

**Bachelor's thesis at the Lucerne School of Engineering  
and Architecture**

<b>Title</b>	<b>Developing new features to the existing value propositions of the smart metering systems in Switzerland</b>
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**Abstract German**

Smart Metering Systeme stellen Echtzeitinformationen über Energiegewinnung und Energieverbrauch zur Verfügung. Die Energiestrategie 2050 des Bundes erklärt Smart Metering Systeme als integralen Bestandteil der Energiestrategie und verlangt einen Anteil von 80% Smart Metering Systeme bei allen neuen Energiezählern bis 2027. Die europäischen unternehmen im Smart Metering-Segment befinden sich in einem fortgeschrittenen Phase. Dies dürfte den Schweizer Unternehmen aufgrund ihrer sozioökonomischen Ähnlichkeiten zugute kommen. Das Ziel dieses Projekts ist es, neue Bestandteile für die bestehenden Wertversprechen der Schweizer Smart Metering Unternehmen zu entwickeln und Ihren Beitrag zur Erreichung der Ziele der Energiestrategie 2050 auszuarbeiten. Eine ontologische Analyse und ein Vergleich der Angebote für bestehende Wertversprechen wurden Ergebnisse zeigen, dass die Firmen eher an epistemischen, funktionalen und ökonomischen Werten interessiert sind. Die Ergebnisse der ethnische und soziale Werte zeigen eher nicht repräsentiert werden. Der Vergleich von Angeboten in einem ähnlichen Marktsegment wurde gebraucht um die Unterschiede im Angebot von Schweizer und Europäischen Firmen zu zeigen. Literaturanalyse der Energieeffizienzziele der Energiestrategie 2050 des Bundes und den Treibern für die Smart Metering Systeme zeigen das die techno-ökonomische Auswirkungen der Smart Metering Systeme ermittelt wurden. Diese Analyse konnte allerdings nicht die direkten Einflüsse der Smart Metering Systeme auf die Energieeffizienz und ihren Beitrag zur Energiestrategie 2050 aufzeigen. Die Studie kommt zum Schluss, dass zur genauen Analyse der Auswirkungen der Smart Metering Systeme auf die Energieeffizienz weitere Studien nötig sind.

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### **Abstract English**

The challenges in energy efficiency measures, the need for sustainable energy resources and the competition in the electricity sector is leading countries to roll-out smart metering systems, that provide a real-time information of energy. The Swiss Federal Strategy 2050 considers smart metering as integral part of the energy efficiency measures and set the mandatory smart meter roll-out of 80% of all the electricity meters up to the year 2050. The study aim is to develop new features for the existing value proposition of the smart metering systems in Switzerland and elaborate their contribution to the energy measures of the Energy Strategy 2050. The Ontology analysis of the of the existing value propositions showed that the companies are more interested in showing the epistemic, functional and economic values whereas the ethical and social values are less likely to be represented. The comparison of offerings in a similar market segment identified the difference in offerings of the Swiss and European companies and helped identify the potentials for new features development for the value propositions for the Swiss companies. The study recommended new features for either to be simply added or adapted to the existing value propositions of the existing Swiss companies. A literature review of the energy efficiency goals of the Swiss Federal Energy Strategy 2050 identified the main drives of the smart metering systems and their techno-economic impacts. The literature review could not find a conclusive information of the energy impact of the smart metering systems and their contributions to the Energy Strategy 2050.

Place, date

Horw, 08.01.2019

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## Executive summary

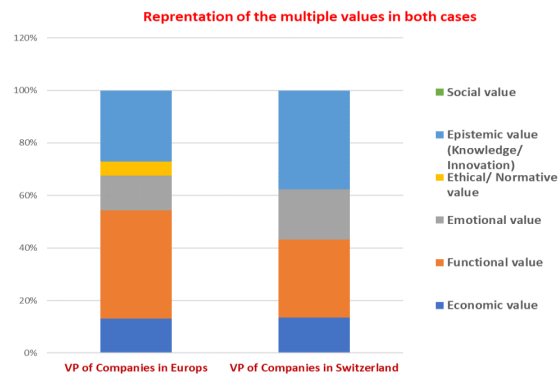
The challenges in regulations for increase in energy security, reduce carbon emissions and the competition in the electricity sector are leading to the deployment of smart metering systems. According to Bill (2015), Smart grids coupled with smart metering systems, an intelligent measuring system, can automatically monitor energy flows and adjust to changes in energy supply and demand accordingly by providing information on near real-time basis. The European commission identified smart metering as one of the measure to achieve their energy efficiency targets, where the roll-out of smart meters is assessed positively, at least 80 % of consumers should be equipped with intelligent metering systems by 2020 (EED, 2012). The Energy Strategy 2050 (Swiss Federal Office of Energy, 2018), with the new energy changes (See Table 15), has set the mandatory roll-out of 80% of all metering systems in the Swiss electricity supply chain up to 2027. It is highly likely that the socio-economic similarity between the European and Switzerland will benefit the Swiss smart metering companies from the experiences and insights made in Europe. However, it is unclear how the smart metering systems add value to their customers, the challenges the smart metering systems face and their contributions to their main goal of energy efficiency targets.

The aim of the project is to develop new features for the existing value propositions of the Swiss smart metering companies by analysing and comparing the value propositions of existing smart metering systems companies. It Furthermore aims to show the contribution of the of the augmented value propositions with the new features to the efficiency goals of the Swiss Energy strategy 2050. The study focuses on smart meters for electricity and tries mainly to answer the questions:

- What are current value propositions of the smart metering systems?
- How could the current value propositions and new features be developed or improved?
- Do the smart metering systems value propositions contribute to the energy efficiency of the Swiss Federal Energy Strategy 2050?

To analyse the value propositions of the existing companies, a comprehensive review of value propositions and offerings of over 40 companies was provided. The list of the companies was narrowed down to seven European and five Swiss smart metering systems companies for further analysis using criteria the developed for the selection of companies (See Table 1). The literature review also showed the existing technical configurations of smart metering systems (See section 3.2).

The ontology analysis was performed to the existing value proposition of the existing companies. The ontology analysis uses multiple value assessment method to analyse the value propositions. The ontology analysis showed that existing companies are more likely to represent the functional, economic and epistemic values in their value propositions. The companies are less likely to represent the other values of the multiple values in their value propositions.



The offerings of the Swiss companies in similar market segment and which have similar value propositions were compared to find the differences of their offerings. The comparison of the offerings found out that the Swiss companies offer less features and their technology is behind the European companies' offerings. The different features (See Table 13) in the European companies but not in the Swiss companies are used to develop or adapt features to the Swiss smart metering companies.

The result of the analysis found out that in comparison the European smart metering market, the swiss smart metering market is at the beginning. Therefore, the Swiss smart metering companies can benefit from their European counter-parts. Based on the comparison of the offerings, with slight adaptations to the Swiss market regulations, the smart metering devices can easily be adapted. The energy display devices, smart energy data platforms and advanced solutions for smart grids and smart cities can be obtained from the European smart systems market can be added or adapted to the Swiss smart metering market. The Smart metering systems infrastructure could also be helpful in the e-mobility sector.

The literature review of the Swiss Energy Strategy 2050 on energy efficiency measures found out that the current available studies focus on the techno-economic impact of the smart metering systems. Whereas the energy impact of the smart metering systems is less likely to be proven with the currently available studies. The study however recommended some features for adaption or simply to be added to the value propositions of the Swiss smart metering companies.

Finally, the study recommends, even though the economic impact is indirectly related to the energy efficiency measure of the Swiss Federal Energy Strategy 2050, the impact of the smart metering systems on the energy efficiency needs a specific assessment. Other than the economic considerations, issues such as the risks of the smart systems need to be further assessed. The government should make sure that all stakeholders benefit from the smart metering systems by creating some incentives.

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## Abbreviations and acronyms

VP	Value proposition
SMS	Smart metering systems
ESMIG	European smart metering industry group
Iot	Internet of things
AMI	Advanced metering infrastructure
AMR	Advanced metering recorder
ESMA	European smart metering alliance
LAN	Local area network
DC	Data concentrator
PLC	Power line communication
WAN	Wide area network
GPRS	General packet radio service is a packet-based wireless communication service
CKW	Centralschweizerische Kraftwerke: A utility company in central Switzerland Lucerne region
ES2050	Swiss Federal Energy Strategy 2050



## 1 Introduction

The growing amount of the decentralized power generation and integration of the power to the power grids is leading to numerous challenges for the power grids such as creating technologies for communication and information with integrated data and electricity networks (Bill, 2015). According to Bill (2015), Smart grids coupled with smart metering systems, an intelligent measuring system, can automatically monitor energy flows and adjust to changes in energy supply and demand accordingly by providing information on near real-time basis. Others also argue that smart metering systems can empower the customer to better manage their electricity consumption, support renewable energy and improve the electricity service (Exchange & North, 2011). The ESB (electricity supply board) networks findings for the commission of energy regulation (CER) Ireland, describes the smart metering as smart metering systems are a hybrid technology consisting of meters and associated devices, communications layer and IT systems which manage data, applications and services (Gary Martin, 2011).

### 1.1 Background

The European commission Energy Efficiency Directive (EED, 2012) laid the ground for energy savings and increasing energy efficiencies by 2020. The reasons for the energy directive are mentioned as energy dependency, climate change and techno-economical such as energy importation, competitiveness. etc. (Frederic & Wallenborn, 2012). The European commission identified smart metering as one of the measure to achieve their energy efficiency targets, where the roll-out of smart meters is assessed positively, at least 80 % of consumers should be equipped with intelligent metering systems by 2020 (EED, 2012). In accordance with the new Energy Strategy 2050 (Swiss Federal Office of Energy, 2018), the Swiss Council wishes to develop and identify the potential for energy efficiency. The new changes in the Swiss energy law states, installing smart meters as an integral part of the energy efficiency policy and sets a mandatory roll-out of 80% of all metering systems in the Swiss electricity supply chain up to 2027. It is highly likely that the socio-economic similarity between the European and Switzerland will benefit the Swiss smart metering companies from the experiences and insights made in Europe. However, it is unclear how the smart metering systems a value to their customers, the challenges the smart metering systems face and their contributions to their main goal of energy efficiency targets.

### 1.2 Project aim and objectives

The aim of the project is to analyse the value propositions of smart metering systems of existing companies and develop new features for the selected companies. Furthermore, the augmented value propositions of the existing companies with the new features will also be discussed to show their contribution to the efficiency goals of the Swiss Energy strategy 2050. The objectives of this study are:

1. Provide an overview of existing companies in the smart metering business segment, that offer services beyond the basic smart metering capabilities (remote meter reading and time dependent tariffs) generally in Europe and specifically in Switzerland
2. Develop the criteria for selecting 5 to 10 offerings out of the overview
3. Analyse the value propositions and the technical configuration of selected offerings on the market

4. Develop new features (elements) for the existing value propositions and discuss their transferability to the Swiss market
5. Collaborate with 3 – 5 companies to validate the new elements as an augmentation to the existing value proposition (VP)
6. Elaborate on the contribution of the original and modified value proposition to the energy efficiency goals of the Swiss Energy Strategy 2050

Smart metering systems are expected to deliver a range of benefits to consumers, which include bringing an end to estimated billing and providing consumers with near-real time information on their energy consumption (Ipsos, 2015). In Smart Grid, the smart metering solutions play important role with intelligent capabilities in order to meet the consumer's demands and their each objective such as measuring and communicating the near real-time electricity usage that facilitate remote real time monitoring and control power consumptions and consumers are provided with real time pricing and analysed usage information (Charantej P., Sunil G., 2015). Such solutions help solve the fluctuations in power production and consumption by offering different technological solutions for the integration of data and communication of electricity networks. Even though the smart metering systems concept started early on the 1990's (Pekka et al., 2008), it is, however, not clear how the value propositions of the smart metering systems add value to the electricity supply chains and their contributions the energy efficiency targets of the Swiss Energy Strategy 2050.

This report focuses on smart meters for electricity and tries mainly to answer the questions:

- What are current value propositions of the smart metering systems?
- How could the current value propositions and new features be developed or improved?
- Do the smart metering systems value propositions contribute to the energy efficiency of the Swiss Federal Energy Strategy 2050?

The first section of the report is devoted to clarifications of a smart meter based on literature reviews, pieces of knowledge, both empirical and theoretical, about the use of smart meters. Furthermore, a list of over 40 existing companies in the smart metering market segment and technical configurations of the current smart metering systems are also explained through literature reviews. The second section is the methodology section and it reviews the list of companies for analysis and the way the information was collected. The companies for this study were narrowed down from the long lists (see Appendix A) of the existing companies, and to do so criteria were developed and introduced (3.4) for further analysis. Selected companies and their value propositions are listed in section (3.4.1). The analysis section reviews the further analysis of seven companies from the European market and 5 companies from the Swiss market. The value proposition of the selected companies was analysed using the ontology analysis and their offerings were compared in the methodology section. The result section consists of the results from the ontology analysis of the value propositions of the companies and the difference of the offerings of the companies. The discussion section and the development of new features for the existing value propositions is in section 6. The last section shows literature review of the Swiss Federal Energy Strategy 2050 and its objectives. Furthermore, a literature review of the contribution of the smart metering systems to the energy efficiency measure of the Energy Strategy 2050 is performed in section 5.5.2. Finally, section 8 consists of the main conclusion of the study and the recommendations. The reference and the Appendices sections are at the end of the report.

## 2 Planning

This section consists of all the organizational matters of the project. For planning, Risks, and Mitigation plans refer to the appendices.

### 2.1 Working process flow

The working process is visually explained in the figure below. The bars with bold letters represent a chapter in the report.

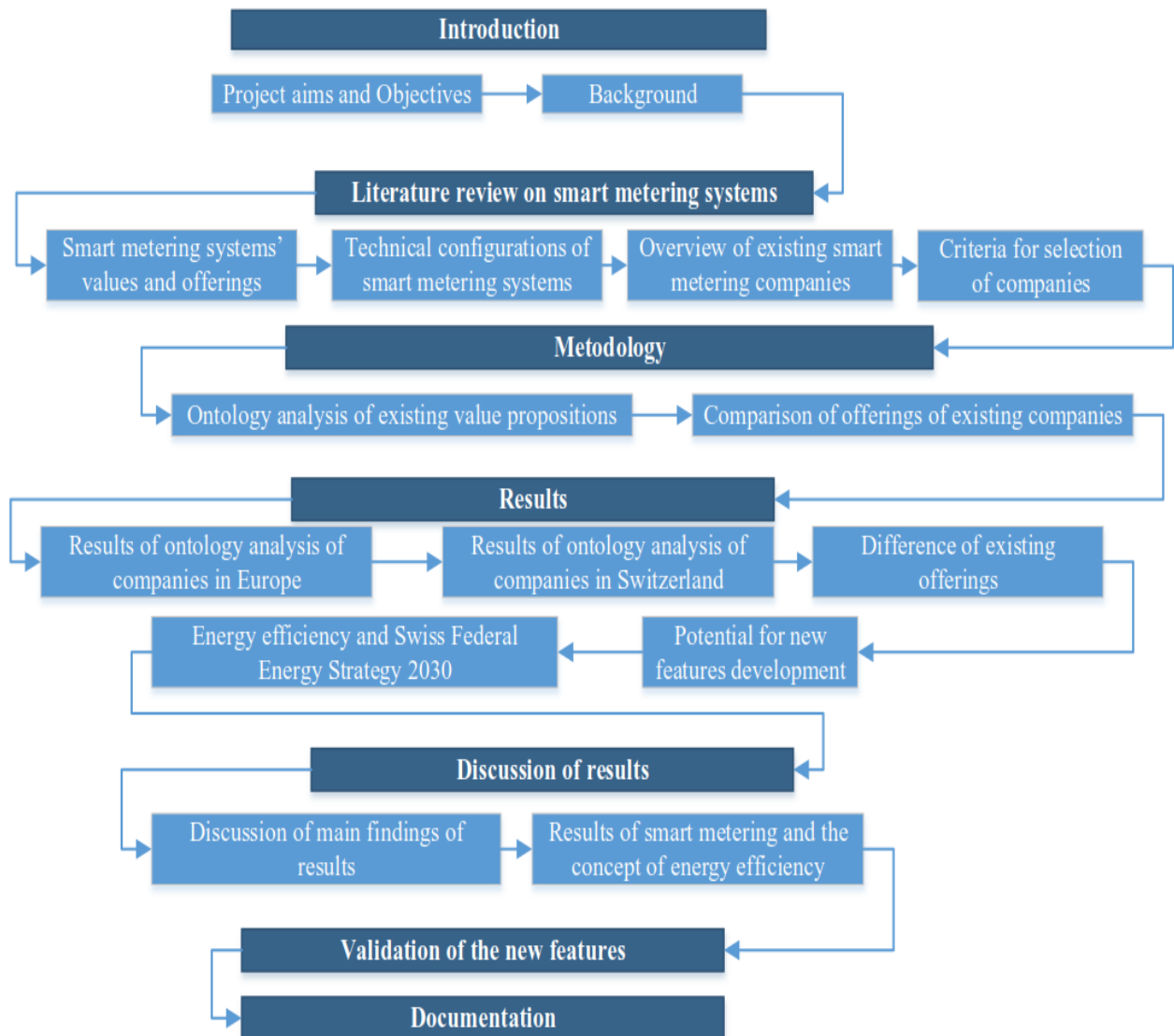


Figure 1: Working process flow

### 3 Literature review: smart metering systems

According to the European Smart Metering Alliance (ESMA), smart metering systems have, automatic processing, management and utilization of metering data, two-way data communications with meters, meaning full and timely consumption information of energy and services that improve the energy efficiency of the energy consumption in the system (Pekka et al., 2008). The existing metering system of a consumer's electrical usage is based on an analogue system that is based on reading the usage of the energy at the customer premises (Khadar, Ahamed Khan, & Nagaraj, 2017). Smart meters can measure and communicate detailed near real-time electricity usage and facilitate remote real time monitoring and control power consumptions and consumers are provided with real time pricing and analysed usage information (Charantej P. et al., 2015). The smart metering systems are energy measuring and communicating systems that contain an advanced metering system with smart electronic meters, smart communication systems and smart metering system that can control, monitor, and configure the overall network of metering devices to provide the data and services required for advanced metering initiatives (Kelley, 2005). The advanced metering infrastructure, or AMI, is a system of utility meters that measure the energy consumption and provide the information to the utility companies, as well as the consumers interested in keeping the usage costs low, or wanting to supply the electricity back to the grid (Pekka et al., 2008). The lack of flexibility and reliability in pricing and billing can therefore be overcome through the smart metering systems (Khadar et al., 2017). Khadar et al., (2017) further argues that smart meter captures and records the electrical energy usage data and highly supports communication in two directional patterns between the central and meter system and the smart metering system has a system that measures the energy consumption in real time. The advanced metering infrastructure (AMI) is such a system to be operated for real-time monitoring and control of electricity usage (Subhash & Rajagopal, 2014). The smart metering system has different levels. Smart Metering is a combination of smart meters, smart interfaces, information technology (IT), and two-ways communication systems (Worldgrid, n.d.). The smart metering is expected to offer a range of benefits to the customers. It can empower the customer to better manage their electricity consumption, support renewable energy and improve the electricity service (Exchange & North, 2011). It is considered that this will provide consumers with better control over their energy use, help them to budget better and help make switching between suppliers smoother and faster. The smart meters benefits include the use of near real time information of energy consumption through display devices provided by smart meters and other intelligent features. "Smart meters are the next generation of gas and electricity meters offering a range of intelligent functions" (Ipsos, 2015). Power generating companies and transmission system operators will directly profit from the precise data gathered by smart meters, whereas distribution system operators will manage the balance in a more efficient way (Worldgrid, n.d.). Smart metering is considered as a new efficient way of measuring energy that will change the existing way of energy production, delivery and consumption.

