Charles University in Prague

Faculty of Social Sciences
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MASTER THESIS

Innovative Financial Instruments:
An alternative to traditional grants

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Declaration of Authorship

The author hereby declares that he compiled this thesis independently, using only the listed resources and literature, and the thesis has not been used to obtain a different or the same degree.

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Prague, January 4, 2016

Bc. Tomáš Jelínek

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Abstract

Innovative financial instruments in the Czech Republic and their hypothetical use in the field of energy efficiency are analysed and assessed in this thesis. We address limited awareness about multiple benefits of energy efficiency improvements and also emerging innovative financial instruments that are promoted by the European Commission as a way to multiply impacts of limited public budgets. Then we identify a suitable segment, Czech residential housing stock and public support of insulation, and compare several forms of possible public support in this field. As the main driver of space heating costs, we predict the future development of heat prices, and assess potential energy savings resulting from renovations. Finally, we assess and also simulate the potential of such an initiative and identify four suitable settings of the innovative financial instrument for a majority of stakeholders. Our findings support an idea that this innovative financial instrument offers a valuable alternative to traditional grants. It also suggests that such an initiative can be interesting for a private sector as well as a public sector, with benefits to public budgets, equity investors, households and many other stakeholders. Moreover, this initiative can be sustainable in the long run.

JEL Classification	G23, G32, H60, H71, L71, L97, O16, Q42, Q43, Q47, Q48, Q55
Keywords	energy efficiency, financial engineering, innovative financial instruments, insulation

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Abstrakt

Inovační finanční nástroje v České republice a jejich hypotetické využití v oblasti energetické účinnosti jsou analyzovány a ohodnoceny v této práci. Zaměřujeme se na omezené povědomí o širších výhodách zvýšení energetické účinnosti a také povědomí o nově zaváděných inovativních finančních nástrojích, jejichž zavedení je podporováno Evropskou komisí jako způsob znásobení celkového dopadu limitovaných veřejných rozpočtů. Následně identifikujeme vhodný segment, veřejnou podporu zateplování českého rezidenčního bytového fondu, a porovnáváme několik možných forem veřejné podpory v této oblasti. Jakožto hlavní driver nákladů na vytápění predikujeme budoucí vývoj cen tepla a vyhodnocujeme potenciální úspory energie vznikající renovací. Nakonec vyhodnocujeme a modelujeme, i pomocí simulací, potenciál této iniciativy a nacházíme čtyři vhodná nastavení inovativního finančního nástroje s přihlédnutím na většinu zasažených stran. Naše zjištění podporují myšlenku, že tento inovativní finanční nástroj nabízí cennou alternativu k tradičním dotacím. Výsledky dále naznačují, že taková iniciativa může být zajímavá pro soukromý sektor, stejně jako i veřejný sektor, a to s přínosy pro veřejné rozpočty, investory, domácnosti a mnoho dalších zasažených stran. Navíc, se tato iniciativa ukazuje jako dlouhodobě udržitelná.

Klasifikace	G23, G32, H60, H71, L71, L97, O16, Q42, Q43, Q47, Q48, Q55
Klíčová slova	energetická účinnost, finanční inženýrství, inovativní finanční nástroje, zateplení

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Acronyms

AB	Apartment buildings
ABS	Asset-backed security
ABS1	IFN settings when 70% of future cash flows are directly recreated into ABS at the end of a specific year during which the investments were made
ABS2	IFN settings when all the equity of the financial instrument is managed by the instrument from the first year and these funds are used only for purposes of insulation
ABS3	IFN settings when investors put one third of equity that they would need to invest in the first year to cover everything, as described in the previous point, and then the same amount in the future when cash in-flows from ABS creation and repayments from already made investments during previous years are not sufficient to cover all investments to insulation made by the financial instrument during that year
All ABS	IFN settings when at the end of each year 100% of all the investments that were made during the year are recreated and marked as ABS
B	Billion
CAGR	Cumulative annual growth rate
CR	Czech Republic
CZK	Czech koruna or Czech crown
CZSO	Czech Statistical Office
EIB	European Investment Bank
EIF	European Investment Fund
ERR	Economic rate of return
EU	European Union
FH	Family house
IFN	Innovative financial instrument
IRR	Internal rate of return

M Million

MBA Mortgage backed security

No ABS IFN settings when no ABS is being applied and all initial investments are covered by the equity of investors and revolving repayments from the monetised value of heat savings

NPV Net present value

PA Partnership Agreement

PS_15_0% Scenario passive standard, 15 years of repaying and no grant

PS_20_0% Scenario passive standard, 20 years of repaying and no grant

PS_15_20% Scenario passive standard, 15 years of repaying and 20% grant

RS_15_0% Scenario recommended standard without technology, 15 years of repaying and no grant

RS_20_0% Scenario recommended standard without technology, 20 years of repaying and no grant

SME Small-medium enterprise

TOE Tonnes of oil equivalent

VAT Value added tax

WACC Weighted average cost of capital

Master Thesis Proposal

Master's Thesis Proposal

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Proposed Topic:

Innovative Financial Instruments: An alternative to traditional public grants

Motivation:

I am going to analyse innovative financial instruments as a novel way to finance projects with a significant environmental, public or social impact. Due to advanced financial methods like risk sharing, first loss guarantees and others, which gave the designation “innovative” to the financial instruments, it is possible to find alternative financial sources to a specific group of projects with little economic return. These projects have to have some economic return but such return is not high enough to be attractive for private investors. Sometimes public financial grants are being used but more often than not these projects are being omitted. The innovative financial instruments offer an alternative by connecting public and private resources.

The purpose of my study is to perform an analytical assessment of a possible use of the innovative financial instruments to allow qualified decisions for the purposes of both governmental policy and business investments. As highly flexible instruments, the innovative financial instruments can be used in numerous ways and therefore I decided to focus only on one particular field of use, ‘the energy efficiency of households’.

A number of studies about energy efficiency and its financing exist as well as studies describing a variety of properties that the innovative financial instruments offer. However, none of them have really evaluated the possible microeconomic impacts on households nor that of the macroeconomic impacts. My goal is to fill this gap and to verify or disprove an appropriateness of the use of the innovative financial instruments in the field of energy efficiency of households.

Hypotheses:

1. Hypothesis #1: The innovative financial instruments offer a valuable alternative to traditional public grants which is interesting for both the public and private sector.
2. Hypothesis #2: The financial schema using innovative financial instruments can be sustainable in the long-run.
3. Hypothesis #3: The innovative financial instruments for the energy efficiency of Czech households would be more effective than that already used in incentive schemas.

Methodology:

I am going to collect and analyse relevant literature describing the possibilities of the innovative financial instruments and also studies analysing energy efficiency. To find relevant data about energy costs and market size, I am going to source information from Czech and

European statistical offices. The rest of the primary data, amount of energy savings after energy efficiency improvements, will be findings from a study by Jan Antonín (2013).

With all the primary data in hand, I am going to perform a bottom-up analysis starting with a finding of the most relevant sector with a high energy consumption and an easy way to implement possible energy efficient remedies. Another crucial part of my thesis is going to be a forecast of the future development of the average heating expenses of subjects identified previously. I am going to use econometric models to forecast the future development of all relevant energy sources within the identified sector and combine them into one unified forecasted time series explaining future development of costs per a unit of energy. Next, I am going to calculate the potential savings of the subjects if the energy efficient remedies were implemented. Finally, I am going to model the actual innovative financial instrument with its financial attributes and other aspects, like the value of an environmental impact, total multiplication effect of public funds on the Czech economy and so on.

The innovative financial instruments would be a valuable alternative to traditional public grants if with the same amount of public funds the resulting impact of the innovative financial instruments would be at least as good as an impact of the traditional public grants. To test the second hypothesis I am going to analyse expected interest of the identified subjects over a period of 25 years together with an overall financial performance and sustainability of the innovative financial instrument. The third hypothesis is correct if values of energy savings would be higher and CO_2 emissions would be lower when the innovative financial instrument would be implemented in comparison to the already used Czech incentive schemes for energy efficiency.

Expected Contribution:

I am going to develop an interactive financial model which is going to be able to evaluate and quantify an opportunity to connect public and private resources through innovative financial instruments to finance projects with substantial environmental, public or social impacts. The findings of my analysis will allow political and business decision makers to make qualified judgements about the innovative financial instruments. If the hypothesis that the innovative financial instruments can serve as a valuable alternative for traditional public grants is proved to be right, then my study will contribute also with a quantitative evaluation of the environmental, public and economical contributions of the innovative instrument. Such findings could consequently help not only to individual households or investors but also to the public in general, for example, thanks to the implementation of new environmentally friendlier technologies. Another significant macroeconomic effect could be a boost of the economy or a significant contribution to reaching environmental goals, such as decreasing carbon dioxide emission which was accepted by the Czech Republic.

Outline:

1. Motivation: I am going to evaluate the appropriateness of innovative financial instruments with a quantitative evaluation of all aspects which has not been done yet.
2. Existing literature: I am going to describe general principles of innovative financial instruments together with a brief list of their possible uses.
3. Data: Time series of energy costs, dataset describing a distribution of houses and corresponding distribution of potential energy savings are going to be the primary data sources.
4. Methods: I am going to construct an interactive model evaluating environmental, economical and financial potentials of the overall schema of the innovative financial instruments.
5. Results: I going to discuss my findings with a focus on the impacts on individual stakeholders as well as both microeconomic and macroeconomic implications.
6. Concluding remarks: Results of my analysis are going to fill in a gap in existing materials about the innovative financial instruments which will consequently allow stakeholders to make a qualified decision.

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Author **Supervisor**

1 Introduction

Pressurised public budgets and virtually countless possibilities of projects seeking public support come with difficult questions: 'Which projects to support with public funds?', and 'How to support as many of these projects as possible?'. It is mainly a topic of the efficiency of the public support than anything else. Efficiency is relatively low in the Czech Republic where public support is a synonym of public grants for many. Currently there is an emerging move within the European Union towards more efficient ways of use for its funds. In many member states, including the Czech Republic, the European Union funds form a significant part of an overall public budget. One of the possible ways, which is promoted by the European Commission, in the way that at least a part of the funds received from the European Union have to be used through this instrument, is so called innovative financial instruments. The promotion of these instruments by the European Commission, the emergence of reacting initiatives by Czech public authorities, and very limited awareness about the topic in the Czech Republic add a relevancy to this thesis.

Innovative financial instruments take advantage of recurring cash flows from previously supported projects, where initial investments were partly or even fully covered by the instrument. This crucial difference from traditional public grants limits projects suitable for the innovative financial instruments to projects with positive internal rate of return. The projects are limited also by positive economic rate of return, which should be a criterion for all forms of public support. Due to the possible complexity and multiple financial means that can be applied, the innovative financial instruments have an ability to transform publically desirable projects that are nowadays overlooked by private investors, into something attractive for them. In many cases, the attractiveness for the private investors rises from the scale of the created instruments, their marketability, application of financial lever, or from another crucial characteristic of the innovative financial instruments – combining of private and public funds including many possible special provisions. Generally, the deployment of combined private and public funds allows for the support of more desirable projects in a more effective way by taking an advantage of both, private and public, expertise and privileges.

The objectives of this thesis are first to introduce the innovative financial instruments together with their functionalities. Second, to place them into a range of global initiatives influencing the Czech Republic and to present segments suitable for the innovative financial instruments implementation. And finally to analyse a hypothetical public initiative within a suitable selected segment. Including an assessment and selection of the most appropriate settings for the innovative financial instrument, and also an assessment of impacts on multiple stakeholders.

This thesis is unique as it combines academic and business approaches, considering the most current knowledge and estimates of experts. It is unique also in its scope and scale, because it moves step-by-step from the general energy situation of the Czech Republic, through the selection of an appropriate segment – energy improvements in the Czech residential housing stock, to the last step of assessing a hypothetical innovative financial instrument. To perform all of this we gather, analyse and combine a number of different data sets from statistical and other offices, from other studies, and the best estimates of experts from public, energy, financial and construction industries.

We have an ambition to increase awareness about possibilities, advantages and risks of both, the innovative financial instruments and energy efficiency improvements, under the existing conditions in the Czech Republic and existing initiatives of the European Union. We also look at the potential of various segments to select one, where we assess financial, ecological and economic potential impacts caused by the hypothetical innovative financial instrument. We also focus on the confirmation or rejection of three main hypotheses aiming to assess the suitability and sustainability of the innovative financial instruments in the Czech Republic within a minimum of the selected segment – 'The innovative financial instruments offer a valuable alternative to traditional public grants which is interesting for both the public and private sector.'; 'The financial schema using innovative financial instruments can be sustainable in the long-run.'; and 'The innovative financial instruments for the energy efficiency of Czech households would be more effective than that already used in incentive schemas.'

The thesis is structured as follows, starting with the introduction where we describe the importance and topicality of this thesis including its objectives. Then, in the second part, we present the innovative financial instruments, their possibilities and functionalities, and also their position within the programming period 2014-2020 and current situation in the Czech Republic. In the third part we focus on energy efficiency initiatives and their benefits, analysing many initiatives, from global scale programmes to impacts on final end-users and even on other indirect stakeholders. The fourth part presents methodology. Next, fifth, chapter describes process of the suitable segment selection and also the selection of an appropriate instrument. In the sixth chapter we go through modelled situations determined by different settings of the innovative financial instrument and by scenarios describing, for example, a future heat price development predicted also by us. All these situations are assessed and compared until the most suitable combination of settings is found. In this chapter, we also summarise our findings and present further possibilities of upgrading or updating of this thesis. The next chapter summarises everything and presents our conclusion. Finally, in the last two parts we show bibliographical sources and more importantly, in the appendix we present individual graphical figures of distributions and outputs of sensitivity analyses from selected scenarios.

2 Innovative Financial Instruments

Innovative financial instruments offer new possibilities for financing various projects that have to fulfil a minimum of two essential requirements. The first requirement is a presence of a positive economic return from initial investments made by the instruments into projects. The second requirement is a sufficient level of internal return that allows repaying of the initial investments over a sustainable maturity period. There is no exact uniform length of the sustainable maturity period or the sufficient internal return. This is given by more factors, mainly a variability of projects, differences between investors and their requirements, and assessment of externalities. The majority of the variance of requirements can be addressed by innovative financial instruments due to the high flexibility in settings allowing support of publically desirable objectives. (Hanzlík, 2013) This flexibility allows for the meeting of different individual needs of projects thanks to a project-based approach, and also to project financing which is required in cases of financial instruments application. The instruments allow not only the individual needs of particular projects to be addressed but also specific processes can be applied to maximise an overall utility brought about by the instrument. The final settings of the innovative financial instruments should always aim to be a perfectly balanced combination of the previously mentioned length of refinancing which is important for end-users and an acceptable return to investors.

2.1 History and designation in European Union context

Financial instruments have been used in line with the goals of the European Structural Funds since the 1994-1999 programming period. (European Commission, 2014f) It might seem like a common instrument, which is already accompanied by over 20 years of expertise and experience. Nonetheless, numbers, rapid evolution, and significant changes do not fully support the initial impression. Significant changes were connected with both the programming period 2007-2013 and then again in the following programming period 2014-2020. This was accompanied not only with a wider variability of possible financial tools, but also a variability of potential fields of application. Additionally, it has been accompanied by a gradually increasing importance of the financial instruments. The importance can be presented best on the amounts of European resources invested through the financial instruments, whereas in the programming period 2007-2013 on average only 1.3% of the budgets of the European Union were processed through the instruments, the Strategy 2020 and mainly the European Commission aims at 10% for the current programming period 2014-2020. (Hanzlík, 2013)

The changes in scope and variety of possible tools that can be implemented through the financial instruments triggered a change in the designation of when official authorities started to refer to these financial instruments as innovative financial instruments. The word innovative refers to innovative ways of using financial instruments. The innovative ways can be specified both by new goals or new tools. Despite the fact that innovative financial instruments can be used, apart from others, for interventions supporting research, developments and innovations, this meaning has nothing in common with the designation of innovative financial instruments. In many European countries, the Czech Republic included, the designation ‘innovative’ might additionally refer also to the fact that any financial instruments, in the sense of the innovative way to support public objectives, have not, or only sporadically, been implemented in the public sector as of yet. (Hanzlík, 2015) Although the full designation of innovative financial instruments is at present commonly used by official institutions, due to the meaning of this designation, innovative, it is questionable how the designation will develop in the future when these instruments will become conventional. An answer to this question might already be hidden in a current practice when some refer to the innovative financial instruments only as financial instruments or even instruments depending on context.

2.2 Characteristics of projects

Looking at the widest possible range of projects, only projects that have financing needs can be considered in connection with innovative financial instruments. The next stage of evaluation has to consider two characteristics for division of these projects: an economic rate of return (ERR) and an internal rate of return (IRR). The term ‘economic rate of return’ is used by the European Commission and other institutions to evaluate impacts of a particular project, not from a perspective of cash flows and exact financial valuations, but to consider the value of all externalities for the public. In other words, all societal overlaps of such a project should be considered and evaluated. Examples of such externalities might be implications on employment, expenses on healthcare, the increase of a gross domestic product and countless others. (Hanzlík, 2015) On many occasions, it has been excessively expensive or even impossible to determine exact values but for purposes of innovative financial instruments it is sufficient to determine whether the ERR is positive or negative. Compared to ERR, the IRR is a commonly used measure of a financial potential specific to a particular project.

The question that needs to be asked is what is the best way to intervene and whether or not any intervention is needed. As can be seen in the schematic chart, Figure 2.1: Division of projects, projects with negative ERR should not in any case be supported with public interventions. In fact, the negative ERR means that over the whole existence of such projects and the whole existence of all consequences of the project too, positive values/revenues for public are lower than incurred costs. In other words, by supporting such projects, the state or other public authority would only widen a pool of problems instead of solving as many problems as possible. Therefore, only projects with positive ERR should be considered for support, since they have potential to solve more problems than they cause.

As we have already mentioned, the IRR measure has to be assigned to an explicit project and it evaluates cash flows from the project. Once again, all projects could be divided into two groups, one with positive IRR and the second with negative IRR. Projects with a positive IRR are preferred by investors because if everything goes in line with their projections, the investors would make money. However, for the purpose of my analysis, this division of positive vs. negative is not sufficient. Risks associated with each project have to be considered as well.

The levels of IRR and the level of risk play an important role in determining whether or not to intervene and potentially how to intervene. The Figure 2.1 shows that at least five groups have to be recognised. Starting from the left of the figure, projects with high positive IRR, which already reflect associated risks, are not suitable for public support. These projects are already interesting enough to be able to find investments in a private market.[1] On the other side, last on the right side in the figure, projects with

[1] We would like to stress two facts. Outcomes of this analysis are based purely on a financial basis and while a perfect valuation should ideally reflect all aspects and risks of any project, it is not the case in the real world, where valuations are connected with some level of uncertainty and therefore even projects with high calculated IRR can struggle or even fail to find financing. For example, due to poor management. The second fact is that primarily financial interventions are considered. This means that when we state in this analysis that no intervention is needed, considering projects with high positive IRR, it does not mean that no intervention from the side of public authorities would not have been sufficient. For example, interventions decreasing administrative burden or some tax changes might still be appropriate.

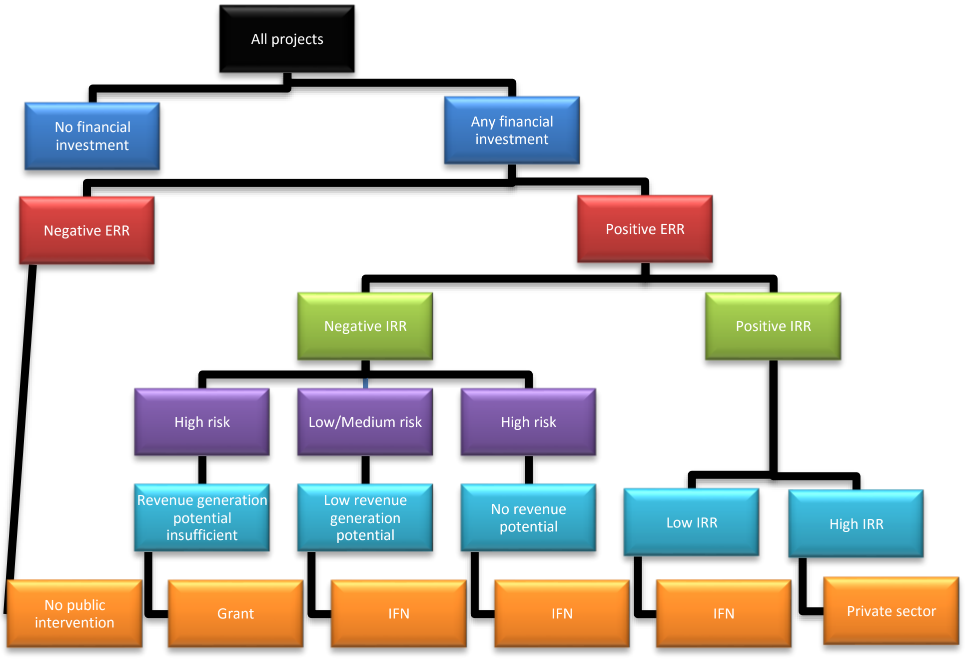

Figure 2.1: Division of projects

Source: Author inspired by Volkery (2013).

negative IRR associated with a high risk and no potential of any revenues should be supported in the form of grants because their positive ERR represents benefits for the public. However, it is important to keep in mind that these grants are non-refundable and can be either one-time or repetitive. All three remaining groups are suitable for support through innovative financial instruments. Due to a high flexibility of tools and settings, which can be implemented through the financial instruments, the range of interesting projects is vast. More in-depth details about the flexibility are presented in the following chapter, Variability and flexibility of innovative financial instruments. The range of projects varies from a group of projects with negative IRR, low to medium risk and low potential of revenue generation, through another group of projects with negative IRR, high risk and insufficient potential for revenue generation and up to the last group of projects with positive but low IRR which is not interesting enough for private investors on its own. (Volkery, 2013)

2.3 Comparison with traditional grants

The number of benefits can be identified when comparing two possible forms of public support: traditional grants and innovative financial instruments. The main benefits of the grants are the universality of application and the existing rich experience with this type of support. Part of the experience leads to the possibility of prompt implementation and the relative ease of processing as well. Contrary to the grants, these are the following main benefits of the innovative financial instruments. Due to a revolving character, which we illustrate in Figure 2.2: Revolving effect of innovative financial instruments, the instruments are more efficient and effective, and there is a possibility to reuse initially invested resources repeatedly in the future. (European Union, 2012) This reusing or reinvesting also means the leveraging of the initial investments, where the leverage effect of public invested resources is even stronger since financial instruments are characterised also by combining public and private resources. This leverage then allows the impact of public interventions to increase significantly thanks to their scale. The attraction of the private sector does not only mean an additional source of financing because the private investors are supposed to contribute also with their expertise. Consequently, benefits of market-based approaches, better quality projects, and the expansion of financial markets should arise. (Hanzlík, 2013) Furthermore, the involvement of the private sector fundamentally means support for public policy objectives and due to the positive IRR of financial instruments, there is also the effect of revenue realisation. Therefore, the innovative financial instruments fulfil goals of both, the public investors and the private investors too. Sometimes, the effect of 'grant dependency culture' distortion is also highlighted. (European Commission, 2014f; Hanzlík, 2015)

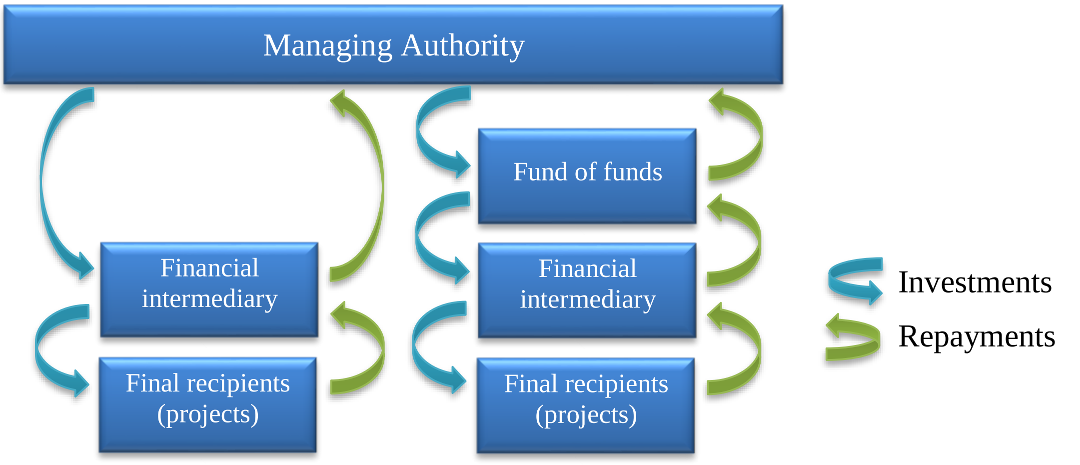

Figure 2.2: Revolving effect of innovative financial instruments

Source: Author inspired by European Commission, European Investment Bank and PricewaterhouseCoopers (2014).

2.4 Variability and flexibility of innovative financial instruments

The flexibility of innovative financial instruments can be presented on a variety of tools but also on the countless possibilities of financial engineering. The European Regulation 966/2012 (2012) defines four possible forms of instruments that can be applied:

- Equity, quasi equity investments (mezzanine) and venture capital
- Loans and guarantees
- Other risk sharing instruments (e.g. co-investments)
- Combinations of previous instruments with grants

The financial engineering then allows tailoring of financial instruments to serve specific projects and goals in the best possible way. Usual tools of financial engineering used on a level of innovative financial instruments are:

- Securitisation
- Seniority
- Differentiation
- Swaps
- Options
- …

2.5 Designing eligible innovative financial instruments

The variability and flexibility of the innovative financial instruments offer countless possible manners of application and consequently countless possibilities. However, these characteristics lead to a challenging process of creating appropriate settings, processes, and other characteristics for a financial instrument, in a way that best serves public objectives. As the European Investment Bank, in cooperation with PricewaterhouseCoopers and the European Commission (2014) describes, there is a sequence of steps that should be followed to create appropriate innovative financial instruments. These steps are:

1. Market failures, suboptimal investment situations and investment needs identification
2. Assessment of the value added of the innovative financial instrument
3. Estimation of potentially raised and private resources by the innovative financial instrument
4. Identification of relevant previous experiences and achievements

5. Creation of a suitable investment strategy
6. Expected results including strategic objectives and monitoring system

A combination of long-term characteristics of a life cycle of the innovative financial instruments together with possible external influences, requires an ongoing evaluation and possibly an adaptation of strategy. This initiative should be based on the interests of individual investors, both private and public, whose best interests are an effective and efficient way of managing a particular innovative financial instrument.

2.6 Structures and managerial bodies

The position of investors is connected with some obligations and rights. While the main and obvious obligation for investors is to provide funds for investments of the financial instrument, the situation with their rights is not so obvious. This is because not all investors have to have the same rights, and also a variety of their rights and obligations

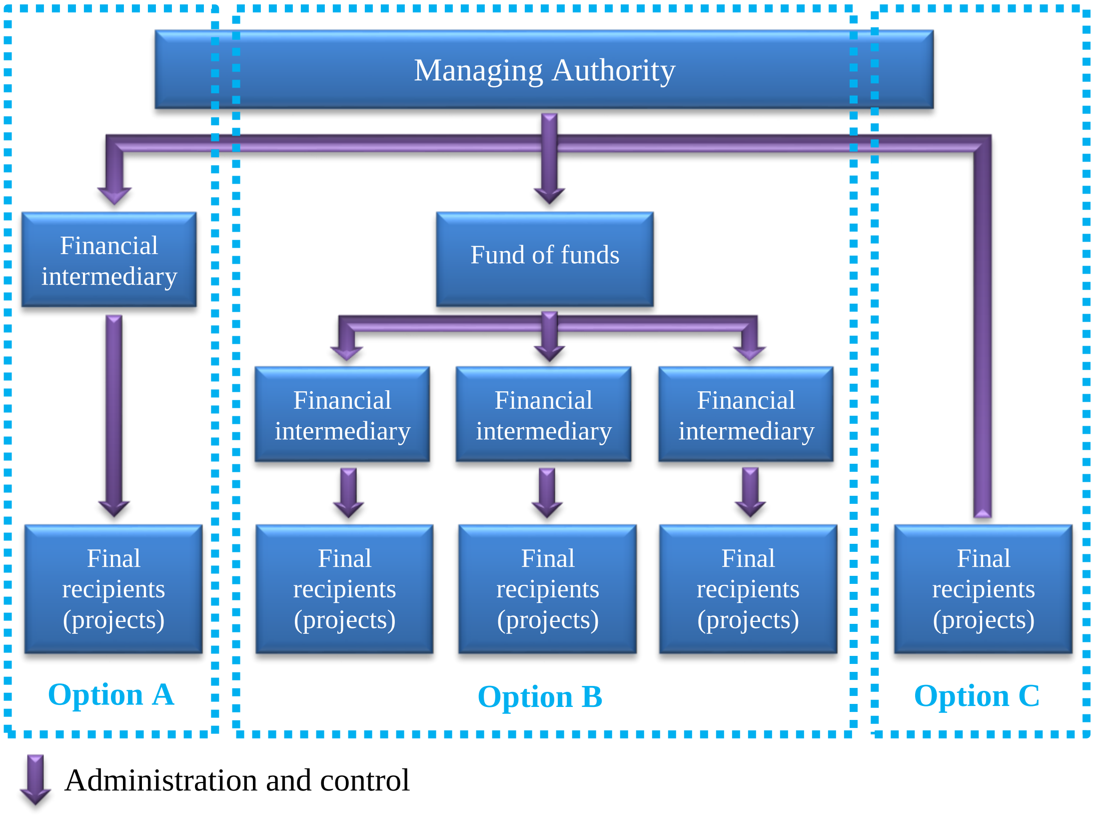

Figure 2.3: Possible structures of managing innovative financial instruments

Source: Author inspired by European Commission, European Investment Bank and PricewaterhouseCoopers (2014).

can be assigned just in accordance to specific properties and goals of the financial instruments. Nevertheless, only three basic structures can be created with respect to the administration of these obligations and rights as Figure 2.3 presents.

Looking at all three options of the organisational structures, at least two elements have to always be present: a managing authority and projects. The managing authority is a body of the structure responsible primarily for creation, monitoring and potential adaptations of strategies aimed at supporting the public objective. The projects then are individual practical applications and recipients of resources from a particular financial instrument. Remaining bodies of some structures are funds or their clustering facility called fund of funds. These bodies serve as financial intermediaries, providing funding to the final recipients, the projects. Funds and funds of funds also manage other responsibilities that are specific to a purpose of a particular instrument, mainly connected with implementation. Fund of funds is sometimes also referred to as a holding fund, which allows a fund setup with the objective of contributing support from one or more programmes to several financial instruments implemented by funds. (European Commission; European Investment Bank; PricewaterhouseCoopers, 2014)

2.7 Scopes and levels of application

For the 2014-2020 programming period, there are three main administration levels where innovative financial instruments can be implemented. (Tyson, 2013) As the following schema shows, Figure 2.4, some innovative financial instruments may be set at the European Union level. These instruments combine for example sources from "ESI Funds with other sources of EU Budget and EIB/EIF resources with a view to stimulate bank lending to SMEs." (European Commission, 2014f, p. 3) Also, projects with over the border overlaps or common projects of more cooperating member states are other examples belonging to this group. (Volkery, 2013) Initiatives to create this type of financial instruments come from the side of the European Commission and it is being promoted through the general Regulatory framework of the financial instruments.

The remaining two groups are more focused on the use of the financial instruments in individual member states. Financial instruments, which can be applied to support goals of more programmes within the particular member state, belong to a group designed as a national or state level in the Figure 2.4. A regulation of these instruments is partially planned in the Partnership Agreement between the member state and the European Commission. Still, "there is no legal basis for inclusion of information on financial instruments in the Partnership Agreement. However, it would be useful to include general information on the use of financial instruments in relation to relevant thematic objectives and/or investment priorities where use of financial instruments is envisaged." (European Commission, 2014, p. 6) For example, the Czech Partnership Agreement speaks about a need to build and implement all necessary structures for financial instruments where one possible application should be the support of seed and venture funds activities. (Ministry of Regional Development CR, 2014). The last group allows the setting up of innovative financial instruments for the purpose of fulfilling objectives of individual operational programmes. Again, only the information basis is described in the operational programme itself.

From a legal point of view, member states have two possibilities that can be used: off-the-shelf innovative financial instruments or 'tailor-made' innovative financial instruments, which are built upon an individual legislation of a member state. (Appel, 2015) The off-the-shelf instruments are prepared and standardised, therefore their roll-out can be quite fast, and moreover there are expertise and experience behind this form of instruments. Contrary to this, there are costs paid to EIB, or more precisely EIF and limited possibilities to modify properties of these instruments for specific local needs in member states. There are also limited opportunities to build sufficient expertise and tools to be able to run innovative financial instruments on state based regulations. The second, tailor-made, group of innovative financial instruments eliminates all the disadvantages mentioned earlier in connection with off-the-shelf instruments. On the other hand, with this solution new disadvantages can arise, for example the need for specific legislation or financial expertise. In the case of the Czech Republic, parts of necessary legislation have to be newly introduced to the legal system, which is time consuming and there exists a risk that faults could occur. (Hanzlík, 2015)

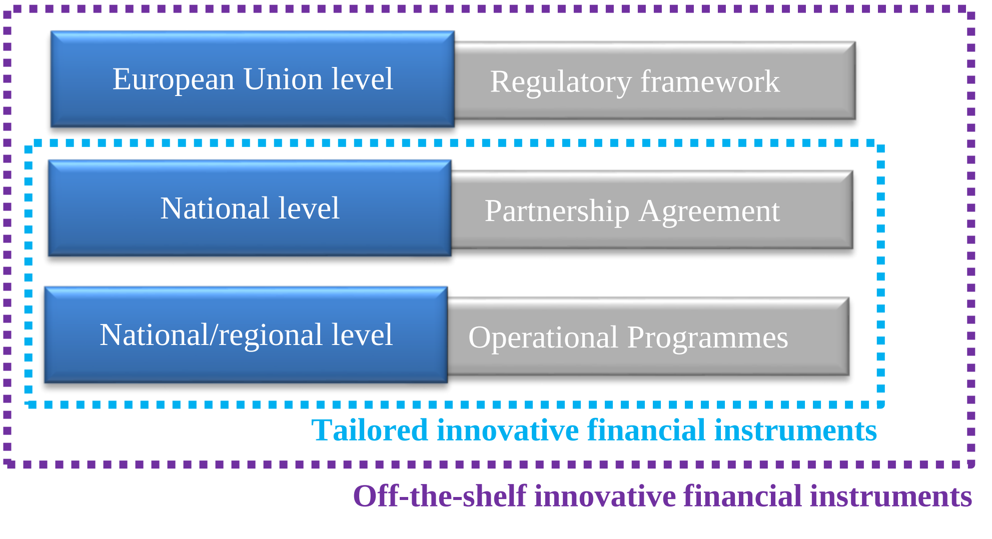

Figure 2.4: Three possible administration levels for implementation of innovative financial instruments

Source: Author inspired by Tyson (2013).

2.8 Financial instruments experience from 2007-2013 programming period

Even in the current situation when innovative financial instruments are undergoing a rapid development, it is still interesting to analyse the previous programming period 2007-2013. There were only three member states, Croatia, Ireland and Luxemburg, that had not implemented any financial instruments. In the Czech Republic, there have been two financial instruments active. These instruments are risk-sharing funds that “act as EIF's intermediaries and provide loans or leasing to research-based and innovative SMEs and Small Mid-Caps established and operating in one or several of the EU Member States or Associated Countries.” (European Investment Fund, 2015) These two funds are operated by Komerční banka and Česká Spořitelna. The total guarantee amount is 95 million EUR which is matched to accumulate 190 million EUR committed to SMEs. (Rouillon, 2013)

Stefan Appel (2015) in his analysis identified 941 financial engineering instruments active in 2013. The majority of them, 872, had a form of specific financial instruments whereas the remaining 69 form funds of funds/holding funds. Looking at a focus of these instruments, the mass majority of focus was on support to enterprises, 854 instruments. The remaining instruments were supporting urban development, 56 funds, or energy efficiency and renewable energy, 32 funds. The last way of division is focused on forms of support. In this case, loans seemed to be more popular than other possible forms, 392 instruments were offering loans, 127 guarantees, 146 equity and the remaining 105 instruments were mixed.

2.9 The programming period 2014-2020 and the current situation in the Czech Republic

The European Commission currently promotes programs using innovative financial instruments in appropriate cases shown in Figure 2.5. The European Commission promotes, as part of its pan-European reach, innovative financial instruments mainly in the form of loans for small and medium businesses. (European Commision, 2011b; Rezessy & Bertildi, 2010) One of the reasons why the European Commission decided to legalise this support is to aid European banks and the business sector, which had struggled the most due to the crisis, which had begun in 2008. Another reason why the European Commission is pushing member states to use innovative financial instruments is the inefficiency of grants and subsidies in some specific areas, more precisely areas with a direct economic return, in comparison to the innovative financial instruments. Another reason is also high pressure on the budget of the European Union caused by grants and subsidies. (Hanzlík, 2013) The innovative financial instruments can efficiently and more appropriately utilize a multiplier effect on European public funds by funds of private investors. In this way, publicly desirable activities that the private sector would not support solely, either due to small economic returns or excessive risk can be more efficiently supported. In many cases, the public sector would not support these activities due to an excessive demand for financing on public budgets caused by countless activities with positive public externalities, but in combination of public and private sources it might be different.

The situation in the Czech Republic is somewhat different compared to most European Union countries and therefore it is necessary to interpret the recommendations of the European Commission carefully, especially with regard to local Czech circumstances. Czech banks had not been affected by the financial crisis as much as other

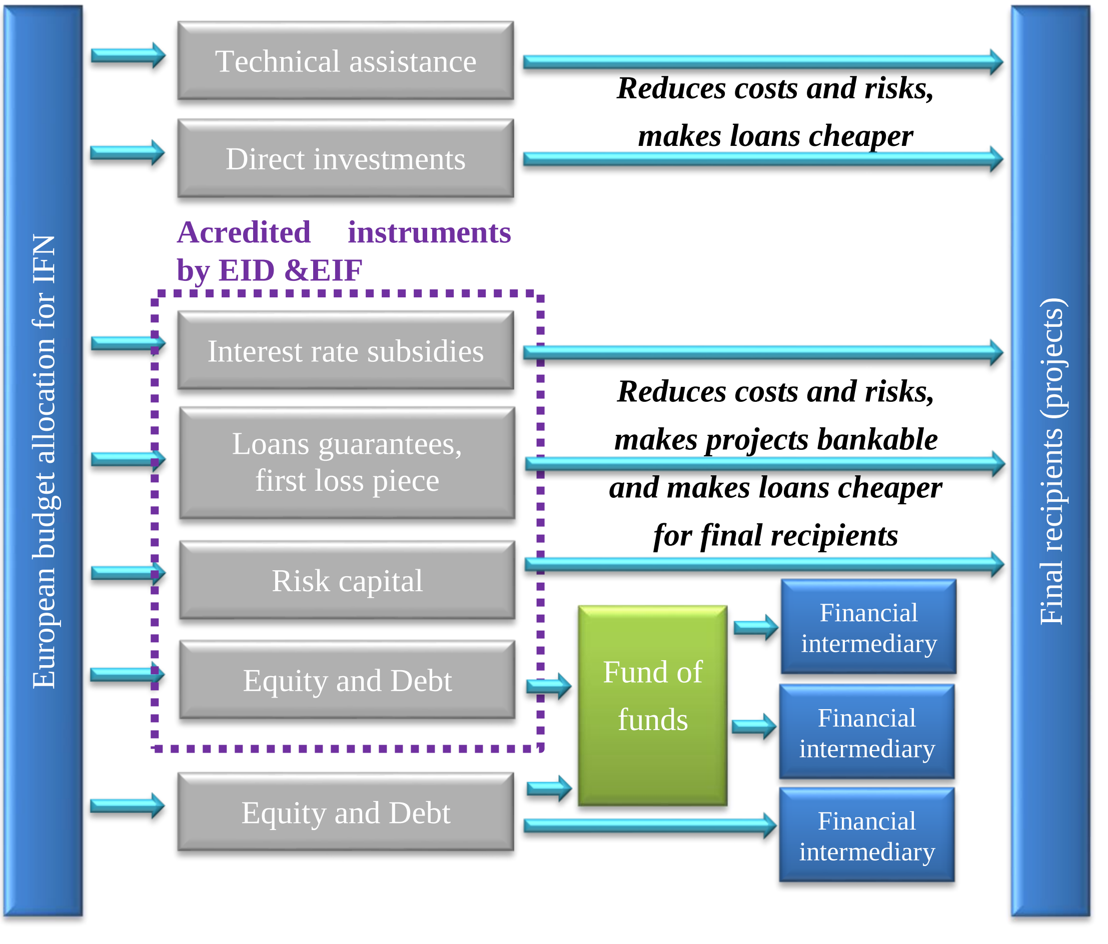

Figure 2.5: Financial flow of European funds through innovative financial instruments

Source: European Commission.

European banks and besides, the Czech banking system is characterized by considerable liquidity. Regular stress tests of the Czech National Bank show Czech banks have not had significant problems with liquidity caused by the financial crisis starting in 2008 and due to that, they did not need to limit credit financing for SMEs. (Czech National Bank, 2015) Even though Czech banks are able to cover credits with deposits of their clients, there are still some limits on the side of SMEs where many of them refrain from taking a credit or have an already high level of debt causing further inability to take more credit. A similar situation can also be observed in cases of households and public institutions as well. At the same time, the current situation is affected by historically low levels of interest rates which might evoke a willingness of further debt financing. (Frait, 2015) The resulting situation when low interest rates are in conflict with the existing debt make it questionable if increasing debt on the sides of SMEs, households and others is desirable or not.

In this situation, innovative financial instruments offer a possible way to avoid and prevent most of the potential problems when using a combination of financial engineering and European funds allocated to the Czech Republic. Historically the European funds were mostly used in a form of grants subsidising various activities. However, as was already stated, this support means a significant burden on the public budget and so limits the number of supported projects. The second and equally important issue is the actual process of support through grants. A beneficiary, who is responsible for the supported activity usually in the form of a specific project, must first execute the project while financing it from his or her funds. Finally, at the end it is controlled if the project was executed in line with plans and all related regulations, and the result of such testing decides if the promised grant will be paid retroactively or not. Imperfections of this system are not only that the beneficiaries do not usually have their own sufficient initial funding but also that they must first take a loan which is always associated with some risk. It is also problematic that additionally to an initial investment an interest to bank has to be paid, and also the ever-present potential risk of failure to obtain a loan. Even in cases when recipients receive the loan, the uncertainty of whether or not all expenses will be reimbursed due to the breaking of any conditions is significant. All these associated risks may result in a lower demand for grants. The outcome of this conflicting situation, when on one side is an activity that has positive externalities, but on the other side there are concerns about risks associated with performing this activity leading as far as to not performing the activity, is not beneficial to anyone. The available solution is an implementation of innovative financial instruments that can eliminate these problems to a certain level when a proper setting is applied.

The previous example with grants is not the only way the innovative financial instruments can help solve a particular problem in the Czech Republic. Another example is a schema where capital injections are offered to projects in situations when such an entry is desirable. Additional examples could be various ways of securitisation or the building up of platforms for capital investments. (Hanzlík, 2013)

2.10 Advantages of the innovative financial instruments

With a deep knowledge of both local and European circumstances, the General Commissioner for the Innovative Financial Instruments in the Czech Republic, Martin Hanzlík (2014; 2013) presented the following advantages and possibilities that could be implemented in the conditions of the Czech Republic. It seems that there are countless possibilities for how the financial instruments could solve a number of market failures and market distortions due to a notable flexibility of the financial instruments. Many times the implementation of the instruments might be interconnected with other positive effects than the primarily aimed problem such as the creation of new work positions, the significant multiplication effect on the Czech economy, or development in highly competitive fields.

The possibilities of project financing are connected, one part of another, with detached financing of individual projects from budgets of a state, firms, municipalities, or regions. Projects with a potential to generate profit can exist as separated entities, which allows them to form their own budget and balance sheet. This can consequently lead to a reduction of the current state budget deficit. Taking into account only currently discussed projects, the reduction could reach up to tens of billions CZK. The project financing also offers a possibility to obtain additional sources of financing for projects with positive public externalities while no additional increase of the state debt would be present. Moreover, this type of financing does not break any international criteria, which are binding for the Czech Republic.

Not in every case is debt the only possibility to obtain funds for demanded financing. In many cases debt can be replaced by an equity investment. The important difference in such cases is that subjects, like firms, municipalities and so on, are not liable with all of their property but only with the project itself. This positive consequence of the project financing has further implications that might play a very significant role in future state budget planning. Currently the funds from the state budget are not a necessary condition because another possibility when the innovative financial instruments can be built upon the funds from the European Union. Moreover, these funds would be multiplied by additional private sources. In this case there could exist special purpose vehicles separated from the state budget activated to serve public needs in either the short run or the long run as well. Due to the fact that projects in innovative financial instruments are expected to have some financial return, the initial investments made by the financial instruments should gradually revolve to the instrument where over time there will be the possibility again to support another beneficial project in the future. This principle could allow finding financing to many more projects than would be possible only with the Czech state budget connected with the European funds offered in the form of grants. In comparison with the traditional grants that offer usually multiplication in a range of 0.2 to 2.0 times the public funds, the innovative financial instruments are estimated to deliver multiples of 5 to 20. (Hanzlík, 2013)

The innovative financial instruments also offer a way to improve the efficiency of using public resources in comparison to grants. A construction when public funds are linked to funds of private institutions or other types of private subjects is being less vulnerable to frauds and thefts. (Zahradník, 2013) The reason for this is a multiplied control from all involved parties. In addition, innovative financial instruments act as financial institutions by themselves and like that they will be controlled by the Czech National Bank. In addition, and perhaps most importantly, they will be carefully overlooked by all the investing parties. Private investors especially have an eminent interest in the efficiency and high performance of projects and due to that, an active involvement of these investors is inevitable. One important consequence of the active involvement is a selection of suitable projects that will be run on market-based principles. Therefore, maybe even more importantly, only projects with a potential to perform well, after an investment phase, will be realised, since this is a necessary condition for any private investor to join a project.

