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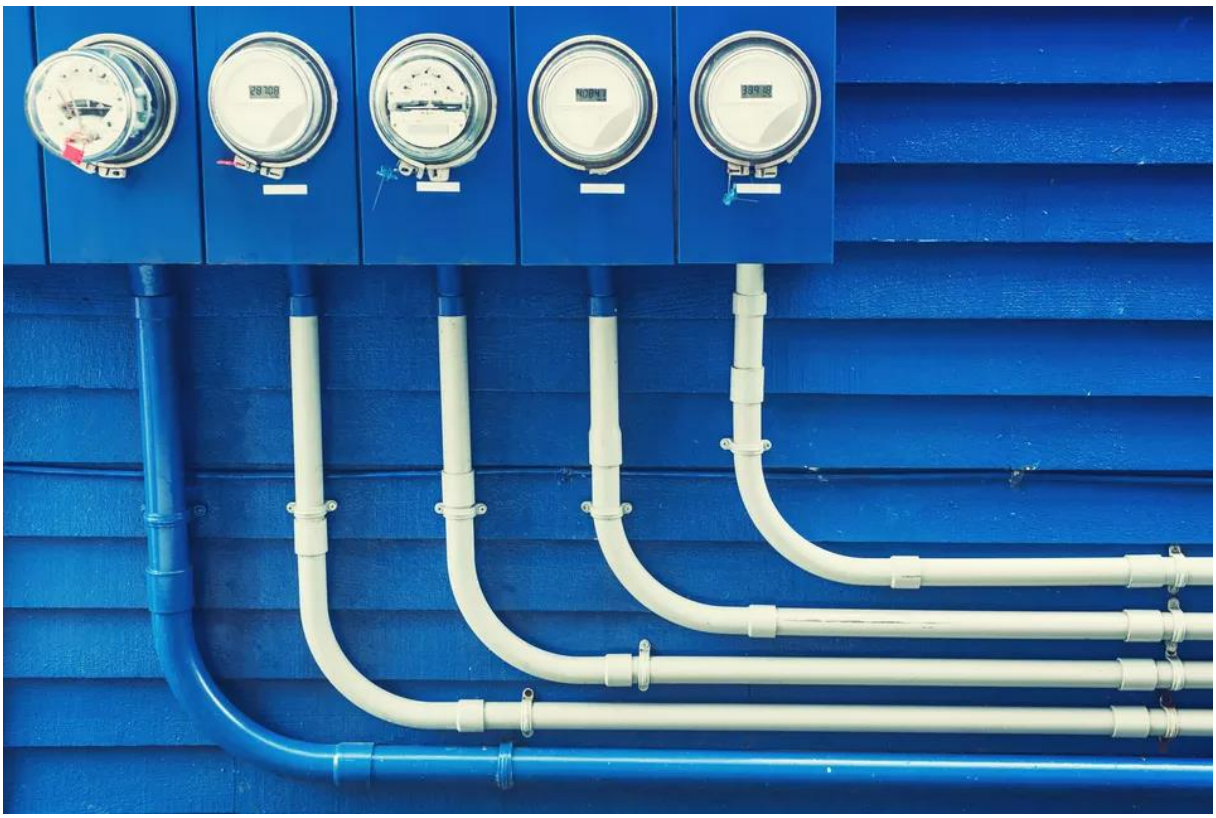

GROWING ENERGY EFFICIENCY INVESTMENT

Global Analysis of Energy Service Companies

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MASTER THESIS – ENERGY SYSTEMS ANALYSIS

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Table of Contents

Abstract

Energy efficiency is not a top priority for most individuals or corporations despite its multiple benefits. Energy service companies (ESCOs) deliver energy efficiency projects that are financed based on energy savings. Given the need to rapidly and significantly increase financing for energy efficiency, interest in ESCO business models is growing.

Prior to this research there was an existing literature gap concerning the global status of the ESCO market. The objective of Growing Energy Efficiency Investment: Global Analysis of Energy Service Companies is to increase investment in energy efficiency via ESCOs by eliminating the existing literature gap surrounding global ESCO market status. Included in this report is a global overview of the ESCO market, country level market analysis, country specific ESCO policy recommendations and the methodology for replicating the entire analysis and policy recommendation process.

A five-step approach is used to build theory for increasing investment in the ESCO industry. This methodology is appropriate because it yields an ESCO information resource that provides actionable recommendations for ESCOs to create market-driven demand for energy services. The methodology is a cyclical process to ensure measurable progress is made. Tracking the implementation of recommended policy in conjunction with ESCO market investment levels will confirm or denied the theory built by this research.

Overall the market maturity indicator scores of country-level ESCO markets are diverse. The most mature ESCO markets include the United States, Germany, China, and Japan. The least mature ESCO markets, of those surveyed, include Chile, Spain and Greece.

Although every ESCO market is unique, there are solutions that benefit a majority of markets. ESCOs should be viewed as a market-based instrument. They form in response to government policy that values energy efficiency as a positive externality. ESCOs have benefited from climate change campaigns such as Paris Climate Accord, the involvement of third-party financing, and the creation of an online ESCO project database (Bertoldi 2006). The presence of ESCO associations, financing options, measurement and verification protocols, and information campaigns ensure the existence of an ESCO market (Ellis 2010). Once an ESCO industry is established the energy industry and power sector should have its subsidies removed and privatized to encourage competition over energy use to prioritize energy efficiency (Vine 2005).

While the global ESCO market size of USD 30.9 billion seems large, it is only a fraction of the total USD 1.3 trillion investment in energy efficiency required to reach the IEA's Efficient World Scenario and better align with Paris Agreement climate targets. The existing investment growth rate is a positive as the global ESCO market has grown at a rate of 8% since 2015. However, much greater energy efficiency investment is needed in the coming years.

Preface

Energy service companies (ESCOs) deliver energy efficiency projects that are financed based on energy savings. Given the need to rapidly and significantly increase financing for energy efficiency, interest in ESCO business models is growing.

Between November 2018 and August 2019, as an intern and external contractor with the International Energy Agency (IEA), I aided in drafting and conducting a survey of 30 national ESCO associations to inform a more in-depth analysis of the global ESCO market. The survey covers ESCO financing models, energy performance contracting, and related policy measures. The majority of the information analyzed in this report is derived from this global survey. Auxiliary sources include a literature review of academic and legislative documents, official statistics, databases, publications, and studies.

Thirteen countries including Austria, Belgium, Bulgaria, China, Germany, India, Italy, Japan, Korea, The Netherlands, South Africa, United Kingdom, and the United States of America are selected for country-level analysis. This analysis yields policy recommendations for growing investment in energy efficiency via ESCOs. Countries were selected for analysis due to their ability to provide detailed information regarding the status of their national ESCO markets. Once countries recognize the insight and recommendations for growing energy efficiency investment enabled by collecting ESCO market information, data collection efforts will expand.

This thesis provides the methodology for replicable ESCO market analysis which informs ESCO policy recommendations. Upon implementation, the recommendations made in this thesis should increase ESCO investment. When ESCO markets grow, global investment in energy efficiency increases.

1. Introduction

1.1. Societal Background

Energy efficiency policies and autonomous energy efficiency improvements have decoupled energy consumption from economic development over the past two decades. Between 2000 and 2017 global energy efficiency improvements have reduced energy use by 12% relative to energy use without energy efficiency. Over the same period GDP has continued to rise at a greater rate than energy use as shown in *Figure 1*.

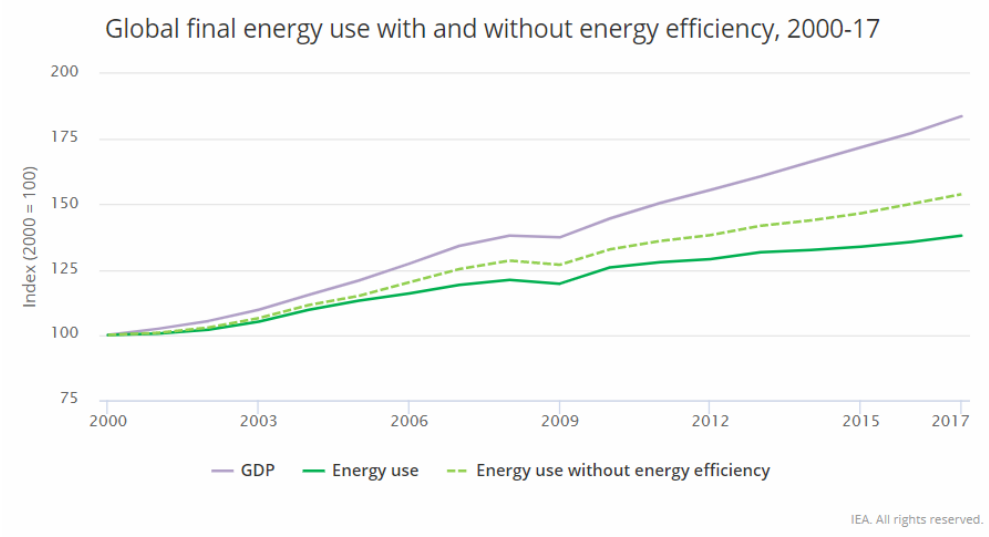


FIGURE 1. DECOUPLING OF ENERGY USE FROM GDP GROWTH VIA ENERGY EFFICIENCY

Undeniably energy efficiency can produce economic, political, and environmental benefits. Unfortunately, huge energy efficiency potential remains untapped. While energy efficiency is improving, its impact on global energy use is being overwhelmed by increasing economic activity across all sectors as shown in *Figure 2*. In 2017 global energy demand rose by nearly 2% compared to 2016, the fastest rise this decade, due to economic growth and altered consumer behavior (IEA 2018).

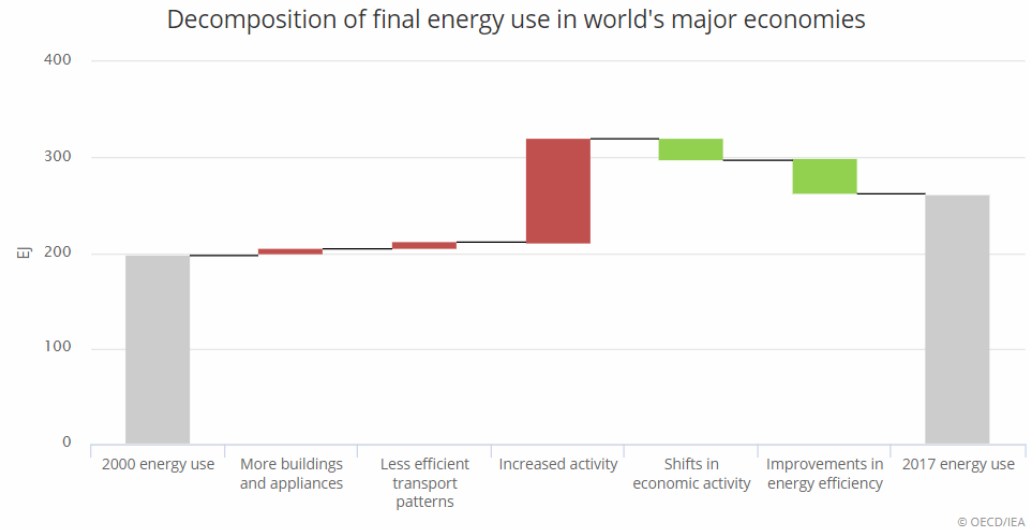


FIGURE 2. ECONOMIC GROWTH OUTPACING ENERGY EFFICIENCY GAINS

Figure 3 shows the level of investment required to achieve the IEA Efficient World Scenario. Average annual investment in energy efficiency must grow from USD 250 billion/year to USD 584 billion/year between now and 2025, and then to nearly USD 1.3 trillion/year between 2026 and 2040. In the Efficient World Scenario, all economically viable energy-efficiency investments are made and all necessary policies to eliminate market barriers to energy efficiency are adopted (IEA 2018). Achieving the Efficient World Scenario would help align the international community with the Paris Agreement's goal of holding the increase in the global average temperature to "well below 2 °C". Investment can be expedited through a combination of government policy and private industrial action.

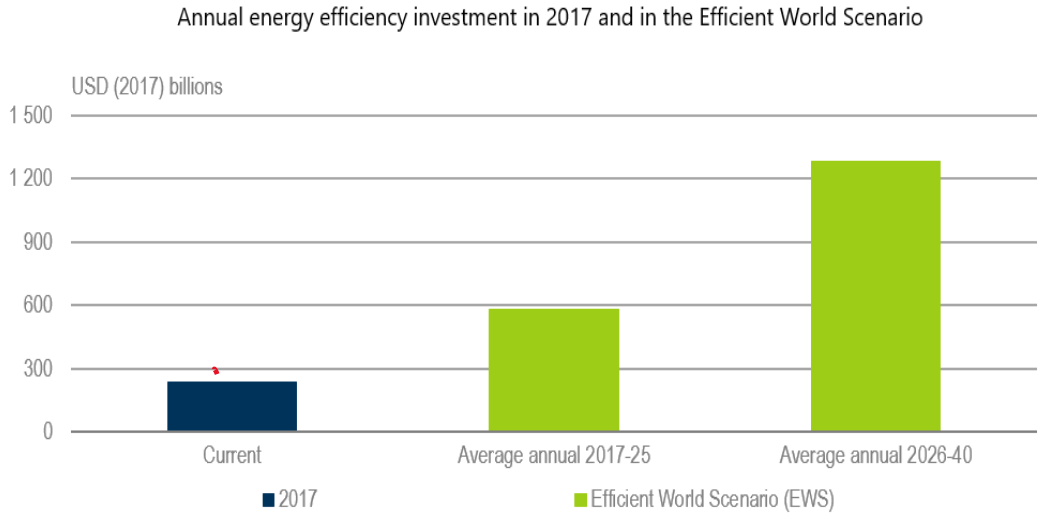


FIGURE 3. INVESTMENT REQUIRED TO ACHIEVE EFFICIENT WORLD SCENARIO

Energy efficiency improves the economy, saves end users money, and improves quality of life. By applying the right policy in the right locale, the multiple benefits of energy efficiency, shown in *Figure 4*, can be achieved (IEA 2019). In the USA alone the sustainability sector employs nearly 4.5 million people (Environmental Defense Fund 2017). The energy efficiency sector creates inherently local jobs in design, installation, maintenance and construction helping grow local economies. As a bonus, average wages for energy efficiency jobs are almost $5,000 above the national median. Once energy efficiency (EE) projects are completed, the client saves money from foregone energy costs while enjoying the benefits of EE improvements such as interior climate regulation.

Strategically, governments would be wise to invest in energy efficiency to improve national security. Increased efficiency reduces the need to import and transport fuels thus cutting dependence on unpredictable foreign powers. It is not difficult to recall unsavory situations that have arisen from interrupted energy supply chains (Zeihan 2014).

The environmental benefits of energy efficiency should be enough to increase investment in this sector. Decreasing global energy consumption preserves finite precious natural resources and creates a less polluted world with reduced levels of greenhouse gas (GHG) in the atmosphere (ASE 2018). All current energy sources contribute to environmental degradation at some point either during production, distribution, or consumption. Energy efficiency curtails all environmental issues through simple reduction of energy demand.

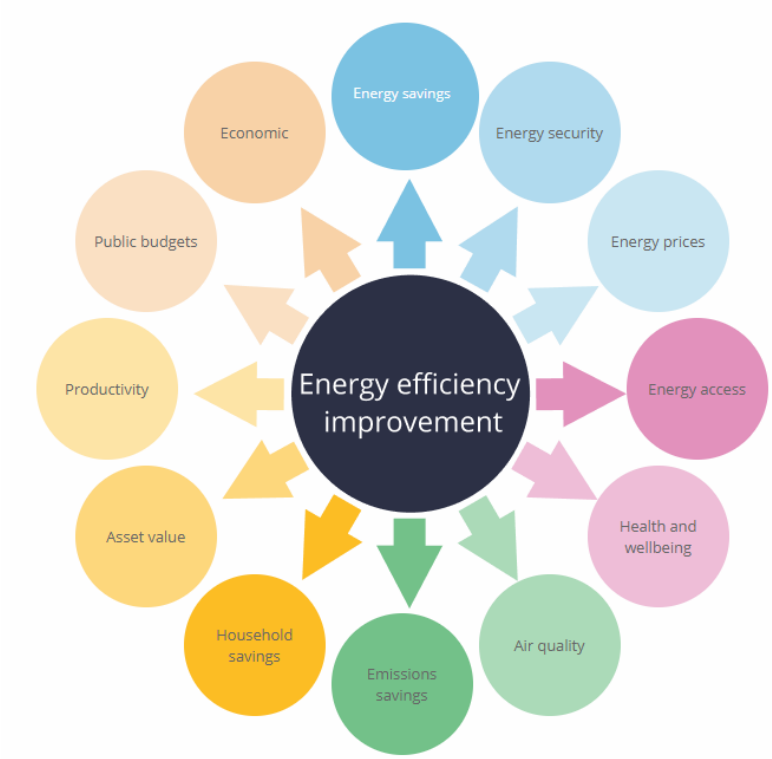


FIGURE 4. MULTIPLE BENEFITS OF ENERGY EFFICIENCY (IEA 2019)

1.2. Energy Service Company (ESCO) & Energy Performance Contract (EPC) Defined

Energy efficiency is crucial to guaranteeing a safe, reliable, affordable and sustainable energy system for the future. Energy efficiency is the quickest and cheapest method of increasing energy security and minimizing environmental and economic difficulties (Langlois and Hansen 2012). Given the need to rapidly and significantly increase financing for energy efficiency, interest in the energy service company (ESCO) business model is growing. ESCOs help bring energy efficiency technology to market and reach investment levels detailed in *Figure 3* above.

The definition of energy service company varies among experts in the field. The Energy Services Directive (2006/32/EC) describes an ESCO as an entity that delivers energy services and/or other energy efficiency improvement measures in a client's facility and accepts some degree of financial risk in so doing. It stresses that the payment for the services is based on future energy savings from the achievement of energy efficiency improvements and on meeting other agreed performance criteria. For the purposes of this report, this will be the accepted definition.

In practice, ESCOs typically design, install, and can finance an energy efficiency project through a contractual agreement with the energy-using client, normally called an energy performance contract (EPC) (Boza-Kiss, Bertoldi and Economidou 2017). *Figure 5* shows the added value that ESCOs bring to energy efficiency projects. Services for energy efficiency projects include providing energy audits, feasibility studies, design of energy efficiency options and financing, installation and project management, operation, maintenance and performance monitoring (Okay and Ugur 2010). Such organizations include design and engineering firms, construction management firms, equipment manufacturers and suppliers, or subsidiary in-house ESCOs in large industrial groups.

FIGURE 5. ENERGY SERVICE COMPANY (ESCO)

ESCO markets vary between countries and regions. Variations include the definition of an EPC, the restrictions and policies ESCOs are subject to, and the technical capability of an ESCO (Bertoldi 2006). The sectors in which these savings are achieved also vary. ESCOs have the ability to work in buildings, industry and transport in both the private and public sectors. The majority of ESCO projects take place in the non-residential buildings sector, followed by industry; projects in the transport sector virtually non-existent. On average ESCO projects deliver energy savings between 15% - 25% (IEA 2018).

ESCOs deliver energy savings using Energy Performance Contracts with the two most popular models being Guaranteed Savings and Shared Savings.

Literature Justifying the Use of EPCs

Well-financed ESCOs prevent missed opportunities to improve energy efficiency. Without ESCOs and other market-based instruments for energy efficiency, delayed action would lock in inefficiencies requiring stronger action in the future (IEA 2018). The success of the ESCO market will result in the associated multiple benefits shown in *Figure 4* including decreased energy intensity, mitigation of climate change, and ease of energy access.

A USAID Brazilian Clean and Efficient Energy Program (BCEEP) report addresses the question "If the energy efficiency technology and its application is financially attractive, why wouldn't the customer just do the project themselves?" (Poole & Stoner 2003). Through answering this question, the report rationalizes that the added benefit of EPCs outweighs the added complication of involving third party financing. EPCs are justified because the contracts increase consumer credibility and comfort for third party financial agents (Poole & Stoner 2003). Increased consumer credibility is created by the ESCO providing a guarantee regarding project risk. More comfort for third party financial agents is created because an EPC (1) Assures an adequate cash flows to pay for a project, (2) Enables third party engineering calculations to confirm project viability, (3) Provides cost estimates guaranteed by the ESCO, (4) Ensures credit is spent on stated purpose and not, for example, to cover operating costs, and (5) Simplifies accounting for possible tax breaks, market based instruments, or carbon credits.

The EPC is necessary for ESCOs to gain access to third party financing (Poole & Stoner 2003). Third party financing ensures that the client installing the energy efficiency project doesn't experience a

negative cash flow. Energy efficiency projects have high capital costs which can be amortized over a fairly short period of time (2 to 5 years). However, many clients prioritize core operational costs over energy efficiency projects. This creates an arbitrage opportunity for a third party – ESCOs – to capitalize on by focusing and providing their core business – energy efficiency services – to other businesses without such a specialization (Poole & Stoner 2003).

Energy Performance Contract (EPC)

The EPC commits the ESCO to installing the necessary equipment, provides guarantees for performance and establishes the terms of any upfront or ongoing payments funded by the project's financial savings. The EPC provides the customer with a guaranteed level of energy savings and the ESCO with a reliable source of revenues. Duration of EPCs, typically between two to twenty years, is determined on a project-to-project basis. Depending on the client's preference and access to capital, the client, the ESCO, or a combination of the two may finance the project. Typically, EPCs are referred to as a shared or guaranteed savings model. A direct loan agreement with a third-party lender is also an option for both parties.

Accounting rules, which vary between countries and regions, determines an EPC's viability as an investment tool. Whether or not an EPC is accounted as on or off-balance sheet is determined by national accounting rules, which do not always take into account the specific situation of ESCO contracting. Reporting an EPC on-balance sheet indicates an increase in the debt or a liability held by the organization (Boza-Kiss, Bertoldi and Economidou 2017). Depending on the size of the ESCO, the inability to record EPCs off-balance sheet may limit or prevent growth as their debt to equity ratio may raise beyond credit-worthiness.

The United States Generally Accepted Accounting Principles (GAAP) considers EPCs to be an operating lease to maintain the asset off the balance sheet (IEA 2018). In Europe, the European Commission defined the terms under which an EPC can be accounted for in the 2017 European System of Accounts (EC 2017; EC 2013). In 2018, Eurostat published a Guide to the Statistical Treatment of Energy Performance Contracts outlining how EPC can be accounted for off-balance sheet, in an effort to increase EPC and overall energy efficiency investment ((European Investment Bank 2018); (European Commission 2017)).

Guaranteed Savings Model

An Energy Performance Contract Guaranteed Savings model (EPC GS) describes when the ESCO guarantees a certain saving on the client's energy bill, taking on all the technical and design risk. The EPC GS model is depicted in *Figure 6*. The client obtains a bank loan, and either retains 100% of the savings then pays the ESCO based on performance, or pays 100% of the project cost upfront and the ESCO reimburses the saving deficit each year. Countries with ESCOs that use this as the main financing model include Canada, USA and Thailand (IEA 2018).

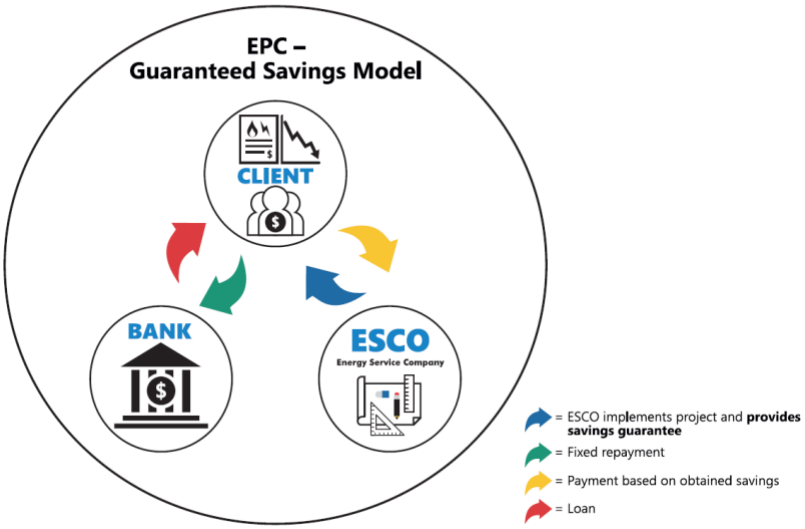


FIGURE 6. GUARANTEED SAVINGS MODEL

Shared Savings Model

Energy Performance Contract Shared Savings model (EPC SS) describes when the ESCO provides financing as well as project development and implementation costs. The consumption savings are shared between the ESCO and the client over the lifetime of the contract as shown in *Figure 7*. In this model, the ESCO is assuming both the technical and the client credit risk. This allows clients to maintain the investment completely off their balance sheet. This model is contingent upon the ESCOs either having enough financial capacity to open loans and balance their financial leverage, or a banking sector well enough developed to buy the debt from the ESCO through forfeiting. Examples of countries where this model is used are India, Chile, and Greece (IEA 2018).

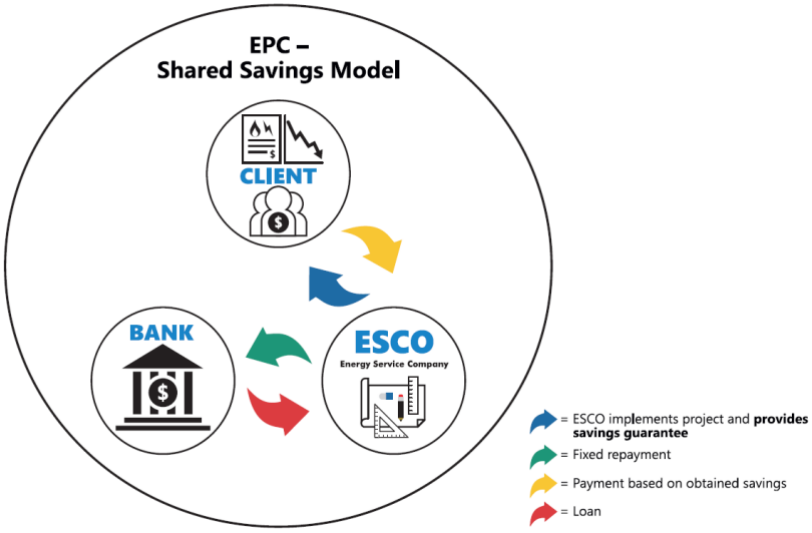


FIGURE 7. SHARED SAVINGS MODEL

1.3. Scientific Background & Existing Literature Gap

Interest sparked by the high-level summary of ESCOs summarized in Chapter 5 of IEA's *Energy Efficiency 2018 Market Report*, the release of the 2018 Eurostat Guide to the Statistical Treatment of Energy Performance Contracts, and the removal of national ESCO incentives in China's 13th Five-Year Plan motivates this in-depth look at the status of the global ESCO market.

The neighborhood of researchers publishing content related to ESCOs is relatively small. The first four of the following five sections outline the existing literature in the European Union, China, United States, and the rest of the world. The fifth section outlines literature surrounding ESCO decision making.

The existing literature gap closed by this research is a global survey and analysis of ESCO markets. The analysis of survey results and other ESCO literature yield standardized market maturity comparisons and associated quantitative and qualitative policy recommendations for increasing investment in ESCOs globally.

European Union ESCO Literature

A name that is strongly associated with the European ESCO market is Paolo Bertoldi, Senior Expert at European Commission's Joint Research Centre (JRC). Prior reports from the JRC, Lawrence Berkeley National Laboratory (LBNL), and EU Horizon 2020 funded QualitEE projects provide insightful ESCO market analysis but do not provide a truly global scope. This limits comparison to established markets (China/USA) or continental comparisons (EU level) (Lawrence Berkeley National Laboratory 2015). Bertoldi et al. (2006) rank the development and status of ESCO industries in the EU and conclude differences are due to level of institutional support, local market structures, and variation in the definitions of ESCOs. ESCOs importance is rationalized due to their cost-effective approach to reducing greenhouse-gas emissions.

Academic reports extract lessons learned from the wider EU system to optimize the Dutch ESCO market (Vreeken 2013). Capelo et al. (2018) conducts a case study of Portugal's ESCO industry using a system dynamics approach to represent underdeveloped EU ESCO markets hindered by delayed impacts from interdependent policies. This model assumes that barriers do not operate independently and must be addressed system wide. Patlitzianas et al. (2006) provided an overview of Mediterranean ESCOs business environment (political–legal, economical–financial, social–cultural and technological). Due to the early stages of energy efficiency adoption and ESCO market formation Mediterranean countries face financial barriers to raising awareness of the importance of energy efficiency and the role ESCOs can play in implementing energy efficiency projects.

Chinese ESCO Literature

Davies and Chan (2001) discuss the benefits, barriers and business environment required for performance contracting applicable to Hong Kong. Zheng (2018) provides a decision-making tool for ESCOs to select the most efficient technologies dependent upon geographic region and appliance end-uses in a Chinese context.

United States ESCO Literature

Stuart et al. (2018) provides an overview of the US ESCO industry evolution since the mid-1980s (Stuart, Carvallo, et al. 2018). Stuart et al. (2016) conducts a survey on the US ESCO-market covering market size, policy support, project size, simple payback period, and trends of national and regional ESCO firms between 1995-2005 (Stuart, Carvallo, et al. 2016). Large, institutional public-sector customers compose the majority of US ESCO market clients. Sorrell (2005) examine the USA and UK ESCO markets. Sorrell (2005) concludes that the EPC model may only be appropriate for specific energy services or energy

consumers and the contributions of ESCOs to a low-carbon economy may be exaggerated by some analysts.

Global ESCO Literature

Three of the most global reaching publications regarding the status of the ESCO market are from Vine (2005), Bertoldi et al. (2009), Langlois & Hansen (2012). In 2005, Vine published a paper in the journal *Energy Policy* detailing the results of a 38-country survey including (1) the number of ESCOs; (2) the key sectors targeted by ESCOs; (3) the four most important barriers facing the ESCO industry; (4) the approximate value of projects conducted by ESCOs in 2001; and (5) the future of the ESCO industry in that particular country (Vine 2005). Vine's survey collected data from 2001.

Another global update was provided in a 2009 book *ESCOs Around the World* (Bertoldi, Langlois and Hansen 2009). This book provides case studies of completed projects with history lessons of the development of the global ESCO market, which started gaining traction in the early 1990s. Langlois & Hansen sans Bertoldi provide a 2012 update of their work on the global ESCO market via the *World ESCO Outlook.* This update relies on the contributions of in-country experts shining a spotlight on the activities from their local perspective on nearly 60 different ESCO markets (Langlois and Hansen 2012). In addition to country overviews, their 2012 work helps ESCO operators by providing a day-to-day operational guide for ESCO development.

A comprehensive review of ESCO market data from the past three years (2016-2019) did not exist prior to the 2018 IEA Global ESCO Survey, which was conducted as part of my main internship project (Findley 2019). This thesis closes the existing knowledge gap by providing a global overview of current – 2015 to 2018 – ESCO market activity.

Literature Surrounding ESCO Decision Making Frameworks

Technological Innovation System Analysis Framework

A Technological Innovation System (TIS) is an interconnected network of agents interacting in a specific economic/industrial area under a particular institutional infrastructure and involves the generation, diffusion, and utilization of technology (Hekkert, Bergek and Jacobsson 2008). Country level ESCO markets are an example of a TIS. Country level ESCO markets are composed of an interconnected network of agents – energy service providers, financial institutions, and clients – in a specific economic/industrial area – their respective country – under a particular institutional infrastructure – country specific governments and policies – involved in the generation, diffusion, and utilization of – energy efficiency – technology.

There are seven functions identified by Hekkert et al. that can be used to assess how well a TIS, such as an ESCO market, is performing. The seven functions are summarized below (Hekkert, Bergek and Jacobsson 2008).

F1. Entrepreneurial Activities: Entrepreneurs create practical and/or commercial business opportunities and innovations. Entrepreneurial activity could be a strength or opportunity while lack thereof could be a weakness or threat.

F2. Knowledge Development: The focus of the ESCO market or the country as a whole on R&D must be considered especially in regard to emerging technology, but also on markets, networks, and users.

F3. Knowledge Diffusion / Knowledge Exchange through Networks: The ability of ESCO associations and ESCO market actors to facilitate the exchange of knowledge between all involved parties must be considered. Knowledge Diffusion activities may include formal or informal partnership, meetings, workshops or conferences. The innovation system approach stresses that innovation happens only where

actors of different backgrounds interact. In the context of the ESCO market this means ensuring that regulatory, financial, end-user, and ESCOs have open channels of communication.

F4. Guidance of the Search: The Guidance of the Search function refers to activities that shape the needs and expectations of market actors during market development. Guidance of the Search refers to individual choices as well as policy targets. It also refers to promises and expectations made by various actors in the ESCO market. Guidance of the Search can be positive or negative. A positive Guidance of the Search means expectations, promises, policy directives are working together and yielding increased investment in ESCO activities. If negative, investment in ESCO market will decrease.

F5. Market Formation: Emerging markets cannot be expected to compete with incumbent markets. In order to stimulate innovation, it is usually necessary to create artificial niche markets. In the case of ESCO market development this niche market is typically found in providing energy efficiency improvement services to government entities which provided policy or directives congruent to the ESCO model. The presence, absence, or expansion beyond a niche market is considered in terms of the SWOT analysis.

F6. Resource Mobilization: Resource Mobilization refers to the allocation of financial, material and human capital. The presence or absence of financing, subsidies/taxes, technology, and a well-trained workforce is considered in the SWOT analysis.

F7. Support from Advocacy Coalitions: An emerging ESCO market may experience resistance based on complexity of concept or a desire to maintain a status quo. In order to overcome this resistance advocacy groups must work with authorities to reorganize the institutional configuration of the system. This may be a political process or not. The presence and effectiveness of lobbies or ESCO Associations is consider during the SWOT analysis to determine levels of support from advocacy coalitions.

Existing Literature Gap for Decision Making Frameworks

There is no existing literature investigating a methodological approach for creating policy recommendations for increased investment in the global ESCO market. This thesis builds a methodology that formulates policy priorities and yields recommendations for increased investment in global ESCO operations. The standard quantitative - described in Section 2.3 - and qualitative - described in Section 2.4 – policy development methodology created and demonstrated in this thesis is applicable to country-level ESCO markets. This methodology enables replicable ESCO market trend tracking and the continuous evolution of ESCO policy recommendations.

Consistent analysis of ESCO markets, which is fundamentally comparative, will encourage the sharing of best practices and prevent emerging markets from making the same mistakes developed markets made in the previous decades (Vreeken 2013). Conversely, innovative methods for project completion in smaller markets may be identified as scalable solutions for niche issues in larger markets.

1.4. Research Design

The aim of this research is to increase investment in energy efficiency by eliminating the existing literature gap surrounding ESCO market status. Included in this report is (1) a global overview of the ESCO market, (2) country level market analysis, (3) policy recommendations for increasing global investment in energy efficiency via energy service companies and (4) a methodology for replicating the entire analysis and policy recommendation process. This scope of research is determined based on the need to reduce greenhouse gas emissions while still enabling economic growth to improve global standards of living.

The target audience of this research is academia, energy clients, insurance agencies, financial institutions and policy makers engaged with ESCOs. It is urgent that this information also be available for decision-makers in these institutions, as ESCOs are critical to realize the full potential of energy efficiency.

Unfortunately, many ESCOs face issues obtaining financing due to the lack of awareness and the complexity of barriers involved (Langlois & Hansen 2012).

Providing information for specialists and non-specialists alike from a credible non-partisan source highlights the policy areas that require action and raises awareness of the ESCO concept. Raised awareness increases the likelihood that more energy efficient projects will be implemented, in turn reducing global energy demand and associated greenhouse gas emissions. As greenhouse gas emissions are permanently reduced the most dangerous impacts of climate change may be avoided (Bertoldi et al. 2006). Following from this need to increase investment in energy efficiency via ESCO operations, this main research question was formulated to guide this research:

What is the current status of the global Energy Service Company market and which policies can be implemented to increase energy efficiency investment, by means of Energy Service Companies, to a level aligned with the Paris Agreement's goal of holding the increase in the global average temperature to "well below 2 °C"?

The main research question is thoroughly addressed by answering the following sub-questions (SQs):

SQ I. *What are the investment levels, compared to current levels, needed to implement all currently economically viable energy efficiency technologies and policies to align with Paris Agreement climate targets?*

SQ II. *How developed is the global Energy Service Companies market in terms of annual growth, revenue by country, number of ESCOs operating, sectors operated within (e.g. Industry, Residential, Non-Residential, Transport), client type (e.g. Public or Private), contract type used, and organizational structure?*

SQ III. *How does the maturity, based on market characteristics, of country level ESCO markets compare with one another and how does this maturity level adjudicate the best policy to increase investment in energy efficiency via ESCOs?*

SQ IV. *Which barriers and drivers are country level ESCO markets facing and how do these factors determine the right policy mix to increase investment in energy efficiency.*

SQ V. *Which policy measures synergistically address selected country's market maturity, business barriers, and business drivers to increase energy efficiency investment?*

SQ I provides context for the required level of investment from both public and private sectors to implement already economically achievable energy efficiency gains. The answer will not rely on any technologies currently undergoing research and development. Section 2.1 explains the methodology. Section 3.1 answers *SQ I*.

The aim of *SQ II* is to develop a global overview of the ESCO industry to provide context for future development. Through this process industry leaders are revealed and lessons from successful policies may quickly be learned. Section 2.2 explains the methodology. Section 3.2 answers *SQ II*.

SQ III creates a quantitative spectrum of low, mid, and mature ESCO markets based on key market characteristics. This standardized spectrum provides the springboard for deeper insight and recommendations. Section 2.3 explains the methodology. Section 3.3 answers *SQ III*.

SQ IV applies a nuanced analysis of ESCO operations on a country level. Dominant business barriers and drivers facing ESCOs are identified. Once identified, the possibilities for future growth or contraction are explored. Section 2.4 explains the methodology. Section 3.4 answers *SQ IV*.

The goal of *SQ V* is to assess which policies or actions are already in place that could improve ESCOs

operating environment and recommend additional policies to ensure a level of ESCO development aligned with Efficient World Scenario energy efficiency investment levels. Section 2.5 explains the methodology. Section 4 answers *SQ V* by providing country level policy recommendations to increase investment in energy efficiency via ESCOs.

2. Methodology

Figure 8 shows the five-step methodology used to conduct this research and to build theory for increasing investment in the ESCO industry. This methodology is appropriate because it yields an ESCO information resource that provides actionable recommendations for ESCOs to create market-driven demand for energy services, through an appropriate awareness raising campaign and information dissemination (Bertoldi 2003). This action has been called for since 2003.

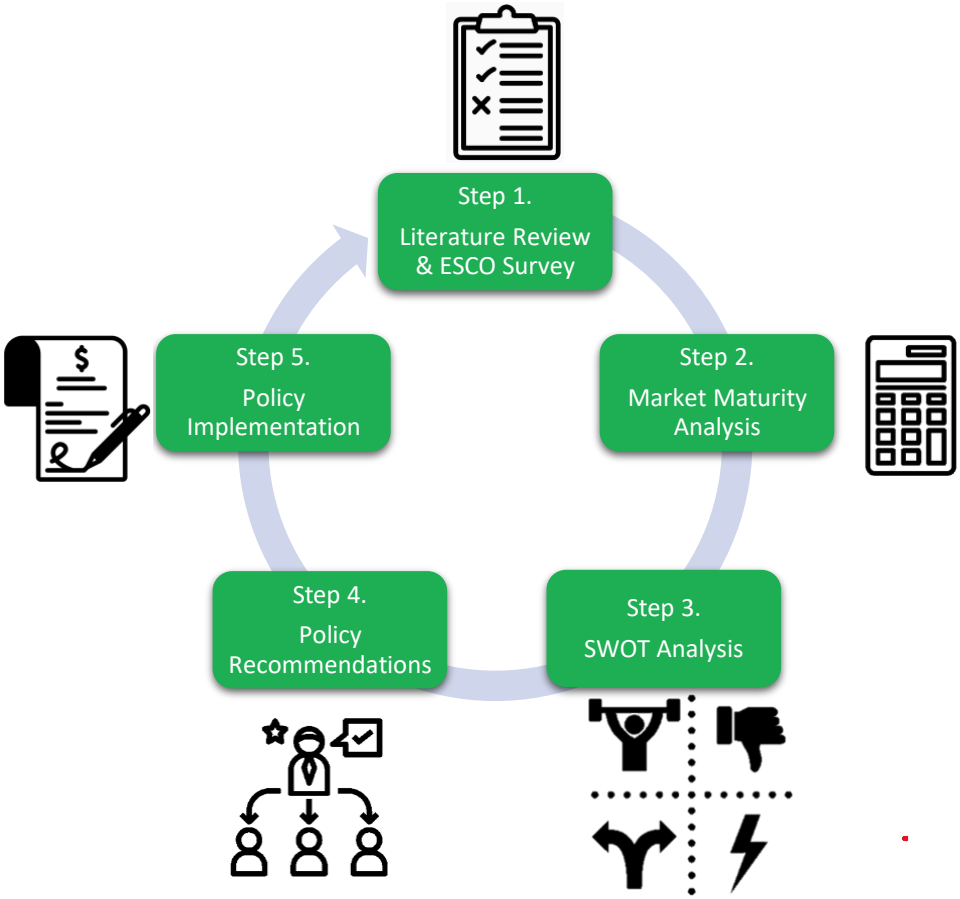


FIGURE 8. RESEARCH METHODOLOGY

The first step of data collection is summarized in Section 2.1 and Section 2.2. The second step of critically analyzing quantitative survey data is summarized as Market Maturity Analysis in Section 2.3. The third step of critically analyzing qualitative ESCO market characteristics is summarized as SWOT Analysis in Section 2.4. The fourth step of synthesizing policy recommendations is explained in Section 2.5. The fifth step of policy implementation is included in *Figure 8* to highlight the key role that policy and decision makers play in turning academic research into real world results. The methodology is a cyclical process to ensure measureable progress is made. Tracking the implementation of recommended policy in

conjunction with ESCO market investment levels will confirm or denied the theory built by this research.

2.1. Determine Required Energy Efficiency Investment

SQ I – What are the investment levels, compared to current levels, needed to implement all currently economically viable energy efficiency technologies and policies to align with Paris Agreement climate targets?

Literature review is used to answer the first sub question. The level of investment required to align with Paris Agreement climate targets is answered by referencing IEA's Policies and Measures Database as well as the IEA 2018 *Energy Efficiency Market Report* (IEA 2018). The purpose of this research is to underscore the importance of energy efficiency for achieving international climate goals. The unit for investment used in this report is United States dollar per year.

2.2. Understand the Global ESCO Market

SQ II – How developed is the global Energy Service Companies market in terms of annual growth, revenue by country, number of ESCOs operating, sectors operated within (e.g. Industry, Residential, Non-Residential, Transport), client type (e.g. Public or Private), contract type used, and organizational structure?

The primary source of data for this global overview is from the IEA Global ESCO Survey. The IEA Global ESCO Survey is tailored specially for the purposes of answering sub-question two and eliminating existing knowledge gaps identified in *Section 1.3*.

This thesis presents the growth of the global ESCO market and explains the reason behind the growth in four regions; United States, European Union, China, and Rest of the World. Growth is delineated by market status information including annual growth, revenue by country, number of ESCOs operating, sectors operated within (e.g. Industry, Residential, Non-Residential, Transport), client type (e.g. Public or Private), contract type used, and organizational structure. The data used for this report is the most up-to-date information available at the time of publication.

Primary Data Collection

Annually, the IEA's *Energy Efficiency Market Report* tracks the global size of the ESCO market. In 2018, the Energy Efficiency Division conducted the Global ESCO Market Survey of 30 national ESCO associations to inform a more in-depth analysis of the ESCO market. Overall, the survey covers five out of six of the IEA Energy Efficiency in Emerging Economies (E4) countries (Brazil, China, India, Mexico, South Africa, excluding Indonesia), 80% of G20 member countries, and 66% of IEA member countries. Country selection is based on the presence of a national ESCO association and their willingness to share data. The survey gathers quantitative and qualitative data on the state of the ESCO market in each region, including market size, sources of finance, applicable policy, contract utilization and aggregate project performance.

The market survey is conducted in the form of a questionnaire coupled with a follow-up phone call with representatives of each national ESCO association. Representatives from industry and internal IEA colleagues are invaluable as supplementary informational resources.

The IEA Global ESCO Survey is selected as the central data source for this thesis because key performance indicators of ESCO market maturity are measured (IEA 2018). The key performance indicators are included in this survey because as an intern and external consultant at the IEA between November 2018 and August 2019 this researcher aided in drafting and conducting the survey. The homogeneity of the collected data enables ease of comparison for ESCO activities in those countries which were surveyed and provided complete responses. Please reference the survey in the Appendix A1 and the

details surrounding the drafting of the survey in my IEA Internship report (Findley 2019).

Fourteen additional data sources are utilized to complete gaps in data or provide information from earlier years. EU level data is collected from QualitEE EU Horizon 2020 ESCO Survey. This was conducted as an online questionnaire among relevant energy efficiency service providers in combination with personal interviews of financial institutions and clients (QualitEE 2017). Supplementary data sources used for analysis are found in JRC's *ESCOs in the EU* (Boza-Kiss, Bertoldi and Economidou 2017), GuarantEE ESCO project (GuarantEE Energy Efficiency 2016), Vine Global ESCO Survey (Vine 2005), Patlitzianas' Mediterranean ESCO study (Patlitzianas, Doukas and Psarras 2006), *Lessons learned from 49 ESCOs* (Bertoldi, Langlois and Hansen 2009), World ESCO Outlook (Langlois and Hansen 2012), Shell SKY model (Royal Dutch Shell 2018), Stuart et al. 2016 & 2018 (Stuart, Carvallo, et al. 2018), Transparense project (Black Sea Energy Research Centre 2013), Boza-Kiss European ESCO Market (Boza-Kiss, Bertoldi and Panev 2013), The World Bank Global GDP data (The World Bank 2019), and census data (United States Census Bureau 2019).

Primary Data Visualization

Following the collection of primary data, a dedicated ESCO webpage hosted on the IEA's Energy Efficiency Global Exchange was created. This web resource presents information concerning the status of the ESCO market, energy performance contract models, energy savings insurance, relevant ESCO accounting principles, and policy. As my main internship project, I utilized HTML and Javascript programming languages in combination with Terminal4 web content management systems to create the webpage and dashboard which enables at-a-glance comparison of key ESCO market information.

A webinar was hosted on February 21st, 2019 to provide an overview of the online IEA ESCO association survey content and subsequent work (Findley and Glicker 2019). This webinar was a video call where stakeholders (energy clients, insurance agencies, financial institutions, academics, and energy service providers) tuned into the presentation of the website and the usability of data sources. A question and answer portion followed the presentation of work to clarify points of weakness and collect feedback for next steps. This feedback included requests for the creation of country level policy recommendations.

2.3. Quantitative ESCO Market Maturity Analysis

SQ III – How does the maturity, based on market characteristics, of country level ESCO markets compare with one another and how does this maturity level adjudicate the best policy to increase investment in energy efficiency via ESCOs?

The third sub question relies on the assessment of ESCO market maturity. ESCO market maturity scores are based on seven indicators. Maturity scores are used to create a standard quantitative foundation for policy recommendations. The result is a three-tiered ranking of each ESCO market.

Standard recommendations for improving the maturity score are made for each of the seven indicators, Section 4.1. The standard maturity-based recommendations are refined using qualitative SWOT analysis to create curated policy recommendations for each country level ESCO market, Section 4.2.

This methodology builds new theory for standardizing ESCO policy recommendation creation. Country selection is based on availability of complete time series data with regards to reliability.

Market Maturity Analysis

Market maturity in the context of this research is a calculated score which indicates a robust ESCO market. The market maturity score is based on the sum of seven market characteristics multiplied by

experts' indicator weighting. The market maturity indicators are indexed to the best value for each indicator. Indexing allows the final aggregate score to be compared.