#### 3.1 Smart metering systems values and offerings

The evolution in the smart metering systems technology is driven by the opening of the energy markets to competition, insuring security supply and emissions reduction objectives (Worldgrid, n.d.). The new technological developments in the electricity energy market

consider the smart grids and smart meter as the main blocks to reach their desired objectives of energy efficiency. The digitalization of the electricity grid opens the way to bundle value added services to the electricity commodity, and possibly shift business value to electricity services in line with the notions of efficiency, conservation and sustainability (Giordano & Fulli, 2012). The need for an automatic meter reading system has led to serve more applications than the traditional basic settlement, billing and load control. The most important applications of the smart systems are, the use of energy efficiency improvement, energy management, energy saving and demand response. (Pekka et al., 2008). The mandatory smart metering roll-out is one of the energy efficiency measures. According to Kaufmann et al. (2013), the mandatory smart metering roll-out would foster the implementation of smart metering nationwide, however, it is unlikely to achieve the intended target of energy efficiency if it fails to provide the value to the customers. “An undifferentiated mandatory smart meter rollout might lead energy providers to either choose the cheapest smart metering solution or to implement smart metering services that provide value to the energy providers but not to the customer” (Kaufmann, Künzel, & Loock, 2013). Kaufman et. al., (2013) argues that the lack of customer value in the smart metering systems prevents consumer acceptance of smart metering technologies thus underachieving the desired results. Therefore, the smart metering systems must provide a value proposition that satisfies all the customers. The value proposition building block describes the bundle of products and services that create the value for a specific customer segment (Osterwalder & Pigneur, 2010). The value proposition and offerings are very similar terms used to describe the values a company offers to its customers. “Value propositions and offerings are closely related concepts that are often confused with one another, since both concepts convey the intuition of what a company "offers" to its customers.” (Sales, Guarino, Guizzardi, & Mylopoulos, 2017). Osterwalder et.al in their study about value proposition claim that a value proposition is composed of one or more offerings (Osterwalder, Pigneur, Bernarda, & Smith, 2015). With this claim, this study tries to identify and analyse the value proposition of different companies in the smart metering systems marketing segment in Switzerland. Even though, the offerings of the existing smart metering companies of each company may differ from the other, the overall smart metering systems offerings contain:

- Smart meters as energy measurement equipment and other smart metering modular products.
- Smart metering software systems as a solution to energy management, data analysis etc.
- Smart metering infrastructure such as Advanced Metering Infrastructure (AMI), cloud.
- Smart Metering Services such as installation, maintenance and support.

Atos WorldGrid have described the values each player could contribute/offer in the electricity value chain in the following schematic:

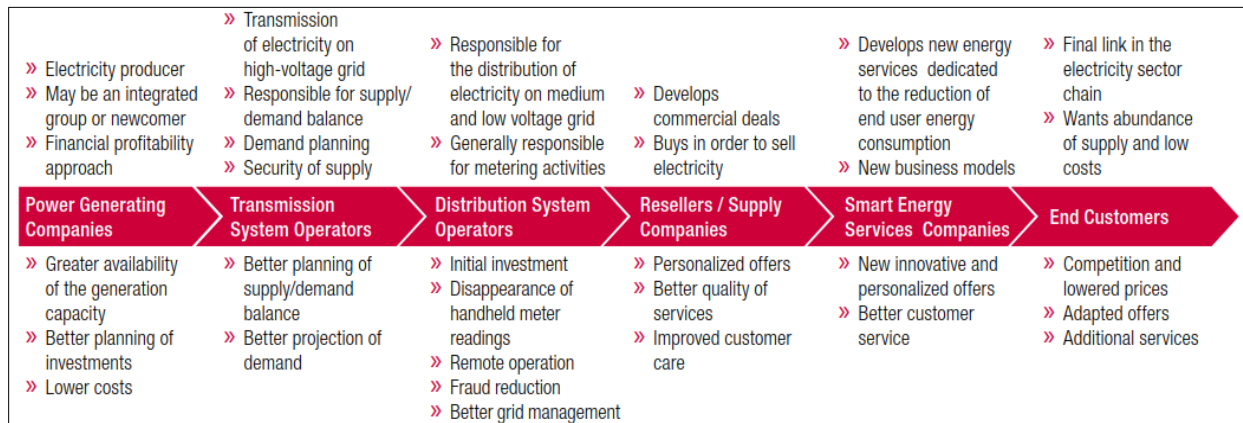


Figure 2: The roles played by the electricity value chain actors and transformations brought about by Smart Metering. Source (Atos, n.d.)

### 3.2 Technical configurations of smart metering companies

Currently there is no universally agreed definition of smart systems technology. According to Pekka et al., (2008), ‘‘Smart Meters are electronic measurement devices used by utilities to communicate information for billing customers and operating their electric systems.’’ The combination of the electronic meters with two-way communications technology for information to monitor and control is commonly referred to as Advanced Metering infrastructure (AMI).

According to ESMA (Pekka et al., 2008) a smart metering has the following features.

- Automatic processing, transfer, management and utilisation of metering data
- Automatic management of meters
- 2-way data communication with meters that provide meaningful and timely energy consumption information to the relevant actors and their systems, including the energy consumer.
- Supports services that improve the energy efficiency of the energy consumption and the energy system (generation, transmission, distribution and especially end-use).

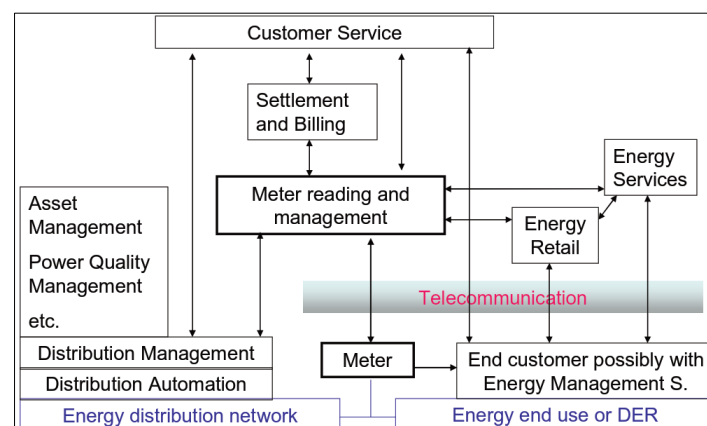


Figure 3: Applications and Smart Metering Infrastructure (Pekka et al., 2008)

According to Pekka et al. (2008) in Figure 3, smart metering systems help provide a correct settlement and billing by providing accurate and up to date consumption data. Another core feature of the smart metering systems is its ability to measure data at any point at time. This



enables a regulator to a more frequent and cheaper switching of retail electricity suppliers. Smart metering also enhances the possibility of providing actual energy consumption to customers and billing. State estimation of power distribution networks can also be improved by adding measurements at different points of the end customers. Continuous monitoring of voltage quality enables fast and accurate response to customer complaints. It also enables preventive reaction to power quality problems before any harm or damage to the network or to the customers occurs.

The ESB Networks group for studies on smart metering systems (The Commission for Energy Regulation, 2011), have used the following, Figure 4, schematic to show the smart metering technology.

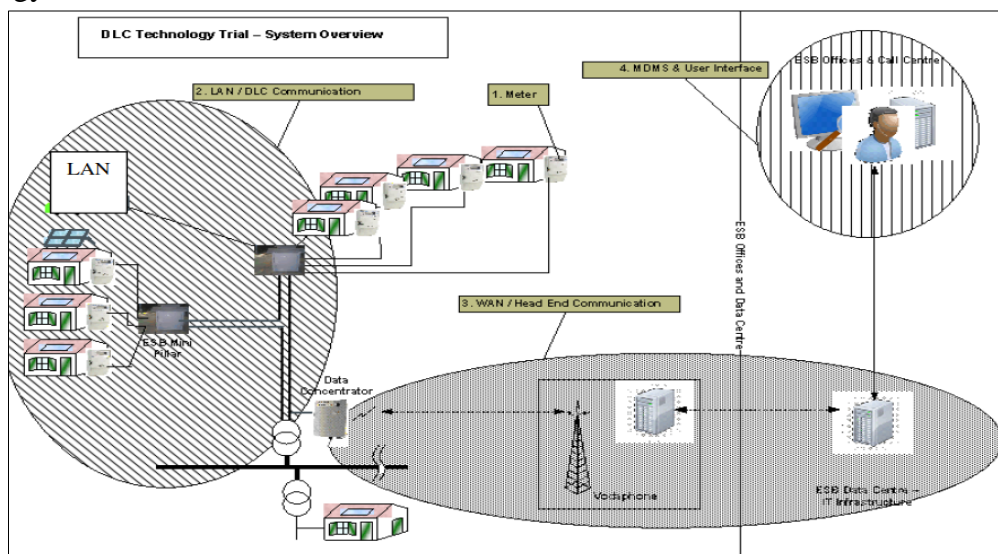


Figure 4: PLC Technology Trial System. (The Commission for Energy Regulation, 2011)

The technology that was used in the trial, Figure 4 consisted of:

1. Electricity Meter, with PLC communication modem;
2. Local Area Network (LAN), using PLC Communications
3. Wide Area Network (WAN), using GPRS Communications
4. Head end System (Ionos)

Meters are installed in the end customers premises to measure the actual data of energy consumption. The Local Area Network (LAN) communication process is managed by the Data Concentrator (DC). The DC communicates with the meter through PLC (Programmable Logic Control) communication.

The WAN (Wide Area Network) communications between the head end and the data concentrators are managed through Vodafone network. GPRS modems are installed in each of the Sagem DCs.

ESB Networks installed the head end software on its own IT infrastructure. The head end is known as Ionos Network Management System (Ionos NMS). The first purpose of the Ionos application is to ensure data collection. Ionos performs automatic reading of the data collected by the DC and stores that data in the Ionos database. The data is then available for processing by ESB Networks. Custom reporting tools were developed by the project team to query the head end metering data repository to provide reports on the performance of the metering system.

### 3.3 List of existing smart metering companies

The list of companies is extracted mainly from the European Smart Metering Industry Group (ESMIG). “ESMIG is the European association representing companies that provide smart energy solutions such as: smart meters, communication equipment and services, data processing and analytics, in-home displays, energy management systems, digital security” (ESMIG, 2016). The other companies are obtained from internet searches and by consulting people. The whole list of companies with their value propositions is provided in Table 14 in the Appendix. The list of companies in this section are the companies selected for analysing the value propositions of the existing smart metering systems.

### 3.4 Criteria for the selection of companies

The ESMIG company list consists of a long list of member companies. This study focuses on companies that fulfil the requirements. The focus of the criteria development was on two points. The first is developed to identify companies based in Europe (see Table 2.) whereas the second batch of criteria is developed to define companies based in Switzerland (see Table 3).


Table 1: Companies selection criteria

Criteria for companies in Europe	Criteria for companies in Switzerland
<ul style="list-style-type: none"> <li>• Company must not be based in Switzerland</li> <li>• The smart metering systems must cover Electricity</li> <li>• The company must be a member of ESMIG</li> <li>• The smart metering system must offer soft/hardware solution</li> <li>• The company must be available in the European smart metering market</li> <li>• It would be preferred if the value proposition information is available in English</li> </ul>	<ul style="list-style-type: none"> <li>• Company must be based in Switzerland</li> <li>• The smart metering systems must cover Electricity</li> <li>• The smart metering system must offer soft/hardware solution</li> </ul>

#### 3.4.1 Selected list of smart metering companies

The following list of companies are companies which are members of ESMIG which are present in one or more countries in Europe but not in Switzerland.

Table 2: List of companies and their offerings of ESMIG member companies in Europe

 <b>Chameleon™ Technology</b> Features <ul style="list-style-type: none"> <li>• In-Home Displays for Smart Meters</li> <li>• Consumer Access Devices for Smart Meters</li> </ul> Present in UK	Chameleon Technology designs and manufactures in-home displaying, consumer access smart meters for real time energy visualization. It also provides cloud services for the global smart meter market.
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## geo (Green Energy Options)

### Features

- energy monitors
- smart metering devices
- cloud services for smart meter market

Present in 7 European countries

geo provides utilities with smart metering products and a range of individual or combined digital solutions for the smart metering program in UK. This includes collection of raw data from meters or solar panels, delivery onto cloud servers, and the processing of information for analysis and presentation. This data can be presented on an in-home display and an energy app. It can also be provided as raw or processed data for further use. The solutions can also include two-way WiFi connectivity to exploit IoT type functionality



## NES (Networked Energy Services)

### Features: Turnkey Smart Grid Solutions

- smart meters and smart grid devices
- control nodes
- communication devices & software
- data collection software
- energy based analytics

Present in 12 European countries and 10+ countries outside Europe

NES Corporation offers the most reliable broadly deployed smart grid platform enabling grid health and efficiency monitoring as well as control and smart metering applications.

The NES System is based on a 3-tier architecture; which includes utility data centre software, field distributed application control and grid devices and sensors, such as single phase, poly phase, and smart meters, and Open Smart Grid Protocol (OSGP) compliant communication devices enabled by our Control Point Modules.



## Vodafone

### Features

- metering solutions
- IoT platform
- utility services

Present in 12 European countries and 16 countries outside Europe.

The core of Vodafone offering is their own managed IoT platform, designed to take away the complexities and cost of deployment by automating provisioning, billing and other logistics processes.

With the IoT Technology Vodafone provides software solutions for smart grids and smart metering



## Wirepass

### Features

- decentralised radio communications protocol for large-scale IoT applications
- protocol software that can be used in any device, with any radio chip and on any radio band

Present in 130+ countries

Wirepas Mesh enables wireless IoT networking at massive scale. It is a de-centralized IoT network protocol that can be used to connect, locate and identify lights, sensors, beacons, assets, machines and meters in cities, buildings, industry, logistics and energy – with unprecedented scale, density, flexibility and reliability. It can be used on any radio hardware and on any frequency band.



## First Fuel

### Features

- information technology
- platform for user engagement & advice
- data analytics

Present in UK, USA and Canada

FirstFuel Software is the global leader in business customer engagement for the energy industry, using advanced analytics. Combining data science, building science and software, our digital engagement platform derives intelligence from over 3 million meters, transforming energy providers into trusted advisers to their business customers. Our SaaS solutions deliver accurate, insightful, and costeffective results at scale.



Luna

## Features

- energy smart meters
- data concentrator and modems for smart grid applications and AMR systems
- smart GSM Modem for AMR Metering applications

Present in 4 countries

LUNA carries out its design and production of electricity meters, the development of software and hardware for the communication between the meters smart grid solutions as a complete system for electrical energy management as well as water metering solutions.

### 3.4.2 List of smart metering companies in Switzerland

This list also shows the list of smart metering companies operating in the Switzerland market but are not members of the ESMIG. The list is collected through consultations and through internet research.

Table 3: List of companies and their offerings of companies in Switzerland



smart-me

## Features

- 3-phase energy meter with dual function as measurement device and as gateway to the cloud for smart-energy devices
- Encrypted Wi-Fi connection directly to the smart-me cloud
- Real time data measurement data with the possibility to remote switch, time switch and switching according to conditions
- Energy data management, automatic invoicing, remote controlling and alarms enabled through the smart-me cloud and installation app

smart-me delivers technology for monitoring, controlling, billing and optimising energy. smart-me energy metering devices combine with cloud platform functions to form a comprehensive energy management system that creates added value for our customers.



Adaptricity

## Features

## Software solutions for

- Smart meter data analyses (use of existing data)
- Continuous monitoring of voltage and grid loading
- Identification of grid bottlenecks
- Overview and prioritization of areas where action is needed (grid operations and planning)
- Evaluation of countermeasures
- Detailed one-year grid simulations and analysis of grid loading

Adaptricity helps to achieve the profitable analysis of extensive smart metering datasets and other data records, and to close existing gaps in the data. Our software facilitates the regular and accurate monitoring of grid states and the relevant grid capacity utilization at the low-voltage level. At the same time, future grid behaviour can also be simulated. This enables the early identification of critical grid states and the initiation of suitable courses of action



#### Features:

- Load management systems
- Multi-Commodity AMI
- Services

Landis+Gyr is a global company present in 17 European countries and 15 countries outside Europe

Landis+Gyr's provides innovative tools that help utilities save losses and balance demand and supply in energy load management, provides smart metering devices with a real-time data measurement, two-way communication and advanced metrics. Landis+Gyr offers a comprehensive portfolio of AMI technology with assistance in maintenance, technical support, system integration and employee training.



#### Features:

- Energy Monitoring
- Smart Meter and
- Communication Module

Present in Switzerland

CKW offers comprehensive know-how around meters and measuring instruments, assistance with the installation of your measuring device or uncovering potential savings and equipment with the necessary accessories.

CKW modules are provided through cooperation with Kamstrup, a company that produces smart metering modules.



#### Features

- M-Bus data logger with integrated web-server
- Internet of things and Industry 4.0 ready system
- M-Bus Meter

EMU's offers to its customers different forms of smart metering devices and software solutions including support for devices, connection to web-based energy management and interfaces for data management.

## 4 Methodology

The methodology section consists of two parts. The first part covers the value proposition analysis of the existing companies based on the ontology theory and the second part covers the comparison of offerings of companies in similar market segment.

### 4.1 Ontology analysis

There are different ways of value proposition analysis, the most common of which is the canvas by Osterwalder et al. (2015). Osterwalder et al. (2015) uses the pains, gains and features of an offering to analyse pain creators, pain relievers of the value proposition. In this study the ontology analysis of a value proposition by Sheth, Newman, & Gross (1991) methodology is implemented to analyse the value proposition of the existing smart metering systems in Europe and Switzerland. According to Sheth et al. (1991), the consumer choice of a specific product depends on multiple values and the values make different contributions in any given choice. Based on Sheth et al. (1991) theory of value proposition analysis, the consumer behaviour is influenced by so called multiple values. These multiple values are the functional values, the economic values, emotional values, epistemic values, ethical values and social values. Based on Sheth et al. (1991) ontology, the value descriptions are as follows:

**Functional values:** the perceived utility of an alternative resulting from its inherent and attribute- or characteristic-based ability to perform its functional, utilitarian or physical purposes. The functional value is represented by the product's ability to do the required job. Examples include,

- Automation / IoT: Provides dedicated offering for automation, Internet of Things.
- Power feed from grid: Pulls power from a higher-order power network to the building / district
- Power feed to grid: Feeds power from the building / district into a higher-owner power network
- Optimization of self-consumption: Allows to raise the degree of self-consumption
- Regulatory compliance: Ensure compliance with applicable laws, by-laws, regulation, for instance electricity standards, registration obligations
- Consumption reduction / avoidance: Offers means to reduce and / or avoid demand for / consumption of power

**Economic values:** Offerings that represent promising financial returns, but not financing per se. Lower prices, return on investment or economic value propositions such as:

- Cost avoidance: Allows to avoid (further / higher) cost
- Cost saving: Allows to save cost
- Revenue generation: Allows to gain revenue from sale of product / service on the market
- Subsidy: Allows to claim subsidy payment from the local authorities
- Tax incentive: Allows to claim tax benefit from local (income) tax
- Value increase: Promised increase of the value from the building / area

**Emotional values:** The perceived value of utility acquired from an alternative's capacity to arouse feelings or affective states such as comfort, security, excitement, romance, passion, fear, or guilt. Example:

- Fears: Offerings that address fears, uncomfortable living spaces

- **Guarantees:** Offerings that address a possible failing of the product and/or guarantee a working service upon installation. Includes financial guarantee that a promised / envisaged financial benefit is received and production guarantees
- **Comfort:** Delivers some / higher degree of comfort for the customer
- **Design:** Offers value through special / good design (of product / service)

**Epistemic (Knowledge/innovation) values:** Is the perceived value utility resulting from an alternative's ability to arouse curiosity, provide novelty, or satisfy desire for knowledge.