A problem with an incomplete drawing of allocated European funds, which the Czech Republic experienced at the end of the program period 2007-2013, could be prevented in the future by the implementation of innovative financial instruments. In the case of the innovative financial instruments, both their primary financial inflows, the European money and the private resources, to individual projects would take place up front. This means that there would not be the problem with underspending and also the problem with a need to secure financing for projects before the repayment of the investment at the end, as is normal concerning traditional grants. For example, if the innovative financial instrument would be designed as a schema combining debt and equity investments then there could be no debt burden for the final recipients of funds from the instrument.

Another advantage of the innovative financial instruments is a possibility to specify types and amounts of investments into the instrument according to the demand of a specific application. Due to this, a significant amount of money could be promptly implemented in a stimulation of the economy. There is a huge variability of possible applications from the whole sectors, as for example, construction, mechanical engineering and so on, to specific projects, which could be promising research, start-up and similar. Another possible type of application is to set up the innovative financial instrument to focus on a general goal, which could be employment and creation of new job positions, research and development, and additional fields of application.

Arrangements around innovative financial instruments might seem to be new in the Czech Republic but despite the fact that interconnection of various principles together might be innovative, the individual principles have been used already. The principles might not be used in the public sector yet, or at least not regularly, but successful examples of their implementation can always be found somewhere. Moreover, over time, the Czech state has collected experience and data from various fields of application thanks to other types of supportive programs. For example, experiences and expertise gained from the running of the Green Savings Programme focused on the energy efficiency of houses might be further leveraged with a new programme using an innovative financial instrument as its platform. Such an instrument would leverage not only the experience of the public sector but also the expertise and skills of private investors investing in the instrument and due to that, the best interests of the Czech Republic and their inhabitants should be reflected and met.

A huge variability of possible settings for innovative financial instruments is accompanied with numerous advantages but there are potential risks involved too. As the instruments should mainly focus on fields with market failures and imperfections to eliminate discrepancies, the precise settings are necessary. Just as traditional grants can solve problems, they can cause problems as well and the situation with the financial instruments is not different. Moreover, some new challenges can arise when financial instruments are used. For example, common risks ever associated with financial tools, minimal or none experience with these tools on the state side, or an unknown general interest to use financial instruments by end-users. One example of a wise use of the innovative financial instruments, which was presented by the general commissioner, is from the Czech banking sector. There are no problems with high interest rates or a liquidity of Czech banks and therefore the best interest of the Czech state is not to offer loans with lower interest rates than those available on the market. However, many possible applications can be found where excessive levels of risk minimise liquidity in the field, therefore the offering of guarantees through the innovative financial instruments might be a better way.

As an additional consideration, innovative financial instruments might revive the role of financial markets in the Czech Republic. As a variety of projects could become attractive to private investors after adjusting the level of risk thanks to guarantees, 'cheap' equity investments and other tools implemented through financial instruments, the Czech financial markets might grow. On the other side, a moral hazard could arise and maybe even create some kind of a market bubble. The use of certain schemas could also increase attractiveness due to a concentration of projects or their combined scale. Such schemas offer diversification but can also standardise information, provide networking opportunities and other synergies. Overall, the final consequences of the implementation of innovative financial instruments can reach as far as higher competitiveness and the boosting of the economy.

3 Energy Efficiency Programmes

The ways energy is used and also sourced nowadays is undergoing a rapid transformation. Changes in a portfolio of primary energy sources can be observed, with the increasing role of renewables especially in the European Union, and the more and more ways in which these primary sources can be used are being rethought. An example of this is the focus on the energy efficiency of houses, cars, appliances and countless other illustrations that could be pointed out. Energy efficiency is sometimes also referred to as the ‘first fuel’ or ‘hidden fuel’ and thanks to its large potential it is being addressed by both, end-users and political representatives. (International Energy Agency, 2014a) Due to huge negative externalities leading to air pollution and global warming, these topics are currently targeted by such organisations as the United Nations, the Organisation for Economic Co-operation and Development (OECD), and the European Union. Moreover, the number and intensity of initiatives in which the use of energies is addressed speaks for itself about the urgency of this up to date topic.

3.1 Organisations and their focus on energy efficiency

In this section we describe public organisations with an influence on planning and creation of legislatives on a worldwide level or for a significant group of countries. These organisations are also responsible for the analytical support behind public initiatives. In our case that would be for example documents about energy consumption, or Ex-Ante and Ex-Post analyses of regulations from any energy field. An important part of the operations of these bodies is co-operation, support and advice to specific groups tackling energy challenges. These organisations also work as hubs where information from all important partners are collected and communicated, therefore we can consider their reports and other publications as a highly relevant source of complex information.

3.1.1 United Nations

The first World Climate Conference had already taken place in 1979 after the auspices of the United Nation. Since then, there have been a number of panels, initiatives and conferences focused on energy efficiency and climate change formed by the United Nations. There are two important topics that are in a locus of interest for this study. First, the accessibility and consumption of energies, especially in connection with the energy efficiency. A publication ‘Realizing the Potential of Energy Efficiency – Targets, Policies, and Measures for G8 Countries’ (Expert Group on Energy Efficiency,

2007) summarises actual needs, practices and other initiatives focused on this field. The second topic is global warming and an urgency to stop it to prevent irretrievable changes in our global climate. The Framework Convention on Climate Change in an organisational body of the United Nations focused on this field. Its successes count for a very recent adoption of the Paris Agreement (United Nations, 2015), which is not a binding document nevertheless it presents an understanding that global warming is, at least partly, caused by human activity and that there is an urgent need to change these trends by all members of the United Nations. Other significant achievements are the Kyoto Protocol or the Doha Amendment.

The international negotiations about targeting of the climate changes are very difficult and time consuming which can be demonstrated on the Kyoto Protocol, which legally binds developed countries to emission reduction targets." (United Nations, 2015) This Protocol had been adopted already in 1997 but it took eight years until it entered into force in 2005. The first binding commitment period started three years later, in 2008, and ended in 2012. Now, the second commitment period is taking place until the 2020. (United Nations, 2015) This long-term perspective and complexity of the complete process, from adoption to actual implementation and realisation of causes, is one of the reasons, stressing out an urgency to start as soon as possible. The newly adopted Paris Agreement might be the game-changing milestone leading to a global reaction, which however inevitably consist of many small initiatives.

3.1.2 Organisation for Economic Co-operation and Development, and International Energy Agency

The OECD established an autonomous organisation that is focused primarily on everything related to energy and its future, the International Energy Agency. This agency was founded in 1974 to co-ordinate all the member states of the OECD to respond collectively to the then major disruption in supplies of oil. Since then, the agency has expended its focus to the majority of energy sources, including the 'first fuel', and it focuses also on non-member states. The agency collects and analyses information about the main energy sources and types, as natural gas, coal, oil, renewables, electricity or CO_2 emissions. In a library of its own publications of the agency it is possible to also find projections of future development on fields of IT and technology but also energy policies. Most of the publications are issued on a quarterly or annual basis, therefore actual data and trends can be found in these publications. This data is also well suited for back-testing and potentially an updating of expectations and policies. As an OECD member, the Czech Republic can also discuss its plans or existing legislation connected in any way to energy with the International Energy Agency. With respect to energy efficiency programmes we would point out two reports issued on an annual basis – the World Energy Outlook 2014 (2014b) and the Energy Efficiency Market Report 2015 (2015a). The names are self-explanatory but it is important to mention that these reports also present the best practices, goals and impacts of individual initiatives, and predictions of the International Energy Agency about future development over the member countries of the OECD.

3.1.3 European Union, and European Commission

For the Czech Republic, the most important organisation is the European Union and especially the European Commission because of its influence on Czech legislation. The European Union also influences the size and shape of supporting programmes aiming at energy efficiency even though the creation of such initiatives is often a competence of individual member states. The European Union is one of the most active and also the most ambitious organisation which is presented by the number and size of energy initiatives, and also its ambitious strategies and visions. Throughout these strategies we can find a number of goals, describing usually how much should this or that indicator decrease or increase by a specific year, or what needs to be done to increase the energy security of the European Union. We specify the main goals further in the text.

There are four main strategies focused on energy topics in the European Union:

- 2020 Energy strategy
- 2030 Energy strategy
- 2050 Energy strategy
- Energy Security Strategy.

These strategies give a global, on the European level, framework and targets that are further translated to individual member states, where state authorities can aim public initiatives to specific needs of their countries and also with respect to local conditions and experience.

The European Union (2015a) stresses that all previously mentioned strategies were formulated with respect to three main drivers:

- Security of energy supplies wherever and whenever needed
- Competitive environment among energy providers ensuring affordable prices for everyone, especially homes, businesses and industries

- Sustainable energy consumption thanks to low greenhouse gas emissions, pollution and minimal fossil fuel dependency.

All the drivers consist of many significant challenges that need to be tackled as soon as possible. Even if many of them would have negative short-term or even medium-term pay-out, they will pay off in the long run. The main reasons why it is important to tackle these challenges that we face are the high dependency of the European Union on imports of energy (currently about 50% worth around 350 billion EUR per year), conflicts in regions rich with energy sources, scarcity of such sources, but also many positive implications – improved competitiveness, economic growth, job creation and many others. (European Commission, 2012)

3.2 European Union strategies

3.2.1 2020 Energy strategy

This first strategy is already being implemented nowadays through a number of adopted action plans. There are four main targets communicated to the public in a form of minimal values that are about to be reached by 2020 in the European Union. All the values were already set in comparison to the then projections in 2007 by the European Council. (European Commission, 2014c) The first one is to reduce greenhouse emissions by 20%, the second one is to increase a share of renewables to 20% of electricity consumption and the third one is to achieve energy savings of 20%. The last one goes from the line of the previous ones, this target does not challenge the overall performance of the European Union, instead it challenges individual member states to achieve minimal 10% share of renewable energy in transportation. (European Commission, 2010)

To tackle and meet these four challenging targets the European Commission (2011a) set five priorities that should help member states to reach the targets.

Priority 1: Promote energy efficiency initiatives to make European Union energy efficient.

Actions leading to the reaching of this priority should focus on the huge potentials of energy savings that were identified in buildings and transportation. Several of the projects that have already been implemented are discussed in the following text. Another set of actions focuses on the increase of competition and competitiveness, especially by making industries more efficient. Already existing examples of these actions would be detailed energy labels or widening eco-design requirements for energy intensive industries. Not only the use of sources by end-users or a centralised power plant but also a distribution of energies is in a locus of the European Union. Energy savings through cogeneration, smart grids, efficient boilers and other advanced technologies are promoted. Even though the majority of such actions are implemented through the action plans of individual member states there is still a need to aggregate and evaluate data through the monitoring of measurable objectives and comprehensive benchmarking. These activities are better performed on the European level, where good practices can be shared too.

Priority 2: Ensure free movement of energies by building a pan-European integrated energy market

This priority needs to concern three ways of approaching. The first action needs to prepare appropriate frameworks, procedures and legislation to allow all stakeholders to have equal and transparent possibilities and rights. The second action, connecting and improving the networks, seems to be more practical, because it allows us to observe some tangible assets. An established blueprint of infrastructure supports creation of such assets. The importance of robust networks is increasingly important as the capacity of renewables increases and the volatility of their energy supplies tests a stability of existing networks. (European Commission, 2010) The third action is close to the second one in that it speaks about establishing of specific agencies, standards and rules that would ensure the robustness of the networks. Thanks to permits procedures the public authorities could influence a form of the networks, their interconnectivity and their ability to ensure maximum access to energies for end-users. Finally, due to the fact that these intended improvements in the infrastructure are financially heavy investments, the European Union needs to prepare appropriate instruments supporting financial investments in these improvements. These instruments need to motivate private investors to put their funds in the improvements. Such motivation can be supported in several ways, for example with public guarantees or with co-financing together with public funds.

Priority 3: Achieve the highest possible safety and security for citizens and businesses

Not only is it important to ensure the stability and reachability of energy supplies in the European Union but even more important, it is to prevent ecological and lives-threatening accidents. Therefore, safety conditions of energy sources extraction as well as their later use need to be reviewed and pushed to the maximum reasonable limits in order to prevent any major accidents. A significant threat, with respect to the Czech Republic, are nuclear power plants placed locally but also in other European states. Similar threats might come in the future from newly developed technologies, for example with highly explosive hydrogen. The second, however no less important action needs to be taken in order to ensure consumer-friendly approach, while keeping or increasing market competition between suppliers. Consumers should have access to energies at affordable prices while suppliers should become more service oriented with the possibility to gain a reasonable profit.

Priority 4: Unhide low-carbon future making a technological shift

Research, development and innovation are crucial for the European union to maintain and possibly also extend its leadership in this field of focus. With six industrial initiatives – wind, solar, bio energy, smart grids, nuclear fission, and carbon capture and storage, the European union should ensure funding for these segments. Another set of actions aim at huge and highly expensive projects leading to a low-carbon future. One of them is a support of smart electricity grids bringing ‘green’ energy to consumers. The second project is aimed at building a leadership on electricity storage, again allowing the use of ‘green’ energy more efficiently. Support of a second generation of biofuels is aimed at technological progress and also at establishing large-scale biofuel production. Finally, there is a project called the ‘Smart Cities’ innovation partnership, which connects several initiatives together to improve the quality of living in cities. This project supports energy savings, the clean mobility of electro mobiles, smart grids and a number of others.

Priority 5: Strengthening international partnerships with significant partners outside of the European Union

So far we have been discussing mainly the situation within the European Union but the Energy Outlook 2014 (2014b) shows the Union is highly dependent on imports of energy sources, especially fossil fuels from neighbouring countries. The first action tries to also join the neighbouring countries to the European energy networks, while this co-operation is directed by European law. The second planned action is very close to the first one as it describes the establishment of privileged partnerships, for example with Norway or Turkey. The European Union with its joined energy market should also take further actions to promote its global role including export of its thoughts, regulations and last but not least, new technologies and other innovations. Similar to that it is also very important for the European Union to play one of the leading roles on a field of security. Mainly, nuclear energy needs to be addressed worldwide because possible negative externalities resulting from a nuclear accident might be global too.

3.2.2 2030 Energy strategy

All member states of the European Union also agreed on a longer perspective strategy than already described 2020 Energy strategy. More precisely, strategies for a period between 2020 and 2030, but also an even longer perspective for the following period until 2050, have been negotiated and agreed. The European Commission (2014c) should ensure similar objectives that were discussed in the previous chapter, the 2020 Energy strategy, however the targets are set to be challenging again. The objectives that are specified for this period are stronger competition and more secured and sustainable energy systems that will lead to massive reduction of greenhouse emissions and consequently also stop global warming by 2050.

The reasoning behind setting up these far looking strategies is clear. The European commission (2015a) “sends a strong signal to the market, encouraging private investment in new pipelines, electricity networks, and low-carbon technology.” All the forthcoming huge investments will need to be not only political will but they need to be economically viable and cost-efficient. These conditions should not be out of reach because it is already known that there is not a substantial difference between implementing energy efficient low-carbon technologies in comparison to classical energy systems that will have to be replaced in any case. (European Commission, 2014a)

Currently the targets that the European Union aim at are:

- 40% decrease of greenhouse gas emissions (compared to 1990 values)
- 27% energy consumption generated by renewables
- 27% extra energy savings compared to business-as-usual scenario.

Again these values are meant as minimum values. Moreover, these values can still change, as this has already happened. In the document ‘A policy framework for climate and energy in the period from 2020 to 2030’ (2014c) the values were set to 8%, respectively 3%, lower in comparison to those mentioned above.

It is proposed by the European Commission (ec.europa.eu, 2015a) to achieve these targets through reformed emissions trading, new indicators for security and competitiveness of energy systems and a combination of common European Union approach with individual action plans of the member states that will ensure stronger investors certainty. It is already clear nowadays that co-operation and coherence has to be present in relations between the European Union and individual member states but maybe even more importantly between public and private investors.

3.2.3 2050 Energy strategy

As an energy interdependency of the European Union countries grows, a decision of one country can have a big impact on others. Therefore, the European energy market needs to work as one. There is a need for co-ordination, to ensure all the previously described objectives and targets. On the other hand, there are positive externalities of the bigger common energy market, such as economies of scale or wider access to capital for capital-intensive investments. (European Commission, 2014d)

The currently prevailing conclusion is that the decarbonisation of energy systems is economically and technically feasible in the long run. The Energy Roadmap 2050 (European Commission, 2014d) set out four main ways to reach the main long-term goal which was politically determined as a reduction of greenhouse gas emissions by as much as 80 to 95 per cent of the emissions in 1990 within the whole European Union. The main means to reach this ambitious goal are energy efficiency, nuclear energy, renewable energy, and carbon capture and storage.

3.2.4 Energy Security Strategy

Released in May 2014 the Energy Security Strategy (European Commission, 2014e) is aimed mainly at the energy imports dependency of European Union countries. The 'In-depth study of European Energy Security' (European Commission, 2014h) points out several possible problems of the energy dependency, especially with respect to crude oil and natural gas, where imports reach up to 90% and 66% of the total consumption. The urgency for action is caused also by the fact that many countries of the European Union are reliant entirely on Russia. The risks and impacts of the severe shortage of any source of energy were manifested for example in 2009 due to a dispute between Russia and Ukraine as a transit country (European Commission, 2014e). The current situation in Ukraine, Syria and many other places of army conflicts as well as problematic relations between the European Union and Russia push these risks to previously unknown levels.

A so-called energy security stress test of 38 European countries from the winter of 2014-2015 helped to specify objectives that should be addressed in order to ensure energy security of the European Union. (European Commission, 2014b) These objectives are further translated into the Energy Security Strategy as needs: to increase interconnectedness between European Union countries, speaking about trade and transit capacities; to lower demand by increasing energy efficiency; to diversify suppliers; and strengthening emergency and solidarity mechanisms.

3.3 Benefits of energy efficiency

One of the most frequently repeated objective is energy efficiency. We described several strategies how this grail is approached and what are the short-term, medium-term and also long-term goals to reach energy efficiency. In this section we describe more closely what the benefits of such improvements are and how to achieve them.

According to recent research of the International Energy Agency 'Capturing the Multiple Benefits of Energy Efficiency' (2014a) benefits of energy improvements go far beyond a classical understanding, which takes into account mainly reduced energy demand with corresponding savings and the lowering of greenhouse gas emissions representing global warming. As can be seen in the following Figure 3.1, the impacts reach far beyond classical opinion and there are several other benefits, often addressed as 'multiple benefits'. Moreover, these benefits do not influence only a prime investor, often also being the end-user too, of the energy efficiency improvements but through positive externalities, it influences many other stakeholders. The aim of the application of the multiple benefits analysis is to capture and measure as much of these externalities and benefits as possible.

Knowing the value of the overall benefits of individual projects requires a deep knowledge and understanding of the multiple implications. The actual process of assessment might be very costly and time-consuming to do. On the other hand, frequently the value of multiple benefits can fundamentally change the original decision to invest or not to invest at all, which makes such analysis valuable. Nonetheless, in many cases an exact value of the multiple benefits is not necessary and an overall polarity, knowledge if the value is positive or negative, is sufficient.

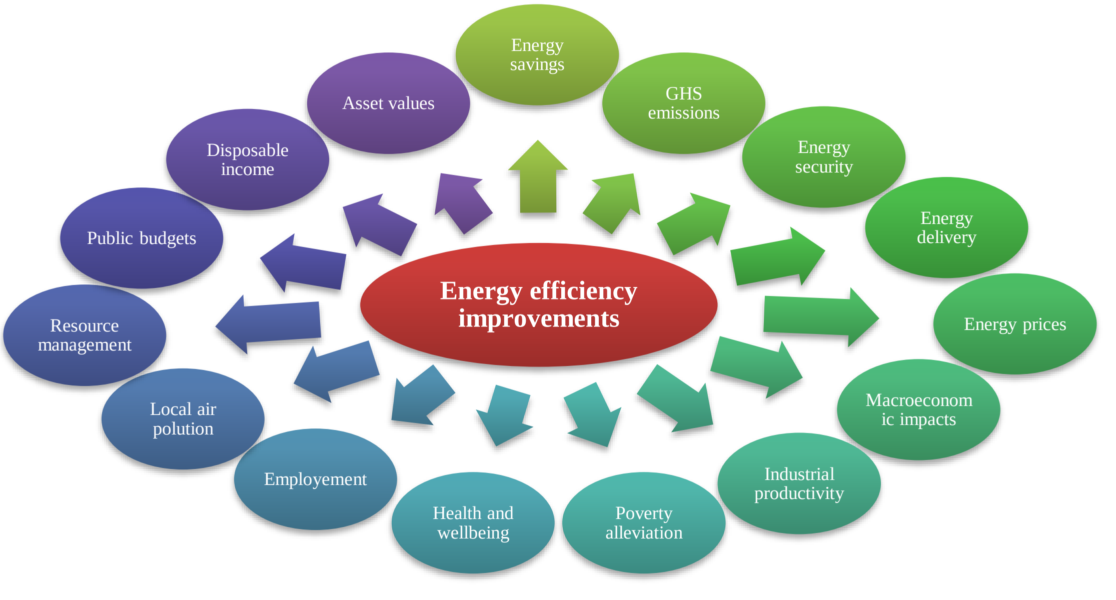

Figure 3.1: Multiple benefits of energy efficiency improvements

Souce: International Energy Agency (2014a).

Multiple benefits can be divided into five major groups: enhancing sustainability of energy systems, economic development, social development, environmental sustainability and increasing prosperity. Even though, all these benefits improve both, wealth and welfare, their prioritisation varies between individual countries. “Lack of critical data and the absence of mature methodologies to measure scope and scale” of multiple benefits results in mainly qualitative assessment, which can be misleading. (International Energy Agency, 2014a, p. 21) The second issue of currently prevailing approaches is that they do not consider the so-called ‘rebound effect’. This effect describes better the reality of when energy savings do not result in savings from an overall consumption. In fact, financial savings created by lower energy consumption are reinvested in more goods and services.

The rebound effect can be further split into three sub-effects that drive the resulting effect. The first effect is the so-called ‘take-back-effect’ which describes a situation when end-users increase their consumption instead of enjoying the same level of services at lower energy consumption and lower costs too. An example might be a situation when a small fridge is replaced by a more energy efficient one but at the same time a much bigger one, which results in the energy consumption of both being the same. The second effect is called the ‘spending effect’ which is very close to the first one but in this case the end-user would invest into another energy-consuming thing or activity. The third remaining effect is called the ‘investment effect’ and it describes a situation when a public stimulation of investments in energy efficiency leads to an indirect increase in energy consumption and economic activity. For example, when a subsidy into energy efficiency of a firm increases its competitiveness. Consequently, also the total output of this firm would increase to such a scale that the firm consumes much more energy than it would use before for the lower output.

The multiple benefits take shape in five overarching areas of impacts. These areas and especially their impacts are: macroeconomic impacts, impacts on public budgets, influences on health and well-being, also impacts on industries and energy delivery. In five upcoming chapters we describe impacts of energy efficiency improvements inspired by an in-depth analysis of the International Energy Agency ‘Capturing the Multiple Benefits of Energy Efficiency’ (2014a).

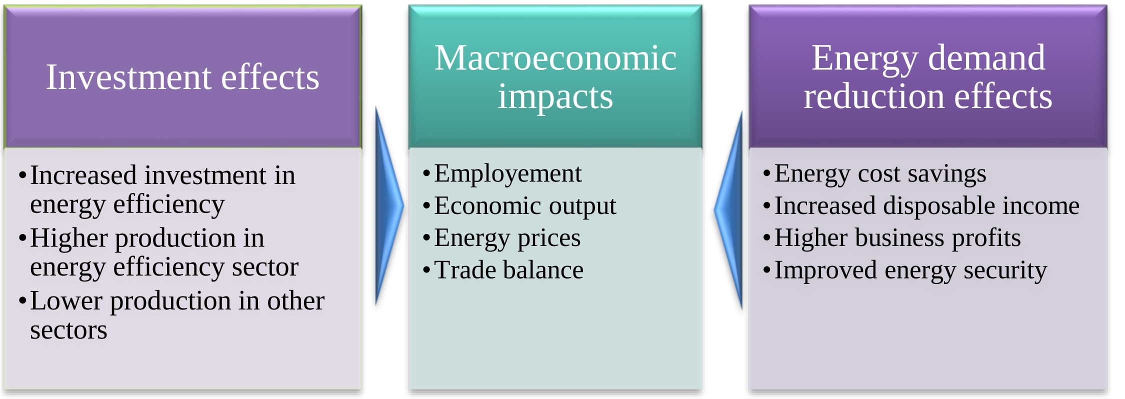

Figure 3.2: Energy demand reduction effect

Source: International Energy Agency (2014a).

3.3.1 Macroeconomic impacts of energy efficiency

The variety of macroeconomic impacts is manifested mainly by economic growth, employment rate, price changes and changes of trade balances. Speaking about the economic growth resulting from energy efficiency initiatives, it ranges from 0.25% to 1.1% measured by GDP. At the same time, it was observed that on average 8 to 27 job-years[2] are created by 1 million EUR investments in energy efficiency. The evidence from price and trade balances is not so clear as there are both winners and losers, speaking about countries, specific companies or end-users. These numbers also result from a total macroeconomic rebound effect that Barker, Dagoumas and Rubin (2009) estimated to count for 31% of the previously described effects by 2020, rising up to 52% by 2030. Figure 3.2 shows what the investment effects and effects of energy demand reduction are.

All the individual effects form a mix of partly positive and partly negative impacts on the overall macroeconomic performance. This mixture results in a number of benefits but it also challenges the relationship between energy performance and economic growth. Therefore, the reasonability of energy investments might be questioned but the evidence and measured values speak in favour of the energy efficiency improvements.

[2] Measured as one full-time position lasting all year long. However, one job-year might be as well represented by two full-time positions lasting six months or accordingly.

3.3.2 Public budget impacts of energy efficiency

General misperception about energy efficiency support, which is meant to cause mainly expenditures for public budgets, can be corrected by applying multiple benefits analysis that can quantify value of created benefits. The benefits for public budgets that should be considered are additional tax revenues, lowered costs of unemployment, social welfare and, consequently to all of it, a higher return on public investments. Impacts of investment effects and effects of energy reduction on public budgets are sorted in Figure 3.3. Again a mix of positive and negative impacts can be observed but the negative ones are outweighed by the positive ones. For example, by expanding markets with energy efficiency, and especially energy efficient goods and services, any public budget revenues lost due to lower energy excise duty or carbon taxes are heavily offset.

Energy efficiency support does not need to target only general public and companies but there is also a huge almost untouched energy savings potential within the public sector itself. The study 'Multiple benefits of investing in energy efficient renovation of buildings' by Copenhagen Economics (2012) estimates the potential of public buildings renovation within the European Union to value between 97 and 112 billion USD annually (compare to 56 billion annual investments) with a potential to create 760 000 jobs. When broader benefits would be considered then the savings increase by about 50% to 147 and 230 billion USD.

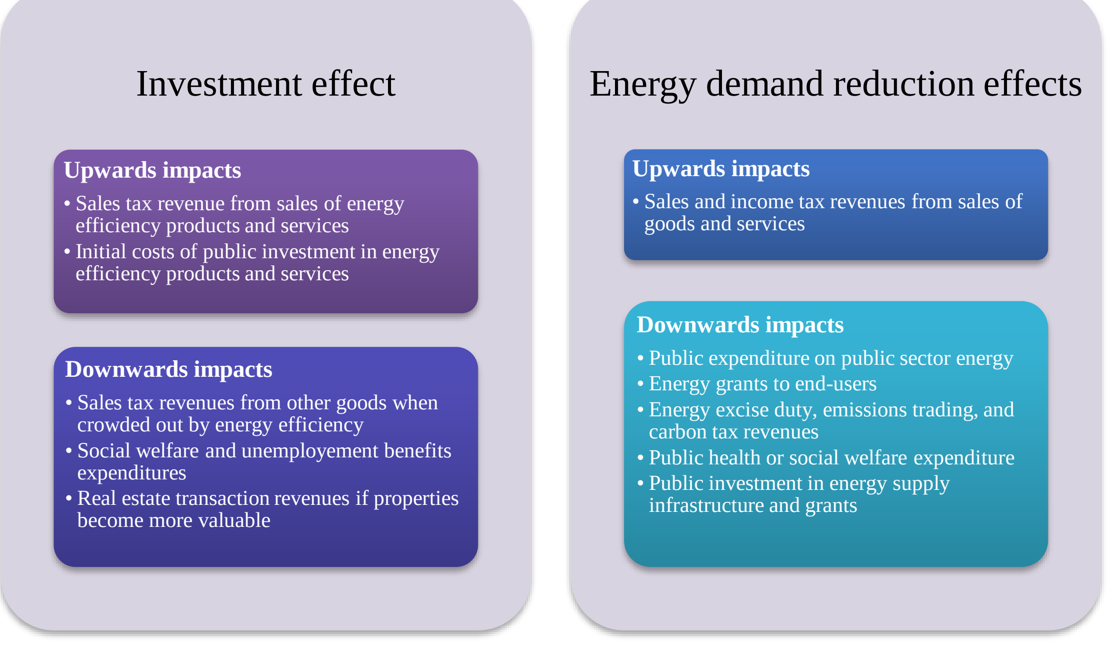

Figure 3.3: Public budget impacts of energy efficiency expansion

Source: Author inspired by International Energy Agency (2014a).

3.3.3 Health and well-being impacts of energy efficiency

Improved energy efficiency, especially in buildings, impacts also health and well-being of occupants. By improving conditions of living, positive impacts are the strongest among vulnerable people. Groups including children, elderly and people with already pre-existing health problem are among the most vulnerable. The majority of people might think about respiratory diseases that can be tackled through energy efficiency but there are several other benefits which are not so obvious in developed and post-developed countries. Still many people in such countries could enjoy benefits that prevent from excess winter mortality, mortality from dehydration or mental illnesses. When focusing on the Czech Republic the mental health might be the most contemporary topic as anxiety, depression, stress and worries about physical health can be positively influenced.

The fatal impacts are often highly correlated with fuel poverty but even when we analyse average impacts of energy improvements, the benefits are not negligible. Figure 3.4 presents connections and a series of impacts, which are not normally considered to be interconnected. For example, bad or missing insulation can influence the seriousness and frequency of respiration illnesses of children that cannot attend school and due to absence, their academic performance is poor which might imply a rejection when applying to a university and that can completely change their lives. This may be too acrimonious an example as it focuses mainly on health but obviously we could speak about well-being in a similar way.

A case study from New Zealand about a heat-smart programme (Grimes, et al., 2011) proves that energy efficiency improvements can also positively influence health and well-being in developed countries. This study quantifies multiple benefits and the

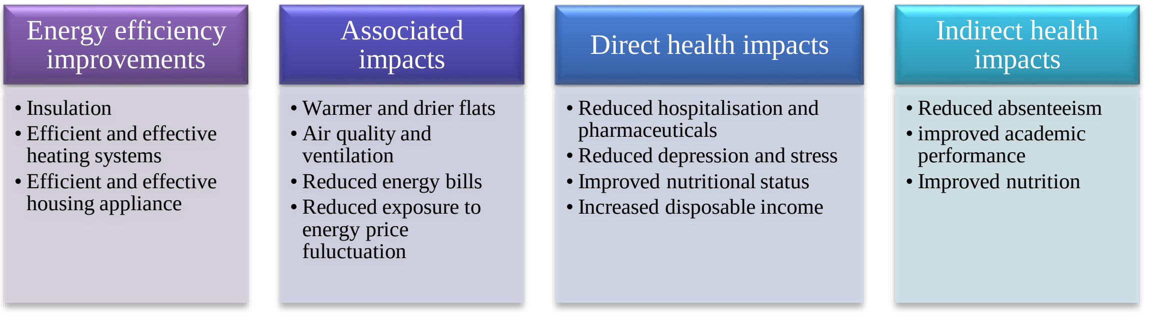

Figure 3.4: Health and well-being impacts of energy efficiency improvements

Souce: Author inspired by International Energy Agency (2014a).

overall benefit-cost ratio of a retrofit programme. Among several already described impacts, savings on public health spending were identified as the major one. The overall benefit-cost ratio was as high as 4:1 with three fourths of total benefits staying for health benefits and one fourth to well-being.

3.3.4 Industrial sector impacts of energy efficiency

The ability to quantify impacts of energy efficiency improvements can play a fundamental role in an investment decision on energy efficiency. These decisions are strategically important for small businesses as well as bigger ones, because they can essentially influence the competitiveness of any business. Thanks to reduced costs, increased value of assets or mitigated risks, businesses can realise multiple benefits across their value chain. Generally, such benefits can effect competitiveness, production, operations and maintenance, working environment, and environment.

Assessing multiple benefits properly in the industrial sector is more important than in any other because this sector has the opportunity to influence a wide range of stakeholders. Starting with employees and ending with general public influences through externalities, but the industrial sector itself is being influenced through its surrounding too. One of the key areas for businesses is the political environment responsible for setting the rules of the game. Here are roots of a key challenge for policy makers that need to consider multiple stakeholders with different needs and goals. With a potential to support any business and consequently also to influence competition, as we already described, there is a call for a collaboration and reasonable measures, allowing to make a qualified decision under ever present uncertainty.

3.3.5 Energy delivery impacts of energy efficiency

At first glance, the situation of energy providers is not so promising with respect to energy savings that cut down from amounts of energy sold but a closer look through the multiple benefits analysis shows that the situation does not need to end up badly for the providers. In fact, both, consumers and providers of the energy, can be better off. Among all the benefits from energy efficiency that we discussed previously, lower energy bills still seem to be the most attractive ones for consumers. The situation of the providers is more complex and requires much deeper analysis. The fact that energy efficiency acts as a disruption for the traditional business model of the energy providers, who have been used to maximise their profit by selling more units of energy or by increasing price of energy units. Nowadays, both of these classical ways are challenged, energy efficient projects result in lower demand and market prices of energies are decreasing or stable under existing conditions. A new business model of the energy

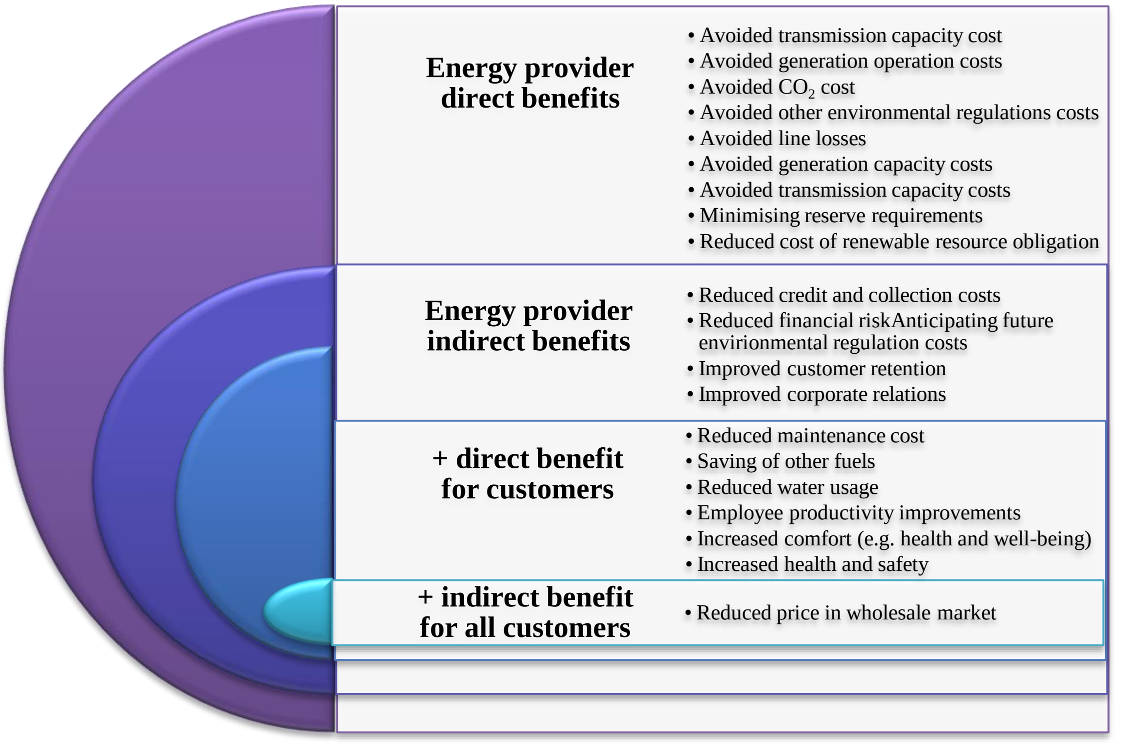

Figure 3.5: Energy provider multiple benefits arising from energy efficiency

Source: Author inspired by International Energy Agency (2014a).

companies might address an opportunity to become a provider of energy services. It means, maybe a little bit contra-intuitively, for example to deliver benefits through energy efficiency projects to customers.

These services can be profitable for the providers when multiple direct and indirect benefits of the lowered energy consumption implied from improved efficiency are considered. The Figure 3.5 presents the most important benefits. As you can see, the number of benefits to providers is in fact quite high. In any case, to resolve it, we need to consider mainly quantitative impacts compared to qualitative ones. The case of American Vermont energy provider (2012) shows that by assessing a broad range of multiple benefits in a business model means the overall benefit-cost ratio for energy services can be positive for the providers, in this case it was 2.3:1. Moreover, when water, fossil fuels and electricity saving were incorporated to the assessment the benefit-cost ratio reached 2.9:1.

4 Methodology

With a primary focus on the Czech Republic, we analyse and assess opportunities and potential of currently still expanding energy efficiency initiatives. Starting with an assessment of energy positions of the Czech Republic with respect to demand and supply of energies and also respecting the already described European Union energy strategies. These strategies need to be converted to local strategies and action plans respecting specific conditions in the Czech Republic, which we also consider. The aim of the first step of our analysis is to isolate the segment with the most promising trade-off between potential size, attractiveness, benefit-cost ratio and feasibility. We look for a segment with a positive economic rate of return that is marginalised by private investors and therefore it would make sense to support it publically.

Throughout our first step of the selection, the potential size is important because we expect a direct proportion between the potential size of the segment and the value of arising benefits. However, we also consider trends in the segments, for example with regards to historical development of energy efficiency. The selected segment needs to be attractive not only for the end-users, who will recognise the direct benefits, but also for investors of the later selected instrument. By investors, in this case we mean subjects who provide funds for the improvements realisation. These can be the end-users themselves but also entities such as the state, European Union or private investors seeking return on their investments. We search for a segment where actions and especially public support make economic sense. The benefit-cost ratio allows us to select the segment not only on the basis of qualitative information but also on quantitative information. Finally, the feasibility of our recommendation is very important for our study as we want to find a way in which it would be acceptable for a maximum number of stakeholders. In cases where contradicting motives of various stakeholders occur, we firstly consider if such a reason was so-called 'no-go'[3] for the specific stakeholder and

[3] 'No-go' status describe a situation in which a specific subject is not willing or cannot make any compromise and at the same time this subject is able to stop or even end the whole initiative.

if yes, then secondly we consider the total combined value of all the benefits.[4] In another case, we try to find a compromise.

Next, we look for appropriate ways of supporting energy efficiency within the selected segment. By gathering experience from relevant local and foreign programmes and initiatives, including the maximum reachable related information we want to prepare a base, to be able to choose appropriate instruments for the public support in the selected segment. We search for various forms, procedures and impacts of the verified instruments and assess these aspects with respect to the previously selected segment. Respecting the historical experience of both, qualitative and quantitative, measures that are obtainable we select the most appropriate instrument for further analysis. In the case that we would not be able to find the appropriate match, we would reconsider the selection from the first step.

For the third step we combine data acquired throughout all the prior phases of the analysis to build an overall picture combining the selected segment and instrument. Having the first version of said picture, we assume a need for additional information, which allows us to perform the upcoming steps of the analysis. With a complete and complex knowledge of the existing and historical situation, we proceed to the next step.

With respect to all previous steps we choose an appropriate method to simulate and assess the resulting situation with the hypothetical instrument. Our model needs to evaluate the current situation as it is today. This As-Is analysis helps us to select a couple of the most relevant settings of the instrument that are further processed. Next, these settings are further applied to simulations that already consider time dimension and uncertainties in assumptions that have to be considered. We use the Monte Carlo simulations and sensitivity analyses to tackle the uncertainty in assumptions. Due to the complexity of the simulations we assume to use a number of indicators to describe the best approach and its parameters. The relevant indicators might be a net present value, benefit-cost ratio, internal rate of return, payback period or others. In the case that there would be more significantly different approaches with similar values of the overall benefits, we might present all of them.

Throughout our study we also look for answers to the three main hypotheses aiming to assess suitability and potential impacts of energy efficiency initiative and also

[4] Benefits in this case might reach both positive and negative values, depending on a specific stakeholder.

application of an innovative financial instrument. Therefore, we need to find an appropriate segment and also show a reasoning around a selection of the most appropriate instruments to tackle energy efficiency challenges within the selected segment, if it is an innovative financial instrument or not. This also means to answer three of our main hypotheses that question these key points. To assess the advantages and disadvantages, and also to compare the performance of innovative financial instruments against common grants we answer the first hypothesis – 'The innovative financial instruments offer a valuable alternative to traditional public grants which is interesting for both the public and private sector.' We also want to assess a time dimension of the recommended hypothetical initiative, if it is most likely to be a single time action or if it creates a schema sustainable over a period of time. To do so, we assess the second hypothesis – 'The financial schema using innovative financial instruments can be sustainable in the long-run.' The last hypothesis outpaces a couple of previously described steps now but it addresses a combination of a later selected segment and instrument – 'The innovative financial instruments for the energy efficiency of Czech households would be more effective than that already used in incentive schemas.'

We decided to describe and explain the reasoning behind individual approaches and methodologies used in relevant chapters. As we apply multiple concepts and methodologies throughout our analysis, we find it confusing to describe them all in one chapter. We prefer to use an approach that connects the description of individual methodologies with their application. Due to the same reasons, we use an identical approach when presenting individual data sets.

5 Segment and instruments selection

5.1 Selection of an appropriate segment for simulation

In order to select the most appropriate sector or even a more specific segment with a reasonable need for public intervention we assess energy consumption, efficiency of energy use, potential of energy improvements, the current situation and the wishes of the general public in the Czech Republic. In this part of our analysis we apply both, quantitative and qualitative assessments. In the quantitative part, we analyse data from statistical offices and numerical results of other studies. Simultaneously, we consider our personal experience, common sense and findings of other institutions or studies that are more of the qualitative character.

5.1.1 Energy consumption and efficiency in the Czech Republic

We analyse data only related to the Czech Republic and more precisely the total yearly amount of energy delivered to end-users and the total energy consumption by the same group and the same time period. This data is available at the Czech and European statistical offices. We use long time series to search for long-term trends but at the same time we also consider the absolute and relative values of individual segments or sectors.

For our analysis, we combine two statistical data sets. First, we use a data set from the European Union statistical office, Eurostat, about the total final amount of all energy sources delivered or consumed by Czech end-users. This data is sometimes also addressed as the total energy consumption but to prevent a possible confusion with our second data set, which also describes energy consumption in a sense of exploitation, we will address it as the amount of energy delivered. The first data describes a sum of total amounts of different energy sources delivered. To make the different types of energy sources comparable, a unit called tonnes of oil equivalent[5] (TOE) is used. One unit of TOE is equivalent to the amount of energy released from burning one tonne of crude oil. Similarly, all other energy sources can be evaluated with TOE and therefore

[5] A single unit of TOE is an equivalent to 41.686 GJ or 11.63 MWh acording to a convention of the International Energy Agency.