Selection Criteria of Market Maturity Indicators

The selection criteria for ESCO market maturity indicators are relevance, measurability, data availability, and clarity. The maturity indicators are selected if they are characteristic of an ESCO markets' ability to; (1) obtain financing; (2) successfully complete efficiency improvement projects in multiple sectors; or (3) achieve long term market stability. Those three interrelated characteristics, summarized in *Figure 9*, define a robust ESCO market. The following three sections are based on this criterion and explain why each indicator is selected and why others are not included.

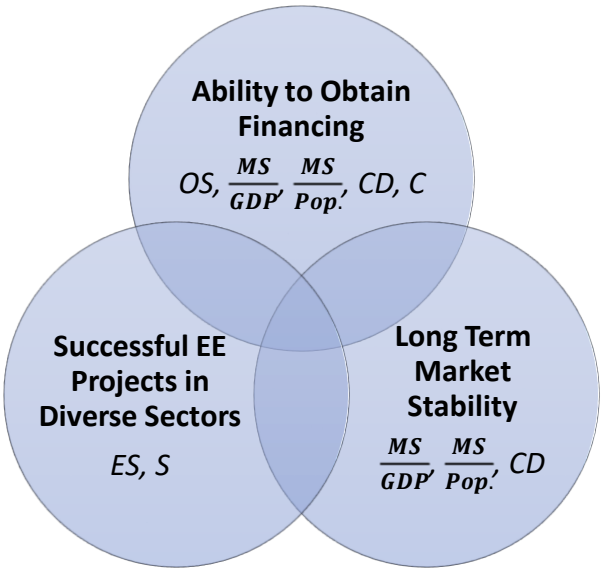


FIGURE 9. MARKET MATURITY DEFINED BY INDICATOR SELECTION CRITERIA

ABILITY TO OBTAIN FINANCING

The ideal indicator for the ability of ESCOs to obtain financing would be the ratio of accepted vs rejected bank loan applications submitted by ESCOs. The more rejected loan applications the greater the difficulty of accessing financing. This assumes projects are of sufficient quality and there are a representative number of applications. Due to financial privacy laws limiting the availability of this information, alternative indicators for ability to obtain financing must be used. The indicators used are organizational structure **(OS),** ESCO market size divided by both gross domestic product and population size **(**$\frac{MS}{GDP}$**,** $\frac{MS}{Pop.}$**)**, average contract duration **(CD)**, and average project cost **(C).**

Organizational structure **(OS)** is used to indicate ability to obtain financing because a high number of subsidiary ESCOs typically indicates large project size, and large ESCO projects cannot be completed without access to financing. This is an imperfect indicator because it may not reflect the general start-up climate in a country, ESCO market risks, or knowledge barriers which may contribute to the failure of stand-alone and the success of subsidiary ESCOs. However, subsidiary ESCOs typically undertake larger projects because they are established, have greater equity, and are motivated to do so in order to minimize the proportion of project costs spent on fixed operational overhead such a legal or accounting (IEA 2018). Therefore, organization structure, or the higher the ratio of subsidiary to stand-alone ESCOs, is a good indicator of availability of financing because the more ESCOs operating as a subsidiary of a large

corporation, the greater the likelihood that ESCOs in the region have access to financing.

ESCO market size divided by both gross domestic product, the broadest measure of economic health, and population size **($\frac{MS}{GDP}$, $\frac{MS}{Pop.}$)** are used to indicate ability to obtain financing. The larger the ESCO market size the more money is being invested in energy efficiency improvement projects. A large ESCO market can exist only if third-party financing options are accessible (Poole & Stoner 2003). One method for an ESCO market to achieve a large market size is to develop from small individual projects to large aggregate projects. In order to make this transition towards capital intensive projects an ESCO must be able to leverage its' creditworthiness.

Market size alone can be misleading. To create context, market size must be considered in relation to GDP and population size. This is demonstrated in *Figure 10*. For example, Country A has a large GDP and population size with a larger absolute market size than Country B. In Country B, the absolute market size is smaller than in Country A, but the role of ESCOs within the country is proportionally larger. By considering market size in context with GDP and population, it becomes clear that ESCOs within Country B can obtain financing with greater ease than ESCOs in Country A, despite the absolute ESCO market size in Country A being larger.

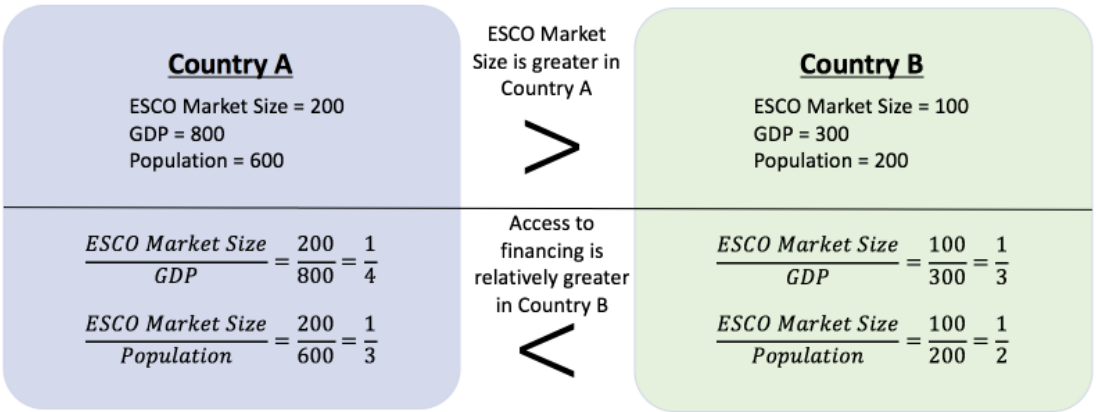


FIGURE 10. ESCO MARKET SIZE INDICATOR LOGIC

Average contract duration **(CD)** is used to indicate ability to obtain financing. Typically, a longer EPC requires greater investment. Financing provides this investment allowing ESCOs to purchase the capital required to execute a multi-year EPC. Without financing multi-year projects are rarely feasible.

Average project cost **(C)** is used to indicate ability to obtain financing. If project costs are high then third-party financing is typically involved. Without access to financing the average project costs are low and limited by ESCOs' or client's private savings. Therefore, high average project costs can be assumed to indicate that third party financing is available.

SUCCESSFUL PROJECTS IN MULTIPLE SECTORS

The ideal indicator for the ability of ESCOs to successfully complete efficiency improvement projects in multiple sectors would be the ratio of the number of initiated vs the number of completed projects per sector. The closer the ratio is to one the better the ESCO industry is at successfully completing projects. Due to lack of data availability concerning the number of projects initiated then not completed, alternative indicators must be used.

An indicator selected to demonstrate ability of ESCOs to successfully complete efficiency improvement projects in multiple sectors is average energy savings per project **(ES)**. This indicator

demonstrates the level of success in terms of energy savings achieved by ESCOs per project. ESCOs which achieve high energy savings (>25%) per project are typically operating in a country with high energy intensity. ESCOs which achieve low energy savings (<15%) are typically reaping the last bits of energy savings in a country with lower energy intensity. As lower energy intensity indicates a more efficient market, the lower the average energy savings per project the more mature the ESCO market can be considered.

Another indicator selected to demonstrate ability of ESCOs to successfully complete efficiency improvement projects in multiple sectors is the percentage of projects completed in each sector; industrial, non-residential, residential, and transport **(S)**. This indicator is selected because it directly indicates if an ESCO operates in multiple sectors. The IEA survey specifically asks for this information and thus data availability is not an issue.

LONG TERM MARKET STABILITY

The ideal indicator for long term ESCO market stability would be the ratio of years that an ESCO operates to the number of years that the ESCO turned a profit. Preferably, the data would reveal how many years the ESCO operates with a net positive profit, where revenue minus costs is positive, because this would indicate that the business will likely continue to provide services. Collecting this data over multiple years would provide an even better indication. Due to lack of data availability, alternative indicators must be used.

An indicator of long-term market stability that could be used, but is not is the number of ESCOs operating in each market. The reason for not selecting this indicator is not due to lack of data availability; rather it is due to the variability between markets. China is a market with 6439 operating ESCOs. 20 out of the 30 other ESCO markets surveyed have less than 50 ESCOs operating. Due to the large discrepancy between the number of ESCOs operating in each market this indicator would have a limited correlation or impact on the calculated market maturity score as indicated by an R Squared value of nearly zero.

Average contract duration **(CD)** is used to indicate long term market stability. If an ESCO is providing contracts that last on average greater than two years, this is a sign of market stability because the ESCO must be operating for the entire duration of the contract. In the USA, about one-third of businesses with employees fail within the first two years and about half fail within at least five years (United States Department of Labor 2012). Therefore, markets that executes contracts exceeding this length indicates stability. Additionally, longer contracts are typically more expensive and require third party financing. By incorporating an external financier there is an additional layer of stability as both parties must default for the project to fail and the market be shaken.

($\frac{MS}{GDP}$, $\frac{MS}{Pop.}$) are again selected to demonstrate achievement of long-term ESCO market stability. A larger ESCO market size has more money being invested in energy efficiency improvement projects. To create context, market size must be considered in relation to GDP and population size. These indicators show ESCO market size as a proportion of GDP and in a per capita ratio. The larger both of these ratios are the more long-term stability can be expected. For an ESCO market size to become a relatively sizeable proportion of any nation's GDP, ESCOs need to complete a huge volume of small projects or a collection of large projects. In either situation, this type of activity requires organization and competency which develop best in a market that has long-term stability. If there is a large market size relative to the population this indicates a cultural dedication to energy efficiency improvement projects. Because shared cultural values are slow to change, an ESCO market is poised for long-term stability in such locales.

Calculation of ESCO Market Maturity Score

Each country's ESCO market receives a maturity score based on a weighted arithmetic mean of key market maturity indicators. The formula for market maturity score is the standard equation for weighted arithmetic mean. The market maturity score is the sum of the seven weighted maturity indicators scores. Each indicator score is calculated by dividing the country indicator score by the best practice indicator score so that each score is between zero and one. Each indicator score is then multiplied by weightings based on a survey of five experts' opinion of the indicator's relevance to ESCO market maturity.

$$M = w_1 * \frac{OS}{OS_{bp}} + w_2 * \frac{\frac{MS}{GDP}}{\frac{MS}{GDP}_{bp}} + w_3 * \frac{\frac{MS}{Pop.}}{\frac{MS}{Pop.}_{bp}} + w_4 * \frac{ES}{ES_{bp}} + w_5 * \frac{S}{S_{bp}} + w_6 * \frac{CD}{CD_{bp}} + w_7 * \frac{C}{C_{bp}}$$

- **M** is market maturity score.
  - The market maturity score is representative of the overall level of ESCO development. ESCO markets are divided into three ranges; Low-Maturity, Mid-Maturity, and Mature markets. The key assumption which justifies placing ESCO markets on a spectrum is that ESCO markets must be considered in a system wide context (Capelo 2018).
- $\boldsymbol{W_{1\ to\ 7}}$ are indicator weightings, *Table 1*, based on a survey of ESCO experts.

TABLE 1. EXPERT ESCO MARKET INDICATOR WEIGHTINGS

	ESCO Market Size/Gross Domestic Product (MS/GDP)	*ESCO Market Size /Population (MS/Pop.)*	*ESCO Organizational Structure (OS)*	*Average Energy Savings/ project (ES)*	*Project Sector Diversity (S)*	*Average Contract Duration (CD)*	*Average Project Cost (C)*
Ailin Huang	*10%*	*5%*	*20%*	*15%*	*15%*	*20%*	*15%*
Armin Mayer	*20%*	*5%*	*20%*	*10%*	*20%*	*10%*	*15%*
Edith Bayer	*20%*	*5%*	*20%*	*10%*	*20%*	*10%*	*15%*
Hugo Salamanca	*20%*	*5%*	*15%*	*10%*	*25%*	*10%*	*15%*
Vida Rozite	*20%*	*5%*	*20%*	*15%*	*15%*	*10%*	*15%*
Average Weighting	18%	5%	19%	12%	19%	12%	15%

  - Experts are selected due to their involvement in the ESCO market as Policy Analysts in the Energy Efficiency division of the IEA.
  - Please see Appendix A2 for the indicator weighting survey.

To provide a recap of Section 2.3, the seven ESCO market maturity indicators are:

- **OS**, Organizational Structure, is the score based on percentage of ESCOs operating as stand-alone or subsidiary.
  - Whether a country hosts stand-alone or subsidiary organizations typically

reflects how large of projects are being completed and whether accounting practices tailored to ESCOs such as off-balance sheet practices are codified into law.
    - For example, the ESCO market in Turkey does not have a clear legal definition of an EPC. Without this legal distinction, the payment based on future savings is reliant upon non-standard individualized contracts (IEA 2018). This type of dynamic client relationship is not stable enough to attract large organizations to invest heavily. This leaves Turkey hosting only stand-alone ESCOs with small consumer focused sales teams.

- **MS / GDP**, ESCO Market Size indexed to Gross Domestic Product, is the score based on ESCO revenue per fiscal year and GDP in United States dollar (market exchange rate) (The World Bank 2019).
    - The countries that have a large market size are typically stable and consist of multi-year projects.
    - Gross domestic product (GDP) is the broadest measure of economic health.
    - GDP is used to standardize the MS score.
    - A country with a large MS and a large GDP is less indicative of a robust ESCO market compared to an equally large MS with a smaller GDP.

- **MS / Pop**., ESCO Market Size indexed to country population, is the score based on ESCO revenue per fiscal year in USD and population (United States Census Bureau 2019).
    - Population size is used to standardize the MS score per capita.
    - A country with a large MS and a large population is less indicative of a robust ESCO market compared to an equally large MS with a smaller population.

- **ES**, Energy Savings, is the score based on average energy savings per ESCO project.
    - This indicator demonstrates the level of success in terms of energy savings ESCOs are achieving per project.
    - This is an imperfect indicator. For example, in Dubai the UAE ESCO Association has reported greater than 30% energy savings per project. This is not due to exceptionally skilled ESCOs but poor pre-retrofit efficiencies particularly in shopping malls where maximum cooling standards are routinely flouted in an effort to induce overheated customers to browse longer. To counteract this type of effect and correct for this imperfect indicator the maximum energy savings per project is limited to 30% energy savings per project. 30% is selected as a maximum because the average energy savings achieved per project is 20% and an additional 10% still allows for the exceptional improvements to be recorded but not have an overwhelming effect on the final market maturity score.

- **S**, Sector Diversity, is the score based on percentage of projects completed in each sector; industrial, non-residential, residential, and transport.
    - This indicator demonstrates ESCOs diversification.
    - ESCOs operating in multiple sectors are more stable and likely to experience long term success.
    - For instance, if an ESCO is solely reliant upon the non-residential sector and there

is a retraction of tax exemptions for non-residential projects the ESCO will lack the necessary service offerings required for new market conditions where perhaps residential retrofits have become less risky projects.

- **CD**, Contract Duration, is the score based on average number of years required to complete each ESCO project
  - Longer contracts typically reflects a more mature market with high capital, multi-year projects.
  - Longer contracts also indicate market stability due to ESCOs operating for entire project lifecycles.
  - Contracts may be longer for one sector of the ESCO market such as Government contracts but this imperfection in the CD indicator is compensated for by the sector diversity indicator.

- **C**, Project Cost, is the score based on average cost of an ESCO project in USD.
  - Large projects are not undertaken without financing available for ESCOs.

If a country does not collect information for one of the seven indicators the missing indicator score is assigned a value equal to the average of the reported indicators.

Once a country score is calculated each is plotted on a maturity spectrum that corresponds with Low, Mid, or Mature ESCO market maturity as seen in *Figure 11*.

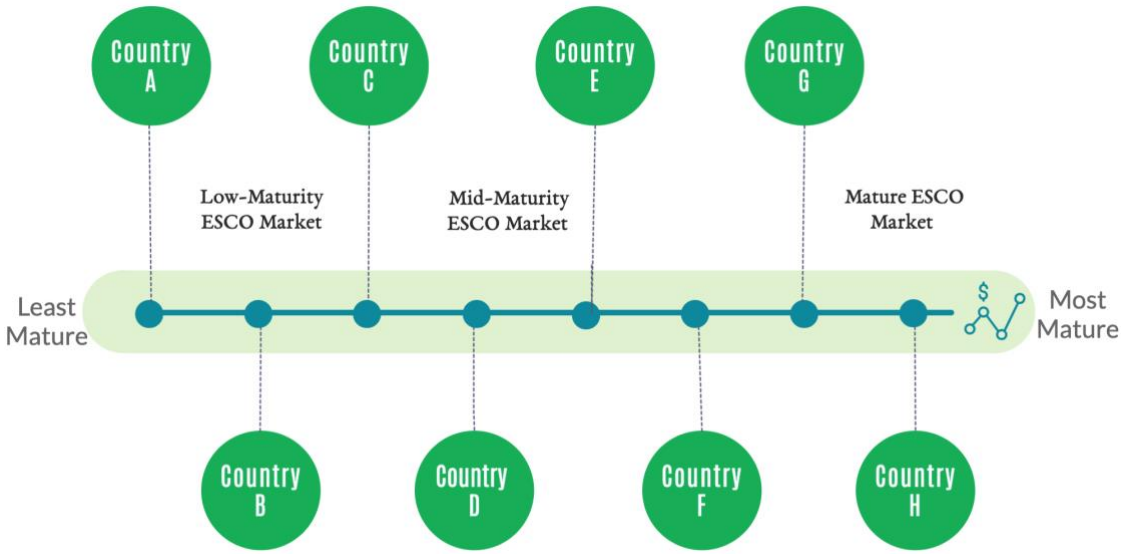


FIGURE 11. EXAMPLE MATURITY SPECTRUM

2.4. Qualitative Strength, Weakness, Opportunity, & Threat (SWOT) Analysis

SQ IV – Which barriers and drivers are country level ESCO markets facing and how do these factors determine the right policy mix to increase investment in energy efficiency.

The objective of the SWOT Analysis is to answer the fourth sub question. The SWOT analysis provides a nuanced explanation of the strengths, weaknesses, opportunities, and threats (SWOT) present in each country's ESCO market. The unique aspects of each country addressed during this analysis include the

institutions of a country, the potential for energy efficiency interventions in different sectors of the economy, prevailing political norms, and a nations' major industries. The results of the SWOT analysis are used as justification for why some policies are better suited than others for increasing ESCO investment. The summary of the SWOT Analysis inputs is shown in *Figure 12*.

Technological Innovation System Research Framework

To ensure that each country is reviewed systematically, the seven functions of the Technological Innovation System analysis framework, explained in Section 1.3, are used as a research framework. Each ESCO market SWOT analysis addresses the seven TIS function areas in at least one quadrant (Hekkert, Bergek and Jacobsson 2008).

The strengths and weaknesses of an ESCO market are identified from the QualitEE market survey which asks national ESCO associations and service providers to identify the main drivers and barriers of their ESCO business. Strengths of an ESCO market are factors which promote capital investment. Weaknesses entail areas of the ESCO market that hinder capital investment. For countries not covered in this survey additional literature review is performed to identify barriers and drivers.

The other two factors require analysis of the business climate that ESCOs operate within. Opportunities are areas of potential growth. This includes reviewing relevant policies and the institutions responsible for policy enforcement. Potential growth is also found by reviewing underdeveloped end use segments, current levels of national building stock efficiency, new service offerings, new contract types to be adopted, or other business opportunities. Alternatively, threats are external factors that pose challenges to the ESCO market such as lack of legislation, political instability, or structural inequality.

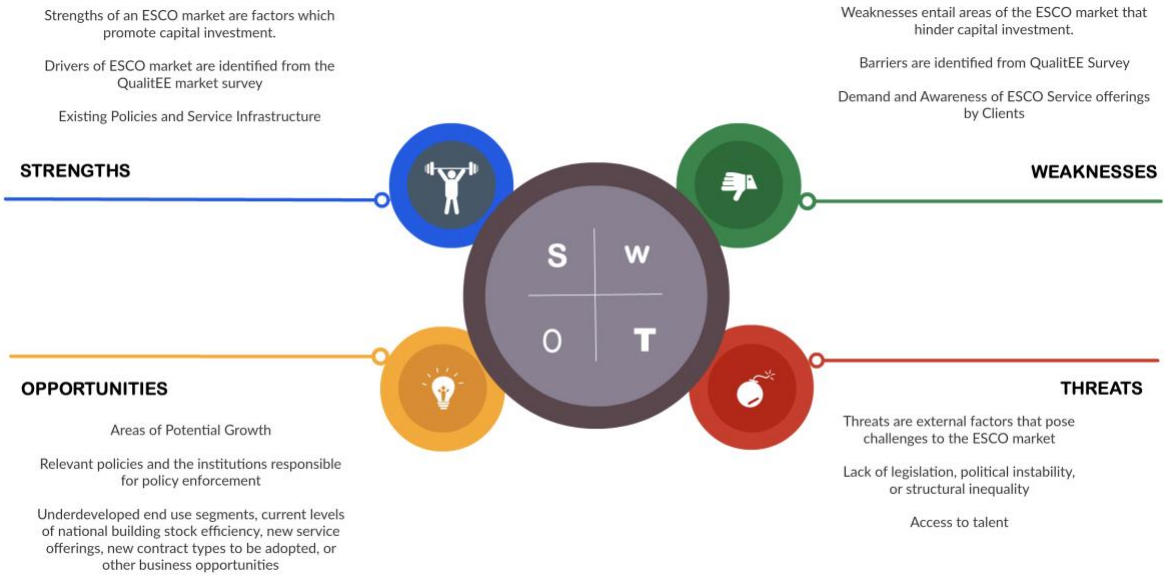


FIGURE 12. SUMMARY SWOT ANALYSIS INPUTS

2.5. Policy Recommendation Process

SQ V – Which policy measures synergistically address selected country's market maturity, business barriers, and business drivers to increase energy efficiency investment

The fourth step is structuring policy recommendations based on the quantitative and qualitative analysis described in Section 2.3 and Section 2.4. Policy recommendations are made for three categories; Regulation, Finance & Incentives, and Information & Capacity Building as shown in *Figure 13*. The reason

for structuring the policy recommendations into three categories is to ensure a diversity of policy recommendations are made.

Regulation covers any intervention to maintain or rebuild the deemed desirable status of a system (Geller 2004). Finance & Incentives motivates actions which might not happen without the monetary benefit. Information & Capacity Building is the process which builds skills, knowledge, equipment or capital required to competently execute an EPC (Geller 2004).

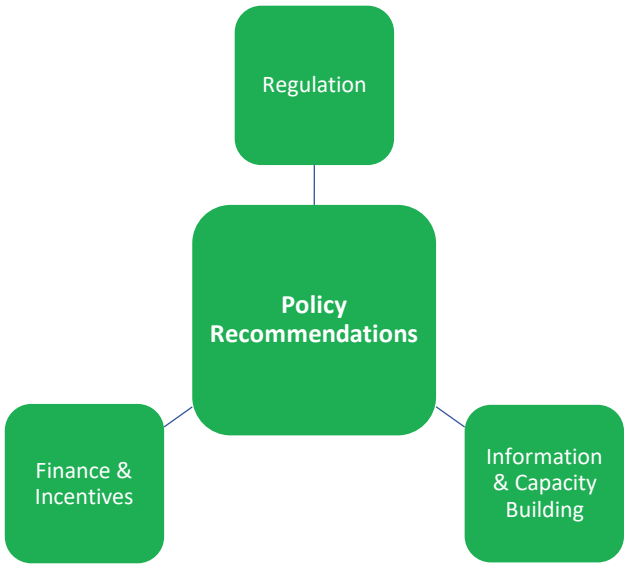


FIGURE 13. STRUCTURE OF POLICY RECOMMENDATIONS

Elements which come together to create suitable business environments do not operate independently, therefore, the removal of barriers to the adoption of EPC must be considered in a system wide context (Capelo et al. 2018). Utilizing this assumption, essential to systems dynamics analysis, the prioritization of policy recommendations based on market maturity indicators is justified.

First, standard ESCO market maturity indicator based recommendations are applied to improve below average country level indicator scores. Then tailored recommendations based on Technological Innovation System (TIS) research framework, applied during a SWOT analysis, are made (Hekkert, Bergek and Jacobsson 2008). Policies that have succeeded in similar markets are recommended with a reference to the successful case study. Additionally, policies that have failed in similar markets are highlighted as lessons already learned. Whenever possible a synergistic policy solution is purposed to take advantage of a strength to overcome a barrier.

Because EPCs are market-based instruments, there is an underlying assumption that a stable market is established before the market maturity analysis is conducted and recommendations for ESCO market development are levied. The recommendations needed to establish a stable economic market and the associated structural institutions which ensure stability is beyond the scope of this research.

3. Results

3.1. Current and Future Energy Efficiency Investment

This section answers *SQ I* by detailing the required level of investment to implement already economically achievable energy efficiency gains.

SQ I - What are the investment levels, compared to current levels, needed to implement all currently economically viable energy efficiency technologies and policies to align with Paris Agreement climate targets?

Future Scenarios of Energy Efficiency Investment

The investment levels, compared to current levels, needed to implement all currently economically viable energy efficient technologies and policies to bring significant gains for energy security, economic development and the environment is answered by the Efficient World Scenario published in the 2018 IEA *Energy Efficiency Market Report*.

The Efficient World Scenario is a forecasting model quantifying the implications for global energy use of pursuing all economically viable opportunities to improve energy efficiency, based on currently available technologies. In the Efficient World Scenario, all economically viable energy-efficiency investments are made and all necessary policies to eliminate market barriers to energy efficiency are adopted (IEA 2018). This scenario is adapted from the IEA 2018 *World Energy Outlook* Sustainable Development Scenario. The two models can be compared based on energy demand in *Figure 14*. The Efficient World Scenario assumes slightly more final energy demand in all three sectors and slightly more total primary energy demand than the Sustainable Development Scenario. This means that the Efficient World Scenario is more easily achievable and will require less investment in energy efficiency than the Sustainable Development Scenario.

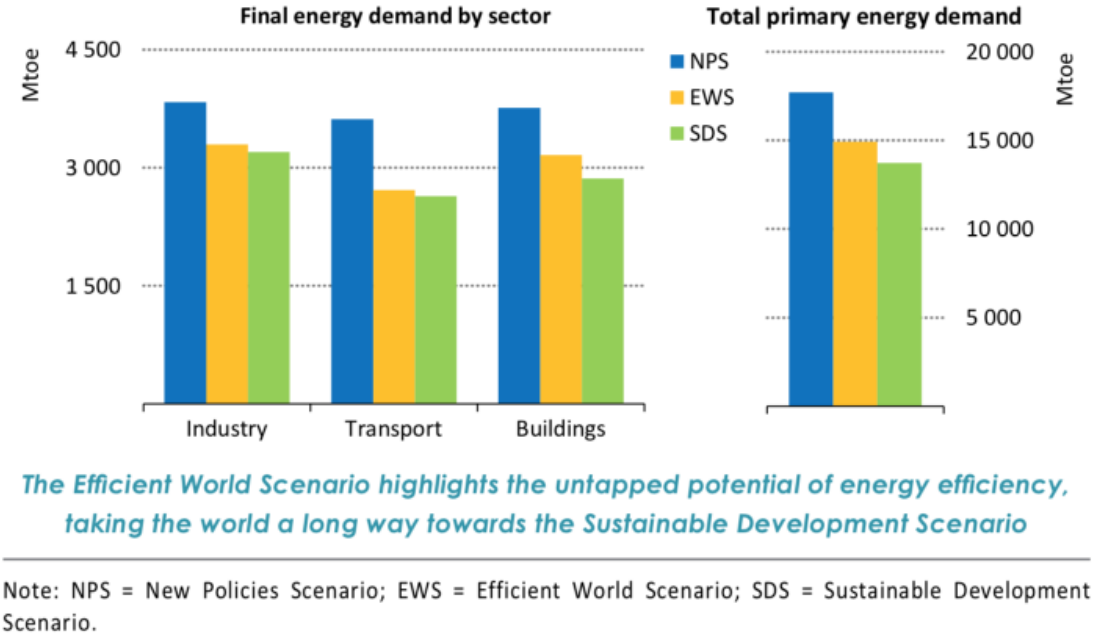


FIGURE 14. IEA 2040 SCENARIOS - SUSTAINABLE DEVELOPMENT SCENARIO (EXCEEDS PARIS GOALS) AND EFFICIENT WORLD SCENARIO (ALIGNED WITH PARIS GOALS) - (IEA 2018)

The Sustainable Development Scenario models a future where the Paris Agreement climate targets are exceeded and the climate remains "well below 2 °C" warming compared to pre-industrial levels. By isolating the investment required for energy efficiency within the Sustainable Development Scenario the Efficient World Scenario numbers for required investment and anticipated energy demand were extracted (IEA 2018).

Figure 3 shows the level of investment required to achieve the IEA Efficient World Scenario. To realize this potential, average annual investment in energy efficiency must grow from current investment levels of USD 250 billion per year to USD 584 billion per year by 2025. Investment must then double again between 2026 and 2040 to nearly USD 1.3 trillion per year. Investment can be expedited through a combination of government policy and private industrial action.

Efficient World Scenario Assumption

A key assumption for the Efficient World Scenario to be achieved is primary energy intensity as a function of GDP is cut in half by 2040. For this to be achieved energy consumption across all sectors must be minimized.

Within the industrial sector, by 2040, the average energy required to produce a tonne of crude steel, paper and pulp all must be reduced by 25% compared to present levels (IEA 2018). The role for ESCOs to play in the industrial sector's energy reduction is facilitating the installation of energy efficient manufacturing equipment. As ESCOs enable access to multi-year financing and minimize the risk to business owners, the expensive process of replacing inefficient equipment becomes more palatable. The equipment ESCOs should target for replacement within the industrial sector are electric motor systems and heat pumps.

Within the buildings sector the per square meter of residential floor space needs to be 26% more efficient in 2040 compared to present levels. For this level of savings to be achieved residential space heating must be 43% less energy intensive and lighting 50% less energy intensive. For non-residential buildings, the needed reduction in energy intensity is 37% (IEA 2018). The role ESCOs should play in achieving this level of reduction within the buildings sector is to implement lightings retrofits, one of the least complicated retrofits. As ESCOs develop and their service offerings grow to entail the entire building envelope HVAC systems retrofits should become a core service.

As shown in *Figure 14,* the Efficient World Scenario does not achieve the Sustainable Development Scenario in terms of energy demand by sector and thus does not exceed the international communities' goal for limiting of global temperature increase to "well below 2 °C" (IEA 2018). This means that energy efficiency alone is not anticipated to reach decarbonisation goals in the Efficient World Scenario. However, by implementing the existing technology and policies the energy system will be much better aligned with Paris Agreement climate targets.

Answer to *SQ I – EE Investment Levels*

The investment levels outlined in the IEA's Efficient World Scenario anticipate the level of energy efficiency investment required to meet the criteria of *SQ I* is USD 584 billion per year by 2025. Investment must then double again between 2026 and 2040 to nearly USD 1.3 trillion per year.

3.2. Global ESCO Market Overview

This section answers *SQ II* by providing a global overview of the ESCO industry.

SQ II - How developed is the global Energy Service Companies market in terms of annual growth, revenue by country, number of ESCOs operating, sectors operated within (e.g. Industry, Residential, Non-Residential, Transport), client type (e.g. Public or Private), contract type used, and organizational structure?

Annual ESCO Market Size

The global ESCO market grew 8% to USD 28.6 billion in 2017, up from USD 26.8 billion in 2016 as shown in *Figure 15*. This is a continuation of steady growth as the market was USD 24.2 billion in 2015 (IEA 2018). The 2018 ESCO market size, shown in *Figure 16*, of USD 30.9 billion was extrapolated using the same growth rate.

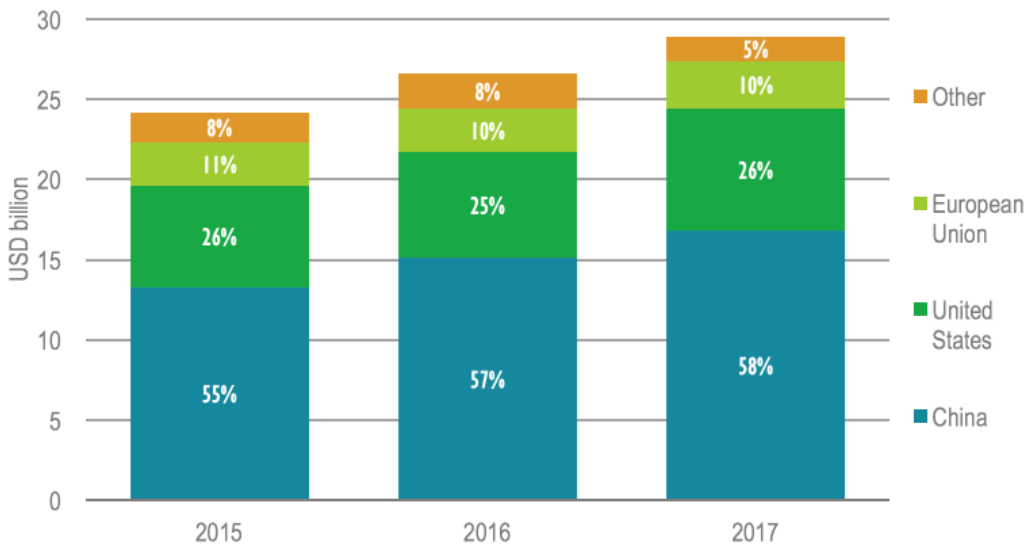


FIGURE 15. GLOBAL ESCO MARKET SIZE ANNUAL GROWTH (IEA SURVEY 2018)

While ESCO market size numbers seem large, it is only a fraction of the total USD 1.3 trillion investment in energy efficiency required to reach the IEA's most recent Efficient World Scenario. The existing investment growth rate is a positive. However, much greater energy efficiency investment is needed in the coming years.

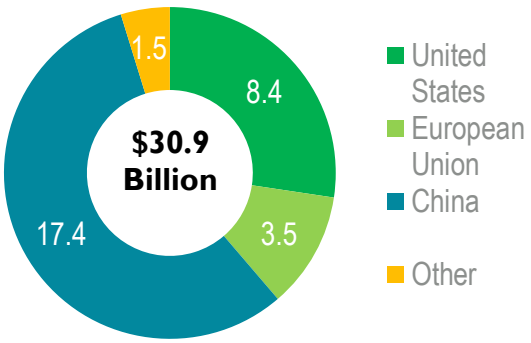


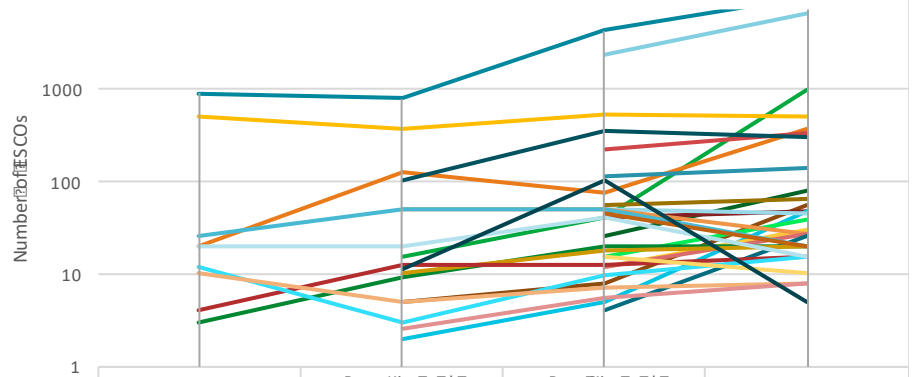
FIGURE 16. ESCO MARKET SIZE BY REGION, 2018[1] (IEA SURVEY 2018)

[1] 2018 ESCO Market Size calculated by extrapolating 8% growth from 2015-2017 data thus not plotted in *Figure 15*

Total Number of ESCOs Per Country

The total number of ESCOs operating globally is estimated to be 9731 (IEA 2018, (Boza-Kiss, Bertoldi and Economidou 2017), (Vine 2005)). *Table 2* is the aggregate of four primary data collection efforts spanning between 2001 and 2017. Globally the number of ESCOs is increasing as shown by the positively sloping lines in the *Table 2* time-series plot.

TABLE 2. NUMBER OF ESCOS PER COUNTRY (2001-2017)



Source and Year	Vine 2001	Boza-Kiss et al. 2010	Boza-Kiss et al. 2013	IEA 2017
Total	892	795	4267	9723
China	23		2339	6439
Spain		15	40	1000
Germany	500	375	525	500
Italy	20	125	75	362
Korea	158		226	330
France		100	350	300
India	6		114	140
Japan	21		25	80
Brazil	60		55	63
Latvia		5	8	55
United States of America			40	48
Greece		2	5	47
South Africa	4		50	44
Chile	3		15	38
Canada	5		12	30
The Netherlands		50	50	27
Philippines	5		12	27
UAE, Dubai			4	25
Austria	25	50	50	20
Czech Republic	3	9	20	20
Denmark		10	17.5	20
Thailand	6		45	20
Belgium	4	12.5	12.5	15
Bulgaria	12	3	9.5	15
United Kingdom	20	20	40	15
Ireland				12
Mexico	7		15	10
Slovakia	10	5	7	8
Slovenia		2.5	5.5	8
Portugal		11	100	5

Unfortunately, there is variability in the time series data. Examples of variability are seen in China and the neighboring countries of Portugal and Spain.

The number of ESCOs operating in China in 2001 was 23 which grew to 2339 by 2013 and continued to explode to 6439 ESCOs by 2017. The growth seen in the Chinese ESCO market can be explained by decade long support from the World Bank and central government programs such as CN-3b: Top-10,000 Energy-Consuming Enterprises Program.

In Portugal, the number of ESCOs fluctuated from 11 in 2010, to 100 in 2013, and back down to 5 in 2017. While the Portuguese fluctuation could be attributed to a typo in data reporting it is assumed to be the correct response.

In Spain, the number of ESCOs grew steadily between 2010 and 2013 from 15 to 40 ESCOs. Between 2013 and 2017 the number of Spanish ESCOs grew from 40 to 1000 ESCOs, the same time the number of Portuguese ESCOs was decreasing. Considering the economic and geographic similarities of Spain and Portugal this is difficult to explain; especially following the sustained growth Portuguese ESCOs experienced between 2010 and 2013.

France reports 300 operating ESCOs, Italy reports 362 ESCOs, Germany reports 500 ESCOs, and Spain reports 1000 ESCOs. Of the 30 countries surveyed, 23 countries reported having fewer than 100 ESCOs operating in their market. Therefore, the countries reporting more than 100 ESCOs are in the minority.

The main reason for variability in reported numbers is that ESCOs form and dissolve often due to advantageous or adverse market conditions. All four surveys used a similar definition of an ESCOs, however it is undeniable that a secondary factor for the variability of the total number of ESCOs is due to the various definitions of an Energy Service Company in each country. What may qualify as an ESCO in one country, may be classified as an engineering consultancy firm or technology provider in another. Due to this variability, the number of ESCOs operating in each country is excluded from the market maturity calculations.

Sector Diversity - Industry, Residential, Non-Residential, Transport

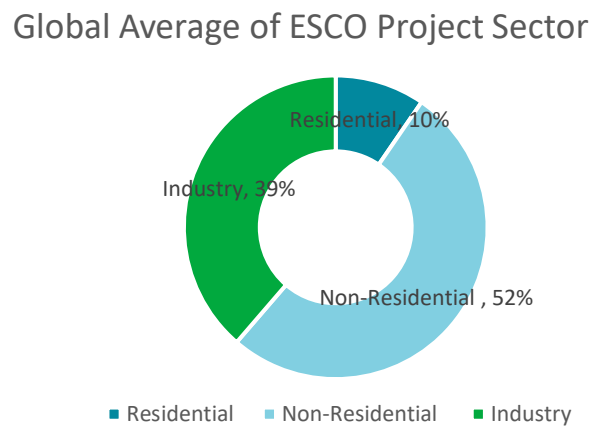
Table 3 shows the percentage of ESCO projects completed in the Industrial, Residential, and Non-residential sectors for 30 different countries. Non-residential, 52%, and Industrial, 39%, sectors provide the majority of global ESCO business. The residential sector is consistently underrepresented with a global average of 10% of ESCO projects. France and Brazil standout in the Residential sector with 38% and 53% of their ESCO business coming from this sector respectively.

Examples of well diversified ESCO markets include The Netherlands, Japan, and Germany. ESCOs in The Netherlands complete 25% of their projects in the Residential sector, 33% within the Non-residential sector, and 42% within the industrial sector. ESCOs in Japan complete 20% of their projects in the Residential sector, 56% within the Non-residential sector, and 24% within the industrial sector. ESCOs in Germany complete 10% of their projects in the Residential sector, 55% within the Non-residential sector, and 35% within the industrial sector. The average ESCO Market Maturity Score of the well diversified ESCO markets is 44%.

ESCOs with low sector diversity include India and Canada. 100% of ESCO projects in India are completed in the industrial sector. 100% of ESCO projects in Canada are completed in the non-residential sector. The average ESCO Market Maturity Score of the least diversified ESCO markets is 37%.

This trend suggests that well diversified ESCO markets are on average more mature than less diversified ESCO markets. ESCOs should be cautious of aligning themselves too closely to one industry, such as construction in the non-residential or steel production in the industrial sector. An ESCO with a full range of service offerings for multiple industries can withstand economic fluctuations.

TABLE 3. PROJECT SECTOR DIVERSITY BY COUNTRY (IEA SURVEY 2018)



	Residential	Non-Residential	Industry
Austria	10%	80%	10%
Belgium	0%	60%	40%
Bulgaria	0%	75%	25%
Czech Republic	5%	70%	25%
Denmark	10%	80%	10%
France	38%	42%	20%
Germany	10%	55%	35%
Greece	0%	0%	0%
Ireland	2%	50%	48%
Italy	15%	10%	75%
Latvia	0%	0%	0%
The Netherlands	25%	33%	42%
Portugal	0%	0%	0%
Slovakia	0%	80%	20%
Slovenia	0%	0%	0%
Spain	0%	0%	0%
United Kingdom	0%	85%	15%
Canada	0%	100%	0%
Mexico	0%	30%	70%
United States of America	7%	86%	8%
China	0%	33%	67%
India	0%	0%	100%
Japan	20%	56%	24%
Korea	25%	0%	75%
Philippines	0%	70%	30%
Thailand	0%	25%	75%
Brazil	53%	10%	38%
Chile	0%	80%	20%
South Africa	8%	30%	60%
UAE, Dubai	0%	0%	0%

Client Type – Public, Private or Both

Table 4 shows the percentage of ESCO clients from the Public, Private or Both sectors. At the global level, there is a slight preference for ESCOs to operate within the Private sector, 46%, rather than the Public sector, 37%. The survey allowed for respondents to mark if they have clients from Both sectors which can be seen in the middle column. Counties which have responded with "Both" have responses with lower percentages in both Public and Private sector i.e. Czech Republic or Slovenia.

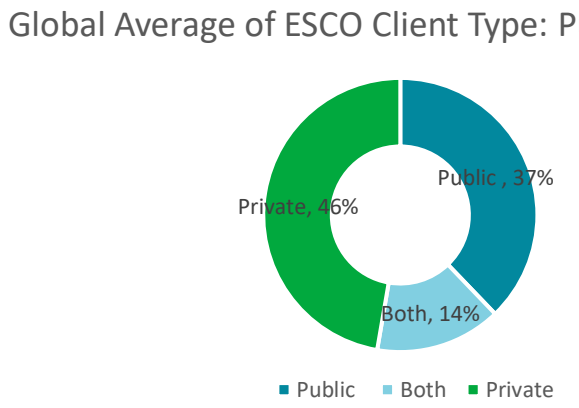
The ESCO markets which have over 70% of their ESCO market clients in the Public sector are Germany, Ireland, United Kingdom, Canada, and the United States. These are developed ESCO markets within Europe and North America. The average ESCO market maturity score of these five countries is 43%.

The ESCO markets which have over 70% of their ESCO market in the Private Sector includes Italy, Latvia, China, India, Korea, Philippines, Thailand, and South Africa. These are slightly less developed ESCO markets within Europe, Asia, and Africa. The average ESCO market maturity score of these seven countries is 42%.

No ESCO markets reported over 70% as Both. The highest reports for Both came from Czech Republic, Denmark, Slovakia, and Slovenia. All are within Europe and have a relatively less developed ESCO market. The average ESCO market maturity score for these four countries is 37%.

This trend suggests that ESCO markets with most of their clients in the public sector are on average more mature than ESCO markets with most of their clients in the private sector.

TABLE 4. CLIENT TYPE BY COUNTRY (IEA SURVEY 2018)



	Public	Both	Private
Austria	50%	40%	10%
Belgium	46%	43%	11%
Bulgaria	50%	38%	12%
Czech Republic	28%	63%	9%
Denmark	50%	50%	0%
France	0%	0%	0%
Germany	75%	0%	25%
Greece	13%	29%	58%
Ireland	71%	0%	29%
Italy	20%	0%	80%
Latvia	25%	0%	75%
The Netherlands	50%	25%	25%
Portugal	22%	22%	56%
Slovakia	50%	40%	10%
Slovenia	22%	56%	22%
Spain	37%	25%	38%
United Kingdom	75%	0%	25%
Canada	70%	0%	30%
Mexico	20%	0%	80%
United States of America	85%	0%	15%
China	10%	0%	90%
India	1%	0%	99%
Japan	38%	0%	62%
Korea	15%	0%	85%
Philippines	0%	0%	100%
Thailand	0%	0%	100%
Brazil	43%	0%	57%
Chile	40%	0%	57%
South Africa	30%	0%	70%
UAE, Dubai	60%	0%	40%

Contract Type Used - EPC GS/SS or ESC

Table 5 shows the contract types used by ESCOs on an aggregate level and on a country level. Energy Performance Contract with Guaranteed Savings is used for 49% of all ESCO activity. Energy Performance Contract with Shared Savings are used for 24% of all ESCO activity. The remaining percentage of contracts are a mixture of Energy Performance Contracts and Energy Supply Contracts.

The ESCO markets which report more than 70% of their projects using EPC GS are Austria, Belgium, Denmark, Latvia, Slovakia, Canada, USA, Korea, Thailand, South Africa, and UAE. The average ESCO market maturity score of these eleven countries is 39%.

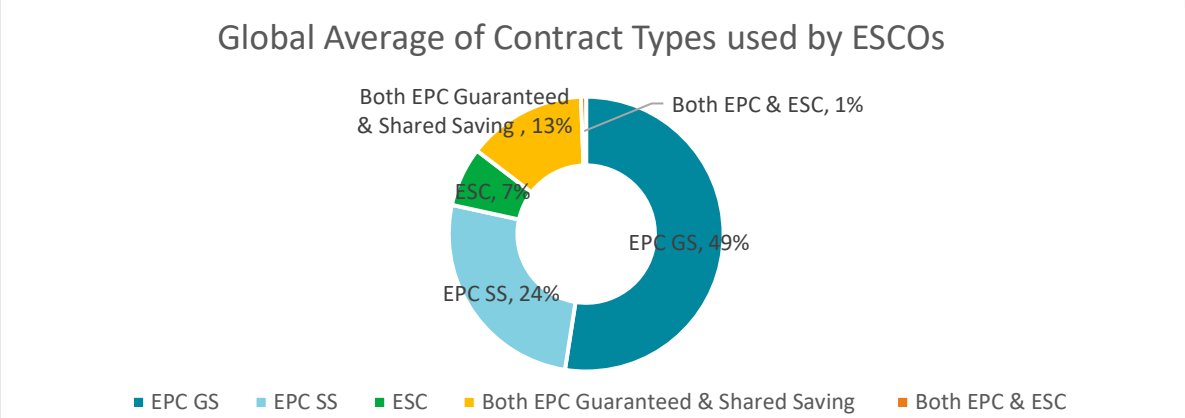
The ESCO markets which report greater than 70% of their projects using EPC SS are Italy, India, and Philippines. Italy has an ESCO market maturity score of 0.38. India has an ESCO market maturity score of 0.32. Philippines did not report market size and that caused the final market maturity score to be unusually high at 0.63. The average for these three markets is 44%.

