.878	**€ 679.221**	€ 679.000	€ 177.391	€ 146.918	€ 141.120	**€ 465.430**	€ 465.000
881	€ 180.162	€ 380.835	€ 139.450	**€ 700.447**	€ 700.000	€ 177.083	€ 194.697	€ 139.707	**€ 511.487**	€ 511.000
882	€ 146.623	€ 414.512	€ 135.162	**€ 696.296**	€ 696.000	€ 167.963	€ 153.761	€ 145.846	**€ 467.570**	€ 468.000
883	€ 154.895	€ 379.483	€ 141.213	**€ 675.591**	€ 676.000	€ 196.719	€ 153.785	€ 154.313	**€ 504.817**	€ 505.000
884	€ 119.956	€ 424.888	€ 149.466	**€ 694.310**	€ 694.000	€ 166.433	€ 175.402	€ 143.081	**€ 484.916**	€ 485.000
885	€ 164.269	€ 317.423	€ 148.604	**€ 630.296**	€ 630.000	€ 153.466	€ 182.477	€ 149.666	**€ 485.608**	€ 486.000
886	€ 165.446	€ 410.174	€ 137.860	**€ 713.479**	€ 713.000	€ 178.590	€ 157.793	€ 149.967	**€ 486.349**	€ 486.000
887	€ 138.438	€ 314.117	€ 145.263	**€ 597.819**	€ 598.000	€ 172.901	€ 152.012	€ 144.224	**€ 469.137**	€ 469.000
888	€ 144.901	€ 344.323	€ 140.058	**€ 629.281**	€ 629.000	€ 203.447	€ 174.327	€ 150.366	**€ 528.140**	€ 528.000
889	€ 167.205	€ 404.728	€ 146.411	**€ 718.344**	€ 718.000	€ 172.699	€ 138.600	€ 141.642	**€ 452.940**	€ 453.000
890	€ 183.367	€ 307.051	€ 151.133	**€ 641.552**	€ 642.000	€ 188.841	€ 174.449	€ 142.532	**€ 505.823**	€ 506.000
891	€ 145.450	€ 425.586	€ 144.285	**€ 715.322**	€ 715.000	€ 137.865	€ 150.799	€ 137.659	**€ 426.322**	€ 426.000
892	€ 151.998	€ 397.239	€ 138.125	**€ 687.362**	€ 687.000	€ 174.640	€ 134.820	€ 145.360	**€ 454.820**	€ 455.000
893	€ 157.152	€ 379.728	€ 142.369	**€ 679.248**	€ 679.000	€ 170.122	€ 174.591	€ 152.776	**€ 497.488**	€ 497.000
894	€ 146.631	€ 366.468	€ 143.663	**€ 656.762**	€ 657.000	€ 178.139	€ 149.785	€ 149.601	**€ 477.525**	€ 478.000
895	€ 155.867	€ 448.221	€ 137.343	**€ 741.430**	€ 741.000	€ 154.762	€ 147.999	€ 151.104	**€ 453.865**	€ 454.000
896	€ 154.831	€ 481.904	€ 145.442	**€ 782.177**	€ 782.000	€ 152.247	€ 147.316	€ 134.689	**€ 434.252**	€ 434.000
897	€ 139.562	€ 309.902	€ 141.112	**€ 590.576**	€ 591.000	€ 218.384	€ 155.952	€ 154.381	**€ 528.717**	€ 529.000
898	€ 145.795	€ 430.749	€ 149.325	**€ 725.870**	€ 726.000	€ 181.930	€ 166.008	€ 148.144	**€ 496.081**	€ 496.000
899	€ 176.662	€ 336.086	€ 138.553	**€ 651.301**	€ 651.000	€ 164.650	€ 157.281	€ 143.630	**€ 465.560**	€ 466.000
900	€ 143.358	€ 403.810	€ 141.216	**€ 688.385**	€ 688.000	€ 208.233	€ 156.359	€ 150.168	**€ 514.760**	€ 515.000
901	€ 175.683	€ 410.170	€ 144.486	**€ 730.338**	€ 730.000	€ 196.853	€ 162.607	€ 139.985	**€ 499.445**	€ 499.000
902	€ 151.575	€ 415.949	€ 148.646	**€ 716.170**	€ 716.000	€ 183.834	€ 173.463	€ 144.900	**€ 502.198**	€ 502.000
903	€ 154.591	€ 344.330	€ 146.680	**€ 645.600**	€ 646.000	€ 164.340	€ 130.948	€ 140.809	**€ 436.097**	€ 436.000