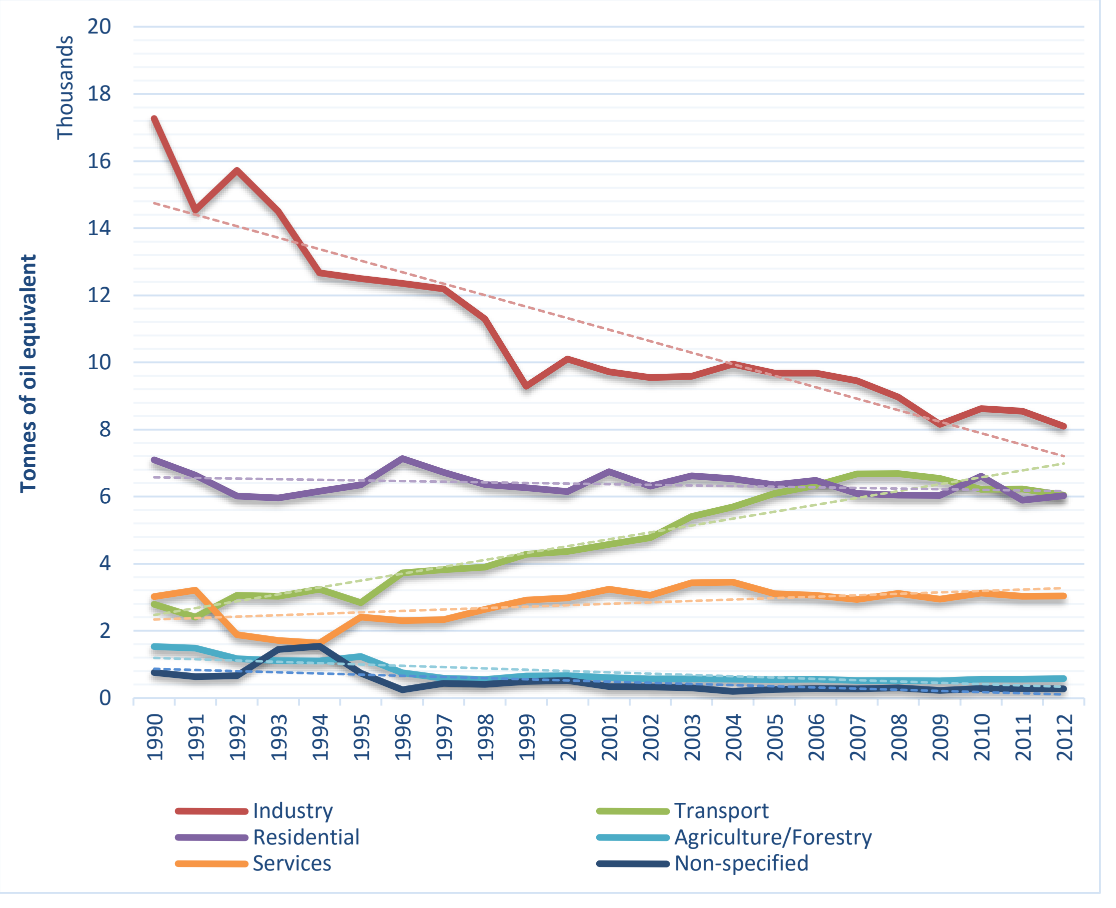

Figure 5.1: Consumption of energy sources in the Czech Republic by segments

Source: Eurostat.

compared. Our second data set comes from a database of the Czech Statistical Office (CZSO) and it describes a quantity of energy consumed or used. In this case, the consumption describes energy exploited from the energy sources or in different words a quantity of joules that end-users effectively use to power their activities.

Figure 5.1 presents a development of the amount of yearly energy delivery in individual segments between the years 1990 and 2012. This measure presents sums of different energy sources divided by segments of their delivery. Overall, the total final amount of delivered energy sources to all end-users lowered by 26% between the years 1990 and 2012. However, not all individual segments demonstrate the same trend. As we can observe segments with also increasing or a stable amount of energy delivered.

By combining the two data sets we calculate a relative efficiency of energy consumption in the Czech Republic. Our approach can be described by the equation:

$$Efficiency\ of\ energy\ consumption = \frac{Amount\ of\ energy\ sources\ delivered}{Quantity\ of\ energy\ consumed\ (used)} \left[\frac{TOE}{J}\right]$$

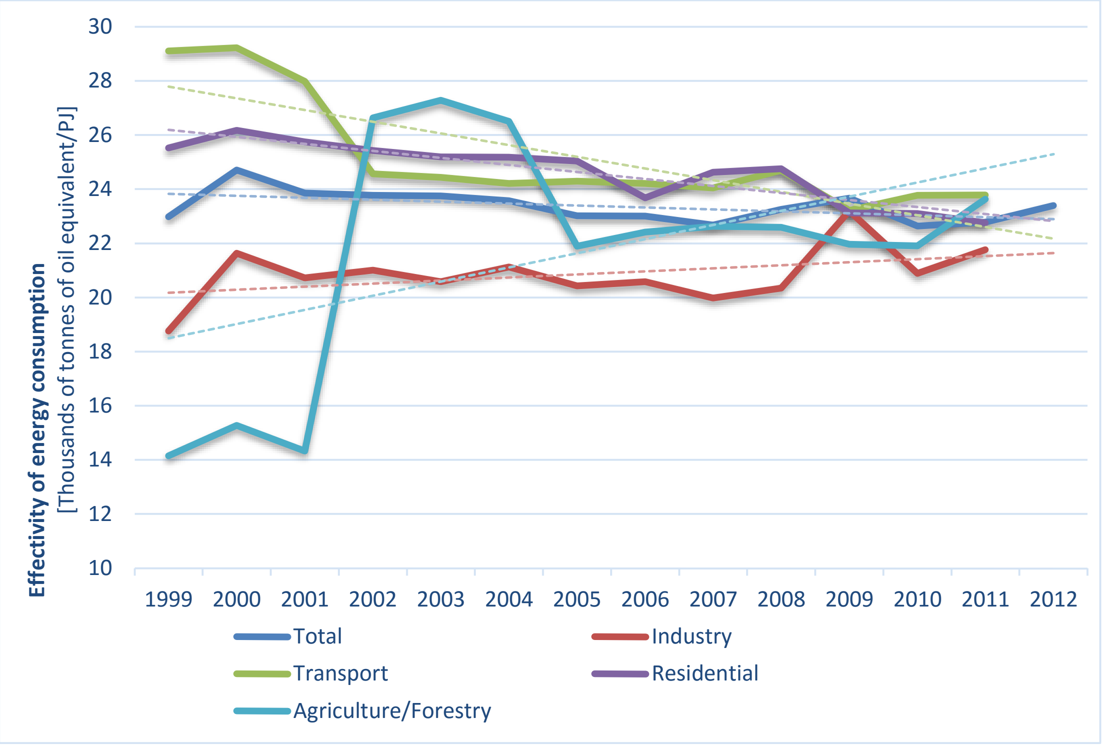

Figure 5.2: Efficiency of energy consumption in the Czech Republic by segments

Source: Author based on data from Eurostat and CZSO.

As the segments in both data sets are the same we can use finding from both of them for a comparable assessment. Unfortunately, the time series about quantities of energy used from the CZSO were available only for the period between the years 1999 and 2012 and the last year is represented only by the total used consumption. Figure 5.2 presenting the calculated efficiency shows some fluctuation, especially in the agriculture/forestry segment but the trends in efficiency development are quite clear. Segments of transport and residential presented a slow, stable improving efficiency. The efficiency of industry decreased slightly as well as agricultural and forestry, where the fall of efficiency was much larger. Finally, convergence of efficiencies of all the segments can be seen, with the overall efficiency staying quite stable over the observed period, only with a very slight improvement from 23.0 kTOE per PJ in 1999 to 23.4 kTOE per PJ in 2012.

5.1.2 Specific characteristics of the individual segments of consumption

The most significant decrease in energy consumption can be observed in the segment called ‘industry’. This segment consists of all industrial operations apart from the consumption used primarily to generate other types of energy, mainly power stations. In 1990 it counted for 53.2% of the overall consumption with over 32 kTOE when in 2012 this amount was only 24 kTOE, which is an equivalent of 24.9% of the then overall consumption. Contrary to that, a slightly decreasing trend of energy efficiency consumption can be seen. The most likely explanation for this trend is a transition of the Czech economy from highly energy-intensive industries, for example metallurgy, to less energy demanding ones. The second possible driver here is most likely the improving of energy efficiency of classical uses that can be linked to cost savings but at the same time many more processes where energy is used were added. Impacts on the competitiveness of Czech firms would need to be further analysed on a more segmented or even individual basis.

Contrary to the industry segment, an increasing consumption can be seen in the transportation segment. The total consumption in this segment more than doubled over the observed period of time. When in 1990 the amount of energy consumed was 2.8 kTOE, 17 years later this amount reached 6.7 kTOE and started to decrease slightly. As this segment consists of the whole range of possible means of transportation from personal, through cargo, air, maritime, rail and all remaining, we could probably find several drivers of the consumption increase. We believe that this increasing trend is mainly caused by volume and not energy efficiency as we see a trend of improving efficiency of energy use (fuel-efficiency) in Figure 5.2.

The third very significant segment with respect to the amount of energy consumed is the residential segment. This segment consists of all residential but also non-residential buildings, buildings serving multiple purposes, mainly: public, private residence, commerce and administrative. Figure 5.1 shows reasonably stable consumption, ranging between 5.9 and 7.1 kTOE a year, which counts for 21% to 27% of the overall energy delivered to end-users. Since a significant amount of the energy counts for heating or cooling, as we describe in more detail later, part of the described variation might be caused mainly by temperatures in a given year. Therefore, it is important to also analyse the efficiency which seems to be increasing recently, by 13% from 2000 to 2011.

The remaining three categories – services, agriculture and forestry, and non-specified might have potential for energy improvements too. However as can be seen in the Figure 5.1, their size is much smaller than the three already described which is the reason why we do not assess them as closely as the previous ones.

5.1.3 Economically viable potential of energy efficiency

The International Energy Agency (2014a) assessed currently known and existing policies that target improvements in energy efficiency within four sectors – industry, transport, power generation and buildings. Figure 5.3 presents a proportion of already targeted potential by investors and by public authorities compared to the unrealised one. This figure shows a huge potential which is still untapped due to information noise, inadequate pricing of externalities or insufficient funds for realisation of such initiatives. A possible solution for the support of the energy efficiency projects might be to create a market for it, which might be created for example by improved knowledge about energy efficiency benefits. (International Energy Agency, 2014a, p. 32). To make energy efficiency marketable, we need to synthesise only projects that are economically viable. An economically viable investment is defined as a project with “the payback period for the up-front energy efficiency investment equal to or less than the amount of time an investor might be reasonably willing to wait to recover the cost, using the value of undiscounted fuel savings as a metric”. (International Energy Agency, 2012)

Figure 5.3 presents all three previously preselected segments for a public intervention. As these figures consider all polices known in the year 2014 in all the OECD countries, they do not need to be extremely precious or directly translated on conditions in the Czech Republic but still it is fairly clear where the biggest potential should be. Current policies are probably going to capture only one third of the total potential economically viable by 2035, which opens multiple opportunities to capture more of the potential. The sector of buildings, which is a sector corresponding to the residential segment described in previous paragraphs, presents the highest untapped potential. Over 80% of energy efficiency improvements, which would be economically viable, might be addressed by a new or updated initiatives.

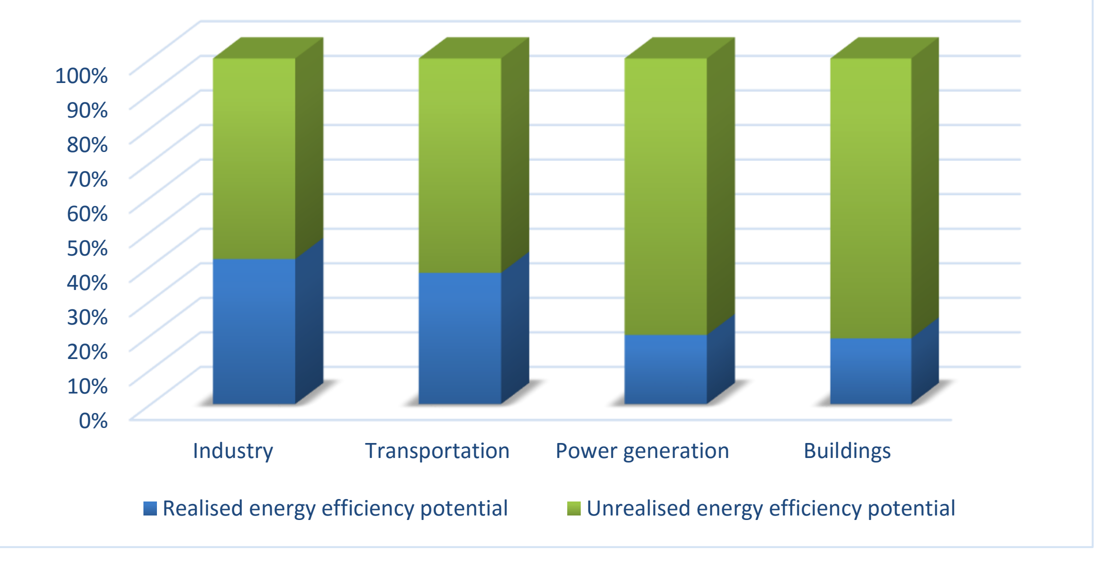

Figure 5.3: Tapped and untapped potential of economically viable energy efficiency improvements by sector

Source: International Energy Agency (2014a).

5.1.4 Residential buildings as a sector well suited for public intervention

Our previous assessment shows potential in all three segments described, industry, transport and residential. However, as the best suited and feasible segment for our further analysis, we have chosen the residential segment. This segment offers the most appropriate mix of features from what we looked for. It has big potential with respect to size, economic viability, existing and viable technologies allowing to improve significantly the energy efficiency. Moreover, this segment is quite homogeneous, stable and substantial for everyone. Finally, we see several multiple benefits that are important for end-users themselves, public authorities and other stakeholders.

We also identified a few risk factors and other possibilities why this segment has still so much of the untapped potential. Some of the reasons seem to be a lack of general knowledge about possibilities and opportunities connected with energy improvements, challenging valuation of all generated externalities and also lack of funds. As the residential segment of energy consumption consists still of a wide range of heterogeneous buildings with variety of purposes we need to specify a smaller homogenous group, a sector which will be politically, socially and economically feasible and also quantifiable. Finding an inspiration in previous similar initiatives abroad and also in the Czech Republic, our further analysis is going to be focused strictly on residential housing.

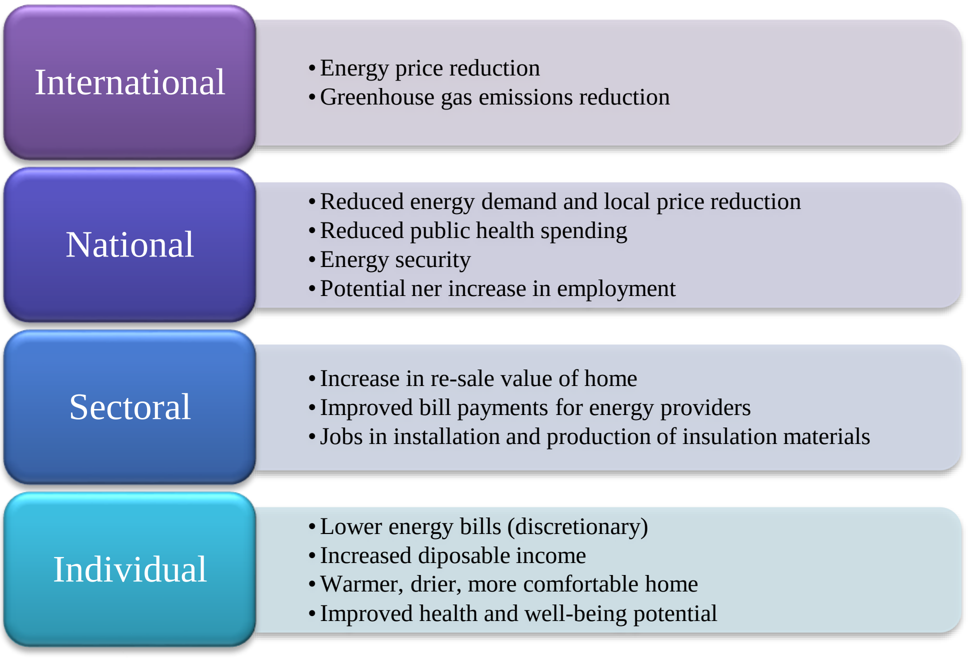

Figure 5.4: Impacts of energy efficiency initiatives across various groups

Source: International Energy Agency,

5.2 Decomposition of energy consumption in the residential housing

To further determine a specific purpose well suited for our analysis and possible public intervention we decompose the energy consumption of the selected segment. We use data from the Department of Microenvironmental and Building Services Engineering at Czech Technical University presented in Figure 5.5 and Figure 5.6. The first figure compares proportionally energy consumed by Czech residential buildings with respect to heating, lighting, ventilation, cooling and water heating. Figure 5.5 shows a dominant consumption for heating which stays for 85% of the overall energy consumption. Due to the dominant proportion of the heating we only focus further on heating. There are multiple uses of the heating by households as you can see in Figure 5.6 on average about half of the heat consumed stays for space heating and the rest is divided into number of other uses (cooking, drying…). As the space heating counts for the most significant part of the energy consumption by households, at the same time this segment is already homogenous enough and energy efficiency improvements are available, we continue perform our analysis and simulations only on this specific segment.

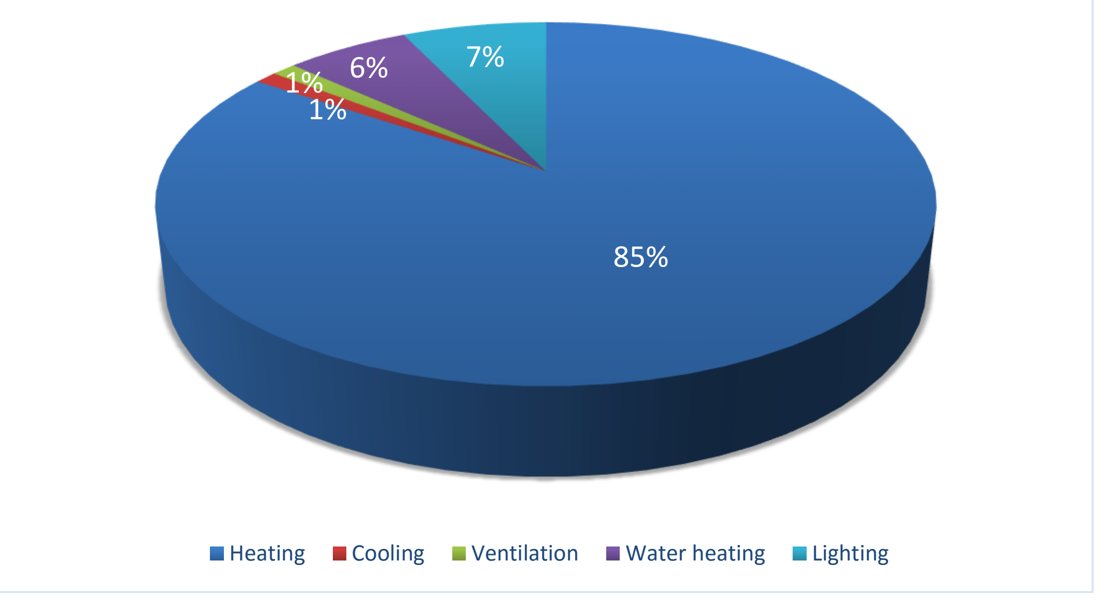

Figure 5.5: Decomposition of energy consumption by purpose of use in Czech residential housing

Source: Czech Technical University in Prague.

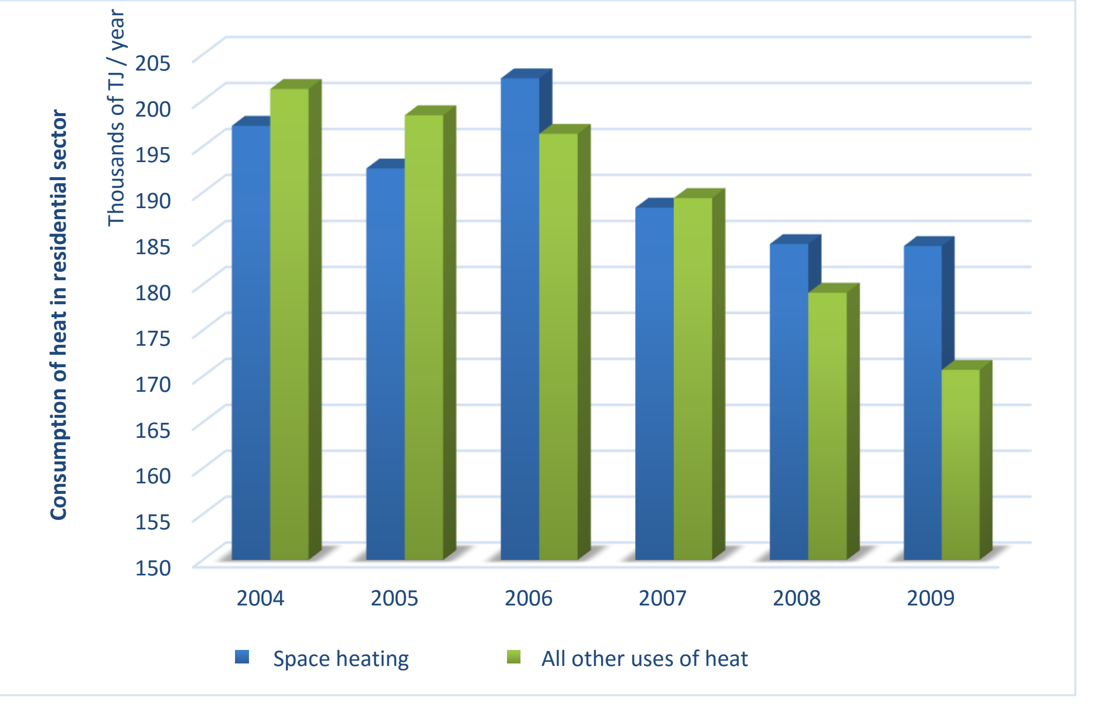

Figure 5.6: Yearly consumption of heat in the residential segment in the Czech Republic

Source: CZSO and Czech Technical University in Prague.

5.3 Possible instruments for public intervention

The selected sector has a huge yet untapped potential to lower its energy consumption by implementing appropriate tools, policies and initiatives promoting its energy efficiency. In this chapter we analyse the search for a relevant means of public support and experiences that we could incorporate in our final recommendation.

5.3.1 Possible way of intervention

There are two feasible levels of intervention improving energy efficiency of space heating. Firstly, changing the behaviour and utilisation of energy, and secondly, to decrease the quantity of space heating needed or to improve the way of heat production. The first way can be targeted through changes in the behaviour of end-users, households and individual residents, for example, through changes of ventilation behaviour, heating patters (when heaters are activated), lowering temperatures and so on. Even though these changes might delivery serious savings, for purposes of our analysis this approach is not well-suited.

The second way energy efficiency improvements could be implemented without any significant unpleasant behaviour changes is represented by technology or construction improvements. For example, the replacement of currently used boilers by newer more energy efficient ones or using of additional sources of heat as solar heating systems or similar. Another possibility is to lower energy consumption of buildings for example through retrofit projects and especially insulation. This possibility is far better suited and has already been implemented in several of such initiatives, see Table 5.1 for a summary from the European Union.

Multiple benefits and impacts that come from initiatives of this kind, range from individual, through sectorial and national to international ones. While considering energy efficiency improvement initiatives in the Czech Republic all of these are applicable from the individual inhabitants who lives in reconstructed buildings, through sectors of construction industry and boilers manufacturing, to the overarching European level. A summary of the most important implications can be found in Figure 5.4.

5.3.2 Existing experience in the Czech Republic

For decades, the housing stock in the Czech Republic has been underinvested. In 2011, estimations of the Czech Ministry of Regional Development and the State Housing Development Fund evaluated this underinvestment at roughly 500 billion CZK. (2011, p. 109) With an undisputable general trend of housing renovations and also a few public support programmes, the situation has been changing and the Czech housing stock has gradually been renovated, yet the pace at which it is happening is not so high. The most likely reasons for why the pace of renovating is not higher are the low awareness of consequences of reconstructing and insulating, as well as high initial costs, which are significant or even unattainable for many households. (Antonín, 2014)

The necessity and appropriateness of public support for the renovation of houses in the Czech Republic has been adopted by many official institutions, for example the already mentioned Ministry of Regional Development or Ministry of the Environment of the Czech Republic. Also, the National Economic Council recommended investing in the insulation of houses as one of the anti-crisis measures. (Zámečník & Hlaváč, 2010) This recommendation was subsequently partially implemented in practice through the first round of the Green Savings Programme ("Zelená úsporám") and Panel Programme, through which a positive impact of thermal insulation was verified. Thanks to the Green Savings Programme, the Panel Programme, and the New Green Savings Programme, the Czech Republic has collected valuable experience and data that can be used as leverage in future programs.

Nowadays there are a couple of public initiatives, mainly run by Státní fond rozvoje bydlení under the Ministry of the Environment of the Czech Republic, where two important ones are the New Green Savings Programme and the Panel Programme

2013+. The New Green Savings Programme which is an updated version of the Green Savings Programme firstly introduced in 2009, aims at both, family houses as well as apartment buildings, and it is an initiative offering up to 50% grant for energy efficiency improvements. These grants can be used to either insulation, or replacements of environmentally unfriendly boilers, solar panels installations and construction of passive family houses. Newly, it can be used also on a partial insulation which was not the case during previous years of the programme and currently two months of experience suggest a strong interest for this kind of insulation. The total planned amount of funds for this running programme is up to 27 B CZK between October 2015 and December 2020. The very first programmes allocation had been up to 25 B CZK while in the upcoming years it was about 2 B CZK a year. These funds were used to support several tens thousands of projects. (Státní fond životního prostředí, 2015b; Czech News Agency, 2015)For example, during two months of the latest initiative there were 1 587 applications registered requesting more than 343 M CKZ. (Státní fond rozvoje bydlení, 2015a)

The second important public initiative which is running nowadays as a schema offering cheap loans (compared to market rates) to apartment buildings, is the Panel Programme 2013+. These loans can cover up to 90% of initial investments into energy efficiency, reparatory works and other complex renovations. There are three possibilities offered with interest rates referring to a European Union base rate. Loans up to 10 years with the referred interest rate, but a minimum of 0.75% p. a., 10 to 20-years loans add 100 bases points and 20 to 30-years loans add 200 bases points therefore their interest rates start at 1.75% p.a., and 2.75% p.a. respectively. At the turn of the years 2015 and 2016, the European Union base rates are around 0.50% p.a. (European Commission, 2015c; Státní fond rozvoje bydlení, 2015c) According to the Czech News Agency (2015) the loans provided in 2013 and 2014 counted cumulatively to about 1 B CZK. The already revealed interest in these two programmes shows first, an interest in energy efficiency improvements by Czech households and second, also a willingness to even take out a loan.

5.3.3 European Union existing experience

There have been hundreds of initiatives over the European Union focused on the energy efficiency of buildings. (European Commission, 2015b) All these initiatives can be sorted into eight groups – preferential loans, subsidies, grants, third party funding, trading of White/Energy certificates, tax reliefs, tax deductions and reduction of value added tax (VAT). We see one more possibility, which has not been implemented on energy efficiency improvements of buildings yet, innovative financial instruments. (Boermans, et al., 2015)

5.3.4 Preferential loans

Loans with more favourable conditions or reduced interest rates provided on enhancement of the energy efficiency of buildings. Currently the preferential loans have been used for improvements of windows, heating systems, installations of central heating, insulation, ventilation systems, renewable technologies installation, house entrances and other modernization projects. These instruments have been implemented for example in Estonia – The Credit and Export Guarantee fund, France – Green Loan for Social Housing or Germany – KfW Programme Energy-Efficient Construction.

5.3.5 Subsidies

A non-refundable public funds covering part of an investment in energy efficiency of buildings. This instrument has been used for insulation, lighting, biomass heating or combined heat & power generation. Its implementation can be found in Poland – Infrastructure and Environmental Operation Programme, Slovenia – Financial stimulation for energy efficiency renovation and sustainable buildings of new buildings, or Great Britain – Carbon Emission Reduction Target.

5.3.6 Grants

Grants are often interchanged with the previously described subsidies but grants are predominantly focused on the financial part of investments. Investments that have been supported through grants have been projects of renewable energy, insulation, waterproofing, heating systems (including biomass, heat pumps, heat controllers and solar power), windows and doors replacements and heating. Examples can be found in the Czech Republic – Model of Green Investments, Hungary – Plan for Revitalisation of Panel Houses or Romania – Plan for Thermal Revitalisation of Multi-Storey Residential Buildings.

5.3.7 Third party funding

Principles of this kind of support are differentiated mainly by the fact that energy efficiency investments are firstly financed by the third party, which are usually banks, energy companies or specialised companies, and afterwards repaid back by owners of the buildings. There are multiple ways of refinancing, it can be taken as a common loan with straight instalments or it can be repaid from energy savings arising from increased energy efficiency of the renovated buildings. The instrument of the third party funding have been implemented with improvements of heating systems or water heating. You can find examples of these initiatives in Austria, where a successful regional market with energy has been created since 2001, then in Netherlands – Programme ‘More with Less’, or in Poland - Thermo-upgrading and renovation Investments.

5.3.8 Trading – White/Energy certificates

A model where future savings arising from energy efficiency improvements can be traded. There is an important role for an authority that guarantees issued certificates proving conducted improvements, implied savings and eligibility of future cash flows. Usually the authority needed for this model is a public authority or major energy supplier. The variety of possible uses ranges from insulation, heating, water heating, lighting, and ventilation to other effective arrangements. The only country from the European Union that has already created this trading schema is France and a programme called White Certificate Trading.

5.3.9 Tax reliefs

The number of different tax reliefs for owners of buildings who decide to invest into energy efficiency has been applied. The forms of the tax reliefs vary from reduction of income tax to reduction of the property transfer tax. Also the possible implementation is wide as it has been already applied to replacement of boilers, solar water heating installation, roof reconstruction, double glazing of windows, central heating systems, voluntary energy audits or proved maintenance of boilers, insulation, waterproofing, passive houses construction, and homes with zero carbon emission. This form of public support could be found in Belgium – Tax Rebates for Home Improvements or Great Britain – Stamp Duty Relief for Zero Carbon Homes.

5.3.10 Tax deductions

A schema where tax deductions from income tax are available for buildings owners. The deducted amount corresponds to a specific part of total investments in energy efficiency of the buildings. This system has been historically applied to investments into insulation, waterproofing or central heating systems. Currently there have been two European Union countries using this schema, Netherlands – Energy Investment Allowance, and Great Britain – Landlords' Energy Saving Allowance.

5.3.11 Reduction of value added tax

The reduced rate of value added tax is applied to specific material and products that are being used for energy efficiency improvements. These materials and products have been selected with respect to their use. For example, insulation, waterproofing, heating control systems, solar panels, wind and water turbines, heat pumps, biomass and other. Again, so far there have been only two European Union countries using this schema which are Belgium – Reduced VAT on home refurbishment, and Great Britain – Reduced Sales Tax for Energy Savings materials.

5.3.12 Innovative financial instruments

We already described opportunities and possibilities connected with this new form of support which have not been implemented yet in this field. As we already described in the chapter Innovative Financial Instruments, we believe that energy efficiency improvements can be financed and implemented through this new schema. This schema offers an opportunity to combine parts of the already used systems, described here, more accurately trading, third party funding, subsidies or grants. We believe that the potential is significant and therefore we want to assess this possibility of applying innovative financial instruments to segment of space heating in Czech residential buildings, which we have selected previously.

Table 5.1: Numbers of significant energy improvements of residential buildings in the European Union

	Belgium	Czech Republic	Denmark	Estonia	France	Italy	Hungary	Germany	Netherlands	Norway	Poland	Austria	Romania	Slovenia	Spain	Sweden	Great Britain
Preferential loans		*1*		*1*	*5*	*3*	*4*	*3*		*1*		*1*		*2*	*2*		*2*
Subsidies	*5*	*1*									*1*	*1*					
Grants		*6*	*1*		*2*	*1*	*3*	*1*		*1*		*3*	*1*	*5*	*2*	*1*	*6*
Third party funding									*1*		*1*	*2*					
Trading (White / Energy Certificates)					*1*	*1*											
Tax reliefs					*1*	*2*			*1*								*2*
Tax deductions	*1*					*1*			*1*							*1*	*1*
Reduction of VAT	*1*				*1*												*1*

6 Simulation and model

Knowing the instrument we want to use and also the specific segment where to apply it, we start to model and assess the previously specified hypothetical situation. We start with a close description of the selected segment, the Czech housing stock, and a composition of space heating in the segment. We then predict the future price of heating, analyse the decomposed potential of energy improvements together with the implied size of energy savings. By combining knowledge of the housing stock, the price of heating and size of potential energy savings we already receive a monetary value of savings which can be used by definition for repaying to the innovative financial instrument in exchange for covering of all initial costs. Next, we define scenarios for our modelling and perform a first selection of well-suited scenarios through so-called 'As-Is analysis', which evaluates existing potential with respect to the current situation. After the selection we add a time dimension to the model and perform final round of the settings selection. The final step of our assessment is to add a level of uncertainty to the model, which we do through, so called Monte Carlo simulations. We also perform some sensitivity analyses to get a better understanding of the underlying drivers and their implications. We apply these sensitivity analyses in the second step of modelling with the time dimension due to the very intensive computational complexity of the third step. Finally, we also analyse the settings of the innovative financial instrument itself and assess both, financial and non-financial outputs of the models.

6.1 Czech housing stock

To understand the Czech residential housing stock, we analyse data from the Czech Statistical Office that describes both, macro and micro characteristics of the stock. From the macro view we look mainly at the numbers of flats and their segmentation according to the age. From the micro perspective we use mainly characteristics of building construction and their energy usage. The data that we use, both, directly into our model and simulations, or indirectly through characteristics of energy savings potential, were collected during two statistical surveys, 'Census and Housing 2011' and 'ENERGO 2004'[6].

6.1.1 Macro segmentation of the housing stock

There are two main characteristics that determine energy consumption with a high degree of probability within the selected segment. These characteristics are the type of building, apartment or family house, and the age of the building determined by the time of construction. (Antonín, 2014) These characteristics are presented in Figure 6.1 and Figure 6.2. A unit that is used as a foundation of these figures is one flat. Whereas it is one of the basic characteristics of apartment houses to consist of multiple flats, the situation with family houses is the opposite. The absolute majority of family houses have just one flat but some of the family houses can consist of more flats too.

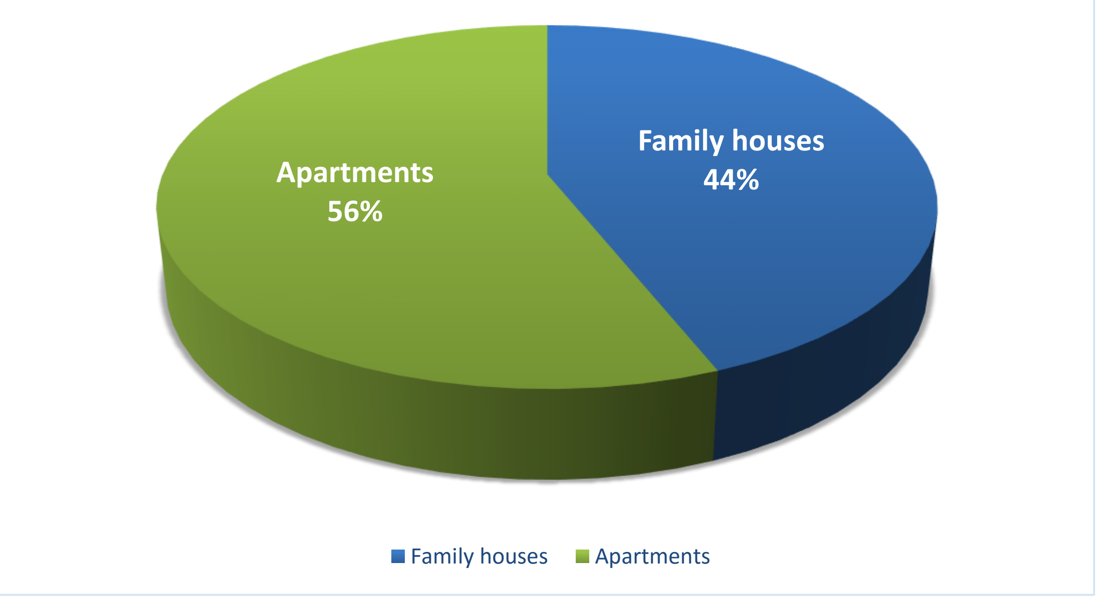

Figure 6.1: Distribution of Czech housing stock in 2011 by number of flats

Source: CZSO.

[6] There is an ongoing survey ENERGO 2015, that can offer a more actual view on energy usage by Czech households but results of this survey are not availanble yet. In any case that is a future possibility for an udate of this study.

As is presented in Figure 6.1, 56% of flats in the Czech Republic are located in apartment houses. On average there are about 10 flats in one apartment building with an average size of 65 m^2. The group of family houses is smaller by the number of flats and the number of households living in this type of housing but the number of actual buildings in higher. The average flat in a family house is about 94 m^2, 45% more than the other group.

6.1.2 Types and age of residential buildings

Figure 6.2 presents the time of construction of the flat units that form the actual existing Czech housing stock. Not only can the quantity of the flats be seen in the figure but also the trends of changing preferences between family houses or flats in apartment houses. This distribution of flats also suggests many implied micro characteristics of buildings as we already mentioned before.

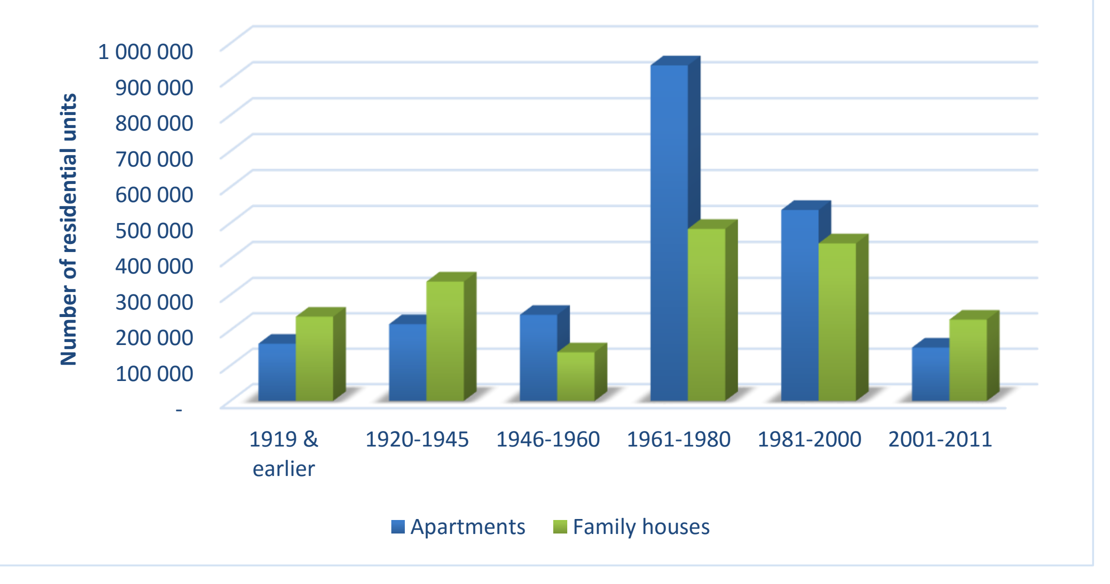

Figure 6.2: Distribution of the Czech housing stock with respect to year of construction

Source: CZSO.

6.1.3 Potential size of energy improvements

To assess a potential value of energy savings caused by insulation we use a data set describing resulting energy savings in a specific segment of the housing stock. This data was first generated as outputs of multiple simulations, considering the majority of technical aspects of a buildings and insulation too, led by Jan Antonín (2014) within a study ‘Survey of the Housing Stock and Potential for Energy Savings.’[7] We discussed the correctness of these data, which we use as an input into our model, with multiple experts from technical and energy sectors. Both, experts on energy efficiency from ČEZ, the biggest Czech energy provider, and a work group of Šance pro budovy, representing experts from technical and construction fields, confirmed the correctness of the data.

This data already takes into account an average energy consumption of space heating in specific sub-segments of the housing stock divided with respect to the date of construction, average size and number of floors, and a specific standard of insulation. We describe the considered standards later in Chapter Three standards of retrofits and insulation. The simulations generating this data further consider different shapes of buildings, varying sizes of flats in the segments, different materials used for the original construction and also different material that can be used for insulation. (Antonín, 2014) The data describes heat consumption per square metre of floor assuming four statuses. The original energy consumption as was identified by the ENERGO 2004 survey held by the Czech Statistical Office, the remaining three describe energy consumptions in a hypothetical situation when buildings would be reconstructed to one of the three specific standards. These standard are: ‘Required standard’, ‘Recommended standard’ and ‘Passive standard’. Having these values, we can easily determine the potential of savings when a complete renovation for one of these standards is conducted. By the complete renovation we understand the insulation of an envelope (outside walls, roof or potentially also the lowest floor) of a building and replacement of windows.

Our data set has 84 different segments of buildings, all with the four already described values, defined by the actual status and three standards. We further distinguish a complete renovation – envelope and windows, and partial ones, for cases closer described in section Types of energy efficiency improvements, when only an envelope or only windows are renovated. During the previously described discussions with the experts, it was explained to us that renovations of windows count on average for about 35% of the overall energy savings potential and the rest is an impact of the envelope renovation. The data shows that there are combinations of segments and standards, mainly the newest buildings, where renovation does make zero economic sense. The reasonability of the renovations on average, not in all cases, increases with the standard

[7] Original name of the study as was published is ‘Průzkum fondu budov a možností úspor energie’.

of renovation, for example from required to a passive one, and with the age of the buildings too.

6.2 Space heating in the residential housing

Knowing the values of energy savings is a required condition but not sufficient information for our modelling of the hypothetical innovative financial instrument. Because we need to determine a monetary value of the achieved savings, we first need to understand the cost side of the space heating for end-users. We identify two main drivers of the cost of space heating for the households, the price of primarily energy sources and the technological transformation of the primary sources to heat.

6.2.1 Decentralised vs. centralised heating

The first major possible distribution of the used technology can be made between centralised and decentralised sources. The centralised sources can be further divided into a number of groups according to the primary energy source used, energy output of a boiler, cogeneration vs. separated heat generation, and others. In the case of the decentralised sources, the primary energy source division is the most important characteristic for our analysis. These are the main macro characteristics of the space heating generation for our model but as was already said, there are a number of other characteristics which might be considered, for example the energy efficiency, environmental performance, ability of regulation and so on. However, these characteristics are more of a micro level specification and therefore not crucial for our model.

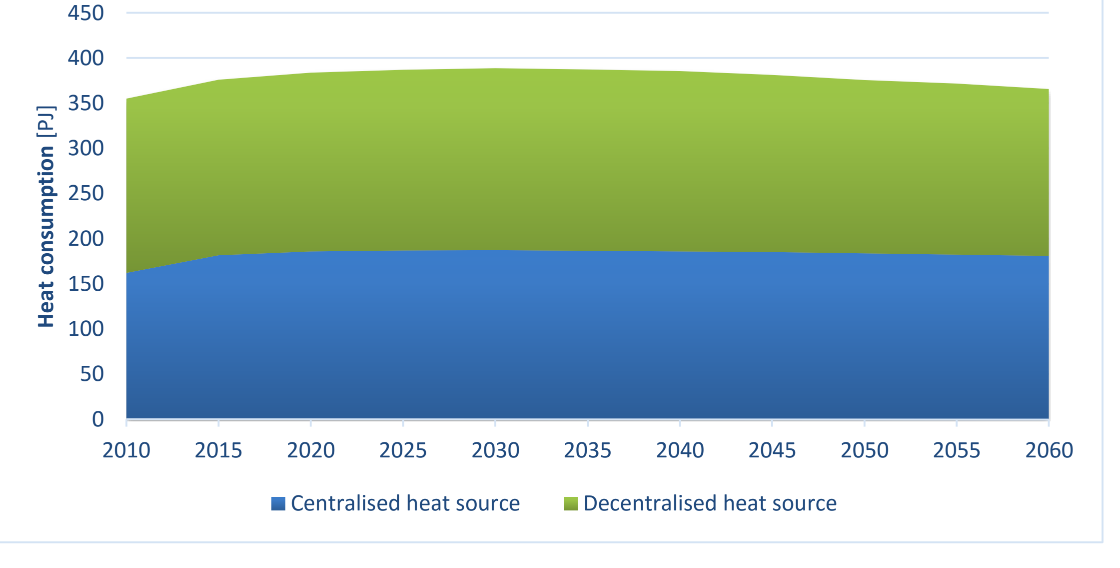

Figure 6.3: Long-term projection of centralised and decentralised heat sources in the Czech Republic

Source: Taures.

According to a study ‘Elaboration on optimal development of heating industry’ (Taureus, 2011), which was created in cooperation and with support of the Ministry of Industry and Trade of the Czech Republic and the Operational Programme for Innovation, the overall distribution between centralised and decentralised sources will most likely stay stable in upcoming decades. As you can see, the prediction in Figure 6.3 , where the centralised heating sources should stay stable, covering about 44% of heat demanded in the whole Czech Republic.

When we analyse the overall heat consumption in the Czech Republic more closely, divided by segments of consumption, as show in Figure 6.4, we can see that historically, central heating sources have covered 33% of the overall heat consumption of residential housing. This percentage considers only data collected by the Czech Statistical Office between the years 2004 and 2009 but as the overall heat generation divided between centralised and decentralised sources is expected to stay stable, we assume that the ratio in the segment of residential housing will stay the same too. A contrary argument might be that the overall heat consumption will probably decrease which might change the ratio, however these factors have already been assumed in a study by the organisation ‘Taureus’ (2011).