Examples:

- **Unique competency / experience:** For example, in Netflix, that provides the value of the very good recommendation algorithms through a high degree of track record / expertise, with technology, from many years in the field, from own product development, from research, or such.
- **Innovation:** Providing an innovative, new, leading-edge, disruptive offering
- **Transparency,** in terms of knowing where a product of a company stands.
- **Knowledge:** a product that shows the indoor temperature

**Social values:** is the perceived utility of an alternative resulting from its image and symbolism in association or disassociation with demographic, socioeconomic, and cultural-ethnic referent groups. For example

- **Reputation:** Offers public acknowledgement for / pride in differentiating installation / special property, e.g. "like a / instead of a Mercedes", making others / neighbours envious, showing leading edge / pioneer status.
- **Community:** Be part of a larger group

**Ethical/ Normative value:** is the perceived utility of alternative values that address benefits for society or nature. Examples

- **Energy transition:** Helping with the transition away from fossil energy sources
- **CO2 compensation / capture:** Offers a means to compensate / capture (and store) CO2 (and/or similar greenhouse gases)
- **CO2 saving / avoidance:** Offers to reduce / avoid the release of CO2 (and/or similar greenhouse gases)

#### 4.1.1 Ontology analysis of selected ESMIG companies

The value propositions of the companies selected for analysis were analysed using the ontology of value propositions according to the theory of Sheth et al. (1991). Table 4 shows the value propositions of the companies from their websites and assigned to the multiple values of the ontology process. The information and texts under each perceived value is taken from the value proposition expressed on each company website.

Table 4: List of European companies' analysis using the multiple values

Company	Economic value	Functional value	Emotional value	Ethical/ Normative value	Epistemic value (Knowledge/ Innovation)	Social value
Chameleon <sup>TM</sup> Technology	-	A home that is enabled with smart meters, and crucially, a secure home area network, will be able to access its valuable real-time energy consumption and pricing data. This will be made possible by the provision of a Consumer Access Device (CAD)	Chameleon employs a "user-centred" design process to create simple, intuitive, helpful and engaging displays "Award-winning, Bespoke and Beautiful Designs"	-	Chameleon Technology designs and manufactures bespoke in-home displays for the global smart meter market	-
geo (Green Energy Options)	-	Structured with flexibility in mind, Tempo gives our utility customers a fully integrated end-to-end service that minimises contractual interfaces and maximises user experience on a smart energy meter.	-	-	We can reliably transfer valuable data out of the home and into the cloud, so that it can be used in new and innovative ways.	-
NES (Networked Energy Services)	-	NES smart meters meet the future market and regulatory needs of a utility by incorporating a rich set of features including prepay, multi-tariff abilities, remote firmware updates, remote connect and reconnect, tamper and outage detection, hardware extensibility, direct relay control, software-configurable service levels, and load factor monitoring.	'Enabling the Most Efficient, Reliable & Secure Delivery of Energy for Utilities"	-	-	-
Vodafone	Designed to take away the complexities and cost of deployment by automating provisioning, billing and other logistics processes. All improvements of the billing process contribute to improved cash flow, less bad debt, and fewer inquiries over billing and payments.	The smart grid gives utilities the means to meet these challenges - remote data management and monitoring capabilities, automation and control, and the systems for the effective utilisation and safe management of transmission and distribution networks.	-	it also opens opportunities for the development of other new low carbon technologies such as the smart home and digital cities.	-	-
First Fuel	-	FirstFuel's cutting edge software platform delivers scalable business customer insights that dramatically improve customer satisfaction, increase revenue and program participation, and reduce service costs.	-	-	Our SaaS solutions deliver and cost-effective results at scale. FirstFuel's cutting edge software platform delivers scalable business customer insights that dramatically improve customer satisfaction, increase revenue and program	-

						participation, and reduce service costs.	
Luna	-	-	-	-	-	LUNA carries out its design and production of electricity meters, the development of software and hardware for the communication between the meters	-
Wirepass	Wirepas Mesh offers a proven and solid way to benefit from low cost mesh	Wirepas Mesh enables wireless IoT networking at massive scale	-	-	-	-	-

The value propositions of smart metering companies in the European market specified under each value from the multiple values helps understand how companies identify their values.

#### 4.1.2 Ontology analysis of companies based in Switzerland

The companies selected for analysis in the Swiss market are analysed in a similar way to the companies in the European market. The information in Table 5 shows the values companies offer their customers, expressed online in their public websites. The values are assigned to the multiple values of ontology process based on the content of their text.

Table 5: list of companies in Switzerland analysis using multiple values

Company	Economic value	Functional value	Emotional value	Ethical/ Normative value	Epistemic value (Knowledge/ Innovation)	Social value
Smart-me	-	The smart-me 3-phase Meter is a precise high-performance energy meter with a built-in Wi-Fi interface.	This is the easiest option to visualise the consumption of energy with the help of a smartphone, a tablet or a computer in real time, to analyse the metered data and to optimise the own-consumption.	-	smart-me delivers technology for monitoring, controlling, billing and optimising energy. smart-me energy metering devices combine with cloud platform functions to form a comprehensive energy management system	-
CKW	uncovering potential savings Equipment with the necessary accessories	-	-	-		-

Landis+Gyr	Replacing outdated metering technology with modern digital options can lead to cost savings and more efficient operations	Landis+Gyr's advanced metering infrastructure (AMI) sends real-time endpoint data back to the utility. Our AMI software manages and processes the data and drives solutions for smarter grid-edge intelligence.	Landis+Gyr experience creates strong foundation for efficient and reliable smart metering rollout	-	Landis+Gyr's smart metering technology delivers real-time data and advanced metrics for smart meters that provide crucial insights that enable utilities to transform customer service, lower operating costs, and make more informed asset investment decisions. Our full suite of applications will seamlessly integrate into your existing system to generate an extremely accurate model of your distribution network and deliver unprecedented planning capabilities and real-time optimization.	-
Adaptricity	Our software facilitates the regular and accurate monitoring of grid states and the relevant grid capacity utilization at the low-voltage level		-	-	Adaptricity helps to achieve the profitable analysis of extensive smart metering datasets and other data records, and to close existing gaps in the data	-
EMU	The web-based software automatically records and analyses all relevant energy and process data. This data allows decisions to be made quickly or processes modified to prevent exceeding energy peaks.	The M-Bus Center is configured entirely using an appealing, user-friendly interface operable with any customary web browser		-	Joulio-Web EMS can quickly be integrated into an existing IT landscape and scaled to an unlimited number of meters or locations.	-

The value propositions of companies on their websites are expressed in terms of the multiple values.

The companies' value propositions were further evaluated according to the multiple values of the ontology analysis. The value propositions of the companies were assigned to the numerical values expressed in percentage that shows relation between the offerings and the description of the multiple values. The result is shown in 4.1.3.

#### 4.1.3 Value propositions compared to multiple values

The percentage values assigned to each value of the multiple values shows, the closeness of the description of the value proposition presented in the companies' text and the widely accepted description given by Sheth et al. (1991). Table 6 shows the percentage of the expressed value proposition to the ontology multiple values descriptions.



Table 6: Companies' value propositions in percentage of perceived multiple values

Company	Economic value	Functional value	Emotional value	Ethical/ Normative value	Epistemic value (Knowledge/ Innovation)	Social value
Chameleon <sup>TM</sup>						
Technology	0%	90%	90%	0%	70%	0%
geo (Green Energy Options)	0%	90%	0%	0%	90%	0%
NES (Networked Energy Services)	0%	90%	80%	0%	0%	0%
Vodafone	90%	90%	0%	70%	0%	0%
First Fuel	0%	80%	0%	0%	90%	0%
Luna	0%	0%	0%	0%	100%	0%
Wirepass	80%	90%	0%	0%	0%	0%

The percentage of the values are purely educated guesses. The values describe the value propositions of the companies described in their websites in comparison to the description of the multiple values. The percentage shows how close the expressed value proposition of a company covers the description of each value from the multiple values. The same is done to the companies in the Swiss market in Table 7.

Table 7: Companies' value propositions in percentage of perceived multiple values

Company	Economic value	Functional value	Emotional value	Ethical/ Normative value	Epistemic value (Knowledge/ Innovation)	Social value
Smart-me	0%	90%	80%	0%	80%	0%
CKW	80%	0%	0%	0%	95%	0%
Landis+Gyr	80%	80%	65%	0%	90%	0%
Adaptricity	0%	90%	0%	0%	90%	0%
EMU	0%	90%	80%	0%	90%	0%

Like the companies in the European smart systems market segment, value propositions of companies from the Swiss market are also compared to the values from the multiple values. The percentage shows how close the value proposition in the companies' description comes to the description of the multiple values.

## 4.2 Comparison of companies' offerings in similar market segment

In this chapter the offerings of the companies in Europe and Switzerland were compared. The comparison focuses on companies who are offering similar features of the smart metering systems. In other words, the companies which have similar value propositions are compared to identify the similarity and differences between their offerings. The selected companies for the comparison of the offerings are listed in the Appendix section.

### Smart-me

Smart-me offers smart meters as a hard ware and a software solution for energy data management, billing and remote control and alarms enabled through smart-me cloud. Smart-me also offers a free app for installation. Table 8 shows the comparison of offerings of smart-me and similar companies

Table 8: Comparison of smart-me offerings to similar companies

smart-me	Alcara Technologies LLC	APATOR
<ul style="list-style-type: none"> <li>Smart Meters with dual function, as a measurement device and as a gate-away to the cloud</li> <li>Energy data management, automatic invoicing, remote controlling and alarms enabled through the smart-me cloud</li> <li>free smart-me app installation available for Android and iOS</li> </ul>	<ul style="list-style-type: none"> <li>electricity meters</li> <li>communications systems &amp; components</li> <li>energy data visualisation</li> <li>IoT solutions</li> <li>grid sensors</li> <li>billing services</li> <li>network control</li> </ul>	<ul style="list-style-type: none"> <li>Electricity, water and gas meters</li> <li>IT solutions</li> <li>power automation products and services (for Smart Grids)</li> </ul>

The comparison between *smart-me*, a Swiss based company and the two (*Alcara* and *APATOR*) companies from Europe shows that all companies offer smart meter devices, energy data management systems and billing services. However, the smart-me communication software is not as broad as the other two companies. *Alcara* offers, in addition to the sensors for grids and the network control systems, IoT (Internet of Things) solutions which are not restricted to smart metering systems but is an advanced solution. *Apator* also offers more power automation products and other services for smart grids than smart-me offers.

### Adaptricity

Adaptricity offerings focuses on data and data analysis. The *Adaptricity* software solutions offer extensive analysis of smart metering data and help the customers to identify the profitability of the datasets. The software also facilitates a regular and accurate monitoring of grid states and grid utilization capacity. The future grid behaviour simulation feature available in the offering also enables grid operators, to identify critical grid states and the initiation of suitable course of action. Table 9 shows the comparison between the offerings of companies from the smart marketing segment in Europe and *Adaptricity*.

Table 9: Comparison of Adaptricity offerings to similar companies

Adaptricity	SAP	HelloData	KISTERS
<ul style="list-style-type: none"> <li>Smart meter data analyses (use of existing data)</li> <li>Continuous monitoring of voltage and grid loading</li> <li>Identification of grid bottlenecks</li> <li>Overview and prioritization of areas where action is needed (grid operations and planning)</li> <li>Evaluation of countermeasures</li> <li>Detailed one-year grid simulations and analysis of grid loading</li> </ul>	<ul style="list-style-type: none"> <li>energy supply chain optimisation</li> <li>operational efficiency for plants and grids</li> <li>meter data management</li> <li>customer experience</li> </ul>	<ul style="list-style-type: none"> <li>smart meter data</li> <li>data platform</li> <li>consumer engagement</li> </ul>	<ul style="list-style-type: none"> <li>energy data management</li> <li>automatic meter reading</li> <li>optimisation</li> <li>forecast</li> </ul>

As can be seen from the comparison, the companies offer software solutions for smart meter data, energy management systems and optimization of utility grids. However, the *Adaptricity* solution focuses on low voltage grids whereas the others offer higher voltage grids solutions as well. The *SAP* energy supply chain optimization is also an advanced solution that is not restricted only to energy management, but it can also be applied to other business applications.

### Landis+Gyr

*Landis+Gyr* is a global company based in Switzerland but with more than 12 plants in Europe. The company offers its customers smart meters, communication modules advanced measuring infrastructure, data analysis and other services such as maintenance, technical support, system integration and employee training. Table 10 shows the comparison of offerings of companies from the smart marketing segment in Europe and *Landis+Gyr*

Table 10: Comparison of Landis+Gyr offerings to similar companies

Landis+Gyr	Meter&Control	NES Technology
<ul style="list-style-type: none"> <li>• electricity and gas smart meters</li> <li>• communication modules</li> <li>• gateways</li> <li>• AMI software</li> <li>• data analytics</li> <li>• other services</li> </ul>	<ul style="list-style-type: none"> <li>• AMI Devices</li> <li>• AMI Software</li> <li>• Custom Solutions</li> </ul>	<ul style="list-style-type: none"> <li>• smart meters</li> <li>• smart grid devices and control nodes</li> <li>• communication devices &amp; software</li> <li>• data collection software</li> <li>• energy based analytics</li> </ul>

The offerings of the *Landis+Gyr* and the other similar (in size and market segment) companies are not different. As *Landis+Gyr* also is present in the European smart metering marketing segment, it is also competing with the compared companies.

### CKW

CKW offers comprehensive know-how around smart meters and measuring instruments. CKW also assists with the installation of measuring devices and uncovering potential savings in necessary equipment accessories. CKW furthermore offers small utility companies with recording, sending and validating energy data. Table 11 shows the comparison of offerings of companies from the smart marketing segment in Europe and CKW.

Table 11: Comparison of CKW offerings to similar companies

CKW	Netinium	Elster Group (Honeywell)	GE Power	Chameleon Technology
<ul style="list-style-type: none"> <li>• Energy Monitoring</li> <li>• Smart Meter and Communication Modules</li> <li>• Measuring, sending and validating energy data service</li> </ul>	<ul style="list-style-type: none"> <li>• Data collection</li> <li>• Installation management</li> <li>• Device management</li> <li>• LV (Low Voltage) Grid monitoring</li> <li>• IoT cloud platform</li> </ul>	<ul style="list-style-type: none"> <li>• Electricity meters and energy management platforms</li> <li>• gas and water meter metering systems and communication systems for water utilities</li> </ul>	<ul style="list-style-type: none"> <li>• data analytics</li> <li>• cybersecurity</li> <li>• operations optimisation</li> <li>• power plant solutions</li> </ul>	<ul style="list-style-type: none"> <li>• In-Home Displays for Smart Meters</li> <li>• Consumer access devices for smart meters</li> </ul>

The main difference between CKW and the other companies' offerings are the communication platforms for energy management and the IoT cloud. Currently CKW provides its smart meters through cooperation with *Kamstrup*. It is unclear if other smart meters and metering systems for gas and water are also offered. The In-Home display offering in other European companies is offered as an option by CKW and it is only web-based.

**EMU**

*EMU*'s offerings are different forms of smart metering devices and software solutions including support for devices, connection to web-based energy management and interfaces for data management. Table 12 shows the comparison of offerings of companies from the smart marketing segment in Europe and *EMU*.

Table 12: Comparison of EMU offerings to similar companies

EMU	Itron	Iskraemeco
<ul style="list-style-type: none"> <li>• M-Bus Smart meters</li> <li>• M-Bus data logger with integrated web-server</li> <li>• Internet of things (IoT) and Industry 4.0 ready systems</li> <li>• Energy Management and Billing systems</li> </ul>	<ul style="list-style-type: none"> <li>• Smart metering devices</li> <li>• smart metering software</li> <li>• data analytics</li> <li>• smart grid communication network solutions</li> </ul>	<ul style="list-style-type: none"> <li>• electricity meters</li> <li>• communication tools</li> <li>• software solutions</li> <li>• support services</li> </ul>

Compared to the European companies, *EMU*'s offerings are not very different. The only difference seems to be the data analysis and other services such as the support to their products.

## 5 Results

The result section shows the ontology analysis of value propositions of the. The value proposition of each company is evaluated through the multiple values. The graphical representation shows the companies' representation of the multiple values in their value propositions. The percentage indicates how close the description of the value proposition of companies is to the description of the multiple values. All the figures shown in the result section are results of Table 6 and Table 7.

### 5.1 Results of multiple the value analysis of companies in Europe

#### *Chameleon™ Technology*

*Chameleon Technology* designs and manufactures bespoke in-home displays for the global smart meter market and creates standalone and embedded solutions to optimise products and services emerging from the connected homes revolution.

Features: real time energy visualization and connected home solutions

- in-Home displays for smart meters
- consumer access devices for smart meters

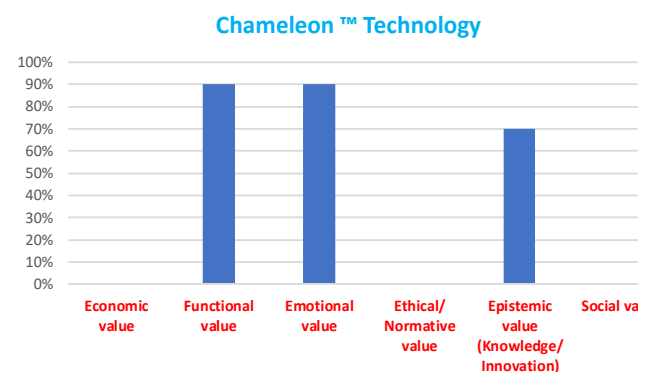


Figure 5: Chameleon Technology multiple value results

Figure 5 shows how *Chameleon technology's* value propositions are indicated in the multiple values. The functional values and economic values are clearly indicated whereas the epistemic value is indicated to some degree. The rest of the values are not represented in the Chameleon Technology value proposition.

#### *Geo (Green Energy Options)*

*geo* provides utilities with smart metering products and a range of individual or combined digital solutions for the smart metering program in UK. This includes the collection of raw data from meters or solar panels, delivery onto cloud servers and the processing of information for analysis and presentation. This data can be presented on an in-home display and an energy app. It can also be provided as raw or processed data for further use. The solutions can also include two-way Wi-Fi connectivity to exploit IoT type functionality.