The ESCO market which report greater than 70% of their projects using ESC is Germany. Germany, one of the most mature ESCO markets, has an ESCO market maturity score of 42%.

The ESCO markets which report greater than 70% of their projects using both EPC GS & SS are France and United Kingdom. The ESCO market maturity score of France is 0.44. The ESCO market maturity score of United Kingdom is 0.38. The average ESCO market maturity score for these two countries is 41%.

This trend suggests that ESCO markets which use EPC Shared Savings for most of their projects are more mature than ESCOs which use any other contract type. This is not necessarily true for two reasons. First there are only three countries which use EPC SS for more than 70% of projects compared to eleven countries which use EPC GS for more than 70% of projects. The low number of ESCOs contributing to the average market maturity score for EPC SS makes the score less meaningful. Secondly, there is score inflation for average EPC SS caused by the Philippines' Market Maturity Score which is based on incomplete indicator information. Due to these two factors, it is not possible to determine which contract is preferred by more mature ESCO markets.

TABLE 5. CONTRACT TYPE USED BY ESCOS IN EACH COUNTRY (IEA SURVEY 2018)



	EPC GS	EPC SS	ESC	Guaranteed & Shared Saving	Both EPC & ESC
Austria	80%	0	0	20%	0
Belgium	75%	12%	0	0	0
Bulgaria	37%	37%	0	26%	0
Czech Republic	67%	0	0	33%	0
Denmark	95%	0	5%	0	0
France	21%	7%	0	71%	0
Germany	14%	0	86%	0	0
Greece	29%	43%	0	29%	0
Ireland	47%	37%	16%	0	0
Italy	10%	90%	0	0	0
Latvia	75%	13%	0	12%	0
The Netherlands	38%	0	0	63%	0
Portugal	11%	67%	0	22%	0
Slovakia	80%	0	0	20%	0
Slovenia	56%	33%	0	11%	0
Spain	33%	20%	30%	0	17%
United Kingdom	11%	0	0	89%	0
Canada	100%	0	0	0	0
Mexico	0	0	0	0	0
United States of America	99%	1%	0	0	0
China	50%	50%	0	0	0
India	10%	90%	0	0	0
Japan	10%	36%	54%	0	0
Korea	95%	5%	0	0	0
Philippines	25%	75%	0	0	0
Thailand	77%	17%	6%	0	0
Brazil	38%	0	0	0	0
Chile	40%	60%	0	0	0
South Africa	80%	20%	0	0	0
UAE, Dubai	80%	20%	0	0	0

ESCO Organizational Structure – Subsidiary vs. Stand-alone

Table 6 shows the percentage of ESCOs which are organized as a Subsidiary or a Stand-Alone ESCO. At a global level, there are more stand-alone ESCOs at 56% of the market compared to 44% of ESCOs operating as a subsidiary. This may be explained by the ease at which small to medium sized ESCOs can form and dissolve based on market conditions. Subsidiary ESCOs will only enter the market once standardized market regulations are in place and corporate risk protocol can be met.

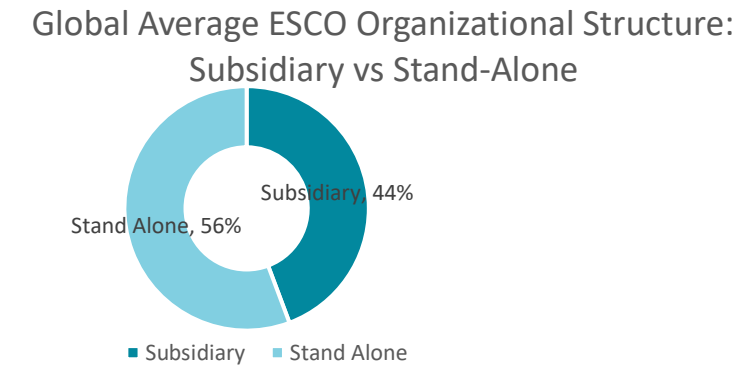
The countries which report 70% or more of their ESCOs operating as Subsidiary are Canada, India, Japan, Korea, Brazil, and UAE. The average ESCO market maturity score of these six ESCO markets is 45%.

The countries which report 70% or more of their ESCOs operating as Stand-Alone are Bulgaria, The Netherlands, Spain, United Kingdom, United States, China, Thailand, Chile, and South Africa. The average ESCO market maturity score of these nine ESCO markets is 36%.

A take-away from results of *Table 6,* is that countries which report more than 70% of their ESCOs operating as subsidiaries are more mature on average than ESCO markets in countries which report more than 70% of their ESCOs operating as stand-alone.

This is interesting as some of the most mature ESCO markets, USA and China, and the least mature ESCO markets, Chile and Spain, report over 70% of their ESCOs operating as stand-alone. A second takeaway from this trend could be that once an ESCO market reaches the level of maturity that the United States (51%), and China (55%), have achieved it is healthy to have ESCOs operate as stand-alone. Prior to such ESCO market maturity, ESCO markets with over 70% of their ESCOs operating as stand-alone struggle to develop such as Thailand (32%), Spain (22%), and Chile (13%). This may be attributed to the financial system of mature ESCO markets possessing the skills to process loan applications for both large and small ESCO projects which is lacking in low-maturity ESCO markets.

TABLE 6. ESCO ORGANIZATIONAL STRUCTURE (IEA SURVEY 2018)



	Subsidiary	Stand Alone
Austria	35%	65%
Belgium	40%	60%
Bulgaria	20%	80%
Czech Republic	0	0
Denmark	0%	0%
France	0%	0%
Germany	34%	66%
Greece	0%	0%
Ireland	33%	67%
Italy	50%	50%
Latvia	0%	0%
The Netherlands	19%	81%
Portugal	0%	0%
Slovakia	0%	0%
Slovenia	0%	0%
Spain	7%	93%
United Kingdom	30%	70%
Canada	80%	20%
Mexico	65%	35%
United States of America	25%	75%
China	30%	70%
India	95%	5%
Japan	77%	23%
Korea	70%	30%
Philippines	60%	40%
Thailand	0%	100%
Brazil	100%	0%
Chile	10%	90%
South Africa	0%	100%
UAE, Dubai	95%	5%

Answer to *SQ II – Global ESCO Market Overview*

The global ESCO market has grown at a rate of 8% since 2015. The revenue by country is summarized in *Table 11*, *Figure 15* & *Figure 16*. The total number of ESCOs operating is 9723, summarized in *Table 2*. The global average sectoral breakdown of ESCO clients is Non-residential (52%), Industry (39%), Residential (10%), shown in *Table 3*. The global average client type breakdown is Private (46%), Public (37%, Both (14%), shown in *Table 4*. The global average for contract type used is EPC with Guaranteed Savings (49%), EPC with Shared Savings (24%), the remaining percentage of contracts are a mixture of EPCs and energy supply contracts, shown in *Table 5*. The global ESCO organizational structure is stand-alone ESCOs (56%) and subsidiary ESCOs (44%) as shown in *Table 6*.

3.3. ESCO Market Maturity Scores

This section creates a quantitative spectrum of low, mid, and mature ESCO markets based on key market characteristics. This standardized spectrum aids in identifying successful ESCO markets and answers *SQ III.*

SQ III - How does the maturity, based on market characteristics, of country level ESCO markets compare with one another and how does this maturity level adjudicate the best policy to increase investment in energy efficiency via ESCOs?

The ESCO market maturity scores are calculated in exact percentages but do not reveal a precise depiction of ESCO market maturity. Each score should be viewed with a tolerance and understanding that the market maturity score does not capture every complex interconnected facet which when combined create the reality of a national ESCO market.

Table 9, on the next page, summarizes indicator scores and resulting market maturity scores for the ESCO markets in 30 countries. The scores are color coded based on geographic area and data completeness to ease comparison between ESCOs. *Table 7* explains the color coding used for *Table 9* and the *Tables 16-22* in Appendix A4.

TABLE 7. LEGEND FOR TABLE 9 & TABLES 16-22

Europe	North America	Asia	All Other Continents	Complete Indicator Information	Incomplete Indicator Information

The maturity score is used to order the countries into three tiers of Low, Mid, and Mature markets. ESCO markets may be establishing their roots (Low-Maturity), in the process of growing their existing ESCO market (Mid-Maturity), or building on an already thriving ESCO market (Mature). *Table 8* explains the logic used to sort the 30 ESCO markets into the three tiers.

TABLE 8. RANKING OF MARKET MATURITY BY PERCENTILE

Mature ESCO Market =	When Market Maturity Score is greater than or equal to the 67th percentile	*Mid-Maturity ESCO Market* =	When Market Maturity Score is less than the 67th percentile and greater than or equal to the 33rd percentile	*Low-Maturity ESCO Market* =	When Market Maturity Score is less than the 33rd percentile

TABLE 9. MARKET MATURITY SPECTRUM & INDICATOR SCORES (IEA SURVEY 2018)

	Country	**Market Maturity Score**	MS / GDP Score	MS/Pop. Score	Organizational Structure OS Score	Energy Saving ES Score	Sector Diversity S Score	Contract Duration CD Score	Cost C Score
Mature ESCO Markets	Mexico	**65%**	0.00	0.00	0.65	0.97	0.33	0.31	0.83
	Philippines	**63%**	0.00	0.00	0.60	0.85	0.33	0.60	0.64
	UAE, Dubai	**56%**	0.10	0.17	0.95	0.74	0.00	0.30	1.00
	China	**55%**	1.00	0.39	0.30	0.91	0.33	0.47	0.47
	USA	**51%**	0.30	0.78	0.25	0.91	0.22	1.00	0.63
	Japan	**50%**	0.04	0.06	0.77	0.97	0.66	0.31	0.47
	Brazil	**48%**	0.11	0.05	1.00	0.00	0.66	0.00	0.04
	France	**44%**	0.06	0.10	0.00	0.00	0.88	0.53	0.43
	Ireland	**43%**	0.09	0.26	0.33	0.94	0.44	0.68	0.00
	Germany	**42%**	0.05	0.11	0.34	0.94	0.55	0.65	0.30
	Mature Avg.	**52%**	**18%**	**19%**	**52%**	**72%**	**44%**	**49%**	**48%**
Mid-Maturity ESCO Markets	Canada	**41%**	0.17	0.34	0.80	0.85	0.00	0.00	0.34
	Netherlands	**41%**	0.02	0.04	0.19	0.81	0.99	0.60	0.09
	Slovenia	**40%**	0.27	0.28	0.00	0.00	0.00	0.67	0.57
	South Africa	**40%**	0.02	0.01	0.00	1.00	0.55	0.10	0.33
	Korea	**40%**	0.04	0.06	0.70	0.99	0.33	0.22	0.31
	Slovakia	**39%**	0.55	0.43	0.00	0.00	0.22	0.54	0.33
	Denmark	**39%**	0.40	1.00	0.00	0.00	0.22	0.50	0.00
	United Kingdom	**38%**	0.03	0.06	0.30	0.85	0.22	0.56	0.72
	Italy	**38%**	0.08	0.11	0.50	0.85	0.33	0.40	0.33
	Belgium	**37%**	0.01	0.01	0.40	0.91	0.44	0.51	0.28
	Mid-Maturity Avg.	**39%**	**16%**	**23%**	**29%**	**63%**	**33%**	**41%**	**33%**
Low-Maturity ESCO Markets	Austria	**35%**	0.06	0.12	0.35	0.91	0.22	0.58	0.33
	Bulgaria	**35%**	0.43	0.16	0.20	0.91	0.33	0.38	0.08
	Latvia	**34%**	0.19	0.13	0.00	0.80	0.00	0.71	0.15
	Czech Republic	**33%**	0.08	0.07	0.00	0.00	0.44	0.53	0.45
	Thailand	**32%**	0.34	0.10	0.00	0.97	0.33	0.00	0.20
	India	**32%**	0.09	0.01	0.95	0.91	0.00	0.12	0.03
	Greece	**23%**	0.01	0.01	0.00	0.88	0.00	0.29	0.17
	Spain	**22%**	0.01	0.01	0.07	0.74	0.00	0.42	0.25
	Portugal	**22%**	0.12	0.12	0.00	0.00	0.00	0.58	0.18
	Chile	**13%**	0.02	0.01	0.10	0.00	0.22	0.33	0.03
	Low Maturity Avg.	**28%**	**14%**	**7%**	**17%**	**61%**	**15%**	**39%**	**19%**

Seven tables, *Table 16-22*, of ranked indicators of market maturity including; MS / GDP, MS/Pop., Percentage of subsidiary vs. stand-alone ESCO, Average energy savings, Percentage of clients per sector, Average contract duration, and Average cost of ESCO projects in ordered lists are located in Appendix A4.

Mature ESCO Markets

The ten countries classified as Mature ESCO Market are from Europe, North America, Asia, South America, and the Middle East. This diversity is a promising sign for the adaptability of the ESCO concept in alleviating inefficient energy consumption around the world.

Overall the scores of Mature ESCO markets are diverse and none score well in all indicators. The most variable indicators are Market Size divided by GDP and Market Size divided by Population. For example, Japan scores a 0.04 for MS/GDP while China has the best value MS/GDP score of 1.00. Considering MS/Population, the most drastic variability between Mature ESCO markets is Brazil with a score of 0.05 and USA with a score of 0.78.

Energy savings and contract duration scores are high for all mature ESCO markets. The average energy savings score of Mature ESCO markets is 9% greater than Mid-Maturity ESCO markets. The average contract duration score of Mature ESCO markets is 8% greater than Mid-Maturity ESCO markets. The average sector diversity score of Mature ESCO markets is 11% greater than Mid-Maturity ESCO markets.

The two indicators which most drastically differentiate Mature ESCO markets from Mid-Maturity ESCO markets are Organizational Structure (OS) and Project Cost (C). Mature ESCO markets have an average Organizational Structure which is 33% greater than the Mid-Maturity ESCO markets. This suggests that a major step towards becoming a Mature ESCO market is to adjust market conditions to be conducive to subsidiary ESCOs. The difference between average Project Cost (C) of Mature and Mid-Maturity ESCOs is 15%. Therefore, the second most effective step towards becoming a Mature ESCO market is to increase the average ESCO project size.

Outliers of the Mature ESCO Markets

While Mexico and Philippines are the two highest scoring ESCO markets, and both markets have high potential growth, it should be noted that neither country provided complete indicator information. Neither provided market size and existing literature provides disparate estimates of market size (Brandt 2015). Thus, Mexico and Philippines benefit from high Energy Savings and Project Cost indicator scores which are used to calculate the average indicator score for the missing MS/GDP and MS/Pop. indicator scores, as explained in Section 2.3. This results in an inflated ESCO market maturity score.

Mid-Maturity ESCO Markets

Seven out of the ten Mid-Maturity ESCO Markets are from the Europe. The other three are from North America, Asia, and Africa. All of the Mid-Maturity ESCO markets have scores which are close to each other, no more than 4% variation.

Mid-Maturity ESCO markets are those which are expected to grow their existing ESCO market. ESCOs which operate in Mid-Maturity markets are usually developing core competitive strength, improving quality of service offerings, and expanding their service area. At this stage of development internal management of ESCOs is tested as projects are scaled and operational excellence is rewarded. Competition between ESCOs intensifies as multiple bids are made per project and firms are confronted with being eliminated from the market. ESCOs of all sizes must brand themselves based on reputation and technological expertise.

Energy savings and contract duration scores are still the two highest scoring indicators for Mid-Maturity ESCOs. The average energy savings score of Mid-Maturity ESCO markets is only 2% greater than Low-Maturity ESCO markets. The average contract duration score of Mid-Maturity ESCO markets is 2% greater than Low-Maturity ESCO markets.

The two indicators which most drastically differentiate Mid-Maturity ESCO markets from Low-

Maturity ESCO markets are Sector Diversity (S) and MS/Population. The average sector diversity score of Mid-Maturity ESCO markets is 18% greater than Low-Maturity ESCO markets. Mid-Maturity ESCO markets have an average MS/Pop. indicator score which is 16% greater than Low-Maturity ESCO markets. This suggests that a major step towards becoming a Mid-Maturity ESCO market is to diversify service offerings for all sectors.

Outlier of Mid-Maturity ESCO Markets

In 2014, the JRC *ESCO Market Report for Non-EU Countries* classified the development status of Canada to be "Very Good/Developed" on a six-point scale of Not exist – Preliminary – Moderate – Good – Developed - Very Good (Panev, et al. 2014). Canada's ESCO market maturity score is just below the cut off for a mature ESCO market. This is due to a lack of project sector diversity. Survey responses indicated that 100% of ESCO projects in Canada are within the Non-residential sector. Canada should strive for further diversity in the sectors that ESCOs target. Once ESCOs expand service offerings to Residential and Industrial clients their ESCO market maturity score will reflect their "Very Good/Developed" market status.

Low-Maturity ESCO Markets

Low-Maturity ESCO markets are those which are establishing their roots or are in the preliminary phase of market development. Seven out of ten of the markets classified as Low-Maturity are from Europe. The other three Low-Maturity ESCO markets are from Asia and South America.

Low-Maturity ESCO markets are characterized by small average project sizes and similarly small market sizes. These markets would benefit from modelling their activities off more developed ESCO markets in their regional vicinity. Particular attention should be dedicated to increasing project sector diversity, as stated above, and increasing average project cost. The average project cost indicator score for Low-Maturity ESCOs is 14% less than Mid-Maturity ESCOs. This difference shows there is potential for increasing ESCO market maturity by increasing the size of ESCO projects. Improving either sector diversity or project cost will help increase ESCO market size.

Outlier of Low-Maturity ESCO Markets

Chile has the lowest market maturity score of 13%. This low score is attributed to low indicator scores in MS/GDP, MS/Population, organizational structure, average energy savings, and low average project cost score. MS/ GDP and MS/Population scores are low because Chile's ESCO market size is USD 6 million. This small market size is made up of 38 ESCOs of which 90% operate as stand-alone businesses. The average energy savings of projects were not reported but 100% of projects were reported to be less than USD 200,000. ANESCO Chile is the national ESCO association guiding initial market development.

Answer to *SQ III – ESCO Market Maturity Comparison*

ESCO markets around the world are systematically compared to one another using the ESCO market maturity analysis. The most mature ESCO markets includes the United States, Germany, China, and Japan. The least mature ESCO markets, of those surveyed, operate in Chile, Spain and Greece. Overall the indicator scores of ESCO markets are diverse. The diversity of indicator scores requires a unique policy mix for each country to properly guide market development.

Mature ESCO markets have an average Organizational Structure which is 33% greater than Mid-Maturity ESCO markets. This suggests that a major step towards developing from a Mid-Maturity ESCO market into a Mature ESCO market is to adjust market conditions to be conducive to subsidiary ESCOs.

Mid-Maturity ESCO markets have an average sector diversity score which is 18% greater than Low-

Maturity ESCO markets. This suggests that a major step towards developing from a Low-Maturity ESCO market into a Mid-Maturity ESCO market is to diversify service offerings for all sectors.

Low-Maturity ESCO markets are developing from a small market. This is confirmed because the lowest indicator scores are MS/GDP and MS/Population. Low maturity ESCOs should focus development efforts on increasing sector diversity and project size.

3.4. SWOT Analysis to Inform Policy Recommendations

This section answers *SQ IV* by applying a nuanced analysis of ESCO operations on a country-level. Dominant business barriers and drivers facing ESCOs are identified (QualitEE 2017). Once identified, the possibilities for future growth or contraction are explored using the SWOT analysis structure. Country-level SWOT Analysis are located in Appendix A5.

SQ IV – Which barriers and drivers are country level ESCO markets facing and how do these factors determine the right policy mix to increase investment in energy efficiency.

Barriers & Drivers

While ESCO operations in most countries are similar to the traditional concept of ESCO in the USA, every country has their own culture and uniqueness. Cultural variation requires the ESCO model be flexible (Bertoldi, Langlois, & Hansen 2009). Understanding local ESCO market conditions is essential for developing ESCOs in both emerging economies and mature markets (Bertoldi, Langlois, & Hansen 2009). While all countries have used government support, the best implementation will be different in each country. Analysis of factors leading to ESCO market success or failure in countries around the world guides future ESCO market development.

A main source of information for the SWOT analysis, in addition to the IEA Global ESCO Survey, is the QualitEE energy efficiency services survey. This survey was conducted between July and October 2017, and completed by 188 respondents from 15 European Countries (109 providers and 79 facilitators of energy efficiency services) (QualitEE 2017). The aggregate responses for business drivers and business barriers are shown in *Figure 17* and *Figure 18*.

In 2013, the main driver (70%) of ESCO business was increasing energy prices. However, with the reduction in renewable electricity prices and inexpensive natural gas the percentage of respondents citing energy prices as a driver of ESCO business has shrank to 30% in 2017. What has remained stable over the years is the economic incentive to work with ESCOs to reduce costs through guaranteed energy savings.

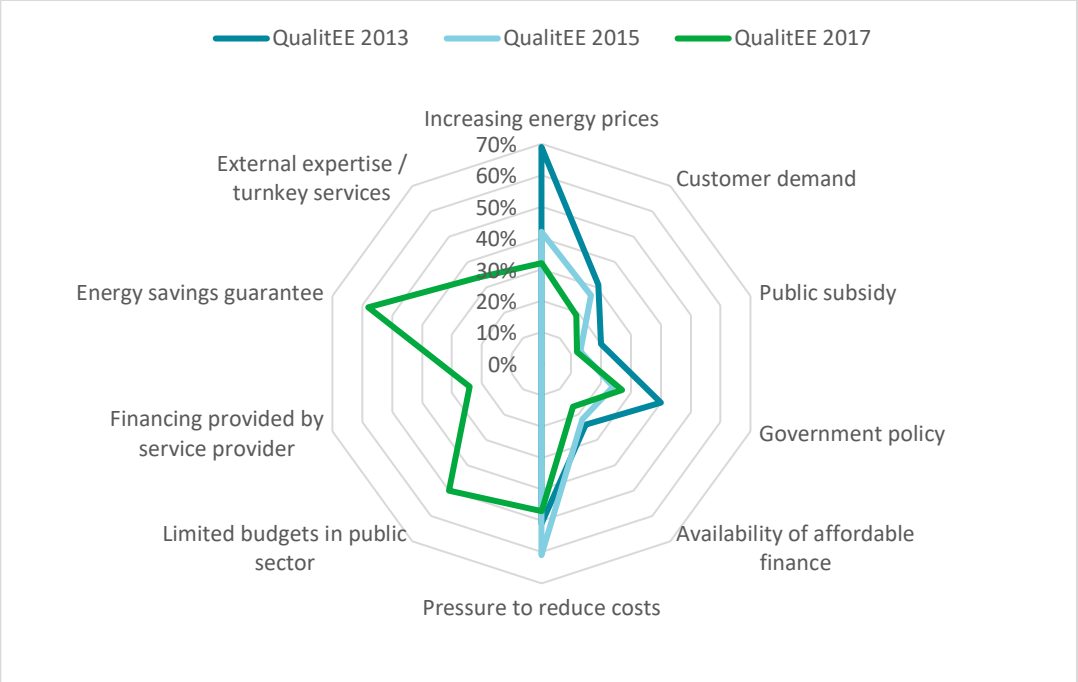


FIGURE 17. MAIN DRIVERS OF ESCO BUSINESS (2013-2017) (QUALITEE 2017)

The main barriers to business have consistently been complexity of the ESCO concept/lack of information, lack of trust in the ESCO industry, lack of support from the government and the closely related problem of subsidy/policy uncertainty. The percentage of respondents citing subsidy/policy uncertainty has reduced from 50% in 2015 to below 40% in 2017. This reduction in policy uncertainty is a reflection of growing confidence from governments in the ESCO concept.

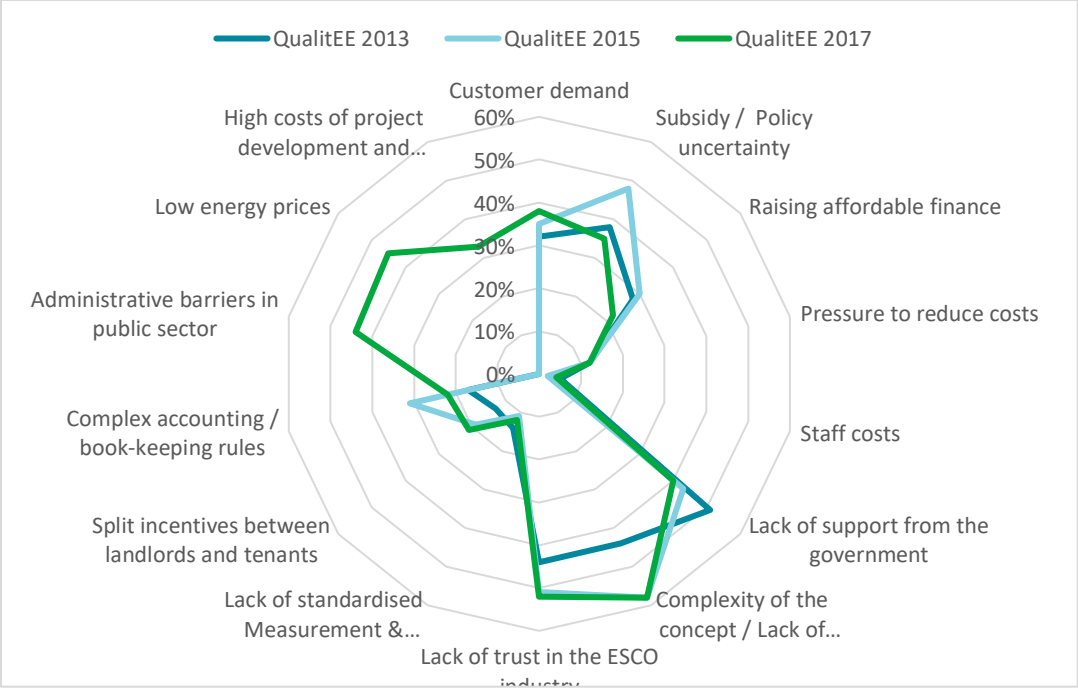


FIGURE 18. MAIN BARRIERS OF ESCO BUSINESS (2013-2017) (QUALITEE 2017)

Country-Level SWOT Analysis Informs Policy Recommendations

Strength, Weakness, Opportunities, and Threats analysis is used to account for the nuances of each national ESCO market beyond the purely objective numbers. As explained in Section 2.4, each country is analyzed to develop a comprehensive understanding of each national ESCO association. This analysis informs country specific policy recommendations.

Country-level SWOT Analysis are located in Appendix A5. Countries are selected for SWOT Analysis if they provided complete information for the 2018 IEA Global ESCO Survey. The countries selected for SWOT analysis are representative of each tier of ESCO market maturity; Low-Maturity (Austria, Bulgaria, India), Mid-Maturity (Belgium, Italy, The Netherlands, United Kingdom, Korea, South Africa), Mature (Germany, United States, China, Japan).

Answer to *SQ IV – How do Strengths & Weaknesses impact Opportunities & Threats*

Common ESCO market barriers include lack of trust in the ESCO concept and the complexity of the ESCO concept itself. Common ESCO market drivers include government policy, pressure to reduce costs, and the energy savings guarantee. A common opportunity for ESCOs is to increase national energy security and aid in the reduction of greenhouse gas emissions. Threats across most markets to future ESCO expansion are withdraw of government support for the ESCO concept and the split-motivation between landlord and tenants in the residential sector for implementing energy efficiency improvements.

Additionally, sustained profitability compared to other industries is drawing more companies to ESCO business and intensifying competition. ESCOs are in demand of high-quality professionals in engineering, equipment, economy, financing, law, marketing, and management. The presence of such talent can drive expansion. Conversely, a talent shortage can slow an ESCO market which is otherwise ready to expand.

By addressing the strengths, weaknesses, opportunities and threats of each ESCO market on a country by country basis the right policy mix for increase ESCO investment emerges.

4. Critical Analysis of Results & Policy Recommendations

This section answers *SQ V* by providing recommendations for increasing investment made in ESCOs.

SQ V – Which policy measures synergistically address selected country's market maturity, business barriers, and business drivers to increase energy efficiency investment?

Section 4.1 provides quantitative recommendations. First low scoring indicators of ESCO Market Maturity, calculated in Section 3.3, are identified. Then measures to improve the score of each country are recommended. Section 4.1.1 through 4.1.6 provide the recommendations which address deficiencies in specific ESCO market maturity indicator scores.

Section 4.2 provides qualitative recommendations based on the country level SWOT Analysis located in Appendix A5.

4.1. Policy Recommendations Based on ESCO Market Maturity Analysis

Table 10 compares each country's market maturity indicators to the global average of the 30 other ESCO markets surveyed. If a country has an indicator score that is below the global average, the difference is written in red. To raise the indicator score, consult the corresponding recommendation at the top of table.

The countries with below average market size indicator scores include; Japan, Germany, The Netherlands, South Africa, Korea, UK, Italy, Belgium, Austria, Bulgaria and India. These countries would benefit from the recommendations made in *Section 4.1.1*.

The countries with below average organizational structure scores include; China, USA, Germany, The Netherlands, South Africa, United Kingdom, Austria, and Bulgaria. These countries would benefit from the recommendations made in *Section 4.1.2*.

The countries with below average energy savings indicator scores include; The Netherlands, United Kingdom, and Italy. These countries would benefit from the recommendations made in *Section 4.1.3*.

The countries with below average sector diversity scores include China, USA, Korea, United Kingdom, Italy, Austria, Bulgaria, and India. The countries which would benefit from recommendations to increase the number of projects completed in the residential sector in include: China, USA, UK, Italy, Austria, Bulgaria, India and Belgium - despite Belgium not having a below average S score. The countries which would benefit from recommendations to increase the number of projects completed in the non-residential sector in include: Korea, UK, Italy, and India. The countries which would benefit from recommendations to increase the number of projects completed in the industrial sector in include: USA and Austria. The percentage of projects ESCOs complete per sector is shown in *Table 3* and in country level SWOT analysis in Appendix A5.

The countries with ESCO markets which have contract duration scores below average include China, Japan, South Africa, Korea, Italy, Bulgaria, and India. These countries would benefit from the recommendations made in *Section 4.1.5*.

The countries with ESCO markets which have project cost scores below average include Germany, The Netherlands, Belgium, Bulgaria, and India. These countries would benefit from the recommendations made in *Section 4.1.6*.

TABLE 10. RECOMMENDATIONS BASED ON MARKET MATURITY INDICATOR SCORES

Market Maturity Indicators compared to Global Average (GA) *Above (+) / Below (-)*							
Recommendations to Improve Indicator Score	*Refer to Section 4.1.1 to Raise MS Indicator Scores*		*Refer to Section 4.1.2 to Raise OS Score*	*Refer to Section 4.1.3 to Raise ES Score*	*Refer to Section 4.1.4 to Raise S Score* *Increase # of projects in this Sector:*	*Refer to Section 4.1.5 to Raise CD Score*	*Refer to Section 4.1.6 to Raise C Score*
Country & Market Maturity Score (MMS)	MS / GDP Score - GA	MS/Pop. Score - GA	Organizational Structure (OS) Score - GA	Energy Savings (ES) Score - GA	Sector Diversity (S) Score - GA	Contract Duration (CD) Score - GA	Project Cost (C) Score - GA
China *MMS: 55%*	0.83	0.21	-0.10	0.01	-0.04 Residential	-0.01	0.16
USA *MMS: 51%*	0.13	0.60	-0.15	0.01	-0.15 Residential & Industrial	0.52	0.32
Japan *MMS: 50%*	-0.13	-0.12	0.37	0.07	0.29	-0.17	0.16
Germany *MMS: 42%*	-0.12	-0.07	-0.06	0.04	0.18	0.17	-0.01
The Netherlands *MM: 41%*	-0.15	-0.14	-0.21	-0.09	0.62	0.12	-0.22
South Africa *MMS: 40%*	-0.15	-0.17	-0.40	0.10	0.18	-0.38	0.02
Korea *MMS: 40%*	-0.13	-0.12	0.30	0.09	-0.04 Non-residential	-0.26	0.00
United Kingdom *MMS: 38%*	-0.14	-0.12	-0.10	-0.05	-0.15 Residential & Non-residential	0.08	0.41
Italy *MMS: 38%*	-0.09	-0.07	0.10	-0.05	-0.04 Residential & Non-residential	-0.08	0.02
Belgium *MMS: 37%*	-0.16	-0.17	0.00	0.01	0.07	0.03	-0.03
Austria *MMS: 35%*	-0.11	-0.06	-0.05	0.01	-0.15 Industrial & Residential	0.10	0.02
Bulgaria *MMS: 35%*	0.26	-0.02	-0.20	0.01	-0.04 Residential	-0.10	-0.23
India *MMS: 32%*	-0.08	-0.17	0.55	0.01	-0.37 Residential & Non-residential	-0.36	-0.28

ESCOs should be viewed as a market-based instrument. They form in response to government policy that values energy efficiency as a positive externality. ESCOs have benefited from climate change campaigns such as Paris Climate Accord, the involvement of third-party financing, and the creation of an online ESCO project database (Bertoldi 2006). Others looking to grow an ESCO market should start with pilot projects in the public building sector or with lighting refit projects (Urmee and Urmee 2018). The presence of ESCO associations, financing options, measurement and verification protocols, and information and education programs ensure the existence of an ESCO market (Ellis 2010). Once an ESCO industry is established the energy industry and power sector should have its subsidies removed and privatized to encourage competition over energy use to prioritize energy efficiency (Vine 2005).

While every market is unique there are solutions that benefit a majority of markets. For example, standardized contracts ease complexity of loan applications. As banks familiarize themselves with standard ESCO loan applications, previously overlooked ESCO projects will benefit from loans designed for ESCOs (Boza-Kiss, Bertoldi and Economidou 2017). As ESCOs are able to finance more projects due to favorable treatment by financial institutions, opportunities to aggregate projects will follow. Favorable treatment could include the creation of tailor-made accounting principles such as re-categorizing energy efficiency projects as an infrastructure investment or through allowing off-balance sheet accounting. At the same time, most ESCO markets can be further supported by legislative efforts to create enforceable minimum energy performance standards for appliances, building systems, and industrial end-uses.

Table 11 provides a summary of recommendations from existing literature for increasing ESCO investment.

TABLE 11. NEXT STEPS FOR ESCO MARKET IN 2019 ((QUALITEE 2017); (EUROPEAN ASSOCIATION OF ENERGY SERVICE COMPANIES 2019); (TAYLOR ET AL. 2008); (MICALE, STADELMANN AND BONI 2015); (WORLD ENERGY COUNCIL, 2008); (IREDA 2006); (BERTOLDI, 2006); (OECD 2018); (VINE 2005); (BOZA-KISS, BERTOLDI AND ECONOMIDOU 2017); (ELLIS 2010); (CHO 2017); (IEA, 2018))

	Next Steps for ESCO Market in 2019		
	Information & Capacity Building	***Finance & Incentives***	***Regulation***
Grow ESCO Market Size *Raise MS/GDP & MS/Pop. Scores*	Establish ESCO Association / Engage with international development organizations	Provide subsidies for pilot projects	Promote ESCOs for government building efficiency improvements
Grow ESCO Organizations Raise OS Score	Diversify the EPC model templates (Belgium - SmartEPC, Contractor; USA – ESPC)	Introduce energy savings insurance (ESI)	Allow project bundling/ Improve legal basis for ESCO projects with private stakeholders
Increase Energy Savings Raise ES Score	Establish an equipment leasing operation	Define specific public financing support programs for ESCOs	Increase spending on energy efficiency R&D

Increase Sector Diversity Raise S Score	Create and maintain an ESCO project database / document energy & financial savings of past projects	Promote on-bill financing	Enforce market-based mechanisms, energy efficiency targets, obligations
Increase Contract Duration Raise CD Score	Standardize contracts / ESCO accreditation standards / Standardize M&V protocol	Create a loan guarantee program	Alleviate up-front costs / Subsidize energy audits / Raise taxes on energy / Remove energy subsidies
Increase Average Project Size Raise C Score	Provide information campaigns surrounding ESCO financing targeting facility managers and commercial bankers	Capitalize development funds & stimulate diversification of commercial bank financing for ESCOs	Categorize ESCO investments as infrastructure investments / Include EE projects in budget

4.1.1 Recommendations for Increasing ESCO Market Size

This section provides recommendations for increasing ESCO market investment justified by the IEA Global ESCO Survey responses, QualitEE survey responses, and additional literature review((QualitEE 2017); (European Association of Energy Service Companies 2019); (Taylor et al. 2008); (Micale, Stadelmann and Boni 2015); (World Energy Council, 2008); (IREDA 2006); (Bertoldi, 2006); (OECD 2018); (Vine 2005); (Boza-Kiss, Bertoldi and Economidou 2017); (Ellis 2010); (Cho 2017); (IEA, 2018)).

Information & Capacity Building: Establish ESCO Association & Raise Awareness

The first step that any ESCO market wishing to increase its market size needs to undertake is the establishment of a National Association of Energy Service Companies. Specific advice for founding an ESCO association can be found by contacting ESCO associations in neighboring countries or attending ESCO conferences.

TABLE 12. JUSTIFICATION FOR ESTABLISHING AN ESCO ASSOCIATION

Country	*Market Size (Million USD)*	*ESCO Association*
China	$16,000	ESCO Committee of China Energy Conservation Association (EMCA)
United States of America	$7,600	National Association of Energy Service Companies (NAESCO)
Canada	$360	The Energy Services Association of Canada (CAESCO)
India	$300	Energy Services Limited
Brazil	$300	Brazilian Association of Energy Conservation Service (ABESCO)
Germany	$250	The German Energy Agency (dena)

Japan	$227	Japan Association of Energy Service Companies (JAESCO), Est. 1999
France	$200	European Association of Energy Service Companies (eu.ESCO)
Italy	$200	ESCO ITALIA , Est. 2002
Thailand	$200	Thai ESCO
Denmark	$171	No
United Kingdom	$115	The Energy Services & Technology Association, Est. 1983
Korea	$85	Korea Association of ESCOs, Est. 1999
Slovakia	$69	Slovak Association of Energy Service Providers (APES)
UAE, Dubai	$50	Etihad SuperESCO
Ireland	$39	Sustainable Energy Authority of Ireland (SEAI)
Portugal	$35	No
Bulgaria	$33	No
Austria	$32	Österreichische Energieagentur - Austrian Energy Agency
Czech Republic	$23	No
The Netherlands	$18	No
Slovenia	$17	No
Spain	$15	ANESE, Asociación Nacional de Empresas de Servicios Energéticos
South Africa	$10	ESCO Association of South Africa (EASA), Est. 2017 Eskom, Est. 1923
Latvia	$8	No
Chile	$6	ANESCO Chile
Belgium	$5	Belgian ESCO Association - Belesco
Greece	$2	No
Mexico	?	Mexican Association of ESCO companies - AMESCO, est. 2011
Philippines	?	Philippine Energy Efficiency Alliance (PE2), Est. 2016 as PE2 (2005 as ESCOPhil)

Reviewing *Table 12* there is evidence that countries with an ESCO Association have a larger market size. There are no countries without an ESCO association with a market size greater than $200 million. The average market size of countries without an ESCO Association is $38.4 million compared to an average

market size of $1.3 billion for those with ESCO Associations. Considering the typical activities that an ESCO Association undertakes the impact they have in the countries where they exist is not surprising.

ESCO Associations are critical to dispersal of information. This includes spurring governmental legislation, educating financial institutions of the ESCO concept, and raising awareness within the industry of existing support policies or on-going market trends. When the government does ease market conditions the National ESCO Association provides visibility and recognition for the responsible governmental ministry. If there is no formal representation for the constituents which benefit from new legislation it will be unlikely to be passed.

Annual conferences, training weeks, and facilitating mutual agreements between Energy Departments and ESCOs are roles for a National ESCO association. Information campaigns can wed energy efficiency and ESCOs as a counter measure to global warming. Energy managers should be the target audience of such information campaigns to inform them of ESCO activities, ESCO projects, measurement and verification (M&V) methods and best practice protocols for assessing energy savings (Vine 2005). As professionals, energy managers should be acquainted with ESCO services and should be able to rely on them for implementing projects in their companies.

In addition to monitoring and disseminating up-to-date policy information ESCO Associations ensure ESCOs provide a qualified and reliable service. In the United States, an ESCO accreditation system has been implemented by the National Association of Energy Service Companies (NAESCO). In Europe, minimum qualifications and a quality assurance system is maintained by European Association of Energy Services Companies (European Association of Energy Service Companies 2019). Countries must understand their ESCO market strengths and weaknesses in order to develop an ESCO accreditation system that meets the needs of both ESCOs and customers in their country (Vine 2005).

Regulation: Eliminate Institutional Barriers Preventing ESCOs from Completing EPC projects in Government Facilities

Government facilities are major energy consumers and can be a large proportion of any potential ESCO market. ESCOs can offer government organizations specialized expertise and private sector investment capital which helps overcome any annual budgetary issues. The beneficial but “unconventional financing” method of an EPC may be a viewed skeptically by government bureaucrats. Regulations may prohibit energy performance contracting on government property. Therefore, institutional rules against ESCOs or EPCs must be removed before ESCOs will be able to enter this market (Vine 2005).

Promotion for ESCOs may be in the form of subsidies to ESCOs and/or request for proposals (RFP) of energy efficiency upgrades in 10–15% of government buildings. Projects may be awarded and divided among the top three to four qualifying ESCOs. The program can be expanded to include all government buildings (Vine 2005).

An ancillary benefit of government projects is the ability to raise the credibility of the ESCO business concept. The ESCO concept becomes more credible when major banks and top performing ESCOs successfully collaborate to complete initial government projects. Once ESCOs provide services to governmental buildings their credibility and experience increases and the ESCO market size will naturally bloom.

Finance & Incentives: Provide Subsidies for Pilot Projects

Providing subsidies or specialized financial support for pilot projects will be critical to the long-term growth and prosperity of the ESCO industry. The goal of pilot projects is to demonstrate the successful

application of the ESCO concept and include energy-efficient technologies, energy performance contracting, and generate areas of expertise in ESCO development. One-off projects typically do not provide many lessons learned or kick start an industry. Rather, sustained support or a series of pilot projects allows for multiple ESCOs to develop over a succession of projects.

Incentivize the "first movers" in the ESCO sector. For example, a country could develop web site dedicated to financial institutions that provide capital for pilot ESCO projects or offer financial assistance such as https://qualitee.eu/fr/get-involved/submit-pilot-project/. The first projects could be joint ventures with well-established international ESCOs.

Clients for pilot projects may be identified by the government or utilities provider. Those with large energy consumption or those which could easily be bundled into a group of energy consuming clients would be the best for pitching a turnkey energy efficiency improvement project. Before issuing a request for proposals (RFP) to ESCOs, the utilities provider should confirm client commitment, assist the client in outlining its decision-making process, determine the acceptable range of financing and contracting terms, perform a preliminary creditworthiness analysis, and perform a baseline assessment of energy consumption for the client's facilities. The RFP should define the proposal format, the standards for evaluation and selection criteria. This preliminary work delivers to the financial institution a qualified and competent client (Vine 2005).

The types of pilot projects which are best suited for each sector are summarized in *Table 13* (Alliance for an Energy Efficient Economy 2017).

TABLE 13. RECOMMENDED PROJECTS PER SECTOR (ALLIANCE FOR AN ENERGY EFFICIENT ECONOMY 2017)

Recommended Pilot Projects by Sector			
Large Industries	Medium and Small Size Enterprises	Buildings	Municipalities
• Waste Heat Recovery • MV Drives for Pumps and Fans • Pumps & Fans optimization	• Power Optimization • Drive Controls for Pumps, Fans and Compressed Air System • Chilled Water Optimization	• Lighting Optimization • HVAC Optimization • Building Management System	• Street Lighting • Pumping Optimization

Information & Capacity Building: Public vs. Private ESCO Services

While there is no best practice mix of public vs private sector clients the percentage of projects completed in the public or private sector should match the percentage of energy consumption per sector. The underlying assumption of this analysis is that diversification of client types creates a more stable ESCO market (Vreeken 2013). If the ESCOs client ratio of public vs private does not match the national public vs private energy consumption ratio then ESCOs should respond to this inequality by tailoring their services to either the public or private sector projects. The supporting logic is the client type which consumes more energy should be the client ESCOs work with so energy efficiency gains are optimized. ESCOs operating in the market modeled in *Figure 19* would benefit from tailoring services to clients from the *public* sector because the percentage of clients is underrepresented in comparison to energy usage.

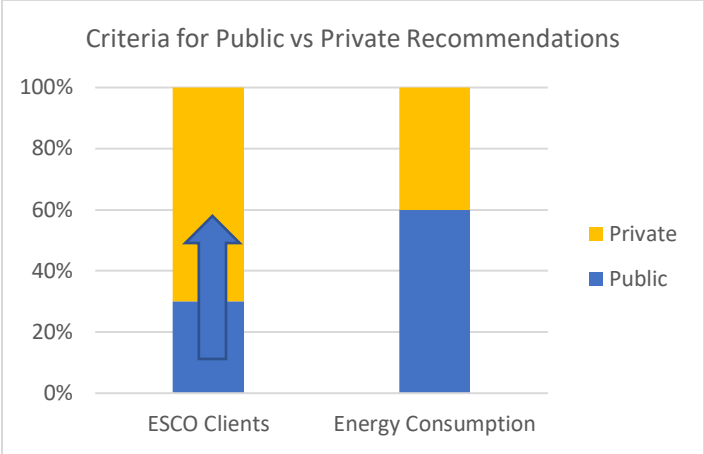


FIGURE 19. PUBLIC VS. PRIVATE ESCO CLIENT SELECTION ANALYSIS

The percentage of ESCO clients from either the Public or Private sector is summarized in *Table 4*.

4.1.2 Recommendations to Grow ESCO Organizations

Regulation: Allow Project Bundling

In order to increase the number of subsidiary ESCOs operating project bundling should occur. Project bundling is when a group of small projects are combined into one large project for the purposes of applying for a loan (Thumann and Woodroof 2013).

Financial institutions prefer to make loans for large projects which justify the high transaction costs of managing a loan including time, expertise, and risk assessment. Small projects, <$500,000, are routinely rejected for this reason. However, the aggregate of all small projects could be an overall large percentage of a viable ESCO industry. Bundling a number of small projects to create one big project decreases transaction costs and increases the likelihood that a bank will provide a loan (Thumann and Woodroof 2013). Bundles could be several commercial or residential buildings, or multi-project facilities. Housing corporations, elderly care or owner-occupiers' associations are a group within the residential sector which would benefit from ESCO project bundling due to the standardized spaces and unitary management structure. The aggregator could be the bank, the ESCO, or the government (Langlois and Hansen 2012).

For example, Indian banks have developed a cluster approach for energy-efficiency lending. A standardized loan application is created for a cluster of project categories in a specific geographical location, in the same industrial sub-sector, or using a specified technology (Taylor et al. 2008).

Bundling projects can obscure the true risk of a loan. Risker projects, such as a full HVAC system replacement, can be bundled together with simple street lighting renovations. This may alter the ability of financial institutions to accurately rate the risk of a loan.

Streamlining small scale project approvals via standardized criteria could also improve access to funding for smaller project (Ellis 2010). For example, once pre-defined parameters are met, the ESCO would qualify for financing. This relies on a homogenous type of project offering and would provide structure to any ESCO, stand-alone or subsidiary.

Finance & Incentives: Enable Energy Savings Insurance

To help ESCOs grow from small ESCOs into larger subsidiary organizations energy savings insurance (ESI) should be introduced to allow for greater competition. Energy Savings Insurance is a way to reduce the risk of an energy efficiency project and make it more attractive to third-party financiers.