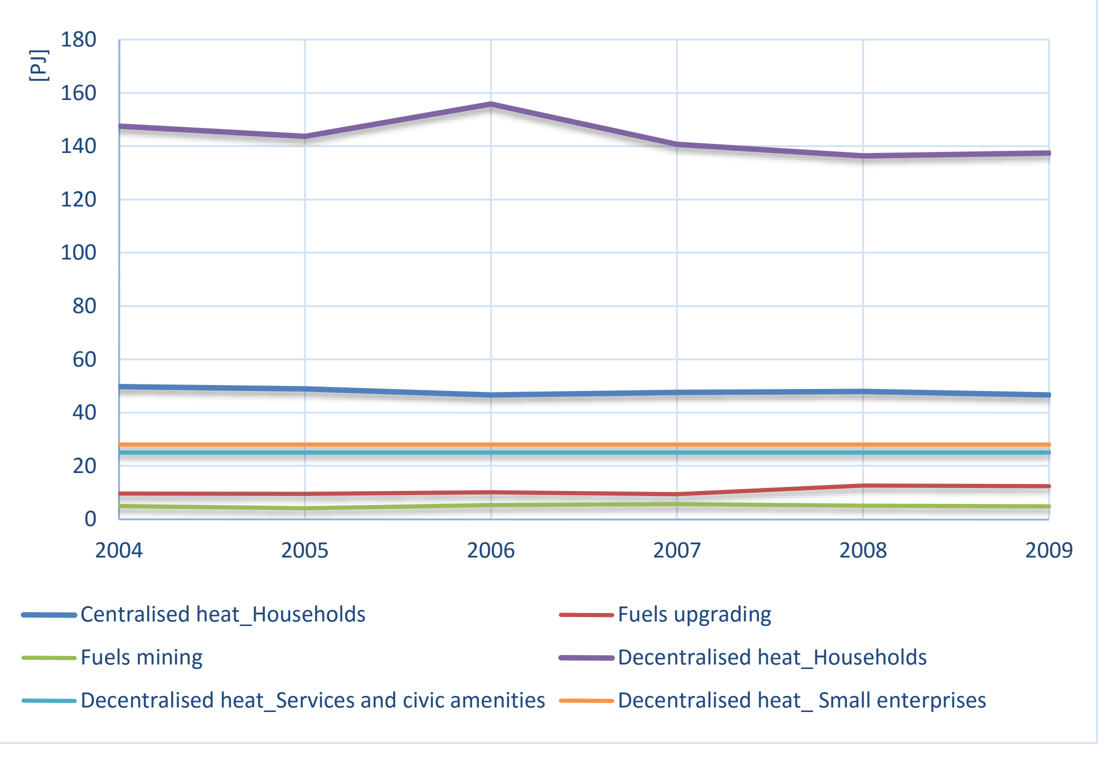

Figure 6.4: Historical development of heat consumption in the Czech Republic divided by segments

Source: CZSO.

6.2.2 Decentralised heating sources

Looking at decentralised energy sources, which would be represented mainly by boilers located either in a family house or in an apartment, we can see that the absolute primary energy fuel is natural gas. Figure 6.5 reveals this further with a quite significant number of biomass boilers, heating by electricity and also brown coal. As we found only figures describing situations six or more years ago we assume that renewable sources might be presented slightly in this mix nowadays too. However, the remaining proportions are assumed to be stable. When we see the dominant position of natural gas it is clear that the average cost of heating will be significantly correlated with its price. But as the Czech Republic is a net importer of the natural gas from abroad we should also consider the risks interconnected with it, for example, the exchange rate risk and security risks, which we already described earlier in the chapter Energy Security Strategy.

Other trends and drivers that need to be considered, apart of the prices of primary energy sources, are factors distinguishing centralised and decentralised sources. The decentralised heating is more labour intensive for the end-user, as they need to operate the boiler, ensure maintenance and also mandatory regulatory inspections. These

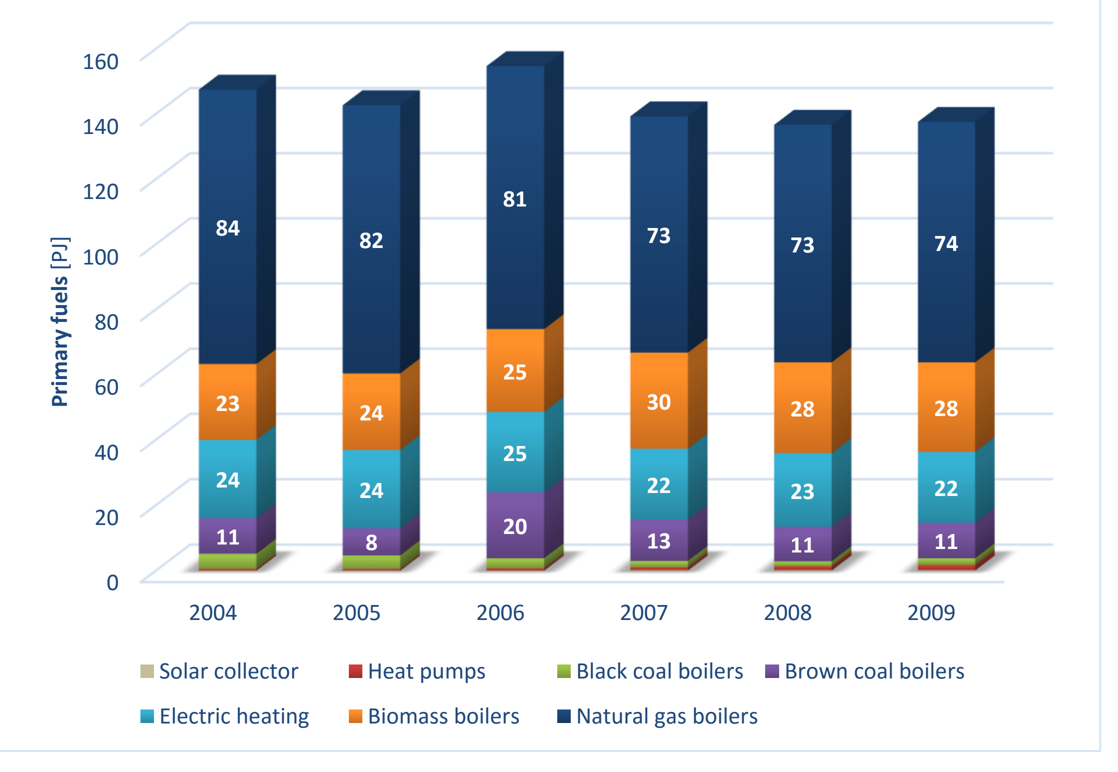

Figure 6.5: Decomposition of primary energy sources used in decentralised heat generators in residential building

Source: CZSO and Energy Regulatory Office.

sources can use a cheaper primary energy source, for example brown coal or biomass, but contrary to that, heating with natural gas or electricity can be more costly despite being more convenient. Also the amortization of technology, mainly the boilers, cannot be ignored. As you can see, there are a number of contradictory arguments that influence the final cost of the space heating for the end-users and therefore the final impact has to be determined carefully and it also has to reflect a market reality. After the discussion with experts from ČEZ we assume that the space heating from the decentralised sources is on average 15% cheaper compare to the centralised heating.

6.2.3 Centralised heating sources

The composition of primary energy fuels is presented in Figure 6.6 and it is expected to follow general trends of lowering consumption of coal in time and increasing the importance of natural gas as can be seen in Figure 6.7. Centralised heating is better suited for locations demanding bigger amounts of heat, for example cities or some factories. For a better understanding, we describe the centralised system and we also compare it to the decentralised one further in this chapter.

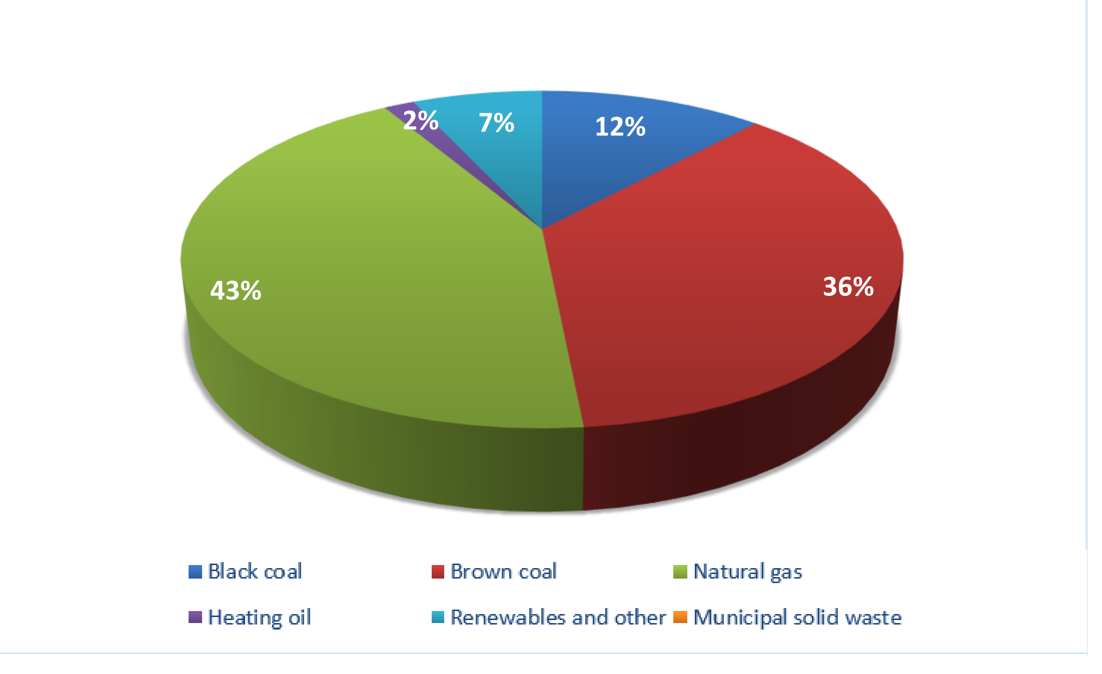

Figure 6.6: Decomposition of primary energy sources used in centralised heat generators

Source: CZSO and Energy Regulatory Office.

To build up an infrastructure and other technology, like boilers or cogeneration units of centralised sources, it is capitally intensive compare to building up the decentralised sources. When comparing the two systems, centralised and decentralised, we consider three main parts of the systems – technology of heat generating, network of culiducts and an in-house network of radiators.

The technology of heat generation in the decentralised systems would be mainly represented by small boilers consuming different fuels as was described in the previous chapter. In the centralised systems we would speak about a smaller number of units with a much bigger capacity of heat generation. Usually that would be either bigger boilers consuming variety of fuels as described in Figure 6.6 or so-called cogeneration units which not only produce heat but they also generate electricity. Considering the cost effectiveness of heat generation technology, centralised units have a huge cost advantage compared to decentralised ones, especially those with cogeneration. From the perspective of the owner of the centralised units, there is an advantage caused by economies of scale and power to negotiate better prices for the primary energy source. The bigger technology units are not only more capitally intensive but usually also more energy efficient and finally when the heat comes from cogeneration, the owner faces two choices, one to emit the heat to the air with no cash-flow generation or to sell it for space heating, water heating and so on.

The network of culiducts is presented only in the centralised systems, which is a huge advantage for the decentralised systems. This network is constructed as a net of pipelines transporting heat from the centralised heating unit through substations to

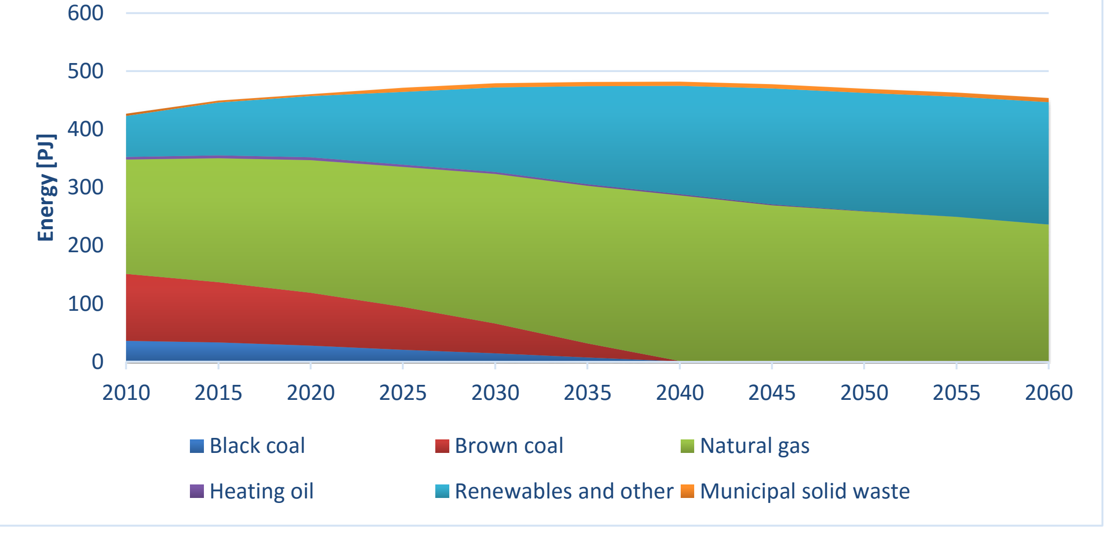

Figure 6.7: Prediction of energy source consumption

Source: Taures (2011).

houses of end-users. These networks are first, capitally intensive for original construction and second, quite expensive to maintain because even a small accident on the network could decommission a branch or the whole network from operation. The amortisation and maintenance costs are the main reasons for the cost disadvantage of centralised systems in this part.

The final part of the chain, the network of radiators in-house, is the same in the majority of cases in the both systems. Usually this network is made from the same pipes and radiators for centralised and decentralised systems too, with the exception of radiators that are constructed directly with incorporated sources of heat, for example when heating with electricity. However, on average there is no cost advantage with any of the compared systems.

As there is one cost advantage for each system, the scale of operations makes the difference. If the maintenance costs of the culidusts can be considered mainly as fixed cost and that is why they need to be divided between all the units sold. Obviously, the higher the amount of heating sold, the lower the cost per unit would be. An analogical situation might occur with an amortization of the technology. This described situation causes a negative rebound effect of insulation and like that, it needs to be considered. There is also a factor of comfort for end-users, where the central heating is more comfortable, which also influences the final cost of the heating. Finally, the regulation by the Energy Regulatory Office comes into role because part of the heating price being regulated, however only in a case of centralised systems.

6.3 Prices of energy fuels and heat

To better understand the possible risks, impacts and trends of the development of fuel prices to the price of heat we analysed data from the Eurostat and more valuably the price indexes of primary energy fuels over a period of the last 15 years. We also combine it with data from the Czech Statistical Office and the Energy Regulatory Office. As you can see in Table 6.1: Prices correlation matrix, the price of heat is highly positively correlated with the majority of energy fuels a part from the price of electricity where the positive correlation is quite low. Similarly to that, a strong positive correlation, 0.993, can be observed between the average cost of heat for Czech households and the price index of the households spending for housing, water, energy and fuel. These findings suggest a very strong interconnectivity, which is stable over the time.

When we focus just on a segment of heat produced by centralised units we find a negative correlation, -0.268, between a quantity of heat distributed and resulting reve-

Table 6.1: Prices correlation matrix

	Heat	Hard coal and lignite	Mineral oil	Natural gas	Remote heat	Electricity	Wood products
Heat	1.000	0.823	0.849	0.819	0.990	-0.128	0.918
Hard coal and lignite	0.823	1.000	0.812	0.895	0.830	-0.700	0.657
Mineral oil	0.849	0.812	1.000	0.943	0.866	-0.116	0.741
Natural gas	0.819	0.895	0.943	1.000	0.853	-0.442	0.645
Remote heat	0.990	0.830	0.866	0.853	1.000	-0.185	0.918
Electricity	-0.128	-0.700	-0.116	-0.442	-0.185	1.000	-0.281
Wood products	0.918	0.657	0.741	0.645	0.918	-0.281	1.000

Source: Author.

nues for heat providers. There is also a positive correlation, 0.763, between total revenues for the providers of centralised heat and heat prices. This suggests that there have to be other important factors than the final end-user price of heat. One of the possible explanations might be the total quantity of energy produced by providers. The correlation between the quantity of heat produced and its price is -0.820 which means that the smaller the amount of heat produced and distributed, the higher its price. This is a negative rebound effect of insulation, which also should be considered as a potential risk.

6.4 Energy Regulatory Office

As was already mentioned in a previous chapter the price of heat from centralised units can be divided into two parts, regulated and unregulated. The regulated part is fully in competence of the Energy Regulatory Office and therefore it cannot be influenced by heat providers. The regulated price is announced to public through so called Price decisions published in the 'Energy Regulatory Bulletin'[8]. The Energy Regulatory Office has been established to control and support various activities concerning all types of energies and especially energy industries and regulation. This regulatory body is responsible for a market supervision but also for a price control, licensing, and support

[8] 'Energetický regulační věstník' in Czech, which as accessible at http://www.eru.cz/cs/teplo/cenova-rozhodnuti.

of renewables and cogeneration. There are four operation fields of the Office – Electricity Industry Department, Gas Industry Department, Heating Industry Department, and Department for Statistics and Security of Supplies. (Energy Regulatory Office, 2015)

6.4.1 Prediction of future heat prices

The next necessary step for this study is to determine the future price of heat for end-users. We use this information further to calculate a monetary value of implied savings from insulation. The prediction is, as almost always, connected with some level of uncertainty, which we try to lower, by the identification of key drivers from the final price, addressing the potential risks and also by discussing with experts to confirm our assumptions. For our prediction, we consider already described characteristics of the existing heating systems and also multiple price drivers. The price drivers count for prices of primary sources, viable technology, decomposition of regulated and unregulated price, but also an impact of exchange rate and other impacts. We decided to determine a weighted average price of one unit of heat for the residential housing segment in the whole of the Czech Republic. We use this macro level unit instead of more precise micro level ones, over individual segments as described earlier, because this approach fits the rest of our data sets and also because any micro level data which would suit our purpose were not feasible to us. After determining the historical drivers and development of heat prices, we predict its future development over the next 25 years.

For our prediction we tested two methodologies, one predicting individual prices of primary sources and combining them with predictions of future composition of centralised and decentralised systems and even their composition of individual heat source technologies. Our second approach is based on prices of heat for end-users sorted by location and composition of centralised and decentralised heating, and also a ratio of prices of heat from these two different systems. By applying both of the methods we found very similar, almost identical values and therefore we decided to use the second method as it is the one with less assumptions. To address the presented uncertainty, we use a sensitivity analysis and definition of three scenarios. Again we confirmed the correctness of both, the methodology and resulted predictions, with experts on heating and statistical methods from ČEZ, Krejčí and Jonáš (2015).

6.4.2 Heat prices from central sources sorted by location

We base our prediction on data from the Energy Regulatory Office that collects the prices of all individual centralised sources of heat in the Czech Republic and sorts them by location. This data set gives us information from the biggest cogeneration units to the smaller units installed for example in a block of flats. We found a date from the year 2001 until predicted prices for the year 2015. Overall the data set has 27 303 observations consisting of multiple information but for us the two most important parts are the price of a GJ of heat and the quantity of heat supplied from the specific source. We first calculate an average weighted price of one unit of heat in a specific year and then compose a unified unit by applying the ratios of centralised and decentralised sources, 1:2, and the ratio of the prices in the same segments, which was earlier identified as 100:85. You can see the resulted values in Table 6.2: Price of heat in the Czech Republic and its prediction until 2040.

6.4.3 Three scenarios of future heat prices

Based on historical values, we determine three scenarios that we describe as Low scenario, Realistic scenario and High scenario addressing the predicted heat price. We determine the scenarios on a basis of extrapolated observed cumulative annual growth rate (CAGR). The low scenario is assumed to continue in a pace of the CAGR between the years 2012 and 2015, similarly to that in the case of the realistic scenario it is CAGR between the years 2011 and 2015, and the high scenario is based on the CAGR of our whole time series from 2001 to 2015. You can see the scenarios in Figure 6.8 where we add also a linear trend-line of the historical prices and a comparison with a 2% inflation rate, which is targeted in a long-term perspective by the Czech National Bank.

Our scenarios are plotted on a nominal basis describing an average price of one kWh in CZK. When we focus first on the low scenario, we can see that the real price

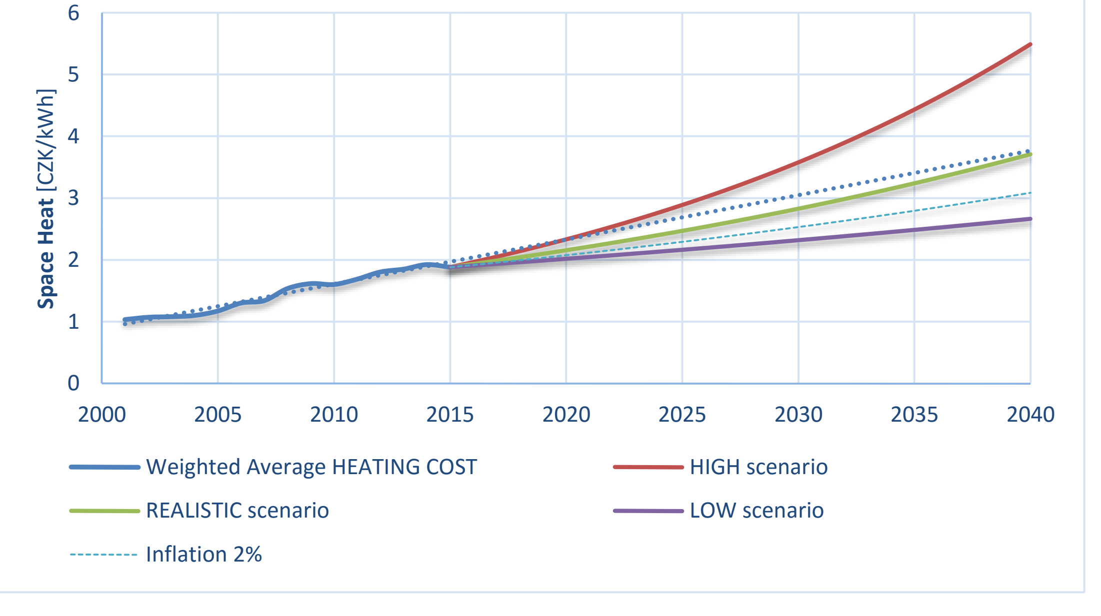

Figure 6.8: Prediction of heat prices development

Source: Author.

of heat is predicted as decreasing, when compared to the 2% inflation growth. The 2% rate is not only a long-term target of the Central Bank but also an average inflation over the last 15 years in the Czech Republic according to Eurostat and it matches our upcoming calculations too. Assuming that relationships marked in the Correlation matrix of prices, Table 6.1, stay the same, this would most likely mean an overall decrease of price level in the majority of energy sectors. Our realistic scenario describes a situation where the heat price stays slightly over an inflation target, compared to the last 15 years, when the heat price increased yearly on average by 4.38%, compared to the 2.00% observed inflation. This scenario is also predicted to develop under the linear trend of the historical values. This scenario could also be described as a slight downturn with non-specified causes. In any case there are many potential causes like decreasing prices of fuels, decreasing demand for heat due to insulation and energy efficiency or expansion of renewables. The last, high, scenario follows the same growth trend as it has done during the last 15 years. The reasoning behind it is that there have already been trends as insulation and increasing energy efficiency presented in the market and the price of heat has been developing with this pace therefore it could be like that in the future too.

Table 6.2: Price of heat in the Czech Republic and its prediction until 2040

	Observer values					Predicted values				
in CZK/kWh	***2001***	***2005***	***2010***	***2014***	***2015***	***2020***	***2025***	***2030***	***2035***	***2040***
Weighted price	1.03	1.17	1.60	1.92	1.88					
HIGH scenario						1.68	1.50	1.34	1.20	1.08
REALISTIC scenario						1.96	2.05	2.13	2.23	2.32
LOW scenario						2.02	2.16	2.32	2.49	2.67

Source: Author.

6.5 Three standards of retrofits and insulation

As was already indicated in the previous chapter Figure 6.2 presents the time of construction of the flat units that form the actual existing Czech housing stock. Not only can the quantity of the flats be seen in the figure but also the trends of changing preferences between family houses or flats in apartment houses. This distribution of flats also suggests many implied micro characteristics of buildings as we already mentioned before.

Potential size of energy improvements, there are three standards describing the energy efficiency of buildings. These standards imply heat throughout materials and many other technical specifications of the construction of buildings. (Antonín, 2014) In order, from the low energy efficiency to higher or in other words from the high energy consumption to the low consumption, these standards are:

- Required standard
- Recommended standard
- Passive standard.

As was already stated, there are differences in type, quality or even use of materials and other technical matters and in any case for the purpose of our analysis it is sufficient to know that these renovations are feasible. The second and last technicality that we consider is the so-called recuperation unit which is a technology that needs to be used in a passive building to reach the low levels of energy consumption and standards of living. In short, the recuperation unit serves ventilation, to deliver fresh air to the building, while keeping heat inside.

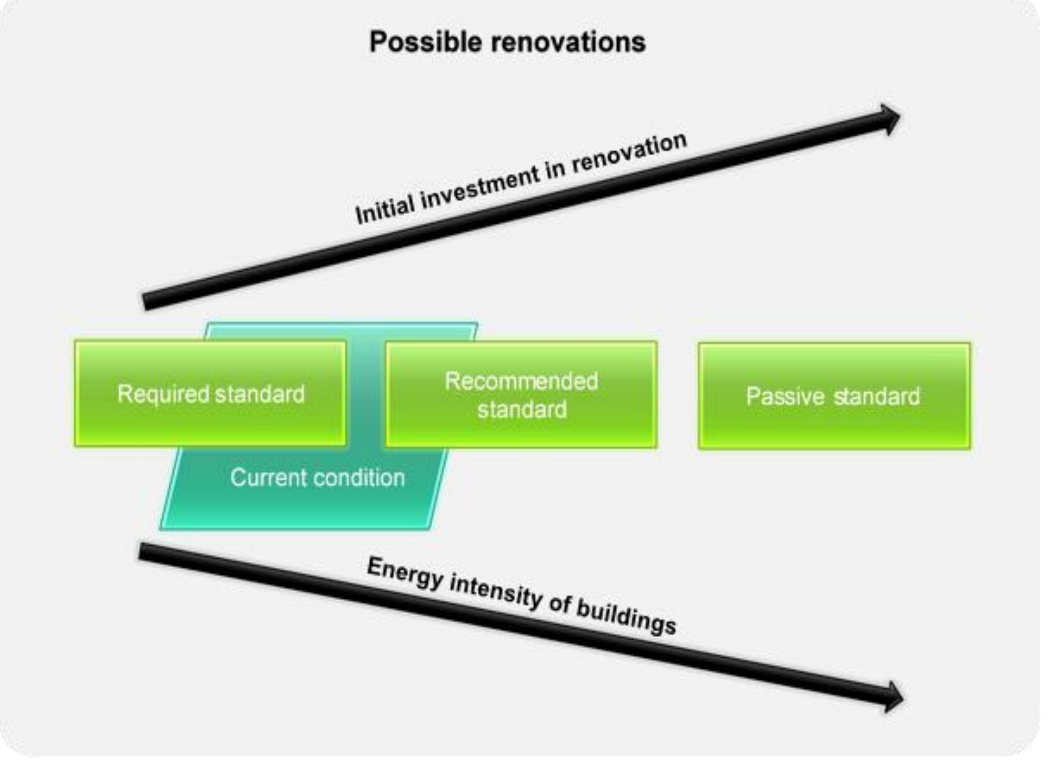

Figure 6.9: Possible standards of buildings and their renovations concerning related size of investments and size of energy savings

Source: Author.

Figure 6.9 presents an important trade-off that needs to be considered and assessed when speaking about energy efficiency improvements of buildings. The trade-off between the monetary value of an initial investment into renovation of a building and the value of future benefits arising is thanks to the lower energy intensity of the renovated building. Whereas, there is a direct relation between the standard and size of initial investments to reach these standards through a renovation, the relation between standards and energy intensity is the opposite. Figure 6.9 also shows the current status of the Czech housing stock which on average would be located somewhere between required and recommended standard. This is also a reason why it does not make any sense nowadays to even speak about energy efficiency improvements when considering renovation with fulfilling only the required standards. Moreover, it would only be suitable for minimum buildings and it is already considered to be obsolete by many. This is also a reason why we do not consider this be an option and therefore we do not assess it as all in our model and simulations.

The situation and reasoning behind energy improvements, or just more specifically the insulation of buildings, with a use of the innovative financial instruments can be seen in Figure 6.10 describing a model situation. The figure describes only the financial side of insulation implementation by the innovative financial instrument and not the overall implied value consisting also multiple benefits. There is also a number of assumptions behind this figure. It assumes an increasing price of heating over time which implies the upward slope of the green surface, then the value of the savings is assumed

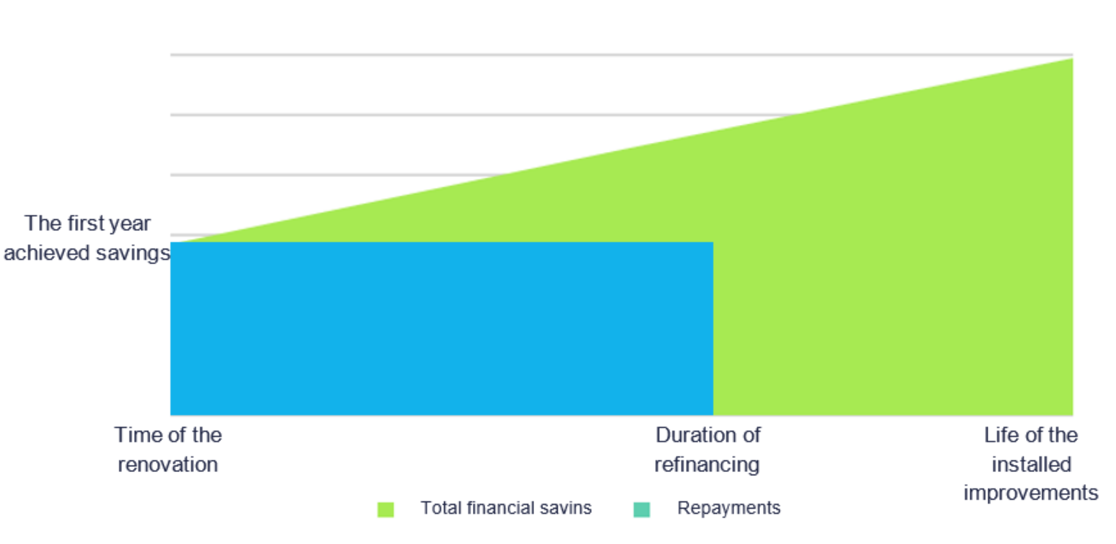

Figure 6.10: Cost savings in renovated buildings (assuming increasing costs of heat over time.

Source: Author.

to be equal to repayments that are stable over a specific period of time, which is represented by the blue surface. We also assume here that the period of refinancing is shorter than the real life expectancy of the installed improvements. This model works in both nominal or real terms.

The blue surface represents repayments to the financial instrument, which are made by the end-user in exchange for the covering of the initial investment into insulation by the innovative financial instrument. The green part represents the net financial benefits from insulation for the end-user under the given assumptions. In the case of when energy prices would decrease during the period of repaying it might happen that the end-user would be worse off from this narrow financial perspective, however there are still all the remaining multiple benefits which should end up in an overall better position of the end-user than without the renovation. The reasons why we assume a stable size of the repayments compared to floating ones are two, first it should prevent the end-user from significant negative changes of their behaviour, the negative rebound effect, for example excessive heating or ventilation, which would result in lower savings. Second, this leads to better predictability implying lower riskiness of the financial instrument itself.

6.6 Types of energy efficiency improvements

To be able to assess the whole potential of insulation and incurred energy savings we consider five groups of buildings, or ten of them when separating family houses and apartment buildings. Firstly, before we start the actual segmentation, we consider buildings that cannot be insulated for any reason, for example due to their protected historical value or because they may not be utilised for living. In our assessment we conservatively assume these buildings to count for 10% out of the overall housing stock. This part is flatly deducted from the housing stock and therefore it is not presented in the next two figures.

The first group, houses that have been already renovated and therefore there is a minimal chance to insulate such building again. However, we speak about a period of 25 upcoming years, which might change the situation when considering a time dimension. We believe that this proportion of houses will not be so significant, also a possibility of reaching sufficient savings in this group is small and moreover by exclusion

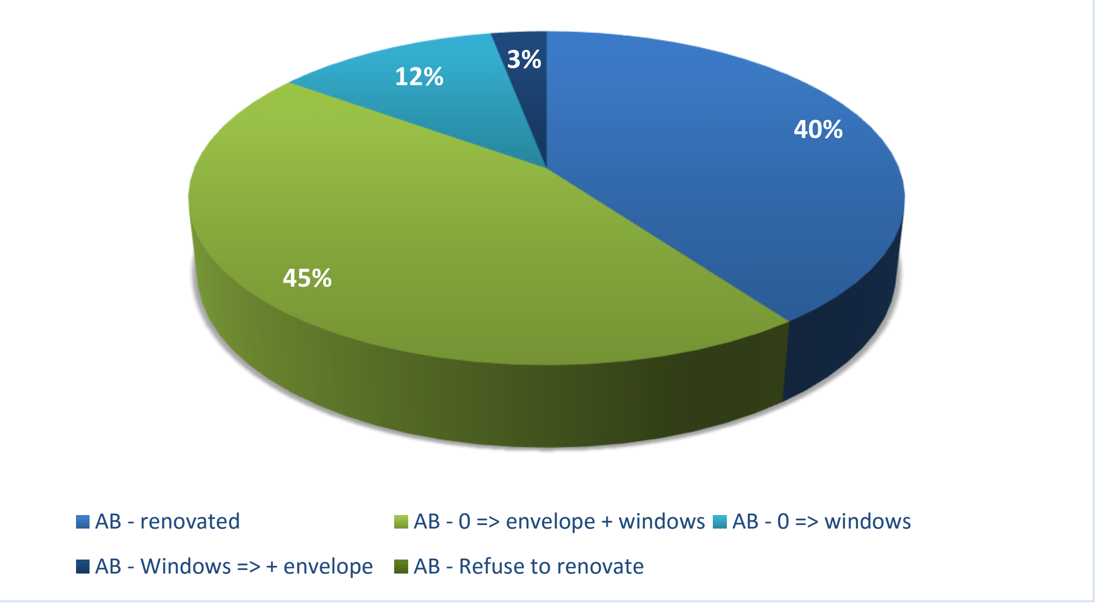

Figure 6.11: Expected distribution of demanded energy efficiency improvements by Czech apartment buildings

Source: Author and experts from Šance pro budovy organization (2014).

we stay conservative, therefore we exclude the already renovated houses nowadays. A complication is that no one can surely say today what is the proportion of already insulated buildings in the Czech Republic. This should change with the ongoing statistical survey ENERGO 2015. For our analysis, we use an estimate of experts from Šance pro budovy (Holub, Šroubek, & Antonín, 2014) which assumes that the proportion counts for 40% of apartment buildings and 25% of family houses. The higher proportion of insulated apartment buildings resulted also thanks to previous public support, mainly the Green Savings Programmes and the Panel Programmes.

The second group we consider are buildings where complete insulation is feasible and realistic. By complete insulation we understand renovation of both, windows and all parts of an envelope, which are the outside walls, roof and possibly also the lowest floor. This group is assumed to be represented by 45% of apartment buildings and 40% of family houses.

Then there are groups of buildings where only part of the insulation is either feasible or realistic. When speaking about renovations of windows the reasons might be more of the feasibility, for example due to the structure, shapes of the envelope or due to a willingness of the owners. Therefore, we assume that there is 12% of apartment buildings and 23% of family houses that might be interested in replacement of windows, which generally counts for about 35% of savings compared to complete insulation.

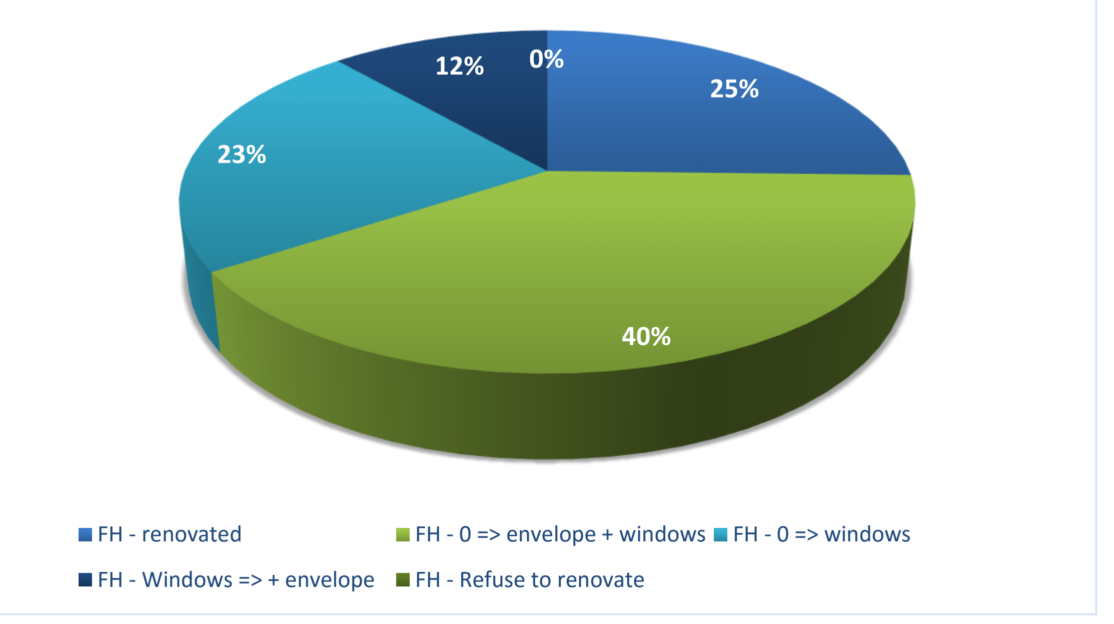

Figure 6.12: Expected distribution of demanded energy efficiency improvements by insulatable Czech family houses

Source: Author and experts from Šance pro budovy organization (2014).

The fourth group are buildings that already invested in the generally more feasible renovation of windows and for example due to financial constrains have not renovated the envelope. When done properly, the envelope can save the remaining 65% of the potential savings. We assume this specific segment to be represented by 3% of apartment buildings and 12% of family houses.

The last group would be the buildings whose owners refuse the idea of insulation for any reason. But ownership of buildings can change and also due to the fact that we assess an overall potential we consider this group to count for 0% of buildings.

6.7 Scenarios definitions

We assess three options respecting energy efficiency standards and technology used. As we already mentioned, to consider the required standard makes zero sense nowadays in the Czech Republic, therefore we consider only the recommended and the passive standards. We also distinguish renovations with and without air recuperation technology. As the passive standard requires the use of the air recuperation we have three base scenarios:

- Recommended standard without technology

- Recommended standard including technology
- Passive standard

We then analyse three lengths of repayment periods in each of the considered standards and technology. We analyse 15, 20 and 25 years periods of repaying a constant nominal value of savings as they would be calculated at the year of renovation. Finally, we also assess a possibility of combining the innovative financial instrument with a public grant covering 20% of the initial investment in insulation. Overall this gives us 18 different situations to assess during the first step of the analysis that describe potentials of the innovative financial instrument.

6.8 Tracked outputs of the model

From the technical point of view, we start by assessing the suitability of the financial instrument characterised mainly by the standard and potentially also the technology used, cost of the renovation and minimal required internal rate of return. We assess the value of potential savings from renovation to the specific standard using the information about heat prices, the average size of the buildings and the per square metre energy savings arising from the renovation. Similarly to that, we also calculate an average initial investment needed within the segment and with respect to the specific standard. Assumed costs of renovations are presented in Table 6.3. Then, having the monetary value of yearly savings and the size of the initial investment needed we calculate IRR within individual segments and its specific cash flow. We decide whether the innovative financial instrument with the specific setting would or would not be suitable for the segment by comparing its calculated IRR and the minimum required IRR. Having the suitability of the instrument with a specific setting and within all individual segments and groups of energy improvements, we aggregate the potential over the whole housing stock.

Table 6.3: Costs of renovations

	Recommended standard			**Passive standard**			**Technology**
Investment CZK per m2	+ windows	+ envelope	+ envelope + windows	+ windows	+ envelope	+ envelope + windows	+ recuperation
Apartment building	1 081	901	1 982	1 211	1 088	2 299	65 000
Family house	1 209	2 367	3 576	1 354	2 822	4 177	110 000

Source: Author.

Important outputs which we observe in the basic As-Is analysis are:

- Proportion of the buildings that are suitable and economically viable to use the innovative financial instrument
- Cumulative ecological savings implied by the energy savings
- Economical value of savings
- Total size of the initial investments
- Amount of public grants with non-revolving character

The percentage of buildings that have not been renovated yet recently, with a potential to use the financial instrument to cover the initial investment and then repaying it back to the financial instrument just from the created savings is one of the most important parameters. It describes indirectly the potential size of the financial instrument and also its appropriateness in the assessed field. This measure serves also as an indicator for public authorities because it describes a proportion of the market, which can be targeted by the financial instrument with a specific setting.

The amount of energy which is saved due to the energy efficiency improvements installed, or in other words the amount of energy consumption which is avoided, implies many positive effects of insulation that we described in the chapter Benefits of energy efficiency, for example the lowering of CO^2 emissions, economic but also security and many other benefits for number of different stakeholders. In our calculations we make strong assumptions to be able to assess this value. We assume moral life expectancy, how long the improvements will be raising the savings instead of real or material life expectancy. In other words, even though used materials will still be in a good shape, people still might replace them, for example due to the changes of their preferences or due to a technological shift. The second assumption that we make here is that the quality of material and therefore also energy savings will be constant over the time which is not a hundred per cent true because there is some level of wear of materials or even a need for small renovations, for example, a change of seal for windows or the painting of an envelope. We assume an average life expectancy of new windows to be between 25 years and 40 years concerning the envelope. These values serve therefore only as an approximation. An identical situation applies to the economical values of savings where we further assume the monetary value to be stable over time. The economic value is calculated as a present value considering 2.33% discount rate. Again these values should be taken only as an uncertain approximation of the future reality.

The total size of the initial investments reflects our calculated values in individual segments and the number of suitable buildings for the innovative financial instrument in these segments. This value is presented in nominal terms. This value is important for the size of the financial instrument and total funds needed but it also means an investment into the Czech economy and due to its local characteristic it would also add a multiplying effect for the economy. When speaking about public funds used to support the actual existence of this injection into the economy it is important to keep in mind the revolving effect of these public funds which are multiplied by private funds in the financial instruments and which should be sooner or later repaid and possibly invested again. On the other side there is a risk of default by some of the covered projects similar to mortgages.

Finally, the total amount of grants represents a non-revolving public support, which is therefore much more costly for a public budget but preferred by recipients at the same time. This measure is only applicable in scenarios where we assess an impact of 20% grant on the overall attractiveness of the financial instruments.

We also take into account a prospect of time and uncertainty in some of our calculations to allow for a more precious assessment than the basic As-Is analysis offers. We describe these in specific chapters where they serve as a basis for the assessments. Now, first we present our model describing the As-Is analysis assessing the overall potential of the financial instrument from a one point of time perspective, which is now. After this first step assessment, we add a time perspective to a pre-selected set of suitable settings selected during the As-Is analysis. Considering the time dimension, we can assess the actual settings and performance of the financial instrument in the way which reflects the reality better. In the last step, we add a level of uncertainty to our analysis by applying a Monte Carlo simulation.

6.9 As-Is analysis in 2015

There is no need to describe any additional assumptions for the As-Is analysis because we have already described all of them in previous chapters. In this chapter, we first present resulting outputs of the model, Table 6.4, as were described in the previous chapter, Tracked outputs of the model, and then we assess a suitability of individual scenarios with a qualitative assessment through a valuation matrix presented in Table 6.5.

Table 6.4 presenting modelled outputs of all the 18 original scenarios shows a variety of results which is determined by implied characteristics of the standards. We can observe also that the values of the majority of results must be partially driven by the length of repaying or by public grants applied. This factor should not need a deep reasoning as it seems to be obvious when the initial investment is the same and the period of receiving cash inflows gets longer, the IRR which is used as the decision factor here increases too. Also the impact of grants is similar, it lowers the initial investment and by that it increases again the IRR of the individual initial investments.