Features:

- energy monitors
- smart metering devices
- cloud services for smart meter market

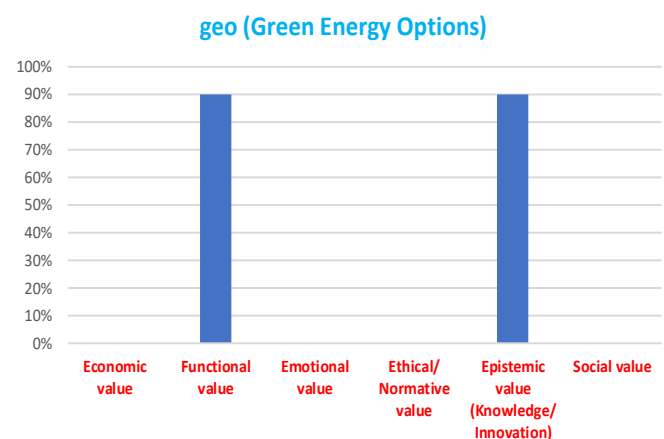


Figure 6: geo multiple value results

The geo multiple value indication, Figure 6, shows that the value proposition of *geo* only describes the functional value and epistemic values.

### NES (Networked Energy Services)

NES Corporation offers the most reliable broadly deployed smart grid platform enabling grid health and efficiency monitoring as well as control and smart metering applications.

The NES System is based on a 3-tier architecture; which includes utility data centre software, field distributed application control and grid devices and sensors, such as single phase, poly phase, and smart meters, and Open Smart Grid Protocol (OSGP) compliant communication devices enabled by the Control Point Modules.

Features: Turnkey Smart Grid Solutions

- smart meters
- smart grid devices
- control nodes
- communication devices & software
- data collection software
- energy based analytics

Figure 7 shows that the functional values and the emotional values are the only values identified in the NES value proposition.

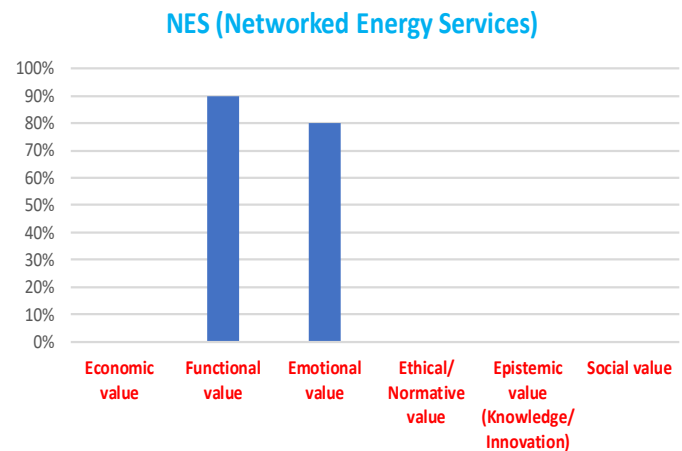


Figure 7: NES multiple value results

### Vodafone

The core of Vodafone offering is their own managed IoT platform, designed to take away the complexities and cost of deployment by automating provisioning, billing and other logistics processes.

With the IoT Technology, Vodafone provides software solutions for smart grids and smart metering.

Features:

- metering solutions
- IoT platform
- utility services

As can be seen in Figure 8, the economic value, the functional value and the ethical values of the multiple values are indicated in the value proposition of the Vodafone value proposition. Both the economic and functional values are clearly indicated, whereas the ethical value is indicated to some extent.

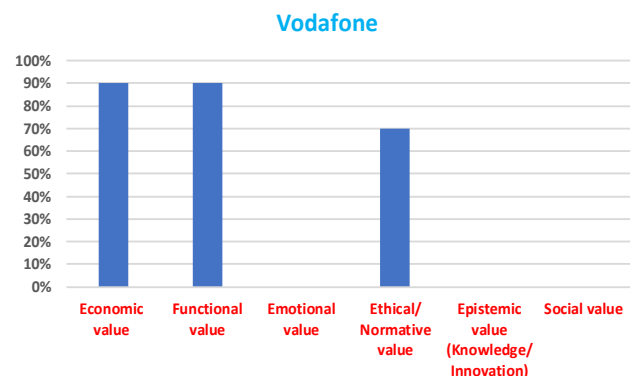


Figure 8: Vodafone multiple value results

### Wirepass

Wirepass Mesh enables wireless IoT networking at massive scale. It is a de-centralized IoT network protocol that can be used to connect, locate and identify lights, sensors, beacons, assets, machines and meters in cities, buildings, industry, logistics and energy, with unprecedented scale, density, flexibility and reliability. It can be used on any radio hardware and on any frequency band.

Features:

- decentralised radio communications protocol for large-scale IoT applications
- protocol software that can be used in any device, with any radio chip and on any radio band.

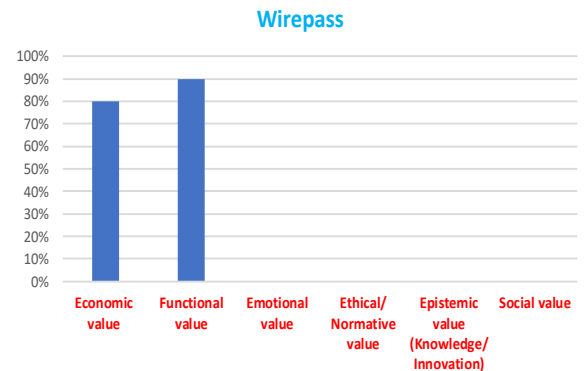


Figure 9: Wirepass multiple value results

The value proposition of Wirepass indicates that the economic value and the functional value are the only values represented as can be seen in Figure 9.

### First Fuel

FirstFuel Software is the global leader in business customer engagement for the energy industry, using advanced analytics. Combining data science, building science and software, their digital engagement platform derives intelligence from over 3 million meters. Their SaaS solutions deliver accurate, insightful, and costeffective results at scale.

Features:

- information technology
- platform for user engagement & advice
- data analytics

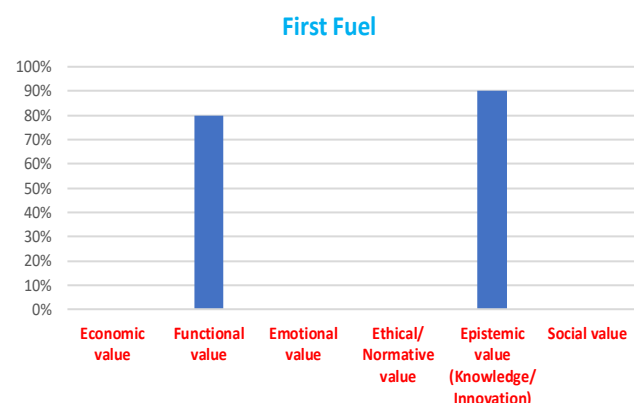


Figure 10: First Fuel multiple value results

Figure 10 shows that the functional value and epistemic values are indicated in First Fuel value proposition.

## Luna

LUNA carries out its design and production of electricity meters, the development of software and hardware for the communication between the meters. Smart grid solutions as a complete system for electrical energy management as well as water metering solutions.

Features:

- energy smart meters
- data concentrator and modems for smart grid applications and AMR systems
- smart Modem for AMR Metering applications

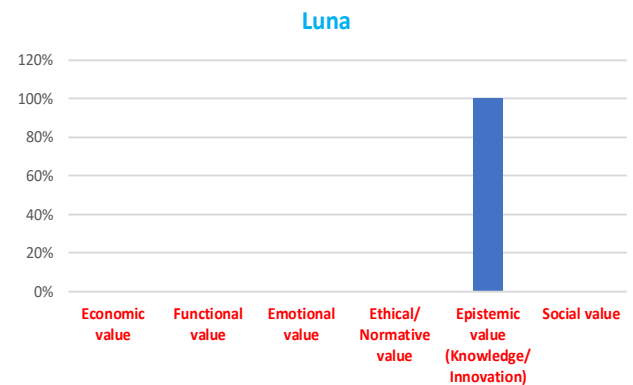


Figure 11: Luna multiple value results

Information about Luna's value proposition is very difficult to find and with the available data, the epistemic value is the only identifiable value as can be seen in Figure 11

## 5.2 Results of the multiple value analysis for companies in Switzerland

This part of the report shows the results of the multiple value analysis of the smart metering systems companies in Switzerland.

### Smart-me

The *Smart-me*, 3-phase meter is a precise, high-performance energy meter with a built-in Wi-Fi interface. No additional hardware is needed for the integration into the *Smart-me* cloud.

The meter uses the existing Wi-Fi network and can be easily controlled and analysed via internet. This is the easiest option to visualise the consumption of energy with the help of a smartphone, a tablet or a computer in real time, to analyse the metered data and to optimise the personal consumption. The connection possibility of three phases allows the incorporation and supervision of whole apartments, entire buildings or complete company sites with low investment costs.

Features:

- Smart meters with dual function, as a measurement device and as a gate-away to the cloud
- Energy data management, automatic invoicing, remote controlling and alarms enabled through the smart-me cloud
- free smart-me app installation available for Android and iOS (iPhone operating system)

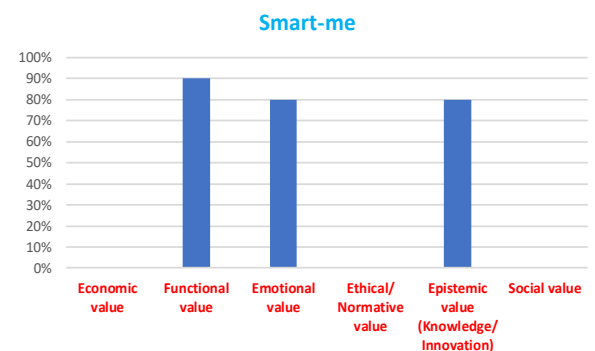


Figure 12: smart-me multiple value results

The *smart-me* value proposition indicates the functional, emotional and the epistemic values as shown in Figure 12.



### Adaptricity

*Adaptricity* helps to achieve the profitable analysis of extensive smart metering datasets and other data records and to close existing gaps in the data. Their software facilitates regular and accurate monitoring of grid states and the relevant grid capacity utilization at the low-voltage level. At the same time, future grid behaviour can also be simulated. This enables the early identification of critical grid states and the initiation of suitable courses of action.

Features:

Software solutions for

- Smart meter data analyses (use of existing data)
- Continuous monitoring of voltage and grid loading
- Identification of grid bottlenecks
- Overview and prioritization of areas where action is needed (grid operations and planning)
- Evaluation of countermeasures
- Detailed one-year grid simulations and analysis of grid loading

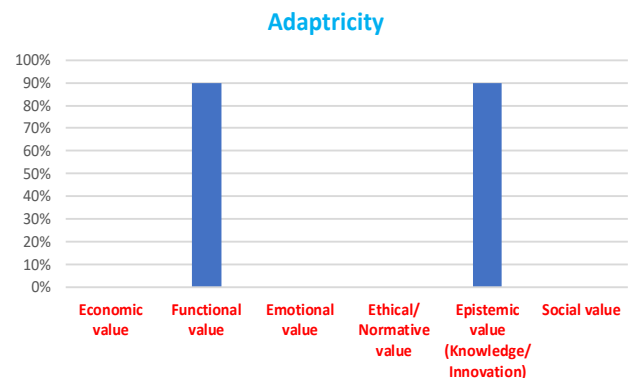


Figure 13: Adaptricity multiple value results

Figure 13 shows the functional and the epistemic values indicated in the value proposition of *Adaptricity*.

### Landis+Gyr

*Landis+Gyr's* provides innovative tools that help utilities save losses and balance demand and supply in energy load management, provides smart metering devices with a real-time data measurement, two-way communication and advanced metrics.

*Landis+Gyr* offers a comprehensive portfolio of AMI technology with assistance in maintenance, technical support, system integration and employee training.

Features:

- load management systems
- multi-commodity AMI
- services

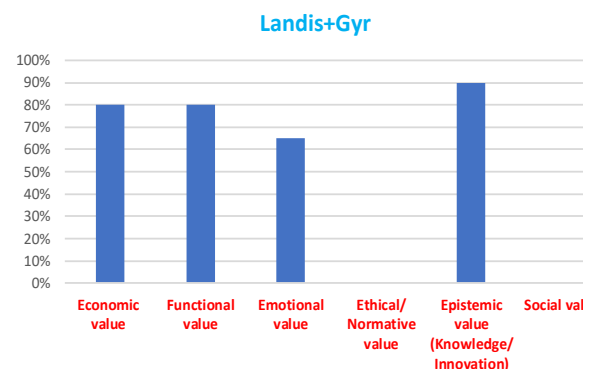


Figure 14: Landis+Gyr multiple value results

As can be seen in Figure 14, *Landis+Gyr's* value proposition indicates that the economic and functional values are indicated less clearly than the epistemic value but more than the emotional value.

## CKW

CKW offers comprehensive know-how around meters and measuring instruments, assistance with the installation of measuring devices or uncovering potential savings and equipment with the necessary accessories. CKW modules are provided through cooperation with *Kamstrup*, a company that produces smart metering modules.

Features:

- energy monitoring
- smart meter and
- communication modules

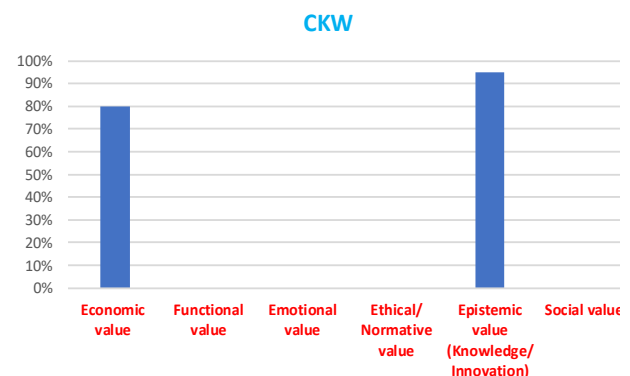


Figure 15: CKW multiple value results

CKW value proposition shows only the economic values and the epistemic values as seen in Figure 15. Unlike the other companies' value propositions the functional value is not indicated in the CKW value propositions.

## EMU

EMU's offers to its customers different forms of smart metering devices and software solutions including support for devices, connection to web-based energy management and interfaces for data management.

Features

- M-Bus data logger with integrated web-server
- Internet of things and Industry 4.0 ready system
- M-Bus Meter

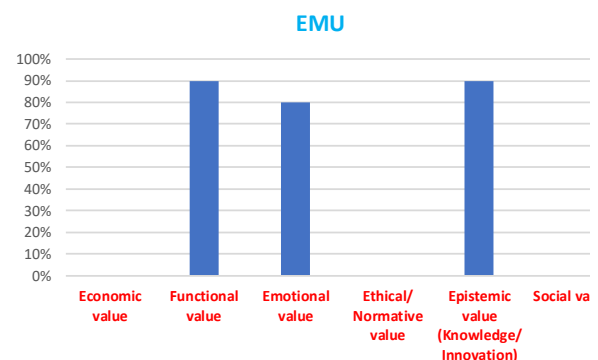


Figure 16: EMU multiple value results

EMU value proposition shows the functional and the epistemic values in a higher degree and the emotional value in a smaller degree as seen in Figure 16.

## 5.3 Difference of the existing Swiss companies' offerings

Even though, the offerings of the Swiss companies analysed in this study are different, the values of the smart systems delivered are similar to the European companies. The values delivered to the customers start from manufacturing smart meters, operation of the smart metering systems and recording and analysing the energy data for further purposes. The offerings of the companies in Switzerland and Europe smart metering market segment are compared the differences are identified. Table 13 shows the difference between the offerings of companies from European market segment and Switzerland. As can be seen from the differences of offerings, *Smart-me* offers smart metering devices and solutions. However, compared to the other companies, it does not offer energy data visualization solution to its customers. The software solution of *smart-me* is also not as advanced as the IoT of other companies in Europe. Furthermore, it does neither offer any billing service solution nor any solution to smart grids such as grid sensors or any network control systems. The *Adaptricity*

solution offers an extensive analysis of smart metering data that helps identify potentials for profitability or problems in small voltage grids. The other companies in a similar marketing segment offer overall energy supply chain optimization tools.

Table 13: main findings of offerings

Company	Offering difference
Smart-me	<ul style="list-style-type: none"> <li>energy data visualisation</li> <li>IoT solutions</li> <li>grid sensors</li> <li>billing services</li> <li>network control</li> </ul>
Adaptricity	<ul style="list-style-type: none"> <li>energy supply chain optimisation</li> <li>Consumer engagement or customer experience</li> </ul>
Landis+Gyr	Cannot be identified from the online available information
CKW	<ul style="list-style-type: none"> <li>operations optimisation</li> <li>power plant solutions</li> <li>IoT cloud platform</li> <li>In-Home Displays for Smart Meters</li> <li>communications and energy management platforms</li> </ul>
EMU	<ul style="list-style-type: none"> <li>smart grid communication network solutions</li> <li>Services such as support in installation, device maintenance etc.</li> </ul>

Another difference is that consumer engagement or customer experiences is not available in the *Adaptricity* offering. *Landis+Gyr* does not show any difference to similar companies from the online available information. *CKW* is currently offering its customers smart meters, installation, energy management, billing processes and other services such as web-based optional visualization of energy consumption. However, the companies in a similar market segment from the European companies offer operation optimization, power plant solutions, IoT cloud and energy management platforms and display devices as part of the smart metering systems. *EMU* offerings are smart metering devices, communication modules to the cloud and communication solutions. However, its solutions are not clear if they offer advanced systems to grids and more advanced network solutions. Other services such as support by installation, maintenance etc. are also not available.

#### 5.4 Potential for new features development

After carrying out the multiple value analysis of the existing value propositions and comparing the offerings of the smart metering systems of the Swiss and European companies, difference in offerings helped identify features that could be adapted or newly developed to the Swiss companies. The main values for smart metering systems start with providing, installing, maintaining the smart meters, recording the energy data, management of the billing system, providing cloud services for data collection and providing the know-how in the form of software solution for the smart metering systems. The value for large companies who operate the grids or distribution systems covers the whole energy chain. In addition to the smart meters the companies need software solutions of smart metering systems for operations optimization, communicating systems, billing and recording energy data, data analysis, cloud services for data spaces etc. The development of new features to the existing value propositions of the Swiss companies begins at the existing offerings of the companies and tries to find new features.

### 5.4.1 Smart metering devices and installation

Companies that manufacture smart meters with precise measuring devices facilitate the accurate measurement of energy data. Companies such as *Landis+Gyr* are global companies with an extensive know-how in manufacturing smart metering devices. The smart metering devices include smart meters, concentrators and communication modules. Currently *Landis+Gyr*, *EMU* and *smart-me* are the market leaders in the smart meter devices market segment in Switzerland (of the companies listed in this study). Other companies such as *CKW* cooperate with *Kamstrup* for their smart metering devices. Installation of smart metering is offered by utility companies such as *CKW*. *CKW* is e.g. the grid operator for Lucerne region and it is mandated to provide and install smart meters for all its customers in Lucerne region.