904	€ 145.372	€ 440.669	€ 151.417	**€ 737.458**	€ 737.000	€ 190.949	€ 136.967	€ 144.343	**€ 472.259**	€ 472.000
905	€ 121.643	€ 445.779	€ 131.916	**€ 699.338**	€ 699.000	€ 174.110	€ 195.260	€ 142.804	**€ 512.174**	€ 512.000
906	€ 154.242	€ 356.887	€ 131.311	**€ 642.440**	€ 642.000	€ 174.121	€ 147.487	€ 131.144	**€ 452.753**	€ 453.000
907	€ 165.916	€ 356.054	€ 144.573	**€ 666.543**	€ 667.000	€ 133.076	€ 166.278	€ 136.436	**€ 435.790**	€ 436.000
908	€ 153.822	€ 419.919	€ 131.460	**€ 705.201**	€ 705.000	€ 201.733	€ 167.339	€ 146.384	**€ 515.457**	€ 515.000
909	€ 178.925	€ 378.274	€ 135.363	**€ 692.562**	€ 693.000	€ 145.853	€ 152.117	€ 154.114	**€ 452.084**	€ 452.000
910	€ 139.386	€ 372.796	€ 142.755	**€ 654.937**	€ 655.000	€ 181.194	€ 176.956	€ 152.496	**€ 510.646**	€ 511.000
911	€ 178.740	€ 357.408	€ 149.568	**€ 685.715**	€ 686.000	€ 186.081	€ 198.537	€ 155.943	**€ 540.561**	€ 541.000
912	€ 160.439	€ 366.106	€ 146.413	**€ 672.958**	€ 673.000	€ 170.425	€ 118.295	€ 147.281	**€ 436.001**	€ 436.000
913	€ 139.059	€ 466.580	€ 147.196	**€ 752.835**	€ 753.000	€ 180.824	€ 145.894	€ 148.520	**€ 475.238**	€ 475.000
914	€ 133.143	€ 416.642	€ 124.771	**€ 674.556**	€ 675.000	€ 187.078	€ 132.199	€ 141.954	**€ 461.232**	€ 461.000
915	€ 146.753	€ 367.245	€ 147.568	**€ 661.565**	€ 662.000	€ 215.662	€ 133.858	€ 147.426	**€ 496.946**	€ 497.000
916	€ 135.176	€ 437.555	€ 146.507	**€ 719.239**	€ 719.000	€ 180.441	€ 138.478	€ 145.174	**€ 464.093**	€ 464.000
917	€ 158.770	€ 363.576	€ 137.466	**€ 659.812**	€ 660.000	€ 162.865	€ 158.781	€ 146.472	**€ 468.117**	€ 468.000
918	€ 175.645	€ 396.246	€ 133.418	**€ 705.309**	€ 705.000	€ 183.897	€ 150.252	€ 145.742	**€ 479.891**	€ 480.000
919	€ 161.697	€ 389.741	€ 149.229	**€ 700.667**	€ 701.000	€ 166.908	€ 128.345	€ 157.423	**€ 452.675**	€ 453.000
920	€ 141.898	€ 374.100	€ 140.508	**€ 656.505**	€ 657.000	€ 159.029	€ 162.067	€ 148.452	**€ 469.547**	€ 470.000
921	€ 134.521	€ 406.199	€ 138.694	**€ 679.414**	€ 679.000	€ 179.007	€ 145.033	€ 145.822	**€ 469.861**	€ 470.000
922	€ 163.694	€ 343.818	€ 124.779	**€ 632.291**	€ 632.000	€ 168.377	€ 147.025	€ 140.868	**€ 456.270**	€ 456.000
923	€ 170.644	€ 343.489	€ 143.675	**€ 657.807**	€ 658.000	€ 153.057	€ 175.075	€ 142.926	**€ 471.058**	€ 471.000
924	€ 161.753	€ 328.473	€ 135.221	**€ 625.447**	€ 625.000	€ 179.102	€ 163.779	€ 148.369	**€ 491.250**	€ 491.000
925	€ 134.713	€ 309.855	€ 143.830	**€ 588.398**	€ 588.000	€ 163.009	€ 153.559	€ 149.484	**€ 466.052**	€ 466.000
926	€ 143.521	€ 382.404	€ 151.647	**€ 677.572**	€ 678.000	€ 170.365	€ 154.894	€ 142.023	**€ 467.282**	€ 467.000
927	€ 144.758	€ 268.150	€ 150.376	**€ 563.284**	€ 563.000	€ 168.646	€ 153.706	€ 150.468	**€ 472.820**	€ 473.000
928	€ 167.442	€ 337.533	€ 142.275	**€ 647.250**	€ 647.000	€ 180.330	€ 186.217	€ 146.542	**€ 513.090**	€ 513.000