Uncertainty associated with the performance of efficiency measures reduces third-party energy

efficiency financing globally, particularly for small to medium sized ESCOs. In response, ESI has emerged as a solution offered by a small number of financial institutions and private companies. ESI is most appropriate for ESCOs or smaller enterprises with poor credit or who lack the means to secure third party financing (IEA 2018).

There are currently two types of insurance packages offered by providers: technical and credit. Under the technical package, the insurance provider covers the ESCO or technology provider in the event that promised energy savings are not achieved. They are assuming the technical risk associated with efficiency projects. Under the credit package, the insurance provider assumes the credit risk of a project. They are ensuring that repayments owed to the ESCO can continue to be made even if a client defaults (IEA 2018).

Evidence indicates that ESI can help an energy efficiency project meet return expectations even if the energy savings of the project is 60% less than expected. This provides a higher degree of investor confidence (Micale, Stadelmann and Boni 2015). Without insurance, a 20% underperformance of energy savings can lead to a loss for the investor. Scaling up ESI will require more providers to enter the market to increase competition and availability. This is dependent on widespread understanding among insurers of energy efficiency projects risks.

4.1.3 Recommendations for Increasing Energy Savings

Regulation: Spend on Research and Development

Lack of advanced and reliable technologies for ESCOs can be remedied via research and development. The best available technologies must be developed and tested before being used in the market. A major challenge for ESCOs around the world is performing the balancing act of implementing new more efficient technologies while mitigating the risk involved with changing technologies and service offerings. Erroring on the side of caution, most ESCOs use mature proven technologies rather than the newest most efficient technologies. Lack of experience with new advanced technologies, such as 5G IoT connected devices, may limit ESCOs to develop new markets where energy savings are yet to be made (Cho 2017).

Governments can lower the risk associated with utilizing the most efficient technologies by encouraging spending on energy efficient R&D. National labs can be encouraged with funding for energy efficient technologies. Private sector solutions include subsidies or tax abatements for private companies which conduct their own R&D programs with an emphasis on energy efficient technologies.

Information & Capacity Building: Establish an Equipment-leasing Organization

When the right equipment is available for ESCOs the energy efficiency improvements will be greater. Existing leasing companies may offer energy-efficient equipment or new leasing companies may need to be established to meet the rental needs of local ESCOS (Vine 2005).

4.1.4 Recommendations for Increasing Sector Diversity

Regulation: Increase Industrial ESCO Activity via Policy Enforcement & Removal of Energy Subsidies

Industrial sector clients may prefer in-house energy-efficiency solutions or may have other priorities. If energy efficiency standards are not enforced, and energy prices are low then industries will not engage with ESCOs. Without changing energy prices, the enforcement of efficiency standards sends a message to the largest industrial energy consumers that saving energy is important for profits and the environment. Removing energy industry subsidies and privatizing the power sector encourages competition over energy use by requiring consumers to react to energy price fluctuations. Variable energy prices encourages clients to limit consumption and prioritize energy efficiency (Vine 2005).

A clear barrier to ESCO activity in the industrial sector is that business/factory owners are hesitant to allow “outsiders” to make recommendations or changes to internal operations (IEA 2018). When the ESCO is viewed as the “outsider” their integrity and the value of their services must be highlighted. Industrial processes are often considered proprietary information which in turn excludes ESCOs from reviewing the process for improvements (World Energy Council, 2008). Opportunities for ESCOs lie in identifying when main production-line technology is up to date, but not the utilities and energy auxiliaries (IREDA, 2006a). ESCOs have also focused on some standard applications/equipment, such as boilers, pumps and projects that do not require temporary shut-downs. There are some instances where entire industrial processes require renovation and small, incremental energy-efficiency projects are undesirable (World Energy Council, 2008).

A second barrier for ESCOs within the industrial sector is the preference and capability to plan and implement energy-efficiency projects independently. ESCOs may have more expertise to complete projects with long pay back periods but industrial sector clients typically consider pay-back periods of three years, unless they are investments in production areas (World Energy Council, 2008).

A third barrier is the incentive structure for efficiency improvements is skewed for some industrial sector managers. Particularly in developing countries, managers are only credited with improvements achieved during their tenure. Thus, long term energy-efficiency improvements are often credited to their replacements (Urge-Vorsatz, et al. 2007). Industries in emerging economies focus on increasing their market share rather than energy efficiency (IEA 2018). Training programs could shape messages to show how increasing efficiency can drive down costs and help improve overall market dominance.

A fourth barrier is competition for time and resources with business-centered projects. It must be very clear what the after-tax benefits for industries are for them to consider energy efficiency improvements over core business investments. Significantly improving the energy efficiency of plants in developing countries often requires a large investment, which is not appealing to industrial operators even when the payback is significant (IREDA 2006).

For ESCOs to gain more clients within the industrial sector, small to medium-sized enterprises should be the focus. SMEs do not have the same level of in-house expertise as larger industries and are less likely to be able to undertake energy-efficiency improvements themselves (Sridharen 2005).

For ESCOs to increase their business with large industrial energy consumers the creation and enforcement of market-based mechanisms, energy efficiency targets, obligations, subsidies or tax rebates would increase the appeal of ESCOs. Once standards are enforced, annual measurement and verification of energy savings, a core competency of any ESCO, will become more valuable. Documentation of energy savings is a valuable service because it qualifies industrial energy consumers for tax rebates or exempts them from penalties.

Enforcement of existing legislation is key to providing industries incentives to actually engage with ESCOs. This may require clarifying legislation which is poorly understood and this need may differ from state to state within the country (Urge-Vorsatz, et al. 2007). This requires a concerted effort by government to prioritize energy efficiency. An example of potential improvement can be seen in the UK. The UK has a Streamlined Energy and Carbon Reporting requirement under the Clean Growth Strategy but the UK does not mandate energy and energy efficiency reporting on statutory company reports. If this reporting requirement was imposed the importance of energy efficiency would be highlighted as well as ESCOs services to measure energy savings.

Information & Capacity Building: Increase Non-Residential ESCO Activity by De-Risking ESCO Investment

The creation of an ESCO project database de-risks ESCO investment and will encourage business owners within the non-residential sector to undertake ESCO projects. A database of successfully completed ESCO projects reduces the perceived risk of undertaking a new project (Brandt 2015). New projects can be compared to old projects for similarities including budget, contract type, loan rate, payback period, measurement and verification methodology and financial institutions involved. Sharing of project information can result in a streamlined underwriting procedure which uses a common language and decreases due diligence and transaction costs.

An existing European database exists on the De-Risking Energy Efficiency Platform (DEEP) at https://deep.eefig.eu/. The mission of DEEP is to create better risks assessment and project benchmarks through high quality and credible data framework (Energy Efficiency Financial Institutions Group 2015).

Most non-residential ESCO activity takes place in government facilities. As the ESCO concept is not always recognized by government procurement or budgetary practices, it is imperative that local government is aware of the ESCO concept and adapts existing procurement protocol accordingly.

Finance & Incentives: Increase Residential ESCO Activity by Overcoming Two Typical Barriers and Implementing On-Bill Financing

To increase ESCO activity within the residential sector ESCOs must overcome two major issues. Split incentives between tenants and landlords and small heterogeneous nature of residential projects (QualitEE 2017).

Issue one is the split incentives between tenants and landlords. Tenants pay rent and thus are not concerned about lowering long-term energy consumption. Landlords are hard-pressed to justify a renovation which may displace tenants, interrupt cash-flow or incur a defined up-front cost which will be paid back based on calculated future savings dependent on energy consumption of non-motivated tenants. Passing the savings or costs onto the tenant adds an undesirable level of complexity to rental agreements.

In order overcome the split incentives between tenant and landlord the landlord could charge a standard inclusive rental rate which allows energy cost savings to accumulate with the landlord. This is dependent on the tenant not increasing energy consumption following an EE improvement project.

Issue two is the small varied type of residential projects. These projects have smaller total energy savings and higher transaction costs. The higher transaction costs stem from the fact that multiple-family dwellings often require difficult coordination with multiple owners and tenants (Urge-Vorsatz, et al. 2007). Transaction costs are also high because residential areas are small and require individual solutions.

If a landlord does choose to undertake any efficiency improvement projects they typically do so themselves (World Energy Council, 2008). This is a response to a view that EPC is too complicated and expensive considering the simplicity of some minor EE improvements. Unfortunately, only completing minor improvements leaves major energy savings potential. ESCOs can implement those larger projects such as sealing of building envelopes, insulation, or HVAC replacement which help capture all available savings.

A policy tool for the private residential sector is minimum energy efficiency standards which make it illegal to rent or sell a building without an Energy Performance Certificate of a certain level. Setting a clear path for future increases in the minimum energy efficiency standards provides a long-term motivation to improve energy efficiency (OECD 2018).

ON-BILL FINANCING

On-bill financing can be implemented to encourage residential building owners to engage with the ESCO concept. Commercial Property Assessed Clean Energy (C-PACE) legislation is an example of on-bill financing which has been enacted in 33 states in the United States ((Pacenation 2017); (Stuart, Carvallo, et al. 2018)). C-PACE enables financing of energy efficiency such as renewable and water conservation measures in buildings via an assessment on the property's tax bill that can be repaid over a loan term of up to twenty years. This type of long-term payment incorporated on a tax bill helps simplify the re-payment process and encourage owners to capture all currently available energy savings.

4.1.5 Recommendations for Increasing Contract Duration

Information & Capacity Building: Adopt Modular Approach to Standardize Contracts

Standard contracts help clients and financial organizations understand EPCs (Urmee and Urmee 2018). A consistently cited barrier is the perceived complexity of ESCO projects (QualitEE 2017). Using standardized contracts simplifies the ESCO concept for financial institutions. When financial institutions engage with ESCOs the average project duration increases as the available credit line increases.

A challenge to standardization is the protectionist view surrounding contracts. ESCOs may perceive proprietary benefit from developing a unique contract. Eight countries participating in the IEA Demand Side Management Implementing Agreement (Finland, France, Italy, Japan, The Netherlands, Norway, Sweden and the United States) have formatted a standard EPC contract for public procurement of ESCO services (Bertoldi et al. 2003). National Association of Energy Service Companies (NAESCO) has provided a modular approach by standardizing language for key contract provisions, such as insurance, equipment ownership and purchase options, which lends itself to the development of standard contract. The flexibility of a modular approach would be particularly useful in small size projects (Vine 2005).

Finance & Incentive: Create Loan Guarantee Program & Collateral Support System

On the financial front, one of the best incentives for banks to engage with ESCOs is a loan guarantee policy (Limaye 2016). Loan guarantees aids financing in both developed and developing countries as it ensures the security of the financial institution to finance ESCO projects by minimizing credit risk. In China GEF funding, and in India 3-CEE funding was used to implement such programs (International Finance Corporation 2018).

4.1.6 Recommendations for Increasing Average Project Size

Finance & Incentives: Capitalize Development Fund by Developing Third-Party Financing Network

To increase the average project sizes countries should capitalize development funds by developing a network of third-party financing. This network would pursue debt and equity financing from a variety of sources, including: private banks and lending institutions; financial institutions well-versed with energy performance contracting; multi-lateral funders and donor agencies (i.e. European Bank for Reconstruction and Development, World Bank, Asian Development Bank, US Agency for International Development, International Finance Corporation (IFC), Carbon Trust, or the Global Environment Facility (GEF)); venture capital firms; equity funds; strategic partners (i.e. utilities and engineering firms); leasing companies; and equipment manufacturers (Institute for Industrial Productivity 2019).

The aim of this network would to further market penetration of energy-efficient technologies. The funds collected from each of these sources could be used to construct a revolving fund to finance ESCO projects (Institute for Industrial Productivity 2019). Marketing, project preparation and development, feasibility studies, or energy audits are all examples of activities the revolving fund could support.

Regulation: Revise ESCO Accounting Rules

Average project size could be increased by revising the ESCO accounting rules. Two accounting practices that benefit ESCOs are; (1) the categorization of energy efficiency improvements as infrastructure investments and (2) off-balance sheet accounting.

CATEGORIZE EE AS INFRASTRUCTURE INVESTMENT / INCLUDE EE PROJECTS IN BUDGET CODE

Countries should use their national ESCO association to lobby for beneficial legislation. Beneficial legislation would re-categorizing 'energy efficiency upgrades' as an 'infrastructure' investment line item. The reason for this re-categorization is because most budgets already include funds for 'infrastructure' investment but not for 'energy efficiency'. Infrastructure funds have a long-term outlook and including EE capital costs with construction project deliverables provides a de-risking mechanism (Alliance for an Energy Efficient Economy 2017). Alternatively including a budget line for energy efficiency improvements into budget codes would remove any uncertainty about how to include ESCO projects in a budget.

ALLOW OFF-BALANCE SHEET ACCOUNTING

Another piece of beneficial legislation would be to allow ESCOs to use "off-balance sheet accounting practices" to limit their debt to equity exposure (Alliance for an Energy Efficient Economy 2017). Such practices allow investments to be made by a third-party financier, while repayment is done through monthly utility bills. Off-balance sheet accounting leverages existing relationships between utility and customer and the default rates are usually very low. It also enables ESCOs to engage with multiple projects and encourages a faster growing ESCO market. For clarification of how Europe permits ESCOs to use off-balance sheet accounting practices review the Eurostat *Guide to the Statistical Treatment of Energy Performance Contracts* (European Commission 2017).

Information & Capacity Building: Provide Information Campaigns Surrounding ESCO Financing

A barrier for ESCOs to access financing for larger projects is the bank's perception of ESCO projects being complex (QualitEE 2017). Providing information campaigns to explain financing addresses this barrier (Energy Efficiency Financial Institutions Group 2015). An example of an informational website is EEFIG.eu is an underwriting toolkit which explains how to process energy efficiency investment from both bank and investor point of views.

Content that could be included in the financial information campaign include investment strategies. The top three recommended ESCO investment strategies include (1) direct investment in ESCOs or EE equipment manufacturers; (2) investment in EE financing institution; or (3) a partnership with local governments on EE project development and finance programs (Cho 2017). In emerging economies, the best method for increasing financing is to work with international organizations to develop a financing system. That system may include low interest loans, loan guarantee program, and establishment of a revolving project development fund (Urmee and Urmee 2018).

4.2. Policy Recommendations Based on Country-Level SWOT Analysis

4.2.1 China SWOT Recommendations

The Chinese ESCO market recommendations are based on *Figure 25* and the Chinese ESCO Market SWOT Analysis in Appendix A5.1.

Prepare an energy consumption database

Following an energy audit, ESCOs can contribute the data to a central database. Energy audit data

can develop an image of the energy use landscape and identify which sectors would benefit most from ESCO involvement.

Technical skill development and employee training

Training ESCOs to provide quality service increases trust in ESCOs and helps them differentiate their service offerings (Murakoshi and Nakagami 2009). Most ESCOs rely on proven technology for retrofitting of old motor systems, lighting systems and boilers. Familiarity with new advanced EE technologies will limit missed opportunities to capture energy savings and expand service offerings.

Training could come in two forms. In-house training for those who are already ESCO employees and pre-workforce training such as the "Training Project for Talents of the ESCO Industry during the Twelfth Five-year Plan Period" (ESCO Committee of China Energy Conservation Association (EMCA) 2018). The in-house training could include information surrounding energy audits, equipment specifications, measurement and verification, and contracts. Pre-work force training could expand ESCO specific training programs rather than relying solely on universities to provide technological research and development, service innovation, talent cultivation and brand building.

Support large industry to realize energy-saving retrofits through EPC

Large energy-consuming companies already apply in-house solutions to increase their energy efficiency (China ESCO Industry Association 2015). If these same companies use EPCs, essentially making themselves ESCOs, the projects undertaken could be more ambitious. Having large energy consumers implement EPCs themselves helps limit complexity by not involving a third-party financier. As complex decision making caused by different departments, reporting lines and budgets is a typical barrier for industrial EPC projects, this is a new solution to increase EE. Another barrier which impact is minimized by encouraging in-house EPCs is the protectionist attitudes surrounding trade secrets or specialized knowledge (China ESCO Industry Association 2015).

Maintain heightened political awareness around energy efficiency

Since 2004, "Energy conservation and emissions reduction" has been listed on the Chinese government's agenda (ESCO Committee of China Energy Conservation Association (EMCA) 2018). Maintaining political pressure to meet the annual energy conservation and emissions reduction target drives customer demand for ESCOs (State Council of the People's Republic of China 2012). Following the withdraw of subsides from the central government, ESCOs should look to provincial and municipal governments as partners for scaling up EE investment because they set energy savings targets (IEA 2018).

Partnerships would promote top ESCOs, energy-saving technologies and successful cases of EPC projects. As a follow up for the 10,000 Enterprises EE Program, a profile of the best EPC projects per industry should be selected and nominated for awards such as the Ministry of Industry & Technology's "Significant Science and Technology Achievement Prize" or the National May 1 Labor Medal (Cho 2017).

Develop financial services for EPC projects

The Chinese ESCO market should continue to develop and provide channels for ESCOs to pursue financing. An example of innovative financing, which should continue, is an account receivables mortgage loan based on future energy savings payments offered by commercial banks such as Shanghai Pudong Development Bank, Industrial Bank, PingAn Bank and Bank of Beijing (ESCO Committee of China Energy Conservation Association (EMCA) 2018). This mortgage loan overcomes the traditional ESCO financing barrier of having too little assets to post as collateral for a loan. Other financing methods which values project assets and future revenues should be developed (Cho 2017).

4.2.2 United States of America SWOT Recommendations

USA ESCO market recommendations are based on *Figure 28* and the American ESCO Market SWOT Analysis in Appendix A5.2.

Expand non-energy benefits for federal ESPC projects

Three types of non-energy benefits are approved by The Federal Energy Management Program (FEMP) to be incorporated into the cost calculation of federal ESPC projects. The three non-energy benefits are; (1) savings from decreased water and sewer usage; (2) O&M savings; and (3) savings from reduced repair and replacement such as less frequent changing of lightbulbs (Office of Energy Efficiency & Renewable Energy 2018). Notably absent from the list is a cost savings for reduced emissions. Equitably pricing emissions is a continual challenge a few ESCOs reported emissions credits in state/local, K–12 and commercial projects (Stuart, Carvallo, et al. 2016).

Provide legislation for small private residential and industrial sector

ESCOs have had limited success undertaking projects in the private commercial (leased) and industrial markets as shown in *Table 3* and the country level SWOT analysis in Appendix A5.2. This is not due to an inability for ESCOs to work in these segments but due to the beneficial legislation supporting the ESCOs in the public non-residential sector. Similar legislation to that which created the non-residential ESCO market should be introduced for the rest of the market. A good starting point would be for each state to review their ESPC contracting process as was done in 2016 in California.

Increase institutional trust in the ESCO concept

Decision makers never want to waste or be perceived as wasting funds. This fear causes political sensitivities which results in appropriation funds being withheld from multi-year EPC projects (Lawrence Berkeley National Laboratory 2015). As the ESCO concept can be complex, especially for multi-year projects, there is a need to present success stories in an engaging manner (Geller 2004). Granting annual awards for outstanding projects could be a method to inspire others to implement their own projects.

Revisit backlogged projects and revise administrative barriers

Projects which may be feasible but have difficult administrative barriers such as New York and Philadelphia K–12 schools, Michigan prisons, and California state government facilities may need to be revisited (Stuart, Carvallo, et al. 2016).

4.2.3 Japan SWOT Recommendations

The Japanese ESCO market recommendations are based on *Figure 30* and the Japanese ESCO Market SWOT Analysis in Appendix A5.3.

Open public and government building for small to medium sized ESCOs to bid on

The ESCO market in Japan hosts large companies operating the private market. Of the 80 ESCOs operating in Japan, 77% of them are subsidiary of a large corporation (IEA 2018). 62% of all ESCO projects are completed in the private sector (IEA 2018). In order to diversify the ESCO market, small to medium sized companies need to implement projects in the public sector. This has been achieved in USA and Canada via reform of procurement regulations (Lawrence Berkeley National Laboratory 2015). In Japan procurement reform could be achieved by promoting non-residential buildings to ESCOs that generate annual revenues below a certain level. Policy makers should work in conjunction with JAESCO to set detailed limits (Murakoshi and Nakagami 2009).

Develop national as well as regional Asian ESCO markets

Often high efficiency equipment with lower life cycle costs are not purchased due to higher initial costs. High performance equipment being passed over due to high upfront investment is typical in immature ESCO markets (Panev, et al. 2014). By developing its own and other Asian ESCO markets, Japan is securing its national manufacturing market as Japan is the producer of high-efficiency equipment. An additional benefit of increasing overall EE in Asia is a reduced dependence on fossil fuels and thus lower energy prices. This benefits Japan as they are a country with scarce natural resources who is dependent on importing costly energy as shown in *Figure 31*.

4.2.4 Germany SWOT Recommendations

The German ESCO market recommendations are based on *Figure 32* and the German ESCO Market SWOT Analysis in Appendix A5.4.

Positioning EE and ESCOs as a solution to energy security

Highlighting the additional energy security benefit of EE projects may help generate buy-in and overcome a perceived lessening of value caused by low or stable gas prices (Zeihan 2014).

Germany relies on energy imports from Russia and would increase their energy security by investing in ESCOs to install energy efficient equipment which reduces energy demand. Russia as both a major energy consumer and exporter faces conflicting interests as an energy provider. There is the continual question of Russian energy supply flexibility. Flexibility in this instance means; how will Russia respond to the trade-off between satisfying its own peak demand and responding to possible higher export calls for its gas from Germany or elsewhere (Yermakov 2019)?

Target industrial sector for modernization by promoting ESCOs as a cost reduction solution

Germany has already found success within the non-residential sector as it comprises 55% of current ESCO projects (IEA 2018). Additionally, 75% of all ESCO projects are completed in the public sector (IEA 2018). As Germany is a manufacturing hub, the number of ESCO projects should increase in the private industrial sector. Currently, 35% of ESCO projects are completed in the industrial sector (IEA 2018). This percentage of projects is substantial and shows that ESCOs can operate in the industrial sector. However, there are barriers to entry in the industrial sector such as the tendency to limit outsourcing, develop technical competencies in-house, or the fact that EE measures in industrial production require specialized ESCOs.

ESCOs technical competency should be tailored for the automobile and electronics industry as these are the areas that Germany specializes in (Workman 2019). When pitching projects, especially within the industrial sector, ESCOs should highlight the cost savings benefits of an EPC project, as pressure to reduce costs was cited by 71% of respondents as a driver for the ESCO industry in 2015 (QualitEE 2017). If possible ESCOs should try to minimize procurement and project development costs as well as this was cited as a barrier to ESCO business by 58% of respondents in 2017 (QualitEE 2017).

4.2.5 The Netherlands SWOT Recommendations

The Dutch ESCO market recommendations are based on *Figure 38* and the Dutch ESCO Market SWOT Analysis in Appendix A5.5.

Develop new business models and innovative financing

As The Netherlands is a stable economy with a healthy ESCO market, there is an opportunity to experiment with new business models to see what helps implement more EE projects (IEA 2018). New business models could be started around performance based rates for operation and maintenance

services for ESCO projects. Multiple ESCOs could contract this one third-party company to measure and collect repayment based on achieved energy savings. Another innovative business model would be to sell energy as a subscription. This would require coordination with the utilities provider but could be structured in such a way as to minimize energy consumption and cost using a combination of load sharing and energy storage.

The Facilitator model is a business model where the ESCO would take on a role as a general contractor rather than performing all of the work in-house (Bleyl-Androschin, et al. 2013). As the services offered by ESCOs, such as energy efficient boiler installation become mainstreamed, there is the opportunity to subcontract equipment installation while still managing system performance and savings based on energy savings.

An innovative financing method is having energy efficiency investments financed within a mortgage. The energy efficiency improvements would be included in the audited value of the house as a structural improvement and the mortgage adjust accordingly (Freehling and Stickles 2016).

Assign an independent ESCO ambassador

The most frequently cited barriers are lack of trust in ESCOs, and complexity of ESCO concept (QualitEE 2017). An independent ESCO ambassador could represent ESCO interests at a high level for ministerial level meetings and deliver a series of speeches at conferences and workshops to raise the level of understanding. The role would be best for an individual already distinguished in the field of energy efficiency.

Simplify tendering, contracting, and management of projects

The Dutch tend to make EPCs tailor-made rather than standardized which increases the cost (Vreeken 2013). The skill required to tailor EPCs to specific projects is a sign of a mature ESCO market. However, creating standardized project management practices, including contract and M&V, could further expand the reach of ESCOs via increased understanding and trust in the concept.

4.2.6 South Africa SWOT Recommendations

The South African ESCO market recommendations are based on *Figure 39* and the South African ESCO Market SWOT Analysis in Appendix A5.6.

Provide development pathways for stand-alone ESCOs to grow

All of the ESCOs operating in South Africa are stand-alone ESCOs (IEA 2018). Overcoming prohibitive operating costs and scaling their business is a barrier (IEA 2018). Measures which can help small ESCOs scale operations include bundling of projects and introducing Energy Savings Insurance (ESI) (Micale, Stadelmann and Boni 2015). ESI provides an additional level of assurance that even if the ESCO fails to meet the EPC guarantee, the financier will not suffer financially. This allows financiers to make riskier loans to smaller unproven ESCOs.

Another development path way for South African ESCOs is through bundling projects and subcontracting the work to small scale ESCOs (Panev, et al. 2014). This provides experience working on a large project while not overwhelming an individual company's service capacity.

Ensure long term market stability via Eskom run demand side management program

The Eskom demand side management (DSM) program requires participating ESCOs to meet minimum quality assurance standards. The same recommendations made to improve the existing quality assurance program in the United Kingdom, would benefit the South African ESCO market (QualitEE 2017). By strengthening the quality assurance requirements, Eskom would raise the competency of ESCOs it works

with. Therefore, even if the DSM program ends, the lasting results of the program will be the increased capacity of South African ESCOs.

4.2.7 Korea SWOT Recommendations

The Korea ESCO market recommendation are based on *Figure 40* and the Korean ESCO Market SWOT Analysis in Appendix A5.7.

Coordinate ESCO market support efforts

The Ministry of Knowledge Economy (MKE) and Korea Energy Management Corporation (KEMCO) should consolidate efforts on financial support, policy improvement, tax incentives for both stand-alone and subsidiary ESCOs, and an associated ESCO awareness campaign.

Position ESCOs as national security solution

Korean energy prices are consistently high because Korea imports 96% of its energy (Huh 2010). Reliance on other nations to provide energy needs can be reduced through increased efficiency. While this is not news for Korean decision makers the ESCO concept may need to be re-branded to highlight their services role in achieving additional energy security in an economic market driven manner. Improved ESCO reputation would garner expanded support via the existing Government Support System for installing Energy Saving Facilities. Expanded support may entail long-term low interest rate loans, tax incentives, and project support (Huh 2010).

4.2.8 United Kingdom SWOT Recommendations

The United Kingdom ESCO market recommendations are based on *Figure 42* and the United Kingdom ESCO Market SWOT Analysis in Appendix A5.8.

Raise ESCO awareness and improve public image by highlighting ESCO role in emission reduction

The weakness of United Kingdom's ESCO market is lack of awareness of the ESCO model (QualitEE 2017). Clients are consistently surprised by the ESCO concept and need to be introduced. This unfamiliarity within the private residential sector causes owners to believe they can manage energy consumption themselves. This is confirmed by the fact that there are zero reported ESCO projects within the residential sector (IEA 2018). Once clients are familiar with the types of renovations and the average energy savings which ESCOs achieve, they will be more likely to engage and overcome preconceived notions.

Present ESCOs as a solution to meeting Carbon Reduction Commitments. ESCOs can measure energy savings as well as emissions reduced. By showcasing the role of ESCOs in emissions reductions their business model may gain more respect (GuarantEE Energy Efficiency 2016).

Consolidate ESTA and EMA working parties into ESCO association.

Opportunities for ESCOs in the UK include consolidating ESTA and EMA working parties into fully focused ESCO association (GuarantEE Energy Efficiency 2016). This would reduce the duplication of tasks and help expedite decision making surrounding ESCOs. Once a unified ESCO group is formed, they could clarify tax exemptions & standardized contracts framework such as the ECA or the Green Deal for metropolitan areas (GuarantEE Energy Efficiency 2016).

Additional work for a unified ESCO association would be coordinating networking, information dissemination, best practice development, and lobbying. ESCOs require skilled workers in the fields of energy and environment, procurement, legal, engineering, financial, and commercial. Due to such varied skillset requirements, any networking events should aim to include multiple talent groups so that no blind

spots remain when developing solutions (Capelo 2018).

Set a long-term, coherent governmental policy program

The *Clean Growth Strategy* has set targets for a 30% public sector carbon reduction target by 2020/21 and a 20% energy efficiency target for business and industry (GuarantEE Energy Efficiency 2016). Both targets should be codified into public policy with either penalties or reward for meeting the target enforced.

Energy Savings Opportunity Scheme (ESOS) which mandates energy audits every four years provides an opportunity to create a centralized project database which could be submitted to the DEEP platform mentioned in Section 4.1.4. Critical project information includes financial, environmental, and energy benefits of energy efficiency actions. Another recommendation which would make the existing ESOS program more effective at raising the UK's energy efficiency would be to mandate that projects with a simple payback period of less than five years be executed as is done the Netherlands (Van Willingen 2015).

Continue to support public procurement frameworks

Public procurement frameworks and associated facilitation / promotion programs such as CEF, ECA, NDEEF, Green Deal, Essentia, and RE:FIT should be continued (Boza-Kiss, Bertoldi and Economidou 2017). Such frameworks raise the visibility of ESCOs, reduce administrative costs, and ensure a steady stream of ESCO business. Those coordinating such programs should publish an annual report which outlines learn lessons share, best practices, how to access currently available financing and up-to-date standard contracts and M&V protocol (QualitEE 2017).

Implement a quality assurance program run by the government or public institution

Lack of trust in the ESCO industry is a key barrier to ESCO business in the UK (QualitEE 2017). Distrust has grown since 2013 when only 40% of QualitEE survey respondents cited lack of trust as a barrier to ESCO business compared to 2017 when 58% cited lack of trust as a ESCO barrier.

This trend has occurred despite the establishment of The European Code of Conduct for Energy Performance Contracting in 2014 (European Association of Energy Service Companies 2019). This code was signed by 17 UK organizations but is too vague to eliminate low performing ESCOs. A comprehensive Code of Practice for EPC in the UK should be developed based on (1) an ESCOs ability to obtain financing, (2) ability to complete projects in diverse sectors, and (3) achieve long-term stability. A structure which quickly rewards ESCOs with credibility for completing small projects would help grow small to medium sized ESCOs.

Figure 20, based on the survey conducted by QualitEE, provides evidence that establishing a quality assurance scheme would improve client trust of EPC projects. The same survey also provides evidence that 'Government/Public institutions' are the most respected providers of a quality assurance program as shown in *Figure 21* (QualitEE 2017). Given that distrust in ESCOs grew between 2013 and 2017 - despite the adoption of a Code of Conduct – a good recommendation to increase trust in ESCOs would be to implement a quality assurance program run by the government or public institution as shown by *Figure 20* and *21* (QualitEE 2017).

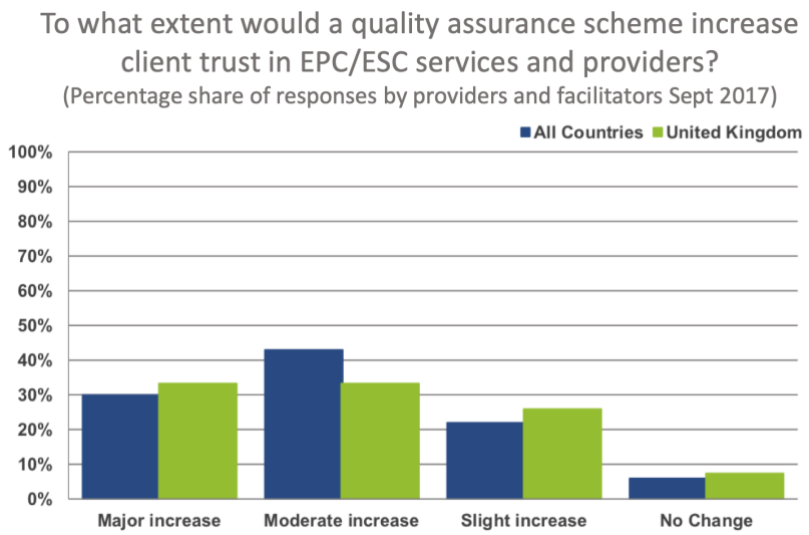


FIGURE 20. QUALITY ASSURANCE SCHEMES INCREASE CLIENT TRUST (QUALITEE 2017)

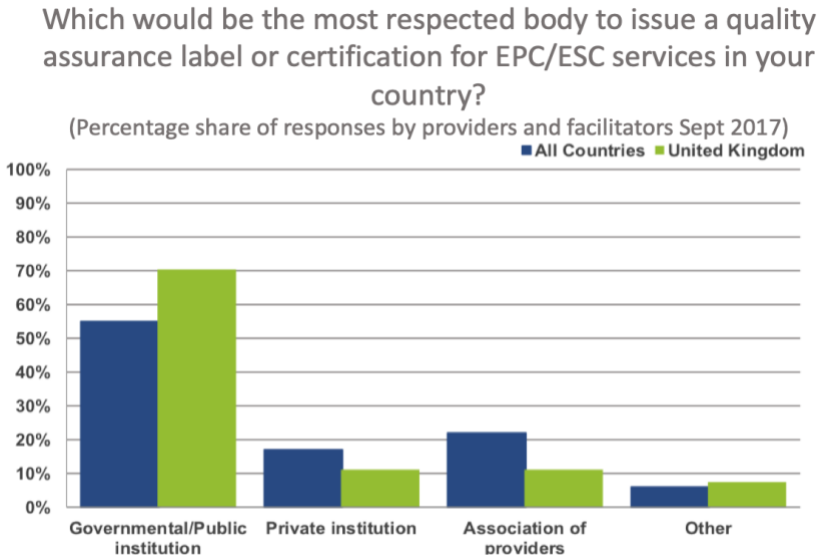


FIGURE 21. GOVERNMENT/PUBLIC INSTITUTION IS MOST RESPECTED QUALITY ASSURANCE PROVIDER (QUALITEE 2017)

4.2.9 Italy SWOT Recommendations

The Italian ESCO market recommendations are based on *Figure 44* and the Italian ESCO Market SWOT Analysis in Appendix A5.9.

Provide tax credits to ESCO operating in the residential or non-residential sector

Italy has some of the highest industrial electricity prices in the EU caused by high taxes as shown in *Figure 37* (European Commission 2019). High energy prices contribute to the success that ESCOs enjoy within the Italian industrial sector. Increasing the taxes on residential electricity prices, shown in *Figure 36*, could stimulate ESCO activity in the residential sector as EE improvements become more economically viable than paying the increased energy tax (European Commission 2019). However, rather than increasing a homeowner's energy tax, the ESCOs could be encouraged to tailor their services to the residential sector by reducing the taxes to be paid on ESCO projects completed in the residential sector.

Standardize energy savings baselining and M&V

Measurement and verification (M&V) of energy savings must improve and become standardized. Improvement could come in the form of third-party M&V companies, or the development of digital technologies which automatically track and report energy consumption (IEA 2018). Improving the ability of existing smart meters to communicate and organize data into meaningful outputs would radically transform the ESCO business (EMCA 2019).

Develop integrated energy services

Integrated energy services are an opportunity for ESCOs to expand their traditional service offerings and develop larger and long-term contracts. This is well suited for the Italian ESCO market as clients have cited a preference for "all-inclusive contracts" with few complications (QualitEE 2017).

Currently the average contract length is six years (IEA 2018). Average contract duration could be lengthened by identifying low-risk customers within the non-residential sector that wish to lower energy consumption. ESCOs should assess client risk based on credit history, utilities payments, and project sector details. By scaling the ESCO concept from small shops to shopping centers and hotels within the non-residential sector ESCOs could achieve long term contracts providing on-going building management services (BMS). BMS should be an area that ESCOs expand service offerings within as remote management of facilities is becoming easier to manage as sensor dependability improves (IEA 2018).

Simplify decision making structure surrounding ESCOs

The dispersion of responsibilities including market status monitoring, development and enforcement of regulations hinders the Italian ESCO market (QualitEE 2017). This dispersion of responsibility could be remedied by consolidating or limiting the number of institutions involved in developing the ESCO market.

4.2.10 Belgium SWOT Recommendations

The Belgian ESCO market recommendations are based on *Figure 46* and the Belgian ESCO Market SWOT Analysis in Appendix A5.10.

Continue to conduct information campaigns

The identified problems within the Belgium ESCO market such as limited budgets in public sector, pressure to reduce costs, limited client demand, complexity of concept, and lack of trust is ESCOS can all be improved by having BELESCO: the Belgian Association of ESCOs and AGORIA Green Building platform build upon previous information campaigns (QualitEE 2017). This would include creating standardized contracts, standardized M&V including standards for energy savings baselining, and aggregating potential projects, with a preference for residential sector, into a list.

Landlords to charge tenants an inclusive energy bill following energy efficiency improvements

Another problem is the split incentive between the landlord and the tenant. The same solution proposed for the Austrian ESCO market should be used within Belgium. The solution is also discussed in Section 4.1.4.

Revise procurement rules to accommodate the EPC model based on future energy savings

Fedesco's financing capabilities as a third-party-investor was 100 million euro in 2009, but not a single loan was made due to Belgium law preventing state funded loans from being classified as off-balance sheet as EPC's function best doing (Citynvest 2015). This is one example of how complex legislation has prevented ESCOs from obtaining financing. Removing administrative barriers requires policy makers to listen to ESCOs when they identify policies which are preventing development (Citynvest 2015).

4.2.11 Austria SWOT Recommendations

Within the Austrian ESCO market the following problems and associated solutions were identified by the EU Horizon 2020 funded GuarantEE project (2016). The solutions were ranked by project stakeholders for feasibility. Additional justification for the policy recommendations can be found in the Austrian ESCO Market SWOT Analysis in Appendix A5.11.

Factor in multiple benefits to ESCO sales package / contracts

An identified problem is administrative barriers (GuarantEE Energy Efficiency 2016). An example of administrative barriers occurs when the department or budget which finances the ESCO project does not benefit directly from the project. The most feasible solution is to factor in the non-monetary benefits or Multiple Benefits of increased property value, comfort, or reduction of maintenance cost to further justify the project beyond the energy savings (GuarantEE Energy Efficiency 2016). The solution considered most doubtful was to update tenancy contracts following energy efficiency improvement projects with additional legal agreements to reflect the new lower operational costs.

Landlords to charge tenants an inclusive energy bill following energy efficiency improvements

Another identified problem is that the landlord invests in energy efficiency measures but cannot recoup investment costs through lower the energy bill as only the tenant benefits from energy cost savings (GuarantEE Energy Efficiency 2016). The solution rated feasible was to have the tenant pay fixed rent which includes operational, heating, and electricity costs. This fixed cost would allow the landlord to recoup the investment through the energy cost savings assuming the tenant does not succumb to the rebound effect and use more energy following the energy efficiency improvements. The solution rated most doubtful was to guarantee that tenants receive an increased comfort/energy savings level for a guaranteed cost (GuarantEE Energy Efficiency 2016). For further explanation refer to Section 4.1.4.

Technology expected to reduce energy consumption more than consumer behavior change

A third identified problem in Austria is that building occupants drastically alter energy demand but altering their energy consumption behavior is difficult. The solution rated most feasible was to rely on technology such as motion sensors, window-contact switches etc. to achieve energy savings without any behavior change required. The solution rated most doubtful to work was profit sharing to motivate energy savings (GuarantEE Project, 2016).

4.2.12 Bulgaria SWOT Recommendations

The Bulgarian ESCO market recommendations are based on *Figure 50* and the Bulgarian ESCO Market SWOT Analysis in Appendix A5.12.

Existing ESCOs and Ministry of Energy can collaborate to establish a national ESCO association

Bulgaria does not have a national ESCO association. Most of the identified barriers to Bulgarian ESCO market development including; limited public budget, lack of trust in ESCOs, lack of standard M&V, lack of standard contracts, and lack of pilot projects would be improved by establishing an ESCO Association (QualitEE 2017). ESCO Associations raise awareness of the ESCO concept, identify financing options, educate financial institutions of the potential opportunity in Bulgaria, and provide guidance to developing ESCOs in the form of loan application pre-qualification or rigorous accreditation (Raytchev 2018).

There is concern about establishing an ESCO Association before there is truly an ESCO market, as the Bulgarian ESCO market is only USD 5 million annually (IEA 2018). Despite the small market size, an ESCO Association can still help the market develop as the association will raise the profile of ESCOs for central and local governments (IEA 2018). The central and local government can establishment of an ESCO

association using funds dedicated to national emission reduction goals. The ESCO association can be established with the stipulation that after the project is complete all related documents must be made public and used to create a standardized industry specific template of project development, financing, implementation, operation, and maintenance (Raytchev 2018). This stipulation will overcome the protectionist and proprietary attitude which typically surrounds EPCs and M&V protocol and acts as a barrier to creating standardized contracts and M&V (Boza-Kiss, Bertoldi and Economidou 2017).

For more information regarding ESCO associations refer to Section 4.1.1.

4.2.13 India SWOT Recommendations

The Indian ESCO market recommendations are based on *Figure 53* and the Indian ESCO Market SWOT Analysis in Appendix A5.13.

Adapt to digitalization

ESCOs business will change as digital technology evolves. Benefits will likely stem from Internet of Things (IOT), block chain/ open ledger contracts, big data analytics, miniaturization and improved accuracy of sensors and meters (IEA 2018). ESCOs will need to keep pace as M&V of energy savings becomes standardized and transparent (Alliance for an Energy Efficient Economy 2017). ESCOs will need to deliver energy efficiency savings while balancing the economics of time-of-use electricity pricing and the cost of energy storage as the energy delivery market evolves in conjunction with digitalization trends.

Centralize market development efforts to one agency

International agencies such as USAID have provided decentralized investment for the Indian ESCO market (Sridharen 2005). The effectiveness of such decentralized investment is hard to gauge. Centralizing market development efforts, as done in China, ensures there is an organization responsible for ESCO market development (China ESCO Industry Association 2015).

The non-government, not-for-profit organization, Federation of Indian Chambers of Commerce and Industry (FICCI) and Bureau of Energy Efficiency (BEE) have taken it upon themselves to guide their own ESCO market. Guidance has come in the form of seminars and training which provide skill development, public awareness, project development, pre-qualification of financial services, and policy strengthening (Murakoshi and Nakagami 2009). Continuing to expand internal market development efforts with clear responsibility is good practice for creating a sustainable long-term trajectory for market growth (Urmee and Urmee 2018).

Refine Service Offerings

Indian ESCOs would benefit from improved energy consumption measurement and verification (IREDA (Indian Renewable Energy Development Agency) 2006). Improving M&V starts with proper book keeping. Regular testing should yield log sheets which track efficiency changes, equipment level energy consumption, and identify areas which are most wasteful. Breaking energy costs down to the equipment level can help identify projects and allows for customized benchmarking.

Equipment which require customized log-sheets are Tri & Co-generation, Boilers, Electrical & Fuel Fired Furnaces, Capacitors, Compressors & Compressed Air System, Chillers, Pumping Systems, Transformers, Motors, Refrigeration & Air Conditioning System, Cooling Towers, Lighting, Fans & Blowers, and Driers (Chittawar 2010).

After standardizing data collection, the next step is linking the data with a tool which visualizes the energy performance of equipment and generates baseline specific energy consumption. By aggregating data, a list of similar successful projects can be made as well as a list of venders & technology providers

which contributed to each project. This type of data presentation coupled with built-in company/vendor exposure would provide additional motivation for ESCOs to contribute data.

An example of an existing tool is LetsConserve (Chittawar 2010). LetsConserve provides pre- and post-EE project energy consumption monitoring and cost baseline at the plant, process, or equipment level. All stakeholders including client, financial institution and ESCO can access the data in real time.

Answer to *SQ V – Policy Recommendations*

Table 10 and Section 4.1 answers the first part of *SQ V* – "Which policy measures synergistically address a selected country's market maturity". The second part of *SQ V* – "Which policy measures synergistically address a selected country's business barriers, and business drivers to increase energy efficiency investment" is answered in Section 4.2.

Some general recommendations which are valuable to most ESCO markets are; (1) Establish an ESCO association; (2) Advertise ESCOs as a solution to energy security; (3) Highlight the role of ESCOs in achieving emissions reductions; (4) Develop integrated energy services and quantify multiple benefits of energy efficiency into ESCO contracts and EPCs; (5) Manage split incentives between land lord and tenants in the residential sector via on-bill financing; (6) Prepare for digitization of building management systems (IEA 2018).

A key finding is that all ESCOs markets are unique. Since each ESCO market is unique, the policy recommendations to increase investment in each market are unique as well ((Capelo 2018); (Boza-Kiss, Bertoldi and Economidou 2017)). This conclusion justifies the country-level analysis developed in Section 2.5 of the methodology and executed in Section 4.

5. Discussion

5.1. Scientific Relevance

The results presented in this report are the forefront of scientific study surrounding ESCOs. By incorporating new information collected while working as an intern and as an external consultant at the International Energy Agency with decades of previous ESCO data and literature, this report creates 30 new time-series data sets, shown in Section 3.2 and the Appendix A3.

This meticulously curated data is then analyzed using a newly-developed, objective, and replicable methodology described in Section 2. The methodology is structured to demonstrate the value of annual data reporting. The value of annual collection of information is demonstrated via policy recommendations which evolve with a country's ESCO market development.

Policy recommendations, in Section 4, are made on an indicator by indicator basis as well as a country level basis. Recommendations are justified by critical analysis of the aforementioned time-series data sets together with analysis of the existing body of ESCO literature, shown in Section 3.4. As each ESCO market develops, there is additional value to tracking which policies are implemented and how the country level ESCO market indicators respond. This databased feedback will reveal the most effective policies and expedite global ESCO market development.

The strength of this research is the scientific and replicable nature of the methodology and results. Leveraging objective indicators, explained and justified in Section 2.3, to develop recommendations for the thirteen countries which provided complete information contributes to the development of theory, methods, practice, and society.

5.2. Innovative Contribution to Theory

Theory has been improved by defining a robust ESCO market as one that fulfills three criteria, summarized in *Figure 9*. These three criteria are: (1) Ability to obtain financing; (2) Successful EE projects in diverse sectors; and (3) Long-term market stability. Prior to this paper, there was no unified definition of a robust ESCO market and no clear indicators of ESCO market maturity.

Through exhaustive data collection and consultation with policy experts at the IEA, energy agencies, national ESCO associations, and ESCO employees the theory of ESCO market maturity has been formalized by this research.

5.3. Innovative Contribution to Methods / Practice

Methods or practices within the ESCO industry and surrounding ESCO development has been improved by this research via the creation and dissemination of the IEA Global ESCO Survey. Additional innovative contribution of this research is the development of methodology for analysis of ESCO markets which yields standardized market maturity comparisons and associated quantitative and qualitative policy recommendations for increasing investment in ESCOs globally.

Targeted and justified data collection

Prior to the 2018 IEA Global ESCO Survey, there was limited ESCO market data collection because the indicators of ESCO market maturity, beyond ESCO market size, had not been identified. Now that the indicators of ESCO market maturity are identified, the IEA Global ESCO Survey and resulting analysis framework provide guidance and a record of ESCO market development. This fills the existing literature gap identified in Section 1.3.

Raised ESCO Concept Awareness

Around the world, this survey has raised the interest and level of knowledge surrounding ESCOs as confirmed by the five news articles promoting the IEA Global ESCO Survey cited in the Appendix A7. Additionally, the ESCO survey results have been translated from English into French, Spanish, and Mandarin indicating global interest in the ESCO concept. This survey and the subsequent publication of results has sparked a level of interest in the ESCO concept that has not occurred before. For example, Ireland had never conducted a survey to gauge the state of its ESCO market prior to implementing the IEA Global ESCO Survey.