### 5.4.2 Software solutions

The software solutions differ from company to company based on the purpose of the solution. There are software solutions for energy data recording and analysis, communication, planning and operation optimization, billing, problem identification, energy simulations and forecasting grid power regulation, clouds etc. Companies such as *CKW* offer the energy data recording and billing. *Adaptricity* offers extensive energy data analysis that can help identify grid problems and bottlenecks, overview of grid planning and operations and grid simulations and analysis of grid loading. *Landis+Gyr* offers an AMI (advanced metering infrastructure) software that allows its customers easy integration to existing IT infrastructure and other systems. The AMI multi-commodity communication solution with a two-way communication system that delivers near real-time data and advanced metrics for smart meters can provide crucial insights that enable utilities to transform customer service, lower operating costs, and make more informed asset investment decisions.

The high speed 3G communication system provided by *Landis+Gyr* also enables its customers to have strong foundation for a future smart grid application. *Smart-me* also provides solutions that use Wi-Fi for communication and this helps its customers use the internet for cloud connection. Other software solutions also include the cloud services that include hosting, data recovery, smart grid and smart city solutions, systems integration. Currently *EMU* is the only company that offers the IoT solutions. There are no companies that offer energy platforms to engage their customers in the Swiss market.

## 5.5 Energy efficiency and Swiss Federal Energy 2050

After carrying out the analysis of the value propositions, further research is performed to elaborate on the Swiss Federal Energy Strategy 2050 goals in general and the energy efficiency targets and measures put forward by the Swiss Council for Energy in particular.

### 5.5.1 The Swiss Federal Energy Strategy 2050

After the Fukushima incident in 2011 and other energy issues, the Swiss Federal Council for Energy started to develop a new strategy which led to the Swiss Federal Strategy Energy 2050. The Strategy has three strategic objectives (Swiss Federal Office of Energy (SFOE), 2017). *Measures to increase energy efficiency* (buildings, mobility, industry and appliances), *measures to increase the use of renewable energy* (promotion and improvement of legal framework) and *withdrawal from nuclear energy* (no new general licences step-by-step withdrawal, safety as sole criterion).

The energy efficiency focusses on measures of energy consumption reduction without losing the current quality and comfort by the energy supply chain. In this context, increasing the degree of energy efficiency means consuming less energy while obtaining the benefits of the accustomed energy services such as availability of lighting, heating and other electricity consumptions. Based on this framework, the Swiss Federal Council for Energy introduced several measures to enforce the energy efficiency of the Swiss energy measure, one of them being the smart metering systems. Based on the strategy (Swiss Federal Office of Energy (SFOE), 2017), the targets of the energy efficiency measures were the reduction in consumption of energy per capita of 16% in 2020 and 43% in 2035 and the reduction in electricity consumption per capita of 3% in 2020 and 13% in 2035 compared to the level in 2000.

The Power Grid Roadmap was formed to provide a new regulation instrument tasked by the Swiss Council for Energy Strategy 2050 to combat the challenges and obstacles the power grids are facing (GALUS, 2017). The main drivers of the Smart Grid Roadmap were to overcome the growing challenges in power grid due to the decentralised power generation and rise in total energy efficiency (Bill, 2015). According to the Roadmap, the smart grids are expected to meet the challenges in power distribution grids, information and communication technologies by creating integrated data and electricity networks.

### 5.5.2 Smart metering systems in the Energy Strategy 2050 context

The intelligent control systems of the smart grid can regulate fluctuating electricity generation from renewable energies and electricity consumption while ensuring systems and grids operate safely, efficiently and reliably. Smart metering systems, intelligent measuring systems, are considered as the core components of the smart grids for measuring energy data and are part of the Energy Strategy 2050. The main driving force for the changes in the smart grids is the environmental sustainability of electricity power generation with overall discussion on climate change (GALUS, 2017) and triggered the restructuring of the electricity sector. The expansion of renewable power generation, the efficiency in production and consumption were the issues. This in turn created the new challenges in the electricity distribution grids such as the integration of renewable energies, the availability and prices of information, communication and computational technology.

The Smart Grid Roadmap based on the Energy Strategy 2050 was tasked to face this challenge and it introduced several regulations. The smart metering roll-out is one of them. The smart meter legal basis describes the costs covering smart meters and the technical requirement for the smart metering roll-out. The main motivation for the smart metering systems are to face the:

- challenges in marketing such as the dynamic pricing, creating the potential for new market players, availability of timely detailed data and liberalisation of the electricity market.
- the digitalisation of the electricity sector for facilitating the coordination of requirements and flexibility to the future electricity market.
- the need for coordination and benefits of the neighbouring European or global emerging energy services.
- optimize own processes such as accounting (billing), reading, changing processes, forecasting, network planning and maintenance.

- Promote transparency, create customer loyalty etc.

According to the Ecoplan (2015) analysis smart metering systems are a prerequisite and portal entry for digitalization. Smart metering is an enabler for business process optimization and is expected to stimulate competition, avoid external costs such as the costs of carbon equivalent emission which is very important for the Energy Strategy 2050. Based on the Smart Grid Roadmap findings, the Ecoplan (2015) confirmed the previous results on smart meters and in favour of the smart metering introduction. The study concluded that the cost benefit analysis resulted in a positive result for the roll-out (Müller, 2017). However, the Roadmap identified the need for harmonizing the current regulations for the privacy and data security. Furthermore, it also recommends further risk analysis to be performed on smart metering systems and control systems.

## 6 Discussion of results

In this part of the report shows the main findings from the analysis. The analysis was done in two ways, the ontology analysis of the value proposition of companies and the comparison of offerings of the Swiss companies to the offerings of the companies in Europe.

### 6.1 Main findings of the analysis

The analysis shows how the value propositions of the companies in both cases represent the multiple values in their value propositions.

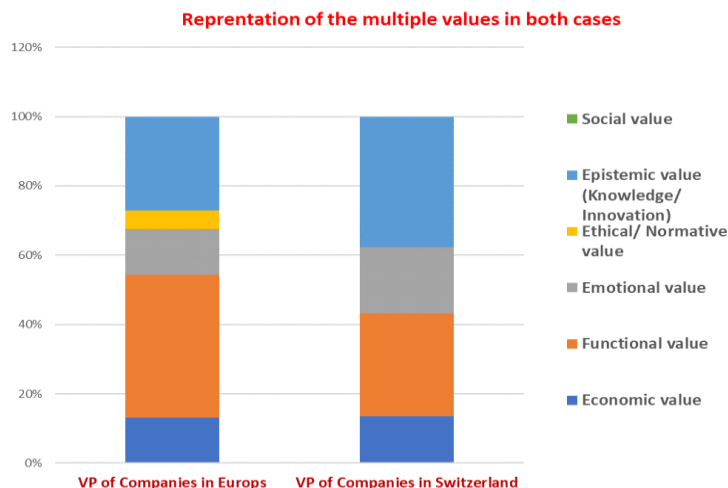


Figure 17: results of the multiple values in Europe and Switzerland companies

The analysis in Figure 17 shows that the companies in Europe focus more on the epistemic value than the companies in Switzerland. Even though the functional value is represented in both cases, the Swiss companies focus slightly higher than European companies in their representation. Similarly, the emotional value is also slightly higher represented in Swiss companies than European companies. But the most striking is that no company is interested to representing the social value in its value proposition. However, the European companies tend to show the ethical value whereas no Swiss company has mentioned the ethical value in its value proposition.

The offering comparison findings (Table 13) showed that the difference of offerings of the companies operating in similar marketing segment. However, the main difference occurs in the software solutions (IT solutions) provided by the European companies. The Swiss offerings seem to offer less features and are not as advanced as the European offerings.

### 6.2 Main results for potential new features

The analysis and the offerings comparison of the two markets led to identify some new potentials for the Swiss market. Based on the comparison, the difference in the smart meter device is minimal. This is due to the smart meters can easily be found in the global market. The companies who are based in Switzerland such as *Landis+Gyr* are also global companies which manufacture and offer the smart meters to their customers. The main difference comes in the development of the software solutions for communication, data analysing, energy management and other services. The companies in the European market offer advanced communication systems such as the IoT, AMI that can also be applied to smart cities and smart grids. However, such offerings seem not to be fully offered in the Swiss companies analysed in this study. Other offerings such as the visualization features are also offered as an



optional which is as a core offering for some European companies. Offerings such as smart metering data platforms for customer engagement are also not being offered in the swiss market.

### 6.3 Results of smart metering in the ES2050 context

After the Fukushima nuclear accident, the Swiss Federal Council for Energy introduced new strategies called the Energy Strategy of 2050. The New strategy considers the energy efficiency as one of the main objective measures. The Swiss Grid Roadmap was tasked to produce regulations on how the efficiency measures could be implemented on the Swiss Grids. The drive to the Swiss Grid Roadmap was to search for ways on how to overcome the growing challenges in power grid due to the decentralised power generation and rise in total energy efficiency. The Roadmap objective was to come to some understanding and form a regulation between stakeholders on the way the challenges in power distribution grids, information and communication technologies could be faced (see section 5.5 for brief review). The Roadmap introduced several regulations and the smart metering roll-out was one of them. The motivations for smart metering were facing the challenges in electricity marketing, digitalisation of the electricity sector, the need for coordination of the neighbouring electricity market, optimisation of processes, promoting transparency etc. The findings of the cost benefit analysis of the swiss smart metering confirmed that the result was positive. Furthermore, the analysis confirmed that smart metering systems are a prerequisite and portal entry for digitalization, an enabler for process optimization and is expected to stimulate competition, avoid cost of carbon emissions. The Roadmap also identified the need for the harmonization of the regulation and data security and further risks analysis needs to be analysed.

### 6.4 Conclusion of results discussion

The ontology analysis is a useful tool to show the specific value of the value proposition. This helps identify easily the value of a product or service. The analysis showed that the main interest of the existing value propositions is the techno-economic values of their products. This is clearly identified by the companies' focus on economic value, functional value and the epistemic value of their offerings. Even though this is important, the ethical value which is the main target of the energy efficiency is being left unanswered. The study in the Swiss Grid Roadmap also focuses on the techno-economic impacts of the smart metering systems. This clearly shows the offerings are more focused on the functional, economic and to some extent the emotional values of the value proposition of the smart metering systems. The ethical values as well as the social values are not yet well addressed in the analysed value proposition of the companies and the literature review also could hardly prove otherwise. Therefore, it is hard to reflect on the contribution of the smart metering systems to the energy efficiency of the ES2050. The motivation for smart metering systems are reflected on the value propositions of the existing companies. The comparison of the offerings also showed that the Swiss companies are behind the companies in Europe in technological development.



## 7 Validation with the new features

Compared to the smart metering systems market in Europe, the Swiss market is at the beginning. The mandatory roll-out started in 2018 where as the roll-out in Europe started earlier. Therefore, the existing smart metering companies in Switzerland can benefit from their European counter-parts. The smart meter devices can easily be obtained from the market. Even though there is an ongoing security check requirement, the companies such as *Landis+Gyr* are already in the market with the smart meters and the potential for new features to develop in the smart meter device is low. However, the Swiss companies can benefit more from the software solutions. Therefore, from the analysis and the comparison of the offerings, some features can be adapted or developed in to the Swiss value propositions.

### 7.1 Secure and reliable smart meters

The smart meter is an integral part of smart systems. Therefore, the development in smart meter devices is the central focus of the smart metering systems. Currently the smart metering devices available on the market should fulfil the security requirements of the government. According to the *CKW* feedback, the current smart meters don't fulfil the security requirements and they are forced to pause the rollout currently. Therefore, the companies must improve the current smart meters and offer a secure and reliable smart metering device that fulfil the requirements the Swiss regulations.

### 7.2 Display devices

The energy consumption management on the demand side depends on the customers and it is very important that customers have the required awareness of their energy consumption. The most visible part of the smart metering systems for consumers will be the standalone in-home display. This provides near real-time information of their energy consumption in a readily accessible form.

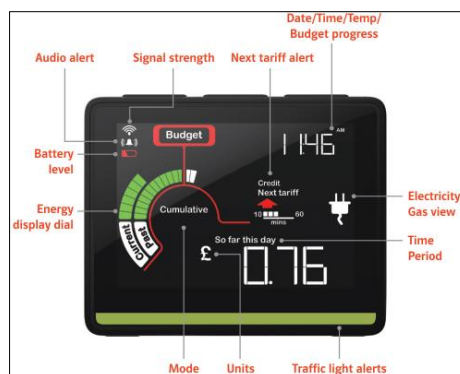


Figure 18: Smart meter display devices. Source Chamelon Technology

A substantial proportion of the benefits of the smart metering is expected to be the improved energy efficiency, either through reduction in energy consumption or in shifting consumption times from the times of peak demand. The display feature in smart metering systems plays a very important factor in raising the awareness of the consumer's behaviour of energy usage. Companies such as *CKW* and *smart-me* provide a web-based visualization as an optional offering to their customers. In conclusion, offerings that raise the awareness of energy consumption are very crucial. Offerings such as smartphones, web-based visualization, and other indicators are easy to find and are easy to integrate in to the current development in

technology. *Chameleon Technology* for example offers its customers In-Home Display devices and customer access devices smart meters.

### 7.3 Smart meter data platforms

The smart metering systems are expected to deliver real-time information of energy consumption so that it helps consumers optimize their energy use, thereby help them save energy costs and play their part in reducing carbon emissions. However, customers need support in realizing such benefits. Services such as consultancy and advice in energy and cost optimization are critical values to the customers. Such services are not easily found in the existing smart metering systems companies in Switzerland. Companies such as *HelloData* in Netherlands offer smart meter data platforms for consumer engagement. The Swiss companies therefore could easily follow such a course and add it to their value propositions.

### 7.4 Advanced solutions for smart grids and smart cities

Smart metering systems are expected to enable the energy generation and distribution systems to cost effectively manage their operations and facilitate the integration of the distributed renewable energy production to the grids. These systems need strong communication systems that show the customer how to manage their energy information in real-time. Concerning the software solutions for communication offered by the existing companies, the Swiss market seems lagging behind the European market. Except *EMU*, no company is found to offering the IoT communication solutions to their customers. The IoT communication is a software solution which offers companies lower cost of communication, operational flexibility, efficiency, shorter response time to market demands and other opportunities. The contribution of distributed power generation from renewable energy sources could be easily realized through such solutions.

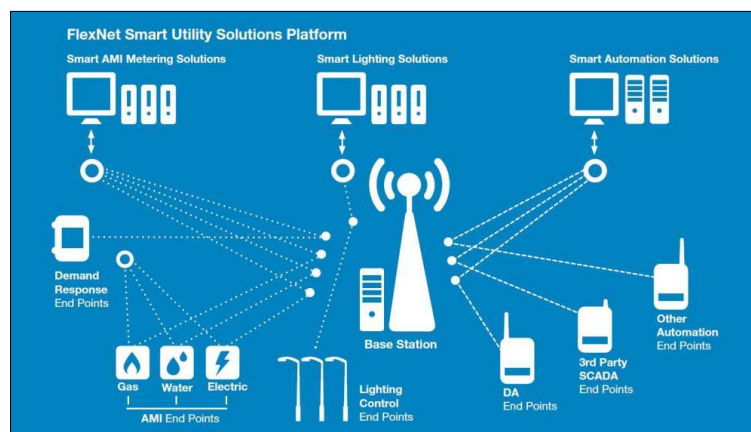


Figure 19: IoT utility solutions. (Source: FlexNet utility solutions)

Smart metering systems are expected to help innovation in both energy demand and supply management such as smart grids, smart appliances and tariffs. The expected change in electricity production from renewable energy productions leads to a more intelligent and smart control of electricity networks. Smart grids at the core of such solutions strive to intelligently integrate energy generators, consumers and those that do both. Smart grids help improve network management which leads to saving in investment infrastructure, integration of renewable energies, improved consumer management and flexible network control. Smart metering systems provide network operators with the information they need to understand the potential requirements for development in their networks. The analysed current value

propositions of the existing Swiss companies show that their offerings don't cover smart grids or smart city solutions.

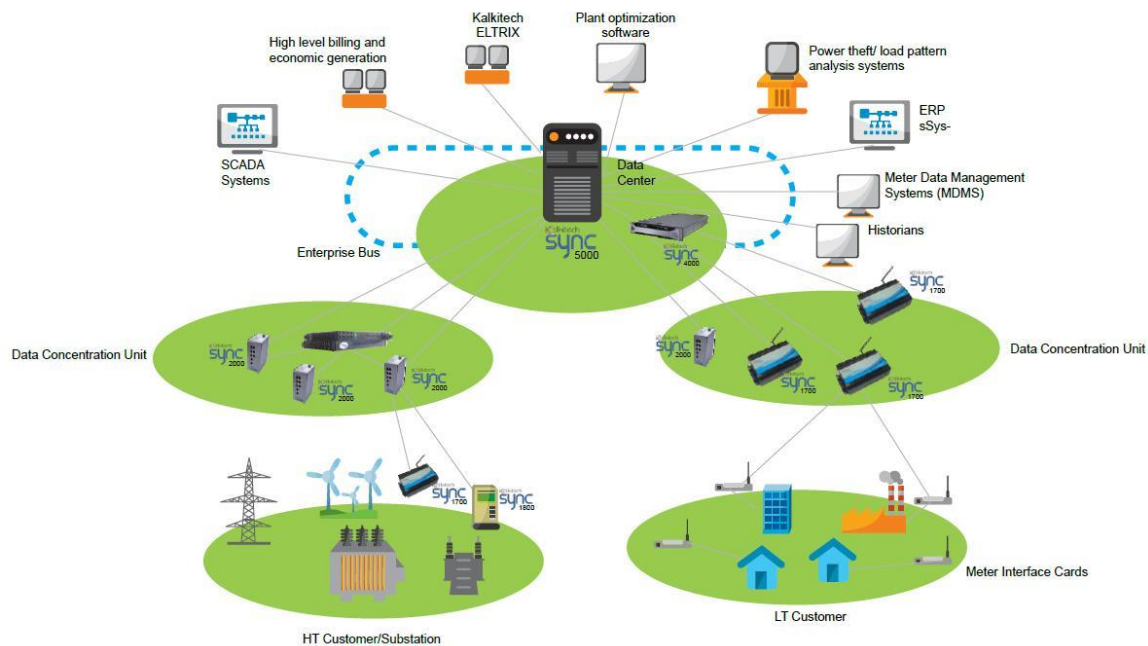


Figure 20: Smart metering (AMR/AMI) solutions. (Source: Kalkitech AMR/AMI solutions)

The advanced metering infrastructure (AMI) provided by the European companies for smart metering systems covers all these services. With evaluating and adaptations to the Swiss smart grids' requirements, it can be easily applied.

## 7.5 Infrastructure for E-mobility

Smart metering systems could also provide infrastructures with the potential for other initiatives such as supporting the energy mobility.

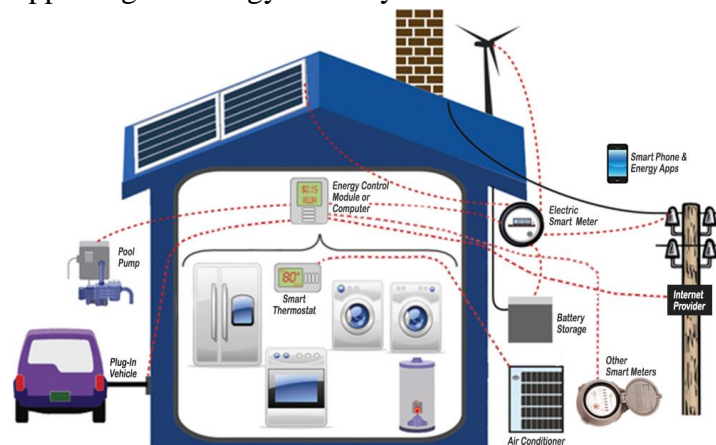


Figure 21: Smart energy and smart home. (Source: EnergyCite)

With the increase in electric vehicles, there may be a potential to charge the vehicles at home using smart metering controls using cheaper and low-carbon electricity. Such solutions are not available either in the European companies or in the Swiss companies'. Therefore, it could be a potential for further research.