Table 6.4: Outputs of 18 scenarios of the As-Is analysis

	Repaying period	Suitable for _ of flats	Energy savings [TWh]	Savings [B CZK]	Investments [B CZK]	Public grants [B CZK]
Recommended standard without technology	15	38%	282	530	159	0
Recommended standard including technology	15	3%	27	52	16	0
Passive standard	15	19%	241	453	142	0
Recommended standard without technology, 20% grant	15	60%	399	750	199	50
Recommended standard including technology, 20% grant	15	16%	157	296	92	20
Passive standard, 20% grant	15	43%	492	926	263	66
Recommended standard without technology	20	60%	399	750	249	0
Recommended standard including technology	20	18%	171	322	127	0
Passive standard	20	45%	499	939	337	0
Recommended standard without technology, 20% grant	20	71%	431	811	223	56
Recommended standard including technology, 20% grant	20	36%	318	598	212	53
Passive standard, 20% grant	20	61%	576	1083	336	84
Recommended standard without technology	25	71%	431	811	279	0
Recommended standard including technology	25	34%	311	584	256	0
Passive standard	25	53%	547	1028	385	0
Recommended standard without technology, 20% grant	25	73%	434	816	227	57
Recommended standard including technology, 20% grant	25	53%	383	719	275	69
Passive standard, 20% grant	25	73%	638	1199	392	98

Source: Author

Table 6.5: Valuation matrix of 18 scenarios of the As-Is analysis

	Repaying period			Suitable for _ of flats		Energy savings [TWh]		Energy savings [TWh/%]		Savings [B CZK]		Savings [B CZK/%]		Investments [B CZK]		Investments [B CZK/%]		Public grants [B CZK]		Public grants [B CZK/%]		Total
Weights			*25%*		*10%*		*10%*		*5%*		*10%*		*5%*		*5%*		*5%*		*15%*		*10%*	**100%**
Recommended standard without technology	15	1	*0.25*	3	*0.30*	3	*0.30*	4	*0.20*	4	*0.40*	4	*0.20*	2	*0.10*	2	*0.10*	1	*0.15*	1	*0.10*	**2.10**
Recommended standard including technology	15	1	*0.25*	5	*0.50*	5	*0.50*	2	*0.10*	5	*0.50*	1	*0.05*	5	*0.25*	1	*0.05*	1	*0.15*	1	*0.10*	**2.45**
Passive standard	15	1	*0.25*	4	*0.40*	3	*0.30*	1	*0.05*	3	*0.30*	1	*0.05*	2	*0.10*	1	*0.05*	1	*0.15*	1	*0.10*	**1.75**
Recommended standard without technology, 20% grant	15	1	*0.25*	2	*0.20*	3	*0.30*	4	*0.20*	3	*0.30*	5	*0.25*	2	*0.10*	3	*0.15*	5	*0.75*	3	*0.30*	**2.80**
Recommended standard including technology, 20% grant	15	1	*0.25*	4	*0.40*	5	*0.50*	3	*0.15*	5	*0.50*	2	*0.10*	4	*0.20*	2	*0.10*	5	*0.75*	5	*0.50*	**3.45**
Passive standard, 20% grant	15	1	*0.25*	2	*0.20*	1	*0.10*	2	*0.10*	2	*0.20*	1	*0.05*	2	*0.10*	1	*0.05*	5	*0.75*	5	*0.50*	**2.30**
Recommended standard without technology	20	3	*0.75*	1	*0.10*	2	*0.20*	4	*0.20*	3	*0.30*	3	*0.15*	2	*0.10*	2	*0.10*	1	*0.15*	1	*0.10*	**2.15**
Recommended standard including technology	20	3	*0.75*	4	*0.40*	4	*0.40*	3	*0.15*	4	*0.40*	2	*0.10*	2	*0.10*	1	*0.05*	1	*0.15*	1	*0.10*	**2.60**
Passive standard	20	3	*0.75*	2	*0.20*	1	*0.10*	2	*0.10*	2	*0.20*	1	*0.05*	1	*0.05*	1	*0.05*	1	*0.15*	1	*0.10*	**1.75**

	Repaying period			Suitable for _ % of flats		Energy savings [TWh]		Energy savings [TWh/%]		Savings [B CZK]		Savings [B CZK/%]		Investments [B CZK]		Investments [B CZK/%]		Public grants [B CZK]		Public grants [B CZK/%]		Total
Weights	*25%*			*20%*		*15%*		*5%*		*15%*		*5%*		*10%*		*5%*		*10%*		*5%*		**115%**
Recommended standard without technology, 20% grant	*20*	3	*0.75*	1	*0.10*	2	*0.20*	4	*0.20*	2	*0.20*	5	*0.25*	2	*0.10*	3	*0.15*	5	*0.75*	3	*0.30*	**3.00**
Recommended standard including technology, 20% grant	*20*	3	*0.75*	3	*0.30*	3	*0.30*	3	*0.15*	3	*0.30*	3	*0.15*	2	*0.10*	2	*0.10*	5	*0.75*	5	*0.50*	**3.40**
Passive standard, 20% grant	*20*	3	*0.75*	1	*0.10*	1	*0.10*	3	*0.15*	1	*0.10*	3	*0.15*	1	*0.05*	2	*0.10*	5	*0.75*	5	*0.50*	**2.75**
Recommended standard without technology	*25*	5	*1.25*	1	*0.10*	2	*0.20*	4	*0.20*	2	*0.20*	5	*0.25*	2	*0.10*	3	*0.15*	1	*0.15*	1	*0.10*	**2.70**
Recommended standard including technology	*25*	5	*1.25*	3	*0.30*	3	*0.30*	3	*0.15*	3	*0.30*	3	*0.15*	2	*0.10*	1	*0.05*	1	*0.15*	1	*0.10*	**2.85**
Passive standard	*25*	5	*1.25*	2	*0.20*	1	*0.10*	3	*0.15*	2	*0.20*	2	*0.10*	1	*0.05*	1	*0.05*	1	*0.15*	1	*0.10*	**2.35**
Recommended standard without technology, 20% grant	*25*	5	*1.25*	1	*0.10*	2	*0.20*	5	*0.25*	2	*0.20*	5	*0.25*	2	*0.10*	3	*0.15*	5	*0.75*	3	*0.30*	**3.55**
Recommended standard including technology, 20% grant	*25*	5	*1.25*	2	*0.20*	3	*0.30*	4	*0.20*	3	*0.30*	5	*0.25*	2	*0.10*	2	*0.10*	5	*0.75*	5	*0.50*	**3.95**
Passive standard, 20% grant	*25*	5	*1.25*	1	*0.10*	1	*0.10*	3	*0.15*	1	*0.10*	3	*0.15*	1	*0.05*	2	*0.10*	5	*0.75*	5	*0.50*	**3.25**

Source: Author.

To choose the most suitable settings of the innovative financial instrument, we assign weights to the individual outcomes and then compare the values between each other. We also add ratios of some values to be able to catch up also efficiency and not only absolute values. For the comparison we use a scale from 1 to 5, where 1 stays for the best and 5 for the poorest or insufficient performance. The final selection can be described as a weighted average of these values. Based on this assessment, which is presented in Table 6.5, we choose three scenarios with the most appropriate combination of outcomes for further analysis with the time dimension – recommended standard without technology, passive standard and passive standard with 20% public grant.

By looking at Figure 6.13 representing the potential quantity of flats entering the innovative financial instruments with respect to minimum required IRR from an initial investment into renovation and a specific scenario, which we identified as an interesting one, a distribution of potentially interesting insulation investments can be seen. The potential reaches up to 61% of flats that have not been renovated recently. However, the range of the potential varies from 21% to the 61%, and there the remaining group of three scenarios shows a very close potential that reaches up to 46%.

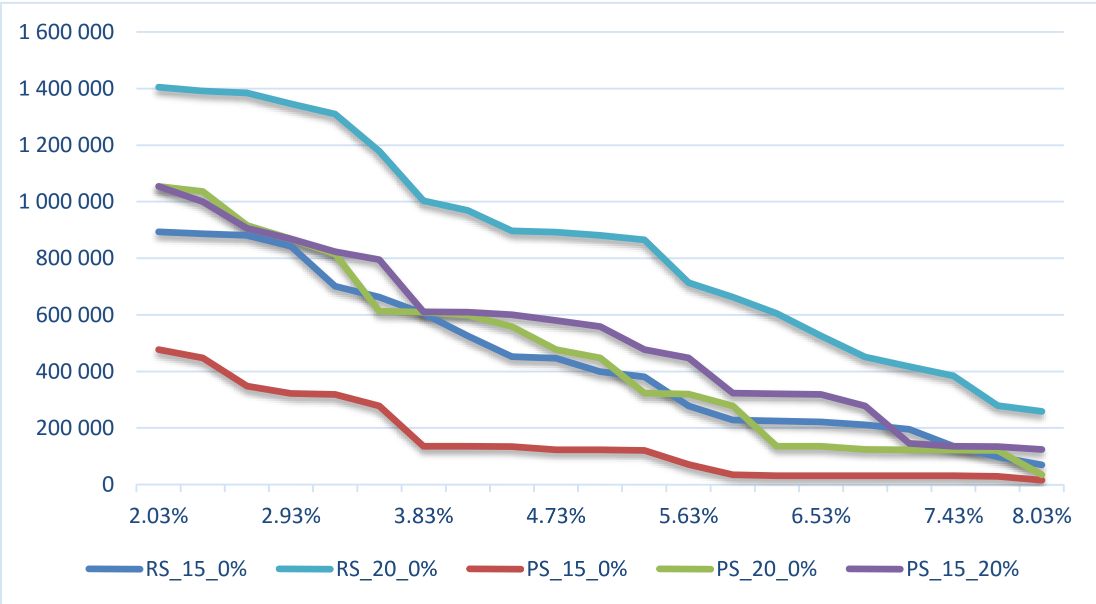

Figure 6.13: As-Is sensitivity analysis representing potential number of flats in the innovative financial instrument with respect to minimal required IRR

Source: Author.

6.10 Most likely scenarios with time dimension

In this section of the modelling we start to consider time dimension and its impact to the hypothetical innovative financial instrument we assess. We first describe additional inputs that we need to consider, for example distribution of interest and feasibility, time-value of money or settings of the actual financial instrument.

The introduction of the innovative financial instrument in the field of energy efficiency and especially, insulation of residential houses in the Czech Republic, which would not demand any initial investment from end-users would most likely be understood as a disruption to common practices. We address this by applying a multidimensional approach to an adoption of the innovative financial instruments. We assume different groups of end-users, in our case probably the owners of residences, to be interested in the instrument at different time. A smaller group, which might be called an early adopters group, is assumed to be interested in the financial instrument first regardless it is something new and untested yet. Gradually we assume that a majority of the end-users will be interested. The interest will culminate and start to decrease as the number of buildings that will be already insulated will increase and consequently will shrink a pool of energy inefficient buildings. (Cooper, 1998)

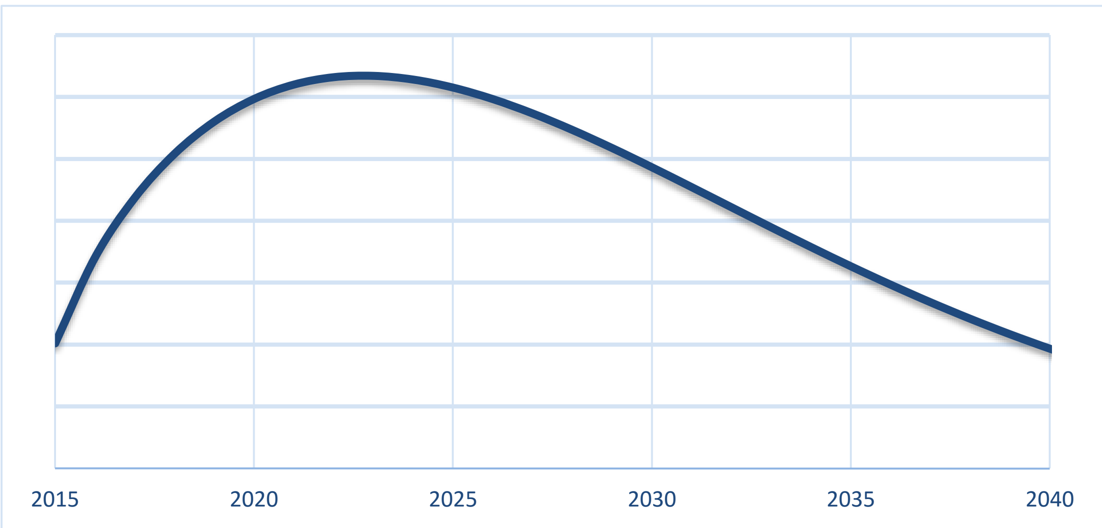

Figure 6.14: Time distribution of innovative instruments acceptance

Source: Author.

The curve in Figure 6.14 represents an assumed distribution of the interest, it also has multiple impacts. It implies also a feasibility of accomplishing of an actual insulation and its construction. It means that it allows markets to gradually prepare for a high number of insulation projects financed through the financial instruments. The reason is that not only the feasibility of funds might be the limiting factor but also the number of firms installing the insulation and production capacities, including construction experts and designers might cause limitations. The gradual adoption should also prevent from unanticipated radical changes of prices which might occur with an overly disproportionate excess of demand for insulation implementation compared to a supply of it.

The model also addresses a time-value of money. We assume an average 2.00% inflation rate influencing mainly the cost of insulation. This assumption also allows us to stay in line with the most likely scenario of heat prices future development, described in chapter Three scenarios of future heat prices. This scenario is also the only one used in this section of modelling. We address the uncertainty of the heat development later on in the next part of the modelling by simulations.

When describing a performance of the financial instrument we use an IRR measure and NPV, where we consider a discount rate equal to 2.63% in the majority of cases. In the cases where the discount rate is different we stress it out explicitly. This rate was discussed with the general commissioner for the innovative financial instruments, Marin Hanzlík (2014), and portfolio manager at Komerční banka, a.s., Vít Hanuš (2015), as a rate well-reflecting current market conditions and also the characteristics of the assessed financial instruments. This rate should reflect a cumulative discount rate of all investors of the financial instrument where different investors most likely would represent different rates, in exchange for different responsibilities or exposure to risk. In that case, the 2.63% rate would also represent the overall weighted average cost of capital (WACC). For comparison, the discount rate suggested by the European Commission (2015c) for public initiatives financed by public resources in the Czech Republic nowadays is around 1.50%. Private investors are assumed to demand a higher discount rate. In any case, this rate serves mainly as a mean of comparison through the NPVs, while the IRR would be the main measure for the investors.

Due to the revolving character of the innovative financial instrument and especially energy efficiency improvements of residential buildings, we see a close similarity with a common mortgage scheme. Therefore, we consider and assess similar tools in our hypothetical situation. Probably the most important one is the creation of so-called asset-backed securities (ABS), which are marketable instruments. The ABS in our case might be very close to mortgage-backed securities (MBS) where an insulated building would work as collateral. There are more possibilities how these securities could be created and how their settings might be determined but this technicality stays far from the primary interest of this thesis. It is enough to know that the financial instrument would create a pool of investment into energy efficiency that could be combined into marketable ABSs. Applying this principal allows the financial instrument to lever equity of investors, which can consequently be lower. On the other hand, the lever comes at the cost of annual coupon payments, repaying of a principal at maturity and some level of financial risk. We consider five different schemas of reaching sufficient funds to cover all the initial investments, if it is by the ABS lever or not, but also what proportion of the total pool of investments is levered by the ABS to keep the financial instrument reasonably safe and robust in the case of defaulting some of the repaying cash-flow streams.

1. No ABS is being applied and all initial investments are covered by the equity of investors and revolving repayments from the monetised value of heat savings.

2. At the end of each year 100% of all the investments that were made during the year are recreated and marked as ABS.

3. The 70% of future cash flows are directly recreated into ABS at the end of a specific year during which the investments were made.

4. All the equity of the financial instrument is managed by the instrument from the first year and these funds are used only for purposes of insulation.

5. The investors put one third of equity that they would need to invest in the first year to cover everything, as described in the previous point, and then the same amount in the future when cash in-flows from ABS creation and repayments from already made investments during previous years are not sufficient to cover all investments to insulation made by the financial instrument during that year.

If not specified explicitly to be different then we consider a leveraging of 85% out of the pool of the initial investments by the ABS with an annual coupon rate of 2.03%. This rate should reflect the current market situation and the fact of involving public funds. (Hanzlík, 2014) We also perform a sensitivity analysis of this measure shown in the chapter Appendix: Four individual scenarios assessment. These sensitivity analyses also address an uncertainty connected with the value of required minimum IRR that all initial investments need to exceed to become part of the financial instrument. If not specified otherwise, we assume this value to be 2.33% which means that in the case of using of the ABS lever, the initial investments contribute by a minimum of 0.30% revenue to equity investors annually.

Under these and partly also the previously presented conditions we run again an assessment of the previously pre-selected scenarios. The outputs are presented in Table 6.6 and the valuation matrix in Table 6.7. There are three settings representing the best combination of values all with no grant included – recommended standard without technology and with 15 years of repaying (RS_15_0%), passive standard with 15 (PS_15_0%) or 20 years (PS_20_0%) of repaying. For further analysis and simulations, we choose also the fourth scenario – passive standard with 15 years of repaying and 20% grant (PS_15_20%), which seems to be a reasonable choice for comparing innovative instruments with and without public support in a form of a grant.

Table 6.6: Outputs of 9 selected scenarios of time dimension analysis

	Repaying period	Suitable for _ of flats	Energy savings [TWh]	Savings [B CZK]	Investments [B CZK]	Public grants [B CZK]
Recommended standard without technology	15	45%	314	831	237	0
Recommended standard without technology	20	66%	413	1073	332	0
Recommended standard without technology	25	72%	428	1108	350	0
Passive standard	15	27%	336	892	268	0
Passive standard	20	50%	525	1366	460	0
Passive standard	25	64%	591	1542	557	0
Passive standard, 20% grant	15	49%	521	1356	364	91
Passive standard, 20% grant	20	69%	614	1595	470	117
Passive standard, 20% grant	25	78%	662	1727	537	134

Source: Author.

All four selected scenarios show significant potential in all ecological and also economical categories. These values however show just a direct impact of the hypothetical initiative. Values of all arising multiple benefits, see chapter Benefits of energy efficiency, are not taken into account. Therefore, these values might be considered as undervalued, at least from a perspective of public authorities. Table 6.6 also suggests two ways of thinking about the ideal setting of the innovative financial instrument. The first one might be, to put the length of the repaying period upfront, where the shorter period implies higher attractiveness for the end-user, and afterwards assessing the remaining outcomes that are highly interconnected. In this case, there are still three scenarios with a shorter repaying period of 15 years. The second possible way is to prioritise the ecological and economic impacts first, and then assess a reasonable repaying period. In this case, the passive standard offers a higher ecological impact. However, when a proportional size of the overall interest would be the primary objective then there are again three scenarios with a potential reach of about 50% of targeted households. From our perspective all the four selected scenarios are somehow reasonable to be considered and maybe also combined. Therefore, the final decision which setting to use should be made after a careful consideration of preferences of all stakeholders. In any case analysis of these preferences goes far beyond the scope of this study and it might be a topic of future studies. It is also likely that the final decision about the setting might be a political decision at the end. For analysis and recommendation of the financial setting of the innovative financial instrument and also for the last step of our assessment targeting uncertainty with simulations we analyse all these four scenarios.

Table 6.7: Valuation matrix of 18 scenarios of the As-Is analysis

		Repaying period		Suitable for _ % of flats		Energy savings [TWh]		Energy savings [TWh/%]		Savings [B CZK]		Savings [B CZK/%]		Investments [B CZK]		Investments [B CZK/%]		Public grants [B CZK]		Public grants [B CZK/%]		Total
Weights		*25%*		*20%*		*15%*		*5%*		*15%*		*5%*		*10%*		*5%*		*10%*		*5%*		
Recommended standard without technology	*15*	1	*0.25*	2	*0.20*	3	*0.15*	3	*0.15*	2	*0.20*	3	*0.15*	3	*0.15*	3	*0.15*	1	*0.15*	1	*0.10*	**1.80**
Recommended standard without technology	*20*	3	*0.75*	1	*0.10*	3	*0.15*	3	*0.15*	1	*0.10*	3	*0.15*	3	*0.15*	3	*0.15*	1	*0.15*	1	*0.10*	**2.00**
Recommended standard without technology	*25*	5	*1.25*	1	*0.10*	3	*0.15*	3	*0.15*	1	*0.10*	3	*0.15*	2	*0.10*	4	*0.20*	1	*0.15*	1	*0.10*	**2.50**
Passive standard	*15*	1	*0.25*	3	*0.30*	1	*0.05*	1	*0.05*	2	*0.20*	1	*0.05*	3	*0.15*	1	*0.05*	1	*0.15*	1	*0.10*	**1.60**
Passive standard	*20*	3	*0.75*	2	*0.20*	1	*0.05*	1	*0.05*	1	*0.10*	1	*0.05*	2	*0.10*	1	*0.05*	1	*0.15*	1	*0.10*	**1.65**
Passive standard	*25*	5	*1.25*	1	*0.10*	2	*0.10*	2	*0.10*	1	*0.10*	2	*0.10*	1	*0.05*	2	*0.10*	1	*0.15*	1	*0.10*	**2.15**
Passive standard, 20% grant	*15*	1	*0.25*	2	*0.20*	1	*0.05*	1	*0.05*	1	*0.10*	1	*0.05*	2	*0.10*	2	*0.10*	5	*0.75*	5	*0.50*	**2.20**
Passive standard, 20% grant	*20*	3	*0.75*	1	*0.10*	2	*0.10*	2	*0.10*	1	*0.10*	2	*0.10*	2	*0.10*	3	*0.15*	5	*0.75*	5	*0.50*	**2.75**
Passive standard, 20% grant	*25*	5	*1.25*	1	*0.10*	2	*0.10*	2	*0.10*	1	*0.10*	2	*0.10*	1	*0.05*	3	*0.15*	5	*0.75*	5	*0.50*	**3.20**

Source: Author.

6.10.1 Innovative financial instrument financial settings

Having the previously described potential, we also know what the size of initial investments is. This amount needs to be covered by the innovative financial instrument where public and private funds are combined. There are countless possibilities how the innovative financial instrument can combine the funds, risk for individual groups of investors, but also for return and responsibilities. In our case, we focus on the overall performance of the financial instrument which represents weighted average values of all groups of investors.

Table 6.8 presents the IRR of the described financial instrument which is one of the most important measures for investors. A closer decomposition of the funds origin is presented by Table 6.9 which compares the individual ways of the leveraging of equity investments of the financial instrument investors by marketed ABS. The ABS brings additional funds to the instrument and offers a possibility to reach a much higher return for the equity investors. Our assessment shows that without the utilisation of any form of the ABS, the IRR is lower than 10% in all of the analysed scenarios. This might be one of the reasons why private investors have not been interested in this field yet. On the other side of the possible ABS utilisation, we assess a situation where all the initial investments made by the financial instruments are levered through the ABS with no safety bumper in a form of initial investments which are not recreated into the ABS. These two possibilities represent the lowest and highest frontier of our model. The remaining three possible ways of utilising the ABS schemas all show promising IRR between 14% to 32% which are values commonly attractive to the majority of private investors.

Table 6.8: IRR assessment of selected scenarios with time dimension

	Internal rate of return			
	RS_15_0%	*PS_15_0%*	*PS_20_0%*	*PS_15_20%*
No ABS	8.92%	6.10%	7.23%	8.44%
All ABS	43.58%	39.76%	39.21%	43.46%
ABS1	23.09%	18.16%	17.62%	21.25%
ABS2	15.74%	14.17%	16.43%	16.82%
ABS3	30.21%	26.68%	30.81%	32.14%

Source: Author.

Table 6.9: Comparison of selected scenarios with time dimension

Financial Comparison	*RS_15_0%*	*PS_15_0%*	*PS_20_0%*	*PS_15_20%*
No ABS				
NPV	99 B CZK	61 B CZK	189 B CZK	146 B CZK
IRR	8.92%	6.10%	7.23%	8.44%
Equity (Investors)	237 B CZK	268 B CZK	460 B CZK	364 B CZK
Levered funds (ABS)	0 B CZK	0 B CZK	0 B CZK	0 B CZK
Financial lever	0 x	0 x	0 x	0 x
All ABS				
NPV	190 B CZK	163 B CZK	447 B CZK	307 B CZK
IRR	43.58%	39.76%	39.21%	43.46%
Equity (Investors)	13 B CZK	15 B CZK	24 B CZK	19 B CZK
Levered funds (ABS)	224 B CZK	253 B CZK	436 B CZK	345 B CZK
Financial lever	17.4 x	16.63 x	18.54 x	18.35 x
ABS1				
NPV	104 B CZK	66 B CZK	178 B CZK	139 B CZK
IRR	23.09%	18.16%	17.62%	21.25%
Equity (Investors)	76 B CZK	86 B CZK	145 B CZK	115 B CZK
Levered funds (ABS)	161 B CZK	182 B CZK	314 B CZK	249 B CZK
Financial lever	2.13 x	2.11 x	2.16 x	2.17 x
ABS2				
NPV	222 B CZK	197 B CZK	416 B CZK	325 B CZK
IRR	15.74%	14.17%	16.43%	16.82%
Equity (Investors)	60 B CZK	70 B CZK	110 B CZK	90 B CZK
Levered funds (ABS)	189 B CZK	221 B CZK	388 B CZK	284 B CZK
Financial lever	5 x	5 x	6 x	5 x
ABS3				
NPV	230 B CZK	207 B CZK	429 B CZK	335 B CZK
IRR	30.21%	26.68%	30.81%	32.14%
Equity (Investors)	52 B CZK	61 B CZK	97 B CZK	79 B CZK
Levered funds (ABS)	197 B CZK	200 B CZK	361 B CZK	295 B CZK
Financial lever	8 x	7 x	8 x	8 x

Source: Author.

Out of the five possible ways of the ABS utilisation, the last one, which considers up to three nominally equal equity investments into the financial instrument in a year when recurring repayments and cash in-flows from the ABS are not sufficient to cover all the initial investments made by the financial instrument. In this case there is a need to collect only about 20 to 30 B CZK in the first year to start the operations of the instrument assuming to reach the total potential.

As you can see in the Appendix: Four individual scenarios assessment, we analyse the sensitivity of all the four selected scenarios with respect to the minimum required IRR of individual energy efficiency investments and the WACC of the combined investors funds. All the sensitivity analyses show a clear indirect relation between the minimum required IRR and the attractiveness for investors. The lower required IRR implies a bigger overall potential for the innovative financial instrument, higher ecologically-economic impacts but also higher return for investors. At the same time, we can see that the assessed values of WACC, 2.63% and 3.43% lead to the highest IRR for investors.

6.11 Analysis with time dimension under uncertainty

The last step of our assessment uses methods of Monte Carlo analysis. These methods address an uncertainty by applying simulations and pseudorandom values of uncertain inputs. In our model we have three major inputs with a high level of uncertainty in future development – interest rate, inflation and the price of heat. We first define the most likely distributions of possible values of the uncertain inputs, then randomly select 500 observations from the distributions which are used in the simulations. There are also other uncertain inputs as for example WACC, proportion of already renovated buildings, distribution of end-users' interest and others, however with these inputs we either do not have any better disclosure of their distribution or it is reasonable to assume them as given which allows for comparison with the outputs from the previous step of the modelling. As was already mentioned earlier, it would be best to use simulations also for all the sensitivity analyses we performed in the previous chapter, unfortunately the simulations are so computationally intensive that this approach is not feasible with our hardware. In any case, the outputs from both methodologies are close and their combination is possible.

6.11.1 Characteristic of pseudorandom distributions

The most challenging task is to determine the possible values of future development of heat prices, which we already predicted in the chapter Three scenarios of future heat prices. In this chapter we already presented three possible future developments of the

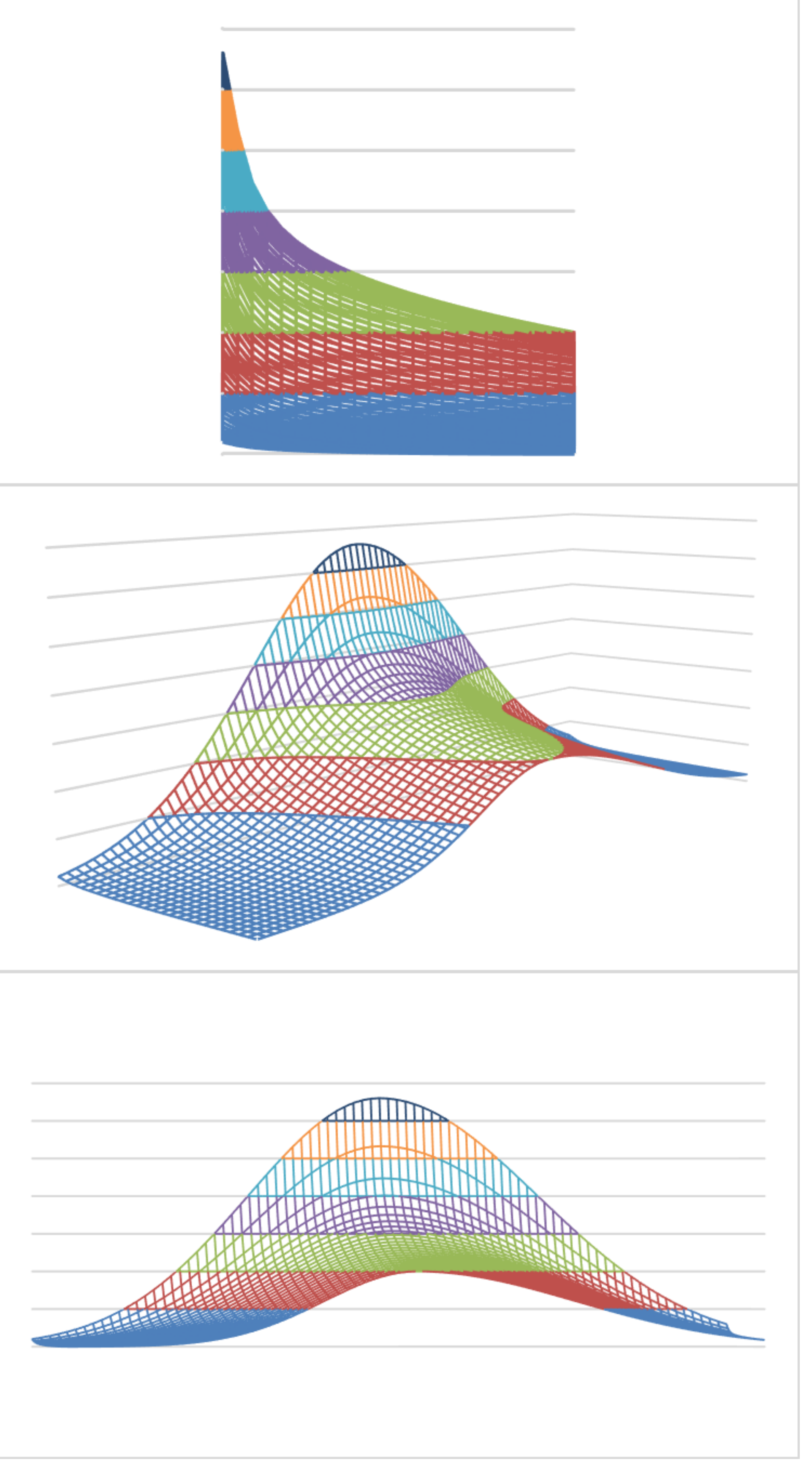

Figure 6.15: 3D histogram of applied price of heat over the time

Source: Author.

price, for more see Table 6.2: Price of heat in the Czech Republic and its prediction until 2040. We defined the low and high scenarios which are somewhat threshold values of the future development and the most likely scenario which we used in the previous, second, step of modelling with a time dimension. To simulate this uncertainty, we determine a distribution in every single year until 2040 as a normal distribution. The mean of such distribution is the value of the most likely scenario, and deviation is set differently for lower and upper values of the distribution, in the way that there is a 95% probability that all possible observations fall between the low and high thresholds. Figure 6.15 presents a 3D histogram of these values. In the upper part you can see that the probability with which we can assume the heat price to strictly follow the most likely scenario to be rapidly decreasing over time. This reflects the fact that significant step changes are not so likely to occur but the gradual ones upwards or downwards are possible. The middle part offers just a different perspective, which is the same for the lowest part of the figure. However, the lowest part marks up a bias towards lower values. This reflects the previously presented way of thinking which stresses a higher probability of lower pace of increasing heat prices than we observed during the last 15 years.

Figure 6.16 represents the most likely distribution of an interest rate applicable to the hypothetical innovative financial instrument for the forthcoming 25 years, we assess. The distribution, seen in the histogram presented by Figure 6.16 and also a distribution of the most likely inflation were discussed with specialists from the financial

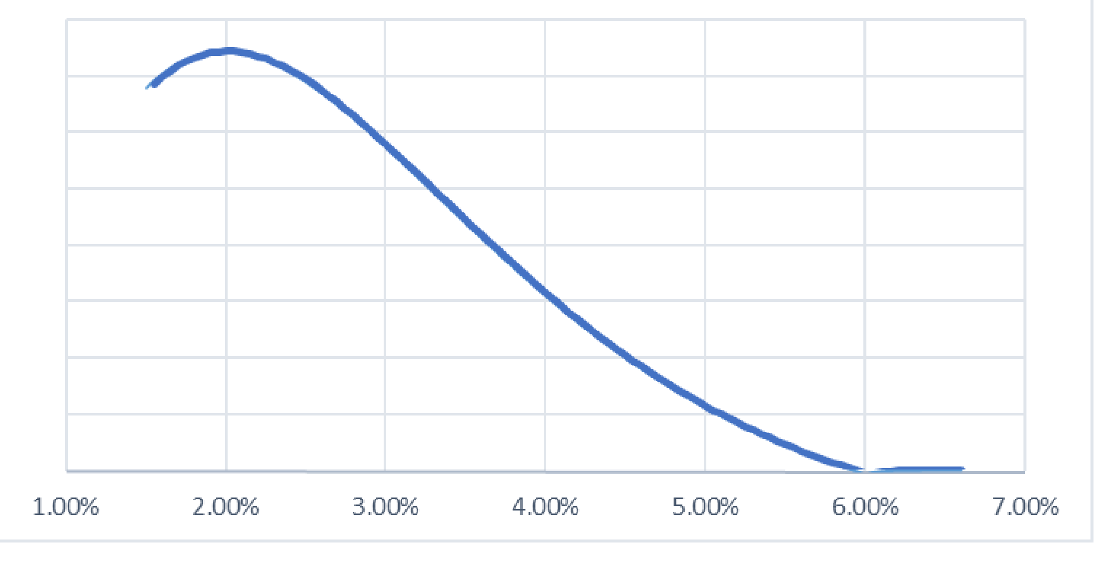

Figure 6.16: Histogram of the applied interest rate distribution

Source: Author.

markets and the Czech banking sector. (Hanzlík, 2014; Hanuš, 2015) The interest rate values range from 1.5% to 6.0% with a most probable value of 2.2%. As can be seen in the histogram, the values are biased towards lower values which reflect current low levels of interest rates and also characteristics of the innovative financial instruments and especially assumed low riskiness due to implied characteristics and the involvement of public funds. This distribution impacts mainly the coupon rates of ABS and minimum required IRR from individual initial investments apart of others.

The inflation rate which is a key driver for the size of initial investments into renovations are assumed to follow a normal distribution. The inflation in our simulations range from 0% to 4% with a mean of 2%. These values are in line with the historical development of the inflation in the Czech Republic over the last 15 years as presented by Eurostat.

6.12 Simulation outputs and comparison

After running 500 simulations in all four selected scenarios we have a range of all observed outputs. Table 6.10 presents a summary of the outputs but you can also find individual descriptive statistics and distributions of the scenarios, in the Appendix: Four individual scenarios assessment. The appendix presents tables showing descriptive statistics of the four simulations and distributions of simulated outputs presented by a number of histograms. These figures and tables confirm that there are minimum differences between mean and median values, but they also show biases presented in many of the simulated outputs. Therefore, we use the median values better describing the most likely value occurring in reality.

Table 6.10: Economic and ecological simulations outputs comparison

	Repaying period	Suitable for _ of flats	Energy savings [TWh]	Savings [B CZK]	Investments [B CZK]	Public grants [B CZK]
Recommended standard without technology	15	40%	280	742	207	0
Passive standard	15	22%	272	740	215	0
Passive standard	20	43%	472	1237	407	0
Passive standard, 20% grant	15	44%	477	1249	329	82

Source: Author.

When we compare the same measures we used in the previous step of the modelling to select the most appropriate scenarios, or more preciously resulting outputs of the assessment with just time dimension and outputs of the simulations, presented in Table 6.6: Outputs of 9 selected scenarios of time dimension analysis and Table 6.10: Economic and ecological simulations outputs comparison, we see that on average simulated values are lower. More precisely, the simulated median outputs are on average lower by about 11% in cases of RS_15_0% and PS_15_20%, lower by about 9% in case of PS_15_20%, and by about 18% in the case of PS_15_0%. Even though these values of simulations might seem low, when compared to the previously described values, in absolute values these impacts would be very promising in reality.

IRR outputs of the simulations, presented in Figure 6.9, are also slightly different from the situation described in the previous step of the modelling where the most likely values of inputs were considered. Looking at the situation when no ABS is utilised, the output of simulations suggest slightly higher values of the financial instrument IRR on average. On the other side, the situation where all the investments are recreated to the ABS shows the IRR lower, even by 10%. Finally, looking at the remaining three scenarios the results are mixed. Even the most promising scenario, ABS3, shows both, under and over estimation, however the differences are small, less than 1%. In any case, these values are still positive and attractive for investors.

Table 6.12 suggests that in the majority of cases there would be less equity needed. A part from the situation All ABS, where the simulations show a significantly higher need for equity to cover all initial investments. This higher need holds especially for the scenario PSS_15_0% where the need for equity is four times higher. When we

Table 6.11: IRR assessment of simulated scenarios

	Internal rate of return			
	RS_15_0%	*PS_15_0%*	*PS_20_0%*	*PS_15_20%*
No ABS	9.23%	6.62%	7.41%	8.62%
All ABS	39.67%	29.73%	35.05%	40.35%
ABS1	21.66%	14.94%	17.27%	21.20%
ABS2	16.42%	14.55%	15.88%	16.67%
ABS3	30.83%	27.31%	29.92%	31.69%

Source: Author.

Table 6.12: Comparison of selected scenarios after simulations

Financial Comparison	*RS_15_0%*	*PS_15_0%*	*PS_20_0%*	*PS_15_20%*
No ABS				
NPV	84 B CZK	51 B CZK	155 B CZK	123 B CZK
IRR	9.23%	6.62%	7.41%	8.62%
Equity (Investors)	207 B CZK	215 B CZK	407 B CZK	329 B CZK
Levered funds (ABS)	0 B CZK	0 B CZK	0 B CZK	0 B CZK
Financial lever	0 x	0 x	0 x	0 x
All ABS				
NPV	162 B CZK	120 B CZK	353 B CZK	254 B CZK
IRR	39.67%	29.73%	35.05%	40.35%
Equity (Investors)	38 B CZK	60 B CZK	61 B CZK	44 B CZK
Levered funds (ABS)	168 B CZK	154 B CZK	346 B CZK	284 B CZK
Financial lever	4.44 x	2.54 x	5.69 x	6.36 x
ABS1				
NPV	85 B CZK	50 B CZK	156 B CZK	124 B CZK
IRR	21.66%	14.94%	17.27%	21.20%
Equity (Investors)	75 B CZK	93 B CZK	140 B CZK	111 B CZK
Levered funds (ABS)	131 B CZK	123 B CZK	266 B CZK	217 B CZK
Financial lever	1.75 x	1.34 x	1.9 x	1.96 x
ABS2				
NPV	184 B CZK	152 B CZK	353 B CZK	283 B CZK
IRR	16.42%	14.55%	15.88%	16.67%
Equity (Investors)	50 B CZK	50 B CZK	100 B CZK	80 B CZK
Levered funds (ABS)	158 B CZK	176 B CZK	315 B CZK	252 B CZK
Financial lever	5 x	5 x	5 x	5 x
ABS3				
NPV	191 B CZK	160 B CZK	367 B CZK	294 B CZK
IRR	30.83%	27.31%	29.92%	31.69%
Equity (Investors)	43 B CZK	43 B CZK	87 B CZK	70 B CZK
Levered funds (ABS)	164 B CZK	171 B CZK	328 B CZK	262 B CZK
Financial lever	8 x	8 x	8 x	8 x

Source: Author.

focus on the ABS3 scenarios, there is no big difference for the IRR of the innovative financial instrument observed. This is a good sign for potential investors, as the value of equity needed also seems to be lower than in the previously modelled situation of the most likely situation with a time dimension. Together with the highest values of NPV among all possibilities of ABS utilisation, which is again a positive sign for investors, the ABS3 seems to be the most appropriate setting among all modelled ones. The highest values of the IRR and NPV show the most appropriate way, out of the assessed, to finance the innovative financial instrument. Moreover, there is still a space for further optimisation of the equity investments schema and its timing.

Having the value of NPV of the innovative financial instrument and also the value of equity adjusted by its time value under the same assumptions allows to calculate benefit-cost ratios for investments into the innovative financial instrument with the specific assessed settings. As can be seen in Table 6.13 this ratio ranges between 1.24 and 6.80 to 1, where the well-suited, ABS3, utilisation of ABS confirms very promising values. These values are just direct impacts of the assessed financial instrument as it was previously defined, however it still does not consider all the impacts which were earlier described as the multiple benefits. If we assumed that the multiple benefits would be the same or at least similar to the practices described by the International Energy Agency (2014a), for more see chapter Benefits of energy efficiency, this ratio would be even higher.

Table 6.13: Benefit-Cost ratio assessment without multiple benefits

	Basic Benefit-Cost Ratio			
	RS_15_0%	*PS_15_0%*	*PS_20_0%*	*PS_15_20%*
No ABS	1.41:1	1.24:1	1.38:1	1.37:1
All ABS	5.30:1	2.98:1	6.80:1	6.74:1
ABS1	2.12:1	1.54:1	2.11:1	2.12:1
ABS2	4.67:1	4.04:1	4.53:1	4.54:1
ABS3	5.42:1	4.69:1	5.21:1	5.22:1

Source: Author.

6.13 Summary of findings

Our literature review, analysis of existing realia and finally also the step-by-step assessment of the hypothetical innovative financial instrument, applied on the suitable sector of energy efficiency improvements in the Czech residential housing stock, shows a significant potential of such initiative. The assessment also showed that such initiative is reasonable not only from a financial point of view but also an ecological one. The analysis of gathered experience also suggests many other indirect impacts, so-called multiple benefits, whose overall impact on all involved stakeholders should almost surely be positive and scale up already good direct results.

The settings of the innovative financial instrument we assessed offer a beneficial insulation to end-users with no initial investment to the actual renovation for them and no impact on their cash flows, assuming a stable price of heat. Moreover, when the heat price increases, which is likely, the effect on cash flow of the end-users is positive and vice-versa. There are however several non-negligible assumptions and considerations behind our results. First of all, we have assessed a potential which means that in reality the results might be different but this holds especially to an extent of the initiative than anything else. We also assume a big scope of the initiative implying many positive characteristics for our model which would not need to be the case in reality. Many other factors would need to be solved or specified as for example all procedures or background structures or selecting between tailored and off-the-shelf structures of innovative financial instruments. In any case we know that similar energy efficiency initiatives, like Green Savings Programmes or Panel Programmes, have been historically very successful in the Czech Republic and that they also created a similar structure which would be needed for the assessed situation too. The experience also shows that the interest of end-users has been significant, many times even overreaching capacities of the programmes which suggests positive response to the introduction of the assessed initiative also in reality. However, we did not find any survey of end-users anticipated interest in a new yet unknown instrument, like the innovative financial instrument in the conditions of the Czech Republic is. Neither did we find any other evidence which would allow us to claim, that the assessed instrument would be received positively by the main stakeholders, with a virtual certainty that the response would be positive. For these reasons we can neither reject nor confirm one of our hypothesis, even though we believe that it is more likely that it might be confirmed – 'The innovative financial instruments for the energy efficiency of Czech households would be more effective than that already used in incentive schemas.'

On the other side, our assessment suggests that the innovative financial instrument we assessed is a very effective instrument, certainly more than the existing grant incentives schemas. It offers a possibility of significant impacts for the majority of stakeholders. We already described benefits for the individual end-users but there are benefits for public and also equity investors. We also need to mention a potential inconvenience for the end-users that they do not probably receive any grant which they would not need to repay back and that they would need to face a risk of decreasing heat prices but the benefits for them seem to be so significant that these negatives would be almost certainly offset multiple times. Some of the benefits from a perspective of public authorities would be that this initiative is in line with obligatory energy efficiency targets set at the European Union level, another might be energy security or a support of economic activity and employment. From the perspective of the equity investors of the innovative financial instrument our assessment has shown significant benefit-cost ratios and also IRR especially by a specific utilisation of ABS. Moreover, the flexibility of settings and the combination of funds from public and private investors allow for further optimisation. For these and previously presented reasons too we can confirm with a high level of probability our second hypothesis – 'The innovative financial instruments offer a valuable alternative to traditional public grants which is interesting for both the public and private sector.'

The last hypothesis – 'The financial schema using innovative financial instruments can be sustainable in the long-run.', has demonstrated to be correct under taken assumptions. Especially, due to the revolving effect of funds invested through the innovative financial instrument and assumed time distribution inputs. An assessment of the end-users' interest in the use of the instrument supports the long-term sustainability of the hypothetical initiative, moreover it is also desirable to distribute the interest and operations of the innovative financial instrument over time. Due to this time distribution of initial investments into renovations the amount of equity can be lowered significantly by use of ABS and also thanks to cash in-flow from already provided initial investments. The time dimension also allows better distribution of construction load for the whole economy, which consequently also supports employment in this sector over time and it should prevent from unfavourable unexpected price increase. Finally, it might also increase a pool of buildings which need to be renovated due to two reason, moral or real life-time of the installed improvements.

6.14 Further research opportunities

We see multiple ways how this study could be both, updated and upgraded. This study could be updated by applying new evidence from the already mentioned ongoing statistical survey of the Czech Statistical Office ENERGO which should closer specify or clarify several assumptions which we made throughout our assessment. The assessment might also be updated with the latest market prices of energy fuels and especially the price of heat. Finally, there will be the potential to reassess the situation if public authorities set characteristics or a framework of application of the innovative financial instruments in the field of energy efficiency.

This study also set a framework and methodology which might be applied partly or completely on other fields of assessment. There are a number of other possible uses of innovative financial instruments which all might be assessed. For example, a similar model might be as well applied on an initiative with innovative financial instruments supporting energy efficiency of boilers or other technologies, like lighting, but also a totally different field than the energy efficiency – social housing, research, development and innovation and countless other possibilities.

7 Conclusion

This thesis is focused on the emerging field of innovative financial instruments. These instruments are by definition a public initiative utilising possibilities by combining private and public funds with other possibilities to differentiate riskiness, return or the form of investments to specific groups of equity investors. Promoted by the European Commission due to the revolving character and implied lowered long-term burden for public budgets, the innovative financial instruments offer a new way of supporting projects with a positive economic rate of return and also a positive but quite low internal rate of return, which can be found in the assessed energy efficiency improvements of Czech residential housing stock.

Generally low or no awareness about the: innovative financial instruments, global or European Union strategies, and an importance of energy efficiency improvements, led us first to present these realities. Our approach allows us to describe individual topics and place them into a current context with implications. This is especially important because of the high complexity of the possible settings and also complexity of the innovative financial instrument itself. Awareness is also important because of the complexity of the surroundings and the various consequences which might occur within these surroundings.

We use multiple data sets in combination with expert opinions and other published works and the scope of this thesis ranges from energy, through politics up to finance. It also considers and assesses both, macro and micro level topics, from the description of energy efficiency global importance to possible impacts on the cash flow of individual households. Therefore, this study might be taken as a significant part of a complete ex-ante assessment as is suggested by European Union authorities, which should forego a real-life introduction of any public initiative, the innovative financial instruments included.