929	€ 152.353	€ 333.455	€ 134.695	**€ 620.503**	€ 621.000	€ 193.384	€ 156.799	€ 147.681	**€ 497.863**	€ 498.000
930	€ 144.746	€ 393.067	€ 126.700	**€ 664.514**	€ 665.000	€ 179.529	€ 163.375	€ 140.467	**€ 483.370**	€ 483.000
931	€ 150.167	€ 468.353	€ 125.540	**€ 744.060**	€ 744.000	€ 149.067	€ 155.148	€ 149.296	**€ 453.510**	€ 454.000
932	€ 182.282	€ 372.473	€ 140.737	**€ 695.493**	€ 695.000	€ 181.458	€ 175.233	€ 145.346	**€ 502.037**	€ 502.000

933	€ 155.012	€ 380.696	€ 144.875	**€ 680.583**	€ 681.000	€ 159.024	€ 183.733	€ 148.521	**€ 491.277**	€ 491.000
934	€ 156.413	€ 383.862	€ 143.099	**€ 683.373**	€ 683.000	€ 145.481	€ 153.076	€ 141.340	**€ 439.897**	€ 440.000
935	€ 140.798	€ 424.417	€ 149.161	**€ 714.376**	€ 714.000	€ 185.196	€ 174.955	€ 142.528	**€ 502.679**	€ 503.000
936	€ 119.643	€ 394.605	€ 138.810	**€ 653.058**	€ 653.000	€ 181.082	€ 182.292	€ 146.528	**€ 509.902**	€ 510.000
937	€ 168.874	€ 304.325	€ 154.491	**€ 627.690**	€ 628.000	€ 174.991	€ 160.746	€ 147.204	**€ 482.941**	€ 483.000
938	€ 151.917	€ 422.999	€ 143.002	**€ 717.919**	€ 718.000	€ 173.015	€ 154.318	€ 148.445	**€ 475.778**	€ 476.000
939	€ 163.518	€ 418.965	€ 133.757	**€ 716.239**	€ 716.000	€ 181.865	€ 167.388	€ 145.122	**€ 494.375**	€ 494.000
940	€ 165.508	€ 348.803	€ 142.501	**€ 656.812**	€ 657.000	€ 150.409	€ 176.680	€ 151.727	**€ 478.816**	€ 479.000
941	€ 135.395	€ 462.010	€ 148.010	**€ 745.416**	€ 745.000	€ 188.232	€ 149.431	€ 143.683	**€ 481.346**	€ 481.000
942	€ 154.467	€ 395.825	€ 146.995	**€ 697.287**	€ 697.000	€ 161.365	€ 175.286	€ 138.422	**€ 475.072**	€ 475.000
943	€ 156.599	€ 365.185	€ 126.839	**€ 648.623**	€ 649.000	€ 148.730	€ 170.191	€ 151.287	**€ 470.208**	€ 470.000
944	€ 158.460	€ 416.378	€ 139.201	**€ 714.040**	€ 714.000	€ 194.068	€ 148.867	€ 139.971	**€ 482.906**	€ 483.000
945	€ 164.615	€ 312.865	€ 149.063	**€ 626.543**	€ 627.000	€ 174.751	€ 145.122	€ 150.095	**€ 469.968**	€ 470.000
946	€ 146.268	€ 458.723	€ 138.997	**€ 743.988**	€ 744.000	€ 186.279	€ 144.786	€ 139.226	**€ 470.291**	€ 470.000
947	€ 144.574	€ 366.780	€ 142.644	**€ 653.998**	€ 654.000	€ 163.953	€ 163.445	€ 141.796	**€ 469.195**	€ 469.000
948	€ 150.198	€ 402.202	€ 132.406	**€ 684.806**	€ 685.000	€ 162.020	€ 170.822	€ 141.309	**€ 474.151**	€ 474.000
949	€ 178.113	€ 433.536	€ 138.209	**€ 749.859**	€ 750.000	€ 173.953	€ 129.693	€ 132.611	**€ 436.257**	€ 436.000
950	€ 145.007	€ 411.457	€ 148.338	**€ 704.802**	€ 705.000	€ 161.083	€ 157.072	€ 150.936	**€ 469.090**	€ 469.000
951	€ 136.456	€ 390.718	€ 136.395	**€ 663.569**	€ 664.000	€ 194.788	€ 157.620	€ 138.756	**€ 491.165**	€ 491.000
952	€ 147.821	€ 409.980	€ 144.640	**€ 702.441**	€ 702.000	€ 149.505	€ 175.241	€ 148.419	**€ 473.165**	€ 473.000