5.4. Innovative Contribution to Society

Society has been improved by this research as ESCOs and their stakeholders now have a centralized resource for consultation. As stated in Section 1.3, prior to this report there had not been a global analysis conducted since the *World ESCO Outlook* (Langlois & Hansen 2012). Seven years later the ESCO market has changed and an update was needed. ESCOs improve the energy efficiency of our society on a global scale. Compiling up-to-date information and policy recommendations supports ESCOs in achieving their goal of reducing energy consumption using innovative technology and financing methods.

Prior to this research there was no existing literature investigating a methodological approach for creating policy recommendations for increased investment in the global ESCO market. This research enables replicable ESCO market trend tracking and the continuous evolution of ESCO policy recommendations. The long-term value of this research encourages continual engagement and annual renewal of ESCO market information.

5.5. Next Steps for ESCO Research Topic

The next step from this research is policy implementation, as identified in Step 5 of *Figure 8*. Following policy implementation, the five-step methodology used to conduct this research and to build theory for increasing investment in the ESCO should begin again starting with a standardized ESCO market survey, such as the IEA Global ESCO Survey.

Aggregating data from various surveys is labour intensive and lacks the scientific consistency which conducting a standard annual survey would yield. A conclusion that can be drawn from the piecemeal nature of existing ESCO market survey information, summarized in Section 1.3, is there should be continued support for the IEA Global ESCO Survey as it is a comprehensive, consistent, and global data collection effort.

Each year the new data, including a list of newly implemented policies, should be analyzed using the quantitative ESCO market maturity analysis and qualitative country level SWOT analysis. Market trends extracted during analysis provide lessons learned. Building upon lessons learned each year, recommendations can be updated for each country. This continual revision of country level recommendations based on new data-will strengthen the impact of this research and ESCO markets each year.

5.6. Limitations of Methodology

Comparing Data from Different Years

This ambitious report is substantiated utilizing fourteen large data collections from reliable and verified sources in academia, industry, and government listed in Section 2.2. The discrepancies between which fiscal year each data is collected from is clearly noted but limits direct comparison in some instances.

In 2018, the IEA ESCO survey collected data regarding fiscal year 2017 and in few instances 2016. The data for; Austria, Bulgaria, Czech Republic, France, Germany, Greece, Latvia, the Netherlands, Portugal, Slovakia, and Slovenia is sourced from the 2017 QualitEE survey project funded by the European Union's Horizon 2020 and the 2017 JRC *ESCOs in the EU* report (Boza-Kiss, Bertoldi and Economidou 2017).

Comparison between counties should therefore be considered with an understanding that the ability for each country to collect data varies, and the terms used to categorize data or operational aspects of the ESCO industry also vary. However, each year understanding of shared ESCO concepts improves. This improvement is in part due to standardization efforts such as the European Commission ESCO Handbook (European Commission 2017).

Limited Time, Data Availability, and Length of Report

Limitations in time and data availability hinder capturing a picture of a truly global ESCO market. Some countries simply do not collect data on market size for instance. Time limitations have prevented the collection of data from the majority of African, Middle Eastern, and South American ESCO associations.

Time limits and a desire for conciseness have prevented a more in-depth analysis of each country-level ESCO market. Entire reports have been written about a single ESCO market. Conducting thirteen country-level ESCO market SWOT analysis and country-specific ESCO market recommendations sacrifices detail in exchange for the value of comparing nearly all of the major ESCOs markets using standardized information. Comparing thirteen ESCO markets from five continents based off standardized and complete survey results is a unique opportunity due to the historically piecemeal nature of global ESCO market data collection.

Available Indicators are Constrained by Current Technology

For a more accurate decision-making framework for future ESCO policy recommendations, the weightings and indicators need to be updated to reflect the developing markets. For instance, the use of digital contracts is not currently used as an indicator of ESCO market maturity. As digitalization increases, the ESCO markets which lead in usage of secure, standardized, digitalized contract will be best poised for long-term operation and maintenance capabilities required in multi-year EPCs. Therefore, the usage of digital contacts may be a good indicator for future ESCO markets which is not incorporated in this model.

Subjective Expert ESCO Market Maturity Indicator Weightings

A limitation of this research is the reliance upon subjective expert weightings of the ESCO market maturity indicators. The expert weightings are summarized in Table 1. The methodology of this research may be challenged by discrediting the central assumption that a maturity factor can be computed using weightings justified by IEA Energy Efficiency Analyst' expertise. Five ESCO market experts were consulted. Increasing the number of analysts' weightings could increase the reliably of the study.

Regression Analysis of Expert Weightings & Dependent ESCO Market Maturity Score

A multiple linear regression analysis is performed to determine the extent of this expert weighting limitation. The regression analysis contextualized the impact of the expert weightings on overall ESCO market maturity scores.

In order to determine the strength of the relationship between the three highest weighted indicators and the dependent ESCO market maturity score a multiple linear regression is performed for the following indicators; Organizational Structure (19%), MS / GDP (18%), and Sector Diversity (19%). The three residual plots are shown in the Appendix A6.1.

The R^2 value equals 0.46 and the Significance F value is less than 0.05 equaling 0.001. Considered

together this analysis suggests that countries which provide data for only the top three indicators will have a reasonably good indication of their ESCO market maturity score. The linear equation for predicted market score in the form of $y = mx + b$ is:

$$Predicted\ Market\ Maturity\ Score_{HWI} = (OS * 20\%) + (\frac{MS}{GDP} * 18\%) + (S * 15\%) + 26\%$$

This $PMMS_{HWI}$ equation based on the highest weighted indicators reveals that when only the top three indicators are considered the lowest maturity score that a country can achieve is 26%. This makes sense as there are four more indicators contributing to the actual ESCO market score which this equation models with three rather than seven indicators. This equation also confirms the relevance and accuracy of the expert defined indicator weightings as shown in *Table 14.*

TABLE 14. HIGHEST WEIGHTED INDICATORS REGRESSION ANALYSIS

Highest Weighted Indicators Regression Analysis			
	Regression Analysis Market Score Weighting	*Expert Market Score Weighting*	$\Delta\ Weightings$
Organizational Structure Score	20%	19%	1%
MS / GDP Score	18%	18%	0%
Sector Diversity Score	15%	19%	-4%

Table 14 indicates that when only the top three weighted indicators are considered Organizational Structure and MS/GDP become relatively more important indicators while Sector Diversity becomes relatively less indicative of the predicted ESCO market maturity score. Experts are justified in weighting Organizational Structure as the score most indicative of a mature ESCO market because the regression analysis weighting also weighted OS the highest with a 20% weighting. While reviewing the results of the linear regression analysis which excludes the four least weighted indicators it can be assessed that the experts may have slightly overvalued the importance of Sector Diversity score in determining a final ESCO market maturity score as there is a 4% drop from the Actual expert assigned Market Score Weighting and the Predicted regression analysis Market Score Weighting.

Incomplete Data Collection in Some Countries

Unfortunately, some countries do not collect the complete data used as indicators for ESCO market maturity. A second multiple linear regression is calculated to determine how well a country's market maturity score can be predicted while using the four indicators which countries collect most often.

Regression Analysis of Most Available Indicators

The four indicators with the most complete information are MS/GDP (18%), Project Cost (15%), Contract Duration (12%), MS/Pop. (5%). The four residual plots are shown in the Appendix A6.2.

The R^2 value equals 0.44 and the Significance F value is less than 0.05 equaling 0.004. Considered together this suggests that countries which provide data for only the most commonly available indicators will have a tolerable indication of ESCO market maturity score. This lower R^2 value suggests that the predictions based on this equation are likely not as accurate as the prediction based on the $PMMS_{HWI}$ equation. This suggestion of inaccuracy is confirmed by reviewing the results of the residuals. This

emphasizes the importance of collecting complete ESCO market information and can be used as justification for national ESCO markets to conduct annual market surveys.

The linear equation for predicted market score in the form of $y = mx + b$ is:

$$Predicted\ Market\ Maturity\ Score_{AI} = \left(\frac{MS}{GDP} * \ 6\%\right) + (C * 30\%) + (CD * \ -5\%) + \left(\frac{MS}{Pop.} * 8\%\right) + \ 30\%$$

The $PMMS_{AI}$ equation based on most available indicator information reveals that when only these four indicators are considered the lowest maturity score that a country can achieve is 30%. This makes sense as there are three other weighted indicators contributing to the actual ESCO market score which this equation models based on four indicators. A comparison of the weightings from the actual and the $PMMS_{AI}$ equation is shown in *Table 15*.

TABLE 15. MOST AVAILABLE INDICATORS REGRESSION ANALYSIS

Most Available Indicators Regression Analysis			
	Regression Analysis Market Score Weighting	*Expert Market Score Weighting*	$\Delta\ Weightings$
MS / GDP Score	6%	18%	–12%
Project Cost Score	30%	15%	15%
Contract Duration Score	–5%	12%	–17%
MS / Pop. Score	8%	5%	3%

Table 15 shows that Project Cost and MS/Pop. Scores became more important for predicting the market maturity score when the scarcer data is excluded; the former more so with a delta of 15%, than the latter with a delta of 3%. Contract Duration and MS/GDP scores become less important for predicting the market maturity score with respective drops of -17% and -12%. This indicates the expert weighting may have overvalued the ability of the length of the ESCO contract to represent ESCO market maturity.

A conclusion to be drawn is that an ESCO market may be relatively developed even if it is only executing contracts lasting only one or two years. Even so, it should be reiterated that the predictive value of the $PMMS_{AI}$ is worse than $PMMS_{HWI}$ and it is of the utmost importance to collect full information if a gauge of ESCO market maturity is to be developed.

Simplified Assumptions for Average Contract Duration and Average Project Cost

The calculation of the average contract duration and the average project cost is a limitation due to the simplifying assumptions used.

Average ESCO Contract Duration

Average contract duration is calculated by summing survey responses for the percentage of projects competed with contracts durations of; $D_{<5yrs}$ = "less than 5 years"; $D_{5\ to\ 10\ yrs}$ = "5 to 10 years"; $D_{11\ to\ 15\ yrs}$ = "11 to 15 years"; $D_{>15\ yrs}$ = "More than 15 years".

$$Average\ Contract\ Duration = \left[\frac{0+5}{2}\ yrs * D_{<5yrs}\right] + \left[\frac{5+10}{2} yrs * D_{5\ to\ 10\ yrs}\right] + \left[\frac{11+15}{2} yrs * D_{11\ to\ 15\ yrs}\right] + \left[(15+2.5) yrs * D_{>15\ yrs}\right]$$

As shown in the formula, the method used is to multiply the percentage response by the average of the lower and upper limits of contract duration ranges. 17.5 years is used for the contracts of "More than 15 years". This is calculated by adding the timeframe of 2.5 years calculated for "less than 5 years" with the lower limit of 15 years.

Average ESCO Project Cost

Average project cost is calculated by summing the survey responses for the percentage of projects competed with capital costs of; $C_{<\$200k}$ = "less than USD 200,000"; $C_{\$200\ to\ \$500k}$ = "USD 200,000 to 500,000"; $C_{\$500\text{k to }\$1\text{M}}$ = "USD 500,000 to 1 million; $C_{\$1\text{M to }\$5\text{M}}$ = "USD 1 million to 5 million"; $C_{>\$5\text{M}}$ = "greater than USD 5 million".

$$Average\ Project\ Cost = \left[\frac{\$0+\$200k}{2} * C_{<\$200k}\right] + \left[\frac{\$200\text{k}+\$500\text{k}}{2} * C_{\$200\ to\ \$500k}\right] + \left[\frac{\$500\text{k}+\$1\text{M}}{2} * C_{\$500\text{k to }\$1\text{M}}\right] + \left[\frac{\$1\text{M}+\$5\text{M}}{2} * C_{\$1\text{M to }\$5\text{M}}\right] + \left[(\$5\text{M}+\$100\text{k}) * C_{>\$5\text{M}}\right]$$

As shown in the formula the method used is to multiply the percentage response by the average of the lower and upper limits of project costs ranges. USD 5.1 million is used for the projects of "greater than USD 5 million". This is calculated by adding the cost of USD 100,000 calculated for "less than USD 200,000" with the lower limit of USD 5 million.

5.7. Limitations of Recommendations

It was not possible to survey experts for the feasibility of every recommendation, as was done in *Figure 20* & *21*. The recommendations made in this report are based on survey results and researcher expertise developed via conversations with ESCO policy experts from international and local energy organizations, representatives of ESCO associations, employees of ESCOs, and via extensive literature review. As ESCO development is cumulative, there is a need, especially in emerging economies, to build upon previous knowledge and anecdotal lessons learned. This reliance on anecdotal information and lessons learned results in some recommendations being based more on experience than scientific justifications. As each ESCO market is unique, what has worked in one ESCO market may not work in another.

6. Conclusions

The aim of this research is to increase investment in energy efficiency via ESCOs by eliminating the existing literature gap surrounding ESCO market status. Included in this report is a global overview of the ESCO market, country level market analysis, policy recommendations for increasing global investment in energy efficiency via energy service companies and the methodology for replicating the entire analysis and policy recommendation process. Scope of research is determined based on the need to reduce greenhouse gas emissions while still enabling economic growth to improve global standards of living.

The main research question formulated to guide this research is:

What is the current status of the global Energy Service Company market and which policies can be implemented to increase energy efficiency investment, by means of Energy Service Companies, to a level aligned with the Paris Agreement's goal of holding the increase in the global average temperature to "well below 2 °C"?

The main research question is thoroughly addressed by answering the following sub-questions (SQs):

SQ I. *What are the investment levels, compared to current levels, needed to implement all currently economically viable energy efficiency technologies and policies to align with Paris Agreement climate targets?*

While ESCO market size of USD 30.9 billion seems large, it is only a fraction of the total USD 1.3 trillion investment in energy efficiency required to reach the IEA's Efficient World Scenario and better align with Paris Agreement climate targets. The existing investment growth rate is a positive. However, much greater energy efficiency investment is needed in the coming years. The investment levels outlined in the IEA's Efficient World Scenario anticipate the level of energy efficiency investment required to meet the criteria of *SQ I* is USD 584 billion per year by 2025. Investment must then double again between 2026 and 2040 to nearly USD 1.3 trillion per year. This is outlined in Section 3.1.

SQ II. *How developed is the global Energy Service Companies market in terms of annual growth, revenue by country, number of ESCOs operating, sectors operated within (e.g. Industry, Residential, Non-Residential, Transport), client type (e.g. Public or Private), contract type used, and organizational structure?*

The global ESCO market has grown at a rate of 8% since 2015. The revenue by country is summarized in *Table 11*, *Figure 15* & *Figure 16*. The total number of ESCOs operating is 9723, summarized in *Table 2*. The global average sectoral breakdown of ESCO clients is Non-residential (52%), Industry (39%), Residential (10%), shown in *Table 3*. The global average client type breakdown is Private (46%), Public (37%, Both (14%), shown in *Table 4*. The global average for contract type used is EPC with Guaranteed Savings (49%), EPC with Shared Savings (24%), the remaining percentage of contracts are a mixture of EPCs and energy supply contracts, shown in *Table 5*.

The global ESCO organizational structure is Stand-alone ESCOs (56%) and Subsidiary ESCOs (44%) as shown in *Table 6*. A take-away from results of *Table 6*, is that countries with majority (>70%) subsidiary ESCOs are more mature than countries with majority (>70%) of stand-alone ESCOs as determined by average ESCO market maturity score. This is especially interesting considering the expert indicator weightings score organization score as highly indicative of a mature ESCO market.

SQ III. *How does the maturity, based on market characteristics, of country level ESCO markets compare with one another and how does this maturity level adjudicate the best policy to increase investment in energy efficiency via ESCOs?*

Overall the market maturity indicator scores of country-level ESCO markets are diverse. ESCO markets around the world are systematically compared to one another using the ESCO market maturity analysis. This analysis is based on seven indicators of ESCO market maturity and results in an ESCO market classification of low, mid or mature. This assessment enables the development of unique country-specific policy recommendation necessary to guide market development in such diverse ESCO markets.

The most mature ESCO markets include the United States, Germany, China, and Japan. The least mature ESCO markets, of those surveyed, include Chile, Spain and Greece. The maturity score helps identify successful ESCOs markets to be used as an example for developing other ESCO markets. The polices such as the Energy Efficiency Building Retrofit Program in USA (Clinton Climate Initiative 2009) or the CN-3b: Top-10,000 Energy-Consuming Enterprises Program in China (Cho 2017) are both good examples of how the right policy can help build an ESCO market.

Mature ESCO markets have an average Organizational Structure which is 33% greater than Mid-Maturity ESCO markets. This suggests that a major step towards developing from a Mid-Maturity ESCO market into a Mature ESCO market is to adjust market conditions to be conducive to subsidiary ESCOs.

Mid-Maturity ESCO markets have an average sector diversity score which is 18% greater than Low-Maturity ESCO markets. This suggests that a major step towards developing from a Low-Maturity ESCO market into a Mid-Maturity ESCO market is to diversify service offerings for all sectors.

Low-Maturity ESCO markets are developing from small market sizes. This is confirmed because the lowest indicator scores are MS/GDP and MS/Population. Low maturity ESCOs should focus development efforts on increasing sector diversity and project size.

SQ IV. Which barriers and drivers are country level ESCO markets facing and how do these factors determine the right policy mix to increase investment in energy efficiency.

Common ESCO market barriers include lack of trust in the ESCO concept and the complexity of the ESCO concept itself. Common ESCO market drivers include government policy, pressure to reduce costs, and the energy savings guarantee. A common opportunity for ESCOs is to increase national energy security and aid in the reduction of greenhouse gas emissions. Threats across most markets to future ESCO expansion are withdraw of government support for the ESCO concept and the split-motivation between landlord and tenants in the residential sector for implementing energy efficiency improvements.

Additionally, sustained profitability compared to other industries is drawing more companies to ESCO business and intensifying competition. ESCOs are in demand of high-quality professionals in engineering, equipment, economy, financing, law, marketing, and management. The presence of such talent can drive expansion. Conversely, a talent shortage can slow an ESCO market which is otherwise ready to expand.

By addressing the strengths, weaknesses, opportunities and threats of each ESCO market on a country by country basis the right policy mix for increase ESCO investment emerges. The country level SWOT analysis are located in Appendix A5.

SQ V. Which policy measures synergistically address selected country's market maturity, business barriers, and business drivers to increase energy efficiency investment?

Synergistic solutions emerge following market analysis. *Table 10* and Section 4.1 answers the first part of *SQ V* – "Which policy measures synergistically address a selected country's market maturity". The second part of *SQ V* – "Which policy measures synergistically address a selected country's business barriers, and business drivers to increase energy efficiency investment" is answered in Section 4.2.

The government, or in emerging economies international organizations, usually take the lead to establish an ESCO market. Once the market has begun to take shape, there are instances where markets

are driven by the private sector, such as Italy, Korea, and India. The policy measures used by such organizations to start an ESCO market have a rough order in which they should be carried out, but if most measures proceed simultaneously there will be synergistic effects, so it is valid to say that there is no universal order for their introduction (Murakoshi and Nakagami 2009).

For example, a characteristic shared among developed ESCO markets is the presence of a national ESCO association, Table 12. Establishing an ESCO associations helps increase trust in ESCOs by educating ESCOs, potential clients, policy makers, and financial institutions of current best practices. As stakeholders are educated of the energy efficiency gains and energy cost savings generated through ESCOs, the level of support increases. Policy legitimizing ESCOs increases trust in the concept, resulting in the execution of pilot projects. Pilot projects raise the experience level of those involved and de-risks the ESCO concept for financial institutions. Snowballing effects of providing information and establishing trust in the ESCO concept, such as the establishment of an ESCO association, are identified and adapted for other emerging markets to increase energy efficiency investment.

Some additional general recommendations which are valuable to most ESCO markets are; (1) Advertise ESCOs as a solution to energy security; (2) Highlight the role of ESCOs in achieving emissions reductions; (3) Develop integrated energy services and quantify multiple benefits of energy efficiency into ESCO contracts and EPCs; (4) Manage split incentives between land lord and tenants in the residential sector via on-bill financing; (5) Prepare for digitization of building management systems (IEA 2018).

A key finding is that all ESCOs markets are unique. Since each ESCO market is unique, the policy recommendations to increase investment in each market are unique as well (Capelo 2018); (Boza-Kiss, Bertoldi and Economidou 2017). This conclusion justifies the country-level analysis developed in Section 2.5 of the methodology and executed in Section 4.

In conclusion, this research yielded:

1. Summary of existing literature surrounding the ESCO market
2. Development of theory which defines the characteristics of ESCO market maturity
3. Creation and distribution of a survey to collect primary data indicators of ESCO market maturity
4. Summary of the global ESCO market
5. Quantitative analysis which calculates market maturity based on expert weighting of identified indicators
6. Qualitative SWOT analysis of country-level ESCO markets based on TIS principles
7. Standardized replicable recommendations based on quantitative ESCO market maturity analysis
8. Tailor-made recommendations based on qualitative ESCO market SWOT analysis

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Appendix

A1. IEA Global ESCO Survey

IEA ESCO Survey

International Energy Agency
Secure Sustainable Together

The International Energy Agency (IEA) tracks policy updates and changing market characteristics of the global Energy Service Company (ESCO) market on the ESCO online resource. To improve the quality and depth of analysis the IEA conducts this annual survey of key regional/national ESCO associations.

This survey aims to obtain information about the ESCO market in your region including its current size, financing mechanisms, policy drivers and prospects. The information collected through this survey is published via the IEA website. Your views are an essential contribution to our analysis and improve the understanding of the status and drivers of the global ESCO market.

If quantitative data are not available for any of the questions in your region, please provide an estimate based on previous years or other information briefly explaining how the estimate is derived.

General

1) What is the name of your association, and what region do you cover?

_____

2) Globally, ESCOs are generally defined as companies that carry out an energy performance contract (EPC). Such providers guarantee a certain level of savings and payment schedule determined in a contract agreed upon between the provider and customer. Overall, is this the definition of an ESCO in your region?

_____

3) How many ESCOs operate in your region?

_____

4) How many ESCOs are members to your organisation?

_____

5) What percentage of ESCO projects come from each of the following end-use sector/s?
   a. Industry
      i. Energy intensive _____%
      ii. Non-energy intensive _____%
   b. Buildings
      i. Residential _____%
      ii. Non-residential _____%
   c. Transport
      i. Freight _____%
      ii. Public _____%
      iii. Private (passenger vehicles) _____%
   d. Municipal services
      i. Public buildings _____%
      ii. Street lighting _____%
      iii. Water & waste management _____%
   e. Utility _____%
   f. Other, please specify_____ _____%

PAGE 1 ESCO SURVEY

6) What percentages of ESCO projects are carried out for private sector and the public sector?
   a. Private _____%
   b. Public _____%

7) What percentage of ESCOs are stand-alone Energy Service Providers or a subsidiary of a larger organisation or energy utility?
   a. Stand-alone ESCO: _____%
   b. Subsidiary of a larger organisation or utility: _____%

8) What percentage of ESCO projects are completed using each contract type in your region?
   a. Energy performance contract-guaranteed savings _____%
   b. Energy performance contract-shared savings _____%
   c. Energy supply contract-guaranteed savings _____%
   d. Energy supply contract-shared savings _____%
   e. Integrated energy contracts (IEC) _____%
   f. Facility Management (FM) _____%
   g. Build-own-operate-transfer (BOOT) _____%
   h. Other_____ _____%

9) What percentage of energy savings does an average project achieve?
   a. Below 15%
   b. 15%-20%
   c. 25%-30%
   d. Other_____

10) What is the typical duration of an ESCO contract in your region?
   a. 1-2 years _____%
   b. 2-4 years _____%
   c. 4+ years _____%

11) What percentage of ESCO projects in 2017 integrated renewable energy?
   _____%

Financial

12) What is the average capital cost of ESCO projects in your region?
   a. Less than USD 200 000 _____%
   b. USD 200 000 to 500 000 _____%
   c. USD 500 000 to 1 000 000 _____%
   d. USD 1 000 000 to 5 000 000 _____%
   e. USD 5 000 000+ _____%

13) What is the size of the ESCO market in your country in 2018 in USD Million?
   _____

PAGE 2 ESCO SURVEY

14) Based on total capital expenditure, how are ESCO projects in your country/region financed?
   a. Debt borrowed by client _____%
   b. Debt borrowed by ESCO _____%
   c. Operating lease _____%
   d. Project finance _____%
   e. Grants _____%
   f. Equity _____%
   g. Self- finance _____%
   h. Other_____ _____%

15) What is the average payback period/Internal Rate of Return (IRR) of an average project?
   _____

16) What are the main challenges in obtaining viable finance for ESCO projects? (Rank from 1 - 10)
   a. Customer demand _____
   b. Complexity of the concept / Lack of information _____
   c. Lack of trust in the ESCO industry _____
   d. Split incentives between landlords and tenants _____
   e. Administrative barriers in public sector _____
   f. Low energy prices _____
   g. Low Technical Competence of Financial Institutions _____
   h. Subsidy / Policy uncertainty _____
   i. Ability to Aggregate Projects _____
   j. Other_____ _____

Policies

17) Does your region have a National Energy Plan? _____
   a. Does the plan specifically address Energy Efficiency? _____
   b. Has this had an effect on the ESCO market? _____

18) Which government policies are most critical to your ESCO market?
   _____
   _____
   _____

19) What policies would you like to see implemented to improve ESCO business?
   _____
   _____
   _____

20) Any recommendations that would help increase the number of ESCO projects completed?
   _____
   _____
   _____

PAGE 3 ESCO SURVEY

Drivers

21) Which factors are driving your business? (Rank influence of driver on a scale of 1-10)

a. Increasing energy prices _____
b. Customer demand _____
c. Government policy / subsidy _____
d. Availability of affordable finance _____
e. Pressure to reduce costs _____
f. Limited budgets in public sector _____
g. Financing provided by ESCO / Energy savings guarantee _____
h. External expertise / turnkey services _____
i. Technology development _____
j. Corporate social responsibility _____

22) Which multiple benefits drive consumer demand for your ESCO services? (Rank from 1-13)

a. Energy efficiency improvements _____
b. Energy/Cost Savings _____
c. Environmental sustainability / Air quality _____
d. Energy access _____
e. Health and well being / Comfort _____
f. Disposable income _____
g. Macroeconomic development _____
h. Public budgets _____
i. Energy prices _____
j. Asset values _____
k. Industrial productivity _____
l. Energy security _____
m. Other_____ _____

Barriers

23) What are the barriers you see to the ESCO market? (Rank from 1-15)

a. Customer demand _____
b. Subsidy / Policy uncertainty _____
c. Raising affordable finance _____
d. Pressure to reduce costs _____
e. Staff costs _____
f. Lack of support from the government _____
g. Complexity of the concept / Lack of information _____
h. Lack of trust in the ESCO industry _____
i. Lack of standardised Measurement & Verification practices _____
j. Split incentives between landlords and tenants _____
k. Complex accounting / book-keeping rules _____
l. Administrative barriers in public sector _____
m. Low energy prices _____
n. High costs of project development and procurement _____
o. Other_____ _____

PAGE 4 ESCO SURVEY

24) What are the changes are currently happening is the ESCO market?

_____
_____
_____

25) What are the changes you hope to see in the ESCO market?

_____
_____
_____

26) Could you summarise the status of the ESCO market in your region?

_____
_____
_____

Digitalisation

27) How has digital equipment/digitalization affected your ESCO market?

_____
_____
_____

28) Which digital technologies do you apply in your ESCO projects? (check all that apply)

a. Programmable devices (without dependence on internet connection – such as programmable thermostats) _____
b. Connected devices, including devices that apply data analytics to improve performance and customer experience, often referred to as Internet of Things (IoT) _____
c. Control systems _____
d. Smart meters (please explain metering capabilities)
_____
e. Artificial intelligence/machine learning _____
f. Other, please specify_____ _____

29) How has digital technologies changed your business/business model? (check all that apply)

a. Identify more energy savings _____
b. Expand access to more energy savings opportunities _____
c. Enable better measurement through more data and indicators _____
d. Enable better marketing of energy savings alongside other benefits _____
e. Improve the efficiency of service provision _____
f. Open up new business opportunities _____
g. Expand and diversify _____
h. Loss of data security _____
i. Increased complexity and organisational issues _____
j. Lack of monetisation efforts surrounding digitalisation _____
k. Implementation costs _____
l. Improved control _____
m. Improved data accuracy _____

PAGE 5 ESCO SURVEY

n. Ability to enforce contracts _____
o. Maturity and investment capabilities of the customers _____
p. Visibility of digital solution to stakeholders _____
q. Customer satisfaction _____
r. Other, please specify_____ _____

30) How do you view the future of digital technologies in the ESCO market?

_____
_____
_____

31) Which market segments show the greatest market potential or the deployment of digital technologies?
   a. Public / Private
   b. Industry: Energy-intensive / Non-energy intensive
   c. Company size: Large / Small to Medium Enterprise (SME)
   d. Other, please specify_____

Additional Information

32) Do we have permission to publish this information online?

_____

33) Is there any additional information beyond your website link that you would like to have published along with this information?

_____
_____

34) Do you have any specific Case Studies/ Success Stories that would be useful to highlight online?
   a. YouTube links, PDF summary, PowerPoint presentation, Website links are all useful.

_____
_____

PAGE 6 ESCO SURVEY

A2. Expert Weighting Survey

Dear Ailin, Armin, Edith, Hugo, and Vida,

I am asking to borrow your ESCO expertise for the creation of a weighting system. The ultimate goal is to determine how mature each national ESCO market is.

Market maturity, in the context of this research, is a comparative measurement of progress towards achieving the most robust market for ESCOs to operate within. For the purpose of this research, a robust market is one where ESCOs have access to financing, successfully complete efficiency improvement projects in multiple sectors, and operate with long term stability.

To gauge market maturity indicators must be used as a proxy. Seven indicators are selected to calculate market maturity using the following equation. Each indicator score is calculated by dividing the country indicator score by the best practice indicator score so that each score is between zero and one.

$$M = w_1 * \frac{OS}{OS_{bp}} + w_2 * \frac{\frac{MS}{GDP}}{\frac{MS}{GDP_{bp}}} + w_3 * \frac{\frac{MS}{Pop.}}{\frac{MS}{Pop._{bp}}} + w_4 * \frac{ES}{ES_{bp}} + w_5 * \frac{S}{S_{bp}} + w_6 * \frac{CD}{CD_{bp}} + w_7 * \frac{C}{C_{bp}}$$

In order to define the influence of each indicator on the overall market maturity I kindly ask you to **assign points to weight each indicator**. More points = more influence. Please ensure points sum to 100.

Indicators	Points
ESCO Organizational Structure (OS) • Percentage of ESCOs operating as stand-alone vs subsidiary. • More subsidiary ESCOs typically reflects larger projects and accounting practices tailored to ESCOs such as off-balance sheet practices being codified into law.	_____
ESCO Market Size divided by Gross Domestic Product (MS/GDP) • The ESCO market size is defined as ESCO revenue per fiscal year. • GDP is used to standardize the MS score. • A country with a large MS and a large GDP is less indicative of a robust ESCO market compared to an equally large MS with a smaller GDP.	
ESCO Market Size divided by Population (MS/Pop.) • Population size is used to standardize the MS score per capita. • A country with a large MS and a large population is less indicative of a robust ESCO market compared to an equally large MS with a smaller population.	
Project Sector Diversity (S) • Percentage of projects completed in each sector; industrial, non-residential, residential, and transport	
Average Energy Savings per project (ES)	
Average Contract Duration (CD)	
Average Project Cost (C)	
Total	/100

Figure 1. Expert Indicator Weighting

A3. ESCO Market Size Bubble Visualization

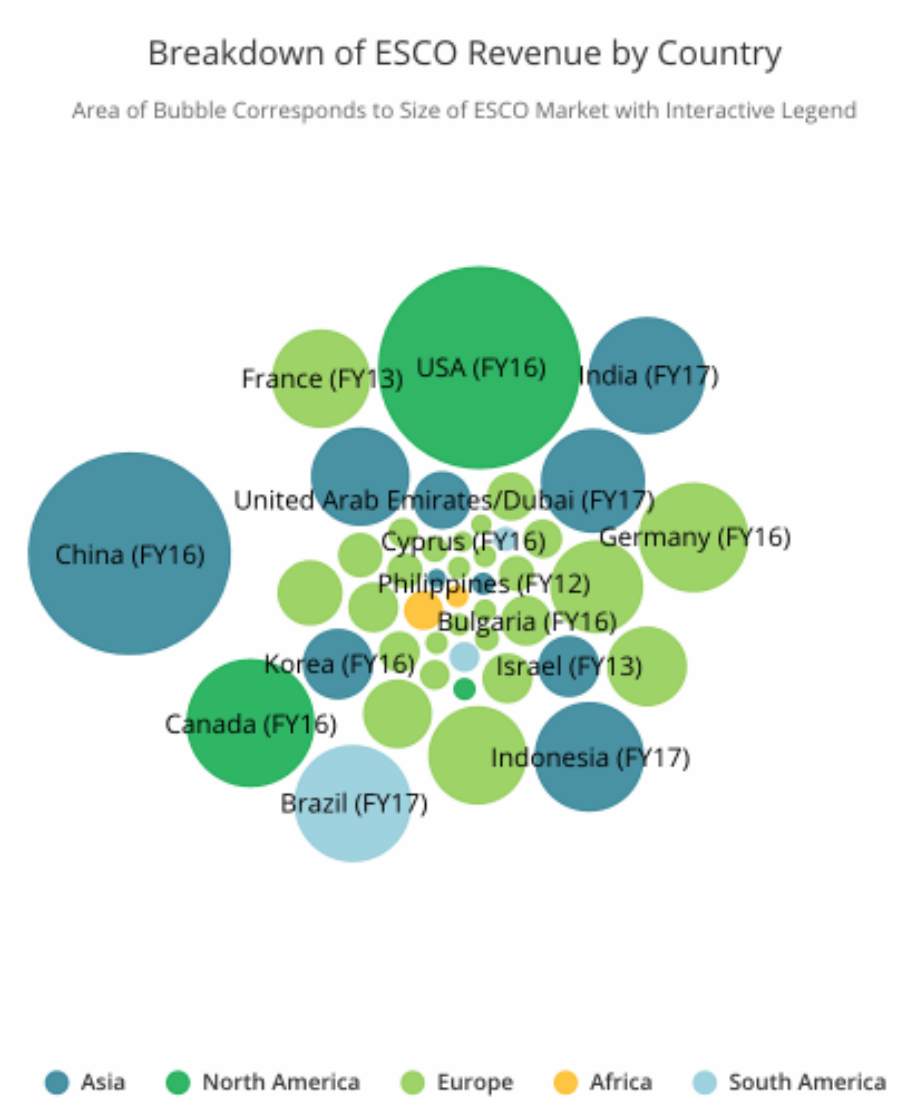


FIGURE 22. GLOBAL ESCO MARKET SIZE BY COUNTRY (IEA ESCO SURVEY 2018)

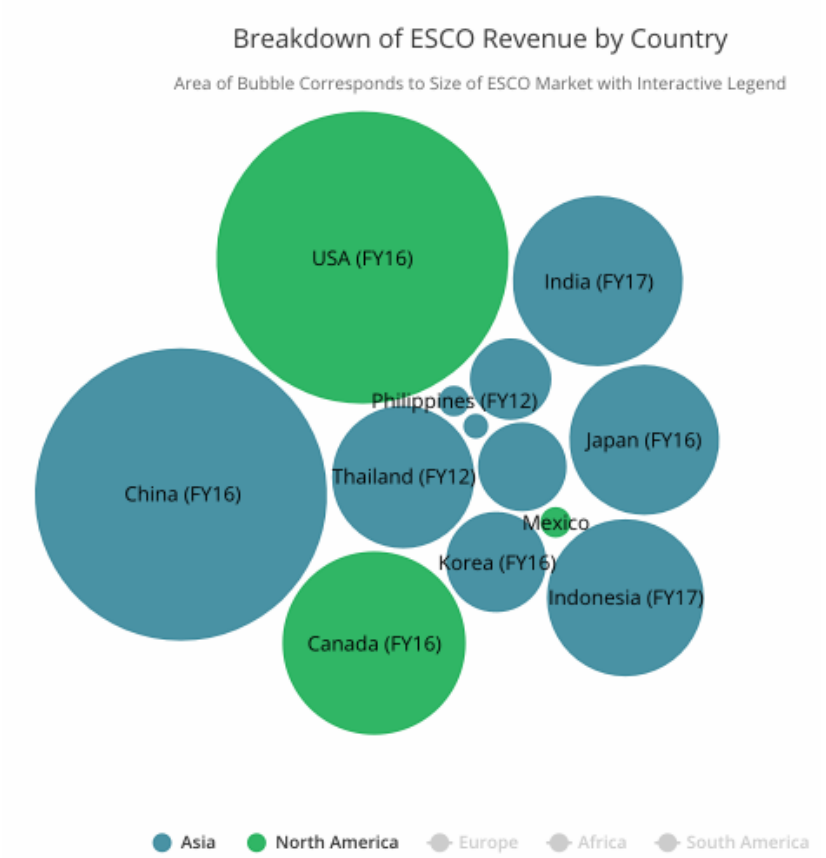


FIGURE 23. ESCO MARKET SIZE BY COUNTRY - NORTH AMERICA & ASIA (IEA ESCO SURVEY 2018)

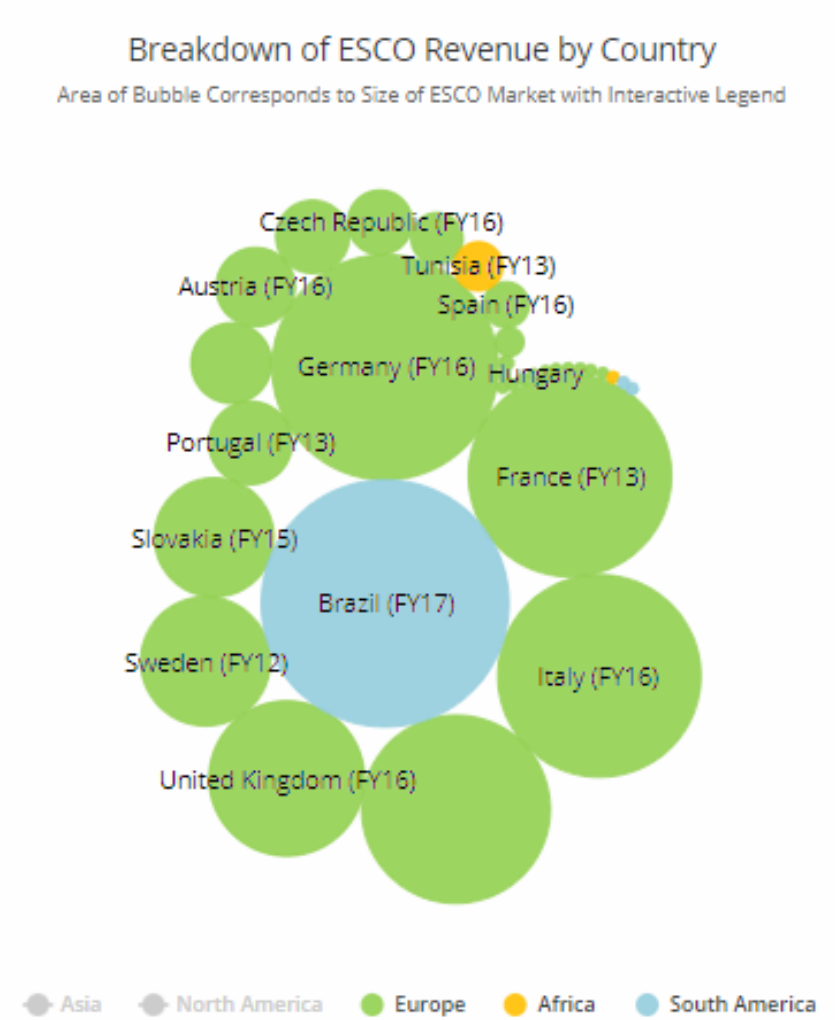


FIGURE 24. ESCO MARKET SIZE BY COUNTRY EXCLUDING NORTH AMERICA & ASIA (IEA ESCO SURVEY 2018)

A4. Indicators of ESCO Market Maturity

The maturity scores are based on a calculation of seven indicators. Following is a review of the seven indicator scores for each country.

A4.1 Market Size / GDP Indicator Scores

In order to improve the ESCO Market Size / Gross Domestic Product (**MS/GDP)** score the ESCO market size must increase, or the GDP must decrease. No recommendations for decreasing GDP are made. China has the highest score in ESCO market size relative to gross domestic product as shown in *Table 16*. Following are recommendations for increasing ESCO market size.

TABLE 16. MARKET SIZE/GDP INDICATOR SCORES

Country	Market Maturity Score	MS / GDP Score	Market Size / GDP
China	55%	1.00	0.131%
Slovakia	39%	0.55	0.072%
Bulgaria	35%	0.43	0.057%
Denmark	39%	0.40	0.052%
Thailand	32%	0.34	0.044%
United States of America	51%	0.30	0.039%
Slovenia	40%	0.27	0.035%
Latvia	34%	0.19	0.025%
Canada	41%	0.17	0.022%
Portugal	22%	0.12	0.016%
Brazil	48%	0.11	0.015%
Ireland	43%	0.09	0.012%
India	32%	0.09	0.011%
Czech Republic	33%	0.08	0.011%
Italy	38%	0.08	0.010%
Austria	35%	0.06	0.008%
France	44%	0.06	0.008%
Germany	42%	0.05	0.007%
Japan	50%	0.04	0.005%
Korea	40%	0.04	0.006%
United Kingdom	38%	0.03	0.004%
The Netherlands	41%	0.02	0.002%
Chile	13%	0.02	0.002%

South Africa	40%	0.02	0.003%
Belgium	37%	0.01	0.001%
Greece	23%	0.01	0.001%
Spain	22%	0.01	0.001%
Mexico	65%	0.00	0.00
Philippines	63%	0.00	0.00

A4.2 Market Size/Pop. Indicator Scores

The same recommendations made for **MS/GDP** can be applied for Market Size / Population (**MS/Pop.**). Scores are shown in *Table 17*.

TABLE 17. MARKET SIZE/POP. INDICATOR SCORES

Country	Market Maturity Score	MS/Pop. Score	Market Size / Population (USD per Person)
Denmark	39%	1.00	29.27
United States of America	51%	0.78	22.90
Slovakia	39%	0.43	12.68
China	55%	0.39	11.51
Canada	41%	0.34	9.96
Slovenia	40%	0.28	8.09
Ireland	43%	0.26	7.61
Bulgaria	35%	0.16	4.71
Latvia	34%	0.13	3.94
Portugal	22%	0.12	3.39
Austria	35%	0.12	3.62
Italy	38%	0.11	3.21
Germany	42%	0.11	3.11
Thailand	32%	0.10	2.91
France	44%	0.10	2.96
Czech Republic	33%	0.07	2.15
Japan	50%	0.06	1.80
Korea	40%	0.06	1.65
United Kingdom	38%	0.06	1.76
Brazil	48%	0.05	1.43
The Netherlands	41%	0.04	1.06
India	32%	0.01	0.23

Chile	13%	0.01	0.33
South Africa	40%	0.01	0.18
Belgium	37%	0.01	0.43
Greece	23%	0.01	0.19
Spain	22%	0.01	0.30
Mexico	65%	0.00	0.00
Philippines	63%	0.00	0.00

A4.3 Organizational Structure (OS) Indicator Scores

In order to raise your Organizational Structure (**OS**) score the percentage of companies in your ESCO market that are subsidiaries of larger corporations must increase. Subsidiary ESCOs typically indicate that large projects as well as financing are available in a market. Brazil has the highest OS score because only subsidiary ESCOs operate there. *Table 18* summarizes the Organizational Structure scores.

TABLE 18. ORGANIZATIONAL STRUCTURE INDICATOR SCORES

Country	Market Maturity Score	Organizational Structure (OS) Score	Subsidiary	Stand Alone
Brazil	48%	1.00	100%	0%
India	32%	0.95	95%	5%
Canada	41%	0.80	80%	20%
Japan	50%	0.77	77%	23%
Korea	40%	0.70	70%	30%
Mexico	65%	0.65	65%	35%
Philippines	63%	0.60	60%	40%
Italy	38%	0.50	50%	50%
Belgium	37%	0.40	40%	60%
Austria	35%	0.35	35%	65%
Germany	42%	0.34	34%	66%
Ireland	43%	0.33	33%	67%
China	55%	0.30	30%	70%

United Kingdom	38%	0.30	30%	70%
United States of America	51%	0.25	25%	75%
Bulgaria	35%	0.20	20%	80%
The Netherlands	41%	0.19	19%	81%
Chile	13%	0.10	10%	90%
Spain	22%	0.07	7%	93%
Denmark	39%	0.00	?	?
Slovakia	39%	0.00	?	?
Slovenia	40%	0.00	?	?
Latvia	34%	0.00	?	?
Portugal	22%	0.00	?	?
Thailand	32%	0.00	0%	100%
France	44%	0.00	?	?
Czech Republic	33%	0.00	?	?
South Africa	40%	0.00	0%	100%
Greece	23%	0.00	?	?

A4.4 Energy Savings (ES) Indicator Scores

In order to raise the Energy Savings (**ES**) score the average energy savings per project must be lowered. The average energy savings per project is typically higher in inefficient countries which have high overall energy intensity. Therefore, ESCOs which are operating in an already efficient environment are rewarded for squeezing the last bits of energy savings from the system. ESCOs which are harvesting the easy to save energy from inefficient systems are still doing great work but are not disproportionately rewarded for inflated energy savings. *Table 19* summarizes the average Energy Savings per ESCO project per country. Following are recommendations for improving the ES score.

TABLE 19. ENERGY SAVINGS INDICATOR SCORES

Country	Market Maturity Score	Energy Savings (ES) Score	Average Energy Savings per Project

South Africa	40%	1.00	12%
Korea	40%	0.99	13%
Japan	50%	0.97	15%
Mexico	65%	0.97	15%
Thailand	32%	0.97	15%
Germany	42%	0.94	17%
Ireland	43%	0.94	18%
India	32%	0.91	20%
Belgium	37%	0.91	20%
Austria	35%	0.91	20%
China	55%	0.91	20%
United States of America	51%	0.91	20%
Bulgaria	35%	0.91	20%
Greece	23%	0.88	23%
Canada	41%	0.85	25%
Philippines	63%	0.85	25%
Italy	38%	0.85	25%
United Kingdom	38%	0.85	25%
The Netherlands	41%	0.81	29%
Latvia	34%	0.80	30%
Spain	22%	0.74	35%
Brazil	48%	0.00	?
Chile	13%	0.00	?
Denmark	39%	0.00	?
Slovakia	39%	0.00	?
Slovenia	40%	0.00	?
Portugal	22%	0.00	?
France	44%	0.00	?
Czech Republic	33%	0.00	?

A4.5 Sector Diversity (S) Indicator Scores

In order to raise the Sector Diversity (S) score overall national ESCOs activity must be split equally among the Industrial, Non-residential, and Residential sectors. Most countries would benefit from increasing ESCO activity in the Residential sector. Non-residential and Industrial sectors are the two sectors ESCOs operate most within. Each country must select applicable recommendations corresponding to national ESCO activity summarized in *Table 20*. Following are recommendations to increase ESCO activity in each sector.