After the problem statement and introduction to the current situation, we select a suitable segment for our assessment, then we specify its characteristics and future perspectives more closely. The suitable segment displays energy efficiency improvements within Czech residential housing stock. More precisely, we focus on the insulation of family houses and apartment buildings that leads to lower energy intensity, especially in the case of space heating. We assess several data sets, from overall energy consumption in the Czech Republic and characteristics of Czech housing stock, to heating prices and data describing potential energy savings within specific segments of the housing stock. The aim, the lowering of space heating energy intensity in residential housing, was selected mainly because of viable technologies, favourable financial characteristics and also because it forms a significant proportion of energy consumption within the overall Czech energy consumption and for individual households too.

The innovative financial instrument we assess works as follows. It collects and combines, using a closely unspecified ratio or conditions, equity from public and private investors, who expect to receive a return. In exchange for future repayments, nominally equal to energy savings in the year of restoration, over a specific period of time, these funds are used to fully cover initial investments into suitable economically viable energy efficiency improvements of residential buildings. If we assumed the most likely nominal increase of heating prices in the future, not only would individual households enjoy multiple benefits of renovated housing without negative impact on their cash flow but they should even save some money in the future. Then, having a pool of such projects and future cash in-flows from repayments, we assess the innovative financial instrument with respect to ABS utilisation and common financial measures. The number of inputs we use in our model are uncertain or variable, therefore we assess 18 original scenarios and perform several sensitivity analyses. For the actual assessment of the innovative financial instrument itself we use three steps of modelling bringing each an extra perspective to the situation, starting with a basic As-Is analyses, then adding a time dimension to the model and finally also assess uncertainty by Monte Carlo simulations.

Due to the character of this thesis and its limited scope we cannot hope to cover all aspects and possibilities of the topic, however we were able to identify a segment which is underinvested and we recommend an initiative with significant potential to improve the situation. We modelled the situation, found the most promising settings and assessed their potentials from perspectives of multiple involved stakeholders. We identified four settings with similar outcomes which we specify by a construction standard of renovating, length of repaying and the possibility to cover part of an initial investment by a grant. These settings are: recommended standard with 15 years of repaying and no grant, passive standard with 15 or 20 years of repaying and no grant, passive standard with 15 years of repaying and 20% grant; these possibilities could be combined too.

Our recommended settings exhibit favourable multiple benefits mainly economic, ecological, financial and social ones. Under taken assumption, an upper bound reach of the innovative instrument is up to 44% of flats that have not been renovated recently, the total energy savings over time range from 270 to 480 TWh which converted to money might mean over 1.2 trillion CZK over a moral life-expectancy of implemented improvements. Moreover, the total investments should range from about 200 to 400 billion CZK when we consider just a direct effect of the innovative financial instrument. Just this direct effect would certainly have a significant positive impact on the Czech economy, employment and publicly desirable measures. The innovative financial instrument itself would also deliver a significant positive return to equity investors. Our simulations show that IRR without financial engineering in a form of ABS utilisation, ranges from 6% to 10% but with a reasonable utilisation of the ABS, the IRR seems to be around 30% in all four scenarios. These values represented as benefit-cost ratios would be about 1.4 to 1 in the case without ABS and 5.14 to 1 on average with the ABS. In the case of ABS utilisation, the equity investment to the innovative financial instrument would be between 40 and 90 B CZK, where the higher values would be represented mainly by scenarios considering a more expensive passive standard. Just for comparison, only the first Green Energy Programme had an allocation up to 25 B CZK. There are also financial and market risks associated with the ABS utilisation and financial engineering, however these risks are commonly taken at the market for example with similar systems of mortgages.

We also found answers to our three main hypotheses. Even though we believe the first hypothesis is correct, we neither found enough evidence to confirm it nor reject it – 'The innovative financial instruments for the energy efficiency of Czech households would be more effective than that already used in incentive schemas.' With a high level of probability, we can however confirm our second hypothesis – 'The innovative financial instruments offer a valuable alternative to traditional public grants which is interesting for both the public and private sector.' Also the third hypothesis has demonstrated to be correct under taken assumptions – 'The financial schema using innovative financial instruments can be sustainable in the long-run.'

There is a question of fine tuning the initiative we presented in this thesis before it would be introduced to reality because we found that significant differences occur with respect to individual settings, however all four selected and assessed scenarios reveal favourable outcomes. We also identified existing experience which suggests an interest of end users and which also can be taken as a base for new initiatives using the innovative financial instruments. Therefore, we would recommend focusing on either one of these four scenarios or their combination, and introduce this initiative through upgraded already existing structures. Moreover, there is a number of possibilities to further update and also upgrade our study, for example to upgrade it by using other energy efficiency improvements than insulation but also to use completely different fields of application. The overall complexity allows many other possible ways of utilisation of the innovative financial instruments but our study shows and assesses one particular favourable segment where their implementation is feasible and recommended by us.

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Appendix: Four individual scenarios assessment

This section summarises findings of the individual selected scenarios. The findings are presented in tables and figures divided always in three chapters with respect to three modelled approaches described previously. All these outputs come from our calculations.

7.1 Recommended standard without technology: 20 years, 0% grant

As-Is assessment

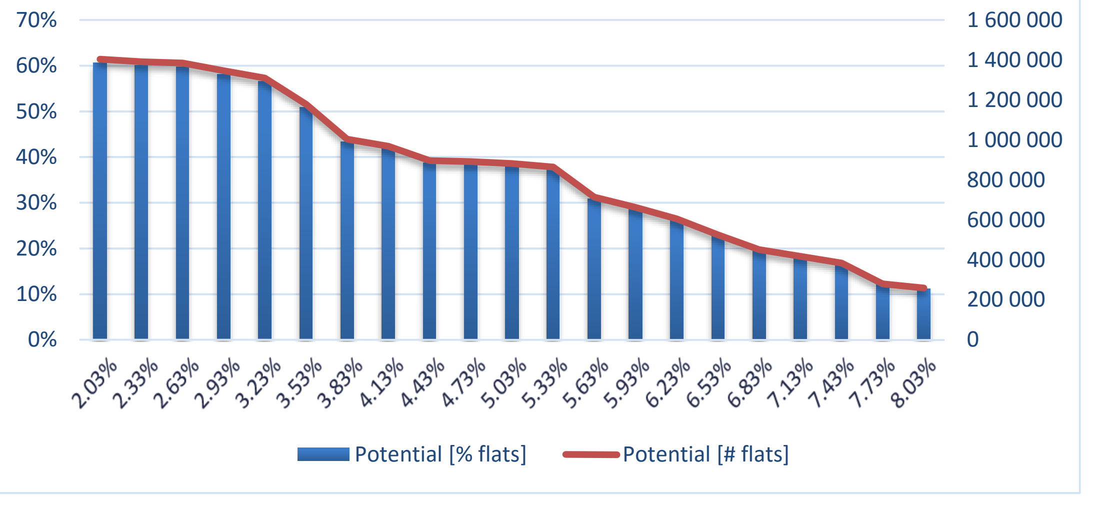


Figure A.1: Sensitivity analysis, As-Is model, total potential with respect to minimum required IRR, RS_20_0%

7.2 Recommended standard without technology: 15 years, 0% grant

7.2.1 As-Is assessment

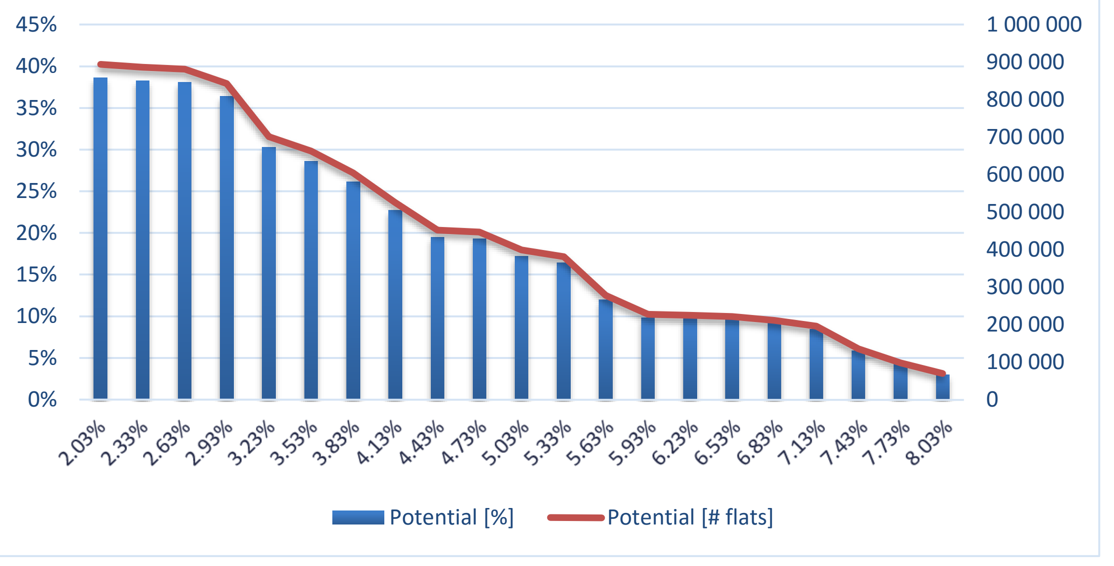


Figure A.2: Sensitivity analysis, As-Is model, total potential with respect to minimum required IRR, RS_15_0%

7.2.2 Assessment with time dimension

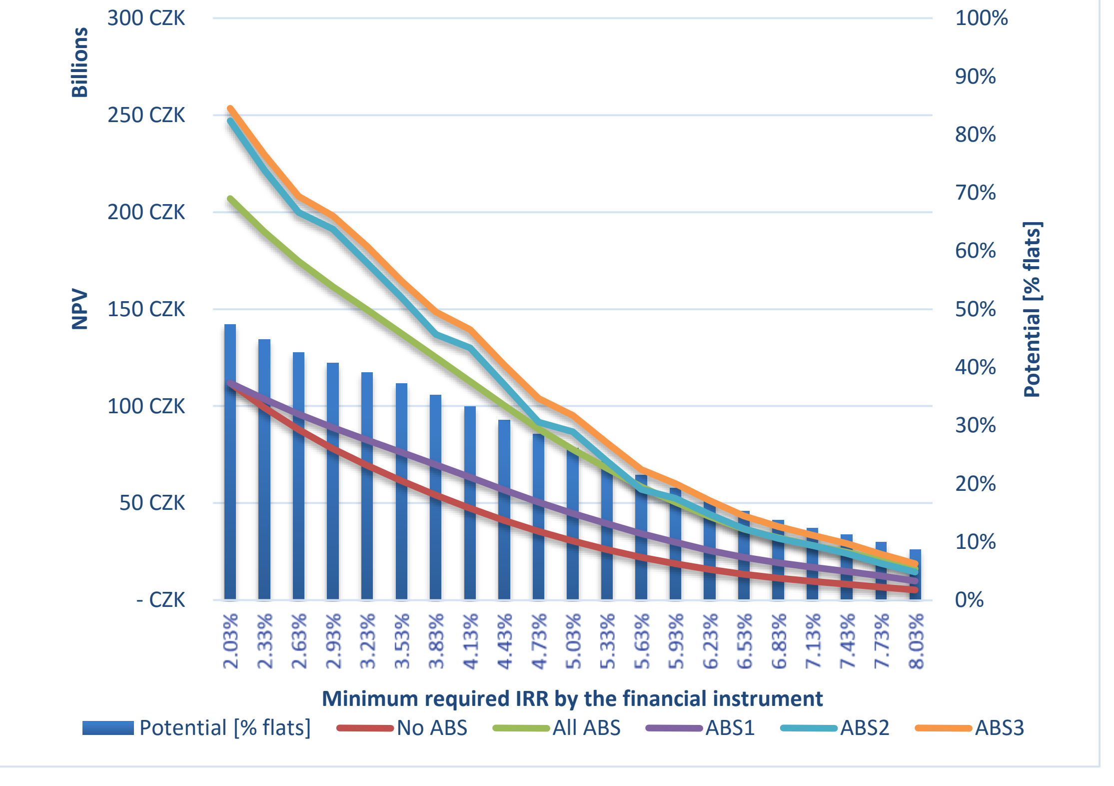


Figure A.3: Sensitivity analysis, time dimension model, total potential with respect to minimum required IRR, RS_15_0%

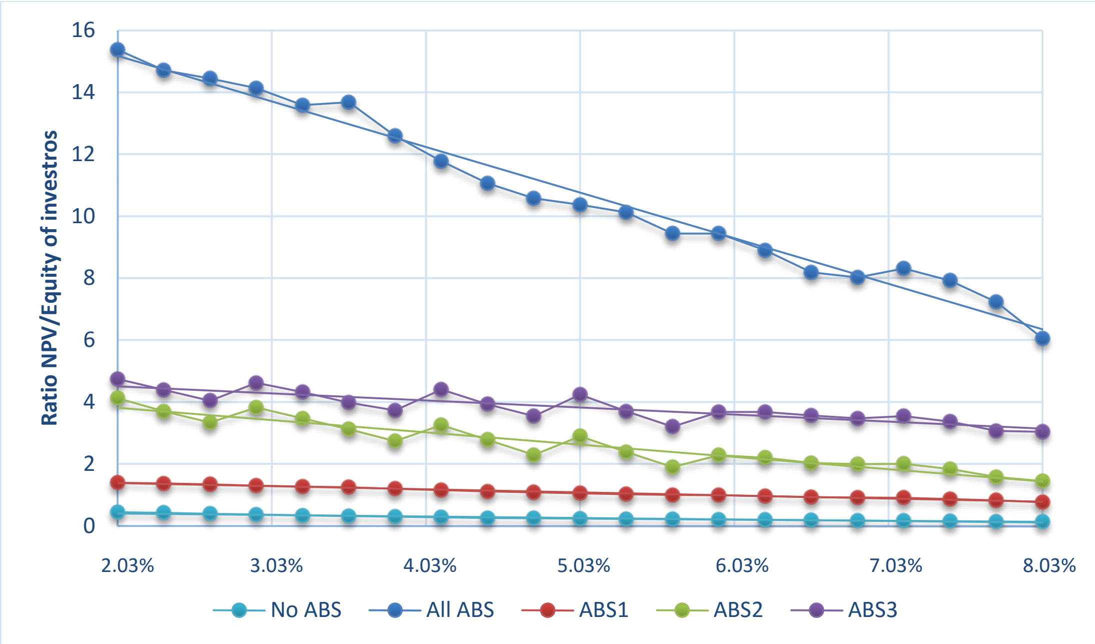


Figure A.4: Sensitivity analysis, time dimension model, NPV/Equity with respect to minimum required IRR, RS_15_0%

Sensitivity Analysis

Legend:

NPV (discount rate = WACC)
IRR
NPV/Total initial investment

*Arrows indicate comparison between all the values

WACC	2.33%	2.63%	2.93%	3.23%	3.53%	3.83%
5.83%	62 B CZK 28.30% 3.60	61 B CZK 28.19% 3.54				
5.03%	94 B CZK 29.58% 4.16	92 B CZK 29.46% 4.09	90 B CZK 29.35% 4.01			
4.23%	131 B CZK 29.75% 4.15	128 B CZK 29.63% 4.07	126 B CZK 29.51% 3.99	123 B CZK 29.39% 3.91		
3.43%	168 B CZK 31.61% 4.05	164 B CZK 31.46% 3.96	161 B CZK 31.31% 3.87	157 B CZK 31.15% 3.79	154 B CZK 31.00% 3.70	
2.63%	204 B CZK 29.78% 3.96	200 B CZK 29.62% 3.88	195 B CZK 29.47% 3.79	190 B CZK 29.31% 3.70	186 B CZK 29.16% 3.61	181 B CZK 29.00% 3.52
1.83%	258 B CZK 27.92% 4.13	252 B CZK 27.79% 4.04	246 B CZK 27.66% 3.94	239 B CZK 27.53% 3.84	233 B CZK 27.39% 3.74	227 B CZK 27.26% 3.64

Minimum required IRR of initial investments

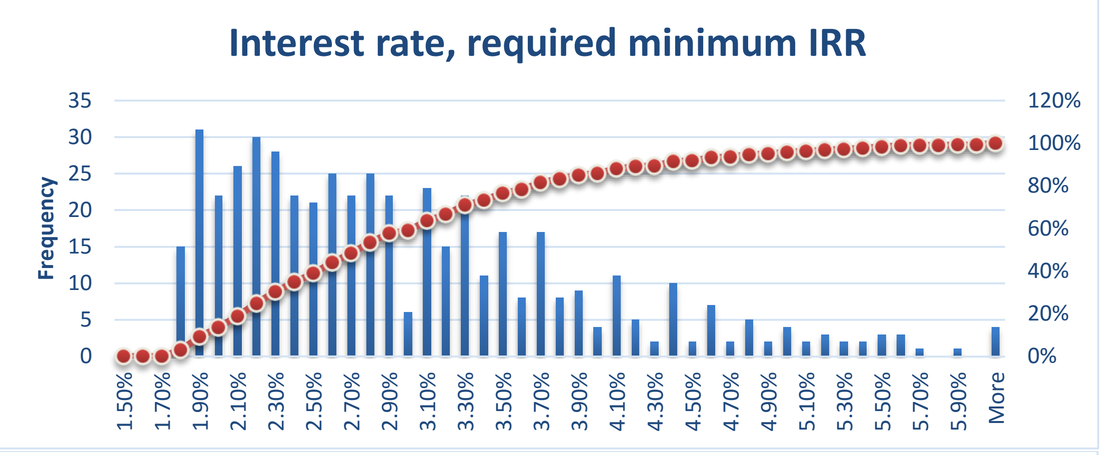
Figure A.5: Sensitivity analysis, time dimension model, WACC with respect to minimum required IRR, RS_15_0%

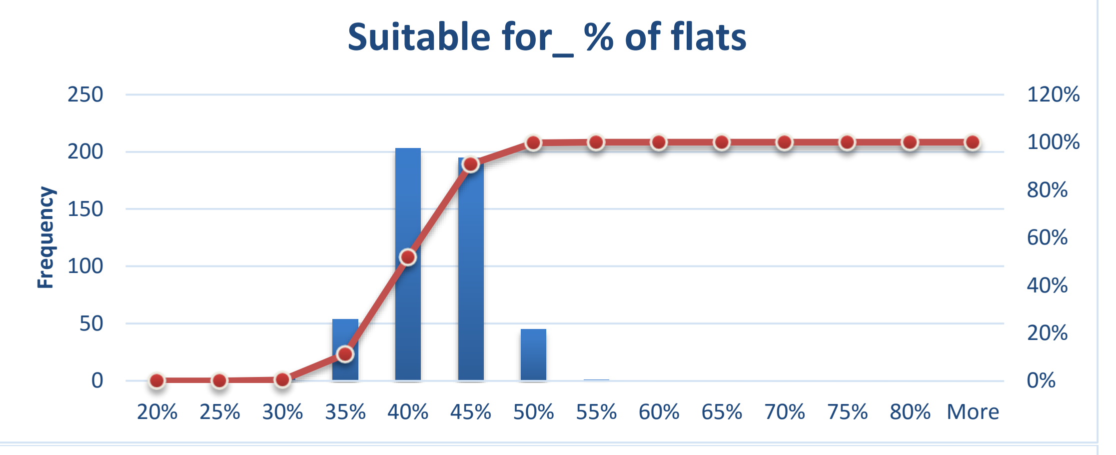
7.2.3 Simulation outputs

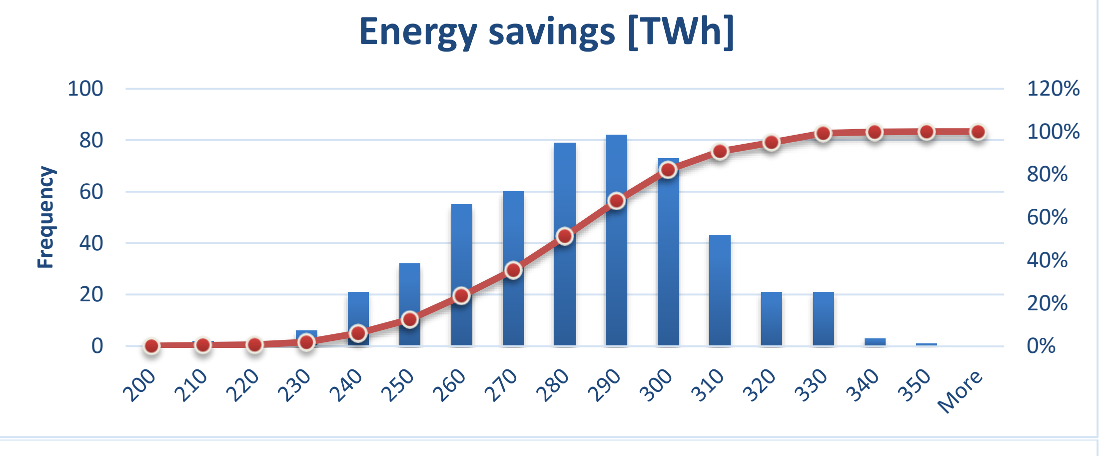
Table A.1: Simulation output, descriptive statistics, RS_15_0%

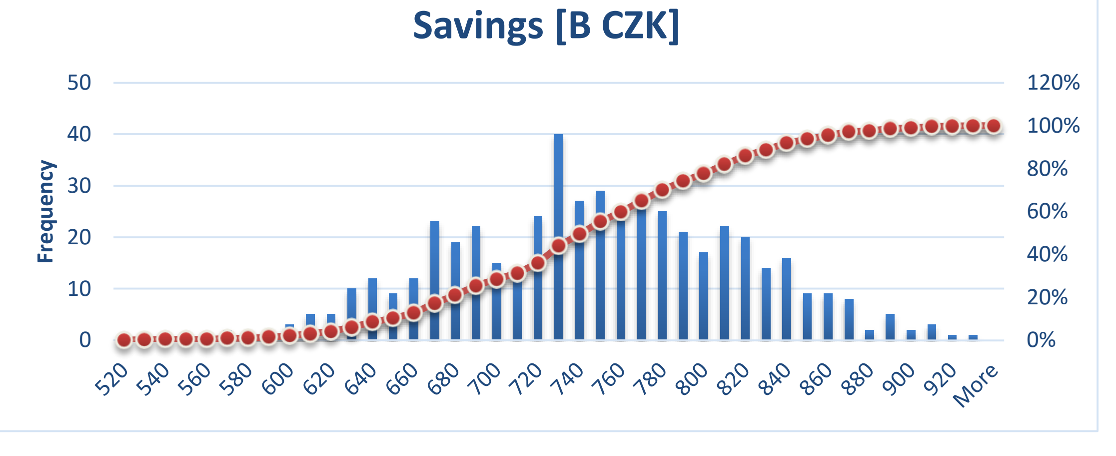
	Mean	St. Deviation	Median	Minimum	Maximum	Sample variance	Skewness	Kurtosis
	Descriptive statistics							
	Recommended standard without technology, 15 years, 0% grant							
Minimum required IRR	2.96%	0.93%	2.75%	1.80%	6.30%	0.01%	105.51%	78.00%
Suitable for _ of flats	39.8%	3.9%	39.8%	28.6%	50.8%	0.1%	4.8%	-29.7%
Energy savings	279	24	280	207	346	574	0	0
Savings	742	71	742	529	930	5045	0	0
Investment	*206*	*16*	*207*	*153*	*246*	*269*	*0*	*0*
Public grant	0	0	0	0	0	*0*	-	-
No ABS								
NPV	85 B CZK	11 B CZK	84 B CZK	57 B CZK	114 B CZK	110 E+18 CZK	0 B CZK	0 B CZK
IRR	9.25%	0.33%	9.23%	8.33%	10.43%	0.00%	21.92%	6.23%
Equity (Investors)	206 B CZK	16 B CZK	207 B CZK	153 B CZK	246 B CZK	269 E+18 CZK	0 B CZK	0 B CZK
Levered funds (ABS)	0 B CZK	0 B CZK	0 B CZK	0 B CZK	0 B CZK	0 B CZK	-	-
Financial lever	0 x	0 x	0 x	0 x	0 x	0 x	-	-
All ABS								
NPV	163 B CZK	23 B CZK	162 B CZK	113 B CZK	241 B CZK	532 E+18 CZK	0 B CZK	0 B CZK
IRR	39.28%	3.14%	39.67%	30.62%	46.30%	0.10%	-33.19%	-48.93%
Equity (Investors)	38 B CZK	7 B CZK	38 B CZK	21 B CZK	67 B CZK	46 E+18 CZK	0 B CZK	0 B CZK
Levered funds (ABS)	167 B CZK	20 B CZK	168 B CZK	108 B CZK	214 B CZK	386 E+18 CZK	0 B CZK	0 B CZK
Financial lever	4.5 x	1.2 x	4.4 x	1.7 x	8.6 x	1.4 x	0.5 x	0.2 x
ABS1								
NPV	85 B CZK	15 B CZK	85 B CZK	43 B CZK	124 B CZK	224 E+18 CZK	0 B CZK	0 B CZK
IRR	21.52%	1.63%	21.66%	15.83%	24.65%	0.03%	-66.56%	12.78%
Equity (Investors)	75 B CZK	5 B CZK	75 B CZK	62 B CZK	90 B CZK	25 E+18 CZK	0 B CZK	0 B CZK
Levered funds (ABS)	130 B CZK	14 B CZK	131 B CZK	88 B CZK	164 B CZK	206 E+18 CZK	0 B CZK	0 B CZK
Financial lever	1.7 x	0.2 x	1.7 x	1 x	2.1 x	0 x	-0.6 x	0.5 x
ABS2								
NPV	183 B CZK	22 B CZK	184 B CZK	114 B CZK	247 B CZK	499 E+18 CZK	0 B CZK	0 B CZK
IRR	16.42%	1.02%	16.42%	13.86%	20.37%	0.01%	28.81%	8.30%
Equity (Investors)	51 B CZK	5 B CZK	50 B CZK	40 B CZK	60 B CZK	24 E+18 CZK	0 B CZK	0 B CZK
Levered funds (ABS)	165 B CZK	16 B CZK	158 B CZK	126 B CZK	189 B CZK	252 E+18 CZK	0 B CZK	0 B CZK
Financial lever	5.2 x	0.6 x	5 x	4 x	6 x	0.4 x	-0.2 x	-0.6 x
ABS3								
NPV	190 B CZK	23 B CZK	191 B CZK	120 B CZK	255 B CZK	524 E+18 CZK	0 B CZK	0 B CZK
IRR	30.84%	2.12%	30.83%	25.59%	40.42%	0.05%	37.60%	75.79%
Equity (Investors)	44 B CZK	4 B CZK	43 B CZK	34 B CZK	52 B CZK	16 E+18 CZK	0 B CZK	0 B CZK
Levered funds (ABS)	164 B CZK	15 B CZK	164 B CZK	114 B CZK	197 B CZK	214 E+18 CZK	0 B CZK	0 B CZK
Financial lever	7.8 x	0.7 x	8 x	7 x	9 x	0.4 x	0.2 x	-0.8 x

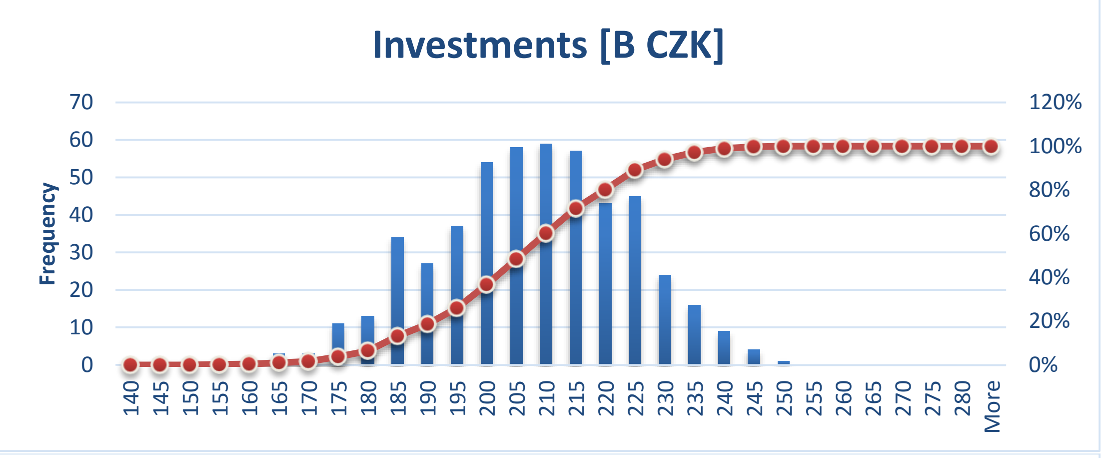
Basic Benefit-Cost Rat	*No ABS*	*All ABS*	*ABS1*	*ABS2*	*ABS3*
	1.41 : 1	5.3 : 1	2.12 : 1	4.67 : 1	5.42 : 1

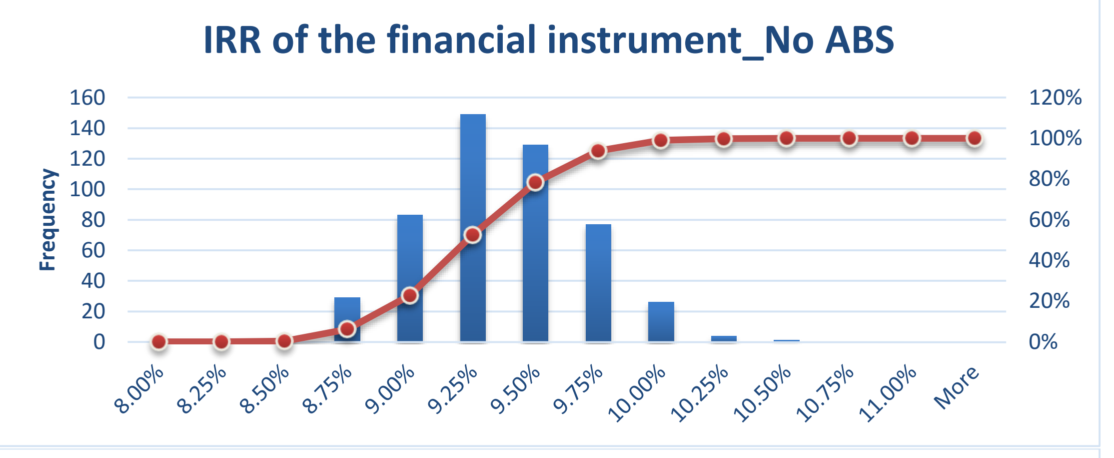

Interest rate, required minimum IRR
Frequency
35
30
25
20
15
10
5
0
120%
100%
80%
60%
40%
20%
0%
1.50%
1.70%
1.90%
2.10%
2.30%
2.50%
2.70%
2.90%
3.10%
3.30%
3.50%
3.70%
3.90%
4.10%
4.30%
4.50%
4.70%
4.90%
5.10%
5.30%
5.50%
5.70%
5.90%
More

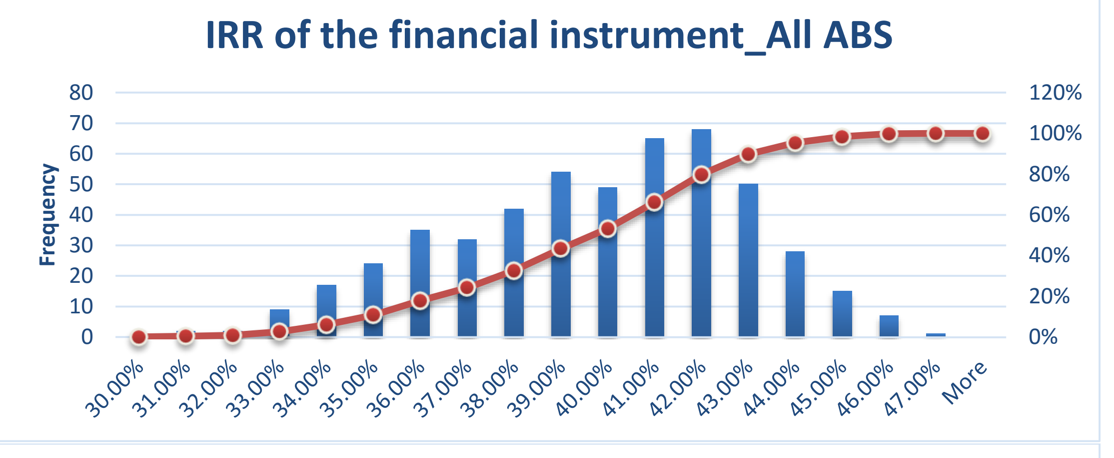

Suitable for_ % of flats
Frequency
250
200
150
100
50
0
120%
100%
80%
60%
40%
20%
0%
20%
25%
30%
35%
40%
45%
50%
55%
60%
65%
70%
75%
80%
More

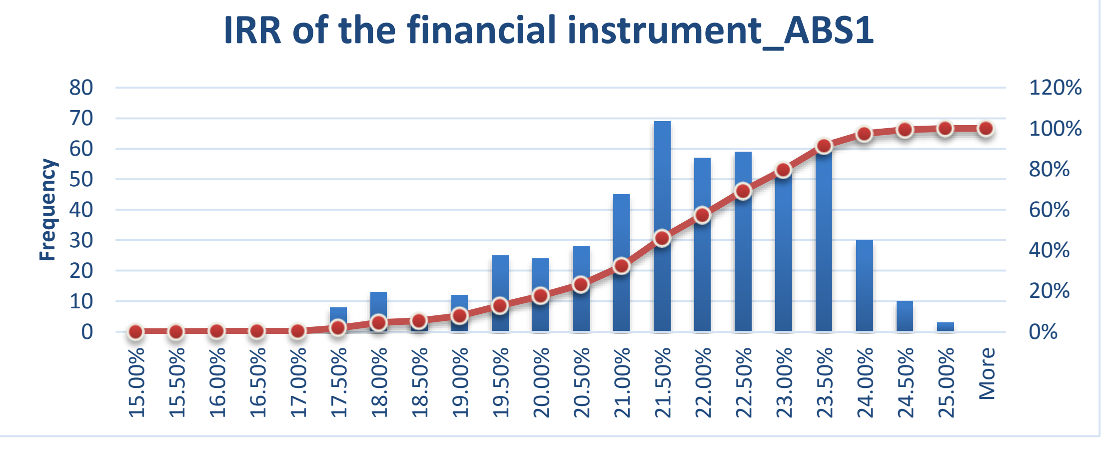

Energy savings [TWh]
Frequency
100
80
60
40
20
0
120%
100%
80%
60%
40%
20%
0%
200
210
220
230
240
250
260
270
280
290
300
310
320
330
340
350
More

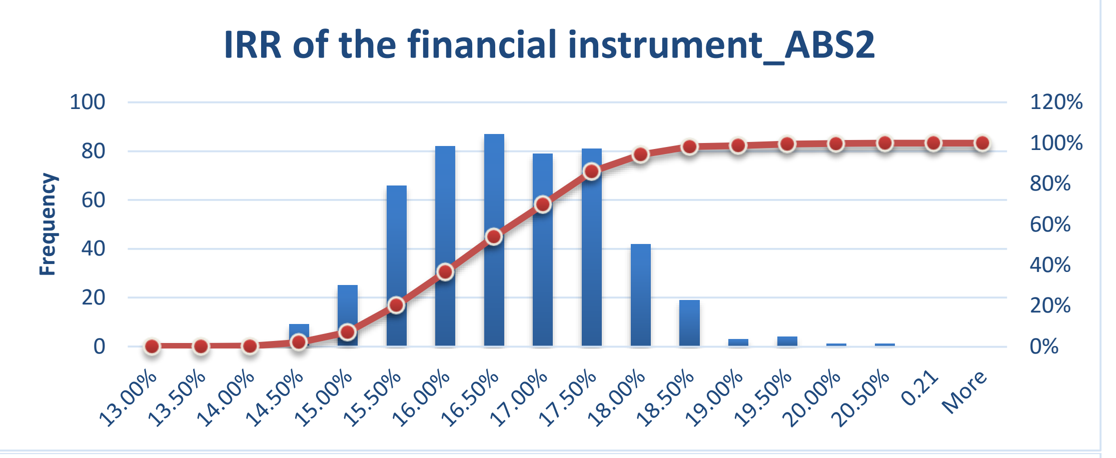

Savings [B CZK]
Frequency
50
40
30
20
10
0
120%
100%
80%
60%
40%
20%
0%
520
540
560
580
600
620
640
660
680
700
720
740
760
780
800
820
840
860
880
900
920
More


Investments [B CZK]
Frequency
70
60
50
40
30
20
10
0
120%
100%
80%
60%
40%
20%
0%
140 145 150 155 160 165 170 175 180 185 190 195 200 205 210 215 220 225 230 235 240 245 250 255 260 265 270 275 280 More


IRR of the financial instrument_No ABS
Frequency
160
140
120
100
80
60
40
20
0
120%
100%
80%
60%
40%
20%
0%
8.00% 8.25% 8.50% 8.75% 9.00% 9.25% 9.50% 9.75% 10.00% 10.25% 10.50% 10.75% 11.00% More


IRR of the financial instrument_All ABS
Frequency
80
70
60
50
40
30
20
10
0
120%
100%
80%
60%
40%
20%
0%
30.00% 31.00% 32.00% 33.00% 34.00% 35.00% 36.00% 37.00% 38.00% 39.00% 40.00% 41.00% 42.00% 43.00% 44.00% 45.00% 46.00% 47.00% More


IRR of the financial instrument_ABS1
Frequency
80
70
60
50
40
30
20
10
0
120%
100%
80%
60%
40%
20%
0%
15.00% 15.50% 16.00% 16.50% 17.00% 17.50% 18.00% 18.50% 19.00% 19.50% 20.00% 20.50% 21.00% 21.50% 22.00% 22.50% 23.00% 23.50% 24.00% 24.50% 25.00% More



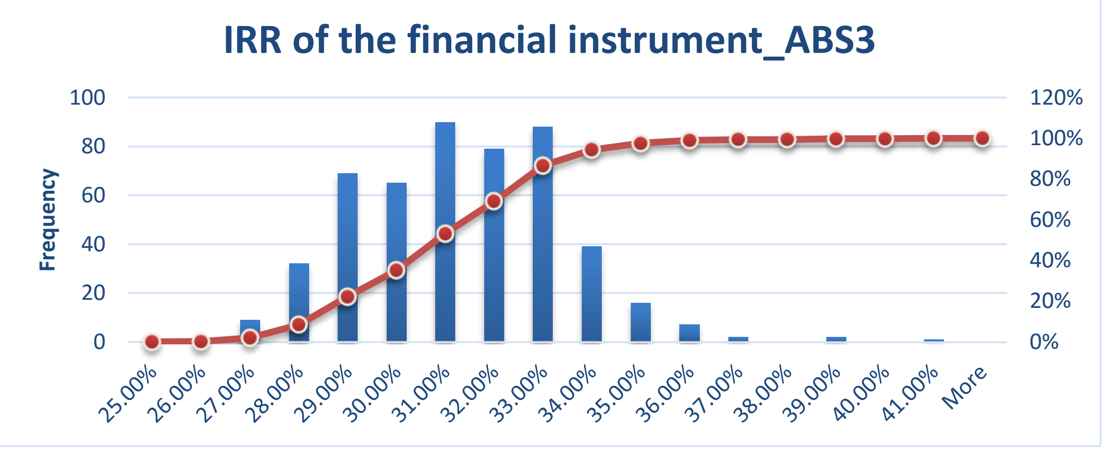


Figure A.6: Simulation output, set of histograms, RS_15_0%

7.3 Passive standard: 15 years, 0% grant

7.3.1 As-Is assessment

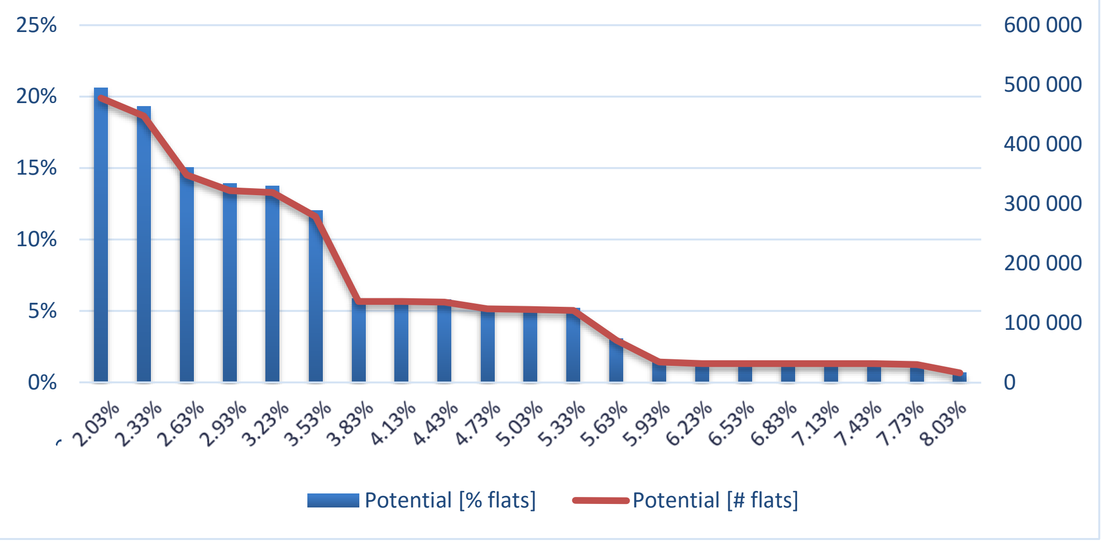


Figure A.7: Sensitivity analysis, As-Is model, total potential with respect to minimum required IRR, PS_15_0%

7.3.2 Assessment with time dimension

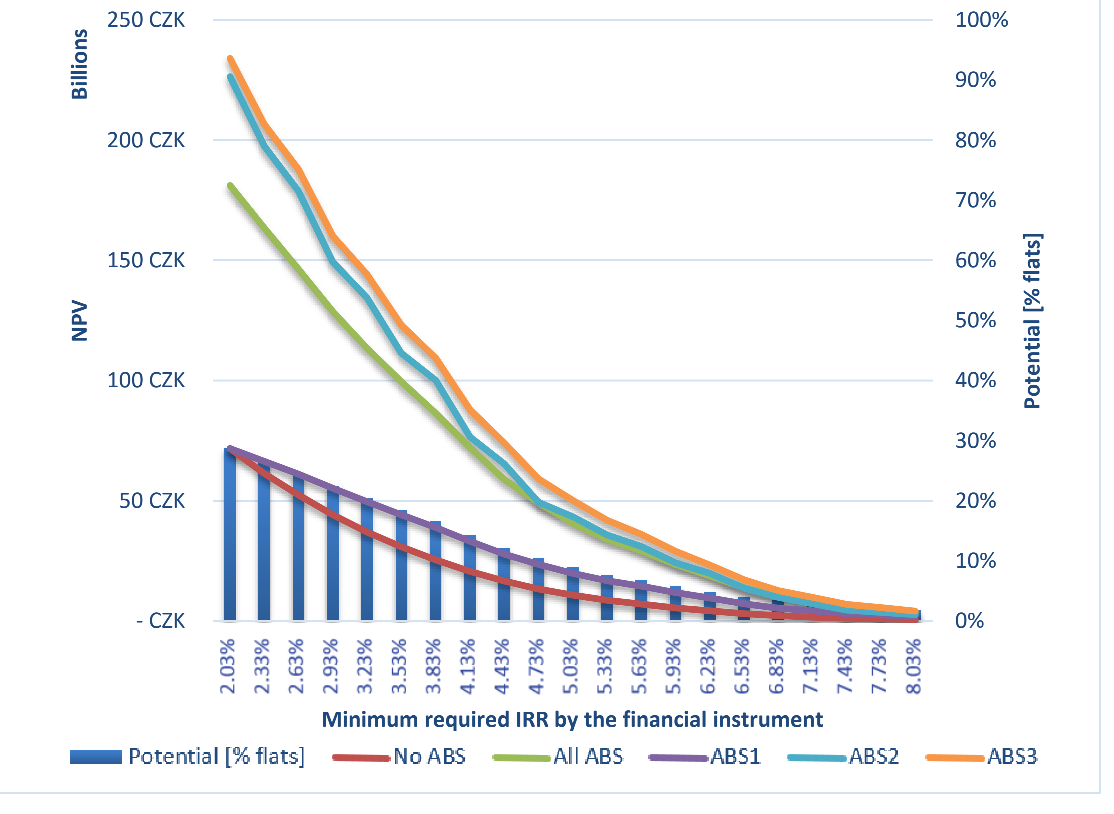


Figure A.8: Sensitivity analysis, time dimension model, total potential with respect to minimum required IRR, PS_15_0%

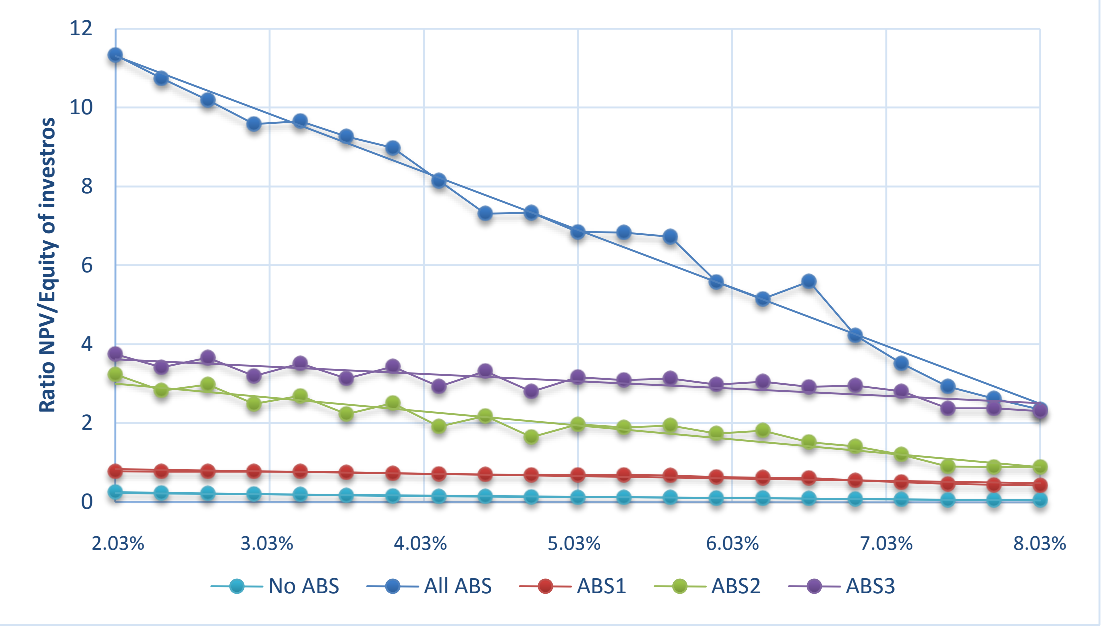


Figure A.9: Sensitivity analysis, time dimension model, NPV/Equity with respect to minimum required IRR, PS_15_0%