953	€ 146.576	€ 423.689	€ 146.511	**€ 716.776**	€ 717.000	€ 189.686	€ 149.059	€ 140.313	**€ 479.058**	€ 479.000
954	€ 159.365	€ 478.273	€ 148.663	**€ 786.301**	€ 786.000	€ 150.389	€ 165.405	€ 148.281	**€ 464.075**	€ 464.000
955	€ 169.924	€ 429.482	€ 142.114	**€ 741.521**	€ 742.000	€ 154.254	€ 182.838	€ 141.018	**€ 478.109**	€ 478.000
956	€ 144.003	€ 392.252	€ 137.805	**€ 674.060**	€ 674.000	€ 168.463	€ 187.140	€ 139.364	**€ 494.967**	€ 495.000
957	€ 161.576	€ 438.035	€ 147.084	**€ 746.694**	€ 747.000	€ 173.531	€ 167.455	€ 140.199	**€ 481.186**	€ 481.000
958	€ 161.153	€ 427.385	€ 143.870	**€ 732.408**	€ 732.000	€ 162.160	€ 162.619	€ 143.577	**€ 468.356**	€ 468.000
959	€ 153.475	€ 448.637	€ 138.582	**€ 740.694**	€ 741.000	€ 183.839	€ 164.972	€ 131.659	**€ 480.471**	€ 480.000
960	€ 157.844	€ 388.735	€ 135.689	**€ 682.268**	€ 682.000	€ 180.816	€ 144.465	€ 151.691	**€ 476.971**	€ 477.000
961	€ 151.446	€ 464.878	€ 138.083	**€ 754.406**	€ 754.000	€ 146.146	€ 173.803	€ 146.039	**€ 465.988**	€ 466.000
962	€ 154.950	€ 378.739	€ 131.281	**€ 664.971**	€ 665.000	€ 186.077	€ 149.261	€ 149.826	**€ 485.165**	€ 485.000
963	€ 155.437	€ 346.587	€ 149.195	**€ 651.219**	€ 651.000	€ 169.374	€ 144.360	€ 152.071	**€ 465.805**	€ 466.000
964	€ 147.591	€ 440.789	€ 144.691	**€ 733.071**	€ 733.000	€ 194.812	€ 159.072	€ 146.534	**€ 500.418**	€ 500.000
965	€ 136.952	€ 408.205	€ 141.558	**€ 686.715**	€ 687.000	€ 121.513	€ 162.251	€ 155.148	**€ 438.912**	€ 439.000
966	€ 147.020	€ 383.286	€ 132.983	**€ 663.289**	€ 663.000	€ 186.992	€ 163.820	€ 140.582	**€ 491.394**	€ 491.000
967	€ 165.142	€ 397.018	€ 140.141	**€ 702.301**	€ 702.000	€ 156.790	€ 159.387	€ 142.494	**€ 458.672**	€ 459.000
968	€ 167.551	€ 361.154	€ 140.909	**€ 669.614**	€ 670.000	€ 155.951	€ 176.418	€ 151.983	**€ 484.351**	€ 484.000
969	€ 158.740	€ 458.941	€ 134.656	**€ 752.336**	€ 752.000	€ 166.379	€ 175.761	€ 153.787	**€ 495.927**	€ 496.000
970	€ 150.447	€ 455.474	€ 147.580	**€ 753.500**	€ 754.000	€ 203.369	€ 183.275	€ 156.020	**€ 542.664**	€ 543.000
971	€ 142.297	€ 313.066	€ 145.113	**€ 600.477**	€ 600.000	€ 184.854	€ 164.441	€ 146.450	**€ 495.746**	€ 496.000
972	€ 141.821	€ 410.263	€ 129.370	**€ 681.455**	€ 681.000	€ 177.434	€ 147.412	€ 149.240	**€ 474.087**	€ 474.000
973	€ 133.010	€ 369.647	€ 148.553	**€ 651.210**	€ 651.000	€ 156.306	€ 163.947	€ 141.000	**€ 461.253**	€ 461.000
974	€ 136.623	€ 346.967	€ 138.419	**€ 622.009**	€ 622.000	€ 156.428	€ 194.703	€ 145.627	**€ 496.758**	€ 497.000
975	€ 181.880	€ 421.423	€ 143.592	**€ 746.895**	€ 747.000	€ 156.226	€ 156.765	€ 148.537	**€ 461.529**	€ 462.000
976	€ 138.467	€ 357.009	€ 138.162	**€ 633.638**	€ 634.000	€ 174.942	€ 149.649	€ 133.114	**€ 457.705**	€ 458.000