TABLE 20. SECTOR DIVERSITY SCORES

Country	Market Maturity Score	Sector Diversity (S) Score	Residential	Non-Residential	Industry
The Netherlands	41%	0.99	25%	33%	42%
France	44%	0.88	38%	42%	20%
Japan	50%	0.66	25%	70%	30%
Brazil	48%	0.66	53%	10%	38%
South Africa	40%	0.55	8%	30%	60%
Germany	42%	0.55	10%	55%	35%
Ireland	43%	0.44	2%	50%	48%
Belgium	37%	0.44	0%	60%	40%
Czech Republic	33%	0.44	5%	70%	25%
Korea	40%	0.33	25%	0%	75%
Mexico	65%	0.33	0%	30%	70%
Thailand	32%	0.33	0%	25%	75%
China	55%	0.33	0%	33%	67%
Bulgaria	35%	0.33	0%	75%	25%
Philippines	63%	0.33	0%	70%	30%
Italy	38%	0.33	15%	10%	75%
Austria	35%	0.22	10%	80%	10%
United States of America	51%	0.22	7%	86%	8%
United Kingdom	38%	0.22	0%	85%	15%
Chile	13%	0.22	0%	80%	20%
Denmark	39%	0.22	10%	80%	10%
Slovakia	39%	0.22	0%	80%	20%

India	32%	0.00	0%	0%	100%
Greece	23%	0.00	N/A	N/A	N/A
Canada	41%	0.00	0%	100%	0%
Latvia	34%	0.00	N/A	N/A	N/A
Spain	22%	0.00	N/A	N/A	N/A
Slovenia	40%	0.00	N/A	N/A	N/A
Portugal	22%	0.00	N/A	N/A	N/A

A4.6 Contract Duration (CD) Indicator Scores

In order to increase the Contract Duration (CD) score, the average duration of an ESCO contract must increase. Currently the longest average ESCO contract duration is 15 years in the United States of America as shown in *Table 21*. There are efforts to expand the contract lengths upwards of 25 years for specific projects. The longer the contract length is, the greater the expected stability and the guarantee that long term energy savings will be achieved.

TABLE 21. CONTRACT DURATION SCORES

Country	Market Maturity Score	Contract Duration (CD) Score	Avg. Contract Duration (yrs)
United States of America	51%	1.00	15.0
Latvia	34%	0.71	10.6
Ireland	43%	0.68	10.25
Slovenia	40%	0.67	10.1
Germany	42%	0.65	9.675
The Netherlands	41%	0.60	9.0
Philippines	63%	0.60	9.0
Austria	35%	0.58	8.7
Portugal	22%	0.58	8.8
United Kingdom	38%	0.56	8.4
Slovakia	39%	0.54	8.1
France	44%	0.53	8
Czech Republic	33%	0.53	7.995
Belgium	37%	0.51	7.61
Denmark	39%	0.50	7.5

China	55%	0.47	7.0
Spain	22%	0.42	6.3
Italy	38%	0.40	6.0
Bulgaria	35%	0.38	5.66
Chile	13%	0.33	5.0
Japan	50%	0.31	4.6
Mexico	65%	0.31	4.6
Greece	23%	0.29	4.305
Korea	40%	0.22	3.3
India	32%	0.12	1.8
South Africa	40%	0.10	1.5
Brazil	48%	0.00	?
Thailand	32%	0.00	?
Canada	41%	0.00	?

A4.7 Average Project Cost (C) Indicator Scores

In order to increase the Average Project Cost (**C**) score, the cost of the average ESCO project must increase. The highest average project cost is in Dubai at $3,630,000 as shown in *Table 22*. The more expensive the average project; the greater the indication that financing is available in the ESCO market.

TABLE 22. AVERAGE PROJECT COST SCORES

Country	Market Maturity Score	Project Cost (C) Score	Average Project Cost (USD)
UAE, Dubai	56%	1.00	$3,630,000
Mexico	65%	0.83	$3,000,000
United Kingdom	38%	0.72	$2,600,000
Philippines	63%	0.64	$2,325,000
United States of America	51%	0.63	$2,300,000
Slovenia	40%	0.57	$2,070,500
Japan	50%	0.47	$1,715,000

China	55%	0.47	$1,700,000
Czech Republic	33%	0.45	$1,648,000
France	44%	0.43	$1,573,500
Canada	41%	0.34	$1,240,000
Italy	38%	0.33	$1,210,000
Austria	35%	0.33	$1,200,000
South Africa	40%	0.33	$1,190,000
Slovakia	39%	0.33	$1,185,000
Korea	40%	0.31	$1,120,000
Germany	42%	0.30	$1,082,000
Belgium	37%	0.28	$1,014,000
Spain	22%	0.25	$898,000
Thailand	32%	0.20	$732,000
Portugal	22%	0.18	$671,000
Greece	23%	0.17	$631,000
Latvia	34%	0.15	$543,000
The Netherlands	41%	0.09	$310,500
Bulgaria	35%	0.08	$296,000
Brazil	48%	0.04	$137,500
India	32%	0.03	$100,000
Chile	13%	0.03	$100,000
Denmark	39%	0.00	?
Ireland	43%	0.00	?

A5. Country Level SWOT Analysis

A5.1 China SWOT

China's ESCO market is classified as Mature. The ESCO market in China is driven by consistent government policies and multi-year energy savings targets designed to achieve China's energy security and climate goals (Cho 2017). China's ESCO development can be broken down into four steps. Pilot, Promote, Develop, and Upgrade. The Pilot phase was when EPCs were introduced and Pilot ESCOs launched. The Promote phase revolved around the establishment of the China Energy Conservation Service Industry Association (EMCA). Develop phase was the promotion of national support policies. The Upgrade phase provided continual support to successful programs (China ESCO Industry Association 2015)

The Chinese ESCO market was built on the premise of financial incentive mechanisms which paid ESCOs for meeting set energy savings and emission reduction targets. This resulted in the world's largest ESCO market, $16 billion, composed of 6439 ESCOs. Typical ESCO projects include lighting, heating network, boilers, and central air conditioning improvements within the non-residential, 67%, and industrial, 33%, sectors. Energy performance contracts Guaranteed Savings and Shared Savings contracts are used equally while other contracting types are used including financial leasing or Build, Own, Operate, Transfer (BOOT Model).

Figure 25 shows the SWOT analysis for the Chinese ESCO market.

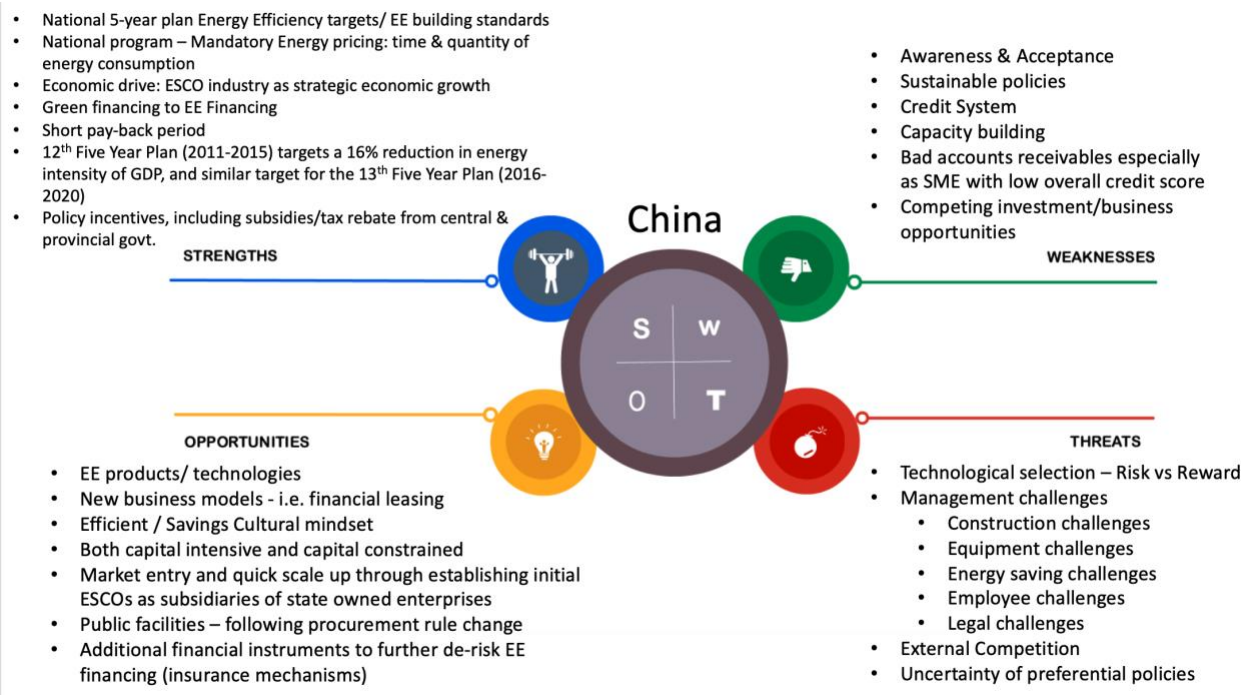


FIGURE 25. CHINA ESCO MARKET SWOT ANALYSIS ((CHO 2017); (EMCA 2015); (MURAKOSHI AND NAKAGAMI 2009); (IEA 2018))

China - Strength

The Chinese ESCO market is the direct result of sustained government support and the Chinese industry structure. The Chinese industry is largely state owned which allowed for pilot ESCOs to be established as a subsidiary of the state owned industrial energy consumers, essentially guaranteeing a steady stream of business. Combined with clear continuous support of the ESCO concept has resulted in the world's largest ESCO market.

Sustained Government Support

The first nationwide plan which incorporated the ESCO concept - 'Announcement concerning Further Promoting EPC in China' - was put forward in June 2000 by the former Department of Resources Conservation & Environment Protection of the State Economic and Trade Commission (Cho 2017).

In the early 2000s various pilot projects were conducted. One pilot project was The China Energy Efficiency Project (CEEP). Between 1998 and 2003 MEEP founded NECIDC (NDRC Energy Conservation Information Dissemination Centre and three ESCOs. Between 2003 and 2008, the MEEP created a loan guarantee system for liabilities, and founded the ESCO association, China Energy Conservation Service Industry Association (EMCA) (Murakoshi and Nakagami 2009).

The loan guarantee system prefers projects with short payback periods of less than two years. The payback period of an ESCO project is the annual energy cost savings divided by total capital cost. The loan guarantee program is a driver of the Chinese ESO market and projects with short payback periods are still common.

On October 28, 2007, the amended Law of the People's Republic of China on Energy Conservation granted legal status to ESCOs (Cho 2017). This legal protection allowed for access to preferential financing.

Regulations on Energy Conservation by Public Institutions passed in the 18th Executive Meeting of the State Council were put into force on October 1, 2008. These regulations allowed public institutions to engage with ESCOs (Cho 2017).

On April 2, 2010, the Opinions on Expediting the Implementation of EPC for Promoting the Development of the ESCO Industry (GBF [2010] No. 25) was issued by the National Development and Reform Commission, the Ministry of Finance, People's Bank of China, and the State Administration of Taxation. The Opinions supported four different aspects relating to the development of EPC business; financial incentive, taxation support, accounting policies, and financial services. GBF [2010] No. 25 also marked a decade of sustained public ESCO support (Cho 2017).

On June 3, 2010, the Ministry of Finance and the National Development and Reform Commission issued the Notice on Interim Measures of Issuing Financial Incentive Fund Management for EPC (CJ [2010] No. 249). CJ [2010] No. 249 allocated CNY 2 billion to support ESCOs operating within industry, construction, transportation, or public institutions. CJ [2010] No. 249 was the first instance of China's using special incentive funds specifically for ESCOs (Cho 2017).

On December 30, 2010, the Ministry of Finance and the State Administration of Taxation issued the Notice on Policy Issues of Value-added Tax, Business Tax, and Business Income Tax for Promoting the Development of the ESCOs Industry (CS [2010] No. 110). This notice excluded ESCOs from income taxes for the first three years they operated and gave a 50% deduction on income taxes for the following three years (Cho 2017).

Both the 12th (2011-2015) and 13th (2016-2020) Five Year Plans expect a 16% reduction in energy intensity of GDP. Clients will need ESCO services to meet these targets. ESCOs will widen its scope of service from industrial services into the commercial space.

Expanded market size and service offerings using innovative contracts.

When ESCOs were first introduced in China the only contract type used was EPC Shared Savings. As of 2018, there are four main contracts used by ESCOs; energy saving sharing, energy saving guarantee, energy service outsourcing, and financial leasing. The percentage breakdown of contract usage is shown in *Figure 26*. Energy saving sharing model is still used for 48% of contracts, but it has been decreasing year by year. The diversification and combination of contracting models is a sign of ESCO markets increasing capacity to implement a wide range of energy savings projects. Such flexibility aids ESCOs in overcoming

challenges such as unclear project boundaries, unknown energy saving amount, as well as disputes on receivables (ESCO Committee of China Energy Conservation Association (EMCA) 2018).

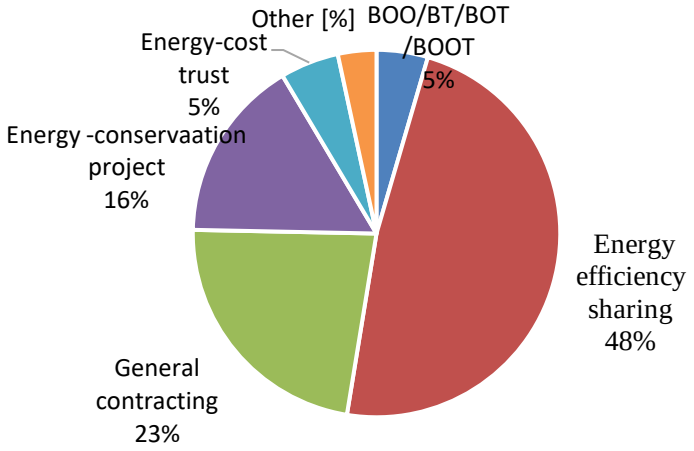


FIGURE 26. CONTRACTS USED IN CHINESE ESCO MARKET (ESCO COMMITTEE OF CHINA ENERGY CONSERVATION ASSOCIATION (EMCA) 2018)

China – Weakness

Lack of Top Talent

The Chinese ESCO market employees 500,000 people and is growing. ESCOs have a difficultly finding and retaining top talent. 2010 is consistently mentioned as a year when talent shortages were first noticed. As of 2018, nearly half of the ESCOs reported difficulty in hiring personnel and increasing labor costs (ESCO Committee of China Energy Conservation Association (EMCA) 2018)

"Training Project for Talents of the ESCO Industry during the Twelfth Five-year Plan Period" is a program aimed at training more employees for the ESCO market and partner industries such as financial institutions, legal agencies, and third-party energy efficiency measuring and monitoring institutions. This is a good compliment for the stream of employees which are currently trained by the university system in technology, engineering construction, project management, risk control, big data, and Internet of Things.

Defaulting on Credit

Financing is available and interest rates are low. As ESCOs are continually operating and taking out debt based on anticipated future payments, an ill-timed client credit default or internal financial mismanagement can be a major threat to ESCO operations. Chinese ESCOs should be wary of taking on too much collateralized debt or contracting with small industrial clients or others with low credit capabilities.

Capacity Building

Chinese ESCOs have done a good job of convincing the government to support the ESCO concept. Experts have suggested that there was an over reliance on government subsidies (IEA, 2018). There is now a need for increased capacity building and guidance of the industry.

Lack of Sector Diversity

ESCOs in China have a Sector Diversity Score that is 0.04 less than average. Referring to *Figure 27* there is little activity occurs in the in the residential sector (IEA 2018).

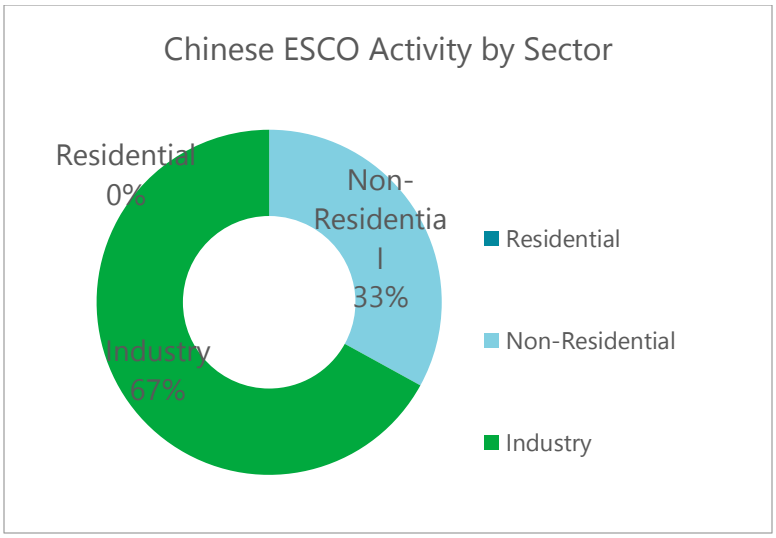


FIGURE 27. CHINESE ESCO ACTIVITY BY SECTOR (IEA 2018)

China – Opportunity

Because China is a huge market which needs to reduce its emissions in order to achieve sustainable growth the ESCO business model is very attractive. ESCOs in China are both capital intensive and capital constrained (Cho 2017). This makes China a target market for financiers.

Expansion of Financing Options

As the Chinese government sets higher and higher requirements on energy conservation and environmental protection the concept of "green finance" has become accepted due to the policy encouragement and the potential for profit. There is an opportunity for existing financiers to expand operations or publish past credit risk information such as interest rates and return on investment (ROI) of past projects.

Plenty of financing options exist but not every ESCO has ease accessing existing options. Chinese ESCOs can find financing with SPD Bank, The Export-Import Bank of China, Bank of Dalian, Bank of Hebei, Bank of Tianjin, Bank of Changhai, Bank of Hangzhou, Huaxia Bank, China Everbright Bank, and China Development Bank. ESCOs have also been supported by international development finance institutions such as World Bank, IFC, Asian Development Bank.

For example, the World Bank and Huaxia Bank have implemented the "Beijing-Tianjin-Hebei Air Pollution Control Financing Innovation Project", which relies on project loans, financing leases and funds. Another example is the joint project "The Air Quality Improvement in the Greater Beijing-Tianjin-Hebei Region - China National Investment and Guaranty Corporation's Green Financing Platform Project" between Asian Development Bank China Investment & Finance Guarantee Co., Ltd. (I&G). This project relies on entrusted loans, green finance leases and direct investments, and SPD bank's green financing system (ESCO Committee of China Energy Conservation Association (EMCA) 2018).

Pay Attention to Government Legislation

Both the 12th (2011-2015) and 13th (2016-2020) Five Year Plans expects a 16% reduction in energy intensity of GDP. The Twelfth Five-year Plan for Energy Saving and Emission Reduction, approved on July 11, 2012 calls out EPCs as a key solution to meeting energy intensity reduction targets.

Both National and provincial spending is increasing to meet Five Year Plan targets. For example, the Energy Savings Funds (ESF) has increased from a one-time subsidy of CNY 250 per annual ton of coal

equivalent (tce) of energy savings to CNY500 – 600 per tce per year in Beijing and Shanghai municipalities (Cho 2017).

Such policy objectives are effective. Following the announcement of the 12th Five Year plan in 2011 an additional 695 ESCOs registered with the Ministry of Finance bringing the number of companies providing energy savings services to 3,900 companies with over 500,000 employees/ The 12th Five Year Plan is estimated to have saved 60 million tce.

Towards the end of the 12th Five Year Plan in December 2015, five different subsidies and financial incentive schemes from central government agencies, which previously rewarded ESCOs for the energy savings they achieved, were phased out (Alliance for an Energy Efficient Economy 2017). Provincial and local government subsidies remained largely intact. Phasing out of subsidies by the central government is an attempt to shift the industry from a policy-driven environment to a market-driven environment. The continued success of the Chinese ESCO market since December 2015 is a sign of ESCO market maturity. The removal of subsidies is also an opportunity for ESCOs with a competitive advantage to increase their market share.

Digitalization trend

Digital technologies, encompassing artificial intelligence (AI), the Internet of Things (IoT), virtual reality, and blockchain, continues to change in the economy at large, structure of industry, and market demand through new/changing service offerings and innovation in business models (EMCA 2019).

The opportunities for ESCOs lie in the potential long-term management arrangement facilitated by digitally interconnected systems. Another opportunity for ESCOs from digitalization is the use of tools such as big data, cloud computing and IoT will also enable ESCOs to improve existing service offerings, such as energy savings M&V, and develop new services (EMCA 2019).

Integrated Energy Services

Chinese ESCOs have the opportunity to respond to client demand for integrated energy services. The Energy Research Institute of the National Development and Reform Commission (NDRC) has proposed that integrated energy services include eight market segments: integrated energy transmission and distribution service market, power market trading service market, distributed energy development and supply service market, integrated energy system construction and operation service market, and energy efficiency service market, environmental energy service market, integrated energy storage service market and integrated intelligent energy service market (ESCO Committee of China Energy Conservation Association (EMCA) 2018).

China – Threat

Increased Competition

External competition in the form of companies from energy intensive industries offering services typically reserved for ESCOs is increasing. Additional demands are being placed on ESCOs by their clients. Whereas clients used to appreciate ESCOs simply replacing their inefficient equipment, they now demand ‘integrated energy services’.

Increased competition causes management challenges and heightens the risk surrounding business decisions such as project or technology selection. In a subsidized market place where there is little competition for projects, there is greater room for error, no longer. What used to be a routine construction delay could now throw off an entire project. As more ESCOs enter the market, there will also be increased competition for employees. These are issues facing any industry but particularly the fast growing ESCO industry.

Legal challenges

Legal challenges should also be expected as any market grows and disagreements about energy savings or owed energy payments between the client, ESCO, and financier abound. This typically stems from non-standardized M&V or difficulties in quantifying the true benefit of a project due to interrelated factors. For instance, an improvement of energy efficiency at the energy source would decrease the on-paper emissions savings of an energy user; as the output of the energy source is the same with less input.

Another legal challenge to be dealt with within the public sector is the budget regulation and purchase system. Currently EPCs leave multiple questions unanswered related to how public institutions enter energy savings into budget accounts. When dealing with state owned asset evaluations, there are many complications.

Digitalization Barriers

Data access and ownership is a core challenge to increasing the role of digital technologies in energy management systems. Privacy and individual data ownership rights must remain an upfront issue.

Currently, there are few technologies which communicate and share data easily. There is especially a lack of technology to coordinate the conversion of different types of energy. It is difficult to clearly evaluate the economic and social benefit brought about by complementary management of energy sources (EMCA 2019).

A5.2 United States of America SWOT

United States' ESCO market is classified as Mature. The United States of America is home to the second largest ESCO market consisting of 48 ESCOs which contribute to a $7.6 billion market. 46% of ESCO projects are completed for the government. Another 34% of ESCOs projects come from schools and universities. Those government and education facilities are the backbone of the United States' ESCO market. 85% of projects are executed in the public sector with the remaining 15% in the private sector. ESCOs in the United States use a modified version the EPC called Energy Supply Performance Contract (ESPC) for the majority of contracts. ESPC projects provide quantifiable cost savings beyond what is typically monetized within contractual constraints, including non-energy-related cost savings such as those shown in Figure 4 (Larsen et al. 2012; Larsen et al. 2014). *Figure 28* shows the SWOT analysis for USA's ESCO market.

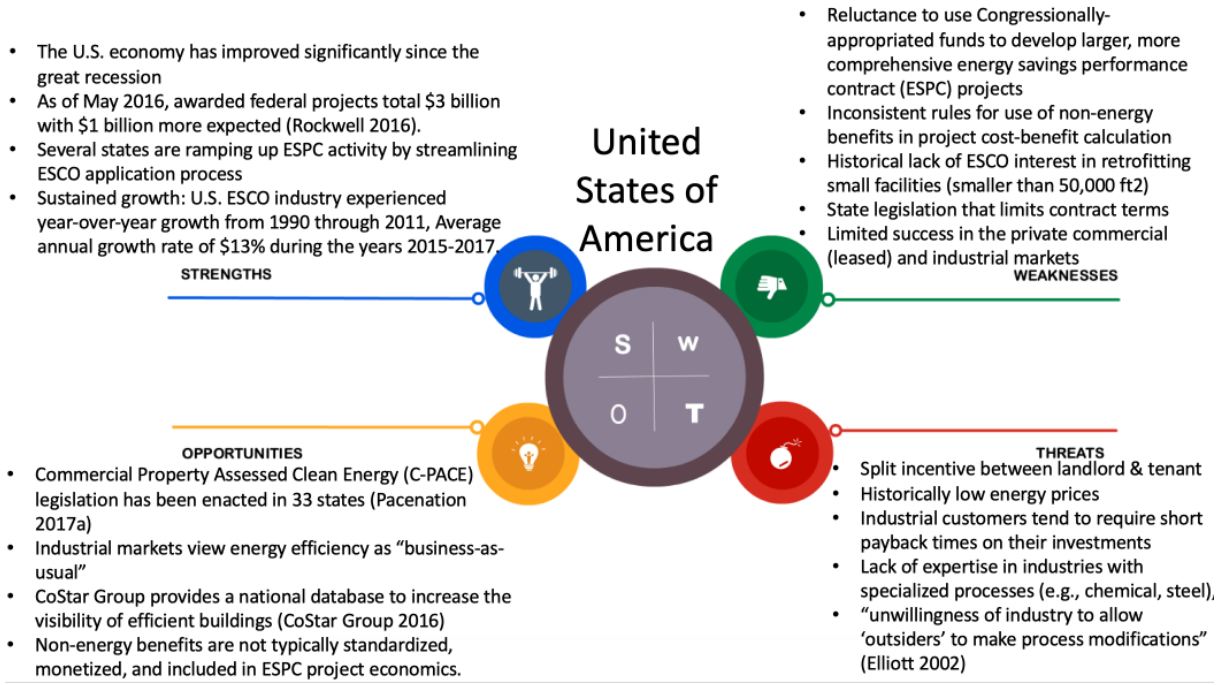


FIGURE 28. UNITED STATES ESCO MARKET SWOT ANALYSIS

United States – Strengths

The United States has a very healthy ESCO market and is looked at as a model for ESCOs around the world. ESCOs in America are heavily dependent on government support. Across all market sectors, more than half of the ESCOs serving each market reported use of tax benefits. More than 85% of the respondent ESCOs in the state/local, K–12 and university/college sectors report using tax benefits (Stuart, Carvallo, et al., U.S. Energy Service Company (ESCO) Industry: Recent Market Trends 2016).

Government dependence is due to the incentives and legislation, such as the 2007 Clinton Climate Initiative's (CCI) Energy Efficiency Building Retrofit Program (EEBRP) which brings together ESCOs, global financial institutions, the suppliers of energy efficient equipment, and municipal, commercial, and educational building owners to reduce energy consumption in existing buildings. Another policy that changed how the public sector could borrow debt with preference to the energy service market was the Dodd Frank Act (IEA 2019). As of May 2016, the federal government had awarded ESCOs a total of $3 billion with $1 billion more expected in EPCs (Rockwell 2016).

Other practices that contribute to the success of the ESCO market are the preferential interest rates

on loans for energy related projects as created by the 2005 Energy Policy Act (Government Publishing Office 2005). Rigorous reporting standards that occur on both federal and state levels including impact assessments of each ESCO project helps provide success stories and share best practices throughout the industry and demonstrate the value of each ESCO project to the local community.

The US ESCO market has experienced sustained growth over the past three decades. Average annual growth rate was 13% between 2015-2017. Between 2000 and 2004 there was a downturn in the US ESCO market due to electric industry restructuring, fallout from the Enron bankruptcy raising concerns about energy project accounting methods; and, a sunset of enabling federal ESPC legislation in 2003 (Hopper et al. 2007). However, the market has since recovered and several states are ramping up ESPC activity by streamlining ESCO application process.

United States – Weakness

The weaknesses of the US ESCO market are common to most developed ESO markets and can be categorized into market, institutional, and regulatory weaknesses.

Market

ESCOs have historically preferred working on projects with floor areas greater than 50,000 ft2. The result is that projects with smaller floor areas have not been retrofitted by ESCOs. Smaller projects have smaller price tags and are not worth the administrative costs. Project bundling is a possible solution is conjunction with eliciting excitement from owners of those smaller buildings to engage with ESCOs.

ESCOs have had limited success undertaking projects in the private commercial (leased) and industrial markets. This is not due to an inability for ESCOs to work in these segments but due to the beneficial legislation supporting the ESCO industry in the public sector. Cracking open the small private residential and industrial sector would be a great market expanding move in USA.

Institutional

Institutional barriers for the US ESCO market are that some large projects are passed over due to political sensitives of leveraging appropriations to complete multi-year ESCO projects. This results in project investment levels being lower without appropriation funds.

Regulatory

The multiple benefits of energy efficiency projects are not standardized, monetized, and included in pay-back calculations. Without including the true returns of the ESCO projects, investment levels are lower. ESPC projects are being used for maintenance needs such as asbestos removal, roof or wiring replacement (Larsen et al 2012). While such projects provide important non-energy benefits, they do not generate energy savings. To make the ESPC viable, the non-energy benefits must be monetized.

Energy savings are at risk of being inflated when markets expect energy prices to increase over the long term. When clients expect energy prices to increase, they may agree to increase expected energy savings by 2-3% annually over the life of the contract. Both assumptions of increased energy prices and energy savings may not come to fruition and inflate the dollar value of savings for projects. (Stuart, Carvallo, et al., U.S. Energy Service Company (ESCO) Industry: Recent Market Trends 2016). To combat such practices contract length for projects in the federal and MUSH markets are also constrained by regulation. Limiting contract lengths causes project investment levels to be lower.

Lack of Sector Diversity

ESCOs in the United States have a Sector Diversity Score that is 0.15 less than average. Referring to *Figure 29,* 86% of ESCO activity takes place in the non-residential sector including projects with the

Federal Government, Healthcare, K-12 Schools, State/Local Government, and Universities/Colleges. Little activity occurs in the in the residential or industrial sector.

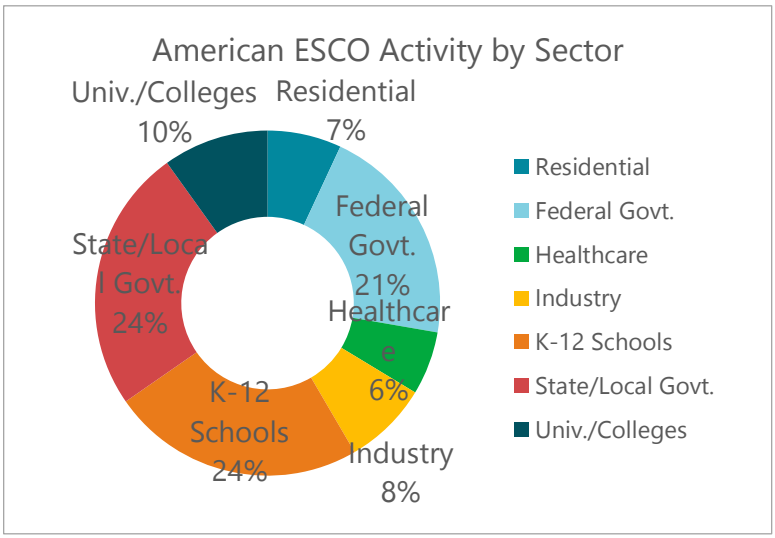


FIGURE 29. AMERICAN ESCO SECTOR DIVERSITY (IEA 2018)

United States – Opportunities

Uncertainty of future gas and electricity prices may create market activity for US ESCOs. Facility managers must balance future budgets and a way to stabilize expected energy costs is by working with an ESCO. ESCOs allow facility managers to hedge a portion of their future costs, by converting a variable expense, energy bills, into a long-term fixed expense, repayment to ESCOs for project costs minus energy savings (Stuart, Carvallo, et al., U.S. Energy Service Company (ESCO) Industry: Recent Market Trends 2016). However, as natural gas prices are expected to remain low due to hydraulic fracking, the perceived benefit is less at the moment. (Stuart, Carvallo, et al., U.S. Energy Service Company (ESCO) Industry: Recent Market Trends 2016)

Other opportunities for US ESCOs always come from working with and staying informed of federal, state, and local government policy updates for energy efficiency and EPCs.

United States – Threats

Companies which do not meet the definition of ESCOs, because they do not use EPCs or are not registered, are completing projects which historically only ESCOs have. Additional competition is over non-technical projects such as lighting, HVAC equipment and controls. This may be due to a decrease in perceived risk of relying on the projected energy savings to repay the cost of current retrofits. Price drops in LEDs or PV cells also make such projects more attractive. De-risking energy efficiency improvement projects and the ESCO concept is a victory for the US ESCO market (Stuart, Carvallo, et al., U.S. Energy Service Company (ESCO) Industry: Recent Market Trends 2016)

Another threat is that the easy to complete ESCO projects may have already been completed. Plenty of smaller projects, <$500,000, with local governments and school districts exist but have not been attractive to larger ESCOs due to high transaction costs and small overall profits. Projects which may be feasible but have difficult administrative barriers such as New York and Philadelphia K–12 schools, Michigan prisons, and California state government facilities may need to be revisited. Finally, projects with non-financial savvy owners may require a new business model or best practices to be developed (Stuart, Carvallo, et al., U.S. Energy Service Company (ESCO) Industry: Recent Market Trends 2016)

A constant threat to ESCOs and ESPC is the accurate modelling of future energy savings costs based on variable future energy prices. The benefit of ESCOs for governments, schools and universities is that they can offload risk to ESCOs and provide a guaranteed energy budget. Documenting and submitting a guaranteed energy budget prevents it from being cut even if annual tax revenue varies or government programs end. (Stuart, Carvallo, et al., U.S. Energy Service Company (ESCO) Industry: Recent Market Trends 2016)

A5.3 Japan SWOT

Japan's ESCO market is classified as Mature. There are 80 ESCOs contributing to a $227 million ESCO market. Most projects last five years and are completed within the private non-residential sector. Energy Supply Contracts Shared Savings are used for 54% of all ESCO projects while EPC Guaranteed Savings are used for 36% (IEA 2019). *Figure 30* shows the SWOT analysis for the Japan's ESCO market.

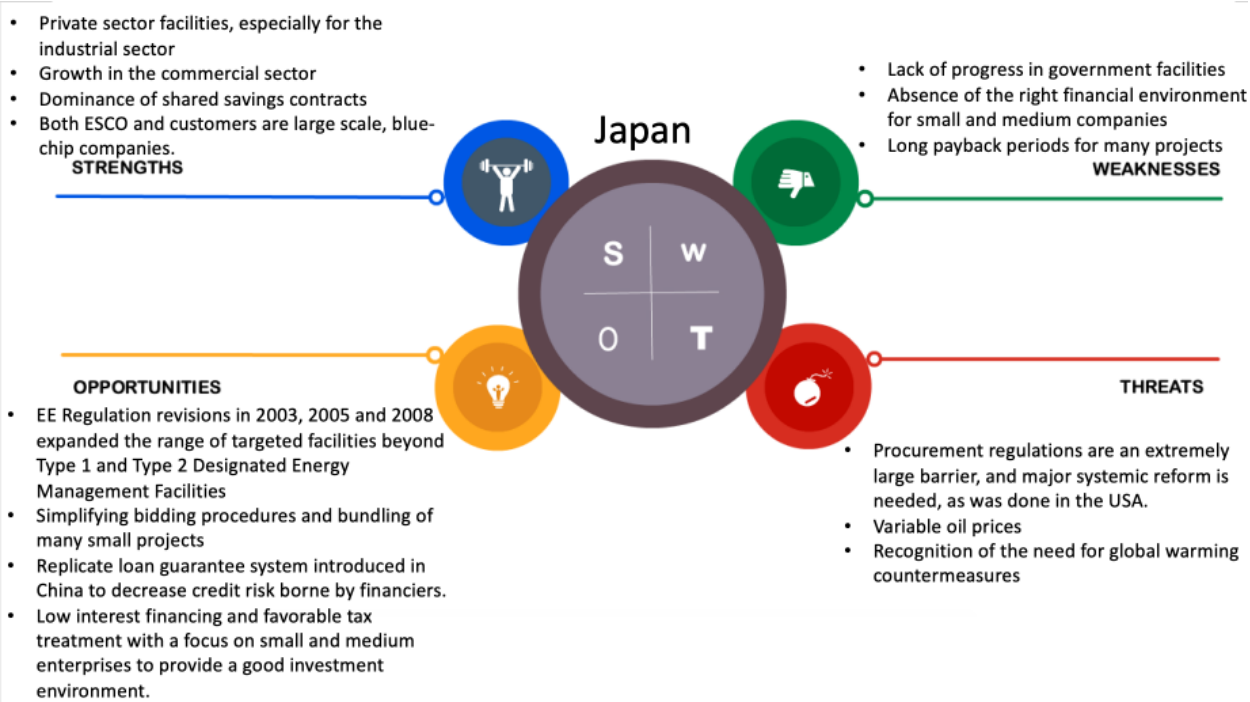


FIGURE 30. JAPAN ESCO MARKET SWOT ANALYSIS

Japan – Strength

The Japanese Association of ESCOs (JAESCO) is an active supporter of the ESCO system. JAESCO has spurred government initiative and regulation for energy efficiency (Murakoshi and Nakagami 2009). Such coordination earned Japan early success. Pilot projects were conducted as early as 1998 as a result of government subsidies allowing for free energy efficiency audits.

The Private sector facilities, especially within the non-residential sector has grown since the late nineties. Clients such as blue-chip companies, in the commercial sector have allowed ESCO in Japan to become large (Murakoshi and Nakagami 2009). 77% of ESCOs in Japan are subsidiary organizations which take on large and long-term projects (IEA, 2019).

Japan has also taken the lead on organizing seminars and international ESCO conferences. In 2005, JAESCO and the Energy Conservation Centre Japan (ECCJ) organized the first Asia ESCO Conference in Bangkok. Two years later the second Asia ESCO Conference was organized in Beijing. The organization of conferences has continued over the past decade.

Japan – Weakness

While long payback periods do allow for projects to be bigger, they also add a level of uncertainty. Balancing the energy savings and payback period of ESCO projects is a challenge in Japan. This is also a reason that small and medium sized companies are absent from the ESCO market. If government facilities were opened to ESCOs this may allow smaller ESCO markets to get a foothold in the market. Japan's

financing structure is well-suited for large ESCOs with large projects but does not have an appropriate financing channel for small and medium sized ESCOs (Urmee and Urmee 2018).

Japan – Opportunity

Japan has the opportunity to expand its ESCOs market into industrial facilities. The Japanese industrial sector pays some of the highest electricity prices in the world as shown in *Figure 31*. The high energy prices are due to a reliance on imported energy. When energy prices are high, energy efficiency improvements become more economical as the cost savings are greater. This is an opportunity for Japanese ESCOs to position their services as a cost savings and environmentally friendly business investment.

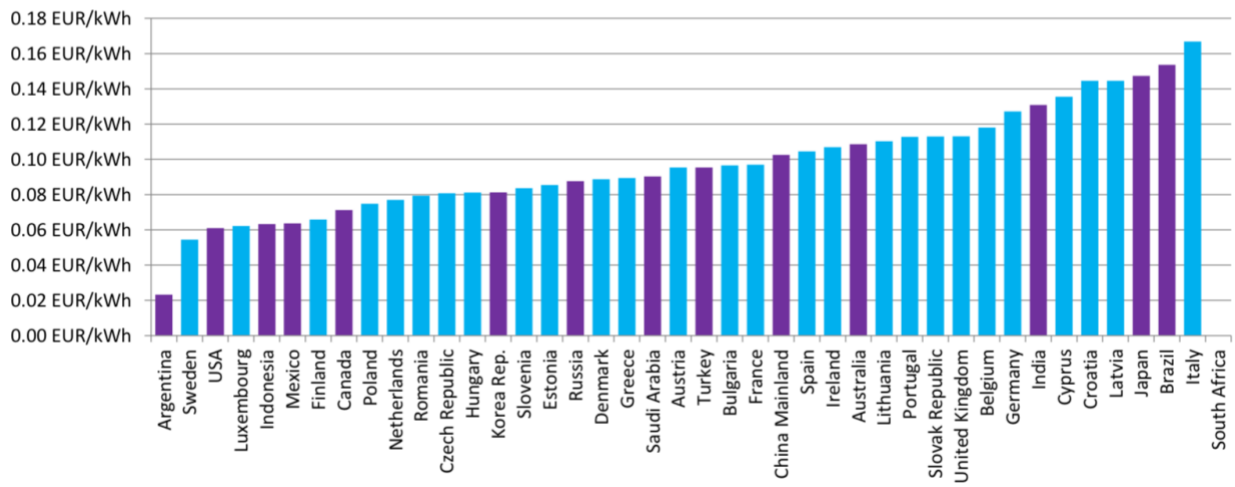


FIGURE 31. ELECTRICITY PRICES FOR INDUSTRY IN EU AND G20 IN 2016 - SOURCE: IMD, EUROSTAT, CEIC, ACCC - (EUROPEAN COMMISSION 2019)

Standards and regulations should be continually updated to keep pace with technological innovation. EE Regulation have been revised in 2003, 2005 and 2008 to match the services offered by ESCOs.

There is a chance for ESCOs in Japan to simplifying bidding procedures and allow for bundling of small projects. As the Japanese ESCO market is similar in maturity to the Chinese ESCO market, there is an opportunity to replicate the loan guarantee system introduced in China. Any opportunity to lower interest rates and provide favorable tax treatment especially for smaller ESCOs would help the Japanese ESCO market.

Japan – Threat

Threats to the Japanese ESCO market are primarily strict procurement regulations. The bidding process is anti-competitive and could benefit from adopting a bidding structure similar to that which ESCOs in the USA use.

Unpredictable energy prices prevent ESCOs from achieving long term energy savings and reduces the value of ESCO services in the eyes of clients looking to offload budgetary risk.

While local governments are engaging with ESCOs the federal government is notably not. Small local projects are not very attractive due to limited profits and limited energy savings (Murakoshi and Nakagami 2009).

A5.4 Germany SWOT

Germany's ESCO market is classified as Mature. There are more than 500 ESCOs contributing to an $8 billion ESCO market which includes energy advice, contracting, and management services. Approximately 85% of all German ESCO projects use energy supply contracts. 75% of the ESCO activity occurs in the public sector. 55% of ESCO projects are non-residential, 35% are within industry, and 10% are residential projects. This diversity of sectors is impressive for an energy intensive manufacturing and export driven economy (Urmee and Urmee 2018). *Figure 32* is the SWOT Analysis for the German ESCO market.

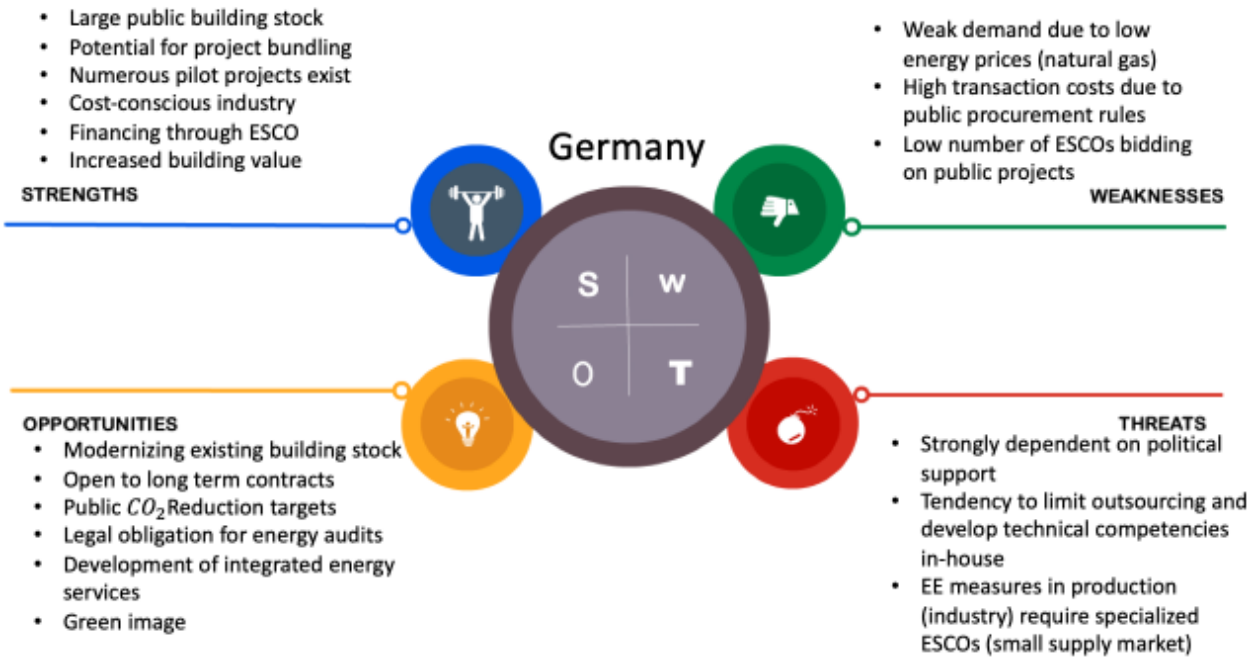


FIGURE 32. GERMAN SWOT ANALYSIS

Germany – Strength

The strength of the German ESCO market is the result of multiple complementary market characteristics. National and European legislation drive the ESCO market in Germany. ESCO advocacy groups have proliferated throughout Germany. And, excellent organizational and logistical management has coordinated project financing for ESCO projects since the 1990s.

Legislation which structures the German ESCO market is Law EDL-G (Gesetz über Energiedienstleistungen und andere Energieeffizienzmaßnahmen. The German Energy Agency (dena) and other local energy agencies such as the Berlin Energy Agency (BEA) promote energy efficiency services in the framework of national and European programs and initiatives. For example, the BEA conducts the German aspect of the European Energy Service Initiative Towards the EU 2020 Energy Saving Targets. Through seminars, training programs and workshop for the promotion of energy services these organizations help overcome non-technological barriers for the ESCO industry such as the lack of systematic information, trust, procurement procedures, or the lack of market facilitators (IEA 2019).

Germany – Weakness

The weakness of the German ESCO market is weak client demand due to low gas prices in both the industrial and the residential sector (QualitEE 2017). 50% of respondents to the QualitEE energy

services survey cited low energy prices and lack of customer demand as a barrier to ESCO business in Germany. *Figure 33* shows that Germany gas prices in the residential sector of 60 eurocents per kilowatt hour7 (kWh) is less than the EU average of nearly 70 eurocents/KWh.

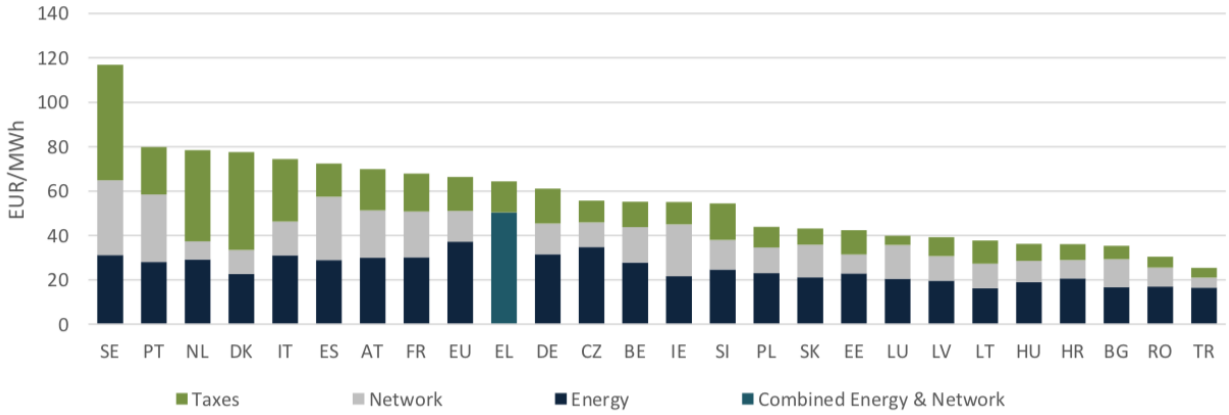


FIGURE 33. RESIDENTIAL GAS PRICES IN 2017 — SOURCES: DG ENER IN-HOUSE DATA COLLECTION (EUROPEAN COMMISSION 2019)

Figure 34 shows that German energy prices within the industrial sector of 30 eurocents/kWh are approximately the same as the EU average. Please note the difference in price that residential and industrial energy consumers pay for gas. Such industrial tax exemptions are made in the name of increasing the competiveness of German industry in the global market place. Furthermore, note the lower taxes imposed upon large energy industrial consumers, column labeled '15', compared to medium energy industrial consumer, column labeled '13'.