## 7.6 Recommendation for policy

Based on the analysis and new features development potentials the following recommendations could be made as a policy:

- The available studies about smart metering systems seem to focus more on the techno-economic impact of the smart metering systems. Even though the economic impact is indirectly related to the energy efficiency measure of the Swiss Federal Energy Strategy 2050, the existing studies do not provide direct impact on the energy efficiency. Therefore, the field of study remains wide open and the impact of the smart metering systems on the energy efficiency needs to be quantified and assessed in a specific way.
- The Swiss Grid Roadmap assessed the cost benefit analysis of the smart metering roll-out and it resulted in a positive result. However, other than the economic considerations, other issues such as the risks of the smart systems need to be further assessed.
- Based on the assessment of the Swiss Grid Roadmap the first beneficiary of the smart metering systems are the end customers and with the current regulations, the costs for grid operators and energy suppliers will be higher than the benefits. The government, therefore, should make sure that all stakeholders benefit from the smart metering systems by creating some incentives.

## 8 Conclusions

Smart metering systems are a hybrid technology consisting of meters and associated devices, communications layer and IT systems which manage data, applications and services. Smart metering systems are intelligent measuring systems that can automatically monitor energy flows and provide near real-time energy information which enables the customer to better manage their energy consumption, optimise processes and improve other electricity services. Smart metering systems as components of smart grids help solve the fluctuations in power production and consumption by providing different technological solutions for the integration of energy data and communication controls for electricity networks.

This study focused on developing new features for value propositions of the existing Swiss smart metering systems companies. A brief literature review on value proposition and the technical configurations of smart metering systems for the existing companies was provided. The literature review provided an overview of a list smart metering companies from member of ESMIG and companies from the smart metering market segment in Switzerland. To develop new features for the value propositions, through the criteria developed, companies were selected from the list of companies. An ontology analysis and comparison of the offerings were performed on the value propositions of the selected companies. The ontology analysis uses the multiple value analysis to analyse the value proposition. The analysis showed that the value propositions of the European companies focus more on the epistemic value than their counter-parts in Switzerland. The functional and the emotional values are represented in both value propositions but with a slightly higher representation in the Swiss companies. The European companies seem more interested showing the ethical values than the Swiss companies. The social value is however, not represented in the value proposition of the companies in both market segments. The comparison of the companies also found out that different offerings exist between the companies from both market segments. The solution offerings in the European companies seem more advanced than the Swiss ones. The comparison also showed that the European companies offer more services. One main difference that emerged from the comparison is the grid solutions. The European companies offer broad solutions for smart grid and smart city solutions whereas the Swiss companies don't offer much. Based on the analysis and comparison of offerings some features were developed (see section 7) for the value propositions of the companies in Switzerland.

To further elaborate the value proposition to the efficiency measure of the Swiss Federal Energy Strategy 2050, a literature review was performed. The literature review showed that the Smart Grid Roadmap was tasked to provide regulations for the smart grid solutions with smart metering as their core components. The study findings resulted in a positive result of the cost benefit analysis for the smart meter roll-out, the smart metering system is a prerequisite and portal entry for digitalization and an enabler for business process optimization. As one of the objectives of the study, the collaboration with 3-5 companies was not achieved. This is because, the companies selected for collaboration unresponsiveness to the request.

## 9 Recommendations for Further research

The ontology analysis is a good tool to identify clearly the types of the values of any value proposition. However, the ontology analysis needs quantifiable values to show it in some figures. The figures in this study are assumptions based on the description of the multiple values and may be hardly enough to conclude based the values given to the figures.

The nature of the study is research based and the information on this report are all publicly available information. All the information in this study is information available the websites of the companies and is taken as a source for the analysis. For some companies the stated information on their online websites may have less information than their internal information. For example, based on feedback of the CKW, it seems that the actual offerings are exceeding the stated information; thus, this should be considered for a future research. Furthermore, the companies that were approached for collaboration were not responsive. This could also be another issue for further studies.

The selection of the European companies focuses only companies that are members of the ESMIG. There are however, other companies involved in the smart metering systems marketing that are not members. The smart metering companies from Switzerland is collected through internet research and through people who have knowledge of smart metering companies. The list of smart metering companies in Switzerland is hard to find. Another issue with the smart metering systems companies in Switzerland is, sometimes it is not clear if the companies are customers or smart metering systems providers. For example, *CKW* acts as both. *CKW* receives its smart meters from smart meter manufacturers *Kamstrup* and provides smart metering systems to its customers. Therefore, future studies should be performed on specified companies.

The study is a holistic approach to analyse the value proposition of the smart metering companies from outside. It lacks the understanding of the resources of the analysed companies. The analysis for future value propositions should identify the resources and capabilities of the companies so that it identifies the constraints and the challenges of the companies.



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## Appendix A

Appendix A shows all the information for the thesis.

Table 14 shows the list of all the companies and their detailed offerings from their online public websites.

Table 14: Smart metering companies and their value propositions from their websites

	Value proposition (select the core VP type and max. 2 additional ones)
Company / Organisation name*	Text* (as written on the website of the company/organisation)
DEPSys Rethink Energy	<p><a href="https://www.depsys.ch/services/">https://www.depsys.ch/services/</a> DEPSys provides a full set of services, from consulting to training and support, to make your life as easy as possible and the integration in your processes seamless.</p> <p><a href="https://www.depsys.ch/products/">https://www.depsys.ch/products/</a> NETWORK KNOWLEDGE: GridEye allows to understand what is the state of in the network by providing a real-time monitoring solution at the most critical points of the grid. NETWORK PROTECTION: GridEye informs before issues occur by alerting on significant voltage deviations or excess current. PLANNING AID: GridEye helps optimizing the infrastructure investment by offerings insights into the critical points and thus avoiding unnecessary network extensions. <b>Resilient and secure</b> POWER REGULATION: GridEye manages decentralized energy sources to reduce peak loads and thus avoid significant voltage deviations or excess current. ENERGY OPTIMIZATION: GridEye optimizes the energy flow in the network to make efficient use of all decentralized energy sources. COST EFFICIENCY: GridEye allows Distribution System Operators decide on the number of measurement and management points that they need to deploy in order to accomplish their mission, and therefore significantly reduces the investment.</p>
smart-me	<p><a href="https://www.smart-me.com/Description/Products.aspx#smartMe3PhaseMeter">https://www.smart-me.com/Description/Products.aspx#smartMe3PhaseMeter</a> <a href="https://web.smart-me.com/en/energy-management-of-the-future/">https://web.smart-me.com/en/energy-management-of-the-future/</a> 'smart-me delivers technology for monitoring, controlling, billing and optimising energy. smart-me energy metering devices combine with cloud platform functions to form a comprehensive energy management system that creates added value for our customers. The smart-me 3-phase meter is a powerful and precise energy meter with integrated WiFi interface. Integration into the smart-me cloud requires no additional hardware. It uses the existing WiFi network and can be controlled and evaluated from anywhere via the Internet. This is the easiest way to visualize energy consumption in real-time on a smartphone, tablet or computer, analyze the measured data and optimize self-consumption. By connecting three phases, entire apartments, buildings or company premises can be equipped and monitored with low investment costs.</p>
CKW	<p><a href="https://www.ckw.ch/netz/produkte-und-dienstleistungen/zahlen-und-messen.html">https://www.ckw.ch/netz/produkte-und-dienstleistungen/zahlen-und-messen.html</a> Rundum versorgt im Bereich Zählen und Messen umfassendes Know-how rund um Zähler und Messgeräte Unterstützung bei der Installation Ihrer Messeinrichtung oder Aufdecken von Einsparpotenzialen Ausrüstung mit dem nötigen Zubehör (All-round supplies in the area of counting and measuring Comprehensive know-how around meters and measuring instruments Assistance with the installation of your measuring device or uncovering potential savings in equipment with the necessary accessories)</p>
SWIBI	<p><a href="https://www.swibi.ch/angebot/energiedatenmanagement">https://www.swibi.ch/angebot/energiedatenmanagement</a> Zeitersparnis durch kompetente Unterstützung all Ihrer Arbeitsprozesse schnelle Berechnungen, Automatisierung und Wegfall von manuellem Aufwand übersichtliche Grafiken und umfangreiche Analysen Investitionsschutz durch BelVis Einsatz bei mehr als 500 Unternehmen europaweit konfigurierbares Berichtswesen (Time savings through competent support of all work processes, fast calculations, automation and elimination of manual effort Clear graphics and extensive analysis Investment protection through BelVis. Applicable in more than 500 companies. Europe-wide configurable reporting)</p>

Landis+Gyr (12 plants in Europe, Present in 17 European countries and 15 countries outside Europe)	<a href="https://www.landisgyr.com/smart-projects/">https://www.landisgyr.com/smart-projects/</a> <a href="https://www.landisgyr.com/challenge/ami/">https://www.landisgyr.com/challenge/ami/</a> It utilizes SAP for Utilities Solutions and Gridstream MDUS for streamlining the key core processes. The load management solution prepares the utility for smart grid. - Landis+Gyr experience creates strong foundation for efficient and reliable smart metering rollout - High speed 3G communication enables future smart grid applications - The solution meets the high standards set towards data security - The solution architecture allows easy integration to Netz Burgenland's existing IT infrastructure and preferred MDMS system - End users get benefit from smart metering: remote meter reading and awareness of consumption Multi-Commodity AMI: the digital sensing and two-way communications provided by Landis+Gyr's smart metering technology delivers real-time data and advanced metrics for smart meters that provide crucial insights that enable utilities to transform customer service, lower operating costs, and make more informed asset investment decisions. Analytics: Data from the AMI and distribution sensors that you already own, our full suite of applications will seamlessly integrate into your existing system to generate an extremely accurate model of your distribution network and deliver unprecedented planning capabilities and real-time optimization. Services: assistance with services that include cloud hosting, disaster recovery, smart grid maintenance, tech support, system integration, employee training and more.
Adaptricity	<a href="https://adaptricity.com/en/adaptricity-products/monitoring/">https://adaptricity.com/en/adaptricity-products/monitoring/</a> Adaptricity helps to achieve the profitable analysis of extensive smart metering datasets and other data records, and to close existing gaps in the data. Our software facilitates the regular and accurate monitoring of grid states and the relevant grid capacity utilization at the low-voltage level. At the same time, future grid behaviour can also be simulated. This enables the early identification of critical grid states and the initiation of suitable courses of action. Our software facilitates the regular and accurate monitoring of grid states and the relevant grid capacity utilization at the low-voltage level. At the same time, future grid behaviour can also be simulated. This enables the early identification of critical grid states and the initiation of suitable courses of action.
Omnetric (Siemens)	<a href="https://www.omnetric.com/enabling-smart-consumption">https://www.omnetric.com/enabling-smart-consumption</a> <a href="https://www.omnetric.com/blog/technology-architecture-smart-metering">https://www.omnetric.com/blog/technology-architecture-smart-metering</a> Enabling Smart consumption: OMNETRIC enables utilities, distribution operators, and retailers to efficiently deploy software solutions that modernize and transform utility business operations. OMNETRIC ensures solutions are future-aware, compliant, and secure. A cloud-hosted option adds flexibility as well as managed services.
Crunchbase (UK)	<a href="https://www.sms-plc.com/our-expertise/metering/">https://www.sms-plc.com/our-expertise/metering/</a> Electricity I&C (Industrial & Commercial) meter Assets: fund, install and operate industrial and commercial electricity meters for the UK's leading electricity suppliers. Electricity meter installation: install and replace meter assets for the UK's leading electricity suppliers with minimum disruption and maximum efficiency. Data Management: secure and scalable data management solutions allow accurate billing and provide invaluable insight for energy management strategies. ADM(TM) (Automated Data Management) bespoke metering solution provides the best possible service for energy providers and their customers.
Enel	<a href="https://www.enel.com/media/news/d/2015/03/enel-offers-turnkey-smart-cities-solutions">https://www.enel.com/media/news/d/2015/03/enel-offers-turnkey-smart-cities-solutions</a> Enel is installing a full range of technologies such as Smart Meters and Smart Grids, which enable real time monitoring of the electricity grid, fault detection, improved service quality, the integration of renewable power plants and consumption optimisation
Sensus Xylem	<a href="https://sensus.com/solutions/advanced-metering-infrastructure-ami/">https://sensus.com/solutions/advanced-metering-infrastructure-ami/</a> <b>The power of the network ensures:</b> Accurate data measurement, Consistent billing and faster billing resolution, Low cost of ownership, Support for multiple Sensus applications including Leak Detection, Pressure Regulation, Distribution Automation, Demand Response, temperature monitoring, etc., Scalability to grow with your needs, Operational efficiency through advanced data analytics and Access to more data to make informed decisions <b>Advanced Metering Infrastructure (AMI):</b> Operational Efficiency: Timely data delivery, Access to more data to make informed decisions, Real-time management of intermittent outages, Fast, reliable remote connect and disconnect, Manages the power grid of the future (Integrate renewables, Manage distributed generation), Managed services: Software as a Service, Disaster recovery as a Service, Network as a Service, and Network Operations Centre
Siemens	<a href="https://w3.siemens.com/smartgrid/global/en/products-systems-solutions/smart-metering/Pages/overview.aspx">https://w3.siemens.com/smartgrid/global/en/products-systems-solutions/smart-metering/Pages/overview.aspx</a> <b>Metering Hardware and System Components:</b> Siemens' hardware offerings include Smart Meters, Data Concentrators and Head-End Systems which meet many regional regulatory requirements. <b>Meter Data Management Solutions:</b> Helping Utilities Harness the Immense Informational Value Smart Metering Provides. <b>Operational Services:</b> Siemens Supports Energy Companies and Utilities with their Operational Management, Business Processes and Specialised Technology Requirements. <b>Smart Metering Software, Systems and Solutions:</b> Siemens provides truly versatile metering solutions capable of supporting multiple communication technologies and multiple meter vendors. <b>eMeter Cloud:</b> Virtually 'unlimited' flexibility that accommodates the unique needs of your utility business. Now offering complete access to Siemens' industry leading smart grid application platform, hosted in a secure cloud environment

ABB	<a href="https://new.abb.com/cpm/energy-manager">https://new.abb.com/cpm/energy-manager</a> ABB offers the tools to help industrial facilities and corporations reduce energy cost, improve their energy efficiency, and manage their carbon footprint. Energy Manager is based on real time data from process monitoring systems, automation systems, production planning systems coupled with the information available from your energy providers. <a href="http://www.abb.ch/cawp/seitp202/81711eafd7630b44c125759e00321fc1.asp">http://www.abb.ch/cawp/seitp202/81711eafd7630b44c125759e00321fc1.asp</a> With the introduction of the electronic domestic supply meter (EDSM) and the integrated mounting and contact device (BKE-I), ABB offers innovative solutions for metering and distribution technology. This metering technology makes it possible to build new meter boards that are even more compact. Moreover, existing meter boards can also be retrofitted with an adapter (BKE-A) for the electronic domestic supply meter. The electronic domestic supply meter from ABB is easy to install and sets a new standard for domestic meters that points the way to the future. It is the basis for smart metering and makes it possible not only to use energy efficiently but also to save money in a deregulated energy market.
SAP (Germany, Present in over 190 countries worldwide)	<a href="https://www.sap.com/industries/energy-utilities/smart-metering.html#device-operations-maintenance">https://www.sap.com/industries/energy-utilities/smart-metering.html#device-operations-maintenance</a> <b>Device Operations and Maintenance:</b> Optimize warehouse and workforce processes to support mass installation and maintenance of meters. <b>Meter Reading and Energy Data Management:</b> Ensure efficient, reliable, and scalable processing of metering and profile data for accurate results. <b>Utilities Planning and Analytics:</b> Streamline planning, execution, and monitoring of metering-related processes with flexible analytics.
Ericsson	<a href="https://www.ericsson.com/ourportfolio/iot-solution-areas">https://www.ericsson.com/ourportfolio/iot-solution-areas</a> Ericsson Device and Data Management service enable developers to perform: Connect IoT devices to the IoT Accelerator Send commands to the devices, retrieve data that the devices produce, store data in an access-controlled environment. Connectivity is the foundation of IoT, supporting digital transformation and development of new business models and offerings. Our future proof IoT connectivity and connectivity management is built for diverse IoT applications ensuring relevance both in IoT today and in a 5G world.
EMU	<a href="http://www.emuag.ch/en/products/energy-management-and-billing/">http://www.emuag.ch/en/products/energy-management-and-billing/</a> Energy Management and Billing: Energy Management System to monitor all usage data and bill utilities at the push of a button. Joulio-Web EMS can quickly be integrated into an existing IT landscape and scaled to an unlimited number of meters or locations. The web-based software automatically records and analyses all relevant energy and process data. This data allows decisions to be made quickly or processes modified to prevent exceeding energy peaks. Energy and Power Meter: With our 3-phase energy meters EMU Professional and EMU Allrounder we set new standards in the field of DIN rail kWh-meters. <a href="http://www.emuag.ch/en/data-loggers/m-bus-data-logger/">http://www.emuag.ch/en/data-loggers/m-bus-data-logger/</a> EMU M-Bus Center: M-Bus data logger with integrated web-server Internet of Things and Industry 4.0 ready
Corinex	<a href="http://www.corinex.com/series/meter-modules">http://www.corinex.com/series/meter-modules</a> <a href="http://www.corinex.com/company/company">http://www.corinex.com/company/company</a> Develop and manufacture complex solutions for Smart Metering and Smart Grid infrastructure projects, with a primary focus on BPL (Broadband over Powerline) communications. Corinex provides integrated AMI and Smart Grid software solutions based on BPL technology. Using its BPL meter communication modules, Corinex can provide communication capabilities to meters from industry-leading manufacturers.
Alcara (US company, One Plant in but present in 4 countries)	<a href="https://www.aclara.com/why-aclara/our-company/">https://www.aclara.com/why-aclara/our-company/</a> <a href="https://www.aclara.com/products-and-services/">https://www.aclara.com/products-and-services/</a> <b>Smart meters:</b> Our full range of Smart Energy Meter products offers robust, flexible and configurable technology for every metering requirement from basic, energy-only metering to comprehensive smart metering functionality – with multiple communication technologies. <b>AclaraONE™ (One Network for Everyone):</b> delivers the broad set of functionalities utilities require to monitor, optimize and improve the operation of their infrastructures under a single platform. Equipped with robust, scalable, next-generation AclaraONE smart infrastructure solution (SIS) software, network operators can react faster and more effectively while improving the technical and economical operation of their distribution grids. <b>Communications Networks (Connecting Point to Point):</b> Power line, radio frequency or cellular – Aclara offers the right combination of hardware, software and service solutions to power your electric, gas and water communications network. <b>Implementation Services:</b> The Aclara Smart Grid Solutions (SGS) field teams, along with Aclara's integrated ProField enterprise planning, workforce and asset management software, work together to manage every phase of your AMI deployment.