977	€ 154.172	€ 374.008	€ 140.483	**€ 668.663**	€ 669.000	€ 169.563	€ 124.242	€ 141.786	**€ 435.591**	€ 436.000
978	€ 157.230	€ 416.864	€ 133.174	**€ 707.268**	€ 707.000	€ 181.359	€ 156.738	€ 149.596	**€ 487.693**	€ 488.000
979	€ 151.632	€ 386.887	€ 145.638	**€ 684.156**	€ 684.000	€ 159.046	€ 150.143	€ 147.012	**€ 456.201**	€ 456.000
980	€ 160.470	€ 344.456	€ 136.903	**€ 641.828**	€ 642.000	€ 179.988	€ 154.277	€ 132.800	**€ 467.065**	€ 467.000
981	€ 187.956	€ 418.964	€ 129.202	**€ 736.122**	€ 736.000	€ 163.664	€ 148.755	€ 149.182	**€ 461.601**	€ 462.000
982	€ 143.417	€ 448.909	€ 141.371	**€ 733.697**	€ 734.000	€ 182.153	€ 174.226	€ 140.049	**€ 496.429**	€ 496.000
983	€ 146.466	€ 356.812	€ 136.150	**€ 639.428**	€ 639.000	€ 119.837	€ 163.094	€ 150.011	**€ 432.942**	€ 433.000
984	€ 166.343	€ 371.738	€ 137.892	**€ 675.974**	€ 676.000	€ 166.034	€ 166.265	€ 156.981	**€ 489.280**	€ 489.000
985	€ 151.110	€ 400.285	€ 128.771	**€ 680.167**	€ 680.000	€ 180.448	€ 151.661	€ 146.220	**€ 478.329**	€ 478.000
986	€ 136.825	€ 481.492	€ 150.015	**€ 768.333**	€ 768.000	€ 176.329	€ 144.893	€ 148.906	**€ 470.128**	€ 470.000
987	€ 138.455	€ 383.240	€ 144.726	**€ 666.420**	€ 666.000	€ 186.474	€ 153.291	€ 142.871	**€ 482.636**	€ 483.000
988	€ 130.058	€ 396.508	€ 136.077	**€ 662.643**	€ 663.000	€ 186.763	€ 171.187	€ 151.753	**€ 509.703**	€ 510.000
989	€ 129.318	€ 328.833	€ 150.059	**€ 608.211**	€ 608.000	€ 180.075	€ 136.559	€ 140.936	**€ 457.571**	€ 458.000
990	€ 137.529	€ 381.257	€ 140.547	**€ 659.333**	€ 659.000	€ 184.519	€ 189.349	€ 147.402	**€ 521.270**	€ 521.000
991	€ 168.673	€ 375.054	€ 137.891	**€ 681.617**	€ 682.000	€ 155.576	€ 172.492	€ 138.402	**€ 466.470**	€ 466.000
992	€ 144.691	€ 435.136	€ 139.128	**€ 718.956**	€ 719.000	€ 169.969	€ 174.270	€ 151.020	**€ 495.259**	€ 495.000
993	€ 152.445	€ 400.967	€ 133.853	**€ 687.264**	€ 687.000	€ 164.872	€ 132.143	€ 140.697	**€ 437.712**	€ 438.000
994	€ 130.182	€ 355.237	€ 140.782	**€ 626.201**	€ 626.000	€ 174.470	€ 170.617	€ 150.575	**€ 495.663**	€ 496.000
995	€ 131.964	€ 367.243	€ 141.887	**€ 641.094**	€ 641.000	€ 152.590	€ 183.264	€ 149.293	**€ 485.148**	€ 485.000
996	€ 166.895	€ 354.607	€ 137.719	**€ 659.222**	€ 659.000	€ 154.628	€ 149.070	€ 139.067	**€ 442.765**	€ 443.000
997	€ 147.607	€ 365.060	€ 127.466	**€ 640.134**	€ 640.000	€ 158.856	€ 164.678	€ 146.867	**€ 470.401**	€ 470.000
998	€ 110.208	€ 482.644	€ 136.532	**€ 729.384**	€ 729.000	€ 165.235	€ 137.735	€ 155.939	**€ 458.908**	€ 459.000
999	€ 140.145	€ 451.985	€ 146.366	**€ 738.496**	€ 738.000	€ 156.696	€ 137.742	€ 149.230	**€ 443.668**	€ 444.000
1000	€ 146.230	€ 377.934	€ 150.909	**€ 675.074**	€ 675.000	€ 175.421	€ 156.152	€ 144.255	**€ 475.827**	€ 476.000