Low gas prices are sustained due to plentiful reserves and the construction of infrastructure projects such as the NordStream 2 guaranteeing Russia's role as a German energy provider. Expansion of global distribution of liquefied natural gas has also provided gas price stability.

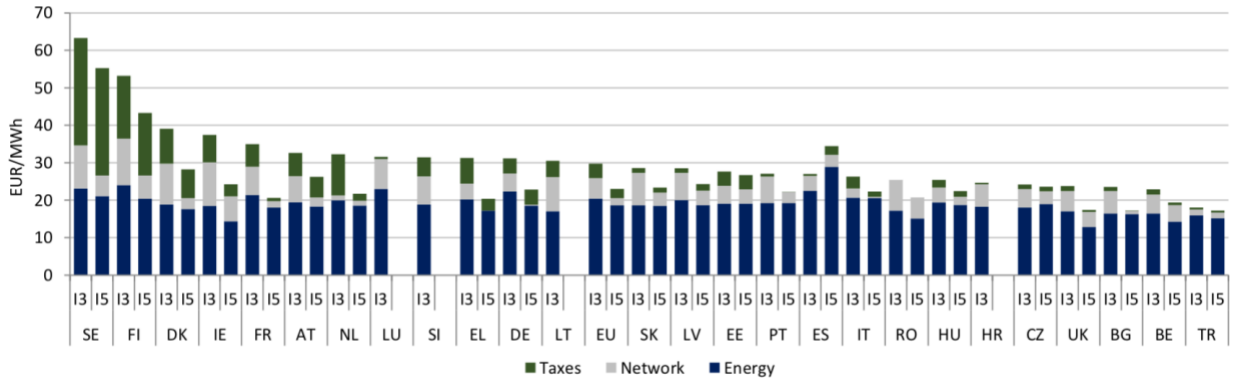


FIGURE 34. MEDIUM AND LARGE INDUSTRIAL GAS PRICES IN 2017 — SOURCE: DG ENER IN-HOUSE DATA COLLECTION (EUROPEAN COMMISSION 2019)

Other weaknesses in Germany are typical of most other European ESCOs. There are high transaction costs due to public procurement rules which was cited as a barrier by 60% of respondents (QualitEE 2017). This translates to a low number of ESCOs bidding on public projects.

Overall the German ESCO industry is strong. For example, 86% of German respondents in 2015 cited lack of information or complexity of concept as a barrier for ESCO market development, shown in *Figure 35*. Through the actions of the national and regional energy agencies and ESCO associations this is a barrier

that has progressively decreased over the years. This can be seen by the 19% decrease in the number of respondents citing complexity/lack of information as a main barrier in 2017 (QualitEE 2017).

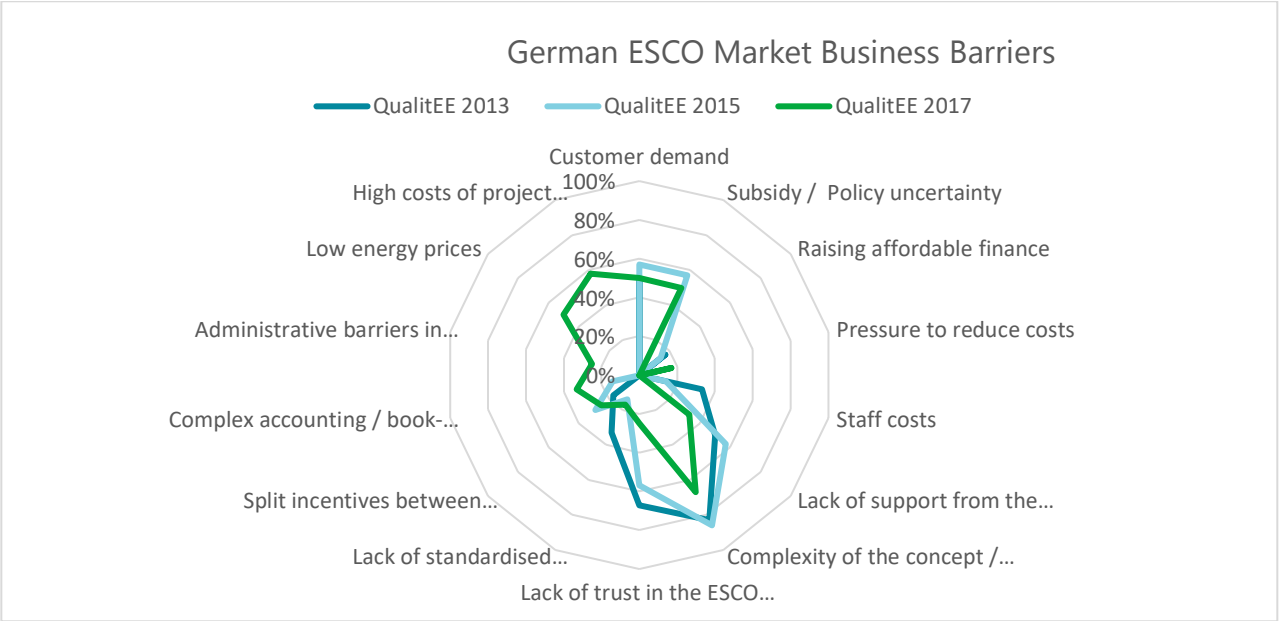


FIGURE 35. GERMAN ESCO MARKET BUSINESS BARRIERS (QUALITEE 2017)

Germany – Opportunity

While they have low gas prices, Germany has the highest electricity prices in Europe in both the residential and industrial sectors (European Commission 2019). *Figure 36* shows that electricity prices within the residential sector are 30 eurocents/KWh compared to the EU average of nearly 20 eurocents/kWh.

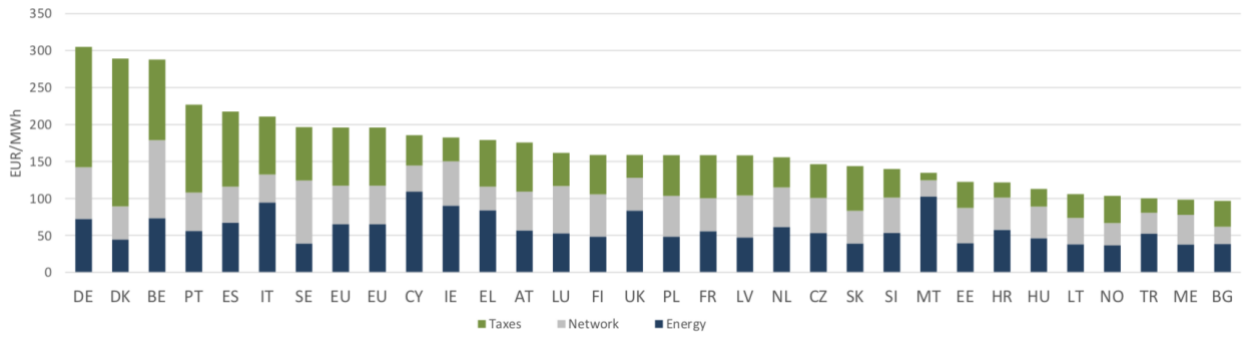


FIGURE 36. RESIDENTIAL ELECTRICITY PRICES IN 2017 — SOURCE: DG ENER IN- HOUSE DATA COLLECTION (EUROPEAN COMMISSION 2019)

Reviewing *Figure 37* shows that within the industrial sector electricity prices are 14 eurocents/kWh compared to an EU average of approximately 10 eurocents/KWh. High electricity prices increase the financial incentive to engage with ESCOs.

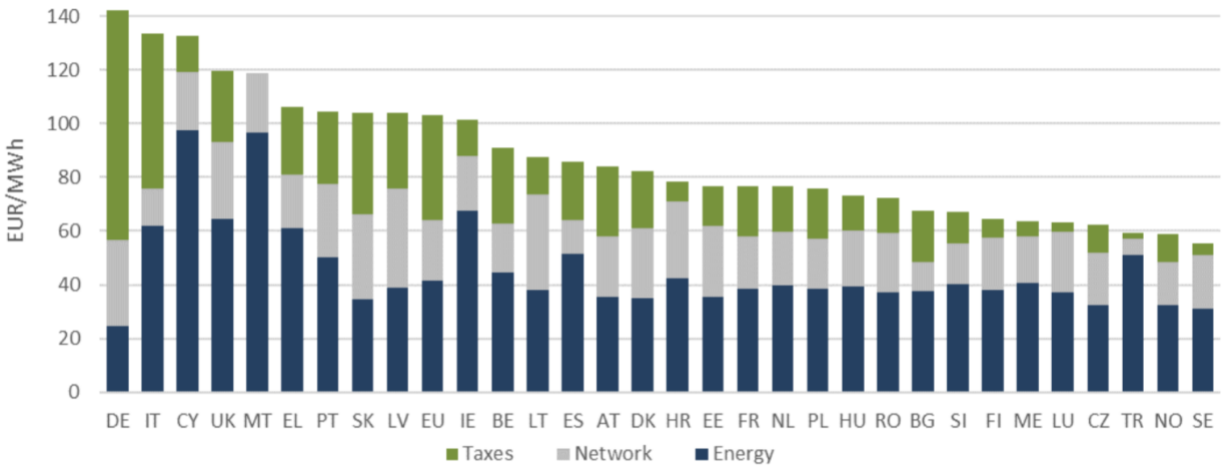


FIGURE 37. INDUSTRIAL ELECTRICITY PRICES IN 2017 — SOURCE: DG ENER IN-HOUSE DATA COLLECTION (EUROPEAN COMMISSION 2019)

There is opportunity for German ESCOs to build on previous success. Limited budget in the public sector and a large public building stock is a great opportunity for ESCOs. ESCOs access private sector financing for public sector projects, alleviating additional strain on public budgets. Project sizes can be increased by bundling projects with similar building types and municipal zoning.

Positioning EE and ESCOs as a solution to energy security is an opportunity to increase political interest. Russia is a politically motivated energy supplier as shown during the high-profile dispute between Ukraine and Russia over transit fees, which left Europe, including Germany, cold during the winter of 2006-07. Willingness to take economic losses for political gain with little regard for international law or public opinion is not an attitude which guarantees fuel will flow in the middle of winter when building heating demand peaks. Energy efficient water heaters and furnaces with energy savings guaranteed by an ESCO will shave the peak load demands and limit reliance on external energy supply assuring that Germany is in control of its own energy security.

Germany – Threat

Threats to Germany's ESCO markets are lack of trust in ESCOs and strong dependence on political support. While unlikely in the foreseeable future, if energy efficiency ceases to be a priority of the German government then the ESCO market will suffer.

Another threat is the nature of Germany's industry. Large multinational corporations and manufacturers in Germany tend to limit outsourcing and develop technical competencies in-house (IEA 2018). This is due to the proprietary nature of industrial processes and their existing specialized expertise.

Germany Example Project

The example project was implemented by Siemens in Berlin (European Association of Energy Service Companies 2018). The project type is a 12-year EPC for 164 buildings including schools, kindergartens, day-care centers, sport facilities (gyms and indoor swimming pools), JVA Tegel correctional facility, and Universities (i.e. Technical University of Berlin and Berlin University of the Arts).

The technical solutions implemented include development and realization of an energy efficiency concept, regulation of heat generation/distribution, renewal of air conditioning and ventilation technology, replacement of lighting systems, installation of water technology, as well as controlling, monitoring and maintenance measures. The non-technical benefits include guaranteed energy cost savings during the entire contract period, energy savings immediately released for other projects, no in-

house investments for energy saving measures, simplified maintenance, and lower transaction costs through project bundling (European Association of Energy Service Companies 2018).

This project provided €1.14 million in annual budgetary reduction for Berlin. The project provided €5.3 million in guaranteed energy cost savings annually. Over the entire contract period this project saves €47.7 – €63.6 million in guaranteed savings for Berlin. The CO2 reduction achieved by this project is 29,000 tonnes/year annually.

Following the expiration of the contracts the client will take ownership of the energy-optimized building without additional compensation (European Association of Energy Service Companies 2018).

A5.5 The Netherlands SWOT

The Netherland's ESCO market is classified as Mid-Maturity. The Netherlands has 27 operating ESCOs with a $18 million national ESCO market. The Netherlands has a well-rounded ESCO market with activity pretty evenly split between Residential, Non-residential, and Industrial projects in both the public and private sector. ESCOs target projects addressing compressed air, cooling, and steam. Energy Performance Contracts Shared or Guaranteed Savings contracts are used for 62% of project and the other 38% is only EPC GS (IEA, 2019). *Figure 38* is the Dutch ESCO market SWOT analysis.

FIGURE 38. THE NETHERLANDS ESCO MARKET SWOT ANALYSIS

The Netherlands - Strength

The strength of the Netherlands' ESCO market is its technical expertise, experienced ESCOs, and well diversified portfolio of EE projects. Dutch ESCOs operate in a market which demands for ESCOs to select the best energy-saving technologies and products. ESCOs consider the whole system and select appropriate energy-saving technologies to ensure energy savings expectations are met. If ESCOs in the Netherlands are to remain competitive they must know how to develop or source high quality energy-saving technologies and products. The ability of ESCOs to remain flexibly and respond to changing market conditions is a clear strength.

In the Netherlands, there is a willingness to outsource maintenance on buildings. This is a great market characteristic, which shouldn't be unexpected when high quality ESCOs are providing energy guarantees. There are approximately 45 million m^2 local government buildings which are all possible renovation projects for ESCOs.

Supporting government policy for ESCOs is plentiful. The Energy Investment Allowance (EIA) stimulates companies to invest in energy efficiency in their buildings or production processes. High energy consumers in the industrial or commercial sectors are motivated to engage with ESCOs via the Long-Term Energy Agreements. This agreement ends in 2020 but provides financial incentives for energy savings of 2% or more per year. The government's goal to reduce CO2-emissions by 40% in 2030 is also a stimulus

for ESCOs and energy efficiency.

Additional policy which has benefited Dutch ESCOs is The Activities Decree, part of Environmental Management Act (Activiteitenbesluit, Wet Milieubeheer). The Activities Decree requires companies to implement energy-saving measures with a cost- recovery period of five years or less. The Decree on Energy Performance of Buildings (Besluit Energieprestatie Gebouwen) requires the owner of non-residential buildings to make an energy certificate (Energielabel) when the building is sold or rented. The Regulation on Energy Performance of Buildings (Regeling Energieprestatie Gebouwen) has required a mandatory inspection of air-conditioning systems since 1 December 2013. This comprises a mandatory inspection every 5 years for systems larger than 12 kW.

Relevant support schemes include a reduction on energy tax when the energy is renewable generated. There is also a tax reduction on investments in energy efficiency investments for companies in the private sector.

The Netherlands - Weakness

Weaknesses of the Dutch ESCO market are the tendering, contracting, and managing projects. Complex internal organization and decision-making processes makes policy less responsive than the market desires. This could be alleviated if there were additional political support or an independent ESCO ambassador. The Dutch tend to make EPCs expensive and tailor made rather than standardized. This isn't particularly a weakness but could become one if large projects become scarce and collection of small projects are required to carry the ESCO market through a slow period.

The Netherlands - Opportunity

The opportunities for ESCOs to improve in the Netherlands can be found implementation of an ESCO facilitator model. This is a business model where the ESCO would take on a role as a general contractor rather than performing all of the work in-house. This recommendation can only be made for a market which is developed enough to already mastered the ESCO concept and is large enough to allow for specialization of ESCO services. The first service that should be specialized within are the M&V. These new firms could introduce performance based rates for maintenance.

The Netherlands have the opportunity to learn from the projects completed in neighboring countries such as Belgium, France, Germany, and the United Kingdom. Housing corporations, elderly care or owner-occupiers' associations are a group within the residential sector which would benefit from ESCO project bundling due to the standardized spaces and unitary management structure.

The Netherlands is in a stable market position where trying innovative concepts regarding energy efficiency proves to have more reward than risk. Some innovative ideas are selling energy as a subscription, energy efficiency investments financed within a mortgage, and the already implemented Energy Performance Compensation (EPV) law which rewards efficient energy consumption.

The Netherlands - Threat

Threats to the Dutch ESCO market include persistently low energy prices, political priorities besides EE, lack of trust by public sector in commercial enterprises, lack of business/ model contracts, and split incentives between landlord and tenant.

As ESCOs expand from their local area to provide services throughout the country they will incur more expense. More human resources, materials and financial support are needed. ESCOs must be careful about passing these higher costs of business expansion onto the client in both the proposal and the M&V stage.

A5.6 South Africa SWOT

South Africa's ESCO market is classified as Mid-Maturity. The ESCO market in South Africa consists of 44 ESCOs with annual revenues of $10 million. Most projects last one and a half years and are completed within the private industrial sector. Energy Performance Contract Guaranteed Savings are used for 80% of all ESCO projects (IEA 2019). All of the ESCOs in South Africa are stand-alone organizations. *Figure 39* shows the SWOT analysis for South Africa's ESCO market.

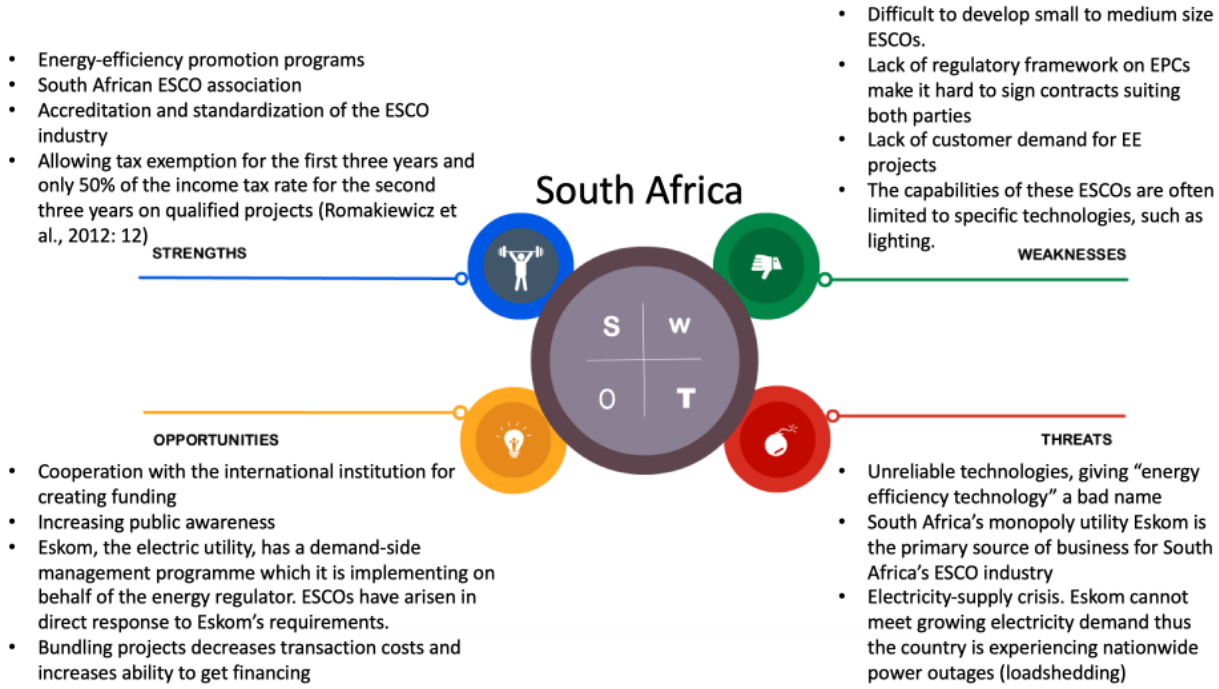


FIGURE 39. SOUTH AFRICA ESCO MARKET SWOT ANALYSIS

South Africa – Strength

The strength of the South African ESCO market is the presence of advocacy groups such as South Africa Association of ESCOs (SAAEs), Eskom, and the Black Energy Service Companies Association. Groups such as these are the key contact for coordinating with international organization as well as providing outreach to the public and business decision-makers, and establishing standards and accreditation. The South African ESCO association runs an ESCO accreditation program which allows registered ESCOs to be exempt from taxes for the first three years of business and pay only 50% of the income tax for the following three years of business (Romakiewicz et al., 2012: 12).

South Africa – Weakness

There are a few weaknesses of South African ESCOs. ESCOs in South Africa struggle to develop. While there are established ESCOs supported by the ESCO accreditation, these companies generally do not grow beyond a few employees with limited service offerings. This is confirmed by the data collected in the annual IEA survey where South Africa reported that there were only stand-alone ESCOs and no subsidiary ESCOs. Additional supporting data comes from the low contract duration score and average project cost score shown in *Table 9*. Conducting short low-cost projects is a characteristic of an ESCO market which is undeveloped an is not stable enough to conduct long-term large budget projects.

There is a lack of regulatory framework for EPCs which causes confusion and distrust while signing contracts. As most ESCOs in South Africa were established within the past decade and have only a few

employees, their reputation is not strong enough to convince clients to engage despite their accreditation with SAAEs. The lack of client demand prevents ESCOs from developing a breadth of technical services and projects are often limited to specific technologies, such as lighting.

South Africa – Opportunity

Offering integrated energy solutions is an opportunity for growth in the South African ESCO market. Developing ESCO markets typically find growth by first establishing equipment sellers. Once equipment is available then installers will appear then engineering services. Engineering services typically adopt an integrated approach to offer a range of equipment and services including financial services.

Eskom, the electric utility, has a demand-side management program which has caused ESCOs to form. The clear standards for the Eskom project has made funding readily available and increased public awareness about the ESCO concept (Eskom 2019). There is an opportunity for this program to become more influential if the South African government ties energy savings targets to the creation of a white certificate market as has been done in France. This will help to provide long term motivation for a utilities provider to encourage energy efficiency.

South Africa – Threat

Threats to the South African ESCO association include the heavy dependence on the utility provider, Eskom, and a proliferation of unreliable technologies giving “energy efficiency technology” a bad name (Ellis 2010).

South Africa’s monopoly utility, Eskom, is the primary source of business for South Africa’s ESCO industry. There are intermittent electricity supply disruptions. The supply disruptions occur because Eskom cannot meet growing electricity demand. Working with ESCOs to help reduce peak load demand through energy efficiency improvements may help Eskom meet South Africa’s energy demands.

While there is an opportunity for ESCOs to develop by engaging with Eskom’s demand side management program, there is an inherent threat as well. As Eskom is a utility operator which sells energy, any program which promotes energy efficiency represents losses in sales revenue (Calemayer, 2008). The pertinacious incentives may result in this program being temporary. Any uncertainty in the ESCO market is crippling to long term development as service providers will not take development risks.

A5.7 South Korea SWOT

Korea's ESCO market is classified as Mid-Maturity. The ESCO market in South Korea consists of 330 ESCOs with annual revenues of $85 million. Most projects last three years and are completed within the private industrial sector. ESCO projects in Korea deal with waste heat recovery systems, heat recovery boiler, mechanical (thermal) vapor re-compressor, heat exchanger for heating or cooling, process Improvement, naphtha cracking heater coil replacement, co-Generation, ice thermal storage system, lighting system, individual heating, and district heating (Huh 2010). Energy Performance Contracts Guaranteed Savings are used for 95% of all ESCO projects (IEA 2019). Most ESCOs in Korea are the subsidiary of a larger corporation. *Figure 40* shows the SWOT analysis for the Korea's ESCO market.

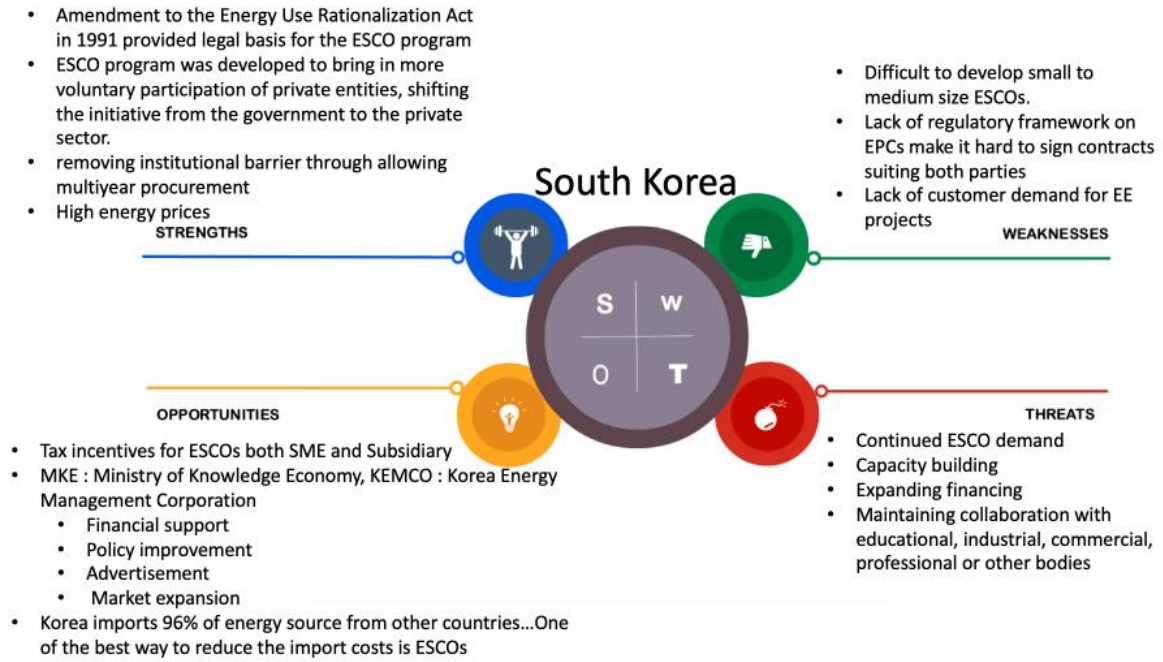


FIGURE 40. SOUTH KOREA ESCO MARKET SWOT ANALYSIS

South Korea – Strength

Government and KEMCO (Korea Energy Management Corporation) support has driven the growth of the South Korean ESCO market (Lee, et al., 2003). Key legislation and programs include the revising Energy Use Rationalization Act in 1991 to define ESCOs, providing ESCOs tax credits and distributing long term low interest loans. The long term low interest loans are distributed by KEMCO and funded by surcharges on the import and sale of oil and petroleum products.

In 1998, government procurement, budget and accounting laws were changed to allow public entities to enter into multi-year contracts (Lee, et al., 2003; Roy, 2003). Previously, energy-efficiency improvements were only made when extra funds were found in the budget.

Once the institutional barriers were removed a pilot project for lighting replacement was conducted. The project costs were $180,000 which yielded annual savings of $100,000 in addition to multiple benefits such as a more productive work space and less maintenance (Roy, 2003). This pilot project in the public sector conducted in the formative years of Korea's ESCO market has grown into a market where most ESCOs are private and the initiative of improving the efficiency of facilities across the country has shifted from the government to the private sector (Ellis 2010).

South Korea – Weakness

It is difficult to develop small to medium size ESCOs. While there are over 300 registered ESCOs only about 10% of them are active. This can be explained by Article 25 of the Energy Use Rationalization Act which requires that all ESCOs must register with their municipality. However, due to the preferred method of financing and due to the specialized nature of ESCOs operating within the industrial sector not every registered ESCO completes EPCs.

Also concerning is the lack of regulatory framework on EPCs make it hard to sign contracts suiting both parties. When simply signing the contract is a challenge ESCOs find that customers do not demand to use EPCs for EE projects.

Lack of Sector Diversity

ESCOs in Korea have a Sector Diversity Score that is 0.04 less than average. Referring to Figure 41, there is little ESCO activity in the non-residential sector.

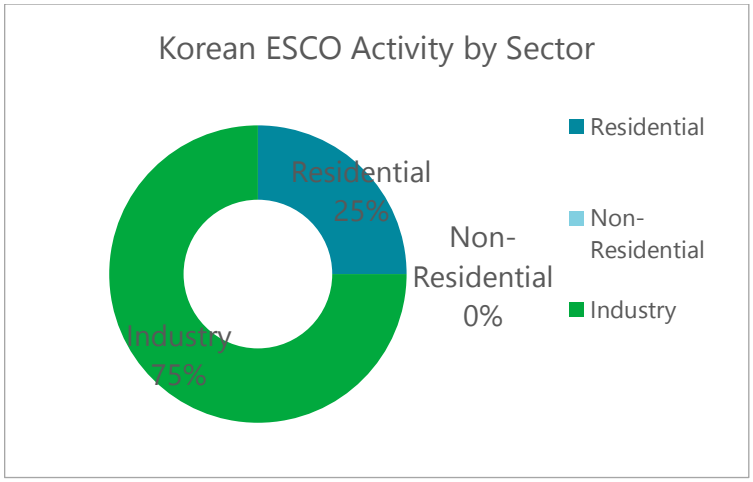


FIGURE 41. KOREAN ESCO ACTIVITY BY SECTOR (IEA 2018)

South Korea – Opportunity

Developed economies have different opportunities than developing economies. In developing economies there is a desperate need for any organizational institution to take an interest in ESCOs. In South Korea, there is another sort of organizational challenge. There are multiple ESCO stakeholders such as the Ministry of Knowledge Economy (MKE) and Korea Energy Management Corporation (KEMCO) which would work better with additional coordination. This coordination could come in the form of financial support, policy improvement, tax incentives for both stand-alone and subsidiary ESCOs or a concerted advertisement campaign.

High energy prices should motivate inter-organizational coordination. Korean energy prices are consistently high because Korea imports 96% of its energy. Korea's economic motivation to avoid high energy prices has made them more energy efficient. This is confirmed by the converse which shows that energy producing countries such as Russia or the US are less energy efficient. China is an exception. Thus, high energy prices may create a demand for energy efficiency which would be an opportunity for ESCOs.

South Korea – Threat

Threats to ESCO expansion in Korea include fluctuating customer demand, need for additional financing, and maintaining collaboration with educational, industrial, commercial, and professional ESCO support organizations (Huh 2010).

A5.8 United Kingdom SWOT

United Kingdom's ESCO market is classified as Mid-Maturity. Within the UK 30 ESCOs contribute to a $115 million ESCO market. 85% of projects are completed in the non-residential sector with the other 15% operating within the industrial sector. 75% of projects are executed in the public sector with the remaining 25% in the public sector. ESCOs from the United Kingdom have focused on financing, installing, operating and maintaining PV systems as well as the traditional ESCO work within the industrial sector, public buildings, hospitals, schools, offices, social housing. UK ESCOs also address supply side energy networks (district heating), HVAC, control technologies, lighting, and public lighting. Both EPC Guaranteed and Shared savings contracts are used. *Figure 42* shows the SWOT analysis for the UK's ESCO market.

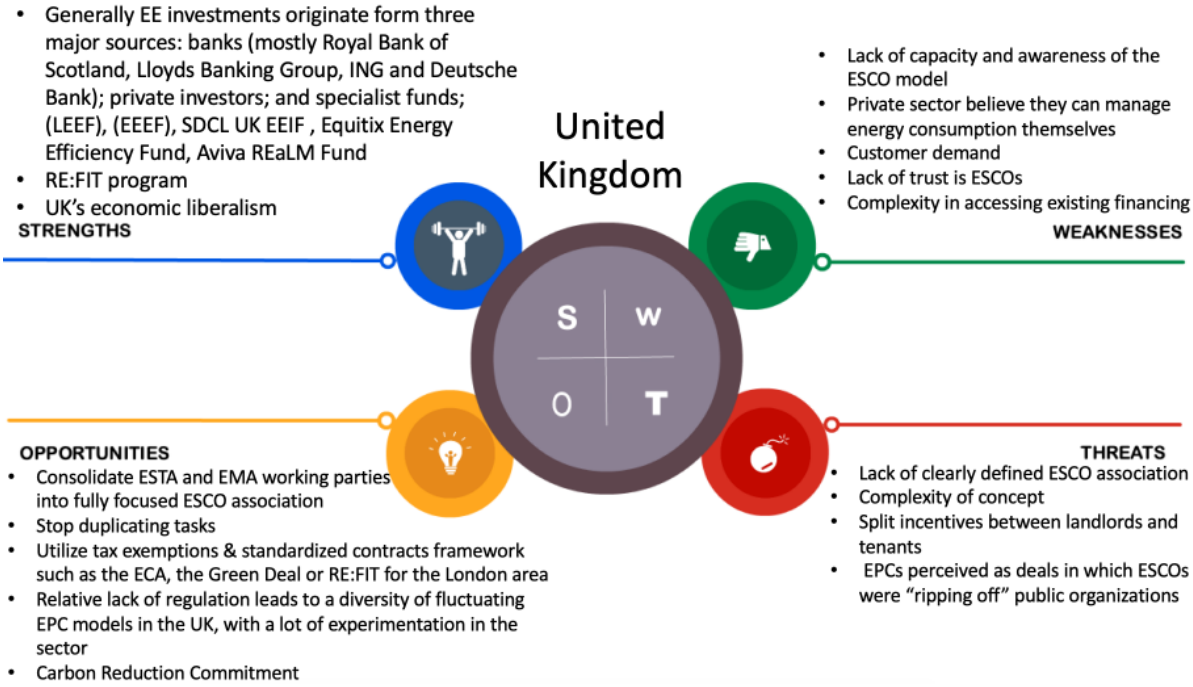


FIGURE 42. UNITED KINGDOM ESCO MARKET SWOT ANALYSIS

United Kingdom - Strength

Financing is not as central of a concern as it is in most ESCO markets. Generally, EE investments originate from three major sources: banks such as Royal Bank of Scotland, Lloyds Banking Group, ING and Deutsche Bank; private investors; and specialist funds such as LEEF, EEEF, SDCL UK EEIF, Equitix Energy Efficiency Fund, or the Aviva REaLM Fund.

Policy support comes in the form of programs such as CEF, NDEEF, Essentia, and RE:FIT. The RE:FIT program encourages retrofits within buildings throughout the country with ESCOs as the preferred facilitator. The UK has also signed onto the Paris Climate Accord which is a good sign for efficiency market in general.

There are various ESCO associations and environmental motivations in the UK which combined with historical economic liberalism creates an environment for ESCOs to thrive.

United Kingdom - Weakness

The weakness of UK's ESCO market is lack of awareness of the ESCO model. Clients are consistently surprised by the ESCO concept and need to be introduced. This unfamiliarity within the private residential sector causes owners to believe they can manage energy consumption themselves. This is confirmed by

the fact that there are zero reported ESCO projects within the residential sector. Once clients are familiar with the types of renovations and the average energy savings which ESCOs achieve they will be more likely to engage and overcome preconceived notions.

Of secondary note, is that while financing does exist accessing it is not as simple as it could be especially for smaller scale projects.

Policy without teeth proliferates

Energy Savings Opportunity Scheme (ESOS) is the result of the UK complying with Article 8 of the EU Energy Efficiency Directive (EED) (Van Willingen 2015). ESOS mandates Energy Audits with recommendations for EE improvement to be completed every four years within the large private sector. Currently there is a framework for submitting energy audit compliance forms based upon ISO50001 but there is no requirement to complete the EE project recommendations. Energy Audits are undertaken as a compliance activity rather than the intended purpose of kick-starting EE projects. Enforcement of compliance is currently seen as poor (QualitEE 2018).

Lack of Sector Diversity

ESCOs in the United Kingdom have a Sector Diversity Score that is 0.15 less than average. Referring to *Figure 43* there is little activity in the residential or non-residential sector.

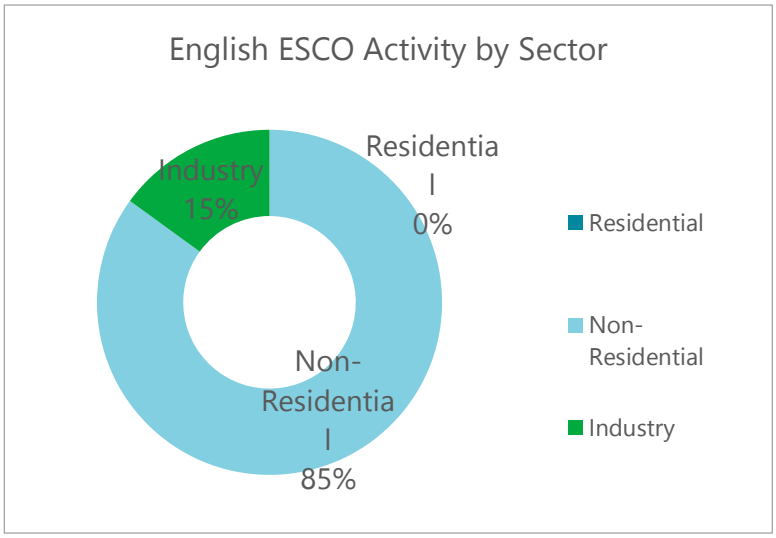


FIGURE 43. ENGLISH ESCO SECTOR DIVERSITY (IEA 2018)

United Kingdom - Opportunity

Opportunities for ESCOs in the UK include consolidating ESTA and EMA working parties into fully focused ESCO association. This would reduce the duplication of tasks and help expedite decision making surrounding ESCOs. Once a unified ESCO group is formed they could clarify tax exemptions & standardized contracts framework such as the ECA or the Green Deal for the metropolitan areas. The relative lack of regulation leads to experimentation and a diversity EPC models in the UK. While experimentation should continue to be encouraged using a hands-off approach, there is an opportunity to identify which new arrangements work best and publicize the findings.

United Kingdom – Threat

Threats to the UK's ESCO market are imperfect business models and difficultly capturing specialized markets. Specific regulation on ESCOs and EPC does not exist in the UK and the business model is

constantly changing. Major energy consumers make great business partners for ESCOs. Trouble arises when there is not a major energy consumer clients for ESCOs to shape their business development around. Identifying a clear target market is a balancing act for most ESCOs in the UK who either spread themselves too thin or risk becoming too specialized and too sensitive to economic downturns.

As with many other European ESCO markets there are threats from the complexity of the ESCO concept, split incentives between landlords and tenants, and a perception that EPCs are deals which ESCOs use to “rip off” public organizations.

A5.9 Italy SWOT

Italy's ESCO market is classified as Mid-Maturity. Italy has 362 operating ESCOs with a $200 million national ESCO market. Nearly all Italian ESCOs work in the private sector, as 80% of ESCO activity is in the private sector (IEA 2019). Energy Performance Contracts Shared Savings are preferred and used for 90% of ESCO projects (IEA, 2019). *Figure 44* is the Italian ESCO market SWOT analysis.

FIGURE 44. ITALIAN ESCO MARKET SWOT ANALYSIS

Italy Strength

The strength of the Italian ESCO market is providing guaranteed energy savings and its well-trained work force. EPCs are now accepted for public energy efficiency improvements which should draw ESCOs into projects in the public sector.

Italy Weakness

In Italy, there are limited market-based instruments encouraging energy-saving investment. Energy savings would increase if compulsory policies, regulations and rules were created specifically for ESCOs. At the moment, rules surrounding ESCOs disperse responsibility causing too many agencies to be involved in congested decision-making. For instance, the ESCO industry does not have evaluation standards for energy-saving performance. Without the minimum standard, competition is discouraged as lower quality services can bring down the reputation of quality service providers. Monitoring and verifying energy savings has been a contentious challenge which has prevented the ESCO system from developing further.

The main risk ESCOs take is achievement of expected energy savings. The measurement and verification of those savings must be accurate and indisputable. Unorganized measurement and verification of energy savings can cause disputes between ESCO and customer even after the projects are completed. Any disputes will prevent ESCOs from recouping investment costs and collecting profits or delay the payment. M&V methods and business models must improve and become standardized.

Lack of Sector Diversity

ESCOs in Italy have a Sector Diversity Score that is 0.04 less than average. Referring to *Figure 45*, there is little activity in the residential or non-residential sector.

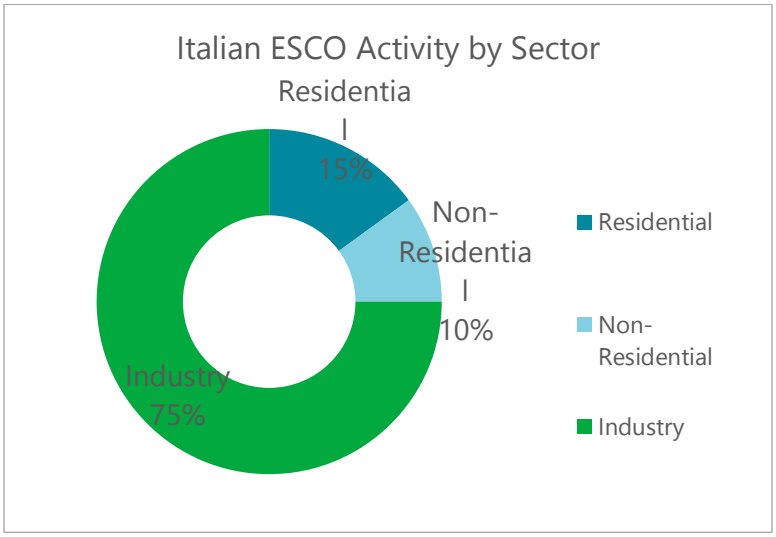


FIGURE 45. ITALIAN ESCO SECTOR DIVERSITY (IEA 2018)

Italy Opportunity

Opportunity within the Italian ESCO market can be found by improving measurement and verification methodology. The creation of new businesses which offer third-party M&V, or development of digital technologies which automatically track and report energy consumption would radically transform the ESCO business.

As Italy has pledged publicly to CO2 reduction goals, this pledge is an opportunity for ESCOs to pursue long term contracts on projects which have high energy and carbon reduction goals.

Italy Threat

The main threat to ESCOs in Italy is the risk that their clients in the private sector will default on their obligations. If a client's business fails or energy consumption declines the expected energy savings and ESCOs' profits decrease. Because ESCOs execute multi-year projects it behooves the ESCO to consider the prospects of the industries and clients they select. Risk control capacity will improve as ESCOs learn from past projects. As project risks in each sector are mapped the restrictions around financing to indebted communities will become more targeted.

A5.10 Belgium SWOT

Belgium's ESCO market is classified as Mid-Maturity. Belgium has 15 operating ESCOs with a $5 million national ESCO market. Belgium ESCOs provide services for public sector buildings and private industry facility projects. The main targets include healthcare facilities, educational and office buildings (Urmee and Urmee 2018). Energy Performance Contracts Guaranteed Savings are used for 75% of all contracts (IEA, 2019). *Figure 46* is the Belgian SWOT analysis.

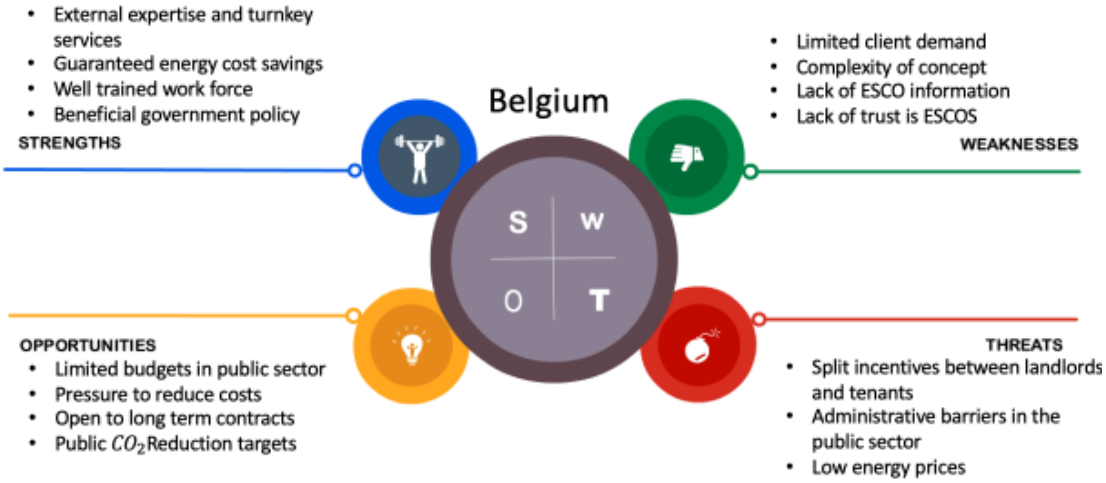


FIGURE 46. BELGIUM SWOT ANALYSIS (QUALITEE, 2017)

Belgium - Strengths

In 2005 Fedesco, one of the first European SuperESCOs, was formed by the Belgian Federal Government in cooperation with the Federal Building Agency and the Federal Public Services to provide energy efficiency retrofits of 1,800 public buildings with target of 22% CO2 savings. When Fedesco was first formed the operating budget was 1.5 million euro. This budget was extended to 6.5 million euro by 2015 when Fedesco was integrated into the building agency. Fedesco's financing capabilities as a third-party-investor were initially 10 million euro which was raised to 100 million euro in 2009, although it never operated as a third-party lender due to Belgium law preventing state funded loans from being classified as off-balance sheet. Fedesco employed a staff of 11 people with three project managers.

Fedesco used a few innovative business models such as the 'separate contractor model' and the 'SmartEPC' which other SuperESCOs could replicate. The 'separate contractor model' formalizes the process of financing subcontractors to perform the work of a typical ESCO with oversight by Fedesco. Projects using this subcontractor model included mainly boiler replacement and boiler room renovation, HVAC regulation, relamping and relighting, co-generation and roof insulation (Citynvest 2015). The 'SmartEPC' is a modified traditional EPC which formalizes and attaches performance guarantees to the operations and maintenance aspect of ESCOs work. Multiple projects were completed successfully using this model.

In 2011, Fedesco created a "Knowledge Center" department to provide EPC facilitation services to regional public administrations. The SuperESCO funded an additional behavioral change campaign targeting building occupants to overcome the pervasive split incentive between landlord and tenant in the residential sector. Currently, BELESCO: the Belgian Association of ESCOs and AGORIA Green Building platform have taken over responsibility for spreading information campaigns and public fund-raising efforts.

Belgium – Weakness

The legal framework for the ESCO sector in Belgium is not yet fully developed yet. For example, an Energy Performance Contract is not defined by law, in spite of the international provisions of the Energy Efficiency Directive (EED). It is expected that when the EED requirements are translated into actions the Belgian ESCO market will experience growth (Coolen et al. 2015).

Additional barriers include complexity of concept which causes difficulty in generating profits for small EPC projects. Complexities of EPCs arise due to the requirement for ESCOs to use multiple complementary skillsets, coordinate multiple stakeholder's interests throughout each project stage, and provide unique energy savings measurement and verification (M&V) protocols for each technology. Even if the ESCO can overcome such complexities the long payback of EPCs, 10-15 years, is rarely compatible with investors or building owner's objectives of short-term profitability.

Lack of Sector Diversity

Despite a sector diversity score that is 0.07 above average the residential sector is underdeveloped. Referring to *Figure 47,* there is zero activity in the residential sector.

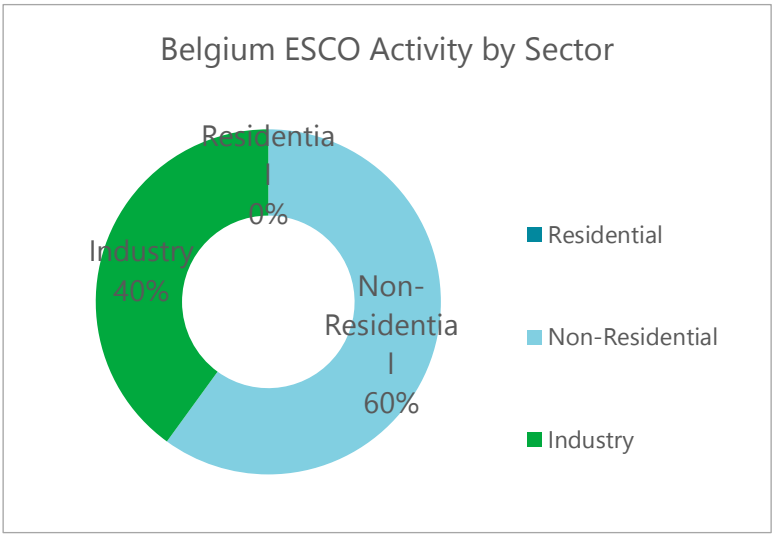


FIGURE 47. BELGIUM ESCO SECTOR DIVERSITY (IEA 2018)

Belgium – Opportunity

Belgium, like most governments, must maximize results using a limited budget. When ESCOs seek contracts in the public sector they are providing a valuable service by accessing private sector financing for the improvement of public sector facilities. By taking the opportunity to use third party financing, ESCOs can spread the EPC and SmartEPC concept and expand the Belgium ESCO market.