<p>APATOR (Poland, 8 plants in Europe, present in 15 countries in Europe)</p>	<p><a href="http://www.apator.com/en/offer/electricity-metering">http://www.apator.com/en/offer/electricity-metering</a></p> <p>Remote Data Read out System: It provides bi-directional remote data read out, data tele-transmission and visualization. It can at the same time acquire data read out and make them available to billing or statistical systems and it can provide with remote manage the metering equipment itself by sending tokens to it. Additionally, owing to the on-line operation of the system it is possible also to monitor the information about errors or failures that enables immediate reaction of the operator in such situation.</p> <p>Prepayment solution (LEWsystem Apator) is a comprehensive solution enabling prepayment sale of electrical energy, based on purchase of a specified amount of kWh by an individual recipient.</p> <p>Analysis of Metering Data: produce, provide and implement IT systems supporting the management of metering information</p> <p>Smart Meters: Meters being offered are multi rate tariff, pre-paid and post-paid electricity meters to direct measurement of active or active and reactive electricity in ac grids. Metering equipment is furnished with communication modules and they have fully automated credit mode and built up prepayment functions.</p>
<p>Chameleon™ Technology (Present in UK)</p>	<p><a href="https://chameleontechnology.co.uk/">https://chameleontechnology.co.uk/</a></p> <p>Chameleon Technology designs and manufactures bespoke in-home displays for the global smart meter market and creates standalone and embedded solutions to optimise products and services emerging from the connected homes revolution.</p> <p>With a strong foundation in the extraction of real-time data in smart metering systems, Chameleon is exploring how it can help to unlock the huge potential in the wider connected home space.</p> <p>A home that is enabled with smart meters, and crucially, a secure home area network, will be able to access its valuable real-time energy consumption and pricing data. This will be made possible by the provision of a Consumer Access Device (CAD). As a natural progression from the supply of mandated In-Home Displays, Chameleon is a notable early leader and shaper of the emerging market for connected home solutions.</p>
<p>Gemalto (France and 180 countries worldwide)</p>	<p><a href="https://www.gemalto.com/m2m/markets/smart-metering">https://www.gemalto.com/m2m/markets/smart-metering</a></p> <p>Gemalto is at the centre of the evolution of providing solutions, services and platforms that Connect, Secure and Monetize the “Internet of Energy.”</p> <p>IoT (Internet of Things): solutions serve as the backbone of a secure smart energy ecosystem providing highly efficient, secure wireless connectivity for smart meters and connected energy assets.</p>
<p>geo smarter energy (United Kingdom, Present in 7 European countries)</p>	<p><a href="https://www.geotogether.com/about-geo/">https://www.geotogether.com/about-geo/</a></p> <p><b>Smarter Energy:</b> provides utilities with a range of individual or combined digital solutions that they use to build a stronger relationship with their customers. This includes the efficient collection of raw data from meters or solar panels, delivery onto cloud servers, and the processing of information for analysis and presentation. This data can be presented on an in-home display and an energy app. It can also be provided as raw or processed data for further use. The solutions can also include two-way Wi-Fi connectivity to exploit IoT type functionality.</p>
<p>HelloData (Present in The Netherlands)</p>	<p><a href="https://hellodata.org/">https://hellodata.org/</a></p> <p>We want to establish an open standard for the secure sharing of real-time energy data from a smart meter. Because of the translation into an open standard, grid operators and energy suppliers can easily establish an independent connectivity between apps and energy consumption within households.</p> <p>Giving consumers freedom of choice about the energy services and apps they utilise to make smarter use of their energy.</p> <p>Also, the consumer can manage their energy, because they have more control over their energy data. The consumers decide for themselves which data they share when, and with whom.</p>
<p>Iskraemeco (Slovenia, 4 plants in Europe, present in 23 countries in Europe)</p>	<p><a href="http://www.iskraemeco.com/en/portfolio/electricity-meters/">http://www.iskraemeco.com/en/portfolio/electricity-meters/</a></p> <p><b>Residential: Smart metering</b></p> <p>Protects revenues: Precise consumption measurements, real-time meter data access and anti-fraud detection are just some of the contemporary features that allow utilities to avoid unnecessary technical losses.</p> <p>Reduces costs: Remote connection/disconnection made possible by automated services reduces costs of field meter reading and cuts utilities’ operational costs.</p> <p>Enables demand response: System monitoring, timely collection of data and understanding consumer patterns makes demand forecasting an easy and transparent step in energy management processes.</p> <p>Engages consumers: End-consumers with access to usage data are able to actively participate in conservation activities. This leads to greater environmental awareness and improves utilities’ customer service.</p> <p>Promotes sustainability: State-of-the-art technologies enable reliable and efficient delivery of electrical energy while accurate and constant data availability leads to environmentally friendly consumer behaviour.</p> <p><b>Industrial: Smart Grid:</b></p> <p>Makes renewable power feasible: Smart grid systems can manage diverse and strategically scattered renewable power sources (wind farms, solar plants and hydro stations).</p> <p><b>Optimizes the network:</b> Direct communication with end-user equipment reduces consumption during peak periods and minimizes the need for costly standby power plants.</p> <p><b>Handles increasing energy demand:</b> Since the system is already strained to near capacity, smart grid improvements are crucial to support the long-term trend of stable electricity consumption growth.</p> <p><b>Overhauls the ageing equipment:</b> By updating the infrastructure, the safety standards continue to be met, power is delivered consistently, and the system is managed efficiently.</p> <p><b>Facilitates real-time troubleshooting:</b> With real-time data at hand, problem solving can begin immediately - this improves the network’s efficiency and reduces operational costs.</p> <p>Enables electric vehicle charging: An increasing number of electric vehicle owners need a reliable, low-cost way to recharge anytime and anywhere, and a network able to handle their rising demand.</p>

Itron (A US company, Present in 8 European countries, APAC, Africa, Latin America and United States)	<a href="https://www.itron.com/eu/technology/product-services-catalog/products/f/5/f/smart-grid-analytics">https://www.itron.com/eu/technology/product-services-catalog/products/f/5/f/smart-grid-analytics</a> Linky smart meters will allow the management of peak demand, integration of renewable energy and electric vehicles and the ability for end consumers to better know, understand and manage their energy consumption. Itron offers technical and consulting services to ensure their utility customers realize the full value their smart grid and IT infrastructure investments.
Janz (1 plant in Europe, Present in 2 European countries and 9 countries outside Europe)	<a href="http://www.janzce.pt/index.php?section=2">http://www.janzce.pt/index.php?section=2</a> It provides products to a high-quality company, its laboratories and its processes that fulfil the requirements of several international standards. For more than 50 years, JANZ - Contadores de Energia, SA has been providing counting (metering) solutions appropriate to each market, supported by traditional electromechanical technology and more recently by information and communication technologies powered by the developments in electronics. In this segment we offer a wide range of equipment ranging from simple single-phase counters (meters) mechanical clock rate to three-phase multitarriff counters able to fit in the most liberalized markets with the most diverse tariff cycles, always guaranteeing the highest quality standard and best accuracy of score.
Kamstrup (Present in 18 European countries and 7 countries outside Europe)	<a href="https://www.kamstrup.com/de-de/products-and-solutions/meter-reading">https://www.kamstrup.com/de-de/products-and-solutions/meter-reading</a> Intelligente Wärme-, Kälte- und Wasserzähler von Kamstrup unterstützen ein breites Spektrum an Kommunikationsformen. Der Kunde hat damit die Möglichkeit, die Datenerfassungsmethode auszuwählen, die seinen Bedürfnissen am besten entspricht. (Our solutions include consumption meters, smart metering systems, hosting and services, analytics and smart grid applications. All the products are produced with the highest certifications for environmental safety and quality in our automated production facilities in Denmark.)
KISTERS (Present in 19 European countries and 12 countries outside Europe)	<a href="https://energy.kisters.de/en/solutions/smart-grid/">https://energy.kisters.de/en/solutions/smart-grid/</a> KISTERS control technology allows system operators to monitor the state of the grid at all times, to respond quickly when needed, and to control the large number of components safely and efficiently. Improved network control results in improved system efficiency, reliability, and quality, and optimized network load reduces technical losses. This creates an intelligent distribution system that is able to control and balance itself.
Meter&Control Solutions for Energy Management	<a href="http://www.meterandcontrol.com/products/">http://www.meterandcontrol.com/products/</a> <a href="https://www.meterandcontrol.com/">https://www.meterandcontrol.com/</a> Our portfolio of smart energy management products and services provides utilities with hardware and data required to manage energy use, anticipate demand and achieve cost-efficient, low-loss operation. It also helps end consumers to act more sustainably. Responding to current and future needs of utilities and consumers for efficient energy management, we have hands-on experience in various topologies of electricity networks and different deployments of solution topologies, seamless integration with different IT systems and AMI devices of other manufacturers, as well as in development and adaption of smart meters to specific requirements of power distribution companies.
Networked Energy Services (NES) (Poland, Present in 12 European countries and 10+ countries outside Europe)	<a href="https://www.networkedenergy.com/en/products/smart-meters">https://www.networkedenergy.com/en/products/smart-meters</a> <a href="https://www.networkedenergy.com/en">https://www.networkedenergy.com/en</a> NES Corporation offers the most reliable broadly deployed smart grid platform enabling grid health and efficiency monitoring as well as control and smart metering applications. The NES System is based on a 3-tier architecture; the offering includes utility data center software, field distributed application control nodes and grid devices and sensors, such as single phase, poly phase, and CT smart meters, and Open Smart Grid Protocol (OSGP) compliant communication devices enabled by our Control Point Modules.
NETINIUM	<a href="http://netinium.com/index.php/netinium-head-end-platform-characteristics/data-collection">http://netinium.com/index.php/netinium-head-end-platform-characteristics/data-collection</a> <a href="http://netinium.com/index.php/netinium-head-end-platform-characteristics/installation-management">http://netinium.com/index.php/netinium-head-end-platform-characteristics/installation-management</a> <a href="http://netinium.com/index.php/netinium-head-end-platform-characteristics/device-management">http://netinium.com/index.php/netinium-head-end-platform-characteristics/device-management</a> <a href="http://netinium.com/index.php/netinium-head-end-platform-characteristics/lv-grid-monitoring">http://netinium.com/index.php/netinium-head-end-platform-characteristics/lv-grid-monitoring</a> Data Collection: offer a single head end that combines all your different meters into a seamless network infrastructure and enables uniform processes across devices from all major brands. Installation management: is one of the flagship functionalities of the Netinium platform. Flawlessly activating and integrating your meters into your grid, and then managing them closely, prevents re-visits ruining your business case. Device management: Despite the many promises on the possibilities of big data, good analysis requires high quality data input (the garbage-in-garbage-out-principle). Proper, ongoing device management guarantees a constant flow of high quality data. Smart meter-based LV Grid Monitoring: Building on the strong foundations of the Netinium AMM+, we enable DSOs to manage their low-voltage grid using data from smart meters. This way, you are able to secure investments, increase efficiency and enable distributed energy resources.
Sierrawireless (Canada, Present in 130+ countries)	<a href="https://www.sierrawireless.com/applications/energy-and-industrial/smart-metering/">https://www.sierrawireless.com/applications/energy-and-industrial/smart-metering/</a> Sierra Wireless has more than a decade of experience helping utilities and OEMs build and deploy smart metering solutions worldwide. We offer industry-leading cellular machine-to-machine (M2M) technologies including industrial-grade embedded modules with long life spans, cloud platforms, expert application development assistance and more.



Sigma Telas (Lithuania, Present in 3 European countries and 4 countries outside Europe)	<a href="http://www.sigmatelas.lt/lt/about-us">http://www.sigmatelas.lt/lt/about-us</a> <a href="http://www.sigmatelas.lt/lt/accounting-solutions">http://www.sigmatelas.lt/lt/accounting-solutions</a> <a href="http://www.sigmatelas.lt/lt/saas">http://www.sigmatelas.lt/lt/saas</a> Sigma is a Smart Metering and AMI/MDM Software developer and system integrator with extended expertise in large-scale projects. Our reference projects are together with 3 National Grid Operating Companies - Transmission System Operator LitGrid in Lithuania, National electricity operators BelEnerg in Belarus and KEGOC in Kazakhstan. They include large installations for electricity, gas and heat distribution companies, national rail way companies, large industrial corporations, telecommunication companies and retail chain operators.
Telit (United Kingdom, Present in all European countries and on all continents)	<a href="https://www.telit.com/m2m-iot-products/">https://www.telit.com/m2m-iot-products/</a> Telit offers the world's most comprehensive portfolio of high-performance IoT (Internet of Things) modules, connectivity services and software.
u-blox (Switzerland, 1 plant in Europe, Present in 20 European countries, 13 countries outside Europe)	<a href="https://www.u-blox.com/en/beyond/blog/iot/grand-vision-one-world-one-device">https://www.u-blox.com/en/beyond/blog/iot/grand-vision-one-world-one-device</a> Developing successful LPWA (low power wide area networks) solutions for global markets calls for a flexible hardware and software solution
vodafone (United Kingdom, 1 plant in Europe, Present in 12 European countries and 16 outside Europe)	<a href="https://www.vodafone.com/business/iot/end-to-end-solutions/smart-grid-and-metering">https://www.vodafone.com/business/iot/end-to-end-solutions/smart-grid-and-metering</a> The core of our offering is our own managed IoT platform, designed to take away the complexities and cost of deployment by automating provisioning, billing and other logistics processes.
Watt-IS intelligent solutions (Present in Portugal)	<a href="https://watt-is.com/data-analytics/">https://watt-is.com/data-analytics/</a> Data Analytics 'as a Service': get valuable information from multiple data analytics modules like benchmarking, load disaggregation, tariff optimization or estimation of demand side flexibility potential for integrate these services into your own visualisation platform Energy efficiency for SMEs: providing to your SME clients a cloud-based "Virtual Energy Manager" with benchmarking and sub-metering capabilities, self-learning alarms and energy efficiency advice, expressly designed to their load profiles. Energy efficiency for households: delivering a user engagement platform with historical energy consumptions, benchmarks, and disaggregated consumption information.
Wirepas (Finland, Present in 4 European countries and 3 countries outside Europe)	<a href="https://wirepas.com/products-and-services/meters/">https://wirepas.com/products-and-services/meters/</a> Wirepas Mesh enables wireless IoT networking at massive scale. It is a de-centralized IoT network protocol that can be used to connect, locate and identify lights, sensors, beacons, assets, machines and meters in cities, buildings, industry, logistics and energy – with unprecedented scale, density, flexibility and reliability. It can be used on any radio hardware and on any frequency band.
Elster Group (Honeywell) (Germany, Present in 11 European countries and 45 countries outside Europe)	<a href="https://www.elster.com/en/electricity">https://www.elster.com/en/electricity</a> Elster electricity meters, communications and energy management platforms are engineered for residential, commercial and industrial, and interchange metering applications. We engineer fully interoperable smart electricity metering products through custom-made options for our utility customers and award-winning end-to-end solutions for the Smart Grid, our multi-utility advanced metering infrastructure (AMI) systems for water, gas and electricity around the world. Energy management solutions from Elster EnergyICT enable you to grow and maintain your energy efficiency programmes with continuous savings.
First Fuel (UK, USA and Canada)	<a href="http://www.firstfuel.com/solutions/overview/">http://www.firstfuel.com/solutions/overview/</a> Combining data science, building science, and software, our digital engagement platform derives intelligence from over 3 million meters, transforming energy providers into trusted advisers to their business customers. Our SaaS solutions deliver accurate, insightful, and cost-effective results at scale.
GE Power (9 major sites in Europe)	<a href="https://www.gegridsolutions.com/SmartMetering/catalog/smos.htm">https://www.gegridsolutions.com/SmartMetering/catalog/smos.htm</a> world leader in power generation with deep domain expertise to help customers deliver electricity from a wide spectrum of fuel sources. We are transforming the electricity industry with the digital power plant, the world's largest and most efficient gas turbine, full balance of plant, upgrade and service solutions as well as our data-leveraging software. Our innovative technologies and digital offerings help make power more affordable, reliable, accessible and sustainable.
Luna (Turkey)	<a href="http://www.lunatr.com/en/main/#">http://www.lunatr.com/en/main/#</a> LUNA carries out its design and production of electricity meters, the development of software and hardware for the communication between the meters smart grid solutions as a complete system for electrical energy management as well as water metering solutions.
Sagemcom Energy & Telecom (France, 2 plants in Europe, Present in 18 European countries and 17 countries outside Europe)	<a href="https://www.sagemcom.com/smart-city/">https://www.sagemcom.com/smart-city/</a> Energy & Telecom Business Unit concentrates Sagemcom's expertise in telecom and metering, enabling the supply of customized connected systems to utilities, telecom operators and services operators worldwide. Thanks to the talents of its R&D and its industrial capacities, Sagemcom Energy & Telecom operates in smart meter, smart grid, smart sites, smart infra and smart services markets. The combination of these activities allows addressing increasing needs of verticals markets and allows Energy & Telecom Business Unit to propose efficient end-to-end turnkey solutions through its high value-added equipment and platforms making easily smart environments a reality.

The value propositions or offerings of the list of companies is a copy and pasted text. It describes the exact texts in their websites except the translated companies.

Table 15 shows the regulations for the smart metering systems roll-out in Switzerland.

Table 15: Smart meter roll-out regulations. Source (Ecoplan,2012)

### **Regulatorische Rahmenbedingungen**

#### **INTELLIGENTE MESSSYSTEME (SMART METERING)**

##### **Art. 15 & Art. 17a StromVG:**

- Anrechenbarkeit in Netzkosten; Bundesrat kann Vorgaben zur Einführung von Smart Metern machen

##### **Art.7 Abs.3 StromVV (Kostentransparenz):**

- **Separate Ausweisung Kosten für intelligente Messsysteme.**

##### **Art.8a StromVV (Definition):**

- Einsatz intelligente Messsysteme bei Endverbrauchern und Erzeugern + Kommunikationssystem + Datenbearbeitungssystem.

##### **Art.8a StromVV (Definition):**

- Anforderungen Zähler:
  - 15-Minute Lastgänge der Wirk-, Blindenergie.
  - Schnittstelle zum Datenbearbeitungssystem.
  - Schnittstelle Endkunde: Echtzeitmesswerte, Lastgänge.
- Interoperabilität: verschiedene Zählertypen möglich.
- Softwareaktualisierung ohne Neueichung.
- **Darstellung der Messdaten für Endverbraucher und Erzeuger.**
- Einbindung anderer Messmittel, z. B. für Wasser, sowie intelligente Steuerungen des VNB.

##### **Art.31e StromVV (Übergangsbestimmung):**

- Abdeckung von **80%** Messpunkte bei VNB in **10 Jahren. (-> 2018 bis Ende 2027)**
- Restliche 20% bei Ende der Lebensdauer bestehender Messgeräte.
- Endverbraucher bei **Netzzugang** und **Erzeuger** bei Neuanschluss **sofort** mit intelligenten Messsystem.
- Schutz bestehender Smart Meter bis Ende Lebensdauer, wenn Lastgangmessung, Kommunikationssystem und Datenübermittlung.
- Schutz nicht konformer intelligenter Messsysteme auf Lebenszeit, wenn vor dem 1.1.2019 installiert. Kostentragung bestehender Lastgangmessungen wie bisher.