Sensitivity Analysis

Legend:

NPV (discount rate = WACC)
IRR
NPV/Total initial investment

*Arrows indicate comparison between all the values

WACC	2.33%	2.63%	2.93%	3.23%	3.53%	3.83%
5.83%	31 B CZK 24.61% 2.89	30 B CZK 24.49% 2.83				
5.03%	49 B CZK 23.71% 3.10	48 B CZK 23.60% 3.03	47 B CZK 23.49% 2.97			
4.23%	86 B CZK 25.41% 3.70	84 B CZK 25.30% 3.62	82 B CZK 25.18% 3.53	80 B CZK 25.07% 3.45		
3.43%	126 B CZK 25.20% 3.13	123 B CZK 25.06% 3.05	120 B CZK 24.92% 2.97	117 B CZK 24.77% 2.89	113 B CZK 24.62% 2.81	
2.63%	183 B CZK 27.44% 3.56	178 B CZK 27.30% 3.46	173 B CZK 27.15% 3.36	168 B CZK 27.01% 3.27	163 B CZK 26.87% 3.17	158 B CZK 26.72% 3.07
1.83%	242 B CZK 26.52% 3.39	234 B CZK 26.37% 3.29	227 B CZK 26.22% 3.19	220 B CZK 26.07% 3.09	213 B CZK 25.92% 2.99	206 B CZK 25.77% 2.89

Minimum required IRR of initial investments

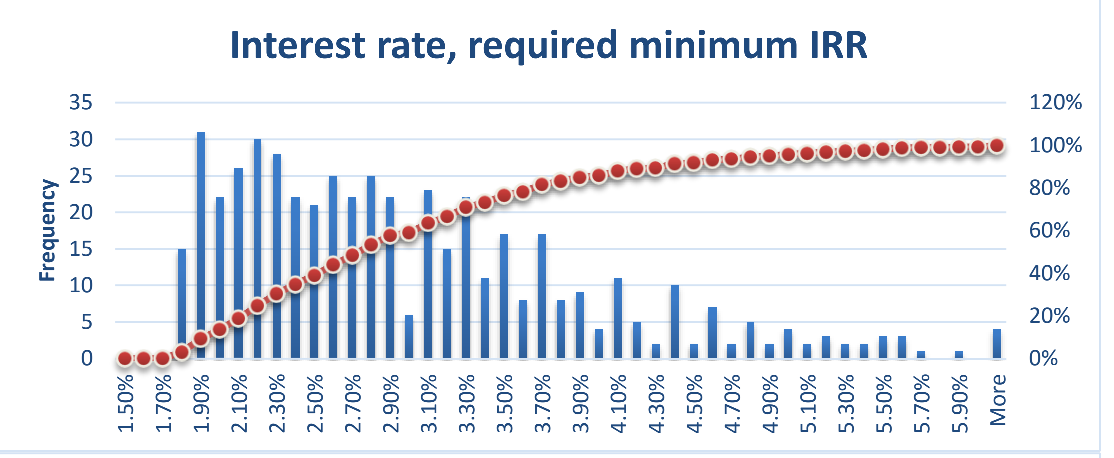
Figure A.10: Sensitivity analysis, time dimension model, WACC with respect to minimum required IRR, PS_15_0%

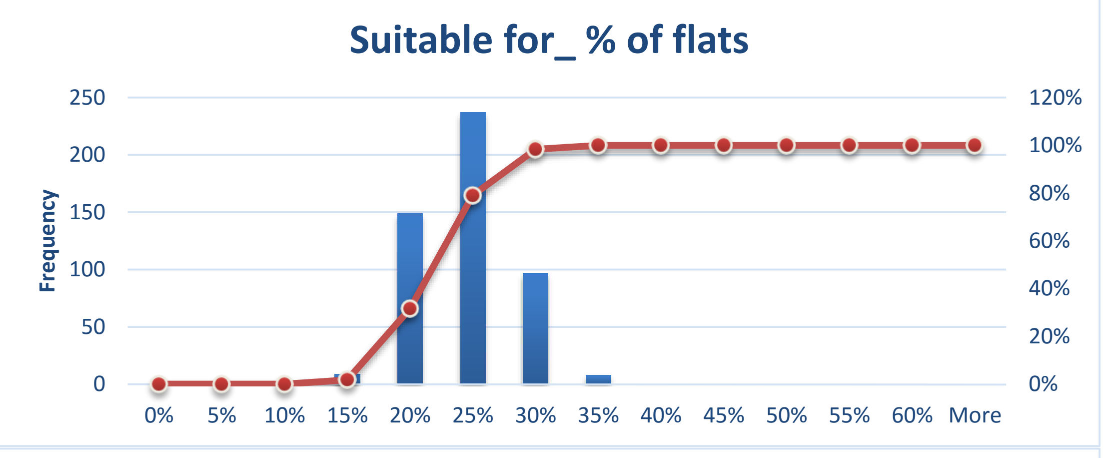
7.3.3 Simulation outputs

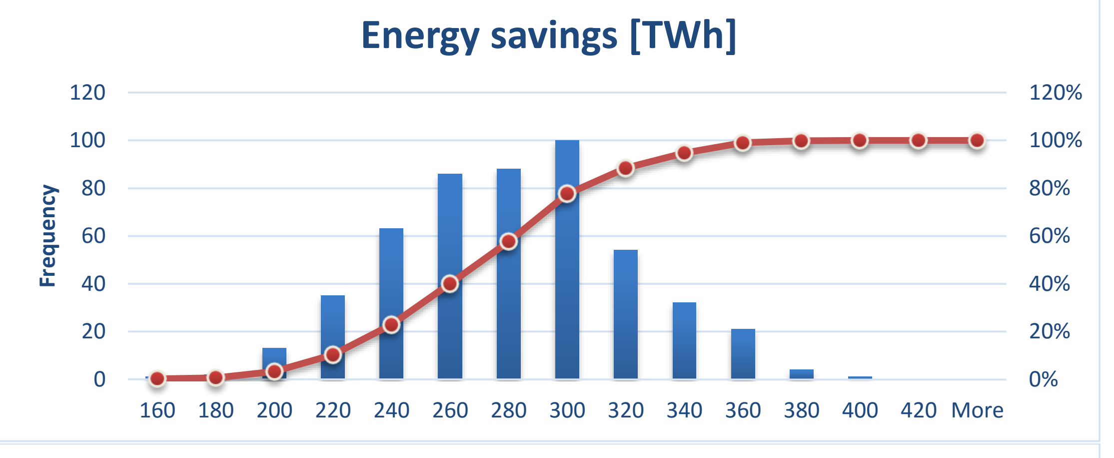
Table A.2: Simulation output, descriptive statistics, PS_15_0%

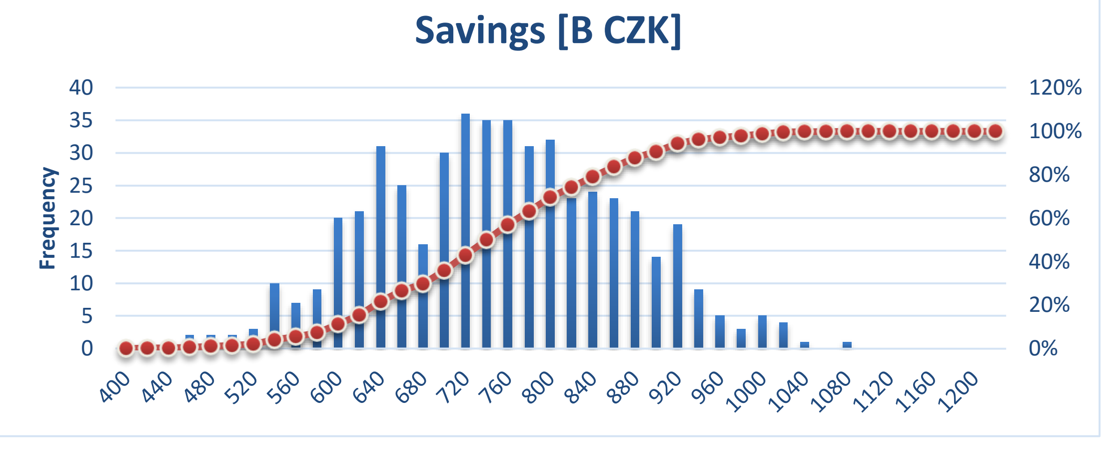
				Descriptive statistics				
				Passive standard, 15 years, 0% grant				
	Mean	*St. Deviation*	*Median*	*Minimum*	*Maximum*	*Sample variance*	*Skewness*	*Kurtosis*
Minimum required IRR	2.96%	0.93%	2.75%	1.80%	6.30%	0.01%	105.51%	78.00%
Suitable for _ of flats	21.9%	3.6%	21.9%	12.2%	32.2%	0.1%	16.4%	-28.9%
Energy savings	272	40	272	160	381	1587	0	0
Savings	742	115	740	419	1061	13244	0	0
Investment	*215*	*30*	*215*	*125*	*298*	*928*	*0*	*0*
Public grant	0	0	0	0	0	*0*	-	-
No ABS								
NPV	51 B CZK	11 B CZK	51 B CZK	26 B CZK	85 B CZK	116 E+18 CZK	0 B CZK	0 B CZK
IRR	6.64%	0.32%	6.62%	5.85%	7.73%	0.00%	30.26%	13.07%
Equity (Investors)	215 B CZK	30 B CZK	215 B CZK	125 B CZK	298 B CZK	928 E+18 CZK	0 B CZK	0 B CZK
Levered funds (ABS)	0 B CZK	0 B CZK	0 B CZK	0 B CZK	0 B CZK	0 B CZK	-	-
Financial lever	0 x	0 x	0 x	0 x	0 x	0 x	-	-
All ABS								
NPV	123 B CZK	28 B CZK	120 B CZK	63 B CZK	223 B CZK	765 E+18 CZK	0 B CZK	0 B CZK
IRR	29.75%	4.17%	29.73%	17.11%	40.68%	0.17%	1.04%	-34.68%
Equity (Investors)	61 B CZK	9 B CZK	60 B CZK	32 B CZK	94 B CZK	90 E+18 CZK	0 B CZK	0 B CZK
Levered funds (ABS)	154 B CZK	32 B CZK	154 B CZK	72 B CZK	255 B CZK	1047 E+18 CZK	0 B CZK	0 B CZK
Financial lever	2.6 x	0.8 x	2.5 x	0.9 x	5.9 x	0.6 x	0.6 x	0.3 x
ABS1								
NPV	51 B CZK	15 B CZK	50 B CZK	13 B CZK	94 B CZK	215 E+18 CZK	0 B CZK	0 B CZK
IRR	14.78%	2.13%	14.94%	8.54%	19.71%	0.05%	-39.50%	-10.70%
Equity (Investors)	92 B CZK	10 B CZK	93 B CZK	59 B CZK	125 B CZK	96 E+18 CZK	0 B CZK	0 B CZK
Levered funds (ABS)	123 B CZK	25 B CZK	123 B CZK	59 B CZK	192 B CZK	617 E+18 CZK	0 B CZK	0 B CZK
Financial lever	1.3 x	0.2 x	1.3 x	0.6 x	1.9 x	0.1 x	-0.1 x	-0.3 x
ABS2								
NPV	152 B CZK	28 B CZK	152 B CZK	75 B CZK	237 B CZK	785 E+18 CZK	0 B CZK	0 B CZK
IRR	14.62%	1.13%	14.55%	11.26%	19.28%	0.01%	47.32%	90.64%
Equity (Investors)	54 B CZK	8 B CZK	50 B CZK	30 B CZK	70 B CZK	66 E+18 CZK	0 B CZK	0 B CZK
Levered funds (ABS)	173 B CZK	26 B CZK	176 B CZK	106 B CZK	247 B CZK	697 E+18 CZK	0 B CZK	0 B CZK
Financial lever	5.2 x	0.6 x	5 x	4 x	7 x	0.4 x	0 x	-0.3 x
ABS3								
NPV	160 B CZK	29 B CZK	160 B CZK	79 B CZK	247 B CZK	843 E+18 CZK	0 B CZK	0 B CZK
IRR	27.46%	2.39%	27.31%	21.35%	39.54%	0.06%	54.47%	122.26%
Equity (Investors)	46 B CZK	7 B CZK	43 B CZK	26 B CZK	60 B CZK	46 E+18 CZK	0 B CZK	0 B CZK
Levered funds (ABS)	172 B CZK	25 B CZK	171 B CZK	98 B CZK	230 B CZK	626 E+18 CZK	0 B CZK	0 B CZK
Financial lever	7.8 x	0.7 x	8 x	6 x	9 x	0.4 x	0.1 x	-0.6 x

Basic Benefit-Cost Rat	*No ABS*	*All ABS*	*ABS1*	*ABS2*	*ABS3*
	1.24 : 1	2.98 : 1	1.54 : 1	4.04 : 1	4.69 : 1


Interest rate, required minimum IRR
Frequency
35
30
25
20
15
10
5
0
120%
100%
80%
60%
40%
20%
0%
1.50%
1.70%
1.90%
2.10%
2.30%
2.50%
2.70%
2.90%
3.10%
3.30%
3.50%
3.70%
3.90%
4.10%
4.30%
4.50%
4.70%
4.90%
5.10%
5.30%
5.50%
5.70%
5.90%
More


Suitable for_ % of flats
Frequency
250
200
150
100
50
0
120%
100%
80%
60%
40%
20%
0%
0%
5%
10%
15%
20%
25%
30%
35%
40%
45%
50%
55%
60%
More


Energy savings [TWh]
Frequency
120
100
80
60
40
20
0
120%
100%
80%
60%
40%
20%
0%
160
180
200
220
240
260
280
300
320
340
360
380
400
420
More


Savings [B CZK]
Frequency
40
35
30
25
20
15
10
5
0
120%
100%
80%
60%
40%
20%
0%
400
440
480
520
560
600
640
680
720
760
800
840
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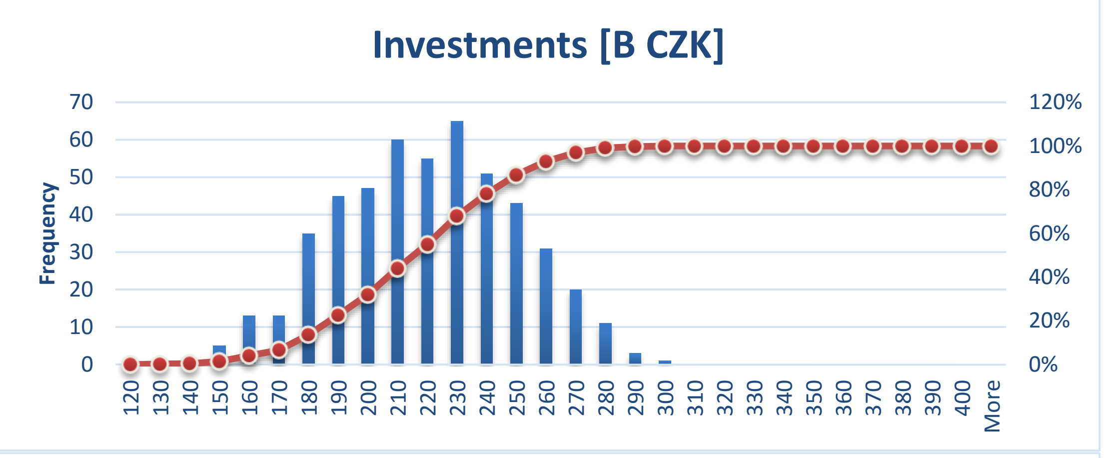
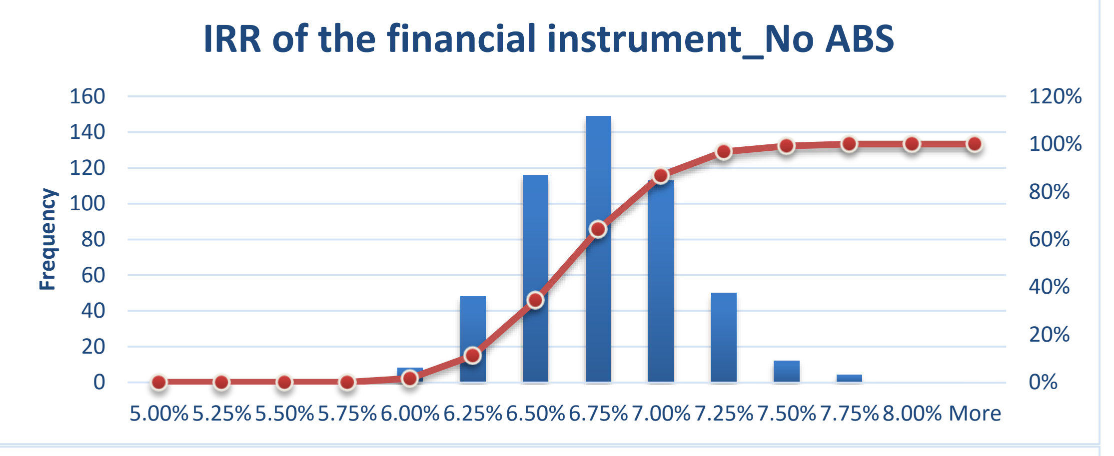
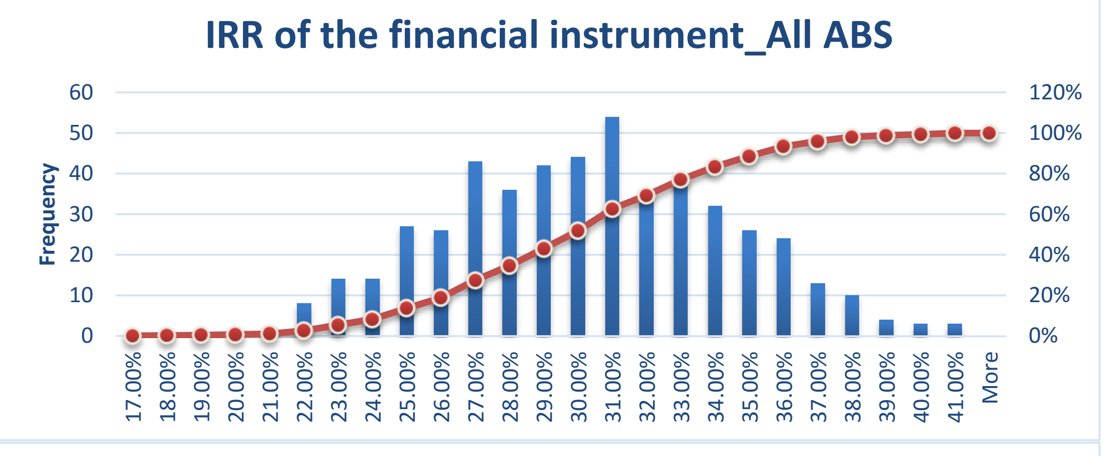
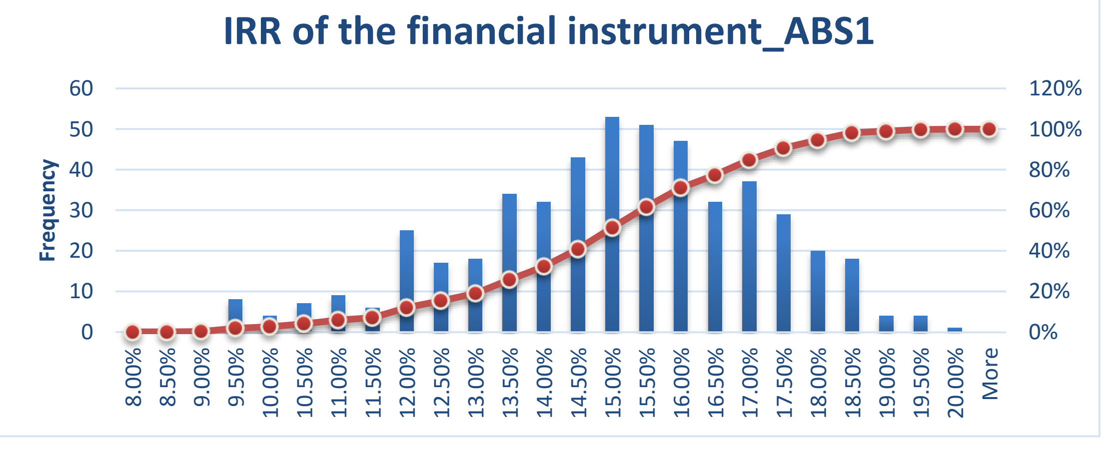
1040
1080
1120
1160
1200


Investments [B CZK]
Frequency
70
60
50
40
30
20
10
0
120%
100%
80%
60%
40%
20%
0%
120 130 140 150 160 170 180 190 200 210 220 230 240 250 260 270 280 290 300 310 320 330 340 350 360 370 380 390 400 More


IRR of the financial instrument_No ABS
Frequency
160
140
120
100
80
60
40
20
0
120%
100%
80%
60%
40%
20%
0%
5.00% 5.25% 5.50% 5.75% 6.00% 6.25% 6.50% 6.75% 7.00% 7.25% 7.50% 7.75% 8.00% More


IRR of the financial instrument_All ABS
Frequency
60
50
40
30
20
10
0
120%
100%
80%
60%
40%
20%
0%
17.00% 18.00% 19.00% 20.00% 21.00% 22.00% 23.00% 24.00% 25.00% 26.00% 27.00% 28.00% 29.00% 30.00% 31.00% 32.00% 33.00% 34.00% 35.00% 36.00% 37.00% 38.00% 39.00% 40.00% 41.00% More


IRR of the financial instrument_ABS1
Frequency
60
50
40
30
20
10
0
120%
100%
80%
60%
40%
20%
0%
8.00% 8.50% 9.00% 9.50% 10.00% 10.50% 11.00% 11.50% 12.00% 12.50% 13.00% 13.50% 14.00% 14.50% 15.00% 15.50% 16.00% 16.50% 17.00% 17.50% 18.00% 18.50% 19.00% 19.50% 20.00% More

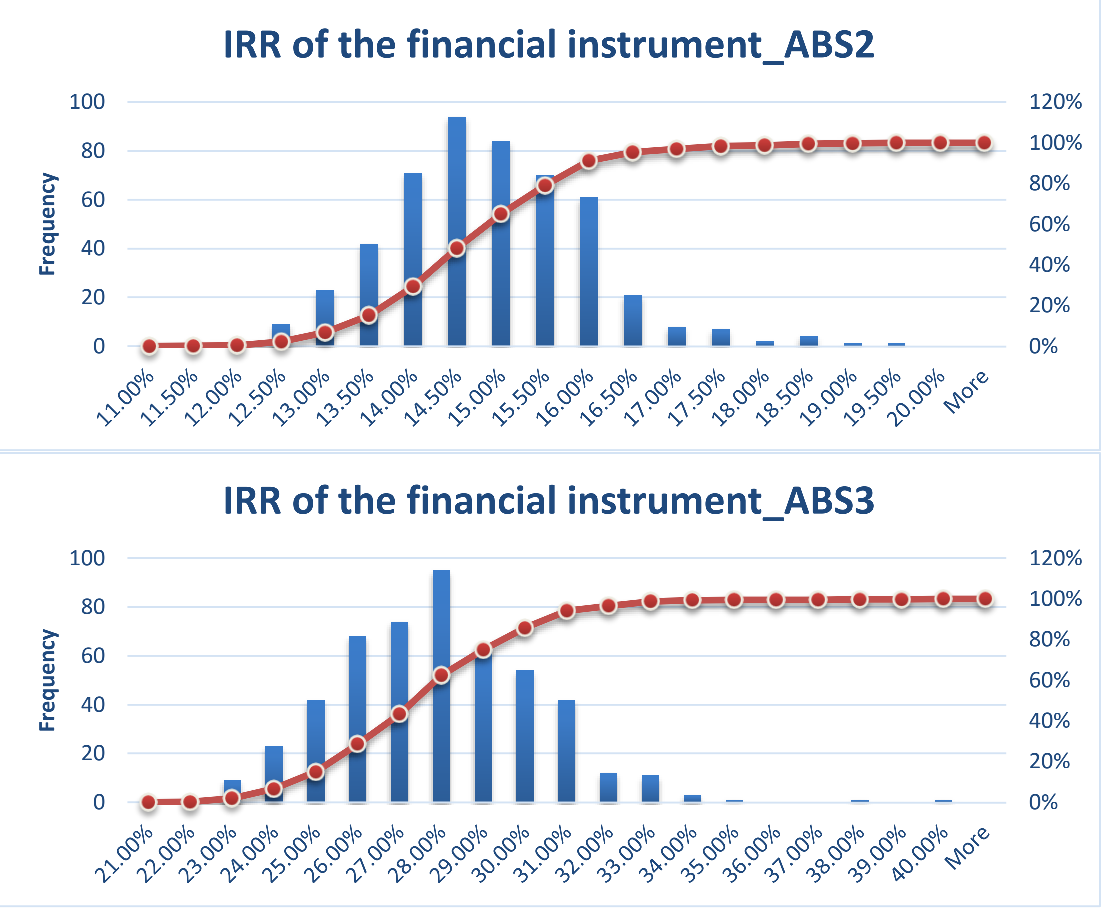


Figure A.11: Simulation output, set of histograms, PS_15_0%

7.4 Passive standard: 20 years, 0% grant

7.4.1 As-Is assessment

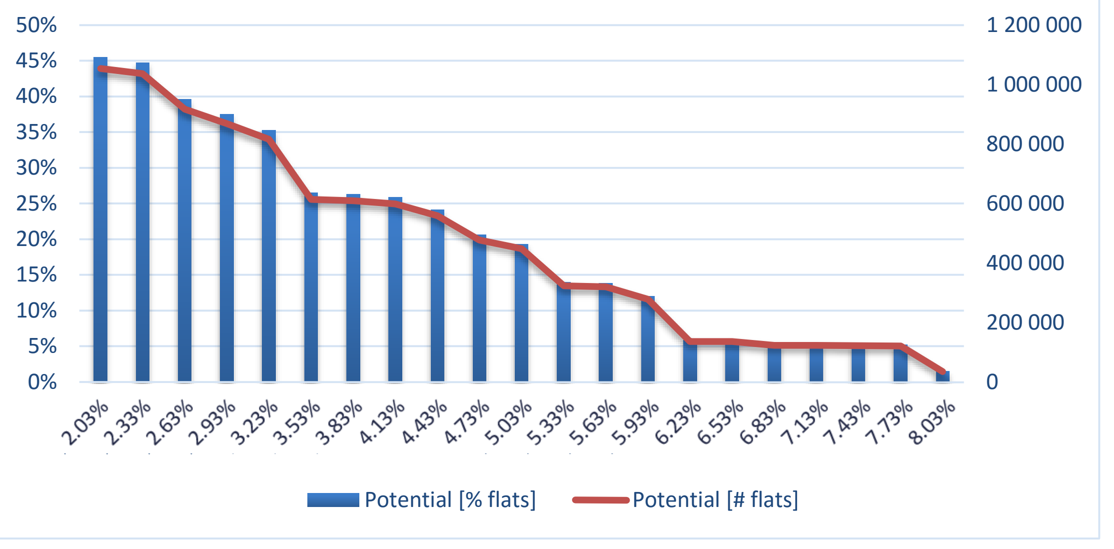


Figure A.12: Sensitivity analysis, As-Is model, total potential with respect to minimum required IRR, PS_20_0%

7.4.2 Assessment with time dimension

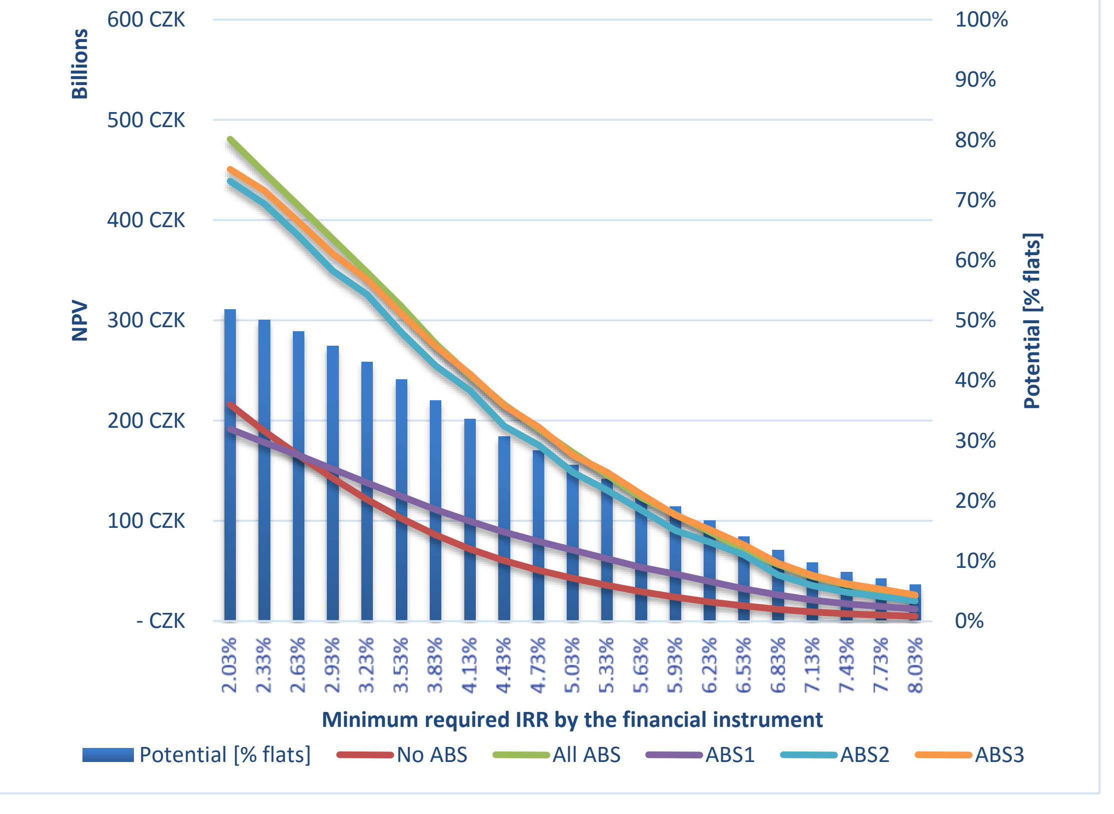


Figure A.13: Sensitivity analysis, time dimension model, total potential with respect to minimum required IRR, PS_20_0%

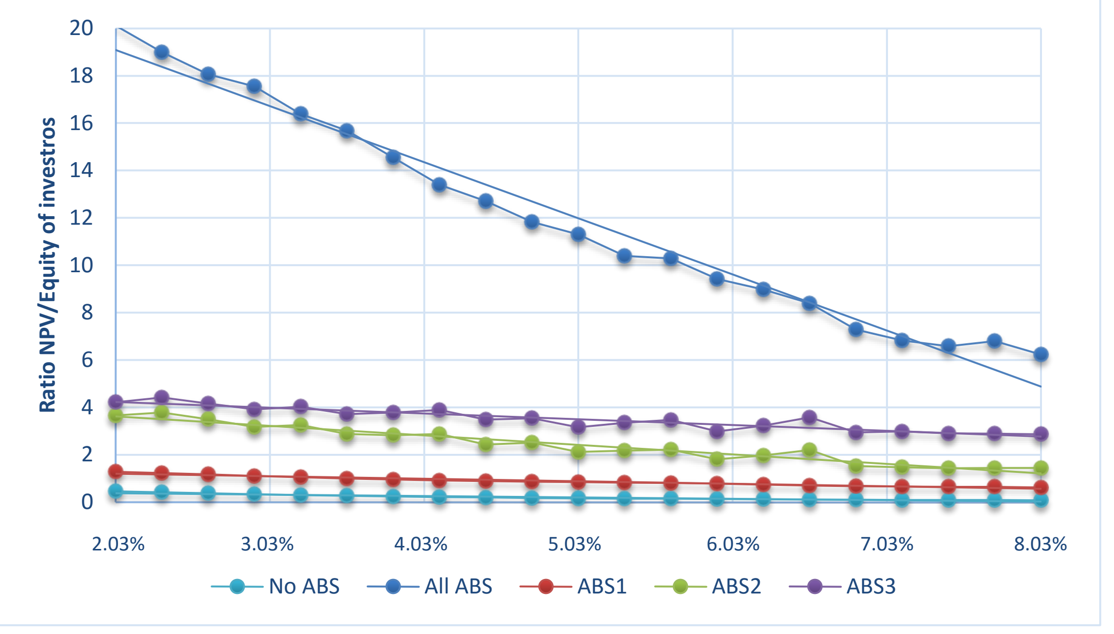


Figure A.14: Sensitivity analysis, time dimension model, NPV/Equity with respect to minimum required IRR, PS_20_0%

Sensitivity Analysis

Legend:

NPV (discount rate = WACC)
IRR
NPV/Total initial investment

*Arrows indicate comparison between all the values

WACC	2.33%	2.63%	2.93%	3.23%	3.53%	3.83%
5.83%	116 B CZK 26.01% 3.26	114 B CZK 25.88% 3.19				
5.03%	170 B CZK 26.59% 3.24	166 B CZK 26.45% 3.16	162 B CZK 26.30% 3.08			
4.23%	242 B CZK 29.07% 3.84	236 B CZK 28.91% 3.75	230 B CZK 28.76% 3.65	224 B CZK 28.60% 3.55		
3.43%	329 B CZK 29.67% 3.96	320 B CZK 29.51% 3.85	311 B CZK 29.34% 3.74	301 B CZK 29.17% 3.63	292 B CZK 28.99% 3.52	
2.63%	411 B CZK 30.50% 4.29	399 B CZK 30.33% 4.17	387 B CZK 30.16% 4.04	375 B CZK 29.99% 3.92	363 B CZK 29.82% 3.79	351 B CZK 29.64% 3.67
1.83%	489 B CZK 30.47% 4.49	473 B CZK 30.31% 4.35	458 B CZK 30.13% 4.21	442 B CZK 29.96% 4.06	426 B CZK 29.79% 3.92	411 B CZK 29.61% 3.78

Minimum required IRR of initial investments

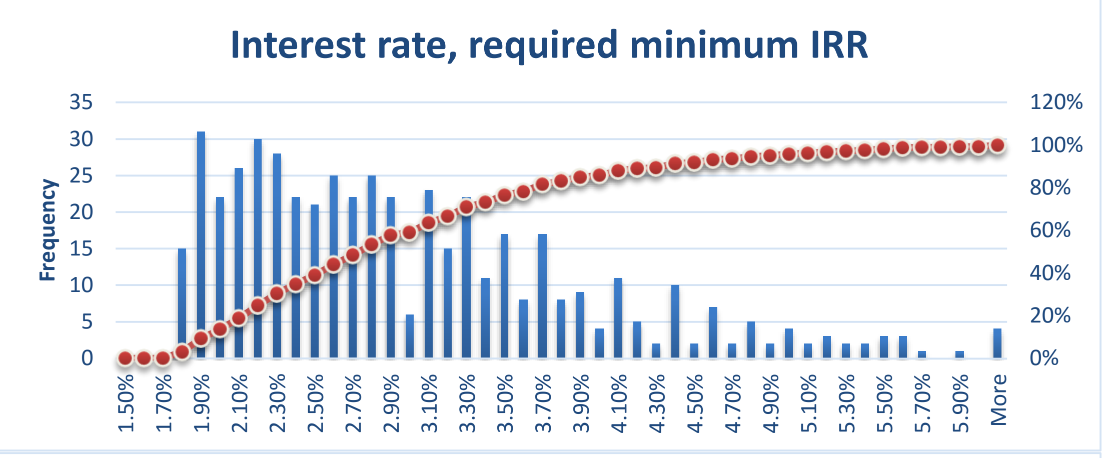
Figure A.15: Sensitivity analysis, time dimension model, WACC with respect to minimum required IRR, PS_20_0%

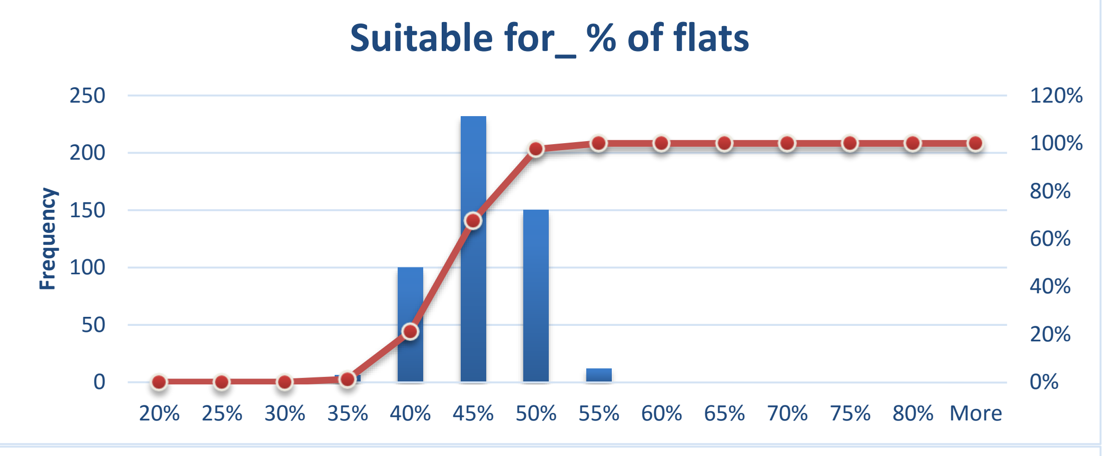
7.4.3 Simulation outputs

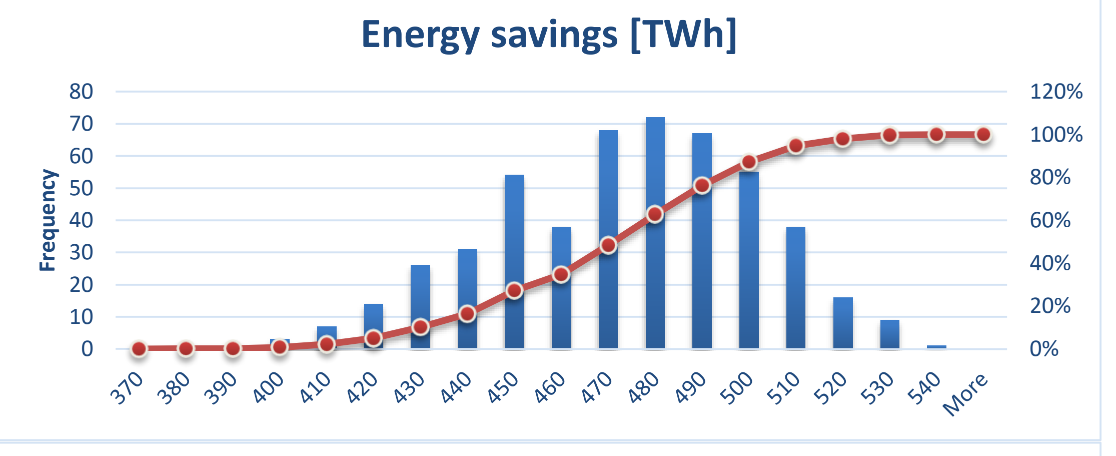
Table A.3: Simulation output, descriptive statistics, PS_20_0%

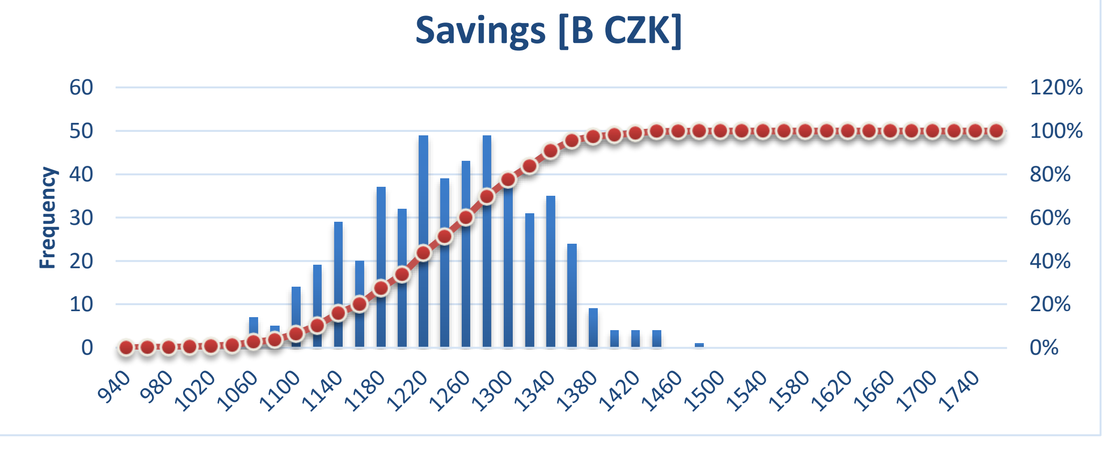
Descriptive statistics *Passive standard, 20 years, 0% grant*	*Mean*	*St. Deviation*	*Median*	*Minimum*	*Maximum*	*Sample variance*	*Skewness*	*Kurtosis*
Minimum required IRR	2.96%	0.93%	2.75%	1.80%	6.30%	0.01%	105.51%	78.00%
Suitable for _ of flats	43.2%	3.7%	43.3%	31.7%	52.7%	0.1%	-7.3%	-39.7%
Energy savings	469	28	472	375	532	786	0	0
Savings	1232	85	1237	949	1464	7181	0	0
Investment	*404*	*22*	*407*	*325*	*458*	*498*	*0*	*0*
Public grant	0	0	0	0	0	*0*	-	-
No ABS								
NPV	155 B CZK	19 B CZK	155 B CZK	103 B CZK	208 B CZK	363 E+18 CZK	0 B CZK	0 B CZK
IRR	7.42%	0.35%	7.41%	6.52%	8.53%	0.00%	18.00%	0.91%
Equity (Investors)	404 B CZK	22 B CZK	407 B CZK	325 B CZK	458 B CZK	499 E+18 CZK	0 B CZK	0 B CZK
Levered funds (ABS)	0 B CZK	0 B CZK	0 B CZK	0 B CZK	0 B CZK	0 B CZK	-	-
Financial lever	0 x	0 x	0 x	0 x	0 x	0 x	-	-
All ABS								
NPV	357 B CZK	49 B CZK	353 B CZK	244 B CZK	526 B CZK	2407 E+18 CZK	0 B CZK	0 B CZK
IRR	34.67%	2.86%	35.05%	26.76%	42.31%	0.08%	-34.14%	-24.45%
Equity (Investors)	62 B CZK	12 B CZK	61 B CZK	37 B CZK	104 B CZK	145 E+18 CZK	0 B CZK	0 B CZK
Levered funds (ABS)	342 B CZK	31 B CZK	346 B CZK	240 B CZK	409 B CZK	977 E+18 CZK	0 B CZK	0 B CZK
Financial lever	5.8 x	1.5 x	5.7 x	2.4 x	10.5 x	2.4 x	0.4 x	-0.3 x
ABS1								
NPV	154 B CZK	33 B CZK	156 B CZK	56 B CZK	233 B CZK	1100 E+18 CZK	0 B CZK	0 B CZK
IRR	17.08%	1.65%	17.27%	11.33%	20.40%	0.03%	-82.68%	62.76%
Equity (Investors)	141 B CZK	7 B CZK	140 B CZK	120 B CZK	164 B CZK	44 E+18 CZK	0 B CZK	0 B CZK
Levered funds (ABS)	263 B CZK	21 B CZK	266 B CZK	191 B CZK	308 B CZK	446 E+18 CZK	0 B CZK	0 B CZK
Financial lever	1.9 x	0.2 x	1.9 x	1.3 x	2.2 x	0 x	-0.7 x	0.5 x
ABS2								
NPV	350 B CZK	43 B CZK	353 B CZK	217 B CZK	448 B CZK	1874 E+18 CZK	0 B CZK	0 B CZK
IRR	15.84%	0.69%	15.88%	13.57%	18.01%	0.00%	-14.24%	-2.78%
Equity (Investors)	101 B CZK	6 B CZK	100 B CZK	80 B CZK	110 B CZK	39 E+18 CZK	0 B CZK	0 B CZK
Levered funds (ABS)	323 B CZK	20 B CZK	315 B CZK	252 B CZK	388 B CZK	419 E+18 CZK	0 B CZK	0 B CZK
Financial lever	5.1 x	0.4 x	5 x	5 x	6 x	0.1 x	2 x	2 x
ABS3								
NPV	364 B CZK	44 B CZK	367 B CZK	232 B CZK	464 B CZK	1964 E+18 CZK	0 B CZK	0 B CZK
IRR	29.72%	1.45%	29.92%	25.52%	35.04%	0.02%	-26.35%	22.65%
Equity (Investors)	87 B CZK	5 B CZK	87 B CZK	70 B CZK	96 B CZK	28 E+18 CZK	0 B CZK	0 B CZK
Levered funds (ABS)	325 B CZK	22 B CZK	328 B CZK	257 B CZK	361 B CZK	476 E+18 CZK	0 B CZK	0 B CZK
Financial lever	7.9 x	0.3 x	8 x	7 x	8 x	0.1 x	-2.2 x	3 x