Belgium – Threats

Belgian ESCOs face similar barriers as their European counterparts, such as complexity of the concept, lack of information, administrative barriers, variability of energy prices, lack of customer demand, and lack of trust in the ESCO industry (QualitEE 2017). Growth rates and core competitive strength will remain low unless government attentiveness to the ESCO market increases. Until then there will remain few market actors characterized by small size, under trained personnel, disordered internal management, and less competitive R&D (Cho 2017).

A5.11 Austria SWOT

Austria's ESCO market is classified as Low-Maturity. Austria has nearly 20 operating ESCOs with a $32 million national ESCO market. Austrian ESCOs provide services for space heating, air conditioning, control and automation, lighting, and building envelope projects. Energy Performance Contracts Guaranteed Savings are used for 80% of all contracts. Most projects are completed in public sector buildings (IEA, 2019). *Figure 48* is the Austrian SWOT analysis.

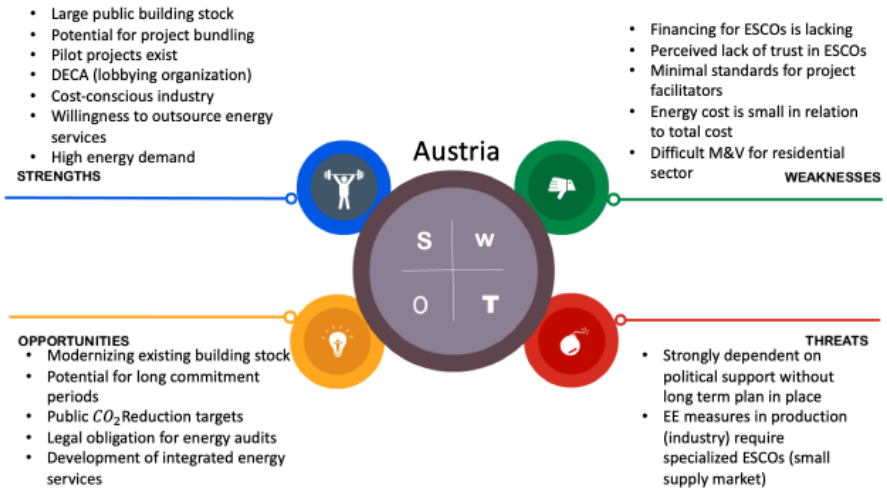


FIGURE 48. AUSTRIA SWOT ANALYSIS (GUARANTEE PROJECT, 2016)

Austria – Strength

The strength of the Austria ESCO market is in part due to the desire of clients for turn-key services. Clients are particularly attracted by the guaranteed savings and the high quality of the ESCOs. ESCO quality is assured by a certification and accreditation scheme. The quality of their products is assured by an eco-labelling program. The contracts ESCOs use are semi-standardized.

Austrian government helps guide ESCO market formation via the Austrian Energy Efficiency Law. The country's main energy efficiency law aims to increase national energy efficiency by 20% by 2020.

The ESCO concept is best suited when there is a limited budget in public sector as ESCOs can access financing from the private sector. As energy prices continue to increase in a cost-conscious country, Austria will reflect upon its existing pilot projects and see the potential benefits from retrofitting their large high energy consuming public building stock.

There is an active ESCO association called DECA - 'Dachverband Energiecontracting Austria' (Professional Association for Energy Contracting).

Austria – Weakness

ESCOs in Austria have cited 'difficulty in financing' as a business barrier (GuarantEE Project, 2016). Long payback periods make financing a necessity for ESCO projects. It is extremely difficult for newly-established ESCOs to raise funds from financial institutions, so they rely on progressive capital accumulation or direct investment.

Typically, energy efficiency improvements are developed at the same time as major renovations. Unfortunately, the energy savings are small in relation to the costs of a total project renovation. This results with construction companies rather than ESCOs making decisions regarding equipment selection with short-term price rather than long-term energy savings as a priority. This dynamic combined with the

complexity of the ESCO concept and little motivation to understand the ESCO concept results in an underdeveloped ESCO market full of small to medium sized firms. 65% of ESCOs in Austria are stand-alone ESCOs (IEA Survey 2017).

Austria ESCOs are not immune to issues which plague all ESCOs including the split incentives between landlords and tenants, lack of demand for energy efficiency services as energy prices decrease, as well as difficulty with measurement and verification of energy savings within the residential sector. The split incentive between landlord and tenant occurs when those responsible for paying energy bills (typically the tenants) are different from those who make decisions about capital improvement investments including building owners or managers (Larsen et al. 2012; Stuart et al. 2014).

Austria – Opportunity

Opportunities for Austrian ESCOs can be found in development of integrated energy services. Austria is a member of the European Union and home to a stable political and economic system. Such stability coupled with public CO2 reduction targets creates the potential for contracts with long commitments. Such long-term commitments could come in the form of modernizing existing building stock or expanding mandated energy audits.

Increasing of Sector Diversity

Austria has an ESCO market centred around the non-residential sector as shown in *Figure 49*. The lack of projects in the industrial and the residential sector is a missed opportunity.

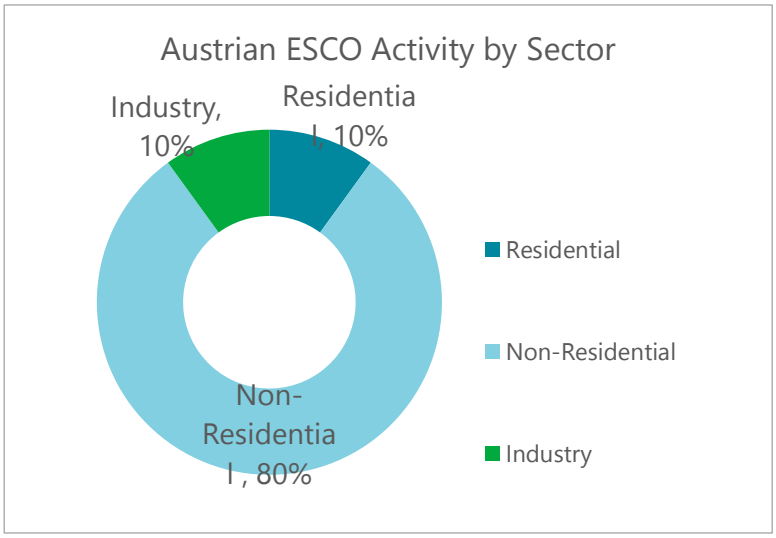


FIGURE 49 AUSTRIAN ESCO SECTOR ACTIVITY (IEA 2018)

Austria – Threat

A continual threat to the ESCO industry is political support. Without political support even long-term commitments can be effectively toothless without proper enforcement. Political support can be lost due to unsuccessful application of market based instruments. For example, the European Emissions Trading System, a market based instrument, has struggled with the over allocation of carbon credits. This perceived failing can damage the reputation of industries such as ESCOs which are dependent on other market based instruments such as white certificates. Both idea and execution of market based incentives must be flawless for ESCOs to find the best results.

Austria is a technologically-advanced society which top exports include $32.4 billion of 'Machinery including computers' (17.5% of total exports), $22.9 billion of 'Electrical machinery, equipment' (12.4% of

total exports), and $18.4 billion of 'Vehicles' (10% of total exports) (Workman 2019). ESCOs operating within this market should be able to capture huge energy efficiency gains in such energy intensive manufacturing sectors. A threat is the required specialization both technical and legal that are demanded of ESCOs to operate in this sphere. The in-house expertise of the engineering firms exporting the aforementioned products also cut into ESCOs' market share within the industrial sector.

Austria Example Project

The example project of modernizing existing building stock was implemented by Siemens within the Austrian Municipality of Amstetten (European Association of Energy Service Companies 2018). The project type is a 10-year EPC for 27 buildings.

The technical solutions implemented included a boiler upgrade, addition of solar collectors for domestic hot water at the stadium, upgraded control technology, rebuilt hydraulic systems (distributors, pumps, etc.), window insulation replacement, partial upgrade of lighting systems, and the addition of meters and an energy management system. The non-technical solutions include raising environmental awareness for students using the new environmentally-friendly facilities.

This project reduced annual energy costs by €75,000 from €355,000 to €280,000. The project reduced CO2 emissions by 25% annually. Total investment in the project was €735,000 (European Association of Energy Service Companies 2018).

A5.12 Bulgaria SWOT

Bulgaria's ESCO market is classified as Low-Maturity. Bulgaria has 15 operating ESCOs with a $33 million national ESCO market. Over 50% of Bulgarian ESCO contracts are executed in the public sector (IEA 2019). Energy Performance Contracts Guaranteed Savings and Shared Savings contracts are used for an equal number of ESCO projects (IEA, 2019). *Figure 50* is the Bulgarian SWOT analysis.

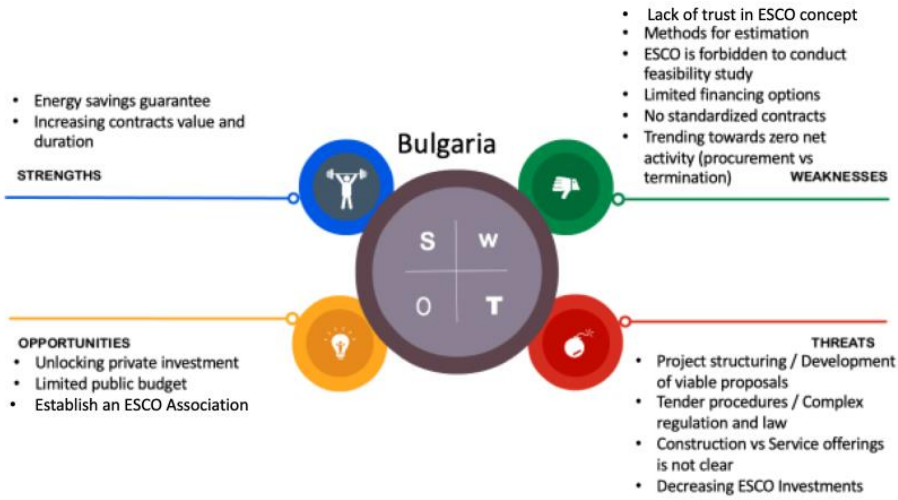


FIGURE 50. BULGARIA SWOT ANALYSIS (QUALITEE, 2017)

Bulgaria - Strength

The strength of the Bulgarian ESCO market is derived from government policy support (QualitEE, 2017). Government institutions that exert influence on the development of the ESCO market in Bulgaria include the Ministry of Energy, Sustainable Energy Development Agency (SEDA) & Ministry of Regional Development and Public Works (MRDPW). The Ministry of Energy is responsible for the development of the national energy policy, including energy services. SEDA is an executive agency to the Minister of Energy responsible for the implementation of the national renewable energy, energy end-use efficiency, and energy services policies. MRDPW sets the requirements for the energy performance of new and refurbished buildings. Other local and regional authorities are both policy makers and facility owners of buildings.

Bulgarian energy agencies enforce two key policies. The Energy Efficiency Act, promulgated SG No. 98/14.11.2008, which is the main legislation regulating the provision of energy services (Ministry of Economy and Energy 2014). The Energy Efficiency Act was amended in 2015 so EPC projects can be signed for up to ten years, instead of the five years. This may be further extended. The Bulgarian Energy Efficiency and Renewable Fund (EERSF) was established through the Energy Efficiency Act. This fund was created using grants from the Global Environment Facility – 9 million euro; the Government of Austria - 1.5 million euro; the Government of Bulgaria - 1.5 million euro and several private Bulgarian companies. The fund is a public-private partnership with independent management and self-sustaining capacity (Black Sea Energy Research Centre 2013). The Law on Municipal Debt Art. 32, P.1 of the Law on Public Finances, dictates which municipalities may take out new debt, up to 15% of their annual capital expenditure for the last four years, for EPCS each budgetary year.

Bulgaria - Weakness

The weakness of the Bulgarian ESCO market is unpredictable regulation and a lack of advocacy coalitions. Energy tariffs are inconsistent and disturb energy price stability. Regulations within the public-

sector limit EPCs to only building renovations and not all funding sources are open for EPC & ESCOs (Black Sea Energy Research Centre 2013).

Another barrier is low capacity in public sector for EPC. Due to the complexity of EPC and lack of experience, it is difficult for public authorities to prepare and evaluate contracts. This inexperience with EPCs extends to the private sector. Ignorance of EPCs creates a lack of trust in ESCOs. Clients are concerned that the contract and M&V will cost them incremental time and money (QualitEE 2017). This ignorance and negative perception are unlikely to change until a national ESCO association is formed to provide information campaign surrounding ESCOs and EPCs (Black Sea Energy Research Centre 2013).

Lack of Sector Diversity

ESCOs in Bulgaria have a Sector Diversity Score that is 0.04 less than average. Referring to *Figure 51,* there is little activity in the residential sector.

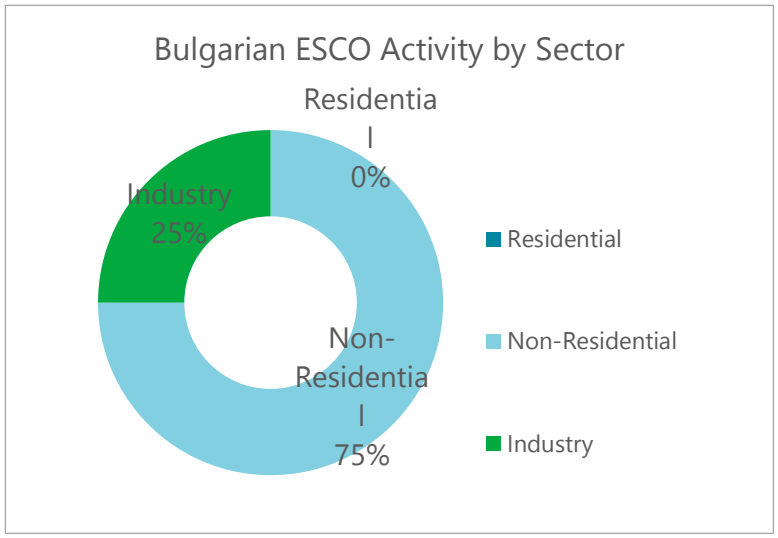


FIGURE 51. BULGARIAN ESCO SECTOR DIVERSITY (IEA 2018)

Bulgaria - Opportunity

The biggest opportunity within the Bulgarian ESCO market is to establish a national ESCO association. A national ESCO association could improve the reputation of ESCOs and help potential clients and ESCO business partners learn about EPCs. Once potential energy clients are informed there is a legitimate enterprise which handles financing and limits exposure by guaranteeing energy savings for energy efficiency improvement projects, they will be more likely to engage with the ESCO concept. Through education ESCOs can gain project experience and improve their reputation.

Bulgaria – Threat

In Bulgaria, few banks finance EPC, and the financing conditions are unfavorable. One reason for this problem is the high amount of required financing for ESCO projects, typically ranging from several hundreds of thousands to several million euro (Black Sea Energy Research Centre 2013). Additionally, most Bulgarian banks are not prepared to accept repayment of financing via EPC energy cost savings. This means that only ESCOs able to provide substantial collateral have the capability to access financing.

When ESCOs cannot access financing, activity levels drop to near zero. This was the trend shown in Bulgaria between 2006 and 2017. *Figure 52* illustrates the decline in Bulgarian ESCO activity (Raytchev, 2018). The number of projects started, shown in blue on the upper plot, and the number of contracts

completed or terminated, shown in red on the upper plot, are now almost equal. This is an ESCO market in decline. The lower plot in *Figure 52* shows to levels of ESCO investment in million Bulgarian Lev. Post-2012 the ESCO market collapsed. The Bulgarian ESCO market needs revitalization from renewed public and private interest.

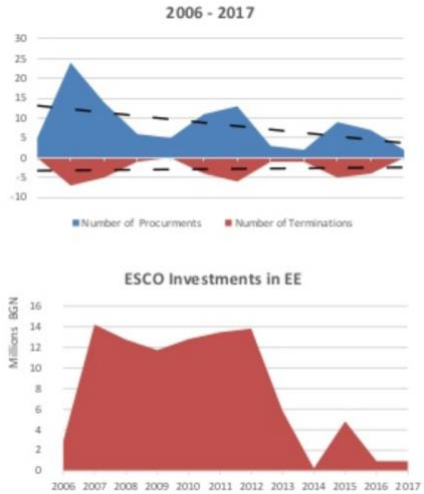


FIGURE 52. BULGARIAN ESCO MARKET ACTIVITY - 2006-2017 - (RAYTCHEV, 2018)

A5.13 India SWOT

India's ESCO market is classified as Low-Maturity. There are 140 ESCOs contributing to a $300 million ESCO market which has potential to be in the billions (Alliance for an Energy Efficient Economy 2017). Most projects are shorter than three years and are completed within the private industrial sector. Examples of projects include efficiency improvement or replacement of cogeneration facilities, industrial dryers, fans, chillers, lighting equipment, or transformers. EPC Shared Savings are used for 90% of all ESCO projects (IEA 2019). *Figure 53* shows the SWOT analysis for the India's ESCO market.

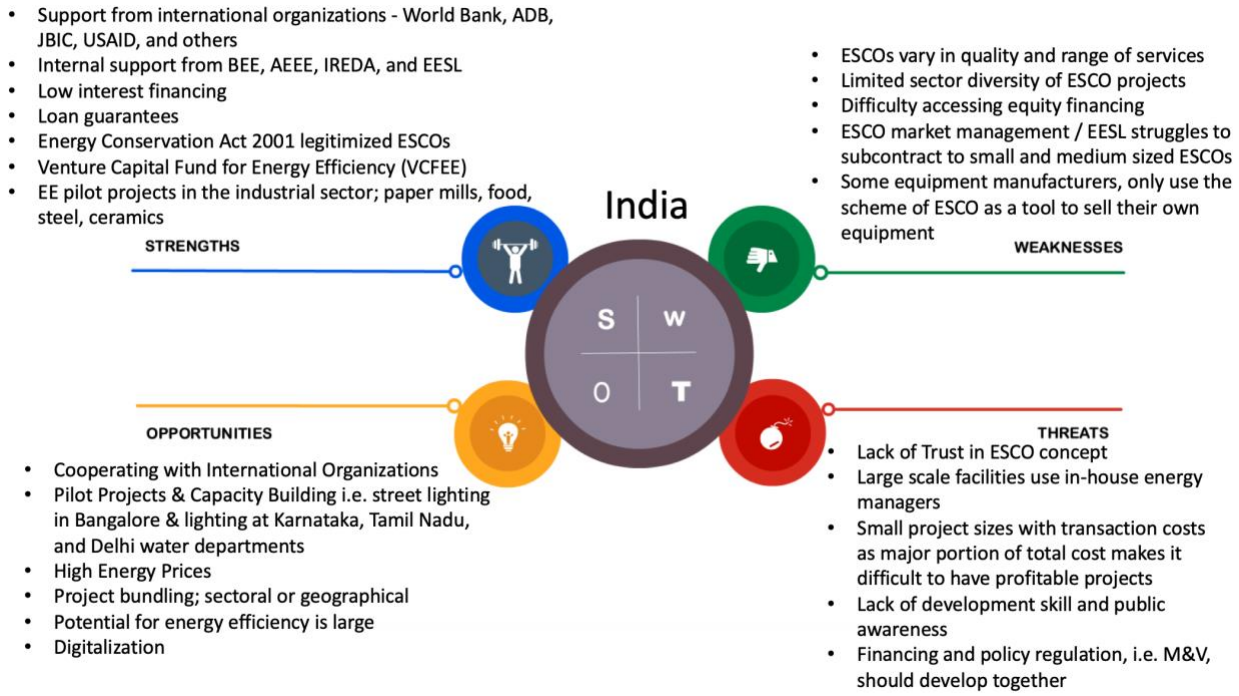


FIGURE 53. INDIA ESCO MARKET SWOT ANALYSIS

India - Strength

Strengths of the Indian ESCO market include support from international organizations, low interest financing, and loan guarantees. Low interest financing programs have been funded in India by the World Bank, ADB, JBIC, USAID, and other international development groups.

Legislation has also provided legitimacy to ESCOs in India. The Energy Conservation Act of 2001 enforced by the Bureau of Energy Efficiency (BEE) within the Ministry of Power gave legal status to Energy Auditors & Energy Management Facilities, building energy efficiency standards and energy consumption standards. (Murakoshi and Nakagami 2009)

The Bureau of Energy Efficiency (BEE) has implemented the Framework for Energy Efficient Economic Development (FEEED) in 2010 as an element of the National Action Plan on Climate Change (NAPCC). Within the FEEED there are two financial instruments which help ESCOs engage with financial institutions, industries, and large commercial establishments – Partial Risk Guarantee Fund for Energy Efficiency and Venture Capital Fund for Energy Efficiency.

Partial Risk Guarantee Fund for Energy Efficiency (PRGFEE)

The Partial Risk Guarantee Fund for Energy Efficiency (PRGFEE) is risk sharing mechanism to provide Participating Financial Institutions (PFI) with a partial coverage of risk involved in making loans for energy efficiency projects. This partial coverage addresses existing credit risk and transactional barriers. The long-

term benefit of the fund is two-fold. Energy efficient projects are implemented and the commercial financial institutions are building their capacity to finance energy efficiency projects on a commercially sustainable basis (Bureau of Energy Efficiency, Ministry of Power 2019)

Venture Capital Fund for Energy Efficiency (VCFEE)

The VCFEE provides risk capital to ESCOs for implementing energy savings technologies and services. The Energy Efficiency Services Limited (EESL) is the administer of these funds. EESL is a joint venture of NTPC (largest coal power company), PFC (Power Finance Cooperation), REC (Rural Electrification India) and POWERGRID. EESL mission is to facilitate energy efficiency projects. EESL attempts to accomplish this mission by acting as a resource for ESCOs and by acting as an ESCO itself. This fund does not have a quantitative target (Institute for Industrial Productivity 2019).

India – Weakness

Varying Quality of ESCOs

The ESCOs which are operating are not executing EPCs as a full-time business due to lack of customer demand and lack of technical capacity. Quality of ESCO services is an overall weakness as some equipment manufacturers claim to be ESCOs only to sell their equipment. ESCOs are small scale, financially weak, and struggle to complete multi-year projects. This is confirmed by the average length of ESCO projects being less than two years. Reliability is a core value ESCOs offer as energy managers. As such forming a portfolio of projects has been a challenge for Indian ESCOs.

ESCO market management / EESL / SuperESCO

Energy Efficiency Services Limited (EESL) is India's well-funded SuperESCO. EESL is successful at attracting investments and implementing large scale initiatives such as their bulk procurement programs. EESL's informational programs such as training weeks and participation in international ESCO conferences is excellent. However, EESL has had trouble translating theory into results in the field.

EESL is less effective in terms of dispersing its funds in a way that expands the Indian ESCO market. An example of successful distribution of funds would be securing a large project then subcontracting to smaller ESCOs thereby stimulating wider market development. This failure to develop a wider ESCO market is confirmed by the fact that 95% of ESCOs in India are subsidiary[2] of a larger organization and 100% of ESCO projects are completed in the private industrial sector.

The Indian ESCO market is hurt by EESL funneling funds exclusively into private industrial energy efficiency projects. The reason for such financial allocation may be worth investigating as lack of inter-organizational coordination will continually hinder ESCO development. For true stability, funds would be distributed to small and medium sized ESCOs which are completing projects in the non-residential and residential sector. A solution would be to increase the coordination on energy efficiency efforts between agencies such as Ministry of Power, Ministry of Petroleum and Natural Gas, Ministry of Non-Conventional Energy Sources, Ministry of Environment and Forests, and others to set targets for distribution of funding to multiple sectors.

Limited Sector Diversity

Indian ESCOs need to expand service offers beyond the private industrial sector. There have been a few projects in the commercial sector such as a hotel in Hyderabad and the India Gandhi International Airport, but ESCO operations in the non-industrial sector are limited. ESCOs in India have a Sector Diversity

[2] EESL acts as an ESCO and is included in the 95% of subsidiary ESCOs

Score that is 0.37 less than average. Referring to *Figure 54*, all reported activity has occurred in the industrial sector. While this data may be incomplete as there have been documented street light improvement projects in the non-residential sector, there is a need to increase the number of ESCO projects in the non-residential and residential sector (IEA 2018).

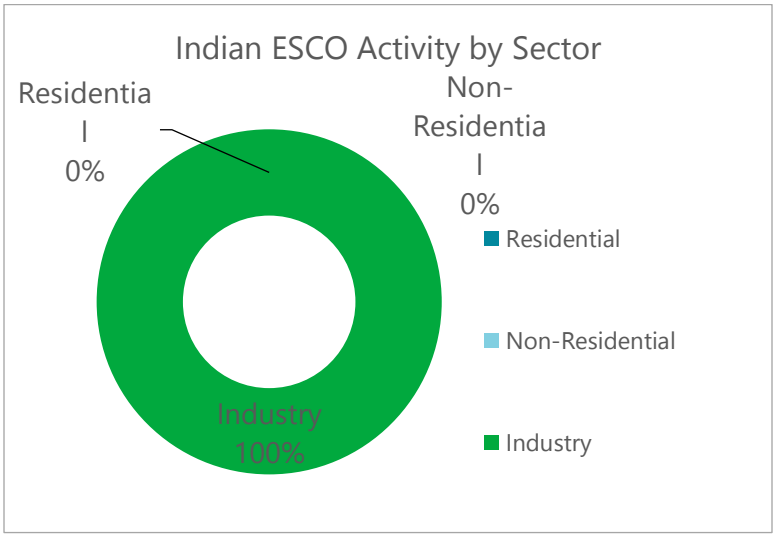


FIGURE 54. INDIAN ESCO ACTIVITY BY SECTOR (IEA 2018)

Difficulty accessing equity financing

Commonly cited issues that financial institutions have while working with ESCOs include; lack of standardized templates for financing EE solutions, lack of credit worthiness of the ESCOs, relatively smaller per project size of EE solutions, technical complexity of EE solutions that increases the transaction costs for project evaluation, and lack of insurance instruments for resolving performance risk (Alliance for an Energy Efficient Economy 2017). Due to these issues cited by Indian financial institutions there is a dearth of equity financing.

India – Opportunity

Pilot Projects & Capacity Building

India has had success with the ESCO concept and has pilot projects which should be used as a guide to further expand into the commercial non-residential and residential sectors. These projects were completed by cooperating with international organizations. Lighting projects have been completed in Bangalore, Karnataka, Tamil Nadu, and Delhi. ESCOs have completed projects in the industrial sector, for paper mills, food, steel, ceramics. If an ESCO develops a specialization for a certain industrial segment bundling projects would help increase project size and decrease transaction costs especially when obtaining a loan. A standardized loan application already exists for projects in a specific geographical location, in the same industrial sub-sector, or using a specified technology (Taylor, et al., 2008).

EESL, Alliance for an Energy Efficient Economy, BEE and other ESCO promotion groups should target plant management, plant personnel, energy auditor and equipment supplier with informational programs surrounding ESCOs. These are the professionals that will champion the use of ESCOs to achieve energy savings targets. Opportunities exist to develop guidelines, tools and events to identify and address issues.

High Energy Prices

India has limited internal energy resources and is dependent on fuel imports which results in high energy prices. Issues with quality of energy supply could be a market opportunity for ESCOs as India has

a high captive power capacity, most of which is highly inefficient and expensive to operate.

Digitalization

As the Internet of Things (IOT), big data analytics, miniaturization and accuracy of sensors and meters, improve the measurement and verification of energy savings will become less of a challenge and turn into an opportunity for monetizing energy savings.

India - Threat

Lack of Trust in ESCO concept

Threats to India's ESCO market include a lack of knowledge and a lack of trust in the ESCO concept. Lack of development skill and public awareness prevent the ESCO concept from growing. Such barriers prevent interest in starting energy efficiency projects as there is little perceived gain (Ellis 2010).

Preference for in-house solutions

Large scale facilities prefer to use in-house energy managers. Small project sizes have transaction costs as a major portion of total cost which dissuade completing these projects. (Chittawar 2010)

Ambiguous definition of ESCOs in India

ESCOs in India suffer from an identity crisis. There are technology providers, aggregators (utilities), SuperESCO, and consulting ESCOs all offering different services but competing for legal recognition and the associated benefits of being classified as an ESCO. Being classified as an ESCO may increase the reputation of a firm and allow preferred access to financing, auditing, and technology.

Energy efficiency is a non-priority

There is limited energy efficiency policy and little enforcement of existing policy at the state and municipal levels (Alliance for an Energy Efficient Economy 2017). Additionally, as renewables lower electricity prices EE projects become less economical as energy cost savings are reduced. Without the incentive to change the status quo will remain. In India, this means a continued reliance on the energy-intensive industrial sector.

Measurement and Verification M&V

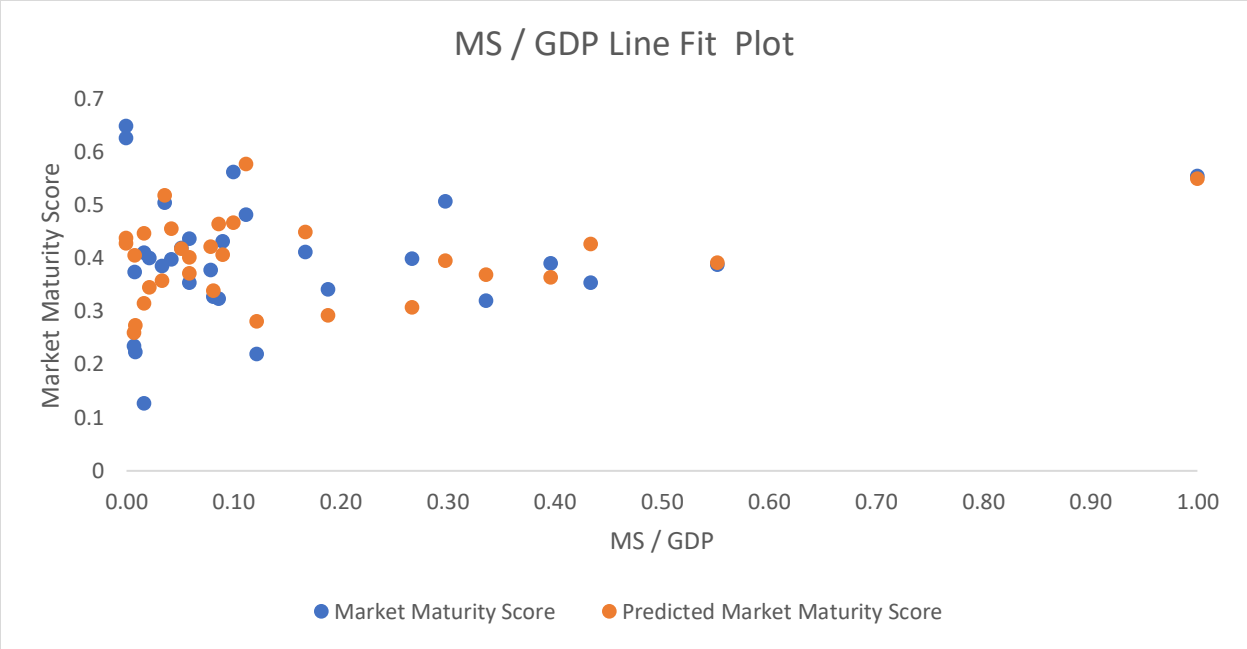
Creating a baseline for measurement and verification is a costly and lengthy process for ESCOs. Often ESCOs do properly conduct baseline measurements and this causes payment disputes which are calculated off baseline energy assessments (Alliance for an Energy Efficient Economy 2017).

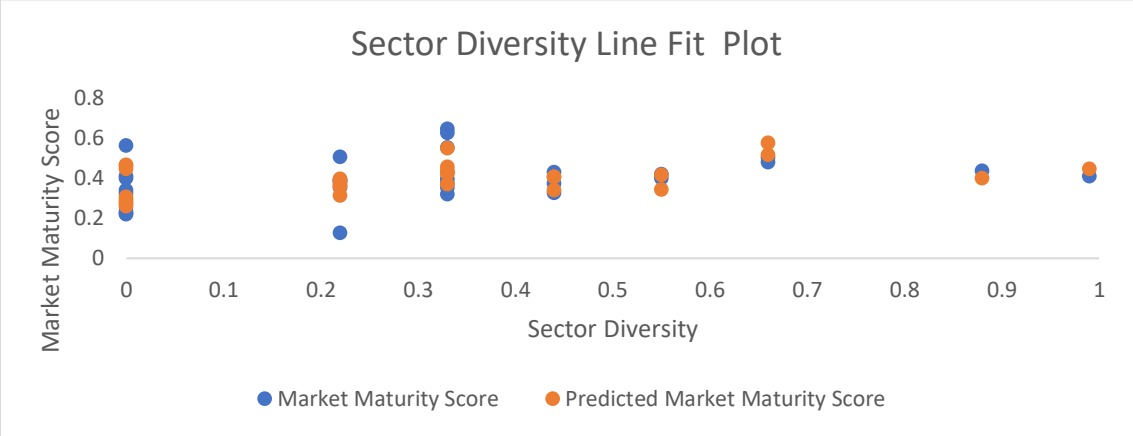
A6. Regression Analysis

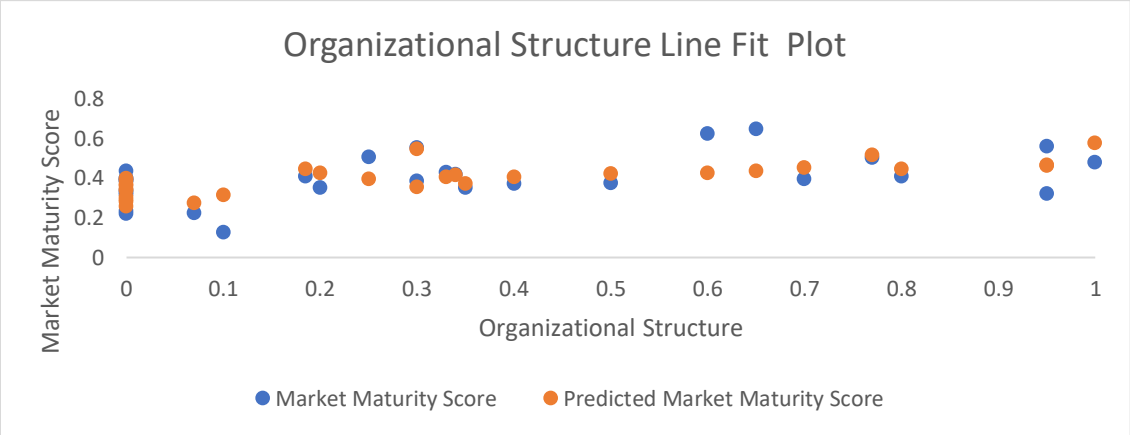
A6.1 Highest Weighted Indicator Regression Analysis

SUMMARY OUTPUT	Highest Weighted Indicators			Highest Weighted Indicators Regression Analysis				
					Predicted Market Score Weighting	*Actual Market Score Weighting*	*Δ Weightings*	
Regression Statistics				*Organizational Structure Score*	20%	19%	1%	(Positive Delta means Actual was *Undervalued* compared to Predicted)
Multiple R	0.6750134			*MS/GDP Score*	18%	18%	0%	
R Square	0.4556431			*Sector Diversity Score*	15%	19%	-4%	(Negative Delta means Actual was *Overvalued* compared to Predicted)
Adjusted R Sq	0.39283268							
Standard Error	0.09008148			Organizational Structure Score	MS/GDP Score	Sector Diversity Score	Predicted Market Score Equation	
Observations	30		Input Scores >				26%	
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	3	0.17659787	0.05886596	7.25426057	0.0010838			
Residual	26	0.21098151	0.00811467					
Total	29	0.38757938						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.25811556	0.03549511	7.27186356	1.0089E-07	0.18515433	0.33107679	0.18515433	0.33107679
MS/GDP	0.18152646	0.08047827	2.25559611	0.03273728	0.01610102	0.34695191	0.01610102	0.34695191
Sector Diversi	0.14996909	0.06404411	2.34165326	0.02713515	0.01832454	0.28161363	0.01832454	0.28161363
Organizational	0.19985053	0.05131157	3.89484373	0.00061466	0.0943781	0.30532297	0.0943781	0.30532297

RESIDUAL OUTPUT		
Observation	*Market Matur*	*Residuals*
1	0.37171518	-0.0187773
2	0.40544529	-0.031849
3	0.42627307	-0.0728972
4	0.33889198	-0.011295
5	0.36308342	0.02746307
6	0.40084086	0.03586853
7	0.4179462	0.00108262
8	0.25948289	-0.0254198
9	0.4063904	0.02527944
10	0.42181596	-0.0441978
11	0.29229842	0.04835193
12	0.44665668	-0.0369486
13	0.2802737	-0.0604611
14	0.39130092	-0.0041059
15	0.30651327	0.09255488
16	0.27368967	-0.0506105
17	0.35711684	0.02787769
18	0.44834168	-0.0369529
19	0.43750821	0.21079824
20	0.3952246	0.11101901
21	0.54908699	0.00561823
22	0.46368719	-0.1399919
23	0.51744854	-0.0127568
24	0.45521038	-0.0572547
25	0.42751568	0.19835027
26	0.36859418	-0.0485799
27	0.57722843	-0.0961456
28	0.3141004	-0.1875392
29	0.3445783	0.05553267
30	0.46611925	0.0959868


MS / GDP Line Fit Plot
Market Maturity Score
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.90
1.00
MS / GDP
Market Maturity Score
Predicted Market Maturity Score

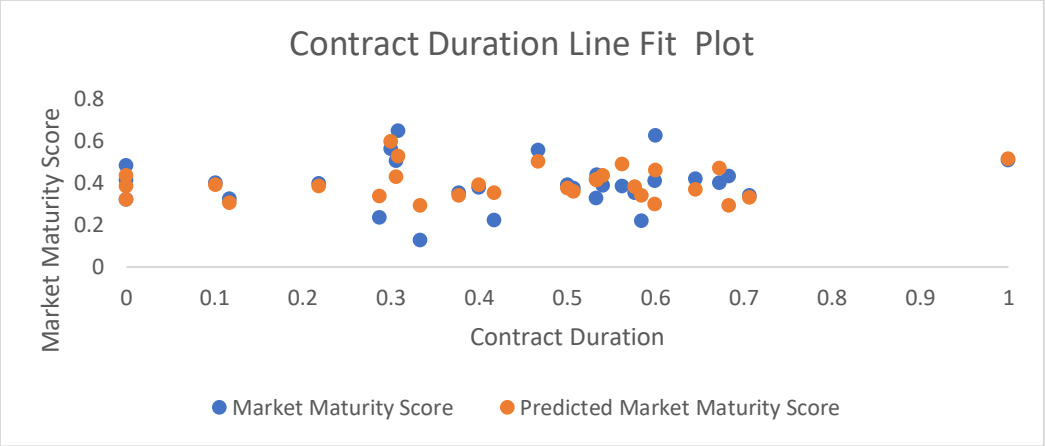

Sector Diversity Line Fit Plot
Market Maturity Score
0.8
0.6
0.4
0.2
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Sector Diversity
Market Maturity Score
Predicted Market Maturity Score

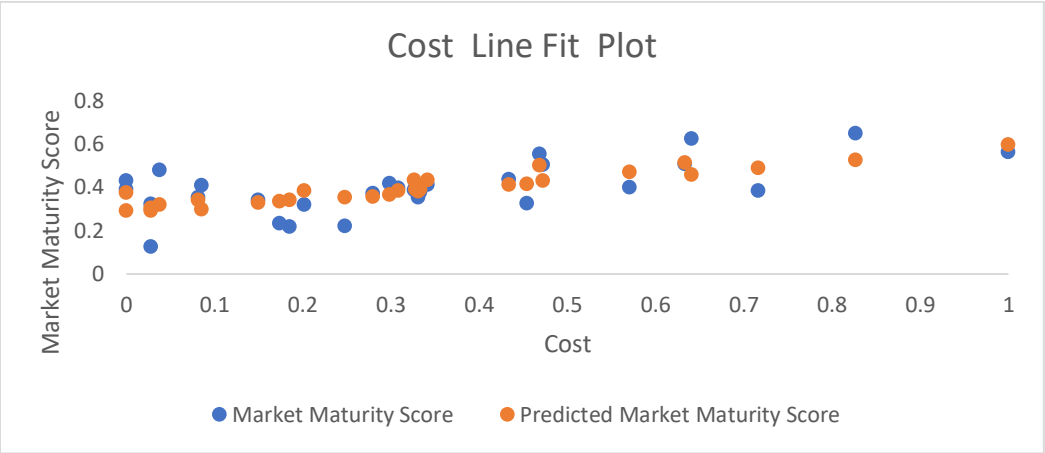

Organizational Structure Line Fit Plot
Market Maturity Score
0.8
0.6
0.4
0.2
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Organizational Structure
Market Maturity Score
Predicted Market Maturity Score

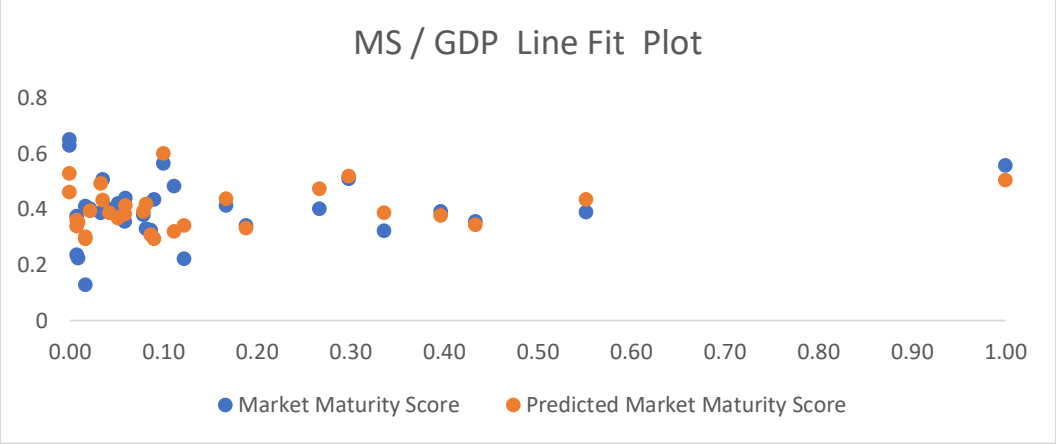
A6.2 Most Available Data Indicator Regression Analysis

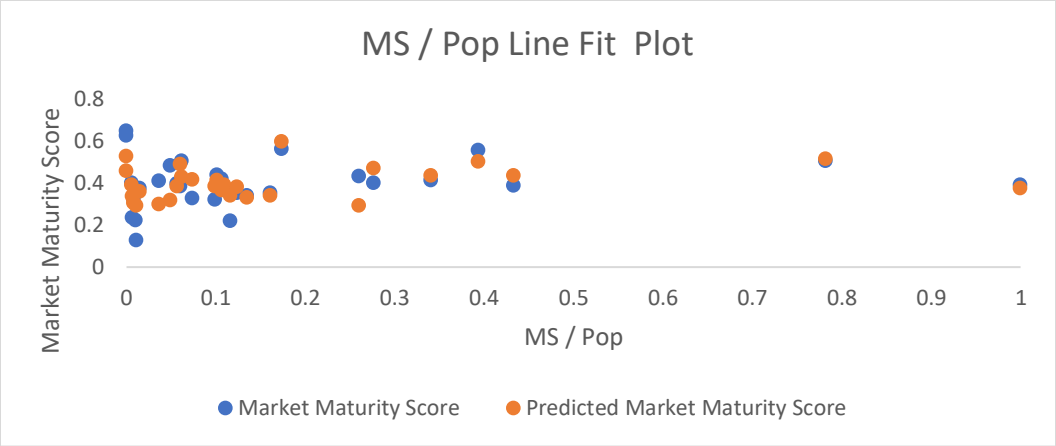
SUMMARY OUTPUT	Most Available Indicators			Most Available Indicators Regression Analysis				
					Predicted Market Score Weighting	*Actual Market Score Weighting*	*Δ Weightings*	
Regression Statistics				*MS/GDP Score*	6%	18%	- 12%	(Negative Delta means Actual was *Overvalued* compared to Predicted)
Multiple R	0.66410776			*Project Cost Score*	30%	15%	15%	(Positive Delta means Actual was *Undervalued* compared to Predicted)
R Square	0.44103911			*Contract Duration Score*	- 4.72%	12%	- 16.72%	
Adjusted R Squa	0.35160537			*MS/Pop. Score*	8%	5%	3%	
Standard Error	0.09308957							
Observations	30			Contract Duration Score	Project Cost Score	MS/Pop. Score	MS/GDP Score	Predicted Market Score Equation
			Input Scores →					30%
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	4	0.17093767	0.042734417	4.931462096	0.00452948			
Residual	25	0.21664172	0.008665669					
Total	29	0.38757938						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.29774118	0.04122075	7.22308918	1.436E-07	0.21284545	0.38263691	0.21284545	0.38263691
Contract Duratio	-0.0472175	0.08083579	-0.584116837	0.564375748	-0.213702	0.11926688	-0.213702	0.11926688
Cost	0.29529359	0.06945669	4.251478033	0.00025915	0.15224486	0.43834232	0.15224486	0.43834232
MS/Pop	0.07781369	0.10009206	0.777421255	0.444205193	-0.1283298	0.28395714	-0.1283298	0.28395714
MS/GDP	0.05658226	0.10043689	0.563361313	0.578207369	-0.1502714	0.26343591	-0.1502714	0.26343591

RESIDUAL OUTPUT		
Observation	*Market Matur*	*Residuals*
1	0.38108745	-0.0281496
2	0.35785159	0.0157447
3	0.34104258	0.01233328
4	0.41696222	-0.0893652
5	0.37438078	0.01616571
6	0.41177442	0.02493496
7	0.36650846	0.05252035
8	0.33644101	-0.1023779
9	0.29080358	0.14086626
10	0.39026688	-0.0126487
11	0.32968049	0.01096985
12	0.29848375	0.11122428
13	0.34064957	-0.120837
14	0.43356669	-0.0463717
15	0.47100487	-0.0719367
16	0.35238277	-0.1293036
17	0.48925251	-0.104258
18	0.43455322	-0.0231645
19	0.52722672	0.12107973
20	0.51537533	-0.0091317
21	0.5011866	0.05351861
22	0.30587327	0.01782205
23	0.42961538	0.07507634
24	0.38532076	0.01263492
25	0.45854497	0.16732098
26	0.38402515	-0.0640109
27	0.31904069	0.1620421
28	0.29195719	-0.165396
29	0.3914923	0.00861867
30	0.59802736	-0.0359213


Contract Duration Line Fit Plot
Market Maturity Score
0.8
0.6
0.4
0.2
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Contract Duration
Market Maturity Score
Predicted Market Maturity Score


Cost Line Fit Plot
Market Maturity Score
0.8
0.6
0.4
0.2
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Cost
Market Maturity Score
Predicted Market Maturity Score


MS / GDP Line Fit Plot
0.8
0.6
0.4
0.2
0
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.90
1.00
Market Maturity Score
Predicted Market Maturity Score


MS / Pop Line Fit Plot
Market Maturity Score
0.8
0.6
0.4
0.2
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0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
MS / Pop
Market Maturity Score
Predicted Market Maturity Score

A7. Links to News Articles promoting IEA Global ESCO Survey

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