#### **Datensicherheit**

**Art. 15 & Art. 17a StromVG:** Anrechenbarkeit in Netzkosten; Bundesrat kann Vorgaben zur Einführung von Smart Metern machen.

##### **Art.8b (Datensicherheitsprüfung):**

- Einsatz intelligenter Messsysteme, deren Elemente eine Datensicherheitsprüfung erfolgreich bestanden haben.
- **Subsidiäre** Richtlinien für Abgrenzung Elemente, Anforderungen, und Art und Weise der Prüfung -> **VSE zusammen mit SM-Hersteller**
- Prüfung wird durch METAS unter Einbezug Dritter Prüfstellen durchgeführt.

#### **Datenschutz**

**Art.17c StromVG:** Bundesrat regelt Einzelheiten zum Datenschutz.

##### **Art. 8d StromVV (Datenschutz):**

- Bearbeitung von 15 Minuten Lastgangdaten (pseudonymisiert): für Messung, Steuerung, Tarife, Netzbilanzierung und Netzplanung.
- Bearbeitung von 15 Minuten Lastgangdaten: für Abrechnungen Energie, Netz, intelligent Steuerungen.
- **Bereitstellung an Dritte** im Strommarkt nach Art. 8 StromVV aber geeignet **pseudonymisiert oder aggregiert.**
- Auslesung maximal ein Mal pro Tag.
- Löschung nach einem Jahr.
- Gewährleistung Datensicherheit im Unternehmen (organisatorisch).

Table 16 shows the quantification of the value proposition of the companies from the European market in their own texts.

Table 16: quantification of the value propositions compared to the multiple values

Company	Economic value	Functional value	Emotional value	Ethical/ Normative value	Epistemic value (Knowledge/ Innovation)	Social value
Chameleon <sup>TM</sup> Technology	0	9	9	0	7	0
geo (Green Energy Options)	0	9	0	0	9	0
NES (Networked Energy Services)	0	9	8	0	0	0
Vodafone	9	9	0	7	0	0
First Fuel	0	8	0	0	9	0
Luna	0	0	0	0	10	0
Wirepass	8	9	0	0	0	0

Table 17 shows the quantified values of the value proposition of the companies from the Switzerland market.

Table 17: quantification of the value propositions compared to the multiple values

Company	Economic value	Functional value	Emotional value	Ethical/ Normative value	Epistemic value (Knowledge/ Innovation)	Social value
Smart-me	0	9	8	0	8	0
CKW	8	0	0	0	9.5	0
Landis+Gyr	8	8	6.5	0	9	0
Adaptricity	0	9	0	0	9	0
EMU	0	9	8	0	9	0

The values are all evaluated out of 10. For example, if the value is very close to the description of the multiple value, it is given 9 out of 10 and if the values is not related to the description of the multiple value, it is given the value 0.



## Appendix B

This part contains the letters that were prepared to communicate with the companies for the value proposition elaboration. The letter was draft with support from Dr. Benjamin Rohrbach.

Dear xxxxxx

I am an undergraduate in the University of Applied Sciences and Arts in Horw (Technisches und Architektur Hochschule Luzern). Currently I am writing a bachelor thesis in developing new elements for the value propositions of smart metering systems in Switzerland. To do that

xxxxxxxxxx (Here could be used according to the different situations and companies) xxxxxx

Could you please connect me with a product manager of [the solution you are interested in] in the smart metering domain? I found offerings in other countries to make use [insert your findings here]-type of value propositions and did not identify such elements in the value propositions of solutions from xxxxx. So, I'm interested in discussing

- a) whether I correctly identified the value propositions from xxxxx,
- b) if the [insert your findings here]-type of value propositions have already been considered by xxxxx and if not, whether this could be of interest for your company. I think it would be best if we could have a quick call. Would that be possible?

Kind Regards  
Haile Kibreab

After sending such emails, only CKW could be reached and the feedback from CKW looks like the following.

CKW Feedback

The conversation was recorded and later summarised as follows:

After a brief introduction, Andre explained me to the smart meter system in CKW

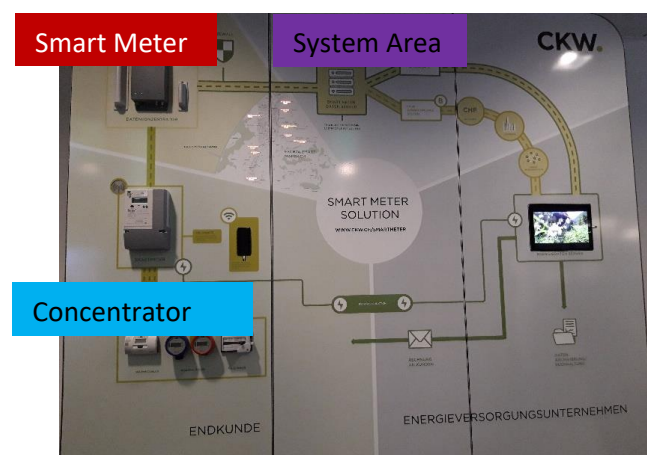


Figure 22: CKW smart metering solution

The smart meter records the energy consumption and it sends the data to the concentrator. The smart meter and the concentrator are communicated using a radio mesh communication system. The data is then sent to the system area.

This one will be our smart meter. It fulfils the government requirement. What is written in the Strom VG, is fulfilled by CKW. The official roll-out will start in the middle of 2020 and our estimation according to our knowledge now is, the roll-out will be fulfilled by 2024.

The meter communicates with the concentrator using a meshed radio communication system. Every meter communicates with another meter. When the smart meter and concentrator communication is constructed, the concentrator communicates to the system area with mobile communication and the energy data is recorded in the system area every 15 minutes.

#### **How the recorded data is communicated to the customer? Or if CKW offers some communication means such as Visualization.**

CKW offers the visualization in their website with a login option. This option shows the customer energy consumption, the bills that are from previous day in a 15 minutes lapse time. There is also another optional module which CKW offers its customers. The customer buys a smart metering module and can communicate over Wi-Fi to see the actual energy consumption from the secondary value online. This helps the customer see the real time energy consumption of the smart meter but its optional.

#### **About Customer control of energy consumption, as this is the main reason why smart meters are being rolled-out to save energy through efficient energy use. Or if the smart meter helps reach the goal of the energy efficiency measure.**

The smart meter would help in the sense if the customers use it with great awareness. However, customers are not aware of such measures. For example, CKW has installed up until now around 10'000 smart meters and the customers interested in such devices are only around 100. The main reasons for that could be the price of the energy, which is too cheap currently, some health and legal reasons. The smart meter pay back is also the main reason. The cost benefit analysis is another reason which customers are interested in. For example, if customers pay 1000 CHF for electricity and 5000 CHF for insurance, it doesn't help persuade customers to invest in smart meters. Another reason is the lack of awareness in energy saving. People are not interested in energy saving in the current situation. This is also a good reason if the electricity is compared to the other forms of energy, it accounts only a quarter of the whole Switzerland energy consumption. The other main consumption is covered by mobility, heating and other forms of energy.

#### **About current situation of the installation of smart meters**

The roll-out was started in 2018 but currently CKW is not installing smart meters any more. The next phase will start from next year and about 100000 meters are expected to be installed. The problem for this is that, the current smart meters don't fulfill the requirements from the government. Security check is the main requirement and the manufactures as well as CKW have to do a security check on the smart meters, but it is not done yet. After the security check the smart meters will be certified and its estimated that the certified smart meters will be available in the middle of 2019. Therefore, until the certification is completed, there will not be any smart meter installation by CKW. The certification regulations are available on the BFE or ELCom websites and can be easily accessed for any reader. The newsletters also provide some special announcements about the smart metering systems.

#### **Challenges the CKW is facing outside of the Certification**

The main challenge facing CKW in the installation phase is that the whole set-up process. The management have to give the permission for the process to proceed because the budget depends on the management. It is expected that the whole installation will restart in the middle of 2020.

### **CKW main Customers**

CKW main customers are all inhabitants of the Kanton Luzern with the exception of the city Luzern and the customers who have a consumption of more than 1000 kVA. The people who live in the city of Luzern are customers of ewl. However, even in the case of the higher energy consumers, the exception is only for energy providing. The grid part is always by CKW. Switzerland energy market is not a fully liberalized market. The grid is a monopoly and is owned by the Swiss grid shareholders. The customers who consume more than 100 kVA can choose, energy provider utility but the grid section remains unchanged. However, this is expected to change in 2025 and CKW is planning to complete the smart meter roll-out in 2024.

### **If CKW have some KPI about Smart metering systems**

The cost saving in the meter reading is expected to be achieved through the smart meter roll-out. The current systems need to be read manually at the premises of customers. It takes high number of workers to read and record the meters and it costs considerable amount. Reduction of cost is a KPI for CKW as energy provider.

### **About the concept of two-way communication**

Energy saving is one of the measures to achieve the energy efficiency. However, according to studies, CKW carried out about smart metering, the energy saving is not sustained over the years. The study showed that the maximum people could save is that only 2% from their consumption. Even this is not in a sustainable way. The consumption changes from year to year, sometimes is down and sometimes is up again. MY opinion on this issue is that, the energy saving concept has to be related to energy price or other cases such as there would be no energy scenarios. However, the “No Energy” scenario is also problematic because nowadays, people’s lives depend on electricity.

### **If there are is more information such as some technical configuration or some not online available information but I could have access to.**

I can provide you an over view of the system configuration. I have your email and I will send you in the coming day.

### **What more CKW does**

This can be seen from two perspectives. From the CKW perspective and from other third-party perspective. From the CKW perspective, CKW provides the smart metering infrastructure for its customers as energy provider and operates the whole operation. The other one is, it sells the smart metering solution, sending, validating recording of the energy consumption service to the third-party customers. The customers receive the energy consumption data and pays does the billing process. In this case the third-party customer owns the smart metering infrastructure. CKW only sells the sending and validation service.

## Appendix C

### Project title

Developing new features for existing value propositions for the smart metering market segment operating in Switzerland

### Technical theme

Sustainable Energy Systems

### Background

Many European countries are rolling out smart metering systems and so does Switzerland. The Swiss population, on May 21<sup>st</sup>, 2017, agreed to the new energy related law, which requires the roll out of smart-meters. Due to their similar socio-economic background, solutions for Switzerland are likely to benefit from experiences and insights made in EU. However, it is not clear how the smart metering technologies offer a value to the customers. What challenges do the systems face and what are the contributions of the smart metering systems to the energy efficiency goals of the Swiss Federal Energy Strategy 2050?

### Project aim

The aim of the project is to develop new elements (features) for selected existing value proposition of smart metering systems. To do so, an overview and analysis of selected European companies in the smart metering business segment and their value propositions will be performed. Based on this analysis, new elements for the existing value proposition in Switzerland will be proposed. Finally, the contribution of the smart metering system and their augmented value propositions to the energy efficiency goals of the Swiss Energy Strategy 2050 will be discussed, as this was a core reason for the introduction of the smart meters in Switzerland

### Project objectives

- Provide an overview of existing companies in the smart metering business segment, that offer services beyond the basic smart metering capabilities (remote meter reading and time dependent tariffs) generally in Europe and specifically in Switzerland
- Develop the criteria for selecting 5 to 10 offerings out of the overview
- Analyse the value propositions and the technical configuration of selected offerings on the market
- Develop new features (elements) for the existing value propositions and discuss their transferability to the Swiss market
- Collaborate with 3 – 5 companies to validate the new elements as an augmentation to the existing VP
- Elaborate on the contribution of the original and modified value proposition to the energy efficiency goals of the Swiss Energy Strategy 2050

### Project deliverables

The main project deliverables for this Bachelor thesis are:

- The project proposal, Scope of work on ESE project platform
- Project management documents such as project plan, risks and mitigation plan etc.
- Midterm presentations
- Final report containing:
  - Overview of existing companies
  - Selection criteria and list of selected companies
  - Analysis of the existing value proposition
  - Validated value proposition with new elements/features
  - Discussion of validated value proposition concerning their contribution to energy efficiency
- Final presentation
- Poster
- Project planning

## Working process dates

Submission agreed scope of work:	07th of September 2018
Start of the project:	17th of September 2018
Interim presentation and reflection:	According to the specifications of the supervising lecturer
Submission report:	07th of January 2019 3:00pm
Submission of project closing containing the success story:	07th of January 2019
Submission of poster:	07th of January 2019
Submission of flyer	07th of January 2019
Final presentation (slides):	2 days before your oral exam

The student is responsible for the generation of the task definition. A review regarding the definition of the objectives and tasks with the supervising lecturer and the industry partner has to be completed before submission.

The final report has to be submitted to the teaching assistant of the department Energy Systems Engineering. The confidentiality level has to be declared in advance. Confidential reports have to be submitted in a closed envelope. The submission on schedule will be confirmed with a stamp.

### Documentation

The final report is to be submitted in triplicate. In addition, the final report contains

### Other documentation:

Submission on [elearning.hslu.ch](http://elearning.hslu.ch) of the report including appendices with presentations, measurement data, programmes, evaluations, etc.

Industry/Business Partner

Company: Hochschule Luzern

Address: Technikumstrasse 21 6048 Horw

Contact person: Benjamin Rohrbach

Email: [benjamin.rohrbach@hslu.ch](mailto:benjamin.rohrbach@hslu.ch)

Phone: +41 41 349 35 02

Responsible Lecturer

Allocated coach: Prof. Dr. Uwe W. Schulz

Expert (for the Bachelor Thesis only)

## Appendix D

Appendix C shows the organizational matters of the thesis. It consists of initial planning, risks and risk mitigation planning

### Gantt diagram of Project plan

The Gant diagram is produced using microsoft excel. The diagram shows the initial planning with several assumptions and the estimated tasks were allocated estimated time.

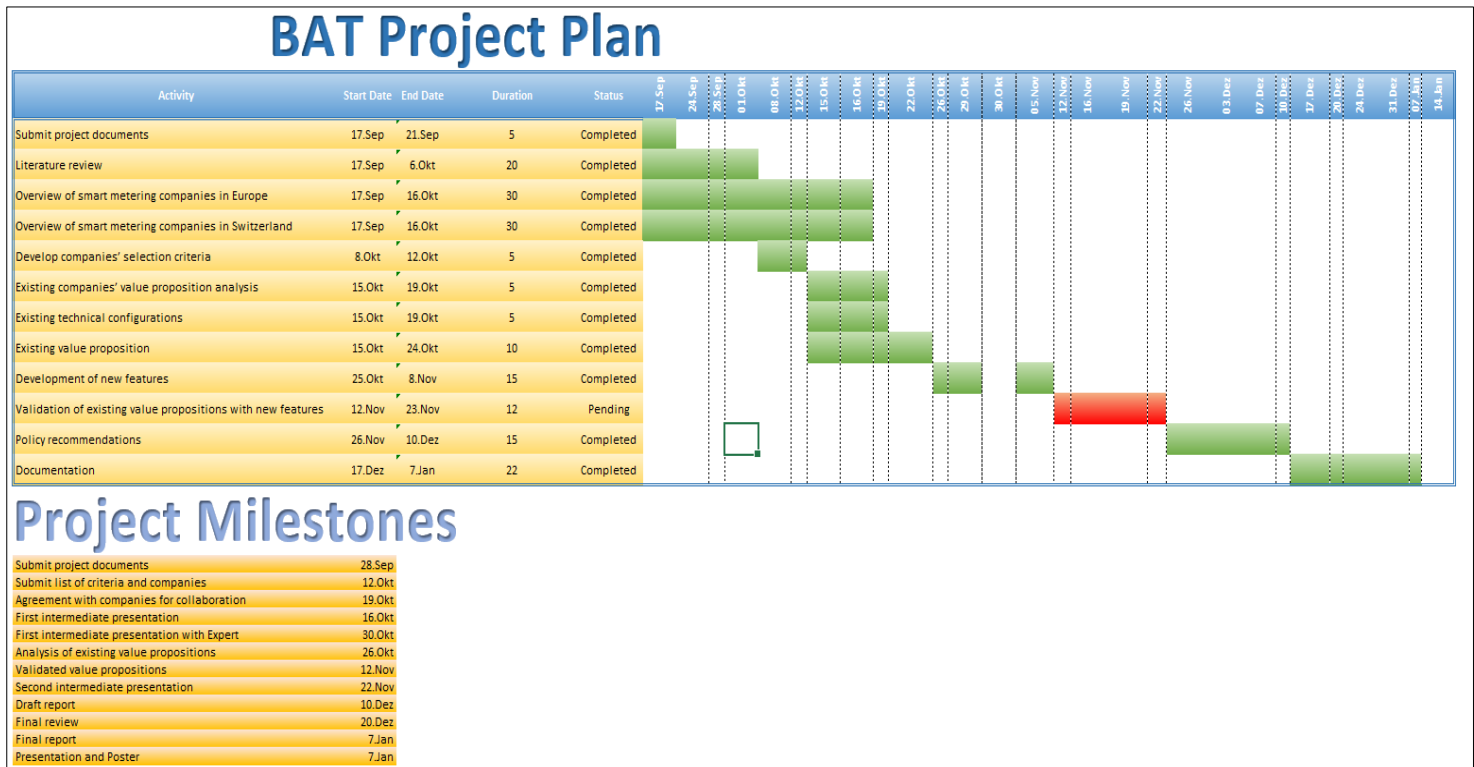


Figure 23: Project plan and milestones

Figure 17 shows the project plan and milestones. The project was planned at the beginning of the semester. However, the work didn't go as planned. There were some irregularities with the plan.

## Risks and Mitigation plan

Risks		Probability	Impact	Total score	Mitigation Plan
<b>ID</b>	<b>Technical</b>				
R001	Availability of data about metering systems	2	5	10	Check again the data in detail Communicate to supervisors, allocate more time to learn the content of information
R003	Complexity of provided data: too long learning time	2	5	10	
	<b>Management</b>				
R004	Communication risk: Supervisor may not have enough time	3	4	12	Communicate with supervisors, create shared documents using online applications prepare clear questions before the meeting, document all agreements. Send requests as early as possible and try to agree on fixed time with supervisors.
R005	Requirement risk: Unclear objectives/requirements from supervisors	3	5	15	
R006	Slow decisions or responses from supervisors	3	5	15	
	<b>Schedule</b>				
R007	Respecting the Milestones	2	2	4	Work according schedule identify overloads quickly and adapt time allocation accordingly
R008	Workload and lack of Information	3	2	6	
	<b>Personal</b>				
R009	Time management with respect to other work loads	2	2	4	allocate specific dates for the projects weekly Read project management books, refer to previous projects for specific questions, ask supervisors for support
R010	Project management knowledge deficiency	3	3	9	

<b>very High Risk</b>	<b>5</b>	<b>&gt;20</b>	very High Risk
<b>High Risk</b>	<b>4</b>	<b>16-20</b>	High Risk
<b>Medium Risk</b>	<b>3</b>	<b>10.-15.</b>	Medium Risk
<b>Low Risk</b>	<b>2</b>	<b>5.0-9.0</b>	Low Risk
<b>Very low Risk</b>	<b>1</b>	<b>&lt; 5.0</b>	Very Low Risk

Figure 24: Risk management and mitigation plan

Figure 23 shows the risks and the mitigation plan for the project.