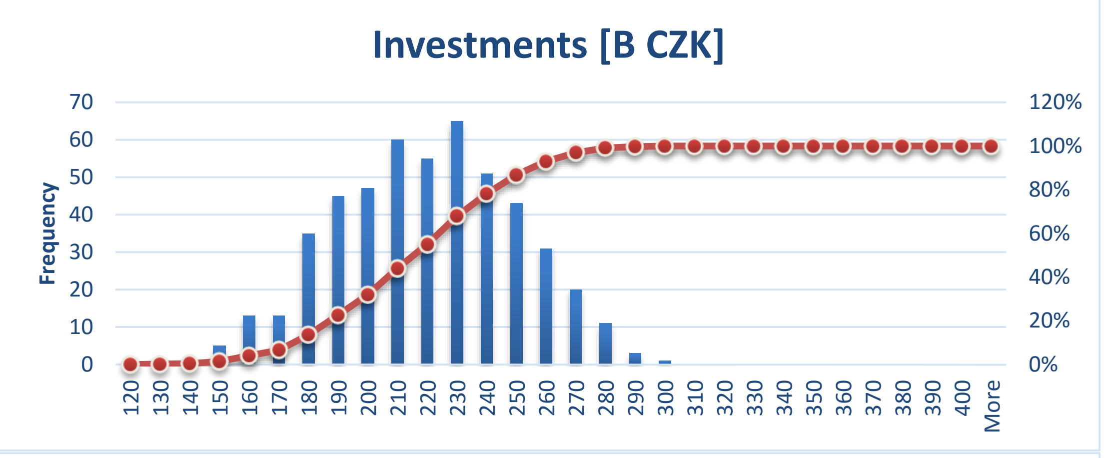
Basic Benefit-Cost Rat	*No ABS*	*All ABS*	*ABS1*	*ABS2*	*ABS3*
	1.38 : 1	6.8 : 1	2.11 : 1	4.53 : 1	5.21 : 1

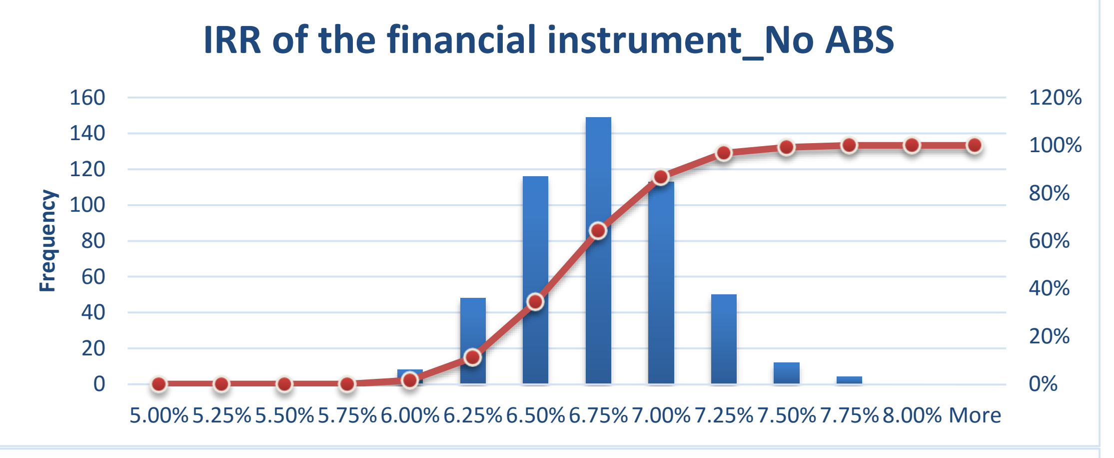

Interest rate, required minimum IRR
Frequency
35 30 25 20 15 10 5 0
120% 100% 80% 60% 40% 20% 0%
1.50% 1.70% 1.90% 2.10% 2.30% 2.50% 2.70% 2.90% 3.10% 3.30% 3.50% 3.70% 3.90% 4.10% 4.30% 4.50% 4.70% 4.90% 5.10% 5.30% 5.50% 5.70% 5.90% More

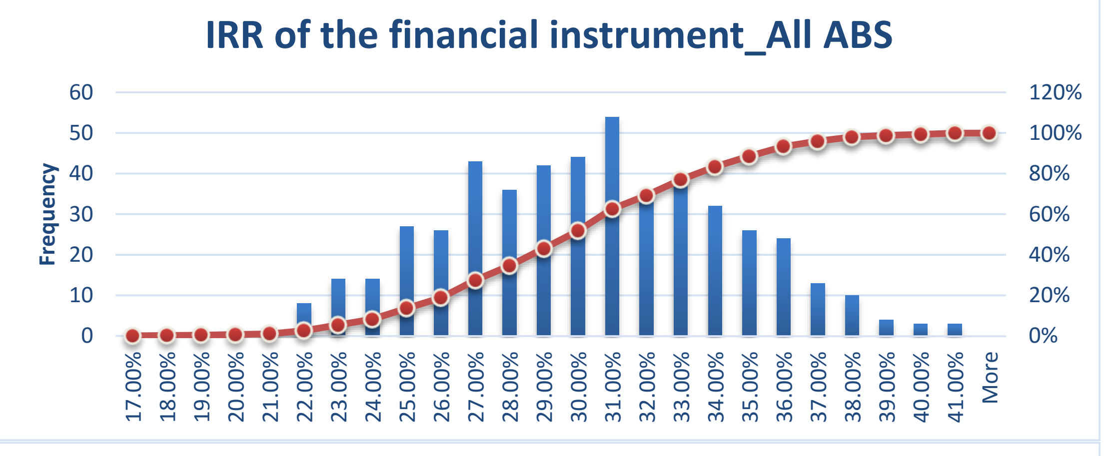

Suitable for_ % of flats
Frequency
250 200 150 100 50 0
120% 100% 80% 60% 40% 20% 0%
20% 25% 30% 35% 40% 45% 50% 55% 60% 65% 70% 75% 80% More

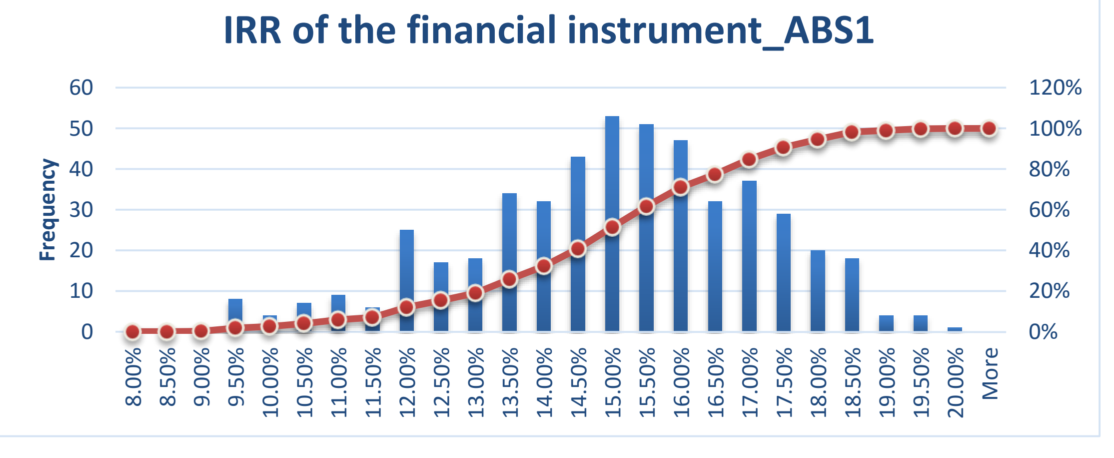

Energy savings [TWh]
Frequency
80 70 60 50 40 30 20 10 0
120% 100% 80% 60% 40% 20% 0%
370 380 390 400 410 420 430 440 450 460 470 480 490 500 510 520 530 540 More


Savings [B CZK]
Frequency
60 50 40 30 20 10 0
120% 100% 80% 60% 40% 20% 0%
940 980 1020 1060 1100 1140 1180 1220 1260 1300 1340 1380 1420 1460 1500 1540 1580 1620 1660 1700 1740


Investments [B CZK]
Frequency
0
10
20
30
40
50
60
70
0%
20%
40%
60%
80%
100%
120%
120
130
140
150
160
170
180
190
200
210
220
230
240
250
260
270
280
290
300
310
320
330
340
350
360
370
380
390
400
More


IRR of the financial instrument_No ABS
Frequency
0
20
40
60
80
100
120
140
160
0%
20%
40%
60%
80%
100%
120%
5.00% 5.25% 5.50% 5.75% 6.00% 6.25% 6.50% 6.75% 7.00% 7.25% 7.50% 7.75% 8.00% More


IRR of the financial instrument_All ABS
Frequency
0
10
20
30
40
50
60
0%
20%
40%
60%
80%
100%
120%
17.00%
18.00%
19.00%
20.00%
21.00%
22.00%
23.00%
24.00%
25.00%
26.00%
27.00%
28.00%
29.00%
30.00%
31.00%
32.00%
33.00%
34.00%
35.00%
36.00%
37.00%
38.00%
39.00%
40.00%
41.00%
More


IRR of the financial instrument_ABS1
Frequency
0
10
20
30
40
50
60
0%
20%
40%
60%
80%
100%
120%
8.00%
8.50%
9.00%
9.50%
10.00%
10.50%
11.00%
11.50%
12.00%
12.50%
13.00%
13.50%
14.00%
14.50%
15.00%
15.50%
16.00%
16.50%
17.00%
17.50%
18.00%
18.50%
19.00%
19.50%
20.00%
More

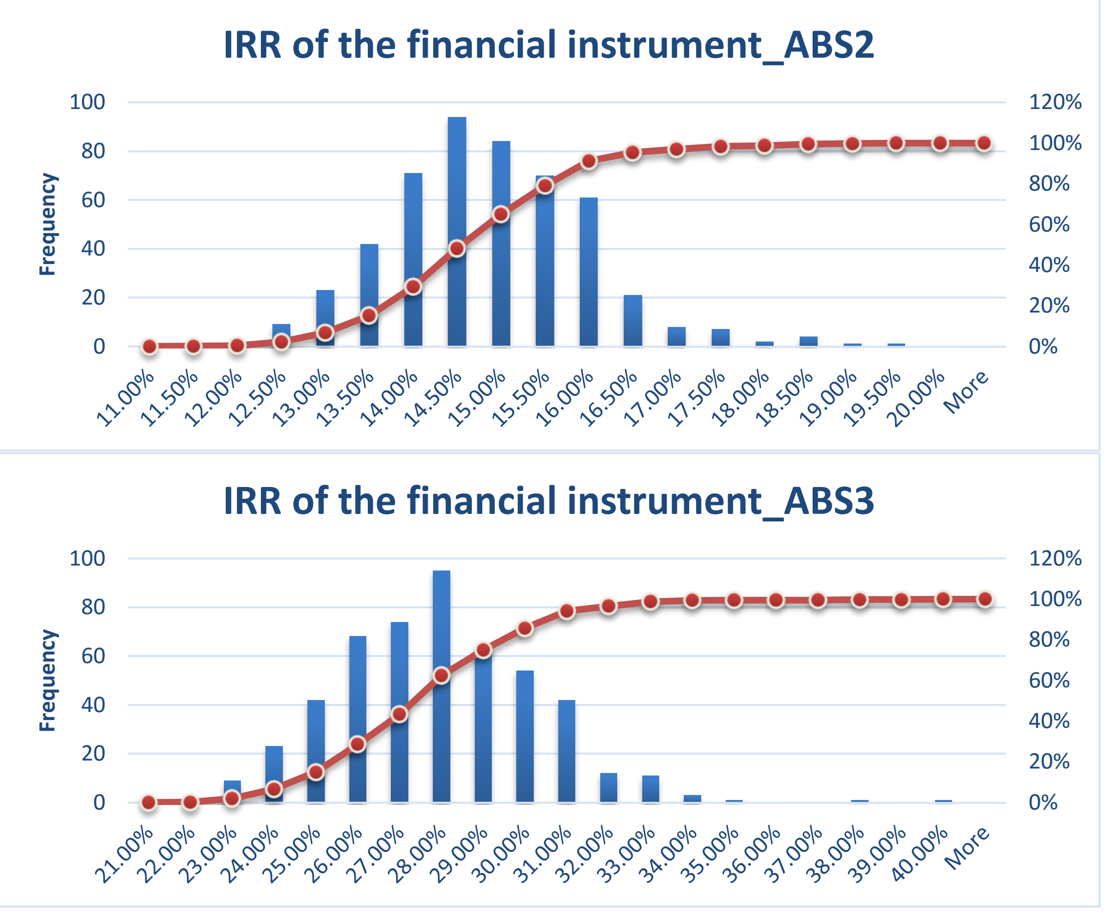


Figure A.16: Simulation output, set of histograms, PS_20_0%

7.5 Passive standard: 15 years, 20% grant

7.5.1 As-Is assessment

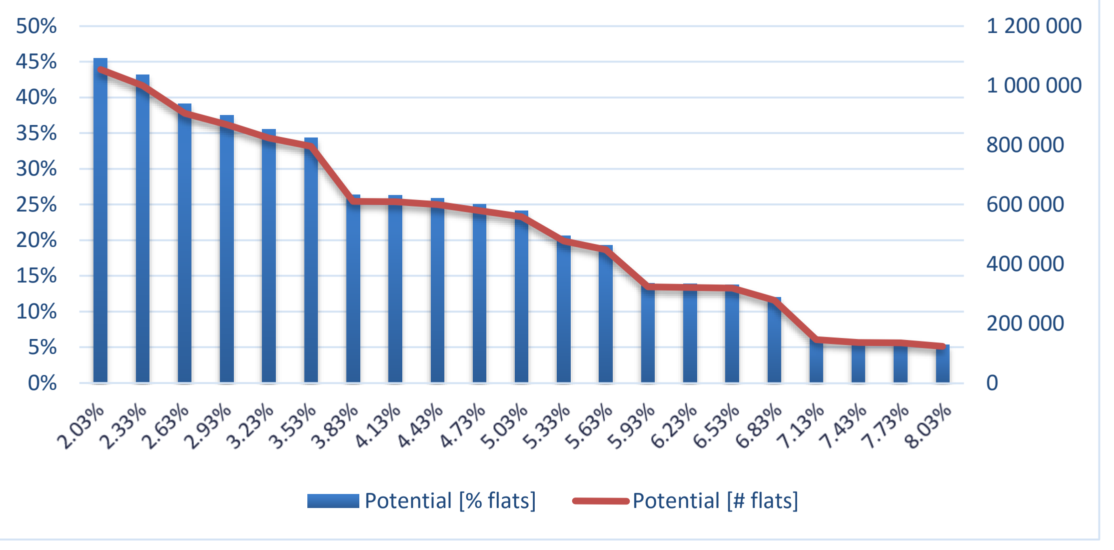


Figure A.17: Sensitivity analysis, As-Is model, total potential with respect to minimum required IRR, PS_15_20%

7.5.2 Assessment with time dimension

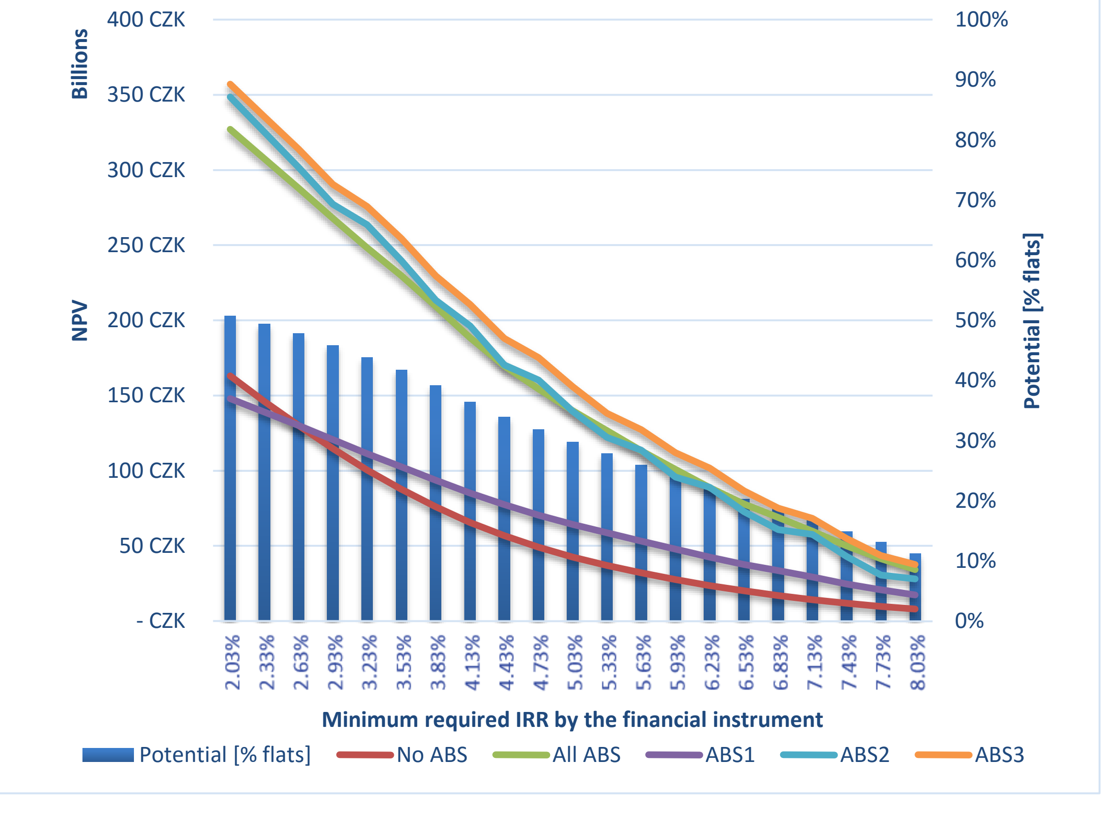


Figure A.18: Sensitivity analysis, time dimension model, total potential with respect to minimum required IRR, PS_15_20%

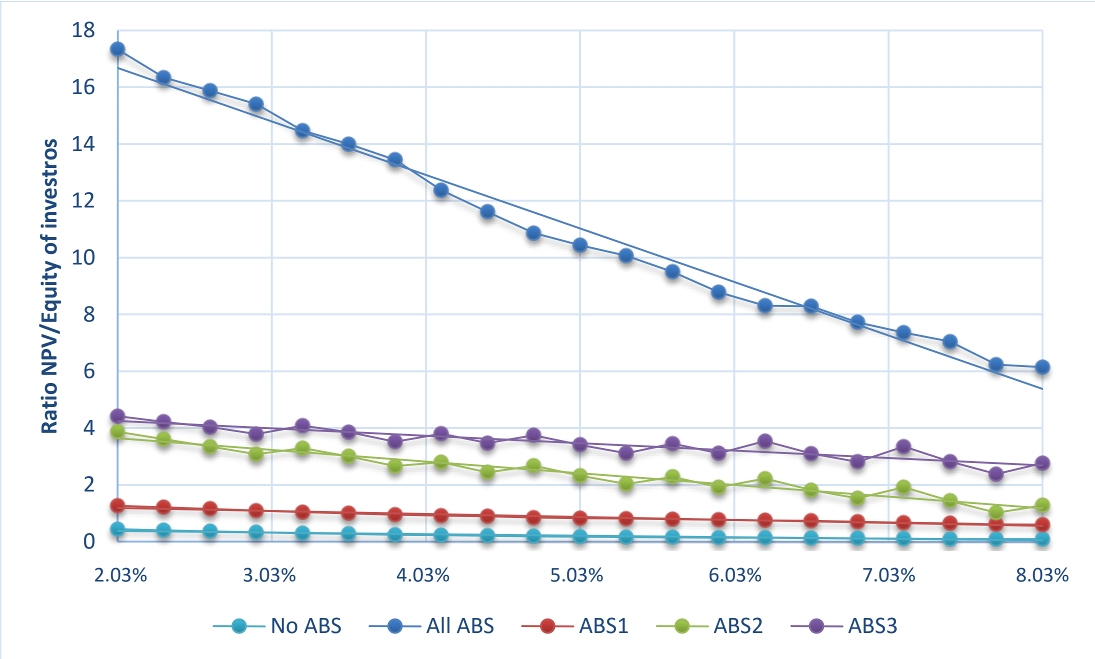


Figure A.19: Sensitivity analysis, time dimension model, NPV/Equity with respect to minimum required IRR, PS_15_20%

Sensitivity Analysis

Legend:

NPV (discount rate = WACC)
IRR
NPV/Total initial investment

*Arrows indicate comparison between all the values

WACC	2.33%	2.63%	2.93%	3.23%	3.53%	3.83%
5.83%	120 B CZK 29.02% 3.32	118 B CZK 28.90% 3.26				
5.03%	159 B CZK 30.25% 3.48	156 B CZK 30.10% 3.41	153 B CZK 29.96% 3.34			
4.23%	207 B CZK 29.05% 3.76	203 B CZK 28.93% 3.68	199 B CZK 28.80% 3.60	194 B CZK 28.68% 3.52		
3.43%	268 B CZK 31.75% 4.03	262 B CZK 31.60% 3.94	256 B CZK 31.45% 3.85	250 B CZK 31.29% 3.76	244 B CZK 31.14% 3.67	
2.63%	322 B CZK 31.61% 4.14	314 B CZK 31.45% 4.04	307 B CZK 31.30% 3.94	299 B CZK 31.14% 3.84	291 B CZK 30.99% 3.74	283 B CZK 30.83% 3.64
1.83%	383 B CZK 32.88% 4.69	374 B CZK 32.73% 4.58	364 B CZK 32.58% 4.47	355 B CZK 32.43% 4.36	346 B CZK 32.28% 4.24	337 B CZK 32.12% 4.13

Minimum required IRR of initial investments

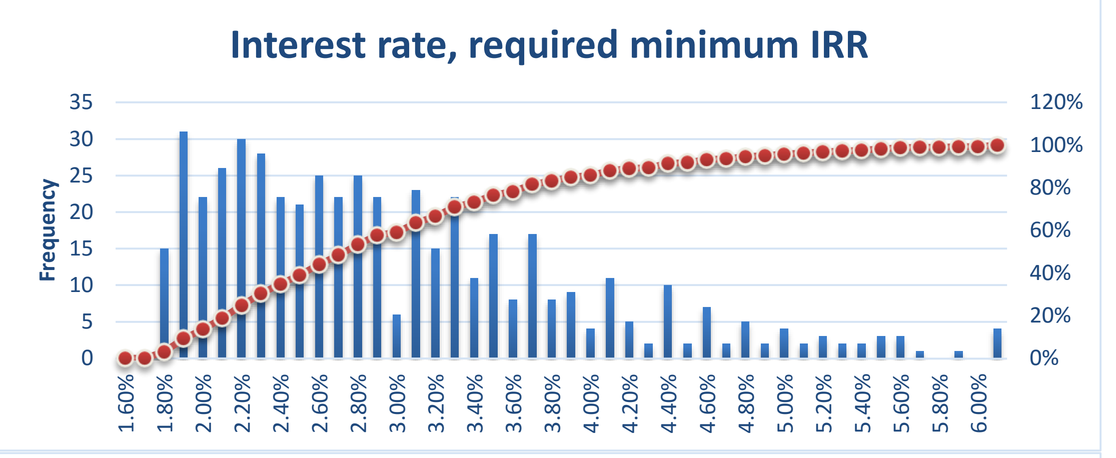
Figure A.20: Sensitivity analysis, time dimension model, WACC with respect to minimum required IRR, PS_15_20%

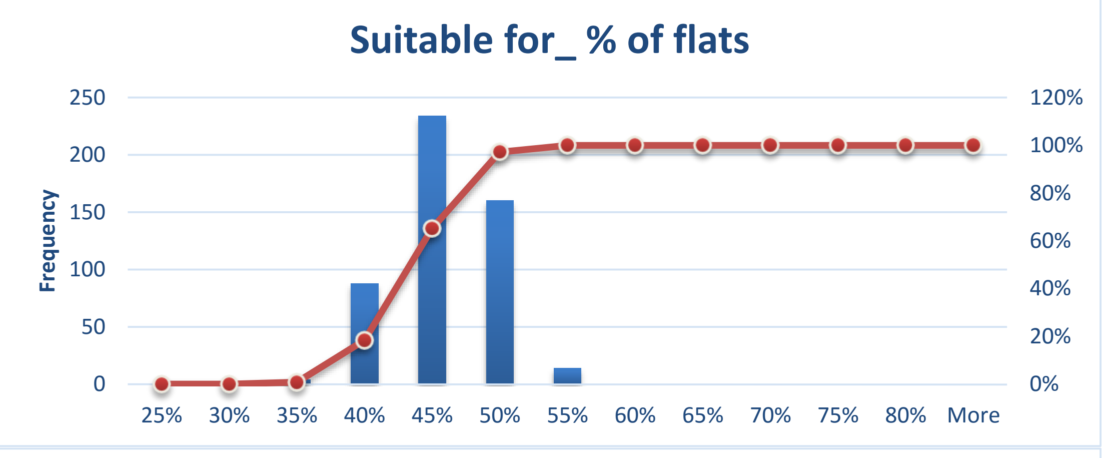
7.5.3 Simulation outputs

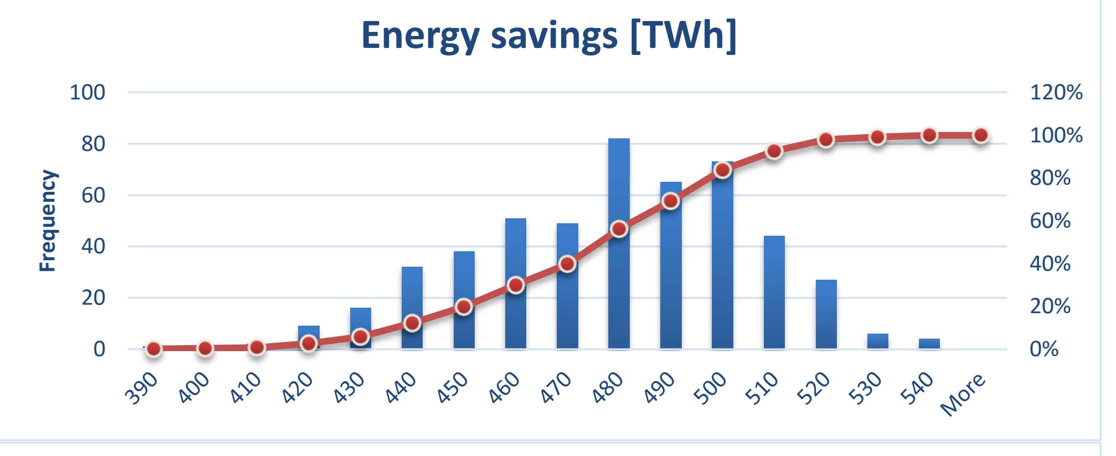
Table A.4: Simulation output, descriptive statistics, RS_15_20%

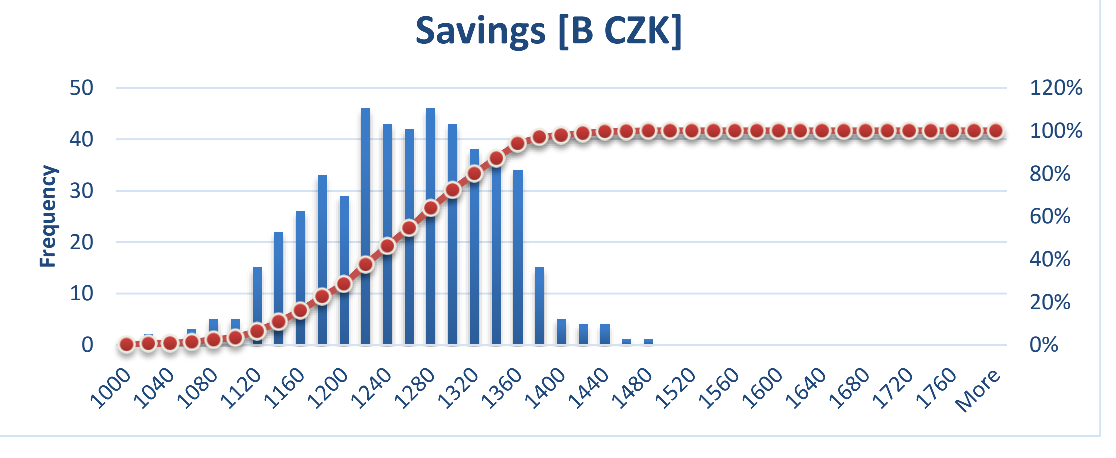
	Descriptive statistics *Passive standard, 15 years, 20% grant*							
	Mean	*St. Deviation*	*Median*	*Minimum*	*Maximum*	*Sample variance*	*Skewness*	*Kurtosis*
Minimum required IRR	2.96%	0.93%	2.75%	1.80%	6.30%	0.01%	105.51%	78.00%
Suitable for _ of flats	43.5%	3.6%	43.6%	32.7%	52.9%	0.1%	-6.8%	-37.1%
Energy savings	475	26	477	389	536	693	0	0
Savings	1246	81	1249	983	1470	6632	0	0
Investment	*327*	*16*	*329*	*270*	*368*	*265*	*0*	*0*
Public grant	82	4	82	68	92	*16*	*0*	*0*
No ABS								
NPV	124 B CZK	15 B CZK	123 B CZK	83 B CZK	166 B CZK	228 E+18 CZK	0 B CZK	0 B CZK
IRR	8.64%	0.43%	8.62%	7.49%	9.91%	0.00%	17.46%	-5.36%
Equity (Investors)	327 B CZK	16 B CZK	329 B CZK	270 B CZK	368 B CZK	265 E+18 CZK	0 B CZK	0 B CZK
Levered funds (ABS)	0 B CZK	0 B CZK	0 B CZK	0 B CZK	0 B CZK	0 B CZK	-	-
Financial lever	0 x	0 x	0 x	0 x	0 x	0 x	-	-
All ABS								
NPV	256 B CZK	33 B CZK	254 B CZK	182 B CZK	374 B CZK	1099 E+18 CZK	0 B CZK	0 B CZK
IRR	40.11%	2.46%	40.35%	33.24%	46.69%	0.06%	-36.93%	-11.84%
Equity (Investors)	45 B CZK	9 B CZK	44 B CZK	29 B CZK	76 B CZK	73 E+18 CZK	0 B CZK	0 B CZK
Levered funds (ABS)	281 B CZK	23 B CZK	284 B CZK	209 B CZK	332 B CZK	507 E+18 CZK	0 B CZK	0 B CZK
Financial lever	6.5 x	1.6 x	6.4 x	2.9 x	10.9 x	2.6 x	0.2 x	-0.5 x
ABS1								
NPV	123 B CZK	23 B CZK	124 B CZK	55 B CZK	182 B CZK	541 E+18 CZK	0 B CZK	0 B CZK
IRR	20.96%	1.59%	21.20%	15.66%	24.25%	0.03%	-82.86%	61.43%
Equity (Investors)	111 B CZK	5 B CZK	111 B CZK	97 B CZK	125 B CZK	22 E+18 CZK	0 B CZK	0 B CZK
Levered funds (ABS)	216 B CZK	15 B CZK	217 B CZK	165 B CZK	247 B CZK	220 E+18 CZK	0 B CZK	0 B CZK
Financial lever	1.9 x	0.1 x	2 x	1.4 x	2.2 x	0 x	-0.9 x	1 x
ABS2								
NPV	282 B CZK	31 B CZK	283 B CZK	186 B CZK	355 B CZK	942 E+18 CZK	0 B CZK	0 B CZK
IRR	16.65%	0.77%	16.67%	14.72%	19.45%	0.01%	12.91%	0.04%
Equity (Investors)	81 B CZK	5 B CZK	80 B CZK	70 B CZK	90 B CZK	25 E+18 CZK	0 B CZK	0 B CZK
Levered funds (ABS)	264 B CZK	16 B CZK	252 B CZK	221 B CZK	284 B CZK	263 E+18 CZK	0 B CZK	0 B CZK
Financial lever	5.2 x	0.4 x	5 x	5 x	6 x	0.2 x	1.2 x	-0.6 x
ABS3								
NPV	292 B CZK	31 B CZK	294 B CZK	194 B CZK	367 B CZK	964 E+18 CZK	0 B CZK	0 B CZK
IRR	31.56%	1.52%	31.69%	26.87%	38.13%	0.02%	-15.12%	61.83%
Equity (Investors)	71 B CZK	4 B CZK	70 B CZK	60 B CZK	78 B CZK	18 E+18 CZK	0 B CZK	0 B CZK
Levered funds (ABS)	260 B CZK	16 B CZK	262 B CZK	229 B CZK	295 B CZK	251 E+18 CZK	0 B CZK	0 B CZK
Financial lever	7.8 x	0.4 x	8 x	7 x	8 x	0.2 x	-1.4 x	0.1 x

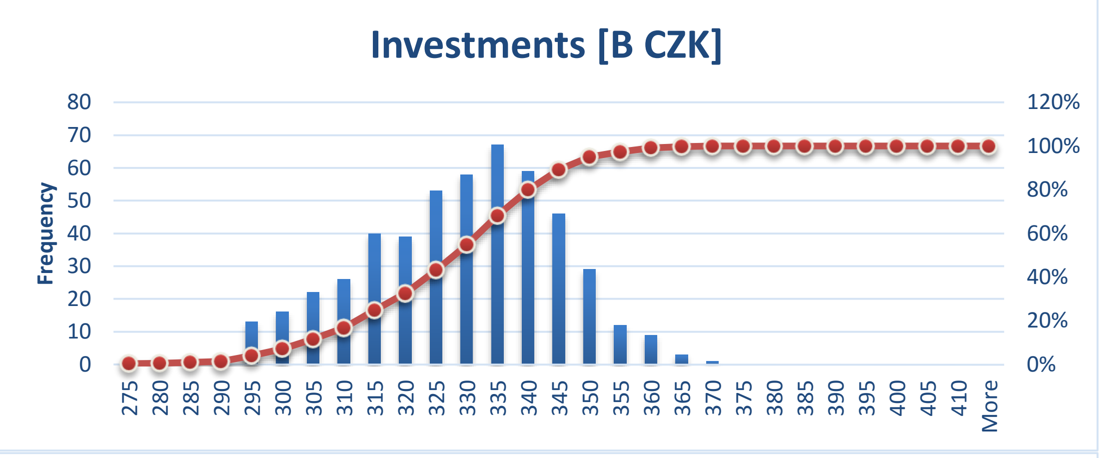
Basic Benefit-Cost Rat	*No ABS*	*All ABS*	*ABS1*	*ABS2*	*ABS3*
	1.37 : 1	6.74 : 1	2.12 : 1	4.54 : 1	5.22 : 1

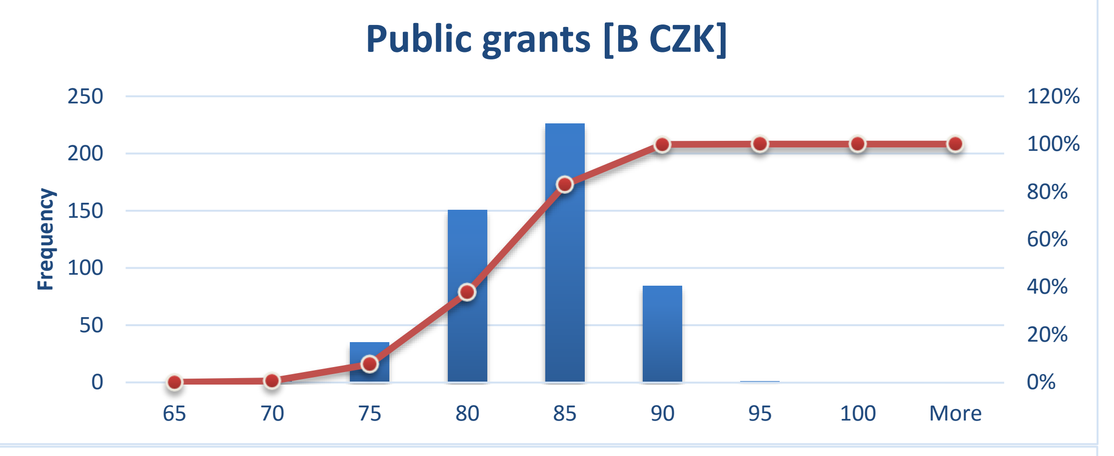

Interest rate, required minimum IRR
Frequency
35
30
25
20
15
10
5
0
120%
100%
80%
60%
40%
20%
0%
1.60%
1.80%
2.00%
2.20%
2.40%
2.60%
2.80%
3.00%
3.20%
3.40%
3.60%
3.80%
4.00%
4.20%
4.40%
4.60%
4.80%
5.00%
5.20%
5.40%
5.60%
5.80%
6.00%

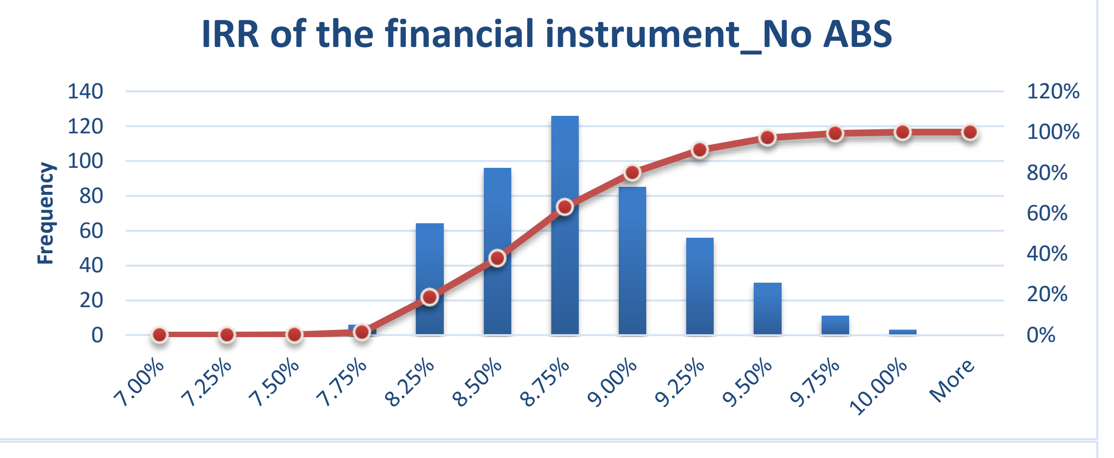

Suitable for_ % of flats
Frequency
250
200
150
100
50
0
120%
100%
80%
60%
40%
20%
0%
25%
30%
35%
40%
45%
50%
55%
60%
65%
70%
75%
80%
More

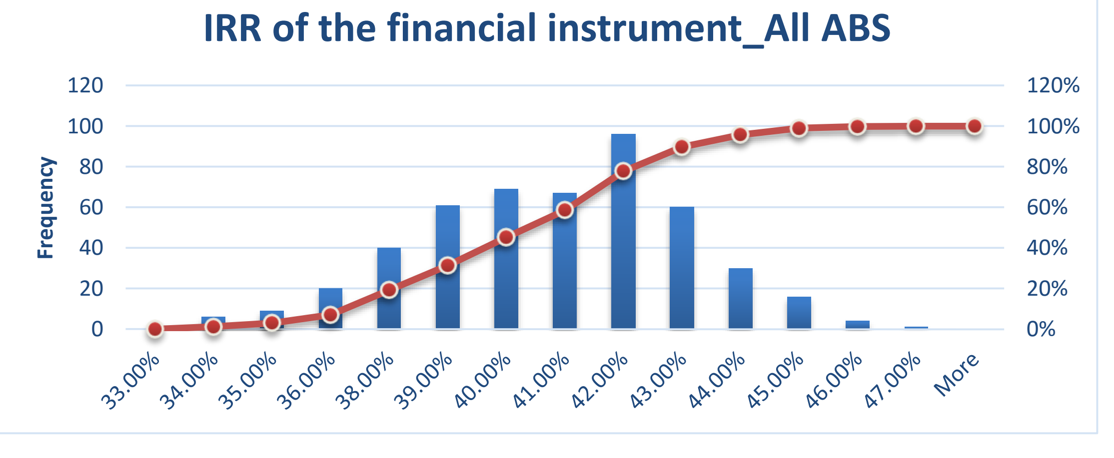

Energy savings [TWh]
Frequency
100
80
60
40
20
0
120%
100%
80%
60%
40%
20%
0%
390
400
410
420
430
440
450
460
470
480
490
500
510
520
530
540
More


Savings [B CZK]
Frequency
50
40
30
20
10
0
120%
100%
80%
60%
40%
20%
0%
1000
1040
1080
1120
1160
1200
1240
1280
1320
1360
1400
1440
1480
1520
1560
1600
1640
1680
1720
1760
More


Investments [B CZK]
Frequency
80
70
60
50
40
30
20
10
0
120%
100%
80%
60%
40%
20%
0%
275
280
285
290
295
300
305
310
315
320
325
330
335
340
345
350
355
360
365
370
375
380
385
390
395
400
405
410
More


Public grants [B CZK]
Frequency
250
200
150
100
50
0
120%
100%
80%
60%
40%
20%
0%
65
70
75
80
85
90
95
100
More


IRR of the financial instrument_No ABS
Frequency
140
120
100
80
60
40
20
0
120%
100%
80%
60%
40%
20%
0%
7.00%
7.25%
7.50%
7.75%
8.25%
8.50%
8.75%
9.00%
9.25%
9.50%
9.75%
10.00%
More


IRR of the financial instrument_All ABS
Frequency
120
100
80
60
40
20
0
120%
100%
80%
60%
40%
20%
0%
33.00%
34.00%
35.00%
36.00%
38.00%
39.00%
40.00%
41.00%
42.00%
43.00%
44.00%
45.00%
46.00%
47.00%
More

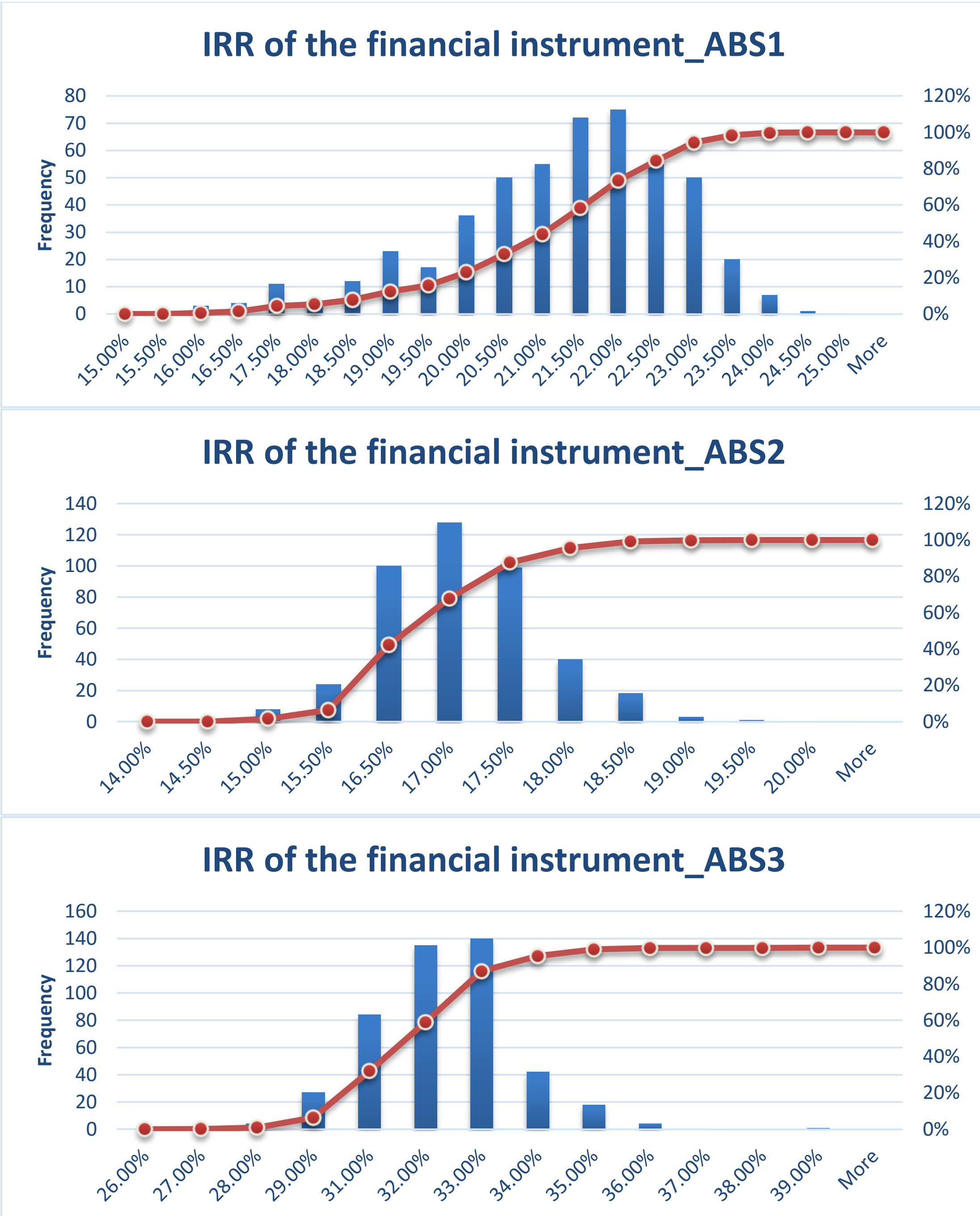


Figure A.21: Simulation output, set of histograms, PS_15_20%